Oblique and Vertical Incidence Sounding of the Ionosphere during the 2017 Solar Eclipse

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The North Amercican total solar eclipse of 2017 offered a unique observational geometry for combined vertical and oblique incidence radio sounding between Wyoming and Colorado.

The ionosphere station at Boulder, Colorado (39.992N, 105.269W) was at 95% totality. The Boulder magnetic meridian intersects the path of totality nearly perpendicular around Lusk, Wyoming (42.750N, 104.554W), where affordable logistics could be obtained. The great circle ground distance separation of the two locations is 312 km. The Vertical Incidence Pulsed Ionospheric Radar (VIPIR) facility at Boulder was restored to operation for this experiment using a bi-static capable VIPIR on loan from the US Naval Research Laboratory. Another VIPIR instrument was prepared for deployed operation in Lusk. The temporary field site featured a 17m tall steel tower supporting a 70m long delta traveling wave transmit antenna and a 100m x 100m array of 8 active dipole receiving antennas on 6m tall fiberglass masts. The instrument was operated out of a camper trailer in a municipal field provided by the Town of Lusk.

Both the Boulder and Lusk VIPIR systems used GPS disciplined rubidium reference oscillators to allow oblique Doppler shift observations practically free of oscillator frequency differences.

The Lusk system was installed, calibrated and operated for 2 days before the eclipse, the day of, and 2 days afterward.

The operational Boulder Digisonde was modified to synchronize with both GPS timing and the Boulder VIPIR in order to share a single 4kW transmitter and transmit antenna. Timing of the Boulder VIPIR system was offset by 5 ms to allow range separation between vertical and oblique incidence echoes.

Observations include vertical incidence Digisonde data from Boulder at a 5 minute cadence, Dynasonde mode vertical incidence data from both Boulder and Lusk, and simultaneous bi-directional oblique propagation data at a 2 minute cadence.

Preliminary analysis of of the VIPIR amplitude data indicate expected decreases in D layer absorption, E and F1 layer plasma densities from first contact to totality, and an expected increase in these values from totality to final contact. However, F2 layer plasma densities continued to decrease after totality, below those of the F1 layer, creating the ionospheric G condition of foF2 ¡ foF1 for over an hour beyond totality.

The experimental setup and preliminarily data are presented.