The Effects of Space Weather on Aviation

Oct. 25, 2013: The next time you step onto an airplane, consider the following: In any given year, the pilot of your aircraft probably absorbs as much radiation as a worker in a nuclear power plant.

And you are about to follow him wherever he goes.

A new ScienceCast video explores the effects of solar storms and cosmic rays on aviation. Play it

The FAA classifies pilots as "occupational radiation workers." Flying high above Earth with little atmosphere to protect them, they can absorb significant doses of cosmic rays and solar radiation. During a typical polar flight from Chicago to Beijing, for instance, a pilot is exposed to the equivalent of two chest x-rays. Multiplied over the course of a career, this can cause problems such as increased risk of cancer and possibly cataracts.

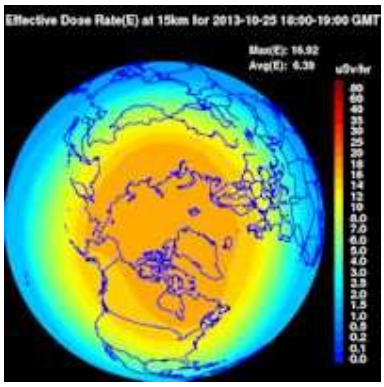
Passengers have reason to be concerned, too.

"A 100,000 mile frequent flyer gets about 20 chest x-rays," points out Chris Mertens, a senior research scientist at NASA Langley Research Center. "This is true regardless of the latitude of the flights."

It's worth noting that even people on the ground absorb some radiation. Cosmic rays and their by-products are so powerful, they can reach all the way down to Earth's surface, giving a person at sea level the equivalent of one chest x-ray every 10 days or so.

On a plane, however, dose rates increase 10-fold or more. The exposure depends on factors ranging from the altitude and latitude of the flight path (polar routes are irradiated most) to sunspot counts and solar activity (a powerful solar storm can boost radiation levels a hundredfold). To help airline companies safeguard passengers and personnel, NASA is developing an experimental tool to predict exposures in real time. Mertens is the PI of the system, called NAIRAS--short for "Nowcast of Atmosphere Ionizing Radiation for Aviation Safety."

Mertens notes that the number of flights over the poles has skyrocketed in recent years. Airlines prefer polar routes for international travel because they are shorter and have reduced head winds, creating fuel savings of tens of thousands of dollars per flight.



A NAIRAS model shows radiation levels over the northern hemisphere on Oct. 25, 2013. More

However, Earth's poles are where the radiation problem can be most severe. Our planet's magnetic field funnels cosmic rays and solar energetic particles over the very same latitudes where airlines want to fly. On a typical day when the sun is quiet, dose rates for international flights over the poles are 3 to 5 times higher than domestic flights closer to the equator.

If a flight controller wants to know the situation around the poles *right now*, NAIRAS can help. It is, essentially, an online global map of radiation dose rates for different flight paths and altitudes. Maps are produced in near real-time by a computer at Langley, which combines cutting-edge physics codes with realtime measurements of solar activity and cosmic rays.

"We are still in an experimental phase," he says. "The ultimate goal of the NAIRAS effort is to adopt a paradigm similar to terrestrial weather forecasting."

The value to the airlines is clear. The ability to fly over the poles can save $35,000 to $40,000 per flight in fuel costs alone. On the other hand, altering course to avoid a polar radiation storm can cost as much as $100,000. A forecasting tool like NAIRAS can help the airlines make the right decision.

Of even greater importance to Mertens is the human factor. "Back in 2004, I went to a workshop on space weather and aviation. A pilot from American Airlines stood up to address the audience: 'Look,' he said, 'we are classified as radiation workers, we are the most exposed than any other group, yet we know the least of all the groups.' That was a turning point for me. I wanted to do something to help pilots better understand what they are flying into." And so NAIRAS was born.

Mertens and colleagues are about to publish a paper in the journal *Space Weather* comparing NAIRAS predictions to actual radiation measurements onboard airplanes. "The results are encouraging," he says, "but we still have work to do."

Credits:

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