Geophysical Research Abstracts
Vol. 21, EGU2019-8480, 2019
EGU General Assembly 2019
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Study on the stability of the reconnection jet fronts

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We performed a series of 3-D fully kinetic particle-in-cell simulations of anti-parallel magnetic reconnection to investigate the three-dimensional development of reconnection jet fronts. The simulations demonstrated evolutions of three instabilities at the jet fronts: the lower-hybrid drift instability (LHDI), the ballooning/interchange instability (BICI), and the ion kink instability. Sufficiently large system size and high ion-to-electron mass ratio of the simulations allow us to investigate the coupling among these instabilities in the fully kinetic regime. In this study, we particularly focused on the dependencies on plasma properties in the background region. When the background density, ion-to-electron temperature ratio and plasma beta are small enough, the rapid growth of the LHDI enhances the BICI growth and the resulting formation of finger-like structures at the jet fronts. These two instabilities become dominant over the ion kink instability. Interestingly, the small-scale jet front structures produced by these instabilities are in good agreements with recent high-resolution observations of the dipolarization fronts in the near-Earth magnetotail using the Magnetospheric Multiscale (MMS) mission. Based on electromagnetic and fully kinetic linear dispersion relations for plasmas with cross-field drifts, we will further discuss the stability criteria of the jet fronts in a possible parameter range in the magnetotail.