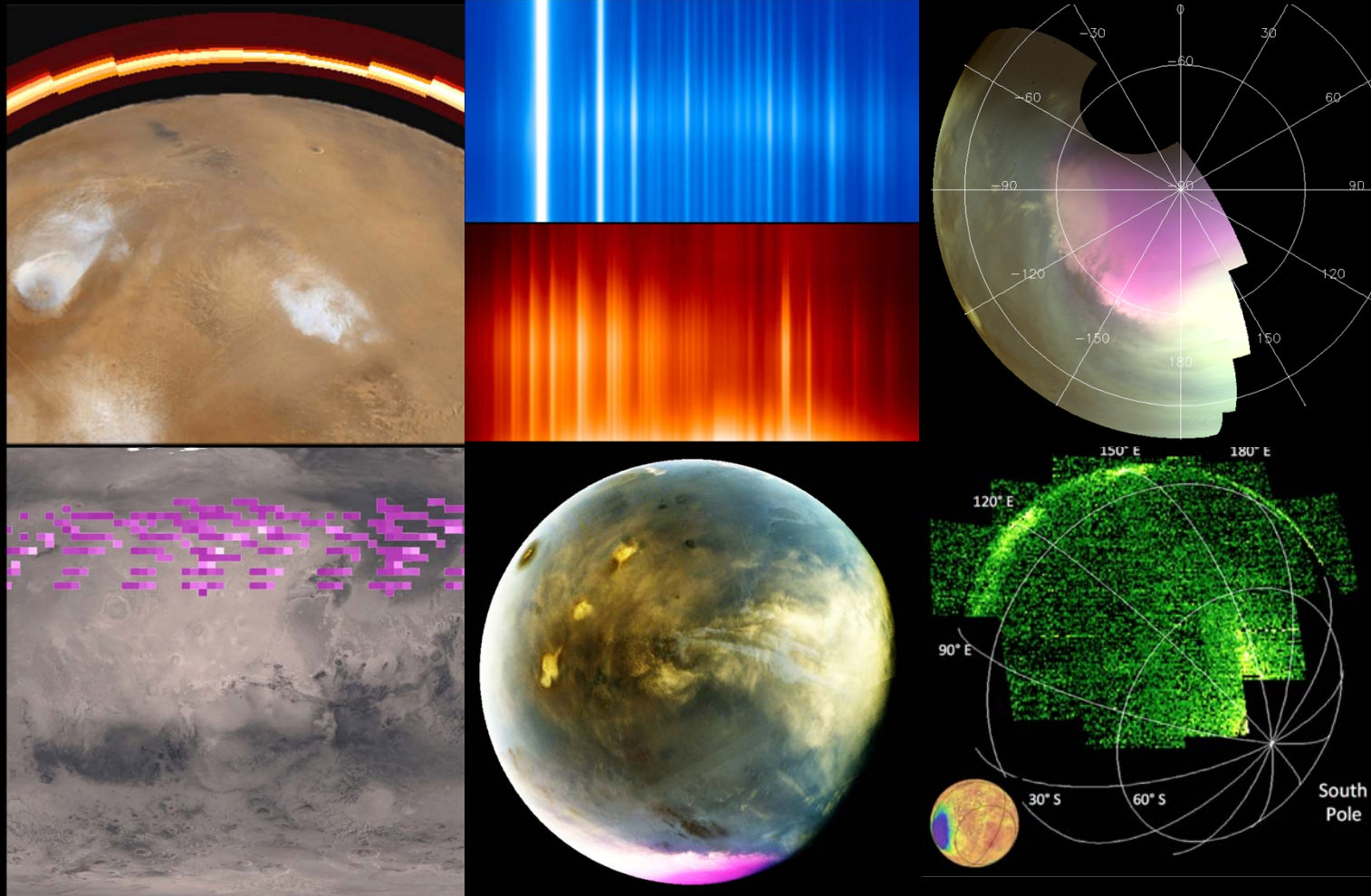


MAVEN IUVS Remote Sensing Highlights

Relevant to Upcoming TGO Observations



From Mars Express to ExoMars
Mike Chaffin, Nick Schneider, and the MAVEN IUVS Team

MAVEN IUVS Remote Sensing Highlights

Relevant to Upcoming TGO Observations

- Mars, MAVEN & IUVS: a quick review
- Selected highlights of the first Mars year
 - H Escape and D/H
 - Global imaging of:
 - Clouds/Ozone
 - Aurora
 - NO Nightglow
- MAVEN: what's ahead?

The MAVEN IUVS Science Team

- Nick Schneider, lead
- Bill McClintock, instrument scientist
- Justin Deighan, deputy lead
- LASP: Ian Stewart, Sonal Jain, Mike Chaffin, Matteo Crismani, Kyle Connour, Greg Holsclaw, Dale Thieling, Chris Jeppesen, Ryan Held, Michael Aye, with past & present undergrads: Katie Fitzgerald, Josh Lothringer, Jeremey Emmet, Natalie Bremer, Sam Stuver, Cami Nasr, Zac Milby, Alysa Derks, Hannah Hartung
- LATMOS (Paris): Franck Montmessin, Franck Lefevre, Jean-Yves Chaufray
- U. Liege (Belgium): Arnaud Stiepen
- Boston U.: John Clarke, Majd Matta, Dolon Bhattacharya
- U. Arizona: Roger Yelle, Hannes Groeller, Daniel Lo
- Naval Research Lab: Mike Stevens
- Computational Physics Inc.: Scott Evans, John Corriera
- Japanese Participating Scientists: Kanako Seki, Hiromu Nakagawa, Naoki Terada

The MAVEN Spacecraft

- Launch (Wet) Mass: 2455 kg at launch
- Spacecraft Dry Mass: 810 kg at launch
- Power: 1135 W at Mars Aphelion

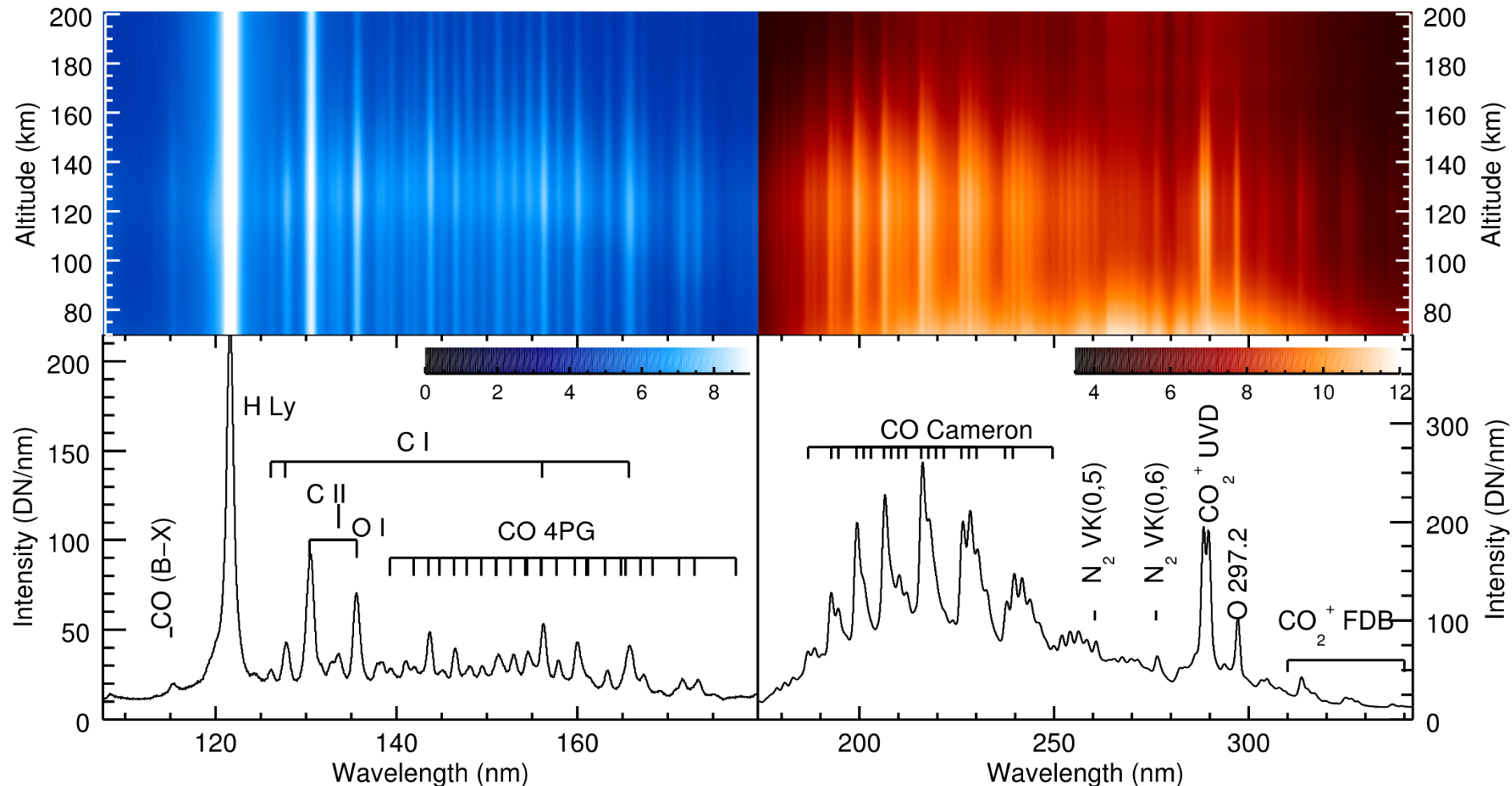


IUVS Observed Phenomena

Limb Scan (Periapse, coronal)	Disk & coronal Scan	Apoapse Disk Imaging	Stellar Occultations
Dayglow • CO₂, N₂, H, O, <u>CO?</u> • n(z), T(z) • variability • tides	H corona, O Corona • escape • seasonal changes	Ozone • polar vortex • Rossby waves • seasonal changes	Altitude profiles • CO₂, O₂ • n(z), T(z) • ozone, aerosols • day: OK, night:OK!
Nightglow (NO)		Clouds • nadir, limb	• gravity waves • planetary waves
Aurora (3 types)		Albedo, dust	
Limb clouds (mesosphere)		Rayleigh scattering	
D/H	D/H	Nightglow (NO)	Miscellaneous
Atomic O 130nm triplet			• Past-terminator clouds
			• Rover overflights
			• Phobos

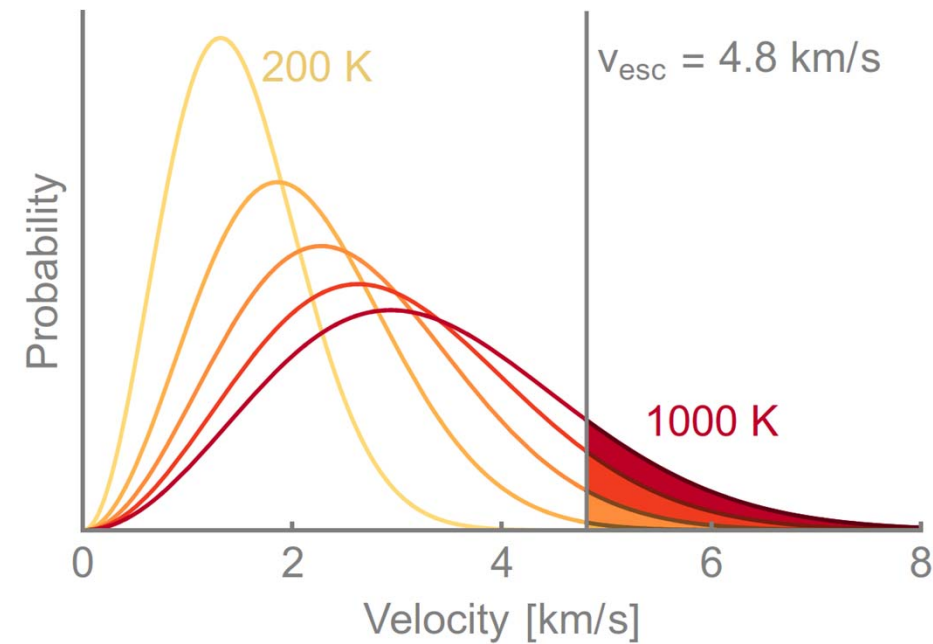
If I don't discuss something of interest to you, please bring it up at the end.

Mars UV Spectrum: *not a model*

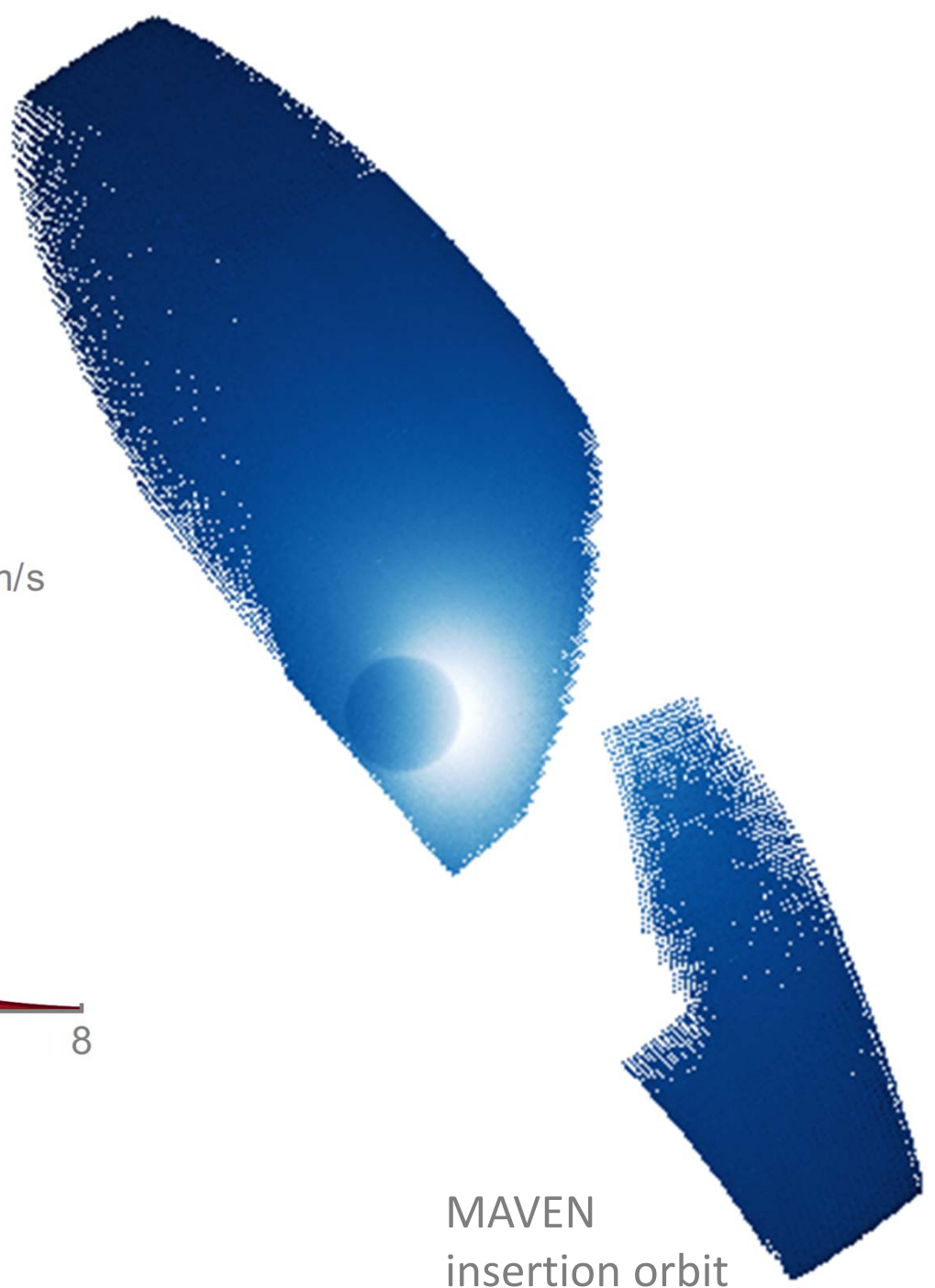


- Nearly 200 orbits, 60 hours total integration
- Most emissions from CO₂ dissociation & ionization products (Barth et al. 71)

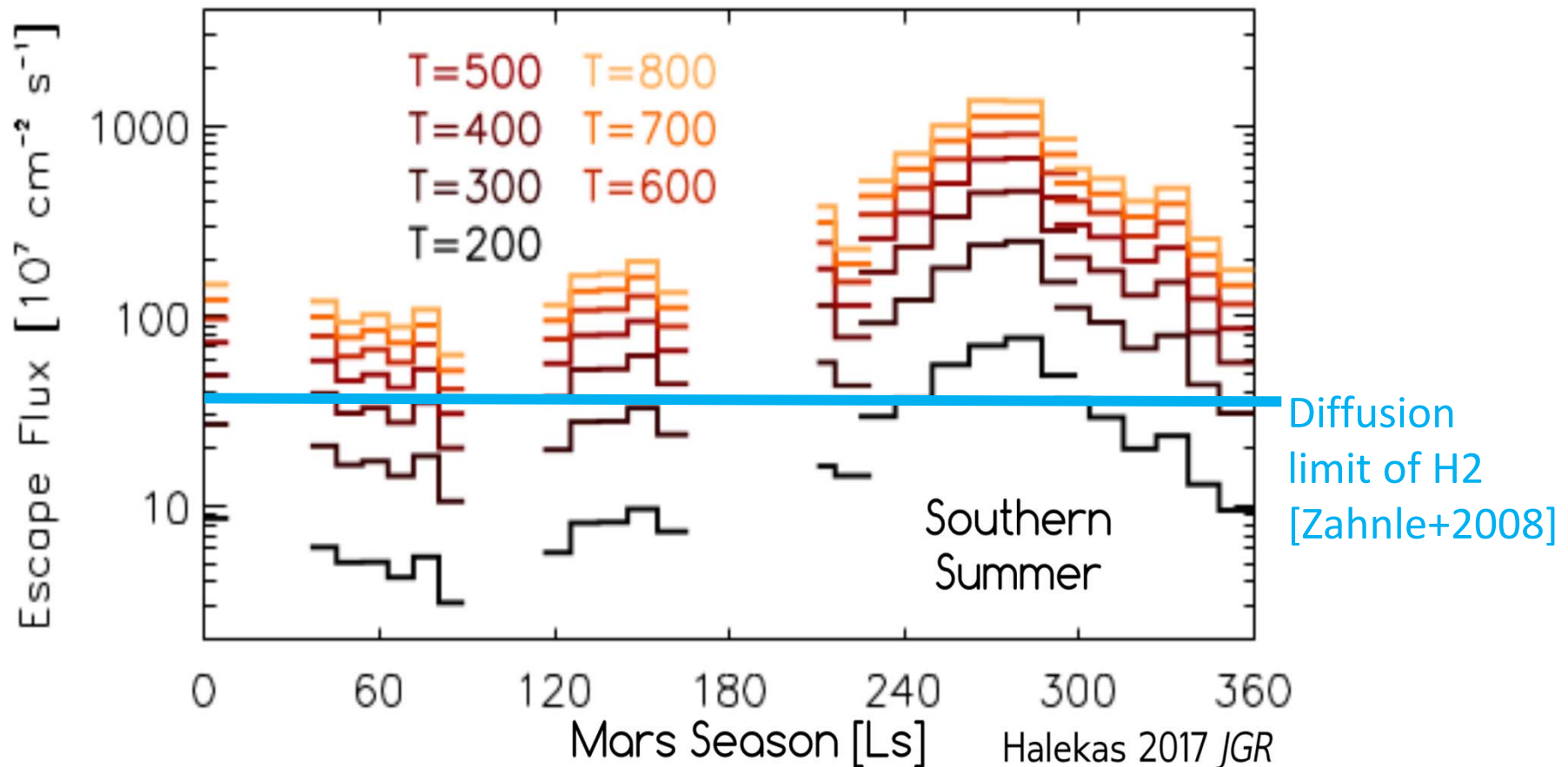
H is escaping
from Mars today
via Jeans escape



*What supplies the
escaping H?*



Several ongoing MAVEN studies reveal significant seasonal variability of Mars H Escape

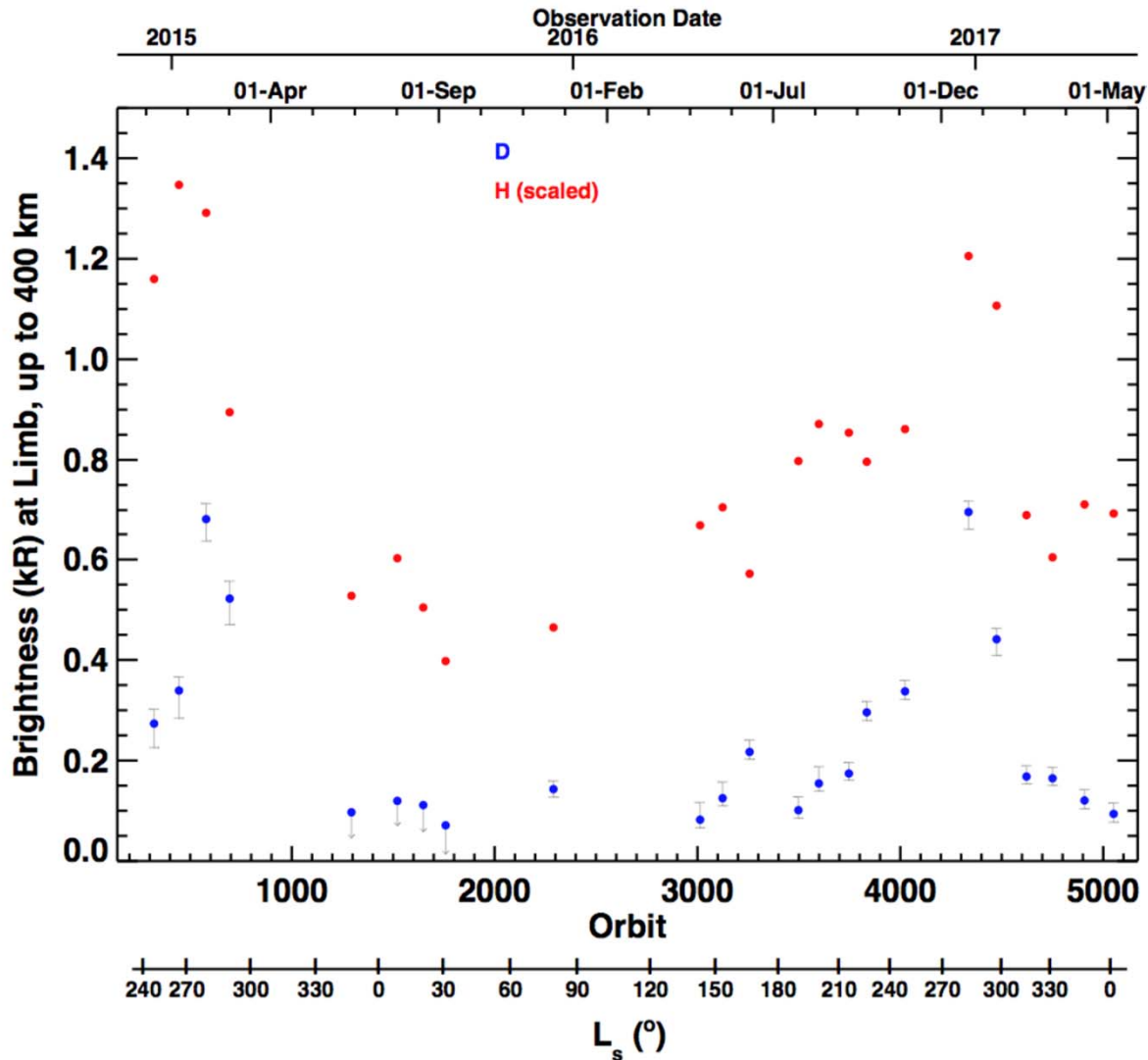


See also Chaffin et al. (2014) GRL

Clarke et al. (2014) GRL,

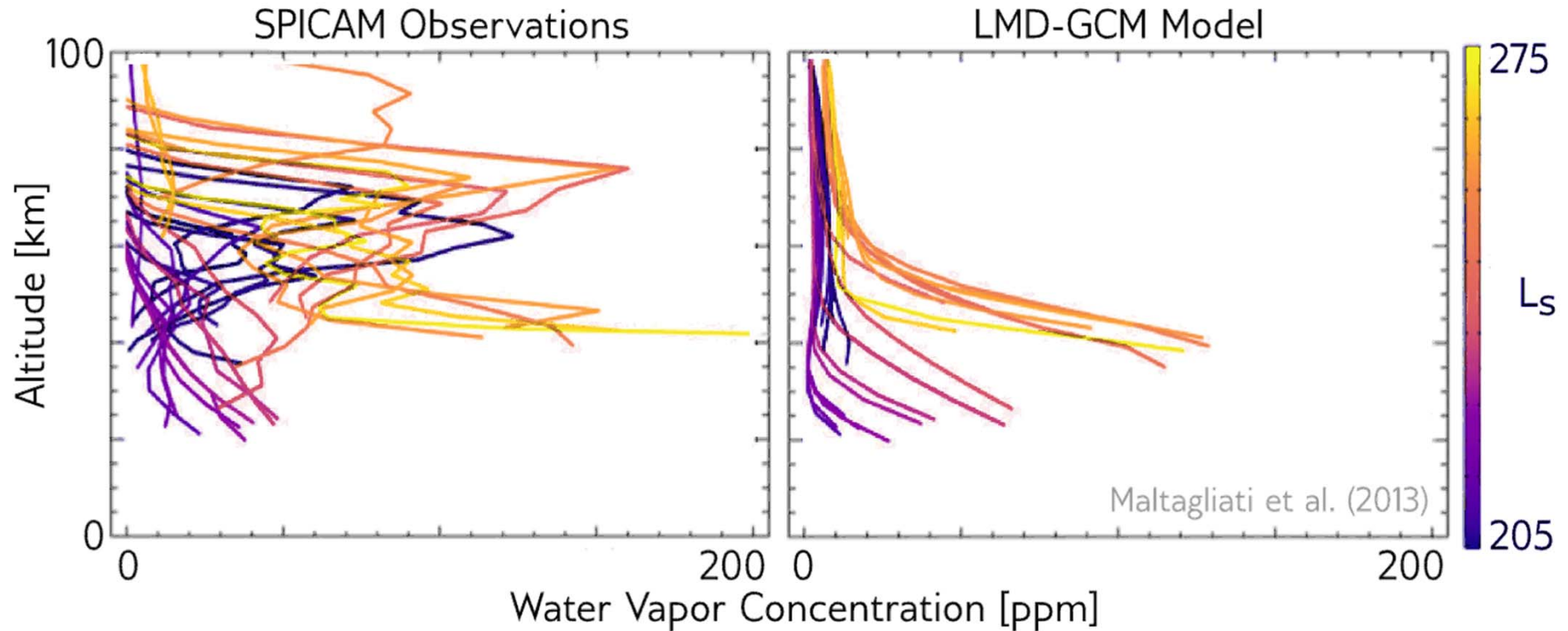
Bhattacharyya et al (2015) GRL

First results from the IUVS Echelle Channel



- Hydrogen and deuterium are greatly enhanced in the upper atmosphere during southern hemisphere summer

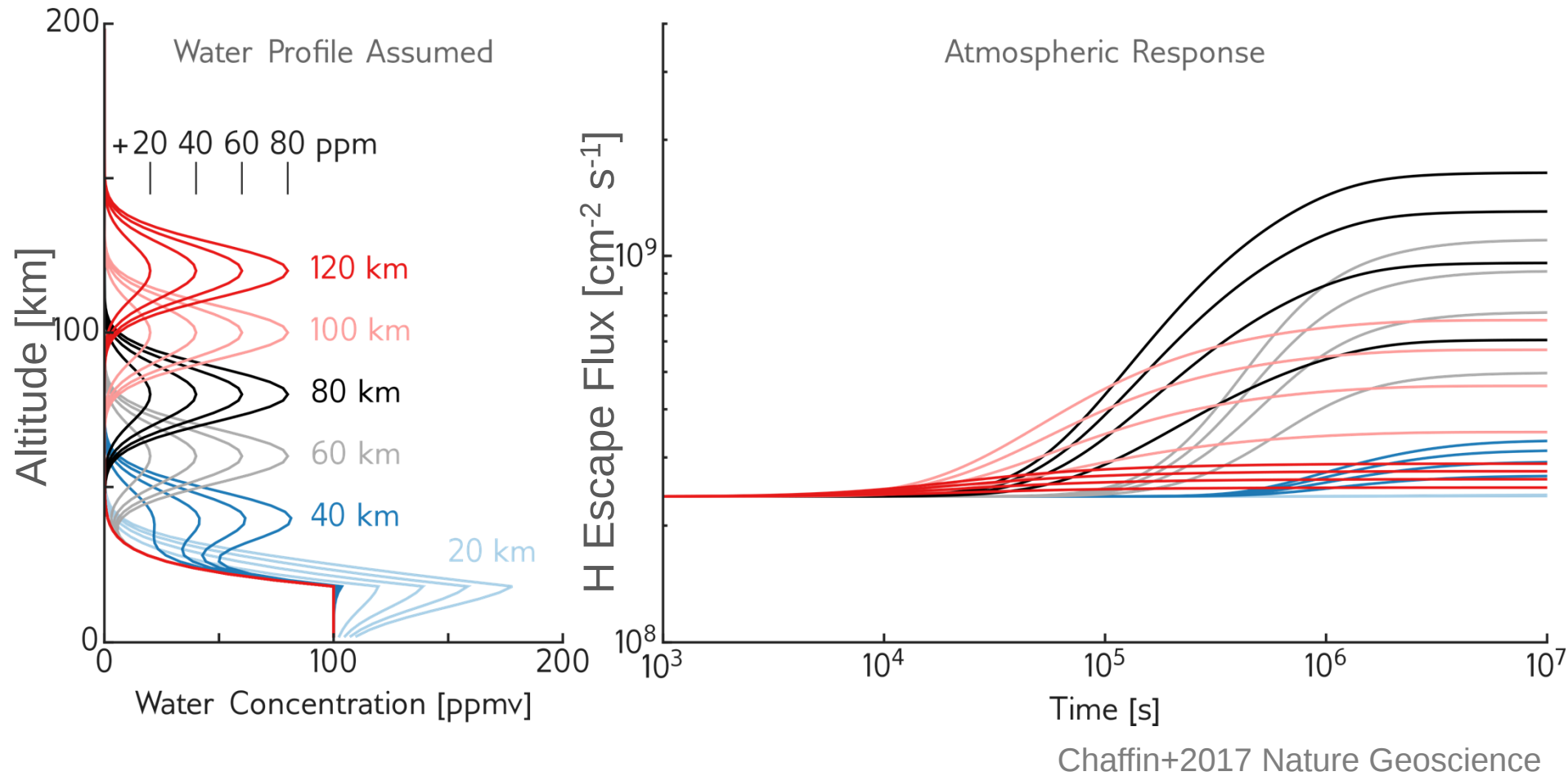
High-altitude water is a likely candidate for powering enhanced H escape.



*Observations find water at high altitudes
not accounted for in previous H escape modeling*

[see also Federova+2017, Heavens+2017]

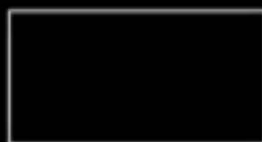
Modeling shows high altitude water is key in powering H escape



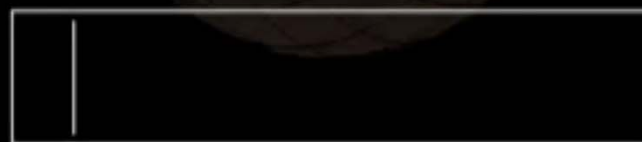
- TGO observations of seasonal variation of high altitude water are essential to testing this new paradigm for the water cycle and H escape!

2015/224 Aug 12 01:30:01 UTC
RA/DEC: 97, -26
Tangent Point Lat, Lon: 22, 154
Tangential Alt: 1458 km
Spacecraft Alt: 5331 km
Sol. Zen. Angle: 142°
Phase: 53°
Sub SC Lat, Lon: 58, 216

Observation Mode: Apoapse

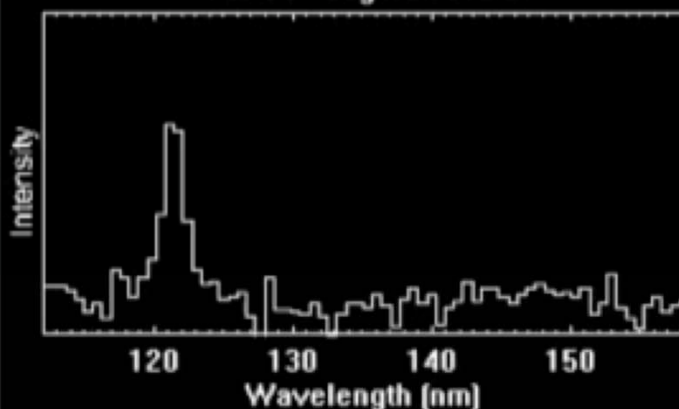


Limb F.O.R.

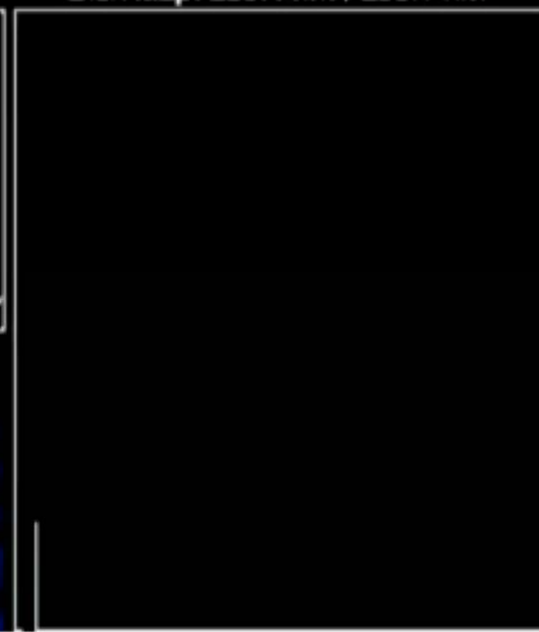


Nadir Field-of-Regard

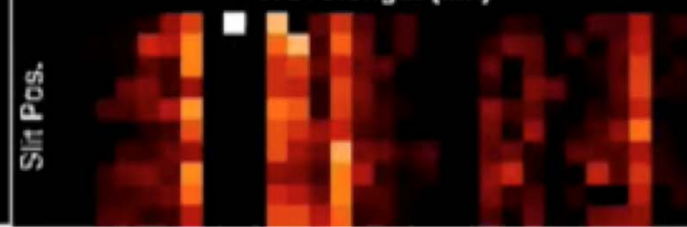
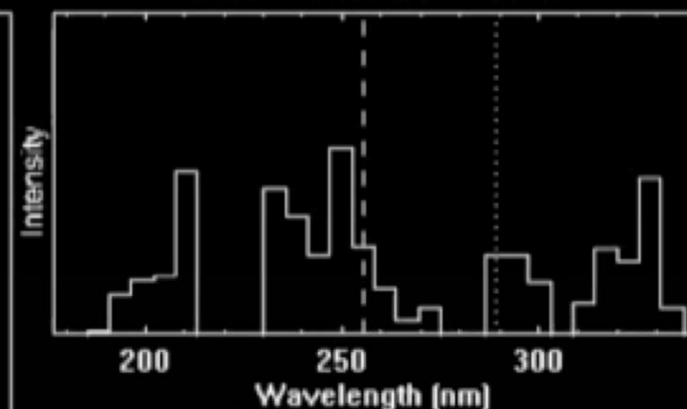
Far UV - Log Autoscale



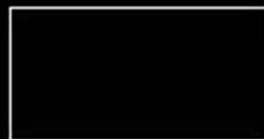
Disk Map: 255.4 nm / 289.1 nm



Mid UV - Fixed Linear Scale



2015/224 Aug 12 01:30:01 UTC
RA/DEC: 97, -26
Tangent Point Lat, Lon: 22, 154
Tangential Alt: 1458 km
Spacecraft Alt: 5331 km
Sol. Zen. Angle: 142°
Phase: 53°
Sub SC Lat, Lon: 58, 216

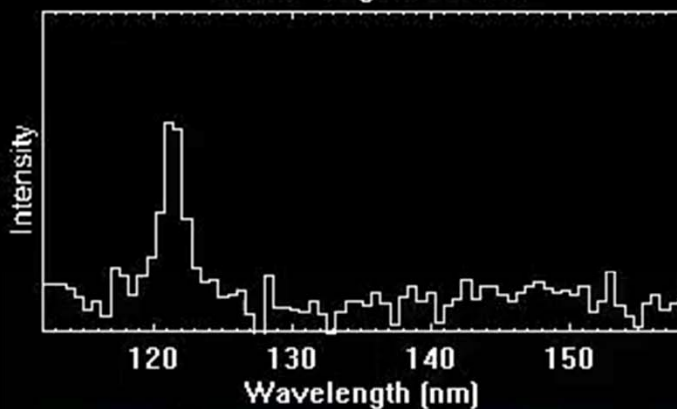


Limb F.O.R.



Nadir Field-of-Regard

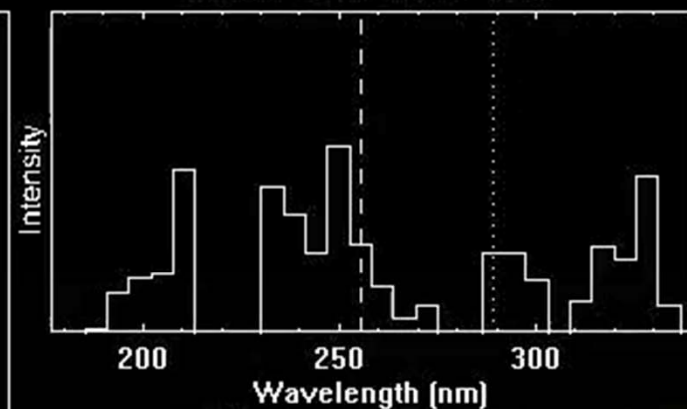
Far UV - Log Autoscale



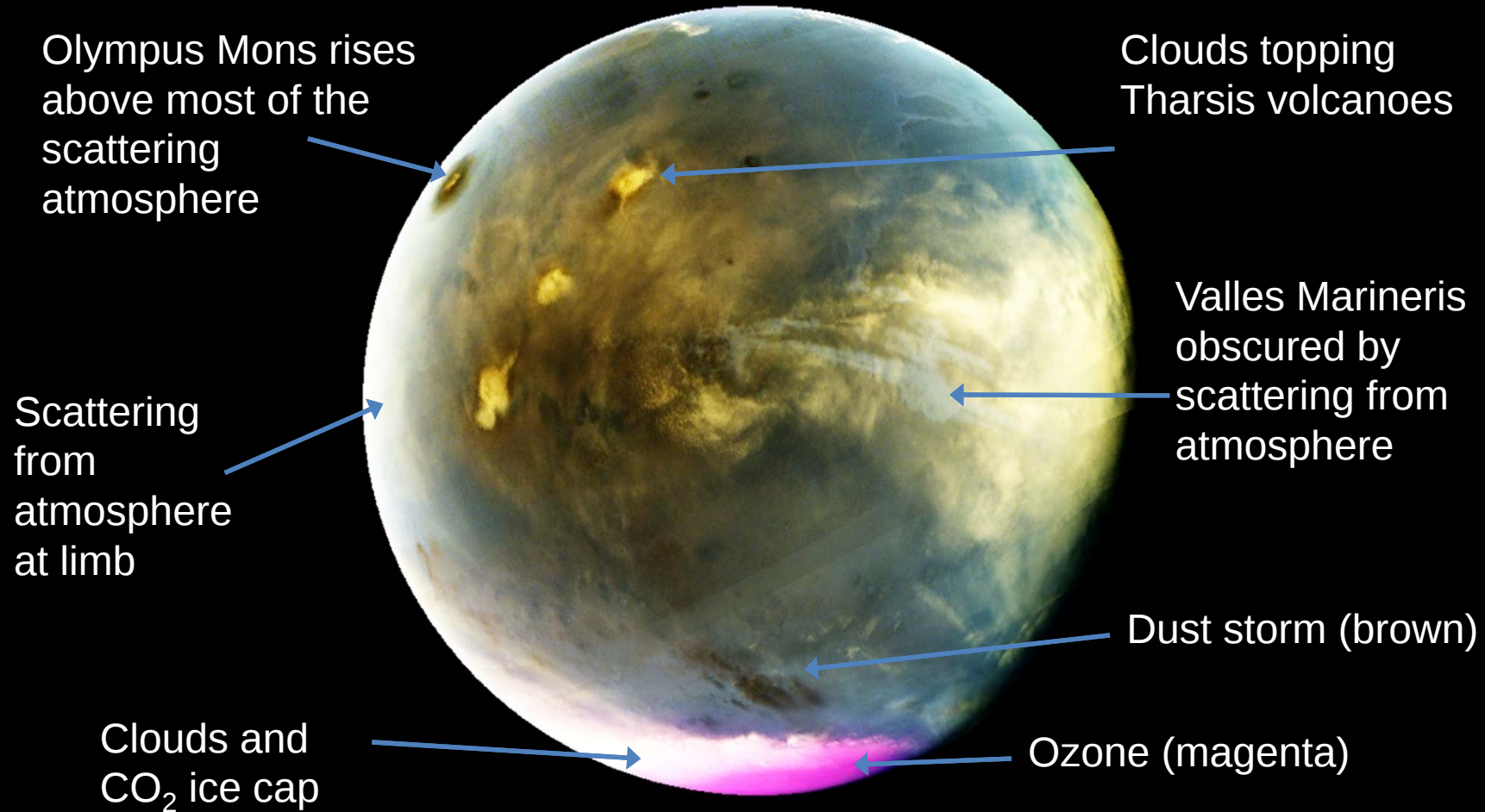
Disk Map: 255.4 nm / 289.1 nm

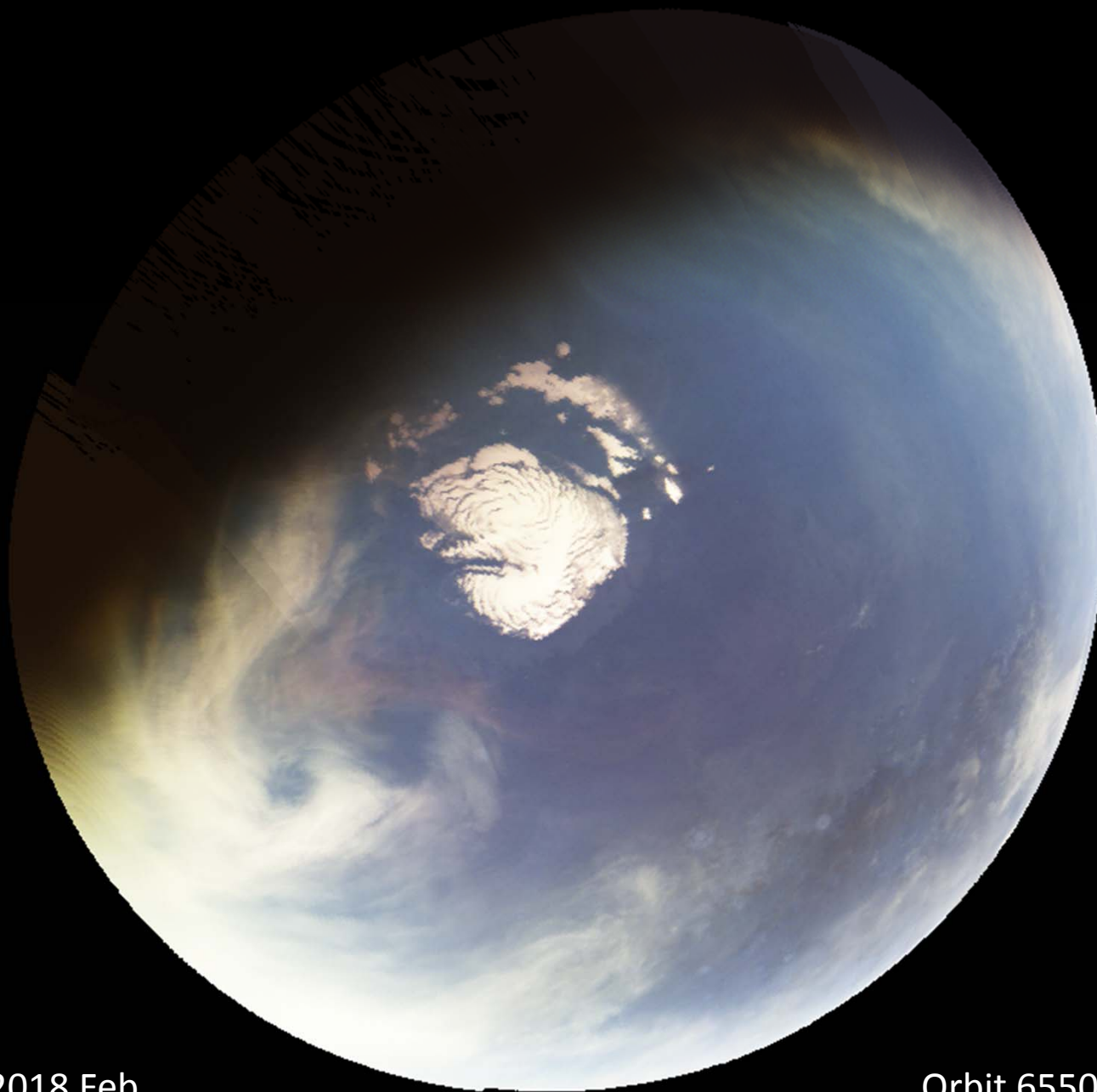


Mid UV - Fixed Linear Scale



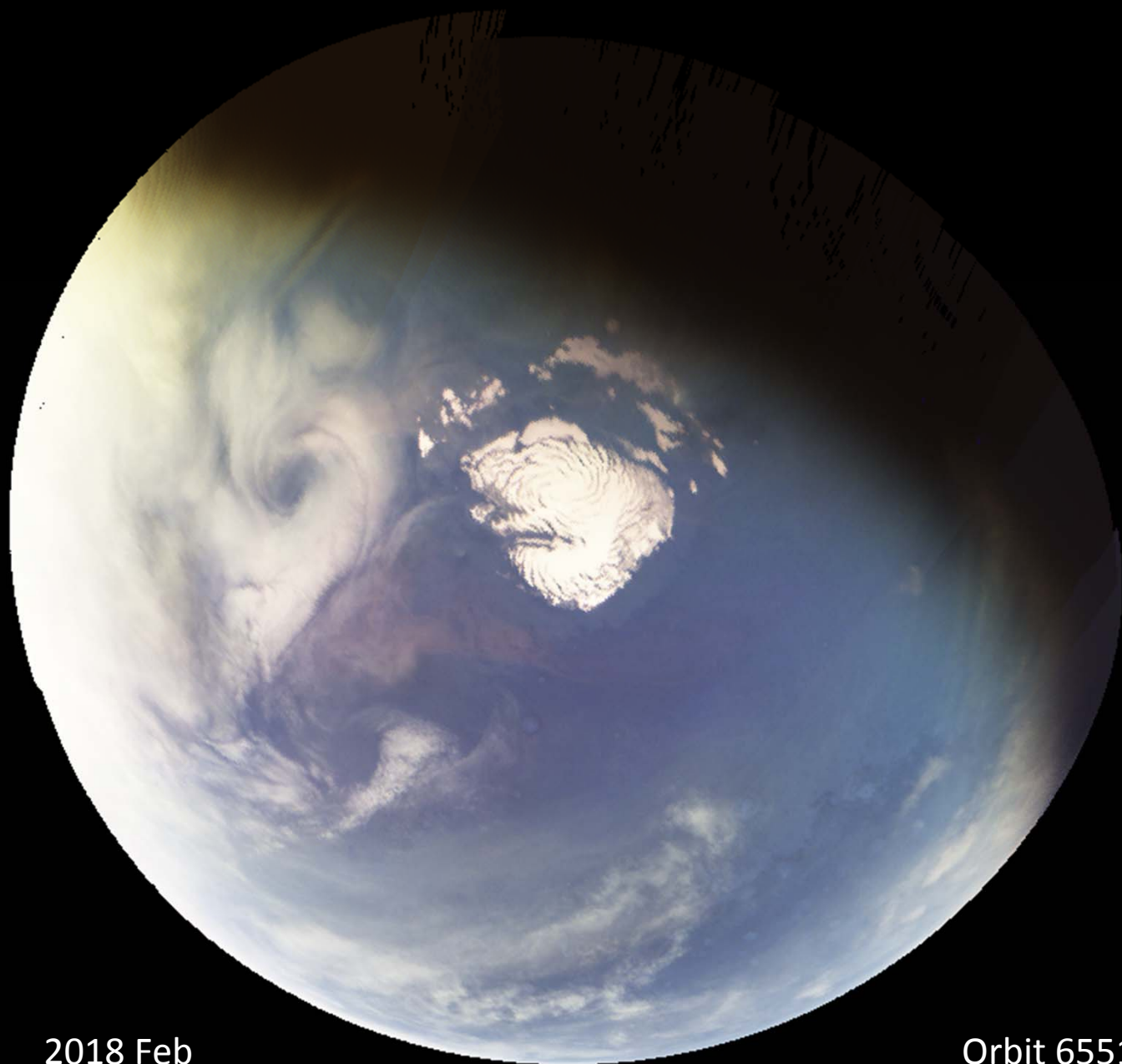
Mars Clouds as seen by MAVEN/IUVS





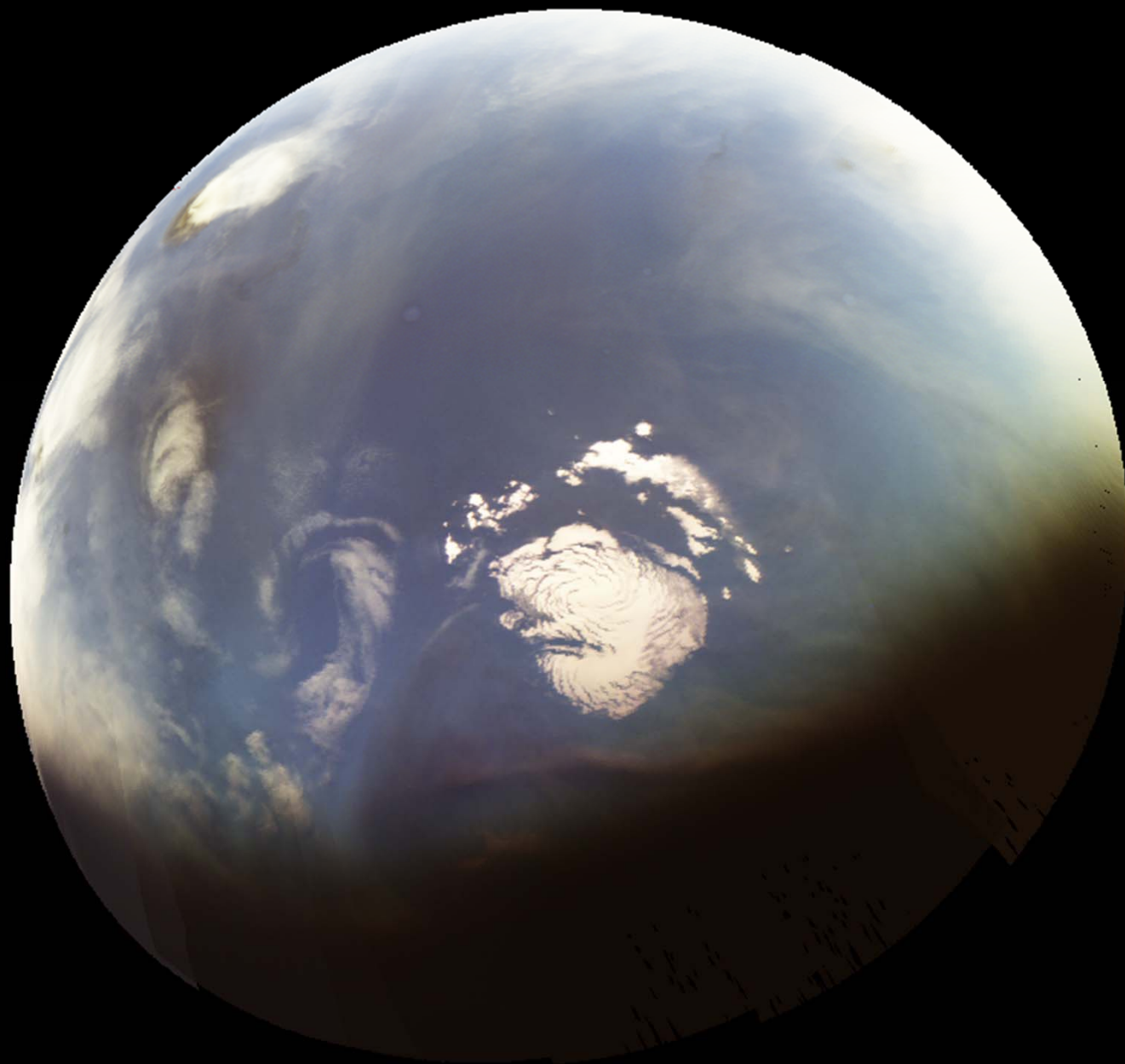
2018 Feb

Orbit 6550



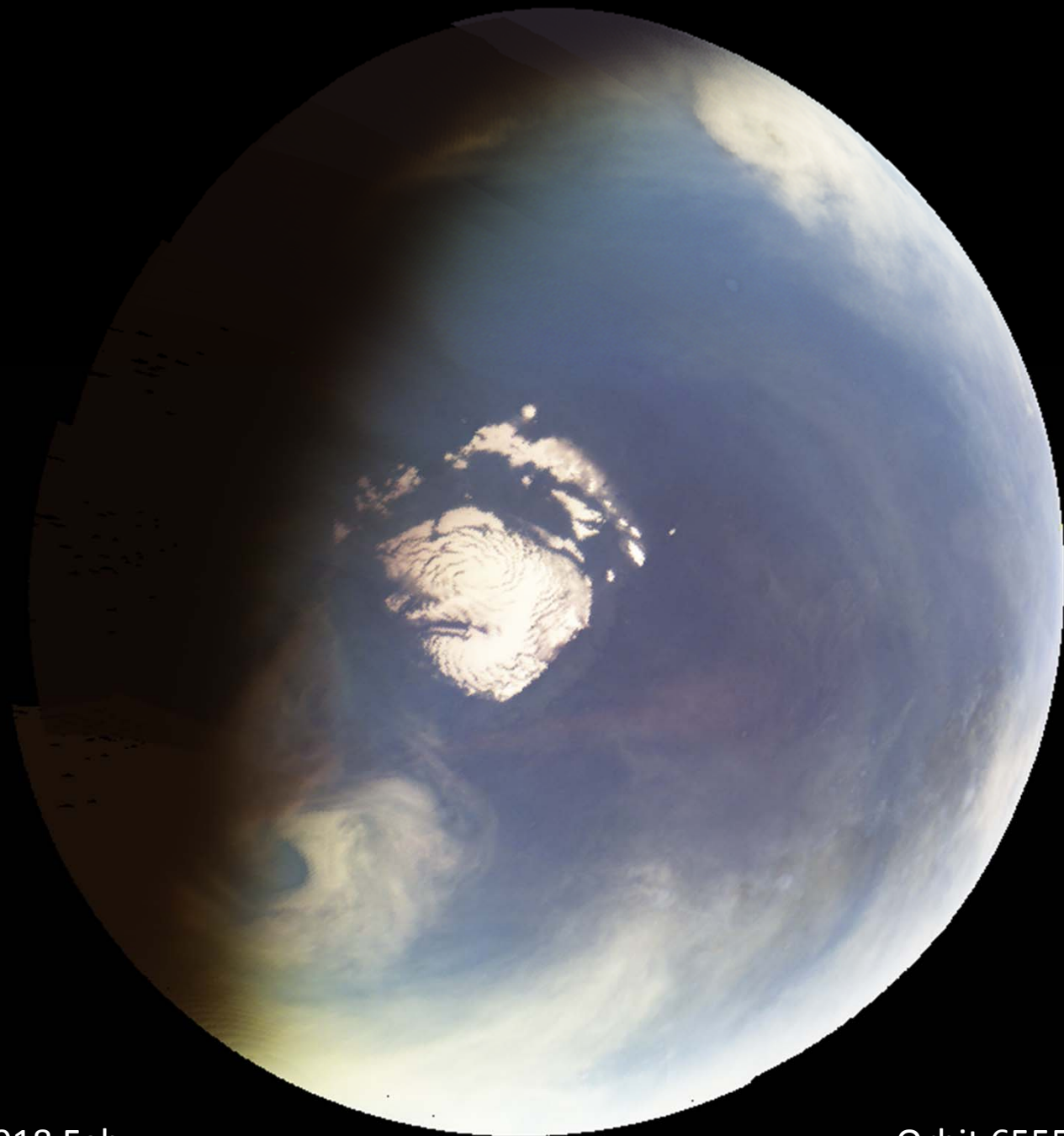
2018 Feb

Orbit 6551



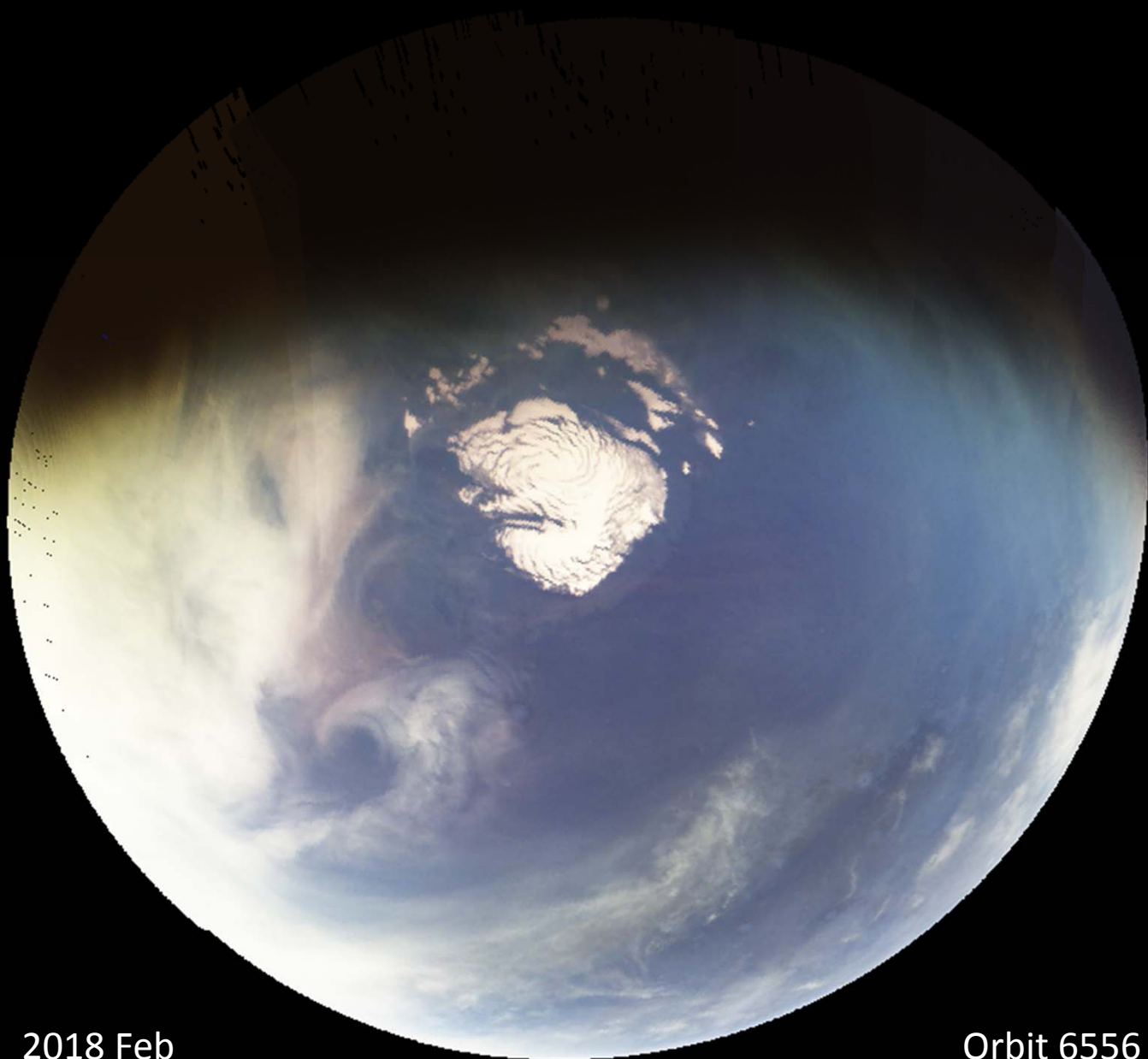
2018 Feb

Orbit 6553



2018 Feb

Orbit 6555



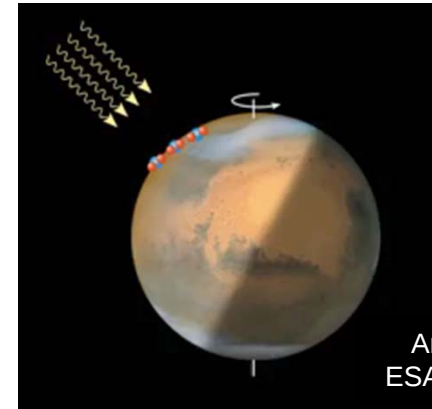
2018 Feb

Orbit 6556

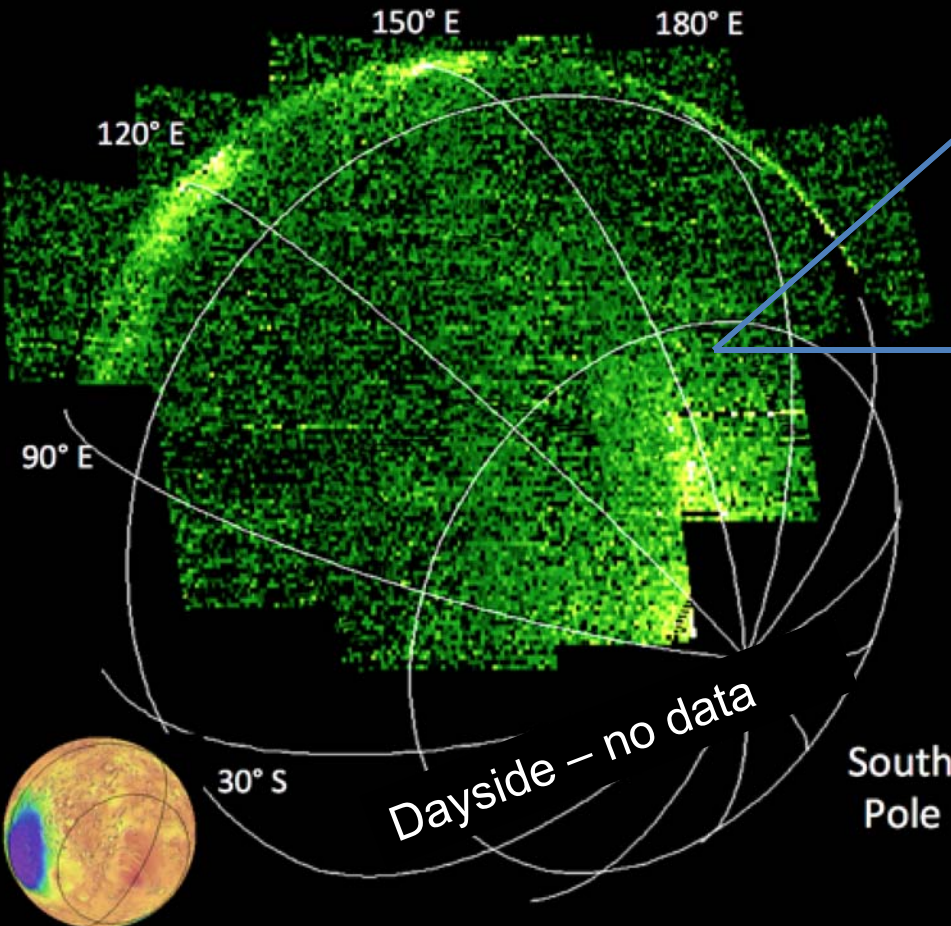
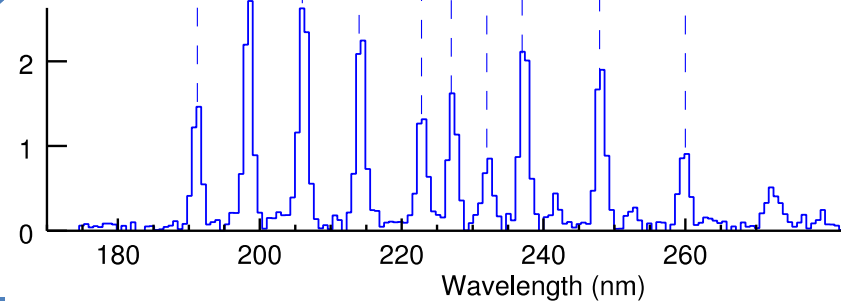
Mars Nitric Oxide Nightglow as

Reactants created on dayside, recombine and
light on nightside

Studied by SPICAM and OMEGA on Mars Ex



Animation credit:
ESA/Mars Express



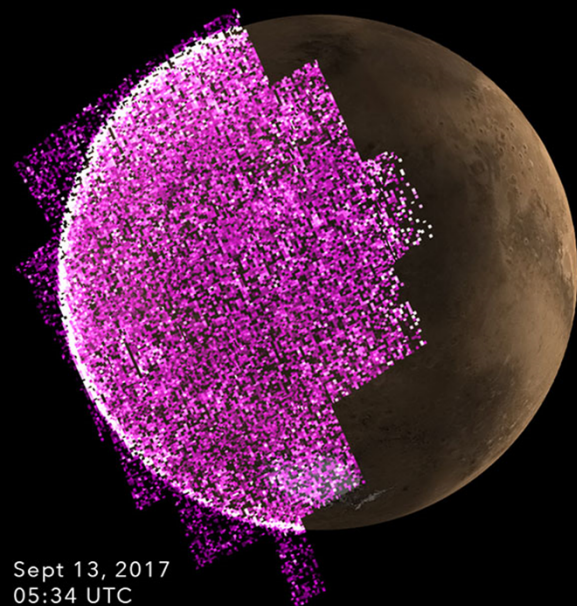
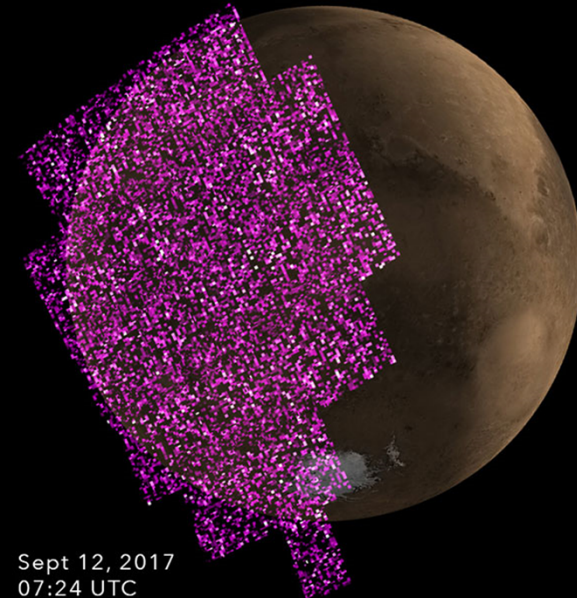
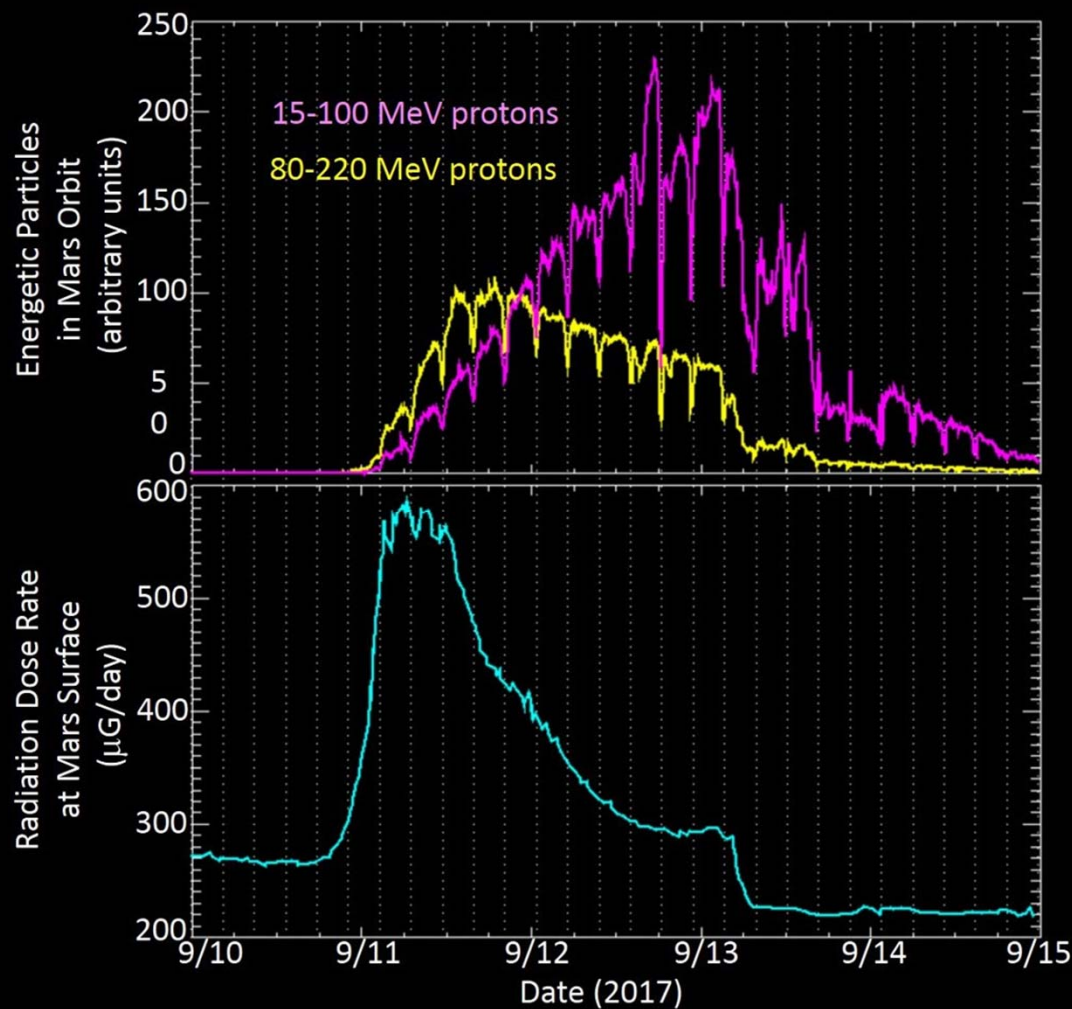
Nightglow: Results

The South Pole confirms GCM
predictions that air flows from the
summer pole to the winter pole

Plotches and streaks indicate
irregularities in global circulation

Modeling and analysis are underway

MAVEN's largest SEP event to date occurred last September



IUVS observed global aurora, spatial structures and trends are present, incl. B-field alignment

Conclusions & Invitations



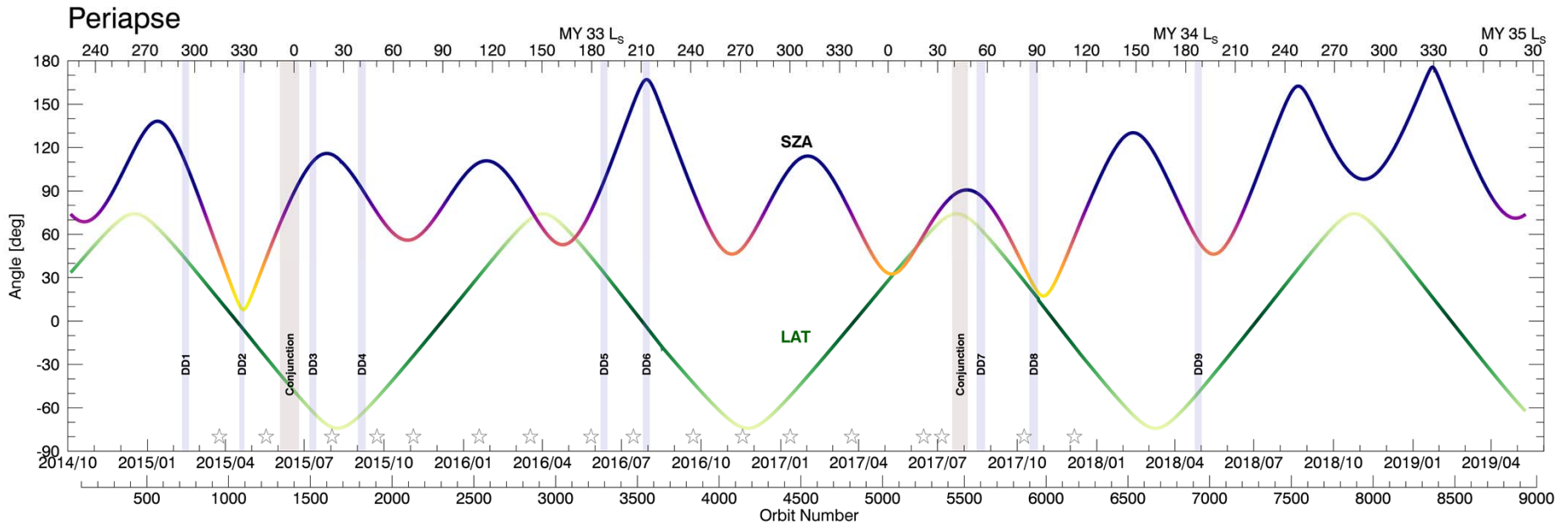
- MAVEN/IUVS has captured dozens of observable phenomena from the ground to the upper atmosphere and beyond
- The UV window excludes many important phenomena, so collaborations with other teams are a high priority
- Come visit us in Boulder, Colorado!

What's Ahead for MAVEN?



- Currently in Extended Mission 2 with more complete coverage of Mars seasons, solar activity, orbit geometry
- IUVS performing as well as at launch, operations aggressively enhanced over the mission
- MAVEN increasing its relay role as “router to the rovers” while still making observations
- Orbit will be lowered via aerobraking March-May 2019 near the equatorial dawn terminator
- Much more excellent science to come, especially in collaboration with TGO and EMM!

What's Ahead for MAVEN?



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