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Research Paper

Statistical analysis on the ionospheric response over South American mid- and near high-latitudes during 70 intense geomagnetic storms occurred in the period of two decades

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ABSTRACT

The first-time statistical response of the positive and negative ionospheric storms phases using Vertical Total Electron Content (VTEC) measurements during 70 geomagnetic storms at near high- and mid-latitudes regions in the Antarctic and Argentine/Chilean sectors in the Southern hemisphere are investigated. The study covers the years between 1999 and 2018 of solar cycles 23 and 24, using the Dst ≤ -100 nT as a criterion for all 70 storms selected. Significant features of solar cycle, seasonal and local time of ionospheric storms are showed. Our results indicate that the occurrence of geomagnetic storms follows a pattern of solar activity dependence, and also indicate a predominance of positive and positive-negative phases during autumn, winter, and spring at mid-latitudes and winter at near high-latitudes. Negative and negative-positive phases occur during all seasons at near high- and mid-latitudes. In addition, positive phases occur more frequently during the daytime while the negative phases occur predominantly in nighttime. There is also a predominance of positive and positive-negative phases simultaneously at near high- and mid-latitudes in the Antarctic and Argentine/Chilean sectors. The percentages of occurrence of positive and positive-negative phases are of 50% and 19%, respectively, at mid-latitude and 60% and 22%, respectively, at near high-latitudes. Negative and negative-positive phases are below 9% at both latitudes.

1. Introduction

Geomagnetic storms are one of the major consequences of space weather disturbances, and they can be caused by the corotation interaction regions (CIRs) or coronal mass ejections (CMEs) from the Sun. CME's impact on Earth's magnetic field can produce a geomagnetic storm, which can cause significant and adverse problems on ground- and space-based technological systems (Buonsanto, 1999). The interaction between the interplanetary magnetic field (IMF) and the Earth's magnetic field occurs through the process of magnetic reconnection, where energy is transferred from the solar wind into the magnetosphere. The southward directed IMF lines (Bz component) interconnect with the northward Earth's geomagnetic field lines on the daytime side carrying the energy over the polar cap towards the magnetospheric tail on the nighttime side. At the tail, a new reconnection occurs and the energy is injected into the Earth's atmosphere. The studies of the geomagnetic storms are described in a large number of works (e.g., Gonzalez and Tsurutani, 1987; Goldstein et al., 2005; de Abreu et al., 2010a, 2011; de Jesus et al., 2013, 2016; Priyadarshi et al., 2018, and references therein).

Ionospheric storms are closely associated with geomagnetic storms and their response is rather complicated because they depend on local time, season, latitude, neutral winds, and electric fields. Two types of storm time electric fields can cause the changes in the ionospheric F-region from equatorial to high-latitudes: prompt or direct penetration of magnetospheric electric fields (PPEF) and disturbed dynamo electric

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