URSI - RCRS 2022, IIT (Indore), India,1 - 4December, 2022

Study of the Impact of Partial Solar eclipse of 21st June 2020 on Equatorial Ionosphere using HF radar at Thumba

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Solar eclipses are important transient events which perturbs the dynamics and electrodynamics of the Thermosphere- Ionosphere System (TIS). The uniqueness of the solar eclipse of 21st June 2020 was that it occurred during the noon time on the summer solstice day of the year over the low latitudes of the northern hemisphere. Present study deals with the investigation of the changes observed in the upper atmosphere over Thumba, Trivandrum during this eclipse. The location is very close to the magnetic dip equator and has mutually perpendicular electric field (east-west), magnetic field(northward) and density gradient(vertical) which gives rise to significant ionospheric phenomena.

Even though Electric Field is an important parameter that governs the TIS, there is no direct method to quantify the dynamo region electric field and to understand its day-to-day changes or changes in response to various transient events. However, the Radar measurements of the ionospheric irregularities can indirectly be used to estimate the E region zonal electric fields [1]. The Doppler shifts obtained from the backscattered radar echoes are indicative of the ionospheric plasma irregularity drift velocity. The drift velocity is dependent on the Electric field along with various other parameters such as the magnetic field (from IGRF model), neutral density and temperature (from MSIS model). Hence with continuous radar observations, the variability in the electric field in response to various external forcing can be understood.

In the present study, 18MHz HF radar located at Thumba, with coordinates 8.5°N, 77°E, dip= 0.5°N is used to probe the plasma irregularities of 8.3m scale size to estimate the E region dynamo electric field during the partial solar eclipse. At Thumba, the eclipse commenced and ended at 10.20 IST and 13.15 IST, respectively, with a maximum obscuration was 23.3% at 11.40 IST. This day falls under the low solar activity period and was geomagnetically quiet; hence there was an opportunity to observe the effect of solar eclipse on the Equatorial Ionosphere distinctively. Even with low obscuration, significant perturbations were observed in the ionospheric plasma drift of this day in contrast with that on a non-eclipse day. The variations in the electric field were validated using the magnetic field variations on ground as observed by the magnetometer at Thumba. The E-region zonal electric field also affects the motion of the plasma in the F-region. The variation of plasma density with time at different altitudes upto the F region peak are examined from the Ionosonde measurements from Thumba.

The competition between the anti- clockwise Sq current system in the northern hemisphere and a clockwise current system generated by the solar eclipse induced fast moving low pressure, alters the prevailing electrodynamics of the region under the eclipse shadow [2]. In the present case, both the Sq focus and the latitude of greatest eclipse coincide, thereby generating a peculiar pattern in the electric field variation and resulting changes in the F region of the ionosphere. These results will be presented and discussed in detail.

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2. J. P. St.-Maurice, K.M. Ambili, and R. K. Choudhary, “Local electrodynamics of a solar eclipse at the magnetic equator in the early afternoon hours”, Geophysical Research Letters, **38**, L04102, February 2011, doi:10.1029/2010GL046085.