



## **Subionospheric VLF perturbations of red sprites: 3D FDTD modeling and experimental results**

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Majority of red sprites occurs in association with large positive cloud to ground discharges. Although the red sprite consists of highly ionized structure, physical properties of the ionization columns such as electron density and spatial extent have not understood well. In this paper 3D finite-difference time-domain (FDTD) method carried out to compute the subionospheric VLF signal perturbations due to the sprite ionization columns. Spatial scales of columns are determined by the sprite images obtained from our optical observations during winter lightning activities over the sea of Japan. Numerical results indicate that the multiple sprites generate the complicated scattering pattern of the VLF transmitter waves depending on special orientation and extent of sprite ionization columns. Spatial dependence of the scattered amplitude are compared with those from the experimental results of VLF observation network.