EPSC Abstracts
Vol. 13, EPSC-DPS2019-540-3, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Jovian dawn storms and terrestrial auroral substorms: similarities and differences

Bertrand Bonfond (1), Zhonghua Yao (1), Randy Gladstone (2), Denis Grodent (1), Jean-Claude Gérard (1), Aikaterini Radioti (1), Joshua Kammer (2), Vincent Hue (2), Thomas Greathouse (2), Maarten Versteeg (2), Marissa Vogt (3), Chihiro Tao (4) , William Kurth (5), Philippe Louarn (6), George Hospodarsky (5), Masafumi Imai (5), John Connerney (7), Daniel Gershman (7), Stavros Kotsiaros (7), Alberto Adriani (8), Alessandro Mura (8), Barry Mauk (9), Frederic Allegrini (2), Steven Levin (10), Scott Bolton (2)
(1) LPAP, STAR Institute, Université de Liège, Belgium, (2) Southwest Research Institute, San Antonio, USA (3) Boston University, Boston, USA (4) NICT, Tokyo, Japan (5) University of Iowa, Iowa City, USA (6) IRAP, CNRS, Toulouse, France (7) NASA Goddard Space Flight Center, Greenbelt, USA (8) Institute for Space Astrophysics and Planetology, Rome, Italy (9) Johns Hopkins University Applied Physics Laboratory, Laurel, USA (10) Jet Propulsion Laboratory, Pasadena, USA
(b.bonfond@uliege.be)

Abstract

Juno's polar orbit allows us to contemplate a complete view of the Jovian aurorae for the first time. Here we mainly use observations from the ultraviolet spectrograph (Juno-UVS) [1] in order to study one of the most spectacular features of Jupiter's aurorae: the dawn storms.

1. Introduction

Dawn storms are remarkable localized brightenings and broadenings of the dawn arc of the main emission. They are linked to some of the most powerful auroral emissions ever recorded at Jupiter [4]. They were identified as soon as the Hubble Space Telescope provided sufficiently resolved images of Jupiter's UV aurorae [3]. They are also associated with very strong methane absorption signatures, an indication that dawn storms are caused by the precipitation of very energetic electrons [2]. However, dawn storms appeared relatively rare in the Earth-based observations [5]. Moreover, the link between their occurrence and the arrival of solar wind compression region at Jupiter was unclear.

2. Observations

Juno-UVS captured several dawn storms at different stages of their evolution. Combined together, they paint a consistent picture of the dawn storm phenomenon, from its initiation to its end. The first step consists of the appearance of small elongated spots around midnight (local time). A few hours later, the main emission at the same local time intensifies and the arc transforms into spots. Methane absorption also increases considerably, indicative of high-energy electron precipitation. This conclusion is confirmed by the particle measurements obtained as Juno was flying through the field lines connected to the auroral dawn storm. The arc then broadens and splits into two arcs, one moving towards the pole while the other migrates equator-ward. Sometimes, the latter further evolves into large patches of emissions. While the dawn storms start around midnight and are initially fixed in local time, they then progressively slip along the dawn flank as they get brighter and accelerate towards full corotation. Finally, the dawn storms are observed both during quiet and compressed solar wind intervals, suggesting that they are related to internal processes rather than external ones.

3. Discussion and conclusions

Many properties of the dawn storms observed by Juno-UVS are similar to those of terrestrial substorms. The midnight spots look like some Poleward Boundary Intensifications (PBIs). The formation of spots along the main emission are reminiscent of auroral beads. The expansion of the dawn storm also looks like the expansion phase of a substorm. While the magnetospheric systems are very different at Jupiter and at Earth, both phenomena appear to be the result of the collapse of overloaded magnetospheres. Using the Earth as a model, the sequence of events forming a dawn storm can then be interpreted as the signature of tail reconnection, dipolarisation/current disruption and injection of hot plasma from the outer magnetosphere into the colder middle magnetosphere. One should however bear in mind that those reconfigurations are internally driven (as a part of the Vasyliunas cycle) and that the system is dominated by Jupiter's rotation. Another major difference is that injections at Jupiter often have a bright auroral signature, contrary to Earth.

References

[1] G. R. Gladstone, M. H. Versteeg, T. K. Greathouse, V. Hue, M. W. Davis, J.-C. Gérard, D. C. Grodent, B. Bonfond, J. D. Nichols, R. J. Wilson, G. B. Hospodarsky, S. J. Bolton, S. M. Levin, J. E. P. Connerney, A. Adriani, W. S. Kurth, B. H. Mauk, P. Valek, D. J. McComas, G. S. Orton, and F. Bagenal. Juno-UVS approach observations of Jupiter's auroras. *Geophysical Research Letters*, 44:7668–7675, 2017.

[2] J. Gustin, S. W. H. Cowley, J.-C. Gérard, G. R. Gladstone, D. Grodent, and J. T. Clarke. Characteristics of Jovian morning bright FUV aurora from Hubble Space Telescope/Space Telescope Imaging Spectrograph imaging and spectral observations. *Journal of Geophysical Research: Space Physics*, 111(A9), 2006.

[3] J. C. Gérard, D. Grodent, V. Dols, R. Prangé, J. H. Waite, G. R. Gladstone, K. A. Franke, F. Paresce, A. Storrs, and L. Ben Jaffel. A Remarkable Auroral Event on Jupiter Observed in the Ultraviolet with the Hubble Space Telescope. *Science*, 266(5191):1675–1678, December 1994.

[4] T. Kimura, J. D. Nichols, R. L. Gray, C. Tao, G. Murakami, A. Yamazaki, S. V. Badman, F. Tsuchiya, K. Yoshioka, H. Kita, D. Grodent, G. Clark, I. Yoshikawa, and M. Fujimoto. Transient brightening of Jupiter's aurora observed by the Hisaki satellite and Hubble Space Telescope during approach phase of the Juno spacecraft. *Geophysical Research Letters*, 44(10):4523–4531, May 2017.

[5] J. D. Nichols, J. T. Clarke, J. C. Gérard, and D. Grodent. Observations of Jovian polar auroral filaments. *Geophys. Res. Lett.*, 36:8101, 2009.