



Correspondence

Reply to comment received from J.M. Gregory et al. regarding “Expert assessment of future sea-level rise by 2100 and 2300 AD” by Benjamin P. Horton, Stefan Rahmstorf, Simon E. Engelhart and Andrew C. Kemp (2014), Quaternary Science Reviews 84, 1–6



There is widespread agreement that global sea level will rise during the 21st century and beyond, but uncertainty surrounds the rate and magnitude of the rise. Horton et al. (2014) reported the results of a formal elicitation, where experts were asked to make probabilistic sea-level projections for 2100AD and 2300AD under two emissions scenarios. Here we respond to a comment provided by 9 of the 14 lead authors of IPCC WGI Chapter 13 (“Sea-level change”) in Gregory et al. (2014). Gregory et al. (2014) provide a valuable discussion of differences between the 4th (Meehl et al., 2007) and 5th (Church et al., 2013a) IPCC assessment reports (AR4 and AR5), including the sea-level rise budget and possible mechanisms for a larger contribution to global sea-level rise. As experienced researchers in this field we are fully supportive of the IPCC process and the AR5 report. It is to be welcomed that the assessment emerging from our survey of expert opinion largely concurs with the AR5 report. It is important to emphasize that the purpose of Horton et al. (2014) was not to discuss the IPCC projections, but to present the results of the formal expert elicitation that we conducted. Thus, many of the criticisms made by Gregory et al. (2014) are misplaced.

We respond as follows to specific points raised by the Gregory et al. (2014) comment:

1. Gregory et al. (2014) write that “the AR5 projections are higher” than those of the AR4, while we described this as an “upward revision”. We do not see any substantive difference between the meanings of these two phrases, and do not understand how ours can be reasonably construed as “misleading”.
2. We are fully aware of the reasons for the lower AR4 projections and have discussed these in previous publications (e.g., Rahmstorf et al., 2012). However, the IPCC projections are not the subject of Horton et al. (2014), in which the AR4 was only briefly mentioned for context in the introduction. This is the second time (after Church et al., 2013b) that a core authorship of the IPCC AR5 WGI sea-level chapter have commented on publications where they feel that inadequate detail was provided about their projections. Surely, it is appropriate for us to mention IPCC projections without requiring that we discuss all of the caveats involved?

3. In 2010, the UN Secretary-General charged The Inter Academy Council (IAC; the international organization of scientific academies) to review IPCC procedures in response to public criticism of the IPCC process. The IAC (2010) recommended that “Where practical, formal expert elicitation procedures should be used to obtain subjective probabilities for key results” (p. 41). In response, the IPCC adopted this recommendation in its guidelines (Mastrandrea et al., 2010): “The AR5 guidance (paragraph 2) encourages the use of formal expert elicitation methods when appropriate” (p. 2). Hence, we are surprised that Gregory et al. (2014) appear dismissive of the concept of an expert elicitation and write that it “should not influence an IPCC assessment”. Further, we are disappointed to learn that the authors chose not to participate in our sea-level expert elicitation although most of them were invited (i.e., those that met our objective selection criteria).
4. Gregory et al. (2014) speculate about the mechanisms that some of our survey respondents had in mind when making their projections. We deliberately refrained from such speculation in Horton et al. (2014), given that the survey did not include questions about mechanisms. A survey with 90 participants is bound to include a few outlier estimates (Fig. 1), but is intended to capture the full range of views in the expert community – that is the rationale behind an expert elicitation. It is not for us

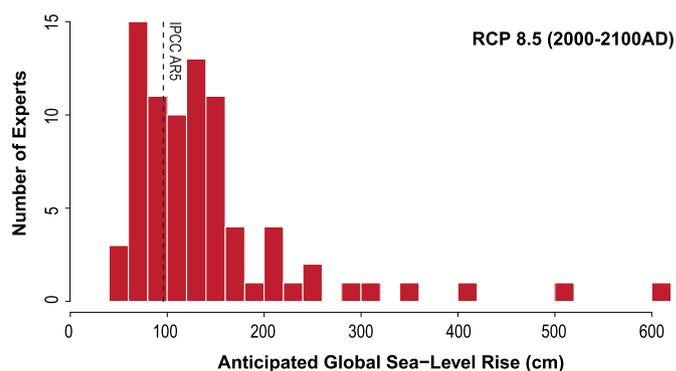


Fig. 1. Histogram of Horton et al. (2014) survey results of the 83rd percentile for the RCP8.5 greenhouse gas scenario at 2100AD, corresponding to the much-cited upper value of the IPCC AR5 range of “likely” sea-level rise (dashed vertical line). Bins are 0–19 cm, 20–39 cm, etc. 65% of the surveyed experts estimated this number to be higher than the IPCC AR5.

to say how realistic these are, but the surveyed experts were selected objectively based on their peer-reviewed publication record, and we may assume they formed their expert views based on their knowledge of the peer-reviewed literature which includes some highly pessimistic estimates. For example, Hansen et al. (2013) suggest that continued business-as-usual CO₂ emissions are likely to spur a “nonlinear response with multi-meter sea level rise this century” (p. 6).

We deliberately cited the median (rather than mean) sea-level ranges provided by the experts in our abstract, since these are not affected by outliers. The median “likely” range given by the experts for the RCP8.5 scenario is 0.7–1.2 m by the year 2100 and thus, as Gregory et al. (2014) rightly say, 0.2 m higher than the corresponding AR5 range.

Horton et al. (2014) is not a criticism of the IPCC's (AR5) assessment of sea level, rather it provides complementary information based on an entirely different methodology. Despite the differences in approach, there is no substantive difference between the conclusions of Horton et al. (2014), IPCC AR5, and Gregory et al. (2014). Further, the recent US National Assessment (Melillo et al., 2014) has projected a probable rise between 0.3–1.2 m for 2100 with a risk up to 2 m, in close agreement with our survey results.

References

- Church, J.A., et al., 2013a. Sea level change. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), *Climate Change: the Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Church, J.A., et al., 2013b. Sea-level rise by 2100. *Science* 342, 1445.
- Hansen, J., Kharecha, P., Sato, M., Masson-Delmotte, V., Ackerman, F., et al., 2013. Assessing “dangerous climate change”: required reduction of carbon emissions to protect young people, future generations and nature. *PLoS One* 8 (12), e81648. <http://dx.doi.org/10.1371/journal.pone.0081648>.
- Inter Academy Council, 2010. *Climate Change Assessments: Review of the Processes and Procedures of the IPCC*. Royal Netherlands Academy of Arts and Sciences, Amsterdam, p. 103.
- Mastrandrea, M.D., Field, C.B., Stocker, T.F., Edenhofer, O., Ebi, K.L., Frame, D.J., Held, H., Kriegler, E., Mach, K.J., Matschoss, P.R., Plattner, G.-K., Yohe, G.W., Zwiers, F.W., 2010. *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties*. Intergovernmental Panel on Climate Change (IPCC).
- Meehl, G.A., et al., 2007. Global climate projections. In: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L. (Eds.), *Climate Change: the Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Melillo, Jerry, M., Terese, T.C., Richmond, Gary, W., Yohe (Eds.), 2014. *Climate Change Impacts in the United States: the Third National Climate Assessment*. U.S. Global Change Research Program, p. 841.
- Rahmstorf, S., Foster, G., Cazenave, A., 2012. Comparing climate projections to observations up to 2011. *Environ. Res. Lett.* 7, 044035 <http://dx.doi.org/10.1088/1748-9326/7/4/044035>.

Benjamin P. Horton *

Institute of Marine and Coastal Sciences, School of Environmental and Biological Sciences, Rutgers University, New Brunswick, New Jersey 08901, USA

Division of Earth Sciences and Earth Observatory of Singapore, Nanyang Technological University, 639798, Singapore

*Stefan Rahmstorf
Potsdam Institute for Climate Impact Research, Telegrafenberg A62, 14473 Potsdam, Germany*

*Simon E. Engelhart
Department of Geosciences, University of Rhode Island, Kingston, Rhode Island 02881, USA*

*Andrew C. Kemp
Department of Earth and Ocean Sciences, Tufts University, Medford, Massachusetts 02155, USA*

* Corresponding author.

E-mail address: bphorton@marine.rutgers.edu (B.P. Horton).