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Convection Driven by Tidal Heating: Numerical Model and Parameterized Theory

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Global volcanic and tectonic activity observed on some satellites of giant planets are probably a result of convection driven by tidal heating. To investigate the problem, 3D model of convection is developed based on the Navier–Stokes equation, the equation of thermal conductivity, the equation of continuity, and the equation of state. Using this model a number of numerical experiments are performed to determine properties of convection. The Nusselt number as a function of Rayleigh number is also found. Using this relationship a parameterized theory of convection driven by tidal and radiogenic heating in celestial bodies is developed and applied to medium size icy satellites. The results indicate that some of the satellites could exist in a few thermal states. Present volcanic activity of Enceladus as well lack of such activity on the other satellites could be explained on the basis of this theory.

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