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Improved Modelling of Sea-Level Patterns by Incorporating Loading and Self-Attraction

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While global sea level has been rising since the onset of the industrialization, regional sea level shows far more variable patterns on multiple scales in space and time. During the last two decades, regional sea-level distributions have been measured by means of satellite altimetry; these measurements can be compared to the output of numerical global ocean models.

We investigate the skill that oceanic general circulation models, in particular the Ocean Model for Circulation and Tides (OMCT), show in reconstructing sea-level patterns. We find that coarse-resolution, non-eddy-resolving models succeed in reconstructing slow, large-scale sea-level variations such as major ocean currents, ENSO, and the seasonal cycle, while they lack skill in simulating local extremes and fast changes that show up in the higher moments of the local statistical distributions.

In addition, we implement a routine into the model that computes sea-level changes due to the Loading and Self-Attraction of the seawater (LSA) using degree-dependent Love numbers. LSA takes into account the interactions of seawater with the solid Earth as well as the gravitational attraction that the seawater exerts on itself. Up to now, only tidal models have considered this effect, and only in a rather basic manner.

The impact of LSA on sea-level fields and ocean dynamics simulated with a baroclinic circulation model is still rather unclear. In previous OMCT simulations, for instance, LSA has been parameterized by including an additional potential proportional to the mass of the local water column. Considering the effect by applying degree-dependent Love numbers is expected to reduce the differences between modelled sea levels and observations considerably. We discuss the difference that our approach makes for sea-level variability on various temporal and spatial scales. Since the exact computation at every time step is costly in terms of computing power, we also investigate possible trade-offs between physical accurateness and computational effectiveness.