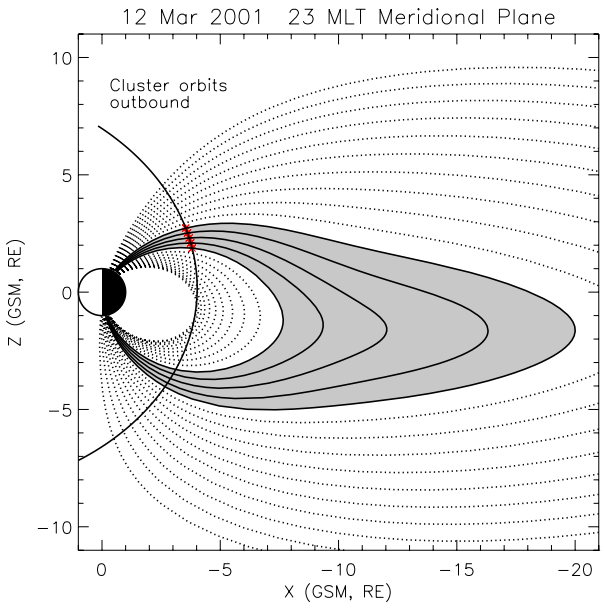
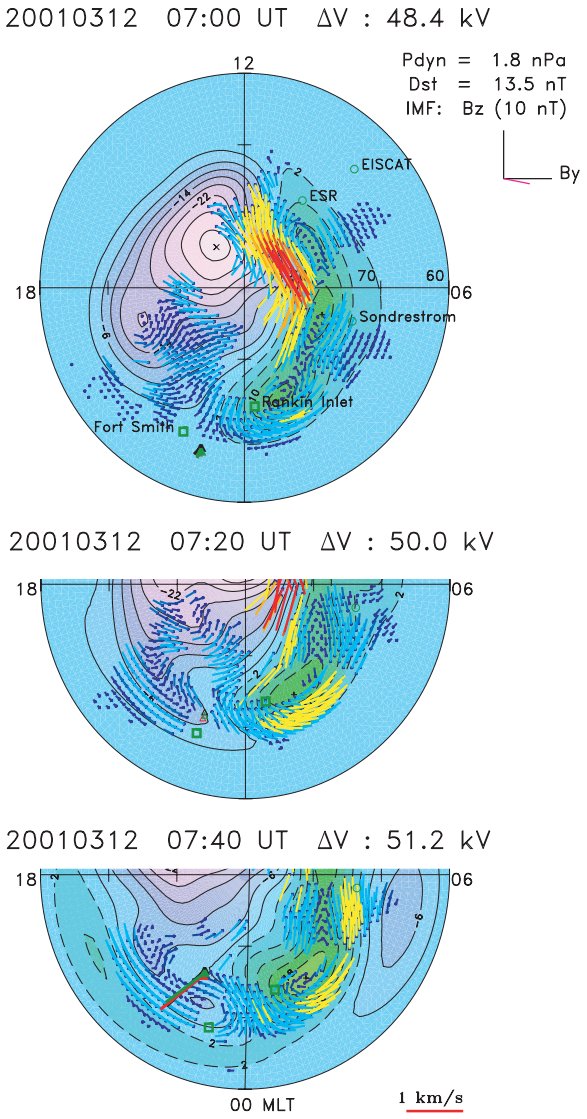
Magnetosphere - Ionosphere Coupling: Substorms

The classical paradigm of the substorm current wedge as diversion of the neutral sheet current closing through the ionosphere from dawn to dusk is probed with the four-point Cluster measurements in a new-fashioned way. We examine the current structures within the high-altitude (at $\sim 4.3\ R_E$) inner–magnetosphere intermediate region between the equatorial plasma sheet and the ionospheric Harang discontinuity or substorm current wedge (SCW) sector for one particular interval during a series of substorm pseudo-onsets. The traditional single–spacecraft methods for current estimations are applied to deduce both the field-aligned (FAC) and field-perpendicular currents. They are supplemented by various methods for the estimation of the current sheet normal and motion to determine the complex current structure in that region. These single–spacecraft methods are then contrasted with the new opportunities of the full vector current estimation with the Cluster tetrahedron by use of the reciprocal vector (RV) method (mathematically identical to the curlometer technique). The four-point methods allow the full vector spatial determination of the current structures with characteristic scale lengths of the satellite's volumetric tensor or larger and enable to differentiate between spatial and temporal variations in the same scales. Single-spacecraft methods allow, on the other hand, a much better resolution of fine structures, although their interpretation is often equivocal. The combination of both proves to be a valuable tool for the unambiguous description of such phenomena. The magnetometer-based current estimations are then compared with measurements of the particle and wave instruments of Cluster to deduce a more complete picture of the phenomenon and to come to conclusions about the intricate substorm-related plasma processes.





SuperDARN measurements of polar cap convection in MLT versus magnetic latitude ($60° - 90°$) coordinates for three characteristic two–minute intervals around the event under study of March 12, 2001, in comparison with EDI drift measurements mapped into the ionosphere (shown as triangles near 23 MLT with the corresponding vector arrows). Solar wind conditions are indicated in the upper right corner as well as the cross–polar cap potential for each subinterval.

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