



SEVENTH MEETING OF THE PACIFIC METEOROLOGICAL COUNCIL (PMC-7)

AGENDA ITEM 9

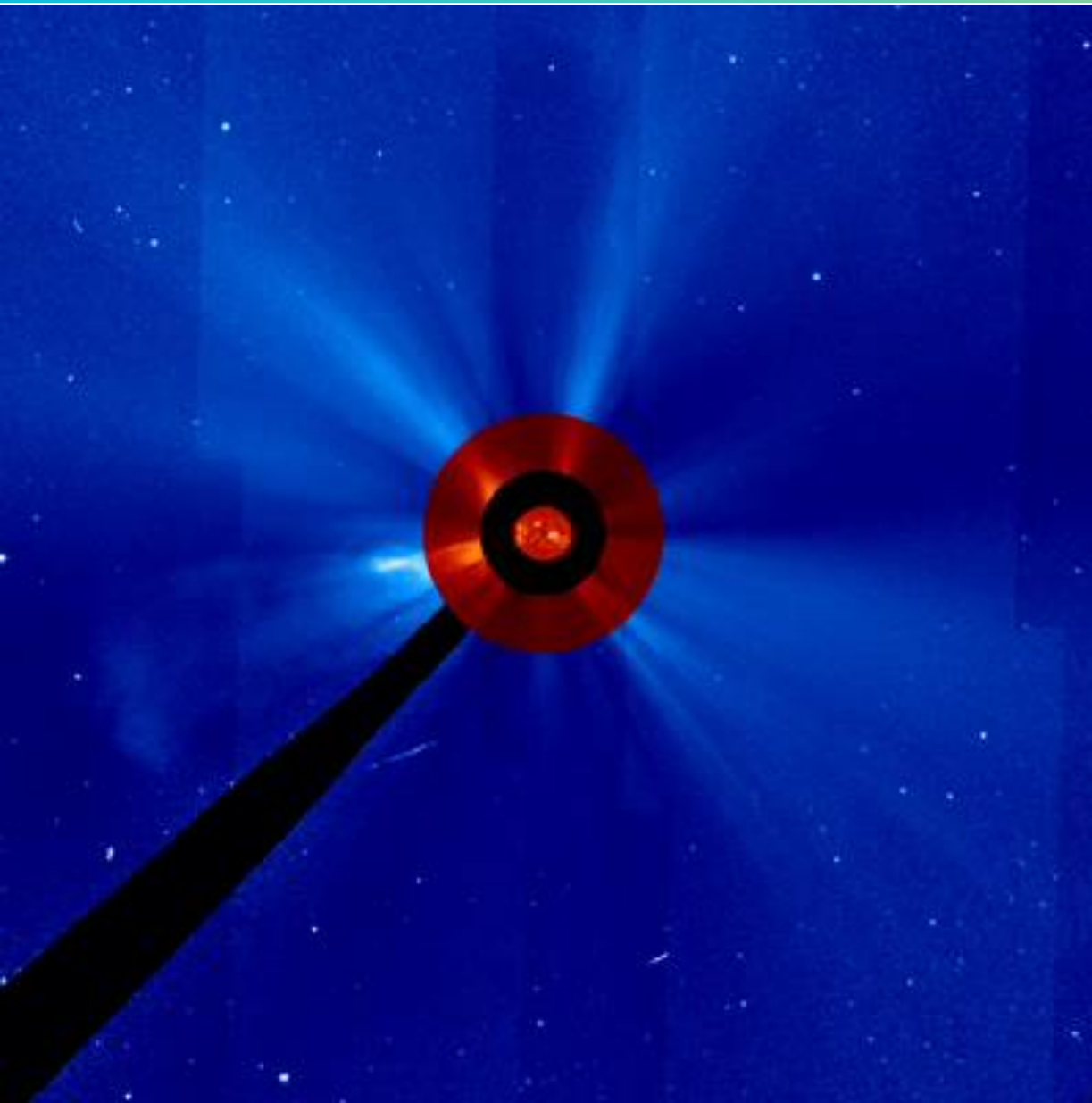
Space Weather – Overview and Potential Impacts

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Purpose of the Paper

- To provide the Meeting with an overview of space weather and its potential impacts.
- To inform the Meeting of the space weather forecast and warning information sources available, including the ICAO space weather advisories for aviation.

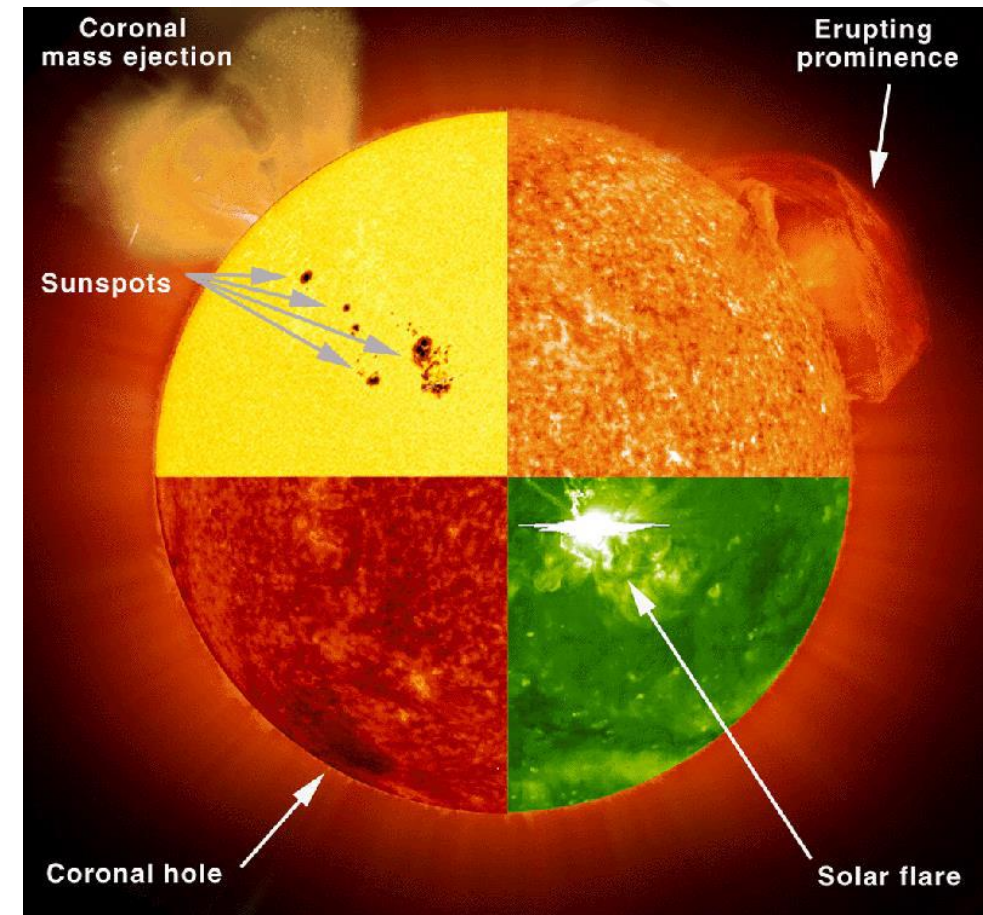


A coronal mass ejection associated with a X4.9 solar flare – recorded by the SOHO spacecraft 24-25 February 2014.

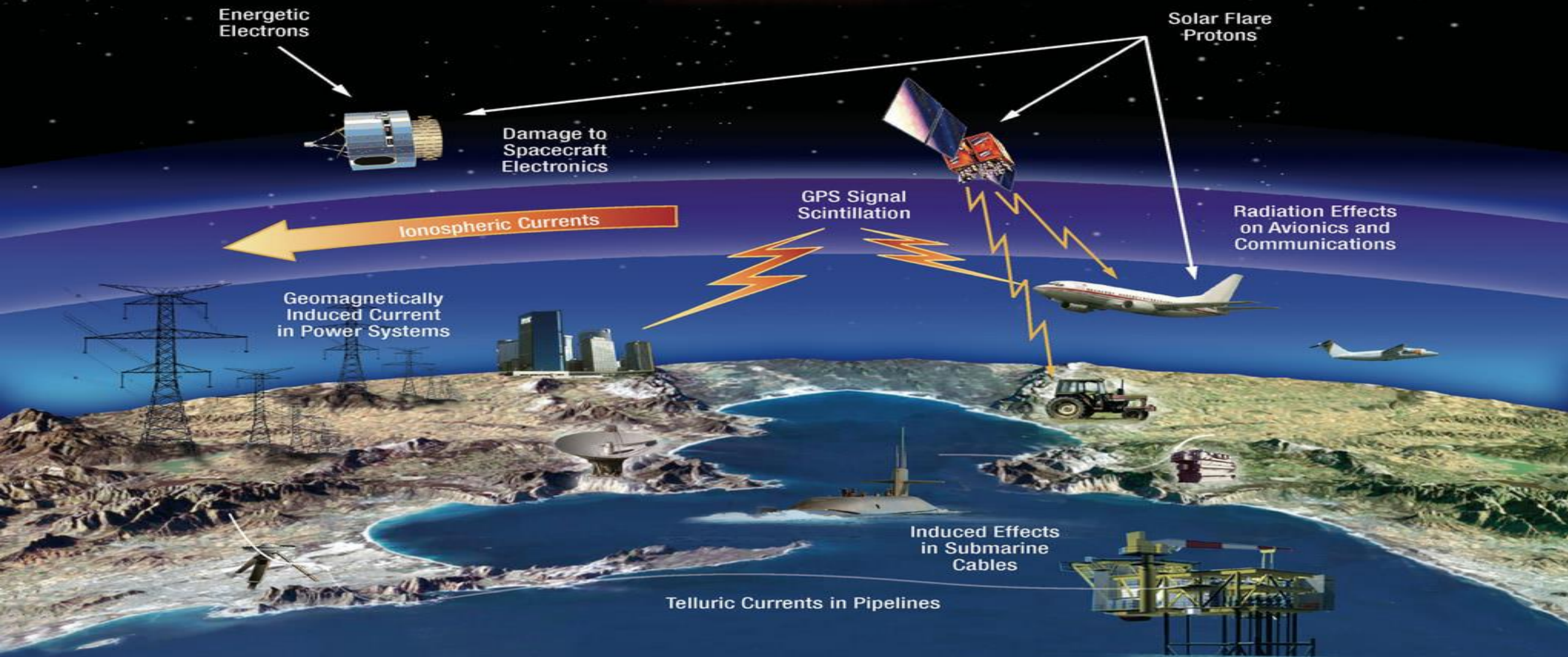


What is space weather?

- Solar wind – continuous stream of charged particles emitted in all directions.
- Solar flares – sudden burst of electromagnetic radiation, particularly at X-ray wavelengths. Typically originate from magnetically complex regions on the surface where sunspots are found.
- Coronal mass ejections (CME) - large clouds of plasma + magnetic field which erupt in the Sun's outer atmosphere. These can be Earth-directed, causing geomagnetic and ionospheric storms.
- Particle radiation events – bursts of high-energy protons. Can arrive in 15 min to several hours, if Earth-directed.



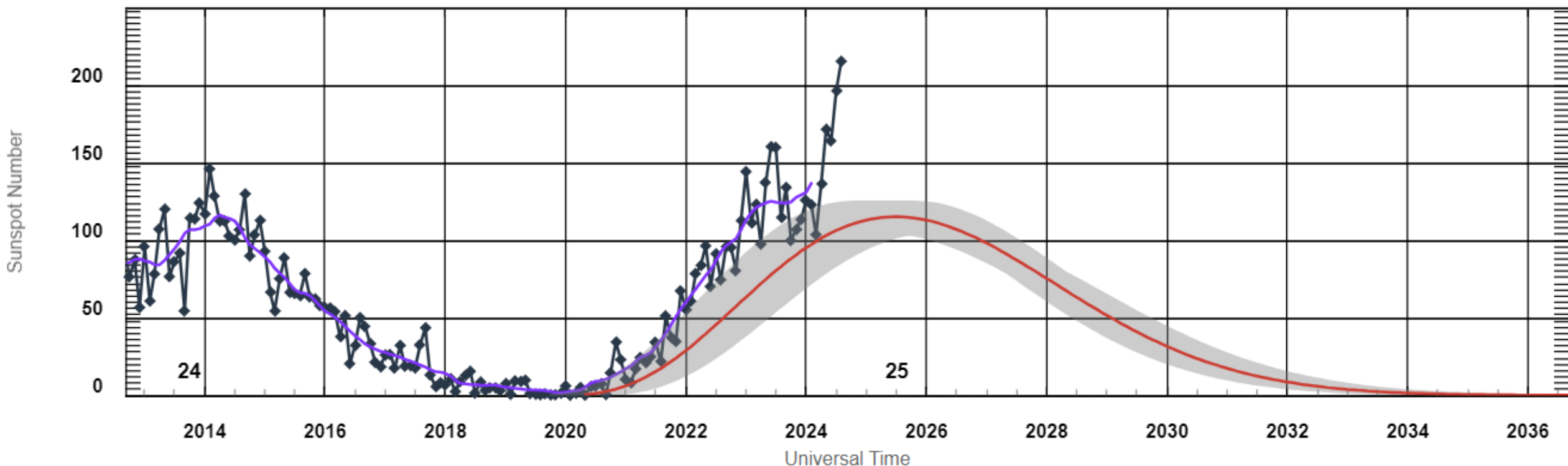
Space weather impacts on aviation





ISES Solar Cycle Sunspot Number Progression

Zoom:



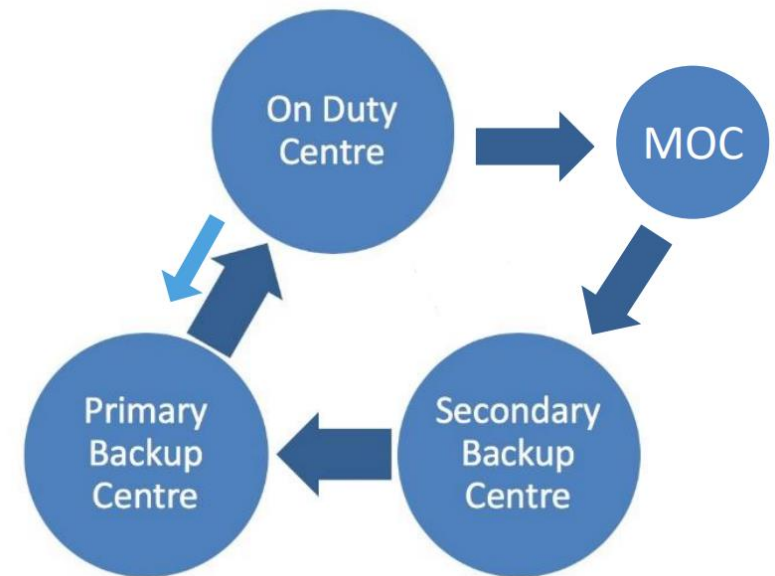
◆ Monthly Values — Smoothed Monthly Values — Predicted Values ■ Predicted Range

ICAO SWX advisories

- ICAO space weather advisory (SWXA) system went live November 2019.
- Four global providers, on fortnightly duty rotation, issuing **impact-based** advisories for two intensity thresholds: moderate and severe
- Three broad space impact areas for aviation:
 - HF Communication (HF COM)
 - GNSS-based navigation and surveillance (GNSS)
 - Radiation impacts on avionics and aircraft occupant health (RADIATION)

(+ impact on satellite comms (SATCOM) planned)

4-centre model





ICAO SWX advisories

No ICAO forecasts provided **yet** (alerts only). No SIGMET for space weather (SWX) – also agreed no NOTAM (to be formalised in Amd 82 to Annex 3 + consequential updates) – due to potential for information overload.

However, situational awareness products are available via SWPC, Australian BoM, among others – can be automatically emailed through. View/sign up at:

- NOAA Space Weather Prediction Center (SWPC):
<https://www.swpc.noaa.gov/>
- Australian Space Weather Forecasting Centre (ASWFC):
<https://www.sws.bom.gov.au/>



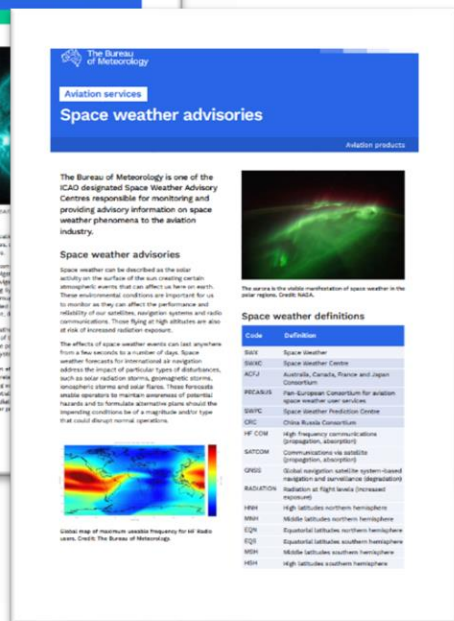
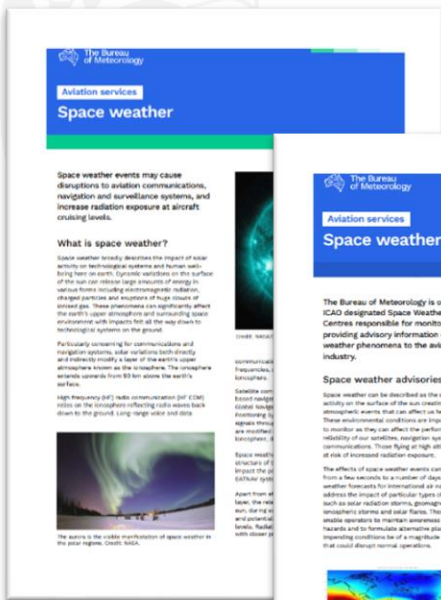
Useful education resources

Excellent BoM video: [sws.bom.gov.au/vid/Space Weather Impacts and Extremes.mp4](https://sws.bom.gov.au/vid/Space%20Weather%20Impacts%20and%20Extremes.mp4)



Useful education resources

- Manual on Space Weather Information in Support of International Air Navigation (ICAO Doc 10100)
- BoM – ASWFC Education
<https://www.sws.bom.gov.au/Educational>
- NOAA - SWPC Education
<https://www.swpc.noaa.gov/content/education-and-outreach>





Recommendations

The Meeting is invited to:

- **Note** the risk to transport and public infrastructure operations posed by significant space weather events.
- **Encourage** the sharing of information on space weather with relevant government organisations for effective planning for extreme space weather impacts.