

## ***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 #1**

Received and published: 11 November 2020

Authors present the coupling of the INFERNO fire model with atmospheric chemistry component of the UKESM1 model. The manuscript is reasonably written but several things require clarification. These are mostly minor comments and I suggest that the manuscript may be published after these comments are taken into account. I have also made several hand written comments on the manuscript. These annotations can be found in the attached PDF. Here, I summarize only the primary minor comments. Some of my comments/questions early on in the manuscript got clarified as I kept reading on. However, this does indicate that some points need to be clarified early on.

1. As I started reading through the manuscript, it was unclear to me if the manuscript was going to compare results from run with specified/prescribed and interactively simulated fire emissions. It was unclear if the prescribed/specified fire emissions had

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inter-annual variability or not. Please try to make this clear upfront.

2. When discussing results, PLEASE mention the figure and its panels in parenthesis so that it's explicitly clear that the results and/or discussion follows from which figure and from which of its panel.

3. There are no sub-headings and panel identifications in several figures which made it really difficult. For example, in Figure 11 and 12 there are no sub headings on panels. The acronyms NHAF, NHSA, SHAF, SHSA threw me off several times. I missed the distinction between NHAF and NHSA even after reading the Figure 11 caption multiple times.

4. The INFERNO fire model appears fairly simple. I am surprised that the average burnt area per PFT (in equation 1) is specified a priori as a model parameter. First, what are the units of this quantity? Table 1 says its units are km<sup>2</sup> but it has to be km<sup>2</sup> per unit SOMETHING? Is it per unit grid cell area (unlikely), per unit 1000 km<sup>2</sup>, per unit ignition? Second, and assuming this quantity represents average area burned per unit ignition, this seems to imply that area burned per unit ignition can never exceed this, assuming  $F_{pft}$  (the flammability) varies from 0 to 1 (please mention this). If true, it's not correct to call this quantity average area burned for a given PFT.

5. In equation (1) and elsewhere the lack of units makes it difficult to understand things. Please mention units for all terms of all equations.

6. My logic tells me that INFERNO should be a module of JULES. If this is the case then meteorological variables from the atmospheric component are passed to JULES which then provides quantities like soil moisture to INFERNO. As it reads, the manuscript seems to imply that INFERNO is a separate component.

7. The part related to INFERNO's description needs an equation for  $I_{\{N\}}$ , natural ignitions. As a reader, I was curious to know how natural ignitions are modelled as a function of lightning frequency.

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8. In equation (2), it seems  $\theta$  cannot be the soil moisture (which varies between 0 and porosity, typically around 0.4), it seems  $\theta$  is more likely the soil wetness which varies between 0 and 1, as the soil moisture itself varies between 0 and porosity.

9. On page 6, line 186-187, I am troubled by the fact that emission factors for aerosols are doubled. Does it mean that the standard emission factors based on Andreae (2019) are too low?

10. In section 3.2.1 changes to land cover result in several differences in regions where the land cover is not changed due to teleconnections. Clearly, these are primarily due to land-atmosphere interactions and not due to fire-atmosphere interactions. Please make this clear.

11. Figure 10. Please make it clear on y-axis that the quantity being shown is CO. Also, please check there are units and quantity name on y-axis of all similar plots.

12. Page 8, line 224, "Aerosol emissions are distributed vertically following an exponential increasing function . . .". Does this mean there are more emissions at the surface and less up in the atmosphere or the other way round?

Please also note the supplement to this comment:

<https://gmd.copernicus.org/preprints/gmd-2020-298/gmd-2020-298-RC1-supplement.pdf>

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

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