*2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018*

# e-POP's measurements of the topside ionosphere's response to the 2017 solar eclipse

Gareth W. Perry[(1)], Chris Watson [(2)], David R. Themens*[(3)], Paul A. Bernhardt[(4)], J. D. Huba[(4)], R. A. Farrow[(5)], H. G. James[(1)], A. D. Howarth[(1)], and A. W. Yau[(1)]

(1) University of Calgary, Calgary, Alberta, Canada, email: perry@phys.ucalgary.ca; james@phys.ucalgary.ca; howarth@phys.ucalgary.ca; yau@phys.ucalgary.ca

(2) The University Corporation for Atmospheric Research, Boulder, Colorado, USA, email: christowatso@gmail.com

(3) University of New Brunswick, Fredericton, New Brunswick, Canada, email: david.themens@unb.ca

(4) Naval Research Laboratory, Washington, D.C., USA, email: paul.bernhardt@nrl.navy.mil; huba@nrl.navy.mil

(5) Non-affiliated

We present measurements the Enhanced Polar Outflow Probe (e-POP) onboard the CAScade, Smallsat and IOnospheric Polar Explorer (CASSIOPE) performed during the August 21, 2017 eclipse. CASSIOPE transited across the path of totality of the eclipse within 10 minutes after totality over Idaho. The spacecraft was moving along a north-south track at an altitude of approximately 650 km. In this presentation, we outline results from 2 of e-POP's 8 instruments: the Radio Receiver Instrument (RRI), and the GPS Attitude, Position and profiling experiment – Occultation (GAP-O) instrument.

For the eclipse operations and subsequent "baseline" (non-eclipse) passes, RRI was operated in a crossed-dipole configuration and tuned to 14.2 MHz to record signals from a transmitter located under the eclipse's path of totality at Ammon, Idaho (43.57°N, -111.96°W). During the eclipse, while CASSIOPE was north of 65° N, the transmissions originating from Ammon and received by RRI were clear and coherent. However, while CASSIOPE was at the same latitudes during subsequent baseline passes, Ammon's signal was significantly distorted and dissipated. South of the path of totality, Ammon's transmissions were clear and relatively unperturbed as far south as 25° N for the eclipse and baseline measurements. RRI's data shows that a substantive meridional asymmetry in the HF propagation conditions was established by the eclipse. However, rather than the more intuitive internal reflection scenario wherein an eclipsed ionosphere with a lower critical frequency than a non-eclipsed ionosphere is pierced by the incident HF rays, modeling hints at an alternative mechanism, namely, that of reduced HF absorption attributed to a cooled electron gas.

Vertical electron density profiles retrieved from GAP-O occulation measurements near the path of totality show depleted plasma densities when compared to GAP-O measurements from non-eclipse days, with the most significant changes occurring in the bottomside ionosphere. GAP-O's data also reveals a reduction in the topside vertical TEC measurements of the order of 1 TEC unit. A closer analysis of GAP-O's occultation data reveals the presence of medium-scale ionospheric disturbances associated with the eclipse. The proximity of the occultation tangent points to the eclipse's path of totality and their timing indicate that the disturbances were established before totality. Furthermore, using wavelet analysis, the wave spectrum of the disturbances is shown to be in good agreement with the wave spectrum of medium-scale traveling ionospheric disturbances detected in the same region using a separate GNSS-to-ground network. This result provides unprecedented and compelling insight into the ionosphere-thermosphere system's response to a solar eclipse. Namely, it supports the notion that the system's initial response is highly-ordered and columnar, which is consistent with theoretical modeling predictions.