Multi-Spacecraft and Ground Observations of Magnetospheric and Ionospheric Responses to Continuous Energy Input from the Solar Wind

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On June 28, 1997, WIND spacecraft measurement indicated a long period of mostly southward interplanetary magnetic field (IMF) Bz while other parameters remained overall quasi-steady. This continuous energy input to the magnetosphere over nearly 6 hours has led to large auroral activities in the ionosphere as well as the magnetospheric disturbances. POLAR UVI measurement showed the active auroral substorm brightening over wide area covering a deep-dusk side to local midnight, but the auroral regions with peak intensity were clearly separated into three events in longitude. They appear to have initiated separately, and have developed rather independently at the early stage from the outset. These independent occurrences among three events are further evidenced by interpreting the corresponding (three) westward electrojets in the ionosphere along with the Geotail spacecraft observations at near-tail which show the magnetic field dipolarization, its corresponding current reduction in the central current sheet, and the signature of the field-aligned current. At later stages of time evolution, on the other hand, auroral brightenings at two events tend to merge and more interestingly spread eastward. This eastward spreading is likely due to eastward drift of precipitating auroral electrons under the enhanced convection. Also, the geosynchronous energetic particle injections though with weak magnitude reveal an opposite pattern to normal energy-dispersion of the typical substorm, another signature of enhanced convection. In conclusion, (i) what was observed here is a spatially-multiple occurrence of not-fully-expanded substorms under the continuous forcing by the prolonged southward IMF, and (ii) this is in strong superposition with the enhanced convection under the same IMF condition.