MODELING TERRESTRIAL VLF TRANSMITTER EFFECTS ON TRAPPED ELECTRON POPULATIONS

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As the number of satellites in low earth orbit continues to increase, renewed interest has arisen in using very low frequency (VLF) radio waves to mitigate the damaging effects of enhanced radiation belts created, for example, by strong solar activity. An analysis by Abel and Thorne (*J. Geophys. Res*, **103**, A2, 2385-2396, 1998) showed the importance of ground-based VLF transmitters to loss mechanisms in the inner belt and slot region of the magnetosphere. At the time, only rough, averaged estimates of contributions from eight powerful terrestrial VLF transmitters could be used in the calculation.

As the Air Force Research Laboratory Space Vehicles Directorates end-to-end wave-particle interactions code has matured, it has become possible to directly simulate the electron depopulation process from transmitter to radiation belt in a unified way. Modern codes estimate the antenna patterns from terrestrial VLF transmitters and their subsequent coupling into the ionosphere. Three dimensional ray tracing computes to where the transmitted power travels, and incorporates changes in intensity due to geometric divergence and Landau damping. Wave-particle interaction codes then use the resulting three-dimensional wave field to compute diffusion coefficients, particle lifetimes, and ultimately electron distributions in the radiation belts.

With these tools, we have modelled the same group of terrestrial VLF transmitters assumed in Abel and Thorne (1998) and computed electron diffusion coefficients and lifetimes for comparison. We have then updated the model to use the set of transmitters existing today and estimated the effects on particle distributions resulting from changes in the ground-based transmitter network. These simulations will eventually lead to similar analyses involving proposed transmitters located in space.

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