Can we explain regional relative sea-level variations for the period 1961-2003?

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In the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), the global mean sea-level budget for the period 1961–2003 could not be closed satisfactorily. Since then, many studies have attempted to close the global budget, and some have succeeded. In this study however, the focus is on the regional sea-level patterns instead of the global mean sea-level change. This study tries to quantify how much is actually understood of the physical processes underlying sea-level change, by examining the regional patterns of the various processes. These are compared with measurements from tide gauges. As tide gauges measure local sea-level variations, the measurements are averaged over 19 larger regions to obtain a regional value. The study focuses on the average linear trend between 1961 and 2003.

As a reference, we take the contributions that were used in IPCC AR4 –thermosteric, land ice and GIA–, calculate regional patterns and find that they explain around 47% of the regionally observed values. By adding patterns for terrestrial exchange –groundwater extraction and dam impoundment–, and by allowing the ice contributions to deviate from the IPCC AR4 values, we try to increase the explained variability. We find that for the period 1961-2003 at most 49% of the regionally measured values can be explained. This shows that regional patterns are still only partly understood and that including terrestrial exchange is not adding much in this respect. Increasing the ice contribution is not the solution to increasing the explained part, since the variability found in the tide gauge measurements cannot solely be explained with the self-gravitational patterns caused by land ice melt as the location of the melt is constrained. For this reason, part of the unexplained contribution is likely to be related to the thermosteric component. This is confirmed by the fact that the differences between explained and observed sea level are largest in regions with sparse and uncertain thermosteric data.