Comparison of substorms observations during two solar cycles maximum: at 1999-2000 and 2012-2013

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INTRODUCTION

We presented the comparative analysis of the substorm behavior in the periods of two solar cycles maximum (1999-2000, with Wp> 100 and 2012-2013 with Wp~60).

All considered substorms were divided into 3 types according to auroral oval dynamic.

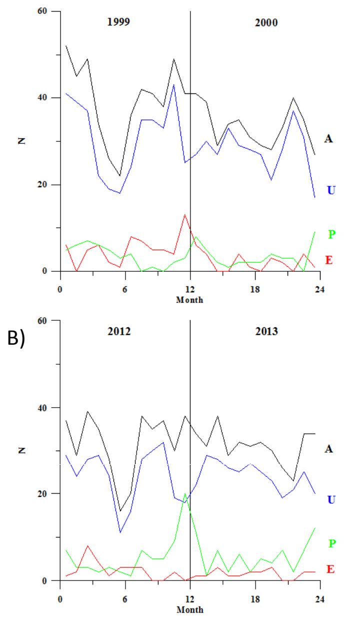
First type - substorms which observed only in auroral latitudes ("usual" substorms);

Second type - substorms which propagate from auroral latitudes (<70º) to polar geomagnetic latitudes (>70º) ("expanded" substorms, according to expanded oval);

Third type is substorms which observed only at latitudes above ~70º in the absence of simultaneous geomagnetic disturbances below 70° ("polar" substorms, according to contracted oval).

For this analysis, we used the observations of 10-s sampled IMAGE meridian magnetometer profile data and the 1-min sampled OMNI solar wind and interplanetary magnetic field (IMF) data. There were analyzed above 1700 events of "expanded", "polar" and "usual" substorms in 1999- 2000 and in 2012-2013 years. .

Results



Seasonal variatons of substorms number in 1999-2000 years.

A- all substorms
U- classical (usual) substorms
P- polar substorms
E- expanded substorms

Seasonal variatons of substorms number in 2012-2013 years.

A- all substorms
U- classical (usual) substorms
P- polar substorms
E- expanded substorms

Fig.1. The results of seasonal variations of substorms during two solar cycle maximums – a)- in 1999-2000 years ; b) – in 2012-2013 years

It is seen that:

- number of substorms is higher during 1999-2000 periods than during 2012-2013 periods;
- summer minimums of substorms number and spring and autumn maximums are common to both periods;
- polar substorms behavior was in opposition to other types of substorms. Number of polar substorms have maximum in the winter months;
- wherein it is noted that expanded substorms maximum was observed in winter 1999-2000, but not observed in winter 2012-2013 .

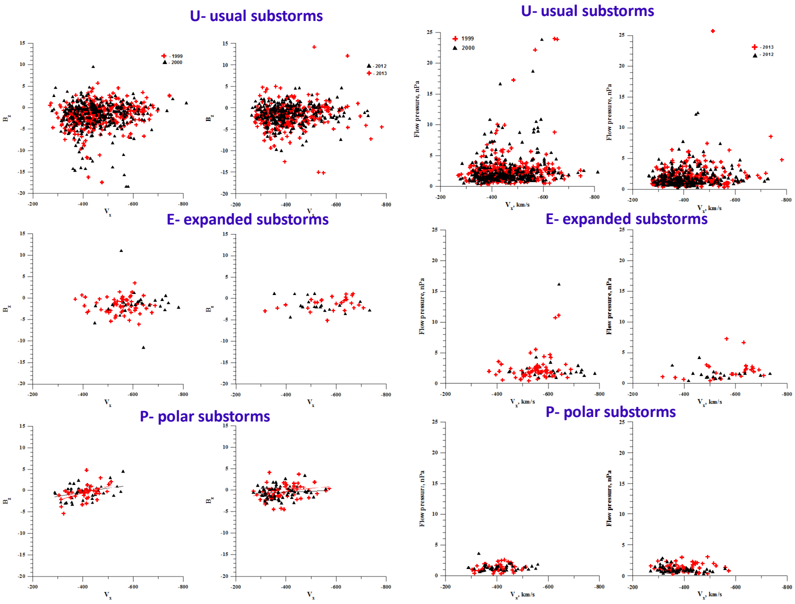


Fig. 2 Parameters of the solar wind and the IMF (B_Z, V_X, P) before substorms onsets for 1999-2000 (left column) and for 2012-2013 (right column)

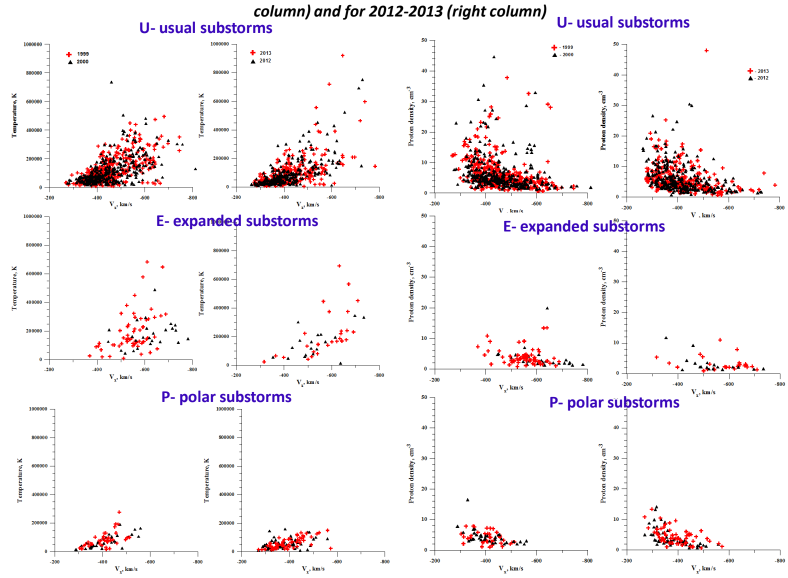


Fig. 3 Parameters of the solar wind and the IMF (T, V_X, N) before substorms onsets for 1999-2000 (left column) and for 2012-2013 (right column)

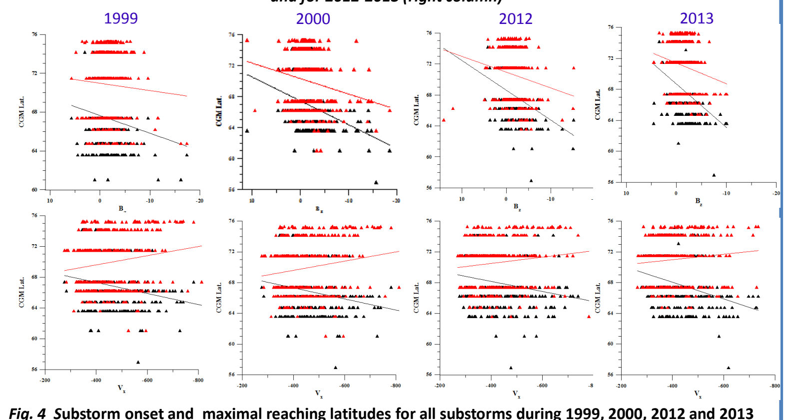


Fig. 4 Substorm onset and maximal reaching latitudes for all substorms during 1999, 2000, 2012 and 2013 periods in dependence on solar wind velosity (V_X) and B_Z component of IMF

It is seen that:

1. Substorms onset latitudes for 1999-2000 years were a little lower that onset latitudes for 2012-2013 years
2. The latitudinal sizes of substorms in 1999-2000 years were a little more than the latituinal size of substorms during 2012-2013 years.
3. Significant differences in dependencies on the solar wind parameters (Vx, Bz, P, N, T) between substorms in 1999-2000 and substorms in 2012-2013 not found.