

Interactive comment on “The C4MIP experimental protocol for CMIP6” by C. D. Jones et al.

Anonymous Referee #2

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The past C4MIPs (e.g., that within CMIP5) have greatly stimulated research on carbon cycle-climate change feedbacks. The next C4MIP in association of CMIP6 is expected to continue such a great influence in the community.

Overall, this manuscript is well written and clearly describes C4MIP experiments and output requirements. If all participating modeling groups can follow the protocol, outputs of this MIP will be extremely useful for the community to learn more about the carbon cycle models in particular and consequently improve carbon cycle science in general.

I have no major criticisms on the manuscript but strongly suggest the protocol may consider require the modeling group to generate a pool-flux diagram for each model such as in Xia et al. 2013 with CABLE. Figs 5 and 6 already outline the pools and fluxes. The pool-flux diagram is a representation of Figs 5 and 6 for individual models and supposed to be corresponding to the matrix form of pools and fluxes. This protocol

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may require modeling groups to report the pool-flux diagram and deposit their model codes in the Earth System Grid Federation (ESGF) or GitHub. In this way, C4MIP will make the C4MIP modeling totally transparent for the community to learn about model structures, parameters, and output variables.

The description of outputs of modeled land carbon pools and fluxes is quite comprehensive but becomes quite lengthy. It will become much easier and clearer if the pools and fluxes are expressed in a matrix form as in Xia et al. 2013. Then all the elements in the matrix equation should be reported to allow accurate analysis of model outputs.

The sentence on page 26 “However, this distinction was not found useful by the community and as a result was not used in many analyses” may not be accurate. Distinguishing different soil pools is essential as repeatedly shown by many empirical and modeling studies. When you lump soil C together from many pools, it is almost impossible to understand how each model simulates soil carbon dynamics. I strongly recommend your protocol to require the report of outputs of individual soil carbon pools.

The same requirement should be make clear to report outputs of soil pools in different depths.

Other minor comments:

P. 6, L4-5, in addition to those differences in model structures, you may also set a goal to understand sciences behind model development, evaluation and improvement.

P.6, third para, we may bear in mind that most of the nitrogen models may not well reflect N processes in the real-world ecosystems as shown in some model intercomparison and model-data intercomparison studies. It requires transparency of models if we want to advance our field.

P.8, L1, should the subtitle 2.2.2 be “evaluation of global carbon cycle” or “evaluation of global carbon cycle models”?

P.9 second para, you may separately discuss evaluation techniques vs. datasets

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P.9 third para, it appears that the idea on isotope modeling is not very well developed.

P. 11, C4MIP: How do you distinguish this C4MIP from other C4MIPs?

P. 14 L. 11-12, The sentence “A model cannot be conformant to the C4MIP protocol unless it can be run in both these configurations” is not very clear and needs more explanation.

P.16, L10. Land carbon cycle spin-up may use the semi-analytic method developed by Xia et al. 2012, which provides much more accurate estimates of steady states after spin-up. At least this protocol should recommend it.

P26. L11-17, Should report how soil carbon module is structured and all pools should be reported.

P28 L19, this is a great point to ensure mass conservation of C.

P28, L21, If all modeling groups use matrices to represent pools and fluxes, we will have a uniform way of reporting.

P27, l23-24 “Some models may also simulate this flux directly from vegetation to soil carbon, for instance, in the case of root exudates.” In a matrix form, all those become straightforward.

P29, L9, for “in order to close the nitrogen budget”, can you use the same language (i.e., mass conservation) as in the carbon cycle?

Page 30, L6 “to close nitrogen cycle budget over land” means the mass conservation but uses different terms.

P31, section 4.1.3. where in the paper did you specify the required outputs of the forcing variables?

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