Nusselt number for convection driven by tidal and radiogenic heating in icy satellites

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The recent progress in 3D numerical modeling of solid state convection driven by radiogenic and tidal heating in planetary bodies makes possible to determine the Nusselt number *Nu* as the following function of Rayleigh number *Ra*: $Nu(Ra)=\varepsilon(Ra+\xi)^{\lambda}$ where λ depends on the rheology and boundary conditions, ε depends only on the mode of heating, and $\xi = \varepsilon^{-(-1/\lambda)}$. The above formula presents an important improvement because it is valid for convection driven by tidal and radiogenic heating and for low and moderate values of the Rayleigh number. Note that the traditional formula $Nu(Ra)=\gamma\, Ra^{\varphi}$ fails for low *Ra* and does not take into account the tidal heating at all. *Nu*(*Ra*) makes possible to develop a parameterized theory of convection in medium size icy satellites. Dimensionless average temperature difference is expressed by$\Delta T'_{conv} = (Ra + \xi)^{-\lambda}$. It is also found that thermal and dynamical properties of convection driven by tidal and radiogenic heating is significantly different than the properties of convection driven exclusively by radiogenic heating. The most dramatic differences are seen for low *Ra*.

Keywords: satellites of Saturn, tides, thermal histories, tectonics, volcanism.