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Interactive comment on "Kinematics and extent of the Piemont-Liguria Basin – implications for subduction processes in the Alps" *by* Eline Le Breton et al.

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General comments The paper of Le Breton and co-authors aims at presenting an updated kinematic reconstructions of the Alpine-Mediterranean area, with a focus on Corsica-Sardinia-Adria, implemented within a recent global plate model. Kinematic scenarios are tested for geodynamic consistency using thermo-mechanical modelling of the rifting phase and compared with geological records from the Alpine region s.l. Some interpretative choices strongly mark the paper. I am not commenting the adopted motion of Iberia, a debated issue with various models present in the literature, but the choice of having the Corsica-Sardina block attached to Iberia is not the most popu-

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lar. Besides the palaeomagneti evidence which is against it, it seems that this choice causes some inconsistencies in the presented kinematic reconstructions (Fig. 4). Some are described below. but the most relevant is the necessity of displaced northern Adria along a lithospheric fault for which there is no geological evidence. The reconstructions by Le Breton et al. present significant critical points that perhaps should be better discussed and compared with previous reconstructions, but above all they should be better supported by geological evidence. For this, I think the paper requires substantial revision work. Some of the critical issues are in the specific comments below.

Specific comments Section 2. Geological setting line 80: The microplate nature of Adria is debated. It not certain whether, when and for how long it was a microplate. Perhaps using just the term Adria avoids any questions. lines 127-128: It is not clear whether the Brianconnaise is considered a microcontinent (as CSB) or as an extensional allochthon. It should be clarified. lines 131-132: I believe that alternative interpretation are equally possible, without kinematically linking the Bay of Biscay and the Valais. lines 153-156: from the reconstructions in Fig. 4 it seems that the Valais ocean opened at 130 Ma; the Jurassic opening is not obvious. Moreover, the location of the Valais to the north of the CSB looks a bit strange. This domain is still there at 83 and 67 Ma and even at 35 Ma, always between Eu and the CSB. I am not aware of evidence of remains of an ocean in Provence. Moreover in the 35 Ma frame a N-ward subduction is present north of the CSB; that subduction disappears in the subsequent 20 Ma frame (are there remains of it somewhere?), where subduction jumps to the south of the CSB. line 162: why subduction initiation is intra-oceanic? Most authors consider that subduction initiated at the southern margin. lines 196-197: the extension in the Strait of Sicily may not reflect the motion of Adria, but it could be related to the dynamics of the subducted African slab (e.g., Argnani, 2009 SP Geol. Soc. London).

Section 3.3 MATF: There is some confusion when describing the tectonics of the Adriatic Sea. The boundary inferred by DAgostino et al. (ca. E-W trending) is just sketched

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and is not related to a specific structure or set of structures. It refers to the present tectonic activity, and that's why a proper boundary is not yet developed... if there will ever be a plate boundary. The Mid-Adriatic Ridge of Scisciani and Calamita is NNW-SSE trending geological feature. It was previously named Central Adriatic Deformation Belt (Argnani and Frugoni, 1997) and is a belt of foreland inversion structures where the Adriatic seismicity tends to concentrate. It has also been considered as the inland continuation of a major transform fault (Argnani, 2009, Bull Soc Geol It). There is no evidence, however, of a major strike-slip displacement, and Scisciani and Calamita describe inversion not strike-slip structures. The age of this deformation ranges from Quaternary to possibly Eocene, whereas the activity of the large strike-slip fault (MATF) used in the reconstruction ranges from Late Cretaceous to Eocene. In addition, the authors use the poles of Northern Adria from Schettino et al. which considered Adria decoupled along the E-W-trending Mattinata Fault, located in the southern part of the Gargano promontory. This fault shows evidence of Paleogene activity (Argnani et al., 2009, GSA) but the amount of displacement is unlikely to be on the order of 100s km.

Section 3.4 From Corsica to the west there is no evidence of an Alpine subduction followed by an Apennine-Maghrebian subduction. The two-subduction model adopted is one of the possible interpretations and other authors, more or less explicitly, prefer two opposite-vergence subductions since the beginning of convergence, handling in different ways the interpretation of Alpine Corsica (e.g., Jolivet et al., 1998, Argnani 2012 Tectonoph.) Critical in the two-subduction model is the presence of the AlCaPeCa (micro) continent, that is represented at 67 and 35 Ma, with a size of about twice the Corsica-Sardinia Block. I found intriguing that the CSB is still almost intact within the Mediterranean, whereas the larger AlCaPeCa micro continent has been completely dismantled. line 380: explaining the Eo-Alpine orogeny using an intra-continental subduction that is part of strike-slip system linking the PL to the Vardar seems an ad hoc solution not based on evidence. (also for lines 407-408)

Section 4.3 The authors take a geological section across the southern Alps to constrain

the initial with of the rift, which is estimated to be ca. 300 km. This rift system has a Beta < 1.5, which is typical of continental rifts that do not evolve to oceanization. As described by many authors, including Froitzheim and Eberli, the rifting leading to oceanization is located further to the west, in present coordinate. Assuming that also this sector was affected by the first stage of rifting, the initial width of rifting was larger than 300 km. Otherwise, the western sector was affected only by the second stage of rifting, but this does not fit the inferred evolution which is at the base of the numerical modelling. This is actually a minor point for the paper, though the mechanical behaviour that controls the location of oceanization is an interesting issue.

Section 4.4 The portions of exhumed mantle that crop out in the Western Alps are considered of subcontinental origin (e.g., Piccardo and Guarnieri 2010, Int. Geol. Rev.), as in type 1 margins of Huismans and Beaumont, 2011 . Does that fit with the result of the numerical modelling? In the model of Fig. 7 it seems that it is a newly formed lithospheric mantle to be exhumed

Section 5.2 lines 600-603: the opening of the Ionian basin in a NW-SE direction, with Malta and Apulia escarpments acting as transform faults, contrasts with using the Malta and Apulia as conjugate margins.

Section 5.3 The max. width of the oceanic domain in PL is taken as 250 km, based on the results of numerical modelling that also sets a length of 120 km for the hyperextended domain (80 + 40 km) and a length of 110 km for the necking domain (65 + 45 km). This gives a width of 480 km for the PL basin. Plate kinematics describe 680 km of convergence, that is subdivided in 420 km subduction and 260 km collision, based on the geologically inferred age of subduction and collision. With subduction initiating at the SE PL margin, and assuming that subduction occurs at the NW tip of the necking zone, after 370 km the conjugate necking zone is entering subduction: would that be considered onset of collision? The numerical modelling is reproducing the various elements of the PL margins, and continental material was certainly subducted. However, I suspect that mixing geological dates of subduction and collision, amount

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of convergence from plate kinematics and time frames from numerical modelling may lead to quantitative results that are not really representative. How representative is the estimate of the amount of subducted continental material?

Figure 4. Some of the reconstructions are puzzling, and many features are not really supported or described in Section 3. Sudden shifts in plate boundaries among frames seem not always justified. The frames from 130 to 35 Ma, in particular, present some intriguing aspects. From 130 to 83 Ma a major plate boundary rearrangement is depicted, with a system of large strike-slip lithospheric faults in the Adria region. I don't see much geological evidence for these features, and the connection between Alpine Tethys and Vardar looks a bit forced. The Valais ocean is positioned between CSB and Europe; such a reconstruction is difficult to support as described above. The MATF that is represented in the frames 83 and 67 Ma has also some problems. as commented above.

Minor corrections Strike slip motion along various fault systems is often mentioned throughout the text; the sense of motion, however, is almost always not indicated. Where possible this is a useful indication. line 23: does the 250 km width refer to the truely oceanic part or does it include the exhumed mantle and hyperextended margin sectors too? The term ocean can be ambiguous. It looks it refers to the truly oceanic part, but this point should be clarified. line 86: Gawlick and Missoni is not in the References list. line 90: Channell and Kozur 1997 should be cited as an early paper describing the oceanic branches. line 371: Handy et al is 2015 line 382: Handy et al is 2015 line 460: "154-145 Ma and... 145-130 Ma". Ma and not km line 470: indicate which is the Brune et al 2017 cited line 878: Handy et al is 2015 Fig. 5: slight increase in velocity: "light to dark blue" instead of "dark to light blue"

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