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Relaxation behavior of a laterally varying earth model in response to glacial loading

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Viscoelastic deformations of an earth structure in response to a time-varying surface load are analyzed in glacial isostatic adjustment (GIA). When solving this problem, aspects like flexure of the lithosphere and retarded response of mantle material become evident. Quantified are these by flexural rigidity and relaxation times. The concepts partly lose their relevance when changing from a 1D earth structure (only radial variations) to a 2D or a 3D earth structure (lateral variations). In regions like Fennoscandia and Laurentide, which are affected by GIA, lateral variations of the lithosphere and mantle structure are moderate and, so, the application of a 1D earth structure is widely accepted. But, also for these two regions one has to keep in mind that the respective 1D earth structures differ and that such an approximation mainly holds in the central part of the respective region. In contrast, lateral variations or a local structure of different viscosity have to be considered in areas like Patagonia, Antarctica or Alaska which is located above tectonic activity or covers a region with significant lateral changes in earth structure. But, already for the two former examples one has to keep in mind that the respective 1D earth structures inferred from GIA modelling differ between the two regions.

Focusing on the relaxation behavior and the mantle-material transport, we discuss the effect of lateral variations on the deformation process. We will assess to which extent a 1D earth structure can represent lateral variability in structural features, and, at which point a 3D earth structure has to be considered. Such questions are of concern, when discussing GIA for geodetic applications as well as in earth system modeling as this study contributes to the climate modeling initiative Palmod.

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