全球雷活動の時間・空間変化と電離圏・磁気圏への影響

佐藤 光輝 [1]; 高橋 幸弘 [2]; 山下 幸三 [3]
[1] 北大・理; [2] 北大・理・宇宙; [3] サレジオ高専・電気

Spatial and Temporal Changes of Global Lightning Activities and Effects on Ionosphere and Magnetosphere

Mitsuteru SATO[1]; Yukihiro Takahashi[2]; Kozo Yamashita[3]
[1] Hokkaido Univ.; [2] Cosmosciences, Hokkaido Univ.; [3] Dept. EE, Salesian Polytechnic.

Recent satellite observations of global lightning discharges conducted by Microlab-1/OTD and TRIMM/LIS revealed that lightning occurs mainly over the continent regions and that ~80% of global lightning occurrences centers in the latitudinal range from 30^{o}S to 30^{o}N. It is also found that lightning occurs with a rate of ~50 flash/s in the global scale. However, it is not possible to estimate rapid spatial and temporal changes of global lightning activities from the satellite data. On the other hand, the continuous electromagnetic wave measurements in the ELF/VLF range excited by lightning discharges enables us to monitor such activity changes. According to the ELF data analysis, it is found that global lightning activities dynamically change with a periodicity of ~5, ~10 and ~30 days and that the lightning activities over Africa, America and Asia are synchronized each other.

Recent results derived from numerical simulations showed that the strong electromagnetic pulses (EMPs) excited by lightning discharges can lead to significant increases in the electron density of the lower ionosphere with a magnitude of ~100% to the ambient electron density. Based on the satellite and ground-based observations, the lightning-induced electron precipitation (LEP) is obviously identified and is considered to be generated by the cyclotron-resonant loss of the trapped electrons in the magnetosphere through the scattering process caused by the lightning-induced whistler waves. It is suggested that LEP has a significant role of the loss process of the trapped particles in the radiation belt. These modulations of the nighttime electron density can be monitored by the ground-based observations of the VLF transmitter signals. Thus, these ionospheric and magnetospheric disturbances may be changed spatially and temporally with same periodicities of the global lightning activities.

In the diurnal variation of the global lightning activities, it is confirmed that the lightning activities reach their peak at 16-18LT in general. Though we need more careful analysis, this fact implies that the lightning activity may have a strong impact on the generation mechanism of the plasma bubble or may be a seed. Based on the analysis of the ELF measurement data, it is found that the active regions of the global lightning activities locate not only at Africa, America and Asia but also over the Pacific Ocean. This result may show that lightning activities and wave-4 structure at the ionosphere have a close relationship.

At the presentation, we will show the results derived from the measurements of lightning-excited ELF/VLF waves and will discuss the possible relationship between lighting activities and ionospheric and magnetospheric responses.