ICAO Space-WX Advisories – in the Ops-Manual! First thoughts

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After a long process, a winding road to success, provisions for Space Weather Advisories were introduced, effective from 11/2018. Since 11/2019, three Global Space Weather Centers have become operational and will provide Space Weather (SWx) advisories when required.

The space weather advisories are using the existing channels, similar to SIGMET. They can thereby go directly to aircraft operators and flight crew throughout the flight as standard meteorological information. ECA reported on this: https://www.eurocockpit.be/news/space-wx-icao-radar-screen

The advisories are providing the most up to date information possible on any solar events and cover these three categories:

a) Shortwave Communications

b) GNSS

c) Increased solar radiation.

ICAO DOC 10100, Manual on Space Weather Information in Support of International Air Navigation, describes the hazards of space-wx as follows:

1.3 THE HAZARDS

1.3.1 Space weather impacts occur in communications, navigation, surveillance, radiation-sensitive electronics, and human exposure. Beyond the more generic indicators described in Section 1.2, the system impacts may include:

a) unexpected loss of communications;

1) HF voice and data link, i.e. controller pilot data link communications (CPDLC), on routes where that manner of communications is used;

2) poor or unusable performance in satellite communications;

b) degraded performance of navigation and surveillance that rely on GNSS;

1) automatic dependent surveillance – broadcast (ADS-B) and/or automatic dependent surveillance – contract (ADS-C) anomalies;

2) sporadic loss-of-lock of GNSS, especially near the equator and post-sunset;

c) unanticipated non-standard performance of on-board electronics resulting in reboots and anomalies;

d) issues related to radiation exposure by aircrew and passengers.

There is almost no guidance material available regarding the practical use of these advisories. EASA, for example, has not transposed the ICAO texts which introduced Space-Wx as of 2018 into its material.

As a first step, some commonly used procedures for failures and the guidance available are put together to form a set of procedures that might be used to deal with SWx Advisories. Procedures such as these need to be in the airlines operations manuals, so that both dispatchers and pilots have a common understanding of how to handle SWx Advisories.

Summary: Solar Events & Actions

Solar Storms

Type of Storm		Sun → Earth	Duration	Affects		
	Abbrv.	***Travel Time***	***Average***	***Aviation***	***Earth***	***Time***
Radio Blackout	R Storm	8 minutes	A few Hours	HF Radio	Equator	Daylight
Solar Radiation	S Storm	Approx. < 1 hour	< 1 day	HF Radio & Health	Poles	Any
Geomagnetic	G Storm	Approx. 18-24hrs	1-2 days	HF Radio	Poles	Any

Flight Superintendent Actions

Type of Storm		Storm Scale				
	Abbrv.	***1***	***2***	***3***	***4***	***5***
Radio Blackout	R Storm	None	None	Awareness – HF issues on sun lit side		
Solar Radiation	S Storm	None	Aware	Avoid 78N to the Pole		
Geomagnetic	G Storm	None	Aware	Avoid 82N to the Pole		

Some airlines have Space-Wx in their Manuals! (© Delta Airlines, 2017, reproduced with permission.)

Procedures to be considered with regards to SWx Advisories

With regards to GNSS, a look into the European GNSS Reversion Handbook for PBN Operations (Link # 4, below), Appendix 1, is recommended. It shows that GPS unavailability impacts / makes unusable the following aircraft systems, depending on installation: GPS receiver / loss of position & time information to aircraft systems, FMC- degraded, reversion to DME/DME & IRS if possible.

Other unusable systems GBAS, SBAS, Synthetic Vision, ADS-B, ADS-C, CPDLC (unusable due to unreliable time-stamp on messages), SATCOM, EGPWS (if no position-updates from IRS with radio updating).

It is possible that ACAS-X may also be unusable, or degraded due to lack of ADS-B input.

Other degraded systems: ATC transponder downlink parameters, ACAS (RF reducing function, ACAS will work), ACARS (no position reporting), Attitude and Heading Reference System, ELT, Digital Flight Data Recorders.

Bottom line for pilots: Loss of GNSS for navigation and time are quite serious issues and need to be treated with caution. The following procedures might be of help:

SWx Advisory	Inflight / en-route	Dispatch / before departure
GNSS MOD	- check means of navigation (DME-updating, IRS, VOR) Check RNAV/RNP-Capability and requirements - check if conventional approach procedures at destination and alternate can be used & plan accordingly	- check means of navigation (DME-updating, IRS, VOR), incl. MEL Check RNAV/RNP-Capability and requirements - check if conventional approach procedures at destination and alternate can be used & plan 2nd alternate - consider adding 30 min contingency fuel for unforeseen events, e.g. airspace closures
GNSS SEV	- check means of navigation (DME-updating, IRS, VOR) - check if conventional approach procedures at destination and alternate can be used & plan accordingly - assure availability of planned route / RNAV/RNP - consider diversion & landing at en-route airport	- check means of navigation (DME-updating, IRS, VOR), incl. MEL - check if conventional approach procedures at destination and alternate can be used & plan 2nd alternate - check airspace and route availability (RNAV/RNP) - consider including 1hr contingency fuel for unforeseen events e.g. airspace-closures - consider flight cancellation

Degradation or un-usability of shortwave radio communications can have serious consequences, especially if HF is the only communications medium. Air Traffic Control does simply not work without communications, and thus, the following is suggested:

SWx Advisory	Inflight / en-route	Dispatch / before departure
HF MOD	- check conditions on all frequencies in the area, use best - use datalink or satcom voice if required	- provide list of best HF frequencies - ensure satcom is available, no MEL exception no dispatch into areas where HF is prime means of communications - consider adding 30 min contingency fuel
HF SEV	- check conditions on all frequencies in the area, use best - use datalink or satcom voice if required - if no VHF or satcom available and HF is only means of com: do not enter area of HF SEV conditions - follow com failure procedures until VHF contact is restored	- do not dispatch into an area with obs or fcst HF SEV where HF is required for communications - consider adding 30 min contingency fuel

When flying, it is normal to be exposed to radiation coming mostly from space and, to a lesser degree, from the sun. During occasional periods, solar activity predominates, and increased radiation levels prevail. To follow the radiation protection principle of ´ALARA´, as low as reasonably achievable, and to help ensure that the radiation dose for the travelling public but also the crew stays within limits, the procedures below are suggested. Note that a reduction in flight altitude by 7000 ft may reduce the radiation dose by half. Details are available in the IFALPA Briefing leaflet, #2 below.

	Inflight / en-route	Dispatch / before departure
RADIATION MOD	- do not perform any planned step-climbs - if above FL designated in RAD MOD message, request descent to 3000 ft below that FL using normal procedures	- restrict max FL to 3000 ft below FL designated in RAD MOD msg. - apply until 12 hrs. after last message
RADIATION SEV	- if above FL designated in RAD SEV message, request descent to 3000 ft below that FL using normal procedures - if no clearance available within 30 min., consider descent with 1000 - 1500 ft/min to 3000 ft below RAD SEV Message FL	- no dispatch into areas with RAD SEV - apply until 12 hrs. after last message

Conclusion

To conclude, we´d like to emphasize that SWx is a complex field, with potentially severe impacts on safety of flight operations. ICAO SWx advisories are needed for effective mitigation – and pilots have a key role in this. It can be best performed when procedures for dealing with SWx advisories are in the airlines´ Operations Manuals.

Links

1, ICAO, Cross Polar Working Group 2019

https://bit.ly/3deDRYc

https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/mission_support/ato_intl/documents/cross_polar/CPWG27/CPWG27_ICAO_SWX_Advisory_Brief.pdf

2, IFALPA Human Performance Briefing Leaflet: Aircrews and Ionizing Radiation

https://www.ifalpa.org/media/3467/19hupbl01-aircrews-and-ionizing-radiation.pdf

3, Australian Bureau of Meteorology, Space Weather Advisories

http://www.bom.gov.au/aviation/data/education/space-wx-advisories.pdf

4, European GNSS Contingency/ Reversion Handbook for PBN Operations - PBN HANDBOOK No. 6

https://www.eurocontrol.int/archive_download/all/node/12154

5, DELTA Airlines, Space Weather Workshop, 2017

https://www.swpc.noaa.gov/sites/default/files/images/u33/%281140%29%202017%20SpaceWx%20Workshop-Delta%20Presentation-03May15.pdf