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Thermo-mechanically coupled subduction with a free surface using ASPECT

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ASPECT (Kronbichler et al., 2012), short for Advanced Solver for Problems in Earth's ConvecTion, is a new Finite Element code which was originally designed for thermally driven (mantle) convection and is built on state of the art numerical methods (adaptive mesh refinement, linear and nonlinear solver, stabilization of transport dominated processes and a high scalability on multiple processors).
Here we present an application of ASPECT to modeling of fully thermo-mechanically coupled subduction. Our subduction model contains three different compositions: a crustal composition on top of both the subducting slab and the overriding plate, a mantle composition and a sticky air composition, which allows for simulating a free surface for modeling topography build-up. We implemented a visco-plastic rheology using frictional plasticity and a composite viscosity defined by diffusion and dislocation creep. The lithospheric mantle has the same composition as the mantle but has a higher viscosity because of a lower temperature. The temperature field is implemented in ASPECT as follows: a linear temperature gradient for the lithosphere and an adiabatic geotherm for the sublithospheric mantle. Initial slab temperature is defined using the analytical solution of McKenzie (1970). The plates can be pushed from the sides of the model, and it is possible to define an additional independent mantle in/out flow through the boundaries.
We will show a preliminary set of models, highlighting the codes capabilities, such as the Adaptive Mesh Refinement, topography development and the influence of mantle flow on the subduction evolution.

Kronbichler, M., Heister, T., and Bangerth, W. (2012), High accuracy mantle convection simulation through modern numerical methods, Geophysical Journal International,191, 12-29, doi:10.1111/j.1365-246X.2012.05609.

McKenzie, D.P. (1970), Temperature and potential temperature beneath island arcs, Teconophysics, 10, 357-366, doi:10.1016/0040-1951(70)90115-0.