Session: B3 Oral presentation

Deep ocean warming assessed from Altimeters, GRACE, in-situ measurements, and a non-Boussinesq OGCM

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Observational surveys have shown significant oceanic bottom-water warming, but they are too spatially and temporally sporadic to quantify the deep ocean contribution to the present day sea-level rise (SLR). In this study, altimetry sea surface height (SSH), GRACE ocean mass, and in-situ upper-ocean (0-700m) steric height have been assessed for their seasonal variability and trend maps. It is shown that neither the global mean nor the regional trends of altimetry SLR can be explained by the upper-ocean steric height plus the GRACE ocean mass. A non-Boussinesq ocean general circulation model (OGCM), allowing the sea-level to rise as a direct response to the heat added into the ocean, is then used to diagnose the deep-ocean steric height. Constrained by sea-surface temperature data, the model reproduces the observed upper-ocean heat content well. Combining the modeled deep-ocean steric height with observational upper-ocean data gives the full-depth steric height. Adding a GRACE-estimated mass trend, the data-model combination explains not only the altimetry global mean SLR but also its regional trends fairly well. The deep ocean warming is mostly prevalent in the Atlantic and Indian Oceans, and along the Antarctic Circumpolar Current, suggesting a strong relation to the oceanic circulation and dynamics. Its comparison with bottom-water measurements indicates that deep-ocean warming below 700 m might have contributed up to one-third of the altimeter-observed SLR of 3.3±0.4 mm/year over 1993-2008.