北陸冬季雷と関連する下部電離圏擾乱の二周波観測

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Dual frequency observation of subionospheric perturbations associated with Hokuriku winter lightning.

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Intense electromagnetic pulses (EMP) radiated from lightning discharge could cause heating and ionization and alter the conductivity in the ionospheric D-region. While modeling studies[1] show that change of ionization state in the lower ionosphere depends on intensity of EMP, there is no clear observational evidence that shows quantitative relationship between them. The purpose of this study is to reveal influence of the lightning on the lower ionosphere and its dependence on properties of lighting discharges. The change of the conductivity in the ionospheric D-region is detected using perturbation in low frequency (LF) manmade radio waves which propagate a waveguide. We have already compared the subionospheric perturbation of a JJY transmitter (Haganeyama, Fukuoka, 60kHz) measured at the Zao station (Miyagi) with intensity of EMP and found a trend of positive relationship between them [2]. However, total number of event used was 72 and the statistical significance was still poor.

For this purpose, two LF radio observation systems were installed in Takine (Fukushima) and Sasaguri (Fukuoka). Radio signals from two JJY transmitters at Haganeyama (Fukuoka, 60kHz) and Otakadoyayama (Fukushima, 40kHz) are simultaneously measured at Takine and Sasaguri, respectively. Radio propagation paths of both transmitter – receiver pairs are almost overlapped and the midpoints of both paths are located over the coast of Hokuriku area. These enable us to investigate the lightning effect on the lower ionosphere at different height because it is expected that reflection heights of radio wave depends on radio frequency.

The LF signature of subionospheric perturbations associated with winter lightning in the Sea of Japan (around Hokuriku) has been observed from December 13, 2014 to March 31, 2015. Signatures of subionospheric perturbation (which is called early event) which occurred immediately after the causative lightning were detected. The total number of the early event detected during the period is 202. We also derived the peak current of causative lightning from LF atmospherics observation. The peak current is usually used for a proxy of the EMP intensity. Using these new data sets, we will show the statistical relationship between the phase change of subionospheric perturbations and the peak current and its dependence on the transmitter frequency.

[1] E. D. Schmitte.: Remote sensing and modeling of lightning caused long recovery events within the lower ionosphere using VLF/LF radio wave propagation, Adv. Radio Sci., 12, 241–250, 2014

[2] Morinaga et al.: Signature of subionospheric LF wave perturbations associated by Hokuriku winter lightning observed at the Zao station, JpGU meeting, Yokohama, 2014