

**“Definitive evidence of the Mediterranean Outflow heterogeneity.
Part2: all along the Strait of Gibraltar”**

Answer to Referee #1 (Comments received on 21 September 2017)

Dear Referee #1,

Let us first of all very sincerely thank you for your careful reading of our manuscript, your very helpful comments and your efficiency in rapidly providing us with your comments, which explains why we are now apologizing for answering with such a large delay; you certainly understood we were waiting for the report from Referee #2 that we received only 2 days ago.

Before answering your comments one by one, please let us specify that, even though you did not express any willingness to review the revised version, we will resubmit this Part2 in a markedly modified form. We will take into account not only your and the Referee #2's remarks and comments but also those we received from the Editor and the Referees of the Part1 paper. Essentially, we have proposed to the Editor a splitting of the former Part1/3 in two (which will make a tetralogy), with a new Part1/4 presenting an overview of the heterogeneity aspect and introducing the Parts2/4 to 4/4 that will focus on the entrance of the Strait, the Strait itself and the exit of the Strait. Two figures will be moved from Part2/3 to Part1/4: the diagram in Fig.1b will be enriched and presented as Fig.2-Part1/4 while the schema in Fig.1c will be presented as a complement to Fig.1-Part1/3 as Fig.3-Part1/4. We are personally convinced that this will markedly improve both the “Presentation Quality” and the “Scientific Quality”, hopefully maintaining the “Scientific Significance” of the paper you reviewed.

Please, even though we perfectly understand you did not think necessary to review the revised version and do not want to engage yourself in another review, let us specify that we would appreciate any “friendly” (i.e. not official) comment (even just a few words!) that you could send us in a fully anonymous way with the help of the OS office, either on our answers below or on the new version we plan to submit before mid-April 2018. In any case, we warmly thank you for all what you did for us.

General comments

The presence in the Gulf of Cadiz and further downstream, of four distinct layers of Mediterranean Water constituting well identified cores, has been generally attributed to bathymetric effects in the Gulf, although some authors sustain the existence of this heterogeneity already in the Strait of Gibraltar. The main reason for this controversy lies in the lack of appropriate historical data in the Strait itself.

I consider you do not only share my own thinking but that it is also **your personal opinion.**

The present manuscript, which is the second part of a sequence of three, provides evidence of heterogeneities of the Mediterranean Outflow along the Strait and is based on a set of CTD transects and yo-yo time series within the Strait. The main objective is to show that the Mediterranean Outflow is already heterogeneous in the Strait itself. The importance of the present manuscript, which complements the first part relative to the Strait entrance, is not only the evidence of the heterogeneity of the outflow within the Strait but also the demonstration of the spatial and temporal variability of the Mediterranean Outflow and the suggestions on the sampling strategy in such a complex area as the Strait of Gibraltar.
This is an exact synthesis of the paper and **I very much appreciate your support.**

Specific comments

In general, the written text (as happens with the first part of the series) could benefit from clarification of the text in some places.

I agree, I think I caught your overall comment in this respect and I hope the Editor will accept my proposition so as to have stand-alone and more focused papers.

The figures illustrate the main conclusions of the manuscript, but some of them could improve by clarifying the respective captions. Page 10, Fig. 2b; page 13, Fig. 2c; page 24, Fig. 2i: the light gray lines of the yo-yo time series are almost invisible in a print
I will darken these gray lines.

Lines 183-188: make more clear the sentence “In addition, : : :Strait entrance”

The previous sentence indicates that θ -S diagrams are straight mixing lines between a given AW and a given MW that has already encountered mixing: because this modified MW cannot be compared with other MWs above (as can be done at the Strait entrance where the MWs are superimposed on the vertical) and not considering what is demonstrated after with the prolongation of the mixing lines towards the unmixed MWs, this given MW cannot be identified/colored.

In addition: i) upstream from where a profile has been collected, numerous examples show that the specific MW it evidences can have been mixed with a different AW, ii) the CTD was not equipped with an acoustic device allowing to guarantee that it was lowered down to just a few m above the bottom, iii) files just indicate the bottom depth at the beginning of the profile, not the depth when the CTD was the closest to the bottom, iv) for a straight mixing line, the three parameters display similar variations with depth, v) while numerical values at the Strait entrance can be identified to this or that MW, this cannot be done after such a mixing has occurred.

Therefore: maximum densities (σ_{\max}) cannot be objectively quantified, classified and colored, as done in Part1. I will make the sentence more clear.

Lines 587-590: clarify the sentence contained in these lines

The lightest ($\sigma_{\max} \sim 28.5 \text{ kg.m}^{-3}$) MW is evidenced ... by the longest transects at $5^{\circ}50'W$ (Fig.2g, 2i) ... at $\sim 36.04^{\circ}N$ ($\sim 36^{\circ}02'N$, see inserted position diagram) ... will, most of the time, not be evidenced at $35^{\circ}50'N$ (location too much south). I will clarify the sentence.

Page 28, Fig. 3a caption: the meaning of the light blue lines and of the dark blue lines should be referred (with mention to the “first group” defined in the text). Page 29, Fig. 3b caption: refer to the “second group” Page 31, Fig. 3d caption: refer to the “third group”

We agree and we suppose you are dealing with the gray (not blue) lines.

Lines 735: clarify the sentence “we inferred: : :”

HydroChanges CTDs were simultaneously moored at Espartel (E) and Camarinal (C) southern sills giving time series: $\theta(C)$, $S(C)$, $\theta(E)$ and $S(E)$. Mixing lines (over time, fitted) at both places display, with a time lag of ~ 8 h, similar slopes, hence giving another time series $\text{MixingLineSlope}(C, E)$. If, for instance, you start with the set $\text{MixingLineSlope}(C, E)$, $S(C)$, $\theta(E)$ and $S(E)$, you can compute a $\theta_{\text{inferred}}(C)$ that you can compare with $\theta(C)$. All details are given and illustrated in Millot (2014a), essentially showing that mixing lines slopes provide a significant information representative of a relatively large along-stream domain. The same “technique” is used in Part2/3 to check whether the mixing lines at $6^{\circ}05'W$ gives, for an S representative of the MWs a representative θ . I will clarify the sentence.

Lines 765-773: clarify the text, which is rather confusing

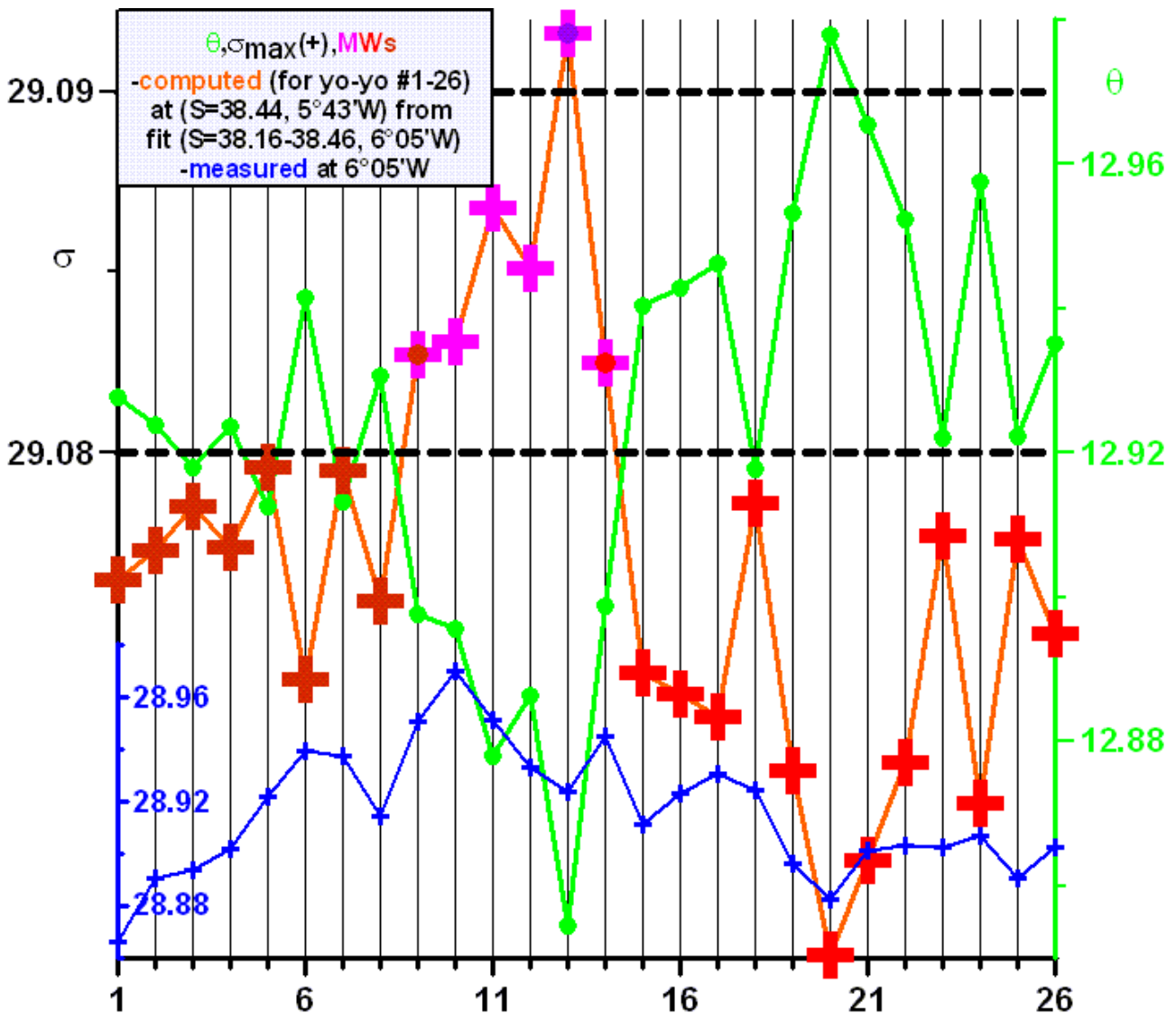
Let us reproduce Fig.6b here below.

The blue curve is from the σ_{\max} at $6^{\circ}05'W$: it does not evidence any group.

The orange curve is from the σ_{\max} inferred (what we did with $\theta_{\text{inferred}}(C)$ in Millot (2014a) can be applied to any parameter) at $5^{\circ}43'W$ from the mixing line slopes at $6^{\circ}05'W$ and for a salinity typical for the unmixed MWs there, $S=38.44$. We could thus deal with $\sigma_{\max, \text{inferred}}(5^{\circ}43'W \text{ or } 38.44)$ and the similar curve in green is for $\theta_{\text{inferred}}(5^{\circ}43'W \text{ or } 38.44)$.

The orange curve can be colored according to the isopycnals (in particular 29.08 and 29.09) defined from the yo-yo time series at $5^{\circ}43'W$ (in Part1). The two sets of red MWs before and after the occurrence of the pink (momentarily violet) MW display different homogeneities that could represent two types of red MW (one is thus colored in brown).

A major interest of such a technique is that, at $6^{\circ}05'W$ for instance, lowering the CTD more or less close to the bottom, hence reaching larger or smaller σ_{\max} values does not matter: what is important is the slope of the linear fit to the deepest values.



Technical corrections

In the whole text, there are several cases of wrong letterings (normal instead of symbol) for the potential temperature (q instead of θ) and potential density anomaly (Sq instead of σ_{θ}).

I am sorry but I did not check enough the conversion of my docx files into pdf ones and I did not realize that errors occurred in converting the Symbol format only in the end of my files (in this paper after l. 289-302 only) and in a very strange way, for instance on l. 553 and not on l. 554! I will obviously check the totality of my files in the revised versions. Your comment being

exactly the same as a comment from Referee#1-Part1, **I warmly thank you for having accepted such a huge work!**

Abstract, line 16: the meaning of “left-hand” or “right-hand” depends on the way you are looking at.

When you are driving a car, I suppose you do not have any problem in turning on the right (left) which is on your right-hand side (left-hand side). Seems to me the parallel is obvious. I am sorry but I always think in terms of dynamics: in the northern hemisphere, the Coriolis effect deflect any motion on the right ... whatever the direction of the motion is. In other words, the E-W orientation of the Strait of Gibraltar has absolutely no consequences and features would be exactly the same with a MO flowing to the east or through a north-south strait. I thus prefer dealing, in some occasions, with “dynamical terms” instead of “geographical terms”!

Line 106: maybe Fig. 1 of Part I should be referred or, otherwise, give the theta,S values for SAW and NACW

I am sorry but, in l. 106, I specify “... as shown in Fig.1b” (of this Part2/3). Don’t you think all the info you require is in this figure?

Line 109: figures below, which is 1oC,
You might be right but I am not sure

Fig. 1a caption: Since latitudes and longitudes in the figure’ axes are in decimal format, there should be a correspondence when lat. or long. values are referred in the caption, e.g., 5o 50’W (-5.8 oW)

I agree. Just note that I am doing all figures by myself and I don't know how to write automatically values in the degree-minute format. Even though correspondences such as between 40' and 0.66° is almost straightforward, I will add the correspondences.

Line 163: Millot (2008) is not in the References
I will check

Fig. 1c caption: explain the meaning of the dot and the cross within circles

I am sorry, these are classical symbols I have always seen everywhere: to remember them, you have to think to a pencil. The point represents the lead (writing side): when you see it, the pencil is directed towards you.

Line 267: few hours apart
I will ask the Editor

Line 269-270: link the m with the exponent -3 (m-3)
Libre-Office is not very powerful, I hope the OS software will cope with this.

Line 439: one can retain
Yes

Line 548: while in its upper part it is similar
Yes

Line 560: when referring to “the orange MW”, a reference should be made to Table 1 of PartI
Yes

Line 562: this light (?)
The density value is the one characteristic of the lightest of the MWs there

Line 604: is close to the
Yes

Line 705: homogeneous, in cyan, : : :, in blue, : : :
I will modify the writing

Pages 35, 36 and 37: Figures 5a, 5b and 5c should all have the same depth intervals (either 25 m or 20 m) in the z scale
Yes

Line 763: much more contrasted
Probably yes

Line 798: \dot{A}_s, \dot{A}_s' (orange)
Sorry, comment not understood

Line 1021: Millot (2008) is missing in the references (although it is referred in the text)
Yes, already said.

Line 829: in particular the
Yes

Line 865: clarify “MO so as follow”

To identify a given MW somewhere, it is necessary to sample the whole MO upstream, up to the Sea where all pure MWs can be identified with a single profile (superimposed MWs). Otherwise, a modified MW can result from any pure MW mixing with either SAW or NACW.

Line 879: define “Mediterranean Inflow”

l. 880: the MI is the counterpart of the MO: the M Inflow is the inflow of AWs into the Sea.

Line 884: S displays
Yes

Line 942: 1-2 days before
Yes

Line 949: CTD through
Yes

Line 986: Baringer & Price, 1997b is not referred in the text Line 990: CIESM group, 2001, is not referred in the text Line 994: García-Lafuente et al., 2011, is not referred in the text Line 1010: Millot, 2013, is not referred in the text
Thanks, I will better check.