

Geneva, 7-8 January 2014

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

A number of international, regional and national organisations are active in, or interested in, space weather.

As background for the CGMS discussion on alignment between existing international space weather groups and future CGMS space weather activities, this document provides in Appendix a brief summary on ten of these international initiatives.

The summaries are extracted from a working document prepared by David Jackson (United Kingdom) for the fourth meeting of the WMO Inter-Programme Coordination Team on Space Weather (ICTSW-4/Doc.10.3).

- A. Summary of COPUOS
- B. Summary of ISWI
- C. Summary of ISES
- D. Summary of CGMS
- E. Summary of COSPAR
- F. Summary of SCOSTEP
- G. Summary of ISWI
- H. Summary of ICAO
- I. Summary of EMS
- J. Summary of ESA SSA

A. UN Committee on Peaceful Uses of Outer Space (COPUOS)

Role

Facilitate international dialogue on space weather

Space Weather activities

In 2013 Space Weather became a new agenda item for the COPUOS Scientific and Technology Sub-Committee. The Long-Term Sustainability of Outer Space Activities Working Group has commissioned a consensus report on best practices; 4 Expert Teams have been working to define guidelines. The Expert Group C on space weather has met over the past 1.5 years and put together a report of its recommendations. The LTS Working Group will be meeting in February 2014 and the guidelines will be discussed in depth by the delegates from COPUOS member states.

The objective of the space weather expert group report is to gather existing information on space weather and its impacts on the long-term sustainability of space activities and on the current practices, operating procedures and technical standards for mitigating the effects of space weather phenomena on operational space systems. The expert group has also proposed voluntary guidelines (not legally-binding under international law) to enhance the safety of space activities and to reduce the risks from space weather phenomena to the long-term sustainability of space activities.

The proposed guidelines encourage member states, international organizations and private space actors to adopt policies for the free and unrestricted sharing of critical space weather data (both space- and ground-based) and forecasts, support the development of advanced space weather models and forecasting tools, share best practices related to mitigating space weather effects and related risk assessment, and promote education and capacity building to sustain global space weather capabilities.

COPUOS is in a unique position to foster the improvement of space weather services, by encouraging research activities, data availability, and capacity building aligned with service needs.

Possible COPUOS / WMO ICTSW interactions

- Improved data exchange / delivery
- Space Weather Services
- Observational Requirements
- Ensure continuity of observations
- Pulling Research into Operations
- Reduce Space Weather Risks to space operations
- Space Weather Policy.

B. International Space Weather Initiative (ISWI)

ISWI is a programme initiated by COPUOS. Its **goal** is to develop the scientific insight necessary to understand the science, and to reconstruct and forecast near-Earth space weather. This includes instrumentation, data analysis, modeling, education, training, and public outreach

ISWI activities include the distribution of small monitoring instruments in countries around the globe and the hosting of workshops and schools to promote joint research and training. As a result of this effort, new instrument arrays are being deployed, and programmes are being created for space science research and education.

Because research institutions often do not have the infrastructure or interest to provide access to continuous, real-time data, many of the data streams from these instruments are not available to support space weather services. A challenge for the future will be to encourage relationships between the service-providing organizations and the research institutions to make the data from the instruments deployed through ISWI available for space weather services..

Space Weather activities

The instrument programme includes the following:

1. African GPS Receivers for Equatorial Electrodynamics Studies (AGREES)
2. African Dual Frequency GPS Network (AMMA)
3. African Meridian B-field Education and Research (AMBER)
4. Atmospheric Weather Education System for Observation and Modeling of Effects (AWESOME) and SID (Sudden Ionospheric Disturbance Monitor)
5. Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO)
6. Continuous H-alpha Imaging Network (CHAIN)
7. Coherent Ionospheric Doppler Receivers (CIDR)
8. Global Muon Detector Network (GMDN)
9. Magnetic Data Acquisition System (MAGDAS)
10. Optical Mesosphere Thermosphere Imager (OMTIs)
11. Remote Equatorial Nighttime Observatory for Ionospheric Regions (RENOIR)
12. South America Very Low frequency Network (SAVNET)
13. Scintillation Network Decision Aid (SCINDA)
14. Space Environment Viewing and Analysis Network (SEVAN)
15. ULF/ELF/VLF network

Possible ISWI / WMO ICTSW interactions

ISWI will finish shortly. Currently, ISWI provides data products which may then be picked up by operational centres. A possible expanded role for ISWI would see it do more research to operations (e.g. using ISWI observations to test predictive models). This, and other areas of interaction, appear below.

- Observational Requirements
- Develop space weather observational infrastructure
- Improved models and analyses
- Education (e.g. summer schools).

C. International Space Environment Service (ISES)

Role

ISES is a scientific non-governmental organization affiliated to the International Council for Science (ICSU). ISES is a global network of space weather service providers that was formed in 1962

Space Weather activities

ISES has a network of 15 Regional Warning Centres (RWCs) worldwide. The RWCs share data and forecasts among the Centers and provide space weather services to customers in their regions. The RWCs provide a broad range of services, including forecasts, alerts and warnings of solar, magnetospheric, and ionospheric conditions; extensive space environment data, customer-focused event analyses, and long-range predictions of the solar cycle. While each RWC concentrates on its own region, ISES provides a forum to share data, to exchange and compare forecasts, to meet customer needs, and to identify the highest priorities for improving space weather services.

Objectives

1. Provide real-time forecasting and monitoring of space weather to reduce and mitigate the risk of space weather impacts on technology, critical infrastructure, and human activities.
2. Facilitate international communication and service coordination regarding space weather, particularly during periods of enhanced activity and in the event of extreme space weather.
3. Improve space weather services and promote the understanding of space weather and its effect for users, researchers, the media, and the general public.

These objectives are met through the involvement of ISES and its members in international space weather communities and by sponsoring meetings and establishing working groups to improve space weather services. ISES members play an active role in the transition of scientific results into operational environments. ISES also maintains the international geophysical calendar which coordinates and recommends dates for solar and geophysical observations which cannot be performed continuously.

Cooperation

ISES cooperates and interacts with local and international agencies to accomplish its mission by encouraging appropriate research and development and by assisting in the transition of research results into operations. As a Network Member of the ICSU-WDS, ISES is committed to the free and open exchange of data and products, long-term data stewardship, compliance with agreed-upon data standards and conventions, and providing mechanisms to facilitate and improve access to data and services. ISES works closely with the WMO and other international organizations to benefit from complementary activities that enhance the availability of data, the exchange of information, and the improvement and dissemination of services.

Actions :

WMO ICTSW / ISES MoA written.

Possible ISES / WMO ICTSW interactions

- Improved data exchange and delivery
- Space Weather Services
- Observational Requirements
- Develop space weather observational infrastructure
- Consistent messages on space weather warnings

D. Coordination Group for Meteorological Satellites (CGMS)

CGMS is the coordination body of space agencies operating meteorological, climate monitoring and environment satellites in support of WMO programmes. CGMS is a forum for global planning coordination, technical harmonization, and exchange of information on geostationary, polar orbiting and other satellite systems with a particular focus on ensuring long-term continuity of observation in support of operational applications.

The CGMS has an interest in space weather, both from the perspective of the impacts of space weather on satellite systems and for the opportunity to coordinate space weather observations being made from meteorological satellites. A permanent action item is for Members “to report to CGMS meetings on their activities and plans related to space weather including: (i) impacts of solar events, space radiation and protective measures, (ii) space weather observations, and (iii) space weather warning systems”.

An important issue for future space weather services is deploying and maintaining the space-based system needed to obtain the required real-time observations. The WMO emphasized the need for a high-level coordination of satellite-based and ground-based space weather observing assets to ensure that high-priority gaps are addressed in a cost-effective manner through shared capabilities. The CGMS can be an important organization to assist with this coordination of space assets.

Scope

The space weather interests of CGMS are complementary to those of the WMO/ICTSW, and the coordination of efforts between CGMS and WMO can enhance the effectiveness of space weather activities and accelerate progress in improving services and resiliency. Specifically, CGMS can:

- contribute to ensuring that observing gaps are addressed and observations are coordinated,
- assist with defining user requirements for space weather products,
- provide information on space weather-related spacecraft anomalies, and
- contribute to the international coordination and sharing of observing assets that will promote the long-term continuity of high-priority observations in a cost-effective manner.

Space Weather and CGMS

- Relevance: expected benefit of addressing Space Weather within CGMS
- What other bodies could best address Space Weather space-based-observation?
- How can CGMS best handle its contribution to Space Weather monitoring ?

Specific space weather activities

Host space weather instruments

- Routinely report on satellite anomalies
- Focus on operational issues
- Can facilitate integration of observing capabilities

Near-term Actions:

1. Develop **Terms of Reference** for space weather activities
2. Work with WMO/ICTSW to develop procedure for collection and use of anomaly information

Possible CGMS / WMO ICTSW interactions

- Improve services and resilience (including optimised use of space weather assets)
- Observational Requirements
- Develop space weather observational infrastructure

E. COSPAR: Transitioning from exploration to application in space weather research: A global road map for 2013-2015

Initiative launched by ILWS and Cospar Panel on Space Weather

Why a Roadmap? A roadmap would identify key areas of research leading to demonstrably improved service provision capability

Roadmap scope

- Currently available data and gaps
- Agency plans for space based SpWx data (both scientific and monitoring aspect)
- Space and ground based data access (eg proprietary data, difficult; access due to location)
- Current capability gaps which would provide a marked improvement in SpWx service capability
- **Outcome should address at least**
 - **Key science challenges**
 - **Data needs**
 - **Smooth organised transition of scientific developments into reliable services**

Group 20 person working group including subgroups

A) assemble / summarize existing and near-term capabilities (obs, data, model, ...)

B) assemble and review agency plans for future instrumentation, analysis, and models around the world.

C) survey the SWx user base, and their needs and expectations, differentiated by user sector; inventory of available space weather products and services

Timeline First draft report should be completed by now. Final presentation Moscow, August 2014

Possible COSPAR / WMO ICTSW interactions

- Observational Requirements
- Information collected on OSCAR data base
- Information about the Space Weather product portal and ISES services
- Focus policy on research and research to operations developments
- Recommendations for development of observational infrastructure

F. Scientific Committee on Solar Terrestrial Physics (SCOSTEP)

The Scientific Committee on Solar Terrestrial Physics (SCOSTEP) is an interdisciplinary body of the International Council for Science (ICSU). SCOSTEP promotes ICSU's mission to strengthen international science for the benefit of society. SCOSTEP runs international interdisciplinary scientific programs and promotes solar-terrestrial physics research by providing the necessary scientific framework for international collaboration and dissemination of the derived scientific knowledge in collaboration with other ICSU bodies. SCOSTEP is a permanent observer at COPUOS.

Mandate

SCOSTEP seeks opportunities for interaction with national and international programs involving Solar-Terrestrial Physics elements. It provides guidance to the STP discipline centers of ICSU's World Data Center system. It attempts to develop and sustain student interest in Sun-Earth connections, to promote efficient exchange of data and information between solar and terrestrial scientists in all countries, and to seek projects and programs that cross over traditional boundaries of physical regions and focused scientific disciplines.

Activities

Climate And Weather of the Sun-Earth System (CAWSES) is an international programme sponsored by SCOSTEP established with an aim of significantly enhancing our understanding of the space environment and its impacts on life and society. The main functions of CAWSES are to help coordinate international activities in observations, modelling, and applications crucial to achieving this understanding, to involve scientists in both developed and developing countries, and to provide educational opportunities for students of all levels.

Connections

SCOSTEP will identify synergy with other organizations such as ILWS and ISWI in promoting STP research and outreach.

Possible SCOSTEP / WMO ICTSW interactions

- Research to operations (encourage operational development of models, methods and observations)
- Develop educational activities with research to operations or operations focus.

G. International Living With a Star (ILWS)

Mission

Stimulate, strengthen, and coordinate space research to understand the governing processes of the connected Sun-Earth System as an integrated entity.

Objectives

To Stimulate and Facilitate:

1. Study of the Sun-Earth connected system and the effects which influence life and society.
2. Collaboration among potential partners in solar-terrestrial space missions.
3. Synergistic coordination of international research in solar-terrestrial studies, including all relevant data sources as well as theory and modeling.
4. Effective and user driven access to all data, results, and value-added products.

Membership

Contributing organizations include the major space agencies around the world as well as agencies engaged in space science research and space weather services. Such organizations are committed to contribute to ILWS over the next decade. Contributions include any of the following:

- Space Flight Missions
- Mission payloads or subsystems
- Mission launch or tracking services
- Additional data sources supporting flight missions (sounding rockets, balloon, or ground-based)
- Data dissemination, storage, distribution, and value adding systems
- Supporting theory and modeling

Possible ILWS / WMO ICTSW interactions

- Transition from co-ordinating research observing missions to operational missions
- Further observation developments

H. International Civil Aviation Organisation (ICAO)

Mission

The International Airways Volcano Watch Operations Group (IAVWOPSG) within ICAO is tasked with defining civil aviation requirements and space weather service needs. IAVWOPSG's **terms of reference** are:

The IAVWOPSG should:

- a) provide advice and guidance to the Secretariat concerning the operation of the IAVW and its effectiveness in meeting current operational requirements.
- b) develop proposals for the development of the IAVW in order to ensure that it continues to meet evolving operational requirements.
- c) assist the Secretariat in the coordination of the arrangements between the various international organizations comprising the IAVW.
- d) coordinate with the SADISOPSG and WAFSOPSG regarding the inclusion of volcanic ash advisories and SIGMETs on the ICAO satellite broadcasts.
- e) assist the Secretariat in the development of appropriate guidance material both for operations with volcanic ash in the atmosphere and also operations with volcanic ash deposited on aerodromes.
- f) develop specific proposals for the provision of warnings for aerodrome management for deposition of volcanic ash on aerodromes.
- g) provide advice and guidance to the Secretariat and the VAACs regarding the future ICAO IAVW and existing VAAC Websites, respectively.
- h) provide advice to the Secretariat regarding the development of international arrangements for the provision of warnings to aircraft of radioactive materials, toxic chemicals in the atmosphere and **space weather**; and
- i) make regular progress reports to the Air Navigation Commission.

Activities

ICAO has drafted a Concept of Operations (CONOPS) for space weather information in support international air navigation. The ICTSW has supplied many comments to ICAO with the aim of enhancing the CONOPS. The CONOPS reviews current operations and capabilities, and provides a description of proposed space weather services for aviation and of associated operational, functional and performance requirements. In addition to the ad hoc ICAO team that was formed to revise the CONOPS, an additional team was also formed to revise another document, "Space Weather Impacts on International Air Navigation." This document is to form the basis of an ICAO manual supporting potential future provisions on space weather.

The ICTSW is coordinating with the International Civil Aviation Organization (ICAO) on its Concept of Operations for International Space Weather Information for Global Aviation. The importance of space weather for international civil aviation is recognized. Space weather concerns include degradation of radio communication, reduction in the accuracy and availability of Global Navigation Satellite Systems (GNSS), and energetic particle impacts to humans and flight avionics. The space weather services required by ICAO, including the international obligations of ICAO member states and the procedures for delivering warnings and alerts, will be specified in an annex to the ICAO Convention, to be jointly adopted by WMO and ICAO.

Possible ICAO / WMO ICTSW Interactions

- Develop Space Weather services for aviation
- Drive observation requirements via need for aviation services
- Develop consistent Space Weather warnings for aviation

I. European Meteorological Society (EMS)

Mission

The European Meteorological Society (EMS) will advance the science, profession and application of meteorology, and of sciences related to it, at the Europe-wide level, for the benefit of the whole population.

To this end, EMS will help its Member Societies and Associate Members, individually and collectively, to benefit all classes of their membership.

In particular, EMS will work to achieve better communication and understanding amongst the members of the European meteorological community under the auspices of Member Societies and Associate Members.

The EMS shall be a non-profit-making organization, and will arrange its activities economically, with the public good in mind.

The role of the EMS is to support and enhance the activities of its Members by:

Creating a European context for the varied activities of Member Societies and Associate Members.

- Running the EMS Annual Meetings to provide a forum for exchange and discussion for the entire meteorological community on a European scale.
- Increasing the exchange of information between meteorological societies.
- Establishing access to an additional information channel for posting meetings, jobs, etc.
- Making available a mechanism by which many individual members of the meteorological community can get involved in an initiative undertaken by a specific Member Society
- Supporting gifted young scientists in Europe through travel grants that enable them to attend scientific meetings, exchange ideas and get feedback, and build networks
- Promoting the contributions of individuals within the meteorological community and beyond by highlighting excellence in young scientists and the outstanding achievements of meteorologists
- Gaining support from WMO and international organisations that could not be easily provided by individual Member Societies.
- Providing assistance for topical and regional meetings organised by EMS Members.

Activities

EMS space weather activities are currently very limited. However, there is a Space weather session at next EMS meeting (2014), so there is scope to expand.

Possible EMS / WMO ICTSW Interactions

- Space Weather alert and forecast services for Europe
- Adopt best NWP practices for space weather services

J. European Space Agency Space Situational Awareness (ESA-SSA)

Role

Developing operational space weather services for Europe (in particular, to protect ESA assets)

Space Weather activities

Initial preparatory programme ran from 2009 to 2012. Phase 2 running from 2013 to 2016
There are 4 existing Expert Service Centres (ESCs) (Solar, Radiation, Ionosphere, Geomagnetism). A heliospheric ESC is being set up in Phase 2.

Projects about to be funded in Phase 2 include:

Services:

Development of all 5 individual ESCs plus support to a Data Centre; Weather Service Developments (multi-ESC, cross domains); Testing of SSA services during rocket launch campaigns, developing services for the Arctic

Observations:

Phase C/D development of a magnetometer for solar wind monitoring missions
Procurement of recurring NGRM instruments and recurring plasma instruments for hosted payload missions
Enhanced Space Weather Monitoring System - first study on the combined L1, L5, L4 monitoring system
Implementation of the EDRS hosted payload mission and of HP instruments mission for Galileo spacecraft

Activities in 2014 – 2016 will build on those above, and will include:

- Addition of new space weather services
- Further enhancement of the ground segment
- Phase C/D development of selected new SWE sensors with identified hosted payload flight opportunities
- Phase B1 of the enhanced space weather monitoring system study
- Continuation of the hosted payload flight opportunity assessments for new missions and new instruments

There is also a General Studies Programme (GSP) related to ESA SSA which is devoted to the preparation of future ESA missions and activities by performing feasibility studies for the selection of new mission concepts. Studies focused on moving research products (eg GIC and satellite drag forecasts) close to operational readiness are also within GSP.

Objectives

Space Weather segment objectives in SSA Period 2 (up to 2014)

1. Networking of available national and European space weather assets (sensors, data centres, service centres, service coordination, user support)
2. Continuation of the preparation of space weather additional services
3. Continuation of the Proba-2 operations and exploitation
4. Implementation of the first flight opportunities for hosted payload space weather instruments and planning for the future HP missions
5. Exploitation of space weather instruments, as well as data and European centres of expertise

6. Study (phase A) of a mission to ensure availability of solar wind, IMF and coronagraph data from L1
7. Studies of mission concepts for enhanced space weather monitoring and forecasting with sensors away from the Sun-Earth line
8. SSA space weather technologies

Possible ESA SSA / WMO ICTSW interactions

- Space Weather Services
- Observational Requirements
- Develop space weather observational infrastructure
- Data exchange and dissemination