Weighing in: Ocean mass changes and their role in understanding sea level

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In this presentation, I will highlight the advances made in observing and understanding ocean mass changes over the last 10 to 20 years. I will summarize the most important findings, discuss the implications for our understanding of regional and global sea level change rates, and the Earth's energy budget.

On regional and basin scales, sea level variations mainly reflect the dynamic redistribution of heat and mass in the ocean, driven for the most part by winds. On the global scale, ocean mass variations reflect the net exchange of water between the oceans, and the balancing reservoirs of the atmosphere, land, and ice sheets. The GRACE twin-satellites have revealed the large role of terrestrial hydrology in year-to-year modulations of sea level rise and fall driven by climate variability (e.g., ENSO & PDO). The observed correlations between interannual climate fluctuations and sea level contributions also enable pre-GRACE era partitioning of sea level variations into steric and non-steric contributions.

A steady decline in ice mass over Greenland, Antarctica and mountain glaciers reveals that these cryospheric systems are out of mass balance in the current climate. The implied addition of freshwater to the oceans can impact the regional and large-scale ocean circulation, and in turn lead to non-uniform regional sea level changes. As the solid Earth adjust elastically to shifting surface masses, a distinct 'fingerprint' pattern of relative sea level variation emerges.

The observations of altimetric sea surface height and gravimetric ocean mass variations since 2002 have for the first time allowed direct observations of the regional and global sea level budget. With the advent of Argo profiling floats since 2004, assessments of the sea level budget (separation into density-related and mass-related components) allow insights into accuracies and biases of independent observing systems. A deep ocean warming below 2000m has been unequivocally observed in South Pacific, and some studies suggest the detection of deep ocean warming on global scales as well.

With the lengthening data record (altimetry: 20+ years, gravimetry: 15+ years, floats: 10+ years) it is also evident that each observing system possesses intrinsic biases that need to be accounted for. I will summarize the current status on this front, and provide an outlook where future observation and analysis efforts might focus on.

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