

COORDINATION GROUP FOR
METEOROLOGICAL SATELLITES

WORLD METEOROLOGICAL
ORGANIZATION

**CGMS TEAM MEETING ON THE TERMS OF REFERENCE
OF FUTURE CGMS SPACE WEATHER ACTIVITIES**

Geneva, 7-8 January 2014

FINAL REPORT

INTRODUCTION

The CGMS team meeting on the Terms of Reference (TOR) of future CGMS space weather activities was convened at WMO headquarters in Geneva, Switzerland, on 7 and 8 January 2014 as a follow-up of CGMS Action 41.14 “CGMS members to nominate a team to develop the TOR for CGMS space weather activities, taking into account the guiding principles discussed in the ad-hoc session, for consideration by CGMS-42”.

The following CGMS members were represented at the meeting: CMA, EUMETSAT, JMA supported by NICT, KMA, NASA, NOAA and WMO. Several members participated remotely via WEBEX (See list of participants in Annex 1). The supporting documentation for the meeting was available on line (<http://www.wmo.int/pages/prog/sat/meetings/CGMS-SWWG.php>).

The meeting was chaired by Suzanne Hilding (NOAA) with Jérôme Lafeuille (WMO) serving as Rapporteur. (See agenda in Annex 2.)

1. ROUND TABLE DIALOGUE ON THE PURPOSE OF CGMS SPACE WEATHER ACTIVITIES

The meeting discussed the draft TOR prepared by the Rapporteur, based on the outcome of the CGMS-41 ad-hoc meeting on space weather. Clarifications were brought regarding the scope of technical and mission planning coordination, the range of user needs to be considered, the dual role of CGMS members as users and providers of space weather information, and the range of space weather missions to be considered, including e.g. space weather payload hosted on meteorological satellites or dedicated space weather satellites.

It was furthermore agreed to recommend that CGMS pursue these objectives in establishing a new CGMS Working Group for Space Weather in addition to the existing CGMS Working Groups on Telecommunications (WG I), on Satellite products (WG II), on Global continuity and contingency planning (WG III) and on Data dissemination (WG IV). The new Working group would address all matters related to space weather, including e.g. space weather products (would thus not be addressed by WG II) or contingency planning (would thus not be addressed by WG III). The proposed objectives of CGMS Space Weather activities would drive the TOR of the new WG.

The meeting agreed on the revised TOR contained in Annex 3.

The meeting acknowledged that, depending on the countries, space weather is addressed by organizations which may or may not qualify to become CGMS Members. In particular, space weather centres are not necessarily satellite operators. The meeting felt strongly that the CGMS criteria to become a CGMS Member or Observer should not be changed, but considered that it would be beneficial if those space weather centres that do not qualify to become CGMS Members or Observers were participating in CGMS space weather activities in partnership with a CGMS Member. Assuming that a CGMS Working Group on Space Weather is established, CGMS satellite operators would be encouraged to invite their space weather partners to assist them and participate with them in the Working Group (e.g. like JMA inviting NICT to support them for space weather activities within CGMS).

The status of such partnership should be acknowledged in the CGMS documentation. The group recalled that for many years until CGMS-40 the reports of CGMS annual meetings included the list of CGMS Members with the following note: “In some cases, delegates are supported by other

agencies, for example SRC Planeta (with Roshydromet) and ISRO (with IMD)”. Although this note is currently not displayed on the CGMS web site, a statement along these lines could be considered by the CGMS Secretariat to acknowledge the role of space weather agencies as important partners of CGMS Members for space weather activities.

2. USING THE OSCAR INVENTORY TO INITIATE AN ASSESSMENT OF THE CGMS SPACE WEATHER MISSIONS, STRENGTHS AND WEAKNESSES, GAPS AND OPPORTUNITIES

2.1 OSCAR/Space

The team was introduced to the Observing System Capability Analysis and Review (OSCAR) on-line tool, which contains a repository of observation requirements and an inventory of space-based observing capabilities (www.wmo.int/oscar/space). The OSCAR inventory contains more than 800 instrument references, including 266 space weather instruments, with two types of information:

- factual information (e.g. launch dates, orbits, payload) provided by agencies, and
- expert assessment (relevance of instruments to variables, compliance with certain targets defined by WMO) to be validated by specific expert groups.

J. Lafeuille underscored that the space weather part of OSCAR was still under review by the WMO Inter-Programme Coordination Team on Space Weather (ICTSW). Therefore, the rating of instrument relevance for space weather variables was not yet adjusted. Furthermore, in what is called in OSCAR the “Capability review”, the target capabilities for space weather had not yet been discussed; two types of space weather observation capabilities were currently identified in a very preliminary way for demonstration purpose:

- [Missions for solar activity, solar wind and deep space](#)
- [Missions for ionosphere and magnetosphere monitoring](#)

The team considered that this tool was an invaluable resource. It has a great potential to support the work of CGMS (in particular WG III and the proposed WG on Space Weather) for mission planning coordination and high-level gap analysis, thanks to the filter function which allows displaying only CGMS missions, operational and/or R&D missions. The team expressed its high appreciation to WMO for developing this resource and strongly encouraged WMO to maintain it in the long term. It encouraged ICTSW to complete the review and validation of space weather instrument assessments as soon as possible in order to enable taking benefit of this tool. For risk assessment purposes, it was suggested to mark the missions that have exceeded their design lifetime. The team stressed that CGMS Members and space weather partner agencies should nominate points of contact to ensure that factual updates are communicated to WMO for OSCAR.

2.2 Strengths and weaknesses, gaps and opportunities

J. Lafeuille recalled the [Statement of Guidance for Space Weather Observations](#) (SOG) developed by ICTSW in 2012, which will be kept under review taking advantage of OSCAR. This SOG contains recommendations which have been assessed and translated into actions in the [Implementation Plan for Evolution of Global Observing Systems](#) (EGOS-IP). The EGOS-IP includes a chapter on space weather observations, which contains five actions of particular relevance to CGMS (W1, W4, W5, W6, W8) as discussed at CGMS-40 in Lugano. Since CGMS-40, the EGOS-IP has been endorsed by the WMO Executive Council, which further raises the importance of these actions.

The team reviewed these actions and agreed that the proposed CGMS Working Group on Space Weather should strive to address them and develop a CGMS response.

3. ROLES AND RESPONSIBILITIES OF SPACE WEATHER AGENCIES

The participants reported on the organization of space weather activities in their respective countries.

USA: NOAA has an operational mandate for space weather monitoring and prediction through the Space Weather Prediction Centre, which serves as global warning centre of the International Space Environment Service (ISES). NASA has a focus on research and development, develops and operates a number of satellite missions for space weather, and monitors the space weather environment of its own satellites; as part of the Heliophysics Explorer Program, NASA has selected in 2013 two new missions for development (ICON and GOLD) tentatively for launch in 2017; Sunjammer will be a solar sail demonstrator to fly beyond the L1 point.

JAPAN: NICT is the national space weather centre, and serves as regional warning centre of ISES. JMA will fly a space environment monitor on its next geostationary satellite for house keeping purposes. JAXA is running or planning space weather research missions (e.g. Akebono/Exos-D, Geotail, HINODE/Solar-B, ERG) and monitors the space environment for satellite housekeeping purposes.

Korea (Republic of): KMA has a mandate to provide operational space weather service for spacecraft operation. KSWC of RRA has a mandate to provide operational space weather service for the telecommunications sector. KASI has a focus on astronomy and space science, and KARI on satellite platform development.

China: Within the China Meteorological Administration (CMA), the National Satellite Meteorology Centre hosts the Space Weather Monitoring and Warning Centre. Within the Chinese Academy of Sciences (CAS), the National Space Science Centre (former CSSAR) hosts the Space Environment Prediction Center (SEPC) and the National Astronomical Observatories of China (NAOC) hosts the Solar Activity Prediction Centre (SAPC); both SAPC and SEPC are regional warning centres of ISES.

4. ALIGNMENT BETWEEN INTERNATIONAL SPACE WEATHER GROUPS AND CGMS SPACE WEATHER ACTIVITIES

The respective roles of the CGMS Space Weather Working Group and other entities should be well defined in order to enable CGMS to best contribute to the global set of space weather activities, avoiding unnecessary overlap and maximizing efficiency through relevant partnerships.

Despite a large number of organisations that are active in space weather no group is coordinating space weather observations at the global level. It is highly relevant for CGMS to take an active role in this respect for what pertains to its mandate, i.e. space weather observations from satellites.

Close relationship with the WMO/ICTSW is essential, since CGMS is committed by its Charter to respond to the requirements of WMO. The ICTSW is the group where space weather activities are currently addressed within WMO. Drawing a parallel with meteorological and climate activities, it is understood that, in the field of space weather, CGMS is expected to develop a

coordinated response to the WMO/ICTSW Vision and requirements for space-based observations and related products. In addition, however, CGMS Members as satellite operators can also have their own requirements for space weather services in support of spacecraft operations.

The team was informed that the WMO/ICTSW had listed international initiatives as follows:

- Research-based: COSPAR¹, SCOSTEP², International unions (e.g. URSI³, IAU⁴, EGU⁵, AGU⁶, ICSU⁷, etc), ISWI⁸, Agency programmes (e.g. ILWS⁹).
- Operations-based: ISES¹⁰, CGMS¹¹, ESA/SSA¹², EMS¹³
- Focusing on specific technologies (ICG¹⁴, IGS¹⁵), applications (ICAO¹⁶/IAVWOPSG¹⁷, ITU¹⁸), or regions (Asia-Oceania SW Alliance)
- COPUOS¹⁹ providing a cross-cutting, high-level, policy forum where members can raise awareness, seek international support and promote coordination on issues related to long-term sustainability of outer space activities including space weather.

WMO/ICTSW has recommended that CGMS engage in space weather activities with a view to:

- Promote a strategy to ensure the long-term continuity of space weather observations, in coordination with WMO and other international organizations;
- Coordinate the acquisition and availability of space weather observations made by meteorological satellites;
- Jointly define with ICTSW a strategy to improve the collection, availability, and uses of satellite anomaly information.

For operational activities, which are the primary focus of CGMS, the team considered that close collaboration among CGMS, ISES and WMO was essential. However, since most of the ISES Members are members of the WMO/ICTSW and since ISES and WMO are in the process of concluding a Memorandum of Agreement, the team appreciated that WMO would continue to serve as the main communication channel between CGMS and ISES.

On the scientific side, COSPAR – through its Panel on Space Weather – is potentially an important partner for CGMS. As the provision of operational space weather services faces a number of scientific challenges, CGMS would benefit of being informed through COSPAR of scientific advances and emerging techniques which can impact on space weather operations. It

¹ COSPAR : Committee on Space Research of ICSU

² SCOSTEP : Scientific Committee on Solar-Terrestrial Physics of ICSU

³ URSI : Union Radio-Scientifique Internationale, member of ICSU

⁴ IAU : International Astronomical Union, member of ICSU

⁵ EGU: European Geosciences Union

⁶ AGU : American Geophysical Union

⁷ ICSU : International Council for Science

⁸ ISWI : International Space Weather Initiative

⁹ ILWS : International Living With a Star program

¹⁰ ISES: International Space Environment Service

¹¹ CGMS : Coordination Group for Meteorological Satellites

¹² ESA/SSA : Space Situation Awareness programme of the European Space Agency

¹³ EMS : European Meteorological Society

¹⁴ ICG : International Committee on GNSS

¹⁵ IGS : International GNSS Service

¹⁶ ICAO: International Civil Aviation Organization

¹⁷ IAVWOPSG : International Airways Volcano Watch Operations Group

¹⁸ ITU : International Telecommunications Union

¹⁹ COPUOS: United Nations Committee on the Peaceful Uses of Outer Space

is recalled that in other areas CGMS is benefiting of active collaboration with international science groups (ITWG, IPWG, IROWG, IWWG).

At the policy level, it is anticipated that an international strategy for space weather will be defined in the framework of COPUOS with COSPAR having a leading role for research aspects and WMO focusing on operational activities. The team therefore recommended that COPUOS be informed of the steps taken by CGMS to support space weather activities. This information can be communicated by WMO and/or by satellite operators through their national delegation to COPUOS.

5. DEVELOP A SUFFICIENTLY DETAILED PLAN OF ACTIONS AND ACTIVITIES THAT WILL MAKE THE SPACE WEATHER GROUP MEANINGFUL AND PRODUCTIVE

The team discussed the decisions expected from the discussions at CGMS-42 in May 2014 in plenary and in the ad-hoc working group.

The team agreed that the ad-hoc group should serve two purposes:

- Preparing the discussion in plenary
- Working as a prototype of the future Working Group on Space Weather, in order to initiate progress and to develop a common understanding of the scope of this group.

The team agreed on the need of an inter-sessional teleconference.

A draft agenda for the inter-sessional telecon, a draft agenda for the space weather ad-hoc meeting, and an overall list of actions are provided in Annexes 4, 5, and 6

Annex 1:

LIST OF PARTICIPANTS

Face-to-face participants

Suzanne HILDING (Chair)	NOAA
Kimberly HURST	NOAA
Mamoru ISHII	NICT (assisting JMA)
Jérôme LAFEUILLE (Rapporteur)	WMO

Remote participants

Jianguang GUO	CMA
Andrew MONHAM	EUMETSAT
Yasushi IZUMIKAWA	JMA
Yukihiko KUMAGAI	JMA
Hyesook LEE	KMA
Elsayed TALAAT	NASA

Annex 2:

PROVISIONAL AGENDA
and related documents

The meeting will take place in Room 7 Lake, starting at 9:00 on Tuesday, 7 January.

0 Welcome and introduction

1 Round table dialogue on purpose of the working group.

[Initial Draft Terms of Reference for CGMS Space Weather Activities](#)

2 Using the OSCAR inventory (www.wmo.int/oscar/space), initiate an assessment of the CGMS space weather missions, strengths and weaknesses, gaps and opportunities.

[Missions for solar activity, solar wind and deep space](#) (List, evaluation and timeline)*

[Missions for ionosphere and magnetosphere monitoring](#) (List, evaluation and timeline)*

(* Use filter on top of the timeline to display only the missions of CGMS Satellite Operators)

Discussion: [Space-based observation needs for space weather and related actions for CGMS](#)

Background: [Statement of guidance for space weather observations](#)

3 Roles and responsibilities of space weather agencies discussion

4 Alignment between international space weather groups and CGMS space weather activities

Background: [ICTSW-4/Doc.10.3, Appendices A to F](#)

5 Develop a sufficiently detailed plan of actions and activities that will make the space weather group meaningful and productive.

6 Conclusions

General Background Information

[Report of the CGMS-41 Ad-hoc Meeting on Space Weather](#)

CGMS home page: <http://www.cgms-info.org/> and [CGMS-41 Report](#)

Contact the organizing committee: Kimberly.Hurst@noaa.gov

Contact the local host: JLafeuille@wmo.int

Annex 3:

PROPOSED TERMS OF REFERENCE FOR CGMS SPACE WEATHER ACTIVITIES

Background

Considering the significant impact of Space Weather events on the integrity of spacecraft

Recognizing the contribution of CGMS Members to Space Weather observation, e.g. in operating space environment monitors, solar imagers, and GNSS radio-occultation sensors;

Noting that the WMO Congress has recognized Space Weather as one area of activity of the WMO Space Programme;

Noting that the WMO Executive Council has highlighted the need of coordination to maintain the continuity of satellite-based solar, solar wind and other space weather measurements;

Noting that in spite of several international initiatives there is no established mechanism to coordinate global efforts for space-based Space Weather observation;

Recalling the CGMS High Level Priority Plan to “Establish a coordinated approach to the monitoring of space weather and the reporting of space weather-related spacecraft anomalies”;

The CGMS agreed at its 41st meeting to develop the Terms of Reference for future CGMS Space Weather activities.

CGMS objectives for Space Weather

The overarching goal of CGMS Space Weather activities is to support the continuity and integration of space-based observing capabilities for operational Space Weather products and services.

This includes:

1. Keeping abreast of major user interests for operational Space Weather products and services (e.g. for spacecraft operations, aviation, energy, disaster management) and the related requirements for space-based observations that can be addressed by CGMS Members;
2. Evaluating existing operational space weather products and services in support of spacecraft operations, and recommending additional services as appropriate;
3. Encouraging Space Weather monitoring missions either through dedicated satellites or through hosting space weather payloads aboard weather and climate monitoring satellites as technically appropriate;
4. Supporting when relevant the dual use of sensors such as GNSS radio-occultation receivers that provide essential information for weather/climate monitoring and ionosphere monitoring;
5. Fostering orbit coordination, on-orbit sensor calibration and harmonization of operational Space Weather sensors and data formats with a view to ensure interoperability and data consistency;
6. Reporting on spacecraft anomalies and sharing the results of anomaly resolution and analyses;
7. Pursuing global coordination of the operational Space Weather observing constellation, with a view to help to sustain future observing capabilities as CGMS has done successfully for terrestrial weather and climate observations, encouraging complementarity, compatibility and possible mutual back-up in the event of system failure through cooperative mission planning,

8. Communicating on socio-economic benefits of space weather prediction with policy makers, public, non technical community.

In pursuing these objectives, CGMS recognizes the complementary roles of the activities of its members and other international organizations or initiatives such as the International Space Environment Service (ISES), the Committee on Space Research (COSPAR) Panel on Space Weather. It promotes partnership with these initiatives with a view to optimize overall efforts.

Working Group on Space Weather

These objectives will be pursued by CGMS through the Working Group on Space Weather, which will address all CGMS matters related to space weather including mission planning, contingency planning, products, telecommunications, and user aspects. The Working Group on Space Weather will report to the plenary.

The Working Group on Space Weather will be composed of CGMS Members with assistance of partner agencies as appropriate.

Annex 4:

Draft agenda for an inter-sessional CGMS Space Weather telecom

1. Outcome of the CGMS Space Weather TOR meeting
2. Review the template for agencies' space weather overview to be reported at CGMS-42
3. Initiate the work to define a procedure for reporting on space weather induced spacecraft anomalies following CGMS Action 41.15 (nominated pocs)
4. Complete the overview of roles and responsibilities of space weather agencies working in support of CGMS members
5. Review the draft agenda for CGMS-42 Space Weather ad-hoc meeting (assuming a 4-hour session)

Annex 5:

Draft agenda for the CGMS-42 Space Weather Ad-hoc Meeting (Assuming a 4-hour session)

- Updates by CGMS Members and partner organizations on their space weather activities and plans, with emphasis on operational or “sustained” space-based missions and on services in support of spacecraft operations
- Review and endorsement of the CGMS Space Weather ToR and proposed establishment of a Working Group on Space Weather
- OSCAR
 - Overview of OSCAR and its usage to support the work of the SW group
 - Mechanism to provide input for OSCAR regarding space weather missions of CGMS members and partner organizations
- Process for recording space weather induced spacecraft anomalies
 - Review and finalize the procedure for reporting these anomalies
 - Discuss the need of information on observed or planned periods of critical space weather activity with potential impact on spacecraft operations
- Develop a response to EGOS-IP actions including:

Action W1: To develop and implement a coordinated plan ensuring continuity of solar measurements, solar wind and interplanetary magnetic field measurements, and heliospheric imaging, including measurements at different locations such as at the L1 Lagrange point, the Sun-Earth line upstream from the L1 point, the L5 Lagrange point, as well as the required global network of ground-based antennas for data reception and processing.

Action W4: To improve the timeliness of space-based GNSS measurements from LEO satellites to get near-real-time information about the 3D electron density distribution of the ionosphere/plasmasphere system. (e.g. by use of a RARS concept or other network of satellite ground stations for rapid transmission).

Action W5: To foster sharing of ground-based GNSS data and GNSS Radio-Occultation among the meteorological and space weather communities, and to facilitate the near-real-time access to these data through WIS.

Action W6: To coordinate the use of dual-frequency radar altimeter observations by Space Weather community to improve or validate ionospheric models and for operational TEC monitoring over the oceans.

Action W8: To develop a plan for maintaining and improving space weather observations of the plasma and energetic particle environment along the following priorities: (1) maintain long-term continuity, and if possible improve the spatial resolution of measurements at all altitudes from LEO through GEO orbits; (2) improve the sharing of existing and planned plasma and energetic particle measurements; (3) include energetic particle sensors on HEO satellites; and (4) conduct research to incorporate the plasma and energetic particle data into numerical models to give flux estimates at all locations where our satellites are in orbit.

Annex 6:

NEXT STEPS

In advance of inter-sessional telecon

- Set the date for an inter-sessional telecon
- Develop template (e.g. 2 slides, using an example) for space weather overviews containing the information required in OSCAR to support mission planning/coordination (Kim)
- Complete the Final Report of the CGMS Space Weather TOR Meeting

In advance of CGMS-42

- Hold the inter-sessional telecon (See draft agenda in Annex 4)
- Prepare an advanced draft of the report to the plenary, following CGMS Action 41.14 (Suzanne, Kim, Jerome)
- Clarify with the CGMS Secretariat the way to acknowledge the status of space weather organizations collaborating with CGMS Members

At CGMS-42

- Hold an ad-hoc space weather meeting (See draft agenda in Annex 5)
- Report to plenary the outcome of the SW ad-hoc group including the response to the two actions assigned by CGMS-41 and the findings from the discussion
- Seek endorsement of the establishment of a Working Group on Space Weather with the ToR proposed in Annex 3.