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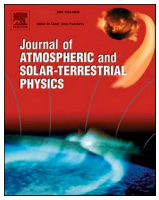

Research Paper

Ionospheric disturbances over the American and African sectors due to the 2019 major Sudden Stratospheric Warming (SSW 2019), under low solar activity conditions

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A B S T R A C T

Sudden Stratospheric Warming (SSW) is one of the most spectacular atmospheric large-scale phenomena, which takes place at high latitudes during winter months and is more frequent in the Arctic region than in the Antarctic region. SSWs can change the vertical, latitudinal, and longitudinal distributions of the neutral atmosphere and its dynamics, which in turn affects the ionospheric electrodynamic processes. Simultaneous inferred VTEC from GPS networks over the American and African sectors are used to investigate the ionospheric response due to the SSW 2019 from DOY 356 to DOY 20 (December 22, 2018–January 20, 2019). This study investigates the VTEC and EIA diurnal and day-to-day responses in the American and African sectors during the SSW. It is noted that the VTEC decreased on most of the days at several latitude regions. However, it is also noted that the VTEC increased on some days and in some latitude regions, particularly during the SSW temperature peak. The EIA exhibits significant changes in its shape, intensity, and symmetry during the SSW. This study using simultaneous observations over American and African sectors covering a large geographical extent demonstrates the similarities and differences in ionospheric response to the SSW 2019 event over different regions.

1. Introduction

Sudden Stratospheric Warming (SSW) is one of the most spectacular dynamical atmospheric large-scale phenomena (Andrews et al., 1987; Matsuno, 1971). The SSW events take place at high latitudes during wintertime and are more frequent in the Arctic region than in the Antarctic region. The latitudinal, longitudinal, and vertical variations of neutral atmospheric dynamics are significantly affected by the SSW events. These neutral atmospheric disturbances cause significant effects on ionospheric electrodynamics (Chao 1985; Goncharenko et al., 2010a, 2010b; Goncharenko and Zhang, 2008; Chau et al., 2012; Fagundes et al., 2015; Vieira et al., 2017). During SSWs the zonal wind decreases or reverses from eastward to westward in the high latitude stratosphere, due to vertical propagation of disturbed planetary waves. The combination of changes in the zonal wind and disturbed planetary waves leads to an increase in the stratospheric polar temperature for several days (Labitzke, 1978, 1981; Fagundes et al., 2015; Vieira et al., 2017).

The SSW events are classified as major and minor events. In major SSW events, the zonal mean flow reverts to the west at 60°N and the temperature can reach ~60 K more than the historical mean temperature. In minor SSWs the zonal mean flow only decreases and the temperature increases at least by 25 K above the historical mean temperature in a week or less (Blume et al., 2012; de Jesus et al., 2017a, 2017b, 2017c; Vieira et al., 2017).

The ionosphere at mid-, low-, and equatorial latitudes can be severely disturbed during the SSWs events. Several ionospheric studies have been carried out during SSWs and it has been reported that the VTEC, electron and neutral densities, and **E** x **B** drift were disturbed from the mid to equatorial latitudes. In recent times, the number of GPS receivers in the American and African sectors has increased significantly, which allowed us to investigate the longitudinal and latitudinal dissimilarities and similarities that occur in the ionosphere due to disturbances caused by the SSW. Therefore, the vertical total electron content (VTEC), rate of change of TEC (ROT), and the VTEC rate of change index (ROTI), derived from GPS receivers, allow for investigation of the positive and negative ionospheric phases, irregularities occurrence, and Equatorial Ionospheric Anomaly (EIA) space-time variation in both sectors simultaneously (Bolaji et al., 2017, 2019; Chau et al., 2010, 2012; de Jesus et al., 2017a, 2017b; Fagundes et al., 2015; Goncharenko et al., 2010a, 2010b; Kakoti et al., 2020; Korenkov et al., 2012; Liu et al.,

Abbreviations: SSW, Sudden Stratospheric Warming; VTEC, Vertical Total Electron Content; EIA, Equatorial Ionospheric Anomaly.

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