放電速度を考慮した帰還雷撃電流モーメント推定法の検討

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Lightning current moment estimation for solving ambiguity of return stroke velocity

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Lightning discharge generates intense electromagnetic pulses (sferics). Sferics include important information on related lightning such as current intensity, lightning location, and the ionospheric condition. In this study, we have studied the technique for extracting the return stroke current from the sferics. Especially, polarity, time constants, duration time, peak value of the current waveform, and the electric charge are estimated from the sferics. Such features of lightning return stroke are important to examine the generation mechanism of transient luminous events related with lightning (e.g., Sprites, Elves, and Blue jets).

Usually, in the current estimation, return stroke model has been used as the transmission line (TL) model, which assumes that the current travels on a lossless transmission line with a constant velocity. In the TL model, the shape of the electromagnetic field waveform becomes the same with that of the return stroke current, and the current amplitude is simply determined by the horizontal distance of the lightning location and the return stroke velocity. The lightning location can be estimated from sferics. However, the return stroke velocity has been an unknown parameter and an average value (i.e., 50-70% of the light speed) has been used for the current estimation. This ambiguity is a serious problem in the return stroke current estimation.

For this problem, we have succeeded in obtaining information on discharge time (equivalent to discharge channel divided by return stroke velocity) of the return stroke from the sferic spectrum feature. In addition, we have reconstructed the return stroke current waveform by using the least-square method for the sferic waveform. From these techniques, we have developed a new estimation method of current moment waveform of the return stroke. By the numerical simulation, the estimation error of the current moment is less than 10% for the horizontal distances over 100 km from the lightning.

In this presentation, we will report on the details of our current estimation method. We will also discuss the method for the other return stroke model such as the modified TL model with linear current decay.