

MIS026-07

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Research on location method based on VLF/LF bands EM source associated with lightning discharges

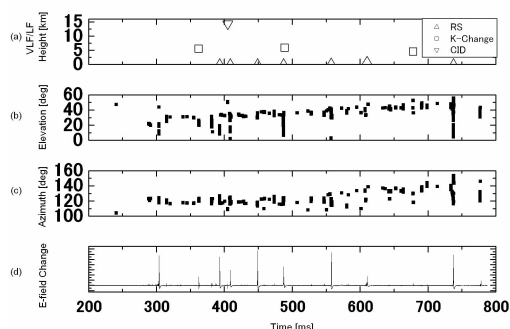
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We have been designing and developing a new type of a 3D lightning location system based on broadband digital interferometry in VLF/LF bands. The VLF/LF interferometer consists of four or more observation stations which detect electromagnetic (EM) waves in a wide frequency range from 1kHz to 150 kHz associated with lightning discharges. Since EM waves in VLF/LF radiated by lightning discharges propagate a long distance, the VLF/LF interferometer locates lightning discharges a few hundred kilometers away from the VLF/LF interferometer. During the summer season in 2009, we had conducted lightning observation campaign with a use of a prototype of the VLF/LF interferometer, which consisted of four stations in Darwin, Australia, to validate the system.

The observation results are compared with the observations of VHF interferometers which enable us to visualize leader developments associated with lightning discharges. The VLF/LF interferometer mainly located EM waves associated with return strokes, K events, and compact intracloud lightning discharges (CIDs), which are energetic breakdowns within thunderclouds. The upper figure shows the time series variation of lightning discharges in 3D location, (a) heights obtained from the VLF/LF band interferometer, (b), (c) 2D mapping which coordinate system uses elevation and azimuth obtained from VHF band interferometer, and (d) E-field change.

The VLF/LF radiation sources associated with the return strokes are located near the ground surface. The recoil streamers in K-events and the CID are located near the 5-8 km and 13-16 km in altitudes, respectively. The clear difference of VLF/LF radiation source altitudes is applicable to decide effective criterion whether cloud to ground discharges or cloud discharges. In addition, we succeed in locating K-events that involved pulse bursts, although it was difficult for other VLF/LF location system to locate them.



Keywords: Broadband Interferometry, EM Source Location, Lightning Discharge