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A solar wind coupled, probabilistic model of the ULF waves driving radial diffusion in Earth's radiation belts

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Radial diffusion is responsible for the energisation and transport of radiation belt electrons. To model this diffusion throughout the magnetosphere, a statistical map of radial diffusion coefficients is necessary. This in turn requires an underlying model of ultra-low frequency (ULF) wave power that has good magnetospheric coverage and is driven by solar wind properties. Current models of ULF waves are not dependent on the solar wind and are deterministic, producing a single output for each set of input parameters. In contrast, a stochastic approach that includes the underlying variability in diffusion coefficients results in significantly different amounts of radial diffusion.

To address these issues, we present a statistical model of ground-based ULF wave power parameterised by solar wind properties shown to effect changes in ULF wave power: solar wind speed v_{sw}, variance in proton number density $var(Np)$ and southward interplanetary magnetic field Bz. We predict ground-based ULF wave power across a range of frequencies, latitudes and magnetic local time sectors. Our output consists of the probability distribution of ULF wave power that is necessary for a stochastic approach. Therefore power can be reproduced probabilistically or deterministically, either by sampling from conditional probability distributions or by using the mean value. Probabilistic predictions of ULF waves faithfully reproduce the original power distributions over long time periods, whilst time series constructed using the means predict power in the next hour better than assuming power persists from the previous hour. Our model can be used to establish probabilistic radial diffusion coefficients and to investigate the underlying physics in a novel manner.