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Space Weather Exercise – 19 and 26 Oct 2022

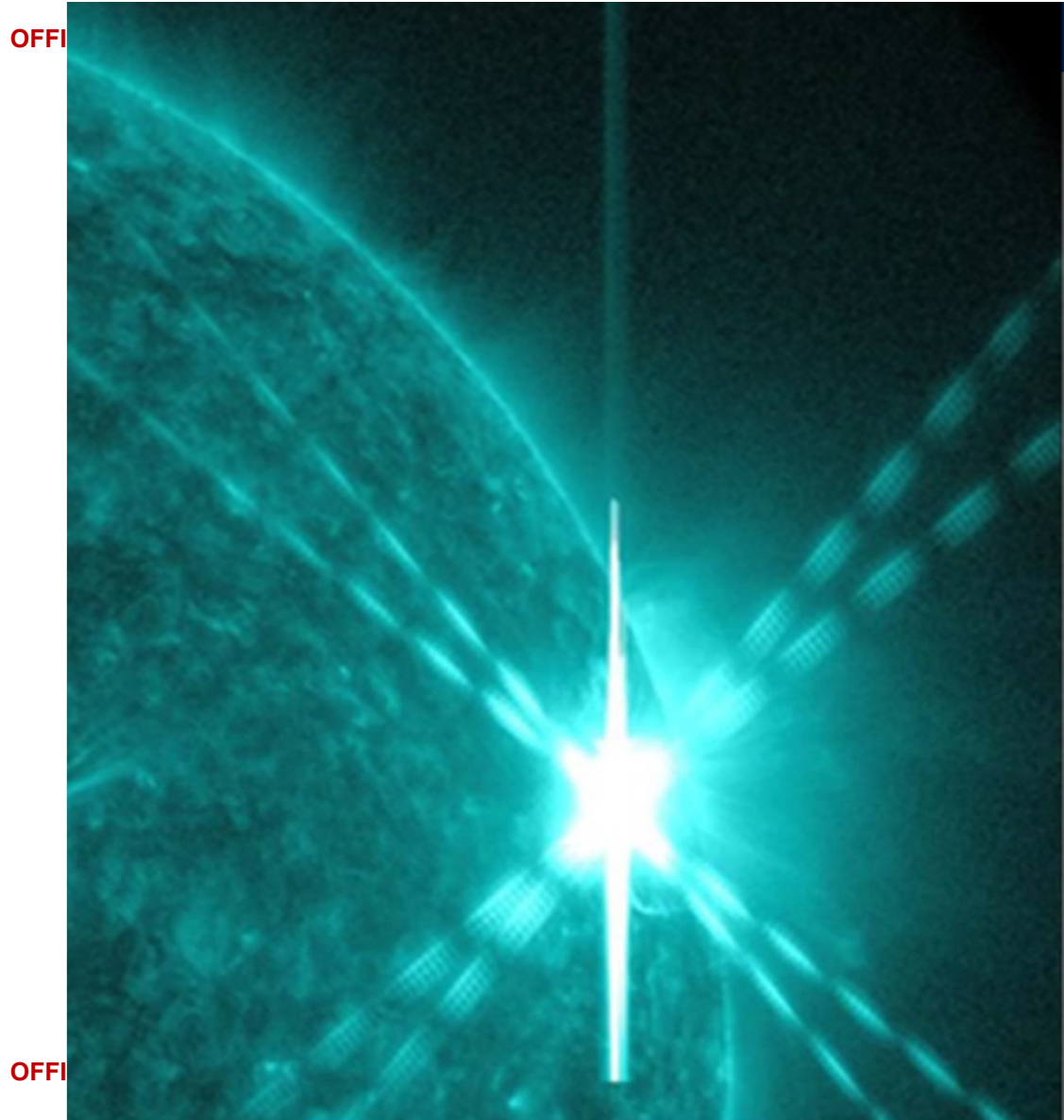
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Bureau of Meteorology



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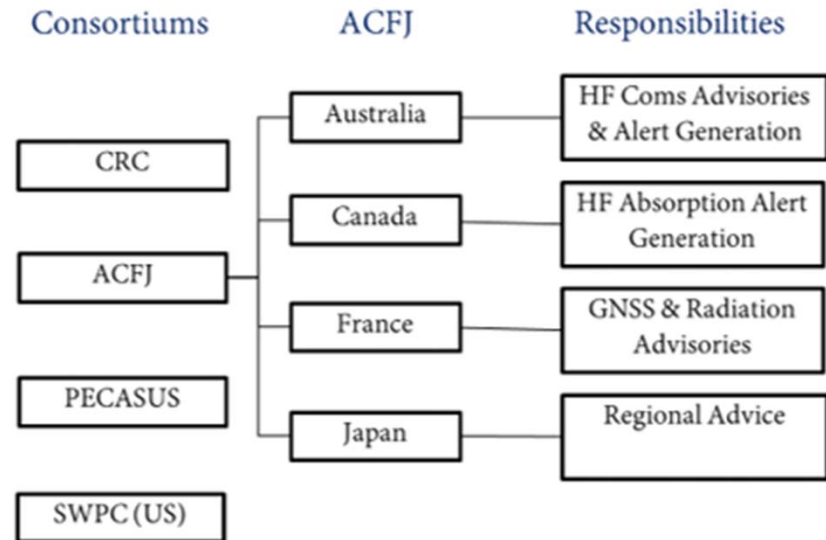
Purpose

- raise awareness of space weather
- work through the exercise in a collaborative format
- determine best practices for how to manage SWX events within the aviation system



Background

1. ICAO SWXA services were introduced in late 2019
2. Four global centres are in place to monitor and provide advisory information.
3. Solar activity is likely to increase with solar maximum in 2025 **and is likely to be stronger than the previous 2014 solar maximum.**



Approach to the Space Weather Exercise

Held over two days

- 19 October and 26 October 2022

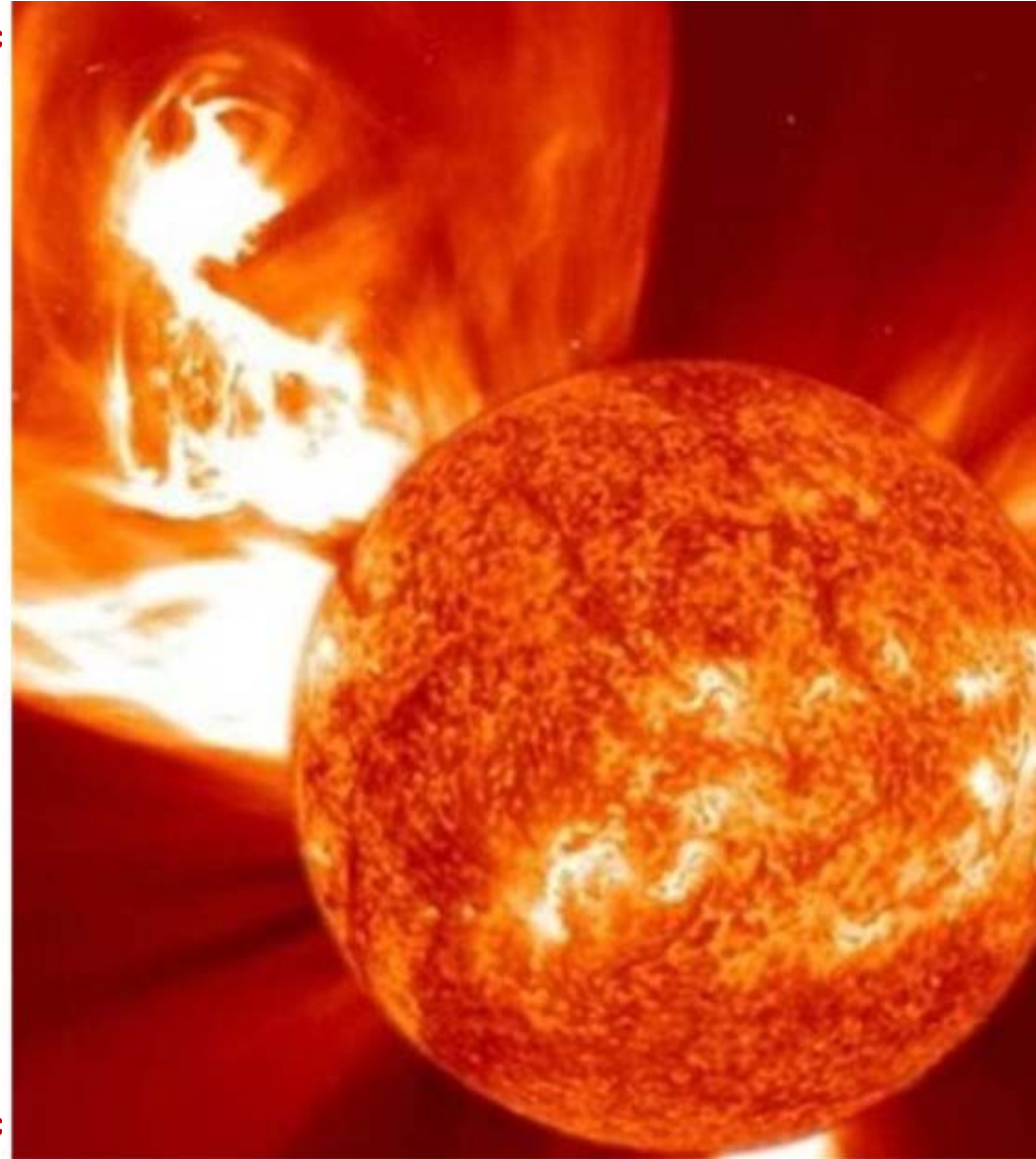
Attendees –

- Airlines, Met Services Providers, ANSPs, Regulators from AU, NZ & FJ

Focus:

- First session:
 - Education session and examples from ANSP and airline
- Second session:
 - Scenario-based exercise for HF communication

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First Day of Space Weather Exercise

ICAO Service

- No SIGMET for SWX
- Advisories are issued for two intensity thresholds: Moderate (MOD) and Severe (SEV)
- Four broad space impact areas for aviation:
 - HF Communication (HF COM)
 - GNSS-base navigation and surveillance (GNSS)
 - Radiation impacts on avionics and health (RADIATION)
 - Satellite communications (SATCOM)**

Effect	Sub-effect	Threshold Parameter	MOD	SEV
GNSS	Amplitude Scintillation	S4 (dimensionless)	0.5	0.8
GNSS	Phase Scintillation	Sigma-phi (radians)	0.4	0.7
GNSS	Vertical Total Electron Content (TEC)	TEC units	125	175
RADIATION		Effective dose rate (micro-Sieverts/hour)*	30	80
HF COM	Auroral Absorption (AA)	Kp index	8	9
HF COM	Polar Cap Absorption (PCA)	dB from 30MHz riometer data	2	5
HF COM	Shortwave Fadeout (SWF)	Solar X-rays (0.1-0.8 nm) (W-m ⁻²)	1x10 ⁻⁴ (X1)	1x10 ⁻³ (X10)
HF COM	Post-Storm Depression	Maximum Usable Frequency (MUF)**	30%	50%
SATCOM	No threshold has been set for this effect			

*MOD advisories will only be issued when the MOD threshold is reached between FL250 and FL460. SEV advisories will be issued when the SEV threshold is reached between FL250 and FL600.

**As compared to a 30-day running median.

Phenomena	WMO Header TAC	WMO Header IWXXM
GNSS	FNXX01	LNXX01
HF COM	FNXX02	LNXX02
Radiation	FNXX03	LNXX03
SATCOM**	FNXX04	LNXX04

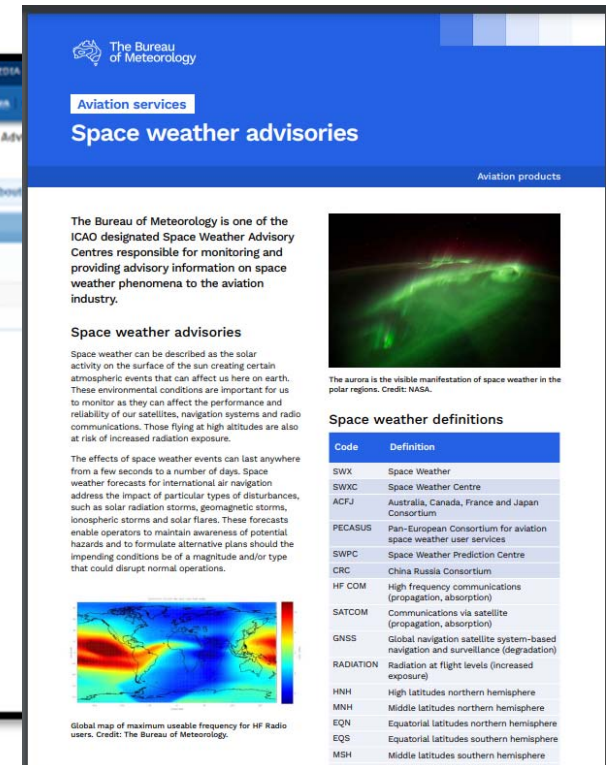
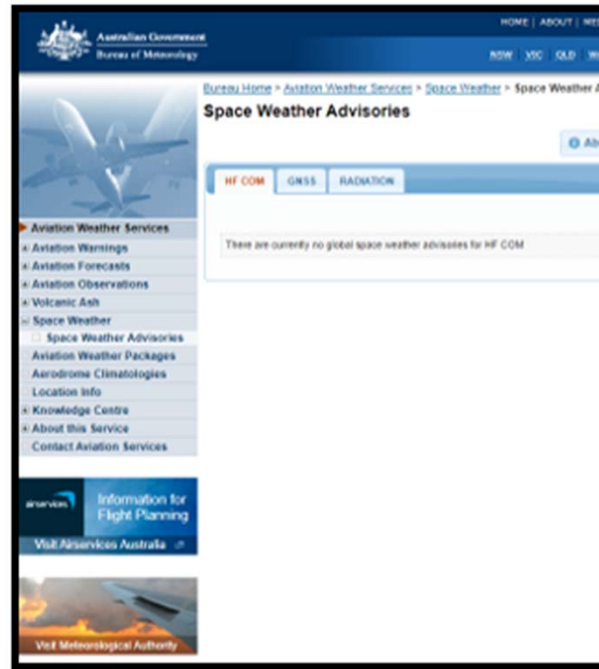
First Day of Space Weather Exercise

Dissemination process

- SWXA are disseminated via AA on AFS
- The Bureau's Aviation webpage (<http://www.bom.gov.au/aviation/space-weather-advisories/>) and
- in NZ via MetFlight/PreFlight/IFIS

Educational material

- SWX Brochures on the BoM webpage



First day of Space Weather Exercise

Day 1 concluded with

- 1) reviewing a real GNSS advisory that was issued during the session (left)
- 2) Bureau issuing a test advisory (right)

FNXX01 LFPW 190039

SWX ADVISORY

DTG: 20221019/0021Z

SWXC: ACFJ

ADVISORY NR: 2022/25

SWX EFFECT: GNSS MOD

OBS SWX: 18/2345Z EQN EQS W105 - W000

FCST SWX +6 HR: 19/0600Z NOT AVBL

FCST SWX +12 HR: 19/1200Z NOT AVBL

FCST SWX +18 HR: 19/1800Z NOT AVBL

FCST SWX +24 HR: 20/0000Z NOT AVBL

RMK: SWX EVENT (SCINTILLATION) INPR

POSSIBLY IMPACTING GNSS PER.

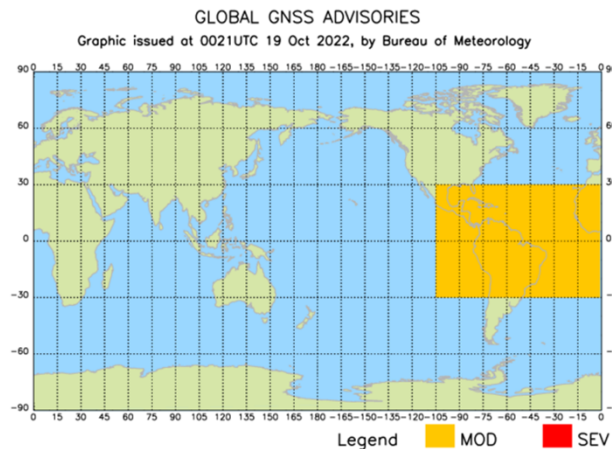
COULD LEAD TO DEGRADATION OF TIMING

AND POSITIONING PER. INTST

GENERALLY STRONGER ON THE NIGHTSIDE.

NXT ADVISORY: WILL BE ISSUED BY

20221019/0621Z=



FNXX02 YMMC 190100

SWX ADVISORY

STATUS: EXER

DTG: 20221019/0100Z

SWXC: ACFJ

ADVISORY NR: 2022/85

SWX EFFECT: HF COM MOD

OBS SWX: 19/0050Z NO SWX EXP

FCST SWX +6 HR: 19/0700Z NO SWX EXP

FCST SWX +12 HR: 19/1300Z NO SWX EXP

FCST SWX +18 HR: 19/1900Z NO SWX EXP

FCST SWX +24 HR: 20/0100Z NO SWX EXP

RMK: EXERCISE EXERCISE TESTING DISSEMINATION.

PLEASE DISREGARD.

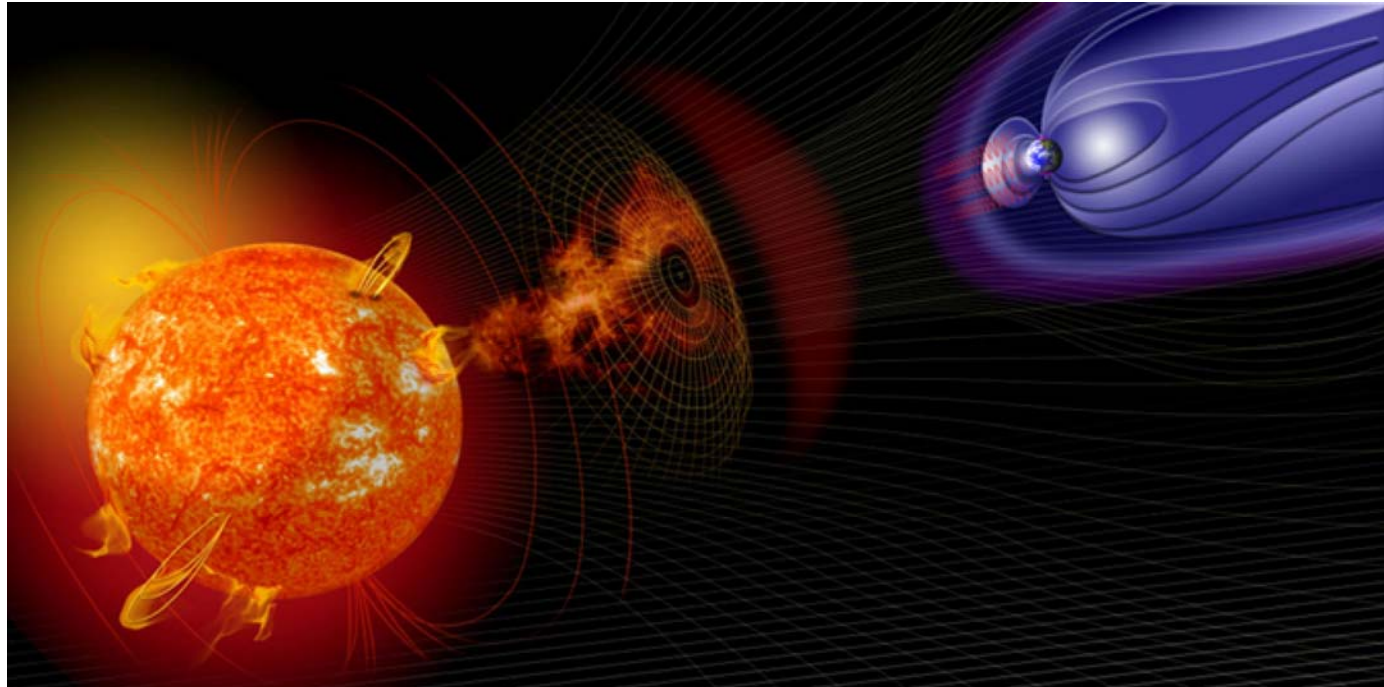
NEXT ADVISORY: NO FURTHER ADVISORIES



Second day of Space Weather Exercise

Space Weather Dissemination

- Reviewed and discussed results about reception of both real and test advisories by each organisation
- Discussed each organisation's procedures for space weather affects on operations
- Mitigation processes to solve any issues and requirements from Air Traffic Controllers during these events



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Second day of Space Weather Exercise

Space Weather Scenario

The event simulated a strong solar flare which would affect HF COM starting at MOD and soon after reaching SEV levels.

FNXX02 YMMC 252200

SWX ADVISORY

DTG: 20221025/2200Z

SWXC: ACFJ

ADVISORY NR: 2022/9

SWX EFFECT: **HF COM MOD**

OBS SWX: 25/2155Z DAYLIGHT SIDE

FCST SWX + 6 HR: 26/0400Z NOT AVBL

FCST SWX + 12 HR: 26/1000Z NOT AVBL

FCST SWX + 18 HR: 26/1600Z NOT AVBL

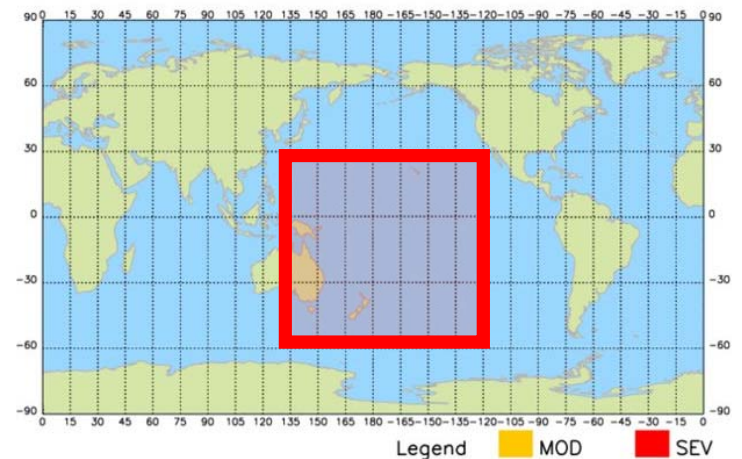
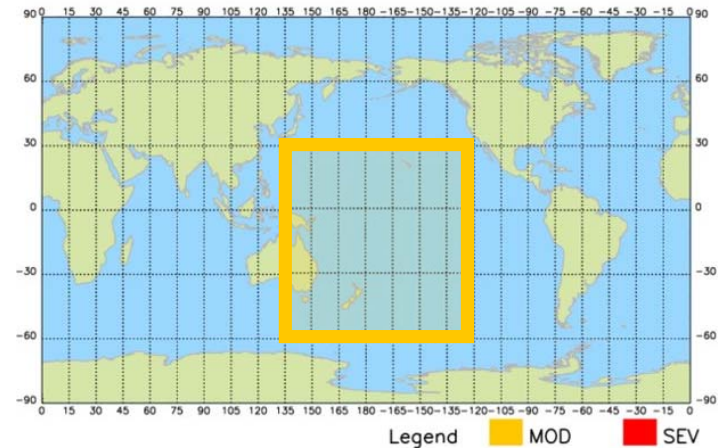
FCST SWX + 24 HR: 26/2200Z NOT AVBL

RMK: SOLAR FLARE EVENT IN PROGRESS IMPACTING HF COM ON DAYLIGHT SIDE. IF DIFFICULTIES TRY HIGHER HF COM FREQUENCIES

NXT ADVISORY: WILL BE ISSUED BY 20221026/0400Z=

The Bureau of Meteorology

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General Discussion

- Impact of Mod HF COM SWXA
 - Most airlines use this for info only and will uplink to impacted aircraft;
 - Some regional operators use HF COM constantly – will try changing primary and secondary HF channels where there are issues.
 - Some operators felt ATC broadcast of MOD HF outages would be beneficial for situational awareness
- Impact of Sev HF COM SWXA
 - Most larger operators have an alternate comms solution (e.g. SatComm)
 - Real-time internal risk assessment conducted
 - Departure of HF only aircraft may not occur



General Discussion

- Radiation
 - Generally limited to polar regions (south of 60S for NZ/Aus FIRs)
 - Delay the flight (pre-flight)
 - Reroute or descend to below FL280 (in flight)
 - Carry contingency fuel (over payload)
- ICAO recommends that both Operational and Exercise SWXA should be disseminated in operational briefing systems. Test Advisories do not need to be disseminated beyond comm systems



Recommendations for airlines and ANSPs

- a) Review and include space weather events into their existing contingency procedures.
- b) Consider benefits of broadcasting MOD and SEV SWX Advisories when impacting the ANSP's airspace.
- c) Ensure systems are configured to support all ICAO space weather advisory headers FNXX01-04
- d) Consider non-ICAO information sources to increase situational awareness as part of managing risks associated with SWX events.
- e) Consider sending both Operational and Exercise SWXA to operational briefing systems, noting Test Advisories do not need to be disseminated beyond comm systems.



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Future Activities:

1. ICAO APAC office planning a space weather webinar – dates TBC.
2. The Bureau in coordination with CAA NZ will plan to conduct another space weather exercise, with the focus on GNSS by the end of 2023.



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Thank you

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