



NASA Atmospheric Ionizing Radiation for Aviation Safety

NAIRAS Quarterly Report: 4th Quarter 2008

Overview

The Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) project has been recently funded by the NASA Applied Sciences Program. The NAIRAS objective is to develop a prototype global, real-time, data-driven prediction of atmospheric ionizing radiation dose for archiving and assessing biologically harmful radiation exposure levels at commercial airline altitudes. The sources of the biologically harmful (i.e., ionizing) radiation are galactic cosmic rays (GCR) and solar energetic particles (SEP) which can accompany disturbances on the Sun's surface. The sources, composition, and energy-spectra of atmospheric ionizing radiation are linked to sources and variability of space weather phenomena. As such, the NAIRAS model provides a space weather decision support tool related to radiation impacts on crew and passengers of long-range aircraft, an area of national priority for NASA's Applied Science Program.

The NAIRAS model will enhance the performance of the decision support tools provided by the NOAA Space Weather Prediction Center (SWPC) and by commercial aviation weather providers, since these decision support systems do not currently monitor or estimate the ionizing radiation present in the atmosphere at commercial airline altitudes. The end-user communities that will benefit from the NAIRAS model are the commercial airline industry (airline corporations and aircrew professional associations), the FAA, the National Institute of Occupational Safety and Health (NIOSH), and NOAA/SWPC. Results from the

NAIRAS model will provide tools for its end-user organizations to develop policy and procedures for mitigating biologically harmful radiation exposure and aircrew career planning – especially during SEP events. NAIRAS results will also aid in the formulation of recommended aircrew annual and career radiation dose limits, and will enhance epidemiological studies conducted to better understand the biological effects of atmospheric ionizing radiation on passengers and crew.

The NAIRAS product output are 4-D global distributions of radiation dose rates, computed from the Earth's surface to approximately 100 km in real-time. NAIRAS output will be made available at NOAA's National Weather Service, Aviation Digital Data Service (ADDS), and through commercial aviation weather product providers. NOAA/ADDS is a decision support system whereby NAIRAS results can provide a tool for commercial airlines and aircrew to monitor current and accumulated radiation exposure. The data format will be in netcdf, which will readily enable private companies to develop more specialized and custom tools for the aviation industry. The long-term goal is to transition the prototype NAIRAS into an operational system that will be adopted by NOAA/SWPC.

The NAIRAS team has completed the first six months of the three year project. The anticipated completion of the prototype NARIAS model is mid-year 2011. Below are highlights and completed milestones from the 3rd and 4th quarters of 2008. More information can be found at the public site of <http://sol.spacenvironment.net/~nairas/index.html>

nairas news

Highlights

System Development

For the project's model development and data integration, the NAIRAS team will use a distributed network developed by Space Environment Technologies. This network uses an architecture that accommodates geographically dispersed institutions yet enables a phased transition from research to operations resulting in a Technology Readiness Level (TRL) 8 prototype demonstration at the project end. The distributed network system development is on schedule with all primary data streams now being accessed 24/7/365 in an operational prototype at TRL 7.

NASA's High Energy and Charge transport code (HZETRAN) is the physics-based radiation transport and dosimetry component of the NAIRAS model. HZETRAN transition to the NAIRAS operational environment is progressing on schedule. A significant improvement to HZETRAN for atmospheric radiation transport has been the incorporation of Dr. Tony Slaba's (Old Dominion University) directionally-coupled forward-backward low-energy neutron transport algorithm, with coupling to light-ion transport.

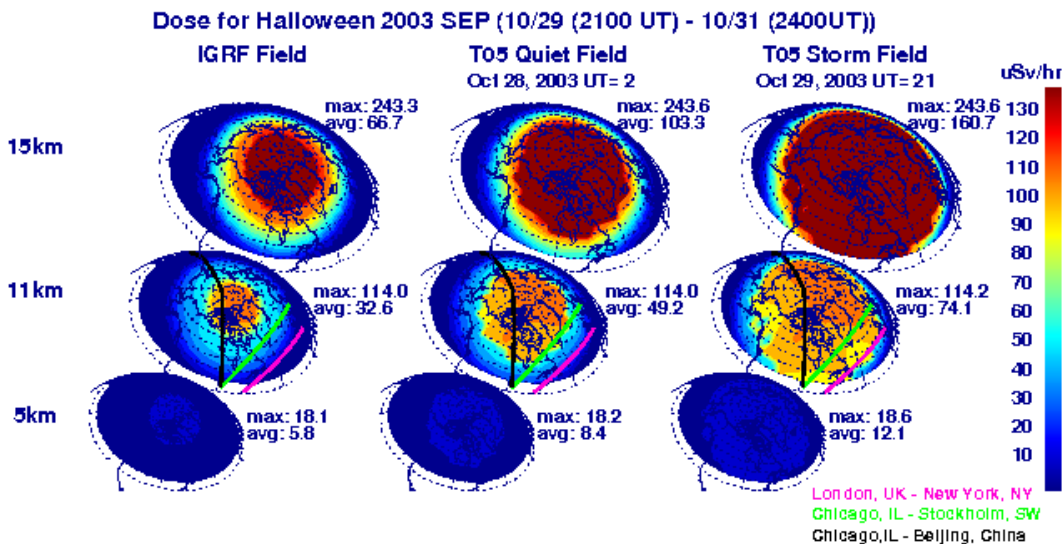
Solar Energetic Particle (SEP) proton and alpha fluence spectra incident on the top of the atmosphere is determined by fitting a single or double power law spectrum to NASA/ACE and NOAA/GOES spectral flux measurements. The operational algorithm has been developed and provided a student research opportunity through the NASA Langley Aerospace Research Summer Scholars (LARSS) program.

Halloween 2003 storm Analysis

The team has conducted a preliminary analysis of the Halloween 2003 SEP events. The atmospheric radiation exposure at a typical commercial airline cruising altitude during the SEP event on October 31, 2003 exceeded the International Commission on Radiological Protection (ICRP) recommended prenatal/public exposure limit (1 mSv) for a representative polar route (Chicago to Beijing). Other representative high-latitude routes received up to 85% of the ICRP prenatal/public radiation exposure limit.

Our analysis revealed the important influence of the magnetospheric magnetic field (via the cutoff rigidity) on SEP atmospheric dose rates. Neglecting the time-dependent geomagnetic storm effects during SEP events can underestimate high-latitude radiation dose from 30% to over a factor of four, depending on the flight-path relative to magnetosphere open-closed boundary. Since not all SEP events are accompanied by a geomagnetic storm, we have assessed and found that ignoring the quiet-time magnetosphere can underestimate high-latitude atmospheric SEP radiation exposure by 30%. Dartmouth College and NCAR/HAO are modeling the geomagnetic storm influences, and are working toward developing a computationally efficient geomagnetic cutoff rigidity model that includes quiet and storm-induced magnetospheric effects on cutoff rigidity.

(See image below.)



Conference and Workshop Presentations

Report from Joe Kunches (NOAA/SWPC) from recent conferences attended: "There has been considerable interest in NAIRAS on two fronts. The FAA and National Weather Service (NWS), in addition to other interested parties, are working to create a SIGMET for aviation that contains data and specifications from NAIRAS. SIGMETs are longstanding messages that relay important information to pilots enroute. The form of that current text message is likely to change soon, but it is acknowledged to be the best way to get information of radiation to aircraft in flight. A second venue that had a strong interest in NAIRAS was the International Association for the Advancement of Space Safety (IAASS). NAIRAS was discussed at their recent conference, as radiation effects on humans and systems at all altitudes, including airline and business jet, was a central theme of the conference."

Report from Barb Grajewski (NIOSH) from recent meeting attended: "Lynne Pinkerton and Barbara Grajewski (National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention) attended the European Studies on Cancer among Flying Personnel meeting in Mainz, Germany December 4-5. This international working group was reconvened to determine whether an update of their pooled study of cancer in air crew should proceed. NIOSH was asked to join the working group and contribute one of its cohorts to the study. The

group discussed possible enhancements to the exposure assessment for the pooled study. The NIOSH investigators informed their colleagues about the NAIRAS program."

Report from Brian Kress (Dartmouth) from recent meetings attended: Variations in geomagnetic shielding of solar energetic particles with the arrival of an interplanetary shock at Earth's magnetosphere was presented at the Fall AGU meeting in San Francisco, California, December 15-19. This work contributes to understanding geomagnetic storm influences on atmospheric radiation dose.

Report from Chris Mertens (NASA LaRC) from recent meetings and workshops: "Analysis of high-latitude, commercial aircraft radiation dose during the Halloween 2003 SEP events was presented at the 37th COSPAR Scientific Assembly in Montreal, Canada, July 13-20. A summary and status report on the NAIRAS project was given at the NASA Applied Sciences Weather Program Review, November 18-19 in Boulder, Colorado. Stan Solomon (NCAR/HAO) gave the presentation. The NAIRAS project and Halloween 2003 SEP radiation exposure analysis was presented in a session on operational space weather products at the Fall AGU meeting in San Francisco, California, December 15-19. Representatives from the Air Force Weather Agency (AFWA) expressed interest in the NAIRAS model."

Team

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