Jupiter's aurora observed by Hisaki: Intrinsic periodic variation
「ひさき」で観測された木星オーロラの周期変動

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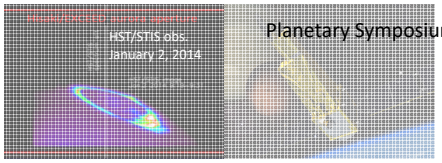
Several parameters of Jupiter magnetosphere, i.e., plasma flow and appearance of auroral spots, show intrinsic periodic variation with a few day to several days [e.g., Woch et al., 2002; Radioti et al., 2008]. Magnetospheric global re-configuration following periodic magnetotail reconnections is proposed for producing these periodicities [e.g., Woch et al., 1998]. Observed auroral power integrated over the pole region shows gradual increase and decrease over 5–10 days with the peaks corresponding to magnetotail magnetic field disturbed periods [Prangé et al., 2001] (slide #3). Hisaki is a space telescope launched by JAXA in 2013 and provides continuous observations of emissions from Jupiter auroral and Io plasma torus. We analyzed Jupiter aurora taken by a spectrometer EXCEED (Extreme Ultraviolet Spectroscope for Exospheric Dynamics) onboard Hisaki (slide #2) and investigate the statistical feature of the auroral periodic variation.

Auroral power revised by the rotational appearance shows periodic variation with gradual increase and decrease (slide #5–6). We analyzed data observed over 2014–2015 which includes periods when Io's volcanic activity was quiet (in 2014–2015) and high (in 2015). The auroral periodicity spreads from 0.8 to 8 days, which is comparative with the periodicity seen in other observations (slide #8). The periodicity does not change significantly between the two volcanic activity periods (slide #7–8). The periodicity does not show correlation with solar wind dynamic pressure (slide #9), auroral power (slide #10), central meridional longitude (CML), nor Io phase angle (slide #11). These suggest that the periodicity is intrinsic and independent of solar wind variation, magnetospheric plasma variation, magnetic field topology, and relative position of Io. A super-epoch analysis shows the symmetric increase and decrease trends of auroral power and magnetospheric source current, while the color ratio, which is a proxy for auroral electron energies, does not show significant variation associated with this periodic variation (slide #12) This symmetric variation of auroral power is contrasting to asymmetric increase and decrease variations seen in the ion flux and spectral slope, which might be due to different representatives of them, i.e., global for the aurora and in-situ/local for the others (slide #13).



Planetary Symposium @Tohoku University,
Feb. 27-Mar.1, 2018

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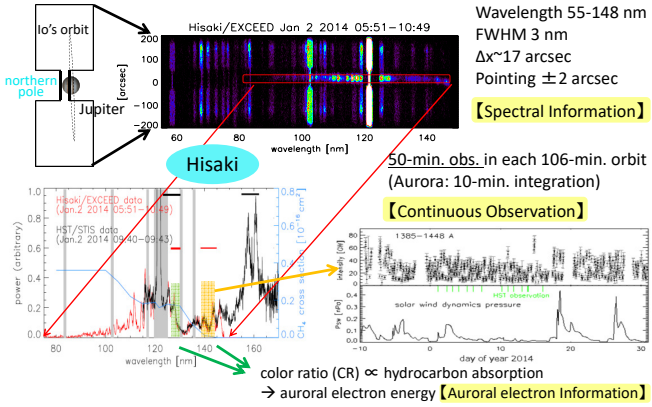
Dataset: Method detail: Kimura et al. [2015GRL]; Tao et al. [2016JGR] 2

Hisaki's Jupiter aurora observation



Wavelength 55-148 nm
FWHM 3 nm
Δx~17 arcsec
Pointing ±2 arcsec
【Spectral Information】

50-min. obs. in each 106-min. orbit
(Aurora: 10-min. integration)
【Continuous Observation】

color ratio (CR) ∝ hydrocarbon absorption
→ auroral electron energy【Auroral electron Information】

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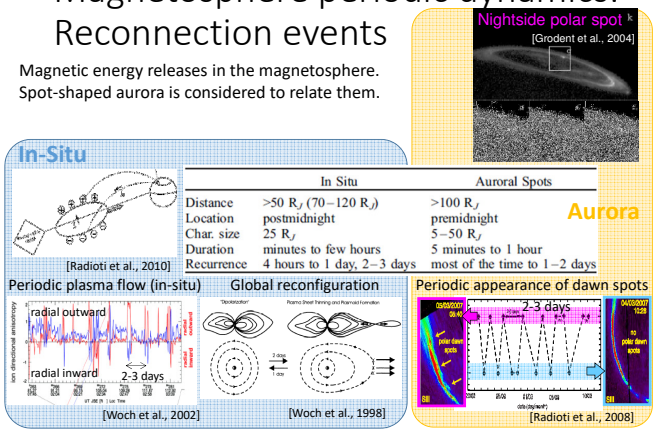
Magnetosphere periodic dynamics: Reconnection events

Magnetic energy releases in the magnetosphere.
Spot-shaped aurora is considered to relate them.



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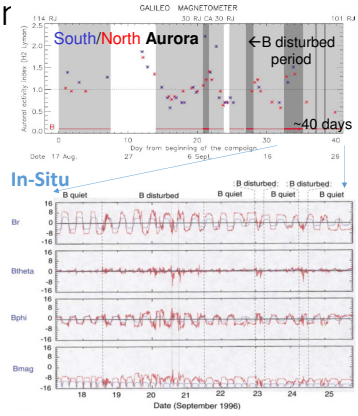
Magnetosphere periodic dynamics: Aurora Variation

Polar-integrated aurora observed by IUE (International Ultraviolet Explore) showed:

1) the 5-10 days periodic variation both in south and north aurora

2) these peaks are associated with the magnetospheric magnetic field observed by Galileo spacecraft.
[Prange et al., 2001]



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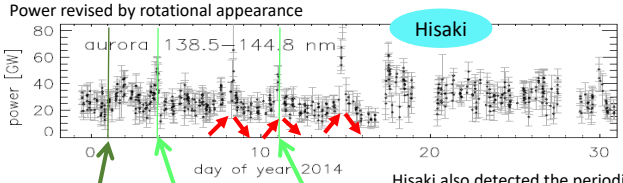
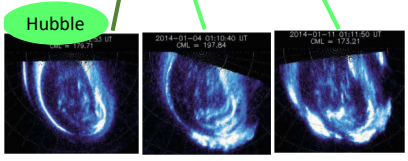
Hisaki Observation

Power revised by rotational appearance





[Kimura et al., 2015; Badman et al., 2016]

Hisaki also detected the periodic variations. At the peaks, the blobs and low-latitude expansion of main aurora is seen in the HST (Hubble space telescope) observation.

→ Statistical survey including Io's volcanic active time in 2015 and solar wind dependence etc.

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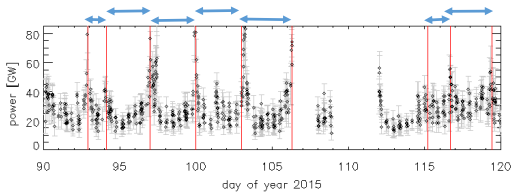
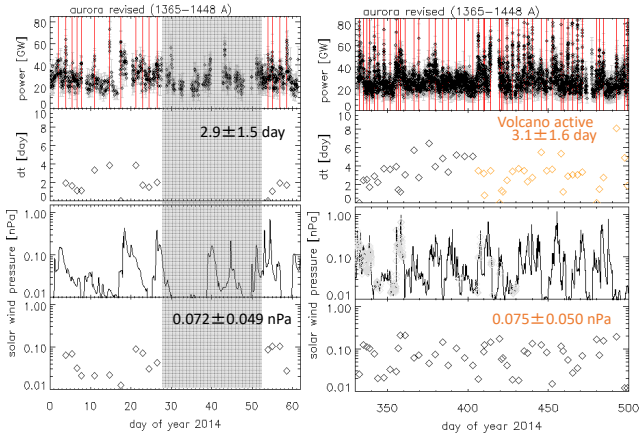
Event selection

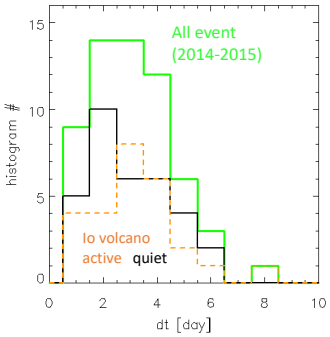
- Subtract 5-day average of intensity during System III 0-30 degree as background.
- To correct visibility effect because of auroral location and magnetic tilt, intensity is normalized by System III dependence [Tao et al., 2016JGR]
- Increase and decrease trends in time variation of $P_{1365\text{-}1448\,nm}$ are selected by eye, excluding the ambiguous events due to data lack.



Detected Periodicity



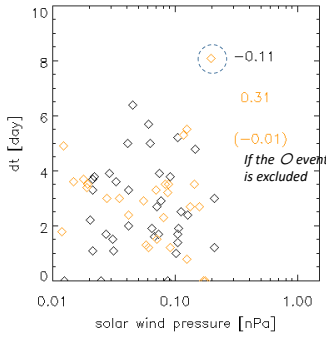
Periodicity analysis



Separation time (periodicity) seen in Hisaki: 0.8-8 days
Mean: 3.0 day, Median: 3.0 day
Standard deviation: 1.5 day
Dependence of the aurora periodicity on the volcanic activity is not clear

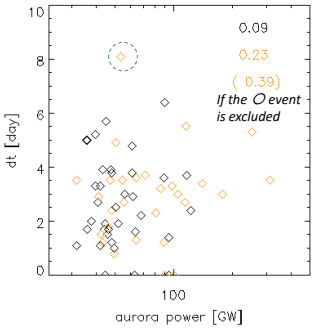
cf. The periodicity is comparable with…
5-10 days: aurora observed by IUE in Aug-Sep 1996 [Prangé et al., 2001]
1.5-7 days: plasma spectra variation [Kronberg et al., 2009]
1-4 days: Magnetospheric reconnection feature seen by Galileo/MAG [Vogt et al., 2010]

Correlation : dt & Psw



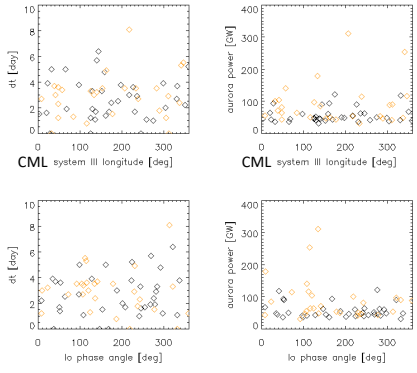
Dependences of the aurora periodicity on the solar wind dynamic pressure and on the volcanic activity are not clear

Correlation : dt & power



Dependence of the aurora periodicity on the power during volcanic quiet is not clear, while small correlation during volcanic active time

Correlation : system-III, Io phase

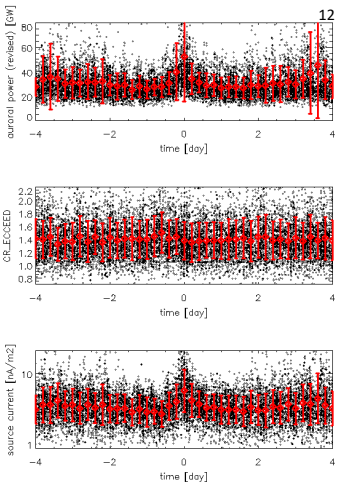


Dependences of the aurora periodicity and local maximum power on the central meridional longitude (CML) and on Io phase angle are not clear.

Statistical variation

Superposed-epoch time variation of parameters

Auroral power, electron flux, and source current increase, while CR, i.e., auroral electron energy, does not increase at the enhancements.

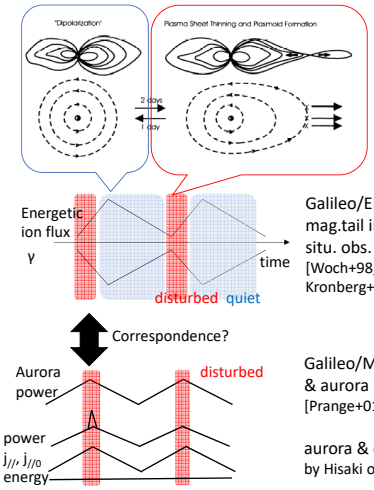


Discussion

Aurora shows the 2-3 days periodic variation as magnetotail plasma.

The peak auroral power is suggested to disturbed time.

Asymmetry is seen in increase/decrease phase of the ion flux and γ, while aurora is rather symmetric.
→ Due to in-situ vs. global difference?



Galileo/EPD mag.tail in-situ. obs. [Woch+98, Kronberg+09]

Correspondence?

Galileo/MAG & aurora [Prange+01]

aurora & ele. by Hisaki obs.

Summary

A few-day periodic variation are detected in Jupiter's aurora power observed by Hisaki. Using 2014-2015 dataset, the following characteristics are found:

- Periodicity 0.8-8 days
- Dependences of the aurora periodicity on the solar wind dynamic pressure and on the volcanic activity are not clear
- Dependences of the aurora periodicity and local maximum power on the system III longitude and on Io phase angle are also not clear.
- Aurora energy does not change, while flux varies with the period
- Aurora rather shows symmetric variation, compared to asymmetric variations seen in in-situ plasma.