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The sea level budget since 2003; Inference on the deep ocean heat content

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This study provides an overview of the various components of the global mean sea level evolution over two time spans: (1) 2005-2012 (corresponding of full deployment of the Argo program) and (2) 2003-2012. Using a sea level budget approach, we compare altimetry-based global mean sea level, global ocean mass from GRACE space gravimetry and steric sea level from Argo and other in situ measurements. One goal of this study is to investigate whether it is possible to constrain any deep ocean contribution to the global mean sea level rise over the last decade. This question is particularly relevant, considering the current debate about the 'hiatus', i.e. the observed recent pause of the global mean air and sea surface temperature evolution while the planet is still in thermal imbalance. We consider a total of 16 different data sets. Differences are noticed between data sets related to each variable (sea level, ocean mass and steric sea level), mostly due to data processing issues. Therefore we perform the analysis using averages of available data sets. For each period, we find that when removing from the global mean sea level, the contributions of the global mean ocean mass and steric sea level (estimated for the 0-1500 m ocean layer), there remains a residual signal displaying a positive slope of 0.3 +/- 0.6 mm/yr and 0.55 +/- 0.6 mm/yr over 2005-2012 and 2003-2012 respectively. Comparing with an ocean reanalysis and according to direct (but sparse) ocean temperature measurements below 1500 m, it seems unlikely that the observed residual signal can be attributed to deep (below 1500m) ocean warming, in agreement with other recently published results. More likely, we estimate that it reflects, at least partly, the signature of missing upper ocean steric signal in regions uncovered by current observing systems. Our study also shows a steady warming increase since 2003 of the 700-1500 m ocean layers (amounting 0.2 mm/yr in steric sea level equivalent), confirming previous findings, but seen in our study in each of the eight different steric data sets considered.