Geophysical Research Abstracts
Vol. 19, EGU2017-11192, 2017
EGU General Assembly 2017

Planetary Ice-Oceans: Numerical Modeling Study of Ice-Shell Growth in Convecting Two-Phase Systems

Divya Allu Peddinti (1) and Allen McNamara (1,2)

(1) Arizona State University, Tempe, United States (divya.allupeddinti@asu.edu), (2) Michigan State University, East Lansing, United States (allenmc@msu.edu)

Several icy bodies in the Solar system such as the icy moons Europa and Enceladus exhibit signs of subsurface oceans underneath an ice-shell. For Europa, the geologically young surface, the presence of surface features and the aligned surface chemistry pose interesting questions about formation of the ice-shell and its interaction with the ocean below. This also ties in with its astrobiological potential and implications for similar ice-ocean systems elsewhere in the cosmos. The overall thickness of the H_2O layer on Europa is estimated to be $\sim$ 100-150 km while the thickness of the ice-shell is debated. Additionally, Europa is subject to tidal heating due to interaction with Jupiter's immense gravity field. It is of interest to understand how the ice-shell thickness varies in the presence of tidal internal heating and the localization of heating in different regions of the ice-shell. Thus this study aims to determine the effect of tidal internal heating on the growth rate of the ice-shell over time.

We perform geodynamic modeling of the ice-ocean system in order to understand how the ice-shell thickness changes with time. The convection code employs the ice Ih-water phase diagram in order to model the two-phase convecting ice-ocean system. All the models begin from an initial warm thick ocean that cools from the top. The numerical experiments analyze three cases: case 1 with no tidal internal heating in the system, case 2 with constant tidal internal heating in the ice and case 3 with viscosity-dependent tidal internal heating in the ice. We track the ice-shell thickness as a function of time as the system cools. Modeling results so far have identified that the shell growth rate changes substantially at a point in time that coincides with a change in the planform of ice-convection cells. Additionally, the velocity vs depth plots indicate a shift from a conduction dominant to a convection dominant ice regime. We compare the three different cases to provide a comprehensive understanding of the temporal variation in the ice-shell thickness due to the addition of heating in the ice.