Author response to: Interactive comment on “The C4MIP experimental protocol for CMIP6” by C. D. Jones et al., Anonymous Referee #1

Review comments in BLACK

Author responses in Blue/Italics

This is a critical manuscript laying out the criteria for a broad community Earth system model inter-comparison project addressing carbon cycling in both land and ocean systems to inform the next IPCC report. The authors provide historical context for the proposed experiment design, modification based on previous efforts, and detailed practical instruction for carrying out the inter-comparison.

I have minor suggestions noted below but otherwise find the manuscript to be a carefully considered continuation of previous efforts. Historically C4MIP has had a high impact on the scientific community and I expect this to continue based on this manuscript.

Thank you for these supportive words

Details: P1L27 “. . .the design and documentation of individual simulations has been devolved to individual climate science communities.” It’s not clear what you mean by this (‘devolved’ is the word that’s tripping me up), possibly reword?

We have reworded this to “delegated”

Title & P1L29 While C4MIP is fairly widely known in the land carbon community it’s still not entirely self-explanatory and I, for one, frequently get it confused with the CMIP3/5/6 notation. I would like to see ‘land carbon’ somewhere in the title to make it a bit more explicit but would be open to other suggestions. The title is very acronym heavy.

As per this and also advice from the editor we have changed the title to better explain the acronym C4MIP. We note though that C4MIP is explicitly global (land and ocean) and coupled and not land-only. There is a land MIP (LS3MIP) and an activity of the Global Carbon Project called TRENDY that cover land-only simulations. C4MIP deals with the fully coupled climate-carbon cycle system.

new title:

C4MIP – The Coupled Climate-Carbon Cycle Model Intercomparison Project: Experimental protocol for CMIP6.

P3L15 Nicely done recognizing that the number of experiments needs to be restricted due to computational challenges. I appreciate that the authors resisted the temptation to pile yet more runs into the design.

Thank you. Although at a recent planning meeting we decided to add an additional (tier-2) simulation to look at carbon cycle feedbacks in an overshoot scenario. So in parallel to ScenarioMIP's SSP5-3.4-OS we now request a biogeochemically coupled version of that scenario. This will only add an extra 60 years (plus optional 200 if extended to 2300). We still feel that our experiment set is very compact and each simulation has a distinct and important application.

P3L29 Is there a citation for WCRP Grand Challenge?

The proposed grand challenge has now been endorsed by WCRP and the text updated to document this. It has been renamed as "carbon cycle" to narrow the scope from the initial proposal of "biogeochemical cycles". We cite the WCRP web page, but welcome the editor's advice on whether this is necessary or not:

http://www.wcrp-climate.org/grand-challenges

P7L19, 21 TCR and TCRE are infrequently used in the manuscript. I suggest the authors consider writing the full names out to avoid cryptic acronyms as much as possible.

We agree these are not used extensively in the manuscript and will spell out on each use

P7L28-31 I'm not entirely clear on the point of this paragraph. These two statements are relatively disjointed and need to be better integration into the section.

We have added a sentence to explain this and join up the two ideas presented here:

"C4MIP will use partially coupled simulations to isolate and quantify the sensitivity of carbon cycle components to climate and CO_2 separately and also the potentially large non-linear combination of these two components (Gregory et al., 2009; Schwinger et al., 2014). Simulations with only carbon cycle model components experiencing rising CO_2 (BGC-coupled) and the radiation components seeing the CO_2 rise (RAD-coupled) are used to quantify the carbon-concentration and carbon-climate feedbacks. Spatial patterns of these metrics can also be calculated (e.g. Roy et al., 2011, or Fig. 6.22 of the last IPCC WG1 assessment report Ciais et al. 2013) to establish areas of model agreement or disagreement."

Figure2 I like this figure but if you need to cut figures I would cut this one. There seems to be a lot of careful treatment around concentration vs emissions forced which seems a tad unnecessary to me but I'm fine leaving it up to author's discretion on this. More pointedly, why are some of the lines solid and others dashed?

We have not been asked to reduce overall length so decided to keep this figure. We have added to the caption that:

"Solid arrows depict internal data flow within the model, dashed arrows depict data output from the model."

P21L28 There is a long space in this line.

Thank you - removed

P22L11 I don't believe that 'anomaly' is the word that you want in this line. Unless this is an American/British conflict, 'opposed' is more common here.

We did mean anomaly in the context that these are added on top of the existing pre-industrial fields (so not instead of). Text has been clarified:

"... it is preferable to use the provided fields as anomalies which should be added to the ESM's pre-industrial N deposition fields."

P25 I like how you address the soil carbon depth and fast/med/slow pool distinction here.

Thank you. On suggestions from other reviews and discussion with colleagues we have added an additional (tier-2) data request for model to output more detail of their soil carbon pools. This will aid tracking and diagnosing turnover times for each model without having to assume a common structure.

Figure 6: Please move the explanation of the colored arrows to the caption instead of stating in the main text.

We agree and have done so

P28 I appreciate the careful walk through discussing the connection between the tier 1 and 2 state and flux variables. Tedious as it is, it is necessary given my experience with CMIP5. I look forward to the improvements this bodes for this next C4MIP round.

Thank you. We agree this is an important aspect to be very clear about

Section 4.2 Please link the variable names with their full description more explicitly. Though this is done with some variables (ex intPb) it is not done with all (ex FICR)

Thank you – we have checked through.

P40L10 Please give a bit more detail on the isotope reporting. The normalization factor could use more explanation.

We have added more detail on isotope reporting:

"Stocks and fluxes of carbon-14 should be normalized with the standard $^{14}C/C$ ratio, Rs, of 1.176 x 10^{-12} (Karlen et al. 1968). This means that reported stocks and fluxes of carbon-14 should be divided by Rs."