Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM29-02 Room:304 Time:May 22 14:30-14:45

Study of quantitative characteristics of ionospheric disturbances during solar flare with the SuperDARN Hokkaido radar

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Ionospheric disturbances during solar flare events have been studied by various kinds of observation instrument in the last few decades. Kikuchi et al. (1985) reported on the positive Doppler shift in the HF Doppler system data during solar flare events, and indicated that there are two possible factors of Doppler shift, i.e., (1) apparent ray path decrease by changing refraction index due to increasing electron densities in the D-region ionosphere, and (2) ray path decrease due to descending reflection point associated with increasing electron density in the F-region ionosphere.

In this study, we use the SuperDARN Hokkaido Radar to investigate the detailed characteristics of solar flare effects on ionospheric disturbances. We focus on positive Doppler shift of ground / sea scatter echoes just before sudden fade-out of echoes. Davies et al. (1962) showed that if the factor (1) is dominant, Doppler shift should have positive correlation with slant range and negative correlation with elevation angle and frequency. On the other hand, if the factor (2) is dominant, Doppler shift should have negative correlation with slant range and positive correlation with elevation angle and frequency. While Kikuchi et al. (1985) studied solar flare events and mainly discussed frequency dependence of Doppler shift, We study mainly slant range and elevation angle dependence, for the first time to the best of our knowledge. We found that the factor (1), in other words, increase of electron densities at D-region ionosphere, is dominant during solar flare events. This result is consistent with that of Kikuchi et al. In order to confirm this result and to study characteristics of ionospheric disturbance in more detail, we are working on the classification of solar flare events according to its intensity, local lime, season and solar zenith angle, and the investigation of their effects on the ionospheric disturbances. We estimated variation of electron densities at D-region ionosphere and will estimated that of F-region ionosphere. In addition, we are trying to estimate variation of ionospheric electron densities by chemical reaction model using X-ray / EUV irradiation data from GOES and SDO satellites. We will compare the variation of ionospheric electron densities obtained from SuperDARN Radar data and that obtained from chemical reaction model. More detailed analysis result will be reported.

Keywords: solar flare, SuperDARN hokkaido radar, lower ionospher, F-region ionospher, Doppler shift