Geosci. Model Dev. Discuss., 7, C771–C774, 2014
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Geoscientific Model Development Discussions
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GMDD
7, C771–C774, 2014

Interactive comment on "Modelling fires in the terrestrial carbon balance by incorporating SPITFIRE into the global vegetation model ORCHIDEE – Part 1: Simulating historical global burned area and fire regime" *by* C. Yue et al.

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Received and published: 5 June 2014

As Referee #1 remarked, in reading this discussion paper we (**Mirjam Pfeiffer, Allan Spessa, Jed O. Kaplan**) were surprised that our paper and the technical revisions we made to the SPITFIRE model appear to have not been taken into account in the current model description. We realize that much of the development of ORCHIDEE-SPITFIRE may have occurred in parallel with our own work, but our discussion paper was published in August, 2012, and the final version of the paper was published more than a year ago, in May, 2013. In our paper, we highlighted several important limitations in the original SPITFIRE implementation, and provided solutions for overcoming these, and included a complete listing of all of the original and new equations we used. Furthermore the LPJ-LMfire source code is, following GMD publishing guidelines, publicly available here: http://sourceforge.net/projects/lpjlmfire.

The authors of the current manuscript argue that their model is a step in the direction of understanding wildfire at global scale. Given recent progress made in global fire modeling, we disagree, and believe that the current manuscript has missed an opportunity to make real progress in improving our understanding by building on previous research work, including ours. Specifically, the last two paragraphs of the discussion section of the current manuscript should be focused to more clearly describe the most important priorities for improving global fire models in light of not only the authors' own interpretations of the limitations of their model, but also other recent developments in global fire modeling, including ours. Aside from crown fire, Pfeiffer et al. (2013) provide solutions for modeling all of the points highlighted for improvement in the last paragraph of the discussion section (Pg 2405, lines 17-19).

We would like to reiterate the importance of commenting on the following specific points in any revision of this manuscript:

- We found that representation of fires that persist over consecutive days was critical to making realistic simulation of fires in boreal regions, where ignitions are rare and fires can grow to very large sizes. Not representing multi-day burning in ORCHIDEE may be one of the important reasons why fire size is underestimated in the ORCHIDEE simulations.

- The rationale for ignoring agricultural burning in ORCHIDEE is not well argued for. For example, we suggested that anthropogenic burning was the main cause of fires in the miombo woodland region of Southern Africa, in South Sudan and the Central African Republic, and in southern Russia and Kazakhstan. If, as noted by Referee #1, the Randerson et al. (2012) burned area dataset is used instead

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of GFED, the modeled burned area is even more underestimated compared to observations.

- We agree with Referee #1 that, if the authors insist on using a(ND) as a scaling factor for anthropogenic ignitions, it should be spatially variable instead of a global constant. The perfectly constant offset in global burned area between spatially variable and constant a(ND) – the black line and gray lines presented in Fig. 6 – looks suspicious to us. If the interannual variability in burned area is caused by climate variability, it seems to us that the offset should not be constant over time as different parts of the world have ideal fire weather in different years. In any case, some more comment on the utility of a(ND) would be useful.

- We explain in Pfeiffer et al. (2013) that fire rate of spread was strongly influenced by surface fuel accumulation and fine fuel bulk density. As noted by Referee #1, the 95th quantile fire rates of spread simulated by ORCHIDEE are excessively high in some places, particularly in the northern boreal forest and tundra regions. With an implementation of multi-day burning as in LPJ-LMfire, these very high rates of spread lead to unrealistically large burned area. We solved this problem by making the bulk density of fine fuels more realistic by implementing a compacted surface litter pool (O-horizon) in LPJ-LMfire, and by making the bulk density of the C3 grass PFT – this is the main plant type that occurs in tundra regions – a function of climate.

- We further found that interannual lightning variability was very important in regions with infrequent lightning but where large fires do occur, e.g., in the boreal forest and tundra regions of the Northern Hemisphere. A justification why the authors decided to ignore interannual variability in lightning and a clear call to include this in the future should be included.

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Interactive comment on Geosci. Model Dev. Discuss., 7, 2377, 2014.

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