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Estimation of lightning location and ionospheric height based on measurements of VLF sferics with a single station

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Large electric current of lightning discharge can emit large amplitude electromagnetic pulses with a wide frequency range. These electromagnetic waves can propagate long distance by reflecting between the earth surface and the lower ionosphere. If the lightning discharge occurs within the distant range of a few km from an observer, observable waveform would be a combination of a direct wave and the following damping oscillations, which are the component of the reflected waves. By measuring the time differences of the wave arrival, we can calculate the ionospheric height where the VLF wave reflects. In addition to this, we can estimate the location of the lightning discharge by measuring electromagnetic waves both in the horizontal magnetic field component and the vertical electric field component. From this method, we can monitor time variation of the ionospheric altitude changes, which are caused by ionization effect of electromagnetic pulses emitted by lightning discharges and by other disturbances related magnetospheric activities, such as storm, solar proton event, etc.

In order to carry out the continuous observation of VLF waves in the frequency range of 3-30 kHz, we have installed two magnetic loop antennas and a vertical electric dipole antenna in Yamanashi Pref.. Also, we are now developing the same type of the VLF observation systems and will install them in Hokkaido and Gifu Pref.. We have developed a data recording system which is consist of personal computer with an A/D converter and a GPS receiver. Using this system, it is possible to measure VLF waves continuously with a 16-bit resolution and 20 us time resolution. At the presentation, we will show the detailed specification of the observation system and will present the preliminary result by analyzing the VLF sferics data.

Keywords: ionospheric height, VLF sferics data, lightning location