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Deformation of Enceladus's ice shell on various time scales – implications for stress distribution, faults' activity and heat flux variations

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With our recently developed three-dimensional finite element code for numerical simulations of the deformation of planetery shells with complex shape and rheology (Soucek et al, 2016), we study the response of Enceladus's outer icy crust to forcing on various time scales. The code allows us to investigate the mechanical response of the shell in three rheological regimes corresponding to the various loading time scales in the viscous, Maxwell viscoelastic and elastic limits.

For the elastic and viscoelastic cases, we study the response of the ice shell to diurnal tidal loading including oribital-period physical libration, long-period libration related to indirect perturbations of the orbit of Enceladus by Dione (with periods 11 and 3.7 years) and possible non-synchronous rotation. We focus on the impact of these forcing contributions on the stress distribution and on the activity of the faults. At the longest time scale, i.e. for quasi-static loading by gravity and centrifugal potential, the viscous limit applies and we study the viscous flow induced in the shell by thickness variations. The shape of the shell is taken from Cadek et al. (2016) and assuming the present-day shape of the shell to be stationary, we study the associated stresses induced by the flow. Considering moreover a simplified conductive temperature distribution in the shell, we infer the necessary heat flux variations at the base of the shell that are required to compensate the dynamic shape variations by the processes of melting and crystallization.

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