Project Details

ROSES ID: NRA-01-OSS-01
Selection Year: 2002
Program Element: Independent Investigation: Geospace LWS

Project Title:
Development and Validation of a Solar-Modulated Atmospheric Ionizing Radiation Model

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Summary:
This proposal addresses a prerequisite for modeling the effects of cosmic radiation on integrated circuits in aviation electronics, which are an increasing concern for avionics reliability. Before these effects can be accurately modeled for avionics under flight conditions, the incident fluence and energy distribution of each of the particle types that cause them must be known. Neutrons are the dominant particles causing effects on avionics components, but protons and light nuclei are also significant, and for high altitude flight platforms, high charge and energy (HZE) ions, which are notorious for causing single event effects. The nucleons and nuclear fragments are produced along with every other type of ionizing radiation in cascades of nuclear collisions initiated by primary cosmic rays striking atoms in the upper atmosphere. The fluence and energy distribution of the particles in the resulting atmospheric ionizing radiation (AIR) depend on altitude (atmospheric depth), geomagnetic location, and solar activity. Changes in solar activity cause galactic cosmic ray induced AIR particle fluence rates to vary by up to a factor of two or more. The proposed project will provide a detailed measurement-validated model of AIR for all locations in Earth's atmosphere and all solar activities. The new AIR model will be based on calculations of cosmic radiation propagation through Earth's atmosphere using the FLUKA and HEAVY Monte Carlo radiation transport codes. HEAVY transports helium and other ions as nuclei instead of as independent nucleons, enabling calculation of light-ion spectra and improving the accuracy of all the calculated particle spectra. Solar-activity dependent primary cosmic ray spectra for input to the transport calculations will be determined from fits to available data from space and balloon-borne measurements. The model will be validated using data from the NASA-funded AIR Project and other existing measurements. The AIR Project was an international collaboration of 15 laboratories that made simultaneous radiation measurements with 14 different instruments on several flights of a NASA ER-2 high-altitude aircraft. The primary instrument was a sensitive full-energy-range neutron spectrometer. The proposed Principal Investigator was the PI of the AIR Project. The new AIR model will enable improved calculations of radiation doses to air crews as well as accurate modeling of the effects of cosmic radiation on avionics.

Publication References:

Summary: no summary

Reference: Wilson, J. W.; Goldhagen, P.; Rafnsson, V.; Clem, J. M.; De Angelis, G.; Friedberg, W.; (2003), Overview of atmospheric ionizing radiation (AIR) Research: SST-present, Advances in Space Research, Volume 32, Issue 1, p. 3-16, doi: 10.1016/S0273-1177(03)90364-4

Summary: no summary

Reference: De Angelis, G.; Clem, J. M.; Goldhagen, P. E.; Wilson, J. W.; (2003), A new dynamical atmospheric ionizing radiation (air) model for epidemiological studies, Advances in Space Research, Volume 32, Issue 1, p. 17-26, doi: 10.1016/S0273-1177(03)90365-6