RADIATION BELT LOSS RATES DUE TO GROUND TRANSMITTERS

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Abstract Submission Form

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2. H - Waves in Plasma

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4. I - Invited Paper

5. No special instructions

In recent years, it has become appreciated that large ground-based VLF transmitters may have a significant impact on the radiation belts. These transmitters, operated by several countries for military communication purposes, have been in essentially continuous operation for most of the space age. Some amount of wave energy inevitably leaks out of the Earth-ionosphere waveguide and into space, where it couples to relativistic electrons through cyclotron-resonant interactions. It has been estimated [1] that this effect may be as large or larger than the effect of VLF waves generated by lightning or by plasma instabilities from anisotropic particle distributions (whistler hiss).

These estimates are based on a quasi-linear description of the wave-particle interactions, using simple models to parameterize the spatial distribution of wave energy and the wavenormal angle distribution. A large-scale ray-tracing effort underway at AFRL provides a more detailed and realistic model of these quantities [2]. It tracks the ray paths, wavevectors, and wave energy density throughout the plasmasphere from the ionospheric footprint of individual ground transmitters, and is being validated by comparison with dedicated observations from the IMAGE spacecraft.

The aggregated result of these ray computations may be used to provide more realistic wave models for the evaluation of quasi-linear diffusion. Of particular interest are the bounce-averaged pitch angle diffusion coefficient as a function of particle energy, equatorial pitch angle, and drift shell parameter L, and the characteristic lifetime for precipitation (scattering) into the loss cone. The transmitted waves are narrowband in frequency, and for low values of L ($\sim$ 1.3, corresponding to equatorial altitude of about 1900 km), the wavenormal angle distributions are also narrow. This reduces the quasilinear expressions from double integrals to discrete sums over isolated resonances. which greatly aids both evaluation and interpretation.

[1] Bob Abel and Richard M. Thorne, Electron Scattering Loss in Earth's Inner Magnetosphere 1. Dominant Physical Processes, J. Geophys. Res., 103, 2385, 1998.

[2] Michael Starks, Bright Small, Rick Quinn, and Gary Sales, Ground-based VLF Transmitters Seen From the Plasmasphere: Modeling and Validation, this meeting.