Evolution of subsurface ocean and constraint for the interior in Pluto

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NASA's New Horizons spacecraft made its close flyby of Pluto on 2015 and has acquired surface images and unveiled a diverse range of landforms. Accurate determinations of Pluto's shape from imaging data suggest that Pluto is almost perfectly spherical and had or has a relatively warm interior (maybe an ocean) for the most part of its history. In addition, reorientation of Pluto arising from tidal and rotational torques implies that the subsurface ocean currently exists. Furthermore, Pluto’s surface has many extensional tectonic signatures, indicating that water ice–based crust has been experienced volume expansion event, e.g., gradually freezing of liquid water. Accurately measured value of Pluto’s radius and inferred bulk density of 1.854 g/cc indicates that Pluto has 30-35 wt% of water and volume ratio between water shell and rocky core could be changed depending on their densities if we assume that two components are perfectly differentiated (e.g., surficial water shell thickness changes several tens of kms depending on the rocky core density). Such difference might have a large impact for the water shell structure in terms of the pressure range, and high-pressure phase ice could be appeared above the rocky core surface in case of the thick water shell.

Considering such wide variety of interior structure according to the bulk density of Pluto’s surface radius, we performed the numerical simulation for the interior thermal history to discuss a constraint of the interior which is capable of sustaining the subsurface ocean at present.

