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ORIGINAL ARTICLE

Solar transients disturbing the terrestrial magnetic environment at higher latitudes

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Abstract Geomagnetic field variations during five major Solar Energetic Particle (SEP) events of solar cycle 23 have been investigated in the present study. The SEP events of 1 October 2001, 4 November 2001, 22 November 2001, 21 April 2002 and 14 May 2005 have been selected to study the geomagnetic field variations at two high-latitude stations, Thule (77.5° N, 69.2° W) and Resolute Bay (74.4° E, 94.5° W) of the northern polar cap. We have used the GOES proton flux in seven different energy channels (0.8–4 MeV, 4–9 MeV, 9–15 MeV, 15–40 MeV, 40–80 MeV, 80–165 MeV, 165–500 MeV). All the proton events were associated with geoeffective or Earth directed CMEs that caused intense geomagnetic storms in response to geospace. We have taken high-latitude indices, *AE* and *PC*, under consideration and found fairly good correlation of these with the ground magnetic field records during the five proton events. The departures of the *H* component during the events were calculated from the quietest day of the month for each event and have been represented as ΔH_{THL} and ΔH_{RES} for Thule and Resolute Bay, respectively. The correspondence of spectral index, inferred from event integrated spectra, with ground magnetic signatures ΔH_{THL} and ΔH_{RES} along with *Dst* and *PC* indices have been brought out. From the correlation analysis we found a very strong correlation to exist between the geomagnetic field variation (ΔHs) and high-latitude indices *AE* and *PC*. To find the association of geomagnetic storm intensity with proton flux characteristics we derived the correspondence between the spectral indices and geomagnetic field variations (ΔHs) along with the *Dst* and *AE* index. We found a strong correlation (0.88) to exist between the spectral indices and ΔHs and also between spectral indices and *AE* and *PC*.

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1 Introduction

During the high energy solar transients, like Solar Flares, a huge amount of energy is released from the Sun in very short duration of time, either in the form of radiation across entire electromagnetic spectrum or mass ejections from the active regions commonly known as Solar Flares and Coronal Mass Ejections, respectively. Coronal Mass Ejections (CMEs) are large-scale expulsions of plasma from the Sun, driving coronal material into interplanetary space which can generate substantial disturbances in the ambient solar wind. The interplanetary counterparts of CMEs known as ICMEs are believed to be the prime cause of geomagnetic storms (Gosling et al. 1991; Bothmer and Schwenn 1995; Webb et al. 2000; St. Cyr et al. 2000; Cane et al. 2000; Tsurutani et al. 2006). Not every CME can lead to a geomagnetic storm; only those CMEs which are directed towards Earth or have a significant earthward velocity component can cause geomagnetic storms. Therefore the occurrence of a front-side halo CME is also responsible for producing a geomagnetic storm and monitoring of these CMEs plays a central role in geomagnetic storm forecasting (Luhmann 1997). However, even if an ICME reaches Earth, it may still not be