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

Rezy Pradipta, Endawoke Yizengaw, and Patricia H. Doherty

Boston College, Institute for Scientific Research

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Executive Summary

- We studied some ionospheric effects associated with the passage of total solar eclipse over North America on 21 August 2017.
- Data from ionosonde as well as GPS TEC measurements were analyzed in the study.
- 45% reduction in TEC, 33% reduction in foF2, and a 50% reduction in foE occurred during the eclipse.
- Midlatitude spread-F echoes and wave disturbances were observed during the 21 August 2017 North American total solar eclipse.
A Total Solar Eclipse during Solar Minimum

The 21 August 2017 total solar eclipse: a total solar eclipse over a midlatitude region during a generally quiet geomagnetic condition at a solar minimum.

Left: Background TEC over North America on 21 Aug 2017 from IRI-2012 model
Right: Gridded GPS TEC data over North America on 21 Aug 2017 from Madrigal
Visible Effects of the Total Solar Eclipse in TEC
Setup for the Ionosonde and TEC Data Analysis

21 Aug 2017 — 18:17 UTC

[Map of North America with TECU values and annotations]

- Trajectory of eclipse totality
- Digisonde IF843
- Ca position of lunar shadow
- Mer Cut #1
- Mer Cut #2
- Mer Cut #3
- Parallel Cut

[Color bar indicating TECU values from 0 to 20]
Spread-F Echoes and TIDs during Solar Eclipse

Total Echo Ampl Count, Digisonde Station IF843 – 21 Aug 2017

Virtual Height (km)

UTC (decimal hours)

17:00 UT
17:36 UT
17:42 UT

spread echoes
TID signatures
maximum eclipse
solar eclipse
Doppler Vel. from Ionosonde during the Eclipse
TEC Reduction during the Total Solar Eclipse

Madrigal TEC – 21 Aug 2017, Lat=44 N Lon=113 W

(a)

TEC (TECU)

universal Time (hours)

moving average
(w/ cubic spline)

7-day median
(± 1 quartile)

(b)

ΔTEC (TECU)

universal Time (hours)

max eclipse

solar eclipse

max eclipse

solar eclipse
Reductions in foF2 and foE during Solar Eclipse

Echo Ampl Count (F-region) – IF843, 21 Aug 2017

Echo Ampl Count (E-region) – IF843, 21 Aug 2017
TEC Reductions along Different Longitudes

(a) TEC – 21 Aug 2017, Mer Cut #1 (115°W)
(b) ΔTEC – 21 Aug 2017, Mer Cut #1 (115°W)
TEC Reductions along the Totality Trajectory

(a) TEC - 21 Aug 2017, Parallel Cut

(b) ΔTEC - 21 Aug 2017, Parallel Cut
Summary and Conclusions

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• Data from ionosonde as well as GPS TEC measurements were analyzed in the study.
• 45% reduction in TEC, 33% reduction in foF2, and a 50% reduction in foE occurred during the eclipse.
• Midlatitude spread-F echoes and wave disturbances were observed during the 21 August 2017 North American total solar eclipse.