REPORT OF THE 47TH PLENARY SESSION OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

CGMS-47
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PLENARY SESSION

1. OPENING SESSION

On behalf of the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), Prof. Vasily Asmus, Director of SRC Planeta, welcomed all participants to the 47th plenary session of CGMS in Sochi city, Russian Federation.

Prof. Asmus noted that the Asia-Oceania region is frequently and steadily more affected by natural disasters such as tropical cyclones, floods and volcanic activity, and satellite data have become increasingly important for the meteorological community.

In Russia, the government has approved the "Strategy for hydrometeorology and related fields for the period up to 2030 (including climate change issues)". According to this strategy, the Russian hydrometeorological space constellation shall consist of four types of satellites: three polar; one oceanographic; three geostationary; and two highly elliptical orbits to cover the Arctic region. For environmental monitoring purposes, it is planned to use data from the constellation of up to eight high-resolution satellites. Roshydromet uses the satellites to address the following objectives: operational hydrometeorology and geophysical monitoring, disaster mitigation services, climate change studies, environmental monitoring, and data collection from the observational network. The Roshydromet ground segment consists of three federal satellite centres: European, Siberian and Far-Eastern. These centres, with more than 40 satellite reception stations, provide full operational coverage of 1/5 of the total Earth's land surface, making this system the largest in Russia and one of the largest in the world in terms of the amount of satellite data received, the number of satellite-based products issued, and the number of users supported.

Prof. Asmus concluded by wishing the participants constructive dialogues, and a fruitful meeting leading to further development of multi-lateral coordination and cooperation across the entire meteorological satellite community in close interaction with its users.

2. APPROVAL OF AGENDA, ACTION REVIEW

2.1 Approval of the Agenda

The CGMS Secretariat presented the objectives of the plenary session and all participants approved the agenda.

2.2 Review of actions from CGMS-46

The CGMS Secretariat provided the status of the list of actions and recommendations resulting from the previous plenary (CGMS-46) with the indication that a few actions were still open pending CGMS-47 plenary discussions (see CGMS-47-CGMS-WP-21).

A summary list of plenary actions and recommendations following CGMS-47 discussions is available in Annex I of this report. This list will be updated regularly and be available on the CGMS website under MEETINGS and CGMS-47.

CGMS members are requested to provide regular feedback on the actions to the CGMS Secretariat (cgmssec@eumetsat.int).

3. USER MATTERS FOR COORDINATION WITH CGMS SPACE AGENCIES

3.1 WMO matters

WMO expressed its appreciation to ROSHYDROMET and the CGMS Secretariat for the excellent preparation and organisation of the present session of CGMS. WMO also thanked all CGMS members for their important work and their vital contributions to WMO, in particular to the implementation of the space-based component of the WMO Integrated Global Observing System (WIGOS).

3.1.1 WMO Space Programme status update

CGMS-47-WMO-WP-01: Update on WMO and WMO Space Programme status

WMO presented an update on recent activities at WMO relevant to the work of CGMS and on the status of the discussions on the WMO governance and constitutional body reform and the WMO Strategic Plan 2020-2030 and their impact on WMO Space Programme activities in view of the forthcoming 18th World Meteorological Congress (WMO Cg-18).

Regarding the governance reform, WMO recognises the need to continuously adapt to a rapidly changing world, driven by environmental degradation, resource constraints, increased competition, technological advances, and other forces. The goal for WMO is to remain fit-for-purpose and to enhance its agility and cost-effectiveness. The reform aims to coordinate systems of observation and data management, standardise observations and measurements, provide mechanisms for engaging with partners beyond the WMO community and harmonise services for decision-making and socio-economic benefits.

The WMO reform process is expected to yield a wide range of benefits for WMO members:

- Earth system approach: meteorology, climatology, hydrology, oceanography, seismology, volcanology, air quality, greenhouse gases;
- Multi-hazard and impact-based seamless services: weather, climate, water, aviation, marine, agriculture, urban, energy, health;
- Wide climate perspective: observations, services, science, mitigation and adaptation;
- Engagement of hydrological services in WMO activities and weather-water synergies;
- Organised and controlled engagement of the private sector in WMO activities;
- Optimal use of National Meteorological and Hydrological Services and Secretariat resources, thus providing more support for regional activities.

The WMO strategic planning for the period 2020–2023 covers two key components:

- The WMO Strategic Plan, which provides a high-level vision and overarching priorities of the future direction of WMO, articulated in long-term goals and strategic objectives with focused implementation areas for the next financial period 2020-23.
- The WMO Operating Plan, which presents outcomes in the form of benefits to members, outputs, activities and related performance indicators to address the global societal needs and achieve the strategic objectives.

Finally, the presentation reviewed the four draft resolutions related to the space-based observing system component for consideration by WMO members and the WMO Cg-18, as well as latest developments in the WMO Space Programme Office.

3.1.2 Vision for WIGOS component systems in 2040

CGMS-47-WMO-WP-02: Vision for WIGOS in 2040

WMO regularly reviews its vision of future global observing systems to support weather, climate and related environmental applications. Over the past four years, a new draft "Vision for WIGOS in 2040" has been in preparation, with the intent of submitting such a document to the WMO Cg-18 for approval. WMO has developed the new vision in consultation with a diverse community of both users and observing system developers and operators, including the space agencies, and CGMS has played an active role in its development.

The WMO Secretariat has submitted the current draft version 2.1 to WMO Cg-18 for discussion in June 2018, and now presents it to CGMS plenary for information.

WMO requested that CGMS space agencies consider incorporating the new 'WMO Vision for WIGOS in 2040' in the planning of their respective activities, based on the WMO gap analysis and the CGMS risk assessment.

The plenary requested WMO to report on the status of affairs at the next plenary session:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	3.1.2	A47.01	**On WIGOS Vision 2040:** WMO to report to CGMS-48 on activities undertaken to respond to the new WIGOS Vision 2040	CGMS-48

3.1.3 OSCAR/Space sustainability and long-term continuity

CGMS-47-WMO-WP-03: WMO OSCAR/Space: Maintenance and evolution

WMO stated that it is committed to maintaining and further developing the online OSCAR/Space tool.

Additional resources, beyond of what is already identified in WMO's regular budget, will however be required to do so.

Based on the resources that will become available for OSCAR/Space, WMO will select the best option for the sustainable maintenance and update of the OSCAR/Space database content and the further development/evolution of OSCAR/Space.

WMO summarised the options under consideration by WMO for ensuring the long-term sustainability of updating and maintaining the OSCAR/Space database and for further developing and evolving the OSCAR/Space functionality (which WGIII had previously discussed in detail).

There was an intervention by IOC regarding OSCAR/Space for the need to include the Essential Ocean Variables. WMO noted that OSCAR/Space is structured by satellite instruments and that ocean observation requirements are already included in the OSCAR/Requirements tool.

The WG III co-chair confirmed the importance of the OSCAR/Space tool for the CGMS Risk Assessment process, and noted that CGMS space agencies accept the responsibility to ensure that the OSCAR/Space database content is updated in a timely manner, whereas the maintenance of the overall OSCAR/Space system must be the responsibility of WMO.

3.1.4 WMO-related issues on climate architecture

CGMS-47-WMO-WP-04: WMO-related issues on climate architecture

In 2000, WMO initaited the development of an 'Architecture for climate monitoring from Space' which aimed to engage R&D space agencies in the same way as operational space agencies are engaged in weather monitoring.

This led to the adoption of Resolution 19 at the 16th WMO Congress (Cg-16) in 2011, which requested WMO to "to develop an architecture ... for climate monitoring as a component of the future WIGOS and GFCS, for consideration by Congress", as a "major initiative of the WMO Space Programme", and "in coordination with satellite operators, CEOS, CGMS, GCOS, GEO and WCRP".

On 6 February 2019, WMO held a workshop on the WMO role in the architecture for climate monitoring from space to review the status of the implementation thereof.

This led to the preparation of a draft resolution which will be submitted to the WMO Cg-18 in June 2019 in response to Resolution 19 (Cg-XVI), (see annex of CGMS-47-WMO-WP-04).

The Joint CEOS/CGMS Working Group on Climate (WGClimate) endorsed the draft resolution at its 10th meeting, CEOS acknowledged it at its 34th CEOS-SIT meeting, and the WMO working paper now presented the draft resolution for the attention of the CGMS-47 plenary.

Noting that no firm dates had been agreed yet for a Cg-18 side event on climate architecture, and the time required for mobilising international experts for such an event was running short, the CGMS Secretariat proposed to re-schedule the demonstration of the architecture for climate monitoring from

space in view of the many other priorities to be discussed at the WMO Cg-18. WMO reiterated its commitment to organise a side event most probably at the 72nd session of the Executive Council (EC-72) in 2020, whereas demonstration opportunities might be offered during WMO Cg-18.

The CGMS plenary acknowledged the draft resolution provided in the annex of the working paper and will maintain their efforts for the full implementation of the space-based climate observing system component in accordance with the Vision for WIGOS in 2040.

3.1.5 WMO Global Basic Observing Network – GBON

CGMS-47-WMO-WP-06: WMO Global Basic Observing Network (GBON)

International exchange of observational data is critical to applications such as global Numerical Weather Prediction (NWP) and climate reanalysis, which form the backbone of most products and services delivered by the National Meteorological and Hydrological Services (NMHSs) of the WMO members. In order to help ensure an adequate supply of observations to these systems, WMO proposes a new approach in which the basic surface-based observing network, that supports these applications, is designed, defined and monitored at the global level. WMO calls this network the Global Basic Observing Network, or GBON.

Design, implementation and management of the GBON will be specified in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160), section 3.2.2 Global Basic Observing System.

WMO bring the GBON development the attention of CGMS for two reasons:

(i) It reaffirms the vital importance of global NWP as a core application area and WMO's commitment to ensure a free and unrestricted access to all relevant observational data; and

(ii) There are areas on the globe where the GBON provisions cannot be met within a reasonable expenditure, due to geographical constraints, and WMO invites the CGMS agencies to take note of this and consider it in their planning of future space-based systems.

CGMS noted the importance of GBON and the need to identify ways for CGMS members to contribute to its implementation. In view of the obvious lack of observations over the oceans, the IOC representative emphasised the need for such observations. Currently, the priority of WMO is to enhance the sharing of observation data over land with focus on Numerical Weather Prediction (NWP) applications, given that NWP data is the basis for all other 13 WMO application areas. This focus has also been chosen to strengthen the wording of the updated provisions that WMO is proposing in its regulatory material to enhance the commitment of WMO members to share the data.

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	3.1.5	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	CGMS-48

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
			of such observations and possible improvements in the future and inclusion in the CGMS baseline document.	

3.2 Public-private engagement

3.2.1 WMO policy framework for public-private sector engagement

CGMS-47-WMO-WP-05: WMO policy framework for public-private sector engagement

Increasing demands from all parts of society for meteorological information and an increasing number of stakeholders with interest in generating and providing this information to various user communities have led to repeated calls for WMO to:

(i) issue guidance on the interaction between public and private sectors; and

(ii) review and update its data policies, in particular as articulated in Congress resolutions 40 (Cg-12), 25 (Cg-13) and 60 (Cg-17).

The working paper consists of two annexes, both for discussion at the WMO Cg-18 in June 2019. The first introduces the draft "Geneva Declaration" articulating a common framework of public-private sector engagement, while the second introduces the step being taken toward an overall review of WMO's data policies.

EUMETSAT noted that this may be an opportunity for CGMS members to adopt an approach similar to GBON (CGMS-47-WMO-WP-06) but for space data. Taking the same focus on NWP, EUMETSAT suggested that WMO could establish a reference list of satellite-based observations and products required by the global NWP centres. CGMS members could then discuss the reference list and assess the delivery of these sets of data to global NWP centres. If there are improvement proposals, CGMS members will discussed these. Once the reference list of observations and products is established, it could be added to the CGMS baseline, which represent the commitments of CGMS members to the WMO Vision for WIGOS 2040. NOAA endorsed that proposal, as it might support the planned activity by WMO to take a fresh look at WMO Resolution 40 on data sharing.

3.2.2 Update on the NOAA commercial weather data pilot (CWDP) project

CGMS-47-NOAA-WP-02: Status of NOAA's commercial engagement and Commercial Weather Data Pilot

NOAA seeks to leverage commercial capabilities and innovation with the aim to move to a more mission-effective, integrated, adaptable, and affordable portfolio of space-based observations. The Commercial Weather Data Pilot (CWDP) serves to demonstrate commercial data prior to their operational use in NOAA's products and services. NOAA has completed CWDP round 1 and is currently undertaking CWDP

round 2 to purchase and evaluate commercial radio occultation (RO) data. Pending results of round 2 and future budget appropriations, NOAA plans to initiate an operational purchase of RO data in FY 2020. NOAA will continue to consider additional types of commercial data and capabilities as part of its future space-based architecture.

The main findings of the CWDP round 1 were:

- The commercial sector was not able to provide the quality and quantity of RO data that NOAA requires for use in operational weather forecasting.
- Commercial RO systems show potential and, if progress continues, could serve in the future as complimentary sources to existing and future government systems.
- Outcomes warrant a second CWDP round focused on RO.

In line with these findings, NOAA initiated the CWDP round 2 in 2018. It includes additional operational considerations for RO data purchase. CGMS members have access to round 2 data for evaluation purposes but these data are not eligible for redistribution. As with other NOAA data, NOAA anticipates that the user organisation will coordinate the assessment with NOAA and that any proprietary information will be protected.

NOAA acknowledged that IROWG provided a valuable input to the CWDP.

The presentation concluded with a review of upcoming commercial engagement activities, including considerations on commercial capabilities as a potential part of future architectures and operational commercial RO data purchase.

CGMS plenary requested that WMO and NOAA continue to provide regular updates on the public private sector engagement to CGMS.

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
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	CGMS-48

3.3 IOC-UNESCO matters

3.3.1 IOC-UNESCO and the global ocean community

CGMS-47-IOC-UNESCO-WP-01: Satellite data requirements for the United Nations (UN) Decade of Ocean Science for Sustainable Development (2021-2030)

The "UN Decade of Ocean Science for Sustainable Development 2021-2030" intends to enhance the system of ocean observing systems at local, regional and global dimensions, known as the Global Ocean Observing System (Fischer et al., 2019). Societal applications include three UN instruments: Sendai

Framework on Disaster Risk Reduction, Agenda 2030 Sustainable Development Goals (SDG), and Paris Climate Agreement (PCA). The paper provides examples of the critically important role of satellite data in the successful implementation of research and services for forecasting hurricane intensification, storm surge, and tsunami inundation related to Sendai; ship routing forecasting and sea level trend related to PCA; and coastal ocean eutrophication related to SDG 14 known as "Life Below Water". Accurate ocean forecasts are a foundational element of progress of ocean science, technology and services for the UN Decade of Ocean Science for Sustainable Development. The paper demonstrates that generation of new knowledge and improved forecast/prediction skill will require sustained, high-spatial and temporal resolution satellite ocean observations for ocean exploration and scientific discovery and for initialisation and verification of forecast/prediction schemes.

IOC-UNESCO recommended the establishment of a joint CGMS-WMO-IOC (via JCOMM) coordination mechanism to mutually enhance CGMS weather and climate activities with the activities of the UN Decade for Ocean Science for Sustainable Development:

- Receive annual briefing on the UN Decade of Ocean Science for Sustainable Development;
- Sustain satellite and in situ system of ocean observing systems;
- Utilise geostationary meteorological satellites for ocean observations;
- Enhance data acquisition for special observing periods;
- Add CGMS-relevant ocean measurements to tsunami watch infrastructure; and
- Add HAB toxic aerosols to coastal air pollution forecasts.

CGMS noted that the future of JCOMM is presently under discussion and further details will be available after the WMO Cg-18, at which point the recommendation could be reconsidered.

Concluding the discussions, the plenary raised the following two actions:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO, IOC-UNESCO	3.3	A47.04	**On operational oceanography:** WMO and IOC-UNESCO to report to CGMS on their coordination following the WMO constituent body reform	CGMS-48
IOC-UNESCO	3.3	A47.05	**On operational oceanography:** IOC-UNESCO to provide to GCMS guidance on satellite data requirement for improved coastal ocean prediction and services	CGMS-48

4. REPORTS ON NEW DEVELOPMENTS AND PROGRAMMES BY MEMBERS SINCE CGMS-46

4.1 CMA

CGMS-47-CMA-WP-01: Reports on new developments and programmes by members since CGMS-46

China Meteorological Administration (CMA) is operating FENG YUN (or FY for acronym) geostationary and polar-orbiting satellite systems. The current FY operational sun-synchronous polar-orbiting fleet is composed of FY-3s, the Chinese second-generation LEO meteorological satellite series. The latest fly unit of FY-3 series, FY-3D, launched 15 Nov 2017, is in service since Jan 2019. Observational capability of FY-3D includes VIS, IR and MV imaging, IR and MV atmospheric sounding, greenhouse gas detection, radio occultation sounding, and space weather monitoring. Core instruments on FY-3D are MERSI (Medium Resolution Spectral Imager) for monitoring environment with main products of ocean color, vegetation indexes, and so on and so forth; MWHS (Micro-Wave Humidity Sounder) and MWTS (Micro-Wave Temperature Sounder) for atmosphere sounding, and HIRAS (Hyperspectral Infrared Atmospheric Sounder) for IR atmosphere sounding, and MWRI (Micro-Wave Radiation Imager) for microwave characteristic of ground surface. The observational data is provided to users through FY-3 Direct Broadcast (DB) service with X-band AHRPT data format. According to program, CMA will deploy FY-3E to an early morning orbit. Launch of FY-3E is planned for the end of 2020.

The CMA operational geostationary satellite observation is supported by FY-2 series. FY-2F/2G/2H are positioned at 112°E, 99.5°E, and 79°E, respectively. FY-2 satellite transmits 5-channel S-VISSR imagery. And FY-2E which located at 86.5°E was out of service since Jan. 2019. CMA is developing the second generation geostationary series FY-4, the first unit, FY-4A, is in service since May.1 2018 and currently located at 105°E (nominal). It's a three-axis stabilized platform carrying AGRI (Advanced Geo Radiation Imager), GIIRS (Geo Interferometric Infrared Sounder), LMI (Lightning Mapping Imager), and SEP (Space Weather Package). FY-4A transmits LRIT & HRIT format data and is capable of Data Collection Service(DCS).

4.2 EUMETSAT

CGMS-47-EUMETSAT-WP-01: EUMETSAT development and plans since CGMS-46

EUMETSAT currently exploits eleven satellites of which eight are EUMETSAT's own (Meteosat-8 to -11 and Metop-A to -C) with the remaining three in partnership (Sentinel-3A/-3B and Jason-2/-3 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. 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).

The Metop-A (secondary) and -B satellites (primary) continue to provide the LEO services with Metop-C successfully launched in October 2018. Both Metop satellites continue to perform well, although signs of ageing are present on some instruments on Metop-A. A detailed Metop-A revised lifetime extension scenario is now in place. EUMETSAT member states will decide in the autumn 2019 on the related priorities.

EUMETSAT continues to support the Jason-3 mission with product distribution.

Regarding future satellites:

The development continues for the Meteosat Third Generation (MTG) satellite system with the operational exploitation expected for the 2021-2042 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, water vapour, profiles for every 30 minutes over Europe) in synergy with the Copernicus Sentinel-4 mission. MTG-I and MTG-S are now planned for launch in 2021 and 2023.

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 2022-2040 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, planned for launch in 2022, and
- Metop-SG B: a microwave imaging mission, planned for launch in 2023.

There will be three successive pairs of satellites with 21 years of operations in the period 2022-2043.

EUMETSAT is developing the ground segment for the Jason-CS/Sentinel-6 programme, which includes two satellites that will ensure continuity of the reference ocean altimetry after Jason-3. The launch of the first Jason-CS satellite is planned for November 2020.

EUMETSAT addressed CO_2 monitoring observations with the need for space-, air-, and in-situ observations together with modelling requirements. EUMETSAT uses Metop's IASI to monitor CH_4 and CO.

Preparations are ongoing in EUMETSAT for the evolution of data access and cloud infrastructure.

4.3 JMA

CGMS-47-JMA-WP-01: JMA report on the status of current and future satellite systems

JMA operates two geostationary meteorological satellites, Himawari-8 and -9, equipped with the Advanced Himawari Imager (AHI). Himawari-9 will supersede Himawari-8, operational since July 2015, in the 2022 timeframe.

In January 2018, JMA launched a new international service, HimawariRequest, in collaboration with the Bureau of Meteorology in Australia. The service allows NMHS users in Himawari-8/-9 coverage area to request the AHI's target area observation covering an area of 1,000 km x 1,000 km every 2.5 minutes. Eighteen NMHSs in the WMO RA II and RA V regions have registered to date, and there has been 18 international requests to monitor tropical cyclones, bush fires, volcanic eruptions etc.. In response to CGMS plenary recommendation R46.12, CMA, JMA and KMA launched a common portal resource on the RA II WIGOS project website for the sake of the users at:

https://www.jma.go.jp/jma/jmaeng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html#request

JMA provided information on past, current and planned observation schedules for target-area observations, including that conducted under the HimawariRequest service.

In the JFY 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.

4.4 KMA

CGMS-47-KMA-WP-01: KMA Report on the status of current and future satellite

COMS (128.2°E) MI is currently operational and KMA distributes the data via landline and satellite over the western Pacific region and COMS GOCI over the East Asian region.

GEO-KOMPSAT-2A (meteorological mission; AMI and KSEM) launched on 4 December 2018, is currently in the commissioning phase and is expected to be declared operational around mid-July 2019.

GEO-KOMPSAT-2B (ocean and environmental mission; GOCI-II and GEMS) is scheduled for launch in the first half of 2020.

*COMS: Communication, Ocean and Meteorological Satellite
*AMI: Advanced Meteorological Imager
*KSEM: Korean Space wEather Monitor
*GOCI: Geostationary Ocean Colour Imager
*GEMS: Geostationary Environment Monitoring Spectrometer

4.5 NOAA

CGMS-47-NOAA-WP-01: NOAA Report on the Status of Current and Future Satellites

NOAA provided an update on its current and future plans including COSMIC-2, GOES-17, and NOAA-20. COSMIC-2 is scheduled for launch later in 2019 and will be critical to supporting the radio occultation observation needs for users. In February, NOAA declared GOES-17 operational. NOAA also discussed the benefit of GEO-LEO applications including for the CGMS flood-mapping pilot project. NOAA shared an update on their future architecture studies that are currently in process.

4.6 ROSHYDROMET/ROSCOSMOS

CGMS-47-joint-ROSCOSMOS/ROSHYDROMET-WP-01: Report on the status of current and future Russian satellite systems

According to the Russian Federal Space Programme (2016-2025) the space system for hydrometeorological and environmental monitoring will consist of four polar-orbiting meteorological satellites, three geostationary meteorological satellites and at least two highly elliptical orbit satellites. Currently, two meteorological satellites are operational: Meteor-M N2 (launched in 2014) and Electro-L N2 (launched in 2015).

Meteor-M N2-2 is scheduled for launch on 5 July 2019 and will be positioned on an afternoon orbit, with Meteor-M N2-3 to follow in 2020. ROSHYDROMET plans to launch a constellation of similar satellites hosting the same payloads. The payload for Meteor N2-3 and N2-4 will contain a MeteoSAR and a modified heliogeophysical measurements suite, GGAK-M2.

Electro-L N3, scheduled for launch in December 2019, will complement the geostationary constellation. The payload will be similar to the Electro-L N1 and -N2 spacecraft.

Development of the unique HEO constellation of Arctica-M series satellites is now under development. It will provide observations over the Arctic region. There will be at least two HEO satellites on a Molnya-type orbit. The payload of Arctica-M series satellites is similar to the one of Electro-L geostationary satellites with a first launch planned in 2020.

4.7 IMD/ISRO

CGMS-47-IMD-WP-01: IMD Agency Report

At present, two INSAT meteorological satellites are in operation, INSAT-3D and INSAT-3DR. INSAT-3D is India's advanced weather satellite located at 82°E and was launched on 26 July 2013 from Kourou, French Guiana and INSAT-3DR was launched on 8 September 2016 from SDSC SHAR, Sriharikota using GSLV-F05 and positioned at 74°E. They are dedicated meteorological satellites and carries four payloads: imager (six channels), sounder (19 channels), Data Relay Transponder (DRT) and satellite aided search and rescue (SAS & R). The DRT payload of INSAT-3DR has 300 kHz bandwidth to support a higher number of unattended meteorological platforms (AWS) of the stations network while INSAT-3D DRT payload have 200 kHz bandwidth. INSAT-3D/-3DR have the capability of providing vertical profiles of temperature and humidity, along with several products similar to Kalpana-1 and INSAT-3A but with increased resolution.

ISRO uses the imager payloads of INSAT-3D/-3DR in a staggered mode to achieve 15-minute temporal resolution for achieving cloud imaging. ISRO has also implemented an integrated scan strategy of the sounder payload of the INSAT-3D/-3DR satellites to provide data of the Indian region on an hourly basis and the ocean region every 1.5 hours. Standard Operating Procedure (SOP) has been finalised by ISRO and IMD for conducting the rapid scan from the INSAT-3DR imager payload with successfully operated rapid scans during four tropical cyclones namely: VSCS Luban, VSCS Titli, VSCS Gaja and Fani. Each rapid scan cover 3 degrees in N-S direction (6 Blocks/234 scan lines) in 4.5 minutes. The rapid scan data has been used to track these cyclones on a near real-time basis.

India assimilates the satellite data in numerical weather prediction models and the outputs are further used to issue short range and medium range weather forecast. T-phi grams at district level for 709 locations are generated using INSAT-3D sounder data for nowcasting. India generate cloud products such as CTT, CTP, cloud fraction, clear-sky-BT from the imager payload and assimilate these in NWP models. ISRO SAC, Ahmedabad, update the calibration coefficients in the processing chain of the IMDPS system, on a monthly basis using GSICS corrections from the last 30 days.

IMD uses satellite data and products by issuing a satellite bulletin every three hours. Cyclone monitoring is made by using the Dvorak technique. IMD also validates some INSAT-3D products such as OLR, SST, wind and

rainfall products on a regular basis. They have noticed improvements in the product accuracy after applying GSICS corrections in the operational processing chain. There is a new webpage (http://satmet.imd.gov.in/insat3d.htm) designed with user name and password protection by making provision to view the last 24 hours' channel and product images along with selectable animation utility and product description similar to other satellite operators. The online archive of satellite images for the past six months is available at http://satellite.imd.gov.in/archive/. A web-based tool named "RAPID" for analysing the satellite data and products can be viewed at http://www.rapid.imd.gov.in and the related user manual is available at http://satellite.imd.gov.in/desc/RAPID_User_Guide.pdf. IMD has also carried out a study for using RAPID and RGB imageries for nowcasting and identification of weather phenomena by identifying their threshold values.

Recently, IMD has developed a tool to visualise the existing lighting network data superimposed on satellite and radar images on a near real-time basis for nowcasting thunderstorm events.

IMD disseminates Scatsat-1 wind data and radio-occultation data from the ROSA payload of Megha-Tropiques on the GTS. IMD is also contributing to the WMO's DBNet group by providing direct broadcast of NOAA and Metop data from Chennai receiving stations. IMD has plans to establish a Cal/Val site for INSAT-3D, and subsequent satellites, at a suitable location in India. Indian scientists have undertaken three field campaigns so far. IMD also joined the SCOPE-CM-06 IOGEO team for calibrating its old archived satellite data from the past 30 years. IMD currently works on two calibration and validation activities:

- IOGEO project with Kalpana-1/INSAT-3D [IMD-EUMETSAT].
- Lunar calibration using INSAT-3D/-3DR [IMD-EUMETSAT].

A network of 25 GNSS stations for measurements of Integrated Precipitable Water Vapour (IPWV) became operational in 2016 and the data is available at http://gnss.imd.gov.in/TrimblePivotWeb/. Furthermore, the implementation of Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS) at IMD is in its final stage. The system will be used to receive, process and disseminate meteorological data from INSAT-3D, INSAT-3DR and INSAT-3DS satellites. This system will have the following advantages compared to the present processing system (IMDPS): MMDRPS will have a very high-end processing system which will cut down the processing time from currently 15 minutes to 5 minutes, MMDRPS will have a storage capacity of the order of 320 Tb flash drive and 2PB Netapp storage which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy. MMRDPS will be commissioned in July 2019.

India will launch INSAT-3DS, the third exclusive meteorological satellite of this series, by 2022 and the first hyperspectral satellite GISAT-1 by 2019.

CGMS-47- ISRO-WP-01: ISRO report on status of present and future satellites

ISRO is presently operating INSAT-3D and INSAT-3DR from geostationary orbit that carry similar types of instruments. They are positioned at 84°E and 74°E and provide observations every 30 minutes, in a 15-minute staggered mode (for further details, see CGMS-47-IMD-WP-01). ISRO also operates Oceansat-2 and SCATSAT satellites from polar orbits. In addition to these missions, Megha-Tropiques and SARAL-AltiKa are operated in

collaboration with CNES. A number of products from INSAT-3D/-3DR are presently operational and being provided to users on a near real-time basis. Recently a number of new operational imager products – like cloud top temperature and pressure, clear sky radiances and total water vapour available to the users. The SCATSAT mission provides valuable measurements of ocean surface winds from a Ku-band scatterometer. More recently, ISRO performs slice balancing at footprint, resulting in more stable radar back scattering measurements across scan, and has improved the wind measurements. Further, ISRO applies a Bayesian approach to the rain correction to the wind speed and it is operationally implemented in the latest version of the product. Several L3 and L4 SCATSAT products are also included and a listing of which is provided in the presentation. Though the Oceansat-2 scatterometer (OSCAT) is no longer operational, the reprocessing of the archived data is made with the SCATSAT algorithm which resulted in significant improvements in the sigma0 and wind measurement accuracy. Megha-Tropiques, a joint ISRO-CNES mission, has experienced some anomaly due to malfunctioning of the media system. ISRO and CNES agreed on a solution to acquire only every third orbit data, and hence now about 5-6 orbits/day are available from all the sensors (except MADRAS). The other ISRO-CNES mission, SARAL-AltiKa has recently gone into drifting orbit and is experiencing a pointing error, which resulted into its limited use.

In the near future, ISRO has lined up new missions in LEO, like Oceansat-3 and -3A with a wind scatterometer; ocean colour monitor (OCM) and an SST monitor (SSTM); RISAT-1A with a SAR system; TRISHNA with high resolution TIR, SWIR and VNIR channels; and NISAR in collaboration with NASA with an advanced SAR system. There are also new GEO systems such as INSAT-3DS that is similar to INSAT-3D/-3DR and GISAT with hyperspectral channels in VNIR and SWIR bands. There are many other missions, which are currently in the planning stage. ISRO provides meteorological and ocean data to the users and collaborative institutions through its portal, MOSDAC. MOSDAC not only hosts the satellite data but also provides various meteorological and ocean services and value-added products.

4.8 ESA

CGMS-47-ESA-WP-01: Latest status and developments at ESA since CGMS-46

ESA has 15 Earth observation missions currently flying and another 25 in development, covering three main areas: Science (Earth explorers), Copernicus, and meteorology. Recent successes are the launch of Copernicus Sentinel-3B in April 2018, Earth explorer Aeolus in August 2018, and Metop-C in November 2018.

Four Earth explorers are currently operational: SMOS, Cryosat, Swarm and Aeolus. As a result of their high scientific value and continuing good performance, operations of the Cryosat and SMOS Earth explorer missions have recently been extended until 2021. Three Earth explorers are under Phase B/C/D development: EarthCARE (jointly with JAXA), Biomass and FLEX, with EarthCARE launch planned in 2022. Selection between two candidate missions, FORUM and SKIM (currently under Phase A development and to fly as the ninth Earth explorer), will take place at a user consultation in Cambridge, UK, in July. Phase 0/A studies on three candidate missions for the 10th Earth explorer (STEREOID, G-CLASS:H2O, Daedalus) are in progress.

Seven ESA-developed satellites are currently operating under the Copernicus space component: Sentinel-1A/-1B, Sentinel-2A/-2B, Sentinel-3A/-3B, and Sentinel-5P. These missions provide free and open data to more than 215,000 registered users, at a rate of 150 Tbytes per day, and importantly serve much of the data needs of the six EU Copernicus services. Further launches of Sentinels-4, -5 and -6 are planned from 2020 onwards, as well as C and D units of Sentinels-1, 2 and 3 from 2022 onwards. During the ESA Space19+ Council Meeting at ministerial level in November, the 4th slice of the Copernicus Space Component (CSC-4) will be proposed to member states. The CSC-4 proposal consists of Phases B/C/D/E development of six new High Priority Candidate Missions (HPCM; "Sentinels expansion"), as well as Phase 0/A development of the enhanced next generation of the existing six Sentinel missions. The HPCMs include missions for CO_2 monitoring, land surface temperature, imaging microwave radiometer, polar ice and snow topography, hyperspectral imaging, and L-band SAR.

Finally, ESA reported on the status of the EarthWatch Global Monitoring of Essential Climate Variables (ECVs) also known as the ESA Climate Change Initiative (CCI). In 2018, the CCI has initiated contracts to begin work developing climate data records (CDRs) responding to GCOS requirements for nine new ECVs, and in 2019 a further 14 contracts were placed to continue R&D on 13 ECVs already addressed by CCI since 2010. CDRs from these 13 CCI ECVs have successfully transferred to operational production under the EU's Copernicus Climate Change Service. Several CCI ECV projects are conducted in partnership with EUMETSAT's Satellite Application Facilities, e.g. cloud, water vapour, sea ice, soil moisture and land surface temperature. The CCI is internationally coordinated via the joint CEOS-CGMS Working Group on Climate (WGClimate).

4.9 JAXA

CGMS-47-JAXA-WP-01: JAXA report on the status of current and future Earth observation program

JAXA presented the status of current and future relevant satellite programmes of its Earth Observation Programme. Current operational satellites include CGOM-C, GOSAT, GOSAT-2, GCOM-W, GPM and ALOS-2. JAXA presented its activities in support to climate monitoring and monitoring of greenhouse gases.

Future JAXA satellites include ALOS-3, ALOS-4, EarthCare and the GOSAT-2 follow-on mission, which will manifest the AMSR3 passive microwave radiometer. JAXA also presented the close collaboration with JMA for development of a regional integrated precipitation product based on both space- and ground-based observations and for improving Aerosol Forecasting.

4.10 NASA

CGMS-46-NASA-WP-01: NASA report on the status of current and future Earth satellite systems

NASA currently supports the operations of 23 Earth science missions. Since CGMS-46, NASA's Earth Science programme launched the Ice, Cloud, and Land Elevation (ICESat-2) satellite, two instruments to the International Space Station (ISS) including the ECOsystem Spaceborne Thermal Radiometer Experiment (ECOSTRESS) and the Global Ecosystems Dynamics Investigation (GEDI), and one CubeSat for research technology demonstration (Compact Spectral Irradiance Monitor). The Earth Science programme also prepared an additional instrument, the Orbiting Carbon Observatory-3 (OCO-3), successfully

launched on 4 May 2019 docking on the International Space Station (ISS). During this time, significant effort was put into the early operations of the US-German Gravity Recovery and Climate Experiment FollowOn (GRACE-FO) satellites launched on 22 May 2018. The CALIPSO satellite exited the A-Train in September 2018 and now orbits in close proximity to CloudSat. Together they now constitute what is called the "C-Train." Finally, the QuikScat satellite completed its service in October 2018 after 19 years of operations.

Although all NASA operated missions discussed in this report are research missions, the efficiency of the communications and ground data handling systems has supported operational and near-real-time applications. NASA has also continued to support the development and deployment of direct operational application Earth sensing missions with the Landsat series for the USGS and the GOES and JPSS series for NOAA.

NASA's Earth Science Division is implementing a balanced and robust plan to accomplish a broad set of critical Earth observation measurements from space for advancing Earth sensing science research. The programme advances knowledge of the integrated Earth system, the global atmosphere, oceans (including sea ice), land surfaces, ecosystems, and interactions between all elements, including the impacts of humans. A balance of satellite measurements, science research, technology development and applications are all needed to address and observe a complex global Earth system. NASA plans to launch nine missions and five instruments (on host missions) in the future, along with two additional CubeSats from its technology programme.

In the last year, the National Academies of Science, Engineering, and Medicine released the updated final version of their decadal survey for "Earth Sciences, Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space". NASA's Earth Science Division has already been in the process of responding to the survey, including the initiation of study plans for the designated observables called for in the report and releasing an announcement of opportunity for the first Earth Venture-Continuity mission, which is focused on Earth radiation budget measurements.

5. WORKING GROUP REPORTS

5.1 Satellite systems and operations – report WGI

PPT **CGMS-47-WGI-WP-01: Outcome and recommendations resulting from WGI discussions**

Vanessa Griffin, chairperson of WGI, presented the outcome of the discussions held in WGI, which included two new items related to space situational awareness and global coordination on handling of future large data volumes, as well as the items WGI recommended for plenary endorsement.

Since Sergey Uspensky, ROSHYDROMET, had stepped down as WGI co-chair prior to the meeting, CGMS plenary raised an action on CGMS members to nominate a WGI co-chair:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	5.1	A47.06	CGMS members to propose a WGI co-chair by Q2 2019	June 2019

The WGI discussions focused on seven topics:

1. Frequency management matters
2. Meteorological satellites space to ground interface (direct readout) and LHRIT global specification (CCSDS based) and best practices for direct readout processing
3. Data collection systems
4. System and operations aspects
5. Space weather data (WGI-SWCG joint session)
6. Implementation of WGI aspects of the global contingency plan
7. Global coordination on handling future large data volumes and associated data circulation

On frequency management matters: WGI received a report from the CGMS/SFCG Liaison Officer on the discussions and outcomes of SFCG-38 (22-30 August 2018). The paper highlighted frequency matters of mutual interest to all CGMS members including issues and concerns involving agenda items at the 2019 and 2023 World Radio Conferences. EUMETSAT provided an overview of the WRC-19 preparations including discussion of the protection of the 24GHz passive microwave band from out-of-band interference from potential 5G systems. NOAA provided updates on their spectrum use changes and issues. NOAA highlighted some small changes in spectrum use and orbital alignment of future satellites and also discussed the passive microwave issues. WGI recommended that all CGMS members work with their representatives to the WRC-19 to discuss the issues around the 24 GZ passive band as well as protection of higher frequency passive bands.

On direct readout: WGI continued work to refine the CGMS agency best practices in support to local and regional processing of LEO direct broadcast data. ~~EUMETSAT discussed the intersessional activity in refining the best practices including provision of a "change" record for the best practices document. There were agency reports from KMA, EUMETSAT, NOAA and CMA on their direct broadcast service including their status of implementation of the CGMS best practices.~~ WGI received a report on progress in NetCDF conventions for climate and forecast regarding space-related instruments. In response, EUMETSAT proposed incorporation of a new best practice on encoding NetCDF data products in satellite viewing geometry.

On data collection systems: WGI received a report from the DCS subgroup~~which was proposed at CGMS46~~. ~~The subgroup has been meeting virtually via intercessional sessions as well as in face-to-face meetings.~~ Subgroup activity included drafting of a DCS Handbook, a CGMS Best Practice for DCP Certification, and a CGMS Best Practice for DCP data access along with discussions of the Enhanced DCP (E-DCP) standard. WGI endorsed the activities and plans by the subgroup, including the further development of a new International DCP standard and a Best Practice on a DCP Data Format. NOAA provided an overview of an opportunity identified as a possible risk mitigation factor for protecting the DCS spectrum in the 401-402 MHz band by enabling small satellites to interface with the GOES DCS receiver during launch, early orbit, and anomaly operations.

On system and operations aspects: ISRO presented an overview of their Multi Mission Meteorological Data Receiving and Processing System (MMDRPS) designed to receive and process the high volumes of data from their new satellites.

WGI and SWCG joint session on space weather data: NICT provided a survey report on their use of space weather data. Based on questionnaire surveys and interviews to space weather users in Japan, several user needs for space weather data were collected. EUMETSAT provided a paper on the expected value to CGMS satellite operators of Space Weather forecast data. The paper discussed the rationale for a space weather anomaly database. ESA provided a paper on their space situational awareness services they provide to satellite operators. WGI held initial discussions related to space debris and collision avoidance. EUMETSAT and NOAA gave presentations on their collision avoidance processes and lessons learned. WGI decided that a Best Practice on Collision Avoidance practices should be prepared for endorsement at CGMS-48 that would provide guidance for other CGMS members. The WGI agreed to form two task groups, one to look at development of space weather anomaly database and the second to propose best practices for space debris and collision avoidance.

On the global contingency plan: WGIII provided a briefing on the global contingency plan and the CGMS Risk Assessment plan. EUMETSAT led a discussion of the need to coordinate the orbit maintenance strategy for multiple satellites in the same low Earth orbits to reduce pass scheduling conflicts. WGI assigned an actions for EUMETSAT to report back on the continued the detailed analysis and to the WG to consider development of a best practice for orbital phasing between satellites.

On large data volumes: ~~This was one of the new topics for WGI in the TOR approved at CGMS46. This CGMS meeting was the first discussion of the topic.~~ NOAA provided an overview of the changes they made in order to support the high volumes of data available from the GOES-R and JPSS satellites. The WG welcomed the paper and encouraged the other agencies to provide similar papers at CGMS-48

In concluding the session, CGMS plenary noted the activities and endorsed the actions and recommendations raised within the framework of Working Group I.

5.2 Support for end users – report WGIV

CGMS-47-WGIV-WP-01: Outcome and recommendations resulting from WGIV discussions

Since Hiroshi Kunimatsu, JMA, had stepped down as WGIV co-chair in April 2019, CGMS plenary endorsed the proposal of working group IV for Kotaro Bessho, JMA, to take on the co-chairmanship.

The WGIV report focused on:

- Big data and cloud services;
- Cyber security;
- Metadata implementation; and
- User readiness for new generation satellites.

On big data and cloud services: JMA and KMA addressed the status of the ongoing user-provider dialogue in WMO RA II and RA V. The RAII WIGOS project demonstrates a good example of best use of satellite data information. In particular, a survey on the use of satellite data led to immediate reaction by JMA to enhance GSMaP data access for the Asia-Pacific countries, including the provision of sea surface AMVs retrieved from Himawari-8.

In the context of global or inter-regional data circulation and access systems, CMA, KMA and Roshydromet presented the further evolution of their respective data access methods. NOAA presented an ongoing project changing the access to open data significantly by using cloud providers and other collaboration partners. Cloud services are becoming a standard service for part of the data access methods with the potential of replacing most of the legacy methods in the future.

WGIV agreed to form a CGMS expert group to address cloud services interoperability, for further discussion in the upcoming inter-sessional meetings. With reference to the WMO WIS 2.0, WMO gave guidance to CGMS space agencies on how to contribute to its implementation, such as participation with demonstration projects and exploring several of the WIS 2.0 principles.

On cyber security: WGIV agreed that an interaction with experts in cyber security is necessary with the goal to share experience, develop best practices and to look at training aspects of cyber security. WGIV will address this matter further in inter-sessional meetings as well as at CGMS-48.

WGI noted that the CEOS LTDP guidelines are fully applicable to CGMS agency data, and agreed to adopt these guidelines for regular review.

On metadata implementation: Since CGMS-46, the Task Force on Metadata Implementation (TFMI) has reviewed the WIGOS metadata standard, the DBNet metadata, and created WIS metadata records for satellite data products. TFMI produced a set of recommendations accordingly, and defined the Task Force working plan for finalising the WIGOS standard assessment (WIGOS Metadata Representation Format).

On user readiness: The NOAA mission-related user readiness work on GOES-R Series and NOAA-20 demonstrated the application of CGMS best practices.

VLab contributed with a progress report and the proposal for the revised 5-year training strategy, and WGIV recommended adding space weather training to the VLab training strategy.

In concluding the session, CGMS plenary endorsed:

- the recommendations available from CGMS-TFMI WIGOS-Standard-Review (ref. CGMS-47-CGMS-WP-07);
- the work plan regarding the assessment of the WIGOS Metadata Representation Format allowing the task force to proceed on the defined tasks; and
- the five-year strategy document proposed by VLab.

CGMS plenary further endorsed the actions and recommendations raised within the framework of Working Group IV and raised a plenary action on members to address cloud services:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	5.2	A47.07	CGMS agencies to analyse if existing cloud service activities can serve as a demonstration project, exploring at least two of the WMO Information Systems (WIS 2.0) principles. (Initially discussed in WGIV/8)	Dec 2019

5.3 Operational continuity and contingency planning – report WGIII

Ajay Mehta, Co-chair of WGIII, presented the outcome of the discussions held in WGIII and the items WGIII recommended for plenary endorsement.

Following an action from CGMS-46, WGIII had reviewed and now proposed a revised WGIII Terms of Reference (ToR), CGMS-47-WGIII-WP-07, taking into account the CGMS baseline and risk assessment process. CGMS plenary endorsed the new ToR as recommended by WGIII.

WGIII presented the results from the first CGMS risk assessment (CGMS-47-CGMS-WP-13WGIIIa) conducted against the new CGMS baseline. The objective was to convey CGMS's posture with respect to its baseline commitment (satellite programmes and observations) and provide a high-level assessment designed to allow members to assess the current contribution to the user community as well as coordinate future planning to meet current and future baseline commitments. WGIII presented the overall results from the CGMS risk assessment, which showed a relatively healthy constellation. WGIII did recognise the possibility of some gaps and presented CGMS plenary with 12 mitigating actions to ensure continuity of the CGMS baseline. The CGMS plenary endorsed these actions and looked forward to receiving an updated assessment at CGMS-48.

WGIII concluded its report with the results of the other discussions in WGIII. It provided an update on the WMO presentations on WIGOS 2040 and OSCAR/Space database. ISRO, CMA, IMD, ROSCOSMOS, ROSHYDROMET, JAXA, and KARI provided updates on their future satellite planning. Finally, the Socio-Economic Benefit Task Team provided an update on recent activities.

5.4 Space Weather Coordination – report SWCG

PPT **CGMS-47-GUEST-WP-03: Need for an operational data exchange in support of ICAO SWxC**

The presentation informed the SWCG on the efforts by the International Civil Aviation Organization (ICAO) to establish a *space weather information service* for the provision of related information and its inclusion in Annex 3 to the ICAO Convention, *Meteorological Service for International Air Navigation,* in November 2018.

The presentation provides background information concerning the process of development of the requirements for information on space weather phenomena (solar radiation storms, solar flares,

geomagnetic storms and ionospheric disturbances) which pose a risk to flight safety, impacting communication, navigation systems, on board avionics as well as to the health of aircraft occupants.

It also describes the process including a schedule for the designation of space weather information providers including criteria (institutional, operational, technical and communication/dissemination of information) to be taken into account in the selection process. In this regard, the presentation provides an overview of the ICAO process through the different ICAO expert and governing bodies, including the WMO assistance, which led to the designation of three global space weather information service providers and two regional centres.

Mr. Raul Romero presented the objectives and requirements for the provision of space weather data services to aviation and the process used to select the providers. In November 2018, ICAO selected the PECASUS (led by FMI) consortium, and the United States to serve as global space weather information service providers, starting November 2019. Two regional centres will be established by November 2022, comprising the China/Russian Federation consortium and South Africa, noting the interest expressed by China and the Russian Federation to serve together as a global centre. A review of the global and regional implementation and cost of service is planned for 2022, and reassessment of the optimal number of service providers by 2027. ICAO is confident that the implementation of the space weather information service will be a significant contribution to the achievement of the safety level needed by civil aviation, especially in light of the remarkable traffic growth that is forecasted.

Finally, the presentation provides information regarding the necessary coordination and governance between designated global and regional centres currently underway to ensure the provision of consistent space weather information towards the implementation of the global service by 7 November 2019.

The CGMSSEC Chair (Mr. Alain Ratier) expressed his appreciation for the clear presentation and requested what level of data exchange is taking place between the various providers. Mr. Romero replied that data exchange is vital for the system and regular interactions are taking place by teleconference, and face-to-face meetings.

Mr. Ratier further enquired whether there is an explicit expectation from the providers of space weather data for the CGMS. Mr. Romero replied that the satellite information is crucial for the system and each provider relies on this to complement other sources of data.

CGMS-47-SWCG-WP-04: Outcome and recommendations resulting from SWCG discussions

Following the SWCG report by the SWCG co-chair, Dr. Nagatsuma, Dr. Holmlund (EUMETSAT) added that the SWCG also discussed working papers based on requirements for space weather data based on an initial assessment of the service providers PECASUS and SWPC. This feedback helps ensuring that the elements are in place for the content of the inter-calibration “White Paper” and the resulting interaction with GSICS. It is proposed that two or three pilot projects will be identified for implementation as a result. Dr. Volz (NOAA) noted that it is important that users do not specify new in-orbit instrumentation, but rather concentrate on the data types and products they require, which can then be assessed by the CGMS member agencies for any new implementation requirements. Dr. Holmlund confirmed that the intention

is indeed to focus on the users' data and product needs, with pilot project proposals looking to solve reported problems with existing data availability and quality. An example of this raised in the SWCG was the Proba-2 satellite space weather data availability which has potential to be improved, but would require further investment. Dr. Talaat also pointed out that a survey has already been issued to space weather data providers and that a second survey will be issued to users, taking into the results from the first survey, which will identify the gaps and allow the identification of mitigating actions, based on existing in-orbit assets.

5.5 Satellite Data and Products (WGII)

CGMS-47-WGII-WP-02: Outcome and recommendations resulting from WGII discussions

WG II addressed the outcome of its discussions, highlighting the following items to plenary:

- International Science Working Groups (IWWG, ITOV, ICWG, IROWG, IPWG). WG II serves as an important link between CGMS and the five CGMS International Science Working Groups (ISWGs);

- Other international initiatives such as SCOPE-CM, SCOPE-Nowcasting, GSICS, VLab, WGClimate, …; and

- Xxxx.

WG II discussed the activities of the various ISWGs and other international initiatives. Two of the five ISWGs, namely the International Cloud Working Group (ICWG) and the International Precipitation Working Group (IPWG), had met since CGMS-46 whose outcomes would be presented later to the CGMS Plenary. The meetings, attended by both satellite research and operation communities, as well as end users, concluded with a number of recommendations to the CGMS Plenary for advancing the value of the space-based observing system, including a large number of actions and recommendations to be followed-up by the ISWGs and WG II. ICWG will hold its next meeting on 24-28 August 2020, in Darmstadt, Germany.

The other three ISWGs (International TOVS Working Group (ITWG), International Radio-occultation Working Group (IROWG) and International Winds Working Group (IWWG)), will hold their next meetings as follows: ITWG on 31 October to 6 November 2019 in Quebec, Canada; IROWG from 19-25 September 2019 in Elsinore, Denmark; and IWWG from 20-25 April 2020, in De Bilt, The Netherlands.

Regarding GSICS, WGClimate, SCOPE-CM and VLab (later presented in detail to the plenary session), WG II specifically recommended to plenary the adoption of the associated actions and recommendations.

Finally, WG II took note of the activities of SCOPE-Nowcasting and of the Polar Space Task Group (PSTG), without raising any associated actions or recommendations to Plenary.

WGII had also reviewed and commented on the CGMS risk assessment provided by WG III. It was concluded that the ISWGs, GSICS and WGClimate can positively contribute to the CGMS risk assessment and to the planned WMO gap analysis. Particularly, it was pointed out that issues with respect to instrument performance, impact of losses, orbit coordination and mitigation opportunities (research satellites, ground based observations, etc.) are within the expertise of the ISWGs. Hence, it is proposed

that the assessment is reviewed by these working groups and that the assessment should not only present the risks, but also evaluate the potential impact of the different risk scenarios.

Regarding space-based lightning observations, WG II took stock of the current activities in CMA, EUMETSAT, NASA and NOAA. In the subsequent discussion, WGII considered the impact of lightning observations on actual forecast improvements. In its response, the US NWS representative (Kevin Schrab) noted that it is still relatively early since many of the products are just becoming operational, and much can be learned on how to best use the data. The data presents significant potential but is only one component supporting very short-range forecasting, nowcasting and extreme events, including potential areas of wildfires started by lightning. The need to have dedicated workshops bringing together the instrument scientists, data users and forecasters was acknowledged. It is anticipated that due to the novelty of the field, only smaller groups of experts would be gathering from the outset. Some of these would also be involved in cloud monitoring activities, specifically with respect to strong convective situations and tropical storms. It was therefore agreed that as a starting point, the ICWG should include a ½ to 1-day session on lightning at the next ICWG meeting in autumn 2020.

In the WG II sessions on selected topics of high priority to members and activities responding to CGMS actions, CGMS members presented a wide range of topics stretching from flood mapping to wind observations from SAR data to polar applications to WG II. The reports generally presented continuing progress in various application areas. For example, the NOAA/CMA flood mapping is now becoming operational with great outreach to the user community and these agencies were requested to report on the status at CGMS-48:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
NOAA, CMA	5.5	A47.08	NOAA and CMA to report on the flood mapping project	CGMS-48

A specific highlight are the CMA activities on the development of a Chinese radiometric benchmark satellite.

In the WG II session on CGMS agency reports, and whilst all agency activities can be commended, WG II highlighted three specific achievements:

WGII congratulated:

- ISRO on their contribution to ocean monitoring, in particular that of scatterometry. ISRO was encouraged to consider future scatterometry missions beyond Oceansat-3/-3A.
- ROSHYDROMET and ROSCOSMOS for the excellent performance of IKFS-2 and noted that Meteor-M N2-2, scheduled for launch on 5 July 2019 with a 15:00 ECT, will be an important contribution to the global observing system.
- JAXA, noting specifically the importance of the GOSAT mission and the critical role the AMSR-mission currently has for all sky, sea and ice retrievals. WG II welcomed the good news on the progress of the planning of an AMSR follow-on mission.

WG II also addressed space weather and noted the presentation by ICAO on the activities of ICAO to establish an operational Space Weather Service. The SWCG gave a report on the current intercalibration activities as well as an overview on current space weather instruments. The SWCG is working on a white paper describing all instruments and the current approaches for calibration, which then can be used to identify how GSICS can support the SWCG activities. CGMS agreed that GSICS would review the white paper and support the analysis.

Please add brief text leading up to this action:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	5.5	A47.09	7th WMO Impact Workshop: WMO to provide a preliminary report from the 7th WMO Impact Workshop (Seoul, May 12-15 2020) at CGMS-48	CGMS-48

Finally, WGII had reviewed and updated the HLPP and the actions and recommendations pertinent to WGII.

The full account of the two-day WG II session is available in the annexed Working Group II report.

5.6 Key results from 20th GSICS EP related to CGMS

CGMS-47-GSICS-WP-02: Report on the "Annual state of the observing system"

Prior to the CGMS-47 meeting, on 16-17 May 2019, the GSICS Executive Panel (EP) members from CMA, EUMETSAT, ESA, IMD, ISRO, JAXA, JMA, KMA, USGS, NASA, NOAA, ROSHYDROMET, ROSCOSMOS , SITP, representatives from GSICS sub-groups and WMO attended the GSICS EP-20 meeting. On the agenda were key decisions, endorsements and guidance from the GSICS EP on topics related to the in-orbit monitoring of meteorological satellites by member agencies. The GSICS activities are distributed among the GSICS Coordination Centre, the GSICS Research Working Group and the GSICS Data Working Group. There have been some changes to the leadership of the various sub-groups and most importantly, the UV subgroup requested a change in its name to more accurately reflect the work of the group and to distinguish it from the VIS/NI group. GSICS EP welcomed and endorsed the proposed new name “Reflective Solar Spectrometer (RSS) sub-group”.

Overall, the GSICS activities are increasing and progressing well. The numbers of subscribers to the quarterly newsletter is rising (now over 400 readers worldwide). GISCS continues to build on existing capacities and collaborates closely with international initiatives like QA4EO and the CEOS Working Group on Cal/Val. Easier access to GSICS products and visualisation of products is an important part of outreach. Integration across agencies is also important and the network of collaborative GSICS servers is now being expanded from CMA, NOAA and EUMETSAT to ISRO. GSICS is involved in several upcoming workshops related to SI traceable observing systems, lunar calibration and re-calibration, the last one in collaboration with WGClimate and SCOPE-CM.

An important part of the GSICS activities is the report on the state of the observing system. This is now mature for geostationary imagers and GSICS will in the future expand these to cover all instruments relevant to GSICS. The Microwave subgroup is working on best practices to use RTM and NWP models as reference standards in addition to using the FCDRs. The UV subgroup focused on identifying reference solar spectrum for UV instruments and calibration of spectrometers. Accordingly, GSICS has also proposed updates to the CGMS HLPP for microwave instruments and reflective solar spectrometers, the latter also in view of the ongoing preparations for operational CO_2 monitoring.

The GSICS EP announced that ESA and the Shanghai Institute of Technical Physics (SITP) are now full members of the GSICS EP. The GSICS EP also highlighted steps taken in the integration of GSICS with the WMO Integrated Global Observing System (WIGOS).

GSICS did not raise any actions or recommendations to the CGMS-47 Plenary. Once ready, the full GSICS EP-20 report will be available from http://www.wmo.int/pages/prog/sat/meetings/GSICS-EP-20/GSICS-EP-20.html.

5.7 International Precipitation Working Group - IPWG

CGMS-47-IPWG-WP-02: Key results of IPWG-9 and coordination between IPWG and CGMS

The report highlighted the recent achievements of IPWG during the past year, including the outcome of IPWG-9 (Seoul, Korea, 5-9 November 2018), the status of a special journal issue dedicated to IPWG-8, increased participation to the IPWG validation protocol, and a joint precipitation assessment with GEWEX. The paper also provides an outlook for the planned activities over the next two years. The report also addresses recommendations and actions from CGMS-46 and -47, as well as any IPWG items from the HLPP.

IPWG made several recommendations to CGMS related to satellite mission planning and coordination. During the discussion at WG II level, it was felt that these are best followed through the WG III risk assessment and subsequent gap-analysis with respect to the CGMS baseline and the WIGOS 2040 Vision. WG II therefore raised an associated action on WG III and the WG II International Science Working Groups, including IPWG, to enable the ISWG to support the WG III activities. The IPWG recommendations were recalled to plenary for ease of reference (plenary recommendations R47.01-R47.06, all transferred to WGIII).

5.8 International Cloud Working Group - ICWG

CGMS-47-ICWG-WP-02: Key results of ICWG and coordination between ICWG and CGMS

The paper presented a summary report of ICWG activities in the past year and recommendations to CGMS from its topical groups. In the period, Karl-Göran Karlsson (SMHI) replaced Rob Roebeling (EUMETSAT) as a co-chair of ICWG.

In ICWG-2, the ICWG formed four semi-permanent sub-working groups: Algorithms, Assessments, Weather Applications and Climate Applications. Within these sub-groups, more dynamic topical groups were formed to address the relevant issues at the time of the meeting. For ICWG-2, seven topical groups

met whose discussions and actions are summarised below. The Geostationary Imager Intercomparison Topical Group under the Assessments Sub-working Group continued to be a main part of ICWG-2. This group assessed the differences in cloud parameter retrievals over the Asian region. CMA, EUMETSAT, JMA, KMA, NASA-GSFC, NASA-LaRC and NOAA participated in this intercomparison study, applying existing retrieval algorithms to Himawari-8 measurements on 19 August 2015 and 21 July 2016 (the IWWG golden day). In addition, the sub-group reanalysed the library of post golden days and plans for a GOES-16 golden day in conjunction with the IWWG. ICWG seeks guidance in how to support this analysis and its reporting going forward.

EUMETSAT will host the next ICWG meeting in Darmstadt, Germany, on 24-28 August 2020.

ICWG raised three recommendations to CGMS Plenary (these are also noted in the WGII list of actions).

CGMS-47 Plenary recommendations			
Lead	**AGN item**	**Rec #**	**Description**
CGMS space agencies	5.8	R47.07 (+ WGII/ R47.03)	(From **ICWG)** CGMS members to budget a baseline funding for the intercomparison study, given its importance and impacts on global cloud products.
CGMS space agencies	5.8	R47.08 (+ WGII/ R47.04)	(From **ICWG)** CGMS members to consider introducing multi-sensor (satellite and ground-based measurements) applications for convective nowcasting when developing/updating product requirements.
CGMS space agencies	5.8	R47.09 (+ WGII/ R47.06)	(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.

6. PASSIVE MICROWAVE OBSERVATIONS

6.1 Follow-up on passive microwave observation discussions at CGMS-46

CGMS-47-CMA-WP-08: International collaboration on passive microwave observations, progress since CGMS-46

Discussions summary outstanding

At CGMS-46, CGMS addressed international collaboration on passive microwave observations in a dedicated thematic session. Since then, GSCIS MWSG and CEOS WGCV MWSG have met on two occasions (August 2018 and March 2019). These sub-groups have agreed to develop best practices for cross-calibration and to prototype GSICS NRT products using the GMI mission as reference.

The low frequency MW gap remains unchanged -> JAXA's follow-on AMSR instrument and the European Copernicus CIMR mission would be welcome to avoid an ECV data gap for ice, SST, precipitation

Next expert meeting will take place during the GSICS annual meeting on 16 March 2020 in Seoul.

7. THEMATIC SESSION – RUSSIAN FEDERATION

7.1 Observations and monitoring of the Arctic

The Arctic is changing at a faster pace than any other place on Earth, and the world is already feeling the effects. Air temperature and annual precipitation (including snowfall) are increasing in many regions of the Arctic; spring snow cover extent is decreasing; lake and river ice freeze-up dates are occurring later and break-up dates earlier; glaciers are retreating rapidly; permafrost temperatures are increasing and, in many cases, the permafrost is thawing; and sea-ice extent is at record minimums and thinning. Much of the changes experienced over the last few decades have been documented through the analysis of data from in-situ observational networks. However, the number of sites contributing data to the networks are generally sparse in space and, in many cases, with limited temporal coverage (i.e. short records and/or record with significant gaps). Earth Observation (EO) has therefore assumed a greater role in monitoring changes in various elements (variables) of the Arctic system.

CGMS-47-GUEST-WP-01: Key note, University of Waterloo, Canada

The paper provided an overview of the role that EO is playing in documenting recent changes occurring across the Arctic, with a particular emphasis on the cryosphere. More specifically, the following areas were highlighted:

1) contributions, but yet still limited use, of EO in international and national (Canada) climate assessments;

2) challenges of EO in meeting observational requirements set by the Global Climate Observing System (GCOS); and

3) opportunities available through the exploitation of satellite data archives as well as the synergy between various data products and instruments in helping to address emerging research questions with regards to the rapidly changing Arctic system.

CGMS-47-joint-ROSCOSMOS-ROSHYDROMET-WP-02: Satellite monitoring of the Arctic region: current status and future plans

The paper addressed the experience of satellite monitoring of the Arctic region based on the Russian oceanographic satellites of the 'OKEAN' series, and an overview of satellite-based products currently issued by Roshydromet for the Arctic region using VIS and IR data from the Russian polar satellites of 'Meteor-M' and 'Kanopus' series.

The paper also focused on the future meteorological satellites 'Meteor-MP' and 'OKEAN' series, as well as the 'Arctica-M' constellation of highly elliptical orbit satellites for monitoring of the Arctic region. The paper further provided sample products based on test 'Arctica-M' data.

CGMS-47-WMO-WP-07: WMO polar and high-mountains activities

The Polar Space Task Group (PSTG) supports the work of the EC Panel of Experts on Polar and High Mountain Observations, Research and Services, which oversees the WMO Polar and High Mountain activities. The objective of the EC Panel is to provide a focused, integrated understanding of global impacts of changes in polar and high-mountain regions, facilitating services in support of resilience and adaptation. The paper presented the status of activities and an outlook for the PSTG.

The PSTG held its 8th Session from 16-18 October 2018 and a summary report is available from http://www.wmo.int/pages/prog/sat/meetings/PSTG-8.php. WMO plans to organise a High Mountain Summit in Geneva, Switzerland, from 29 to 31 October 2019 (https://highmountainsummit.wmo.int). The dialogue aims to engage decision-makers and local actors providing and using hydro-meteorological and climate services, for developing a roadmap to science-based, socially relevant, urgently needed, reliable, and user-driven knowledge and information systems supporting sustainable development and risk reduction in mountain and downstream regions. WMO has invited PSTG members to attend and contribute to this high-level dialogue.

CGMS-47-CMA-WP-02: The observations and investigation over the Arctic from CMA

CMA to provide a WP summary please.

CGMS-47-NASA-WP-03: NASA's Arctic observation and products

NASA's Earth Science Division maintains an active programme for observing the Arctic using satellites, airborne observations, and surface-based measurements. Most of NASA's research satellites are in polar sun-synchronous orbits, so the convergence of orbits over the poles means that there are frequent observations with good spatial coverage in the Arctic. NASA brings an Earth system science focus to bear on its observations, so Arctic observations include a broad suite of relevant environmental parameters (ice, atmospheric physical/chemical variables, ocean physical and biogeochemical variables, land surface properties, etc.). In the past year, launches of the GRACE-Follow On (GRACE-FO) and ICESat-2 missions will lead to the provision of new data, which is of particular interest to those addressing the Arctic (GRACE FO for ice sheet mass, ICESat-2 for ice sheet thickness and sea ice freeboard). Aircraft observations complement the satellite observations and provide calibration information for satellites from NASA and its partners. Several of NASA's surface-based measurement networks have stations in the Arctic as well. Models are used to integrate observations, provide for hypothesis testing, and carry out projections for future evolution.

In addition, NASA's Heliophysics Division is keenly interested in the dynamics of the boundary of Earth's atmosphere and space in the high latitude polar regions. These regions are where extreme impacts during space weather magnetic storms occur. Investigating this region from space and with ground-based assets provides better understanding of the dynamics of space weather and leads to improved predictive capability. Currently, the Heliophysics Division supports several sounding rocket initiatives within the Arctic Circle with the latest occurring in Norway. Here, Earth's magnetic field lines bend toward the poles

allowing solar radiation to interact with Earth's magnetic field lines creating a unique location to study interactions of space weather with the Earth.

CGMS-47-NOAA-WP-03: NOAA activities and observations of the Arctic

NOAA discussed the US Arctic Observing Network that was developed following a September 2016 White Arctic Ministerial Meeting held with 25 other countries. NOAA developed an action and strategy plan to meet the US government objectives and NOAA highlighted the work done by the National Ice Center and JPSS Arctic Initiative. NOAA and the US are committed to working in several international activities with the Arctic Council, Sustaining Arctic Observing Networks, and, in the future, GEO. NOAA noted the possibility for future CGMS collaboration in a future ArcticGEOSS initiative.

CGMS-47-EC-WP-01: Copernicus polar activities - status and plans

Copernicus, the Earth observation programme of the European Union is monitoring the Earth, its environment and ecosystems including the polar regions. The Copernicus Sentinels and the value-adding Copernicus Services cover already important aspects of the polar areas including climate, marine, and land. Still, the Copernicus users' needs for data covering the polar regions are increasing.

This increase in data needs and the publication of the EU Arctic Policy in 2016 led to that the European Commission (EC) organised a Polar Expert Group in 2017 identifying the observation requirements and gaps in the polar regions.

The Polar Expert Group resulted in two reports describing following high-level requirements:

- Floating ice parameters
- Glaciers, caps and ice sheets parameters
- Snow parameters

Based on the requirements above, ESA identified three satellite missions relevant for the polar regions. These three missions would be an expansion to the current Copernicus Sentinel satellites:

- Copernicus Imaging Microwave Radiometer (CIMR) - Conically scanning multi-frequency microwave radiometer;
- Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) - SAR Interferometric Altimeter;
- Radar Observing System for Europe (ROSE-L) - L-band SAR.

Consequently, ESA is leading three Mission Advisory Groups defining the mission requirements for the following three candidate missions (indicative launch period 2026-2028). The increased interest in the Arctic is also affecting the Copernicus value-adding services and in-situ component.

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMSSEC	7	A47.10	**Arctic observations:** CGMSSEC to secure the inclusion of Arctic observations on the plenary and working group agendas for future CGMS plenary sessions	CGMS-48
CGMS members	7	A47.11	**Arctic observations:** Provide product priorities for Arctic observations for a special Arctic session in WG II during CGMS-48	CGMS-48

In addition, and for future thematic sessions in CGMS, CGMS plenary agreed to address hyperspectral sounding observations:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CMA, CGMSSEC	7 (5.5)	A47.12	**Hyperspectral sounding:** CGMSSEC together with CMA to organise a thematic session at CGMS-48 on hyperspectral sounding observations	CGMS-48

8. SUPPORT TO OPERATIONAL CLIMATE AND GREENHOUSE GAS MONITORING

8.1 GCOS

CGMS-47-WMO-WP-08: GCOS status and plans

The paper addresses the Global Climate Observing System (GCOS) and its relationship with other observing systems. GCOS includes surface-based, air-borne, and space-based components and constitutes, in aggregate, the climate observation component of the Global Earth Observation System of Systems (GEOSS). GCOS is a joint initiative of WMO, IOC-UNESCO, the UN Environment Programme and the International Science Council (ISC). These four organisations agreed to cooperate in organising and supporting GCOS based on the coordination of existing and planned operational and research observing programmes in support of all aspects of the World Climate Programme, the IPCC and the UNFCCC and relevant aspects of other climate-related global programmes.

GCOS published a new implementation plan in 2016 to guide global observations over the next 5-10 years: "The Global Observing System for Climate: Implementation Needs (GCOS-200)". The Plan lays the foundation for a new GCOS strategy, which is to be endorsed by a high-level engagement committee of the four sponsors, and approved by the WMO Executive Council and IOC Assembly, both in June 2019.

GCOS was established in 1992. However, it is now facing new challenges. Climate science has improved dramatically: the existence of anthropogenic induced climate change is clear and warming of the climate system is unequivocal. With the UNFCCC Paris Agreement of 2015, there is a wide consensus that supporting climate policy to address adaptation and mitigation is vital. This consensus leads to the need

to ensure that the necessary requirements are in place, together with improving and expanding observational technologies leading to more demands on the global climate observing system in general, and down towards regional level.

In order for climate observations to support an improved understanding of the climate system, a better attribution of events, and more reliable forecasts and projections, GCOS will need to ask for the whole climate system to be monitored. GCOS will ensure that the appropriate requirements are in place in order to understand, monitor and close the Earth's water, carbon and energy budgets in their entirety and aim to explain the changing conditions of the biosphere.

The status of the implementation will be reviewed in 2021, supported by a status report, with the next update to be published in 2022.

In the discussion, GCOS confirmed that, with respect to the changing requirements, it is working towards ensuring that the right requirements are in place by 2022. In that context, GCOS recalled that it is critical to maintain traceability of the origin of the requirements as they may respond to different application areas. GCOS confirmed that traceability is indeed an important issue and implemented by GCOS.

IOC-UNESCO found it refreshing to see that GOOS (Global Ocean Observing System) is central to GCOS and noted the relevance of the new GOOS strategy for issuing by 2023.

8.2 CEOS/CGMS Joint Working Group on Climate

CGMS-47-JWGCLIM-WP-03: Status and plans of CEOS-CGMS Joint Working Group on Climate (WGClimate)

The document describes the progress of the implementation of the WGClimate objectives since CGMS-46 in 2018.

WGClimate emphasised that GCOS shall remain the "single voice" for requirements for climate data. In this respect, it is important to consider requirements for different application areas including those related to research as represented by WCRP.

WCRP has new strategic priorities and works on an implementation plan to be ready in the course of 2020. A joint meeting of the WGClimate and the WCRP Data Advisory Council proposed to consider the establishment of joint panels between WCRP and GCOS, instead of a set of individual panels per organisation. This would benefit considerations on climate cycles (energy, water and carbon) becoming a new focus area of GCOS. In particular, requirements for energy and water cycles ought to be developed jointly with the GEWEX Data and Analysis Panel.

Major items addressed in the paper:

- **Endorsement of leadership changes for WGClimate:** The current Vice-Chair, John Dwyer (USGS) can unfortunately not assume the Chair position in November 2019 as foreseen. The proposal is

therefore that the current Chair, Jörg Schulz (EUMETSAT), will continue until November 2020 with Albrecht von Bargen (DLR) as Vice-Chair who would become Chair from November 2020. The 32nd CEOS Plenary 2018 and 34th CEOS SIT 2019 endorsed this proposal.

- **Greenhouse gas monitoring:** Following requests from CGMS-46 and CEOS Plenary 2018, WGClimate has decided to implement a task team on GHG monitoring to establish the coordination between CGMS and CEOS entities on this topic. To incorporate the activity within the WGClimate a small update of the ToRs is required. The 32nd CEOS Plenary endorsed the changes of the ToRs in 2018. The GHG task team works on the implementation roadmap, and will present it in autumn 2019 to the 33rd CEOS plenary and to CGMS. The implementation of the roadmap will require specific resources for the coordination effort and WGClimate will provide a dedicated proposal including a roadmap at that stage. WGClimate will ask CGMS to make an endorsement through a written procedure.

- **ECV Inventory and ongoing gap analysis:** Almost 400 new entries have been submitted, with KMA contributing for the first time as well as enhanced contributions from many other agencies. The gap analysis 2019 has been scoped and automated tools for the generic gap analysis parts developed. The gap analysis will address ECVs specifically mentioned being at risk in the GCOS Implementation Plan. This includes an analysis of Ocean Surface Vector Winds (Action 46.10). WGClimate presented the detailed schedule and informed CGMS the actual gap analysis has just started. WGClimate will submit the final draft of the gap analysis report and the updated coordinated action plan to CEOS and CGMS in October 2019 with a targeted endorsement by the 33rd CEOS plenary and in writing by CGMS. The implementation of the coordinated actions has started and the status is presented in this document.

- **UNFCCC Subsidiary Board on Scientific and Technological Advice (SBSTA):** CEOS/CGMS delivered a statement to SBSTA-49 in Katowice, Poland, in December 2018. The statement included an extra report, and contributions to the SBSTA Chair report, however there was no agreed outcome on systematic observations from SBSTA-49 because of lack of agreement on text related to the IPCC 1.5° report. Therefore, an updated CEOS/CGMS statement is needed for SBSTA-50 in June. CGMS plenary endorsed the presented version at CGMS-47 (CEOS plans to endorse the statement via correspondence). The SBSTA-51 takes place in December 2019 in Santiago de Chile, and the WGClimate will prepare a CEOS/CGMS statement for endorsement at CEOS-33 plenary and by CGMS through written procedures.

In the subsequent discussion, the European Commission noted that this is the first CGMS plenary since the CEOS AC-VC White paper on a greenhouse gas monitoring constellation was finalised. EC also lauded the efforts put in by the writing team in achieving the full report and specifically noted the efforts of David Crisp, NASA. The CGMS Secretariat pointed out, and CGMS-47 plenary formally endorsed the greenhouse gas monitoring constellation white paper.

The WGClimate roadmap will also present considerations on the required resourcing to support the GHG coordination activities. These resources will have to be endorsed by CEOS and CGMS and are part of the roadmap to be presented to 33rd CEOS plenary and in writing to CGMS.

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	8.2	A47.13	CGMS members to endorse (through a written procedure): the ECV inventory gap analysis report	Oct 2019
CGMS members	8.2	A47.14	CGMS members to endorse (through a written procedure) the updated CEOS/CGMS statement for SBSTA-51	Nov 2019

Noting that GCOS should be the single voice for the requirements, it is important for CGMS plenary to understand the potential implications following the WMO constituent body reform on the interfaces between CGMS and the requirements/GCOS. Hence, plenary raised the following action on WMO:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	8.2	A47.15	**Climate session:** WMO to present implications of the WMO constituent body reform to the interface between CGMS and the requirements/GCOS at CGMS-48.	CGMS-48

With respect to ocean surface vector wind, GCOS clarified that the requirements cover both wind vector and wind speed. Hence, surface winds derived with altimeter data should be taken into consideration for climate data records. ISRO noted that Scatsat-1 should be considered as well. WGClimate responded that indeed, this would be a useful contribution and noted that ISRO shall consider making a plan to provide a climate data record derived from Scatsat data, and encouraged ISRO in a first step to contribute to the gap analysis 2019 to identify gaps on surface vector wind data records.

During the discussion, plenary noted that the CDRs could provide great benefit for regional applications. However, it was further noted that there is an implied regional training in using these data sets. Therefore, the following updates to the HLPP were proposed:

HLPP 5.2.2 on xyz:

Update and develop new training material where necessary, and in collaboration with partner institutions such as Collaboration among Education and Training Programmes (COMET) and the Committee on Space Research (COSPAR); disseminating such material through the VLab:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	8.2	A47.16	**Climate session:** CGMS members are invited to provide application	CGMS-48

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
			case studies that use climate data record to support training	

HLPP 5.3 on User Conferences:

Conduct regional satellite users' conferences to (i) share experience and foster the exchange of ideas; ii) promote better access, and improve the utilisation of, existing satellite data and products; (iii) prepare the user community on new satellite systems' data products and services, (iv) engage with the user community on the application of new ECVs, supported by the CEOS-CGMS Joint Working Group on Climate: (v) gain user feedback on data, product and system real-world application (vi) engage young people entering the field and (v) other items as appropriate.

Concluding the discussions, the CGMS Plenary made the following endorsements:

- The White Paper on Greenhouse Gas Monitoring written with CEOS AC-VC lead;
- The proposed approach for WGClimate leadership;
- The updated Terms of Reference for WGClimate; and
- The closing of the CGMS-46 plenary actions 46.10, 46.13, and 46.18.

CGMS-47-JWGCLIM-WP-04: Endorsement of CEOS/CGMS statement for UNFCCC SBSTA-50

Annex A of **CGMS-47-JWGCLIM-WP-04a** includes the text of the CEOS/CGMS statement for UNFCCC/SBSTA-50 presented to CGMS-47 plenary for endorsement.

Despite efforts by the UNFCCC Secretariat, SBSTA-49 delegations could not agree on the conclusion for systematic observations in 2018, primarily because of the disagreement on a statement related to the IPCC 1.5° report. However, the UNFCCC Secretariat targets to achieve agreement at SBSTA-50 (17-27 June 2019 in Bonn, Germany). UNFCCC Secretariat supports the space agencies to achieve better recognition for space agency work and this provides the opportunity for a statement recalling the architecture for climate monitoring from space and the constellation architecture for monitoring atmospheric CO_2 and CH_4 concentrations and their natural and anthropogenic fluxes from space into the SBSTA-50 conclusion.

The UNFCCC has requested an updated statement from CEOS and CGMS for presentation to the SBSTA-50. The statement had previously been distributed by CGMS and CEOS Secretariats for review by their respective members. The CEOS/CGMS statement for SBSTA-50 is open for comments until 31 May 2019 and validation of the endorsement will take place on 7 June (at the latest) unless substantive comments/corrections are proposed prior to this date. If endorsed by CGMS and CEOS the statement will be presented on 17 June 2019 to SBSTA-50 by the Joint CEOS/CGMS Working Group on Climate chairperson.

In conclusion, CGMS-47 plenary endorsed the joint statement as presented in the paper.

CGMS-47-SCOPE-CM-WP-01: SCOPE-CM workshop outcome and future plans

In 2018, the CGMS-46 plenary charged the SCOPE-CM Executive Panel Chair, Jeff Privette (NOAA), with convening a strategy planning meeting and reporting back to CGMS-47 with a revised strategy and implementation plan (CGMS-46 WGII/5 A46.09). Having completed the strategy meeting, SCOPE-CM provided the revised strategy and implementation approach. SCOPE-CM conducted an analysis of several alternatives for its future strategy before arriving at is recommendation to the CGMS Plenary. In sum, SCOPE-CM recommends its strategy to evolve from its prior focus on improving the sustainability of Climate Data Record (CDRs) generated by investigator-led CDR development projects, to a new focus on coordinating and securing agency-level CDR provision and sustainment. SCOPE-CM shall remain part of the WMO's Space Programme, and its activities will be closely coordinated with the Joint CEOS-CGMS Working Group on Climate (WGClimate) and remain responsive to the Global Climate Observing System (GCOS) user requirements and priorities. Under the revised strategy, SCOPE-CM will effectively serve to coordinate CGMS agencies' contributions to the Architecture for Climate Monitoring from Space, specifically for the so-called Pillar II function of creating and preserving CDRs. As such, SCOPE-CM will henceforth report to the CGMS Working Group II (Satellite Data and Products) and Plenary for endorsement of its plans and activities.

The presented report comes at the end of SCOPE-CM's Phase 2 period, and as such, it includes accomplishments and lessons learned from that phase. SCOPE-CM supported sustainability advances in nine investigator-led international CDR development and/or production projects, primarily through in-kind agency coordination, data access, expert advice and greater international visibility. Project leaders recommended that this SCOPE-CM support be continued to projects in future phases, and was particularly helpful in agency coordination and data access areas. However, despite making advances in project sustainability, the leaders concluded that persistent funding issues among diverse international project team members limited their ability to address SCOPE-CM objectives. Specifically, the funding and institutional priorities rarely aligned in time. These issues, among others, led SCOPE-CM to conclude that successful CDR sustainment requires stronger agency ownership, commitment and coordination going forward.

The proposed three major aims of CM are:

1. Facilitate CDR-generation solutions to gaps identified in the WGClimate Inventory
2. Facilitate agency commitments to sustain existing production capabilities, and
3. Facilitate CDR-generation more responsive to WMO user community needs (GCOS)

The proposed next steps are:

- Document Phase II successes, challenges, lessons-learned for agency evaluation in form of a peer reviewed publication;
- Identify CGMS agencies' planned CDRs, correlate with Phase II projects to assess potential for continuation of existing projects;

- Analyse CGMS contributions vs. gaps (e.g. on FCDRs) to develop an initial agenda to be proposed to CGMS-48. This will include next generation satellites to enable participation of many agencies in SCOPE-CM.

The WGClimate confirmed that identified gaps emerging from the ECV inventory could result in SCOPE-CM proposals after careful analysis of a way forward. Such proposals would be discussed with contributing agencies requesting commitments and, if implementation is feasible, be presented to CGMS plenary for endorsement.

The CGMS Plenary endorsed the new SCOPE-CM strategy, the proposed way forward, and noted the following action:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SCOPE-CM	8.2	A47.17	**On SCOPE-CM:** SCOPE-CM to provide an implementation plan based on the agreed new concept (CGMS-47-SCOPE-CM-WP-01).	CGMS-48

8.3 Support to operational greenhouse gas monitoring

CGMS-47-JWGCLIM-WP-02: CEOS-CGMS state of the art of the greenhouse gas monitoring from space

The document, presented by the Chair of the Joint WGClimate, summarises the status of the joint CEOS/CGMS activities in the area of greenhouse gas monitoring. The 47th session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) acknowledged the increasing capability of satellite and in-situ data to systematically monitor greenhouse gas concentrations and emissions. The paper addressed the major elements of the whitepaper describing a constellation architecture for monitoring atmospheric CO_2 and CH_4 concentrations and their natural and anthropogenic fluxes from space to support climate policy. This architecture provides a reference for individual agencies planning space-based CO_2 and CH_4 missions as well as for the broader coordination on CO_2 and CH_4 measurements through CEOS and CGMS. The paper further described the joint way forward for CEOS and CGMS enabled through the coordination by the Joint CEOS/CGMS Working Group on Climate.

The WGClimate will present a roadmap outlining the roles of multiple CEOS & CGMS entities, specific actions for the 2021-2025 period, resource implications, and a high-level timeline. The roadmap will be discussed in a specific meeting in Tokyo on 9 June 2019, with a draft available by the CEOS SIT Technical Workshop in September 2019. The final version will be delivered to CGMS and to the 33rd CEOS plenary in October 2019.

It is important that CGMS agencies having an interest in GHG monitoring, remain engaged in CEOS AC-VC on the technical aspects (mission and products). CGMS agencies having a broader interest in GHG emission monitoring, systems implementation and interface to the inventory community should consider providing colleagues to contribute through the WGClimate Task Team.

In the discussion, the European Commission emphasised to the CGMS agencies that the activities are driven by the milestones defined by the global stocktakes. It is also imperative not to wait for completing the activities related to the first stocktake before starting to work towards the second one. CGMS members with their operational background are strongly recommended to start implementing their components already now. With respect to the mentioned additional resources, it was clarified that the overall resources stemming from the roadmap are at the level of 0.1-0.2 full-time employee per action for the coordination activity within the WGClimate. The implementation of the actions will take place within CEOS and CGMS working groups and associated resources are covered there. The roadmap provided in the paper contains a specific section addressing the additional resources and CGMS agencies are asked to provide feedback on the availability of such resources by CGMS-48.

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS agencies	8.3	A47.18	**Climate/GHG session:** WGClimate to present the roadmap for the implementation of the recommendations from the GHG monitoring constellation white paper (including resource implications)	CGMS-48

In conclusion, CGMS plenary endorsed the proposed way forward.

CGMS-47-EC-WP-02: Greenhouse gas monitoring status and plans - Europe

The European Union has taken the initiative to establish, as part of the Copernicus programme, an operational capacity to monitor anthropogenic CO_2 emissions supported by a self-standing, robust and operational global observation system that includes a unique space-based component. With the support of ESA, EUMETSAT and the European Centre for Medium-range Weather Forecasts (ECMWF), the European Commission has adopted a holistic approach towards implementation. It is based on optimal use of all relevant information and knowledge, including observations, statistical data, geophysical models of the Earth system, as well as fossil fuel emission models.

Successful implementation critically depends on achieving a significant increase of high-quality observations from space related to atmospheric CO_2 concentration. Contributing to the operational monitoring of anthropogenic emissions requires high precision (0.5–0.7 ppm) CO_2 concentration observations with 2–3 days geometrical revisit time at mid-latitudes. Without such an increase, it will not be possible to reliably estimate human CO_2 emissions for all locations on Earth. The plan therefore foresees a substantial increase of the number of relevant space observations to an unprecedented capacity. The overarching goal, baseline requirements, functional architecture and system elements needed to implement such an operational capacity are discussed. Satellite and in-situ atmospheric measurements, in addition to bottom-up inventories, would enable the transparent and consistent quantitative assessment of CO_2 emissions and their trends at the scale of megacities, regions, countries, and the globe as well. Such a capacity would provide the European Union with a unique and independent source of information, which can be used to inform on the effect of policy measures, and to track their

impact enroute towards decarbonising Europe and meeting national emission reduction targets. Further, there would be potential synergies at international level with observation systems under discussion with other third parties.

CGMS-47-CMA-WP-05: CO_2 measurements from TanSat and FY-3 in China

Space-based remote sensing is now providing new tools for studying atmospheric carbon dioxide (CO_2), methane (CH_4) and their contributions to the global carbon cycle.

CMA/NSMC has deployed two instruments, ACGS and GAS, respectively on TanSat and FY-3D, to measure CO_2 and CH_4 from space. NSMC operates the two instruments for greenhouse gas measurements from space. These utilise different techniques to obtain high-resolution spectra in the near infrared band. TanSat, successfully launched in December 2016, is a scientific satellite dedicated to the observation of CO_2 utilising a passive SWIR (Short Wave Infra-Red) spectrometer with sensitivity near the surface.

For the ACGS mission XCO2 was derived successfully (with a 1 ppm accuracy) during a 2-year science mission since launch. However, the degradation of ACGS CryoCooler performance in the weak CO_2 band has affected the stability and accuracy of the CO_2 measurements and subsequently the two CO_2 bands were switched off. The O2 A-band continues to be very healthy. The chlorophyll fluorescence product can still be retrieved from O2 A-band.

The FY-3D GHG Absorption Spectrometer (GAS) mission targets retrieval of CO_2 and CH_4 column density (during the orbital daytime using the near infrared band. The interferometer (FTS) is used to obtain high spectral resolution of 0.27 cm^{-1}. CMA successfully launched FY-3D in November 2017. The test from 8 months data in 2018 demonstrates that the signal to noise ratio (SNR), spectral response, and also the instrumental line shape (ILS) meet the requirement, except for the SNR in 0.76µm band that are affected by micro-vibration effect on orbit.

A GAS follow-on instrument will fly on FY-3G tentatively planned for launch in the 2020+ timeframe with a design lifetime of 8 years. In addition to providing continuity for CO_2 and CO_2 flux measurements FY-3G GAS mission objectives include improvements of the precision of retrievals for the density of column CO_2.

That said, further work is needed to provide valuable products with high accuracy and precision for monitoring the carbon cycle and climate research.

CGMS-47-JAXA-WP-02: What GOSAT has demonstrated for 10 years and how GHG satellite observations can contribute to the global stocktake

The second Greenhouse gases Observing SATellite, GOSAT-2, successfully launched on 29 October 2018, has provided global column density of CO_2 and CH_4 with typical accuracy of 2 ppm or 0.5% and 13 ppb or 0.7%, respectively and reduced uncertainty in global flux estimation. CO monitoring capability was added on the instrument to improve identification of anthropogenic CO_2. The new instrument also has wider pointing angles, fully customised observation pattern and cloud avoiding pointing. With the agile pointing system, GOSAT-2 has targeted large emission sources of CH_4 and mega cities to estimate local flux.

JAXA has performed comparisons between GOSAT, GOSAT-2, OCO-2 and OCO-3, and results show agreements between 1.5 to 3.3 ppm depending on surface type. On Level-2 matchup: (ACOS-GOSAT B7.3 vs. OCO-2 B7) agreement is within 0.17-0.57 ppm depending on surface type.

In the subsequent discussion, CGMS noted that comparison exercises are highlighted in the White Paper on GHG monitoring led by CEOS AC-VC and supported by CGMS. In general, it is important to emphasise the importance of instrument calibration and intercalibration etc., and that CGMS agencies also take this into consideration in their respective plans. NASA noted that OCO-3 was launched on 4 May 2019 and deployed on the international space station, followed by decontamination. OCO-3 should however be ready for pointing mirror calibration and first light in June 2019.

In concluding the greenhouse gas monitoring session, the Chairman noted the discussions on the White Paper on GHG Monitoring together with presentations by CMA, JAXA and NASA on their existing and future missions and the plans in Europe for an operational CO_2 monitoring capability. Whilst it is still early days, we have also seen results with model integration. It is important to build on the experience from the pre-cursor missions. Plenary stressed the important role of CGMS and noted the existing capabilities such as GSICS for inter-satellite calibration.

9. EDUCATION AND TRAINING

9.1 VLab status and revised 5-year training strategy

CGMS-47-VLab-WP-01: VLab progress report and 5-year training strategy for endorsement

This document reports on activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) and its future plans. Since CGMS-46, VLab members have offered a variety of training opportunities, focusing on training efforts addressing the new generation of satellites, as this proved to be the major training need identified by VLab members in recent years. Furthermore, IPET-SUP, at its 5th session in February 2019[1], endorsed the new five-year strategy document for VLab activities 2020-2024 as proposed by the VLab Management Group (VLMG). The VLab co-chair invited CGMS members to take note of the strategy, provide comments and to endorse it.

The VLMG continued to coordinate its activities and support for training events via regular online meetings. Additionally, the group met face to face in July 2018 for the 9th meeting of the VLab management group (VLMG-9), hosted by the Cooperative Institute for Research in the Atmosphere (CIRA), on behalf of NOAA and WMO.

The VLab Trust Fund continues to receive a steady level of contributions from NOAA/NWS, EUMETSAT, and KMA. However, a larger number of contributing CGMS agencies is required to improve the resilience of VLab. Regular financial contributions from CGMS members are critical to maintain technical support to the VLab.

[1] See http://www.wmo.int/pages/prog/sat/meetings/IPET-SUP-5.php.

Since October 2017, Dr. Mark Higgins (EUMETSAT Training Manager) has been a VLab co-chair on behalf of CGMS satellite operators. Such co-chairing covers a period of up to three years and is coming to an end in September 2020. Hence, VLab requests CGMS satellite operators to provide nominations to secure the continuation of this partnership after that date.

CGMS members noted and endorsed the new five-year VLab strategy and raised the following action and recommendation:

CGMS-47 actions – PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	9.1	A47.19	**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.	Dec 2019

CGMS-47 recommendation – PLENARY			
Lead	**AGN item**	**Rec #**	**Description**
CGMS members	9.1	R47.10	**On training and education:** CGMS members to provide contributions into the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab. CGMS members considering to provide additional support should contact the WMO Space Programme Secretariat (wbalogh@wmo.int)

9.2 KMA and JMA update on the RA II WIGOS project

CGMS-47-joint-JMA-KMA-WP-01: Progress report on the RAII WIGOS project to develop support for NMHSs in satellite data, products and training

The WMO Regional Association (RA) II WIGOS project to develop support for National Meteorological and Hydrological Services (NMHSs) in satellite data, products, and training, is a regional framework formed to assist NMHSs in RA II for better use of satellite-related information in collaboration with relevant satellite operators, users and WMO.

The first joint meeting of the RA II WIGOS project and RA V TT-SU for relevant NMHSs took place in Jakarta, Indonesia, on 11 October 2018, hosted by the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG).

At the meeting, the participants reviewed and discussed the status of the project, user and provider perspectives, and the related work plan. In response to the action established at CGMS-45 (WGIV/4 A45.01), JMA and KMA are now conducting a regional user survey that started in 2018 in collaboration with the Australian Bureau of Meteorology. A final report will be presented to the next joint meeting held at the AOMSUC-10, in Melbourne, Australia, the first week of December 2019.

The joint meeting also considered the common gateway for the RA II WIGOS project webpage for rapid scan imagery from CMA, JMA and KMA. Country coordinators defined and provided the training requirements for the user-focused training event planned in conjunction with AOMSUC-10. The final report from the joint meeting is included in the CGMS working paper.

WMO thanked the three satellite operators for making their rapid scan services available and for working on coordinating and harmonising their respective services.

CGMS plenary took note of the report.

10. CEOS AND GEO

10.1 CEOS

CGMS-47-CEOS-WP-01: CEOS-SIT Report

Dr. Volz, NOAA, and CEOS SIT Chair, informed CGMS on the current CEOS SIT priorities including clarifying the relationship between CEOS and CGMS. He shared a proposal for a new working group on information provision and an update on GEO-LEO application activities. NOAA will host the CEOS-SIT Technical Workshop in Fairbanks on 9-12 September 2019.

11. HLPP

11.1 HLPP 2019-2023

CGMS-47-CGMS-WP-08: Status of implementation of CGMS High Level Priority Plan (2018-2022)

The working paper presented the status of implementation of the CGMS High Level Priority Plan (2018-2022). It incorporates inputs from:

- WG I, II, III and IV chairs and rapporteurs
- International Science Working Group chairs and rapporteurs
- GSICS project
- SCOPE-CM project
- CEOS-CGMS Joint Working Group on Climate, and
- CGMS Space Weather Coordination Group

The CGMS plenary noted the good progress in the implementation of the HLPP and took note of the actions initiated by CGMS Working Groups to advance the implementation.

CGMS-47-CGMS-WP-03: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2019-2023

The working paper presented the proposed revision of the CGMS High-Level Priority Plan (HLPP) to cover

the period 2018-2022, based on inputs from WGs I, II, III, and IV as well as SWCG.

- The Working Groups recommended the following targets to be considered achieved at CGMS-47:
  - Establish best practices for DCP certification, including lessons learnt and shared experiences on certification of DCS platforms (especially High Rate DCPs);
  - Share information on the development of their High Rate DCPs and share lessons learned on mitigating interference between DCPs.

- The working groups also proposed the following new priorities for inclusion in the revised HLPP:
  - Establish within GSICS a consistent calibration for reflective solar spectrometers by using instruments with stable orbits, good ground-based pre-launch calibration, adequate on-board degradation and wavelength scale characterisation, and monitored records over PICS and ground-based atmospheric composition measurement sites with state of the art RT generation of radiance/irradiance ratios either absolute or relative constituent pattern differences;
  - Establish a methodology to establish consistent calibration for microwave instruments. The individual satellite operators will implement this successively.

- The Working Groups also proposed several amendments to existing priorities, as reflected in **CGMS-47-CGMS-WP-03.**

The CGMS plenary endorsed the final proposal for the revised CGMS High-Level Priority Plan to cover the period 2019-2023, subject to agencies providing any final comments within the two weeks following CGMS-47.

CGMS-47 actions - PLENARY				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	11.1	A47.20	**On the HLPP:** CGMS members to comment on the revised HLPP text and provide feedback to CGMSSEC@eumetsat.int	1 July 2019

12. REVIEW OF CGMS-47 ACTIONS AND RECOMMENDATIONS

12.1 CGMS-47 actions and recommendations

The CGMS Secretariat presented the draft list of CGMS-47 plenary actions and the status of CGMS-46 actions and resulting from the deliberations at CGMS-47 (**CGMS-47-CGMS-WP-02 and -21**).

A summary list of actions and recommendations following CGMS-47 discussions is available in Annexes I-VI of this report. This list will be updated regularly and be available on the CGMS website under MEETINGS and CGMS-47.

CGMS members are requested to provide regular feedback on the actions to the CGMS Secretariat (cgmssec@eumetsat.int).

13. AOB AND CLOSING SESSION

13.1 CGMS nominations and representatives at meetings

CGMS-47-CGMS-WP-06 provides an update since CGMS-46 in 2018, and lists the representatives and any nominations for co-chairs and rapporteurs of the CGMS Working Groups and CGMS International Science Working Groups, as well as CGMS representation at various international meetings, for endorsement and confirmation by CGMS-47 plenary.

CGMS-47 plenary:

- endorsed Mr. Kotaro Bessho, JMA, as co-chair of WGIV;
- invited CGMS members to nominate candidates for the WGI co-chair, the WGClimate vice-chair, and VLab co-chair positions and provide these to the CGMS Secretariat (cgmssec@eumetsat.int); and
- endorsed and noted a number of other meeting representatives from or for CGMS.

13.2 Any other business

There was no other business discussed.

13.3 Schedule of future CGMS plenary sessions (2020 and beyond)

The tentative plan of CGMS plenary sessions in the period 2021-2030 is:

CGMS plenary #	Year	Location
CGMS-48	2020	China - *CONFIRMED*
CGMS-49	2021	Japan
CGMS-50	2022	WMO
CGMS-51	2023	North America
CGMS-52	2024	Europe
CGMS-53	2025	South Korea
CGMS-54	2026	India
CGMS-55	2027	Russian Federation
CGMS-56	2028	China
CGMS-57	2029	Japan
CGMS-57	2030	WMO

13.4 Handover of CGMS flag

The CGMS-47 hosts, ROSHYDROMET and ROSCOSMOS, handed over the CGMS flag to CMA who will host the 48th plenary session of CGMS on 24-29 May 2020, in China. See also CGMS-47-CMA-WP-10 PPT.

13.5 Closing remarks

In concluding the meeting, Prof. Vasily Asmus, SRC Planeta/ROSHYDROMET, stated he was happy to declare that CGMS-47 had been a fruitful meeting with a number of actions generated and discussed, and hoped that these will be dealt with by the next plenary session. He also thanked the representatives of all CGMS members and observers as well as the Co-chairs and working group members for their dedicated efforts prior to and during the meeting. He conveyed his special thanks to Mr. Alain Ratier, Director-General, EUMETSAT, and Head of the CGMS Secretariat, and to all those who contributed to organising the meeting including the local organising committee and the CGMS Secretariat.

Finally, CGMS looked forward to the 48th CGMS plenary session in China in 2020.

All participants thanked ROSHYDROMET and ROSCOSMOS warmly for the excellent organisation and hosting of the meeting in Sochi City.

The 47th plenary session adjourned at 16:10 on 24 May 2019.

PARALLEL WORKING GROUP SESSIONS

WG I REPORT

Chair: Vanessa Griffin (NOAA)
Rapporteur: Sean Burns (EUMETSAT)

8. 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 Terms of Reference for WGI.

In view of the actions agreed at CGMS-46 in relation to Space Weather, the representatives of the related Task Team also participated in joint WGI-SWCG meeting under dedicated agenda item 6.1.

WGI included representatives of the satellite operators from CMA, ESA, EUMETSAT, IMD, ISRO, JMA, KARI, KMA, NICT, NOAA, ROSCOSMOS, ROSHYDROMET and WMO (full list of participants is available in the annexes of this report).

8.1 Election of WGI Co-chair

Mr. Sergey Uspensky (ROSHYDROMET), WGI co-chair since CGMS-44, stepped down as the Co-Chair of WGI prior to CGMS-47.

There is now a vacant position for Co-Chair of WGI. CGMS members are requested to provide nominations to the CGMS Secretariat.

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS member	WGI/ 1.1	A47.01	CGMS members are requested to provide nominations to the CGMS Secretariat for the position of Co-Chair of CGMS Working Group I	Q2 2019

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

WGI discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-46 and earlier) and the final status is provided in Annex II of this report.

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

10.1 Frequency management topics and WRC-19 preparation status

CGMS-47-CGMS-WP-01: Report from the CGMS/SFCG Liaison Officer

This document provides a report from the CGMS Space Frequency Coordination Group (SFCG) Liaison Officer on the discussions and outcome of SFCG-38 (22 – 30 August 2018, Moscow) on frequency matters of mutual interest/concern, namely:

- World Radio Conference (WRC)-19 issues of mutual interest/concern to SFCG and CGMS,
- Space agency reports on national/regional regulatory changes/issue,
- Space weather observations using radio frequencies (in preparation for a WRC-23 agenda item),
- RFI to EESS (passive) sensors and interference reporting,
- Optimisation of the use of the S-band (2025-2110 MHz and 2200-2290 MHz),
- SFCG-Recommendations related to the new EESS uplink allocation in 7190-7250 MHz.

Furthermore, information is also provided on consequential/resulting activities in WMO Steering Group for Radio Frequency Coordination (SG-RFC), ITU-R Working Parties (WPs) 7B and 7C and ITU-R Conference Preparatory Meeting (CPM19-02) on issues of relevance to CGMS.

The Working Group noted this report and were encouraged to provide feedback to SFCG-39 (July 2019) on any frequency related matter as appropriate.

CGMS-47-EUMETSAT-WP-21: Status of WRC-19 preparations for agenda item 1.13 (IMT-2020/5G)

This document provides an overview on the WRC-19 preparations for agenda item 1.13 (International Mobile Communication (IMT)-2020 (5G)) and the global situation/proposals/views with regard to the protection of passive sensors from IMT-2020/5G unwanted emissions as observed from the discussions and conclusions of the ITU-R Conference Preparatory Meeting CPM19-2 held in February 2019.

For the band of highest interest for an identification for IMT-2020/5G, namely the band 24.25-27.5 GHz, the views on the required limits for the protection of the passive band 23.6-24 GHz from unwanted emissions of IMT-2020/5G diverge significantly between the 6 regional groups preparing for WRC-19.

European Conference of Postal and Telecommunications Administrations (CEPT) and the European Union (EU) adopted decisions with 5G unwanted emissions of -42 dBW/200 MHz for IMT base stations, and -38 dBW/200 MHz for IMT user equipment. These limits constitute a compromise between interests in Europe to facilitate the introduction of IMT-2020/5G while providing a certain level of protection to passive sensors in the band 23.6-24 GHz.

In order to achieve a similar level of protection for passive sensors in the band 23.6 – 24 GHz at global level, other regional groups would have to be convinced about the need for unwanted emission limits like those adopted in CEPT/EU (-42 dBW/200 MHz for BS) or even -49 dBW/200 MHz as proposed by the Russian Federation.

CGMS members are recommended to take appropriate actions towards their national frequency regulatory authorities to support unwanted emission limits for IMT-2020/5G at 26 GHz in the order of -42 dB(W/200 MHz) for base stations and -38 dB(W/200 MHz) for terminal stations to protect passive sensors in the 23.6 – 24 GHz band.

For the protection of the other, higher passive bands neighbouring to the bands under study for IMT-2020/5G identification, the question arose what could/would be appropriate 5G unwanted emission

limits. The following limits are proposed by ESA/EUMETSAT in the CEPT preparatory process for WRC-19, if and identification for IMT-2020/5G would be decided at WRC-19:

EESS (passive) band to be protected	ESA/EUM proposed unwanted emission limits	IMT-2020/5G band, if decided by WRC-19 for identification
36-37 GHz	-45 dBW/100 MHz for BS and -44 dBW/100 MHz for UE	37-43.5 GHz
50.2-50.4 GHz	-49 dBW/200 MHz for BS and -48 dBW/200 MHz for UE	47.2-50.2 GHz
50.2-50.4 GHz	-49 dBW/200 MHz for BS and -48 dBW/200 MHz for UE	50.4-52.6 GHz
52.6-54.25 GHz	-45 dBW/100 MHz for BS and -44 dBW/100 MHz for UE	50.4-52.6 GHz
86-92 GHz	-49.9 dBW/100 MHz for BS and -49.8 dBW/100 MHz for UE	81-86 GHz

However, the safeguarding the use of the passive bands in the long term, in particular the bands 50.2-50.4 GHz and 52.6-54.25 GHz, it would be beneficial if no identification of the bands 47.2-50.2 GHz and 50.4-52.6 GHz for IMT-2020/5G would be agreed at WRC-19.

CGMS members are therefore are recommended to propose to their national frequency regulatory authorities not to support an identification for IMT-2020/5G in the bands 47.2-50.2 GHz and 50.4-52.6 GHz in order to protect passive sensors in the neighbouring passive bands 50.2-50.4 GHz and 52.6-54.25 GHz.

CGMS-47-NOAA-WP-04: NOAA Spectrum Updates on Use and Issues

NOAA satellite spectrum use has changed slightly from the information presented to the CGMS last year. Only the changes from last year are presented, however the full listing of NOAA satellites, current and future, and their spectrum use is available to CGMS members.

COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate – 2) is now expected to launch in July of 2019. The COSMIC-2 satellite constellation will only consist of six satellites in a 24-degree inclined orbit. The main ground stations will be at Taiwan (Chungli and Tinan), Darwin (Australia), Mauritius, and Ghana. Multiple receive-only stations are planned at equatorial locations, including Mark IV B sites in Guam, Kuwait, Hawaii, and Honduras, as well as a receive only station located in Cuiaba, Brazil.

The GOES N-P Satellite Series, as part of the implementation of the GOES-R Satellite Series, is being partially placed into storage. GOES-13 is in storage at 60W and GOES-14 is in storage at 105W. GOES-15

will continue to operate at 128W until July of 2019 as a supplement for the GOES-17 (formerly S) Advanced Baseline Imager.

The GOES-R Series of meteorological satellites now has two operational satellites, GOES-16 (East) and GOES-17 (West). GOES-R satellites will be located in the geostationary locations of 75.2W and 137.2W for their permanent operations. GOES-S became operational as GOES-17 on February 12, 2019 at 137.2W.

Passive sensors are especially vulnerable to RFI because of the very low levels of the detected signal that carries information. Even in protected and non-shared bands, RFI can still originate from sources emitting in adjacent bands. Within NOAA, the Jason (AMR), JPSS (ATMS), SNPP (ATMS), POES (AMSU-A), and DMSP (SSMIS) satellites, all rely heavily on the availability of passive bands that are free of artificial noise. Continued efforts to protect the passive bands from incursions is essential to the continued ability of meteorological satellites to provide necessary weather data.

Auctions have already begun for 5G identified spectrum within the US. Other countries are also expected to have conducted or will conduct similar activities in the very near future. Several passive bands are adjacent or very close to these proposed 5G bands. Based on the CPM text and concerns expressed by the WMO, the protection levels planned for the adjacent bands may not be adequate to protect passive band observations through-out the globe.

It is expected that harmful interference will occur in two manners. The first type of interference is low level RFI similar to the expected radiance measurements. This will be very hard to distinguish from legitimate reading and will corrupt measurements. The second type of interference is high level RFI (periodically observed today) which is easily identified and eliminated from the data, but that area will lack any measurement.

CGMS-47 recommendations – WGI			
Lead	**AGN item**	**Rec #**	**Description**
CGMS member	WGI/ 3.1	WGI R47.01	CGMS members are recommended to take appropriate actions towards their national frequency regulatory authorities to support unwanted emission limits for IMT-2020/5G at 26 GHz in the order of -42 dB(W/200 MHz) for base stations and -38 dB(W/200 MHz) for terminal stations to protect passive sensors in the 23.6 – 24 GHz band.
CGMS member	WGI/ 3.1	WGI R47.02	CGMS members are therefore are recommended to propose to their national frequency regulatory authorities not to support an identification for IMT-2020/5G in the bands 47.2-50.2 GHz and 50.4-52.6 GHz in order to protect passive sensors in the neighbouring passive bands 50.2-50.4 GHz and 52.6-54.25 GHz.

11. Meteorological satellites space to ground interface (direct readout) and LHRIT global specification (CCSDS based) and best practices for direct readout processing

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

CGMS-47-KMA-WP-05: GK2A data broadcast: UHRIT/HRIT/LRIT service for users

This paper describes the recent updates of GK2A's (GEO-KOMPSAT-2A) UHRIT (Ultra High Rate Information Transmission), HRIT (High Rate Information Transmission) and LRIT (Low Rate Information Transmission) services for users. GK2A was successfully launched on December 5, 2018 (KST) and will be operational in mid-July of 2019 after commissioning. KMA will broadcast L1B data after conducting radiometric correction and geometric correction via UHRIT, HRIT and /LRIT services to users.

HRIT / LRIT (L band) is used to succeed the existing COMS satellite broadcasting service, and UHRIT (X band) is a newly developed high resolution weather broadcasting service to distribute large capacity data of GK2A. UHRIT's file structure and format basically follow the Global Specification released by CGMS.

The goal of GK2A satellite broadcasting is to complete the transmission within 3 minutes after the end of observation.

CGMS-47-EUMETSAT-WP-06: Update of CGMS agency best practices in support to local and regional processing of LEO direct broadcast data

The endorsed CGMS agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data is now available as a CGMS document. It is located on the CGMS home page under Publications -> Best Practices. This paper presents ongoing work and potential evolutions of the CGMS agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data. Manufacturers and operators of Direct Broadcast reception stations for the polar orbiting satellites critically depend on support from the satellite operating CGMS agencies. This includes the provision of technical specification of the Direct Broadcast, TLE orbit information, software packages for product processing, auxiliary operational data for instrument processing as well as operational coordination. The paper has been written in coordination with all CGMS members via dedicated Inter-sessional meetings after CGMS 46.

CGMS-47-EUMETSAT-WP-05: EUMETSAT status of implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data

This paper presents status of implementation at EUMETSAT of the CGMS agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274) for each of the Metop and Metop-SG LEO satellite missions, noting that Metop is compliant to the current Best Practices, and that work in progressing on the implementation for Metop-SG.

CGMS-47-NOAA-WP-05: Implementation of CGMS Best Practices for LEO Direct Broadcast Data at NOAA

This paper presents the Implementation of CGMS Best Practices for LEO Direct Broadcast Data at NOAA, noting that POES, S-NPP and JPSS are compliant.

CGMS-47-CMA-WP-14: Implementation of CGMS Best Practices for LEO Direct Broadcast Data at CMA

This paper presents the status of implementation at CMA of the CGMS best practices in support of local and regional processing of LEO direct broadcast data for FY-3D and FY-3E LEO satellite missions, noting that FY-3D is compliant and that work continues on the implementation of the Best practices for FY-3E.

CGMS-47-CGMS-WP-14: Change record of CGMS agency best practices in support to local and regional processing of LEO direct broadcast data

This paper presents the change record of the CGMS agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data document. The purpose is to keep a record of how the Best Practices have evolved during CGMS meetings, inter-sessional meetings and other exchanges.

WG1 appreciated all the presentations concerning the Direct Broadcast Best Practices and the implementation status of the agencies. Several potential Best practices were identified for future work as well as updates to existing Best Practices.

It was noted that a peer review process between the agencies (e.g. NOAA, CMA and EUMETSAT) of the Implementation of CGMS Best Practices for LEO Direct Broadcast Data documents prepared by these agencies could improve the overall quality and consistency of these documents and references prior to presentation at the CGMS plenary sessions. An action was taken to implement the peer review process.

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

CGMS-47-EUMETSAT-WP-07: Proposal for best practice on encoding netCDF data products in satellite viewing geometry

This paper presents a proposal for good practices on encoding netCDF data products in satellite viewing geometry. The rate of adoption of netCDF as a data format for space-based observations is increasing. This has many benefits for both data producers and users, as the same libraries can be used to encode and decode data products from many different missions.

The use of netCDF, however, does not obviate the need for good data encoding practices. While data encoded in this format can be read and displayed by a variety of software, this does not automatically mean that it is interpreted correctly. Furthermore, the richness of features available to data encoders creates the potential for different data providers to encode similar data differently. Developing software that is capable of decoding this data and interpreting it can require a similar amount of effort to creating new decoding software.

Data formatting standards are helpful in ensuring that decoding and interpreting data products is as straightforward as possible. Some of these efforts have been reflected at CGMS and WMO. The work of the Climate and Forecast Conventions community is particularly noteworthy. Standards from these organisations are helpful in encoding variables in such a way that their values can be interpreted correctly. However, no standard currently exists for expressing data in the original viewing geometry of satellites, which is a common spatial representation for satellite data.

This paper introduces several examples of “swath” data, namely data encoded in the satellite’s “swath” viewing geometry. They are considered especially clear and succinct formulations of the observations and members can use them as guidelines for producing new product format specifications.

In conclusion it was noted that several good practices currently exist and are in use within the Earth Observation Community. While many ways exist to encode Earth Observation products, it is recommended to use practices that have been proven through use by several data producers in various, long-running missions. Users are already familiar with these encoding styles and software exists that can readily interpret it. Anchoring these practices in an appropriate format standard, such as the CF Conventions, would therefore save significant effort on the part of both producers and consumers of Earth Observation data.

CGMS-47-EUMETSAT-WP-08: Report on progress on conventions for climate and forecast (CF) regarding space-related instruments

At CGMS-46 a WGI liaison between CGMS and the governing bodies of the netCDF Climate and Forecast (CF) Conventions was appointed to represent the interests of CGMS members within the CF community. Since then progress has been made in consolidating the needs of CGMS members with reference to the CF Conventions, building relationships to the CF community, and taking part in the evolution of the CF Conventions in order to better support the needs of CGMS. Simultaneously, activities have taken place within WMO that suggest the possibility of collaboration between the CF and WMO communities; the potential benefits of this collaboration for CGMS are being closely followed.

To support interactions with the CF community a survey of intersessional work group participants was conducted in order to ensure full visibility of members’ needs. Several members answered questions concerning data and metadata formatting standards. The feedback provided indicated that:

- Standardisation of the use of netCDF-4 groups and the encoding of data products in satellite viewing geometry (swaths) has a high priority;
- Good CF compliance checkers are considered useful in confirming the validity of new data products, especially as standards continue to be refined; and
- The CF governance process has been experienced as slow and difficult to navigate by multiple organisations in the past.

Continued engagement in this area is expected to bring further benefits as the relationships between CGMS, CF and WMO mature. This paper presents the progress made so far and proposes goals to pursue until CGMS-48, namely:

- The adoption of the proposal to regulate the use of netCDF-4 groups within the CF Conventions should continue to be pursued.
- Once that proposal has been adopted, the CF Conventions should be further extended to cover the use of new data types that are available in the netCDF-4 format, such as strings and enumerated values.

- Additionally, the encoding of data in instrument viewing geometry should be described (CGMS-47-EUMETSAT-WP-07).

Furthermore, the potential contribution of WMO to the governance of the CF Conventions is considered positive. CGMS should provide support to this process where possible in order to maximise benefit for all organisations involved.

WGI endorsed the continued work liaising between the CF community and CGMS, as well as participation in collaborative talks between WMO and the CF community.

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WGI	WGI/ 4.1	WGI/ A47.02	Consider the advantages of using RHCP/LHCP against the simplicity/affordability of the Direct Broadcast stations and to formulate a CGMS agency Best Practice on use of Circular Polarisation for Direct Broadcast	CGMS-48
WGI	WGI/ 4.1	WGI/ A47.03	Analyse possible solutions to address the expected increase in instrument data from future polar orbiting satellites and to propose new DB standards and/or Best Practices as required	CGMS-48
WGI	WGI/ 4.1	WGI/ A47.04	Initiate a peer review process between the agencies (e.g. NOAA, CMA and EUMETSAT) of the Implementation of CGMS Best Practices for LEO Direct Broadcast Data documents prepared by these agencies, with the aim of improving quality and consistency of these documents and references prior to presentation at the CGMS plenary sessions	End of 2019
WGI	WGI/ 4.1	WGI/ A47.05	To review and if appropriate identify any common viewing geometries that are missing from the proposed list of NetCDF encoding good practices	End of 2019

12. Data collection systems

12.1 DCS sub-group reports

CGMS-47-CGMS-WP-19: DCS sub-group status report and plans

At CGMS-46, CGMS 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 standards, the development of DCS best practices for common DCP data access mechanisms and DCP certification, as well as the development of CGMS DCS webpage as a contribution to the Satcom Forum 2018.

The DCS sub-group, consisting of DCS Managers from each of the satellite operators, have met virtually as part of the WGI Intersessional meetings, but also face-to-face in the context of other already scheduled

DCS-related meetings. The first DCS sub-group face-to-face meeting was held on the occasion of the Satcom Forum, which took place during the Meteorological Technological World Expo in Amsterdam in the period from the 9th October to the 11th October 2018. During the Satcom Forum EUMETSAT and NOAA co-hosted a DCS Workshop.

This paper presents the status of the DCS sub-group activities and progress since the creation of the group at CGMS-46. This has included the creation and review of a DCS Handbook, a CGMS Best Practice for DCP Certification, a CGMS Best Practice for DCP data access and the discussions of the Enhanced DCP (E-DCP) standard. The discussions of a new DCP standard indicated there is a possibility to once again have a truly international DCP standard that could be used with either EUMETSAT, NOAA or JMA satellites, and could extend to other DCS satellite providers. Discussions of the micro satellite experiment which is being conducted by NOAA have also highlighted the need for an international standard.

All CGMS members are encouraged to regularly review the DCS system capabilities in the Annex to the DCS sub group report.

WGI welcomed the work that had been performed by the DCS Sub Group, and appreciated the publication of the Best Practices on DCS Certification and the work toward a Best Practice on Data Access. The WG also endorsed the planned future work proposed by the Group, including the further development of a new International DCP standard and a Best Practice on a DCP Data Format.

CGMS-47-NOAA-WP-08: Report and status of the small satellite DCS use concept validation project

An opportunity was recently identified to NOAA as a possible risk mitigation factor in protecting, to a degree, the DCS users from aggregate RFI as a result of increased use of the space operations service (s-E) allocation located at the 401-402 MHz band.

The concept of the Satellite DCS Use Concept Validation Project, is to enable satellites, typically LEO smallsats, to interface with the GOES DCS Platform Radio receiver and thereby provide a low rate data (100, 300 or 1200 bps) service to satellite users; primarily to assist in launch, early orbit, and anomaly (LEO&A) operations or low data rate information transfer. Satellite DCS users are good candidates for using an 18 kHz common band of random access DCS users, potentially within the IDCS band. The IDCS is designed to allow use between the various DCS radio receivers (GOES, METSAT, HIMAWARI) so it's well suited for using with satellites. It is thought that using DCS will assist in decreasing the risk of interference but will not eliminate it. Additional regulatory controls and protections will continue to be needed.

While risk reduction was the original driver in identifying the opportunity, additional benefits have also been identified:

- Low cost enablement of scientific, educational, and development satellite low data rate communications to respective mission centres.
- Ability to enable LEO&A during clustered deployments.

- Demonstrated continued efforts by NOAA/NESDIS to facilitate good spectrum stewardship and efforts towards responsible sharing of spectrum resources.
- Increased use of the International channels, which are currently underutilized.
- Projected demand for enabling the two-way communications capabilities of the DCS. (Use of two-way capability being developed on GOES independent of satellite DCS use concept validation project.)

The 401-402 MHz band continues to experience pressure from smallsat constellation companies that wish to use it for their systems. While NOAA continues to work and negotiate with these companies as well as with the spectrum regulatory authorities, effective, long-term solutions remain elusive. Identifying the opportunity for satellite use of the DCS system is expected to alleviate some of the risk and further strengthen the value of protecting the system.

The nature of smallsat development is different from traditional satellite acquisition. The development and build cycles are very short. Short life spans decrease the need for hardening. Rapid prototyping and inexpensive launch rides enable a greater degree of testing in space to establish proof of concept.

The first test satellite, TechEdSat-8, was launched on 5 December to the International Space Station (ISS) and was successfully ejected from the ISS on 31 January 2019. Prior to testing the Satellite DCS Use Concept Validation payload, the satellite suffered a power failure involving the solar panels and never recovered from its “safe mode.” A follow-on satellite will be launched in July, TechEdSat-9, which will host our payload and test the concept for validation. The project is expected to be conducted in the approximately September 2019 timeframe. Slight modifications, such as selectable frequency and modulation parameters, are being considered to allow some testing on Meteosat in addition to GOES.

Once the concept is validated with TechEdSat-9, a third satellite is being considered to develop a more operationally useful version of satellite DCS use and is expected to be tested on TechEdSat-10 early in 2020.

CGMS-47-CGMS-WP-16: Proposed best practices on DCP certification process

The first draft of potential CGMS agency Best Practices in support of Data Collection Platform (DCP) Transmitter certification process was presented at CGMS-46 (CGMS-46-CGMS-WP-02). Following this initial presentation at CGMS-46 and a subsequent review of the Best Practices by the DCS Sub-group, a global set of Best Practices on certification is now ready for endorsement at CGMS-47.

CGMS endorsed the proposed Best Practices on DCP certification process.

CGMS-47-CGMS-WP-17: Proposed best practices on DCP data access

The first draft of potential CGMS agency Best Practices in support of Data Collection Platform (DCP) data access was presented at CGMS-46 (CGMS-46-CGMS-WP-09). Following this initial presentation at CGMS-46 and a subsequent review of the Best Practices by the DCS Sub-group, a set of Best Practices on DCP data access is now ready for endorsement at CGMS-47.

CGMS reviewed the Best Practices on DCP data access, noting that this version of the Best Practices focuses on the provision of DCP data via the Internet. The Working Group requested the DCS sub group to clarify some of the proposed best practices, separating those which maybe considered system requirements versus Best Practices, and additionally consider the addition of a best practice regarding data formats.

CGMS-47-CGMS-WP-18: Draft DCS Handbook

Currently information on Data Collection Services (DCS) is provided on the different satellite DCS operator websites, but it tends to be technical or aimed at existing or potential users with some existing knowledge of DCS. The Satcom Forum and DCS Workshop held in October 2018 identified the need for a DCS Handbook tailored to readers with no previous knowledge of DCS, to help them assess whether DCS could fulfil some or all of their remote data collection requirements and how to make use of the available data collection services. As a result, a first draft of the DCS Handbook was prepared by the DCS Sub-group and is included in this report for review by CGMS.

This report provides a short overview of the DCS Handbook and also contains the full Draft V1B of the DCS Handbook for review by CGMS. Once reviewed by CGMS, this draft of the DCS Handbook will be updated to reflect all feedback and any additional agency specific inputs. It will then be proposed for endorsement by CGMS.

12.2 Operational DCS systems – agency reports

CGMS-47-ROSHYDROMET-WP-01: Status of Russian data collection system

This document addresses 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 the 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. The number of DCPs is now 634 DCPs allocated. DCPs are distributed all over the Russian territory, including 127 DCPs in hard-to-reach areas. The Russian DCS will be further complemented with the launch of Electro-L N3 (166ºE) scheduled for 2019.

CGMS-47-CMA-WP-15: CMA DCS status report

The paper briefs on the Chinese Data Collection System along with DCP technical descriptions. Currently the FY- 4A at 104.7E is operationally used for DCS. It has 433 channels, of which 400 are HDCP channels (750Hz spacing/600bps) and 33 international channels (3KHz/100bps) . The Chinese DCS is established based on approach of FD with combination of TD. Currently 51 HDCP are deployed within China territory.

CGMS-47-EUMETSAT-WP-13: EUMETSAT DCS status report

This paper presents the status of the EUMETSAT Data Collection Services (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, Data Collection Platform (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 serves an important role in enabling DCP operators to use the Meteosat system to receive environmental data collected from DCP platforms. EUMETSAT DCS, initially established with the Meteosat First Generation (MFG) satellites 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 (HRDCP) allow for improved capabilities and warnings of potentially devastating natural phenomena such as tsunamis. The prime Indian Ocean Data Coverage (IODC) application is for the Indian Ocean Tsunami Warning Network (IOTWS). As of April 2019, there are 134 DCP operators located in 74 countries (Europe, Africa, Asia). There are a total of 1490 DCPs allocated, with 574 actively transmitting. Out of these 138 are HRDCPs (113 supported by Meteosat-11 at 0° and 25 by Meteosat-8 at 41.5°E). The remaining 1352 are standard rate DCPs (1204 supported by Meteosat-11 at 0° and 148 by Meteosat-8 at 41.5°E). Since March 2018, approximately 100 new DCPs have been assigned (90 of them HRDCP). The EUMETSAT DCS has a typical reliability greater than 99%.

CGMS-47-ISRO-WP-02: ISRO DCS status report

Data Relay Transponder (DRT) payload is currently available on 3 Indian satellites – INSAT-3D, INSAT-3DR and GSAT-1, 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 ~1100 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.

CGMS-47-JMA-WP-02: Himawari-DCS's international contributions to disaster risk reduction

The Japan Meteorological Agency (JMA) has operated the Data Collection System (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 considering the Himawari-8/9 follow-on program that will replace Himawari-8/9, including the DCS.

CGMS-47-NOAA-WP-09: NOAA Status on the International Data Collection System (IDCS)

This paper presents the current status of the NOAA IDCS and GOES DCS Systems.

The GOES DCS has approximately 30,000 active Platforms being tracked by approximately 500 agencies in the footprint of GOES representing. There are more than 8 million daily observations are delivered into the global observing system. The DCS Administration and Data Distribution System (DADDS) has approximately 1,700 individual users. Data is provided for fire, flood, hurricane, tsunamis, and other severe event info.

- GOES-16 = GOES-East = HRIT
- GOES-17 = GOES-West = HRIT

The LRIT service was shut down in February 2018. The DOMSAT (rebroadcast) service will end in May 2019. The DCS Administration and Data Distribution System (DADDS) servers & software refresh was completed in April 2019. A new HRIT File Format was implemented in December 2018 with a Full Operational Capacity (FOC) by May 2019. Regarding the Two Way Prototype Development: Continued effort to provide a command and interrogate capability for remotely located user Data Collection Platforms (DCPs).

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
DCS sub group	WGI 5.1	A47.06	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	CGMS-48
CGMS member	WGI 5.1	A47.07	Review and provide comments to Draft V1B of the DCS Handbook	31 Aug 2019

13. System and operations aspects

CGMS-47-IMD-WP-02: Multi Mission Meteorological Data Receiving & Processing System

This paper presented the Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS).

The MMDRPS, is a state of art receiving and processing system which is under implementation phase at India Meteorological Department, New Delhi. MMDRPS will have the capability to acquire and process data from three data-streams of INSAT series of satellites and one data stream of AWS/ARG simultaneously. Three of the satellites (INSAT-3D, INSAT3DR & INSAT-3DS) data streams and the AWS data stream will be received in redundant configuration using three set of Antenna. MMDRPS will have very high-end processing system which will cut down the processing time from currently 15 minutes to 5 minutes. MMRDPS system comprise the following major components viz three Earth stations, Data Acquisition system, Data Processing System, Data storage & data supply system and Satellite Imagery Display system. MMDRPS will have storage capacity of the order of 2PBMain and 2 PB mirror along with SSD/Flash Storage of capacity 324TB which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy in desired format. Some of the salient features of MMDRPS system are:

- Image processing software for INSAT-3D/3DR/3DS, INSAT-3A and KALPANA-1 satellites data,
- Offline processing facility for derivation of Geo Physical parameters from Level-1 data,
- modification of GISCS calibration coefficient in operational chain,
- Improved version RAPID for analyzing NWP products, RADAR products, Surface Observations, and LEO satellite's data like SCATSAT-1 along with operationally generated satellite data set to serve the forecaster community in better way and efficiently.

13.1 Use of space weather data (e.g. space weather related ARs) for operations. Anomaly survey results and the anomaly reporting process

The following papers were presented as part of a joint session between WGI and the SWCG.

CGMS-47-NICT-WP-02

This paper introduces the needs survey report on space weather data by the National Institute of Technology and Communications (NICT). To identify the user's needs on space weather information for the safety of social infrastructure, and to establish a framework which mitigate a risk of space weather disturbances to social infrastructure, the needs of space weather information from the users, such as power companies, airlines, satellite operators, communications, positioning, and resource exploration, were examined based on questionnaire surveys and interviews. The results were wrapped up as a needs survey report. This working paper focussed on the needs from Japanese spacecraft operators from the survey report.

Based on questionnaire surveys and interviews to space weather users in Japan, several kinds of user need on space weather data were collected. This specific information will help fill the gap of current space weather observation, and to prioritise which space weather model and product are developed. This activity is also useful both satellite operator and provider of space-based space weather observation in CGMS.

CGMS-47-EUMETSAT-WP-14

This Paper outlines the expected value to CGMS member satellite operators of Space Weather forecast data and the rationale for the Space Weather Anomaly Forms which the CGMS members have been requested to populate on a yearly basis. It is recognised that some CGMS operators do not currently view Space Weather data as an actionable input into spacecraft operations, other than for post-anomaly investigations. Furthermore, the rationale for the Space Weather Anomaly Data Form has not been clearly understood. In particular, the process through which the Anomaly Form inputs are to be analysed, the outputs expected and the value-added feedback to be made to the spacecraft operators is in need of clarification. With reference to the 2017 Satellite Operator Space Weather Survey results, the reasons for the lack of extensive use of Space weather forecast data are highlighted. Perceived robustness of the spacecraft in the low solar activity environment experienced over the past decades may lead to complacency as evidence suggests solar storms with the potential to cause spacecraft temporary or permanent impact have a significant probability of occurrence. An example of an actionable space weather service forecast usage is described, with use cases, which EUMETSAT is intending to integrate

into its operational processes. The rationale for the Space Weather Related Anomaly Forms is described, together with an explanation of the data needed in the various fields and potential enhancements expressed as desirable by the Space Weather community. However, it is pointed out that no managed database is in place and this is an issue in need of resolution. CGMS members are nevertheless encouraged to fill out these forms on an annual basis, in order to help secure a critical mass of data which can be used to justify resource commitments to new anomaly database management processes and to promote a deeper understanding for spacecraft design robustness and space weather service operators.

The issue of confidentiality and security is raised along with the "Trusted Agent" concept. A Task Group on Space Weather Database is proposed to help secure resources and develop a prototype database in line with requirements from all Space Weather actors.

Taking into account the additional explanations of the Space Weather Anomaly Form contained in this document, CGMS members are encouraged to provide the annual inputs as completely as possible. This data can be retrospectively of use to the various user groups once fully functioning databases and supporting processes in place.

CGMS-47-ESA-WP-03: ESA SSA Space Weather Services for Satellite Operators

This paper provides an overview of the space weather services that are currently available in the ESA SSA Space Weather Service Portal supporting satellite operation.

ESA has implemented a number of pre-operational space weather services in the framework of its Space Situational Awareness (SSA) Programme. In the course of the Programme Period 3 (2017-2019) many of the services are reaching a mature status and will be ready for transition into operations by the end of the year 2019.

ESA is a satellite operator and developing space weather services targeting satellite operation has been one of the focus areas of the SSA Programme. The currently available portfolio of space weather services includes products and tools that allow satellite operators to receive near-real time information about space environment in the orbit heights around the Earth, potential impacts on the spacecraft, carry out post-event analysis of the satellite anomalies and receive forecasts of the space environment and solar activity. Because ESA is the only European operator of deep space missions, the portfolio of services contains also space weather forecasts for other locations in the solar system including for example Mars, Venus and Mercury.

The Working Group appreciated the work carried out since CGMS-46 regarding the use of space weather data (e.g. space weather related ARs) for operations including anomaly survey results and the anomaly reporting process.

To progress further it was decided to create a joint SWCG/WGI Task Group comprising spacecraft operations experts, spacecraft design experts in space weather resilience / standards committees, - space weather service providers and possibly space weather researchers. The objectives of this Space Weather Database Task Group (TG) would be to:

1. To encourage the commitment of resources from CGMS member agencies to allow a prototype Space Weather Anomaly Database to be developed and validated within at least one agency, noting that software licenses must not prevent the sharing of the database globally.
2. Interact with the TG participants representing the various user groups to reaffirm, refine and prioritise the requirements of the anomaly database.
3. Establish the requirements for the Security / Confidentiality aspects (Trusted Agent model) and draft the procedural mechanisms and process to ensure uniform handling of the data in dispersed databases and sharing mechanisms at a global level.
4. Oversee the development and validation of a prototype Space Weather Anomaly Database undertaken by one agency resulting in an acceptance by the TG.
5. Deliver the accepted prototype to other CGMS members who have committed resources to host a local anomaly database and validate the Trusted Agent model at local level with data sharing at global level.
6. Communicate the work performed to the wider Space Weather community (HLPP 5.1.2) to encourage participation in this database project.
7. Support the establishment of long-term commitments to develop and maintain operational versions of the database.

EUMETSAT agreed to initiate the formation of the Group and establish the ToR, the initial requirements for the Space Weather Database, and the rules for access to the data. WGI members were requested to provide PoC for the Group.

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
EUM	WGI 6.1	A47.08	Form a Space Weather Database Task Group. A first report Form the TG on its activities would be presented at CGMS-48 including: • Establish the membership and ToR of the 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	CGMS-48

13.2 Space debris and collision avoidance. Coordination with the IADC

CGMS-47-EUMETSAT-WP-15: Collision Avoidance Process and Lessons Learned in EUMETSAT

The paper describes the current operational practices in EUMETSAT to manage the risk of in-orbit collision between the EUMETSAT operational satellites and other space objects, (i.e. both operational satellites and space debris); these are referred to as conjunction analysis (CA) operations.

Lessons learned in the implementation of the CA operational process are described, namely:

- Improvements in collision risk detection
- Optimisation of the collision risk mitigation
- Monitoring of the overall debris environment.

On-going and planned evolutions of the CA operational system are also described including an assessment of the impact of the implementation of the Space Fence on EUMETSAT CA processes.

CGMS-47-NOAA-WP-10: NOAA's response to space debris and concerns on the increasing threat or danger

This paper presents NOAA's response to Space Debris and concerns on the increasing threat or danger. The paper describes the approaches used in its three main orbits: LEO, GEO and deep space. In response to increasing Collision Avoidance workload, NOAA implemented three changes to reduce the likelihood of “false” threat warnings:

1. Reduced the Hard Body Radius used to calculate threats to the spacecraft to a value closer to the physical dimensions of the spacecraft (ALL SPACECRAFT)
    - Reduced the number of “false” threat warnings and the staff time to evaluate/respond to those threats
2. Reduced response time to plan and implement an avoidance manoeuvre
    - Allows to wait longer for uncertainties to dissipate before beginning planning, reduce the number of unexecuted manoeuvres planned, and to reduce the magnitude of planned manoeuvres due to increased confidence in the position of the secondary object
3. Developed/tested process to manoeuvre vehicle without pitching, allowing the spacecraft to manoeuvre over a greater portion of the orbit
    - Though this reduces the efficiency of the manoeuvre it allows a manoeuvre at a more optimal position in the orbit, making up for at least a portion of the loss.

In 2014, NOAA responded to 219 threats, 38 High Interest Events (HIE), planned 11 manoeuvres, and executed two manoeuvres. The changes made helped reduce that to 21 threats, three HIE and then to plan/execute one manoeuvre in 2018.

WGI appreciated the presentations from EUMETSAT and NOAA regarding Collision Avoidance processes. The WG decided that a Best Practice on Collision Avoidance practices should be prepared for endorsement at CGMS-48 that would provide guidance for other CGMS members. This would help ensure CGMS members are best-placed to implement state-of-the-art CA approaches, thereby reducing the risk of CGMS member satellites loss and contamination of critical operational orbits and carrying more collective weight than individual CGMS member agency’s inputs to Best Practice and Standards formulation on the wider international stage. To produce this Best Practice, a Task Group focussed on Space Debris and Collision Avoidance would be formed. NOAA agreed to initiate the formation of the Group. WGI members were requested to provide PoC for the Group

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
NOAA	WGI 6.2	A47.09	Form a Task Group on Space Debris and Collision Avoidance to produce a Best Practice on Collision Avoidance	CGMS-48

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

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

CGMS-47-CGMS-WP-13WGIII: WGIII report on outcome of the risk assessment workshop and next steps

This paper describes the outcome of the CGMS Risk Assessment again the CGMS Baseline. The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System – includes Space Weather.

The CGMS baseline responds to end-user requirements expressed in WMO's Rolling Review of Requirements (RRR). The CGMS Baseline strives to support the WMO Integrated Global Observing System (WIGOS) 2040 vison. The Key principles are:

- Commitment: The CGMS members are providing, or have firm plans to provide, the observations, measurements, and services enumerated in the Baseline;
- Sustained: The observations, measurements, and services are provided on a sustained basis;
- Available: The observations, measurements, and services are available on a free and open basis;
- Operational: The data and products can be utilized in operational applications.

The Risk Assessment was carried out in early 2019 against the CGMS Baseline with the following objective:

- Convey CGMS's posture with respect to its baseline commitment;
- Provide a high-level assessment designed to allow members to assess the current contribution to the user community as well as coordinate future planning to meet current and future baseline commitments.

Working Group III held a workshop 27 Feb – 1 Mar, hosted by EUMETSAT and attended by EUMETSAT, NOAA, JMA, CMA, WMO, and CGMSSEC. Working Group III reviewed how CGMS current and future missions match the commitments made in the CGMS Baseline. The findings and proposed mitigation actions from this Workshop were sent to the other Working Groups for review.

WGI reviewed and commented on the presentation noting that the Report from WGIII will provide a detailed discussion on the risk assessment.

CGMS-47-EUMETSAT-WP-09: Coordination of LEO orbits – An analysis

This paper presents an analysis of the coordination of LEO orbits.

To reduce pass scheduling conflicts and maximising the amount of instrument observation collected, it is beneficial to coordinate the orbital phasing of satellites within and between satellite operating agencies. A preliminary analysis is provided of the drivers and constraints in coordinating LEO satellite orbits and potential gains in improving overall mission return and improved efficiency in usage of ground resources. This could then be used as an input to a Best Practice formulation.

The analysis is based around the common reference orbit of the EUMETSAT satellites supporting the missions EPS-Metop and EPS-Metop Second Generation and includes discussion of example potential partner orbits in the analysis, namely those orbits being used by the NOAA JPSS and CMA FY3-E satellites.

The high level orbital maintenance strategy of the Metop / Metop-SG satellites is presented. An analysis of drivers and constraints for orbital coordination on similar and different orbital planes is made. The potential improvements in terms of conflict-free operations benefiting both the Direct Broadcast Missions and the Global Missions of the Metop and other coordinated satellite systems are highlighted.

Several actions were taken to further develop the analysis further to allow the formulation of a future Best Practice.

CGMS-47 actions – WGI				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
EUM	WGI 7.1	A47.10	Perform a detailed analysis consisting of: • Developing a simulation algorithm considering all variables affecting the LEO Orbit coordination • Developing plots and other simulation outputs as tools for illustrating the potential coordination possibilities and improvements in both global and direct broadcast mission return in a cross-member coordinated mission analysis approach.	CGMS-48
WGI	WGI 7.1	A47.11	Develop a Best Practice on the considerations to be made on orbital phasing between satellites, as a measure for reducing pass scheduling conflicts and maximising the amount of instrument observation collected.	CGMS-48

15. Global coordination on handling future large data volumes and associated data circulation

CGMS-47-NOAA-WP-11: NOAA's enterprise approach to data delivery: Space segment to ground system

This paper describes NOAA's Enterprise Approach to Data Delivery: Space Segment to Ground System.

NOAA has recently completed several major system upgrades to enable acquisition and processing of the high-volume telemetry data from the next generation Geostationary Operational Environmental Satellite

- Series R (GOES-R) and Joint Polar-orbiting Satellite System (JPSS) meteorological satellites. Upgrades to accommodate the significantly increased data volumes and transmittal rates were needed to NOAA's antenna systems, command and control systems, communication networks, and physical infrastructure.

The effectiveness of NOAA's effort allowed NOAA to bring three new weather satellites, GOES-16, GOES-17, and NOAA-20 (JPSS-1) into operations with two additional satellites: GOES-T and JPSS-2, set to launch in the near future. The data rates from these new satellites are up to 40 times larger than the data from NOAA's legacy weather satellites.

NOAA's system and infrastructure enhancements included new GOES-R antennas and receiving equipment at Wallops Virginia Command and Data Acquisition Station (CDAS) as well as at a new backup site in Fairmont WV along with installation of improved polar antennas at McMurdo Antarctica Station, Svalbard Norway Station, and at the Fairbanks Alaska CDAS.

NOAA made significant upgrades to our satellite command and control and data processing systems with development and operations of two, new ground data processing systems at the NOAA Satellite Operations Facility (NSOF). These new systems provide command and control, mission planning, flight simulation, spacecraft and payload telemetry monitoring, and space situational awareness services.

NOAA needed to make significant upgrades to our physical infrastructure at the NSOF (even though the facility opened in 2007) as well as build a back up facility for satellite and data handling. These upgrades included completely remodelling the NSOF satellite operations control center while continuing to operate over 17 satellites without interruption.

Lastly, NOAA expanded data capacity over critical networks, developing a new network infrastructure utilizing the Internet-2 research networks that can interconnect to research networks with our CGMS partners.

WGI welcomed this presentation and looked forward to similar presentations from other CGMS members which may lead to proposals for Best Practices.

16. Any other business

No further items were presented for discussion

17. Review and updating of the HLPP

CGMS-47-CGMS-WP-03WGI: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2019-2023

A review and update of the HLPP was performed.

18. Nomination and representatives at meetings

No changes were proposed.

19. Date/time of inter-sessional activities/meetings in 2018-2019 [CGMS-47 -> CGMS-48]

Best Practices for Direct Broadcast NOAA (J. McNitt (NOAA) & A. Soerensen (EUMETSAT):

- Review of new and updated BP, establish DB implementation report process – 10 September 2019
- Review of new and updated BP – 26 February 2020
- Review of BP implementation reports – 21 April 2020

Data formats and formatting standards (Daniel Lee (EUMETSAT)):

- Data format and metadata standards 3 December 2019
- Data format and metadata standards 4 February 2020

Data Collection Systems: (Nick Coyne, EUMETSAT):

- DCS sub group meeting 9 July 2019
- DCS sub group meeting 3 September 2019
- DCS sub group meeting 5 November 2019
- DCS sub group meeting 14 January 2019
- DCS sub group meeting 25 February 2019
- DCS sub group meeting 24 March 2019

Space Weather Database Task Group: (Andrew Monham, EUMETSAT):

- Space Weather Database Task Group meeting 1 – Finalise ToR and membership: 12 September 2019
- Space Weather Database Task Group meeting 1 – Finalise ToR and membership: 5 February 2020

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

- Space Debris and Collision Avoidance Task Group 1st meeting – November 2019
- Space Debris and Collision Avoidance Task Group 2nd meeting – March 2020

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

The summary list of WGI actions and recommendations resulting from CGMS-47 is included in Annex II of this report.

WG II REPORT

Co-chairs: Dohyeong Kim (KMA), Werner Balogh (WMO)
Rapporteurs: Mitch Goldberg (NOAA), Kenneth Holmlund (EUMETSAT)

1. Welcome and opening

The Co-chairs Dohyeong Kim (KMA) and Werner Balogh (WMO) opened the meeting. The Chairs thanked Roscosmos and Roshydromet for hosting CGMS-47.

2. Review of actions and recommendations from previous meetings

Looking at the Agenda it was agreed to review the status of current Actions at the end of the meeting. It was also pointed out that the schedule is tight and strict adherence to schedule should be followed in order to timely conclude the meeting.

3. Interaction between WGII and ISWGs

The ISWGs continue to struggle with the funding, which is barely sufficient to support the actual meetings. Considerations have been raised to charge a registration fee; however, this is currently not seen to be a good way forward. The participation of the co-chairs in other ISWGs meetings has in the cases when it has been realised proven to be very useful. This however is relying on adequate travel-funding which is rarely available. It was noted that in the past this has been raised to Plenary, where the issue has been left to the agencies/Organisations for whom the Chairs work for.

It was further discussed that intersessional teleconferences between the ISWG Chairs may prove useful to discuss common issues, approaches and progress on Actions and Recommendations, and consider collaboration across ISWGs. It was also suggested that the annual CGMS meeting could include in its schedule time for a face-to-face coordination meeting of the attending co-chairs of the ISWGs. This however should be confirmed during the intersessional meetings. Therefore, Recommendation WGII/R47.01 was placed.

CGMS-47 RECOMMENDATIONS – WGII			
Lead	**AGN item**	**Rec #**	**Description**
ISWG Chairs	WGII 3	WGII/R 47.01	ISWG Chairs to organise intersessional teleconferences amongst the co-chairs.

4. Working papers on international groups/initiatives (IWWG, IPWG, ITWG, IROWG, ICWG, SCOPE-CM and GSICS EP)

CGMS-47-GSICS-WP-01: GSICS-EP-20 report

Prior to the CGMS-47 meeting, on 16-17 May 2019 the GSICS Executive Panel (EP) members from CMA, EUMETSAT, ESA, IMD, ISRO,JAXA, JMA, KMA, USGS, NASA, NOAA, ROSHYDROMET, ROSCOSMOS , SITP

along with WMO Secretariat (Toshiyuki Kurino) and GSICS Coordination Center, got together for the GSICS EP-20 meeting. On the agenda were key decisions, endorsements and guidance from the GSICS EP on topics related to in-orbit monitoring of meteorological satellites by member agencies. Some of the aspects that were reported are stated below. There have been some changes to the Leadership of the various sub-groups and most importantly, the UV subgroup requested a change in its name to more accurately reflect the work of the group and to distinguish it from the VIS/NI group. The proposed new name Reflective Solar Spectrometer (RSS) sub-group was welcomed by the EP and endorsed.

GSICS Coordination Center (GCC) reported that interest in GSICS activities has increased and the quarterly newsletter is subscribed by over 400 readers worldwide. GSICS EP endorsed a QA4EO based 'GSICS Deliverable' acceptance criterion proposed by GCC and welcomed SSMI lookup tables as the first GSICS deliverables in GSICS. GCC received valuable guidance on fine tuning the GPPA to enable faster acceptance and maturity assignment of classical GSICS products generated from newer reference instruments (such as IASI-B/C, J1-CrIS) as the current references instruments like IASI-A and SNPP-CrIS complete their mission lives. GCC provided updates on new features of Action Tracker, Visualization on GSICS product catalogue and the publication of four GSICS quarterly newsletter in the past year.

GSICS Research Working Group (GRWG) reported calibration results of next generation satellites. This included FY-4A, SLSTR, GOES-16 and CrIS and VIIRS in NOAA-20 as well as SNPP. Advances in lunar calibration, Gap filling and AI/Machine Learning and re-processing have provided new opportunities to collaborate. The Microwave subgroup is working on best practices to use RTM and NWP models as reference standards in addition to using FCDR's as reference. The UV subgroup focused on identifying reference solar spectrum for UV instruments and calibration of spectrometers. The GRWG plans to hold workshops on SI traceable observing systems, Lunar Calibration and Re-Calibration.

The GSICS Data Working Group provided updates to the EP on three vital tasks that it under took this year. First is the collaboration server that hosts and shares GSICS Products and has hub in CMA, NOAA and EUMETSAT. ISRO has established a threads server that has been integrated into the collaboration server architecture. Second is the GSICS Plotting tool that plots the GSICS products and will soon be upgraded. Third is the agreement on Satellite Instrument event logging among agencies. The GDWG Chair also presented the report on State of Observing System which summaries the monitoring of instruments of member agencies along with relevant uncertainties. A follow up report on this was presented at the CGMS by the GSICS EP.

The executive panel announced that European Space Agency (ESA) and Shanghai Institute of Technical Physics (SITP) are now full member of the GSICS Executive Panel. EP also highlighted steps taken in the integration of GSICS with the WMO Integrated Global Observing System (WIGOS).

The detailed EP-20 report will be available at http://www.wmo.int/pages/prog/sat/meetings/GSICS-EP-20/GSICS-EP-20.html

GSICS also reviewed the HLPP and suggested the inclusion of two new HLPP targets:

- 4.1.x: Establish within GSICS a consistent calibration for reflective solar spectrometers by using instruments with stable orbits, good ground-based pre-launch calibration, adequate on-board degradation and wavelength scale characterization, and monitored records over PICS and ground-based atmospheric composition measurement sites with state of the art RT generation of radiance / irradiance ratios either absolute or relative constituent pattern differences.
- 4.1.x: Establish a methodology to establish consistent calibration for microwave instruments. The implementation will be done successively by the individual satellite operators.

WG II took note of the report and commended GSICS on its achievements, WG II endorsed all proposed new GSICS actions, which will be tracked within GSICS, and the proposed new HLPP targets. During the discussion, it was however noted, that the current GSICS Status Report on the Observing System is mainly focussing on GEO imagery. GSICS is therefore encouraged to expand the report in the future and an associated action was placed.

In addition, it was noted that there is a need to change the formulation of the link in OSCAR to the agency landing pages and accordingly an associated Action was placed on WMO.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
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.	??
WMO	WGII4	A47.02	WMO to remove current formulation of 'GSICS calibration' and to rename 'calibration and events' to 'instrument landing page'	??
GSICS	from WGIII	WGII/A 47.29	GSICS to continue cross calibration progress of microwave imagers. (WGII)	CGMS-48

CGMS-47-IROWG-WP-01: IROWG status report

The IROWG community has not met since September 2017. The next IROWG-7 meeting will be held on September 19-25, 2019 in Elsinore, Denmark. It will be combined with the EUMETSAT Radio Occultation Meteorology Satellite Applications Facility (ROM SAF) workshop. Therefore, we re-state the four key recommendations previously presented at CGMS-46, endorsed by the IROWG community at IROWG-6 (Estes Park, September 21-27, 2017). However, we note that COSMIC-2 polar was cancelled following IROWG-6.

The four key recommendations carried forward from IROWG-6 are:

- Ensure that both equatorial and polar components of COSMIC-2 are fully funded and launched; this is required for Numerical Weather Prediction, Climate, and Space Weather.

- IROWG recommends targeting at least 20,000 occultations/day providing good spatial and local time coverage, to be made freely available to the operational and research communities of Numerical Weather Prediction, Climate, and Space Weather.
- International space agencies (in particular NASA, ESA and CNSA, where LEO-LEO and GNSS-RO&-Reflectometry proposals are pending) to support mission preparation and implementation projects towards LEO-LEO microwave occultation and GNSS-RO&-Reflectometry demonstration missions. This should include recommending new OSSEs for these missions.
- IROWG stresses the importance of long-term archiving of the Level 0 data – and all the relevant metadata – from both the agency-led and "commercial" missions. These long-term costs should be included in mission budgets. Researchers, across multiple processing centres, need access to these data, and to information about the GNSS-RO receiver performance, for climate reprocessing activities. Access to just the retrieved products is not considered sufficient for many research applications.

It now seems unlikely that the target number of 20,000 occultations/day will be met with "agency led" missions in the 2020's. Finally, we encourage more collaboration and exchange of results when assessing data from proposed commercial missions.

WG II took note of the activities of IROWG and confirmed the actions from CGMS-46. WGII noted that there are significant activities ongoing within the commercial sector, with agencies now starting to evaluate the quality and availability of the data. Furthermore, as COSMIC-2 polar is now no longer planned it may be of interest to gain a better understanding of the impact of various orbital planes on coverage. WG II therefore placed the following Actions:

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS	WGII 4	A47.03	Agencies assessing commercial radio occultation data are requested to present their efforts at IROWG-7 to facilitate community planning.	Sep 2019
IROWG	WGII 4	A47.04	IROWG to provide recommendation on orbital planes in order to improve coverage.	??
IROWG	WGII 4	A47.05	IRWOG to evaluate outcome of agency funded commercial weather data pilot following IROWG-7 and report to CGMS-48.	CGMS-48
ROSH	WGII 4	A47.06	Roshydromet to report on future plans for RO missions at WG II.	CGMS-48
IROWG, WMO	WGII/4(from WGIII)	A47.31	CGMS baseline and RO: IROWG and 7th WMO Impact Workshop needs to validate the current Baseline in terms of the coverage, number, quality and sampling of RO.	2020, CGMS-48

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
IROWG	WGII/4(from WGIII)	A47.32	IROWG to review the CGMS Baseline and validate wording that captures CGMS Member contribution to RO data in terms of coverage, number, quality and sampling; and share impact studies of RO data between the CGMS Baseline and WIGOS 2040 vision observing targets.	2019/ 2020

CGMS-47-IPWG-WP-01: IPWG status report

The report highlights the recent achievements of IPWG during the past year, including the outcome of IPWG-9 (Seoul, Korea, November 5-9, 2018), the status of a special journal issue dedicated to IPWG-8, increased participation to the IPWG validation protocol, and a joint precipitation assessment with GEWEX. The paper also provides an outlook for the planned activities over the next two years. The report also addresses recommendations and actions from CGMS-46, as well as any IPWG items from the HLPP.

Specific actions and recommendations resulting from IPWG-9 include:

For WG II:

- Provide letter of endorsement for the continuation of the OCEANRAIN project (which is out of funding as of December 31, 2018), which provides vital oceanic validation data sets (note: letters of support were transmitted by WMO, as requested by IPWG);
- Provide letters of support to specific telecommunications companies to provide IPWG access to cellular microwave communications links which are capable of providing land validation data sets in normally data sparse regions;
- Increase financial support to IPWG co-chairs for collaborations with the other ISWG's.

For CGMS:

- IPWG strongly recommends to CGMS members to continue the constellation of PMW sensors to ensure high quality satellite precipitation products for weather, climate, and hydrological applications. Additionally, IPWG would like to be kept informed of longer-term plans for subsequent launches of microwave sensors to ensure continuity of long-term observations that meet the documented needs of the user community;
- 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;
- As precipitation estimates move to higher temporal rates, we recommend to CGMS members to synchronize full-disk geostationary sampling schedules which will optimize GEO scans to improve temporal sampling of precipitation products and unknown future PMW imager availability for merged products;

- Encourage openly available full-coverage global geostationary data. At a minimum, full disk data at 15-30 min at 0.65, 6.7, 7.3, 8.7, 11 and 12 microns should be openly available to the IPWG community;
- IPWG encourages close collaboration between space programs and data assimilation (DA) centres to incorporate DA requirements as part of scientific requirements when developing new satellite observing systems. This includes keeping pace with the increasing horizontal and vertical resolutions of NWP models and DA systems, as well as improving the latency of satellite observations to meet high temporal resolution of DA cycles;
- IPWG encourages the continued development of satellite programs with high temporal resolution (GOES, TROPICS, TEMPEST, geo-MW, etc.) and the coordination between agencies for UHF/VHF ground stations to full-fill the needs of future constellation of Cubesats data dissemination (e.g. TROPICS).

The proposed Actions from IPWG were discussed. Regarding those to WG II it was noted that a letter to support Oceanrain should really come from individual agencies and access to ground-based data is a WMO matter. With respect to funding of activities it was noted that this has been raised to Plenary in the past, but the issue has been left with the agencies themselves. On the recommendations proposed to CGMS, it was noted that many of these subjects related to the CGMS baseline and are covered by the WGIII Risk Assessment and discussion on gaps with respect to implementation and the CGMS baseline, which is the CGMS commitment towards WIGOS2040 (CGMS-47 plenary recommendations R47.01-R47.06 transferred to WGIII). It was also noted that some of these matters should be considered at Plenary level as part of the IPWG report to Plenary.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WGII	WGII 4	A47.07	WG II to discuss with WMO the way forward to have access to telecommunications microwave link data in support of IPWG validation activities.	??
CMA	WGII /13	WGII/A 47.27	CMA to provide PoC for the IPWG validation protocol (HLPP 4.3.1)	??

CGMS-47-ICWG-WP-01: ICWG status report

This working paper presents a summary report of ICWG activities in the past year and recommendations to CGMS from its topical groups. In ICWG-2, four semi-permanent sub-working groups were formed and these including Algorithms, Assessments, Weather Applications and Climate Applications. Within these sub-groups, more dynamic topical groups were formed to address the relevant issues at the time of the meeting. For ICWG-2, 7 topical groups met, and their discussions and actions are summarized below. The Geostationary Imager Intercomparison Topical Group under the Assessments Sub-working Group continued to remain part of ICWG-2. This group assessed the differences in cloud parameter retrievals over the Asian region. CMA, EUMETSAT, JMA, KMA, NASA-GSFC, NASA-LaRC and NOAA participated in this intercomparison study, applying existing retrieval algorithms to Himawari-8 measurements on 19

August 2015 and July 21, 2016 (the IWWG golden day). In addition, the library of post golden days was reanalyzed and plans for a GOES-16 golden day in conjunction with the IWWG were made. ICWG seeks guidance in how to support this analysis and its reporting going forward. ICWG came up with the following key recommendations to CGMS and other working groups:

- CGMS members to budget a baseline funding for the intercomparison study, given its importance and impacts on global cloud products.
- CGMS members to consider introducing multi-sensor (satellite and ground-based measurements) applications for convective nowcasting when developing/updating product requirements.
- ICWG to work with IWWG on the golden days observations to provide cloud height uncertainty for AMV applications.
- 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.

WG II took note of the report and supported the proposed four recommendations above, of which three would be presented to Plenary:

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Rec #**	**Description**
CGMS	WGII 4	WGII/ R47.02	CGMS members to budget a baseline funding for the intercomparison study, given its importance and impacts on global cloud products.
CGMS	WGII 4	WGII/ R47.03	CGMS members to consider introducing multi-sensor (satellite and ground-based measurements) applications for convective nowcasting when developing/updating product requirements.
ICWG and IWWG	WGII 4	WGII/ R47.04	ICWG to work with IWWG on the golden days observations to provide cloud height uncertainty for AMV applications.
CGMS	WGII 4	WGII/ R47.05	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.

CGMS-47-ITWG-WP-01: ITWG Status Report

There has been no ITWG meeting since CGMS-46. The next meeting, the 22nd International TOVS study conference (ITSC-22) will be held from October 31 through November 6, at Saint-Sauveur, Quebec, Canada. The meeting will highlight updated activities from the six working groups: 1) Radiative Transfer and Surface Property Modelling, 2) Climate, 3) Data Assimilation and NWP, 4) Advanced Sounders, 5) International Issues and Future Systems, and 6) Products and Software. In addition, there will be meetings of technical sub-groups for 1) Radiative transfer software packages (RTTOV and CRTM) and 2) Direct Readout broadcast packages. There will also be a GSICS outreach side event.

WG II took note of the report.

CGMS-47-IWWG-WP-01: IWWG Status Report

This paper presents the current status of IWWG activities that have been realised since the CGMS-46 meeting. It includes the responses to CGMS-46 actions and recommendations. The IWWG has proposed two new recommendations for CGMS consideration. 1) That NWP centres test Aeolus HLOS winds in their model and to assess the impact on NWP. Results are expected by IWW15 (April 2020) and 2) That AMV producers compare common AMVs against HLOS winds in order to investigate AMV HA issues. Results are also expected by IWW15 (April 2020). The IWWG has two open HLPPs. The first is HLPP 3.2.1 to establish commonality in the derivation of AMV for global users where appropriate (e.g., through sharing of prototype algorithms) and consider backwards compatibility when designing AMV algorithms for the 16-channel imagers, so that present state-of-the-art algorithms can be applied to old imagery. In response the final results of the 3rd AMV inter-comparison presented at IWW14 showed that the use of a Common QI by all the participants has real skill in filtering collocated AMVs for an improved statistical agreement. The Common QI is located on GitHub at https://github.com/swanzong/IWWG.git and is freely available. The owner of the site is Steve Wanzong (stevew@ssec.wisc.edu). At this time, EUMETSAT and the NWCSAF/HRW have included the Common QI into their algorithm repositories. NOAA, KMA and JMA have plans to complete their integration later in 2019.

The IWWG co-chairs will begin planning the 4th AMV Inter-comparison study and present the scope of the work associated with this at the upcoming IWW15, in April 2020. Close coordination with the Aeolus and MISR programs and the ICWG is planned to discuss the use and time period of GOES-16 and GOES-17 data in the next AMV inter-comparison study. We also propose to break up HLPP 3.2.2 into two different HLPPs. HLPP 3.2.2: Investigate the best configurations to be used by the AMV producers for use in global and regional NWP models respectively, and clearly define the appropriate requirements for each of them. HLPP 3.2.3: Assess the impact of Aeolus HLOS wind profiles on NWP and investigate the possibilities to improve AMV HA using Aeolus data. Work has not begun on either of these two HLPPs. A correct BUFR sequence (3.10.077) has been approved by the WMO. We will get up to date progress at the upcoming IWW15.

The IWWG does not make clear recommendation for the three MetOP satellites configurations. TRISTAR configuration produces two complementary Global AVHRR wind products that are asymmetric, impacting both the coverage and quality. Discussion with users are still on going and a final decision by EUMETSAT will be revealed in autumn 2019.

WGII took note of the report, welcomed the progress of work done under IWWG, in particular on optimising AMVs at different scales, and endorsed the following changes to HLPP:

To revise target 4.2.2 to: Investigate the best configurations to be used by the AMV producers for use in global and regional NWP models respectively and clearly define the appropriate requirements for each of them;

To include new target 4.2.3: Assess the impact of Aeolus HLOS wind profiles on NWP, and investigate AMV HA issues using Aeolus data.

CGMS-47-SCOPE-CM-WP-01WGII: SCOPE-CM Report

SCOPE-CM presented a proposal for Revised SCOPE-CM Strategy for Sustained Climate Data Records.

The CGMS-46 Plenary charged the SCOPE-CM Chair with convening a strategy planning meeting and reporting back to CGMS-47 with a revised strategy and implementation plan (WGII/5 A46.09). Having completed the strategy meeting, SCOPE-CM is herein providing the revised strategy and implementation approach. SCOPE-CM conducted an analysis of several alternatives for its future strategy before arriving at is recommendation to the CGMS Plenary. In summary, SCOPE-CM recommends its strategy evolve from its prior focus on improving the sustainability of Climate Data Record (CDRs) generated by investigator-led CDR development projects, to a new focus on coordinating and securing agency-level CDR provision and sustainment. Although SCOPE-CM will remain part of the World Meteorological Organization's (WMO's) Space Programme, its activities will be closely coordinated with the Joint CEOS-CGMS Working Group on Climate (WGClimate) and remain responsive to Global Climate Observing System (GCOS) user requirements and priorities. Under the revised strategy, SCOPE-CM will effectively serve to coordinate CGMS agencies' contributions to the Architecture for Climate Monitoring from Space, specifically for the so-called Pillar II function of creating and preserving CDRs. As such, SCOPE-CM will henceforth report to the CGMS Working Group II (Satellite Data and Products) and Plenary for endorsement of its plans and activities.

This report comes at the end of the SCOPE-CM's Phase 2 period, and as such it includes accomplishments and lessons learned from that phase. SCOPE-CM supported sustainability advances in nine investigator-led international CDR development and/or production projects, primarily through in-kind agency coordination, data access, expert advice and greater international visibility. Project leaders recommended that this SCOPE-CM support be continued to projects in future phases, and was particularly helpful in agency coordination and data access areas. However, despite making advances in project sustainability, the leaders concluded that persistent funding issues among diverse international project team members limited their ability to more fully address SCOPE-CM objectives, given that SCOPE-CM is not a funding program. Specifically, the technical, funding, SCOPE-CM phases, and investigator priorities rarely aligned time. These issues, among others, led SCOPE-CM to conclude that successful CDR sustainment requires stronger agency ownership, commitment and coordination going forward.

WG II took note of the presented new concept and considers this to be a good way forward. An associated recommendation will be presented to Plenary and CGMS agencies are encouraged to actively participate in the implementation of the new approach.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SCOPE-CM	WGII 4	A47.08	SCOPE-CM to report on the conclusion of the 9 pilot projects.	CGMS-48
SCOPE-CM	WGII 4	A47.09	SCOPE-CM to develop strategy, agenda and updated ToRs.	??

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Rec #**	**Description**
WGII	WGII 4	WGII/R 47.06	WGII recommends to CGMS-47 plenary the endorsement of the proposed new concept for SCOPE-CM.

CGMS-47-JWGCLIM-WP-01: CEOS-CGMS Joint Working Group on Climate status report

This document describes the progress in the implementation of the Joint CEOS/CGMS Working Group on Climate (WGClimate) objectives since CGMS-46.

Major items addressed in this report:

- Endorsement of leadership changes for WGClimate; Plenary is invited to confirm the one-year extension of the current Chair and the change of the current Vice-chair and to nominate candidates for the Vice-chair post starting November 2020 for a 2-year period:
  - Chair: Jörg Schulz, EUMETSAT (until November 2020)
  - Vice-chair: John Dwyer, USGS (until 31 May 2019), Albrecht von Bargen (DLR) (from 1 June 2019 who will take over as Chair in November 2020 for a 2-year period)

- Status of the ECV Inventory and ongoing gap analysis. Almost 400 new entries have been submitted with KMA contributing for the first time and enhanced contribution from many other agencies. Gap analysis 2019 has been scoped and results will be provided for endorsement in October 2019. The gap analysis will also address Ocean Surface Winds (Action 46.10);

- The implementation of the coordinated actions has started, and the status is presented in this document;

- WGClimate has decided to implement a task team on GHG monitoring to establish the coordination between CGMS and CEOS on this important topic. The task team is working out the implementation roadmap which will be presented in autumn 2019 to CEOS Plenary and shared with CGMS as well;

- WGClimate presented the CEOS/CGMS statement to SBSTA-49, an extra report, and contributions to the SBSTA Chair report in December 2018. A presentation on the architecture for climate

monitoring from space was delivered to SBSTA-49 Systematic Observations Delegates. The next statements to SBSTA-50 shall be delivered in June 2019 and for SBSTA-51 in December 2019.

WGII took note of the report and congratulated on the work done. WGII welcomed the way forward for Leadership and the inclusion of GHG activities as well as the associated change in ToRs to be presented and approved by CGMS Plenary.

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Rec #**	**Description**
WGII	WGII 4	WGII/R 47.07	WGII recommends to CGMS-47 plenary the proposed approach for leadership in WGClimate.
CGMS	WGII 4	WGII/R 47.08	WGII recommends to CGMS-47 plenary the adoption of the updated ToRs.
CGMS	WGII 4	WGII/R 47.09	WGII recommends to CGMS-47 plenary the inclusion of Greenhouse Gas Monitoring activities in WGClimate as presented in CGMS-47-JWGCLIM-WP-03WGII.

CGMS-47-WMO-WP-07WGII: WMO polar and high-mountain activities (including status and plans of the Polar Space Task Group (PSTG))

This presentation provides an update on the status of the:

- WMO Global Cryosphere Watch (GCW);
- the activities of the WMO Polar Space Task Group (PSTG), as reported at the 8thSession of the PSTG, held 16-18 October 2018;
- The integration of cryosphere activities in view of the WMO's proposed Earth System Approach and Governance Reform is discussed.

The Polar Space Task Group (PSTG) supports the work of the EC Panel of Experts on Polar and High Mountain Observations, Research and Services, which oversees the WMO Polar and High Mountain activities which aim to provide a focused, integrated understanding of global impacts of changes in polar and high-mountain regions, facilitating services in support of resilience and adaptation.

Draft Resolution 6.1(4)/3 (Cg-18) - PRE-OPERATIONAL PHASE OF THE GLOBAL CRYOSPHERE WATCH (GCW) submitted for approval by WMO members at the 18th World Meteorological Congress, recommends the creation of a Cryosphere Monitoring Application Area, within the framework of the WMO Rolling Review of Requirements.

WG II took note of the above.

CGMS-47-WMO-WP-10: Update on WMO SCOPE-Nowcasting

This document is a status report on the WMO Sustained Coordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-Nowcasting) initiative. Formerly an ad-hoc group, the SCOPE-

Nowcasting Executive Panel met for the first time on 18-20 September 2017 in Geneva, Switzerland. The Executive Panel reviewed four existing SCOPE-Nowcasting projects and developed proposals for three new pilot activities.

The applications addressed by the original four pilot projects are: RGB imagery for nowcasting, volcanic ash detection and characterization in support of aviation, analysis and nowcasting of precipitation, and detection and characterization of Asian dust storms.

The new SCOPE-Nowcasting pilots complement the CGMS working groups on clouds, precipitation, and soundings by seeking to establish best practices for utilizing and integrating sounding, cloud property, and precipitation products for nowcasting convective weather events.

WGII to note of the activities.

CGMS-47-VLab-WP-01: VLab progress report and 5-year training strategy for endorsement

This document reports on activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) along with future plans. Since CGMS-46, VLab members have offered a variety of training opportunities, with highlight to training efforts addressing the new generation of satellites, as this proved to be the major training need identified by VLab members in recent years. Furthermore, the new Five-year Strategy Plan for VLab activities 2020-2024 was proposed by the VLab Management Group (VLMG) and endorsed by IPET-SUP. CGMS members are invited to take note of the Strategy, provide comments and endorsement. VLMG continued to coordinate its activities and support for training events via regular online meetings. Additionally, the Group met face to face in July 2018 for the ninth meeting of the VLab management group - VLMG-9. The meeting was hosted by the Cooperative Institute for Research in the Atmosphere (CIRA), on behalf of NOAA and WMO. The VLab Trust Fund continued to receive a steady level of contributions from NOAA/NWS, EUMETSAT, and KMA. However, a larger number of contributing CGMS agencies is required to improve its resilience. Regular financial contributions from CGMS members are critical to maintain technical support to the VLab (Action ii). Since October 2017, Dr Mark Higgins (EUMETSAT Training Manager) has been a VLab co-chair on behalf of CGMS satellite operators. This co-chairmanship was established for a period of up to 3 years. Nominations need to be considered by CGMS satellite operators.

There may be a need to develop an easily accessible overview/entry for all training activities and resources integrating with regional activities. Hence the following recommendation was placed:

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS agencies	WGII 4	A47.10	Agencies to continue to support the WMO maintained trust-fund that enables the work of the VLAB technical officer.	??
CGMS agencies	WGII 4	A47.11	Agencies to endorse the VLAB 5-year strategy plan.	CGMS-47

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS and VLAB	WGII 4	A47.12	Agencies to provide links to their training events and resources for VLAB communication.	
CGMS agencies	WGII 4	A47.13	Agencies to provide nominees for next VLAB co-chair starting in 2020 for three years.	

CGMS-47-IMD-WP-05: Validation of the Satellite-derived Atmospheric Motion Vectors (AMV) from INSAT-3D Imager

Atmospheric motion vectors (AMVs) are operationally derived by tracking features in sequential Thermal Infrared-1 (TIR-1), Water vapor (WV), Mid-Infrared (MIR) and Visible (VIS) imageries of INSAT-3D at a temporal resolution of 30 minutes. Significant improvement in retrieval technique and accuracy of the AMV derived from INSAT-3D has been observed compared to earlier versions. The validation exercise is done for the period of July 2014 to May 2017. In order to validate the derived AMV's, Radiosonde observations and National Center for Environmental Prediction (NCEP)/ Global Data Assimilation System (GDAS) numerical model analyses winds are used with the collocation criteria of spatial difference of 1° and vertical difference of 25 hPa are used in this study. For IR-1 and WV winds RS winds of 0000UTC and 1200UTC, MIR winds NCEP winds for 1800UTC and 0000UTC and VIS winds NCEP winds for 0600UTC and 1200UTC are used for validation process.

For example, the Root-Mean-Square Vector Difference (RMSVD) of IR AMV's at three levels (i.e., high, mid and low level), The root-mean-square vector difference (RMSVD), for IR AMV's at all levels i.e. high, mid & low are 5.34ms-1, 4.85ms-1 and& 3.95ms-1 respectively. And those of WV's and VIS's are similar values. RMSVD for WV AMV's for high & medium levels are 6.21ms-1 & 5.59ms-1 respectively. RMSVD for VIS AMV's for low & medium levels are 3.37ms-1 & 3.65ms-1 respectively. RMSVD for MIR AMV's for low & medium levels are 3.80ms-1 & 4.06ms-1 respectively. In addition to these RMSVD, and Bias is calculated separately for Tropics, Northern Hemisphere and Southern Hemisphere. All results are lying between standard AMV accuracy.

5. Cross-coordination between various Working Groups

CGMS-47-CGMS-WP-13WGIII: WGIII report on outcome of the risk assessment workshop and next steps

This working paper describes the outcome of the CGMS Risk Assessment against the CGMS Baseline. The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System – includes Space Weather.

The CGMS baseline responds to end-user requirements expressed in WMO's Rolling Review of Requirements (RRR). The CGMS Baseline strives to support the WMO Integrated Global Observing System (WIGOS) 2040 vison. The key principles are:

- Commitment: The CGMS members are providing, or have firm plans to provide, the observations, measurements, and services enumerated in the Baseline;

- Sustained: The observations, measurements, and services are provided on a sustained basis;
- Available: The observations, measurements, and services are available on a free and open basis;
- Operational: The data and products can be utilized in operational applications.

The Risk Assessment was carried out in early 2019 against the CGMS Baseline with the following objectives:

- Convey CGMS's posture with respect to its baseline commitment;
- Provide a high-level assessment designed to allow members to assess the current contribution to the user community as well as coordinate future planning to meet current and future baseline commitments.

Working Group III held a workshop from 27 Feb to 1 Mar, hosted by EUMETSAT and attended by EUMETSAT, NOAA, JMA, CMA, WMO, and CGMSSEC. Working Group III reviewed how CGMS current and future missions match the commitments made in the CGMS Baseline.

The findings and proposed mitigation actions from this Workshop were sent to the other Working Groups for review.

WGII reviewed and commented on the presentation noting that the Report from WGIII will provide a detailed discussion on the risk assessment. Following on from the presentation on the IPWG activities it was concluded that the ISWGs, GSICS and WGClimate can positively contribute to the risk assessment and future gap analysis. Particularly it was pointed out that issues with respect to instrument performance, impact of losses, orbit coordination and mitigation opportunities (research satellites, ground based observations, etc) is within the expertise of the ISWGs. Hence it is proposed that the assessment is reviewed by these working groups and that the assessment should not only present the risks, but also evaluate the potential impact.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WGIII	WGII 5	47.14	WGIII to provide their assessment and planning for the next risk assessment to the ISWGs, WGClimate and GSICS.	Mar/Apr 2020
ISWGs	WGII 5	47.15	The ISWGs, WGClimate and GSICS to review WGIII Risk assessment and consider mitigation opportunities.	CGMS-48

6. Working papers on other international science community reports – oceans, CEOS VCs

7. Space-based lightning observations

CGMS-47-CMA-WP-06: Primary application of Chinese Lightning Mapping Imager (LMI) on the FY-4A satellite

The working paper describes the preliminary performance results of Chinese first satellite lightning imager LMI onboard FY-4A in its The lightning imager LMI onboard FY-4A is Chinese first satellite lightning imager. Since the launch of FY-4A, we have carried out a lot of on-orbit monitoring, data validation and comparison analysis research. We also carried out lightning mapping products generating and observing data application research, such as data assimilation, convection monitoring. Preliminary results show that FY-4A LMI can correctly detect lightning activities and has the ability of strong convection monitoring. FY-4A LMI shows good consistency with ground lightning observation data.

When Satellite and ground lightning observation data have good consistency. Ccompared with observations of the LIS (Lightning Imager Sensor) onboard NASA ISS during 2017 summer, the lightning Detecting Efficiency of FY-4A LMI over the Tibetan Plateau (TP) is quite low. Further analysis shows that lightning activities over the TP is quite different from thosewith these over eastern China Plains in lightning radiation, including shorter life time of lightning plus, fewer average numbers of groups and events in each flash, and weaker flash radiation intensity etc. These characteristics may be related to high altitudes of the plateau, differences in cloud characteristics and heights of tropopause, and other factors. Thee comparison result implieshows that the on-board algorithm for extracting lightning signals over the TP applied on FY-4 LMI must be set different from that over the eastern part of the observations.

CGMS-47-EUMETSAT-WP-02: Status and plans – EUMETSAT

EUMETSAT presented the technical specifications of the Lightning Imager (LI) instrument, to be flown on the Meteosat Third Generation - MTG-I. EUMETSAT highlighted the importance of the end-to-end simulator and the challenges of the Cal/Val of lightning. International cooperation on space-borne lightning instrument Cal/Val, for example through exchanges with NOAA and CMA scientific teams, have been beneficial to EUMETSAT and strongly encouraged for CGMS in the future. The LI is currently scheduled for launch on MTG-I in late 2021.

CGMS-47-NOAA-WP-12: GOES-R series lightning detection and applications

New to the GOES-R series of NOAA satellites, the Geostationary Lightning Mapper (GLM) is now operating on both the GOES-16 and GOES-17 satellites. It provides continuous total lightning measurements over the full disk mode of the satellite, with a detection efficiency of over 70% with minimal false alarms.

This working paper summarizes the current status of the product suite that was developed at NOAA for use in AWIPS applications (e.g., flash extent density, lightning energy and flash area) and provides preliminary results from GOES-16. The working paper also highlights some of the challenges in interpreting and filtering out false signatures from the GLM.

In the subsequent discussion the impact of lightning observations on actual forecast improvements was questioned. In its response NWS representative noted that it is still early days and much can be learned on how to best use the data. The data presents significant potential but is only one component supporting very short range forecasting, nowcasting and extreme events. The need to have dedicated workshops bringing together the instrument scientists, data users and forecasters was acknowledged. It is anticipated due to the novelty of the field there would in the beginning only be smaller groups of experts gathering.

Some of these would also be involved in cloud monitoring activities, specifically with respect to strong convective situations and tropical storms. It was therefore agreed that as a starting point the ICWG should include a 0.5 – 1.0 long session on lightning at the next ICWG meeting in Autumn 2020.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
ICWG	WGII 7	47.16	ICWG to organise a dedicated session (0.5 -1 day) on lightning observations from space (calval, algorithms, applications and products).	??

8. Selected topics of high priority to members

CGMS-47-WMO-WP-11: Satellite data and products for WMO application areas

Satellite applications are evolving fast with access to new instruments of board of satellites like the Copernicus Sentinel series. These instruments provide data with enhanced spatial, spectral and temporal resolutions and there are also major advanced with developments on passive and active microwave payloads plus multichannel IR and VIS instruments. Data are accessible through different Earth Observation portals, including those provided by meteorological satellite operators or through services provided by Copernicus. WMO has been involved in several donor projects that are applying satellite products. The WMO Commission for Agricultural Meteorology (CAgM) is in particular concerned with improving access to satellite soil moisture information and to develop in-situ soil moisture monitoring that can be used for validation of satellite soil moisture observations. WMO experts have provided guidance to several Satellite Soil Moisture Validation and Application Workshops held from 2014 to 2017. In addition, there are several projects such as the Weather and climate Information SERvices for Africa (WISER) programme and the HIGH impact Weather lAke sYstem (HIGHWAY) project in East Africa. Over the past four years, there have also been requests from countries and regions to conduct training courses on various topics in agricultural meteorology. Nine training courses were jointly organised by WMO and EUMETSAT in cooperation with many other supporting organizations. WMO will continue these collaborations between providers of satellite products and to the application areas of agriculture, drought and other applications.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS space agencies	WGII/8	A47.17	CGMS agencies encouraged to present papers at CGMS-48 on use of satellite products for agricultural applications (ref CGMS-47-WMO-WP-11)	CGMS-48

WG II took note of the paper.

CGMS-47-WMO-WP-12: Request by tropical cyclone community regarding high-resolution observations from SENTINEL-1 mission

The Tropical Cyclone (TC) community recommends that WMO facilitate the creation of an internationally coordinated framework for targeting Synthetic Aperture Radar (SAR) acquisitions of tropical cyclones, for both operational tropical cyclone analysis and forecasting and research uses. For this purpose, the TC community recommends WMO to request the European Union's Earth Observation Programme - space component of Copernicus, to prioritize acquisition and access to these data. The SAR observations provide valuable ground truth for development and validation of guidance used in operations. SAR data may also be of value for evaluation and data assimilation for high-resolution tropical cyclone numerical weather prediction models. In addition, the routine collection/creation of these data will be invaluable in post season reanalysis of the forecast model's TC tracks and wind structure and will also provide a high-quality research database of tropical cyclone structure. Starting 2016, a feasibility study (Satellite Hurricane Observation Campaign - SHOC) has been performed within the framework of an ESA Scientific Exploitation of Operational Missions. It shows that he Sentinel-1 mission planning team can ingest forecasts of TC tracks to modify the acquisition plan and acquire high resolution observations; the new capabilities of combined with new algorithms allow the derivation of high resolution surface wind field over the ocean; Sentinel-1 high resolution measurements provide high quality and unique observations of the ocean surface under extreme weather conditions and in all ocean basins; the acquisition of SAR data over TC does not disturb the existing Copernicus services. Copernicus should investigate the possibility of creating a European service (or a component within an existing service) to optimize SAR acquisitions over TCs, and to provide, in near real time, the SAR observations and surface wind field estimates to the Tropical Cyclone community at large, both with data formats.

WG II took note of the presentation and found the proposed special observation mission interesting and encourages ESA and the EC to further explore this potential.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
ESA	WGII/8	A47.30	ESA to present a paper on SAR applications for storms and flooding with information on enhanced acquisitions and latency. (ref. CGMS-47 WMO-WP-12)	CGMS-48

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Rec #**	**Description**
ESA and EC	WGII/8	WGII/R47.10	ESA and EC to explore the possibility of creating a European service (or a component within an existing service) to optimise SAR acquisitions over TCs, and to provide, in near real time, the SAR observations and surface wind field estimates to the Tropical Cyclone community at large, both with data formats

CGMS-47-WMO-WP-13: SATELLITE-DERIVED COASTAL BATHYMETRY

The impact of extreme events such as tropical cyclone landfall and the associated storm surge and waves requires good estimates of coastal bathymetry. The sparseness of medium to high resolution bathymetry for areas of interest requires the use of various technologies and techniques to acquire better datasets. Extracting bathymetric data from satellite imagery through the development of algorithms is one of them. The Tropical Cyclone (TC) community, the operational forecasting community, the research community, the integrated operational and research communities, repeatedly recommended to pursue synergies among partners to collect bathymetry for target areas in order to improve coastal hazards modelling and warnings. These recommendations are underpinned by the space agency response regarding “Improved Bathymetry” to the Global Climate Observing System Implementation Plan and by the collaborative project "Seabed 2030” between the Nippon Foundation and GEBCO, aiming to bring together all available bathymetric data to produce.

WGII welcomed the paper and the requirements. It was confirmed that in the case of tropical storms the required information on storm surges is not available in a timely fashion.

CGMS-47-NOAA-WP-13: Status of JPSS satellite products and applications in polar regions

Polar-orbiting satellites orbits provide data and products in multiple, over-lapping passes over arctic regions. These satellites provide critical environmental data in remote areas where ground-based instrumentation is not otherwise available. The JPSS high spatial resolution and night-time capabilities are ideally suited for arctic regions. NOAA and the University of Alaska have established a robust satellite antenna system in Alaska, ensuring ready access to satellite data and products. The JPSS Proving Ground and Risk Reduction Program (PGRR) has maintained effective partnerships with arctic stakeholders in AK and in other countries of the world. The PGRR Program has a specific Arctic Initiative and many other PGR initiatives have an arctic focus in their activities. The Arctic Initiative includes demonstration with the NWS in Alaska and the National Ice Center. The purpose is to demonstrate the value of JPSS operational and experimental cryosphere products. They include:

- Ice Age/Thickness (VIIRS)
- Ice Concentration (VIIRS and ATMS)
- Ice Surface Temperature (VIIRS)
- Ice Motion (VIIRS/AMSR-2) [experimental]
- Ice Leads (VIIRS) [experimental]
- Sea Ice Characterization (AMSR-2)
- Multi-year Ice Fraction (AMSR-2) [experimental]
- Cloud, SST, and Imagery Products (VIIRS)

Feedback has been positive, and a report is being prepared. The JPSS Proving Ground program is interested in engaging other stakeholders with Arctic missions where satellite data products may support your applications. Is there adequate international science engagement in this area, as we currently have within the existing CGMS international science working groups.

In the discussion it was noted that other agencies do provide similar products. It was suggested that NOAA contacts the EUMETSAT Ocean and Sea Ice Satellite Application Facility to investigate further the opportunities for collaboration.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
EUMETSAT	WGII 8	A47.18	EUMETSAT to provide PoC for NOAA for OSI SAF for discussion on future collaborative work/workshop for development of cryospheric products	??
CGMS space agencies	WGII 8	A47.19	CGMS agencies to present solutions at CGMS-48 for satellite-based bathymetry (CGMS-47-WMO-WP-13)	CGMS-48

CGMS-47-CMA-WP-04: The Development of Chinese Radiometric Benchmark Satellite

To promote the absolute accuracy and stability of essential climate variable (ECV) measured by satellite, and to provide a space-based radiometric reference to homogenize the Earth observation from multiple satellite platform, the radiometric benchmark satellite is strongly recommended by several communities. As a result, the Climate Absolute Radiance and Refractivity Observatory (CLARREO) was proposed by NASA, Traceable Radiometry Underpinning Terrestrial- and Helio- Studies (TRUTHS) was proposed by JPL, Chinese Radiometric Benchmark Satellite (CRBS) by CMA and CAS independently.

In this working paper, the status of CRBS is introduced. CRBS is funded by Ministry of Science and Technology (MOST) since 2012. There are three phases have been set for this project. Phase A is from 2014 to 2018 and the goal is to develop the SI-traceable calibrator for infrared (IR), reflective solar band (RSB). Phase B is from 2018 to 2022 and the goal is to develop engineering model of the reference instruments. Phase C is from 2022 to 2025 and the goal is to develop the flight model of CRBS.

WGII welcomed this important initiative and urged CMA to continue the work.

CGMS-47-CMA-WP-03: Retrospective Calibration of Historical Chinese Fengyun Satellite Data

In this working paper, the progress on the re-calibrating the 30-years' historical Chinese FY satellites will be introduced. The historical Chinese FY satellites include thirteen meteorological satellites (FY-1A, FY-1B, FY-1C, FY-1D, FY-2A, FY-2B, FY-2C, FY-2D, FY-2E, FY-2G, FY-3A, FY-3B and FY-3C) and seven varieties on-boarded instruments (VIRR, VISSR, MERSI, IRAS, MWTS, MWHS and MWRI).

The first Chinese meteorological satellite (FY-1A) was launched in 1988. So far, the Chinese meteorological satellite has been continuously observed for nearly 30 years. Satellite replacement and on-board sensors upgrade make the old and new observation data uneven in terms of accuracy, stability and consistency, and cannot meet the basic needs of long-term sequence climate and environmental change research.

To enhance the capability on the space-based essential climate variable (ECV), a new National Key Research & Development Program of China was funded since 2018 to re-calibrate the historical Chinese

Earth Observation satellite data including the Chinese Fengyun Meteorological Satellites (FY), the Chinese Haiyang Oceanic Satellites (HY), and the Chinese Ziyuan Resource Satellites (ZY).

The vicarious China radiance calibration site (CRCS) calibration, the pseudo invariant calibration sites (PICS) calibration, the deep convective clouds (DCC) calibration, and the lunar calibration have been considered in the procedure of the re-calibration for solar reflectance bands. In addition, some initial results for the re-calibration was reported.

In the discussion it was noted that in order for the wider community to support the CMA activities on hyperspectral instrument data, it is necessary to have access to detailed information on the instrument characteristics, e.g. Instrument Line Shape and Spectral Response functions. It was also noted that in general these activities would benefit from a dedicated workshop on instrument recalibration.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CMA	WGII 8	WGII/A 47.20	CMA to provide information on ILS and SRF and other relevant documentation to the user community for the development of necessary RTMs/tools for the exploitation of HIRAS and GIIRS data.	??
GSICS, JWG Climate, SCOPE-CM	WGII 8	WGII/A 47.21	GSICS, WGClimate and SCOPE-CM to organise a workshop on calibration supporting reprocessing.	??

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

CGMS-47-ISRO-WP-05: ISRO Report on Highlights and Issues in Datasets and Products

ISRO's status report presented an update on the geostationary INSAT-3D and -3DR, Megha-Tropiques and the ocean missions Oceansat-2, Saral and Scatsat. For the geostationary satellites, new products like Cloud Top properties, Clear Sky Brightness Temperature and Total Precipitable Water have been developed. Full disk AMVs have also been developed and is in the approval process. For Megha-Tropiques and the ocean missions the current status of the missions were given. In addition to the existing scatterometers, I Oceansat-3 and -3A, ISRO is also considering possible follow-on missions.

WGII took note of the paper and congratulated ISRO on their great contribution to ocean monitoring. The strong contribution by ISRO to scatterometry was highlighted and ISRO was encouraged to consider future scatterometry missions beyond Oceansat-3/3A.

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Rec #**	**Description**
ISRO	WGII 9	WGII/ R47.11	ISRO is encouraged to consider follow-on missions on scatterometry to Oceansat-3/3A.

CGMS-47-KMA-WP-03: KMA report on highlights and issues in dataset and products

The working paper presents the status of KMA global model, GK2A commissioning, and drought monitoring.

The horizontal resolution of KMA global model was improved from 17km to 10km in June 2018. GOES-16 AMV and polar wind data from SNPP/VIIRS and Metop-A(B)/AVHRR data was investigated for use in global model. The impact of MSG-4/SEVIRI CSR, NOAA-20/CrIS & ATMS, Scatsat-1/OSCAT and Metop-C/ASCAT wind & GRAS data will be evaluated in 2019. Regional model was retired in February 2019. CSR and AMV from COMS and Himawari-8 started to be used in local model in April 2019.

GeoKOMPSAT-2A (GK-2A) was successfully launched in December 2018 and is under in-orbit test and commissioning. The pre-launch science algorithms for 52 geophysical products for GK-2A were evaluated and prepared by using Himawari-8 data. KMA starts their maturity evaluation using GK-2A AMI data, and plans to release the products after evaluation. AMV and CSR data expected to be provided to international users by the end of this year.

KMA utilizes JAXA AMSR-2 soil moisture and COMS evapotranspiration for drought monitoring. Deep learning approach is tried for further improvement on COMS hydro-meteorological parameters. At the same time, KMA is developing drought monitoring based on Vegetation Health Index (VHI) for GK-2A application.

WG II took note of the report.

CGMS-47-ROSHYDROMET-WP-02: Satellite data and product applications in Roshydromet

The working paper presents an overview of operational and research activity in Roshydromet (SRC Planeta) related to the derivation and application of remote sensing products from satellite data. For example, cloud images and cloud analysis products generated from MSU-MR/Meteor-M №2 data; Barents Sea ice cover map based on Kanopus-V (IR) data; Total Ozone Column retrievals from Electro-L №2 data; CO2 concentration estimates from IKFS-2/Meteor-M №2 data; cloud motion winds from Electro-L №2 data. In additionassimilation of hyperspectral IR sounder IKFS-2 (Meteor-M N2) data in the Hydrometcenter of Russia is discussed. Analysis of the IKFS-2 measurements accuracy was carried out, and detailed description of IKFS-2 data assimilation are reported. The assimilation of IKFS-2 data has led to a noticeable increase in the accuracy of three-day weather forecasts.

WG II took note of the presentation.

CGMS-47-ROSCOSMOS-WP-01: The functional and calibration features of the multispectral scanner MSU-GS onboard Elektro-L No. 2

The working paper presents the overview of the constructive features and the estimation of the metrological characteristics of the multispectral scanner MSU-GS (Elektro-L No. 2), based on the results of operation of MSU-GS No. 2.

In comparison with MSU-GS onboard Elektro-L No. 1 constructive and radiometric characteristics of MSU-GS onboard Elektro-L No. 2 were significantly enhanced, especially for IR module. Also, ground calibration complex, located at JSC "Russian space systems", was substantially upgraded. Due to that the uncertainties connected with ground spectro-radiometric calibration were reduced.

MSU-GS (Elektro-L No. 2) radiometric characteristics have been compared with the VIIRS (SUOMI NPP) and SEVIRI (Meteosat-10). The sample products are presented based on Elektro-L No. 2 data survey.

The estimation of metrological characteristics of MSU-GS onboard Elektro-L No. 2 in comparison with VIIRS (SUOMI NPP, GEO-LEO) and SEVIRI (Meteosat-10, GEO-GEO) showed a good match between these instruments received data, and an opportunity of thematical products formation based on MSU-GS image data. The resulting products meet the world quality standards.

The application of new constructive solutions in MSU-GS production provided technical groundwork, which is used in the development of the perspective multispectral scanning instruments for "Meteor-M", "Meteor-MP", "Kanopus-V-IK", "Elektro-L", "Arctica-M" satellites.

WG II took note of the presentation.

CGMS-47-ROSCOSMOS-WP-02: Calibration of microwave imager/sounder MTVZA-GY onboard «Meteor» satellites series

The working paper presents the calibration of the conical scanning microwave imager/sounder MTVZA-GY onboard the Meteor satellite series of ROSCOSMOS. The instrument covers several bands with 18 channels from 10.65 to 183.31 GHz with a spatial resolution from 16 to 198 km. The design of the calibrator was introduced and results from pre-launch calibration were shown. The black-body and in-orbit calibration results confirmed that the instrument calibration is meeting the specifications. These results were further corroborated by tropical rain forest calibration. These results have been confirmed with measured data of the radiometer AMSR2 on GCOM-W1 and with ground-based measurements at the Concordia station (Antarctica) and GEOSammit (Greenland).

Data MTVZA-GY are a source of valuable quantitative information about the environment and can make a significant contribution to the study of dynamic processes in the system atmosphere - underlying surface by increasing the temporal resolution of satellite sounding data, the availability of the channels to restore the characteristics of the ocean, sea ice, integral parameters. The next satellite will be launched in summer 2019 and will be the first Russian satellite in the afternoon orbit (ECT 15:00).

WGII took note of the report and congratulated Roshydromet and Roscosmos for the excellent performance o IKFS/2 and noted that the next Meteor, which will be launched early July 2019 with a 1500 ECT will be an important contribution to the global observing system.

CGMS-47-JAXA-WP-03: JAXA Earth Observation Program and Data Product

The working paper gives an update of the status of JAXA's satellite systems now in operation and to be launched in the near future. Mainly focused on the remote sensing satellites for earth observation which

is and be able to contribute to the climate issues. JAXA is currently operating the Dual-Frequency Precipitation Radar (DPR) on the Global Precipitation Measurement Mission (GPM), the Global Change Observation Mission -Water "SHIZUKU" (GCOM-W), the Global Change Observation Mission - Climate "SHIKISAI" (GCOM-C), the Greenhouse gases Observing SATellite "IBUKI" (GOSAT), the Greenhouse gases Observing SATellite-2 "IBUKI-2" (GOSAT-2) and the Advanced Land Observing Satellite-2 "DAICHI-2" (ALOS-2). The major updates since CGMS-46 is that GCOM-C and GOSAT-2 has successfully been in the normal operation. JAXA is preparing the Cloud Profiling Radar (CPR) on the EarthCARE, the Advanced Optical Satellite "DAICHI-3" (ALOS-3), and the Advanced SAR Satellite "DAICHI-4" (ALOS-4). JAXA is also working for joint mission of the GCOM-W follow-on instrument and GOSAT-2 follow-on instrument, which is the mission of Ministry of the Environment in Japan. Focusing on precipitation radar measurement missions, JAXA is now starting the discussion of future precipitation radar mission.

WG II welcomed the contribution by JAXA noting specifically the importance of the GOSAT satellites and the critical role the AMSR-mission currently has for all sky sea and ice retrievals. WGII welcomed the good news on the progress of planning an AMSR-follow on mission.

CGMS-47-WMO-WP-14: WMO Space Programme Report (including on IPET-SUP work)

This presentation provides an update on the status of the WMO Space Programme Office.

The activities since CGMS-46 are described under the four main components of the Programme: 1) space-based observing system; 2) access to satellite data and products; 3) awareness and training; and 4) space weather coordination.

The draft resolutions submitted by the WMO Space Programme Office to the 18thWorld Meteorological Congress and the proposed WMO Governance Reform and its impact on space-based observations are discussed.

Action/Recommendation proposed: CGMS-47 to take note of the above and to provide feedback to the WMO Space Programme Office.

The 5th IPET-SUP session was held from 11 to 13 February 2019. It resulted in 13 actions, most of which are already progressing. A new strategic plan for IPET-SUP (2020-2023) and the role of IPETSUP activities in the context of the WMO Governance Reform were discussed.

WG II took note of the report.

CGMS-47-JMA-WP-03: JMA report on highlights and issues in datasets and products

The working paper summarizes JMA's reporting on datasets/products and related issues, with focus on:

1. Himawari-8 observation data quality
2. Level-2 products - AMV based Sea-surface Wind (ASWind) - Aerosol Optical Depth - Fog Detection.

The main points presented are:

- Details of radiometric calibration and 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 navigation errors within 600 m at the sub-satellite point, while radiometric calibration biases are less than 5% of reflectivity for visible and near-infrared bands 1 to 6 and less than 0.3 K of brightness temperature for infrared bands 7 to 16. The slope and intercept for correction of sensor sensitivity for bands 1 to 6 were updated on 9 July 2018.
- A health check was conducted on the satellite's back-up Himawari-9 unit in October 2018, with no problems being found in the satellite and ground systems.
- The ASWinds sea surface wind product is currently provided to RSMC-Tokyo and utilized as a source of effective information on typhoon analysis. In June 2019, it will be released on the MSC website to support tropical cyclone monitoring for disaster risk reduction activities in the Asia-Oceania region.
- The new AOD retrieval algorithm developed by JAXA is currently in operational use. The resultant data product is provided every 10 minutes and used to monitor Aeolian dust events and will be assimilated into JMA's aerosol prediction model.
- The Fog Detection product has been provided online since March 2019 for domestic aviation operators. Although coverage is still limited to the Japan area, a global version of the product is being developed.

WGII took note of the report.

CGMS-47-NOAA-WP-14: Status of NOAA Agency Report on Highlights and Issues in Dataset Product Generation

The paper presents the recent update of NOAA's next generation GOES-16/17 and SNPP/NOAA-20.

The launch of NOAA's JPSS-1, the first in a series of four satellites, provides the advanced global observations for the next 20 years to feed weather forecast models and to provide critical environmental intelligence. NOAA is on track to perform the Cal/Val activities for NOAA-20 in a much more accelerated timeline than S-NPP. L1b instrument data for all instruments were validated and ready for operations in 3 months. The validation and operational readiness for L2 products are in progress and on track with the first set of these achieving operational readiness in 3 months.

NOAA's operational LEO suite is enhanced with the addition of NOAA-20 to it. Having NOAA-20 and NPP observations separated by 50 minutes, for example, provides improved coverage of significant environmental events.

NOAA's operational GEO suite has been enhanced with the launch of GOES-17 mon March 1, 2018 GOES-17 became the NOAA's operational GOES-West satellite at 137W on February 11, 2019. ABI 10-min FD scanning has been implemented on GOES-16 and GOES-17 which provides improved temporal sampling, and now matches the cadence of observations from neighbouring Himawari-8/9 AHI, GeoKompsat-2A AMI, and the planned scans from MTG's FCI.

The validation and operational readiness of GOES-17 L1b and L2 products are in progress and on track. The GOES-17 ABI thermal system is not functioning properly which impacted the operation of the ABI instrument. Successful calibration mitigation efforts have resulted in the restoration of approximately 97% of the ABI data. Mitigation efforts to update L2 product algorithms are underway. The GOES Lightning Mapper (GLM) instrument detects electrically active storms and the areal lightning extent and allows forecasters to track embedded convective cells, identify strengthening and weakening storms and monitor convective mode and storm evolution. An intensive effort is underway to develop a new suite of gridded GLM products (Flash extensity density and total optical energy) that are specifically tailored to NWS operations.

NOAA's Integrated Calibration/Validation System (ICVS) Long-Term Monitoring provides real-time environmental satellites performance monitoring, and timely technical support to NOAA-20, S-NPP, GOES-16, and GOES-17 on-orbit calibrations.

WG II took note of the report.

CGMS-47-NASA-WP-02: NASA report on highlights and issues in dataset and product generation

NASA provides significant knowledge about the Earth's global environment with its current fleet of 23 operating missions and a vigorous program of airborne and surface-based observations that both complement and provide calibration/validation for space-based sensors, laboratory calibration facilities, and the production of model/data hybrid products through data assimilation and modelling. This knowledge extends both to quantitative knowledge of Earth system parameters (many of which are not well documented through previous space-based measurement programs), and the understanding of the processes that drive Earth system behaviour. This working paper presents recent results and a summary of several NASA activities we believe are of particular interest to CGMS members, many of which are not addressed in separate working papers. These include particular activities in calibration/validation (both from laboratory facilities and field campaigns that can provide relevant information for satellite missions of interest to CGMS) and data products from NASA satellite missions (including selected highlights from recently-launched missions).

WG II took note of the report.

CGMS-47-EUMETSAT-WP-16: EUMETSAT Report

EUMETSAT's working paper focussed on the status of the Metop-C satellite, the last of three Metops, which successfully launched on 8 November 2018. The presentation covered the latest status of the Metop-C platform, of the instruments, and of the products. The mission Operational Readiness Review (ORR) took place in early May and Metop-C should be declared operational in July, replacing Metop-B as the primary Metop mission. The final flight configuration of the three Metops, i.e. in "trident" or "tristar" configurations, is being analysed. A decision on the final positioning of the satellites will take place in the second half of 2019.

WG II took note of the report.

CGMS-47-ESA-WP-02: Update on the ADM-Aeolus mission

The Working paper presents 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) world-wide. The primary mission objective is to demonstrate the DWL technique for measuring wind profiles from space, intended for assimilation in Numerical Weather Prediction (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 Atmospheric LAser Doppler INstrument (Aladin) instrument switch-on was completed with first high energy output in wind mode on 4 September 2018. The on-ground data processing facility worked excellent, allowing L2 product output in near-real-time from the start of the mission. Aeolus was commissioned between August 2018 and January 2019, and the early operational phase started in February 2019. The Instrument calibration, product validation and algorithm refinements are still on-going. The Aeolus observations were released to the 25 CAL/VAL Teams from across the world in December 2018. The first Aeolus CAL/VAL and Science Workshop was held in ESA-ESRIN in March 2019. Representatives of the European, US, Canadian, Chinese and Japanese user communities and space agencies were present. It was reported that the Doppler Wind Lidar technology for space-based measurements of winds of high quality was fully demonstrated already shortly after the instrument switch-on in September 2018. First results from the wind profile product (L2B) assessment by CAL/VAL teams and NWP centres show that the winds are of high quality, with random errors in the free Troposphere within (cloud/aerosol backscatter winds: 2.1 m/s) and larger (molecular backscatter winds: 4.3 m/s) than the requirements (2.5 m/s), but still allowing statistically significant positive impact in first preliminary NWP impact experiments by several NWP centres. The impact seen is comparable to other in-orbit satellite observing systems. However, longer datasets of fully calibrated data are needed to confirm these very positive first results. The higher than expected random errors at the time of writing are amongst others due to a lower instrument out- and input photon budget than designed. The instrument calibration is working well, and some of the data processing steps are currently being refined to allow to fully correct instrument alignment related drifts and elevated detector dark currents causing biases in the first data product version. The optical properties spin-off product (L2A) is being compared e.g. to NWP model clouds, air quality model forecasts, and collocated ground-based observations. The L2A CAL/VAL results show that the product is reasonable, but less mature and needs more work to give robust results. The output energy of the primary laser (Laser-A) is, however, decreasing with time, and the user community decided to switch to the redundant Laser-B around mid-June 2019 in order to raise the instrument output energy to ensure good and stable data quality. Laser-B has an improved design compared to Laser-A, and it is expected that further laser energy drifts will be mitigated after the switch. Longer calibrated datasets are expected to become available in the second half of 2019, in time for the next Aeolus CAL/VAL and Science workshop in March 2020 and the WIGOS2020 global observing system impact assessment meeting in May 2020. In the Workshop summary session, it was again underlined that first results from Aeolus are very positive and that the motivation and interest of the community is very high as already noted at the in-orbit commissioning review. ESA thanked the CAL/VAL teams and NWP centres for their great work and first results presented. The community is looking forward to the next processor updates when the instrument calibration will be gradually switched on.

WG II took note of the report and congratulated ESA on this excellent mission. It has already achieved one key objective, namely the ability to derive wind profiles using lidars in space, but also that the required accuracy is possible. Furthermore, the initial results on impact on NWP data assimilation and forecasts is encouraging, particularly noting this is still only early days.

10. Working papers responding to or raising CGMS actions

CGMS-47-CMA-WP-09: Monitoring Flood based on Multi-source Satellite Observations

The working paper presents the efforts of CMA on flood disaster prevention.

Flood disaster is one of the most frequent natural disasters in the world. Flood disaster prevention and mitigation are of great concern to many countries. Satellite remote sensing technology can play an important role in flood monitoring and assessment. The spatial resolution of meteorological satellite remote sensing data ranges from 100 meters to kilometres, and the temporal resolution can reach more than one day. It can play an irreplaceable role in flood disaster monitoring. The method of OSTU algorithm is a global binarization algorithm with self-adaptive threshold. When the optimal threshold is chosen, the difference between water and land reaches the maximum, which can better distinguish water and land information. Using this method, based on the Fengyun satellite data, the flood disaster monitoring applications in China and foreign regions have been carried out, and satisfying results have been obtained.

In order to obtain detailed flood information, flood disaster monitoring applications using high spatial resolution radar and optical remote sensing data with the meter and ten meters spatial resolution are also used. The radar satellite data of Sentinel-1 and GF-3 have the characteristics of all-weather and all-time. They have become the key data source of flood disaster monitoring and detailed disaster assessment in key regions under the weather conditions of clouds and rains often accompanied by floods. Optical remote sensing data with high spatial resolution such as HJ satellite and GF-1 can also obtain more refined spatial distribution information of flood water body in clear sky. Based on these high-resolution data, the application of regional flood disaster monitoring in China is developed, which provides satellite remote sensing information support for flood disaster monitoring and assessment.

WG II took note of the paper and deferred the discussion until after the NOAA paper.

CGMS-47-NOAA-WP-15: Status of CGMS Flood Mapping Pilot Study

Floods events have the highest frequency and most damaging impact of all-natural disasters. New operational weather satellites such as JPSS, GOES-R, Himawari, FY-3D, FY-4A for the very first time have the spectral bands for inundation mapping and large geographic and temporal coverage. These satellites have real-time distribution capabilities allowing fast generation and utilization of disaster products for critical decision-making. The operational polar satellites have direct broadcast and the geostationary satellites have direct broadcast, rebroadcast, and/or cloud services for immediate access to data.

CMA and NOAA submitted a proposal in response to a CGMS-45 action to develop a flood pilot proposal with the focus on the use of operational LEO and GEO satellites. The NOAA/CMA proposal will include the

development and inter-comparisons of flood products from the new generation of operational satellites with verification using flood maps/imagery provided by the CEOS agencies and those collected if available through International Disaster Charter. The goal of the CGMS flood initiative is to work towards the generation and distribution of flood maps to users of the new operational LEO and GEO satellites.

The proposal called for identifying flood case studies from May 2018 to October 2018 (this allows the new FY3D and FY4A to be used – post commissioning). Eight cases were selected and processed. The pilot study will include an evaluation stage where potential users from National Meteorological and Hydrological Services (NMHSs) working through the WMO will be asked about the utility of the product. After the evaluation stage, the WMO will reach out to the different WMO regions to establish formal user requirements. NOAA will provide software for processing flood maps from JMA, (and at a later date KMA) geostationary satellites direct broadcast and/or cloud data using its Community Satellite Processing Package (CSPP) for Geostationary Satellites. NOAA already provides flood mapping software for JPSS direct broadcast. NOAA will provide training through WMO/CGMS VLAB coordination. CMA likewise will provide software and training for their satellites and may provide the product on CMACAST. Intercalibration via GSICS will provide more consistent products.

WG II congratulated CMA and NOAA on the great progress that has been done with this pilot project. The outreach to the regions and to non-space fairing countries was highly appreciated. It seems that the product and approaches are now achieving an operational maturity and can hence be well integrated in operational services.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
NOAA and CMA	WGII 10	A47.22	NOAA/CMA to provide final report from the flood-mapping pilot for CGMS-48.	CGMS-48

CGMS-47-NOAA-WP-16: Status of NOAA Landing Pages on Calibration Events

NOAA has two very comprehensive landing pages for JPSS and GOES-R which included calibration events. Information is provided on instrument specifications (spectral response functions), instrument events, data outages, instrument monitoring and relevant documents. Also, the display and monitoring products are included, as well as their Algorithm Theoretical Basis Documents and points of contacts of lead scientists responsible for the science quality of the sensor data records and derived environmental data records. A readme file will be provided to help navigate the website. The landing pages still need to be linked from the WMO OSCAR. Meanwhile users can use www.star.nesdis.noaa.gov/jpss and www.star.nesdis.noaa.gov/goesr.

WG II took note of this activity which is closely related to the GSICS activities.

CGMS-47-CMA-WP-07: The status of FY satellite data quality and its assimilation in NWP

After the successful launch of FY-3A (the first one of the second-generation FY polar orbit meteorological satellites) in 2008, the NWP community had the opportunity to assimilate the directly observed radiances

from the FY-3 satellite program into NWP models to further improve their forecast skill. Five instruments onboard FY-3 are of particular interest to the NWP community—namely, MWTS, MWHS, the High spectral Infrared Atmospheric Sounder (from IRAS to HIRAS), GNOS and MWRI. Besides, the three new instruments on FY-4A, i.e., GIIRS, AGRI and LMI, are also of interest to the NWP community. A satellite data status monitoring system has been established to real-time monitor the satellite telemetries and the difference between observations and simulations. The L1 radiance data of these instruments are also rigorously evaluated with other various methods. The evaluated results for every instrument data are introduced in this paper. The CMA, ECMWF and UKMO have already operationally assimilated FY-3's data, proving that they are of good quality for NWP. Evaluation of the quality of three instruments on FY-4A and their potential to improve forecasts is under way.

WG II congratulated CMA in the progress of their activities and encourages them to present their work at the next WMO NWP Impact Workshop.

CGMS-47-WMO-WP-15: Implementation of landing pages on CGMS agencies' calibration events (for the WMO Oscar space database)

WMO please provide a summary of the paper

CGMS-47 RECOMMENDATIONS - WGII			
Lead	**AGN item**	**Action #**	**Description**
CMA	WGII 10	WGII/ R47.12	CMA is encouraged to present their impact analysis work at the upcoming WMO NWP Impact Workshop in May 2020.

11. Space weather matters: SWCG interactions with WGII

CGMS-47-GUEST-WP-06: Update on ICAO space weather services

CGMS-47-SWCG-WP-01: SWCG outcome and salient points for WGII (including on inter-calibration of space weather sensors in cooperation with GSICS)

CGMS-47-SWCG-WP-02SWCG: Task group on inter-calibration of high energy particle sensor

SWCG presents the inter-calibration of space weather sensor especially high energy particle sensor, and the establishment and the activity of task group.

Observation of high energy particle in geospace (space environment around the Earth) is used for housekeeping information of individual satellite, and risk assessment of satellite anomaly due to deep dielectric charging. Although high energy particle sensor is on-board several meteorological satellites in GEO, there have been no distinguished activity of the inter-calibration so far. Since particle observation is in-situ measurement, two-dimensional or three-dimensional particle distribution in geospace needs to construct from the combination of many satellite data. So, inter-calibration of space weather sensor is needed for making advanced product of space weather. For these reasons, the task group of inter-calibration of high energy particle sensor was established. And we had a kick-off teleconference in Feb.

2019. The activity of task group is just started. Based on the previous intercalibration activity and the results of discussion in the kick-off meeting of the task group, we have reported status of our intercalibration activity to GSICS Annual meeting and GSICS EP meeting. Task group of inter-calibration of high energy particle sensor will contribute practical use of space-based space weather data and product.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SWCG	WGII 11	WGII/A 47.23	SWCG to further develop white-paper on current instruments and their calibration and to provide report to GSICS for review.	??
GSICS	WGII 11	WGII/A 47.24	GSICS to review SWCG white-paper on calibration and consider opportunities for GSICS support to aforementioned activity.	??

12. Review and updating of the WGII TOR (due 2020)

CGMS-47-WGII-WP-01: WG II Terms of Reference

The WG II terms of reference are due for review at CGMS-48. It was therefore proposed to consider possible modifications during the intersessional teleconferences.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WG II	WGII 12	A47.25	WG II to review its terms of references during intersessional meetings before CGMS-48.	Nov 2019, Mar 2020

13. Review and updating of the HLPP

CGMS-47-CGMS-WP-08WGII: Status of implementation of CGMS High Level Priority Plan (2018-2022)

The status of implementation of CGMS High Level Priority Plan (2018-2022) is presented. It incorporates inputs from: - WG – I, II, III and IV chairs and rapporteurs - International Science Working Group chairs and rapporteurs - GSICS project - SCOPE-CM project - CEOS-CGMS Joint Working Group on Climate - CGMS Space Weather Coordination Group To guide the considerations of the working groups, the colour coding in the table indicates: Green: Priority is reflected in ongoing CGMS actions Yellow: Actions have been defined associated to the priority, but progress is limited Red: No actions associated with the priority can be identified or major obstacles is hindering progress.

Action/Recommendation proposed:

- WGs I, II, III and IV to consider and amend the status of implementation of the HL
- The WGs should in particular:
  - identify priorities within their area of focus that can be considered achieved and should be removed from the HLPP.

- Identify new or modified priorities, that should be considered by CGMS for inclusion in the revised HLPP. Some recommendations have already been identified during the preparation of this document and are reflected in the tables below
- Consider whether priorities where no actions can be identified should be retained in the HLPP.

CGMS-47-CGMS-WP-03WGII: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2019-2023

WG II reviewed the status of the HLPP and provided additional updates to the status. In addition, three new HLPP targets were proposed, one was proposed to be reformulated and two transferred to WGIII.

During the review it became apparent that the JMA testbed for volcanic ash is accessed only by a limited number of people and does not warrant maintaining/upgrading the infrastructure, JMA will therefore close it down. There is therefore an Action on WG II to consider alternatives.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WGII	WGII 13	A47.26	WG II to consider alternatives to the JMA Volcanic Ash algorithm Testbed.	??
CMA	WGII 13?	A47.27	CMA to provide a PoC for the IPWG validation protocol (HLPP 4.3.1).	??

14. Any other business

CGMS-47-WMO-WP-22: Update on the 7th WMO NWP impact workshop 2020

Since 1997, WMO has regularly convened Workshops aimed at assessing the respective contributions to numerical weather prediction (NWP) skill of all components, both space-based and conventional, of the Global Observing Systems. These Workshops have been instrumental both in helping data assimilation and NWP to progress and in issuing guidance regarding the future development of space-based and conventional observing systems.

At the kind invitation of the Republic of Korea, the 7th WMO Workshop on the Impact of Various Observing Systems on NWP is planned to take place in Seoul in May 2020. A scientific organising committee has been established and it has developed a list of proposed science questions based on input from various stakeholders, including the CGMS agencies. The First Announcement regarding the workshop is provided below for information.

WGII took note of the upcoming NWP impact workshop.

CGMS-47 ACTIONS - WGII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WGII	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-48

15. Nomination and representatives at meetings

No new nominations were considered at this session.

16. Date/time of inter-sessional activities/meetings in 2019-2020 [CGMS-47 -> CGMS-48]

The following dates and times of inter-sessional meetings were agreed:

- 14 November 2019, 12:00-14:00 UTC
- 12 March 2020, 12:00-14:00 UTC

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

The summary list of WGII actions and recommendations resulting from CGMS-47 is included in Annex III of this report.

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

The summary list of CGMS-47 actions and recommendations is provided in Annex III of this report.

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
IROWG	4	A45.02	**IROWG** to develop a detailed proposal for OSSEs regarding LEO-LEO MW occultation and GNSS-RO&-reflectometry.	*CGMS-47: Pending IROWG meeting autumn 2019* WGII IS#2 2019: Next update expected at next IROWG meeting in September 2019. WGII IS#1 Dec 2018: OSSE work to assimilate GNSS-R observations has already started in the context of the CYGNSS mission, but there is still work to be done. Regarding LEO-LEO: The critical missing link is to develop a LEO-LEO forward operator that can be used in NWP systems. Currently it is unclear who would be paying for such a development. Detailed status report on this action dated 6 June 2018 is available from IROWG (contact: ulrich.foelsche@uni-graz.at). CGMS-46: Action remains open following WGII discussions. WGII IS#2 15 Mar 2018: No progress information. 1 Feb 2018/29 Nov 2017: Activity initiated, IROWG has reached out to its members, deadline extended. Regarding the GNSS-R OSSEs, some work has been done to be extended as the global observing system develops. Regarding LEO-LEO occultation OSSEs, limited progress is expected prior to CGMS-46.	Sept 2019 (CGMS-47, 1 Nov 2017, CGMS-46)	**OPEN**
IPWG	4	A45.04	**IPWG** to produce documentation on precipitation climate data record generation and related activities	CGMS-47: Ongoing. In conjunction with GEWEX, a precipitation assessment is underway and was discussed in detail at IPWG-9 through a dedicated session. The goal	CGMS-47	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			worldwide, including prospects for continuity	is to have the assessment competed in 2020. WGII IS#2 2019: IPWG engaged with SCOPE-CM, working closely with GEWEX. Proposed to be closed at CGM-47 due to progress as follows (Ralph Ferraro will make presentation): 1. IPWG maintains updated information on its web page regarding CDR quality data sets (and solicits this from its members). See http://www.isac.cnr.it/~ipwg/data.html This is done in concert with other groups such as CEOS, GEWEX, etc. 2. For the recommendation, this is where our precipitation assessment comes into play. One of our past co-chairs, Remy Roca, leads the GEWEX Data Working Group, and Remy, along with outgoing co-chair, Ziad Haddad, organized a precipitation assessment. WGII IS#1 Dec 2018: At IPWG-9 (in Nov 2018) updates were given on the joint precipitation work with GEWEX. Goal is to have this assessment completed by the end of next year (2019). ECV gap analysis on this theme led to a coordinated action to be considered by IPWG, CEOS PCVC and SCOPE-CM (coordinated action within JWG Climate). CGMS-46: Action remains open following WGII discussions. WGII IS#2 15 Mar 2018:	(CGMS-46)	

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				ECV gap analysis on precipitation CDRs ongoing with involvemetn from IPWG. Part of IPWG report to CGMS-46. 7 Mar 2018: In conjunction with GEWEX, a precipitation assessment is being planned; a mature outline, with associated section leads, have been identified and will be discussed further over the coming months and at IPWG-9. WGII IS #1 20 Nov 2017: IPWG is organsing a precipitation assessment jointly with GEWEX - with a kick off meeting held in Oct. 2017. Co-Chair Haddad and former co-chair Roca (who serves as lead of the GEWEX Data Working Group) are co-organisers.		
CGMS agencies	4	A45.06	CGMS Agencies to implement Landing Pages on calibration events accessed via WMO-OSCAR.	CGMS-47: See CGMS-47-WMO-WP-15 for status update. Some agencies still to provide landing page information. WGII IS#1 Dec 2018: Ongoing - WMO is in the process of updating/implementing missing Landing Pages. EUMETSAT and the CGMS Secretariat will verify the CGMS agencies landing pages in OSCAR. Sep 2018: See also WGIII action A46.03 CGMS-46: Action remains open following WGII discussions. CGMS-46 WMO-WP-02 WGII IS#2 15 Mar 2018: Other agencies are requested to provide the URL to their respective landing pages.	CGMS-47 (CGMS-46)	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				KMA implemented the Landing Pages on COMS calibration events on June 2016. http://nmsc.kma.go.kr/html/homepage/en/landing/info.do#coms **IMD** Dr. Ashim K. Mitra, Scientist-D (SR-Cal/Val) **NASA** charles.webb@nasa.gov **NOAA** mitch.goldberg@noaa.gov **ROSH** z.andreeva@meteorf.ru http://planet.rssi.ru/calval/portal-main-en (the web-page is under construction)		
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-47: No update. Mitch to go back and discuss with ITWG. Presentation to be given to CGMS-48. WGII IS#2 2019: Ken/Mitch to check with CGMS-Secretariat if action has been taken to ask CGMS members to provide input. CGMS-47 EUM-WP-xx	CGMS-48 (By CGMS-47)	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	WGII/5	A46.02	All AMV producers to implement the "Common QI module" in their algorithms.	CGMS-47: Common QI showed skill in filtering collocated AMVs and led to improved agreement between AMVs generated by satellite operators • Action 1 to IWWG co-chairs: Place the Common QI in a public repository. • Done -> https://github.com/swanzong/IWWG • Send any questions to stevew@ssec.wisc.edu • Recommendation 1 to AMV producers: Implement the software prior to IWW15 • Partially complete : EUMETSAT and NWCSAF/HRW have included the Common QI in their repositories. NOAA, KMA and JMA have plans to complete the integration in late 2019. WGII IS#2 2019: Request to developers to implement this. On-going. WGII IS#1 Dec 2018: There is a Gitlab repository (who is the owner of it?), tested by a few people. An email needs to be sent out to the IWWG community asking them to add this to their software (Steve Wanzong, Co-Chair, IWWG)	By IWW15, CGMS-48	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
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-47: The AMV sequence 3.10.067 endorsed by the WMO in November 2017 has been rejected by some users in early 2018 because it could not be used in automated framework. • The WMO corrected the sequence appropriately and endorsed the new AMV BUFR sequence 3.10.077 in November 2018. • NOAA, EUMETSAT and JMA are working on the production of the test data, planning an operational change early 2020. The NWCSAF will release a software patch later in 2019 which includes the new BUFR sequence. A new deadline to IWW15 (spring 2020) has been set to agencies to change their AMV BUFR sequence. • AMV producers to provide their users with a small test dataset (a few hours of data) encoded in the new BUFR format as soon as possible. • Nine months later, AMV producers will provide parallel dissemination of their AMV data in the new and old BUFR sequence over a 2-3 month period of time to allow the switch to take place.	End 2019	**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-47: The Met Office and Met Norway is planning to test various configurations of AMVs, via the NWC SAF software, to work towards optimal configurations. • There are no updates to report at this time. • We expect more discussion at the IWW15. • No results to report yet. • This topic and results will be re-visited at IWW15.	By IWW15, CGMS-48	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				WGII IS#1 Dec 2018: The two NWP contacts that will help with this action are: Mary Forsythe mary.forsythe@metoffice.gov.uk and Roger Randriamampianina rogerr@met.no (Steve Wanzong, Co-Chair, IWWG)		
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)	CGMS-47: Research activities continue that aim to identify additional quality information from the AMV derivation that could be used to filter out poor quality AMVs and/or set observation errors for the AMV height assignment. • Quality measure associated with the correlation surface (addresses feature tracking) • Optimal estimation cost associated with cloud top temperature retrieval (addresses AMV height assignment) • Cloud top pressure error estimates (addresses AMV height assignment) • No results to report at this time. • We expect that some useful information relevant to this action may be extracted from work associated with A46.04. • This topic will be re-visited at IWW15. WGII IS#2 2019: no update	CGMS-48 (By CGMS-47)	**OPEN**

WGII actions open from previous plenary sessions (at CGMS-47)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
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-47: IWWG has reviewed the gaps identified by the last Essential Climate Variables (ECV) inventory. • The international status of polar and geostationary AMV reprocessing has been updated and is presented in Annexe 1 of the IWWG Working Paper. • This topic will be discussed in a specific session at the next at IWW15. WGII IS#2 2019: no update	CGMS-48 (By CGMS-47)	**OPEN**
IROWG	WGII/5	A46.08	IROWG to develop process and principles for RO data quality control to ease intercomparison of data from different providers.	WGII IS#2 2019: to be raised at next IROWG in September 2019. 10 Oct 2018: Best practices to be developed. (WGII to consider extension to other areas e.g. winds/IWWG). To be raised at the next IROWG meeting (date TBD)	Sep 2019	**OPEN**
CGMS members	WGII/7	A46.13	CGMS members to provide comments on the impact studies conducted by ECMWF on OSES vs. FSOI and how CGMS members can benefit from the findings. (Ref. CGMS-46-WMO-WP-13)		CGMS-48? (CGMS-47)	**OPEN**
CGMS members	WGII/10	A46.14	CGMS members to provide points of contact for GOFC-GOLD to the CGMS Secretariat (Ref. CGMS-46-GUEST-WP-02)	CGMS-47: WGII to reach out to GOFC-GOLD. WGII IS#2 2019: check with CGMS-Sec	By 31 August 2019	**OPEN**
CGMS members	WGII/10	A46.15	CGMS members to provide points of contact for AEROSAT to the CGMS Secretariat (Ref. CGMS-46-GUEST-WP-01)	CGMS-47: WGII to reach out to GOFC-GOLD. WGII IS#2 2019: check with CGMS-Sec	By 31 August 2019	**OPEN**

The CGMS-47 actions and recommendations will be included following review by WGII of the report text.

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS members	WGII/5	R46.02	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)	*CGMS-47: ICWG invited IPWG representative Ben Johnson to present at ICWG-2 and engagement is developing. Recommendation maintained.* WGII IS#2 2019: needs to be further precised/developed (GCOS?, FCDR). Possibly with WGClimate? WGII IS#1 Dec 2018: WGII co-chairs to check with Mitch Goldberg Sep 2018 CGMSSEC: WGII is requested to make this more specific.
ISRO	7	R45.07	ISRO to consider adding a direct broadcast capability to future satellites.	***CGMS-47: ???***

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS agencies	8	R45.09	CGMS agencies encouraged to document their products online, including ATBDs and validation reports, and link product page URLs to the WMO Product Access Guide following defined documentation criteria. (current agency focal points in WMO IPET-SUP: Sally Wannop (EUMETSAT), Natalia Donoho (NOAA), Geun-Hyeok Ryu (was Chu-Yong Chung) and Jin Woo (KMA), Xiang Fang (CMA), Shiro Ohmori (JMA))	*CGMS-47: Ongoing.* *CGMS-47 NOAA-WP-16 (Landing pages include this information).* WGII IS#1 Dec 2018: To be addressed in IPET-SUP-5 in February 2019. WGII IS#2 15 Mar 2018: WMO has taken these into account. **KMA** has registered a link to COMS L1B imagery in 2015 for WMO PAG and is currently available. KMA's renewed web page has been setup including MI level 2 products image and ATBD. KMA is preparing its registration process for PAG. -MI Level 2 products image http://nmsc.kma.go.kr/html/homepage/en/ver2/satellites/coms/searchSatelliteImageN.do?data_type=1089 -MI Level 2 products ATBD http://nmsc.kma.go.kr/html/homepage/en/ver2/common_board/Data/selectData.do?board_c_cd=023&cmn_data_seq_n=5322 **KMA** POC - Geun-Hyeok Ryu (geunhyeokryu@korea.kr) - Jin Woo (superjwoo@korea.kr) **IMD** will prepare an online product document including ATBD, validation report and its link will be communicated to WMO product access guide.

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS members	WGII/ 4	R44.05	CGMS members to budget a baseline funding for the cloud intercomparison study, given its importance and impacts on global cloud products.	***CGMS-47: ???*** WGII IS#1 Dec 2018: Discussed at the ICWG . Message to remain. IWWG side funded. ICWG not yet. WGII IS#2 15 Mar 2018: For further discussion within ICWG. Co-chair to provide an update. CGMS-45: ICWG-WP-01: Currently, ICWG helps to facilitate the collection of data used for assessments (e.g., level-2 retrieval assessment in TG "Assessment of level-2 retrievals" or level-3 climate data records in TG "Assessment of cloud parameter data records for climate studies"), but many teams carried out the efforts on a volunteer basis. Lack of funding has limited the scope and prohibited a definitive analysis of the new HIMAWARI-8 data set.
CGMS R&D agencies	WGII/ 4	R44.07	Research agencies to consider continuing space-borne lidar for ice/liquid water since they have proven very valuable to validate retrievals from passive sensors	*CGMS-47: Recommendation maintained.* WGII IS#2 15 Mar 2018: Maintain it as a recommendation. US decadal survey on EO from space, specific measurements were noted, will influence the decision-making.

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS space agencies	WGII/ 4	R44.15	Future satellite programmes should include the provision of high temporal frequency MW humidity sounding radiances (alongside cloud and precipitation sensitive observations).	***Rec maintained?*** *CGMS-47: Not part of the CGMS baseline. Monitor progress, in particular with regards to small satellites.* WGII IS#2 2019: Check if discussed in WG III Risk Assessment Workshop. Mails have been sent to WGIII co-chairs/rapporteur to check. WGII IS#1 Dec 2018: WGII co-chairs to contact WGIII co-chairs and the pass recommendation to WGIII. *Sep 2018 CGMSSEC: Suggest this is an action on WGIII for consideration.* CGMS-45: NASA Cubesat mission Tropics underway CGMS-44 WGII - For reference: WG III should discuss this and come up with results at CGMS-45.
ROSC, ROSH	WGII/ 4	R44.16	Roscosmos to develop and release a direct broadcast processing package (for level 1 data) for the MTVZA-GY microwave imager. Roshydromet to provide dissemination of this package to interested users.	***CGMS-47: ???*** WGII IS#1 Dec 2018: Letters have been sent Apr 2018: Following feedback from Roshydromet, the text of this recommendation has been updated (as discussed during CGMS-45 WGII).

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS space agencies	WGII/ 4	R44.18	CGMS satellite operators to consider coordination of orbits for scatterometer instruments and to provide open and timely access to data in order to maximise independent coverage and benefits to nowcasting and NWP from assimilation of scatterometer wind data.	*CGMS-47: Proposed to be transferred to WG III. -> **was this agreed - did you inform WGIII?*** Following further discussion in the CGMS Secretariat, we propose that this recommendation is maintained in WGII until CGMS-47, and then taken up when the risk assessment is discussed, at that stage we can see if it should be transferred to WGIII (or stay in WGII or other). WG II IS#2 2019: Mails have been sent to WGI co-chairs/rapporteur to transfer this recommendation to WG I. WGII IS#1 Dec 2018: WGII co-chairs to contact WGI co-chairs to forward recommendation to WGI. *Sep 2018 CGMSSEC: Suggests this is an action on WGI to consider coordination of orbits.* CGMS-44 WGII - For reference: WG III should discuss this and come up with results at CGMS-45.
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	***CGMS-47: ???*** WGII IS#2 15 Mar 2018: Maintain it as a recommendation.
CGMS space agencies	WGII/ 7	R44.25	For monitoring the Polar Regions, the Group stressed the importance of the deployment of HEO missions	*CGMS-47: NOAA considering this 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

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS space agencies	WGII/8	R44.26	Satellite operating agencies should support proposals and programs to acquire high-accuracy characterization measurements of the Moon, to develop a new, high accuracy, SI-traceable lunar reference standard for reflected solar wavelengths.	*CGMS-47: Maintain* 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/8	R44.28	Agencies to explore the possibilities to develop suitable processing packages to support a direct broadcast implementation of RO processing, within the DBNet to improve timeliness for space weather applications	*CGMS-47: Pending outcome of the IROWG meeting in September 2019. On the understanding that the requirements are defined, an action would be placed on WGI.* WGII IS#1 Dec 2018: To be maintained (See also CGMS-44 WGI action A44.08 related to IROWG)
CGMS members	WGII/3	R43.02	CGMS members to consider removing spectral gaps from future hyperspectral sounders to support GSICS intercalibration of IR imagers.	***CGMS-47: ???*** WGII IS#2 15 Mar 2018: Maintain it as a recommendation. To be discussed at second WGII inter-sessional meeting after CGMS-44. (For WG III to consider)
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.	***CGMS-47: ???*** WGII IS#2 15 Mar 2018: Maintain it as a recommendation. To be discussed at a second WGII inter-sessional meeting after CGMS-44. (For WG III to consider)

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
CGMS space agencies	WGII/ 10	R43.07	CGMS agencies to make available a non real-time cache of satellite level 1 data over the previous 2-3 months, similar to the NOAA CLASS system.	***COMPLETED*** *Following WG II discussions at CGMS-47* Update IMD: IMD is final stage of implementing MMRDPS system in July 2019 and will start sharing INSAT-3D/3DR level 1B data to all NMA after on line registration on our on-line data supply portal similar to NOAA. Though at present we are sharing L1B data to NOAA and Canada Meteorological Agencies nearly real time basis through FTP. WG II IS#2 2019: Mails have been sent to WGIV co-chairs/rapporteur to transfer this recommendation to WG IV. WGII IS#1 Dec 2018: WGII proposes to transfer this to WGIV WGII IS#2 15 Mar 2018: - Nov 2017: Satellite Level1 data availability of last three months will be implemented after installation and commissioning of MMDRPS system expected in June 2018. CGMS-44 IMD: At present there are no such plans (until a new data centre is installed).

CGMS-47 WGII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/conclusions**
ISRO	WGII/5	R43.10	ISRO is encouraged to implementing a multi-sensor precipitation estimate based on SAPHIR and INSAT-3D	***Rec. stays open?*** *CGMS-47: ISRO has carried out following activities:* (1) Using Bayesian formulations, a new rain retrieval algorithm for SAPHIR is developed. (2) This algorithm is recently made operational on MOSDAC. (3) This is being used for merging the SAPHIR rain with INSAT measurements. INSAT-3D/3DR based Hydero-Estimator algorithm that provides pixel-scale and half-hourly precipitation is already operational. We will likely to complete the merging of precipitation from SAPHIR and INSAT-3D in near future. This action may be kept open. WGII IS#2 15 Mar 2018: ISRO/IMD invited to report on this at CGMS-46. Nov 2017: IMD will coordinate with SAC (ISRO) to develop and implement the multi sensor precipitation estimate based on SAPHIR and INSAT-3D/3DR data on priority. CGMS-45: ISRO/IMD have plans

WG III REPORT

Co-chairs: Peng Zhang (CMA), Ajay Mehta (NOAA)
Rapporteur: Lars Peter Riishojgaard (WMO)

1. Objectives

Working Group III (WGIII) Co-chairs and rapporteur welcomed the participants, consisting of representatives from CMA, EUMETSAT, IMD, ISRO, JMA, JAXA, KARI, KMA, NOAA, ROSCOSMOS, ROSHYDROMET and WMO (see Annex VII for full list of participants).

WGIII reviewed and adopted the draft agenda prior to the meeting, in line with the Terms of Reference.

2. Review of actions and recommendations from previous meeting

WGIII discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-46 and earlier) and the final status is provided in Annex IV of this report.

3. Review and adoption of WGIII Terms of Reference

In CGMS-46 Plenary, it was decided to review and update the Terms of Reference for every working group every five (5) years. Working Group III agreed to review its Terms of Reference and present a new version at CGMS-47.

CGMS-47-CGMSWGIII-WP-07 introduces revised draft Terms of Reference for Working Group III. The draft ToRs were reviewed during the WGIII meeting on the occasion of CGMS-47 and were submitted to CGMS-47 Plenary ession for approval.

4. Update on the WIGOS Vision 2040 document

CGMS-47-WMO-WP-18: Update on WMO Gap Analysis and on status of EGOS-IP/WOS-IP

This document provided the latest information on WMO Rolling Review of Requirements (RRR), and related gap analysis in WMO Applications Areas. There are 14 Application Areas included in the process, for which technology free observational user requirements are quantitatively recorded in OSCAR/Requirements database in terms of space and time resolution, uncertainty, timeliness, and stability. Gap analysis is conducted by the Points of Contact nominated for each Applications Area by comparing these requirements with space- and surface- based capabilities recorded in OSCAR/Space and OSCAR/Surface respectively, and by assessing impact of observations where tools exist. Gap analysis is reflected in Statements of Guidance of the Application Areas, available on WMO Website. However, maturity level is variable between the Application Areas, and WMO and its Commission of Basic Systems (CBS) is working with the Points of Contact to have the requirements and Statements of Guidance updated.

Responding to the Vision for the Global Observing System in 2025, the CBS has developed an Implementation Plan for the Evolution of Global Observing System (EGOS-IP), which was adopted by the Executive Council in 2013. EGOS-IP includes 13 overarching and cross-cutting actions, 59 surface-based observing systems actions, 35 space-based observing systems actions, and 8 space weather observing systems actions for identified agents to implement. Now that WMO is about to adopt the WIGOS Vision 2040, the RRR will then initiate a process for developing an Implementation Plan for the Evolution of WIGOS Component Observing Systems (WOS-IP). The WOS-IP will eventually replace the EGOS-IP.

CGMS-47 actions - WGIII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	WGIII4	A47.01	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-48

5. Maintenance of WMO OSCAR space database

CGMS-47-WMO-WP-03: OSCAR/Space sustainability and long-term continuity and overall strategy for OSCAR as a whole

The WMO space-based Observing System Capability Analysis and Review tool (OSCAR/Space) is an essential tool for CGMS and WMO members at large to assess the status, to guide the planning and evolution of the space-based component of the WMO Integrated Global Observing System (WIGOS) by supporting the Rolling Review of Requirements (RRR) throughout the WMO Application Areas.

OSCAR/Space is required for the risk assessment of current contributed observing system components by CGMS members against the CGMS baseline, which is conducted annually, and for the gap analysis between the CGMS baseline and the Vision for WIGOS in 2040, which is conducted every four years.

OSCAR/Space is also the basis for the compilation of the Essential Climate Variable (ECV) Inventory by the Joint CGMS/CEOS Working Group Climate.

This paper reviews the status and options for ensuring the sustainability of the:

1) Maintenance and update of the OSCAR/Space database content in the short- and in the long-term.

2) Evolution of the OSCAR/Space database functionality to ensure that it meets current and anticipated CGMS and WMO requirements to support RRR, risk assessment and gap analysis and the needs of WMO Application Areas.

CGMS-47-WMO-WP-17: Risk assessment from the WMO OSCAR/Space gap analysis

This report is a follow-on of the discussion occurred at CGMS-46 on the subject of risk assessment, handled by WG III. A preliminary, partial, draft, was discussed at a CGMS WG III risk assessment workshop, Darmstadt 27 February - 1 March 2019. It contains a much more detailed analysis as compared with the short report from the workshop, presented by the CGMS Secretariat as a different WP.

The analysis in entirely based on the information recorded in OSCAR/Space as of end-March 2019. The approach is as follows:

For each of the ~188 Variables processed in OSCAR/Space (~123 for Earth observation, ~65 for Space weather), all the suitable observing techniques have been identified and, for each technique, the relevant instruments, current or planned, have been sorted from the Gap analysis section of OSCAR/Space. From the timeline, the situation of availability in the decade 2020-2030, split in the first and the second half (2020-2024 and 2025-2030) has been analysed. The level of redundancy to deal with contingency requirements also has been analysed, separately for the two half- decades. Comments have been pointed out to identify and emphasise the reason of the gaps and risks.

Whilst this approach by Variable is the most suitable from the User viewpoint, and easier to be applied by exploiting the curren architecture of OSCAR/Space, for Space agencies may be more convenient to sort the information by Instrument type as, in fact, was used in CGMS-46 and previous sessions. To this end, the tables Variable- to-Instruments have been sorted in the opposite direction, Instrument-to-Variables, that shows more clearly to the Space agencies which systems are needed to be provided with continuity or developed.

CGMS-47 actions - WGIII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	WGIII 5	A47.02	WMO to conduct a Gap Analysis against the approved WIGOS Vision 2040 and to explore the possibility of coordinating this with the impact assessment planned by the CGMS Science Working Group reporting to WG-II	CGMS-48
WMO	WGIII 5	A47.03	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	2020
WMO	WGIII 5	A47.04	CGMS members and observers to provide updated information on the status of their satellites and instruments following the instructions and tables in CGMS-47 WMO-WP-17b (New action following WGIII report preparation)	30 Sep 2019
WMO	WGIII/ 5	WGIII/ A47.05 (WGIII R44.02)	Noting the recent conclusions of the WMO IPET-DRMM and the concurrence expressed in CGMS WG III, 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. - changed from recommendation to action following CGMS-47 WGIII discussion).	CGMS-48

6. Updates on significant observational missions

6.1. Operational missions

CGMS-47-ISRO-WP-03: ISRO Report on Operational Continuity and Contingency Plans

ISRO provided an overview of its future planned mission, highlighting the capabilities of a number of platforms, including OCEANSAT-3 (2020), OCEANSAT-3A (2022), RISAT-1A (2020), TRISHNA (2021), NISAR (2021), and GISAT (2019)-

Continuity to the operational satellite series – OCEANSAT (ocean color) and INSAT (geostationary met imager) is ensured.

In addition, ISRO expressed interest in developing additional missions such as temperature and humidity sounding, advanced microwave radiometer, altimeter, precipitation radar, wind profiler, atmospheric chemistry, and aerosol mapping missions. They mentioned several opportunities for collaboration with international partners.

In response to inquiries about data policy for scatterometer data, ISRO informed that group that real-time data are available by bilateral agreements and on the GTS.

CGMS-47-IMD-WP-03: Rapid Scan from INSAT-3DR

Tropical cyclones are one of the many natural hazards which affect the Indian Sub-continent. Because of their vast potential for destruction both in terms of lives and property, tropical cyclones have been in the center of intensive research. With the launch of meteorological satellites in mid twentieth century, the scientific community got first insights of the structure and vast spatial coverage of the tropical cyclones along with their movement from deep seas towards landmass.

INSAT-3DR is the third generation INSAT series dedicated meteorological satellite, which was launched on 08th September 2016. INSAT-3DR is identical to INSAT-3D in terms of payloads. INSAT-3DR has four payloads namely: IMAGER, SOUNDER, Data Relay Transponder (DRT) and Satellite Aided Search, Aid and Rescue. IMAGER is used for imaging the Earth six spectral bands i.e. visible (0.55-0.75 um), shortwave infrared (1.55-1.70 um) having resolution of 1X1 kms, mid infrared (3.8-4.0 um), thermal infrared1 (10.3-11.3 um), thermal infrared2 (11.5- 12.5 um) having resolution of 4X4 kms and water vapour (6.5-7.1 um), having resolution of 8X8 kms. The Imager payload of INSAT-3DR can be operated in three modes: Full Frame Mode, Programmed Normal Scan Mode, Programmed Sector Scan Mode. IMD and ISRO has finalized standard operating Procedure (SOP) for conducting Rapid Scan of INSAT-3D Imager payload under program sector scan mode. The full globe is divided into 36 blocks and each rapid scan covered up 6 blocks in 4.5 minutes with six repetitions in half an hour period. The "Rapid Scan" has been conducted on operational basis during "VSCS LUBAN" and "VSCS TITLI" (00UTC of 08 October 2018 till 1015UTC of 13 October 2018). Both "VSCS LUBAN" and "VSCS TITLI" were tracked with INSAT-3DR. It has been demonstrated that, with Rapid Scan mode the movement of Cyclones and associated convective cloud mass can be seen at a regular interval of 05 minutes. Rapid Scan precisely captured the landfall locations

for both the cyclones. Rapid Scan mode is a very useful mode which can be used for motoring and tracking various convective systems.

CGMS-47-IMD-WP-04: IMD GNSS Network for IPWV estimation and its Validation

Water vapour is an important greenhouse atmospheric gas. The concentration of water vapour in the atmosphere is highly variable both spatially and temporally. Conventional in situ measurements of atmospheric water vapour is provided by radiosonde humidity sensors profile twice a day at 0000 and 1200 UTC mainly from limited land regions. In recent years India Meteorological Department (IMD) has been computing precipitable water vapour from INSAT- 3DR 19 channel sounder in three layers i.e. 1000hPa-900 hPa, 900-700 hPa, and 700-300 hPa and total precipitable water (TPW) vapour in the vertical column of atmosphere stretching from surface to about 100 hPa during cloud-free conditions. These data were most commonly were validated using spatially and temporally collocated radiosonde measurements. In this paper INSAT-3DR satellite retrieved TPW data were validated with column-integrated precipitable water (IPWV) vapour estimates from a network of ground-based GNSS (Global Navigational Satellite System) receivers in near-real time which IMD recently commissioned. Good agreement has been realized between GNSS derived IPWV and from INSAT3-DR sounder under cloud free condition. However, the correlation coefficients (R) range from 0.8 to 0.9, with root-mean-square (rmse) differences of 5 to 6 mm. In the present work we have shown the real-time computation of GNSS IPWV and its comparison with INSAT-3DR sounder derived TPW.

CGMS-47-WMO-WP-16: Re-establishment of Tiger Team on assessment of EM orbit impact

At CGMS-40, it was decided that (action 40-03) “WMO {should} convene a CGMS tiger team to coordinate the technical evaluation of the global and regional impact of flying a FY-3 satellite in early morning orbit, in order to support CMA in the assessment process”.

As a result of subsequent studies, China announced its intention to deploy FY-3E in an early morning orbit, and according to current plans, this system will provide data to the international user community during the 2020-2025 time frame.

At this point (early 2019) there are no firm plans for an operational meteorological satellite in the early morning orbit after the end of FY-3E, and it was therefore to discussed whether to re-establish a WMO Tiger Team to study the impact of these data and the prospects for continued coverage. It was decided that the team should be re-established, but not reconvened until such a time that there would be data available from FY-3E for impact experiments.

CGMS-47-ROSCOSMOS-WP-03: Planned instrument set for the Russian single hydrometeorological and geophysical satellite constellation

This working paper introduced the composition, purpose of use, main characteristics and structure of specific-purpose equipment complex of advanced system for hydrometeorological and geophysical monitoring which includes the following spacecraft constellations: non- magnetospheric, geostationary, magnetospheric, ionospheric, hydrometeorological, oceanographic, and radio occultation. WG-III considers the proposed constellation very compelling and recognizes that it appears to meet all existing

requirements of the system proposed in the WMO Vision for WIGOS in 2040 as “Group 1”. ROSCOSMOS is encouraged to undertake studies regarding the feasibility of implementing this constellation.

CGMS-47-ROSHYDROMET-WP-03: Prospects for the development of the equipment of complexes for heliogeophysical measurements of spacecraft for hydrometeorological appointment

Prospects for the development of the equipment of complexes for heliogeophysical measurements of spacecraft for hydrometeorological appointment. ROSHYDROMET presented in WGIII the overview of prospective types of equipment for spacecraft for heliogeophysical measurements of spacecraft for hydrometeorological appointment.

The Institute of Applied Geophysics (FSBI «IAG») serves as the parent organization for ionospheric, magnetic and heliogeophysical observations – monitoring of space weather in the country. Information flows from the ground segment, spacecrafts, international exchange channels. The Russian space segment currently consists of spacecraft series «Meteor-M» and «Electro-L».

A new generation of spacecraft for hydrometeorological and heliogeophysical purposes have also been developed:

- Meteor-MP (fourth generation);
- Elektro-M (third generation);
- Arctic-MP.

One of the planned systems for heliogeophysical monitoring is the space complex «Ionosonde». The task of the complex is to monitor the current state of the ionosphere using radiosonding equipment (ionosonde) installed on each spacecraft of this group. Also, the use of small satellites (cubesats - micro and nano satellites for monitoring space weather) is growing.

The Space Weather Centre is operating in production mode since 2019. A consortium of Russian Space Weather Centre and National Space Weather Centre of China is undergoing integration procedures and would enter global service as soon as they are complete.

CGMS-47-CMA-WP-11: Description of Services under the Emergency Support Mechanism of FENGYUN Satellite

CMA described the detailed information of Services under the Emergency Support Mechanism of FENGYUN Satellite (FY_ESM). This is a direct CMA Response to the Jakarta Declaration issued after the Joint RA-II/RA-V WIGOS Workshop on Disaster Risk Reduction held in October 2015.

China Meteorological Administration (CMA) introduced the Emergency Support Mechanism of FENGYUN (FY) Satellite (FY_ESM) in 2018, open to international users who made a request once visited by such extreme events as typhoon, heavy rain, severe convection, forest or grassland fire and sand and dust storm.

The eligibility of a user is open to members of World Meteorological Organization (WMO). A Permanent Representative with WMO presents a written application to the Permanent Representative of China with WMO and designates a focal point as an authorized user contact.

6.2. Research missions

CGMS-47-JAXA-WP-04: Update on the AMSR2 follow-on mission

JAXA provided an update on operation and data processing and product generation for AMSR2, following the path previously explored by MOS-1, ADEOS-II and AMSR-E for multi-pol and multi-spectral microwave imaging; they also provided an update on the plans for a follow-on mission.

JAXA's GCOM-W mission is now flying more than 6-years without any serious problem. Satellite and sensor (AMSR2) is in healthy condition. AMSR2 products are distributed to public via internet. Transfer to G-Portal (https://www.gportal.jaxa.jp/gp/) has completed in June 2018. Eight standard geophysical parameters and three research products are now available. Two additional research products are close to being ready for release.

AMSR-E reprocessing products applying AMSR2 format and algorithms are in preparation, expecting contribution to CDRs

- L1B and L1R (resampling: new) products are already available at G-Portal
- L2 products will be uploaded in mid-2019

AMSR2 follow-on sensor (AMSR3) and TANSO-2 successor sensor will be joint mission and JAXA has initiated pre-project team phase in Sep. 2018. System Definition Review (SDR) is expected to be completed in mid-2019, with a start of start of Phase B in latter half of 2019.

Orbit is defined to keep AMSR2 LT observation (13:30 ATAN), but altitude is lower than GCOM-W (699km -> 666km: same as GOSAT orbit). JAXA is still considering the addition of optional channels of 166H & 183+/3V.

CGMS-47-NASA-WP-04: Update on the status of the NASA CubeSat missions

NASA's Earth Science Division (ESD) has begun to make extensive use of CubeSats in its programs. Many of the current and planned CubeSats were selected by the ESD Technology program (Earth Science Technology Office) through its In-Space Validation of Earth Science Technology (InVEST) program through competitive solicitations in 2012, 2015, and 2017, respectively. Additionally, cubesat-containing satellite projects were selected in response to Earth Venture Instruments Announcements of Opportunity (TROPICS, PREFIRE, TEMPEST-D), and the Compact Solar Irradiance Monitor was also initiated. Several of these are currently flying, with the remainder being planned for future use. These satellites include ESD's first "CubeSat-based radar" (RainCube) whose operation has been extended beyond its initially planned period. Data from several of these satellites were combined with those of other satellite sensors (NASA and interagency/international partner) to study Typhoon Trami in September, 2018. ESD is also engaged

in a Commercial Satellite Pilot Data Buy with three small satellite vendors and is currently in the process of assessing the usefulness of the purchased data to address its research and/or applications objectives.

CGMS-47-KMA-WP-07: Update on the status of GEO KOMPSAT-2B

KMA provided an update on the plans for GEO-KOMPSAT-2B, the second platform in the new geostationary constellation following the launch of GEOKOMPSAT-2A in 2018.

The main missions of the new platform are:

(i) Ocean Monitoring Mission, aimed at maintaining of COMS mission continuity and quality in ocean color observations in the GK2B timeframe, with Improved monitoring of ocean biophysical phenomena and maritime disasters with enhanced spatial resolution and increased spectral bands;

(ii) Environment Monitoring Mission, including measurements of atmospheric chemistry, precursors of aerosols and ozone with high temporal and spatial resolution over Asia, as well as monitoring of regional transport events (trans-boundary pollution and Asian dust) and monitoring of air quality for long-term trends.

The main payloads are GOCI-II (ocean color), GEMS (environmental monitoring). KMA also informed the WG about recent integration and test activities in preparation for the GEO-KOMPSAT-2B to be launched by Ariane-5 launcher within the 1st quarter of 2020.

7. CGMS risk assessment

7.1 Review of activities at risk assessment workshop

CGMS-47-CGMS-WP-13WGIII: CGMS Risk Assessment

The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System – includes Space Weather. The CGMS baseline responds to end-user requirements expressed in WMO's Rolling Review of Requirements (RRR), and as such it strives to support the WMO Integrated Global Observing System (WIGOS) 2040 Vison.

Key principles (criteria for inclusion in the Baseline):

- Commitment: The CGMS members are providing, or have firm plans to provide, the observations, measurements, and services enumerated in the Baseline;
- Sustained: The observations, measurements, and services are provided on a sustained basis;
- Data availability: The observations, measurements, and services are available on a free and open basis;
- Operational: The data and products can be utilized in operational applications.

The CGMS baseline will be included in the WMO Manual on WIGOS as the official description of the space-based component of WIGOS. WMO will conduct a *Gap Analysis* between the WIGOS 2040 Vision Group 1 System and the CGMS Baseline to monitor progress in the implementation of WIGOS. CGMS will conduct

a *Risk Assessment* against the baseline to ensure CGMS is meeting its commitments. The CGMS Baseline will be revised every four years to match the update cycle for the Manual on WIGOS. The WMO Gap Analysis will occur every four years, serving as an input to the definition of the revised CGMS Baseline. The CGMS Risk Assessment will be completed every year forming the basis for CGMS actions to ensure continuity.

The WG was informed about the process behind and the outcome of the WG-III Risk Assessment Workshop held in Darmstadt Feb 27 – Mar 1. An extensive risk assessment had been undertaken for a long series of missions for which significant operational impact had been identified.

In the discussion, WGIII agreed to change the cadence for updating the CGMS Baseline to every two years. This would ensure that CGMS was working in conjunction with WMO schedule for Congress meetings.

7.2 Finalise WGIII risk assessment findings

It was decided to request the SWCG to review space weather sections. It was further decided that WGIII would do another review during the upcoming intersessional period consistent with the notion of updating the CGMS Risk Assessment on an annual basis to reflect possible changes in launch schedules, budget environment and on-orbit system availability.

The proposed schedule for CGMS Baseline changes and the link with the update cycle for WMO Regulatory Material was included in the WG-III Report to the CGMS-47 Plenary.

It was finally decided to share the risk assessment with the other WGs and request their input about potential impact on their activities prior to CGMS-48.

7.3 Contingency actions/recommendations

As an outcome of the assessment, the following mitigating actions were recommended by the Working Group:

CGMS-47 actions - WGIII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
WMO	WGIII 7	A47.06	**Early Morning Orbit:** WMO to reconvene a WMO-CGMS Tiger Team on the impact of the Early Morning orbit. It is premature to convene this Tiger Team until an assessment of FY-3E is conducted.	2021
EUM	WGIII 7	A47.07	**GEO coverage in the IODC region:** EUMETSAT to conduct a study on GEO Imager coverage, data quality, availability and resilience in the IODC region	CGMS-48
CGMSSEC	WGIII 7	A47.08	CGMSSEC to write to NSOAS stating the importance of HY-2B MWI and ALT data.	Dec 2019

CGMS-47 actions - WGIII				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
NOAA	WGIII 7	A47.09	**MW imaging in LEO for SST:** NOAA to provide an update on SSMI status and possible follow-on	CGMS-48
ISRO	WGIII 7	A47.10	ISRO to provide an update on its plans for follow-on mission to Oceansat-3A.	CGMS-48
ISRO	WGIII 7	A47.11	ISRO to confirm data latency for Aditya-L1 mission	CGMS-48
ISRO	WGIII 7	A47.12	**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, transferred to WGIII)	CGMS-48
JAXA, NASA	WGIII 7	A47.13	NASA and JAXA to provide future plans for precipitation measurement mission(s)	CGMS-48
WGIII	WGIII 7	A47.14	WGIII to update the CGMS baseline and conduct the annual risk assessment for submission to CGMS-48	CGMS-48
EUM	WGIII	A47.15 (WGIII R46.01)	CGMSSEC to enquire with EUMETSAT NWP SAF Radiative Transfer Model (RTM) support for FY-2E/H Indian Ocean coverage. (Formerly WGIII recommendation R46.01 changed to action following CGMS-47 discussions)	Dec 2019

Following plenary discussions, plenary recommendations R47.01 to R47.06 related to the IPWG, were transferred to WGIII (also addressed within the framework of WGII):

CGMS-47 WGIII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	
CGMS space agencies	From plenary 5.7 to WGIII	R47.01	**(From IPWG): IPWG** strongly recommends to CGMS members to continue the constellation of PMW sensors to ensure quality satellite precipitation products for weather, climate, and hydrological applications. Additionally, IPWG would like to be kept informed of longer term plans for subsequent launches of microwave sensors to ensure continuity of long-term observations that meet the documented needs of the user community.	*Transferred from plenary*

CGMS-47 WGIII Recommendations				
Lead	**AGN item**	**Rec #**	**Description**	
CGMS space agencies	From plenary 5.7 to 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.	*Transferred from plenary*
CGMS space agencies	From plenary 5.7 to 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 scans to improve temporal sampling of precipitation products and unknown future PMW imager availability for merged products.	*Transferred from plenary*
CGMS space agencies	From plenary 5.7 to WGIII	R47.04	**(From IPWG)**: Collaboration between space programs and data assimilation centers should be specifically encouraged to incorporate DA requirements as part of scientific requirements when developing new satellite / observing systems. This would reduce barriers for operational assimilation of observations, and potentially provide a greater range of utility for various sensors.	*Transferred from plenary*
CGMS space agencies	From plenary 5.7 to WGIII	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.	*Transferred from plenary*
CGMS space agencies	From plenary 5.7 to WGIII	R47.06	**(From IPWG):** Latency and quality of satellite data should be improved, from both operational and research missions, to fit in the DA high temporal resolution cycle.	*Transferred from plenary*

8. SWCG interactions with WGIII

The Space Weather Coordination Group (SWCG) Co-chairs summarised the discussion held in the SWCG meeting about the CGMS baseline and risk assessment. SWCG agreed to review the space weather observations in the baseline and determine the need for magnetometers in LEO.

9. Update on Socio-Economic Benefits Tiger Team (SETT)

CGMS-47-CGMS-WP-20: Update on Socio-Economic Benefits Tiger Team (SETT)

A brief update on the activities of the Tiger Team was provided. The Team had

- Completed a literature review
- Identified socio-economic expertise
- Conducted 4 Workshops
- Developed a Guidance Document for CGMS members
- Engaged in monitoring activities of members & related organizations, such as the VALUABLES Consortium

In addition the team had commenced undertaking a pilot socioeconomic benefit study. The selected topic was "Understanding & Assessing the Value of Improved Satellite Data for the Users of Operational Sea Ice Products & Information."

10. Any other business

None brought forward

11. Review and updating of the HLPP

CGMS-47-CGMS-WP-08WGIII: Status of implementation of CGMS High Level Priority Plan (2018-2022)

The status of implementation of CGMS High Level Priority Plan (2018-2022) was presented (see separate section in Plenary Report).

CGMS-47-CGMS-WP-03WGIII: Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2019-2023

12. Nomination and representatives at meetings

CGMS-47-CGMS-WP-06WGIII: Nomination and representation at meetings

Nothing to report. The Co-chairs and rapporteur will continue through the upcoming intersessional period.

13. Date/time of inter-sessional activities/ meetings 2019-2020 [CGMS-47 -> CGMS-48]

Working Group III will hold intersessional meetings on the following dates/times:

- 10 October 2019 at 12:00 UTC
- 29 January 2020 at 12:00 UTC
- 15 April 2020 at 12:00 UTC

Working Group III will also hold the second risk assessment workshop in spring 2020 in addition to some WGII/WGIII joint intersessional meetings to be scheduled.

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

The summary list of WGIII actions and recommendations resulting from CGMS-47 is included in Annex IV of this report.

WG IV REPORT

Co-chairs: Hiroshi Kunimatsu (JMA), Vasily Asmus (ROSHYDROMET)
Rapporteur: Klaus Peter Renner (EUMETSAT)

1. Welcome, objectives of the meeting

During the plenary session of CGMS-46, Mr. Vasily Asmus (ROSHYDROMET), Mr. Hiroshi Kunimatsu (JMA) and Mr. Klaus-Peter Renner (EUMETSAT) were appointed as Co-Chairs and Rapporteur of Working Group IV, respectively. Representatives of the following organisations attended the session: CMA, ESA (via WEBEX), EUMETSAT, IMD, ISRO, JAXA (via WEBEX), JMA, KMA, NICT, NOAA, ROSCOSMOS, ROSHYDROMET and WMO (the full list of participants is included in annex VII).

In view of the actions agreed in relation to Space Weather, the representatives of the related Task Team also participated in the meeting under the dedicated agenda item 10.

2. Election of WGIV Co-chair

Mr. Hiroshi Kunimatsu (JMA) was no longer able to support CGMS WGIV and stepped down as the Co-Chair of WGIV prior to CGMS-47. JMA is continuing to support WGIV activities in providing a Co-chair and nominated Mr. Kotaro Bessho for this role.

WGIV unanimously endorsed the nomination and proposed to plenary to adopt the recommendation for Mr. Kotaro Bessho to become WGIV Co-chair.

3. Approval of agenda

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 WGI, with a minor change. The paper CGMS-47-ROSHYDROMET-WP-04 was moved from item 6 to item 8 of the agenda.

4. 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 6 actions and 2 recommendations were proposed to be closed: A43.03, A43.05, A45.01, A45.04, A46.01, A46.07, R44.01 and R46.01.

WG-IV The WG agreed to develop a “best practises” document on end user services that captures (at a minimum) the lesson’s learned from some of the on-going, older recommendations.

11 Actions and 3 recommendations remained open.

Further details are provided in the updated list of CGMS actions and recommendations, in Annex V of this report.

5. WGIV key issues

After the update of the WGIV ToR and the corresponding introduction of new objectives the standard agenda was also updated and is now covering all objectives of WGIV. Therefore the Working Group agreed that this item "WGIV key issues" will remain optional and appear in the agenda only if needed.

6. User-provider dialogue on regional/global scales

GMS-47-joint-JMA-KMA-WP-01WGIV: Progress Report on the RAII WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training in 2018-2019

The WMO Regional Association (RA) II WIGOS Project to Develop Support for National Meteorological and Hydrological Services (NMHSs) in Satellite Data, Products, and Training is a regional framework formed to assist NMHSs in RA II for better use of satellite-related information in collaboration with relevant satellite operators, users and WMO.

The First Joint Meeting of RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs was held in Jakarta, Indonesia on 11 October 2018. The meeting was hosted by the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG). At the meeting, the Group reviewed and discussed the status of the project, user and provider perspectives, and the work plan of the project. In response to the action established at CGMS-45 (WGIV/4 A45.01), it was decided that JMA and KMA would conduct a regional user survey in 2018 in collaboration with the Australian Bureau of Meteorology and will provide the working paper at CGMS-47. The common gateway in RA II WIGOS project webpage for rapid scan imagery from CMA, JMA and KMA will be considered. And co-coordinators will define and provide the training requirement from country report for the user-focused training event in conjunction with AOMSUC-10 The final report from the meeting is attached to this working paper.

WMO thanked KMA/JMA and appreciated this activity as an example of best use of satellite data information.

CGMS-47-joint-JMA-KMA-WP-02: RA II and RA V Survey on the Use of Satellite Data 2018

The RA II and RA V Survey on the Use of Satellite Data 2018 was produced by the Coordinating Group of the RA II WMO Integrated Global Observing System (WIGOS) Project to Develop Support for National Meteorological and Hydrological Services (NMHSs) in Satellite Data, Products and Training and the RA V Task Team on Satellite Utilization. Its objective was to collect up-to-date information on the use of satellite data for meteorological, climate, water and other environmental applications in WMO RA II and RA V. WMO issued the survey questionnaire on 3rd December with a return deadline of 31st January, and 32 countries/regions submitted responses. The Project and the Task Team plan to present the final report at the 2nd Joint Meeting of the RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs in December 2019.

JMA pointed out the high usage of GSMAP data and scatterometer data in Asia and Pacific countries in the survey results. Following these results, JMA will provide GSMaP data to these countries in cooperation

with JAXA as an activity of RSMC Nowcasting. JMA will also provide Sea-Surface AMVs retrieved from Himawari-8 to these countries for their disaster risk reduction activities.

7. Implementation and evolution of sustained and coordinated communication satellite broadcast systems

There were no papers presented. The Working Group acknowledged that the communication satellite broadcast systems GEONETCast Americas, EUMETCast, CMACast and HimawariCast are well established and coordinated systems, and no significant issues are observed.

8. Global or inter-regional data circulation and access (e.g. WIS/GTS/RMDCN, academic networks, etc.) systems

CGMS-47-ROSHYDROMET-WP-04: Satellite data exchange in Roshydromet

Roshydromet is sharing satellite data with international community in accordance with WMO resolution 40 and acting Bilateral Agreement with EUMETSAT.

Roshydromet has an operational access to the data distributed via EUMETCast, and now contributes to the EUMETSAT Advanced Retransmission Service (EARS) by provision of regional coverage of NOAA, Metop and SNPP data. SRC Planeta has become an official member of the EARS in 2009. A number of MEOS polar receiving stations by Kongsberg Spacetec were procured, as those stations became an unofficial standard for the EARS purposes. Now European, Siberian and Far Eastern centers of SRC Planeta are contributing to the EARS network operationally, all providing data from Metop, SNPP and NOAA series satellites. A dedicated 10 Mbit/sec landline channel was installed between Moscow and EUMETSAT headquarters in Darmstadt for the EARS program purposes. Plans are now in motion in EUMETSAT to upgrade the channel bandwidth up to 100 Mbit/sec. The Internet channels are used as a backup.

Data from Russian operational polar meteorological satellite is widely available to all interested parties in NRT via HRPT downlink (1700 MHz). Mission specific format implementation is published at SRC Planeta WEB site: http://planet.iitp.ru/english/spacecraft/meteor_m_n2_structure_eng.htm. The microwave sounder MTVZA-GY data, declared as Essential according to Roshydromet-EUMETSAT bilateral Agreement, have been provided to EUMETSAT operationally starting June 2016, up until instrument failure in September 2017. The MTVZA-GY data service will be resumed once the next mission will be launched. In addition, data from IR sounder IKFS-2 is also available to EUMETSAT via the same FTP channel. Starting 2018, IKFS data is available via Roshydromet GSICS Processing and Research Centre website http://planet.rssi.ru/calval/. Data from Russian geostationary satellite Electro-L N2 (76E orbital position) is available to EUMETSAT users in NRT in HRIT data format via EUMETCast.

CGMS-47-CMA-WP-12: The development of FENGYUN satellite data distribution and services

This document describes the data policy of FENGYUN satellite data, the status and future plan of the FENGYUN satellite data distribution and services. FENGYUN satellite data are open to NMSs and other international organizations and users for free charge via many ways. For real-time users, FENGYUN satellite data can be accessed via direct broadcasting station, CMA data broadcasting system (CMACast),

GTS, WIS and public cloud. For non-real-time users, FENGYUN satellite data can be accessed from the FENGYUN satellite data center website, downloading toolkits and offline data services. For emergency users, FENGYUN satellite emergency support mechanism is useful to NMSs.

Following a question from CGMS secretariat about the availability of additional non-FY data on the cloud services, CMA confirmed that only FY satellite data is currently available.

Questions from KMA and ISRO about data access and policy questions for the different access methods were positively answered. CMA also confirmed that it is planned that cloud services will replace legacy ftp download services.

CGMS-47-KMA-WP-06: GEO-KOMPSAT-2A (GK-2A) DATA DISSEMINATION AND DATA FORMAT

KMA will provide GK2A data in various ways such as landline based data service and satellite broad casting service.

The GK2A level 1B data will broadcast after conducting radiometric correction and geometric correction via UHRIT, HRIT and /LRIT services to users.

HRIT / LRIT (L-band) is used to succeed the existing COMS satellite broadcasting service, and UHRIT (X-band) is a newly developed high resolution weather broadcasting service to distribute large capacity data of GK2A. UHRIT's file structure and format basically follow the Global Specification released by CGMS. The goal of GK2A satellite broadcasting is to complete the transmission within 3 minutes after the end of observation.

The GK2A data dissemination via landline can be categorized as real time and non-real time service. GK2A level 1B data will be released to FTP in real time for NMHSs(similar to the Himawari Cloud) and to NMSC website(http://nmsc.kma.go.kr/html/homepage/en/ver2/main.do) in non-real time for every users.

GK2A level 1B and level 2 data are generated in netCDF format. The sample data and sample codes for reading data are available on NMSC website (http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=gk2aMicro).

The GK2A level 1B data will be public in July of 2019 and the level 2 data will be open based on validation phases of each product.

CGMS-47-NOAA-WP-17: Enhancing Access to NOAA's Open Data

NOAA presented a summary of NOAA's Big Data Project and NESDIS' (National Environmental Satellite, Data, and Information Service) Strategic Cloud Approach.

NOAA generates tens of terabytes of data a day from satellites, radars, ships, weather models, and other sources. While these data are publicly available, it is difficult to download and work with such high volumes. The NOAA's Big Data Project (BDP) was created to explore the potential benefits of storing copies of key observations and model outputs in the Cloud to allow computing directly on the data without

requiring further distribution. The goal of BDP is to provide public access to NOAA's open data through public-private partnerships with commercial cloud platform providers.

The NOAA Big Data Project, through Cooperative Research and Development Agreements (CRADAs), currently works with five infrastructure-as-a-service (IaaS) providers to broaden access to NOAA's data resources. This collaboration is designed to facilitate full and open data access at no net cost to the taxpayer, and to foster innovation by bringing together the tools necessary to make NOAA's data more readily accessible.

Several questions were raised following this interesting outlook into the cloud technologies which were new to most in the Working Group.

KMA emphasized user training, WMO enquired about changes in interfaces, data formats and applications on and between different clouds. WMO and CGMS secretariat addressed the interoperability between cloud providers, and clouds from different agencies.

Another aspect raised by JMA was the cost model for data access, i.e. is archive data free or not-free for end users. Also environments play a role, e.g. high availability operational environments, test and research environments, all with slightly different requirements.

Some of the issues are considered transparent, due to the nature of clouds, and others need more consideration, such as user training, the culture of data access, and in particular inter-operability. One key to success is to have common metadata definitions. These questions could not entirely be answered in the meeting. Therefore the Working Group agreed to consider the establishment of a dedicated expert team, starting off in an inter-sessional teleconference with experts nominated by each member, and a related action was raised.

CGMS-47 actions - WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	WGIV/ 8	A47.01	To provide a point of contact for participation in regular inter-sessional teleconferences lead by NOAA, starting discussions to establish an expert group on cloud services interoperability.	July 2019

CGMS-47-WMO-WP-20: Status of WIS 2.0 and how CGMS space agencies should contribute to its implementation

The WMO Information System (WIS) 2.0 implementation approach has been developed by the WMO Task Team on Evolution of WIS and is going to be presented for approval to WMO Congress 18, in June 2019. The implementation approach is based on 11 principles underpinning the new functional architecture of WIS 2.0. A list of demonstrator projects is being drafted to have a number of examples of use of the new technologies considered in the 11 principles for the development of the WIS 2.0 technical regulations. WMO Secretariat organized a workshop on future technologies with the aim to be informed of the

technologies trends and to ensure that the WIS 2.0 plan is in line with industry developments and expectations.

NOAA commented that the proposed usage of containers would provide portability for applications and this solution would work on the NOAA cloud and WIS 2.0.

WMO is asking for contribution from CGMS members in the form of participation with demonstration projects, exploring several of the WIS 2.0 principles. A related action was raised.

CGMS-47 actions - WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	WGIV/ 8	A47.02	To analyse if existing cloud service activities can serve as a demonstration project, exploring at least two of the WIS 2.0 principles.	Dec 2019

9. Widening of data access, to new missions/providers as well as for other user communities

CGMS-47-ISRO-WP-04: Widening of ISRO's data access to user community

Meteorology and Oceanography Data Archival Centre (MOSDAC) is a data centre of Space applications Centre (SAC) and has facility for satellite data reception, processing, analysis and dissemination. MOSDAC is operationally supplying earth observation data from Indian meteorological and oceanography satellites, to cater to national research requirements.

This paper briefly discusses new data access mechanisms and new capabilities introduced in MOSDAC.

As part of data access open data is now made available as HTTPS download, without any requirements of registration. MOSDAC has also introduced Micro services based dissemination of information/alerts. This services based interface allows other uses to integrate/use services of MOSDAC on their website or applications. Currently Beach alert, Weather alert and location based Weather forecast are available as service.

Some new capabilities introduced in MOSDAC includes support for INSAT-3DR rapid scan acquition (5 mins), Interactive Visualization and analysis using LIVE (https://mosdac.gov.in/live), quick visualization and animation using satellite image gallery and new SCATSAT-1 value added products.

CGMS-47-WMO-WP-19: Harmonization of GEO rapid scan services

In 2018, Japan Meteorological Agency (JMA) launched a new international service "Himawari Request" to request Target Area observation, China Meteorological Administration (CMA) commenced the Emergency Support Mechanism of FENGYUN Satellite and Korea Meteorological Administration (KMA) launched GEO-KOMPSAT-2A which will also provide a rapid-scanning service. At its 46th session and in the framework of the WMO RA II WIGOS Project, CGMS recommended CMA, JMA, KMA to jointly build a portal in the Project website for their operational information regarding rapid-scanning observations on demand from geostationary meteorological satellites in the regions (R46.12). This recommendation was brought to the

attention of the Tropical Cyclone (TC) community which welcomed the availability of rapid-scan services in the regions and thank the providers (CMA, JMA, KMA) for making those services available. The TC community noted that those services can contribute to disaster preparedness and risk reduction associated with Tropical Cyclone. It noted further that information about the service, its accessibility, availability and utilization should be made available and widely advertised, especially to WMO Tropical Cyclone Regional Specialized Meteorological Centres (RSMCs) and Tropical Cyclone Warning Centres (TCWCs).

JMA commented that in cooperation with CMA and KMA, JMA will enhance the activities of user readiness and notification of these Rapid Scan services through its portal site liaising with WMO, and the result will be reported to CGMS-48.

WMO welcomed the feedback from this activity. CMA pointed out that it is important to address how to provide the RSS data to the users.

A related action was raised to support the user preparedness for the new service.

CGMS-47 actions - WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CMA, KMA, JMA	WGIV/9	A47.03	To liaise with WMO and prepare the report of RSS observation activities including user readiness and notification.	CGMS-48

9.1 Disaster mitigation purposes - International Charter on Space and Major Disasters

There were no papers under this item. EUMETSAT verbally reported on the implementation of automatic retrieval and dissemination of value added disaster charter products. It turned out that the interfaces are more complex that anticipated and required several iterations.

10. Space weather matters

There were no papers under this item.

The space weather related actions for WGIV were superseded by the survey issued by the SWCG, which was aimed at data providers, formats, dissemination and latency issues. With this survey the existing actions could be closed. Next steps are to complete the data provider survey and start a user specific survey. WGIV will be involved again when needed.

A question was raised on planned GTS dissemination and the used WMO grib2 format. However this would only serve the WMO community. This will be addressed in SWCG as part of the above mentioned surveys.

11. Data formats and standards (use of open standards)

No papers were presented and no issues identified.

12. Coordination of Metadata

CGMS-47-CGMS-WP-07: CGMS TFMI Activity Report

This report describes the activities performed by the CGMS Task Force on Metadata Implementation since CGMS 46 and in particular its work undergone regarding the WIGOS Standard Assessment (A45.02), the DBNet Metadata review (A43.05) and the creation of WIS metadata records for satellite data products. The Task Force has reviewed the WIGOS metadata standard and produce a report including recommendations for amending the WIGOS metadata standard to support the description of Satellite products. The assessment report can be brought forward and submitted to the Inter-Commission Coordination Group on WIGOS Task Team in WIGOS Metadata. The report also defines the Task Force working plan for finalising the WIGOS standard assessment, i.e. a review of the WIGOS Metadata Representation Format to ensure that Satellite observations can be properly described. In addition the Task Force presents the outcome of the DBNet Metadata review and the work performed regarding the publication of Satellite observation discovery metadata on the WIS. Recommendations have been defines regarding those tasks. The Task Force invites the Working Group IV to review and approve the different recommendations.

- The CGMS TFMI recommends the CGMS working group IV to endorse and approve the recommendations available from CGMS-TFMI-WIGOS-Standard-Review.
- The CGMS TFMI would like the CGMS working group IV to approve the presented working plan regarding the assessment of the WIGOS Metadata Representation Format and allow the task force to proceed on the defined tasks
- The CGMS TFMI recommends to close the action A43.05 because it has been completed.
- The CGMS Task Force on metadata invites Satellite Providers taking advantage of the Metadata Guidance documentation to create WIS discovery records in addition to the existing WIS documentation.
- The CGMS Task Force on metadata is seeking guidance and support from WG IV to enable the connectivity between the OAI PMH NESDIS repository and GISC Washington.

WMO and CGMS secretariat welcomed the work on implementing WIGOS in the metadata activities.

The Working Group agreed with all recommendations and raised the following action and recommendations:

CGMS-47 actions - WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
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.	July 2019

CGMS-47 recommendations - WGIV			
Lead	**AGN item**	**Rec #**	**Description**
CGMS	WGIV/12	R47.01	CGMS-47 Plenary to endorse the recommendations available from CGMS-TFMI-WIGOS-Standard-Review (link see CGMS-47-CGMS-WP-07).
CGMS	WGIV/12	R47.02	CGMS-47 Plenary to endorse the presented working plan regarding the assessment of the WIGOS Metadata Representation Format and allow the task force to proceed on the defined tasks.

13. User readiness for new satellite systems

CGMS-47-NOAA-WP-18: NOAA User Readiness Work on GOES-R Series and NOAA-20

NOAA WP-18 presented a summary of NOAA user readiness with respect to GOES-R and JPSS. The paper presented a number of key best practices being employed for user engagement. NOAA has developed application initiative teams to foster collaboration and training needs. JPSS and GOES-R have integrated their training resources to now focus on scenario training (e.g. fire, convective initiation, etc.), instead of focusing on the capability of one observing system. Quick guides of products are available for both JPSS and GOES-R. The training is now focused on the life cycle of the scenario and how different assets can contribution to decision making. Best practices also include testing of data flow prior to a new satellite launch to ensure that key users are ready for the data and provide feedback during the commissioning stage. Both GOES-R and JPSS participate in the Hazardous Weather Testbed spring experiment in Norman, Oklahoma to train forecasters on the use of satellite products to support severe weather forecasting.

CGMS-47-VLab-WP-01: VLab progress report and 5-year training strategy for endorsement

This document reports on activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) along with future plans. Since CGMS-46, VLab members have offered a variety of training opportunities, with highlight to training efforts addressing the new generation of satellites, as this proved to be the major training need identified by VLab members in recent years. Furthermore, the new Five-year Strategy document for VLab activities 2020-2024 was proposed by the VLab Management Group (VLMG), and endorsed by IPET-SUP. CGMS members are invited to take note of the Strategy, provide comments and endorsement (Action i). VLMG continued to coordinate its activities and support for training events via regular online meetings. Additionally, the Group met face to face in July 2018 for the ninth meeting of the VLab management group - VLMG-9. The meeting was hosted by the Cooperative Institute for Research in the Atmosphere (CIRA), on behalf of NOAA and WMO. The VLab Trust Fund continued to receive a steady level of contributions from NOAA/NWS, EUMETSAT, and KMA. However, a larger number of contributing CGMS agencies is required to improve its resilience. Regular financial contributions from CGMS members are critical to maintain technical support to the VLab (Action ii). Since October 2017, Dr Mark Higgins (EUMETSAT Training Manager) has been a VLab co-chair on behalf of CGMS satellite operators. This co-chairmanship was established for a period of up to 3 years.

Nominations need to be considered by CGMS satellite operators in order to ensure the continuation of this partnership after October 2020 (Action iii).

Following an enquiry by CGMS secretariat about space weather training, the Working Group recommended to include space weather training in the VLab.

WMO emphasized the usefulness of this activity and supported the endorsement of the 5 year plan.

KMA pointed out that the technical expertise is a challenge in many development countries. If it is not properly funded experts will move on to other jobs and leave a gap.

The working Group raised a recommendation for plenary to endorse the 5 year strategy.

CGMS-47 recommendations - WGIV			
Lead	**AGN item**	**Rec #**	**Description**
CGMS	WGIV/13	R47.03	CGMS-47 Plenary to endorse the Five-year Strategy document proposed by VLab, w.r.t. items in the scope of WG-IV.

14. Notification of changes (and alerts) in satellite data and/or products impacting users

No papers were presented under this item. There are still open actions which are under analysis or under implementation.

15. Cyber security towards end users

CGMS-47-EUMETSAT-WP-12: Template for Interconnection Security Agreements

EUMETSAT IT infrastructure interconnect with several other organisations in the world for ingesting and disseminating data, for both sharing remote spacecraft monitoring and control resources, and covering partner's spacecraft orbits, and also for supporting the validation and testing, the launch and LEOP and the in-orbit testing of the new missions.

Establishing such interconnection is challenging in terms of information security because the most critical ground segments assets of each organisation become reachable from remote location outside their own scope of responsibility. To mitigate related information security threats, Interconnection Security Agreements (ISA) are set up with partners, following international standards and best practices. EUMETSAT defined a template for such agreement, refined from the guide proposed by CCSDS (Consultative Committee for Space Data Systems) and provided feedback to the CCSDS for preparing the release of the new version of the "CCSDS Guide for Secure System Interconnection" (CCSDS350.4-G-1).

CGMS-47-NOAA-WP-19: NOAA's Report on Operational Cyber Security

NOAA's National Environmental Satellite, Data, and Information Service is preparing for a new paradigm. While continuing to provide highly accurate and consistent delivery of data, information, products and services, NESDIS is also assessing our current state and responding to changing technology. One area

NOAA has focused on is cybersecurity. This area potentially impacts on NOAA's ability to meet its commitments to its partners and ensure the integrity of the data it provides. To support its mission in this area, NOAA has developed IT security guidance in the form of the IT Security Manual. It also receives guidance at the departmental level from the Department of Commerce Information Technical Requirements. NOAA has implemented Defense-in-Depth in compliance with national, departmental and agency requirements. In the materials provided, NOAA outlines the approach taken to cybersecurity incidents as well.

Several questions were raised regarding 24/7 support, training, intrusion exercises, the impact of secure ingests, etc. The Working Group agreed that more must be done with experts on this topic in order to share experience, develop best practices and to look at training for cyber security in general.

A corresponding action with the goal to address these questions was raised, starting with collecting points of contact.

CGMS-47 actions – WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
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.	July 2019

16. Long term data preservation

CGMS-47-EUMETSAT-WP-11: Presentation of the CEOS LTDP guidelines

In response to the discussion of a potential new CGMS Long Term Data Preservation objective, the applicability of existing CEOS resources to CGMS missions needs to be investigated. EUMETSAT reviewed the CEOS EO Data Preservation guidelines (CEOS DPG) which is intended to assist Organisations in the tasks of ensuring the Long Term Data Preservation (LTDP) of Earth Observation space data sets, their accessibility and usability.

The CEOS DPG evolved from the European LTDP Common Guidelines which CGMS in 2012 found to be appropriate for CGMS members to be used as basis for any further consolidation or update (CGMS-41WMO-WP-05). The guidelines and the recommended step-wise approach to reach adherence were adopted by CEOS and have not changed. The CEOS LTDP are therefore considered fully applicable to the CGMS LTDP aspects.

The Working Group recommended to plenary that the CEOS Data Preservation Guidelines be adopted by the CGMS. On the understanding that plenary endorses such recommendation, the Working Group would review CGMS members' adherence levels regularly as per the following action:

CGMS-47 actions – WGIV				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	WGIV/ 16	A47.06	CGMS members, through WGIV, to review CGMS members' adherence levels to the CEOS Data Preservation Guidelines on a regular basis (every 2-5 years). For review at CGMS in the 2021-2022 timeframe.	2021-2022

17. Aspects on the implementation of the global contingency plan from Plenary (as proposed by WGIII)

CGMS-47-CGMS-WP-13: CGMS Risk Assessment

This paper describes the outcome of the CGMS Risk Assessment again the CGMS Baseline. The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System – includes Space Weather.

The CGMS baseline responds to end-user requirements expressed in WMO's Rolling Review of Requirements (RRR). The CGMS Baseline strives to support the WMO Integrated Global Observing System (WIGOS) 2040 vison. The Key principles are:

- Commitment: The CGMS members are providing, or have firm plans to provide, the observations, measurements, and services enumerated in the Baseline
- Sustained: The observations, measurements, and services are provided on a sustained basis
- Available: The observations, measurements, and services are available on a free and open basis
- Operational: The data and products can be utilized in operational applications

The Risk Assessment was carried out in early 2019 against the CGMS Baseline with the following objective:

- Convey CGMS's posture with respect to its baseline commitment
- Provide a high-level assessment designed to allow members to assess the current contribution to the user community as well as coordinate future planning to meet current and future baseline commitments

Working Group III held a workshop 27 Feb – 1 Mar, hosted by EUMETSAT and attended by EUMETSAT, NOAA, JMA, CMA, WMO, and CGMSSEC. Working Group III reviewed how CGMS current and future missions match the commitments made in the CGMS Baseline. The findings and proposed mitigation actions from this Workshop were sent to the other Working Groups for review.

WGIV reviewed and commented on the presentation noting that the Report from WGIII will provide a detailed discussion on the risk assessment.

18. Any other business

N/A.

19. Review and updating of the HLPP

CGMS-47-CGMS-WP-08WGIV: Status of implementation of CGMS High Level Priority Plan (2018-2022)

CGMS-47-CGMS-WP-03WGIV: CGMS High Level Priority Plan (HLPP) Presented to WG-IV

The status of implementation of CGMS High Level Priority Plan (2018-2022) as relevant for WGIV was presented. It incorporates inputs from the WGIV chairs and rapporteurs.

To guide the considerations of the working groups, the colour coding in the table indicates:

- Green: Priority is reflected in ongoing CGMS actions
- Yellow: Actions have been defined associated to the priority, but progress is limited
- Red: No actions associated with the priority can be identified or major obstacles is hindering progress

No targets overseen by WGIV are proposed to be considered achieved, therefore all HLPP items remain valid.

Following items are recommended to be considered by WGIV:

- Should the implementation of the CEOS Long-Term Data Preservation Guidelines be included?
- It is assumed that Big Data and Cloud Technology, as well as Cybersecurity could be considered for inclusion at CGMS-48
- Target on promotion of metadata formats for Ocean observations has not been converted into any actions
- Consider and comment on the status of implementation of the HLPP
- Formulate a final proposal for revision of the HLPP to cover the next four years period.

These recommendations will be addressed in an inter-sessional meeting.

20. Nomination and representatives at meetings

WGIV discussed nominations for CGMS-48 and reconfirmed the current Co-chair Vasily Asmus (ROSHYDROMET), the rapporteur Klaus-Peter Renner (EUMETSAT), the WGIV liaison contact to WGIII for contingency related issues Sean Burns (EUMETSAT), and agreed to nominate and propose to plenary the recommendation for Mr. Kotaro Bessho to become WGIV Co-chair.

21. Date/time of inter-sessional activities/meetings in 2019-2020 [CGMS-47 -> CGMS-48]

- GODEX NWP (EUMETSAT): 10-12 September 2019
- Cloud services and interoperability (NOAA): 24-26 September 2019
- Cyber Security including related training aspects (NOAA/EUMETSAT): 8-10 October 2019
- Best Practices (EUMETSAT): 10-12 December 2019
- CGMS-48, Metadata (JMA/TFMI/EUMETSAT): 14–16 January 2019
- HLPP (CGMS/EUMETSAT): 28-30 January 2019

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

The Working Group reviewed the new actions and recommendations and agreed to convert recommendations to best practises, as much as possible.

The working group identified as key issues big data and cloud services including WIS 2.0, cyber security and metadata implementation.

The summary list of WGIV actions and recommendations is available in Annex V of this report.

SWCG REPORT

Co-chairs: Tsutomu Nagatsuma (NICT/JMA), Elsayed Talaat (NOAA)
Rapporteur: Andrew Monham (EUMETSAT)

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

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).

Note that the meeting was preceded by the Joint WGI-SWCG Meeting, which is documented in the WG1 Report.

SWCG 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 SWCG.

2. Review of actions and recommendations from previous meeting

SWCG discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-46 and earlier) and the final status is provided in Section 14 of this report. The summary list of actions and recommendations resulting from the CGMS-47 SWCG discussions is available in Annex VI.

3. Update on the CGMS baseline

Mr. Butler (NOAA) provided an overview of the paper CGMS-47-CGMS-WP-13WGIII (fully presented as Agenda Item 7.1 of WGI) describes the outcome of the CGMS Risk Assessment again the CGMS Baseline. The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System and includes Space Weather considerations.

The CGMS baseline responds to end-user requirements expressed in WMO's Rolling Review of Requirements (RRR). The CGMS Baseline strives to support the WMO Integrated Global Observing System (WIGOS) 2040 vison. The Key principles are:

- Commitment: The CGMS members are providing, or have firm plans to provide, the observations, measurements, and services enumerated in the Baseline;
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SWCG reviewed and commented on the presentation which was focussed on the space weather related items, noting that the Report from WGIII will provide a detailed discussion on the risk assessment.

Discussion on the absence of Magnetometer data in LEO led to the following actions:

CGMS-47 actions – SWCG				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SWCG	SWCG/3	A47.01	CCMS members to assess whether magnetorquer TM can be extracted to allow assessment for magnetic field derivation	July 2019
SWCG	SWCG/3 (WGIII)	A47.02	Survey ISES on need for operational spaceborne LEO magnetometer data and propose updates to CGMS Baseline as appropriate.	July 2019
SWCG	SWCG/3	A47.03	Encourage WMO CGMS Early Morning Tiger Team to include Space Weather data in their impact analysis. *(The study is expected to be carried out in 2020/2021 timeframe, launch ~2021)*	CGMS-48/-49

4. Updates on space-based observational capabilities

CGMS-47-NOAA-WP-20: NOAA update on Space Weather Follow-On (SWFO)

Dr. Talaat presented an update on NOAA's spade weather observing infrastructure. In addition to continuity of current assets, NOAA has begun formulation of its Space Weather Follow-On (SWFO) program which includes the SWFO-L1 satellite that will provide needed continuity of solar coronagraph and upstream solar wind measurements. SWFO-L1 is planned to launch in 2024 as a rideshare on the NASA's Interstellar Mapping and Acceleration Probe (IMAP) mission launch vehicle. The presentation also covered the upcoming Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC)-2, a partnership between NOAA and Taiwan, that will launch in to low Earth orbit as a rideshare payload flying on the U.S. Air Force's Space Test Program-2 (STP-2) mission. In Taiwan, COSMIC-2 is known as FORMOSAT-7. COSMIC-2 will provide dense coverage of the ionosphere at low and mid-latitudes through radio occultation and in situ sampling.

CGMS-47-CMA-WP-13 : CMA update on FENGYUN satellite SWx sensors

Dr. Guo provided an overview of the update information on CMA space-based follow-on capability in space weather.

The report informs that FY-4B will give in-situ measurements of high, medium and low energetic charged particles. FY-4C solar measurement will consists of X-EUV flux and EUV image. FY-4C will also carry on multi-wavelength ultraviolet ionospheric imager.

The report also mentions that the space weather payload on FY-3E will consists of multi-angle ionospheric photometer and solar X-ray and EUV Imager.

CGMS-47-ESA-WP-04: ESA Lagrange L5 mission and D3S update.

Mr. Luntama presented the ESA Space Situational Awareness (SSA) Programme, which has started the development of the Lagrange mission to L5 point for operational space weather monitoring by Phase 0 mission feasibility studies in 2015. In 2019 the mission development has reached Phase B1. The objective of the Programme is to complete the Phase B1 with a successful Initial System Requirements Review (ISRR) in September 2019. This will allow starting the mission Phase B2/C/D phases in 2020, subject to the approval of the mission proposal by ESA member States in the Ministerial Council in November 2019.

In parallel to the Lagrange mission development, ESA's SSA Programme has initiated the development of the Distributed Space Weather Sensor System (D3S) for monitoring of the space weather impacts on the near-Earth space. The first D3S hosted payload mission, SOSMAG magnetometer, was launched successfully with the Korean GEO-KOMPSAT-2A satellite in December 2018. The next hosted payload launch will be in July 2019 when the Next Generation Radiation Monitor (NGRM) instrument will be launched with the EDRS-C satellite. Development of the D3S will be continued with procurements of additional hosted payload instruments and planning of SmallSat/cubesat missions targeting operational space weather services.

Mr. Luntama updated SWCG on the status of the Lagrange mission and the D3S system developments.

SWCG expressed their appreciation for the presentations and discussed the papers, noting the developments and issues regarding ensuring operational services from these new space-based capabilities. No actions were raised.

5. Updates on space weather activities

CGMS-47-KMA-WP-04: KMA space weather activities and plans

Dr. Kim described the recent updates of GK2A's space weather mission, KSEM (Korean Space wEather Monitor) project and KMA's space weather services.

(KSEM) GK-2A is successfully launched in December 5, 2018 and the transition of GK-2A to geostationary orbit is completed in the early of January 2019. Other sensors of GK-2A for monitoring space weather,

KSEM, is on in-orbit test(IOT) now. All of the initial activities checks for operation finished, including SOSMAG's boom release, PD(Particle Detector) sweep test, and Look-up Table and EEPROM parameter uploads etc. We are repeating performance check and noise monitoring for adjusting parameters on the last step of IOT. The first space weather data from GK-2A will be shared in coming July 2019, if IOT of KSEM is going smoothly.

(KREAM) A cosmic radiation dose model for aviation, KREAM(Korean Radiation Exposure Assessment Model for aviation route dose) was developed during 2013-2016 and has verified with ARMAS (The Automated Radiation Measurements for Aerospace Safety) to improve the model accuracy. KMA will open the estimated effective dose through the KMA website of KREAM in the first half of this year.

CGMS-47-ROSHYDROMET-WP-05: Russian Space Weather Center to support International Air Navigation: Composition, Duties, international cooperation.

Dr. Kholodkov presented the working paper discussing the organizational and technical aspects of the creation and operation of the Russian Space Weather Center based on the Institute of Applied Geophysics of Roshydromet (IAG).

At present, Russian Space Weather Center is working in accordance with the latest amendments made by the ANC ICAO to the Regulations of the Meteorological Service for International Air Navigation, and provides a full range of such services. The center uses various data sources, such as data from spacecraft, data from ionospheric stations, GNSS receivers and riometers, from both Russian and foreign observational platforms. Using modern solutions for modeling of the ionosphere and using data from a large area, Russian Space Weather Center is able to provide services to pilots in real time mode. The hardware infrastructure and the developed software allow the center to work 24 hours a day and seven days a week in automatic mode. This center along with China National Centre for Space Weather are implementing integration mechanisms to act as global SWXC as "China Russian Consortium".

CGMS-47-NICT-WP-01: NICT Space Weather Activities

Dr. Nagatsuma explained that the National Institute of Information and Communications Technology (NICT) is in charge of space weather forecast services in Japan as a regional warning center of International Space Environment Service(ISES). Since 1952, NICT have operationally measured solar radio spectrum, and started operational alert service for radio propagation since 1957. Now, NICT has been routinely providing Space Weather forecast information and plan to operate 24/7 since 2019. We maintain space weather observation network in Asia & West Pacific region under the international collaboration. And we have developed empirical models and numerical simulation for space weather forecast. Recently, we have developed Solar flare prediction model based on machine-learning technique, Warning System of AVIation Exposure to Solar energetic particles (WASAVIES). These products will be available on the web in the near future. We are also developing Space Environment Customized Risk Estimation for Satellite (SECURES) based on the combination between space weather forecast model and surface charging model with specific satellite information.

CGMS-47-Joint-NOAA/NASA-WP-01: Joint NOAA-NASA updates on space weather activities

Dr. Talaat presented an update on NOAA and NASA space weather activities. Highlights for NOAA included new operational models planned including a Ground E-Field model that will be operational in 2019, and two models for the ionosphere and thermosphere that will be operational in 2020. NOAA's Space Weather Prediction Center was also selected as ICAO Global Space Weather Center and is working with other centers to stand up Initial Operating Capability by November 2019. Highlights for NASA include updates on the Heliophysics System Observatory fleet of science missions, including updates on missions in formulation. NASA also has initiated a Space Weather Science and Applications effort designed to expand space weather science within Heliophysics through collaboration, directed and competed efforts. Included in that is the NOAA, NASA, and National Science Foundation effort for Operations to Research that kicked off last year. Finally, the United States has updated its national Space Weather Strategy and Plan that updates the 2015 plan and aligns with current Administration priorities.

Additional Paper Presented in WGIII:

The following paper has been presented in WGIII subsequent to SWCG. Due to the relevance to this agenda item in SWCG, the summary is duplicated in this report.

CGMS-47-ROSHYDROMET-WP-03: Prospects for the development of the equipment of complexes for heliogeophysical measurements of spacecraft for hydrometeorological appointment

Dr. Nikolaev presented in WGIII the overview of prospective types of equipment for spacecraft for heliogeophysical measurements of spacecraft for hydrometeorological appointment.

The Institute of Applied Geophysics (FSBI «IAG») serves as the parent organization for ionospheric, magnetic and heliogeophysical observations – monitoring of space weather in the country. Information flows from the ground segment, spacecrafts, international exchange channels. The Russian space segment currently consists of spacecraft series «Meteor-M» and «Electro-L».

A new generation of spacecraft for hydrometeorological and heliogeophysical purposes have also been developed:

- Meteor-MP (fourth generation)
- Elektro-M (third generation)
- Arctic-MP.

One of the planned systems for heliogeophysical monitoring is the space complex «Ionosonde». The task of the complex is to monitor the current state of the ionosphere using radiosonding equipment (ionosonde) installed on each spacecraft of this group. Also, the use of small satellites (cubesats - micro and nano satellites for monitoring space weather) is growing.

The Space Weather Centre is operating in production mode since 2019. A consortium of Russian Space Weather Centre and National Space Weather Centre of China is undergoing integration procedures and would enter global service as soon as they are complete.

SWCG expressed their appreciation to the presenting CGMS members for these updates.

No specific SWCG actions were identified.

6. International Space weather activities

CGMS-47-WMO-WP-21SWCG: WMO space weather activities update

Dr. Balogh presented the achievements of the WMO Open Programme Area Group on Data-Processing and Forecasting Systems (OPAG-DPFS) Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWeISS) and its four task teams on systems (TT-SYS), science (TT-SCI), applications (TT-APP) and aviation (ad hoc TT-AVI), in 2017–2019:

- Space weather observations were included in WMO Rolling Review of Requirements;
- Space-based space weather observations were included into the WMO OSCAR database (OSCAR/Requirements, OSCAR/Space);
- WMO Statement of Guidance on space weather was updated;
- Creation of an inventory of space weather relevant frequencies in preparation for the International Telecommunication Union (ITU) World Radiocommunication Conferences (WRC);
- Cooperation with the International Civil Aviation Organization (ICAO) to audit potential candidates for providing space weather information for international air navigation.

These activities are aligned with the Four-year Plan for WMO's Coordination of Space Weather Activities 2016-2019 (FYP2016-19) and demonstrate the ability of WMO to effectively facilitate coordination of space weather activities and to play a recognized role in the international space weather community through IPT-SWeISS.

A "Four-year Plan for WMO Activities Related to Space Weather (FYP2020-23)" will be submitted for approval to the Eighteenth World Meteorological Congress (Cg-18) in 2019 (Draft Resolution 6.1(5)/3 (Cg-18)). The implementation of space weather services and applications aligned with the FYP2020-23 is expected to provide significant benefits to WMO members, leading to more precise observations and improved reliability, accuracy, and timeliness of space weather forecasts and warnings.

SWCG was also informed that an extract of the OSCAR gap analysis and risk assessment for space-based space weather observations is contained in working paper CGMS-47-WMO-WP-21. SWCG is invited to review the report and the contents related to space weather observations contained in the OSCAR/Space database and provide feedback to WMO Space Programme Office (please refer to Agenda Point 7).

CGMS-47-GUEST-WP-03SWCG: Need for an operational data exchange in support of ICAO SWxC

Dr. Balogh presented the objectives and requirements for the provision of space weather data services to aviation and the process used to select the providers. In November 2018, ICAO selected the PECASUS (led by FMI) consortium, and the United States serve as global space weather information service providers, with start of service planned for November 2019. Two regional centres, comprising the China/Russian Federation consortium and South Africa, were also agreed to be established no later than November 2022, noting the interest expressed by China and the Russian Federation to serve together as a global centre. ICAO is confident that the implementation of the space weather information service will be a significant contribution to the achievement of the safety level needed by civil aviation, especially in light of the remarkable traffic growth that is forecasted.

Roshydromet further explained that ICAO has recently concluded (on 2 May 2019) that every previously qualified space weather center may opt-in for becoming global thus the Russian – Chinese Consortium would opt-in as global as soon as integration procedures complete.

CGMS-47-GUEST-WP-02: Space Weather Measurement Needs from ICAO PECASUS Consortium

Mr. Luntama presented charts expressing the space weather data measurement needs of the ICAO Pecasus consortium (source Finnish Meteorological Institute).

CGMS-47-NOAA-WP-21: Space Weather Measurement Talking Points from NOAA for ICAO

Dr. Talaat presented a short summary of the existing capability of NOAA SWPC in their service for ICAO and the SWPC view on improvements which should be considered, including improved scintillation measurements and magnetometers in LEO.

SWCG thanked the presenters for their compilation of the service provider views. It was noted that for PECASUS, no need has been highlighted for scintillation data, in contrast to the emphasis given to this by SWPC. Scintillation data provision should be highlighted as a point to be addressed in responses to the User Survey (Refer to SWCG/A47.05 from Agenda Item 8.)

CGMS-47-SWCG-WP-05: Update on UNCOPUOS activities

Dr. Talaat presented a short summary of the activities of the Expert Group on Space Weather in UNCOPUOS, stressing the importance of the Group in coordinating an international policy and strategy for space weather activities.

The complementary roles of UNCOPUOUS and WMO space weather activities was discussed amongst SWCG members, with WMO taking care of implementation approaches, which is not in the scope of UNCOPUOS activities.

7. OSCAR review for space weather – Completeness and suitability of space weather related content

The OSCAR/Space database review to assess the contents related to space weather will become a standard agenda item of SWCG and the related action SWTT/7 A4601 is closed.

However, further assessment of the suitability of the parameters describing space weather measurements is required and hence a new action is raised:

CGMS-47 actions - SWCG				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
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.	CGMS-48

8. Expansion of space weather user survey

Mr. Butler (NOAA) gave a summary of the survey sent out to Space Weather data providers through WGI and WGIV. A number of further responses can be expected before end-May. The survey has been forwarded also to SWCG members who were not on the original distribution in the other WGs. A survey of Space Weather data Users (Space Weather Service Providers and Satellite Operator end-users) is to be compiled, with the intention to include results of the Providers survey for their comment. A small Task Group is to be formed to identify the gaps and areas for improvement and subsequently to propose specific mitigating actions.

The following actions have been agreed:

CGMS-47 actions - SWCG				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SWCG	SWCG/ 8	A47.05	CGMS members to complete the on-going Space Weather data provider survey	May 2019
SWCG	SWCG/ 8	A47.06	Identify Space Weather Data and Services Users and send survey including findings from the Data Providers Survey for their comment.	June 2019
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 2020	July 2019

9. Task Group on space weather calibration

CGMS-47-SWCG-WP-02: Task group on inter-calibration of high energy particle sensor (T. Nagatsuma)

Dr. Nagatsuma presented how the observation of high energy particle in geospace (space environment around the Earth) is used for housekeeping information of individual satellite, and risk assessment of satellite anomaly due to deep dielectric charging. Although high energy particle sensor is on-board several meteorological satellites in GEO, there have been no distinguished activity of the inter-calibration so far. Since particle observation is in-situ measurement, two-dimensional or three-dimensional particle distribution in geospace needs to construct from the combination of many satellite data. So, inter-calibration of space weather sensor is needed for making advanced product of space weather. For these reasons, the task group of inter-calibration of high energy particle sensor was established. And we had a kick-off teleconference in Feb. 2019. The activity of task group is just started. Based on the previous inter-calibration activity and the results of discussion in the kick-off meeting of the task group, we have reported status of our inter-calibration activity to GSICS Annual meeting and GSICS EP meeting. Task group of inter-calibration of high energy particle sensor will contribute practical use of space-based space weather data and product.

CGMS-47 actions - SWCG				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SWCG IC TG	SWCG/9	A47.08	Space Weather Inter-calibration Task Group members to agree on a specific period of data for validating the inter-calibration approach for high energy particle sensors on-board GEO satellites.	July 2019
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 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.	July 2019

10. Any other business

The request from WMO-CM to SWCG concerning the usage of the GRIB Edition 2 format was discussed. SWCG requested WMO to recommend that IPT-SWeISS give their feedback in the first instance.

11. Review and updating of the HLPP

CGMS-47-CGMS-WP-03SWCG

Dr. Rattenborg presented the Space Weather items of the HLPP. Following discussion in SWCG, the following update is proposed for Section 6.2.1:

- Coordinate with the space weather user community, in particular the ICAO Space Weather Centres, ISES, WMO IPT-SWeISS and the UNCOPUOS Space Weather Expert Group.
- Advance the integration of Space Weather coordination activities into the relevant CGMS working groups.
- In coordination with IROWG establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring.

12. Nomination and representatives at meetings

This document is an update since CGMS-46 in 2018, and lists the representatives and any nominations for co-chairs and rapporteurs of the CGMS Working Groups and CGMS International Science Working Groups, as well as CGMS representation at various international meetings, for endorsement and confirmation by CGMS-47 plenary. CGMS is invited to note, propose, or endorse representatives as necessary for the meetings/groups indicated in this document. N.B. The paper will be updated following the CGMS-47 working group meetings.

SWCG identified that the following should be added to the list of relevant meetings in Section 2.1.5:

- US Space Weather Workshop
- AOSWA Space Weather Workshop.

13. Next meetings 2019-2020 period

Planning:

4 SWCG Intersessional Meetings are scheduled:

- 24 July 2019
- 8 October 2019
- 21 January 2020
- 1 April 2020

Relevant Space Weather meetings:

- 28 July-1 August 2019, AOGS/AOSWA Space Weather Workshop, Singapore
- 18-22 November 2019: European Space Weather Week, Liège, Belgium
- WMO IPT-SWeISS 25-27 November 2019
- February 2020 (TBC), UN COPUOS Space Weather Expert Group, Vienna, Austria
- 20-24 April, 2020, US Space Weather Workshop, BOULDER, CO

- 18-22 May 2020, SpaceOps, Cape Town, South Africa
- 24-29 May 2020, CGMS-47, City TBC, China

Currently TBD meetings:

- Other UNOOSA activities (UN COPUOS and International Space Weather Initiative)

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

The summary list of actions and recommendations resulting from the CGMS-47 SWCG discussions is provided in Annex VI.

SWCG actions open from previous plenary sessions (at CGMS-47)							
Actionee	AGN item	Action #	Description	Action feedback/closing document	Deadline	Status	HLPP ref
CGMS members	SWTT/10 (WGII/9)	A45.02	SWTT members review GSICS activities and deliver recommendations for its use as a framework for space weather sensor inter-calibration activities.	17 Oct 2018 IS#1: Agreement has been reached to use GSICS as a framework.	CGMS-47 (30 Dec 2017)	**CLOSED**	6.2.2
SWCG	SWTT/7	A46.01	CGMS SWTT to review the contents related to space weather stored in OSCAR/Space database and provide any updates to tkurino@wmo.int	*CGMS-47-WMO-WP-21SWCG (Toshi Kurino): Inputs Provided. This is a continuous process and will be a standing agenda item. A new action is raised to capture the assessment of suitability of the OSCAR space weather parameter description.*	CGMS-47	**CLOSED**	
SWCG, WMO	SWTT/9	A46.02	Clarify what information needs to be provided in each field of the space weather anomaly form	*CGMS-47: CGMS-47-EUMETSAT-WP-14 provided inputs. All issues concerning progress on the anomaly form and database to be in ToR of the proposed Space Weather Database Task Group.*	Feb 2019	**CLOSED**	2.4.1
CGMS members	SWTT/9	A46.03	Expand on space weather template inputs to include full investigations when available and when possible.	*CGMS-47: CGMS-47-EUMETSAT-WP-14 provided inputs.* *All issues concerning progress on the anomaly form and database to be in ToR of the proposed Space Weather Database Task Group.*	CGMS-47	**CLOSED**	2.4.1
SWCG	SWTT/11	A46.05	Survey CGMS members to identify cross-member use of space weather data	*CGMS-47: Closed in favour of new survey-related actions with follow-up by the proposed Space weather User Task Group.*	Dec 2018	**CLOSED**	2.4.1

SWCG actions open from previous plenary sessions (at CGMS-47)							
Actionee	AGN item	Action #	Description	Action feedback/closing document	Deadline	Status	HLPP ref
SWCG	SWTT/11	A46.06	Investigate issues (e.g., access, calibration, format) regarding data dissemination and use of space weather data by end users (will coordinate with WGIV)	*CGMS-47: Closed in favour of new survey-related actions with follow-up by the proposed Space weather User Task Group: To be discussed with WGIV.*	CGMS-47	**CLOSED**	3.10
SWCG, WGI	SWTT/9	A46.07	Develop strategies to increase reporting into the space weather anomaly database through intersessional meetings with WGI	*CGMS-47: Closed in favour of new survey-related actions with follow-up by the proposed Space weather User Task Group.*	CGMS-47	**CLOSED**	2.4.1
SWCG (from WGI)	SWTT/9	A46.08	Provide use case(s) from space weather anomaly analyses and any recommendations to operators arising	*CGMS-47: Closed in favour of new survey-related actions with follow-up by the proposed Space weather User Task Group.*	CGMS-47	**CLOSED**	2.4.1
CGMS members	SWTT/11	A46.09	CGMS members to nominate representatives to participate in a task group on space weather calibration	CGMS-47: ROSHYDROMET, ESA, NASA participation confirmed. ***TG participation is:*** ***CMA: guojg@cma.gov.cn*** ***EUM: Kenneth.holmlund@eumetsat.int, Andrew.Monham@eumetsat.int*** ***ISRO: TBD*** ***KMA: dkim@kma.go.kr*** ***NICT: tnagatsu@nict.go.jp*** ***NOAA: terry.onsager@noaa.gov, elsayed.talaat@noaa.gov, matthew.butler@noaa.gov*** ***ROSH: k.litovchenko@meteorf.ru*** ***ESA: piers.jiggens@esa.int*** ***NASA: jim.spann@nasa.gov***	Oct 2018	**CLOSED**	

CGMS-46 SWTT/SWCG Recommendations (at CGMS-47)					
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**HLPP ref**
CGMS	SWTT/3	R46.01	CGMS-46 Plenary to endorse Space Weather Coordination Group terms of reference	**COMPLETED.** Endorsed by CGMS-46 plenary on 7 June 2018.	

ANNEXES

ANNEX I: SUMMARY LIST OF PLENARY ACTIONS AND RECOMMENDATIONS

CGMS-47 plenary actions and recommendations resulting from CGMS-47 deliberations.

Will be incorporated following the final report review

ANNEX II: SUMMARY LIST OF WGI ACTIONS AND RECOMMENDATIONS

CGMS-47 working group I (WGI) actions and recommendations resulting from CGMS-47 deliberations.

Will be incorporated following the final report review

ANNEX III: SUMMARY LIST OF WGII ACTIONS AND RECOMMENDATIONS

CGMS-47 working group II (WGII) open actions and recommendations resulting from CGMS-47 deliberations:

Will be incorporated following the final report review

Closed or completed WGII actions and recommendations following discussions at CGMS-47:

ANNEX IV: SUMMARY LIST OF WGIII ACTIONS AND RECOMMENDATIONS

CGMS-47 working group III (WGIII) open actions and recommendations resulting from CGMS-47 deliberations:

Will be incorporated following the final report review

Summary list of closed/completed WGIII actions and recommendations following discussions at CGMS-47:

ANNEX V: SUMMARY LIST OF WGIV ACTIONS AND RECOMMENDATIONS

Summary of CGMS-47 working group IV (WGIV) actions and recommendations following CGMS-47 discussions:

Will be incorporated following the final report review

ANNEX VI: SUMMARY LIST OF SWTT/SWCG ACTIONS AND RECOMMENDATIONS

CGMS-46 working group SWTT/SWCG actions and recommendations resulting from CGMS-46 deliberations.

The following tables provide the list of open and closed/completed actions and recommendations raised following the SWTT/SWCG deliberations at CGMS-46.

Will be incorporated following the final report review

ANNEX VII: LIST OF PARTICIPANTS

CGMS-47 – Plenary Session - List of Participants		
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NOAA	VOLZ	Stephen
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KMA	CHUNG	Chu-Yong
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NICT	NAGATSUMA	Tsutomu
NOAA	GOLDBERG	Mitchell
NOAA	ST GERMAIN	Karen
NOAA	MEHTA	Ajay
NOAA	TALAAT	Elsayed
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ROSCOSMOS	BARSUKOV	Igor
ROSCOSMOS	TROFIMOV	Dmitry
ROSCOSMOS	ZORIN	Sergey
ROSCOSMOS	ZUBKOVA	Ksenia
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CMA	XIAN	Di
EUMETSAT	MASTRODDI	Livio
EUMETSAT	BURNS	Sean
IMD	GIRI	R K
ISRO	VARMA	Atul
JMA	BESSHO	Kotaro
JMA	TAKAHASHI	Masaya
KARI	JIN	Kyoung-Wook
KARI	YANG	Koon Ho
KMA	SHIN	Dongkee
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NOAA	SCHRAB	Kevin
NOAA	BUTLER	Matthew
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ROSCOSMOS	ERMAKOV	Valery
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EUMETSAT	MASTRODDI	Livio
EUMETSAT	RENNER	Klaus Peter
EUMETSAT	MONHAM	Andrew
EUMETSAT	BURNS	Sean
IMD	GIRI	R K
IMD	VIJAPURAPU	Prasad
ISRO	VARMA	Atul
JMA	BESSHO	Kotaro
JMA	TAKAHASHI	Masaya
KARI	JIN	Kyoung-Wook
KARI	YANG	Koon Ho
KMA	SHIN	DONGKEE
NOAA	GRIFFIN	Vanessa
NOAA	BACKUS	Beau
ROSCOSMOS	FEDOTOV	Alexandr
ROSCOSMOS	DEMIN	Denis
ROSHYDROMET	ASMUS	Vasily
Vlab	HIGGINS	Mark
WMO	BELDA	Fernando

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KMA	KIM	Dohyeong
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ROSCOSMOS	KARELIN	Alexander
ROSCOSMOS	TKACHENKO	Alexander
ROSHYDROMET	KHOLODKOV	Kirill
ROSHYDROMET	LITOVCHENKO	Konstantin
WMO	BALOGH	Werner

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-47

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-47).

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.

General enquiries

Please contact the CGMS Secretariat at CGMSSec@eumetsat.int in case of any enquiries related to CGMS.

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