Integrating Space Weather Observations & Forecasts into Aviation Operations

American Meteorological Society & SolarMetrics
Highlights of a Policy Workshop

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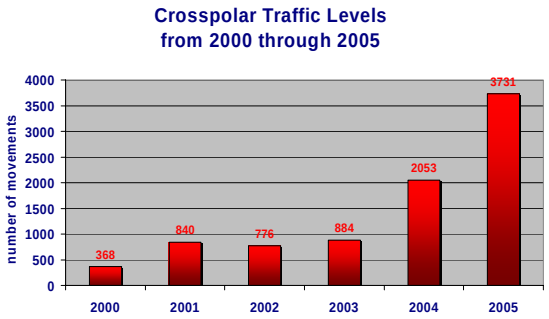
Space Weather Impacts on Aviation Operations are Increasing

As cross-polar traffic increases, the aviation industry is becoming more aware of the impacts space weather can have on operations. (*Space weather* refers to the conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health.) The industry is primarily concerned about risks during high-latitude (>50°N) and polar operations (>78°N) since impacts of space weather can be greatest in these regions. Effects include disruption in High Frequency (HF) communications, satellite navigation system errors, and radiation hazards to humans and avionics.



Cross polar traffic levels for the years 2000–2005 (D. Rome, NAVCANADA)

These concerns not only apply to current operations, but become even more important at all latitudes when considered within the framework for the Next Generation Air Transportation System (an interagency initiative to transform the U.S. air transportation system by 2025). Additionally, with the potential space tourism and intercontinental space flight markets, these risks are equally important to the commercial space transportation industry.

What are the Issues?

Economic

In the last several years, airspace over Russia and China has opened up to commercial traffic, allowing for polar routes between North America and Asia. These flight paths provide a shortcut to Asia, reducing travel time and operating costs (e.g., fuel, delays, reroutes). For example, a United Airlines operations manager stated that if polar routes are not available, the additional operating costs and penalties for an unscheduled stop or reroute can total hundreds of thousands of dollars per flight. The economics of cross-polar air traffic will become even more important as travel is expected to increase sharply in anticipation of the 2008 Summer Olympic Games in Beijing and will continue to grow.

Operational

Space weather phenomena (geomagnetic storms, solar radiation storms, solar flare radio blackouts, solar radio bursts, and cosmic radiation) can impact aviation operations. Effects include degradation or loss of HF radio transmission and satellite navigation signals; navigation system disruptions; and avionics errors. Dispatchers need space weather forecasts for flight planning at high latitudes, especially for the polar routes. However, operators want additional products that assist in decision making processes.

Safety

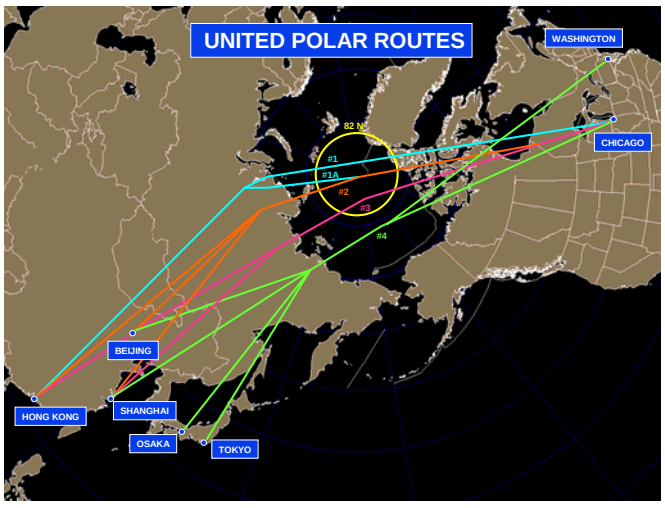
Impacts on aviation operations can directly impact safety, which is the primary concern of air carriers. In addition, solar radiation and cosmic rays can also impact human health. However, current medical research and epidemiological studies are inconclusive regarding the actual impacts to aircrew over the length of a flying career. This issue is a concern for the aviation and sub-orbital space industries, and more accurate data and more extensive studies are needed to assist medical research in identifying the long-term health effects.

Current and Future Capabilities

Currently, the National Oceanic and Atmospheric Administration (NOAA) Space Environment Center (SEC) provides space weather forecasts and products useful to the aviation industry. Based on these products, air carriers may decide whether to reroute an aircraft. Ideally, dispatchers would like forecasts, a minimum of 12–18 hours before a flight, to be applied to pre-flight operational planning. This capability is currently not available; therefore improved observations, modeling, and scientific understanding are needed in order to improve forecasts.

Additionally, there are several policy issues that need to be addressed to ensure the best use of current space weather information:

- Communication of space weather information
- Standardization of information and regulations
- Education and training
- Cost benefit and risk analysis



Polar routes used by United Airlines (M. Stills, United Airlines)

To date, there are a lot of gaps between the development of space weather information and the needs of the aviation

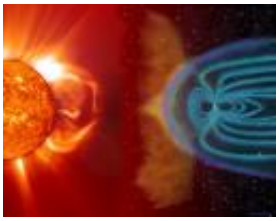
industry. In response, the American Meteorological Society (AMS) Policy Program and SolarMetrics conducted a study on key policy issues governing effective integration of space weather information with the aviation system. In addition, AMS and SolarMetrics organized a workshop in November 2006 that led to specific recommendations.

Recommendations

The AMS/SolarMetrics report, *Integrating Space Weather Observations and Forecasts into Aviation Operations*, offers recommendations to increase the safety, reliability, and efficiency of aviation operations through more effective use of space weather information. Aviation is global and therefore these recommendations can be applied nationally and internationally. Here are a few abbreviated recommendations; the complete list can be found in the report.

1) Improve Communication of Space Weather Information

Communication is key in integrating observations and forecasts into operations; the information needs to be understandable and disseminated in a timely manner to the aviation industry. Within the U.S., aviation terrestrial weather services are provided to non-military aircraft primarily by NOAA, the Federal Aviation Administration (FAA), and the private sector. While the same channels for dissemination of space weather information are available in principle, communication varies. Dispatchers receive space weather information from in-house meteorologists, private-sector companies, and NOAA SEC alerts and forecasts, or go directly to the NOAA SEC website. The current FAA system that distributes meteorological information as text cannot distribute graphical products required for interpreting space weather information. Currently, many aviation operators find space weather information to be too technical and prefer products that aid in decision making.



The Sun-Earth Interaction

Recommendations

- **Define requirements for space weather information and how it is incorporated into the operational decision making process**
- **Deliver space weather information in an internationally agreed upon standardized format as defined by the aviation user requirements**
- **Increase the interaction between the aviation community and the space weather research and service provider community**
- **Incorporate aviation user requirements into space weather research planning**

2) Improve Standardization of Information & Regulations

Air travel is global and international cooperation is therefore essential. However, there is a lack of policy and process, both nationally and internationally, for use of space weather information in the aviation industry. Many operators are not willing to take official action based on space weather information unless they are provided more guidance on how to interpret the information. They want a level playing field. The FAA has not issued any specific requirements regarding space weather except that an operator must have effective communications capability with dispatch and air traffic control for all portions of the flight. Additionally, different U.S. and international groups are not in agreement on their standards for space weather information.

Recommendations

- **Create international standards for aviation space weather information, products, and services**
- **Provide aviation operations with a minimum set of requirements for making decisions based on space weather information**
- **Provide aviation operations with a minimum set of requirements for incorporating space weather into operational training**
- **Evaluate user requirements for integrating into requirements definition and investment analysis**

3) Improve Education & Training

Overall, the aviation industry does not understand space weather effects or its impacts on operations. This inhibits awareness of the potential risks involved, and makes it difficult to get key industry stakeholders interested in education and training, which is needed at all levels.

Recommendations

- **Develop aviation space weather training curricula for aviation operators and meteorologists**
- **Develop aviation space weather education curricula for university students**
- **Provide a global public portal for aviation space weather education**

All aviation operators need space weather training

4) Develop Cost Benefit and Risk Analysis

In 2000, NAVCANADA conducted a feasibility study which identified 33 potential city pairs that could benefit from polar routes. Some examples of time savings in minutes and dollars per flight include (in Canadian dollars):

Atlanta – Seoul 124 minutes / $44,000
Boston – Hong Kong 138 minutes / $33,000
Los Angeles – Bangkok 142 minutes / $33,000
New York – Singapore 209 minutes / $44,000

Very little information is available on how much space weather is responsible for reroutes or delays on polar routes. The aviation industry needs a better understanding from scientific, engineering, and medical communities regarding risks. Analysis of impacts should be segmented into HF communications, navigation, radiation, and new modes (suborbital).

Recommendations

- **Define and collect operational data that can be used to assess the different impact areas, cost of improved services, and return on investment**
- **Link aviation space weather cost benefit analysis to requirements for ongoing consistent data collection from ground and space**
- **Coordinate research studies focusing on aviation impact areas (health, avionics, navigation, and communications)**

The American Meteorological Society (AMS) is a scientific and professional society of more than 12,000 members from the U.S. and over 100 foreign countries. SolarMetrics is a UK consultancy that provides services to airlines and corporations to enable them to deal effectively with the impacts of space weather on air travel.

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