

Microwave radiation associated with lightning discharges

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The detections of the electromagnetic waves associated with lightning flashes have contributed to understand lightning physics in the past several decades. The electromagnetic waves in a wide frequency range from dc to several hundreds MHz has been investigated. The microwave radiations associated with lightning flashes seem to be emitted from smaller discharges than the discharges we have ever detected from lightning. Studies for microwave radiations emitted from lightning lead us to discover a new smaller discharge associated with lightning and to establish a new system to locate lightning discharges in a new frequency band.

In order to research the microwave radiation from lightning, we conducted lightning observation campaign in Hokuriku, Japan, which borders the Sea of Japan from December 2007 to January 2008. Our observation system consists of three detectors, a pyramidal horn antenna, a VHF broadband interferometer, and a slow antenna. The pyramidal horn antenna is designed for detecting the microwaves in a frequency range from 2.6GHz to 3.95GHz. The beam width of the antenna is 30.6 degree horizontally, 31.0 degree vertically and the maximum antenna gain is 15 dB. Each electrical signal at a frequency of 2.9 GHz from the antenna is down-converted to 500 kHz and digitalized in a PC with a 1 us sampling interval. The VHF broadband digital interferometer is a system to locate the source of a VHF wideband impulsive electromagnetic wave caused by lightning progression in two dimensions. The slow antenna enables us to measure the E-field change on the ground.

We had several CG flashes striking near our sites during the observation period. The flashes show the distinct increases of the intensity of 2.9 GHz electromagnetic waves occurred simultaneously both positive and negative leader developments and lightning currents. The maximum intensity of microwaves during observation period is -68.0 [dBm/m²] associated with a CG flash striking a tower about 380 [m] away from the horn antenna. These results indicate the leaders and lightning currents have great radiations in this range and the possibility of the localization of lightning discharges by microwaves.