High-latitude propagation of substorms under high-speed solar wind: Which other solar wind parameters affect the phenomenon?

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It is known that propagation of the substorm related electrojet and precipitation to very high latitudes is possible only under high-speed solar wind conditions. One may suggest that this is due to enhancement of the cross-tail current in the magnetotail related to increase of the solar wind pressure (the dynamic pressure controls the near and mid-tail, the kinetic and magnetic pressure control the far tail). This led us to investigation of the relationship between the solar wind velocity and pressure. Some previous studies showed that the solar wind thermal proton pressure do increases during high-speed solar wind flows. Now the account of the electron pressure is possible on the basis of large data set from the Wind spacecraft. Our consideration based on the Wind data showed that, in fact, the total thermal pressure (nkTi+nkTe) does not correlate with solar wind velocity. This is because the plasma density decreases as the velocity increases. We also found that neither solar wind dynamic pressure nor magnetic field pressure are crucial parameter for the “high-latitude” substorms. But, some correlation has been found between the substorms and solar wind electric field (Esw = Vx*Bz) integrated for two-hour interval before the appearance of the substorm at high latitude. In particular, we found that under Vsw>500 km/s conditions the probability to observe the substorm at higher latitude increases as the integrated Vx*Bz increases.