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Interactive Comment

Interactive comment on "Modelling the role of fires in the terrestrial carbon balance by incorporating SPITFIRE into the global vegetation model ORCHIDEE – Part 2: Carbon emissions and the role of fires in the global carbon balance" *by* C. Yue et al.

Anonymous Referee #2

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Yue and colleagues investigated the spatial and temporal patterns of global fire carbon emissions during 1901-2012 using the ORCHIDEE model. The goal of this work was to evaluate regional characteristics of fire activity (Pyromes, GFED regions) and esti-amte the net effects of fire activity for global carbon cycling. Model simulations with and without fires considered the potential impacts of fire activity on vegetation carbon storage over a range of time scales. The sequence of analyses stem from simulations of contemporary fire activity, using the GFED3.1 dataset of burned area observations and modeled fire emissions to characterize ORCHIDEE model results. Unfortunately, these comparisons highlight gross disparities between ORCHIDEE results and observations. The inability to reproduce a reasonable pattern of burned area and fire emissions (1997-2010) precludes a more detailed analysis of the century-scale patterns of fire activity and NBP. At these longer time scales, the analysis likely propagates model biases, rather than elucidating carbon cycle dynamics over time scales relevant for carbon cycling.

Comparisons between ORCHIDEE and GFED3.1 for the spatial and temporal patterns of global fire activity are puzzling (Table 1, and Figures 2-7). Not getting Africa right is a problem, or even wrong for the right reasons, since this is the region with the most consistent patterns of burned area (see Andela & van der Werf, 2014; also van der Werf et al., 2010 and Giglio et al., 2013). Burned area estimates for Africa are only 27-46% of observations, yet fuel consumption estimates are very high (3-4x). These differences point to significant limitations of the current model setup to reproduce fire activity and fire emissions; NHAF and SHAF are dominated by savanna and woodland fire typesâĂŤtwo of the major fire types represented in this version of ORCHIDEE. Australia follows the same pattern («burned area, »fuel consumption). Temporal variability in global burned area and fire emissions is also underrepresented in the model results, with little interannual variability in fire emissions at the regional scale.

The validity of the sink reduction (SR) estimates fundamentally depends on getting burned area in the right amounts in the right biomes. Since tropical fires are underestimated, but total emissions are even higher than contemporary estimates from GFED3.1, does this lead to a biased estimate of the SR? Similarly, underestimating interannual variability of fire activity in ORCHIDEE could dampen distinct phases of higher or lower fire activity, with important implications for NBP calculations and contemporary fire risk. Since the model is unable to capture regional and interannual variability in burned area and fire emissions, deeper model interrogation of NBP and SR seems risky, at best (Section 3.3).

Additional comments on model setup: Static land cover assumption: Estimates of contemporary land cover may be suitable for decadal simulations. However, over century time scales, landscape connectivity and biome distributions can differ substantially. How might land cover differences alter the time series of burned area?

Ignitions: Why was the lightning data cycled, especially for a 5yr period with a strong ENSO event, rather than linking lightning to climate data?

Format: The first paragraph of Section 2.2 seems out of place. Comparisons with burned area were done in Yue et al., 2014 and could be referenced, rather than repeated.

Mixture of methods and results in Section 2.3. (e.g., 9026, lines 4-15).

Interactive comment on Geosci. Model Dev. Discuss., 7, 9017, 2014.