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Ionospheric impact of the solar eclipse on 21 August 2017

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The total solar eclipse on August 21, 2017 occurred over the United States from 16:00 to 20:00 Universal Time. Most parts of the North American continent were affected by more than 50 % of obscuration. Such a solar eclipse provides a unique opportunity to study photochemistry and dynamics of the ionosphere and its coupling with the thermosphere. The ionosphere was monitored by using ground based GNSS measurements providing the Total Electron Content (TEC) and peak electron density data from ionosonde stations located in the vicinity of the zone of totality. In addition, very low frequency (VLF) measurements were recorded via the Global Ionosphere Flare Detection System (GIFDS) of DLR [1] to monitor the eclipse impact on the lower ionosphere across and nearby the totality zone. Applying ground based GNSS techniques for monitoring, calibrating, modelling and mapping TEC [2, 3], a solar eclipse related TEC depletion was found that follows mostly the obscuration function with a time delay of about 20-30 min reaching a maximum depletion of about 35% (3 - 4 $x10^{16}m^{-2}$) in the totality zone. The peak electron density reached a depletion of up to 50% (1.5 $x10^{11}$ m^{-3}) accordingly. This is in agreement with former observations [4, 5, 6] and specific predictions [7]. However, the related equivalent slab thickness showed an unusual increase of more than 100 km over the Boulder ionosonde station. It is assumed that dynamic processes, e.g. initiated by large scale traveling ionospheric disturbances have seriously modified the vertical electron density distribution. The paper will compare results obtained at 4 different solar eclipses [4, 5, 6, 8] to draw some general conclusions on the ionospheric response to solar eclipses.
VLF measurements across the zone of totality showed an immediate response of the D-layer ionosphere to the eclipse. In addition, a C3 X-ray solar flare has been detected at an obscuration level of about 50%. Despite the TEC depletion, due to increasing solar obscuration, the associated EUV flare stopped the TEC depression by approximately 3% for about 10 minutes.

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