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Estimation of dissipated lightning energy by infrasound measurement

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Rainfall by thunderstorms and typhoons causes a large-scale disaster, especially in Southeast Asia and other tropical regions. Damage caused by disasters could be minimized by monitoring and predicting in real-time. It is known that typhoon shows the maximum wind speed 1-2 days after the peak of lightning frequency. There is a strong correlation between lightning activity and torrential rainfall. If we could monitor the lightning activity quantitatively, it must be useful to monitor and predict strong rainfall. Lightning is an electrical phenomenon, and the magnitude of its significance is usually represented by its peak current and charge moment change before and after the stroke. However, the energy dissipation by lightning, which might be a good indicator of atmospheric convection, cannot be estimated only from the electromagnetic field measurement since it is impossible to measure the conductivity in the discharge path. Here we focus on infrasound below 20 Hz, which may be a good proxy of energy dissipation caused by lightning stroke. In order to estimate the dissipated energy by lightning stroke, we need to know the quantitative relationship between the dissipated energy and the intensity of infrasound in another way.

In the present research, we try to calibrate the quantitative relationship between infrasound intensity measured at a known distance and dissipated energy in the atmosphere, using two kinds of fireworks displays. At a building of Hokkaido University we measured infrasound pressure of fireworks for some cases which occurred at the range of 5 km. We also carried out similar measurement in lakeside of Lake Toya in Hokkaido in distance range of 0.3 - 4 km. The maximum dissipated energies of the fireworks are in ~10^6 J, which is approximately 1,000-5,000 times smaller than that of typical lightning, namely. Based on these measurements, we determined the constant to calculate the dissipated energy from infrasound pressure measurement. On the other hand, this constant is not very stable for different cases probably due to the variations in sound spectrum, height of explosion, temperature profile of the atmosphere near surface. We need to consider such conditions when we estimate the dissipated energy of lightning, adding to the effect of line source of the sound in lightning path while the fireworks has a point source.

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