Water as a Potential Sculptor of the M Dwarf Radius Valley

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https://tinyurl.com/Bennett-Skinner-CASCA2024

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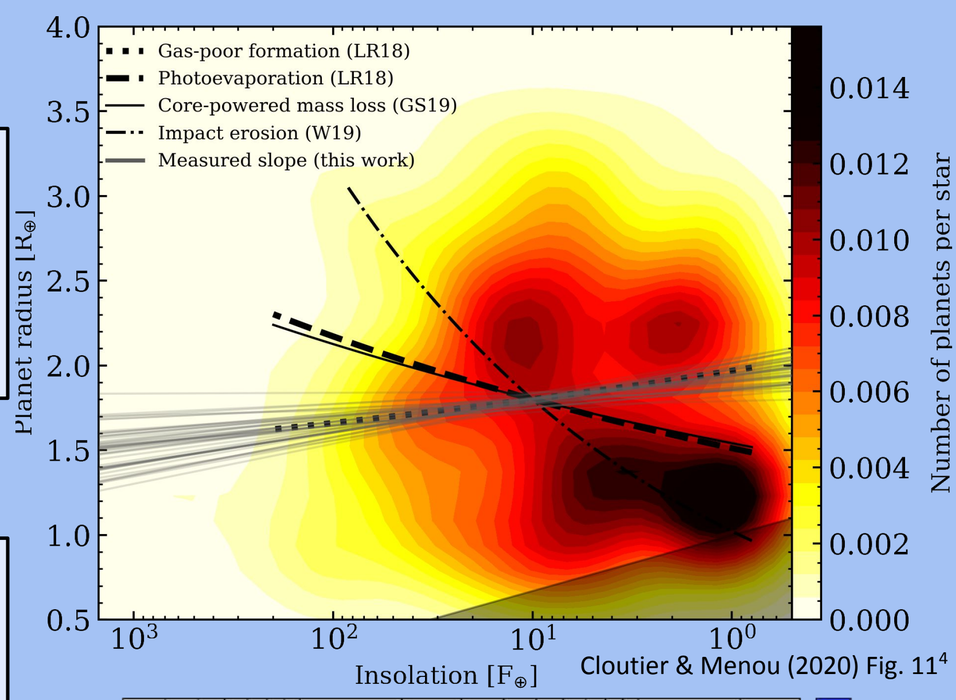
Background

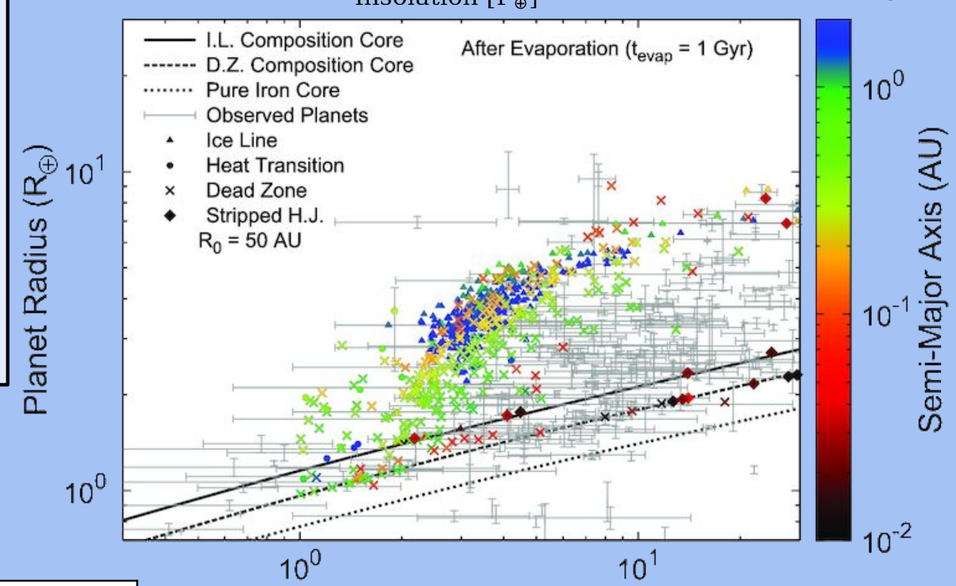
- Distribution of planetary radii is bimodal – "Radius Valley"[1]
  - Slope w/ instellation around FGK stars implies atmospheric escape[2,3]
- Slope different around M v. FGK stars[4]
  - Different formation mechanism? – Water worlds?[5]



Cloutier & Menou (2020) Fig. 11[4]

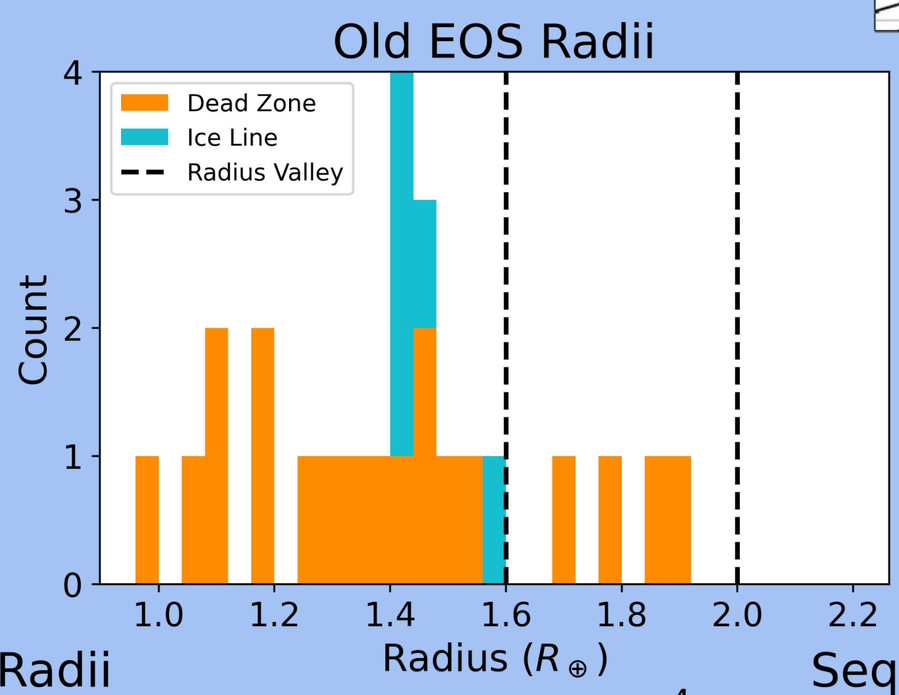
The Project

- McMaster Planet Population Synthesis model[6]
  - Planetesimal accretion in disk around FGK star
  - Planets form in planet traps at dead zone (dry) and ice line (wet)
  - Disks chemically evolve
- Recalculate planet radii w/ new advances
  - New Equations of State (EOS) for water[7], iron[8], silicates[9], opacities[10]
  - Sequestration of water into planetary interior[11]
- **Can radius valley be replicated solely w/ water?**



Alessi et al. (2020) Fig. 7[6]

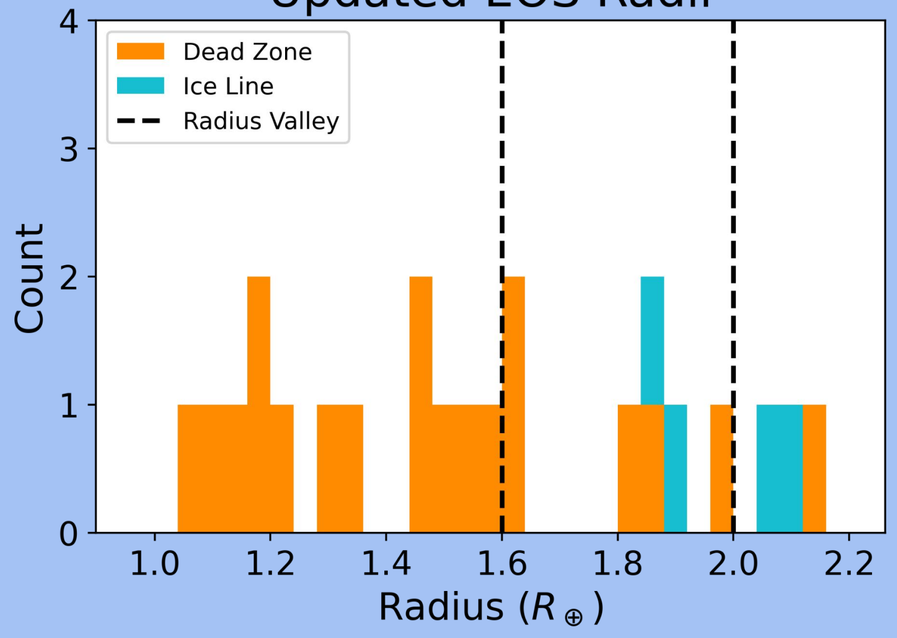
Data

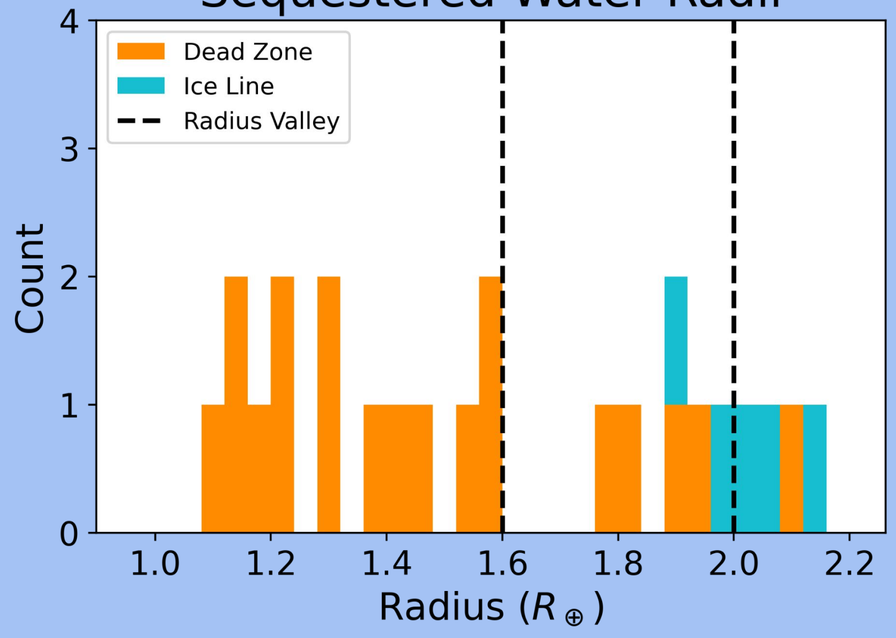


P < 100 days
H/He mass frac < 1e-3

Update EOS

Sequester Water





Results

- Updated EOS and sequestration separate water and dry worlds
  - Water does NOT solely replicate radius valley, but could contribute
  - Some water worlds in the valley

Future Work

- Update McMaster Planet Population Synthesis model for M stars
- Increase sample size by running more simulations
- Take advantage of disk chemistry tracking to improve mantle model

Acknowledgements & References

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[5]Burn, R., Mordasini, C., Mishra, L., Haldemann, J., Venturini, J., Emsenhuber, A., and Henning, T. (2024)
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