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Influence of atmospheric absorption on time change of thunder spectrum

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Lightning discharge is a large-scale spark discharge that takes place in nature. Thunder is the sound wave from lightning. The sound wave from familiar short-distance spark discharge like a static electrical spark is pulse-like one, that has flat frequency characteristics. However in thunder low-frequency component is dominant. Foregoing rumbling of thunder has been discussed. Atmospheric absorption and interference of sound waves from spatially-dispersed sound source are thought as causes of rumbling. However quantitative understanding of these is insufficient.

We observed thunder and examined time change of its amplitude spectrum. Here the spectrum at a certain time is an analysis of about 0.5 seconds around the time. We did such an analysis through one thunder and obtained time change of thunder spectrum. As a result, the gradient of the spectrum of a thunder was found to become steep at a rate of about 0.002 dB/Hz a second; attenuation occurs from high-frequency component.

On the other hand, we calculated thunder as superposition of sound waves from each point on lightning channel. Here we approximate lightning channel by a simple straight line sound source and a pulse is generated from each point on the line source. Each pulse attenuates depending on frequency by atmospheric absorption. We used standard atmosphere model to calculate attenuation. Amount of attenuation increases with duration, because the waves from distant source arrive late and attenuate greatly. As a result, the spectrum steepened at a rate of about 0.002 dB/Hz a second. This almost corresponds to observation and indicates the effect of atmospheric absorption on rumbling of thunder.

Keywords: thunder, atmospheric absorption, lightning channel