

Interactive comment on “Seasonal variability of intermediate water masses in the Gulf of Cadiz: implications of the Antarctic and Subarctic seesaw model” by David Roque et al.

Anonymous Referee #2

Received and published: 21 July 2019

Dear Prof. Stevens,

Roque et al. present an interesting study on the influence of Antarctic Intermediate Water (AAIW) on the seasonal hydrographic changes within the Gulf of Cadiz. These findings certainly present an advancement on the current understanding of the influence of AAIW and its interactions with Mediterranean Outflow Water (MOW); the latter is considered an important modulator of North Atlantic hydrography and its meridional overturning circulation. As a paleoceanographer myself, these findings could be potentially extremely interesting for studies on the MOW behavior throughout the geological past and reach a wide readership. Although the manuscript is overall well written, I do

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have some questions I would like to invite the authors to address in a revised version of this manuscript:

In the beginning, the authors define four major water masses that are the basis for their analysis and discussion. However, I am bit confused by their terminology. In past studies, the Eastern North Atlantic Central Water (ENACW) was separated in a subtropical and a subpolar fraction (i.e. Voelker et al., 2015). Yet, the authors only define ENACW without specifying its origin. The authors instead define Subarctic Intermediate water (SAIW) which I am not sure what the difference is between the previously reported ENACW of subpolar origin. Perhaps the authors could clarify this for the reader. I think this would help to relate their study better to previously published papers on the modern hydrography of the region.

Secondly, the authors argue that AAIW “pushes” MOW up the shelf during autumn. I was wondering how these findings relate to the seasonal changes in MOW density. During autumn, MOW reaches its annual density minimum (Millot et al. 2006). Though my question is, does the MOW flow higher up on the shelf during autumn due to the AAIW pushing it up or does the less dense MOW simply settle higher up on the shelf by itself, and thus allows AAIW to extend vertically within the water column?

Generally, I feel the authors missing the opportunity here to also analysis their data sets for any decadal patterns. For instance, I would be very interested in knowing if the authors can make any statement regarding the temporal stability of the relationship between AAIW intrusion into the Gulf of Cadiz and its interactions with MOW. Millot et al. (2006) argued that MOW become more saltier and warmer after the 1990s. The change in MOW characteristics between 1960-1980 vs the 1990-2000s is often used as an analog for glacial-interglacial changes of MOW conditions. Hence, I am wondering if the authors see any change in AAIW presence and simultaneously MOW settling depth between 1950-1980 and 1990-2000s? I feel that including this kind of temporal information could substantially enhance the current discussion under section 4.2. where the authors try to hint at this relationship and its possible interest for paleo-

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ceanographers but do not provide any real new insights.

Minor comments

Please use, if not otherwise requested by OS, continuous line numbering across all pages for the next version. I find the current page wise numbering a bit confusing.

I feel the introduction might need a bit more rephrasing as some of it reads a bit confusing and repetitive at times.

There are a number of typographic issues throughout the manuscript as well as some issues with the format of the citations. I picked the ones out I could find but please check this carefully again.

p.1 Line 13: 4 is italic when the others are not.

p.2 Lines 2 to 4: Please rephrase this sentence. It is very long and contains too much information. Please break it up into at least two sentences. Although meridional heat transport is not the same as MOC? Does meridional freshwater transport not imply THC?

p.2 Line 4: please subscript the 2 in CO₂.

p.2 Line 4: What do you mean by “their”? THC or MOC or any other transport you listed previously? Specify.

p.2 Line 9: Citation missing for the depth information

p.2. Line 12-13: What do you mean by “cold” and “warm” periods? Interglacial and glacial? Stadial and interstadials? Specify.

P2. Line 14 to 15: The sentence starting with “The AAIW is well...” feels completely out of place here. In the sentence above you were stating something about warm/cold periods and now we suddenly jumped to seasonality? Please rephrase this sentence!

p.2 Line 16: Why is the GOC not included in the brackets with the Citation?

p.2. Line 22 to 23: What is the difference between MOW and upper MOW suddenly? I

do not understand why the upper MOW is singled out here right now.

p.2. Line 24: Is this the right citation style? First names are usually not included in citations! Please check this with the OPS guidelines.

p.2 Line 25 to 26: Is this not more or less the same information as provided in Lines 15-17. Please check if this sentence and the above-mentioned sentences one cannot be spliced together.

p.2 Line 33: Please delete the comma between regions and progresses.

p.3 Line 3: double space in front of the Citation.

p.2 Line 4 to 5: Again, check the Citation style! See comment above!

p.3 Line 14: Please replace “near” with “vicinity”.

p.3 Line 19: Is the “the” really necessary here? Maybe just “Data set”.

p.3 Line 21: please add a “the” between “and” and “surrounding”.

p.3 Line 21: what do you mean by surrounding areas? Specify.

p.3 Line 23: how many cruises? In what years did they take place? and what do you mean by “mostly carried out by the University of Cadiz”? If they were not carried out by this University then list the institution that carried them out. Please provide enough information for the reader!

p.4 Line 3: It might be useful to add the expeditions also in Table 1. The Table caption should be listed above the table unless OS guidelines suggest otherwise.

p.4. Lines 5 to 9: Did you compare the wind data between 1979-2018 only to hydrographic data for the same time frame or did you use the entire data set from 1900 to 2013 for that? If you used the entire time series of the hydrographic data set would that not be problematic given the effects that global warming had on wind field changes in the last decades?

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p.4 Line 10: I think it should be “the” and not “an” Optimum Multi. . .

p.4 Line 11: What do you mean by “each data set”? Each data set separated by data base origin? Yearly data across all data bases? Seasonal data? Please specify.

p.4 Line 15: add an “s” to equation.

p.5 Line 9: Caption of Table 2 should be above the table I think.

p.5 Line 11ff: Generally, I am missing some statements here regarding the data pre-processing steps, and the software (e.g. MATLAB?) used for the analysis. To the best of my knowledge PCA requires the data to be gaussian distributed prior to analysis. How did you pre-process your data?

p.6: Line 18 to 24: This is does not like a result. Does this paragraph really require a section header and number? I find this bit somewhat confusing.

p.7 Line 14: double space before Citation

p.7 Line 20: What do you mean by “. . .seems to have a certain intra-annual variability,..”. Please elaborate on this if you consider it important; if not rephrase it.

p.8 Line 11: Should it not read “PCA” instead of “PC”?

p.8 Line 12ff: Just for clarification for me the percentage of explained variance of the PC’s is the number stated in Figures 6 and 7?

p.8 Line 30: double spacing before Citation.

p.9 Line 10: In the beginning you defined GoC as Gulf of Cadiz but you jumping back and forth throughout the entire manuscript between using the abbreviation or not. Please streamline this.

p.10 Line 16: double spacing before Citation.

p.10 Line 17: I would change “Until now” to “Thus far”.

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p.10 Line 31: I think this is a typo by resolution of “1o” of the wind. . . do you mean 10?

p.12 Line 4: substitute “gulf” with GoC or Gulf of Cadiz.

p.12 Line 12: the “;” between 2003 and 2011 should be a “,”.

p.14 Line 12: replace “thanks” with “due”.

p.14 Line 19: include “the” between “west” and “Gulf of Cadiz”.

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