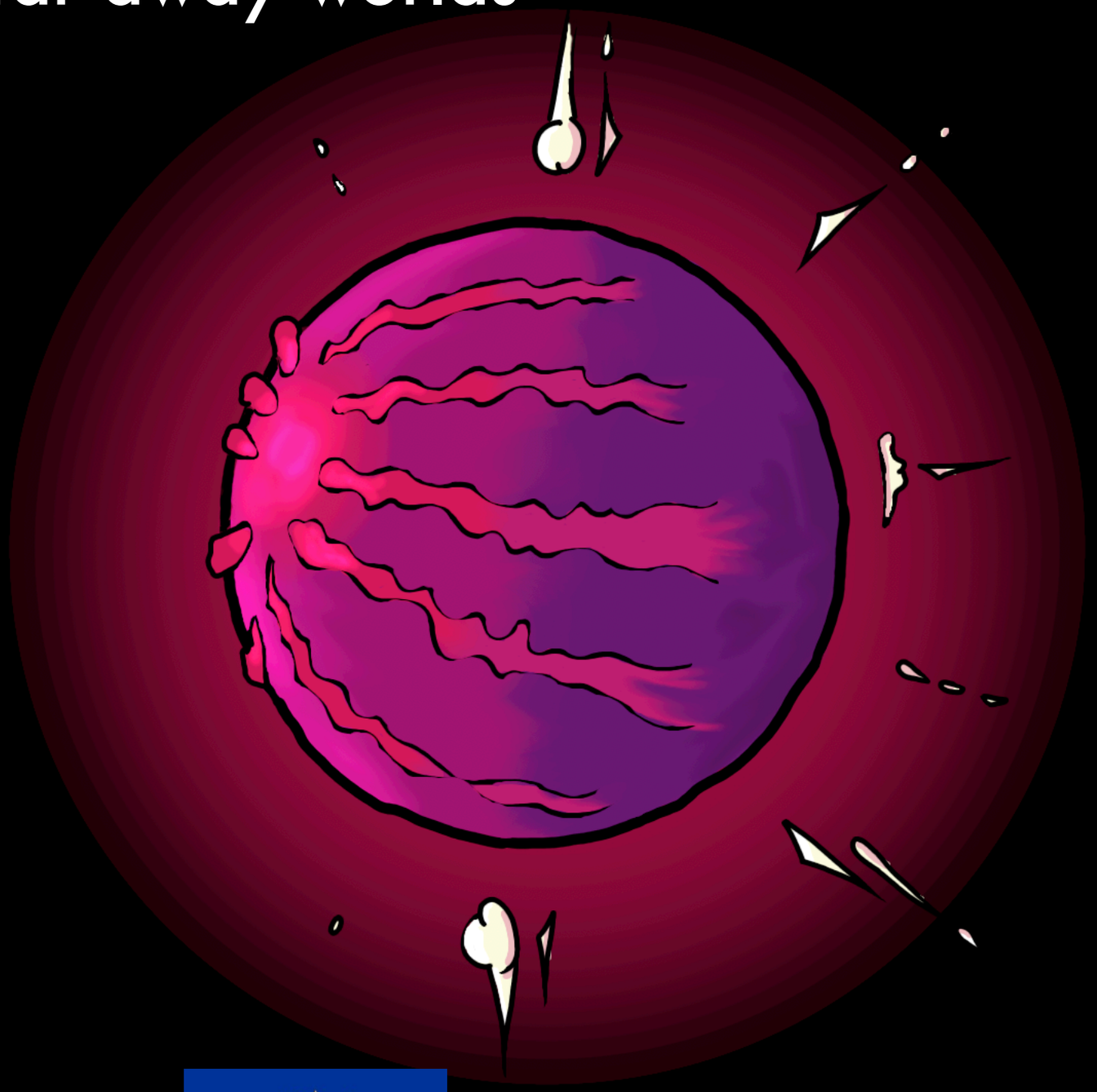
Exoplanet meteorology?
Studying wind dynamics of far away worlds



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Physikerinnentagung 2020

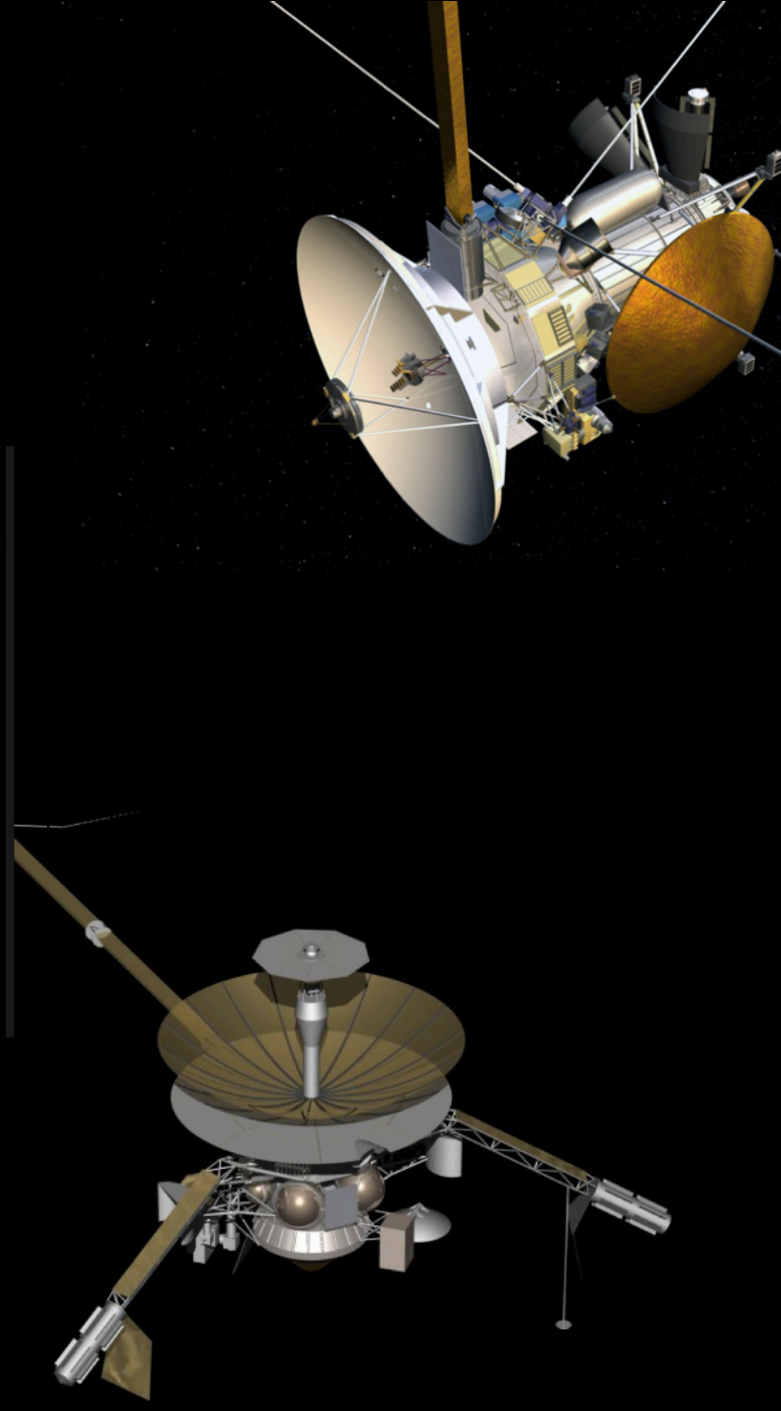
UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département d'astronomie

erc

PlanetS

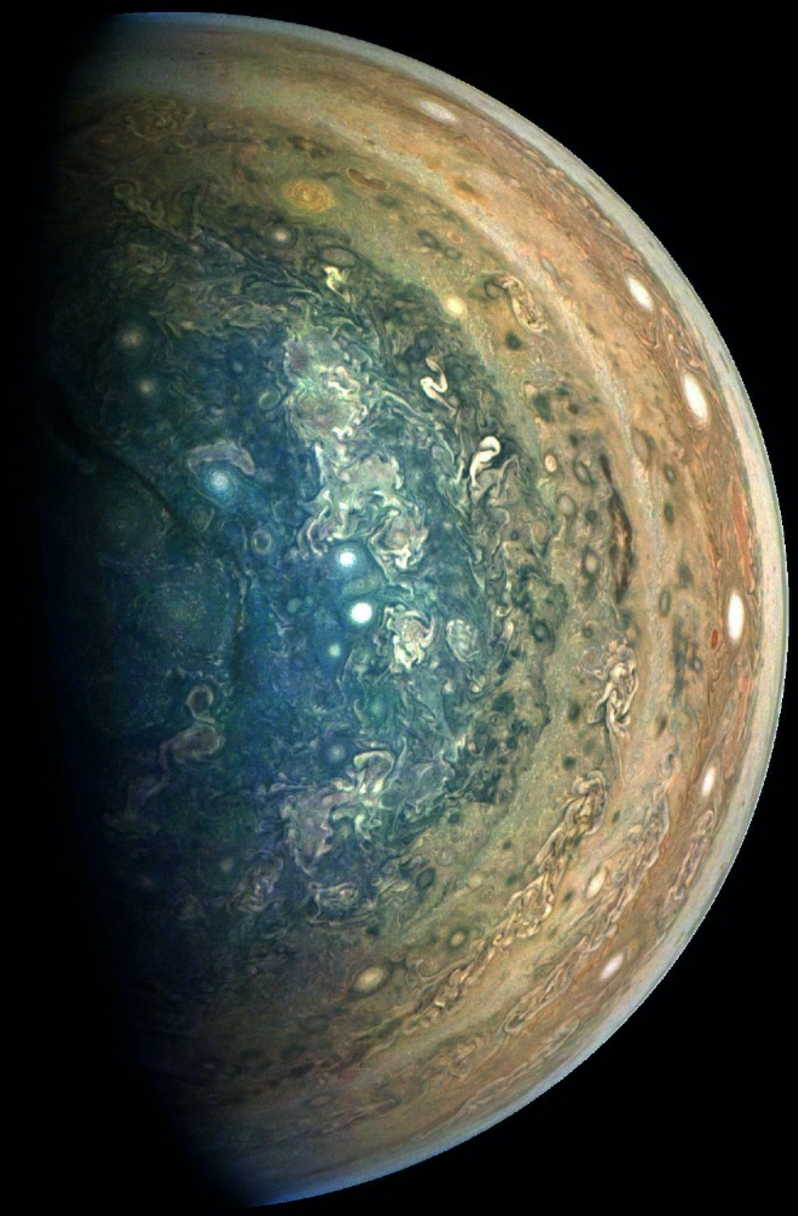
Jupiter

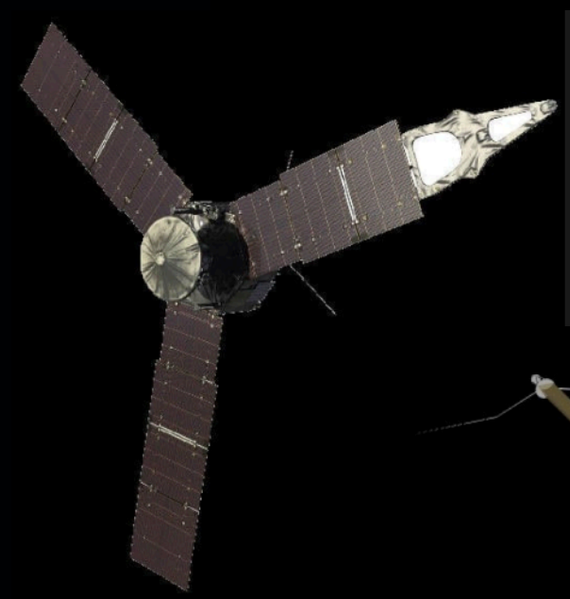
Jupiter

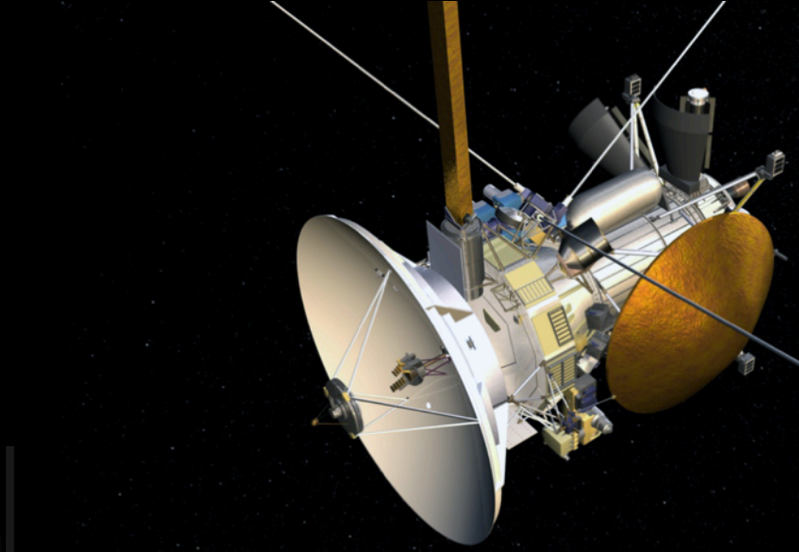


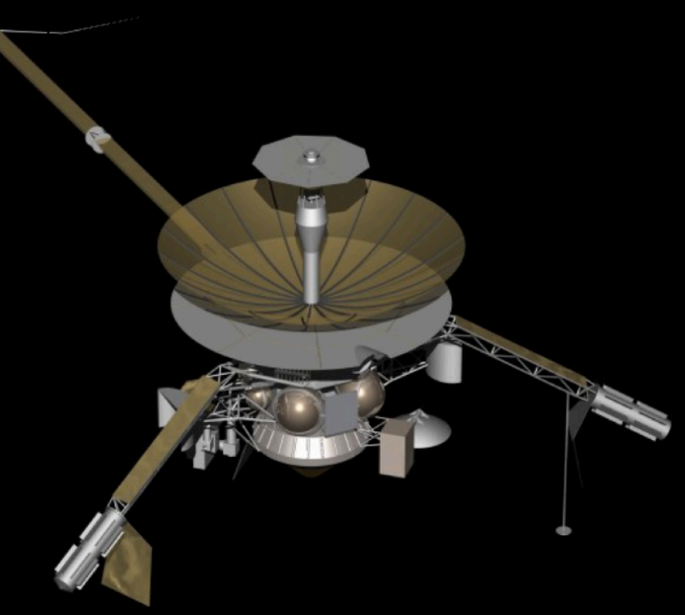
@NASA

Jupiter









@NASA

Distances

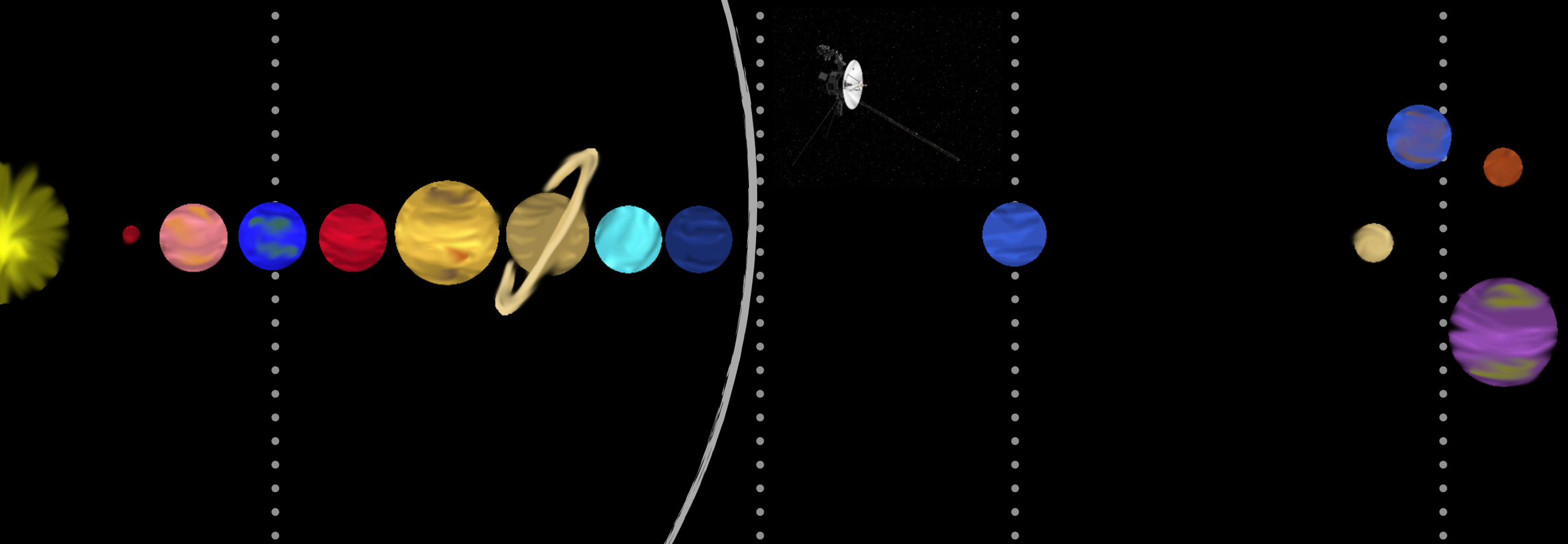
Sunlight travel time:

8 min

140 hours

4 years

50 - 3000 years



Edge of the solar system

Proxima Centauri b

Most known exoplanets

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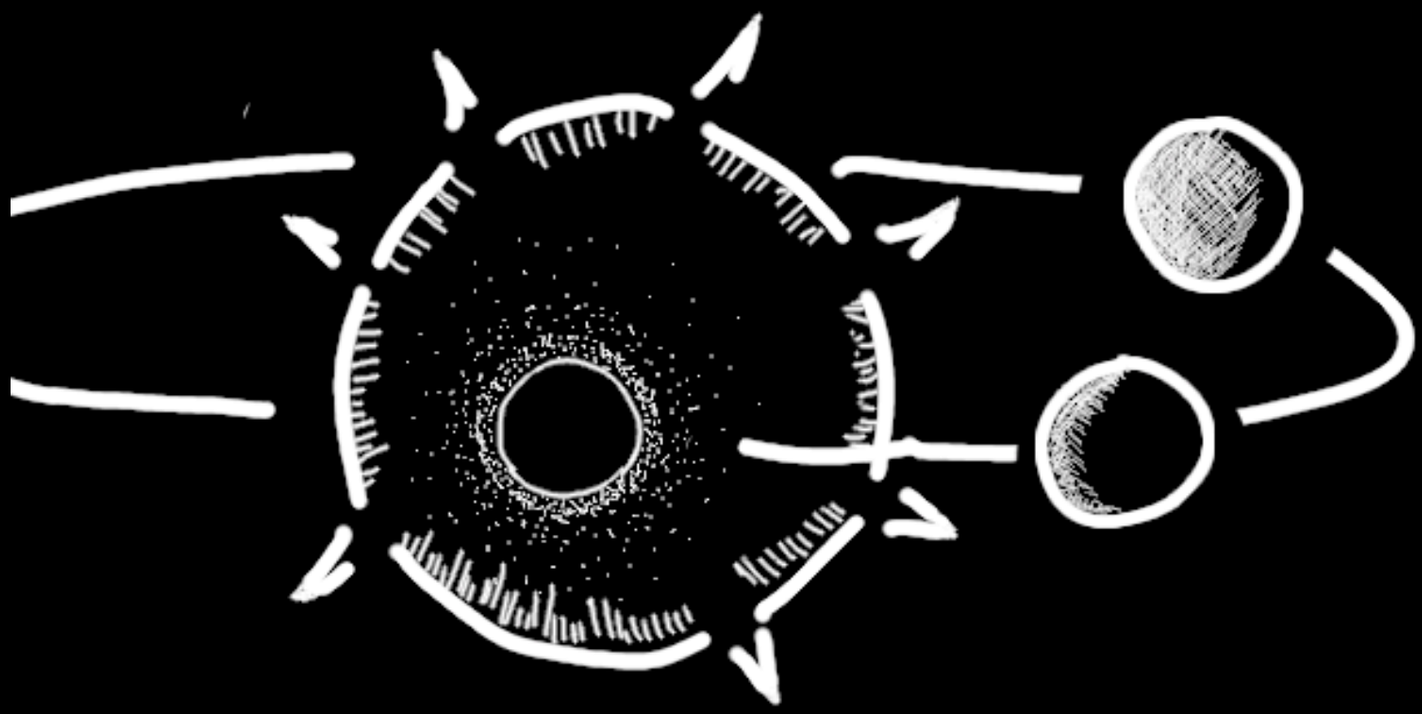
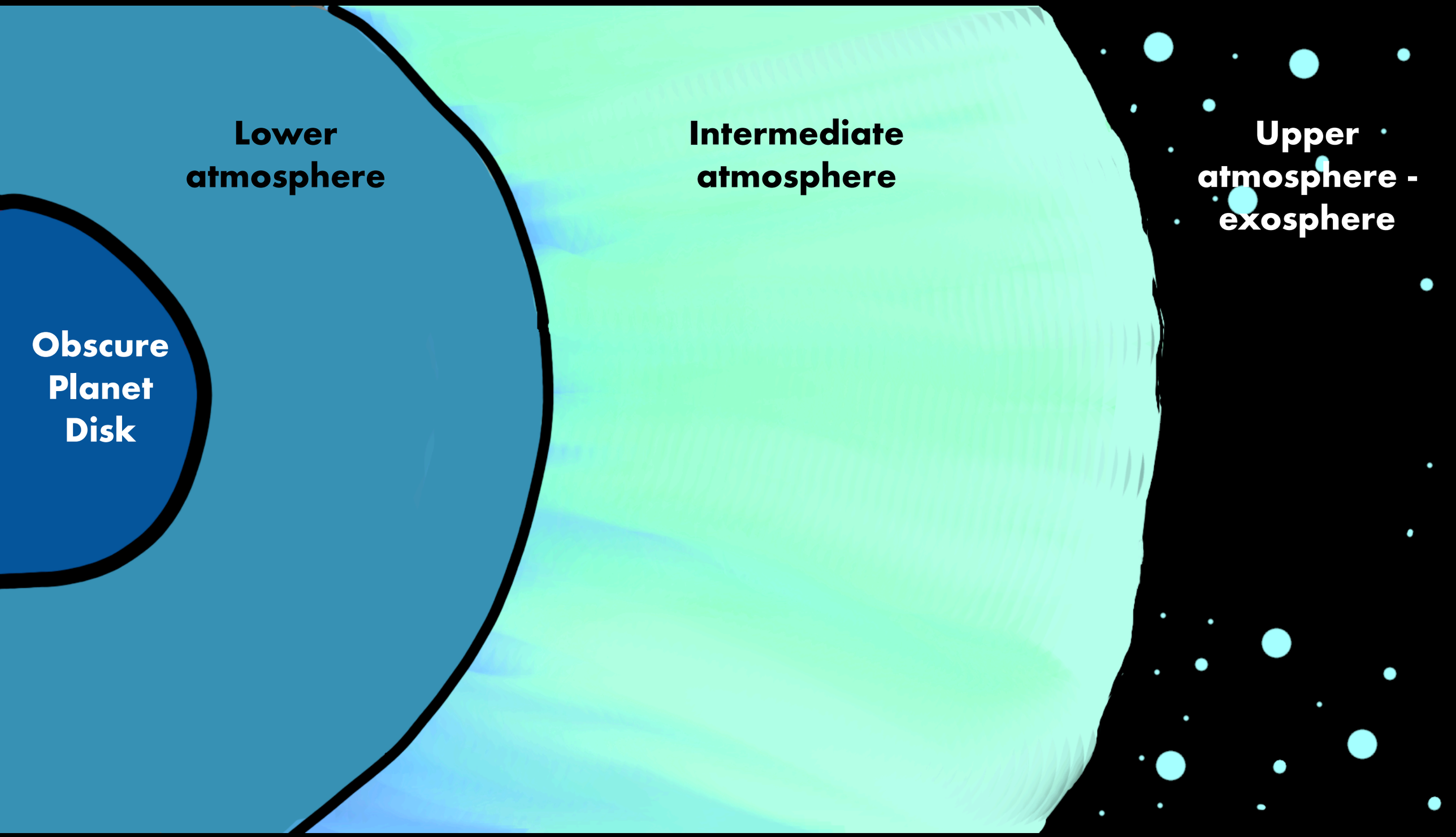
So how can we learn something about the winds on these planets?





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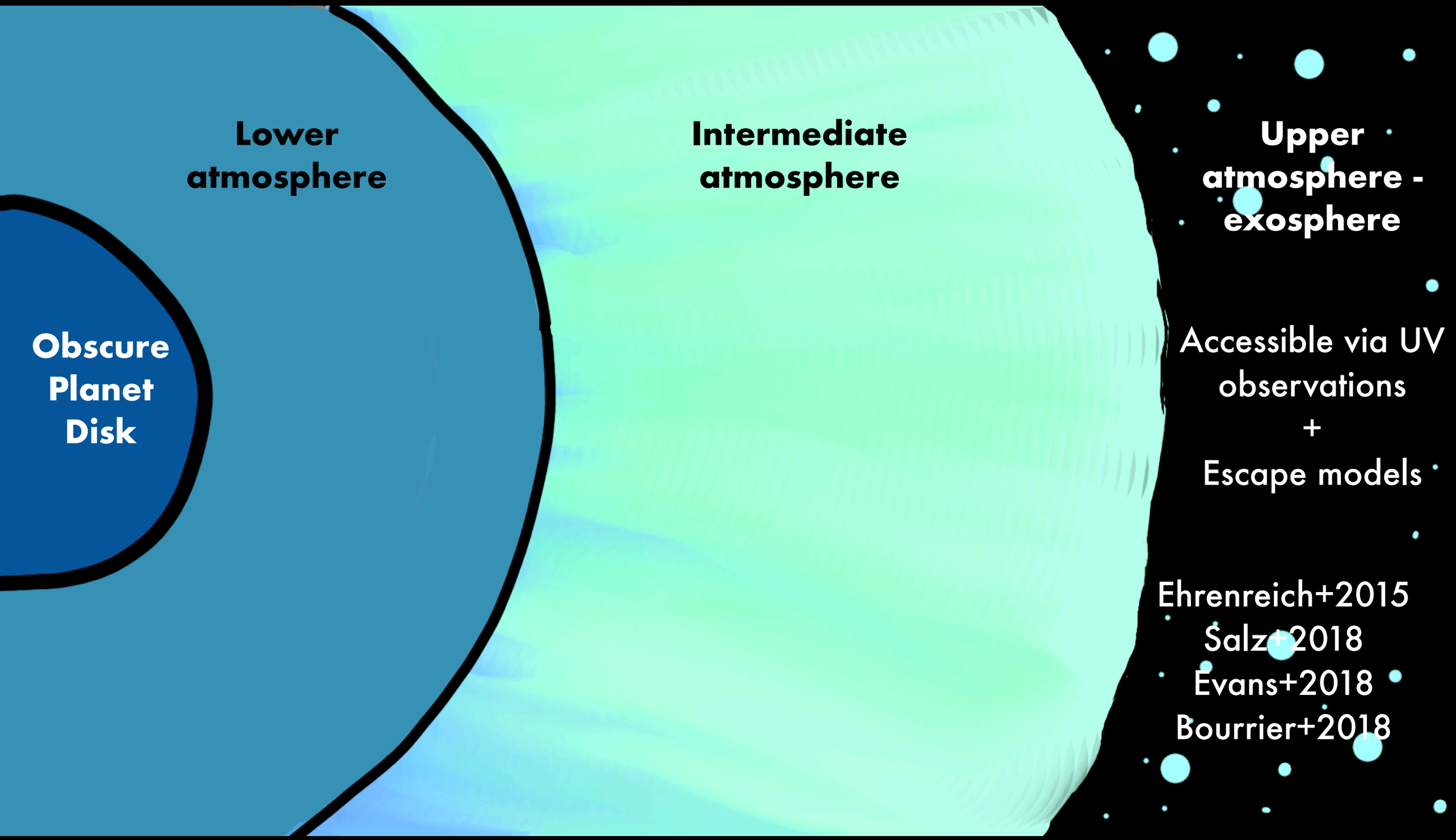
Lower atmosphere
Intermediate atmosphere
Upper atmosphere - exosphere
Obscure Planet Disk
Accessible via UV observations
+
Escape models
Ehrenreich+2015
Salz+2018
Evans+2018
Bourrier+2018

Lower atmosphere

Obscure Planet Disk

Accessible via phase curves + GCMs

Showman+2009
Parmentier+2013,18
Steinrueck+2019

Intermediate atmosphere

Upper atmosphere - exosphere

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Ehrenreich+2015
Salz+2018
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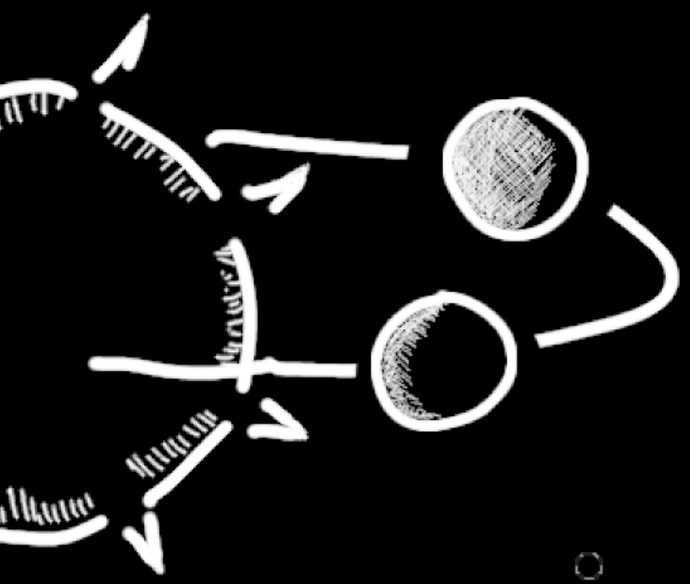
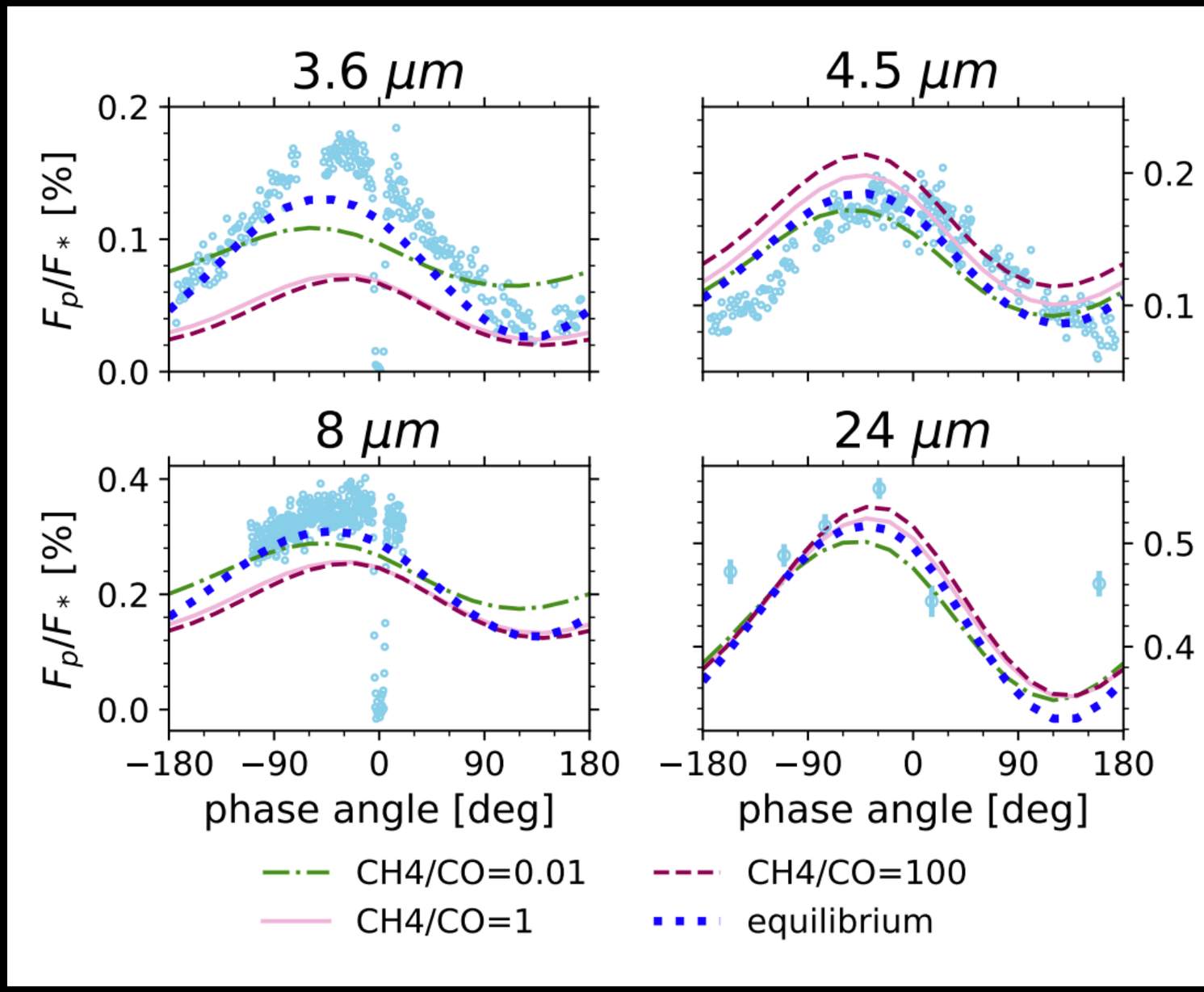
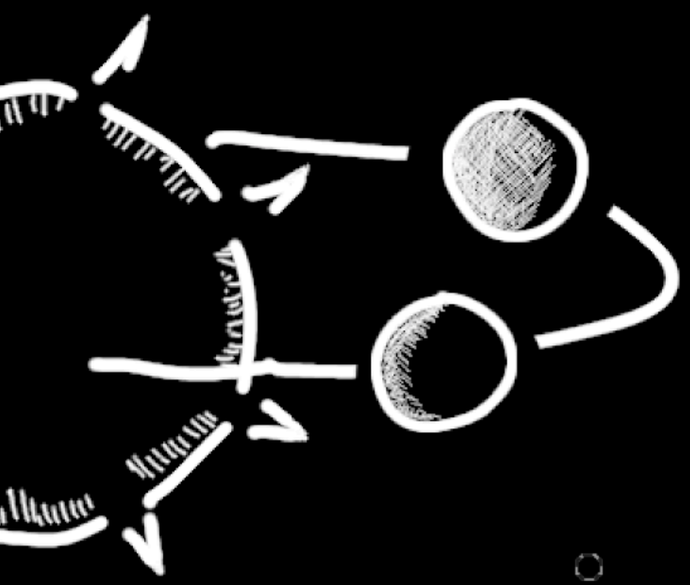
Lower atmosphere
Phase curves

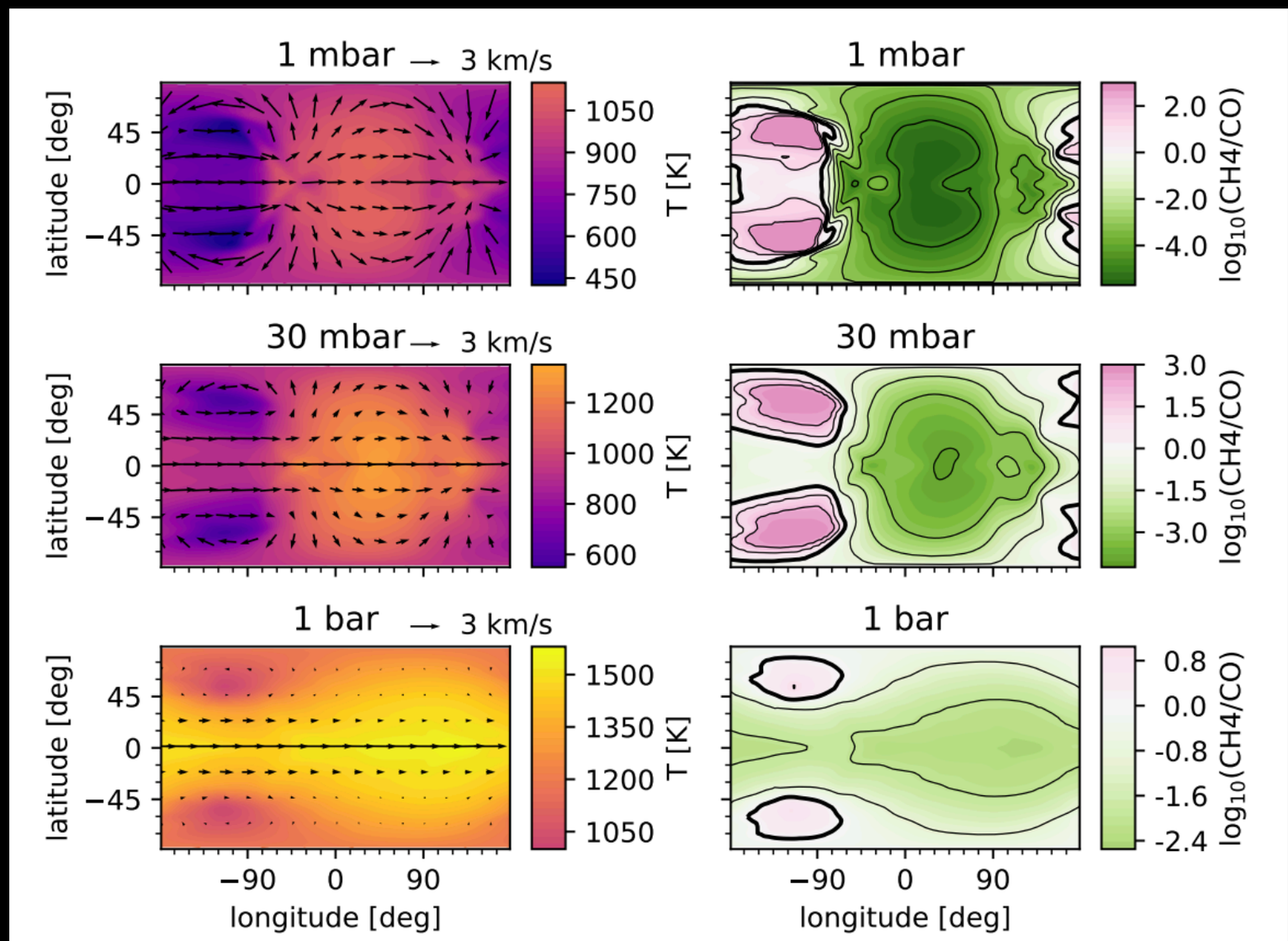




Steinrueck et al. 2019
Arcangeli et al. 2019

Lower atmosphere
Global Circulation Models





Steinrueck et al. 2019
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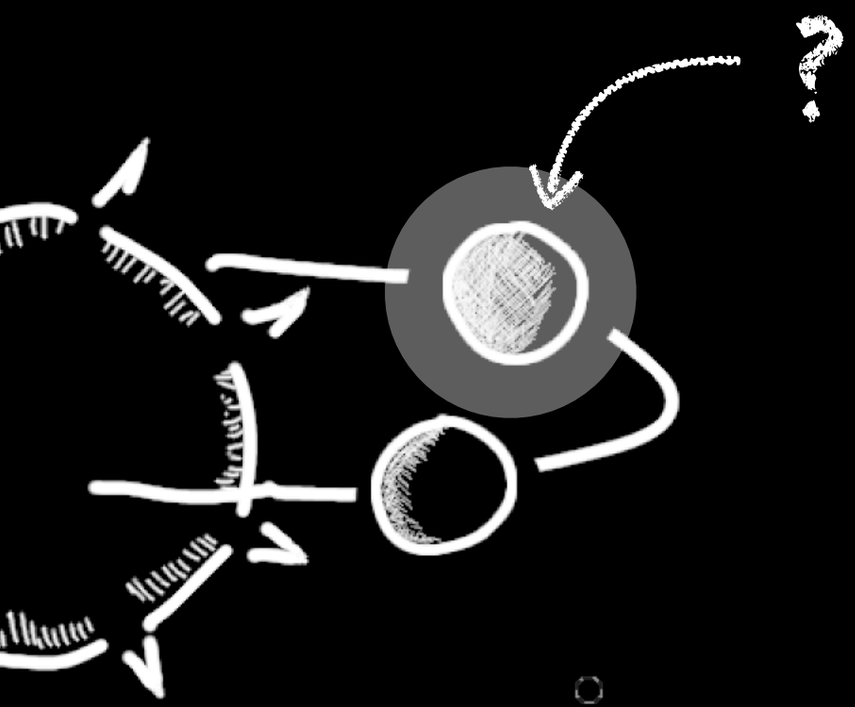
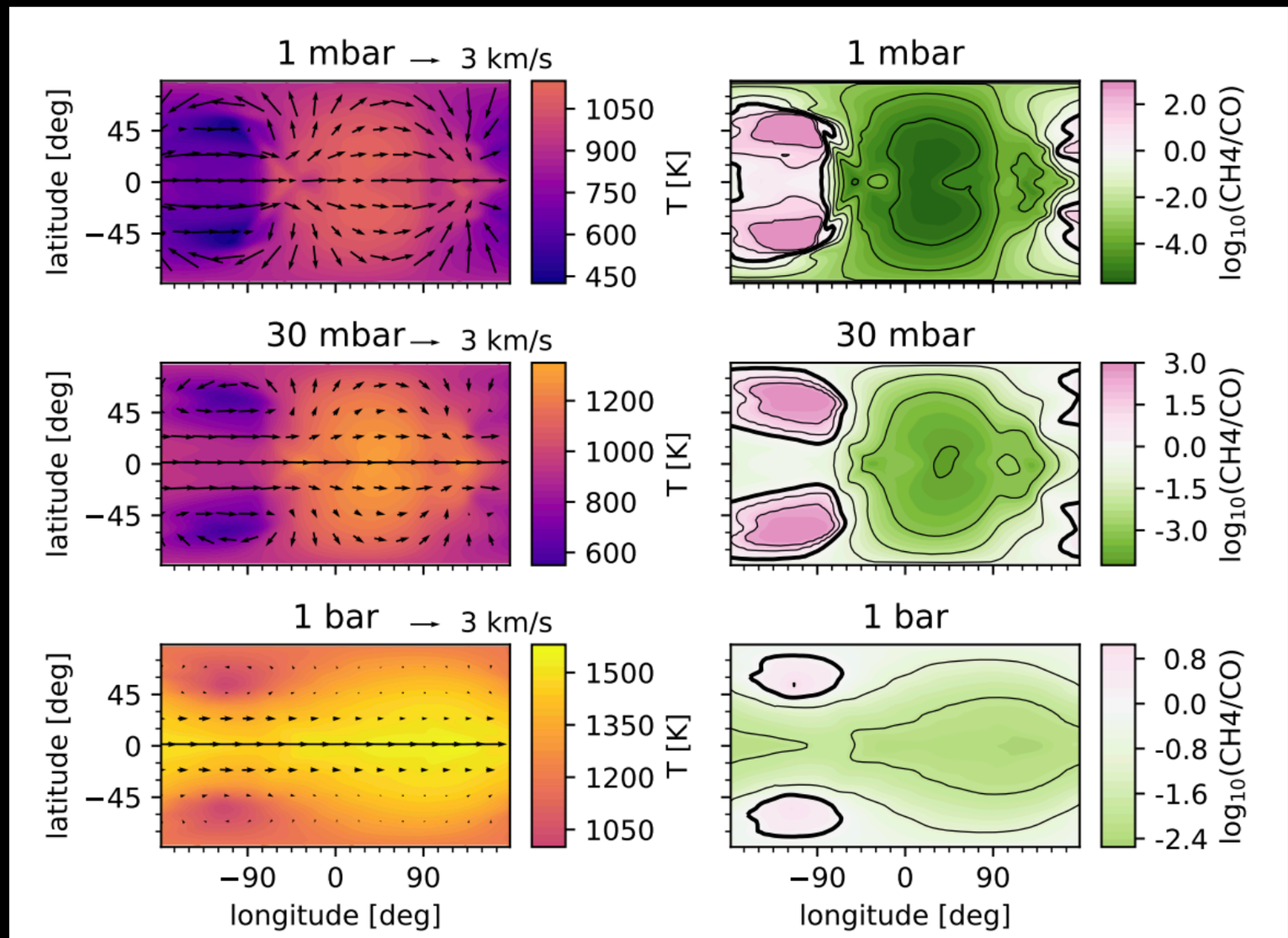
Lower atmosphere
Global Circulation Models





Steinrueck et al. 2019
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Lower atmosphere

Obscure Planet Disk

Accessible via phase curves + GCMs

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Lower atmosphere

Obscure Planet Disk

Accessible via phase curves + GCMs

Showman+2009
Parmentier+2013,18
Steinrueck+2019

Intermediate atmosphere

Accessible via resolved lines

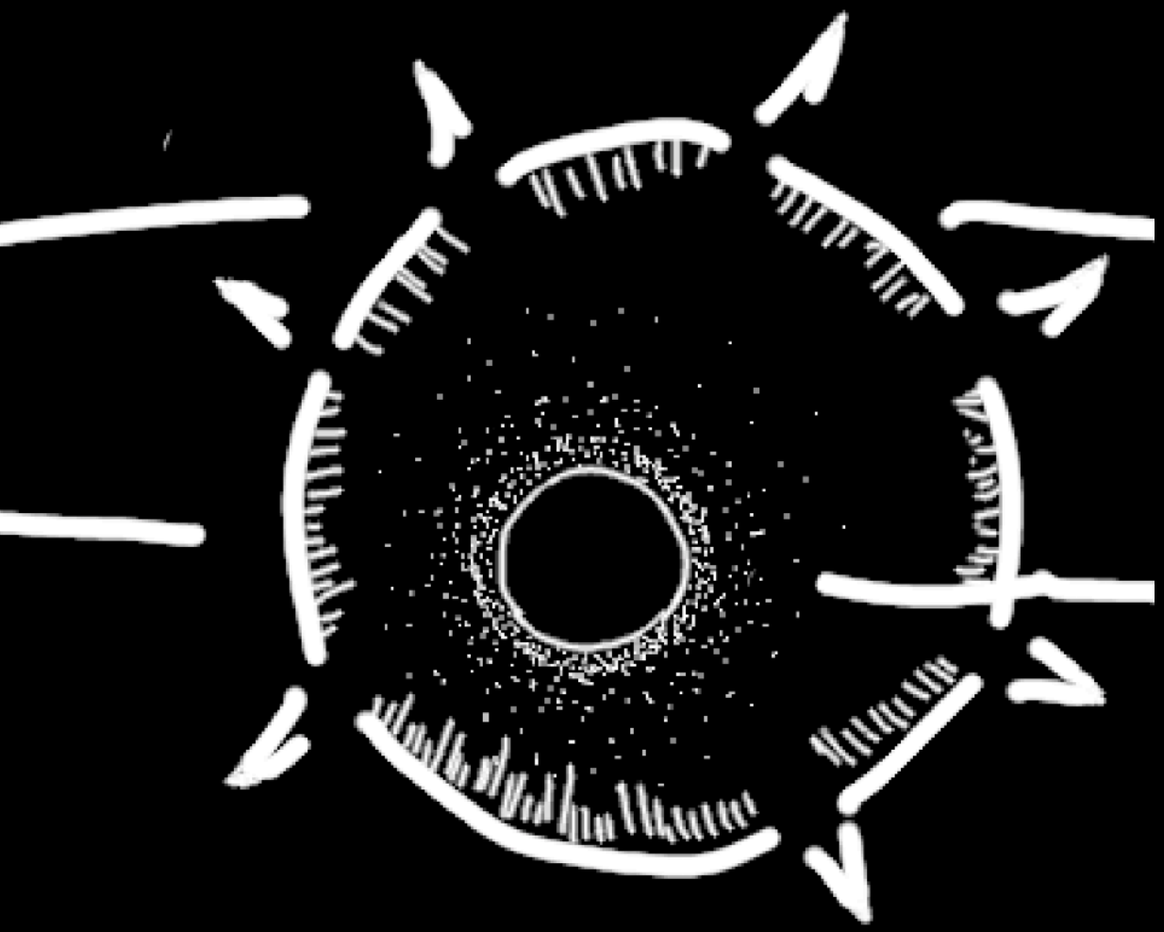
Seidel+2019
Seidel+2020a

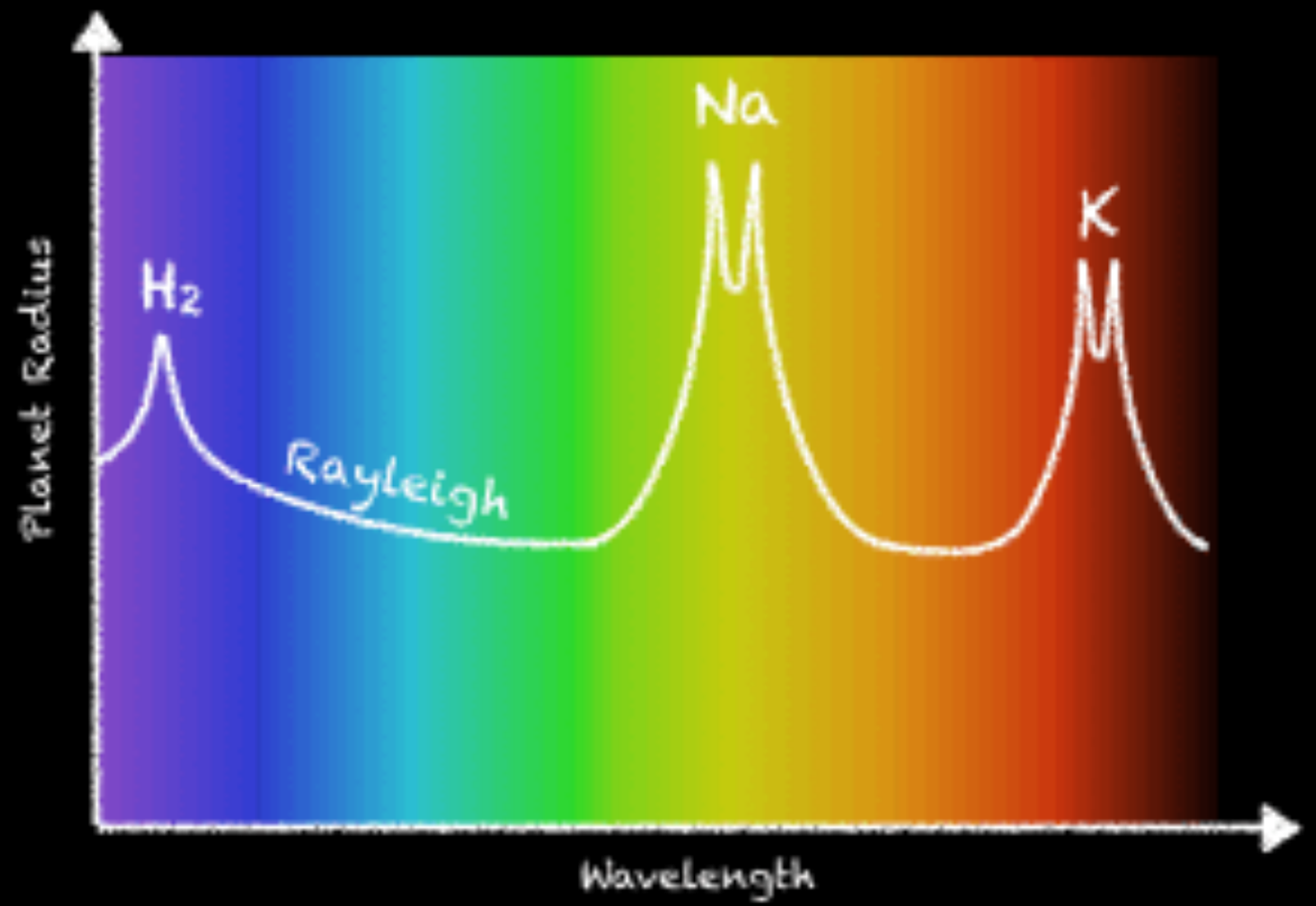
Upper atmosphere - exosphere

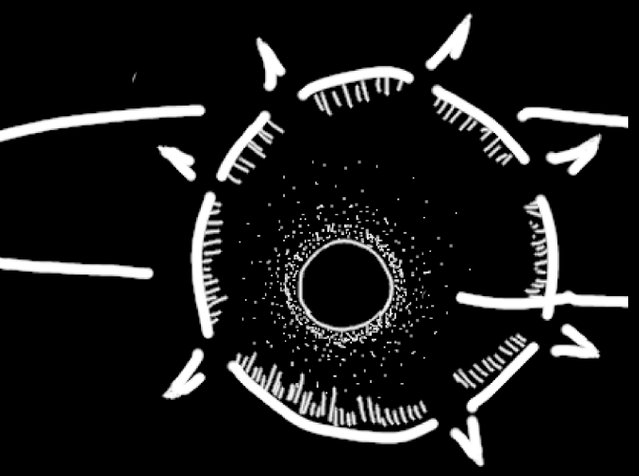
Accessible via UV observations + Escape models

Ehrenreich+2015
Salz+2018
Evans+2018
Bourrier+2018

Intermediate atmosphere
Transmission spectroscopy

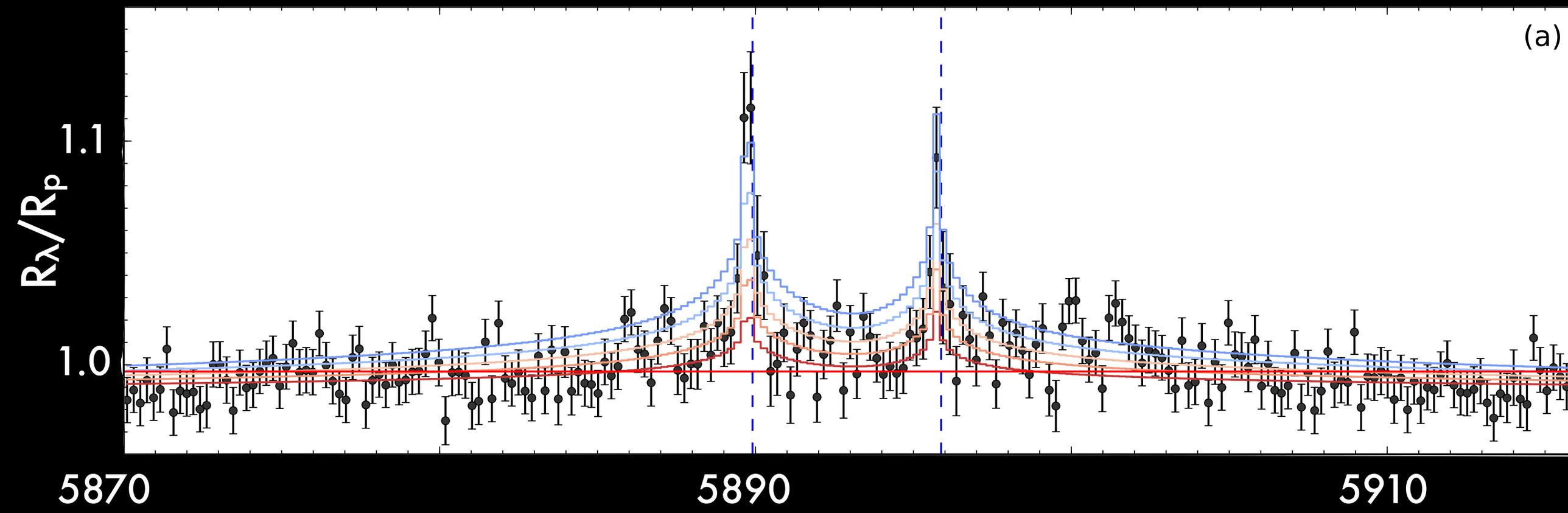






Intermediate atmosphere
Modeling resolved spectral lines

HD 189733b



Wyttenbach et al. 2015
Ehrenreich et al. 2006

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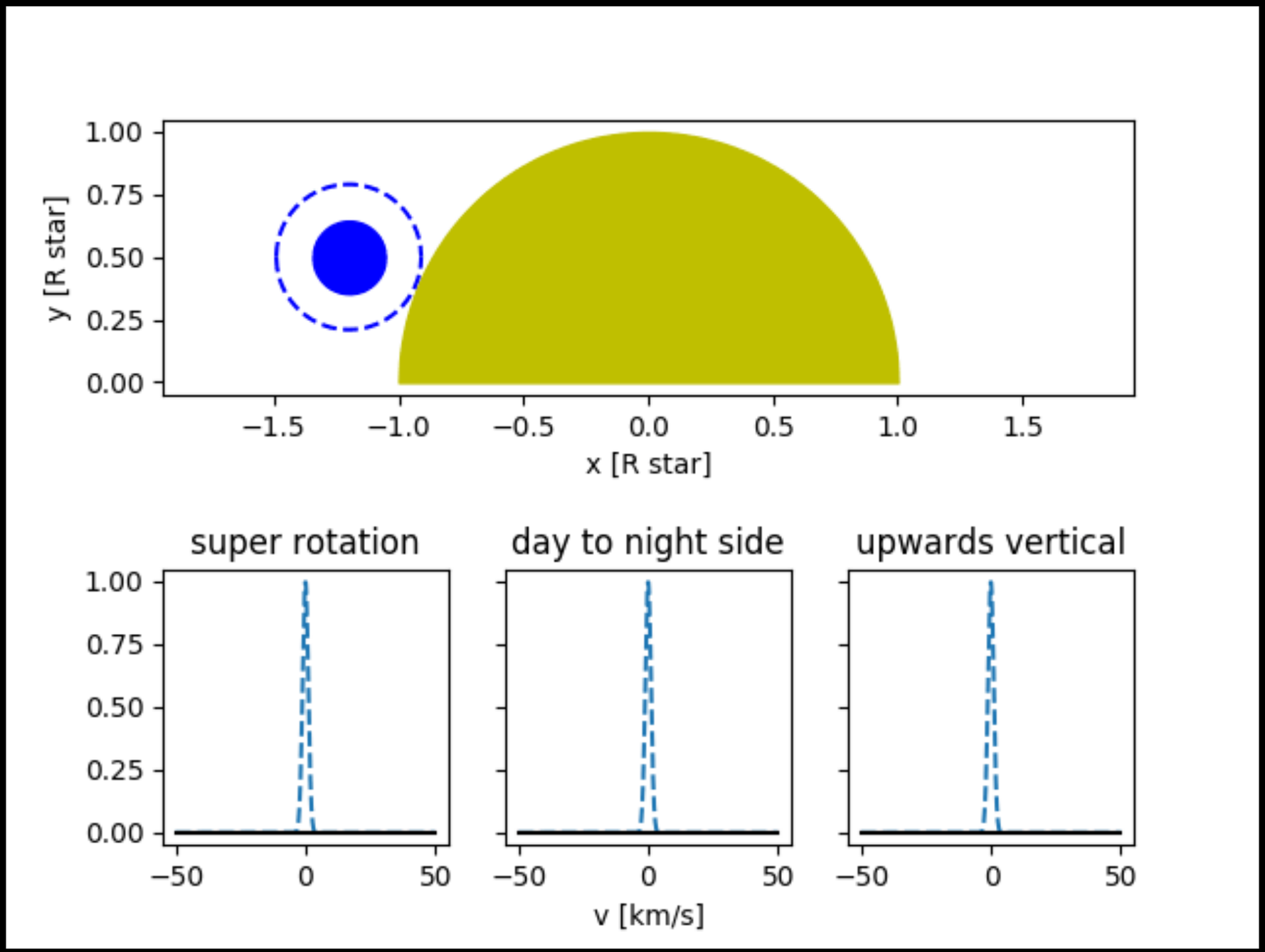
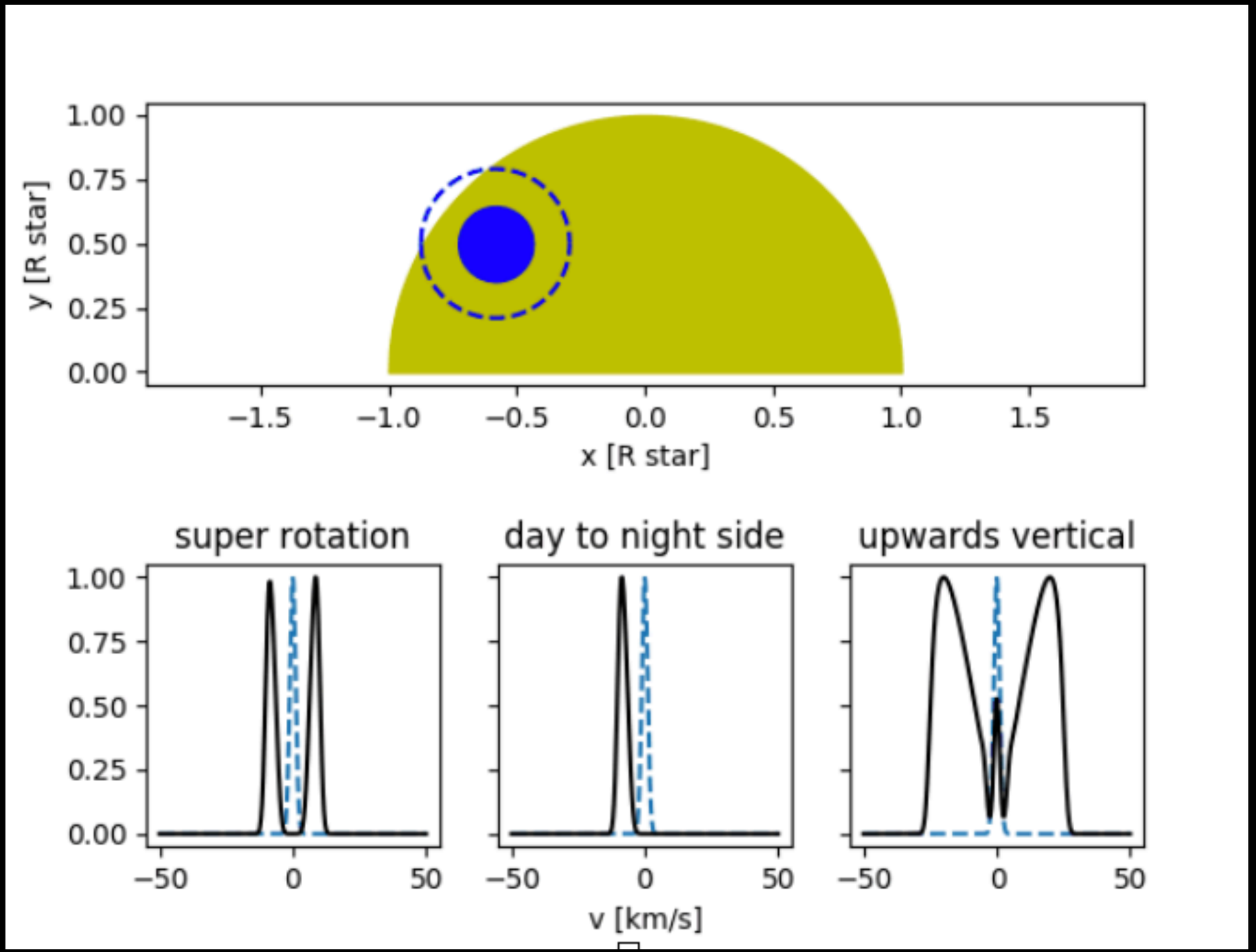
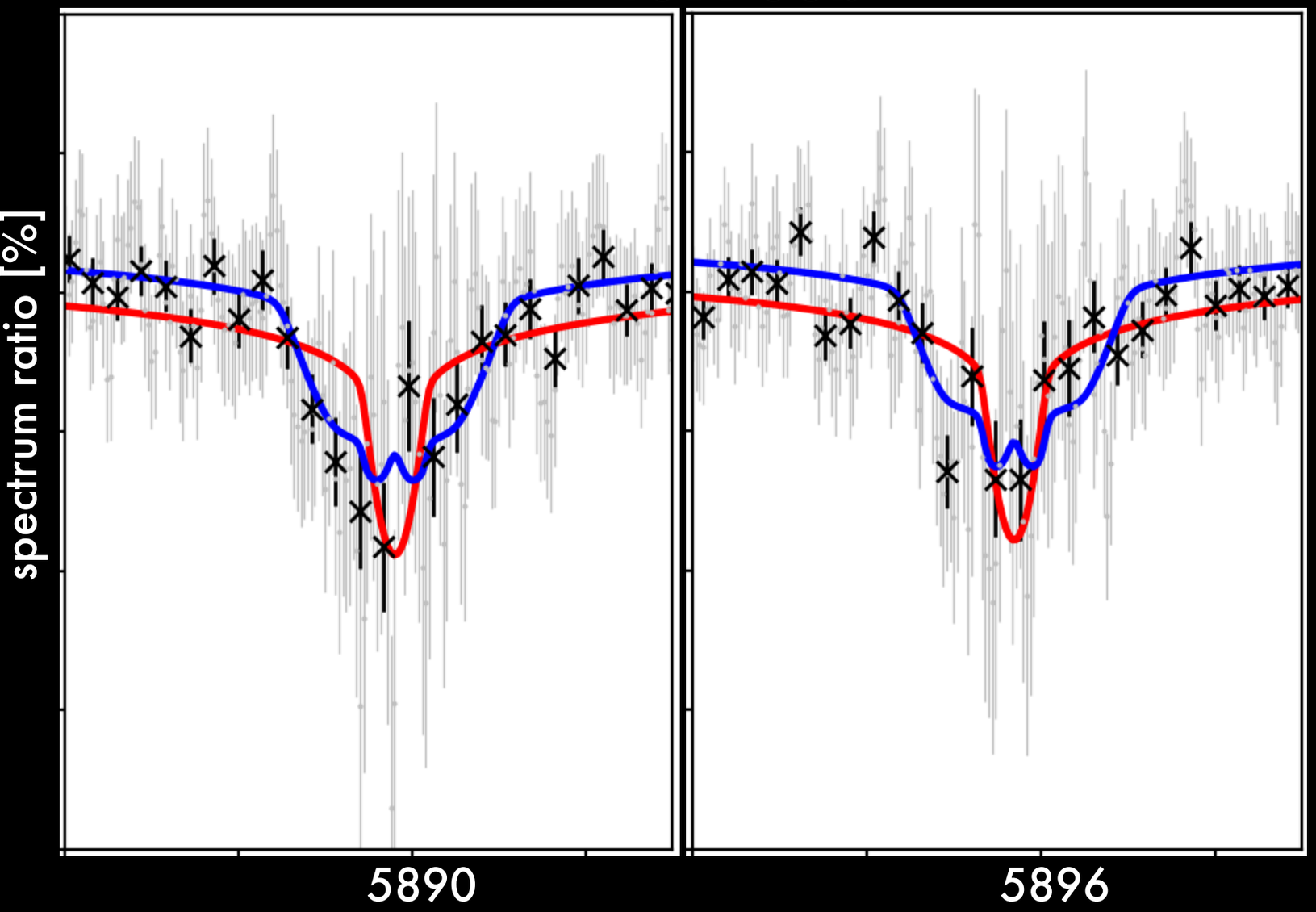
Intermediate atmosphere
Modeling resolved spectral lines

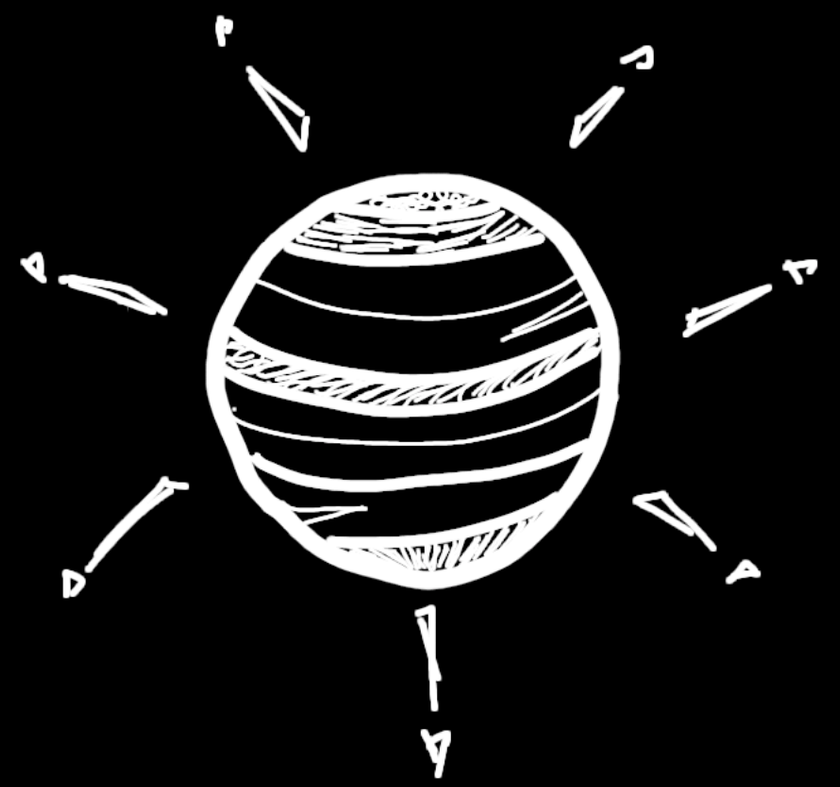


Intermediate atmosphere
Modeling resolved spectral lines



HD 189733b





Seidel et al. 2020a

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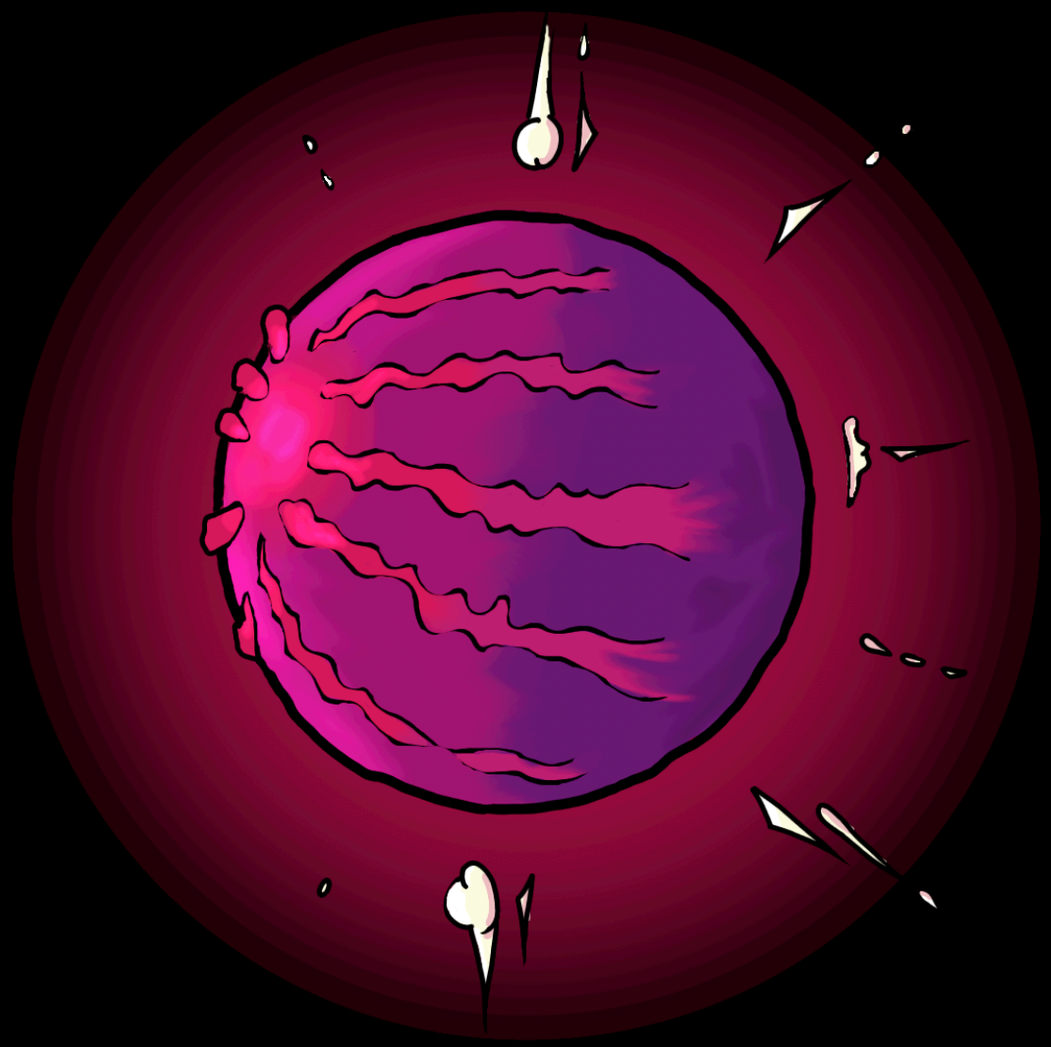
Ehrenreich et al. 2020
F. Peeters

Summary

- We cannot directly translate the methods we use in the Solar System to exoplanets due to the distance
- We can use studies of reflected light in wide wavelength bands (phase curves) to create wind surface maps in the lower atmosphere
- We can use the transmission spectrum of resolved spectral lines (like sodium) to probe higher up in the atmosphere
- For Jupiter-like exoplanets, we have found zonal winds, such as equatorial jets, in the lower atmosphere and vertical, expanding winds in the intermediate atmosphere

Danke/Merci



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