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# Heterogeneous oceanic mass distribution in GRACE observations and its leakage effect

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Signal separation between the land and ocean is a challenge in using Gravity Recovery and Climate Experiment (GRACE) observation data to study global mass redistributions. Gravity signals of land/ocean mass anomalies will leak into ocean/land regions and let us underestimate the mass changes on land/ocean in two mechanisms. On one hand, the gravity signal on the land/ocean is reduced because a part of the coastal mass changes leaks out. On the other hand, the signals leaking in from the other regions always have the opposite sign. Therefore, both leakage effects should be corrected to avoid the underestimation. However, people have been paying more attention to the land-to-ocean leakage and less to the ocean-to-land leakage. The ocean mass has been increasing over 2 mm/yr during the period of the GRACE operation, and the accumulated anomaly could be as large as 20 mm when we study mass changes over a decade. To estimate ocean-to-land leakage, we need to understand the geometric distribution of ocean mass anomalies. A simple uniform model was proposed for the long-term ocean mass anomalies, but dynamic ocean currents make this assumption unrealistic especially in the monthly timescale. Here, we propose a flexible method to quantify the heterogeneous ocean-to-land leakage and separate the gravity signals from the land and ocean in GRACE observations.