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Using GRACE to test glacial isostatic adjustment models in North America

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We use the secular rate of change of gravity, as measured by GRACE, to test models of last glacial maximum (LGM) deglaciation in North America. Predictions of the gravity field trend due to glacial isostatic adjustment (GIA) are compared to observations, and discrepancies in the magnitude and location of the signal maximum are noted. These differences may be due to errors in the GIA modelling or an incorrect interpretation of the GRACE data. We argue that a significant proportion of the trend in equivalent water thickness present in the GRACE data for North America may be due to a secular hydrological signal, and that the GRACE data must be corrected for this signal before being compared to GIA predictions. Using observations of lake heights from satellite and in situ measurements across North America we estimate the linear trend in equivalent water thickness due to lake height changes since 2002. A positive trend in equivalent water thickness is observed for this period in a 500,000 km^2 region south-west of Hudson Bay. The signal is of a similar magnitude to the localised trend in the GRACE data, and is attributed to a 're-filling' of the lakes in this area following low precipitation rates in the first few years of the current decade. After correcting the GRACE data for the hydrological signal we compare the remaining signal to our GIA predictions, and evaluate the accuracy and applicability of the ice and earth models used in our calculations. In particular, we investigate whether the corrected GRACE data can help resolve the discrepancy between GPS-observed uplift rates south-west of Hudson Bay and rates predicted by the ICE-5G model. The data suggest that model ice volumes are too large in this region. However, the global LGM ice volume for ICE-5G is confirmed by far-field sea-level data, therefore any excess LGM ice in North America must be placed elsewhere, for example in Antarctica, or transient rheology must

be invoked in order to explain the present-day GIA signal in North America.