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Comparison of Terrestrial, Jovian and Saturnian Substorms

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The substorm is an important magnetospheric process to energize and transport magnetospheric plasmas. Studies of terrestrial substorms have shown that magnetotail reconnection plays a critical role in initiating substorms. Discovery of Jovian tail reconnection and associated growth phase indicates the substorm nature of Jovian tail dynamic events. The growth phase of Jovian substorms is caused by internal processes, i.e., the mass-loading at the Io torus, while that of terrestrial substorms is caused by the addition of energy through dayside reconnection with the solar wind. Similar to the Jovian magnetosphere, the Saturnian magnetosphere is different from the Earth's magnetosphere due to its fast rotation. Tail reconnection is also reported in Saturnian tail, which probably also causes substorm-like process in the Saturnian magnetosphere. In this study, we investigate the properties of the Saturnian tail reconnection with Cassini observations and compare them with their counterpart Jovian tail dynamic events to examine if these reconnections can truly cause Saturnian substorms. The growth phase in the Saturnian tail is found to be more transient than those for Jovian substorms, lasting hours instead of 3 days. The location of tail reconnections inferred from dipolarization and plasmoid observations is also different in the Saturnian tail from Jovian tail reconnection. However, the mechanisms that drive substorms in both magnetospheres are similar, the mass-loading driven process.