Hierarchy of the Ionosphere and Magnetosphere Storms in the Earth's Environment

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Analysis of interdependencies between the different geomagnetic and ionospheric indices is made to estimate their predictive capability. The regression between geomagnetic and ionospheric indices with the High-Speed Stream (HSS) solar wind observed during 477 ring current storms at the 23rd-24th solar cycles is used for ranking the minor, moderate and intense geo-storms for their prediction.

Superposed epoch analysis is applied to the solar wind Vsw, its increment ΔVsw, the geomagnetic AE, AL, AU, kp, ap, aa, and Dst indices and the ionospheric weather WE, WU, WL indices with zero time t_0 put at the onset of Dst storm. Global negative WL, positive WU and combined WE indices present ensemble of the local W-index effects of solar storms at each cell of the global GIM-TEC map while the local W index denotes deviation of instant ionospheric parameter (TEC, foF2, hmF2) from the quiet reference [1-4]. Thresholds for the quiet conditions, minor storm G0, moderate storm G1 and intense storm G2 are introduced and provided Table 1.

Table 1. Thresholds for quiet conditions and three categories of storm for the solar wind, geomagnetic and ionospheric indices.

Category	Quiet	Minor storm G0	Moderate G1	Intense G2
Vsw, km/s	Vsw < 450	450 ≤ Vsw < 550	550 ≤ Vsw < 700	Vsw ≥ 700
ΔVsw, km/s	ΔVsw < 65	65 ≤ ΔVsw < 100	100 ≤ ΔVsw < 160	ΔVsw ≥ 160
AE, nT	AE < 250	250 ≤ AE < 500	500 ≤ AE < 1000	AE ≥ 1000
AL, nT	AL > -150	-150 ≥ AL > -400	-400 ≥ AL > -700	AL ≤ -700
AU, nT	AU < 100	100 ≤ AU < 200	200 ≤ AU < 350	AU ≥ 350
kp, i.u.	kp < 3	3 ≤ kp < 5	5 ≤ kp < 6	kp ≥ 6
ap, nT	ap < 15	15 ≤ ap < 48	48 ≤ ap < 80	ap ≥ 80
aa, nT	aa < 27	27 ≤ aa < 60	60 ≤ aa < 100	aa ≥ 100
Dst, nT	Dst > -30	-30 ≥ Dst > -50	-50 ≥ Dst > -100	Dst ≤ -100
WE, i.u.	WE < 4.3	4.3 ≤ WE < 5.0	5.0 ≤ WE < 6.0	WE ≥ 6.0
WL, i.u.	WL > -2.2	-2.2 ≥ WL > -2.8	-2.8 ≥ WL > -3.5	WL ≤ -3.5
WU, i.u.	WU < 2.0	2.0 ≤ WU < 2.4	2.4 ≤ WU < 3.0	WU ≥ 3.0

The geomagnetic and ionospheric activity indices are ranked to provide hierarchy of their response to high-speed streams HSS of the solar wind. Regime of assimilation of the instant data by the reference models and maps allows build up the instantaneous maps of the F2 layer critical frequency and height for more than half-century period which would provide new data base for further analysis, modeling and validation of three categories of geo-storms.

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