



Space Weather Users Workshop ICAO Requirements

16-17 November 2017, Sydney

**Sue O'Rourke
National Manager Aviation Meteorological Program
ICAO Meteorology Panel Member**



ICAO

- ▶ The **International Civil Aviation Organization (ICAO)** is a United Nations (UN) agency, established in 1944 to manage the administration and governance of the Convention on International Civil Aviation (Chicago Convention).
- ▶ There are **191 Member States** and industry groups working together to establish **Standards and Recommended Practices (SARPs)** and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector.
- ▶ SARPs and policies are used by ICAO Member States to ensure that their local civil aviation operations and regulations conform to global norms, which in turn permits more than 100,000 daily flights in aviation's global network to operate **safely and reliably** in every region of the world.



Space Weather and Aviation

- ▶ Space weather is an important consideration for the aviation industry. It can cause disruptions to communications, navigation and surveillance systems.
- ▶ In 2002 the ICAO Meteorology Divisional Meeting requested the evaluation of the need to provide information for international air navigation, inter alia, on solar radiation storms.
- ▶ ICAO and the World Meteorological Organization (WMO) worked closely together over many years to mature a proposal for space weather requirements (through the International Airways Volcano Watch Operations Group (IAVWOPSG)).
- ▶ In 2011 the International Air Transport Association (IATA) confirmed a high-level user requirement for information on space weather.





Space Weather and Aviation

In 2014 the Meteorology (MET) Divisional Meeting recommended:

Recommendation 2/7 – Development of provisions for information concerning space weather

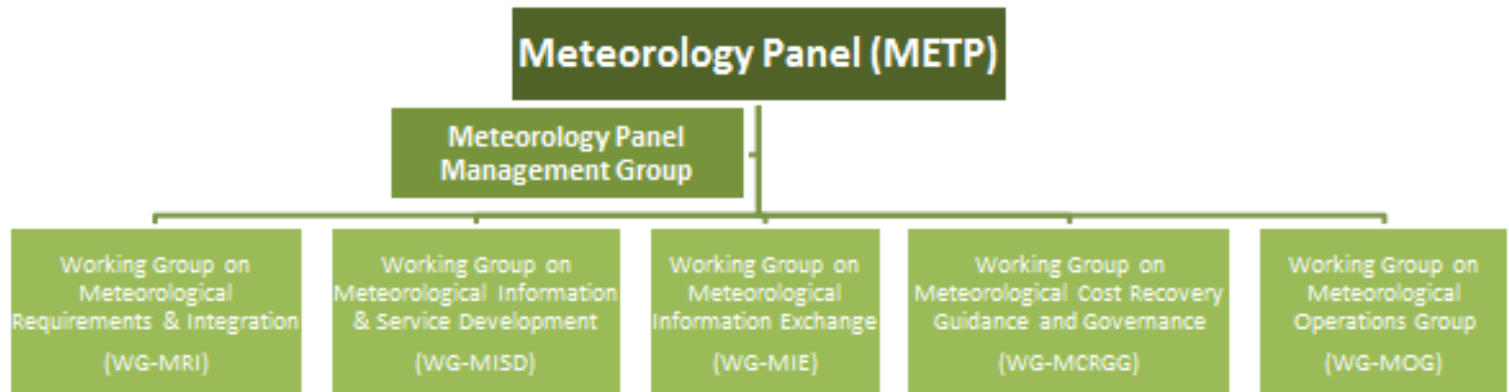
That an appropriate ICAO expert group, in close coordination with WMO, be tasked to develop provisions for information on space weather to international air navigation consistent with the *Global Air Navigation Plan* (Doc 9750), including the integration of the information produced into the future system-wide information management (SWIM) environment underpinning the future globally interoperable air traffic management system, specifically addressing:

- a) requirements for space weather information services consistent with the draft concept of operations for space weather information services;
- b) selection criteria and associated capability for the designation of global and regional space weather centres; including optimum number thereof;
- c) appropriate governance and cost recovery arrangements for the provision of space weather information services on a global and regional basis; and
- d) considerations on the use of space weather information and the various impacts space weather events could have on international air navigation.



Meteorology Panel

- ▶ The ICAO **Air Navigation Commission** (ANC) has tasked the **Meteorology Panel** (METP) to develop international SARPs and guidelines for space weather that may present a hazard to aviation operations.
- ▶ The METP was established in 2015 and has met as a full Panel in April 2015 and October 2016.
- ▶ Space Weather is on of the Work Streams associated with the METP **Working Group on Meteorological Information & Service Development** (WG-MISD).
- ▶ Sue O'Rourke is a Member of the METP. Mike Terkildsen is an expert advisor on space weather matters.





Meteorology Panel Job Card

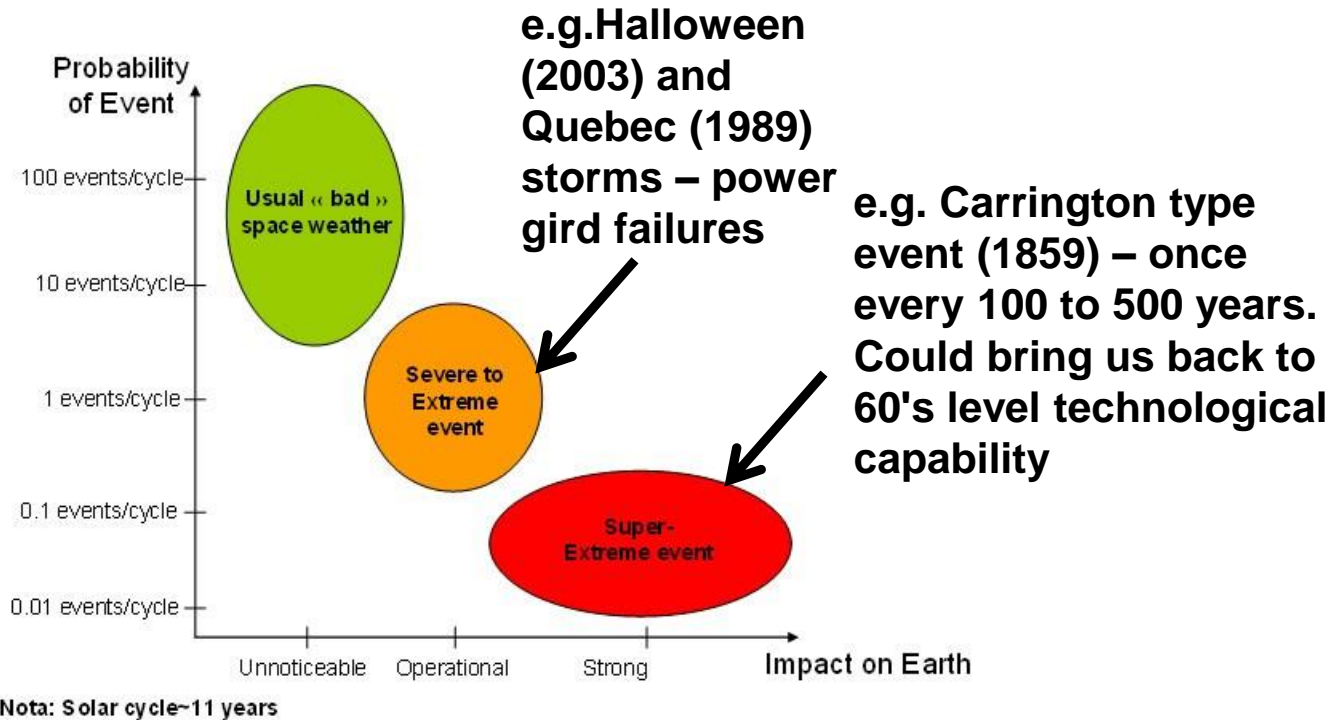
Job card METP.009 - *Development of provisions for information on space weather to international air navigation*

- ▶ **Problem Statement:** Space weather events such as solar radiation storms, solar flares, geomagnetic storms and ionospheric disturbances that impact earth pose a risk to flight safety, impacting communication, surveillance, navigation systems, on board avionics and also posing a risk to the health of aircraft occupants.
- ▶ **Specific Details:** MET Divisional Meeting (Recommendation 2/7)
- ▶ **Expected Benefits:** To provide information on space weather and to avoid the risks posed to flight safety regarding communications, navigation (including the global positioning system (GPS)), surveillance, and avionics, as well the risk to the health of aircraft occupants (i.e. flight crew and passengers) due to radiation exposure. Integrate the information produced into the SWIM environment in line with the GANP.



Preparing Aviation for Space Weather Impact

Space Weather can cause disruption of the air traffic on scale similar to volcanic ashes, but are rare and can be more damaging – from Space Safety Magazine 2013



Probability of space weather events versus impact on Earth – credit to Eurocontrol

Worldwide workshops to address the effects of the space weather on aviation:

- March 2013, by the European Aviation Safety Agency and Eurocontrol
- March 2016, by the Australian Bureau of Meteorology



Meteorology Panel Job Card

▶ ICAO Documents:

- *Annex 3 - Meteorological Service for International Air Navigation*
- *Annex 15 - Aeronautical Information Services*
- *Doc 4444 - Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM)*
- *Doc 8400 - Procedures for Air Navigation Services — ICAO Abbreviations and Codes (PANS-ABC)*
- *Doc 9377 - Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services*
- *Doc 8896 - Manual of Aeronautical Meteorological Practice*
- *Doc 9750 - Global Air Navigation Plan (GANP)*
- *Doc xxxxx - Space Weather Manual*
- *Electronic Air Navigation Plans (eANP)*
- *Concept of Operations (ConOps) for Space Weather Information in support of International Air Navigation.*



Space Weather Provisions

ICAO Annex 3 – *Meteorological Service for International Air Navigation*

- ▶ Proposed for an applicability date of 8 November 2018

Space weather centre (SWXC)

- ▶ A centre designated to monitor and provide information on space weather expected to affect communications, GNSS-based navigation and surveillance systems and/or pose a radiation risk to flight crew members and passengers.

Note. – A space weather centre may be designated as global or regional.

Space Weather Advisory

- ▶ *Space weather effects:*
 - *HF communication (propagation, absorption) - HF COM*
 - *GNSS-based navigation and surveillance (degradation) - GNSS*
 - *Radiation at flight levels (increased exposure) - RADIATION*
- ▶ *Intensities:*
 - *Moderate - MOD*
 - *Severe - SEV*
- ▶ *Updates:*
 - *As necessary but at least every six hours*
- ▶ *Formats:*
 - *Plain language and, from 7 November 2019, in XML/GML*



Space Weather Provisions

Element		Range	Resolution
Flight Level:		250-600	30
Longitudes for advisories:	(degrees) (minutes)	000 – 180 00	15° 0
Latitude bands for advisories:	High latitudes northern hemisphere (HNN)	N9000 - N6000	30°
	Middle latitudes northern hemisphere (MNH)	N6000 - N3000	
	Equatorial latitudes northern hemisphere (EQN)	N3000 - N0000	
	Equatorial latitudes southern hemisphere (EQS)	S0000 - S3000	
	Middle latitudes southern hemisphere (MSH)	S3000 - S6000	
	High latitudes southern hemisphere (HSH)	S6000 - S9000	



Space Weather Advisory

SWX ADVISORY	
DTG:	20161108/0100Z
SWXC:	(to be determined)
SWX EFFECT:	GNSS MOD AND HF COM MOD
ADVISORY NR:	2016/2
REPLACES ADVISORY NR:	REPLACES NR: 2016/1
OBS SWX:	20161108/0100Z HNH HSH E18000 – W18000
FCST SWX +6 HR:	20121108/0700Z HNH HSH E18000 – W18000
FCST SWX +12 HR:	20161108/1300Z HNH HSH E18000 – W18000
FCST SWX +18 HR:	20161108/1900Z HNH HSH E18000 – W18000
FCST SWX +24 HR:	20161109/0100Z NO SWX EXP
RMK:	LOW-LEVEL GEOMAGNETIC STORMING IS CAUSING INCREASED AURORAL ACTIVITY AND SUBSEQUENT MOD DEGRADATION OF GNSS ACCURACY AND HF COM AVAILABILITY IN THE AURORAL ZONE. THIS STORMING IS EXPECTED TO SUBSIDE IN THE FORECAST PERIOD. SEE WWW.SPACEWEATHERPROVIDER.WEB
NXT ADVISORY:	NO FURTHER ADVISORIES



Space Weather Advisory

SWX ADVISORY	
DTG:	20161108/0000Z
SWXC:	(to be determined)
SWX EFFECT:	RADIATION MOD
ADVISORY NR:	2016/2
REPLACES ADVISORY NR:	REPLACES NR: 2016/1
FCST SWX:	20161108/0100Z HNH HSH E18000 – W18000 ABV FL350
FCST SWX +6 HR:	20121108/0700Z HNH HSH E18000 – W18000 ABV FL350
FCST SWX +12 HR:	20161108/1300Z HNH HSH E18000 – W18000 ABV FL350
FCST SWX +18 HR:	20161108/1900Z HNH HSH E18000 – W18000 ABV FL350
FCST SWX +24 HR:	20161109/0100Z NO SWX EXP
RMK:	RADIATION LEVELS HAVE EXCEEDED 100 PERCENT OF BACKGROUND LEVELS AT FL350 AND ABOVE. THE CURRENT EVENT HAS PEAKED AND LEVELS ARE SLOWLY RETURNING TO BACKGROUND LEVELS. SEE WWW.SPACEWEATHERPROVIDER.WEB
NXT ADVISORY:	NO FURTHER ADVISORIES



Space Weather Advisory

SWX ADVISORY	
DTG:	20161108/0100Z
SWXC:	(to be determined)
SWX EFFECT:	HF COM SEV
ADVISORY NR:	2016/1
OBS SWX:	20161108/0100Z DAYLIGHT SIDE
FCST SWX +6 HR:	20121108/0700Z DAYLIGHT SIDE
FCST SWX +12 HR:	20161108/1300Z DAYLIGHT SIDE
FCST SWX +18 HR:	20161108/1900Z DAYLIGHT SIDE
FCST SWX +24 HR:	20161109/0100Z DAYLIGHT SIDE
RMK:	PERIODIC HF COM ABSORPTION HAS BEEN OBSERVED AND IS LIKELY TO CONTINUE IN THE NEAR TERM. COMPLETE AND PERIODIC LOSS OF HF ON THE SUNLIT SIDE OF THE EARTH EXPECTED. CONTINUED HF COM DEGRADATION LIKELY OVER THE NEXT 7 DAYS. SEE WWW.SPACEWEATHERPROVIDER.WEB
NXT ADVISORY:	20161108/0700Z



Space Weather Centres

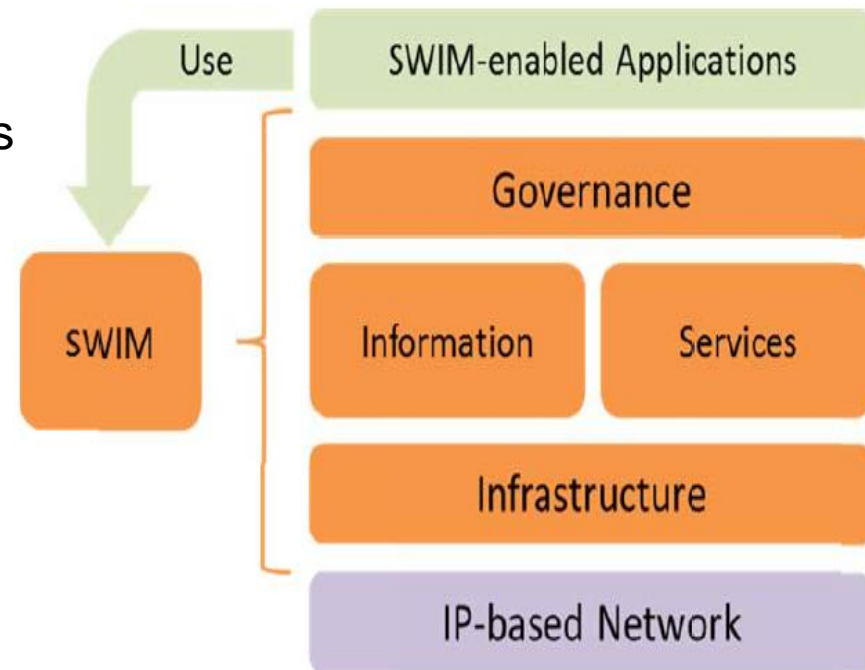
Selection Process

- ▶ WMO will assist in assessing potential provider(s).
- ▶ The criteria are divided into the following four areas:
 - 1) Institutional;
 - 2) Operational;
 - 3) Technical; and,
 - 4) Communications/Dissemination.
- ▶ Need to be able to deliver the space weather information services as defined in Annex 3 (proposed for applicability in November 2018).
- ▶ Guidance on the selection of providers doesn't delineate between potential provider(s) of the global scale space weather information capability and the regional scale.
- ▶ The optimal number of space weather information provider(s) to efficiently deliver a globally harmonized space weather service may be comprised of a single entity or multiple entities as part of a consortium.



System Wide Information Management (SWIM)

- ▶ SWIM covers a complete change in paradigm of how information is managed along its full lifecycle.
- ▶ Global interoperability and standardisation allowing **integration of information** (including Meteorology) into aviation systems (including Air Traffic Management).
- ▶ Move from product-centric information to data-centric.
- ▶ Meteorological and space weather information will include phenomenon/parameter and data characteristics such as severity, accumulation, intensity, probability of occurrence, confidence/uncertainty of forecasts and reliability, etc.
- ▶ SWIM will be based on Service Oriented Architecture (SOA) and open and standard mainstream technologies.





?? QUESTIONS ??

Sue O'Rourke

National Manager Aviation Meteorological Program, Bureau of Meteorology

ICAO Meteorology Panel Member

03 9669 4662

sue.orourke@bom.gov.au

