Statistics of ionospheric storms at mid latitudes: Agreement between observations and theory

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In this paper we present the statistics of the ionospheric storms at the low-mid latitude station Kokubunji (35.7N, 139.5E; 26.8N geo. mag.) in Japan and mid latitude station Boulder (40N, 255E; 49N geo. mag.) in America by analyzing 21 years each of the peak electron density (Nmax) data measured during 1985-2005 covering two solar cycles. A striking result is that the frequency of occurrence of positive ionospheric storms at the low-mid latitude location Kokubunji (26.8N geo. mag.) is nearly double that at the mid latitude station Boulder (49N geo. mag.). This observation agrees with the latitude variation of the physical mechanisms of positive ionospheric storms reported in our recent paper.

A total of 579 geomagnetic storms (Dst <-50 nT) occurred during 1985-2005, which includes 19 super storms (Dst <-250 nT), 153 major storms (Dst < -100 nT <-250 nT) and 407 moderate storms (Dst <- 50 nT <-100 nT). The ionospheric data (Nmax) are available for 512 storms at Kokubunji and 485 storms at Boulder. The analysis of the data shows five categories of ionospheric storms: (1) Positive storms (P storms) 248 at Kokubunji and 122 at Boulder, (2) negative storms (N storms) 102 at Kokubunji and 220 at Boulder, (3) positive followed by negative storms (PN storms) 61 at Kokubunji and 54 at Boulder, (4) negative followed by positive storms (NP storms) 10 at Kokubunji and 18 at Boulder, and (5) non-significant storms (NS storms) 91 at Kokubunji and 71 at Boulder.

The statistics of occurrence of the different types of ionospheric storms are presented as function of solar cycle phases, season and local time of onset of the main phase (MP) of the geomagnetic storms. The occurrence of all types of ionospheric storms as expected is more frequent at solar maximum and less so at solar minimum. With season, the P storms and PN storms are frequent in winter while N storms are frequent in summer (June solstice). With local time (LT), the P storms occur frequently for morning-noon MP onsets centered at 09 LT while N storms occur frequently for evening-morning MP onsets. The strength of the ionospheric storms (or peak storm-time deviation of Nmax from quiet-time average level) shows better positive correlation with the intensity of geomagnetic storms at Boulder than at Kokubunji. The statistical results are discussed with the latitude variations of the physical mechanisms of positive and negative ionospheric storms.