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Model and GRACE analyses of self-attraction and loading effects on ocean mass redistribution

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Self-attraction and loading (SAL) effects caused by changes in mass loads associated with land hydrology, atmospheric pressure, and ocean dynamics produce time-varying, non-uniform spatial patterns in ocean bottom pressure. Using a number of geophysical models and GRACE data, we studied the mass redistribution associated with SAL effects. Our analysis shows that SAL effects are an important contributor to ocean bottom pressure variability, on scales from months to years. Comparisons with GRACE data illustrate that accounting for SAL effects provide for a better description of the observed bottom pressure annual cycle. The estimated signals associated with SAL effects can explain 0.2 cm^2 (16%) of GRACE annual variance on average, and exceeding 1 cm^2 in some ocean regions.

We examine the causes and magnitude of the SAL-induced mass variations as a function of time scale and each different surface load (land hydrology, atmospheric pressure, ocean dynamics). With the exception of some small regions, annual variations account for the most variability in SAL-related mass signals and can be induced by all the loads considered, with land hydrology having the largest contribution. At sub-annual and inter-annual time scales, impact of land hydrology is minimal and variations are mostly related to load changes from ocean dynamics and from changes in atmospheric circulation, depending on ocean region. Our results demonstrate that the SAL-induced ocean mass variations have magnitudes comparable to the dynamic bottom pressure signals at sub-annual, annual and inter-annual time scales in many ocean regions and should not be ignored in studies of ocean mass.