COMPARISON BETWEEN GROUND OBSERVED SUBSTORM ONSET TIMING AND THEMIS SATELLITE OBSERVATIONS.

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The unprecedented coverage of the THEMIS GBO station network coupled with high temporal and spatial resolution allowed us to determine the various stages of the global scale developments of the optical aurora at substorm onsets. We identified several steps of the substorm onset auroral phenomena and we suggest that the most rapid development is the starting of the Substorm Poleward Expansion (SPE) and it is most useful for accurate timing of the substorm onset. The physical significance of this step is the start of the large scale substorm energy dissipation in the atmosphere due to particle precipitation and auroral electrojet currents. We also recognized several pre-cursor features. We also measured the time of arrival of magnetic impulses associated with the same substorms at the THEMIS satellites. We used these times and a simple model consisting of a variable Alfven speed combined with assumed iono-acoustic speeds in the range from 300 to 800 km/s to calculate the location and time of the origin of the magnetic impulses propagating from substorm onset. The assumption was made that the substorm occurred between two THEMIS satellites and the impulses propagated away from a singular starting point in and out along the magneto tail GSM-x axis. This technique is only useful in cases where the ground based signature of the substorm is very close in local time (or longitude) to the foot of the field lines of the THEMIS satellites. The x distance of the calculated origins were naturally highly dependent on the assumed propagation velocity model and the associated magneto-sonic speed. The resulting x distances of the starting point for the three events ranged between 11 and 17.6 R_e. denoting a starting region that requires highly stretched field lines to map to the auroral onset latitude. The corresponding start times were in the range of 0 to 170 seconds prior SPE depending strongly on the propagation speed.

THEMIS, substorm

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