

Reply to referee 1 review

We would like to thank the referee for taking the time to read the manuscript and share their detailed and constructive comments. All their comments and suggestions have been addressed and have been thoroughly beneficial in improving the manuscript.

The authors present an enhancement to the JULES fire model INFERNO, which enables that model to simulate peat fire (ground fire) in northern latitudes. INFERNO-peat is implemented in Python as an external model that is driven by output from JULES-INFERNO. Simulations driven by two different ignitions forcing datasets for 1997 - 2014 were compared to several global and one regional observational datasets. The INFERNO-peat implementation increases northern latitude burnt area estimates bringing it closer to observation products such as GFED5 and FireCCILT11. The spatial correlation with observations is reasonable, but with some biases. The simulations also had larger and more realistic inter annual variability than INFERNO. Emissions were correspondingly increased with INFERNO-peat, closer to total emissions estimates. Again, regional biases were present. The GFED 500 meter product, which contains aboveground and below-ground emission estimates was used to look at emissions more closely. This revealed that biases were dominated by below-ground carbon emissions being too low or too high in different regions. Inaccuracies in estimates of vegetation in JULES-INFERNO are likely propagating through to drive some of the biases in INFERNO-peat as well. Improving prediction of peat fires in models is important because of the both climate and societal impacts. Improvements to INFERNO-peat could come from better representing human behavior and the specifics of peat emissions. The authors also highlight the need for better detection and estimation of ground fires, which is not always observable with current satellites.

The authors have presented a well written and interesting article documenting INFERNO-peat. The model extension is welcome advancement and the simulations results are compelling. This work is relevant and novel. I can only suggest a few minor changes and areas for improvement as follows:

Thank you for the detailed summary of the manuscript, and your kind comments.

In Figure 1. the 'r' is missing in 'moisture'.

Thank you for spotting this mistake. This has been rectified in the revised manuscript.

The equations in section 2 would be easier to understand if units were given with the first mention of each variable. While the units for some are implied or inferable, others are not. Specifically, I could not determine the units for FlamPFT in section 2.1, soil moisture (SM) in 2.2, and burnt area (BApeat) in section 2.3.

Agreed, the units for all variables have been added into the revised manuscript to aid understanding and avoid any incorrect assumptions.

In figure 3 the color scale makes it very hard to make out any signal in Fennoscandia and Alaska for most panels. Changing the scale so that true zero cells have their own color (white?) while low non-zero values have another color would make comparisons easier.

Agreed. The scale has been adjusted in the revised manuscript so that low levels of burning are now much more visible.

Figure 9 is interpretable with aid of the text. However, it would be clearer if the INFERNO bar was marked as “aboveground” and the peat only as “below-ground” in the legend.

Thank you for this feedback, the legend of Figure 9 has been updated in the revised manuscript.

The discussion is quite complete. However, a few lines discussing any potential benefits of (or obstacles to) full integration of the INFERNO-peat logic into JULES-INFERNO would be appreciated.

Thank you. Agreed, adding in a discussion of how INFERNO-peat can be integrated into JULES-INFERNO would add extra depth and detail to the manuscript. This has been added into the revised manuscript lines 429 to 432.

Given the number of colors in supplemental figure 5 it would be helpful to either mark any PFTs not shown in the plot or remove them entirely from the legend.

Thank you for this feedback, the legend is likely too overcrowded. Therefore, in the revised manuscript any PFTs not shown in the plot have been removed entirely from the legend.