

Aerosols and Sub-Neptune Diversity

Yoni Brande

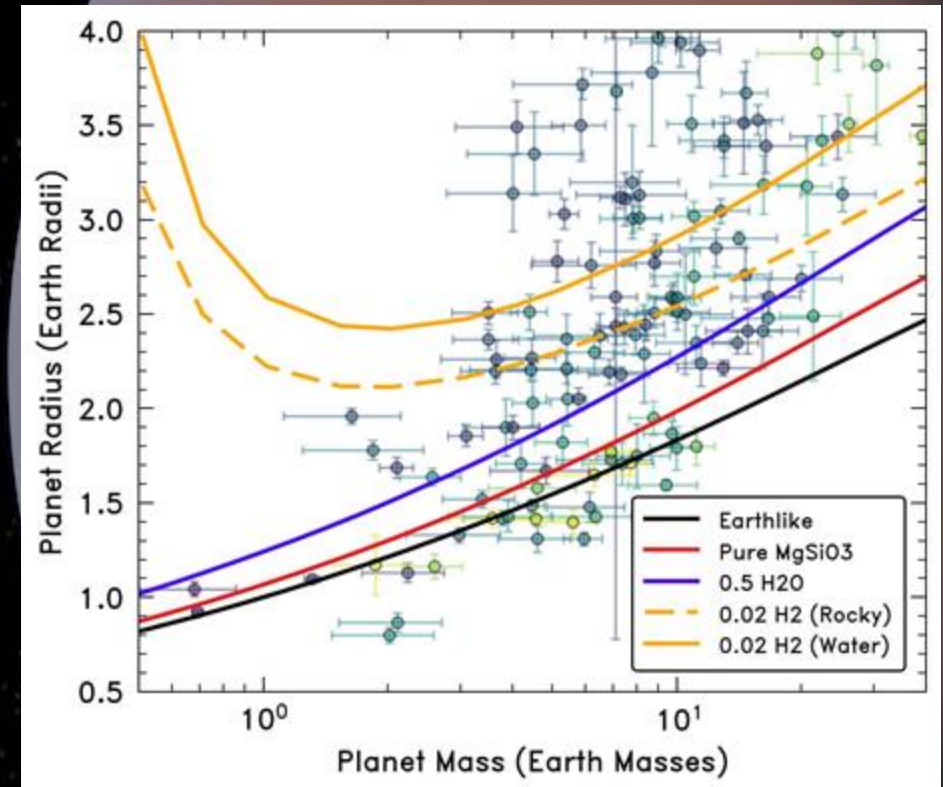
ExoPAG 31

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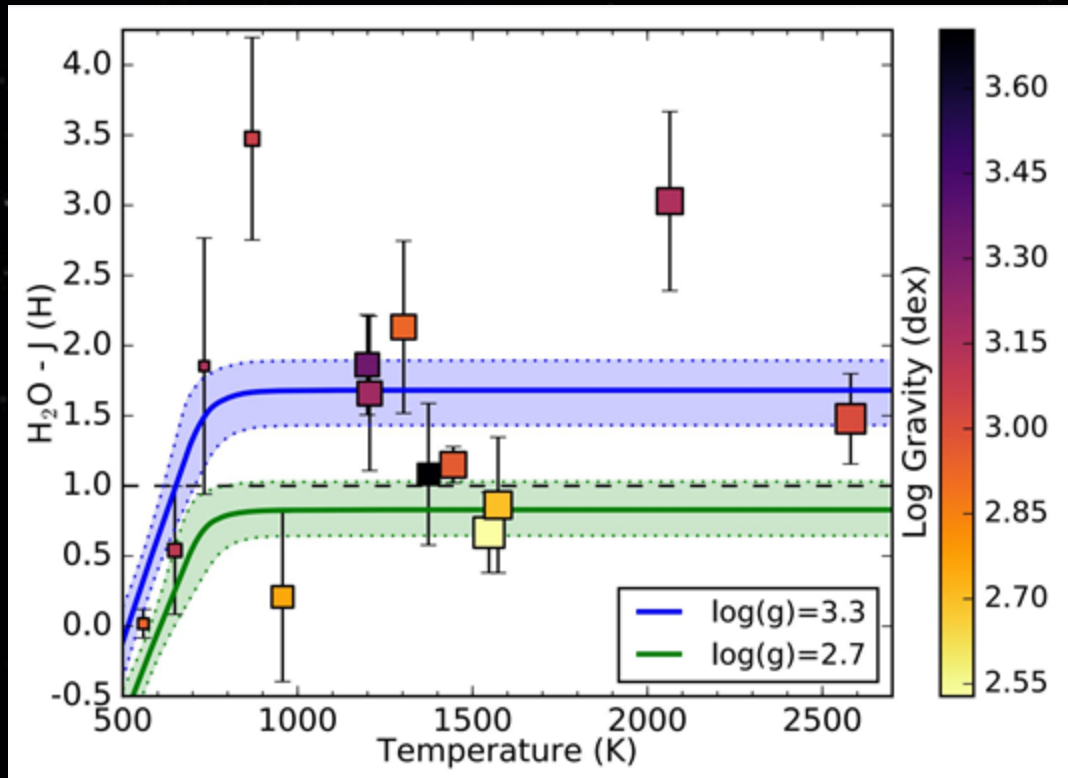


Are Sub-Neptunes Hiding Something?

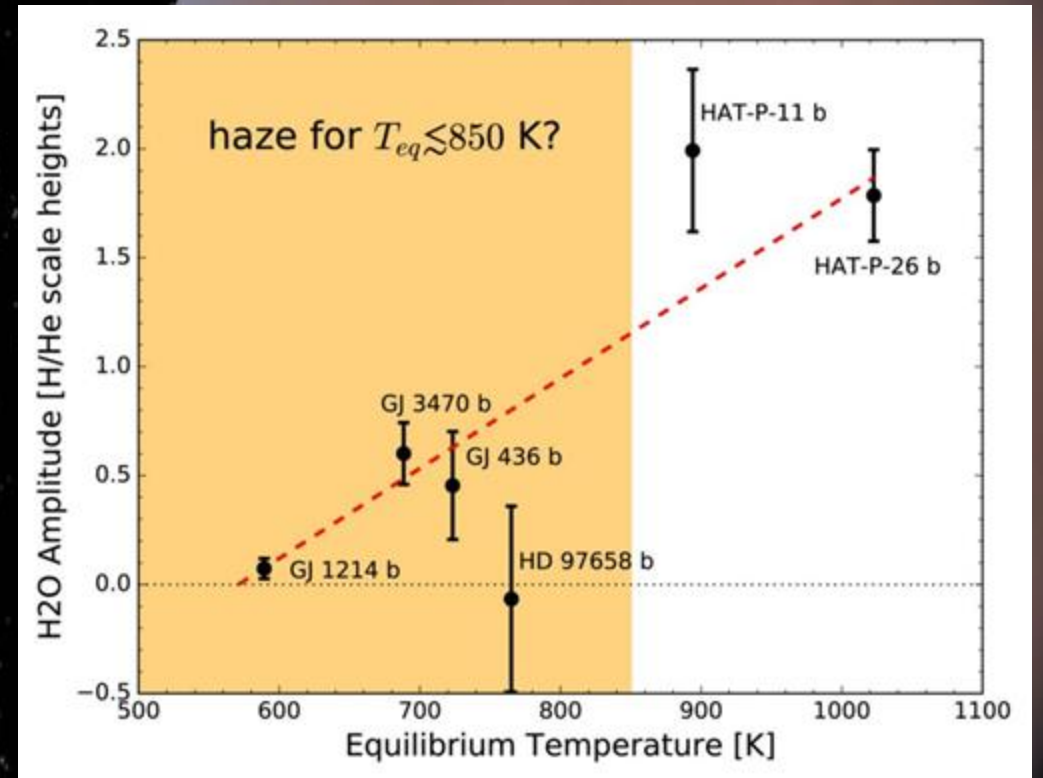
- Most common -> most interesting!
 - No local analogs
- Molecular Absorption
 - Metallicities, Ratios
 - Composition
- Aerosols – Clouds/Hazes
 - Trends?



Trends – Clouds/Hazes

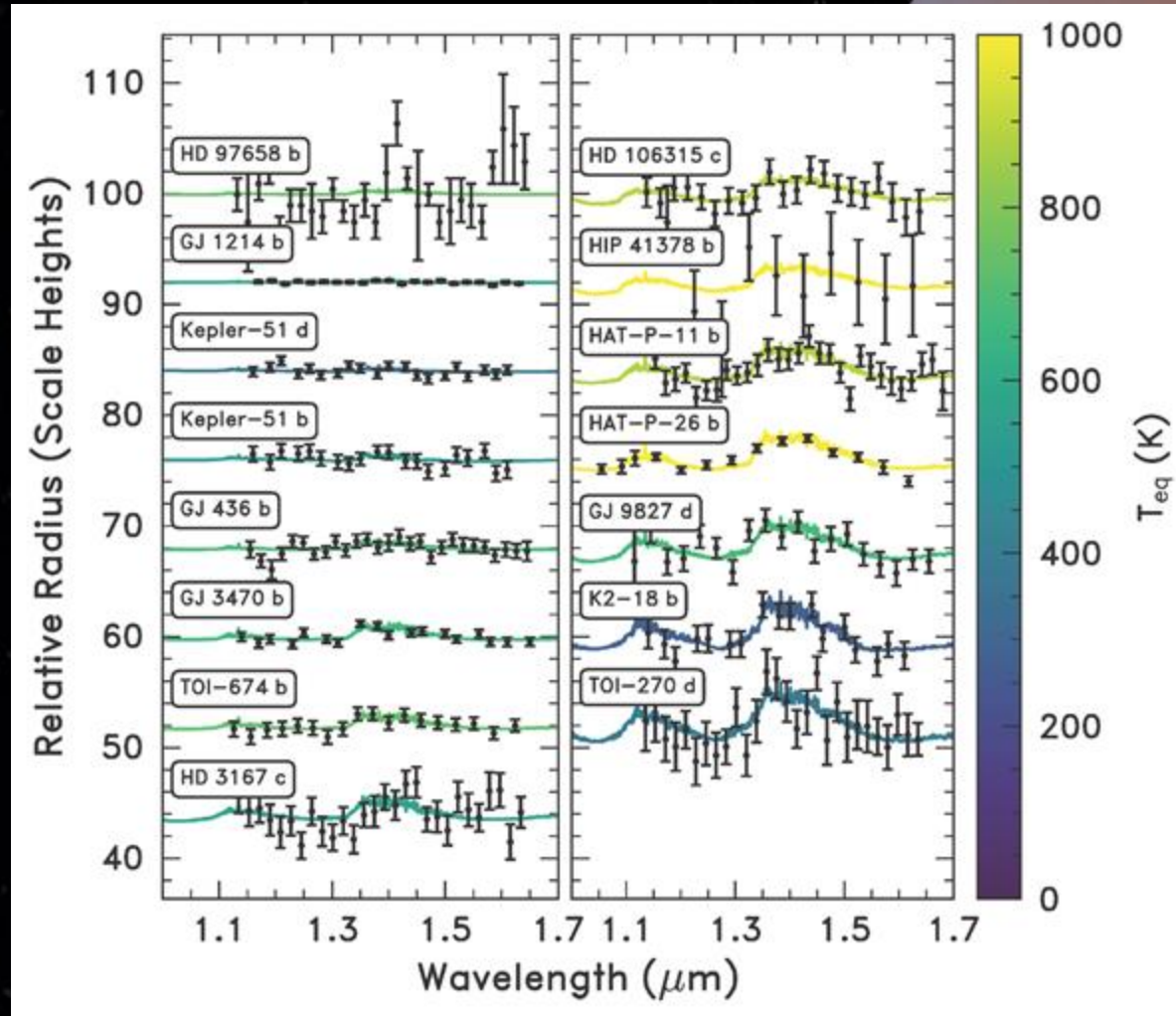


Stevenson (2016)



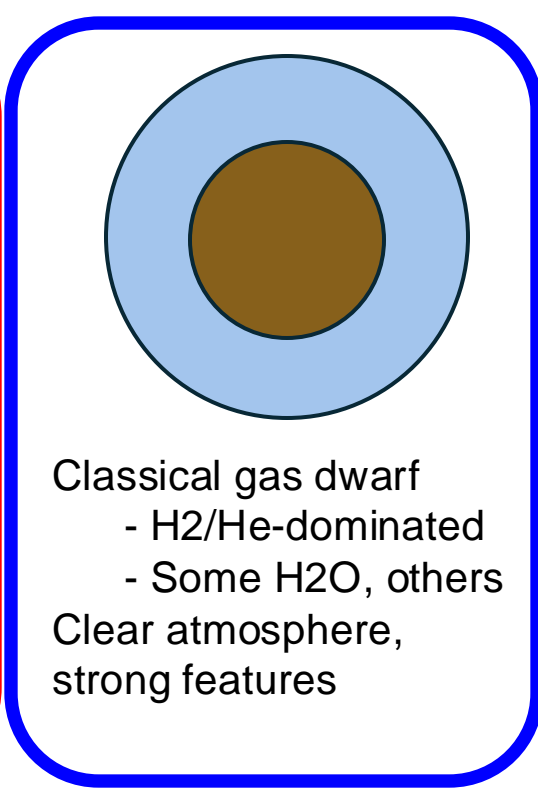
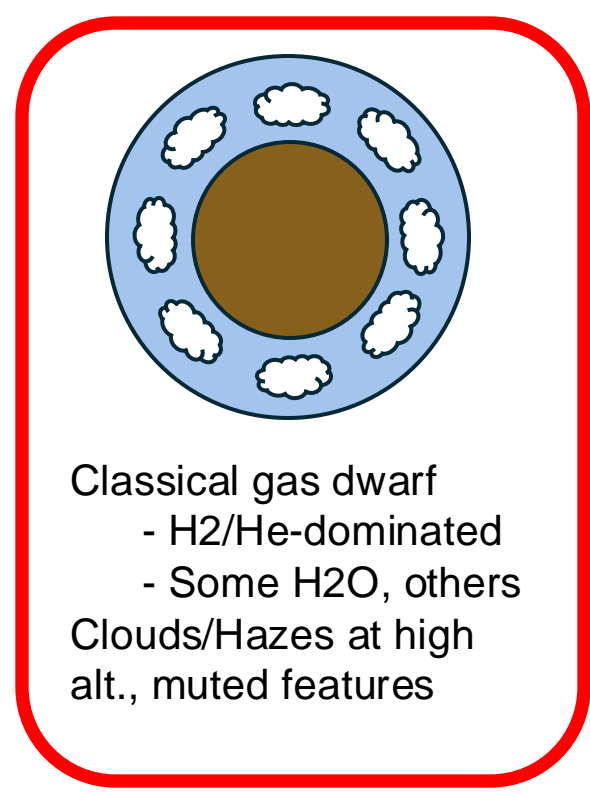
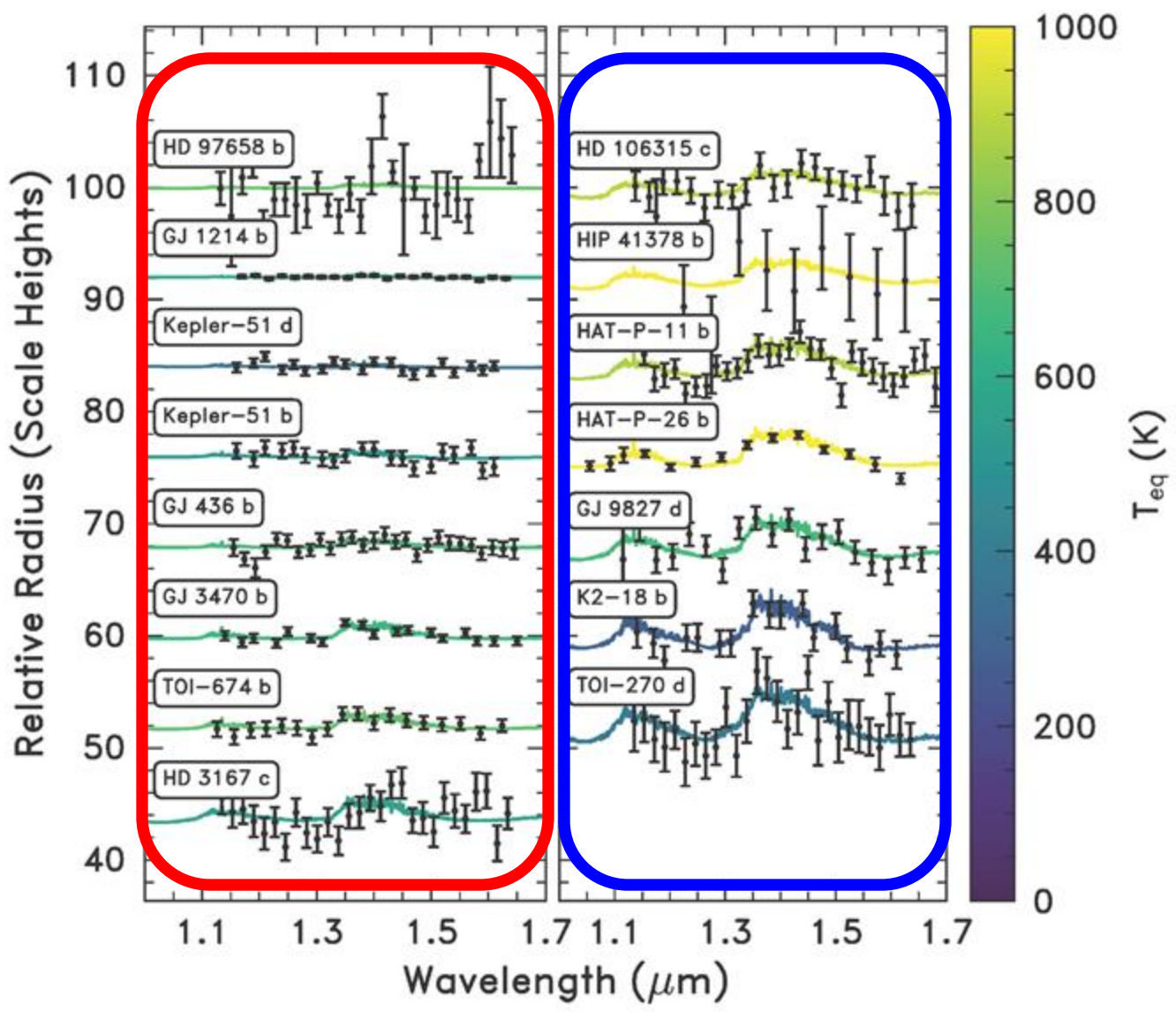
Crossfield & Kreidberg (2017)

Hubble's Neptune Aerosol Survey



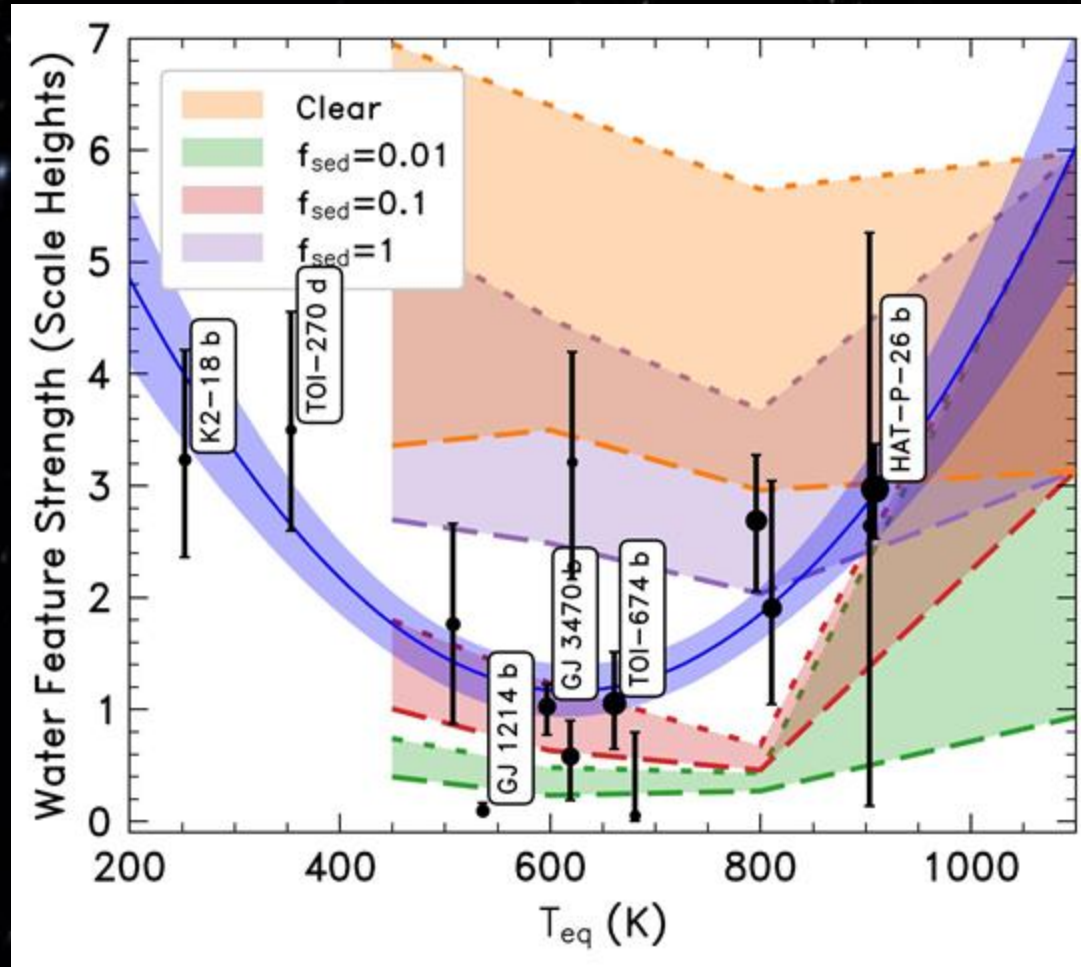
Brande et al. (2024)

How Things Work



Brande et al.
 (2024)

Plug-and-Play Models

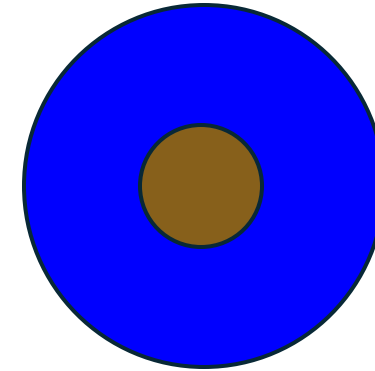
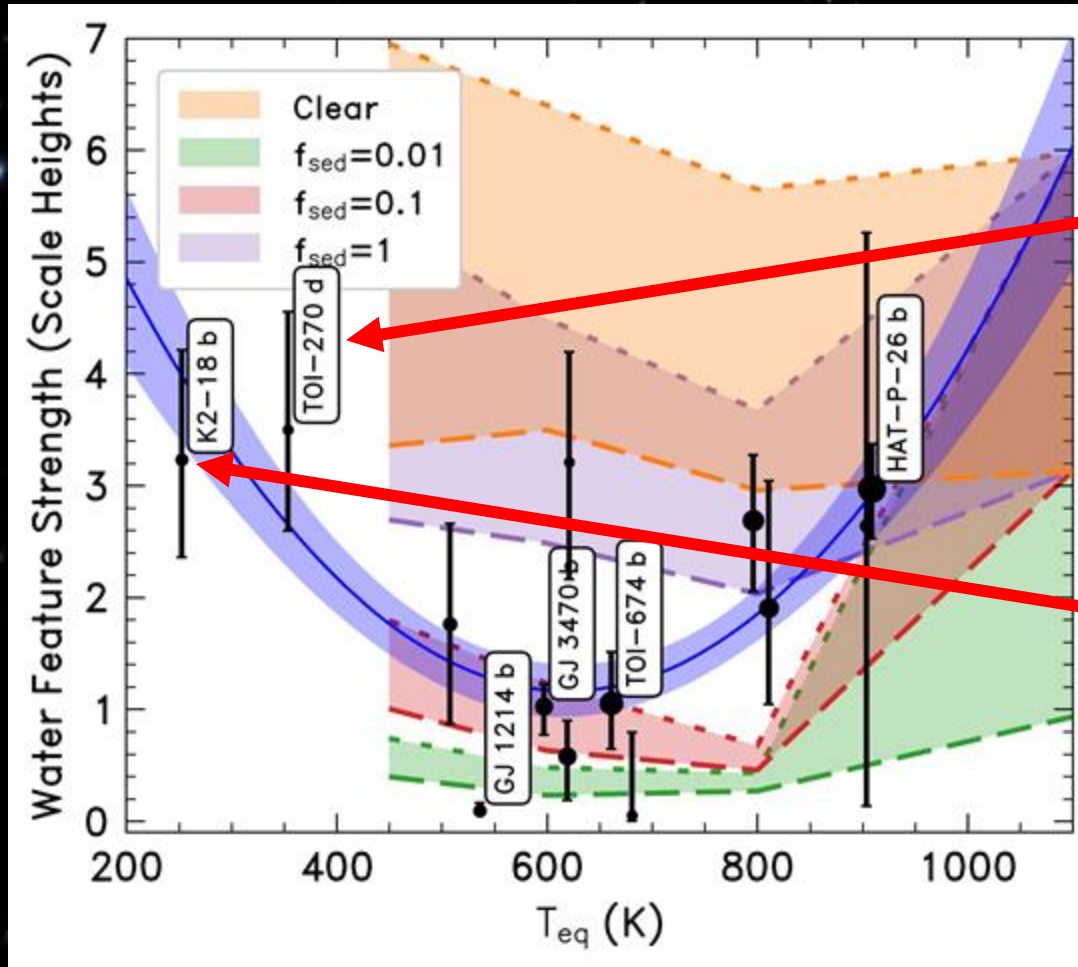


Brande et al. (2024)

2025-01-12

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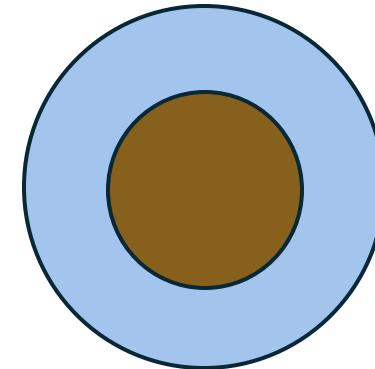
Exotic Interiors?



Water World/Vodka Planet/Other

- High M/H atmosphere
- (Steam, H/H₂O miscible)

High μ , intrinsically low H , but lots of water! \rightarrow high A_H



Classical gas dwarf

- H₂/He-dominated
- CH₄, CO₂

Clear atmosphere, strong features

Brande et al. (2024)

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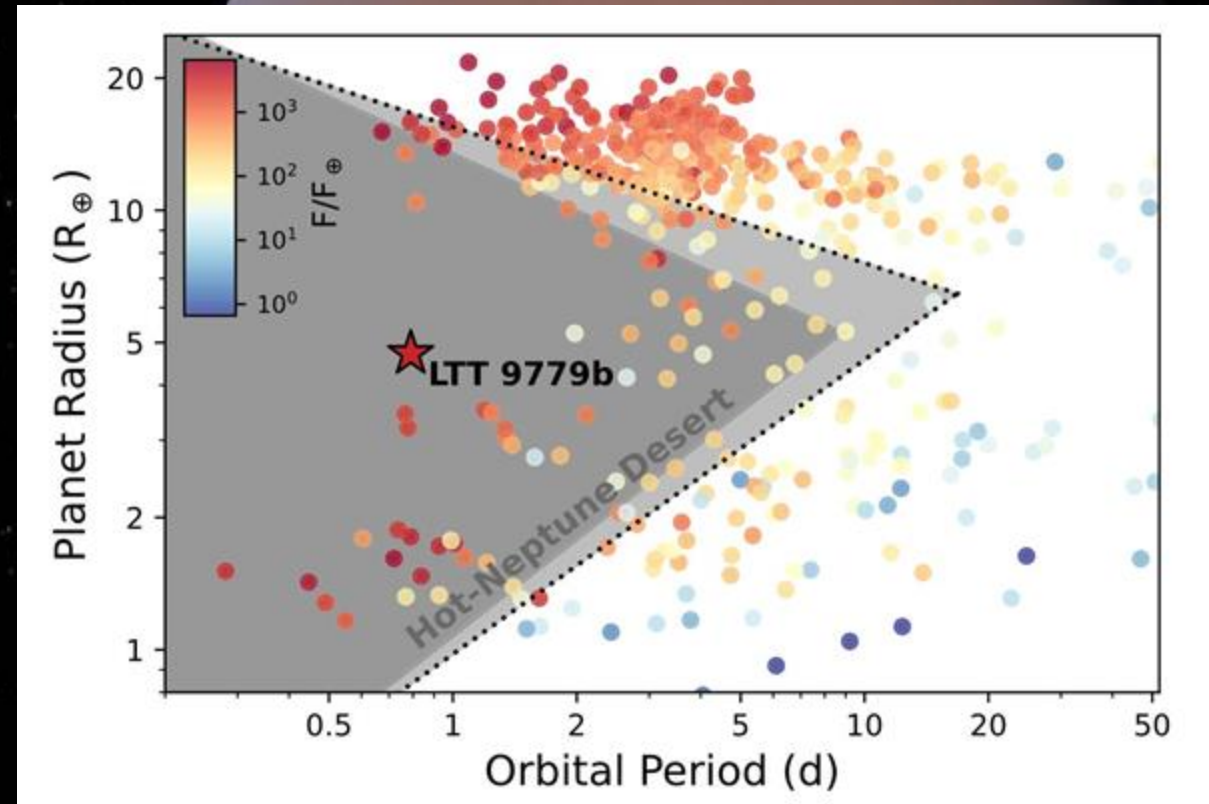
Aerosol Modeling - ExoHaze

- eddysed/virga for hazes
- Simplify, streamline, modernize CARMA
- Directly model coagulation/transport
- Free haze production/decomposition
- User specified K_{zz}



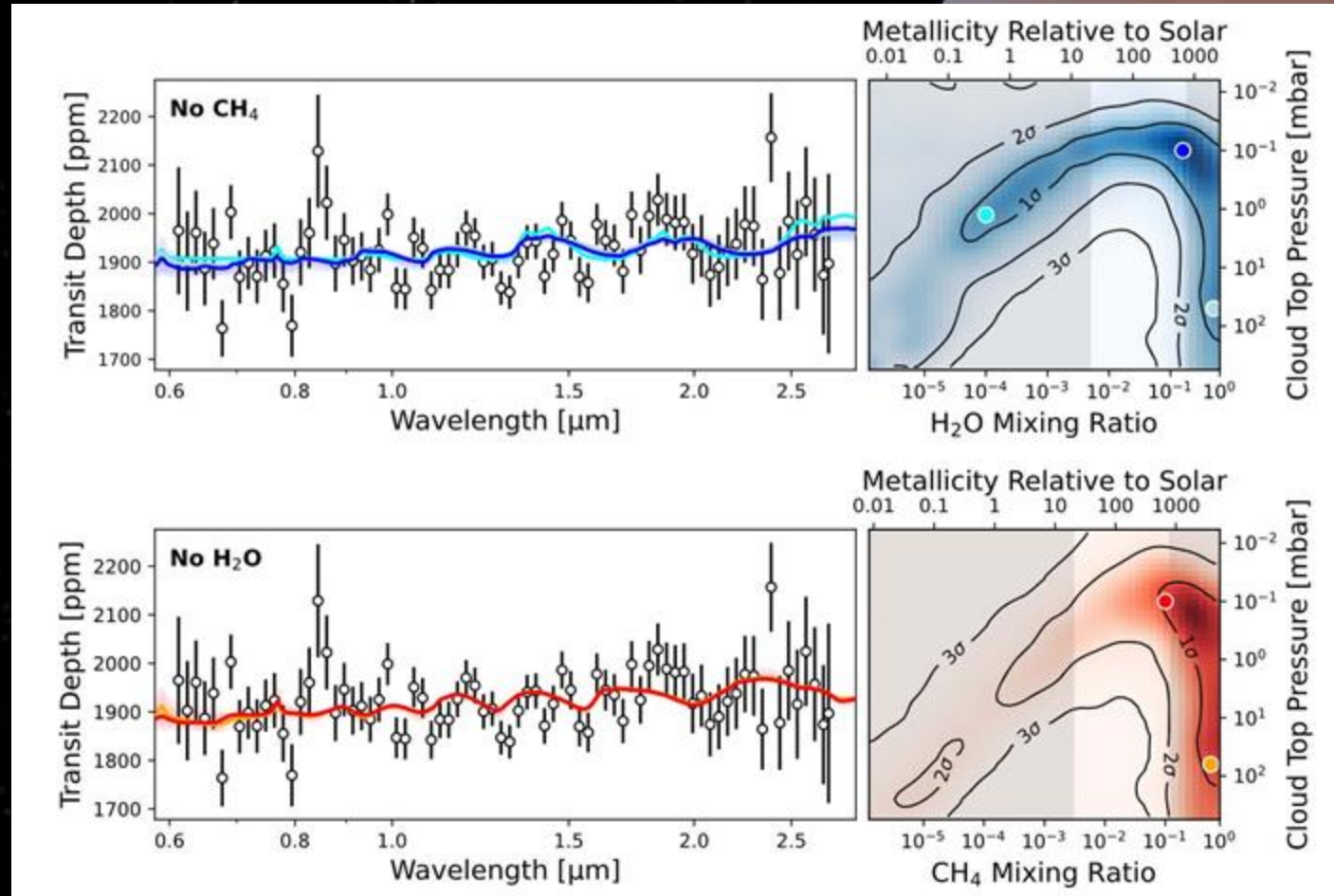
Hot Neptunes

- “Neptune desert” not totally empty!
- Several high-priority targets known (e.g. TOI-674 b)
- Very few fully characterized
- LTT 9779 b – 2000K, 4.7 RE, 30 ME



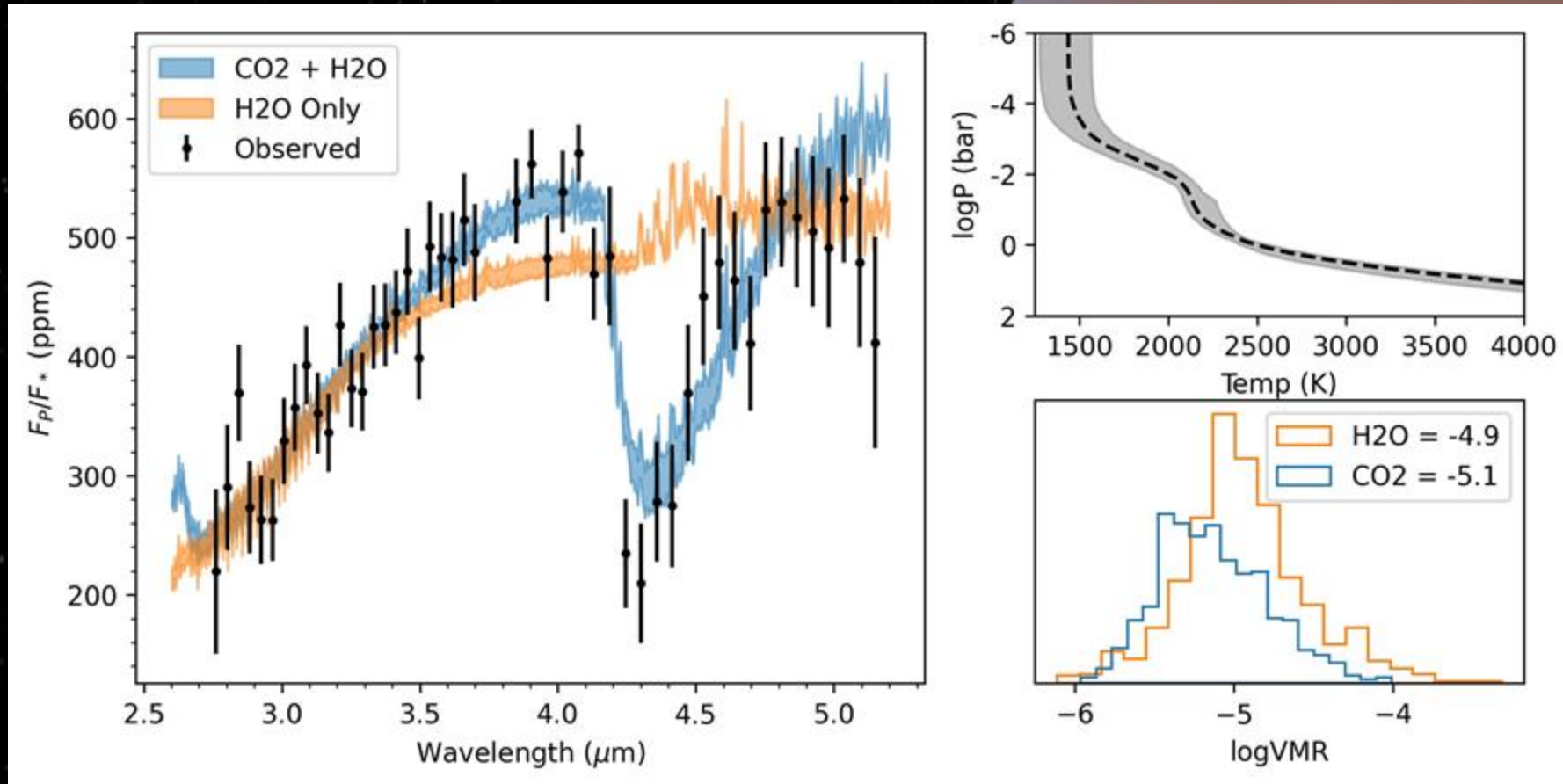
Radica+ 2024

NIRISS Transmission – LTT 9779 b



Radica+ 2024

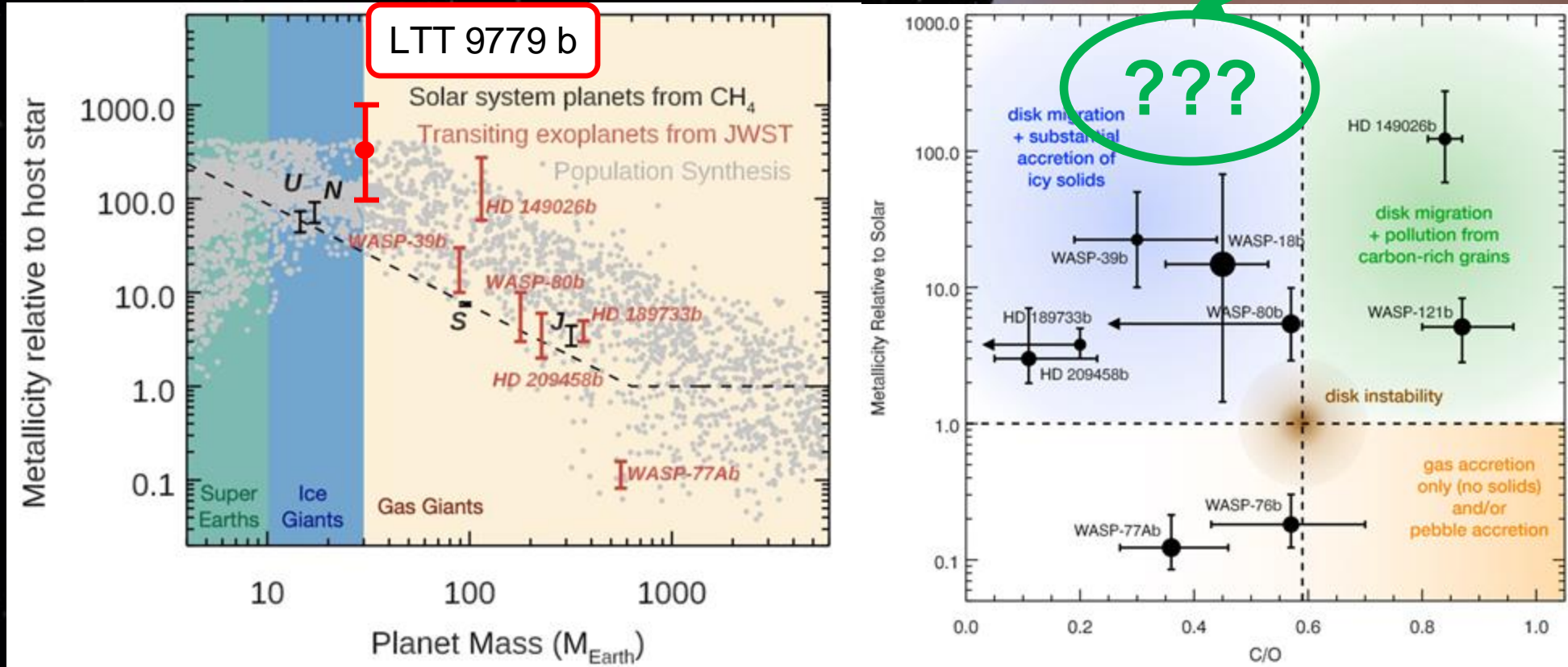
NIRSpec G395H – LTT 9779 b



Brand+ in prep.

LTT 9779 b in Context

LTT 9779 b
way up here!
(maybe)



Kempton 2024

Conclusions

- Sub-Neptunes are fun!
 - JWST data is great!
 - HST is still good!
- Aerosol trends appear to hold (with some model caveats)!
- We should support modeling efforts to catch up with data!
- We need to use all our tools (transmission, emission, phase curves) to fully explore our planet samples

