Thank you very much for the helpful review. Below we show each comment from the review individually followed by our response.

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.**

   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 CH4 and CO2) for every run. We will submit this as supplementary material.

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 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.**

   We agree that it would be interesting to examine this, however, we have 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_2 and H_2 levels may have been present in the Archean which would have resulted in significant N_2-H_2 CIA across much of the infrared spectrum including the water vapour window. Overlap between N_2-H_2 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.*"

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.**

   This is now explicitly included in the introduction:

   "*Recent GCM studies have found that reasonably warm climates can be sustained within the bounds of the CO_2 constraints if the greenhouse is supplemented with elevated CH_4 concentrations (Wolf-2013, Charnay-2013). Wolf and Toon (2013) find modern day surface temperature with 0.02 bar of CO_2 and 1000 ppmv of CO_2 with 80% of present solar luminosity.*"

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

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^2" 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, CO2 and CH4.

In the lowest 10 km of the atmosphere, 10 ppm of OCS would absorb approximately 60 W/m2 of the 300 K thermal emission in the window region, which is roughly the same as that of 1 % CO2 or 100 ppm CH4.”

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.

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"**

   This has been clarified :

   “... 0.21 bar is needed with 0.5 bar of *atmospheric N_2* , 0.13 bar with 1 bar of *atmospheric N_2* , or 0.07 bar with 2 bar of *atmospheric N_2*.”