SIMULTANEOUS INVERSION FOR THE EARTH'S MANTLE VISCOSITY AND ICE MASS IMBALANCE IN ANTARCTICA AND GREENLAND.

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Redistribution of mass in the Earth due to Pleistocene deglaciation and to present-day glacial melting induces secular changes in the Earth’s gravitational field. The Earth is affected today by the former mechanism because of the viscous memory of the mantle and by the latter due to ongoing surface-mass redistribution and related elastic response. A self-consistent procedure allows us to invert simultaneously for the lower and upper mantle viscosity and for the present-day mass imbalance in Antarctica and Greenland using the observed time variations of the long-wavelength gravity field from Satellite Laser Ranging (SLR) analyses. The procedure is based on our normal mode relaxation theory for the forward modelling and a newly developed inversion scheme based on the Levenberg-Maquardt method. We obtain a large viscosity increase across the 670-km depth transition zone separating the upper and the lower mantle, with the lower mantle viscosity varying over the range $5 \times 10^{21}$ to $10^{22}$ Pa s and the less resolved upper mantle viscosity of the order of $10^{20}$ Pa s. When Antarctica is the only present-day source, its rate of melting is $-240$ Gt/yr, corresponding to a sea level rise of 0.7 mm/yr; when Greenland is added as a source of ice loss, the rates of melting are $-280$ Gt/yr for Antarctica and $-60$ Gt/yr for Greenland, corresponding to a sea level rise of 0.8 and 0.2 mm/yr. While SLR data alone cannot discriminate between two possible scenarios of present-day melting limited to Antarctica or occurring in both Antarctica and Greenland, they do indicate that ice melting in the polar regions of the Earth is ongoing.