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Can we estimate the global ocean mass balance via sea level change?

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Global sea level has been monitored by satellite altimetry for more than a decade. The observed mean sea level rise is due to two contributions: The freshwater budget, i.e. precipitation and evaporation as well as inflow of mass from land and cryosphere, and the steric expansion of sea water. Additionally mass is redistributed by the ocean circulation. Unfortunately these contributions cannot be estimated from observations to a sufficient accuracy, only their sum is known with certainty.

We apply a global ocean circulation model which treats the mass and the volume balance of the ocean separately, i.e. it conserves mass and includes steric volume changes. Sea surface height and sea surface temperature for the period 1993-2003 are assimilated into this model using the 4DVAR technique. The ocean model reproduces the measured free sea surface determined as the difference between the altimetric sea surface and the mean GRACE geoid with success.

Our findings are that local sea level variability on annual to interannual periods is dominated by steric effects. They can be explained mostly by thermal expansion but also by haline contraction due to salinity changes. On global scale the annual cycle is given by the freshwater budget, which can be confirmed by comparing the modeled bottom pressure anomalies to the results from the GRACE satellite mission. The global sea level trend in the analysis is a consequence of the increase in heat content of the ocean with only minor contribution from the freshwater budget.