Clim. Past Discuss., 10, C637–C639, 2014
www.clim-past-discuss.net/10/C637/2014/

Climate of the Past Discussions
Open Access

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

J. Kasting (Referee)

jfk4@psu.edu

Received and published: 2 June 2014

This is a workmanlike paper that will add substance to the literature on past climates without making much of a splash. The authors use their radiative code SMART to calculate the radiative forcing of 28 different molecules that might have been part of Earth's ancient atmosphere. The calculations are well done and the results are believable. The reason there won't be a splash is that they do not attempt to calculate the concentrations of any of these gases in the ancient atmosphere. It would be useful if they surveyed the literature a bit more carefully and pointed out which, if any, of their greenhouse gases are predicted to have been present in published models of the early atmosphere. Haqq-Misra et al. (2008), referenced in the proposal, suggest that CO2, H2O, CH4, and C2H6 could all have been quantitatively important during the

Late Archean. Did these authors miss anything? It should not take long to figure out the answer.

Below are a few points that ought to be addressed in a revised paper:

1. (Abstract) “For CO2 to resolve the FYSP alone, 0.21 bar is needed with 0.5 bar of atmospheric pressure, 0.13 bar with 1 bar of atmospheric pressures, or 0.07 bar with 2 bar of atmospheric pressure.” –At what time do these estimates apply? From reading the rest of the paper, the answer is 2.8 Ga, and the solar luminosity is 80% of present, but this info should accompany these results in the abstract.

2. (p. 2015) “Increasing pressure increases the moist adiabatic lapse rate.” –Say why. I presume this is because it pushes the lapse rate closer to the dry adiabat. This is not really a pressure effect, though; rather, it’s a dilution effect.

3. (p. 2021) “. . .given that there is near-complete absence of evidence of glaciation during the Archean” –This is not really true. Evidence for the oldest glaciation occurs at 2.9 Ga in the Pongola Supergroup in S. Africa (Young et al., J. Geol., 1998). Later, 2.7 Ga glacial rocks are found in the Dharwar Supergroup, India (Ojakangas et al., Current Science, 2014). Given the sparse nature of the rock record during this time, it may not be surprising that few glaciations are recorded. This doesn’t necessarily mean that the Archean climate was warm.

4. (p. 2022) “If the stratosphere is optically thin and heated by upwelling radiation, it will be isothermal at the atmospheric skin temperature. . .” –The authors cite Pierrehumbert’s 2010 book to back up this statement. But Leconte et al. (Nature, 2013) cite Pierrehumbert as saying something quite different: upper atmospheres can be well below the skin temperature if they are non-gray. Which statement is correct? I’m almost sure it is the latter.

5. (p. 2024) “Large increases in CO2. . .result in a cooling of the troposphere. . .” –This statement does not make sense. Do you mean the upper troposphere, the strato-

CPD

10, C637–C639, 2014

sphere, or what? The lower troposphere should be warmed by increases in CO2.

6. The units 'ppv' are used for gas concentrations throughout the manuscript. I'm unfamiliar with this notation, although it is obvious what is meant. Does this stand for "parts per volume"? 'ppmv' makes sense, but 'ppv' does not.

7. (p. 2027) The authors mention the near-IR absorption by CH4 and point out that it leads to surface cooling at high enough mixing ratios. But they fail to mention that high CH4:CO2 ratios lead to organic haze formation in low-O2 atmospheres, and this leads to even greater cooling. The problem of haze formation should be mentioned.

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