REPORT OF THE 46TH PLENARY SESSION OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

DRAFT!

CGMS-46
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CGMS MR 46

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PLENARY SESSION

A OPENING SESSION

Tapan Misra, welcomed all participants to the 46th plenary session of CGMS in Bengaluru, India and thanked the organising committee for the excellent arrangements in preparing and running this year's meeting.

The opening address is provided in annex I.

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B APPROVAL OF AGENDA, ACTION REVIEW

B.1 Approval of the Agenda

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

B.2 Review of actions from CGMS-45

The CGMS Secretariat provided the status of the list of actions and recommendations resulting from the previous plenary (CGMS-45) with the indication that a few actions were still open pending CGMS-46 plenary discussions (see **CGMS-46-CGMS-WP-17, -19, -29**).

A summary list of plenary actions and recommendations following CGMS-46 discussions is available in annex III of this report. This list will be updated regularly and be available on the CGMS website under MEETINGS and CGMS-46.

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

C WMO ISSUES FOR COORDINATION WITH CGMS SPACE AGENCIES

At the beginning of this session, WMO announced that the Consultative Meeting on High-Level Policy on Satellite Matters (CM-14), will be held at WMO HQ in Geneva, Switzerland, on 23 June 2018, and invited CGMS members to participate in the meeting **(CGMS-46-WMO-WP-20)**. The purpose of the Consultative Meeting, established by WMO Congress XIV in 2003 as a mechanism for discussions between the Meteorological and Hydrological Services and the environmental satellite communities, is to discuss matters of mutual interest between satellite operators and WMO user communities and to agree on advice and guidance to be forwarded to the WMO Executive Council and/or satellite operators. CM-14 will focus on the 2030 agenda and WMO WIGOS, the physical architecture of climate monitoring from space and on data exchange policies. Meeting details are available from http://www.wmo.int/pages/prog/sat/meetings/CM-14.php.

C.1 Vision for WIGOS component system in 2040

WMO regularly reviews its vision of future global observing systems to support weather, climate and related environmental applications. Currently, a "Vision for WIGOS in 2040" is under preparation, with the aim of submitting it for approval to the 18th World Meteorological Congress in 2019. **CGMS-46-WMO-WP-01** presented the status of the development of this vision. The document defines the important linkages between the WIGOS vision and the CGMS baseline and their relations to the WIGOS gap analysis and the CGMS risk assessment.

The vision draws on inputs from a diverse community of both users and observing system developers and operators and has been under development since 2015. Since CGMS-45 a new vision document has been edited, incorporating the respective contributions from the drafting groups that provided the initial component vision documents.

The revised document will be presented at the 70th WMO Executive Council Session in June 2018, and it is expected that the CGMS agencies will have a final opportunity to review and comment on the draft during the second half of 2018, prior to the preparation of the document for WMO Congress in 2019.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC CGMS members	C.1	A46.01	**On WIGOS Vision 2040 (CGMS-46-WMO-WP-01):** CGMS members to comment (through CGMSSEC) in particular on Chapter II - space-based WIGOS component - based on WMO's current understanding of the CGMS Baseline, Contingency Plan and Gap Analysis.	1 Nov 2018	**OPEN**

C.2 OSCAR Space

CGMS-46-WMO-WP-02 provided an update on the OSCAR/Space Database contents and maintenance scheme (see https://www.wmo-sat.info/oscar/spacecapabilities).

The WMO plan for the OSCAR/Space database maintenance scheme was submitted to CGMS-45, and CGMS members and observers were asked to support the WMO effort to maintain and update OSCAR/Space database.

For facilitating the provision of information on programmes, satellites and instruments, templates have been created and made available to satellite operators by WMO to streamline the provision of input to the WMO Space Programme (A45.03). The templates are available from http://www.wmo.int/pages/prog/sat/meetings/GSICS-EP-19/documents/GSICS-EP-19_Doc_8.2_CGMS-46-WMO-WP-02_Annex1_Templates.xlsx. This will help the OSCAR/Space project team to properly inject new and updated information into the OSCAR architecture. The task of keeping OSCAR/Space up to date can only be achieved with the network of experts from space agencies.

To achieve a sufficient maintenance and support for OSCAR/Space with keeping the database updated with information of sufficiently high quality, WMO proposed a new scheme for strengthening the cooperation with CGMS members and observers from other space agencies through newly established support groups: the OSCAR/Space Support Team (O/SST) and the OSCAR/Space Science and Technical Advisory team (O/SSAT), to ensure the sustainability of OSCAR/Space in the years to come. It was discussed in CGMS-45 and the list of members for O/SST and O/SSAT were provided by the CGMS Secretariat. This scheme will lay the foundation of cooperation with CGMS for sustaining the OSCAR/Space updating process through provision of information on their satellite programmes by making use of the provided templates.

OSCAR/Space Users' Workshop was held in October 2017 on the occasion of the EUMETSAT Users' Conference in order to a) further promote the use of OSCAR/Space, b) invite users to present their experiences in using OSCAR/Space; and c) seek contributions from users to the maintenance of OSCAR/Space.

As of CGMS-46, the appointed points of contact for OSCAR/Space are:

OSCAR/Space Science and Technical Support (O/SSAT)

- IROWG: Harald Anlauf <harald.anlauf@dwd.de> (nominated by IROWG co-chairs 3 Aug 2017)
- IWWG: Regis Borde <regis.borde@eumetsat.int> (nominated by IWWG co-chairs 1 Aug 2017)
- IPWG: Sophie Cloche <Sophie.Bouffies-Cloche@ipsl.jussieu.fr> (26 Sep 2017)
- ICWG: Steven Sherwood <s.sherwood@unsw.edu.au
- ITWG & GSICS: Mitch Goldberg <mitch.goldberg@noaa.gov>

OSCAR/Space Support Team (O/SST)

- CMA: lufeng@cma.gov.cn
- CNES: TBD
- CNSA: TBD
- ESA: ivan.petiteville@esa.int
- EUMETSAT: TBD
- IMD: ashimmitra@GMAIL.COM, sunil.peshin@gmail.com
- ISRO: jvthomas@isro.gov.in
- JAXA: oki.riko@jaxa.jp
- JMA: r_yoshida@met.kishou.go.jp
- KMA: dohyeong@gmail.com
- NASA: charles.webb@nasa.gov
- NOAA: Matthew.Butler@noaa.gov
- ROSC: avkarelin@mail.ru
- ROSH: uspenskys@planet.iitpp.ru
- CSA: TBD

Commented [AT3]: CGMSSEC to enquire with CNSA and CNES

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Remaining CGMS members and observers should nominate experts for membership in the OSCAR/Space Support Team (O/SST). Reference is also made to CGMS-44 action WGIII-A44.03.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CNES, CNSA, CSA, EUM (CGMS members)	C.2	A46.02	**On OSCAR space (CGMS-46-WMO-WP-02):** CGMS members and observers to confirm the focal points of contact/members for the OSCAR/Space Support Team (O/SST) to tkurino@wmo.int, wbalogh@wmo.int copy to cgmssec@eumetsat.int	31 Aug 2018	**OPEN**

The OSCAR/Space Support Team will continue providing information on their satellite programmes to be recorded in OSCAR/Space, according to the recommended procedure through the templates provided by the WMO Space Programme.

WMO and the CGMS Secretariat recommended CGMS members to utilise the OSCAR/Space database as a reference common tool for gap analysis and risk assessment.

In the discussion it was stressed that it is essential to keep the information in the OSCAR/Space database up-to-date. Without this, neither gap analysis nor risk assessment will be possible. In addition to nominating CGMS member points of contacts it is also necessary to receive a commitment from CGMS members to maintain the information in the database related to their respective missions.

Two related actions were raised by plenary for WGIII (the actions are included in the WGIII summary list of actions).

C.3 Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP) in East Asia and Western Pacific

CGMS-46-WMO-WP-16 presented the status of the SWCEM project.

The workshop on Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP) was held 19-22 March 2018 in Jakarta, Indonesia. It was a kick-off workshop for the implementation of the project in the East Asia and Western Pacific regions.

The workshop was conducted by the WMO Regional Climate Centres with NMHSs in East Asia and Western Pacific regions. During the project, the WMO RCCs will validate satellite derived products with CLIMAT and/or SYNOP data for monitoring persistent heavy/little rainfall and drought. The goal is to do the monitoring over relatively short periods from pentads (5-day) up to a month.

The Workshop report with the SEMDP Implementation Plan is available from:
http://www.wmo.int/pages/prog/sat/meetings/SEMDP_Workshop/SEMDP_Workshop.html

C.4 WMO policy framework for public-private sector engagement

CGMS-46-WMO-WP-03 presented the status of discussions on the WMO policy framework for public-private sector engagement

The weather enterprise, up through the 20th century, was primarily built on public investments. WMO Member States collectively built a global weather observation infrastructure under a globally coordinated World Weather Watch (WWW) Programme, composed of three systems – the Global Observing System (GOS), the Global Telecommunication System (GTS) and the Global Data Processing and Forecasting System (GDPFS) to support the development and delivery of weather services to their constituencies. Significant changes to this basic structure have happened over the last 10 – 15 years, and the following five primary factors are driving these changes:

- Scientific and technological innovation;
- Growing demand for meteorological, climatological, hydrological, marine and related environmental products and services;
- Global action for adaptation to climate change and the United Nations Sustainable Development Goals;
- Public-sector institutional and resource constraints; and
- Private-sector increased involvement, consolidation and globalisation.

It is broadly recognised within the WMO community that WMO guidance on engagement with the private sector would help the National Meteorological and Hydrological Services of the WMO Members keep pace with the activities at the national and international levels and enhance efficiency and service delivery, including in support of the development of observational and communication infrastructures at local and regional level. At its 69th session in 2017, the WMO Executive Council thus decided to develop a "WMO Policy Framework on Public Private Engagement (PPE)" to assist WMO Members and stakeholders from all sectors by providing a set of guiding principles and highlighting the challenges and opportunities that need to be addressed in order to harness the potential benefits from working together for the benefit of society.

This policy document provides background information regarding the rationale and the process for developing a WMO Policy Framework on Public-Private sector Engagement, with the aim of adopting such a Framework at the 18th World Meteorological Congress in 2019.

WMO plans to organise a Global Weather Enterprise/Public Private Partnership (PPP) event in 4Q of 2018 and all stakeholders are invited and strongly encouraged to support and co-sponsor the event.

The issue of data exchange and how it relates to and may be affected by PPP development will be discussed at CM-14 in Geneva on 23 June 2018. CGMS agency participation in this discussion will be helpful to WMO (and perhaps also to CGMS agencies).

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	C.4	A46.03	**On PP sector engagement (CGMS-46-WMO-WP-03):** CGMS members are requested to participate in the CM-14 on 23 June 2018 at WMO in Geneva.	23 Jun 2018	**OPEN**

WMO requested that the remaining CGMS members nominate a focal point of contact in view of the discussion on the PPE as per the plenary action from CGMS-45 plenary action A45.28:

Actionee	Description/feedback
CGMS members (CNSA, CNES, JAXA, JMA, ROSH)	CGMS members to provide a focal point of contact to WMO (wbalogh@wmo.int) for participation in the WMO Public Private Engagement discussion. **CNSA: TBD** **CNES: TBD** **JAXA: TBD** **JMA: TBD** **ROSH: TBD** **ESA:** ivan.petiteville@esa.int **EUM:** paul.counet@eumetsat.int **IMD:** sunil.peshin@gmail.com> **ISRO:** bpshantanu@isro.gov.in (Mr. Shantanu Bhatawdekar) **KMA:** cychung0530@korea.kr (Chu-Yong Chung) **NASA:** sandra.a.cauffman@nasa.gov cc kevin.j.murphy@nasa.gov **NOAA:** karen.st.germain@noaa.gov **ROSC:** tkachenk_2000@mail.ru (Alexander Tkachenko)

Commented [AT6]: Remaining CGMS members are invited to provide a point of contact.

C.5 Update on the NOAA commercial weather data pilot (CWDP) project

In **CGMS-46-NOAA-WP-02** NOAA presented its Commercial Weather Data Pilot (CWDP). NOAA is evolving toward a more mission-effective, integrated, adaptable, and affordable portfolio which includes leveraging commercial capabilities where appropriate. The CWDP provides an opportunity for NOAA to evaluate the suitability of commercially available data to support weather prediction.

In the first CWDP project in 2016, NOAA identified radio occultation (RO) as an initial set of data for evaluation. NOAA will soon issue the final reports on the outcome of that project. NOAA will again focus on RO for the second pilot project and has recently released the request for proposal (RFP) with anticipated contract award(s) later in 2018. CGMS Members will have access to data from the second pilot for evaluation purposes but will not have redistribution rights. NOAA has also recently released a broad request for information to inform future planning, including a third pilot project that will be initiated in 2019.

NOAA is actively engaged with the SmallSat and calibration communities to work on addressing the many open issues related to the CWDP.

EUMETSAT thanked NOAA for its presentation and agreed that the use of data from the commercial sector raised a number of issues which was well reflected in the presentation. In order to be able to assess if such data could be used for operational applications, in addition to the scientific quality of the data, it would be important to assess the capacity of the commercial sector to meet the requirements of operational services in terms of timeliness, long-term commitment, access to instruments information enabling proper interpretation of measurement data. This is mainly the scope of the second phase of the CWDP. Finally, an issue which has not been addressed so far is the business model which will apply, particularly considering that it is important for space agencies to maintain the principle of free exchange of data.

In the discussions, IROWG noted that a major concern is access to Level 0 data and long-term archiving of the data for reprocessing. It was noted that WGII also addressed issues of quality control and assessment related to commercial data buys. WMO noted that it is a CGMS member and it wanted to confirm if it (and its members) would therefore have access to the data of the second pilot.

Regarding data access NOAA confirmed that it will retain all data purchased under this contract for non-operational use, including, but not limited to, analysis related to the CWDP or weather research and modelling. The contractor shall grant NOAA a limited license, allowing it to provide free access to data upon delivery to NOAA, not for further dissemination for commercial purposes, to U.S. government agencies, NMHSs, WMO-designated Regional Specialized Meteorological Centers, and CGMS members.

NASA informed that it has also been requesting information from private Earth observation companies and that contracts for data purchase are under consideration.

Finally, NOAA together with WMO took the following action:

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO, NOAA	C.4, C.5	A46.04	**On PP sector engagement (CGMS-46-WMO-WP-03, CGMS-46-NOAA-WP-02):** WMO and NOAA to report on the status of affairs and related issues on public private sector engagement to CGMS-47	**CGMS-47**	**OPEN**

C.6 Development of a WMO Position on Critical Satellite Data

CGMS-46-WMO-WP-04 presents the status of development of a WMO position on critical satellite data.

The 4th session of the Inter-Programme Expert Team on Satellite Utilization and Products (IPET-SUP) was convened in Geneva, Switzerland, from 26 February to 1 March 2018.

A major item for discussion was finalisation of a position paper on critical satellite data for WMO applications, and implications of a possible revision of WMO Resolution 40 annex 1.

The position paper is a key outcome of discussions in IPET-SUP. It considers principles that should govern global exchange of satellite data under a scenario where the prospect of private-sector operators of basic satellite systems has triggered renewed attention to the issue of data access and availability for global WMO applications, in particular for near-real-time applications. It formulates eight principles that providers of satellite data should fulfil to meet the critical needs of the meteorological community and defines what critical satellite data are.

The position paper was presented to the Technical Conference of the Commission for Basic Systems (CBS) held at the WMO Headquarters in Geneva, Switzerland, from 26 to 29 March 2018, and is annexed to **CGMS-46-WMO-WP-04**.

The CBS Management Group (CBS-MG) agreed to submit a draft decision for the 70th session of the WMO Executive Council (EC-70) to translate the Critical Satellite Data Position Paper into WMO guidance material and to publish it as a WMO Space Programme technical publication.

The representative of IOC-UNESCO noted that with regards to principle 1 (free and unrestricted international exchange of critical satellite data), the ocean community would take a more open approach. While many critical ocean observation data were already included in the tables, other data of importance to the oceanographic community could be added, including surface wind speed and surface waves.

The representative of EUMETSAT noted that it needed clarifications on what impact that paper would have on WMO Resolution 40 and Resolution 60. In particular, EUMETSAT would not support opening discussions on Resolution 40. With regards to the archiving of data in Principle 8, the 5-year limit for archiving of data should be removed as it is desirable to permanently archive data, specifically in the case of climate applications.

GCOS highlighted the importance of securing unrestricted access to climate change monitoring data and NOAA noted that the paper and its findings should be harmonised with the efforts of the WIGOS Vision 2040.

WMO replied that there is no intent to re-open discussions on WMO resolutions 40 and 60. However, the paper should define the next step towards binding obligations, which is not the case for the WMO resolutions. The critical datasets definition is closely related to the CGMS baseline and should therefore be included in the CGMS baseline (for example, as an annex). The CGMS baseline is intended to become part of WIGOS and will then take on a regulatory status.

NOAA noted that the IPT-SWeISS should be invited to provide input to the paper. Specifically, other orbital planes need to be added in addition to LEO and GEO for critical space weather observations.

It was concluded that the principles are a step in the right direction, however not yet mature enough to be formally adopted by CGMS.

D REPORTS ON NEW DEVELOPMENTS AND PROGRAMMES BY MEMBERS SINCE CGMS-44

D.1 CMA

CGMS-46-CMA-WP-01 presented an update on the FENGYUN (FY) satellite programme and development. CMA operates the FY geostationary and polar-orbiting satellite systems. The current FY operational sun-synchronous polar-orbiting fleet is composed of FY-3, the Chinese second-generation LEO meteorological satellite series. FY-3D was successfully launched on 15 November 2017 and is under orbital test planned for completion in May/June 2018. The observational capability of FY-3D includes VIS, IR and MW imaging, IR and MV atmospheric sounding, greenhouse gas detection, radio occultation sounding, and space weather monitoring. The core instruments on FY-3D are the **MERSI** (Medium Resolution Spectral Imager) for monitoring the environment whose main products are ocean colour and vegetation indexes; **MWHS** (Micro-Wave Humidity Sounder) and **MWTS** (Micro-Wave Temperature Sounder) for atmospheric sounding, and **HIRAS** (Hyperspectral Infrared Atmospheric Sounder) for IR atmospheric sounding, and **MWRI** (Micro-Wave Radiation Imager) for microwave characteristic of ground surface. The observational data are provided to users through the FY-3 Direct Broadcast (DB) service with an X-band AHRPT data format. CMA plans to deploy the FY-3E in an early morning orbit and is planned for launch in November 2019.

The current CMA operational FY-2 geostationary constellation consists of FY-2E/F/G positioned at 86.5°E, 112°E, and 99.5°E respectively, and transmits 5-channel S-VISSR imagery. FY-2H is planned for launch on 5 June 2018 and will be located at locate at 79°E. CMA is also developing the second generation geostationary series FY-4, with the first experimental unit, FY-4A, launched in December 2016 and now located at 105°E, its nominal location. FY-4 has a three-axis stabilised 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 and HRIT format data and has a Data Collection Service (DCS) capacity.

D.2 EUMETSAT

CGMS-46-EUMETSAT-WP-11 presented the status of current and future EUMETSAT satellite systems.

Regarding current satellites in orbit:

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.

The Metop-A (secondary) and -B satellites (primary) continue to provide the LEO services. 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. The preparations for the launch of the Metop-C satellite planned for October 2018 continue.

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

The routine operations of the first Copernicus ocean observation satellite, Sentinel-3A, started in October 2017. Sentinel-3B was successfully launched on 25 April 2018. Both satellites are currently in tandem operation with a 30-second separation and following the commissioning phase there will be a 140° separation.

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.

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 2021-2040 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, and
- Metop-SG B: a microwave imaging mission.

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.

Furthermore, EUMETSAT has initiated discussions with the European Commission and ESA in anticipation of a potential Copernicus Sentinel dedicated to CO2 observations.

D.3 JMA

CGMS-46-JMA-WP-01 reported on the status of current and future satellite systems of JMA.

This document summarises the status of JMA's current and future GEO satellite systems. JMA operates two geostationary satellites named Himawari-8 and -9. Both satellites have identical specifications, and these twin satellites are expected to support JMA's operation of robust satellite observation services to the Asia-Oceania region until 2029. JMA has also started initial discussions on a follow-on mission for the late 2020s.

D.4 KMA

CGMS-46-KMA-WP-01 reported on the status of current and future satellite systems of KMA.

COMS (Communication, Ocean and Meteorological Satellite, positioned at 128.2ºE) MI (Meteorological Imager) is operational and data distributed via landline and satellite over the Western Pacific region, and COMS GOCI (Geostationary Ocean Colour Imager) over the East Asian region.

The development of GEO-KOMPSAT-2A (meteorological mission) and -2B (ocean and environmental mission) is progressing and the launches are planned for November 2018 and the 2nd half of 2019 respectively.

D.5 NOAA

In **CGMS-46-NOAA-WP-01** NOAA presented the status of its current and future missions. It highlighted the launches of its new generation satellites, GOES-16 (November 2016) and GOES-17 (March 2018) as well as NOAA-20 (November 2017). Both GOES-16 and NOAA-20 are already serving as operational satellites. NOAA is planning to launch its next GEO satellite, GOES-T, in 2020; its next LEO satellite, JPSS-2, in 2021; and the COSMIC-2 radio occultation satellites in 2018. NOAA addressed in what way the new generation of data is providing benefits to forecasting.

NOAA also presented its NOAA Satellite Observing Systems Architecture (NSOSA) Study that is helping NOAA determine what its next generation architecture will be comprised of. NSOSA is reviewing a wide range of options and looking at a number of hybrid architectures in order to meet NOAA requirements in the most cost-effective way.

D.6 ROSHYDROMET/ROSCOSMOS

CGMS-46-joint-ROSCOSMOS/ROSHYDROMET-WP-01 reported on the status of current and future Russian satellite systems addressing the current status of the Russian satellite systems: Meteor-M N2 polar-orbiting meteorological satellite (launched on 8 July 2014), Electro-L N2 geostationary meteorological satellites (launched 11 December 2015).

The paper also presents the future Russian GEO, LEO and HEO missions.

The future geostationary meteorological constellation will consist of three Electro-L series satellites. These satellites will be positioned at 14.5°W, 76°E and 166°E. The future Meteor-3M polar-orbiting satellite system will comprise three meteorological and one oceanographic satellites; and the next generation polar satellite series, Meteor-MP, is also briefly described.

The Arctica-M constellation of highly elliptical orbit satellites is to be deployed in the 2019-2025 timeframe. The system will consist of four spacecraft and will provide continuous observations over the Arctic region.

The document provides the mission objectives, payloads and ground segment details of the various missions.

D.7 IMD/ISRO

CGMS-46-joint-IMD/ISRO-WP-01 reported on the status and developments at ISRO and IMD since CGMS-45.

At present, two INSAT satellites are in operation. INSAT-3D is India's advanced weather satellite located at 82°E and was launched on 26 July 2013 from Kourou, French Guiana. It is a dedicated meteorological satellite and carries four payloads: imager (six channels), sounder (19 channels), Data Relay Transponder (DRT) and satellite aided search and rescue (SAS & R). INSAT-3D has 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. The significant improvements incorporated in INSAT-3D are:

- Imaging in middle infrared band to provide night time pictures of low clouds and fog;
- Imaging in two thermal Infrared bands for estimation of sea surface temperature (SST) with better accuracy;
- Higher spatial resolution in the visible and thermal Infrared bands;
- Provision of yaw flipping to maintain patch temperature on half yearly basis; and
- Sounding for atmospheric profiles.

INSAT-3DR, similar to INSAT-3D, is an advanced meteorological satellite of India configured with an imaging system and an atmospheric sounder, launched on 8 September 2016 from SDSC SHAR, Sriharikota using GSLV-F05 and positioned at 74°E. The DRT payload of INSAT-3DR has 300 kHz bandwidth to support a higher number of unattended meteorological platforms (AWS) of the stations network. Thus, INSAT-3DR will provide service continuity to earlier meteorological missions of ISRO and further augment the capability to provide various meteorological as well as search and rescue services.

INSAT-3DR is used in a combined mode with INSAT-3D to achieve 15-minute temporal resolution. Kalpana-1, also a meteorological satellite was decommissioned in September 2017. On 12 August 2017, ISRO implemented a modified INSAT-3D/-3DR scan strategy of the sounder payload. Data of the Indian region is now available on an hourly basis and the ocean region data every 1.5 hours. The INSAT-3D rapid scanning has been in tested in the operational chain and a Special Operations Procedure has been finalised which can be activated on demand.

INSAT Meteorological Data Processing System (IMDPS) is used to receive, process and disseminate the data from current operational satellites. The output generated by the system is used for efficient and successful forecasting of major weather events such as fog, thunder storm and cyclones. The satellite data is assimilated 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. Cloud product such as CTT, CTP, cloud fraction, clear-sky-BT from the imager payload are generated and assimilated in NWP models. Calibration coefficients are updated in the processing chain of the IMDPS system by SAC, Ahmedabad, 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 products and rainfall product on a regular basis and improvements in product accuracy after applying GSICS corrections in the operational processing chain have been noticed.

There is a new webpage (http://satellite.imd.gov.in/insat_new.htm) designed by making provision to view 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.

SCATSAT-1, launched on 26 September 2016, is a continuity mission of the Oceansat-2 scatterometer providing wind vector data products for weather forecasting, cyclone detection and tracking services to the users. The SCATSAT-1 dataset is available here: ftp://ftp.mosdac.gov.in/ and the Scatsat-1 wind data is also disseminated on the GTS since April 2018.

Radio-occultation data from the ROSA payload of Megha-Tropiques and SCATSAT-1 are being disseminated via GTS in BUFR format since the last week of September 2017. IMD is also contributing to the WMO's DBNet group by providing direct broadcast of NOAA and Metop data from the Delhi and Chennai receiving stations.

IMD has plans to establish a CAL/VAL site for INSAT-3D, and subsequent satellites, at a suitable location in India and three field campaigns have already been undertaken by Indian scientists. 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) was made operational in 2016 and the data is available at http://gnss.imd.gov.in/TrimblePivotWeb/.

Furthermore, IMD is in the process of implementing a Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS). The system will be used to receive, process and dissemination of 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 in the order of 1PB which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy.

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

D.8 ESA

CGMS-46-ESA-WP-01 presented the status of the current and future ESA Earth observation missions and programmes where two of them, MSG and MetOp, are in cooperation with EUMETSAT.

The SMOS satellite, launched on 2 November 2009, continues to be operational and all reprocessed Level 1 and 2 data are available from the ESA portal https://smos-ds-02.eo.esa.int/oads/access/ . The CryoSat-2 satellite, launched on 8 April 2010, continues to provide systematic CryoSat products (Level 1b and 2) to the scientific community, see https://earth.esa.int/web/guest/-/how-to-access-cryosat-data-6842. The Swarm satellites, launched on 22 November 2013, continue to provide geomagnetic and electric field monitoring products. SMOS, CryoSat, and Swarm all perform extremely well and the related data exploitation is based on continuous data of excellent quality. These missions also feature strong elements of international collaboration and a growing synergy between them.

The coarse resolution imager of the Proba-V small satellite, launched on 7 May 2013, continues the data acquisition of the Vegetation payload on-board SPOT-4 and 5.

About 4,000 data user projects worldwide use data from the ESA Earth observation missions, a number on the increase. The total volume of ESA Earth observation mission data downloaded in the last four years exceeds 63 Petabytes, available to users free of charge and just for the Sentinel missions more than 144,000 users have registered.

CGMS was further informed of the status of the future ESA Earth observation missions. The Living Planet Programme has three lines of implementation: Earth explorer satellites, Earth watch satellites plus services and applications demonstration. The paper describes the progress in the preparation of the forthcoming explorer missions ADM-Aeolus, EarthCARE, BIOMASS and FLEX. The current launch date for Aeolus is 21 August 2018.

Earth Explorer 9: the Phase A activities for FORUM (Far-infrared Outgoing Radiation) and SKIM (wide-swath scanning multibeam radar altimeter) have been initiated, in record time from approval of the selection of the candidates.

Copernicus represents the major new initiative of European efforts in Earth observation. Currently seven dedicated Sentinel satellites are operational: Sentinel-1A, launched on 3 April 2014; Sentinel-2A in June 2015; Sentinel-3A in February 2016; Sentinel-1B in April 2016; Sentinel-2B in April 2017; Sentinel-5P on 13 October 2017; and Sentinel-3B on 25 April 2018. Other Sentinels will follow in the coming years. The Sentinel missions are developed in partnership with the European Union. The Sentinel-4 and -5

instruments developed by ESA will fly respectively on the MTG-S and Metop-SG missions also developed in cooperation with EUMETSAT.

CGMS was also informed of the status of the Earth Watch Programme Element, Global Monitoring of Essential Climate Variables (also known as the 'ESA Climate Change Initiative' or CCI). The CCI programme has continued to progress well. The existing project teams have made significant progress on algorithm development and on specifying a future operational system. The programme achieved its Phase 1 objectives end 2013, and continued with Phase 2 early 2014 which represents a strong source of ECV data sets for the Copernicus Climate Change Services. ESA's member states have extended the programme to continue until 2024.

D.9 JAXA

In **CGMS-46-JAXA-WP-01** JAXA reported on the latest status and future plan of its environmental satellites, such as Global Change Observation Mission – Climate "SHIKISAI" (GCOM-C) launched on 23 December 2017; the follow-on mission of the Advanced Microwave Scanning Radiometer (AMSR)-2; the Greenhouse gases Observing SATellite (GOSAT), which is the first satellite dedicated to monitor greenhouse gases, and its successor satellite, GOSAT-2, to be launched in 2018.

GCOM-C covers 15 Essential Climate Variables and produces 29 products, such as cloud, aerosols and vegetation that are essential to improve the accuracy of global warming predictions. GCOM-C data will be released to users in December 2018 after verification of the data.

The AMSR-2 follow-on mission will be hosted by GOSAT-3 and the related Mission Definition Review (MDR) including orbit considerations is ongoing.

GOSAT has observed carbon dioxide and methane for more than 9 years, and as a consequence JAXA provides products generated from these long term observational data. GOSAT-2, the successor satellite, will be launched in 2018 and is designed to achieve more precise and accurate greenhouse gases observations.

Lastly, JAXA reported on the Global Satellite Mapping of Precipitation (GSMaP) application for meteorological operations. GSMaP data, together with data from JMA's Himawari satellite, are used by meteorological agencies in Pacific islands affected by precipitation on the sea or having difficulties installing in-situ instruments for their weather services. JAXA will conclude an agreement with the Indian Space Research Organisation (ISRO) to cooperate on the provision of more precise weather forecast by improving accuracy of GSMaP.

D.10 NASA

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

NASA currently supports the operations of 21 Earth science missions. Since CGMS-45 (June 2017), NASA's Earth Science programme launched the Gravity Recovery and Climate Experiment Follow-on (GRACE-FO)

mission (jointly with Germany's GFZ German Research Centre for Geosciences), several U-class technology demonstration satellites, and one instrument (Total Solar Irradiance Sensor, TSIS-1) to the International Space Station (ISS), as well as continued development of several new missions. During this time, GRACE (a twinspacecraft mission, which represented a long-standing partnership with Germany) ceased operations and the Tropospheric Emission Spectrometer (TES) instrument was turned off following a detailed assessment as part of the biennial senior review. CloudSat moved out of the A-Train because of hardware limitations, and some instruments in extended mission operations continue to have reduced capability, but still routinely provide valuable data. Although all NASA operated missions discussed in this report were conceived as 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 (ESD) 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's plans include the launch of 11 missions and 8 instruments (on host missions) in the future.

During this past year, the National Academies of Science, Engineering, and Medicine released their latest decadal survey for Earth Sciences, Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space, which provides guidance to the NASA Earth Science Division on scientific questions to be addressed and observations to be made over the coming decade. NASA's ESD is in the process of responding to the survey, working in consultation with the community as it develops plans for the future. (See also chapter D.11 of the report).

D.11 Results of the US decadal survey

CGMS-46-NASA-WP-06 presents the new US decadal survey.

The US National Academies of Science, Engineering, and Medicine released their new Decadal Survey, *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space*, in early 2018. In this report, the Academies laid out a blueprint for how NASA, NOAA and USGS might implement a coordinated approach for their Earth science research and operational satellite programmes over the next decade, focusing on observations that it considers to be of the highest priority to meet identified scientific objectives. The Academies used multiple disciplinary panels to collect inputs (over 200 white papers from the community) from which consensus recommendations on scientific priorities were generated, and then used a steering committee to narrow the potential observations down to a limited set that they thought was achievable within a realistic budget scenario.

The Academies organised the recommended observations into a variety of categories (designated, explorer, and incubator, as well as the addition of a new Earth Venture Continuity line) that could be implemented with different solicitation approaches and cost constraints. Five designated observations were identified (aerosols, clouds/convection/precipitation, surface biology and geology, mass change, surface deformation) that could be initiated as larger, but still cost constrained missions. Seven candidate observations were identified for the new explorer line (greenhouse gases, ice elevation, ocean surface winds and currents, ozone and trace gases, snow depth and show water equivalent, terrestrial ecosystem structure, and atmospheric winds), three of which they felt could be initiated in the coming decade. The incubator programme involved preparatory work (e.g. technology development/airborne demonstration) for three potential measurements (atmospheric winds, planetary boundary layer, and surface topography and vegetation). There was a strong focus on competition in implementing these new observations. The report also included guidance on agency investments, technology on-ramps, use of commercial data providers, international cooperation, and other ideas to make optimal use of limited resources.

The agencies are currently conducting internal activities and engaging with their scientific communities to support implementation of the Academies' recommendations.

E WORKING GROUPS REPORTS

E.1 Realigned terms of reference of WGI and WGIV

In response to CGMS-45 A45.15 "WGI (Global issues on satellite systems and telecommunication coordination) and WGIV (Global data dissemination) to establish a small task team to examine the current Terms of Reference in light of the thematic areas covered by both working groups to address overlap and to consider adding relevant topics related to satellite and ground system operational topics not currently covered in either of the two working groups and to report to CGMS-46", the WGI and WGIV task team met to review the results and recommend a way forward.

The outcome of the discussions was the proposal at the Working Groups would focus on the following complementary areas and be renamed accordingly:

WG I – Satellite Systems and Operations

- Frequency use and protection (including space weather) delegated to the SFCG is delegated
- Meteorological satellites Space to Ground Interface (Direct Readout) and LHRIT Global Spec. Global Specs (CCSDS based) and Best Practices for DR processing
- Data Collections Systems.
- Use of Space weather data for satellite operations.
- Space debris monitoring and collision avoidance. Coordination with IADC
- System technical aspects (sharing/rationalisation of orbits)
- Handling of future large data volumes and associated data circulation.
- Relevant aspects on the implementation of the global contingency plan from plenary (as proposed by WGIII)

WG II – Support for End Users

- Metadata. Delegated to Task Force on metadata
- Commercial Satellites broadcast solutions (e.g. Geonetcast related).
- Global or supra-regional data circulation and access (e.g. WIS/GTS/RMDCN, academic networks,…) with coordination with WMO dedicated expert teams
- Data formats and standards (use of open standards). Delegated to CGMS Task Teams on data Formats
- Cybersecurity towards end users related topics
- Notification of changes (and alerts) in satellite data and/or products impacting users
- User readiness for new satellite systems (SATURN PoCs)
- Long Term Data Preservation
- Relevant aspects on the implementation of the global contingency plan from plenary (as proposed by WGIII)

plenary endorsed the proposed and revised Terms of Reference of WGI and WGIV including the renaming of WGI to "Satellite Systems and Operations" and WGIV to "Support for end users" as provided in **CGMS-46-CGMS-WP-18**.

E.2 Global issues on satellite systems and telecommunication coordination - report WGI

WGI reviewed the open action items and recommendations from previous CGMS sessions closing all but one action. This action – WMO to assess the impact of improved data latency from polar orbiters on NWP (WMO Impact Workshops) and other applications – is ongoing. Preparations have started for the next WMO Impact in Workshop 2020, with questions currently being formulated. There have also been discussions at IPET-SUP to define the questions that could be answered, in particular regarding the impact of data latency.

WGI discussions focused around four main themes:

Frequency Issues: CGMS members have made significant contributions to the WRC-19 agenda, where it was noted that there are 19 items that could impact CGMS agencies. Space weather frequency protection is a key topic added to the WRC-23 agenda.

Direct Broadcast Services for regional LEO: Proposals for the Best Practices (BP) in support to Local and Regional Processing of LEO Direct Broadcast data were agreed by plenary and will be finalised for publication.

Data Formats: CGMS will continue to work with the Climate and Forecast (CF) metadata conventions for NetCDF, to ensure that CGMS Member use of NetCDF is taken into account when updating the convention. To expedite the coordination it was proposed to nominate a liaison between CGMS and the governing bodies of the Net CDF Climate and Forecasting Conventions.

Data Collection Systems (DCS). Preparations are well underway for the Satcom Forum 2018 and EUMETSAT DCS workshop to be held alongside the Meteorological Technology World Expo that will take

place in October 2018. New DCP designs from ESA and NOAA will be presented that could become CGMS IDCS standards. It was agreed that CGMS DCS activities will be coordinated through a new sub group, which would provide a consolidated DCS reporting to future WGI meetings

Space Weather: In reviewing the contribution from CGMS Members on their use of Space Weather information during operations, several improvements to the process and procedures were identified to allow more meaningful analysis in future, including satellite anomaly reporting, and establishment and utilisation of the space anomaly database

In addition, the WG discussed several new topics that will be added to the agenda for future meetings. These included WGI response and actions from the global contingency planning being conducted by WGIII, handling of future large data volume data sets, and space situational awareness and space traffic management.

Lastly, the working group participants reviewed and updated the CGMS High Level Priority Plan.

The following nominations and representatives were proposed and endorsed by plenary:

- WGI Rapporteur: EUMETSAT (Sean Burns)
- WGI liaison between CGMS and the governing bodies of the Net CDF Climate and Forecasting Conventions: EUMETSAT (Daniel Lee)
- WGI liaison to WGIII for contingency related issues: EUMETSAT (Sean Burns)

The complete WGI report is provided in a dedicated chapter later in this report and the list of participants in annex IX.

E.3 Global data dissemination - report WGIV

CGMS-46-CGMS-WP-01

Being one of the key issues, the IODC data dissemination plan supported by CMA, EUMETSAT, ISRO and ROSHYDROMET made considerable progress. The implementation of dissemination of essential data, as previously defined, is expected to be completed in autumn 2018. Furthermore, data from FY-2H located at 79° East is available from CMA and ISRO is planning to implement a new "ISROCast" dissemination infrastructure, based on terrestrial and also satellite communication networks.

The global data exchange from next generation GEO satellites remains another key issue. Although the current level of data exchange is still manageable with existing infrastructure, the scalability of download services may become an issue considering an increasing demand for high volume data, e.g. from NWP centers and a growing precipitation community. Enhanced methods of terrestrial near real time data access (e.g. cloud services) are being investigated at experimental stages. A relevant action was defined for WMO to further refine the requirement from IPWG, in terms of users and geographical resolution.

WMO presented the WIGOS Data Quality Monitoring System (WDQMS). Several areas for improvement were identified and its potential for use also in satellite operations - related to one of the new objectives

in WGIV. A relevant action was defined for WMO to liaise with GSICS on implementing GSICS monitoring capabilities in WDQMS and to include incident management capabilities, and to report back to WGIV. The goal is to come up with potential operational implementations or best practises for data quality monitoring and management for satellite operators.

The report from the ITWG conference, ITSC-21, contains a number of recommendations relevant for WGIV. Most are already reflected in existing working practises or arrangements, however, two recommendations in the area of user notifications were translated into actions:

One action was defined for CGMS data providers to consider an enhancement of advance notifications of processing changes resulting in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), and this should be made clear in notifications to users. A second action was defined for CMA to consider implementing a subscription-based anomaly/event notification service.

There was little progress on the work from the Task Force on Metadata Implementation, due to resource constraints, and two related actions therefore remained open. These will be specifically addressed in inter-sessional meetings between WGIV and the Task Force on Metadata Implementation.

Based on the feedback from satellite operators on the space weather instrument data formats a discrepancy was found in the needs from SWTT (now SCWG) and what is currently available. This issue will be further addressed through several actions related to data formats and data access for certain space weather instruments and a response is requested by CGMS-47.

Following the update of the Terms of Reference for WGIV, new objectives were added and some of them are already covered in existing discussions and actions. The new topics of "cybersecurity towards end users" and "long term data preservation" are planned to be further developed with experts initially in dedicated inter-sessional meetings.

During CGMS-46 there were 2 actions closed, 8 actions remained open, one action was put on hold, and 5 new actions were created. 3 existing recommendations were still considered relevant and were therefore extended.

The complete WGIV report is provided in a dedicated chapter later in this report and the list of participants in annex IX.

E.4 Operational Continuity and Contingency Planning - report WGIII

Working Group III presented the highlights of its meeting in **CGMS-46-CGMS-WP-22.**

Working Group III began this meeting with WMO's Gap Analysis against the existing CGMS Baseline. WMO identified eight gaps: geostationary hyperspectral sounding, radio occultation, altimetry, ocean surface winds, Earth radiation budget, limb soundings passive microwave imaging, and spectral gaps on future hyperspectral sounders. Working Group III noted these gaps and that there are recommended actions on CGMS Members to address the gaps identified. The ITWG also presented its ITSC-21 report and the recommendations that are relevant to Working Group III. Working Group III noted these

recommendations and believe they are being addressed in current activities in the review of the CGMS Baseline and Contingency Plan.

Working Group III also reviewed the IODC Roadmap implementation. EUMETSAT presented on implementation and noted that all actions had been completed. CMA announced that FY-2H to be launched in June 2018 will be moved to provide service consistent with requirements for IODC until 2025.

Working Group III discussed the maintenance of the OSCAR/Space database. Working Group III noted the importance of the database in the CGMS Gap Analysis and the importance of all members to providing updates to the WMO Secretariat in order to ensure the database is up to date.

Finally, Working Group III presented their new CGMS Baseline and Contingency Plan documents **(CGMS-46-CGMS-WP-20 and CGMS-46-CGMS-WP-04).**

CGMS plenary adopted the new CGMS Baseline that enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System and responds to end-user requirements expressed in WMO's Rolling Review of Requirements. The CGMS Baseline will strive to support the WMO Integrated Global Observing System (WIGOS) 2040 Vision and serves as CGMS' response to the WIGOS 2040 Vision to document what missions are currently being flown or are planned on being flown.

CGMS plenary also adopted a process to actively conduct an annual risk assessment of CGMS' contribution towards its Baseline.

Furthermore, it adopted the CGMS Contingency Plan which provides guidance and processes for identifying, mitigating, and coping with capability loss against the CGMS Baseline. The plan provides guidance to CGMS Members to ensure continuity of their missions, discusses steps Members can take to coordinate continuity among themselves, and steps CGMS can take to monitor and respond to losses.

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO, CGMS space agencies	E.4	A46.05	**Report from working group WGIII:** CGMS WGIII members i) to do the initial risk assessment against the CGMS baseline using the OSCAR Space database as a reference; ii) propose a process to incorporate the annual risk assessment into the regular work programme of CGMS and WGIII; and iii) to explore ways of integrating WMO's position on critical satellite data (CGMS-46-WMO-WP-04) into the CGMS baseline; to be addressed at a dedicated workshop by Q1 2019	by Q1 2019	**OPEN**

The complete WGIII report is provided in a dedicated chapter later in this report and the list of participants in annex IX.

E.5 Space Weather Task Team - report SWTT

The Space Weather Task Team (SWTT) presented the highlights of its meeting in **CGMS-46-SWTT-WP-04.**

The SWTT presented on the activities of the UN Committee of the Peaceful Uses of Outer Space (COPUS) and the UNISPACE +50 Initiative. One of the seven priorities is "International framework for space weather services." UNCOPUOS Space Weather Expert Group met on the margins of the UNCOPUOS Science and Technical Subcommittee (STSC) to discuss the creation of an international coordination group for space weather. The group is developing a mandate, terms of reference, and membership of the coordination group to be submitted to COPUOS in 2019. UNCOPUOS recognizes CGMS along with WMO, ICAO, and ISES as important international organizations that play an important role in space weather activities.

The SWTT also discussed its work on inter-calibration of energetic particles using GSCIS as a methodology. SWTT discussed their current work and collaboration with GSICS and the desire to continue. SWTT noted the need for members to identify POCs on Space Weather that could assist in the inter-calibration process. SWTT also noted that activities will continue over the next year.

SWTT highlighted the space weather anomaly survey it conducted in the last year. The survey found that operators do not take any action prior to a solar event and that space weather data is more consulted for LEO, Lunar, and Earth trailing missions, but typically during anomaly resolution investigations. Members did request additional support from L1 and better modelling to determine the impact to satellites. SWTT agreed to continue working with Working Group one in assessing the impact of space weather data on operations and will work with WMO to provide guidance to Members when filling out the space weather anomaly form.

SWTT then presented its new Terms of Reference in **CGMS-46-SWTT-WP-01.**

CGMS plenary endorsed the transition of the Space Weather Task Team (SWTT) into a permanent working group called Space Weather Coordination Group (SWCG). The SWCG will support the continuity and integration of space-based observing capabilities for operational Space Weather products and services throughout CGMS and the user community, and in supporting the satellite operators in CGMS with regard to space weather phenomena.

There was a discussion about making the SWCG a permanent working group. All Member agreed to have this Terms of Reference, and all working groups terms of reference, reviewed by plenary every five years.

In order to ensure that the space weather user community is participating in the CGMS space weather activities, CGMS will invite the International Space Environment Service (ISES) to become a permanent observer. The CGMS plenary also endorsed Andrew Monham (EUMETSAT) to serve as rapporteur of the SWCG in the next year.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC	E.5	A46.06	**Report from working group SWTT/SWCG:** CGMSSEC to invite ISES (poc: terry.onsager@noaa.gov) to become a permanent observer of CGMS.	31 Aug 2018	**OPEN**

The complete SWTT/SWCG report is provided in a dedicated chapter later in this report and the list of participants in annex IX.

In view of the revised Terms of Reference of WGs I, IV and SWTT/SWCG, plenary also raised the need for regularly reviewing these as necessary:

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC (and CGMS WGs)	E.5	A46.07	**On CGMS working groups:** The Terms of Reference of the CGMS Working Groups to be reviewed every 5 years. CGMSSEC/CGMS WGs to secure this is included on relevant future plenary meeting agendas. WGII to review its ToRs in 2020 WGIII to review its ToRs in 2019 (WGI, WGIV and SWCG to review its ToRs in 2023)	May 2019 (WGIII), mid 2020 (WGII)	**OPEN**

E.6 Satellite Data and Products (WGII)

WGII presented the outcome of its deliberations in the working group meeting in **CGMS-46-CGMS-WP-23**.

WG II serves as an important link between the annual CGMS plenary session and the CGMS International Science Working Groups (ISWG) which provide regular reports and feedback to CGMS.

These are currently:

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

WG II is also the primary interface between CGMS and other international initiatives, such as GSICS and SCOPE-CM and user communities, such as those organised in the areas of oceanography and marine meteorology, and atmospheric composition.

ITWG, IROWG and IWWG representatives came with a large number of recommendations from their respective communities to the CGMS members for advancing the value of the space-based observing system as well as a plan for future activities, including algorithm development, intercomparison and user engagement. The activities from these three Working Groups are discussed in detail in the subsequent sections. CGMS related work has also been undertaken by the ICWG and the IPWG, and as a specific example the classification of various precipitation products enabling stronger user engagement can be mentioned. The ICWG and IPWG will report on their activities to the CGMS-47 plenary in 2019.

WGII highlighted the progress performed by GSICS on geostationary satellite inter-calibration with hyperspectral infrared data, enabling a first ever assessment of the status of the satellite observing system. WGII informed CGMS plenary about the progress of the SCOPE-Climate Monitoring (CM) and SCOPE-Nowcasting (NWC) projects, particularly noting the need for SCOPE-CM to revise its strategy and develop a new implementation plan. WG II therefore placed the following action which was endorsed by plenary:

WGII/5 A46.09: SCOPE-CM Executive Panel Chair to convene a strategy planning meeting with high-level representatives from SCOPE-CM members and other interested agencies, who are empowered to authorise resources, to agree on a revised strategy for SCOPE-CM and a new Implementation Plan, which shall be reported back to CGMS-47. (Ref. CGMS-46-WMO-WP-10)

Several new SCOPE-NWC projects have started and WGII looks forward to following the progress of all projects. Finally, WGII noted the progress of the work performed by the joint CEOS-CGMS Working Group on Climate, particularly on the work undertaken for the gap analysis.

WG II discussed working papers from other international science communities. In particular the papers presented on “Redefining operational satellite oceanography – Improved coordination for data providers and users” and “Update on the second International Indian Ocean Expedition (IIOE-2) and linkages to CGMS going forward” triggered discussion on the need to further elevate discussions on operational oceanography and marine meteorology within CGMS. WG II therefore placed the following recommendation:

WGII/7 R46.07: CGMS Secretariat to consider organising a special plenary session or a side event on operational oceanography at CGMS-47 to help advance the operational nature of ocean observation. (Ref. CGMS-46-NOAA-WP-11, CGMS-46-IOC-UNESCO-WP-02)

CGMS-46 plenary endorsed this recommendation and raised the following action on the CGMS Secretariat:

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC	E.6	A46.21	CGMS Secretariat to organise a special plenary session or a side event on	CGMS-47	**OPEN**

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
			operational oceanography **at CGMS-47** to help advance the operational nature of ocean observation. (Ref. CGMS-46-NOAA-WP-11, CGMS-46-IOC-UNESCO-WP-02)		

Furthermore, plenary endorsed the WG II action related to the first International Operational Satellite Oceanography Symposium (IIOE-1):

WGII/6 A46.10: CGMS to endorse the first "International Operational Satellite Oceanography Symposium" as a CGMS activity and to nominate points of contact for serving on the symposium programme committee. (Ref. CGMS-46-NOAA-WP-11)

The session also noted and discussed the non-meteorological application (NMA) initiated flood mapping project and based on the encouraging new results presented by NOAA, invited further CGMS members to join the project through a WGII action:

WGII/6 A46.11: CGMS members (ESA, IMD, …) interested in participating in the CMA/NOAA operational flood mapping initiative to contact Mitch Goldberg (mitch.goldberg@noaa.gov). (Ref. CGMS-46-NOAA-WP-10).

Finally, WGII discussed the WMO Polar Space Task Group (PSTG). PSTG has traditionally had a strong focus on SAR measurements, but is now reviewing and revising its Terms of Reference. There is an opportunity to bring in a stronger focus on other measurement techniques and application areas and CGMS was invited to support the activities. WGII therefore made the following recommendation which was endorsed by plenary:

WGII/6 R46.08: CGMS members to consider nominating 2-3 persons to support the drafting of the updated terms of reference for the Polar Satellite Task Group and to engage with Global Cryosphere Watch to support the activity.

In addition to the recommendations, WGII agreed on four actions affecting CGMS and the ISWGs (see the complete WGII report).

In the session on "Selected topics of high priority to members" various presentations were given ranging from validation of level 1 and 2 data, benefits of the new satellite systems, progress on non-meteorological applications and reprocessing activities. Furthermore, WGII considered a paper prepared by ECMWF on behalf of WMO discussing the benefits and disadvantages of the use of FSOI vs OSEs. It is important for anyone using these measures to assess the value of the observing system to take into account the specificities of these metrics when designing the experiments and considering the results. The aim of the paper is to establish guidelines for an easier use by space agencies, amongst others. Finally,

WGII noted NOAA/JPSS's reprocessing activities and placed the following recommendation which was endorsed by plenary:

WGII/7 R46.09: CGMS to take note of the status of the NOAA/JPSS SNPP Reprocessing of Sensor Data Records reprocessing effort and encourage all satellite operators to reprocess their mission data and make them easily accessible. (Ref. CGMS-46-NOAA-13)

In the topical session on "Preparation for future generation of Indian geostationary and scatterometer missions", WGII noted that today the situation over the Indian Ocean with respect to geostationary satellites looks very good with INSAT-3D, -3DR and Meteosat-8 in place and with the anticipated launch of FY-2H that is intended to be placed at 79 degrees East. On the scatterometer side WGII lauded ISRO for deciding to launch Oceansat-3 and -3A with an equatorial crossing time of 12:00 since today all scatterometer missions are in the morning/early morning orbit.

In WGII session 9, the CGMS space agencies gave a status update on the highlights and issues in dataset and product generation. Several papers demonstrated great progress overall in terms of quality of data, novel applications and also synergistic use of satellite data and a common base for algorithms.

In WGII session 10, WG II discussed the CGMS baseline and its relationship to the WIGOS 2040 and other plans. WGII proposed some changes to the baseline and plenary endorsed the approach.

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In response to CGMS-45 plenary actions, GOFC-GOLD and AEROSAT provided presentations to Working Group II on possibilities and opportunities for cooperation with the CGMS community. Both initiatives are considered beneficial for CGMS and in some areas a stronger involvement of CGMS would ensure a more focused approach within the initiatives targeting operational applications. Plenary endorsed the proposed WGII actions to this purpose:

WGII/10 A46.14: CGMS members to provide points of contact for GOFC-GOLD to the CGMS Secretariat (Ref. CGMS-46-GUEST-WP-02)

WGII/10 A46.15: CGMS members to provide points of contact for AEROSAT to the CGMS Secretariat (Ref. CGMS-46-GUEST-WP-01)

In the session on space weather, SWTT provided a short summary of activities. SWTT highlighted that it would present Terms of Reference for (a transition of the SWTT into) a Space Weather Coordination Group (SWCG) to CGMS plenary. In that context it was also noted that there will be a formalisation of the point of contacts between SWCG and the CGMS Working Groups. In anticipation of an endorsement by plenary Tsutomu Nagatsuma, co-chair from the current SWTT, attended the WG II discussions. In the future, the coordination between WGII and Space Weather activities will be addressed through specific WGII agenda items as required, and followed up during intersessional meetings with the support of the space weather team rapporteur to WG II.

The recent progress on applying GSICS approaches to intercalibration of space weather instruments on-board geostationary satellites was highlighted, between Himawari-8/SEDA and GOES-15 particle detectors as also noted in the presentation by GSICS.

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WGII also reviewed and updated the HLPP and all actions and recommendations pertinent to WGII.

The complete WGII report is provided in a dedicated chapter later in this report and the list of participants in annex IX.

Plenary discussions on other relevant WGII actions and recommendations were deferred to the related CGMS-46 plenary agenda items.

E.7 Key results from 19th GSICS EP related to CGMS

CGMS-46-GSICS-WP-02

Prior to the CGMS-46 meeting, on 1-2 June 2018, the GSICS Executive Panel (EP) members from CMA, EUMETSAT, ISRO, JAXA, JMA, KMA, NASA, NOAA, ROSHYDROMET, ROSCOSMOS along with WMO, GSICS Coordination Center and CGMS SWTT Chair, met for the annual GSICS EP meeting.

The objective of the meeting was to secure key decisions, endorsements and guidance from the GSICS EP on topics related to in-orbit calibration performance monitoring of meteorological satellites by member agencies. A specific highlight was the first GSICS "State of the Observing System Report" and specific aspects of interest to the CGMS plenary are reported below.

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GSICS continues to reach out to the user community. This is reflected by the increased subscription to the quarterly newsletter, over 340 worldwide to date, and facilitated by the development of fact sheets that can be used for promoting activities internally as well as for outreach and are prepared for the various GSICS entities. More than 50 products are now available through publicly accessible websites that also enable easy assessment of the performance of instruments monitored. GSICS continues to support workshops and conferences like AOMSUC (Asia Oceania Meteorological Satellite User Conferences) and organises its own dedicated workshops such as the lunar calibration workshop in Xi'an, China (13-16 November 2017).

In the first GSICS "State of the Observing System Calibration Report" the performance of several instruments were presented and intercompared. The results increase the confidence in the performance of the instruments in question, but also enable detailed analysis of issues impacting the data like contamination/decontamination, spectral response functions and bias/rms (whilst the instrument is still within specifications).

In view of the ongoing activities in the various agencies, the Executive Panel decided to invite the European Space Agency to become a full member of the GSICS Executive Panel. GSICS also considers inviting the Shanghai Institute of Technical Physics, Chinese Academy of Sciences (SITP/CAS) to join GSICS.

The GSICS EP also decided to continue discussions with the space weather community on their involvement with GSICS and, WGII placed the following action endorsed by plenary:

WGII/5 A46.16: CGMS members to provide points of contacts for space weather instrument inter-calibration. (Ref. CGMS-46-GSICS-WP-01)

All GSICS EP actions and recommendations were subsequently endorsed by Working Group II. The following recommendation was presented to plenary:

WGII/5 R46.01: European Space Agency to consider becoming a full member of the GSICS Executive Panel.

CGMS plenary welcomed the presentation on the outcome of the GSICS EP meeting, specifically the report on the status of the observing system and reaffirmed its interest in having such a status presented annually and endorsed the above recommendation.

E.8 Key results of ITSC-21 and coordination between ITWG and CGMS

CGMS-46-ITWG-WP-02 The latest biennial meeting of the ITWG, the ITSC, was hosted by EUMETSAT in Darmstadt on 29 November - 2 December 2017, raised a large number of recommendations with the top 20 presented to CGMS WGII. A subset of these were highlighted to CGMS-46 plenary.

During the workshop the critical importance of satellite sounding data for numerical weather prediction (NWP) was again demonstrated and the strong requirement for state-of-the-art infrared and microwave sounders in at least three complementing orbital planes confirmed. As a consequence ITWG fully supports CMA's efforts to cover the early morning orbit starting with FY-3E.

The meeting saw significant progress in enhanced calibration/validation of satellite data and long-term climate data records, not least through fruitful interaction of the NWP and climate communities. These highlight more clearly where better knowledge or reduction of uncertainties is required, for instance in the area of radiative transfer or ocean surface emissivity modelling. Improvements in retrieved products are also more fully appreciated through these calibration-validation efforts. A strong climate session highlighted how well-calibrated data records can be used for trend detections and process studies

The efficient use of high quality satellite data today also implies that any changes to the system has to be carefully analysed and prepared. Furthermore, further investments in spectroscopy are required in order to maximise the benefits of satellite data. The associated CGMS-46 WGII recommendations (R.46.03 and R46.04) and action (A46.02) have been tabled and endorsed by WG II (see above).

Critically contributing to the successful data usage are the continued developments of processing packages such as the ATOVS and AVHRR Pre-processing Package (AAPP) and the Community Satellite Processing Package (CSPP). The developments of direct broadcast packages also underpin a continued strengthening of fast retransmission services which uses existing local ground stations to process locally received data and to re-distribute it via the GTS to achieve a timeliness of 30 minutes or better through

the DBNet initiative of WMO. ITWG encourage the inclusion of software to process Russian satellite data from the Meteor-M N2 series for active exploitation of the promising data source.

CGMS plenary took note of the presentation and congratulated ITWG on its achievement. The broad range of activities were recognised and ITWGs contribution to the exploitation of satellite data recognised.

CGMS-46 plenary endorsed the ITWG recommendations and actions as proposed by WG II, among other:

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)

WGII/5 R46.03: CGMS members should give due consideration to potential impacts of changes to instrument data processing changes. Specifically ITWG proposes that if the expected maximum change (temporally, geographically) in the observed brightness temperature of any channel of the instrument exceeds 0.1K or 20% of NEdT (whichever is smaller) it should be made clear in notifications to users. User notifications to be made no later than 8 weeks in advance of the change and with test data (at least a few orbits, ideally more) provided whenever possible.

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)

Further details are available in the complete WG II report (see dedicated chapter in this report).

E.9 Key results of IWWS-14 and coordination between IWWG and CGMS

CGMS-46-IWWG-WP-02

The International Winds Working Group (IWWG) recently completed its 14th International Winds Workshop (IWW14) hosted by KMA on 23-27 April 2018 on Jeju Island, Korea. The related CGMS-45 recommendations and HLPP items were addressed during the week. Three actions defined by the two working groups, Wind Extraction Methods (WG1) and Data Assimilation (WG2) emerged from the meeting as well as three recommendations, as tabled under the outcome of WG II.

A specific highlight from the meeting was the result from the third AMV intercomparison with the following main outcomes:

- JMA had the best overall performance using a new HA method (1DVAR plus differential evolution);
- Differences between centres is greater in the height assignment;

- Common QI has real skill in filtering collocated AMVs for an improved statistical agreement; and
- Common Quality Indicator (QI) module (Fortran 90) was developed and supplied to the AMV producing centres.

WGII considered the activities, recommendations and actions raised by the IWWG however noting that:

- regarding the phasing of three Metop satellites, further analysis is required to understand the benefits of the Tristar configuration for Metop satellites, noting that Metop-A is drifting;
- high resolution AMV generation for mesoscale, regional and NWC applications warrant a revision of the adopted QI methodology which has been based on geostrophic balance; and
- there may be benefits in higher level AMV only climate data sets.

After further discussion and clarifications, WGII placed three associated actions on IWWG as recorded in the WG II report and recommended to plenary the endorsement of the following recommendations and actions:

WGII/5 R46.04: CGMS member AMV producers to provide a 9-month overlap period when transitioning to a new generation of satellite and for major derivation changes.
WGII/5 R46.05: CGMS member AMV producers to reduce as much as possible the product data latency.
WGII/5 A46.02: All CGMS member AMV producers to implement the "Common QI module" in their algorithms.
WGII/5 A46.03: CGMS member AMV producers to adopt the new AMV BUFR template.

CGMS plenary noted the outcome of the IWWG and specifically acknowledged the progress in the derivation and utilisation of AMV data in NWP in the past years, rendering AMVs a key element in the global observing system. Plenary further endorsed the IWWG actions and recommendations as proposed by WG II.

E.10 Key results of IROWG- 6 and coordination between IROWG and CGMS

CGMS-46-IROWG-WP-02 IROWG informed CGMS of the outcome of the 6th session of the IROWG, and noted the following recommendations to CGMS and the need for:

1. Ensuring that both, equatorial and polar components of COSMIC-2 are fully funded and launched;

2. Recommending 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;

3. Supporting mission preparation and implementation projects towards LEO-LEO microwave occultation and GNSS-RO&-Reflectometry demonstration missions (by international space agencies and in particular NASA, ESA and CNSA, where LEO-LEO and GNSS-RO and reflectometry proposals are pending). This should include recommending new OSSEs for the LEO-LEO observations; and

4. Stressing the importance of long-term archiving of the Level 0 data and all the relevant metadata from both agency-led and "commercial" missions. Researchers need access to these data, and the information about the GNSSRO receiver performance, for climate reprocessing activities.

It was also noted that the current radio-occultation constellation is declining and whilst new missions are emerging the decision not to pursue COSMIC-2 polar has a tremendous impact on data availability. Whilst the assessment of IROWG on the availability of RO-data (unlikely to exceed 10000) was questioned and needs clarification taking into account the extended lifetime of current missions, WG II raised the following recommendation:

WGII/5 R46.06: CGMS members to consider hosting radio occultation payloads on future missions (Ref. CGMS-46-IROWG-WP-01)

In response to WGII on the quality of RO data and impact on NWP, the IROWG Chair and rapporteur responded there are quality assessment concerns with respect to commercial data as the quality approach is diverse. Subsequently, WGII agreed there is a need to pursue an approach for consistent quality control for RO data in order to enable consistent intercomparison of RO data from different providers and placed an associated action on IROWG.

CGMS-46 plenary noted the presentation and further discussed the recommendations proposed by IROWG. Regarding the first recommendation, and to some extent also the third one, plenary re-emphasised the importance of common quality control and impact assessments as raised by WG II, which is key in order to fully understand correctly the importance of various elements of the RO constellation and for planning of a future RO constellation. CGMS-46 plenary therefore fully supported the CGMS-46 WGII action (A46.08) and further noted the importance of accurate assessments of the impact of radio-occultation data in NWP, which in the future may come from a wider range of heterogeneous sources. IROWG and GCOS further clarified that access to retrieved products is considered insufficient for many research applications. Reference is also made to the GCOS IP, 2016, p.59/60, chapter 2.4.2 recovery of instrumental data, early satellite data https://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/programme/brochure/GCOS-200_OnlineVersion.pdf?PlowENiCc1RGh9ReoeAoGBT0QhnJYm6 and GCOS action G 26 "Ensure long-term data preservation of early satellite raw and level 1 data, including metadata". Subsequently plenary raised the following recommendation:

CGMS-46 recommendation – PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS space agencies	E.10	R46.01	**Report from IROWG (CGMS-46-IROWG-WP-02):** IROWG recommends to CGMS: - that raw data and level 1 data (including meta data) be made available for reprocessing/reanalysis of climate data records and for data validation - the long-term archiving of such data (incl. meta data)

E.11 Actions and recommendations related to the CGMS ISWGs from previous plenary sessions

The below action and recommendation from CGMS-45, related to the CGMS ISWGs, are recalled here for the sake of reference:

CGMS action from previous plenary sessions (CGMS-45)		
Actionee	**Action #**	**Description**
CGMS space agencies, IROWG, IPWG, IWWG, ICWG, ITWG	A45.02	CGMS International Science Working Groups and CGMS space agency members to, including the impact of data latency, in view of the 7th Impact WS 2020 (ref. CGMS-45-WMO-WP-02) and provide these to lriishojgaard@wmo.int. Questions are needed for CGMS-46 for the analysis to be made and results provided to the workshop in 2020. *New deadline: Dec 2018 (CGMS-46)* 7 Jun 2018: Action remains open following CGMS-46 plenary discussions. WMO expects to provide a formal announcement in the 2nd half of 2018 to which the remaining ISWGs can respond. CGMS-46-IWWG-WP-02 US Polar AMVs latency issues previously discussed.

CGMS recommendation from previous plenary sessions (CGMS-45)			
Lead	**Rec #**	**Description**	**Status/Feedback**
WMO (+IPWG)	R45.02	Recognising that IPWG has considerable expertise in precipitation science and applications, IPWG requests the WMO (likely via VLAB) to establish regular training events on precipitation data sets and applications, for which IPWG will provide disciplinary expertise.	**ONGOING** 5 Jun 2018, following CGMS-46 WGII discussions: IPWG co-chair participated in training event at AOMSUC-8. IPWG rapporteur has engaged VLAB requesting that any future training associated with precipitation should include IPWG involvement. We are awaiting the current year training priorities at WMO to see if these include precipitation. This also addresses HLPP 3.5.3

CGMS recommendation from previous plenary sessions (CGMS-45)			
Lead	**Rec #**	**Description**	**Status/Feedback**
			21 Feb 2018: Discussions between IPWG and VLab have started on how to organize regular joint training activities in response to identified needs. CGMSSEC IS#2 30 Jan 2018: WMO/Bojinski to provide feedback to CGMSSEC For information: Nov '17: IPWG co-Chair (Haddad) provided training at AOMSUC-8, Oct. 2017

F PASSIVE MICROWAVE OBSERVATION

CGMS-46-EUMETSAT-WP-14 provided background information for the session on the potential gap in microwave observations, in particular for SST and ice monitoring. In 2017 CEOS SST-VC pointed to the risk in loss of low frequency Passive Micromave imager measurements which CEOS SIT confirmed in April 2018. Subsequently a Nature article and the EGU blog have discussed the issue with special focus on impact on SST and ice extent. In December 2017, ECMWF and ESA arranged a workshop on using low frequency passive microwave measurements in research and operational applications, and a dedicated AGU cryosphere session was held on the topic (with participation from operational space agencies). WGClimate also raised concerns at their latest meeting.

Since the AGU session late 2017, a user survey was conducted and feedback sought from the following entities:

- CGMS agencies - responses received from CMA, ESA, EUMETSAT, ISRO, JAXA, NASA, NOAA, Roshydromet;
- CEOS VCs and CGMS WGs - responses received from SST-VC, GSICS, ICWG, IPWG; and
- From numerous users and services including ECMWF, MeteoFrance, FMI, NSIDC, NOAA/CoastWatch, CMEMS, OSI-SAF, H-SAF.

With respect to the low frequency microwave observations, the survey confirmed there is:

- Concern about reliable/sustained data streams from as early as 2019;
- The loss of low-frequency imaging instruments will critically impact the all-weather SST measurements and the ice concentration measurements;
- Potential impact/interruption of long-term ice monitoring, snow and precipitation timeseries;
- Concern by users/end-users that there may be no suitable follow-up to SSMIS-series or to AMSR-2, and that the dedicated Copernicus mission (CIMR) currently in phase A/B1 will not be launched until the late 2020s.

The survey also confirmed that besides the specific low frequency issue, the microwave imager data collection seems to be in good shape with the instruments onboard the FY-3 and METEOR-M series of missions and the future EPS-SG and GCOM-W series. EUMETSAT however stressed the need for a coordinated effort to share information on current and future passive microwave imagers and asked CGMS to consider a dedicated expert meeting and/or a task force in GSICS for intercalibration to secure operational use and meet the WIGOS 2040 targets

CGMS-46-CMA-WP-07 presented the status of CMA's passive micro-wave imagers and sounders: MWRI, MWTS and MWHS onboard the FY-3 series of satellites. The operational continuity for these instruments in syn-synchronous orbits is secured until the middle of the next decade, and to be noted is that MWRI will fly on the low inclination rainfall monitoring mission FY3-RM, to be launched in 2020.

It was:

- noted that passive microwave measurements from FY-3 will continue to be an important part of global precipitation measurement constellation. It is important to increase the number of in-orbit passive microwave payloads, and improve the temporal resolution of rainfall measurement; and

- recommended that satellite agencies continue to develop passive microwave payloads, in order to keep the continuity of the long term passive microwave dataset, in particular for climate applications.

CGMS-46-JAXA-WP-03 provided the status of JAXA's passive microwave projects.

GCOM-W1, which carries AMSR2, was launched in May 2012. It passed its designed mission life of 5-years in May 2017 and continues to function. AMSR2 is a successor of AMSR-E on NASA's Aqua satellite. With its capability of 2-meter diameter antenna and C-band channels, AMSR2 enables observations of SST and soil moisture with the highest spatial resolution among other passive microwave imagers. AMSR2 data is widely used in weather forecast, sea ice monitoring, fisheries, etc.

Currently, the AMSR-2 follow-on sensor has been planned to be installed on the GOSAT-3 satellite, and the Mission Definition Review for the two missions was completed on 6 June 2018. The optimum orbit for both missions has to be discussed, and JAXA invites the CGMS members to comment.

CGMS-46-NOAA-WP-25 presented key applications of AMSR-2/GCOM-W Data Products and discussed the concerns about the long-term continuity.

The paper demonstrated the unique weather and related capabilities/contributions from GCOM-W/ AMSR-2 for public safety, infrastructure protection – land, sea, air:

- Tropical Cyclones - Helps accurately determine storm center location, structure, and track intensity;

- Heavy rain - High spatial resolution precipitation products important for predicting heavy rainfall events, floods, etc.;
- Sea ice – Sees through clouds to distinguish sea ice from ocean, available day and night in often data sparse regions (e.g. the Arctic) – critical for navigation along with SAR and visible imagery;
- Marine wind forecasts – surface wind information where in situ data is sparse (e.g. over oceans);
- Global soil moisture information for numerical weather models – Beyond AMSR2, there is limited satellite coverage for this observational parameter today; and
- Sea surface temperature - Contributes to sea surface temperature products, providing ocean surface information through clouds. This is important since the average cloud cover over oceans is 69%, and even more in eastern Pacific.

In summary:

- JPSS level 1 requirements for microwave imagery are met by GCOM-W1 AMSR2. JPSS provides real-time access via Svalbard to meet NOAA and Japan's latency requirements;
- AMSR2 provides all-weather information critical for tropical cyclone forecasting, hydrological applications such as extreme precipitation, flash flood forecasting and drought forecasting, and marine environmental weather information (wind speed, which contributes to wave height forecasting, and sea surface temperature);
- Microwave imager observations from AMSR2 are routinely used by NOAA, DoD, Japan, EUMETSAT, and other environmental agencies for weather forecasting and environmental monitoring applications;
- Importance of AMSR2 data for tropical cyclone forecasting is evident in many forecast discussions from the National Hurricane Center and Joint Typhoon Warning Center; and
- ***Continuity of AMSR2 type observations is important and a risk analysis is needed.***

CGMS-46-ISRO-WP-08 presented the status of ISRO passive microwave activities.

A passive microwave radiometer is desired to ensure simultaneous availability of key meteorological parameters such as Surface Precipitation, Sea Surface Temperature (SST), Ocean surface Wind Speed (WS), Cloud Liquid Water (CLW), Total Precipitable Water (TPW) and Cloud Micro-physics. These are essential for understanding various atmospheric and oceanic phenomena and processes including latent and sensible heat, atmospheric dynamics and convection, air-sea interaction, atmospheric and ocean state forecast, etc. ISRO launched a passive microwave radiometer, MADRAS, and a sounder, SAPHIR, onboard Megha-Tropiques (MT) satellite in a low inclination orbit (20^{o}) in 2011. While both the instruments provided valuable observations over the tropical region, due to a technical problem MADRAS stopped functioning after about 13 months of operations. SAPHIR continues to provide valuable measurements. With Megha-Tropiques measurements, a number of retrieval algorithms for geophysical parameters were developed and application programmes initiated. The paper highlights the applications of the passive microwave instruments MADRAS and SAPHIR for various atmospheric and oceanic studies and services.

As of today the following passive microwave instruments are operated by different space agencies such as GMI on GPM; AMSR-E on GCOM-W1; SAPHIR on Megha-Tropiques; SSMIS on DMSP-F16, F17 and F18; AMSU-A and MHS on METOP-B; NOAA-18 and NOAA-19; and ATMS on SNPP. This capability will be reduced significantly by 2020 when fewer numbers of passive microwave instruments (GPM-GMI, AMSU and MHS on METOP-C, ATMS on JPSS1, AMSR2 on GCOM-W2 and W3) would be available for providing global observations. The failure of DMSP-F19 and no news about a replacement in the next few years, the global observations from passive microwave instruments would be reduced by a factor of about 0.5 by the year 2020.

ISRO has initiated work on a passive microwave radiometer with an objective to have more frequent observations over the tropical region with frequency channels ranging from 6.6 to 183 GHz in a low inclination orbit (20^o-40^o). ISRO also plans to launch a temperature sounding unit (TSU) with channels at 23, 31 and 50-60 GHz), and a humidity sounding unit (HSU) with 6 channels at 89 GHz and other close to the water vapour absorption line at 183.31 GHz. This may not only provide continuity of observational capability and associated applications of Megha-Tropiques, but also provide additional measurements for more applications. These instruments are in the initial stage of development and may take a few years before a launch.

The presentation provided an insight into the present and future observational capability for passive microwave instruments. It highlighted the applications taken up at ISRO with Megha-Tropiques and other passive microwave instruments. It provides ISRO's resolve to enhance the global capability of passive microwave measurements by launching new instruments. ISRO is also a member of GSICS and committed to the uniform and cross-calibration of the instruments in LEO satellites, particularly passive microwave instruments. This activity may also be pursued in ISRO with full vigour.

Following the presentations, CGMS concluded that several issues had to be considered as regards data gaps and optimisation of the observing system for microwave soundings and imagery, with the objective to realise the WIGOS Vision 2040.

Discussion on low-frequency microwave imaging

The first issue is the high risk of a gap in the low frequency microwave imagery (6.6 to 10 GHz), in relation to the capacity to provide all weather SST measurements, and the need to cover several orbits in the future.

The plenary session noted that polar orbiting passive microwave imagers are essential to operational activities in meteorological agencies and climate monitoring as required by GCOS and that the CGMS member must ensure operations and data distribution for these missions.

CGMS noted that the continuation of the AMSR2 GCOM-W mission was critical, and strongly recommended JAXA to deploy the AMSR3 instrument to ensure continuity, recognising that orbit optimisation was not a critical issue in view of the uniqueness and criticality of the AMSR3 mission. Likewise, CGMS recommended to the European Commission to deploy its proposed Copernicus Imaging

Passive Microwave (CIMR) mission in a different orbit. CGMS also welcomed the instruments deployed and planned by CMA and NSOAS.

Discussion on general microwave issues

Concerning higher frequency microwave imagery, CGMS stressed the need for more and diverse orbits, in particular for the sampling of precipitation, in line with the WIGOS Vision 2040, noting that CMA was planning one imager in a low inclination orbit mission flying also a rain radar.

Concerning microwave soundings of moisture and temperature, CGMS noted that the three main orbits of the WIGOS Vision 2040 will be filled for the first time following the launch of CMA's FY-3E on the early morning orbit, and that high additional impact on NWP was expected from complementary orbits. Furthermore, based on the experience gained from the Megha-Tropiques mission, CGMS stressed the benefits of soundings from low inclination orbits and welcomed ISRO's plans for a follow up low inclination mission.

Concluding the discussions, the following actions and recommendations were noted:

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
GSICS	F	A46.08	**On passive microwave observations:** GSICS is requested to organise an expert meeting on the intercalibration of operational PMW sensors to meet the WIGOS 2040 targets for a coordinated effort to share information on current and future PMW instruments and report to CGMS-47 (CGMS-46-EUM-WP-14)	CGMS-47	**OPEN**
NOAA	F	A46.09	**On passive microwave observations:** NOAA to inform CGMS on the U.S.'s plans/frequency/features of the post WindSat/SSMI MW radiometry missions	CGMS-47	**OPEN**

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
JAXA	F	R46.02	**On passive microwave observations:** CGMS recommends JAXA to confirm the AMSR3 mission to mitigate the risk of a critical gap in low frequency microwave imagery
EC/ Copernicus	F	R46.03	**On passive microwave observations:** CGMS recommends the European Commission to confirm

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
			the CIMR Sentinel mission to provide coverage from an additional orbit.
EUM, CMA, ISRO, JAXA, NOAA, …	F	R46.04	**On passive microwave observations:** CGMS recommends all agencies planning MW imagery missions, to consider expanding to 6.6 GHz and increasing horizontal resolution to provide constellation for all-weather SST, and ice monitoring
CGMS operators	F	R46.05	**On passive microwave observations:** CGMS agencies to optimise their plans to fill the gaps between the CGMS baseline and the WIGOS Vision 2040
KMA	F	R46.06	**On passive microwave observations:** KMA is recommended to confirm its planned MW sounding mission on an orbit that complements the early morning, mid-morning and afternoon orbits.
ISRO	F	R46.07	**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.

G THEMATIC SESSION - INDIA

G.1 Future perspectives of global scatterometry observations

CGMS-46-ISRO-WP-04 considered the future perspectives for scatterometry.

Ocean wind is the major source of dynamical forcing for oceanic general circulation and for the generation of surface waves. Ocean surface winds play a pivotal role in studies of air-sea interactions, coastal upwelling, bio-geo-chemical transport, estimation of ocean currents and many other processes. The surface wind vector is the primary forcing for numerical ocean state forecast models. Numerical weather prediction (NWP) models also depend significantly on the availability of observations of ocean surface winds.

For the last four decades, ocean surface vector winds are operationally measured by space-borne scatterometers. Such operational winds are being used by operational NWP centres world-wide. The global stack-holders in the field of satellite scatterometers are JPL/NASA, EUMETSAT/ESA and ISRO. The operational scatterometers developed by ESA are operated in C-band with fan-beam configuration compared to the U.S.-based scatterometers operated in Ku-band with conically scanning pencil-beam

configuration. With the successful launch of Oceansat-2 scatterometer (OSCAT) in 2009, ISRO started its scatterometer missions. In this series, presently operational through the Scatsat1 scatterometer, launched in 2016, which provides high quality data in Ku-band using a pencil-beam configuration.

With due course of time, conventional scatterometer observations have achieved an acceptable level of maturity. Apart from using scatterometer derived vector winds in operational NWP, those winds are also used to study climate variability. To improve the retrieved wind quality further, the stake-holders are coming up with novel proposals with improved accuracy as well as other parameters such as for ocean surface currents.

ISRO plans a follow-on scatterometer missions onboard Oceansat-3 and Oceansat-3A in the coming years. Such follow-on missions will cater to the WMO requirement of high temporal wind observations over the global oceans.

ISRO would like CGMS to consider:

- Coordinated efforts of all CGMS agencies to have well temporally distributed scatterometer observations.
- Generation of climate quality scatterometer observations.
- Look into possibility of future scatterometer in low inclination orbit for higher temporal resolution.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WG Climate	G.1	A46.10	**On scatterometry observations:** WGClimate to analyse and facilitate the generation of ocean surface wind ECVs from scatterometer observations and report to CGMS-47	CGMS-47	**OPEN**

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS operators (WGIII)	G.1	R46.08	**On scatterometry observations:** CGMS operators (through WGIII) are requested to coordinate efforts to have well temporally distributed scatterometer observations.
CGMS operators	G.1	R46.09	**On scatterometry observations:** CGMS operators to consider looking into the possibility of future scatterometer missions in low inclination orbit for higher temporal resolution.

G.2 Future perspectives of geostationary imaging missions for the Indian Ocean region

CGMS-46-ISRO-WP-06 considered the future perspective of GEO imaging coverage of the Indian Ocean.

The overall objective of the Indian geostationary meteorological satellite programme (INSAT) is to provide round-the-clock surveillance service of weather systems including severe weather events around the Indian region. The first generation of INSAT satellites were built in the U.S. and were multipurpose satellites for meteorological and telecommunications services. The first satellite INSAT-1A was launched in 1982 and the last in this series, INSAT-1D, was launched in 1990. The INSAT-1 series carried a 2-channel VHRR (Very HighResolution Radiometer) in visible and infrared bands. The second and subsequent generation satellites were designed and built indigenously by ISRO. VHRR/2 onboard INSAT-2E carried an additional WV channel and a 3-channel CCD camera (VIS/NIR/SWIR). The first dedicated meteorological satellite, Kalpana-1, with VHRR/2 instrument was launched in 2002.

The third generation satellites, INSAT-3D/3DR were launched in 2013/2016, are exclusive advanced meteorological satellites designed for enhanced meteorological observations, land/ocean applications, weather forecasting and disaster warning. These satellites carry a 6-channel imager and a 19-channel sounder. The sounder measures the vertical profile of humidity and temperature over Indian landmass and adjacent Ocean. The imager carries a pair of splitwindow channels in addition to MWIR channel. The INSAT-3D has helped in improving the cyclone track prediction and intensity estimation. These data have contributed a great deal to nowcasting and short range forecasting which includes severe weather conditions such as heavy rainfall and thunderstorms, besides fog detection and aviation forecasts. The INSAT-3D data are made available to the international scientific community and weather forecasters through MOSDAC web portal of SAC/ISRO.

There is a growing need for improved weather prediction at very short spatial and temporal scale, particularly for the high impact weather event such as cyclones, thunderstorm/lightning, cloudburst/ heavy-rainfall, etc. ISRO is initiating plans for future upgradations of instruments for the 4th generation of Indian geostationary satellites with the aim of reducing the risk for life and property for the greater benefits to the society. The instrument of prime importance is an advanced imager that will provide combined and enhanced application potential of present INSAT-3D/3DR imager and sounder instruments with better accuracy and spatio-temporal resolution. This will also fill a big data gap that presently exists over the Indian Ocean region, available over other parts of the globe through MSG/SEVIRI, Himawari-8/AHI, GOES-R/ABI. Other important instruments being looked into are Lightning Imager (LI) and Hyperspectral Infrared Sounder onboard GEO platforms to enhance the temporal resolution of high quality 3-D temperature/humidity/wind structure in the atmosphere, leading to a possible quantum jump in our capability to monitor and predict the extreme weather events.

In this particular session, the ideas by various participating agencies and discussions on the new ways of observations, highly calibrated systems for climate quality data generation and innovative applications will be highly advantageous for all international agencies involved in geostationary missions.

ISRO will continue to participate in GSICS to realise well inter-calibrated GEO sensors and recommends that CGMS operators promote the integrated use of GEO-LEO satellites where applicable, for various applications.

H SATELLITE MEASUREMENTS AND OCEAN VARIABLES

H.1 IOC-UNESCO and the global ocean community

CGMS-46-IOC-UNSESCO-WP-01 presented IOCs Guidance to CGMS on Geostationary Satellite Measurements of Essential Ocean Variables**.** IOC (David Halpern) made the presentation on behalf of the writing team of Chu-Yong Chung (KMA), Misako Kachi (JAXA), Toshiyuki Kitajima (JAXA), Raj Kumar (ISRO), Yukio Kurihara (JMA), Shiro Omori (JMA), Stéphane Saux Picart (Météo-France) and Huai-min Zhang (NOAA NCEI). The writing team was established in September 2017 through CGMS Secretariat announcements calling for volunteers to participate in the preparation of the Working Paper. Only a small subset of Essential Ocean Variables (EOVs) are measurable geostationary-orbiting satellites compared to EOVs recorded from polar-orbiting satellites. The primary advantage of EOVs recorded from geostationary orbit compared to polar orbit is the higher temporal sampling (e.g. 5 minutes compared to 1 day), which strongly reduces aliasing (Nyquist Theorem) and reduces data loss by clouds of near- and thermal-infrared and visible measurements. Three themes were discussed: weather, ocean circulation, and environmental security and examples provided. Capturing the diurnal signal in sea surface temperature (SST), which has a critically important influence on atmospheric circulation, is very important because SST could reach 3-4 °C above the ambient SST. The SST amplitude is related to insolation, surface wind speed, clouds and precipitation. The surface current was estimated by tracking successive images of brightness temperatures and chlorophyll-*a*. The turbidity and harmful algal bloom of coastal waters, which impact public health, were measured. Measurements of sea ice, which affects coastal marine transportation, enabled improved navigation. In summary, geostationary-orbiting satellite measurements of EOVs would advance understanding of ocean-atmosphere interactions and improve predictability of oceanic processes.

The following recommendations should be considered by CGMS:

- determine the significance of a 5-min temporal interval in contrast to 10- or 15-minute time intervals for measurements of EOVs from geostationary-orbiting satellite for multiple applications;
- develop a constellation of geostationary-orbiting satellites recording EOVs continuously with sufficient spatial overlap of field of view to conduct intercomparison tests;
- establish a CEOS-CGMS working group for coordination of best practices for EOVs measured from geostationary orbit; and
- develop efficient, effective methods to integrate EOV measurements from geostationary-orbiting and polar-orbiting satellites.

Discussions:

ISRO raised the question of GEO measurements of salinity. IOC stated that this is difficult to achieve with GEO satellites.

CGMS noted that 5-minutes temporal interval may be considered for the next generation of GEO satellites (presently 10 minutes), but the value of going to 5 minutes needs to be clearly demonstrated.

It was also noted that a constellation of LEO satellites can provide effective temporal resolution better than daily.

In **CGMS-46-IOC-UNESCO-WP-03** IOC presented an overview of the United Nations (UN) Decade of Ocean Science for Sustainable Development.

In December 2017, the UN General Assembly proclaimed the UN Decade on Ocean Science for Sustainable Development with the vision to "Develop scientific knowledge, build infrastructure, and foster partnerships for a sustainable and healthy ocean" (see https://www.un.org/en/sections/observances/international-decades/). Potential collaborations between CGMS and the UN Decade would enhance: (1) integration of the oceanic in-situ observing systems, represented by IOC, leader of the UN Decade, and satellite meteorological observing systems, represented by CGMS; (2) knowledge about spatial and temporal variabilities of ocean circulation; (3) access to evolving ocean data portals; and (4) accuracy of forecasts for tsunamis, storm surge, and other phenomena that impact the coastal zone. A recommendation was provided for consideration by the CGMS: Develop linkage between CGMS and UN Ocean Decade, through the IOC, to enhance joint capabilities to improve predictability of atmosphere-ocean interactions, leverage global atmosphere and ocean observing systems with space-time fidelity for regional and local applications, and leverage the development of atmosphere and ocean open data portals.

IOC proposed that at CGMS-47, the IOC would provide guidance to CGMS on satellite data requirements for the UN Ocean Decade. IOC would enlist the newly appointed JCOMM Satellite Data Coordinator and soon-to-be-established Task Team to make the presentation. One of the Terms of Reference of the JCOMM Satellite Data Coordinator is to "coordinate satellite data requirements activities within JCOMM and act as a JCOMM liaison with the CBS ET-SAT and IPET-SUP and with CEOS and CGMS".

EUMETSAT saw opportunities for the future to engage closer with the ocean community, but noted that WMO/IOC now plan to restructure JCOMM, and considered it prudent to await this and then respond to the IOC request.

WMO noted that it is in the middle of a governance reform, which will also affect JCOMM. All of WMO's observing system issues will be centralized in one single technical commission and there may be a new name or another entity taking over the tasks of JCOMM.

Concluding the discussions, CGMS plenary requested IOC-UNESCO to provide guidance to CGMS on satellite data requirements for the UN Ocean Decade at CGMS-47.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO	H	A46.11	**On ocean variables:** In view of the anticipated reorganisation and resuscitation of JCOMM, WMO to provide a report with proposals on future coordination/cooperation between JCOMM and CGMS.	CGMS-47	**OPEN**

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
IOC-UNESCO	H	A46.12	**On ocean variables (CGMS-46-IOC-WP-03):** IOC to provide guidance to CGMS on satellite data requirements for the UN Ocean Decade	CGMS-47	**OPEN**

I CLIMATE MONITORING

I.1 GCOS

CGMS-46-WMO-WP-05 reported on the next steps and future planning for the Global Climate Observing System (GCOS).

GCOS includes surface-based, air-borne, and space-based components and constitutes, in aggregate, the climate observing component of the Global Earth Observation System of Systems (GEOSS). GCOS is a joint initiative of WMO, the IOC-UNESCO, UNEP and the ICSU. 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), lays the foundation for a new GCOS strategy.

There are now new challenges arising from the increasing needs of adaptation, mitigation, early warning systems and disaster risk response. The recent implementation plan outlines concrete plans to ensure continuity of the observation records whilst improving it where needed, according to the above new requirements. To achieve that, the implementation plan discusses ECVs, sets out actions to support cross-domain use (i.e. to close the carbon, water and energy budgets) and assures relevance to the growing users community.

The future plans regarding the update of the Status Report, revision of the GCOS Implementation Plan and a potential second GCOS Conference in fall 2021 will aim towards that GCOS delivers to the Global Stocktake in 2023, a mechanism set-up by the UNFCCC`s Paris Agreement.

The final edited English version of "The Global Observing System for Climate: Implementation Needs" (GCOS-200) is available from the WMO Library, and also available in French from gcos.wmo.int.

CGMS-46-CGMS-WP-03 presented a proposal for the Space Agencies response to the GCOS implementation plan.

Space agencies and Earth observation (EO) programme owners continue to evolve their systematic observation of the climate system, now over several decades, strengthening scientific knowledge on climate, supporting provision of knowledge-based information to climate services and to support decision making. Space agencies are doing this by implementing the Strategy Towards an Architecture for Climate Monitoring from Space, 2013, developed by a team comprised of representatives from CEOS, CGMS, and WMO. This Architecture involves the identification of existing and potential future gaps in the provision of the climate data requested by the UN's Global Climate Observing System Programme (GCOS).

The consolidation of space agency and EO programme owner efforts through the establishment of the joint CEOS-CGMS Working Group on Climate has resulted in a significant increase in efficiency in responding to the needs of systematic observations as required by the United Nations Framework Convention on Climate Change (UNFCCC).

The synergistic relationship with the UN's GCOS Programme continues to strengthen. GCOS published a new implementation plan in 2016 to guide global observations over the next 5-10 years. On behalf of CEOS and CGMS agencies the joint CEOS-CGMS Working Group Climate developed the space agency response to the 2016 GCOS Implementation Plan in 2017. This response was formally endorsed by CEOS in October 2017 and presented to the 47th session of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) in November 2017.

The space agency response to the GCOS IP was submitted to CGMS in October 2017 but not yet formally endorsed by the CGMS plenary. This document contains as an annex Version 2.2.1 (containing a few corrections compared to the 2017 version 2.2) of the Space Agency response to the 2016 GCOS Implementation Plan and is asking for its endorsement at this and 46th CGMS plenary.

Following the presentation of the paper, CGMS plenary endorsed the space agency response to the 2016 GCOS Implementation Plan attached as annex I to the paper as well as the WGClimate Climate Gap Analysis Report and the WGClimate Coordinated Action Plan provided as annex I and annex II. In addition, the following action was raised:

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	I.2	A46.13	**On CEOS-CGMS WGClimate (CGMS-46-CGMS-WP-03):** CGMS members are requested to support the future work of the joint WGClimate by: • Providing annual inputs for the ECV Inventory; • Provide experts to support further gap analysis, coordinated actions implementation and other related activities, and • regular participation to WGClimate meetings.	CGMS-47	**OPEN**

I.2 CEOS/CGMS Joint Working Group on Climate – Progress and next steps

In **CGMS-46-JWGCLIM-WP-02** the CEOS-CGMS Joint Working Group on Climate presented a status report since CGMS-45 together with next steps.

Major progress achieved to date:

- The coordinated response of CEOS and CGMS agencies to the 2016 GCOS Implementation Plan has been submitted to GCOS and UNFCCC in October 2017. The response was endorsed by CEOS plenary in October 2017 and formal endorsement by CGMS plenary is sought at this meeting;
- The ECV Inventory of climate data records containing almost 1000 data records has been verified and published under climatemonitoring.info in October 2017;
- A comprehensive gap analysis of the ECV Inventory with respect to missing data records for ECVs, missed opportunities to use existing observations, and missing measurements from space in the future has been performed and the results including recommendations are provided in the WGClimate ECV Inventory Gap Analysis Report;
- The recommendations from the Gap Analysis Report have been used to compile a Coordinated Action Plan. The actions are planned to be performed by coordination bodies within and outside of CEOS and CGMS and the implementation of actions has started;
- Both the Gap Analysis Report and the Coordinated Action Plan have been endorsed by CEOS plenary on 18 May 2018;
- UNFCCC SBSTA-47 noted with appreciation the space agency response to the GCOS-IP and particularly highlighted the progress made in the development of the ECV Inventory their conclusions;

- WGClimate leads had broad appearance at COP-23 leading and participating in several side events;
- The 9th session of the WGClimate in March 2018 adopted a new definition for Interim Climate Data Record (ICDR).

In **CGMS-46-JWGCLIM-WP-01 the** CEOS/CGMS Joint Working Group on Climate (WGClimate) presented progress and next steps and the need for the endorsement of the Gap Analysis report and the coordinated action plan.

The WGClimate is tasked to implement the Architecture for Climate Monitoring from Space (HLPP 5.1). This Architecture involves the identification of existing and potential future gaps in the provision of the climate data requested by the UN's Global Climate Observing System Programme (GCOS). The consolidation of space agency and EO programme owners' efforts through the establishment of the joint CEOS/CGMS Working Group on Climate has resulted in a significant increase in efficiency in responding to the needs of Systematic Observations as required by the United Nations Framework Convention on Climate Change (UNFCCC). In particular, this has led to three times as many climate data records submitted by agencies to the Essential Climate Variable (ECV) Climate Data Record Inventory with respect to the first exercise implemented in 2015, with the current version having more than 900. This version of the Inventory was published under climatemonitoring.info in October 2017.

The ECV Inventory fully describes current and planned implementation arrangements (ECV-by-ECV) within the Architecture. Its content is fully verified through one-to-one interactions with contributing agencies. The ECV Inventory was presented to the 47th session of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) in November 2017 and was particularly highlighted in the 47th SBSTA conclusions (see CGMS-46-JWGCLIM-WP-02 for details).

Comprehensive analysis of the Inventory with respect to missing data records for ECVs, missed opportunities to use existing observations, and missing measurements from space in the future is provided in the WGClimate ECV-Inventory Gap Analysis Report, v1.1 (provided as annex I). The result of the analysis led to 25 Recommendations and 28 Coordinated Actions to be addressed in coming years (WGClimate Coordinated Action Plan, v1.1 provided as annex II). CEOS had previously endorsed these on 18 May 2018.

Concluding the discussions, the CGMS plenary endorsed the WGClimate Gap Analysis Report and the WGClimate Coordinated Action Plan provided as annex I and II to the paper.

CGMS-46-WMO-WP-06 presented the concept for the physical view of the architecture for Climate Monitoring from Space (pillars I and II).

WMO Resolution 19 (Cg-XVI) called for the Development of an Architecture for Climate Monitoring from Space to provide a framework for the sustained and coordinated monitoring of the Earth's climate from space as a major initiative of the WMO Space Programme.

In 2013, CEOS, CGMS and WMO jointly prepared a report on the "Strategy Towards an Architecture for Climate Monitoring from Space" which had been reviewed by GCOS, GEO and the WCRP. The report defines the terminology, a logical view and an implementation roadmap for the architecture for climate monitoring from space. As a next step, it calls for the development of a physical view of the architecture.

This paper proposes a concept for such a physical view, focussing on the practical implementation of Pillar I ("Sensing") and Pillar 2 ("Climate Record Creation and Preservation") of the logical view.

Concerns were voiced by EUMETSAT, ESA and NOAA that the key functions proposed are duplicating already existing mechanisms. While the physical architecture could be documented, it is found that the planned implementation should rely on the WGClimate and no new structure should be created. The CEOS-CGMS joint working group on climate (WGClimate) can action the ISWGs and CEOS VCs and it also reports to both CGMS and CEOS plenaries and as such the reporting lines are already established and fulfilled. CGMS plenary recommended the proposal be revised prior to submitting it to the WMO Executive Council in June 2018 and the WMO Congress in May 2019.

J EDUCATION AND TRAINING

J.1 VLab status and plans

CGMS-46-WMO-WP-07 provided a report on the activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) along with future plans. Since CGMS-45, VLab members have offered a variety of training opportunities, with an emphasis on training efforts addressing the new generation of satellites, as this proved to be the major training need identified by the VLab members. Furthermore, VLab conducted a comprehensive review and update of the Guidelines on Satellite Skills and Knowledge for Operational Meteorologists.

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

The VLab Trust Fund received a steady level of contributions from NOAA, EUMETSAT, and KMA since May 2017 compared to the previous year. 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.

Since October 2017, Mr. Mark Higgins (EUMETSAT Training Manager) holds the role as VLab co-chair on behalf of CGMS satellite operators. This co-chairmanship was established for a period of up to 3 years. Future nominations should be considered by CGMS satellite operators in order to ensure the continuation of this partnership from 2020 onward.

CGMS-46 actions – PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	J.1	A46.14	**On VLab (CGMS-46-WMO-WP-07)**: CGMS members active in VLab to indicate to WMO whether they would in principle be interested and in a position to indicate a candidate to co-chair VLab on behalf of CGMS satellite operators from 2020 (nominations to be presented to CGMS-47 2019).	Q1 2019	**OPEN**
CGMS operators	J.1	A46.15	**On Vlab (CGMS-46-WMO-WP-07)**: CGMS satellite operators active in VLab are requested to ensure a suitable representative and attendance at VLMG-9 meeting in USA, 16-20 July 2018	15 Jun 2018	**OPEN**

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS members	J.1	R46.11	**On VLab (CGMS-46-WMO-WP-07)**: CGMS members to provide regular annual contributions into the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab.

CGMS members noted with appreciation the revised document Guidelines on Satellite Skills and Knowledge for Operational Meteorologists.

ISRO asked what kind of support to VLab activities is required from CGMS members. WMO clarified that the support consists of providing trainers to the VLab, hosting of VLab events and contributions to the VLab Trust Fund.

WMO urged ISRO/IMD to consider sending a representative to VLMG-9 to discuss possible collaboration between Vlab activities and capacity-building activities of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP). CSSTEAP (http://www.cssteap.org) is part of the network of Regional Centres for Space Science and Technology Education, affiliated to the United Nations (see http://www.unoosa.org/oosa/en/ourwork/psa/regional-centres/index.html) which is also providing capacity-building in the field of meteorology (see education curriculum at http://www.unoosa.org/oosa/en/ourwork/psa/regional-centres/study_curricula.html).

J.2 KMA and JMA update on the RA II WIGOS project

CGMS-46-joint-JMA-KMA-WP-02 presented the "Progress Report on the RAII WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training in 2017-2018".

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 5th Meeting of the Coordinating Group of the project was held at the Far Eastern Federal University on Russky Islands in Vladivostok, Russia, on 21 October 2017. The meeting was hosted by the Federal Service for Hydrometeorology and Environmental Monitoring of Russia (Roshydromet) and was coordinated by the Japan Meteorological Agency (JMA) and Korea Meteorological Administration (KMA). Totally 31 participants from RA II and RA V Members, and a WMO secretariat attended the meeting. At the meeting, the group reviewed and discussed the status, 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 at the meeting that JMA and KMA would develop and conduct a regional user survey in 2018 in collaboration with the Australian Bureau of Meteorology. The final report from the meeting is provided in **CGMS-46-joint-JMA-KMA-WP-02**.

CGMS recommended that CMA, KMA and JMA jointly establish a cooperative framework for providing a rapid-scanning observation on demand from geostationary meteorological satellites in the regions. JMA agreed to take the lead in the discussions foreseen at the upcoming AOMSUC-9, in October 2018 in Jakarta, Indonesia.

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
CMA, JMA, KMA	J.2	R46.12	**On RAII WIGOS project (CGMS-46-JMA/KMA-WP-02)**: 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.

K GREENHOUSE GAS MONITORING

Introduction

The CGMS Secretariat introduced the session and gave a brief overview of the background to the session. It was noted that discussions on CGMS's role in a space-based carbon monitoring system started at the CGMS-44 plenary session in 2016 and a dedicated session on carbon observations was held at CGMS-45 in 2017. At CGMS-45, CGMS plenary re-emphasised a commitment to support the development and operation of a space-based carbon monitoring system. CGMS plenary confirmed the CGMS contribution to the CEOS AC-VC writing team and the specific contribution CGMS can provide to a future space-based carbon monitoring system. It also noted the potential contribution by current operational meteorological missions.

Specifically, CGMS-45 plenary endorsed the following HLPP item:

- Provide a coordinated contribution to the planning of a future satellite-based carbon constellation and to related activities on mission coordination, data distribution, exchange, formatting, and on training and outreach.

CGMS-45 plenary further discussed the way forward to respond to CGMS-44 A44.13 on the provision of input to the WIGOS Vision 2040. Therefore the following HLPP item was agreed and an associated action raised (CGMS-45 A45.19):

- Deliver to WMO, for inclusion in WIGOS Vision 2040, a proposal for a target architecture for GHG and carbon monitoring from space.

Finally, the CGMS Secretariat recalled the objective of this session to take stock of progress regarding greenhouse gas monitoring from space, the activities related to carbon monitoring and the establishment of a way forward for CGMS to contribute to an operational space-based carbon monitoring system from space.

Status of CEOS AC-VC CO_2 white paper and next steps

The European Commission, supported by the CGMS Secretariat, introduced paper **CGMS-46-CEOS-WP-01** on the status of the CEOS AC-VC CO_2 white paper and next steps. The paper is based on the need for and a timely and efficient development of the architecture which is critical in order to be ready to support the global stock-take in 2028. It is important to realise that what is needed is an overall architecture including ground and satellite-based observations together with modelling, in a similar fashion as has been set up for NWP. There are a number of missions planned for the future, however most are science missions designed to identify optimal methods for measuring CO_2 and CH4, not “operational” missions designed to deliver policy relevant greenhouse gas products focused on anthropogenic emissions. The approach taken now is building from important lessons learned, in particular from GOSAT and OCO-2. These lessons highlight the need for high accuracy and low bias, high spatial resolution, imaging rather than sampling but also needed are transport models for flux inversion. Furthermore, p roxies (SIF, CO, NO2) may be needed for attribution. Potential future constellation requirements should also consider those from GCOS for carbon and methane.

A candidate greenhouse gas constellation architecture should be based on a minimum of three LEO, three GEO and one or more HEO. However, in order to have global daily coverage (excluding limitations by clouds) a constellation of 9-10 LEO satellites would be required.

The paper also gave an example demonstrating the benefits of adding another three satellites to a baseline of three satellites. It was noted that the benefits are significantly larger with well-coordinated orbit altitude and phasing. This emphasises the need to follow the model developed by the operational meteorological satellite constellation for coordination of satellite missions. Hence a future greenhouse gas constellation will also need to focus on orbit and mission coordination, data distribution, data exchange, and data format requirements. To fully exploit the information collected by future greenhouse

gas constellations, the missions will also have to invest in training and capacity building as well as public outreach. All these items should build on the experience already gained by the CGMS members.

The paper then gave a brief update on the status of the AC-VC white paper activities. It was noted that they are now progressing well and a first draft for review is anticipated early autumn. The finalisation of the whitepaper was also positioned in the broader context of the priority, on greenhouse gas monitoring, pursued by the European Commission in the context of their chairmanship of CEOS. In that context three specific activities are being addressed:

1. Facilitate the completion and follow-on activities of the AC-VC whitepaper on defining an optimum constellation for CO_2 and greenhouse gas monitoring, including the joint competences of CEOS and CGMS, and in the general framework of the continued implementation of the CEOS carbon strategy;

2. Advance the relationship with CGMS for an operationally implemented and sustained observation capability. Consider establishing a formal working relationship between CEOS and CGMS as with the successful ongoing relationship on systematic observations of ECVs in support of UNFCCC; and

3. Place the space segment in the broader context of a fully sustained system for CO_2 monitoring. Individual CEOS agencies have counterparts in their individual countries/regions who have responsibility for inventories, the required modelling, in-situ infrastructure and the ground segment elements.

In conclusion it was noted that:

- White Paper activities are progressing;
- CGMS responds to WIGOS 2040 that GHG are in Tier 1;
- Observational capabilities should take advantage of the experience from meteorological satellites; and
- CGMS has a role coordinating the observations.

With respect to HLPP (5.4 Greenhouse gas and carbon monitoring from space) it was noted that:

- Provide a coordinated contribution to the planning of a future satellite-based carbon constellation and to related activities on mission coordination, data distribution, exchange, formatting, and on training and outreach, remains open (5.4.1);
- Deliver proposal for WMO to include in WIGOS 2040 a proposal for a target architecture for GHG and carbon monitoring from space, can be closed (5.4.2); and

In addition, a new HLPP action was proposed:

Commented [AT10]: Item?

- New HLPP action: To integrate work within the CGMS Working Groups I-IV.

In the subsequent discussion it was noted that CGMS had provided inputs to WIGOS 2040 and that GHG are in Tier 1. However, the WIGOS 2040 has in the meantime been substantially rewritten and it would therefore be important to confirm that greenhouse gas observations are indeed in Tier 1.

Plenary raised the following actions accordingly:

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO	K	A46.16	**On greenhouse gas monitoring:** WMO to provide the latest version of the integrated WIGOS 2040 by 31 August to CGMS and CEOS SIT members for review.	31 Aug 2018	**OPEN**
CGMS members	K	A46.17	**On greenhouse gas monitoring:** CGMS Members to review the WIGOS 2040 vision wrt to GHG/carbon monitoring and provide feedback to WMO by 1 November 2018	1 Nov 2018	**OPEN**

CGMS plenary was also requested to consider expressing a formal position on the CEOS white paper conclusions and inform CEOS. CGMS plenary noted that although there is progress, CGMS will only be able to comment on the white paper conclusions once the paper is available.

Options for CEOS-CGMS cooperation on greenhouse gas monitoring

The European Commission introduced the paper **CGMS-46-EC-WP-01** "Options for CEOS-CGMS cooperation on greenhouse gas monitoring".

The paper recalled the CEOS Chair 2018 GHG priority and the specific Chair initiative "Laying the foundation for an international CO_2 and GHG monitoring system". Three specific activities are foreseen for advancing this effort in 2017-2018 and have been noted earlier. The paper specifically noted the need for advancing the relationship with CGMS for an operationally implemented and sustained observation capability; and to consider establishing a formal working relationship between CEOS and CGMS as with the successful ongoing relationship on systematic observations of ECVs in support of UNFCCC.

The paper also addressed the wider policy context and demand, in particular:

- Action in the Global Climate Observing System Implementation Plan (GCOS IP, T71)
  - "CEOS and CGMS will undertake, over the next few years, dedicated preparatory work in a coordinated international context…";
- COP-23/SBSTA-47
  - The SBSTA invited the UNFCCC Secretariat to communicate with the WMO Secretariat, including regional centres to inform work on climate services; and

- The SBSTA noted the increasing capability to systematically monitor greenhouse gas concentrations and emissions, through in situ as well as satellite observations, and its relevance in support of the Paris Agreement.

The paper then introduced four options that are currently considered for a more structured CEOS CGMS coordination on greenhouse gas monitoring:

1. continue ad hoc collaboration in the context of the CEOS Carbon Strategy Actions e.g. as in joint efforts on AC-VC Whitepaper;
2. establish a sub-group (with dedicated resources) in the context of an existing standing WG i.e. Joint WG on Climate;
3. extend the current CEOS Atmospheric Composition Virtual Constellation to be a Joint CEOS-CGMS Virtual Constellation; and
4. establish a dedicated Joint WG specifically on carbon/greenhouse gas observations.

It was noted that option 1) does not really bring things forward and would not efficiently support the future efforts towards an operational carbon monitoring system. It was also noted that option 4) may be too ambitious and may duplicate efforts and would also not necessarily build efficiently on already existing mechanisms. Hence, the focus has been more on options 2) and 3) and a more detailed comparison between the two has been performed:

	Option 2 **Subgroup to Joint WGClimate**	**Option 3** **Joint AC-VC**
Pros	• The Joint CEOS-CGMS WGClimate already exists, just need to decide on assigning subgroup lead, maybe update ToR; • Existing and strong working relationship with GCOS and UNFCCC/SBSTA; • May provide basis for longer-term home for CEOS Carbon Strategy Action; • Will Ensure that the GHG products requirements/improvement process follows same being implemented for other ECVs/CDRs; • Take advantage of other ECVs associated to the natural carbon cycle.	• Could build on existing *ad hoc* collaboration started in context of GHG Whitepaper; • If focus is primarily on building a physical constellation, based on GHG Whitepaper, then competence are within VC; • Would provide an additional "model" of collaboration between CEOS and CGMS; • GHG may not be the only area of CEOS-CGMS collaboration within AC-VC e.g. Air quality
Cons	• Enlarges scope/mandate of WGClimate; • Would definitely need additional resources competences from CEOS agencies to WGClimate; • Would need strong dialogue between WGClimate and AC-VC.	• Concern on creating parallel track with SBSTA and GCOS; • Risks to remain disconnected to other activities of CEOS Carbon Strategy.

The paper further noted the options discussed at the recent CEOS-SIT-33. The next steps include discussions with AC-VC co-leads and the WGClimate Chairs and targeting going to the CEOS plenary 2018 for decision.

In conclusion it was noted that there is an increasingly strong policy demand for coordinated provision of information on greenhouse gas monitoring and it has strong synergies with the successful existing collaboration between CEOS and CGMS on more traditional systematic observations (ECVs, CDRs). Following the effective but ad hoc collaboration between CEOS and CGMS in preparing the draft white paper a number of options are available for a more structured collaboration.

Finally, CGMS was requested to confirm its interest in pursuing a more structured collaboration with CEOS on greenhouse gas monitoring and provide comments or preferences on the options presented.

In the discussion it was noted that whilst recognising the technical capabilities of the CEOS AC-VC team and the support it is providing in terms of drafting the White Paper, concerns were raised by several members that it may not be the most suitable entity to lead activities with strategic implications and reporting to various bodies like UNFCCC and SBSTA. It was also noted that WGClimate has demonstrated its ability to take on board complex and heavy tasks and deliver on schedule. Furthermore, WGClimate already has all the reporting lines in place. Whilst having concerns on the workload it was noted that the situation is now improving.

The WGClimate noted that they are also looking at the implementation options with a view to understand the implications on workload and activities of having a sub-group established reporting to WGClimate. The CGMS plenary then decided on the following action:

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CEOS-CGMS WGClimate	K	A46.18	**On greenhouse gas monitoring:** WGClimate to complete their analysis of the feasibility of establishing a subgroup on CO_2/GHG in the WGClimate	Nov 2018	**OPEN**

Finally, whilst research and network activities and structures for greenhouse gas monitoring exist, they are not suitable to take on board the coordination activities and reporting required for a joint CGMS-CEOS working group. In conclusion, CGMS plenary therefore supported option 2) and placed the following recommendation:

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
European Commission (EC)	K	R46.13	**On greenhouse gas monitoring:** CGMS to recommend to the CEOS Chair the

CGMS-46 recommendation - PLENARY			
Actionee	**AGN item**	**Rec #**	**Description**
			establishment of a subgroup within WGClimate for the coordination of greenhouse gas monitoring activities.

Measuring Greenhouse Gases from Space with NASA's OCO-2, OCO-3 and GeoCarb Missions

NASA introduced the paper **CGMS-46-NASA-WP-03** "Measuring Greenhouse Gases from Space" with NASA's OCO-2, OCO-3 and GeoCarb Missions. OCO-2 is the first NASA satellite designed to measure atmospheric carbon dioxide (CO_2) with the precision, accuracy, resolution and coverage needed to identify surface sources and sinks on regional scales. In 2019, OCO-2 will be joined by OCO-3, which will be deployed on the International Space Station (ISS). In December 2016, NASA selected the Geostationary Carbon Cycle Observatory (GeoCarb) as the second complete mission in the NASA Earth Ventures series.

The measurements from OCO-2 are now being used by the carbon cycle science community to study the natural carbon cycle and anthropogenic emissions. These measurements will continue and be enhanced by the follow-on missions for further in-depth studies. There has been significant progress within this research and the following key issues were noted:

- Space based sensors are providing new tools for studying atmospheric CO_2, CH4 and other greenhouse gases (GHGs).
- OCO-2 has demonstrated that space-based measurements can provide the precision and accuracy needed to constrain CO_2 sources and sinks on regional scales.
- The OCO-3/ISS and GeoCarb missions will demonstrate the spatial resolution and coverage needed to trace greenhouse gas sources and sinks on the scales needed to track both natural and anthropogenic fluxes of CO_2, CH4, and other greenhouse gases.
- Efforts are under way to cross calibrate and to cross validate the data products of these satellites and others, such as the Japanese Greenhouse gases Observing SATellite (GOSAT) and GOSAT-2 mission and the Copernicus Sentinel-5P, to produce a continuous, harmonised environmental data record that spans the operational lifetimes of these missions.

Furthermore, the following issues to be considered by CGMS were raised:

- CEOS and CGMS are currently investigating the feasibility and utility of future greenhouse gas monitoring constellations;
- While OCO-2, OCO-3, and GeoCarb are scientific satellites designed to assess the information content of space-based greenhouse gas measurements, these satellites and those from NASA's partner agencies (GOSAT, GOSAT-2, Sentinel-5P) pave the way for future operational greenhouse gas monitoring constellations; and
- The experience of the CGMS agencies will be critical for implementing the transition between these science experiments and operational missions.

CGMS plenary took note of the paper.

Space-based CO_2 observations in CMA

CMA introduced paper **CGMS-46-CMA-WP-09** "Space-based CO_2 observations in CMA". The paper gave a brief overview of the current status of the CMA satellite programmes and the CO_2 relevant missions. Today CMA operates the TanSat satellite and the Greenhouse-gases Absorption Spectrometer (GAS) instrument onboard FY-3D. It was noted that contrary to the other instruments onboard FY-3D, GAS is still considered an experimental mission. In the future a new GAS instrument will be developed for FY-3G based on a grating spectrometer planned for launch in 2022. In particular it was noted that the swath width of GAS/FY-3G will be significantly higher than the current GAS instrument. Hence, a stronger contribution to the overall greenhouse gas space-based monitoring system will be provided.

The presentation gave further details on the status and performance of the currently flying missions, showing amongst other comparison of absorption spectra from TanSat with OCO-2.

Discussion on CGMS contribution to greenhouse gas monitoring from space

In conclusion, CGMS reconfirmed its commitment to support the establishment of the space-based component of a future operational greenhouse gas monitoring system, as demonstrated through the input given to the WIGOS2040 vision.

L CEOS

L.1 CEOS-CGMS coordination

In **CGMS-46-CEOS-WP-02,** NOAA, as CEOS-SIT Chair, presented its four main CEO-SIT priorities:

1. Ensure the efficient execution of existing SIT responsibilities as described in the SIT Terms of Reference, including addressing Working Group and Virtual Constellation (VC) continuity, sustainability, and outputs;

2. Enhance the utility of new observations from next generation of geostationary satellites and exploring development of LEO/GEO combination products and data processing capabilities;

3. Improve and clarify CEOS relationships with CGMS, GEO, and to a lesser degree WMO, by identifying coordinated activities and, where appropriate, holistic interaction among CEOS, CGMS, GEO, and WMO, emphasising the unique values of each; and

4. Support initiatives undertaken by the CEOS Chairs in 2018 and 2019.

NOAA highlighted the work on LEO-GEO combined products that was discussed in the CEOS-SIT meeting in April 2018. Two main recommendations resulted in these discussions: i) CEOS to follow-up on several years of effort on land surface imaging using data from both GEO and LEO missions, and ii) Coordinate with CGMS the development of combined GEO-LEO products for fire, flood, and aerosol monitoring.

M HLPP

M.1 HLPP

CGMS-46-CGMS-WP-12 presented the status of implementation of the CGMS High Level Priority Plan (2017-2021). 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 Task Team.

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-46-CGMS-WP-11 presented the proposed revision of the CGMS High-Level Priority Plan (HLPP) to cover the period 2018-2022.

WGs I, II, III, and IV considered the proposed updated set of high-level priorities, and, after making some amendments:

- confirmed that the proposed revision represents the high-level priorities in guiding CGMS activities for the next four-year period;

- The Working Groups recommended the following targets to be considered achieved:
    - Conduct studies to trade off benefits of spectral, radiometric, and spatial resolutions of infrared sounders considering the noise floor due to atmospheric noise and current uncertainties in spectroscopy enabling improved spatial resolution and increased number of field of views for next generation CrIS and IASI (WGII);
    - Revise the scope and framework of the CGMS contingency planning to reflect the new generation of satellite systems and to adopt a risk management framework in developing contingency plans (WGIII);
    - Update the CGMS baseline to reflect the new WIGOS 2040 vision for space (WGIII);
    - Identify the baseline space-based space weather observational system and review with respect to the WIGOS 2040 vision for space-based global observing system (WGIII and SWTT); and
    - Deliver proposal for WMO to include in WIGOS 2040 a proposal for a target architecture for GHG and carbon monitoring from space (WGIII and SWTT).

- The following was proposed for inclusion in the final proposal for the revision of the HLPP:
    - Explore options for optimal data exchange of advanced data from new generation GEOs, in consultation with the global NWP centres through GODEX-NWP (WGIV);
    - Specific targets on identified or potential losses of capability for µwave and EM orbit (CGMS-46 plenary session on passive microwave observations);
    - Specific aspirational targets regarding gaps between baseline and WIGOS vision for GEO IR sounding, µwave for SST, increase in altimetry coverage, enhancement of the RO constellation and on space weather observations from L-5 (WGIII); and
    - Integrate specific activities related to space based GHG monitoring in the working structure of CGMS, in particular WGs I-IV (CGMS-46 plenary greenhouse gas session).

The CGMS plenary endorsed the final proposal for the revised CGMS High-Level Priority Plan to cover the period 2018-2021, subject to agencies providing any final comments within the two weeks following CGMS-46.

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	M	A46.19	**On HLPP:** CGMS members to comment on the revised HLPP text and provide feedback to CGMSSEC@eumetsat.int	1 Jul 2018	**OPEN**

Following CGMS-46, and the review period, the revised version of the updated HLPP will be published on the CGMS website.

N REVIEW OF CGMS-46 ACTIONS AND RECOMMENDATIONS

N.1 CGMS-46 actions and recommendations

The CGMS Secretariat presented the draft list of CGMS-46 plenary actions and the status of CGMS-45 actions and resulting from the deliberations at CGMS-46 (**CGMS-46-CGMS-WP-17, 19, -29**).

A summary list of actions and recommendations following CGMS-46 discussions is available in annexes III-VIII of this report. This list will be updated regularly and be available on the CGMS website under MEETINGS and CGMS-46.

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

O AOB AND CLOSING SESSION

O.1 CGMS nominations and representatives at meetings

The CGMS Secretariat provided the list of nominees and representatives at meetings in **CGMS-46-CGMS-WP-21** and plenary endorsed these.

O.2 Any other business

There was no other business discussed.

O.3 Schedule of future CGMS plenary sessions (2019 and beyond)

CGMS plenary highly welcomed ROSCOSMOS/ROSHYDROMET's confirmation to host CGMS-47 in Sochi, Russian Federation, on 19-24 May 2019. ROSCOSMOS/ROSHYDROMET provided a taste of what is to come in **CGMS-46-ROSCOSMOS/ROSHYDROMET-WP-06.**

The tentative plan of CGMS plenary sessions in the period 2020-2027 is:

CGMS plenary #	Year	Location
CGMS-48	2020	China
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

(see also **CGMS-46-CGMS-WP-13**).

To confirm the CGMS-48 venue in 2020, CGMSSEC agreed to take the following action:

CGMS-46 actions - PLENARY					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC, CMA	O	A46.20	**Schedule of future plenary sessions:** CGMSSEC to propose a plan for future CGMS plenary sessions after CGMS-47 in 2019	CGMS-47	**OPEN**

O.4 Handover of CGMS flag

The host of CGMS-46, ISRO, handed over the CGMS flag to ROSHYDROMET who together with ROSCOSMOS will host the 47th plenary session of CGMS on 19-24 May 2019 in Sochi, Russian Federation.

O.5 Closing remarks

Commented [AT11]: ISRO is requested to add the address of Dr Sivan and closing remarks by Tapan Misra.

Concluding the session, the Chairman, Mr. Tapan Misra, ISRO, declared that CGMS-46 had been very fruitful and thanked the representatives of all members and observers for their dedication, ensuring that the meeting had been a success.

The discussions on the proposal and updates of the High Level Priority Plan (HLPP) will continue to guide CGMS on the way forward over the next five years.

The Chairman, thanked all those who contributed to organising the meeting, namely the work performed by the Working Groups, the CGMS Secretariat and the local organising committee.

Finally, he looked forward to the 47th CGMS plenary session in Sochi in 2019.

All participants warmly thanked ISRO and IMD for the excellent organisation and hosting of the meeting in Bengaluru.

The 46th plenary session adjourned at 16:50 on 8 June 2018.

PARALLEL WORKING GROUP SESSIONS

WG I REPORT

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

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

During the plenary session of CGMS-44, Mrs. Vanessa Griffin (NOAA), Mr. Sergey Uspensky (ROSHYDROMET) and Mr. Joaquin Gonzalez (EUMETSAT) were appointed as Co-Chairs and Rapporteur of Working Group I, respectively. Unfortunately, Mr. Uspensky and Mr. Gonzalez could not attend CGMS 46. Mr. Sean Burns (EUMETSAT) acted as Rapporteur for WGI at CGMS-46.

WGI included representatives of the satellite operators from CMA, EUMETSAT, ISRO, JMA, KMA, NOAA, ROSCOSMOS, ROSHYDROMET and WMO (see CGMS report for full list of participants). In view of the actions agreed at CGMS-45 in relation to Space Weather, the representatives of the related Task Team also participated in the meeting under dedicated agenda item 6.1.

WGI reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting which is in line with the draft Terms of Reference for WGI and WGIV **CGMS-46-CGMS-WP-18.**

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

WGI discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-45 and earlier) and the final status is provided in annex IV of this report.

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

3.1 Frequency management topics and WRC-19 preparation status

CGMS-46-NOAA-WP-03
NOAA Current and Future Satellite Networks
With the recent NOAA satellite launches, NOAA satellite spectrum use changed from the information presented to CGMS 45. Only the changes from 2017 were presented, however the full listing of NOAA satellites, current and future, and their spectrum use is available to CGMS members.

JPSS-1 (Joint Polar Satellite System 1) is also known as NOAA-20 in keeping with standard NOAA nomenclature for polar satellites. JPSS-1 successfully launched on 18 November, 2017.

COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate – 2) is now expected to launch in October 2018 at the earliest. The COSMIC-2 satellite constellation will only consist of six satellites in a 24-degree inclined orbit. The main ground stations will be at Wallops (Virginia), 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, Guam, 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 placed into storage. GOES-15 will continue to operate at 135W until replaced by GOES-S. GOES-13 is in storage at 60W and GOES-14 is in storage at 105W.

The GOES-R Series of meteorological satellites has increased by one this year with the successful launch of GOES-S on 1 March 2018. GOES-R satellites will be located in the geostationary locations of 75.2W and 137W for their permanent operations. (Checkout and Extended Operations will be conducted at 89.5W for GOES-S). GOES-R became operational as GOES-16 on December 18, 2017 at 75.2W. Checkout and extended operations for GOES-S will last approximately six months. GOES-S will become GOES-17 upon reaching GSO orbit at 137W.

Jason-CS / Sentinel-6 is a new mission being developed in conjunction with EUMETSAT, ESA, NASA and JPL. The first satellite is planned to launch November 2020. It will use S-band and X-band for its TT&C and data links. There will be a total of 2 satellites. Ground stations will be located in Kiruna, Sweden; Fairbanks (NOAA), AK; LEOP ground support in Troll, Antarctica and Svalbard, Norway.

The future Joint Polar Satellite System-2 (JPSS-2) will vary a bit from JPSS-1. The significant spectrum difference from its predecessor is the bandwidth of the X-band changing from 30 to 50 MHz. Launch for JPSS-2 is expected in 2021.

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. Just 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.

CGMS-46-CGMS-WP-10

Report from the CGMS/SFCG Liaison Officer

This document provides a report from the CGMS/SFCG Liaison Officer on the discussions and outcome of SFCG-37 (6 – 13 September 2017, Montreal) on frequency matters of mutual interest/concern, namely:

- Space agency reports on national/regional regulatory changes/issue;
- Space weather observations using radio frequencies (in preparation for a WRC-23 agenda item);
- WRC-19 issues of prime concern to CGMS;
- Compatibility of passive sensors in the 23.4-26 GHz band and IMT-2020 (5G) in the 24.25-27.5 GHz and higher band;
- Optimisation of the use of the band 2200-2290 MHz.

Furthermore, information 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 Task Group 5/1 on those issues is provided.

CGMS-46-WMO-WP-08

WMO SGRFC status report and next steps

WMO Steering Group on Radio Frequency Coordination prepared a preliminary position paper on the Agenda of the World Radio Communications Conference 2019 (WRC-19) in January 2017 and updated in January 2018. This position paper is available online at https://wis.wmo.int/file=3379 .

Among WRC-19 agenda items, twelve items are related to frequency bands or issues of prime interest or concern for meteorology and the related fields.

- Agenda item 1.1: Amateur service in the 50-54 MHz band
- Agenda item 1.2: Satellite hard limits at 400 MHz
- Agenda item 1.3: METSAT and EESS at 460-470 MHz
- Agenda item 1.6: Non GSO FSS at 37.5-51.4 GHz
- Agenda item 1.7: Small satellites
- Agenda item 1.13: IMT2020 (i.e. 5G)
- Agenda item 1.14: HAPS
- Agenda item 1.15: FS/MS above 275 GHz
- Agenda item 1.16: RLAN 5 GHz
- Agenda item 9.1.5: RLAN 5 GHz and reference to radar ITU-R recommendations
- Agenda item 9.1.9: FSS at 51.4-52.4
- Agenda item 10: Agenda for next meeting

All might be of specific interest to CGMS members.

There are also nine WRC-19 agenda items (1.11, 1.12, 2, 4, 7, 9.1.4, 9.1.6, 9.1.7, 9.1.8) that are currently not involving specific frequency bands used for meteorological operations but that may potentially have an impact on WMO interests.

The WG noted the inputs on frequency-related matters. India reiterated the need to protect the 403 MHz band for data collection.

3.2 Frequency-related topics in support to space weather

CGMS-46-NOAA-WP-04

NOAA Space Weather Frequency Plans and Forecasts

Space weather sensors currently do not have regulatory recognition or protection in the Radio Regulations, therefore operational systems are at risk of receiving interference, and currently have no recourse to address the interference.

At the March 2014 meeting of the SG-RFC, held in Boulder, Co, staff from the WMO Secretariat and the NOAA Space Weather Prediction Center presented information showing a need to address regulatory protection of space weather sensors that rely on the use of radio spectrum. As an outcome of the discussion at the meeting work was undertaken within ITU-R Working Party 7C to collect technical and operational parameters for spectrum-reliant space weather sensors. In 2015 the ITU-R approved Question 256/7, and WRC-15 placed the issue on the WRC-23 Preliminary Agenda (WRC-15 Resolution 810).

Working Party 7C began work on an ITU-R Report on the technical and operational characteristics and spectrum requirements of spectrum-reliant space weather sensors. This Report should be completed in time (well before WRC-19) so that the necessary background is provided to administration to allow them to support the retention of the agenda item related to space weather on the WRC-23 Agenda. The current version of the ITU-R Report that is under development is directly available to CGMS members upon request. It is envisaged to finalise this ITU-R Report at the September 2018 meeting of ITU-R Working Party 7C.

While this has been primarily worked by the SG-RFC since March 2014, the WMO IPT SWeISS became engaged in June 2017 as they are an expert group on space weather operations and systems. David Franc (USA) briefed the group on the effort and sought to gain support in obtaining system characteristics. Since then, David Jackson (UK) has been working with IPT-SWeISS members and the space weather community to collect system characteristics.

Many comments have been inserted into the Preliminary Draft New Report ITU-R RS. [SPACE_WEATHER_SENSORS] to identify areas where the document still has to be improved and where input is required from system experts. It should be noted that Working Party 7C envisages to finalise this ITU-R Report at the September 2018 meeting of ITU-R Working Party 7C. The comments are inserted taking into account the following objectives:

- Systems that are missing all or most parameters in the tables of characteristics are being deleted. In order to finish this Report effort must be focused on filling in all missing data fields. ITU-R Reports cannot be approved with data missing from the tables.
- Systems that are missing a small number of parameters in the characteristics tables have those data fields flagged with a comment. *They must be filled in for the September 2018 Working Party 7C meeting or the system should be deleted.* ITU-R Reports cannot be approved with data missing from the tables.
- Rows containing parameters in the characteristics tables that would contain useful information, but that information is not necessary for interference analysis, have been deleted. These rows are mostly empty and holding up finalization of the ITU-R Report for these parameters in not necessary.

Regarding the Preliminary draft new Report ITU-R RS. [SPACE_WEATHER_SENSORS] (Technical and operational characteristics of RF-based space weather sensors), CGMS agencies are invited to provide comments/inputs to the next meeting of ITU-R Working Party 7C (19-25 September 2018), in order to provide the missing information on space weather instruments/applications, either directly as input

contribution to the ITU-R WP 7C meeting or to a designated focal point CGMSSEC who gathers the inputs and sends them as one input to the WP 7C meeting in September.so that deadlines can be met for WRC-19. This report is available via the CGMS Secretariat.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	3.1	A46.01	CGMS agencies to provide to the next meeting of ITU-R Working Party 7C (19—25 September 2018), comments/inputs to the Preliminary draft new Report ITU-R RS.[SPACE_WEATHER_SENSORS] (Technical and operational characteristics of RF-based space weather sensors) in order to provide the missing information on space weather instruments/ applications, either directly as input contribution to the ITU-R WP 7C meeting (with deadline 7 September 2018) or to the CGMSSEC (deadline 3 September 2018)) who gathers the inputs and sends them as one input to the WP 7C meeting in September	07/09/18	**OPEN**

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

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

CGMS-46-NOAA-WP-05

Implementation of CGMS Best Practices for LEO Direct Broadcast Data at NOAA.

The paper describes the status of the implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data at NOAA.

NOAA described the implementation of CGMS best practices in support of local and regional processing of LEO direct broadcast data at NOAA. Since CGMS 45, NOAA participated in three Intersessional meetings and worked with EUMETSAT to rewrite BP#09. The key points made by NOAA were:

- The HRD builds upon a set of applicable Consultative Committee for Space Data Systems (CCSDS) standards as described in the Joint Polar Satellite System 1 (JPSS-1) Spacecraft High Rate Data (HRD) to Direct Broadcast Stations (DBS) Radio Frequency (RF) Interface Control Document (ICD) (BP#01). The ICD is available to Direct Broadcast users (BP#02)
- JPSS Field Terminal Support (FTS) provides Mission Support Data (ancillary data, auxiliary data and Mission Notices) and the necessary hardware and software specifications needed for processing

the broadcasts. Orbital data is also provided on the FTS web portal, to assist the DB community in locating the satellites of interest. http://noaasis.noaa.gov/NOAASIS/ml/jpss-fts.html (BP#03).

- The Community Satellite Processing Package (CSPP) supports the Direct Broadcast (DB) meteorological and environmental satellite community through the packaging and distribution of open source science software (BP#04).
- Regarding the availability of source code – For U.S. government agencies, the scope of licensing rights generally depends upon the source of the funding (i.e., government, mixed, or private), the nature of the data (commercial or non-commercial) and any negotiated terms of the contract. Hence, as long as NOAA has unlimited rights to the source code, NOAA should be able to make it available. The s/w installation procedure is user friendly. The CSPP software installation process is user friendly. (BP#05)
- NOAA is compliant with BP#07, Spacecraft and Instrument Operational Status, and BP#08, Operational Announcements.
- NOAA helped EUMETSAT prepare a revised BP#09. The JPSS-1 Link Budget has a positive margin when assuming Reference Rain and Atmospheric losses and Station Reference Performance, however the impact of a radome and local atmospheric conditions could require the reception station operator to exceed the performance defined in BP#09.
- NOAA presented the current operational orbit maintenance strategy for S-NPP and NOAA-20 at the April 2018 Intersessional meeting.

CGMS-46-NOAA-WP-06

Update of the NOAA JPSS Demonstration Direct Broadcast System and contribution to DBNET

The NOAA Direct Broadcast Real-Time Network is a demonstration project and includes international coordination through the WMO DBNET Programme and close collaboration with EUMETSAT. It was originally funded through the NOAA Sandy Supplemental, and now sustained by JPSS Program Science for mitigating gap in polar satellite observations by providing all other available polar satellite data (NOAA & EUMETSAT) with much lower latency. It supports the goals of JPSS Program Science/Proving Ground to demonstrate new science/applications and provide low latency data for regional forecast models and applications (e.g. flood mapping, smoke forecasts). There is currently no JPSS level 1 requirement for a Direct Broadcast Network – the JPSS level 1 requirement is for the spacecraft to ground transmission, the processing software and receiving antenna and processing system requirements. The NOAA DB demonstration system supports the WMO DBNET architecture of a network of DB stations for lower latency applications – compliant to WMO DBNET Guidelines.

NOAA DB Real-Time Network (DBRTN) consist of:

- Five NOAA funded antennas owned and operated by CIMSS/SSEC at Honolulu, Madison, Miami, Mayaguez and Guam.
- Two NOAA-funded antennas owned and operated by NWS and UAF at Monterrey and Gilmore Creek.
- Three partner antennas at Hampton, New York City and Corvallis (funded by other agencies, owned by universities).

Progress since CGMS-45:

NOAA DB network now provide ATMS, CrIS, and IASI data in AAPP BUFR format to EUMETSAT for dissemination via EUMETCAST as a pilot service. NOAA AMSU's are provided to EUMETSAT via an earlier EARS/NOAA agreement. ATMS, CrIS, and IASI BUFR files from the NOAA DB network are now routinely ingested by NCEP; ATMS and CrIS are now on GTS.

CGMS-46-CGMS-WP-07
Change record of CGMS agency best practices in support to local and regional processing of LEO direct broadcast data (information paper)
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.

CGMS-46-CGMS-WP-08
Role of CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data
The paper describes the reasons for producing the Best Practices:

- Expresses the commitments taken by the CGMS agencies operating DB satellites with respect to the coordination and support provided to the Direct Broadcast user community.
- The coordination and support is required by the user community to successfully establish and operate optimised DB reception and processing systems compatible with the different DB satellites.
- CGMS agencies operating DB satellites need to guide the user community towards the new capabilities of future satellites and the next generation of DB reception systems.
- By adopting the Best Practices, CGMS Agencies are also increasing users' access to data, improving timeliness of satellite data in environmental models and reducing demands on alternative data distribution systems

CGMS-46-CGMS-WP-15
Update of CGMS agency best practices in support to local and regional processing of LEO direct broadcast data
This paper presents updates of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data, most recently presented as CGMS-45-EUM-WP-32.

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.

Note that changes in the Best Practices relative to the CGMS-45 version are explained at the beginning of each section using grey italic text. This explanatory text is not part of the Best Practice. For a full change

record, see the separate document 'Change record of CGMS agency best practices in support to local and regional processing of LEO direct broadcast, CGMS-46-CGMS-WP-05'.

The paper has been written in coordination with all CGMS members via dedicated Inter-sessional meetings after CGMS 45.

WG I noted the progress made during the intersessional meetings, and agreed that the following should be considered for future evolutions of the Best Practice:

- CGMS operators to consider if the installation of processing S/W packages can be made more user friendly and if there is a potential for standardising the approach, considering the available methods and tools.

- CGMS operators to 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.

As a first step in considering the feasibility of orbital phasing, as a measure for reducing pass scheduling conflicts and maximising the amount of instrument observation collected it is proposed to ask each operator present the current operational orbit maintenance strategy.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS operators	WGI/ 4.1	A46.02	Present the current operational orbit maintenance strategy, as an input the discussion of the advantages of orbital phasing between satellites as a measure for reducing pass scheduling conflicts and maximising the amount of instrument observation collected, with a view to producing a future best practice.	by Q1 2019	**OPEN**

CGMS-46-EUMETSAT-WP-13

Status of implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data at EUMETSAT

This paper presents status of implementation at EUMETSAT of the CGMS best practices in support to local and regional processing of LEO direct broadcast data (CGMS-46-CGMS-WP-15) for each of the Metop and Metop-SG LEO satellite missions for each of the nine Best Practices (BP).

The meeting noted that the EPS SG information should be provided well in advance of the launch of the first spacecraft.

Information regarding the status of implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data at CMA is given in **CGMS-46-CMA-WP-01**

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	4.1	A46.03	Provide the status of implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data	CGMS-47	**OPEN**

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

CGMS-46-EUMETSAT-WP-03

The use of netCDF standards and conventions for data formatting

Since CGMS-45 there have been three Working Group I inter-sessional meetings on the topic of data formats and formatting standards. The primary outcome of these meeting was a comparison of the use of the CF Conventions in netCDF products across agencies and the identification of use patterns which fall outside the scope of the CF Conventions.

It is proposed that a point of contact is identified who represents the CGMS community within the governing bodies of the CF Conventions in order to ensure that the evolution of this important standard reflects the community's requirements.

It is also proposed that CGMS members continue to exchange information concerning their use of netCDF and their needs for evolving community standards.

WGI proposed to plenary that EUMETSAT (Daniel Lee) act as liaison between CGMS and the governing bodies of the CF Conventions.

5. Data collection systems

CGMS-46-EUMETSAT-WP-09

Proposal for a WGI sub-group on DCS activities

In the past CGMS has contributed to the successful uptake of DCS for the international user community. This included ensuring dedicated bandwidth for IDCS as well as an International Data Collection System User's Guide (2009). More recently developments by the CGMS operators – NOAA, EUMETSAT and JMA have evolved relatively independently, especially given the lack of utilisation of the IDCS system, noting that NOAA no longer supports the 100bps standard advocated for IDCS. IDCS still remains a potential solution to user needs, however the IDCS design needs to evolve to better suit user requirements e.g. a design more robust against platform movement. Additionally common data access mechanisms and coordinated DCP certification may provide a better platform to encourage further IDCS uptake.

The CGMS Working Group I meeting and even the Intersessional meetings are not necessarily conducive to making effective progress on several of the ongoing DCS issues. Taking into account the lack of progress on the evolution of the IDCS, a dedicated sub-group on DCS activities is proposed. This Group would initially address:

- The need for and proposals for a new IDCS DCP standards, work on new designs that could serve as a basis for a new standard
- The development of DCS best practices: common DCP data access mechanisms and DCP certification
- The development of a CGMS DCS webpage as a contribution to the Satcom Forum

The Group would consist of DCS Managers from each of the satellite operators, who would meet virtually as part of the WG I Intersessional meetings, but also face-to-face in the context of other already scheduled DCS-related meetings. The first such meeting would be the Satcom Forum 2018/EUMETSAT DCS meeting 9 to 11 October 2018.

WGI endorsed the proposal for a WGI DCS sub-group, and agreed on the first meeting to be held on the occasion of the Satcom Forum 2018/DCS Workshop. The first agenda of the Sub-Group would include:

- Review of the Best Practice for DCP Certification
- Review of the Best Practice for DCP data access
- Review of designs for a potentially new IDCS DCP standard

A report from the sub-Group will be presented at CGMS-47 WGI, covering the topics above.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
All Members	5	A46.04	Appoint DCS Managers as members to the WGI DCS sub-group, noting that the first meeting will be held on the occasion of the Satcom Forum 2018/DCS Workshop in October 2018. The first agenda of the Sub-Group would include: • Review of the Best Practice for DCP Certification • Review of the Best Practice for DCP data access • Review of designs for a potentially new IDCS DCP standard Members should review and provide inputs on these topics prior to the first meeting.	01/09/18	**Open**
DCS sub group	5	A46.05	Provide a consolidated DCS report covering the items in A46.03	CGMS-47	**Open**

CGMS-46-ROSHYDROMET-WP-02

Status of Russian data collection system

The Russian data collection system (DCS) is established to provide satellite channels for meteorological data transmission from data collection platforms (DCPs) via meteorological satellites (backup option – via

Luch communication satellites). The DCS was developed according to the international requirements of WMO and CGMS and has to provide transmission of the messages every 3 hours (standard synoptic h

The DCS comprises of the network of DCPs at Roshydromet' observational sites, relay transponders at Russian satellites of Electro-L and Luch series, and ground reception stations at SRC Planeta satellite centers. DCP signals are transmitted via dedicated satellite channels at frequency ranges of 401.5-402.5 MHz (uplink) and 1696.5-1697.5 MHz (downlink) with transmission rate of 100 or 1200 bps. The message size is up to 15 000 bit. The transmission time is synchronized with GLONASS/GPS signals. The System capacity allows data transmission from 300 DCPs simultaneously that provides throughput of 3000 DCPs in 10 minutes.

The Russian DCS is developed for data transmission via meteorological satellites: series of Electro-L GMS (constellation of three spacecraft to be located at 76E, 14.5W and 166E), series of Meteor polar-orbiting satellites (constellation of three spacecraft), series of Arctica highly elliptical orbit satellites (constellation of two spacecraft), and also series of Luch geostationary communication satellites.

The constellation of Electro-L GMS (with backup option via Luch communication satellites) provides coverage of the territory from about 75ºS to about 75ºN, the highly elliptical orbit satellites will give the coverage of high Arctic latitudes, polar-orbiting satellites will cover the regions outside the area mentioned above, but less frequently ours), and also storm warnings at any time.

Roshydromet has developed and deployed the national DCS based on Electro-L series GMS with backup option via Luch series communication satellite. The DCS is based on the national technical equipment. Messages transmitted from DCPs to Electro-L N2 and Luch-5B are relayed to the European (Moscow region), Siberian (Novosibirsk) and Far Eastern (Khabarovsk) satellite centers of SRC Planeta. The number of DCPs is now more than 600 DCPs allocated (April, 2018). DCPs are distributed all over the whole territory of Russia, including 119 DCPs in hard-to reach areas. The national DCS has a reliability of 99.8 % based on the number of messages successfully received.

CGMS-46-NOAA-WP-08

Overview and status of GOES DCS programme

There are more than 29,000 active GOES Data Collection Platforms serving nearly 800 programmes in the GOES foot print. Over 6 million messages are delivered into the global observing system while the DCS Administration and Data Distribution System has nearly 19,000 registered users.

GOES-16 become GOES East since 18 Dec 17. GOES-17 is expected to replace GOES 15 as GOES-West by late 2018. Please note that the DOMSAT rebroadcast service end in May of 2019. NOAA are planning a DADDS refresh or recapitalization of the DADDS systems at Wallops, NSOF and the development system at our contractor, Microcom Design. NOAA are also planning to develop a new File Format which will be developed by 2020. Please note that NOAA will go describe the Two Way communications prototype development in a separate briefing (CGMS-46-NOAA-WP-24):

- Active DCS Platforms: nearly 29,000
- DADDS Registered Users: nearly 19,000
- Version II Transmitters: over 11,000 with less than 15 of the 29,000 reporting @ 100 bps

Overall Challenge: Frequency matters do remain a concern for the DCS programme. Telecommunication companies are strongly petitioning for use of the 1675 – 1695 MHz band which GOES DCS uses for downlink transfer of data to Command and Data acquisition stations, DRGS (direct readout ground stations) and LRGS (local readout ground stations). There is also concern with greater and greater use of the 401 – 403 MHz uplink band by micro sats or cube sats. NOAA are trying to pursue mitigations with regard to spectrum management and specifically potential impacts of shared use of the downlink while pursuing a mitigation of shared used of the uplink signal with small or microsatellites.

Spectrum Management

During the March GOES DCS TWG meeting in Miami, Alion Science and Technology presented and described NOAA's Spectrum Pipeline Reallocation Engineering Study (SPRES) that is intended to identify issues associated with the FCC petition to share the 1675 – 1680 MHz band between meteorological satellite services and terrestrial mobile commercial use in the United States. NOAA is attempting to quantify the potential impacts to the DCS users and identify possible techniques to facilitate successful spectrum sharing.

5.1 User requirements on data access

CGMS-46-CGMS-WP-09

CGMS agency best practices in support to DCP user data access

The paper EUMETSAT DCP data access 'CGMS-45-EUMETSAT-WP-28' was presented at CGMS 45 giving the status of EUMETSATs DCP data access mechanisms and the future development plans. The paper also presented the case to consider a common tool that all DCS operators could use to provide access to DCP data, especially in the context of IDCS. During the discussion in the WG I intersessional meetings, it was proposed to develop a CGMS agency best practice in support of user data access especially for DCP data.

This paper presents the first draft of the CGMS Agency Best Practices in support to access of the DCP data for review by all members. DCP operators have several mechanisms to retrieve DCP data including the WMO GTS; satellite dissemination services and the Internet. This first draft of CGMS best practice focuses on the retrieval of the DCP data via the internet.

The access to DCP data via the internet critically depends on support from the CGMS agencies operating DCS. This includes the provision of technical specification of DCP standards, the division of the DCP bandwidth and it's recognised and agreed usage by these agencies, as well as operational coordination.

There is currently no standard global specification for the access to DCP data through via the internet. This has caused issues for the users when operating systems from different agencies and also Manufacturers when delivering solutions to the users. Rather than provide a specification, a more

pragmatic way forward is to develop best practices which would form a basis for the DCS satellite providers to provide solutions that allow the user community and the manufactures to obtain the most effective use from the system.

Each of these best practices in this section are already used by at least one of the agencies:

1. All users and manufacturers should be able to access the DCS web services via the internet.
2. The DCS internet service should be made robust by means of redundancy.
3. A mechanism to monitor the availability of the system and inform users of unavailability of the service.
4. Control access by use of strong passwords.
5. A user should be able to request a password reset at any time and this request should be fulfilled within 30 mins.
6. A user should be able to maintain their own contact information.
7. All DCP data should be available to a logged in user.
8. From the DCP transmission time until the message is made available on the application should be less than 30 mins.
9. Users should be informed of any service changes.
10. Users are able to select download parameters in a flexible way.
11. Provide the users with a full set of documentation to allow them to achieve the best possible service form the system.
12. Provide an on-line DCP data archive of at least 30 days

Several recommendations are made for practices not currently implemented by any agency, but are already considered in future enhancement plans.

1. Configurable email notification for non-active DCPs.
2. Registration from within the interface.
3. Provide a DCP data push service from within the interface
4. Provide DCP operators access to a database containing all DCP transmitter manufacturer information
5. A standardised web interface for all CGMS DCS operators could use to provide access to DCP data.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
DCS sub-group	5.3	A46.06	The DCS sub group is invited to review and provide comments to this draft of the CGMS agency best practices in support to user DCS data access.	CGMS-47	**OPEN**

5.3 Lessons learnt and feedback on certification process

CGMS-46-CGMS-WP-02

CGMS agency best practice in support to DCP TX certification process

This paper presents the first draft of CGMS agency best practices in support to DCP TX (Transmitter) certification process. It is derived from answers to a specific CGMS WG I DCP certification questionnaire to satellite operators and manufacturers and also from lessons learnt during the METEOSAT HRDCP certification process and additionally from further discussions with NOAA.

Each of these best practices described are already used by at least one of the agencies.

1. Minimise the costs for the certification process
2. Provide an online registration process for a manufacturer certification
3. The Manufacturer should perform initial testing and supply results to the Satellite operator
4. Favourable assessment of the initial report should lead to preliminary over the air testing
5. Provide test DCP encoding message and examples of the coding process at the different steps
6. Contingency time should be built into any certification plan

Points for discussion

The IDCS certification for a DCP design, for 100 bps, as performed by EUMETSAT, NOAA and JMA, was then valid for operation on all of the DCS operated by those agencies. 100 bps is no longer supported by NOAA, therefore the standard is no longer truly International. If CGMS decide on a new IDCS standard, then a common certification process could also be put in place. WG I and specifically the CGMS DCS operators should first discuss if a new IDCS standard is required prior to a decision on a common certification.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
DCS sub-group	5.3	A46.07	DCS sub group to discuss and if agreed propose a new IDCS standard. This is the pre-requisite for a decision on a common certification	CGMS-47	**Open**

5.4 SATCOM Forum 2018 preparations

CGMS-46-CGMS-WP-25

Status of the SATCOM Forum 2018 preparations

This paper presents an update on the work performed on behalf of CGMS in the SATCOM Forum in the context of Data Collection Systems, in particular the preparations for the 2018 SATCOM Forum.

The International Forum of users of satellite data telecommunication systems (SATCOM Forum) is an entirely self-funded body jointly sponsored by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, of the United Nations with the view to address the requirements of these two Organizations for the timely collection of environment data from observing platforms.

The Terms of Reference agreed by the Executive Committee are:

- Provide proper coordination amongst the users of satellite data telecommunication systems and represents their collective interests in working with the satellite telecommunication service providers and the industry in order to advance the awareness and understanding of the user requirements;
- Advance the awareness and understanding of available and planned capabilities;
- Facilitate adoption of interoperability and quality standards and principles as needed;
- Investigate and propose as appropriate cooperative and tariff negotiation mechanisms on the use of satellite data telecommunication systems;
- Provide guidance to best meet user needs of each considered application;
- Report to the executive bodies of WMO and IOC through the Commission for Basic Systems (CBS), the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), and the GOOS Steering Committee respectively.

Membership is open to all representatives of the co-sponsors stakeholders. EUMETSAT (Sean Burns) is the CGMS representative to SATCOM and is also a member of the Executive Committee.

Information about the Data Collection Systems of CGMS members is contained in annex II and III. This data needs to be reviewed to give the latest information for the CGMS input into the SATCOM Forum meetings.

The aim of SATCOM Forum is to help “Bring the right data, in the right format, to the right people, at the right time for the right price,” where satellite communications are involved in at least one part of the process. As noted in the “Outreach strategy and action plan”, SATCOM will achieve this through bringing together representatives from SATCOM users, SATCOM network operators and those involved in the design, manufacture and sales of SATCOM terminals.

The First SATCOM Forum was held at IFEMA – Feria de Madrid, in Spain as a side event of the Meteorological Technology World Expo 2016 (Meteo Expo), 27-29 September 2016 hosted by Spain. Meteo Expo also included CIMO TECO 2016 and the "Metrology for Meteorology and Climate, 2nd conference" (MMC-2016). As reported at CGMS 45, the following steps were identified as activities post Satcom Forum 2016 in preparation for the 2018 Satcom Forum:

- Market Survey of WMO/IOC Members followed by identifying case studies on Satcom requirements – Completed;

- A Handbook for Satcom Buyers Guide is being reviewed and updated, planned for release prior to Satcom Forum 2018;
- Web hosting for information is being investigated;
- Training and Outreach – slides being developed and planned for release prior to Satcom Forum 2018.

Additionally there was a need to ensure continued support by WMO/IOC (as well as engagement by CGMS/Networks providers, Equipment Manufacturers and users etc.). This has progressed in the last year, in particular with HMEI (The Association of "Hydro-Meteorological Equipment Industry).

2018 SATCOM Forum

The format of the 2018 Forum is once again based on presentations and discussions, with time built in to allow networking and to take advantage of exhibitors at the Met Expo. The location will be at Amsterdam RAI, The Netherlands from 9 – 11 October.

In preparation for the Satcom Forum and DCS Workshop, it is proposed to create a DCS page on the CGMS Website.

WGI took note and comment on the status of preparations for the 2018 SATCOM Forum and endorsed the proposal for a CGMS DCS webpage.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	5.3	A46.08	Review and update CGMS-46-CGMS-WP-25 annexes regarding DCS information	01/09/18	**OPEN**
CGMSSEC	5.3	A46.09	In preparation for the Satcom Forum and DCS Workshop, it is proposed to create a simple DCS page on the CGMS Website.	01/09/18	**OPEN**

5.5 Future DCS standard

CGMS-46-EUMETSAT-WP-05

Progress report on the E-DCP (ref. ESA study)

This Paper details the progress of the ESA study for an Enhanced Data Collection Platform (E-DCP). The E-DCP is a proposed enhancement to the existing DCP designs supported by EUMETSAT and may be proposed as a CGMS standard for potential use by other DCP operators world-wide.

The project has been performed by SCISYS Deutschland GmbH. The project aims to define and prototype the implementation of a New Air DCP radio interface providing a service to a wider range of applications. The definition of the interface is based on the results of a survey within the group of DCP stakeholders including Satellite operators, DCP operators and DCP manufacturers.

Once the study has been finalised, a further presentation will be made to the satellite operators and DCP manufacturers in the context of the EUMETSAT DCS Workshop in October 2018, where a discussion is expected on the potential adoption of the E-DCP standard by CGMS operators.

5.6 Operational DCS systems - agency reports

CGMS-46-NOAA-WP-07

NOAA 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 this opportunity, commonly called “Satellite DCS Use Concept Validation”, is to enable satellites, typically LEO smallsats, to interface with the GOES DCS Platform Radio receiver and thereby provide a low rate data (300 or 1200 bps) service to satellite users; primarily to assist in launch, early orbit, and anomaly (LEO&A) operations. Satellite DCS users are good candidates for using the relatively unused international DCS (IDCS) channels. 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 and current NOAA DCS users won’t be further crowded. 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:

- Increased use of the International channels, which are currently underutilized.
- Low cost enablement of scientific, educational, and development satellite low data rate communications to respective mission centers.
- Ability to enable LEO&A during clustered deployments.
- Projected demand for enabling the two-way communications capabilities of the DCS.
- Demonstrated continued efforts by NOAA/NESDIS to facilitate good spectrum stewardship and efforts towards responsible sharing of spectrum resources.

The 401-402 MHz band is under pressure from smallsat constellation companies to use 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 still 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.

Challenges were found in implementing this new use of DCS, however NOAA did not find any issues that could not be resolved via engineering or policy. This concept demonstrates NOAA and the meteorological community’s commitment to spectrum sharing in a responsible manner.

The development team has developed a concept validation plan for testing the satellite DCS use concept over the next two years. Since no change is required for the DCS receiver system, once this use is validated, it can also be used by other DCS systems in the international community, thus expanding the availability of DCS satellite use in the international bands while further decreasing the pressure on the DCS spectrum.

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.

CGMS-46-NOAA-WP-24

NOAA Update on GOES DCS Two-Way Prototype Development

Challenge: The DCS community requires a communication link to remote Data Collection Platforms
Purpose: the two way enhancement would allow DCS users to send commands to DCPs and receive acknowledgements via the GOES (geostationary satellite system. Beneficial when commanding remotely located DCPs and also mitigates impact on personnel (supporting DCPs).

Background:
Two way communication concept is not new as the original 1965 design was based on interrogate operation. It was not widely used at that time due to limited capability as well as receiver cost. The design did not meet NTIA Power Spectral Density Requirements also. The SUTRON Company was able to overcome this by proving out a Direct Sequence Spread Spectrum approach for DCP command but it was not fully implemented by NOAA. Another note is that the GOES satellites as recently as the R-Series are actually capable of two way communications as they host transponders for interrogate & command although not used. Another challenge is that DCS is a secondary NTIA license holder and must operate on a non-interference basis with the FCC primary license holder (the Land Mobile Radio).
2015 study directed by NOAA and executed by the Mircrocom Design Company recommended the Frequency Hopping Spread Spectrum approach over the Direct Sequence Spread Spectrum which will allow DCS not to interfere with LMR in that environment. Also, recommended that NOAA fund and provide for a reference receiver design, the utilization of the DADDS system in order to allow users to interrogate or command their DCPs and finally to synchronize hop pattern, packet structure and error correction to UTC (Universal Time Clock). The benefit of synchronizing with the UTC is that DCPs will actually be able to get their timing from the two way communication without a GPS. Currently there is a periodic re-synchronization with the GPS but, will not be necessary with a two way comm signal synced to the UTC.

In 2016, Microcom Design was as able to complete a follow-on study with goals of extending the simulation model to further confirm the Frequency Hopping Spread Spectrum performance in the presence of Land Mobile Radio interference as well as the impact on Bit Error Rate with truncated RS (Reed Solomon). This study effort confirmed minor BER degradation in the presence of two LMR signals which where 20 dB higher than the FHSS signal. It also showed performance difference was negligible with shortened RS (250,218) vs. (255,233). The success of this study led to NOAA requesting a proposal for Microcom Design to build a prototype modulator and demodulator for a bench test.

Bench Test prototype work began in Fall of 2016. The overall work was delayed by budget constraints, changes in DCS management team and needed focus on GOES 16. Work continued in October of 2017. Microcom Design was able to design a custom modulator and ultimately to develop a demodulator with a combination of off the shelf parts and custom components.

Prototype modulator can produce test signals & FHSS BPSK (Binary Phase Shift Key) at 200 bps with pseudo-random data while the demodulator can demodulate FHSS BPSK signals. The bench test was run with two LMR signals for interference (30 db stronger than 2 way signal) with the results showing the improvement of hopping vs stationary in an environment with strong LMR interferers.

Current status: Over the Air Test/ Demonstration in option year #2 (Spring – Fall of 2018). The planned next steps are to extend the bench demodulator to receiver and the interface modulator to WCDA (Wallops) transmit system.

Note: The test will setup a prototype demodulator as a "test DCP" and the prototype modulator will be affixed to a transmitter in Wallops to conduct the over the air test

Note: Power Spectral Density (PSD) indicates level of power output

Demonstration goals:

- Demonstrate the ability to handle 0.24 second travel path delay as signal propagates up to and back down from GOES satellite
- Verify expected operational performance and link margin
- To yield an over-the-air proof of concept of the FHSS approach

Note: NOAA has not identified specific Key Performance Parameters (requirements) for the operational performance or link margin of the Two Way Comms

- Currently, Target BER is 10*-5 (or 1 in 100,000) @ 6.5 db
- Team is considering application for an FCC experimental license to allow experiment of simulated LMR signals to radiate as interference for Over-The-Air test

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Notes: The main difference between FHSS and DSSS is that FHSS utilizes frequency hopping while DSSS utilizes pseudo noise to modify the phase of the signal Direct Sequencing Spread Spectrum spreads the information across the band by introducing pseudo-random noise into the signal to change its phase at any given time. This will result in output resembling static noise however, a “de-spreading” process can extract the original message as long as the pseudo-random sequence is known. In order for the receiver to decode the transmitted information, it must be synchronized with the transmitter.

For FHSS it is relatively easy as the transmitter simply waits on one of the channels and waits for the decodable transmission. Once that occurs, it can follow the sequence being used by the transmitter which jumps across different channels. DSSS is just not as simple as a timing algorithm needs to be employed for the receiver to correctly establish synchronization.

Bottom-Line: FHSS is a simpler approach than DSSS to achieve the spread spectrum approach needed to not interfere with Land Mobile Radios that may be operating near or in proximity to the terrestrial DCPs.

CGMS-46-JMA-WP-03

Himawari-DCS's international contributions to disaster risk reduction

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. In July 2015, Himawari-8 entered operation and took over the DCS service from MTSAT. In March 2017, Himawari-9 entered a period of in-orbit standby as back-up to Himawari-8. It is expected to take over the DCS service in 2022 and continue in this role until 2029.

Himawari-8 and -9 use the Ka band (18 GHz) as the downlink frequency for relaying DCP data. To take into account rainfall attenuation in this band, the main and sub antenna sites, which are more than 800 km apart, both receive the downlink for redundancy.

The paper shows the distribution of tidal/tsunami and seismic intensity DCPs allocated to regional channels in Himawari-DCS, including tidal/tsunami DCP stations 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. In 2017, a new tidal DCP began operation in the western Pacific.

6. System and operations aspects

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

CGMS-46-SWTT-WP-05

CGMS Space Weather Anomaly Survey Results

Agencies have provided reports on anomalies from solar events at CGMS plenary sessions using the same space weather anomaly reporting table, created by WMO, since 2012. EUMETSAT, KMA, and NOAA have provided updates, but not all fields of the table were filled out and key details were omitted. In previous discussions within the SWTT, it was unclear what the ultimate use of the reporting will be and what procedures were used by agencies in determining that satellite anomalies were caused by space weather event. Furthermore, space weather data collection is represented in multiple tasks within the CGMS HLPP. As a result, SWTT developed a space weather anomaly survey that, working with WGI, was sent to CGMS satellite operators and addressed how space weather data was utilized during periods of nominal operations, when a satellite anomaly is taking place, and post analysis of anomalies. EUMETSAT, JMA, NOAA, and NASA responded and the key findings included that no preventative actions are performed before solar events; space weather data is consulted more frequently for LEO, lunar, and earth trailing missions; and that operators requested more data from L1 and better modelling to better predict and understand impact.

CGMS-46-NOAA-WP-09

NOAA NCEI Evaluation of CGMS Anomaly Reports

NESDIS NCEI has reviewed reports of spacecraft anomalies received from CGMS members and would like to encourage members to continue their submission of reports. In addition, NCEI would like to encourage those members who have not yet contributed, to begin doing so. The NCEI has several recommendations to offer to the CGMS members as they continue to provide these reports. Members should not limit their reports to events that have an assured connection to a space weather event. There can be usable information in anomalies that do not have a clear cause attributed to them. It would also be helpful to those submitting reports if clearer definitions of the required fields were offered for the WMO anomaly form. NCEI understands that there may be some sensitivities contained within these anomaly reports and therefore recommends that CGMS members employ the use of a "trusted agent" to communicate sensitive information among members. These "trusted agents" can help safeguard sensitive information while still providing usable information to the anomaly database. Finally, allowing for reports to be augmented once a final investigation is available, would be very useful as well.

WGI took note of the papers from the SWTT representatives, and agreed on the actions and recommendations in the papers. The WG also formulated an additional action to make a presentation/paper to the next CGMS on use case/s from their analyses and any recommendations arising.

6.2 Space debris and collision avoidance. Coordination with the IADC

The item is new to WGI, an action was placed requesting Members to provide the status of their Collision Avoidance processes and the lesson learned when implementing these processes.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
SWTT	6.1	A46.10	To make a presentation/paper to the next CGMS on use case/s from their analyses and any recommendations to operators arising.	CGMS-47	**OPEN**
CGMS members	6.2	A46.11	Members to provide the status of their Collision Avoidance processes and the lesson learned when implementing these processes	CGMS-47	**OPEN**

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

No inputs were presented under this item.

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

No inputs were presented under this item.

The representative from WGIII requested that a Point of Contact be nominated from WGI to participate in WGIII for any contingency related issues. EUMETSAT (Sean Burns) was appointed as the PoC.

7.2 Handling of future large data volumes and associated data circulation

The item is new to WGI, an action was placed requesting Members to provide the status of their systems already in place and those planned, along with their overall approach to dealing with the challenges associated with handling and circulating large data volumes.

CGMS-46 actions – WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	7.2	A46.12	Members to provide the status of their systems already in place and those planned, along with their overall approach to dealing with the challenges associated with handling and circulating large data volumes	CGMS-47	**OPEN**

8. Review and updating of the HLPP

CGMS-46-CGMS-WP-12

A review and update of the HLPP was performed.

9. Nomination and representatives at meetings

CGMS-46-CGMS-WP-21

The following nominations and representatives were proposed or agreed:

- WGI Rapporteur
  EUMETSAT (Sean Burns)
- WGI liaison between CGMS and the governing bodies of the CF Conventions
  EUMETSAT (Daniel Lee)
- WGI liaison to WGIII for Contingency related issues
  EUMETSAT (Sean Burns)

10. Any other business

No further items were presented for discussion.

11. Date/time of inter-sessional activities/meetings in 2018-2019 [CGMS-46 -> CGMS-47]

Frequency Management – EUMETSAT (Markus Dreis)

- Review of inputs for comments/inputs to the next meeting of ITU-R Working Party 7C
  21 – 24 August 2018 during SFCG meeting

Best Practices for Direct Broadcast NOAA (J. McNitt)

- Meeting on Direct Broadcast 1 — September 25, 2018, 1200 UTC
- Meeting on Direct Broadcast 2 — March 15, 2019, 1200 UTC

Data formats and formatting standards (Daniel Lee)

- Data format and metadata standards — 17 October 2018 1200 UTC:
- Data format and metadata standards — 5 February 2019 1200 UTC

Data Collection Systems: EUMETSAT (Sean Burns)

- DCS Workshop/Satcom Forum 2018 preparation — July 2018
- DCS Workshop/Satcom Forum 2018 — 9-11 October 2018
- DCS CGMS report preparation — 6 February 2019 1200 UTC

Space Weather NOAA (Elsayed Talaat)

- Space Weather Anomaly Reports — 5 December 2018
- Space Weather Data use — 6 March 2019
- Preparation of use case for CGMS presentation — Q1 2019

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

The summary list of WGI actions and recommendations resulting from CGMS-46 is included in annex IV 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-chair Dohyeong Kim opened the meeting and welcomed the participants. It was noted that the Agenda was quite full and focus should be on the most important aspects relevant to the CGMS Members. No additional items were identified for WGII.

2. Election of WG II co-chair

The previous Co-chair Stephan Bojinski from WMO has left WMO and he is no longer able to support CGMS WGII. WMO would however still be happy to provide support to the WGII activities by providing a Co-chair. Hence, WMO put forward Werner Balogh as a candidate for new Co-chair.

As no other candidates were proposed, WGII proceeded to consider the candidature of Werner Balogh. WGII unanimously endorsed the candidature and proposed to plenary to adopt the recommendation for Werner Balogh to become WGII Co-chair.

3. Review of actions and recommendations from previous meetings

All WGII and plenary Actions relevant to WGII were reviewed and assessed. The WG reviewed the actions and recommendations of past CGMS sessions related to its work. The following actions were proposed to be closed:

- A44.13
- A45.01
- A45.07
- A45.08
- A45.09
- A45.10
- A45.11

Further details are provided in the updated list of CGMS actions and recommendations. Additional details can be found in the updated HLPP (CGMS-46-CGMS-WP-17).

The summary list of WGII actions and recommendations resulting from previous plenary sessions and following CGMS-46 discussions, is available in annex V of this report.

4. Interaction between WGII and ISWGs (ref. WGII ToRs)

No issues were raised. However it should be noted that guidance was given in advance to the co-chairs on content of presentations to WGII and plenary, ensuring consistent efficient and complementary reporting at CGMS.

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

CGMS-46-IMD-WP-02

Calibration Activities at Satellite Division of IMD

In IMD, five major activities related to calibration and validation of INSAT/Kalpana-1 data for past, present and future are performed on an operational basis at SATMET IMD. These are mainly:

- Establishment of In-situ Calibration and Validation site for INSAT- 3D/3DR satellite for Visible and SWIR sensor,
- Sustained and Coordinated Processing of Environmental Satellite data for Climate
- Monitoring (SCOPE-CM) for past Kalpana-1 and INSAT series of satellites
- Lunar/Moon Calibration of INSAT-3D/3DR
- Deep Convective Clouds (DCC) Calibration Approach

The tasks include:

1. The analysis of in-situ data along with satellite data for CAL/VAL of INSAT-3D/3DR missions and generation of calibration coefficients.
2. Cross comparison of sensors with other contemporary sensors.
3. Validation of Geophysical products/parameters e.g. reflectance, aerosol, soil moisture, T & H vertical profiles, rain fall, OLR etc.
4. Generation of Fundamental Climate Data Records (FCDRs) of calibrated and quality-controlled geostationary sensor data.

GMS-46-GSICS-WP-03

Report from the GSICS Executive Panel-19 report and Status of the Observing System

Prior to the CGMS-46 meeting, on 1-2 June 2018 the GSICS Executive Panel (EP) Members from CMA, EUMETSAT, ISRO,JAXA, JMA, KMA, NASA, NOAA, ROSHYDROMET, ROSCOSMOS along with WMO Secretariat (Toshiyuki Kurino), GSICS Coordination Center and CGMS SWTT Chair, got together for the Annual GSICS EP meeting.

On the agenda were key decisions, endorsements and guidance from the GSICS EP on topics related to in-orbit calibration performance monitoring of meteorological satellites by member agencies. Some of the aspects that were reported are stated below.

GSICS Coordination Center (GCC) reported that interest in GSICS activities has increased and the quarterly newsletter is subscribed by over 340 readers worldwide. GCC reported that seven new monitoring

products were added into GSICS product catalogue. These include monitoring of Himawari 8 and MSG4 using IASI-A, AIRS and IASI-B as reference in Near Real Time and Re-Analysis mode. Development of an Action Tracker on Google Cloud and Instrument monitoring images added onto the GSICS product catalogue were the new accomplishments reported by GCC to EP. GCC received vital guidance from EP on the GSICS Procedure for Product Acceptance (GPPA) and actions were generated to make the GPPA more efficient in assigning Operational Maturity to products and a faster acceptance into GSICS fold.

GSICS Research working Group (GRWG) reported calibration results of next generation satellites. This included FY-4A satellite (GIIRS, AGRI and LMI), GOES-16 and CrIS and VIIRS in NOAA-20 as well as SNPP. Advances in SRF retrieval method, Spectral Gap filling, MTF, cross-talk characterization were reported to EP. In the UV comparison of solar measurement from backscatter ultraviolet instrument, and the white paper on ground-based characterization of UV spectrometers was reported. In the advances in Microwave Inter-Calibration best practices and monitoring using Fundamental Climate Data Records as a reference were reported.

GRWG decided to accept CrIS as a GSICS reference instrument since it passed the suggested criteria, and also provided to approve the criteria and procedure for accepting instruments as GSICS reference by EP. Hyperspectral sounders of IASI and CrIS completed the reprocessing and GRWG was requested to analyse the impact of GEO-LEO inter-calibration using reprocessed hyperspectral sounders.

The GSICS Data Working Group provided the EP updates 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 upgrade is underway. 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.

GRWG and GDWG reported the summary of the State of the Observing System Calibration Reports for each GSICS member agency, and reported examples of GSICS inter-calibration methods for the validation which were prepared by EUMETSAT, JMA, KMA and NOAA. GRWG reported the proposed minimum information of specifications and methodologies for CGMS agency development of operational instrument performance monitoring system in response to the actions in GSICS-EP-18.

The executive panel decided to invite European Space Agency, to become full member of the GSICS Executive Panel. It also decided to continue discussions with the Space Weather Community on their involvement with GSICS and placed the following Action:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	WGII /5	A46.16	CGMS members to provide points of contacts for space weather instrument inter-calibration. (Ref. CGMS-46-GSICS-WP-01)	By 31 August 2018	**OPEN**

Overall 19 Actions and two recommendations were generated in this EP meeting. Detail EP-19 report would be uploaded at http://www.wmo.int/pages/prog/sat/meetings/GSICS-EP-19/GSICS-EP-19.html.

WGII endorsed the Actions and Recommendations from GSICS-EP and following discussions on memberships placed the following Recommendation:

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
ESA	WGII/5	R46.01	European Space Agency to consider becoming a full member of the GSICS Executive Panel.

CGMS-46-ITWG-WP-01

The ITWG's ITSC-21 Report

The 21st International TOVS Study Conference, ITSC-21, was hosted by EUMETSAT at the Darmstadtium conference centre in Darmstadt, Germany, between 29 November and 5 December 2017. This time, 180 participants from 49 organizations attended the Conference, providing a wide range of scientific and technical contributions. Eighteen countries and three international organizations were represented: Argentina, Australia, Brazil, Canada, China, Czech Republic, France, Germany, India, Italy, Japan, Norway, Russia, South Korea, Spain, Taiwan, United Kingdom, United States, ECMWF, EUMETSAT, and the WMO. Working Groups were formed for key topic areas, leading to very productive discussions.

The group again expressed a strong requirement for state-of-the-art infrared and microwave sounders in at least three complementing orbital planes, and fully supports CMA's efforts to cover the early morning orbit starting with FY-3E. The wide uptake of FY-3 data among international NWP centres establish CMA as a leading provider of satellite sounding data with global reach. Concepts are emerging to provide observations with higher temporal frequency, either through geostationary sounders or through fleets of satellites (e.g. cubesats). International real-time data exchange and efficient use of such data is essential for optimal exploitation of these resources.

The meeting saw significant progress in enhanced calibration/validation of satellite data and long-term climate data records, not least through fruitful interaction of the NWP and climate communities. The use of metrological approaches combined with reference observations are leading to better quantitative evaluations. These highlight more clearly where better knowledge or reduction of uncertainties is required, for instance in the area of radiative transfer or ocean surface emissivity modelling. Improvements in retrieved products are also more fully appreciated through these calibration-validation efforts. A strong climate session highlighted how well-calibrated data records can be used for trend

detections and process studies. A well-attended evening workshop was organised by the EU-funded GAIA-CLIM project to showcase enhanced validation of satellite data through a combination of NWP and reference observations.

Prompted by calibration/validation efforts and new applications in cloudy areas, there was renewed activity regarding improved radiative transfer, recognising the need for improved spectroscopy and better uncertainty characterisation for enhanced quantitative use of sounding data. Initial work towards better uncertainty characterisation was presented, for instance, regarding line mixing in the important 50 GHz temperature-sounding band and the 183 GHz humidity sounding region. Growing accuracy demands, particularly from NWP, are calling for more work on radiative transfer aspects.

Several presentations again demonstrated the critical importance of satellite sounding data for Numerical Weather Prediction and highlighted the growing sophistication of assimilation approaches. The active assimilation of cloud or precipitation affected radiances is becoming a wide-spread operational activity at several NWP centres, particularly for microwave radiances, but promising activities are also emerging for the infrared. Treatment of uncertainties, both random and systematic, continues to be a hot topic, with renewed attention to the role of forecast model bias in adaptive bias correction schemes. Treatment of three-dimensional effects and the actual viewing geometry are starting to receive attention, aimed at reducing errors in the forward calculations for radiance assimilation. The use of reconstructed radiances for the efficient assimilation of the full spectral information contained in hyperspectral infrared radiances is showing promising results. Impact studies also demonstrate that assimilation of passive sounding data provides key 3-dimensional information on wind analyses in modern assimilation systems, for instance through the ability to trace humidity structures in 4D-Var. The optimal exploitation of this will become even more important with the provision of data with high temporal resolution, such as from geostationary sounders or fleets of cubesats.

Critically contributing to the successful data usage are the continued developments of processing packages such as the ATOVS and AVHRR Pre-processing Package (AAPP) and the Community Satellite Processing Package (CSPP). The developments of direct broadcast packages also underpin a continued strengthening of fast retransmission services which uses existing local ground stations to process locally received data and to re-distribute it via the GTS to achieve a timeliness of 30 min or better through the DBNet initiative of WMO. The inclusion of software to process Russian satellite data from the Meteor-M N2 series was encouraged for active exploitation of the promising data source.

Twenty one main recommendations are discussed in the full working paper, and 3 of them have been elevated to be reported in detail at the CGMS-46 plenary.

It is seen critical that the agencies provide due consideration to changes that affect the calibration of their instruments. Recent examples show that changes may have an unforeseen impact on NWP and better coordination of changes is requested for.

The development of spectroscopy for radiative transfer development and maintenance of LBL-models needs further attention, in particular noting the ageing expertise

Climate requirements should be considered in the establishment of future observational capabilities.

As an outcome of the subsequent discussion WGII placed the following actions and recommendations:

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
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 members	WGII/5	R46.03	CGMS members should give due consideration to potential impacts of changes to instrument data processing changes. Specifically ITWG proposes that if the expected maximum change (temporally, geographically) in the observed brightness temperature of any channel of the instrument exceeds 0.1K or 20% of NEdT (whichever is smaller) it should be made clear in notifications to users. User notifications to be made no later than 8 weeks in advance of the change and with test data (at least a few orbits, ideally more) provided whenever possible.

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
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)	By CGMS-47	**OPEN**

CGMS-46-IWWG-WP-01

Status Report from the International Winds Working Group and IWWS-14

The International Winds Working Group (IWWG) recently completed its 14th International Winds Workshop (IWW14), held on 23-27 April 2018 on Jeju Island, Korea. The meeting was sponsored by KMA, EUMETSAT, WMO, and BAE Systems. All CGMS-45 recommendations were addressed during the week. Three actions defined by the two working groups, Wind Extraction Methods (WG1) and Data Assimilation (WG2) emerged from the meeting.

IWW14 Action 1: All AMV producers to implement the "Common QI module" in their algorithms. A common Quality Indicator (QI) module (Fortran 90) was developed and supplied to the AMV producing centres. Due date: before IWW15.

IWW14 Action 2: AMV producers to adopt the new AMV BUFR template. New AMV BUFR sequence is now officially referenced on the WMO website (Nov 2017).A new sequence, to fix an error in the current one will be finalized soon. It will not be officially endorsed by the WMO until November. However, this should not stop producers from adopting this new sequence. Due date: end 2019.

IWW14 Action 3: NWP community to define the best configuration to be used by the AMV producers, for use in global and regional NWP models. In plenary discussion at IWW14 it became apparent that different AMV requirements are needed for producing AMVs that would meet the needs of Global NWP, Regional NWP and Nowcasting. Due date: before IWW15.

Three recommendations were also produced during the week.

IWW14 Rec 1 to AMV producers: To provide a 9-month overlap period when transitioning to a new generation of satellite and for major derivation changes. GOES-13 to GOES-16 overlap before the move to GOES-16 proved to be not sufficient for NWP users to evaluate AMV data before including into their operational chains.

IWW14 Rec 2 to EUMETSAT: To consider that "Tristar" configuration for tandem Metop-A/B/C is best for both AMV generation and to maximize ASCAT scatterometer coverage. A "Tristar configuration" of the 3 Metop Satellites will be applied during the commissioning of Metop-C. The final configuration is still to be decided.

IWW14 Rec 3 to AMV producers: To reduce as much as possible the product data latency.

WGII considered the activities, recommendations and actions by IWWG noting that:

- further analysis is required to understand the benefits of the Tristar configuration for Metop satellites, noting that Metop-A is drifting;

- high resolution AMV generation for mesoscale, regional and NWC applications warrants a revision of the adopted QI methodology which has been based on geostrophic balance;

WG II therefore endorsed the following Recommendations and Actions:

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS members	WGII/5	R46.04	AMV producers to provide a 9-month overlap period when transitioning to a new generation of satellite and for major derivation changes.

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS members	WGII/5	R46.05	AMV producers to reduce as much as possible the product data latency

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	WGII/5	A46.02	All AMV producers to implement the "Common QI module" in their algorithms.	By IWW15	**OPEN**
CGMS members	WGII/5	A46.03	AMV producers to adopt the new AMV BUFR template.	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.	By IWW15	**OPEN**

After further discussion and clarifications WGII placed the following three actions on IWWG:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
IWWG	WGII/5	A46.05	IWWG to provide information to clarify their preference for flying the Metop satellites in a TRISTAR configuration. (Ref. CGMS-46-IWWG-WP-01)	By CGMS-47	**OPEN**
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)	By CGMS-47	**OPEN**
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)	By CGMS-47	**OPEN**

CGMS-46-IROWG-WP-01

Outcome and recommendations from the IROWG-6 workshop

This report summarises the IROWG-6 meeting held on 21-27 September 2017 in Estes Park, USA. It provides the recommendations from the four IROWG subgroups: NWP, Climate, Space Weather and Receiver Technology/Innovative Occultation Techniques.

The four key recommendations for CGMS-46 - endorsed by the IROWG community at the plenary session - 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 meta data – from both the agency-led and "commercial" missions. These long term costs should be included in mission budgets. Researchers need access to this data, and to information about the GNSSRO receiver performance, for climate reprocessing activities.

Access to just the retrieved products is not considered sufficient for many research applications.

It was also noted that the current radio-occultation constellation is declining and whilst new missions are emerging the decision not to pursue COSMIC-2 polar has a tremendous impact on data availability. The WGII therefore placed the following recommendation:

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS members	WGII/5	R46.06	CGMS members should consider hosting radio occultation payloads on future missions. (Ref. CGMS-46-IROWG-WP-01)

Workshop minutes and this CGMS working paper from IROWG-6 are/will be made available at http://www.irowg.org. Workshop presentations available at https://cpaess.ucar.edu/cosmic-10th-data-users-workshop-irowg-6-about.

Based on a clarification request from WG the IROWG Chair present and Rapporteur noted that: there are quality assessment concerns with respect to commercial data as the quality approach is diverse.

Subsequently, WGII agreed there is a need to pursue an approach for consistent quality control for RO data in order to enable consistent intercomparison of RO data from different providers and placed an associated Action on IROWG.

CGMS-46 actions – WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
IROWG	WGII/5	A46.08	IROWG to develop process and principles for RO data quality control to ease intercomparison of data from different providers.	??	**OPEN**

Commented [AT12]: Please add

CGMS-46-ICWG-WP-01

Status report from the International Cloud Working Group

ICWG will convene its second meeting in November 2018 in Madison, Wisconsin, USA. ICWG-1 was held in Lille, France in 2016. Based on that experience, the ICWG has reformulated its topical groups in 4 permanent ones with dynamic sub-groups. Registration closes on 3 August 2018 and ICWG encourage all interested parties to participate. In addition, it was noted that data is still being collected for inter-comparison efforts and submissions from all participants was encouraged. ICWG is hoping to further our collaboration with other CGMS groups (IWWG and IPWG) as well as GSICS and SCOPE-CM. Approaching the second meeting, the following recommendations for discussion at the CGMS plenary were put forward.

- To provide means to strengthen collaboration with other working groups (as first step would be good to have small funding to cover costs of co-chairs to attend each other's meetings).
- To provide a means to perform level-2 assessments prior to each workshop (space agencies could be encouraged to provide resources covering about 3 person months, e.g. though visiting scientist activities)
- To discuss in collaboration with CEOS WG Climate the organization of a level-3 cloud assessment (to be discussed at ICWG-2)
- To discuss the homogenization of the geostationary temporal sampling to 10 minutes. This recommendation came from the severe weather topical group but would aid in the global consistency of many products.

CGMS-46-IPWG-WP-01

Status report from the International Precipitation Working Group

Working paper IPWG-WP-01 was written by the two co-chairs of the International Precipitation Working Group (IPWG), Dr. Ziad Haddad and Dr. Dong-Bin Shin. The report highlights the recent achievements of IPWG during the past year, including the planning for IPWG-9, 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-45, as well as any IPWG items from the HLPP.

Primary accomplishments since CGMS-45 include (and are detailed in the following sections of this working paper):

- Maintained and updated the IPWG web page (http://www.isac.cnr.it/~ipwg/IPWG.html), including formal tracking of IPWG working group action items (see http://www.isac.cnr.it/~ipwg/wg.html) ;
- Continue to develop an IPWG focused publication (summarizing key scientific achievements from the IPWG-8 workshop in October 2016) in the Quarterly Journal of Royal Meteorological Society:
- https://rmets.onlinelibrary.wiley.com/journal/1477870x. Currently, over 20 papers have been accepted for publication, with several others still undergoing final revision.

- Expanded the IPWG validation protocol to India;
- Participated at training activities as part of the 8th Asia/Oceanic Meteorological Satellite Users' Conference (Vladivostok, Russia, October 2017);
- Engaged with CGMS on topics of interest, including participation at CGMS sponsored meetings and engagement with other science working groups;
- Engaged with other entities like CEOS, GEO, GEWEX, GSICS and other applications groups, including participation at relevant meetings.

As an example of its achievements it was noted that in response to CGMS plenary action CGMS-45 A45.07 "IPWG co-chairs and rapporteur to provide guidance on the estimation of uncertainties and representativeness of the short-latency precipitation products related to the Space-based Monitoring of Weather and Climate Extremes project (CGMS-45-WMO-WP-05)" IPWG co-chairs developed a white paper that summarizes the uncertainties in the most widely used precipitation products generated by CGMS members.

IPWG also developed a guidance table for a various range of precipitation products noting the advantages and disadvantages of each:

Product	Advantages	Disadvantages (in addition to possible local bias)
Hydro-estimator / SCaMPR	- High temporal sampling frequency (~10 mins) - High spatial resolution (~5 km) - Attempts to separate convective and stratiform rain - Uses model-analysis total water vapor to help interpret IR	Highly indirect and non-monotone sensitivity to surface rain
Level-3 MiRS	- Reasonably good sensitivity - instantaneous estimate for every MW-constellation obs - same approach over land or water	Snapshots every ~80 mins Revisit time could be 3 hours
Level-3 GPROF	- Reasonably good sensitivity - instantaneous estimate for every MW-constellation obs - estimates calibrated by the reference GPM radiometer	Snapshots every ~80 mins Revisit time could be 3 hours
Level-3 GPM radar/combined	- High direct sensitivity to surface rain - High spatial resolution (~5 km)	Revisit time calculated in days
HOAPS	Conically-scanning MW radiometers only	Ocean only
RSS	Conically-scanning MW radiometers only	Ocean only
CMORPH	- Frequent temporal reporting (~30 mins) - Good spatial resolution (~25 km) - Uses MiRS for instantaneous MW estimates -Uses advection scheme from IR in between MW overpasses	Persistence of any misdetection / amplification of estimation uncertainty
GSMaP	- Frequent temporal reporting (~30 mins) - Good spatial resolution ( ) - Uses GSMaP_mwLUT for instantaneous MW estimates - Uses change in IR to adjust MW-estimated rain	Persistence of any misdetection / amplification of estimation uncertainty
IMERG rt	- Frequent temporal reporting (~30 mins) - Good spatial resolution ( ) - Uses GPROF for instantaneous MW estimates - Uses advection scheme from IR in between MW passes - Available within about 5 hours of obs	Persistence of any misdetection / amplification of estimation uncertainty
IMERG late	- Frequent temporal reporting (~30 mins) - Good spatial resolution ( ) - Uses GPROF for instantaneous MW estimates - Available within a few weeks of obs	Persistence of any misdetection / amplification of estimation uncertainty
IMERG science	- Frequent temporal reporting (~30 mins) - Good spatial resolution ( ) - Uses GPROF for instantaneous MW estimates - Available 3 months after obs	Persistence of any misdetection / amplification of estimation uncertainty
PERSIANN	-Long record back to ~1979 -NN approach accounts for regional variability	Mainly IR based – highly Indirect and non-monotone sensitivity to surface rain
MSWEP	Optimal merging of satellite, gauge and reanalysis estimates	Not continuous (latest version: 1979-2016)

The IPWG-9 will be held at the Seoul Garden Hotel in Seoul, Korea on 5-9 November 2018. KMA and Yonsei University are the primary sponsors. The programme agenda is being developed (abstracts are due on July 31).

CGMS-46-WMO-WP-10

SCOPE-CM initiative: Status and plans

The presentation provided an update on the status of the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring SCOPE-CM) initiative, a network of agencies and

operators of environmental satellite systems and interfaces with WMO, WCRP, GCOS, CGMS, CEOS and GEO. It offers its support to coordinate and facilitate international activities to generate Climate Data Records (CDR) from multi-agency satellite data. Within SCOPE-CM, the contributing organisations coordinate their scientific and technical development activities and cooperate on the basis of shared and distributed responsibilities for the generation of global products.

Established in 2008, based on a recommendation of the WMO Consultative Meeting on High-Level Policy on Space Matters, five pilot projects were conducted during the first phase of SCOPE-CM from 2008 to 2012. The second phase began in 2012 and put the focus on elevating the maturity of existing satellite CDR production efforts using a bottom-up approach.

Further details on these projects are available from the SCOPE-CM webpage at http://www.scope-cm.org/projects/.

As a result of discussions at the SCOPE-CM Executive Pane Meeting held in Rome, Italy, in October 2017, considerations are underway to re-defining/re-purposing SCOPE-CM to be more useful and productive to the agencies and the climate change user community. In particular, SCOPE-CM should be more strongly linked to the work of the CEOS/CGMS Working Group Climate (WGClimate).

Action to be provided by Joerg Schulz (call for a meeting to consider the future of SCOPE-CM)

- WGII CGMS-45 A45.01 have been closed.
- WGII CGMS-43 R43.01, and CGMS-44 R44.02 and R44.03 have been closed.

The WGII noted that the two most important things to achieve for SCOPE-CM in the near future are the successful conclusion of the ongoing projects including a successful delivery of data products and the establishment of a new strategy that takes the WGClimate into account and enables funded activities to maintain and establish efficient climate data records from multi agency mission data. Hence the following action was placed:

CGMS-46 actions – WGII

Actionee	AGN item	Action #	Description	Deadline	Status
SCOPE-CM EP Chair	WGII/5	A46.09	SCOPE-CM Executive Panel Chair to convene a strategy planning meeting with high-level representatives from SCOPE-CM members and other interested agencies, who are empowered to authorise resources, to agree on a revised strategy for SCOPE-CM and a new Implementation Plan, which shall be reported back to CGMS-47. (Ref. CGMS-46-WMO-WP-10)	First half of 2019	**OPEN**

Commented [AT13]: Please include a new action as necessary

Commented [AT14]: In what way? Following WGII discussions at CGMS-46?

Commented [AT15]: Idem

Realistically, such a meeting may only happen in the first half of 2019.

CGMS-46-WMO-WP-11

SCOPE-NWC initiative: Status and plans

The presentation provided an update on the status of the of the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-Nowcasting) initiative which aims to demonstrate continuous and sustained provision of consistent, well- characterized satellite products for nowcasting and severe weather risk reduction.

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. In an era of rapidly increasing satellite data volumes, transforming data into actionable information that is routinely available to NMHSs is critical. SCOPE-Nowcasting, in coordination with relevant international efforts, is working in support of this critical need.

The four existing SCOPE-Nowcasting projects are:

- Pilot Project 1: Basic Nowcasting, Provision of RGB imagery
- Pilot Project 2: Satellite derived volcanic ash information for aviation
- Pilot Project 3: Satellite derived precipitation information
- Pilot Project 4: Satellite derived sand and dust information

The proposed new pilot projects are:

- Proposed Pilot Project A: Nowcasting in a Big Data World: Multi-sensor feature-based nowcasting of convective impacts
- Proposed Pilot Project B: Advanced nowcasting: Utilization of low-level satellite-derived moisture fields for nowcasting convective development
- Proposed Pilot Project C: Advanced nowcasting: Incorporating satellite-based MW observations about column condensed water into nowcasting applications

Details on these projects are available from the SCOPE-Nowcasting webpage at http://www.wmo.int/pages/prog/sat/scope-nowcasting_en.php.

CGMS-46-JWGCLIM-WP-02

Status and plans of the CEOS-CGMS joint WG on climate

This presentation described the progress in the implementation of the Joint CEOS/CGMS Working Group on Climate (WGClimate) objectives since CGMS-45. WGClimate submitted the coordinated response of CEOS and CGMS agencies to the 2016 GCOS Implementation Plan to GCOS and UNFCCC in October 2017. In addition, the statement of space agencies on progress implementing the architecture for climate monitoring was provided to UNFCCC SBSTA-47 in November 2017. UNFCCC SBSTA-47 noted with appreciation the space agency response to the GCOS-IP and particularly highlighted the progress made in the development of the ECV Inventory their conclusions.

WGII took note and endorsed the activities currently pursued by WGClimate.

CGMS-46-JWGCLIM-WP-01
Endorsement of the gap analysis report and the coordinated action plan
The ECV Inventory of climate data records containing almost 1000 data records has been verified and published under climatemonitoring.info in October 2017. A comprehensive gap analysis of the ECV Inventory with respect to missing data records for ECVs, missed opportunities to use existing observations, and missing measurements from space in the future has been performed and the results including recommendations are provided in the WGClimate ECV Inventory Gap Analysis Report. The recommendations from the Gap Analysis Report have been compiled into a Coordinated Action Plan and the implementation of actions with coordination bodies within and outside CEOS and CGMS has started. Both the Gap Analysis Report and the Coordinated Action Plan have been endorsed by CEOS plenary on 18 May 2018 and endorsement is sought from CGMS-46 plenary. In addition to the above the 9th session of the WGClimate in March 2018 adopted a new definition for Interim Climate Data Record (ICDR) and will revisit definitions for other types of climate data records in the future."

After discussion WGII concluded that the activities in this area performed by JWGClimate have been performed thoroughly in a timely manner. WGII therefore raised no concerns and endorsed the report.

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

CGMS-46-NOAA-WP-11
Redefining Operational Satellite Oceanography – Improved Coordination for Data Providers and User
Space-based oceanographic measurements are becoming increasingly mature and have transitioned (in most cases) into routine and sustained operations with high expectations of continuity by users. Despite the maturity and availability of these satellite oceanographic data, challenges (both real and perceived) remain to the more routine, effective, and sustained utilizations. For example, there is a prevailing perception that operational satellite missions, and the associated data generated by operational agencies, can only support near-real time applications. Another perception is that quality is not a primary driver for operational data. Researchers are also frequently viewed as not being users of operational data, ostensibly falling into a different bucket. None of these are true, but these perceptions persist in the community.

In this context, we need to redefine what operational means relative to satellite oceanography, specifically that it should be the routine and sustained provision of accurate, consistent, and fit for purpose quality oceanographic satellite observations spanning different time-scales, i.e., NRT to climate, and different users, e.g., research, operational applications and services (Brown et al., manuscript in development for the Journal of Operational Oceanography).

As a result, operational satellite oceanography missions must provide routine & sustained data of the highest possible quality supporting research and end user-driven applications and services, spanning NRT to climate-scales, unequivocally underpinned by fundamentally strong science. To realize these requirements, operational missions need to implement and maintain integral supporting space-based and

ground system infrastructure and associated scientific and technical activities, e.g., extensive pre-launch characterization; calibration/validation; on-orbit manoeuvres; life of mission reprocessing; and, on-going product development, refinement and science monitoring ensuring data are fit for purpose for all users (not just for NRT applications).

In many respects, as a community we are "data-rich" and information-poor". Collectively (the ocean observing community), we need to do a better job in the execution of the end-to-end value chain in support of user needs. Some specific activities to consider in this context include:

- Facilitate more timely transitions between research & operations (R-2-O-2-R);
- Allow requirements to evolve as appropriate (they are not etched in stone!), particularly given scientific and technological advancements and innovations;
- Pursue measurement-based, source agnostic enterprise approaches for algorithms et al. that leverage the international constellation and ensure high-quality, fit-for-purpose data;
- Co-locate and Fuse multi-sensor ocean satellite data, along with in situ measurements, especially across multiple time and space scales – make things easier and better for users;
- Accelerate modelling efforts & assimilation of ocean data for enhanced products & info;
- Strive for greater focus on the overarching, end-to-end value chain, moving from ocean observations and data to derived products & info that provides knowledge to users;
- Advance and encourage private sector use/transformation of ocean remote sensing data.

To address these and other related issues, NOAA has partnered with EUMETSAT and begun planning for the First International Operational Satellite Oceanography Symposium, to take place 18-19 June 2019 in College Park, MD USA at the NOAA Center for Weather and Climate Prediction. The symposium aims to enable the understanding the barriers (perceived or actual) and facilitate the widespread incorporation of satellite ocean observations into the value chain from data to useful information across the range of operational applications. In this symposium, an international community of satellite operators, information producers and users will exchange facts and ideas to 1) understand user needs and expectations, and 2) develop interoperability standards and establish best practices that will lead to more universal use of ocean satellite data. For further information see the meeting website for an announcement flyer and return later for additional details to be posted in the coming months as the symposium programme is developed: https://coastwatch.noaa.gov/OSOSymposium/OpSatOce_FirstAnnouncementFlyer_Distribute.pdf; point of contact: veronica.lance@noaa.gov.

In this broader context, we:

- Request guidance on how to enhance the visibility and utilization of operational satellite oceanography data, and to identify and support related internal coordination activities within CGMS;
- Request that CGMS endorse the "First International Operational Satellite Oceanography Symposium" as a CGMS activity;

- Request representatives from CGMS agencies to serve on the Symposium Programme Committee;
- Propose that CGMS work with GEO Blue Planet Initiative and other related external activities to better assess and address user needs and requirements.

During discussion it was noted that at this stage the bullets 2-4 above are the way to achieve bullet 1. WGII therefore endorsed the way forward and placed the following action:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	WGII/6	A46.10	CGMS to endorse the "First International Operational Satellite Oceanography Symposium" as a CGMS activity and to nominate points of contact for serving on the Symposium Programme Committee. (Ref. CGMS-46-NOAA-WP-11)	CGMS-46 plenary	**OPEN**

CGMS-46-NOAA-WP-10

NOAA/CMA flood mapping initiative proposal

Until very recently satellite flood mapping was done primary by research satellites with coordination through the CEOS via the CEOS flood pilot project. The new generation of operational LEO and GEO satellites are now capable of contributing to flood products. NOAA demonstrated the use and applications of flood products from JPSS VIIRS (SNPP and NOAA-20) and GOES-16 ABI and these products are now starting to be used in operational applications in downstream services. 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-comparison of flood products from operational satellites with verification using flood maps provided by the CEOS flood pilot. The goal of the CGMS flood initiative is to work towards the generation and distribution of flood maps from operational satellite agencies to their operational services and stakeholders.

It should be noted that the activities will specifically work towards consistent products derived from different satellite data. Furthermore the benefits of meteorological satellite data as providing a broad scale overview in flood situations and also the high temporal resolution from geostationary data gives complementary information to downstream services responding to flood events. WGII therefore place the following action:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
ESA, IMD and other	WGII/6	A46.11	CGMS members interested in participating in the CMA/NOAA	31 Aug 2018	**OPEN**

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members			operational flood mapping initiative to contact Mitch Goldberg (mitch.goldberg@noaa.gov). (Ref. CGMS-46-NOAA-WP-10)		

CGMS-46-IOC-UNESCO-WP-02

Update on the Second International Indian Ocean Expedition (IIOE-2) and linkages to CGMS going forward

This presentation follows that given on the subject at CGMS-44, where the IIOE-2 was introduced and the CGMS kindly invited that a possible working relationship be explored between CGMS and the IIOE-2 in the context of it being considered as user community of satellite derived information and perhaps even as a source of strategic or operational input to the CGMS constituency.

The talk revisits the IIOE-2 for CGMS. IIOE-2 is 2.5 years into its current 5-yr programme, has a fully developed and working Steering Committee comprising an integrated governmental, institutional, scientific and community-based constituency. So far, seven IIOE-2 National Committees have been formed and some 30 projects have been endorsed, most of which involve deep ocean research cruises. See http://www.iioe-2.incois.gov.in/.

IIOE-2 constituents are, of course, already big users of satellite data, such as for bio-physical oceanographic and for related and coupled atmospheric (weather) related variables. The question is: IIOE-2 opportunistically has a CGMS community to relate to now and so is it sensible and imperative that the IIOE-2 and CGMS develop a mutually relevant working relationship to enhance the benefits that the two parties can derive from meteorological satellites; is there scope for joint and /or revised programming of CGMS's missions and variables; can the IIOE-2 in fact bring benefits to the satellite community, for example by virtue of the valuable 'IIOE- 2' platforms cruising around the Indian Ocean that have capacities for additional tasking; and if so, by which collaborative mechanism and by whom? The opportunities for such will extend into the next decade, not only because IIOE-2 is being strongly mooted as extending its own tenure beyond 2020, but also for the links that would likely form with the now proclaimed UN Decade of Ocean Science for Sustainable Development 2021-30 (https://en.unesco.org/news/united-nations-announces-decade-ocean-science-2021-2030.

WGII noted a strong interest in IOE-2 and proposed development of a stronger relationship to various CEOS initiatives and the CEOS virtual constellations. EUMETSAT also expressed a strong relevance and opportunity noting the wide range of activities proposed within IIOE-2.

As an outcome of the discussion it was noted that establishing a stronger presence of operational oceanography e.g. through a topical session at CGMS would be beneficial and WGII therefore placed the following recommendation:

CGMS-46 recommendation - WGII				
Actionee	**AGN item**	**Rec #**	**Description**	**Deadline**
CGMSSEC	WGII/6	R46.07	CGMS Secretariat to consider organizing a special plenary session or a side event on operational oceanography at CGMS-47 to help advance the operational nature of ocean observation. (Ref. CGMS-46-NOAA-WP-11, CGMS-46-IOC-UNESCO-WP-02)	CGMS-46 plenary

CGMS-46-WMO-WP-12

PSTG update including snow science requirements and mission concepts (PSTG/GCW)

The document provides:

1. An update on the activities of the Polar Space Task Group (PSTG) and on the outcome of its 7th session held in Innsbruck, Austria, in December, 2017, which assessed the progress made since its 6th session held in 2016.
2. A summary of the findings of the snow radar science workshop, which was organized by the PSTG Synthetic Aperture Radar (SAR) Coordination Working Group in collaboration with the Global Cryosphere Watch (GCW) in Jan 2018 and which made several recommendations for addressing current and future needs of the international snow science community.

The governance of PSTG within WMO is ensured by the WMO Executive Council Panel of Experts on Polar and High-Mountain Observations, Research and Services (EC-PHORS).

EC-PHORS held its 8th session in March 2018. With regards to the work of PSTG, it recommended that the Terms of Reference and Membership of PSTG should be updated and that a broader gap analysis should be conducted by mid-2019, by mapping the needs for cryosphere space observations. In particular, it recommended, that the gap analysis should also include the observation of cryosphere at lower latitudes and at high elevation, e.g. snow glaciers, permafrost, lake ice, and river ice.

The WMO partners, as well as the WMO Technical Commissions, are invited to contribute to the gap analysis and to the assessment of options for addressing them, which will be linked to the Vision for WIGOS-2040 and to the Rolling Review of Requirements process of WMO. On the basis of this recommendation by EC-PHORS, a draft decision has been prepared for and consideration by the 70th session of the Executive Council of WMO, which will be held later this month.

WGII noted that traditionally the activities within PSTG has been focused, partially based on heritage, by SAR related activities. A stronger focus on the Capabilities of meteorological satellites should be emphasized and also, in order to have a balanced and direct view from some of the major players, the Global Cryosphere Watch should be involved. It was seen by WGII that there is an opportunity to shape PSTG that should be followed up.

CGMS Members are invited to:

Take note of the outcomes of the PSTG-7 session, and of the Snow Radar Science meeting;

- Participate in the gap analysis for updating the Terms of Reference and the Membership of PSTG, for ensuring an increased focus on cryosphere (e.g. snow, glaciers, permafrost) at lower latitudes and at high elevation.
- Engage with WMO on the monitoring of cryosphere in high mountain regions, where this is within the scope of current or planned activities. In particular, the participation of the space agencies that are already active in these regions, is very important.

The next PSTG meeting will be organized at WMO Headquarter, in Geneva, in October 2018.

Possible Actions for CGMS:

- CGMS participants to express an interest to contribute to the PSTG.
- Invite GCW to make a presentation to CGMS.

After discussion WGII concluded that it would indeed be beneficial for CGMS to contribute to the review and update of the Terms of Reference of the PSTG, but also noted that Global Cryosphere Watch should be involved. WGII hence places the following recommendation and actions:

CGMS-46 recommendation - WGII			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS Members	WGII/6	R46.08	CGMS to consider nominating 2-3 persons to support the drafting of the updated terms of reference for the Polar Satellite Task Group and to engage with Global Cryosphere Watch to support the activity.

7. Selected topics of high priority to members [90'] (WPs will be pre-selected)

CGMS-46-IMD-WP-04

Validation of INSAT-3D derived rainfall products with the rain gauge data

Being a monsoon fed agricultural economy which is also affected by severe droughts and floods at the same time India needs a vast network of weather monitoring stations. Mountainous terrain and remote forests limit the number of these in-situ stations. With advances in the Geostationary Satellite platforms newer precipitation products are available to the forecasters. These products provide near real time rainfall estimates throughout the country and beyond. However they need to be validated against the in-situ measurements before they can be used extensively in rainfall monitoring.

India Meteorological Department has a dedicated meteorological satellite INSAT-3D which provides the rainfall estimate products at every 30 minutes interval. A daily rainfall product is also made available which comprises of the rainfall occurred between 0300 UTC of previous day up to 0300 UTC of that day. The rainfall products from INSAT-3D are available with two different algorithms viz. Hydro estimator (HE) and

INSAT Multispectral Rainfall (IMR). HE is available per pixel whereas the IMR is available in gridded format. In the present study we have validated these two daily products against the in-situ rain gauge measurements available at 3525 stations. The data was interpolated to the geographic positions of rain gauge stations using Inverse Distance Weighted (IDW) approach with a radius of 5 km. The interpolated data then was subjected to various statistical analysis like correlation, RMSE, BIAS etc to validate the data qualitatively as well as quantitatively. Spatial correlation maps were plotted using the Krigging technique. Various skill scores such as Probability of detection, False Alarm Ration, Threat scores etc. were calculated to estimate the detection capabilities.

The results indicate consistent detection of rainfall occurrences however HEM and IMR differ in their quantitative estimates of the rainfall owing to the differences in the algorithm. Monthly spatial correlation map of Rain gauge with IMR and HEM for the study period shows similar distribution over India. HE method captures the heavy rainfall events with better accuracy compared to IMR. These rainfall estimation products can be used in monitoring of advancement of rainfall, active and break spells and rainfall structure in Cyclone.

After discussion the following action was placed:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
EUM, IMD	WGII/7	A46.12	EUMETSAT and IMD to establish contact for collaboration on SAF Nowcasting activities (Ref. CGMS-46-IMD-WP-06)	By 31 August 2018	**OPEN**

CGMS-46-JMA-WP-04

Validation of Himawari-9/AHI Level-1 and -2 data during its Health Check

The Meteorological Satellite Center of the Japan Meteorological Agency (JMA/MSC) updated the ground data processing system on 25 July 2017 and changed the sensor configuration on 13 February 2018. Level-2 products including Atmospheric Motion Vector (AMV), Clear Sky Radiance (CSR) and High-resolution Cloud Analysis Information (HCAI) data are continuously generated and disseminated via GTS (the Global Telecommunication System) and JDDS (the JMA Data Dissemination System).

The RSMC Tokyo – Typhoon Center began utilizing low-level AMV data from Himawari-8 to determine sea surface winds around typhoons on 6 July 2017. Since July 2017, Convective Cloud Information has also been provided on JMA's dedicated website for Significant Meteorological Information (SIGMET) coordination groups. From 7 to 9 November 2017, JMA hosted the RGB Experts and Developers Workshop 2017 in Tokyo, Japan, in collaboration with WMO and EUMETSAT. The workshop sessions highlighted a variety of existing applications and RGB concepts enabled by Himawari-8 imager data and generated active discussions among attendees.

The Himawari-9 geostationary meteorological satellite of the Japan Meteorological Agency (JMA) was launched on 2 November 2016 and entered in-orbit standby as backup for Himawari-8 on 10 March 2017. Himawari-9 features Advanced Himawari Imager (AHI), which is identical to the AHI on Himawari-8.

Following the validation of Himawari-9/AHI Level-1 and -2 products during in-orbit testing (IOT) in early 2017, the same validation was performed during Himawari-9 Health Check Operation periods from mid-2017 to early 2018. Image navigation and registration errors determined from observation conducted during these periods were in the same order as those for Himawari-8/AHI. Validation results for calibration relating to both units generally showed close correspondence. Differences between level-2 products made from Himawari-8 and -9 data were evaluated during Health Check Operation. Little difference was seen between the two for atmospheric motion vectors (AMVs), clear-sky radiance (CSR), cloud mask, cloud top height, sea surface temperature, aerosol optical depth and aerosol Angstrom exponents.

WGII took note of the paper.

CGMS-46-CMA-WP-03

CMA Report on Development and Application of Non-meteorological Products

This presentation is mainly to response to ACTION45.10 "Develop a proposal to develop GEO-based flood mapping as a potential SCOPE-Nowcasting pilot project". In NMSC, CMA, a special department, Center of Remote Sensing Applications & Services (CRSA), is mainly responsible for the service and application of satellite data. Meanwhile, CMA is constructing a national remote sensing application architecture to promote the use of new generation satellites. Over the past decades, CMA has made significant progress on many non-meteorological application domains, such as air pollution, flood mapping, fire monitoring, drought monitoring etc. However, the non-meteorological application of meteorological satellites still face many challenges. Generally, most users need high accuracy, high spatial and temporal resolution, and all sky information service, while the current capability of meteorological satellites can't meet those requirements. To resolve that issue, some proposes are put forward, including:

- To enhance the detection capability of future meteorological satellites, aiming at the requirement of general non-meteorological applications, such as fire monitoring, flood mapping, etc. If possible, SAR should be carried on meteorological satellite.
- To organize a working group working on quick data collection, high accuracy algorithm development, product validation, and information service. Operational agencies should be included in the group to reduce data latency.
- To establish a global alerting system to provide quick response service.

In conclusion WGII noted that the paper supported the conclusions from the NOAA presentation on flood mapping. As specific actions related to flood mapping were already raised on the earlier paper no further actions or recommendations were raised.

CGMS-46-NASA-WP-04

Land Monitoring from Geostationary Satellites

The latest generation of geostationary satellites carry sensors such as Advanced Baseline Imager (GOES-16/17) and the Advanced Himawari Imager (Himawari-8/9) that closely mimic the spatial and spectral characteristics of the widely used MODIS and VIIRS for monitoring land surface conditions. More importantly, they provide observations at 5-15 minute intervals. Such high frequency data offer exciting possibilities for producing robust biophysical variables by overcoming cloud cover, enabling studies of

local-to-regional biosphere-atmosphere interactions, and operational decision-making in agriculture, forestry and range management. But the data come with challenges that need special attention. For instance, geostationary data feature changing sun angles but constant view angles for each pixel, which is nearly reciprocal to sun-synchronous MODIS/VIIRS observations, and thus require careful adaptation of existing algorithms designed for MODIS/VIIRS sensors.

We have embarked on a collaborative effort called GEONEX among scientists from NASA, NOAA, JAXA and other institutions from around the world exploring the feasibility of producing operational land surface products similar to those from MODIS/VIIRS (Nemani et al., 2017). Preliminary efforts using AHI/ABI data suggest that EOS-quality land surface products can be derived from these sensors with minor adjustments to currently used algorithms. Additionally, we have created software containers of the algorithms such that they can be deployed with data from any of the geostationary sensors (AHI, ABI, AGRI, etc.) on a variety of compute infrastructures. Scientists from around the world can access, modify and deploy these containers and produce the desired products on-demand for selected regions and time periods.

WGII took note of the paper.

CGMS-46-WMO-WP-13
Impact studies by ECMWF, including OSES vs FSOI - A guidance note to help CGMS members prepared by ECMWF
Pros and cons of both and what has to be careful in interpreting results. (e.g. FSOI is sometimes only integrated to 200 hPa. Metrics has to be defined in advance. OSE on the other hand is sensitive to the order in which instruments are included. It is also important to work on how to present the results, not necessarily one number (example RO vs IASI).

- The guidance note will be circulated to many WP centres and also to WMO's expert teams (C-SEIS, IPETSUP, ETSAT);
- It will be updated based on their feedback;
- We would like to present a final version to CGMS in 2019;
- The goal is to help CGMS understand sometimes (apparently) conflicting conclusions from multiple studies and to ensure conclusions drawn, which can influence major programmes, are well founded.

Feedback from CGMS members on their use of these measure and areas of uncertainty in their use and interpretation is very welcome.

Analysis of strengths and weaknesses of FSOI and OSE approaches:

- OSEs answer the question "what if I lose/add not have this data type?"
- FSOI answers the question "given the setup how much does this data type contribute to forecast error reduction?"

Example 1: add datatype with unrealistic low observation errors. OSE will show negative impact. FSOI will show this datatype contributes most to forecast error reduction.

- Both are correct! But both are open to misinterpretation.
- FSOI measures impact in that setup.

Example 2: add two identical datatypes, first one, and then other. OSEs show first has large impact, second small impact. FSOI show they have the same impact.

- Both are correct! But both are open to misinterpretation.
- OSEs are sensitive to order of changes.

Aim of document is to give guidance to CGMS members on interpretation of OSE and FSOI methods to evaluate value of observations. It should be disseminated for wider consultation and presented again at next CGMS

After discussion WGII endorsed the proposed way forward and placed the following action:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
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)	By CGMS-47	**OPEN**

CGMS-46-NOAA-WP-12

GOES-16 Contributions to a Weather-Ready Nation

Initially launched in November 2016, GOES-16 conducted its on-orbit validation and checkout over the course of the following year. Based on the user readiness conducted in advance of the launch, the NWS was ready to utilize GOES-16 in operations even during checkout. Within five days of seeing data at Weather Forecast Offices, new capabilities with respect to monitoring wild fires were demonstrated and have been used extensively since. GOES-16 was utilized to monitor an extremely active hurricane season, noting when storms were intensifying, when “eyes” were transiting over the coastlines, where flooding was occurring (in concert with polar satellite data), and even afterward, where needed to mitigate the loss of weather radar. GOES-16’s new lightning mapper gives weather forecasters a new view of severe weather that can be used to protect life and property, including over the oceans where ground based lightning data is unavailable.

Following the 2017 Atlantic Hurricane Season, GOES-16 was moved into operations as the GOES-East satellite. GOES-16 monitored multiple nor’easters that threatened the eastern U.S. It continues to support situational awareness of weather over the Western Hemisphere, and work is ongoing on how to best exploit the new capabilities of the satellite, including the merging of products from multiple spectral bands that best inform forecasters and contribute to a Weather-Ready Nation.

The paper contained some nice illustrations on the benefits of GOES-16, in particular animations with lightning and early detection of fire (with hanging wind direction) were impressive.

CGMS-46-NOAA-WP-13

Status of NOAA/JPSS SNPP Reprocessing of Sensor Data Records

The NOAA JPSS cal/val team have reprocessed S-NPP Sensor Data Records (SDRs) starting from 2011-11-08 to 2017-03-08 (Block 1.2) for continued consistency of SDR Data products (Block 2.0). Now consistent SNPP SDRs are available for CrIS, ATMS, VIIRS, and OMPS. The reprocessed data is available on NESDIS STAR-CICS Linux Cluster (~1100 TB) at http://jlrdata.umd.edu/opendap/thredds. Plans are underway to provide the reprocess data to the NOAA CLASS archive. There are several reasons for the need for consistent SDRs. Without reprocessing, data products in the archive would have varying accuracy due to periodic updates of algorithms (to fix shortfalls) used for real-time product generation. All retrospective applications benefit from reprocessed data Anomaly products depend on an accurate climatological baseline (30 years or even 1 year - how does this year's green vegetation compares with last year's) NWP users requested reprocessed SDRs for their next reanalysis plan.

CGMS-46 RECOMMENDATIONS - WGII			
Actionee	**AGN item**	**Action #**	**Description**
CGMS members	WGII/7	R46.09	CGMS to take note of the status of the NOAA/JPSS SNPP Reprocessing of Sensor Data Records reprocessing effort and encourage all satellite operators to reprocess their mission data and make them easily accessible. (Ref. CGMS-46-NOAA-13)

8. Preparation for future generation of Indian geostationary and scatterometer missions

CGMS-46-ISRO-WP-06

Future perspectives of geostationary imaging missions for the Indian Ocean region

The overall objective of the Indian geostationary meteorological satellite programme (INSAT) is to provide round-the-clock surveillance service of weather systems including severe weather events around the Indian region. The first generation of INSAT satellites were built in USA and were multipurpose satellites for meteorological and telecommunications services. The first satellite INSAT-1A was launched in 1982 and the last in this series, INSAT-1D, was launched in 1990. INSAT-1 series carried a 2-channel VHRR (Very High-Resolution Radiometer) in visible and infrared bands. The second and subsequent generation satellites were designed and built indigenously by ISRO. VHRR/2 onboard INSAT-2E carried an additional WV channel and a 3-channel CCD camera (VIS/NIR/SWIR). The first dedicated meteorological satellite, Kalpana-1, with VHRR/2 instrument was launched in 2002.

The third generation satellites, INSAT-3D/3DR were launched in 2013/2016, are exclusive advanced meteorological satellites designed for enhanced meteorological observations land/ocean applications, weather forecasting and disaster warning. These satellites carry a 6-channel Imager and a 19-channel Sounder. Sounder measures vertical profile of humidity and temperature over Indian landmass and

adjacent Ocean. Imager carries a pair of split-window channels in addition to MWIR channel. The INSAT-3D has helped in improving the cyclone track prediction and intensity estimation. These data have contributed a great deal to nowcasting and short range forecasting which includes severe weather conditions such as heavy rainfall and thunderstorms, besides fog detection and aviation forecasts. The INSAT-3D data is made available to the international scientific community and weather forecasters through MOSDAC web portal of SAC/ISRO.

There is a growing need for improved weather prediction at very short spatial and temporal scale particularly for the high impact weather event such as cyclones, thunderstorm/lightning, cloudburst/ heavy-rainfall, etc. ISRO is initiating plans for future upgradations of instruments for the 4th generation of Indian geostationary satellites with aim of reducing the risk for life and property for the greater benefits to the society. The instrument of prime importance is an Advanced Imager that will provide combined and enhanced application potential of present INSAT-3D/3DR Imager and Sounder instruments with better accuracy and spatio-temporal resolution. This will also fill a big data gap that presently exists over Indian Ocean region, available over other part of the globe through MSG/SEVIRI, Himawari-8/AHI, GOES-R/ABI. Another important instruments being looked into are Lightning Imager (LI) and Hyperspectral Infrared Sounder onboard GEO platform to enhance the temporal resolution of high quality 3-D temperature/humidity/wind structure in the atmosphere, leading to a possible quantum jump in our capability to monitor and predict the extreme weather events.

In this particular session, the ideas by various participating agencies and discussions on the new ways of observations, highly calibrated systems for climate quality data generation and innovative applications will be highly advantageous for all international agencies involved in geo-stationary missions.

In conclusion WGII noted that the situation today over the Indian Ocean region is reasonably good. In addition to Insat-3D/3DR also EUMETSAT with Meteosat-8 and CMA with the intention to place FY2-H at 79 degrees East are providing data services. Hence, noting the improvements in product quality from Insat-3D/3DR and the intention of China to provide Clear Sky Radiances with FY-2H there is reasonable redundancy in terms of data and products.

CGMS-46-ISRO-WP-06

Future perspectives of global scatterometry observations

Ocean wind is the major source of dynamical forcing for oceanic general circulation and for the generation of surface waves. Ocean surface winds play a pivotal role in studies of air-sea interactions, coastal upwelling, bio-geo-chemical transport, estimation of ocean currents and many other processes. The surface wind vector is the primary forcing for numerical ocean state forecast models. Numerical weather prediction (NWP) models also depend significantly on the availability of observations of ocean surface winds.

For the last four decades, ocean surface vector winds are operationally measured by space-borne scatterometers. Such operational winds are being used by operational NWP centres world-wide. The global stack-holders in the field of satellite scatterometers are JPL/NASA, EUMETSAT and ISRO. Most of the operational scatterometers from the European agency mainly operated in C-band with Fan-beam

configuration. Whereas, US-based scatterometers operated in Ku-band with conically scanning Pencil-beam configuration. With the successful launch of Oceansat-2 scatterometer (OSCAT) in 2009, ISRO has started its scatterometer missions. In this series, presently operational Scatsat- 1 scatterometer, launched in 2016 is providing high quality data with Ku-band with Pencil-beam configuration.

With due course of time conventional scatterometers observations have achieved an acceptable level of maturity. Apart from using scatterometer-derived vector winds in operational NWP, those wind are being used to study climate variability also. To improve the retrieved wind quality further, the stake-holders are coming up with novel proposals with improved accuracy as well as other parameters such as for ocean surface currents.

ISRO is also planning for follow-on scatterometer missions on-board Oceansat-3 and Oceansat-3A in coming years. Such follow on missions will cater to the WMO requirement of high temporal wind observations over the global oceans. It will be highly beneficial for all international agencies involved in scatterometry to express their views and have discussions for coordinated efforts towards the innovative ways of observations strategy, calibration, validation and novel applications, in this session.

WGII noted that currently all scatterometer missions are flying with an early or mid-morning Equatorial Crossing Time (ECT). The decision by ISRO to fly Oceantsat-3 and -3a with an ECT of 12:00 was therefore seen as a forward looking excellent decision improving the overall scatterometer coverage. WGII therefore expressed a strong support to the current plans by ISRO.

9. Member agency reports on highlights and issues in dataset and product generation (15 min per agency)

CGMS-46-IMD-WP-01
INSAT-3D/3DR existing and proposed Products

Presently, two geostationary satellites are in operations namely: INSAT-3D and INSAT-3DR. INSAT-3D is an India's advanced weather satellite and was launched in the early hours of July 26, 2013 from Kourou, French Guiana. INSAT-3DR is the similar to INSAT-3D which was launched on 8 September 2016. Both the satellites carry four payloads: Imager (Six Channels), Sounder (Nineteen Channels), Data Relay Transponder (DRT) & Satellite Aided Search and Rescue (SAS & R). INSAT-3DR is being used in staggered mode with INSAT-3D to have effectively 15 minutes temporal resolution. Kalpana–1 was a meteorological satellite, launched in September 2002 and repositioned in 2016 at 73.2° E, was decommissioned in September 2017. Modified scan strategy of INSAT-3D and INSAT-3DR sounder payload has been implemented with effect from 12 August 2017. INDIAN region sector data is now available on hourly basis and Ocean region data is available on one and half hourly basis. Rapid Scan strategy of Imager of INSAT-3DR has been tested in operational chain and SOP has been finalized which can be activated on requirement basis.

IMD generate the different types of spectral band, RGB, BD and NHC curve images at full globe & special sectors level to serve different stake holders for their specific use in aviation, tourism and power sectors. The geophysical products are being generated by both the satellites namely: Aerosol Optical Depth, Cloud

Mask, Fog, Fire, GOES Precipitation Index (GPI),Hydro Estimator, IMSRA (Improved version),Outgoing Longwave Radiation, Smoke, Snow cover, Sea Surface Temperature, Upper Tropospheric Humidity, Wind Vectors (IRW, WVW, VSW, MIR), Wind Derived Products(Convergence, divergence, wind shear & vorticity), Land Surface Temperature, Insolation from Imager, Sounder atmospheric Profiles(Temperature, Water Vapour & Geopotential Height), Total ozone, Total & layer precipitable water vapour, clear sky radiances and various indices from Sounder payload. The satellite data is assimilated in Numerical Weather Prediction Models, the output which further used to issue short range and medium range weather forecast. T-phi grams at district level for 709 locations are being generated by using INSAT-3D sounder data for nowcasting. Generation of Cloud product such as CTT, CTP, Cloud fraction, clear-sky-BT from Imager payload has been started and these products also being assimilated in NWP models. Calibration Coefficients are being updated in processing chain of IMDPS system on monthly basis by using GSICS corrections of last 30 days dynamically carried out by SAC Ahmedabad. INSAT-3D derived Winds (IR/WV/Vis) in BUFR format is also being provided to UKMET Office through GTS. IMD is validating some products of INSAT-3D on regular basis such as OLR, SST, Wind products and rainfall product and improvement has been noticed in the accuracy of products after applying GSICS corrections in operational processing chain.

It was noted that radio-occultation data from ROSA on-board Megha-Tropiques and SCATSAT-1 wind are being disseminated on GTS.

The new proposed products are High Density Visible Cloud Drift Winds, Composite Wind Pattern of 15/30 Days, Merged Wind Products of INSAT-3D &3DR Surface Albedo, Actual Evo-Transpiration (AET), Relative Evo-Transpiration (RET), Biomass Burning Emission Product (BBEP), MIR Reflectance, Himalaya Snow Cover, Net Radiation (Rnet), Cloud Microphysics, Short Wave Radiation Over Ocean from Imager and Cloud Properties (CTH, CTP, CTT, Isentropic Surface Analysis) from Sounder after establishment of Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS) in end of this year.

WGII took note of the paper.

CGMS-46-KMA-WP-03

KMA report on highlights and issues in dataset and products

KMA has been newly assimilated HIMAWARI-8 CSR, MTSAPHIR, AMSR2, LEOGEO, GPSRO (TanDEM-X, TerraSAR-X, GRACE-A) and FY-3C/MWHS-2 data in upgraded global NWP system since October 2017. MTSAPHIR and AMSR2 data enhanced convective activities in middle and lower tropospheric layers over Tropics and they had an effect on increasing the initial specific humidity in DA process. Analysis Increments were mainly modified by MTSAPHIR data. The impacts for global model showed a slightly positive improvement in wind and humidity.

KMA has developed GK-2A AMI meteorological products and application techniques. This is on the final stage of GK-2A pre-launch period. And KMA has expanded the satellite applications of not only meteorological areas such as NWP model data assimilation, nowcasting and climate monitoring but non-meteorological areas such as dust, flood, fire and so on using various satellite data including COMS and the future GK-2A/B.

The on-going works of satellite application for supporting nowcasting with COMS and GK-2A is reported. By combining the convective initiation technology with the rapidly developing thunderstorm detection-tracking-discrimination technology, GK-2A RDT is capable that continuous analysis and monitoring of severe weather over Korea and providing forecast guidance. GK-2A RDT products will provide support for operational real-time forecasting of up to 6 hours on events such as heavy rainfall, snowfall, and preventative measures of environmental disasters.

WGII took note of the paper.

CGMS-46-ROSHYDROMET-WP-03

Meteorological satellite data and products applications in Roshydromet

The presentation from Roshydromet is focused on the operational use of meteorological satellite data. The progress in development of operational products for numerous applications is briefly outlined.

In particular, multi-channel medium and far IR range radiometer onboard Kanopus-V (IR) provides the unique combination of moderate spatial resolution (200 m) and relatively wide swath width (2000 km). Such combination of characteristics is the unique in Russian satellites and allows to obtain the ice cover maps for the seas of the Arctic Ocean.

The other key point of the presentation is devoted to use a Fourier-transform spectrometer IKFS-2 on board LEO satellite Meteor –M #2 for different meteorological and climate applications. The high stability of IKFS-2 radiometric characteristics allowed to develop an algorithm to retrieve of CO_2 column-averaged dry-air mixing ratio from its data. The first version of CO_2 ratio maps were obtained for Central Siberia and the Pacific Ocean in the region of Hawaii.

The RMS error of the maps under clear sky conditions does not exceed 1.5 ppm. The RMS value was estimated by comparisons on independent ground-based measurements in Central Siberia (ZOTTO observatory, Zotino, Krasnoyarsk Krai) and Pacific Ocean (NOAA ESRL observatory, Gavaii) performed in 2017.

WGII commended Roshydromet on the progress made in the last years and particularly on IKFS-2.

CGMS-46-JMA-WP-05

JMA agency report on highlights and issues in dataset and product Generation

The Himawari-8 geostationary satellite was launched on 7 October 2014 and was put operation on 7 July 2015. The Meteorological Satellite Center of the Japan Meteorological Agency (JMA/MSC) updated its ground data processing system on 25 July 2017 and changed the related sensor configuration on 13 February 2018. Level-2 products, including Atmospheric Motion Vectors (AMVs), Clear Sky Radiance (CSR) and High-resolution Cloud Analysis Information (HCAI), are generated and disseminated via GTS (the Global Telecommunication System) and JDDS (the JMA Data Dissemination System). The RSMC Tokyo – Typhoon Center began utilizing low-level AMV data from Himawari-8 to determine sea surface winds around typhoons on 6 July 2017. Basic related imagery is provided on the JMA/MSC website under the framework of the SCOPE-Nowcasting WMO Severe Weather Forecasting Demonstration Project (SWFDP) and the WMO Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP). Since July 2017,

Convective Cloud Information has also been provided on JMA's dedicated website for SIGMET coordination groups. From 7 to 9 November 2017, JMA hosted the RGB Experts and Developers Workshop 2017 in Tokyo, Japan, in collaboration with WMO and EUMETSAT. The workshop sessions highlighted a variety of existing applications and RGB concepts enabled by Himawari-8 imager data and generated active discussions among attendees. JMA/MSC collaborates with the Australian Bureau of Meteorology (BOM) on research regarding RGB color composite combinations optimized for RA-II and RA-V.

WGII took note of the paper.

CGMS-46-JAXA-WP-02 JAXA

Earth Observation Programme and Data Products

Purpose of this report is to update the current status of JAXA's satellite systems now in operation and to be launched in the near future. Mainly focused on the remote sensing satellites which is and be able to contribute to the climate issues, especially for precipitation measurement. GCOM-C was successfully launched and SGLI products will be released at the end of this year via G-Portal. GCOM-W and GPM achieved designed mission life in May 2017, and transferred to Extended Mission period. GOSAT-2 will be launched in 2018, and EarthCARE will be launched around 2020.

As for precipitation measurement, 3-D observation of the GPM/DPR enables us to analyse precipitation not only over tropics but also mid latitudes. Better continuity between TRMM/PR and GPM/DPR was realized.

We would like to promote the operational use of the DPR in the numerical weather prediction system of meteorological agencies. In terms of GSMaP, its applications are ongoing, such as climate extremes monitoring.

WGII took note of the paper.

CGMS-46-CMA-WP-04

CMA Report on Highlights and Issues in Dataset and Product Generation

At present, CMA has nine meteorological satellites in orbit, 6 in operation, 1 in testing and 2 to be decommissioned. The post launch test for FY-4A was finished on 31 December 2017, and it has been put into operation since May.1, 2018. FY-3D was Successfully Launched on 15 November 2017, and commission test started from December 2017. FY-2H will be launched in June 2018. It mainly provides operational service over the Indian Ocean. Meanwhile, CMA also responsible for the operation of two joint satellite: TANSAT and GF-4. TANSAT data has been released to international users formally.

FY-4A can provide cloud, atmosphere, surface, environment, radiation, lighting, and space weather products. Currently, the cross-comparison and validation of FY-4A products have been finished. Some operational products can be downloaded from NSMC home page. A web-based application tool has been developed. Depend on that tool, Users can browse FY-4A satellite data in near real time.

In orbit testing of FY-3D began on 12 December 2017. Currently the first testing has been finished. Preliminary results show that the satellite platform and main payloads function well, and meet the

requirements. FY-3D quantitative products also in testing and validation. According to the schedule, FY-3D will be handed over for trial operation in July, 2018.

WGII noted that the user community is eager to see data from FY-3D and is looking forward to seeing data and products becoming operational during the summer.

CGMS-46-NOAA-WP-14

NOAA agency report on highlights and issues in dataset and product generation

The NOAA paper provided a detailed overview the status of the JPSS and GOES-R cal/val programmes. The schedule of the maturity declaration of both level 1 and level 2 products were presented, as well as examples of applications. The cal/val programme for JPSS includes reprocessing. Detail information on the JPSS and GOES-R Programme, algorithms, data distribution, validation, near real-time visualizations and user readiness can be found at http://www.jpss.noaa.gov/, https://www.star.nesdis.noaa.gov/jpss/, https://www.goes-r.gov/ and https://www.star.nesdis.noaa.gov/goesr/.

WGII took note of the paper.

CGMS-46-NASA-WP-02

NASA Report on Highlights and Issues in Dataset and Product Generation

With its current fleet of 21 operating missions and a vigorous programme 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, NASA provides significant knowledge about the Earth's global environment. This knowledge extends both to quantitative knowledge of Earth system parameters (many of which are not well documented through previous space-based measurement programmes), 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 relevant to CGMS), major reprocessing of previously-released data sets, data products from NASA satellite missions (including selected highlights from recently-launched missions), and advances in data assimilation and modelling.

WGII took note of the paper.

CGMS-46-EUMETSAT-WP-15

EUMETSAT agency report on highlights and issues in datasets and product generation

EUMETSAT gave an overview of its current and future missions, highlighting the April 2018 launch of the Copernicus Sentinel-3b satellite and the upcoming September 2018 launch of the METOP-C. In addition, examples from current products development activities at EUMETSAT, including from selected Satellite Application Facilities (SAF) and from reprocessing and climate activities, were presented.

WGII took note of the paper.

10. Working papers responding to or raising CGMS actions [10 min max per WP]

CGMS-46-CGMS-WP-24
CGMS baseline
Working Group III presented the updates to the CGMS Baseline and Contingency Plans to Working Group II. Since CGMS-45, working group III held multiple intersessional meetings to develop draft documents and later held a workshop hosted by WMO. This workshop had representatives from CMA, EUMETSAT, KMA, JMA, JAXA, NOAA, WMO, and the CGMS Secretariat. The documents presented to CGMS are the result of the comments and discussion from the workshop.

The CGMS Baseline enumerates the observations, measurements, and services that form the CGMS contribution to the space-based Global Observing System. The Baseline constitutes the CGMS response to the WIGOS Vision and documents what missions are currently being or planned to be flown. The Baseline is organized by sensor type, but also includes information on the orbit and observation/measurement.

With this new approach to the CGMS Baseline, there will now be two analyses done. First, a gap analysis between the WIGOS 2040 Vision and the CGMS Baseline that will describe the progress of implementation of the WIGOS Vision. The second will be a risk assessment between the CGMS Baseline and current contribution that will describe how well CGMS is meeting its commitments.

To help ensure continuity of the CGMS Baseline, the CGMS Contingency Plan provides guidance and processes for identifying, mitigating and coping with gaps to the CGMS Baseline. It does this in three ways. First, it provides guidance to members to ensure continuity of its missions through internal actions. Second, it provides guidance to CGMS Members to coordinate bilaterally or tri-laterally to ensure continuity through back-up arrangements and other methods. Finally, it provides a CGMS level process to conduct a risk assessment and respond to gaps. Working Group III requested a point of contact from Working Group II to participate in the risk assessment discussions.

WGII took note of the presentation. Subsequently some additional inputs to the baseline were provided offline.

CGMS-46-GUEST-WP-02
GOFC-GOLD presentation
The Global Observation of Forest Cover – Global Observation of Land Cover Dynamics (GOFC – GOLD) was set up as a panel of the Global Terrestrial Observing System (GTOS), and has as its overall objective is to improve the quality and availability of observations of forests and land cover at regional and global scales and to produce useful, timely and validated information products from these data for a wide variety of users. Landscape fire is the greatest terrestrial disturbance agent worldwide, and the Fire Implementation Team of GOFC-GOLD acts as an international forum for ensuring the provision of long-term, systematic satellite observations necessary for the production of the full suite of landscape fire products. The team works with the GOFC-GOLD Regional Networks to bring together space agencies, satellite fire product developers and data users to exchange information on capabilities and needs. The networks allow for

lateral exchange of information and provide a means for strengthening regional and in particular national related fire activities.

The presentation focused on active fire products, which are based on the detection of thermal radiation emitted from fires as they are burning, and in the case of fire radiative power (FRP) quantification on the use of these observations to estimate characteristics such as the rate of fuel consumption and smoke emission to the atmosphere. Landscape fire is characterized by a typically very strong diurnal cycle that means that sampling time affects the information content of active fire products very significantly. Thus, whilst polar orbiting systems show advantages for burned area mapping due to their higher spatial resolution data, the near continuous observations made from geostationary systems demonstrate some clear and unique benefits for the delivery of active fire detection and fire radiative power products. The current suite of geostationary meteorological satellites have imaging characteristics well suited to the delivery of these products, with spectral channels in the midwave and longwave infrared (3-5 μm, 8-14μm), relatively higher spatial resolution than prior geostationary systems (2 – 3 km sampling distance at the sub-satellite point), and sometimes an extended dynamic range in the MWIR band that helps prevent sensor saturation over larger or more strongly radiating fires. Certain data characteristics of the level 1b data can still be sub-optimal for the AF application however. Nevertheless, active fires covering only 10-4 of a pixel can be identified with advanced AF detection algorithms, though this still means fires with an FRP below ~ 40 MW are generally undercounted by geostationary systems (c.f. MODIS which has a minimum FRP detection limit of ~ 8 MW), but this depending on the application this disadvantage maybe outweighed by their near continuous data coverage. Furthermore, Meteosat Third Generation will offer the same minimum FRP detection limit over Europe as MODIS, demonstrating the significant advancements still being made. There are a variety of AF products being generated from geostationary systems, many of which are produced routinely and some of which meet operational requirements (e.g. those from the EUMETSAT LSA SAF). Product inter-comparisons are conducted, and polar orbiting AF datasets often used as an independent evaluation tool. With regards to the FRP application, one significant issue is the value of the conversion factors used to estimate smoke emission (or fuel consumption) from this metric, since those derived in small-scale experiments may not be fully applicable at landscape-scales and when applied to FRP data collected from space borne systems. New work directly linking satellite observations of smoke plume aerosols to geostationary-derived temporally integrated FRP observations of the causal fires are showing promise for more directly specifying coefficients suitable for use with satellite FRP data. Applying these coefficients to geostationary FRP data provides a means to estimate e.g. aerosol emissions, at a far higher temporal resolution (e.g. sub-hourly) and with more spatial detail (geostationary pixel resolution) than is possible with other fire emission estimation methods currently. GOFC-GOLD has the development of a geostationary fire network as one of its Fire IT goals and is working towards that aim via exploitation of the new generation of geostationary imaging systems. Operationalisation of the resulting data products would be an important step in their use in time-sensitive decision making (e.g. by land managers, those working on hazard prevention, and those working in local to regional air quality forecasting).

WGII discussed the GOFC-GOLD activities in detail. Particularly it was noted that a strong focus on R2O is present and that there would be benefits for CGMS member to strengthen their participation in the activities. WGII therefore place the following action:

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
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)	By 31 August 2018	**OPEN**

CGMS-46-GUEST-WP-01

AEROSAT presentation

The AEROSAT organization aims to make satellite aerosol data as useful as possible, especially to climate and air quality modellers. As such, we meet annually in conjunction with the AeroCom group of aerosol modellers, allowing for many joint sessions during which ideas are exchanged between the two communities. Top priorities for AEROSAT include satellite aerosol retrieval optical depth (AOD) and aerosol-type product inter-comparisons, developing long-term climate data records and associated documentation, improving pixel-level uncertainty estimates, and exploring ways to apply the satellite data products as validation and/or constraints on climate and air quality models. A number of projects introduced by AEROSAT members address parts of these goals. All work of the AEROSAT group leverages efforts supported by outside agencies.

This presentation also summarized the aerosol products generated by the geostationary GOES-R Advanced Baseline Imager (ABI) and the Meteosat Second Generation SEVIRI instruments, and the DSCOVR spacecraft's EPIC camera at the L1 point, 1 million miles above Earth. The ABI algorithm, led by S. Kondragunta at NOAA, is an adaptation of the MODIS Dark Target aerosol retrieval algorithm. With 1-2 km spatial resolution over much of the western hemisphere landmass, the GOES-R product offers mid-visible AOD at between 0.02 and ~ 0.1 compared to coincident AERONET sun photometer observations. The SEVIRI algorithm, led by Y. Govaerts at ESA, uses an optimal estimation method, and provides AOD at ~ 3km near the sub-spacecraft region, and ~5 km over central Europe. Mid-visible AOD validation against AERONET shows agreement over land for AOD $\leq$ 0.8, and systematic underestimation for higher AOD, as is common for remote-sensing aerosol retrievals. (Mean global AOD is about 0.14.) The DSCOVR EPIC algorithm, led by A. Lyapustin, is based on the MODIS MAIAC algorithm that aggregates data acquired at multiple angles to separate surface from atmosphere. Pixel size is ~12 km near-nadir. O. Torres has developed UV Aerosol Index and estimated AOD retrievals for EPIC, based on the TOMS and OMI algorithms that show good, qualitative agreement with the OMI products, and better coverage. Torres also derives aerosol layer height from the EPIC oxygen A and B band data.

WGII discussed the AEROSAT activities in detail. It was noted that there is a strong research focus on the activities, however many of them are directly relevant to what is intended to be achieved under the Non-Meteorological Applications initiative. WGII therefore concluded that a stronger participation of CGMS in

the activities would be beneficial and in particular bringing in aspects relevant for operations would ensure a strong contribution of AEROSAT to the CGMS members' aerosol activities. WGII therefore place the following action:

Action: CGMS members to provide points of contact for AEROSAT to the CGMS Secretariat (Ref. CGMS-46-GUEST-WP-01)

CGMS-46 actions - WGII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
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)	By 31 August 2018	**OPEN**

CGMS-46-EUMETSAT-WP-14

Passive microwave measurement

EUMETSAT introduced the session on passive microwave observations in order to prepare the WGII members for the discussion at plenary. There is a potential risk for loss of capabilities due to the discontinuation of the DMSP SSMI/S mission and uncertainty about the realisation and schedule for a continuation of the AMSR-mission currently flying on GCOM-W. The following points have been raised in the past:

- CEOS SST-VC identified risk in loss of low frequency PMW imager measurement capabilities in 2017 (& CEOS SIT in 4/2018)
- 2017-2018 Nature article and EGU blog with special focus on impact on SST and ice extent
- December 2017: ECMWF/ESA workshop on using low frequency passive microwave measurements in research and operational applications
- December 2017: Dedicated AGU cryosphere session on the topic (with participation of operational space agencies)
- CEOS/CGMS WGClimate raised the concern at their last WG meeting (coordinated action plan, Action 19)

A potential gap in low-frequency observations provided with high enough resolution would have a negative impact on NWP, SST, ice extent, snow water equivalent, precipitation, as well as continuity of measurements and sustaining climate records amongst other.

11. Space weather matters: SWTT interactions with WGII

A short summary of activities of the SWTT was given verbally. It was highlighted that the SWTT will presented Terms of Reference for a Space Weather Coordination Group (SWCG) to CGMS plenary. In that context it was also noted that there will be a formalisation of the point of contacts between SWCG and the CGMS Working Groups. In anticipation of an endorsement by plenary Tsutomu Nagatsuma from the current SWTT attended the WGII discussions.

The recent progress on applying GSICS approaches to intercalibration of space weather instruments on-board geostationary satellites was highlighted, between Himawari-8/SEDA and GOES 15 particle detectors as also noted in the presentation by GSICS.

12. Review and updating of the HLPP

CGMS-46-CGMS-WP-12
Status of implementation of CGMS High Level Priority Plan (2017-2021)
The WG reviewed the items of the HLPP related to its work and provided progress updates on the following items:

- 3.2.2 – Assimilation of high resolution winds
- 3.2.3 – Development of ash products
- 3.2.6 – Data utilisation, products generation and
- 3.5.1 – Sustained interaction with Nowcasting communities
- 3.6.1 – Support for line-by-line reference model development
- 3.6.2 – Validation and inter-comparison of LBL models/spectroscopy
- 3.7.1 – Trade off studies for infrared sounders

Updated HLPP will be captured in CGMS-46-CGMS-WP-11.

13. Nomination and representatives at meetings

CGMS-46-CGMS-WP-21
CGMS nominations and representatives
No updates to the nominations were noted at the meeting.

14. Any other business

No additional items were addressed.

15. Date/time of inter-sessional activities/meetings in 2018-2019 [CGMS-46 -> CGMS-47]

The following two dates were agreed:

- 15 November 2018
- 14 March 2019

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

The summary list of WGII actions and recommendations raised following the WGII deliberations at CGMS-46 is provided in annex V of this report.

WG III REPORT

Chair: Ajay Mehta (NOAA)
Rapporteur: Lars Peter Riishojgaard (WMO)

1. Objectives

The Chair welcomed the participants to the meeting and reminded them of the main objectives of Working Group III, per the Terms of Reference as approved by CGMS-45. The main objectives identified for this meeting were:

1. Review CGMS contribution against the Baseline, including WMO Gap analysis
2. Finalise CGMS Baseline and Contingency Plan to be sent to plenary for endorsement
3. Review Implementation of Indian Ocean Data Coverage

2. Review of actions and recommendations from previous meetings

The summary list of WGIII actions and recommendations following CGMS-46 discussions is provided in annex VI of this report.

3. Status of Implementation of CGMS Baseline

3.1 WMO gap analysis

CGMS-46-WMO-WP-14
Risk Assessment and Gap Analysis
The WMO gap analysis is based on the OSCAR/Space database. The Paper were reviewed for updating information from CGMS-5 WMO-WP-11 with possible recommendations. The detailed analysis of the eight open issues are reported and WG-III members were invited to review and update the status of the identified critical items.

1	Geostationary infrared sounding	It is recommended that ISRO, JMA, KMA and NOAA implement hyperspectral sounding on the next generations of INSAT, Himawari, GEO-KOMPSAT and GOES satellites.
2	Radio-occultation	It is recommended that NOAA and allied agencies attempt to recover the plan for the COSMIC-2b constellation.
3	Altimetry	It is recommended that CNES, NASA and JAXA bring to completion their development of large-swath altimeters.
4	Active ocean surface wind	It is recommended that ISRO and RosHydroMet consider the issue of long-term continuity of radar scatterometers in the afternoon orbits.
5	Earth Radiation Budget	It is recommended that the agencies that are about to start defining the mission for their next-generation GEO satellites (ISRO, JMA and NOAA) give consideration to an ERB instrument.
6	Limb sounding	It is recommended that R&D agencies with a strong heritage in atmospheric chemitry missions (e.g., ESA with ENVISAT, NASA with Aura) give consideration to a limb sounding mission in IR and Mm-submm.
7	Passive microwave imaging	It is recommended that • CMA/CNSA and NASA report on progress with development of MW sounders in GEO. • NASA/DoD report on progress with development of MIS to provide large-antenna measurements in the early morning. • CMA confirms the FY-3RM programme and its long-term continuation. • ESA and NASA give consideration to follow-on missions for L-band radiometry for sea-surface salinity and volumetric soil moisture.
8	Spectral gaps on future hyperspectral sounders	It is recommended that: • WMO and GSICS to continue the interaction on the subject of spectral gaps. • GSICS to continue reporting on the instruments used for intercalibration exercises.

Action proposed:
WMO to undertake new Gap Analysis against the Tier I satellite WIGOS components as described in the "Vision for WIGOS in 2040", to be submitted in CGMS-47.

The Working Group anticipated that CGMS at that point should be expected to formulate a response to the WMO Gap Analysis. It was suggested that this could be presented either in the context of the HLPP update or as a self-standing document. A decision was made to fold this response into the HLPP update, at least in the short term.

A discussion ensued regarding the CGMS Baseline and what the proper number of GNSSRO soundings cited in this document should be. In order to stay consistent with the overall philosophy behind the Baseline, it was decided to stay with the number of occultations that are expected to be provided by the current satellites plus those that will be flying in the future based on current commitments of the CGMS Members. The current estimate thus stands at 6,000 occultations per day.

Scatterometers in the afternoon orbit. ISRO is planning for Oceansat-3 in 2019 in a noon orbit.

Gap in radiation balance measurements is unclear – needs to be coordinated with WGII and with the CEOS-CGMS WG on climate.

CGMS-46-ITWG-WP-01
The ITWG's ITSC-21 Report
The 21st International TOVS Study Conference was hosted by EUMETSAT in Darmstadt in Nov-Dec 2017. **CGMS-46-ITSC-WP-01** presented the recommendations from ITSC-21 related to the remit of WGIII. ITSC-21 had made the following recommendations related to the CGMS baseline and contingency planning:

1. To CGMS and other satellite agencies: The constellation of at least three polar orbits (early morning, morning, and afternoon), each with full sounding capabilities (IR and MW), should be maintained. The overpass times of operational satellites with sounding capability (IR and MW) should be coordinated between agencies to maximize their value.

2. To CGMS and other satellite agencies: Noting the growing evidence of likely benefits from hyperspectral geostationary soundings, ITWG recommends where possible to work towards the provision of such instruments in plans for future geostationary systems.

3. To CGMS, other satellite agencies, and users: ITWG recognises the opportunities arising from the provision of sounder data from small satellites as supplements to the global observing system, particularly for better temporal sampling. ITWG recommends the evaluation of such missions by appropriate agencies, including already planned missions (e.g., TROPICS).

4. To CGMS and other satellite agencies: Instrumentation to allow continued sounding of the temperature of the upper stratosphere and mesosphere (as for the SSMIS UAS channels) should be explored, in support of maintaining a robust global satellite observing system.

5. To CGMS and other satellite agencies: ITWG recommends to develop, test, and implement an SI-traceable radiometric standard in space as soon as feasible.

6. To satellite agencies: Consider implementing high spatial resolution and contiguous sampling detector arrays in future hyperspectral infrared sounding instruments.

3.2 IODC roadmap implementation

CGMS-46-EUMETSAT-WP-10
IODC roadmap implementation
The status of the implementation of the CGMS Indian Ocean Data Coverage Roadmap agreed at CGMS-43 was presented. The paper also included a list of the current satellites in orbit and future planned satellites in orbit for the Indian Ocean region.

The Indian Ocean Data Coverage (IODC) mission is a best effort undertaking, which reflects a decision of the EUMETSAT Council to use a residual Meteosat First Generation capacity for this purpose, in the context of a temporary data gap over the Indian Ocean. Meteosat-7, the last satellite of the Meteosat First Generation, reached its End-of-Life in March 2017 and was re-orbited in April 2017, thereby ending the EUMETSAT IODC mission. CGMS endorsed the CGMS IODC roadmap and timeline with associated

actions (as described in **CGMS-43 EUM-WP-14**) that aimed at establishing resilient multi-partners IODC services in the region, which fulfilling the baseline requirements agreed at CGMS-42. The paper recalls the agreed IODC service requirements and presents an updated status of current and future satellites in the region, and also the implementation of services to users. The status of the agreed actions and associated timeline in presented.

The current satellites covering the IOCD region are:

Satellite	Longitude	Operator	Launch date	Projected EOL
Meteosat-8*	41.5°E	EUMETSAT	28/08/2002	2019 ~ 2020
Elektro-L N2	76.1°E	Roshydromet	11/12/2015	≥ 2022
Kalpana-1	74°E	ISRO	12/08/2002	≥ 2018
INSAT-3A	93.5°E	ISRO	04/10/2003	≥ 2016
INSAT-3D	82°E	ISRO	25/07/2013	≥ 2021
INSAT-3DR	74°E	ISRO	08/09/2016	≥ 2024
FY-2E	86.5°E	CMA	23/12/2008	≥ 2018
FY-2F	99.5°E	CMA	31/12/2014	≥ 2018
FY-4A	104.7°E	CMA	10/12/2016	≥ 2021

Future Satellites:

Satellite	Longitude	Operator	Launch date	Projected EOL
INSAT-3DS (Spare)	74°E	ISRO	≥ 2022	≥ 2029
GISAT	85.5°E*	ISRO	≥ 2019	≥ 2026
FY-2H	79°E	CMA	2018	≥ 2022
FY-4B	105°E	CMA	≥ 2018	≥ 2025
FY-4C	86.5°E	CMA	≥ 2020	≥ 2022

CGMS-46-CMA-WP-08

Updates of CMA Indian Ocean Data Coverage service

CMA reported on the updates of its IODC service. In response to CGMS actions to ensure continuity of geostationary coverage and data access over the Indian Ocean the FY-2H satellite will be launched on Jun 52018, and will provide operational observation service starting from Q4, 2018, located over 79°E; it is planned to provide service until 2025.

CMA intends to provide access to the L1 data, as well as AMV and CSR products; the users will be able to access the products via the D/B service, CMACAST, or GTS. CMA implements an open data policy towards WMO members.

CMA requested Radiative Transfer Model (RTM) support for FY-2E/H in order for NWP user community to benefit from these data. The Working Group endorsed this request.

CGMS-46 recommendations - WGIII			
Lead	**AGN item**	**Rec #**	**Description**
CGMSSEC (NWP SAF)	WGIII/ 3	R46.01	CGMSSEC to enquire with EUMETSAT NWP SAF Radiative Transfer Model (RTM) support for FY-2E/H Indian Ocean coverage.

4. Operational agencies - future planning

4.1 Early morning orbit (CMA, KMA)

No formal update regarding future Early Morning (EM) activities provided by CMA at this time. It was implied that future commitment to EM orbit depends on impact from FY-3E. Hence: Science question to 7th WMO Impact Workshop: Early assessment of impact of FY-3E data is critical to securing the commitment to future maintenance of the EM orbit.

CGMS-46 actions - WGIII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO	WGIII/ 4.1	A46.01	7th WMO Impact Workshop to include EM orbit impact among its science questions	CGMS-47	**OPEN**

4.2 Contributions from other operators

CGMS-46-NOAA-WP-26
Importance and Use of GCOM - W Data Products
This paper demonstrated the importance of GCOM-W1 AMSR2 data and applications to NOAA and its US agency partners. AMSR2 data acquisition is part of the JPSS level 1 requirements, which translates to the implementation of data being received at Svalbard, transmitted to NOAA operations for product generation and distribution to NOAA users through a partner agreement with JAXA. AMSR2 products are used for the following critical applications areas:

- Tropical Cyclones - Helps accurately determine storm center location, structure, and track intensity - critical to accurate predictions to protect life and property;
- Heavy rain - High spatial resolution precipitation products important for predicting heavy rainfall events, floods, etc. – provides much improvement over soundings for very difficult to predict parameters;
- Sea ice – Sees through clouds to distinguish sea ice from ocean, available day and night in often data sparse regions (e.g., Arctic) – critical for navigation along with SAR and visible imagery;
- Marine wind forecasts – surface wind information where in situ data is sparse (e.g., over oceans);
- Global soil moisture information for numerical weather models;
- Sea surface temperature products – Provides ocean surface information through clouds, Important since the average cloud cover over oceans is 69%, and even more in eastern Pacific.

GCOM-W1 is part of the global observing system of microwave conical imagers. For all typical microwave imager parameters (e.g. total integrated water vapour, precipitation rate and type, and sea ice) the constellation is healthy. Of course, real-time access and data accuracy must also be accounted for. With respect to SST the observing system is very unhealthy and vulnerable. SST is a critical parameter for weather and climate models, and GCOM-W1 is the only available source. It is highly desirable for JAXA to make a commitment for the continuity of a robust GCOM-W series to achieve a high probability availability of all-sky microwave SST global data from the early afternoon orbit. It is also critical to have at least one additional orbit with such capabilities to obtain a robust constellation of all-sky microwave SST; ideally in the mid-morning orbit since there is already a mature constellation of other satellite derived essential variables from that orbit.

CGMS-46 actions - WGIII						
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**	**HLPP ref**
WGIII	WGIII/ 4.2	A46.02	WGIII to consider how to account for the unique SST conical microwave imager in the CGMS Baseline and Risk Assessment	CGMS-47	**OPEN**	

CGMS-46-ISRO-WP-03
ISRO report on the Status of Current and Future Satellites
Update on Indian operational and planned satellite constellation.

SUMMARY of WP requested

Commented [AT16]: ISRO/Raj Kumar is invited to provide a summary of the WP and in particular related to wide-swath altimetry, … etc for the discussions to be properly reflected.

CGMS-46-IMD-WP-02
Multi-Mission Meteorological Data Reception and Processing System
IMD is in the process of implementing a Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS). The system will be used to receive, process and dissemination of 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 in the order of 1PB which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy.

5. Integration of R&D missions research to operations transition

5.1 NASA (Decadal Survey and CYGNSS)

There were no new updates on the occasion of CGMS-46.

5.2 IROWG (Radio occultation missions)

There were no new updates on the occasion of CGMS-46.

5.3 Other contributions

CGMS-46-ROSCOSMOS-WP-01

Development of the conception of deployment of the single hydrometeorological and geophysical Russian orbital constellation

To solve the problems of predicting the changes in the geophysical media (atmosphere, ocean, ionosphere, magnetosphere etc.), it is necessary to have measuring instruments to determine quantitative data of geophysical phenomena and processes that can be obtained through regular observations involving space resources. It's necessary to create a single geophysical and hydrometeorological observing system. The Russian geophysical and hydrometeorological observing system should include six constellations of spacecraft: RO (radio occultation), LEO (hydrometeorological and ocenografic), GEO (geostationary), HEO ("Molnya" type orbit, magnetospheric), ionospheric and extramagnetospheric (L1 and L5 points).

The working paper provided the basic constellation which consists of proposed GEO, LEO, HEO and RO satellites.

Elektro-L-N3 will be launched mid-2019 and positioned tentatively at 76°East, with Elektro-L–N2 to be relocated to 165.8°East.

6. SWTT interactions with WGIII

At CGMS-45, the Space Weather Task Team (SWTT) held a discussion on space weather measurements that could be proposed for the CGMS baseline and drafted an initial set. These SWTT inputs to the baseline were further refined during an intersessional meeting held on 14 Sep 2017. The SWTT submitted the proposed inputs to WG-III and a joint intersessional between WG-III and SWTT was held on 27 Sep 2017 to discuss the proposed new baseline. A follow-on SWTT intersessional was held on 12 Oct 2017 to finalize the SWTT inputs based on the discussions from the joint intersessional.

7. Review of the CGMS baseline and the CGMS contingency plan updates

CGMS-46-CGMS-WP-26

Report of CGMS WGIII Workshop on Baseline and Contingency Planning

CGMS-45 had noted that updates to the CGMS Baseline and to the CGMS Global Contingency Plan were needed, as several years had elapsed since the current versions were adopted. At CGMS-45 WMO had taken the action to coordinate this task with WG-III, with a view to presenting the results for endorsement at CGMS-46. WG-III convened a face to face Workshop hosted by WMO in Geneva on April 30-May 2, 2018 to update the CGMS Baseline and Contingency Plan. The Workshop was attended by WG-III representatives from CMA, EUMETSAT, KMA, JMA, JAXA, NOAA, WMO and the CGMS Secretariat. The deliberations of the Workshop resulted in new CGMS Baseline and Contingency Plans, submitted here as CGMS-WP-04 and CGMS-WP-20, respectively.

The CGMS Baseline constitutes the CGMS response to the WIGOS 2040 Vision to document what missions are currently being, or planned on being flown. The CGMS baseline will be included in the WMO Manual on WIGOS. WMO will be conducting a regularly recurring Gap Analysis between the Tier I satellite systems outlined in the WIGOS 2040 Vision and CGMS Baseline to review implementation of WIGOS. CGMS will conduct an annual Risk Assessment against the baseline to ensure CGMS is meeting its commitments. The CGMS Baseline will be revised every four year 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 issue of how to institutionalize the Risk Assessment was discussed. It was decided that it should rely on OSCAR/Space as the reference source of information on the status of the implementation of the CGMS baseline. It was further decided that the risk assessment should done be via a dedicated Workshop for the first year, with the intention of subsequently folding it into the regular WG-III and CGMS Plenary agendas.

CGMS-46 WGIII recommendation to CGMS-46 plenary
WGIII raised the following recommendation to plenary:
Hold a CGMS Risk Assessment Workshop prior to CGMS-47 with the dual purpose to (i) Provide the initial risk assessment of the CGMS Baseline, and (ii) Propose a way forward on how to incorporate an annual risk assessment in the regular work programme of CGMS, including agenda of WG-III. Solicit volunteer agency to host Workshop. (See CGMS-46 plenary action A46.05)

7.1 CGMS baseline review

CGMS-46-CGMS-WP-27
CGMS Baseline review
Working Group III addressed the draft CGMS Baseline line-by-line with a goal of having a consensus document at the end of the meeting. All comments were incorporated into the final document presented at plenary (CGMS-WP-20).

7.2 CGMS contingency plan review

CGMS-46-CGMS-WP-28
CGMS Contingency Plan Working Group III addressed the draft Contingency Plan line-by-line with a goal of having a consensus document at the end of the meeting. All comments were incorporated into the final document presented at plenary (CGMS-WP-04).

7.3 Maintenance of the WMO OSCAR space database

CGMS-46-WMO-WP-02
WMO OSCAR Space Database Maintenance Scheme
WMO proposed a new scheme in CGMS-45 for strengthening the cooperation with CGMS members to support the WMO effort to maintain and update OSCAR/Space database contents through newly

established support groups, the OSCAR/Space Support Team (O/SST) and the OSCAR/Space Science and Technical Advisory team (O/SSAT), and the initial list of members for O/SST and O/SSAT were provided by CGMS Secretariat. This scheme will lay the foundation of cooperation with CGMS for sustaining the OSCAR/Space updating process through provision of information on their satellite programmes by making use of the provided templates.

The current O/SST list of experts are:

CMA: lufeng@cma.gov.cn
CNES: TBD
CNSA: TBD
CSA: TBD
ESA: ivan.petiteville@esa.int
EUM: TBD
IMD: ashimmitra@GMAIL.COM, sunil.peshin@gmail.com
ISRO: jvthomas@isro.gov.in
JAXA: oki.riko@jaxa.jp
JMA: r_yoshida@met.kishou.go.jp
KMA: dohyeong@gmail.com
NASA: charles.webb@nasa.gov
NOAA: Matthew.Butler@noaa.gov
ROSC: avkarelin@tsniimash.ru
ROSH: uspenskys@planet.iitpp.ru

CNES, CNSA, CSA and EUMETSAT are requested to provide their focal points of contact (see plenary action CGMS-46 A46.02).

CGMS-46 actions - WGIII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS members	WGIII /7.3 (plen C.2)	A46.03	**On OSCAR space (CGMS-46-WMO-WP-02):** Nominated OSCAR/Space Support Team (O/SST) pocs (ref. CGMS-46 A46.02) to review and provide updates to the Oscar landing pages relevant to their respective agencies to tkurino@wmo.int and wbalogh@wmo.int copy to cgmssec@eumetsat.int	25 Sep 2018	**OPEN**

CGMS-46 recommendations - WGIII			
Lead	**AGN item**	**Rec #**	**Description**
CGMS Members	WGIII/ 7.3	R46.02	CGMS Members recommended to utilise OSCAR/Space database as a reference common tool for gap analysis and risk assessment.

CGMS-46 actions - WGIII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMSSEC, WMO	WGIII/ 7.3 (plen C.2)	A46.04	**On OSCAR space (CGMS-46-WMO-WP-02):** CGMSSEC to investigate the provision of a dedicated resource to support the CGMS risk assessment and coordinate the provision of OSCAR/Space content.	end 2018	**OPEN**

8. Update on Socio-Economic Benefits Tiger Team (SETT)

CGMS-46-NOAA-WP-15

Socio-Economic Benefits Tiger Team Update

SETT Chair reported on the Team's achievements. These included: Continued literature review and identification of relevant socio-economic expertise; development of Guidance Document: Valuing Meteorological Satellite Programme: Guidelines for Socioeconomic Benefit Studies; conducting four workshops. Upcoming activities planned are to: complete pilot socioeconomic benefits study; hold workshop on study findings; develop Guidance Document v.2 incorporating results of pilot study; and monitoring activities of members and related organizations. Despite the delay in initiating the economics part of the pilot study, SETT members have reconfirmed their interest in moving forward with it as soon as possible.

9. Review and updating of the HLPP

The overall updates to the HLPP are discussed elsewhere in the Report from CGMS-46.

Specific input from WGIII were the following two recommendations:

Commented [AT17]: I understand i) was incorporated in the revised HLPP directly whereas ii) should possibly be an action on WMO – please modify/introduce text as necessary.

(i) It was recommended that separate NWP impact studies be undertaken regarding the impact of sounder (MW and IR) data from an early morning orbit satellite and regarding the sensitivity of the impact of satellite data to various levels of data latency, and that these two issues be included as Science Questions in the preparations for the 7th WMO Impact Workshop in 2020.

It was agreed to incorporate this in the revision of the HLPP.

(ii) In order to be consistent with the Baseline and to facilitate a proper gap analysis, the GPSRO element of the "Vision for WIGOS 2040" should be sharpened to include more precise language about what the Tier 1 constellation will include and/or will provide.

CGMS-46 actions - WGIII					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
	WGIII/ 9	A46.??			**OPEN**

10. Nomination and representatives at meetings

There were no nominations.

11. Any other business

No other business was discussed.

12. Date/time of inter-sessional activities/meetings in 2018-2019 [CGMS-46 -> CGMS-47]

Deferred (to be done via email/doodle at a later stage). There was agreement that one face to face meeting on gap analysis and two to three virtual meetings would be needed. Suggested dates are:

- Intersessional #1: October 24 at 12 UTC
- Intersessional #2: January 23 at 12 UTC
- Intersessional #3: ~March for Risk Assessment Workshop
- Intersessional #4: April 10 at 12 UTC

Commented [AT18]: These need to be confirmed ASAP! Please fix before we publish the report. Thanks.

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

The summary list of WGIII actions and recommendations following CGMS-46 discussions is included in annex VI of this report.

WG IV REPORT

Co-chairs: Hiroshi Kunimatsu (JMA), Vasily Asmus (ROSHYDROMET)
Rapporteur: Klaus Peter Renner (EUMETSAT)

1. Welcome and review of agenda with objectives for 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 IX).

In view of the actions agreed at CGMS-45 in relation to Space Weather, the representatives of the related Task Team also participated in the meeting under the dedicated agenda item 12.

WGIV reviewed the draft agenda proposed by the CGMS Secretariat prior to the meeting and added as agenda item 14 a discussion of the new objectives from the updated WGIV Terms of Reference.

2. Review of actions and recommendations from previous meetings

The summary list of WGIV actions and recommendations following CGMS-46 discussions is provided in annex VII of this report.

3. WGIV key issues

3.1 IODC data dissemination plan (CMA, EUM, ISRO, ROSH)

CGMS-46-EUMETSAT-WP-08
Update of EUMETSAT Contribution to the IODC Dissemination Plan
EUMETSAT presented the latest status of EUMETSAT's activities related to the enhancement of the IODC service since CGMS-45.

The identified essential data and products from Meteosat-8 and FY2E are being disseminated on EUMETCast Europe, Africa and on CMACast. The addition of the essential data and products from INSAT-3D and Elektro-L N2 to the new EUMETCast Africa Service is in progress. The existing interfaces between EUMETSAT and CMA will be used for the transfer of INSAT-3D and Elektro-L N2 data and products to CMA, in order to support the dissemination on CMACast. The implementation is expected to be completed in summer 2018.

CMA commented that FY-2H located at 79° East is providing better instrument performance and even better coverage over the IODC region than FY-2E.

CGMS-46-ISRO-WP-05
ISRO's contribution for IODC Data Dissemination and Visualization Plan

ISRO is continuously designing, developing and operationalizing satellite data missions for observation of the Indian Ocean. MOSDAC is the main ISRO data centre for dissemination of meteorological and oceanographic data over the Indian Ocean. Web applications are developed for data and information visualization and dissemination. ISRO currently has two Geostationary Meteorological Satellites namely INSAT-3D and INSAT-3DR and three low earth orbiting satellites namely MEGHA-TROPIQUES, SARAL-ALTIKA and SCATSAT-1 in orbit. They contribute to the Integrated Global Observing System of the WMO i.e. WIGOS.

Data is currently disseminated via GTS and ftp download. The ISROCast system is under development and is planned to provide satellite broadcast in Ku band on the SAARC satellite and terrestrial multicast capabilities to end users. The MOSDAC-LIVE (Let's Interactively Visualize Earth) portal provides a web enabled data and information visualization and analysis system. The data access portal includes an online data order system which complies with the OpenSearch standard.

3.2 Global data exchange from next generation GEO satellites - data provision from operators to users globally

CGMS-46-EUMETSAT-WP-12
Evolution of EUMETSAT Third Party GEO Satellite DATA Services
The paper describes the status and future planned evolution of the EUMETSAT third-party GEO satellite services. GEO data exchange with partner organisations is active for FY2E from CMA, INSAT-3D from ISRO, Himawari-8 from JMA, GOES-15 and GOES-16 from NOAA, and Elektro-L N2 from Roshydromet. It is planned to also include FY4 from CMA, once the data is available.

The full set of this GEO data is made available to EUMETSAT Member States, and a subset is further distributed to other partners. The dissemination methods include EUMETCast Satellite, EUMETCast Terrestrial and point to point links. The main challenge for the data exchange and dissemination is the increase in data volume which is at this moment manageable.

A variety of data formats are used for dissemination with the preference for the new generation data to keep the format from the originator.

CGMS-46-NOAA-WP-17
GOES-R Data Distribution
NOAA now has GOES-17 on geostationary orbit. GOES-17 joins GOES-16, which occupies the GOES-East assignment, as the second satellite in the GOES-R series to achieve successful launch and orbit raising. This presentation provides the current and future status of the GOES constellation, the schedule and status of science products from both GOES-16 and GOES-17, and metrics for customer's direct readout reception from GRB, and HRIT/EMWIN. In addition, these slides explain the process for submitting international requests for the mesoscale domain sectors and highlight upcoming international training opportunities.

CGMS-46-NOAA-WP-16
NOAA Status on the Product Distribution & Access (PDA) System

The United States National Oceanic and Atmospheric Administration (NOAA) has responsibility for the United States of America's constellation of operational environmental satellites. NOAA's Satellite and Information Service provides command and control as well as data services for several geostationary and low-earth orbiting satellites that provide near real-time data to time critical customers and data broadcast services, and products to the science community.

In the past two years, three new meteorological satellites were launched - GOES-R (now GOES-16), JPSS-1 (now NOAA-20) and GOES-S (now GOES-17). These three new satellites will provide greater improvements to the detection and observation of environmental phenomena that directly affect public safety, protection of property and our nation's economic health and prosperity. These satellite platforms will deliver key observations to the global community with essential products and services, including forecasting severe weather like hurricanes, severe thunderstorms and hazardous winter storms days in advance. They will also continuously assesses environmental hazards such as droughts, forest fires, poor air quality, land use and coastal waters.

This presentation covers the near real-time distribution methods utilized by NESDIS to send environmental satellite data to approved users, with a focus on the PDA (Product Distribution and Access System). PDA is an enterprise system for ingesting, producing delivering near real-time data to our core, time critical users. There are four major segments of the system including data production, data distribution, support for direct broadcast, and a high-speed network infrastructure. The PDA system has been operational since March 2017 and is actively supporting near real-time operations for more than 70 organizations.

NOAA acknowledged that scalability of data access with increasing data volumes and user demands is an issue. This will be addressed with further development including a cloud based system which is currently in an experimental phase.

The WG discussed the request from action A45.05 and concluded that further refinement is needed before CGMS members can assess this action. A related action was raised on WMO.

CGMS-46 actions – WGIV					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
NOAA	WGIV/ 3.2	A46.01	To appoint a new PoC on SATURN for GOES	Dec 2018	**OPEN**
WMO	WGIV/ 3.2	A46.02	To further refine the requirement from IPWG, in terms of users and geographical resolution	Dec 2018	**OPEN**

5. Implementation of sustained and coordinated communication satellite broadcast systems

CGMS-46-EUMETSAT-WP-04
Update on EUMETCast Europe and Africa Services
EUMETSAT's baseline dissemination systems for NRT data are EUMETCast Europe for users in RA-VI, EUMETCast Africa for users in RA-I and RMDCN for the global WMO community. This paper presents an update of the EUMETCast Europe and EUMETCast Africa status and describes the future evolution of data rates and transponder resources. EUMETCast Europe, since its upgrade to DVB-S2, has grown from a single transponder to 2 Ku band transponders. The service will significantly grow in transponder capacity to several hundred Mbps with the implementation of the next generation GEO and LEO satellites.

A new DVB-S2 based EUMETCast Africa Service became operational in May 2018 and replaces the current DVB-S based turn-around service. A less pronounced growth up to 14 Mbps is expected on EUMETCast Africa with the introduction of MTG-I1.

CGMS-46-NOAA-WP-18
NOAA Report on GEONETCast Americas (GNC-A) System
The GEONETCast Americas (GNC-A) is a regional satellite broadcast system serving much of North America, the Caribbean Basin, as well as Central and South America. NOAA works closely with the WMO, GEO, AmeriGEOSS, and other regional partners to support the satellite data requirements for WMO RA III/IV and GEO-GEOSS societal benefit area and initiatives.

As of May 2018, GNC-A broadcast system has increased the bandwidth to 12 Mbps and it has 78 operational stations in 19 countries. With GOES-16's operation, 7 bands Cloud Moisture Imagery products and the baseline level 2 products have been and will be available to GNC-A users. Besides GOES-16 data and products, a selective list of JPSS products have been in GNC-A system. As planned, the GOES-17 products and more JPSS products will be broadcasted to GNC-A users in the coming months. In addition, a software package SIGMACast has been developed for GNC-A users to perform the visualization and manipulation of the data and products carried on GNC-A. NOAA will also continue to provide GNC-A users the trainings about GNC-A system, GOES-16/17 and JPSS products etc.

6. Global or supra-regional data circulation and access (e.g. WIS/GTS/RMDCN, academic networks, etc.)

EUMETSAT Data Services Roadmap (verbal presentation)
EUMETSAT has embarked since 2 years ago in a series of projects to determine the future evolution of its data services portfolio. This activity, while preserving the highly reliable and proven concept of data dissemination via EUMETCast, is exploring more flexible ways of data access.
6 Data Services Pathfinder Projects have been initiated:

- OGC defines web service (WMS, WCS, WFS), WMS.EUMETSAT.INT
  Aim is to allow access to visualizations and data, pulling layers into various GIS clients or other web services and applications, via GUI or API.
- Online data access, OLDA.EUMETSAT.INT
  Direct online download in native format or netCDF rather than data ordering, via GUI or API.

- Format Conversion Toolbox
  To be deployed downstream of a EUMETCast reception station or centrally at EUMETSAT.
- EUMETCast Terrestrial,
  Enhancement of multicast dissemination on terrestrial links, up to Gbps.
- Hosted processing
  Bring the user to the data to allow mass data processing or reprocessing on a central infrastructure.
- Integration of these capabilities for EUMETSAT Satellite Application Facilities.

EUMETSAT is currently conducting a validation phase with users from Member States leading to a scenario for operationally upscaling these new data services in the coming years. These new demo services will also be featuring at the EUMETSAT Conference in Tallin in September.

It has been agreed with the European Commission, ECMWF and Mercator Ocean to develop jointly a Copernicus DIAS platform facilitating user access to Copernicus Data and Information across the Copernicus Ecosystem including all Sentinel missions. This service will be launched this month, and will have two further releases before end of the year, ramping up the first version of this DIAS Platform.

7. Use of the WMO Information System (WIS) infrastructure for data provision and discovery

CGMS-46-WMO-WP-17
The WIGOS Data Quality Monitoring System (WDQMS)
This document describes the concept of the WIGOS Data Quality Monitoring System (WDQMS), the ongoing activities for its development and implementation, as one of the five priority areas of the WIGOS Pre-operational Phase (2016-2019). The paper is presented in response to an action from IPET-SUP-4: WMO Secretariat to draft a WMO working paper for CGMS on the topic of global satellite data monitoring, providing the status and proposal for formal incident management of satellite data. The purpose of the WDQMS is to monitor, evaluate and trigger corrective actions relating to departures of actual WIGOS data quality from expected WIGOS data quality. It includes observational availability, observational quality and observational timeliness for all WIGOS observations, i.e. data produced by all WIGOS observing components which are the Global Observing System (GOS), the observing component of Global Atmospheric Watch (GAW), the WMO Hydrological Observations (WHO) and the Observing component of Global Cryosphere Watch (GCW); It also covers the WMO contributions to co-sponsored observing systems in particular the Global Climate Observing System (GCOS). The WDQMS consists in real-time and near-real time monitoring of the performance of all surface-based and space-based observing systems, as well as delayed mode monitoring of data quality as measured against reference sources of information for non-real time observations. It is intended to describe how well WIGOS is functioning, by producing and making available results, using online tools that will allow to make searches by region, by country, by station type, by time interval, etc. It depends critically on observational metadata being kept accurate and up to date. The concept has been developed as generically as possible to allow fitting to all WIGOS observing components.

NOAA commented that GSICS already contains monitoring capabilities from which WDQMS could benefit. Further discussion revealed that incident management aspects should be included as well. An action on WMO was raised to address these.

CGMS-46 actions – WGIV					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO	WGIV/6	A46.03	To liaise with GSICS on implementing GSICS monitoring capabilities in WDQMS, to include incident management capabilities, and report back to WG-IV, proposing a way forward	CGMS-47	**OPEN**

8. Incorporation and dissemination of R&D and pre-operational mission data

CGMS-46-ITWG-WP-01
The ITWG's ITSC-21 Report
The recommendations relevant for WGIV (14-20) were presented and discussed as follows:

14. To satellite agencies: For new sensors, pre-launch test datasets should be provided well before launch, in order to allow software development teams (e.g., AAPP, OPS-LRS, CSPP) and other operational users (e.g., NWP centres) to test processing software before satellite launch. New operational data dissemination infrastructure should be tested at an early stage (well before launch) with simulated data.

15. To satellite data providers: The overlap period where one satellite resource is replacing another should be chosen after consultation with the user community and should follow WMO guidelines.

16. To satellite agencies: ITWG recommends open access to new satellite data during the calibration/validation phase (particularly for all NWP centres) to help with calibration and validation.

17. To CMA: Consider making available as soon as possible the GIIRS hyperspectral data on FY-4A and of HIRAS on FY-3D to the international user community.

18. To WMO/CGMS/space agencies: ITWG supports initiatives to make data from R&D and pre-operational missions available, with a timeliness suitable for operational near-realtime applications. We re-emphasize best practise is to consider timeliness requirements early in the planning stage of new missions, including for research and pre-operational missions, and note that high reliability levels (e.g. >95%) do not need to be a requirement at the pre-operational stage or for short-term research missions.

19. To CGMS satellite agencies and other data providers: Advance notifications of processing changes should be an integral component of data provision. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data should be provided if possible.

20. To CMA: Consider implementing a subscription-based anomaly/event notification service, similar to that provided by NOAA and EUMETSAT.

The WG concluded that recommendations 14 to 16 are already reflected in existing working practises and recommendation 17 will be fulfilled after passing the first validation. However it was found that the timeliness requirement in recommendation 18 may have a potentially high impact on not foreseen development and/or operational, and this recommendation was therefore not followed up.

For recommendation 19 and 20 two actions were raised.

CGMS-46 actions - WGIV					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS satellite operators	WGIV/7	A46.04	To consider an enhancement of advance notifications of processing changes as specified below and provide feedback to WG-IV. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data should be provided if possible.	CGMS-47	**OPEN**
CMA	WGIV/7	A46.05	To consider implementing a subscription-based anomaly/event notification service, similar to that provided by NOAA and EUMETSAT and provide feedback to WG-IV.	CGMS-47	**OPEN**

9. Coordinated dissemination services for additional user communities

9.1 Disaster mitigation purposes - International Charter on Space and Major Disasters

CGMS-46-NOAA-WP-19
JPSS Support of International Disaster Charter Activations
New advanced capabilities of operational satellite programmes - advanced polar satellites and geostationary satellites will have large impacts on disaster response coordination activations. Therefore CGMS capabilities to respond to disasters will grow significantly in the next few years.

Products from the NOAA's new generation of polar satellites – JPSS - supports the International Charter on Disasters particularly in response to Flood Activations. Other areas – such as fires, volcanic eruptions, oil spills are relevant to JPSS – but requests are very fewer. Near real-time global Suomi-NPP/VIIRS flood maps are now available and distributed via the Space Science Engineering Center at University of Wisconsin and a website displaying these products are available at their RealEarth website (https://realearth.ssec.wisc.edu/) . These flood maps can provide daily monitoring on flood extent at 375-m spatial resolution, which show flood extent and dynamic change automatically. VIIRS flood maps are generated based on the geographic coverage of the activations and then sent back to the coordinators of

WMO's Disasters Charter in NOAA and USGS. USG Portal has information from all agencies responding to the activations. Since 2016, JPSS has responded to more than 12 activations.

CGMS-46 recommendation - WGIV			
Actionee	**AGN item**	**Rec #**	**Description**
CGMS satellite operators	WGIV/8.1	R46.01	CGMS agencies interested in accessing near real-time flood maps should be made aware of the RealEarth Website. A training module is also available from the UCAR COMET MetED website. The flood mapping algorithm from VIIRS is also provided for direct broadcast users through the CSPP software package. Contact Mitch.Goldberg@noaa.gov for further information.

Using EUMETCast in Disaster Charter Activations (verbal presentation)
EUMETSAT explained the ongoing activities on making use of GEONETCast for Disaster Charter Activations. As a first step, an automatic retrieval of Value Added Products from the Disaster Charter WEB site and re-dissemination on EUMETCast will be implemented. The interface has been defined and tests are in progress.

10. Coordination of metadata for satellites and instruments

No papers were presented under this agenda item. The resource problem of the task team on metadata and further progress of activities will be discussed in inter-sessional meetings.

11. Evolution and promoting harmonisation of data access portals

The related action was closed and the WG agreed that this topic can be removed from future agendas.

12. User dialogue and interface

12.1 Response to region-based requirements for satellite data access and exchange

CGMS-46-ROSHYDROMET-WP-04
Satellite Data Exchange in ROSHYDROMET
The document presents an overview of satellite data exchange mechanisms between ROSHYDROMET and EUMETSAT, including participation in the EUMETSAT Advanced Retransmission Service (EARS).

ROSHYDROMET has an operational access to EUMETSAT data distributed via EUMETCast, and data from ROSHYDROMET is available to EUMETSAT vie ftp download.

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.

Data provided from ROSHYDROMET includes regional data from NOAA, Metop and SNPP, microwave sounder MTVZA data and Electro-L N2 data. In addition, data from IR sounder IRFS-2 is also available in near real time via the same ftp channel.

CGMS-46-JMA-WP-06
Report on the HimawariRequest Service

In January 2018, the Japan Meteorological Agency (JMA) launched a new international service "HimawariRequest", in collaboration with the Australian Bureau of Meteorology. The service allows NMHS users in Himawari8/9 coverage area to request Target Area observation covering a 1,000km x 1,000km area every 2.5 minutes.

Target Area observation supports JMA's national/international services including the RSMC Tokyo - Typhoon Center and the Tokyo VAAC. In response to a recommendation made at the 2015 Joint RA II/RA V Workshop on WIGOS for Disaster Risk Reduction, JMA developed the service through the RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training.

As of 10 May 2018, JMA had taken registrations from nine NMHSs in RA II and RA V (the Solomon Islands, Myanmar, Australia, Hong Kong, Bangladesh, New Zealand, Malaysia, Samoa and Nepal), and opened the service to the four (the Solomon Islands, Hong Kong, New Zealand and Nepal) whose preparations for request submission were complete.

JMA expects the HimawariRequest service to support disaster risk reduction activities in the Asia Oceania region based on the regional monitoring of extreme events such as tropical cyclones and volcanic eruptions using the Target Area observation.

CGMS-46-joint-JMA-KMA-WP-02
Progress Report on the RA II 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 Fifth Meeting of the Coordinating Group of the Project was held at Far Eastern Federal University on Russky Islands in Vladivostok, Russia on 21 October 2017. The meeting was hosted by the Federal Service for Hydrometeorology and Environmental Monitoring of Russia (Roshydromet) and was coordinated by the Japan Meteorological Agency (JMA) and Korea Meteorological Administration (KMA). Totally 31 participants from RA II and RA V Members, and a WMO secretariat attended the meeting. At the meeting, the Group reviewed and discussed 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 at the meeting that JMA and KMA would develop and conduct a regional user survey in 2018 in collaboration with the Australian Bureau of Meteorology. The final report from the meeting is attached to this working paper.

12.2 User readiness preparations for new satellites

CGMS-46-NOAA-WP-20
NOAA status report on user preparedness for new NOAA satellite Direct Broadcast
The PowerPoint presentation will describe the status of the preparations to increase DB user readiness for GOES-17, NOAA-20, and JPSS-2. GOES-16 user readiness is described as an example.

The GOES-R and JPSS programmes made user readiness a high priority. In regards to Direct Broadcast an emphasis was placed on user readiness during the requirements phase and resources were allocated during development to mitigate the risk of DB users not being prepared for the new capabilities.

GOES-R series GRB is a significant change for GOES-NOP GVAR users. The GRB is a dual-polarized signal and the design accounted for users who might want to receive only LHCP by placing products similar to the legacy imagery on GVAR on LHCP. The GOES-R Ground Project developed and maintained 5 GRB Simulators that were loaned to vendors, manufacturers, and system integrators. The PUG Volume 4 and the GRB Downlink Specification fully document GRB. The GRB User Group has met 11 times and has over 130 members. There are approximately 80 GRB sites and about one-half of those are currently receiving GOES-16. The remaining 40 GRB sites plan to be operational in 2018. A prototype HRIT/EMWIN receiver was specified for users. The HRIT/EMWIN User Group formed in April 2018 and plans to meet quarterly similar to the GRB User Group meetings. NESDIS has been providing bi-monthly GOES-17 readiness for the International Extension and Public Alert Systems through the University of Corporation of Atmospheric Research, funded by the National Weather Service and International Activities Office at NOAA. These meetings serve to organize a specialized project for upgrading deteriorated LRIT equipment from remote Pacific Islands regions to be ready for GOES West transition to HRIT. The GOES-R website provided documentation, sample data, news updates, and other useful information. The DCS community also meets regularly and has received updates on GOES-R Series DCS during STIWG meetings and on the OSPO DCS Website.

The GOES-17 Post Launch Test period started in April 2018 and included the GRB to DB User tests and HRIT tests. GRB User Group members participated in the GRB to DB Users tests. GOES-17 is expected to assume operations as GOES West in October 2017. GOES-T is expected to launch in 2020.

The S-NPP and JPSS DB is the High Rate Data (HRD) and the JPSS requirements include the HRD downlink, Field Terminal Support (FTS), and a HRD Link Monitor (HLM) capability. The JPSS HRD to Direct Broadcast Stations (DBS) Radio Frequency (RF) Interface Control Document (ICD) documents the HRD. The HRD User Group was formed in November 2017 and it has 55 members. NOAA is participating in the effort to establish Best Practices for LEO Direct Broadcast Data through the CGMS WG-I.

CGMS-46-NOAA-WP-21
JPSS Status on User Readiness
This paper covers engagement part of User Readiness, instead of data distribution.

JPSS User Readiness (Engagement) includes a Proving Ground/Risk Reduction Program and User Training. (GOES-R also has an extensive programme). JPSS Information is included in SATURN. For information on user readiness and other matters the following link is recommended: WWW.JPSS.NOAA.GOV.

MTG User Preparedness (verbal presentation by EUMETSAT)
EUMETSAT has launched its MTG User Preparedness Programme with NMHSs of it member states last year. In this effort we undertake activities related to the following:

- Test Data and Formats - provision of test data and format information;
- Science engagement - provision of, and output from, scientific studies and demonstration projects which explore the capabilities of MTG data;
- User Training - supporting user preparation and early use of the MTG services through training on the utilisation of MTG data and products in operational and research meteorological application areas;
- User Information and Communication - providing information, documentation and communication channels to support user preparation and to facilitate the exchange of knowledge and ideas;
- Data Access - ensuring the smooth release of MTG data through the multi-mission data access services available during the pre-operational and operational phases and the provision of information on any enhancements made to these data access services in order to accommodate the future MTG services.

An online discussion forum has been setup and launched a couple of months ago. A central landing page for all users has been created and is also referenced in WMO's Saturn portal, see URL https://www.eumetsat.int/website/home/Satellites/FutureSatellites/MeteosatThirdGeneration/MTGServices/index.html. Next year a larger MTG User Prep workshop is planned most likely in the second half of the year. The announcement will be shared with CGMS agencies.

In the second half of 2018, EUMETSAT member states through the delegate bodies are expected to agree on an update of the End User Requirements document which among others will have a bearing on the dissemination baseline.

13. Space weather matters

13.1 Current data formats for space weather observations

MSG SEM Data Format and Dissemination (verbal presentation by EUMETSAT)
The Metop Space Environment Monitor instrument (SEM) data is currently made available in near real time via ftp download. The data is L0 in the native Metop PFS format. Data format description is available on request from the EUMETSAT helpdesk (ops@eumetsat.int). The metadata is included in the Product Navigator (navigator.eumetsat.int).

13.2 Near-real-time access to and global exchange of space weather data from instruments hosted on meteorological satellites

CGMS-46-IMD-WP-03

New Proposed Data Dissemination Scheme

The presentation provides an overview of present and future data dissemination schemes from IMD. It includes GTS, WEB based access, ftp download in push and pull mode.

CGMS-46-NICT-WP-02

Himawari/SEDA Database Web

Space Environment Data Acquisition Monitor (SEDA) is on board Himawari-8 and -9 operated by JMA. SEDA consists high-energy proton sensor (SEDA-p) and electron sensor (SEDA-e), respectively. JMA have been providing near real time SEDA data for NICT. NICT is operating near real time online database of SEDA data, Himawari/SEDA database web (http://seg-web.nict.go.jp/himawari-seda/) for the users of space weather information. The functions of Himawari/SEDA database web are real time plot, archived data distribution, and near real time data distribution for registered users. In Himawari/SEDA database web, files of Himawari/SEDA data based on Common Data Format (CDF), and those based on plain text format are distributed and archived.

13.3 Feedback from SWTT discussions related to data access and dissemination (WGIV)

Based on the feedback from satellite operators on the space weather instrument data formats a discrepancy was found in the needs from SWTT and what is currently available. The collection of defined data formats from present and future satellites carrying space weather instruments is important and should be completed. Near real time data access does not seem to be a problem. The existing actions remain open until all affected CGMS members have responded.

The following action was raised by SWTT for WGIV:

Action raised by SWTT for WGIV:					
WGIV	(SWTT/ SWCG)	A46.07	From SWTT/SWCG to WGIV: Determine data formats of space weather measurements use by CGMS Members, particularly particle sensor data (GEO and LEO) and magnetic field data (GEO)	CGMS-47	**OPEN**

14. Review and updating of the HLPP

CGMS-46-CGMS-WP-12

Review and updating of the HLPP

The status of implementation of CGMS High Level Priority Plan (2017-2021) 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.

After the reorganisation of WGIV, the area of User Readiness is listed as objective 7 as follows:

"7) Address the user readiness for new satellite systems, with support from SATURN point of contacts;"

The two HLPP targets related to User Readiness are therefore proposed to be moved from the cross-cutting area to the section of the HLPP overseen by WGIV.

15. New objectives from the updated ToR

For the new objectives from the updated Terms of Reference for WGIV **CGMS-46-CGMS-WP-18** V2, which were not covered by the current ToR, the following way forward was defined:

8) Address the notification of changes (and alerts) in satellite data and/or products impacting users, with the aim of defining Best Practices;

   The new action related to WDQMS under agenda item 6 is related and addresses this objective.

9) Address topics related to cybersecurity towards end users, within the WG and through Inter-sessional meetings with additional experts with the aim to develop the topic in the WG;

   A specific inter-sessional meeting is proposed to develop this topic.

10) Address long term data preservation, within the WG and through Inter-sessional meetings with additional experts with the aim to develop the topic in the WG;

    A specific inter-sessional meeting is proposed to develop this topic.

11) Discuss relevant aspects on the implementation of the global contingency plan from plenary (as proposed by WG-III);

    This objective will be addressed when needed (triggered by WGIII).

16. Nomination and representatives at meetings

WGIV discussed nominations for CGMS-47 and reconfirmed the current Co-chairs and rapporteur (Vasily Asmus (ROSHYDROMET) and Hiroshi Kunimatsu (JMA), and Klaus-Peter Renner (EUMETSAT) and agreed

to nominate and propose to plenary that Sean Burns (EUMETSAT) will be the WGIV liaison contact to WGIII for contingency related issues.

17. Any other business

No further items were presented for discussion.

18. Date/time of inter-sessional activities/meetings in 2018-2019 [CGMS-46 -> CGMS-47]

Tentative dates for the inter-sessional meetings are proposed as follows:

Commented [AT19]: Please fix the dates asap, prior to publication.

17 October 2017, 12:00 UTC:
WGIV intersessional meeting, topics: develop new objective cyber security, TFMI open actions

5 December 2017, 12:00 UTC:
WGIV intersessional meeting, topic: develop new objective long term data preservation, status of actions/recommendations

23 January2018, 12:00 UTC:
WGIV intersessional meeting: preparation/agenda for CGMS-47

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

During discussion of several working papers it became clear that the recommendations A42.01 (provide WIS Discovery Metadata), A44.01 (contribute to the implementation of the Best Practices for User Readiness) and A44.2 (provision of up-to-date User Readiness information in the SATURN portal) are still relevant and the recommendations were therefore retained.

The following action was added following plenary discussions related to long-term data preservation:

CGMS-46 actions - WGIV

Actionee	AGN item	Action #	Description	Deadline	Status
WGIV	(plen E.10)	A46.06	Following CGMS-46 plenary discussions related to IROWG and GCOS IP: CGMS WGIV to consider the GCOS IP actions on long-term data preservation (LTDP). Ref. GCOS IP action G 26.	CGMS-47	**OPEN**

The summary list of WGIV CGMS-46 actions and recommendations following CGMS-46 discussions is provided in annex VII of this report.

SWTT REPORT

Co-chairs: Tsutomu Nagatsuma (NICT/JMA), Elsayed Talaat (NOAA)
Rapporteur (acting)**:** Matthew Butler (NOAA)

1. Objectives and Chairmanship

The meeting opened on Sunday 3 June 2018 at 9.00, co-chaired by Elsayed Talaat (NOAA) and Tsutomu Nagatsuma (NICT).

The list of participants is included in this report. There were 33 participants.

The objectives for these meetings were:

1. Agree to Space Weather Coordination terms of reference to send to plenary for endorsement
2. Review updated CGMS Baseline
3. Discuss path forward on space weather anomaly database

2. Review of actions and recommendations from previous meeting

The status of the SWTT/SWCG actions and recommendations resulting from previous plenary sessions (CGMS-45 and earlier) and following CGMS-46 discussions is provided in annex VIII of this report.

3. Discussion and recommendation of Terms of Reference for a permanent CGMS Space Weather Coordination Group (SWCG)

After CGMS-45, the Space Weather Task Team met for an intersessional meeting to discuss the development of a terms or reference for a new Space Weather Coordination Group (SWCG). This terms of reference was sent out to the entire SWTT email list server for review.

The scope of Space Weather Coordination Group is to support the continuity and integration of space-based observing capabilities for operational space weather products and services throughout CGMS and the user community, and in supporting the satellite operators in CGMS with regard to space weather phenomena.

The Space Weather Coordination Group (SWCG) has the following objectives:

1. Coordinate space weather activities within and across CGMS WGs including space weather data, ensuring space weather operational measurements are incorporated into the CGMS baseline, relevant frequencies, products, knowledge, policy, etc.
2. Address space weather topics relevant to CGMS that are not currently within the purview of other CGMS WGs, for example, discussion of satellite anomalies and their mitigations
3. Facilitate dialogue between CGMS members and space weather communities

4. Identify which space weather organizations/forums the SWCG should interact with both as an active participant and/or engaging them within CGMS activities
5. Identify needs and requirements from space weather communities that should be managed and coordinated by CGMS or its members
6. Follow current and future international and domestic space weather policies which may have an effect on CGMS or its members
7. Review the CGMS High Level Priorities related to space weather

CGMS-46 recommendations – SWTT					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
CGMS	3	R46.01	CGMS plenary to endorse Space Weather Coordination Group terms of reference	CGMS-46 plenary	**OPEN**

4. Updates on space-based observational capabilities

CGMS-46-CMA-WP-06

CMA Update on Space-based Space Weather Capability and Activity

CMA presented an update on space-based capability and activity in space weather since its last report at the CGMS 45 meeting in 2017. FY-3D satellite was successfully launched in November 2017 and is under orbital checkout. In addition to the Space Environment Package (SEP) and GNOS radio occultation sounder flown on previous FY polar-orbiting units, FY-3D also carries an Ionospheric PhotoMeter (IPM) and Wide-field Aurora Imager (WAI) for monitoring Ionospheric phenomena. CMA also discussed some of the results last year in capability building, and the engagement in becoming a global civil aviation service provider of ICAO.

CGMS-46-ISRO-WP-07

An update on ISRO's Aditya-L1 mission to study the Sun

ISRO presented an update on its upcoming Aditya-L1 satellite mission. To have uninterrupted view of the Sun, Aditya-L1 satellite will be placed in the halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system. The projected timeline for the launch of Aditya satellite is 2019 – 2020.

The Aditya-L1 satellite with its suit of payloads will not only observe the solar corona, but also facilitate observations of Sun's Photosphere (soft and hard X-ray), Chromosphere (UV) and corona (Visible and NIR). In addition, particle payloads will study the particle flux emanating from the Sun and reaching the L1 orbit, and a magnetometer payload will measure the variation in magnetic field strength at the halo orbit around L1.

CGMS-46-NOAA-WP-22

NOAA's Space Weather Space-Based Observational Capabilities

NOAA presented on its space-based space weather observational capabilities. NOAA has requirements from LEO, GEO, L1, and L5 orbits. NOAA highlighted the new capabilities on the GOES-R series of geostationary satellites including new x-ray flux, EUV, and energetic particle detectors. NOAA is also preparing for launching the COMSIC-2 radio occultation satellites as a follow-on to COSMIC-1.

NOAA is continuing to develop its Space Weather Follow-on mission at L1. This mission will include a compact coronagraph and a solar wind instrument suite. NOAA is also developing a partnership with ESA where NOAA is responsible for observations on the Sun- Earth line (L1) and ESA is responsible for the off-axes (L5) observations.

CGMS-46-NASA-WP-05

NASA Space Weather Activities

The NASA presentation covered four topics: new missions being launched, coordination with the National Space Weather Strategy, the development of SnAP – a Science Applications Project for space weather, and the emphasis of NASA Heliophysics on international cooperation. Four missions are launching or beginning Phase E (operations) in 2018. These are: Global Observations of the Limb and Disk (GOLD), Ionospheric Connection Explorer (ICON), Parker Solar Probe, and Space Environments Testbed 1 (SET-1). GOLD will begin operations in mid-October, 2018. It uses an imaging ultraviolet spectrometer in geostationary orbit to investigate hemispheric-scale "weather" of the ionosphere and thermosphere, particularly as it reacts to forcing from the sun, magnetosphere, and lower atmosphere. GOLD is the first NASA science instrument to be hosted on a commercial spacecraft. ICON, launching in June 2018, will study the dynamic zone in the upper atmosphere where terrestrial weather from below influences space weather above. Parker Solar Probe, ready for launch in July 2018, is a mission to the sun, to revolutionize our understanding of the solar corona and expand our knowledge of the origin and evolution of the solar wind. SET-1, launching no earlier than October 2018, will carry instruments to reduce uncertainties in estimating space weather effects on spacecraft and their payloads, so that spacecraft anomalies and failures due to environmental effects are reduced.

CGMS-46-ESA-WP-02

ESA Space Weather Activities

ESA presented an update on the current status of the various elements of the ESA Space Situational Awareness (SSA) space weather segment (SWE) system. SSA SWE strategic objectives are to reinforce and mature the SWE system, reduce dependence on non-European systems, and begin transition towards an operational system. The SWE enhanced space segment includes the Lagrange mission, which is currently in mission Phase A/B1 The development is proceeding for an L5 mission to complement the planned L1 Space Weather Forward Observatory (SWFO) and other space weather observations on the Sun-Earth line. NOAA and ESA signed a Letter of Intent establishing the coordinated approach. ESA also updated the status of the Distributed SWE Sensor System (D3S) including two precursor missions awaiting launch in 2019.

5. Updates on space weather activities

CGMS-46-ROSHYDROMET-WP-05

Ionosphere disturbances monitoring by means of satellite measurement techniques

Roshydromet presented an overview of satellite measurement techniques used by it to monitor the ionosphere disturbances. Institute of Applied Geophysics (IAG) of Roshydromet uses an extensive GLONASS / GPS network of satellite signal receivers to registration of ionosphere disturbances over the Russian Federation. Each platform includes a receiver that measures various characteristics of satellite signals at multiple frequencies.

CGMS-46-NOAA-WP-23

NOAA's Space Weather Activities

The NOAA Space Weather Prediction Center (SWPC) provided an update on significant space weather activities since CGMS-45. During that period, there was one major period of storming which occurred from 04-13 September 2017. The known impacts from this were limited to degraded or non-existent HF radio communications and high-altitude, high-latitude radiation exposure for aircraft. Although there was also moderate to severe geomagnetic storming present during this period, there were no reported impacts to power grid operators or GNSS users. NOAA SWPC also provided an update on its work to build a "Sun to Earth" space weather modelling framework and recent progress to date. It also provided an update on its recently completed space weather economic impact study and currently ongoing customer requirements study.

CGMS-46-NICT-WP-01

NICT Space Weather Activities

NICT presented on its space weather activities (CGMS-46-NICT-WP-01). Recently, NICT have developed high energy electron flux forecast using near real-time ARASE (JAXA's radiation belt explorer) high energy particle data. They are now developing new visualization product of high energy electron flux in the whole inner magnetosphere using ARASE and GEO satellites real time data. Adding ARASE satellite data, the area of visualization can be expanded from around GEO to the whole inner magnetospheric region. To produce user-oriented information about risks of satellite anomaly for satellite operator, NICT have also started developing Space Environment Customized Risk Estimation for Satellite (SECURES).

CGMS-46-KMA-WP-04

KMA space weather activities and plans

KMA described the recent updates of the KSEM (Korean Space wEather Monitor) project that will fly on-board the GEO-KOMPSAT-2A (GK2A) satellite and KMA's space weather services. The KSEM flight model has been integrated into GK2A and is now in the final system-level test. EMI/EMC, vibration and TVAC tests at system level successfully has completed this May. KSEM associated ground segment is in the final development phases in parallel with NMSC ground segment's sub-system level test.

Regarding space weather service, KMA has been focused to build the infrastructure in three fields of 1) satellite operation, 2) aviation, and 3) the ionospheric environment. KMA has developed cosmic radiation dose model (KREAM) to support the space weather information for the aviation and verifies the mode.

6. UN COPUOS Space Weather Expert Group update

Elsayed Talaat, SWTT co-chair, presented on the status of the efforts of the Space Weather Expert Group chartered by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). Within UNCOPUOS, the UNISPACE+50 thematic priority for UNCOPUOS includes international framework for space weather services. Under this thematic priority the objectives for UNCOPUOS are:

- Strengthen reliability of space systems to adverse space weather
- Develop space weather roadmap for international coordination and information exchange on space weather events and their mitigation

- Utilise risk analyses and assessments of user needs
- Recognise space weather as a global challenge
- Increase awareness through communication, capacity building, and outreach
- Identify governance and cooperation mechanisms to support this objective

The Expert Group is developing a plan for the framework to coordinate space weather services. The Expert Group plans to propose that UNCOPUOS perform a role as a coordination body to facilitate communication and collaboration between existing space weather organizations and international bodies such as ISES, CGMS, ICAO, and WMO.

7. WMO space weather activities update

CGMS-46-WMO-WP-15

WMO Space Weather Activities Update

In late October 2017, WMO was officially notified by International Civil Aviation Organization (ICAO) that a total of ten (nine countries plus one consortium) site assessments and audits would be required before the end of March 2018. WMO organized the site assessment and audit team from WMO expert team, IPT-SWeISS, and the WMO final report on the site assessment and audit of prospective space weather information providers has been finalized and submitted to ICAO in March 2018. ICAO is expected to take the WMO findings into account during ICAO's designation of space weather information providers in by July 2018 prior to the introduction of the operational service by November 2018.

CGMS-46 actions - SWTT					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
SWTT	7	A45.01	CGMS SWTT to review the contents related to space weather stored in OSCAR/Space database.	CGMS-47	**OPEN**

8. Update on the CGMS baseline

CGMS-46-CGMS-WP-26

Report of CGMS WG-III Workshop on Baseline and Contingency Planning

In CGMS-45, WGIII determined it was necessary to update the CGMS Baseline because of several new additions over the last several years, including space-based space weather observations. SWTT and WGIII held a joint intersessional to develop a space-based space weather observation baseline. Following this meeting, WGIII developed principles for determining what will be included in the baseline. The CGMS Baseline, as drafted, lists contributions by sensor type, but also includes orbit, observations/measurement, and relevant orbital details. WGIII accepted all SWTT contributions, but decided to include L5 observations to the High Level Priority Plan because they did not met the principles required to be included in the baseline at this time.

9. Results of the space weather anomaly survey

CGMS-46-SWTT-WP-05

CGMS Space Weather Anomaly Survey Results

Agencies have provided reports on anomalies from solar events at CGMS plenary sessions using the same space weather anomaly reporting table, created by WMO, since 2012. EUMETSAT, KMA, and NOAA have provided updates, but not all fields of the table were filled out and key details were omitted. In previous discussions within the SWTT, it was unclear what the ultimate use of the reporting will be and what procedures were used by agencies in determining that satellite anomalies were caused by space weather event. In addition, space weather data collection is represented in multiple tasks within the CGMS HLPP. Furthermore, SWTT developed a space weather anomaly survey that, working with WGI, was sent to CGMS satellite operators and addressed how space weather data was utilized during periods of nominal operations, when a satellite anomaly is taking place, and post analysis of anomalies. EUMETSAT, JMA, NOAA, and NASA responded and the key findings included that no preventative actions are performed before solar events; space weather data is consulted more frequently for LEO, lunar, and earth trailing missions; and that operators requested more data from L1 and better modelling to better predict and understand impact. It was noted that NICT is developing the SECURES tool to assist satellite operators specifically.

CGMS-46-NOAA-WP-09

NOAA NCEI Evaluation of CGMS Anomaly Reports

NOAA/NCEI did a review of space weather anomalies submitted to CGMS. All but one anomaly report was a single event upset (SEU), showing that space weather may be a catch all for unknown anomalies. In addition, location for the anomalies were not exact making further analysis difficult. NOAA/NCEI provided a number of lessons learned:

1. Accumulating more anomaly report will aid in understanding
2. Discuss what constitutes an anomaly that should be reported to CGMS
3. Clarify what is needed for each field in the WMO form
4. In any database, fields for documenting updated attribution should supplement the WMO fields
5. Agency-supported space environment experts should be an integral part of all anomaly resolution teams and contribute to the writing of agency CGMS space weather related anomaly reports.
6. Consider adopting a ‘trusted agent’
7. Industry should create and support its own ‘trusted agent’ process

CGMS-46 actions - SWTT					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
SWTT and WMO	9	A46.02	Clarify what information needs to be provide in each field of the space weather anomaly form	Feb 2019	**OPEN**
CGMS Members	9	A46.03	Expand on template inputs to include full investigations when available and when possible.	CGMS-47	**OPEN**

10. Anomaly reporting and database discussion

SWTT discussed the possibility to reconsidering the space weather anomaly reporting form and how to use the space weather anomaly reports from CGMS Members. It was determined that it was most important to include CGMS operators in this discussion and as a result, SWTT decided to discuss this topic further in WGI.

11. Review and updating of the HLPP

CGMS-46-CGMS-WP-12
Status of implementation of CGMS High Level Priority Plan (2017-2021)
The SWTT noted the progress that is being made on 5.2.1: Establish dialogue with Space Weather User Community and define the future framework for continuing this dialogue and on 5.2.2: Investigate feasibility of a consistent inter-calibration for energetic particle measurements using instruments with adequate in-orbit calibration and vicarious methods, using GSICS methodology as reference. However, more work remains and both were kept as HLPP items.

The SWTT agreed to continue to work on 5.2.3: Evaluate existing operational space weather products and services in support of CGMS members' spacecraft operations and recommend additional services as appropriate.

12. Nomination and representatives at meetings

SWTT agreed that it was important to identify points of contact between the SWTT and the other working groups. Those points of contacts were identified as:

- Working Group I: Andrew Monham (EUMETSAT)
- Working Group II: Tsutomu Nagatsuma (NICT)
- Working Group III: Elsayed Talaat (NOAA)
- Working Group IV: Brent Gordon (NOAA)

13. Any other business

The International Radio Occultation Working Group highlighted the elements of space weather that are included in their report that will be presented in Working Group II.

14. Next meetings 2018-2019 period

Upcoming international meetings of interest:

- Asian-Oceania Space Weather Association – September 2018
- COSPAR Capacity Building Workshop – September 2018
- European Space Weather Week – November 2018
- UNCOPUOUS Science and Technical Subcommittee Meeting – February 2019
- GSCIS Data and Research Working Group – March 2019
- US Space Weather Workshop – April 2019

Intersessional Meetings:

- October 17, 2018
- January 16, 2019
- April 17. 2019
- Space Weather Anomaly review (joint with WGI) – December 5, 2018
- Space Weather Data Use (joint with WGI) – March 6, 2019

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

The summary list of new actions and recommendations raised following the SWTT/SWCG deliberations at CGMS-46 is available in annex VIII of this report.

ANNEXES

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CGMS Agenda and Working Papers

The agenda and Working Papers (WPs) are available at http://www.cgms-info.org/agendas/Default.aspx

CGMS List Servers

There are currently six CGMS list servers for plenary, WGs I-IV and SWTT 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.

ANNEX I: OPENING AND CLOSING ADDRESSES BY MR. TAPAN MISRA, ISRO

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ANNEX II: ADDRESS BY DR. K. SIVAN, ISRO

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ANNEX III: SUMMARY LIST OF PLENARY ACTIONS AND RECOMMENDATIONS

CGMS-46 plenary actions and recommendations resulting from CGMS-46 deliberations.

CGMS-46 plenary actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/ closing document**	**Deadline**	**Status**	**HL ref**

Commented [AT23]: Summary list of new actions/recs will be added following review of the plenary and WG texts by participants. The new actions/recommendations have been incorporated in the report text.

ANNEX IV: SUMMARY LIST OF WGI ACTIONS AND RECOMMENDATIONS

CGMS-46 working group I (WGI) actions and recommendations resulting from CGMS-46 deliberations.

WGI actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGI/6	A43.06	WMO to assess the impact of improved data latency from polar orbiters on NWP (WMO Impact Workshops) and other applications	CGMS-46: Preparations have started for the next WMO Impact in Workshop 2020, with questions currently being formulated. There have also been discussions at IPET-SUP to define the questions that could be answered, in particular regarding the impact of data latency No progress was presented at CGMS-44 or 45.	CGMS-47? (CGMS-44, -45, -46)	**OPEN**	1.1.2
CGMS space agencies, IROWG	WGI/6.1	A44.08	CGMS agencies with satellites with DB and RO occultation sensors to assess the technical feasibility of a RARS/DBNet RO occultation service in support of the Space Weather community.	May 2018: IROWG paper postponed potentially to CGMS-47 Deadline for extended following CGMS-45 and 46 discussions, noting that NOAA has no plans to do implement such a service. CGMS 44: CGMSSEC request IROWG representative to provide and present a paper to WGI to support the discussion on the technical feasibility of a service.	CGMS-47 (CGMS-45, 46)	**OPEN**	1.4

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CGMS-46 WGI actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS members	WGI/3.1	A46.01	CGMS agencies to provide to the next meeting of ITU-R Working Party 7C (19—25 September 2018), comments/inputs to the Preliminary draft new Report ITU-R RS. [SPACE_WEATHER_SENSORS] (Technical and operational characteristics of RF-based space weather sensors) in order to provide the missing information on space weather instruments/ applications, either directly as input contribution to the ITU-R WP 7C meeting (with deadline 7 September 2018) or to the CGMSSEC (deadline 3 September 2018)) who gathers the inputs and sends them as one input to the WP 7C meeting in September		07/09/18	**OPEN**	1.4
CGMS operators	WGI/4.1	A46.02	Present the current operational orbit maintenance strategy, as an input the discussion of the advantages of orbital phasing between satellites as a measure for reducing pass		by Q1 2019	**OPEN**	1.4

CGMS-46 WGI actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
			scheduling conflicts and maximising the amount of instrument observation collected, with a view to producing a future best practice.				
CGMS members	WGI/4.1	A46.03	Provide the status of implementation of CGMS best practices in support to local and regional processing of LEO direct broadcast data		CGMS-47	**OPEN**	1.4
CGMS members	WGI/5	A46.04	Appoint DCS Managers as members to the WGI DCS sub-group, noting that the first meeting will be held on the occasion of the Satcom Forum 2018/DCS Workshop in October 2018. The first agenda of the Sub-Group would include: • Review of the Best Practice for DCP Certification • Review of the Best Practice for DCP data access • Review of designs for a potentially new IDCS DCP standard		01/09/18	**OPEN**	1.2

CGMS-46 WGI actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
			Members should review and provide inputs on these topics prior to the first meeting.				
DCS (WGI) sub-group	WGI/5	A46.05	Provide a consolidated DCS report covering the items in A46.03		CGMS-47	**OPEN**	1.2
DCS (WGI) sub-group	WGI/5.3	A46.06	The DCS sub group is invited to review and provide comments to this draft of the CGMS agency best practices in support to user DCS data access.		CGMS-47	**Open**	1.2
DCS (WGI) sub-group	WGI/5.3	A46.07	DCS sub group to discuss and if agreed propose a new IDCS standard. This is the pre-requisite for a decision on a common certification		CGMS-47	**Open**	1.2
CGMS members	WGI/5.3	A46.08	Review and update CGMS-46-CGMS-WP-25 Annexes regarding DCS information		01/09/18	**OPEN**	1.2
CGMSSEC	WGI/5.3	A46.09	In preparation for the Satcom Forum and DCS Workshop, it is proposed to create a simple DCS page on the CGMS Website.		01/09/18	**OPEN**	1.2
SWTT	WGI/6.1	A46.10	To make a presentation/paper to the next CGMS on use case/s from their analyses and any		**OPEN**	**OPEN**	

CGMS-46 WGI actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
			recommendations to operators arising.				
CGMS members	WGI/6.2	A46.11	Members to provide the status of their Collision Avoidance processes and the lesson learned when implementing these processes		**OPEN**	**OPEN**	
CGMS members	WGI/7.2	A46.12	Members to provide the status of their systems already in place and those planned, along with their overall approach to dealing with the challenges associated with handling and circulating large data volumes		CGMS-47	**OPEN**	

Closed WGI actions and recommendations from previous plenary sessions (CGMS-45 and earlier) following CGMS-46 discussions.

WGI actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGI/6	A43.06	WMO to assess the impact of improved data latency from polar orbiters on NWP (WMO Impact Workshops) and other applications	CGMS-46: Preparations have started for the next WMO Impact in Workshop 2020, with questions currently being formulated. There have also been discussions at IPET-SUP to define the questions that could be answered, in particular regarding the impact of data latency No progress was presented at CGMS-44 or 45.	(CGMS-44) New deadline CGMS-46	**OPEN**	1.1.2
CGMS space agencies	WGI/2	A44.05	CGMS agencies to provide prior to CGMS 45 a report on the space weather activities (including spacecraft and instruments) of relevance on frequency management and frequency protection topics	Closed on the occasion of a dedicated WGI inter-sessional meeting on 7 Sept 2017. CGMSSEC to request SWTT representative to provide a paper to WGI to this purpose (and present it in WGI). SWTT informed by e-mail 7 April 2017. CGMS-45 NOAA-WP-04 Agency reports on Frequency topics to include a dedicated chapter on space weather.	(Feb 2017) CGMS-46	**CLOSED**	1.3
CGMS space agencies, IROWG	WGI/6.1	A44.08	CGMS agencies with satellites with DB and RO occultation sensors to assess the technical feasibility of a RARS/DBNet RO occultation service in support of the Space Weather community.	May 2018: IROWG paper postponed potentially to CGMS-47 Deadline for extended following CGMS-45 and 46 discussions, noting that NOAA has no plans to do implement such a service. CGMS 44: CGMSSEC request IROWG representative to provide and present a paper to WGI to support the discussion on the technical feasibility of a service.	CGMS-47 (CGMS-45, 46)	**OPEN**	1.4

Commented [AT25]: Remove once report is finalised. Include in CGMS-46 LOA.

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WGI actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS space agencies	WGI	A44.09	From CGMS-44 WGII: CGMS operators and WMO to work with GODEX-NWP to explore options for optimal data exchange of advanced data from next-gen GEOs	CGMS-46: Discussed in WGI and the matter has been incorporated in the HLPP There is an ongoing discussion with RO working group. There is a need for low latency RO data - technical feasibility of doing it needs to be analysed. May 2018 proposed to be closed. Dedicated WP on the topic at CGMS 46 and covered by the update of the ToR of WG-I and WG-IV and the related HLPP Mar 2018 To be discussed at WGI intersessional on data formats. Deadline extended following CGMS-45 discussions. As a member, NOAA agrees that the GODEX-NWP group would be an excellent source of information on the planned types of next-gen GEO data to be disseminated and methods of data dissemination between the international NWP modelling centers. The GODEX-NWP group is also at the forefront of RARS endeavours.	(CGMS-45) CGMS-46	**CLOSED**	

CGMS-45 WGI actions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
EUM	3	A45.01	WGI chair to draft a letter, on behalf of CGMS, to ITU Secretary-General emphasizing the need for protecting EESS and passive bands necessary for remote sensing	CGMS/LET/17/926178 sent to ITU on 6 Jul 2017 and circulated to CGMS and WGI list servers. ITU response letter 60(DIR)O-2017-003233 of 11 Jul 2017 circulate on CGMS and WGI list servers 17 Aug 2017 Supporting WMO letter 27975/2017/OBS/WIS/ITS/RF of 31 Jul 2017, circulated on CGMS and WGI list servers 17 Aug 2017	End June 2017	**CLOSED**	1.3
EUM	3.1	A45.02	CGMS/SFCG liaison officer to share SF36-45/D with WGI participants, IROWG chair and IPT-SWeISS members	Circulated at CGMS-45.	End June 2017	**CLOSED**	1.3

CGMS-45 WGI actions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				Inter-sessional webex on frequencies and space weather frequencies took place on 7 Sept 2017.			
WMO	3.1	A45.03	WMO to share with all CGMS members the outcome of the survey prior to the inter-sessional meeting	Draft survey circulated on WGI list server on 13 September 2017.	Aug 2017	**CLOSED**	1.3
CGMS WGI members	4.2	A45.04	WGI members to nominate/confirm points of contact participating in the related inter-sessional meetings	**NOAA**: vanessa.l.griffin@noaa.gov	Jun 2017	**CLOSED**	1.4
EUM	5	A45.05	EUMETSAT to report to CGMS-46 on the status of progress on future EDCP (ESA study)	CGMS-46-EUMETSAT-WP-05	CGMS-46	**CLOSED**	1.2
CGMS members	5	A45.06	WGI participants to review annex I of CGMS-45-EUMETSAT-WP-30 and update the related information in time for the first inter-sessional meeting	Update provided at CGMS-46 (CGMS-46 CGMS-WP-25) May 18 2018 proposed to be closed after Satcom Forum meeting in 2017 and dedicated WP for CGMS-46 CGMS-46-CGMS-WP-25	Sep 2017	**CLOSED**	1.2
CGMS members	6.2	A45.07	WGI to re-assess during the dedicated inter-sessional meetings the aspects of S/W delivery and installation needs in BP.04 for avoiding, if considered adequate, making explicit reference to any tool or package.	Update to be provided by EUMETSAT at CGMS-46 , CGMS-46-CGMS-WP-15	CGMS-46	**CLOSED**	1.4
CGMS members	6.2	A45.08	CGMS member with satellites with a Direct Broadcast service to evaluate the draft template for reporting status of implementation and to address possible updates in the first of the inter-sessional meeting on DB topics identified above.	Discussed at CGMS-46 May 18 2018, template agreed in Inter-sessional and being used by NOAA and EUMETSAT (CGMS-46-NOAA-WP-05 and CGMS-46-EUMETSAT-WP-13) as precursors for other CGMS members. WGI intersessional to be held in 11 April 2018 closure expected at that stage. WGI-IS-DB 6 September 2017: EUMETSAT presented the updated template for the Implementation Status. It was agreed to distribute the document as is across the different CGMS organizations and review its completion during the following intersessional meeting. The template can evolve when feedback is provided. EUMETSAT and NOAA will present their Implementation Status during the next intersessional meeting.	Oct 2017	**CLOSED**	1.4.

CGMS-45 WGI actions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WGI and WGIV chairs and rapporteurs	9 (AOB)	R45.01	A small task team be established to examine the current Terms of Reference of WGs I and IV in light of the thematic areas covered by both working groups. The team should propose additional operational topics as well as possible alternatives for realignment of the themes for both working groups to include the possible merger of the two working groups.	Activity completed and new ToR for both WGs drafted in CGMS-46-CGMS-WP-18 for CGMS 46 consideration and decision	CGMS-46	**CLOSED**	

CGMS-45 WGI recommendations (at CGMS-46)						
"Actionee"	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**Status**	**HLPP ref**
CGMS space agencies	WGI/2	R44.01	CGMS agencies to inform their Frequency Managers on the space weather activities to ensure the necessary protection and coordination at Frequency management level	NOAA has informed their spectrum managers on space weather activities. They are actively working to identify spectrum for the SWFO as well as coordinating with other SMs on COSMIC-2 in preparation for launch. NOAA SM are also engaged in WRC Agenda Item 2.3 "relating to the technical and operational characteristics, spectrum requirements and appropriate radio service designations for space weather sensors"	**Completed**	1.3
CGMS space agencies	WGI/5	R44.02	All CGMS DCS operators to consider making all DCP messages available on the GTS.	Draft Best practices were proposed in CGMS-46 WGI, which recommended that all DCP messages are made available on the GTS. CGMS-46 CGMS-WP-09	**Completed**	1.2

CGMS-45 WGI recommendations (at CGMS-46)						
"Actionee"	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**Status**	**HLPP ref**
CGMS space agencies	WGI	R44.03	From CGMS-44 WGII: 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	Closed with reference to WGI CGMS-44 action A44.08.	**Completed**	5.2

ANNEX V: SUMMARY LIST OF WGII ACTIONS AND RECOMMENDATIONS

CGMS-46 working group II (WGII) actions and recommendations resulting from CGMS-46 deliberations.

CGMS-46 WGII actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/ closing document**	**Deadline**	**Status**	**HLPP ref**

Commented [AT27]: To be completed following review of the text by participants

Summary list of WGII actions and recommendations from previous plenary sessions (CGMS-45 and earlier) following discussions at CGMS-46:

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies	WGII/4	A44.02	CGMS members to submit data to the ICWG intercomparison: full-disk data at 10 minute temporal resolution, 2 km spatial resolution in the native AHI projection is preferred. The data should be submitted by 1 September 2016.	CGMS-46: Action remains open following WGII discussions. WGII IS#2 15 Mar '18: ICWG meets in Nov 2018 and expects it to be closed by then. 26 June 2016 date TBC WGII IS #1 20 Nov '17: Two golden days for intercomparison studies have been chosen: 19 Aug 2015 (ICWG cloud properties), 21 July 2016 (ICWG and IWWG). CGMS-45: remains open since some submissions missing or forthcoming and closing is now foreseen for spring 2018. IPWG will assess the initial results at the next IPWG meeting in Autumn 2018. CGMS-44: ICWG plans underway. Communicate new golden days to CGMS members as soon as decided.	New: CGMS-47 (1 Sept 2016, CGMS-46)	**OPEN**
IMD	WGII/6	A44.08	IMD to provide more information (documentation, availability details, URL) about the RAPID tool,	WGII IS #1 20 Nov '17: Documentation provided by ISRO on 12 June 2017. WMO to forwarded document to CGMSSEC and action is closed accordingly.	1 Oct 2016	**CLOSED**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			for inclusion in the WMO webpage on Visualization Tools to CGMSSEC	CGMS-45: Details to be provided by ISRO.		
IROWG	WGII/8	A44.13	IROWG to define the requirements on timeliness for RO observations	CGMS-46: Closed following WGII discussions.WGII IS#2 15 Mar '18: IROWG is expected to attend/report to CGMS-46.WGII IS #1 20 Nov 2017: N.B. COSMIC-2B has been discontinued in its current form, NOAA is considering alternativesCGMS-45: IROWG-WP-01: We recommend that future RO missions include communications infrastructure that will enable 95 % of the measurements to be available for use in operational models within 30 minutes or less. Data older than 30 minutes is of lower value for current models. Near-real time data latency would be optimal, but is not always practical, and should be considered to be a useful goal for future missions when possible. In the specific case of COSMIC-2 Polar, south polar ground stations (e.g., McMurdo, Troll)should be deployed to reduce data latency IROWG to look at the implications of the requirement on ionospheric processing. IROWG rapporteur to check status (space weather-related); state-of-the-art to be reported out through IROWG	New deadline: CGMS-46(CGMS-45)	**CLOSED**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SCOPE-CM Chair	4	A45.01	SCOPE-CM Chair to inform ISRO about the maturity matrix model, to enable its application to ISRO datasets.	WGII IS#2 15 Mar 2018: Action closed following discussions. WGII IS #1 20 Nov 2017: SCOPE-CM EP-12 held in Oct 2017 (ISRO participated remotely). WGII to follow up on the maturity model	15 Aug 2017	**CLOSED**
IROWG	4	A45.02	IROWG to develop a detailed proposal for OSSEs regarding LEO-LEO MW occultation and GNSS-RO&-reflectometry.	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.	CGMS-47 (1 Nov 2017, CGMS-46)	**OPEN**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
IWWG	4	A45.03	IWWG to liaise with the NOAA representative on PSTG (Jeff Key, jeff.key@noaa.gov) regarding the potential use of 3D winds from AIRS for Year of Polar Prediction studies.	CGMS-46: Action remains open following WGII discussions.WGII IS#2 15 Mar 2018: Yr of polar prediction ongoing. NASA will start looking at these in NRT in their model. Steve Wanzong NASA will talk to NOAA.WGII IS #1 20 Nov 2017: No update; NRT product by Dave Santek (SSEC/U Wisconsin) used by NASA GMAO as part of a project; Steve Wanzong to inform Jeff Key	CGMS-47 (1 Jul 17, CGMS-46)	**OPEN**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
IPWG	4	A45.04	IPWG to produce documentation on precipitation climate data record generation and related activities worldwide, including prospects for continuity	CGMS-46: Action remains open following WGII discussions. WGII IS#2 15 Mar 2018: 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-47 (CGMS-46)	**OPEN**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
GSICS	4	A45.05	GSICS to produce annual state of the observing system report to be delivered at CGMS	CGMS-46: Action remains open following WGII discussions. See CGMS-46-GSCIS-WP-01 WGII IS#2 15 Mar 2018: GRWG/GDWG will provide the template and sample to GSICS-EP as Action in 2018 GSICS annual meeting. Mitch will report in WG II at CGMS-46 WGII IS #1 20 Nov 2017: It is related to the action of GSICS-EP-03 "to develop an approach for an Annual GSICS report on the State of the Observing System with Respect to Instrument Performance and Intercomparisons with GSICS Reference Instruments (from presentations given at the GRWG meeting)". GRWG/GDWG (meeting in March 2018) is preparing for the template regarding the report. It will be reported on in CGMS-46.	CGMS-47 (CGMS-46)	**OPEN**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS agencies	4	A45.06	CGMS Agencies to implement Landing Pages on calibration events accessed via WMO-OSCAR.	CGMS-46: Action remains open following WGII discussions.CGMS-46 WMO-WP-02ESA, IMD, NASA, ROSHYDROMET are requested to provide focal points.WGII IS#2 15 Mar 2018: Other agencies are requested to provide the URL to their respective landing pages.KMA implemented the Landing Pages on COMS calibration events on June 2016. http://nmsc.kma.go.kr/html/homepage/en/landing/info.do#comsIMD Dr. Ashim K. Mitra, Scientist-D (SR-Cal/Val) NASA charles.webb@nasa.govNOAA mitch.goldberg@noaa.govROSH http://planet.rssi.ru/calval/portal-main-en (the web-page is under construction)	CGMS-47 (CGMS-46)	OPEN
CGMSSEC	5	A45.07	CGMS SEC to approach GOFC-GOLD to explore the possibility for CGMS members to become part of the fire project.	CGMS-46: Closed following WGII discussions. 18 May 2018: GOFC-GOLD will provide a presentation to WGII at CGMS-46. 9 Apr 2018: CGMSSEC sent an invitation to CGMS-46 WGII to GOFC-GOLD co-chairs to explore possible cooperation areas. WGII IS #1 20 Nov 2017: No progress yet	CGMS-46	**CLOSED**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMSSEC	5	A45.08	CGMS SEC to explore with AEROSAT if they pursue an activity regarding the use of new-generation GEO data	CGMS-46: Closed following WGII discussions. 18 May 2018: AEROSAT will provide a presentation to WGII at CGMS-46. 10 Apr 2018: Co-chairs of AEROSAT has responded positively, and expects to attend remotely with a presentation. 9 Apr 2018: CGMSSEC sent an invitation to CGMS-46 WGII to AEROSAT to explore possible cooperation aeras. WGII IS #1 20 Nov 2017: No progress yet	31-Jul-17	**CLOSED**

Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS agencies	5	A45.09	To confirm interest in a flood mapping pilot project using GEO satellites, as a proposal for the SCOPE-Nowcasting executive panel meeting (18-20 Sep 2017	CGMS-46: Closed following WGII discussions.See CGMS-46-NOAA-WP-10WGII IS#2 15 Mar 2018: NOAA update: - JPSS flood mapping projects ongoing as part of JPSS proving ground; on GNC-A- Int'l Charter Space and Major Disasters contribution- Contribution by NASA-USAID and other federal agencies supporting the ServirHubs- NOAA and CMA to discuss in week of 21 March 2018 CGMS-46 NOAA-WP-xx plannedCMA supports the intent to collaborateFor discussion at WGII at CGMS-46WGII IS #1 20 Nov 2017:(Ref. plenary action A45.27 and NOAA-CMA plenary action A45.32)INSAT-3D/3DR rainfall products are disseminated. **IMD** confirms its participation in the flood mapping pilot project to SCOPE-Nowcasting EP.CEOS WG Disasters just completed a pilot study on using satellites for flood mapping (http://ceos.org/ourwork/workinggroups/disasters/floods/); No action on the part of SCOPE-Nowcasting action required at this moment.	CGMS-46(Sep 2017)	**CLOSED**

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Status of WGII actions resulting from previous plenary sessions (at CGMS-46)						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
NOAA and CMA (lead), WMO (contributing)	5	A45.10	Develop a proposal to develop GEO-based flood mapping as a potential SCOPE-Nowcasting pilot project. The WMO Multi-Hazard Early Warning System (MHEWS) and the Flash Flood Guidance System (FFGS) should be invited to collaborate in this proposal.	CGMS-46: Closed following WGII discussions. See CGMS-46-NOAA-WP-10 WGII IS#2 15 Mar 2018: CMA has progressed on flood mapping. Discussions to take place during GSICS EP on in-situ NOAA/Mitch Goldberg and CMA/Zhang Peng WGII IS #1 20 Nov 2017: (Ref. plenary Action A45.32) Potential interest by EUMETSAT Land, Nowcasting and Climate SAFs. EUMETSAT to invite experts to participate in next WG II IS call (March 2018).	01-Sep-17	**CLOSED**
CMA	7	A45.11	CMA to add Clear-sky Radiance as an FY-4A baseline product	CGMS-46: Closed following WGII discussions.5 Apr 2018: CGMS Secretariat provided a link to the MSG ATBD to CMA http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_MSG_MET_PROD_ATBD&RevisionSelectionMethod=LatestReleased&Rendition=Web. CMA confirmed it plans to add CSR products to its operational products list (but this might take some time to do so).WGII IS#2 15 Mar 2018: CMA would like guidance materials, end products JMA, EUMETSAT, NOAA provide guidance material (ATBD etc) to CMA regarding CSR products. WGII IS #1 20 Nov 2017:Not yet added as baseline product	CGMS-46	**CLOSED**

ANNEX VI: SUMMARY LIST OF WGIII ACTIONS AND RECOMMENDATIONS

CGMS-46 working group III (WGIII) actions and recommendations resulting from CGMS-46 deliberations:

Commented [AT29]: Completeness pending review of report text by participants.
To be modified as necessary.

WGIII actions raised at CGMS-46							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGIII/4.1	A46.01	7th WMO Impact Workshop to include EM orbit impact among its science questions		CGMS-47	**OPEN**	
WGIII	WGIII/4.2	A46.02	WGIII to consider how to account for the unique SST conical microwave imager in the CGMS Baseline and Risk Assessment		CGMS-47	**OPEN**	
CGMS members	WGIII/7.3 (plen C.2)	A46.03	On OSCAR space (CGMS-46-WMO-WP-02): Nominated OSCAR/Space Support Team (O/SST) pocs (ref. CGMS-46 A46.02) to review and provide updates to the Oscar landing pages relevant to their respective agencies to tkurino@wmo.int and wbalogh@wmo.int copy to cgmssec@eumetsat.int	Moved from plenary	25 Sep 2018	**OPEN**	
CGMSSEC, WMO	WGIII/7.3 (plen C.2)	A46.04	On OSCAR space (CGMS-46-WMO-WP-02): CGMSSEC to investigate the provision of a dedicated resource to support the CGMS risk assessment and coordinate the provision of OSCAR/Space content.	Moved from plenary	end 2018	**OPEN**	1.1

WGIII recommendations raised at CGMS-46					
Lead	**AGN item**	**Rec #**	**Description**	**Feedback/Conclusion**	**HLPP ref**
CGMSSEC (NWP SAF)	WGIII/3	R46.01	CGMSSEC to enquire with EUMETSAT NWP SAF Radiative Transfer Model (RTM) support for FY-2E/-2H Indian Ocean coverage		
CGMS Members	WGIII/ 7.3	R46.02	CGMS Members recommended to utilise OSCAR/Space database as a reference common tool for gap analysis and risk assessment.		

Summary list of WGIII actions and recommendations from previous plenary sessions (CGMS-45 and earlier) following discussions at CGMS-46:

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS members	WGIII/	A44.01	CGMS Members: To review and react to the WIGOS Vision 2040 as it develops	WGIII IS #3: Closed in view of progress of the Vision. If needed, new actions will be raised on the occasion of CGMS-46. Feb 2018: CGMSSEC has provided an update to WMO based on feedback from CGMS Members (see also CGMS-45 plenary actions). Nov 2017: WMO is currently consolidating the space part into an integrated Vision 2040 document for which a draft will be presented to CGMS-46. Jul 2016: Input provided by EUM, NOAA	(Aug 2016) New deadline: CGMS-46	**CLOSED**	1.1

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGIII/	A44.02	WMO Secretariat to present the draft Vision at CEOS, GEO plenary sessions 2016.	WGIII IS #3 10 Apr 2018: WMO to confirm if the vision will be presented to CEOS. (Not on the CEOS SIT AGN in April 2018). WGIII IS 28 Nov 2017: WMO organised a side event at GEO plenary. WMO will seek to present the Vision to CEOS in the course of 2018. CGMS-45: Status presented, CGMS agencies invited to provide comments (including on carbon observations). Deferred to next plenary cycle (2017)	(End 2016) New deadline: CGMS-46	**OPEN**	1.1

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS members	WGIII/3	A44.03	CGMS operators nominate focal points for maintaining these elements (dates, landing pages), and other elements included in OSCAR/Space (e.g., instrument characteristics).	CGMS-46: Discussed, this action has been closed and a new related action opened (for remaining members/observers to provide a focal point). CGMS-46 WMO-WP-02 WGIII IS#3 10 Apr 2018: Other CGMS members are requested to provide their points of contact. O/SST: • CMA: lufeng@cma.gov.cn • CNES: TBD • CNSA: TBD • CSA: TBD • ESA: ivan.petiteville@esa.int • EUMETSAT: TBD • IMD: ashimmitra@GMAIL.COM, sunil.peshin@gmail.com • ISRO: jvthomas@isro.gov.in • JAXA: oki.riko@jaxa.jp • JMA: r_yoshida@met.kishou.go.jp • KMA: dohyeong@gmail.com	30 Sep 2018 (31 Jul 2017)	**CLOSED**	5.3

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				• NASA: charles.webb@nasa.gov • NOAA: Matthew.Butler@noaa.gov • ROSC: avkarelin@mail.ru • ROSH: uspenskys@planet.iitpp.ru			
CGMS	WGIII/4	A45.01	Initiate review of CGMS Baseline, to be synchronised with development of WMO "Vision for WIGOS in 2040"	CGMS-46: Closed following WGIII discussions. 29 May 2018: Closure proposed. Discuss and covered at CGMS Baseline and Contingency Plan Workshop April 30 - May 2, 2018 WGIII #3 10 Apr 2018: Ongoing To be discussed at the workshop at WMO on 30 Apr-2 May 2018.	CGMS-46	**CLOSED**	

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGIII/ 5.1.1	A45.02	Update the risks assessment and gap analysis of implementation against the CGMS baseline; include the potential risk of gaps in the capability for passive microwave imaging in this update	CGMS-46: Closed following WGIII discussions. CGMS-46 WMO-WP-14 29 May 2018: **Closure proposed**: Microwave imaging was included in CGMS baseline. WGIII IS#3 10 Apr 2018: Will be addressed at the Apr/May workshop , and the outcome will be provided to CGMS-46. WGIII IS 28 Nov 2017: WMO to provide a process proposal at the Apr/May 2018 workshop.	CGMS-46	**CLOSED**	
CGMS members	WGIII/ 5.4	A45.03	WMO to support one face to face Inter-sessional meeting to start off new planning effort.	WGIII IS#3 10 Apr 2018: Closed since the meeting is now scheduled. Workshop planned for 30/4-2/5 2018 at WMO, Geneva. Agenda to be discussed at the next WGIII inter-sessional and circulated ~end January 2018	CGMS-46	**CLOSED**	

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
SETT	WGIII/8	A45.04	Propose a way forward for guiding and coordinating socio-economic benefit studies among the CGMS community.	CGMS-46: Remains open following WGIII discussions. See CGMS-46-NOAA-WP-15 WGIII IS#3 10 Apr 2018: Apr/May meeting at which stage more information will follow. SETT seeking to identify new case studies. WMO recommends looking at risk analysis and SETT could look at potential consequences thereof.	CGMS-47 (CGMS-46)	**OPEN**	
WGIII and SWTT	WGIII/9	A45.05	WGIII and SWTT to organise a joint inter-sessional to discuss SW updates to CGMS baseline	16 Oct 2017: SWTT draft space-based space weather baseline circulated, which includes SWTT and joint SWTT/WGIII discussions WGIII-SWTT IS held 27 Sep 2017.	Jul-17	**CLOSED**	

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGIII/ 10	A45.06	Include impact of data latency among science questions posed to 7th WMO Impact Workshop (in 2020)	CGMS-46: Closed following WGIII discussions (new related action raised). WGIII IS#3 10 Apr 2018: WMO to confirm to what extent this is incorporated properly in the questions and address it at CGMS-46 as the latest. WGIII IS 28 Nov 2017: WMO expects to form the organising committee in the course of 2018 to address the WS content.	End 2018	**CLOSED**	
CGMS Agencies	WGIII/ 5.1.2	A45.08	Agencies to consider contributing resources (financial, in-kind, or via secondment) to the development and maintenance of OSCAR/Space	CGMS-46: Remains open following WGIII discussions. WGIII IS#3 10 Apr 2018: CGMS-46 WMO-WP-xx to provide a status report, issues, and way forward. Linked to the issues of the gap analysis process. WGIII IS 28 Nov 2017: WMO to articulate the needs and what type of support is needed to then be circulated to space agency members	CGMS-47 (CGMS-46)	**OPEN**	

Commented [AT30]: ??

WGIII actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WGIII	WGII/4	A45.07	**Action from WGII (from CEOS VC SST):** Study the continuity of the current constellation of passive microwave sensors (for high quality satellite precipitation products for weather, climate and hydrological applications) through proper coordination of satellites, sensors and equatorial crossing times.	CGMS-46: Closed following WGIII discussions. 29 May 2018: **Closure proposed.** Discussed and covered at CGMS Baseline and Contingency Plan Workshop April 30 - May 2, 2018 WGIII IS#3 10 Apr 2018: To be discussed at the Apr/May workshop. WGIII IS 28 Nov 2017: To be considered in the framework of the gap analysis, contingency planning/baseline at the March 2018 workshop.	CGMS-46	**CLOSED**	

Recommendations raised at previous plenary sessions following CGMS-46 discussions					
"Actionee"	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**HLPP ref**
WMO	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.		2.7

Recommendations raised at previous plenary sessions following CGMS-46 discussions					
"Actionee"	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**HLPP ref**
CGMS space agencies	WGII	R44.03	**From CGMS-44 WGII**: CGMS Members to continue an operational constellation of conically-scanning microwave platforms to guarantee sustained support for the current level of capability	**COMPLETED** CGMS-46: Closed following WGIII discussions. 29 May 2018: Closure proposed. Discussed and covered at CGMS Baseline and Contingency Plan Workshop April 30 - May 2 Ref. gap analysis discussion	
CGMS space agencies	WGII	R44.04	**From CGMS-44 WGII:** CGMS to have a special discussion on the value of formation flying similar to the A Train – especially for precipitation and other hydrological applications		
CGMS space agencies	WGII	R44.05	**From CGMS-44 WGII:** 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 members	WGIII/ 2.2	R43.01	CGMS members are encouraged to consider including RO capabilities on all future polar-orbiting satellites.	Discussed at CGMS-44, 45, and 46	1.1.4

ANNEX VII: SUMMARY LIST OF WGIV ACTIONS AND RECOMMENDATIONS

CGMS-46 working group IV (WGIV) actions and recommendations resulting from CGMS-46 deliberations.

CGMS-46 WGIV actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/ closing document**	**Deadline**	**Status**	**HL ref**

Commented [AT31]: To be completed following review of the text by participants.

Status summary of WGIV actions and recommendations resulting from from previous plenary session (CGMS-45 and earlier) following CGMS-46 discussions.

WGIV actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
EUMETSAT	WGIII/2	A43.02	(Action transferred from WGIII) EUMETSAT to propose dissemination plan for data from Indian Ocean Data Coverage partners identified in CGMS-43-EUM-14 roadmap.	Progress reported in CGMS-46-EUMETSAT-WP-08 CGMS-46-ISRO-WP-05 and closure expected in autumn 2018. previous related working papers: CGMS-45-EUMETSAT-WP-37 CGMS-45-ISRO-WP-05 CGMS-44 EUM-WP-14	(CGMS-44/45/46) ***New deadline Dec 2018***	**OPEN**	1.1.6

WGIV actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
NOAA	(WGI/4) WGIV/7	A43.03	NOAA to consider including GLM products in the HRIT stream	At CGMS-46: A usable GLM product provided to PDA is still in development within the National Weather Service as the current GLM product available in PDA is not a feasible solution for HRIT due to bandwidth limitations. NOAA is testing multiple imagery configurations to determine availability and frequency of all level 2 products from GOES-R series satellites including GLM. From this information coupled with end user feedback, NOAA can balance the demand for multiple bands of high resolution imagery data and the inclusion of level 2 products without increasing current latencies.	(CGMS-44, 45) **New deadline CGMS-47**	**OPEN**	
TFMI	(WGI/6) WGIV/ 10.1	A43.05	CGMS Task Force on Metadata Implementation to define discovery metadata for DBNET	No progress due to lack of resources by key TFMI members, will be addressed with TFMI in inter-sessional meetings.	(CGMS-44, -45) ***New deadline CGMS-47***	**OPEN**	3.4.1

WGIV actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
CGMS members		A43.06	CGMS members to provide a listing of their data access portals.	At CGMS-46: CGMS-46-NOAA-WP-17 **CMA**: http://data.cma.cn/en http://satellite.nsmc.org.cn/PortalSite/default.aspx?currentculture=en-US **EUM**: http://navigator.eumetsat.int https://eoportal.eumetsat.int CGMS-44-EUMETSAT-WP-17 **ISRO**: http://mosdac.gov.in **IMD:** www.satellite.imd.gov.in and www.rapid.imd.gov.in **JMA/MSC:** http:/www.jma-net.go.jp/msc/en/ **NASA**: https://search.earthdata.nasa.gov **NOAA**: CGMS-44-NOAA-WP-14 PPT **ROSC**: CGMS-45-ROSCOSMOS-WP-03	(CGMS-44) **New deadline CGMS-46**	**Closed**	-
EUMETSAT	WGIV/7	A44.02	To provide a timeline for the users preparation information for MTG, in accordance with "CGMS-44-WMO-WP-02 Best Practices for Achieving User Readiness for New Meteorological Satellites"	At CGMS-46: WG-IV agenda item 11.2 verbal presentation. WG-IV WEBEX 18 Jan 2017 EUMETSAT: High Level information for Saturn was provided. CGMS-45: Ongoing work, keep open until more mature. Extend deadline to WG-IV IS meeting.	(30 Dec 2016) ***New deadline Dec 2017***	**Closed**	5.3

WGIV actions open from previous plenary sessions (at CGMS-46)							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
CGMS Secretariat	WGIV (WGII)	A44.05	From CGMS-44 WGII: CGMS operators and WMO to work with GODEX-NWP to explore options for optimal data exchange of advanced data from next-gen GEOs.	At CGMS-46: No further input, feedback from GODEX-NWP required. 22 May 2018: To be discussed in WGIV at CGMS-46, which needs participation/representation from WGII to explain the background and purpose to enable WGIV to move forward. The next GODEX-NWP meeting will be held 27-30 Nov 2018 in New Delhi, India. WG-IV WEBEX 18 Jan 2017: WMO: GODEX-NWP scheduled May 2017, needs will be addressed there, WMO will provide feedback. CGMS-45: GODEX-NWP not yet ready to provide feedback.	(CGMS-45, CGMS-46) CGMS-47	**OPEN**	

WGIV CGMS-45 following CGMS-46 discussions:							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
JMA/KMA	WGIV/4	A45.01	JMA/KMA to coordinate a regional user survey in RA II/V based on the WMO 2016 global survey (CGMS-45 WMO-WP-15) in collaboration with BOM and WMO, taking into consideration the communication satellite broadcast systems available in the regions.	CGMS-46-Joint-JMA/KMA-WP-02, user survey planned in 2018. **JMA** 11 Oct '17: The Coordinating Group meeting of RA II WIGOS satellite project on 21 Oct '17 will take place in Vladivostoc after AOMSUC-8. The topic regarding the user survey will be included in the agenda.	(CGMS-46) ***New deadline CGMS-47***	**OPEN**	2.1, 2.2
TFMI	WGIV/9	A45.02	TFMI to work on the WIGOS metadata standard, in particular to assess the WIGOS Metadata OGC Observations and Measurements standard, and recommend possible adjustments for satellite observations to the WMO WIGOS team.	No progress due to lack of resources by TFMI key members, will be addressed with TFMI in inter-sessional meetings.	(CGMS-46) ***New deadline CGMS-47***	**OPEN**	2.7
CGMS satellite operators	WGIV/ 12.1	A45.03	CGMS satellite operators to provide documentation on the data formats for space weather observations, and to forward related space weather metadata to the WIS.	CGMS-46-NICT-WP-02 see also CGMS-46 WGIV/12.1	(CGMS-46) ***New deadline CGMS-47***	**OPEN**	2.8

WGIV CGMS-45 following CGMS-46 discussions:							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP**
CGMS satellite operators	WGIV/ 12.2	A45.04	CGMS members to report on the status of near real-time access to space weather data from instruments hosted on meteorological satellites. This includes data from space environment monitor suites, solar X-ray/EUV sensors, and radio occultation instruments on any orbiting satellite. Members are asked to detail product level definitions including near real-time availability of each level and user access required to obtain each level of data.	CGMS-46-NICT-WP-02 see also CGMS-46 WGIV/12.1	(CGMS-46) ***New deadline CGMS-47***	**OPEN**	2.9
WG IV	WGII/4	A45.05	**Action from WGII:** Ensure timely (< 1 hr) and free access to all geostationary visible, IR and water vapour data that is required to improve global hydrological prediction.	Put on hold until requirements are clarified (see new action A46.xx) 29 May 2018: NOAA provides this data at the requested latency. 14 Mar 2018: IPWG recognises it is not feasible having all channel data from the new era of GEO satellites, however: a) At a minimum, sustained 30-min refresh full disk longwave IR (10 to 15-min desired), near realtime access; b) Given the expanded spectral bands of the operational global geo constellation, additional 6.2 um water vapor channel data, at the same	CGMS-47	**OPEN**	

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				refresh as IR c) Finally, visible channel data desired 25 Oct '17: CGMSSEC has sent a message to IPWG co-chairs to this purpose asking for more details to enable WGIV to react. [enquiry sent to R Ferraro 19 Feb 2018] WGIV IS 11 Oct '17: This action was discussed and WGIV concluded the request is too open and would have a significant impact on the data access in this form. The following clarification was formulated and CGMSSEC is asked to pass this on to the IPWG: The precipitation community to clarify what data are needed, in terms of time/spatial resolution, spectral channel selection, and sub-setting. CGMSSEC to follow this up with IPWG.			

WGIV recommendations from CGMS-45 or earlier following CGMS-46 discussions						
Actionee	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**	**Status**	**HLPP**
CGMS space agencies	WGIV/7	R42.01	Satellite operators to provide WIS Discovery Metadata Records, compliant to WIS requirements and following the guidance to be provided by the CGMS-WMO Task Force on metadata implementation, in order to facilitate satellite information discovery and access	CGMS-45: Recommendation still valid, to be retained. **IMD:** To be conveyed in due course [Nov 2017] NOAA: Related to metadata, the best reference is NGDC metadata provided here the URL: http://www.ngdc.noaa.gov/metadata/ WGIV CGMS-43 discussions: Ongoing and routine activity. WGIV webex 9 Dec 2015: To be taken up at the TT on Meta Data meeting the week of 14 Dec 2015. See CGMS-44-EUMETSAT-WP-17.	**OPEN**	2.7
CGMS members	WGIV/3.2	R44.01	CGMS members to contribute to the implementation of the Best Practices for User Readiness for meteorological satellite systems under development, both GEO and LEO	CGMS-45: Recommendation still valid - retained. Closed for NOAA.	**OPEN**	5.3
CGMS members	WGIV/3.2	R44.02	CGMS members to continue the provision of up-to-date User Readiness information in the SATURN portal	CGMS-45: Recommendation still valid - retained. **PoC NOAA**: Mitch.Goldberg@noaa.gov	**OPEN**	5.3

ANNEX VIII: 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 new actions and recommendations raised following the SWTT/SWCG deliberations at CGMS-46. These are in addition to those actions and recommendations carried over from previous plenary sessions listed at the start of the SWTT report.

SWTT/SWCG actions raised at CGMS-46							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/ closing document**	**Deadline**	**Status**	**HLPP ref**
SWTT	SWTT/7	A46.01	CGMS SWTT to review the contents related to space weather stored in OSCAR/Space database.		CGMS-47	**OPEN**	5.2.3
SWTT and WMO	SWTT/9	A46.02	Clarify what information needs to be provide in each field of the space weather anomaly form		February 2019	**OPEN**	5.2.3
CGMS Members	SWTT/9	A46.03	Expand on space weather template inputs to include full investigations when available and when possible.		CGMS-47	**OPEN**	5.2.3
~~CGMSSEC~~	~~Plenary item?~~	~~A46.04~~	~~Invite representative from ISES to be permanent observer to SWTT~~		~~December 2018~~	~~**OPEN**~~	~~5.2.1~~
SWTT	SWTT/??	A46.05	Survey CGMS Members to identify cross-member use of space weather data		December 2018	**OPEN**	5.2.3
SWTT	SWTT/??	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	**OPEN**	2.10
SWTT and WGI	SWTT/??	A46.07	Develop strategies to increase reporting into the space weather anomaly database through intersessional meetings with WGI		CGMS-47	**OPEN**	5.2.3
SWTT (from WGI)	SWTT/??	A46.08	Provide use case(s) from space weather anomaly analyses and any recommendations to operators arising		CGMS-47	**OPEN**	5.2.3

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SWTT/SWCG actions raised at CGMS-46							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/ closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS Members	SWTT/??	A46.09	CGMS Members to nominate representatives to participate in a task group on space weather calibration		October 2018	**OPEN**	5.2.2

CGMS-46 action raised by SWTT/SWCG for WGIV						
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**	**HLPP**
WGIV	SWTT/??	A46.10	From SWTT/SWCG to WGIV: Determine data formats of space weather measurements use by CGMS Members, particularly particle sensor data (GEO and LEO) and magnetic field data (GEO)	CGMS-47	**OPEN**	2.9

CGMS-46 SWTT recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**HLPP**
CGMS	SWTT/3	R46.01	CGMS-46 plenary to endorse Space Weather Coordination Group terms of reference	

The below table provides the status of the SWTT/SWCG actions and recommendations resulting from previous plenary sessions (CGMS-45 and earlier) and following CGMS-46 discussions:

SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
SWTT		A44.01	SWTT to conduct a workshop with leadership from the various space weather communities that will benefit from CGMS coordination of space-based space weather observing systems.	CGMS representatives attended European Space Weather Week, Workshop on Energetic Electrons, UN/US international space weather workshop, and IPT-SWeISS meetings.	15 Dec 2016	**CLOSED**	5.2.1
CGMS space agencies	SWTT/7	A45.01	SWTT members to identify initial baseline for space-based space weather measurements and hold inter-sessional with WGIII to plan forward analyses. This will be finalised in the first inter-sessional to be held on 14 September 2017.	SWTT IS held on 14 Sep 2017. Joint IS held on 27 Sep 2017 discussing baseline. 12 Oct: 2nd SWTT Inter-sessional held Proposed space-based space weather CGMS baseline distributed 16 Oct 2017 to SWTT and WGIII.	30 Sep 2017	**CLOSED**	1.1.7

SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
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.	3 June, discussions are actively with GSICS, but further coordination with GSICS is required. 1 Dec 2017, discussed during CGMS topical discussion at European Space Weather Week; awaiting submittal of space weather intercalibration product – energetic electrons Oct 2017, Decision made to pursue GSICs as framework for inter calibrations of space weather products. 12 Oct 2017, discussed GSICS as topical discussion at ESWW. 14 Sep 2017, GSICS materials discussed during IS. 11	30 Dec 2017	**OPEN**	3.1.3

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SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
SWTT Co-Chairs	SWTT/10 (WGII/9)	A45.03	Invite a GSICS representative to the next SWTT inter-sessional meeting; and to a topical discussion during the European Space Weather Week Nov-Dec 2017 in Oostende, Belgium	1 Dec 2017, discussed during CGMS topical discussion at European Space Weather Week, Toshi Kurino presented CGMS topical discussion 11 Oct 2017, Decision made to pursue GSICs as framework for inter calibrations of space weather products. ESWW will be determined on 12 Oct 2017. Action on GSICS to name ESWW attendee. 14 Sep 2017, Mitch Goldberg attended the SWTT IS.	30 Dec 2017	**CLOSED**	3.1.3

SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CGMS space agencies	SWTT/11	A45.04	CGMS operators report on internal procedures to determine if an anomaly results from a space weather event including what thresholds are used.	14 Sep 2017, operator survey reviewed during SWTT IS. Updated inputs sent to WGI for review. Comments incorporated and updated survey questions distributed on 10 Oct 17 by Joaquin to WGI; and by Elsayed to SWTT for collection by WGI (Responses provided by EUM, JMA, NASA, NOAA, …) 7 Nov 17: Joint meeting to discuss results from space weather anomalies survey	30 Dec 2017	**CLOSED**	
SWTT Co-Chairs	SWTT/11	A45.05	CGMS to engage WMO IPT-SWeISS to encourage incorporation of an analysis of anomaly collection, reporting, and resolution processes into their work plan.	3 June 2018: Elsayed Talaat attended for CGMS. Anomaly collection, reporting, and resolution process included in their work plan. SWTT Co-chair Elsayed Taalat, NASA, nominated (EUM/SCIR/LET/17/928853 of 5 July 2017). Door open to further nominations.	30 Dec 2017	**CLOSED**	

SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				19 Oct 17: Elsayed emailed the WMO, STEERING GROUP ON RADIO FREQUENCY COORDINATION (SG-RFC), Collection of Technical and Operational Characteristics for RF-based Space Weather Sensors, to Toshi for its inclusion into the next IPT-SWIeSS meeting 3 Nov 17: Co-chair learned while attending Space Weather meeting in Canada that the deadline is late December for Statement of Guidance for Space Weather Observation (SGSWO) comments			
SWTT Co-Chairs	SWTT/10	A45.06	Engage ISES as an observer for CGMS plenary meeting and/or include with SWTT inter-sessional activities.	1 Dec 17: Discussed with Terry Onsager, part of ISES, during ESWW; he co-sponsored the CGMS discussion at ESWW	30 Dec 2017	**CLOSED**	5.2.1
SWTT Co-Chairs	SWTT/10	A45.07	Survey CGMS member operators regarding if and how actions are taking	Included in SWTT A45.04 7 Nov 17: Joint meeting to discuss	30 Dec 2017	**CLOSED**	3.6.4

SWTT/SWCG actions resulting previous plenary sessions and after CGMS-46 discussions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
			by satellite operators in response to space weather threats and/or conditions	results from space weather anomalies survey			
SWTT	SWTT/15	A45.08	SWTT develops recommendation as to future structure of the interface between CGMS and the space weather community going forward.	3 June 2018: Terms of reference included in CGMS-46-SWTT-WP-01. 1 Dec 17: SWTT will create Terms of Reference to become Ad hoc Working Group on Space Weather Coordination to be presented at CGMS-46	CGMS-46	**CLOSED**	

SWTT/SWCG recommendations raised at previous plenary sessions and following CGMS-46 discussions						
Lead	**AGN item**	**Rec #**	**Description**	**Action feedback/closing document**	**Status**	**HLPP ref**
		R44.01	**On Space Weather Task Team:** Sustain the SWTT for another year in order to enable CGMS space weather integration.	18 May 2018: A proposal will be made to CGMS-46 plenary to transfer SWTT into a Space Weather Coordination Group (SWCG) (SWTT agenda item 3). CGMS-45 discussions: Sustain the SWTT for another year in order to enable CGMS space weather integration into existing Working Groups until CGMS-46. CGMS-45: CGMS presentation and discussions have occurred at European Space Weather Week (ESWW) and UNCOPUOS. Discussions have been held with leadership of ISWI, COSPAR, and ISES. CGMS SWTT organised electron inter-calibration mini-workshop at US Space Weather Workshop CGMS space weather role is included in draft UNCOPUOS framework for space weather services.	**Completed**	5.2

SWTT/SWCG recommendations raised at previous plenary sessions and following CGMS-46 discussions						
Lead	**AGN item**	**Rec #**	**Description**	**Action feedback/closing document**	**Status**	**HLPP ref**
				Planned: Dedicated CGMS ESWW topical discussion meeting ("Space Weather Activities in the Coordination Group for Meteorological Satellites.") - Nov 2017 Presentation of CGMS at UN/US ISWI workshop - Jul/Aug 2017 CGMS-44: Recommendation endorsed by *CGMS-44* plenary.		

ANNEX IX: LIST OF PARTICIPANTS

CGMS-46 – Plenary List of Participants		
Organisation	Lastname	Firstname
CGMS Sec	Mikael	RATTENBORG
CGMS Sec	Sylwia	MIECHURSKA
CGMS Sec	Anne	TAUBE
CMA	Feng	LU
CMA	Dongfeng	LUO
CMA	Shihao	TANG
CMA	Xiang	FANG
ESA	Ivan	PETITEVILLE
EUMETSAT	Alain	RATIER
EUMETSAT	Bojan	BOJKOV
EUMETSAT	Joerg	SCHULZ
EUMETSAT	Livio	MASTRODDI
EUMETSAT	Joachim	SAALMÜLLER
EUMETSAT	Klaus Peter	RENNER
EUMETSAT	Kenneth	HOLMLUND
EUMETSAT	Sean	BURNS
EUMETSAT	Paul	COUNET
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IMD	Suman	GOYAL
IMD	Ashim	KUMAR MITRA
IMD	SUNIL	PESHIN
IMD	Virendra	SINGH
IMD	V.S	PRASAD
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IPWG	Ziad	HADDAD
IROWG	Ulrich	FOELSCHE
ISRO	Pradeep	THAPLIYAL
ISRO	Darshan	PATEL
ISRO	Atul	VARMA
ISRO	Tapan	MISRA
ISRO	Raj	KUMAR
ISRO	Jayaprakash V	THOMAS
ISRO	Chandra Mohan	KISHTAWAL
ISRO	Rashmi	SHARMA
ISRO	Anjani	MALINEEDI
JAXA	Moeka	YAMAJI
JAXA	Akiko	SUZUKI
JMA	Hiroshi	KUNIMATSU

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Idem for all tables below.

Organisation	Lastname	Firstname
JMA	Hiroya	ENDO
JMA	Koji	YAMASHITA
JMA	Seiichiro	KIGAWA
KMA	Eun Ha	SOHN
KMA	Jinho	SHIN
KMA	Sung-Rae	CHUNG
KMA	Hoon	PARK
KMA	Dohyeong	KIM
NASA	Jack	KAYE
NASA	Elizabeth	YOSEPH
NICT	Tsutomu	NAGATSUMA
NOAA	Elsayed	TALAAT
NOAA	Charles	WOOLDRIDGE
NOAA	Paul	DIGIACOMO
NOAA	Mitch	GOLDBERG
NOAA	Brent	GORDON
NOAA	Matthew	BUTLER
NOAA	Beau	BACKUS
NOAA	Joseph	PICA
NOAA	Ajay	MEHTA
NOAA	Steven	PETERSEN
NOAA	Kerry Ann	SAWYER
NOAA	Vanessa	GRIFFIN
NOAA	Natalia	DONOHO
NOAA	Ame	FOX
NOAA	Karen	ST. GERMAIN
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ROSCOSMOS	Vitaly	MIRONICHEV
ROSCOSMOS	Teselkin	SERGEY
ROSCOSMOS	Alexander	TKACHENKO
ROSCOSMOS	Sergey	ZORIN
ROSCOSMOS	Dmitry	TROFIMOV
ROSCOSMOS	Alexander	KARELIN
ROSHYDROMET	Sergey	TASENKO
ROSHYDROMET	Tatiana	LABENETS
ROSHYDROMET	Alexey	RUBLEV
ROSHYDROMET	Vasily	ASMUS
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WMO	Lars Peter	RIISHOJGAARD
WMO	Werner	BALOGH
WMO	Toshiyuki	KURINO

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IWWG	Steve	WANZONG
JMA	Ryo	YOSHIDA
JAXA	Misako	KACHI

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EUMETSAT	Sean	BURNS
EUMETSAT	Joachim	SAALMÜLLER
EUMETSAT	Livio	MASTRODDI
IMD	Ashim	KUMAR MITRA
IMD	Virendra	SINGH
IMD	V.S	PRASAD
IMD	Suman	GOYAL
ISRO	Tarun	PANT
ISRO	Pradeep	THAPLIYAL
ISRO	P.V.	KUMARAMOHAN
ISRO	Jayaprakash V	THOMAS
JMA	Hiroshi	KUNIMATSU
JMA	Hiroya	ENDO
KMA	Jinho	SHIN
NICT	Tsutomu	NAGATSUMA
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NOAA	Charles	WOOLDRIDGE
NOAA	Mitch	GOLDBERG
NOAA	Brent	GORDON
NOAA	James	MCNITT
NOAA	Matthew	BUTLER
NOAA	Beau	BACKUS
NOAA	Vanessa	GRIFFIN
NOAA	Natalia	DONOHO
ROSHYDROMET	Tatiana	LABENETS
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EUMETSAT	Joachim	SAALMÜLLER
EUMETSAT	Kenneth	HOLMLUND
IMD	Ashim	KUMAR MITRA
IMD	Virendra	SINGH
IMD	Suman	GOYAL
IPWG	Ziad	HADDAD
IROWG	Anthony	MANNUCCI
IROWG	Ulrich	FOELSCHE
ISRO	Pradeep	THAPLIYAL
ISRO	Atul	VARMA
ISRO	Raj	KUMAR
ISRO	Tarun	PANT
ISRO	Rashmi	SHARMA
ISRO	Jayaprakash V	THOMAS
JAXA	Moeka	YAMAJI
JMA	Koji	YAMASHITA
JMA	Seiichiro	KIGAWA
KMA	Dohyeong	KIM
NASA	Jack	KAYE
NASA	Elizabeth	YOSEPH
NOAA	Elsayed	TALAAT
NOAA	Paul	DIGIACOMO
NOAA	Mitch	GOLDBERG
NOAA	Matthew	BUTLER
NOAA	Ajay	MEHTA
ROSCOSMOS	Alexander	TKACHENKO
ROSCOSMOS	Sergey	ZORIN
ROSCOSMOS	Dmitry	TROFIMOV
ROSCOSMOS	Alexander	KARELIN
ROSHYDROMET	Tatiana	LABENETS
ROSHYDROMET	Alexey	RUBLEV
WMO	Werner	BALOGH

Via Webex		
ECMWF	Stephen	ENGLISH
ECMWF	Niels	BORNMAN
EUMETSAT	Rob	ROEBELING
GOFC-GOLD	Martin	WOOSTER
ICWG	Andrew	HEIDINGER
IWWG	Steve	WANZONG
NASA	Ralph	KAHN
NASA	Tsengdar	LEE

CGMS-46 - WGIII List of Participants		
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CMA	Xiang	FANG
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EUMETSAT	Livio	MASTRODDI
EUMETSAT	Sean	BURNS
EUMETSAT	Paul	COUNET
ISRO	Jayaprakash V	THOMAS
JMA	Hiroshi	KUNIMATSU
JMA	Hiroya	ENDO
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NOAA	Ajay	MEHTA
NOAA	Vanessa	GRIFFIN
NOAA	Natalia	DONOHO
NOAA	Beau	BACKUS
NOAA	Matthew	BUTLER
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ROSCOSMOS	Alexander	KARELIN
WMO	Lars Peter	RIISHOJGAARD
WMO	Toshiyuki	KURINO

CGMS-46 - WGIV List of Participants		
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CMA	Dongfeng	LUO
CMA	Xiang	FANG
ESA	Ivan	PETITEVILLE
EUMETSAT	Klaus Peter	RENNER
EUMETSAT	Sean	BURNS
EUMETSAT	Joachim	SAALMÜLLER
EUMETSAT	Livio	MASTRODDI
IMD	Ashim	KUMAR MITRA
IMD	Virendra	SINGH
IMD	V.S	PRASAD
IMD	Suman	GOYAL
ISRO	Atul	VARMA
ISRO	Tarun	PANT
ISRO	Pradeep	THAPLIYAL
ISRO	P.V.	KUMARAMOHAN
ISRO	Jayaprakash V	THOMAS
JAXA	Moeka	YAMAJI
JMA	Hiroshi	KUNIMATSU
JMA	Hiroya	ENDO
KMA	Jinho	SHIN
NICT	Tsutomu	NAGATSUMA
NOAA	Elsayed	TALAAT
NOAA	Charles	WOOLDRIDGE
NOAA	Brent	GORDON
NOAA	James	MCNITT
NOAA	Matthew	BUTLER
NOAA	Beau	BACKUS
NOAA	Vanessa	GRIFFIN
NOAA	Natalia	DONOHO
ROSCOSMOS	Teselkin	SERGEY
ROSCOSMOS	Sergey	ZORIN
ROSCOSMOS	Dmitry	TROFIMOV
ROSHYDROMET	Sergey	TASENKO
ROSHYDROMET	Alexey	RUBLEV
ROSHYDROMET	Vasily	ASMUS
WMO	Toshiyuki	KURINO

Via Webex		
EUMETSAT	Anders	SOERENSEN
JMA	Ryo	YOSHIDA

CGMS-46 - SWTT List of Participants		
Organisation	**Lastname**	**Firstname**
CGMS SEC	RATTENBORG	Mikael
CGMS SEC	TAUBE	Anne
CMA	FANG	Xiang
CMA	LU	Fang
CMA	LUO	Dongfeng
EUMETSAT	BURNS	Sean
EUMETSAT	HOLMLUND	Kenneth
IMD	KUMAR MITRA	Ashim
IMD	GOYA	Sumon
IROWG	MANNUCCI	Anthony
ISRO	THAPLIYAL	Pradeep
ISRO	PANT	Tarun
JMA	KUNIMATSU	Hiroshi
JMA	ENDO	Hiroya
KMA	KIM	Dohyeong
NICT	NAGATSUMA	Tsutomu
NOAA	TALAAT	Elsayed
NOAA	GORDON	Brent
NOAA	BUTLER	Matthew
NOAA	BACKUS	Beau
NOAA	PICA	Joseph
NOAA	GRIFFIN	Vanessa
ROSCOSMOS	ZORIN	Sergey
ROSCOSMOS	TROFIMOV	Dmitry
ROSCOSMOS	KARELIN	Alexander
ROSHYDROMET	TASENKO	Sergey
ROSHYDROMET	LABENETS	Tatiana
ROSHYDROMET	RUBLEV	Alexey
WMO	KURINO	Toshiyuki
WMO	BALOGH	Werner

Via Webex		
ESA	LUNTAMA	Juha-Pekka
EUMETSAT	MONHAM	Andrew
JAXA	HIGASHIO	Nana