



ICAO

*WACAF Office*

# INTERNATIONAL CIVIL AVIATION ORGANIZATION

A UN SPECIALIZED AGENCY

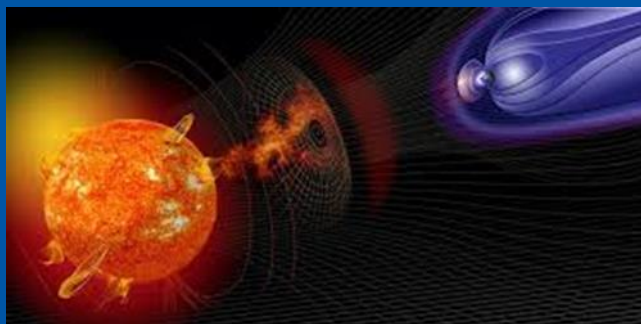
*ASECNA Seminar on the Implementation of  
requirements for the provision of Space  
Weather Information to Aviation: From  
Awareness to Operational Readiness*

*Dakar, 8-12 December 2025, Dakar, Senegal*



## Session 2

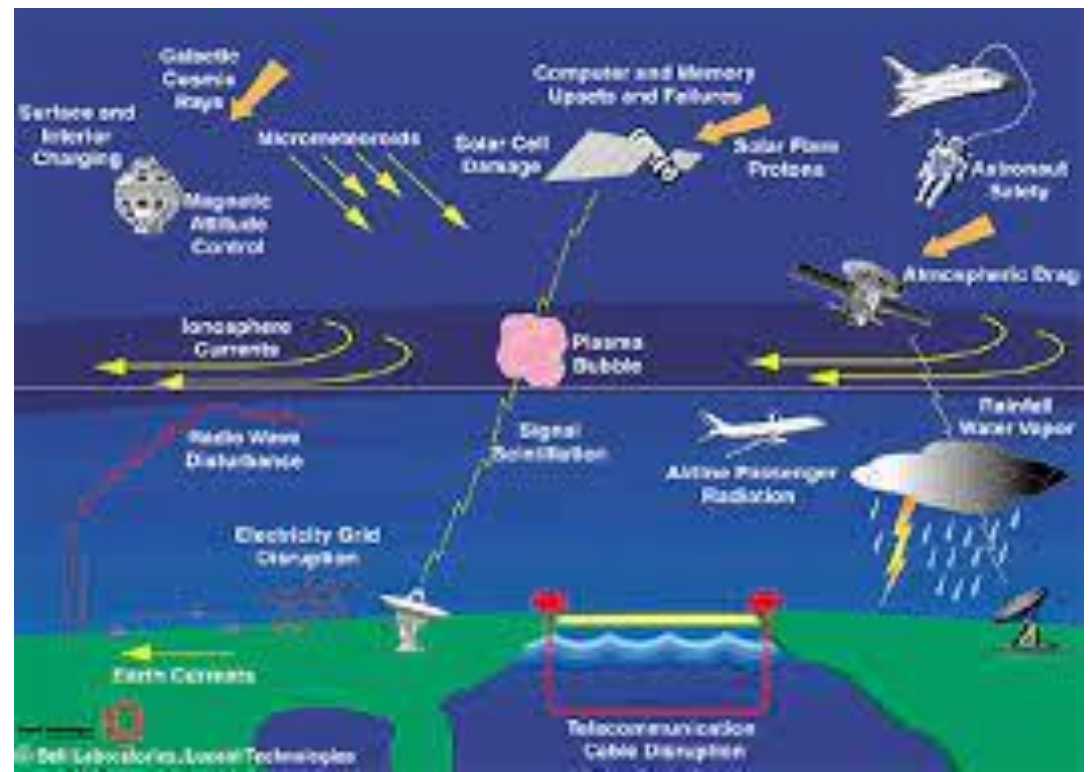
# ICAO Requirements and Global



**2.5 Response to Space  
Weather Events (Actions by  
MET authorities, ANSPs,  
Operators, regulators, etc.)**

# Outlines

- 01** Introduction
- 02** Principles guiding best practices
- 03** Stakeholders and Responses to a Space Weather Event



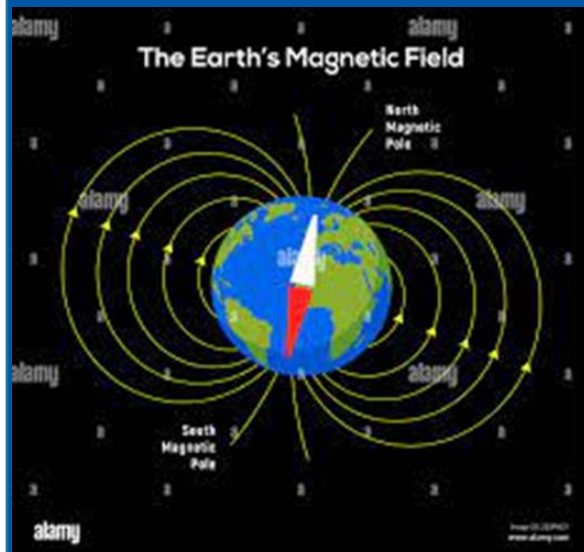
## Use of Space Weather Advisory Information



## Introduction

- Space weather advisories shall be prepared and issued **in accordance with the provisions of Annex 3** to the Chicago Convention.
- **SWXA timely issued** may allow operators **to prepare appropriate response** through a develop a **response plan** that **do not involve any change** to an already planned flight.
- **SWXA issued at the last minute, or en route**, will require **the flight plan to be recalculated**.
- In any cases, due to the **insidious impacts** on systems and **high levels of radiation**, flight crews and ANSPs may suddenly be faced **with situations requiring rapid action**.
- **Principles guiding best practices** and **appropriate actions** may help to **mitigate SWx phenomena impacts**.

## PRINCIPLES GUIDING BEST PRACTICES



## Guidance to reduce the SWX impacts

- Solar radiation storms are one type of space weather event that may necessitate a fast response due to the immediacy of its impacts.
  - The **lead time** for the radiation advisory should be **only a few minutes at most**.
  - To avoid radiation, **considerations of time, distance and shielding enable decisive actions to mitigate the threat**.
- Shielding from radiation consists of protection, including consideration of the following:
  - **The overhead atmosphere:** As far as possible, **flying at the lower altitude**, will increase the protection by the air overhead; and
  - **The geomagnetic field.** When the field vector is more horizontal than vertical, charged particles are diverted away. **The Earth's magnetic field is vertical at the poles and horizontal at the equator, so flying at lower latitudes increases the shielding.**

## RESPONDING TO A SPACE WEATHER EVENT

### Flight Crew



## Flight Crew

- Advisories of **imminent or on-going disruptions** to **HF** and **GNSS** and of **radiation effects** enable **alternate route planning** or **delayed use of polar routes**. Options may include:
  - **Time** — delayed entry into regions specified in the advisory.
  - **Distance** — not only avoiding specified regions, but in the case of radiation, flying at a non-optimal but lower altitude for more shielding by the atmosphere.
- **Mitigation options for GNSS and HF degradations are limited to:**
  - **Time** — wait for the disturbance to abate;
  - **Distance** — an element of the disruption is due to **the movement overhead of structures** in the ionosphere. Knowing those trajectories **in advance** can help to trigger appropriate mitigation strategy.
  - **Other — HF** can sometimes improve by **using higher frequencies during HF absorption events** (solar flares, solar radiation storms) or **employing lower frequencies during HF depressions** (ionospheric storms).

## RESPONDING TO A SPACE WEATHER EVENT

## OPERATORS



### BY AIRCRAFT OPERATORS

- Operators should develop **operational procedures** for managing flights in areas impacted by space weather events.
- Procedures should include the use of **risk assessment techniques** to determine informed actions based on the provision of space weather advisory information.
- Conduct **situational awareness capacity building** to ensure safe and efficient flight management.
- **Operators should work with SWXC** to familiarize themselves with the products and services provided, as well as to develop a strong working relationship.

## RESPONDING TO A SPACE WEATHER EVENT

### ANSPs



## BY AIR NAVIGATION SERVICE PROVIDERS

- **Strengthen situational awareness**, within the broader context of managing multiple flights **to maintain safe and efficient operations**.
- The **insidious nature of space weather impacts** on critical systems requires a **well-designed and useful advisory**.
- Unlike convective weather, there is **no visual clue** to space weather impacts.
- **GNSS uncertainties** may require **greater separation between aircraft depending on the phase of flight**. Terminal and en-route requirements differ in the extent to which GNSS errors become significant.

## RESPONDING TO A SPACE WEATHER EVENT

### SWXC



## SWXC - Institutional requirements

- **Experience** as a designated national space weather information provider.
- **Establishment of quality management system for aviation weather services** as required by Annex 3 to the Chicago Convention.
- **Appropriate training and qualifications of personnel** engaged in the preparation and provision of space weather information for international air navigation. WMO is amending the WMO N° 1209 to include competency requirements relating to space weather and other environmental events (the Cg-19 held from 22 May to 3 June 2023 refers).
- **Procedures to coordinate and liaise with all stakeholders** and other space weather information providers.

## RESPONDING TO A SPACE WEATHER EVENT

### SWXC



## SWXC - Operational & Technical capability

- **Operational capability**
  - 24/7 operational capability;
  - Capability to ensure a system reliability, availability and maintainability.
- **Technical capability**
  - Ability to provide the space weather information service, both **near real-time** and **forecast information**, as prescribed in the SARPs for Amendment 78 of Annex 3
  - Ability to access observations (own observations and received from other space weather providers)
  - Ability to **produce near real-time and forecast information**
  - Ability to **coordinate and harmonize information** with the **Space weather information providers for adjacent areas of responsibility**, as necessary.

## RESPONDING TO A SPACE WEATHER EVENT

### SWXC



## SWXC - Communication/Dissemination capability

- The SWXCs are the **data originator**. They will produce the SWX Advisories in text form and, **from no later than 5 November 2020, in IWXXM form**.
- Ability to provide a **communications system and infrastructure** that supports the **availability, maintainability, and reliability** requirements.
- Ability to provide the space weather information service via the following means of dissemination:
  - ICAO Aeronautical Fixed Service (AFS)
  - World Area Forecast System Internet File Service (WIFS)
  - Secure Aviation Data Information Service (SADIS)
  - National OPMET Centres (NOCs)
  - Regional OPMET Centres (ROC), the inter-regional OPMET gateways (IROGs), Regional OPMET Data Banks (RODBs) .

## RESPONDING TO A SPACE WEATHER EVENT

### AMO



## Aeronautical MET Office

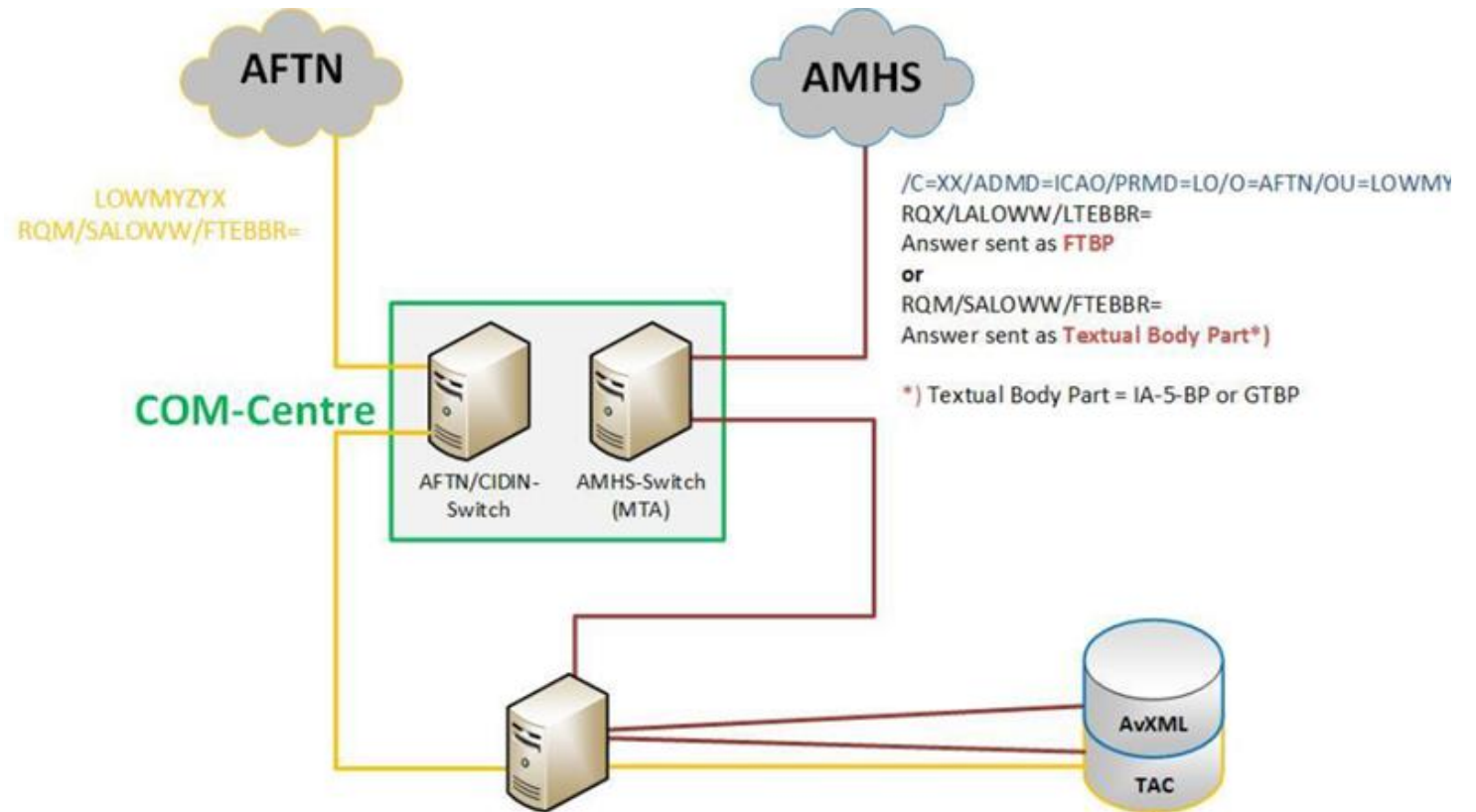
- **Ground system infrastructure** and **dissemination systems** for SWX information (capability to receive and exchange the SWX advisory information).
- **Operational Procedures** for the **dissemination** of space weather information
- **Training for meteorological and aviation IT personnel**, including NOC/ROC/RODB/IROG personnel on the exchange/handling of SWX information
- **Implementation of the ICAO Meteorological Information Exchange Model (IWXXM)** scheme used to enable the provision of SWX information in digital format.

## RESPONDING TO A SPACE WEATHER EVENT

## OPMET Data Banks



## International /Regional OPMET Databanks



Regional OPMET Interface Control Documents (ICD) and  
Regional OPMET Bulletin Exchange Handbooks up to date.

## RESPONDING TO A SPACE WEATHER EVENT

### Civil Aviation Authority



## State Safety Oversight System relating to SWX

- As the State authority regulating and overseeing all aspects of civil aviation, the CAA is responsible for properly integrating space weather into existing aviation considerations.
- Prescribed actions, centre requirements and other functional necessities within the jurisdiction of the State must be put in place to remedy adverse effects on aviation.
- State Civil Aviation Act shall empower CAA to carry out surveillance activities on the implementation of SWX requirements by SWX information Provider.
- Technical regulations relating to MET to be updated to integrate as appropriate requirements of space weather information as prescribed in Annex 3 to Chicago Convention.

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## Conclusion

The **quality, reliability, and integrity** of the space weather information service for international air navigation necessitates :

- **Full coordination between SWXCs and between the SWXCs and all other stakeholders** involved.
- **Quality management system** to ensure quality assurance of SWX information.
- Adequate **communication infrastructure and systems**
- A **regulatory framework** for the provision of space weather information.
- Adequate **development of competency of personnel** involved in the provision of SWX information (WMO No-49, 2023 Edition Updated in 2025).



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Thank You!