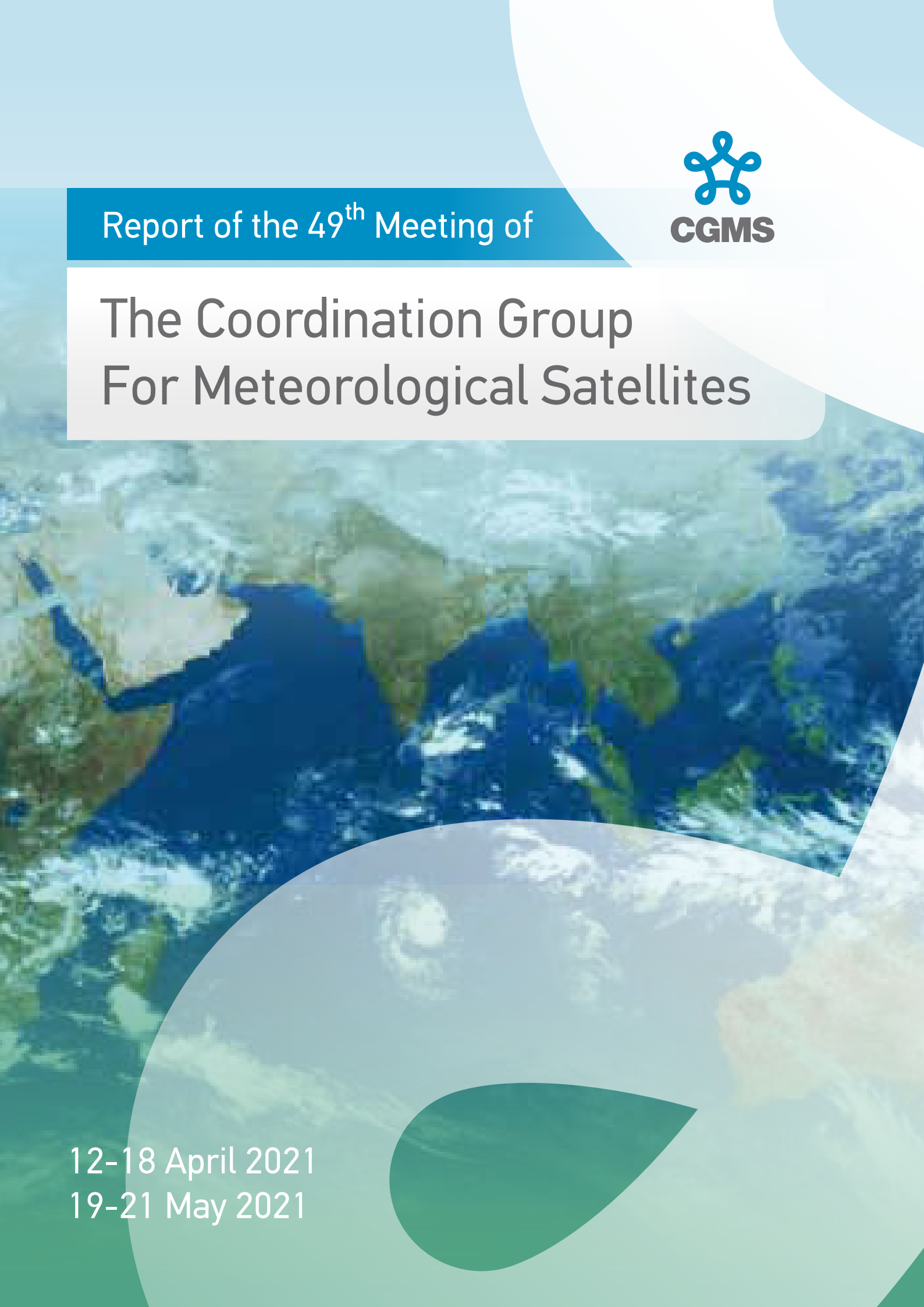
Report of the 49th Meeting of

CGMS

The Coordination Group For Meteorological Satellites



12-18 April 2021
19-21 May 2021

REPORT OF THE 49TH PLENARY SESSION OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

CGMS-49
Virtual meetings
12-28 April 2021
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PLENARY SESSION

1. OPENING SESSION

Welcome addresses by CMA, the CGMS Secretariat and the WMO

Address by Dr. YU Xinwen, Deputy Administrator, China Meteorological Administration (CMA)

On behalf of the CMA Administrator, Mr. ZHUANG Guotai, Dr. YU Xinwen, Deputy Administrator of CMA, warmly welcomed all participants to the 49th virtual plenary session of CGMS. He appreciated the challenges associated with the pandemic and the continued virtual nature of meetings, and thanked delegates for their flexibility and understanding.

He recalled that CGMS serves as a model for building a community with a shared future in terms of global observations for meteorology, climate, and oceans. CGMS promotes the continuation and complementarity of the satellite space infrastructures globally in order to enable users to access satellite data on a sustained basis.

He informed CGMS that in the next couple of months, FengYun (FY)-4B and the long-awaited early morning orbit satellite FY-3E will be launched to service the international community.

CGMS already addresses greenhouse gases, climate monitoring, and space weather to meet the challenges arising from the global climate change, increased extreme weather and climate events as well as atmospheric environmental pollution with the aim to continuously contribute to achieving the goals of a global low-carbon level and emission reduction. In addition, he called upon the meteorological satellite agencies and organisations worldwide to further strengthen their cooperation, and to improve meteorological satellite data and products, in order to better serve the global user community.

He concluded by wishing the 49th plenary session of CGMS a success and good health to all participants.

Address by Mr. Phil Evans, Head of CGMS Secretariat and EUMETSAT Director-General

Mr. Evans welcomed all CGMS members and all participants to the 49th CGMS plenary meeting. He explained he took over as Director-General of EUMETSAT on 1 January 2021 and consequently became the Head of CGMS Secretariat. He confirmed his and EUMETSAT's committed support to CGMS including that of the CGMS Secretariat. The group is an important mechanism to keep coordination among space agencies responding to the observation requirements of WMO. Altogether, CGMS is committed to respond to the Vision for WIGOS 2040 and he looked forward to the discussions.

He thanked CMA for their readiness to twice host the meeting virtually and under these particular circumstances, and all CGMS members for their flexibility.

In addition to the working group reports, he looked forward to the dialogue with WMO in particular regarding the evolution of the WMO Data Policy and the restructuring of GCOS - an important programme to articulate requirements for climate observations.

Evans explained that the thematic session on the impact assessment of satellite data on numerical weather prediction (NWP) might influence the members' responses to new observations needs or approaches required by future global NWP models, including the planning and coordination of the members' future observing space infrastructures. The same could be said for the greenhouse gas monitoring. He concluded by saying he looked forward to meeting everyone in person as soon as circumstances permit.

Address by Prof. Petteri Taalas, WMO Secretary-General

Prof. Taalas said it was a pleasure to join the 49th plenary session of CGMS. He recalled that WMO is undergoing significant reform within the framework of the WMO Strategic Plan 2020-2023. He added that the key issues for WMO members include: readiness for extreme weather events, climate monitoring, supporting decision making related to climate change, advancing the required observational and modelling capabilities required for the implementation of the Paris agreement, and increasing socio-economic value of environmental services. WMO is now taking a holistic Earth-system modelling and monitoring approach, recognises that global NWP underpins most WMO application areas. Accordingly, WMO has recently prepared a position paper on the "Satellite data Requirements for global NWP" emphasising the need for open, free, and timely access to critical satellite observations. In this context, WMO is working towards a new updated Data Policy that takes into account the scientific, technical, and societal challenges, changes, and opportunities towards a holistic data policy encompassing all WMO application areas for approval by WMO Congress in October 2021. The new Data Policy foresees the notion of 'core data' – such data to be made available openly and freely – and WMO would like to engage with the space agencies in determining and agreeing on those data as well as to maximise the benefits for all users. Prof. Taalas further called upon the CGMS space agencies to consider closing some of the gaps and establish a way forward to support WMO in meeting the WIGOS Vision 2040.

Prof. Taalas concluded by informing CGMS that WMO will host CGMS-50 in 2022 in the headquarters of WMO, Geneva.

The full addresses are provided in the Annex.

2. AGENCY INTERVENTIONS/REPORTS

Main developments since CGMS-48 and an outlook for the future

China Meteorological Administration (CMA)

Address by Dr. WANG Jingsong, CMA NSMC Director-General

Dr. WANG Jingsong informed CGMS that he was appointed Director-General of CMA NSMC a day earlier (18 May 2021). Previously, he had held the positions of Director-General of the Department of Integrated Observations of CMA, Deputy Director-General of CMA NSMC, and was partially involved in the FengYun programme over past decade. He recalled that the Chinese government attaches great importance to the development of the FengYun satellites and their international

applications, and that CMA would continuously provide data and product services to global users. He concluded by wishing everyone a fruitful session and good health.

The full address is provided in the Annex.

CGMS-49-CMA-WP-15: Status report on the current and future satellite systems by CMA

CMA is operating the FY geostationary and polar-orbiting satellite systems. Currently, six FY satellites are on-orbit and fully operational, including four geostationary meteorological satellites and two polar orbiting meteorological satellites. The two FY satellites series with the odd number represent the LEO satellites, the even numbered series the GEO satellites.

The current operating LEO satellite system is the FY-3 series satellites flying on AM and PM orbits. The latest one, FY-3D, launched on 15 November 2017, became operational in January 2019. The observational capabilities of FY-3D include VIS, IR, and MW imaging, IR and MW atmospheric sounding, greenhouse gas detection, radio occultation sounding, and space weather monitoring.

Four operational GEO satellites are on-orbit, including three FY-2 and one FY-4 satellites. FY-2H is positioned at 79° especially for Indian Ocean observations. FY-2F and FY-2G are positioned at 112°E and 99.5°E respectively. The FY-2 satellites transmit 5-channel S-VISSR imagery. FY-4A, the first in the second-generation series, was launched on 11 December 2016. It has enhanced imaging, sounding, lightning mapping, and space weather monitoring capabilities. FY-4B, with significant performance improvements, was launched on 2 June 2021.

Another highlight to be mentioned is the FY-4 series GEO microwave programme expected to be confirmed in 2021.

Centre National d'Études Spatiales (CNES)

CGMS-49-CNES-WP-01: Update on the latest programmatic news in relation with CGMS

CNES continues its cooperation with EUMETSAT on the exploitation of the three IASI instruments, which are all operationally assimilated into several NWP models (Météo-France, Met Office UK, ECMWF), with significant impact on the quality of weather forecast. Intensive work on IASI data for atmospheric composition studies is also ongoing.

An increase of ammonia over Europe during the first lockdown (spring 2020) was detected, which is an interesting example of the impact of COVID on air quality.

In parallel, the CNES-EUMETSAT development of the next generation instrument, IASI-NG, continues, as part of the EPS-SG (Europe's polar satellite second generation) programme. The proto flight model instrument is planned for delivery by the end of 2021, with delays due to COVID. The launch of EPS-SG/MetOp-SG A is targeted for 2024.

The tripartite CNES-EUMETSAT-UKSA development of the MicroCarb mission, dedicated to the measurement of CO_2, is ongoing. The targeted launch date is now set to 2022. The launch date of Merlin, a CNES-DLR mission dedicated to CH_4 measurements, has been postponed to 2026.

CNES continues to cooperate with EUMETSAT and other partners on in-flight missions: Jason-3, Sentinel-3A and -3B and Sentinel-6 Michael Freilich, launched in November 2020, whose commissioning phase (cal/val) is ongoing.

Sentinel-6/Michael Freilich, and part of Jason-series missions, are going to be the future altimetry reference mission by end of 2021. CNES has a key expert role to ensure the performance of these altimetry missions. In parallel, the French space agency prepares the future wide-swath altimetry mission SWOT. The mission is dedicated to ocean and hydrology, and tentatively planned for launch in November 2022.

CNES is working on developing the Space Climate Observatory (SCO) initiative in collaboration with several dozens of space agencies around the world in support of climate change adaptation. Several projects have been facilitated through this initiative to increase the use of satellite data in conjunction with in-situ data, socio-economic data, and models for monitoring the impact of climate change on the environment at national and local scales. CNES is also assisting different initiatives within CEOS and through different working groups.

China National Space Administration (CNSA)

CGMS-49-CNSA-WP-01: CNSA space activities and outlook

CNSA presented the status of its satellite programmes. CNSA has launched the following satellites since CGMS-48:

- HY-1D ocean satellite, launched in June 2020
- ZY-3 stereo mapping satellite, launched in July 2020
- High-resolution multi-mode integrated imaging satellite, launched in July 2020
- HJ-2A/B Environmental satellite, launched in September 2020
- HY-2C ocean satellite, launched in September 2020

In June 2019, CNSA joined the CNES-initiated Space Climate Observatory (SCO). CNSA has so far submitted 13 projects to SCO.

CNSA plans to deliver over 30 satellites for land survey, oceanic, and meteorological applications in the 2021 to 2025 timeframe. These include:

- 3 satellites for global carbon monitoring
- 4 satellites for environmental monitoring
- 11 satellites for oceanic monitoring and science
- 7 satellites for meteorology

The upcoming launch campaigns scheduled for 2021 are:

- HY2-D, ocean dynamics satellite
- FY4-02 (FY-4B), GEO-meteorological satellite.
- FY3-05 (FY-3E), Polar-meteorological satellite.

- ZY1-02E, optical land resource satellite
- GF3-02, C-band SAR satellite

European Space Agency (ESA)

CGMS-49-ESA-WP-03: ESA latest developments and plans since CGMS-48

The paper provides the current status of ESA's Earth observation missions currently in-orbit. Two of them, MSG and MetOp, are in cooperation with EUMETSAT.

Copernicus represents the major continuing initiative of European efforts in Earth observation. The first Copernicus dedicated satellite ("Sentinel-1A") was launched on 3 April 2014, followed by Sentinel-2A in June 2015, Sentinel-3A in February 2016, Sentinel-1B in April 2016, Sentinel-2B in April 2017, Sentinel-5P satellite in October 2017, Sentinel-3B in April 2018, and Sentinel-6 Michael Freilich on 21 November 2020. Other Sentinels will follow in the upcoming years. Sentinel missions are developed, launched, and operated in partnership with the European Union and EUMETSAT. The Sentinel-4 and -5 instruments developed by ESA will fly on the MTG-S and MetOp-SG respectively within the framework of a joint cooperation scheme between ESA and EUMETSAT.

The Earth Explorer missions currently in orbit (SMOS, CryoSat, Swarm, Aeolus) are all performing extremely well, and the related data exploitation is based on continuous data of excellent quality. The three missions all feature strong elements of international collaboration and a growing synergy between them. The SMOS satellite was launched on 2 November 2009. The CryoSat-2 satellite was launched on 8 April 2010, the Swarm satellites on 22 November 2013. Aeolus is the last Earth Explorer satellite put into orbit on 21 August 2018 and its Doppler Wind Lidar technique used for measuring wind profiles from space has already been fully demonstrated. The positive impact of Aeolus data on weather forecasting has been confirmed by multiple NWP centres world-wide, ECMWF in particular.

The Proba-V small satellite was launched on 7 May 2013. Its coarse resolution imager has, together with Sentinel-3, continued the data acquisition of the vegetation payload onboard SPOT-4 and -5, during the reporting period. However, from July 2020 onwards, owing to its orbital drift, Proba-V is no longer considered as a mission fulfilling an operational role, and will instead be dedicated to experimental activities with a reduced data acquisition scheme.

CGMS was further informed of the current status of ESA's future Earth observation missions. Two of them, MTG and MetOp-SG, are in cooperation with EUMETSAT.

ESA's Living Planet Programme has three lines of implementation: Earth Explorer satellites, Earth Watch satellites plus services, and applications demonstration. The paper describes the progress of preparations of the forthcoming Explorer missions: EarthCARE, Biomass, FLEX, and FORUM. FORUM was selected for implementation as Earth Explorer 9 (EE-9) on 23-25 September 2019. The phase A/B1 for FORUM is close to completion and the bidding period for the FORUM Space Segment ITT for the phases B2, C/D, and E1 has been extended to 18 May 2021.

The Phase A system studies are ongoing for the Earth Explorer 10 (EE-10) candidate mission, Harmony, with two parallel system studies.

On 25 May 2020, ESA issued a Call for Ideas for Earth Explorer 11 (EE-11). Fifteen proposals were submitted and are currently under evaluation. Earth Explorer 11 is foreseen to be launched in the 2031–2032 timeframe. The decision on the mission ideas proceeding to phase 0 will be taken by the ESA Programme Board for Earth Observation (PB-EO) at its meeting on 10 June 2021.

Following the decisions taken at Space19+ (ESA's Council at Ministerial Level), new activities related to Aeolus Follow-On, Arctic Weather Satellite (AWS), TRUTHS, and ALTIUS are ongoing. Each of these missions is planned to contribute to routine, operational monitoring data to improve our understanding of the Earth system and climate change.

Looking to the future, the six Copernicus Expansion missions are currently in phase B2/C/D/E1, addressing EU policy and gaps in Copernicus user needs, and each expanding the current capabilities of the Copernicus space component: CHIME, CIMR, CO2M, CRISTAL, LSTM, and ROSE-L.

CGMS is also informed of the status of the Earth Watch Programme element, Global Monitoring of Essential Climate Variables (also known as the 'ESA Climate Change Initiative' or CCI). The CCI has continued to progress very well since its inception in 2008. In 2016, a second phase of the programme, CCI+, was approved by ESA member states, which allows to study and monitor 23 essential climate variables (ECV) derived from satellite data, fulfilling GCOS objectives. Out of these 23 ECVs, 16 have been handed over to the Copernicus Climate Change Service (C3S) for operational use.

As a general observation, the COVID-19 pandemic has affected several activities related to the procurement of satellites and instruments at different degrees. Thanks to appropriate measures, the impacts on development projects have been mitigated as much as possible, while overall, the operations of ESA satellites currently in orbit and services to users have been kept nominal.

European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

CGMS-49-EUMETSAT-WP-18: EUMETSAT latest developments and plans since CGMS-48

EUMETSAT currently exploits eleven satellites of which seven are EUMETSAT's own (Meteosat-8 to -11 and MetOp-A to -C) with the remaining in partnership (Sentinel-3A/-3B and Jason-3 and Sentinel-6A/Michael Freilich missions).

Since February 2018, Meteosat-11 provides the 0° service and Meteosat-10 at 9.5°E the 5-minute rapid scanning service. Meteosat-9 is on standby at 3.5°E. Meteosat-8 continues to be operational at 41.5°E to support, on a best effort, the multi-partner service for the continuation of the Indian Ocean Data Coverage (IODC). Launched on 19 October 2006, the deorbiting and end-of-life operations of MetOp-A will take place in the November to December 2021 timeframe. Dual-MetOp operations with MetOp-B and MetOp-C continue nominally up until 2027.

Regarding future satellites: The development continues for the Meteosat Third Generation (MTG) satellite system with the operational exploitation expected for the 2023-2040s timeframe. The MTG imagery mission, MTG-I, will provide 10-minute full disc imagery and carries a lightning imager (LI). The MTG sounding mission, MTG-S, will carry a hyperspectral infrared sounder (IRS,

temperature, and water vapour, with profiles for every 30 minutes over Europe in synergy with the Copernicus Sentinel-4 mission. MTG-I1 and MTG-S1 are now planned for launch in 2022 and 2023 respectively.

The LEO EPS-SG programme is under development and will provide a continuation and enhancement of the service from the mid-morning polar orbit in the 2024-2040s timeframe. The space segment is composed of a twin satellite in-orbit configuration with MetOp-SG A: an optical imagery and sounding mission which also will host the Copernicus Sentinel-5 instrument for launch in 2024 and MetOp-SG B: a microwave imaging mission, planned for launch in 2025. There will be three successive pairs of satellites with 21 years of operations.

EUMETSAT is also preparing for the operations of Sentinel-3C and-3D in 2023 and 2028, for the continuity of the reference ocean altimetry observations. EUMETSAT also considers supporting CNES's MicroCarb mission planned for launch in the 2022 timeframe, a precursor to a potential European CO2 and GHG monitoring mission CO2M. Preliminary discussions are ongoing at a European level for an Arctic Weather Satellite, and a follow-on Aeolus mission potentially for the next decade.

India Meteorological Department (IMD)

CGMS-49-IMD-WP-04: Main developments since CGMS-48 and an outlook for the future

At present, two meteorological satellites, INSAT-3D and INSAT-3DR, are in operation. INSAT-3D located at 82°E and was launched on 26 July 2013 while INSAT-3DR locates at 74° was launched on 8 September 2016.

These are dedicated meteorological satellites and carry four payloads: imager (six channels), sounder (19 channels), Data Relay Transponder (DRT), and satellite aided search and rescue (SAS & R).

The imager payloads of INSAT-3D and INSAT-3DR are used in a staggered mode to achieve 15-minute temporal resolution to provide cloud imaging.

The INSAT-3D sounder reached its end of life in September 2020, since then the INSAT-3DR sounder is being used to collect data on an hourly basis of the Indian land region.

IMD has established the Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR, and the proposed satellite INSAT-3DS. The system has three dedicated Earth station and data receiving systems. Each Earth station is receiving the data in redundant mode from each payload (imager, sounder, and DRT) and it has a dedicated raw data archival storage facility. MMDRPS has a very high-end processing system, which reduces the processing time from 15 to 7 minutes and foresees to update the calibration coefficient in the operational chain using Cal/ Val site and GISCS data. The system is capable of processing rapid scan data of the INSAT-3DR imager payload conducted during extreme weather events. MMDRPS has storage capacity of the order of 2.0/2.0PB (Main/Mirror) and 324TB SSD facilitating online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy. All available past satellite datasets starting from 1983 will be available online in due course.

Currently, IMD has archived the Kalpana-1 satellite data from 2014 to 2017. The MMDRPS system was declared operational on 12 November 2020.

Data exchange between IMD and other national and international agencies takes place on a real-time basis. A dedicated link over National Knowledge Network (NKN) has been established by IMD with ISRO and also with National Centre for Medium Range Weather Forecast (NCMRWF) for real time transfer of INSAT-3D radiance data along with LST, winds, and GNSS-IPWV data to be assimilated in the NWP models. INSAT-3D and -3DR wind products are being disseminated in BUFR format through the WMO Global Telecommunication system (GTS) network for international agencies on a real time basis. The MMDRPS has a dedicated web-based Data Supply System (DSS) in redundant mode to cater for web-based data dissemination requirements in near real time to both local and international users, based on the data dissemination policy of IMD.

The web based DSS which is in an advanced stage of implementation, will have a user registration/authentication mechanism in accordance with the data dissemination policy of IMD: metadata generation for data search; data search and order with a facility to handle band, format, area, and temporal selection options; user administration (add, edit, delete); user order processing system; data order workflow monitoring; report generation and data download history based on satellite/sensor and duration; satellite, sensor parameters, data products and metadata management (add, edit, delete). IMD has two dedicated webpages (http://satellite.imd.gov.in/insat.htm; http://satmet.imd.gov.in/insat3d.htm) and RAPID, which are updated every 15 minutes.

In addition, the RAPID Beta Version is also in the final stages of implementation. It will enable users to visualise NWP, radar, and in-situ observational data on a real time basis overlaid on satellite data with geo-referencing information and compatible to mobile users.

The INSAT-3DR imager payload was used to conduct rapid scans during four tropical cyclones, namely: SuCS Amphan, SCS Nisarga, VSCS Gati, and CS Burevi from May 2020 to April 2021. Each rapid scan covers 3 degrees in north-south direction (6 Blocks/240 scan lines) in 4.5 minutes. The rapid scan data is used to track cyclones on a real time basis. The processed data are disseminated on a dedicated webpage (http://satellite.imd.gov.in/rapid/rapid_scan.htm).

As per the demand of forecasters, several new geophysical products (imager/sounder) are being generated operationally by MMDRPS at a pixel level with range of frequencies (half hourly, daily, weekly, monthly, 15-day composite). These products are Net radiation, Improved INSAT Multispectral Rainfall, Land Surface Albedo (land), Short Wave Radiation over Ocean, Total Precipitable Water over Ocean, Potential Evapotranspiration over land, Actual Evapotranspiration and Cloud Top Pressure, Effective Emissivity, and Cloud Top Temperature respectively. SST derivation using 1-ID Var technique has been implemented.

Recently, new Advanced Dvorak Techniques (ADT) are implemented in MMDPRPS using INSAT-3D and -3DR imager data and tested on an experimental basis for the two cyclones Amphan and Nisarga. 10-day sliding composite snow maps and snow anomaly maps are generated operationally in the public domain for mountain regions to identify the fresh snow, melting snow area, and potentially vulnerable areas of landslide/flash flood in mountain regions.

To monitor ground based real time Integrated Precipitable Water Vapour (IPWV), IMD installed 25 GNSS stations all over India as the Indian Global Navigation and Satellite System (GNSS) which is operationally used in day-to-day weather forecasting and monitoring the convective development. The real time GNSS IPWV estimated from the IMD network is available in the public domain as http://gnss.imd.gov.in/TrimblePivotWeb/. In this web analysis, tools are available to plot real time, daily, weekly, and monthly data with maximum and minimum values.

Intergovernmental Oceanographic Committee of UNESCO (IOC-UNESCO)

CGMS-49-IOC-UNESCO-WP-02: IOC Global Ocean Observing System

The IOC thanked CMA for hosting CGMS-49 and expressed its deep appreciation to EUMETSAT and the CGMS Secretariat for the excellent arrangements in hosting meetings of the CGMS-49 Working Groups and plenary.

The IOC Global Ocean Observing System (GOOS) is a fundamental component of the UN Decade of Ocean Science for Sustainable Development. Of particular interest to CGMS, GOOS will provide an integrated system of in-situ and satellite ocean observing systems to improve predictability of ocean weather and climate and, consequently, enhance WMO services on global integrated Earth systems. To illustrate the GOOS oversight and coordination of in-situ and satellite ocean observing systems, ocean surface stress was chosen from the 31 GOOS Essential Ocean Variables because of the newly established CGMS Ocean Surface Wind Task Group. To strengthen GOOS oversight and coordination activities, GOOS is considering establishing a Satellite Data Coordinator, and IOC will report on this at CGMS-50.

CGMS-49 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
IOC-UNESCO	2	A49.01	IOC-UNESCO to provide CGMS-50 guidance of the Global Ocean Observing System (GOOS) for improved IOC and WMO ocean and atmosphere predictions and other services.	CGMS-50	**OPEN**

The CGMS Secretariat informed plenary that plenary action A47.05 had been transferred to WGII:

CGMS-46 action - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
IOC-UNESCO	3.3	A47.05	**On operational oceanography:** IOC-UNESCO to provide to GCMS-48 guidance on satellite data requirement for improved coastal ocean prediction and services	CGMS-50 (CGMS-47)	**OPEN**

CGMS-46 action - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
			Status: 2021 May 25: Transferred to WGII for further review (and reporting to plenary by WGII). Postponed to CGMS-50 (CGMS-49 being virtual again).		

Indian Space Research Organisation (ISRO)

CGMS-49-ISRO-WP-09: ISRO Agency Report

ISRO is committed to developing and launching satellite instruments for meteorological and ocean applications and providing support to Indian user agencies. The organisation maintains web portals (MOSDAC, VEDAS, and BHUVAN) for dissemination of satellite data to the international community and developed the Multi-Mission Data Reception and Processing System (MMDRPS) under a Memorandum of Understanding (MoU) with IMD (MoES), which is operational at IMD New Delhi since January 2021 for INSAT-3D/-3DR. 15 new parameters have been added compared to the old IMDPS system.

A 1-D Var based physical retrieval algorithm has been implemented for SST from INSAT-3D/-3DR Imager observation to mitigate the diurnal/seasonal dependency on SST biases. INSAT-3D/-3DR radiances are monitored using the GSICS procedure. Inter-calibration of IR channels are in a demonstration phase with IASI-A/-B and under implementation for IASI-C and CrIS. Inter-calibration procedure Vis/SWIR channels with MODIS is under testing.

Under the ISRO Processing Platform for the International Charter: Space and Major Disasters, a prototype for online image processing and analysis tools has been developed and is expected to become operational soon (https://vedas.sac.gov.in).

The INSAT-3DR sounder is being used operationally however, the INSAT-3D sounder stopped functioning in September 2020.

The re-processing of Scatsat-1 data in v1.1.4 was completed in June 2019. Due to an anomaly in the redundant chain, data delivery is suspended since 28 February 2021. This will be replaced by Oceansat-3 scatterometer data in October 2021.

SARAL/AltiKa, the ISRO-CNES joint mission, is in drifting mode. Crossover analysis using Jason suggests that the bias remains more or less the same. The data sets are still useful for oceanographic applications and very useful for Geodesy research.

Upcoming satellites:

- GISAT-1 is scheduled for launch in May 2021, at 85.5°E. Mx-VNIR and HyS-VNIR/SWIR will have a daytime rapid scan of 500 x 500 km every 5 min for monitoring of natural disasters.

- Oceansat-3 will be launched in October 2021, with 13 narrow bands OCM-3, 2 band SSTM, Ku band scatterometer and Argos-4 (CNES).
- INSAT-3DS (ground spare) is planned for launch in mid-2022 to provide continuity to INSAT-3D/-3DR.
- Aditya-L1, the first Indian observatory class mission for solar and heliospheric studies is scheduled for launch in 2022.

Missions under study:

- LEO: (a) MW temperature and humidity sounder in low-inclination orbit, (b) 6-89 GHz MW radiometer in low-inclination orbit, (c) dual frequency scatterometer, C-/Ku-band with 5 km (Regional)/25 km (global) resolution.
- GEO: INSAT 4th generation satellite with advanced imager, hyperspectral sounder, lightning mapper.

Japan Aerospace Exploration Agency (JAXA)

CGMS-49-JAXA-WP-05: JAXA report on the status of current and future satellites systems

JAXA operates various kinds of satellite sensors and opens the products to the public. JAXA continuously develops and improves the products to address climate and disaster issues. The major update since CGMS-48 is the Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW), which will carry the GCOM-W follow-on instrument (Advanced Microwave Scanning Radiometer 3; AMSR3) and GOSAT-2 follow-on instrument (Total Anthropogenic and Natural emissions mapping SpectrOmeter-3; TANSO-3). The mission is being developed and planned for launch in the Japanese Fiscal Year (JFY) of 2023.

As for the next generation precipitation radar following the TRMM/PR and GPM/DPR, JAXA proposed the advanced Ku-band Precipitation Radar with doppler capability and higher sensitivity. JAXA is discussing a possible collaboration with NASA.

The mission definition review of the next generation precipitation radar in JAXA is planned to be held in August 2021 (TBD). JAXA would like to utilise the report to be delivered by IPWG in showing requirements from the international meteorological community. This issue was discussed in the context of the IPWG report to the plenary, see later under 4.1.

Japan Meteorological Agency (JMA)

CGMS-49-JMA-WP-09: Main development since CGMS-48 and an outlook for the future by JMA

JMA operates two geostationary meteorological satellites, Himawari-8 and -9, equipped with Advanced Himawari Imagers (AHI). Himawari-8 has been stably operational since July 2015, with Himawari-9 to take on the operational phase in 2022.

In Fiscal Year 2018, JMA started considering the next geostationary satellite programme. JMA will pursue a seamless geostationary satellite system, keeping in mind the CGMS baseline and Vision for WIGOS in 2040.

Korea Meteorological Administration (KMA)

CGMS-49-KMA-WP-05: KMA Report on the Status of Current and Future Satellite

KMA's first GEO satellite, COMS, ended its meteorological mission at the end of March 2020 and its follow-on, GEO-KOMPSAT-2A (GK2A), has been operational since July 2019.

In order to support early warning of severe weather events, KMA started the service of a request-based 'rapid scan target area observation' for international NMHSs in February 2021.

GEO-KOMPSAT-2B for ocean and environmental mission was launched in February 2020 and the L1B data will be public in the 2nd half of 2021.

KMA is executing the feasibility study to prepare for the follow-on of GK2A meteorological mission in 2021.

National Aeronautics and Space Administration (NASA)

CGMS-49-NASA-WP-03: NASA Report on Current & Future Satellite Systems

The National Aeronautics and Space Administration (NASA) continues to provide operational support for 22 Earth-observing satellites. Guided in its efforts by the recommendations of the decadal survey "Thriving on our Changing Planet" NASA's Earth Science Division (ESD) continues to execute a balanced and robust programme of technology development, research, and applications.

The highlight of last year was the launch of the joint US-European satellite, Sentinel-6 Michael Freilich. The satellite was named in honour of the late former director of NASA's ESD, Michael Freilich, who was a pioneer in oceanography from space. Sentinel-6 Michael Freilich is the first of two identical satellites in the Copernicus Sentinel-6/Jason-CS (Continuity of Service) mission that will continue the uninterrupted collection of sea level measurements that began in 1992.

The RainCube mission provided the first-ever demonstration of pulse compression applied to a spaceborne precipitation radar, which is needed to achieve high sensitivity and resolution without high-power amplifiers.

In May 2021, NASA initiated Pre-Phase A activities that address four out of the five designated observables prioritised by the 2017 Earth Science Decadal Survey. This transition authorises NASA centres to establish project offices to further define the mission concepts, execute trade studies related to architecture(s) identified during the DO studies, and continue to develop opportunities for collaboration with international partners.

The Decadal Survey Incubation Study Teams completed white papers to inform strategy and decisions related to the release of a research solicitation in 2021, which will accelerate the readiness of cost-effective flight implementation of planetary boundary layer and surface topography and vegetation targeted observables.

National Oceanic and Atmospheric Administration (NOAA)

CGMS-49-NOAA-WP-01: NOAA Update: Main developments since CGMS-48 and an outlook for the future

NOAA provided an update on the main developments since CGMS-48 and an outlook for the future, including an emphasis on the four pillars of NOAA's next-generation Earth observations: LEO, GEO, Space Weather, and Common Ground Services. Dr. Volz noted that NOAA is currently planning the LEO SounderSat Initiative to develop an operational pathfinder for the post-JPSS era, and to ensure continued data flow from the early-morning orbit. Specifically, government and industry studies are underway to evaluate LEO MW, IR, and RO sounders, potential mission constellations, and potential spacecraft platforms. Moreover, NOAA is planning more frequent launches to enhance, refresh, and augment global observations collected from Earth observation satellites, beginning in mid-2020s with a focus on replenishing critical sounding data. Dr. Volz highlighted NOAA's formulation of plans for the GeoXO (Geostationary Extended Observations) programme planned for operation over the 2030-2050s. A series of User Engagement Workshops was held in 2020 to assess user needs, and the robust participation of our CGMS colleagues was appreciated. In addition, Dr. Volz announced that NOAA is planning a new space weather programme to encompass the diverse observation requirements that must be made from distributed vantage points in LEO, GEO, HEO, L1, and off the Sun-Earth line. Currently, NOAA is building the compact coronagraph for GOES-U, and building and preparing for NOAA's Space Weather Follow-On L-1 Mission scheduled for launch in 2025. Finally, NOAA has begun implementing enterprise ground services including the secure ingest of data from their partners and the private sector, using a flexible, scalable platform. In addition, NESDIS has adopted a common services approach integrating cloud, AI, and machine-learning capabilities to verify, calibrate, and fuse data into new and better products and services.

ROSCOSMOS-ROSHYDROMET

CGMS-49-joint-ROSCOSMOS-ROSHYDROMET-WP-01: Status of current and future Russian Meteorological satellites systems

Roshydromet provided the status of the current Russian satellite systems: Meteor-M N2 (2014) and N2-2 (2019) polar-orbiting meteorological satellites, and Electro-L N2 (2015) and N3 (2019) geostationary meteorological satellites and their respective mission objectives, payload, and ground segment details.

Further, Roshydromet presented information on the Arctica-M project of at least two satellites at highly elliptical orbits. The first HEO meteorological spacecraft Arctica-M N1 was launched on 28 February 2021 and is now in the commissioning phase. The launch of the second Arctica-M satellite is scheduled for 2023. It will provide frequent observations similar to geostationary satellites, but over the Arctic region. The payload of Arctica-M satellites is similar to those of the Electro-L series.

3. WMO MATTERS FOR COORDINATION WITH CGMS SPACE AGENCIES

3.1 WGI - Satellite systems and operations

CGMS-49-WMO-WP-22: Status of the update of the WMO Data Policy (Resolution 42)

WMO updated CGMS on its activities for the establishment of the new WMO Data Policy, Resolution 42.

The international exchange of data is a major purpose of WMO. The new unified Data Policy is one of the most impactful pieces of work of WMO in the last 25 to 30 years. It considers all WMO Earth system data and identifies two main categories of data, namely core and recommended. The new Data Policy provides clear definitions of terms, specifically it defines ”free and unrestricted” to mean “available for use, re-use and sharing without charge and with no conditions on use”. Free and unrestricted remains the essence of the Data Policy as it has unequivocally been demonstrated that it gives the best value for money. The benefits of the new Data Policy are:

- Enables access to a vastly increased pool of Earth system data (observations, model fields, and other types of data) from other members and partners:
    - Increased data exchange will result in improved data quality, both models and observations;
    - Opportunity for all members to improve and extend the range of their services to national constituencies;
- Takes into account the current impact of satellite data on WMO application areas (currently not well captured in the existing Resolution);
- Expectation of members to increase exchange of their own data with other members and external partners;
- Gives opportunity to strengthen the national role in the coordination around acquisition and use of Earth system data; and
- A better defined and mutually beneficial relationship between public and private sectors.

WMO noted that the term “essential data” has been removed from the resolution text because, since 1995, the term has developed a different meaning in several communities.

WMO noted that the new resolution will not in itself immediately lead to new obligations for members to exchange data, however the groups of users with whom data are exchanged will be broadened significantly. It is also important to note that in the end governments will maintain the ownership of the data and will decide through national policies on what they will commit to.

What core satellite data constitutes will have to be agreed between WMO and the space agencies, and it is currently framed primarily in terms of importance to global NWP and will be detailed in the technical regulations on WIGOS and GDPFS.

It was also noted that the policy does not state a position on commercial providers since WMO will not dictate what the private sector should do.

WMO clarified the relationship between WMO Data Policy and WMO Regulatory material, noting that whilst Congress owns both, updates to the regulatory material is simpler. Before Congress in October 2021, the Data Policy will be discussed at the Executive Council 73 in June 2021.

Following the presentation, EUMETSAT indicated it had participated in the discussions with WMO and had had the opportunity to consult with EUMETSAT member States that are all fully behind the new WMO Data Policy. EUMETSAT has insisted on a mechanism on agreeing between satellite operators and WMO on what is 'core satellite data' and noted with appreciation this is now addressed in the new Data Policy.

NOAA applauded the emerging way forward for a unified Data Policy and is fully supportive of the discussion on 'core' or 'recommended' types of data. NOAA noted that all satellite data are not necessarily 'core' which WMO confirmed, but the new resolution and the position paper on requirements for NWP responds to the need for defining core data for global NWP.

WMO emphasised that it has supported international data sharing for a long time and that the approval and discussion process was still ongoing prior to Congress approval in October 2021. It was also noted that the Data Policy is only a framework, and this will lead to a detailed definition of core data in the Technical Regulations. WMO thanked CGMS for its support and added that WMO is planning a high-level consultative meeting on satellite matters, where the way forward for the establishment of core satellite data should be addressed. Indeed resolution 40 envisaged agreements about which satellite data should be considered core for WMO, but these agreements were not fully formalised, and the high-level consultative meeting is a means to start this process.

In closing the session, the Chair noted that CGMS is indeed a good platform to discuss Data Policy, core satellite data, and implications on the satellite agencies.

The following action raised at CGMS-46 is maintained and WMO is expected to report to CGMS-50:

CGMS-46 action - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	H	A46.11	**On ocean variables:** In view of the anticipated reform of JCOMM, WMO to provide a report with proposals on future coordination/cooperation between JCOMM and CGMS. Status: 2021 May 16: Postponed to CGMS-50 (CGMS-49 being virtual) 2021 Apr: WMO expected to report to plenary. (JCOMM activities have been refocused following the WMO reform)	CGMS-50 (CGMS-47)	**OPEN**

4. WORKING GROUP REPORTS

4.1 WGI - Satellite systems and operations

CGMS-49-WGI-WP-01: Report from WGI

WGI informed plenary of the status of discussions on frequency matters and the initial preparations for the WRC-23. SFCG and WMO are, on a yearly basis, defining and refining their positions for WRC-23, and providing CGMS with the latest status available. WGI reviews and provides its feedback on issues of mutual interest/concern, as appropriate, and will include relevant WRC-23 issues in the HLPP. WGI will set-up a group to investigate collectively mechanisms for detection and long-term monitoring and mapping of RFI (for example, but not limited to, from IMT-2020/5G into the 24 GHz passive band) at satellite or instrument level, or any other means, as the knowledge base for assessing the impact on the passive sensor measurements. WGI presented the status of the implementation of CGMS agency best practices in support to local and regional processing of LEO direct broadcast data. It was proposed to perform a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis of low latency data access from LEO meteorological spacecraft and present the result at CGMS-50. The SWOT analysis would primarily focus on the needs of the main user application areas, and secondarily on the possible technical implementations. The goal is to present a coordinated view for consideration by CGMS for future data access mechanisms from LEO meteorological satellites.

The WGI Data Collection Service (DCS) subgroup had proposed a revised simplified approach regarding the new IDCS standard, rather than a completely new standard, looking to enhance an existing standard taking into account user feedback and requirements. The subgroup also plans to perform a SWOT analysis on the geostationary meteorological satellites Data Collection Services as a basis to provide CGMS with a coordinated view on a proposed future of the service.

WGI also informed plenary on the progress within the development and operations of LEO satellite systems with coordinated orbital phasing. The plans are to perform a broad SWOT analysis for maximising the return/minimising the cost taking into account new mission and reference mission concepts and associated technologies, highlighting the potential for inter-agency cooperation.

The CGMS-49 plenary endorsed the nomination of Dr. Dohyeong Kim, KMA, as the co-chair of WGI, a long-standing vacancy.

Following an enquiry by EUMETSAT, the WGI co-chair responded that data compression aspects will be taken into account as part of the SWOT analysis of low latency data access from LEO meteorological spacecraft.

4.2 WGII - Satellite data and products

CGMS-49-WGII-WP-01: Report from WGII

WGII provided an overview of its activities undertaken since CGMS-48, as well as of its CGMS-49 discussions. The working group presented to plenary the updated WGII Terms of Reference for endorsement; agency reports on highlights and issues in data and product generation; activities of three CGMS International Science Working Groups on precipitation (IPWG), winds (IWWG), and radio occultation (IROWG); discussions on the proposal of a new CGMS International Earth Surface Working Group (IESWG); a proposed baseline for GEO Level-2 products; updates of the GSICS State of the Observing System; Arctic observations; and the activities undertaken by the CEOS-CGMS Joint Working Group on Climate and its Greenhouse Gas Task Team.

Plenary endorsed the following three actions as proposed by WGII:

CGMS-49 actions - Plenary Session					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	4.1	A49.02	CGMS members to endorse the IPWG paper "*A review of the different operational applications of spaceborne precipitation radars within the International Precipitation Working Group (IPWG) community*" by 15 June (e-mail procedure) following review and recommendation by WGII by 7 June	7 and 15 Jun 2021	**OPEN**
CGMSSEC	4.1	A49.03	CGMS to provide a letter of support to JAXA on the DPR follow-on mission/precipitation radar efforts and following endorsement of IPWG paper (see A49.02)	End Jun 2021	**OPEN**
CGMSSEC	4.1	A49.04	CGMS to provide a letter of support to NOAA and NASA on the implementation of the GeoXO ACX mission, for the purpose of mitigating the gap for geo air quality measurements post NASA's Tempo observations.	Aug 2021	**OPEN**

CGMS-49 plenary further endorsed all Working Group II recommendations (and action WGII/A49.11) *except* for the establishment of a new International Earth Surface Working Group:

WGIIR49.01	WGII recommends to plenary the adoption of the new WGII Terms of Reference as presented in CGMS-49-CGMS-WP-09
WGIIR49.02	WGII recommends to plenary to confirm the nomination of JV Thomas as the second Chair of WGII.
WGIIR49.05	Working Group II recommends to CGMS plenary the adoption of the proposed baseline products presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.
WGIIR49.08	WGII recommends to plenary the adoption of the IWWG Terms of reference.
WGIIR49.11	WGII recommends to plenary the nomination of Joe Turk as the new IPWG rapporteur.
WGIIR49.12	WGII recommends to plenary the adoption of the updated IPWG Terms of Reference.
WGIIR49.13	WGII recommends to plenary to consider the establishment of a new International Science Working Group: “International Earth Surface Working Group” based on a successful organisation of the next IESWG workshop including broad CGMS member participation.
WGIIR49.17	WGII recommends to plenary the establishment of an Ocean Surface Wind Task Group (OSW TG) in the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS and the IOVWST and other relevant entities.

WGIIR49.07	WGII recommends to plenary to address the gap of global 3D wind profile observations with high priority. Based on the Aeolus experience, a combination of lidar & IR missions can provide complimentary wind observations which look to be very promising.
WGIIR49.09	WGII recommends that Agencies when pursuing data buy clearly defines all aspects of the data, e.g. orbits and coverage, in order to optimise the benefits of the data.
WGIIR49.10	WGII recommends that Agencies consider data buy with an option for redistributing data to global NWP centres.
WGIIR49.18	WGII recommends to plenary the endorsement for future OSOS Symposia
WGII/A49.11	The dissemination strategy for the baseline products presented in CGMS-49-WMO-WP-14, including SST, should be presented to and discussed with CGMS WG IV.

CGMS plenary members *took note* of the following six WGII recommendations:

WGIIR49.06	WMO together with Working Group II to develop a baseline recommendation for channels from geostationary satellite imagers
WGIIR49.14	CGMS members to collaborate with users and L3 developers on spatial resampling chains “respectful of spatial scale”
WGIIR49.15	CGMS members are encouraged to engage with the MOSAiC PIs for widespread use of the campaign data
WGIIR49.16	CGMS member to consider derivation of Level-2 products using the new proposed Level-1g data.
WGIIR49.21	WMO to take into consideration the requirements for microwave imaging and sounding constellations, also in terms of equatorial crossing time in future reviews of the WIGOS Vision 2040.
WGIIR49.22	CGMS members to consider using all currently available microwave imager data for their precipitation products.

The following plenary action, raised at CGMS-48, was transferred to WGII:

CGMS-48 action - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS space agencies	6.2	A48.05	CGMS agencies, in particular those operating geostationary satellites, are encouraged to make commitments within GSICS and SCOPE-CM that enable the creation and maintenance of the cross-calibrated 'geo-ring' radiance climate data record and in second step to a project for the cloud property data records. Status: 2021 26 May: Action will be transferred to WGII and reported on by WGII to plenary. - NOAA is committed to supporting these initiatives and has participated in relevant meetings and conversations, providing leadership in appropriate areas. - See also CGMS-49-EUMETSAT-WP-06.	CGMS-50 (CGMS-49)	**OPEN**

CGMS-49-WGII-WP-03: Updated terms of reference of WGII

WGII presented its updated Terms of Reference (ToR) (primarily of an editorial nature). The plenary endorsed these as well as the new composition of the WGII co-chair and rapporteur team: Dr. JV Thomas, ISRO, and Dr. Kenneth Holmlund, WMO, as WGII co-chairs and Dr. Mitch Goldberg, NOAA, and Dr. Paolo Ruti, EUMETSAT, as WGII rapporteurs.

CGMS-49-IPWG-WP-05: Updated Terms of Reference for the CGMS International Precipitation Working Group

CGMS-49 plenary endorsed the updated ToRs for the IPWG. Changes included adding listed names of national and international agencies, specifying precipitation-relevant satellite missions hosted on increasingly diverse missions, and creating Chair term limits. The next IPWG meeting (IPWG-10) will be held jointly with the International Workshop on Space-based Snowfall Measurement (IWSSM) community in June 2022.

CGMS-49 plenary also endorsed the new IPWG rapporteur, Joe Turk, NASA.

CGMS-49-IPWG-WP-04: A review of the different operational applications of spaceborne precipitation radars within the IPWG

CGMS-49 plenary endorsed the way forward for the approval of the IPWG report "*A Review of the Different Operational Applications of Spaceborne Precipitation Radars Within the IPWG Community*", which was written by 22 authors from 18 institutes in response to action CGMS-48 WGII A48.13.

The final CGMS approval will be performed through a written (e-mail) procedure after completion of the final WGII review by mid-June.

The report highlights three applications that need continuity of precipitation radar observations to sustain development and/or operations:

(1) Use of precipitation radars as calibrators for precipitation retrievals from the constellation of PMW instruments;

(2) Use of precipitation radars in NWP (model validation and data assimilation); and

(3) Use of precipitation radars as calibrators for ground radar networks. The report also includes a recommendation section for future spaceborne precipitation radar instruments.

It was agreed that based on the final IPWG report, the CGMS Secretariat will send a letter of support for the continuity of the precipitation radar mission to JAXA.

Concluding the discussion, plenary noted the following two actions:

CGMS-49 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	4.1	A49.02	CGMS members to endorse the IPWG paper "*A review of the different operational applications of spaceborne precipitation radars within the International Precipitation Working Group (IPWG) community*" by 29 June (e-mail procedure) following review and recommendation by WGII by 17 June	17 and 29 Jun 2021	**OPEN**
CGMSSEC	4.1	A49.03	CGMS to provide a letter of support to JAXA on the DPR follow-on mission/precipitation radar efforts and following endorsement of IPWG paper (see A49.02)	End Jun 2021	**OPEN**

CGMS-49-GUEST-WP-04: Preparations for the establishment of a new CGMS International Science Working Group

The working paper proposed the establishment of a new CGMS International Science Working Group (ISWG), notionally called the International Earth Surface Working Group (IESWG).

A draft set of ToR has been prepared and the objectives of the IESWG include:

- Use of Earth observation (EO) data for Cryosphere and Biosphere modelling relevant to study
  processes at the land-atmosphere interactions;
- Use of EO-data for parameter optimisation including those for the land surface, vegetation, and snow, and the resulting surface emissivity/reflectance spectra;
- Land Data Assimilation Systems (LDASs) both current state and recent developments; sensitivity studies of surface model parameters to remotely sensed data;
- Radiative transfer and emissivity/reflectivity model development: VIS/IR/MW, review of current parameterisation for forward modelling surface boundary; and
- Retrievals of land surface parameters: product characteristics and performances.

CGMS-49 plenary was not in a position to endorse the IESWG and requested more information on the purpose of the working group, and in particular, the need for securing that there is no overlap with other already existing initiatives. Plenary further tasked the IESWG and CGMS WGII members to provide an updated proposal to CGMS-50 in 2022.

CGMS WGII will reach out to CGMS agencies to ensure broader participation for the next IESWG meeting in April 2022 in Helsinki, Finland.

4.3 WGIII - Operational continuity and contingency planning

CGMS-49-WGIII-WP-01: Report from WGIII

Ajay Mehta, WGIII co-chair, provided the report of Working Group III (WGIII). Mr. Mehta began by noting that WGIII held the 3rd Risk Assessment Workshop in March 2021 with good participation from CGMS member agencies. The 3rd Risk Assessment Workshop focused on capturing the risk posture relative to the CGMS space agency baseline commitments.

Further, the WGIII plenary session took place virtually mid-April, followed by a joint session with WGII at the end of April.

On these occasions, WMO informed WGIII on the satellite data requirements for Global NWP, the WMO Gap Analysis, and WMO's efforts to update OSCAR/Space.

- WGIII analysed the satellite data requirements for Global NWP and determined that all the "Backbone" and "Additional" sensors are covered in the CGMS baseline with the exception of solar irradiances and some emerging sensors such as wind lidar.

- The WMO Gap Analysis resulted in 16 gap areas, and noted that most of them are supported by the CGMS baseline, the HLPP, or open CGMS recommendations and actions with the exception of polar ice and deep space observations.

- WMO continues to maintain and evolve the technical capability of OSCAR/Space and CGMS members are encouraged to provide accurate and timely updates to the database. WMO continues to work to establish reliable focal points from CEOS, non-CGMS members, as well as from commercial satellite operators to ensure completeness of OSCAR/Space.

WGIII received a report from the CGMS Socio Economic Tiger Team (SETT) noting their progress and that the SETT Socioeconomic Pilot Study had been cancelled. Consistent with the SETT report, WGIII recommended to the plenary that the work of the SETT can be concluded at this stage and instead to retain an agenda item in WGIII on socioeconomic benefits with WGII to review the scientific impact of any related studies.

The joint WGII-WGIII session looked at additional applications to include in the CGMS baseline, including trace gases, and also under the UV and hyperspectral sounder sensors.

CGMS-49-WGIII-WP-05: CGMS risk assessment following review of the CGMS working groups

The WGIII co-chair, Ajay Mehta, provided an overview of the 3rd risk assessment undertaken including the underlying assumptions. The focus areas of the risk assessment in 2021 included:

A long-term continuity risk for critical sensors (e. g. microwave and hyperspectral sounders and multipurpose imagers) in the early morning orbit comes towards the end of the decade; and WGIII identified a number of ongoing actions taken by members to address such gaps. This includes CMA's considerations for an FY-3E early morning orbit follow-on mission – the FY-3I.

Regarding the continuity risk for the number and geographic distribution of radio occultations, especially in the low inclination orbits, Mr. Mehta acknowledged the earlier discussions on this topic during both the WGIII and in plenary. He thanked the IROWG for their work, highlighted the recommendation for CGMS members to fly RO sensors providing coverage in the low- to mid-latitudes, and added that the WGIII plans to revisit this on the occasion of the 4th risk assessment and CGMS baseline review.

CGMS members are also addressing the long-term continuity risk for broadband short/long wave radiometer in the early morning orbit, and again CMA's plans for a follow-on to FY-3E in the early morning orbit would support this. However, WGIII took an action to consider if GEO contributions not identified in the CGMS baseline should be included.

Regarding the lack of long-term plans for precipitation radar observations, WGIII requested that CMA confirms its plans beyond FY-3G, and NASA and JAXA confirm their plans beyond GPM Core.

ISRO is requested to confirm its plans beyond Oceansat-3 to address the long-term continuity risk for scatterometry in the early morning and afternoon orbits.

The biggest risks are with respect to space weather observations at L-1. The first is a gap in coronagraph sensors in the near term until SWFO L-1 is launched in 2025. WGIII also identified risks

for the energetic particle sensor, plasma analyser, and magnetometer until SWFO L-1 is launched. To address the space weather observation requests, WGIII recommends:

- SWCG to identify alternative data sources to mitigate potential unavailability of coronagraph observations;

- CGMS members to propose near-term alternative data sources for consideration as gap mitigation in event of loss or degradation of current L1 capabilities prior to SWFO-L1 data availability;

- WGIV to consider recommended gap mitigation observation requests and develop plans to ensure near real-time access to those data; and

- SWCG to review the baseline requirements for orbital positions as opposed to number of satellites.

Mr. Mehta highlighted the recommended new and recalled existing actions to address the risks identified during the 3rd Risk Assessment Workshop as outlined below.

Risk assessment, recommended new actions:

- ISRO to update CGMS-50 on their plans for a hyperspectral sounder in geostationary orbit.
- CMA to confirm plans to fly a precipitation radar beyond FY-3G.
- NASA and JAXA to confirm plans to fly a precipitation radar beyond the GPM Core mission.
- EUMETSAT and ESA to report on plans for the CIMR (Copernicus Imaging Microwave Radiometer) Mission.
- ISRO to confirm plans beyond Oceansat-3 series.
- SWCG to identify alternative data sources to mitigate potential unavailability of coronagraph observations
- SWCG to review baseline requirements for orbital positions as opposed to number of satellites for energetic particle observations.

Risk assessment – ongoing associated actions:

- CMA planning is underway for a follow-on to FY-3E in the early morning orbit with CMA and WMO to establish a Tiger Team following the launch of FY-3E to assess the benefit of the early morning orbit to support CMA's future planning of such missions.
- NOAA and NASA to confirm plans on accommodation of a radiation budget instrument on JPSS-3 and beyond.
- WGII/WGIII to consider whether observations from the geostationary orbit should be added to the CGMS baseline requirements for the broadband short/long wave radiometer.
- CGMS members to continue to propose near-term alternative data sources for consideration as a gap mitigation in the event of loss or degradation of current L1 capabilities prior to SWFO-L1 data availability;

- WGIV to consider recommended gap mitigation observation requests and develop plans to ensure near real-time access to those data.

CGMS-49-WGIII-WP-06: CGMS baseline, following CGMS working group discussions

WGIII-WP-06 presents the revised CGMS baseline for endorsement by CGMS plenary.

The WGIII co-chair, Mr. Mehta, briefly reviewed the updates to the CGMS baseline. He noted that the baseline has a horizon of 10-12 years and includes observations needed for operations that are made available on a full free and open basis. He noted that in addition to some editorial changes, observations and application areas were expanded to capture support to atmospheric composition, including specific trace gases, for the hyperspectral sounder and visible/UV spectrometer (nadir and limb); and aerosol observations from narrow band imagers and high-resolution optical imagers. Further, the section on Direct Broadcast Services was updated to highlight low latency objectives. For the first time, the baseline will include CGMS member instruments to be flown on a commercial platform when launch dates are agreed with the commercial provider, highlighting the importance of commercial hosting as we approach a more disaggregated space segment.

EUMETSAT and NOAA endorsed the recommendations of WGIII and there were no reservations expressed by any other CGMS members. The session Chair offered if members had specific edits to the risk assessment or the CGMS baseline, they could submit these via email to cgmssec@eumetsat.int.

EUMETSAT and NOAA endorsed the nomination of Heikki Pohjola, WMO, as the rapporteur of CGMS WGIII and there were no objections from other CGMS members.

4.4 WGIV - Data access and end user support

CGMS-49-WGIV-WP-02: Report from WGIV

WGIV presented the key issues and outcomes of the WGIV plenary session last April, which focused on global and inter-regional data access including WMO's Information System (WIS) and big data, capacity building and user readiness, and cyber security and cloud services.

On data exchange: The commercial satellite broadcast system from CMA is reaching capacity limits and is complemented by terrestrial services using high-speed networks and the internet. The HimawariCast service by JMA is planned to optimise satellite data usage with the provision of additional satellite derived products. NOAA's GEONETCast Americas is still expanding and benefitting from the migration to DVB-S2.

Presentations by IMD, IRSO, KMA, EUMETSAT, ROSHYDROMET, and CMA demonstrated that a variety of new terrestrial data access methods are being explored and implemented for data exchange between providers and to end users. The common goal is to provide increasing data volumes to users at low latency, interactive, and automated. Web visualisation services using web browsers become a standard tool following the concept of bringing the user to the data and thus unloading the network.

A gap exists in the coordination of the efforts to strengthen sustained capacity and use of EO. Currently, multiple global networks contribute to EO capacity development. In order to close this gap, CEOS recently endorsed the EOTEC DevNet initiation plan, which includes using a network of networks approach between CEOS WGCapD, GEO CD-WG, CGMS VLab, WMO, and UNOOSA.

In the context of disaster service support, CMA and JMA will strengthen their capabilities, in cooperation with CMA, JMA, and KMA. ISRO presented a web-based processing platform to better support the International Charter on Space and Major Disasters.

In the context of user readiness for new satellite systems, NOAA presented an outlook into the future with an Overview of GeoXO's User Engagement Process.

The VLab report highlighted that, since CGMS-48, VLab members have offered a variety of training opportunities addressing the new generation of satellites, which continues to be the major training need identified by VLab members. Furthermore, stronger collaboration and coordination of efforts between VLab members resulted in increased opportunities for user training during the past year.

On a request by NOAA, WMO clarified that the VLab has two co-chairs and both were vacant.

NOAA nominated Dr. Bernadette Connell from the Cooperative Institute for Research in the Atmosphere of Colorado State University and CMA nominated Mr. Wen Bo, from the CMA Training Center in Beijing, for the positions of the two VLab co-chairs.

Plenary endorsed Dr. Connell as new VLab co-chair representing the CGMS space agencies, noting that Mr. Wen Bo’s nomination shall be endorsed by WMO.

In March 2021, the first meeting of the newly created WG IV Cyber Security Expert Group was held. The focus of the first meeting was to create and review the ToR.

The Cloud Expert Group was established in July 2020 and was formed to share cloud lessons learnt and develop a set of best practices for each organisation to maximise interoperability. The Cloud Expert Group has focused on agency best practices, cloud optimised data formats, and how the group’s cloud work aligns with WIS 2.0 Strategy.

The WGIV rapporteur and the TFMI Chair roles are vacant, and WGIV members are encouraged to nominate candidates.

4.5 IROWG-International Radio Occultation Working Group

CGMS-49-IROWG-WP-02: Key IROWG outcomes and recommendations to CGMS plenary

The paper summarises the outcome of the IROWG-8 meeting held virtually on 7-13 April 2021, hosted by NOAA and UCAR. It covers science highlights, discussions, and community concerns.

As a result, the IROWG community raised a number of key recommendations to the CGMS plenary:

- IROWG reaffirms that all providers of radio occultation (RO) observations should classify these as essential in the sense of WMO Resolution 40. IROWG further stresses the

importance of free, timely, and unrestricted access in real time to essential RO data, and free and unrestricted access to archived raw data including auxiliary data. (Note that this can be updated to reflect upcoming WMO data policy changes, e. g. "essential" → "core" data, at least for the 20,000 "backbone constellation" as defined by the HLPP target);

- IROWG continues to recommend that WMO and CGMS space agencies should coordinate any GNSS RO data purchases. Specifically, IROWG suggests convening a meeting of all agencies considering procuring these data, in order to discuss if, how, and when the current 20,000 daily target will be met with global and full local time coverage;

- As per CGMS priority HLPP 1.1.4 (optimised system for atmospheric and ionospheric RO observations), IROWG recommends that CGMS encourages ongoing and future GNSS RO and non-RO missions, including potential commercial providers of RO observations, to incorporate a complete set of ionospheric measurements;

- GNSS RFI jamming has been identified as a problem and recommended that the issue should be addressed by CGMS (WGI) and a corresponding WGI action has been raised;

- All of the IROWG sub-groups recognised the importance of Level 0 (raw) data. Raw data should be included in data purchase plans from commercial providers. An IROWG subgroup will be formed to develop an exchange format for raw data;

- New RO data probe the lower troposphere better than before. An IROWG task force for the lower troposphere will be established. RO-derived water vapour shall be further explored as a climate variable;

- An IROWG subgroup will be formed on how best to extract profile information in the planetary boundary layer;

- The IROWG recommends that CGMS encourages technology and retrieval developments for improving planetary boundary layer profiling from GNSS-RO and their utilisation in NWP data assimilation – and the further exploration of RO-derived water vapour as a climate variable.

The IROWG stressed that Global Navigation Satellite System (GNSS) RO data with high spatial and temporal resolution allow for unprecedented studies of atmospheric and ionospheric phenomena, greatly improve NWP model accuracy, and help monitor climate change. The IROWG articulated that there is a high risk of not meeting the CGMS baseline number of occultations per day after COSMIC-2 ends its mission after 2030 or earlier. Commercial data could help fill this gap, but challenges remain. Science highlights included the demonstration of high impact in NWP in the lower troposphere for water vapour.

The IROWG-8 workshop minutes and the related CGMS working paper will be made available at http://irowg.org/workshops/irowg-8/, and all IROWG-8 workshop presentations are available at https://cpaess.ucar.edu/meetings/2021/irowg-8.

CGMS-49 thanked IROWG for its work and noted that the recommendations from IROWG are considered in the list of proposed actions/recommendations from WGII.

Further, CGMS WGIII will update the RO data availability and potential future gaps in the CGMS baseline accordingly at the next risk assessment workshop in February 2022 (a WGIII action has been raised accordingly).

4.6 International Winds Working Group(IWWG)

CGMS-49-IWWG-WP-02: Key IWWG outcomes and recommendations to CGMS plenary including proposal for a Scatterometer Task Group and related ToRs

The IWWG presented its activities and recommendations to plenary since the CGMS-48 plenary session, following the 15th IWWS on 12-16 April, and the CGMS-49 WGII meeting on 26-28 April.

Noteworthy highlights of the IWWS15 are:

- Aeolus winds (NWP impacts, validation studies, comparisons to AMVs).
- NOAA stereo winds and dense optical flow.
- Inter-comparison study plans with ICWG. Key areas to explore, golden day data, etc.
- AMV Reprocessing within JMA, EUMETSAT.
- Cloud height estimation and AMV generation with Machine Learning.
- OSW error analysis and assimilation.
- Use of satellite-derived winds in Numerical Weather Prediction (NWP).

The discussions resulted in a number of recommendations, all supported by WGII, for recommendation to CGMS-49 plenary for endorsement.

Recommendation 1: For consideration by CGMS plenary the IWWG recommends space agencies to address the gap of global 3D wind profile observations with high priority. Based on the Aeolus experience, a combination of lidar and IR missions can provide complimentary wind observations which look to be very promising. This is because:

- Aeolus shows significant positive impact on global NWP models as shown by ECMWF, Météo-France, Met Office, DWD, NOAA, JMA, NCMRWF, and ECCC and is better than expected prior to launch.
- Operational assimilation at ECMWF, Météo-France, DWD, and the Met Office.
- Strength within the entire assimilation scheme.
- Valuable as an AMV intercomparison dataset.

CGMS-49 noted that space-based lidar is addressed in the proposed revision of the HLPP.

Recommendation 2: In response to the CGMS-48 actions WGII A48.10 and plenary A48.09/A48.10, IWWG presented the establishment of an Ocean Surface Wind Task Group (OSW TG) within the framework of the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS, and the IOVWST.

The associated related OSW TG Terms of Reference are embedded within those of the IWWG Terms of Reference (CGMS-49-IWWG-WP-02PL), implying that any OSW TG actions and recommendation will be reported to/from CGMS through the established IWWG mechanisms and in addition to CEOS and IOVWST.

CGMS-49 plenary endorsed the establishment of the OSW TG with the understanding that the IWWG reports on the progress of the OSW TG to CGMS-51 in 2023 to evaluate the activities of the Task Group and the need for its continuity.

Recommendation 3: The IWWG presented its newly drafted Terms of Reference, including the Terms of Reference of the Ocean Surface Winds Task Group (OSW TG), for endorsement by the GCMS plenary.

Looking back, there have been no formal Terms of Reference since the establishment of the IWWG, and it was therefore necessary to assure such a document exists (**CGMS-49-IWWG-WP-02PL: Revised Terms of reference for the International Winds Working Group**)

CGMS-49 plenary endorsed the new IWWG Terms of Reference, and requested they be reviewed on approximately a 5-yearly basis.

Recommendation 4: NOAA to continue operating NOAA-15, -18, and -19 as long as the sensing instruments perform adequately and continue to produce AMVs;

CGMS-49 plenary noted the unique contributions of the remaining POES satellites due to instrument health and their specific orbits and CGMS-49 endorsed this recommendation.

4.7 Space Weather Coordination Group (SWCG)

CGMS-49-SWCG-WP-04: Report from SWCG

Elsayed Talaat presented the SWCG Report and the status of ongoing activities. The scope of the report covered the SWCG session as well as the joint WGI-WGIV-SWCG session.

An overview was provided of the agreed updates to the CGMS Baseline on energetic particle monitoring as well as precision of the magnetometer commitment and definition of Sun-Earth line.

Plans for the deployment of operational services at L1 through NOAA SWFO to reduce reliance on ageing spacecraft were highlighted. It was noted that contingency measures to mitigate a potential gap are limited and although ISRO Aditya L1 mission (due for launch in 2022) has good potential for coordination of data with the NOAA L1 SWFO, it is currently not planned to support operational data latency requirements. The ESA Lagrange (L5) mission development is also proceeding well and foreseen to embark NOAA and NASA payloads.

A white paper for the inter-calibration of energetic particle sensors in GEO is ready for presentation to GSICS, having benefited from good cooperation and data sharing between members.

Various members reported progress in deploying energetic particle sensors in GEO and LEO. ESA is also deploying sensors as hosted payloads on commercial satellites (first is Hotbird F1, launch 2022). Preparations for deploying radiation sensors for the Lunar Gateway are ongoing.

NASA and NOAA are working under a new directive to facilitate the exchange of new observations, models and applications between research and operations activities.

Progress is made on ensuring the correct structuring of space weather data within the WMO OSCAR database. Further work on handling data latency commitments is ongoing.

The following points were raised in discussion:

WMO clarified that regarding the proposed new Expert Team, to continue activities previously performed by the Inter-Programme Team on Space Weather Information, Systems and Services (IPT SWeISS), WMO are currently drafting the related Terms of Reference, the reporting structure, work plan, and eventual composition. WMO endorsement will be required before it can commence work.

As for the joint WGI-WGIV-SWCG session the following points were noted:

Spacecraft anomaly reporting for the Space Weather Anomaly Database from all members is compiled into a dedicated document, with data so far supplied by EUMETSAT and CMA. The SWCG Task Group is making progress on defining use cases and getting historical data for analysis. Polls will be made of members to address reasons for difficulties in supplying data to ensure the process overcomes these points and the latter will also be extended to commercial operators.

Low latency RO provision is being improved through the COSMIC-2 mission and further measures are in place to ensure a sub-30-minute median latency is achieved. An SWCG Task Group is also being established to address how to meet low latency requirements through adaptions to other existing and planned LEO missions. IROWG commented that at the recent IROWG Workshop, the IROWG space weather subgroup raised an action to contact CGMS SWCG, in order to ensure improved communications between the IROWG and CGMS activities and to manage any overlap between the groups' activities.

Potential improvements in data access are being identified as a result of interactions with the ISES community of operational space weather prediction centres. A dedicated SWCG Task Group will now identify pilot projects for priority implementation, with candidates including:

- Improving access to high energy particle sensor data;
- Selection of standard ionospheric RO product formats;
- Provision of metadata;
- Provision of data on GTS/WIS

There were no recommendations for endorsement raised by the SWCG.

5. THEMATIC SESSION: NWP IMPACT ASSESSMENT OF SATELLITE DATA

5.1 Key notes

CGMS-49-GUEST-WP-20: The Earth-Observing Satellite Constellation, A Complex, Inter-Connected Global System with Extensive Applications: A Review from a Meteorological Perspective (the evolution of the observation network) – Sid Boukabara, NOAA

The global Earth-observing satellite constellation (EOSC) is a major international asset that has developed over the past six decades with a dramatic growth in size and complexity in the recent past. This paper takes stock and summarises, from a meteorological perspective, the current constellation's capabilities, highlights the complex value chain of satellite data from measurements to decision making, and illustrates the interconnected and evolving nature of those processes. When assessed in terms of application areas (atmosphere, oceans, land/hydrology, space weather), the constellation is highly interdependent, robust, and the observations it provides complement each other. EOSC is deemed a remarkable international success story that depended on effective collaboration and coordination of international partners and on free and open exchange of critical environmental data.

EOSC is rapidly evolving with many factors driving it, including technology, emerging data providers, commercial sector, new capabilities, etc. In this context, EOSC optimisation to meet applications needs (current and future) would need a concerted effort to optimise its evolution, possibly including ground and space components. This paper offers suggestions on ways to achieve this and on how CGMS could help in the essential coordination and in highlighting both the technical and socio-economic benefits of EOSC.

WMO highlighted that this important presentation offered a valuable perspective on the future Earth System Prediction and would appreciate to remain involved in further discussions.

CGMS-49-GUEST-WP-03: Future evolution of the data assimilation system – Stephen English, ECMWF

Many requirements for global Earth System NWP could be met by the commitments and aspirations in the CGMS baseline, the CGMS HLPP, and the Vision 2040 of WMO. The demonstrated value of the COSMIC-2 and Spire observations in 2020 confirm the need for more GNSS data. Duncan (2020) has demonstrated the value of microwave data from additional LEO orbits. The Aeolus mission has demonstrated the value of wind profile data from lidar. There is a long history of skill gains from improved atmospheric models, data assimilation, and observations.

The value of each observation needs to be determined through impact analysis studies. Mature assimilation systems, which are increasingly coupled and run at higher resolution, use sparse and incomplete observations better than less mature systems. Less mature systems struggle to demonstrate the value of observations. Further, high quality observations drive increased system maturity. Radiative transfer models and other key components of the analysis system also need to be developed to reach a mature level.

In less mature systems, effort is needed to assess the full potential of existing "interface" observations (science) before the need for new observations can be fully assessed. The sharing of research observations should be encouraged to accelerate the path to demonstration and maturity.

As the use of existing observations matures, some gaps may still persist, and at that stage, one can address such gaps with new observations..

EUMETSAT noted that there is a consistency among new satellite constellations - while the previous polar orbit satellites showed a convergence of frequencies used in measurements, recent evolutions demonstrate that this alignment among agencies is deviating. This is a useful topic to be discussed, especially considering the new microwave small sat constellations.

NOAA noted that in the near future dozens of new kinds of data sets are envisaged, and asked if there is a pathway to take the new measurements into the forecasting system. In response, ECMWF noted the importance of assimilating the Level 1 data, which makes it easier to handle such diversity and differences as well as extending the capability of models such as RTTOV to simulate a wider range of data (e. g. visible, active sensors).

5.2 WMO impact assessment workshop outcomes and recommendations to CGMS agencies

CGMS-49-WMO-WP-23: Outcome from the 7th Workshop on the Impact of Various Observing Systems on NWP

The 7th WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction (NWP) was organised virtually by WMO on 30 November – 3 December 2020. Some 110 participants attended including experts in data assimilation and observation impact, climate change and seasonal forecasting, space agencies, managers of observing networks, as well as from private industry.

During the Workshop, the results presented were reviewed in plenary discussion sessions. Conclusions to help guide the design and evolution of components of the WIGOS for NWP were drawn.

The impact workshop made the following recommendation relevant to CGMS:

- Space agencies to continue pursuing wind profile measurements from space;
- Effort encouraged to assess complementarities/synergies between different wind measurement systems/technologies (e. g. Aeolus and AMV);
- Special, concerted effort should be considered to protect the MW frequencies given their critical importance for NWP forecast skills at all scales; and
- There's a need to sustain impact assessment studies, also for satellite data.

CGMS-49 noted that these recommendations are well addressed in the proposed revision of the HLPP.

CGMS-49-WMO-WP-20: Satellite data Requirements for Global NWP

The WMO Expert team on Space Systems and Utilization has prepared a position paper on "Satellite Data Requirements for Global NWP". The paper represents a user perspective on the needs for data to ensure that global NWP models are performing at the state-of-the-art level.

During the preparation of the position paper, views from other WMO Expert Teams as well as international expert bodies and meetings have been collected, like the Joint Expert Team on Earth Observing System Design and Evolution, Global Data Exchange for NWP(GOIDEX-NWP), 7th Workshop on the Impact of Various Observing Systems on NWP, and the CGMS WGII/III risk assessment workshop.

The position paper captures a snapshot in time and will have to be reviewed and revised over time as user requirements change. It will therefore be presented to CGMS on a regular basis, nominally on a four-year cycle, or when significant changes to the user requirements occur. This process is still under implementation.

The WMO Commission for Observation, Infrastructure and Information Systems decided in April 2021 to adopt the satellite data requirements for global NWP and, recognising the need for future updates to the satellite data requirements for global NWP, to identify a mechanism to publish the Annex of the position paper to this decision that supports future updates, and to submit it to the next INFCOM session for consideration.

The position paper was also presented to CGMS-49 WGIII in April 2021 for consideration and possible implications on the CGMS baseline.

Plenary took note and reiterated the need for CGMS to remain involved in the further process.

5.3 CGMS space agency NWP impact assessment updates since CGMS-48

CGMS-49-CMA-WP-14: CMA NWP impact assessment of satellite data

Dr. Zhang Peng, Deputy DG of NSMC, held a presentation titled "CMA NWP impact assessment of satellite data" during CGMS-49 plenary. Observations from FY polar-orbiting and geostationary satellites are assessed by CMA and the international NWP communities. Compared with the control test, the forecast results of AGRI data are generally neutral and positive for the GRAPES assimilation system. It is generally positive for East Asia and the Tropics, while neutral for the northern and southern hemisphere. Assimilation of GNOS data in GRAPES produces a positive impact on global medium range forecast. An observing system experiment shows that the FY-3 instruments jointly contribute significantly to the forecast skill in the ECMWF system. Results from the Met Office UK and the Swedish Meteorological and Hydrological Institute are also reported on in this presentation.

CGMS-49-JMA-WP-02: Himawari-8/9 follow-on satellite programme and NWP impacts assessment of hyperspectral IR sounder

The Japan Meteorological Agency (JMA) has been considering the Himawari-8/9 follow-on programme since JFY2018, keeping in mind the CGMS baseline and the Vision for WIGOS in 2040, including in particular the deployment of hyperspectral infrared sounder (HSS) across the full GEO ring.

In 2018, the Meteorological Operation Focusing on Science and Technology Toward 2030 was recommended by the Meteorological Subcommittee under the Council of Transport Policy implemented by Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The direction was taken into account in JMA's NWP Strategic Plan Toward 2030, which was also established in 2018 to promote strong and steady technical development in the area of NWP as part of social information infrastructure in disaster prevention and related fields. A Hyper Spectral Sounding instrument on a geostationary satellite (GeoHSS) is expected to play an important role to meet the goals in the strategy.

To consolidate the potential impacts of GeoHSS on the NWPs which were derived in the previous study, reanalysis-based OSSEs were conducted for the typhoon and heavy rainfall events using GDAS and RDAS. GeoHSS data with high frequency over wide area improved both synoptic and meso scale atmospheric state, and this leads to significant improvements of typhoon track and heavy rainfall location forecasts with a long lead-time. Even though the demonstrated results in this study have yet to reach the goals of the JMA's NWP Strategic Plan Toward 2030, a full utilisation of real GeoHSS observation data with higher spatial resolution in the upgraded future NWP models might play a critical role for achieving them.

In response to questions from EUMETSAT and NOAA, JMA explained that the GeoHSS would have a 30 km spatial and 1-hourly temporal resolution. JMA expects to take the decision on this mission within two years' time with financial decisions to be taken by JFY2023.

CGMS-49-NOAA-WP-18: NOAA's space-based commercial data activities

NOAA issued its first contracts for the purchase of commercial RO data for operational use in November 2020. The two-year indefinite delivery indefinite quantity contracts went to GeoOptics and Spire Global, and NOAA has issued two delivery orders to date under these contracts. NOAA plans to begin operational use of the purchased data in May 2021 following data evaluation and system readiness. NOAA will be evaluating the impact of the data purchased under the second delivery order. The administration continues its Commercial Weather Data Pilot (CWDP) programme and a Request for Information (RFI) to inform future pilots was issued in September 2020. NOAA is currently evaluating responses to this RFI and is planning to pursue a third pilot under the CWDP programme in FY 2022.

The IROWG co-chair noted that geographic coverage and local time availability of RO data was presented during the IROWG presentation. When the impact of data purchased is assessed, this should be taken into consideration. The impact should in principle be higher when the purchased data belong to a data sparse geographic region and local time zone.

ECMWF highlighted the need for using both commercial and non-commercial RO data in operational reanalysis products, that in turn are used freely by a wide community for any purpose.

NOAA indicated that their procured data are open for all users after 24 hours from data purchase with the only restriction that the data cannot be used for commercial purposes as per its agreement with the provider of commercial radio occultation data.

CGMS plenary noted the importance and opportunity to exploit these data for the purpose of reanalysis and in the context of climate change analyses.

CGMS-49-CGMS-WP-30: NWP impact assessment of satellite data: guiding questions

In wrapping up the session, the discussions focused on three topics, namely the impact of NWP in view of the new constellations planned; the need for collecting users' experience and cases towards a harmonised development of future missions; and the use and application of Artificial Intelligence/Machine Learning (AI/ML) as accelerators for NWP uptake of new observations.

Regarding consistency among new satellite constellations: While the previous polar orbit satellites showed a convergence of frequencies used in measurements, recent evolutions demonstrated that this alignment among agencies is a bit out of focus. This would be a useful topic to be considered in future CGMS meetings especially considering the new microwave small sat constellations.

As concerns collecting users' experience and case studies: NOAA has developed a series of user consultation workshops/studies for the new geostationary and polar systems. EUMETSAT will organise these for future missions. At the same time, the CGMS agencies are working on proof of concept analyses for small-sat microwave constellations. An effective approach would call for a CGMS collection of users' experience and a coordination of new proofs of concepts to avoid reinventing the wheel (to be coordinated within the framework of CGMS WGIII).

Further, several agencies already demonstrated advanced plans (ie NOAA, CMA) and applications of AI/ML applications to satellite products. CGMS represents an important forum for exchange of information and coordination when it comes to L1 and L2 products (ie validation, verification of methods).

6. SUPPORT TO OPERATIONAL CLIMATE AND GREENHOUSE GAS MONITORING

6.1 GCOS, GCOS IP, study group and conference announcement

CGMS-49-WMO-WP-21: Joint Study Group on the Global Climate Observing System - Interim report on the GCOS evolution

WMO presented the status of activities of the Joint Study Group on GCOS. Since its establishment in 1992, GCOS has operated for more than two decades. However, the associated MoU has however not been updated since 1998 and therefore there is a need to review the role and responsibilities of GCOS, the governance, and the role of the co-sponsors also taking into account the WMO reform and the increased need for climate observations. The Study Group will review the GCOS governance and structure and propose an optimal approach recognising GCOS as an activity across the WMO Commissions and Research Board. In addition, relevant programmes of IOC, ISC, and UNEP - recognising the need for strengthening inter-agency links with appropriate representation - will be taken into account.

The Study Group membership ensures an appropriate engagement across beneficiaries, users, stakeholder programmes, and space agencies. An interim report has been produced compiling the findings of the sub-teams, has been presented to the WMO Infrastructure Commission in April 2021, and is being discussed with the GCOS co-sponsors.

The next phase of activities will clarify the roles of the GCOS sponsors and other types of GCOS support functions, it will look at the involvement of GCOS in the overall observing system, engagement with funding organisations, agencies and climate science programmes such as WCRP, and improve the connection between GCOS and UNFCCC.

It is important to ensure that the needs of the space agencies are covered and, in conclusion, the following four questions were raised to CGMS plenary:

1) Are the agencies happy with the GCOS governance?
2) What role should CGMS have in GCOS (if any)?
3) What are the agency expectations from GCOS?
4) How could the agencies consider supporting GCOS?

NOAA noted they endorse the work of the Study Group and that they have been actively supporting the work. NOAA is looking forward to further clarifications and delineation of the questions raised above. The Study Group is addressing these issues and NOAA appreciates the opportunity to participate.

WMO thanked NOAA for their active engagement and support to the GCOS Secretariat as well.

EUMETSAT also supports the work of this Joint Study Group and it would be important to discuss and clarify the role of the co-sponsors. GCOS remains the source for the requirements for various users and this needs to be recognised and not forgotten.

The European Commission also noted that it is important to identify how those that are contributing to the trust fund can give guidance for future activities because they see value in what GCOS is providing. This is valid both for the provision of support to programmes and to the framework for collaboration.

WMO responded that this is recognised and taken into consideration by the Study Group, noting the importance of scientific independence of GCOS and the provision of adequate products.

NASA noted the importance of the role of the sponsors and that sponsors actually contribute and guide [direct] the work of the GCOS. Further, NASA underlined that it should be also noted that there are various types of support, not only direct support to the trust fund, but also to the activities, e. g. supporting the organisation of meetings, providing observations etc.

WMO confirmed the importance of recognising the different types of support, including the provision of observations.

CGMS-49-WMO-WP-01: GCOS status report

GCOS informed CGMS plenary that the ECV stewards have monitored and reported on the status of their respective ECVs for the GCOS Status Report. The status report itself is at a fairly high level and the details are given in the annexes. It has been out for public review and is now under consolidation. The report focuses on the adequacy of the ECVs with respect to the key cycles water, energy, and carbon. It further analyses the adequacy of the ECVs with regard to the three main domains: atmosphere, ocean, and terrestrial, and gives an overview of the space component. The main highlights of the observing system since 2016 include improvements in satellite data, type, quality, and temporal and spatial resolution. Satellite data are generally well accessible and curated, which is not necessarily true for the other components of the observing system. There have been improvements in the in-situ observations, however, there is scope for improvement for some ECVs. Further, GCOS is propagating the establishment of reference networks for in-situ observations. One of the ongoing tasks involves developing a GCOS reference network and improvement/definition of global climate data centres.

A number of specific findings regarding satellite data were pointed out:

- Long-term continuity of some satellite observations are not assured;
- There are some gaps in the satellite-based observations, e. g. lower tropospheric ozone and stratospheric methane globally; and
- Quantitative assessment of anthropogenic greenhouse gas fluxes for which more supportive observations from satellites are needed.

The presentation also gave an overview on some of the shortcomings in the in-situ observations. In particular, it was noted that not all data are well archived or stewarded.

It was further noted that the status report is an important input to the next implementation plan and that GCOS is preparing its input for the next global stocktake.

The GCOS/WCRP Climate Conference will be held online from 30 August – 3 September 2021. GCOS encourages space agency contributions to the conference in order also to facilitate broader input for the next implementation plan.

NASA noted that the term “operational” is difficult in their case with respect to funding. This is generally the case for R&D agencies. That said, some of the so-called research networks have been around for a long time, 30 years or more, so they are not only of a short-term nature.

GCOS noted this is understood, and the question is indeed related to some research networks where the funding is short-term. This should be clear in the report.

WMO emphasised the importance of reference networks for supporting cal/val of satellite systems in addition to providing independent observations.

NOAA noted that “sustained funding” would be more appropriate than “operational funding”. NOAA further noted that in-situ and satellite observations are two halves of the same issue and it

is important to look at the connections and identify where the critical breakages are between the two e. g. for calibration or validation, impacting the other observation type.

The connectivity is essential and NOAA asked if GCOS considered this. NOAA further noted that a weakness in one can be compensated through capabilities in the other, an important factor when aiming at assuring the best value of the investment. GCOS responded that it is already considering this in the status report. This will likely be more addressed in the implementation plan noting that satellite observations will become more critical for the ECVs and the in-situ will increasingly be for providing a calibration/validation input.

6.2 CEOS/CGMS Joint Working Group on Climate, and Greenhouse Gas activities

CGMS-49-WGII-WP-02 Agency highlights on GHG initiatives at the CGMS-49 WGII meeting

The WGII rapporteur gave an overview of the GHG monitoring session in Working Group II.

CMA/CNSA, JAXA, Roshydromet, and NASA gave an overview of their current activities and the main focus was on the current status of products and missions. Furthermore, the presentations gave a forward look towards improving GHG monitoring from space. Several important missions were highlighted including EU Copernicus CO2M, JAXA GOSAT-GW, NASA GeoCarb, CNES MicroCarb, US MethaneSat, CNES-DLR Merlin, and the private sector GHGSat. The presentation further highlighted the synergies between different observing systems and auxiliary observations as well as the importance of ground facilities and additional initiatives like GSICS. The key points raised were:

- Value of international coordination across CGMS and CEOS;
- Strong integration between EO and data assimilation systems;
- Long term continuity of geostationary GHG monitoring capabilities; and
- Enhanced coordination towards Global Greenhouse Gas Reference Networks.

On the long-term continuity of geostationary GHG monitoring capabilities, it was noted that the capabilities had been discussed at the CGMS-49 joint WGII and WGIII meeting and there is also an associated recommendation from WGII on a letter of support to NOAA for the continuity for air quality GHG monitoring from GEO as a follow-on of NASA's future Tempo mission.

After the presentation, NASA noted there are many other initiatives that provide important contributions e. g. the CarbonMapper. ESA also noted the value of the TROPOMI instrument on the Sentinel-5p satellite.

CGMS-49-JWGCLIM-WP-01: WG Climate status report including gap analysis report and action plan for endorsement by plenary

The population of the ECV inventory is continuously progressing. The version 4.0 will be consolidated in the second half of 2021. The gap analysis related to inventory version 3.0 is delayed due to the pandemic situation but will be completed by autumn 2021. The gap analysis for inventory version 4.0 will focus on the carbon cycle, including the global stocktake aspect. This gap analysis is planned to be carried out through a workshop at the end of 2021/beginning of 2022,

preferably face-to-face circumstances permitting. JWGClimate invited CGMS space agencies to nominate scientific experts for participation in the workshop.

The collection of use cases for Climate Data Records is a new and continuous activity of the JWGClimate in order to i) demonstrate the value of the Climate Data Records for applications and decision/policy making etc., and ii) provide feedback for quality improvements. All use cases will be published on the web (climatemonitoring.info), and a special WMO report is planned for 2022 with a selection of the diverse types of use cases. To identify and collect more use cases from the broader user community, CGMS member agencies are requested to proactively reach out and advertise this activity within their respective data user communities.

The greenhouse gas monitoring activities continue and the CGMS WGI to WGIV have nominated points of contact to support the implementation of a virtual operational GHG monitoring and verification constellation (S. Burns for WGI&IV, J. Privette for WGII, and P. Zhang for WGIII). These CGMS WGs will support the update of the GHG monitoring roadmap and its implementation.

In preparation of the COP-26, JWGClimate is drafting a statement on behalf of CGMS and CEOS. CGMS agencies will be requested to comment on the draft statement at the end of August and to approve it in September. The statement will be posted via the national delegation of the CEOS Chair (NASA) to the COP-26 during the SBSTA-52 opening session.

The Earth Information Day (EID) takes place in addition to the COP meetings. Although the COP meeting was cancelled, the JWGClimate participated in the virtual EID 2020. The JWGClimate participated in the panel on mitigation and contributed with three posters demonstrating an excellent participation.

During the CGMS WGII session, WGII encouraged the JWGClimate to have a closer link to the CGMS International Science Working Groups. Representatives from IPWG, IWWG, IROWG, ITWG, and ICWG are now included on the JWGClimate communication list and will be invited to joint sessions during future JWGClimate meetings as necessary.

JWGClimate further addressed the link to the GCOS requirements, and explained it had addressed differentiating ECV requirements for application cases. The relation to GCOS requirements was brought to attention during discussion. JWGClimate explained its exchange with GCOS on differentiating ECV requirements related to the application case. Additionally, there is an investigation ongoing at EUMETSAT on how to map such specific requirements. It is noted that such a detailed degree of formulating requirements is a challenging demand for the GCOS Secretariat which may exceed its resources.

Finally, the presentation noted the following key issues for CGMS:

- The ECV inventory gap analysis support for the upcoming cycle (end 2021/beginning 2022);
- Encouraged further contributions of use cases for Climate Data Records;
- That the COP 26/SBTSA statement of space agencies is under preparation and a draft will be circulated in late summer;
- The HLPP has been updated demonstrating the actual status (slight changes);

- Recalled CGMS-47 Action 47.14 and proposed the following new action: "CGMS members shall nominate scientific experts (not necessarily agency staff) in order to support the upcoming ECV inventory gap analysis with respect to the Carbon Cycle ECVs, including Global Stocktake aspects."

WGII raised the need for the translation of the GCOS technology-neutral requirements to space based observation requirements. JWGClimate noted that it had raised to GCOS the need for dedicated ECV requirements per climate application cases, but also in establishing links to the space-based observations. Additionally, there is an investigation ongoing at EUMETSAT on how to map such specific requirements. It was noted that such a detailed degree of formulating requirements is a challenging demand for the GCOS Secretariat which may exceed its resources. The EC provided an example for the need for application-oriented requirements: the need to monitor the CO_2 concentration in the atmosphere over long times, whilst nevertheless detecting emission hotspots. Both types of observations are needed in the context of the Paris Agreement but has very different requirements which needs to be reflected in the GCOS Implementation Plan. Recent discussions in the GCOS study group identified that this is a major task and not likely to be executed by GCOS and its science panels alone. Thus, it is important to develop a framework and gross standards that enable other organisations such as WCRP, CEOS, and GEO to support the development of useful requirements that can become part of the periodically updated GCOS Implementation Plan. In support of GCOS, and within the framework of the JWGClimate, EUMETSAT is currently establishing such a framework and gross standards. This includes examples for some ECVs on how requirements can be derived for different applications.

Finally, it was fully recognised that CMA is now contributing to the ECV inventory V4.

CGMS-49 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS Members	6	A49.05	CGMS members to nominate scientific experts (not necessarily agency staff) in order to support the upcoming ECV inventory gap analysis with respect to the Carbon Cycle ECVs, including Global Stocktake aspects.	Aug 2021	**OPEN**

The following open action was also recalled:

CGMS-48 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	8.2	A47.11	**Climate session:** CGMS members to endorse (through a written procedure) the ECV inventory gap analysis report and updated coordinated action plan	Dec 2021 (Oct 2019)	**ONGOING**

CGMS-48 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
			Status: *2021 16 May: Version 3.0 expected to be published end 2021 and will be endorsed via written/e-mail procedure. (Version 4.0 is under preparation, CGMS-49-JWGCLIM-WP-01 and CGMS-49-JWGCLIM-WP-03)*		

CGMS-49-JWGCLIM-WP-02: Status of architecture for monitoring carbon dioxide and methane from space and GHG Task Team activities

Within the framework of the JWGClimate, the GHG Task Team's activities include contributions from a vast range of colleagues. Recently, the CEOS Virtual Constellation on Atmospheric Composition has taken on the lead of the preparation of the products required for the support of the first global stocktake of the Paris Agreement. The GHG Monitoring Implementation Roadmap includes activities that map out to other activities within CEOS and CGMS e. g. CEOS virtual constellations, CGMS WGs and GSICS, in other words a truly collaborate approach.

Three main points were raised:

- Work towards the global stocktakes of the Paris Agreement;
- Work organised towards the future operational GHG system to deliver first outputs for the second global stocktake in 2026/2027; and
- Engagement with CGMS for contributions to enable and maintain an operational system.

The CEOS/CGMS WGClimate Greenhouse Gas Task Team coordinates efforts among member agencies. The objectives of the GHG roadmap are to:

1. Work with the atmospheric CO_2 and CH_4 measurement and modelling communities, stakeholders and national inventory compilers to define requirements and plans for atmospheric flux inventories;

2. Deliver pilot atmospheric CO_2 and CH_4 flux inventories in 2021 to inform the 2023 Global Stocktake (GST);

3. Use lessons learnt from these pilot inventory products to refine requirements needed to implement a purpose-built, operational, and atmospheric inventory system for future global stocktakes.

For the 2023 GST, mostly research products will be provided noting that the quality of today's top-down inventories is limited by available space-based measurements and inverse models. Hence, it is important to take a holistic view of the analysis. It is important to identify the requirements and products as the overall system requires specific kinds of observations, noting that inventory quantities are derived from surface flux products.

The concept for generating carbon emission inventories is based on an overall system including ground- and space-based observations assimilated in circulation models. Specifically, it is important to establish an interface to the user community and inventory providers (mostly statistical national entities that provide carbon emission data from fossil fuel burning per country). It is important to demonstrate the mutual benefits of the traditional bottom-up inventory assessments and the top-down assessments using space-based observations, e. g. on their validation, and ensure feedback on prototype products. The GHG TT will also looking towards an operational implementation by the Stocktake in 2028 and beyond and this is where CGMS contributions will become extremely valuable.

The GHG Task Team will maintain the Roadmap and establish user interfaces, track requirements, capabilities and deliverables, and identify additional resource needs and relevant CEOS/CGMS agencies to dedicated, appropriate resources. The GHG TT has broad Agency participation, not only space agencies, but also representatives from the ground-based observations and modelling communities. The Task team has also established interfaces to the CGMS Working groups and is in the process of detailing the potential areas where the CGMS WGs can contribute.

CGMS plenary took note.

The following open actions were also recalled:

CGMS-48 actions - Plenary Session					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
Chairs of WGClimate/GHG TT	6.2	A48.07	WGClimate/GHG TT Chair together with the CGMS WG representatives to define priorities for CGMS WGI-IV contributions. Status: 2021 May 19: Partially complete. Each CGMS WG has nominated a liaison who will be invited to participate in future WGClimate meetings. Before and during the next WGClimate meeting (August/September), WGClimate will work with these representatives on priorities.	CGMS-50 (Nov 2020)	**ONGOING**
Co-chairs of WGI, WGII, WGIII, WGIV	6.2	A48.08	CGMS WGs I-IV to reflect the operationalisation of the GHG monitoring system and to discuss with the WGClimate GHG Task Team the roles of each WG for the implementation that becomes part of the roadmap's work plan (deadline CGMS-49 plenary to serve as input for next WGClimate presentation) Status: 2021 21 May: To be addressed at the next GHG TT meeting	CGMS-50 (CGMS-49)	**OPEN**

7. CGMS HIGH LEVEL PRIORITY PLAN (HLPP)

Endorsement of the CGMS High Level Priority Plan (HLPP) 2020-2024

CGMS-49-CGMS-WP-15: Revised HLPP 2021-2025 - for plenary endorsement

As part of the agreed revision cycle for the CGMS HLPP, CGMS-WP-15 presented a proposed HLPP covering the period 2021-25. The plan is based on the following intersessional activities:

- Meetings of the International Science Working Groups
- Recommendations from of WGI, WGII, WGIII, WGIV, SWCG, and JWGClimate

WGI, WGII, WGIII, WGIV, and SWCG considered the draft revision at the WG meetings in April 2021 and proposed a number of amendments, all highlighted in this document.

The CGMS-49 plenary session endorsed the proposal for a revised HLPP covering the period 2021-25.

Following CGMS-49, a final version of the updated HLPP will be published on the CGMS website.

8. FUTURE CGMS PLENARY SESSIONS

CGMS-49-CGMS-WP-23: Future running of CGMS plenary sessions

The CGMS Secretariat informed plenary on the lessons learnt on holding virtual plenary sessions and there were at least three main findings:

i) On the positive side: Increased participation (numbers of participants) and lower cost (no travel necessary);

ii) Drawbacks: The timing of the meeting – very late for the Asia/Asia Pacific region and very early for the American region; and

iii) Generally for the future: Requests for hybrid meetings.

As for the last point, this has been the case for a few years also prior to the pandemic (WebEx access during the face-to-face meeting) which is expected to continue.

The CGMS Secretariat will send out a post-plenary survey to complement the feedback.

CGMS-49-CGMS-WP-04: Tentative schedule of future CGMS plenary sessions

The CGMS Secretariat informed plenary of the schedule for the future plenary sessions:

CGMS plenary #	Year	Location
CGMS-50 - confirmed	2022	WMO
CGMS-51 - confirmed	2023	Japan
CGMS-52	2024	North America
CGMS-53	2025	Europe
CGMS-54	2026	South Korea
CGMS-55	2027	India
CGMS-56	2028	Russian Federation
CGMS-57	2029	China
CGMS-58	2030	WMO
CGMS-59	2031	…

CGMS-49-CGMS-WP-31: 50th CGMS plenary session

WMO provided a short announcement on the 50th plenary session, tentatively scheduled to be face-to-face and at WMO HQ in Geneva, Switzerland, in the second half of May 2022.

9. AOB AND CLOSING SESSION

9.1 Any other business

The CGMS Secretariat informed CGMS plenary that the draft list of actions would be circulated shortly after the meeting for confirmation and that the plenary report would be prepared and circulated to participants for review and commenting as necessary in the course of the summer. The status of CGMS-48 actions resulting from CGMS-49 discussion is provided directly after this report.

9.2 Closing remarks

The Deputy Director-General of CMA NMSC recalled the importance of CGMS as a way to advance the international coordination of space-based Earth observations and to collectively respond to the user community. Despite the fact that the face-to-face plenary session had been postponed twice, the willingness of CGMS to work together remains unchanged.

He expected that CGMS will continue to coordinate and improve the meteorological satellite constellation in order to better meet the user requirements.

CMA concluded by thanking all the participants, for their active contributions and the achievements made and concluded by sincerely hoping for a face-to-face meeting in 2022.

The Head of the CGMS Secretariat thanked the CGMS members, the host CMA, the participants, and the organising committee for their contributions to the 49th CGMS plenary session. Although a remote configuration is not ideal, CGMS has discussed a broad range of topics of importance to WMO and the space agencies, some for which the participants have taken decisions and adopted recommendations, some of which need further addressing. It shows that the CGMS mechanisms are alive and that the interactions between the Working Groups and plenary are working well. He stated he was impressed by the broad support from all CGMS members to the various CGMS groups.

He recalled the 7th WMO Impact Workshop of Various Observing Systems on NWP which further highlighted the importance of satellite observations to guarantee high quality predictions and downstream applications and the GHG session highlighted how CGMS might collectively respond to the observation needs of the Paris Agreement. Moving towards an Earth system approach will further require international coordination on how optimally to evolve and design space-based Earth observations given the diversity of applications and systems.

He looked forward to interacting with CGMS and, circumstance permitting, to meet face-to-face at CGMS-50 in Geneva next year.

Plenary adjourned at 16:10 on 21 May 2021.

STATUS OF CGMS-48 PLENARY ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WMO	H	A46.11	**On ocean variables:** In view of the anticipated reform of JCOMM, WMO to provide a report with proposals on future coordination/cooperation between JCOMM and CGMS.	*2021 May 16: Postponed to CGMS-50* 2021 Apr: WMO expected to report to plenary. (JCOMM activities have been refocused following the WMO reform)	CGMS-49 (CGMS-47, CGMS-48)	**ONGOING**
WMO	3.2.5	A47.02	**On global NWP:** WMO to provide a report at next CGMS on baseline requirements for satellite products for global NWP, to trigger a CGMS discussion on status of delivery of such observations and possible improvements in the future and inclusion in the CGMS baseline document.	*2021 20 May: Closed following plenary deliberations.* *2021 28 Apr: A dedicated session on satellite data impact on global NWP will be held in plenary* *CGMS-49-WMO-WP-20/CGMS-49-WMO-WP-23*	CGMS-49 (CGMS-48)	**CLOSED**
NOAA, WMO	3.2	A47.03	**On PP sector engagement:** WMO and NOAA to report on the status of affairs and related issues on public private sector engagement to CGMS-48	*2021 20 May: Closed following plenary deliberations.* *2021 May 12: NOAA will report at CGMS-49 in NOAA-WP-18 and WMO in CGMS-49-WMO-WP-22* 2021 Apr: Due to the virtual nature this will partly be addressed in the CGMS-49 plenary session on satellite data impact on NWP (but is expected to be addressed in future CGMS WG and plenary sessions). It is proposed to close	CGMS-49 (CGMS-48)	**CLOSED**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				the action at this stage and raise new actions as necessary.		
IOC-UNESCO	3.3	A47.05	**On operational oceanography:** IOC-UNESCO to provide to GCMS-48 guidance on satellite data requirement for improved coastal ocean prediction and services	*2021 May 25: Transferred to WGII for further review (and reporting to plenary by WGII)* *2021 Mar/2020 Aug: Postponed to CGMS-50 (CGMS-49 being virtual again).*	CGMS-49 (CGMS-48)	**CLOSED** (in plenary)
CGMS members	5.1	A47.06	WGI co-chair: CGMS members to propose candidates for the WGI co-chair	*2021 21 May: Plenary endorsed Dr KIM, KMA, as new co-chair of WGI.* 2021 Mar: WGI recommends Dr Dohyeong Kim, KMA, as co-chair for WGI for plenary endorsement	Jan 2021 (Dec 2019)	**CLOSED**
CGMS members	8.2	A47.11	**Climate session:** CGMS members to endorse (through a written procedure) the ECV inventory gap analysis report and updated coordinated action plan	*2021 16 May: Version 3.0 expected to be published end 2021 with a written endorsement e-mail procedure for confirmation. (Version 4.0 is under preparation, CGMS-49-JWGCLIM-WP-01 and CGMS-49-JWGCLIM-WP-03)*	Dec 2021 (Oct 2019)	**ONGOING**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	8.2	A47.14	**Climate session:** CGMS members are invited to provide application case studies that use climate data record to support training	*2021 27 Apr/11 Mar/Jan: Space agencies requested to continue to provide further use cases. [WMO lead. K Holmlund & A von Bargen] CGMS-49-JWGCLIM-WP-03. JWGClimate will provide annual feedback to CGMS.*	CGMS-49 (CGMS-48)	**CLOSED**
CGMS members	9.1	A47.17	**On training and education:** CGMS members active in VLab to propose the next Co-Chair to represent CGMS satellite operators in the VLab (starting October 2020). Nominations to be presented to VLab by December 2019.	*2021 21 May: Plenary endorsed B Connell from NOAA as new co-chair and satellite operator representative, and noted that WMO expects that Mr. WEN Bo, from CMA Training Center, Beijing, will be the second co-chair.* 2021 27 April: CGMS-49 WGIV recommends Bernadette Connell/NOAA as the future co-chair of VLab to plenary for endorsement.	Oct 2020 (Dec 2019)	**CLOSED**
CMA	4.3	A48.01	CMA to consider sharing a state-of-the-art reference FY-4A GIIRS dataset	*2021 Apr: Data have been shared in the meantime. (If needed, to be addressed in future within the framework of WGII)*	CGMS-49	**CLOSED**
CMA, EUM, NOAA, ROSH, JMA	4.3	A48.02	CGMS operators to make available and discuss HSIR OSSE/OSE assessment results for weather/environment applications.	*2021 20 May: Closed following plenary deliberations. The HLPP addressed HSIR. 2021 Apr: To be addressed in the NWP session at CGMS-49 plenary*	CGMS-49	**CLOSED**
CGMS space agency members	5.3	A48.03	CGMS space agency members to nominate a new co-chair for WGII (the action will be allocated to WGII)	*2021 May 19: Endorsed by plenary* 2021 28 Apr: WGII recommended JV Thomas/ISRO as new WGII Co-chair to plenary for endorsement	CGMS-49 (Dec 2020)	**CLOSED**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
EUM	5.3	A48.04	EUMETSAT to nominate a new rapporteur for WGII (the action will be allocated to WGII)	*2021 19 May: Endorsed by plenary* 2021 28 Apr: WGII recommends Paolo Ruti/EUMETSAT as new WGII rapporteur to plenary for endorsement	CGMS-49 (Dec 2020)	**CLOSED**
CGMS space agencies	6.2	A48.05	CGMS agencies, in particular those operating geostationary satellites, are encouraged to make commitments within GSICS and SCOPE-CM that enable the creation and maintenance of the cross-calibrated 'geo-ring' radiance climate data record and in second step to a project for the cloud property data records.	*2021 26 May: Action will be transferred to WGII and reported on by WGII to plenary.* 2021 19 May: NOAA is committed to supporting these initiatives and has participated in relevant meetings and conversations, providing leadership in appropriate areas. 2021 20 April: Addressed within the framework of WGII (to be referred to WGII LOA). CGMS-49-EUMETSAT-WP-06	CGMS-49	**CLOSED** (in plenary) open in WGII
Co-chairs of WGI, WGII, WGIII, WGIV	6.2	A48.06	CGMS WGI - WGIV co-chairs to identify a point of contact from CGMS WGI, WGII, WGIII and WGIV to become a member of the WGClimate GHG Task Team, therefore providing the interface as well as a direct reporting line back to that specific area of CGMS competence (deadline end of October 2020)	2021 24 Feb/3 Mar: Representatives from GHG TT, WGClimate, CGMS representative, CGMS Secretariat, held an initial Webex to identify initial focal points of contact: WGI and WGIV sean.burns@eumetsat.int; WGII jeff.privette@noaa.gov, mitch.goldberg@noaa.gov; WGIII ZHANG Peng CMA	Oct-20	**CLOSED**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
Chairs of WGClimate/GHG TT	6.2	A48.07	WGClimate/GHG TT Chair together with the CGMS WG representatives to define priorities for CGMS WGI-IV contributions.	*2021 May 19: Partially complete. Each CGMS WG has nominated a liaison person who will be invited to participate in future WGClimate meetings. Before and during the next WGClimate meeting (August/September), WGClimate will work with these representatives on priorities.* Expected to be addressed at CGMS-49 WGII and in the plenary climate session (and at the next GHG Task Team meeting)	CGMS-50 (Nov 2020)	**ONGOING**
Co-chairs of WGI, WGII, WGIII, WGIV	6.2	A48.08	CGMS WGs I-IV to reflect the operationalisation of the GHG monitoring system and to discuss with the WGClimate GHG Task Team the roles of each WG for the implementation that becomes part of the roadmap's work plan (deadline CGMS-49 Plenary to serve as input for next WGClimate presentation)	*2021 21 May: GHG TT meeting to take place.* 2021 24 Feb: To be addressed initially on the occasion of the CGMS-49 working groups in April and at the next GHG TT meeting	CGMS-50 (CGMS-49)	**OPEN**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	7.3	A48.09	CGMS members to provide point(s) of contact to cgmssec@eumetsat.int to be part of the SCAT task team (together with Ad Stoffelen, OSVW-VC (Co-chairs Paul Chang/NOAA, Raj Kumar/ISRO, Stefanie Linow/EUM), and IWWG (Co-chairs Regis Bordes/Steve Wanzong),	Other members to nominate pocs as necessary CMA: Dr. Fangli Du (doufl@cma.gov.cn), Dr. Jian Shang (shangjian@cma.gov.cn) IOC-UNESCO: Dr. David Halpern (dhalpern@ucsd.edu) NASA: Ernesto Rodriguez (ernesto.rodriguez@jpl.nasa.gov) and Svetla M. Hristova-Veleva (svetla.hristova@jpl.nasa.gov) WMO: Heikki Pohjola (hpohjola@wmo.int) (EUM, ISRO, NOAA are represented in the existing team)	Dec-20	**CLOSED**
SCAT task team	7.3	A48.10	SCAT task team to present the Terms of Reference, and roadmap for the work to CGMS-49 plenary for endorsement	*2021 20 May: Plenary endorsed the ToRs of the SCAT TG - now named OSW (Ocean Surface Wind) Task Group within the framework of the IWWG - and requested to review the status in 2-years-time (and initially within the framework of WGII).* 2021 28 Apr: CGMS-49 WGII recommended the creation of the SCAT Task Group, within the framework of the IWWG, and the related ToRs to plenary for endorsement. It will be presented to plenary in the report by the IWWG.	CGMS-49	**CLOSED**

Status of CGMS-48 plenary actions following CGMS-49 discussions)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				CGMS-49-IWWG-WP-02 and CGMS-49-IWWG-WP-02PL		

Status of CGMS-48 plenary recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**STATUS (feedback / conclusions)**
CMA, EUM, NOAA, ROSH	4.3	R48.01	CGMS operators to provide HSIR data with sufficient latency meeting NWP requirements, in particular regional NWP, through direct broadcast or other means.	***COMPLETED.*** *CGMS-49 2021 April: These aspects are now incorporated/covered by the HLPP*
CMA, EUM, NOAA, ROSH	4.3	R48.02	CGMS operators to implement and distribute reduced volume HSIR datasets in NRT for NWP, using a subset of channels.	***COMPLETED.*** *CGMS-49 2021 April: These aspects are now incorporated/covered by the HLPP*

Status of CGMS-48 plenary recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**STATUS (feedback / conclusions)**
CMA, EUM, NOAA, ROSH	4.3	R48.03	CGMS Operators are encouraged to continue supporting research activities facilitating the use of hyperspectral infrared data.	***COMPLETED.*** *CGMS-49 2021 April: These aspects are now incorporated/covered by the HLPP*
ROSC, ROSH	4.3	R48.04	Roshydromet/Roscosmos to consider deploying future IKFS instruments in orbits complementary to operational HSIR instruments.	*2021 16 April:* ***COMPLETED*** *following discussions in CGMS-49 WGIII. Addressed within the framework of WGIII and the regular annual review of the CGMS baseline and risk assessment.*
ROSH	4.3	R48.05	Roshydromet to work towards improved timelines.	*2021 16 April:* ***COMPLETED.*** *Addressed in CGMS-49 ROSH-WP-04: Following the recommendations of CGMS-48, the data is dumped over European, Siberian and Far-Eastern centers of SRC Planeta to improve timeliness, and allowing per-pass data to be available for NWP purposes. The recommendation is considered completed.*
CMA, EUM, NOAA, ROSH	4.3	R48.06	CGMS operators to improve spatial resolution of HSIR instruments to meet NWP requirements for cloud clearing, noting that spectral resolution remains important for atmospheric composition.	***COMPLETED.*** *CGMS-49 2021 April: These aspects are now incorporated/covered by the HLPP*
CMA, EUM, NOAA, ROSH	4.3	R48.07	CGMS operators to share the information on HSIR such as instrument developments, observation performance, data processing, operation, and applications.	***COMPLETED.*** *CGMS-49 2021 April: These aspects are now incorporated/covered by the HLPP*
SETT	4.3	R48.08	CGMS to promote the public awareness of the socioeconomic benefits of HSIR observations. SETT to explore how this might be undertaken.	***COMPLETION*** *- WGIII reported to plenary 49. Socio-economic benefits to be addressed regularly within the framework of WGIII and as a standing agenda item.* Recommendation from WGIII to

Status of CGMS-48 plenary recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**STATUS (feedback / conclusions)**
				sunset the SETT and to have a standing agenda item addressing socio-economic aspects/impacts.
WMO	6.3	R48.09	WMO to ensure that the GCOS requirements as well as the process to define them are designed in such a way that requirements, stemming from the CGMS agencies' need to assess performances, can be captured.	***COMPLETION following CGMS-49 plenary.*** *GCOS status report CGMS-49-WMO-WP-01 to plenary. Also addressed in CGMS-49 WGII with related actions raised (on GCOS and JWGClimate).*

WORKING GROUP I (WGI)

CGMS

Satellite systems and operations

WGI REPORT

Chair: Vanessa Griffin (NOAA)
Acting Co-Chair: Dohyeong Kim (KMA)
Rapporteur: Sean Burns (EUMETSAT)

1. Welcome and review of agenda with objectives of the meeting

WGI reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting, which is in line with the ToR for WGI.

WGI included representatives of the satellite operators from CMA, EUMETSAT, ESA, IMD, ISRO, JMA, KMA, NASA, NICT, NOAA, ROSHYDROMET, and WMO (see CGMS report for full list of participants).

The WGI meeting was once again conducted by WebEx.

In view of the common items of interest in relation to Space Weather, the representatives of WGI, WGIV, and the Space Weather Coordination Group participated in the joint WGI-WGIV-SWCG meeting

Dr Dohyeong Kim from KMA was nominated as acting co-chair for the meeting.

2. Review of actions and recommendations from previous meetings and status update

CGMS-49-CGMS-WP-01WGI: CGMS-49 list of actions and recommendations

WGI discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-48 and earlier) and the final status is provided in Annex II of this report.

3. Frequency Management matters (incl. space weather matters)

3.1 Frequency management topics and WRC-19 and WRC-23

CGMS-49-CGMS-WP-17: Report from the CGMS/SFCG Liaison Officer

Due to COVID-19, SFCG-40, planned to be held in Palm Cove (Australia) in September 2020, was moved to October 2021.

To progress the work and deal with the items that cannot wait until 2021, some work has been carried out by correspondence.

The issues of relevance for CGMS that were discussed and progressed by correspondence are:

- SFCG Objectives for WRC-23 and beyond;
- Response to action 1 of SFCG Action Item 39/7.

CGMS is invited to note this report and to provide feedback and information on its activities to SFCG-40 (October 2021) on any frequency related matter as appropriate.

An action was placed on SFCG A39.07 to review the status of information on the frequency plan of meteorological satellites recorded in OSCAR/Space and to provide guidance and a plan for updating the missing and outdated information as identified in CGMS-48-WMO-WP-03. This was discussed at the WMO ET-RFC meeting in February 2021, noting that OSCAR became a global reference for sensor characteristics and therefore there is an obligation to ensure that it is accurate. Once this first action of agreeing on the data set and format is completed, the onus is on the SFCG members to submit their information based on the agreed format. SFCG would then merge the information in a single SFCG Report. Such a report could then be submitted as an SFCG input to WMO for inclusion into the OSCAR database.

CGMS-49-CGMS-WP-11: CGMS monitoring and responding to future interference challenges on microwave sensing

In recent years, the trend towards broadband applications in commercial terrestrial and satellite-based systems and networks, either fixed or mobile, has accelerated. The most imminent example is IMT-2020/5G.

The necessary bandwidth for such broadband applications requires these systems to use much higher frequencies. Unfortunately, these spectrum regions are extensively used by passive microwave sensors.

The accommodation of such broadband systems in, or neighbouring to, frequency bands used by passive sensors could be accompanied with some compatibility issues and the potential for radio frequency interference (RFI) to the passive sensor measurements.

Even though regulatory conditions are established at regional and/or global (ITU) level to protect passive sensors, their effectiveness cannot always be ensured fully, due to various reasons, leading potentially to a steadily increasing level of RFI over time.

Especially this kind of interference, which slowly grows with the level of deployment of such networks, is difficult to detect and monitor.

This document is aimed at triggering discussion on how CGMS agencies could collaboratively find and establish mechanisms on how to detect and long-term monitor such kind of interference on a global basis.

CGMS requests agencies to nominate participants to a Task Group to establish the initial ideas about mechanisms regarding the detection, monitoring, and mapping of RFI, initially in the 24 GHz passive band. Proposals from the Group could be presented at CGMS-50. Task Group participants would coordinate internally with relevant experts. The initial tasks of this Group could include:

- Gathering the views and ideas members already developed and activities they have already undertaken in this context;
- Exchange on members interaction with scientists and forecasters regarding ways for extracting data from existing instruments for impact assessments;
- Developing possible plans for approaching detection, monitoring, and mapping of RFI and evaluate their feasibility;

- Summarising the findings of the group for presentation at CGMS-50.

WGI agreed that Simon Elliott from EUMETSAT would lead this Task Group on RFI detection, monitoring, and mapping.

CGMS-49 ACTIONS – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
	3.1		CGMS via a dedicated Task Group to investigate collectively mechanisms for detection and long-term monitoring of and mapping of RFI (for example, but not limited to, from IMT-2020/5G into the 24 GHz passive band) at satellite or instrument level, or any other means, as the knowledge base for assessing the impact on the passive sensor measurements.	CGMS-50	**OPEN**

CGMS-49-CGMS-WP-16: Status of Preparations for WRC-23

The preparations for the World Radiocommunication Conference 2023 (WRC-23) are in progress already for over one year. However, due to the global pandemic the preparatory works at ITU, regional, and national level are slowed down since complex technical and regulatory issues cannot be discussed and negotiated effectively in virtual meetings.

The agenda for WRC-23 contains again a number of items of potential concern to CGMS members as they could negatively affect the frequency usage of MetSat and EESS satellite systems and their active and passive sensors. Among those are:

- A number of agenda items for new frequency usage of commercial satellite systems (1.15, 1.16, 1.17, and 1.18) and also
- Three agenda items (1.2, 1.4, and 9.1c) related to additional frequency bands for IMT (5G) systems.

Thus, the preparatory works at regional and ITU-R level need to be carefully followed.

In addition, the WRC-23 agenda also contains an item of direct interest to CGMS, namely 1.14. The objective of this agenda item is to ensure that passive microwave measurements in the frequency range 231.5-252 GHz are protected and the required spectrum is allocated to future passive microwave sensors, for example for the Ice Cloud Imager (ICI) instrument on MetOp-SG satellites.

Also of interest to the scientific community is WRC-23 agenda item 9.1a) aimed at gathering information on space weather sensors/instruments/missions, and identifying their spectrum requirements and protection needs, and ways to reflect space weather in the ITU Radio Regulations.

CGMS-49-WMO-WP-04: **WMO Preliminary Position Paper for WRC-23**

The WMO preliminary positions on WRC-23 agenda were initially agreed in February 2020 and have been recently updated during the last meeting of the WMO Expert Team for Radio Frequency Coordination (ET-RFC) held from 2-4 February 2021.

A subset of the agenda items listed in the WMO position paper, those that are of most relevance to CGMS, were presented.

CGMS were invited to review the preliminary WMO position paper and to assist in making this information known to its members' national and international preparation processes for WRC-23.

The HLPP was proposed to be updated to reflect the priorities outlined in the WMO position paper.

CGMS-49-WMO-WP-05: Status of OSCAR/Space including frequency matters

OSCAR/Space is a key tool and information source to support the WMO Rolling Review of Requirements (RRR) process and WMO Gap Analysis (CGMS-48-WMO-WP-13), which are used to monitor the compliance of satellite programmes in the implementation of the CGMS Baseline and the space-based component of the Vision for WIGOS in 2040 (WMO-No. 1243).

WMO Space Programme Office has established and demonstrated a successful framework with a contractor for the OSCAR/Space technical maintenance. According to the development plan in 2020, this resulted in a software release including a major technical platform update, and in the implementation of new features.

The ongoing development phase includes work packages to make OSCAR/Space compatible with WIGOS metadata records and implementing Gap Analysis for WIGOS Vision 2040 Subcomponents was successfully kicked off.

The main mechanism for the WMO Space Programme Office to collect the relevant information for the database content updating is through templates submitted to the OSCAR/Space Support Team (O/SST) members, usually three to four times per year. The latest status of the satellites requiring updated information was sent to all O/STT focal points in April 2021.

3.2 Frequency-related topics in support to space weather

No papers reported under this agenda item.

4. Meteorological satellites Space to Ground Interface (Direct Readout) and LHRIT Global Spec. Global Specs (CCSDS based) and Best Practices for DR processing

4.1 CGMS agency best practices in support to local and regional processing of LEO direct broadcast data)

The following papers present the implementation status of CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data CGMS/DOC/18/1008274, v1B.

CGMS-49-CMA-WP-03: Update of CGMS agency best practices for LEO direct broadcast data at CMA

This paper presents the status of implementation at CMA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data for each of the FY-3D and FY-3E LEO satellite missions.

CGMS-49-EUMETSAT-WP-02: Implementation of CGMS best practices for LEO direct broadcast data at EUMETSAT

This paper presents the status of implementation at EUMETSAT of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data for each of the MetOp and MetOp-SG LEO satellite missions.

CGMS-49-NOAA-WP-03: Implementation of CGMS best practices for LEO direct broadcast data at NOAA

This paper presents the status of implementation at NOAA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data for the NOAA-15, NOAA-18, NOAA-19, S-NPP, and NOAA-20 missions.

Working Group I took note of the status of implementation of the best practices of CMA, EUMETSAT, and NOAA.

CGMS-49-EUMETSAT-WP-04: Planned studies for future direct broadcast data rates from polar orbiting satellites

An action had been placed on the Direct Broadcast Best Practice Working Group to agree a set of studies to be performed by the CGMS agencies on the mechanisms that could be used to address higher data rates from polar orbiting meteorological satellites (WGI A48.04). The group discussed the potential studies during the Intersessional meetings and this was then outlined in the paper 'Future Direct Broadcast Data Rates from Polar Orbiting Satellites CGMS-48- EUMETSAT-WP-15'.

In response to the continuous increase in instrument data rates, a migration from L-band (1.8 GHz) to X-band (7.8 GHz) based direct broadcast is currently ongoing. However, even while this migration is still ongoing, indications are that the latest generation of satellites is gradually reaching the limits of the current conventional design of the direct broadcast downlink in X-band.

Today, a user of the direct broadcast data from the polar orbiting satellites is able, with the same integrated reception system, to acquire data from a rich set of satellite families, operated by different satellite agencies. This is referred to as the multi-mission capability of the direct broadcast reception systems.

The multi-mission capability is highly valuable to the user, increasing the benefit of the investment in the reception system and enabling a range of local and regional applications of the satellite data.

Considering this, the proposed update to the CGMS Baseline section 3.1.1 Direct Broadcast Services includes:

The core meteorological satellite systems in LEO orbits, and other operational satellite systems where applicable, should ensure low latency data access of imagery, sounding, and other real-time data of interest to users by means of direct broadcast or other mechanisms.

Application areas where low latency and availability is suitable include Severe Weather Monitoring, Nowcasting and Short- and Medium-Range Numerical Weather Prediction. Other application areas could also benefit from very low latency products, e. g. ionospheric monitoring. CGMS members should follow the best practices for direct broadcast services developed by CGMS Working Group I.

Before continuing the existing action, as currently stated, it was proposed to perform a SWOT analysis of low latency data access from LEO meteorological spacecraft and present the results at CGMS-50.

The SWOT analysis would primarily focus on the needs of the application areas described above, and secondarily on the possible technical implementations. Where relevant, it would take into account CGMS-48-EUMETSAT-WP-15, Future Direct Broadcast Data Rates from Polar Orbiting Satellites, as well as the current presentation and also any other studies that have already been performed by member agencies. Furthermore, other technical solutions for transmitting data from space to ground beyond DB would be considered, including the use of data relay satellites.

Subsequent to the SWOT analysis and the related discussions in WGI, the topics, priorities, and lead agencies for any further studies would then be identified. The goal is to present a coordinated view for consideration by CGMS for future data access mechanisms from LEO meteorological satellites.

WGI agreed to the proposal with the following action.

CGMS-49 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WGI	4.1		Perform a SWOT analysis of low latency data access from LEO meteorological spacecraft	CGMS-50	**OPEN**

4.2 Development of efficient standardised data handling for high-resolution imaging and hyper-spectral instruments

CGMS-49-CGMS-WP-18: Review of status and Terms of Reference of Task Force on Satellite Data and Codes

The CGMS Task Force on Satellite Data and Codes has been actively supporting the coordination of work on satellite product format issues within the CGMS community and providing support to the work of WMO's expert teams since its first meeting in 2008. This paper reviewed the current status of the Task Force and looks forward to its forthcoming activities.

During the forthcoming intersessional period, in addition to its routine activities, the group's focus will be on revisiting its ToR and evaluating the use of WIGOS Station identifiers for satellite products.

CGMS-49-CGMS-WP-07: Report on activities in Climate and Forecast (CF) conventions regarding space data products

A WGI liaison between CGMS and the governing bodies of the netCDF Climate and Forecast (CF) Conventions actively represents the interests of CGMS members within the CF community. This report detailed the key developments that have taken place in this regard over the past year:

- Stronger collaboration between CF and WMO
- Work towards representing coordinates using interpolation zones in CF.

In addition to presenting the details of these steps, this paper also proposed goals to be pursued in this area by CGMS-50 as agreed with the participants of the intersessional meetings on data formats and formatting standards.

Significant progress has been made in evolving the CF Conventions to cover the needs of satellite data producers. Efforts on the part of WMO to assist in the evolution and governance of the CF Conventions are likely to have positive effects on the standard by providing better representation to users from operational communities. Further involvement in the evolution of the CF Conventions will benefit CGMS members and their users.

5. Data collection systems

5.1 DCS sub-group reports

CGMS-49-CGMS-WP-12: Report from CGMS DCS sub-group

At CGMS-46, WGI endorsed the proposal for the creation of a Data Collection Service (DCS) sub-group dedicated to DCS activities. The main purpose of the group was to make more effective progress with DCS activities and issues in the context of CGMS. The first task of the group has been to address the need for and make proposals for a new IDCS DCP standard, the development of DCS best practices for DCS data access and for DCP certification, as well as the inclusion of CGMS DCS webpage.

The DCS sub-group, consisting of DCS Managers from each of the satellite operators, has met virtually as part of the WGI Intersessional meetings, but also face-to-face in the context of other already scheduled DCS-related meetings. Due to COVID, none of the planned face-to-face meetings were possible. The last face-to-face took place in Boston as part of the AMS on 30 September and 1 October 2019.

This paper presents the status of the DCS sub-group activities and progress since CGMS-48. The discussions of the Enhanced DCP (E-DCP) standard have continued and is a major topic for the sub-group. The group proposed a revised approach regarding the new IDCS standard. Rather than defining a completely new standard, the group would look at enhancing an existing standard taking

into account user feedback and requirements. This would simplify the implementation of the standard, e. g. perform firmware changes to existing platforms, improving forward error correction and other modifiable parameters.

The group also plans to perform a SWOT analysis on the Geostationary Meteorological satellites Data Collection Services as a basis to provide CGMS with a coordinated view on a proposed future of the service.

CGMS-49 ACTIONS – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
	5.1		Analyse existing DCP standards taking into account user feedback and requirements, and propose a common standard that could be used as a future IDCS standard. The standard could include improving forward error correction and other modifiable parameters.	CGMS-50	**OPEN**
	5.1		Perform a SWOT analysis on the Data Collection Service from Geostationary Meteorological satellites.	CGMS-50	**OPEN**

CGMS-49-NOAA-WP-04: Validation of the small satellite DCS use concept project

The basic concept of the Satellite DCS Use Concept Validation project is to determine if satellites, primarily small satellites in low earth orbit, can successfully interface with the DCS receivers and thus provide a low-rate data (100, 300, or greater bps) service to satellite users; primarily to assist in launch, early orbit, and anomaly (LEO&A) operations or low data required observations. Satellite DCS users are good candidates for using the underutilised international DCS channels (IDCS). The IDCS is designed to allow use between the various geosynchronous located DCS receivers (i. e. GOES, METEOSAT, HIMAWARI) and thus it's well suited for using with satellites. This would also mean that current regional DCS users will not be crowded by the additional users. It is expected that the satellite use of DCS may assist in minimising the risk of interference but will not eliminate it. Additional regulatory controls and protections will continue to be needed as well.

This project is designed to be carried on two hosted satellites. The first hosted payload was launched on 15 February 2020 and ejected from the International Space Station on 13 July 2020. This satellite focused on and was successful in demonstrating that the concept of satellites using the DCS is valid. Messages were successfully sent from the hosted payload through the DCS and received by the mission operations team (the user). The second hosted payload, planned for launch in September 2021, will focus on operational considerations, primarily if a satellite can use the transponders at any time and access any subscribed DCS (i. e. EUMETSAT, NOAA, JMA).

While risk reduction was the original driver in identifying the opportunity, additional benefits have also been identified. 1) Increased use of the International channels, which are currently underutilised. 2) Low-cost enablement of scientific, educational, and development satellite using

low data rate communications to respective mission centres. 3) Ability to enable LEO&A during clustered deployments. 4) Projected demand for enabling the two-way communications capabilities of the DCS. 5) Demonstrated continued efforts by NOAA/NESDIS to facilitate good spectrum stewardship and efforts towards responsible sharing of spectrum resources. 6) Development of technology and techniques applicable to sensor deployment and monitoring on the Moon, Mars, and other planets.

5.2 Operational DCS systems – agency reports

CGMS-49-CMA-WP-07: CMA DCS status report

The paper is an updated introduction on the Chinese Data Collection System of meteorological satellites along with DCP technical descriptions. The FY4A at 104.7°E is the first scientific experiment satellite of the FY4 series. The FY4A is the main satellite for DCS. It has 433 channels composed of 400 HDCP channels (750Hz spacing/600bps) and 33 international channels (3KHz/100bps). The Chinese DCS is established based on an approach of FD (Frequency Division) with the combination of TD (Time Division). The FY-4A DCS is operated by NSMC (National Satellite Meteorological Center) which is one of the operational units of CMA. Currently, there are 52 HDCPs deployed within China territory. Further satellites to be launched in the future are FY4B and FY4C. And at least 23 cross-industry DCPs and applications will be funded.

CGMS-49-EUMETSAT-WP-03: EUMETSAT DCS status report

This paper presents the status of the EUMETSAT DCS currently supported by Meteosat-11 at 0° and Meteosat-8 at 41.5°E IODC (Indian Ocean Data Coverage). Included are details of channel utilisation, DCP allocation, geographical distribution, and DCP data dissemination mechanisms.

The DCS is one of the core services operated by EUMETSAT in support of meteorology and weather prediction. It plays an important role in enabling data collection platform (DCP) operators to use the Meteosat system to receive environmental data collected from DCP platforms.

EUMETSAT DCS, initially established with the first generation of Meteosat satellites (MFG) in 1977, has continued and expanded with Meteosat Second Generation (MSG), and will also be embarked on the future Meteosat Third Generation (MTG).

The EUMETSAT DCS currently supports both standard-rate (100bps) and high-rate (1200bps) DCPs. The high-rate DCP (HRDCP) has improved capabilities and can be used for application such as warnings of potentially devastating natural phenomena such as tsunamis. The prime IODC application is for the Indian Ocean Tsunami Warning Network (IOTWS). As of 31 March 2021, there are 139 DCP operators located in 77 countries (Europe, Africa, Asia). There are a total of 1523 DCPs allocated, with 419 actively transmitting. Out of those DCPs allocated, 180 are HRDCPs transmitting at 1200 bps (155 supported by Meteosat-11 at 0° and 25 by Meteosat-8 at 41.5°E). The remaining 1343 are Standard Rate DCPs (1195 supported by Meteosat-11 at 0° and 148 by Meteosat-8 at 41.5°E). Since March 2020, 54 new DCPs have been assigned (49 HRDCP and 5 SRDCP). The EUMETSAT DCS has a typical reliability greater than 99%.

CGMS-49-ISRO-WP-05: ISRO DCS status report (verbal)

Data Relay Transponder (DRT) payload is currently available on 3 Indian satellites – INSAT-3D, INSAT-3DR, and GSAT-17, which provides uplink facility at 402 MHz with global coverage and downlink at 4503 MHz with coverage over India. DRT are supporting 125 PRBS, 560 AWS, and 1350 ARGs of Indian Meteorological Departments, 592 terminals of Central Water Commission, 95 terminals of Snow and Avalanche Study Establishment, 83 terminals of the state of Andhra Pradesh, 10 ARGS of TIFC, and ~1187 AWS of ISRO.

ISRO AWS provide half-hourly measurements of surface temperature, pressure, humidity, wind speed and direction, precipitation, and sunshine. ISRO's present AWS are uplinked to DRT, but additional capability of transmitting data through GSM/GPRS is under consideration. At present, 30 of these AWS are taken up for GSM/GPRS compatibility for data transfer. IMD is planning to add 550 AWSs and 2000 ARGs, and CWC is planning to add about 2000 terminals of water resource monitoring.

CGMS-49-JMA-WP-03: Himawari-DCS's international contributions to disaster risk reduction

The Japan Meteorological Agency (JMA) has operated the DCS since its first Geostationary Meteorological Satellite (GMS) went into operation in 1978. The system plays important roles in collecting meteorological information as well as seismic intensity and tidal/tsunami data collaborating with the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). In Japan, more than 400 DCPs collect seismic intensity data. Himawari-8's DCS has been operational since July 2015, and it is planned that Himawari-9 will take over the DCS service in 2022 and continue in this role until 2029.

JMA has no plans to change the specifications of the Himawari-8/9 DCS. The Agency is currently considering whether the planned Himawari-10 programme set to replace Himawari-8/9 will assume the same DCS.

CGMS-49-NOAA-WP-05: GOES DCS Overview

The GOES DCS Environmental Data Relay system supports over 669 user agencies, 2,222 individual users operating approximately 40,000 DCPs. Over 32,000 of these DCP platforms are utilised to collect and transmit data through either a DCS transponder hosted on either the GOES East or West satellite. The DCS Administrative and Data Distribution System is used to manage user channel access for distributing over 7.2 million observations made through the DCPs.

Key projects and events include ongoing spectrum sharing challenges, random reporting documentation updates, two-way communication prototype development, and ongoing support of the small satellite concept validation project.

CGMS-49-ROSHYDROMET-WP-01: Status of Russian data collection system

This document addressed the current status and technical specifications of the Russian data collection system and related future plans. The DCS is established to provide collection and distribution of meteorological data from remote areas, and to support natural hazards warning system.

Roshydromet has developed and deployed the national DCS based on Electro-L series geostationary satellites with a backup option via Luch series communication satellite. There are 686 DCPs currently deployed. DCPs are distributed all over the Russian territory, including 138 DCPs in hard-to-reach areas.

Highly elliptical orbit satellite Arctica-M was launched on 28 February 2021, and is now undergoing the flight tests and commissioning phase. It is designed to support DCP data relay over the Arctic region.

The Russian DCS will be further complemented with the launch of the geostationary meteorological satellite Electro-L (166º E) and the second highly elliptical orbit satellite Arctic-M. It is planned to increase the number of platforms up to 3,000 DCP.

6. System and operations aspects

6.1 Space debris and collision avoidance. Coordination with IADC

CGMS-49-WG1-WP-03: Potential creation of working group on space debris avoidance (verbal)

The Working Group discussed the need for the Task Team and the Group agreed on the value of creating such a group and working towards a Best Practice on Collision Avoidance. Therefore, CGMS Action #47.09 remains open.

CGMS-49-EUMETSAT-WP-05: Best Practice for the Coordination of LEO Orbits – Progress and Next Steps

Following on from analyses performed in previous years, the Task Group has the ultimate goal of establishing a “Best Practice for the Coordination of LEO Orbits” whilst assessing the prototype simulation tool’s applicability to operational and planned missions and determining whether further work is required on that tool.

This paper reports on the status and progress of the Task Group, including within Annexes:

- The Terms of Reference, refined during discussions,
- A preliminary formulation of the Best Practice for information

The Task Group met four times since CGMS-48. During these meetings, the group refined its ToR, with the latest version contained in Annex 1.Task Group membership currently comprises delegates from CMA, EUMETSAT, JAXA, KMA, NASA, and NOAA.

i. The Task Group decided that the CGMS Best Practice shall be structured in two main sections:
   a. Best Practice for the coordination of data acquisition for LEO satellite systems with uncoordinated/variable orbital phasing; and
   b. An analysis of the potential benefits and considerations to be made in the development and operations of LEO satellite systems with coordinated orbital phasing.

However, a revised proposal is made for WGI to discuss a broader approach to the TG work than foreseen above (a), covering new mission concepts and technologies to achieve the same objective of maximal return at minimal cost.

CGMS-49 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
	6.1		Coordination of LEO Orbits Task Group to issue Draft Best Practice on Coordination of Data Acquisition for LEO Satellite Systems (with uncoordinated / variable orbital phasing)	Feb 2022	**OPEN**
	6.1		Coordination of LEO Orbits Task Group to perform a broad SWOT analysis for maximising the return / minimising the cost taking into account new mission and reference mission concepts and associated technologies, highlighting the potential for inter-Agency cooperation	CGMS-50	**OPEN**

7. Implementation of WGI aspects of the global contingency plan (as proposed by WGIII)

7.1 System technical aspects (sharing/rationalisation of orbits) and operational aspects on the implementation of contingency plans

CGMS-49-WGIII-WP-02WGI: Status and outcome of the 3rd CGMS risk assessment

The objective of the Risk Assessment Workshop is to:

- Update the CGMS Baseline based on member inputs;
- Prepare a consolidated Risk Assessment against the CGMS Baseline;
- Identify contingency actions to be taken, or actions to identify in the HLPP;
- Identify ways to integrate satellite data into the CGMS Baseline and characterise CGMS' contribution (e.g. space weather contribution was updated).

The Working Group III held a virtual workshop from 1-3 March 2021, hosted by EUMETSAT and attended by representatives of WGII and SWCG.

WGI reviewed the draft update of the CGMS Risk Assessment.

CGMS-49-CGMS-WP-24WGI: CGMS Baseline - draft revision following the 3rd risk assessment workshop (for recommendation to CGMS-49 plenary)

CGMS endorsed the first CGMS baseline, the commitment of observational missions synchronised with the development of the WMO Vision for WIGOS 2040, at CGMS-46 in Bengaluru (ref. CGMS-46 CGMS-WP-04, and -27).

The 3rd CGMS WGIII risk assessment workshop was held in EUMETSAT on 1-3 March 2021 on whose occasion the CGMS baseline and related risk assessment was conducted. The working group

reviewed the CGMS baseline and proposed revisions. The draft text of the revision of the CGMS baseline is included in the paper.

The text was reviewed by WGI and other WGs during CGMS-49 in April 2021, in order to conclude on a final text for endorsement by CGMS-49 plenary on 20-21 May 2021.

Following the CGMS-49 working group discussions, CGMS members are requested to recommend the 3rd revision of the CGMS baseline to CGMS-49 plenary for endorsement (and, at that stage, for WMO to take into account the new baseline in forthcoming updates of the Manual on the Global Observing System and related materials).

8. Any other business

For the future, WGI agreed to rename the groups working under WGI as follows:

Current Name	New Name
Direct Broadcast Best Practice Working Group	Task Group on Direct Broadcast Systems
CGMS Task Force on Satellite Data and Codes	Task Group on Satellite Data and Codes
Data Collection Service (DCS) sub-group	Task Group on Data Collection Services
Task Group on Space Debris and Collision Avoidance	Task Group on Space Debris and Collision Avoidance
Coordination of LEO Orbits Task Group	Task Group on the Coordination of LEO Orbits
New	Task Group on RFI detection, monitoring and mapping

9. Review and updating of the HLPP

CGMS-49-CGMS-WP-03WGI: Status of implementation of CGMS High Level Priority Plan (2020-2024)

WGI reviewed and provided inputs to the current status of the HLPP.**CGMS-49-CGMS-WP-04WGI: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2021-2025**

WGI provided inputs for updates to the relevant sections of the HLPP.

10. Future WGI plenary sessions

10.1 Nominations and representatives at meetings (CGMS, ISWGs, VLAB - Co-chairs and rapporteurs)

Dr Dohyeong Kim from KMA was nominated as the Co-Chair of WGI for plenary endorsement.

10.2 Decision on dates of inter-sessional activities/meetings in 2021-2022 [CGMS-49 to CGMS-50]

Should the CGMS-50 plenary session take place virtually, a virtual WGI meeting in 2022 was tentatively agreed to take place on 25 - 26 April 2022.

The following intersessional meetings were agreed, taking place at 1200 UTC.

Working Group I

- Tuesday 14 September 2021
- Tuesday 25 January 2022
- Tuesday 22 March 2022

Task Group on Direct Broadcast System (James McNitt (NOAA) & Antoine Jeanjean (EUMETSAT)):

- Tuesday 31 August 2021
- Tuesday 16 November 2021
- Tuesday 15 February 2022
- Tuesday 26 April 2022

Task Group on Data and Codes (Simon Elliott (EUMETSAT)):

- Thursday 30 September 2021
- Thursday 24 February 2022

Task Group on Data Collection Systems: (Nick Coyne (EUMETSAT)):

- Thursday 6 May 2021
- Thursday 1 July 2021
- Thursday 2 September 2021
- Thursday 4 November 2021
- Thursday 13 January 2022
- Thursday 3 March 2022

Task Group on Space Debris and Collision Avoidance Task Group (Scott Leonard (NOAA))

- Dates will be defined following the formation of the Group

Task Group on the Coordination of LEO Orbits (Andrew Monham (EUMETSAT))

- Wednesday 8 December 2021, 12:00 UTC

11. Review of actions/conclusions, preparation of WG report for plenary

CGMS-49-CGMS-WP-01WGI: CGMS-48 status of actions and recommendations

The summary list of CGMS-48 WGI actions and recommendations resulting from CGMS-49 discussions is provided below.

STATUS OF WGI CGMS-48 ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of WGI CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies	WGI/1.1	WGI/A47.01	CGMS members are requested to provide nominations to the CGMS Secretariat for the position of Co-Chair of CGMS Working Group I	KMA proposed Dohyeong Kim as co-chair, recommended by WGI and endorsed by CGMS-49 plenary	Aug 2020 (Q3 2019)	**CLOSED**
NOAA	WGI/6.2	WGI/A47.09	Form a Task Group on Space Debris and Collision Avoidance to produce a Best Practice on Collision Avoidance	Action closed - repeat of action 48.07	Aug 2020 (CGMS-48)	**CLOSED**
CGMS members Lead?	WGI/3.1	WGI/A48.01	WGI to review the status of information on the frequency plan of meteorological satellites recorded in OSCAR/Space and to provide guidance and a plan for updating the missing and outdated information as identified in CGMS-48-WMO-WP-03	*CGMS-49: Action ongoing* The action is ongoing. Status on this action was discussed at the WMO ET-RFC meeting in February 2021 It was noted during that OSCAR became a global reference for sensor characteristics and therefore there is an obligation to ensure that it is accurate. Once this first action is completed, it is on the SFCG members to submit their information based on the agreed format. SFCG would then merge the information in a single SFCG Report. Such a report could then be submitted as an SFCG input to WMO for inclusion into the OSCAR database.	CGMS-50 (CGMS-49)	**ONGOING**
CGMS space agencies	WGI/3.1	WGI/A48.02	CGMS is invited to review the preliminary WMO position paper and to assist in making this information known to its members' national and international preparation processes for WRC-23	The WMO positions paper is introduced in all relevant international and European including national WRC-23 preparation meetings. Therefore proposed to be closed.	CGMS-49	**CLOSED**

Status of WGI CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies spell out ag names!	WGI/4.1	WGI/A48.03	CGMS Direct Broadcast operators to consider if the installation of processing S/W packages can be made more user friendly and if there is a potential for standardising the approach, considering the available methods and tools and report to WGI	*CGMS-49: Action ongoing* 2021 10 Feb IS: Remains open (NOAA completed this action and described the CSPP LEO approach in CGMS-48-NOAA-WP-03)	CGMS-50 (CGMS-49)	**ONGOING**
DB subgroup (ag names…)	WGI/4.1	WGI/A48.04	DB Working Group to agree a set of studies to be performed by the CGMS agencies on the mechanisms that could be used to address higher data rates from polar orbiting meteorological satellites. The CGMS agencies are invited to contribute to these studies, either as a lead entity or in support.	Following inter-sessional meetings, a paper presented at CGMS-49 outlining the list of potential studies, their priority, indicative cost, schedule. Action closed. Further actions may proposed following the SWOT analysis	CGMS-49	**CLOSED**
CGMS members	WGI/4.2	WGI/A48.05	CGMS Members are asked to update their nomination of experts to participate in the Task Force on Satellite Data and Codes in coordination with WGIV	Sufficient members now in the Group Lead: Simon Elliott (Simon.elliott@eumetsat.int) Current Members: CMA: Xu Zhe (xuzhe@cma.gov.cn) EUMETSAT: Simon Elliott (simon.elliott@eumetsat.int) JMA: Akihiro Shimizu (aki-shimizu@met.kishou.go.jp) JMA: Kazuki Shimoji (kazuki.shimoji@met.kishou.go.jp) KMA: Jae-Dong JANG (jaedongjang@kma.go.kr) NOAA: (A.K.) Sharma (awdhesh.sharma@noaa.gov)	Aug-20	**CLOSED**

Status of WGI CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				ROSHYDROMET: Nikita Ekimov (nikitaekimov@planet.iitp.ru) WMO: Enrico Fucile (efucile@wmo.int)		
DCS subgroup	WGI/5.1	WGI/A48.06	To coordinate the elaboration of the user requirements (based on potential applications), and the technical specifications, for a new DCP Standard, including the definition of the DCP format (To coordinate the elaboration of the user requirements, the technical specifications, and potential applications for a new DCP Standard and make a proposal to WGI also to include a section on DCP formats into the E-DCP Specification)	The subgroup proposes to change the goal of the action. Rather than defining a completely new standard, the group would look at enhancing an existing standard taking into account user feedback and requirements. This would make the implementation of the standard simpler, with for example firmware changes to existing platforms improving forward error correction and other modifiable parameters. The details of the proposed action have been put forward in the DCS Sub Group Report to the CGMS 49. Close this action and raise new action	CGMS-49	**CLOSED**

Status of WGI CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
NOAA	WGI/6	WGI/A48.07	Form a Task Group on Space Debris and Collision Avoidance to produce a Best Practice on Collision Avoidance	*CGMS-49: Need for Task Group reaffirmed.* Future of task group to be discussed in CGMS-49 WGI meeting in April and need reaffirmed. Lead scott.leonard@noaa.gov, EUM: andrew.monham@eumetsat.int, PierLuigi.Righetti@eumetsat.int	Dec 2021 (Aug 2021)	**ONGOING**
CGMS members	WGI/7.1	WGI/A48.08	CGMS Members are requested to nominate mission analysis experts to a Task Group, who are then invited to review the Simulation algorithm and outputs for the coordination of LEO orbits. The Task Group would:• ascertain the applicability to operational and planned missions• assess its role in the formulation of a Best Practice on coordination of LEO orbits• determine further work required on the prototype simulation tool	Task Group membership completed. Intersessional meeting demonstrated the simulation algorithm.Paper presented at CGMS-49: • Draft Best Practices on coordination of LEO orbits• Future stepsAction closed	Aug 2020	**CLOSED**

Status of WGI CGMS 48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS space agencies	WGI/3.1	WGI/R48.01	CGMS member agencies to monitor the actual IMT-2020/5G deployment in the 26 GHz band and its impacts on passive microwave measurements and inform WGI as appropriate.	**CLOSED.** Converted into an action at CGMS-49 WGI (CGMS via a dedicated Task Group to investigate collectively mechanisms for detection and long-term monitoring of and mapping of RFI (for example, but not limited

Status of WGI CGMS 48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
				to, from IMT-2020/5G into the 24 GHz passive band) at satellite or instrument level, or any other means, as the knowledge base for assessing the impact on the passive sensor measurements).
CGMS space agencies	From plenary 5.7 and WGIII	R47.02	**(From IPWG): IPWG** also recommends that there be a CGMS-wide coordination of the crossing times of precipitation relevant satellites in an effort to improve the temporal sampling of diurnal cycle, convective systems lifecycles, and severe storms.	**CLOSED** following CGMS-49 discussions. 2021 21 Feb: Current CGMS baseline has 3 coordinated sun-synchronous orbits, nominally early morning, mid-morning and afternoon for precipitation relevant satellites. Propose that IPWG provide the need/scientific impact of improving/augmenting the three orbits. Proposals could then be discussed in WGIII and considered for the HLPP. It is proposed to **close** this recommendation for WGI.
CGMS space agencies	From plenary 5.7 and WGIII	R47.03	(From **IPWG**): As precipitation moves to higher temporal rates, we recommend to CGMS members to synchronize full-disk geostationary sampling schedules which will optimize GEO full disk scans to improve temporal sampling of precipitation products and unknown future PMW imager availability for merged products.	**CLOSED** following CGMS-49 discussions. 2021 21 Feb: Current CGMS baseline has nominally 6 evenly spaced GEO satellites (NOAA/GOES-R including). The nominal repeat cycle is 10 minutes full disk and are approximately synchronised. Rapid Scan repeat cycles are typically driven by regional considerations. It is proposed to **close** this recommendation for WGI 2021 10 Feb IS: Remains 2020 May 28, CGMS-48 WGIII: Transferred to / to be addressed in WGI. (Initially transferred from plenary CGMS-47 to WGIII).

Joint WGII-WGIII report

WGII REPORT

Co-chairs: JV Thomas (ISRO), Kenneth Holmlund (WMO)
Rapporteurs: Mitch Goldberg (NOAA), Paolo Ruti (EUMETSAT)

1. Opening, objectives, and expected outcomes/WGII co-chair and rapporteur status and confirmation

CGMS-49-CGMS-WP-09: Update of WGII Terms of Reference

CGMS Working Group II (WGII) held its CGMS-49 plenary meeting on 26-27 April 2021. WGII addressed aspects of technical and scientific nature related to satellite data and products. WGII membership consists of satellite data and products experts drawn from CGMS members and observers. WGII serves as the link between CGMS and the CGMS International Science Working Groups (ISWGs), which provide regular reports and feedback to CGMS through WGII:

- International Clouds Working Group (ICWG)
- International Precipitation Working Group (IPWG)
- International Radio Occultation Working Group (IROWG)
- International Satellite Winds Working Group (IWWG)
- International TOVS working group (ITWG)

WGII is also the primary interface between CGMS and other relevant international initiatives, such as the Global Space-based Inter-Calibration System (GSICS), the CEOS-CGMS Joint Working Group on Climate (WGClimate) and user communities, such as those organised in the WMO Application Areas. During its inter-sessional work in the 2020/2021 period, WGII reviewed its ToR as endorsed by plenary at CGMS-48 (see CGMS-48-CGMS-WP-30). The proposed update to the ToR broadens the selection of the second co-chair to the Asia-Pacific region.

There were no comments raised with respect to the updated ToRs during the discussion and subsequently, WGII decided to recommend to plenary the adoption of the new ToR.

The Chair then introduced the current status of the co-chairs and rapporteurs. He noted that one of the Chairs is to be nominated by WMO, and that WMO has nominated Ken Holmlund, Head of the Space Systems and Utilization at WMO. He further noted that ISRO has nominated JV Thomas currently acting co-chair for WGII as the second co-chair. Finally, he noted that Mitch Goldberg, NESDIS Chief Scientist will continue as rapporteur and that EUMETSAT has nominated Paolo Ruti, the EUMETSAT Chief Scientist as second rapporteur.

As there were no additional nominations for co-chair or comments raised with respect to the WMO and EUMETSAT nominations, WGII then welcomed JV Thomas as the new co-chair for WGII. JV Thomas thanked WGII for the confidence and accepted the nomination.

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	1	WGIIR49.01	WGII recommends to plenary the adoption of the new Terms of Reference as presented in CGMS-49-CGMS-WP-09
Plenary	1	WGII49.02	WGII recommends to plenary to confirm the nomination of JV Thomas as the second Chair of WGII.

2. CGMS agency reports on highlights and issues in dataset and product generation

CGMS-49-CMA-WP-09: CMA report on highlights and issues in dataset and products

This report highlights the current status and progress of CMA FY meteorological satellite products. The overview of FY satellite Earth observations products from FY-3 and FY-4 satellite are introduced. Then four products including the tropopause folding detection from FY-4, the atmospheric temperature and humidity profiles from FY-3D, and the ocean vector wind and sea ice parameters from FY-3E are highlighted in detail. The summaries are shown as follows.

1) The tropopause folding detection algorithm based on the FY-4 Advanced geostationary radiation imager (AGRI) observations is introduced. The output fields of the FY-4 tropopause folding detection product consist of tropopause pressure, tropopause folding identification, and the depth of tropopause folding. The validations against numerical model reanalysis data are made for the output fields of the FY-4 tropopause folding detection product. Results show that the accuracy of the product basically meets the application needs. However, to meet the requirement of aviation users, further validation against the in-flight turbulence observations for this product is urgently needed.

2) The recently developed algorithm for retrieving vertical atmospheric temperature and water vapour profiles from microwave and hyperspectral infrared sounding instruments onboard FY-3D is introduced. The independent training set from ERA5 was used for validation. The results demonstrate significant performance improvements over the previous operational sounding retrievals. This new technique will be used for sounding product generation from FY-3E.

3) The ocean vector winds (OVWs) retrieval algorithm for the FY-3E satellite WindRAD has been introduced. OVWs products retrieval algorithm has been developed and primarily validated with a high-fidelity forward model and with CFOSAT (Chinese-French Oceanography Satellite) operational products. The validation results show that the dual-frequency method was shown to have the ability to acquire more accurate wind vectors than single-frequency measurements. Further tests for the retrieval algorithm based on dual-frequency observations will be carried out in the FY-3E on-orbit testing this year. The ocean calibration algorithm and the updated GMFs will be developed in the same stage.

4) The FY-3E/WindRAD sea ice prototype algorithm using CFOSAT/SCAT as proxy data has been developed and introduced. The machine learning Random Forest classification was used to classify not only between sea and ice, but also between first-year ice and multi-year ice. The long-

time series retrieved results from were evaluated and compared with NSDIC sea ice products. The validation results show that both sea ice edge and sea ice type are well below the accuracy requirement in different season periods, validating the robustness and accuracy of this algorithm. Further tests for the retrieval algorithm will be carried out in the FY-3E on-orbit testing this year. The optimal inversion algorithm of sea ice parameters based on dual-frequency fusion will be developed in the same stage.

During the discussion, it was noted that the FY-3E WindRAD data will be a significant contribution to the overall scatterometer constellation and WGII thanked CMA for its effort to establish the mission. WGII also congratulated CMA for the excellent performance of HIRAS. Finally, CMA confirmed that the tropopause folding products is still under operational implementation and has therefore not yet been provided to aviation users for validation.

CGMS-49-EUMETSAT-WP-16: EUMETSAT highlights and issues in dataset and products

In addition to the ongoing preparations for the future EPS-SG and MTG missions, EUMETSAT has a number of new or improved products in development, a selection of which are highlighted in this paper. The first of these is the Sentinel-3/SLSTR Sea Surface Temperature (SST) product operationally produced at EUMETSAT through the Copernicus delegation agreement. Evolution of the current SLSTR SST products, which will lead to a new Day-2 product suite, is now starting, with a target for operational implementation in 2023 and the final goal of SLSTR SST becoming the community endorsed reference SST product. The roadmap for SST developments and additionally for new Sea-Ice Surface Temperature products is also included. Second, the New Wave Optics for Radio Occultation missions – a “Fast Phase Transform” based on Canonical Transform-2 Fourier Integral Operators – was also presented. The MetOp GRAS products generated using this New Wave Optics are currently being validated jointly with the ROM SAF with the expectation that the products will be declared operational in the May 2021 time frame. The same processor will be used for the Sentinel 6 RO-NTC and reprocessing of CHAMP, COSMIC, and GRACE, and also for commercial RO processing. An update was also provided on AMV developments, in particular the status of the AMVs from the Sentinel-3/SLSTR A&B platforms, and also on the potential for 3-D winds generation from IASI and the future MTG-S IRS missions. An overview of Aerosol product developments was also provided. In particular, the status of the MetOp PMAp product, but also the Sentinel-3 AOD product and the suite of missions expected to contribute to the observation of aerosols from the EPS-SG missions. Finally, an overview of activities for the development of a Copernicus Sentinel-3/OLCI TCWV product was presented. This product is currently in the prototype stage, but plans are being made for future operational implementation.

During the discussion EUMETSAT clarified that the IASI 3D-winds are based on multi-satellite data. Furthermore, it was noted that whilst many global NWP centres will more likely look at radiance assimilation from MTG IRS, there is a potential to use IRS 3D winds in regional modelling and other application areas. The full potential and need for 3D winds are still being explored.

CGMS-49-IMD-WP-02: IMD highlights and issues in dataset and products

At present, two INSAT Meteorological satellites are in operation, i. e. INSAT-3D and INSAT-3DR. INSAT-3D is India’s advanced weather satellite located at 82°E and was launched on 26 July 2013 and INSAT-

3DR was launched on 8 September 2016. They are dedicated meteorological satellites and carry four payloads: imager (six channels), sounder (19 channels), Data Relay Transponder (DRT), and satellite aided search and rescue (SAS & R).

The imager payload of INSAT-3D and INSAT-3DR are used in a staggered mode to achieve 15-minute temporal resolution for getting cloud imaging. INSAT-3D Sounder reached its end of life in September 2020, since than INSAT-3DR sounder is being used to collect data on hourly basis of the Indian land region (Sector-A) twenty times and Indian Ocean Region (Sector-B) four times on hourly basis.

IMD has established the Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR, and INSAT-3DS. The system has three dedicated earth station and data receiving system. Each Earth station is receiving the data in redundant mode from each payload (Imager, Sounder, and DRT) and Raw data archival storage facility. MMDRPS have very high-end processing system which cut down the processing time from 15 minutes to 7 minutes and has provision to update calibration coefficient in operational chain using Cal/ Val site and GISCS data. The system is capable to process RAPID scan data of INSAT-3DR Imager payload conducted during Extreme weather events. MMDRPS have storage capacity of the order of 2.0/2.0PB (Main/ Mirror) and 324TB SSD which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy. All available past satellite datasets starting from 1983 will be kept in online mode in due course of time. The MMDRPS system has been declared operational on 12th November 2020 and being used to receive and process the INSAT-3D and INSAT-3DR satellites data.

IMD has started the generation of some new products such as Net radiation, Improved IMSRA(R/F), Land surface albedo, shortwave radiation and Total Precipitable water vapour over Ocean from INSAT-3DR Imager payload and Cloud Top temperature, Cloud Top pressure, and effective emissivity from Sounder payload in addition current geophysical parameters. In addition to this Potential Evapotranspiration and Actual Transpiration for agromet advisories using IMD WRF model and SEVRI NDVI Products as inputs along with INSAT-3D/3Dr satellite data with better accuracy. Recently, IMD has also started the generation of a state-wide snow cover variation map of the last 24 hours for six states of mountain region along with LST (Max & Min) spatial state plot and the last six days average LST graph. This is found very useful for identifying potential vulnerability area land slide/flash flood in mountain regions. The new algorithm SST (1D-VAR) and ADT have been implemented in the MMDRPS operationally. The satellite data is assimilated in NWP models and the outputs are further used to issue short range and medium range weather forecast.

INSAT 3DR and a new set of products are integrated in both of the dedicated webpages (http://satellite.imd.gov.in/insat.htm and http://satmet.imd.gov.in/insat3d.htm) and RAPID. The webpages are being updated every 15 minutes. These Web sites can now be assessed using the username “guest” and a password may be obtained through email from virendra61.singh@imd.gov.in.

The INSAT-3DR Imager payload is used to conduct rapid scans during four Tropical Cyclones namely: Amphan, Nisarga, Nivar, and Burevi cyclonic events during June 2020 to March 2021. Each Rapid scan cover up to 3 degree in N-S direction (6 Blocks/240 scan lines) in 4.5 minutes. Rapid scan data has been

used to track these cyclones in real time basis. The processed data is being disseminated on a dedicated webpage (http://satellite.imd.gov.in/rapid/rapid_scan.htm).

Working Group II took note.

CGMS-49-ISRO-WP-04: ISRO highlights and issues in dataset and products

The following key points were raised in the ISRO presentation:

- Developed the MMDRPS under MoU between ISRO and IMD (MoES), which is finally commissioned at IMD New Delhi since January 2021 for INSAT-3D/3DR.
- A 1-D Var based physical retrieval scheme was implemented for SST from INSAT-3D/3DR Imager observation to mitigate the diurnal/seasonal dependency on bias and uncertainties.
- Re-processing of Scatsat-1 data in v1.1.4 since 20 June 2019 completed (after main chain TWTA failure) and data from Fairbanks station went into operational chain in August 2020. An anomaly was observed in the on-board system of the redundant chain of Scatsat-1 since first week of March 2021. An analysis is being carried out.
- ISRO-CNES joint mission – The SARAL/AltiKa post star sensor anomaly from February 2019 is in mis-pointing phase. Cross-over analysis carried out using Jason series of altimeter suggests that, although the bias remains more or less same, there is relatively more error in the mis-pointing phase as compared to exact repeat and geodetic phase.
- INSAT-3D/3DR Imager/Sounder radiances are monitored using GSICS procedure. Presently, inter-calibration of IR channels is in demo phase with IASI-A/B and being implemented for IASI-C and CrIS. A ray-matching method was developed for inter-calibration of Vis/SWIR channels with MODIS and is under testing.

During the discussion, it was clarified that the anomaly observed on the redundant side of SCATSAT-1, causing full data loss, is critical and may have an impact on mission lifetime.

CGMS-49-JAXA-WP-02: JAXA Earth Observation Programme and Data Product

JAXA operates various kinds of satellite sensors and opens the products to the public. The agency keeps developing and improving the products to address the climate issues. The major update since CGMS-48 is the Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW), which will carry the GCOM-W follow-on instrument (Advanced Microwave Scanning Radiometer 3; AMSR3) and GOSAT-2 follow-on instrument (Total Anthropogenic and Natural emissions mapping SpectrOmeter-3; TANSO-3), is being developed and to be launched in Japanese Fiscal Year (JFY) of 2023. In terms of the extremes monitoring, JAXA contributes to the WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Project by providing GSMaP rainfall product with climate normal. JAXA plans to improve the algorithm in Spring 2021 (algorithm version 8). After the release of this version, JAXA will reprocess the past 21-year dataset, and re-calculate the climate normal again. As for the next generation precipitation radar following onto the TRMM/PR and GPM/DPR, the agency proposed the advanced Ku-band Precipitation Radar with doppler capability and higher sensitivity. JAXA is discussing the possible collaboration with NASA. The mission definition review of the next generation precipitation radar in JAXA is planned to be held in August 2021 (TBD). JAXA would appreciate if the

report that IPWG delivers is authorised in the plenary session of CGMS-49 in May 2021, which can go a long way in showing requirements from the international meteorological community.

During the discussion, it was noted that the efforts by JAXA, in collaboration with NASA, to secure a follow-on precipitation radar are critical and address a risk identified by the CGMS Risk analysis. It is therefore important for CGMS to express its support to the JAXA efforts.

Concerning data access, it was noted that JAXA data is freely available over their web-service. For access to direct readout data, JAXA requires bilateral agreements in order to enable the direct readout over interested station operator areas. Furthermore, it has been noted that e. g. for GPM, data is globally available in NRT using Direct Relay Satellite (DRS) systems.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS SEC	2	WGIIA49.01	WMO/CGMS SEC to write a letter of support to JAXA on the GPM follow-on/precipitation radar efforts	Jun 2021	**OPEN**

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	2	WGIIR49.03	WGII recommends to plenary that CGMS provides a letter of support to JAXA on the GPM follow-on mission/precipitation radar efforts
Plenary	2	WGIIR49.04	WGII recommends to plenary the adoption of the IPWG Precipitation Radar Position Paper after WGII review

CGMS-49-JMA-WP-04: JMA highlights and issues in dataset and products

Details of radiometric calibration and image navigation performance for JMA's Himawari-8 geostationary satellite (which started operation on 7 July 2015) are provided on the JMA/MSC website. The monitoring pages show that the image navigation errors are within 600 m at the sub-satellite point, while radiometric calibration biases are less than 5% in reflectivity for visible and near-infrared bands and less than 0.3 K in brightness temperature for infrared bands.

The slope and intercept for correcting sensor sensitivity for visible and near infrared bands were updated on 13 July 2020. In this work, a homogeneous Atmospheric Motion Vector (AMV) dataset was produced by reprocessing past satellite data using the latest algorithm for derivation from GMS-5 to MTSAT-2 (1995-2015). The dataset had been used as input for JMA's long-term reanalysis project (JRA-3Q). SST data are provided for JMA's regional SST product, aerosol data are provided for assimilation in JMA's aerosol prediction model, and Convective Cloud Information (CCI) is provided for aviation

safety. Verification of CCI elements shows good results for rapidly developing cumulus areas (RDCAs) in summer, with low POD and high FAR values in winter. The English version of the Himawari RGB Quick Guides was released in late September 2020 and translated into Russian by Roshydromet, RSHU, and EUMETSAT. Such activities support the promotion of international usage for RGB images. The progress of a Hyperspectral IR Sounder (HSS) Observing System Simulation Experiment (OSSE) on the follow-on programme performed after CGMS-48 is reported here, with influences on observational frequency. OSSE research updates have been provided at the 7th Workshop on the Impact of Various Observing Systems on NWP (30 November – 3 December 2020) and on other occasions. Although global NWP has clearly improved with HSS assimilation, further research is needed on regional model.

Working Group II took note.

CGMS-49-KMA-WP-02: KMA highlights and issues in dataset and products

This document describes the update and issues of GK2A products application in data assimilation, weather forecasting, and GK2A L1B quality monitoring etc. Data assimilation results of GK2A Clear Sky Radiance (CSR) and Atmospheric Motion Vector (AMV) on the forecast performance in the Korean Integrated Model (KIM) system data showed a significant impact on the overall performance of the KIM system, new KMA NWP system in Southern Hemisphere and Asian region. In addition, GK2A products have been focused on the improvement to support the hazardous weather monitoring such as fog, dust, and convective initiation, and provide more intuitional information such as RGB images which help forecasters to interpret weather phenomena more easily than other products. Recently, with AI technique, KMA has been developing the proxy night-time visible data from IR data. The current performance is not perfect in dust and fog detection, but it is anticipated to be better with further consistent improvement. It would also be good chance to open a new era in satellite products application. Meanwhile, GK2A channels have been monitored in near-real time using GSICS since 25 July 2019, too. New SRF (-0.8cm-1 shifted) of CO_2 channel of GK2A showed lower bias and RMSE values, but the trend of visible channels shows seasonal variation of 5% to 10% in compared with LEOs. Eccentric feature is found in result of SW038 channel compared with that of IASI, which has large negative value lower than -1K at cold scene within 230K.

Working Group II noted the report.

During the discussion, WGII requested additional details about the dust detection method to support dust monitoring. Through an evaluation using RGB composite images and ground observation data, the algorithm was verified to be capable of distinguishing desert and dust on land, as well as fog from dust on the ocean.

CGMS-49-NASA-WP-06: NASA highlights and issues in dataset and products

NASA is a significant contributor to global knowledge of the Earth's environment. The scientific infrastructure supports 22 satellite missions including surface and airborne assets that allow calibration and validation of remotely sensed imagery, Earth system model development, data analysis, processing, delivery, and storage. Rigorous quality assurance standards ensure delivery of high-quality data suitable for acquiring an improved quantitative understanding of Earth system parameters and processes. This working paper presents a summary of NASA activities that may be of interest to CGMS members. It includes highlights of NASA's ongoing work with partners, including its

support for the expansion of the global in-situ ground networks, recent airborne field campaigns to understand the physical and chemical processes that govern the transport and transformation of trace gases and particles, and newly released techniques and datasets that reliably track changes to the Earth system.

WGII welcomed the presentation noting the high importance of demonstrating the need for synergetic approaches using ground-based/in-situ data with satellite data to fully understand the capabilities of satellite data, the related science, and for validation/calibration activities.

CGMS-49-NOAA-WP-09: NOAA report on POES Data Denial Studies

At least 3 LEO orbits, nearly equally spaced, continue to be important with evidence of additional benefits especially for nowcasting applications including tropical cyclone intensification, precipitation, and volcanic ash monitoring. NOAA conducted a study showing the impact of removing DMSP and POES legacy satellites which are currently in the early morning. There were significant degradations which underscores the importance of the FY-3E early morning orbit. The NOAA study showed statistically significant degradation in forecast skill when POES legacy satellites are removed for some regions and atmospheric levels. However, COSMIC-2 GPS RO observations mitigated negative impacts in the Tropics. There is an outstanding question whether more RO observations covering the mid latitudes and polar regions mitigate the loss of skill from the POES satellites covering the early morning orbit for NWP. But at the same time, RO cannot provide good low level moisture information needed for NWP. Microwave and Infrared soundings are multipurpose – not just NWP; nowcasting applications which RO cannot provide. AVHRR imagery from NOAA-15, 18, and 19 are critical for Aviation (clouds/ash) applications in higher latitudes. Without these satellites there will be approximately a 4-hour gap in observations. AVHRR imagery is also used for deriving atmospheric motion vectors (AMVs) which are used in nowcasting and NWP applications. Without POES and DMSP legacy microwave sounders, there will be significant degradations in NOAA's satellite-based precipitation products for several hours each day. Precipitation products are critical for assessing flood conditions. POES legacy and DMPS microwave observations are used for estimating tropical cyclone strength – without them there is a large degradation in wind estimates.

WGII noted that whilst the WIGOS Vision 2040 baseline, which is also reflected in the CGMS baseline, has a primary focus on the three main orbital planes, early morning, mid-morning, and early afternoon, there is a need and ambition to expand this to six orbital planes. WGII therefore complimented NOAA for the efforts made to demonstrate the added value of better temporal coverage of LEO data beyond NWP. It was noted that further cases demonstrating the benefits are required in order to advance on a broader (than three orbital planes) constellation.

CGMS-49 actions – WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS WGII members	2	WGIIA49.02	Agencies to provide case studies demonstrating the benefits of additional orbital planes, beyond use of data in NWP.	CGMS-50	**OPEN**

CGMS-49 actions – WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS WGII members	2	WGIIA49.03	Define driving applications to determine the temporal coverage and spectral coverage needed as part of a LEO constellation. (For example – what temporal, spectral, and spatial resolutions needed to monitor tropical cyclones in "all sky conditions"?)	CGMS-50	**OPEN**

CGMS-49-ROSHYDROMET-WP-02: Satellite Data and Products Applications in Roshydromet

The document presents an overview of operational and research activity in Roshydromet related to the derivation and application of remote sensing products from satellite data. The sample products are presented based on measurements of Russian LEO (Meteor-M N 2 and N 2-2) and GEO (Electro-L N 2 and N 3) satellites.

WGII welcomed the presentation and requested further clarifications on the validation of the optical flow method used for AMVs. Roshydromet clarified that the method is still under implementation and validation will follow. WGII further noted that presenting the methodology and validation to the IWWG would be beneficial and further recommended Roshydromet to engage with the new AMV intercomparison study.

WGII also asked about the status of the recently launched Arctica mission. Roshydromet confirmed the satellite is currently doing well and is undergoing in-orbit checkout/commissioning that should be concluded in August 2021. Preliminary imagery examples and animations can be viewed at:

IR channel animation 5.7-7.0µm band:
http://planet.rssi.ru/news/img/arktika-m-1_2021_03_25/2.gif

IR channel animation 10.2-11.2µm band:
http://planet.rssi.ru/news/img/arktika-m-1_2021_03_25/1.gif

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
Roshydromet	2	WGII/A 49.04	Roshydromet to present the optical flow methodology and validation activities to next IWWS	IWWS-16/2023	**OPEN**
IWWS	2	WGII/A 49.05	IWWS to provide presentations given at IWWS-15 on optical flow methodologies to Roshydromet	May 2021	**OPEN**

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
Roshydromet	2	WGII/A 49.06	Roshydromet to consider providing optical flow-based products for the next IWWG intercomparison study	IWWS-16/2023	**OPEN**

CGMS-49-WMO-WP-14: WMO GEO Satellite Product Survey

This Paper reports on the GEO Satellite product Survey performed by WMO as a response to action WGII A48.11. Results of a preliminary analysis based on the survey responses received are presented together with a proposed common baseline for products from geostationary meteorological imagers. A wide range of data and level-2 products, containing geophysical parameters from the geostationary meteorological satellites are provided in near-real time by the satellite operators using various dissemination approaches including GEONETCast (and its components), direct broadcast by the operators, GTS, and internet. The geostationary data and products are derived with various methodologies. Intercomparison and validation activities generally assure that their quality and performance are well characterised and consistent. However, differences remain, in particular in terms of resolution, generation frequency, and distribution methods. Whilst a primary focus for geostationary data is in regional applications, there are also global applications, like global NWP, that benefit from the data. Furthermore, there are global application areas, like aviation, that require consistency of the data across operator domains to avoid a negative impact on the downstream services. This survey therefore aims at identifying a common set of level-2 products that should be derived by all operators and when feasible with common resolution, generation frequency, and distribution methods in agreed formats. Furthermore, for these products, regular intercomparisons and assessments as well as the use of common algorithms are encouraged. Only products from the meteorological imagers have been considered.

During the discussion, it was noted that the baseline products are Level-3 (blended products e.g. precipitation. It was further noted that whilst NOAA does not provide GEO only volcanic ash products, there are near real time volcanic ash products, VOLCAT, which is based on all available satellite data, also LEO data. Furthermore, it was noted that in some instances, the volcanic ash products are only been made available to the Volcanic Ash Advisory Centres.

It was also noted that several centres provide SSTs and that NOAA had proposed it as a baseline product. During the discussion it was however not clear what the optimal frequency for such a product would be. Subsequently, it was noted that the same issue on frequency may also be applicable to precipitation products.

The importance of a baseline set of channels for the geostationary imagers were also discussed and it was noted that there is already a large level of commonality for the new generation imagers.

Furthermore, IMD noted that there is some additional information with respect to the INSAT-3D/3DR satellites that should be included.

In conclusion, WGII was content to endorse the products proposed in CGMS-49-WMO-WP-14 as baseline products, with the addition of SSTs. However, further clarifications are required with respect to:

- Frequency of SSTs
- Frequency of precipitation product
- Dissemination approach for the volcanic ash product

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS WGII members	2	WGII/A49.07	CGMS members to consider the proposed baseline and to complete the information for the proposed baseline, including SSTs	Aug 2021	**OPEN**
WMO	2	WGII/A49.08	Precipitation – review specification involving key users	Dec 2021	**OPEN**
WMO	2	WGII/A49.09	SST – review specification involving key users	Dec 2021	**OPEN**
WMO	2	WGII/A49.10	Review the baseline dissemination strategy for volcanic ash product	Dec 2021	**OPEN**
WGII	2	WGII/A49.11	The dissemination strategy for the baseline products presented in CGMS-49-WMO-WP-14, including SST, should be presented to and discussed with CGMS WG IV.	CGMS-50	**OPEN**
WMO	2	WGII/A49.12	WMO conduct a survey on baseline Level-2 product requirements for LEO satellites.	CGMS-50	**OPEN**

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	2	WGIIR49.05	Working Group II recommends to CGMS plenary the adoption of the proposed baseline products presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.
WMO	2	WGIIR49.06	WMO together with Working Group II to develop a baseline recommendation for channels from geostationary satellite imagers

3. CGMS International Science Working Groups

CGMS-49-IWWG-WP-01: Status Report of the International Winds Working Group Activities

This paper presents the ongoing activities and relevant discussion items of the International Wind Working Group (IWWG) since the CGMS-48 meeting. This paper includes i) ToR for IWWG, ii) Ocean Vector Winds Task Group, iii) Status of HLPPs and associated actions, iv) IWW15 summary

WMO CGMS-48 plenary (A.48.10) actioned a SCAT task team, led by Dr Ad Stoffelen, to present ToR and a Roadmap at the CGMS-49 plenary. This is furthermore related to the action of the CGMS-48 WGII (A.48.10) Ocean Surface Winds (OSW) team to present at next GSICS meeting the potential benefits and issues of cross-calibration of scatterometer data. The ToR of the International Winds Working Group (IWWG) that were drafted for CGMS-49 include "(ii) ocean surface winds derived from radar scattering and conical-scanning microwave radiometers" and objectives "To exchange results on novel developments regarding the use of satellite-derived winds, in particular for numerical weather prediction (NWP)", "To support and perform routinely scheduled wind inter-comparison activities in close collaboration with (CGMS) scientific working groups", "To establish agreement for standards in the verification and validation of satellite-derived winds", "To support the definition of user requirements and gap analysis for atmospheric wind parameters in the framework of future Global Observing System (WIGOS, WMO OSCAR database)" and "To make recommendations to CGMS and to national and international agencies regarding the utilisation of current and the development of future satellite instruments on polar satellites.". Since these objectives in particular are not fully covered by CEOS and the International Ocean Vector Wind Science Team (IOVWST), it is proposed to form an OSW task group (TG) within the IWWG. This would formalise a long tradition of the representation of the scatterometer NWP users and scatterometer wind producers at the IWWG. The CGMS and WMO are user organisations with a strong focus on the user exploitation of satellite data. In particular, the OSW services for use in NWP need further coordination and collaboration through the IWWG. This moreover becomes increasingly pressing as models are coupled to the ocean. Finally, the GSICS action would be very relevant to this OSW WG and furthermore closely linked to the CEOS Working Group on Cal/Val (WGCV) Microwave Sensors Subgroup (MSSG). Other IWWG objectives, e. g. on methods and training, that in parts overlap with CEOS and the IOVWST will also need coordination. Hence the OSW and SCAT task team recommendation:

Establish an Ocean Surface Wind Task Group (OSW TG) in the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS and the IOVWST

This implies that OSW TG actions and recommendation will be reported to/from CGMS through established IWWG mechanisms and in addition to CEOS and IOVWST.

IWWS brought the following main points for consideration to WGII:

1) For consideration by CGMS the endorsement of the IWWG ToR. Recommendation
2) For consideration by CGMS the endorsement of the Ocean Surface Winds Task Group and associated ToR. Recommendation
3) For consideration by CGMS 49: The IWWG recommends space agencies to address the gap of 3D wind profile observations (lidar and IR missions) with a global coverage as high priority, and

to especially consider a joint system for operational lidar missions based on the successful Aeolus experience.

WGII requested a clarification on what is implied with a "joint system for operational lidar missions". In the discussion, it was noted that lidar missions are sensitive to the thermal conditions and hence orbits with strongly variable illuminations conditions (on the spacecraft) are more challenging. It was clarified that the most likely approach considered for now is to first develop an Aeolus follow-on mission in a dusk-dawn orbit and that a constellation would then consider additional missions in the same orbital plane. It was also noted that whilst dual-lidar missions with two perpendicular lidars on the same platform would have some benefits in the tropic, such a mission would be more complex than developing missions with single lidars. It was further emphasised that the constellation also should consider the capabilities of hyperspectral infrared data, which can provide important wind increments in a data assimilations system. In conclusion, WGII endorsed the proposed recommendations from IWWG, however requesting a clarification for item 3 above. Additionally, it has been mentioned that Météo France will look at regional scale impacts of the Aeolus data.

Subsequently, it was noted that the discussion on the scatterometer team will be addressed under agenda item 7.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
IWWG	3	WGII/A49.13	To clarify approach for 3D wind profile measuring constellation in recommendation	Mid-May 2021	**OPEN**

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.07	WGII recommends to plenary to address the gap of global 3D wind profile observations with high priority. Based on the Aeolus experience, a combination of lidar & IR missions can provide complimentary wind observations which look to be very promising."

CGMS-49-IWWG-WP-03: Terms of reference for the International Winds Working Group

During the preparations for CGMS-49, it was noted that IWWG does not yet have formally approved ToR. The Working Paper CGMS-49-IWWG-WP-03 introduced the proposed ToR.

WGII discussed the ToR for IWWG and approved them with a request for a small addition of GNSS reflectometry in the list of missions considered.

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.08	WGII recommends to plenary the adoption of the IWWG Terms of reference.

CGMS-49-IROWG-WP-01: Outcome and Recommendations from the IROWG-8 Workshop

This report summarises the IROWG-8 meeting held on 7-13 April 2021 as a virtual conference, hosted by NOAA and UCAR. It provides the main recommendations from the four IROWG sub-groups: Numerical Weather Prediction; Climate; Receiver Technology and Innovative Occultation Techniques; and Space Weather. The key recommendations for CGMS – endorsed by the IROWG community at the plenary session – are:

IROWG reaffirms that all providers of RO observations should classify these as essential in the sense of WMO Resolution 40.

1. IROWG reaffirms that all providers of RO observations should classify these as essential in the sense of WMO Res 40. IROWG stresses the importance of free, timely, and unrestricted access in real time to essential RO data, and free and unrestricted access to archived raw data (including auxiliary data).

2. IROWG continues to recommend that WMO and CGMS should coordinate any GNSS-RO data purchases. Specifically, we suggest convening a meeting of all agencies considering procuring these data, in order to discuss if, how, and when the current 20,000 daily target will be met with global and full local time coverage.

3. IROWG recommends that CGMS encourages technology and retrieval developments for improving planetary boundary layer profiling from GNSS RO and their utilisation in NWP data assimilation – and the further exploration of RO-derived water vapour as a climate variable.

4. Per CGMS priority HLPP 1.1.4 (optimised system for atmospheric and ionospheric RO observations), IROWG recommends that CGMS encourages ongoing and future GNSS RO and non-RO missions, including potential commercial providers of RO observations, to incorporate a complete set of ionospheric measurements.

Full workshop minutes and this CGMS working paper from IROWG-8 will be made available at http://irowg.org/workshops/irowg-8/. All given workshop presentations can be found at https://cpaess.ucar.edu/meetings/2021/irowg-8.

WGII took note of the presentation. WMO noted that it is currently preparing a new Data Policy and that the new Data Policy proposal has now passed its first intergovernmental body review. It is planned to have the new Data Policy approved by the WMO extraordinary Council in October 2021. WMO further clarified that the new Data Policy includes a reference that core data (previously essential data)

has to be agreed between WMO and the Space Agencies as is already now in the current resolution 40.

WMO therefore recommended that the above recommendation 1) would at this stage not be presented to plenary as " is ", as the issue is anyway well understood with a new proposed formulation:

1) IROWG stresses the importance of free, timely and unrestricted access in real time to essential RO data, and free and unrestricted access to archived raw data (including auxiliary data).

WMO further noted that the issue on coordination of data purchase is complex. In the subsequent discussion, it was noted that coordinated data buy would have some significant potential benefits, but for now the pilot data buy activities do not include free exchange of data at all. Furthermore, it was noted that more explicit descriptions of the data to be purchased is required in order to optimise the benefits of the data, e. g. in terms of filling temporal and spatial gaps.

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.09	WGII recommends that Agencies when pursuing data buy clearly defines all aspects of the data, e.g. orbits and coverage, in order to optimise the benefits of the data.
Plenary	3	WGIIR49.10	WGII recommends that Agencies consider data buy with an option for redistributing data to global NWP centres.

CGMS-49-IPWG-WP-01: Summary and Highlights from IPWG

Despite the IPWG-10 meeting postponement in 2020, it was deemed important to hold discussions on several topics of interest to the IPWG community. Several online meetings have been organised (2 held in 2020 and 3 planned for 2021). A new validation site over the Republic of Korea has been added thanks to KMA's efforts. Several algorithm improvements are currently under development to further enhance existing satellite precipitation products. This new site is now operational and linked to the IPWG website. A working group with IPWG and VLab trainers, with an interactive session on visualisation tools, will be organised as part of IPWG10. IPWG participated in a training event organised by Iran. Responding to CGMS actions, a report on the different operational applications of precipitation radars within the IPWG community is nearing completion and a joint IPWG/GEWEX Precipitation Assessment is at publication stage.

IPWG further noted that three nominations for the position for IPWG rapporteur had been received, and that IPWG recommends Joe Turk from NASA as new rapporteur replacing Ralph Ferraro.

Working Group II took note. WGII further thanked Ralph Ferraro for his diligent support to IPWG, WGII, and CGMS, and as there was no further discussions supported the recommendation for Joe Turk as the new rapporteur.

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.11	WGII recommends to plenary the nomination of Joe Turk as the new IPWG rapporteur.

CGMS-49-IPWG-WP-03: Terms of Reference for the International Precipitation Working Group (IPWG)

It was proposed at the first session of the IPWG (20-22 June 2001) to establish the International Precipitation Working Group (IPWG) as a permanent Working Group of CGMS. The IPWG will focus the scientific community on operational and research satellite based quantitative precipitation measurement issues and challenges. It will provide a forum for operational and research users of satellite precipitation measurements to exchange information on methods for measuring precipitation and the impact of space borne precipitation measurements in numerical weather and hydrometeorological prediction and climate studies.

TOR was updated to reflect neutral gender throughout the text (e. g. chairperson vs. chairman). Objective 2c was modified slightly to include "routinely generated" data in addition to operational data. Objective 2e was substantially revised to include more specific programmes that IPWG engages with (e. g. CEOS, GEWEX), as well as broadening the characterisation of satellite missions beyond GEO and LEO (e. g. "missions hosted by an increasingly diverse set….").

WGII took note of the ToR and had no further comments.

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.12	WGII recommends to plenary the adoption of the updated IPWG Terms of Reference.

CGMS-49-GUEST-WP-01: Proposal of Terms of Reference of the International Land Surface Working Group

The International Land Surface Working Group aims at enhancing the use of EO data for Cryosphere and Biosphere modelling applications both from IR/MW, active/passive remote sensing for the study of processes at the surface-atmosphere interactions with the aim of advancing data assimilation for application in weather and climate. The ISWG is also actively collecting user requirements and needs in relation to the most important challenges and gaps related to surface monitoring, in particular for soil moisture, snow and ice, vegetation state, and surface temperature.

During the discussion, it was noted that WGII had been under the impression that the proposed group would mainly address issues related to the modelling of land surfaces for NWP: However, the proposed ToR also consider issues related to radiative transfer and emissivity over sea ice. Furthermore, it was noted that the description of activities related to sea ice were somewhat vague causing a potential confusion between the objectives of the Group and other international initiatives looking at sea ice

monitoring. Whilst WGII fully supports the establishment of the group, it was felt that further articulation of the ToR are needed as well as using a different title for the group.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WGII	3	WGII/A49.14	WGII to review the updated draft Terms of Reference of the International Earth Surface Working Group (IESWG), including the naming scheme	10 May 2021	**OPEN**
CGMS members	3	WGII/A49.15	CGMS members to provide Points of Contacts for the proposed IESWG and for the upcoming workshop planned for May 2022.	Jun 2021	**OPEN**
WGII	3	WGII/A49.16	WGII to assess the organisation and CGMS participation of the planned IESWG workshop in May 2022 and to confirm its support for the establishment of a new ISWG.	CGMS-50	**OPEN**

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.13	WGII recommends to plenary to consider the establishment of a new International Science Working Group: "International Earth Surface Working Group" based on a successful organisation of the next IESWG workshop including broad CGMS member participation.

CGMS-49-GSICS-WP-01: Report from GSICS EP

The GSICS annual meeting was held virtually from 31 March – 2 April. Agencies demonstrated the on-orbit performance of their instruments and revealed the results of re-processing activities that used inter-calibration algorithms and applied adjustments NWP-GSICS to interact more closely in monitoring satellite instruments. The GSICS Annual meeting conveyed a positive outlook for the Space Component of the State of Observing System as Satellites supported by robust CAL/VAL systems (such as GSICS, CEOS) continue to provide high quality observations to the community. GSICS joined hands with communities such as NWP, WGCV/CEOS, ISCCP, and GPM-X to build CAL/VAL algorithms that can help generate and apply adjustments to satellite measurements thereby correcting them of any biases and provide traceability to in-space and on ground targets. Advances in Lunar and Solar reference data have resulted in development of robust (lunar/solar) models and algorithms that provide crucial calibration capability to measurement spectrum spanning VIS/NIR to Microwave. With the launch of

the first Geostationary UV measuring platform (GMES), the CAL/VAL community has acquired new opportunities to perform GSICS (SNO) style intercalibration with other UV under flights, thereby building a robust CAL/VAL system within the UV observing domain. GSICS has now produced over 74 Inter-Calibration products that are created by intercomparing monitored instruments with stable references such as IASI-A/B/C, CrIS, VIIRS. New references are being sought to span more monitored instruments.

WGII took note.

4. Arctic observations

CGMS-49-EUMETSAT-WP-09: Outcomes and recommendations of the EUMETSAT workshop on "the use of operational satellite microwave data for high-latitude and polar area models" (February 2021)

Microwave observations from satellites have a key impact on weather, ocean prediction, and climate analysis systems in the polar and high latitudes regions. Yet their use is suboptimal, limited by aspects of the observation, assimilation, and modelling components of those systems. A two-day science workshop was organised by EUMETSAT with the WMO Polar Prediction Project to discuss those limitations and ways to address them, in the context of coupled models and with a view to the future introduction of new microwave observations from e. g. EPS-SG, Copernicus CIMR, and potentially the Arctic Weather System. Workshop communications and panel discussions allowed to narrow down the issues and limitations, highlighted promising developments and evolutions and allowed formulating a few recommendations such as : (i) to continue investing in all components of the analysis and prediction systems, (ii) to develop the representation of snow and sea ice at the interface of coupled models, bridging their physical and radiative properties, (iii) to better take into account the spatial sampling characteristics of low-resolution microwave products in higher resolution assimilation processes.

WGII raised a question with regard to the meaning of “respectful of spatial scale” in one of the recommendations. EUMETSAT clarified that when the data is used in NWP, the observational operator is applied to the available data on a grid cell. If the footprint of the observation covers more than one cell, there is a risk to oversample the same data, so it will be important to take this into account. The same applies to the derivation of Level-2 and -3 products, particularly for multi-channel/instrument products with different resolution. Therefore, it is important to understand and take into account the effect of different footprints.

WGII took further note of the proposed recommendations and considered two of the recommendations appropriate for CGMS.

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	4	WGIIR49.14	CGMS members to collaborate with users and L3 developers on spatial resampling chains “respectful of spatial scale”

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	4	WGIIR49.15	CGMS members are encouraged to engage with the MOSAiC PIs for widespread use of the campaign data

CGMS-49-NASA-WP-01: ICESat-2's capabilities and products for the Arctic

As a result of the tight schedule, NASA combined the foreseen presentations on arctic and bathymetry capabilities of ICESat-2 into one presentation.

ICESat-2, which was launched on 15 September 2018, is carrying NASA's next generation laser altimeter, ATLAS (Advanced Topographic Laser Altimeter System), which is a photon-counting lidar designed to measure changes in ice sheet height, sea ice freeboard, and vegetation canopy height. ICESat-2 is NASA's flagship cryospheric sciences mission that was borne out of the 2007 NAS Decadal Survey recommendation to continue high-quality elevation measurements over Earth's polar regions using laser altimetry. For sea ice, ICESat-2's primary mission objective is to estimate sea ice thickness to examine ice-ocean-atmosphere exchanges of energy, mass, and moisture by making direct observations of sea ice height and sea ice freeboard. All along-track height products are available for download from the NSIDC DAAC, with ATL03 (the global geolocated photon cloud) being the primary lower-level data product from which all upper-level data are derived. Two along-track sea ice products are also available for download from the NSIDC DAAC (ATL07 (sea ice height) and ATL10 (sea ice freeboard)). Additionally, two gridded/derived sea ice products from ICESat-2 are now available (ATL20 (gridded sea ice freeboard) and ATL21 (gridded monthly sea surface height inside the sea ice cover)). All sea ice products are generated for both the Arctic and Southern oceans.

While ICESat-2 has no requirement to generate or produce a bathymetric data product, it was discovered shortly after launch that ATLAS was powerful enough to penetrate shallow bodies of water and provide estimates of seafloor depth down to 40 m. Using refraction correction techniques, ICESat-2 scientists have developed methods for calculating the depth of the seafloor in numerous near-shore environments and are developing a near-coastal bathymetry data product.

WGII took note of the presentations and the highly interesting capabilities of ICESat-2, in particular on ice monitoring capabilities and the measurements of seafloor depth.

CGMS-49-ECCC-WP-01: Status of plans for an Arctic Observing Monitoring mission by Canada

- Canada is coordinating a whole of government strategy for Space-Based Earth Observation (SBEO) and the Arctic Observing Mission (AOM) is a major proposed initiative of the strategy and this potential future programme.

- AOM would consist of two satellites in a Highly Elliptical Orbit (HEO) formation to make quasi-geostationary observations of meteorological parameters, GHGs, air quality (AQ) and space weather over northern regions (~45-90°N) addressing the current sparsity in spatial and temporal coverage beyond the viewing range of geostationary satellites.

- AOM is envisioned to be implemented as a Canadian-led mission with international partners. Discussions are underway with potential partners, and collaborative studies will begin in 2021 to mature the mission design and define the roles and contributions of each partner.
- Pending formal commitments in the future, AOM would launch around 2032 with a 10-year operational lifetime.

- AOM is viewed as being highly complementary to other existing and planned international Arctic missions.

ECCC clarified that the final approval is still two years away and targeted for 2023-24.

It was noted that for some imagery applications, like fire monitoring, resolution is important and hence polar orbiting satellites, despite the lack of temporal coverage, provide some advantages. ECCC responded and noted that fire monitoring would be a potential application and it has been already demonstrated in other GEO missions. In this context spatial resolution will be a relevant factor to be considered in the designing phase. Furthermore, it was noted that the performance and capabilities of the imager will closely follow those of the current ABI-class of instruments.

5. Working papers on climate

CGMS-49-JWGCLIM-WP-03: Status report of WGClimate

The population of ECV inventory is continuously ongoing so that version 4.0 will be consolidated in summer/fall 2021. The gap analysis related to version 3.0 is delayed due to the pandemic situation but will be terminated in fall 2021, latest. The gap analysis for version 4.0 shall be focused on the carbon cycle including the Global Stocktake aspect. This gap analysis is planned to be carried out during a workshop end of this year/beginning of 2021, favourably in person. For that, science experts are needed from agencies. Agencies are invited to nominate!

Use cases for Climate Data Records started as a new continuous activity of JWGClimate in order to demonstrate the value of the Climate Data Records for applications and decision making etc., but also in providing feedback towards quality improvements. Use cases shall be published on the web but a special WMO report is planned for 2021 on a representative selection. There is a need for an outreach to the broader community. CGMS member agencies are requested to advertise pro-actively this activity!

The Global Stocktake activities are ongoing and CGMS WGs had nominated PoCs in order to support the implementation of a virtual GHG monitoring and verification constellation (S. Burns for WGI&IV, J. Privette for WGII, and P. Zhang for WGIII). With updating the roadmap, the WGs will be included into the activities.

CMA was querying about the support to FCDR activities given by JWGClimate. JWGClimate clarified that the level of support depends on available resources. Furthermore, the discussion on the terminology FCDR/FDR is ongoing, which may also have an implication on the level of engagement of JWGClimate in the related activities.

It was also noted that during the report from IWWG, more guidance for the generation of the TCDRs is needed. JWGClimate noted that the International Science Working Groups should be represented on JWGClimate through their respective Chairs or Co-chairs. To date however, very little participation from the ISWGs has been seen and the ISWG are hence encouraged to clarify their PoCs for JWGClimate and to support the related activities.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	5	WGII/A49.17	CGMS members shall nominate scientific experts (not necessarily agency staff!) in order support the upcoming ECV inventory gap analysis	Aug 2021	**OPEN**

CGMS-49-WMO-WP-11: GCOS status report

The GCOS Status report is being finalised after a period of public review. It will be presented to the UNFCCC COP this year. It summarises the status of observations for each ECV and action from the 2016 GCOS Implementation Plan, with the full details contained in annexes. A chapter on satellite observations was contributed by the Joint CEOS/CGMS JWGClimate. Since 2016, satellite observations have improved their coverage both spatially, temporally, and in terms of observed variables. Satellite data are accessible and well curated.

There have been improvements due to new in situ observations while GCOS and WMO are establishing a reference network for in situ observations (similar to GRUAN). Best practices for ocean observations, data and meta-data were agreed and the development of improved sensors for a range of ocean ECVs. However, the long-term continuity of some satellite observations is not assured: no continuity is assured for cloud radar and lidar on research satellites, and only one limb sounder with similar capabilities to the Aura Microwave Limb Sounder (MLS) is planned.

For in situ observations, sustainable and operational funding is needed. Many atmospheric observations are made on an operational basis, with most ocean observations and terrestrial observations supported through research funding with a typical lifetime of a few years. In situ observations for almost all the atmospheric and terrestrial ECVs are consistently deficient over certain regions, most notably Africa, South America, South East Asia, the Southern Ocean, and ice-covered regions.

To support the UNFCCC Global Stocktake ECVs quantitative assessment of anthropogenic greenhouse gas fluxes, and ECVs that track physical, chemical, and biological cycles as well as direct measures of the ocean overturning circulation are needed. Preservation of the fundamental climate data records is essential. While there are many successful global climate data centres, even when there is a recognised global data repository, it is sometimes incomplete and/or inadequately supported. The GCOS/WCRP Climate Observations conference will be held online from 30 August to 3 September 2021 (see https://www.eventsforce.net/eumetsat/27/dailyAgenda). GCOS would encourage the Satellite

community to contribute, submit abstracts, and participate in this event. [NB the GCOS conference has in the meantime been postponed to 2022 due to the pandemic].

The Status Report and the Climate Observations Conference will be key inputs into the next GCOS Implementation Plan due in 2022. GCOS would like to ask CGMS to contribute to the development of the Implementation Plan.

- CGMS is invited to take note of the upcoming GCOS Status Report and GCOS/WCRP Climate Observations Conference.

Proposed Action CGMS WGII: CGMS to provide input for the next GCOS Implementation Plan based on the findings of the Status Report and Climate ConferenceWGII took note of the report. During the discussion, the translation of technology free GCOS requirements to space-based observation requirements was raised. Both GCOS and JWGClimate agreed that this translation of the requirements is critical and that a formal mechanism for the translation is currently missing. It was further considered that GCOS and JWGClimate would jointly be in the best position to consider the best way forward towards establishment of a formal approach to achieve the objective.

CGMS-49 actions – WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	5	WGII/A49.18	CGMS to provide input for the next GCOS Implementation Plan Observations Conference.	TBD	**OPEN**
GCOS/ JWGClimate	5	WGII/A49.19	GCOS and JWGClimate to develop a proposal for a formal approach for the translation of GCOS technology free requirements to requirements for space-based observations.	CGMS-50	**OPEN**

CGMS-49-CMA-WP-06: Progress of Fengyun satellite FCDRs

This document presents the progress of Fengyun satellite fundamental climate data record (FCDR) generation. Historical sensor data records (SDR) are being reprocessed for 7 series of instruments including 3 optical imagers (FY-1/3 VIRR, FY-3 MERSI, and FY-2 VISSSR), 1 optical sounder (FY-3 IRAS), 2 microwave sounders (FY-3 MWTS and MWHS), and 1 microwave imager (FY-3 MWRI). Three versions dataset are planned (beta, trial, and formal) with the release times of 2019, 2020, and 2021, respectively. The beta version (V1) datasets have been completed through the lifetime recalibration of each instrument in 2019, using the consistent calibration framework. The trial version (V2) dataset focuses on the improvement of the recalibration model to achieve the accuracy and stability. At present, the trial version (V2) datasets are completed for MWRI, MWTS, and VIRR solar bands, meanwhile others are still ongoing.

In responding to a clarification from WGII, it was noted that reprocessed outgoing LW radiation and AMV products have been provided to the JWGClimate inventory and regarding FCDRs the issue is open and waiting clarification of the overall engagement of JWGClimate in FCDR activities.

CGMS-49-EUMETSAT-WP-06: Progress on EUMETSAT FCDRs

The presentation addresses recent progress at EUMETSAT in the preparation of Fundamental (Climate) Data Records (FCDRs). EUMETSAT produces FCDRs for the usage in:

1. Direct exploitation for GCOS Essential Climate Variables;
2. Data assimilation schemes for global and regional reanalysis employing NWP models. Progress has been made on a number of items with data being available at https://navigator.eumetsat.int:
3. Date rescue, image radiometric anomaly detection, uncertainty estimation, and recalibration for all Meteosat and Japanese (in collaboration with JMA) instruments in geostationary orbit;
4. Recalibration and improved quality flagging for HIRS-1/2/3/4 IR sounders;
5. Consistent uncertainty estimates for 183 GHz channels for MW sounders (SSM/T2, AMSU-B, MHS, ATMS, MWHS-1/2);
6. Radio occultation data records with application of consistent wave optics algorithms for CHAMP, GRACE, COSMIC, and MetOp GRAS;
7. Assessment of bias correction models for reanalysis for HIRS, MVIRI, SSM/T2, and SMMR instruments.

A long-term goal is the implementation of CGMS plenary action A48.05 to generate quality controlled, recalibrated, and uncertainty characterised Fundamental Data Records (FDRs) for each individual geostationary platform addressing all spectral channels. Generation of a quasi-Global Fundamental Climate Data Record (FCDR) derived from the individual FDRs. To foster activities EUMETSAT plans to revive the SCOPE-CM IOGEO project under a new name: *Geostationary ring of meteorological satellites FCDR for Climate (GeoClim)* and asks CGMS agencies for participation. This project can support the needs of many geo 'ring' FCDR users for global ECV data records including the ISCCP-NG project

CMA noted that it would be important to ensure that data series go back in time as far as possible and would welcome additional validation activities with CMA data.

With respect to Sentinel-3 reprocessing, EUMETSAT noted its responsibility for the ocean mission, so L2 reprocessing is guaranteed, together with some L1 for the altimetry. However, the overall mission responsibility is split between ESA and EUMETSAT, with ESA being responsible for land products and reprocessing of those products fall on ESA. Furthermore, the level-1 reprocessing activities are joint and the way forward for coordinated consistent reprocessing is currently under discussion.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
EUM, CMA	5	WGII/A49.20	EUMETSAT and CMA to consider opportunities for intercomparison of their reprocessed data sets.	CGMS-50	**OPEN**

CGMS-49-NOAA-WP-19: Use cases from NOAA CDRs

NOAA has produced and extended Climate Data Records (CDRs) derived from its operational satellite fleets for nearly two decades. CDRs typically merge data from multiple satellites extending over multi-decadal time periods to provide the longest homogeneous and consistent time series data records possible from historical observations. Most NOAA CDRs are global and extend from the late 1970s through present. They provide about 200 different data fields characterising the dynamic Earth system, from atmospheric temperature to Arctic sea ice, vegetation density and health, and solar irradiance.

CDRs are used in a wide range of research and applications. Government, industry, and academia use CDRs to monitor climate by putting current forecasts and observations into historical context, and to reliably identify climate trends, patterns, anomalies, and extremes. They also support many climate adaptation, risk-assessment, and other socioeconomic applications. Most CDRs address the Essential Climate Variable (ECV) requirements of the Global Climate Observing System (GCOS), support global modelling efforts and national and international assessments (e. g. Intergovernmental Panel on Climate Change, IPCC).

In this presentation, example uses and applications of NOAA's CDRs were described, including the validation of climate projections, assessing agricultural droughts, and predicting domestic energy demand.

WGII took note of the presentation, which provides important examples demonstrating the benefits of CDRs beyond use of the products in NWP reanalysis. It was further noted that more cases are needed and whilst the CGMS members may not themselves develop use cases, the members are encouraged to reach out to their data users to identify additional use cases

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	5	WGII/A49.21	CGMS members are requested to reach out to the users of their respective CDRs for additional use cases.	Dec 2021	**OPEN**

CGMS-49-ISCCP-WP-01: Status of the International Satellite Cloud Climatology Next Generation (ISCCP-NG)

With the availability of MTG in 2023, the entire geostationary ring will be encircled by imagers which offer capabilities far superior to those from the previous generation of imagers. The Next Generation of the International Satellite Cloud Climatology Project (ISCCP-NG) is proposed as a follow-on to the classic ISCCP to more fully exploit the new capabilities. The challenge facing ISCCP-NG is to define a new baseline from these data and processing methods to extract meaningful information for the scientific community in the coming decades. Since the inaugural workshop in late 2019, ISCCP-NG has focused on its gridded Level-1 (L1g) data. L1g is meant to be the primary input into all ISCCP-NG Level-2 and Level-3 and is an attempt to make access to these new data easy for the ISCCP-NG community. L1g combines all of the data from all of the sensors into one standard and consistent format. Currently,

L1g concepts are being prototyped and made available for testing. L1g development is relying on the GSICS project for calibration. With L1g data available, the work on ISCCP-NG Level-2 data is beginning and will be discussed at future International Cloud Working Group (ICWG) Workshops in the next two years.

WGII welcomed the presentation and in particular noted the importance of connecting with GSICS as shown. During the discussion, the importance of having consistent long-term time series was underlined and the question was raised on how ISCCP-NG, which is based on the current generation of satellites, can be used for older satellite data. In response, Andy Heidinger noted that reprocessing past data is a big important topic that the group will work on. With respect to the use of the proposed L1g for Level-2 reprocessing activities, it was confirmed that this currently is a request for cloud products, but other products are welcomed too. Furthermore, it was noted that this is an additional activity on top of NRT Level-2 production and nominal reprocessing activities.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	5	WGII/A49.22	CGMS member to provide feedback on the proposed L1g concept for ISCCP-NG.	TBD	**OPEN**

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	5	WGIIR49.16	CGMS member to consider derivation of Level-2 products using the new proposed Level-1g data.

6. Agency response to the greenhouse gas initiative and applications

CGMS-49-CMA-WP-08: Space observation of greenhouse gas from China

The three instruments for greenhouse gas measurements from space are operated by China: Atmospheric Carbon-dioxide Grating Spectroradiometer (ACGS) TanSat, GHG (GreenHouse Gases) Absorption Spectrometer (GAS) on FengYun-3D (FY-3D) and Greenhouse-gas Monitoring Instrument (GMI) on Gaofen-5 (GF-5). They utilise different technique to obtain high resolution spectra in near infrared band. XCO2 and SIF products are successfully retrieved from these missions in China. But much work is still needed to investigate in order to provide valuable products with high accuracy and precision for monitoring the carbon cycle and climate research.

WGII congratulated CMA on their progress on the provision of space-based high-quality Greenhouse Gas monitoring data.

CGMS-49-EUMETSAT-WP-12: Status of the CO2M mission

As part of the European Copernicus Programme, ESA, together with the support of EUMETSAT and ECMWF, are preparing the expansion of the first-generation Copernicus Space Component to include measurements for anthropogenic CO_2 emission monitoring. The greatest contribution to the increase in atmospheric CO_2 comes from emissions from the combustion of fossil fuels and cement production. In support of well-informed policy decisions and for assessing the effectiveness of strategies for CO_2 emission reduction, uncertainties associated with current anthropogenic emission estimates at national and regional scales need to be improved.

ESA has been tasked by the European Commission to develop the space-segment and its payload, as well as parts of the overall ground-segment of a future CO_2-Monitoring (CO2M) mission. Through an envisaged Contribution Agreement with the European Union, it is expected that EUMETSAT will be tasked to develop the remaining parts of the overall ground-segment including the Mission Data Ground-Processing Sub-Segment (MDGS), which facilitates the continuous processing, monitoring, validation and, where needed, vicarious calibration of the payload data-products and their operational dissemination to users. EUMETSAT will also undertake the routine operations of the CO2M satellites, while ESA will perform the satellite in-orbit verification and satellite commissioning activities whilst taking care of the satellite operations during this phase.

In the paper an overview of the mission objectives is provided, the space-segment payload and their target requirements, as well as the main logical elements of the CO2M operational processing system currently implemented and established as part of ESAs CO2M Phase B2/C/D/E1 and EUMETSATs CO2M Phase A/B1 activities. Particular focus is put on giving an overview of the key parameters and products, which can be expected from CO2M and point to specific challenges for a future operational CO2 monitoring system.

WGII noted the presented schedule is challenging in terms of actual launch, data processing, and provision of data in time for the global stocktake in 2028. For the data to be considered, it would need to be available latest early 2027. EUMETSAT and ESA clarified that the launch readiness review is in quarter 4 2025 and the launch would nominally be roughly three months after the review. Furthermore, it is currently foreseen to initially launch two satellites, with the third satellite of the constellation being launched later. With respect to the data processing challenges, it was noted that through international collaboration the mission can take benefit from lessons learnt by the OCO-2 and GOSAT teams and furthermore there are several similarities with EUMETSAT EOS-SG instruments that alleviate the challenges. However, all-in-all, it was agreed that the schedule remains challenging.

CGMS-49-JAXA-WP-04: Decade-long global GHG observation by GOSAT towards the global stocktake

The Japanese Greenhouse gases Observing SATellite (GOSAT), in orbit since 23 January 2009, monitors carbon dioxide and methane globally every 3 days and targets large cities in over 50 locations frequently and has been doing so for more than 12 years. Within the GOSAT mission, GOSAT-2 was launched in 29 October 2018 and has been in normal operation. GOSAT and GOSAT-2 are equipped with a single Fourier transform interferometer and have simultaneously observed both reflected SWIR solar light and TIR emissions with the Thermal And Near-infrared Sensor for carbon Observation Fourier-Transform Spectrometer (TANSO-FTS) and TANSO-FTS-2, respectively. JAXA Earth Observing Research Center (EORC) has newly developed the retrieval method to derive the difference between

the partial column-averaged dry-air mole fractions of the two individual layers of lower and upper troposphere (LT and UT) by combining TIR and two linear polarised SWIR spectra data simultaneously, thereby constraining the accurate total column density of XCO2 and XCH4. To contribute to the 2023 Global Stocktake, JAXA continuously provides observation data and research products to the public. In addition, the agency tries to elucidate the local emissions though the intense target observation dataset of GOSAT and GOSAT-2. The key for estimating the localised emission is how to identify the background concentration with discreating sources. JAXA assumes that the upper partial column results represent background CO_2 concentrations, which are less affected by the city, while the lower partial column results track the CO_2 concentration changes within the city. In 2020, the agency detected lower anomalies than previous years over mega cities such as Beijing and Tokyo. JAXA/EORC products have a potential to open a state-of-the-art approach in local flux estimation. Their research products are available at the JAXA GOSAT EORC site (https://www.eorc.jaxa.jp/GOSAT/index.html).

WGII congratulated JAXA on their progress on GHG monitoring. In response to a query from WGII, JAXA clarified that they regularly monitor several megacities beyond those mentioned in the presentation. It was further clarified that JAXA uses modelling and other satellite observations like Sentinel-5p, to detect high CO_2 levels and then guide the mission for target acquisition. Furthermore, inputs from other entities are considered as well.

CGMS-49-NOAA-WP-08: NOAA report on GHG monitoring

NOAA is of the opinion that an integrated and sustained, multi-platform, surface-to-space GHG observing system capable of tracking ecosystem, ocean, and anthropogenic emissions and removals is needed to improve climate predictions and support mitigation efforts.

Recent studies demonstrate the complementarity of diverse satellite and in situ measurements for tracking GHG emissions and removals.

Systematic errors in current XCO2 and XCH4 satellite datasets are large relative to key ecosystem and anthropogenic flux signals.

Stability requirements for diagnosing processes and tracking emissions cannot be realised without a greatly expanded and sustained Global Greenhouse Gas Reference Network of well-calibrated in situ measurements with sufficient density and frequency to reliably correct regional, time-dependent, and cross-platform biases.

A continuum from research to sustained operations should be maintained to ensure measurement compatibility over decades while allowing for innovation

The paper proposes for CGMS actioning:

- Creation of a GCOS Global Greenhouse Gas Reference Network consisting of rigorously calibrated in situ surface, aircraft, and balloon measurements to enable the reliable detection of trends over decades to centuries.
- Creation of GCOS National and/or Regional Greenhouse Gas Reference Networks with sufficient density and frequency to reliably detect and correct significant time-dependent

regional biases in satellite GHG datasets. High priority for new observations should be focused on data-poor regions and regions sensitive to change.

- These activities should be conducted in close collaboration with the WMO Global Atmosphere Watch Programme and the WMO Integrated Global Greenhouse Gas Information System.

During the discussion, it was noted that CGMS is well aware of the importance of ground-based/in-situ observations, and this has been discussed previously in this and earlier meetings. Furthermore, whilst recognising the need for this data not only from an overall monitoring system, but also for satellite calibration/validation activities, CGMS does not establish or operate ground-based networks. It was further noted that the need for ground-based/in-situ observations and evolution of reference networks should be discussed in the JWGClimate Task Team. As suggested by the paper, coordination on the requirements for and access to reference network data are already discussed with GCOS and GAW/IG3IS.

CGMS-49 actions - WGII					
Actionee	**AG**	**Action**	**Description**	**Deadline**	**Status**
JWGClimate	6	WGII/A49.23	JWGClimate GHG task team to provide a report on the progress of the evolution of ground-based/in-situ GHG observations to CGMS.	CGMS-50	**OPEN**
WMO	6	WGII/A49.24	WMO to raise the concern on adequacy of existing GHG reference networks to GAW/IG3IS and GCOS and to report on the current status of the development of reference networks at WMO.	Sep 2021	**OPEN**

7. Working papers on ocean monitoring

CGMS-49-EUMETSAT-WP-11: CGMS Ocean Vector Winds Task Team - Terms of Reference and roadmap

WMO CGMS-48 plenary (A.48.10) actioned a SCAT task team, led by Dr Ad Stoffelen, to present ToR and a Roadmap at the CGMS-49 plenary. This is furthermore related to the action of the CGMS-48 WGII (A.48.10) Ocean Surface Winds (OSW) team to present at the next GSICS meeting the potential benefits and issues of cross-calibration of scatterometer data. The ToR of the International Winds Working Group (IWWG) drafted for CGMS-49 include “(ii) ocean surface winds derived from radar scattering and conical-scanning microwave radiometers” and objectives “To exchange results on novel developments regarding the use of satellite-derived winds, in particular for numerical weather prediction (NWP)”, “To support and perform routinely scheduled wind inter-comparison activities in close collaboration with (CGMS) scientific working groups”, “To establish agreement for standards in the verification and validation of satellite-derived winds”, “To support the definition of user requirements and gap analysis for atmospheric wind parameters in the framework of future Global

Observing System (WIGOS, WMO OSCAR database)" and "To make recommendations to CGMS and to national and international agencies regarding the utilisation of current and the development of future satellite instruments on polar satellites". Since these objectives in particular are not fully covered by CEOS and the International Ocean Vector Wind Science Team (IOVWST), it is proposed to form an OSW task group (TG) within the IWWG. This would formalise a long tradition of the representation of the scatterometer NWP users and scatterometer wind producers at the IWWG. The CGMS and WMO are user organisations with a strong focus on the user exploitation of satellite data. In particular, the OSW services for use in NWP need further coordination and collaboration through the IWWG. This moreover becomes increasingly pressing as models are coupled to the ocean. Finally, the GSICS action would be very relevant to this OSW WG and furthermore closely linked to the CEOS Working Group on Cal/Val (WGCV) Microwave Sensors Subgroup (MSSG). Other IWWG objectives, e. g. on methods and training, that in parts overlap with CEOS and the IOVWST, will also need coordination. Hence the OSW and SCAT task team recommendation:

Establish an Ocean Surface Wind Task Group (OSW TG) in the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS, and the IOVWST

This implies that OSW TG actions and recommendation will be reported to/from CGMS through established IWWG mechanisms and in addition to CEOS and IOVWST.

IOC welcomed the presentation and noted it is trying to organise a scatterometer task team. Vector wind is a fundamental parameter for ocean science. IOC already started the UN ocean decade. IOC should be involved in this discussion. IOC further expressed its interest to join and support the work of the team.

It was further noted that as the scatterometer observations have become a fundamental part of the operational space-based observing system, a coordination mechanism within CGMS is long overdue. CGMS welcomed the foreseen coordination with ongoing CEOS initiatives to assure there will not be duplication of efforts. In addition, the coordination with other international efforts is important.

In conclusion, WGII supported the creation of the dedicated Task Group:

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	7	WGIIR49.17	WGII recommends to plenary the establishment of an Ocean Surface Wind Task Group (OSW TG) in the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS, and the IOVWST and other relevant entities.

CGMS-49-NOAA-WP-10: The value of NOAA CoastWatch/OceanWatch/PolarWatch to operational satellite oceanography

Satellite-based ocean/water remote sensing products are being integrated into many operational applications for routine and event-driven environmental assessments, predictions, forecasts, research, and management decisions, providing societal and economic ("the blue economy") benefits. The significant potential for many more applications will be realised as satellite data providers/agencies work with users to increase their awareness of data fit for their purposes, reduce barriers to understanding and access, and develop new tools and analytical methods with capacities to exploit large quantities of remotely-sensed data without the need for users to become "satellite data experts". Since its origins in 1987, NOAA CoastWatch/OceanWatch/PolarWatch (a.k.a. "CoastWatch", https://coastwatch.noaa.gov) has been connecting users and applications with ocean and coastal satellite data, bridging gaps, and facilitating the transition from data to information. CoastWatch serves all NOAA missions (including National Weather Service, National Marine Fisheries Service and National Ocean Service, and the office of Oceanic and Atmospheric Research) and others in the US or internationally, including other government agencies, academia, industry/commercial sector, non-profit organisations, and the general public. CoastWatch data products and services include value-added and analysis-ready data products, data portals, visualisation software, training courses and tutorials, helpdesk and user forums as well as direct collaboration with stakeholders on application development. In June 2019, NOAA and EUMETSAT jointly hosted the First International Operational Satellite Oceanography Symposium (OSOS) which was held at the NOAA Center for Weather and Climate Prediction in College Park, MD, US. The Second International Operational Satellite Oceanography Symposium (OSOS-2) will take place virtually 25-27 May 2021 and will build upon the outcomes and recommendations of the first, this time focusing on users and applications in a few specific themes. One of the recommendations of the first OSOS was to engage with CGMS to promote understanding and actions on oceanographic satellite observations and requirements. The corresponding paper aims at familiarising CGMS with the role of NOAA CoastWatch in promoting and facilitating the use of satellite data in ocean and coastal applications (operational satellite oceanography). In light of the growing role of ocean satellite observations for operational applications and "the blue economy" as well as their importance in weather and climate forecasting, CGMS is hereby urged to consider adopting explicit ocean-related objectives and activities in the next HLPP, leveraging the knowledge and expertise of the organising committees and the outcomes and recommendations of the International OSOSs.

The Chair appreciates the multiple service perspective presented in this talk.

HLPP would be the place where CGMS could stress more the ocean context. The data access section would be a suitable place for this reference. CGMS could be more specific in terms of referring to the ocean. NOAA could provide a more specific statement to be used.

An ocean and coastal WG/Task Team could be a solution to reinforce the CGMS support to operational oceanography. It could be a significant contribution to the UN Ocean Decade and its Global Coastal Ocean programme (CoastPredict, coastpredict.org - Programme Document).

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
NOAA	7	WGII/A49.25	To provide specific suggestions to CGMSSEC for updated language in HLPP with respect to Oceans.	CGMS-50	**OPEN**
CGMSSEC	7	WGII/A49.26	CGMS SEC to suggest updates on HLPP on oceans to CGMS WG I-IV Chairs	CGMS-50	**OPEN**
WGII	7	WGII/A49.27	WGII to consider the value and approach for the establishment of a new Ocean and Coast Working Group as a new International Science Working Group	CGMS-50	**OPEN**

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	7	WGIIR49.18	WGII recommends to plenary the endorsement for future OSOS Symposia
OSO	7	WGIIR49.19	WGII recommends that OSOS engages with the full International community

CGMS-49-IOC-UNESCO-WP-01: Need for satellite observations for ocean monitoring and synergies with surface-based observations satellite oceanography

The proposed presentation by IOC on "Need for satellite observations for ocean monitoring and synergies with surface-based observations satellite oceanography" was withdrawn due to schedule issues. IOC however proposed to WGII that such a paper would be presented at CGMS-50 and would invite additional people to support the presentation. The paper would look at the need for satellite observations and synergies with in-situ observations to improve predictability of weather and climate. The expansion of the observation considerations to the entire oceans, bottom to top and coast to coast, also fits the new WMO strategy. The theme is also very appropriate for IOC and the new UN Decade on Ocean Science for sustainable Development. It is proposed that an action from WGII to IOC to provide a paper at CGMS-50 is tabled.

The CGMS Secretariat noted that there is a standing action to invite IOC to CGMS to present key issues with respect to ocean observations and hence there is no need for a new action.

8. Selected topics of high priority to members

CGMS-49-ESA-WP-02: Status of Aeolus data and products

ESA's wind mission, Aeolus, was launched on 22 August 2018. Aeolus is an ESA Earth Explorer Core mission, hosting a single payload – the first space-based Doppler Wind Lidar (DWL) worldwide. The primary mission objective is to demonstrate the DWL technique for measuring wind profiles from

space, intended for assimilation in NWP models. The wind observations will also be used to advance atmospheric dynamics research and for evaluation of climate models. Mission spin-off products are profiles of cloud and aerosol optical properties. The Aeolus data quality is less good than anticipated before launch (random errors: 3 -6.5 m/s), but still provides a larger than expected positive impact in global NWP models, as demonstrated by ECMWF, DWD, Météo-France, UK Met Office, NOAA, ECCC, NCMRWF, and JMA (also reported at 15th IWWG workshop, 12-16 April 2021).

The Aeolus instrument is suffering from slowly drifting alignment causing an increase of the product random errors with time. Mitigating activities are ongoing to allow for sufficient data quality to ensure positive NWP impact also beyond 2021 (design lifetime: 3 years). The mission was recently extended to the end of 2022. Follow-on DWL missions delivering improved-quality winds in the next decade are strongly supported by the IWWG.

Public data release in May 2020:

- Distribution of L1, L2A, L2B, L2C data within 3 hours of sensing (NRT) via ESA's Aeolus Data Dissemination Facility (ADDF, http://aeolus-ds.eo.esa.int/oads/access/)
- Distribution of L2B BUFR formatted data NRT via EUMETSAT and DWD on EUMETCAST
- WMO GTS (to initiate GTS reception, please contact DWD)

Further algorithm baseline updates improving further on product random and systematic error performance and classification:

- Baseline 11, implemented in near real-time-processing as of October 2020
- Baseline 12, delivered and will be implemented in NRT processing in May 2021

Data reprocessing datasets, for use e. g. in OSE and other impact experiment activities:

- Baseline 10, reprocessed dataset: July 2019 –December 2019 (initial part of Aeolus FM-B laser dataset) available to users since October 2020. Improvements include e. g. bias correction and improved signal processing reducing random errors
- Baseline 11, reprocessed dataset: July 2019 – to date: Reprocessing ongoing and data scheduled for delivery to users in Q3 2021

Centres currently operationally assimilating Aeolus L2B wind observations:

- ECMWF (since January 2020)
- DWD (since May 2020)
- Météo-France (since June 2020)
- UK MetOffice (since December 2020)
- Possibly also in 2021: NCMRWF, JMA

WGII congratulated ESA on the success of Aeolus and wished them continued success with the mission despite the challenges. WGII especially noted gratefully that ESA is considering every possible option to maintain the mission as long as possible. ESA responded that the intention is to continue the mission as long as the data is of value to the users.

ESA also clarified that in the presence of clouds, Aeolus either measures wind at the top of cloud or for thin clouds also in clouds. Aeolus is also exploiting gaps between the clouds to optimise coverage.

CGMS-49-JMA-WP-05: Sunshine duration product estimated from 2.5-minute Himawari-8 observation data

JMA operates a surface meteorological observation network incorporating around 1,300 stations using automatic observation equipment collectively known as the Automated Meteorological Data Acquisition System (AMeDAS). Stations are situated at average intervals of 17 km nationwide (with around 1,200 unmanned), and the Weather Analysis Map (WAM) gridded weather product developed from the data collected helps to meet user demand for 2-D meteorological information. Enhanced Himawari-8/AHI temporal resolution enables sunshine duration analysis using 2.5-minute rapid observation over Japan, which was added to the WAM product on 23rd September 2020. Gradient-boosting decision-tree machine learning is used for related estimation with AMeDAS sunshine duration observation teacher data excluding values affected by shadows from surrounding obstacles. Himawari-8 observation data, grid point data from NWP (e. g. atmospheric transmittance) and geometrical condition information such as sun zenith angle are used as input. Comparison of estimated one-hour sunshine durations with AMeDAS observation data for the period from July 2018 to June 2020 shows a BIAS of 0.73 minutes and an RMSE of 8.26 minutes. The one-hour sunshine duration product is used to monitor the latest meteorological conditions. The sunshine duration observation role of AMeDAS stations was terminated in March 2021 in favour of the 10-minute sunshine duration product.

WGII thanked JMA for their presentation. It was clarified that the sunshine products are already provided to a number of users.

In response to a query on plans for a full disk product JMA clarified that the current product is mainly targeting Japan and the development of a full disk product is not currently considered.

CGMS-49-NOAA-WP-06: Status of GEOXO plans

GOES-R series in operations now, with 2 more launches in late 2021 and 2024, and will be in operations in the 2030s

Expected loss of an on-orbit spare in 2032 drives the need date for NOAA’s next generation geostationary satellite series

A NOAA working group formed in early 2020 and was tasked with recommending user requirements for the future geostationary programme, called Geostationary and Extended Orbits (GeoXO).

A series of user engagement workshops were held in 2020 to assess user needs and expected observing requirements for the 2030-2050 time period.

Five instrument types in geostationary orbit were recommended: Imager, IR Hyperspectral Sounder, Lightning Mapper, Atmospheric Composition, and Ocean Colour.

The Chair noted that following the same presentation given at the joint WGII-WGIII meeting, the importance of operational continuity of air quality/atmospheric composition measurements after TEMPO, which could be provided by GEO XO ACX, was discussed. He further noted that a letter of support in that respect to NOAA from CGMSSEC could be considered with an associated recommendation to plenary. The proposal was supported by WGII.

In response to a query from KMA it was clarified that there are some advantages and disadvantages of both proposed constellations. The advantage of the first constellation which also looks at payload hosted on non-NOAA satellites is that it provides better coverage for the hyperspectral infrared sounder data. The disadvantage is that both the sounder and imager are large instruments, leading to a larger overall spacecraft, which is more costly to develop with a high risk. The advantage of the three NOAA provided satellite system is the provision of the hyperspectral capabilities on a different platform than the imager, which then leads to smaller spacecraft, cost, and reduced risk, however at the cost of hyperspectral sounder coverage.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS SEC	8	WGII/A49.28	WMO/CGMS SEC to write a letter of support to NOAA on the GEO XO ACX efforts.	Aug 2021	**OPEN**

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	8	WGIIR49.20	WGII recommends to plenary that CGMS provides a letter of support to NOAA on the GEO XO ACX efforts

CGMS-49-IPWG-WP-02: Precipitation Monitoring and the constellation of microwave instruments

Regarding the status of the constellation of microwave instruments, IPWG held an open online session in June 2020 to discuss future needs for precipitation monitoring. This online session, with 120 remote participants, paved the way for a smaller group of IPWG members led by C. Kidd (NASA) to submit a paper summarising the observational needs for precipitation monitoring, how these needs are met with the current constellation, as well as how these may be met with future instruments. The presentation summarises the outcomes of this paper, recently accepted for publication in the *Bulletin of the American Meteorological Society, as well as recent efforts made on this subject within the IPWG community.*

The Chair noted that it is important to take these kinds of analysis into account, providing a more detailed description of the requirements, when considering the WMO WIGOS Vision 2040 and for CGMS baseline.

It was further noted that it would be useful to have additional information from IPWG to determine detailed requirements for microwave baseline observations as an input to the gap analysis and for the

optimisation of the precipitation constellations (e. g. frequency, spatial and temporal coverage). IPWG responded noting that a recently published BAMS paper has important input to define baseline dependency on different configurations.

It was also noted that new private initiatives such as ClimateCell could be interesting in the future portfolio, however it is necessary to wait for the quality of the data.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
IPWG	8	WGII/A49.29	To further detail the observational requirements for microwave observations (sounder and imager) from an IPWG perspective, including frequencies, resolution, orbits…	CGMS-50	**OPEN**

CGMS-49 recommendations - WGII			
Actionee	**AGN item**	**Rec**	**Description**
WMO	8	WGIIR49.21	WMO to take into consideration the requirements for microwave imaging and sounding constellations, also in
CGMS members	8	WGIIR49.22	CGMS members to consider using all currently available microwave imager data for their precipitation products.

CGMS-49-WMO-WP-07: Results from the 7th WMO Impact Workshop in 2020

The seventh WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction was organised by WMO from 30 November – 3 December 2020 as a virtual event. The workshop was conducted in English.

The workshop was attended by roughly 110 participants each for the four days; the core participants ("panellists") were the members of the Scientific Organizing Committee (SOC) and the 42 authors whose contributions had been selected for presentation, and an additional 70 interested individual attended the Workshop in listening mode.

The overall Workshop attendance included experts in data assimilation and observation impact, experts in climate change and seasonal forecasting, representatives from space agencies and from private industry, as well as managers of observing networks.

During the Workshop, the results presented were reviewed in plenary discussion sessions. Conclusions to help guide the design and evolution of components of the WIGOS for NWP were drawn.

IROWG requested a clarification on the impact of ground-based "radio-occultation measurements." WMO clarified that the presentation was based on a first draft of the report and still has not been consolidated. With respect to the question raised, WMO further clarified that the reference is indeed

to ground-based GPS and not to radio occultation and noted that this will be clarified for the final report.

IROWG noted that with respect to radio-frequency and protection, there is a clear impact on RO observations from what appears to be intentional jamming of the GPS frequency band. This has been documented in e. g.: https://cpaess.ucar.edu/sites/default/files/meetings/2021-irowg-8/posters/Roberts1_Detection%20copy.pdf

9. Working papers responding to or raising CGMS actions

There were no other papers addressed.

10. Any other business

During the AOB section, the updated terms of reference for IWWG and the new proposed working group "International Land Surface Working Group" (ILSWG) were reviewed.

After an additional minor change, the ToR of IWWG were recommended to plenary for adoption (see also agenda item 3 and recommendation (WGIIR49.08)).

Based on an Action from Session 3, ILSWG reconsidered the name of the group and proposed "International Earth Surface Working Group" as the new name. Furthermore, an updated ToR was presented. WGII noted that support to modelling is still the primary focus of the working group, however as the actual activities are well defined in the updated ToR, the new proposed name of the group is acceptable. WGII then subsequently endorsed the proposal and ToR for the new group with an associated recommendation to plenary for adoption (see also agenda item 3 and recommendation WGIIR49.13).

11. Review and updating of the HLPP

CGMS-49-CGMS-WP-03WGII: Status of implementation of CGMS High Level Priority Plan (2020-2024), CGMS-49-CGMS-WP-04WGI: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2021-2024

CGMSSEC introduced the subject and noted that there had not been any recorded proposed changes to the HLPP during the meeting, however some refinements are expected with respect to ocean monitoring. It was therefore proposed that the review of the HLPP will be done by the Chairs, rapporteurs, and CGMSSEC separately in time for CGMS-49 Plenary.

WGII took note of and endorsed the way forward.

12. Future CGMS plenary sessions

CGMS-49-CGMS-WP-06WG11: Nominations CGMS, ISWGs, VLAB - Co-chairs and rapporteurs

There is a need to fill a number of vacancies (or upcoming ones in the near future) for co-chairs and rapporteurs in some of the CGMS Working Groups, rapporteurs in the CGMS international science working groups, and the co-chair position in VLab. The status is provided in the working paper

indicating either existing vacancies or upcoming ones in the near to medium term future. CGMS members are invited to nominate candidates for the co-chair and rapporteur vacancies (or upcoming vacancies) and to inform cgmssec@eumetsat.int accordingly. The CGMS rapporteur for the CGMS International Science Working Groups shall come from one of the CGMS member organisations. CGMS-49 plenary will be requested to endorse the nominations as recommended by the CGMS working groups.

It was further noted that as per this meeting all position are currently filled, except for the Technical Officer supporting VLab.

CGMS-49 actions – WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	12	WGII/A49.30	CGMS members are invited to nominate candidates for the co-chair and rapporteur vacancies, or upcoming vacancies, for endorsement by CGMS plenary. Please provide any nominations to cgmssec@eumetsat.int.	CGMS-49 Plenary	**OPEN**

CGMS-49-CGMS-WP-21: Decision of dates of WGII inter-sessional meetings (CGMS-49 to CGMS-50)

Post-meeting the following dates for intersessional meetings were agreed:

- 27 September 2021
- 24 January 2022
- 28 March 2022

CGMS-49-CGMS-WP-22: Future CGMS WG plenary sessions

CGMS SEC introduced the current way forward for CGMS-50, which will be hosted by WMO. Some uncertainty still remains with respect to the meeting and if it will be a face-to-face meeting or a virtual meeting. It was therefore decided that the CGMS-50 WGII plenary session would be held on 25-28 April 2022 if virtual and in the second half of May if face-to-face.

WGII took note of the proposal and had no objections to the proposed dates.

13 Review of actions/conclusions, preparation of WG report for plenary

CGMS-49-CGMS-WP-01WGII: Review of CGMS-48 and CGMS-49 list of actions and recommendations (25 March 2021)

WGII reviewed the actions raised at CGMS-49 WGII meeting. It was noted that there is still the opportunity to refine the actions and recommendations as well as the actionees and deadlines during the review of the report. The report will be made available by 3 May and the review needs to be concluded by mid-May.

Due to lack of time, the review of existing open actions and recommendations could not take place. It was therefore proposed that this review would be done by the co-chairs, rapporteurs, and CGMSSEC in time for the upcoming CGMS-49 Plenary meeting. WGII endorsed the proposal.

During the discussion, it was also noted that it is critical to identify the correct actionee/lead for any action to be actionable and monitored. The same issue applies to recommendations. It was considered that this is a wider issue across all CGMS Working Groups and therefore the issue should be further discussed with CGMS Secretariat.

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS Secretariat	13	WGII/A49 .31	CGMS Secretariat to discuss with the CGMS WG co-chairs on the approach for actions and recommendations for improving traceability, monitoring and efficiency.	Dec 2021	**OPEN**

13 Summary list of new WGII actions and recommendations

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS SEC	2	WGIIA49 .01	WMO/CGMS SEC to write a letter of support to JAXA on the GPM follow-on/precipitation radar efforts	Jun 2021	**OPEN**
CGMS WGII members	2	WGIIA49 .02	Agencies to provide case studies demonstrating the benefits of additional orbital planes, beyond use of data in NWP.	CGMS-50	**OPEN**
CGMS WGII members	2	WGIIA49 .03	Define driving applications to determine the temporal coverage and spectral coverage needed as part of a LEO constellation. (For example – what temporal, spectral, and spatial resolutions needed to monitor tropical cyclones in “all sky conditions” ?)	CGMS-50	**OPEN**
Roshydromet	2	WGII/A49.04	Roshydromet to present the optical flow methodology and validation activities to next IWWS	IWWS-16/2023	**OPEN**
IWWS	2	WGII/A49.05	IWWS to provide presentations given at IWWS-15 on optical flow methodologies to Roshydromet	May 2021	**OPEN**
Roshydromet	2	WGII/A49.06	Roshydromet to consider providing optical flow based products for the next IWWG intercomparison study	IWWS-16/2023	**OPEN**

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS WGII members	2	WGII/A4 9.07	CGMS members to consider the proposed baseline and to complete the information for the proposed baseline, including SSTs	Aug 2021	**OPEN**
WMO	2	WGII/A4 9.08	Precipitation – review specification involving key users	Dec 2021	**OPEN**
WMO	2	WGII/A4 9.09	SST – review specification involving key users	Dec 2021	**OPEN**
WMO	2	WGII/A4 9.10	Review the baseline dissemination strategy for volcanic ash product	Dec 2021	**OPEN**
WGII	2	WGII/A4 9.11	The dissemination strategy for the baseline products presented in CGMS-49-WMO-WP-14, including SST, should be presented to and discussed with CGMS WG IV.	CGMS-50	**OPEN**
WMO	2	WGII/A4 9.12	WMO conduct a survey on baseline Level-2 product requirements for LEO satellites.	CGMS-50	**OPEN**
IWWG	3	WGII/A4 9.13	To clarify approach for 3D wind profile measuring constellation in recommendation	Mid-May 2021	**OPEN**
WGII	3	WGII/A4 9.14	WGII to review the updated draft Terms of Reference of the International Earth Surface Working Group (IESWG), including the naming scheme	10 May 2021	**OPEN**
CGMS members	3	WGII/A4 9.15	CGMS members to provide Points of Contacts for the proposed IESWG and for the upcoming workshop planned for May 2022.	Jun 2021	**OPEN**
WGII	3	WGII/A4 9.16	WGII to assess the organisation and CGMS participation of the planned IESWG workshop in May 2022 and to confirm its support for the establishment of a new ISWG.	CGMS-50	**OPEN**
CGMS members	5	WGII/A4 9.17	CGMS members shall nominate scientific experts (not necessarily agency staff!) in order support the upcoming ECV inventory gap analysis with respect to the Carbon Cycle ECVs including Global Stocktake aspects.	Aug 2021	**OPEN**
CGMS members	5	WGII/A4 9.18	CGMS to provide input for the next GCOS Implementation Plan Observations Conference.	TBD	**OPEN**

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
GCOS/ JWGClimate	5	WGII/A4 9.19	GCOS and JWGClimate to develop a proposal for a formal approach for the translation of GCOS technology free requirements to requirements for space-based observations.	CGMS-50	**OPEN**
EUM, CMA	5	WGII/A4 9.20	EUMETSAT and CMA to consider opportunities for intercomparison of their reprocessed data sets.	CGMS-50	**OPEN**
CGMS members	5	WGII/A4 9.21	CGMS members are requested to reach out to the users of their respective CDRs for additional use cases.	Dec 2021	**OPEN**
CGMS members	5	WGII/A4 9.22	CGMS member to provide feedback on the proposed L1g concept for ISCCP-NG.	TBD	**OPEN**
JWGClimate	6	WGII/A4 9.23	JWGClimate GHG task team to provide a report on the progress of the evolution of ground-based/in-situ GHG observations to CGMS.	CGMS-50	**OPEN**
WMO	6	WGII/A4 9.24	WMO to raise the concern on adequacy of existing GHG reference networks to GAW/IG3IS and GCOS and to report on the current status of the development of reference networks at WMO.	Sep 2021	**OPEN**
NOAA	7	WGII/A4 9.25	To provide specific suggestions to CGMSSEC for updated language in HLPP with respect to Oceans.	CGMS-50	**OPEN**
CGMSSEC	7	WGII/A4 9.26	CGMS SEC to suggest updates on HLPP on oceans to CGMS WGI to WGIV Chairs	CGMS-50	**OPEN**
WGII	7	WGII/A4 9.27	WGII to consider the value and approach for the establishment of a new Ocean and Coast Working Group as a new International Science Working Group	CGMS-50	**OPEN**
CGMS SEC	8	WGII/A4 9.28	WMO/CGMS SEC to write a letter of support to NOAA on the GEO XO ACX efforts.	Aug 2021	**OPEN**
IPWG	8	WGII/A4 9.29	To further detail the observational requirements for microwave observations (sounder and imager) from an IPWG perspective, including frequencies, resolution, orbits..	CGMS-50	**OPEN**

CGMS-49 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	12	WGII/A4 9.30	CGMS members are invited to nominate candidates for the co-chair and rapporteur vacancies, or upcoming vacancies, for endorsement by CGMS plenary. Please provide any nominations to cgmssec@eumetsat.int.	CGMS-49 Plenary	**OPEN**
CGMS Secretariat	13	WGII/A4 9.31	CGMS Secretariat to discuss with the CGMS WG co-chairs on the approach for actions and recommendations for improving traceability, monitoring and efficiency.	Dec 2021	**OPEN**

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	1	WGIIR49.01	WGII recommends to plenary the adoption of the new WGII Terms of Reference as presented in CGMS-49-CGMS-WP-09
Plenary	1	WGII49.02	WGII recommends to plenary to confirm the nomination of JV Thomas as the second Chair of WGII.
Plenary	2	WGIIR49.03	WGII recommends to plenary that CGMS provides a letter of support to JAXA on the GPM follow-on mission/precipitation radar efforts
Plenary	2	WGIIR49.04	WGII recommends to plenary the adoption of the IPWG Precipitation Radar Position Paper after WGII review
Plenary	2	WGIIR49.05	Working Group II recommends to CGMS plenary the adoption of the proposed baseline products presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.
WMO	2	WGIIR49.06	WMO together with Working Group II to develop a baseline recommendation for channels from geostationary satellite imagers
Plenary	3	WGIIR49.07	WGII recommends to plenary to address the gap of global 3D wind profile observations with high priority. Based on the Aeolus experience, a combination of lidar & IR missions can provide complimentary wind observations which look to be very promising."
Plenary	3	WGIIR49.08	WGII recommends to plenary the adoption of the

CGMS-49 WGII recommendations			
Actionee	**AGN item**	**Rec**	**Description**
Plenary	3	WGIIR49.09	WGII recommends that Agencies when pursuing data buy clearly defines all aspects of the data, e.g. orbits and coverage, in order to optimise the
Plenary	3	WGIIR49.10	WGII recommends that Agencies consider data buy with an option for redistributing data to global NWP
Plenary	3	WGIIR49.11	WGII recommends to plenary the nomination of Joe Turk as the new IPWG rapporteur.
Plenary	3	WGIIR49.12	WGII recommends to plenary the adoption of the updated IPWG Terms of Reference.
Plenary	3	WGIIR49.13	WGII recommends to plenary to consider the establishment of a new International Science Working Group: "International Earth Surface Working Group" based on a successful organisation of the next IESWG workshop including broad CGMS
CGMS members	4	WGIIR49.14	CGMS members to collaborate with users and L3 developers on spatial resampling chains "respectful
CGMS members	4	WGIIR49.15	CGMS members are encouraged to engage with the MOSAiC PIs for widespread use of the campaign
CGMS members	5	WGIIR49.16	CGMS member to consider derivation of Level-2 products using the new proposed Level-1g data.
Plenary	7	WGIIR49.17	WGII recommends to plenary the establishment of an Ocean Surface Wind Task Group (OSW TG) in the CGMS International Winds Working Group (IWWG) that coordinates its actions and recommendations with GSICS, CEOS and the IOVWST and other
Plenary	7	WGIIR49.18	WGII recommends to plenary the endorsement for
OSO	7	WGIIR49.19	WGII recommends that OSO engages with the full International community
Plenary	8	WGIIR49.20	WGII recommends to plenary that CGMS provides a letter of support to NOAA on the GEO XO ACX efforts
WMO	8	WGIIR49.21	WMO to take into consideration the requirements for microwave imaging and sounding constellations, also in terms of equatorial crossing time in future reviews of the WIGOS Vision 2040.
CGMS members	8	WGIIR49.22	CGMS members to consider using all currently available microwave imager data for their precipitation products

STATUS OF WGII CGMS-48 ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
IPWG	4	A45.04	**IPWG** to produce documentation on precipitation climate data record generation and related activities worldwide, including prospects for continuity	*2021 May 16: The IPWG report needs to be endorsed by plenary - written e-mail procedure (for conclusion by end of June).* CGMS-49 WGII Apr 2021: To be published shortly and will then be closed.	17 Jun 2021 (CGMS-46 to 49)	**OPEN**
ITWG (CGMS members)	WGII/5	A46.01	CGMS members to provide a summary of their known unfilled spectroscopy needs, and to develop a means of facilitating interaction between laboratory spectroscopy groups to spur cooperation and mitigate the lack of resources (financial and persons). (Ref. CGMS-46-ITWG-WP-01)	*CGMS-49 WGII Apr 2021: Expected to be closed after the ITSC in June 2021.CGMS-49-IPWG-WP-01* 2021 11 Mar: Done as part of the RTM subgroup in ITWG, statement under preparation. Summarizing the current unfilled needs and resource issues. 2021 Jan: Jun/July 2021 meeting, final report close to completion. Report to CGMS-49 WGII.	Jun 2021 CGMS-49 (By CGMS-47 - 49)	**OPEN**
CGMS members	WGII/5	A46.02	All AMV producers to implement the "Common QI module" in their algorithms.	*CGMS-49 WGII Apr 2021: CGMS-49-IWWG-WP-01* *Most agencies have or are in the process of implementing this.* 2021 11 Mar/2021 Jan: To be addressed at the IWW15 (mid April 2021)	By IWW15, CGMS-48	**CLOSED**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGII/5	A46.03	AMV producers to adopt the new AMV BUFR template.	*CGMS-49 WGII Apr 2021: CGMS-49-IWWG-WP-01* *EUM / NWP SAF, NOAA, IMD have implemented, CMA to implement, other agencies invited to adopt template.* 2021 11 Mar/Jan: IWW15 takes place mid April	**By IWW15,** CGMS-48	**OPEN**
NWP community	WGII/5	A46.04	NWP community to define the best configuration to be used by the AMV producers, for use in global and regional NWP models.	*CGMS-49 WGII Apr 2021: A requirements document to be prepared, experiments ongoing expected to continue until IWWS-16 (~2023)* 2121 11 Mar/2020 Mar 6: Pending IWW15, postponed until mid April 2021	CGMS-51 (By IWW15, CGMS-48)	**ONGOING**
IWWG	WGII/5	A46.06	IWWG to look at improving quality indicators for high resolution wind derivation for mesoscale and regional applications. (Ref. CGMS-46-IWWG-WP-01)	*2021 May 16: CGMS-49-IWWG-WP-02* CGMS-49 WGII Apr 2021 2121 11 Mar/2020 Mar 6: IWW15 postponed until 14-18 April	**CGMS-49** (CGMS-48/-47)	**ONGOING**
IWWG	WGII/5	A46.07	IWWG to consider developing climate projects from Atmospheric Motion Vectors (AMVs) and to report to the CEOS/CGMS WGClimate with a potential pilot project. (Ref. CGMS-46-IWWG-WP-01)	*CGMS-49 WGII Apr 2021: Progress on reprocessing activities, however, further discussions needed between the IWWG and the JWGClimate.* 2121 11 Mar/2020 Mar 6: IWW15 postponed until 14-18 Sept	CGMS-50 (CGMS-48/-47)	**ONGOING**
GSICS	WGII/4	A47.01	GSICS to expand GSICS Report on the State of the Observing System to successively cover the calibration status of all instruments relevant GSICS.	*CGMS-49 WGII Apr 2021: Discussed at annual GSICS meeting and will be implemented progressively and reported through GSICS quarterly report.*	CGMS-49 (CGMS-48)	**CLOSED**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2121 11 Mar: Still under development and to be discussed at the Annual meeting and GSICS EP.		
SCOPE-CM	WGII/4	A47.08	SCOPE-CM to report back on the conclusion of the 9 pilot projects	*CGMS-49 WGII Apr 2021: WMO Secretariat to publish the related report.* 2121 11 Mar: Still open, WMO to finalize 2021 Jan: Draft report under preparation.	Dec 2021 (CGMS-48)	**ONGOING**
SCOPE-CM	WGII/4	A47.09	SCOPE-CM to provide an implementation plan based on the agreed new concept including an agenda and updated ToRs.	*CGMS-49 WGII Apr 2021: Implementation plan provided and ToRs updated.* 2121 11 Mar: WMO to organise a splinter with Jeff, Mitch, Ken and Joerg on way forward, before WGII (This is also a plenary action A47.15.)	CGMS-48	**CLOSED**
ICWG	WGII/7	A47.16	ICWG to organise a dedicated session (0.5-1 day) on lightning observations from space (calval, algos, applications and products)	*CGMS-49 WGII Apr 2021: ICWG virtual meeting around mid June (TBC).* 2121 11 Mar: Further delayed, Agenda under preparation, date TBC (potentially in April) 2021 Jan: Meeting to be held late Feb. Lightning matters to be addressed there (topical group established under ICWG).	CGMS-50 (Dec 2019)	**OPEN**
GSICS, WGClim, SCOPE-CM	WGII/8	A47.21	GSICS, WGClimate and SCOPE-CM to organise a workshop on calibration supporting reprocessing.	*CGMS-49 WGII Apr 2021: Workshop to be planned (delayed due to the pandemic).* 2121 11 Mar: JWGC to discuss in March and GSICS at Annual meeting community.	CGMS-50 (Mar 2020, CGMS-48)	**OPEN**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SWCG	WGII/11	A47.23	SWCG to further develop white-paper on current instruments and their calibration and to provide report to GSICS for review	*CGMS-49 WGII Apr 2021: Paper has been provided in March 2021 and is under review and will be discussed at the next GSICS EP.*	CGMS-50 (Dec 2019)	**ONGOING**
GSICS	WGII/11	A47.24	GSICS to review SWCG white-paper on calibration and consider opportunities for GSICS support to aforementioned activity.	*CGMS-49 WGII Apr 2021: Paper has been provided in March 2021 and is under review and will be discussed at the next GSICS EP.* 2121 11 Mar: See A47.23	CGMS-50 (Mar 2020)	**ONGOING**
WMO	WGII/14	A47.28	WMO to provide a preliminary report from the 7th WMO Impact Workshop (Seoul, May 12-15 2020) at CGMS-48	*CGMS-49: Presentation provided to CGMS-49 plenary.* 2121 Mar/Apr: Meeting held, presentation given to WGII. 2021 Jan: Workshop held in Nov-Dec	CGMS-49 (CGMS-48)	**CLOSED**
IROWG, WMO	WGII/4 (from WGIII)	A47.31	**CGMS baseline and RO:** IROWG and 7th WMO Impact Workshop needs to validate the current Baseline requirements in terms of the coverage, number, quality and sampling of RO.	*CGMS-49 WGII Apr 2021: Ongoing discussions.* 2121 11 Mar: The requirements have been confirmed. The main gap is the local time coverage beyond 40 degrees latitude. Whilst the issue will be mitigated by FY-3 satellites in two different orbital planes together with Sentinel-6 in a drifting orbit the issue still remains and needs further discussion in the context of the constellation as discussed at the CGMS WGIII risk assessment. This action should be closed, but a new action should be formulated reflecting the above.	CGMS-50 (CGMS-48)	**ONGOING**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
ICWG	WGII/3	WGII/A48.01	ICWG to establish a liaison with EUMETSAT Convective Working Group or SCOPE Nowcasting.	*CGMS-49 WGII Apr 2021: Report expected following ICWG meeting mid 2021.* 2021 11 Mar/2021 Jan: ICWG to be discussed at Convectivion WG which meets in April. SCOPE NWC limited progress to date.	Aug 2021	**OPEN**
CMA, EUM, NOAA (Space agencies)	WGII/3	WGII/A48.02	Data providers to document data processing QC processes (including a month of QC statistics, e.g. rejection percentage at each QC step) and space sampling information and provide to IROWG.	*Addressed in CGMS-49 WGII Apr 2021. For further discussion.* 2021 11 Mar: Waiting for IROWG meeting. 2021 Jan: CMA, EUM, NOAA to consider and implement as far as is possible. IROWG noted that RO data from KOMPSAT-5 are also of interest.	**Apr-21**	**ONGOING**
ITWG	WGII/3	WGII/A48.03	ITWG to send a report demonstrating the value of temperature sounding of the upper stratosphere and mesosphere (as for the SSMIS UAS channels).	*CGMS-49 WGII Apr 2021: To be addressed at the upcoming ITWG meeting in June 2021.* 2021 11 Mar/2021 Jan: ITWG meeting to be held in June 2021. Mitch to provide progress information. Some reports expected at ITWG.	CGMS-50 (CGMS-48)	**OPEN**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
International [Earth] Surface WG	WGII/3	WGII/A48.04	International Surface Working Group were asked to report to CGMS-49 with a well-defined draft Terms of Reference of a proposed new International Land Surface Working Group, which could be reviewed by WGII and, if endorsed by CGMS Members, subsequently adopted by the CGMS Plenary.	*CGMS-49: Plenary requested further information on the expected benefits as well as the need to secure there is no overlap with existing initiatives. For review at CGMS-50 WGII and plenary.* CGMS-49 WGII Apr 2021: Draft ToRs CGMS-49-GUEST-WP-06. WGII co-chairs/rapporteurs to prepare ppt for plenary (naming scheme considerations, etc.)	CGMS-50 (CGMS-49)	**ONGOING**
GSICS	WGII/3	WGII/A48.05	GSICS to establish a partnership with the ISCCP-NG to provide the necessary geostationary intercalibration coefficients required for ISCCP-NG creating integrated seamless geostationary products,	*CGMS-49 WGII Apr 2021: Monthly/bi-monthly meetings are now established between GSICS and ISCCP-NG* 2021 11 Mar: Report under preparation for WGII 2021 Jan: ISCCP-NG 1st prototype data released.	Nov-20	**CLOSED**
WGClimate	WGII/3	WGII/A48.06	WGClimate to establish with the CGMS WGs interfaces with the WGClimate GHG Task Team (TT) with a definition of anticipated support from the WGs.	2021 11 Mar: Representatives from GHG TT, WGClimate, CGMS representative, CGMS Secretariat, held an initial Webex to identify initial focal points of contact: WGI and WGIV sean.burns@eumetsat.int; WGII jeff.privette@noaa.gov, mitch.goldberg@noaa.gov. WGIII Zhangp@cma.gov.cn Related actions to be addressed in the respective CGMS WGs in April 2021.		**CLOSED**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WGClimate	WGII/3	WGII/A48.07	WGClimate to provide the publication of the ECV Inventory #3, the Gap analysis report and the updated Coordinated Action Plan for endorsement by CGMS-48 Plenary in August.	*CGMS-49 WGII Apr 2021: Inventory v3 expected to be completed by end 2021. V4 under preparation* 2021 11 Mar: JWGClimate meeting coming up end March, action basically done 2021 Jan: To be addressed with WGClimate	Dec 2021	**ONGOING**
WMO and WGII	WGII/3	WGII/A48.08	WGII and WMO to develop a mature Strategic Implementation Plan for SCOPE-CM for endorsement by CGMS-48 Plenary.	Endorsed by CGMS-48 plenary.	CGMS-48	**CLOSED**
ISCCP-NG TT	WGII/3	WGII/A48.09	ISCCP-NG task team to meet every two months with SCOPE-CM and GSICS, to develop a complete plan for ISCCP-NG expanded to full global coverage including the poles and identifying roles and responsibilities of GSICS and SCOPE-CM.	*CGMS-49 WGII Apr 2021: Established.* *2021 20 Apr: CGMS-49-ISCCP-WP-01* 2021 11 Mar: Some progress to be reported to WGII 2021 Feb: No meeting yet. (focal point: A. Heidinger).	CGMS-49	**CLOSED**
GSICS, OSVW	WGII/4	WGII/A48.10	OSVW to present at next GSICS meeting the potential and potential benefits and issues of crosscalibration of scatterometer data (at the GSICS annual meeting).	*CGMS-49 WGII Apr 2021: GSICS meeting to take place in June.* 2021 Jan: OSVW group to be invited to the next GSICS meeting.	CGMS-50 (Mar 2021)	**OPEN**
WMO	WGII/4	WGII/A48.11	WMO to prepare a survey to collect the current and planned status of GEO product providers to achieve a detailed understanding of the current characteristics, commonalities, differences, access and formats.	Endorsed by CGMS-49 plenary. CGMS-49 WGII Apr 2021: Proposal to plenary *2021 20 Apr: CGMS-49-WMO-WP-14* 2021 11 Mar: GEO survey has been issued. 2021 Jan: Prepared a survey for distribution by February, feedback by	CGMS-49	**CLOSED**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				end March, with results presented to WGII and CGMS-49 plenary		
WGII	WGII/4	WGII/A48.12	WGII to propose a GEO Product Baseline for endorsement by CGMS-49 Plenary	***CGMS-49 presented to plenary - can we close?*** CGMS-49 WGII Apr 2021: To be presented to plenary *2021 20 Apr: CGMS-49-WMO-WP-14*	**Feb 2021, CGMS-49**	**ONGOING**
IPWG	WGII/7	WGII/A48.13	IPWG to review the operational utilisations of spaceborne precipitation radar and to submit a report regarding the necessity of the precipitation radar.	*Recommended to CGMS plenary. Final endorsement to be made by e-mail written procedure by mid June 2021.* *CGMS-49 WGII Apr 2021: Report is near completion and expected by mid-May 2021*	17 Jun 2021 (CGMS-49 or IPWG-11)	**ONGOING**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGII/8	WGII/A48.14	CGMS Members to review the contents of the Landing Pages accessible through the links recorded in OSCAR/Space and to provide the missing information as identified in working paper CGMS-48-WMO-WP-08. *(2021 Feb: This action asks all space-agencies are asked to add links to the SRFs of your instruments on your space agency instrument landing pages (for example on CMA's FengYun landing pages @ http://gsics.nsmc.org.cn/portal/en/fycv/monitoring.html). As you may know, WMO includes the addressed of these landing pages on the WMO-OSCAR page of the concerned instrument (for example for CMA's FY3 satellite @ https://www.wmo-sat.info/oscar/satellites/view/fy_3a), and thus providing a link to the calibration information @ the space agencies (CMA, EUMETSAT, ESA, IMD, JMA, KMA, NASA, NOAA, Roshydromet).*	*CGMS-49 WGII Apr 2021* *2021 11 Mar: WMO to follow* 2021 Feb: WMO-OSCAR changed the addresses of the instrument pages. Thus the links to WMO-OSCAR that were originally put on the landing pages are now dead. Please check if this is the case for on your landing pages and replace the links with the new ones. For example http://www.wmo-sat.info/oscar/instruments/view/607 becomes https://www.wmo-sat.info/oscar/instruments/view/virr_fy_3 2021 Jan: EUM has provided inputs expected to be "live" by February	CGMS-50 (CGMS-49)	**ONGOING**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGII/8	WGII/A48.15	CGMS Members shall make available their validated instrument SRFs together with uncertainty information through their instrument calibration landing pages. In addition, a document summarising the currently available SRFs and their status (accurate/inaccurate) as well as identifying any missing information shall be provided through the landing pages.	*CGMS-49 WGII Apr 2021: ISRO & IMD have held a coordination meeting and implementation is ongoing.* 2021 Feb: Some space-agencies may already provide SRFs on separate websites, but do not link this webpage to their landing pages. In order to complete the action would, thus, be to add links to your SRF subpages on your space agency instrument landing pages. 2021 Jan: EUM, JMA, have included such information. A reminder will be sent (by Rob Roebling, EUMETSAT) CMA information is included on the GSICS web page. http://gsics.nsmc.org.cn/portal/en/fycv/srf.html	**CGMS-49**	**ONGOING**
WMO	WGII/8	WGII/A48.16	WMO will establish links to this information (ref. WGII/A48.15) through the relevant instrument entries in the OSCAR/Space database. This information will be updated with the help of the OSCAR/Space Support Team though the regular requests for satellite status updates.	*CGMS-49 WGII Apr 2021: WMO - ongoing.* 2021 11 Mar/2021 Jan: Ongoing	**CGMS-49**	**ONGOING**
CGMS Members	WGII/8.1	WGII/A48.20	CGMS Members to provide Points of Contacts for collaboration with WMO on drought monitoring activities.	*2021 May: NOAA: richard.heim@noaa.gov* CGMS-49 WGII Apr 2021: No progress 2021 Jan/Mar: WMO to remind relevant CGMS members	**CGMS-49**	**OPEN**

Status of WGII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGII/8.1	WGII/A48.17	CGMS members to provide Points of Contacts for collaboration with WMO on flood monitoring activities	*CGMS-49 WGII Apr 2021: Further points of contact to be nominated. WMO to follow-up on this activity.* 2021 Jan/Mar: WMO to remind relevant CGMS members NOAA: william.straka@ssec.wisc.edu ROSHYDROMET: z.andreeva@meteorf.ru (Zoya Andreeva)	**CGMS-49**	**OPEN**
Plenary 48	WGII/9	WGII/A48.18	Plenary to endorse the updated WGII Terms of Reference	Endorsed by CGMS-48 plenary.	CGMS-48	**CLOSED**
CGMS members (from plenary to WGII)	7	WGII/A48.19 (from Plenary A47.09)	***Action transferred from plenary 48 to WGII*** **Arctic observations:** Provide product priorities for Arctic observations for a special Arctic session in WGII during CGMS-49 (Members with planned Arctic observation missions are requested to include a status report in the agency report)	*CGMS-49 WGII Apr 2021: CGMS-49-NASA-WP-01, CGMS-49-ECCC-WP-01* 2021 11 Mar/2021 Jan: Topic on the WGII CGMS-49 agenda (and for plenary at CGMS-50).	CGMS-50 (CGMS-49)	**ONGOING**

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
Space agencies	WGII/3	WGII/R48.01	IROWG recommends that GNSS-RO data with at least 20,000 occultations per day - globally distributed and providing good sampling of the diurnal cycle	***CGMS-49 - recommendation concluded?*** 2021 Apr CGMS-49 WGII: IROWG-WP-01 will also be raised in plenary and addressed in the joint WGII-WGIII meeting (coverage issue. Ref to WGIII and CGMS baseline and risk assessment. **Closure proposed**

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
				following CGMS-49 plenary and to be addressed within the framework of the WGIII baseline and risk assessment reviews. Review at CGMS-49
Space agencies	WGII/3	WGII/R48.02	On Climate-6 the group recommends satellite agencies to keep and/or establish a 2-satellite configuration for the same sensor in the same orbit (same equator crossing time) to improve the confidence in derived CDRs and to also provide a measure to assess the stability and health of the instruments on the two satellites. (originating from ITWG)	***CGMS-49 - included and covered by the HLPP. Recommendation concluded?*** 2021 Apr CGMS-49 WGII: Tentatively to be closed - TBC (part of best practices?) Review at CGMS-49
Space agencies	WGII/3	WGII/R48.03	Space agencies to consider building in as much RFI screening and mitigation into their ground segment processing as possible, noting efforts already starting at ESA and in research groups in the US, Japan and China.	***CGMS-49 - included and covered by the HLPP. Recommendation concluded?*** 2021 Apr CGMS-49 WGII: Tentative closure - could be built into best practice Review at CGMS-49
NASA	WGII/3	WGII/R48.04	NASA to continue to provide AIRS Aqua data in real-time to NWP centers for as long as calibration of the instrument is possible.	***CGMS-49 - Recommendation concluded?*** 2021 Apr CGMS-49 WGII: **Closure proposed.**WMO has updated its best practices in its WIGOS Manual (maintatin in-orbit assets as long as is feasible and applicable to all relevant observations). Review at CGMS-49
Space agencies	WGII/3	WGII/R48.05	All agencies to consider to make available full spectral resolution for all bands, e.g. HIRAS. This also applies to all future hyperspectral sounders.	***CGMS-49 - included and covered by the HLPP. Recommendation concluded?*** 2021 Apr CGMS-49 WGII: Tentative closure - could be built into best practice Review at CGMS-49

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
Plenary 48	WGII/3	WGII/R48.06	Endorsement of leadership changes for WGClimate: WGClimate #12 has unanimously recommended Dr Jeff Privette as next WGClimate Vice Chair. CGMS-48 Plenary is asked to endorse the proposal.	**CONCLUDED.** CGMS-48 plenary endorsed the recommendation.
CGMS members	WGII/3	WGII/R48.07	CGMS members to be fully engaged with WMO in the implementation of the IG3IS initiative, capitalising on the intergovernmental policy-level recognition and established partnerships. In particular, the implementation of the space-based observing component for Green House Gas observations shall be coordinated with IG3IS to ensure that it meets established user requirements.	***CGMS-49 - included and covered by the HLPP. Recommendation concluded?*** Apr CGMS-49 WGII: Proposed for closure. Note connection between GAW/IG3IS and JWGClimate/GHG TT has been established.
Space agencies	WGII/6	WGII/R48.08	CGMS agencies ensure that volcanic cloud product development efforts are consistent with the actual needs of the IAVW and re-visit L2+ product requirements as needed.	*2021 Apr CGMS-49 WGII: No progress. To be reviewed at CGMS-50 WGII.*
CMA, WGClimate	WGII/6	WGII/R48.09	CMA to coordinate with WGClimate and GSICS to host workshop on reprocessing.	*2021 Apr CGMS-49 WGII: Open due to the pandemic situation*
CMA	WGII/6	WGII/R48.10	CMA to provide CDRs/ECVs for the WGClimate inventory	*2021 Apr CGMS-49 WGII: Provided.* ***Completed.***
CGMS members	WGII/8	WGII/R48.11	CGMS Members shall ensure that accurate channel Spectral Response Functions (SRFs) for all microwave and infrared instruments are measured and made available as described in the CGMS Best Practise.	*2021 Apr CGMS-49 WGII:* ***CLOSED*** *(best practices are in place).* Review at CGMS-49

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS members		WGII/R48.12	The CGMS agencies to consider the needs and recommendations of the international airways volcano watch (IAVW) in implementing their volcanic ash products.	*2021 Apr CGMS-49 WGII:* ***CLOSED*** *(duplication, see WGII/R48.08)*
ISWG Chairs	WGII/3	WGII/R47.01	ISWG Chairs to organise intersessional teleconferences amongst the co-chairs.	*2021 Apr CGMS-49 WGII:* ***OPEN.*** *WGII co-chairs to contact ISWG co-chairs.* 2020 May CGMS-48 WGII session: No significance progress was reported.
CGMS members	WGII/4	WGII/R47.02	From ICWG: CGMS members to budget a baseline funding for the intercomparison study, given its importance and impacts on global cloud products.	*2021 Apr CGMS-49 WGII: ICWG to hold a short virtual meeting in June 2021 timeframe (TBC).* 2020 May CGMS-48 WGII session: To be followed up with the ICWG.
ICWG, IWWG	WGII/4	WGII/R47.04	ICWG and IWWG: ICWG to work with IWWG on the golden days observations to provide cloud height uncertainty for AMV applications	*2021 Apr CGMS-49 WGII: ICWG to hold a short virtual meeting in June 2021 timeframe (TBC). ICWG & IWWG to be promted by CGMSSEC/Paolo Ruti.* 2020 May CGMS-48 WGII session: Progress was reported at CGMS 48 WGII. Coordination with IWWG, however IWWG is reconsidering its Golden Day due to the COVID-19 delays
CGMS	WGII/4	WGII/R47.05	From ICWG: CGMS agencies to continue operating conically-scanning passive MW sensors in an early afternoon orbit as well as in a dusk/dawn orbit in order to maintain this unique long-term time series. Progress was made in the interaction of the ICWG	*2021 Apr CGMS-49 WGII: ICWG to hold a short virtual meeting in June 2021 timeframe (TBC).* 2020 May CGMS-48 WGII session: The recommendation remains relevant as

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
ISRO	WGII/9	WGII/R47.11	ISRO is encouraged to consider follow-on missions on scatterometry to Oceansat-3/3A	*2021 Mar 11: **COMPLETED.** This is covered by the annual WGIII risk assessment review* 2020 May CGMS-48 WGII: ISRO will review the Oceansat programme in June 2020.
CMA	WGII/14	WGII/R47.12	CMA is encouraged to present their impact analysis work at the upcoming WMO NWP Impact Workshop in May 2020.	*2021 Mar 11: **COMPLETED.** 7th NWP impact workshop held in 2020 (results to be presented at CGMS-49 plenary.* 2020 May CGMS-48 WGII: NWP impact workshop postponed.
CGMS space agencies	5.8	Plenary R47.07	(From **ICWG**): CGMS members to budget a baseline funding for the intercomparison study, given its importance and impacts on global cloud products.	*2021 Apr CGMS-49 WGII: Consideration: It could be part of best practices describing product development activities.* 2020 Aug: Transferred from plenary CGMS-47 to WGII
CGMS space agencies	5.8	Plenary R47.08	(From **ICWG)** CGMS members to consider introducing multi-sensor (satellite and ground-based measurements) applications for convective nowcasting when developing/updating product requirements.	*2021 Apr CGMS-49 WGII: Consideration: It could be part of best practices describing product development activities.* 2020 Aug: Transferred from plenary CGMS-47 to WGII
CGMS members	WGII/5	R46.02	**(**From **ITWG)** CGMS member are encouraged to take due consideration to climate applications requirements during the planning for new meteorological satellite missions. (Ref. CGMS-46-ITWG-WP-01)	*2021 Apr CGMS-49 WGII: Consideration: It could be part of best practices describing product development activities.*
CGMS space agencies	WGII/8	R44.28	Agencies to explore the possibilities to develop suitable processing packages to support a direct broadcast implementation of RO processing,	*2021 Apr CGMS-49 WGII: Discussions on actual requirements are still ongoing.* CGMS-47: Recommended to be transferred to WG I.

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
			within the DBNet to improve timeliness for space weather applications	WGII IS#1 Dec 2018: To be maintained (See also CGMS-44 WGI action A44.08 related to IROWG)
CGMS space agencies	WGII/8	R44.26	Satellite operating agencies should support proposals and programs to acquire high-accuracy characterisation measurements of the Moon, to develop a new, high accuracy, SI-traceable lunar reference standard for reflected solar wavelengths.	*2021 Apr CGMS-49 WGII:* ***CONCLUDED.*** *Progress in US and China.* CGMS-47: Maintain 10 Apr 2019: Tom Stone who is the leader of lunar calibration in GSICS VINIR subgroup provided feedback see at end of this table. WGII IS#1 Dec 2018: KMA (Dohyeong Kim) to check with GSICS. WGII IS#2 15 Mar 2018 Update expected at the March '18 GSICS meeting. SWTT is preparig a proposal on integrating space weather products into GSICS. To be discussed at CGMS-46. CGMS-45: GSICS discussed this issue
CGMS space agencies	WGII/7	R44.25	For monitoring the Polar Regions, the Group stressed the importance of the deployment of HEO missions	*2021 20 Apr:* ***CLOSED.*** *Arctic observations is now included on the agenda as a standing item.* 2021 Mar 11: - 2020 May CGMS-48 WGII session CGMS-47: NOAA considering in its system studies and talking with potential partners. WGII IS#1 Dec 2018: Meeting on 5 Dec 2018 at EUMETSAT to discuss HEO missions. Sep 2018 CGMSSEC: This recommendation needs rephrasing/formulation, closing or other. Link to WGIII required

Status of WGII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS space agencies	WGII/6	R44.21	Operators to take into account in the planning of their data distribution systems the emerging stringent requirements on data latency from SRNWP	*2021 Apr CGMS-49 WGII: **CLOSED.** Topic transferred to WGI.* CGMS-47: maintain recommendation WGII IS#2 15 Mar 2018
ISRO	WGII/5	R43.10	ISRO is encouraged to implement a multi-sensor precipitation estimate based on SAPHIR and INSAT-3D	*2021 Apr CGMS-49 WGII: **CLOSED** (superseeded by events) ISRO has reported to CGMS. SAPHIR is no longer active.*
CGMS members	WGII/6	R43.03	CGMS members to consider include a water vapour channel and a CO2 channel to polar-orbiting imagers, to maintain accuracy and coverage of polar winds and cloud height retrievals achieved by MODIS.	*2021 Apr CGMS-49 WGII: Consideration: It could be part of best practices.* CGMS-48: To be discussed to at WGII/III gap analysis. To be discussed with WGII and III as part of best practices document for future missions. CGMS-47: recommendation maintain
CGMS members	WGII/3	R43.02	CGMS members to consider removing spectral gaps from future hyperspectral sounders to support GSICS intercalibration of IR imagers.	*2021 Apr CGMS-49 WGII: Consideration: It could be part of best practices.* 2020 May CGMS-48 WGII session: To be addressed in the intersessional between WGIII/WGII 2020 Feb 19: It was agreed that this recommendation shall be led by WGII. It could be addressed within the framework of WGII&WGIII discussions at CGMS-48. CGMS-47: recommendation maintained WGII IS#2 15 Mar 2018 To be discussed at second WGII inter-sessional meeting after CGMS-44. (For WGIII to consider)

WORKING GROUP III (WGIII)

CGMS

Operational contingency and continuity planning

WGIII REPORT

1. Opening, objectives / WGIII rapporteur status and confirmation

Co-chairs Ajay Mehta and Peng Zhang welcomed all participants to the WGIII session. They briefly presented the agenda and the objectives of the meeting related to the CGMS baseline and the CGMS risk assessment.

WMO informed WGIII that Lars Peter Riishojgaard needed to step down as rapporteur and instead proposed that Heikki Pohjola takes the role of the WGIII rapporteur. WGIII supported the change and recommended to plenary to endorse the change of WGIII rapporteurs.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WGIII	11	WGIII/A49.21	WGIII recommends to plenary to endorse H. Pohjola (WMO) as WGIII rapporteur	CGMS-49 plenary	**OPEN**

WGIII participants approved and adopted the agenda proposed by the CGMS Secretariat prior to the meeting. Agenda items no. 2, *Status of discussion on WMO Res 42,* was moved to agenda item 5. (Day 2 of the meeting) waiting for the WMO INFCOM meeting feedback for the related working paper. The INFCOM meeting was running at the same time with this meeting.

Participants were introduced shortly agency by agency. See the list of participants in the Annex.

2. Status of discussions on WMO Resolution 42 and WMO's satellite data exchange requirements for global NWP

CGMS-49-WMO-WP-I6: Status of discussions on draft Unified WMO Data Policy Resolution (presented under agenda item 5.)

K. Holmlund (for L. P. Riishojgaard) presented the status of the unified WMO data policy preparation. The modernisation of the existing WMO data policy is combining existing resolutions 25, 40, and 60 into one draft WMO Unified Data Policy Resolution. WMO Congress 2019 requested a review of WMO data policies as expressed in Resolutions 40 (“weather”), 25 (“hydrology”), and 60 (“Climate”). This led to the establishment of Study Group on Data Issues and Policies (SG-DIP), which recommended that new overarching draft Congress resolution on data policy should be developed. The SG DIP recommendation was adopted by Executive Council and the initial drafting of the new overarching WMO data policy resolution for Extraordinary Congress in 2021 is now completed, building also on the outcome of the WMO Data Conference in November 2020.

The new resolution covers all WMO Earth system data (weather, climate, hydrology...). There are two main categories of the data. The data which shall be exchanged is under category *Core* and the data which should be exchanged is under category *Recommended*. The specifics of the data categories are referred to Technical Regulations, primarily Manuals on WIGOS and GDPFS. The term “*Free and*

unrestricted " exchange is defined directly in the Resolution, which means that data is available for use, re-use, and sharing without charge and with no conditions to use. It also covers the data exchange between all partners, including private sector and academia etc.

A draft Unified WMO Data Policy was introduced and discussed as Doc. 5.1.5 at First Session of WMO Infrastructure Commission (INFCOM) on April 13th in 2021. It was the first intergovernmental text of the new draft. Three days of intense discussion resulting in some adjustments to the text, but the basic principles of the resolution remained unchanged and it was accepted by WMO INFCOM on April 15th in 2021.

The next major gate will be the WMO Executive Council in June 2021 followed by submission to WMO Congress for its approval in October 2021. Regulatory material with agreement on specifics of data exchange (what, when, where , how,..) will be supported by Global Basic Observation Network (GBON) provisions, approved by the Infrastructure Commission in November 2020. Financial and technical support and capacity development where needed will be facilitated under Systematic Observations Financing Facility (SOFF) and Climate Risk and Early Warning Systems (CREWS).

WGIII Co-chair (A. Mehta) commented that the impact of data policy change needs to be reflected in the CGMS documentation. K. Holmlund proposed that after Congress approval, the Secretary-General of WMO could send the CGMS space agencies a letter requesting them to confirm what data are core and what data are additional.

ESA commented that the new data policy should be also studied from the scientific consortium perspective, which has limited open data policy not open for commercial use. K. Holmlund responded that this is not yet clear, and it should be analysed and further studied. Further, the commercial sector has requested more details.

ESA commented on EU's data policy for the systems and their mission and if these are considered. WMO responded that this is involved (for example Copernicus).

EUMETSAT commented on constrains related to WIS, which is limiting the open and restricted data to be sent in the same data package at the moment and if the limitation remains the same related to Core and Recommended data. K. Holmlund commented that this is not yet clear.

CGMS-49-WMO-17: Status of discussions on the WMO's Position paper on Satellite data Requirements for Global NWP

WMO provided the status of WMO's Position paper on Satellite data Requirements for Global NWP. The final document was not available for the meeting due to the INFCOM presentation and decision happening at the same time with this meeting. The Position Paper is discussed at the WMO Commission for Observation, Infrastructure and Information Systems (INFCOM) Session I part III and expected to be approved upon 16th Apr 2021, formally adopting the position paper as a WMO Position Paper. Subsequently, the full paper will be provided to CGMS.

The WMO Expert team on Space Systems and Utilization has prepared a Position paper on Satellite data Requirements for Global NWP. The paper presents a user perspective on the needs for data to ensure that global NWP models are performing at state-of-the-art level. During the preparation, views

from other WMO Expert Teams as well as other international expert bodies and meetings have been collected, like the Joint Expert Team on Earth Observing System Design and Evolution, Global Data Exchange for NWP, 7th Workshop on the Impact of Various Observing Systems on NWP, CGMS WG II/III Risk assessment Workshop. The Position paper captures a snapshot in time and will have to be reviewed and revised over time as user requirements change. It will therefore be presented to CGMS on a regular basis, nominally on a four-year cycle or when significant changes to the user requirements occur. This process is still under implementation.

The paper reflects the user requirements for satellite data for global NWP and it follows the terminology of the WIGOS Vision 2040. It is fully decoupled from the Unified WMO Data Policy discussion. Overall, the position paper responds to CGMS A47.02 action ("On global NWP: WMO to provide a report at next CGMS on baseline requirements for satellite products for global NWP, to trigger a CGMS discussion on status of delivery of such observations and possible improvements in the future and inclusion in the CGMS baseline document.").

The Position Paper developed by ET SSU will be presented to INFCOM for decision and then INFCOM will develop a process for reviewing and revising the Position Paper turning it into a formal WMO Position Paper. However, the paper will not be turned into technical regulations. In addition, WMO will consider developing similar position papers for other WMO application areas with the support of expert teams.

The content of the paper captures the principles of WIGOS manual maintaining the space-based assets beyond their design lifetime. The document contains the tables listing requirements for backbone, additional, and emerging data. The document content is not static and expected to have further evolutions. CGMS should consider any possible improvements and inclusion in the CGMS baseline as indicated in the position paper. For now, the CGMS baseline will remain the same and existing WMO Res 40, CGMS, and Space agencies should agree which data shall be exchanged.

A. Mehta noted the need of the process to implement the outcome of the position paper to the CGMS baseline. K. Holmlund responded that this is not evaluated yet, but there will be an action team to review that baseline will be consistent with the position paper outcome.

A. Mehta also commented that it is important to capture the position paper outcome related to WMO Gap Analysis. H. Pohjola supported that idea and commented that ongoing development will release a new Gap Analysis elements on OSCAR/Space directly supporting this.

It was agreed that data tables in the position paper will be compared to CGMS baseline and presented during the second day of the meeting (see outcome later in the meeting notes).

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	2	WGIII/A49.01	WMO to implement the outcome of the Position paper on Satellite data Requirements for Global NWP to WMO activities like Rolling Review of	TBD	**OPEN**

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
			Requirements, Gap Analysis, WIGOS Vision etc.		

3. Updates on significant observational missions (in response to/from a CGMS baseline/risk assessment point of view)

3.1 Operational missions

CGMS-49-ISRO-WP-07: ISRO current missions status and future plans

J.V. Thomas reported on ISRO's current missions and their future mission plans. Current LEO missions are OceanSat 2, SARAL, and SCATSAT-1, which has some problems. It stopped operation on 28th February 2021 due to redundant chain malfunction. Current GEO mission are INSAT-3D and 3DR, which provide observations at 15-minute interval (48 images per day and sounding every hour).

The next ISRO satellite, INSAT-3D-S, will be launched 2022 to GEO ring. It is similar to INSAT-3D and 3DR. GEO Imaging Satellite is under planning: Providing multiple daily observations at any place imaging, rapid scan 500 x 500 km in 5 mins, improved monitoring of crops, vegetation condition, water bodies and rapid forest change, more frequent monitoring of natural disasters and flood inundation.

The next ISRO satellite to be launched to LEO ring will be OCEANSAT 1 in October 2021. It will be the first satellite of OCEANSAT series. It has 13 channels including 5 new channels.

The missions under study phase are microwave temperature and humidity sounder to be located 35 deg inclined orbit (following SAPHIR payload), microwave radiometer (dual pol, 2 km res, low inclination), DF-SCAT on C and Ku band, next generation INSAT with payload of VIS/NIR/SWIR imager, hyperspectral infrared sounder and lighting mapper.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
ISRO	3.1	WGIII/ A49.02	ISRO to update CGMS-50 on their plans for hyperspectral infrared sounder.	February 2022 CGMS-50	**OPEN**

CGMS-49-NOAA-WP-11: User requirement development for NOAA's next generation of measurements from Geostationary Extended Observations (GeoXO)

D. Lindsey presented the current status of NOAA's GEO missions and their future plans. NOAA's GOES-R series of geostationary satellites currently has GOES-16 and GOES-17 in operations as GOES-East and GOES-West with two more launches planned over the next 3-4 years. That constellation will remain in operations into the 2030s, but by the early 2030s the need exists for a replacement on-orbit spare. That drives the timeline for the follow-on geostationary satellite series, which NOAA calls Geostationary and Extended Orbits. A working group was formed in early 2020 to collect the various

recommendations from NOAA Satellite Observing Systems Architecture (NSOSA) and the SPRWG, examine current NOAA observing requirements, perform user outreach to assess their future needs, and ultimately use this information to recommend the future geostationary constellation. The recommended instruments to comprise this constellation are Imager, Lightning Mapper, IR Hyperspectral Sounder, Ocean Colour, and Atmospheric Composition instruments. It was also recommended that a Day-Night-Band be included as a part of either the imager or the sounder.

Although a GEO-XO programme has not been approved, the nominal recommended constellation puts the Imager (hurricane tracking and many other applications), Sounder (new capability, NWP, severe storm forecasting, nowcasting), and Ocean Colour (assessment of ecosystem change, monitoring coastal water quality and tracking harmful blooms) instruments in East and West locations, Lightning Mappers (operational benefit for lightning safety situational awareness) on commercial hosted payloads in the East and West locations, and an Atmospheric Composition (improved observations for air quality on GEO) instrument on a commercial host near the centre of the Continental U.S. It should be noted that this recommended constellation may change, and nothing is official until the programme is approved.

During the GEO-XO presentation, D. Lindsey suggested to CGMS members that NOAA would appreciate data sharing of relevant partner instruments (including GEMS from Korea, MTG instruments, etc).

K. Holmlund asked what kind of AC instrument is going to be developed. D. Lindsay responded that NASA is launching the research mission TEMPO with UV/VIS instrument payload and that will give an idea for the GEO-XO AC instrument design.

P. Zhang asked if the GEO-XO road map is publicly available. D. Lindsey responded that the road map will be public from September after the final review.

T. Kim commented that Ocean Colour and Atmospheric Composition instrument data is not yet ready to be shared publicly and NOAA should contact KMA for data access.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	3.1	WGIII/A49.03	WMO prepare a letter of support for the GEO-XO Atmospheric Composition instrument.	Aug 2021	**OPEN**

CGMS-49-CGMS-TBD - Other members' significant updates (operational missions)

P. Zhang updated CMA's upcoming launch schedules. The second satellite of FY-4B will be launched in May 2021 and LEO Early morning orbit FY-3E will be launched in June 2021. He also mentioned that CMA's final approval for GEO MW satellite is still pending. Related to CNSA missions, he also updated that the successor for GaoFeng-5 will be launched in September 2021.

3.2 Research missions

No updates.

4. Outcome and finalisation of 3rd risk assessment including mitigation actions for consideration by plenary

CGMS-49-WGII-WP-02: **Status and outcome of the 3rd CGMS risk assessment**

The 3rd risk assessment workshop was held online in March 2021. The CGMS risk assessment captures the observations and services for the CGMS contributions to Earth observation measurement capabilities. A. Mehta introduced the preparation of the risk assessment including the assumptions and how the outcome is reviewed for the plenary.

The 3rd CGMS risk assessment recognised the following top-level risks:

- Early morning LEO due to FY-3E continuation
- No planned low inclination RO observations after COSMIC-2.
- Precipitation radar: continuation after FY-3G and GPM
- Broad band radiometer: continuation of FY-3G
- Scatterometer: risk in the early morning and afternoon orbits after FY-3E and Oceansat-3A
- Coronagraph: risk of near-term gap until SWFO-L1 and GOES-U are launched
- Energetic Particle Sensor, magnetometer, plasma analyser: risk of near-term gap until SWFO-L1 is launched

The recommended actions are recorded in the table below.

A. Mehta explained that the member-owned and -operated payloads hosted on the commercial platforms are also included when the launch dates are determined. J. Luntama commented that ESA has two instruments on the hosted platforms. In the current operating model, the ownership of the instruments is by a CGMS member. In the future, the ownership of the instrument can be also the platform owner/operator.

K. Holmlund commented that the work related to action for CMA and WMO to establish a Tiger Team following the launch of FY-3E to assess the benefit of the early morning orbit to inform CMA's future planning will be prepared by plenary session in May 2021 (see CGMS-49-WMO-WP-15).

JAXA commented on the plans for the next generation precipitation radar that the feasibility study considering the support by NASA is ongoing and to be concluded by the end of the summer 2021. Then, the mission definition plan will be delivered in IPWG. This is going to be updated in CGMS-50.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CMA	4	WGIII/A49 .05	CMA to confirm plans to fly a precipitation radar beyond FY 3G.	Feb 2022	**OPEN**
NASA and JAXA	4	WGIII/A49 .06	NASA and JAXA to confirm plans to fly a precipitation radar beyond the GPM Core.	Feb 2022	**OPEN**
EUMETSAT and ESA	4	WGIII/A49 .07	EUMETSAT and ESA to report on plans for the CIMR (Copernicus Imaging Microwave Radiometer) Mission	Feb 2022	**OPEN**
ISRO	4	WGIII/A49 .08	ISRO to confirm plans beyond Oceansat 3 series	Feb2022	**OPEN**
SWCG	4	WGIII/A49 .09	SWCG identify alternative data sources to mitigate potential unavailability of coronagraph observations	Jan 2022	**OPEN**
SWCG	4	WGIII/A49 .10	SWCG review baseline requirement for orbital positions as opposed to number of satellites for energetic particle observations	Jan 2022	**OPEN**

CGMS-49-WMO-WP-13: WMO gap analysis

H. Pohjola presented the WMO Gap Analysis 2021. He explained how the annual CGMS WGIII Risk Assessment Workshop performs the analysis with regards to three different viewpoints: 1) the CGMS Baseline, i. e. the scenario encompassing the satellite systems that the CGMS member and observers commit to implement and sustain for at least the next decade, 2) the User requirements, i. e. the needs expressed by several user communities represented by several bodies and groups belonging to or coordinated with WMO, aiming at reviewing the actual status of observation processing capability and observing technology, and providing guidance for developments so as to pursue convergence (Rolling Requirements Review, RRR) and 3) the WIGOS Vision, i. e. the projected developments of the WMO Integrated Global Observing Systems to meet long-term objectives (some two decades) of the RRR.

This working paper faces the WMO Gap Analysis mostly under the RRR viewpoint. The WMO Gap Analysis against the RRR and WIGOS are promoted by WMO to be considered by the agencies as reference user requirements to guide future developments for the medium (RRR) and long-term (WIGOS).

The work is a follow-on of the working paper CGMS-48-WMO-WP-13 and concluded by listing 16 "Gap areas". Focus is placed on each of these areas, recalling the results of the detailed analysis presented in the related working paper attempting to draw specific recommended actions.

01	Early-morning LEO	09	Sea surface temperature and Ocean colour
02	Coverage from GEO	10	Soil moisture, Snow, Sea-surface salinity, Sea ice
03	Trace gas detection	11	Space weather from L_1
04	Earth Radiation Budget	12	Space weather from the Ecliptic
05	Aerosol observation	13	Space weather from solar orbits
06	Precipitation measurement	14	Space weather from GEO and Molniya orbits
07	Sea-surface wind	15	Space weather from HEO and MAG
08	Ocean altimetry	16	Space weather from LEO

4.1 Outcome and finalisation of 3rd CGMS baseline review - for recommendation to plenary

CGMS-49-CGMS-WP-24: CGMS Baseline - draft revision following the 3rd risk assessment workshop (for recommendation to CGMS-49 plenary)

A. Mehta presented a draft CGMS Baseline document indicating the recommended edits. This year there are no major edits related to the content and most of the document changes are editorial. The edits can be summarised as follows:

- WMO Gap analysis reference changed
- Sun Earth line was defined more clearly because there are different positions from where the Sun Earth line can be defined. In the document, it follows the remote sensing perspective.
- Orbital slots were defined now in longitudes and it was also proposed that agencies use their orbital positions as defined in the document.
- IR dual-angle view imagery for high-accuracy STT was accidentally left out when documentation was edited last time and added again now. This relates to Sentinel-3 for example, when one orbit should comply with this. This is long term commitment with Copernicus.
- GEO longitudes added for all GEO satellites contributing multi-purpose met imagers and lightning mappers. Meteosat on IODC not included when it is not long-term commitment
- Energetic particle sensors defined with longitude locations as well. This is including also hosted payloads and their future launches.
- Magnetrometer GEO locations updated.
- Data sharing services was updated by WG I.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CMA	4.1	WGIII/A49.11	For CGMS Baseline, confirm if FY-4 has magnetometer.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.12	CGMS Baseline Calibration and Validation section to be updated according to NWP position paper outcome.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.13	CGMS Baseline to be reviewed if aligned with WMO unified data policy when available.	Feb 2022	**OPEN**

WMO's Position paper on Satellite data Requirements for Global NWP and CGMS Baseline

M. Rattenborg presented a short comparison between WMO's Position paper on Satellite data Requirements for Global NWP and CGMS Baseline, considering the High-Level Priorities for extending the CGMS response to the WIGOS vision. In general, WMO's Position paper refers to the specific products required for NWP, whereas the CGMS Baseline refers to broader observation categories, which do not always correspond to specific products.

All sensors stated as Backbone and Additional in the NWP paper are part of the CGMS Baseline, except for solar irradiance. However, the relation between the CGMS Baseline for Radio Occultation and the Basic Radio Occultation Constellation in the NWP paper should be clarified. In addition, the HLPP covers the extension of advanced capabilities to the whole GEO ring and the altimetry coverage. Some Emerging sensor types are not yet covered in the CGMS baseline or HLPP, such as wind lidar, cloud lidar, and cloud radar.

The list of the CGMS baseline sensor observations should be reviewed against the list of products required for NWP and the CGMS baseline document (section 4, Ensuring Data and Services) should be reviewed against the WMO Principles for Backbone and Additional Satellite Data.

The CGMS Baseline has observations not considered in NWP Position paper like VIS/UV Spectrometer in GEO, SWIR imaging spectrometer, narrow band Imager for Ocean Colour, and Space Weather observations, including ionospheric measurements.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WGII	4.1	WGIII/A49.14	The list of CGMS baseline sensor observations should be reviewed against the list of products required for NWP in the WMO's Position paper on Satellite data Requirements for Global NWP.	Jan 2022	**OPEN**

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WG I, II and IV	4.1	WGIII/A49.15	Review of CGMS baseline Section 3. against the WMO's Position paper on Satellite data Requirements for Global NWP.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.16	Review the mission planning related to irradiance, cloud/wind lidar and cloud radar observations related to the WMO's Position paper on Satellite data Requirements for Global NWP.	Feb 2022	**OPEN**

5. Final preparations for the joint WGII-WGIII session on 27 April

CGMS Secretariat presented the draft agenda for the joint WGII/III session. The agenda was agreed and it will be provided with the guidelines for the session.

6. WMO OSCAR/Space database status update

CGMS-49-WMO-WP-02: Current status of WMO OSCAR/Space

H. Pohjola presented the status of OSCAR/Space as a key tool and information source to support the WMO Rolling Review of Requirements (RRR) process and WMO Gap Analysis (CGMS-48-WMO-WP-13), which are used to monitor the compliance of satellite programmes in the implementation of the CGMS Baseline and the space-based component of the Vision for WIGOS in 2040 (WMO-No. 1243).

The WMO Space Programme Office has established and demonstrated a successful framework with a contractor for the OSCAR/Space technical maintenance. According to the development plan (Phase 1) in 2020, it resulted in a software release including major technical platform update and implementation of new functionalities.

The ongoing development (Phase 2) includes work packages to make OSCAR/Space compatible with WIGOS metadata records and implementing Gap Analysis for WIGOS Vision 2040 Subcomponents. The main mechanism for the WMO Space Programme Office to collect the relevant information for the database content updating is through templates submitted to the OSCAR/Space Support Team (O/SST) members, usually three to four times per year. The latest status of the satellites requiring updated information was sent to all O/STT focal points in April 2021. In addition, a similar request was sent out to some non-CGMS members having their satellites in OSCAR/Space. The data records related to non-CGMS members are challenging to keep up to date when many non-CGMS focal points are missing. WMO continues the work establishing also non-CGMS focal points as part of the routine update plans.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	6	WGIII/A49.17	Continue preparing and submitting to O/SST templates on OSCAR/Space data that needs to be updated, approximately 3-4 times a year.	CGMS-50	**OPEN**

7. Socio-economic benefits and impacts of satellite data

CGMS-49-NOAA-WP-12: Socio-economic Task Team update

M. A. Kutny gave a presentation on the Socio-economic Task Team (SETT) activities. It completed the related literature review, identified socio-economic expertise, organised four workshops and developed guidance material for CGMS members (http://bit.ly/SETTguide). The pilot socioeconomic benefit study was cancelled.

M. A. Kutny proposed as next steps to issue a call to update the SETT page on CGMS and then recommend an action to plenary sunset SETT. In addition, she recommended an action to WGII to add updates on member socioeconomic benefit studies to the WGIII agenda.

A. Mehta commented that other impact studies should be also reviewed, but this does not need necessarily a task team. M. A. Kutny responded that also CEOS has some related topics and she agreed NOAA to take an action to make a summary of those and present for CGMS.

K. Holmlund commented that it should be coordinated between WGII and III. A. Mehta responded that WGIII view is purely programmatic and the scientific perspective is under WGII.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WGIII	7	WGIII/A49.18	CGMS-49 Plenary to sunset Socioeconomic Task Team.	CGMS-49 plenary	**OPEN**
SETT/NOAA	7	WGIII/A49.19	SETT to provide presentation (in WGIII intersessional) on possible synergies between CEOS and CGMS socioeconomic impact related activities	Jan 2022	**OPEN**

CGMS-49-WMO-WP-15: Establishment of the FY-3E Tiger Team

K. Holmlund presented verbally the situation of the FY-3E Tiger Team. When the FY-3 early morning mission was discussed, the follow-on mission was not clear. Then, the Tiger Team was needed to see the placement of follow-on mission. In addition, CMA needed the support from the Tiger Team for their future mission plans. Furthermore, CMA should be encouraged to have users for the early data access, so that the impact assessment can be done as soon as possible. The level of impact assessment is not clear, and this influences the need of the Tiger Team. The work related to action for CMA and

WMO to establish a Tiger Team following the launch of FY-3E to assess the benefit of the early morning orbit to inform CMA's future planning will be prepared by plenary session in May 2021.

P. Zhang commented that CMA puts a very high priority on the early morning orbit. He thanked WMO and its Tiger Team for supporting CMA. P. Zhang commented that perhaps it is not necessary to establish Tiger Team again for early morning orbit.

CGMS-49 actions - WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO, CMA	7	WGIII/A49 .20	WMO and CMA to clarify the need to establish an FY-3E Tiger Team.	TBD	**OPEN**

8. AOB

No other business.

9. HLPP implementation and update

GMS-49-CGMS-WP-03 WGIII: Status of implementation of CGMS High Level Priority Plan (2020-2024)

M. Rattenborg presented the CGMS HLPP document and the sections reviewed by WGIII. Other parts of the document were reviewed by other working groups.

CGMS-49-CGMS-WP-04 WGII: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2021-2024

Item 1.2.7 was edited in order to specify the altimetry measurements due to WMO's request to emphasise the importance of the altimetry missions with high inclinations. Also, M. Rattenborg commented that it is too early to include the NWP position paper perspective. In addition, some editorial changes were made.

10. Review of WGIII actions and recommendations

CGMS-49-CGMS-WP-01WGIII: Review of CGMS-48 and CGMS-49 list of actions and recommendations

Actions were reviewed and updated accordingly in the list of actions.

11. Future plenary sessions

CGMS-49-CGMS-WP-06WGIII: Nominations CGMS, ISWGs, VLAB - Co-chairs and rapporteurs

A. Taube presented the current situation of co-chairs. WGIII recommended the nomination of H. Pohjola, WMO, as a rapporteur for WGIII.

CGMS-49 actions - WGIII				
Actionee	**AGN item**	**Action**	**Description**	**Deadline**
Plenary	11	WGIII/A49.21	Plenary to endorse H. Pohjola (WMO) as the rapporteur for WGIII	Plenary CGMS-49

CGMS-49-WGIII-WP-03: Decision on dates/times of WGIII inter-sessional meetings (CGMS-49 to CGMS-50)

A. Taube presented tentative dates for the WGIII intersessional meetings as well as the 4th risk assessment and CGMS-50 meetings as follows:

- 1st IS meeting 28 Sep 2021
- 2nd IS meeting 19 Jan 2022
- 3rd IS meeting 24 March 2022
- Risk assessment workshop 22-24 Feb 2022
- CGMS-50 WGIII 28-29 April

CGMS-49-WGIII-WP-04 (verbal only): Future CGMS WG plenary sessions

WMO will host the CGMS-50 plenary session in the second half of May 2022. Should the CGMS-50 plenary session need to be virtual, it was agreed to hold the CGMS-50 WGIII plenary session on 28-29 April 2022. The CGMS Secretariat will secure the plenary dates with WMO and make an announcement accordingly.

A. Mehta proposed an idea to prepare a paper about the history of CGMS highlighting its achievements. A. Taube commented that it is a great idea and CGMS Secretariat has some initial plans already which will be coordinated with WMO.

12. Wrap-up, WGIII report considerations for plenary and conclusions

The co-chairs closed the meeting. Concluding documents for the plenary will be prepared and communicated by email.

13. List of new actions CGMS-49 WGIII

Actionee	AGN item	Action	Description	Deadline	Status
WMO	2	WGIII/A49.01	WMO to implement the outcome of the Position paper on Satellite data Requirements for Global NWP to WMO activities like Rolling Review of Requirements, Gap Analysis, WIGOS Vision etc.	TBD	**OPEN**
ISRO	3.1	WGIII/A49.02	ISRO to update CGMS-50 on their plans for a geostationary hyperspectral infrared sounder.	Feb 2022 CGMS-50	**OPEN**
WMO	3.1	WGIII/A49.03	WMO prepare a letter of support for the GEO-XO Atmospheric Composition instrument.	Aug 2021	**OPEN**
ISRO	4	WGIII/A49.04	(Duplicate with WGIII/A49.02) ISRO to update CGMS 50 on their plans for a hyperspectral sounder in		**CLOSED**
CMA	4	WGIII/A49.05	CMA to confirm plans to fly a precipitation radar beyond FY 3G.	Feb 2022	**OPEN**
NASA and JAXA	4	WGIII/A49.06	NASA and JAXA to confirm plans to fly a precipitation radar beyond the GPM Core.	Feb 2022	**OPEN**
EUMETSAT and ESA	4	WGIII/A49.07	EUMETSAT and ESA to report on plans for the CIMR (Copernicus Imaging Microwave Radiometer) Mission	Feb 2022	**OPEN**
ISRO	4	WGIII/A49.08	ISRO to confirm plans beyond Oceansat 3 series	Feb 2022	**OPEN**
SWCG	4	WGIII/A49.09	SWCG identify alternative data sources to mitigate potential unavailability of coronagraph observations	Jan 2022	**OPEN**
SWCG	4	WGIII/A49.10	SWCG review baseline requirement for orbital positions as opposed to number of satellites for energetic particle observations	Jan 2022	**OPEN**
CMA	4.1	WGIII/A49.11	For CGMS Baseline, confirm if FY-4 has magnetometer.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.12	CGMS Baseline Calibration and Validation section to be updated according to NWP position paper outcome.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.13	CGMS Baseline to be reviewed if aligned with WMO unified data policy when available.	Feb 2022	**OPEN**

Actionee	AGN item	Action	Description	Deadline	Status
WGII	4.1	WGIII/A49.14	The list of CGMS baseline sensor observations should be reviewed against the list of products required for NWP in the WMO's Position paper on Satellite data Requirements for Global NWP.	Jan 2022	**OPEN**
WGI, WGII and WGIV	4.1	WGIII/A49.15	Review of CGMS baseline Section 3. against the WMO's Position paper on Satellite data Requirements for Global NWP.	Feb 2022	**OPEN**
WGIII	4.1	WGIII/A49.16	Review the mission planning related to irradiance, cloud/wind lidar and cloud radar observations related to the WMO's Position paper on Satellite data Requirements for Global NWP.	Feb 2022	**OPEN**
WMO	6	WGIII/A49.17	Continue preparing and submitting to O/SST templates on OSCAR/Space data that needs to be updated, approximately 3-4 times a year.	CGMS-50	**OPEN**
WG III	7	WGIII/A49.18	CGMS-49 Plenary to sunset Socioeconomic Task Team.	CGMS-49 plenary	**OPEN**
SETT/ NOAA	7	WGIII/A49.19	SETT to provide presentation (in WG III intersessional) on possible synergies between CEOS and CGMS socioeconomic impact related activities	Jan 22	**OPEN**
WMO,	7	WGIII/A49.20	WMO and CMA to clarify the need to establish an FY-3E Tiger Team.	TBD	**OPEN**
WGIII	11	WGIII/A49.21	Plenary to endorse H. Pohjola (WMO) as WGIII rapporteur	CGMS-49 plenary	**OPEN**

STATUS OF WGIII CGMS-48 ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WMO	WGIII/4	WGIII/A47.01	**Gap analysis, EGOS-IP/WOS-IP:** WMO to report on the action it plans to undertake in response to the Vision for WIGOS in 2040 once it has been approved by the World Meteorological Congress (CGMS-47-WMO-WP-18: Update on WMO Gap Analysis and on status of EGOS-IP/WOS-IP)	*2021 Jan: Ongoing in WMO (re. Evolution of the GOS). Work kicked-off. Report expected to CGMS-50 (TBC)*	CGMS-50 (CGMS-48)	**ONGOING**
WMO	WGIII/5	WGIII/A47.02	**Gap analysis:** WMO to conduct a Gap Analysis against the approved WIGOS Vision 2040	*2021 1-3 Mar: Latest gap analysis presented at the 3rd risk assessment WS. It is included as a standing item on the risk assessment agenda and action is therefore closed.* 2021 Jan: Draft submitted, to be reviewed by ET-SSU and available for the WGIII risk assessment in March.	CGMS-49 (CGMS-48)	**CLOSED**
WMO	WGIII/5	WGIII/A47.03	**OSCAR/Space:** WMO to hold a workshop on OSCAR/Space in order to develop plans for its sustainment and future development, both in terms of information content and system capability	*2021 Jan: Expert teams now functional. WGIII agreed to close the action and raise new actions if/as needed. WMO has secured the OSCAR database(s) in the medium term. CGMS-48 WG WMO-WP-11, Workshop postponed to 2021 due to pandemic.*	spring 2021 (2020)	**CLOSED**

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies, O/SST members	WGIII/5	A47.06a	The OSCAR/Space Support Team (O/SST) to continue providing information on their satellite programmes for accurate recording in OSCAR/Space, according to the recommended procedure with templates provided by the WMO Space Programme. Instructions and templates are available in working paper CGMS-47 WMO-WP-17b.	*2021 16 Apr: The O/SST is now well established. Closed on the occasion of CGMS-49 WGIII*	CGMS-49 (Dec 2019)	**CLOSED**
WMO	WGIII/7	WGIII/A47.07	**Early Morning Orbit:** WMO to reconvene a WMO-CGMS Tiger Team on the impact of the Early Morning orbit. (It is currently premature to convene this Tiger Team until an assessment of FY-3E is conducted).	*2021 16 April: WMO (K. Holmlund), together with CMA, working on establishing the tiger team*	CGMS-49	**ONGOING**
NOAA	WGIII/7	WGIII/A47.10	**MW imaging in LEO for SST:** NOAA to provide an update on SSMI status and possible follow-on	*2021 16 Apr: NOAA confirmed that the data can be shared with CGMS members.*	CGMS-49 (CGMS-48)	**CLOSED**
ISRO	WGIII/7	WGIII/A47.11	ISRO to provide an update on its plans for follow-on mission to Oceansat-3.	*2021 1-3 Mar: provided at CGMS-49 WGII*	CGMS-49 (CGMS-48)	**CLOSED**
ISRO	WGIII/7	WGIII/A47.12	ISRO to confirm data latency for Aditya-L1 mission	*2021 16 Apr: Action closed on the occasion of the CGMS-49 WGIII meeting.*	CGMS-49 (CGMS-48)	**CLOSED**

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
ISRO	WGIII	WGIII/A47.13	**On passive microwave observations:** ISRO is recommended to confirm its plans for a Megha-Tropiques follow up mission in low inclination and its plans for TSU and MSU MW sounders and to consider complementary orbits for the deployment of these sounders. (Formerly plenary recommendation R46.07)	*2021 1-3 Mar:* *4. On passive microwave observations: ISRO is recommended to confirm its plans for a Megha-Tropiques follow up mission in low inclination and its plans for TSU and MSU MW sounders and to consider complementary orbits for the deployment of these sounders.*	CGMS-49 (CGMS-48)	**CLOSED**
JAXA, NASA	WGIII/7	WGIII/A47.14	NASA and JAXA to provide future plans for precipitation measurement mission(s)	*2020 May 29, CGMS-48 WGIII: CGMS-48-JAXA-WP-03. Closed. JAXA and NASA are requested to keep CGMS regularly informed.*	CGMS-48	**CLOSED**
WGIII	from WGII/5	WGIII/A47.17 (WGII/A47.14)	WGIII to provide their assessment and planning for the next risk assessment to the ISWGs, WGClimate and GSICS. (Action from WGII).	*2021 Jan: WGII-WGIII joint session to be held on 27 April 2021. WGIII agreed to close this action since it is included in the risk assessment review and interactions (including joint WGII-WGIII sessions).*	Apr 2021 (Apr/Mar 2020)	**CLOSED**
WGIII (co-chairs, rapporteurs)	WGIII	WGIII/A47.0	WGIII to review its ToRs in 2024 (The Terms of Reference of the CGMS Working Groups to be reviewed every 5 years. CGMSSEC/CGMS WGs to secure this is included on relevant future plenary meeting agendas).	2021 Jan: Include on the WGIII AGN (or RA WS AGN) to review WGII-WGIII interactions for possible update of the WGIII ToRs.	2024	**OPEN**

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies	WGIII/3.2 & 4.1	WGIII/A48.01	WGIII to reflect the aspect of latency in the CGMS baseline/risk assessment. *(Ref. from IPWG CGMS-47 plenary item 5.7 R47.06, passed to WGIII as a recommendation and converted to an action at CGMS-48 WGIII, 29 May 2020: Latency and quality of satellite data should be improved, from both operational and research missions, to fit in the data assimilation high temporal resolution cycle).*	*2021 16 Apr: Ref. to CGMS-49-WMO-WP-02. Also to be addressed within the framework of WGI.* 2021 1-3 Mar: WMO to consider addressing this in the status requests to O/SST to enable incorporation in the gap analysis (TBC). 2021 Jan: Data latency, quality, … for WGII-WGIII joint session. 3rd risk assessment results to be shared with the other WGs (April 2021) for feedback/comments to WGIII. (WMO: Data latency/operational data - link to OSCAR space to enable filtering between operational and non-operational missions for improving gap analysis)	CGMS-50 (Mar/Apr 2021, Feb 2021)	**ONGOING**
EUMETSAT (NSOAS)	WGIII/3.2 & 4.1	WGIII/A48.02	CGMS-48 WGIII discussions May 2020 (and the now closed 1RAWS2019.4): WGIII recognised the need for a long term plan for ~6Ghz frequency microwave imaging in at least one LEO orbit for all weather Sea Surface Temperature observations. Recommended Mitigating Action #4: [EUM and SOA] to ensure data availability for HY-2B MWI.	*2021 16 Apr: Currently the data policy is not fully free and open. EUMETSAT is addressing this with NSOAS.* 2021 Jan: No progress, action on CGMSSEC	Jun 2021 (Feb 2021)	**ONGOING**

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
EUMETSAT (NSOAS)	WGIII/3 .2 & 4.1	WGIII/A48. 03	CGMS-48 WGIII discussions May 2020 (and the now closed 1RAWS2019.8): WGIII recognised that there is no radar altimetry data availability in the early morning orbit in the short term and that there are no plans in the long term for coverage. Recommended Mitigating Action #8: [EUM and SOA] to ensure data availability for HY-2B ALT.	*2021 16 Apr: Currently the data policy is not fully free and open. EUMETSAT is addressing this with NSOAS.* 2021 Jan: No progress, action on CGMSSEC.	Jun 2021 (Feb 2021)	**ONGOING**
EUMETSAT (NIER)	WGIII/3 .2 & 4.1	WGIII/A48. 04	EUMETSAT to explore with NIER of GEO KOMPSAT 2B GEMS observations can be considered for the CGMS baseline and risk assessment.	*2021 16 Apr: KMA to reach out to NIER* 2021 1-3 Mar: EUMETSAT to continue reaching out to NIER (NIER expected to provide a status presentation to WGII at CGMS-49). 2021 Jan: No progress, action on CGMSSEC.	CGMS-49 (Feb 2021)	**ONGOING**
WMO	WGIII/5	WGIII/A48. 05	WMO to prepare templates on OSCAR/Space data that needs to be updated and submitting them to O/SST, approximately 3-4 times a year, for providing the missing information and to provide these to the CGMS space agencies. (Ref. CGMS-48-WMO-WP-10a)	*2021 16 Apr: Closed following CGMS-49 WGIII discussions. The process is now well established.* 2021 1-3 Mar: To be addressed in WGIII discussions in April and then likely closed, but needs to be recalled and noted in WMO working papers and in the meeting report(s).	Apr 2021 (01/07/20 20)	**CLOSED**
WMO	WGIII/5	WGIII/A48. 06	WMO to continue efforts to establish reliable O/SST focal points from CEOS members other than CGMS members and commercial satellites operators.	*2021 16 Apr: Ref CGMS-49-WMO-WP-02. CGMS agencies to provide input overall the focal points have been established. Closed on the occasion of CGMS-49 WGIII*	Apr 2021 CGMS-49	**CLOSED**

Status of WGIII CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies	WGIII/5	WGIII/A48.07	CGMS members, through their O/SST focal points, to provide accurate and timely updates on OSCAR/Space database content in response to requests made to them by the WMO Space Programme Office. (Ref. CGMS-48-WMO-WP-10a)	*2021 16 Apr: Covered by the ToRs of the O/SST. See also Ref CGMS-49-WMO-WP-02. Closed on the occasion of CGMS-49 WGIII.*	Apr 2021 (01/07/2020)	**CLOSED**
CGMSSEC, WGII co-chairs/rapporteurs	WGIII/3	WGIII/A48.08	CGMSSEC to follow up with WGII co-chairs/rapporteurs to secure their input on the CGMS Baseline	2021 11/3 Mar: Ajay Mehta, WGIII co-chair briefed WGII in the WGII intersessional meeting on 11 March. (in preparation of the CGMS-49 joint WGII-WGIII session on 27 April) 2021 Jan: To be addressed at the 3rd risk assessment WS in March and the joint WGII-WGIII session in April.	Mar-Apr 2021 (01/08/2020)	**CLOSED**

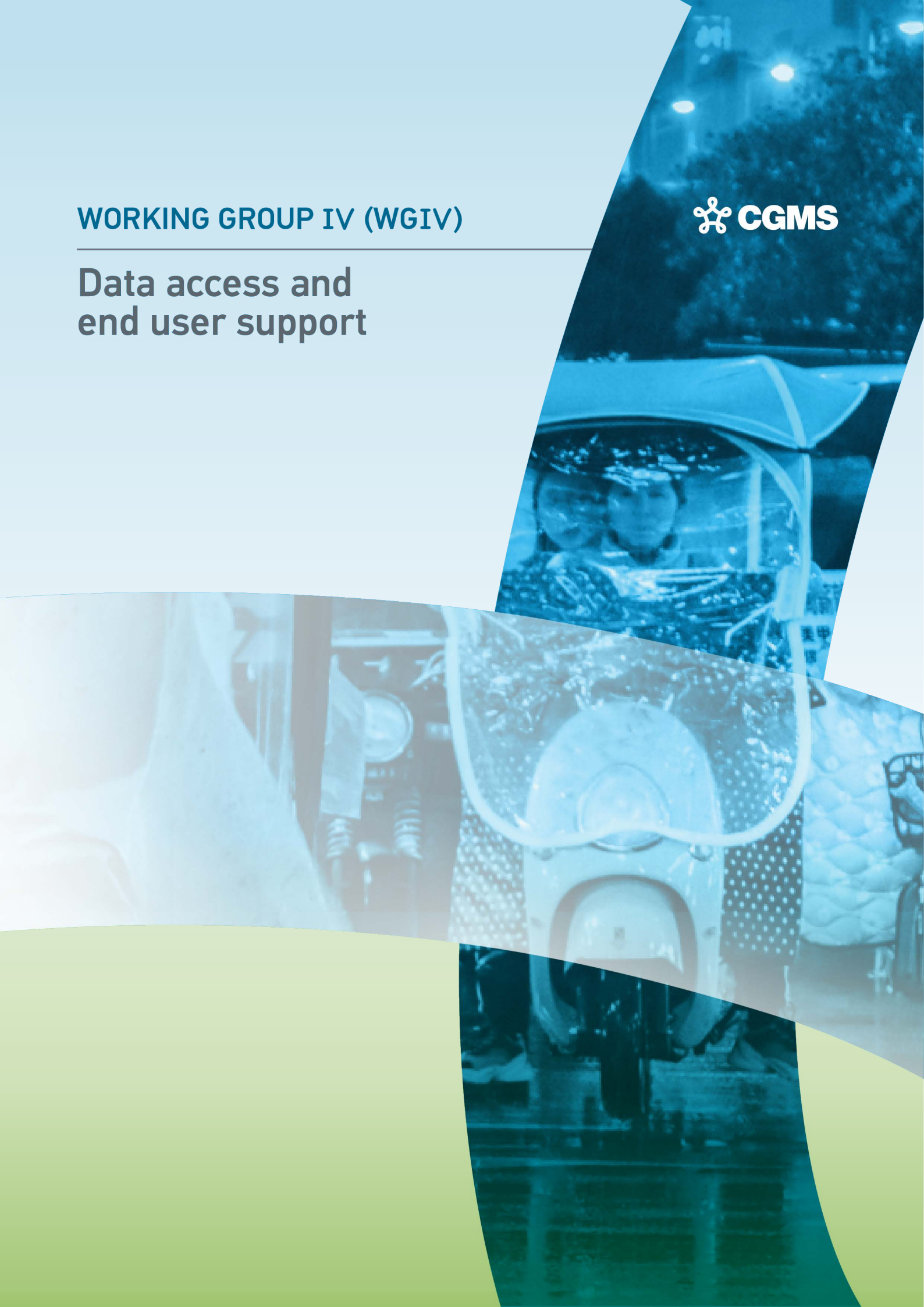
Status of WGIII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS space agencies	From plenary 5.7	Plenary R47.05	**(From IPWG):** Higher spatial and temporal (sub-hourly) resolution and higher spectral sampling in the microwave measurement of clouds and precipitation should be considered in future observing systems. [Recommendation transferred from plenary].	***COMPLETED*** *2021 1-3 Mar: Consider concluded at this stage. To be reopened as necessary once more concrete input is available. CGMSSEC to address it with IPWG within the framework of the HLPP.* 2021 Jan: Reference to WIGOS Vision. Address in WGII-WGIII joint session in April. 2020 May 28, CGMS-48 WGIII: CGMS members to take note/consider in the preparation of new programmes. Recommendation proposed to be

Status of WGIII CGMS-48 recommendations following CGMS-49 discussions				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
				closed. It will be addressed within the framework of the CGMS baseline/risk assessment.
CGMS space agencies	5.8	R47.09	(From **ICWG**) CGMS agencies to continue operating conically-scanning passive MW sensors in an early afternoon orbit as well as in a dusk/dawn orbit in order to maintain this unique long-term time series.	***COMPLETED*** *2021 1-3 Mar: WMO to consider this within the framework of the gap analysis.* 2021 Jan: Reference to WIGOS Vision. Address in WGII-WGIII joint session in April. 2020 Aug: Transferred from plenary CGMS-47 to WGIII

CGMS

WORKING GROUP IV (WGIV)

Data access and end user support



WGIV REPORT

Co-chairs: Kotaro BESSHO (JMA)
Rapporteur: Klaus-Peter Renner (EUMETSAT)

1. Welcome, objectives of the meeting

WGIV reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting, which is in line with the Terms of Reference for WGIV.

Representatives of the following organisations attended the session: CMA, ESA, EUMETSAT, IMD, ISRO, JMA, KMA, NASA, NICT, NOAA, NSSC, ROSCOSMOS, ROSHYDROMET, UK Met Office, and WMO.

The WGIV meeting was conducted via Webex.

In view of the common items of interest in relation to Space Weather, the representatives of WGI, WGIV, and the Space Weather Coordination Group participated in the joint WGI-WGIV-SWCG meeting to address space weather related topics.

2. Review of actions and recommendations from previous meetings and status update

The WG reviewed the actions and recommendations of past CGMS sessions related to its work. The following 15 actions were proposed to be closed: A44.05, A45.03, A46.02, A46.04, A46.06, A46.08, A47.03, A47.04, A47.05, A48.03, A48.04, A48.05, A48.07, A48.10, and A48.11. Six actions and three recommendations remained open. One new action was created as a follow-up on A46.08, and one recommendation as follow-up on A46.04.

CGMS-49 actions - WGIV					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
Satellite operators who launched new satellites since 2016	2	WGIV/A49.01	To provide updates for WMO "Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites" https://library.wmo.int/doc_num.php?explnum_id=3553	CGMS-50	**OPEN**

CGMS-49 WGIV recommendations			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	2	WGIV/R49.01	To consider an enhancement of advance notifications of processing changes as specified below and provide feedback to WG-IV. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8

CGMS-49 WGIV recommendations			
Actionee	**AGN item**	**Rec**	**Description**
			weeks before the change and test data should be provided if possible. [From the ITWG ITSC-21 Report]

3. User-provider dialogue on regional/global scales

There were no discussions under this item.

4. Implementation and evolution of sustained and coordinated communication satellite broadcast systems

CGMS-49-CMA-WP-12: CMA Report on the Update of CMACast

This document describes the status and future plan of the CMACast system and services. In the framework of GEONETCast, CMACast distributes data to Asia-Pacific users who use the Integrated CMACast system to receive and process data as well as to make weather forecasts. In order to service users better, the CMACast system will be updated in 2021. After the upgrade, CMACast can distribute data by satellite for all users in the footprint, by meteorological broadband network for domestic users and internet for international users. In addition, the coverage of CMACast will be further expanded to West Asia, the Middle East, and most of Africa, with the same transponder capacity as before. The new CMACast coverage will be available in 2022.

CGMS-49-JMA-WP-06: Data dissemination and distribution of Himawari-8/9 and their recent update

The document presents an overview of Himawari-8/9 data dissemination and distribution in JMA and reports their recent updates. JMA provides Himawari-8/9 data via its HimawariCast and HimawariCloud systems, with online satellite imagery improved in February 2021. New developments such as HimawariCast enhancement and a new HimawariCloud connection method are under consideration. A novel HpFP protocol was developed by the National Institute of Information and Communications Technology (NICT) based on the User Datagram Protocol and enables high throughput even with high latency and packet loss.

EUMETSAT asked if HpFP is already in use and JMA confirmed that HpFP is implemented in the HimawariCloud system.

CGMS-49-NOAA-WP-13: NOAA Report on GEONETCast Americas (GNC-A)

The GEONETCast Americas broadcast (GNC-A) is a NOAA-funded, commercially provided broadcast stream that has been operational since 2008, serving satellite, in-situ, and various other earth observational data to North, Central, and South American communities via the Intelsat-21 satellite at 58° West. The GNC-A broadcast has evolved since 2018 with a larger user community, additional NOAA Geostationary and polar orbiting products, and more external data providers. In 2020, the satellite

broadcast itself has been modified with a change in the transponder that accommodates a higher data rate change, a change in data formatting, and centre downlink frequency requiring GNC-A users to modify ground station receiving equipment. NOAA still maintains its partnership with the Brazilian Ministry of Science, Technology, and Innovations (INPE), which has been instrumental in end user outreach and the open source GNC-A SHOWCast visualisation software suite.

Responding to a question from JMA on the relationship between the US and Brazil, NOAA said an agreement is in place with INPE as full-time partner, for helpdesk and customer support covering Portuguese and Spanish language, which also includes local support to users.

5. Global or inter-regional data circulation and access, WIS

CGMS-49-IMD-WP-03: Update on MMDRPS data access

IMD has established the Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR, and INSAT-3DS. MMDRPS has a very high-end processing system, which cuts down the processing time from 15 to 7 minutes. All available past satellite datasets starting from 1983 will be kept in online mode in due course of time. The MMDRPS system has been declared operational on 12th November 2020 and is being used to receive and process the INSAT-3D and INSAT-3DR satellites data. Data exchange between IMD and other national and international agencies takes place on a real time basis. A dedicated National Knowledge Network (NKN) has been established by IMD with ISRO and with NCMRWF. Data transmission also takes place through the Global Telecommunication system (GTS) network for international agencies. The MMDRPS has a dedicated Web-based Data supply System (DSS) in redundant mode to cater web-based data dissemination requirements in near real time basis to various users (both local and remote global) based on the data dissemination policy of IMD. In addition, the MMDRPS system is also in the final stage of implementing the RAPID Beta Version. The new RAPID tool, along with satellite data visualisation, also ingests NWP, radar, and in-situ observational data on a real time basis. The different types of data can be overlayed to understand the weather patterns from various sources for improved weather forecasting.

CGMS-49-ISRO-WP-01: Meteorological and oceanographic data dissemination from MOSDAC

The paper discusses the information and products available for dissemination from Meteorological and Oceanographic Satellite Data Archival Center (MOSDAC). It also highlights details of data interconnect and provides an overview of data dissemination. New applications released on MOSDAC are also introduced.

MOSDAC is a data centre of ISRO for the dissemination of data, value added products, and satellite-derived information products related to meteorology and oceanography. Currently, these data sets are being disseminated using well established data exchanges and data transfer protocols.

As part of data access, MOSDAC has introduced the micro services-based dissemination of information and alerts. This services-based interface allows other uses to integrate or use services of MOSDAC on their website or applications. Currently, beach alert, weather alert, and location-based weather forecast are available as a service. Some new capabilities introduced in MOSDAC includes city weather,

safe beach and visualisation, and the display of Automatic Weather Station (AWS) data and Interactive Visualisation and analysis using LIVE (https://mosdac.gov.in/live).

MOSDAC provides different mechanisms for dissemination of data to its users. Users registered with MOSDAC can log-in and place an order for archived products. The open data is available for download to registered users, without any requirement of ordering. MOSDAC also provide access to data as WMS layers, Email, and RSS feeds. MOSDAC-registered users can also use MOSDAC API to access data and information.

When asked by JMA about the benefit of data access through micro services, ISRO explained that this method is primarily for API access and the data guidelines were updated accordingly. The paper also contains a link to the updated guidelines.

WMO pointed out similarities in the developing strategies for WIS2.0 where GTS will be phased out, in relation to ISRO's activities in the new test Amazon cloud, using S3 bucket, using message queuing protocols, and working towards RSS-based feeds for message distribution.

ISRO confirmed that AWS data is freely available through MOSDAC web, but not on GTS. It is planned to start a project for exposing this data on WIS2.0.

CGMS-49-KMA-WP-03: KMA Report on the update of GK2A data service

The GK2A satellite is operational since July 25, 2019. It produces 16 channels level 1b and many kinds of meteorological data and is operating for rapid scan local observation at interval of 2 minutes as well as normal observation at every 10 minutes for full disk. KMA has implemented the GK2A data service via several ways such as real-time FTP, open API, WMO WIS DCPC, and web-based download.

In order to promote GK2A data utilisation in public and private sectors as well as the NMHS, KMA has implemented the open API service of the GK2A data for 79 AMI products and 8 KSEM products from this year.

When asked about a free download policy for commercial and academic users, KMA responded that this is possible for GK2A data through the API access method.

CGMS-49-EUMETSAT-WP-10: Update on the EUMETSAT NRT Data Access Services

The presentation provides an overview and the current status of the new data access services: EUMETView, Data Store, and Data Tailor. EUMETView is an Online Map Service that provides visualisations of EUMETSAT products through a customisable web user interface and an enhanced set of Open Geospatial Consortium (OGC) standard APIs. The EUMETSAT Data Store is providing access to NRT products, historic products, and climate data records through an online web user interface and via a suite of APIs. EUMETSAT Data Tailor (standalone or via Data Store) allows users to subset and aggregate EUMETSAT's data products in space and time, filter layers, generate quicklooks, re-project, and reformat into common GIS formats. The existing EUMETCast services were enhanced, i. e. the EUMETCast Europe non-restorable service using flexible transponder capacity from the back-up satellite as needed, and the access to EUMETCast Terrestrial via commercial internet to complement

the National Research and Education Network (NREN) access. The operational start of new terrestrial based data services (EUMETView, Data Store, Data Tailor, and EUMETCast Terrestrial enhancements) is planned for mid-2021, and for the EUMETCast Europe non-restorable Satellite service in 2023 to 2024.

CGMS-49-ROSHYDROMET-WP-05: Satellite data exchange in Roshydromet

Roshydromet shares satellite data with the international community in accordance with WMO resolution 40 and the current Bilateral Agreement with EUMETSAT. Data from Russian geostationary and polar meteorological satellites is provided to the EUMETSAT land channel for distribution to EUMETSAT users in NRT via EUMETCast. This data includes IR sounder IKFS-2 (Meteor-M N2) and microwave sounder MTVZA-GY (Meteor-M N2-2). Following the recommendations of CGMS-48, the data is dumped over European, Siberian, and Far-Eastern centres of SRC Planeta to improve timeliness, and allowing per-pass data to be available for NWP purposes. Since 2018, IKFS data is available via the Roshydromet GSICS Processing and Research Centre website. Roshydromet has access to the data distributed via EUMETCast and uses this data in operational practice. Roshydromet (SRC Planeta) contributes to the EUMETSAT Advanced Retransmission Service (EARS) by provision of regional coverage of NOAA, MetOp, and SNPP data. A dedicated landline channel between Moscow and EUMETSAT headquarters in Darmstadt was recently updated by EUMETSAT to meet the data exchange requirements. The Internet channels are used as a backup.

CGMS-49-WMO-WP-08: WMO Integrated Global Observing System Station identifiers

The paper examines the identification of satellites in products exchanged within the context of the WMO Integrated Global Observing System. The use of Common Code Table C-5 from the WMO Manual on Codes is explained, together with the concept of WIGOS station identifiers and their applicability for satellites. The paper concludes by recommending that the CGMS Task Force on Satellite Data and Codes works with WMO to address the use of WIGOS Station Identifiers (WSI) for satellites.

CGMS-49 actions - WGIV					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS Task Force on Satellite Data and Codes, WMO	5	WGIV/A49.02	The CGMS Task Force on Satellite Data and Codes to work closely with WMO on addressing the following points: i. Linking between OSCAR/Space and the WSI and/or CCT C-5 identifiers (WMO internal) ii. Potential extension of the use of the Issue Number in the WSI for satellites in order to explicitly indicate metadata which are otherwise only implicitly embedded in the Local	CGMS-50	**OPEN**

CGMS-49 actions - WGIV					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
			Identifier (CGMS-50) iii. Identification of when and how the WSI should be included in the satellite products exchanges in the context of the WIGOS (CGMS-50) (ref CGMS-49-WMO-WP-08)		

CGMS-49-CMA-WP-11: Fengyun Satellite Data Services and Applications and Their Updates

The document describes the data policy of FY satellite data, the status, and future plans of and for the FY satellite data distribution and services. FY satellite data are open to NMSs and other international organisations and users for free charge via many ways. For real-time users, FY satellite data can be accessed via direct broadcasting stations, CMA data broadcasting system (CMACast), GTS, WIS, and public cloud. For non-real-time users, F197

Y satellite data can be accessed from the FY satellite data centre website, downloading toolkits, and offline data services. For emergency users, FY satellite emergency support mechanism (FY_ESM) is useful to NMSs.

JMA thanked CMA for the contribution, in particular for the RSS service as part of the emergency support mechanism.

6. Widening of data access, to new missions/providers as well as for other user communities

CGMS-49-CEOS-WP-01: A report on the initiation of the Earth Observation Training Education and Capacity Development (EOTEC DevNet) on behalf of CEOS WG for Capacity building and Data Democracy (WGCapD)

The Working Paper presents the Earth Observation Training, Education, and Capacity Development Network (EOTEC DevNet) initiation plan. A gap exists in the coordination of the efforts to strengthen sustained capacity and use of EO to meet user needs in support of the sustainable development agenda. Currently, multiple global networks contribute to EO capacity development. Each has overlapping interests and existing relationships that can be further coordinated and leveraged to bring the power of EO to more users. CEOS recently endorsed the EOTEC DevNet initiation plan, which includes using a network of networks approach between CEOS WGCapD, GEO CD-WG, CGMS VLab, WMO, and UNOOSA. This two-year pilot aims to improve coordination and enhancement of EO space-based asset providers and training providers in support of key global development outcomes. Through greater communication, EOTEC DevNet will improve strategic and ad hoc coordination of activities. Through systematic assessment of relevant capacity development resources and current state of skills to use them, gaps will be identified, and approaches will be developed to close the gaps, leading to improved application of EO to meet the 2030 sustainability framework goals. By creating leadership coordination meetings and a practitioner community among capacity building professionals that serve as a marketplace to facilitate information and knowledge flows, greater global and regional

communication will be enabled between the participants in the multiple networks. Part of the CEOS Work Plan 2020-2022, the EOTEC DevNet initiation plan begins with a two-year pilot with WGCapD initiating a new Task Team, called the EOTEC DevNet Task Team, to implement EOTEC DevNet tasks. To implement EOTEC DevNet, initial actions for each of the individual network organisations are to work within their respective governance structures to gain approval and support of participation, prepare an estimate of effort required, and host the first official EOTEC DevNet regional meetings in June 2021 and leadership convening in September 2021. Building off of the recent WGCapD-10 Annual Meeting regional discussions, EOTEC DevNet will focus on floods as the initial case study for coordination across networks.

WGIV and the VLab co-chair supported this initiative and encouraged WGIV member to participate in regional discussions planned in June. A related action was created.

CGMS-49 actions - WGIV					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	6	WGIV/A49.03	To participate in the next EOTEC DevNet regional discussions planned in June, held online across time zones. Invitations have been sent to WGIV members by CGMS secretariat.	Jul 2021	**OPEN**

6.1. Disaster support

CGMS-49-CMA-WP-13: CMA Report on FY_ESM

The document describes the updated information of Rapid Scan Services under the Emergency Support Mechanism of FY Satellite (FY_ESM), including the update of the FY_ESM webpage, rapid scan products, working flow, and suggestions on cooperation with JMA and KMA. CMA will strengthen capabilities on disaster prevention and mitigation with FY satellites.

In response to a question from JMA, CMA confirmed that FY-3 LEO satellites are used in disaster support cases, too, e. g. in Guatemala, Russia, and South America.

CGMS-49-ISRO-WP-08: Web-based platform for disaster data analysis

The International Charter on Space and Major Disasters is a worldwide collaboration through which satellite data are made available for the benefit of disaster management. By combining EO assets from different space agencies, the Charter allows resources and expertise to be coordinated for rapid response to major disaster situations. This unique initiative is able to mobilise agencies around the world and benefit from their know-how and their satellites through a single access point that operates 24x7 at no cost to the user. The paper presents a solution, responding to the need for web-based online processing platforms for disaster analysis due to (i) a large number of satellites and data products, (ii) to reduce the Turn-around-time for analysis, (iii) a non-availability of processing resources. The Web based platform for Disaster Data Analysis is intended for project managers (PM),

Value Adders (VA), and members, allowing creation and visualisation of the reports from an increasing number of satellites and products.

ISRO explained in response to a question from JMA that the system is not depending on local data, but is automatically downloading all required data or providing links to download.

CGMS-49-JMA-WP-07: Status of JMA HimawariRequest service

In January 2018, JMA launched a new international service "HimawariRequest", in collaboration with the Australian Bureau of Meteorology. The service allows NMHS users in the Himawari8/9 coverage area to request Target Area observation covering a 1,000km x 1,000km area every 2.5 minutes. Target Area observation supports JMA's national/international services including the RSMC Tokyo - Typhoon Center and the Tokyo VAAC. In response to a recommendation made at the 2015 Joint RA II/RA V Workshop on WIGOS for Disaster Risk Reduction, JMA developed the service through the RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products, and Training. As of 6 April 2021, JMA had taken registrations from 22 NMHSs in RA II and RA V, and 17 have completed preparation for their requests. There have been 118 international requests since the commencement of the service, among which 104 have been approved. Targets have included tropical cyclones in the South Pacific, extreme weather and bushfires in Australia, and volcanic activity in Indonesia. JMA expects the HimawariRequest service to support disaster risk reduction activities in the Asia Oceania region based on the regional monitoring of extreme events such as tropical cyclones and volcanic eruptions using the Target Area observation.

6.2 Support to the Ocean user community

There were no discussions under this item.

6.3 Support for Arctic observations

There were no discussions under this item.

6.4 Support for Hyperspectral infrared instruments

There were no discussions under this item.

7 Data formats and standards (use of open standards)

There were no discussions under this item.

8 Coordination of Metadata (incl. standards within ocean communities)

CGMS-49-EUMETSAT-WP-25: Status of metadata coordination

The presentation provides an update regarding the open actions on the Task Team on Metadata Implementation, namely WGIV-48.03: Approach to the improvement of the WIS catalogue and the publication of new metadata records, and WGIV-45.03: Provide documentation/information for generating the space weather related metadata. The TFMI has produced and published guidance

documents and reports on these actions with online links provided in the paper and recommends closing the actions.

The TFMI chair, G. Aubert, also informed WGIV about his intention to step down from the role as chair with immediate effect.

WGIV agreed with the closure of the actions, and thanked Guillaume Aubert for his long-lasting support, the comprehensive work done, and progress achieved within the TFMI.

WGIV members are encouraged to nominate a candidate for the TFMI chair, and a related action was created under agenda item 18.

9 User readiness for new satellite systems - WG-IV key issue

CGMS-49-NOAA-WP-14: Overview of GeoXO's User Engagement Process, Findings and Next Steps

NOAA is a service organisation that provides science data to society and advances Science technology. It is critical to continuously advance knowledge and understanding of user needs, user capabilities and how information fuels the decisions and actions that impact society. NOAA is planning for the Geostationary and Extended Orbits (GEO-XO) Programme to follow the Geostationary Operational Environmental Satellites (GOES) – R Series and Space Weather Follow-On (SWFO) missions in the 2030-2050 timeframe. The GEO-XO Programme builds off of progress made by the NOAA Satellite Observing Systems Architecture (NSOSA) study, which examined a wide range of space sensor and platform options. Now in Phase A of pre-formulation, GEO-XO's user engagement will be most active reaching out to user communities and collecting information to develop requirements associated with GEO-XO observations. In this report, a high-level summary of the 2020 user engagement efforts that informed the GEO-XO instrument requirements and provide insight into the current GEO-XO User Engagement effort and value studies is provided. GEO-XO user engagement effort leverage various communities and builds on the legacy user knowledge in fire, weather forecasting, agriculture, human health, and ocean life. Decision-driven discussions were used to identify current and future needs of information that would then be translated into geophysical requirements for Geo-XO as well as all of NESDIS. The user information captured during the 2020 workshops helped identify key needs of said user communities and identified user requirements for GEO-XO proposed future instruments: a visible and near IR imager, a lightning mapper, a sounder, an atmospheric composition instrument, a day/night imager or band, and an ocean colour instrument. GEO-XO's user engagement will continue to build upon user information to develop value studies across specific economic sectors, that will help quantify the value of GEO-XO for society. To do this, the programme will rely heavily on the future SME users of GEO-XO, known as the Pathfinders, to connect the value of observations to society. Sector expert Pathfinders will be identified and selected to tell the story for how GEO-XO data will contribute to the evolving needs of society and quantify the return on GEO-XO investment. The paper will summarise the process, activities, and findings of the GEO-XO user engagement efforts and give a brief update on the next steps of the user engagement planning. It serves as an opportunity to recruit future GEO-XO Pathfinders and prepare the public for future GEO-XO data through training and future

workshops. A GEO-XO User Engagement Plan will be published in Spring 2021 explaining the user engagement strategies and the GEO-XO Pathfinder Programme.

EUMETSAT asked about the time frames of the engagement steps up to launch.

NOAA explained that user engagement spreads over more than a decade up to launch, with initial analysis done to better understand user needs at decision making level, then to understand the product needs with 1-2 years of collecting information, then to understand user services and delivery. These steps are not necessarily going on sequentially, as the information is flowing in parallel. Subject matter experts and pathfinders are involved to help demonstrate the use of data.

VLab asked if there are international use cases. For NOAA, the current focus is the USA, but international use cases will be considered in the context of pathfinders.

NASA invited NOAA to engage with NASA in a regional Americas perspective, NOAA is happy to follow up.

JMA explained that it is following a similar user engagement process for the follow-on GEO satellites, at a smaller scope, with the involvement of scientists to collect commercial and international user requirements.

NOAA emphasised that combining information from instruments, organisations, and constellations is more important than looking at individual satellites, therefore collaboration at international level is essential.

CGMS-49-WMO-WP-12: VLab Progress Report 2021

The document reports on activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) in 2020. Since CGMS-48, VLab members have offered a variety of training opportunities, with highlight to training efforts addressing the new generation of satellites, which continues to be the major training need identified by VLab members. Furthermore, stronger collaboration and coordination of efforts between VLab members resulted in increased opportunities for user training during the past year. The VLab Management Group (VLMG) continued to coordinate its activities with support from co-chairmanship representing CGMS satellite operators and VLab Centres of Excellence. Dr Mark Higgins (EUMETSAT Training Manager) has been a VLab co-chair on behalf of CGMS satellite operators since 2017. This co-chairmanship was initially established for a period of up to 3 years and then a candidate for the co-chair replacement is needed. The VLab Trust Fund continues to receive yearly contributions from NOAA/NWS, EUMETSAT, and KMA. However, a larger number of contributing CGMS agencies is required to expand VLab activities to meet WMO-CGMS members' requirements and needs for training and to improve the long-term sustainability of VLab activities. Regular financial contributions from CGMS members are critical to maintain the VLab training activities. VLMG continued to coordinate its activities and support for training events via regular online meetings. Due to travel restrictions caused by the COVID-19 pandemic, the tenth meeting of the VLMG has been postponed. CGMS members active in VLab are invited to send representation to participate in the meeting.

The Vlab chair invited WGIV to make use of the VLab training calendar as resource to publicise events to a wide number of communities.

NASA thanked VLab for the training calendar engagement, in particular the opportunity to connect other calendars.

NOAA thanked VLab for the contribution, in particular in times when everybody is going online. NOAA also introduced Dr. Bernadette Connell, from Cooperative Institute for Research in the Atmosphere of Colorado State University, and nominated her for the VLab Co-chair position. She has a strong background on VLab since its inception.

EUMETSAT/VLab supported the nomination of Dr. Bernadette Connell.

WGIV agreed to recommend Dr. Bernadette Connell (NOAA) as next VLab Co-Chair for endorsement by CGMS-49 Plenary.

It should be noted that a nomination by CMA for the second VLab Co-Chair was not known at the time of the WGIV meeting and was presented directly to plenary.

10 Notification of changes (and alerts) in satellite data and/or products impacting users

There were no discussions under this item.

11 Cyber security towards end users - WG-IV key issue

CGMS-49-EUMETSAT-WP-15: Report from the expert group on cyber security including proposal for ToR

On 17th March 2021, the first meeting of the newly created WG IV Cyber Security Expert Group was held. The focus of the first meeting was to create and review the ToR. The subsequent meetings will address the cyber security topics as proposed by the members.

ISRO asked if involving industry experts is planned or would add value to the discussion. The Cyber Security Expert Group chair explained that it is not foreseen at this stage, and it would need to be assessed if external industry participation is within the policy of the expert group.

CGMS-49 WGIV recommendations			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	12	WGIV/R49.02	The WGIV Cyber Security Expert Group welcomes any other members who are not yet represented in the group, and to propose new security related topics to be addressed by the group

12 Cloud Services interoperability

CGMS-49-CMA-WP-10: The Recent Progress on the Usage of Cloud Services in CM

NSMC/CMA is working on solutions for FY series meteorological satellites data service and cloud images processing by using public cloud service. The applications are: satellite data sharing based on Cloud Storage, satellite data processing based on Cloud Computing, NSMC/CMA Website speeding-up based on Cloud CDN, and document sharing based on Cloud App service. By using public cloud service for FY satellite data service, NSMC/CMA provide a new solution for the users to obtain satellite data. The performance of the NSMC/CMA website has improved by using Cloud service. NSMC/CMA reported the recent progress of these cloud solutions in the working paper

JMA asked who is providing the public cloud services. CMA explained that two cloud services are used, Microsoft run by a Chinese company with data centres in China, and Alibaba with data centres also in foreign countries, both with an open data policy for meteorological data.

JMA enquired about the purpose of the recalibration data assimilation system, and if there are plans for data re-analysis in China. CMA's prime intention is to make FY satellite data usable by the public and to expand in socioeconomics, for national and international users. There are also plans to make re-analysis data sets.

CGMS-49-NOAA-WP-15: Summary and Highlights from CGMS WGIV Cloud Service Expert Group

The Cloud Expert Group was established in July 2020 and is comprised of members from NOAA, EUMETSAT, KMA, CMA, JMA, ISRO, and WMO. The group was formed to share cloud lessons learnt and develop a set of best practices for each organisation to maximise interoperability. The Cloud Expert Group's vision is to enable an interoperable cloud services environment for the transmission and sharing of meteorological satellite data. The cloud expert group meets quarterly to focus on cloud computing, dissemination, and interoperability. The team has focused on agency best practices, cloud optimised data formats, and how the group's cloud work aligns with WMO's Information System (WIS) 2.0 Strategy. The group's main goals are to establish a suite of best practices and standards for commercial cloud use and to define how to make cloud-based dissemination more interoperable.

The report concluded with a recommendation that new members are welcome to join the group. A corresponding WGIV recommendation was created.

NOAA emphasised the expert group and WGIV should ensure that WGI is involved in the discussions.

CGMS-49 recommendations - WGIV			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	12	WGIV/R49.03	The Cloud Expert Group welcomes any other members who are adopting cloud services to discuss best practices, exchange information, and identify emerging coordination opportunities.

13. Space weather matters in WGIV (see joint WGI-WGIV-SWCG meeting agenda)

This topic was discussed in the Joint WGI-WGIV-SWCG session.

14. Long term data preservation

There were no discussions under this item.

14. Aspects on the implementation of the global contingency plan from Plenary (as proposed by WGIII)

CGMS-49-WGIII-WP-02WGIV: Status and outcome of the 3rd CGMS risk assessment

CGMS-49-CGMS-WP-24WGIV: CGMS Baseline - draft revision following the 3rd risk assessment workshop

An overview of the status and outcome of the 3rd CGMS risk assessment and the draft revision of CGMS baseline were presented.

One risk relevant to WGIV was identified, which is covered by an existing action: "CGMS members to continue to propose near-term alternative data sources for consideration as gap mitigation in event of loss or degradation of current L1 capabilities prior to SWFO-L1 data availability. WGIV to consider recommended gap mitigation observation requests and develop plans to ensure near real-time access to those data".

WGIV is ready to follow up on ensuring near real-time access to those data using already existing mechanisms, should the risk materialise.

There were no significant updates to the CGMS baseline within the scope of the working group, and WGIV agreed to the update of the CGMS baseline.

16. Any other business

There were no discussions under this item.

17. Review and updating of the HLPP

CGMS-49-CGMS-WP-03WGIV: Status of implementation of CGMS High Level Priority Plan (2020-2024)

CGMS-49-CGMS-WP-25: HLPP proposal 2021-2025

No targets overseen by WGIV are proposed to be considered fully achieved, therefore all existing HLPP items remain valid. The HLPP was updated following review of WGIV related matters:

Item 3.2.1 "User Readiness for New Meteorological Satellites…" was refined to reflect the lessons learnt from the experience gained so far.

Item 3.11 "… access to … space weather data …" was refined following a proposal from SWCG.

Items 3.12 to 3.14 were revised to match the objectives of WGIV.

Two new items were added:

3.17 Develop Best Practices for Operational User Notifications

3.18 Develop Best Practices for Cloud Services Interoperability

Although assigned to WGIV, it was agreed to continue discussing item 3.18 with attendance of WGI members, e. g. in joint WGI/IV working group meetings.

18. Future WGIV plenary sessions

CGMS-49-CGMS-WP-06WGIV: Nominations CGMS, ISWGs, VLAB - Co-chairs and rapporteurs)

WGIV discussed nominations for CGMS-50 and reconfirmed the current Co-chairs Kotaro Bessho (JMA), Vasily Asmus (ROSHYDROMET), and the WGIV liaison contact to WGIII for contingency related issues Sean Burns (EUMETSAT). WGIV noted that the rapporteur Klaus-Peter Renner and the TFMI chair Guillaume Aubert stepped down and created corresponding actions on the CGMS members to nominate candidates for the vacant positions.

CGMS-49 actions – WGIV					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS members	9	WGIV/A49.04	To nominate a candidate for the TFMI chair.	CGMS-50	**OPEN**
CGMS members	9	WGIV/A49.05	To nominate a candidate for the WGIV rapporteur.	CGMS-50	**OPEN**

CGMS-49-WGIV-WP-03: Decision on inter-sessional activities in 2021-2022

The following intersessional meetings via WebEx were agreed:

- Cloud services expert group, led by NOAA; 13 Jul 2021, further dates to be defined by expert group
- Cyber security expert group, led by EUMETSAT; meeting dates to be defined by the expert group.
- WGIV Intersessional meeting #1, 15 September 2021 12:00-13:00 (UTC)
  - Call for WGIV rapporteur

- Discussion on how to address working on new Best Practise by existing or new task teams, the purpose is to convert or include WGIV recommendations in Best Practises, e. g. on the following topics
  - User notification
  - Data access
  - Update of metadata

- WGIV Intersessional meeting #2, 9 November 2021 12:00-13:00 (UTC)

  - Continued discussion addressing Best Practise by existing or new task teams,
  - Verbal reports from Expert Groups
  - Actions review
  - Preliminary agenda CGMS-50

- WGIV intersessional #3, 18 January 2022 12:00-13:30 (UTC)

  - Approval CGMS-50 agenda
  - Actions review

- WGIV Intersessional meeting #4, 15 March 2022 12:00-13:30 (UTC)

  - Preparations for CGMS-50
  - Verbal report from expert groups
  - Actions review

CGMS-49-WGIV-WP-04: Future CGMS WG plenary sessions

WMO will host the CGMS-50 plenary session in the second half of May 2022. Should the CGMS-50 plenary session need to be virtual, it was agreed to hold the CGMS-50 WGIV plenary session on 27-28 April 2022.

20. Summary list of new WGIV actions and recommendations

CGMS-49 actions - WGIV					
Satellite operators who launched new satellites since 2016	2	WGIV/A49.01	To provide updates for WMO "Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites" https://library.wmo.int/doc_num.php?explnum_id=3553	CGMS-50	**OPEN**

CGMS-49 actions - WGIV					
CGMS Task Force on Satellite Data and Codes, WMO	5	WGIV/A49.02	The CGMS Task Force on Satellite Data and Codes to work closely with WMO on addressing the following points: i. Linking between OSCAR/Space and the WSI and/or CCT C-5 identifiers (WMO internal) ii. Potential extension of the use of the Issue Number in the WSI for satellites in order to explicitly indicate metadata which are otherwise only implicitly embedded in the Local Identifier (CGMS-50) iii. Identification of when and how the WSI should be included in the satellite products exchanges in the context of the WIGOS (CGMS-50) (ref CGMS-49-WMO-WP-08)	CGMS-50	**OPEN**
CGMS members	6	WGIV/A49.03	To participate in the next EOTEC DevNet regional discussions planned in June, held online across time zones. Invitations have been sent to WGIV members by CGMS Secretariat. (ref CGMS-49-CEOS-WP-01)	July 2021	**OPEN**
CGMS members	9	WGIV/A49.04	To nominate a candidate for the TFMI chair.	CGMS-50	**OPEN**
CGMS members	9	WGIV/A49.05	To nominate a candidate for the WGIV rapporteur.	CGMS-50	**OPEN**

CGMS-49 WGIV recommendations			
Actionee	**AGN item**	**Rec**	**Description**
CGMS members	2	WGIV/R49.01	To consider an enhancement of advance notifications of processing changes as specified below and provide feedback to WG-IV. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data should be provided if possible. [From the ITWG ITSC-21 Report]
CGMS members	12	WGIV/R49.02	The WGIV Cyber Security Expert Group welcomes any other members who are not yet represented in the group, and to propose new security related topics to be addressed by the group
CGMS members	12	WGIV/R49.03	The Cloud Expert Group welcomes any other members who are adopting cloud services to discuss best

CGMS-49 WGIV recommendations			
Actionee	**AGN item**	**Rec**	**Description**
			practices, exchange information, and identify emerging coordination opportunities.

STATUS OF WGIV CGMS-48 ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMSSEC, WMO, space agencies	WGIV (WGII)	A44.05	From CGMS-44 WGII: CGMS operators and WMO to work with GODEX-NWP to explore options for optimal data exchange of advanced data from next-gen GEOs.	2021 Mar 25: NOAA hosted GODEX-NWP 15-16 Oct 2020 and it was proposed to close this action.	CGMS-49 (CGMS-45/46/47/48)	**CLOSED**
TFMI	WGIV/12.1	A45.03	CGMS satellite operators to provide documentation on the data formats for space weather observations, and to forward related space weather metadata to the WIS.	CGMS-49: closed by CGMS-49-EUMETSAT-WP-25	CGMS-48 (CGMS-46)	**CLOSED**
WG IV	WGII/4	A45.05	Action from WGII: Ensure timely (< 1 hr) and free access to all geostationary visible, IR and water vapour data that is required to improve global hydrological prediction.	***CGMS-49 Status?*** 2021 2 Feb: On hold	CGMS-49	**OPEN**
WMO	WGIV/3.2	A46.02	WMO to further refine the requirement from IPWG for GEO image data, in terms of users and geographical resolution	CGMS-49: closed by CGMS-49-WMO-WP-14, which reports on a survey and the resulting proposed common minimum baseline for Level-2 products generated from geostationary imagery data, recommending implementation of the baseline. 2021 2 Feb: related activity in WGII, survey to be submitted in Feb 2021 (WMO)	CGMS-49 (CGMS-47/48)	**CLOSED**

Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS satellite operators	WGIV/7	A46.04	To consider an enhancement of advance notifications of processing changes as specified below and provide feedback to WG-IV. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data should be provided if possible. [From the ITWG ITSC-21 Report]	CGMS-49: agreed to convert into recommendation, and later include in Best Practises once available	CGMS-49 (CGMS-47/48)	**CLOSED**
WGIV	(Plenary E.10)	A46.06	Following CGMS-46 plenary discussions related to IROWG and GCOS IP: CGMS WGIV to consider the GCOS IP actions on long-term data preservation (LTDP). Ref. GCOS IP action G 26.	2021 2 Feb: approved and published, action to be closed	Dec 2020 (Dec 2019)	**CLOSED**
CGMS satellite operators	IS-2	A46.08	CGMS members to review the "CGMS/WMO best practices for achieving user readiness for new meteorological satellites" (https://www.cgms-info.org/documents/CGMS-BP_user_readiness_Apr2016.pdf) and to provide feedback and make recommendations on updates.	CGMS-49: replaced by new action 2021 Mar 25: NOAA recommends closing this action and creating a new CGMS-50 Plenary action for satellite operators who launched new satellites since 2016 to provide updates for WMO "Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites" https://library.wmo.int/doc_num.php?explnum_id=3553 2021 2 Feb: Feedback in experience on implementation of Best Practises to be provided	CGMS-49 (CGMS-48)	**CLOSED**

Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CMA, JMA, KMA, WMO	WGIV/9	A47.03	To liaise with WMO and prepare the report of RSS observation activities including user readiness and notification.	CGMS-49: closed by CGMS-49-JMA-WP-07 2021 2 Feb: Report to CGMS-49 expected CGMS-48 WGIV: CGMS-48-joint-JMA-KMA-WP-01 refers, work in progress JMA-CMA-KMA discussion held at recent AOMSUC and will report progress to next CGMS.	CGMS-48	**CLOSED**
NOAA	WGIV/12	A47.04	To support enabling the connectivity between the OAI PMH NESDIS repository and GISC Washington, to be able to harvest metadata.	2021 2 Feb: Completed, action to be closed 2019, 10 Dec, IS WGIV: M Butler to follow up. (M Butler left NOAA).	Aug 2020	**CLOSED**
CGMS members	WGIV/15	A47.05	To provide a point of contact for participation in regular inter-sessional teleconferences on cyber security including related training aspects.	CGMS-49: replaced by recommendation "new members welcome" Agencies to provide pocs. NOAA: shawnn.shears@noaa.gov and james.schreiber@noaa.gov EUM: guillaume.texier@eumetsat.int ISRO: Utkarsh Tyagi (utkarsh@sac.isro.gov.in) Nitant Dube (nitant@sac.isro.gov.in) JMA: K Bessho kbessho@met.kishou.go.jp KMA: TBD ROSH: Nikita Ekimov (nikitaekimov@planet.iitp.ru)	Aug 2020	**CLOSED**
CMA, EUMETSAT	WGIV/3	WGIV/A4 8.01	To report on the status of data dissemination from Indian Ocean Data Coverage partners, as identified in CGMS-43-EUM-14 roadmap	CGMS-49: several related WP CGMS-49-CMA-WP-12, CGMS-49-ISRO-WP-01, CGMS-49-EUMETSAT-WP-10 EUMETSAT will compile a consolidated report	CGMS-50 (CGMS-49)	**OPEN**

Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				summarising the status, taking into account changes in data access and data policy		
Satellite Operators	WGIV/8	WGIV/A4 8.02	To provide focal points for WIS Metadata to support WMO in the review of the metadata records inserted in the WIS catalogue and to identify any gaps. The focal points (names and email address) shall be sent to CGMS Secretariat.	CGMS-49: open 2021 2 Feb: No feedback to date. CGMS agencies are requested to provide points of contact. Pocs: NOAA: kenneth.casey@noaa.gov EUMETSAT: Guillaume.Aubert@eumetsat.int	Aug 2021 (Dec 2020)	**OPEN**
TFMI	WGIV/8	WGIV/A4 8.03	CGMS to discuss the proposed approach to the improvement of the WIS catalogue and the publication of new metadata records and to provide its feedback.	CGMS-49: closed by CGMS-49-EUMETSAT-WP-25 2021 2 Feb: Open	CGMS-49	**CLOSED**
CGMS members	WGIV/9	WGIV/A4 8.04	CGMS members active in VLab to nominate the next Co-Chair to represent CGMS satellite operators in the VLab (starting October 2020). Nominations to be presented to VLab during CGMS-48 plenary.	CGMS-49 plenary endorsed the nomination. NOAA has nominated Ms Bernadette Connell to the position of the VLab Co-Chair. TBC: *WGIV recommended Ms Bernadette Connell as VLab Co-Chair to Plenary*	Aug 2020	**CLOSED**
CGMS members	WGIV/9	WGIV/A4 8.05	CGMS members are invited to contact WMO to provide contributions to the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab through the VLab Technical Support officer as well as to the implementation of VLab projects.	2021 2 Feb: Followed by R48.01, can be closed	CGMS-49	**CLOSED**

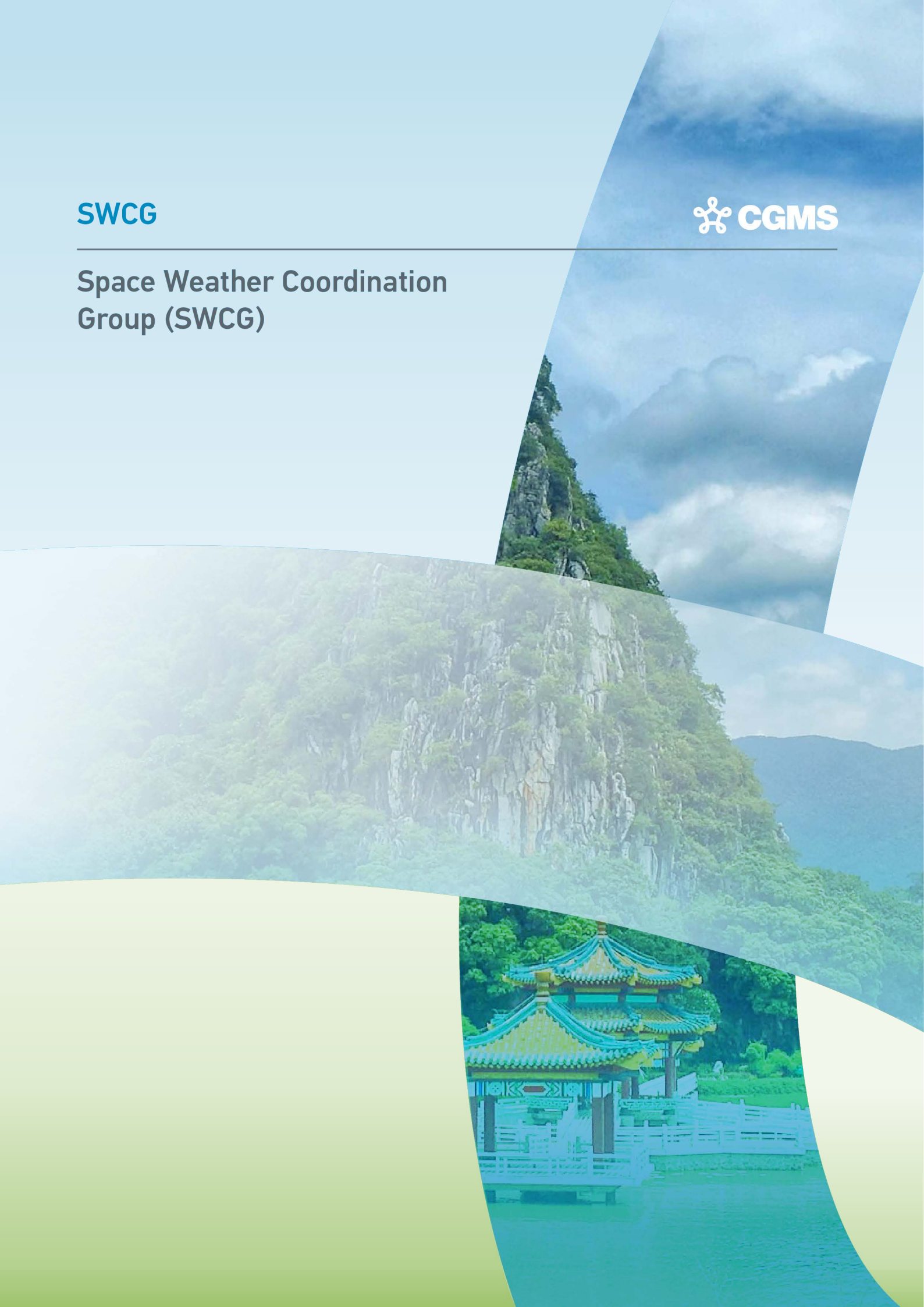
Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGIV/9	WGIV/A48.06	CGMS members active in VLab to send representation to participate in the Tenth VLab Management Group Meeting (VLMG-10) to be held in Darmstadt, Germany, 13-17 September 2021.	CGMS-49: Still valid for CGMS Members. 2021 2 Feb: Open	Aug 2021	**OPEN**
CGMS and VLAB	WGIV/9	WGIV/A48.07	Agencies to provide links to their training events and resources for VLAB communication.	2021 2 Feb: Closed by yearly survey performed 2020 May CGMS-48 WGII: Transferred to WGIV following intersessional and WGII discussions.	Sep 2020	**CLOSED**
CGMS members	WGIV/17	WGIV/A48.08	To provide a point of contact for participation in regular inter-sessional teleconferences to convert identified WGIV recommendations into Best Practises.	CGMS-49: will be addressed in intersessional meetings, starting 15 Sep 2021 2021 2 Feb: CGMS members to provide pocs ISRO: Nitant Dube (nitant@sac.isro.gov.in)	CGMS-50 (CGMS-48)	**OPEN**
WMO + EUM (CGMS space agencies)	WGIV/	WGIV/A48.09	Noting the recent conclusions of the WMO IPET-DRMM and the concurrence expressed in CGMS WGIII, WMO is encouraged to add the satellite identifier (from Common Code Table C5) and satellite instrument identifier (from Common Code Table C8) to OSCAR Space. (This action originates from WGIII discussions at CGMS-44, WGIII R44.02 and WGIII/A47.05 and discussions at CGMS-48 WGIII, May 2020)	***CGMS-49: Status? Closed?*** *2021 22 Feb: EUMETSAT has addressed this with WMO. To be incorporated in the OSCAR space database. Action recommended for closure.* 2020 May 29: Action transferred to WGIV (lead EUM/Simon.Elliott@eumetsat.int). 2020 Feb 19: WMO now focuses on the NWP station identifiers.	CGMS-49 (CGMS-48)	**OPEN**
CGMS and VLAB	WGIV (WGII/4)	WGIV/A48.10 (WGII A47.12)	Agencies to provide links to their training events and resources for VLAB communication.	*2021 2 Feb: Closed by yearly survey performed*	Aug 2020 (Dec 2019)	**CLOSED**

Status of WGIV CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS Agencies	WGII/4	WGIV/A48.11 (WGII A47.13)	Agencies to provide nominees for next VLAB co-chair starting in 2020 for three years.	*2021 2 Feb: closed, duplicate. See WGIV A48.04*	Aug 2020 (Dec 2019)	**CLOSED**

SWCG

CGMS

Space Weather Coordination Group (SWCG)



SWCG report

Co-chairs: Tsutomu Nagatsuma (NICT/JMA), Elsayed Talaat (NOAA)
Rapporteur: Andrew Monham (EUMETSAT)

1. Welcome, objectives, and review of the agenda

SWCG Co-Chairs, Dr. Elsayed Talaat and Dr. Tsutomu Nagatsuma, supported by Rapporteur Mr. Andrew Monham, welcomed the participants, consisting of representatives from CMA, ESA, EUMETSAT, ISRO, JMA, KARI, KMA, NICT, NOAA, ROSCOSMOS, ROSHYDROMET, and WMO (see Annex 1 for full list of participants).

SWCG reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting which is in line with the ToR for SWCG.

2. 3rd CGMS risk assessment and baseline update

CGMS-49-WGIII-WP-02SWCG: Status and outcome of the 3rd CGMS risk assessment, and
CGMS-49-CGMS-WP-24SWCG: CGMS Baseline - draft revision following the 3rd risk assessment workshop

A. Mehta presented the status and outcome of the 3rd CGMS risk assessment workshop, held 1-3 March 2021, with particular focus on the space weather related issues. Of particular note is that member-owned and operated payloads hosted on commercial platforms are now included when launch dates are determined (this being the case for some ESA space weather particle sensors for example).

The main risk continues to be the continuity of Coronagraph sensors, there is an increasing risk of a gap until GOES-U and SWFO-L1 are launched. CGMS members are to continue to propose near-term alternative data sources for consideration as gap mitigation in event of loss or degradation of current L1 capabilities prior to SWFO-L1 data availability (including coronagraph, Plasma Analyser, Magnetometer, and particle sensors) and WGIV to consider recommended gap mitigation observation requests and develop plans to ensure near real-time access to those data.

Furthermore, proposals for redefining the categorisation of particle sensors into different orbital positions and energy ranges were discussed and will be defined further prior to the 2021 Risk Assessment Meeting.

A. Mehta also presented the corresponding draft revision of the CGMS Baseline. CGMS endorsed the first CGMS baseline, commitment of observational missions synchronised with the development of the WMO Vision for WIGOS 2040, at CGMS-46 in Bengaluru (ref. CGMS-46 CGMS-WP-04, and -27). The 2nd CGMS WGIII risk assessment workshop was held at EUMETSAT on 19-21 February 2020. The 3rd CGMS WGIII risk assessment was held on 1-3 March 2021. The working group reviewed the CGMS baseline and proposed revisions. The draft text of the third revision of the CGMS baseline is included in this paper.

The text was reviewed in the SWCG meeting, in order to conclude on a final text for endorsement by CGMS-49 plenary on 19-21 May 2021. Following the CGMS-49 working group discussions, CGMS members are requested to recommend the 3rd revision of the CGMS baseline to CGMS-49 plenary for endorsement (and, at that stage, for WMO to take into account the new baseline in forthcoming updates of the Manual on the Global Observing System and related materials).

The following action was noted:

CGMS-49 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead- line**	**Status**
SWCG	SWCG/2	SWCG/A49.01	Review the RO Capability Table and add to CGMS website for configuration control and confirm content in OSCAR.	Oct 2021	**OPEN**

3. Update on space-based observational capabilities

CGMS-49-ISRO-WP-06: Data products and data policy of ISRO's Aditya-L1

Dr Sankaranarayanan presented that Aditya-L1 is India's first dedicated mission to study the dynamical events on the Sun continuously from Sun-Earth Lagrangian-1 (L1) point. It carries four remote sensing and three in-situ payloads. The remote sensing payloads will observe the inner corona (1.1 to 3Rsun) in imaging, spectroscopy as well as spectro-polarimetry, photosphere in broadband, and chromospheres in selected spectral lines. Sun-as-a-star X-ray spectroscopy will continuously provide information about flares and its energetic. The in-situ payloads observe the solar wind as well as the strahl component of the solar wind components. The directional information of the solar wind is also provided by these payloads along with the in-situ magnetic field variations during CMEs.

Though the mission is configured for studying the physics of the energetic events, Aditya-L1 has been configured to obtain important space weather flags through telemetry whenever the spacecraft is visible to the ground station. Some of the telemetry includes CME and solar flare flags, strength and approximate location of the flare, and variation of the solar wind and Bz-component of the magnetic field. The data from the payloads can be configured to download in about 30-minutes of the observation when ground station visibility is available. The mission is expected to provide research quality data for solar observations along with space weather specific observations. The science ready data would be available from early 2023 after the payload calibration and verification phase planned during the initial part of the mission.

CGMS-49-ESA-WP-04: ESA Lagrange L5 and D3S missions update

In 2020-2021, ESA has continued the development of the space segment of ESA's Space Weather System within the framework of the Space Safety Programme (S2P). Implementation of the Lagrange mission has been continued with completion of Phase B1, de-risking technology developments for the payload instruments, and mission consolidation phase. Lagrange implementation will continue with

the start of the Phase B2/C/D in 2021. The mission is now designed to be compatible with an option for a shared launch to GTO. This provides flexibility with the launch opportunities but launch to GTO will extend the transfer phase to L5 to 46 months. However, the mission is planned to start providing low latency measurement data for operational applications after 30 degree separation from the Sun-Earth line, which would be about 26 months after the foreseen launch in 2027. The Lagrange payload instruments include a coronagraph, heliospheric imager, magnetograph, EUV imager, X-ray flux monitor, solar wind plasma analyser, magnetometer, and a high energy particle radiation monitor. The coronagraph will be the Compact Coronagraph (CCOR) provided by NOAA and flying also with the SWFO-L1. ESA also continues the implementation of the Distributed Space Weather Sensor System (D3S). Two first D3S hosted payload missions, Service Oriented Spacecraft Magnetometer (SOSMAG) onboard the GK2A satellite and the Next Generation Radiation Monitor (NGRM), are working well and providing high quality measurement data for space weather applications. Two new hosted payload missions utilising ICARE-NG radiation monitors are in preparation. The first ICARE-NG unit will fly onboard Eutelsat HotBird F1 telecommunication satellite that will be launched in early 2022. The second ICARE-NG unit will be part of the ESA Radiation Sensor Array (ERSA) instrument package onboard Lunar Gateway Power and Propulsion Element (PPE). The next steps of D3S are planned to include dedicated space weather satellite missions utilising SmallSat and nanosat platforms for Auroral imaging, radiation and plasma environment monitoring, and sensing the upper atmosphere. A radiation monitor onboard the Lunar Pathfinder mission is also under implementation. ESA continues to carry out technology development for future space weather missions in S2P and Technology Programmes.

CGMS-49-EUMETSAT-WP-19: Updates on EUMETSAT space weather activities

A. Monham presented that EUMETSAT is continuing to support in-orbit energetic particle monitoring missions from the NOAA SEM-2 instrument on the MetOp first generation satellites, and the equivalent ESA NGRM instrument is also now in-orbit on the Sentinel-6-Michael Freilich satellite. This instrument will also be embarked on the upcoming MetOp Second Generation satellites (operational from 2024) and the Meteosat Third Generation (GEO) satellites, operational from 2023. EUMETSAT also successfully tested the extension of RO measurements from MetOp first generation to the ionosphere and operational measurements are expected to commence later in 2021. Related data products are also under development. Regarding third party space weather data dissemination, EUMETSAT is distributing the GOES-16 data over EUMETCast and is in discussion with other cooperation partners to access additional space weather data for further distribution.

CGMS-49 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead- line**	**Status**
EUMETSAT	SWCG/3	SWCG/A49.02	EUMETSAT to request expression of interest from SWCG and ISES for the possible MetOp GRAS RO TEC product	Sep 2021	**OPEN**

CGMS-49-KMA-WP-04: KMA Report on the update of space weather activities

Jiyoung Kim presented the update for KMA's space weather activities.

The cross-satellite calibration of Korean Space wEather Monitor (KSEM) particle detector (PD) data was carried out. The result shows that electron flux of the GeoKOMPSAT-2A(GK2A) KSEM is well correlated with those of other geostationary satellites (i. e. GOES-16 and Himawari-8). KMA will actively participate in the intercalibration activities by the SWCG Inter-Calibration Task Group. And KMA has a plan to develop a new space weather payload to be equipped on the GK2A Follow On satellite. New sensors such as particle detector, magnetometer, and so on are considered to be included in the payload.

CGMS-49-NOAA-WP-16: NOAA Space Weather Observations Update

E. Talaat presented the update for NOAA Space Weather Observations.

NOAA has moving rapidly in the last year to develop new programs and continue existing ones. These include the ongoing preparations for the Space Weather Follow On (SWFO) programme and its observational platforms, the delivery of products by the COSMIC-2 mission, the initiation of the new Space Weather Observations (SWO) programme, and other projects. This update reviews this progress with emphasis in the areas of solar/heliospheric monitoring and ionospheric effects.

Programmatic framework: The space weather mission of NOAA and several agencies has been defined by an extensive interagency working group, the Space Weather Operations, Research and Mitigation (SWORM) team, supported by the latest three Administrations. The PROSWIFT Act (2020) authorises NOAA to maintain and improve space weather observations. This means observational resiliency for continuous delivery of services, and a comprehensive capability at several vantage points for the National Weather Service to generate timely and accurate watches, warnings, and alerts.

SWFO: NOAA/NESDIS has established this baseline operational programme and has been appropriated funding in the NOAA budget for L1 coverage and Compact CORonagraph (CCOR) on GOES-U. The fabrication of two CCOR units is proceeding on time. NOAA is coordinating with ESA on data sharing, instrument hosting, and potential ground-station cooperation. The Ground Segment's Command and Control (C2) contract was awarded and the SWFO Antenna Network (SAN) was awarded in April 2021. NOAA is planning for further collaborations with several international organizations on downlink provision and data sharing by expanding the Real-Time Solar Wind network (RTSWnet).

COSMIC-2: The 6-satellite mission has provided a steady rate of ionospheric occultations (4,000+ per day) with 30-min average data latency. The TGRS instrument has passed its Initial Operational Capability (IOC) and the constellation is about to reach Full Operational Capability (FOC). Several data releases have taken place over the last year (TGRS TEC, scintillation, IVM density, etc.) and several are planned for summer 2021 (IVM drift products). JPL is working to incrementally upgrade TGRS flight software in parallel with cal/val efforts to meet ionospheric profile requirements.

SWO: NOAA initiated planning for a broad-ranging programme in March 2020 to subsume a number of space weather projects that have been developed individually, such as SWFO, or are currently hosted on the agency's GEO and LEO missions. In addition to the Programme of Record (the existing

or near-term planned missions and instruments), a number of new capabilities are planned to be added. The programme will be operational in the 2025-2040 timeframe and is envisioned to have observational capabilities at LEO, GEO, HEO, Lagrange 1, and off the Sun-Earth line. Currently, initial requirements have been defined and prioritised, instrument and constellation studies are underway, and user needs assessment is continuing.

During discussion, NOAA explained they are analysing whether to continue embarking space weather payloads on a single platform (such as GOES-R), or to use several collocated platforms.

4. Updates on space-weather activities

CGMS-49-CMA-WP-05: CMA Update on Space Weather Activities

The paper describes the recent space weather activities of CMA associated with space weather observations, forecasts, and services. CMA has participated in the inter-calibration activities by the SWCG Inter-Calibration Task Group and the result shows that electron flux of the FY-2G is well correlated with those of other GOES-16 and Himawari-8. The National Center for Space Weather (NCSW/CMA) has been providing daily space weather forecasts for more than one and half decades. A preliminary verification analysis was applied to evaluate the performance of the NCSW forecasts of fundamental space weather parameters such as the F10.7 radio flux, geomagnetic index, and event probabilities of solar flare and geomagnetic storm. As the 4th of the global space weather information centres designated by the Council of International Civil Aviation Organization (ICAO), the NMSC/CMA and the Aviation Meteorological Center, Civil Aviation Administration of China (AMC/CAAC) are preparing for the operation of the providing service for global customers.

CGMS-49-ESA-WP-05: ESA space weather service network: progress and next steps

The presentation described data utilisation in the context of space weather services for spacecraft operators initially developed and tested as part of ESA's SSA Programme and now being further developed within the Space Safety Programme.

The ESA Space Safety Programme targets coordinated development of a European space weather system through a process of developing and federating capabilities which are provided via a distributed network of European institutions and entities. These capabilities are structured into end-user driven services targeting a range of user communities from spacecraft operations through to power system operation on ground. Services for spacecraft operators aim to monitor and predict space weather phenomena which may lead to effects such as external or internal charging, single event effects in on-board electronics, and star-tracker disruption. Tools and facilities supporting post event analysis are also provided. The federated approach centres on five Expert Service Centres (ESCs) providing access to domain specific space weather expertise and assets, with first line user support provided via a centralised helpdesk and coordination centre. These are complemented by the ESA SWE Data Centre hosting components including the SWE portal and a supporting data repository.

Within the framework of its services for space systems, the ESA Space Weather Service Network actively engages with stakeholders in multiple domains. Teams work closely with these stakeholders to develop services in the form that they prefer, and the Service Network carries out both regular test

campaigns together with these stakeholders and network-wide exercises to ensure that response plans will work as efficiently as possible in the event of a major space weather event. The presentation highlighted data utilisation in the context of ESA's space weather services for spacecraft operators, the services' current level of maturity and development plans geared towards enabling affected user communities to prepare for, and to react during, a significant space weather event.

During discussion, ESA stated that their radiation modelling is agile enough not to be tied to a single data source and they are using or planning to use data from GOES, hosted ESA payloads, radiation monitors on Galileo, as well as data from Proba V.

CGMS-49-NASA-WP-10: TBD - NASA space weather activities

J. Spann presented the NASA space weather update.

NASA supports space weather research through the Heliophysics Division. One of the Division's objectives is to understand the Sun and its interactions with the Earth, and the solar system, including space weather. Mapping out this interconnected system requires a holistic study of the Sun's influence on space, Earth, and other planets. NASA has a fleet of spacecraft strategically placed throughout our heliosphere. These include the Parker Solar Probe and Solar Orbiter orbiting the Sun and observing the very start of the solar wind, to satellites around Earth such as MMS investigating the fundamental processes of magnetic reconnection that drive the explosive accelerations that cause space weather, and Global-scale Observations of the Limb and Disk (GOLD) and the Ionospheric and Connection Explorer (ICON) that observe the impacts of space weather near Earth, to Voyager, the farthest humanmade object, which is sending back observations on interstellar space. Each mission is positioned at a critical, well-thought out vantage point to observe and understand the flow of energy and particles throughout the solar system.

Heliophysics System Observatory: In 2020, NASA's Heliophysics Division has had multiple highlights relevant to space weather and supported the initiation and planning of 11 missions in formulation and another 7 under study, representing the largest increase in missions in the history of the Division.

- Solar Orbiter: Joint ESA/NASA mission launched in February 2020. Will ultimately be the first mission to send back images of the Sun's poles. First data was released to the public on Sep. 30, with more discoveries to come!

- Parker Solar Probe: Completed 4th, 5th, and 6th periheliums with closest distance within 8.4 million miles of the Sun's surface.

    - July Venus gravity assist: Cross helio/planetary/astro collaboration. Using telescopes at Apache Point Observatory in New Mexico, Lick Observatory in California, and Keck Observatory in Hawaii, scientists searched for Venus aurora from the ground in coordination with Parker's pass. An unprecedented look at the interactions between Venus and the solar wind.

- New Missions: Heliophysics currently has 11 missions in formulation and another 7 under study, representing the largest increase in missions in the history of the Division.

- AWE: Catching waves in Earth's upper atmosphere: From a berth on the ISS, AWE will study gravity waves in order to understand connections within Earth's atmosphere, and between our atmosphere and space. Launching NET 2022.
- PUNCH: Making the Connection Between Sun and Space: PUNCH is a mission made up of four suitcase-sized satellites that will spread out around Earth to form a planet-sized solar telescope to provide a 360-degree view of the Sun's outer atmosphere as it flows out to become the solar wind. Launching NET 2023.
- TRACERS: Mapping the Magnetopause: Building on missions first launched on sounding rockets, TRACERS will launch NET 2023 to study how magnetic fields around Earth interact with those from the Sun.
- IMAP: Celestial Cartographer: A mission to map the physics of space, both near Earth and how it interacts with interstellar space. To be launched on a Falcon 9 Full Thrust Rocket in February 2025.
- SunRISE: Investigating Giant Particle Storms: Six CubeSats working as a single large telescope to study how the Sun generates and releases giant space weather storms – known as solar particle storms – into planetary space.
- ESCAPADE: Understanding Mars's atmosphere: This mission characterises the acceleration processes allowing Mars's atmosphere to escape.
- GDC: Exploring Space Weather's Core: The Geospace Dynamics Constellation provides the first direct global measurements of Earth's dynamic, complex ionosphere – akin to the launch of the first weather satellites that gave scientists the first worldwide view of weather systems.
- GLIDE: Understanding upper reaches of Earth's atmosphere: The Global Lyman-alpha Imagers of the Dynamic Exosphere will gather ultraviolet light emitted from hydrogen at a high rate, with a view of the entire exosphere.
- Solar Cruiser: Sailing in the solar wind: Designed to mature solar sail technologies and demonstrate a novel solar coronagraph for SmallSat applications.
- EUVST: Observing magnetic and plasma interactions: The Extreme Ultraviolet HighThroughput Spectroscopic Telescope (EUVST) Epsilon Mission would observe simultaneously, for the first time and over a wide range of the lower solar atmosphere, how magnetic fields and plasma interact; instrument to fly on JAXA's Solar-C mission

- EZIE: Mapping auroral electrojets: Electrojet Zeeman Imaging Explorer (EZIE) would focus on an electric current known as the auroral electrojet, which circles through the atmosphere around 60 to 90 miles above Earth, near the poles.

Space Weather Science Application (SWxSA): The recently established Heliophysics Division Space Weather Science Application (SWxSA) programme expands the role of NASA in space weather science under a single budget element and supports the multi-agency Space Weather Strategy and Action Plan.

It competes ideas and products, leverages existing agency capabilities, collaborates with other agencies, and partners with user communities to facilitate the effective transition of science knowledge to operational environments. In 2020, seventeen research proposals were selected for the Heliophysics Space Weather Operations-to-Research element, as part of the NASA Research Opportunities in Space and Earth Science (ROSES) solicitation. The research will improve the reliability of numerical models and/or data utilisation techniques that could advance forecasting capabilities, and which could also lead to improved scientific understanding. Six space weather technology proposals were selected for Phase I in the Small Business Innovation Research (SBIR) programme and three for Phase II. These efforts range from developing model techniques, tools to support space weather extremes, and measurement technologies to measure radiation levels aboard aircraft. Six proposals were selected jointly with the National Science Foundation (NSF) to quantify the uncertainties in space weather. In total, over 60 space weather research proposals have been selected over the last four years. NASA is working with the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) and NSF to promote space weather operations-to-research (O2R) activities in support of the National Space Weather Action Plan. As part of this effort, NASA and NOAA recently developed a framework that leverages available talent and resources to accelerate and streamline both research-to-operations, and operations-to-research activities. Other programs within the Heliophysics Division that support space weather include instrument and technology development activities, the Community Coordinated Modeling Center, which supports space weather modelling efforts, and missions such as Solar Terrestrial Relations Observatory (STEREO), Advanced Composition Explorer (ACE), Solar and Heliospheric Observatory (SOHO), Global-scale Observations of the Limb and Disk (GOLD) and the Ionospheric and Connection Explorer (ICON) mission.

Gateway and the Artemis Programme: The Heliophysics Division is working closely with the Artemis Programme to support the human exploration of deep space and on potential approaches to measure the radiation environment on and around the Moon. These measurements will aid in the prediction and validation of the radiation environment to which our astronauts will be subjected. To this end, the Heliophysics Division is providing radiation and space weather instruments on the first element of the Lunar Gateway, an early key component of the Artemis Programme. HERMES (Heliophysics Environmental and Radiation Measurement Experiment Suite) is the NASA investigation chosen as one of two external scientific payloads to fly on Gateway in support of Artemis. HERMES will measure low energy radiation and improve our ability to forecast space weather. The ESA European Radiation Sensors Array (ERSA) is the other external Gateway space weather relevant payload and will observe higher energy radiation including galactic cosmic rays. The Internal Dosimeter Array (IDA), an ESA/JAXA payload will measure the radiation levels internally on the Gateway. These three complimentary payloads will provide a pathway for future onboard and earth-independent space environment forecasting for deep space human exploration. In coordination with the Heliophysics two-spacecraft mission THEMIS/ARTEMIS already in lunar orbit, the Gateway observations will initiate a heliophysics lunar constellation to conduct science investigations not possible before. This payload will enable meaningful science, support Artemis, and be forward looking to crewed missions to Mars.

CGMS-49-NICT-WP-01: NICT Space Weather Activities

NICT Space Environment Laboratory routinely operates space weather services on 24/7 bases as a part of ICAO's global centers, ACFJ. The space weather information is also provided to domestic users. Several user applications (Radio Propagation Simulator, Space Environment Customized Risk Estimation for Satellite, and Warning System for Aviation Exposure to Solar Energetic Particle) have been developed under PSTEP (Project for SolarTerrestrial Environment Prediction). The services of these applications are already operated or will be operated soon. For continuation of space environment monitoring at Japanese meridian of geostationary orbit, the feasibility study on space environment monitor onboard the next Japanese meteorological satellite is started.

During discussion, it was explained the SECURES charging model currently focusses on surface charging, rather than internal charging and is currently only available within Japan, but may be opened up to other partners later. KMA offered to cooperate with the work they are performing on internal charging.

CGMS-49-NOAA-WP-17: NOAA Space Weather Activities

The NOAA Space Weather Prediction Center continues focused efforts to bring in new observations, new models that use those observations, and new application tools to improve the accuracy and usefulness of our forecasts and products. Over the past year, NOAA considers to have made great progress with the incorporation of satellite-based ionospheric observations into its operations. The agency is also increasing its development efforts on the ground station for the Space Weather Follow-On Programme. It continues to upgrade and add to its sun to Earth modelling suite and is excited to be building a testbed centre where the acceleration of new observations, models, and applications into operations can be made into operations.

During discussion, it was clarified that GOES-17 space weather data will become operational in summer 2021.

5. International space weather data user activities

CGMS-49-GUEST-WP-02: Space Weather Services by members of the International Space Environment Service (ISES)

M. Ishii, Deputy Director of ISES, presented the recent activities of ISES. First, the function and structure were introduced. In 2020, the Finnish Meteorological Institute joined ISES as Regional Warning Center (RWC) Finland resulting in 21 RWCs, one Collaborative Expert Center (CEC), ESA and 4-5 Associated Warning Centers (AWCs). As a consortium of operational space weather organisations, ISES has been discussing two essential topics: Real-time operation and long-term improvement and development. This includes in particular, related to the sharing of in-situ and satellite observations, information about modelling and simulation, as well as forecast validation and evaluation. As a core entity of operational space weather organisations, ISES remains committed to supporting international entities, UN/COPUOS, WMO, ITU, ICAO, ISWI, and ISO, as well as CGMS.

During discussion, it was explained that a report will be issued on the results of the UN COPUOS survey of space weather activities mentioned in the presentation.

CGMS-49-ROSHYDROMET-WP-06: Updates to China-Russia Consortium advances towards scheduled duty operations [paper not presented]

The China-Russia Consortium (CRC) is progressing towards entering duty as the fourth global space weather centre. Currently, each member state of the CRC utilises their own orbital observations, however, the CRC has agreed to join the effort into the highly integrated entity in the future. One of the major phases of the integration is obtaining clearances and arrangement of data sharing of both orbital and ground observations.

CGMS-49-WMO-WP-06: Status on WMO Expert Team on Space Weather

K. Holmlund presented for WMO that space weather activities have in the past been supported by an Inter-Programme Team on Space Weather Information, Systems and Services. During the WMO reorganisation, a review of the various WMO expert teams has been conducted and the need for continued support to WMO Space Weather activities has been confirmed. WMO will therefore (re)establish an Expert Team on Space Weather (ET-SWx), which will support the WMO Space Weather activities with an end-to-end focus, from observations to downstream services. A key focus in the medium term is to support the provision of required space weather data, ground and space-based, as foreseen by the new WMO Data Policy, particularly in support of near-real time space weather services. In addition, ET-SWx will support the overall coordination of Space Weather activities between WMO and other international programmes, like the ICAO Space Weather Services and UNCOPUOS SWEG. Next Steps:

- Preparation of Terms of Reference
- Preparation of Draft Work Plan
- Establishment of WMO internal reporting structure,

CGMS is invited take note of the information provided in the working paper and to consider the appropriate interface between CGMS SWCG and ET-SWx

6. OSCAR review for space weather

CGMS-49-WMO-WP-03: OSCAR review for space weather - Completeness and suitability of space weather related content

The annual CGMS WGIII Risk Assessment Workshop performed the analysis with regards to three different viewpoints:

- The CGMS baseline, i. e. the scenario encompassing the satellite systems that the CGMS member and observers commit to implement and sustain for at least the next decade;

- The user requirements, i. e. the needs expressed by several user communities represented by several bodies and groups belonging to or coordinated with WMO, aiming at reviewing the actual status of observation processing capability and observing technology, and providing guidance for developments so as to pursue convergence (Rolling Requirements Review, RRR);

- The WIGOS Vision, i. e. the projected developments of the WMO Integrated Global Observing Systems to meet long-term objectives (some two decades) of the RRR. This working paper faces the WMO Gap Analysis mostly under the RRR viewpoint. The WMO Gap Analysis against the RRR and WIGOS are promoted by WMO to be considered by the agencies as reference

user requirements to guide future developments for the medium (RRR) and long-term (WIGOS).

The report is a follow-on of the working paper CGMS-48-WMO-WP-13 and concluded by listing 16 “Gap areas”:

01 Early-morning LEO
02 Coverage from GEO
03 Trace gas detection
04 Earth Radiation Budget
05 Aerosol observation
06 Precipitation measurement
07 Sea-surface wind
08 Ocean altimetry
09 Sea surface temperature and Ocean colour
10 Soil moisture, Snow, Sea-surface salinity, Sea ice
11 Space weather from L1
12 Space weather from the Ecliptic
13 Space weather from solar orbits
14 Space weather from GEO and Molniya orbits
15 Space weather from HEO and MAG
16 Space weather from LEO Focus is placed on each of these areas, recalling the results of the detailed analysis and attempting to draw specific recommended actions.

CGMS-49 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead- line**	**Status**
SWCG	SWCG/6	SWCG/A4 9.03	Propose improvements to the space weather parameters in the OSCAR DB with respect to energetic particle energy ranges and review WMO approach to highlighting data latency.	Nov 2021	**OPEN**
SWCG	SWCG/6	SWCG/A4 9.04	Check content of OSCAR/Space and populate with the missing information on quarterly basis	Jul 2021	**OPEN**

7. Task Group on space weather calibration

CGMS-49-SWCG-WP-05: Task Group Report on Intercalibration of High Energy Electron Sensor

The roles of the task group on intercalibration of high energy electron sensor are how to apply inter-calibration of energetic particle sensor onboard meteorological satellite, discussing standard method of inter-calibration, and considering products using energetic particle sensor data. After CGMS-48, the group summarised the white paper about space-based high energy electron observation for space weather forecast. It realised that not all the high energy particle data from GEO Ring could be available in near real-time. Data availability is one of the issues to be solved for producing space weather products and continuous inter-calibration.

8. Any other business

There was no other business discussed.

9. Review and updating of the HLPP

CGMS-49-CGMS-WP034SWCG: Status of implementation of CGMS High Level Priority Plan (2020-2024)

CGMS-49-CGMS-WP-04SWCG: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2020-2024

SWCG provided inputs for updates to the relevant sections of the HLPP.

10. Future SWCG inter-sessional, plenary and other meeting

CGMS-49-CGMS-WP-06SWCG: Nominations and representatives at meetings (CGMS, ISWGs, VLAB - Co-chairs and rapporteurs)

SWCG noted that there were currently no changes foreseen in the SWCG. The CGMS Secretariat informed SWCG members of the status of nominations and representatives related to CGMS.

CGMS-49-SWCG-WP-10: Decision on dates of inter-sessional activities/meetings in 2021-2022 (CGMS-49 to CGMS-50

The following intersessional meetings were agreed, taking place at 1200 UTC.

<u>Space Weather Coordination Group</u>

- IS#1: Thursday 21 October 2021
- IS#2: Thursday 27 January 2022
- IS#3: Wednesday 23 March 2022

<u>Dates for Task Groups:</u>

- Space Weather Inter-calibration TG
  - TG#1 15 July 2021
  - Remaining dates TBD
- Spacecraft Space Weather Anomaly Database TG (all dates TBD)
- Space Weather Data Access TG (all dates TBD)
- Low Latency Ionospheric RO TG (all dates TBD)

CGMS-49-CGMS-WP-26SWCG: CGMS plenary sessions in future

WMO will host the CGMS-50 plenary session in the second half of May 2022. Should the CGMS-50 plenary session need to be virtual, it was agreed to hold the CGMS-50 SWCG session on 26-27 April 2022.

A survey will be initiated by the Secretariat regarding the future working arrangements for the CGMS Working Group and plenary meetings.

11. Summary list of new SWCG actions and recommendations

CGMS-49 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead- line**	**Status**
SWCG	SWCG/2	SWCG/A49.01	Review the RO Capability Table and add to CGMS website for configuration control and confirm content in OSCAR.	Oct 2021	**OPEN**
EUMETSAT	SWCG/3	SWCG/A49.02	EUMETSAT to request expression of interest from SWCG and ISES for the possible MetOp GRAS RO TEC product	Sep 2021	**OPEN**
SWCG	SWCG/6	SWCG/A49.03	Propose improvements to the space weather parameters in the OSCAR DB with respect to energetic particle energy ranges and review WMO approach to highlighting data latency.	Nov 2021	**OPEN**
SWCG	SWCG/6	SWCG/A49.04	Check content of OSCAR/Space and populate with the missing information on quarterly basis	Jul 2021	**OPEN**

The status of SWCG CGMS-48 actions and recommendations is provided immediately after the conclusions of this report.

12. Conclusions

Please refer to the plenary report for the conclusions.

STATUS OF SWCG CGMS-48 ACTIONS AND RECOMMENDATIONS FOLLOWING CGMS-49 DISCUSSIONS

Status of SWCG CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SWCG	SWCG/7	A47.04	Propose improvements to the space weather parameters in the OSCAR DB and request support for implementation from WMO. The parameters available in the existing DB may not be sufficient to properly describe measurement capabilities of SW instrumentation.	2021 CGMS-49: Closed, noting WMO will propose updates for dealing with latency. Also see new action on changes to definition of energetic particle monitoring. *2021 Mar 23: Closed for NOAA*	Jul 2020 (CGMS-48)	**CLOSED**
SWCG	SWCG/8	A47.05	CGMS Members to complete the on-going Space Weather data provider survey	2021 CGMS-49: Closed. Data Access Task Group will interact with CGMS Members on ad hoc basis. *2021 Mar 23: Ongoing, waiting for inputs*	May 2019	**CLOSED**
SWCG	SWCG/8	A47.07	Establish a small task group to identify gaps and disconnects from service and perspective of operational space weather communities (e. g. ICAO, ISES, etc.) with objective to report out in Jan 2019	CGMS-49: PROPOSE TO MAKE FORMAL TG with ToR based on responses already received. *2021 Mar 23: Established task group (incl. NOAA); possibly closed or ongoing?*	CGMS-50	**OPEN**
SWCG IC TG	SWCG/9	A47.09	Space Weather Inter-calibration Task Group to produce a "White Paper" with the objective of getting feedback from GSICS on issues faced by CGMS members concerning inter-calibration of high-energy particle	*2021 Mar 23: Draft white paper under review. Expected to be closed.* CGMS-48: Draft White Paper presented. Address feedback in	Aug 2020 (Jul 2019)	**CLOSED**

Status of SWCG CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			sensors, including, how to share data, use of each sensor for space weather products, identified problems and associated estimates of effort. Consider also the inter-calibration issues of other space-based space weather observation.	next IC TG session. Discuss next steps with GSICS. *2020 April 1, IS#4*		
SWCG	SWCG/3	SWCG/A48.01	Verify the requirement in CGMS Baseline for electron density measurements up to 500km with CGMS Members and IROWG. What is feasible and actually useful	*2021 Mar 23: Pending feedback - see also action SWCG/A48.02. Expected to be closed at CGMS-49 SWCG.*	Jul-2020	**CLOSED**
NOAA, EUM, KMA, CGMS Members	SWCG/3	SWCG/A48.02	Provide a consolidated CGMS Member RO capability table indicating the measurement profile (e. g. altitude of measurements) supported. This should include current and planned missions (COSMIC, KOMPASAT, …)	*2021 Mar 23: Closure expected. Such table to be published with versioning number and doc control. Also need confirmation on how to capture this within OSCAR space databas.*	Jul-2020	**CLOSED**
EUMETSAT	SWCG/3	SWCG/A48.03	Report on the testing of MetOp-A GRAS RO measurements to include ionospheric data and resulting plans for inclusion in the operational NRT data dissemination for all GRAS instruments.	*2021 Mar 23: CGMS-49-EUMETSAT-WP-19. Closed at CGMS-49 SWCG*	Nov-2020	**CLOSED**
CMA	SWCG/3	SWCG/A48.04	Investigate whether RO measurements from the FY-3 GNOS instruments can be enhanced to include ionospheric data	*2021 Mar 23: Information not available. CMA feedback at CGMS-49 SWCG.*	CGMS-49	**CLOSED**

Status of SWCG CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS Members	SWCG/7	SWCG/A48.05	Check content of OSCAR/Space and populate with the missing information before CGMS-48 Plenary	*2021 Mar 23: Closed from NOAA's side. Expected to be closed by plenary.*	Jul-2020	**CLOSED**
SWCG	SWCG/7	SWCG/A48.06	SWCG to fill out the WIGOS Vision Template shown in CGMS-48-WMO-WP-20	*CCGMS-49: WMO to iterate with SWCG, further SWCG member feedback requested*	Jul-2020	**OPEN**
NOAA, NICT, CMA, Roshydromet, ESA	SWCG/6	SWCG/A48.07	Establish an information exchange with ICAO data service providers to understand requirements on CGMS Members' data delivery mechanisms and formats.	*2021 Mar 23: To be addressed in SWCG in April*	Jul-2020	**OPEN**
SWCG	Joint WGI-WG-IV-SWCG/5	SWCG/A48.08	Follow-up on the User Survey interaction to get more specific information on data formats / availability constraints and check implication of delivering the data on WIS/GTS with these users. Consider Task Force on Satellite Data and Codes taking a role in following up on this initial interaction (see Simon Elliott Paper EUM-WP-08 in WGI).	CGMS-49: PROPOSE THAT TG FROM A47.07 FOLLOW THIS UP *2021 Mar 23:* 2021 Feb 17: Feedback on Space Weather User Survey sent at SWCG level to ISES members based on survey feedback.	Jul-2020	**OPEN**
EUM/NOAA	Joint WGI-WG-IV-SWCG/5	SWCG/A48.09	Request responses from additional users of data from space weather satellite instruments	*2021 Feb 17: Closed with survey feedback email of 17 Feb*	Nov-20	**CLOSED**
EUM/NOAA	Joint WGI-WG-IV-SWCG/5	SWCG/A48.10	CGMS SWCG to engage with survey respondents on an individual basis to clarify inputs made, with support of ISES / IPT-SWeISS where appropriate.	*2021 Feb 17: Closed with survey feedback email of 17 Feb*	Nov-20	**CLOSED**

Status of SWCG CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SWCG/WGI	Joint WGI-WG-IV-SWCG/3	SWCG/A48.11	Space Weather Spacecraft Anomaly Database Task Group: • Establish the requirements of the Space Weather Database parameters • Establish the requirements for the Security / Confidentiality aspects • Establish the process and rules for access the Database content	*2021 Mar 23: First bullet activity ongoing.* Equivalent actions were closed in WG1 - transferred to SWCG	CGMS-49	**OPEN**
CGMS Members	Joint WGI-WG-IV-SWCG/3	SWCG/A48.12	CGMS members are encouraged to nominate participants to the Space Weather Spacecraft Anomaly Database Task Group	*2021 Mar 23: Closed* Equivalent actions were closed in WG1 - transferred to SWCG	Nov-20	**CLOSED**
CGMS Members	Joint WGI-WG-IV-SWCG/3	SWCG/A48.13	CGMS members to state their potential interest in leading the prototyping of the Space Weather Spacecraft Anomaly Database Task Group	*2021 Mar 23: remains open until clarification on confidentiality requirements/mechanisms made.* Equivalent actions were closed in WG1 - transferred to SWCG	Nov-20	**OPEN**
CGMS Members	Joint WGI-WG-IV-SWCG/3	SWCG/A48.14	CGMS Members to provide their Space Weather Anomaly Data Forms in dedicated template as input to the Plenary Paper: CGMS-48 Member Space Weather Anomaly Data Inputs, which will collect all the forms with a Section for each member agency.	*2021 Mar 23: Closed but requested for CGMS-49 again.*	July-2020	**CLOSED**

Status of SWCG CGMS-48 actions following CGMS-49 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
NOAA, EUM, CMA, KMA, CGMS Members	Joint WGI-WG-IV-SWCG/4	SWCG/A48.15	Identify CGMS Members with current or planned RO data provision capability and possibly able to support low latency provision (Step 1 in CGMS-48-EUMETSAT-WP-06)	*2021 Mar 23:*	July-2020	**OPEN**
SWCG	Joint WGI-WG-IV-SWCG/4	SWCG/A48.16	Clarify and iterate the high level RO requirements with IROWG & WMO based on the EUMETSAT ROM SAF inputs. (Step 2 in CGMS-48-EUMETSAT-WP-06)	*2021 CGMS-49: Request for meeting / feedback made to IROWG/ROM SAF 10 March 2021* *2021 Mar 23: Ongoing*	Nov-2020	**OPEN**
SWCG	Joint WGI-WG-IV-SWCG/4	SWCG/A48.17	Analyse technical feasibility at RO system, end-to-end level for the identified space systems from Step 1. (Step 3 in CGMS-48-EUMETSAT-WP-06)	*2021 Mar 23:*	Feb-2021	**OPEN**
NOAA, EUM, CMA, KMA, CGMS Members	Joint WGI-WG-IV-SWCG/4	SWCG/A48.18	CGMS Members operating the RO instruments to respond to requirements according to agreed System Concept (req. acceptance / implementation). (Steps 4,5 in CGMS-48-EUMETSAT-WP-06).	*2021 Mar 23:*	CGMS-49	**OPEN**
SWCG	SWCG/8	SWCG/A48.19	CGMS members to provide sustained resources to perform energetic particle sensor inter-calibrations both retrospectively on existing instruments and to include it in their plans for future instruments	*2021 Mar 23: Closed for NOAA, ESA. Potential action closure.*	CGMS-49	**CLOSED**

Joint WGI-WGIV-SWCG report

CGMS

JOINT WGI-WGIV-SWCG REPORT

Co-chairs: Tsutomu Nagatsuma (NICT/JMA)
Rapporteur: Sean Burns (EUMETSAT), Andrew Monham (EUMETSAT)

1. Welcome, objectives and review of the agenda

The joint meeting Co-Chairs, Dr Tsutomu Nagatsuma and Vanessa Griffin, supported by Rapporteurs Andrew Monham and Sean Burns, welcomed the participants, consisting of representatives from CMA, ESA, EUMETSAT, ISRO, JMA, KARI, KMA, NICT, NOAA, ROSCOSMOS, ROSHYDROMET, and WMO (see Annex 1 for full list of participants).

The joint meeting reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting.

2. Review of interactions and activities between WGI, WGIV and the SWCG (incl. action review)

It was agreed that all relevant interactions and review of actions would be covered in the relevant agenda items.

3. Benefits of space weather data usage for satellite operators and role of anomaly report database

CGMS-49-SWCG-WP-01 - CGMS agency spacecraft space weather anomaly reports compilation

A. Monham presented the paper designed to contain a compilation of all suspected Space Weather related anomalies on all operational missions operated by CGMS Agencies reported to CGMS-49. At the time of this meeting, only EUMETSAT data had been received and therefore included in the compilation document. All CGMS members performing spacecraft operations were encouraged to submit their anomalies using the dedicated anomaly template form on the CGMS website prior to the Plenary meeting.

CGMS-49-EUMETSAT-WP-17 - EUMETSAT Spacecraft Space Weather Anomaly Report

A. Monham highlighted that this is the EUMETSAT input to the previously described compilation document and members should use the template available on the CGMS website to make their own inputs. It is stressed that members do not need to be certain that anomalies reported are due to space weather, but only that it cannot be ruled out as a factor. If in doubt, members should include the anomaly information.

CGMS-49-SWCG-WP-02 - Report on progress of the Space Weather Spacecraft Anomaly Database Task Group

A. Monham presented. The Space Weather Spacecraft Anomaly Database objective is to be the data source for space weather actors to analyse the impact of space weather on satellite systems to further knowledge and develop tools space weather effects, spacecraft design robustness, and operational SpWx warnings, for example. The Task Group gained sufficient participation after CGMS-48 to allow limited progress to be made on the objectives of securing resources to develop a prototype database, defining the requirements of the anomaly database (with use cases), identifying feasible and reliable

mechanisms to supply anomaly data for analysis and addressing the requirements for the security/confidentiality aspects (Trusted Agent model).

With little data supplied since the CGMS requested anomaly data provision at CGMS-44, some additional historical data is being compiled and more requested. Furthermore, the quarterly supply of new data is requested going forward for analysis by the TG/interaction with operators.

CGMS members are encouraged to state issues which are preventing them from supplying data.

CGMS-49 actions – Joint WGI-WGIV-SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead- line**	**Status**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A4 9.05	Poll CGMS members on reasons for sparse anomaly data supply to CGMS.	Jul 2021	**OPEN**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A4 9.06	Poll satellite manufacturers and commercial operators on ability / constraints to providing anomaly data to CGMS	Oct 2021	**OPEN**

4. Requirements and feasibility of low latency RO data dissemination for space weather data users through direct broadcast

CGMS-49-NOAA-WP-21 - COSMIC-2 RO latency

E. Talaat presented the work ongoing to improve the COSMIC-2 median data latency for ionospheric RO to below the currently achieved 31 minutes. It is possible that these improvements could result in a data latency of under 22 minutes, which comfortably exceeds the 30 minutes requirement.

CGMS-49-EUMETSAT-WP-07 Update on efforts to define requirements and feasibility of low latency RO Data Dissemination – formation of Task Group

A. Monham presented a review of the limited progress made on the associated actions, indicating that engagement with the ROM SAF and IROWG is being re-established to further define requirements, as well as presenting the Radio Occultation capability table for CGMS members. A discussion on the separate treatment of availability/latency requirement for the low latency services from those of the global data service is made. To aid progress before CGMS-50, it is proposed a Task Group is established.

5. Space Weather Data Access (outcome of User Survey)

CGMS-49-SWCG-WP-03 Status of Space Weather Data Access including data formats (as an outcome of User Surveys)

A. Monham presented that CGMS member space agencies operating in-orbit space weather sensors and their related ground segment systems are aiming at making improvements in the provision and availability of data in a suitable format to the operational space weather community.

A series of surveys and follow-up actions have been performed since 2019.

The main areas with potential for improvement are indicated, in particular:

- Data availability and latency
- Data format standardisation, with metadata
- Standardised data delivery mechanisms

It is recommended a dedicated Task Group identifies a priority list of tasks/pilot projects to address these issues and initiates implementation in coordination with all CGMS Working Groups and relevant external bodies.

CGMS-49-SWCG-WP-06 Current Availability of High Energy Particle data from GEO Ring

Dr Tsutomu Nagatsuma presented that sharing and distributing near real time and archived space weather sensor data are key issues for CGMS members, space weather service providers, and data users. During the meeting of the task group of high energy electron sensor intercalibration, availability of (NRT and archived) sensor data from GEO Ring was discussed. The TG members were asked about availability of NER and archived high energy particle data from GEO Ring. The results suggest that Several CGMS members are already established NRT and Archived data distribution although data format and method of data distributions depend on the agencies. However, some members recommended to perform an official inquiry/official report to promote SW data sharing and distribution. Thus, it is recommended to perform an inquiry into how to improve the availability of high energy particle (NRT and Archived) data from GEO Ring operated by CGMS member space agencies.

6. Any other business

No other business was identified.

7. Summary list of actions of the joint WGI-WGIV-SWCG session

CGMS-49 actions – Joint WGI-WGIV-SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Dead-line**	**Status**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A4 9.05	Poll CGMS members on reasons for sparse anomaly data supply to CGMS.	Jul 2021	**OPEN**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A4 9.06	Poll satellite manufacturers and commercial operators on ability/constraints to providing anomaly data to CGMS	Oct 2021	**OPEN**

(These actions will be monitored within the framework of SWCG)

Joint WGII-WGIII report

JOINT WGII-WGIII REPORT

Co-chairs: Mehta/P. Zhang (WGIII) and K. Holmlund (WGII)

Rapporteur: H. Pohjola

1. Opening

WGII and III co-chairs decided that K. Holmlund will chair this joint session. K. Holmlund welcomed all the participants to this WGII and III joint session. He concluded that the most import topic to cover is the risk assessment together with science questions related to which aerosol and trace gas parameters can be committed to with the CGMS baseline instruments.

2. Status of the 3rd CGMS baseline and risk assessment (verbal)

CGMS-49-WGIII-WP-III: Status and outcome of the 3rd CGMS risk assessment

A. Mehta explained shortly the top-level risk assessment and noted that additional details were already presented to the working groups. Top level risk assessment can be summarised as follows:

- Early morning LEO after FY-3E: no planned low inclination RO observations after COSMIC-2.
- Precipitation radar: continuation after FY-3G and GPM
- Broad band radiometer: continuation of FY-3G
- Scatterometer: risk in the early morning and afternoon orbits after FY-3E and Oceansat-3A
- Coronagraph: risk of near-term gap until SWFO-L1 and GOES-U are launched
- Energetic Particle Sensor, magnetometer, plasma analyser: risk of near-term gap until SWFO-L1 is launched
-

CGMS-49-CGMS-WP-III- CGMS Baseline - draft revision following the 3rd risk assessment workshop (verbal)

A. Mehta presented the CGMS Baseline updates which can be summarised as follows:

- IR dual-angle view imagery for high-accuracy SST was accidentally left out when documentation was changed. It is added again now. This relies for example on Sentinel-3, when one orbit should comply with this, which is a long-term commitment with Copernicus.
- Baseline shall be reviewed later if it is aligned with the WMO Position paper on Requirement for Global NWP. Deadline is until the next risk assessment workshop 2022.
- In addition, some editorial changes were made.

K. Holmlund commented that JAXA presented follow on for GPM mission in WGII session and noted that associated actions for a support letter to JAXA have been tabled at WGII.

3. Establishment of way forward for science questions raised during baseline and risk assessment review.

3.1 Visible/UV spectrometer - WGII to discuss UV observations in GEO, and the inclusion of trace gases as an observation from GEO to which CGMS can commit [4'/presentation + discussions]

CGMS-49-WMO-WP-18: Satellite data needs in support of atmospheric composition monitoring

V-H. Peuch gave a presentation on Satellite data needs in support of atmospheric composition monitoring. In recent years, EO-based atmospheric composition information services have gained maturity and become mainstream (more a revolution than an evolution).

It is at the core of the vision of the WMO Global Atmospheric Watch (GAW) programme to stimulate this new generation of research-enabled operational monitoring and forecasting products and services. It puts requirements on modelling, in situ and satellite observations. Indeed, satellite observations need to be considered together with modelling/data assimilation and in-situ measurement capabilities, rather than in isolation.

In his presentation, he discussed briefly the requirements for the space segment regarding six application areas: air quality, atmospheric composition hazards (wildfires, dust plumes, volcanic eruptions…), ozone layer recovery, emissions monitoring for pollutants and greenhouse gases, with a special focus on anthropogenic CO2, atmospheric composition, and NWP.

A central requirement is the consolidatation of the space-based Global Observing System that will be in place around 2025, with a constellation of multi-spectral instruments/missions onboard LEOs and GEOs with spatial resolution of ~5km or better. Additional needs are mainly in the area of: vertical profiles of aerosol, including size/speciation (lidars); stratospheric profiles of water vapour, ozone and related tracers (limb sounding); lowermost troposphere (0-3km) at high spatial and temporal resolution for species not covered by current planned GEO (High Resolution IR). There are also emerging requirements for high resolution monitoring (~100m) for emissions characterisation during campaigns or on-demand (micro satellites, High-Altitude Pseudo-Satellites, drones…), which need to be further consolidated.

Besides these specific requirements, there are also generic ones regarding operationality (NRT, low data outages), continuity (dependency of user services and climate monitoring), calibration/intercalibration of instruments (use of constellations), and routine quality monitoring (not just CAL-VAL campaigns).

The following requirements to be considered by CGMS were presented:

EO-based atmospheric composition information services have gained maturity and impact (more a revolution than an evolution). It is at the core of the vision of GAW to stimulate a new generation of research-enabled operational products and services. This puts requirements on modelling, in situ and satellite observations. For the latter, these are:

- Generic: operationality (NRT, low data outages), continuity (dependency of user services and climate monitoring), calibration/intercalibration of instruments (use of constellations), routine quality monitoring (not just CAL-VAL campaigns).
- Consolidation of the space-based Global Observing System of ~2025: LEOs UV+VIS+IR+Polarimeter, GEOs UV+VIS+(IR)
- Atmospheric CO2 and anthropogenic emissions monitoring
- Stratospheric profiles of water vapour, ozone, and related tracers (limb sounding)
- Vertical profiles of aerosol, including size/speciation (lidars)
- Lowermost troposphere (0-3km) at high spatio-temporal resolution for species not covered by GEMS, Sentinel-4, TEMPO (High Resolution IR GEO)
- New: very high resolution (100m) for emissions characterisation during campaigns or on-demand (Drones and High-Altitude Pseudo-Satellites)

CGMS-49-EUMETSAT-WP-14: Sentinel-4, products instruments

R. Munro gave a presentation proving a short summary of the Copernicus Sentinel-4 mission to be flown on the EUMETSAT MTG Sounding platform (MTG-S). The Copernicus Sentinel-4/UVN mission consists of an Ultraviolet-Visible-Near-infrared (UVN) imaging spectrometer instrument embarked on

the Meteosat Third Generation Sounding (MTG-S) satellite. The main objective of the Sentinel-4/UVN mission is to monitor key air quality trace gases and aerosols over Europe in support of the Copernicus Atmosphere Monitoring Service (CAMS) at high spatial resolution and with a frequent revisit time. The instrument is built under the responsibility of ESA with the instruments and Level-1b prototype processor being developed by a consortium led by ADS. The operational Level 0 – 1b processor is developed under EUMETSAT responsibility and the Level-2 operational processor developed by a consortium led by DLR. The expected mission lifetime is 15 years and will be operated by EUMETSAT which will also be responsible for the provision, maintenance, and evolution of all operational product processors. Launch is currently expected in 2023. The spatial resolution will be ~ 8 x 8 km (at a point in central Europe) with hourly temporal resolution. The geophysical products to be provided from Sentinel-4 include O_3, NO_2, SO_2, HCHO, (CHOCHO), UV, AAI, AOD, and ALH.

CGMS-49 actions - Joint WGII-WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	3.1	JWGII-WGIII/A49.01	WMO to explore what is the need of establishing an international science working group in support of the atmospheric composition/air quality services, taking the existing initiatives e. g. under GAW and CEOS into account.	CGMS-50	**OPEN**

CGMS-49-GUEST-WP-05: GK2B GEMS operation status and plan

J. Jong gave a presentation on GEMS operation status and plans. NIER has successfully completed the In-Orbit Test (IOT) of about 8 months after GEMS launch and has been making efforts to stabilise the data production system and verifying the data quality. Last year, the first GEMS data that observed air pollutants in Asia was released and the disclose and distribute some of the verified GEMS Level 2 (L2) product from 22 March 2021 has begun. The products currently being released are Aerosol Optical Depth (AOD), NO2, Cloud, Ozone, and some of UVI products. Details can be found on the NESC/NIER website. In the second half of this year, additional GEMS L2 products and original data with NetCDF are planned for release and as well as the establishment of an FTP service considering large-capacity data. At the moment, only image data format is available.

CGMS-49-NASA-WP-08: Tropospheric Emissions: Monitoring of Pollution (TEMPO)

B. Lefer gave a presentation on TEMPO mission. The TEMPO instrument will be integrated to a Maxar 1300 Series Spacecraft Bus on an Intelsat Commercial Satcom mission (IS40e) and launched to 91 West. Maxar Technologies holds the prime contract for hosting services and Intelsat is a sub-contractor to provide host operations and data routing. The instrument will be shipped to Maxar in July 2021 and then shipped to the launch site for an October 2022 launch on a SpaceX Falcon 9 rocket.

The grating spectrometer measures solar backscattered radiance from ultraviolet (UV; 290-490 nm) to visible (540-740 nm) wavelengths with a spectral resolution (0.6 nm FWHM) and sampling every 0.2 nm at sub-urban spatial resolution of 2.0 km x 4.75 km at the centre of the Field of Regard (FOR). It has 2 Detectors providing 2k×1k image with the full spectral range for each geospatial scene.

It has nominal spatial resolution 8.4 km N/S × 4.7 km E/W at the centre of domain (can often measure 2.1 km N/S × 4.7 km E/W). Standard data products are Retrieval of aerosol and cloud parameters; tropospheric ozone (O_3); nitrogen dioxide (NO_2), sulphur dioxide (SO_2), formaldehyde (HCHO), glyoxal ($C_2H_2O_2$), water vapor (H_2O), and UVB radiation. It will also provide enhanced sensitivity to O_3 in the lowest 2 km of the troposphere, thereby characterising boundary layer, free tropospheric, and stratospheric O_3.

In the discussion, V.-H. Peuch noted that surface observations are important because there are lots of gaps and ground-based observations cannot be replaced by satellite observations. Surface observations are however regulated in some countries. If countries are taking this seriously, they need to change the strategy to city level monitoring. B. Lefer added that it is a combination of both observations systems and also a combination of different satellites also covering different frequency ranges. He also pointed out that UVN is acceptable for daytime, but IR measurements are needed for night-time.

P. Ruti asked where the requirement/definition for the resolution of 5 km is coming from and what is then the requirement for the urban meteorology. V.-H. Peuch responded that 5 km is coming from the air quality agencies that have now been presented with that type of data and found it useful. In general, the requirements seem to be somewhere between 3 and 10 km. Use case for special events and urban modelling need higher resolution (hundred-meter scale) to be able to follow the event in time and space and may in the future warrant additional observational capabilities like High Altitude Platform Systems (HAPS).

K. Holmlund asked what the implication to CGMS agencies is. V.-H. Peuch responded that the consolidation and utilisation of new observations coming is a very important first step. Also, all continents should be covered with the same capacity, which is critical for climate change monitoring.

K. Holmlund commented that true capabilities should be understood first before new plans and see that it is important that CGMS reflects GEO and LEO capabilities. V.-H. Peuch responded that it is a golden era for LEO observations with UV, IR, and polarimetric measurements. Consolidation of those is indeed needed. Calibration is also important, as seen with Sentinel 3A/B, which have already some issues. Requirements for LEO calibration and intercalibration over GEO coverage are important. K. Holmlund commented that concreate recommendation to GSICS must be prepared.

During the discussion, it was further noted that that new geostationary capabilities are now emerging, however it is important to ensure operational continuity. It was noted that the current GEMS mission is planned until 2030 and follow-on missions are considered. However, it was noted that a follow-on mission to TEMPO has not yet been agreed, but an atmospheric composition/air quality mission is considered for the NOAA GEO XO.

K. Holmlund asked about the importance of active measurement for CO_2. V.-H. Peuch responded that it is a measurement capability, which is down the line, but would provide important reference observations, also in night-time.

Atmospheric composition as well as NWP modelling group composition and communication was discussed. It was noted that today the Copernicus Atmospheric Monitoring Service (CAMS) is leading the modelling activities, however, there are also important research and modelling activities covered by WMO Global Atmospheric Watch (GAW). It was further noted that CEOS, e. g. CEOS AC-VC, activities should be considered. However, there may be a need to establish a CGMS-like international science working group bringing together the operators of the space based capabilities, the research and operational modelling community.

3.2 WGII to discuss aerosol observations in GEO and LEO, and the inclusion of aerosols as an observation from GEO and LEO to which CGMS can commit

CGMS-49-CMA-WP-04: Aerosol products from Fengyun satellite

L. Chan gave a presentation on aerosol products provided by Fengyun satellite. In the past few decades, most of the studies of aerosol remote sensing retrieval have been carried out using polar-orbiting satellites Terra/MODIS and Aqua/MODIS, Suomi-NPP/VIIRS, etc. With the rapid development of remote sensing in China, the potential of FY-series satellite remote sensing data has been explored in atmospheric environment. So far, China has launched seventeen meteorological satellites, including polar-orbiting and geostationary satellites, and at least five instruments can observe atmospheric aerosol properties. The aerosol retrieval algorithms using the imagery sensor on-board the satellite over land and ocean was introduced, as well as the operational products' formats, resolution, and accessible methods. Using the AERONET observations and MODIS operational AOD products, the accuracy of existing AOD datasets based on FY satellites was evaluated and compared. Aiming at the deficiency of the operational FY AOD products, the study examines the enhanced directions in the next stage, further improving the benefit of FY-satellite remote sensing data.

Since 2009, the China Meteorological Administration has released aerosol products over land and ocean to the public, with a resolution of 1km/5km for polar-orbit satellite and 4km for geostationary satellite. The future improvement plan is to ameliorate 1) identification of cloud and haze: The existing AOD products take the service cloud identification products as the basis of cloud identification, while the selection principle of the cloudy pixels is very strict, without distinguishing the haze scenes separately; 2) Aerosol type classification; and 3) surface reflectance relationship over brighter pixels when the existing algorithm mainly focus on the development and optimisation of dark target areas with dense vegetation coverage, but there are still some limitations in the process of bright surface areas. In the future, the processing strategy of dark blue algorithm for bright surface will be explored.

CGMS-49-EUMETSAT-WP-13: Aerosol Observations from EUMETSAT and Third-Party Missions

R. Munro gave an overview presentation of aerosol observing capabilities from EUMETSAT and third-party missions. Those missions with aerosol observing capabilities in Low Earth Orbit include MetOp GOME-2, AVHRR and IASI, which are used together to generate the Polar Multi-mission Aerosol product (PMAp), Copernicus Sentinel-3 SLSTR & OLCI, EPS-SG 3MI, Copernicus Sentinel-5, METimage, and IASI-NG, which will also be used together to provide MAP (Multi-mission Aerosol product). In the Geostationary Orbit, there are aerosol observing capabilities from the MSG SEVIRI, MTG-I FCI, and the MTG-S Copernicus Sentinel-4 and IRS.

The currently available products are AOD provided from MetOp PMAp & Copernicus Sentinel-3 SLSTR. The products are currently operational over ocean and demonstrational over land, with improvements in progress. Information about the aerosol type is also provided and aerosol sources via the Sentinel-3 SLSTR Fire Radiative Power (FRP) product. Products in development include improved AOD from MetOp PMAp and Sentinel-3 SLSTR, refined and more robust AOD from EPS-SG 3MI and MAP, aerosol model information from EPS-SG 3MI and MAP, optimised for the needs of the Copernicus Atmosphere Monitoring Service (CAMS) model (Sea Salt, Dust, Black Carbon, Sulphates, Organic matter). Aerosol layer height is expected to be provided from Sentinel-3 OLCI, EPS-SG MAP, and Copernicus Sentinel-4 and Sentinel-5. Finally, high frequency AOD information will be available from the MTG-I FCI and dust/ash information from the MTG-S IRS.

CGMS-49-JAXA-WP-03: GCOM-C and AHI aerosol product development

H. Murakami gave a presentation on JAXA's GCOM-C and AHI aerosol product development. JAXA has developed a common algorithm to estimate aerosol optical thickness AOT, AE, and SSA applicable to

both the polar orbit satellite imager, GCOM-C/SGLI, and the geostationary satellite imager, Himawari-8/AHI. JMA/MRI has developed the global aerosol model called MASINGAR assimilating the satellite AOTs. The AHI frequent observation can improve random noise, cloud screening, and increase non-cloud area in a day (Kikuchi et al. 2018). SGLI near-UV channel and polarimetry at red and NIR wavelengths can observe aerosol absorption and fine mode aerosols globally including higher latitudes by 1 km or 250 m spatial resolution. In 2020, the aerosol algorithm was revised to use the MASINGAR predicted aerosols as the initial guess, and the error of AOT, AE, and SSA were reduced by 6%, 40%, and 10%, respectively in the case of match-up comparison between the AHI estimates and AERONET measurements (Yoshida et al. 2021). The satellite aerosol products and outputs from MASINGAR are open to the public through the JAXA G-portal, Himawari Monitor, and P-Tree system. JAXA continues a more effective synthesis of the GEO and LEO data (including the vertical profile from EarthCARE) in close collaboration with the model assimilation research including JMA/MRI.

CGMS-49-NOAA-WP-20: NOAA Aerosol Capabilities

S. Kondragunta gave a presentation on NOAA's aerosol measurement capabilities. The use of polar-orbiting satellite-derived aerosol optical depth (AOD) in estimating surface PM2.5 concentrations has been on the rise in the last two decades. The estimated PM2.5 values are of high accuracy when conditions are favourable (e. g. well mixed boundary layer) and are less accurate when conditions are not favourable (e. g. aerosols are aloft). A major limitation of using polar-orbiting satellites is one single satellite observation in a day, which is not a true representative of daily average PM2.5, especially when diurnal variation is significant. Additionally, the boundary layer height that is also critical for scaling the column AOD to surface PM2.5 changes during the day.

A single satellite sensor or a pair of satellite sensors that can provide simultaneous retrievals of highly accurate AOD, aerosol layer height, and aerosol composition (single scattering albedo, SSA) are expected to improve the estimated surface PM2.5 from AOD. Knowledge of composition is important because the health effects vary depending on the type of aerosol. Layer height matters because if aerosol is closer to the surface in the boundary layer, it impacts human health. Researchers have used Aqua Moderate Resolution Imaging Radiometer Suite (MODIS) and Aura Ozone Monitoring Instrument (OMI) to demonstrate that AOD from MODIS can be extrapolated to UV wavelengths and given as input to OMI UV aerosol algorithm to retrieve aerosol layer height and single scattering albedo.

Until we have access to near real-time full vertical profile and adequate spatial coverage of aerosols along with composition information with sensors like MetOp-SG 3MI, NOAA is proposing to expand the technique to a constellation of geostationary satellites covering the globe, both land and ocean. We plan to use Advanced Himawari Imager/Geostationary Environmental Monitoring Spectrometer (AHI/GEMS) as a testbed for the development of synergistic algorithms that retrieve AOD, aerosol layer height, and SSA covering Asia. The retrievals, once evaluated and optimised, will be used as input to algorithms that derive surface PM2.5 by National Institute for Environmental Research (NIER) in Korea. The new algorithms will also be applied to Advanced Baseline Imager/Tropospheric Emissions: Measurement of Pollution (ABI/TEMPO) after TEMPO so the methodology can be applied to GeoXO ACX and AXI.

The global constellation of geostationary satellite imagers and spectrometers will provide aerosol information from UV to Visible. Synergistic retrievals can be attempted to optimise the aerosol information – GEO ring for air quality. Complete aerosol characterisation from polarimeters will be in a midmorning polar orbit. Polarimeters on PACE and ACCP, Lidar on ACCP likely in the mid-afternoon. NASA MAIA will be a mid-morning mission targeting mega cities for PM2.5 monitoring.

K. Holmlund asked about the use of aerosol product from GEO ring. V-H. Peuch commented that they are useful and important, especially for monitoring processes with short timescales. There is also a strong need for polarimetric products, which puts additional requirements on the accuracy and noise of the measurements. He also emphasised that for CO_2 observations collocated aerosol observations are needed.

K. Holmlund commented that the CGMS baseline should be reflected with new capabilities and baseline products should be included that can be derived from the CGMS baseline missions. M. Rattenborg confirmed that this indeed was the intended approach for this suggested session and that the updates should be agreed by mid-May for inclusion in the updated baseline for CGMS-49 Plenary.

CGMS-49 recommendations – joint WGII-WGIII			
Actionee	**AGN item**	**Rec**	**Description**
CGMS member	3.2	JWGII-WGIII/R49.01	WGII recommends that CGMS Members develop aerosol products capitalising on synergies across multiple instruments

CGMS-49 actions - Joint WGII-WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
Presenters at CGMS-49 JWGII-III session	3.2	JWGII-WGIII/A49.02	Provide updated information on observables/species, which can be committed by CGMS constellation and added to CGMS baseline.	Jan 2022	**OPEN**

4. Wrap-up, WGIII report considerations for plenary and conclusions

K. Holmlund concluded the joint session and thanked for the good discussion and outcome of both, the aerosols and the atmospheric composition topics.

5. Summary list of actions and recommendations of the joint WGII-WGIII session

CGMS-49 actions - Joint WGII-WGIII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
WMO	3.1	JWGII-WGIII/A49.01	WMO to explore what is the need of establishing an international science working group in support of the atmospheric composition/air quality services, taking the existing initiatives e. g. under GAW and CEOS into account.	CGMS-50	**OPEN**
Presenters at CGMS-49 JWGII-III session, WGII	3.2	JWGII-WGIII/A49.02	Provide updated information on observables/species, which can be committed by CGMS constellation and added to CGMS baseline.	Jan 2022	**OPEN**

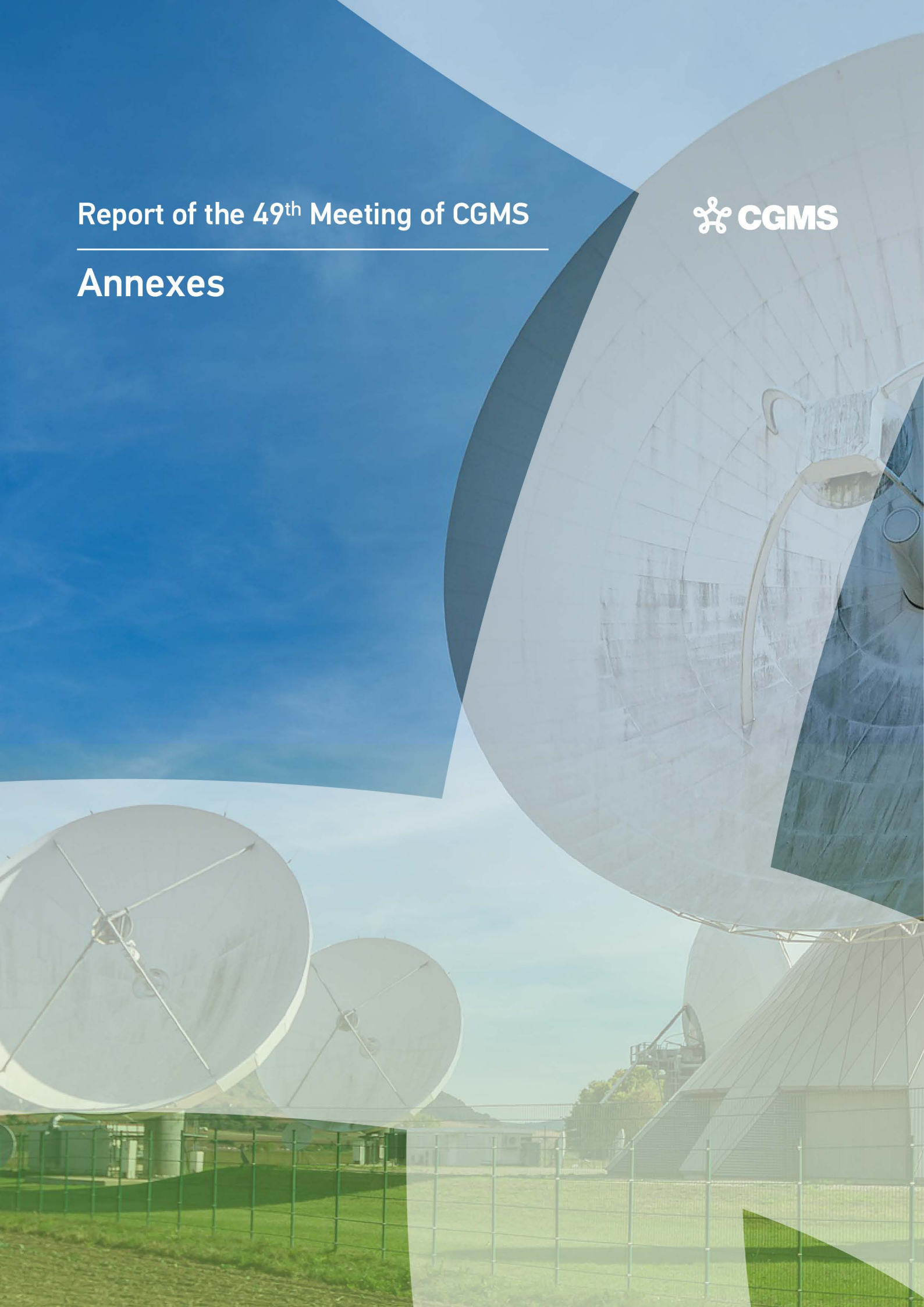
CGMS-49 recommendations – Joint WGII-WGIII			
Actionee	**AGN item**	**Rec**	**Description**
CGMS member	3.2	JWGII-WGIII/R49.02	WGII recommends that CGMS members develop aerosol products capitalising on synergies across multiple instruments

(These actions and recommendations will be monitored within the framework of WGII and WGIII)

Report of the 49th Meeting of CGMS

CGMS

Annexes



ANNEX I ADDRESSES

[The spoken word prevails]

Opening address BY Mr. YU Xinwen, Deputy Administrator of CMA

Distinguished Mr. Phil Evans,
Distinguished Professor Petteri Taalas,
Dear delegates of CGMS members,
Ladies and Gentlemen,
Good morning (good afternoon, good evening)!

First of all, on behalf of Mr. ZHUANG Guotai, Administrator of China Meteorological Administration (CMA), I would like to extent my warm welcome to you all to attend the virtual 49th Plenary Session of the Coordination Group for Meteorological Satellites (CGMS)! This session is hosted by CMA, and co-organised by the National Satellite Meteorological Center of CMA and CGMS Secretariat. I appreciate all the delegates for overcoming the time difference to attend the meeting. Meanwhile, my thanks also goes to Mr. Evans, an old friend of CMA, and to the colleagues of CGMS Secretariat, and I believe that with your strong support, this session will be as fruitful as ever.

CGMS serves as a model for building a community with a shared future in terms of global meteorological satellites. As an important organisation in international earth observations, CGMS plays an important role in coordination of satellite operations and future plans of various countries, optimisation of global meteorological satellite observation systems, improvement of meteorological services, and prevention and mitigation of natural disasters. It has promoted the continuation and complementarity of the meteorological satellite space infrastructures worldwide to enable users to access satellite data in a sustained and steady way.

Especially during COVID-19 pandemic, CGMS members jointly made excellent contributions to making up for insufficient meteorological observation capability caused by the pandemic, and to the prevention and mitigation of global meteorological disasters, which I think should be applauded!

The Chinese government attaches great importance to the development of meteorology and related satellites and their international applications, and benefited a lot from the development of global satellite observation systems. On several major international occasions, Chinese President XI Jinping put forward the use of FY meteorological satellites and meteorological remote sensing satellite technologies to serve the international community. CMA has actively involved in CGMS activities, and this is the fourth time for CMA to host the CGMS plenary session. Last year, CMA celebrated the 50th Anniversary of Fengyun Satellite Programme. Over the past 50 years, China has successfully launched 17 Fengyun meteorological satellites, with 6 in orbit, achieving the upgrade of polar and geostationary meteorological satellite series and their continuously stable operations to persistently provide data and product services globally. Here, I am glad to inform the Session that within the next two months, China will launch FY-3E, an early-morning orbit meteorological satellite and FY-4B, the second new generation geostationary one, so long awaited by the international community. These will join the international meteorological satellite family to provide more and better data and products.

Ladies and gentlemen,

Greenhouse Gases, climate monitoring and space weather are already included as CGMS's important coordination areas to meet the challenges arising from global climate change, increased extreme weather and climate events as well as atmospheric environmental pollution. These are consistent with China's philosophy of pursuing a path of green and low-carbon development with priority given to ecological conservation, green and low-carbon development. I hope that satellite monitoring services will continuously contribute to achieving the goal of global low-carbon and emission reduction. Meanwhile, I also call on the meteorological satellite agencies and organisations worldwide to further strengthen their cooperation, and make practical efforts to improve meteorological satellite data and products, in order to provide more and better services for various users around the world.

Finally, I wish the 49th Plenary Session of CGMS a complete success! And I also wish you all good health!

Thank you!

Opening address by Mr. Phil Evans, Head of CGMS Secretariat and EUMETSAT Director-General

- I would like to welcome all CGMS members and all participants to the 49th CGMS Plenary meeting.
- I am Phil Evans – and I took over as Director-General of EUMETSAT on 1 January 2021. Being the new DG of EUMETSAT I also became Head of CGMS Secretariat
- I have been briefed on CGMS and I can commit to support this group and to support EUMETSAT in its role of CGMS Secretariat. I think it is an important mechanism to keep coordination among space agencies responding to the observation requirements of WMO. All together we are committed to respond to the Vision for WIGOS 2040 and I am looking forward for the discussions in the three days to come.
- I realised that it is the 2nd year that we have a virtual CGMS plenary meeting and I would like to thank CGMS members for their flexibility in these difficult times. I want to address a special thanks to CMA for their readiness to host the meeting twice under these special circumstances. You have been very flexible and I am sure that all CGMS member appreciated it.
- We have a long agenda in front of us. On top of the reports of our Working Groups, I am looking forward to the dialogue we will have with WMO on important matters discussed in Geneva, i.e. with regard to the evolution of the WMO Data Policy but also with regard to the restructuring of GCOS, which is an important programme to articulate requirements for climate observations.
- The thematic session that we have on the impact assessment of satellite data on NWP is also particularly key – as it might influence the way we will all together respond to new observations needs or approaches required by future global NWP models. This might

influence the way we plan and coordinate our future observing space infrastructures. The same applies to the session on Green House Gases monitoring

- I am however looking forward to meeting you in person as soon as circumstances permit. I should now like to suggest we proceed with the agenda.

Opening address by Petteri Taalas, WMO Secretary-General

- It is a pleasure to join the CGMS-49 Plenary meeting
- As you know WMO has undergone significant reform under the WMO Strategic Plan 2020 - 2023
- Key issues for WMO members include
    - readiness for extreme weather events,
    - climate monitoring,
    - supporting decision making related to climate change,
    - advancing the required observational and modelling capabilities required for the implementation of the Paris agreement, and
    - increasing socio-economic value of environmental services.
- WMO is therefore taking a holistic Earth-system modelling and monitoring approach, and recognises that global NWP underpins most WMO application areas.
- In that respect it should be noted that space-based observations are key for any state-of-the-art NWP system and WMO has recently prepared a position paper on the 'Satellite data Requirements for global NWP' emphasizing the need for open, free and timely access to critical satellite observations.
- In this context it is important also to note that WMO is working towards a new updated Data Policy that takes into account the scientific, technical and societal challenges, changes and opportunities towards a holistic Data Policy encompassing all WMO application areas.
- The new Data Policy has now been endorsed by the first WMO intergovernmental body, Infrastructure Commission, with a target of approval by the WMO Congress in October 2021. The new Data Policy foresees that with respect to 'core data', that is data that should be made available openly and freely, WMO should engage with the Space Agencies in determining and agreeing those data.
- I am looking forward in constructive discussions with the Space Agencies in ensuring a space-based observation system that will maximise benefits for us all.
- The aspirational future space-based observing system is detailed in the WMO Vision for WIGOS in 2040 and WMO welcomes the CGMS contributions towards the implementation of

the Vision. However, there are still critical gaps and today there is still a long way to go towards a full implementation of the Vision. WMO therefore calls upon the Space Agencies to establish a way forward towards fulfilling that Vision.

WMO remains committed towards the space agencies and CGMS and I am looking forward to hearing the outcomes of this Plenary session. I also look forward to seeing you in person at CGMS-50, when WMO would like to host this event at WMO in Geneva.

Address by Dr. WANG Jingsong, CMA NSMC Director-General

Distinguished Mr. Phil Evans,
Distinguished Professor Petteri Taalas,
Ladies and Gentlemen,
Good morning (good afternoon, good evening)!

This is WANG Jingsong, was just nominated as new DG of CMA/NSMC yesterday. Previously I was the DG of the Department of Integrated Observations of CMA, and I also served as Deputy DG of NSMC for several years. Actually I was partially involved in the FengYun Programme over last decade. It's a great honor for me to attend this plenary session as my debut to join CGMS family. As Dr. YU expressed in his opening remarks, the Chinese government attaches great importance to the development of FengYun satellites and their international applications, and CMA will continuously provide data and product services to the global users.
As a new DG of NSMC, I will do my best to support it with my team. I believe that you will get more information about the latest progress and future programme of FengYun satellites from Dr. ZHANG Peng's presentation in a moment.

I believe this session will be as fruitful as ever. And I also wish you all good health!

Thank you!

ANNEX II: ABBREVIATIONS

Abbreviation	Meaning
ACE	Advanced Composition Explorer
AMV	Atmospheric Motion Vector
AOD	Aerosol Optical Depth
AWS	Automatic Weather Station
CAMS	Copernicus Atmosphere Monitoring Service
CCI	Convective Cloud Information
CCOR	Compact Coronagraph
CDR	Climate Data Records
CFOSAT	Chinese-French Oceanography Satellite
CRC	China-Russia Consortium
CSR	Clear Sky Radiance
D3S	Distributed Space Weather Sensor System
DCP	data collection platform
DCS	Data Collection Service
DRS	Direct Relay Satellite
DRT	Data Relay Transponder
DWL	Doppler Wind Lidar
E-DCP	Enhanced DCP
EARS	EUMETSAT Advanced Retransmission Service
ECV	essential climate variables
EO	Earth Observation
EORC	JAXA Earth Observing Research CenteR
EOSC	Earth-observing satellite constellation
EOTEC DevNet	Earth Observation Training, Education, and Capacity Development Network
ERSA	ESA Radiation Sensor Array
ESA PB-EO	ESA Programme Board for Earth Observation
ESC	Expert Service Centres
ESD	NASA's Earth Science Division
ET-SWx	Expert Team on Space Weather
EUVST	Extreme Ultraviolet HighThroughput Spectroscopic Telescope
EZIE	Electrojet Zeeman Imaging Explorer
FCDR	fundamental climate data record
FDR	Fundamental Data Records
FOC	Full Operational Capability
FRP	Fire Radiative Power
FY	FengYun
FY_ESC	Emergency Support Mechanism of FY Satellite
GAW	WMO Global Atmospheric Watch
GBON	Global Basic Observation Network
GEO-XO	Geostationary and Extended Orbits
GeoHSS	Hyper Spectral Sounding instrument on a geostationary satellite
GNC-A	GEONETCast Americas broadcast
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellites
GOLD	Global-scale Observations of the Limb and Disk
GSICS	Global Space-based Inter-Calibration System

Abbreviation	Meaning
GST	2023 Global Stocktake
GTS	Global Telecommunication system
HAPS	High Altitude Platform Systems
HERMES	Heliophysics Environmental and Radiation Measurement Experiment Suite
HSS	Hyperspectral IR Sounder
ICON	Ionospheric and Connection Explorer
IDA	Internal Dosimeter Array
IDCS	international DCS channels
INFCOM	WMO Commission for Observation, Infrastructure and Information Systems
INPE	Brazilian Ministry of Science, Technology, and Innovations
IOC	Initial Operational Capability
IODC	Indian Ocean Data Coverage
IPWV	Integrated Precipitable Water Vapour
IS40e	Intelsat Commercial Satcom mission
ISCCP-NG	Next Generation of the International Satellite Cloud Climatology Project
ISES	International Space Environment Service
KSEM	Korean Space wEather Monitor
MAP	Multi-mission Aerosol product
MMDRPS	Multi-Mission Meteorological Data Receiving and Processing System
MODIS	Moderate Resolution Imaging Radiometer Suite
MOSDAC	Meteorological and Oceanographic Satellite Data Archival Center
MTG-S	Meteosat Third Generation Sounding
NCMRWF	National Centre for Medium Range Weather Forecast (India)
NGRM	Next Generation Radiation Monitor
NKN	National Knowledge Network
NREN	National Research and Education Network
NSF	National Science Foundation (USA)
NWP	Numerical weather prediction
OGC	Open Geospatial Consortium
OMI	Ozone Monitoring Instrument
OSOS	First International Operational Satellite Oceanography Symposium
OSSEs	Observing System Simulation Experiment
OSW TG	Ocean Surface Wind Task Group
OVW	ocean vector winds
PMAp	Polar Multi-mission Aerosol product
PSTEP	Project for SolarTerrestrial Environment Prediction
RDCA	rapidly developing cumulus areas
RO	radio occultation
ROSES	Research Opportunities in Space and Earth Science
RRR	Rolling Requirements Review
RTSWnet	Real-Time Solar Wind network
S2P	Space Safety Programme
SAN	SWFO Antenna Network
SAS & R	satellite aided search and rescue
SBIR	Small Business Innovation Research
SCO	Space Climate Observatory
SDR	sensor data records

Abbreviation	Meaning
SETT	Socio Economic Tiger Team
SOHO	Solar and Heliospheric Observatory
SOSMAG	Service Oriented Spacecraft Magnetometer
SSA	single scattering albedo
SST	Sea Surface Temperature
STEREO	Solar Terrestrial Relations Observatory
SWCEM	WMO Space-based Weather and Climate Extremes Monitoring
SWFO	Space Weather Follow-On
SWO	Space Weather Observations
SWORM	the Space Weather Operations, Research and Mitigation team
SWOT	Strengths, Weaknesses, Opportunities, and Threats
SWxSA	Space Weather Science Application
TANSO-FTS	Thermal And Near-infrared Sensor for carbon Observation Fourier-Transform Spectrometer
TEMPO	Tropospheric Emissions: Monitoring of Pollution
ToR	Terms of Reference
VLab	WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology
VLMG	VLab Management Group
WIS	WMO's Information System
WSI	WIGOS Station Identifiers

ANNEX III LIST OF PARTICIPANTS

CGMS-49 - Plenary list of Participants		
Organisation	**First name**	**Last name**
CGMSSEC	Esther	Maina
CGMSSEC	Mikael	Rattenborg
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CMA	Weixia	Lin
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CMA	Shengli	Wu
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CMA	Di	Xian
CMA	Lizi	Xie
CMA	YU	Xinwen
CMA	Zhe	Xu
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IPWG/Météo France	Philippe	Chambon
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KMA	Dohyeong	Kim
KMA	Okhee	Kim
KMA	Ilhwan	Park
KMA	Dong-kee	Shin
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CMA	Wenguang	Bai
CMA	Fangli	Dou
CMA	Hui	Liu
CMA	Yixuan	Shou
CMA	Ling	Sun
CMA	Xuebao	Wu
CMA	Na	Xu
CMA	Xiaochun	Zhai
CMA	Lu	Zhang
CMA	Peng	Zhang
CMA	Xingying	Zhang
CMA	Jian	Shang
CSA	Konstantin	Baibakov
ECCC	Ray	Nassar
ECMWF	Gianpaolo	Balsamo
ESA	Stephen	Briggs
ESA	Juha-Pekka	Luntama
ESA	Ivan	Petiteville
ESA	Anne Grete	Straume-Lindner
EUMETSAT	Ruediger	Lang
EUMETSAT	Francois	Montagner
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EUMETSAT	Paolo	Ruti
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IMD	Ram Kumar	Giri
IMD	Virendra	Singh
IMD	Srinivasa Prasad	Vijapurapu
IOC/UNESCO	David	Halpern
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IPWG	Viviana	Maggioni
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IWWG	Jaime	Daniels
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JAXA	Takuji	Kubota
JAXA	Toshiyuki	Kurino
JAXA	Osamu	Ochiai
JAXA	Hiroshi	Suto
JAXA	Moeka	Yamaji
JMA	Miki	Abe
JMA	Kenji	Date
JMA	Takahito	Imai
JMA	Kouki	Mouri
JMA	Shunya	Oike
JMA	Hiromi	Owada
JMA	Nakayama	Ryuichiro
JMA	Yuuki	Saeki
JMA	Kazuki	Shimoji
JMA	Shun	Shiraishi
JMA	Mayu	Sumita
JMA	Hiroshi	Suzue
JMA	Yurika	Yamada
JMA	Yusuke	Yogo
JMA	Shiro	Omori
JMA	Kazuki	Kodera
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JMA	Kazuki	Shimoji
JMA	Yoshiaki	Takeuchi
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KMA	Dohyeong	Kim
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NASA	Maudood	Khan
NASA	Thorsten	Markus
NASA	Mitch	Goldberg
NICT	Tsutomu	Nagatsuma
NIER	Jaehoon	Jeong
NSSC	Xingou	Xu
NOAA	Jordan	Gerth
NOAA	Ken	Knapp
NOAA	Shobha	Kondragunta
NOAA	Jilian	Mayer
NOAA	Jeff	Privette
NOAA	Elsayed	Talaat
NOAA	Arlyn	Andrews
NOAA	Kevin	Schrab
NOAA	Andrew	Heidinger
NOAA	Dan	Lindsey
NOAA	Mary Ann	Kutny
NOAA	Satya	Kalluri
NOAA	Veronica	Lance
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WMO	Kenneth	Holmlund

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CGMSSEC	Anne	Taube
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CMA	Qifeng	LU
CMA	Haofei	Wang
CMA	Shengli	Wu
CMA	Xuebao	Wu
CMA	Peng	Zhang
ESA	Juha-Pekka	Luntama
EUMETSAT	Sean	Burns
EUMETSAT	Simon	Elliott
EUMETSAT	Thomas	Heinemann
EUMETSAT	Andrew	Monham
IMD	Ram Kumar	Giri
IMD	Virendra	Singh
IMD	Ramshray	Yadav
IMD	Srinivasa Prasad	Vijapurapu
ISRO	Rashmi	Sharma
ISRO	Pradeep	Thapliyal
ISRO	Jayaprakash V	Thomas
ISRO	Atul	Varma
JAXA	Toshyiuko	Kurino
JAXA	Osamu	Ochiai
JAXA	Riko	Oki
JAXA	Moeka	Yamaji
JMA	Kotaro	Bessho
JMA	Yasutaka	Hokase
JMA	Hiroki	Morita
JMA	Takuya	Sakashita
JMA	Mikito	Yamamoto
JMA	Ryo	Yoshida
KMA	Dohyeong	Kim
KMA	Jin	Woo
KMA	Okhee	Kim
KMA	Hyunjong	Oh
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NICT	Tsutomu	Nagatsuma
NOAA	Natalia	Donoho
NOAA	Melissa	Johnson
NOAA	Ajay	Mehta

CGMS-49-WGIII List of Participants		
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NOAA	Vanessa	Griffin
NOAA	Mary Ann	Kutny
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WMO	Heikki	Pohjola

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CMA	Minyan	Wang
CMA	Di	Xian
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EUMETSAT	Sean	Burns
EUMETSAT	Simon	Elliott
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EUMETSAT	Guillaume	Texier
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IMD	Ram Kumar	Giri
ISRO	Nitant	Dube
ISRO	Rashmi	Sharma
ISRO	Pradeep	Thapliyal
ISRO	Atul	Varma
JMA	Miki	Abe
JMA	Kotaro	Bessho
JMA	Masaki	Hasegawa
JMA	Yasutaka	Hokase
JMA	Takuya	Sakashita
JMA	Mikito	Yamamoto
JMA	Ryo	Yoshida
KMA	Sung-Rae	Chung
KMA	Dohyeong	Kim
KMA	Jin	Woo
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NOAA	Seth	Clevenstine
NOAA	Natalia	Donoho
NOAA	Vanessa	Griffin
NOAA	Melissa	Johnson
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NOAA	Shobha	Kondragunta
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WMO	Guangxin	He

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ESA	Juha-Pekka	Luntama
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EUMETSAT	Paolo	Ruti
ISRO	Sankarasubramanian	Kasiviswanathan
ISRO	Tarun	Pant
JMA	Masaya	Takahashi
JMA	Mikito	Yamamoto
JMA	Ryo	Yoshida
KMA	Jiyoung	Kim
NASA	James	Spann
NICT	Mamoru	Ishii
NICT	Tsutomu	Nagatsuma
NICT	Kaori	Sakaguchi
NOAA	Melissa	Johnson
NOAA	Ajay	Mehta
NOAA	Elsayed	Talaat
NOAA	Brent	Gordon
NOAA	Franz	Zichy
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WMO	Guangxin	He
WMO	Kenneth	Holmlund
WMO	Heikki	Pohjola

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CGMSSEC	Mikael	Rattenborg
CGMSSEC	Anne	Taube
CMA	Lin	Chen
CMA	Ling	Sun
CMA	Haofei	Wang
CMA	Shengli	Wu
CMA	Xuebao	Wu
CMA	Na	Xu
CMA	Xiaochun	Zhai
CMA	Lu	Zhang
CMA	Peng	Zhang
CMA	Xingying	Zhang
CMA	Xingou	Xu
ECMWF	Vincent-Henri	Peuch
EUMETSAT	Ruediger	Lang
EUMETSAT	Rosemary	Munro
EUMETSAT	Paolo	Ruti
ICWG/SMHI	Karl-Göran	Karlsson
IMD	Shibin	Balakrishnan
IMD	Virendra	Singh
IMD	Srinivasa Prasad	Vijapurapu
IMD	Ramashray	Yadav
IOC UNESCO	David	Halpern
IPWG	Viviana	Maggioni
IROWG/NASA	Anthony	Mannucci
IROWG/University of Graz	Ulrich	Foelsche
ISRO	Pradeep	Thapliyal
ISRO	Jayaprakash V	Thomas
ISRO	Atul	Varma
ISWG/LAND	Gianpaolo	Balsamo
IWWG	Regis	Borde
IWWG/UW/Madison/SSEC CIMSS	Steve	Wanzong
JAXA	Misako	Kachi
JAXA	Takuji	Kubota
JAXA	Toshiyuki	Kurino
JAXA	Hiroshi	Murakami
JAXA	Moeka	Yamaji
JMA	Kenji	Date
JMA	Takahito	Imai
JMA	Shin	Koyamatsu
JMA	Kouki	Mouri

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JMA	Yuuki	Saeki
JMA	Kazuki	Shimoji
JMA	Hiroshi	Suzue
JMA	Yoshiaki	Takeuchi
JMA	Kazutaka	Yamada
JMA	Yurika	Yamada
JMA	Yurika	Yamada
JMA	Yusuke	Yogo
JMA	Ryo	Yoshida
JMA	Shiro	Omori
KMA	Junghun	Choi
KMA	Dohyeong	Kim
KMA	Dohyeong	Kim
KMA	Okhee	Kim
KMA	Byung-il	Lee
KMA	Hyunjong	Oh
KMA	Hyunjong	Oh
KMA	Eunha	Sohn
NASA	Jack	Kaye
NASA	Maudood	Khan
NASA	Barry	Lefer
NICT	Tsutomu	Nagatsuma
NIER	Jaehoon	Jeong
NMSC	Juntea	Choi
NOAA	Jaime	Daniels
NOAA	Jordan	Gerth
NOAA	Mitch	Goldberg
NOAA	Andrew	Heidinger
NOAA	Satya	Kalluri
NOAA	Shobha	Kondragunta
NOAA	Mary Ann	Kutny
NOAA	Renata	Lana
NOAA	Jilian	Mayer
NOAA	Ajay	Mehta
NOAA	Jeff	Privette
NOAA	Kevin	Schrab
NOAA	Arlyn	Andrews
ROSHYDROMET/SRC Planeta	Konstantin	Litovchenko
ROSHYDROMET/SRC Planeta	Zoya	Andreeva
WMO	Guangxin	He
WMO	Kenneth	Holmlund

CGMS-49-Joint WGII-WGIII List of Participants		
Organisation	First name	Last name
WMO	Heikki	Pohjola

CGMS-49 -Joint WGI-WGIV-SWCG		
Organisation	First name	Last name
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CGMSSEC	Mikael	Rattenborg
CGMSSEC	Anne	Taube
CMA	Jianguang	Guo
CMA	Xiaowei	Jiang
CMA	Weixia	Lin
CMA	Peng	Wang
CMA	Lizi	Xie
CMA	Di	Xian
ESA	Juha-Pekka	Luntama
ESA	Ivan	Petitville
EUMETSAT	Sean	Burns
EUMETSAT	Nicholas	Coyne
EUMETSAT	Simon	Elliott
EUMETSAT	Andrew	Monham
EUMETSAT	Karolina	Nikolova
EUMETSAT	Klaus-Peter	Renner
EUMETSAT	Paolo	Ruti
EUMETSAT	Anders Meier	Soerensen
EUMETSAT	Michael	Williams
EUMETSAT	Markus	Dreis
IMD	Srinivasa Prasad	Vijapurapu
ISRO	Nitant	Dube
ISRO	Sankarasubramanian	Kasiviswanathan
ISRO	Jayaprakash V	Thomas
JAXA	Toshiyuki	Kurino
JMA	Kotaro	Bessho
JMA	Kenji	Date
JMA	Yasutaka	Hokase
JMA	Toshiyuki	Kitajima
JMA	Hiroki	Morita
JMA	Masami	Moriya
JMA	Takuya	Sakashita
JMA	Masaya	Takahashi
JMA	Yoshiaki	Takeuchi
JMA	Kazutaka	Yamada
JMA	Mikito	Yamamoto
JMA	Yusuke	Yogo
JMA	Ryo	Yoshida
KMA	Dohyeong	Kim
KMA	Jiyoung	Kim
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NASA	James	Spann
NICT	Mamoru	Ishii
NICT	Tsutomu	Nagatsuma
NICT	Kaori	Sakaguchi
NMSC	Junghun	Choi
NMSC	Xiaoru	Li
NOAA	Richard	Antoine
NOAA	Beau	Backus
NOAA	Natalia	Donoho
NOAA	Vanessa	Griffin
NOAA	James	McNitt
NOAA	Awdhesh	Sharma
NOAA	Elsayed	Talaat
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GENERAL CGMS INFORMATION

CGMS Agenda and Working Papers

The agenda and Working Papers (WPs) are available at:

https://www.cgms-info.org/Agendas/agendas/CGMS-49

List of actions and recommendations

The list of actions and recommendations are kept on the related plenary session web page (see e.g. https://www.cgms-info.org/index_.php/cgms/meeting-detail/cgms-49

CGMS members, observers and relevant actionees are requested to provide feedback as necessary to the CGMS Secretariat (CGMSSec@eumetsat.int), and when preparing Working Papers to refer to relevant actions and recommendations if needed.

CGMS List Servers

There are currently six CGMS list servers for plenary, WGs I-IV and SWCG respectively. Information on points of contact and list servers is available upon request from the CGMS Secretariat at CGMSSec@eumetsat.int.

CGMS Charter, members and observers

Other information such as the CGMS Charter and the current list of members and observers are available at http://www.cgms-info.org/index_.php/cgms/page?cat=ABOUT&page=INDEX.

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