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Steric sea level change in the Bay of Bengal: investigating the most variable component of sea level change

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Regional sea level change is influenced by contributions from mass sources, like melting of glaciers and the ice-sheets in Greenland and Antarctica, as well as steric contributions from changes in temperature and salinity of the oceans. Radar altimetry indicates a sea level trend in the Bay of Bengal of about 6 $\frac{mm}{yr}$ over the time period of 2002-2014, which is significantly larger than the global mean trend. Here, we explain 80% of this rise by steric contributions and 20% by mass-related contributions.

The increased rise of sea level in the Bay of Bengal threatens the coastal vulnerability of the surrounding countries like Bangladesh, where this effect is exacerbated in combination with land subsidence of the very low lying coastal areas. The BanD-AID (Bangladesh Delta: Assessment of the Causes of Sea-level Rise Hazards and Integrated Development of Predictive Modeling Towards Mitigation and Adaptation) project tries to assess the current and future sea level rise and its impacts on the people living in the threatened coastal areas. As a part of this, it is necessary to analyze the different mass and steric contributors to the total sea level rise to aid in the prediction of future risks.

We use data from radar altimetry and the GRACE mission to separate the total sea level rise into contributions from mass sources and steric changes. In our approach, temporal GRACE gravity data and Jason-1 and -2 along track altimetry data are fitted to time invariant spatial patterns (fingerprints) to avoid problems with GRACE resolution, filtering, geocenter and related issues. Our results show that in the Bay of Bengal the steric component is influenced by annual and interannual phenomena and, at the same time, it is significantly larger compared to the individual mass contributions, which show a linear and relatively stable behavior over time.

We validate the steric component of our inversion by comparing it to independent steric estimates from 4-D gridded temperature and salinity products from different ARGO processing facilities. We also compare to the classical approach of subtracting the mass component, estimated by GRACE, from the total sea level change, measured by altimetry. Furthermore, we assess the sensitivity of our inversion to the normalized steric fingerprints, which are either based on ARGO fields or derived from ocean modeling. While most steric changes are taking place in the upper 700 m of the ocean, our inversion also allows us to (indirectly) assess the influence from the deep ocean, which is not negligible for the total steric trend.