Project Details

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Topic: Characterization of the Earth's Radiation Environment

Project Title:
RADIation environment using ARMAS data in the NAIRAS model (RADIAN)

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Summary:
This study, called RADIation environment using ARMAS data in the NAIRAS model (RADIAN), will expand a physics-based modeling capability using Kalman filter data assimilation. Recent, current epoch, and a few hours of forecast radiation environment information will be available from this system to specify the global dose rate environment from the surface of the Earth into Low Earth Orbit. This task addresses a primary goal and measure of success of the 3.1.2 Characterization of the Earth s Radiation Environment FST, i.e., demonstrating the temporal, spatial, and magnitude variability in the radiation environment, from tropospheric altitudes to the radiation belts, using observations and existing models reported with appropriate metrics of uncertainty.

These results can be used in applications for informing pilots and air traffic control of radiation hazards. Aircrew, high-altitude pilots, frequent flyers and ultimately commercial space travelers face radiation hazards originating from Galactic Cosmic Rays (GCRs), Solar Energetic Protons (SEPs), and trapped particle energetic electrons particularly when traveling at and above commercial aviation altitudes greater than 8 km. GCRs originate from outside the solar system, SEPs originate from flaring events on the Sun, and energetic electrons originate in the outer Van Allen radiation belt. These particles impact the atmosphere where secondary and tertiary particles then collide with the aircraft hull and interior components, people, or fuel to cause a further alteration of the radiation spectrum. This complex radiation spectrum has components shown to cause an increased cancer risk.

The current state-of-the-art radiation environment model is the NASA Langley Research Center (LaRC) Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) system. The NAIRAS data-driven, physics-based climatology gives the time-averaged radiation weather conditions using HZETRN radiation transport code. It characterizes the global radiation environment from the surface to LEO for radiation dose rate and total dose hazards. Global data-driven data are currently reported hourly at http://sol.spacenvironment.net/~nairas/index.html. However, to produce more realistic weather of the radiation environment NAIRAS will be updated to assimilate near real-time data using a Kalman filter technique. A primary data type is Total Ionizing Dose (TID) that can be reported as either absorbed dose in silicon or ambient dose equivalent for tissue relevance. The Automated Radiation Measurements for Aerospace Safety (ARMAS) NASA program developed through a Space Environment Technologies (SET) SBIR activity already provides TID data streams from aircraft at commercial altitudes. It uses Iridium satellites to transfer data to the ground and provides NAIRAS data comparisons at http://sol.spacenvironment.net/~ARMAS/index.html. ARMAS uses a Commercial-Off-The-Shelf (COTS) TID micro dosimeter combined with a microprocessor and a variety of real-time data collection methods (Iridium transceivers, Bluetooth, RS232, Ethernet, or micro SD data logger) to report the dose rate from aircraft during flight. This Technology Readiness Level (TRL) 8 system has been flying on aircraft since 2013 using the NASA Armstrong Flight Research Center (AFRC) DC-8, B-747, ER-2, the NOAA and NSF/NCAR G-IV and G-V Gulfstreams, and commercial Boeing 737, 747, 757, and 777 as well as Airbus 319 and 320 jets. The NASA Goddard Space Flight Center (GSFC) Community Coordinated Modeling Center (CCMC) has a vision and capability to independently compare and validate NAIRAS modeled results, ARMAS measurements, and their integration through data assimilation. SET, LaRC, and CCMC have joined in this study to promote the innovative development of a calibrated data source integrated into a physics-based model for understanding the dynamic variation of the radiation environment from the recent past into the near future.

Publication References:

no references