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Flexural anisotropy in the continental lithosphere: How robust are our estimates?

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In addition to considering the magnitude and lateral variation of the long-term strength of the lithosphere, we must also consider its directional variation, its anisotropy. Many geological materials and processes are themselves anisotropic; this might lead to a natural expectation of widespread anisotropy in lithosphere strength, which both modulates and is modulated by many key tectonic processes. Cratons, with their long, complex geological histories, and orogenic belts, the result of extremely anisotropy processes, might seem especially likely to show anisotropy in their flexural rigidity.

The observed coherence between gravity and topography remains the most popular metric for the analysis of flexural rigidity, and, indeed, it is frequently anisotropic. However, does this correspond to anisotropy in the actual mechanical strength of the lithosphere? Using coherence, we should only reject the null hypothesis of isotropy when there is significant anisotropy in both the observed coherence and the resulting flexural strength. In addition, the anisotropy should not arise purely from marginal (in the statistical sense) anisotropy in the topography and gravity data themselves.

We use wholly isotropic synthetic models to test two common methods for estimating coherence, multitapers and wavelets, and find widespread spurious anisotropy using both methods. Using a series of statistical and geophysical tests developed to identify and remove such spurious directionality, our global reanalysis shows sparse evidence for meaningful anisotropy in the mechanical strength of the lithosphere. Although the geological argument for anisotropy in these regions and its role in tectonic cycles remains highly plausible, this anisotropy has not yet been convincingly verified by any cross-spectral method.