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Rheological stratification of the lithosphere: A new result from glacial isostatic adjustment constrained by space geodesy

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Although the ICE-5G (VM2) model of the global process of glacial isostatic adjustment has been extremely successful in reconciling the vast majority of observables related to this phenomenon, there exists (at least) one data set that has proven difficult to understand. This data set consists of simultaneous measurements of both present day vertical and horizontal motions outboard and to the south of the region of North America once covered by the Laurentide ice-sheet. In Argus et al. (1999; JGR 104, 29077-29093) it was shown that when the ICE-4G (VM2) model that accurately fits the 14C dated RSL histories along the US east coast, is employed to predict the horizontal motions that should be observed in the same region, large misfits were observed. The same circumstance turns out to be a property shared by the ICE-5G (VM2) model. These misfits are such that the predicted horizontal motions are as much as an order of magnitude in excess of those observed on VLBI antennas in the same region. Here we show that these misfits are entirely removed by introducing realistic radial stratification in lithospheric rheology. This modification to the radial visco-elastic structure of the VM2 model has no appreciable impact upon the high quality of fits to the 14C records of RSL history in either the North American or the Eurasian sectors of the model. The horizontal motion observations, however, are now simultaneously explained.