Biogeosciences Discuss., 12, C3446–C3448, 2015
www.biogeosciences-discuss.net/12/C3446/2015/
© Author(s) 2015. This work is distributed under
the Creative Commons Attribute 3.0 License.

Biogeosciences
Discussions
Open Access

# *Interactive comment on* "Earth system responses to cumulative carbon emissions" *by* M. Steinacher and F. Joos

**Anonymous Referee #1**

Received and published: 9 July 2015

M. Steinacher and F. Joos present in their manuscript 'Earth system responses to cumulative carbon emissions' a probabilistic analysis of the climate sensitivity of an Earth System Model of intermediate complexity, the Bern3D-LPJ model, constrained by a large set of observations covering different components of the Earth system. They find in this Monte-Carlo type study that the transient climate response to a doubling of atmospheric CO2 lies between 1.3 to 2.2 degree C (68% confidence intervall) with a mean value of 1.7 deg C and the equilibrium climate sensitivtiy between 2.0 and 4.2 deg C with a mean value of 2.9 deg C consistent with the estimates from the CMIP5 ensemble but somewhat higher than the estimates given in the 5th assessment report of the IPCC.

Overall the manuscript deals with a very relevant question, i.e. what is the sensitivity



of the Earth system to a doubling of CO2 with respect to surface air temperature but in addition, and that is a new and enlightening aspect, also to a whole range of other target quantities of interest such as sea surface temperature, sea level rise, atlantic meriodinal overturning strength, surface ocean pH, surface aragonite saturation in the southern and tropical oceans as well as soil carbon stocks. Another new aspect is that the authors analyse these sensitivities based on a large ensemble of model simulations constrained by 26 different observational data sets, i.e. providing skill scores for each of the ensemble member. The manuscript is well written and the results are clearly presented. The manuscript only requires some minor clarifications listed below before it can be published.

P 9841, Ll 11-13: One could think of several other impact relevant parameters such as precipitation or extreme events (heat waves, droughts, floods). The exact choice is of course always subjective but maybe the authors could add an explanation why they have chosen their specific list of targets.

P 9842, L 24: It would be good to define 'metrics' here, in the following sentences the authors give example of these metrics but the term is never explicitly defined.

P 9843, Ll 22-24: What are these 'recent studies', the authors should clarify this and provide some more details here, are they observational based, if yes, which observations, or model based. What is meant by 'low TCR'?

P 9844, L 1: It should be '21st' century.

P 9845, Ll 4-9: It would be good to provide some more details on the observational data sets: where do they come from, what are the temporal and spatial characteristics, what are the uncertainties?

P 9845, L 18: The cumulative skill should be the sum of all Sm over m. The authors should clarify this and add this in the manuscript.

P 9858, Ll 1-21: Does the observational constrain on the posterior distribution depend

on the order of applying the different data groups, for instance would it make a difference if ‘heat’ is applied before ‘CO2’ compared to the other way around?

P 9861, Ll 15-20: What would be an appropriate time scale for SAT records to constrain TCR or ECS?

Figures: The figures could be increased in size for better readability, esp figures 2 and 3.

---

Interactive comment on Biogeosciences Discuss., 12, 9839, 2015.