Mitigating the Impacts of Space Weather on Aviation Operations

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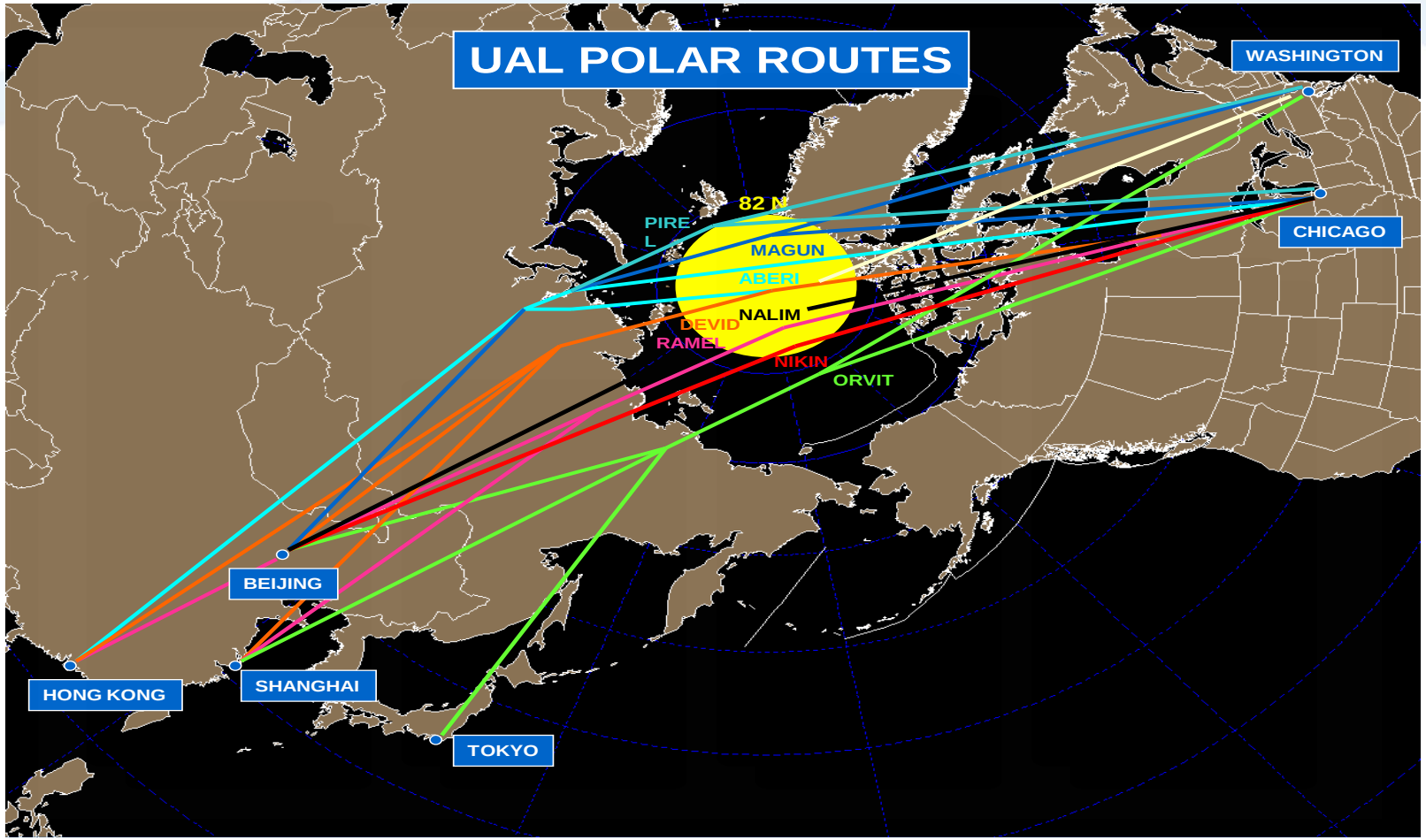
Potential Impacts of Space Weather Aviation

- 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

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
  - Both 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

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 communications (no satellite communications coverage) which can be disrupted by solar radiation events.

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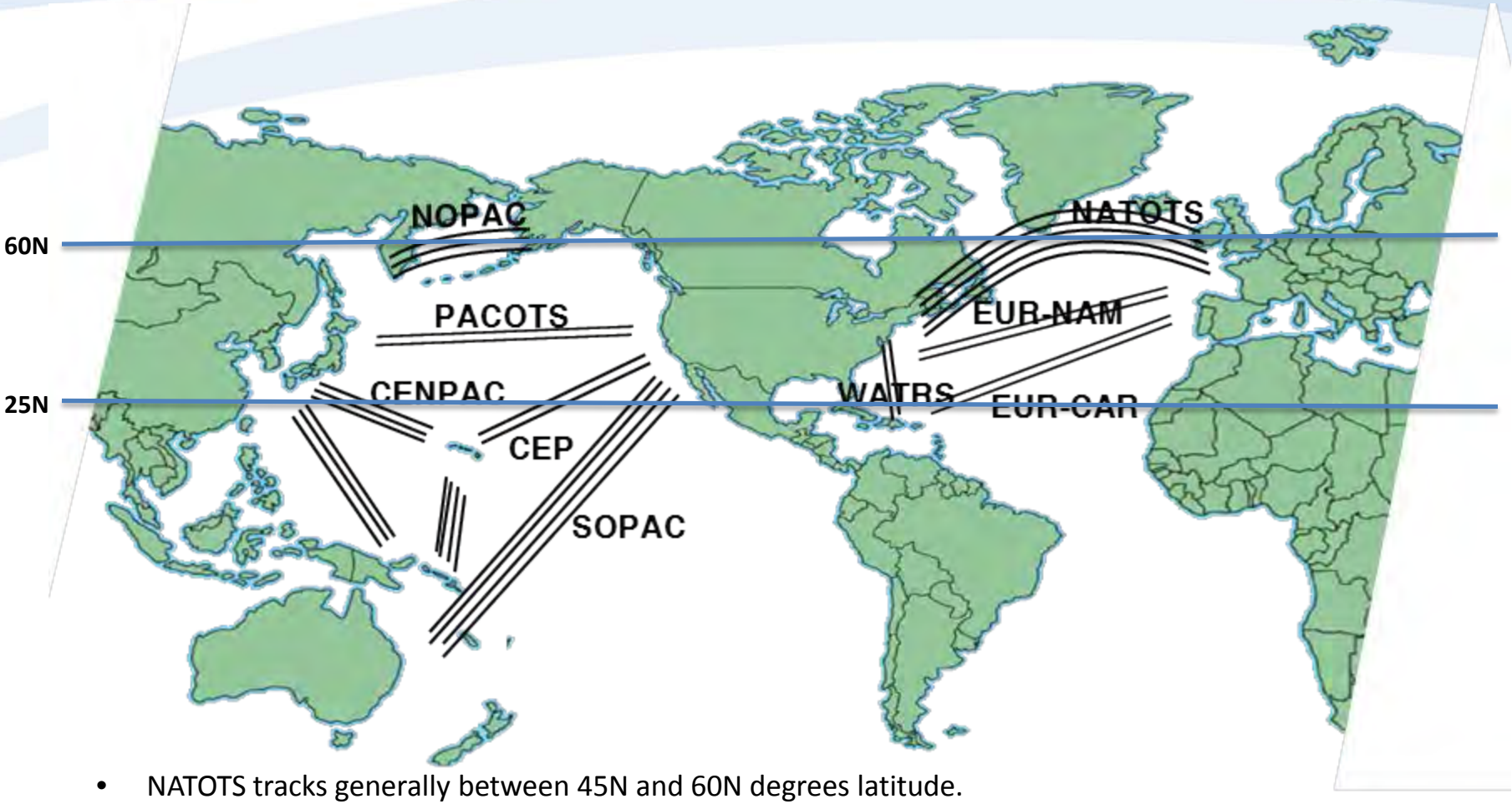
World-wide Organized Track Systems



- NATOTS tracks generally between 45N and 60N degrees latitude.
- PACOTS tracks generally between 25N and 45N degrees latitude.
- NOPAC tracks generally between 45N and 60N 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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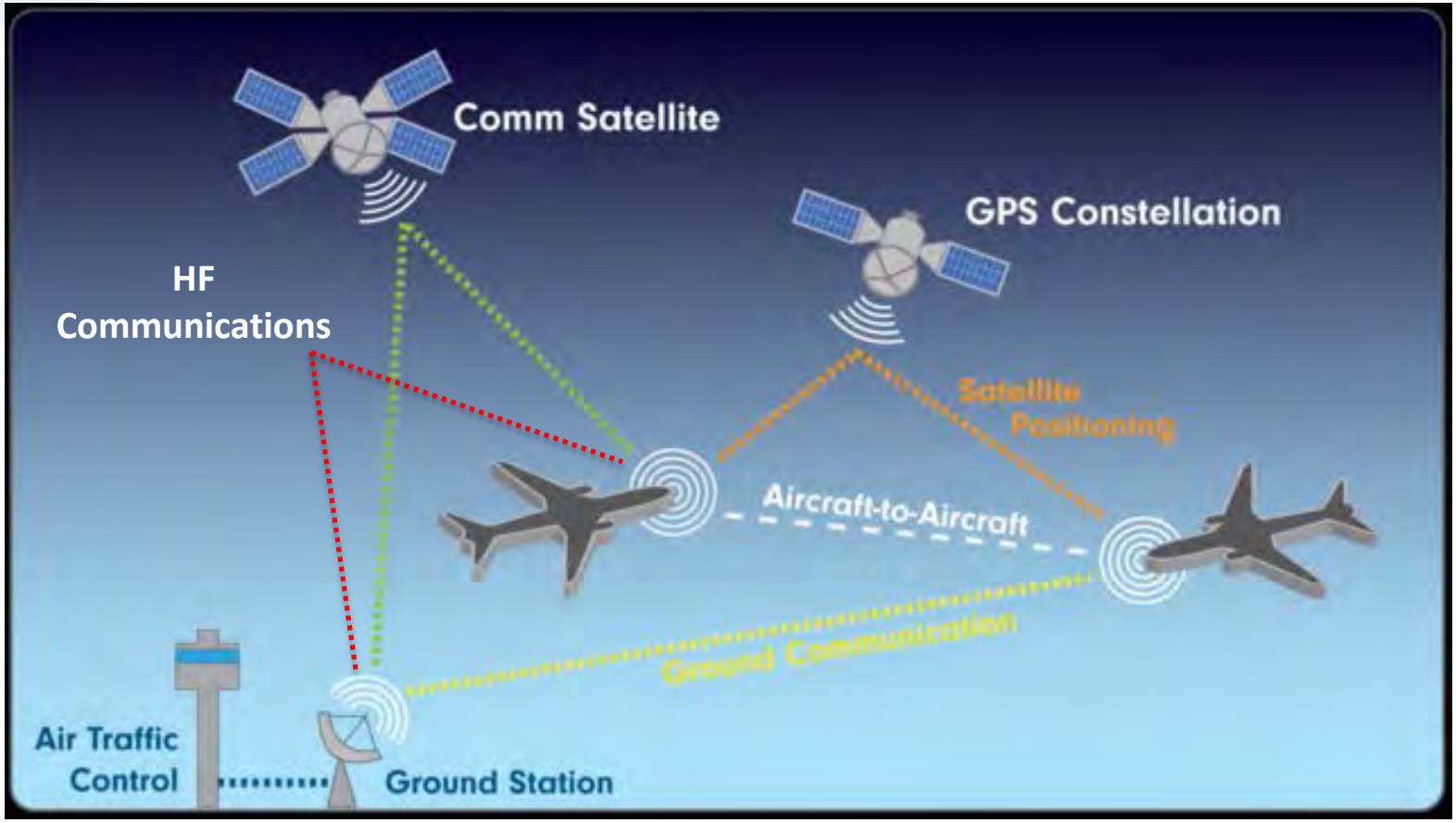
Communications Links in NextGen Environment



- At full implementation, NextGen will rely on satellite comms
- HF comms will continue as back-up and cheaper alternative
- All three comms links are susceptible to space weather events

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Mitigating the Impact of Space Weather Events

- System Redundancy
  - Communications Systems
    - High-Frequency and Very High-Frequency Radio Capabilities
  - Aircraft Navigation Systems
    - Inertial navigation systems
  - Ground-Based Navigation Systems
    - Multiple instrument landing systems at most airports
- Procedures
  - Aircraft
    - Loss of communications
    - Loss of navigation systems (pilotage)
  - Air Traffic Management/Air Traffic Control
    - Loss of communications
      - ATM/ATC procedures for communications loss are geared toward single aircraft events, not widespread loss of communications capabilities
      - FAA is collaborating with the international community to develop procedures for mass turn-back and mass descent operations in certain airspaces (e.g., NATOTS)

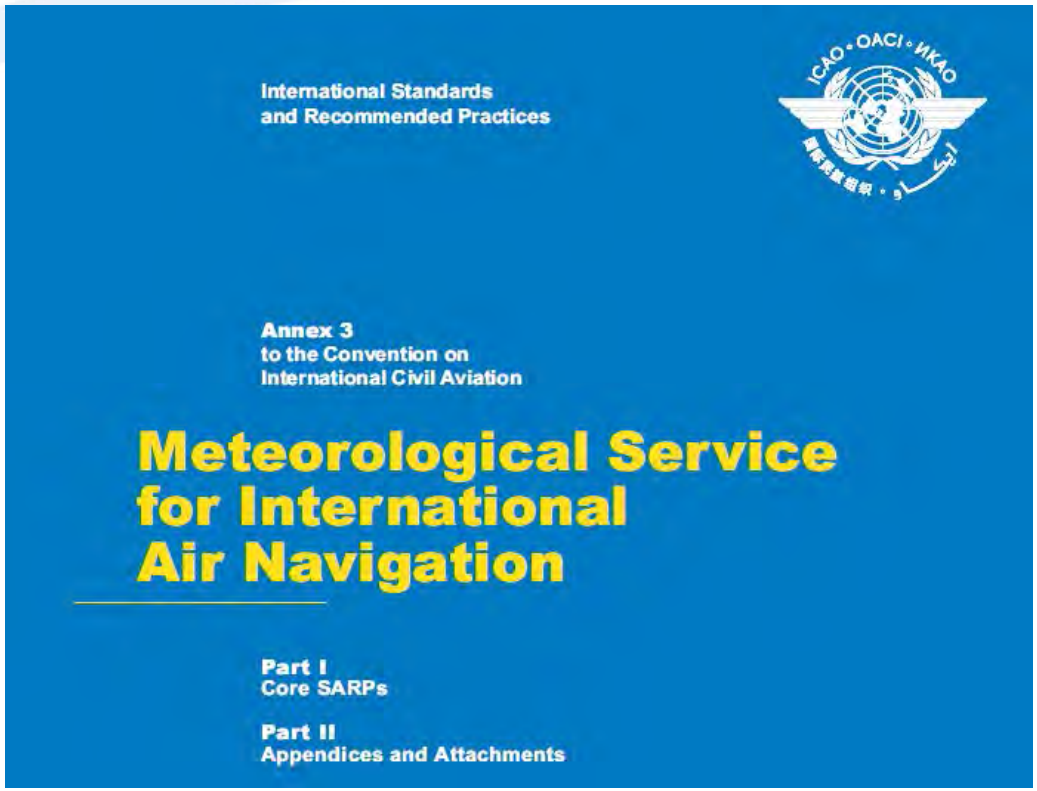
Avoiding the Impact of Space Weather Events

- Aircraft and Air Traffic Management/Air Traffic Control may work to avoid the impact solar radiation events through:
  - Course changes
    - Reroute to lower latitude flight path
  - Altitudes changes
    - Decrease altitude
- However, such en route responses to space weather events require more fuel which must be determined in the pre-flight phase which, in turn, depends upon ***reliable forecasts of space weather events and potential impacts***

Space Weather Action Plan

- On behalf of DOT, FAA will coordinate with other agencies in completing the following actions identified in the Space Weather Action Plan:
  - 4.2.3 Define the requirements for real-time monitoring of the charged particle radiation environment to protect the health and safety of crew and passengers during space weather events.
  - 4.2.4 Define the scope and requirements for a real-time reporting system that conveys situational awareness of the radiation environment to orbital, sub-orbital, and commercial aviation users during space weather events.
  - 4.2.5 Develop or improve models for the real-time assessment of radiation levels at commercial flight altitudes.
  - 6.1.2 Provide global space weather information and services for international aviation with the UN International Civil Aviation Organization (ICAO).

Global Standards for Space Weather Information



ICAO Annex 3 contains the standards and recommended practices (SARPs) for the provision of meteorological information

- ICAO Meteorology Panel is responsible for developing requirements for meteorological information
- FAA leads a MET Panel working group to develop requirements for space weather information
- Requirements for space weather information will be added to Annex 3 with Amendment 78 (2018)
- ICAO will identify criteria for selecting space weather centers to provide the information

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