

# The circulation of Europa's ocean

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There is strong evidence that the Jovian moon Europa hosts an ocean below its icy surface. The depth of the ocean and the thickness of the ice crust are rather uncertain. It is assumed that the ocean is about 100 km deep and that the ice crust is about 15 km thick.

To study Europa's ocean, we employ the Hamburg Large Scale Geostrophic Ocean General Circulation Model (LSG). Gravity and rotation period are adjusted to Europa's values. To avoid instabilities due to the shallow water approximation, our model moon is double the size of Europa and the ocean is only 22 km deep. As boundary conditions we prescribe radiative equilibrium temperatures at the ice surface and heat fluxes at the ocean floor according to the tidal stress pattern.

The model has been integrated for 100 000 model years. For the first 75 000 years, the model was step by step adapted and tuned to Europa. Since 25 000 years, boundary conditions and parameters are kept constant. We observe a dynamic interaction between circulation and ice crust. A pronounced area of reduced ice thickness is present since 50 000 model years.

So far, only a simple thermodynamic ice model is implemented and direct tidal heating of the ice crust has not been considered. To further investigate the evolution and dynamics of the coupled ocean/ice system, we will implement a fully rheologic ice model inherited from terrestrial ice-shelf models. We expect a superposition of horizontal (ice-shelf like) flow and convection in the icy crust.

These modelling studies may enable the validation of the ocean circulation by observation of ice raft or of a surface elevation pattern which is related to the ocean circulation. They can also contribute to the planing of a lander mission to Europa.