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Generation of Nonlinear Electric Field Bursts in the Outer Radiation Belt through Electrons Trapping by Oblique Whistler Waves

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Huge numbers of different nonlinear structures (double layers, electron holes, non-linear whistlers, etc. referred to as Time Domain Structures - TDS) have been observed by the electric field experiment on board the Van Allen Probes. A large part of the observed non-linear structures are associated with whistler waves and some of them can be directly driven by whistlers. The parameters favorable for the generation of TDS were studied experimentally as well as making use of 2-D particle-in-cell (PIC) simulations for the system with inhomogeneous magnetic field. It is shown that an outward propagating front of whistlers and hot electrons amplifies oblique whistlers which collapse into regions of intense parallel electric field with properties consistent with recent observations of TDS from the Van Allen Probe satellites. Oblique whistlers seed the parallel electric fields that are driven by the beams. The resulting parallel electric fields trap and heat the precipitating electrons. These electrons drive spikes of intense parallel electric field with characteristics similar to the TDSs seen in the VAP data. The decoupling of the whistler wave and the nonlinear electrostatic component is shown in PIC simulation in the inhomogeneous magnetic field system. These effects are observed by the Van Allen Probes in the radiation belts. The precipitating hot electrons propagate away from the source region in intense bunches rather than as a smooth flux.