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Mantle flow influence on the evolution of subduction systems.

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Evolution of the subducting slab has been widely investigated in the past two decades be means of numerical and laboratory modeling, including analysis of the factors controlling its behavior. However, until present, relatively little attention has been paid to the influence of the mantle flow. While for large subduction zones, due to the high slab buoyancy force, this effect might be small, mantle flow might be a primary factor controlling the evolution of a regional subduction zone.
Here we investigate the impact of prescribed mantle flow on the evolution of both generic and real-Earth subduction models by means of 3D thermo-mechanical numerical modeling. The generic setup consists of a laterally symmetric subduction model using a $3000\times2000\times1000$ km modeling domain with a lateral slab width varying from 500 to 1500 km. Non-linear rheology is implemented including diffusion, dislocation creep and a viscosity-limiter. To satisfy mass conservation, while implementing mantle inflow on some side boundaries, we keep other sides open (Chertova et al. 2012).
To test the mantle flow influence on the dynamics of real-Earth subduction zone we adopt the numerical model from Chertova et al. (2014) for the evolution of the western Mediterranean subduction since 35 Ma. First, this model was tested with the arbitrary mantle flow prescribed on one of the four side boundaries or for the combination of two boundaries. In the last set of experiments, for side boundary conditions we use time-dependent estimates of actual mantle flow in the region based on Steinberger (2015) given for every 1 My.
We demonstrate that for the western-Mediterranean subduction, the surrounding mantle flow is of second-order compared to slab buoyancy in controlling the dynamics of the subducting slab. Introducing mantle flow on the side boundaries might, however, improve the fit between the modeled and real slab imaged by tomography, although this may also trade-off with varying rheological parameters of the lithosphere and mantle.

Chertova, M., T. Geenen, A.P. van den Berg, and W. Spakman (2012), Using open sidewalls for modelling self-consistent lithosphere subduction dynamics, Solid Earth.
Chertova, M.V., W.Spakman, T. Geenen, A.P. van den Berg, D.J.J. van Hinsbergen (2014), Underpinning tectonic reconstructions of the western Mediterranean region with dynamic slab evolution from 3-D numerical modeling, JGR.
Steinberger (2016), Topography caused by mantle density variations: Observation-based estimates and models derived from tomography and lithosphere thickness, in revision.