

The global ocean salt budget as an alternative approach for estimating changes in ocean mass

Plain language summary

Global mean sea level rise is an important indicator and direct consequence of global warming. This rise has increased continuously since the early 20th century, due to two factors: (1) thermal expansion of ocean waters as they have warmed and (2) the addition of an increasing amount of freshwater from ice sheets, glaciers and rivers (i.e. increased “ocean mass”).

Various ‘direct’ measurements of sea level rise have become possible during the last ~30 years (the satellite era), however methods that measure ocean mass are the least certain and reveal disagreements when combined.

In this study, we investigated the global ocean salt budget as an alternative approach for estimating changes in ocean mass. In other words, we used the observed ‘freshening’ of the global oceans to infer the mass change that must have occurred in order to produce it.

The global network of Argo floats provides an unprecedented global record of salinity and temperature measurements for the upper 2000 meters of the oceans. We used all available Argo data – combined with high quality hydrographic measurements from World Ocean Circulation Experiment (WOCE) hydrographic program and the Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) – to estimate an ocean mass trend for 2005-2015 of 1.30 ± 1.13 mm per year. This trend has been corrected to exclude melt from floating sea ice, which does not affect sea level.

Adding in measurements of salinity changes in the deep ocean (>2000m depth) increases our estimate of ocean mass trend for 2005-2015 to 1.55 ± 1.20 mm per year.

Our new ocean mass trends are smaller than some previous direct estimates, though not statistically different given the large uncertainties involved. More investigations are needed to reduce these uncertainties. Specifically, the Argo network of salinity and temperature measurements are not equally distributed around the globe, and the current generation of Argo floats do not operate below 2000m depth. New hydrographic missions and observing systems are needed to continuously sample the temperature and salinity changes for the deep ocean, the high latitude regions and some coastal areas.

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