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Modeling Lower Ionospheric Perturbations During Typhoons 15 and 19 Using 2D FDTD Method

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Introduction Tropical Cyclones (TCs) have been observed in recent years regarding their effect on the disturbance on the ionosphere. There is also a consideration for the disturbance in the ionosphere due to the lightning discharge characteristics from thunderstorms inside TCs [1, 2]. Our recent experimental study shows the coupling between the atmosphere and overlaying ionosphere through powerful Typhoons 15 and 19 in 2019 hit Japan. We have analyzed the data of lightning activity, meteorological characteristics, and lower ionospheric responses by using VLF transmitter signals. In this study, the temporal dependence of the amplitude of the sub-ionospheric VLF propagation is modeled during Typhoons 15 and 19 to obtain spatio-temporal dependences of lower ionospheric perturbations. We use the Finite Difference Time Domain (FDTD) method to calculate received VLF electric amplitude for several different VLF transmitters - receiver paths around Typhoons. VLF transmitters used are NPM in Hawaii, NWC in Australia, and JJI and JJY in Japan with a frequency of 21.4 kHz, 22.3 kHz, 24.8 kHz, and 40 kHz respectively, whilst the data from two receivers are used in this work i.e. YMG in Yamaguchi and MSR in Moshiri. Yamaguchi is in southern Japan and Moshiri is in northern Japan. These receivers are chosen to cover most parts of Japan and have transmitter-receiver paths close to Typhoons. We are going to present in detail how the spatial scale of the lower ionospheric perturbations vary with different stages of Typhoon by comparing the results from numerical modeling and real observational data.

References

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[2] A. Nina et al, "Low Ionospheric Reactions on Tropical Depressions Prior Hurricanes", Advances in Space Research, vol. 60, no. 8, pp. 1866-1877, 2017, doi: 10.1016/j.asr.2017.05.024.