R005-P19
ポスター 3 ：11/25　PM1/PM2 （13:15-18:15）

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Large amplitude perturbations in equatorward wind surges during the intense geomagnetic storm on 3-4 November 2021

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During geomagnetic storms energy is injected into the high latitude atmosphere via precipitating particles and strong electric fields that map down from the magnetosphere to the ionosphere. The acceleration of the ionospheric plasma leads to joule heating of the thermosphere producing a steep latitudinal pressure gradient. The resulting strong equatorward winds are important to the middle and low latitude ionospheric response to magnetic storms by driving the ionospheric disturbance dynamo whose effects last on even after the high latitude ionosphere already recovered [Blanc and Richmond, 1980]. Disturbances of those equatorward winds might have a significant impact on the evolution of the disturbance dynamo, but scale and occurrence rate of strong disturbances are poorly understood [e.g. Shiokawa et al., 2003; Zhang et al., 2015; Guo et al., 2018]. In this study we searched for variations in the equatorward surge at mid-latitudes and especially focused on disturbances at which the thermospheric wind reverses and turns northward.

To investigate thermospheric winds we used data from ICON MIGHTI observations, and data from Fabry – Pérot interferometers (FPIs) distributed over north and middle America. For ICON MIGHTI observations we focused on simultaneous observations with FPIs characterized by a radial distance of less than 500 km at 250 km altitude, which is the approximate altitude of red line (630.0 nm) observations made by both instruments. ICON MIGHTI observations are limb observations, which means that the observed winds are integrated over a horizontal line of sight, which makes it difficult to identify local perturbations. Simultaneous observations enable us to combine information about averaged background winds with information about local wind changes, so we can gain a more holistic image of local conditions at FPI observatories. To search for travelling ionospheric disturbances that originate from thermospheric winds we used the GNSS TEC data binned 1 degree longitude by 1 degree latitude at a 5-minute interval.

This poster focuses on a strong geomagnetic event from November 3^{rd} to November 4^{th}, 2021, with a peak Kp index of 8^{-} and a SYM-H low-peak of -118nT on November 4^{th}. The strong storm was preceded by several moderate geomagnetic disturbances beginning on October 27^{th} [Geleta and Mengistu Tsidu, 2024]. Previous studies have analyzed the intensity and effect of the storm induced equatorward surge with wind speeds up to 250 m/s [e.g. Regi et al., 2022; Gan et al., 2024], but FPI observations also show significant perturbations, some with rapid changes in wind speed of over 300 m/s. In this poster we present a detailed analysis of the characteristics of such disturbances.