

Comments for NAS Panel on Planetary Protection

March 21, 2024

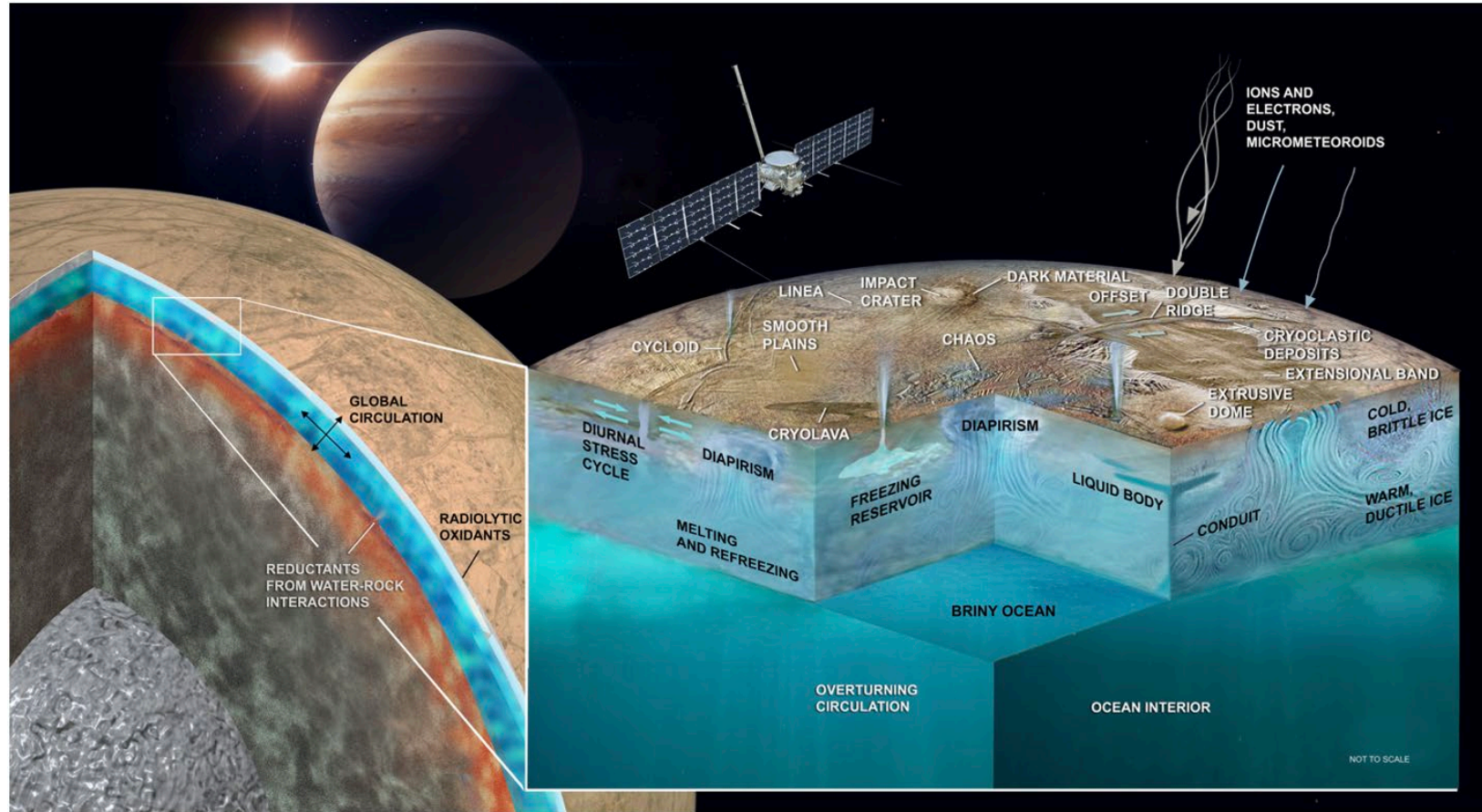
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There's so much we don't know!

- The COSPAR protocol prudently assumes the lower-limit activity of water (LLAw) is met
- This allows for downward revision of LLAw based on evolving understanding of life on Earth

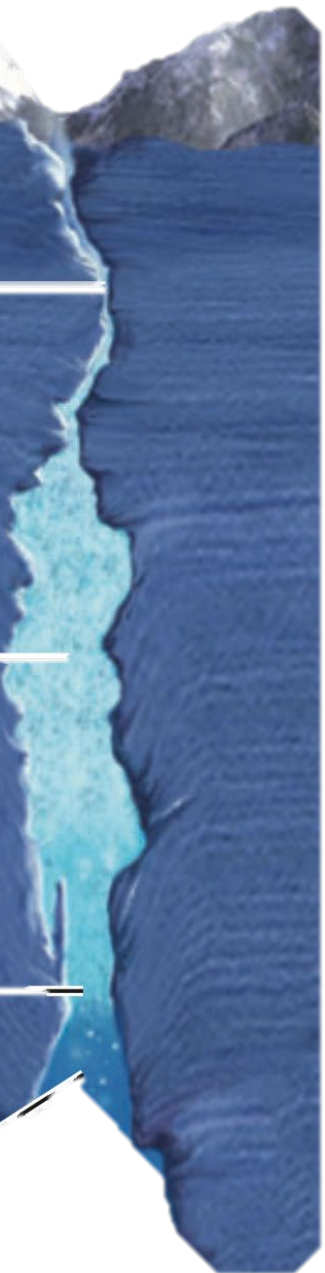
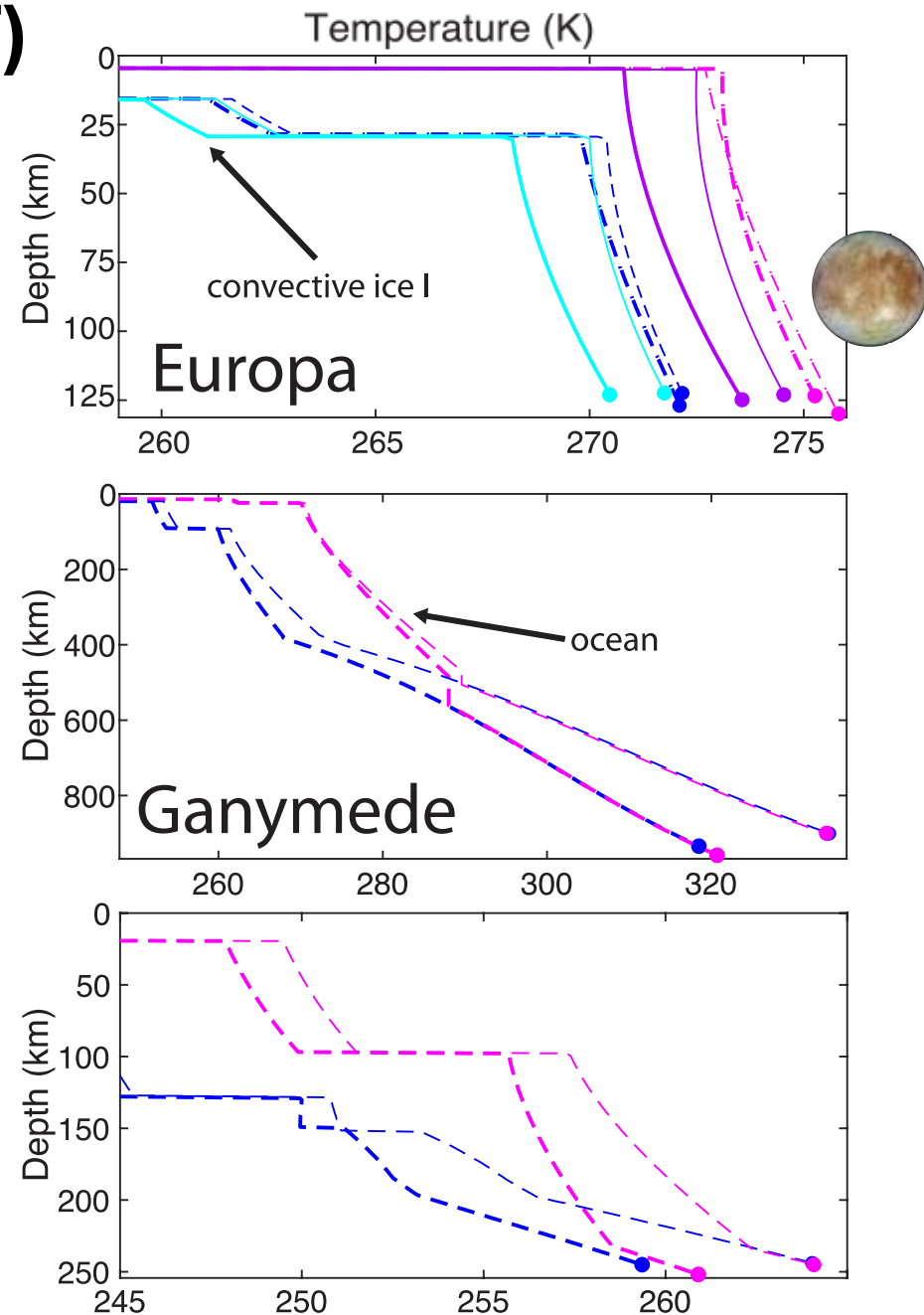


Lower-Limit Temperature (LLT)

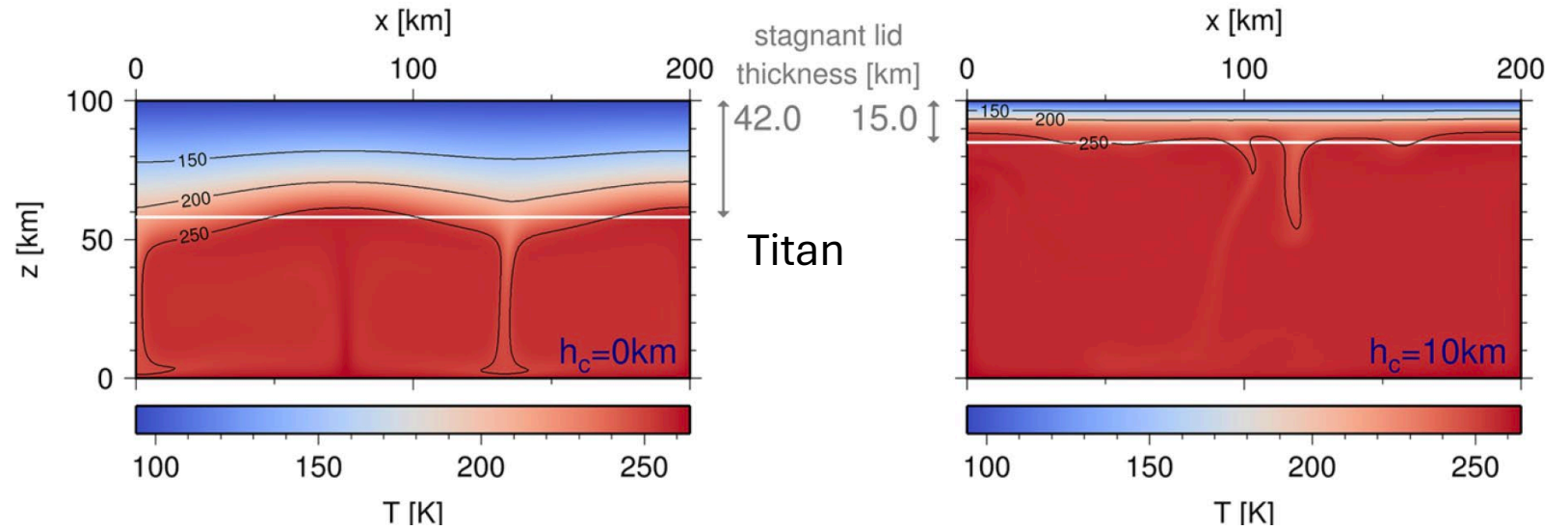
A major goal of Europa Clipper is to understand the tectonics of an icy world. At present it is difficult to say definitively where the -28°C line is reached.

At Enceladus, the workings of the plume and individual jets also remain unknown. Temperatures along the Tiger Stripes might exceed -28°C close to the surface.

Thermal models typically do not account for thermal “blanketing” of low porosity near-surface materials or clathrates.



Lower-Limit Temperature (LLT)

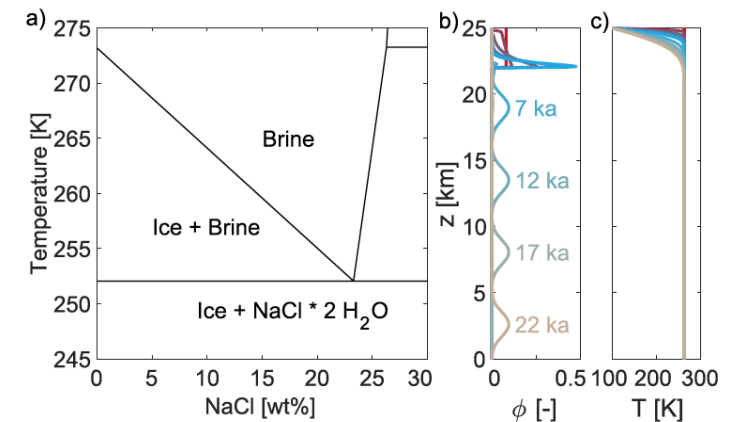


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Kalousova and Sotin 2020

Lower-Limit Temperature (LLT)

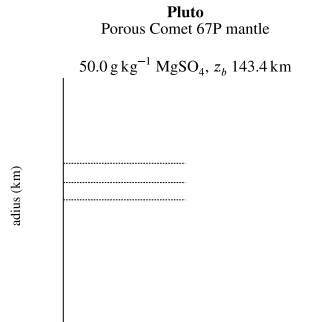
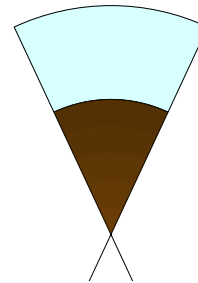
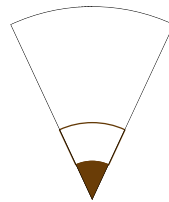
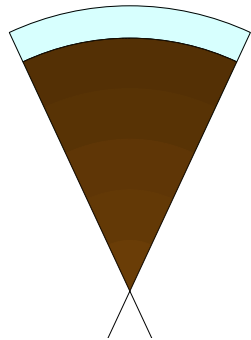
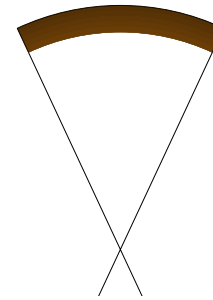
- Major questions remain about the rheology of tidally forced icy bodies in terms of
 - their complex frequency response (Bierson 2024)
 - Intragranular melting (McCarthy et al. 2016)
- The timescale of downward transport is likely $>1000\text{yr}$, but this remains an area of active research
 - E.g., Kalousova et al. 2014, Hesse et al. 2022



Hesse et al. 2022

*Icy Worlds in our Solar System are defined as all bodies with an **outermost layer** that is believed to be greater than 50% water ice by volume...*

Ganymede



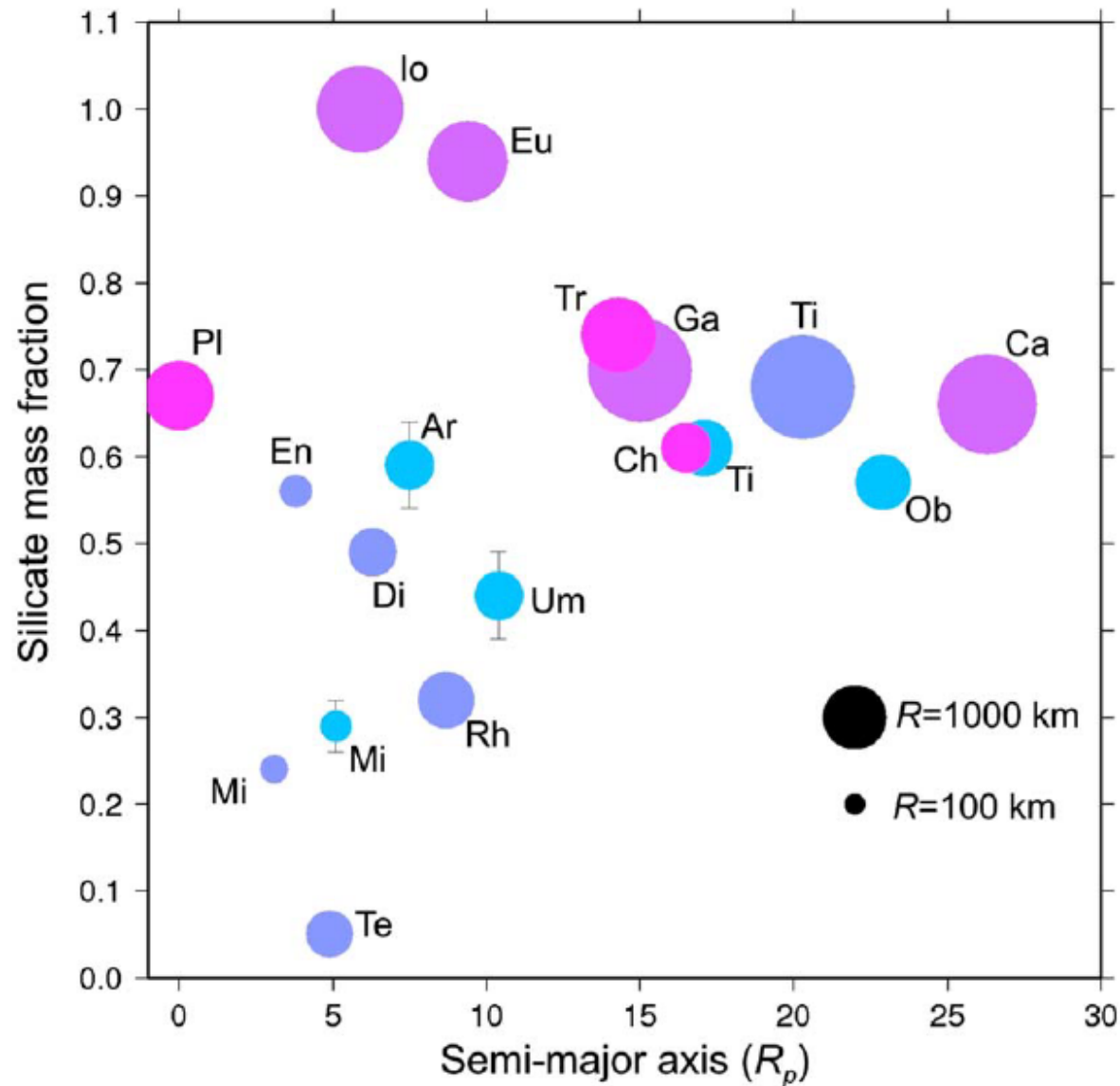
Umbriel
Porous CI chondrite mantle
undifferentiated
10.0 g kg⁻¹ Seawater, z_b 102.4 km

Miranda



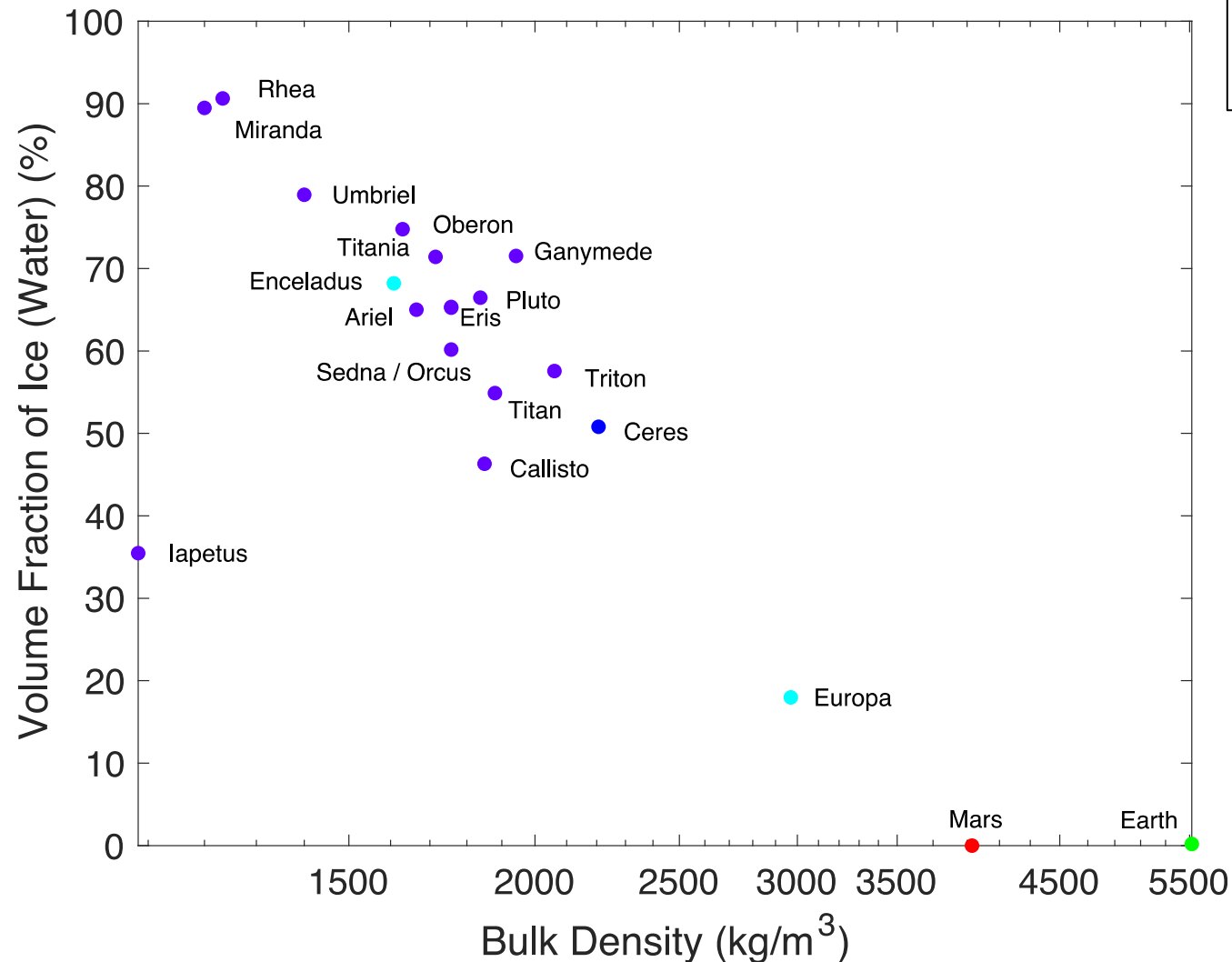
How thick does the layer need to be?

Icy Worlds in our Solar System are defined as all bodies with an outermost layer that is believed to be greater than 50% water ice by volume...



*We chose 50 % because bodies of the outer Solar System are **half ice/ rock** and, if they have a round shape, differentiation is going to make the crust >50 % water ice by volume (we consider water ice in this definition to encompass both amorphous ice and clathrate).*

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Further comments

- *(5) Restructure or remove Category II* from the policy as it becomes largely redundant with this new approach*
 - PP policy should address organic environments on Titan (and possibly other bodies, e.g. Pluto), where some hypothesize that life might exist in liquid hydrocarbons

Minor comments on the paper*

- No induced field detected at Ganymede