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Evaluation of geomagnetic storm effects on the GPS derived Total Electron Content (TEC)

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Abstract. The geomagnetic storm represents the most outstanding example of solar wind-magnetospheric interaction, which causes global disturbances in the geomagnetic field as well as triggers ionospheric disturbances. We study the behaviour of ionospheric Total Electron Content (TEC) during the geomagnetic storms. For this investigation we have selected 47 intense geomagnetic storms (Dst $\leq$ -100nT) that were observed during the solar cycle 23 i.e. during 1998- 2006. We then categorized these storms into four categories depending upon their solar sources like Magnetic Cloud (MC), Co-rotating Interaction Region (CIR), SH+ICME and SH+MC. We then studied the behaviour of ionospheric TEC at a mid latitude station Usuda (36.13N, 138.36E), Japan during these storm events produced by four different solar sources. During our study we found that the smooth variations in TEC are replaced by rapid fluctuations and the value of TEC is strongly enhanced during the time of these storms belonging to all the four categories. However, the greatest enhancements in TEC are produced during those geomagnetic storms which are either caused by Sheath driven Magnetic cloud (SH+MC) or Sheath driven ICME (SH+ICME). We also derived the correlation between the TEC enhancements produced during storms of each category with the minimum Dst. We found the strongest correlation exists for the SH+ICME category followed by SH+MC, MC and finally CIR. Since the most intense storms were either caused by SH+ICME or SH+MC while the least intense storms were caused by CIR, consequently the correlation was strongest with SH+ICME and SH+MC and least with CIR.

1. Introduction

Energy emitted from sun drives the earth's magnetosphere, thermosphere and ionosphere. The most powerful solar events like Coronal Mass Ejections (CME) are a result of plasma 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. CMEs faster than ~500 Km/s eventually drive shock waves which normally strike the earth's magnetosphere in 24 to 36 hours after the event onset on sun.