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Space Weather Information and the International Civil Aviation Organization

Provision of the Space Weather Advisory for International Air Navigation

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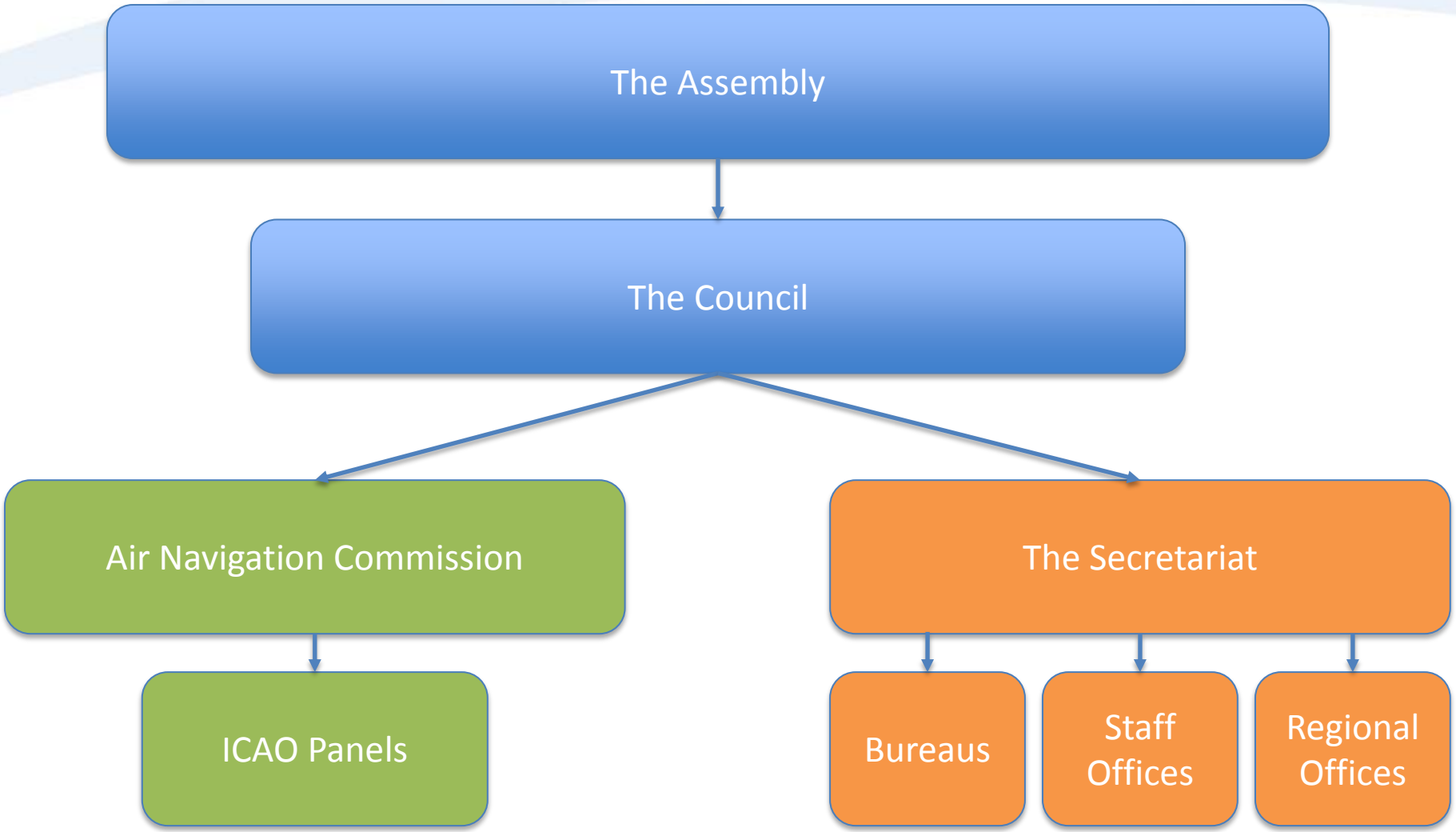
What is the International Civil Aviation Organization (ICAO)?

Overview of ICAO

- A UN specialized agency established in 1944 by the Convention on International Civil Aviation
- The “Chicago Convention” oversees international cooperation on regulations, standards, and procedures governing civil aviation
- 191 member States
- Headquarters: Montreal
- Regional Offices: Bangkok, Cairo, Dakar, Lima, Mexico City, Nairobi, Paris
- Composed of three main bodies
  - Assembly
  - Council
  - Secretariat

ICAO Structure



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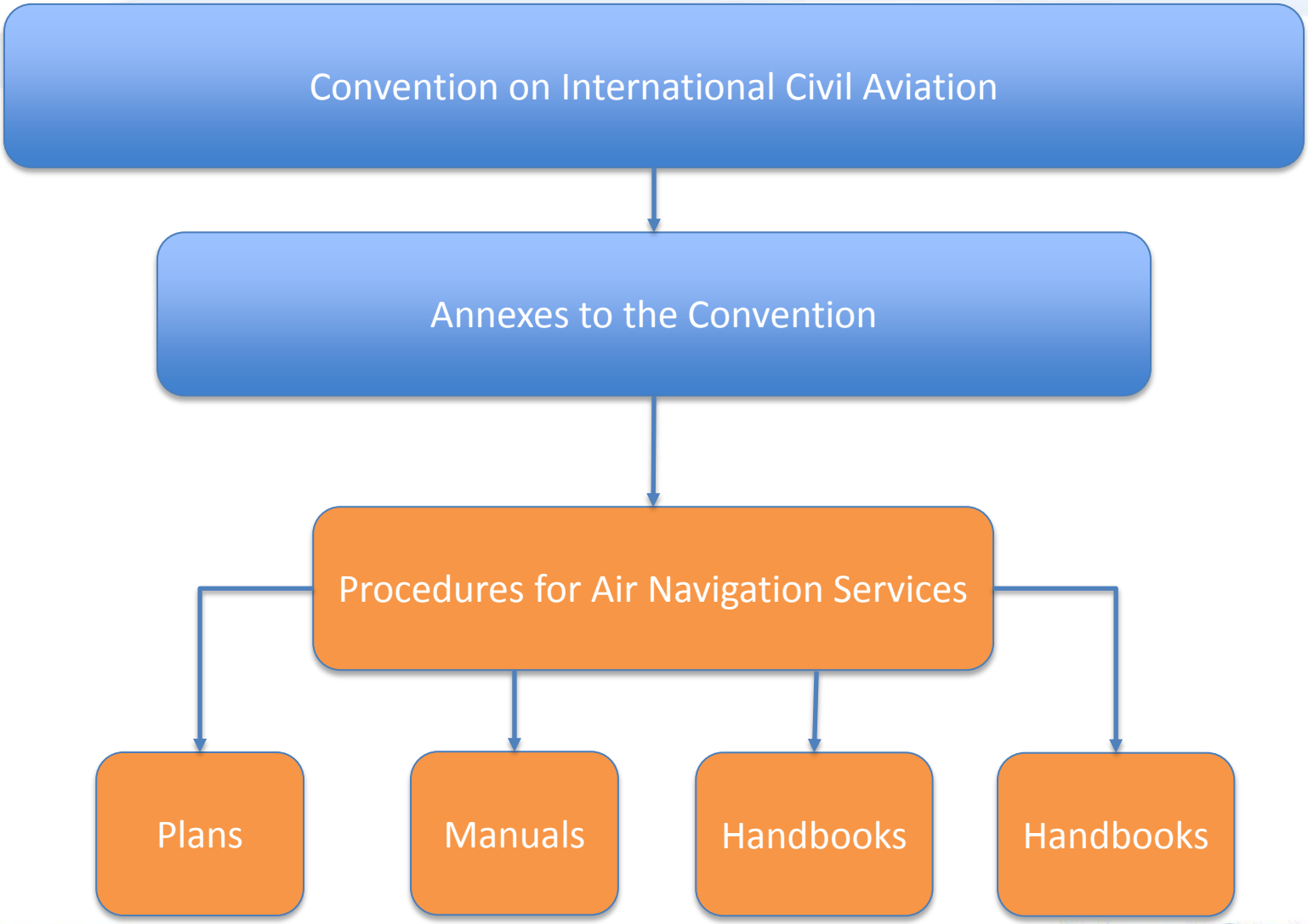
ICAO Document Structure



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Why is ICAO interested in space weather?

Potential Impacts of Space Weather on Aviation

- Communications
  - Degraded High-Frequency (HF) radio communications
    - Note: HF radio communications already inferior to VHF or satellite communications
  - Degraded or complete outage of satellite communications
- Navigation
  - Degraded or complete outage of satellite communications
    - Note: Degraded satellite navigation system performance can result in the use of erroneous information by the flight crew
- Health
  - Potential for increased radiation exposure during certain high latitude and high-altitude flights

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Increasing Exposure of Aviation to Space Weather

- Increasing use of polar routes for intercontinental flights
  - Polar route flights especially susceptible to degradation of communications and navigation capabilities due to solar radiation
- Increasing frequency of flights on North Atlantic Organized Track System, Pacific Organized Track System, and North Pacific Tracks
  - High latitude flights are more susceptible to degradation of communications and navigation capabilities due to solar radiation
- Increasing reliance on satellite-based navigation and surveillance systems
  - Commercial and general aviation aircraft increasingly rely on navigation and surveillance system requiring a Global Positioning System link
- Increasing use of satellite communications systems
  - Satellite communications systems increasingly common with “high end” business aviation and air carriers

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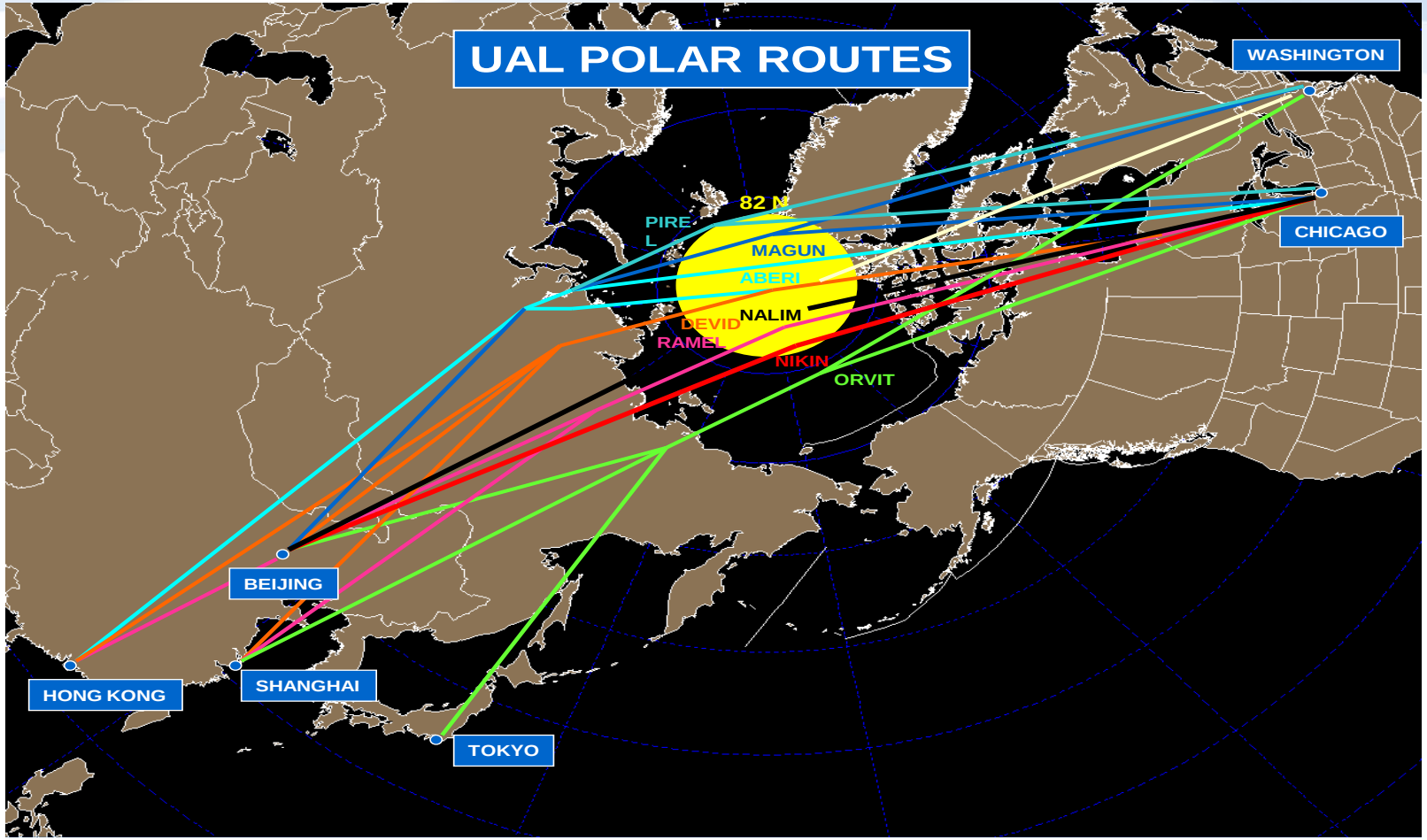
Polar Routes



Source: Mike Sills, United Airlines, "Polar Operations and Space Weather"

- Total polar operations exceed 10,000 flights/year and that number is growing
- Yellow circle indicates high latitude area requiring use of HF comm (no satellite comms coverage) which can be disrupted by solar radiation events

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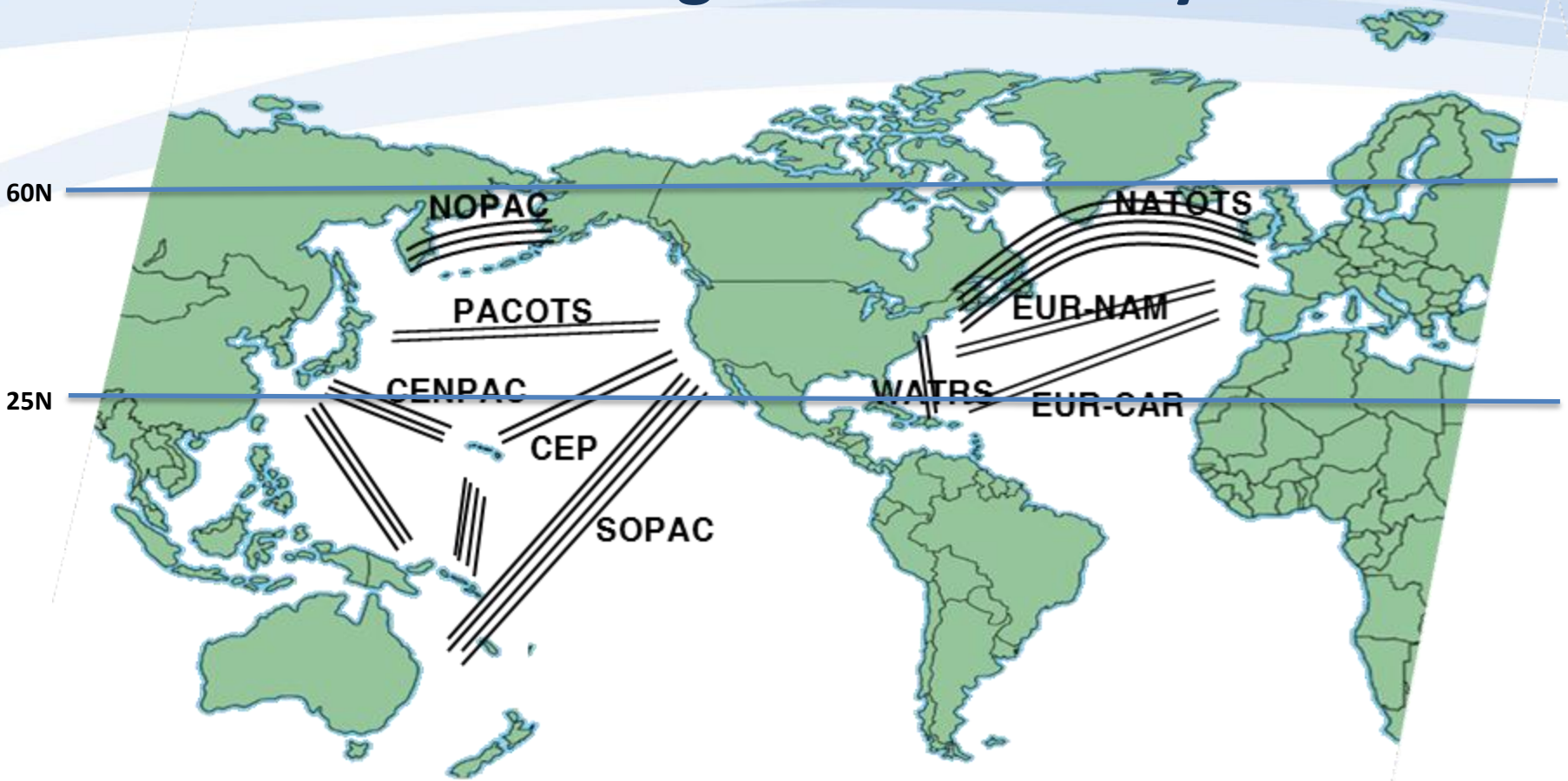
Worldwide Organized Track Systems



- NATOTS and NOPAC tracks generally between 45N and 60N degrees latitude
- PACOTS tracks generally between 25N and 45N degrees latitude
- Increased risk of comms/nav system degradation at higher latitudes due to solar radiation events
- Solar radiation events can impact comms/nav systems as far souths as ***25N degrees***

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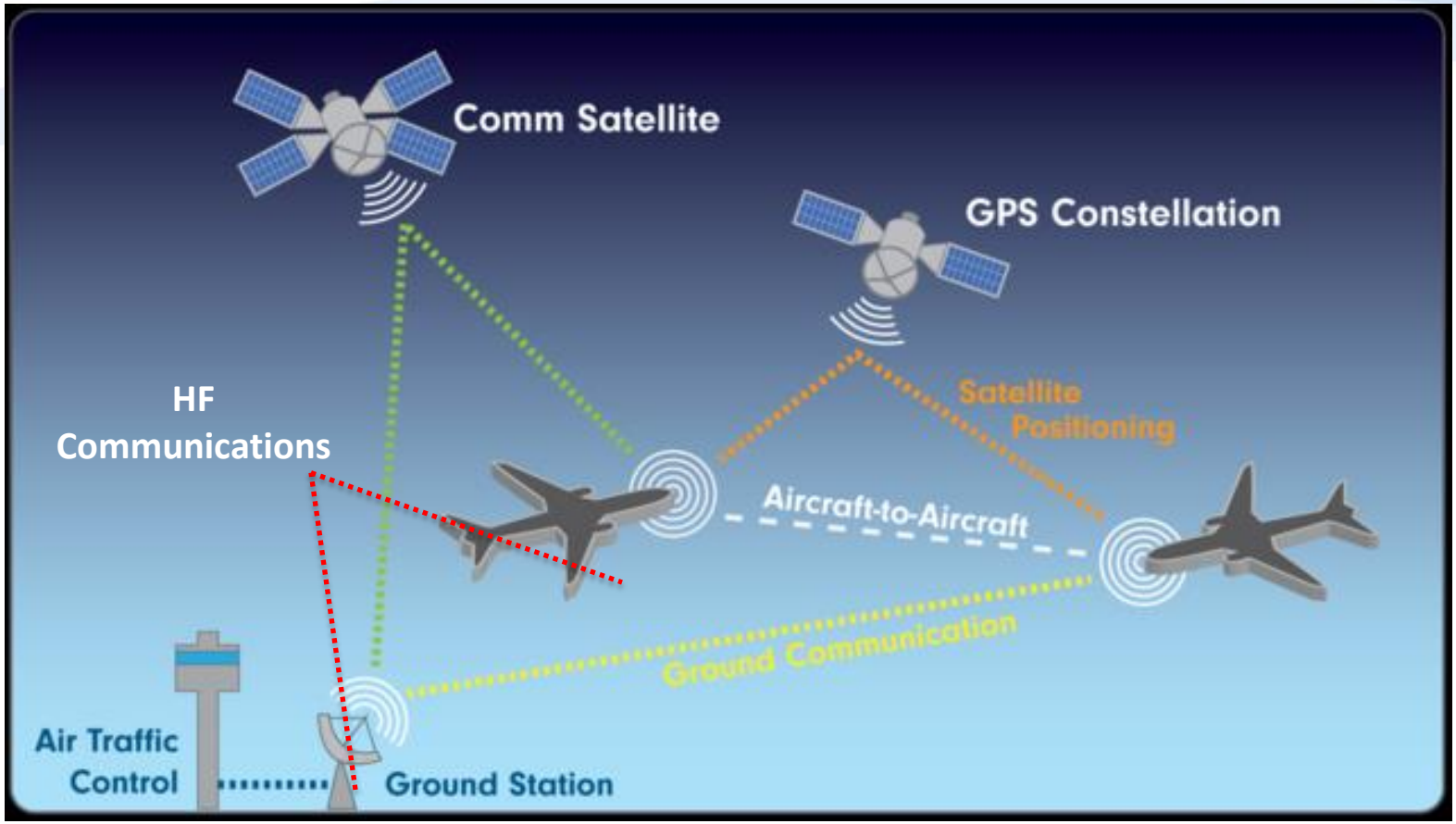
Communications Links in NextGen Environment



- International air navigation increasingly relies on satellite communications and navigation
- HF communications will continue as back-up and cheaper alternative in the foreseeable future
- All three communications links are susceptible to impacts of space weather events

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What is ICAO doing to address space weather?

Timeline of ICAO Space Weather Efforts

Provision of the Space Weather Advisory

2002

MET Divisional Meeting

Recommendation 1/20:

To assess the need for providing information for international air navigation on solar radiation storms and other bio-hazards

Intersessional Period 2002-2014

Development of operational requirements for space weather products

- IATA wrote high level user requirements
- Concept of Operations f or provision of SWX information was drafted
- Product requirement specification created

2014

MET Divisional Meeting

Recommendation (2/7):

Development of provisions for information concerning space weather (Job Card 10).

METP established by ANC in 2015

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Timeline of ICAO Space Weather Efforts

Provision of the Space Weather Advisory

2015

- Finalized functional and performance requirements for SWX forecasts
- Developed universal SWX advisory templates
- Developed guidance on the process for selecting SWX information providers
- Drafted outline for the SWX manual

2016

- Endorsed draft SARPs for the provision of SWX information (July 2018)
- Endorsed process for establishing the global SWX information capability
- Endorsed schedule to complete process to establish SWX info providers
- Recommended WMO conduct site assessments and audits of prospective SWX information providers

2017

- Developed draft Manual on Space Information in Support of Air Navigation
- Recommended an optimum number of global and regional SWX centres
- Update SARPs for Amendment 80 to include provision of SWX information by regional centres

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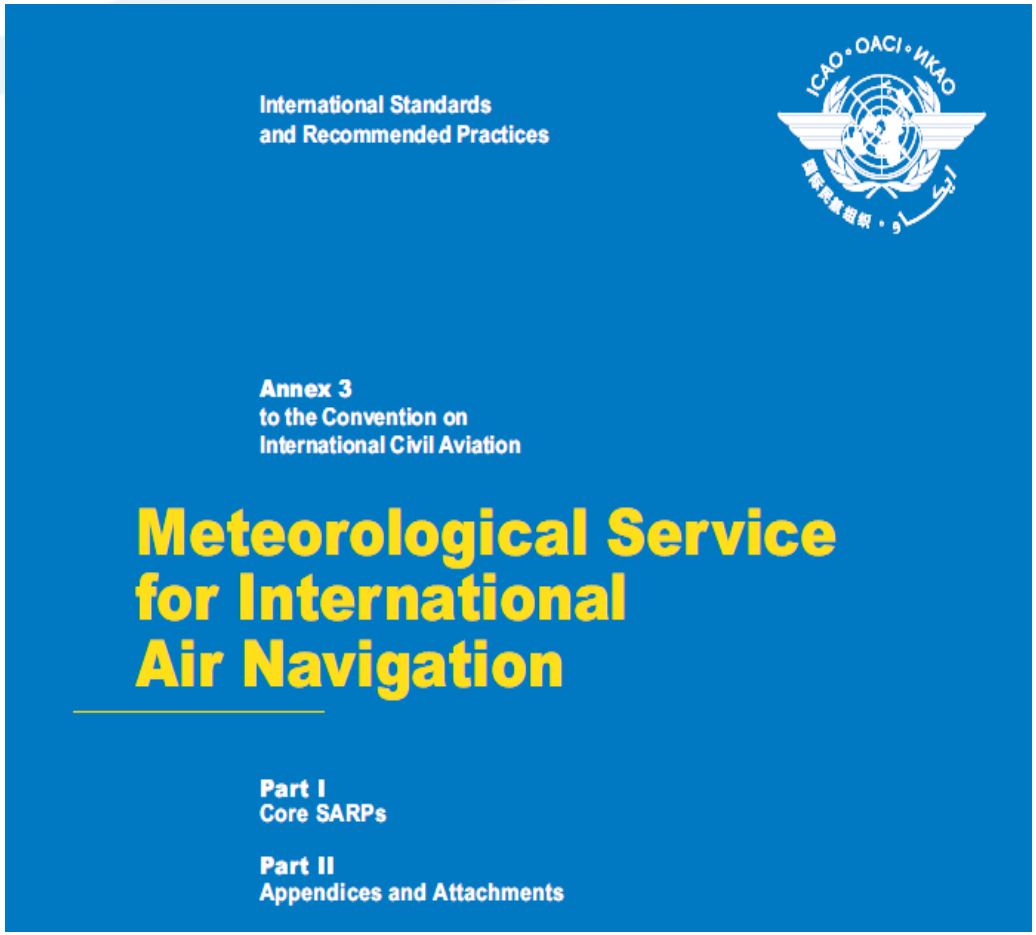
Global Standards for Space Weather Information



- ICAO Annex 3 contains the standards and recommended practices (SARPs) for the provision of meteorological information
- Amendment 78 to Annex 3 will introduce SARPs for the provision of space weather information
- ICAO Council will designate the providers of the Space Weather Advisory product
- ICAO will publish a manual on the provision and use of space weather information for international air navigation

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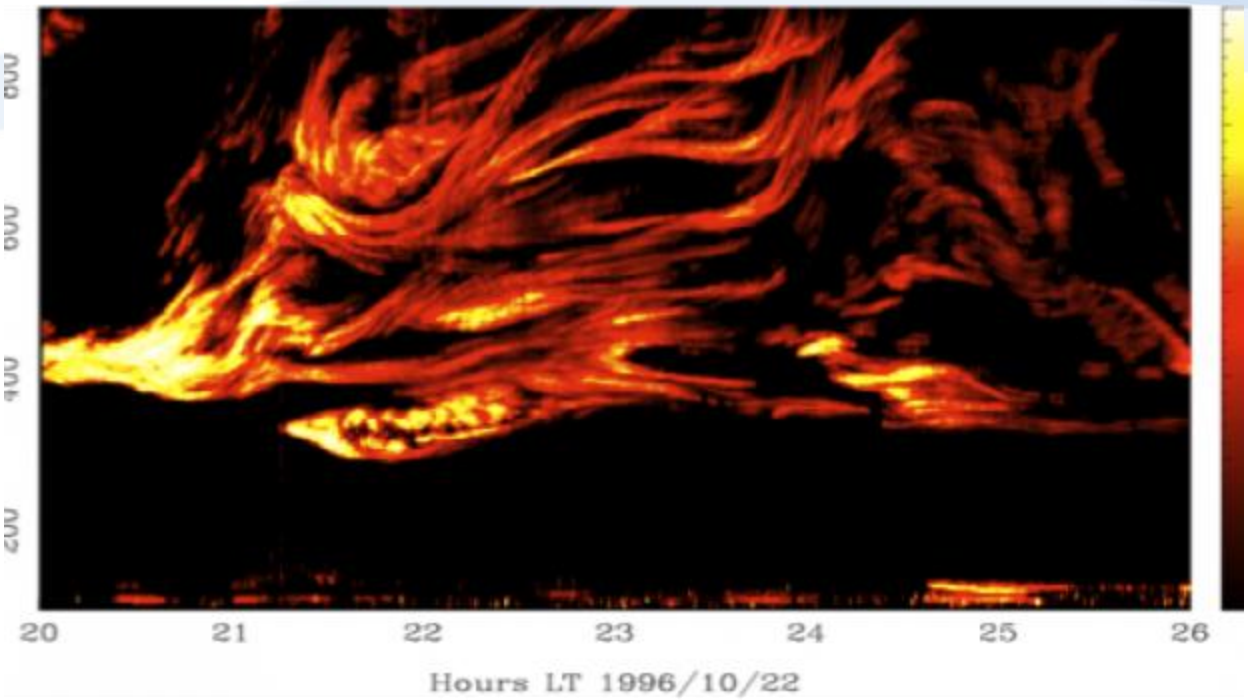
Conclusions



Source: U.S. Space Weather Prediction Center – Ionospheric Scintillation

- ICAO and the SWX information provider community responded to the aviation industry need for standardized information regarding potential global hazards → space weather advisory
- SWX information will still be used primarily for pre-flight decisions regarding route, altitude, communications channels, and fuel load
- Ongoing improvements in aviation systems, such as GPS, may mitigate the potential impacts of SWX events on international air navigation

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