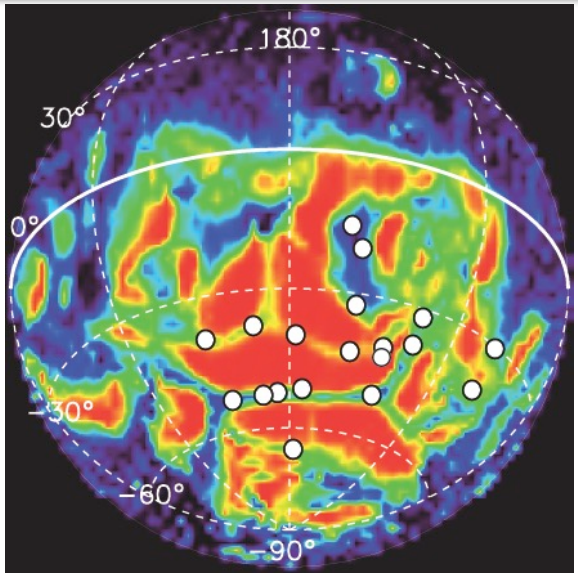
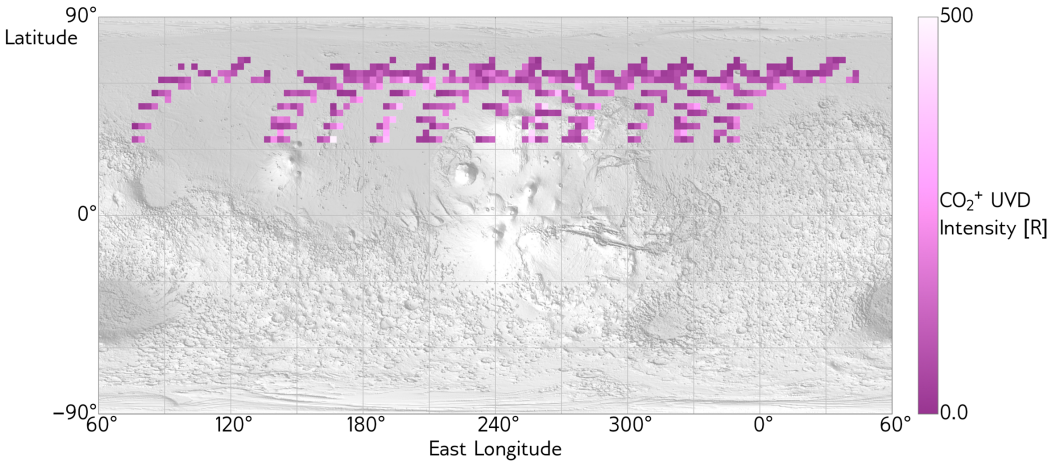




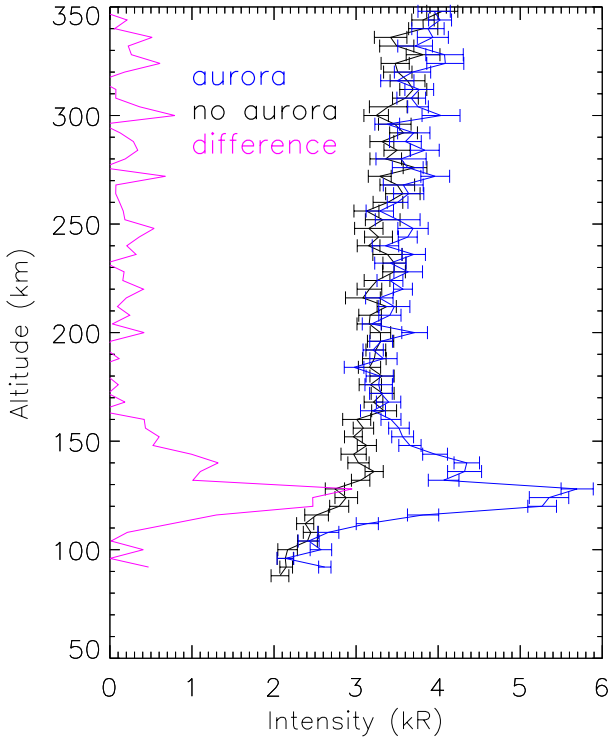
Aurorae on Mars

B. Ritter, J.-C. Gérard, B. Hubert, L. Gkouvelis

LPAP / STAR Institute / Université de Liège

« From MarsExpress to ExoMars »

27-28 February 2018, ESAC Madrid, Spain



Université de Liège

Introduction

- *Auroral emissions are those that result from impact of particles other than photoelectrons* (Fox, 1986)

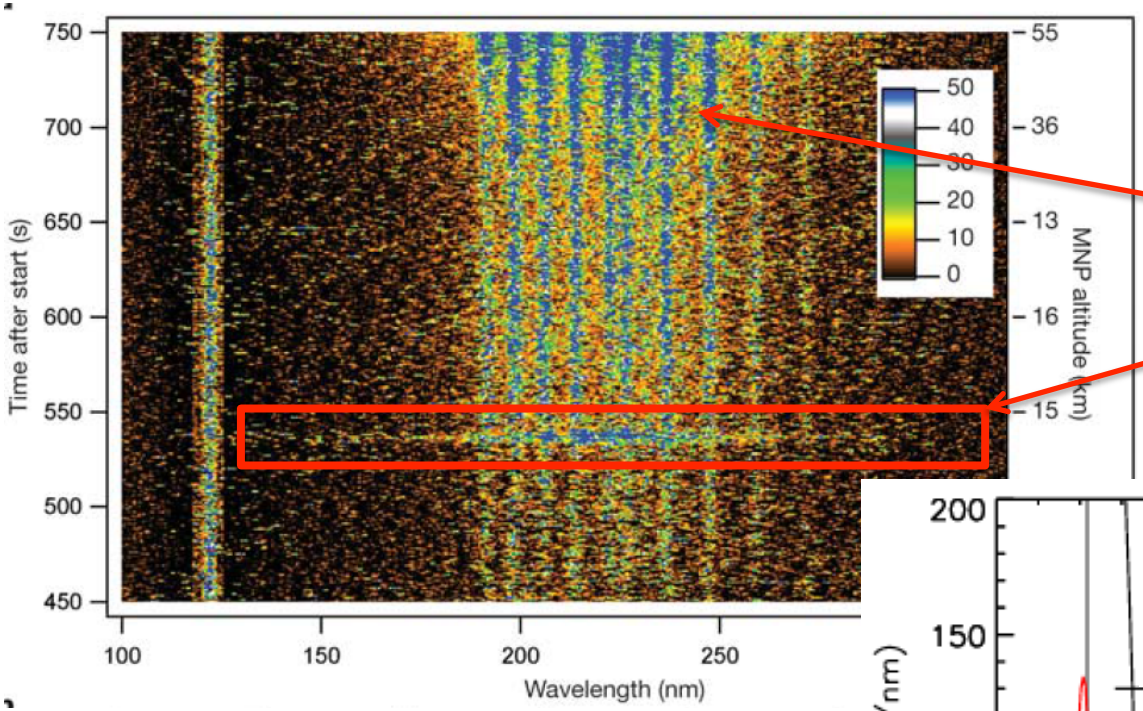
- Three kinds of aurora observed on Mars in the UV
  - **Discrete aurora**, electron impact, nightside
  - **Diffuse aurora**, electron impact, nightside
  - **Proton aurora**, proton impact, dayside

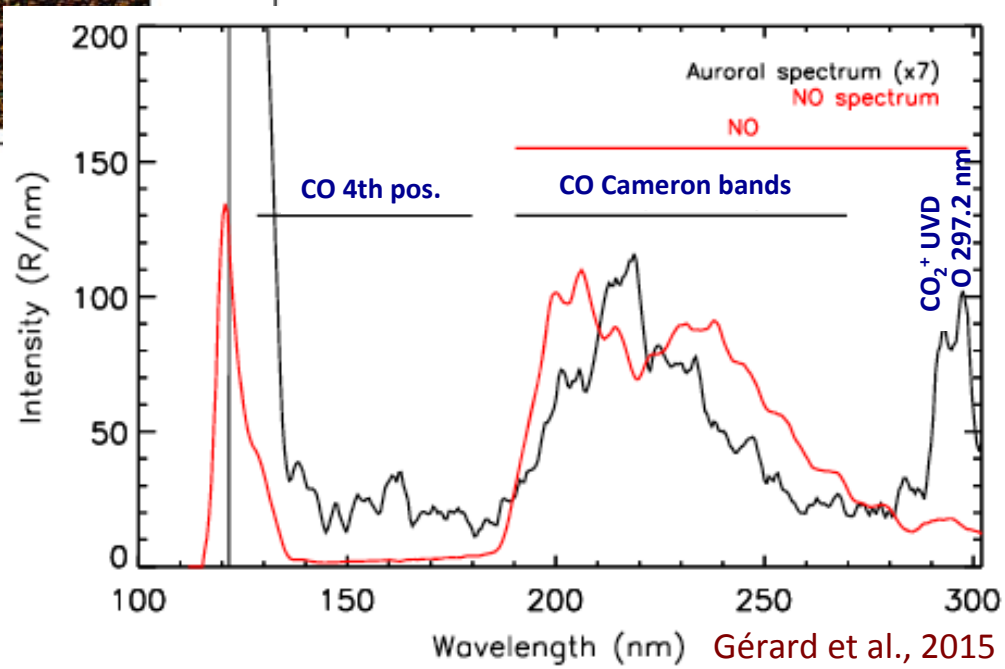
- Observed by the UV spectrometers SPICAM on board Mars Express and IUVS on board MAVEN

- Observation possible with UVIS-NOMAD on board TGO?

Discrete Aurora – SPICAM/MEx Observation

- First seen by SPICAM on board Mars Express (Bertaux et al. 2005)



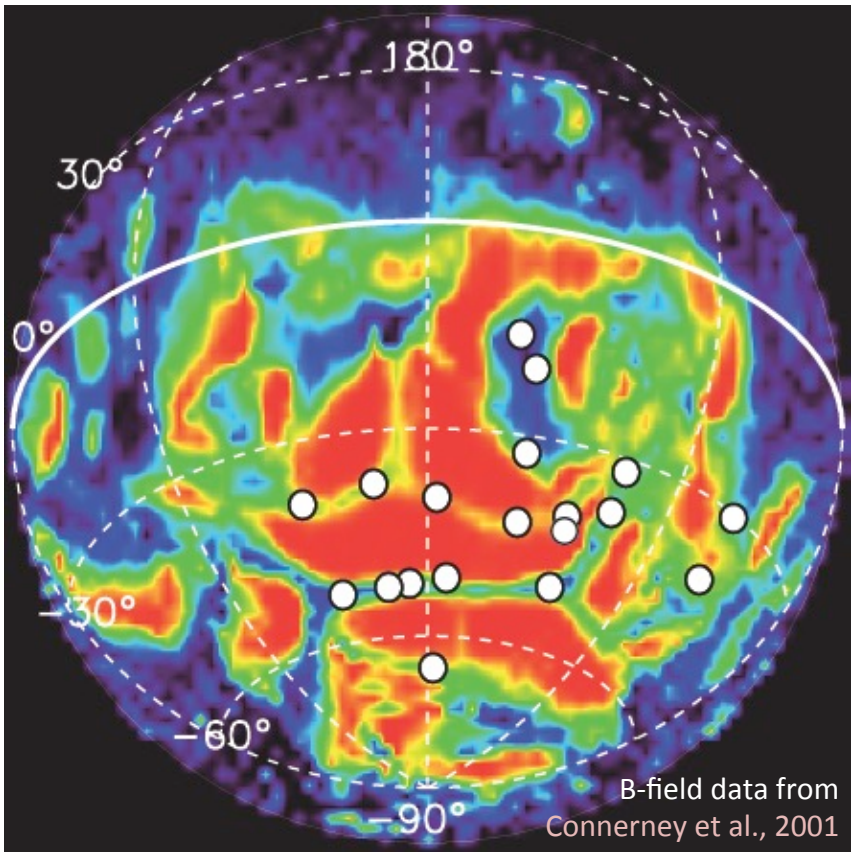


Gérard et al., 2015

- In total 19 observations of the spatially confined aurora in 10 years of observation

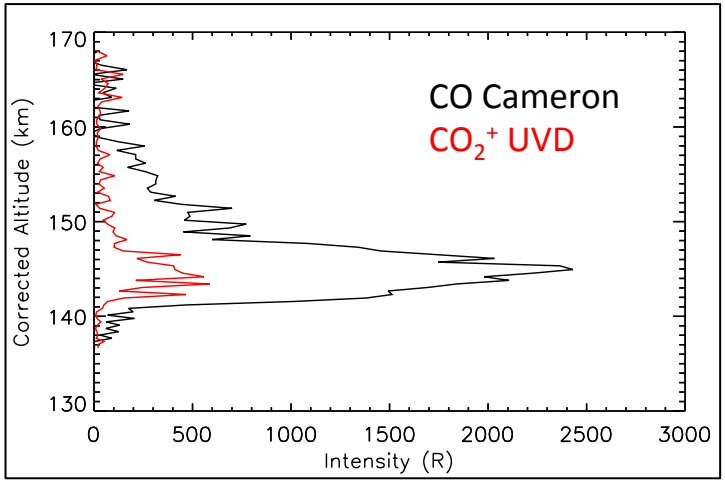
Discrete Aurora – SPICAM/MEx Observation and Modeling

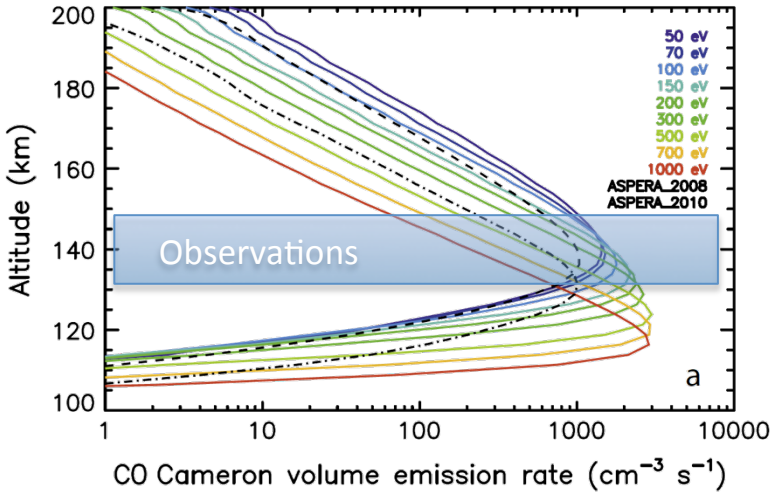
- All are observed locations are related to the Martian crustal magnetic field



Leblanc et al. 2006 / Gérard et al., 2015 / Soret et al., 2016

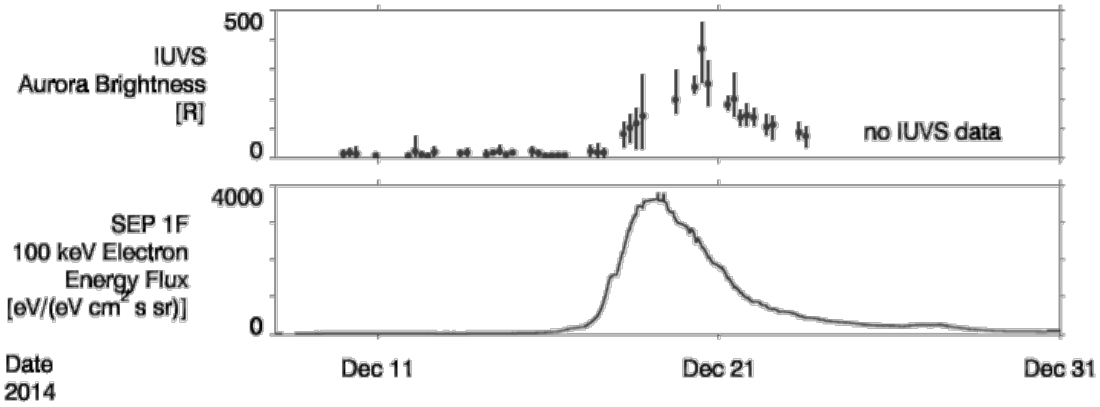
- Altitude of observed auroral emission and MC modeling in good agreement



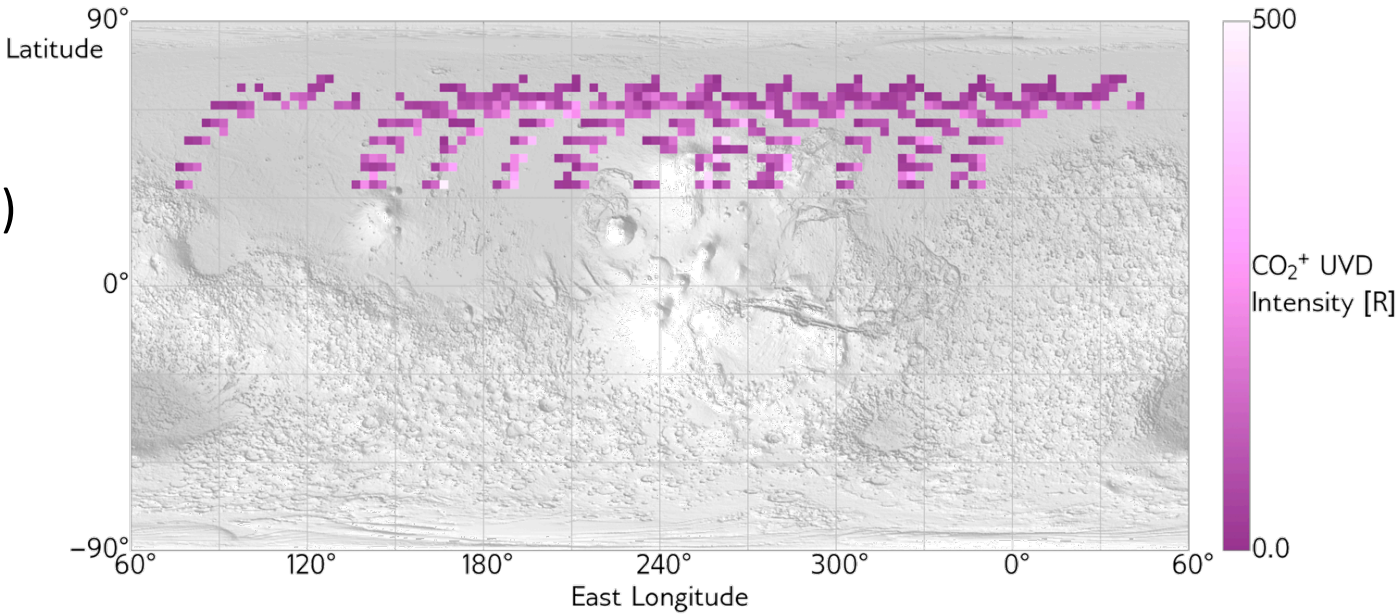


Diffuse Aurora – IUVS/MAVEN Observations

- First seen by IUVS on board MAVEN (Schneider et al., 2015)
- Simultaneous measurements of auroral emission on the nightside and energetic solar wind electrons



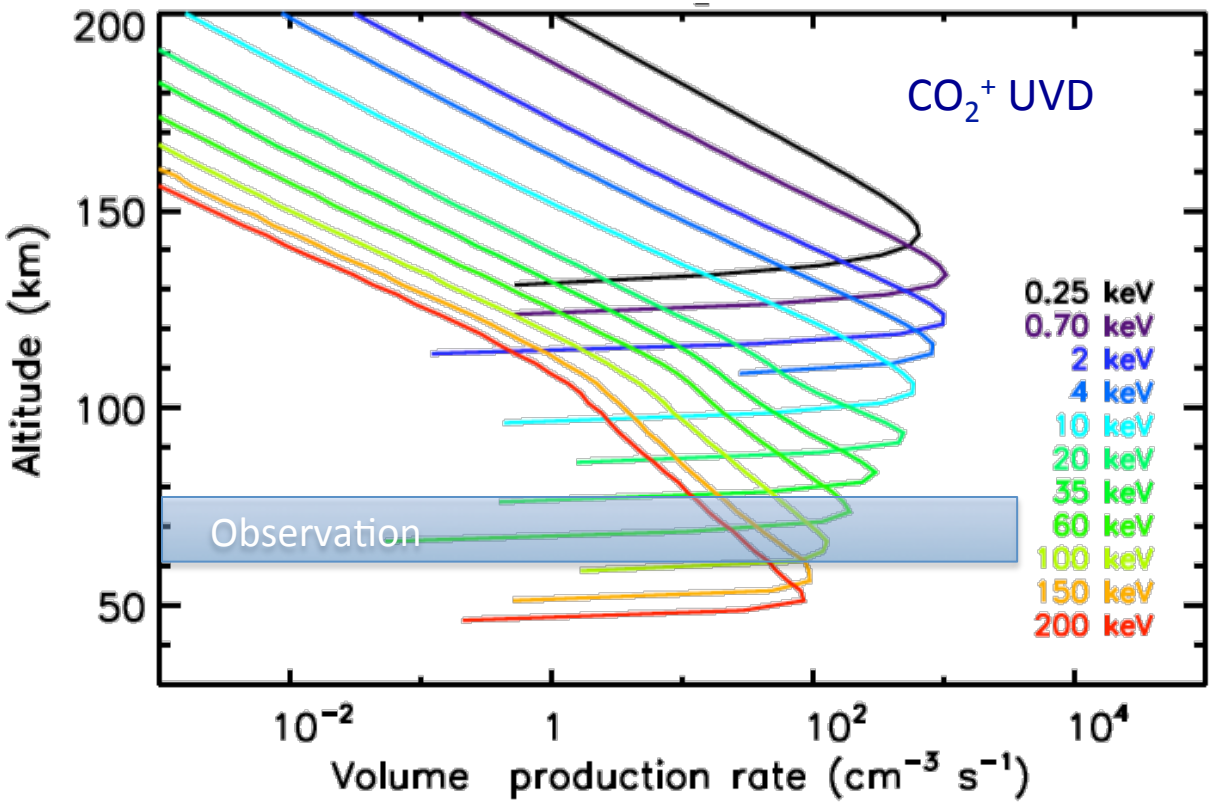
- Widespread over the Northern hemisphere (observational bias)
- During several subsequent orbits (days)



Diffuse Aurora – Modeling

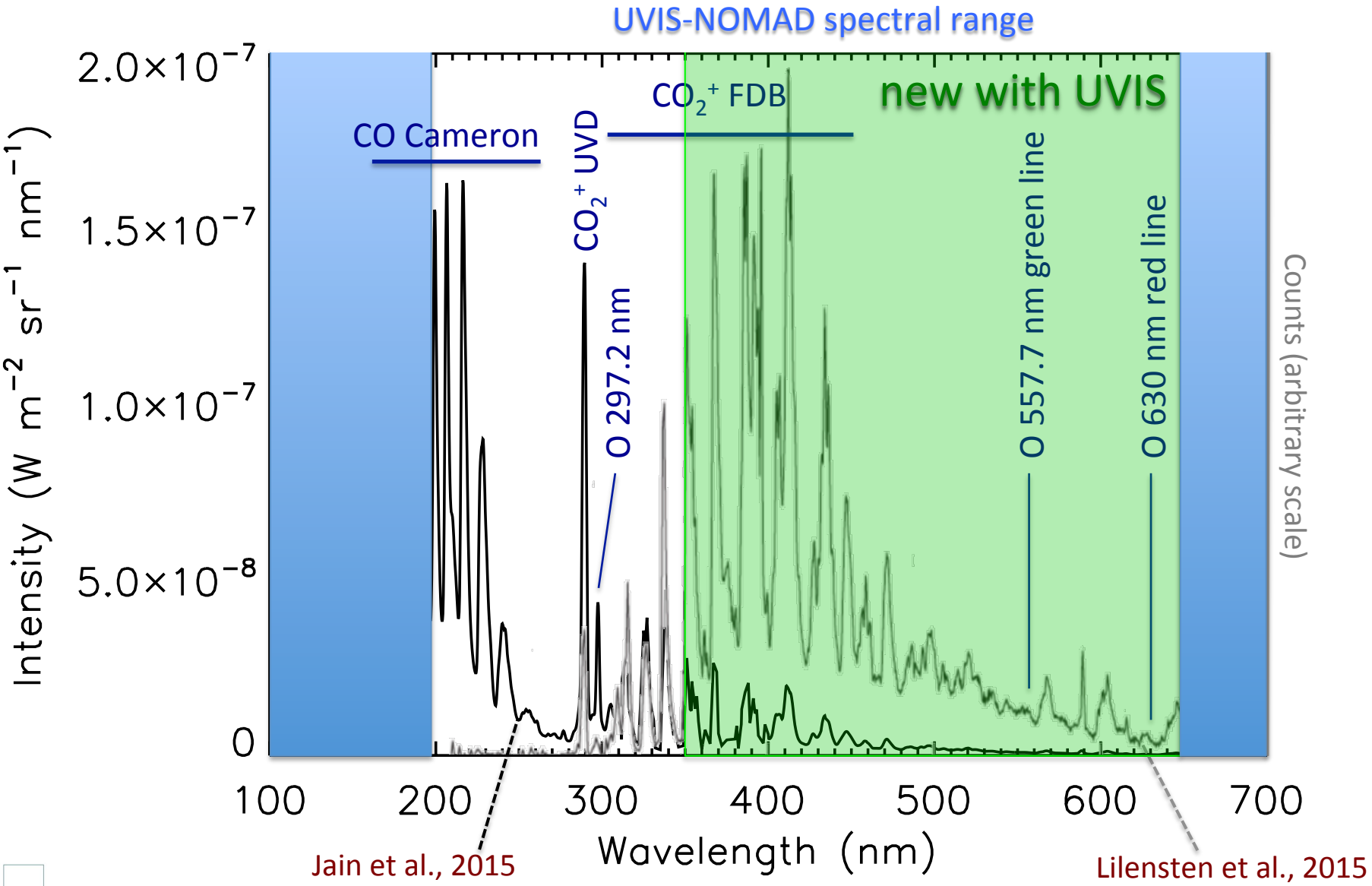
- Observation: emission peaks at ~70 km
- MC modeling: calculation of volume emission rates for mono-energetic e^- beams

- Rather hard electron spectrum required to reach the observed altitude of 70 km: ~100 keV



Gérard et al., 2017

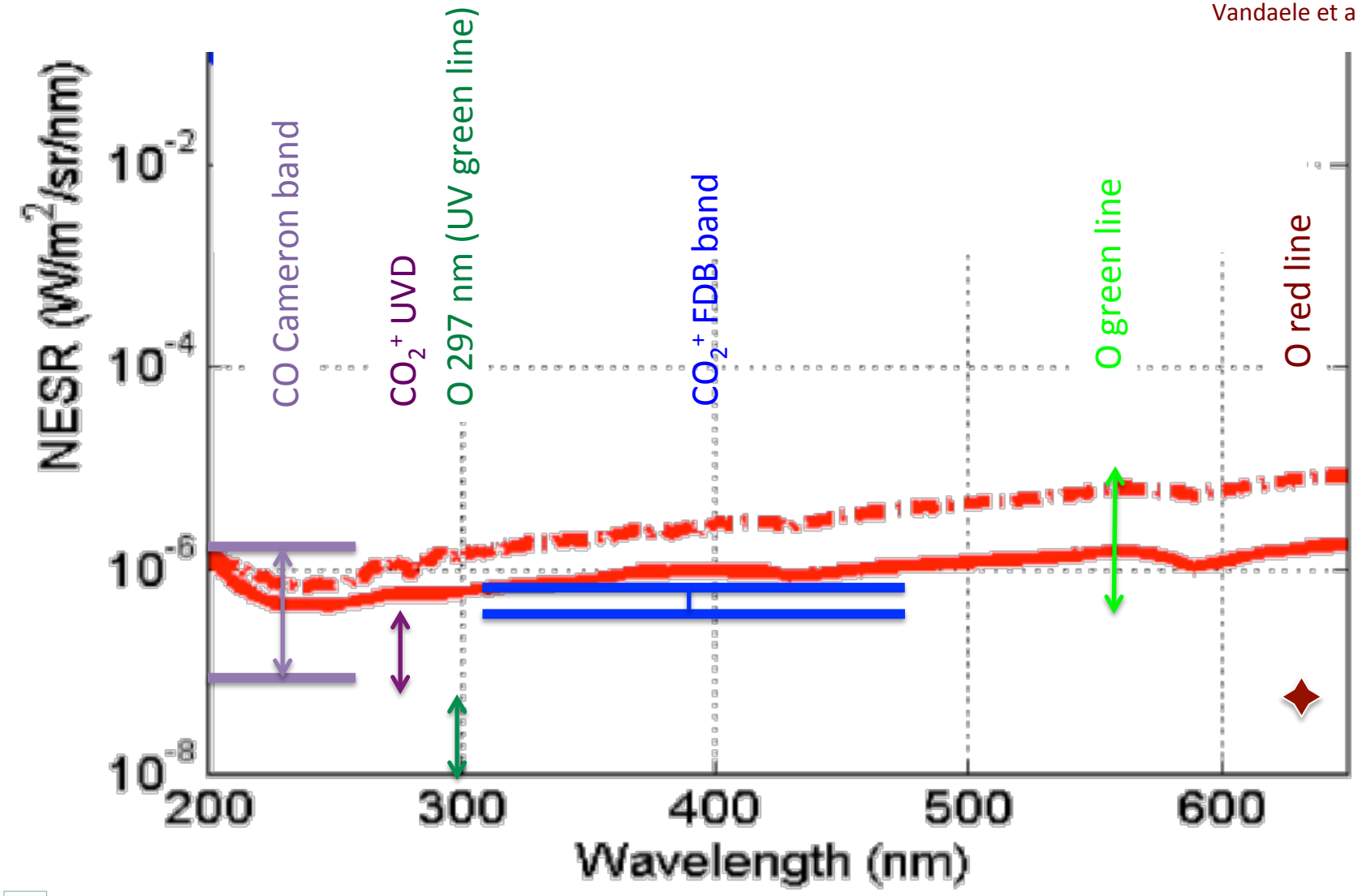
Electron Aurora Spectrum



Observability with UVIS-NOMAD/TGO – Electron Aurora

Noise Equivalent Spectral Radiance (NESR) of the UVIS-NOMAD nadir observation mode

Vandaele et al., 2015



Data taken from Lundin et al., 2006 / Gérard et al., 2015 / Lilensten et al., 2015 / Schneider et al., 2015 / Gérard et al., 2017

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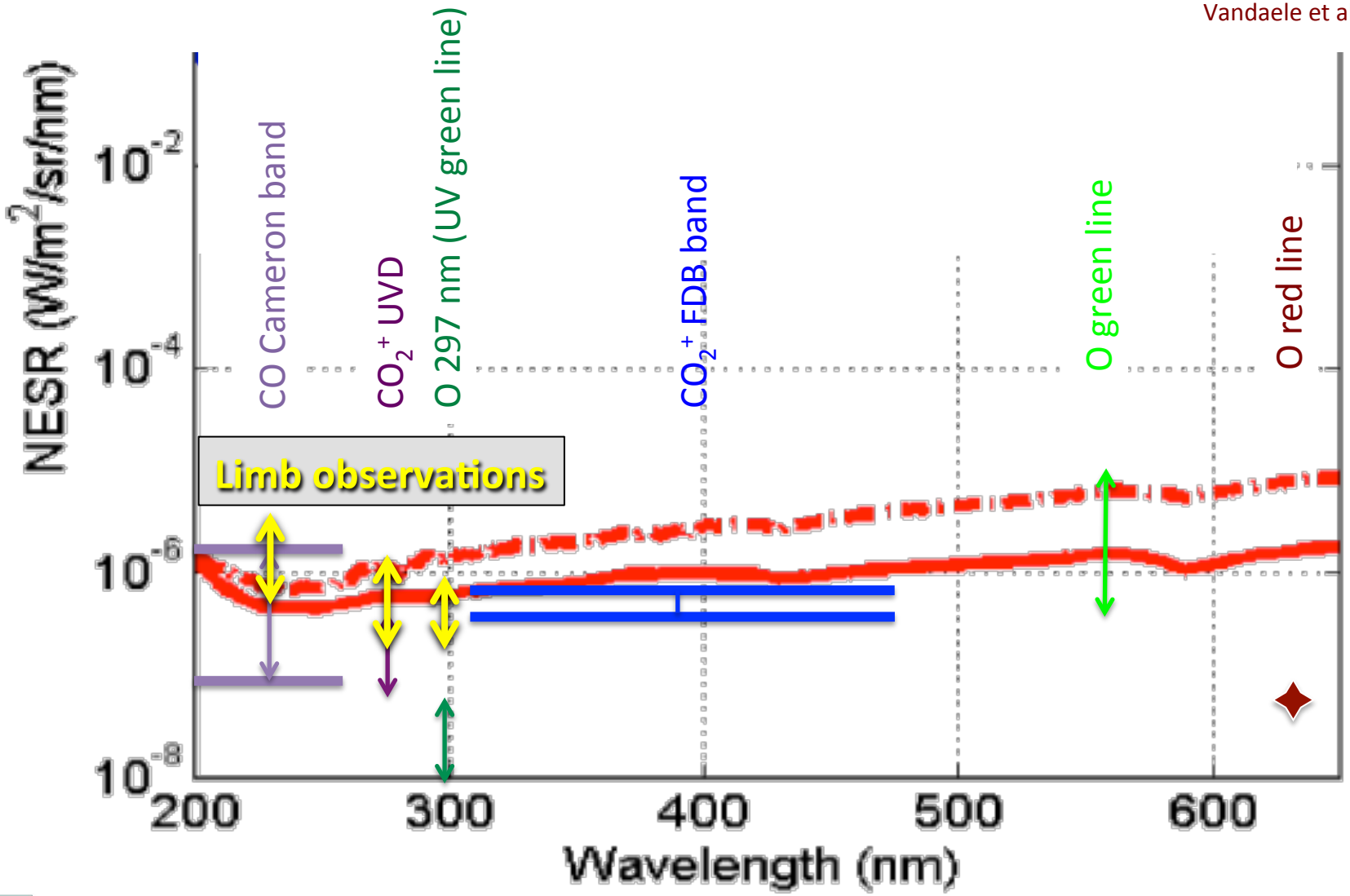
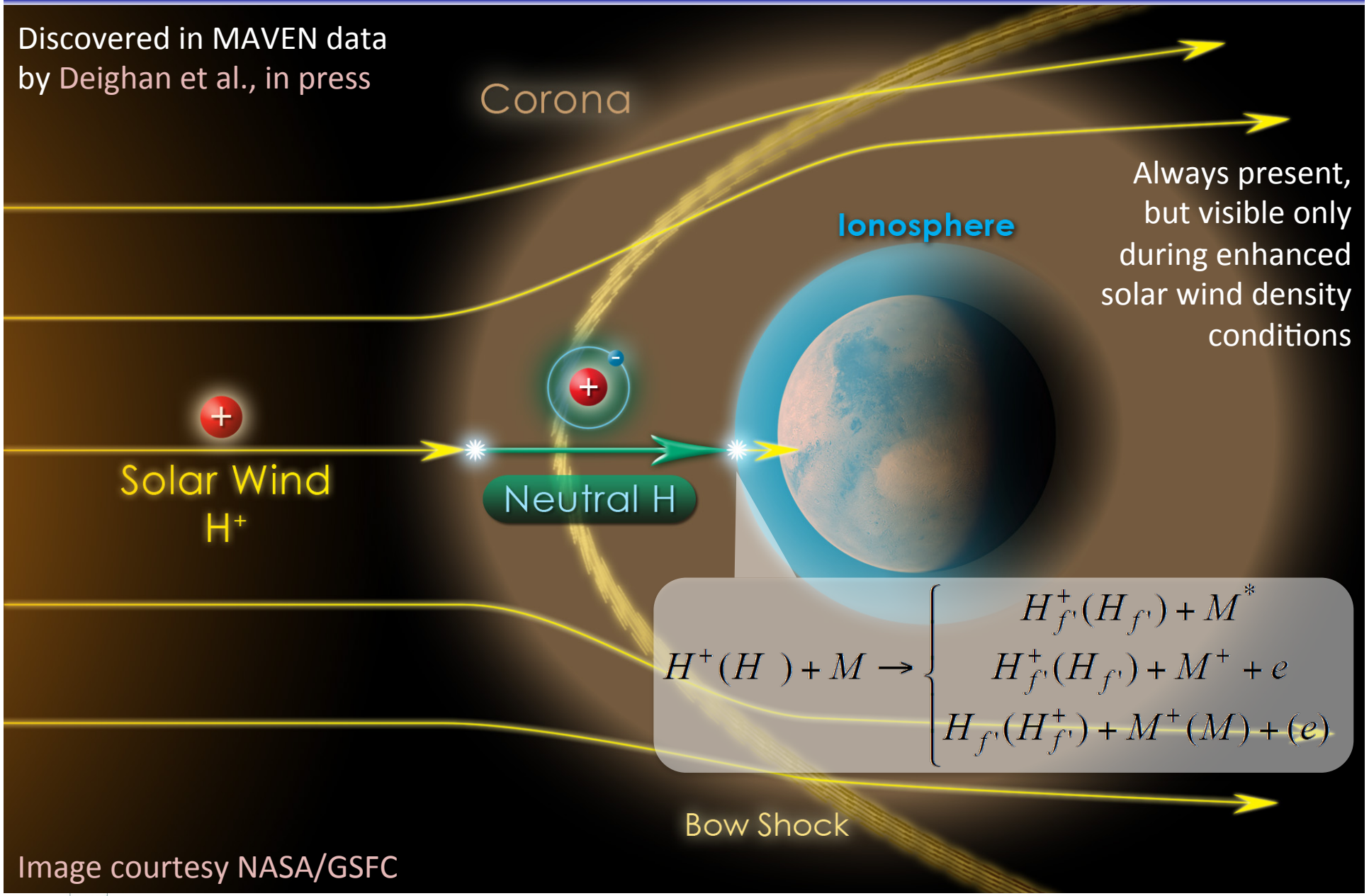


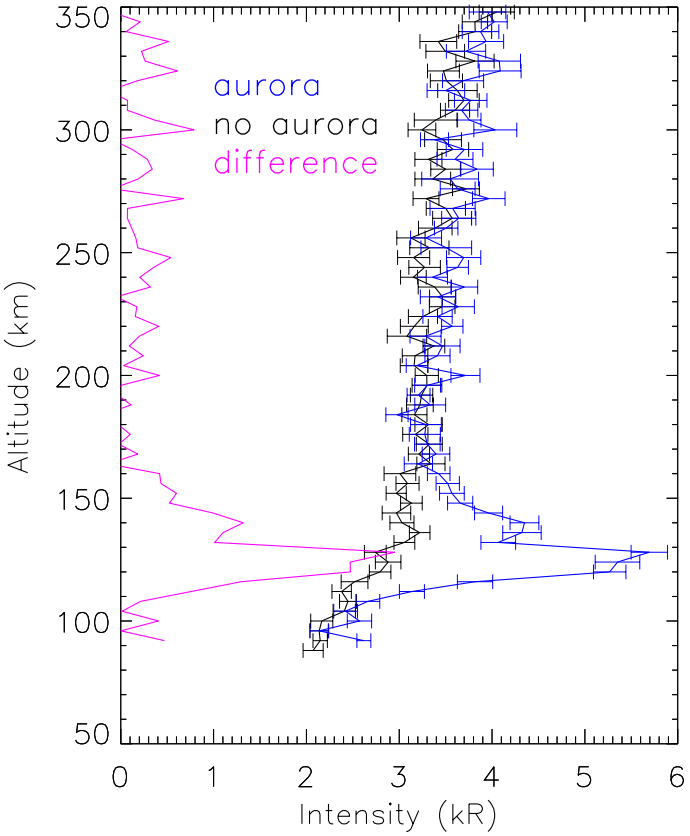
Data taken from Lundin et al., 2006 / Gérard et al., 2015 / Lilensten et al., 2015 / Schneider et al., 2015 / Gérard et al., 2017 / Soret et al., 2016

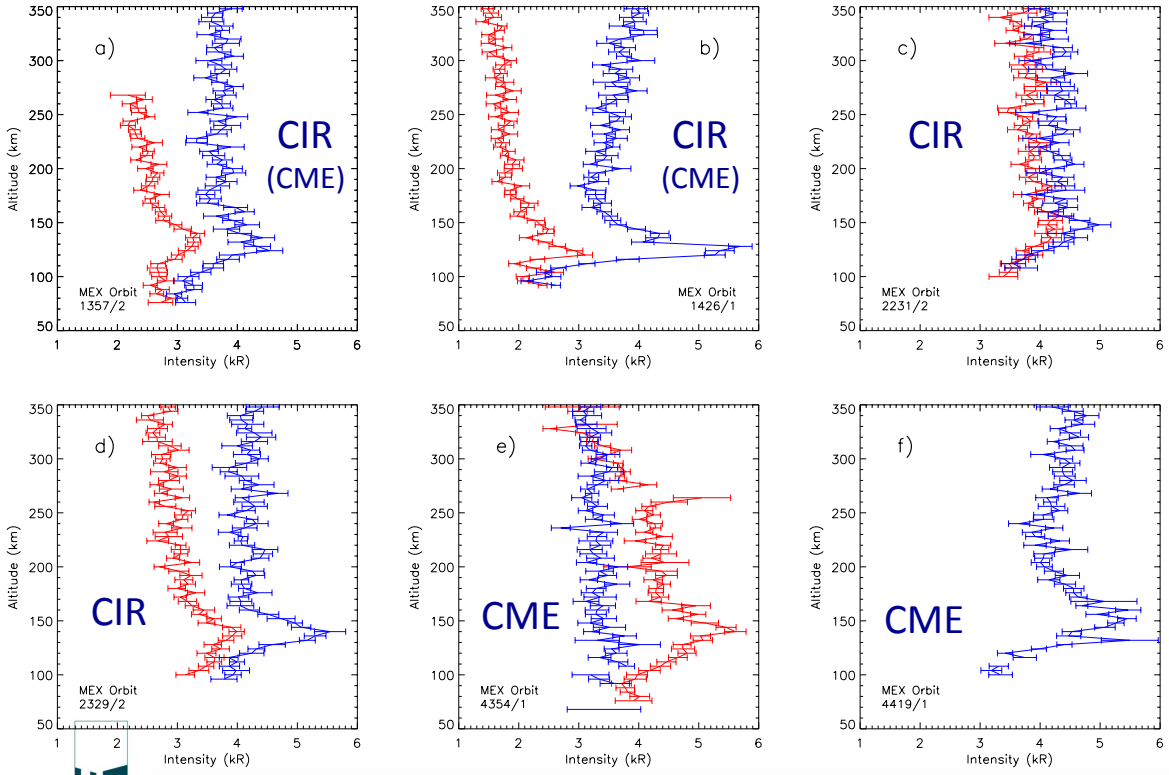
Proton Aurora



Proton Aurora – SPICAM/MEx Observations

- Observed as an enhancement in the Lyman-α intensity between 120 and 150 km
- Survey of SPICAM database revealed proton aurora in 6 orbits out of 143 (limb observations)
- Correlated to solar events: coronal mass ejections (CMEs) or corotating interaction regions (CIRs)





ingress scan
egress scan

Ritter et al., 2018

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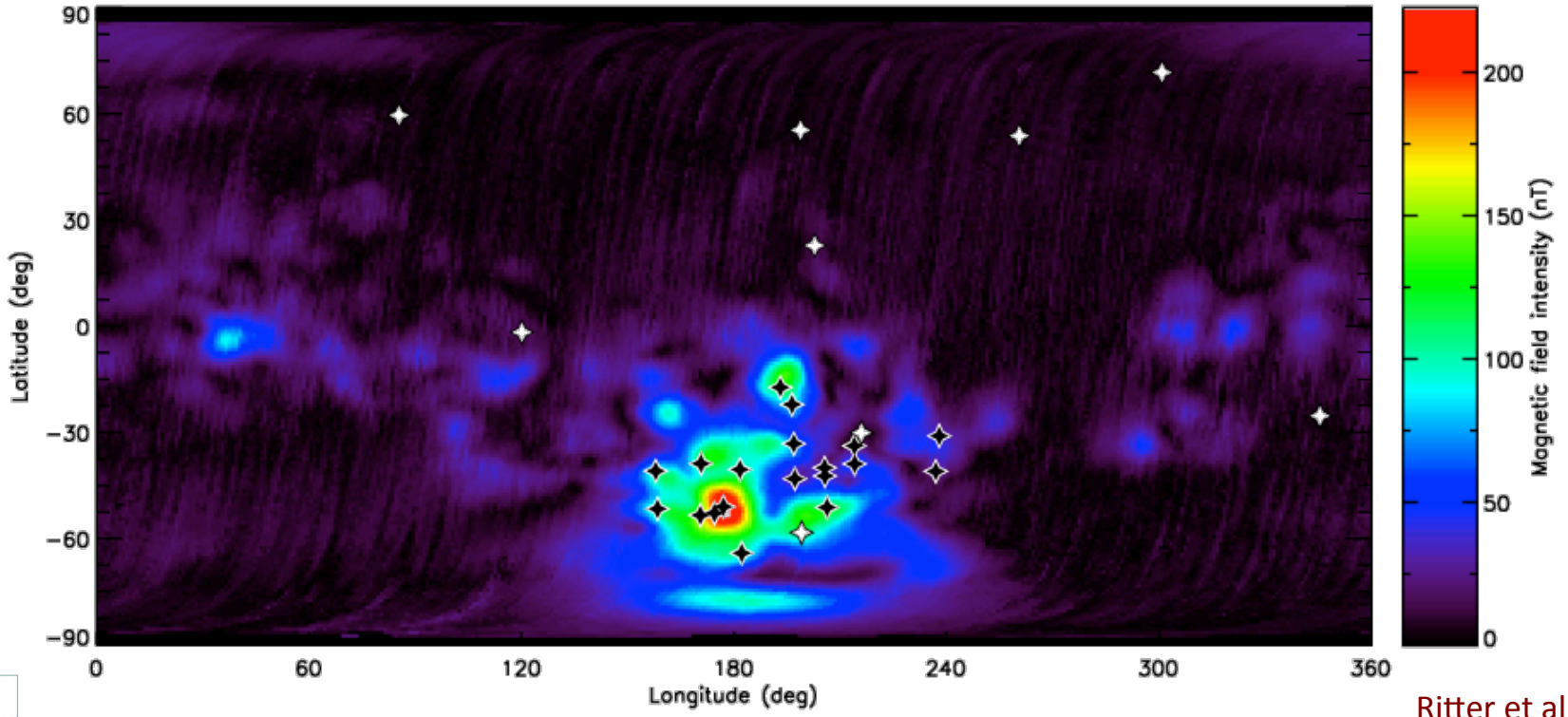
- No correlation with magnetic fields

✧ Proton aurora

✦ Discrete aurora



Ritter et al., 2018

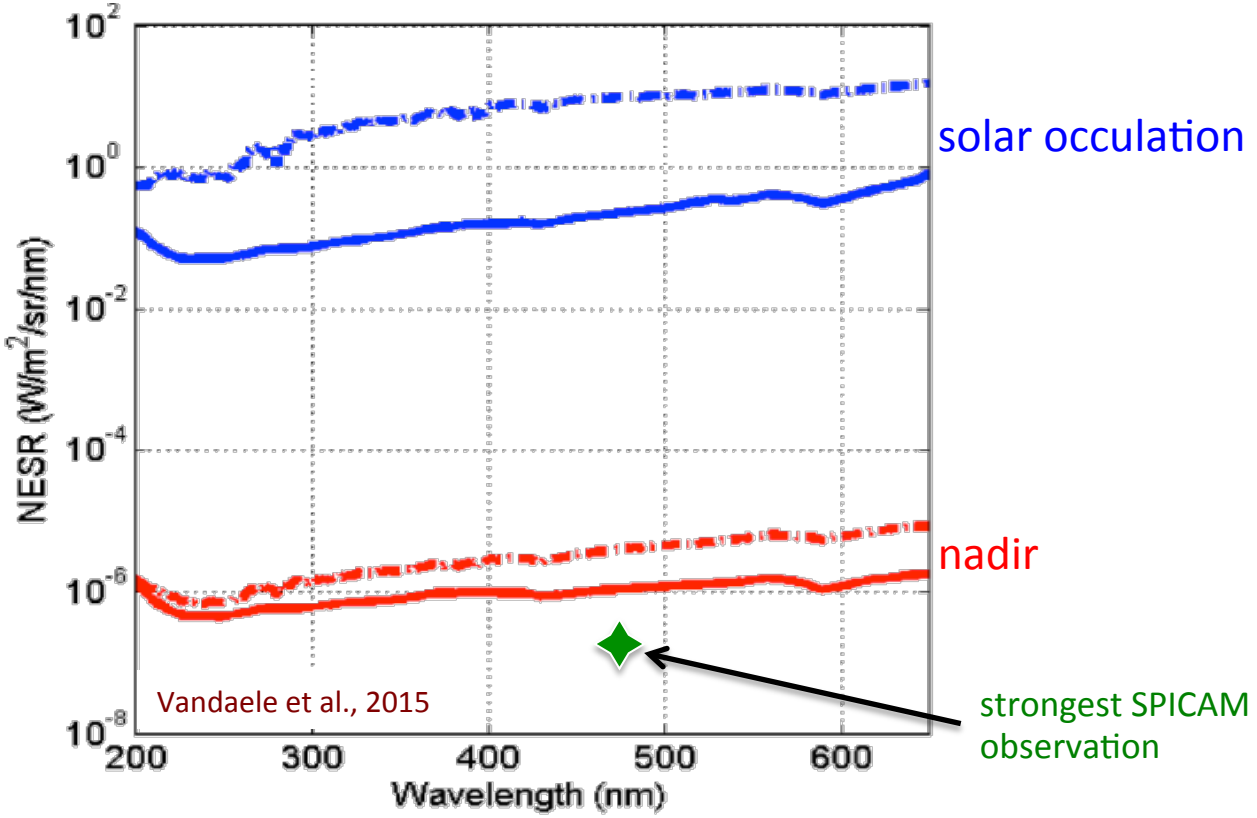
Proton Aurora – Modeling

Gérard et al. submitted

Observability with UVIS-NOMAD/TGO – Proton Aurora

- Lyman-α not in spectral range (121.6 nm)
- Hβ (486.1) in the visible (greenish/bluish)
- But ~22 times weaker (scaling from Earth observations):
  - Ly-α 3 kR ➔ Hβ few 100s R
  - Observation in nadir mode possible (no resonance scattering)

- Stronger events can occur
- Observation in limb mode would enhance signal



Summary

	Discrete Aurora	Diffuse Aurora	Proton Aurora
Origin	**Electron** impact, e^- < 1 keV	**Electron** impact, e^- in the order of 100 keV, Solar active times	To ENAs converted **protons** from dense (fast?) solar wind, CMEs / CIRs
Distribution	**Nightside** **Localized** to magnetic fields	**Nightside** **Widespread**, potentially global	**Dayside** **Widespread**, no correlation with magnetic fields
Timescale	**Minutes**, possibly hours	Long lasting, **days**	**Hours**, probably up to days
Intensity	100s of Rayleigh up to kR	100s of Rayleigh	Up to few kR
Altitude	~140 km	Down to 60 km	~120 – 150 km
Observability by NOMAD-IUVS	Near UV and visible lines for the first time, limb mode?	Near UV and visible lines for the first time, limb mode?	Possibly in the visible (Hβ) during strong events, limb mode?