AOGS 2006

The QinetiQ Atmospheric Radiation Model and Solar Particle Events

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The QinetiQ Atmospheric Radiation Model (QARM) [1] employs atmospheric response functions generated by Monte Carlo radiation transport codes, in conjunction with cosmic ray and solar particle spectra and computed particle cut-off rigidities, in order to generate the radiation field in the atmosphere at any given location and time. The cosmic ray spectra are generated from the Badhwar and O'Neill model while the solar particle spectra are calculated from ground level neutron monitor data in conjunction with spacecraft data. The radiation along a flight path may be calculated using either a nominal great circle route or actual flight coordinates. Both directionality and all significant particle species are modelled and the outputs can be used to estimate integral properties of the environment such as aircrew dose and rates of single event effects in avionics. The geomagnetic cut-off rigidity can be computed using the latest model of the magnetic field including both internal and external source terms from IGRF and the Tsyganenko model respectively. Hence allowance can be made for both long-term variations and for short-term disturbances during geomagnetic storms. The calculations for galactic cosmic rays are validated against a wide range of data. However only a limited number of solar particle events have been measured in flight and validation is limited to the events of September and October 1989 observed on Concorde and the event of 15 April 2001 observed on two flights from Europe to North America. Reasonable fits have been obtained and the models are used to scope the solar particle enhancements for a number of routes. The model enables exploration of the influence of concurrent geomagnetic disturbances and the influence of the difference between take-off time and event start-time. Hence worst-case radiation fluences and doses can be estimated. However accurate estimates for any given route and real-time warnings require widespread deployment of radiation monitors. To this end a compact monitor, QDOS, has been developed and a flight campaign commenced. Keywords: Cosmic rays, solar particle events, dose, single event effectsReferences[1] F. Lei, S. Clucas, C. Dyer, P. Truscott, IEEE Trans. Nucl. Sci., Vol.51, No.6, pp.3442-3451, Dec. 2004.