



28 August 2015

Dear Warwick

Please find responses to your questions below.

1. *What was the global average sea level in the 1986 - 2005 period?*

Global mean sea level (or eustatic sea level) can only be expressed relative to something. Most commonly it is expressed relative to the level at a different point in time, i.e. to show *change* in global mean sea level.

The global mean sea level in 1986-2005 was about 17cm higher than it was in 1880 (see Church and White, (2011). *Sea-Level Rise from the Late 19th to the Early 21st Century*. *Surveys in Geophysics*, 32:585-602). For the purpose of projecting global mean sea level into the future, the 1986-2005 baseline is set at zero and the projection is expressed in mm of change from the baseline.

2. *What is the average so far in the 2006 - 2015 period and how much higher is it compared to the 86-05 average.*

Changes to global mean sea level are generally calculated using the average of multiple years (often 20 years). Due to the short time period since 1986-2005, estimates of change using multiple year averages are yet to be published. While the change between particular years can be calculated, it must be treated with caution because of annual variability. The trend over time is more important than changes between particular years.

Estimates of sea level rise based on satellite data covering the period from 1993 to mid-2015 have been published by the University of Colorado Sea Level Research Group (see <http://sealevel.colorado.edu/>).

These data estimate that the global mean sea level in 2014 was 67 mm higher than in 1993 [Merrifield *et al.* (2015). *Sea level variability and change*, pg S84. In "State of the Climate in 2014". *Bulletin of the American Meteorological Society*, 96(7)].

This measured amount of rise falls within the range of all four projections of sea level rise made by the IPCC. The four projections diverge very little over this short timeframe.

The IPCC projections of global sea levels do not rise linearly. Under all four scenarios, the rate of rise is projected to increase (i.e. accelerate) over the latter part of

the century. The melting of large ice sheets is expected to play a much greater role in sea level rise over the second half of the 21st Century. The projections also increasingly diverge over time, influenced by differences in each scenario for future greenhouse gas emissions.

3. *How accurate are these averages, +/- how many mm are required to get 90% confidence.*

The estimates of the rate of sea level rise from satellites are generally presented with 90% confidence bounds. [See IPCC (2013) AR5 Working Group 1, Chapter 3, pg 291; and, for an example of the method for calculating the confidence bounds, see Ablain, *et al.* (2009). A new assessment of the error budget of global mean sea level rate estimated by satellite altimetry over 1993–2008, *Ocean Science*, 5, 193–201].

The most recent analyses estimate the size of the 90% confidence bound to be +/- 0.4 mm per year (for examples, see the University of Colorado Seal Level Research Group (<http://sealevel.colorado.edu/>); Watson, *et al.* (2015). Unabated global mean sea-level rise over the satellite altimeter era. *Nature Climate Change*, 5: 565-568).

For confidence bounds other than those published (such as 66% or 95% confidence bounds), you would need to contact the authors of the published analyses directly.

I hope that these answers help clarify your questions, and that the sources referenced also assist you with any other queries you have about the measurement and projections sea level rise used by the IPCC.

Yours sincerely



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