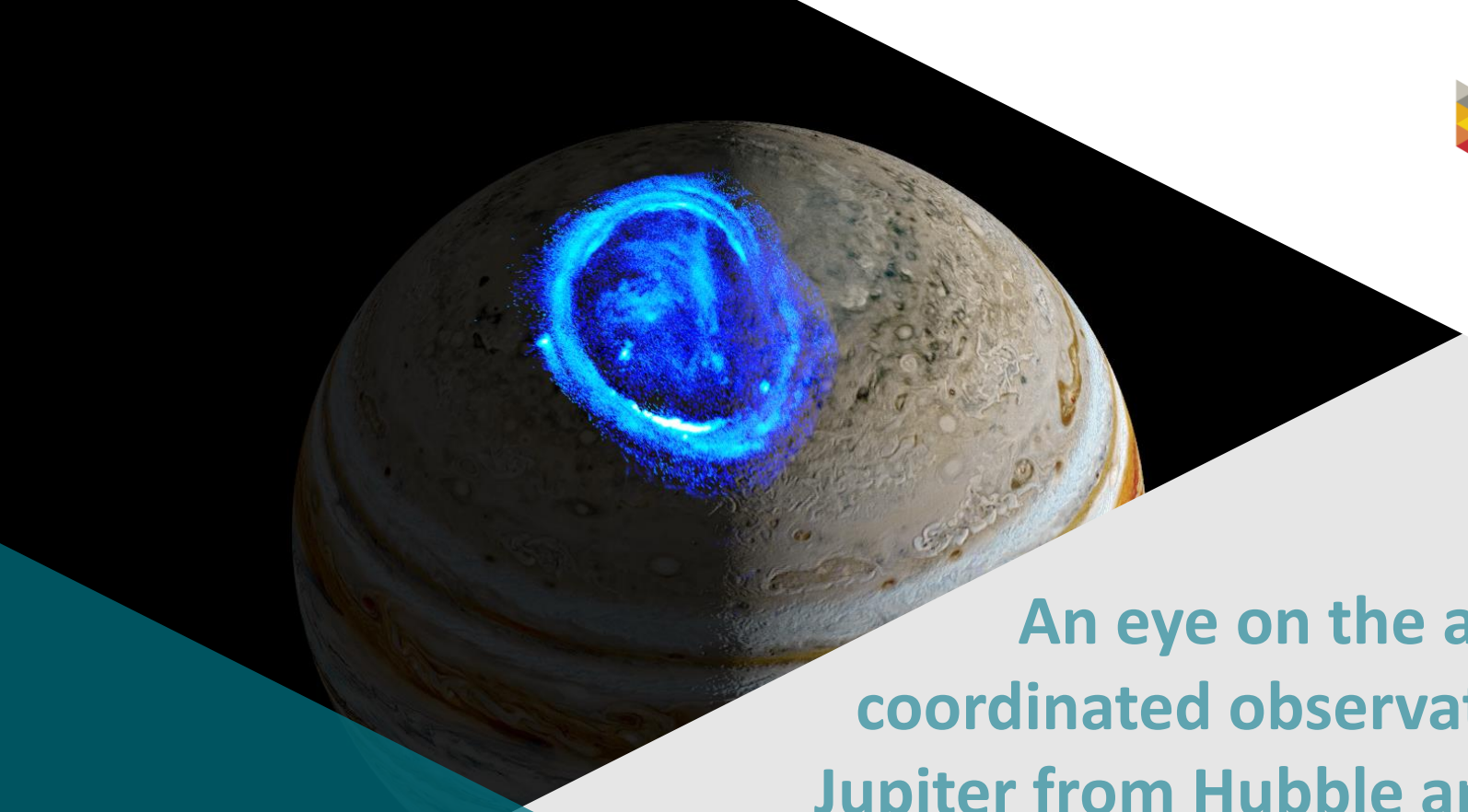
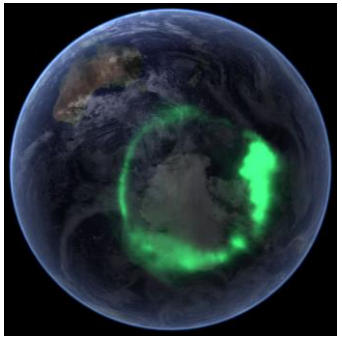


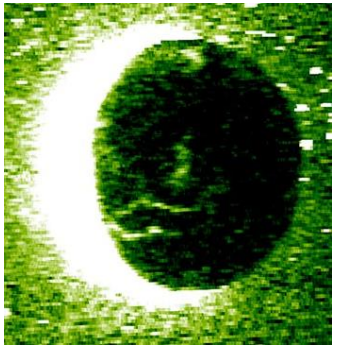
An eye on the auroras: coordinated observations of Jupiter from Hubble and Juno

B. Bonfond, D. Grodent and B. Palmaerts

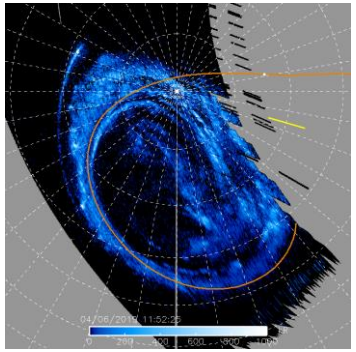
Planetary auroras



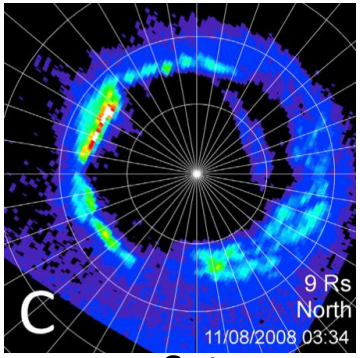
Earth



Mars

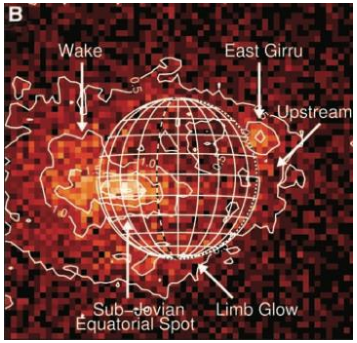


Jupiter

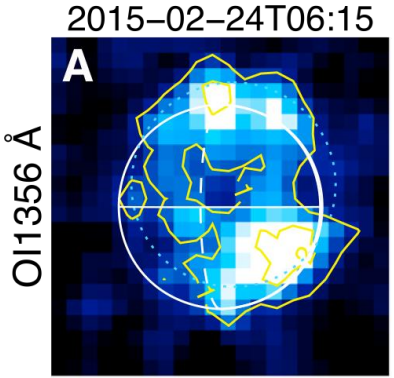


Saturn

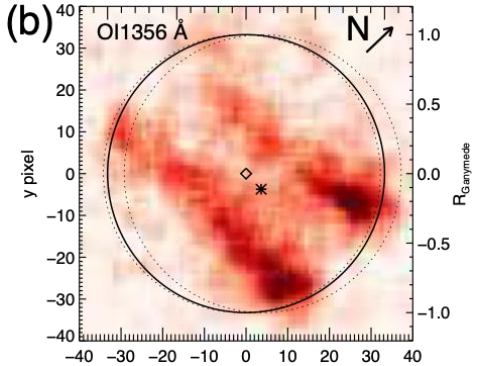
Uranus



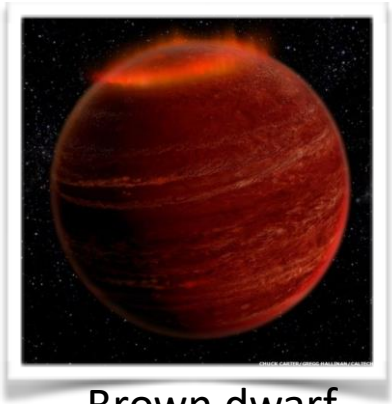
Io



Europa



Ganymede

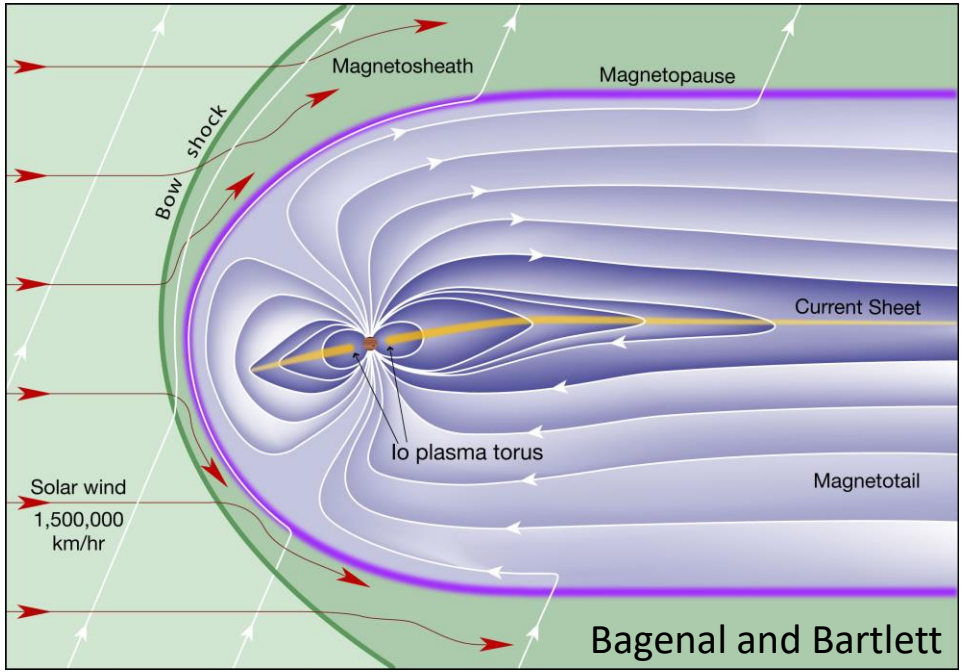


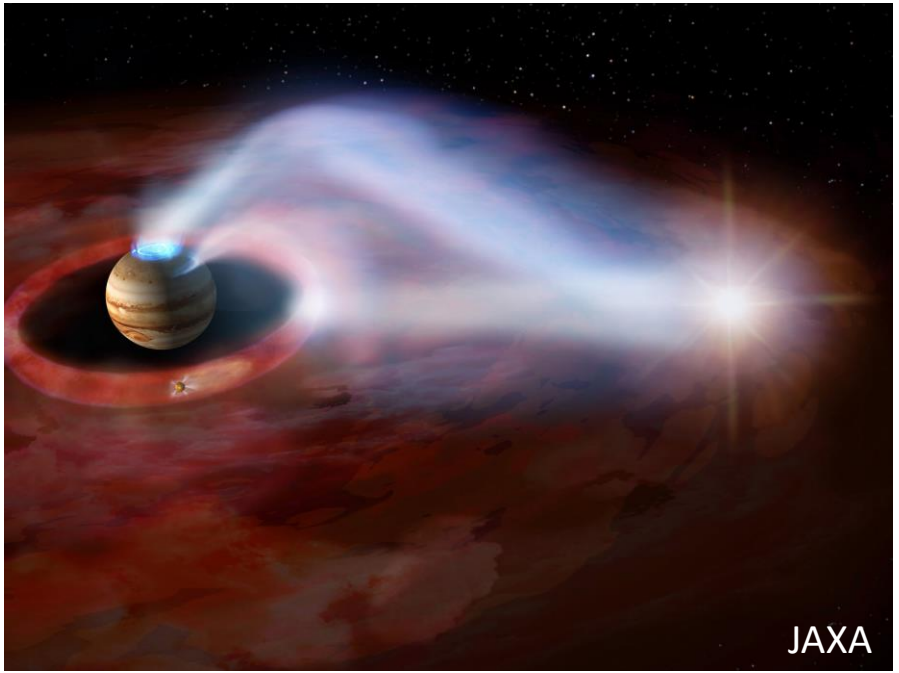
Brown dwarf

Planetary auroras

- At the interface between the atmosphere and the magnetosphere
- Provide an overview of the dynamics of the magnetophere
  - Global vs. Local
  - Transient events
  - Response to external and internal drivers (solar wind, etc.)
- Context for in situ measurements

Auroras are an image of the dynamics of the magnetosphere



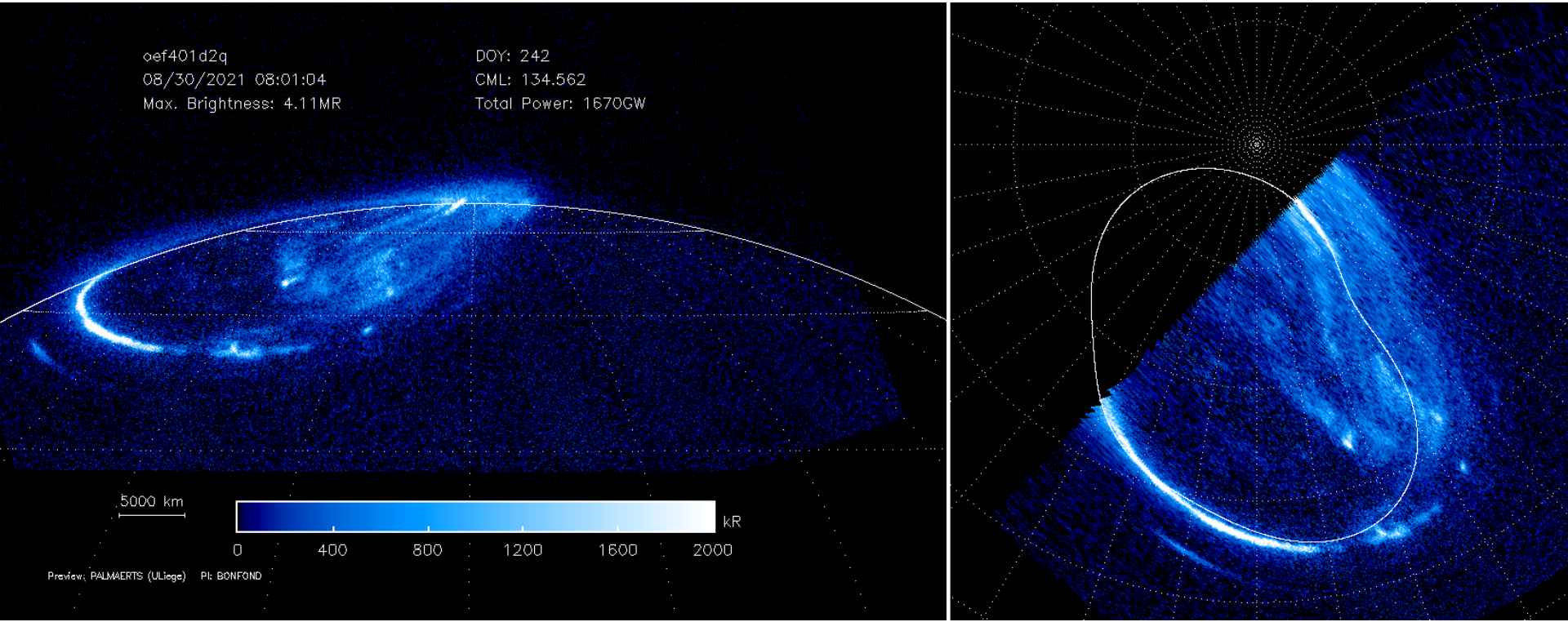


UV for auroral observations

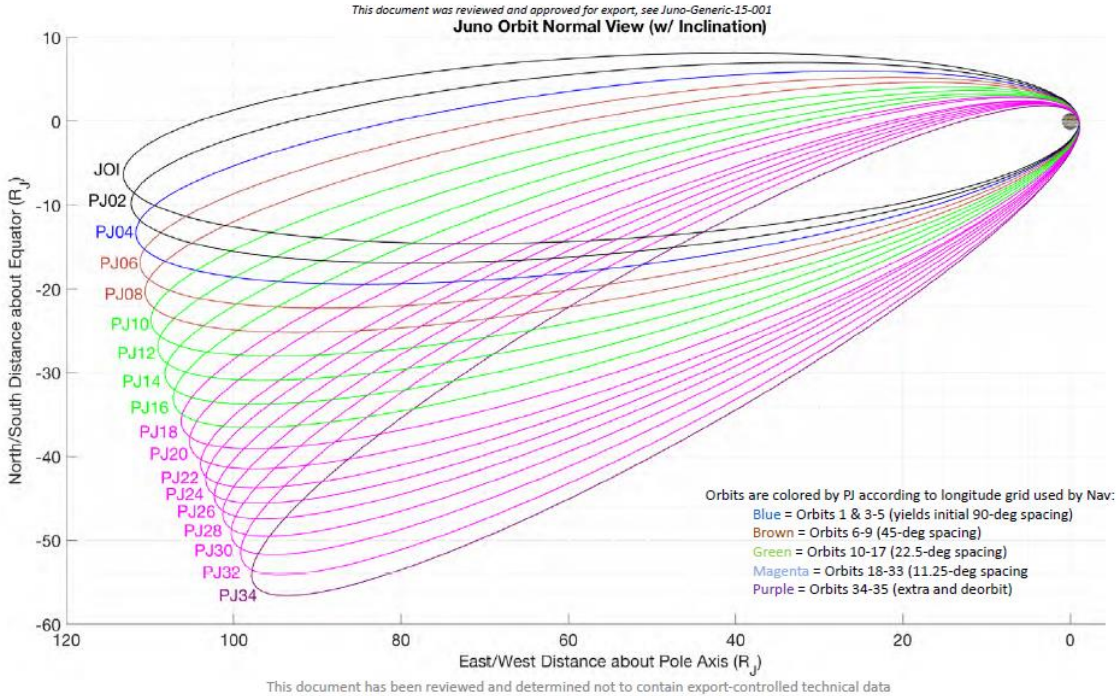
- Neutral atomic and molecular emissions
  - H2 Lyman and Werner bands
  - H Lyman-α

  } Jupiter
- Less reflected solar light => high contrast
- UV absorption by the atmosphere (hydrocarbons)

An example of what HST can do:

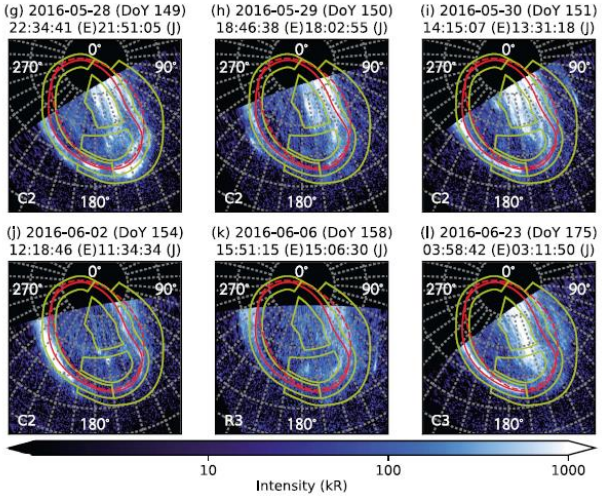


A spacecraft can not be everywhere at the same time

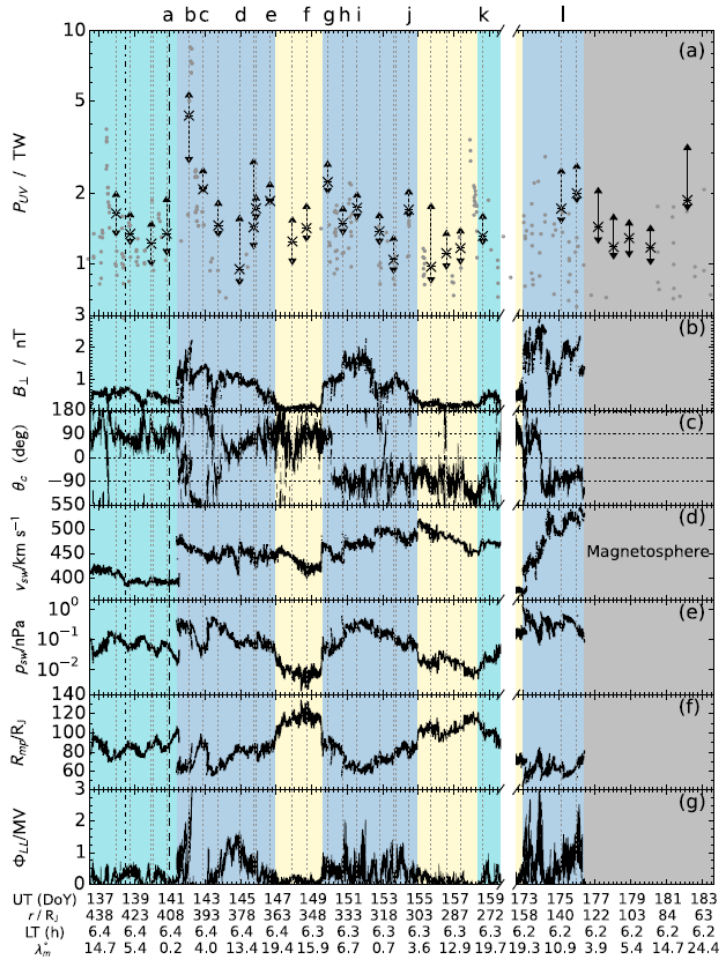


Juno approaching Jupiter

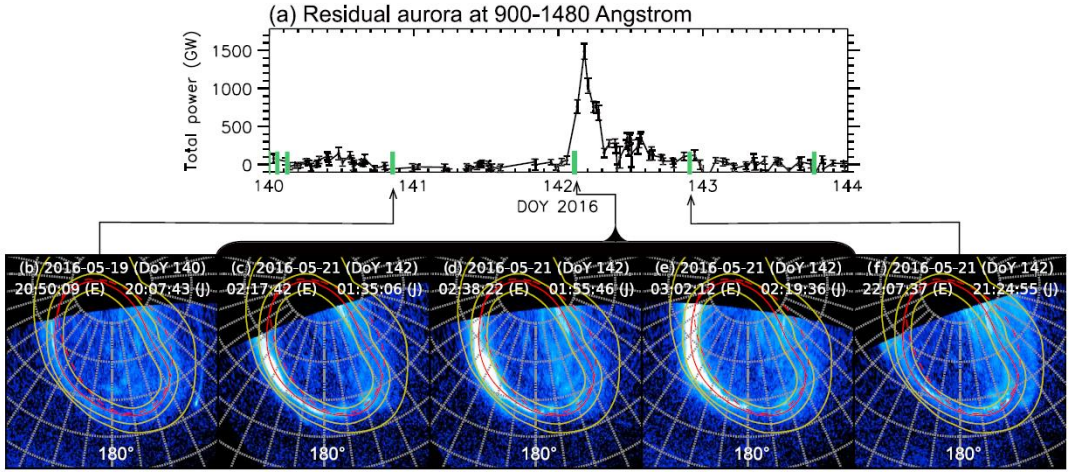
- Jupiter's response to the solar wind was unclear
- Juno served as a solar wind monitor
- HST provided the UV observations



Nichols et al., 2017



Juno approaching Jupiter: A Dawn storm



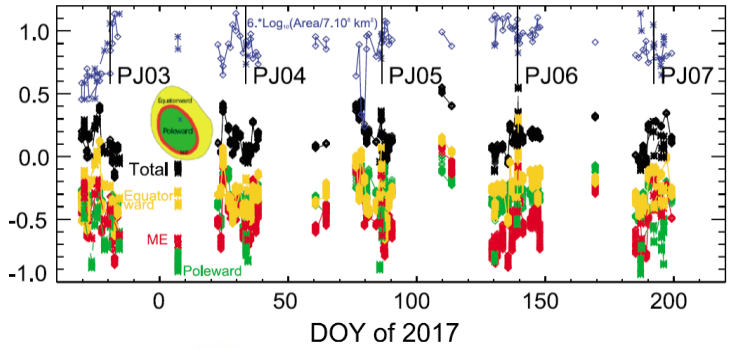
- A study combining Juno, HST, Hisaki and ground based telescopes.
- A dawn storm was observed at the arrival of a SW shock, but it was also partially linked to internal processes
- Evidence of heating of the Io plasma torus
- A window on the plasma and energy transport in the magnetosphere of Jupiter

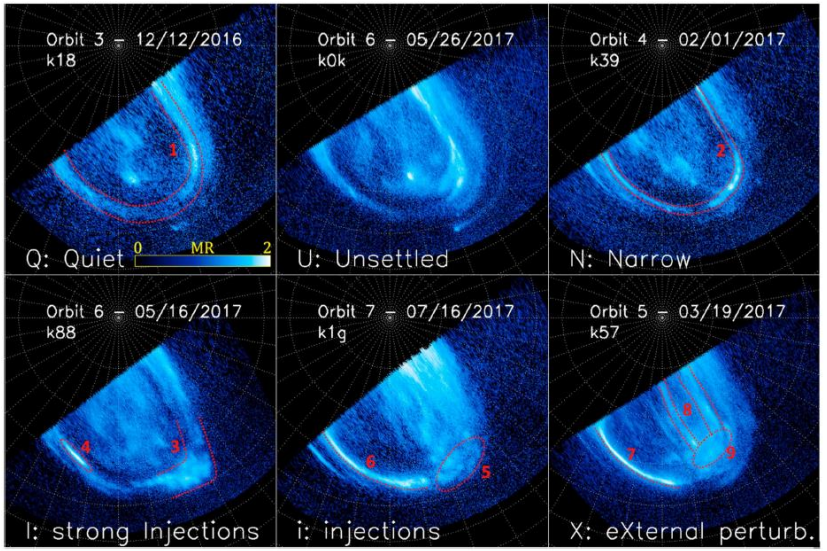
Kimura et al., 2017

Grodent et al., 2018

Long term monitoring

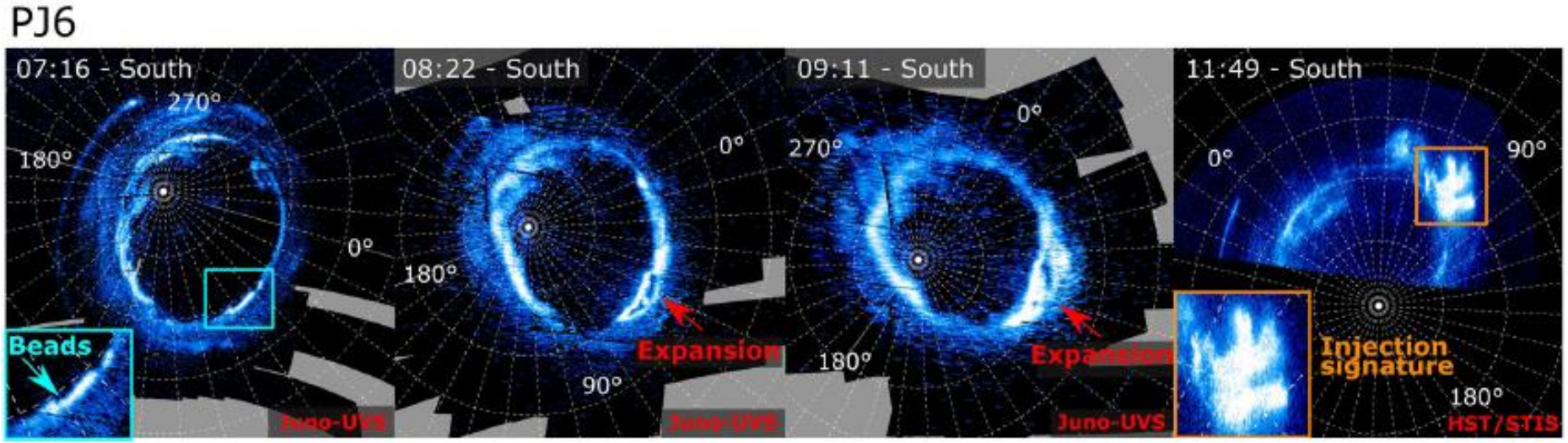
- Several HST campaigns have been carried out to support the Juno mission.
- Monitoring the evolution of the different parts of the aurora.
- Identification of “classes” of auroral morphologies.





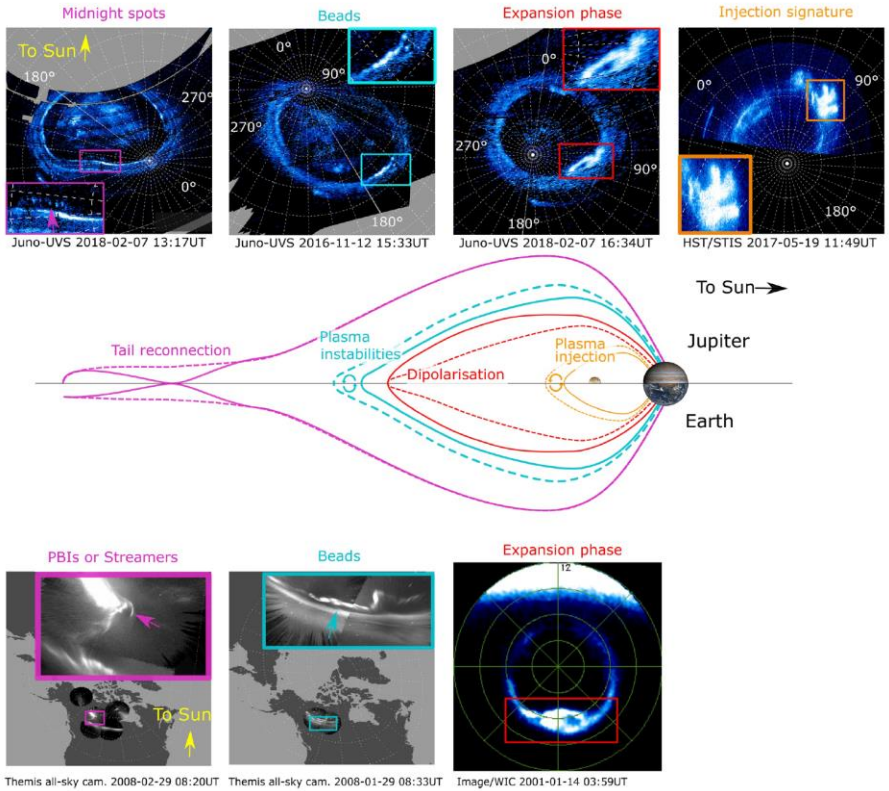
Dawn storms: Juno close to Jupiter

- HST allowed us to track the evolution of dawn storms after Juno moved too far away.



Dawn storms: Juno close to Jupiter

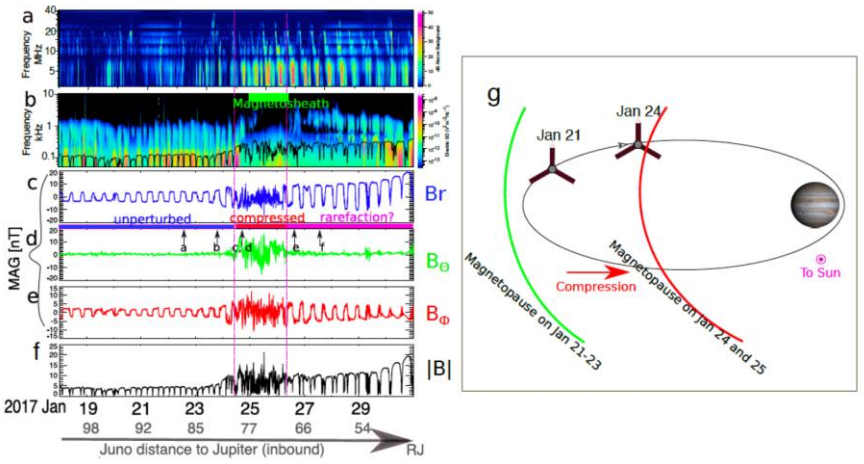
- These observations revealed that Jovian dawn storms share a lot of similarities with terrestrial sub-storms.

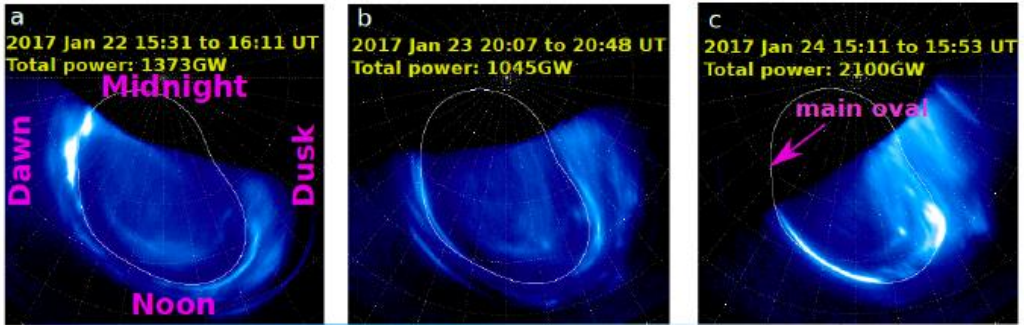


Yao et al., in revision

Magnetopause monitoring

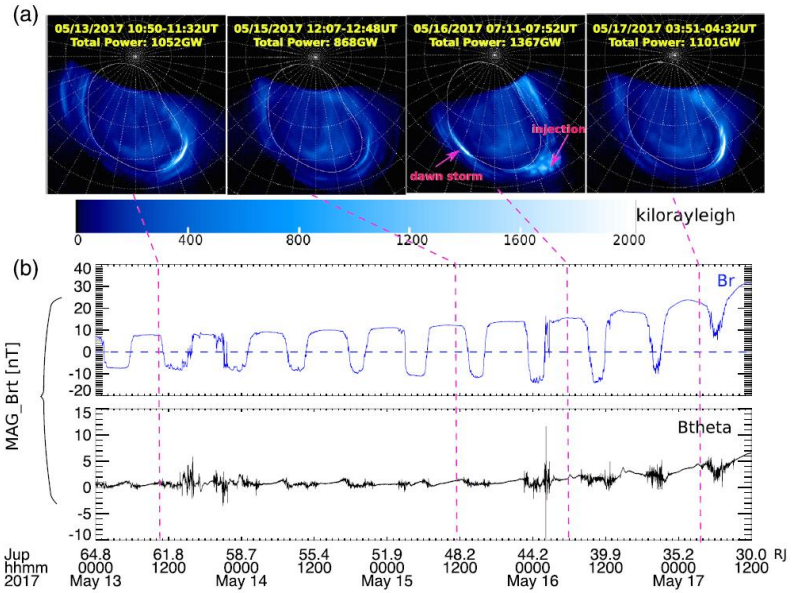
- The size magnetopause changes
- Juno can detect magnetopause crossings while HST looks at the aurora
- Some auroral brightenings are typical of compressed states while others are not.

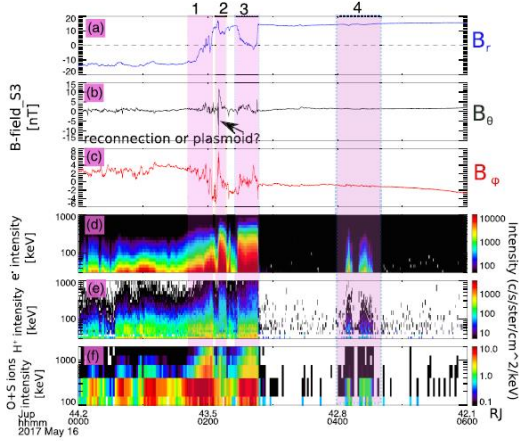




HST observations when Juno in the distant magnetosphere

- HST observations during:
  - Dawn storms with Juno inside (Yao et al. 2020) or outside the reconnection X-line (Swithenbank-Harris et al. 2021)
  - Juno observations of drizzle (i.e. small scale) reconnection (Guo et al. 2021)
  - Juno observations of ULF- waves (large scale Alfvén waves) (Pan et al. 2020).
  - Juno observations of EMIC waves while XMM-Newton observed quasi-periodic flares in X-rays (Yao et al. 2021)





Summary

- HST is a crucial tool to explore and understand the auroras of Jupiter (since 1992).
- Large HST campaigns in support of the Juno mission
  - Multi-instrument studies
  - Temporal context
  - Spatial context