High resolution neodymium characterization along the Mediterranean margins and modeling of εNd distribution in the Mediterranean basins.

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We thank the anonymous reviewer #1 for her/his constructive comments on the manuscript. We have carefully considered all questions and concerns raised. The structure of our reply is as follows; each comment from the anonymous reviewer is recalled in blue, and our reply in black.

1.Disagreement of LIW eNd values (eNd > -5) towards the western basin between the field data and the simulation. The advection of high eNd LIW (eNd > -5) towards the western basin has not been observed for the field data. I agree that seawater eNd data are still sparse to provide a robust diagnostic. But the authors ignored seawater Nd isotopic compositions reported by Henry et al. (1994) and Vance et al. (2004). The eNd value from site BAOR in the Strait of Sicily (eNd = -7.7 ±0.6; Henry et al., 1994) provides a constraint for eNd values of LIW entering the W Med Sea. Indeed, this value is consistent with other seawater Nd isotopic compositions from the intermediate water depths in the E Med Sea showing that high LIW values are confined in the easternmost part of the Levantine Sea (Fig. 5). Personally, I had never seen the LIW eNd values at sites close to the Strait of Sicily as high as -5 for the modern seawater and recent archives. I suggest that the authors consider all the existing Med seawater data to optimize the relaxation time (Figs. 4, 5 and 6) and add explanation about the possible reasons for the data-model decoupling for the LIW eNd values.

Our modeling approach gives a realistic simulation of eNd in the eastern part of Levantine basin (value up to -4.8, in agreement with in-situ data from Tachikawa et al., (2004)). However we agree with the referee that the simulated LIW IC are too radiogenic in the Ionian sub-basin and around the Sicily strait compared to in-situ observation, as mentioned in the paper (see P1-L11; P11-L4; and P12-L30).

The purpose of this work is to test the impact of the BE on the Nd IC distribution in the Med Sea starting from the global expertise of Nd modeling by Arsouze et al., (2007, 2009) and by using a realistic representation of the margin Nd IC exclusively compiled from in situ data. Among all the sensitivity tests made on the calibration of this relaxing time, the EXP with 3 months produces the best agreement with available in-situ data.

We have used Tachikawa et al., (2004) and the recent unpublished data from the Meteor cruise M84 in 2011 (P. Montagnia et al, in prep, not showing here). All in-situ data for the

LIW layer gave an isotopic signature of almost -7 ± 1 (Tachikawa et al., 2004; Henry et al., 2004, and from P. Montagnia, in prep). Hence, we added the mentioned data from Henry et al. (1994) and Vance et al. (2004) to the statistic estimation of tau from Fig.4 (see the new Fig.4 and new Fig.5).

The model-data decoupling for the LIW layer can be explained by the fact that the LIW are formed in NW of Levantine sub-basin near the Cretan Arc, where the margin IC are about -4, leading to a relatively radiogenic signature as we consider only the margin Nd source. Adding dust (eNd ~-12) and river inputs could likely improve the model performance for the representation of the LIW layer (on going work). Also, tritium/3He (Ayache et al., 2015) and CFC (Palmiéri et al., 2015) simulations have shown that the model overestimates the mixing near the Cretan Arc, and in consequence the Levantine sub-basin isotopic signature is over-represented in this water mass.

A sentence was added to the text in the revised manuscript about the possible reasons for the data-model decoupling for the LIW eNd values (see §5).

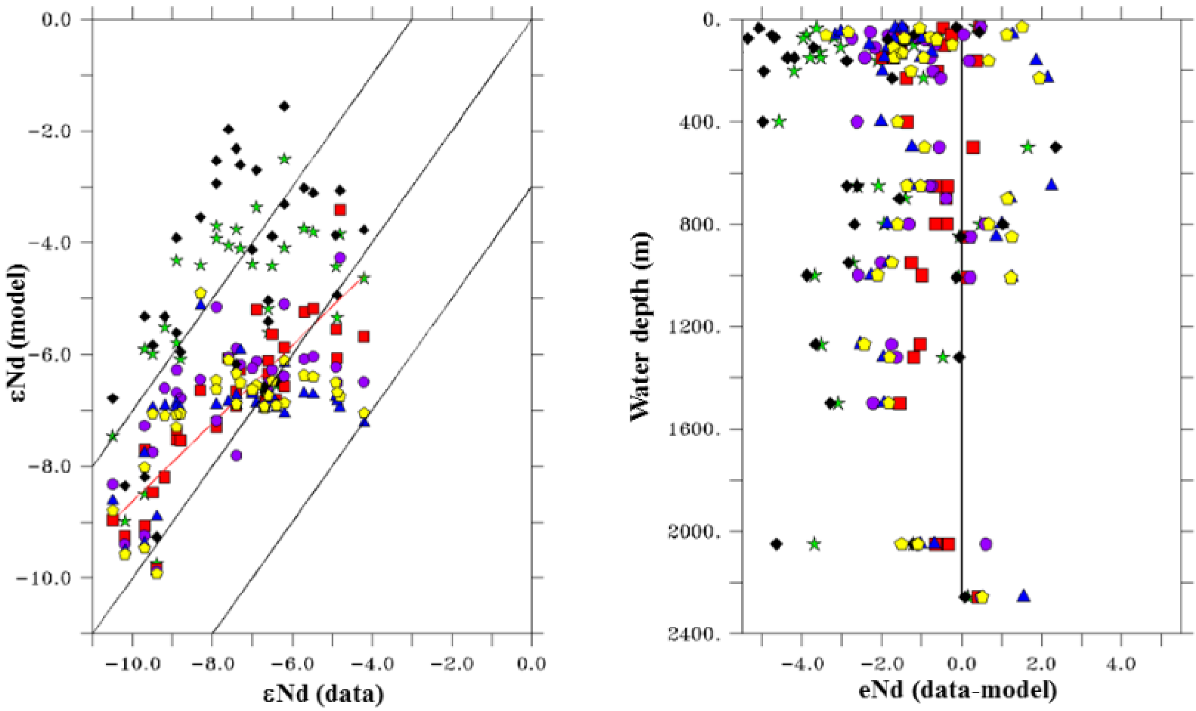

Fig.4. Model/data comparison for the 6 simulations performed with different relaxing time at the steady state (see Tab.3) and the in-situ data from Tachikawa et al., (2004) and Vance et al., (2004): **(a)** model-data correlation, red line is the linear regression from EXP2. Diagonal black lines are lines εNd (modeled) = εNd (data), εNd (modeled) = εNd (data) + 3 εNd and εNd (modeled) = εNd (data) −3 εNd. **(b)** model/data comparison as a function of depth, black solid line represents the data from Tachikawa et al., (2004) and Vance et al., (2004) and Henry et al., (1994).

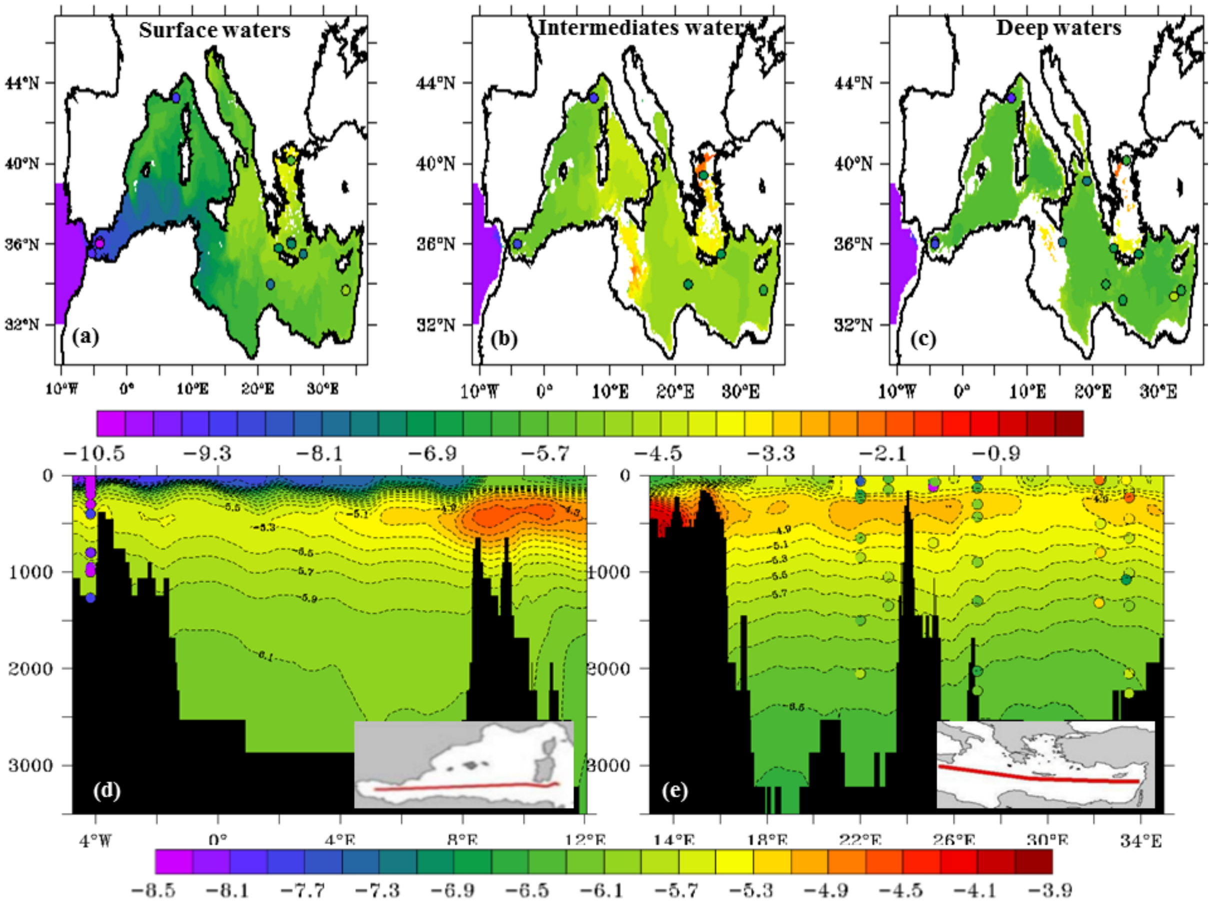

Fig.5. Output of model from EXP3 (t =3 months) at the steady state. Upper panel: horizontal maps for surface waters (a), intermediate waters (b), and deep waters (c). Lower panel E-W section in WMed (d), and EMed (e), whereas colour-filled dots represent in situ observations (Tachikawa et al., 2004; Vance et al., 2004; Henry et al., 1994). Both use the same colour scale.

2. Diagnostic of simulation performance with vertical eNd profiles In relation to point 1, the comparison of vertical eNd profiles between the simulation and data would be carried out for site by site instead of the average profiles as shown in Figure 6. Seeing Figure 5d and 5e, one can have impression that simulated eNd is more stratified than the field data (for example Alboran Sea) but this feature does not appear in Figure 6. Since the number of sites providing seawater eNd profiles is limited, I suggest that the data-model comparison will be done for site by site along the longitude. This new Figure 6 will clarify the areas of data-model decoupling and will provide the elements of further discussion.

We agree with the referee that site by site data-model comparison gives a more interesting diagnostic of the simulation; however the available in-situ data are mainly localized in the Levantine sub-basin with one vertical profile in the Alboran sub-basin (see fig.5). In the revised manuscript we provide a new Figure 6 with a separation between these two sites (see Fig below).

The simulated values is realistic in the Alboran sub-basin surface water, but too radiogenic in the deep layer by more the 2.5 eNd units relative to in-situ data from Tachikawa et al. 2004. This shortcoming cold be associated with the Mediterranean outflow (mainly formed by the combination of LIW, EMDW and WMDW), where the Nd IC is overestimated in the LIW layer (see response 1), and the southern penetration of new WMDW is weaker in the simulation compared to what was deduced from in situ observations, leads to excessively high eNd values at depth of Alboran sub-basin (Ayache., et al 2015).

Contrastingly the simulated isotopic signatures give a satisfying agreement with the data in the Levantine sub-basin leading globally to the same conclusion from the previous Fig.6 in the paper.

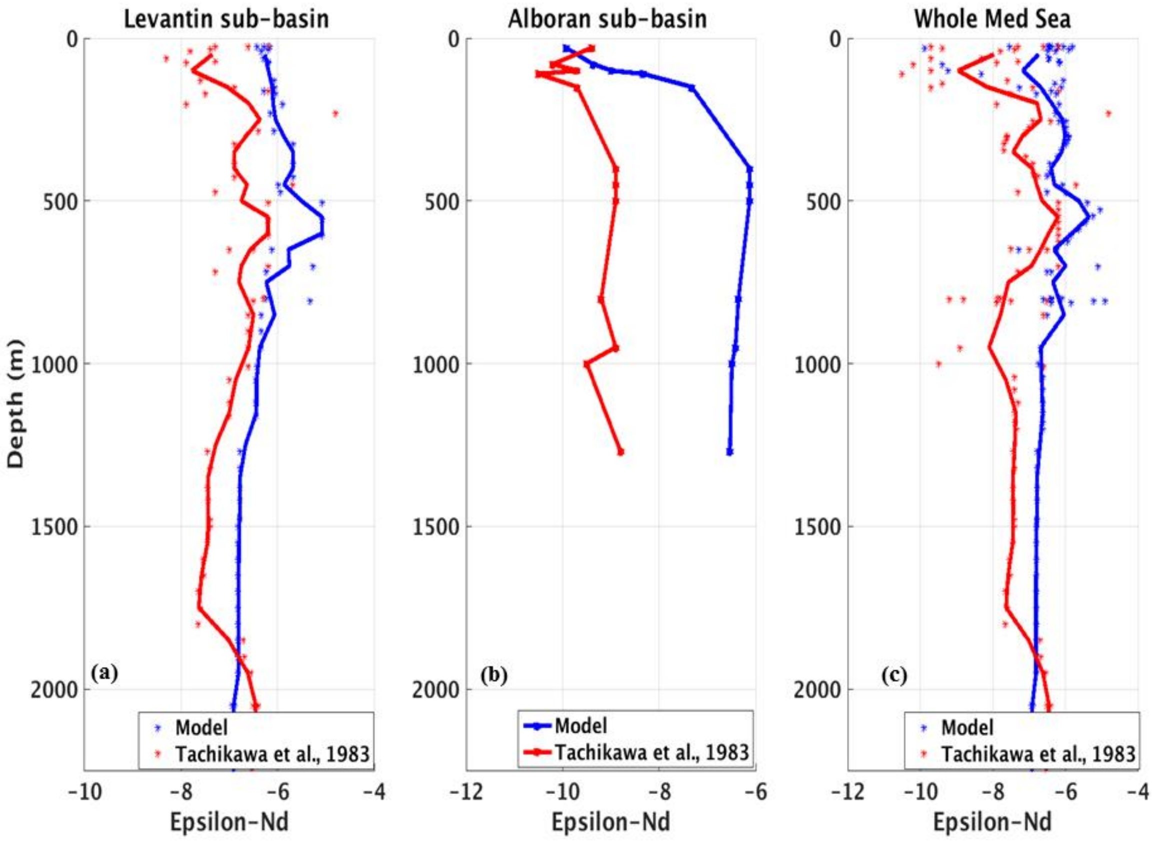

Fig.6: Comparison of average vertical profiles of Nd isotopic signature (Nd-IC) from EXP3 **(a)** in the Levantine sub-basin, **(b)** in the Alboran sub-basin, and **(c)** in the whole Mediterranean Sea. Model results are in blue, while red indicates the in situ data.

3. Too radiogenic eNd values for the Aegean Sea and its impact on the simulated EMT. The direct measurement of seawater samples indicates that Aegean seawater eNd values do not exceed -5.9 0.2 (Tachikawa et al., 2004). The simulated values are higher than this limit. The EMT simulation result could be sensitive to the performance Aegean Sea eNd simulation. Considering the overestimation of Aegean eNd values and too weak formation of the Adriatic Deep Water formation, the simulated shift of seawater Nd isotopic signatures due to EMT could be overestimated. It is true that more negative eNd values of surface water in southern part of the E Med Sea will be obtained by Saharan dust contribution. In contrast, it is not obvious that the Aegean Sea water eNd will decrease by considering Nd sources other than the BE. Since the simulated eNd shift due to the EMT is relatively small, some comments about this point would be added.

As explained in response to the first comment, we agree that the model simulates too radiogenic values compared to in-situ data. Nevertheless, our calculations from this sensitivity test on the EMT are not affected by the “initial” value in the Aegean sub-basin because our purpose here is to evaluate the impact of a like-EMT event on the Nd IC in the EMed. Hence our results suggest that the shift is more important in the Levantine deep water, compared to intermediate water where the EMT impact is lower.
One of our goals is to give a useful diagnostic on the long term variability of Med Sea circulation and to demonstrate the potential of Nd to detect a like-EMT event. However we agree with the referee that the weak formation of AdDW could affect the simulated sift of seawater Nd IC.

For the sake of clarity specific paragraph has been added to the text (see §5)

Taking into account the above-mentioned points, I am not totally convinced by the BE alone can explain the major features of the Mediterranean seawater eNd distribution. Nonetheless, this work provides an important advance of understanding seawater eNd distribution in the Mediterranean Sea. Considering the compilation effort and the originality of modelling aspects, I strongly recommend accepting this work after moderate revision.

Many thanks for these positive remarks.
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Minor or specific comments

Page 2, line 9, delete “all stable”.
Done

Page 2, line 26. Define “IC”.
Done Nd IC => Nd Isotopic Composition

Page 2 footnote about the eNd definition.

The equation should be corrected: eNd=[(143Nd/144Nd)sample/(143Nd/144Nd)CHUR-1]x10^4
Corrected

Page 3, line 5. The eNd value of the Mediterranean outflow was estimated to be -9.4 (Henry et al., 1994; Tachikawa et al., 2004).
Changed

Page 5, line 16. Acid concentrations are shown with wrong fonts. “HN03” should be “HNO3”.
Corrected

Page 6, line 9. Delete “Nd” after “eNd”.
Done

Page 9, lines 9-10. "Lacan et al., (2012)" should be replaced by "Spivack and Wasserburg, 1988".
Replace, we thank the referee for this suggestion

Page 10, line 15. "underestimation" should be "overestimation".
Done

Page 11, line 5. About the comparison of intermediate eNd values between the model and the data. It is not clear the referred values here correspond to which part of Table 2.

Corrected to: However averaged simulated values are relatively too radiogenic at the intermediate level (-5.8 compared to **-9.4± 0.69**, Tab.2).

Page 14, line 16."eps Nd" should be corrected.
Done

Figure 1. Indicate the relationship between the geological province and colour code in the caption.

Done, see change below:

The filled contours indicate the geological province limit based on the geological age (i.e. each color represent a separate age) from a high resolution digital geological map (http://www.geologie.ens.fr/spiplabocnrs/spip.php?rubrique67while the circles filled in blue represent the location of the discrete data compiled from EarthChem database (see Appendix1), and in red the location of the stations corresponding to the sediments analysed as part of the present work

Figure 4. The x-axis should be delta eNd (data-model) and the y-axis should be "Water depth (m)" not "profondeur". There is no "dashed line" as indicated in the caption. It should be the black solid line.
Done.

Figures 8 and 9. The colour code indicates eNd difference between specific year and 1987. Please indicate this information in the captions.
Done.

Appendix 2, 3 and 4. EXP5. The conditions of the relaxation time are different from Table 3. Please correct.
Corrected

We would like to thank you for the mentioned references; we will introduce the references in the introduction section.

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