Dynamics of icy crust of Enceladus with tidal heating and asymmetric distribution of heat source in internal ocean

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Enceladus is the sixth-largest moon of Saturn. The interior structure of Enceladus has been briefly revealed as icy crust, global internal ocean and rocky core. On the icy crust, it seems to be extremely diverse for surface geology. The most striking regions is the South Polar Terrain(SPT), which may have the tiger stripes with young geological age and seems to be caused by tectonic deformation in icy crust. For understanding the tectonics deformation in icy crust, with an analogy of the Earth's plate tectonics, the convective dynamics in icy crust has been investigated by various researchers, which also includes an effect of tidal heating that is currently considered as a major heat source in Enceladus. For reconciling a diversity of surface geological features found by space craft observations, it would be quite essential to reveal an interaction between tidal heating and convective dynamics in the icy crust.
Here we develop a numerical model of icy crust dynamics including the tidal heating based on numerical mantle convection simulation model of the Earth. For the tidal heating in the icy crust, we impose an analytical solution of tidal deformation considering viscoelasticity in a thin shell on the surface (See Ojakangas and Stevenson, 1989). Moreover, we include asymmetric distribution of heat source in the internal ocean for exhibiting active tectonics in southern hemisphere.
Our preliminary results indicate that, with imposing tidal heating, high temperature along the poles and low temperature along the equator throughout the icy crust. However, such a feature is disappeared with asymmetric distribution of heat source in the internal ocean and small-scale plumes come up from the bottom of icy crust in southern hemisphere. It seems that, for understanding the active tectonics in southern hemisphere of icy crust in Enceladus, a heterogeneous distribution of heat source in the internal ocean may be significant rather than the tidal heating effect. However, this interpretation would not be sufficient because, in the current model, an effect of orbital resonance between Saturn and Enceladus is not incorporated. In the presentation, we will also show how the orbital resonance may affect the convective dynamics in the icy crust of Enceladus and give further discussion on formation of surface geologic feature in Enceladus.

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