Reconstruction of Global Mean Sea Level Variations Using Altimeter and Tide Gauge Data: A Sensitivity Analysis

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Abstract

Satellite altimetry and tide gauges provide complementary measurements of sea level change. The former measures the rate of change at the ocean surface, while the latter measures changes in local sea level at fixed locations. Satellite altimetry was used to develop a global data set from 1993 to 2004. Tide gauges, on the other hand, provide measurements of local sea level variation at specific locations. A reconstruction was used to extend the altimeter data set back to 1950. This reconstruction was compared to a record of altimeter data that had been used previously to extend the tide gauge data back to 1950. The analysis was conducted to determine how each reconstruction used a different number of empirical orthogonal functions (EOF), a different tide gauge data set and processes the data differently. By investigating the sensitivity of these analyses to the different initial assumptions, one might ask how these errors affect the reconstruction of past sea level changes.

Background

One of the limitations of the reconstruction process however, is only just over one decade worth of data is available to provide the best estimate of the sea level at each gridded location for the length of the reconstruction. For more information on the reconstruction process, the references provided will give more detail.

The tide gauge data set supplied by the Permanent Service for Mean Sea Level. The TOPEX/POSEIDON and Jason satellite altimetry from 1993 to 2004 were combined over the time frame of 1993 to 2004. The reconstruction was run from 1950 to 2000. The reconstructions stop at 2000 due to the decrease in available tide gauge information before a gentle climb.

Acknowledgements

The tide gauge data set supplied by the Permanent Service for Mean Sea Level. The TOPEX/POSEIDON and Jason data was supplied by NASA/JPL. This paper was published by G. S. R. A. N. I. for research purposes.

References


EOF Sensitivity

The numbers of EOFs varied from 3 to 11 to maximize the effect of the number of EOFs on the trend, difference between 1993-2000 and before 1993. A 10 year tide gauge set was selected for this analysis. The actual numbers will vary depending on the specific tide gauge data set selected.

Number of Gauges Sensitivity

This graph was created by varying the tide gauge selection criteria to allow for a different number of gauges to be used. The RMS differences between the tide gauges and the reconstructions at each location are shown.

Tide Gauge Locations

This plot is of the location of all the tide gauges in the 15 year minimum tide gauge data set. There is a total of 482 tide gauges used in this data set.

Weighting Metric Effects

A key metric used in reconstruction is weighting the tide gauge data by the number of tie gauge stations within a certain radius. In this case, a gauge is weighted by one over the number of gauges within a 1000 km radius. This metric was used in both the reconstruction used in this study and one used to obtain the weighting scheme.

Conclusions

• The satellite tide gauge data set is composed of tide gauges that have been selected to provide the best information about what is occurring further out in the ocean. The reconstruction process, however, has been designed to remove any biases in the tide gauge data set, and thus no adjustments were made to the tide gauge data set.

The three different time spans are depicted in the above graph. The black line represents the time series of the reconstruction, the light blue line represents the time series for the first 150 years, and the dark blue line represents the time series for the last 50 years.

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