

## Sea-level rise and global climate change by John Church, Chair WCRP JSC

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Global averaged sea level continued to rise through 2006 and 2007. Modern satellite measurements reveal that since 1993, sea-level has been rising at an average rate of about 3 mm per year, substantially faster than the average for the 20<sup>th</sup> century of about 1.7 mm per year, estimated from coastal sea-level measurements. These coastal measurements indicate that the 2006/2007 global averaged sea level is about 200 mm higher than in 1870 and that since 1870 there has been a significant increase in the rate of the sea-level rise. Both data sets show interannual variability in the rate of rise with the tide-gauge data indicating a slightly slower rate of rise over the last few years. Since the start date of the IPCC projections in 1990, both data sets indicate that global sea level has been rising near the upper end of the projections.

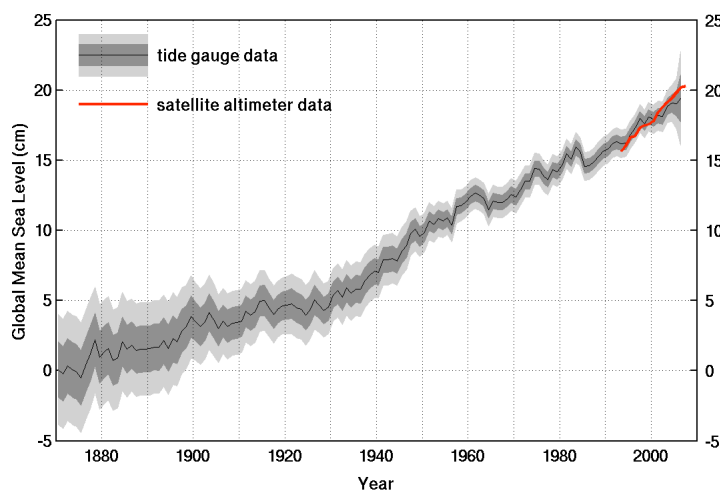


Figure. Global averaged sea level determined from coastal sea-level measurements (solid line with one and two standard deviation error estimates, from 1970 to 2006) and from satellite altimeter data (red, from 1993 to November 2007). [Figure provided by CSIRO Marine and Atmospheric Research based on coastal tide-gauge data from the Permanent Service for Mean Sea Level (PSMSL) and altimeter data from NASA and CNES.]

The increase in the rate of rise during the latter half of the 19<sup>th</sup> century and the early 20<sup>th</sup> century is confirmed by the few multi-century direct coastal sea-level measurements, sea level estimated from sediment cores in various parts of the World, and is consistent with estimates made from sea-level benchmarks carved in rock in Tasmania in 1840 and other data such as the height of ancient Roman fish tanks. Together these results imply that there had been little net change in the sea-level from the first to the 19<sup>th</sup> century AD and the 20<sup>th</sup> century rate of rise is anomalous relative to the recent holocene.

The main contributions to 20<sup>th</sup> and 21<sup>st</sup> century sea-level change are:

- thermal expansion of the oceans (water expands as it warms),
- the addition of mass to the oceans from the melting of glaciers and ice caps in regions like the Himalayas, Alaska, Patagonia, etc.,
- the exchange of mass with the ice sheets of Antarctica and Greenland, and
- the exchange of mass with terrestrial water storages (ground water, aquifers, dams, lakes).

Since 1960, ocean thermal expansion of the ocean and the melting of glaciers and ice caps are the largest contributions to sea-level rise. There has also been an increasing contribution from

surface melt from the Greenland Ice Sheet over this period. These contributions are directly related to recent climate change.

Over the last decade, there are indications of a larger contribution from the movement of outlet glaciers of both the Greenland and West Antarctic Ice Sheets. If this is a signature of an acceleration in response to global warming (as some argue), it would be a major concern as the ice sheets contain enough water to raise sea level by 7m and 6 m, respectively, and any such dynamic response could raise sea level significantly faster than surface melting alone.

The impacts of sea-level rise will be felt through both an increase in mean sea level and through an increase in the frequency of extreme sea-level events (e.g. storm surges) of a given level. Impacts include increased flooding (both severity and frequency) of low-lying areas, erosion of beaches, and damage to infrastructure and the environment, including wetlands, inter-tidal zones and mangroves, with significant impacts on biodiversity and ecosystem function. Millions of people in low-lying nations such as Bangladesh, the Mekong and other deltas, and Pacific islands such as Tuvalu, will have to respond to rising sea levels during the 21<sup>st</sup> century and beyond.

The impacts of sea-level rise are being felt now and they will be felt during the 21<sup>st</sup> century and in the longer term, as sea-level rise will continue for centuries after greenhouse gas concentrations in the atmosphere have been stabilized. Society will need to adapt to the effects of these rising sea levels.

Improved sea-level rise projections will contribute to more effective coastal planning and management. Adaptation measures include, for example, enhanced building codes, restrictions on where to build and developing infrastructure better able to cope with flooding.

Given the amount of warming (and hence sea-level rise) “in the pipeline” it is essential that appropriate adaptation and mitigation measures (e.g. better coastal planning, erection of suitable barriers etc) be put in place soon.

## **Links**

WCRP Sea-level rise activities [http://wcrp.wmo.int/AP\\_SeaLevel.html](http://wcrp.wmo.int/AP_SeaLevel.html)