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Radio and optical investigation of role of E-F region coupling on the generation of nighttime MSTIDs

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Northwest to southeast phase fronts with southwestward moving features are commonly observed in the nighttime midlatitude ionosphere during the solstice months during low solar activity. These features are identified as nighttime MSTIDs (medium scale traveling ionospheric disturbances). Initially, they were considered to be a manifestation of neutral atmospheric gravity waves. Later on, investigations showed that the nighttime MSTIDs are electrified in nature and mostly confined to the mid and low latitude ionosphere. Although the overall characteristics of the nighttime MSTIDs are mostly well understood, the causative mechanisms are still not well known. Recent studies suggests that at suitable conditions the nighttime electrified MSTIDs can reach even very low latitudes (e.g., below 5°N latitude) [1, 2]. However, the northern edge of the mid latitude MSTIDs are not investigated. Therefore, this presentation focus on the investigation of the role of E and F region coupling on the generation of nighttime MSTIDs as well as the northern limit of the occurrence of the MSTIDs.

Simultaneous observations from a 630 nm all-sky airglow imager, GNSS-TEC receivers, and an ionosonde are used to investigate the role of E- and F-region coupling on the generation of medium-scale traveling ionospheric disturbances (MSTIDs). The primary observations are OI 630 nm airglow images taken by an all-sky imager in Kühlungsborn (54.07°N; 11.46°E, 53.79°N magnetic latitude), a site in northern Germany. Out of 226 nights of observations, MSTIDs were found only in 18 nights, demonstrating the low occurrence rate over Kühlungsborn. We focused on four MSTIDs events: two during the vernal equinox and two during summer. Coincident measurements of detrended GNSS-TEC supported the presence of MSTIDs during the selected events, and simultaneous observations from the ionosonde in Juliusruh (54.60°N, 13.4°E, 54.02°N magnetic latitude) showed sporadic-E (Es) layer and spread-F activity in the E- and F-region, respectively. We observed the onset of the observed MSTIDs to be around the 15°–20°E longitude and 60–45°N latitude belts. Additionally, we found that in each case, the onset of MSTIDs coincides with the presence of an Es layer with critical frequency foEs exceeding 4 MHz. This suggests that an Es layer with foEs ≥ 4MHz was a driver of the generation of these MSTIDs in northern Germany. Altitude of the Es layer could be another important factor in generating of MSTIDs. The Es layer should exist at an altitude where Hall conductivity is large, as happened in the present study.

References

[1] M. Sivakandan, D. Chakrabarty, T.K. Ramkumar, A. Guharay, A. Taori, and N. Parihar, "Evidence for deep ingression of the midlatitude MSTID into as low as ~3.5° magnetic latitude," *Journal of Geophysical Research: Space Physics*, 124, 16, February 2019, pp. 749– 764. doi:10.1029/2018JA026103

[2] V.L. Narayanan, A.K. Patra, S. Gurubaran, P. Pavan Chaitanya, and K. Emperumal, "Coincident airglow, VHF radar, and ionosonde observations of electrified medium-scale traveling ionospheric disturbances in the equatorial latitudes," *Geophysical Research Letters*, 46, 23, July 2019, pp. 7173– 7181. Doi:10.1029/2019GL083266