Geophysical Research Abstracts
Vol. 18, EGU2016-13779, 2016
EGU General Assembly 2016

A data-driven model of present-day glacial isostatic adjustment in North America

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Geodetic measurements of gravity change and vertical land motion are incorporated into an a priori model of present-day glacial isostatic adjustment (GIA) via least-squares inversion. The result is an updated model of present-day GIA wherein the final predicted signal is informed by both observational data with realistic errors, and prior knowledge of GIA inferred from forward models. This method and other similar techniques have been implemented within a limited but growing number of GIA studies (e.g., Hill et al. 2010). The combination method allows calculation of the uncertainties of predicted GIA fields, and thus offers a significant advantage over predictions from purely forward GIA models. Here, we show the results of using the combination approach to predict present-day rates of GIA in North America through the incorporation of both GPS-measured vertical land motion rates and GRACE-measured gravity observations into the prior model. In order to assess the influence of each dataset on the final GIA prediction, the vertical motion and gravimetry datasets are incorporated into the model first independently (i.e. one dataset only), then simultaneously. Because the a priori GIA model and its associated covariance are developed by averaging predictions from a suite of forward models that varies aspects of the Earth rheology and ice sheet history, the final GIA model is not independent of forward model predictions. However, we determine the sensitivity of the final model result to the prior GIA model information by using different representations of the input model covariance. We show that when both datasets are incorporated into the inversion, the final model adequately predicts available observational constraints, minimizes the uncertainty associated with the forward modelled GIA inputs, and includes a realistic estimation of the formal error associated with the GIA process. Along parts of the North American coastline, improved predictions of the long-term (kyr-scale) GIA response and its uncertainty at present-day allows better constraint of both the magnitude and uncertainty of the component of measured present-day sea-level change that is attributable to shorter-term forcing.