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Rad-Sat Project Highlights on Wave-Particle Interactions

Richard B. Horne[(1)], Sarah A. Glauert[(1)], Nigel P. Meredith[(1)], Johnathan Ross[(1)], Misha Balikhin[(2)], Richard Boynton[(2)], Jonny Rae[(3)], Jasmin Sandhu[(3)], Clare Watt[(3)], Oliver Allanson[(3)], Colin Forsyth[(4)], Jonathan Eastwood[(5)] and Ravindra Desai[(5)]
(1) British Antarctic Survey, Cambridge, UK, e-mail: rh@bas.ac.uk; sagl@bas.ac.uk; nmer@bas.ac.uk; johros@bas.ac.uk;
(2) University of Sheffield, Sheffield, UK, e-mail: m.balikhin@sheffield.ac.uk; r.boynton@sheffield.ac.uk;
(3) Northumbria University, e-mail: jonathan.rae@northumbria.ac.uk; jasmine.k.sandhu@northumbria.ac.uk; clare.watt@northumbria.ac.uk; oliver.allanson@northumbria.ac.uk;
(4) Mullard Space Science Lab., Dorking, UK, e-mail: colin.forsyth@ucl.ac.uk;
(5) Imperial College, London, UK, e-mail: jonathan.eastwood@imperial.ac.uk; Ravindra.desai@imperial.ac.uk

The Rad-Sat project was set up to model the acceleration, transport and loss of high-energy (relativistic) electrons in the Earth's radiation belts. The project draws together many different aspects of radiation belt modelling, including the solar wind coupling to the radiation belts, wave-particle interactions inside the radiation belts, including an assessment of quasi-linear and fully nonlinear wave-particle effects, ULF waves driving radial diffusion, global modelling using both a Fokker-Planck and an MHD approach.

Here we present some of the recent highlights from the first two years of the project. We show how the NARMAX code can be used to forecast lower band chorus waves inside the magnetosphere using data from the solar wind and compare the results to new surveys of plasma waves responsible for electron acceleration and loss. We show event specific radial diffusion coefficients derived from satellite observations and discuss their differences from standard models. We show an example of particle-in-cell simulations and compare them against the results of quasi-linear theory of wave-particle interactions. We show results of modelling signals from ground-based transmitters and show how they can reduce electron lifetimes near L = 1.7 but are unable to remove MeV electrons as previously suggested. We show the results of a 30-year simulation of the outer radiation belt and illustrate how the electron flux varies with solar cycle for both geostationary and medium Earth orbit. Finally, we show an example of MHD modelling of the rapid compression of the magnetosphere similar to the 1991 shock event. We show how the geomagnetic field was distorted together with the production of an induced electric field within the magnetosphere and discuss the effects on the electron radiation belt. We discuss some future plans to bring these different elements together.