Geophysical Research Abstracts
Vol. 21, EGU2019-4392, 2019
EGU General Assembly 2019

3D numerical models of thermal convection inside Triton's icy shell

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Heating due to obliquity tides may drive the present-day geological activity on Neptune's major moon Triton [1]. One of the various surface types discovered during the Voyager 2 flyby in 1989 is the so-called cantaloupe terrain [2] that is comprised of non-circular dimples with a mean wavelength of 47 km [3]. A compositionally-driven overturn has been proposed [3] to explain the formation of the cantaloupe terrain; however the very young age of Triton's surface [4] makes this explanation unlikely since such an overturn happens only once.
Here we test whether thermal convection inside Triton's ice shell is able to reproduce the basic surface features of the cantaloupe terrain. For this purpose we employ the state-of-the-art finite-difference marker-in-cell code I3ELVIS [5] to model visco-plastic convection in 3D cartesian geometry using the sticky air method [6,7] to simulate a free surface. The initial model setup is based on the results of 1D thermal models of Triton's evolution until present-day [1]. We test both the influence of plastic yield stress and Rayleigh number on the model outcome. Using the Matérn parameters [8] we compare the outcome of numerical simulations to the observed topography of the cantaloupe terrain.
Our preliminary results indicate that for plastic yield stresses ranging from 0.05 – 0.5 MPa the surface remains deformable, while large-scale overturn events (cf. [9]) are absent. On the other hand ice viscosities $<10^{18}$ Pa s are necessary to produce surface deformation on lengthscales comparable to those of the cantaloupe terrain.

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