Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2020-88-AC1, 2021

Earth System Dynamics Discussions

Interactive comment on "First Assessment of the Earth Heat Inventory Within CMIP5 Historical Simulations" *by* Francisco José Cuesta-Valero et al.

Francisco José Cuesta-Valero et al.

fjcuestavalero@gmail.com

Received and published: 22 March 2021

Response to Reviewers Document for "First Assessment of the Earth Heat Inventory Within CMIP5 Historical Simulations" by Francisco José Cuesta-Valero, Almudena García-García, Hugo Beltrami, and Joel Finnis.

We thank the Reviewers for their thoughtful and constructive feedback.

This Response to Reviewers file provides a complete documentation of the changes made in response to each individual Reviewer's comment.

Reviewers' comments are shown in plain text. Author responses are shown in bold blue text.

Reviewer 1

The article 'First Assessment of the Earth Heat Inventory Within CMIP5 Historical Simulations' provides an evaluation of the Earth heat inventory from climate model simulations, and assess the dissemination of heat storage distribution in the different Earth system components. The article is well written, timely and addresses a fundamental topic, and I recommend minor revision before publication following the different aspects provided below.

Comments:

L30-35: The addition of more recent references would further support this part of the introduction, particularly while referring to outcomes of IPCC SROCC (and respective chapters).

More recent references have been added, including the IPCC SROCC.

L84: This is not correct, as also observation-based products have been accounted for in their estimate: Wegener Center (WEGC) multisatellite RO data record, WEGC OPSv5.6 (Angerer et al., 2017), as well as its radiosonde (RS) data record derived from the highquality Vaisala sondes RS80/RS92/VS41, WEGC Vaisala (Ladstädter et al., 2015). Also, microwave sounding unit (MSU) data records (Mears and Wentz, 2017) have been discussed, but have been finally excluded for the ensemble average used in the EHI. See Steiner et al. (2020) for references (https://doi.org/10.1175/JCLI-D-19-0998.1).

Thank you for noticing this. We have modified the text to reflect this comment.

L97: This evaluation of ocean heat content is different from what is done by the observational community, where the integral of temperature anomalies is used instead of density integration. It would be interesting to understand why this approach is used

here instead, and what the impact/difference between those different approaches are.

We use all available information from climate simulations to produce estimates of heat content as comprehensive as possible. These approaches do not always coincide with the methods employed to derive heat content estimates from observations, as the information available for each case is different. For example, estimates of ground heat content within CMIP5 simulations take into account the simulated water and ice content in the subsurface, which cannot be implemented in observation-based continental heat storage estimates. In the case of the ocean heat content, we concluded that using both temperature and salinity profiles constitutes a more comprehensive approach to estimate OHC changes, although such an approach is challenging to implement in global ocean observations due to the lack of salinity measurements. In any case, we performed additional OHC estimates integrating only simulated sea temperature profiles, reaching similar conclusions (Figure 1 in this document). We have included this figure as supplementary information, accompanied by a brief explanation on the text.

L.115-124: I recommend to consider the study of Steiner et al. (2020): https://doi.org/10.1175/JCLI-D-19-0998.1, 2020.

We appreciate the link to this recent research; however, we aren't sure there is a clear connection between Steiner et al. (2020; estimates temperature trends at different heights from a number of observational datasets), and the indicated lines of our text, which describe the method applied to estimate the atmospheric heat content from CMIP5 simulations. We have interpreted this as an indication that our wording was not clear, thus we have reworded the original text to improve its clarity.

L.330-339: The conclusion could be extended a bit more, and draw a synthesis of all heat content components as discussed in the course of the article. More specific

recommendations for future evolution, and knowledge gaps would further support the strength of the conclusion part. A specific element of discussion is also missing, i.e. on how the obtained results of this study further support the interpretation and future developments of climate models, and on how observation based and model based evaluations could seek strengthening of collaboration in the future to further advance on climate research topics, as well as on more robust and more robust potential for prediction validation – this is an essential element which should be addressed in this article. Finally, the consequences for climate models based on the outcomes, i.e. underestimates/overestimation of Earth system heat storage components should be commented as well (qualitatively in the conclusion, or as part of knowledge synthesis from previous publications in the introduction part).

We have expanded the Conclusions section in the new version of the manuscript addressing the points raised by the reviewer.

Minor:

Supplement Fig. S3: error in ref in figure caption (last sentence).

We have corrected this in the new version of the article.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2020-88, 2020.

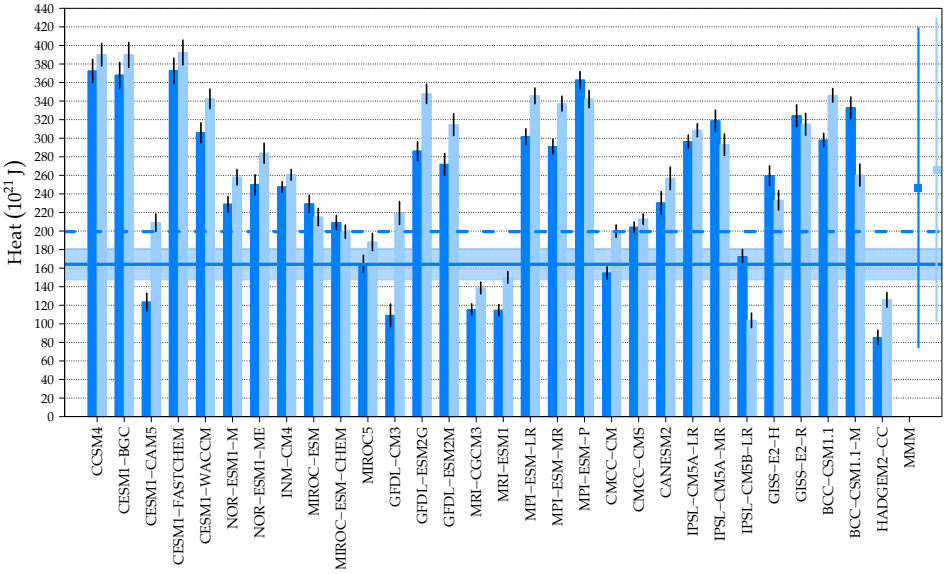

Fig. 1. Simulated change in OHC from integrating temperature and salinity profiles (blue) and from integrating temperature profiles alone (light blue). Observations indicated as horizontal lines and shadows.