

## **Review of:** Quantifying uncertainties of permafrost carbon-climate feedbacks

Burke et al.

### **Overall evaluation:**

The manuscript documents numerical experiments conducted with three land surface models (two of which are variants of JULES) to estimate the strength of the permafrost carbon cycle feedback to climate change. The experiments show an added warming of 0.2 to 12% by year 2100 and 0.5 to 17% by year 2300 due to the permafrost carbon feedback. The manuscript is well written and provides detailed descriptions of methods used and the results of the experiments.

Overall the manuscript is a timely and original contribution to the study the permafrost carbon feedback to climate change. I recommend that the manuscript be published subject to minor revisions.

### **General Comments:**

I am concerned with using 60°N as the boundary for the permafrost zone, given that the continuous permafrost zone extends down to 55°N in Siberia and the discontinuous zone down to 45°N. I understand the rationale behind selecting common region for comparison for the two land-surface models and the observational data, but leaving so much of the permafrost zone out of the analysis seem misguided. I believe using the region north of 60°N will create problems when comparing model results for future studies.

One solution would be to include results for several regions in a table. For instance: 55°N, 60°N, the simulated permafrost zone in 1860, and the observed permafrost zone mask. It may also be useful to include both carbon release from the 'old' carbon pool and net change in carbon from all permafrost affected soils.

### **Specific Comments:**

**Units:** Gt C °C<sup>-1</sup> may be more clear as GtC K<sup>-1</sup>. Having both the C for carbon and the C for Celsius in the same unit can cause confusion.

**Page 2 line 2-4:** This sentence is unclear, please re-write.

**Page 2 line 17:** new-> latest (CMIP5 is now over 4 years old, not that new anymore).

**Page 3 line 14:** I think the symbol here is gamma but if so an odd font is used, and one inconsistent with the gamma used latter in the paper.

**Page 3 line 21:** Citation should be to MacDougall & Knutti (2016).

**Page 4 line 1:** Change “permafrost release of carbon” to “release of permafrost carbon”.

**Page 4 line 28:** I cannot find where “GCM” is defined.

**Page 5 1<sup>st</sup> paragraph:** Include a better rationale for using CMIP3 instead of CMIP5.

**Page 5 line 3:** Change “driven” to “simulated”.

**Page 6 line 5:** What is the total depth of the subsurface in the modified JULES?

**Page 7 line 14:** Does the litter C go into permafrost soil layers? If so what stops infinite build-up of C in permafrost layers during spin-up. Is there sub-freezing respiration or does the mixing take care of this?

**Page 8 line 3:** Missing subscript in CO<sub>2</sub>

**Page 12 line 14:** How do you turn the permafrost carbon off in the model?

**Page 15 line 6 to 9:** Paragraphs need at least two sentences, attached this sentence to the previous paragraph.

**Page 17 line 25:** Somewhere in the manuscript include a caveat on the potential effects of nutrient limitations on the CO<sub>2</sub> fertilization effect. It does not seem like either of the models include nutrient limitations thus such limitation may considerably change the results shown here.

**Page 19 line 16:** It may be useful to explain here that the forcing from CO<sub>2</sub> is approximately a logarithmic function of CO<sub>2</sub> concentration. The way the paragraph is presently worded may throw off readers less familiar with radiative forcing.

**Page 21 line 5:** “permafrost” typo.

**Section 3.5:** The quantity you define here is a classical residence time (reservoir size over out-flux). Thus “Frozen Carbon Residence Time” may be more intuitive than “vulnerability timescale”.

**Page 28 line 1:** Change to MacDougall, A.H. and Knutti, R.  
See: doi:10.5194/bg-13-2123-2016

**Table 1:** “GMT” is not defined.

**Figures 1, 3, and 3:** If you continue to use 60°N as your region of intercomparison you should place a line on the maps at the latitude.

**Figure 6:** The captions of Row 2 and of the axis-labels of row 1 overlap.