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Impacts of Space Weather on International Aviation

- HF Communications – Degraded to Blackout
- GNSS – Increased position errors to Denial of Service
- Radiation Exposure – Potentially elevated exposure levels for onboard computers, flight crew members, and passengers
- Sat Comm – Anecdotal evidence of degradation for frequencies below 2 GHz but needs further definition and analysis
Space Weather Conditions

- Impacts to international aviation caused by:
  
  - Eruptions from the Sun which disrupt dayside and polar HF communications, elevate radiation very quickly
  
  - Magnetic storms disrupt HF in other ways, degrade GNSS-based navigation and surveillance, but start hours to days after parent solar eruption
  
  - Affected areas vary from a few km² to a large portion of the earth’s surface and are altitude dependent
Space weather centers, including the US Space Weather Prediction Center, have produced space weather information for years. Information used by several industries, including power and communications, is not necessarily specific to aviation needs and decisions. ICAO Annex 3 Space Weather Advisories were intended to meet users' needs for space weather information to support international civil air navigation. They provide a standardized service and information for over 200 airlines globally, with information specific to aviation impacts. Developed in response to user needs articulated by IATA, they can be supplemented with more detailed space weather information as needed through websites.
2002 Users identified space weather events as a potential safety hazard at the ICAO Meteorology Divisional Meeting

2014 ICAO International Airways Volcano Watch Operations Group developed the initial Concept of Operations for space weather information

2015 ICAO Meteorology Panel assigned responsibility for developing space weather information

2016 Updated the Concept of Operations for Space Weather

2016 Developed functional and performance requirements for space weather information

2016 Developed draft Standards and Recommended Practices for space weather information for inclusion in ICAO Annex 3

2017 Developed Space Weather Manual

Note: Meteorology Panel includes representatives of the user communities (IATA, IFALPA, IFATCA)

2017 Industry updated on space weather information at ICAO GANIS meeting
Provision of Space Weather Information

- Annex 3 to the Convention on International Civil Aviation, “Meteorological Service for International Air Navigation” Amendment 78
- Amendment 78 applicable 8 November 2018
- Issue Space Weather Advisory for:
  - HF Voice/Data & Satellite Communications
  - Radiation Exposure to Crew and Passengers
  - GNSS Based Navigation & Surveillance
- Space Weather Information Service operational beginning 7 November 2019
Sample ICAO Space Weather Advisory

FNXX01 YMMC 020100
SWX ADVISORY
DTG: 20190202/0100Z
SWXC: ACFJ
ADVISORY NR: 2019/10
SWX EFFECT: HF COM MOD
OBS SWX: 02/0100Z DAYLIGHT SIDE
FCST SWX + 6 HR: 02/0700Z DAYLIGHT SIDE
FCST SWX + 12 HR: 02/1300Z DAYLIGHT SIDE
FCST SWX + 18 HR: 02/1900Z NO SWX EXP
FCST SWX + 24 HR: 03/0100Z NO SWX EXP
RMK: LOW END OF BAND HF COM DEGRADED ON SUNLIT ROUTES. NEXT 12 HOURS MOST POSSIBLE, DECLINING THEREAFTER.

NXT ADVISORY: 20190202/0700Z
Designation of ICAO Space Weather Centers

- ICAO issued State Letter AN 10/1-IND/17/11 on June 9th, 2017 requesting States to provide a formal expression of interest in providing the space weather information service.

- WMO conducted an audit of all States and consortia that indicated a formal interest:
  - Audit against criteria developed by MET PANEL (accepted by ANC)
  - Did not assess the “quality” of meeting criteria
  - Did not make a judgement (e.g. ranking) of States – only reported results of States' meeting or not meeting the identified criteria

- ICAO Council designates States to provide Space Weather in Nov 2018
  - Considered ‘optimum number” recommended by METP
  - Based on WMO audit results
  - Based on “other” considerations
Designated ICAO Centers

Three Global – Consortiums are considered once center

- PECASUS (European consortium lead by Finland) (Finland, UK, Germany, Austria, Poland, Italy, Netherlands, Belgium, Cyprus)
- ACFJ (Australia, Canada, France, Japan)
- NOAA SWPC (United States)

Two Regional

- China/Russia Consortium
- South Africa

Numbers do not reflect ranking or order. All centers are equal in their designation.
Global Centers working to meet Annex 3 Global Provision → operational Nov 7, 2019
One “On Duty” Center at any given time
Two week rotation
“On duty” Center issues all advisories
Centers coordinate and collaborate continually
Other two centers ready for 1st and 2nd backup
Regional Centers operational by 2022
Sooner if feasible
ICAO Space Weather Manual and Other Guidance Material

➔ Space Weather Manual
  ➔ Released October 2019
  ➔ Specific to aviation needs and decisions

➔ Other Guidance Material
  ➔ CAA information and guidance
  ➔ Space Weather Center Operations Handover Manual
Benefit to Operators

- Impact-based (vs. phenomenological) information
- Actionable information
- Will evolve as technology advances
- Supports individual risk assessment by operators
Enhancements to Space Weather Advisories

- Amendment 80 to Annex 3
  - MET Panel is developing SARPs to refine the information in the Advisor
- Anticipated Future Enhancements
  - Provision of probabilities within the Advisory
  - Polygons will be introduced in 2022 to better define the impact area
Implementation Considerations

- Now near solar minimum, which should equate to few advisories being issued
- Hand-off procedures between space weather centers
- Back-up responsibilities and procedures
- Information sharing between space weather centers
Questions?
Contact Information

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