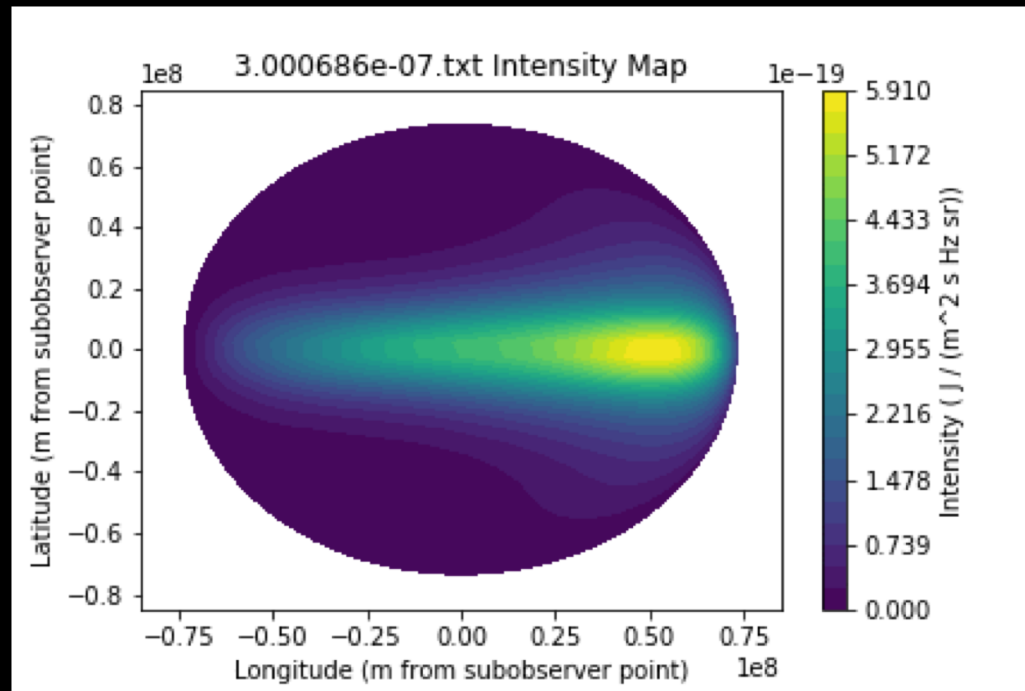


# Current Mysteries of Exoplanet Atmospheres

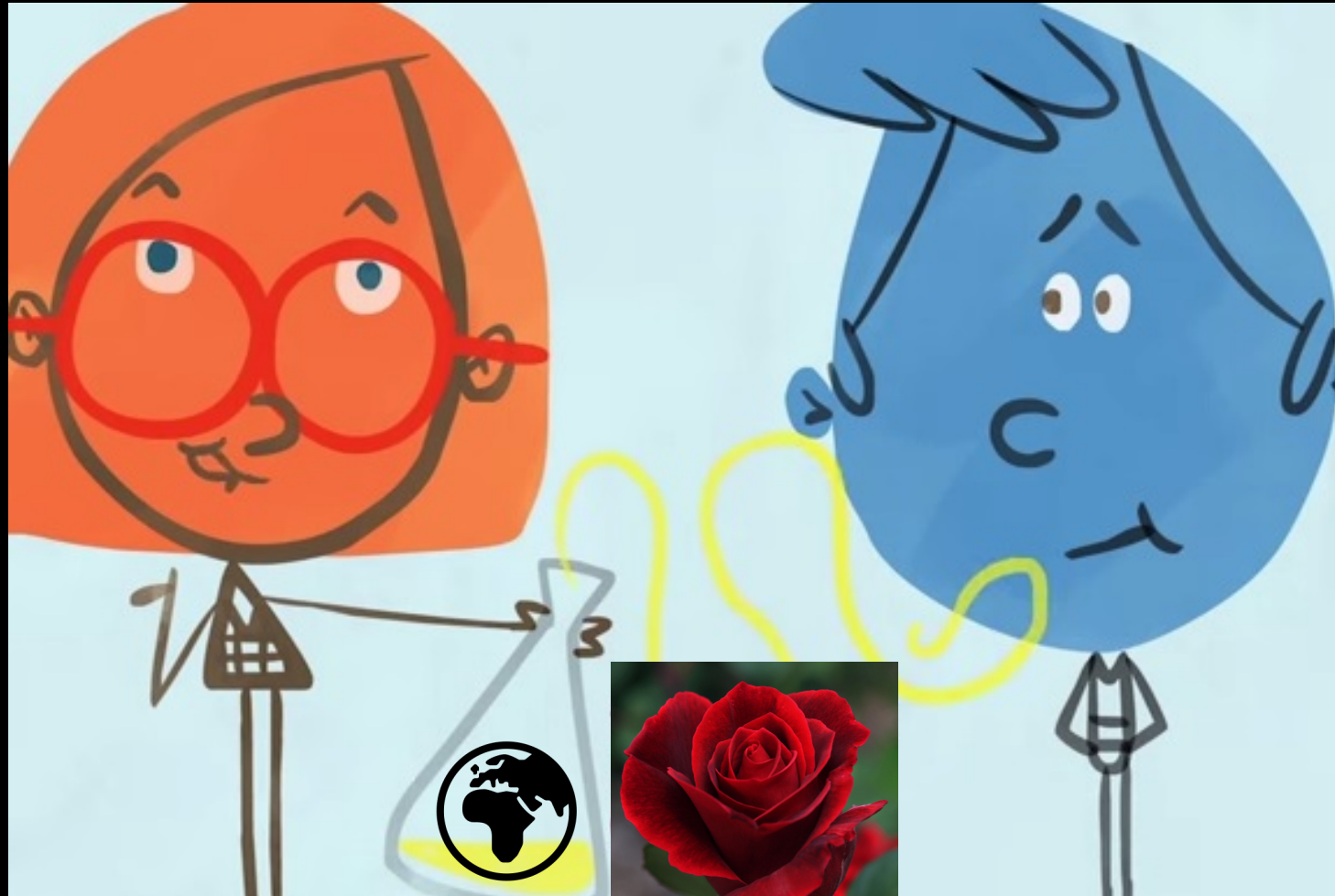
Emily Rauscher

University of Michigan



Credit: L. Larson

# Eventually: "is that a biosignature?"



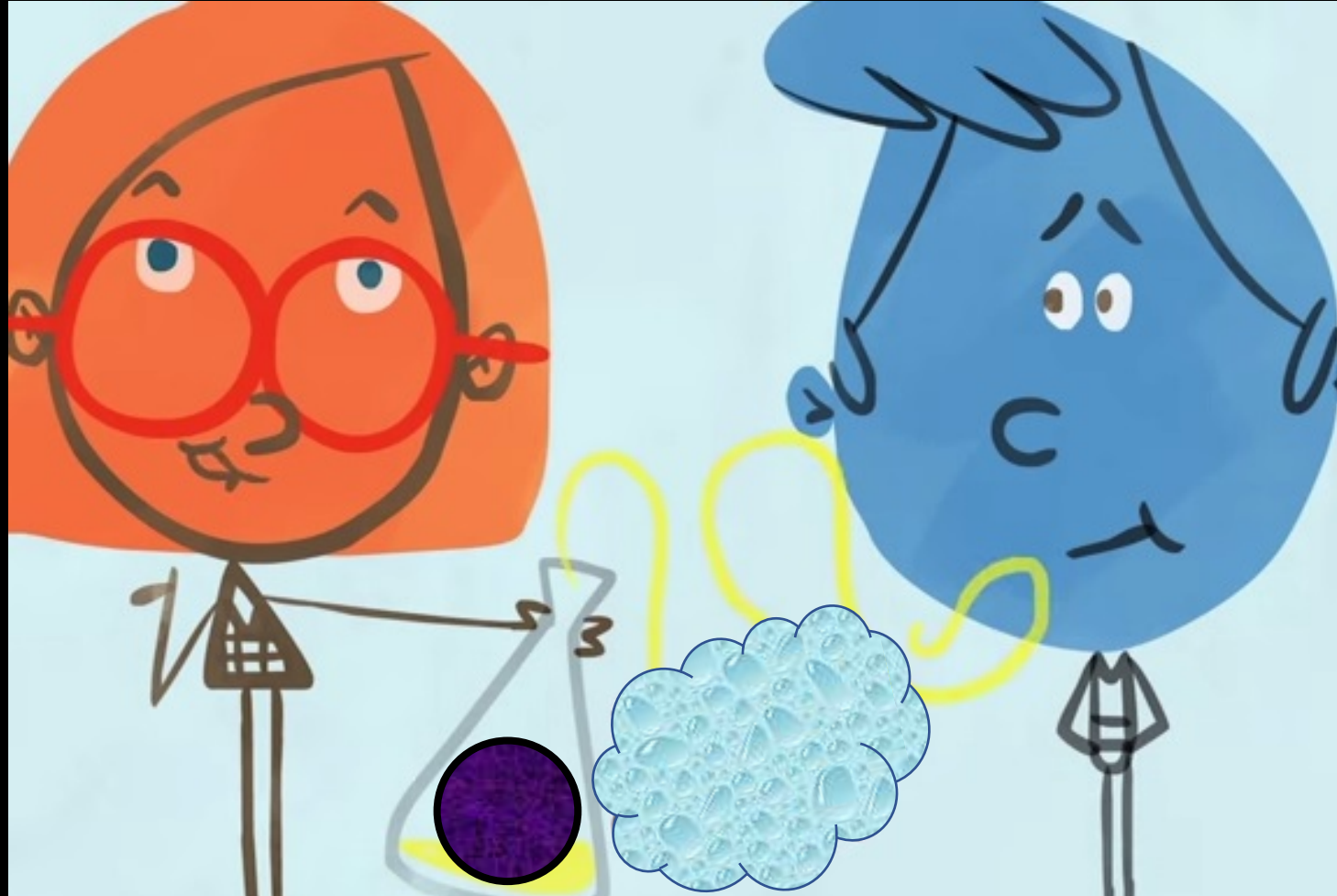
Source: Youtube/TED-Ed



July 2000 by iStockphoto.com

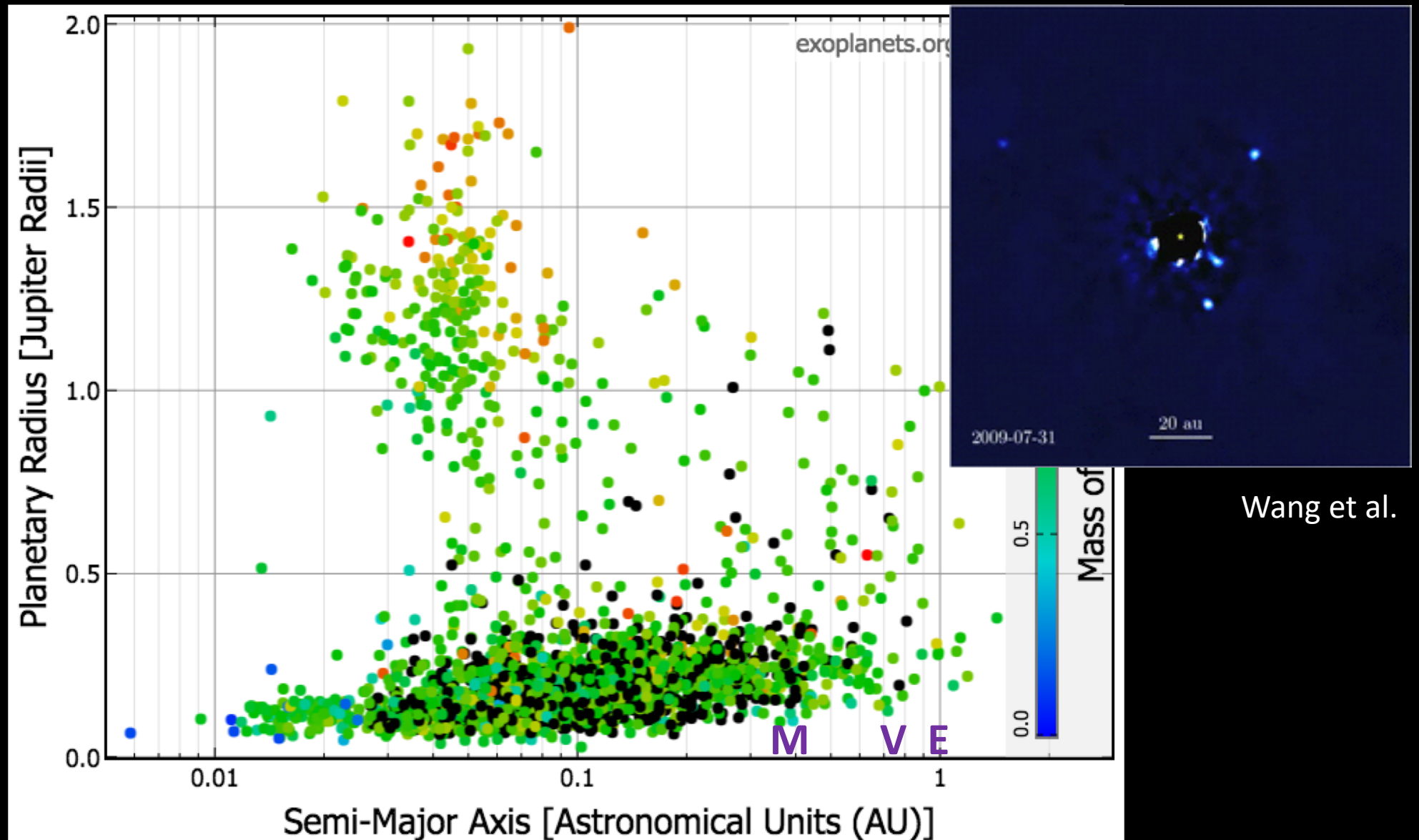


# Currently: what is that smell??!?



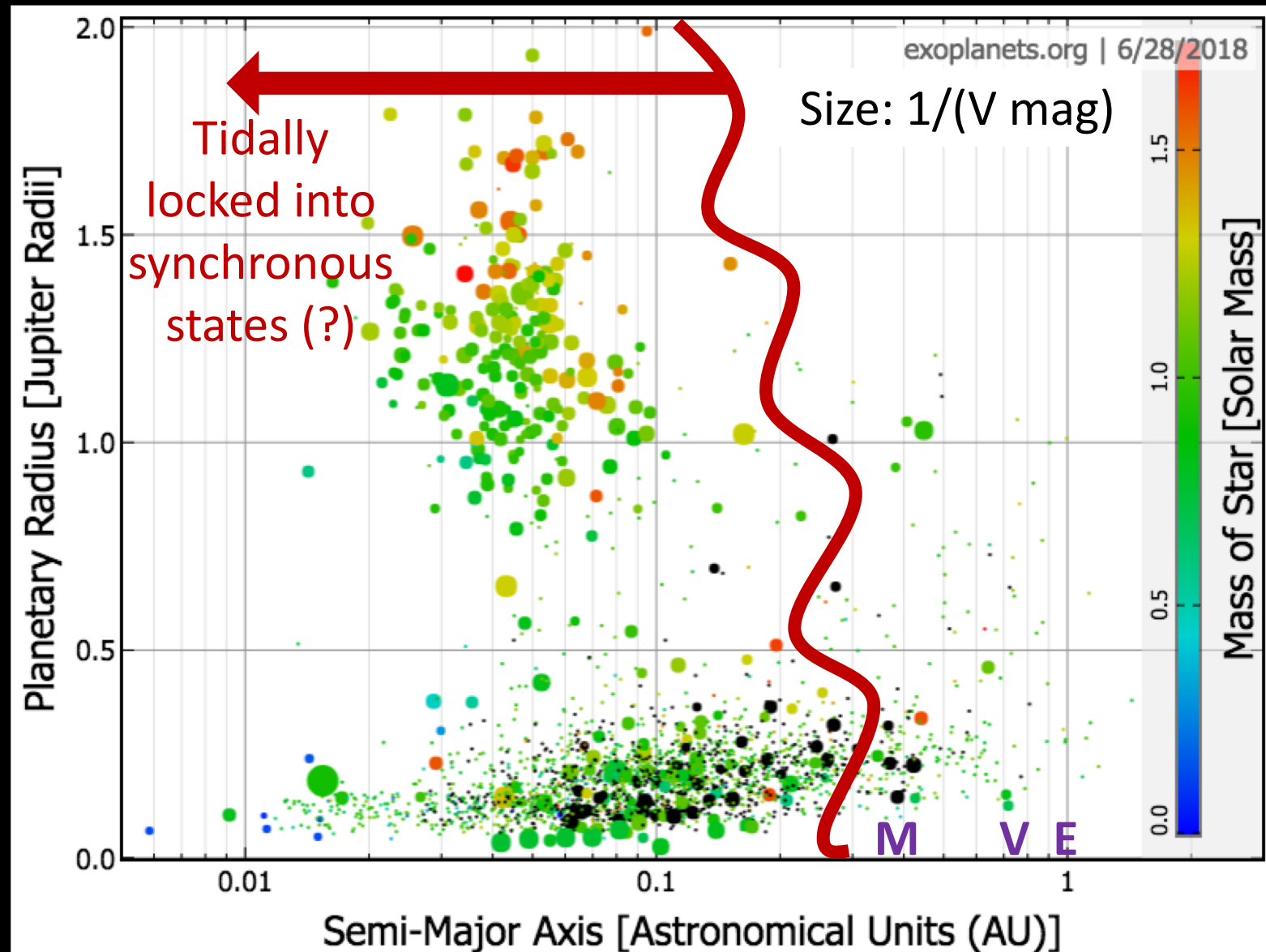
Source: Youtube/TED-Ed

# Extrapolating into the unknown ...

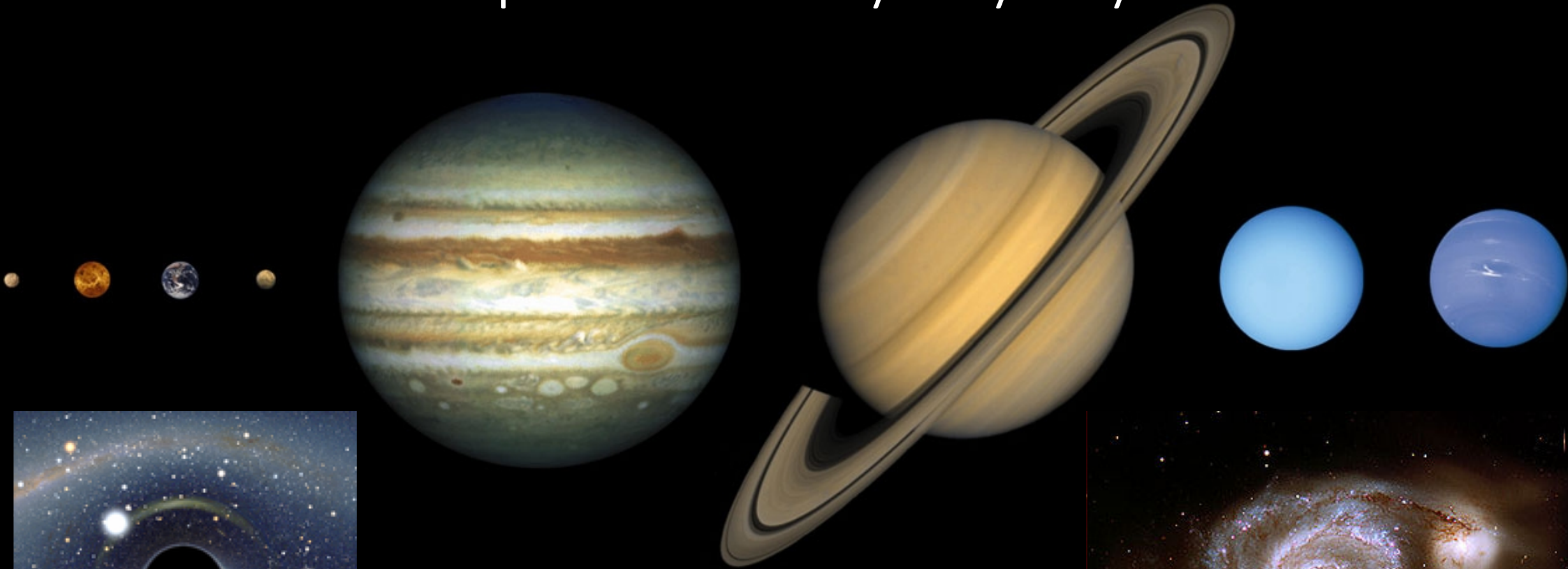


Wang et al.

# Extrapolating into the unknown ...



# We should expect diversity anyway



More like these →  
← Than like these

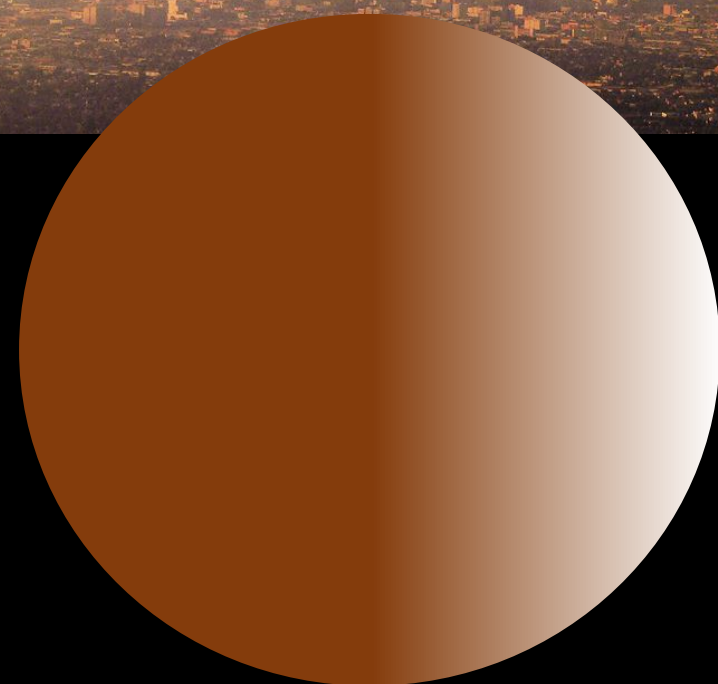
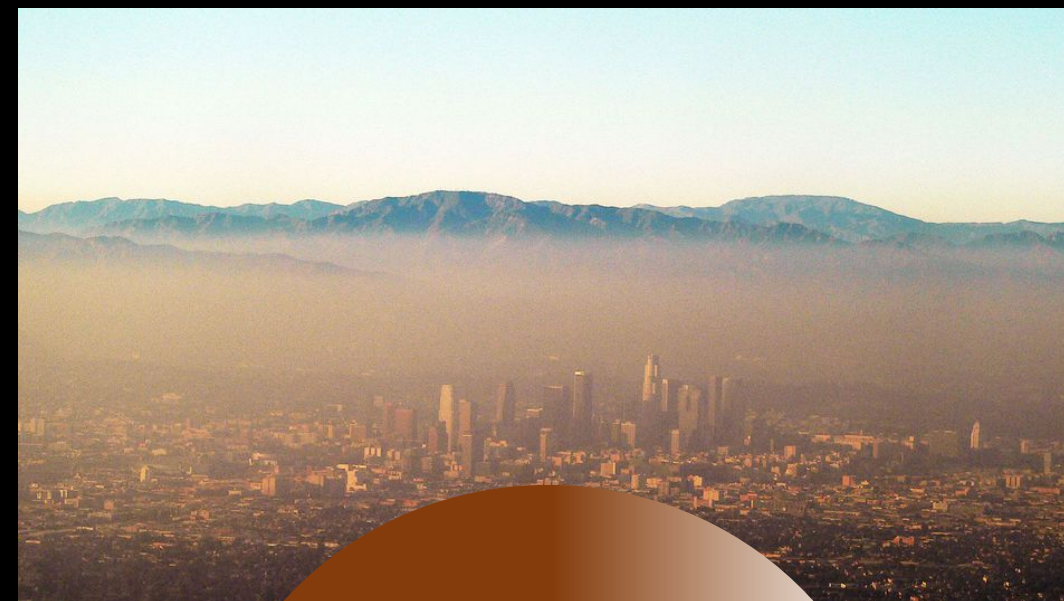
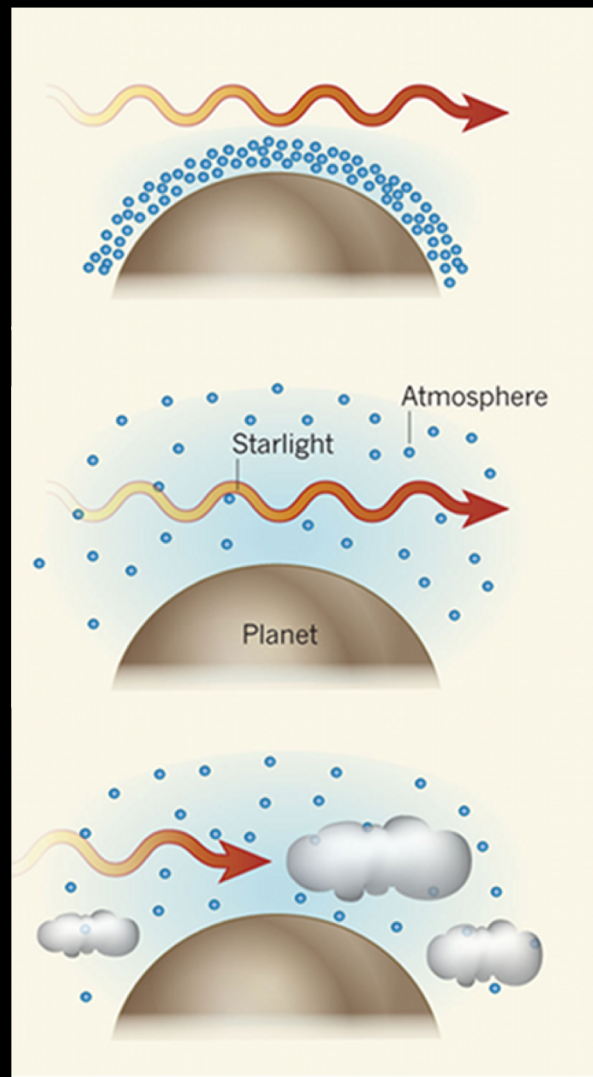
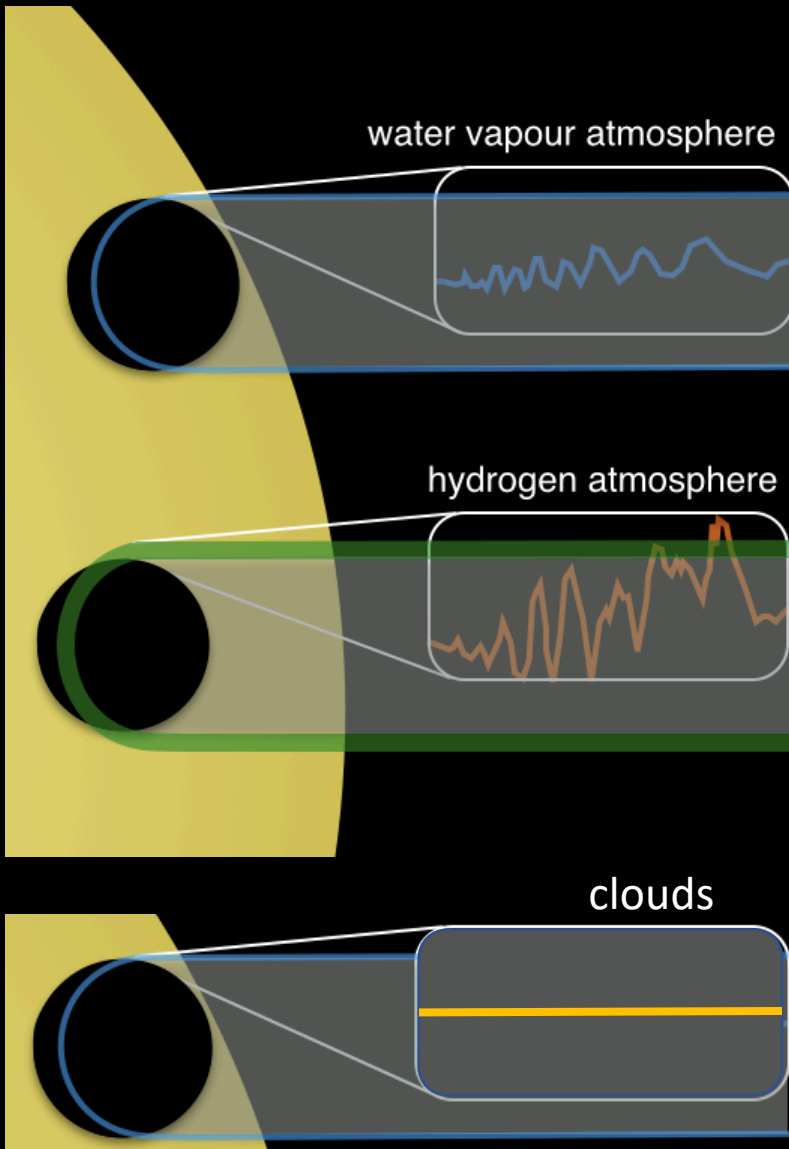
# Types of unsolved mysteries

- **What is in the atmosphere?** (0D, 1D, 3D)
  - Aerosols
- **How does the atmosphere work?** (physical processes)
  - Shocks, dissociation, magnetism
- **What can we actually measure, and how well?**
  - Multi-dimensional, multi-parameter retrievals



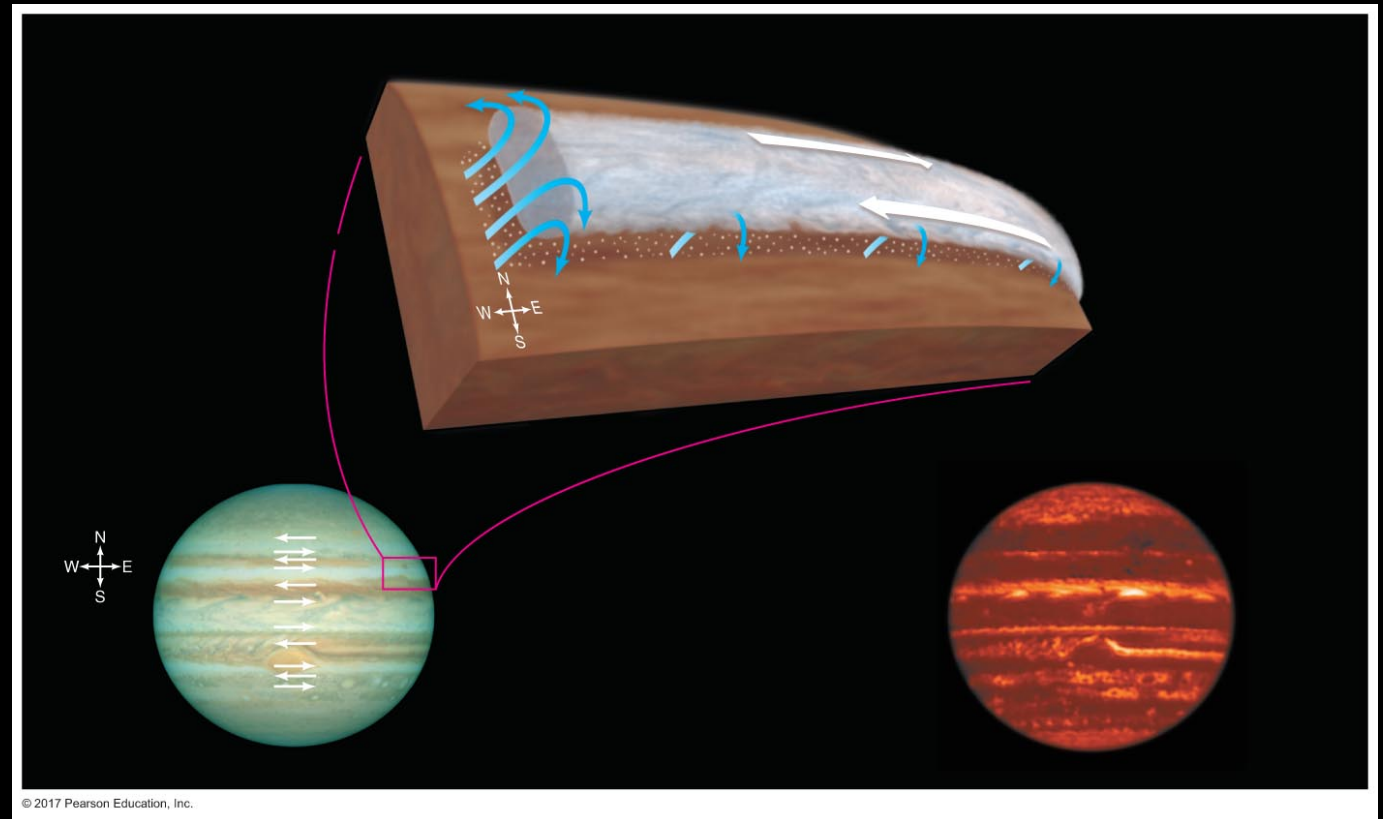
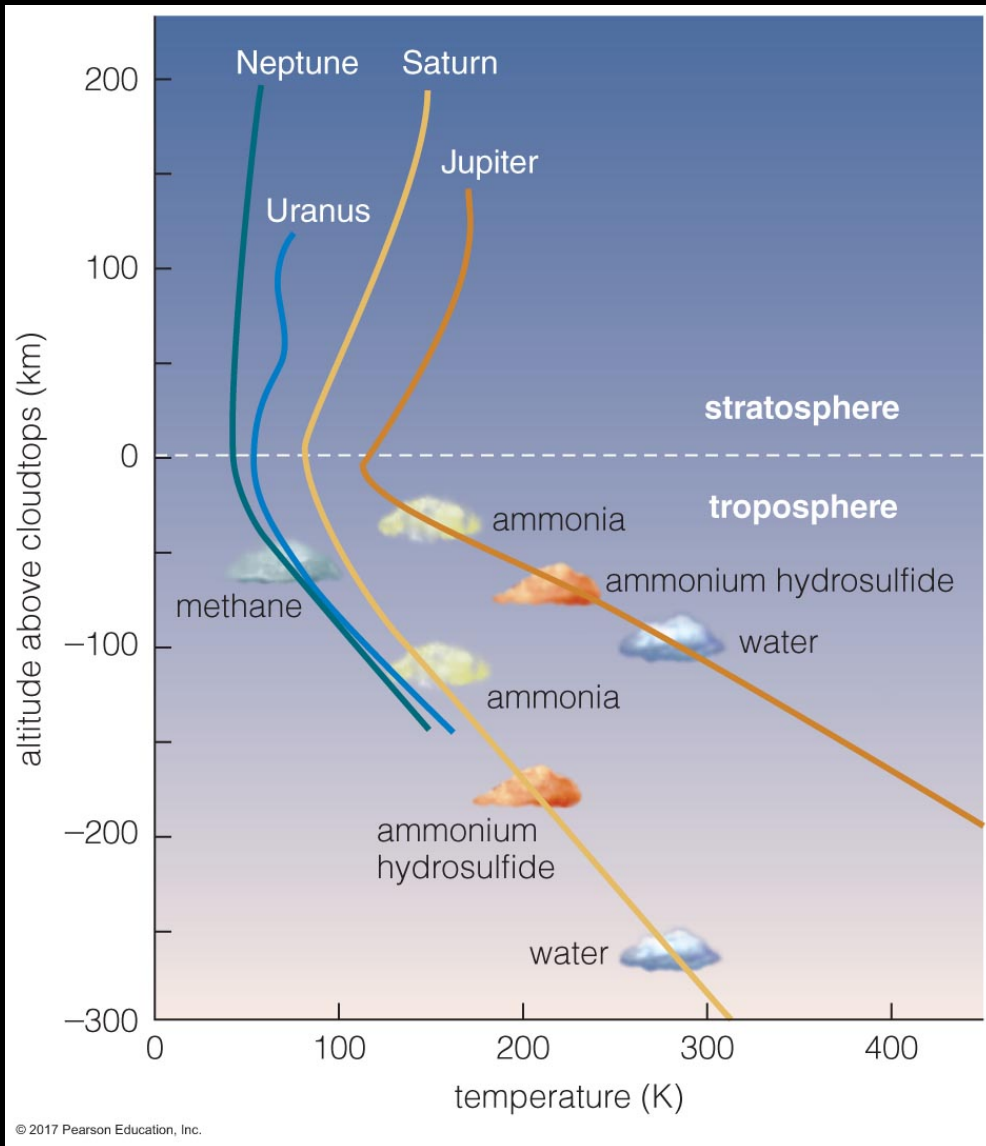
# Aerosols (clouds/hazes)

## Smog

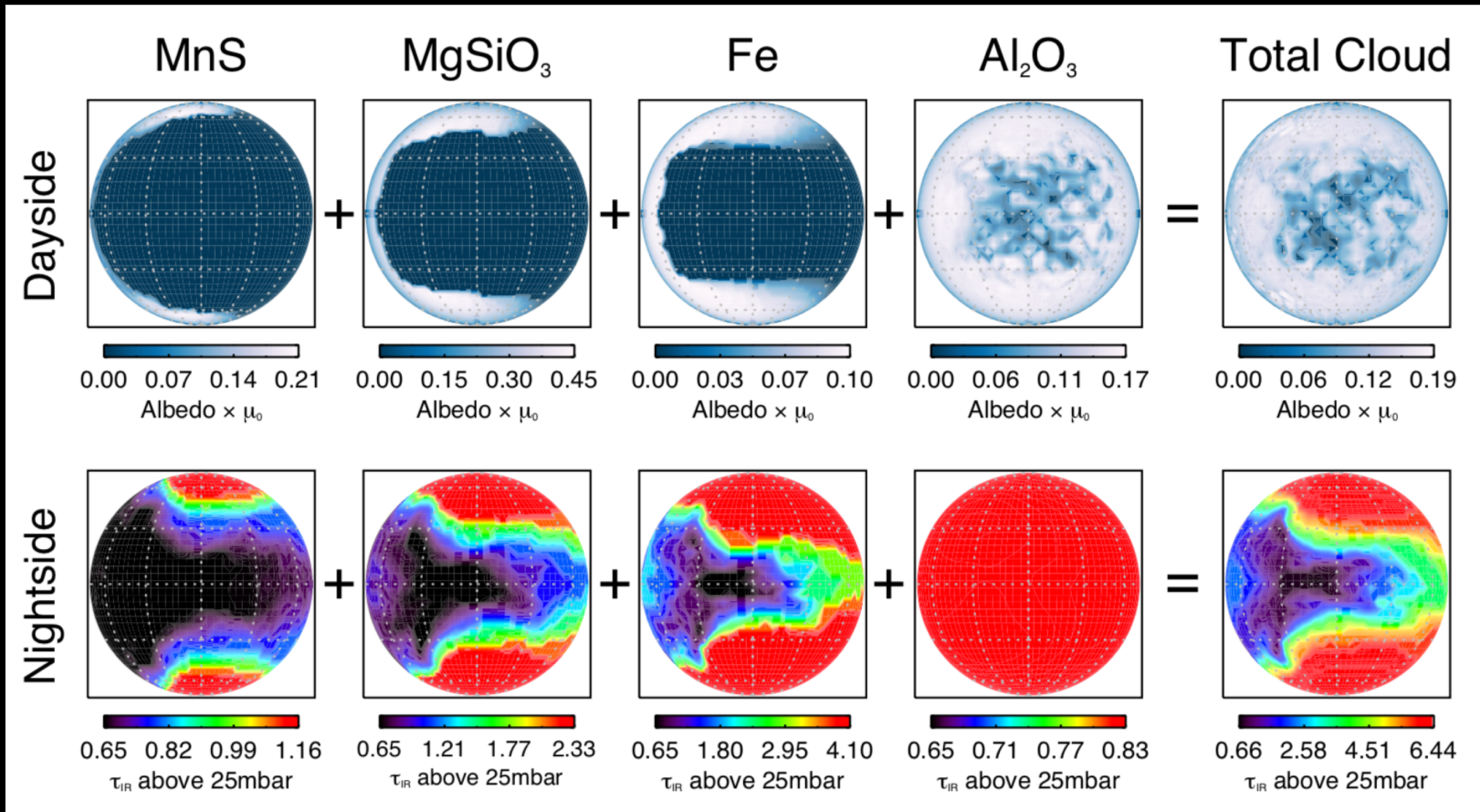




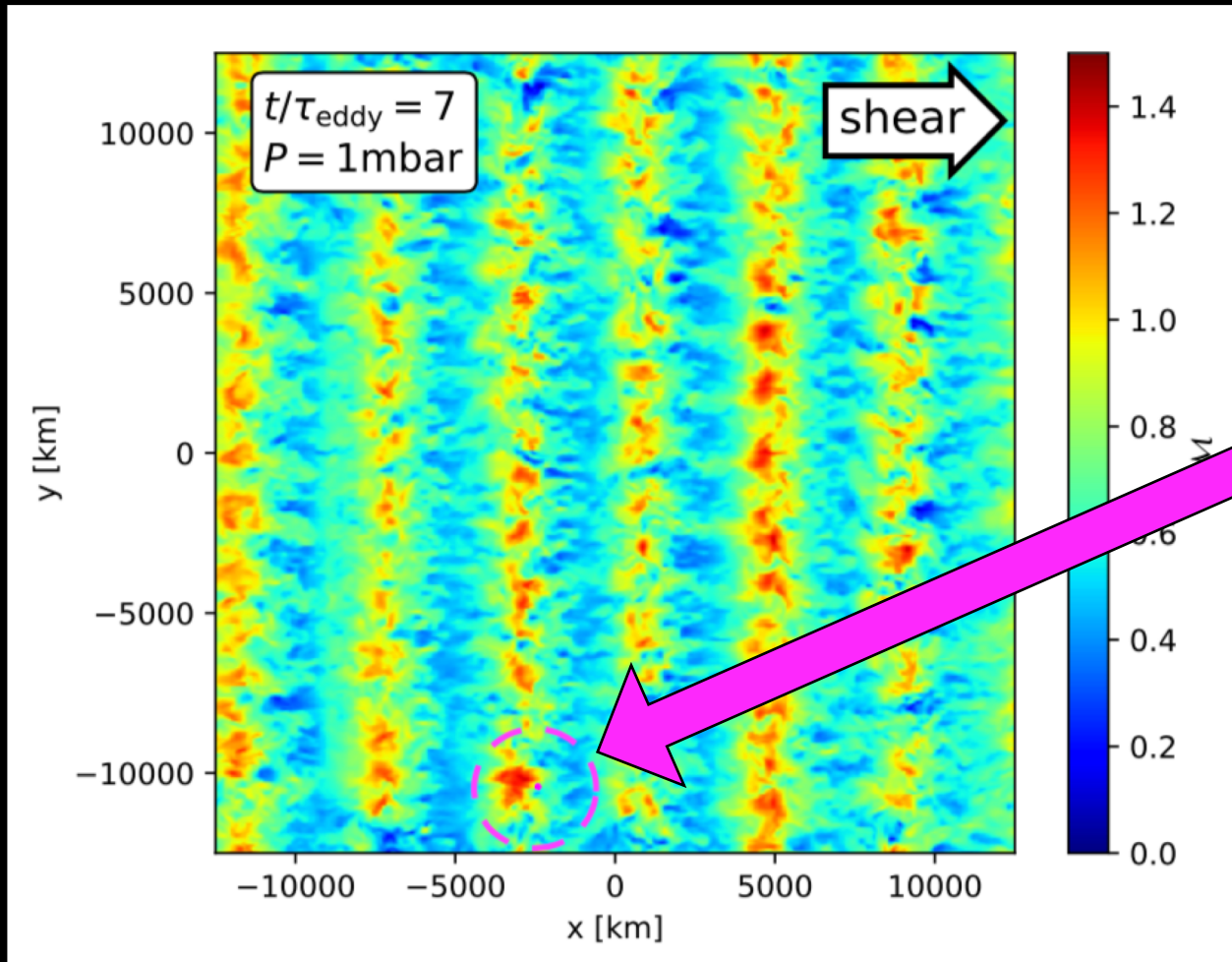
# Aerosols (clouds/hazes)



# Aerosols (clouds/hazes)



# Exotic physical processes

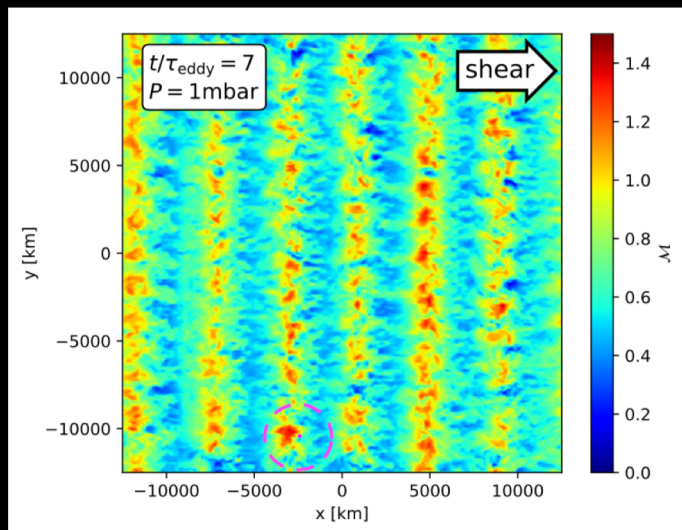


Shocks

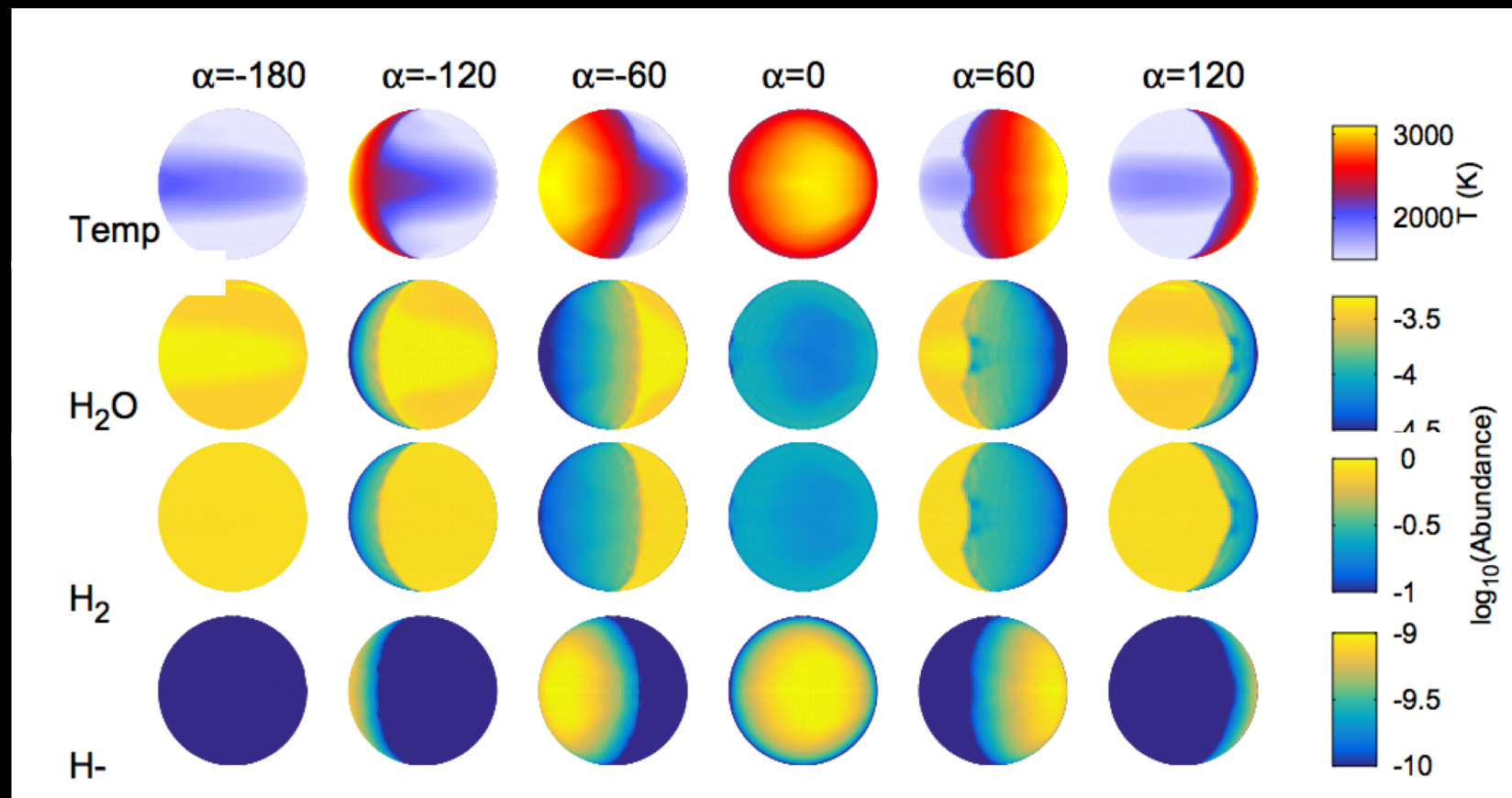


# Exotic physical processes

## Dissociation and ionization



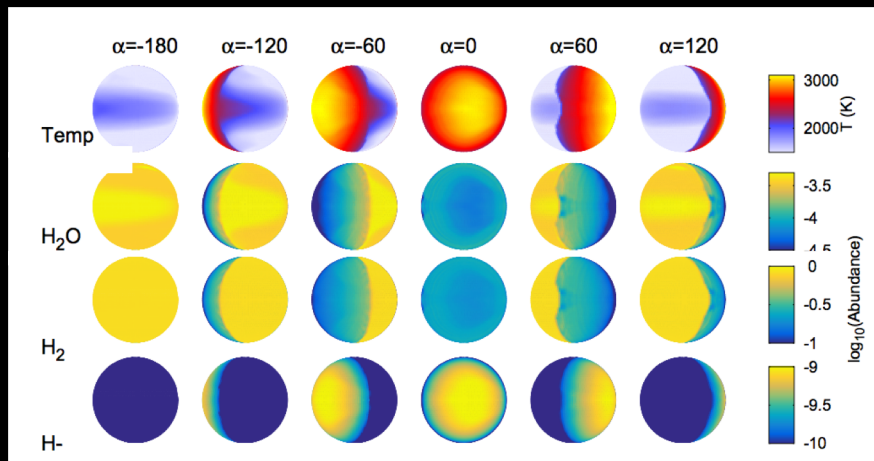
Ryu, Zingale, & Perna (2018)



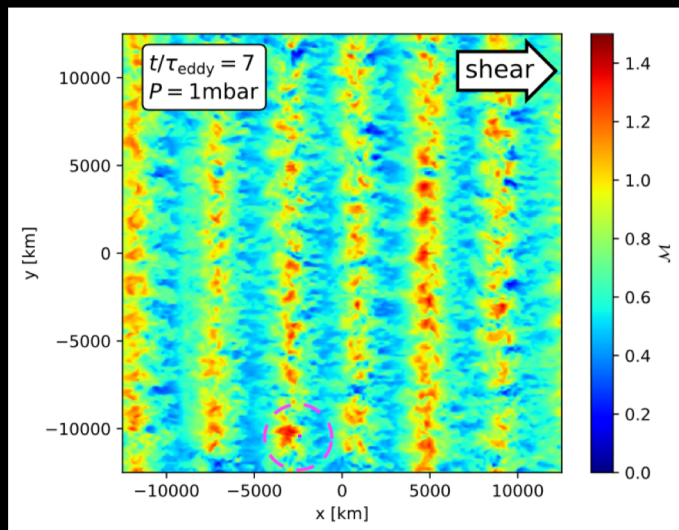
Parmentier et al. (2018)

# Exotic physical processes

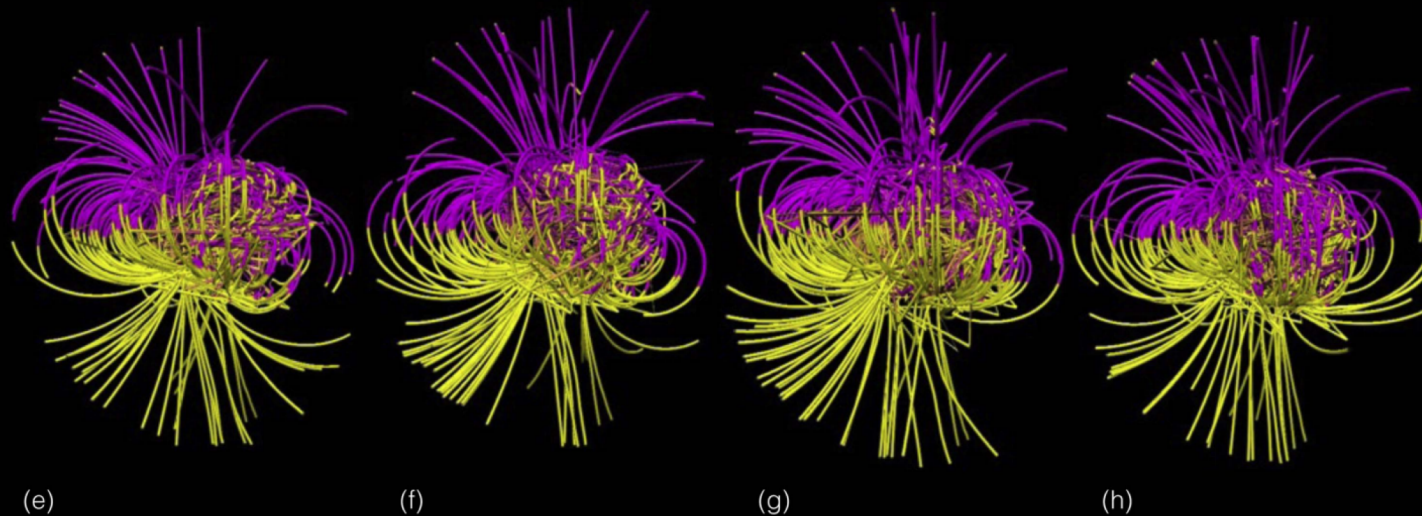
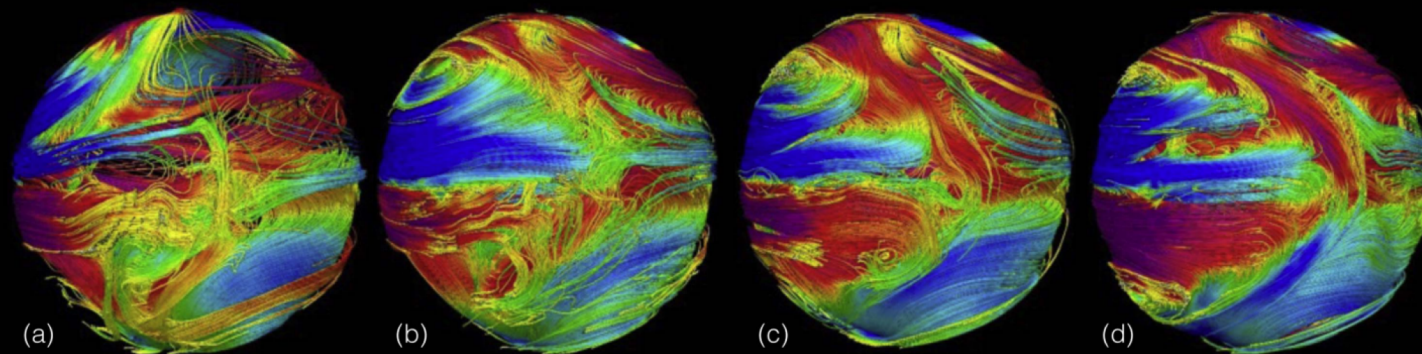
## Magnetic fields



Parmentier et al. (2018)

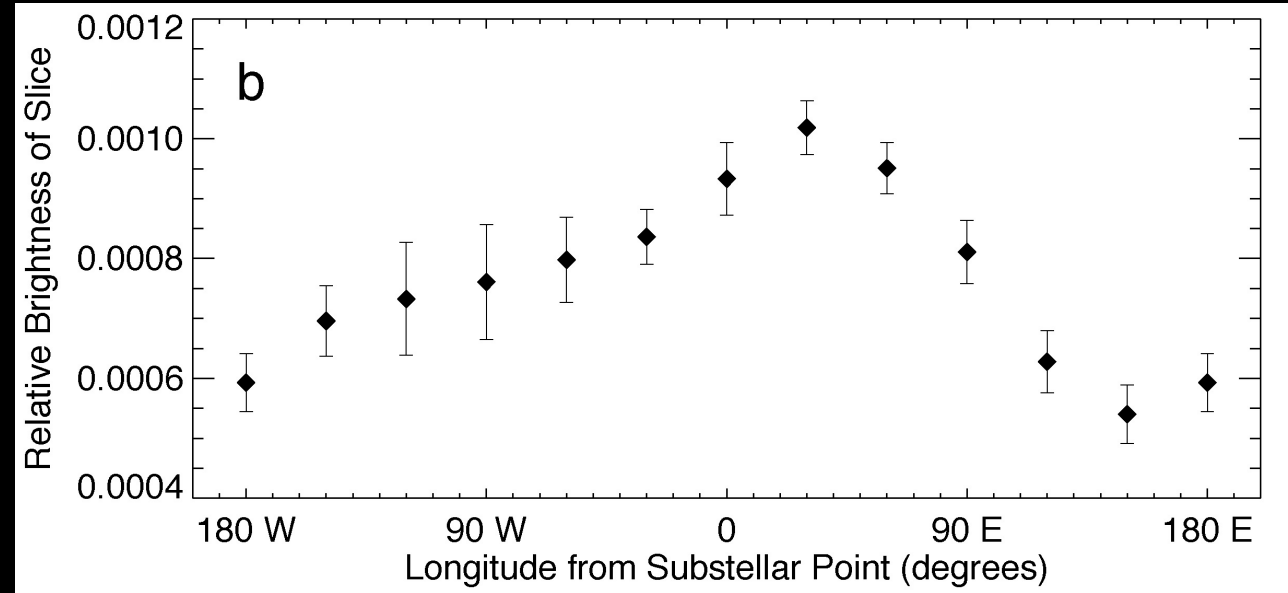
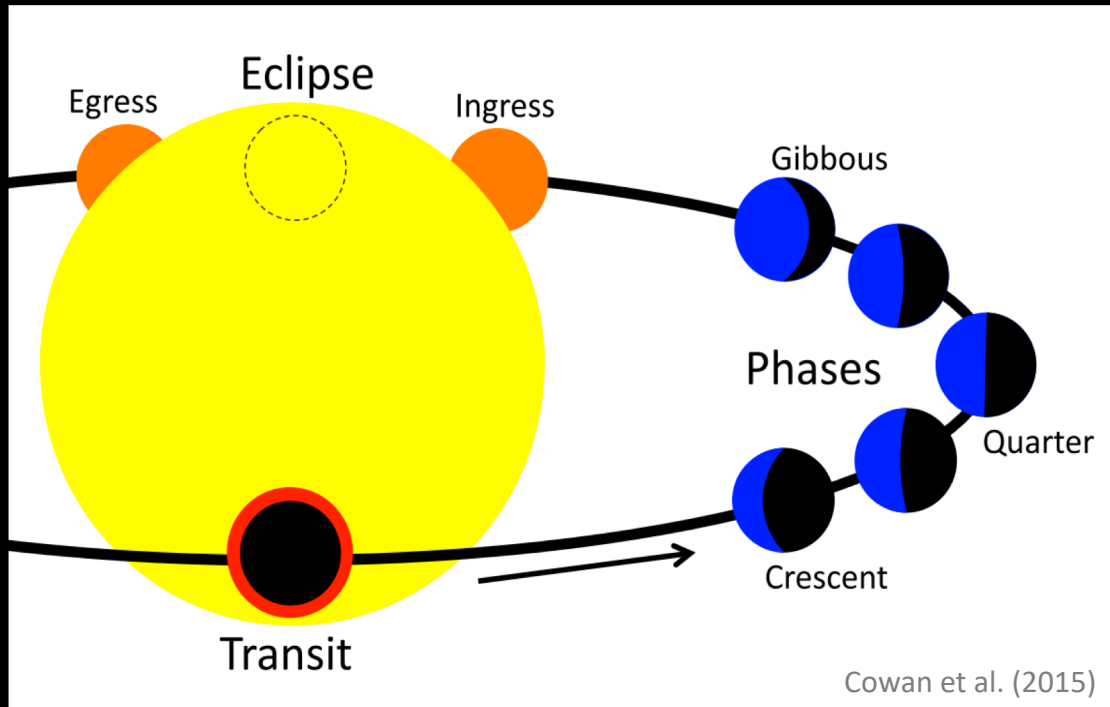


Ryu, Zingale, & Perna (2018)



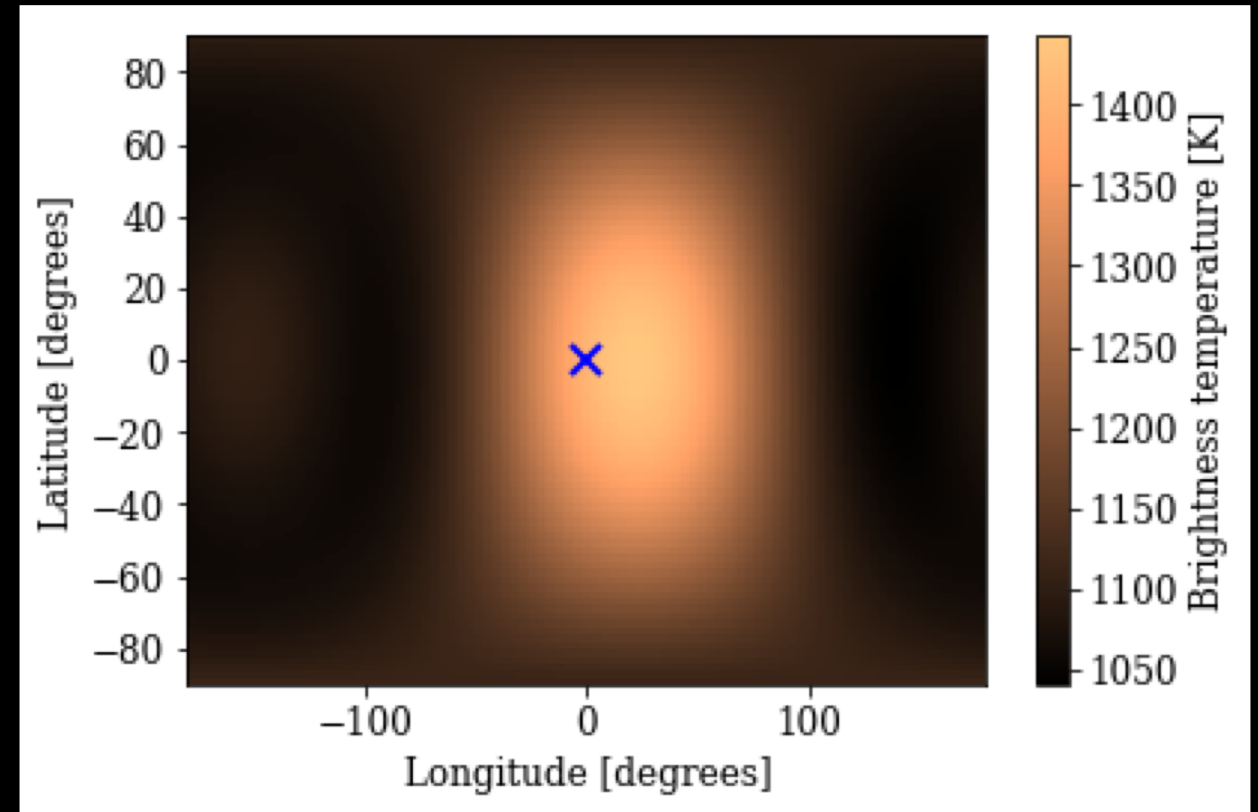
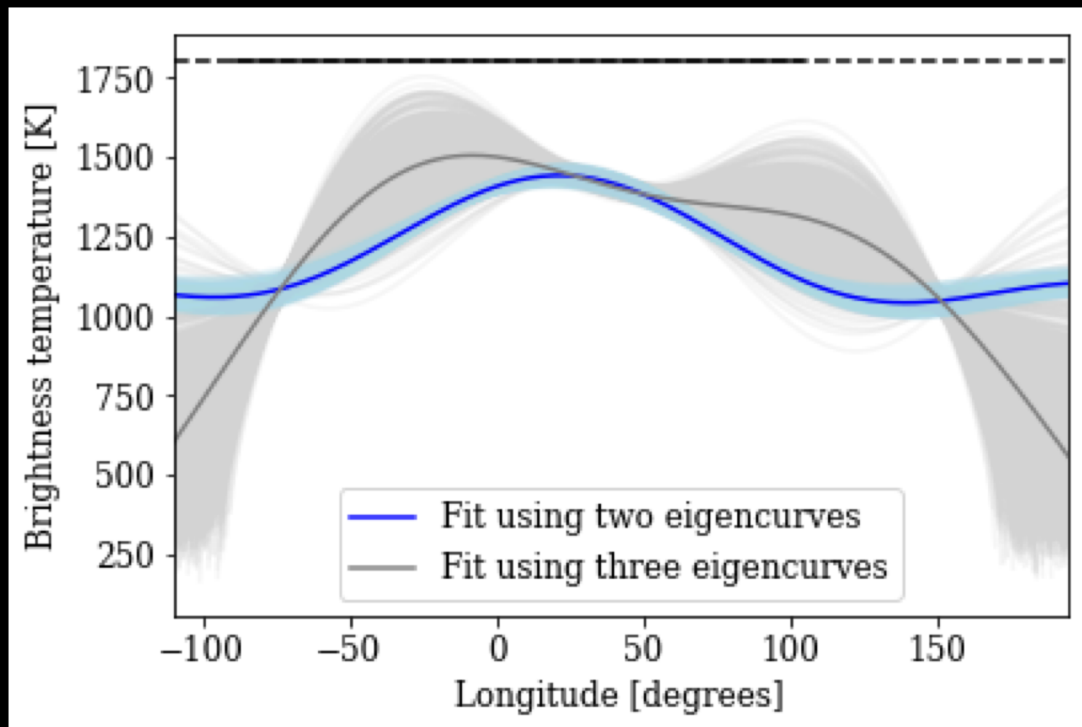
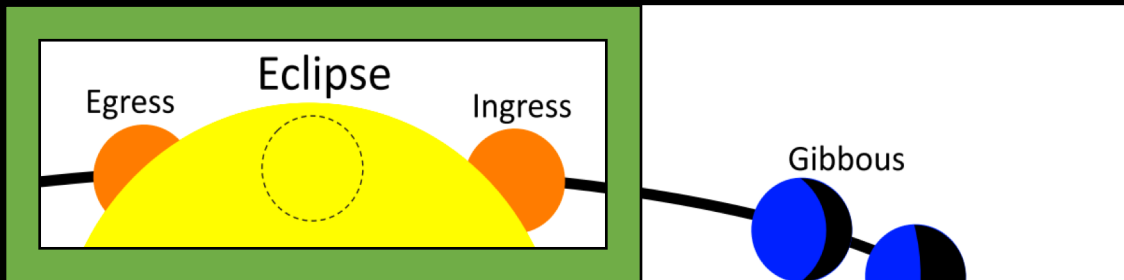
Rogers & McElwaine (2017)

# Multi-dimensional, multi-parameter retrievals





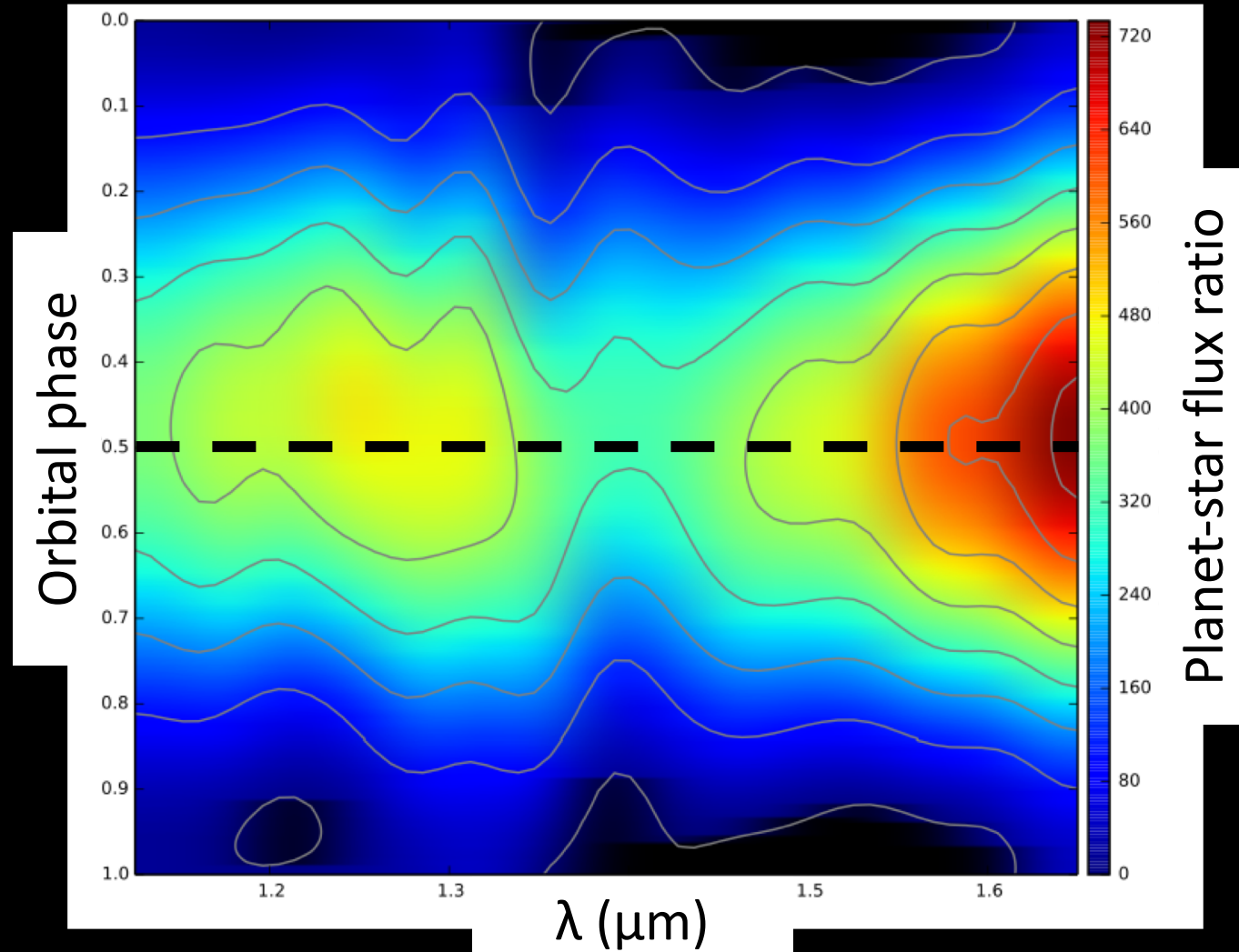
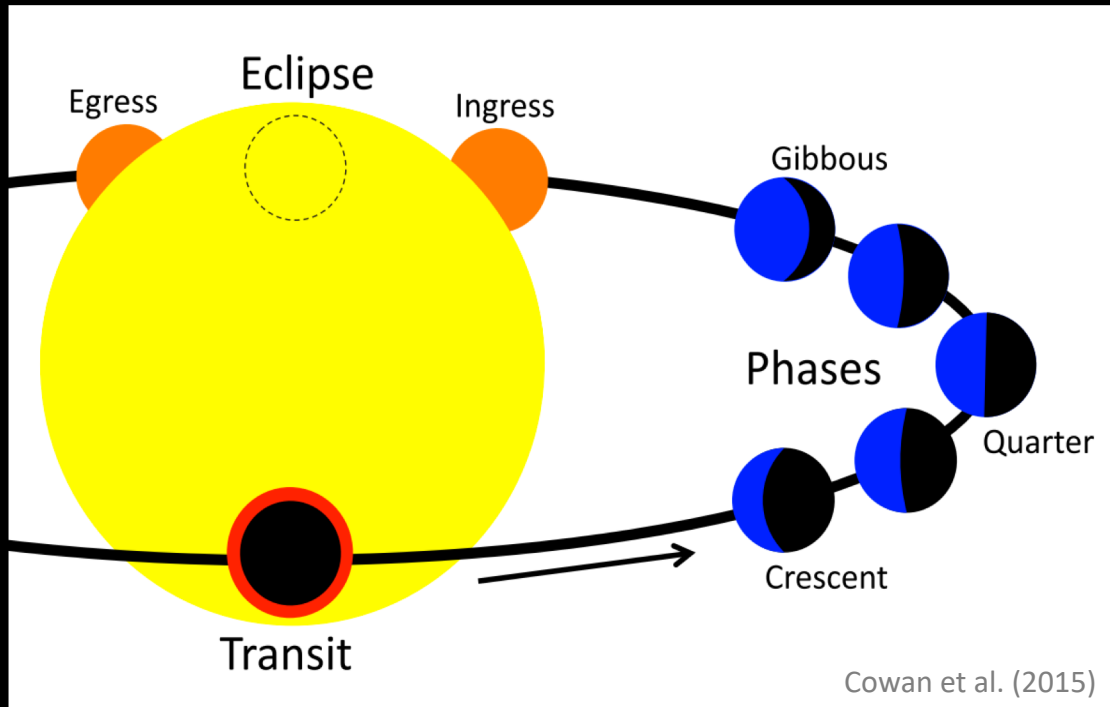
# Multi-dimensional, multi-parameter retrievals



Rauscher et al. (2018)

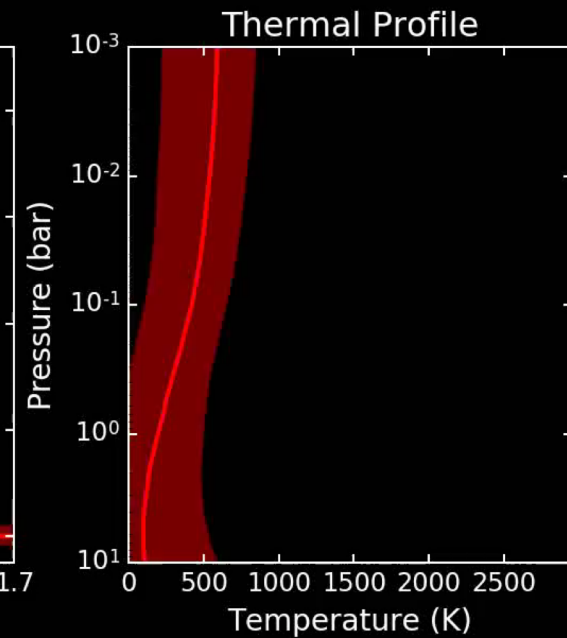
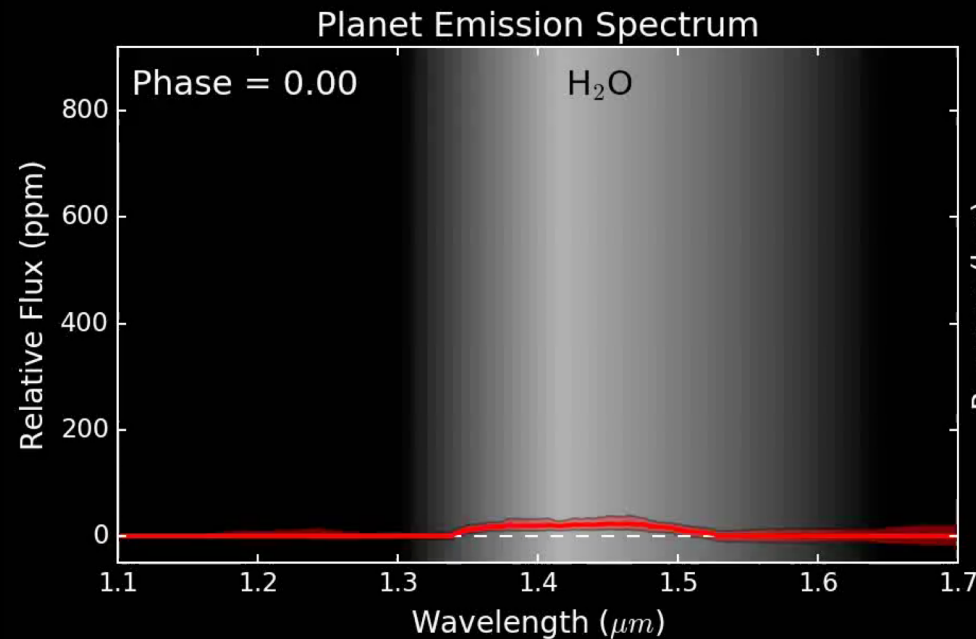
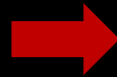
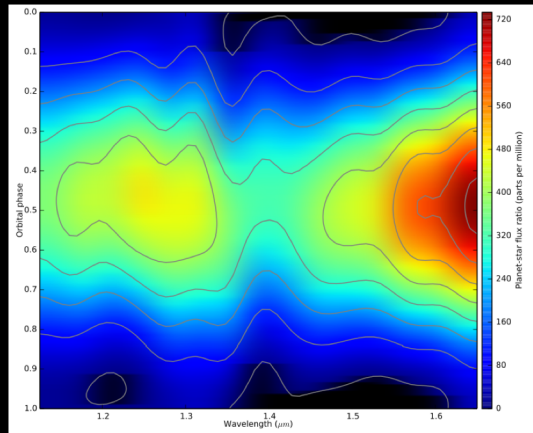
See also: de Wit et al. (2012), Majeau et al. (2012)

# Multi-dimensional, multi-parameter retrievals

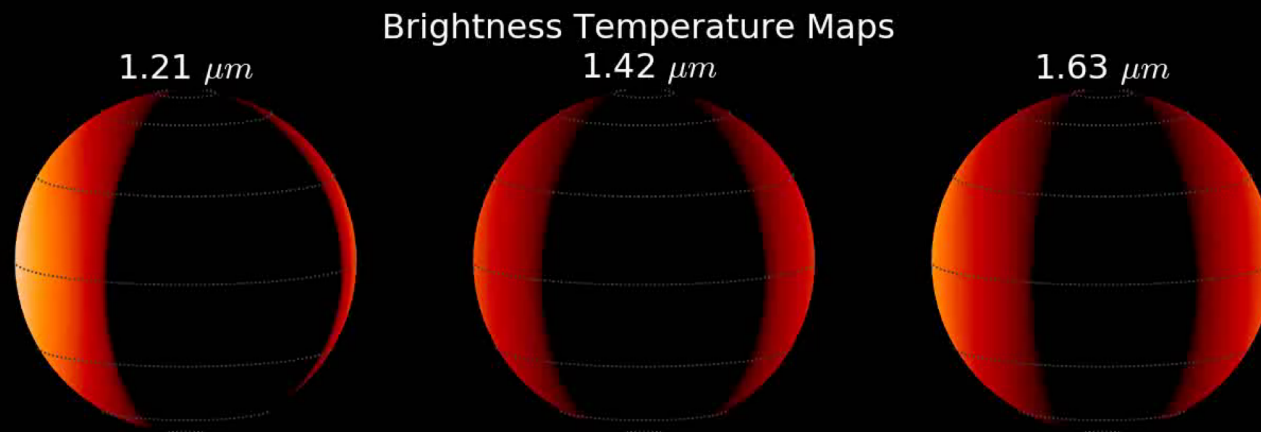


Stevenson et al. (2014)

# Multi-dimensional, multi-parameter retrievals



But we should not solve for vertical and horizontal info separately!



# Mysteries of Exoplanet Atmospheres

- Exoplanet atmospheres exist in new regimes
- What is in the atmosphere? (1D, 3D)
  - Aerosols
- How does the atmosphere work? (physical processes)
  - Shocks, dissociation, magnetism
- What can we actually measure, and how well?
  - Multi-dimensional, multi-parameter retrievals



For references: search arXiv for "Handbook of Exoplanets"