Response to SC C5401: 'Missing historic sea level data, improbable heat transfer to reduce sea level rise', Michel de Rougemont, 29 Jul 2015

The commenter makes a good point, if he is saying that it is important not to fool oneself (and others) in the way data are plotted. He then proceeds to do exactly that, fool himself.

Our point in providing a graph of sea level change was to counteract the impression left by some sea level graphics in the IPCC reports, specifically an impression that the rate of sea level rise since 1900 is not far from linear (e.g., Figure SPM.3 in the 2013 Summary for Policymakers). It would be pretty difficult for any policymaker to get any sense of urgency about sea level change – because, as far as they can see in that figure, sea level has been going up slowly at a nearly constant rate for the past 115 years.

One obtains a hugely different impression based on the research of Hay et al (Nature 517, 481-484, 2015), who conclude that the rate of sea level rise in the period 1901-1990 was only 1.2 ± 0.2 mm/year. Combining the latter information with the fact that multiple analyses of satellite + tide gauge data yield sea level increase at a rate 3.3 ± 0.4 mm/year, and the fact that preindustrial sea level could not have been rising at a rate greater than a fraction of 1 mm/year (1 mm/year is 1 m per millennium, clearly much larger than reality during the past few millennia), we would conclude that there has been a large acceleration in the rate of sea level rise.

Incidentally, although this may appear to imply an empirical doubling time of several decades, that inferred rate is relevant to the sum of all contributions to sea level change, several of which one would anticipate relatively more linear response than that for ice sheet disintegration. Only in the past decade or so have the ice sheets become large. 1 mm/year is 360 Gt/year, so Greenland + Antarctica now provides of order 1 mm/year, perhaps somewhat more, of the measured 3.3 mm/year.

That leads to another prediction. The apparently near-linear rate of sea level rise of the past two decades should be ending soon. Since satellite measurements began in the early 1990s the rate of sea level rise has hovered about 3.3 mm/year, not changing much. However, now that ice sheet mass loss is a significant fraction of total sea level rise, the global rate should begin to increase noticeably during the next several years. A quantitative estimate could be obtained, e.g., by using the curves fit to Greenland and Antarctic mass loss and extending them with, say, 10 year doubling time for Antarctica and 20 years for Greenland. A longer record will be revealing, so it is important to continue good satellite gravity and sea level measurements.

Tide gauge data alone cannot yield a very accurate estimate of the rate of sea level change, as they sample such a small fraction of the ocean. The "finding" by de Rougemont of a short period of rapid sea level change 200 years ago is not significant given the data source.

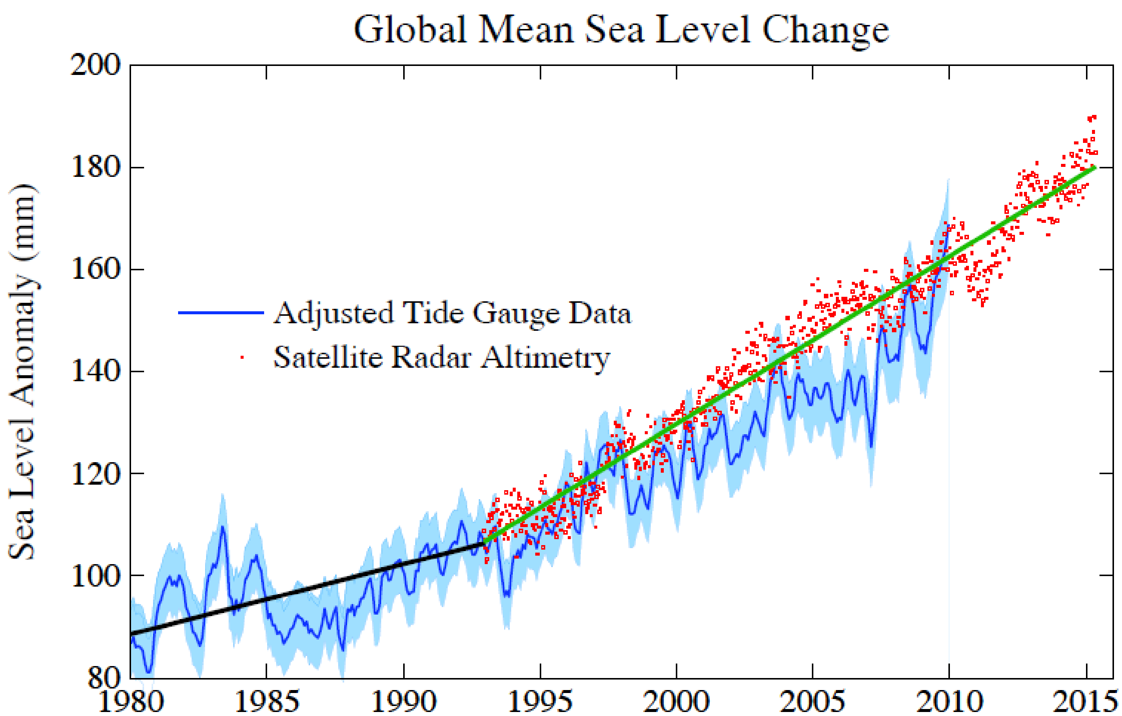

Fig. C5401. Tide gauge data of Church and White (2011) is extended into the period of satellite altimetry data, the latter data shown in red. The rate of change of the tide gauge data prior to the period of satellite data was multiplied by 0.78 to produce a 1901-1990 change rate of 1.2 mm/year. The data for 1993-2009 is the original Church and White data.

All the above being said, de Rougemont is right that it may be useful to show the longer tide gauge record, including recent years providing overlap with satellite data, which we do in Fig. C5401. We do not multiply the reported tide gauge data for 1993-2009 by any factor, because, unlike 1991-1990, we have no basis for adjusting the tide gauge estimate – indeed, without knowing the reason for the apparent tide gauge overestimate of the rate for 1901-1990 one could argue as well for a factor >1 as <1 for the following period. Analysis of the reasons for the differences between the tide gauge data and satellite data is beyond the scope of our present paper, but a good topic for others to investigate.

As for the comment that we should not attribute rapid sea level oscillations to ice sheet mass loss, we have never done so. We consider the gravity satellite data as our best way to estimate ice sheet mass loss, and surface mass balance measurements as a valuable complement – it is encouraging that these two approaches are in reasonably good agreement, as shown, e.g., by Velicogna, et al. (GRL 41, 8130-8137, 2014) and references therein. We have not used global sea level rise to estimate ice sheet change, because up until the present there have been several significant terms contributing to sea level change (including, e.g., ground water depletion, dams, thermal expansion of sea water, flooding, etc.).

Finally, as for the objection that we should not describe numerical experiments with a climate model as experiments, we can only say that this is a common practice and a useful shorthand that we hope does not cause confusion among most readers.