A Statistical Analysis of Conjugate Lightning-induced Electron Precipitation Events

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Following the St. Patrick's Day 2015 geomagnetic storm, a large number of lightning-induced electron precipitation (LEP) events were simultaneously observed using very low frequency receivers in both the northern and southern hemispheres. Fifty clear and well-defined conjugate LEP events are selected and used to statistically analyze the longitudinal and hemispheric dependence of LEP characteristics, such as onset time, onset duration, maximum perturbation, and recovery time. We investigate the role that the Earth's asymmetric geomagnetic field plays in these observations. Scattered field analysis is adopted for both isolated and overlapping events. Different types of overlapping events are observed and defined. Overlapping events are separated by modeling the recovery period and subtracting the recovery from subsequent events. As opposed to previous technique, we model the recovery of the scattered field with time for this purpose. Several new LEP event characteristics are identified for use with scattered field analysis. For instance, the event onset time and duration are different when calculated using scattered field magnitude than using simple signal amplitude. LEP events were detected in the northern hemisphere using the VLF remote sensing method by tracking the NAA transmitter signal (24.0 kHz, Cutler, Maine) at Tuscaloosa, Alabama. In the southern hemisphere, the NPM transmitter signal (21.4 kHz, Laulaulei, Hawii) is tracked at Palmer station, Antarctica. In each case, the GLD-360 dataset from Vaisala is used to determine the location and timing of the causative lightning flash. In this paper, we compare and contrast LEP event properties calculated using multiple different methods, and we provide a statistical analysis of the properties using 50 conjugate LEP events.