Geophysical Research Abstracts
Vol. 13, EGU2011-12700, 2011
EGU General Assembly 2011

Mechanical Thickness of the Continents Worldwide: A Re-Analysis

Frederik J. Simons (1), Sofia C. Olhede (2), and Dong V. Wang (3)

(1) Princeton University, Geosciences, Princeton, NJ, United States (fjsimons@gmail.com, +1 (609) 258 2598), (2) University College London, Statistical Science, London, United Kingdom, (3) University of North Carolina, Statistics and Operations Research, Chapel Hill, NC, United States

Estimating the effective elastic strength of the lithosphere via spectral analysis and the inversion of the coherence or admittance between gravity anomalies and topography benefits from using optimal localization techniques. In practice, these take the form of the construction of data windows that are applied before Fourier transformation. We have designed a new class of spatio-spectral localization windows that optimize Slepian's classical concentration criterion in two-dimensional Cartesian geometry, for geological regions of arbitrary description. Despite existing generalizations of Slepian's one-dimensional results to the surface of the sphere, about which we reported elsewhere, this had never been done before. With these we have conducted a global study, on each of the worlds' continents, of their mechanical thickness (as defined to be the flexural rigidity or effective elastic thickness in the traditional sense). Our technique is also sensitive to possible anisotropy in the coherence or isostatic response, and we report on the difficulties of separating the anisotropy in the rheological behavior lithosphere from that which characterize the driving topographic loading processes. We pay particular attention to the uncertainties in our estimates, which are large and usually poorly characterized, and use this knowledge when discussing correlations with other measures of thermal or chemical thickness for the world's continents. Our coherence-based approach represents our "final attempt" to derive a uniformly reliable map of continental mechanical thickness. All too often, comparisons between results have been hampered by the use of different techniques or different assumptions. However, in conducting this study, we also identified a number of key problems in *any* coherence- or admittance-based approach for the estimation of flexural rigidity. Thus, we conclude our presentation with a discussion of a new, maximum-likelihood theory to solve the long-standing problem of reconciling various estimates in the literature, without the intermediary of having to estimate coherence or admittance. Indeed, we have derived the exact statistical distribution of the unknowns to be estimated estimated (flexural rigidity and loading ratio, as well as three parameters that characterize the power spectral density of the driving topographic loading processes). These are the parameters of a differential equation with stochastic inputs, with minimal assumptions on the distribution of the data themselves. From this we construct practical algorithms. So far these have been thoroughly tested on synthetic data, and as we will show, after adaptation to be suitable for the analysis of data or arbitrary size, the resulting estimates of mechanical thickness will be Gaussian, and unbiased, with an estimation variance that is below that of any other possible estimate. Finally, our method *subsumes* the estimation of coherence and admittance, which is a useful check for making comparisons with literature estimates based on these earlier techniques.