EARLY/FAST VLF PERTURBATIONS CAUSED BY SCATTERING FROM TRANSIENT LUMINOUS EVENTS

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While early/fast type perturbations of VLF transmitter signals have been seen for many years, they have recently been explained as perturbations closely associated with transient luminous events. An ongoing debate has questioned whether the scattering observed is a forward-scattering from the large, diffuse sprite halo regions, or an isotropic scattering from the grid of sprite features. In some cases, large perturbations seen from events near the transmitter may be attributed to mode-coupling of non-propagating modes into propagating modes, caused by the scattering body. Modeling work has shown that most VLF perturbation signatures compare well to modeled perturbations caused by sprite halos, large luminous conductivity changes in the lower ionosphere caused by quasi-electrostatic heating following an intense cloud-to-ground discharge. Meanwhile, studies in Europe during collaborative sprite campaigns have shown a near one-to-one correlation between early/fast events and sprites. However, in these cases the simultaneous appearance of sprite halos is not readily apparent. In this paper, we present evidence showing that both theories may occur simultaneously. By investigating three types of events (near-transmitter, mid-path, and near-receiver), we attribute possible causes are compare each to existing models. Many historic early/fast events can only be attributed to backscatter, lending credence to the isotropic scattering theory. In other cases, early/fast events are observed when there was no sprite seen coincident with the causative cloud-to-ground discharge. Using simple analytical models for isotropic scattering for sprite-like conductive elements, we estimate the possible distance from the transmitter path at which isotropic scattering events can be seen, and compare this to observed events.

Abstract Submission Form

2006 National Radio Science Meeting

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Date Received: September 17, 2005

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2. G - Ionospheric Radio and Propagation

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4. I - Invited Paper, Program chair: Pasko / Gerken

5. Invited to Joint Session organized by Commissions G and H: Ionospheric Effects of Lightning