Evolution of mid-latitude density irregularities and scintillation during storms

*Toshi Nishimura[1], Sebastijan Mrak[1], Josh Semeter[1]

1. Boston University

While high-latitude and equatorial density irregularities and radio signal scintillations have been explored in detail, studies on mid-latitude density irregularities and scintillation are scarce and their properties are less understood. Mid-latitude scintillation is not frequent, but because much more human activities are present at mid-latitudes than at high and equatorial latitudes, radio signal disturbances at mid-latitudes despite their lower occurrences have a large impact on technology such as aircraft navigation using GNSS. Due to the small number of scintillation observations, past ground-based studies of mid-latitude density irregularities and scintillations are limited to case studies in small regions, statistical studies using limited satellite coverage or a small number of receivers, or inference from TEC variations (e.g., ROTI which does not necessarily indicate scintillation). Thus it has been difficult to determine event-specific spatial distribution of scintillation over a continental scale and changes shorter than satellite orbital periods. In the present study, we determine the event-specific 2-d distributions of mid-latitude GNSS signal scintillation and fluctuation, and their relation to large-scale density structures using a network of GNSS receivers in North America. In the 7-8 September 2017 storm event, we found that GNSS signal scintillation is closely associated with the mid-latitude trough equatorward boundaries. As the trough moved equatorward and the plumes and troughs developed, the phase scintillation increased further in the density gradient, while amplitude scintillation increased in the trough and plume. Other regions are covered by the receivers but did not show GNSS signal scintillation/fluctuation, indicating that our technique can specify occurrence regions of scintillation/fluctuation, and scintillation/fluctuation in this event was confined along the steep TEC gradients and trough. Our study indicates that scintillation structures and evolution can be detected can be precisely determined in this technique.

Keywords: TEC, scintillation, mid-latitude, storm

