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Compressible Resistive and Hall MHD Dynamics of the m=1 Sawtooth Instability K. GERMASCHEWSKI, A. BHATTACHARJEE, C.-S. NG, University of New Hampshire, X. WANG, Dalian University of Technology, L. CHACON, Los Alamos National Laboratory — In order to understand the mechanism underlying the sawtooth crash in a tokamak, we have undertaken simulations of the m=1 kink-tearing instability using the Magnetic Reconnection Code, which is a fully implicit code that integrates the compressible Hall MHD equations. The results of our simulations bring out surprising features, not captured in previous simulations based on reduced equations. It is well established that the reduced resistive MHD equations typically show a regime of linear exponential growth followed by a slower nonlinear regime of algebraic growth (Waelbroeck regime). We show that the fully compressible resistive MHD equations admit another possibility whereby the linear exponential growth regime is not followed, even transiently, by the Waelbroeck regime. Instead, a regime of super-exponential or near-explosive growth occurs due to the phenomenon of flux pile-up, which is not realized in reduced MHD. When the Hall current and the electron pressure gradient is included via a generalized Ohm's law, the near-explosive tendency persists even though the pile-up effect is reduced. In both resistive and Hall MHD simulations, the geometry of the current sheet is seen to change from Y-points to near X-points, accounting for the impulsive transition to near-explosive growth. Nonlinear diamagnetic effects can thwart this near-explosive tendency.

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