

## Spectral analysis of ionospheric and atmospheric perturbations associated with typhoons using HFD and microbarometer

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It is reported that ionospheric perturbations are observed by extreme weather conditions such as tornadoes and typhoons, and they cause ionospheric disturbances. However, the features and propagation characteristics of atmospheric waves is still unclear. We examined atmospheric waves caused by typhoons, using HF doppler (HFD), which is maintained by The University of Electro-Communications, and microbarometer located at Mineyama, Kyoto prefecture. In this study, HFD receiver data for 5006 kHz observed at Sugadaira is used. Because of unstable ionosphere in the nighttime, we examined HFD data from 7:00 to 18:00. Details of typhoons, path, barometric pressure, and wind speed, are provided by Digital Typhoon, managed by National Institute of Informatics. Here, we give a brief description of Typhoon No.26 in 2013. This typhoon passed Japan in 2013/10/15 ~10/17. It was closest to the Sugadaira observation point on 10/16. From dynamic spectrum of HFD data, it is found that perturbations of spectral intensity at the frequency under 5 mHz were observed in these 3 days even though Typhoon No.26 didn't get closed to Japan. On the other hand, spectral intensity of perturbations were enhanced at the frequency from 5 mHz up to 40mHz when Typhoon No.26 got closed to Japan. Simultaneously, a perturbation of doppler shift was observed whose amplitude is 0.2 Hz. Spectral intensity on microbarometer data also tended to be strong at the frequency from 5 mHz up to 50 mHz. Then we also examined temporal variations of spectral intensity at 4 mHz and 30 mHz, comparing them with the distance between Sugadaira observation point and the center of Typhoon No.26, and with wind velocity at Chichibu, which is the nearest observatory to the reflection point. Data of wind velocity was provided by AMeDAS, maintained by Japan Meteorological Agency. As a result, when Typhoon No.26 was approaching Japan, the spectral intensity of the perturbations at 30 mHz was clearly enhanced, but not at 4mHz. Therefore, it is clear that typhoons seem to affect spectral intensity at frequency higher than 5mHz. The spectral intensity reaches its maximum when the distance between Sugadaira and the center of Typhoon No.26 became the shortest. At this moment the wind velocity at Chichibu became the strongest.

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