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Ionospheric total electron content variation along the annularity path during June 21, 2020, annular solar eclipse

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Solar eclipses are being studied since several decade but still considered an important event due to their uniqueness to understand several unknown problems related to the radio wave propagation and ionospheric variation in the sudden absence of ionizing radiation. In this paper we focused on the low and equatorial latitude ionospheric response to the annular eclipse of 21 June 2021. The eclipse took place on the day of the June solstice and covering long path starting from Africa to Asia with maximum eclipse over Indian region. The special focused in this work is to understand local time dependence of solar eclipse effect along the annularity path, which is not studied earlier. The analysis followed ground based and space born global navigational satellite system (GNSS) derived total electron content (TEC) data of the 06 International GNSS service (IGS) stations, 06 GNSS stations operated by IIRS, ISRO, India, FORMOSAT-7/COSMIC-2 (F7/C2) data and Global Ionosphere Maps (GIMs) data, which were utilized during the eclipse. The main focus to understand TEC along annularity path, thus entire path divided on four major regions: Africa, Arab, India and Taiwan. Over the Africa and Arab regions eclipse occurred during early morning time, over Indian region eclipse happened during noon time, while over Taiwan region, it was late afternoon or evening local time. The GNSS station lying nearly same eclipse magnitude/obscuration are chosen in the current work. In order to understand dynamical variation of eclipse, two PRNs 06 & 19 covering eclipse duration were analyzed. The average change in VTEC on eclipse day with reference to the normal days, for both PRNs during three different time of the day, varies as ~4.5-1.5 TECu during morning (Africa & Arab), ~4.5-1.5 TECu (India) during noon time, and ~7.5-3TECu during evening time (Taiwan). For those stations, where PRN06 pass close to maximum eclipse, it dominates over PRN19.

The change in the vertical electron density profile as obtained from COSMIC-2 profile showed significant decrease over the altitude range of 100-350km, with maximum decrease over Taiwan region (~40%), while closely similar decrease over Africa, and minimum decrease over Indian region. Further, the TEC variation using GIM maps showed maximum change (in terms of negative anomaly) over Africa and Taiwan region, whereas over Indian region less negative anomaly reported. All three methods, showed maximum decrease over Taiwan region similar to the previous reports on the same eclipse, but intriguing result in this work is slightly similar decrease over Africa region during morning time. We suggest effect of background density, eclipse induce change in photo-chemical process and eclipse induced change in equatorial fountain effect collectively producing considerably TEC reduction during morning time as seen in the present case.

References

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