

WMO AND SPACE WEATHER

This document reports on preliminary activities of WMO Secretariat regarding Space Weather and on the outcome of the sixtieth Executive Council (EC-LX) in this respect. A report was prepared in April 2008 on the potential scope, cost and benefit of a WMO involvement in support of international coordination of Space Weather services, and is available online ([The potential role of WMO in Space Weather, WMO, April 2008](#)).

EC-LX has recognized the importance of Space Weather phenomena, in particular with regard to their impact on the space-based observing system and on radio-communications, and has noted the potential synergy between meteorological and Space Weather service delivery. EC-LX has thus endorsed the principle of WMO activities in support of international coordination in Space Weather. Given the strict limitation of budgetary and staff resources available for WMO programmes, this additional activity should rely on external resources and the Council thus urged WMO Members to consider the provision of resources through secondments and Trust Fund donations. Work programmes will be developed in respect of Space Weather for the Commission for Basic Systems (CBS) and the Commission for Aeronautical Meteorology (CAeM), in consultation with relevant organizations.

In view of the critical impact of Space Weather events on satellite status and operations, CGMS may wish to play a proactive role, in the future, in this area.

Action/Recommendation proposed

CGMS Members are invited to:

- Comment on this WMO initiative;
- Consider participating in such Space Weather activities;
- Consider an increased involvement of CGMS in Space Weather matters.

WMO AND SPACE WEATHER

INTRODUCTION

1. Space Weather encompasses the conditions and processes occurring in space, including on the sun, in the magnetosphere, ionosphere and thermosphere, which have the potential to affect the near-Earth environment. Space Weather processes can include changes in the interplanetary magnetic field, solar wind, coronal mass ejections from the Sun, and disturbances in the Earth's magnetic field. Space Weather can affect the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. The effects of Space Weather can range from damage to satellites arising from charged particles to disruption of power grids on Earth during geomagnetic storms. Space Weather monitoring, study and applications are more and more important with the increasing use of space technique in day-to-day life for telecommunications, observation and navigation, and further with the prospect of planetary exploration.

2. Following a request from the seventh session of Consultative Meetings on High-level Policy on Satellite Matters (CM-7), the WMO Secretariat has made a preliminary review of Space Weather activities of some WMO Members (China, Russian Federation and United States) where this activity is under the authority of the NMHS and the possible scope of a WMO activity in this respect was identified. Upon request from CM-8, the Secretariat has then worked with the International Space Environment Service (ISES) to provide a report analyzing the economic impact of Space Weather phenomena, their potential synergy with meteorological activities, and the expected cost and benefit of a WMO involvement to support international coordination of Space Weather activities worldwide. This report is available on line ([The potential role of WMO in Space Weather, WMO, April 2008. http://www.wmo.int/pages/prog/sat/Refdocuments.html#SpaceWeather](http://www.wmo.int/pages/prog/sat/Refdocuments.html#SpaceWeather))

HIGHLIGHTS OF THE REPORT

3. Space Weather is highly relevant to WMO activities, primarily because it has a strong impact on environmental satellites, which are key components of the Global Observing System (GOS), and on radio communications, which are operational components of the WMO Information System (WIS). Furthermore, considering that Space Weather affects important economic activities such as aviation, spacecraft operations, satellite positioning and energy distribution, which involve major users of meteorological services, there is a potential for synergy between the emerging operational activities in the area of Space Weather and current WMO activities regarding meteorological services delivery. Such a synergy could mainly occur in the sharing of space- and ground-based observing platforms, in the delivery of routine information through the WMO Information System, in the issuance of Space Weather warnings within a multi-hazard approach, and in interactions with operational users in general.

4. Several WMO Members have placed Space Weather activities under the authority of their National Meteorological or Hydrological Services and are encouraging WMO to engage in this field, in partnership with relevant international organizations. The main international coordination mechanism for Space Weather is currently the International Space Environment Service (ISES). ISES is a permanent service of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS), which involves thirteen Regional Warning Centres (RWC) located in its Member nations: Australia, Belgium, Canada, China, Czech Republic, France, India, Japan, Poland, Russian Federation, South Africa, Sweden, the United States of America, soon to be joined by Brazil. The SWPC in Boulder, CO, USA acts as a "World Warning Agency" for data exchange and forecasts.

5. Space Weather is evolving from research to operational services. The ISES has expressed interest in cooperating with WMO, considering that the WMO framework would be appropriate to enhance international cooperation on operational aspects of Space Weather. It is noted that no United Nations organization is currently responsible for international coordination in Space Weather.

6. Examples taken from aviation, space operations, global satellite navigation systems, and electric power grid management indicate how Space Weather warnings enable substantial reduction of economic losses due to Space Weather events, and it is anticipated that a modest investment in coordination activities under the auspices of WMO could significantly expand the ability to minimize these losses.

Aircraft over polar regions may have to be re-routed when exposed to unexpected high radiation levels and communication outages. Coordinated and timely Space Weather predictions could save more than two million US dollars a year for one airline operating trans-polar routes. There are currently twelve of them and it is increasing.

The accuracy of Global Navigation Satellite Systems (GNSS) such as the GPS is degraded by intense solar events. As GNSS services are increasingly used for professional activities, whether traffic management or oil exploration, improved prediction and monitoring of these phenomena would avoid important losses up to 100,000 USD a day for offshore geophysical exploration campaigns.

Geomagnetic storms are adversely affecting electric power grids in inducing unwanted currents that could lead to the catastrophic collapse of a network as has occurred in Sweden in 2003 and in Canada in 1989, with costs estimated up to 10 million US dollars.

Space operations are particularly exposed to Space Weather events which are a primary cause of spacecraft anomalies or catastrophic failures. Space Weather timely alerts can avoid considerable costs during launch operations. They are vital for astronaut safety, and they can allow putting sensitive payload or spacecraft in safe mode thus avoiding losses of several hundred millions of US dollars.

Extreme events only occur on the order of five to 10 times in a solar cycle of 11 years, but geomagnetic storms causing disturbances to electric network and radio-communications, and harmful radiation levels for spacecraft and astronauts may be 10 times more frequent than extreme events.

EXECUTIVE COUNCIL CONCLUSIONS

7. In view of the considerable impact of Space Weather on meteorological infrastructure and on a growing number of human activities, of the potential synergy between meteorological and Space Weather services, and bearing in mind the specific expertise of WMO, the Council endorsed the principle of WMO activities in support of international coordination in Space Weather. The Council agreed that WMO's involvement in Space Weather should focus on:

- Harmonization of observation requirements, sensors and standards within WIGOS;
- Definition of products in interaction with major application sectors;
- Exchange and delivery of Space Weather information through the WIS;
- Issuance of emergency warnings in the context of multi-hazard WMO activities;

Encouraging the dialogue between the research and operational Space Weather communities.

8. The Council stressed that this new activity should rely on external resources and urged WMO Members to consider the provision of resources through secondments and Trust Fund donations for Space Weather coordination activities and thanked the United States for their offer of such support.

RECENT DEVELOPMENTS

9. The fourth meeting of the WMO CBS/OPAG IOS Expert Teams on Satellite Systems (ET-SAT) and on Satellite Utilization and Products (ET-SUP) discussed this subject. The meeting considered that this issue was beyond the scope of ET-SAT and ET-SUP and suggested that an Inter-commission Team be established among the Commission for Basic System (CBS) and the Commission on Aeronautical Meteorology (CAeM) to look after Space Weather matters. The team should include satellite and aeronautical meteorology experts and be supported by representatives of the Space Weather community.

10 ET-SAT/ET-SUP suggested that the initial work plan of this team include, as a priority:

Liaison with the Committee for the Peaceful Use of Outer Space (COPUOS), the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO), and the International Telecommunications Union (ITU), in order to seek their requirements, expectations, and potential support;
Seeking financial and staff resources from interested WMO Members;
Identification of pilot activities among the areas pre-identified by the Council and listed in paragraph 8 above.

11. In June 2008, ISES held its general assembly and was informed of the outcome of the Executive Council. Mr Joe Kunches, from NOAA Space Weather Prediction Centre, and Mr Jerome Lafeuille, from the WMO Space Programme Office, were nominated by ISES and WMO respectively as points of contact to prepare a joint work plan.

12. The Chairman of the Committee for the Peaceful Use of Outer Space (COPUOS) was informed of the outcome of EC-LX. The International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO) and the International Telecommunications Union (ITU) will be informed of this development as well and invited to work in partnership with WMO on these topics.

13. At the European level, WMO was invited to participate in the Fifth European Space Weather Week to be held in Brussels in November 2008, where the institutional context of Space Weather activities will be addressed.

CONCLUSIONS

14. CGMS is addressing spacecraft anomalies from solar events, as part of its regular agenda item B4. Given the critical impact of Space Weather events on satellite status and operations, CGMS may wish to play a more proactive role, in the future, in this area.

15. CGMS Members are invited to:

- Comment on the WMO initiative to support coordination of Space Weather activities;
- Consider participating in such coordinated Space Weather activities;
- Consider an increased involvement of CGMS in Space Weather matters.