Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2020-79-AC1, 2020

Earth System Dynamics
Discussions

Interactive comment on "Bayesian estimation of Earth's climate sensitivity and transient climate response from observational warming and heat content datasets" *by* Philip Goodwin and B. B. Cael

Philip Goodwin and B. B. Cael

p.a.goodwin@soton.ac.uk

Received and published: 10 December 2020

We thank both reviewers for their helpful and insightful comments. Below we show how we shall amend our manuscript for a revised submission to address the points made by Reviewer 1

Review 1

Summary The authors present an update of the WASP model, using datasets up to the year 2019 of surface temperature, ocean heat content and carbon uptake. They use

a time-varying feedback parameter and compare outcomes of climate response and sensitivity on different timescales and using different datasets. They complement this with an analysis of the principal components of their fitted parameters. The model are useful addition to discussions about the information it can be derived from observations and climate sensitivity, and am happy to see an updated version.

We thank Reviewer 1 for their careful reading of the manuscript. We agree with Reviewer1's finding that the model and method represents a useful addition to the literature, and we are pleased that the reviewer will be happy to see an updated version. Below, we specify how we will update a revised manuscript to address the points made by the reviewer.

Major points 1. The authors compare without much comment different datasets of global warming and ocean heat uptake. The HadCRUT dataset is incomplete dataset of global temperature, with missing data at the poles, which warm faster than the average. In contrast, Cowtan and Way is an example of a dataset that does have global coverage. I would recommend switching HadCRUT out for another dataset that has taken into account polar warming (for instance NOAAGlobalTemp). Alternatively, wait (one week?) for the new version of HadCRUT, which does account for missing data. Similarly, but probably less important, the authors compared two datasets of ocean heat uptake without comment. According to the IPCC's SROCC report, older estimates of ocean heat uptake have biases that may lead to an underestimate of ocean heat uptake (Bindoff, 2019, p.457). Cheng et al (2017) can be considered superior to the old standard of Levitus (2012).

We thank the Reviewer for highlighting the importance of the distinction between the different statistical methods are used to generate historical datasets.

Both Reviewer 1 and Reviewer 2 make clear why temperature records with infilling (e.g. Cowtan and Way) should be preferred over those without infilling (e.g. HadCRUT4). Reviewer 1 also notes that newer estimates of ocean heat uptake (e.g. Cheng et al.)

should be preferred over older records with identified biases.

In light of these comments from Reviewer 1 and Reviewer 2, we will highlight how our findings show that different climate sensitivities arise from these different methods of statistical historical reconstruction. Principally, a revised manuscript will highlight how HadCRUT4 with infilling (Cowtan and Way) implies a higher climate sensitivity to the standard HadCRUT4 (without infilling).

In a revised paper, we will discuss the relative merits of different data sets, and present our results in terms of the increased climate sensitivity implied when missing surface temperature anomaly data is infilled, compared to when infilling is absent. We think this is an important result, and so we would not like to remove the HadCRUT4 without infilling from our manuscript – but rather discuss the importance of infilling the surface temperature record regarding calculating climate sensitivity.

2. I didn't get an intuitive understanding of how the time varying feedback parameter works. Why is there a difference between equation 4 and 5? It would be nice if some additional details could be included here and a reference to the first paper which you derive this.

We agree that a revised manuscript would be improved by providing additional insight into the time varying feedback parameter within WASP. In a revised manuscript we will provide additional insight, and clearly cite the reference to the original study that presents this formulation within WASP. We will also present new figures in the supplementary material that show the time evolution of lambda according to equations (4) and (5) for idealised forcing.

Briefly, equation (4) describes how the climate feedback to an existing source of radiative forcing exponentially decays from its value at the previous time-step towards some equilibrium value. Equation 5 produces an aggregate response from: (i) the climate feedback to the existing radiative forcing (which is decayed from the value at the previous time-step towards the equilibrium value) and (ii) the climate feedback to new

radiative forcing introduced since the previous time-step (which is decayed from zero towards the new equilibrium value).

Minor points Abstract: it might be easier to include the 140 year response time scale, for better comparability with climate models?

We agree that improving comparability with complex climate models will enhance the manuscript, and we will consider how this should be achieved given the assumptions used in the model framework.

L61: should multiple be two?

Agreed that greater clarity would improve this explanation: The general code for the WASP model allows multiple climate feedbacks to act over different response timescales (see Goodwin, 2018 referenced on line 62). Here we use the Planck feedback (acting over an instantaneous timescale) plus two more feedbacks. In a revised manuscript we will state that this study chooses to consider two feedbacks, but that the WASP model may be configured for 'multiple' feedbacks.

L 71: the first word is a typo, right?

Agreed, this first word is a typo.

L 83: halocarbons is not capitalised

Agreed.

L92: I thought all the data used was after 1850. Why do you need volcanic aerosols before that date?

Agreed that an explanation would clarify this. The default setting for WASP model simulations is to start in the year 1765, with sources of radiative forcing defined from that date onwards. Since the temperature in year 1850 (and just afterwards) is affected by the volcanic aerosol (and all other) sources of radiative forcing just prior to 1850, we keep the with default WASP model configuration.

L111: should the j be an i?

Agreed, a revised manuscript will state “for each of the i sources of radiative forcing”.

L118: why not use the default definition of TCR of a 20 year average?

Agreed, we will adopt the default definition of a 20-year average for the TCR when calculating using the WASP simulations in a revised manuscript.

L240. This section or the discussion can do with more context. Why is this interesting?(I think it is, but I needed some brain racking!)

Agreed that additional context on this section will improve the manuscript. This will be provided within a revised manuscript.

L344: Figs 2 -> Fig 2

Agreed, this will be changed.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2020-79, 2020.