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Biogeosciences Discussions



# *Interactive comment on* "Interactions between nitrogen deposition, land cover conversion, and climate change determine the contemporary carbon balance of Europe" *by* G. Churkina et al.

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Reviewer 1 comment: The explanation of the factorial design could be improved in the text to expand the information presented in table 2. I believe this is a very clever analysis that represents a modeling experiment which could be improved (in the future) by a multi-factorial approach (page 2249).

Authors' response: To clarify the factorial design we added the following text on page 2236 on line 22. 'Thereafter three transient simulations were performed with different combinations of environmental drivers for 1700–2007 (Table 2).The first transient simulation, "Reference", was performed by four models without changes in climate,



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atmospheric CO2 concentrations, N deposition, and land cover. In the “Clim” simulations only changes in climate were implemented in all four models. In “Clim+CO2” simulation four models were driven by changes in climate and rising atmospheric CO2. In “Clim+CO2+LUC” simulation JULES and ORCHIDEE models were driven by changes in climate, increasing CO2, and land cover conversion. BIOME-BGC and OCN models were driven by changes in climate, rising CO2, and nitrogen deposition in “Clim+CO2+N” simulation.’

Reviewer 1 comment: My main concern is that once the actual factorial experiment was done (according tothe description provided in table 2), the results are not treated according to a statistical factorial experimental design. Instead, all the interpretation of the results are based on the observed absolute means without consideration of the errors associated with each model, model simulation, and the interactions among the factors of the experiment (from a statistical approach). Multiple examples of the lack of a rigorous statistical analysis are found in the manuscript and I encourage the authors to explore the interactions and differences from this factorial experiment to support the results. In fact, the authors state at the end of the manuscript (page 2249 line 20-21) that the absolute values need to be treated with caution. Examples on how the results could be supported by a factorial analysis could be found in figure 3 and 4. For example, in figure 3 there are several questions that remind unanswered: the effects of climate and LCC seem to be not significant different from zero (testing this could support the discussion in the text); the effect of all factors seem to be only significant different from zero for JULES and BIOME-BGC (is this correct?). Figure 4 does not have error bars and similar to figure 3 there is no test to show if the results (1) are different from zero, or (2) if there are significant differences among the models. Finally, all the interpretations are based on the absolute means without considering the errors derived from interannual variation and different models. I encourage the authors to test the important results (sections 3.1 to 3.2.2) from this clever factorial approach, and then use those results to support the interpretations presented in the current version of the manuscript. Does a rigorous test of this factorial experiment



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supports the interpretations based on absolute means? It is likely that the results and interpretations will not change, but this additional effort will make the manuscript more elegant and robust.

Authors' response: We have performed a Welch t-test of the model outputs, because this test does not assume that variances of two samples are equal. Welch t- test was applied to simulated annual net ecosystem exchange (1951-2000) for factorial analysis displayed on Figure 3 and annual changes in vegetation and soil carbon stocks is played on Figure 4. For each factorial experiment, we tested the hypotheses that the output from each model was equal to zero and that the average simulated net ecosystem exchange (Figure 3) or stock changes (Figure 4) were similar between the individual models. Statistical significance was tested with a threshold value of 0.05. The total simulated carbon sink in Europe was similar in JULES, BIOME-BGC, and OCN models - at least if one considers only the European-wide mean values and their interannual variability. Responses of net ecosystem exchange to changes in all factors were also significantly different from zero in simulations with the abovementioned three models, but not in simulations with ORCHIDEE. Responses of net carbon flux to changes in climate were significantly different from zero in simulations with JULES and ORCHIDEE, but not in BIOME-BGC and OCN simulations. Responses of all models to rising CO2 were significantly different from zero. Although net carbon flux responses to land use change simulated with ORCHIDEE was significantly different, response simulated with JULES was not. Changes in total carbon stocks were significantly different zero in most model simulations except JULES for land use change scenario and BIOME-BGC for climate change scenario. Changes in vegetation carbon stocks were significantly different between most models' pairs except between JULES and ORCHIDEE for land use change scenario and between JULES and BIOME-BGC for climate change scenario. Changes in soil carbon stocks were significantly different between all pairs of models.

Interactive comment on Biogeosciences Discuss., 7, 2227, 2010.