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Statistical study of interplanetary condition influence on the geomagnetic substorm onset location inferred from SuperMAG auroral electrojet indices

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It is well known that the magnetospheric substorm occurs every few hours, in response with the interplanetary condition variation and the increase of energy transfer from the solar wind to the magnetosphere. Since the substorm activity correlated well with the geomagnetic index, Newell and Gjerloev [2011] identified the substorm onset and its contributing station, using the SuperMag auroral electrojet indices. In this study, we investigate the distribution of these substorm onset locations and its response to the varied interplanetary condition. It is surprise that the substorm onset locations show double-peak structure with one peak around pre-midnight sector and the other at the dawn side. The substorm onset tends to occur in pre-midnight sector during non-storm time while it often takes place in late morning sector ($\sim$4 MLT) during storm time. Furthermore, substorms, appearing in magnetic storm main phase predominate in late morning. As the geomagnetic index Dst decreases, the substorm onset occurs in late morning more frequently. The substorm onset locations were also classified based on the solar wind parameters. It is shown that the peak number ratio of the substorm onset location in late morning over pre-midnight increases as IMF Bz decreases from positive to negative and the solar wind velocity Vsw enhances. The more intense interplanetary electric field E promotes the substorm onset occurring in late morning.
It is widely accepted that both the directly driven (DD) and loading/unloading (LL/UL) processes play an essential role in the energy dispensation from the solar wind into the magnetosphere-ionosphere system. In general, the former one corresponds to the DP2 current system, which consists of the eastward electrojet centered near the dusk and the westward electrojet centered in the dawn, while the latter one corresponds to the DP1 current system, which is dominated by the westward electrojet in the midnight sector. Our statistical results of substorm onset locations imply that the energy from the solar wind tends to deplete in the directly driven process, as the interplanetary electric field is stronger.