Relation of Substorm Disturbances Triggered by Abrupt Solar-Wind Changes to Physics of Plasma Sheet Transport

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Abstract

We will describe interplanetary magnetic field (IMF) and solar wind dynamic pressure P changes that lead to substorms and the significant differences in the features of substorms triggered by IMF and by P changes. We will also describe important interplay from simultaneous IMF and P changes that can prevent substorm triggering. This interplay leads to what we call "null events", since the IMF or P change alone would trigger a substorm but the effect of that change is nullified by a simultaneous change in the other quantity. We will then use the plasma sheet continuity equation to show how basic plasma sheet sources and losses offer an explanation for:

1. The substorm growth phase build up of plasma energy and formation of the Harang electric field reversal,

2. Steady magnetospheric convection events via the finite tail width giving particle flux and energy flux divergence and tail stretching that prevents excess build up of pressures,

3. Substorm onsets via IMF changes or P increases that substantially decrease the inner plasma source but not the loss,

4. Null events via competing effects of IMF and P changes that lead to an unchanged or increased plasma sheet source,

5. Pseudo-substorms via a nullifying IMF or P change that increases the plasma sheet source after onset, terminating substorm expansion before full development.