FINAL

STATUS REPORT
The Physical Elements of Onset of the Magnetospheric Substorm

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(Final Report)

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During this reporting period effort continued in the areas: (1) understanding the mechanisms responsible for substorm onset, and (2) application of a fundamental description of field-aligned currents and parallel electric fields to the plasma-sheet boundary layer.

1. Onset and Early Expansion of Magnetospheric Substorms

Based on global stability analysis of two-dimensional solutions of the substorm growth phase, we had suggested that outward displacement of plasma flux tubes along the inner edges of the plasma sheet puts the near-Earth plasma sheet out of its quasi-static pressure balance with the tail lobes resulting in substorm expansion onset. We have been collaborating with Nelson Maynard, Bill Burke and others in interpreting CRRES data preceding and during substorm expansions. We have found the following: (1) A reversal of the dawn-dusk electric field is seen as an immediate precursor of onset of dipolarization in the vicinity of the upward leg of the substorm current wedge. (2) Electron injection occurs after start of dipolarization (onset) in association with reflected Poynting flux which had been released toward the ionosphere during the electric field reversal. (3) An "explosive-growth-phase" signature is observed associated with the post-onset injection. (4) Electric field signatures are inconsistent with the notion that near-geosynchronous onset resulted from fast plasma flows eminating from a reconnection site downtail. Indeed, in another study using ground spectrometer data we inferred activation of the near-Earth X-line occurred approximately 6 minutes after onset. This delay is consistent with propagation times from near-geosynchronous (onset region) to $35R_E$ in the tail (reconnection region) and back to the ionosphere. There is one event when CRRES appears to be in the midst of the onset region in the plasma sheet. Careful analysis of this event showed magnetic and electric field oscillations prior to onset were consistent with drift-Alfvén ballooning along the inner edges of the plasma sheet. These findings have been published in the papers listed at the end of this report.

2. The Fundamental Description of Field-Aligned Currents and Parallel Electric Fields in Magnetospheric Plasma

The fundamental description of inertial currents and associated parallel electric field described in the paper "Inertial Currents in Isotropic Plasma" by M. Heinemann, G. M. Erickson, and D. H. Pontius Jr. [*J. Geophys. Res., 99*, 8635, 1994] has been expanded to include finite Larmour radius effects. This description has been applied to a new model for currents generated in the plasma-sheet boundary layer. An interim model was presented at the last Fall Meeting of the American Geophysical Union in San Francisco. We are currently preparing a paper for publication describing this model.

Publication Summary:

Maynard, N. C., W. J. Burke, E. M. Basinska, **G. M. Erickson**, W. J. Hughes, D. A. Hardy, H. J. Singer, A. Yahnin, and F. S. Mozer, Dynamics of the Inner Magnetosphere Near Times of Substorm Onsets, *J. Geophys. Res., 101*, 7705, 1996. (Preprint last report.)

Erickson, G. M., W. J. Burke, M. Heinemann, J. C. Samson, and N. C. Maynard, Towards a Complete Conceptual Model of Substorm Onsets and Expansions, in *Substorms 3*, pp. 423–428, ESA SP-389, October 1996. (Reprint enclosed.)

Maynard, N. C., W. J. Burke, **G. M. Erickson**, E. M. Basinska, and A. G. Yahnin, Magnetosphere-Ionosphere Coupling During Substorm Onset, in *Substorms 3*, pp. 301–305, ESA SP-389, October 1996. (Reprint enclosed.)

Maynard, N. C., W. J. Burke, **G. M. Erickson**, M. Nakamura, T. Mukai, S. Kokubun, T. Yamamoto, B. Jacobsen, A. Egelane, J. C. Samson, D. R. Weimer, G. D. Reeves, and H. Lühr, GEOTAIL Measurements Compared With the Motions of High-Latitude Auroral Boundaries During Two Substorms, *J. Geophys. Res., 102*, 9553, 1997. (Reprint enclosed.)

Presentations:

Erickson, G. M., W. J. Burke, M. Heinemann, J. C. Samson, and N. C. Maynard, Towards a Complete Conceptual Model of Substorm Onsets and Expansions (Poster), Third International Conference on Substorms, Versailles, France, 13–17 May 1996.

Maynard, N. C., W. J. Burke, **G. M. Erickson**, E. M. Basinska, and A. G. Yahnin, Magnetosphere-Ionosphere Coupling During Substorm Onset (N. C. Maynard), Third International Conference on Substorms, Versailles, France, 13–17 May 1996.

Erickson, G. M., and M. Heinemann, A Next-Generation, Physically-Based, Magnetospheric Convection Model (Poster), GEM GGCM, Snowmass, 24–28 June 1996.

Erickson, G. M., W. J. Burke, M. Heinemann, J. C. Samson, and N. C. Maynard, The Role of M-I Coupling in Substorm Onsets (Poster), GEM Tail/Substorm, Snowmass, 24–28 June 1996.

Burke, W. J., N. C. Maynard, **G. M. Erickson**, M. Nakamura, and S. Kokubun, High-Latitude Auroral Boundaries Compared With GEOTAIL Measurements During Two Substorms (W. J. Burke), Huntsville 1996 Workshop: Encounter Between Global Observations and Models in the ISTP Era, September 15–20, 1996.

Heinemann, M., and **G. M. Erickson**, Mathematical Model of Field-Aligned Currents and Parallel Potential Drops in the Plasma Sheet Boundary Layer, AGU Fall Meeting, San Francisco, 15–19 December 1996.

Erickson, G. M., W. J. Burke, M. Heinemann, and N. C. Maynard, CRRES Observational Constraints for Substorm Onset, AGU Fall Meeting, San Francisco, 15–19 December 1996.