4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Effect of 14 October 2023 Annular Eclipse on the Ionosphere and Earth Magnetic Field

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Annular solar eclipse represents a unique solar phenomenon. It results from the supersonic Moon's motion between the Sun and the Earth which leads to the partial obscuration of the solar disk. The strong dependency of the ionospheric dynamics on solar variabilities and the rareness of such events make the study of its impact especially interesting. In addition, eclipses are able to generate magnetic perturbations due to the strong influence of the ionization process on the Earth's magnetic field.

During the 14 October 2023 annular eclipse, the Moon's shadow progressed from the north-western part of North America to the north-eastern part of South America. The instance of a solar eclipse over multiple hemispheres is particularly rare. The involvement of the South American equatorial region constitutes, therefore, an exceptional occasion to investigate the eclipse's impact on the Equatorial Ionospheric Anomaly (EIA) as well as the Equatorial Electrojet (EEJ).

In this work, we study the ionosphere and magnetic field response to the eclipse through a multi-instrumental approach. We first analyze the total electron content (TEC) provided by the Madrigal Database from which we derive differential TEC (dTEC) maps. Then, we make use of ionosonde data as well as the electron densities provided by the Swarm mission. Regarding the earth's magnetic field, we study the magnetic components variations recorded at multiple locations along the eclipse path. We show that the eclipse generates a noticeable decrease in the TEC by approximately 25-45 % (Figure 1). We observe a similar behaviour for the peak frequency foF2 (20-25 %) and the electron density Ne. We note, furthermore, that TEC and foF2 responses differ between the two hemispheres with the recording respectively of a stronger feedback over North America and equatorial regions. Finally, we put into evidence the solar event's influence on the magnetic field as it led to the decrease of the total magnetic intensity F.

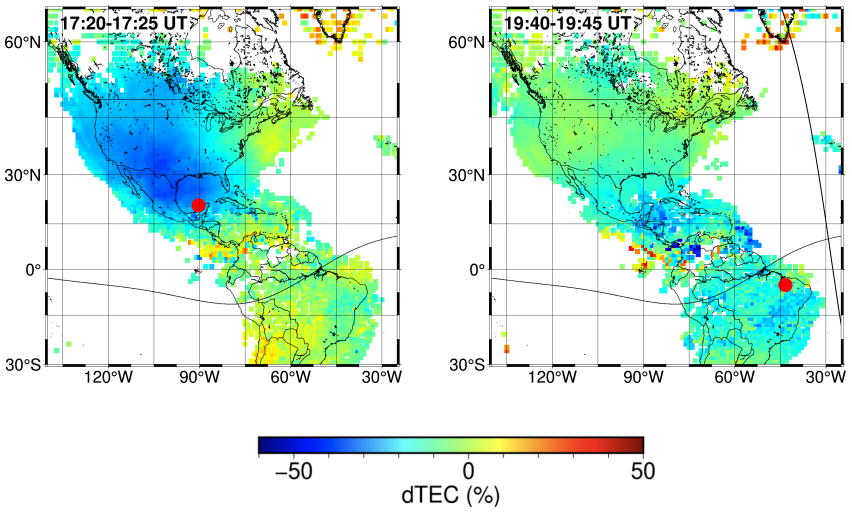

Figure 1. TEC response to 14 October 2023 annular eclipse