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Testing the influence of different plate motion reference frames on the dynamics of subduction in the westernmost Mediterranean region.

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The question to which extent lithospheric plate motions control the dynamics of the subduction process is still unresolved. For small subduction zones, as in the westernmost Mediterranean, plate motions can be an important factor controlling the subduction evolution and present day stress field. So far, research on neotectonic modeling of the western Mediterranean region as well as on developing tectonic reconstructions for the region, only utilizes relative plate motion reference frames. These reference frames either adopt a fixed African plate with Iberia moving to the SE, or a fixed Iberia frame with Africa moving in NW direction. However, only when considering the evolution of this region in an absolute plate motion frames for Africa and Iberia one can investigate the coupling between plate motion, mantle, and subduction.

Here, we perform a first step in this direction by testing the influence on the evolution of slab morphology as a result of using different absolute plate motion models.

Our starting point is the 3D numerical model of westernmost Mediterranean subduction during the past 35 My from Chertova et al. (2014). The end-stage of this model shows a good correlation with deep mantle structure of this region imaged by seismic tomography (Spakman and Wortel 2004, Bezada et al. 2013). In this model the absolute plate motions adopted from the global moving-hotspot reference frame (GMHRF) of Doubrovine et al. (2012) were used. In addition we experimented with 3 other absolute models: (2) a model with Africa fixed and with Europe/Iberia moving to the SE; (3) a model with Europe fixed and Africa moving in NW direction, and lastly (4) a GMHRF-model with two times faster Africa motion. In all models we implemented the same relative motion between Africa and Iberia. Motion models (2) and (3) are inspired by the common use of relative motions when assessing regional tectonics.

We demonstrate that, among the four plate motion frames tested, the best results in terms of fitting present day mantle structure can be achieved only when using GMHRF plate motions. Plate motion frames (2) or (3) do not provide us with the slab shape similar to the present day structure inferred from tomography images and also demonstrate significant differences in development between these two models. Using plate motion model (4) (with faster continents) does not result in slab rollback ending in the Gibraltar region. Instead, the lithosphere tearing process along the African margin and the slab stall under the eastern Betic and the slab assumes a NS extent towards the African margin.

Our models show a clear dependency of the evolution of slab rollback and slab morphology on the assumed absolute plate motion models. In addition, we also infer a dependency of the speed of the lithosphere tearing along the north-African margin and associated westward rollback on the absolute motion of the African plate.