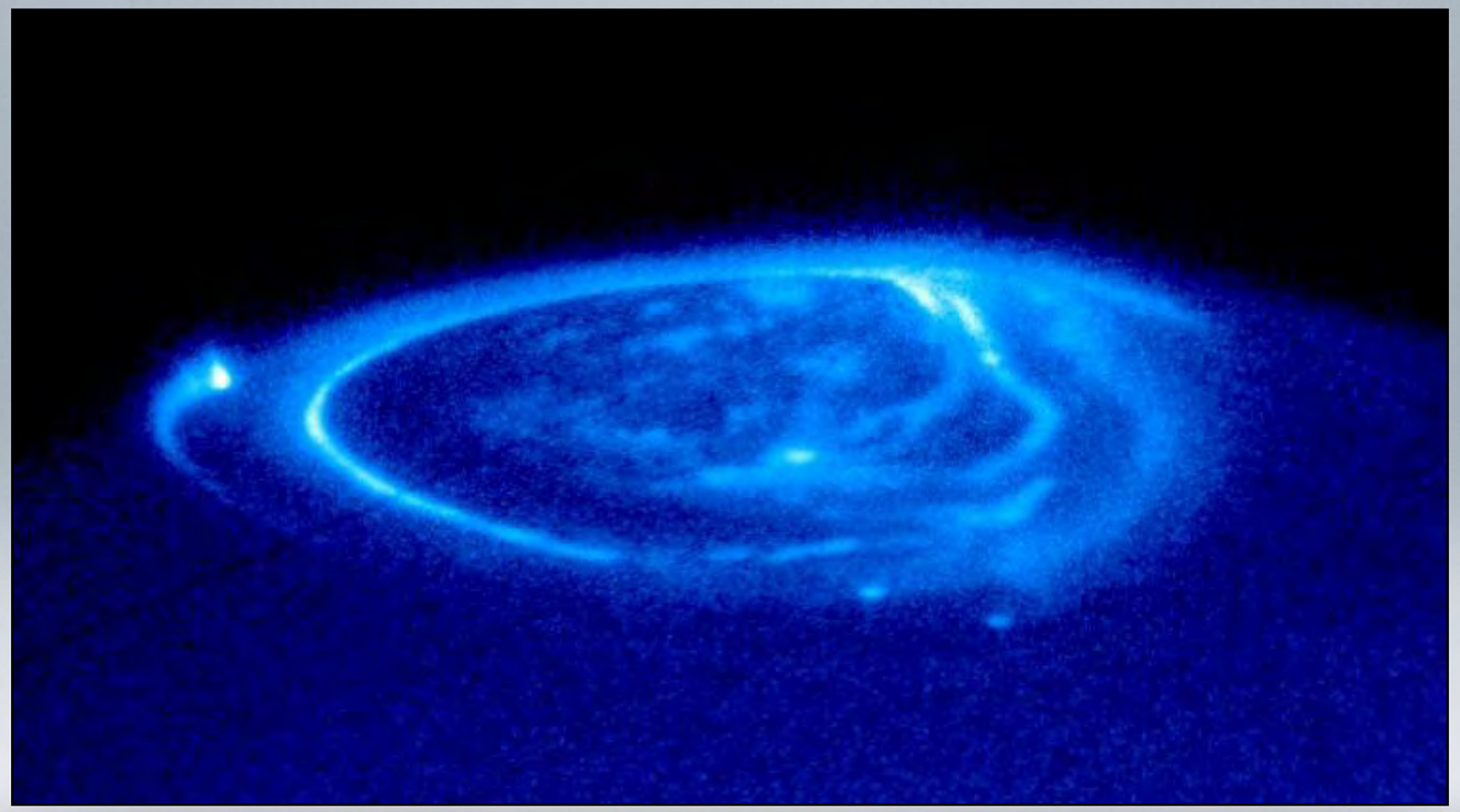
An overview of Jupiter's auroras

J. D. Nichols



Juno auroral planning workshop
University of Colorado, Boulder
7 March 2016

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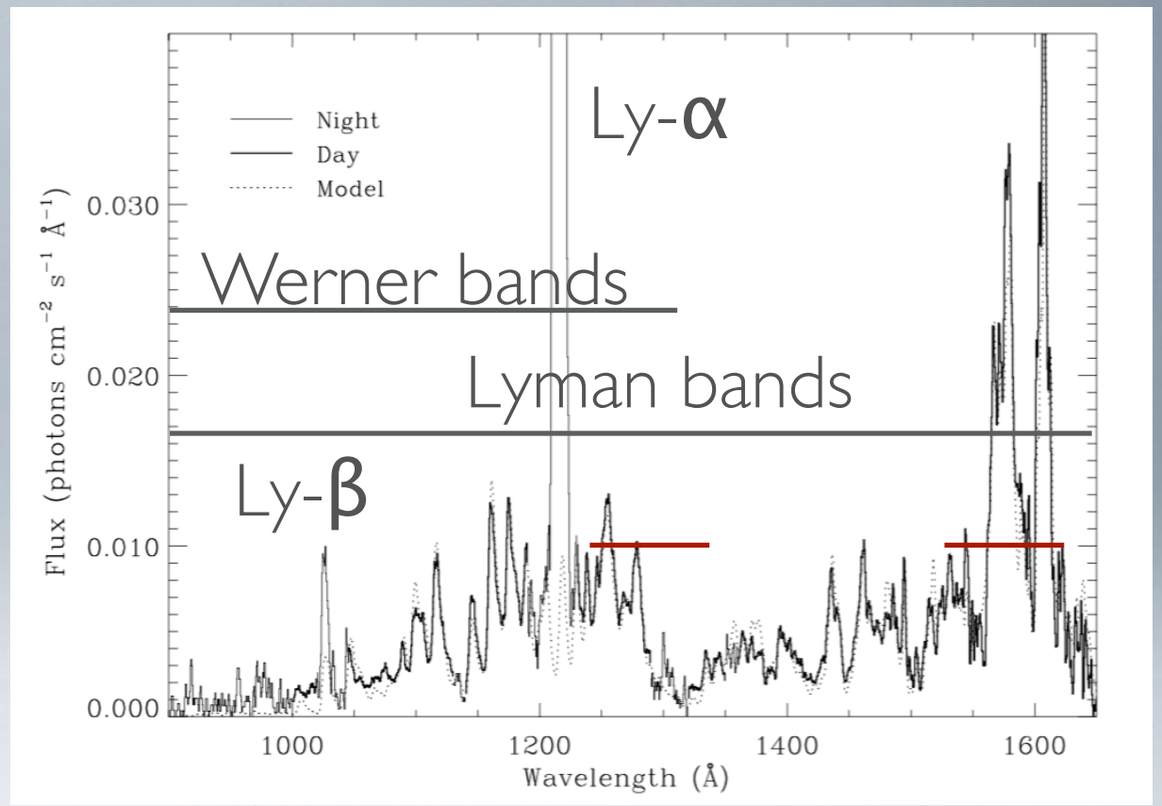
A brief history of observations

- First detected by Voyager 1 UVS (Sandel et al., 1979)
- Most prominent emission is H_2 Lyman and Werner bands plus H Ly-α
- IUE observations confirmed collisional excitation (Clarke et al., 1980; Waite et al., 1982)
- HST provided imaging with increasing sensitivity - FOC, WFPC2, STIS, ACS



Morrissey et al. (1990)

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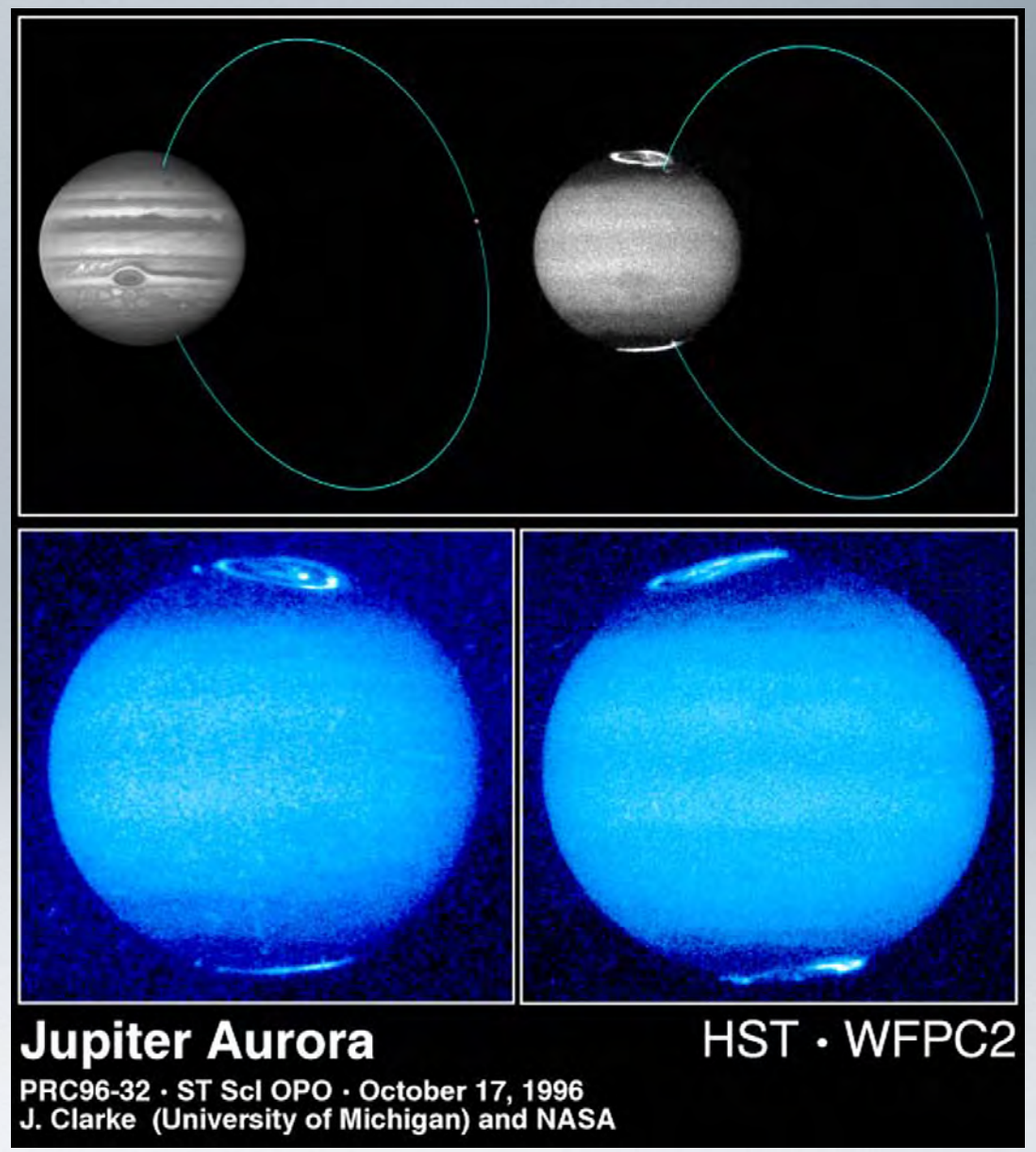
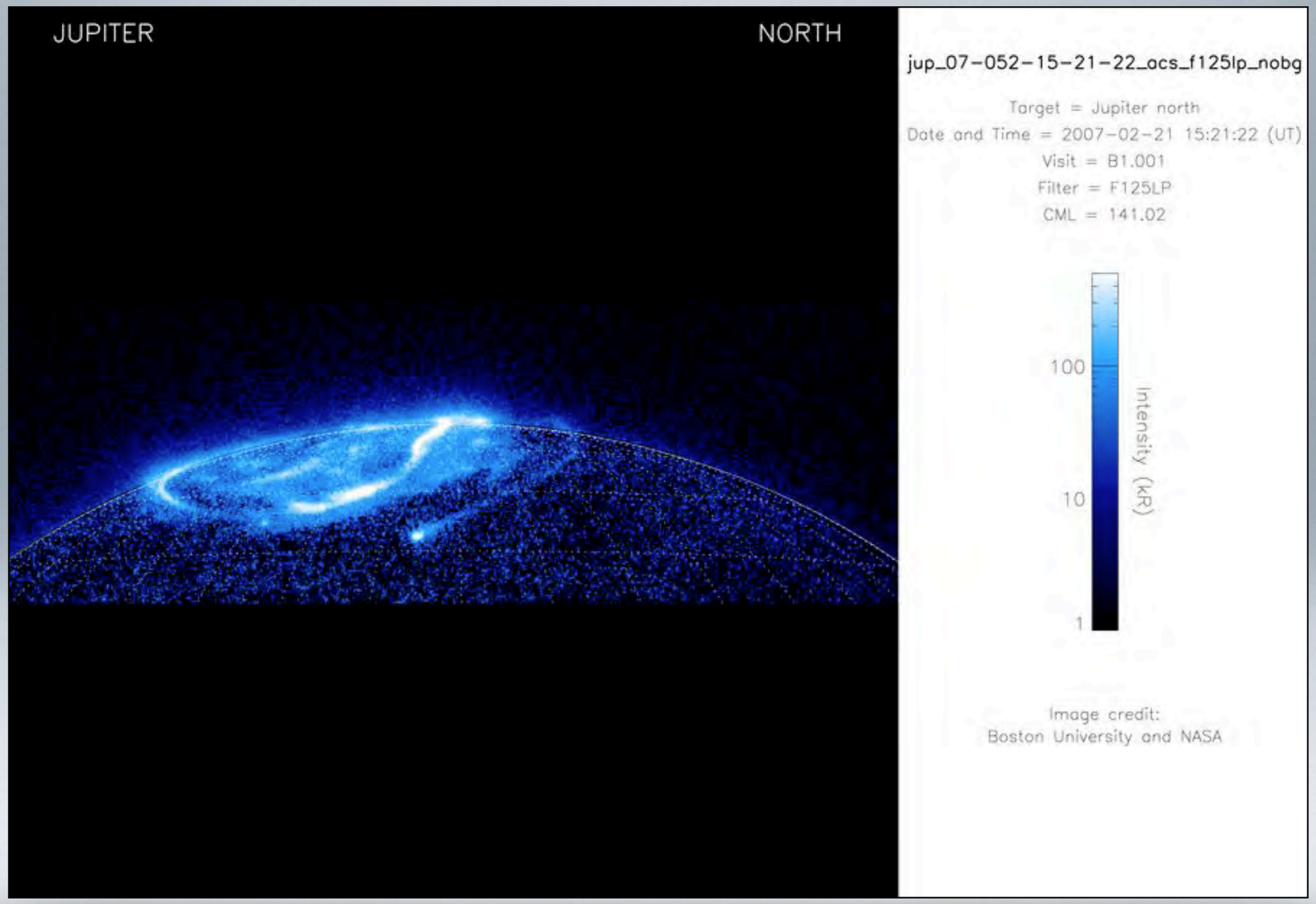
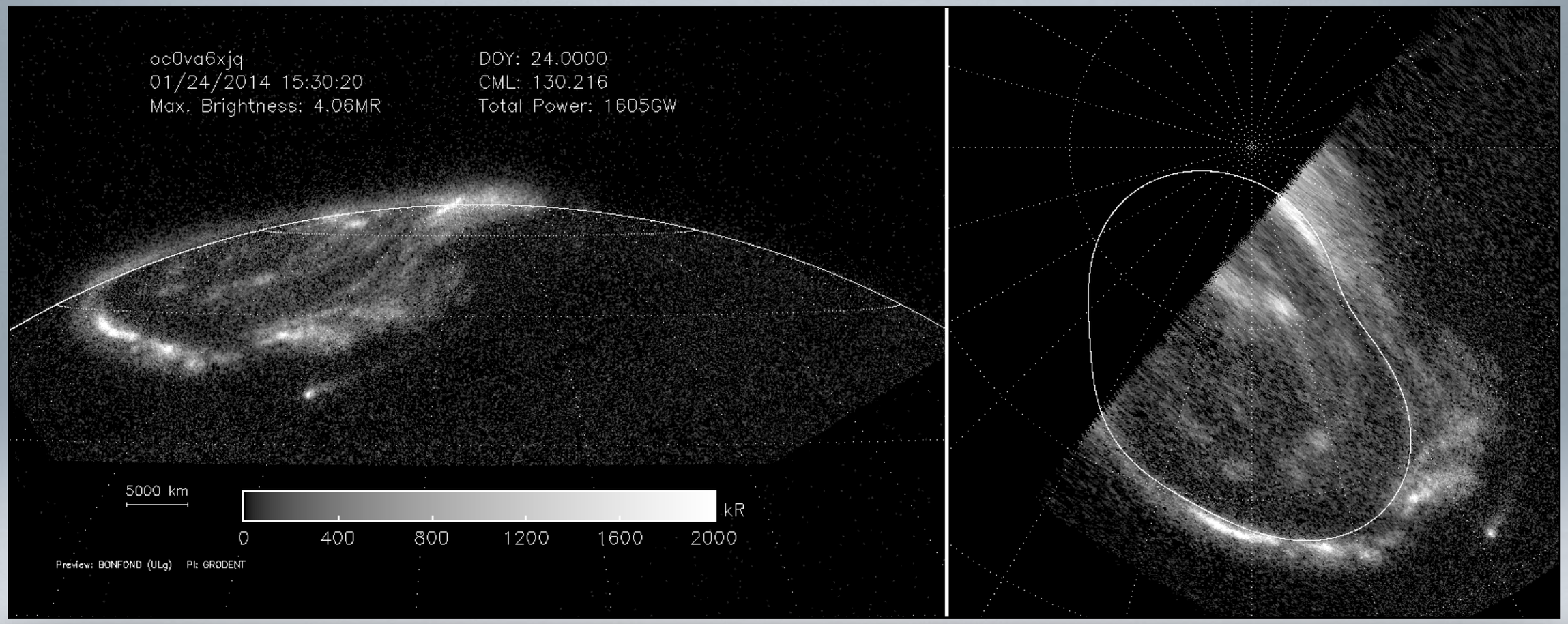


A brief history of observations



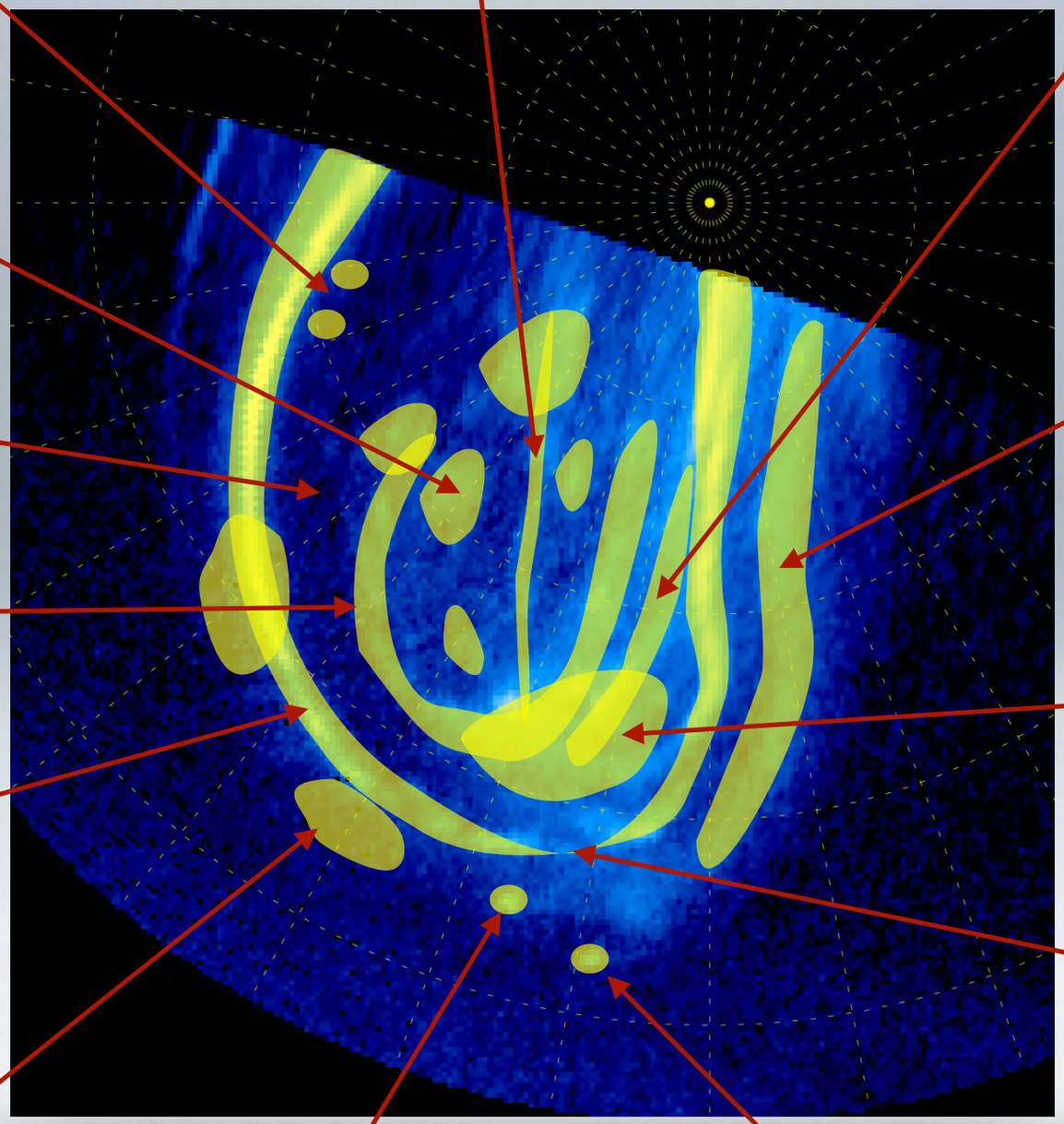
e.g. HST/ACS Clarke et al. (2009), Nichols et al. (2009)
0.025''/pixel, PSF FWHM ~2 pixels (~STIS)

A brief history of observations



HST/STIS time-tagged data; 30 s extractions Bonfond et al.

Anatomy of the FUV auroras



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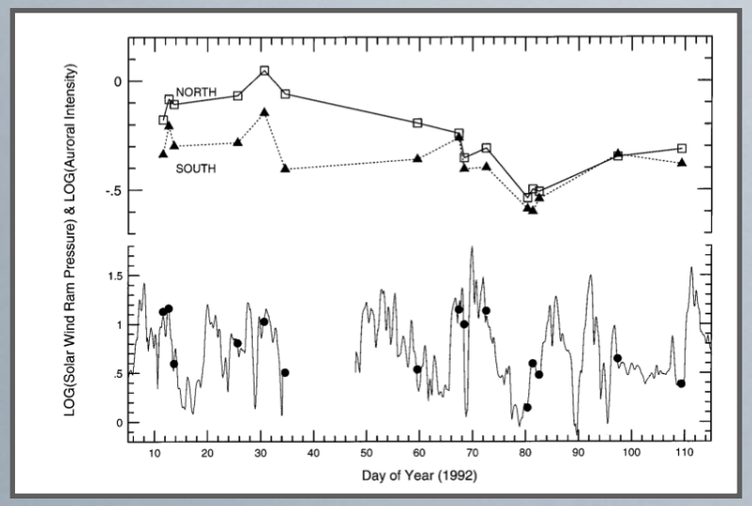
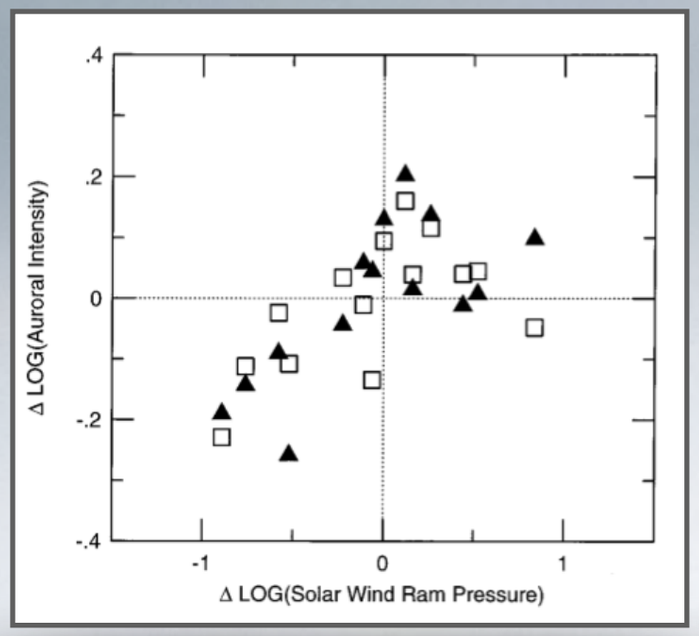
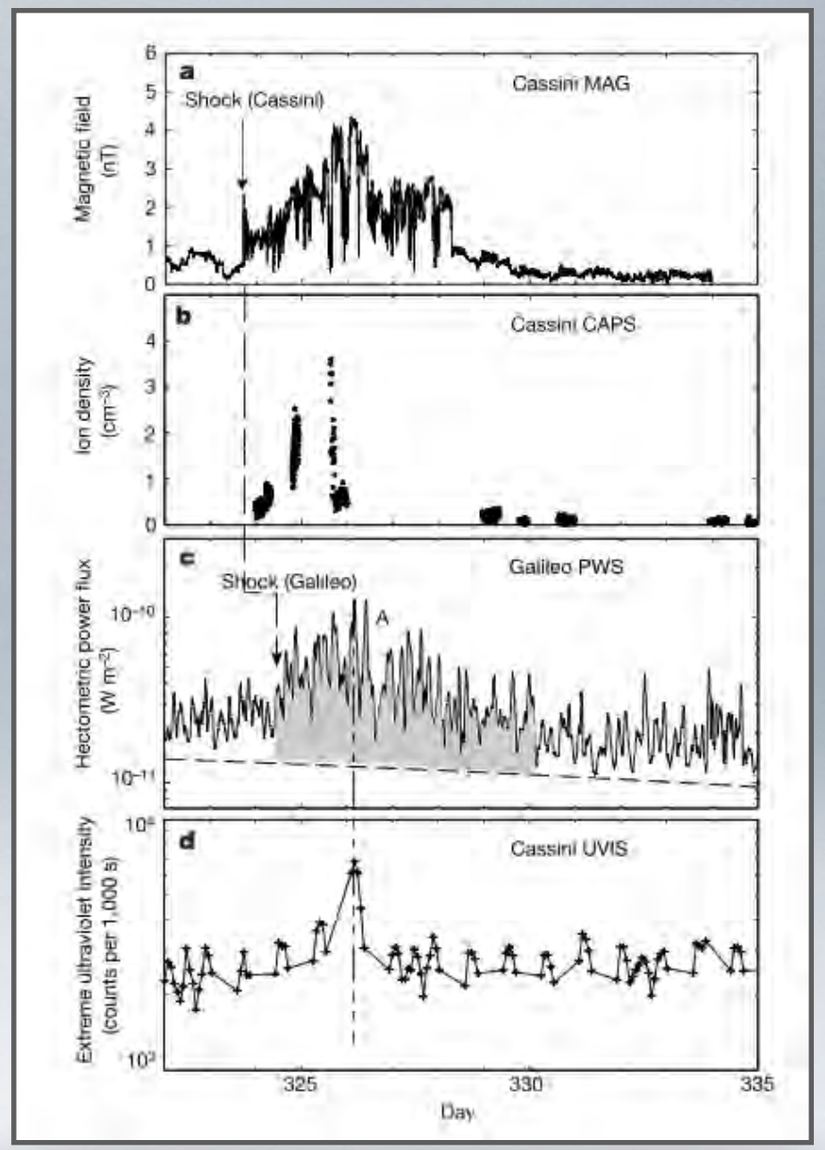
Solar wind control of the auroras





Baron et al. (1993)



Gurnett et al. (2002)
Pryor et al. (2005)

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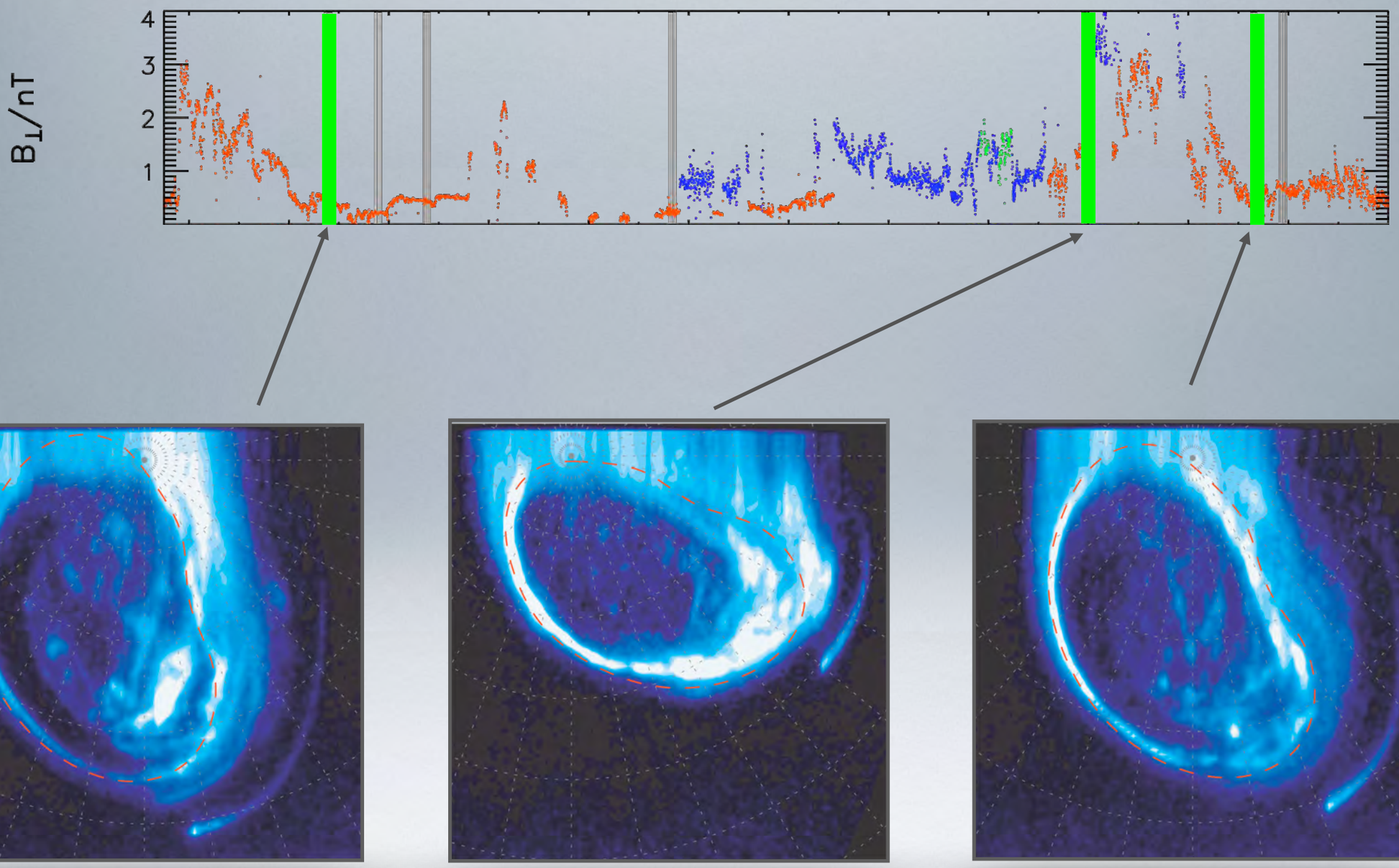
Solar wind control of the auroras



Nichols et al. (2007)

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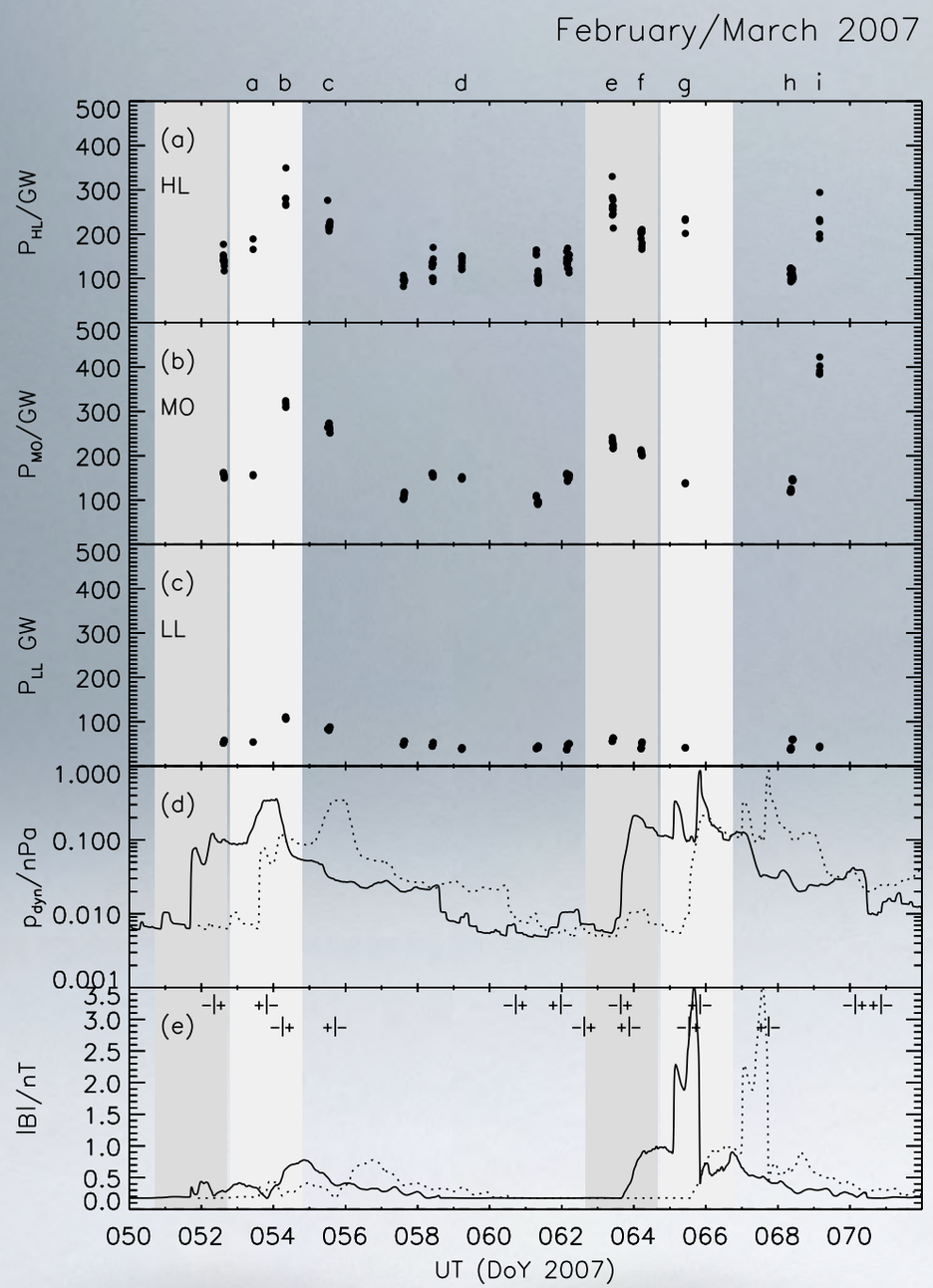
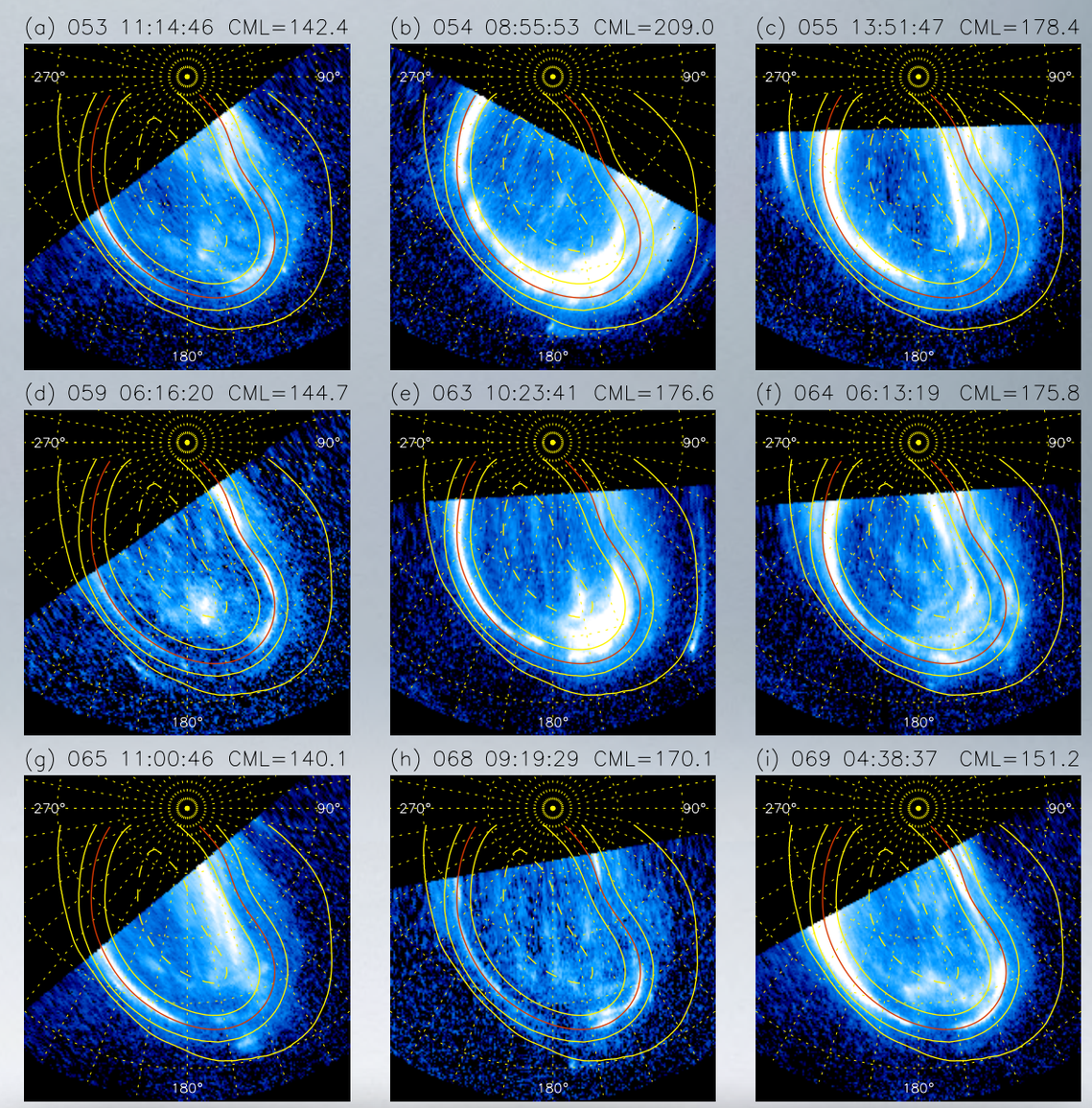
Solar wind control of the auroras





Nichols et al. (2009)

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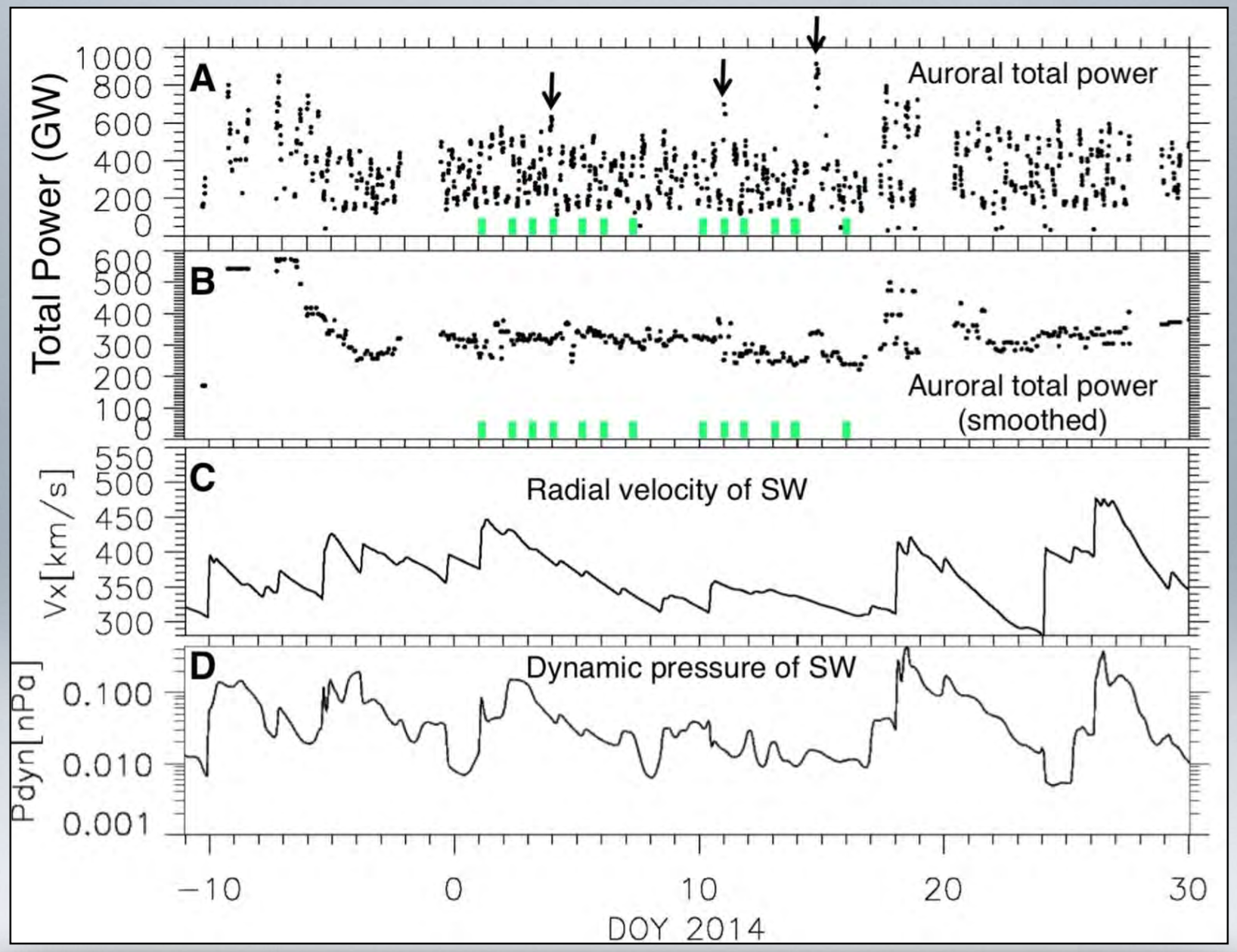
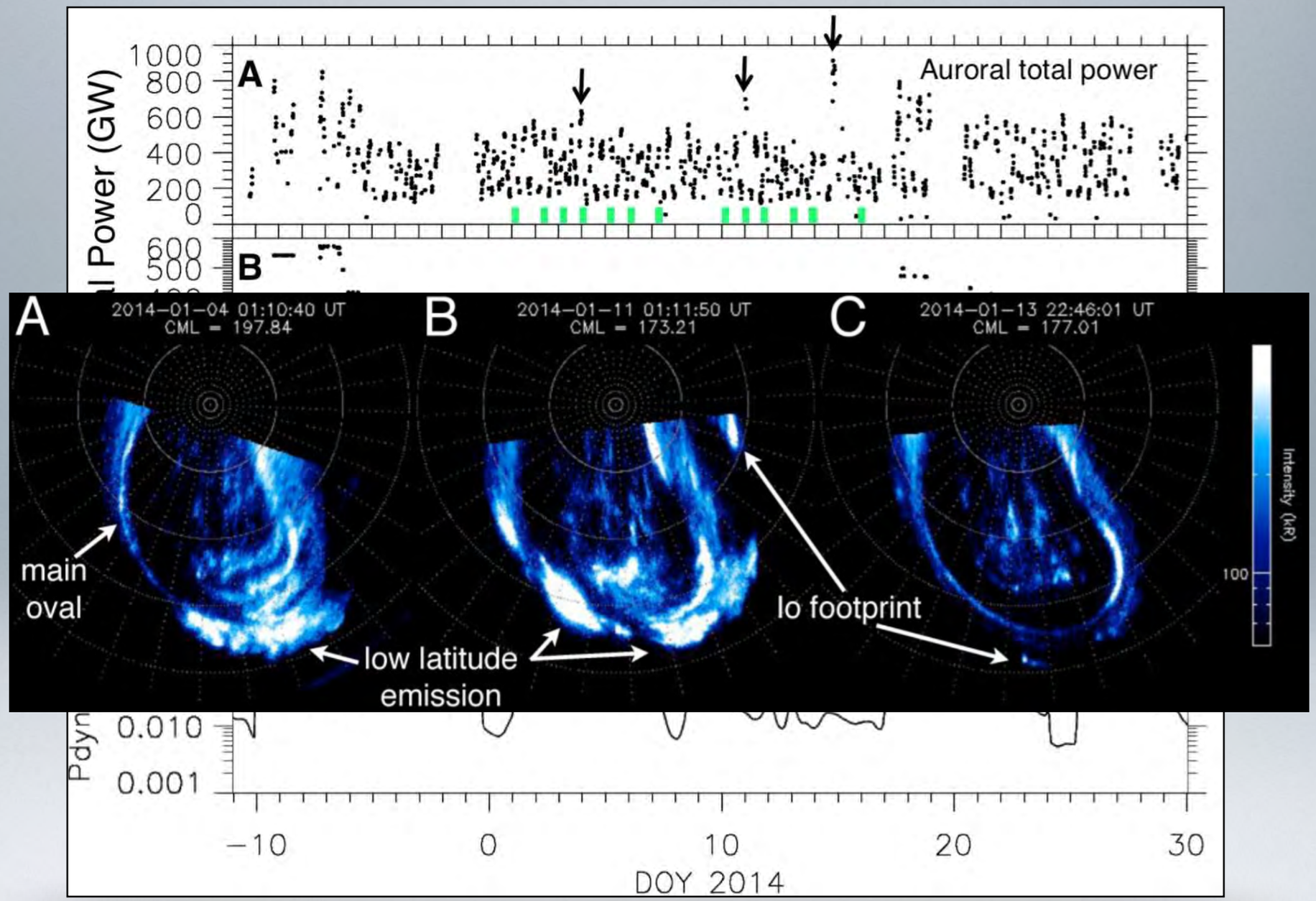
Internal control of the auroras



Kimura et al. (2015)

Internal control of the auroras



Kimura et al. (2015)

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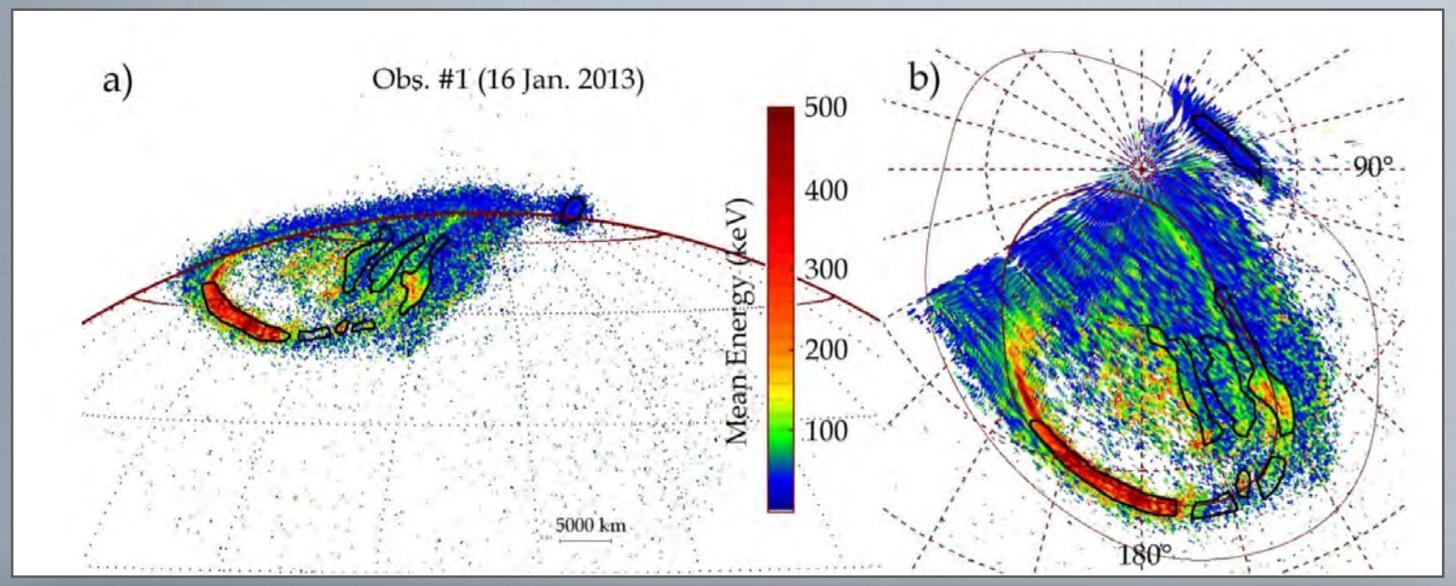
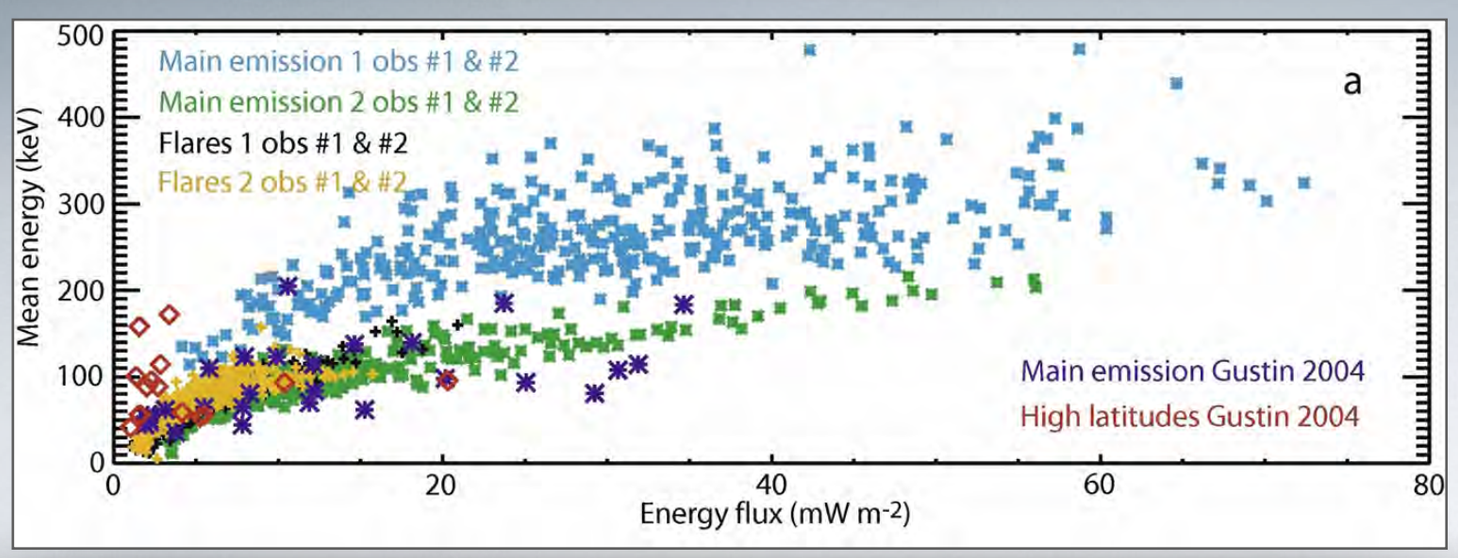
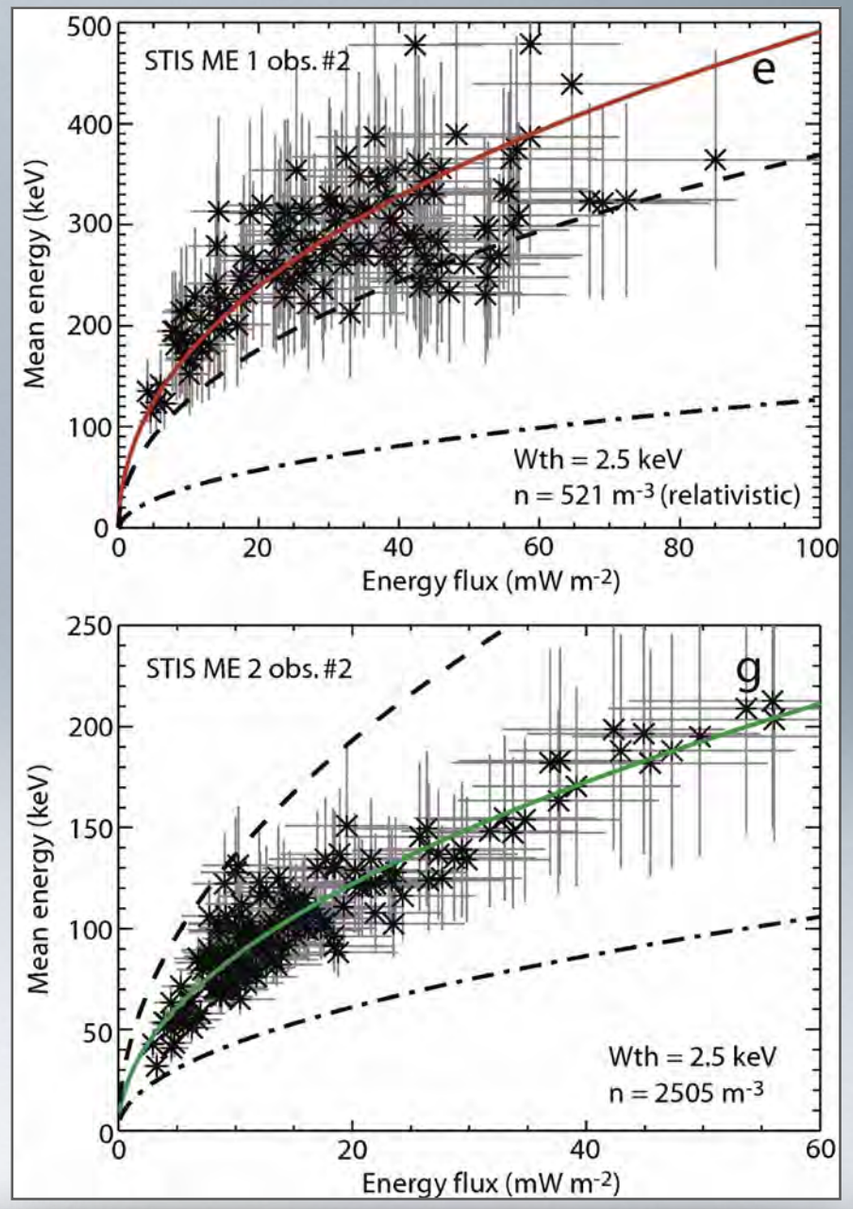
Investigating auroral acceleration







Gustin et al. (2016)

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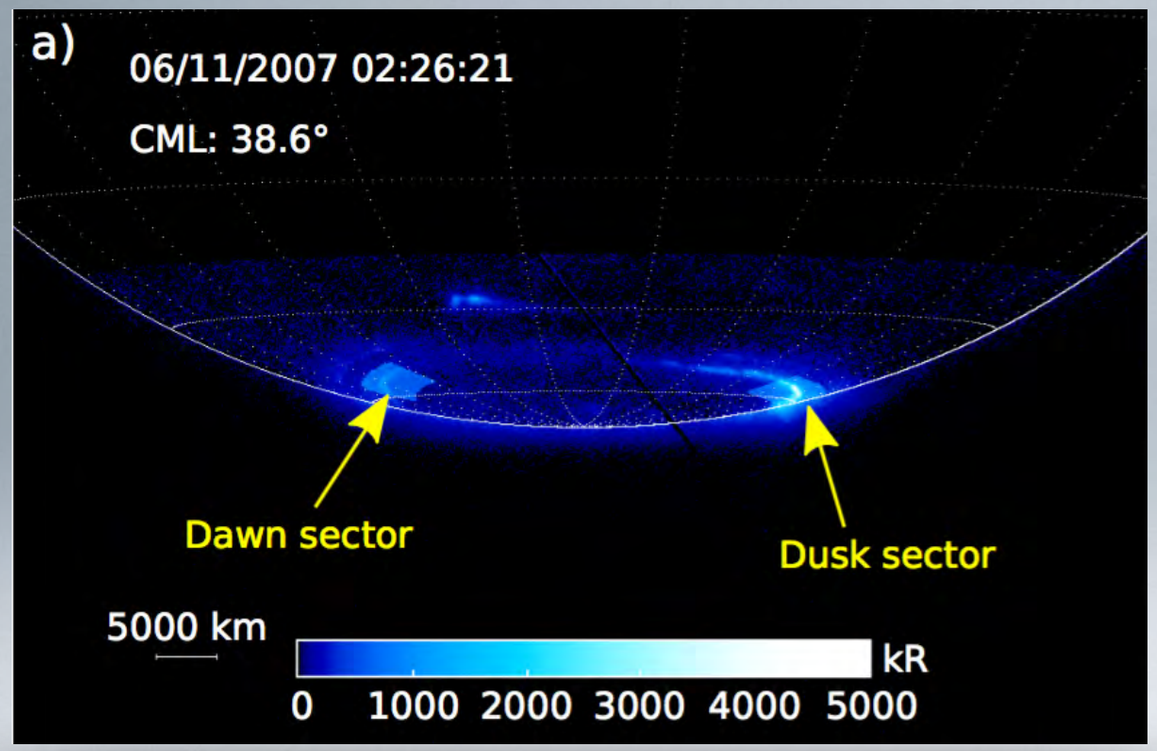
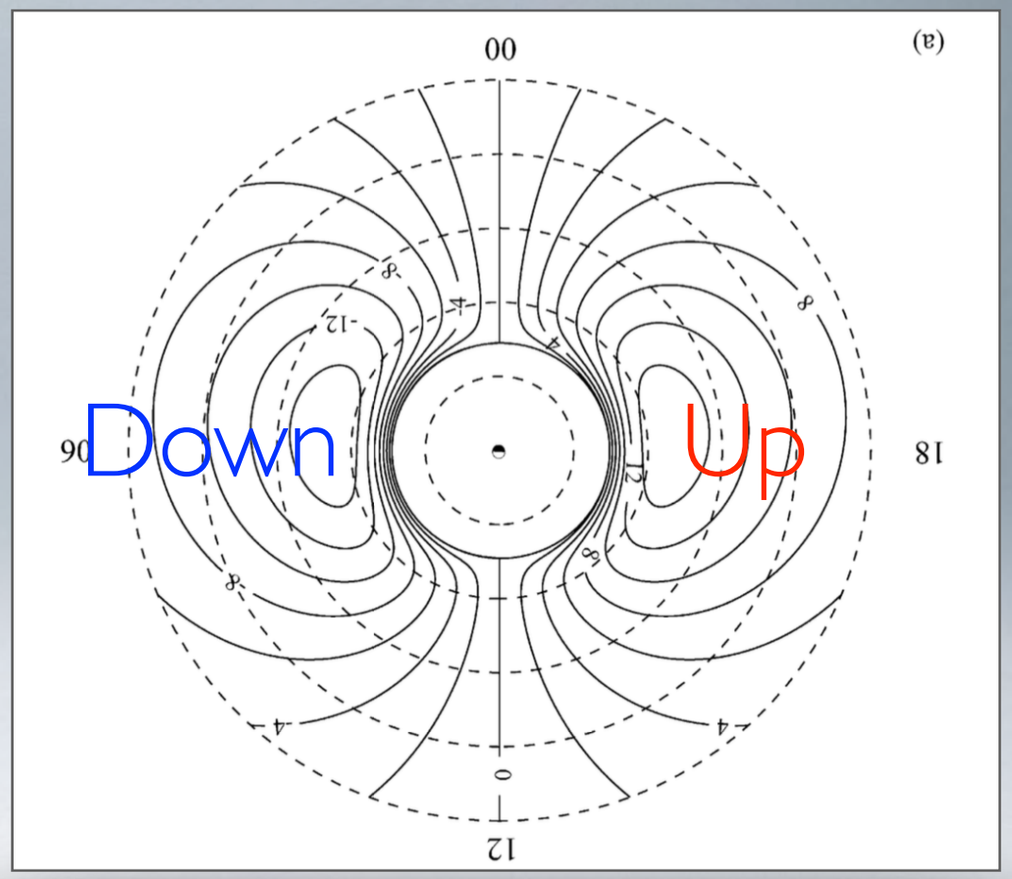
Relation to magnetospheric currents

Auroral intensity



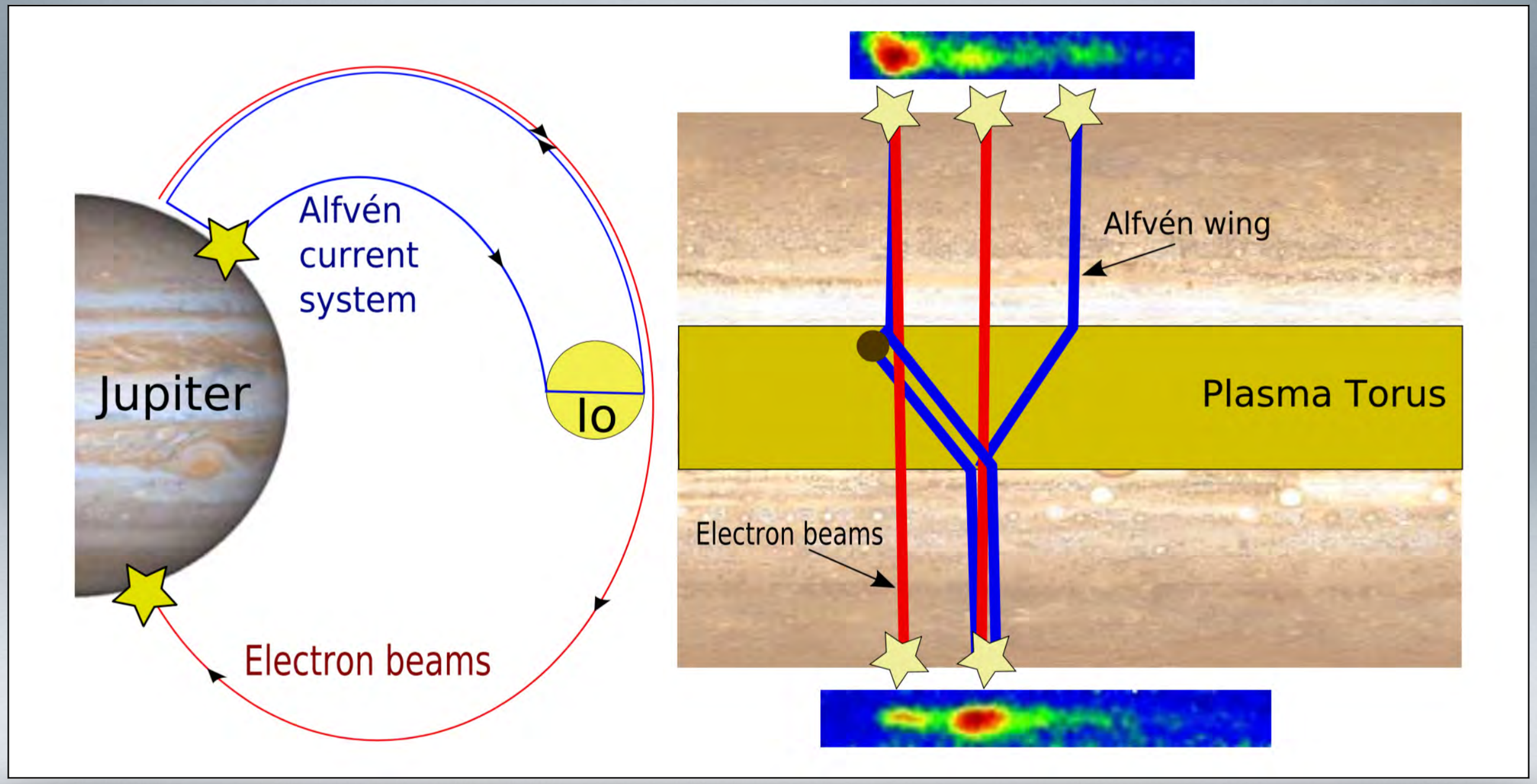
Bonfond et al. (2015)

Equatorial current divergence



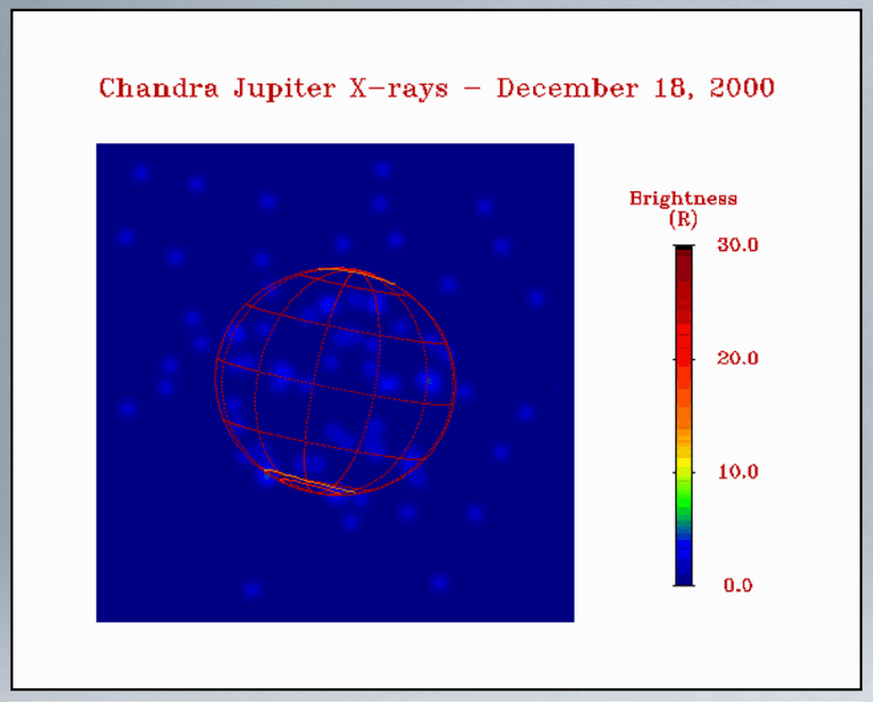
Bunce et al. (2002)

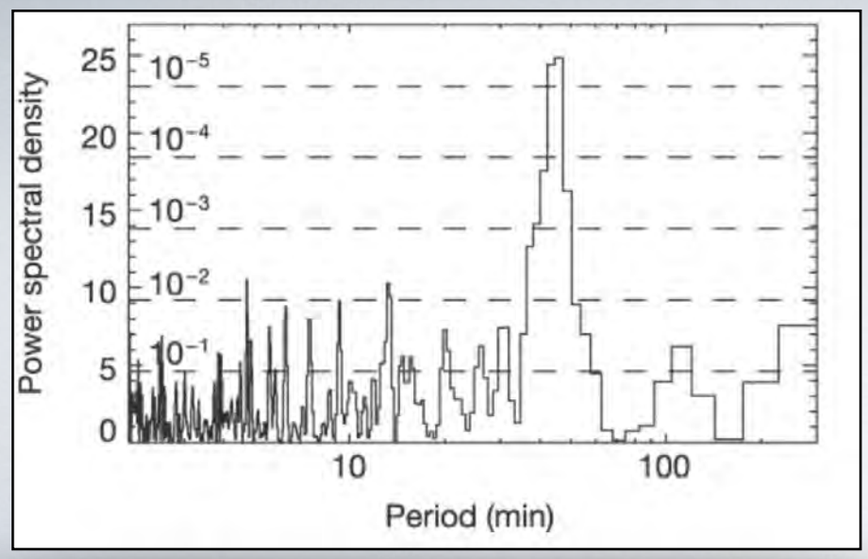
Moon-magnetosphere interactions



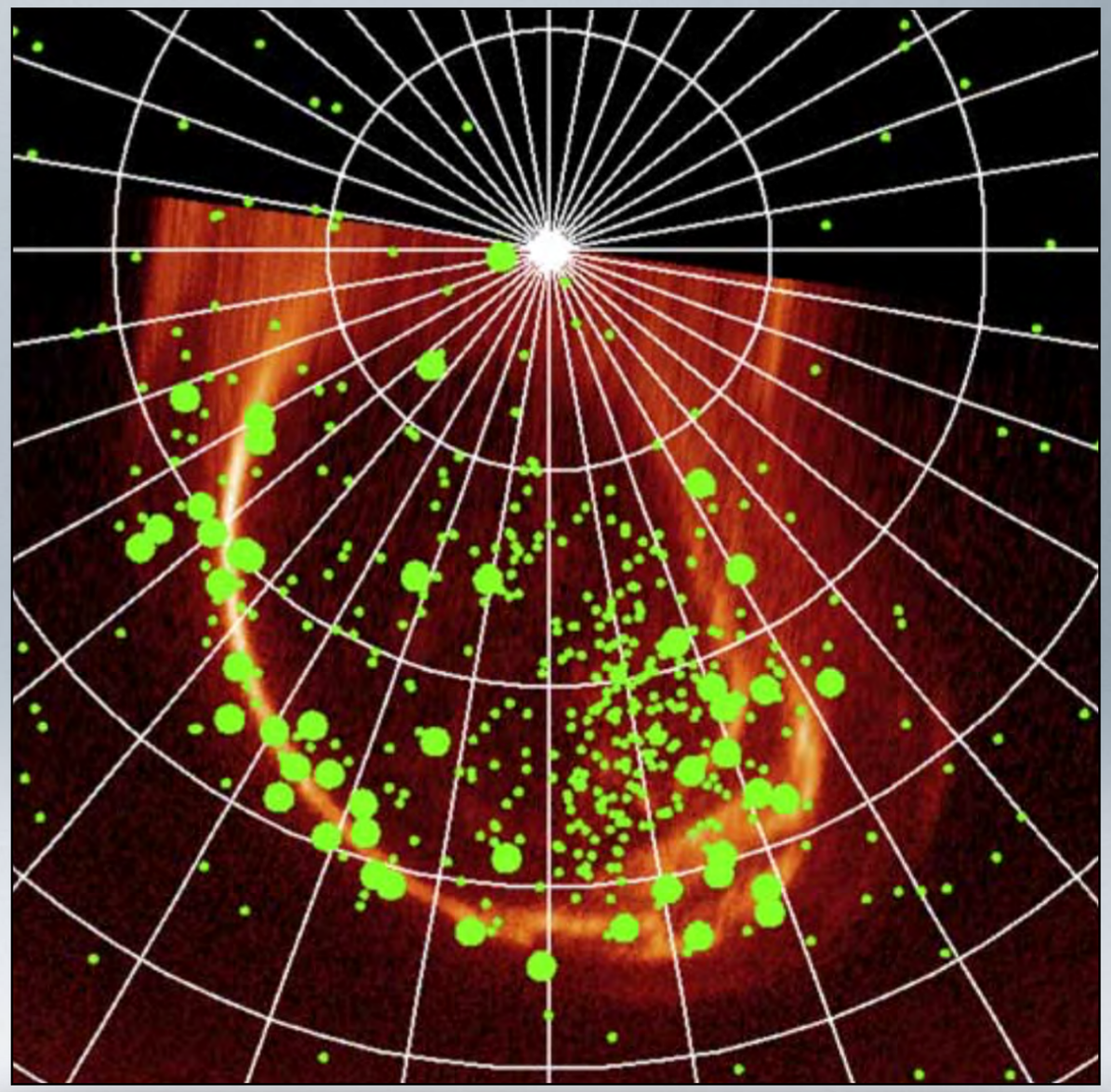
Bonfond et al. (2008)

X-ray emissions



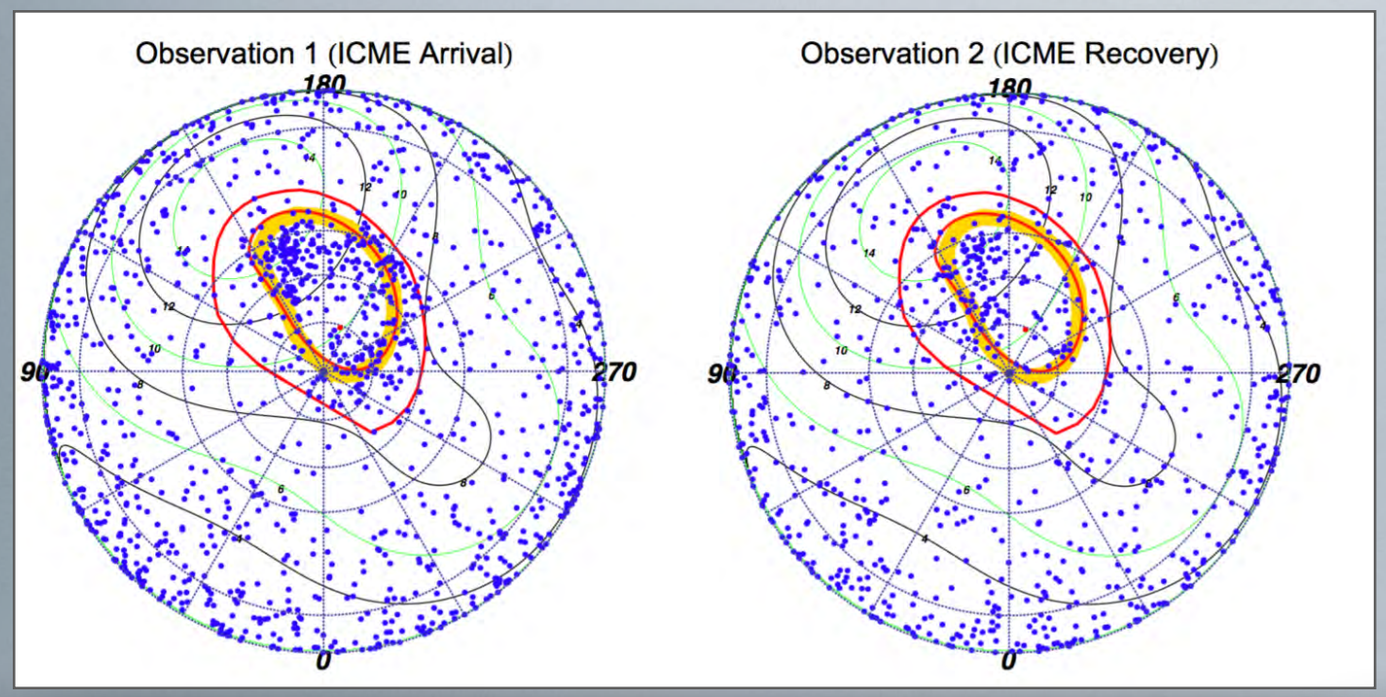


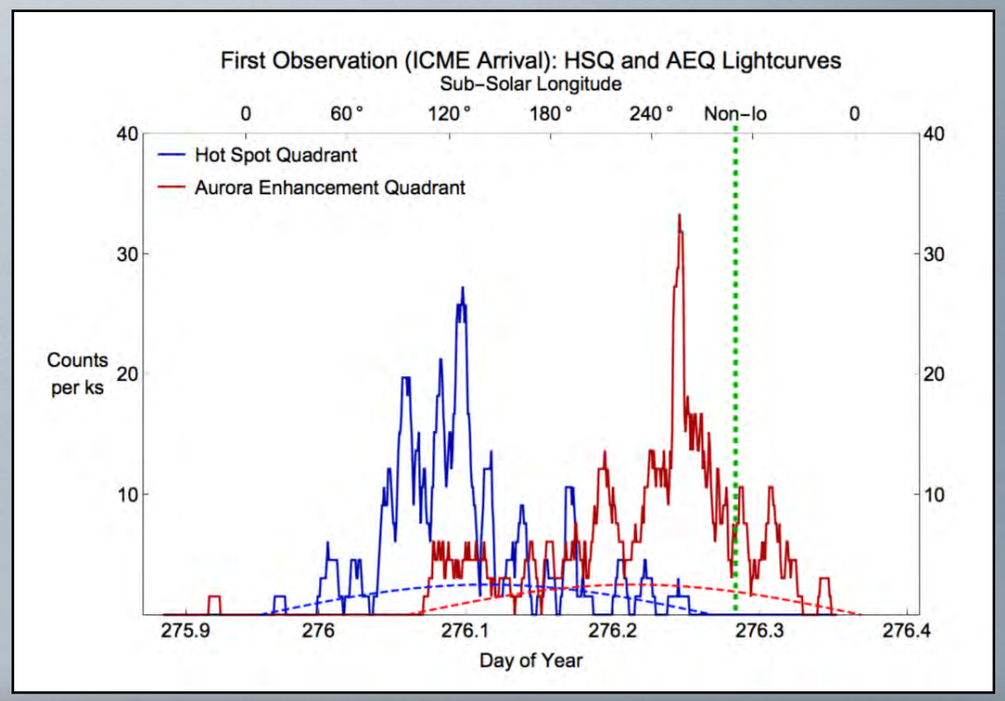
Gladstone et al. (2002)

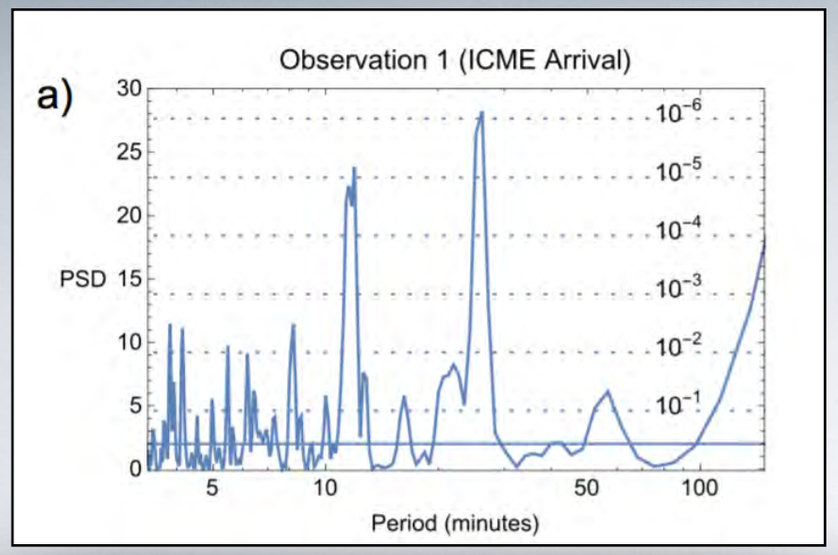


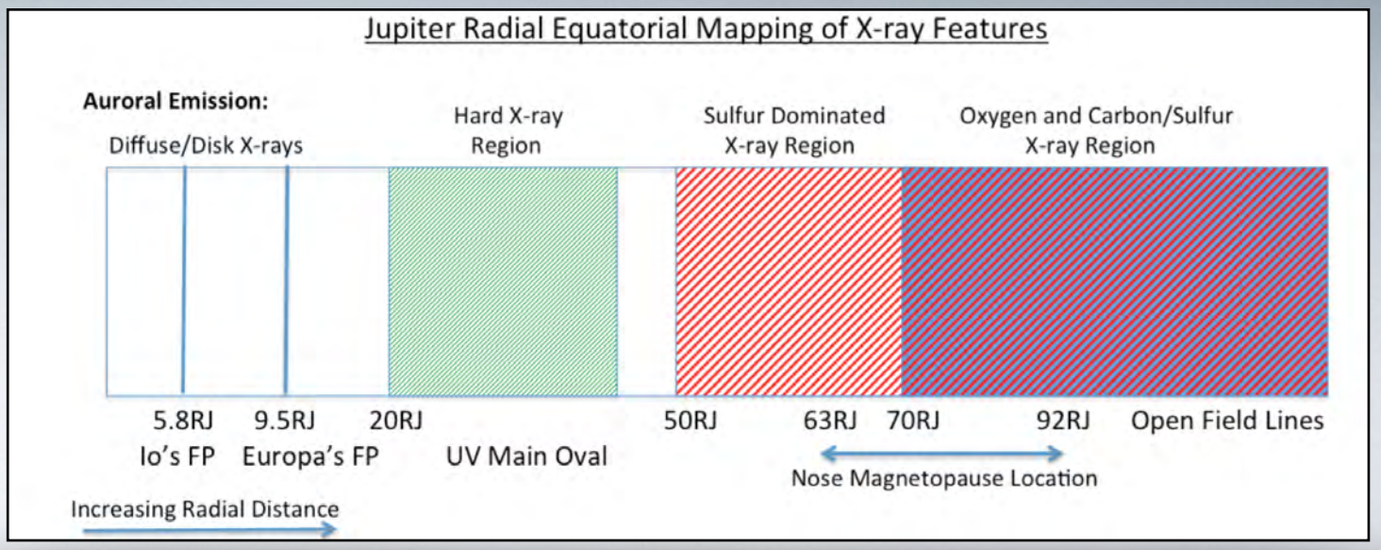
Branduardi-Raymont et al. (2008)

X-ray emissions









Dunn et al. (2016)

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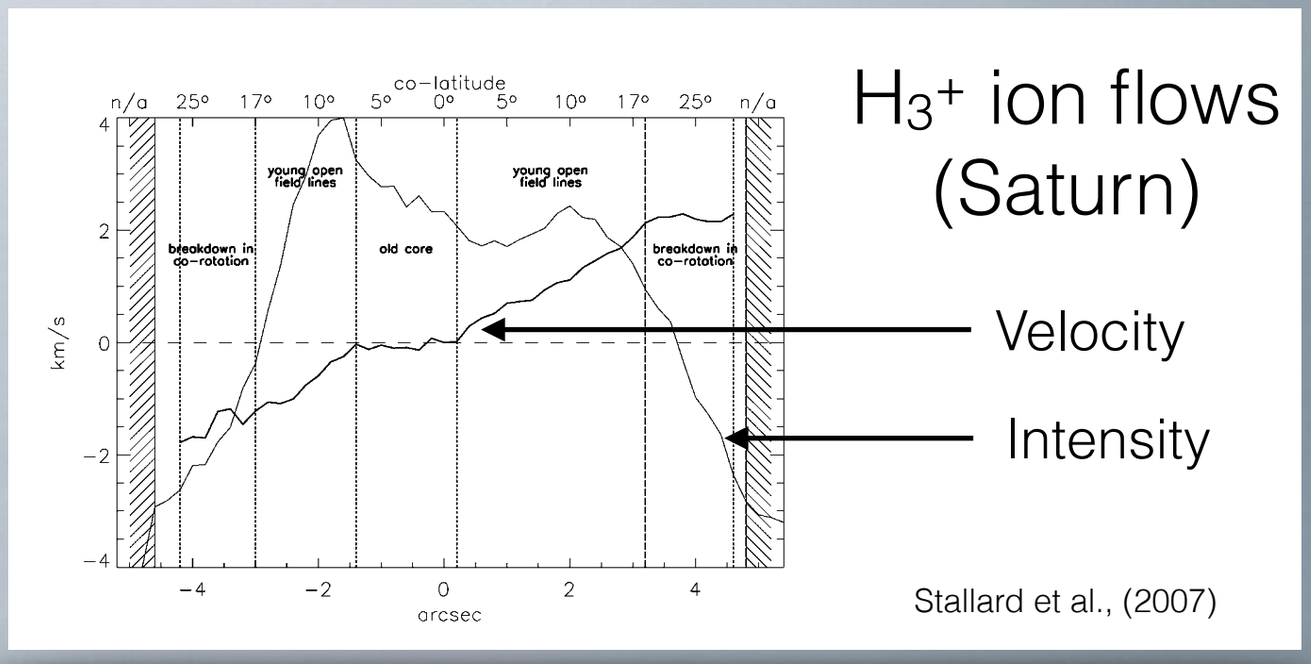
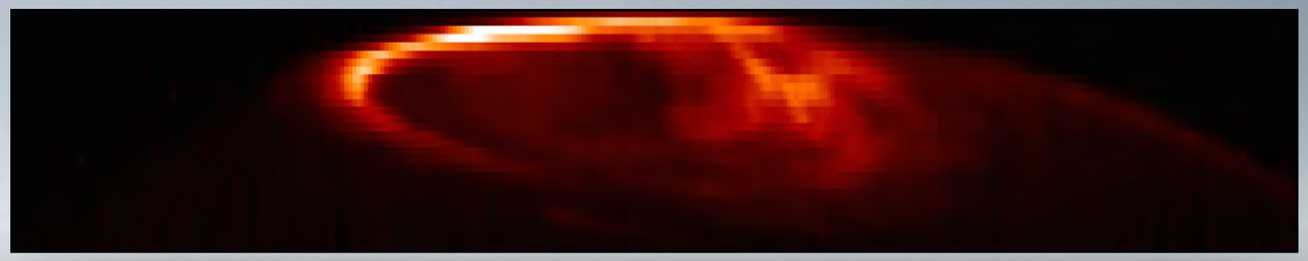
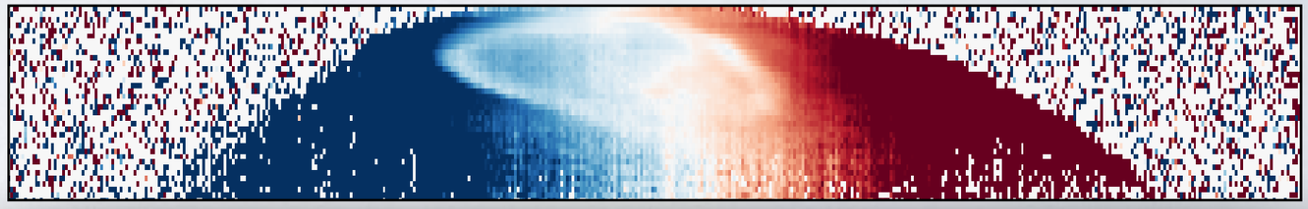
H_3^+ emissions

- The emission of H3+ traces the energy injected into the upper atmosphere
- Ground based observations provide broad scale dynamics, temperature, and densities, whilst Juno will provide high resolution views of auroral emissions.
- Science products: Ion velocities, temperatures, densities, and radiative cooling rates.
- Extensive support activities planned during 2016 & 2017





H_3^+ intensity



Line of sight velocity

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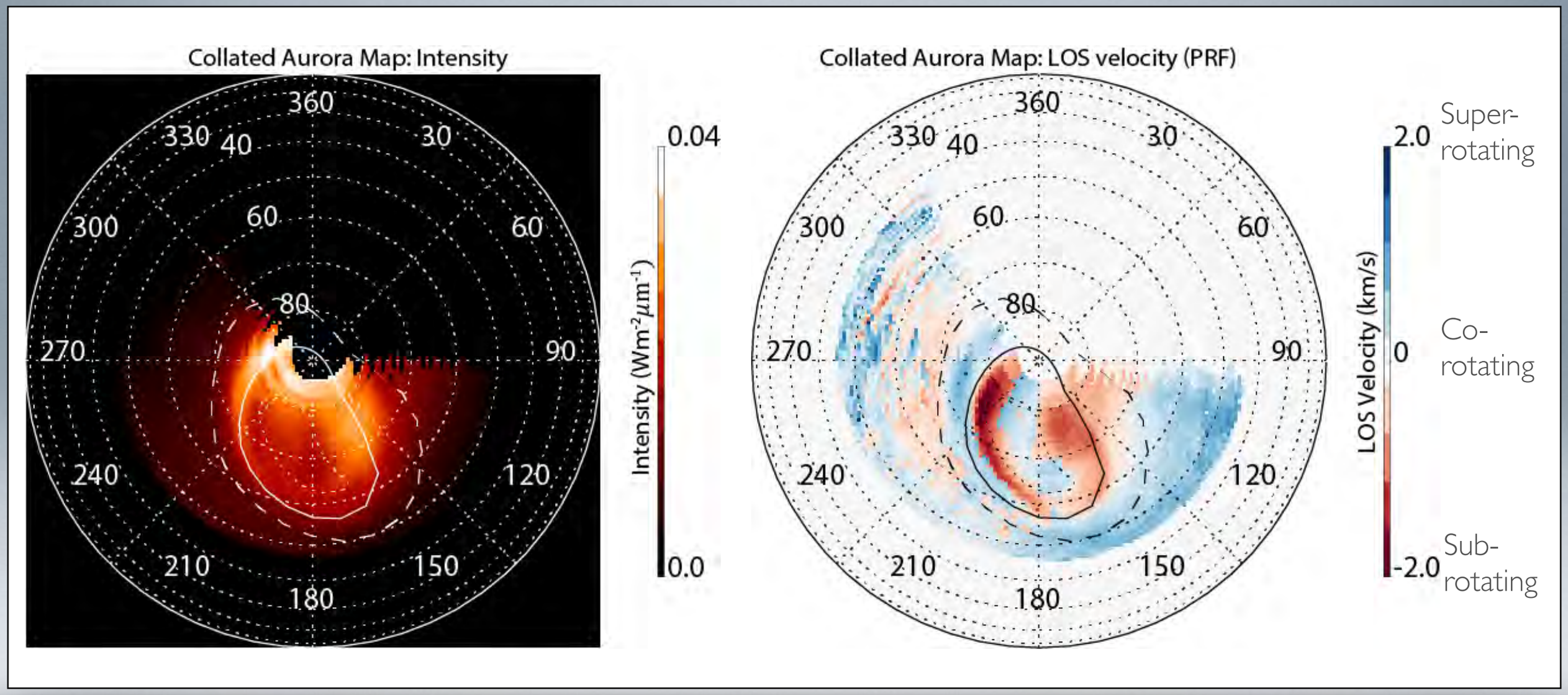
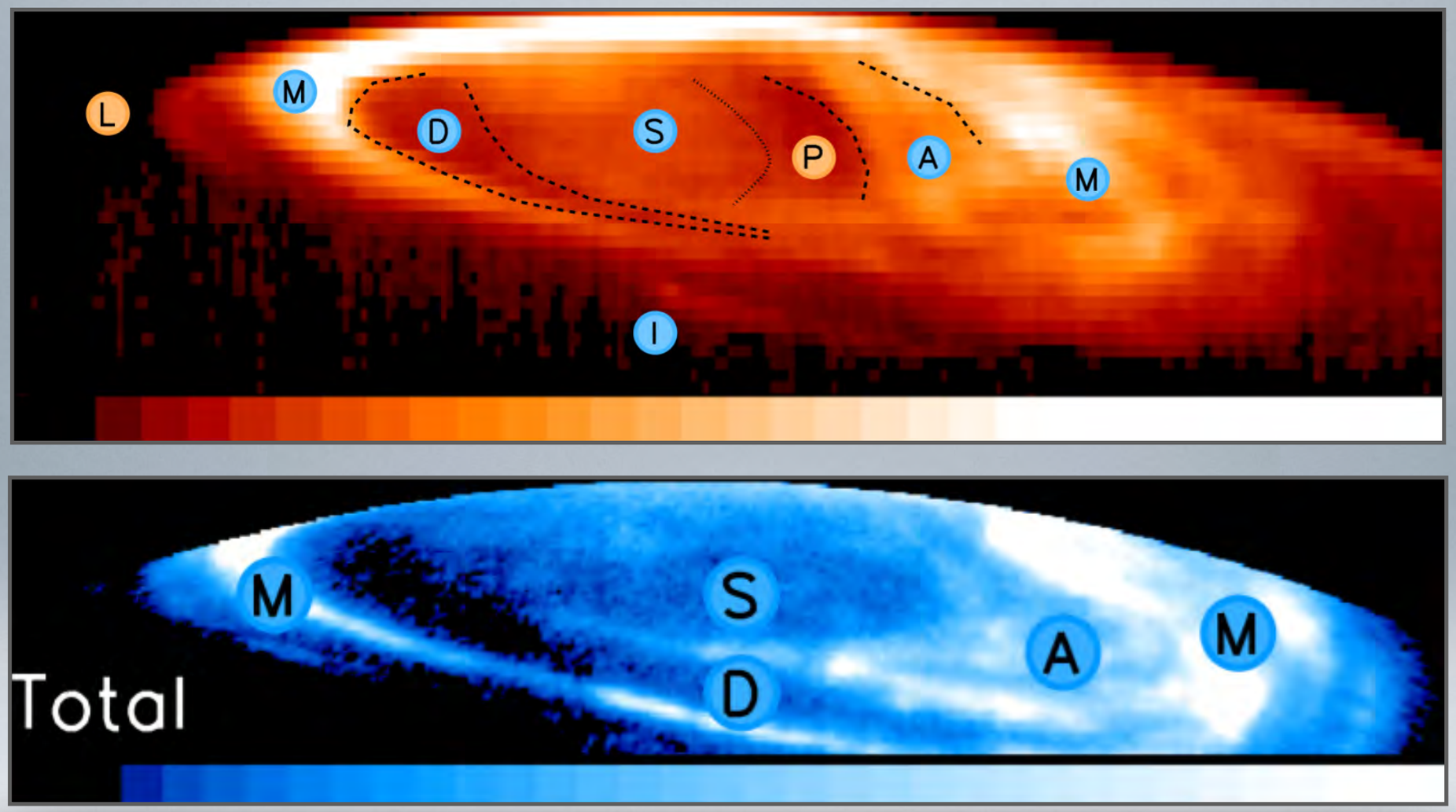
H_3^+ emissions



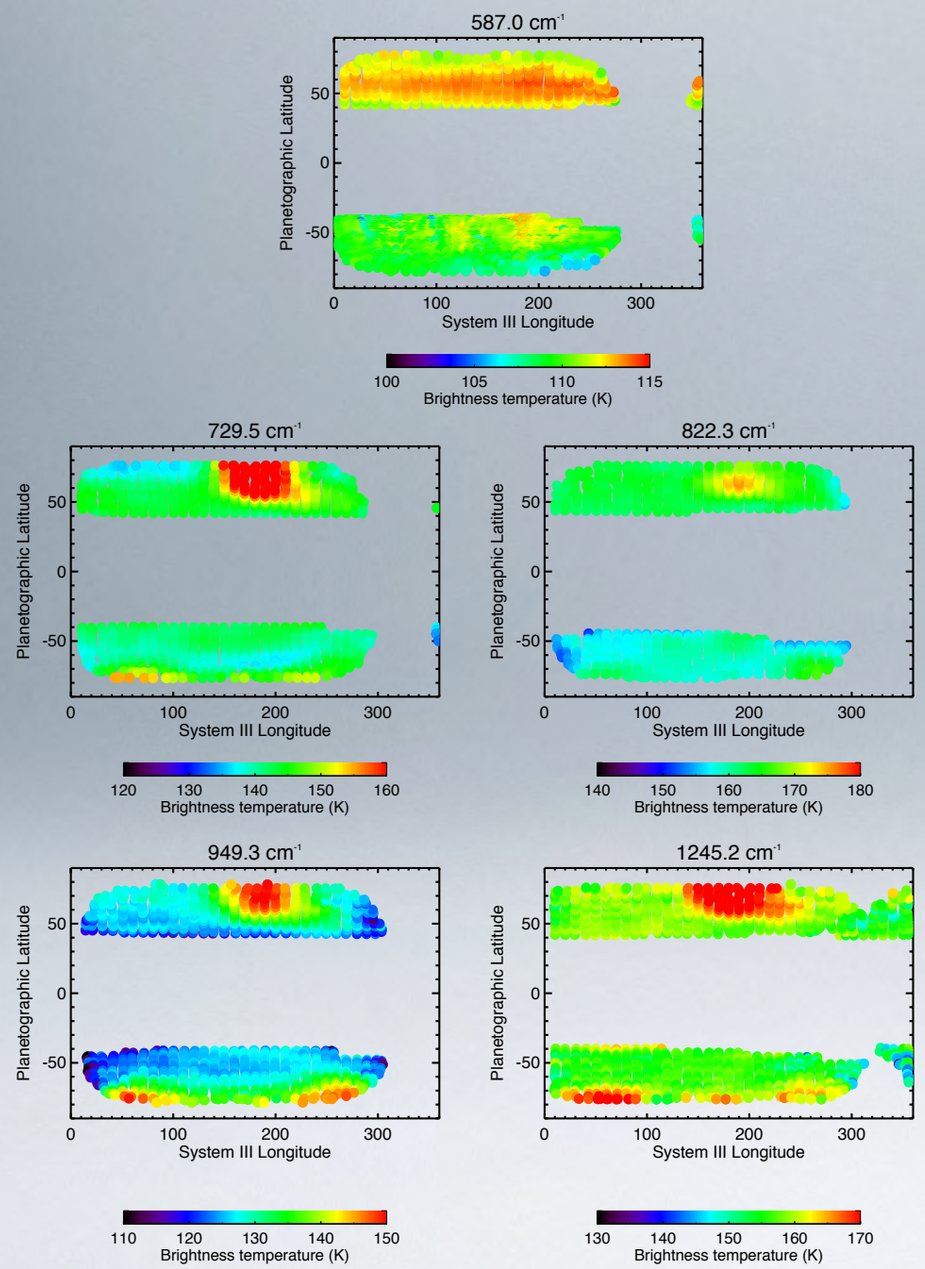
Johnson et al. (in prep.)

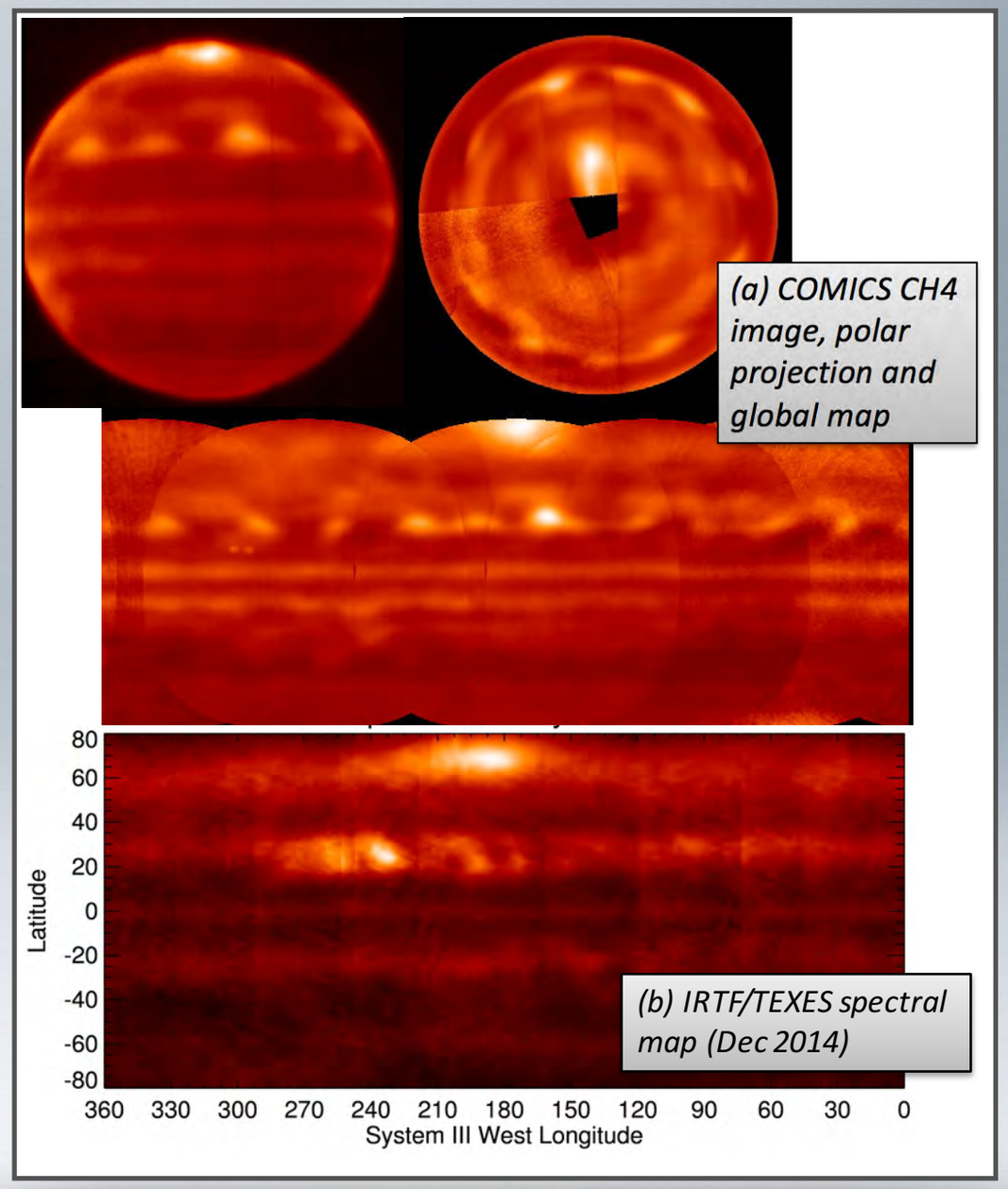
H_3^+ emissions vs. UV emissions



Stallard et al. (2016)

Mid-IR (2-25μm) observations





Sinclair et al. [EPSC, 2015]

Fletcher et al.

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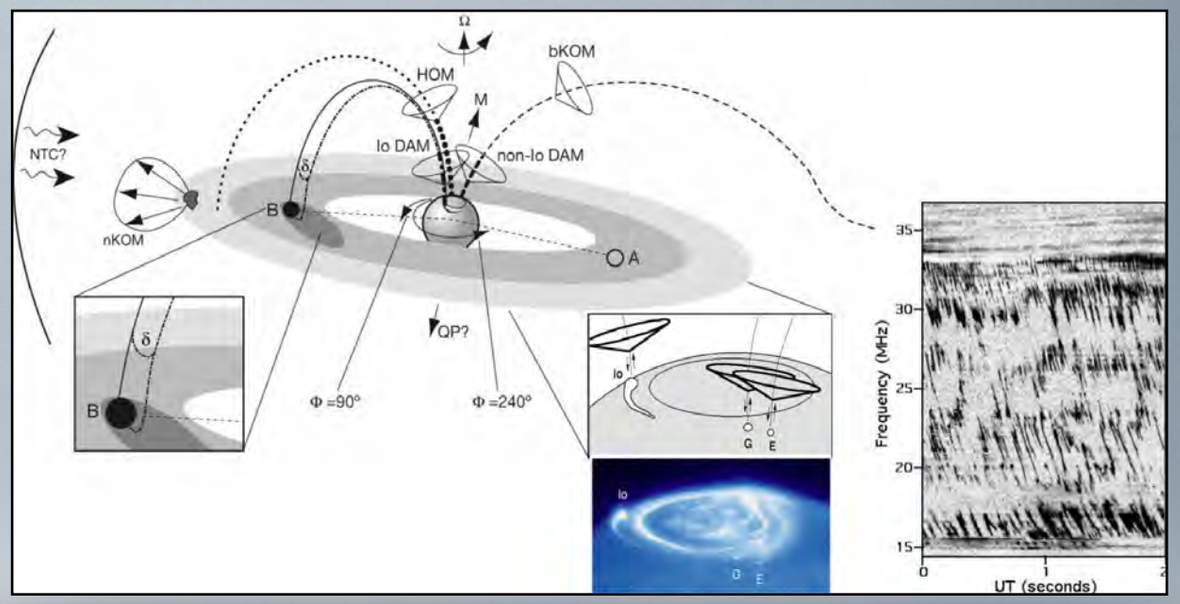
Radio emissions

- Planned decametre radio observations
  - Context for in situ source passes
  - Stereo observations for the remainder of the orbit
  - ExPRES modelling
- Coordinate long/continuous observations, over the broadest possible bandwidths, survey + high res, polarization measurements (not available on Juno)
- Plan to put data in common formats and distribute them to interested people



Contact: P. Zarka

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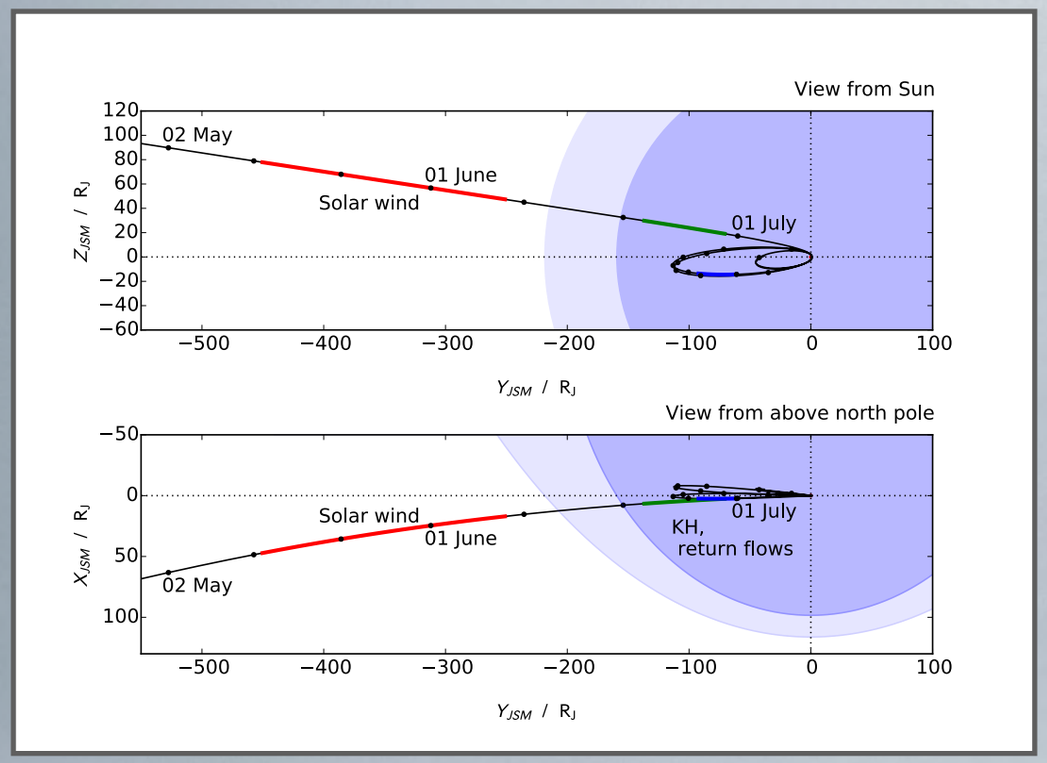
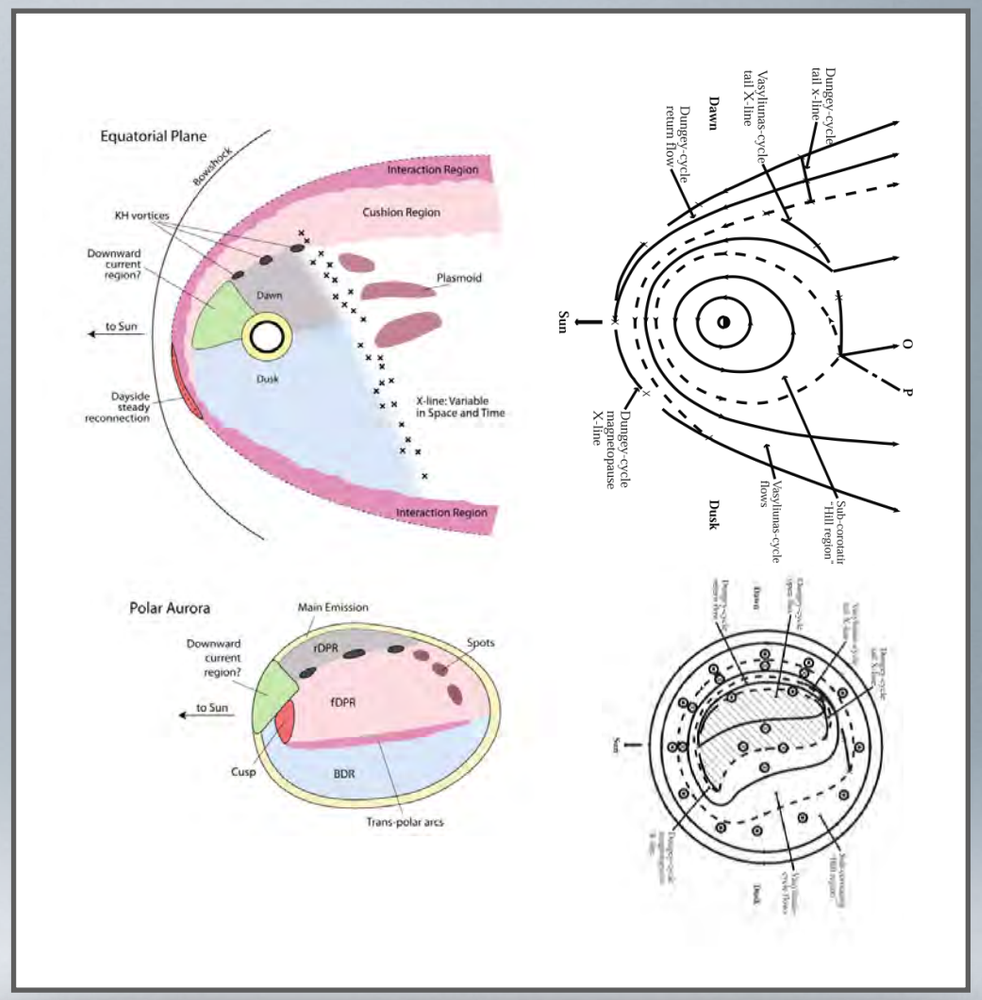
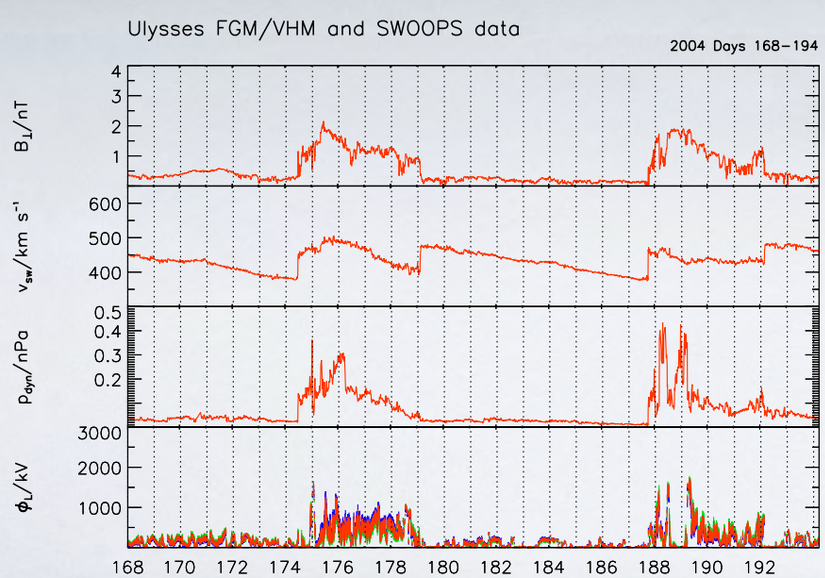
Scheduled Cycle 23 observations





47 orbits:
May 17-June 11
June 24-29
July 11-18



From Nichols et al.(2006)

Mainly images
4 spectral scans

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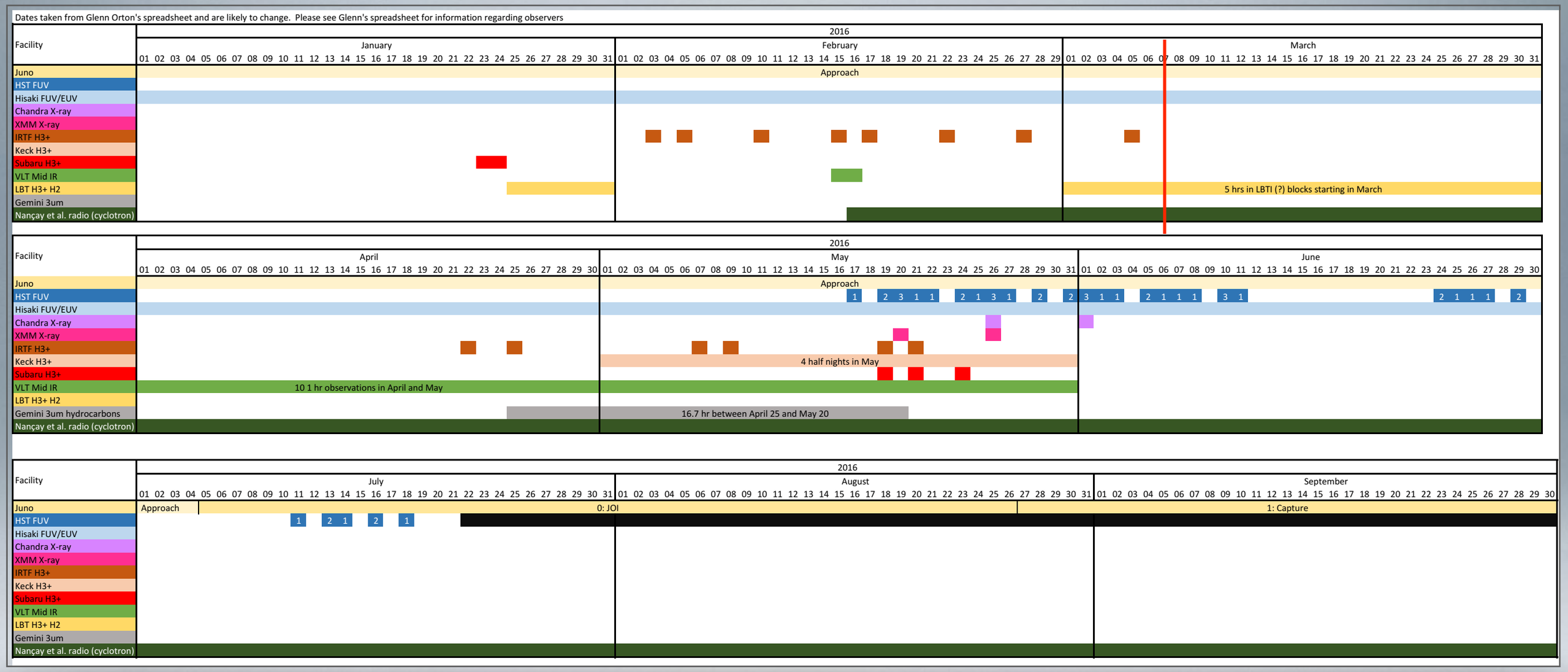
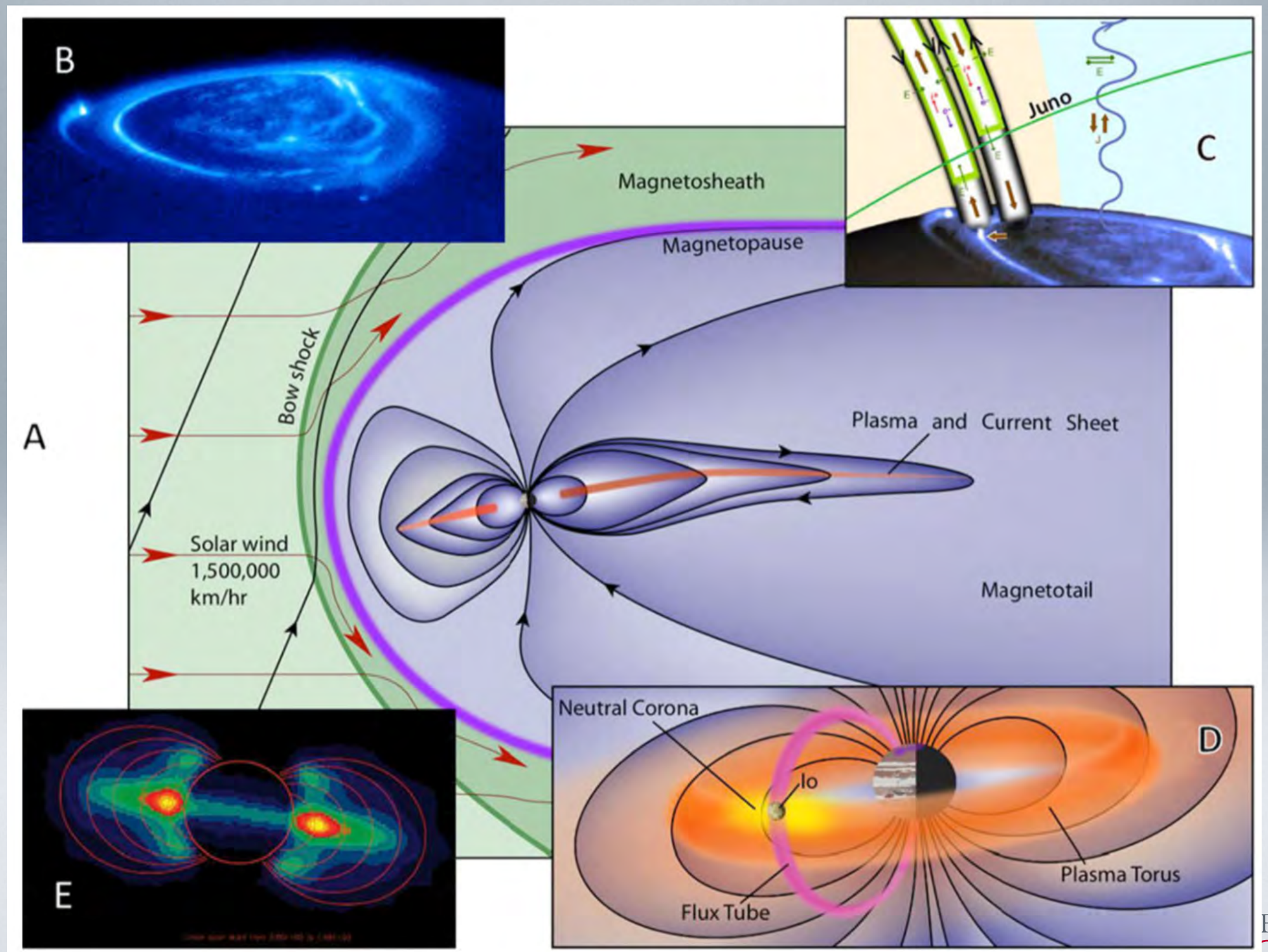
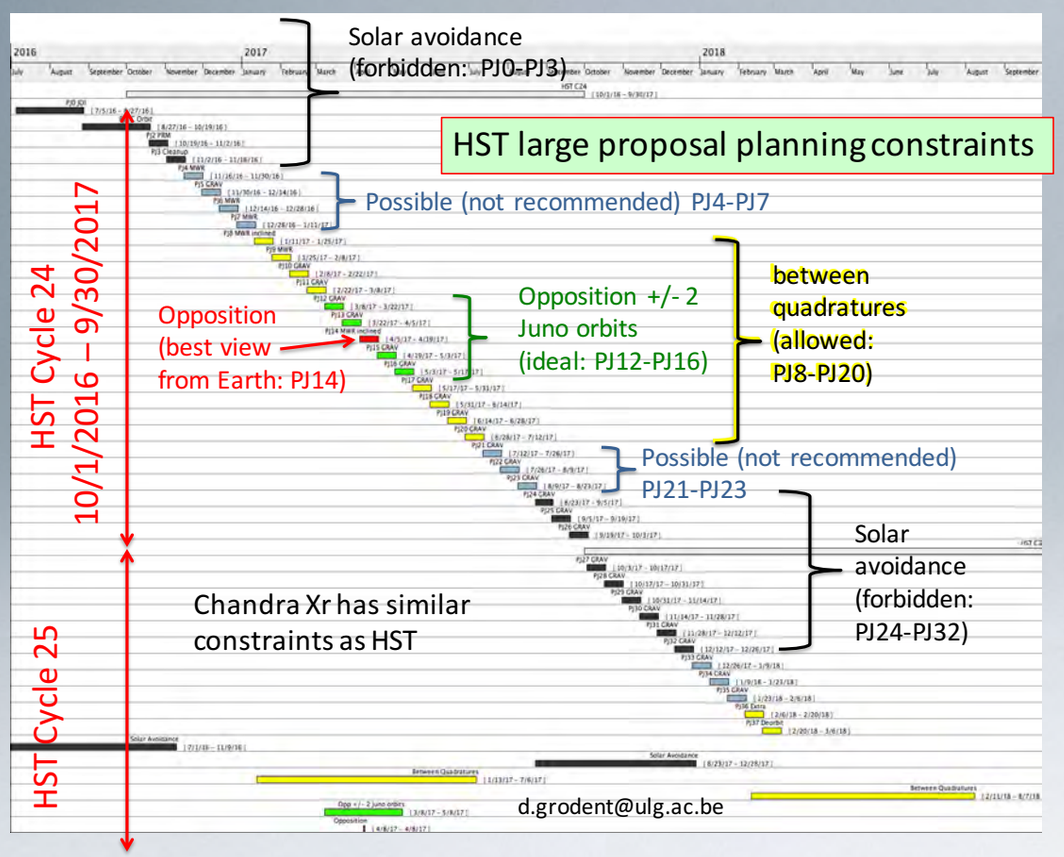
Timeline of observations



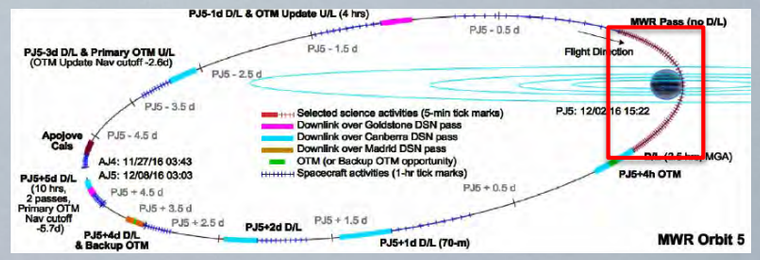
Juno


B
Magnetosheath
Magnetopause
Juno
C
Bow shock
A
Plasma and Current Sheet
Solar wind
1,500,000
km/hr
Magnetotail
Neutral Corona
D
Io
Plasma Torus
Flux Tube
E

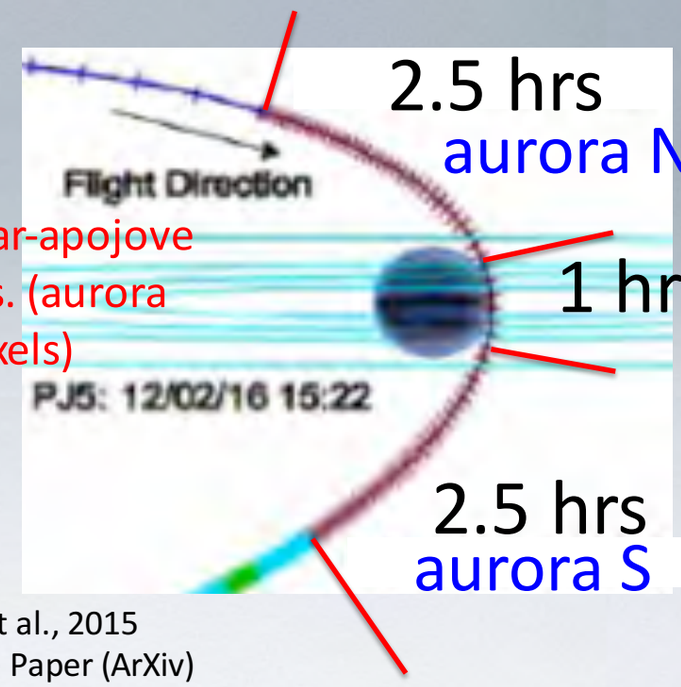
Proposed Cycle 24 Large program



33 14-Day orbits



UVS segment:
~6 hours of
continuous
operations



Also near-apojove
UVS obs. (aurora
~few pixels)

UVS observes
aurora
< 2% of orbit

we need HST for
the rest (> 98%)
of the time

Grodent et al., 2015
HST White Paper (ArXiv)

D. Grodent ULg

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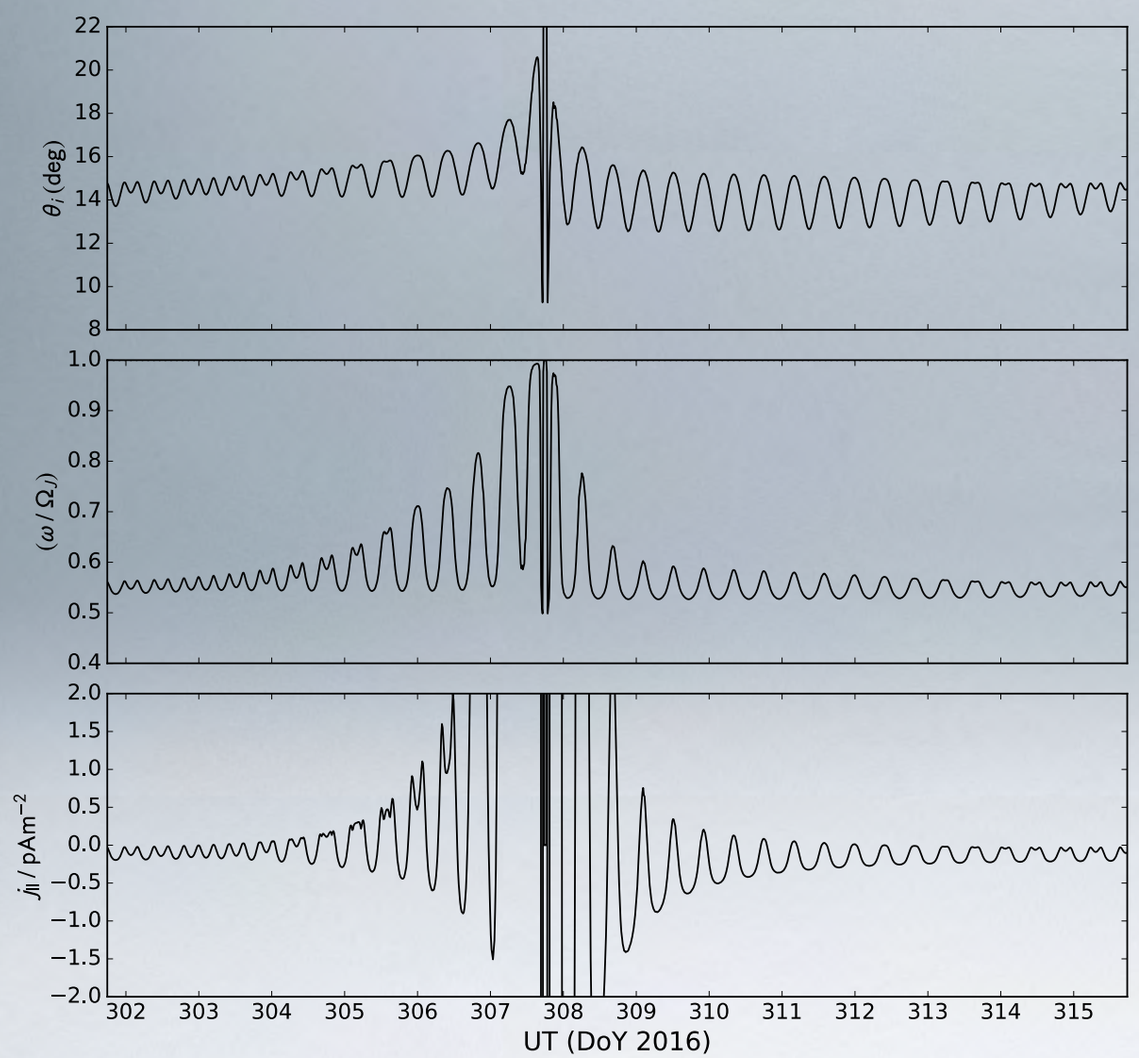
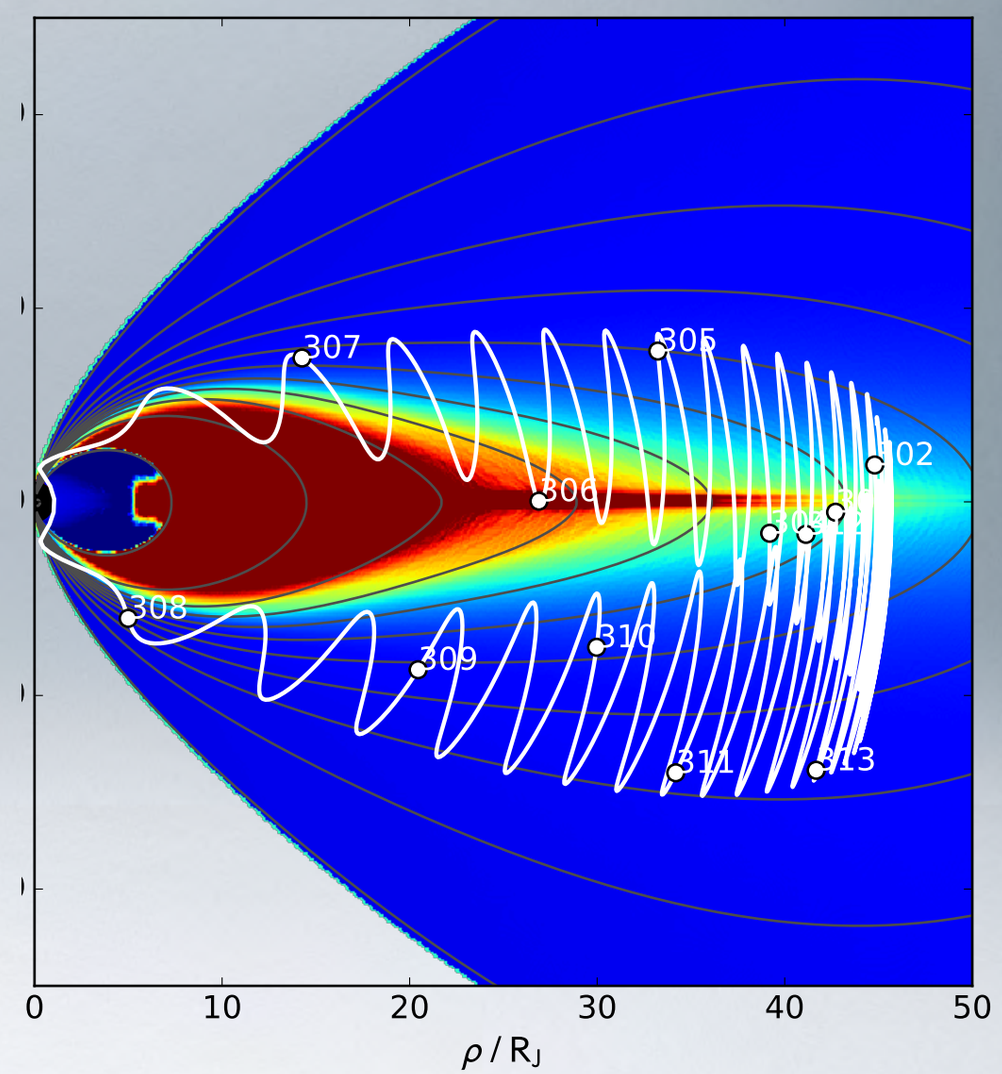
Juno data and theoretical modelling





Questions* - to be finally answered?!

- What drives the <insert name here> auroras?
- To where do these auroras - and dark regions - map?
- Where is the polar cap? (is there one?!)
- What lies behind solar wind modulation of main emission?
- How does the auroral acceleration process work at Jupiter?
- How does field-aligned current density relate to auroral intensity?
- How does auroral electron energy relate to colour ratio?
- Do auroras reveal the energy and mass transfer in Jupiter's magnetosphere? If so, how?
- What is the vertical energy deposition profile?
- How are X-ray-UV-visible-IR-radio emissions related?
- Why is the north so different to the south?
- Are auroras key to solving the 'energy crisis'?

* an inexhaustive and probably biased list

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