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The Cryosphere Discussions

Interactive comment on "Evaluating permafrost physics in the CMIP6 models and their sensitivity to climate change" *by* Eleanor J. Burke et al.

Eleanor J. Burke et al.

eleanor.burke@metoffice.gov.uk

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Significant points:

1. The models assessed are now limited to one per institution as indeed the results are very similar for different model versions from the same institute. Another advantage of this is that it enables a few of the more recent additions to be included without expanding the figures further.

2. We have briefly looked at the land-hist simulations and produced a few plots. However, we feel that a comprehensive analysis would be beyond the scope of this paper. In particular it will require extensive collaboration with the respective modelling groups to understand their behaviour.

Minor points:

1. We can't find a version number for HTESSEL - https://cera-www.dkrz.de/WDCC/ui/cerasearch/cmip6?input=CMIP6.ScenarioMIP.EC-Earth-Consortium.EC-Earth3. CLM5 added for NorESM.

2. Indeed the Chadburn et al. (2017) method provides a probability of permafrost – this has been included in the references.

3. We have added a sentence to clarify that "the D metric enables taliks to be identified, although this is more relevant considering soils deeper than 2 m"

4. "present day" has been added to line 220.

5. I have had a quick look at UKESM with respect to different ensemble members. There are 16 in the CMIP archives. The supplement shows a few of the results. This is briefly alluded to in the discussion.

6. "ensemble member" has been replaced with "model"

7. Another line has been added to the middle two plots of Figure 2 showing the bias between the two observationally based PF data sets and hence the bias against the models.

8. Again 'ensemble' has been replaced with 'multi-model'

9. Observations of the effective snow depth have been added to Figure S1.2

10. A discussion on the snow depth observations has been added in the 'Large scale snow depth product' section and when discussing the models' ability to represent the snow depth.

11. We have sorted this paragraph

12. We have sorted this paragraph

13. MOHC is removed

14. The figure attached shows the coupled and uncoupled results from CESM(coupled-historical) /CLM (uncoupled-land-hist). Yaxis shows winter offset, i.e. difference between air and soil surface temperature in winter and x-axis is effective snow depth. The data has been binned by winter air temperature – each colour represents the 5 degree C bins around the mean winter air temperature shown in the legend. This is the equivalent of Figure 6. There are some interesting differences between the two model versions.

15. The paragraph discussing MIROC and CESM has been re-written for clarity.

16. Figure 8 has been re-drawn to keep the obs the same and reports the number of sites where the model doesn't simulate permafrost.

17. NorESM is now hatched in Figure 10.

18. This has been re-written for clarity. Figure 9 suggests that the annual mean thawed fraction in the models is typically larger than in the observations. This has now been explicitly stated In the document.

19. This is an interesting comment and one we debated when preparing the Chadburn et al. (2017) paper. Some papers quote per degree of global warming and some per degree of high latitude warming. We would prefer to keep it as per degree of global warming as we think it is more policy relevant.

20. Changed as suggested.

21. This middle paragraph of the discussion has been re-written in response to the other reviewer's comments.

22. Analysis of carbon stocks removed from the end of the paper.

Please also note the supplement to this comment:
https://www.the-cryosphere-discuss.net/tc-2019-309/tc-2019-309-AC1-supplement.pdf

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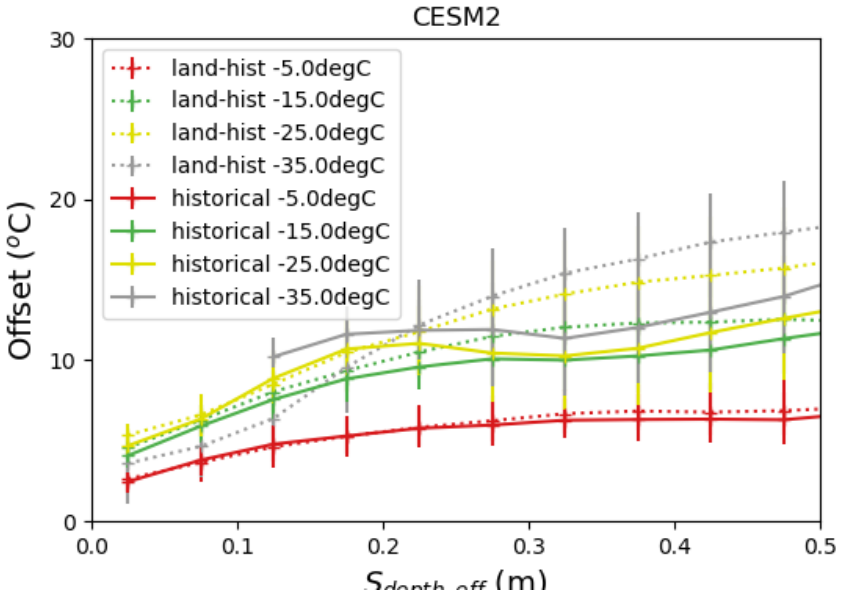

Fig. 1. Winter offset vs effective snow depth for CLM/CESM.