

Ionospheric Density Irregularities, Turbulence, and Wave Disturbances during the Total Solar Eclipse over North America on 21 August 2017

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Data from ionosonde and GPS total electron content (TEC) observations reveal a number of ionospheric phenomena that occurred in response to the total solar eclipse on 21 August 2017 over North America. The eclipse started over the US west coast at ~16:00 UTC (08:00 LT) and ended over the US east coast at ~20:00 UTC (15:00 LT). We identify the growth of plasma density irregularities and turbulence on the bottomside ionosphere during the eclipse totality (at ~10:34 LT over the Idaho station), signified by the distinct appearance of spread-F echoes in the ionosonde data. These spread-F echoes appeared in both O-mode and X-mode traces, and they lasted for approximately 10 minutes. Preceding the appearance of the spread echoes, an uplift of the ionospheric F-layer and steepening of the bottomside ionospheric density gradient were seen in the ionosonde data. In addition, data from the ionosonde observations also show some characteristic signatures of traveling ionospheric disturbances (TIDs) at ~300 km altitude during the eclipse. The TIDs in the ionosonde observations were observed roughly 30 minutes after the time of maximum eclipse, and they have a wave periodicity of approximately 10 minutes. In other words, these TIDs were in the wake of the eclipse totality (lagging behind the umbra), and the wave period was shorter than the medium-scale or short-scale TIDs typically seen in the GPS TEC data. Finally, large reductions in TEC and ionospheric plasma densities (by 33%–45%) as a response to the eclipse were observed in both the GPS TEC and ionosonde data. The ionospheric density in the ionospheric E-region reached minimum roughly at the same time as the maximum eclipse, while the ionospheric F-region density and GPS TEC reached minimum 20-30 minutes after the maximum eclipse.