Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-298-RC2, 2021

Geoscientific Model Development Discussions

Interactive comment on "Coupling interactive fire with atmospheric composition and climate in the UK Earth System Model" *by* João C. Teixeira et al.

Anonymous Referee #2

Received and published: 13 February 2021

The authors present a novel attempt at producing a coupled fire-atmospheric composition-climate Earth system model using established models. While the radiative forcing and CO and aerosol emission implications are interesting, the performance of INFERNO-UKESM1 overshadows these results. It does not appear that burnt area or emissions have been accurately modeled outside of Amazonia and Sub-Saharan Africa, performing particularly poorly in the boreal - which has direct impacts on the Arctic. A major revision is recommended to make the performance of this model clearer, so that potential improvements in subsequent versions can be made. General and specific comments follow.

Line 34: black carbon is missing a letter.

Line 90 introduce the significance of peat fires. The authors should note that both

GFED4s and GFAS rely on MODIS products, which are less capable of detecting low temperature smouldering peat fires than VIIRS and other moderate resolution sensors. By line 320, it is noted that peatland fires are not included. It would be good to clarify this at the beginning of the manuscript.

Lines 235-237: Some extra spaces in the text. Further GFED4s is a multi-sensor satellite dataset that uses a statistical model to predict small fires. The small fires are not observed directly from active fire data.

Section 3.1: The model's poor performance in the boreal means a significant underestimation of burned area in forest and peat areas that are often the dominant source regions of emissions for the Northern Hemisphere - as well as large impacts on the Arctic. If the point of INFERNO is to develop a coupled fire-climate-composition Earth system model, leaving out much of the boreal does not mean the model estimates burned area fraction well. Why is this happening? The authors have a good explanation for why north Africa is underestimated. Can the authors explain why the overestimation of tree fraction in the SHSA produces smaller fires? Recent Amazonia fires have shown smaller fires in grasslands turning into large understory fire complexes that dry out the system for large canopy fires. Is this fire behaviour of rainforests well represented in the model?

Figure 1 and the dominant PFT: since the model was found to be sensitive to underlying vegetation, do that authors have an uncertainty analysis of the PFT used in UKESM1UKESM1-AMIP configuration with other global land use products, like the MCD12C1 0.05 degree MODIS land cover product for climate modeling? The PFT ignores the Cerrado and established croplands in eastern Amazonia, as well as overestimating C4 grasses in northern Australia.

Figure 3. Burnt area fraction is underestimated in the boreal and all of Australia, as noted by the authors, but also in the Indo-Gangetic Plain, the southeastern U.S., much of central American and extending into Ecuador, Venezuela, and Colombia, eastern

China, and Indonesia. In terms of climate, nor representing emissions from peat fires in southeast Asia and near the Himalayas and Andes calls into question the performance of the fire-composition-climate coupling. Further, many of these locations of human-dominated fire regimes - whereby lightning strikes are not the main drivers of fire. So how well is the HDI performing?

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-298, 2020.