Geophysical Research Abstracts, Vol. 9, 01964, 2007
SRef-ID:

Conjugate Cluster and MIRACLE observations during an omega band event

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The substorm recovery phase is in the ionosphere often characterised by large-scale undulations of the substorm electrojet, which can be associated with auroral forms such as eastward (dawnward) propagating omega bands or torches. While detailed studies of the ionospheric current system that is associated with such forms exist, little is known as yet about the relation of these current systems to the magnetospheric source regions and the ionosphere-magnetosphere coupling of such events. The combination of data from Cluster, which can resolve spatial structures in the magnetotail, and the MIRACLE network of ground-based instruments in Fennoscandia, which can resolve mesoscale structures in the auroral ionosphere, makes it possible to monitor the spatio-temporal evolution in the ionosphere and the magnetosphere simultaneously with excellent resolution.

We analyse Cluster and MIRACLE data for an omega band event in the night of August 9/10, 2005. The Cluster satellites are located at X $\sim$ -15 RE in the central postmidnight magnetotail, with its footprints skimming along the poleward edge of an eastward moving omega band structure, as determined from the ground-based data. The satellites observe dawnward moving magnetic field structures, with a velocity corresponding to the mapped speed of the eastward moving omega band structures in the ionosphere. These magnetic field structures are not, however, caused by local FAC which are likely to map to more earthward locations in the magnetotail, but are due to moving bulges or kinks in the magnetosheet structure. Further, enhanced and mostly earthward pointing ion velocities up to 500 km/s are observed on a temporal scale similar to that of the enhancement of ionospheric current densities.

This study shows that omega bands, which were previously believed to map to the inner magnetosphere, interact with the magnetosphere up to at least X $\sim$ -15 RE in form of dawnward traveling plasma sheet deformations. It further implies that at least at times, omega bands may be related to fast earthward plasma flows in the tail-current sheet.