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Post-Glacial Rebound, Lateral Viscosity Variations and Transient Creep

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Post-glacial rebound models often involved a layered viscosity and a Maxwell viscoelastic rheology. The inverted lithospheric thickness was found to be of th e order of 100km. However, there is a thick cratonic lithosphere below the areas of Holocene glaciation. Assemblages of Maxwell solids do not behave like Maxwel l solids and the mantle is expected to be heterogeneous at various scales: At a millimetric scale, it is made of minerals with different viscosities. At larger scale, variations of water content or of temperature should induce viscosity var iations. Therefore, a Maxwell rheology may not describe appropriately the macros copic properties of the mantle.

Here, post-glacial rebound is modeled with lateral variations of the mechanic al properties associated with cratonic roots and a Voigt-Reuss rheology, using a 3D spherical finite element code.

The short wavelengths observed in the present-day rate of uplift, in particul ar in North-America, are compatible neither with a too stiff cratonic lithospher e neither with a very low average viscosity in the upper mantle. Dissipation in the lower part of the cratonic roots can explain the long time-scale associated with the relaxation of the short wavelengths. The transient rheology helps to ha ve a long-term viscosity compatible with the stability of the cratonic roots. It also allows a larger viscosity contrast (100) between the sublithospheric upper mantle and the lower mantle. The asthenospheric viscosity below oceans and youn g continents is poorly constrained but can be as low as $3.10^{19} Pas$, in agre ement with models of heat transfer at the base of the plates.