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# How to measure the strength of the lithosphere *without* using the admittance or coherence between gravity and topography

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The lithosphere is modeled using a differential equation. As such it is characterized by a set of parameters, at least one of which, under the assumption of elastic behavior, is generally thought of as a proxy for its strength: the *flexural rigidity* ($D$), or, by extension, the *elastic thickness*. This lithospheric "system" then takes an input: topographic loading by mountain building and other processes, and maps it into an output: the gravity anomaly and the final, measurable, topography. The input is not measurable but some of its properties can be characterized. The outputs are measurable but the relation between them is obfuscated by their stochastic nature and the presence of unmodeled components (such as non-linearity, non-elasticity, non-stationarity etc). Estimating $D$, most usually in the spectral domain, generally involves an exercise in constructing summaries of gravity and topography. Both admittance and coherence are popular; both are ratios of the cross-spectral density of gravity and topography to the power spectral densities of either, the whole sometimes squared. Despite the fact that neither admittance nor coherence have a Gaussian distribution, estimating $D$ usually comes down to the least-squares fitting of a parameterized curve to the non-Gaussian data, where Gaussian behavior is tacitly, but still incorrectly, assumed. In this two-step procedure, admittance or coherence are first estimated, usually aided by tapering of the spatial input data prior to Fourier transforming (which introduces bias but lowers the estimation variance), and subsequently inverted for the strength parameters. Rarely, if ever, are lithospheric models found that satisfy *both* coherence and admittance to within their true error. This has led to much handwringing in the literature, ever since the methods were introduced in the eighties. Yet, if models of the lithosphere are "true", and "fit" the data, they should fit *both* representations, i.e. both statistics of it. Why don't they? Poorly characterized errors of admittance and coherence are not the only problems with this procedure. There is also the implicit annihilation of information during the construction of these "statistics" (coarsely sampled, sometimes squared, ratios, measures of the data as they are) themselves. Then there is the fact that we do not want to know coherence and admittance at all — we want to know properties of the lithosphere! In this presentation, we intend to abandon coherence and admittance studies for good, by proposing an entirely different method of estimating flexural rigidity, which returns it and its confidence interval, as well as a host of tests for the suitability of the assumptions made along the way, and the possible presence of correlated loads and anisotropy in the response. The crux of the method is that it employs a maximum-likelihood formulation that remains very grounded in the data themselves, and which is formulated in terms of variables that do have a Gaussian distribution.