ELF 波動観測に基づく全球雷放電活動と極端気象・気候変動の監視計画

佐藤 光輝[1]、高橋 幸弘[1]、門倉 昭[2]、岡田 雅樹[2]、山岸 久雄[2]
[1] *北海道大学 大学院理学研究院*
[2] *国立極地研究所*

Monitoring of Global Lightning Activities, Severe Weather and Climate Change Based on ELF Waveform Observations

Mitsuteru Sato[1], Yukihiro Takahashi[1], Akira Kadokura[2], Masaki Okada[2], and Hisao Yamagishi[2]
[1]*Faculty of Science, Hokkaido University*
[2]*National Institute of Polar Research*

Continuous measurement of the electromagnetic waves in the 1-100 Hz ELF frequency range excited by lightning discharges is carried out at Syowa station since February 2000. The main objective of this observation is to monitor global lightning activities and the activities of lightning-associated Transient Luminous Events (TLEs), such as sprites, elves and blue jets. The observation system consists of two horizontal search-coil magnetometers to detect magnetic field perturbations in the 1-100 Hz frequency range, a main amplifier and a data recording system with a time-code generating GPS unit. The operation of this system is so stable, and there is almost no trouble since for the last 13 years. For the waveform observation of the 1-100 Hz electromagnetic waves excited by lightning discharges, Syowa station is one of the best places in the world since the noise level caused by the power line system is quite low. In addition to this, Syowa station locates almost equal distance from the main lightning source regions, *i.e.*, North and South America, Africa and South-East Asia. Thus, it is possible to detect lightning discharges with almost uniform detection efficiency. These benefits bring the world-best quality for the ELF magnetic field waveform data. Now, same observation system was also installed in Japan, Sweden and USA. Using these ELF waveform data, it is possible to estimate global occurrence distributions and rates of lightning discharges [*Sato and Fukunishi*, 2003; *Sato et al.*, 2008; *Yamashita et al.*, 2011]. It is also possible to estimate the charge moment change ($Q \cdot dl$), which is the product of the charge amount of the discharge (Q) and the length of the discharge channel (dl). The charge moment change is the basic physical parameter to estimate the discharge energy of lightning and to examine the occurrence of TLEs. Thus, the ELF observation system becomes the basic infrastructure for the studies of lightning discharges and TLEs. Recently, it is suggested that the amplitude change of the lightning-excited ELF waves is closely correlated with the global cloud coverage [*Sato and Fukunishi*, 2005; *Takahashi et al.*, 2010], upper-tropospheric water vapor variability [*Price and Asfur*, 2006], hurricane intensity [*Price et al.*, 2009], and tropical temperature anomaly [*Williams*, 1992]. These facts imply that the lightning activities are the good proxy for the monitoring of the severe weather and climate change since the lightning activities are closely related with the vertical strong convections. Then, it can be concluded that the continuous measurement of the ELF magnetic field waveforms excited by lightning discharges at the polar region is the best way to monitor not only global lightning/TLE activities but also global activities of the severe weather and climate changes. At the presentation, we will discuss the future observation plan, the management structure of the ELF observation system at Syowa station, and possible scientific contributions derived from the ELF observations.

References

Price, C., and M. Asfur, Can Lightning Observations be Used as an Indicator of Upper-Tropospheric Water Vapor Variability?, *Bull. Amer. Meteor. Soc.*, **87**, 291–298, 2006.

Price, C., M. Asfur, and Y. Yair, Maximum hurricane intensity preceded by increase in lightning frequency, *Nature Geosci.*, **2**, 329–332. doi:10.1038/NGEO477, 2009.

Sato, M., and H. Fukunishi, Global sprite occurrence locations and rates derived from triangulation of transient Schumann resonance events, *Geophys. Res. Lett.*, **30 (16)**, 1859, 2003.

Sato, M., and H. Fukunishi, New evidence for a link between lightning activity and tropical upper cloud coverage, *Geophys. Res. Lett.*, **32 (12)**, L12807, 2005.

Sato, M., Y. Takahashi, A. Yoshida, and T. Adachi, Global distribution of intese lightning discharges and their seasonal variations, *Journal of Physics D: Applied Physics*, **41**, 234011, doi:10.1088/0022-3727/41/23/234011, 2008.

Takahashi, Y., Y. Okazaki, M. Sato, H. Miyahara, K. Sakanoi, and P. K. Hong, 27-day variation in cloud amount and relationship to the solar cycle, *Atmos. Chem. Phys.,* **10**, 1577-1584, 2010.

Williams, E.R., The Schumann resonance: A global tropical thermometer, *Science*, **256**, 1184-1187, 1992.

Yamashita K, Takahashi Y, Sato M, and Kase H, Improvement in lightning geolocation by time-of-arrival method using global ELF network data, *J. Geophys. Res.*, **116**, A00E61, doi:10.1029/2009JA014792, 2011.