SPACE WEATHER The International Journal of Research and Applications AGU

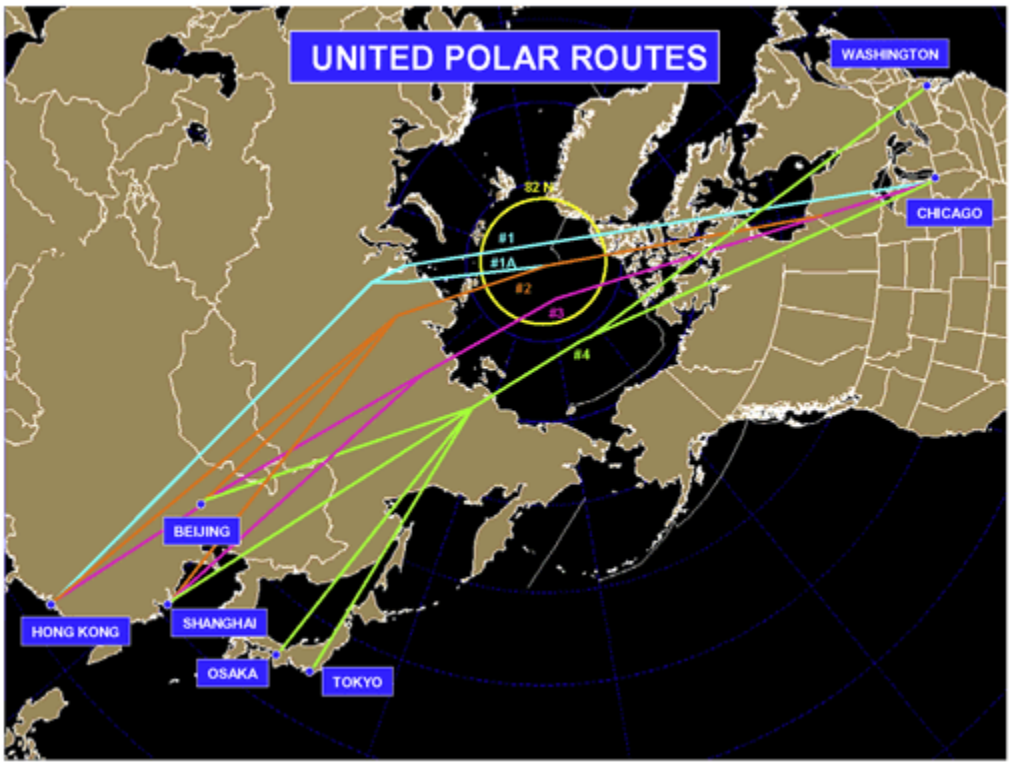
29–30 November 2006, Washington, D.C.

Meeting Report: Integrating Space Weather Observations and Forecasts Into Aviation Operations

Genene Fisher and Bryn Jones

4 July 2007

The policy and operational aspects of applying space weather information to the international aviation industry are of growing concern to both operators and regulators, especially since the number of cross-polar flights has increased from a handful of demonstration flights in 1999 to more than a dozen daily schedules today. The aviation industry is concerned primarily about risks during high-latitude (>50°N) and polar operations (>78°'N) because impacts of space weather can be greatest in these regions. Effects include disruption in high-frequency (HF) communications, Global Positioning System (GPS) errors, and radiation hazards to humans and avionics.



(source: M. Stills, United Airlines)

Figure 1: Polar routes used by United Airlines. Note that all airlines must follow one of the four polar routes, known to the aviation community as Polar 1, 2, 3, and 4.

These concerns not only apply to current operations, but also become even more important when considered within the framework for the Next Generation Air Transportation System (NextGen) concept of operations, which will address critical safety and economic needs for sustaining civil aviation. NextGen's goal is to transform the U.S. air transportation system by 2025 so that it will be able to handle up to 2 or 3 times the current demand. The technological developments required to implement NextGen (e.g., avionics, GPS, communication for data transmission) are all susceptible to space weather impacts, particularly over the poles. Additionally, with the potential space tourism and intercontinental space flight markets, these risks and policy concerns are now equally important to the developing commercial space transportation industry. However, consideration of policy issues has not been discussed in any detail.

In response to this need, Genene Fisher (American Meteorological Society) and Captain Bryn Jones (SolarMetrics Limited) are conducting a 3-year policy research study, funded by the National Science Foundation, that will lead to recommendations that if accepted will increase the safety, reliability, and efficiency of aviation operations through more effective use of space weather forecasts and information. This study

revealed that there are four main policy issues that need to be addressed to ensure the best use of current space weather information: communications, standardization of information and regulations, education and training, and cost-benefit and risk analysis.

To complement this study, AMS and SolarMetrics held a policy workshop entitled "Integrating Space Weather Observations and Forecasts Into Aviation Operations" in Washington, D. C., on 29–30 November 2006. This event brought together representatives from the aviation community, the federal government, and the space weather community. These key stakeholders discussed the main policy issues and explored a range of options for coping with the challenges.

The workshop began with a series of background presentations given by officials from the NextGen Joint Planning and Development Office (JPDO), the Federal Aviation Administration (FAA), the NOAA Space Environment Center (NOAA/SEC, now the NOAA Space Weather Prediction Center), United Airlines, NAV CANADA, and the National Space Weather Program (NSWP). It concluded with a talk by Brigadier General D. L. Johnson, former director of the National Weather Service (NWS). The speakers provided details about the weather integration requirements for NextGen, posed regulatory and policy questions, described the space weather environment and some of its technological impacts, provided examples of operational and air traffic control impacts, gave details on the state of the NSWP with reference to aviation, and presented envisaged developments of space weather services within the NWS. These presentations were then followed by four policy working sessions, each designed to stimulate discussion among all participants with the objective of developing a set of findings and recommendations.

Communication of Space Weather Information

The opening policy issue was on the understandability and dissemination of current space weather information in a timely manner to the aviation industry. Within the United States, aviation terrestrial weather services are provided to nonmilitary aircraft primarily by NOAA, FAA, and the private sector. While the same channels for dissemination of space weather information are available in principle, communication varies. Dispatchers stated that they receive space weather information from in-house meteorologists, private-sector companies, and NOAA/SEC alerts and forecasts or go directly to the NOAA/SEC Web site. The point was raised that the current FAA system that distributes meteorological information in text cannot distribute graphical products required for the ease of interpreting space weather information. This highlighted the issue that many aviation operators find space weather information to be too technical and prefer products that aid in decision making.

The Cross Polar Trans East Working Group, an ad hoc group of U.S., Canadian, and Russian air traffic controllers, airline dispatchers, and operations managers, was identified as the best group to lead the process of defining user requirements. In addition, representatives from NOAA/SEC and the International Space Environment Service (ISES) were suggested as new members for this group in order to provide space weather expertise. This strategy to improve the interaction between the aviation and scientific communities is also a key recommendation from the recently published Report of the Assessment Committee for the NSWP, a 10-year review recently conducted under the auspices of the Office of the Federal Coordinator for Meteorology.

Standardization of Regulations and Information

In general, the aviation operators stated they were not willing to take unilateral action based on space weather information. They want a level playing field that all airlines would be required to act on. Therefore, some prefer that the FAA set guidance that all operators would have to follow, similar to guidance on HF communication loss.

This led to discussion about the need for the different U.S. and international regulatory groups (International Civil Aviation Organization (ICAO), World Meteorological Organization (WMO), International Organization for Standards (ISO), and ISES) that set standards for aviation and meteorology to ensure global harmonization of space weather information. For example, global harmonization of all standards dealing with human exposure to cosmic radiation and solar proton events must be achieved for any exposure-reducing decisions (e.g., altitude lowering) to be applied safely and correctly in any airspace region. Universally accepted policies for exposure risk levels would provide a level commercial playing field for the industry as well bolster confidence in crew and passengers that the aviation and space tourism industries are dealing correctly with this issue.

Education and Training

The next policy issue covered was the need to educate and train. Overall, participants agreed that 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 and senior management interested in educating and training.

Participants agreed that industry and academia should work together to develop aviation space weather curricula for aviation operators, meteorologists, and university students. Furthermore, it was agreed that a global public portal for aviation space weather education should be created. ISES will soon provide this through their broader space weather educational material online at http://www.spaceweather.org.

Cost-Benefit and Risk Analysis

Aviation operators confirm that the polar routes reduce both travel time and operating costs. However, a challenge facing the industry is how to quantify the issues associated with HF communication loss, quantify the risks associated with the lack of information and the associated operational decisions, and develop policies that will not cost the industry more money.

In 2000, NAV CANADA, Canada's provider of civil air navigation services, conducted a feasibility study that identified 33 potential city pairs that could benefit from polar routes. Some examples of time savings in minutes and Canadian dollars per flight are listed in Table 1.

Table 1: Savings in Minutes and Dollars Per Listed Flight (year 2000)

Flight Path	Minutes Saved	Money Saved ($Can.)
Atlanta–Seoul	124	$44,000
Boston–Hong Kong	138	$33,000
Los Angeles–Bangkok	142	$33,000
New York–Singapore	209	$44,000

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. Very little information is available on how much space weather is responsible for delays or reroutes on polar routes. Workshop participants agreed that the aviation industry needs to find ways to collect operational data in order to assess the different impact areas, cost of improved services, and the return on investment.

The full report is available online at http://www.ametsoc.org/atmospolicy and http://www.solarmetrics.com. A hard copy of the report can be obtained from Genene Fisher (fisher@ametsoc.org) or Bryn Jones (bryn.jones@solarmetrics.com).

Acknowledgments

The workshop was organized in coordination with the FAA, NextGen/JPDO, NOAA, and NSF. The event was cosponsored by the AMS Policy Program Study Series underwriters (Raytheon, Lockheed Martin, and ITT) and the workshop sponsors (the Office of the Federal Coordinator for Meteorology on behalf of the NSWP and Ball Aerospace and Technologies).

Genene Fisher is a Senior Policy Fellow with the American Meteorological Society Policy Program, based in Washington, DC.

Bryn Jones is a commercial long haul pilot and the CEO of SolarMetrics Limited, based in the United Kingdom.

Citation: Fisher, G. and B. Jones (2007), Meeting Report: Integrating Space Weather Observations and Forecasts Into Aviation Operations, *Space Weather, 5*, S07003, doi:10.1029/2007SW000328.