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Jumps of the solar wind direction and the substorm probability

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Magnetospheric substorm commonly supposed to consist of two stages, loading and unloading. During the first stage the magnetic energy is stored in the magnetotail, which leads to increasing of the magnetic field intensity in the lobes and electric currents in the plasma sheet. The next uloading stage usually related to the reconnection process, which releases accumulated magnetic energy and produces the bursty bulk flows (BBFs) in the magnetotail. Such a scheme has been confirmed from both experimental and theoretical points of view. The weakest point of this scheme is the physical conditions which are necessary for the onset of the reconnection, but although the huge number of investigations was made to this end. Among them substorm triggers such as pressure pulses, turning of the interplanetary magnetic field (IMF) to the north direction and so on. We would like to emphasize the role of the bent current sheets first proposed by Kivelson and Hughes in 1990.

The idea is that in the asymmetric configurations gradients and current density growth, so these conditions are supposed to be favorable for the reconnection. Then the minimal stress of the system can lead to the substorm onset.

In the presented study we have analyzed the possibility of the current sheet asymmetry to be the trigger in theory and in observations (by statistical analysis of substorm occurrences). The bent of the current sheet can be produced by different sources. The most evident of them are the dipole tilt angle variations and the changes of the solar wind direction. The first source, tilt variations, are slow, so in the current study we at first analyzed the fast changes of the solar wind.

The experimental analysis includes the investigation of the number of the events against dipole tilt angle and the solar wind direction, which both produce the distortion and inclination of the dipole current sheet. Theoretical investigation of this issue is based on the analysis of the quasi-dynamical analytical models of the asymmetric current sheet configurations. We found that in the model configuration current sheet can be constricted or distorted by the additional electric field produced by the fast changings of the configuration symmetry, and results agree with the statistical analysis. The effect will be much noticeable for the periods of the big tilt angle, so we suppose that this effect can be responsible for the bigger number of the small substorm events in this time intervals.