Solar Eclipse Effects on VLF Wave Propagation and LWPC Modeling

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On August 21, 2017 a total solar eclipse occurred over the United States commencing on the west coast moving across to the east coast providing an opportunity to observe how the rapid day-night-day transition changed the ionosphere's D-region chemistry (electron density, plasma frequency and reflection height) and how these cumulative effects alter very low frequency (VLF) electromagnetic wave propagation. To observe these solar obscurity effects, VLF receivers were deployed in two locations: One in the path of totality in Lakeside, Nebraska as well as another south of the totality path in Hugo, CO. The locations were chosen in relation to the eclipse path and VLF transmitter in North Dakota, which operates at 25.2 kHz.

VLF amplitude and phase changes were observed in both Lakeside and Hugo during the eclipse. As the 25.2 kHz signal passed through the path of totality a negative phase change was observed at both receivers as solar obscuration progressively increased. The observed phase changes became positive as solar obscuration reduced. The opposite trend was observed for the amplitude of the transmitted signal: growth as max totality approached and decay during the shadow's recession. Comparing the observations made at the two sites shows that the phase and amplitude changes observed at Lakeside (in the path of totality) had a more gradual gradients than observed at Hugo (south of the path of totality).

The Long Wave Propagation Capability (LWPC) code developed by the US Navy is used to model the observations. LWPC is a modal solution finder for Earth-ionosphere waveguide propagation that takes into account the D-region density profile.