(NASA-CR-195271) CONFIGURATION OF THE NEAR-EARTH PLASMA SHEET Status Report, 1 Apr. 1993 - 31 Mar. 1994 (Boston Univ.) 3 p

N94-27438

Unclas

G3/46 0000445

STATUS REPORT
Configuration of the Near-Earth Plasma Sheet
Year-3

April 1, 1993 – March 31, 1994

NASA Grant NAGW-2627

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During the past year, research has continued in three related areas: (1) understanding the mechanisms responsible for substorm onset, (2) a fundamental description of field-aligned currents and parallel electric fields, and (3) consequences of dawnside depletion and the physics of the Harang discontinuity.

1. A Mechanism for Magnetospheric Substorms

Considerable effort was devoted to understanding the role of the various mechanisms suggested as responsible for the onset of the magnetospheric substorm in context with M-I coupled convection process and large-scale stability of the magnetosphere. The outcome of this investigation is contained in a report prepared for the GEM Workshop on the Physics of the Tail and Substorms. A reprint of this report is enclosed. A related paper is being prepared for publication in the proceedings of the Second International Conference on Substorms held this past month in Fairbanks.

Our idea as to the triggering mechanism of the substorm has been summarized in earlier reports. Our suggestion is a modification of the ballooning instability whereby the displacement of plasma along flux tubes, as would occur as parallel potential drops develop, puts the near-Earth tail out of its quasi-static pressure balance. In an attempt to restore pressure balance, the already thin current sheet collapses under the overpressure of the lobe field. This disturbance propagates as a wave downtail. Instabilities accompanying demagnetization of ions as the current sheet is forcibly compressed (e.g., Lui et al.'s modified two-steam instabilities) allow tearing and X-line formation. As described in the renewal proposal, the physics of the possible trigger mechanism (development of parallel potential drops) will be developed for conditions appropriate to the near-Earth plasma sheet in its growth phase.

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

The fundamental description of field-aligned current and parallel electric field generation is crucial for the understanding of magnetospheric convection and substorms. In collaboration with Mike Heinemann and Duane Pontius, this description has been generalized to account for ion inertia. A new finding relates to the role of polarization in a steady-state isotropic plasma in the development of parallel currents and electric fields. Simply, ions see changing electric fields along their bounce paths and are displaced from magnetic field lines, i.e., the electrons' bounce path, resulting in polarization of the plasma. In the presence of density gradients or an inhomogeneous magnetic or electric fields, a parallel electric field is required so that the electron density distribution along field lines can be equal that of the ions. Time variations or perpendicular gradients in the polarization charge require parallel

currents to maintain quasineutrality. The paper "Inertial Currents in Isotropic Plasma" by M. Heinemann, G. M. Erickson, and D. H. Pontius Jr. has been accepted for publication in *Journal of Geophysical Research.* A second paper describing the above physics, but uncomplicated with mathematics, has been submitted to *Geophysical Research Letters.* The next challenge is to explicitly include gradient and curvature drifts in this description.

3. Consequences of Dawnside Depletion

We have shown earlier that dawnside depletion of energetic plasma in Earth's plasma sheet is responsible for the Harang electric-field reversal [*Erickson et al., J. Geophys. Res., 96*, 1633, 1991]. The association of this feature with substorms is well known. The growth of this current system might be the substorm onset trigger as described above. The paper "The Physics of the Harang Discontinuity, 2. Consequences of Dawnside Depletion" has been revised again for publication in *Journal of Geophysical Research*, but the referees are still not satisfied. It is hoped that additional runs of the Rice Convection Model, planned during the coming months to model this physics, will verify the suggestions made in that paper.

Other Tasks:

Papers describing the electrical coupling of the far-tail reconnection region with the ionosphere via the plasma sheet boundary layer have been published with Bill Burke and others.

Publication Summary:

Burke, W. J., J. S. Machuzak, N. C. Maynard, E. M. Basinska, G. M. Erickson, R. A. Hoffman, J. A. Slavin, and W. B. Hanson, Auroral Signatures of the Plasma Sheet Boundary Layer in the Evening Sector, *J. Geophys. Res., 99*, 2489–2499, 1994. (Reprint enclosed.)

Erickson, G. M., Substorm Theories: Are They Converging, in *Report on the GEM Workshop on the Physics of the Tail and Substorms, Snowmass, Colorado, 1–2 July, 1993*, edited by W. J. Hughes, Boston University Center for Space Physics, Boston, 1994. (Reprint enclosed.)

Smith, M. F., F. Herrero, M. Hesse, D. N. Baker, P. Bochsler, P. Wurz, H. Balsiger, S. Chakrabarti, G. Erickson, D. Cotton, T. S. Stephen, C. Jamar, J. C. Gerard, S. A. Fuselier, A. G. Ghielmetti, S. B. Mende, W. K. Peterson, E. G. Shelly, R. R. Vondrak, D. L. Gallagher, T. E. Moore, C. Pollock, R. Arnoldy, M. Lockwood, and R. Gladstone, The High-Latitude Ion Transport and Energetics (HI-LITE) Explorer: A mission to investigate ion outflow from the high-latitude ionosphere, in *Instrumentation for Magnetospheric Imagery II*, SPIE, vol. 2008, 1993.

Burke, W. J., J. S. Machuzak, N. C. Maynard, E. M. Basinska, G. M. Erickson, R. A. Hoffman, J. A. Slavin, and W. B. Hanson, Electrodynamic Signatures of the Plasma Sheet Boundary Layer in the Evening Ionosphere, in *Physical Signatures of Magnetospheric Boundary Layer Processes*, edited by A. Egeland, J. A. Holtet, and P. E. Sandholt, Kluwer Academic Press, in press. (Preprint enclosed.)

Erickson, G. M., R. W. Spiro, and R. A. Wolf, The Harang Discontinuity and Magnetospheric Forecasting, in *Solar-Terrestrial Predictions - IV, Vol. 2*, edited by J. Hruska, M. A. Shea, D. F. Smart, and G. Heckman, pp. 508–523, NOAA, Boulder, 1994. (Preprint last report.)

Heinemann, M., G. M. Erickson, and D. H. Pontius, Jr., Inertial Currents in Isotropic Plasma, *J. Geophys. Res.*, in press. (Preprint enclosed.)

Erickson, G. M., The Physics of the Harang Discontinuity, 2. Consequences of Dawnside Depletion, *J. Geophys. Res.*, revised. (Preprint earlier report.)

Heinemann M., D. H. Pontius Jr., and G. M. Erickson, Parallel Electric Fields in Isotropic Plasma, *Geophys. Res. Lett.*, submitted.

Erickson, G. M., and M. Heinemann, A Mechanism for Magnetospheric Substorms, in *Proceedings of the International Conference on Substorms 2, Fairbanks, 7–11 March 1992*, in preparation.

Hau, L.-N., and G. M. Erickson, Plasma Sheet Convection With Magnetic B_y Component, *Geophys. Res. Lett.*, in preparation.

Presentations:

Erickson, G. M., The Physics of the Harang Discontinuity, Consequences of Dawnside Depletion, Boston University, Center for Space Physics, 1 April 1993.

Burke, W. J., J. S. Machuzak, N. C. Maynard, E. M. Basinska, G. M. Erickson, R. A. Hoffman, and J. A. Slavin, Electrodynamic Signatures of the Plasma Sheet Boundary Layer in the High-Latitude Ionosphere (N. C. Maynard), AGU Spring Meeting, Baltimore, 24–28 May 1993.

Erickson, G. M., Field-Aligned Current Structure Within the Harang Discontinuity Sector, AGU Spring Meeting, Baltimore, 24–28 May 1993.

Jorgensen, A. M., T. A. Fritz, and G. M. Erickson, Dynamics of a Plasmoid Formed During the May 13th, 1985 AMPTE Barium Release (Poster), AGU Spring Meeting, Baltimore, 24–28 May 1993.

Erickson, G. M., and S. Stahara, Coupled Magnetosheath-Magnetosphere Model, GEM Working Group 5 Meeting, Boston College, 26–27 October, 1993.

Hau, L.-N., and G. M. Erickson, Penetrations of the IMF B_y Into Earth's Plasma Sheet (Poster, G. M. Erickson), AGU Fall Meeting, San Francisco, 6–10 December, 1993.

Jorgensen, A. M., T. A. Fritz, and G. M. Erickson, Dynamics of a Plasmoid Formed During the May 13th, 1985 AMPTE Barium Release (Poster), AGU Fall Meeting, San Francisco, 6–10 December, 1993.

Erickson, G. M., and M. Heinemann, A Mechanism for Magnetospheric Substorms, International Conference on Substorms 2, University of Alaska, Fairbanks, 7–11 March 1994.

Invited Talks:

Burke, W. J., N. C. Maynard, J. S. Machuzak, E. M. Basinska, G. M. Erickson, R. A. Hoffman, and J. A. Slavin, Signatures of the Plasma Sheet Boundary Layer in the Evening Sector, (N. C. Maynard), NATO Advanced Research Workshop: Physical Signatures of Magnetospheric Boundary Layer Processes, Oslo, Norway, 9–14 May 1993.

Erickson, G. M., Substorm Theories: Are They Converging?, GEM Workshop on the Physics of the Tail and Substorms, Snowmass, Colorado, 1 July 1993.