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Thermal stability of internal liquid water reservoir at Enceladus' South pole

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The total heat power released at Enceladus' South pole is about 50 times larger than the available radiogenic power, implying that an additional source of energy exists. Tidal dissipation is the most likely candidate, but the observed power and its particular location at the south pole can be reproduced only if a liquid layer exists at depth (Tobie et al. Icarus 2008). Moreover, this liquid reservoir should spread over at least half of the southern hemisphere to induce sufficient tidal deformation at the pole. In order to determine the stability of this internal liquid reservoir and its effects on the dynamics of the overlying ice shell, we have developed a new tool that solves simultaneously mantle convection and tidal dissipation in 3D spherical geometry (Běhounková et al. JGR, 2010). Using this new 3D technique, we demonstrate that the tidal strain rates are strongly enhanced in hot upwellings when compared with classical methods of tidal dissipation computation, and therefore that lateral variations of viscosity must be explicitly taken into account to correctly describe the dissipation field. Moreover, our 3D simulations show that tidal dissipation in Enceladus tends to focus hot upwellings at the South pole and cold downwellings in the equatorial region, and that the heat flux at the base of the ice shell is strongly reduced at the pole, thus favoring the preservation of a liquid reservoir at depth. By systematically varying the orbital and internal parameters, we investigate the conditions under which a liquid reservoir can be thermally stable in Enceladus' interior and what is its possible extension at equilibrium.