Constraining the dynamics of the present-day Alps with 3D geodynamic inverse models

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The goal of this project is to incorporate the (secondary) geological observables: i) temperature structure, ii) Moho surface, iii) plate boundary reconstructions and iv) wavespeed reconstructions, to build a geodynamic model that represents the current state of the Mediterranean with focus on the alpine region. We then describe this model by different rock types and solve the Stokes equations for the surface velocity and stress distribution. The result of these simulations is then compared to GPS velocities and stress direction measurements, possibly also to gravitational anomaly models, exhumation rates and seismic anisotropy inversions. The Stokes equations can also be formulated as an inverse problem to automatically detect the rheological parameters of the rockt types that reproduce the measured GPS velocities.

We are currently working on a reference model that is based on a combined Moho map that includes Molinari & Morelli (2011), Spada et al. (2013) and Tesauro et al. (2008), the temperature structure of Tesauro et al. (2009) and a seismic model produced in collaboration with T. Meier and A. Al-Sharkawy at CAU Kiel. The material parameters as well as the geometry of the slabs is varied to reproduce the general velocity patterns of Serpelloni et al. (2005) and to ultimately define a reference model. The current version of the reference model is shown in figure 1. Based on this reference model we will investigate the effect of the different subduction zones and rheological parameters in a more systematic way and optimize the fit to the GPS velocities automatically with an adjoint inverse approach (similar to Reuber et al., 2018). Our models start with an initial flat topography, which then isostatically equilibrates. We developed a new algorithm that can automatically create a density structure to fit a given topography, which is a necessary condition for a reference model.
The main results, so far, suggest that the balance in subducted material between the Dinaridic subduction zone and the Apenninic subduction zone controls the rotational behaviour of Adria, e.g. removing parts of the slab in the northern Dinarides will move the rotation pole of Adria further South. The movement of Sicily is mainly controlled by the subduction zone beneath Sicily and acts independently of the subduction beneath the Apennines. The Carpathian subduction and the alpine subduction zone do not have a major impact on the motion of Adria in our models.

Our project combines many fields of the AlpArray research theme, since it is based on the data that is acquired by the distinct research groups, with the aim to build one consistent geodynamic model.

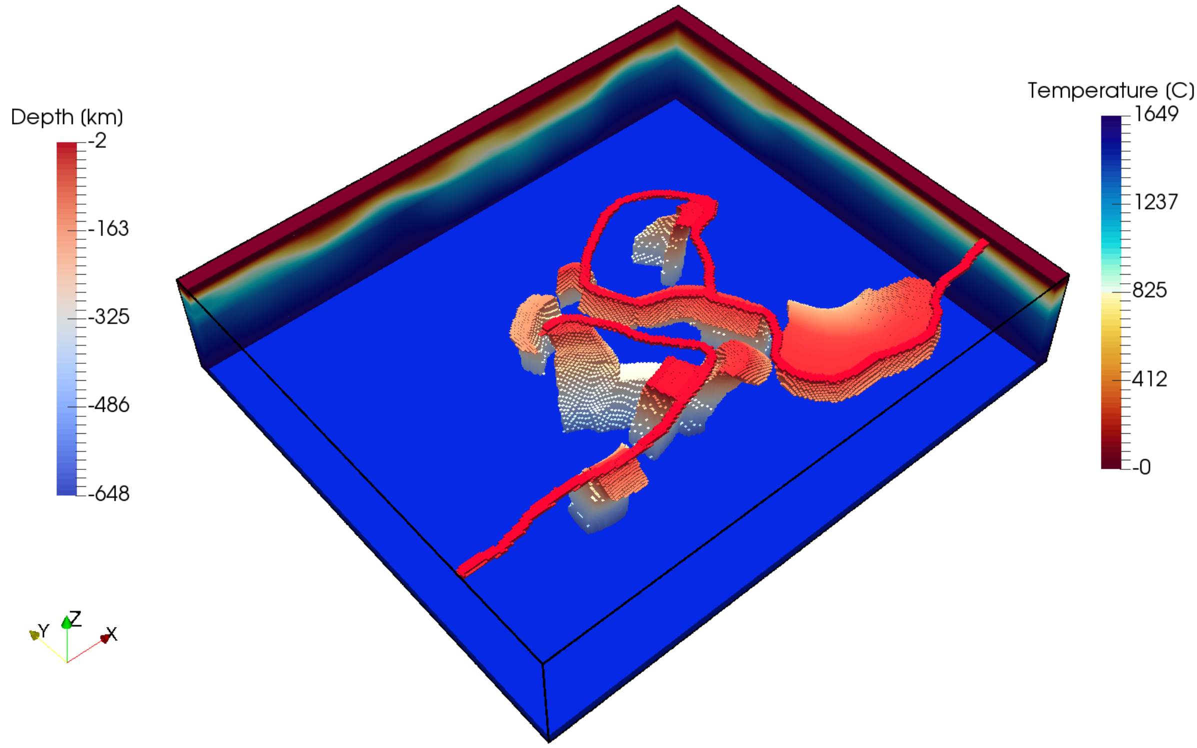

Figure 1: Current reference model. The domain extends roughly from northern Africa to northern Russia.

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