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Renormalisation of Global Mantle Dynamic Topography Predictions using Residual Topography Measurements for "Normal" Ocean Crust

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The best constraint on model predictions of present day mantle dynamic topography are measurements of residual topography. Residual topography is calculated by removing the isostatic effects of bathymetry, sediments, ice, crustal thickness variation and lithosphere thermal anomalies from the observed topography. Comparison of global model predictions of mantle dynamic topography with global compilations of residual topography, while showing a broadly similar pattern at long wavelengths, differ substantially in amplitude. A strong contribution to the present day surface topographic signal arises from crustal thickness variation. As a consequence it is difficult to accurately determine residual topography for continental crust and for oceanic regions with substantially thicker than average oceanic crust (e.g. oceanic crust adjacent to volcanic rifted margins, oceanic plume tracks, volcanic plateaux, micro-continents). Residual topography is best measured on ocean crust of "normal" oceanic thickness. We use global mapping of crustal thickness using gravity inversion to identify crust with thicknesses greater than that of "normal" oceanic crust in order than we can eliminate the less accurate measurements of residual topography for these thicker crustal regions. Comparison of model predicted mantle dynamic topography with residual topography measurements for the remaining regions of thinner "normal" oceanic crust shows an improved correlation but with a dynamic topography showing a positive bias with respect to residual topography and a greater amplitude. We use residual topography measurements for "normal" oceanic crust to downward shift (by approximately 600 m) and rescale (by 0.6) predicted global mantle dynamic topography. We present maps of the renormalised model predictions of global mantle topography from Steinberger (2007) and Flament et al. (2013). One consequence of renormalization is to reduce the amplitude of predicted mantle dynamic topographic uplift in the Pacific. The gravity inversion methodology includes a correction for the elevated geothermal gradient of oceanic and rifted continental margin lithosphere and sediment thickness. Caveats on this methodology are (i) that the gravity inversion methodology used to determine crustal thickness for screening out thick crust is itself dependent on mantle dynamic topography (but fortunately only weakly so) and (ii) that the renormalization procedure is biased towards oceanic regions.