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Continental mass change from GRACE over 2002-2011 and its impact on sea level

O. Baur (1), M. Kuhn (2), and W.E. Featherstone (2)

(1) Austrian Academy of Sciences, Space Research Institute, Graz, Austria (oliver.baur@oeaw.ac.at), (2) Western Australian Centre for Geodesy and The Institute for Geoscience Research, Curtin University of Technology, Perth, Australia

Present-day continental mass variations as observed by space gravimetry reveal secular mass decline and accumulation. Whereas the former contribute to sea-level rise, the latter result in sea-level fall. As such, consideration of mass accumulation (rather than focussing solely on mass loss) is important for reliable overall estimates of sea-level change. Using data from the Gravity Recovery And Climate Experiment (GRACE) satellite mission, we quantify mass-change trends in 20 continental areas that exhibit a dominant signal. During the integer nine-year period May 2002 to April 2011, (GIA-adjusted) mass gain and mass loss in these areas contributed, on average, to $-(0.79 \pm 0.25)$ mm/yr of uniform sea-level fall and $+(1.80 \pm 0.18)$ mm/yr of uniform sea-level rise. The net effect was $+(1.01 \pm 0.31)$ mm/yr. Ice melting over Greenland, Antarctica, Alaska and Patagonia was responsible for $+(1.28 \pm 0.18)$ mm/yr of the total balance. Hence, land-water mass accumulation compensated about 20% of the impact of ice-melt water influx to the oceans. In order to assess the impact of geocentre motion, we converted geocentre coordinates derived from Satellite Laser Ranging (SLR) to degree-one geopotential coefficients. We found geocentre motion to introduce small systematic biases to mass-change and sea-level change estimates. Its overall effect is $+(0.12 \pm 0.05)$ mm/yr, but mainly compensates part of the sea-level fall contribution to the total sea-level change budget. This value, however, should be taken with care owing to questionable reliability of secular trends in SLR-derived geocentre coordinates.