Geophysical Research Abstracts
Vol. 15, EGU2013-9705, 2013
EGU General Assembly 2013
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Reconnection at the high and low latitude magnetopause

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Recent investigations have renewed the debate on the occurrence and location of magnetic reconnection (MR) on the Earth's dayside magnetopause, where evidence exists for predominantly component driven X-line regions, independent of guide field conditions, and extending across a wide range of preferred, and often multiple, locations. Recent findings in active sites of MR have also increased the theoretical understanding of the detailed structure within the ion diffusion region surrounding the magnetic X-line or null field, although direct measurements of this small region are still relatively rare. Nevertheless, investigations have benefitted from an unprecedented growth in complexity of multi-scale and multi-point, in situ measurements, on the small and meso-scale, from, for example, the Cluster and THEMIS space missions. Furthermore, during April to July 2007 a combination of 10 spacecraft (Cluster, THEMIS and Double Star TC-1) provided simultaneous monitoring of the dayside magnetopause across a wide range of local times. Here, we first investigate repeated sampling of the ion diffusion region and associated null magnetic field of a high-latitude reconnection site by the four Cluster spacecraft flying in formation to interpret the plasma structures surrounding the X-line, which is located on initially closed field-lines and where the magnetic field orientations inside and outside the magnetopause are close to anti-parallel. The plasma populations confirm details of the ion and electron mixing, time history and acceleration through the current layer. We secondly investigate the plasma distributions near X-line structures for key conjunctions of the Cluster, THEMIS and TC-1 spacecraft around the magnetopause, showing the operation of MR at wide locations along the expected sub-solar merging line. The results are also consistent with the occurrence of reconnection activity, simultaneously across the sub-solar and flank magnetopause, linked to the (large-scale) extended configuration of the merging line. Other small scale spacecraft configurations have revealed substructure in MR regions and details of the 3-D behaviour in multiple X-line scenarios.