Ionospheric Signatures of the 21 August 2017 Solar Eclipse

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On 21 August 2017, during daytime hours (16:00–20:00 UT), a total solar eclipse occurred along a narrow path, approximately 100 km wide, that spanned the continental United States from Oregon to South Carolina. Outside of this region, a partial solar eclipse covered the rest of the continental United States. MIT's Haystack Observatory was one of several institutions whose ground-based eclipse research was funded by NASA to study the eclipse. As part of its many activities, MIT Haystack Observatory coordinated the placement of 7 GNSS receivers in the region of totality at sites in Missouri, South Carolina, Wyoming, Oregon. These receivers were provided by UNAVCO and MIT and collected total electron content (TEC) data at a 1 to 10 second cadence from all GPS and GLONASS satellites in view. In addition, MIT utilized the dense global network of GNSS receivers across North and South America to produce both TEC and differential TEC maps. Five days of GNSS data - the eclipse day, two days prior and two days after - were analyzed for the electron density latitudinal response and for the presence of traveling ionospheric disturbances (TIDs), with the aim of identifying signatures specifically associated with the solar eclipse. Differential TEC techniques were used for TID detections by subtracting a background TEC. In addition, TIDs in the region near totality were examined by comparing the individual line of sight TEC from nearby receivers. Data and model comparisons of the eclipse

The GNSS TEC observations will interpreted in parallel with the Millstone Hill incoherent scatter radar observations. During the eclipse, full altitude profiles of electron density, electron temperature, ion temperature, plasma velocity were collected by the Millstone radar allowing for a detailed analysis of altitude changes of plasma parameters during the eclipse. DMSP and NASA TIMED GUVI and SEE satellite data will also be examined for spatial variations of neutral composition and temperature and compared to GNSS TEC observations.

Unexpected effects included the first unambiguous evidence of ionospheric bow waves as electron content disturbances over central/eastern United States, with ~1 h duration, 300–400 km wavelength and 280 m/s phase speed emanating from and tailing the totality region. Enhanced large-scale TID activity occurred over the United States prior to and following the large totality associated TEC depletion, with significant structures over the Rocky Mountain chain. Millstone Hill ISR measurements revealed large decreases in mid-latitude plasma density and temperature. Initial observations of TEC signatures in the opposite hemisphere will be described.