

## ***Interactive comment on “Radiative forcings for 28 potential Archean greenhouse gases” by B. Byrne and C. Goldblatt***

**B. Byrne and C. Goldblatt**

bbyrne@uvic.ca

Received and published: 1 August 2014

Thank you very much for the helpful review. Below we show each comment from the review individually followed by our response. We have also uploaded a pdf of our response with changes to the manuscript underlined.

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

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



Interactive  
Comment

RESPONSE: We have created text files with atmospheric temperature, pressure and water vapour concentrations for use in calculating radiative forcings as-well as text files with the atmospheric thermal fluxes (and solar fluxes for CH<sub>4</sub> and CO<sub>2</sub>) for every run. We will submit this as supplementary material.

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

RESPONSE: We agree that it would be interesting to examine this, however, we have not been able to include this due to time constraints. We have added a discussion of this in the overlap section:

“Other background absorption could have been present which would have had overlapping absorption with these gases. Wordsworth and Pierrehumbert (2013) propose that elevated N<sub>2</sub> and H<sub>2</sub> levels may have been present in the Archean which would have resulted in significant N<sub>2</sub>-H<sub>2</sub> CIA across much of the infrared spectrum including the water vapour window. Overlap between N<sub>2</sub>-H<sub>2</sub> absorption and the gases examined here would likely be significant as many of these gases have significant absorption in the water vapour window. However, performing these overlap calculations is beyond the scope of this work.”

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

RESPONSE: This is now explicitly included in the introduction:

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Interactive  
Comment

“Recent GCM studies have found that reasonably warm climates can be sustained within the bounds of the CO<sub>2</sub> constraints if the greenhouse is supplemented with elevated CH<sub>4</sub> concentrations (Wolf-2013, Charnay-2013). Wolf and Toon (2013) find modern day surface temperature with 0.02 bar of CO<sub>2</sub> and 1000 ppmv of CO<sub>2</sub> with 80% of present solar luminosity.”

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

RESPONSE: We have been in contact by email with Dr. Ueno about how their calculation was performed. Quoting from our email conversation, their calculation of the OCS radiative forcing was described as follows:

“The “60W/m<sup>2</sup>” is not the radiative forcing defined by Pinock et al. I would rather simply calculated total IR adsorption in a 10 km column of our model Archean atmosphere for comparing the effect from OCS, CO<sub>2</sub> and CH<sub>4</sub>.

In the lowest 10 km of the atmosphere, 10 ppm of OCS would absorb approximately 60 W/m<sup>2</sup> of the 300 K thermal emission in the window region, which is roughly the same as that of 1 % CO<sub>2</sub> or 100 ppm CH<sub>4</sub>.”

We are not able to discern exactly what they did from this description and have asked for further clarification but are still awaiting a reply. He did note that he was not surprised that our result yielded a value that differed by a factor of 3. We are uncomfortable with explaining this discrepancy in the manuscript until we are clear on how they performed their calculation.

COMMENT: 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 N<sub>2</sub>. Based on p.2016, I think the authors mean “0.21 bar is needed with 0.5 bar of N<sub>2</sub> background gas”

RESPONSE: This has been clarified :

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

“... 0.21 bar is needed with 0.5 bar of atmospheric N<sub>2</sub> , 0.13 bar with 1 bar of atmospheric N<sub>2</sub> , or 0.07 bar with 2 bar of atmospheric N<sub>2</sub>.”

Please also note the supplement to this comment:

<http://www.clim-past-discuss.net/10/C1217/2014/cpd-10-C1217-2014-supplement.pdf>

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

## CPD

10, C1217–C1220, 2014

Interactive  
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

C1220

