Signature of Unsteady Asymmetric Magnetic Reconnection at the Magnetopause

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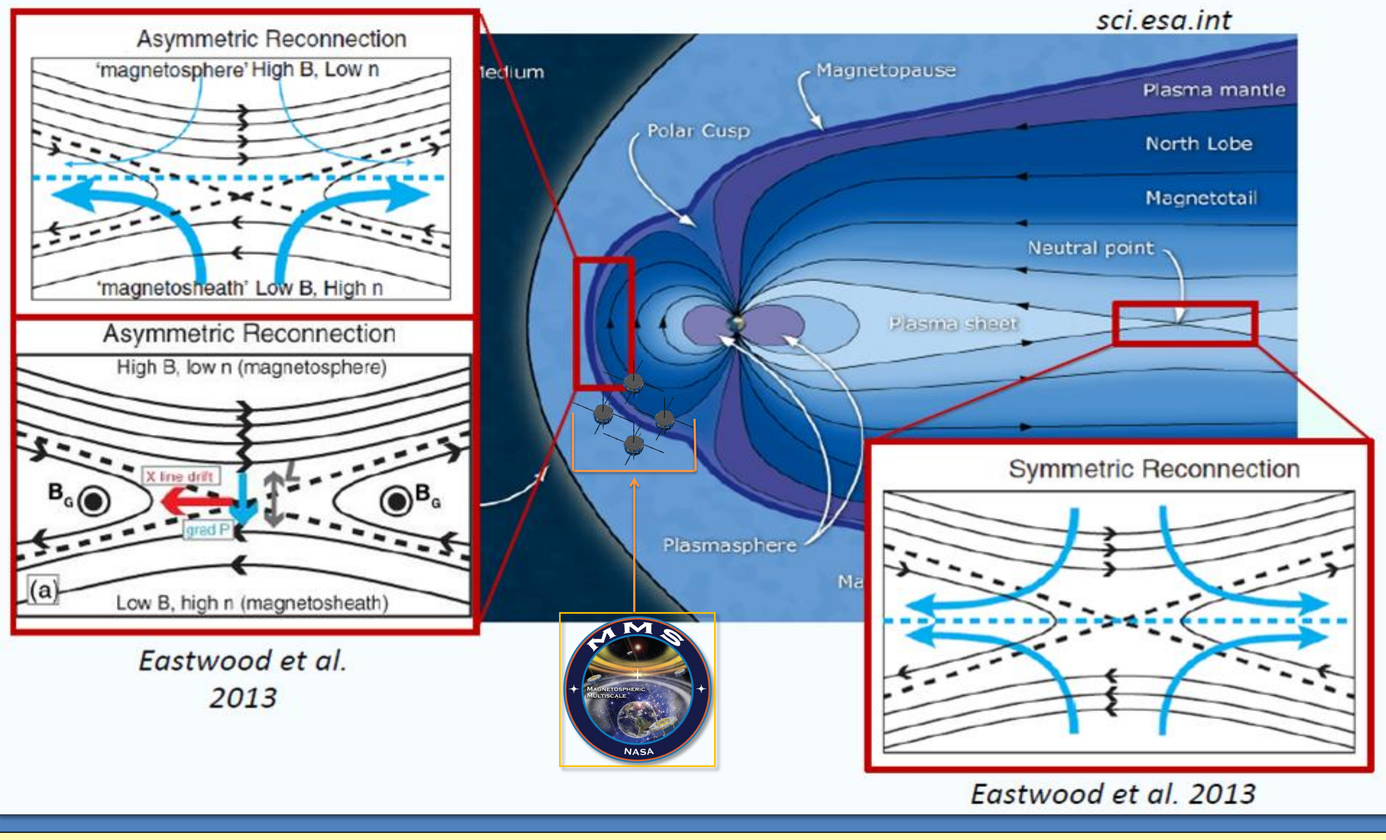
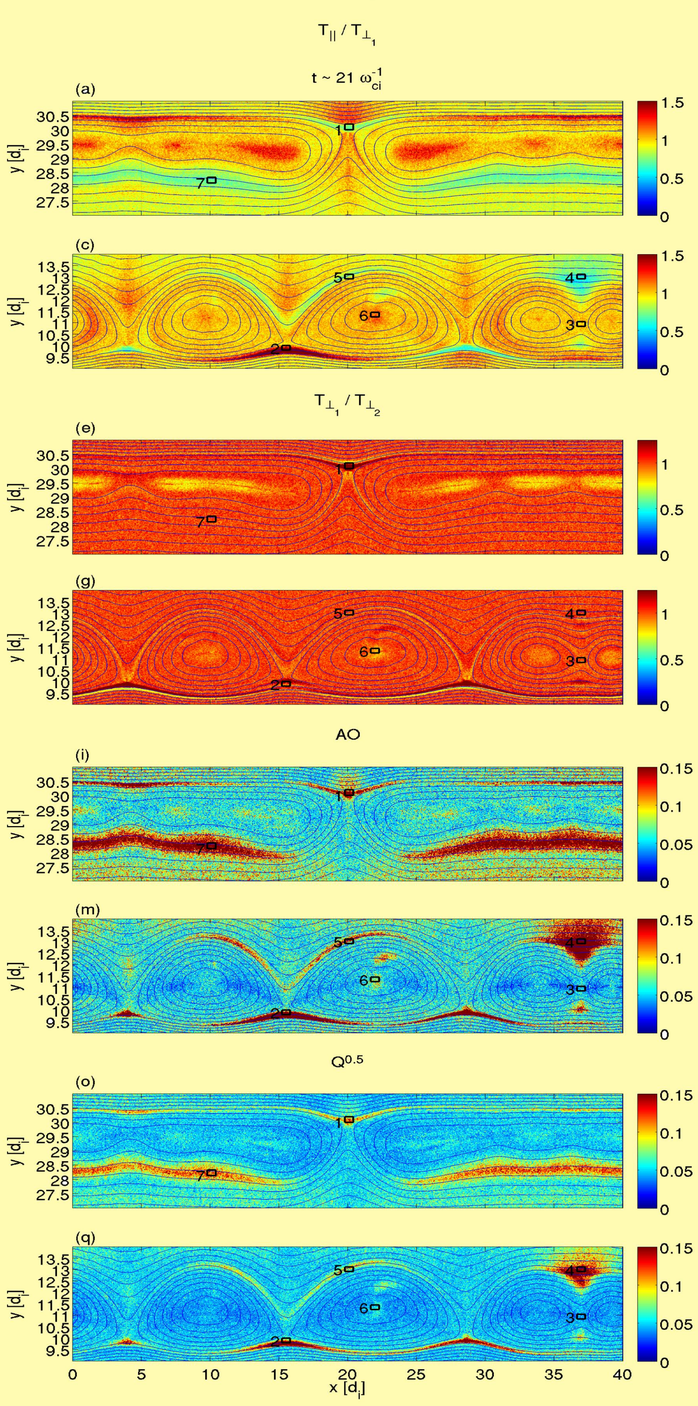
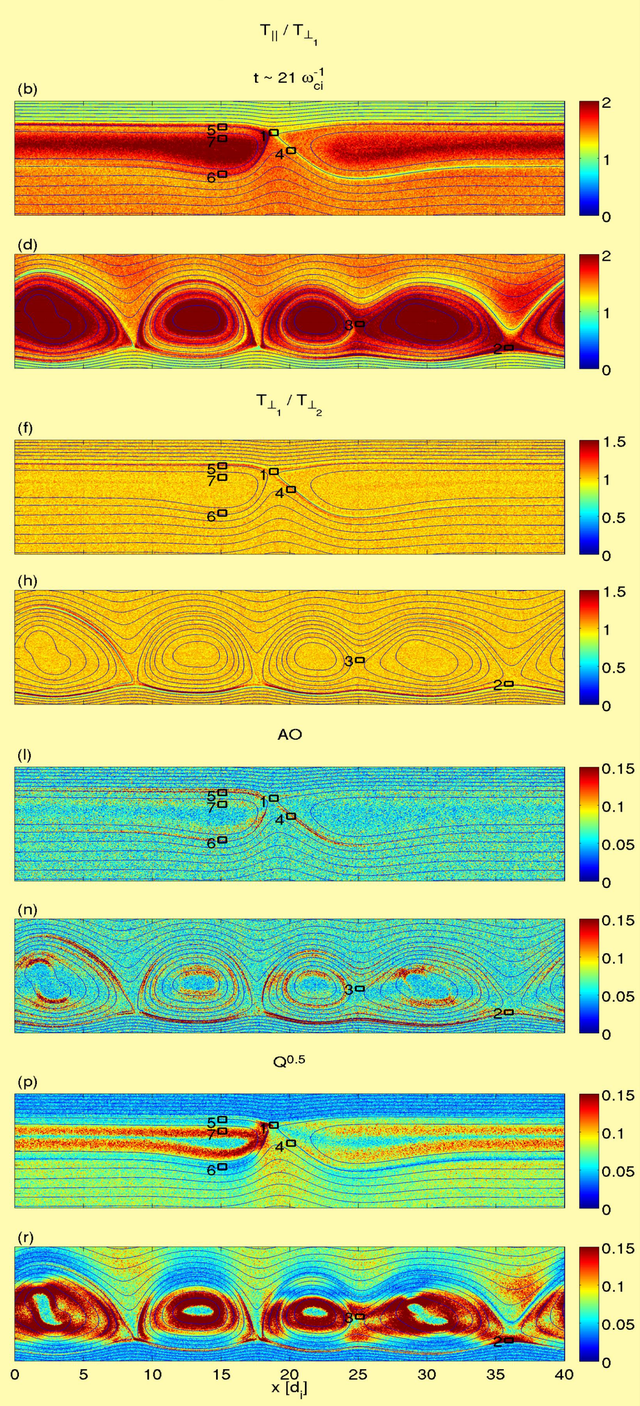


Abstract. With this work we aim at studying with more details the highly multiscale kinetic process of magnetic reconnection occurring at the dayside magnetopause. This process is partially responsible for geomagnetic substorms and capable of producing highly energetic particles. In particular, we present results on the electron dynamics from fully kinetic Particle-in-Cell (PIC) simulations. The ultimate aim is to produce simulation insights for the observations registered by the recently launched Multiscale MagnetoSpheric NASA mission, which features unprecedented space and time resolution instruments. In a previous work we have studied the electrons behavior during rapid magnetic island coalescence in absence of a guide field. We have ultimately identified three different reconnection regions marked as X-, D- and M-regions according to their *local* anisotropic and agyrotropic properties (Cazzola et al. 2015). Here, we extend the analysis to the case with guide field, where the same type of regions are also observed. The electron velocity distributions characterizing these regions are additionally provided for a straightforward identification with observations. Finally, different rendering methods to highlight agyrotropic regions from PIC simulations are addressed, revealing important discrepancies in some relevant areas, such as the separatrices and the inner islands.

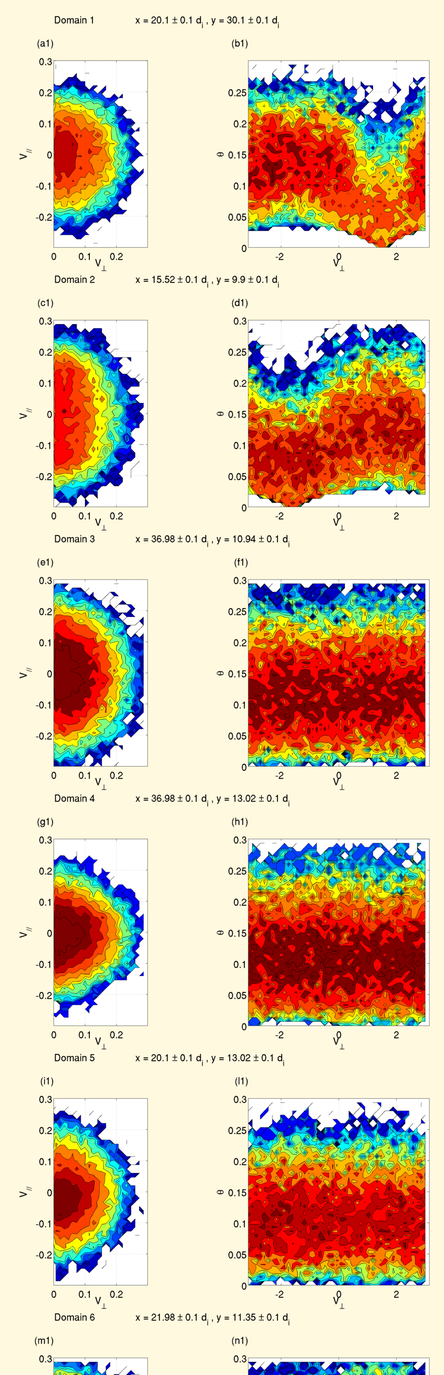
with no guide field



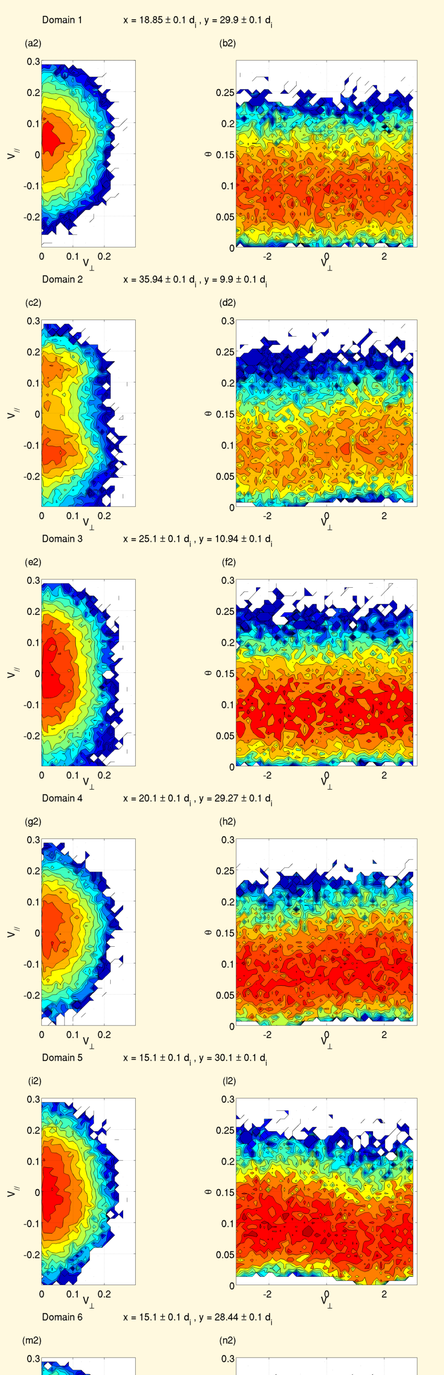
with guide field



with no guide field



with guide field



Main Conclusions.

Methodology Remarks. Given the frame-dependence of the ratio $T_{\perp 1} / T_{\perp 2}$, the latter is particularly suited to address an *in-situ* estimation of agyrotropy, when a fixed frame of reference is set. The other methods give more generic results. Unlike the case without guide field, which shows a good agreement between the models, some remarkable difference is noticed in some important regions in the case with guide field, such as at the separatrices (domain 4, 5 and 6) and within magnetic islands (domain 7). Such differences are probably due to the parallel pressure component considered within a model (Q) rather than the other (AO).

X-regions (Domain 1). *Single Reconnection Event* **-** Very strong agyrotropy in the case with no guide field and very weak agyrotropy in the case with guide field, the latter accompanied by a strong anisotropy. Situation confirmed by quantity AO.

D-Regions (Domain 2). *Opposite behavior to X-regions* **-** Weak agyrotropy in both the cases with and without guide field, together with a strong anisotropy and the double-beam found in Cazzola et al. 2015.

M-Regions (Domain 3). *Merging Island Reconnection Event* **-** Given the particular configuration, this regions with guide field features a more irregularity. No relevant agyrotropy is shown in the phase-spaces, whereas a strong anisotropy is only observed for the case with guide field. This situation is well-represented by AO, while a noticeable agyrotropy is differently highlighted by Q.

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