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Interactive comment

Interactive comment on "TRAPPIST-1 Habitable Atmosphere Intercomparison (THAI). Motivations and protocol" *by* Thomas Fauchez et al.

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This is an interesting proposal for a exoplanet GCM (global climate model) intercomparison. I am a fan of the general idea and the project's open nature – given the booming interest in the field, model intercomparisons such as this one will be playing an important ongoing role. I also think the experimental setup is generally appropriate, but clarifications on the overall design and on some of the modeling choices would be helpful. See below.

*Major comments: - What plans do the authors have for an online presence to share necessary input files as well as model outputs? In particular, it is not clear to me how participants who are interested in submitting a model would obtain the necessary host

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Discussion paper

star spectrum. I would also strongly encourage the authors to make their main output netcdfs publicly available (=not on a personal/professional website) so that model developers or graduate students will still be able to access the results five years from now. Github sounds like an easy option. Similarly some of the co-authors, e.g., the ROCKE3D team, have been doing great work in making their files available to the rest of the community, which might also be feasible here.

- To understand the likely-important impact of cloud parameterizations, what about a version of Hab1/Hab2 that still includes water vapor/latent heating effects but disables the radiative effects of clouds (see Yang et al 2019)? This setup should be easy to implement in most GCMs.

- I know that this is not easily done with many GCMs, but adding a 1D single column case to the intercomparison would be very useful for isolating differences due to clearsky radiative transfer. These differences can be far from negligible (see Yang et al, 2016), and at least some of the models in this study should be able to run in 1D. Even if a 1D intercomparison isn't feasible here, calling for such an option would at least be a useful sign to model developers.

- For the pure N2 case, do the authors still want models to include N2-N2 collision-induced absorption or is this supposed to be an atmosphere that is completely transparent? For an intercomparison, the latter case would presumably be interesting. However, I'd think that a zero-opacity atmosphere might easily lead to numerical issues (first, some radiation codes just crash if run with zero optical thickness; second, a zero- or low-opacity atmosphere might become extremely warm, because it is still heated by sensible heat fluxes on the dayside but can't easily shed the heat via radiative cooling, leading to potential further numerical issues). If such issues arose during the study, it would be worth discussing how participating models have dealt with them.

*Minor comments: - Figure 1, bottom row: add global-mean albedos somewhere on this figure?

- Page 7: the intercomparison fixes albedos, but what about sea ice dynamics?

- Page 7: do the Hab1 and Hab2 cases with a zero-ocean-heat-transport slab ocean reach steady state on the nightside? In particular, does the sea ice thickness asymptote to a finite value?

- Page 9 "should have reached radiative equilibrium" To what precision, in W/m2? Also, the global-mean top-of-atmosphere radiative equilibrium will be dominated by the warm dayside. The nightside could take much longer to reach equilibrium (smaller flux = longer equilibration timescale). Have the authors looked at the nightside surface budget, to see if it reaches equilibrium?

- Page 11 "LMD-G is available upon request." From whom?

*Technical comments: - Abstract, l.3: "... may soon be able to characterize, through transmission spectroscopy, the atmospheres of rocky exoplanets..." Why emphasize transits over other techniques that the manuscript mentions later on (e.g., emission spectra or phase curves)? The results of this work will be interesting more broadly.

- Abstract, l.14 "The four test cases included two land planets composed of pure N2 and pure CO2, respectively..." ... pure N2 and pure CO2 *atmospheres*, ...

- P2, l.6-7: "... and represent nearly 20% of astronomical objects in the stellar neighborhood of the Sun. " Interesting! Citation?

- P6, l.7: "because all the models do not include CO2 condensation" - because not all the models include X, or because all the models do not include X?

- P7, l.29: " to much the model" - typo, too.

- P7, l. 30: "disable the gravity waves" - the gravity wave parameterization in the stratosphere? The dynamical cores should still be resolving some internal gravity waves.

- Page 8, Table 2: molecular air mass is referring to the dry background gases only?

- Page 8, Table 2: momentum roughness length and heat roughness length are missing units.

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