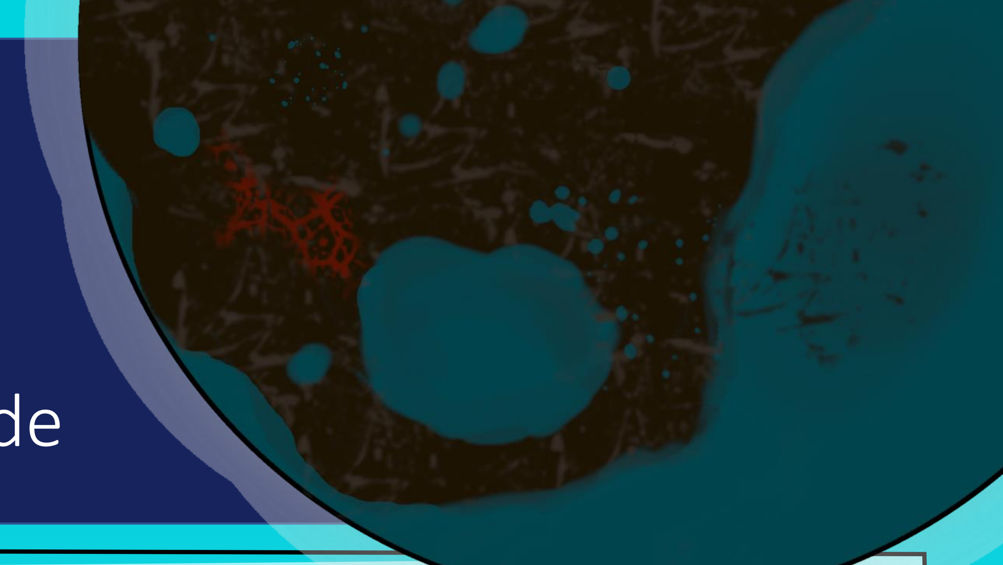

Planet mass influences the potential outgassing of water into the atmosphere of super-Earths

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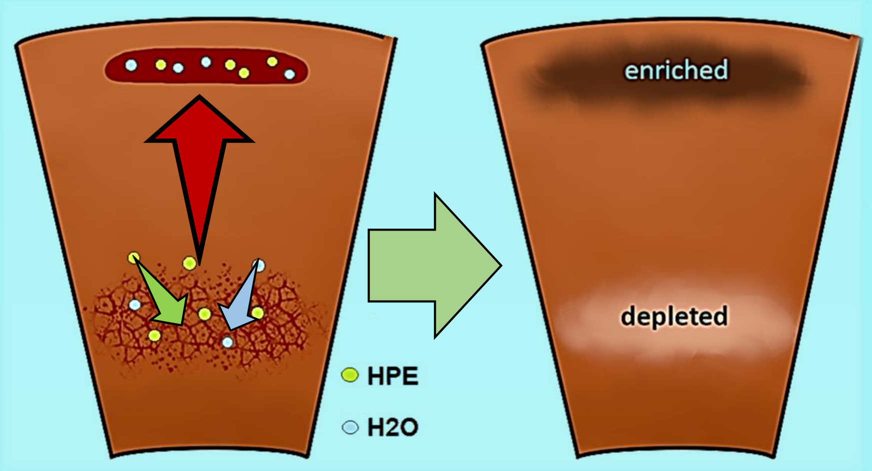
1 Objectives & Methods

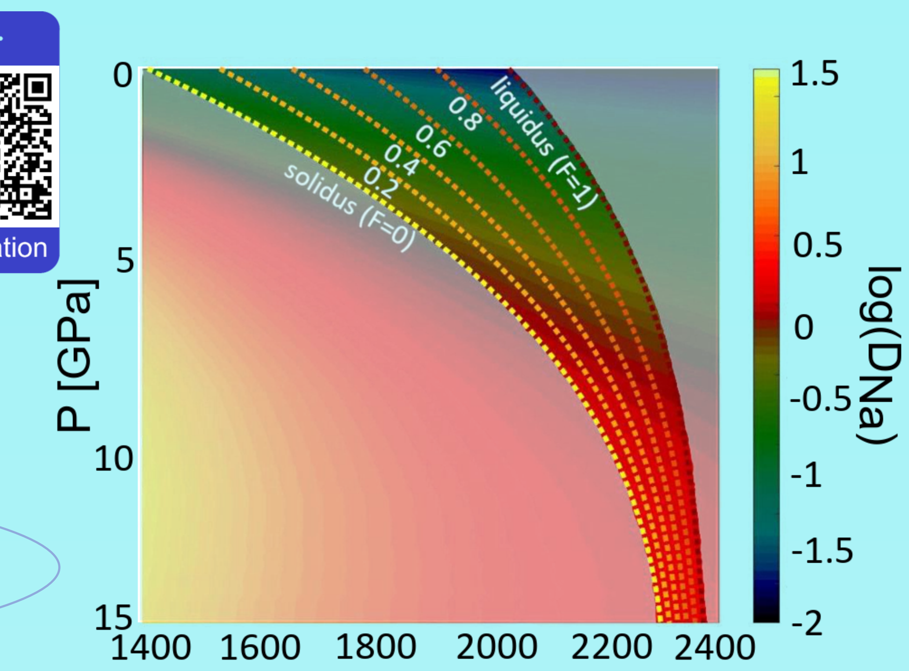


*HPE = Heat Producing Elements (very incompatible)

- Trace elements that are **incompatible with the solid upper mantle** redistributed into **partial melt.** The melt rises towards the surface:
  → this enriches the crust and depletes the mantle in incompatible elements and volatiles.
- **Mineral/melt partition coefficients ($D^{mineral/melt}$)** help to determine the compatibility of an element or volatile and therefore how many elements or volatiles are redistributed. They are highly dependent on **pressure**, **temperature**, and **compositional** changes.
  - <0-1: incompatible (goes into the melt),
  - >=1: compatible with the solid material.
- We include a P-T-X dependent partition coefficient model in a **1D interior evolution code** for stagnant lid (SL) and mobile lid (ML) **planets up to ME=1.8**, starting after the crystallisation of a global magma ocean.

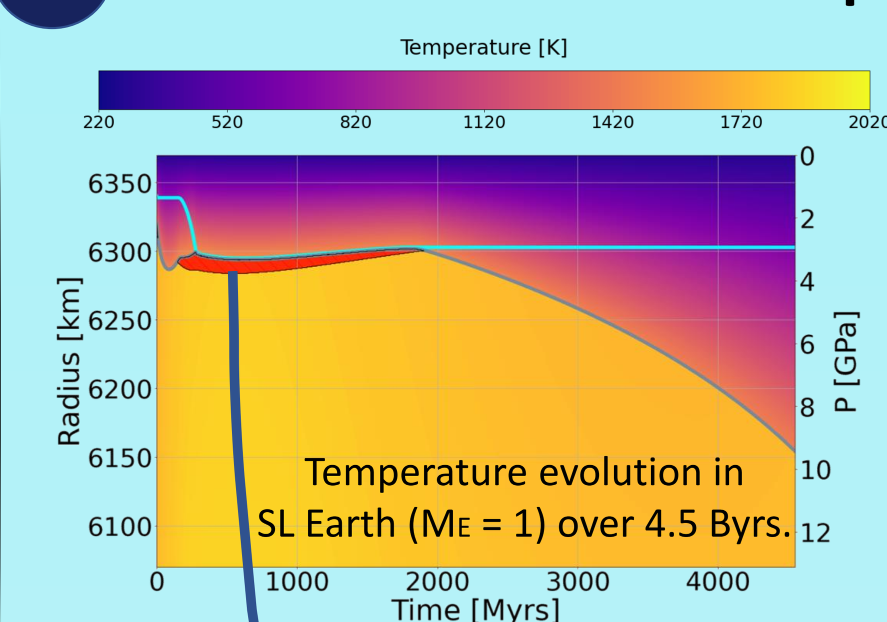
How do the modeled partition coefficients affect the redistribution of H2O and potential outgassing in mantle evolution models?

Publication

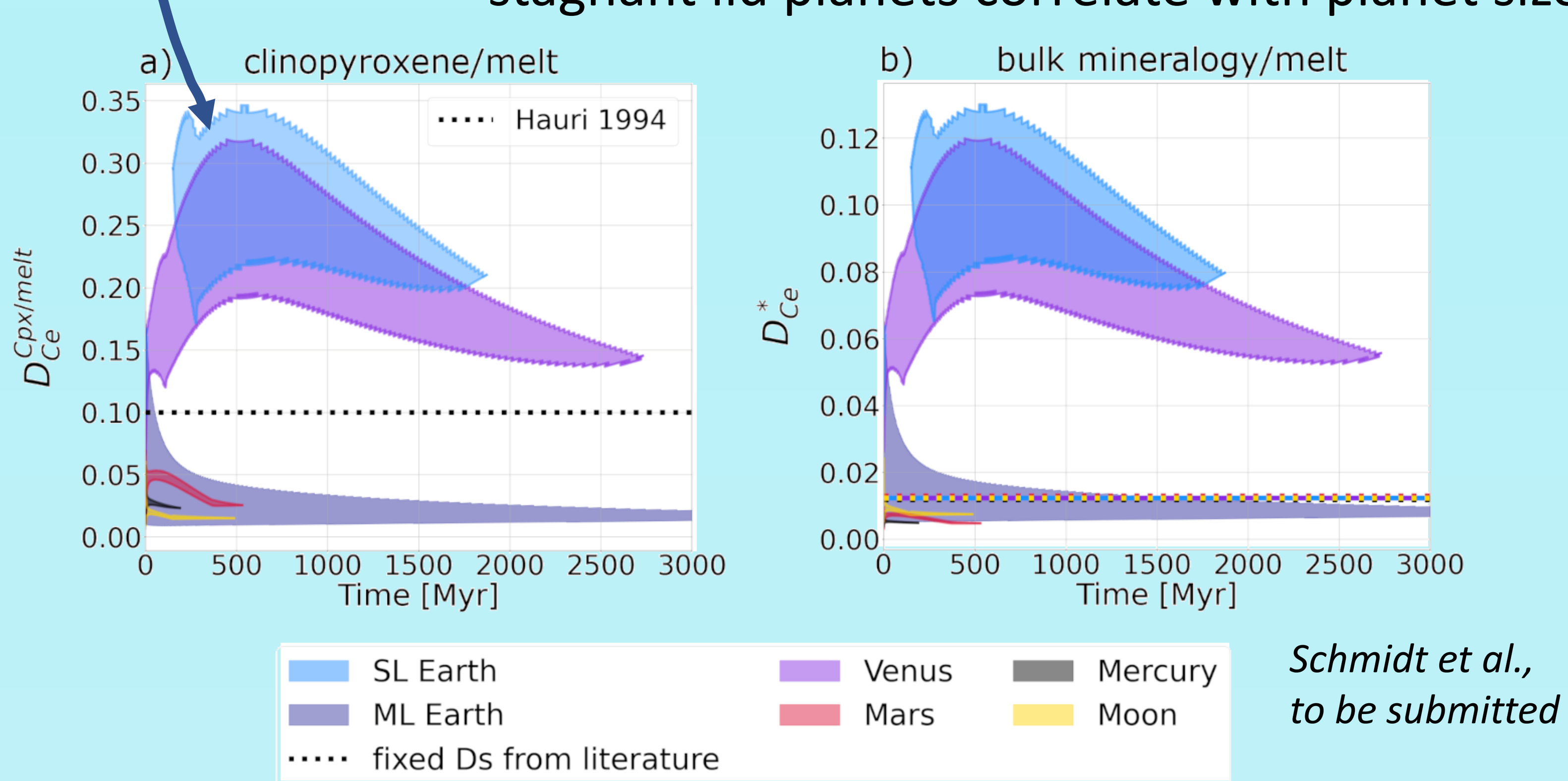


Schmidt & Noack (2021)

2 Thermal evolution and partitioning in the solar system



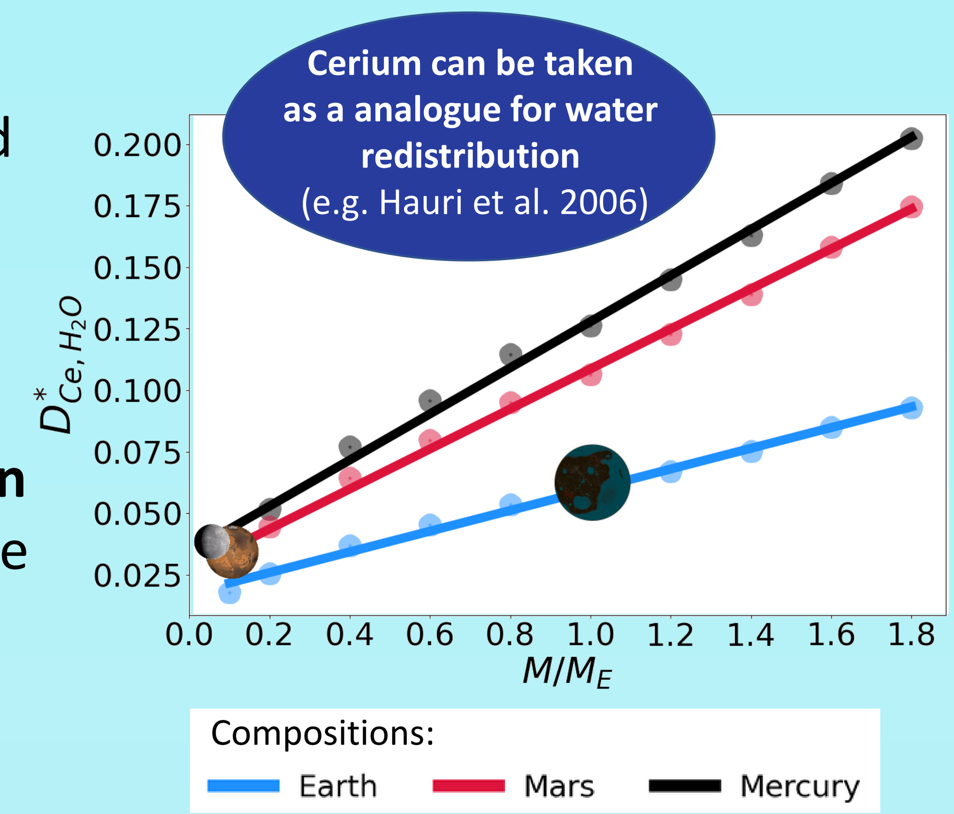
- The rocky planets form a global partial meltzone (red) under the stagnant lid (green line).
- Larger planets exhibit larger D ranges inside their melt zones.
- Ds for Cerium (and H2O) in the meltzones of stagnant lid planets correlate with planet size.

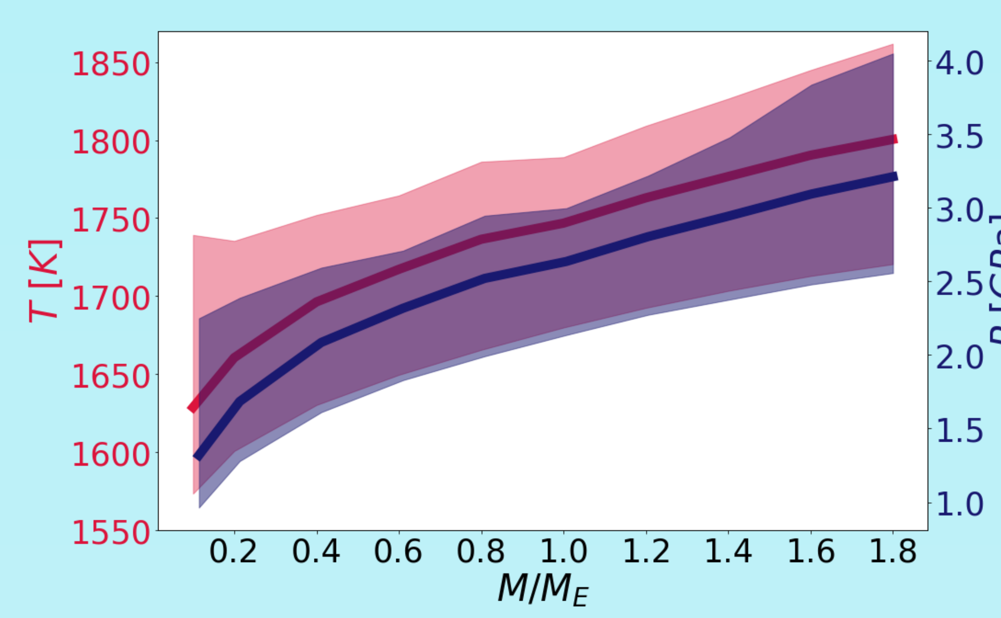


Schmidt et al., to be submitted

3 Partitioning trend in super-Earths planets

- In super-Earths, the average Ds for Ce and H2O **increase the larger the planet mass**.
- The **melt composition** and **mineralogy** of the upper mantle have a large influence on potential H2O redistribution.



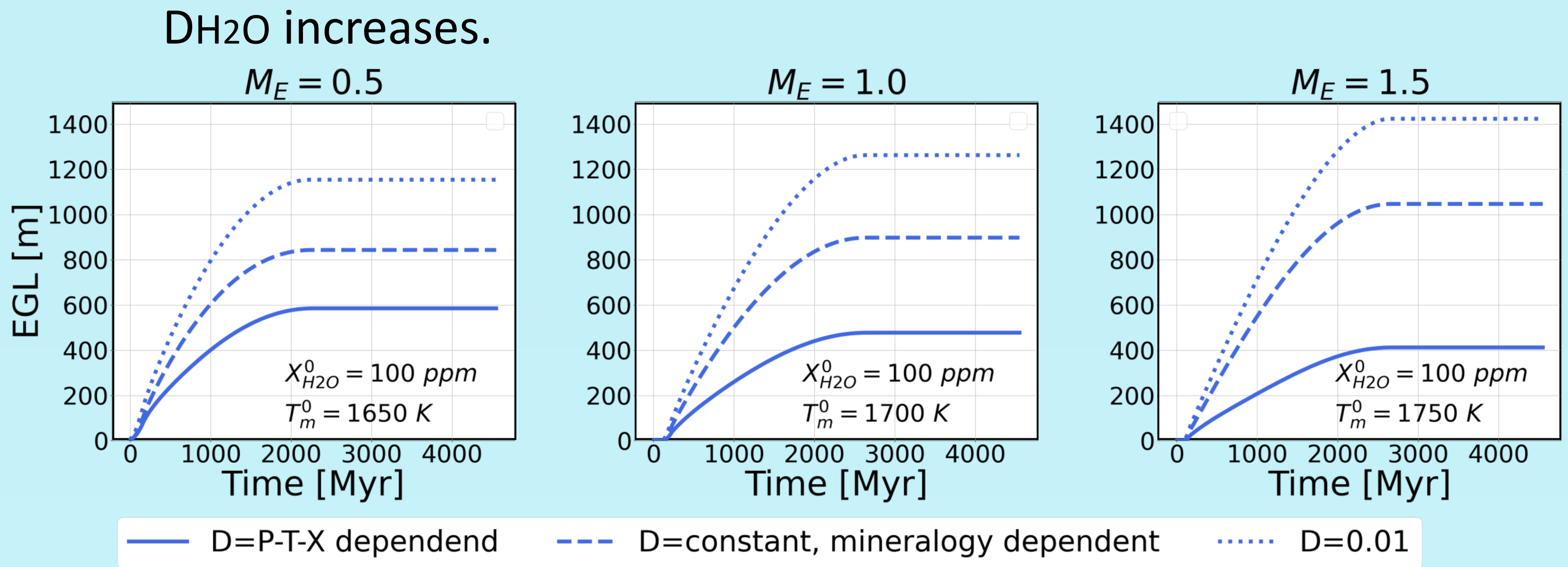


- The **rising P-T conditions** inside a partial melt zone with increasing planet mass lead to higher Ds for Ce and H2O.

4 Potential Equivalent Global Layer (EGL) of Exoplanets

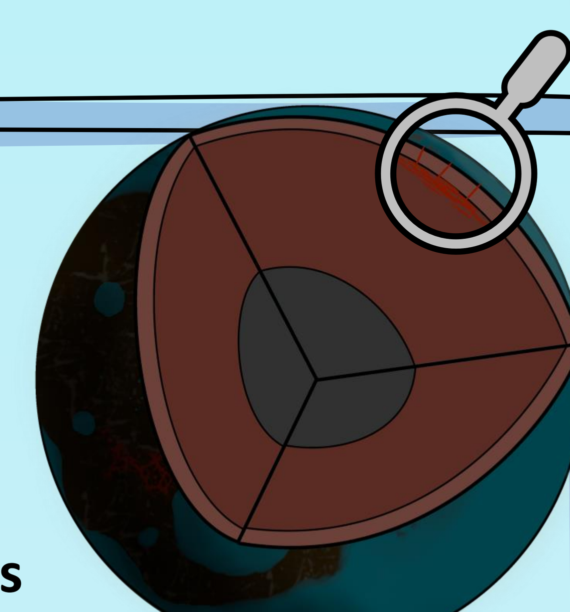
EGL = potential ocean composed of all outgassed H2O

- **Without D calculations**: With larger planet mass, we achieve more outgassing and a thicker EGL.
- **With D calculations**: With larger planet mass, we achieve more outgassing and a thicker EGL.
- Taking into account the high pressures inside a partial melt zone, DH2O increases.



*EGL if other processes important for outgassing (partial pressure, oxygen fugacity,…) are ignored

5 Summary & Conclusion



- **Pressures** and **temperatures** inside a partial melt zone **rise** with increasing planet mass due to higher gravity.
- From ME=0.1 to ME=1.8, **DH2O increases almost one order of magnitude**:
  - The larger the plant mass, the larger the discrepancy between the assumed P-T-X dependent model Ds from this study.
  - More water is retained inside the mantle due to higher DH2O, resulting in less outgassing and a thinner EGL.

Open Questions:
Influence of other processes inhibiting or futhering outgassing?
Is Ce still behaving similar to H2O in high-pressure regimes like super-Earth still applicable?

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