Effect of Geomagnetic Storms of Different Solar Origin on the Ionospheric TEC

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Abstract. We have studied the behaviour of ionospheric Total Electron Content (TEC) at a mid latitude station Usuda (36.13^{0}N, 138.36^{0}E), Japan during intense geomagnetic storms which were observed during 23 solar cycle (1998-2006). For the present study we have selected 47 intense geomagnetic storms (Dst ≤ -100nT), for the given period, which were then categorised into four categories depending upon their solar and interplanetary sources like Magnetic Cloud (MC), Co-rotating Interaction Region (CIR), Sheath driven Interplanetary Coronal Mass Ejection (SH+ICME) and Sheath driven Magnetic cloud (SH+MC). From our study we found that the geomagnetic storms significantly affect the ionosphere having any of the solar origin. However the geomagnetic storms which are either caused by SH+MC or SH+ICME produced maximum effect in TEC.

INTRODUCTION

The Sun is the major source of energy that controls the near earth environment and its weather and climate. Energy emitted from Sun drives the earth's magnetosphere, thermosphere and ionosphere. The most powerful solar event is Coronal Mass Ejections (CMEs) which is a result of solar wind outbursts from active region of the sun [1]. CMEs interact with solar wind and Interplanetary Magnetic Field (IMF) during their propagation and disrupt the solar wind flow. Geomagnetic storms are largely associated with CMEs from the Sun. High latitude electric field can penetrate into mid, low and equatorial ionosphere during a geomagnetic storm causing significant disturbances in ionospheric conditions [2-4]. The disturbed ionosphere is manifested as a large increase or depletion of electron density from their normal level. This kind of response of the ionosphere to the geomagnetic storms is known as ionospheric storms. The ionospheric storms can cause many serious problems such as time delay, range error and scintillation in satellite communication and navigation. The ionospheric response to geomagnetic storms has been a subject of numerous researches for several decades using various ground and satellite based instruments/techniques likes Ionosonde, Incoherent Scatter Radar (ISR), magnetometer and satellite observations. ISRs are limited by their local coverage, and ionosonde can only cover the bottom part of the ionosphere, whereas Global Positioning System (GPS) measurements enable the ionosphere to be well monitored. GPS has been used as a powerful tool to monitor and estimate the ionospheric TEC [5-8]. The magnitude of the TEC in the ionosphere is not constant and it varies with season, solar activity phase, local time, geographical position and the time of storm onset [9-10]. International GPS network spread all over the globe provide a great opportunity to researchers for studying the upper atmosphere. Now-a-days number of researchers is using GPS based observations to investigate the impact of geomagnetic storm on the TEC [1, 7, 11-16].

Since each geomagnetic storm has its own unique characteristics therefore prediction, forecasting and now-casting of ionospheric response to geomagnetic storms is a topic of intensive interest for researchers from decades.

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