Commission G

Global monitoring of lightning discharges

Global monitoring of lightning discharges is performed by Hokkaido University. The lightning occurrences and their relation to sprite activity and climate variability are investigated in detail with the 1–100 Hz ELF magnetic field waves observed at the Syowa station in Antarctica, Onagawa in Japan, Esrange in Sweden and Santa Cruz in US (see Figure 1).

From the transient Schumann resonance of the ELF magnetic field whose amplitude exceeds 40 pT at all stations, the lightning locations are estimated by a triangulation method with an estimation error of 0.5 Mm. It is found that in the summer season (from June to August) the lightning occurrence rates are higher in the northern hemisphere than in the southern hemisphere with large enhancements in North America, South-East Asia and the northern part of Africa. On the other hand, in the winter season (from December to February) these rates are higher in the southern hemisphere with large enhancements in South America, Australia and the southern part of Africa (see Figure 2). These features are consistent with the results of global lightning measurements from space conducted by the Optical Transient Detector and the Tropical Rainfall Measuring Mission satellite.

The new global observation of cloud-to-ground (CG) discharges based on ELF with Qdl of <470 C km is carried out at 4 locations in the world. The number of CGs whose location and Qdl are determined is about a million events per month in 2004, enabling an investigation of the day-to-day variations of the global CG distribution with transferred charge amount. The accurate geolocation show active regions in North America, South-East Asia, the northern part of Africa and the center of the Pacific Ocean (see Figure 3). The distribution in longitude is similar to the wave 4 structure of F-layer ionospheric electron density. The result suggests that there is the strong coupling between the meteorological and the upper atmospheric phenomena.

References

M Sato, Y Takahashi, A Yoshida and T Adachi, Global distribution of intense lightning discharges and their seasonal variations, J. Phys. D: Appl. Phys. 41 (2008) 234011.

Kozo Yamashita, Yukihiro Takahashi, Mitsuteru Sato, Hiromi Kase, Improvement in lightning geolocation by time of arrival method using global ELF network data, J. Geophys. Res., DOI:10.1029, 2010.

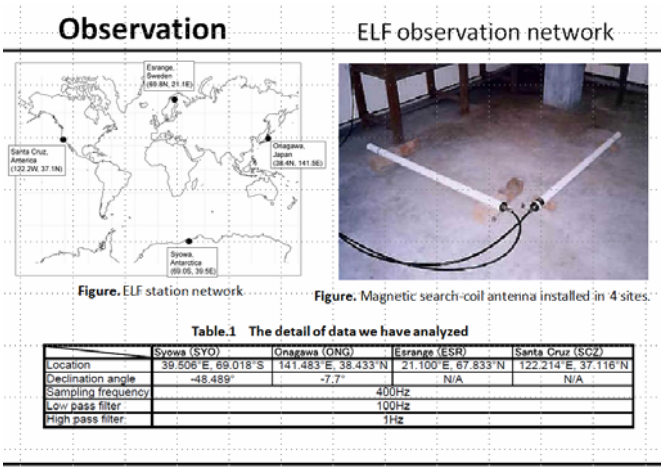

Figure 1. Observation stations at the Syowa in Antarctica, Onagawa in Japan, Esrange in Sweden and Santa Cruz in US.

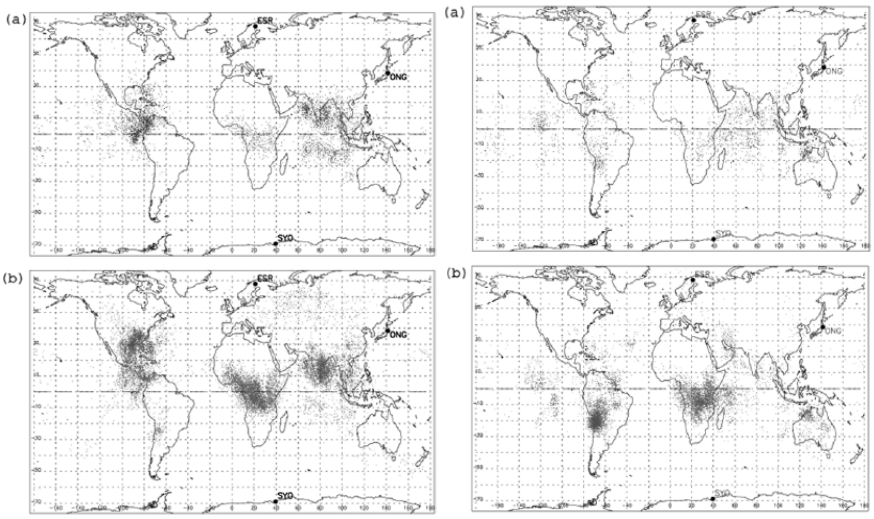

Figure 2. Global map of the intense cloud-to-ground (CG) discharges in the summer season. (*a*) Global distribution of −CG discharges and (*b*) +CG discharges (left panels), and those in the winter season (right panels).

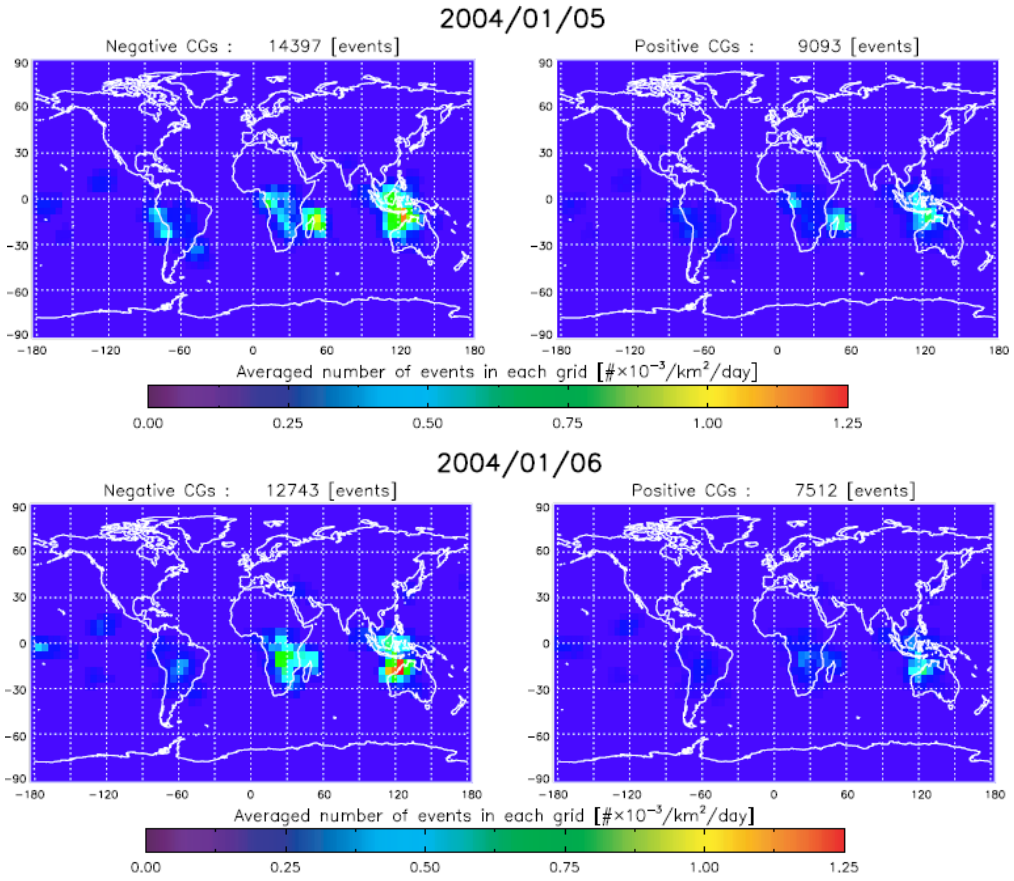

Figure 3. Spatial distribution of lightning discharges in 2004/01/05 and 2004/01/06. The left panels show the mapping of negative CGs, and the right panels show that of positive CGs.