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Horizontal Inhomogeneity in the D-region Ionosphere During a X-class Solar Flare Using OCTAVE VLF/LF Observations

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When solar flares occur, electron density in the ionosphere (60-100 km altitude) increases because of intense X-rays. So far, relationship between VLF (3-30 kHz) and X-ray flux has been reported [1], although there are few reports for horizontal inhomogeneity of the reflection height in the D-region ionopshere. The purpose of this study is to reveal horizontal homogeneity of electron density in the D-region ionosphere during a X-class solar flare using multi-path VLF/LF (30-300 kHz) transmitter signals of "Observation of CondiTion of ionized Atmosphere by VLF Experiment (OCTAVE)" network. When solar flares occur, VLF/LF amplitude and phase vary with decreasing the reflection height. The transmitters used in this study were NWC (21.817°S, 114.167°E, 19.8 kHz), JJI (32.05°N, 130.82°E, 22.2 kHz), JJY (37.37°N, 140.85°E, 40.0 kHz; 33.47°N, 130.18°E, 60.0 kHz), and BPC (34.63°N, 115.83°E, 68.5 kHz). The receivers were located at KAG (Tarumizu, Kagoshima, Japan, 31.59°N, 130.55°E), PKR (USA, 65.125°N, 147.488°W), and RKB (Rikubetsu, Hokkaido, 43.45°N, 143.77°E), which are part of OCTAVE network. A X2.2-class solar flare occurred at 08:57 UT on 6 September, 2017. During the solar flare, amplitudes of variations in the VLF/LF amplitude (ΔA) and phase (ΔP) were 2.65-14.73 dB and 31.0-150.25 degrees, respectively. Using wave-hop method, we estimated reduction in reflection height (Δh) from the observed ΔA and ΔP. When the reference height was assumed to be 78.08-84.99 km, the Δh were estimated to be 1.0-4.8 km for BPC-KAG, BPC-RKB, JJY40-KAG, JJY60-RKB and JJY40-RKB paths. The difference in the Δh for each path would be caused by distance between the sub-solar point and each path, and sunset effects. Based on the IRI(International Reference Ionosphere)-2016 model, variations in electron density, ΔN with χ (the solar zenith angle) =64.34° was larger (5465.7 cm^{-3}) than that with χ =80.18° (200.4 cm^{-3}) at 85 km heights. We found that there was such homogeneity for D-region ionization due to the solar flare. In this presentation, we will discuss the horizontal inhomogeneity of the reflection height and electron density during the solar flare in detail.

References

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