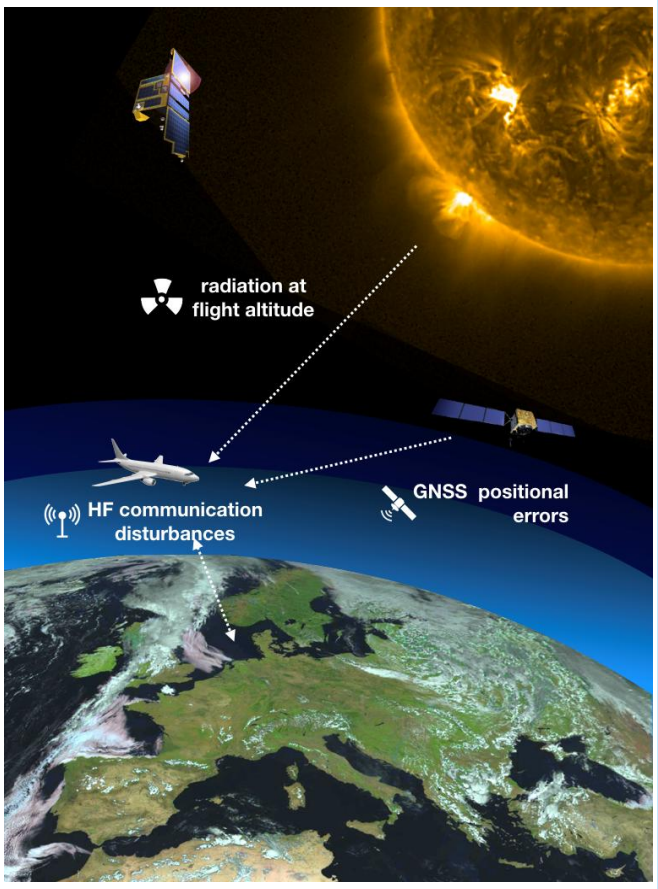
The ICAO Space Weather Information Service

Space Weather (SWX) and Aviation:

What is SWX? The Sun drives our planet's weather and climate patterns and is the main driver for space weather. SWX relates to the dynamic processes on the Sun which affect the interplanetary space and can impact various technological systems as well as human well-being on Earth.

Impacts on Aviation: SWX effects can impact GNSS, positioning and navigation, deteriorate and limit radio communications, or cause an increased radiation exposure at certain flight altitudes[4].

ICAO SWX Information Service*: The goal is to advise aviation users when SWX events are expected to cause a moderate or severe impact related to the deterioration or loss of satellite navigation or HF communication (long-distance radio) or enhanced radiation dose at specific flight levels. Advisories are disseminated through ICAO's standard communication channels and are required for completeness of flight documentation.



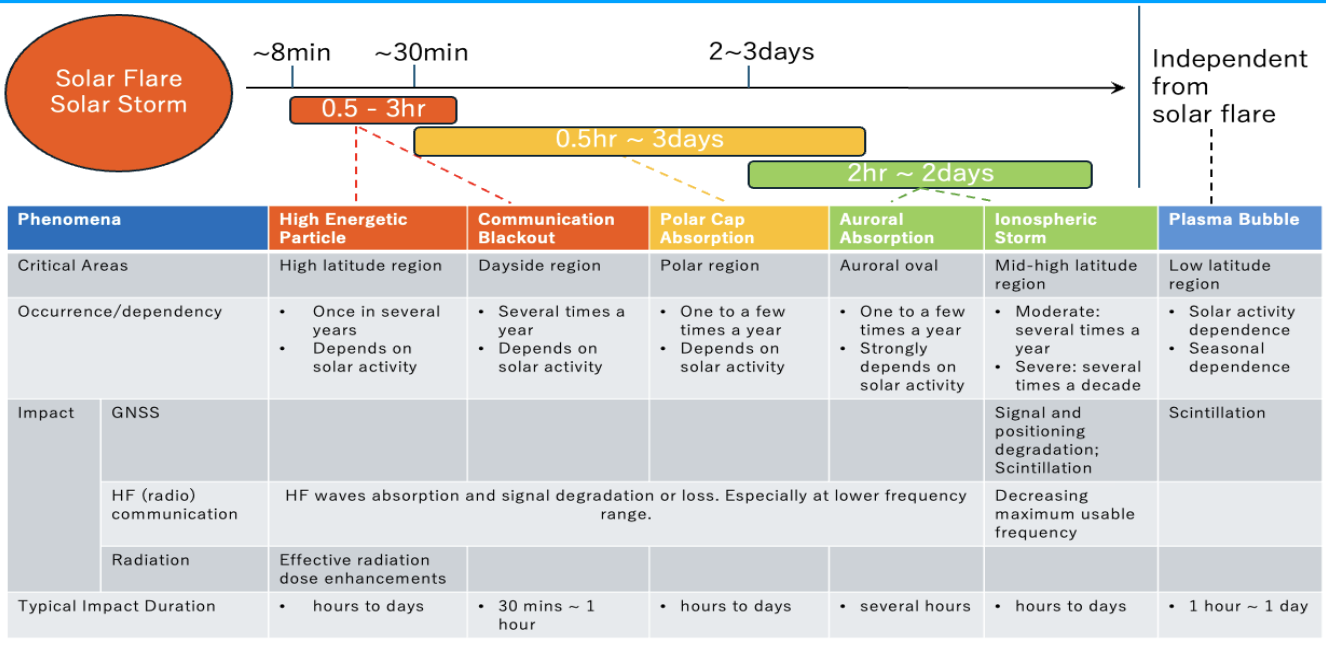
SWX Advisories definitions:

- ★ Similar in structure to volcanic ash and tropical cyclone advisories.
- ★ Advisory triggers and relevant thresholds are defined in the Manual on Space Weather Information in Support of International Air Navigation, ICAO Doc 10100[1]; detailed service specification including advisory format, and upcoming changes are provided in Annex 3[2] and PANS-MET (Doc 10157)[3].
- ★ Spatial range of SWX Advisory can vary largely from isolated sectors to large areas on Earth.
- ★ Duration of a SWX impact can range from tens of minutes to several days.
- ★ Impacted areas are given in terms of polygons with maximum 6 corners (7 points) based on geographic coordinates with resolution of 5° in latitude and longitude; alternatively, one or more pre-defined latitude bands may be used varying by 30° (e.g. HNH, MNH, EQN) and a longitude range with 5° increments.

SWX Advisories in a nutshell:

- ★ Start: Resilient 24/7 staffed operations since November 2019.
- ★ Service: Near-real-time ICAO advisories issued by 4 global SWX centers supported by 1 regional center.
- ★ Impact: Cover domains of navigation (GNSS), radiation exposure (RAD) and radio communications (HF COM).
- ★ Standards: Impact-based advisory thresholds tailored to ICAO standards.
- ★ Updates: Within 6 hours from start of event.
- ★ Severity levels: MOD or SEV

NOTE: SIGMETs and NOTAMs are not issued based on SWX Advisories.



Phenomena		High Energetic Particle	Communication Blackout	Polar Cap Absorption	Auroral Absorption	Ionospheric Storm	Plasma Bubble
Critical Areas		High latitude region	Dayside region	Polar region	Auroral oval	Mid-high latitude region	Low latitude region
Occurrence/dependency		• Once in several years • Depends on solar activity	• Several times a year • Depends on solar activity	• One to a few times a year • Depends on solar activity	• One to a few times a year • Strongly depends on solar activity	• Moderate: several times a year • Severe: several times a decade	• Solar activity dependence • Seasonal dependence
Impact	GNSS					Signal and positioning degradation; Scintillation	Scintillation
	HF (radio) communication	HF waves absorption and signal degradation or loss. Especially at lower frequency range.				Decreasing maximum usable frequency	
	Radiation	Effective radiation dose enhancements					
Typical Impact Duration		• hours to days	• 30 mins ~ 1 hour	• hours to days	• several hours	• hours to days	• 1 hour ~ 1 day

Global Navigation Satellite System (GNSS):

Ionosphere's Role: The ionosphere, a top layer in our atmosphere ionized by sunlight, affects satellite navigation signals.

Signal Disruption: Solar storms can cause ionospheric disturbances, altering GNSS signal strength, velocity and phase.

Scintillation: This rapid change can prevent receivers from locking onto signals, making it hard to determine position.

Vertical Total Electron Content: Increased VTEC in the ionosphere during solar storms can cause positioning errors in satellite navigation.

Advisory Severity Levels: GNSS MOD; GNSS SEV

Increased radiation dose at flight levels (RAD):

Energetic Particles: During solar storm events, high-energy solar particles like protons can be rapidly accelerated and travel towards Earth.

Radiation Increase: Once energetic particles reach Earth, they can penetrate the atmosphere, especially close to the magnetic poles, creating a shower of particles, possibly reaching the ground.

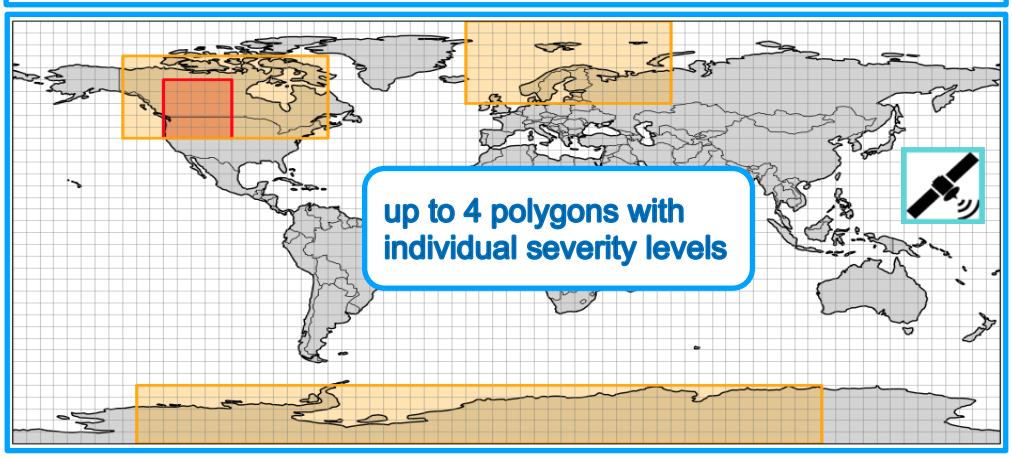
Impact on Flights: This can affect crew and passengers by exposing them to increased levels of ionizing radiation, especially at high altitudes and polar routes.

Advisory Severity Levels: RADIATION MOD; RADIATION SEV

***Note**: MOD RAD advisories will only be issued at and below FL460.

0000073001
FNXX01 LFPW 192237
SWX ADVISORY
DTG: 20260119/2233Z
SWXC: ACFJ
SWX EFFECT: GNSS
ADVISORY NR: 2026/30
NR RPLC: 2026/29
OBS SWX: 19/2220Z SEV N40 W125 - N40 W100 - N65 W100 - N65 W125 - N40 W125 MOD S90 E115 - S90 W135 - S65 W135 - S65 E115 - S90 E115 MOD N40 W140 - N40 W065 - N75 W065 - N75 W140 - N40 W140 MOD N55 W015 - N55 E060 - N90 E060 - N90 W015 - N55 W015
FCST SWX +6 HR: 20/0500Z NO SWX EXP
FCST SWX +12 HR: 20/1100Z NO SWX EXP
FCST SWX +18 HR: 20/1700Z NO SWX EXP
FCST SWX +24 HR: 20/2300Z NO SWX EXP
RMK: SWX EVENT (SCINTILLATION) INPR POSSIBLY IMPACTING GNSS PER. COULD LEAD TO LOSS OF GNSS SIGNALS AND/OR DEGRADATION OF TIMING AND POSITIONING PER.
NXT ADVISORY: WILL BE ISSUED BY 20260120/0433Z=

MOD and SEV areas can be reported in one advisory



HF Communication (HF COM):

HF Radio Waves: These waves (3-30 MHz) are used for long-distance communication, especially important for polar and transatlantic flights.

Ionosphere's Role: The ionosphere reflects HF radio waves, enabling communication beyond the horizon by bouncing signals between the Earth and the ionosphere.

Impact of Solar Storms: Events like solar flares and coronal mass ejections add extra energy to the ionosphere, highly disturbing it.

Communication Disruption: This extra energy can cause unexpected absorption or reflection of HF radio waves, leading to communication failures.

Affected Areas: Disruptions can occur near the poles, on the sunlit side of the Earth or even affect the entire globe, depending on the type and severity of the solar storm.

MUF Reduction: Ionospheric changes after geomagnetic storms can significantly lower the maximum usable frequency (MUF) for HF communication, affecting any location on Earth.

Advisory Severity Levels: HF COM **MOD**; HF COM **SEV**

For more information and trainings, see references[5,6].

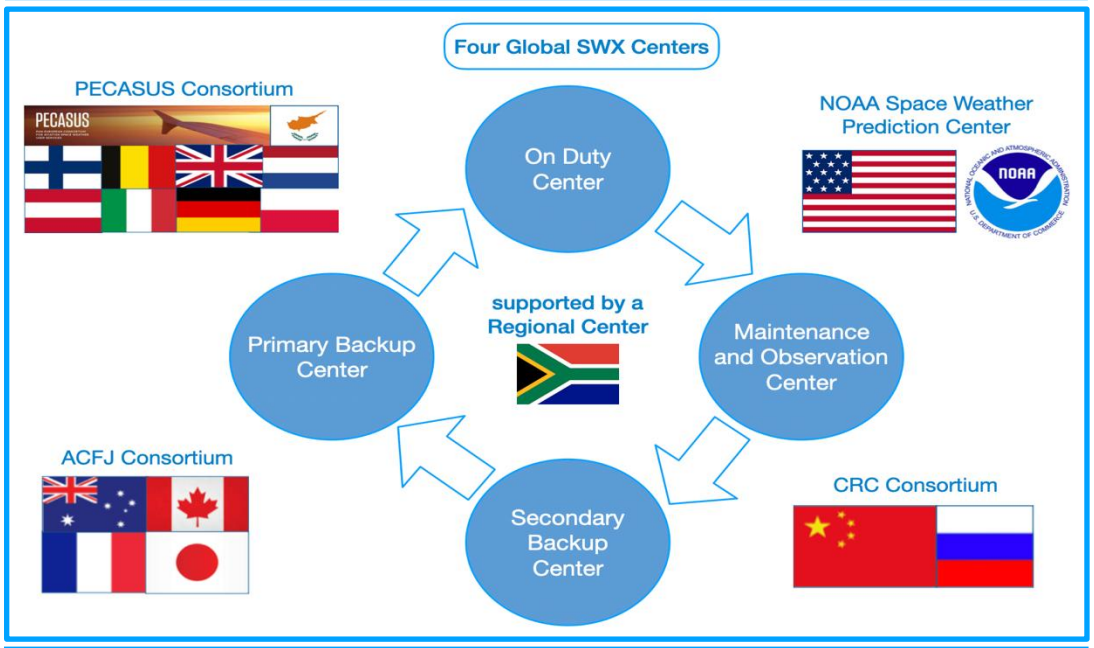
Dissemination of SWX Advisories via AFS*

★ Advisories are disseminated in TAC and IWXXM formats with different WMO headers[6].

★ SWX advisories for different domains (GNSS, HF COM, RAD) have different WMO headers.

★ Every global SWX center has a WMO 4-letter identifier.

01 = GNSS
02 = HF COM
03 = RADIATION

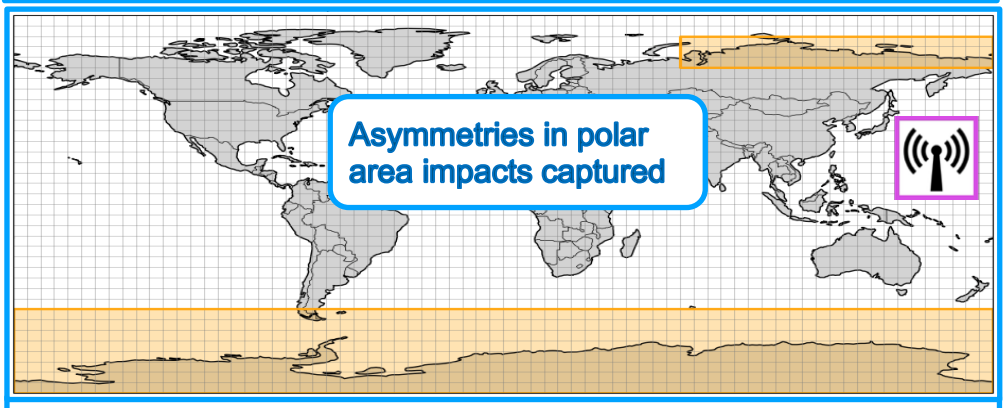


Space Weather Information Service Provision Centers:

Four global centers (PECASUS, ACFJ, SWPC and CRC) provide ICAO SWX services, switching responsibility roles every two weeks. The global centers are supported by a regional center (SANSA) which continuously supports the “On Duty” center with additional datasets and models.

0000090201
FNXX02 EFKL 210425
SWX ADVISORY
DTG: 20260121/0425Z
SWXC: PECASUS
SWX EFFECT: HF COM
ADVISORY NR: 2026/37
NR RPLC: 2026/35
OBS SWX: 21/0410Z MOD N65 E180 - N80 E180 - N80 E065 - N65 E065 - N65 E180 MOD S90 E180 - S50 E180 - S50 W180 - S90 W180 - S90 E180
FCST SWX +6 HR: 21/1100Z MOD N65 E070 - N80 E070 - N80 W030 - N65 W030 - N65 E070 MOD S90 E180 - S50 E180 - S50 W180 - S90 W180 - S90 E180
FCST SWX +12 HR: 21/1700Z MOD N65 E010 - N80 E010 - N75 W080 - N65 W080 - N65 E010 MOD S90 E180 - S50 E180 - S50 W180 - S90 W180 - S90 E180
FCST SWX +18 HR: 21/2300Z NOT AVBL
FCST SWX +24 HR: 22/0500Z NOT AVBL
RMK: EVENT UPDATE. SPACE WEATHER EVENT (HF COM POLAR CAP ABSORPTION) IN PROGRESS. IMPACT ON LOWER HF COM FREQUENCY BANDS EXPECTED AT HIGH LATITUDES.
NXT ADVISORY: WILL BE ISSUED BY 20260121/1010Z=

5 deg resolution for polygon lats and lons



Asymmetries in polar area impacts captured

0000087301
FNXX03 EFKL 141251
SWX ADVISORY
STATUS: TEST
DTG: 20260114/1237Z
SWXC: PECASUS
SWX EFFECT: RADIATION
ADVISORY NR: 2026/1
OBS SWX: 14/1232Z MOD N60 E180 - N90 E180 - N90 W180 - N60 W180 - N60 E180 ABV FL340 MOD S90 E180 - S60 E180 - S60 W180 - S90 W180 - S90 E180 ABV FL340
FCST SWX +6 HR: 14/1900Z MOD N60 E180 - N90 E180 - N90 W180 - N60 W180 - N60 E180 ABV FL450 MOD S90 E180 - S60 E180 - S60 W180 - S90 W180 - S90 E180 ABV FL450
FCST SWX +12 HR: 15/0100Z MOD N60 E180 - N90 E180 - N90 W180 - N60 W180 - N60 E180 ABV FL450 MOD S90 E180 - S60 E180 - S60 W180 - S90 W180 - S90 E180 ABV FL450
FCST SWX +18 HR: 15/0700Z NO SWX EXP
FCST SWX +24 HR: 15/1300Z NO SWX EXP

one severity area per FL range

Upcoming changes to the SWX Advisories:

★ 7-points polygon implementations

★ L-shaped or arbitrary shaped polygons

Changes coming in Nov 2027:

★ Forecast fields change from +6h, +12h, +18h and + 24h to +3h, +6h, +9h and +12h (effective Nov 2027).

★ Flight levels resolution for RAD advisories changes from 1000 ft to 5000 ft.

Have a safe flight!

Read more:

1 2 3 4 5 6

*Space weather information service (SWIS) is a globally coordinated service where space weather centres provide information on space weather phenomena that may affect communications, navigation and surveillance systems and/or pose a radiation risk to aircraft occupants.
*AFS stands for Aeronatical Fixed Service