

## ***Interactive comment on “Examining the role of varying surface pressure in the climate of early Earth” by Junyan Xiong and Jun Yang***

**Anonymous Referee #1**

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Recommendation: Rejected

The paper is well written and presents clearly results concerning solutions to the Faint Young Sun Problem (FYSP). However I identified a fundamental issue requiring clarification. Indeed the authors use ClimT model, an Earth system modelling toolkit, and CAM3 (a General Circulation Model) for investigating extreme climate conditions without presenting diagnostics showing the validity of their radiative scheme. For instance, the collision-induced absorption is of great importance to the overall radiative budget in dense atmospheres, but its representation in climate models remains uncertain. If RRTGM (the radiative scheme implemented in ClimT) is a state of the art radiative transfer code (and used in many climate models), that not means that this component is adapted for this specific purpose mainly due to a lack of accurate experimental and

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theoretical data to explore the early Earth (and especially the surface pressure). This point is not easy to solve which explains why I recommend “rejected” rather than “major revision”. If the authors want to solve this issue, the methodology is described in Wolf and Toon 2013 (study also using CAM3). Consequently sections 2.1 and 2.2 should describe the general behavior of the radiative schemes AND sets of results demonstrating the validation.

In addition here is a list a suggestions to improve the manuscript

- line 4 p6. Why the obliquity is set to 0. ?
- line 3 p 5. Citations concerning the Eocene epoch are irrelevant here (to my knowledge the surface pressure is assumed held constant and the load in carbon dioxide does not overcome 1120ppmv, so very far from values used in the present study)
- p14 section 4.3. The discussion deserves more attention. As summarized by Charnay et al. 2020 (a review paper entitled “Is the FYSP for Earth Solved ?”) the explanation of a temperate early Earth is not problematic anymore (as illustrated in the table 2 p15). Despite the cooling provided by the decreasing surface pressure (table 1 p5), this section does not conclude if the FYSP becomes more (or very) problematic to solve.
- p15 table 2 (Charnay et al. 2013 and Le Hir et al. 2014 both used a mixed-layer ocean (with Ekman transport for Charnay et al. so more complex than a standard mixed-layer model). please correct this point.

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