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FTE Growth Mechanisms: A Comparative Analysis

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We present Magnetospheric Multiscale (MMS) in-situ high temporal and spatial-resolution measurements of reconnection signatures associated with two flux transfer event (FTE)-type flux ropes at the magnetopause and compare observations to the Vlasiator kinetic global simulations. FTEs grow via: 1) continuous reconnection whereby two active X-lines on both sides of the FTE continue to add plasma and new layers of magnetic flux to the flux rope, and 2) coalescence by which neighboring FTEs merge to form larger flux ropes via reconnection. Multi-point analysis techniques are applied on MMS fields and plasma measurements of two FTEs at the magnetopause. In one FTE encounter, an ion inertial length-scale FTE is found located between two active X-lines. The observations on both sides of the FTE include |B| $\sim$ 0 and ion jets with |Δv_(i, para) | $\sim$ 300 km/s. MMS observations also indicate that ions become demagnetized and energized (parallel to B near the X-lines and perpendicular to B near the FTE's central axis) inside this FTE. In the other FTE encounter, the topological rearrangement of field lines at the X-line, which is characterized by a B|-depression region (ΔB/B $\sim$ - 0.25) between the two merging FTEs, is identified by a local release of magnetic energy (j . E' $\sim$ +2 nW/m$\acute{3}$) that produces intense localized ion heating (|ΔT_(i, para)/T_(i, para) | $\sim$ 0.25) and Alfvenic jetting (|Δv_(i)/v_(i) | $\sim$ 1.0). These observations are compared to results from the University of Helsinki's hybrid-Vlasov global code Vlasiator. The Vlasiator simulation results clearly show 2-dimensional magnetic islands growing via continuous reconnection and coalescence at the magnetopause. The Vlasiator's noise-free 3-dimensional ion velocity distributions across growing magnetic islands are found to closely agree with the in-situ MMS observations.