Review Comments to "Representation of disturbance in the Joint UK Land Environment Simulator Vn4.8 (JULES)"

General Comment:

This study touches on the issue of representation fire disturbance in the Joint UK Land Environment Simulator (JULES). New model features including a better description on updating the natural mortality due to the fire activity/burnt area simulated by INFERNO (Mangeon et al, 2016) for five selected PFTs (plant function types: broadleaf tree needle leaved tree, shrub, C3&C4 grass) and formulations of the carbon emission due to fires from two selected soil carbon pools (decomposable and resistant plant material soil carbon pools) are presented in the manuscript. In the revised manuscript, the authors have been already addressed most of the comments from previous two reviewers.

The behavior of enhanced model was tested with and without imposed the global LULCC (S2&S3), and incorporating the new feature (S2F & S3F). The authors concluded that the new implementation can improve the model representation of the global vegetation cover after considering the global LULCC and fire disturbance simulated by INFERNO, however the new implementation shows the deficit on the tree coverage over the boreal regions. I think this new development is quite important for the applications of the UK ESM, especially for understanding the impact of biomass burning in the future.

Due to the scope of manuscript type is model development for the publication in GMD, I have a few suggestions for the authors to revise their manuscript. In the third section, I suggest to rename the title "Method" to "Experimental set-up and model evaluation", and also to provide a more detail description on the forcing to the developed model, for example: the potential forest/agriculture land cover fraction in HYDE 3.2 from 19XX to 2015 was forced and updated annually to the land for the S3/SF3 simulations, and what is expected to be observed from comparing the result between two simulations. Within this section, I also spotted a few minor issues which were unclear to me, please see the specific comment for the detail. In the result section, the authors only chosen the result for the present day (2014) to evaluate the model performance; however it would be nice to show the mean state from long-term period to avid the model bias in warm year or cold year. Another approach is by adding additional information to the **Fig. 4**, which shows the transient evolution of the model prediction, upper limited and lower limited from the observation.

Finally, I recommend the authors to restructure the discussion session into several sub-sessions, i.e. current model limitation, modelling the disturbance (including the anthropogenic disturbance and natural disturbance), modelling improvement in the future, and others. For example, the model currently only can simulate a realistic fire

activity with a reliable LULCC reconstruction/observation. For the representation of fires, does the model capture the fire activity in the peatland and its emission over the peatland? Fires over those region can produce heavy air pollution and transport pollutants from tropics to temperate climate zone. Does the model reasonable simulate the demography after the fire disturbance? Does the model explicitly couple the other natural disturbance agents, such as windthrow or pest outbreak, through a large scale LULCC forcing after this new development? I listed several references which are relevant for these discussion.

References:

Yue, C., et al.: Representing anthropogenic gross land use change, wood harvest, and forest age dynamics in a global vegetation model ORCHIDEE-MICT v8.4.2, *Geosci. Model Dev*., 11, 409-428, https://doi.org/10.5194/gmd-11-409-2018, 2018.

Haverd, V., et al.: A new version of the CABLE land surface model (Subversion revision r4601) incorporating land use and land cover change, woody vegetation demography, and a novel optimisation-based approach to plant coordination of photosynthesis, *Geosci. Model Dev.*, 11, 2995-3026, https://doi.org/10.5194/gmd-11-2995-2018, 2018.

Marra, D. M., et al: Windthrow control biomass patterns and functional composition of Amazon forests, *Global Change Biology*, doi:10.1111/gcb.14457.

Chen, Y.-Y., et al.: Simulating damage for wind storms in the land surface model ORCHIDEE-CAN (revision 4262), *Geosci. Model Dev.*, 11, 771-791, https://doi.org/10.5194/gmd-11-771-2018, 2018.

Landry, J.-S, et al.: Modelling long-term impacts of mountain pine beetle outbreaks on merchantable biomass, ecosystem carbon, albedo, and radiative forcing. *Biogeosciences* 13, 5277-5295, 2016.

Specific Comment:

1. Please provide a table which summaries parameters that were tuned in this study. For example, in the P30L15, I can't find the information of the spreading parameter (lambda) in the Table 1.
2. Please explain the value of theta (soil moisture) that applies for the equation (4). Does this value represent a vertical average of soil layer or using the soil depth associate with the soil carbon pools for the decomposable and resistant plant material?
3. Can you explain why most of your simulation result from the SF3 shows a relative low tree coverage which comparing with the ESA observation, when you apply a

smaller background mortality (half of the original values) for tree species in the new development?

4. Please add an extra column in **Table 3**, which indicates the variable was updated from LULCC map or INFERNO fire module.

Technical Comment:

1. In the **Fig. 5**, please replace "S2, fire" to "SF2, fire" and "S3, fire" to "SF3, fire" in the figure legend for the consistence

2. Please use "burnt area" to replace "burned area" throughout the manuscript both for plots and texts throughout the manuscript.

3. Please use "windthrow" to replace "windfall"

4. When doing a final check of the references cite in this manuscript, I can't find the citation of Avitabile et al. 2016: An integrated pan-tropical… in the text. In the **P17L4**, "Klein Goldewijk et al., 2011" should be "Klein Goldewijk et al., 2013".