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Global sea-level and ocean-mass budgets using advanced data products and uncertainty characterisation

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Studies of the global sea-level budget (SLB) and ocean-mass budget (OMB) are essential to assess the reliability of our knowledge of sea-level change and its contributors. The SLB is considered closed if the observed sea-level change agrees with the sum of independently assessed steric and mass contributions. The OMB is considered closed if the observed ocean-mass change is compatible with the sum of assessed mass contributions.

Here we present results from the Sea-Level Budget Closure (SLBC_cci) project conducted in the framework of ESA's Climate Change Initiative (CCI). We used data products from CCI projects as well as newly-developed products based on CCI products and on additional data sources. Our focus on products developed in the same framework allowed us to exercise a consistent uncertainty characterisation and its propagation to the budget closure analyses, where the SLB and the OMB are assessed simultaneously.

We present time series of global mean sea-level changes from satellite altimetry; new time series of the global mean steric component generated from Argo drifter data with incorporation of sea surface temperature data; time series of ocean-mass change derived from GRACE satellite gravimetry; time series of global glacier mass change from a global glacier model; time series of mass changes of the Greenland Ice Sheet and the Antarctic Ice Sheet both from satellite radar altimetry and from GRACE; as well as time series of land water storage change from the WaterGAP global hydrological model. Our budget analyses address the periods 1993–2016 (covered by the satellite altimetry records) and 2003–2016 (covered by GRACE and the Argo drifter system). In terms of the mean rates of change (linear trends), the SLB is closed within uncertainties for both periods, and the OMB, assessable for 2003–2016 only, is also closed within uncertainties. Uncertainties (1-sigma) arising from the combined uncertainties of the elements of the different budgets considered are between 0.26 mm/yr and 0.40 mm/yr, that is, on the order of 10% of the magnitude of global mean sea-level rise, which is 3.05 ± 0.24 mm/yr and 3.65 ± 0.26 mm/yr for 1993-2016 and 2003-2016, respectively. We also assessed the budgets on a monthly time series basis. The statistics of monthly misclosure agrees with the combined uncertainties of the budget elements, which amount to typically 2-3 mm for the 2003–2016 period. We discuss possible origins of the residual misclosure.

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