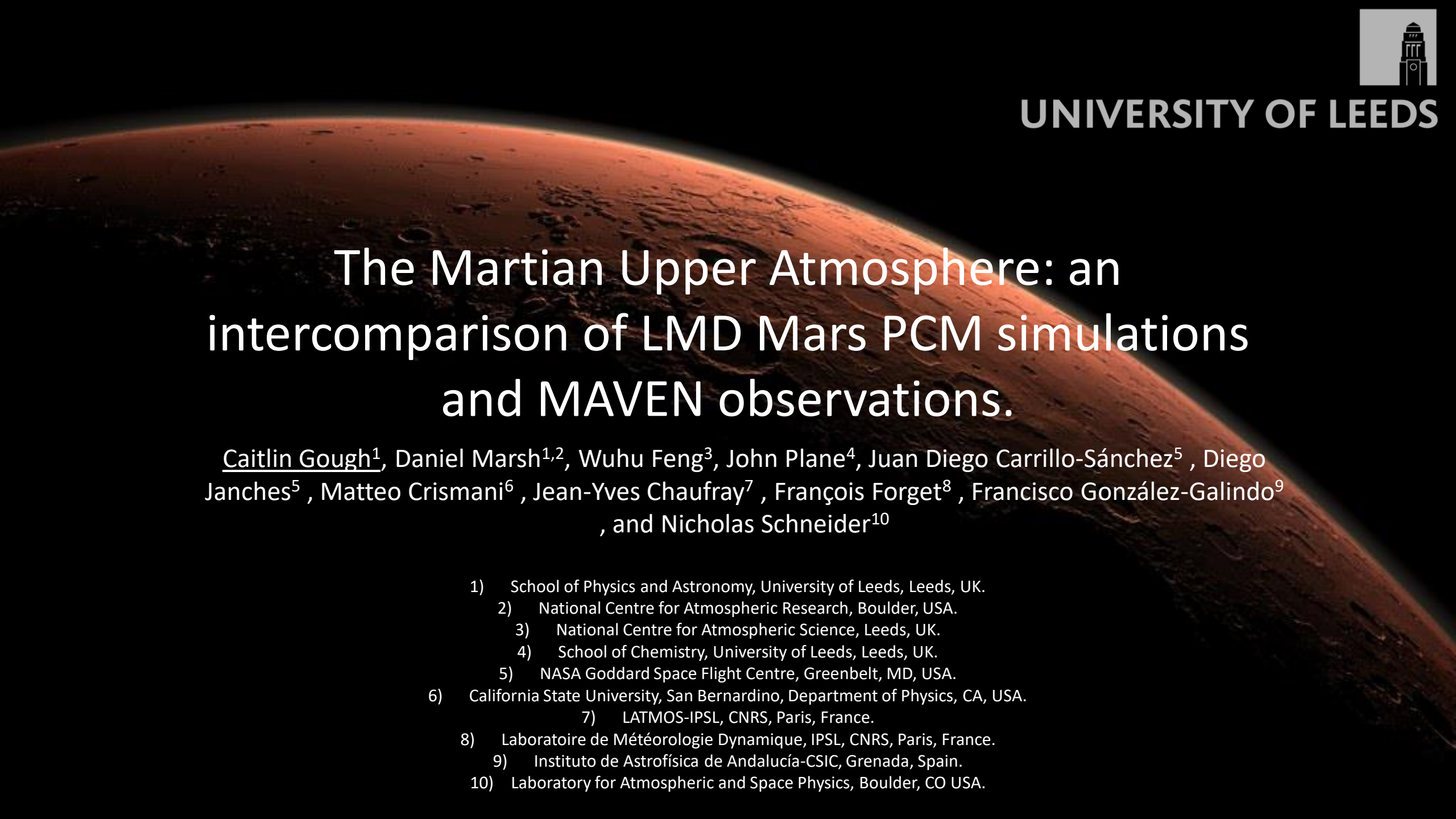

UNIVERSITY OF LEEDS

The Martian Upper Atmosphere: an intercomparison of LMD Mars PCM simulations and MAVEN observations.

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Motivation

- NASA's MAVEN (Mars Atmosphere and Volatile EvolutioN) satellite entered Mars' orbit in 2014.

- It was the mission dedicated to measuring the atmosphere of Mars.

- Before MAVEN only metallic species in the Earth's atmosphere could be directly measured.

- The Imaging Ultraviolet Spectrograph (IUVS) instrument has detected a persistent layer of Mg^+ in the Martian upper atmosphere.

- Mg^+ has a long lifetime due to its inability to undergo dissociative recombination reactions and hence it is an important tracer for dynamics in the upper atmosphere.

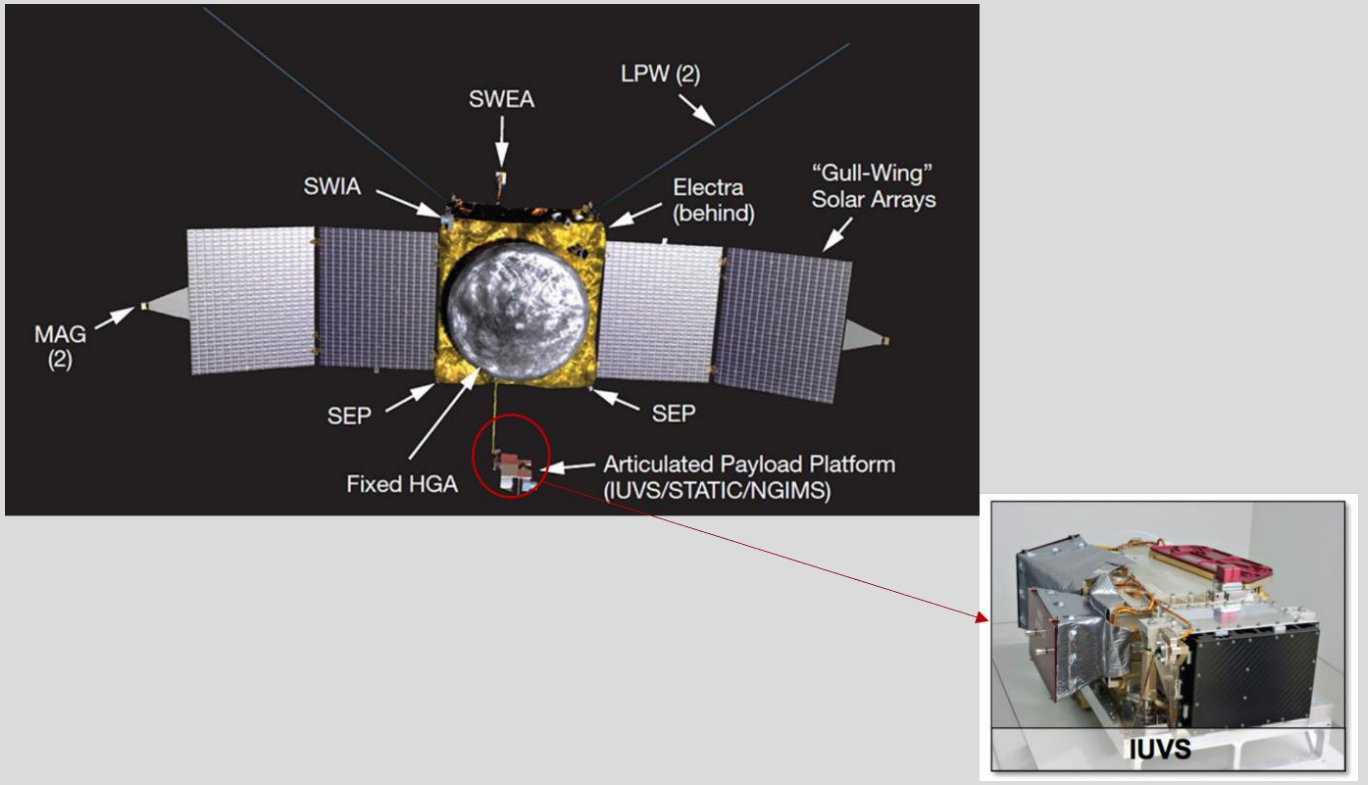


Figure modified from NASA's MAVEN Press Kit.

LMD Mars Global Circulation Model (LMD Mars PCM)

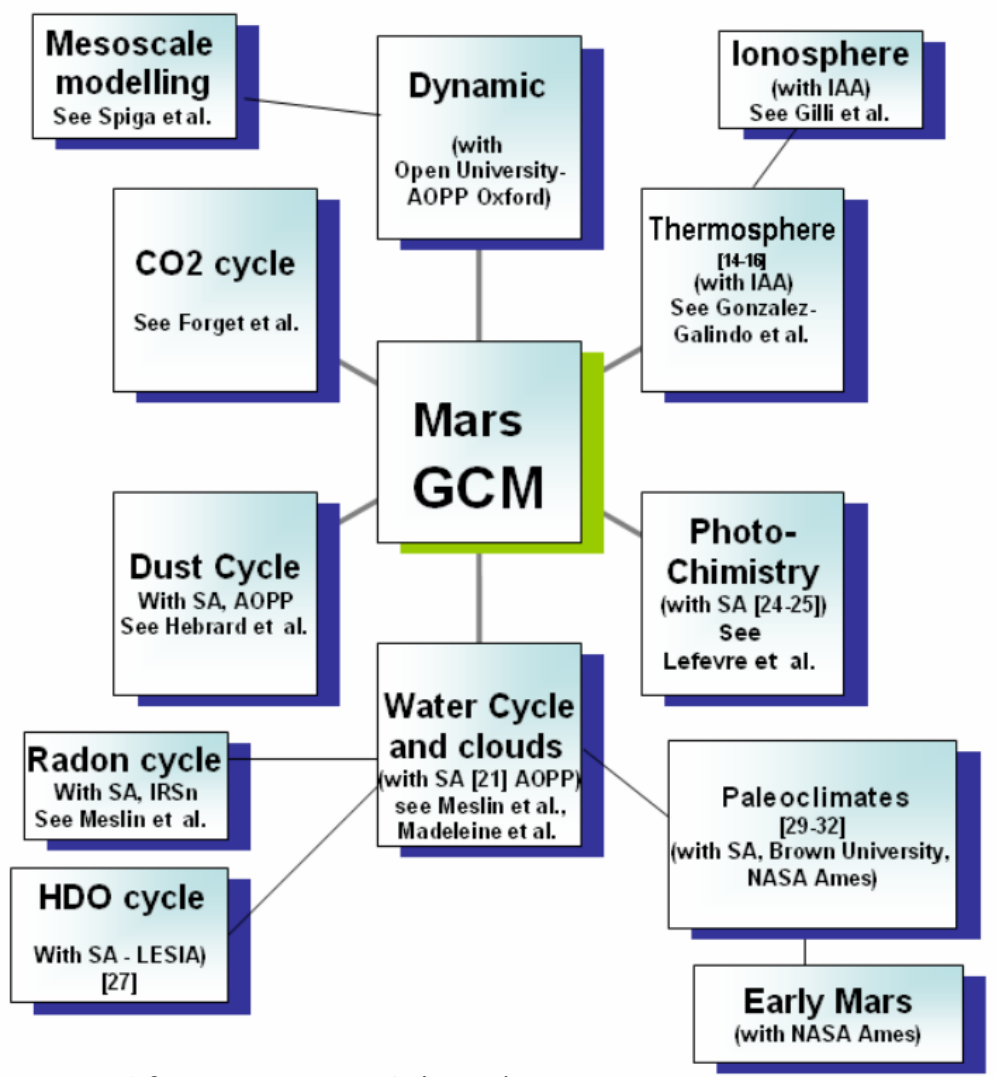


Figure copied from Forget et al. (2008).

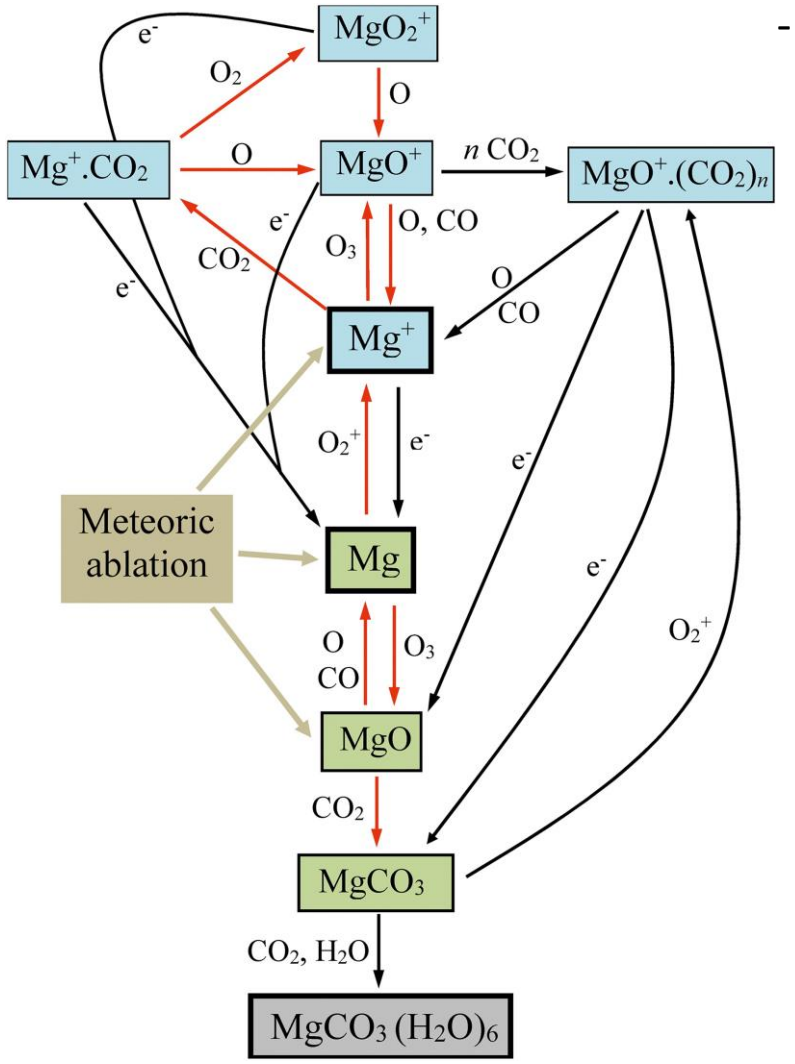
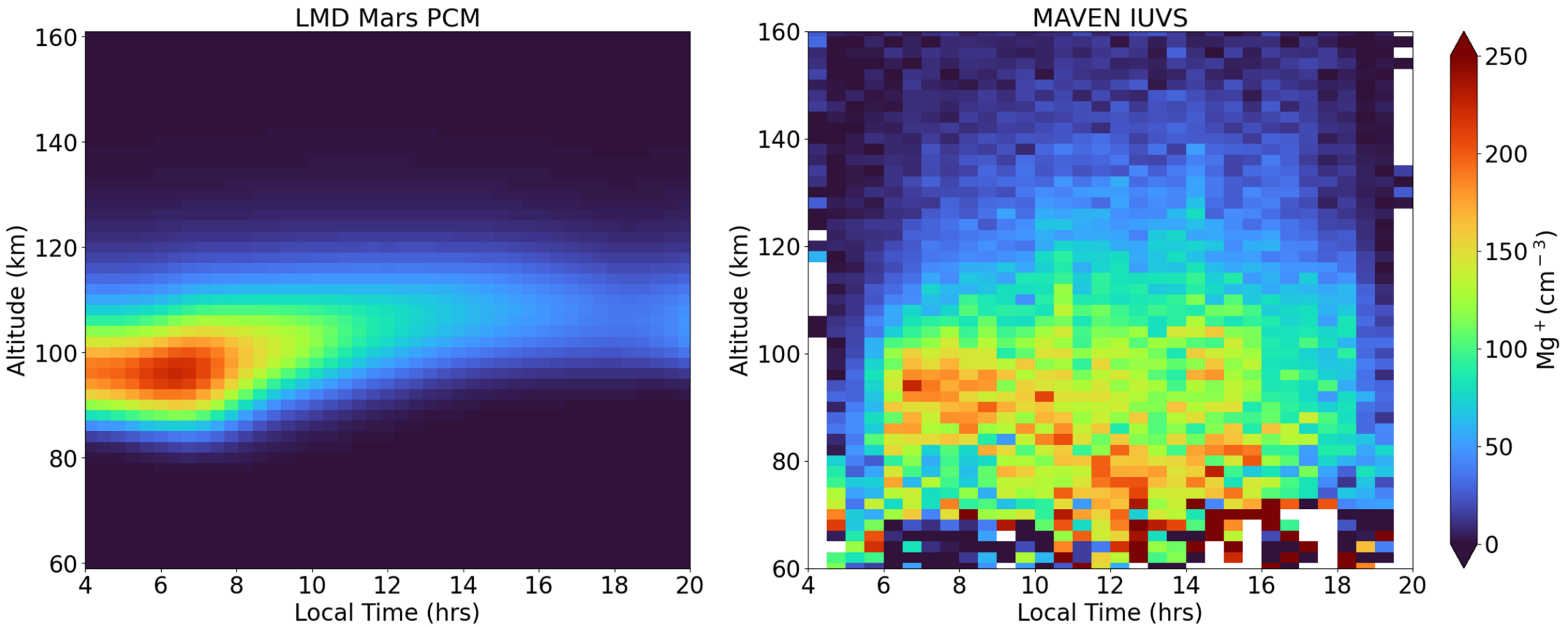


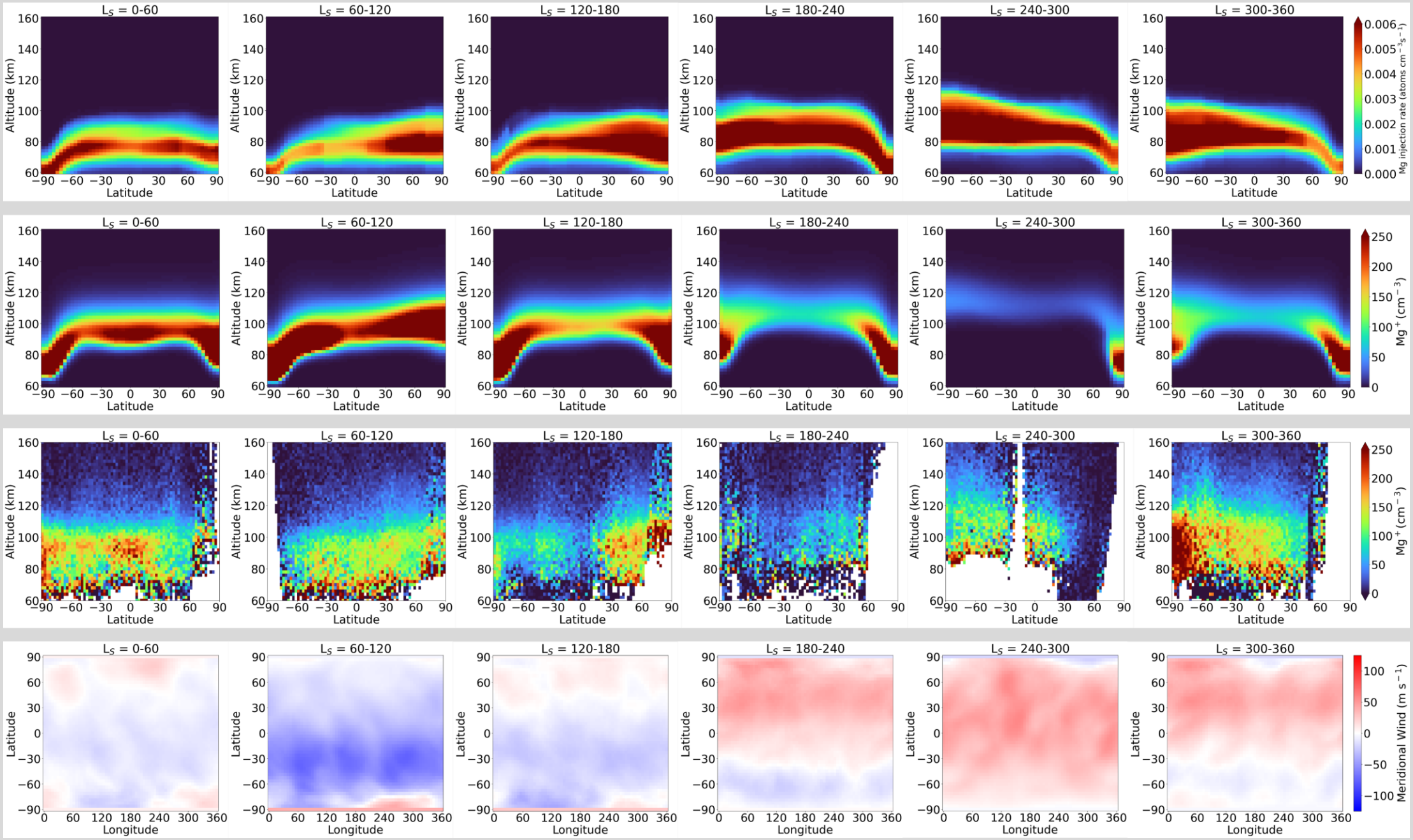
Figure copied from Plane et al. (2018).

- Meteor Input Function (MIF) simulates input of Mg via meteoric ablation.
- Chemical scheme involves 7 neutral and 8 ionised Mg species resulting in 42 reactions.

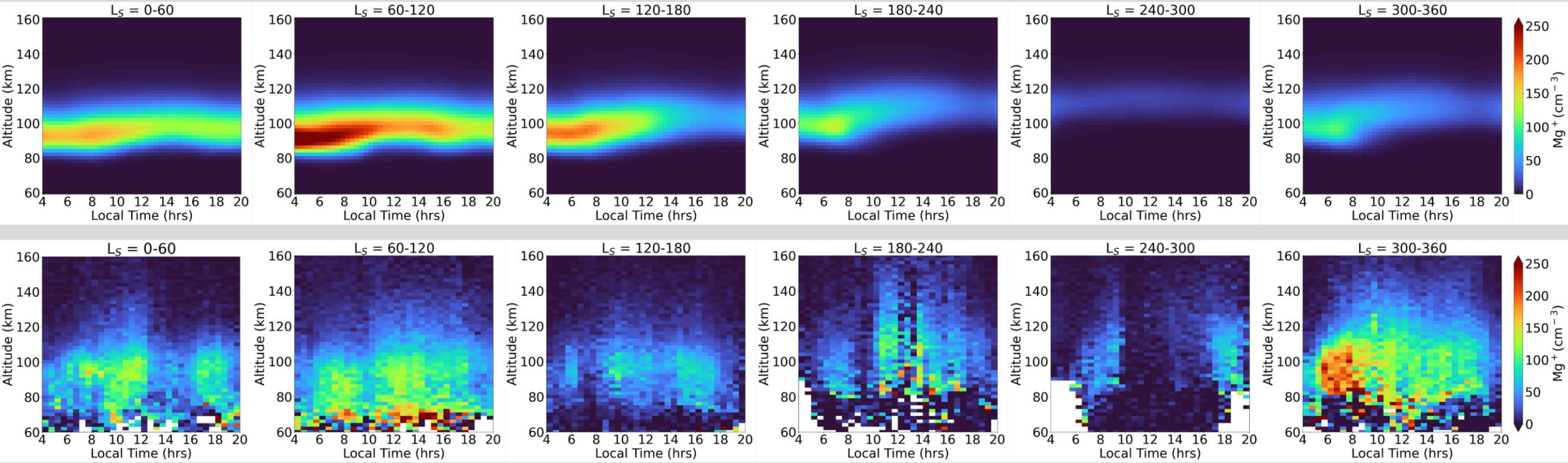
Diurnal Variability of Mg^+

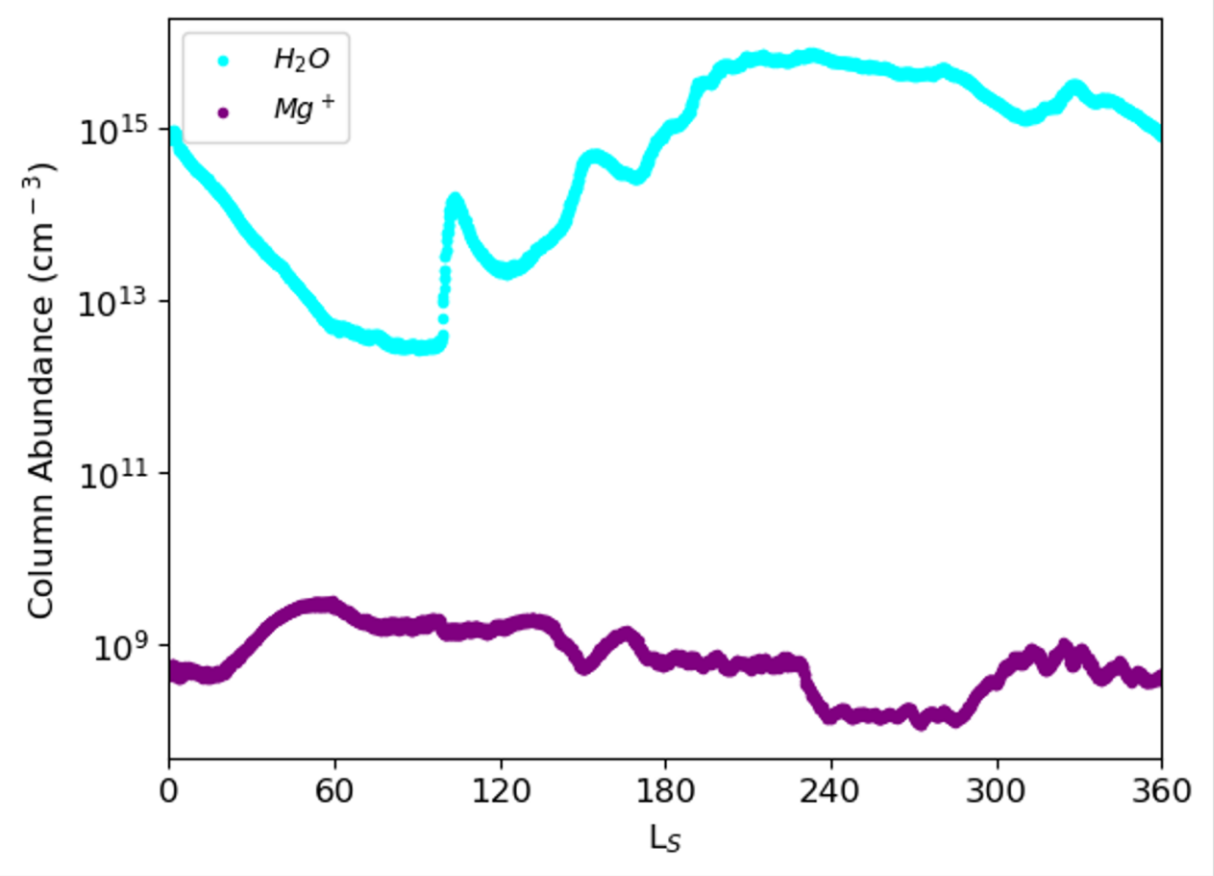


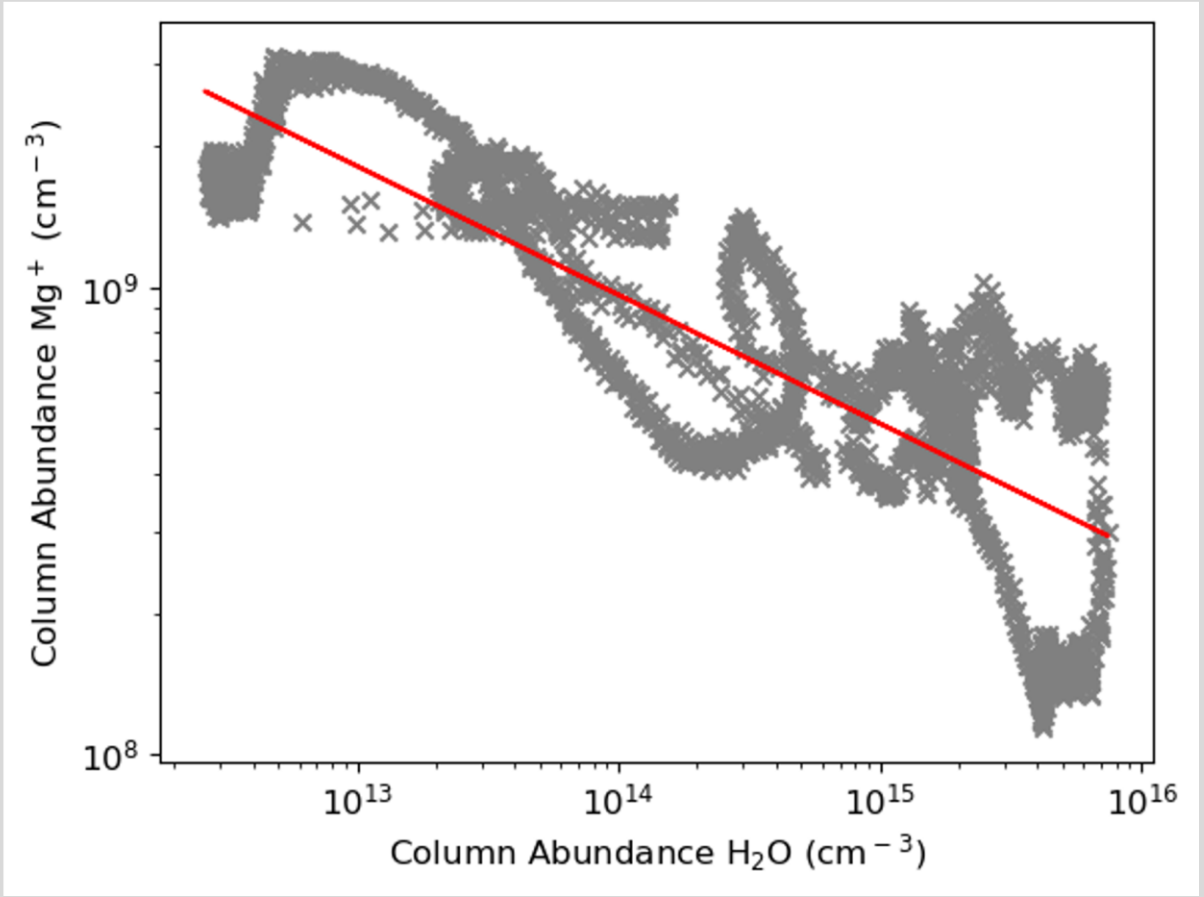
Latitudinal Variability of Mg^+



Seasonal Variability of Mg^+




H_2O
Mg^+
Column Abundance (cm^{-3})
10^{15}
10^{13}
10^{11}
10^{9}
0
60
120
180
240
300
360
L_S

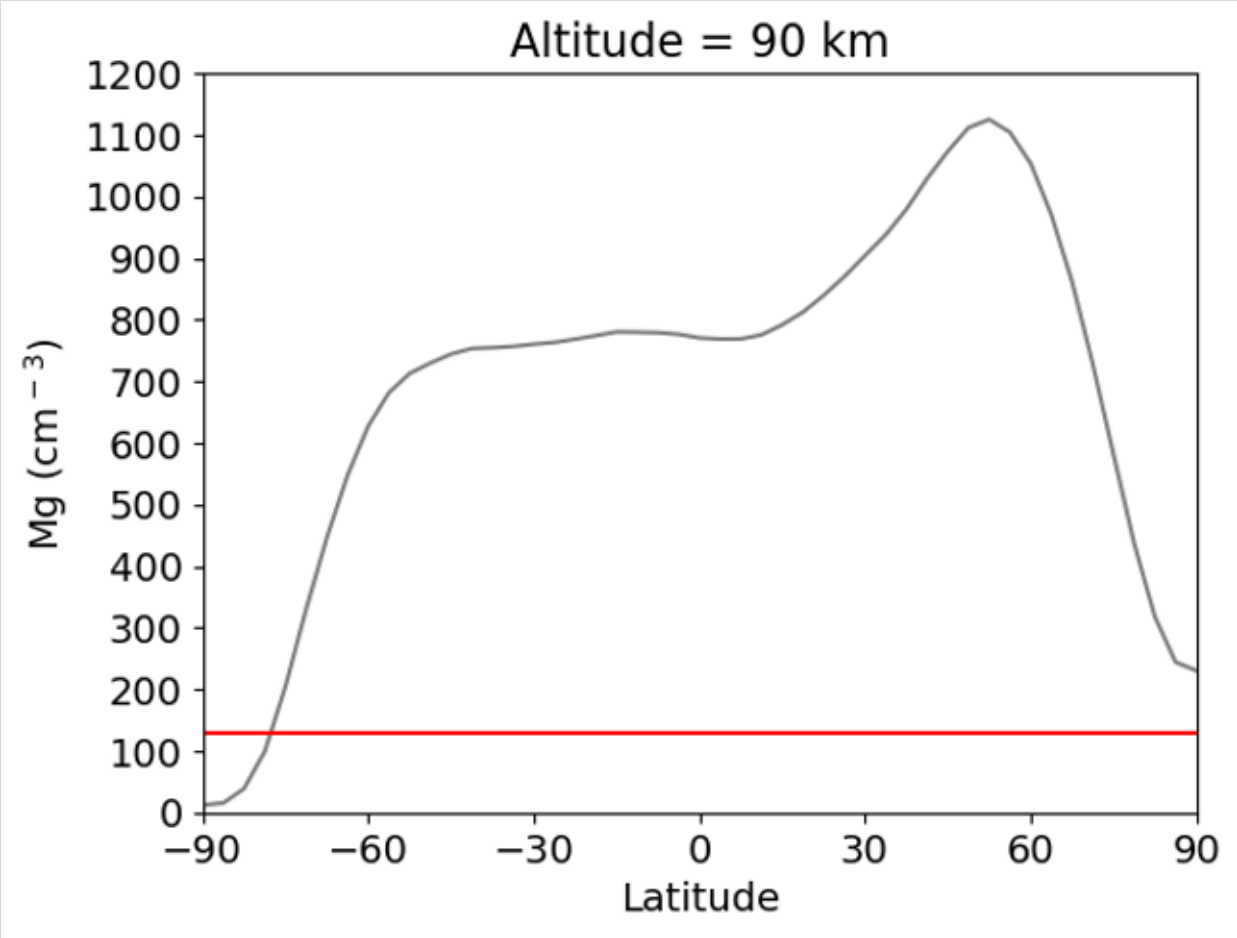

Column Abundance Mg^+ (cm^{-3})
10^{9}
10^{8}
10^{13}
10^{14}
10^{15}
10^{16}
Column Abundance H_2O (cm^{-3})

Conclusion

- MAVEN has been measuring Mg^+ in the Martian upper atmosphere since 2014.
- The long lifetime of Mg^+ means it is an important dynamical tracer.
- The diurnal cycle peaks at ~6:00 is due to the downward transport of air during the night.
- The latitudinal variability is determined by both the Meteoric Input Function (MIF) and meridional winds.
- Seasonal variations in atmospheric temperature alter the altitude at which meteoric ablation occurs, altering the height of the Mg^+ layer throughout the year.
- The higher temperatures around perihelion reduce Mg^+ in the southern hemisphere summer due to the evaporation of surface water ice increasing the abundance of atmospheric water vapour and hence the rate of conversion of Mg^+ to $MgCO_3(H_2O)_6$.

Future Work

- Explore the absence of an observable neutral Mg layer.
- Include the other ablated metals (Na, Fe, and Si).
- Model the close passing of comet Siding Spring (C/2013 A1) in October 2014.
- Investigate the observed sporadic metal layers in the upper atmosphere - Grebowsky *et al.* (2017).



Thanks for listening!

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