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Kinetic Simulations of Substorm Onset From the Coupling of Reconnection and Three-Dimensional Cross-Tail Instabilities SAMUEL TOTORICA, AMITAVA BHATTACHARJEE, Princeton University — Substorms are explosive disruptions that play a critical role in the response of the magnetosphere to the solar wind. Observations show a slow growth phase involving magnetic flux loading and current sheet thinning, followed by a rapid onset. Models involving various instabilities have been proposed, however the onset mechanisms and interplay between near-Earth and distant tail regions are still under debate. We perform two-dimensional (2D) and three-dimensional (3D) electromagnetic kinetic particle-in-cell simulations of substorm onset starting from an exact kinetic equilibirium that captures both the near-Earth and distant tail regions. Our simulations reproduce features of observations including reconnection onset, plasmoid formation, current sheet flapping, and dipolarization fronts. Comparing 2D and 3D allows the isolation of reconnection from 3D instabilities. A critical difference between 2D and 3D is an explosive disruption of dipolarization fronts in the near-Earth region by a 3D cross-tail instability. We examine the roles of ballooning and drift-kink in the disruption, and compare with MMS and THEMIS observations. The disruption produces field-aligned currents and nonthermal particles, and we examine the acceleration mechanisms and connection to auroral signatures.

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