Geophysical Research Abstracts
Vol. 19, EGU2017-7092, 2017
EGU General Assembly 2017

On the ratio of dynamic topography and gravity anomalies in a dynamic Earth

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Growing evidence from a variety of geologic indicators points to significant topography maintained convectively by viscous stresses in the mantle. However, while gravity is sensitive to dynamically supported topography, there are only small free-air gravity anomalies ($<$ 30 mGal) associated with Earth's long-wavelength topography. This has been used to suggest that surface heights computed assuming a complete isostatic equilibrium provide a good approximation to observed topography. Here we show that the apparent paradox is resolved by the well-established formalism of global, self-gravitating, viscously stratified Earth models. The models predict a complex relation between dynamic topography, mass, and gravity anomalies that is not summarized by a constant admittance—i.e., ratio of gravity anomalies to surface deflections—as one would infer from analytic flow solutions formulated in a half-space.