木星オーロラ･電磁圏現象のモニタリング観測

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Solar wind response of Jovian aurora

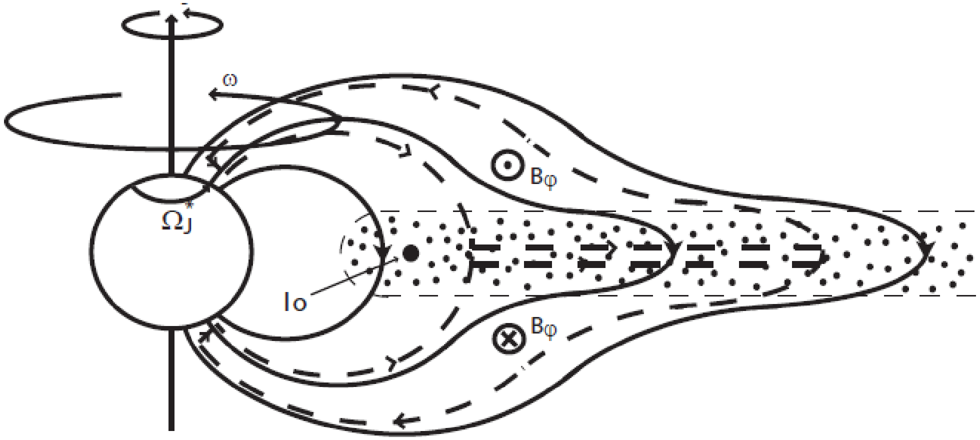
Jovian auroral emission results from magnetosphere-ionosphere coupling current system

- Io supplies massive plasma to the magnetosphere
- Angular velocity decreases and corotation breakdown occurs around 15~40Rj
- The strong current system produces main auroral emission.

Cowley and Bunce [2003]

- Angular velocity of magnetospheric plasma increases when the Jovian magnetosphere is compressed by enhanced solar wind pressure, which decreases the field-aligned current.

➔Anti-correlation between intensity of aurora and solar wind pressure



Solar wind response of Jovian aurora

HST obs. [Clarke et al., 2009]

- Two campaigns in 2007 (Feb-Mar, May-Jun)
- The correlation between EUV aurora and solar wind dynamic pressure is less strong. Total auroral power increases near the arrival of solar wind shocks.

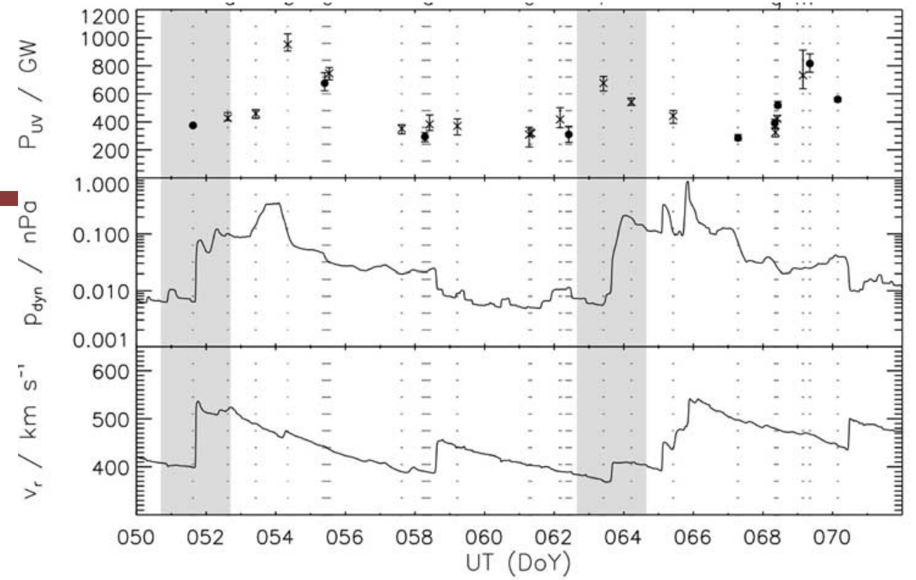


Figure Total auroral power from Jupiter's north (crosses) and south (filled circles) polar regions obtained from HST observations.

IRTF obs. [Baron et al., 1996]

- Total intensity and the solar wind pressure have correlation

➔Not consistent with theoretical expectation

However, the data set lacks of continuity and it is necessary to use continuous data set to reveal solar wind response

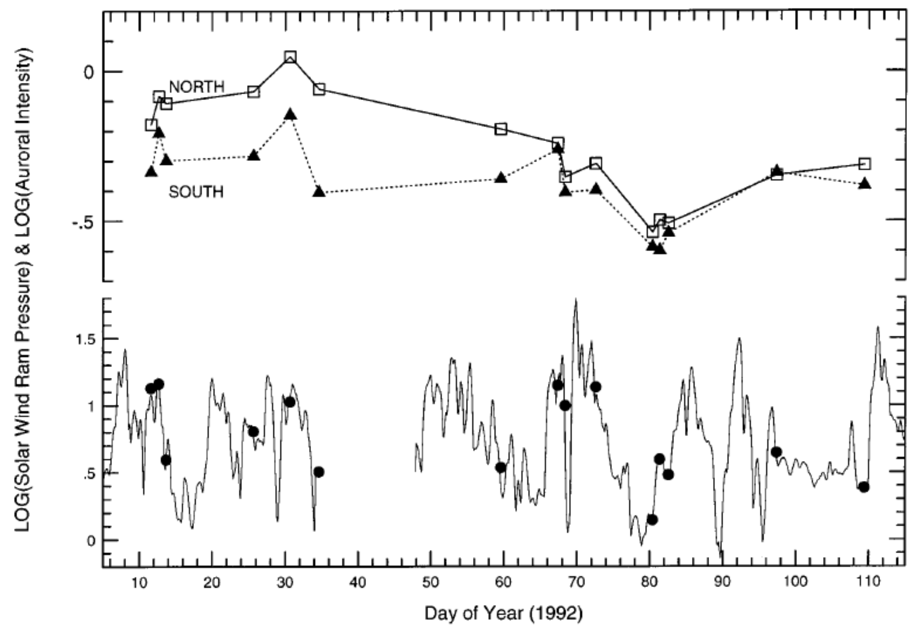


Figure. Scatter plot of the intensity of Jovian infrared aurora and solar wind dynamic pressure.

HISAKI observations of Jovian aurora

We could find clear solar wind response of EUV aurora. However, EUV aurora does not always respond to the solar wind

➔It seems that the solar wind shock with <u>long rarefaction region</u> causes large enhancement of EUV aurora.

- Io supplies plasma to the Jovian magnetosphere.
  - <u>long quiescent interval → more plasma supplied from Io?</u>
- Mass loading process also controls the solar wind response of aurora?

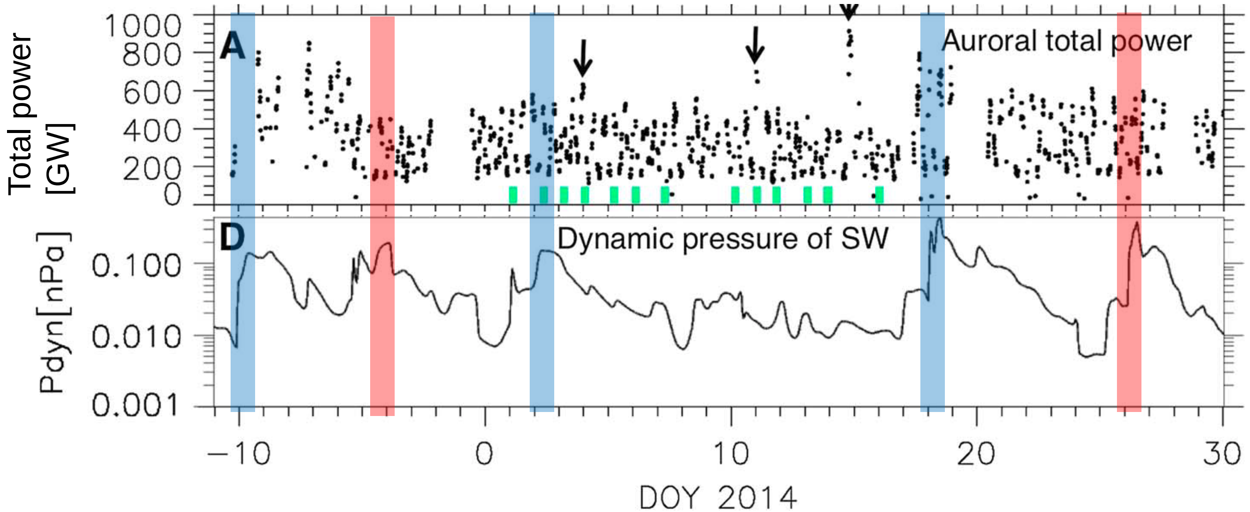


Figure. Time variation of Jovian EUV aurora obtained from HISAKI observations. We can find clear solar wind response of EUV aurora (Blue hatched), but some times aurora do not respond to the solar wind (Red hatched) infrared aurora and solar wind dynamic pressure.

Purpose

- Cowley model expects that increase of the solar wind dynamic pressure is anti-correlated with the intensity of the EUV aurora.
- However, observation showed that Jovian aurora increase with solar wind dynamic pressure [e.g. Baron et al., 1996; Nichols et al., 2009].
- Recent HISAKI observations showed that sometimes aurora does not respond to the enhancement of the solar wind dynamic pressure.

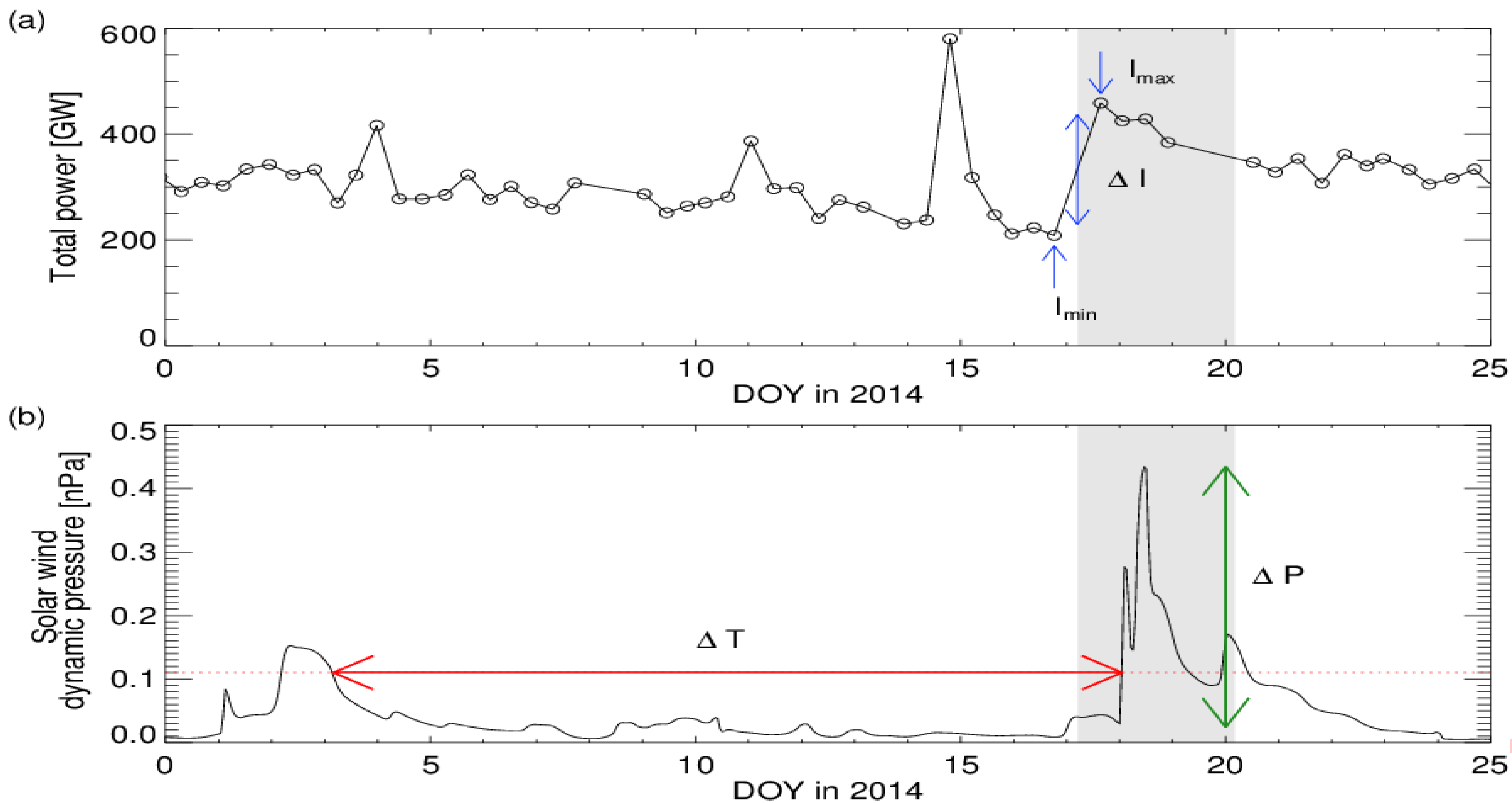
➔ <u>Investigate solar wind response on Jovian EUV aurora from continuous HISAKI data set.</u>

<u>Purpose of this study</u>

- Reveal a statistical feature of Jovian EUV aurora to the solar wind properties.
  (duration of the quiescent interval affects the Jovian EUV aurora??)

Definition of each parameter

- Duration of quiescent interval (ΔT)：the period of P<0.11[nPa].
- Variation of solar wind dynamic pressure (ΔP)： maximum during the period of P>0.11 ÷ mean during the rarefaction region
- EUV variation ΔI = (maximum intensity during the period of P>0.11 +/- 20~40h) − (minimum intensity during ΔT)



Summary of HISAKI observation (2014)

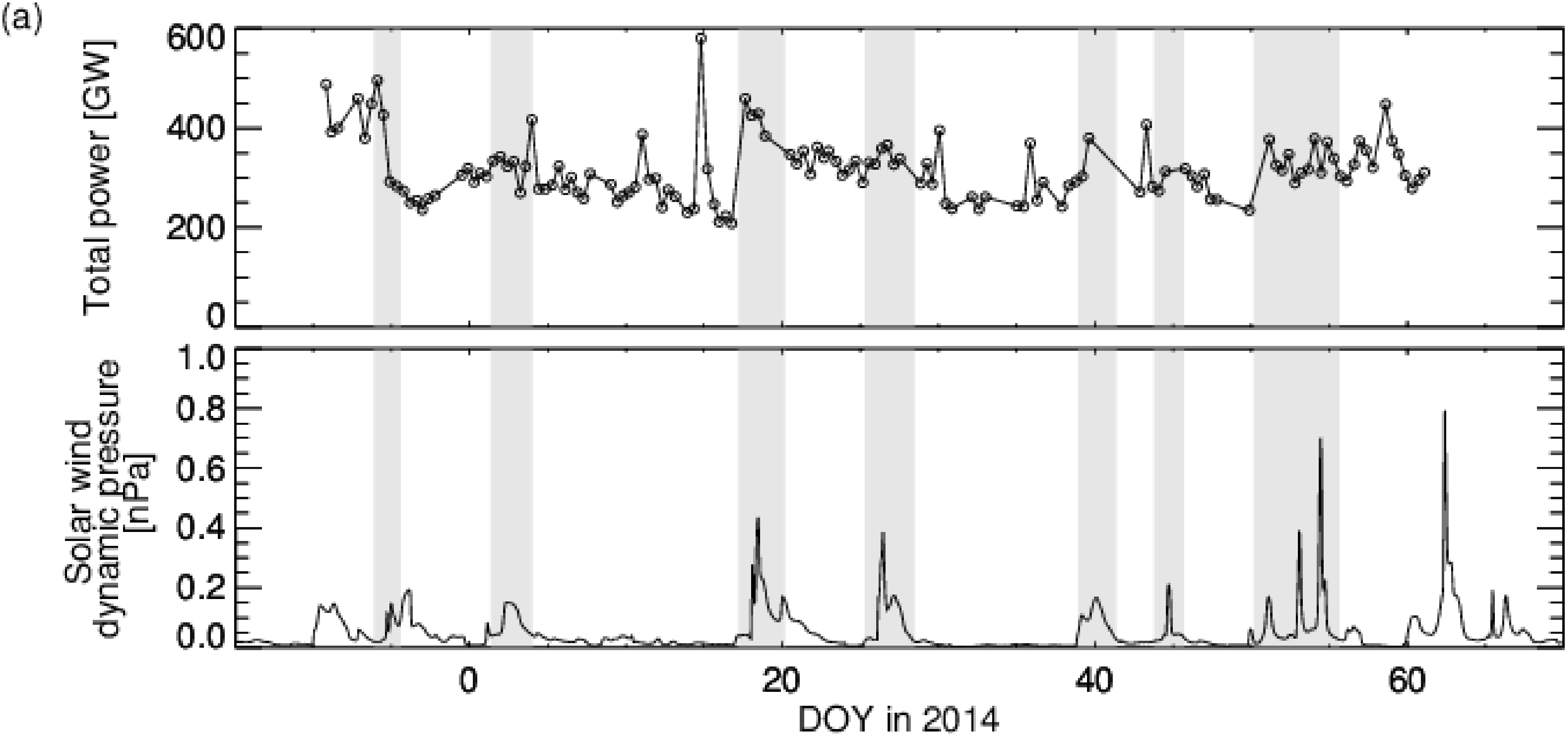


Figure Top：Total intensity of Jovian EUV aurora from 900 to 1480Å. Bottom：A and solar wind dynamic pressure which is extrapolated at Jupiter using a one dimensional magnetohydrodynamic (MHD) model from Tao et al., [2005].

Summary of HISAKI observation (before volcanic eruption affect EUV aurora)

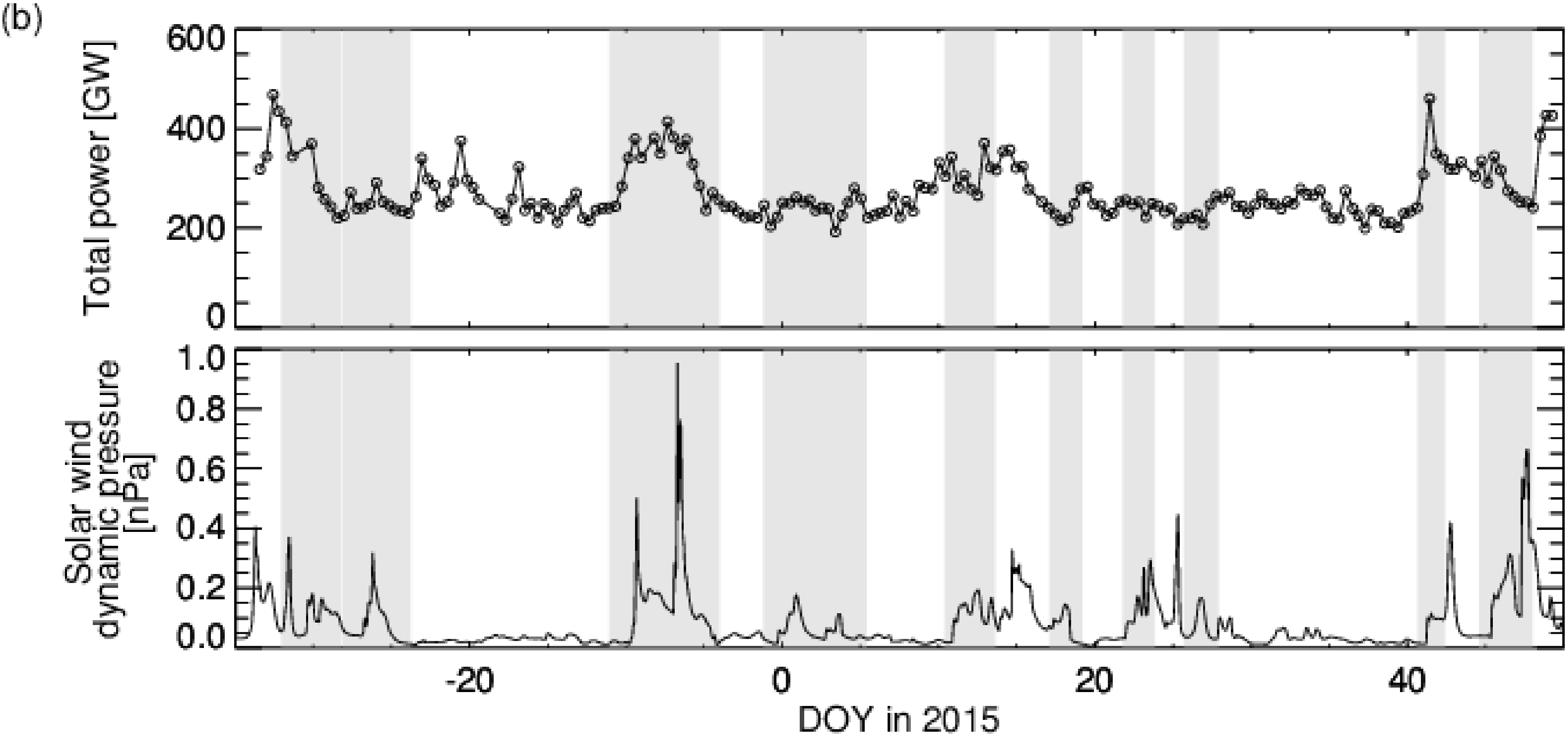


Figure　Top：Total intensity of Jovian EUV aurora from 900 to 1480Å. Bottom： A and solar wind dynamic pressure which is extrapolated at Jupiter using a one dimensional magnetohydrodynamic (MHD) model from Tao et al., [2005].

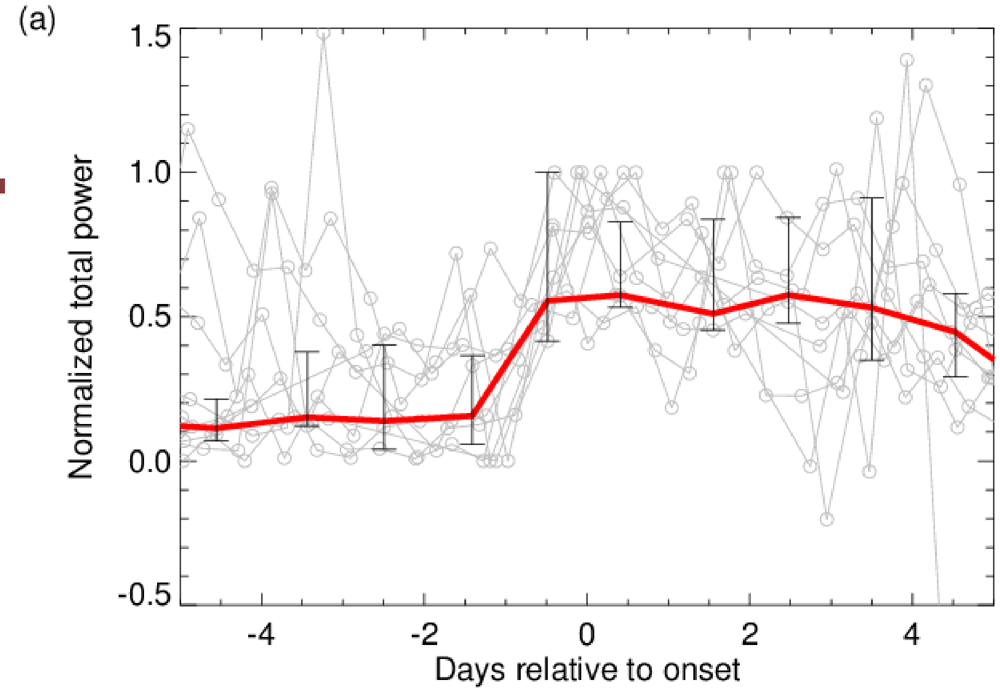
Superposed profile

- Cowley found that after an impulsive compression the main oval will dim because of the increased angular velocity of the equatorial plasma.

  ➔We made superposed epoch analysis for the event of ΔT > 5 days.

  The data are aligned to the onset of dynamic pressure enhancement.

- Aurora does not dim during solar wind compression.



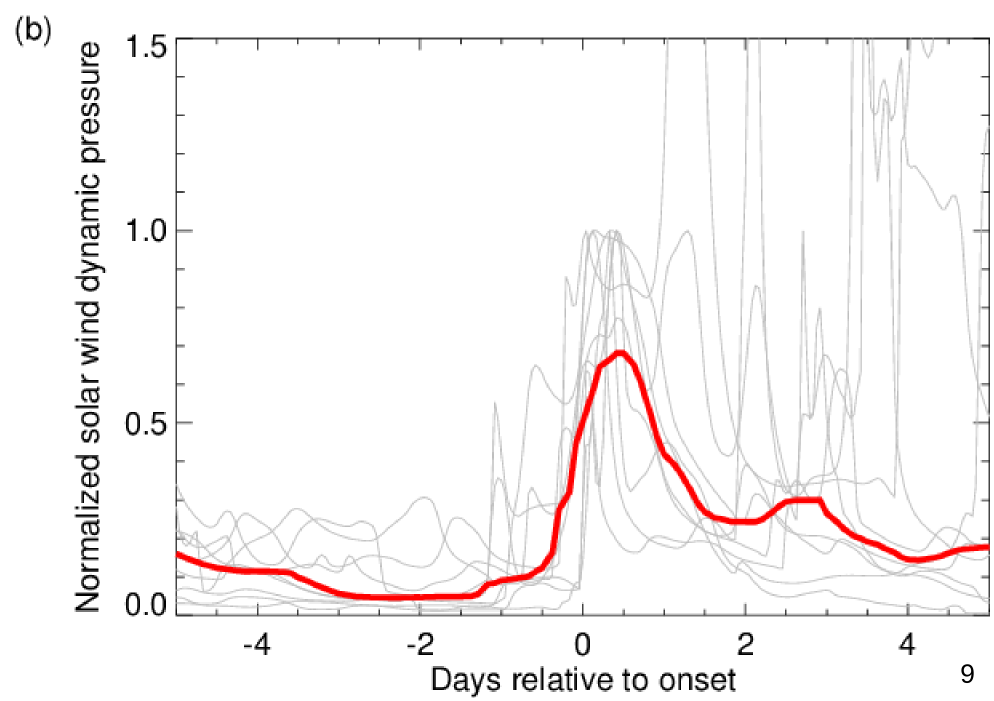


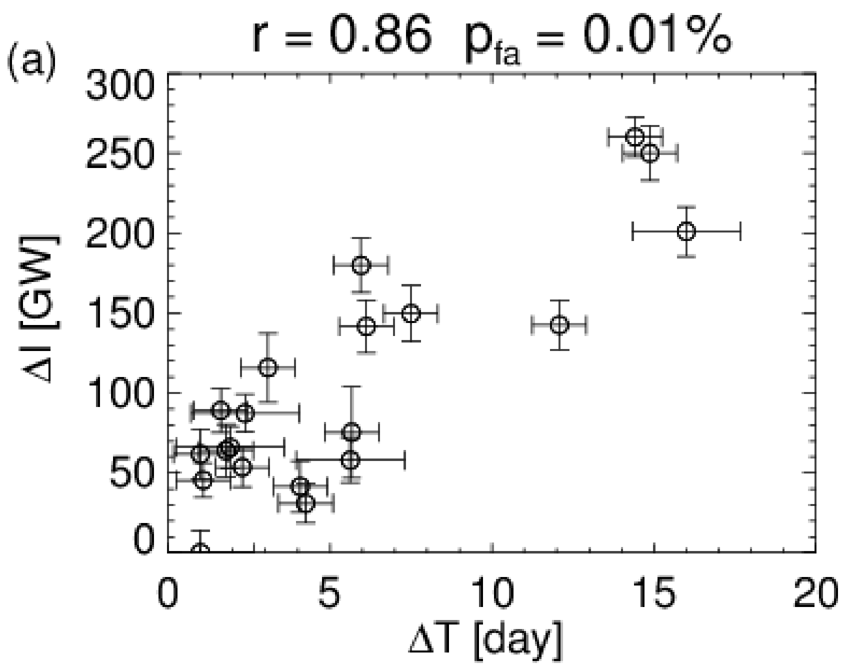
Figure (Top) superposed profile of EUV aurora. Red line indicates median profile for one-day window. Errorbars indicate Interquartile range. (Bottom) superposed profile of the solar wind dynamic pressure. Red line indicates median profile.

Correlation analysis

ΔT—ΔI

- Correlation coefficient (R) = 0.86
- False alarm probability: <1%

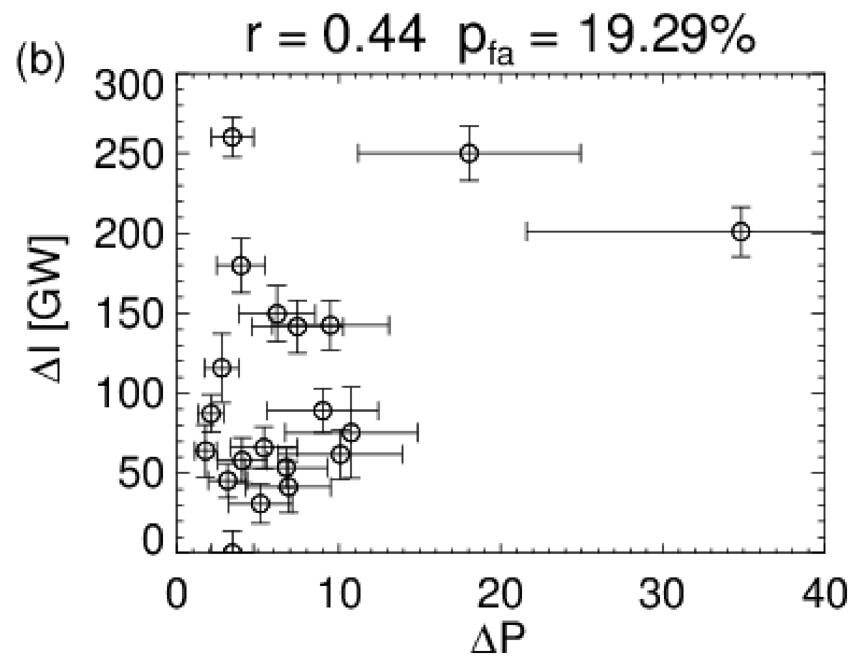
→ΔT-ΔI have correlation



ΔP—ΔI

- Correlation coefficient = 0.44
- False alarm probability: ~19%

→ΔP-ΔI do not have correlation

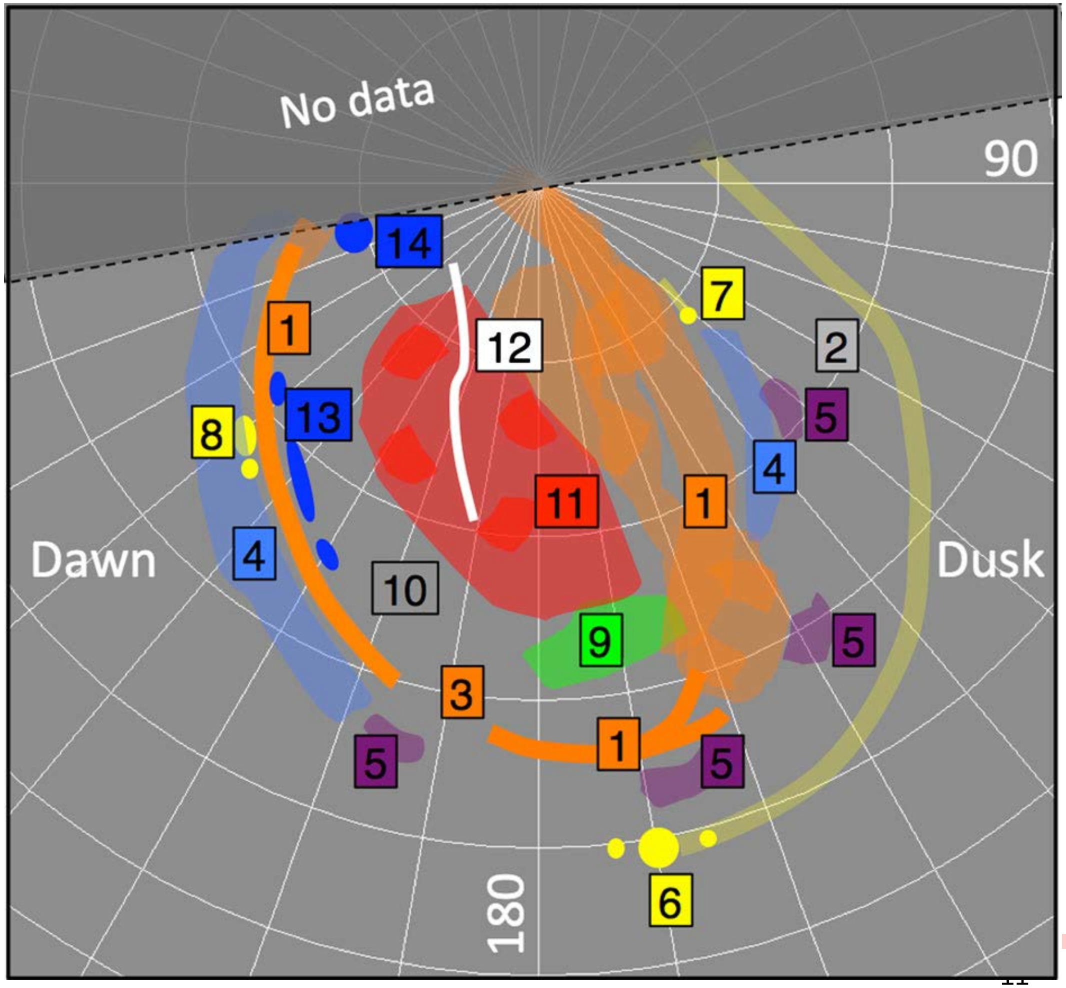


- EUV aurora depends on the duration of rarefaction region. (➔some process related to the mass loading??)
- EUV aurora does not depend on the pressure variation.

Expected scenario

By noting that the main oval contribute ~50% of the auroral total power [Nichols et al., 2009], we should also consider the possibility of solar wind response of other components, brightening outside and inside of the main oval.

- Main oval (1, 4?)
  - Angular velocity gradient of the plasma is generated in the middle magnetosphere?
- Outside of the main oval (5)
  - ➔caused by particle injections
- Inside of the main oval (9, 11)
  - sporadic tail recconection → polar spot



Future works

- Morphological variations during the solar wind event (→main oval and/or outside and/or inside region??)
- The emission mechanism of IR and UV is different, but it gives us a clue to understand which region increases during solar wind event.
  - Long-term HST UV May-June (2016)
  - IRTF SPEX H_3^+ from Dec. 2015
- As we noted from Hisaki observations, long-term monitoring is effective tool to understand solar wind control of Jovian UV aurora
  - PLANETS H_3^+
  - TAO MIMIZUKU H_3^+
    - Hawaii + Chile cover wide local time range, which is enable us to catch sporadic event (~10h)

Summary

- We found that the correlation between the EUV intensity variation and the solar wind dynamic pressure, and aurora does not dim during compression period.

- We also found that the time duration of rarefaction region of the solar wind has correlation with the intensity variation, which had never been reported.
- Variation in the thermal current has correlation with the duration of the rarefaction region.

  ➔Mass loading process might control Jovian EUV aurora.

- We propose several variation mechanisms, however, we cannot identify one or a combination of these scenarios for auroral time variation.