FIRST RESULTS ON CLIMATOLOGICAL RESPONSE OF INDIAN LOW LATITUDE IONOSPHERE TO GEOMAGNETIC STORMS DURING SOLAR CYCLES 23 AND 24

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ABSTRACT

For the first time, a climatological response of low latitude ionosphere over Indian region to geomagnetic stormsis presented using long term global ionospheric maps (GIM) data from June 1998 to June 2015 covering two solar cycles 23 and 24. The results are not only the first from this region but also the first around the globe to bring out the latitudinal character of daytime ionospheric storms withuse of newly defined criteria. Seasonal statistics for totalstorms, effective positive and negative storms, and amplitude of mean seasonal perturbation intotal electron content are obtained

Key words: Space Weather, Ionospheric storms, Climatology, Equatorial and low latitude Ionosphere, Global Ionospheric Maps (GIM)

1. Ionospheric storm selection

The results are presented for daytime forenoon and afternoonsectors under minor (Dst<-50 nT), moderate (-200nT<minimum Dst<-100nT) and major (Dst<-200 nT) ionospheric storm categories based on minimum Dst index criterion. For the first time the effectiveness of storms is identified using monthlystandard deviation as an indicator of the day-to-day variability in equatorial and low latitudeionosphere. Thus results on climatology are definitive and form a data base that would becomparable to statistical results from any other longitude and time.

2. Occurrence statistics

Total and effective storms are found to be higher in solarcycle 23 than in 24 and only couple of effective storms occurred during low solar activity 2007-2009 that also in minor category. Afternoon sector is found to be favourable for occurrenceof maximum number of effective positive storms. A latitudinal preference is found for a given storm to be effective in either time sectors.

3. Seasonal distribution

Equinoctial asymmetry in ionospheric responseboth in terms of occurrence and perturbation amplitude is found. September equinoxes are found to bear maximum total, effective positive and negative storms. Winters are found moreprone to negative storms whereas summers have recorded minimum number of either of stormsand minimum perturbation amplitudes.

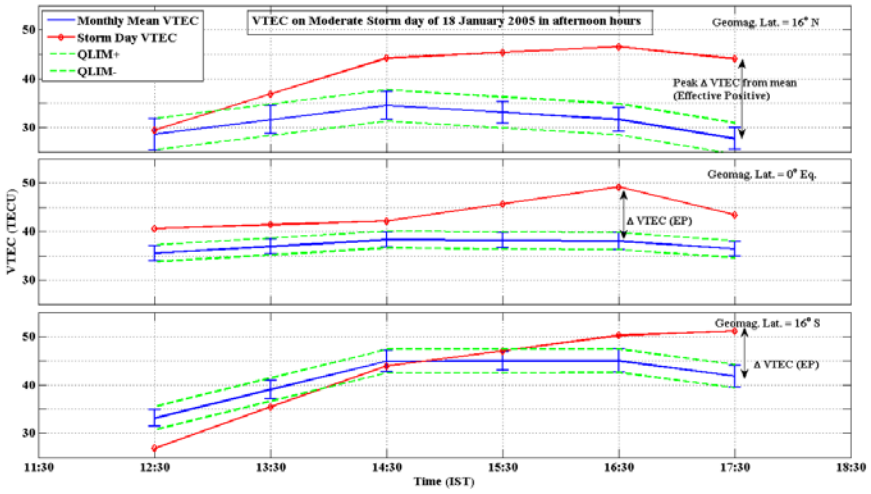

Figure 1.Selection criteria adopted for an effective ionospheric storm. The three columns indicate the same storm day for the three chosen latitudes.

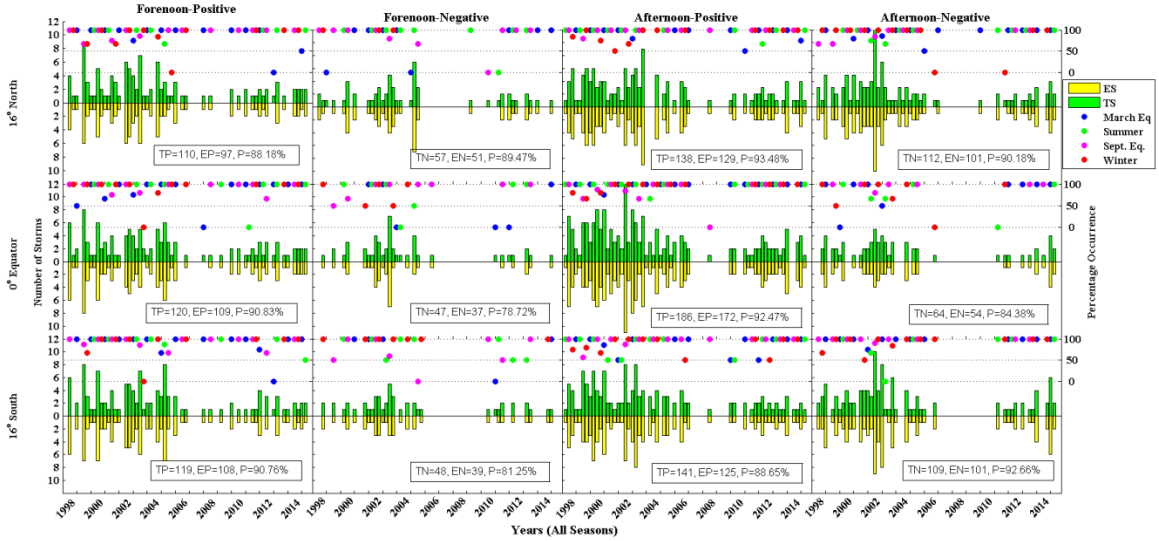

Figure-2 Minor **ionospheric** storm (-100nT<Minimum Dst<-50nT) occurrence statistics for all seasons between June 1998 to June 2015 with number of total storms (**TP and TN**) shown as green bars and number of effective storms (**EP and EN**) as yellow bars for Northern, Equatorial and Southern locations respectively from top to bottom and positive and negative occurrences given in left and right columns each for both the forenoon (columns 1 and 2) and afternoon (columns 3 and 4) sectors. The seasonal percentage occurrence (P) of ES upon TS is shown on the right ordinate with coloured markers. The cumulative TS, ES and P figures for each box are annotated as text. The solstices are taken hemispheric-local and equinoxes are common for all three locations.

4. Perturbation amplitude of VTEC

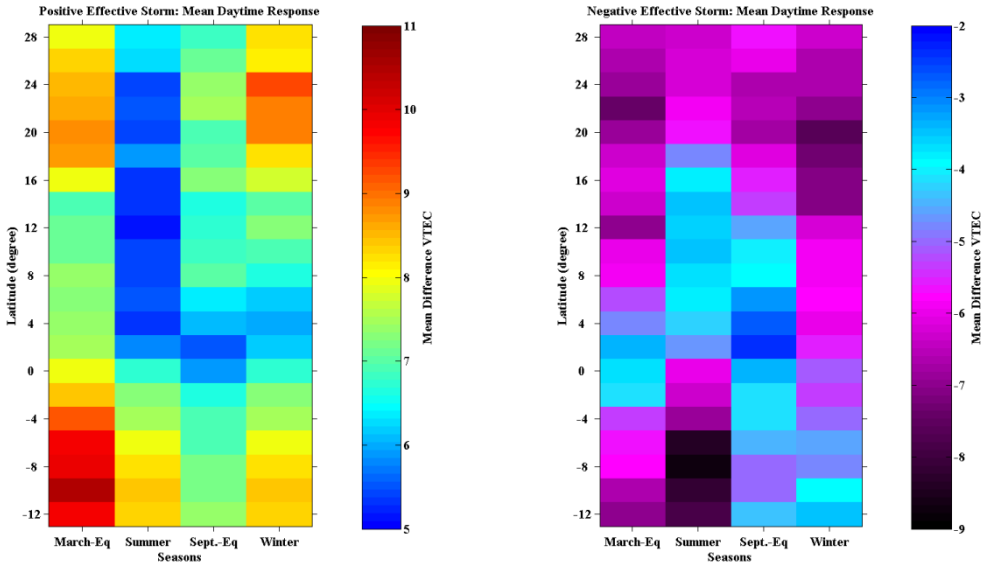

Figure-3. Latitudinal distribution of seasonal average of maximum deviations of VTEC from quiet time seasonal mean VTEC for **positive (left panel) and negative (right panel) effective ionospheric storms** from 1998 to 2015 in minor **ionospheric** storm category.

A new criterion is defined for effectiveness of an ionospheric storm in low latitudes. The effective positive and **negative s**torms occur more in **afternoon** hours under all **ionospheric** storms categories at all latitudes in comparison to forenoon hours. This has been explained by combined net positive effect of PPEF and TADs in main phase supported by higher background VTEC in EIA zone in late afternoon hours. [6].The percentage occurrence of total and effective storms peak in September equinox closely followed by March equinox but found lesser in winter and summer solstices. Also the probability of a storm to be positive (negative) and effective positive (negative) is found higher over dip equator (low latitude locations). The probability of an effective storm to be positive (negative) is found higher in winter/March equinox (summer/September equinox).

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