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Interactive comment on "Mantle flow below the central and greater Alpine region: insights from SKS anisotropy analysis at AlpArray and permanent stations" *by* Laura Petrescu et al.

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General comments

Dear Referee 3
in the following you will find our answers and/or description of changes we applied to our manuscript following you useful suggestions. Within 2-3 days we upload the revised version of the manuscript so you can follow our changes.

Specific comments

REF3: 1) The introduction section needs more information about anisotropy. There should be some mention of anisotropic fabrics especially when there is later discussion of lithospheric (A-type) versus asthenospheric (C- and E-type) anisotropy. a. I don't know how applicable this is in the Alps, but it seems like some of the invoked mantle flow is where the wedge would traditionally be located. So B-type fabric may also be worth mentioning.
ANSW: In this manuscript we started with the idea to give a general view of the study region, where uncertainties on the slab shape, dimensions and positions are still debated. We would work on possible X-type of anisotropy using further results after we clarify some doubts about the slab geometries. In the Introduction we mainly describe the geodynamic information we use in the discussion. We mention the common assumption of A-type olivine fabrics to interpret the observations and briefly discuss the role of other olivine fabrics in 5.4 paragraph.

REF3: 2) Did the authors examine different frequency bands for splitting?
ANSW: No, we did not.

REF3: 0.3 Hz seems on the high end. a. How does this frequency band compare to the previous studies of splitting in the region?
ANSW: It is not uncommon to use this corner frequency. Other SKS studies use a similar filter bandwidth of 0.04-0.3 Hz (e.g. Darbyshire et al., 2015, Lidell et al., 2017, Venereau et al., 2019) or an even higher corner frequency: 0.09–0.35 Hz (Eakin et al., 2015). In the Alpine region, some authors did not apply any filtering (Bokelman et al., 2013, Qorbani et al., 2015), while others used 0.02-1 Hz (Wustefeld et al., 2007), 0.02-0.2 Hz (Barruol et al., 2011; Salimbeni et al., 2018) or a range of bandpass filters between 2–10s, 5–20s and 10–50 s (Walther et al., 2013).

REF3: b. Might some of the variability in splitting be coming from the Alpine crust since high frequencies are being included?
ANSW: The expected crustal contribution to the SKS signal is incomparably smaller than our estimated dt values. In the manuscript we mentioned that estimated delay times associated with the crust range between 0.1-0.3 s (Silver, 1996) or 0.1-0.5 s (Barruol and Mainprice, 1993) while our average delay time is 1.4 s, requiring a mantle contribution.

REF3: 3) In the Methods or Results sections, please include error information such as maximum allowable and average errors in phi and dt.
ANSW: We added the following information in the Method section: "We allow measurements where the SKS phase is clear, the particle motion is successfully linearized, and the misfit surface minimises around one δt-φ solution pair. The majority of allowed individual measurements have φ errors less than 20° (81

REF3: 4) Did you use Splitlab? SplitRacer? Sheba? Or your own splitting program?
ANSW: We now modified the text to include this information. In the second paragraph, the text now reads: "To determine the φ and dt parameters [...] by minimizing the energy on the tangential component, as implemented in the Sheba software (Wüstefeld et al, 2010)."

REF3: 5) How well do the null orientations agree with the splitting directions in each region?
ANSW: In the Results section we added : "These directions are similar to the estimated anisotropy fast axes throughout the region (Figure 4a). This is expected since SKS waves polarized in the direction of anisotropy should not exhibit splitting."

REF3: a. The nulls in the NW alps obviously don't have a lot of splits at those stations, but is that telling of downwelling?
ANSW: In our opinion, the lower amount of null measurements in NW Alps (Swiss to

be more precise) may be due to the fact that cross checking prevailing back azimuth directions (plot bottom right in Figure 4b) and prevailing directions of splitting anisotropy here, it is quite low the probability to have null measurements.
In addition, previous geophysical studies for this region did not refer of any downwelling. A low amount of nulls is a weak support for this hypothesis, mainly if it is highly possible the cause previously described.

REF2: 6) Did the authors try modeling splitting with layered anisotropy in the NW Alps where single station splitting variability is high?
ANSW: We are going in this direction, mainly with permanent stations (longer dataset available). Our first attempt on TUE MedNet station (located at the boundary between Swiss and Italy) was not very satisfactory. The back azimuthal variation probably is not due to a two layers structure, but we have still a lot of data to analyse with this purpose.

REF2: 7) In figure 4c, I think it would help to show the null pierce points as well a. That might be what the red dots are, in which case that should be in the caption.
ANSW: Red dots are the stations (information lacking in the caption and now added). We tried to do what you suggest, but having so many measurements, plotting also nulls makes a map hardly readable. For this reason we decided to show them separately.

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