Geophysical Research Abstracts
Vol. 19, EGU2017-4648, 2017
EGU General Assembly 2017

Flexural isostasy: Constraints from gravity and topography power spectra

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We have used the spherical harmonic coefficients that describe the EGM2008 gravity and topography model (Pavlis et al. 2010) to quantify the role of flexural isostasy in contributing to Earth's gravity and topography. Power spectra show that the gravity effect of the topography and its flexural compensation contributes significantly to the observed free-air gravity anomaly field for degree 33-180, which corresponds approximately to wavelengths of 220-1200 km. The best fit is for an elastic thickness of the lithosphere, Te, of 34.0$\pm$4.0 km. Smaller values of Te, under-predict while high values of Te, over-predict the observed gravity spectra. The best fit value is a global average and so it is reasonable to speculate that regions exist where Te is both lower and higher. This is confirmed in studies of selected regions such as the Hawaiian-Emperor seamount chain and the Ganges-Himalaya foreland fold and thrust belt where we show that flexural isostatic anomalies are near zero in regions where Te approaches 34 km (e.g. Hawaiian ridge) and of large amplitude in regions of lower (e.g. Emperor) and higher Te (e.g. Ganges-Himalaya). Plate flexure may be significant at higher (180-441) and lower (12-33) degrees, but topography appears either uncompensated or fully compensated at these degrees, irrespective of the actual Te. Nevertheless, all isostatic models under-predict the observed gravity spectra at degree <12 and so we interpret the low order Earth's gravity field as caused by non-isostatic processes due to dynamic motions such as those associated with mantle convection.