

## **Report of the ICTSW Co-Chairs**

*(Submitted by T. Onsager and X. Zhang)*

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### **Summary**

The Inter-Programme Coordination Team on Space Weather was formed in May, 2010 and currently includes members from 21 countries and 7 international organizations. ICTSW was established under the Commission for Basic Systems and the Commission for Aeronautical Meteorology and works to Terms of Reference that cover all elements of the space weather enterprise, including observational systems, product improvement utilizing current research, end products and services for the major applications sectors, and capacity building to expand the provision of space weather services.

As a result of ICTSW actions, space weather is now fully integrated into the WMO processes and plans for observing systems. Space weather observing requirements and an initial gap analysis are documented, and space weather is now a new chapter in the WMO Implementation Plan for the Evolution of the Global Observing Systems. ICTSW has been working closely with numerous international organizations, including the International Civil Aviation Organization on space weather services for commercial airlines. The Space Weather Product Portal has been established to provide the broad awareness of space weather products, and ICTSW is exploring the use of the WMO Information System for exchange of space weather forecasts.

For the future, the ICTSW has a full complement of actions it is pursuing, and effort to establish short-term and long-term strategic priorities is ongoing.

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### **ACTION PROPOSED**

The Inter-Programme Coordination Team on Space Weather is invited to consider the mission of the ICTSW, the progress made to date, and strategies for effective future progress.

## **DISCUSSION**

### **1. INTRODUCTION**

The Inter-Programme Coordination Team on Space Weather (ICTSW) was established by the WMO in May, 2010, under the auspices of the Commission for Basic Systems (CBS) and the Commission for Aeronautical Meteorology (CAeM). The purpose of the ICTSW is to facilitate the international coordination of space weather observations, data exchange, product and service delivery, and operational applications. Currently ICTSW includes members from 21 countries and 7 international organizations.

The ICTSW conducts its activities in accordance with the following initial Terms of Reference defined by CBS and CAeM:

- (a) Standardization and enhancement of space weather data exchange and delivery through the WMO Information System (WIS);
- (b) Harmonized definition of end-products and services, including e.g. quality assurance guidelines and emergency warning procedures, in interaction with aviation and other major application sectors;
- (c) Integration of space weather observations, through review of space- and surface-based observation requirements, harmonization of sensor specifications, monitoring plans for space weather observation;
- (d) Encouraging the dialogue between the research and operational space weather communities.

The ICTSW utilized a combination of regular telecons and face-to-face meeting to accomplish its objectives. To date ICTSW has held approximately 40 telecons over the 3.5 years it has been active, averaging about one telecon per month. ICTSW has had three face-to-face meetings over this time period: ICTSW-1 in April, 2011 (Boulder, Colorado); ICTSW-2 in December, 2011 (Namur, Belgium); and ICTSW-3 in November, 2012 (Brussels, Belgium). Through the regular telecons and occasional face-to-face meeting, ICTSW has been able to maintain progress in a number of areas consistent with its Terms of Reference and make substantial progress toward the goal of international space weather coordination.

Recognizing the substantial efforts of numerous international organizations in various aspects of space weather, ICTSW has worked closely with these organizations to promote awareness of complementary missions and to encourage coordination. Organizations that have a close working relationship with ICTSW and its members include: International Space Environment Service (ISES), International Civil Aviation Organizations (ICAO), Coordination Group for Meteorological Satellites (CGMS), UN Committee for the Peaceful Uses of Outer Space (COPUOS), and Committee on Space Research (COSPAR). Each of these organizations contributes to specific elements of the global space weather effort, extending from basic research to operational services. Through its diverse membership, ICTSW strives to maintain communication and, where practical, promote coordination among these organizations.

### **2. ACCOMPLISHMENTS TO DATE**

ICTSW activities to date have included the establishment of a Space Weather Product Portal, completion of a first iteration of space weather observing requirements for global services, and an assessment of the current gaps in our observing systems as documented through

the Statement of Guidance for Space Weather Observations. Space weather is now a new chapter in the WMO Implementation Plan for the Evolution of the Global Observing Systems and fully integrated into the WMO processes and plans for the evolution of the observing systems.

The ICTSW has made progress in all areas identified in its Terms of Reference.

**(a) Standardization and enhancement of space weather data exchange and delivery through the WMO Information System (WIS);**

Through a partnership with the International Space Environment Service, ICTSW has begun a pilot project to use the WMO Information System for the exchange of space weather information. The initial information to be made available through WIS will be selected core forecast products (geomagnetic activity, solar flares, and solar energetic particles). The products will be exchanged using BUFR, which is a compact format and well used within WMO. An important aspect of WIS is that data must be transferred to the by a designated Data Collection or Processing Center (DCPC). Because a number of ISES Regional Warning Centers and national institutions represented by ICTSW members are not directly affiliated with their national meteorology centers, a special effort will need to be made to coordinate with the WMO members in order to designate this institutions as DCPCs.

The ICTSW is also considering standards for data exchange, particularly with respect to GNSS data. A proposed format (GTEX) for GNSS-TEC data has been discussed, and standards for GNSS radio occultation data are being investigated with the International Radio Occultation Working Group, which is co-sponsored by CGMS and WMO.

**(b) Harmonized definition of end-products and services, including e.g. quality assurance guidelines and emergency warning procedures, in interaction with aviation and other major application sectors;**

The ICTSW has been working closely with ICAO to establish a framework for space weather services for civil aviation. The ICTSW reviewed and provided substantial comments on the Concept of Operations for International Space Weather Information in Support of International Air Navigation (CONOPS), which was developed by the International Airways Volcano Watch Operations Group (IAVWOPSG) of the International Civil Aviation Organization (ICAO). This document aims to define the functional, operational and performance requirements for the international production and delivery of space weather information to aviation. At the IAVWOPSG-7 meeting in March, 2013, ICTSW was included as a member of an ad hoc team tasked with revising the CONOPS. Revisions were submitted, and ICTSW now awaits release of the next version.

The ICTSW is supporting the harmonized definition of end products and services through the Space Weather Product Portal, and emergency warning procedures are being considered through an investigation of the processes involved and issues to be considered during extreme space weather events. Working jointly with ISES, a panel discussion was held at the U.S. Space Weather Workshop on current preparedness and issues regarding the delivery of services during extreme events. This discussion highlighted many of the areas where service improvements and international coordination are required to ensure global preparedness for extreme space weather.

**(c) Integration of space weather observations, through review of space- and surface-based observation requirements, harmonization of sensor specifications, monitoring plans for space weather observation;**

The ICTSW has made significant progress in the integration of space weather observations

within the WMO Integrated Global Observing Systems (WIGOS). Space weather observations are required to forecast space weather disturbances, to detect hazardous events and drive alerts, to establish a Space Weather “climatology” for the design of both space based systems (i.e., satellites and astronaut safety procedures) and ground based systems (i.e., electric power grid protection and airline traffic management), to validate numerical models and to conduct research. A comprehensive space weather observation network must include ground- based and space-borne observatories and will require the global coordination of assets.

The ICTSW has established a baseline set of observing requirements and document an initial gap analysis (Statement of Guidance). The observing requirements and the gap analysis each will be reviewed by ICTSW every two years. In 2013, the observing requirements were revised to include measurements of thermospheric properties and radiation dose rates at aircraft altitudes. In 2014, the Statement of Guidance will be reviewed and updated.

In order to promote actions that will fill key observing gaps, ICTSW is working with international organizations and committees, such as COSPAR, CGMS and UN COPUOS, to raise awareness of the need to maintain the long-term continuity of the space-based and ground-based measurements needed for space weather services.

**(d) Encouraging the dialogue between the research and operational space weather communities.**

ICTSW members are actively engaged in advancing the dialogue between the research and operational space weather communities within national and international organizations. There are now three annual venues that bring together the research and the operational efforts. These are: the U.S. Space Weather Workshop, the European Space Weather Week; and the Asia-Oceania Space Weather Alliance. ICTSW members have lead roles in the planning and organization of these meetings and place a priority on informing the research community of operational needs and on ensuring that the operational community takes advantage of improved capabilities developed through current research. ICTSW members are also actively involved in the current COSPAR Space Weather Roadmap exercise that will benefit from many of ICTSW’s accomplishments to date and develop recommendations for future observational and research efforts.

**3. OUTSTANDING ACTIONS AND FUTURE PLANS/ISSUES**

The ICTSW is currently addressing a large number of actions that were discussed at ICTSW-3 (November, 2012). Whereas some ICTSW-3 actions have been completed, others still require substantial effort. Outstanding actions are summarized below, organized by the broad areas defined by the Terms of Reference.

*a. Harmonized definition of end products and services, including e.g. quality assurance guidelines and emergency warning procedures, in interaction with aviation and other major application sectors*

- Coordinate with ICAO in establishing space weather services for aviation
- Recommended an approach to evaluate, improve, and expand as necessary the set of global and local Space Weather scales
- Draft an overview of the processes involved and issues to be addressed for extreme event warning, for use by ICTSW as a background for organizing future work

- Improve and expand the Product Portal, including training
- b. *Standardize and enhance space weather information exchange and delivery through the WMO Information System (WIS)*
- Develop a plan with all ISES RWCs and the space weather service providers within ICTSW for registering relevant space weather products to the WIS
  - Ensure that ICTSW is invited to contribute to revise the WMO core metadata profile to describe space weather data in the ISO 19115 standard
- c. *Integration of Space Weather observations, through review of space- and surface-based observation requirements, harmonization of sensor specifications, monitoring plans for Space Weather observation*
- Review space-based capabilities in OSCAR and prepare a template for the specification of surface-based capabilities to be added to OSCAR
  - Review the categories of instruments used for Space Weather observations, their characteristics and implementation status and plans and the possibility of organizing sensor intercalibration procedures.
  - Develop a plan to address the long-term continuity of essential space weather satellite observations and promote efforts to fill observing gaps
- d. *Encouraging the dialogue between the research and operational Space Weather communities.*
- No specific actions have been initiated. However, as mentioned above, ICTSW members are engaged in numerous national and international efforts to promote the linkages between research and operational services.

#### **4. CONCLUSION**

The ICTSW is currently engaged in activities that address all of its Terms of Reference. As envisioned by the ICTSW in its early discussions, one of its initial objectives has been to demonstrate value to WMO Members by providing improved services through its coordination activities. This objective is being pursued in multiple ways, for example: by making products and services available to all Members through the Product Portal; by assisting in the definition of services for civil aviation and in defining how those services will be delivered; by identifying and documenting the gaps in observing capabilities; by working closely with international organizations to ensure that efforts are aligned and not duplicated; and by working to utilize the substantial infrastructure and expertise within the WMO and to organize the global space weather service efforts in close collaboration with ISES.

While continuous progress is being made, there is considerably more that can be done. The improvement of global space weather services can occur in a number of ways, such as by increasing the quality of current capabilities, increasing the coordination and interoperability of existing services, and by increasing the number of Members who are capable of providing services to their local users. As ICTSW moves forward in its space weather effort, it should maintain its focus on the goal of improving services.

It should also be recalled that the sixtieth WMO Executive Council (EC-60, June 2008) *“requested CBS and CAeM to develop plans for WMO activities in Space Weather,*

*identifying objectives, activities, resources, deliverables and expected outcomes, in close cooperation with ISES and relevant bodies of COPUOS, ICAO, IMO and ITU. The Council further invited the two Technical Commissions to submit proposals to the Council, in advance of next Congress, for appropriate inclusion into the future WMO Strategic Plan with respect to formal WMO involvement in Space Weather.”*

In 2011, an important step was accomplished when the sixteenth WMO Congress (Cg-16) recognized space weather coordination as one of the activities of the WMO Space Programme. However, only a limited funding was allocated to this activity with the expectation that most of the resources would be provided by Members on a voluntary basis, including for instance the secondment of staff. Bearing in mind the request from EC-60, the ICTSW should discuss what broader strategy and plans should be submitted to CBS and CAeM in 2014 in preparation for the seventeenth WMO Congress in May-June 2015 with a view to ensure the sustainability of WMO' activities in support of space weather.