

## Properties of Lightning Associated with Long Recovery Early VLF Events

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### Abstract

Ionospheric disturbances produced by lightning discharges are capable of scattering sub-ionospherically propagating VLF waves, leading to amplitude and/or phase perturbations of the received VLF signal. A specific class of perturbation is known as the "early" VLF event, which occurs within ~20 msec of the causative lightning discharge and indicates a direct and immediate effect on the overlying ionosphere. Typical early VLF events recover over the course ~10-100 seconds. A very interesting sub-class of early VLF events, known as long recovery early VLF events, exhibits recoveries on the order of several minutes to hours. In this paper, we analyze over 50 long recovery events observed in North America together with VLF observations of the causative lightning discharge. Not only are the causative lightning return strokes (of both polarities) unusually strong, but they also exhibit unusual waveform characteristics. We critically compare the observed characteristics of lightning associated with long recovery events to the characteristics of natural lightning observed at the International Center for Lightning Research and Testing at Camp Blanding, Florida.