Evaluating IPCC projections of global sea-level change from the pre-satellite era

Torbjörn E. Törnqvist[1], Clinton P. Conrad[2], Sönke Dangendorf[3], Benjamin D. Hamlington[4]

1. Department of Earth and Environmental Sciences, Tulane University, New Orleans, LA 70118, USA
2. Centre for Planetary Habitability, University of Oslo, 0371 Oslo, Norway
3. Department of River-Coastal Science and Engineering, Tulane University, New Orleans, LA 70118, USA
4. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

e-mail: tor@tulane.edu

Supporting Information

The SAR report (Warrick et al., 1996) presented projections for several climate variables. These projections begin from a reference year of 1990 and extend through the year 2100. We compare SAR projections made in 1995/1996 with the observed record of the past three decades (main text, Figures 1 and 2). To do this, we must extract projections of future CO_2, global mean sea level, and the individual contributions to global sea-level change from the SAR. This information is contained in SAR Figures 2.3, 7.7, and 7.8, respectively.

To obtain an empirical expression for the sea-level projections presented in the SAR figures, we employ a curve defined as a linear trend plus a power law of the form:

$$y(t) = y_{1990} + R_{1990}(t - 1990) + \left(y_{2100} - (y_{1990} + R_{1990}\Delta t)\right)\left(\frac{t - 1990}{\Delta t}\right)^{b(t)}$$

where $y(t)$ is the time-varying climate variable of interest, t is the year between 1990 and 2100, and Δt is 110 years. The remaining variables define the end points and the shape of the curve. For the end points, we pick values for y_{1990} (the initial value of y in 1990), R_{1990} (the initial rate of increase of y in 1990), and y_{2100} (the ending value of y in 2100) from Figures 2.3, 7.7, and 7.8. The shape of the curve can be adjusted by changing $b(t)$. Here we define $b(t)$ as linearly varying between initial and final values (b_{1990} and b_{2100}) as given by:

$$b(t) = b_{1990} + (b_{2100} - b_{1990})\left(\frac{t - 1990}{\Delta t}\right)$$

We plotted the above expression for $y(t)$ on scanned reproductions of the SAR figures. Using trial and error, we adjusted the values of b_{1990} and b_{2100} such that the $y(t)$ curves lie

atop the SAR projections (for an example, see Figure S1). We found that this method produces a closer reproduction of the SAR projections, including their curved shapes, than direct digitization. Values for the curve fitting parameters are provided in Table S1.

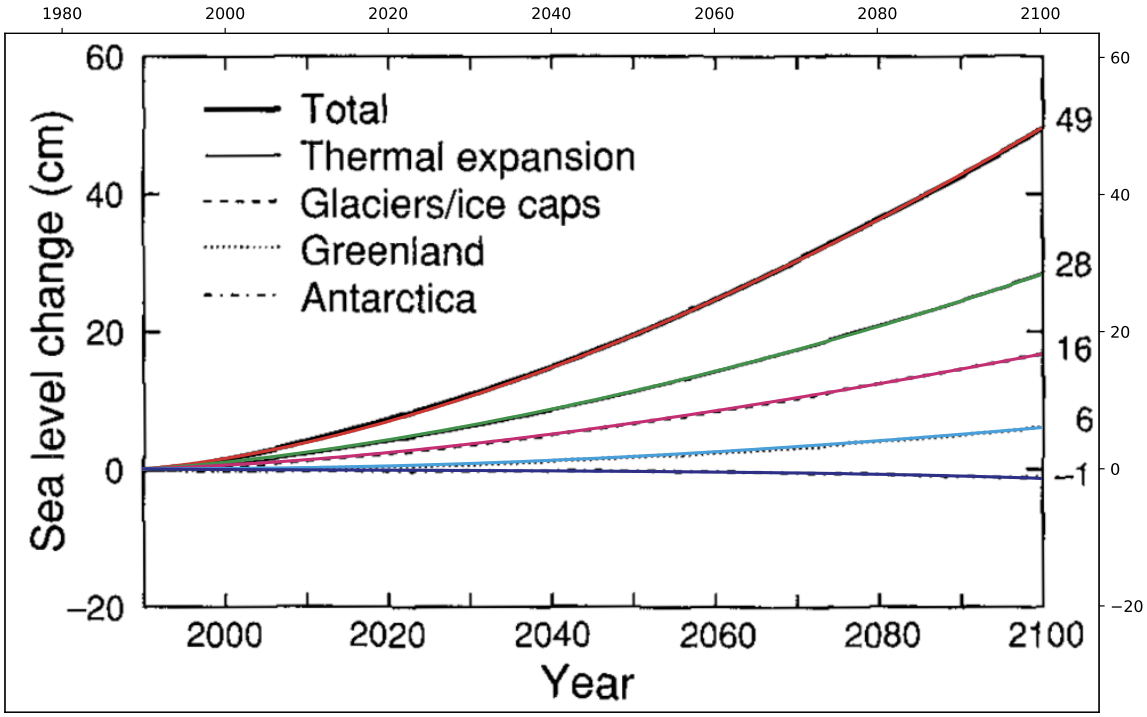

Figure S1. Reconstruction of the projected individual contributions to global sea-level change from SAR Figure 7.8. The SAR is available as a scanned document (Warrick et al., 1996). From this document, we cropped an image of Figure 7.8 (shown in the background), and rotated it 0.3 degrees counterclockwise to orient the axes parallel to the page. We defined a figure coordinate system (outside border and numbers) that is aligned to match that of the SAR figure. By matching endpoint values y_{1990}, R_{1990}, and y_{2100}, and by choosing appropriate values for b_{1990} and b_{2100} (see Table S1), we defined (colored) curves using the equations above that lie atop the sea level projections (black dash-dot curves) of the SAR figure. These fitted curves are reproduced in Figures 1 and 2 of the main text, using the same colors.

Table S1. Parameter values that reproduce curves in SAR Figures 2.3, 7.7, and 7.8.

SAR Figure	Curve	y_{1990}	R_{1990}	y_{2100}	b_{1990}	b_{2100}
2.3	IS92a	354 ppm	1.75 ppm/yr‡	689 ppm	1.91	2.18
7.7	HIGH	0	1.31 mm/yr†	86.0 cm	1.46	1.38
7.7	MID	0	0.75 mm/yr*	49.6 cm	1.68	1.68
7.7	LOW	0	0.31 mm/yr†	20.0 cm	1.99	1.74
7.8	Total	0	0.75 mm/yr*	49.6 cm	1.68	1.68
7.8	Thermal Expansion	0	0.40 mm/yr*	28.3 cm	1.55	1.69
7.8	Glaciers / Ice caps	0	0.35 mm/yr*	16.7 cm	1.80	1.63
7.8	Greenland	0	0.00 mm/yr*	6.0 cm	2.11	1.88
7.8	Antarctica	0	0.00 mm/yr*	-1.4 cm	0.86	3.22

* Obtained from SAR Table 7.7.

† Estimated by scaling the "middle" scenario of SAR Table 7.7 with values for y_{2100}.

‡ Estimated by fitting the initial slope of the curves in SAR Figure 2.3.

Reference

Warrick, R. A., Le Provost, C., Meier, M. F., Oerlemans, J., & Woodworth, P. L. (1996). Changes in sea level. In J. T. Houghton, L. G. Meira Filho, B. A. Callander, N. Harris, A. Kattenberg, & K. Maskell (Eds.), *Climate Change 1995. The Science of Climate Change* (pp. 359-405). Cambridge: Cambridge University Press.