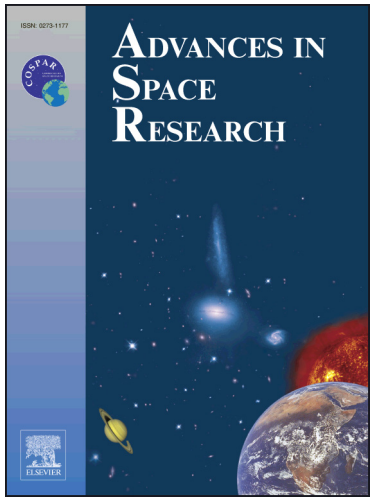

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The ionospheric storms in the American sector and their longitudinal dependence at the northern middle latitudes

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Abstract On the basis of the total electron content (TEC) observations from Madrigal database, we have made a statistical analysis of the ionospheric response during 217 geomagnetic storms from the year 2001 to 2015, including observations at 6 different latitude zones along one meridian in the American sector and 4 different longitudes **at** the **middle** latitude zone. Our results show that the ionospheric storm has prominent latitudinal dependence, with negative storm prevailing at high latitudes and positive storm at lower latitudes. The maximum ratio of positive to negative storms is observed at around 30°N magnetic latitude. The ionospheric **response** depends also on the phases of the storm. The occurrence of positive storm decreases **during** recovery phase when compared to that during main phase, while the negative storm presents opposite pattern. However, the occurrence of positive storm increases at equatorial and low latitudes **during** recovery phase. Additionally, **during** main phase, the occurrence of negative storm is higher at equatorial and low latitudes than **that** at middle latitudes. The local time dependences of the ionospheric storm onsets are quite different for different latitudes. The negative storm mainly occurs from post-middle night to morning hours and the positive storm mainly occurs during daytime at middle latitudes; while both the positive and negative storms mainly occur during nighttime at equatorial latitude. For all **latitudes**, the typical time delay **between the main phase onset and the onset time of ionospheric** negative storm is longer than 10 hours, while it is shorter than 10 hours for positive storm (expect at low and equatorial latitudes). We further **check** the longitudinal dependence of the ionospheric storm at middle latitude, and **find** that the occurrence of positive storm is higher **in American** and Asian sectors than that in European sector, and the non-significant storm is mostly observed **in European** sector. The 'forbidden time interval' of negative storm **in Asian** sector is different with that **in American and European sectors**.

Keywords: Ionospheric storms; TEC; Latitude and longitude dependences;

1. Introduction

During geomagnetic storms, the solar wind with higher velocity and increased density compresses the Earth's magnetosphere and transfers huge energy into the upper atmosphere in the forms of intense electric fields, rapid convection of plasma and energetic particles precipitation and so on (Buonsanto, 1999). The enhanced energy input can cause significant perturbations of ionospheric parameters from their quiet-period levels, exhibiting as positive or negative phases of the ionospheric storms. The disturbances of the ionospheric storms can last from several hours to several days, affecting the ground-based and space-based technological systems and **human** activity. Therefore, the understanding of the ionospheric storms has great importance on modeling

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