

## ***Interactive comment on “Comment on “Clouds and the Faint Young Sun Paradox” by Goldblatt and Zahnle (2011)” by R. Rondanelli and R. S. Lindzen***

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Following the structure of the comment, this review is divided into three.

Firstly, regarding the isotopic evidence for a warmer-than-present Archean, I agree with the comment by Rondanelli & Lindzen (2011) (hereafter RL11) completely. The chert oxygen isotope data are topic of ongoing debate. The issue is not just whether or not the ocean's  $\delta^{18}\text{O}$  was 10 lighter (e.g., Muehlenbachs and Clayton, 1976; Kasting *et al.*, 2006; Jaffres *et al.*, 2007), making the temperatures determined by Knauth and Lowe (2003) only  $\sim 20\text{--}40^\circ\text{C}$ , but also what exactly the oxygen (and silicon, e.g., Robert and Chaussidon, 2007) isotopic composition of the cherts records. It is almost certainly a

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diagenetic signal and no agreement exists on how this signal relates to the isotopic composition of seawater. The uncertainty in the paleotemperature estimates presently does not justify seeking a solution to the much harder problem of maintaining not only a thawed Earth, but a warmer-than-present one.

Secondly, I agree also with the RL11's point regarding the iris hypothesis. Irrespective of its merit, or evidence in support or against it, a determination of the effect of clouds on the Faint Young Sun Paradox (FYSP) is warranted. After all, this is what Goldblatt & Zahnle (2011) (hereafter GZ11) set out to achieve, too. It seems to me that the authors of both studies were careful in presenting the results of their studies for what they are. The statement that inclusion of clouds (whether high or at variable altitude) in early Earth climate models is important to solving the FYSP is unobjectionable.

Lastly, the discussion of what value of cloud parameters is reasonable to include in 1D models is very interesting. Certainly, it is possible, as Rondanelli & Lindzen (2010) (hereafter RL10) have done, to assign parameter values that best fit present-day observations. In fact, similar to RL10, GZ11 chose their cloud properties to best reproduce Earth's observed radiative budget. An important difference, however, is that whereas GZ11 picked their values from within the observed ranges of their model parameters, RL10 had to pick values that lie outside of observed parameter ranges. The question is, then, what is missing from the model of RL10 that requires such a choice to be made. In the comment, RL11 suggest that this choice must be made because of inherent difficulties in modeling radiative transfer in clouds. Other possibilities come to mind, however, including the representation of lower-altitude clouds with a fixed surface albedo of 0.2. Whatever the reason for these choices, and despite the convincing argument by GZ11 that 1D models are indispensable in the study of deep-time Earth (and planetary) climate, the field would benefit from investigation of a few key cases with 3D models.

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