The region-2 current driven model of the substorm

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A substorm mechanism is investigated by analyzing the numerical results obtained with a use of the recent refined magneto-hydrodynamic (MHD) model. These results reproduce the observed signatures of a substorm onset, including a dipolarization, the geosynchronous D deflection, a formation of a near earth neutral line (NENL), earthward directed flow in the plasma sheet, a development of the nightside field aligned currents (FACs), and electrojets in the ionosphere. This onset is triggered by the abrupt formation of a high-pressure region in the inner magnetosphere. This high-pressure region results from a release of energy from the magnetic tension at NENL. A primary driver of the substorm current system is the partial ring current and incidental region 2 FAC which is driven through the conversion of thermal energy to electromagnetic energy by convection, crossing the high-pressure region formed at the geosynchronous altitude. Associated nightside region 1 FAC does not result from the traditional current wedge but from the ordinary cusp dynamo. The region 1 FAC path to the ionosphere varies from dayside to nightside, so as to form a short circuit in the ionosphere with the region 2 FAC from the partial ring current. In the expansion phase, convection develops to relax the distorted pressure distribution formed at the onset, accompanying a development of dipolarization and thickening of plasma sheet in the magnetosphere and an increase of westward and eastward electrojets in the ionosphere. The present model can explain the longstanding question concerning the position of first brightening arc, together with the explosive growth phase and the thinning of mid-tail plasma sheet just after the onset.