Proudman Oceanographic Laboratory
NATURAL ENVIRONMENT RESEARCH COUNCIL

PSMSL

Decadal rates of sea level change during the twentieth century.

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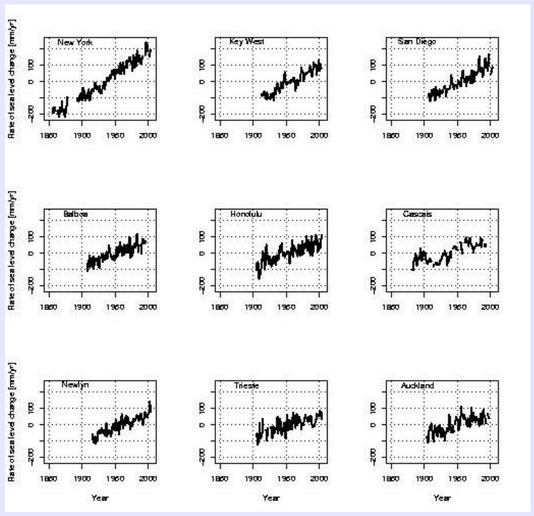
Abstract:

Decadal rates of sea level change over the 20th century were explored using nine long and nearly continuous sea level records. These records were found to capture the variability found in a larger number of records over the last half century.



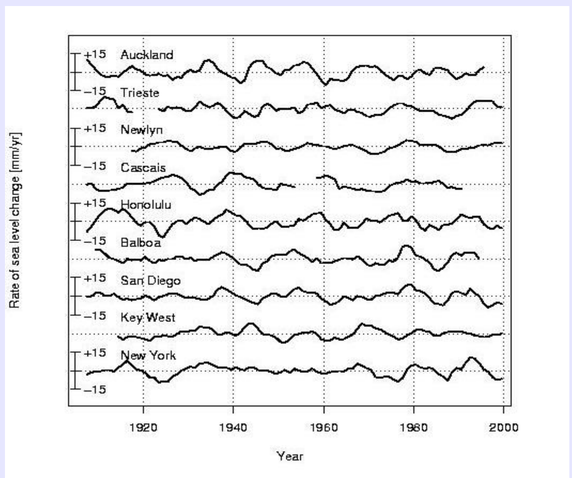
Non-GIA corrected sea level curves for the nine selected stations

Method:

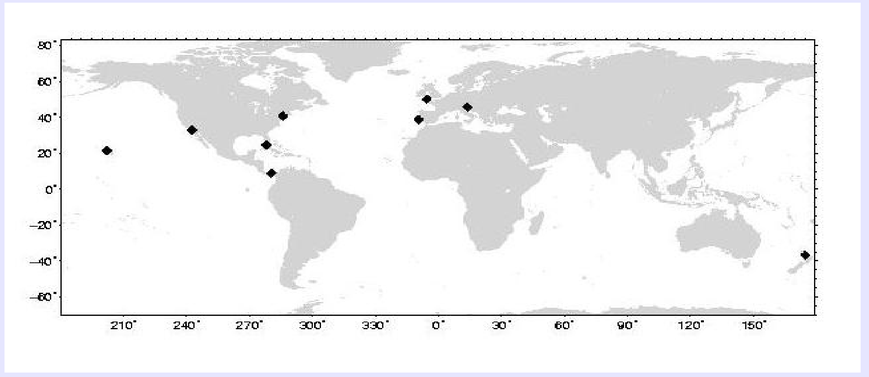
In order to avoid the problem that each sea level record is relative to a local datum, 10 year running mean rates were calculated for each of the nine stations.

The rates of change were corrected for GIA using the ICE-4G model of Peltier (2001) and for inverse barometer effects using the HadSLP2 pressure data set (Allan and Ansell, 2006)

From the figure it can be seen that there is generally little correlation between the individual records, with the exception of Balboa and San Diego (r=0.79). Both these stations are affected by similar oceanic processes even though they are separated by a large distance.



Comparison of the decadal rates of sea level change for each of the nine stations.



The distribution of the long tide gauge records used in this study.

Introduction:

Tide gauges are distributed extremely non-uniformly around the globe. Most previous analyses of "global" sea level data have resolved the problem of the inhomogeneity of the tide gauge distribution by averaging over regions.

However, all tide gauge records are not equal. Here we take the highest quality long records from the PSMSL RLR data set. These records are from regions which do not experience high rates of Glacial Isostatic Adjustment (GIA) and which are not significantly affected by earthquakes. The large spatial coherence of sea level variations allows us to use these high quality tide gauge records in place of regional means.

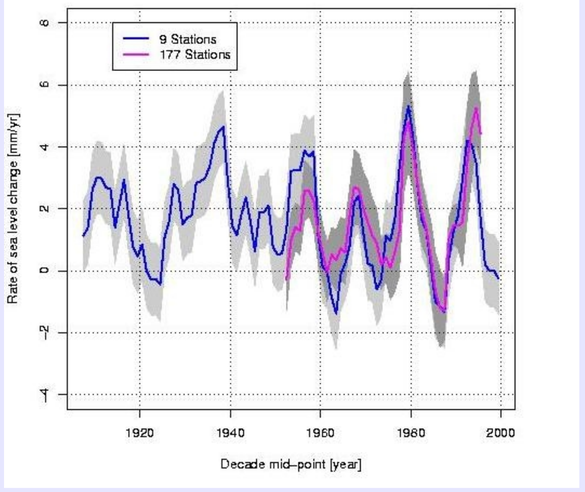
Validation:

A key question in validating this approach is how well do the nine stations capture global sea level variability?

If our reasoning that a single high quality sea level record from a region is better (or at least as good as) a regional mean of a number of records, then the picture of global sea level that we obtain from the nine stations should be similar to that obtained from a larger number of gauges.

The mean of the decadal rates from the nine records provides a "global" mean which is compared with the "global" mean calculated from 177 tide gauges averaged into 13 regions (Holgate and Woodworth, 2004).

The comparison shows that over the common period of the two analyses (1955-1998) there is very strong agreement between the two "global" means. This provides confidence that the nine station set can be used to study decadal rates of global mean sea level change throughout the 20th century.



Comparison of the "global" mean rates of sea level change calculated from nine stations with those calculated from 177 stations averaged into 13 regions. The shaded region indicates ±1 S.E.

Error analysis:

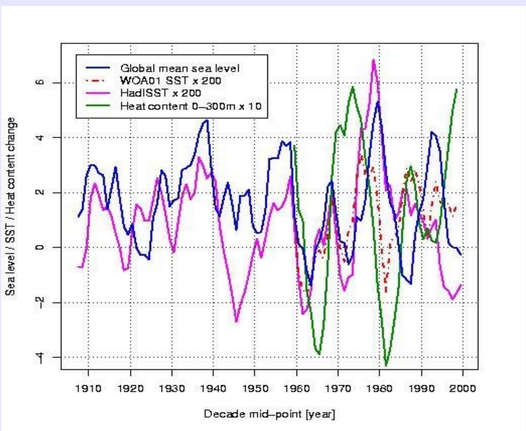
The standard error of a sea level trend estimate, based on the assumption that each annual men s independent, under-estimates the the true error as the serial error is not accounted for.

Here a a more rigorous approach was adopted by employing a First Order Gauss Markov stochastic model.

Relationship of sea level variability to sea level:

The decadal rate of sea level change is significantly correlated at the 95% level (r=0.50) with sea surface temperature change based on the Hadley Centre HadISST data set (Rayner et al, 2003).

Given the apparently large thermosteric contribution to sea level rise, it might be expected that the rate of sea level rise be realted to variability in ocean heat content. However, there is no significant zero lag correlation with decadal rates of change in heat content based on Levitus et al. (2005).

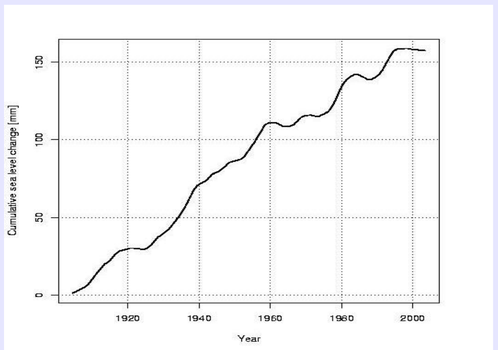


Comparison of the "global" decadal rates of sea level change with decadal rates of change of change of heat content and the HadISST sea surface temperature data set.

Integrated sea level curve for the 20th Century:

When the decadal rates of change are integrated over the entire twentieth century we obtain the figure on the right. Sea level can be seen to have risen around 170 mm on average over the past century.

The mean rate for the twentieth century calculated in this way is 1.67±0.04 mm/yr. The first half of the century (1904-1953) had a slightly higher rate (1.91±0.14 mm/yr) in comparison with the second half of the century (1.42±0.14 mm/yr 1954-2003).



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