The ionospheric disturbances associated with the natural hazards using HFD and GPS-TEC

Hiroyuki Nakata (Graduate School of Engineering, Chiba University)

It has been reported that the ionospheric disturbances are observed in association with natural hazard such as earthquakes, volcanic eruptions, and typhoons. These disturbances are due to the atmospheric waves excited by the perturbations of the ground and the atmosphere. This implies that the monitoring of the ionosphere contributes to the warning systems of these natural hazards. To do so, detailed studies of the ionospheric disturbances depending on each natural hazard are inevitable. In this study, the characteristic features of the disturbances associated with natural hazards (earthquakes, volcanic eruptions, typhoons) are examined.

The observations used in this study are the total electron content (TEC) determined by GPS navigation system, and HF Doppler observation. In Japan, Geographical Survey Institute has installed the dense network of GPS receivers. Since TEC is derived in each pair of satellites and receivers, the TEC observation is useful for the detection of the ionospheric perturbations occurred in the wide area of Japan. On the other hand, the HF Doppler observation detects the vertical perturbations of the ionosphere by observing the Doppler shift of the transmitted wave. Although the HF Doppler observation is the single-point observation, its sensitivity is even more precise than the TEC observation.

Using TEC data, the perturbations associated with earthquakes are observed. The amount of TEC variation is almost perpendicular to the magnitude of the earthquakes (Nakata et al., 2016). In association with the eruptions of Mt. Asama, TEC variations are also observed. Although the eruptions excite the vertical perturbations of the atmosphere similar to earthquakes, the frequency of the TEC perturbation is rather higher than those for earthquakes. On the other hand, in HFD data, the spiky perturbations firstly appeared and the slower perturbations (-4 mHz) were followed. It is found that the TEC perturbations is due to the shock wave of the eruption. As compared to these hazards, the perturbations associated with typhoons are very small and rapidly. The HF Doppler observation is enable to detect the perturbations associated with typhoons, and the range of the perturbation is in the higher than several millihertz. This result shows that the perturbations associated with typhoons are due to the atmospheric waves continuously generated around typhoons.

References

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