Deployment Plan of ELF Observation System in Asian Countries to Monitor Severe Weather Development

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Recent studies on the relation between lightning activity and severe weather activity revealed that lightning occurrence numbers and charge amounts neutralized by lightning discharges are the good proxy to predict the intensity development of severe weathers. We installed an ELF observation system at Onagawa station in 2001 and Kuju station in 2013 and are conducting continuous measurements of ELF waveforms excited by lightning discharges. Using the ELF data and lightning current waveform data obtained by the Rogowski coil, which is installed at Mt. Ogami in Niigata, we found that the shape of the lightning-exciting ELF waveform is comparable to that of lightning current waveform. As the distance between the ELF station and the Rogowski coil is about 300 km, observed ELF waveforms are mainly induction magnetic fields and become proportional to lightning current waveforms. By comparing time-integrated magnetic field amplitude (ΣB) to time-integrated current waveform amplitude, which becomes the charge amount neutralized by lightning discharges (Q), we obtained an empirical equation to estimate the neutralized charge amount of any lightning discharges. Then, we analyzed the relation between the lightning charge amount and temporal development of thundercloud activity using both ELF and meteorological C-band radar data. It is found that the temporal variation of neutralized charge amounts of lightning discharges occurred at active thunderclouds is proportional to that of rain volumes, and it is also found that downbursts occurred just after/before the variations of lightning charge amounts and −CG occurrence numbers reached their peak. These facts imply that the measurement of ELF waveforms is a good and cheap way to continuously monitor meteorological conditions in active thunderclouds. From April 2017, the project of Science and Technology Research Partnership for Sustainable Development (SATREPS) will start. In this project, methodologies on a short term forecast of severe weather and typhoon intensities will be developed. For this purpose, 60 automatic weather stations equipped with slow-antenna lightning sensors and VLF receivers will be installed in Philippines. We will also install the same type of the ELF observation system in this project and will conduct continuous measurements of ELF waveforms excited by lightning discharges and meteorological conditions in active thunderclouds occurred near Philippines and other Asian countries. At the presentation, we will show the basic specification of the ELF observation system and discuss the usefulness of ELF measurements for the short term forecast of severe weather and typhoon intensities more in detail.

Keywords: lightning discharges, ELF waves, severe weather, extreme weather

