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Zoom meeting C ：11/1 PM1 (13:45-15:30)
14:15〜14:30

Relationship between Es and MSTIDs: Comparison of Doppler shift from HFD and GPS-TEC from GEONET

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Sporadic-E (Es) is a thin layer in the E-region ionosphere (˜100 km) which is mainly composed of dense metallic ions and electrons. Es is known to appear in the mid-latitude region during summer months. Recent theoretical studies and numerical simulations have suggested that Es plays an important role in generating wave-like structures at F-region altitudes in summer nighttime, which are known as Medium-Scale Traveling Ionospheric Disturbances (MSTIDs). However, there have been only a few studies investigating the simultaneous observations of Es and MSTIDs at two different altitudes; thus, the coupling of these two phenomena has not yet been fully confirmed. To overcome this limitation, we employed data from the HF Doppler (HFD) sounder network in Japan to detect Es and tried to evaluate the E-F coupling, i.e., Es in the E-region and MSTIDs in the F-region. The HFD system is composed of a transmitting station in Chofu, Tokyo (35.7N, 139.5E) and receiving stations at 11 places in Japan. Based on these multipoint observations, we derived the dynamical characteristics, such as propagation speed and direction. A statistical analysis of the propagation characteristics of Es and MSTID was performed using a combination of HFD and Total Electron Content (TEC) data from GEONET GPS receivers for four years from 2014 to 2017. The statistical results demonstrate that the propagation characteristics of Es and MSTIDs were similar to each other, suggesting the occurrence of E-F coupling. However, it has not been confirmed if the variations in the HFD data actually reflect the behavior of Es (i.e., if the reflection actually takes place at the E-region altitude).

In this paper, we used the Doppler frequency data from HFD to estimate the reflection height of the possible Es traces in the HFD data. We employed data from Sugito, Saitama (36.0N, 139.7E) obtained in four summer seasons from 2014 to 2017. At the times of the possible Es reflections in the HFD data, the Doppler frequency plotted in the format of dynamic spectra showed a train of diagonal lines extending from upper left to lower right across the zero line. The figure shows an example of the HFD data when Es was observed. The upper panel shows the Doppler frequency for time at 8 MHz and the lower panel shows the Doppler frequency for time at 5 MHz. These diagonal traces, traversing from positive to negative Doppler frequency, indicated that the length of the ray-path became shorter first and then, after the crossing across the zero line, it again got longer. In most cases, the slope of such diagonal lines is too small to be explained only by the vertical motion of the Es layer; thus, the change in the Doppler frequency represents the change of the ray-path due to the horizontal motion of Es structures. Clear signatures of diagonal traces were identified in 79 cases out of 122 events where Es and MSTIDs occurred at the same time. On the other hand, there were only 66 cases of diagonal traces in 193 events where only Es were observed, and many of the diagonal lines in those cases were relatively unclear. These facts imply that the existence of the diagonal traces in the HFD data can be used as a proxy for the discreteness of the structures of Es and MSTIDs (i.e., how the E-F coupling is effectively working for producing clear spatial structures in both the altitudes). The duration of most of the diagonal structures ranges from 5 to 15 min; the corresponding spatial scale of the structure relatively smaller than the wavelength of MSTIDs. This suggests that the diagonal traces are manifestation of small-scale Es structures which have been observed in the past as QP echoes in the coherent VHF radars. In the presentation, we will show the altitude of reflection estimated from the slope of the diagonal traces in order to further confirm the E-F coupling seen in the statistics.