Clim. Past Discuss., 10, C735–C736, 2014
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Interactive comment on "Radiative forcings for 28 potential Archean greenhouse gases" *by* B. Byrne and C. Goldblatt

Anonymous Referee #2

Received and published: 18 June 2014

Given the growing interest in GCM modeling of ancient Earth and Earth-like exoplanets, this paper is a timely contribution to the literature. It is well-written and its methodology clear. The paper's highlights are: a) summarizing uncertainties in current spectroscopic data and their implications for climate modelers b) trying to create a benchmark for other radiative codes.

My comments, arranged in order of importance, are:

1. To facilitate comparison with other radiative codes or, down the road, updated spectroscopic data, the authors would ideally have used more idealized boundary conditions. For example, I'm not convinced that an observed modern relative humidity profile does better in this context than using an analytical profile or constant relative humidity, but the latter would be easier to implement for other groups. At least I would

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urge the authors to include all datasets as machine-readable files in the supplementary materials.

2. It would be interesting to explore how the assumed background gas affects the inferred greenhouse strengths. For the prebiotic Archaean or exoplanets, have the authors considered adding H2 (cf. Wordsworth & Pierrehumbert 2013)? A lot of potentially strong greenhouse gases in Fig.10 look like they might significantly overlap with H2-N2 CIA.

3. It's worth stating explicitly in the introduction that current GCMs do find "reasonably warm" climates within the bounds of many paleo-constraints (Charnay 2013, Wolf 2013). This does not diminish the authors' work since there is still large uncertainty about how cold or warm the Archaean might have been, and thus motivation to consider the potential impact of other greenhouse gases.

4. (p. 2031) Any reason why the radiative forcing of OCS is so much lower than in Ueno et al (2009)?

5. (p. 2012) "0.21 bar is needed with 0.5 bar of atmospheric pressure". It's not clear here if 0.5 bar is the total surface pressure, or the partial pressure of N2. Based on p.2016, I think the authors mean "0.21 bar is needed with 0.5 bar of N2 background gas".

* References: Wordsworth, R., and R. Pierrehumbert, 2013: Hydrogen-Nitrogen Greenhouse Warming in Earth's Early Atmosphere. Science, 339, 64–67.

For other references, see main text.

Interactive comment on Clim. Past Discuss., 10, 2011, 2014.