



# Federal and International Space Weather Policy Initiatives

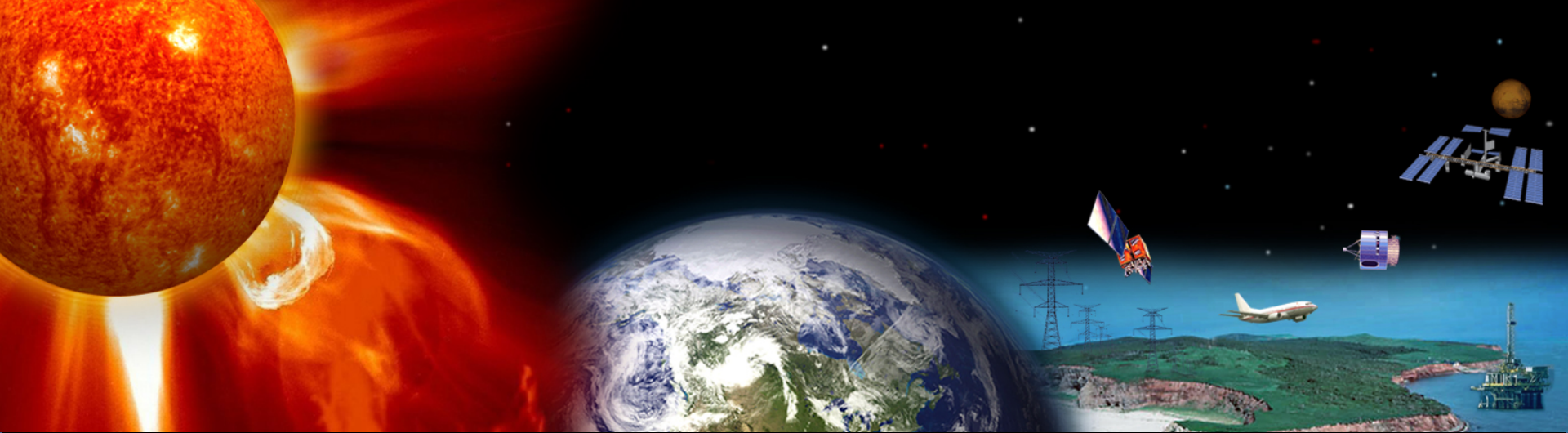
*National Business Aviation Association*

18 November 2015

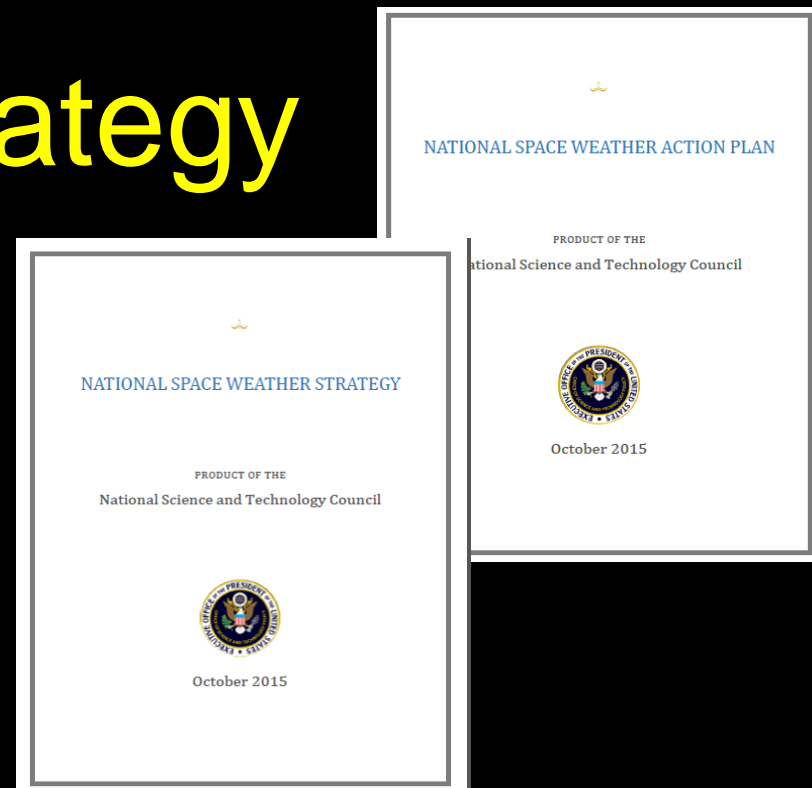
Bill Murtagh

Assistant Director for Space Weather

White House Office of Science and Technology Policy



# The National Strategy



Released on 29 October 2015



# Severe Space Weather – Societal and Economic Impacts



# Space Weather Impacts – 4 Nov 2015

SECTIONS HOME SEARCH The New York Times

## Solar Storm Knocks Out Flight Control Systems in Sweden

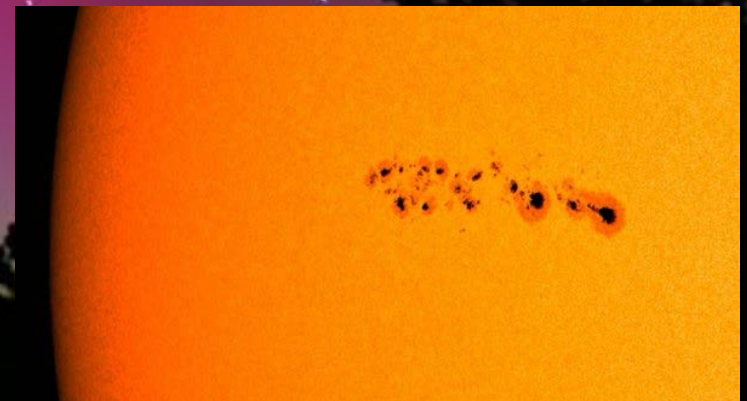
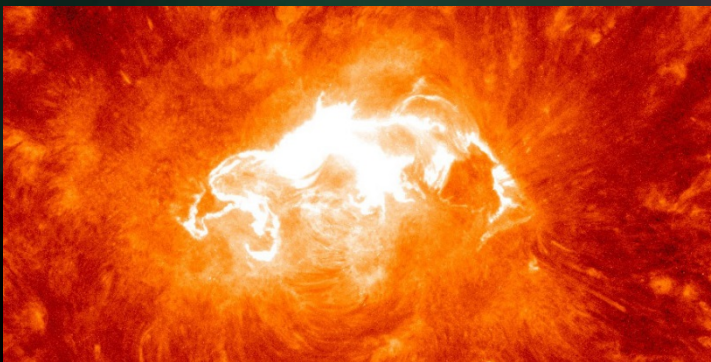
The Weather Channel 29° Anchorage, AK 46° Vilnius, Lithuania 84° Patangam, India

Science

### Massive Solar Storm Halts Air Travel in Sweden

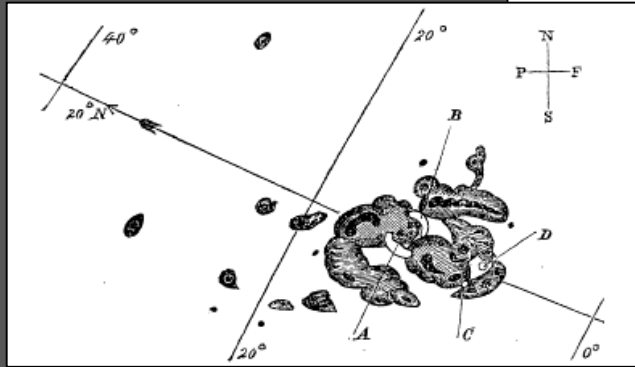
Published Nov 5 2015 09:09 AM EST | The Associated Press

*“Flights disappeared from radar screens in Swedish air traffic control towers during the blackout, which lasted about an hour”*





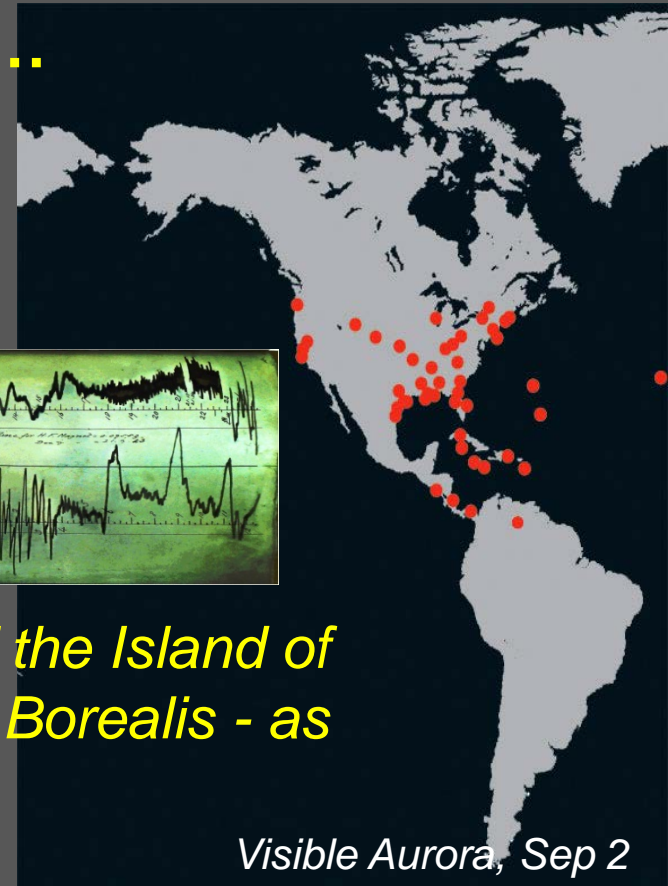
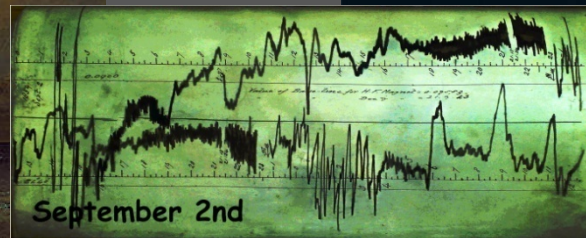
# Extreme Events: Carrington – Sep 1-2, 1859



*Description of a Singular Appearance seen in the Sun on September 1, 1859. By R. C. Carrington, Esq.*

While engaged in the forenoon of Thursday, Sept. 1, in taking my customary observation of the forms and positions of the solar spots, an appearance was witnessed which I believe to be exceedingly rare. The image of the sun's disk was,

**18 hours later...**



***“All our exchanges, from the northern coast of the Island of Cuba gave glowing descriptions of the Aurora Borealis - as bright in the tropics as in the northern zones”***

*New Orleans Daily Picayune, September 7, 1859*

*Visible Aurora, Sep 2*

# Space Weather Awareness

Multiple efforts underway to address space weather, across government agencies and the private sector – nationally and internationally

- **Congress** – Grid Reliability and Infrastructure Defense (GRID) Act, S. 2158; Critical Infrastructure Protection Act, H.R. 1073
- **U.S. Regulatory Action** – FERC reliability standards
- **Space weather in Strategic National Risk Assessment**
- **FEMA Federal Interagency Response Plan** – Will include a Long – Term Power Outage Annex
- **International** – UN World Meteorological Organization Inter-Programme Coordination Team on Space Weather; FAA and UN International Civil Aviation Organization; NATO space weather teams including Transport



# National Space Weather Strategy

*A cohesive all-of-government strategy was necessary to ensure the federal government was positioned to mitigate, respond to and recover from a major space weather storm*

Nov 2014 – Space Weather Operations, Research, and Mitigation (SWORM) Task Force is established

Tasked to develop:

- National Space Weather Strategy (NSWS)
- Space Weather Action Plan



# National Space Weather Strategy – Whole Enterprise Involvement

- Multi-agency effort
- All Actions coordinated with White House Office of Science and Technology Policy, National Security Council, and Office of Management and Budget
- Public Comment Period - stakeholders provided input and feedback on National Strategy

Strategy will require us to strengthen our interagency, public-private and international partnerships, in a whole community approach.





# National Space Weather Strategy – Structure

Strategy articulates six high-level goals

1. Establish Benchmarks for Space-Weather Events
2. Enhance Response and Recovery Capabilities
3. Improve Protection and Mitigation Efforts
4. Improve Assessment, Modeling, and Prediction of Impacts on Critical Infrastructure
5. Improve Space-Weather Services through Advancing Understanding and Forecasting
6. Increase International Cooperation

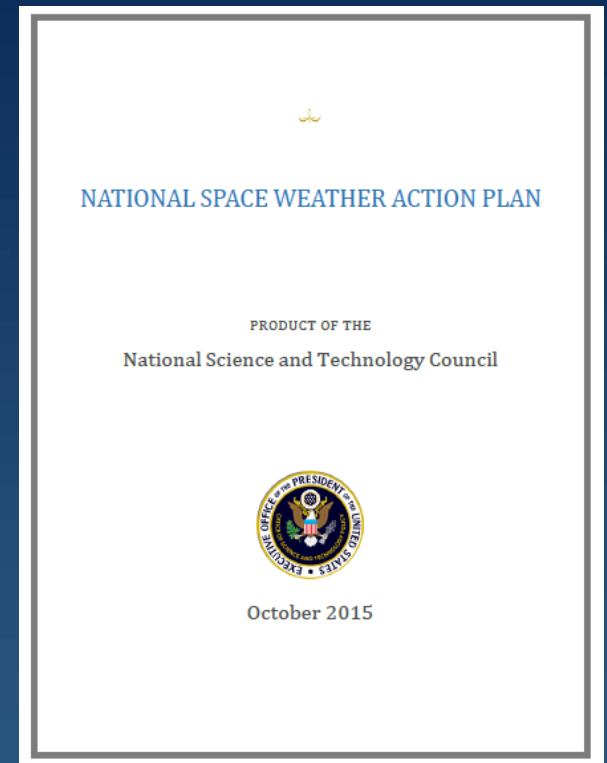


# National Space Weather Action Plan

A National Space Weather Action Plan (NSWAP) establishes a process to implement the National Space Weather Strategy

The NSWAP establishes specific activities with:

- implementation timelines
- detailed actions
- specific agency assignments



## 4.1 Assess the Vulnerability of Critical Infrastructure Systems to Space Weather

**4.1.1** DHS, in collaboration with Sector Specific Agencies (SSAs), will assess the vulnerability of critical infrastructure to space-weather events (as described in Goal 1). The assessment will include interdependencies and failure modes among sectors that can lead to cascading failures and will identify gaps where scientific or engineering research is required to understand or mitigate risks to critical infrastructure.

**Deliverable:** Complete assessment reports

**Timeline:** The initial assessments will be completed within 18 months of the development of Phase 1 benchmarks.

Reevaluations based on the Phase 2 benchmarks will be completed within 1 year of the development of Phase 2 benchmarks





## 4.2 Develop a Real-Time Infrastructure Assessment and Reporting Capability

4.2.5 DOC and DOT, in coordination with NASA, academia, the private sector, and international partners, will develop or improve models for assessment of radiation at commercial flight altitudes.

**Deliverable:** Develop commercial aviation radiation-environment models ready for operational transition

**Timeline:** Within 2 years of the publication of this Action Plan

## 6.3 Strengthen International Coordination and Cooperation on Space-Weather Products and Services

6.3.2 DOT, in coordination with DOC and DOD, will lead U.S. efforts to develop international standards for the provision of space-weather information for international air navigation.

**Deliverable:** Develop proposal for ICAO

**Timeline:** Within 1 year of the publication of this Action Plan



# The Way Forward

## Ensuring effective implementation

- Currently defining effort to oversee implementation of Action Plan
- Oversight of Action Plan will be led by White House with full agency involvement
- Working groups will focus on specific tasks
- Semi-annual reporting



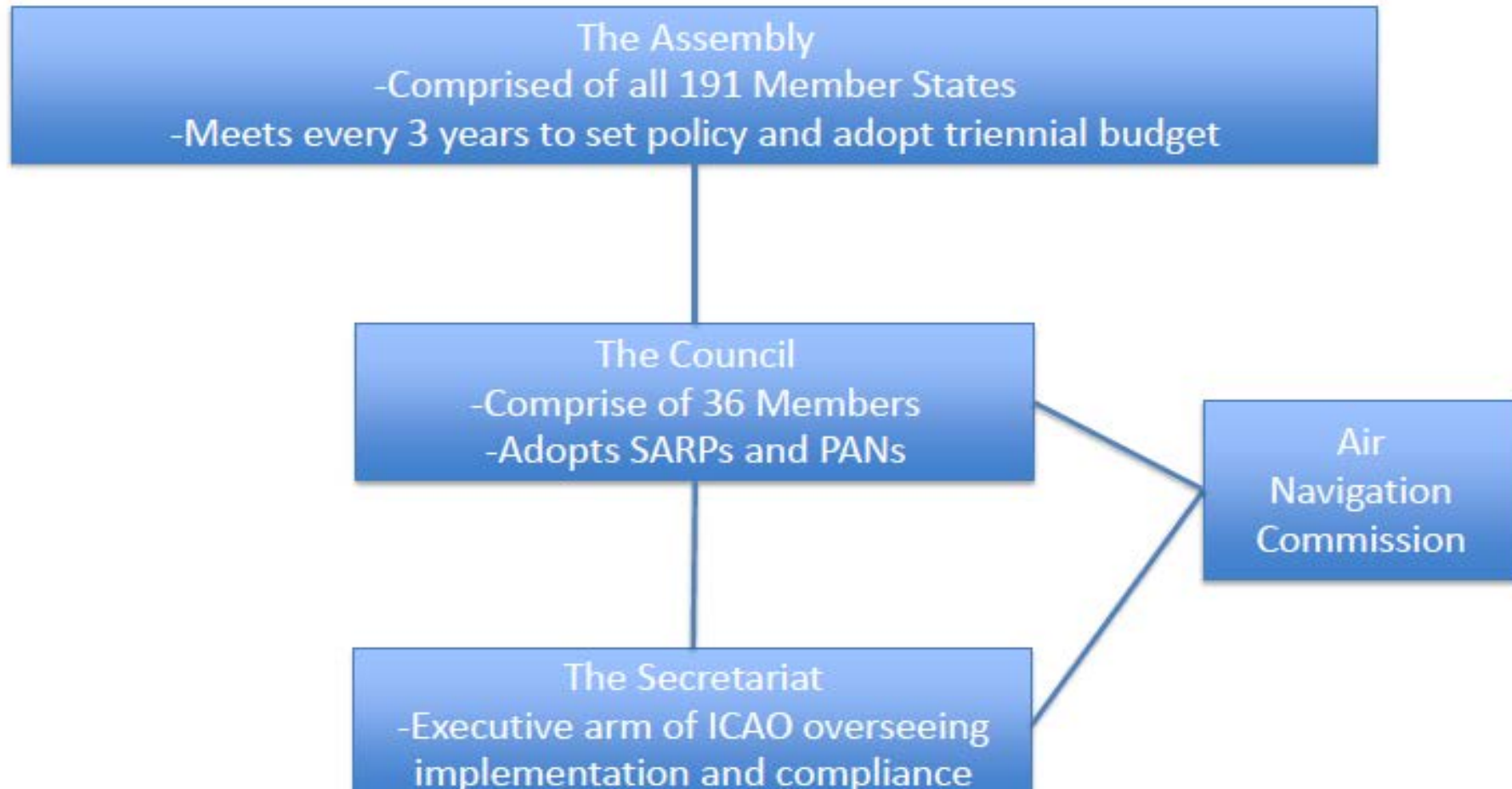
# International

Update on recent developments in the UN International Civil Aviation Organization (ICAO) and World Meteorological Organization (WMO) on the provision of space weather information for international air navigation.





# ICAO Organizational Structure



The Air Navigation Commission (ANC) considers and recommends Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS) for adoption or approval by the ICAO Council.

# ICAO Meteorology Panel (METP)

In 2014, ICAO completed a significant reorganization of the Secretariat and the panel structure

There are now 17 ICAO panels, the **METP** is one of approximately 11 new or “rebranded” panels

The METP shall:

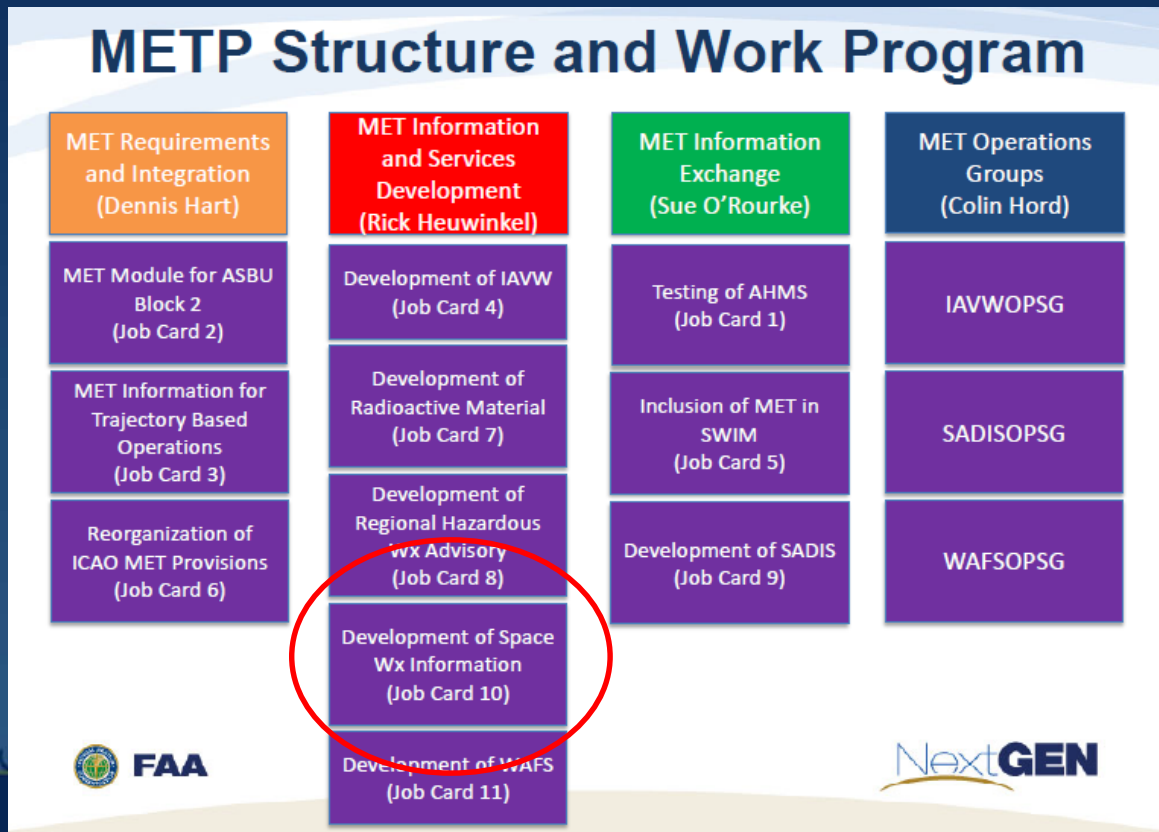
- determine operational requirements for aeronautical MET service provision as an enabling function for a future globally interoperable air traffic management system
- identify solutions, in coordination with WMO, to effectively and efficiently fulfil the requirements through sound scientific and/or technological capabilities.



# MET Panel Organization

MET Panel organized its work program around 11 job cards provided by the Secretary

- Job Cards are unique to ICAO and define what work needs to be done by any ICAO Panel.
- MET Panel established four working groups to complete work program
- Job Card on space weather





Job Card defines work program that will lead to the development and implementation of a standard and recommended practice for the provision of space weather information.

Title	Development of provisions for information on space weather to international air navigation	Reference:	10
Source	MET Divisional Meeting 2014 (Recommendation 2/7)		
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, navigation systems, on board avionics and also posing a risk to the health of aircraft occupants.		
Specific Details (including impact statements)	<p>It was recommended by the MET Divisional Meeting (Recommendation 2/7) that an appropriate ICAO expert group, in close coordination with WMO, develop provisions for information on space weather to international air navigation.</p> <p>The development should specifically address:</p> <ul style="list-style-type: none"> <li>a) requirements for space weather information services consistent with the draft concept of operations for space weather information services;</li> <li>b) selection criteria and associated capability for the designation of global and regional space weather centres, including the optimum number thereof;</li> <li>c) appropriate governance and cost recovery arrangements for the provision of space weather information services on a global and regional basis; and</li> <li>d) considerations on the use of space weather information and the various impacts space weather events could have on international air navigation.</li> </ul> <p>It should be taken into account that development of provisions should be consistent with the evolving Global Air Navigation Plan (Doc 9750), including integration of the information produced into the future system-wide information management (SWIM) environment underpinning the future globally interoperable air traffic management system.</p> <p>This development will be supported by the World Meteorological Organization (WMO) Inter-Programme Coordination Team on Space Weather.</p>		
Expected Benefit	To provide information on space weather and to avoid the risks posed to flight safety regarding communications, navigation (including the global positioning system (GPS)) 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.		
Reference Documents	Annex 3 — <i>Meteorological Service for International Air Navigation, Global Air Navigation Plan (Doc 9750), Manual of Aeronautical Meteorological Practice (Doc 8896), Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services (Doc 9377)</i> , Concept of operations for space weather information in support of international air navigation, 6 December 2013, Draft version 3.0, Meteorology (MET) Divisional Meeting (2014) Report, Doc 10045.	Attachment	
Primary Expert Group:	METP		

# Space Weather Job Card

"An ICAO expert group, in close coordination with WMO, will develop provisions for information on space weather to international air navigation. The development should specifically address:

- 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 the optimum number thereof."



# World Meteorological Organization (WMO)

WMO is the scientific body that ICAO works with to help define Meteorological services.

ICAO defines the operational requirement for the service and consults with WMO on how services can be provided

WMO uses requirements to screen potential Provider States based on the functional and performance requirements.

At the WMO Executive Council (2009), it was agreed that a space weather expert group was needed:





# Inter-Program Coordination Team on Space Weather (ICTSW)

ICTSW established in May 2010

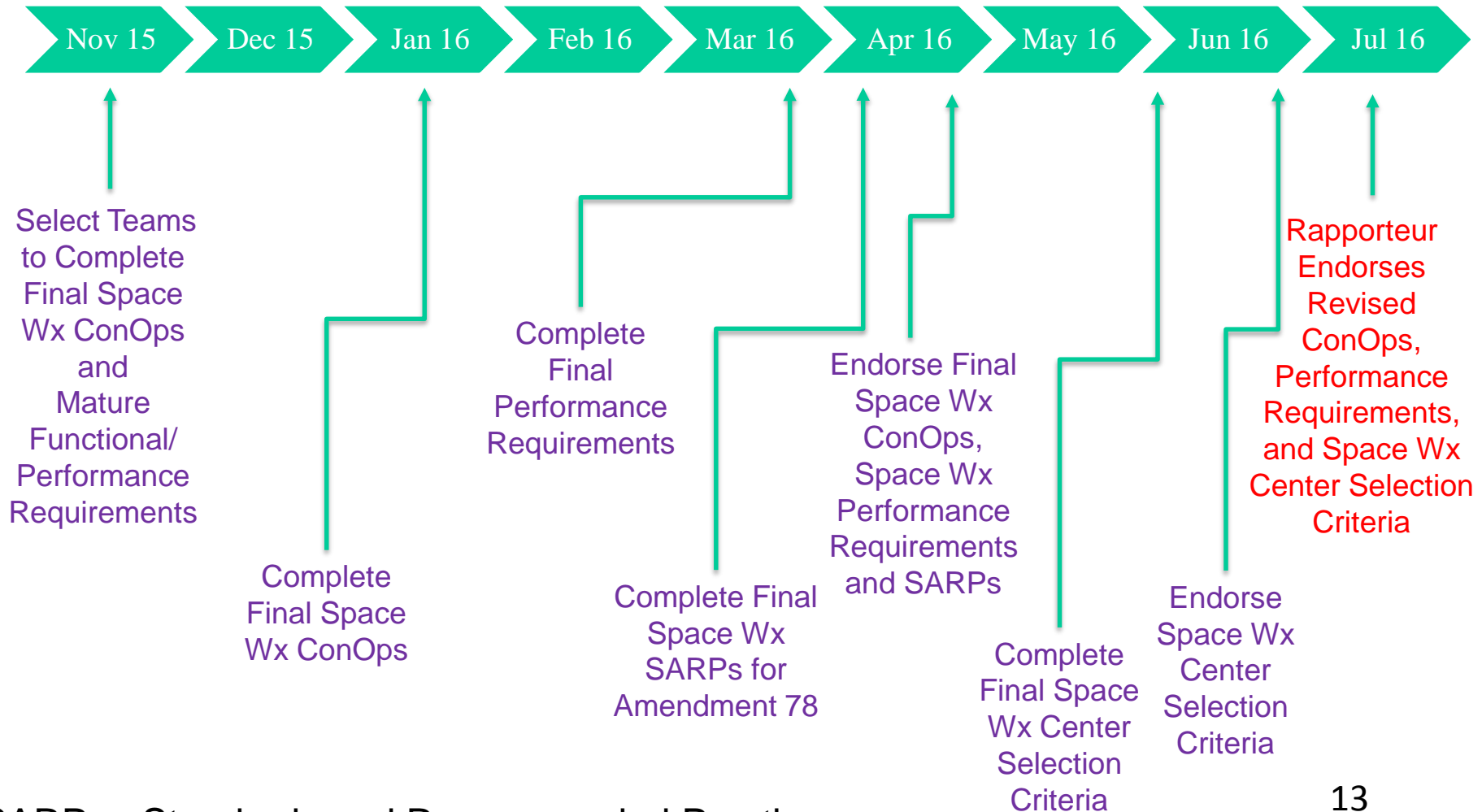
Proposed by WMO Commission for Basic Systems supported by the Commission for Aeronautical Meteorology

- Function: Harmonize definition of end-products and services in interactions with aviation and other major application sectors

ICTSW will work closely with ICAO on Space weather requirements and will assist in defining capabilities of the global and regional service centers.



# Space Weather Timeline





*THANK YOU!*

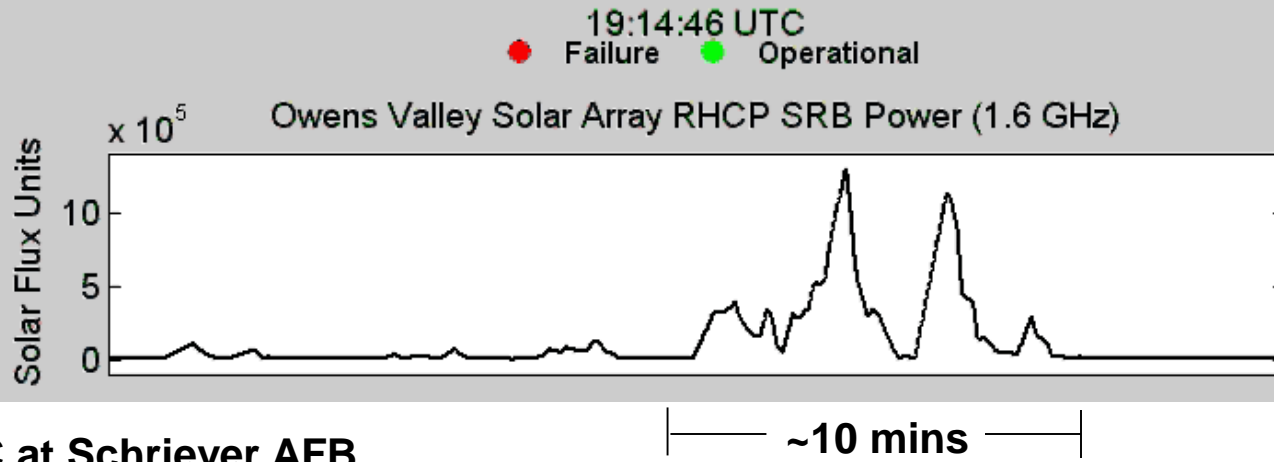
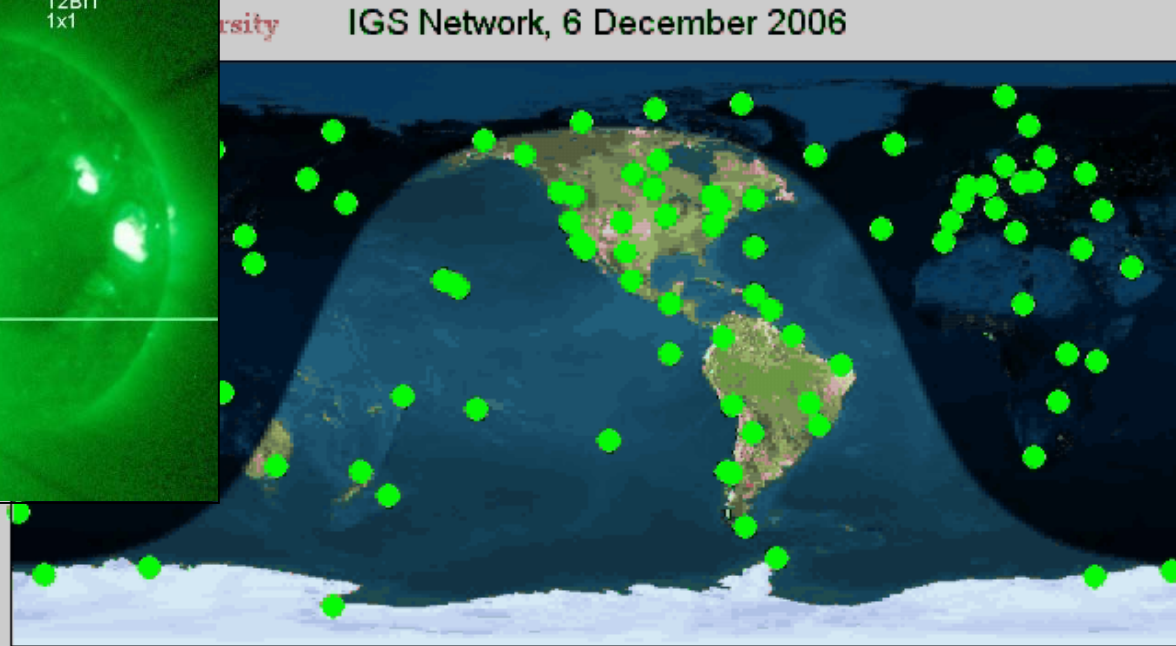


# Additional Slides





# Solar Flare (Radio Burst) Impact on GPS – 6 Dec 2006



## GPSOC at Schriever AFB

- "At approximately 6 Dec/1930Z there was a widespread loss of GPS in the Mountain States region. Several aircraft reported losing lock on GPS...were tracking 7-9 satellites, and abruptly lost lock and were tracking 0-1."

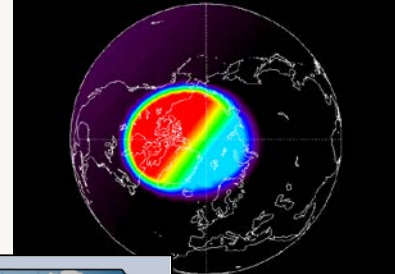
# March 2012 Impacts on Aviation

6-7 March 2012: “Severe impact at 2249Z initially affecting CWP [*Central West Pacific*] but by 2400Z, impact peaked and was affecting all communications. 25 ATC messages were delayed.”

- *Air Traffic Communications*

7 March 2012: INCERFA was issued for Air Canada 003 (Vancouver to Tokyo) until communications were established with the flight.

***(INCERFA is issued when there is uncertainty as to the safety of an aircraft and its occupants.)***



Attributed by Ionospheric Absorption  
Frequency (MHz) 25 30  
Strong Ionospheric Flux  
NOAA/SWPC Boulder, CO USA



U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION

ORDER  
JO 7110.10V  
Effective Date:  
February 9, 2012

Subject: Flight Services

## Section 3. Alerting Service

### 7-3-2. ALERTING PHASES

a. Air traffic services units must notify rescue coordination centers immediately when an aircraft is considered to be in a state of emergency in accordance with the following:

1. Uncertainty phase when:

(a) No communication has been received from an aircraft within a period of 30 minutes after the time a communication should have been received, or from the time an unsuccessful attempt to establish communication with such aircraft was first made, whichever is the earlier.

# Carrington Event



## AURORAL PHENOMENA.

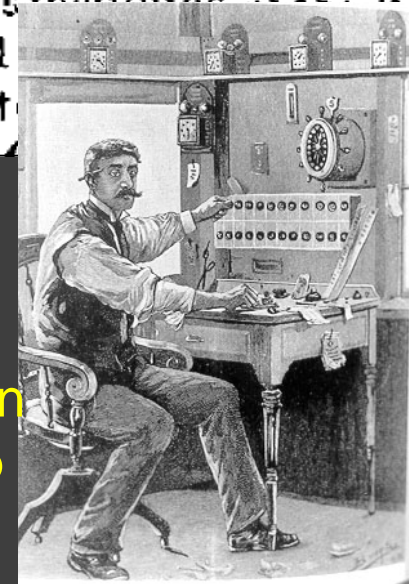
### Remarkable Effect of the Aurora Upon the Telegraph Wires.

The Aurora which occurred on Thursday night produced effects much more remarkable than those of the previous Sunday night. The auroral currents were sufficiently powerful on Thursday to enable the telegraphic operators at Portland to transmit messages to Boston without resorting to the use of the batteries; and similar phenomena were observed at Pittsburgh. A series of experiments upon this curious electrical condition was instituted at the Boston office. The results are noticed in the following operators, which

## The New York Times

Published: September 5, 1859

Copyright © The New York Times



“Happening to lean towards the sounder, my forehead grazed a ground wire. Immediately I received a very severe electric shock. An old man sitting facing me said he saw a spark of fire jump from my forehead to the sounder”

# May 1921 Geomagnetic Storm

## **SUNSPOT CREDITED WITH RAIL TIE-UP**

### ***New York Central Signal System Put Out of Service by Play of Northern Lights.***

The sunspot which caused the brilliant aurora borealis on Saturday night and the worst electrical disturbance in memory on the telegraph systems was credited with an unprecedented thing at 7:04 o'clock yesterday morning, when the entire signal and switching system of the New York Central Railroad below 125th Street was put out of operation, followed by a fire in the control tower at Fifty-seventh Street and Park Avenue.

This is the first time that a sunspot has been blamed for such a piece of mischief. From other accounts it appeared

**The New York Times**

Published: May 16, 1921

Copyright © The New York Times

## **CABLES DAMAGED BY SUNSPOT AURORA**

**Ships to Be Sent Out to Mend  
Lines Put Out of Service  
by Magnetic Display.**

## **ELECTRIC DISTURBANCES AFFECT FRENCH WIRES**

***Aurora Not Visible, Its Absence  
Being Attributed to Atmos-  
pheric Conditions.***

Copyright, 1921 by The New York Times Company  
By Wireless to THE NEW YORK TIMES.

PARIS, May 17.—The disturbance which interrupted telegraphic transmission in the United States last week has been making itself felt also in France.

On Saturday night, especially the operators at the central transmission stations came to the conclusion that a strange force had got into their instruments, for nothing would go right. Morse instruments, instead of making dots and dashes, recorded one long line,



# Lloyds Report (21 May 2013): Solar Storm Risk to the North American Electric Grid

- US population at risk of extended power outage: **20-40 mil**
- Duration: **16 days to 1-2 years**
- Economic cost: **\$0.6-2.6 trillion USD**
- Highest Risk: **DC-NYC corridor**
- Gulf Coast states, including Florida, identified as a "high risk" area.

LLOYD'S  
THE WORLD'S SPECIALIST  
INSURANCE MARKET

Search lloyds.com Search

ABOUT US THE MARKET **NEWS AND INSIGHT** TOOLS GLOBAL OFFICES CONTACTS LOGIN/REGISTER

## RISK INSIGHT

Research, reports and studies from Lloyd's.

**NEWS AND INSIGHT** Risk insight

- Solar Storm Risk to the North American Electric Grid - in pictures
- Global underinsurance research
- Risk Reports

### SOLAR STORM RISK TO THE NORTH AMERICAN ELECTRIC GRID

The East Coast of America is at high risk from solar storms which could leave tens of millions of people without electrical power, potentially costing trillions.

> Download Solar storm report

Executive summary

- A Carrington-level, extreme geomagnetic storm is almost inevitable in the future. While the probability of an extreme storm occurring is relatively low at any given time, it is almost inevitable that one will occur eventually.

### LLOYD'S RISK REPORTS

Emerging Risk Risk Issues

**Solar Storm Risk to the North American Electric Grid**

The report, which was produced in collaboration with the Atmospheric and Environmental

[www.lloyds.com/news-and-insight/risk-insight](http://www.lloyds.com/news-and-insight/risk-insight)