EPSC Abstracts
Vol. 6, EPSC-DPS2011-970, 2011
EPSC-DPS Joint Meeting 2011

Comparative Global Magnetospheric Dynamics of Earth, Saturn and Jupiter

Pontus C. Brandt (1), D. G. Mitchell (1), K. Keika (2), K. Dialynas (3), S. Ohtani (1), V. G. Merkin (1), J. Yang (4), X. Jia (5)
(1) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, (2) New Jersey Institute of Technology, Newark, NJ, USA, (3) Office for Space Research and Applications, Academy of Athens, Athens, Greece, (4) Department of Physics and Astronomy, Rice University, Houston, TX, USA, (5) University of Michigan, Ann Arbor, MI, USA.

Abstract

We compare magnetospheric particle acceleration events, their auroral response and their signatures in radio measurements at Earth, Saturn and Jupiter using observations from IMAGE, Cassini and Galileo. We discuss implications of plasma transport and heating from the magnetotail to the inner magnetosphere driven by plasma instabilities.

Global energetic neutral atom (ENA) and ultra violet (UV) imaging of the terrestrial and saturnian magnetospheres have revealed surprising similarities in how plasma is transported and heated from the magnetotail to the inner magnetosphere. At Earth, magnetospheric activity is clearly controlled by the sign of the interplanetary magnetic field (IMF). The global observations suggest that the night side ion plasma sheet beyond synchronous either moves earthward or thins simultaneously with the onset of auroral brightening and a burst of auroral kilometric radiation (AKR) and is then followed by a gradual (~10-30 min) increase of ion intensities in the inner magnetosphere inside geosynchronous ("ring current region") [1]. Some auroral observations display ripples accompanying the expansion phase. Model runs imply the presence of plasma instabilities at the inner edge of the plasma sheet creating fine finger-like structures protruding in to the inner magnetosphere that could explain the auroral ripples [2]. At the same time, protons and O+ display a distinctly different spectral evolution indicative of mass dependent acceleration processes in the large-scale magnetic field reconfiguration ("dipolarization") [3].

At Saturn, dramatic ENA intensifications are observed on the night side simultaneously with the onset of auroral brightening and burst of Saturn kilometric radiation (SKR) [4]. The activity appears to be strongly modulated by solar wind dynamics pressure or speed [5, 6]. However, the injected plasma drifts eastward around Saturn, which can be explained by Saturn's stronger co-rotational electric field [7]. Auroral observations reveal fine-scale structure that could be indicative of plasma instabilities acting on the injected plasma population. In addition, protons and O+ display different spectral behaviors during the injection process, similar to the terrestrial magnetosphere [8].

At Jupiter, very limited global ENA imaging of the magnetospheric energetic particles has been performed [9], but in-situ particle measurements indicate that processes similar to those in the terrestrial and saturnian magnetosphere may be at work and that the solar wind plays a role in regulating that activity [10]. Radio emissions are periodic, but their strength modulation and relationship to the global magnetospheric dynamics is still an open question [11].

References

[1] Brandt, P., R. Demajistre, E. C. Roelof, S. Ohtani, D. G. Mitchell, and S. Mende, IMAGE/high-energy energetic neutral atom: Global energetic neutral atom imaging of the plasma sheet and ring current during substorms, J. Geophys. Res., 107(A12), 1454, doi:10.1029/2002JA009307, 2002.

[2] Yang, J., F. R. Toffoletto, R. A. Wolf, S. Sazykin, R. W. Spiro, P. C. Brandt, M. G. Henderson, and H. U. Frey (2008), Rice Convection Model simulation of the 18 April 2002 sawtooth event and evidence for interchange

instability, J. Geophys. Res., 113, A11214, doi:10.1029/2008JA013635.

[3] Keika, K., P. C. Brandt, S. Ohtani, D. G. Mitchell, K. Min, M. Nosé, T. Obara, H. Koshiishi, and H. Matsumoto (2010), Mass‐dependent evolution of energetic neutral atoms energy spectra during storm time substorms: Implication for O+ nonadiabatic acceleration, J. Geophys. Res., 115, A00I12, doi:10.1029/2010JA015889.

[4] Mitchell, D. G., et al., Recurrent energization of plasma in the midnight-to-dawn quadrant of Saturn's magnetosphere, and its relationship to auroral UV and radio emissions. Planet. Space Sci. (2009), doi: 10.1016/j.pss.2009.04.002

[5] Brandt et al., Magnetospheric Storms at Saturn and Earth, AGU Fall Meeting Abstracts, 2007.

[6] Zarka et al., Modulation of Saturn's radio clock by solar wind speed, Nature, Vol 450|8 November 2007| doi:10.1038/nature06237.

[7] Brandt, P. C., C. P. Paranicas, J. F. Carbary, D. G. Mitchell, B. H. Mauk, and S. M. Krimigis (2008), Understanding the global evolution of Saturn's ring current, Geophys. Res. Lett., 35, L17101, doi:10.1029/2008GL034969.

[8] Dialynas et al., Particle energization in the Saturnian plasma sheet on day 184 of 2004 as revealed by Cassini/MIMI measurements, Journ. of Geophys., 2011.

[9] Mitchell, D. G., C. P. Paranicas, B. H. Mauk, E. C. Roelof, and S. M. Krimigis (2004), Energetic neutral atoms from Jupiter measured with the Cassini magnetospheric imaging instrument: Time dependence and composition, J. Geophys. Res., 109, A09S11, doi:10.1029/2003JA010120.

[10] Mauk et al., Storm-like dynamics in Jupiter's inner and middle magnetosphere, Journ. and Geophys., 1999.

[11] Louarn, P., et al. (2007), Observation of similar radio signatures at Saturn and Jupiter: Implications for the magnetospheric dynamics, Geophys. Res. Lett., 34, L20113, doi:10.1029/2007GL030368.