Glacial Isostatic Adjustment models most often assume a mantle with a viscoelastic Maxwell rheology and a given ice history model. Here we use a Bayesian Monte Carlo with Markov Chains formalism to invert the global GIA signal simultaneously for the mechanical properties of the mantle and for the volume of the various ice-sheets using as starting ice models two distinct previously published ice histories. Burgers as well as Maxwell rheologies are considered.
The fitted data consist of 5720 paleo sea level records from the last 35kyrs, with a world-wide distribution. Our ambition is to present not only the best fitting model, but also the range of possible solutions (within the explored space of parameters) with their respective probability of explaining the data, and thus reveal the trade-off effects and range of uncertainty affecting the parameters.
Our a posteriori probality maps exhibit in all cases two distinct peaks: both are characterized by an upper mantle viscosity around 5.10^{20}Pa.s but one of the peaks features a lower mantle viscosity around 3.10^{21}Pa.s while the other indicates lower mantle viscosity of more than 1.10^{22}Pa.s.
The global maximum depends upon the starting ice history and the chosen rheology: the first peak (P1) has the highest probability only in the case with a Maxwell rheology and ice history based on ICE-5G, while the second peak (P2) is favored when using ANU-based ice history or Burgers rheology, and is our preferred solution as it is also consistent with long-term geodynamics and gravity gradients anomalies over Laurentide. P2 is associated with larger volumes for the Laurentian and Fennoscandian ice-sheets and as a consequence of total ice volume balance, smaller volumes for the Antactic ice-sheet. This last point interfers with the estimate of present-day ice-melting in Antarctica from GRACE data. Finally, we find that P2 with Burgers rheology favors the existence of a tectosphere, i.e. a viscous sublithospheric layer.

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