Data assimilation for coupled ice-ocean-solid-Earth models

This project is part of the Advanced Earth System Model Capacity (ESM, www.esm-project.net) project by the Helmholtz Association. The objective of the ESM project is to "develop, evaluate and apply a world-leading Earth system modelling infrastructure with the aim to contribute to providing solutions to grand challenges faced by the Earth and environmental sciences for the benefit of society." (ESM Implementation Plan).

In our part we investigate methods for data assimilation for coupled Earth systems. In particular, we want to gain insight into the joint model behaviour of sea-level and ice models in combination with a model for the visco-elastic deformation of the Earth.

In a first step we utilize the VILMA, a model for the visco-elastic deformation of theEarth in response to mass load changes, and integrate a particle filter into the model. For that purpose we use the Parallel Data Assimilation Framework (PDAF). It allows to easily integrate a variety of data assimilation techniques into existing dynamical models. Our first aim is to constrain the viscosity distribution in the Earth's mantle with a parameter estimation. We use the rate of sea-level change as observations for the data assimilation.

Uncertainties of the mantle's viscosity are still very high (in the order of magnitudes). But in order to compute reliable sea-level change estimations for the past and the future the Earth's response to changing mass loads (as are expected due to melting glaciers and ice sheets) needs to be quantified. For this task the mantle viscosity and its change with depth are essential parameters since they strongly influence the time scale and deformation distribution at the surface.

In a second step the project aims at implementing the data assimilation algorithm for a coupled model of solid-Earth deformation and the mass load development due to glaciation and deglaciation.