



International Civil Aviation Organization

**EIGHTEENTH MEETING OF THE METEOROLOGY  
SUB-GROUP (MET SG/18) OF APANPIRG**

ICAO Regional Sub-Office, Beijing, China  
18 – 21 August 2014

**Agenda Item 7: Research, development and implementation issues in the MET field**

**7.9 Other**

**THE PROVISION OF GLOBAL SPACE WEATHER INFORMATION IN SUPPORT OF  
INTERNATIONAL AIR NAVIGATION**

(Presented by the United States of America)

**SUMMARY**

This paper presents the capabilities of the United States' (U.S.) Space Weather Prediction Center (SWPC) as an example of the capabilities required for a global centre to provide information on space weather events to support international air navigation.

**1. Introduction**

1.1 Most space weather events affect large parts of the globe and thus cross multiple flight information regions. This is quite different from terrestrial weather events which are relatively smaller in scale and slower in movement.

1.1 The three primary types of space weather that impact aviation are solar flares, solar radiation storms, and geomagnetic storms, with geomagnetic storms being the main driver of severe ionospheric disturbances. The effects of each are generally felt across large sections of Earth. Additionally, ionospheric disturbances occur as a result of the normal diurnal processes of the Earth as well as in response to geomagnetic storms. Different latitudes and longitudes are affected differently in response to both of these drivers.

1.2 Consistent and coherent space weather information is essential to minimize any risk associated with conflicting information in support of operational decision-making, both in flight planning and in tactical maneuvering. Space weather requires coordination and collaboration between centres to ensure harmonization of the forecast information. At the MET Divisional Meeting it was understood or agreed that any Provider State of space weather information will need to be able to coordinate and collaborate in a timely manner to provide information that is time-critical to Air Traffic Management, Operations Centers, and Flight Crews.

## 2. Discussion

2.1 SWPC is part of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service. SWPC is the official source of civilian space weather information in the U.S. SWPC is also the lead Regional Warning Center for the International Space Environment Service. SWPC provides real-time monitoring and forecasting of space weather events which can impact satellites, power grids, communications, navigation, and many other advanced systems.

2.2 SWPC operates 24x7x365, and in the event of a service interruption, the U.S. Air Force's Air Force Weather Agency (AFWA) provides backup services. To support domestic and international aviation operations, SWPC fulfills the following functions:

- a) Monitor relevant ground-based and space-based observations to detect and predict the following space weather phenomena:
  - 1) Geomagnetic storms;
  - 2) Solar radiation storms;
  - 3) Solar flares; and
  - 4) Ionospheric activity.
- b) Provides space weather information regarding the type, intensity, and extent of the space weather phenomena referred to in a);
- c) Supply the space weather information referred to in b) to:
  - 1) U.S. Federal Aviation Administration (FAA) in support of Air Traffic Management,
  - 2) Airlines and,
  - 3) Other space weather centres.

2.3 In fulfilling the functions described in Section 2.2, SWPC meets the following performance standards for quality, reliability, and integrity of space weather information:

- a) Maintains continuous operations in support of real-time observation, analysis, forecasting, and event-driven product dissemination 24-hours per day, continuously;
- b) Maintains observations of:
  - 1) Solar Extreme Ultraviolet and X-ray output (detection of solar flares)
  - 2) Near-Earth energetic proton environment (detection of solar radiation storms)
  - 3) Coronal mass ejections (the primary driver of significant geomagnetic storms)

- 4) Ground-based magnetometers
- 5) Ionospheric measurements (a combination of ground-based GNSS measurements, space-based GNSS radio occultation, etc.)
- c) Data availability of the critical observations referred to in b) meet the 98.0 percent level or greater when assessed continually over a 1-year period with no single outage exceeding 90 total minutes in a 24-hour period;
- d) Adheres to applicable information security standards to ensure availability, reliability, and integrity of products and services (with SWPC adhering to the U.S.'s Federal Information Processing Standard (FIPS) 199, High set of standards);
- e) Maintains redundancy in processing and infrastructure and the implementation of continuity of operations plans and procedures to ensure the availability and reliability of products and services that ensures 99.9 percent overall system availability when assessed continually over a 1-year period with no single outage exceeding 4 hours; and
- f) Maintains comprehensive verification and validation activities to continually assess performance and generate estimates of uncertainty.

2.4 The FAA and SWPC continue to collaborate and promote improved space weather information services in support of international air navigation. An example of SWPC's current products and services in support aviation are included in Appendix A. Additionally, the FAA and SWPC are supporting the development of a manual on space weather to meet Conclusion 8/23 from the Eighth Meeting of the International Airways Volcano Watch Operations Group (February 2014).

**Conclusion 8/23 – Development of a manual on space weather for international air navigation**

That an ad hoc group consisting of Australia, China, France, Germany, Japan, United Kingdom, United States (as rapporteur), IATA, ICCAIA, IFALPA, and WMO, be tasked to:

- a) Develop a *Manual on space weather for international air navigation* that should include information to support the required space weather services and their associated effects and impacts on international air navigation; and
- b) Provide a draft to the IAVWOPSG/9 meeting.

2.4 The development of the *Manual on space weather for international air navigation* is expected to include defining the minimum functional requirements of future centres for the provision of space weather information services. The U.S. anticipates working collaboratively within ICAO and WMO to define the performance requirements that must be met for the establishment of a global space weather centre(s).

**3. Action by the Meeting**

3.1 The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matters as appropriate.

-----

### APPENDIX A

SWPC provides a host of products and services in support of commercial aviation. As an example, Figure 1 depicts the current SWPC Aviation Community Dashboard, a collection of products and services frequently used by the aviation community.

For example, the D-Region Absorption Prediction (D-RAP, upper left) depicts the high frequency radio impacts driven by both solar flares and radiation storms. The D-RAP product page allows users to visualize impacts within specific frequency bands. Solar radiation storm levels are also depicted in the space weather details plot (lower left), where the current NOAA Space Weather Scales levels of all three primary phenomena are depicted. Current conditions and the forecasts are also provided in the slider at the top of this user page. The state of the ionosphere affecting single frequency Global Positioning System (GPS) range errors is shown in the U.S. Total Electron Content product in the upper right. These products and products like these are critical to assessing the space weather impacts to aviation.

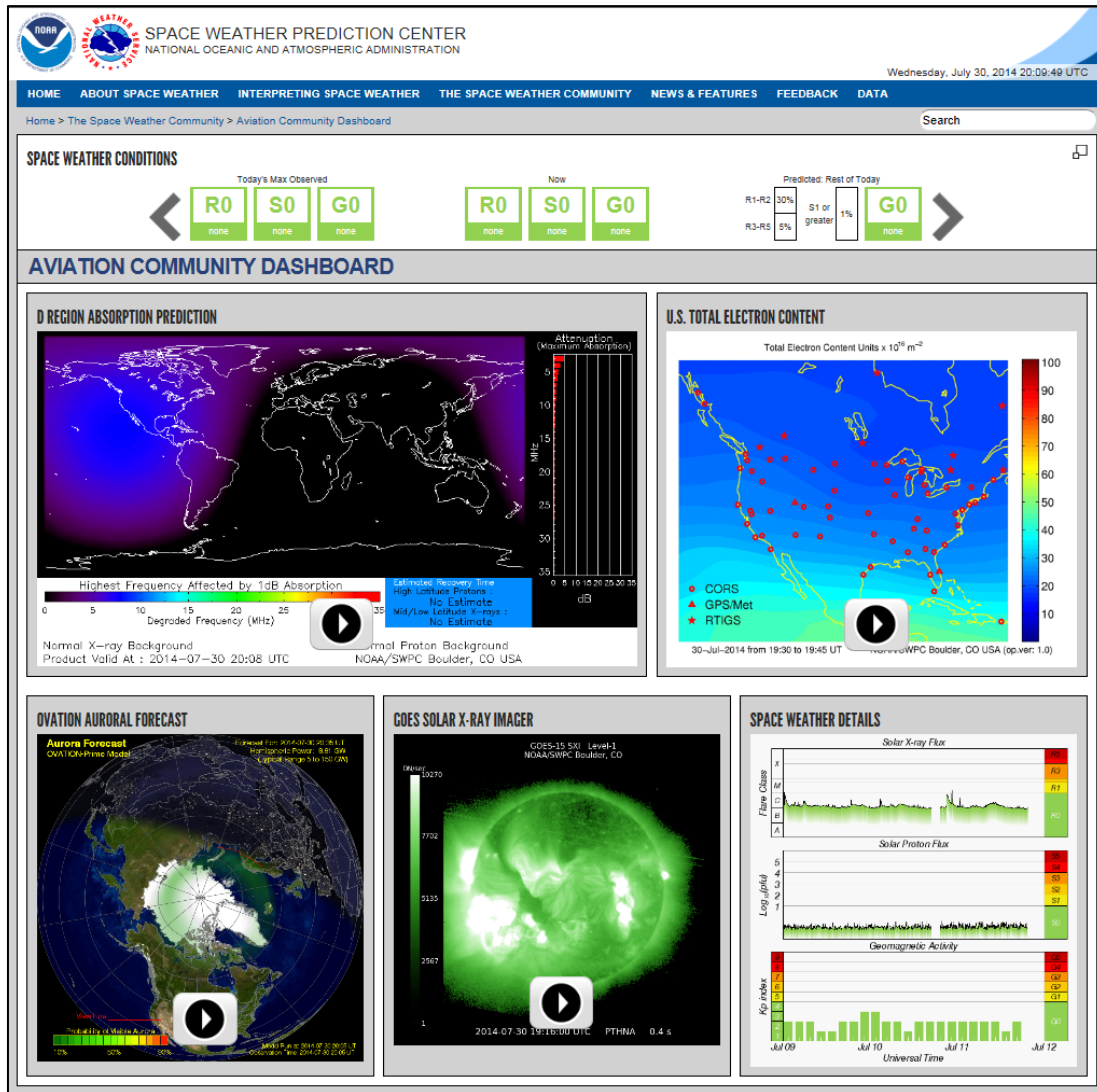


Figure 1. The SWPC Aviation Community Dashboard, available at <http://origin-www.swpc.noaa.gov/communities/aviation>