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Post-Glacial Rebound: Lateral Viscosity Variations, Transient Creep and the Constraints on Holocene ice-sheets

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We consider post-glacial rebound models with a viscoelastic rheology involving transient creep and also lateral variations of the mechanical properties associated with cratonic roots.

The forward models involving transient creep reproduce well the short wavelengths observed in the present-day rate of uplift, in particular in North-America, without having to invoke a low (10 21 Pas) long-term viscosity of the cratonic roots. The long-term viscosity of the lower mantle can also be of the order of 10 22 Pas in agreement with models of geoid and global flow in the mantle. As found in previous studies, when the viscosity of the cratonic roots is laterally homogeneous, little differences in the uplift rates of Scandinavia and Canada are found between, on one hand, models with cratonic roots below cratons and an asthenosphere below oceans and young continents and, on the other hand, models with cratonic roots everywhere.

Using the models without lateral viscosity variations (i.e. with a cratonic root everywhere), we attempted to invert for mechanical properties and ice thicknesses over Scandinavia and Canada which yield the best fitting past sea-level. Starting from previously published models (Lambeck et al. 2002) the allowed variations of ice thicknesses are simply introduced through proportionality coefficients affecting the ice thicknesses over Scandinavia and Canada,the ice thickness over Antarctica being readjusted to keep the same global sea-level. Models with a 10 per cent to 15 per cent increase of ice thickness over Scandinavia are favored. The rheological properties are close to those of the starting forward model involving transient creep.

The case of cratonic roots with an intrinsically laterally varying viscosity is also con-

sidered. The pattern of uplift can be considerably affected by these lateral variations of mechanical properties. The constraints on the shape of past ice-sheets deduced from the uplift rates must then be used with some caution.