Evidence for Nonlinear VLF Wave Physics from EMFISIS Instrument Suite on board Van Allen Probes

C. Crabtree[(1)], E. Tejero[(1)], G. Ganguli[(1)], G. B. Hospodarsky[(2)], C. A. Kletzing[(2)]
(1) Division of Plasma Physics, Naval Research Laboratory, Washington, D.C., USA.
(2) Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA.

VLF waves in the whistler mode branch in the Earth's radiation belts play a critical role in both the acceleration and loss of energetic electrons. VLF waves are often observed with magnetic field amplitudes that are a significant fraction of the background magnetic field suggesting that nonlinear effects may be important. We develop new Bayesian time-series analysis tools to investigate magnetic and electric field data from the EMFISIS instrument on board the Van Allen Probes. We also validate the analysis techniques through laboratory experiments. We apply these tools to Chorus waves to show that the picture of a single coherent plane wave is insufficient to explain EMFISIS data and that nonlinear collective wave interactions play an important role in moderating Chorus wave growth. We also apply these techniques to show that nonlinear induced scattering by thermal electrons can play a significant role in controlling the propagation of large amplitude lightning generated whistlers inside the plasmasphere.