Viscosity structure of icy satellites: constraints from topography relaxation

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The extensive data collected during the Galileo and Cassini missions provide a better insight into the internal structure and dynamics of icy satellites of giant planets. However, more constraints on the rheological parameters of the satellites' interior are still needed. Examining the viscous relaxation of topography, in case of an icy satellite especially of the topography of impact craters, may constraint the viscosity structure of the satellite's ice mantle. In this study, we model the mantle of a satellite as a viscous spherical shell with radially dependent viscosity. An arbitrary topography is decomposed into spherical harmonics and the topography relaxation is studied separately degree by degree. We show that a single parameter, relaxation time, is sufficient to describe the relaxation at each degree even for relatively complex viscosity models. We investigate the dependence of the relaxation time on the model geometry, gravity acceleration, boundary conditions and especially the viscosity stratification of the mantle. Finally, the relaxation times are determined for several models with parameters of selected icy satellites. Applicability of this approach in determining the viscosity structures of icy satellites is discussed.