

## ***Interactive comment on “Anthropogenic and natural CO<sub>2</sub> exchange through the Strait of Gibraltar” by I. E. Huertas et al.***

### **Anonymous Referee #3**

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#### General Comments

The manuscript shows interesting and new research. It presents a valuable set of data covering temporal variations in the water exchange through the Strait of Gibraltar. Therewith it gives the bases for improved estimates for the exchange of carbonate system parameters in the Strait, including the fluxes of anthropogenic carbon between the Mediterranean Sea and the Atlantic. The introduction section nicely describes the scientific topic and open questions; it introduces the research area and lists the work that has already be done in this field. The methods are clearly described and the results are detailed. I suggest only some minor corrections for the previously mentioned sections, whereas the discussion part needs some revision and has to be more clearly structured. Overall I recommend the publication of this work after taking into account

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the comments and suggestions.

### Specific Comments

Abstract: In the result and discussion sections new estimates are given for the water mass exchange through the Strait of Gibraltar and for the alkalinity budget in the Mediterranean Sea based on a two-year time series - why not mentioning these results in the abstract?

Page 1025, Line 27: The Strait of Gibraltar behaves as a net sink for alkalinity but not due to carbonate sedimentation. Carbonate sedimentation is a sink for alkalinity in the Mediterranean basin.

Page 1027, Line 29: For me it is not clear what role a reduced gravity of  $\sim 0.02 \text{ m s}^{-2}$  plays in this two-layer system. If it is important, please explain it in a further sentence or, if it is extraneous, it might be deleted.

Page 1030, Line 5: What data were used for the fresh water balance?

Page 1031, Line 12: Where there any duplicate samples measured to determine the precision?

Page 1033, Line 10: In the introduction you mention that Mediterranean waters are supersaturated with respect to calcite and aragonite. Why should there be calcium carbonate dissolution? As proposed by Schneider et al. (2007) the excess alkalinity ( $\Delta\text{AT}$ ) at depth is caused by the inflow of high alkalinity water from rivers and the Black Sea. Thus, the carbon content would not be changed (unless the rivers and the Black Sea carry exceptional inorganic carbon concentrations). How will the Cant distribution look like without this term?

Page 1033, Line 18-21: It might be helpful to mention the two different surface AT-S-relationships used to calculate the preformed alkalinity.

Page 1034, Line 1-7: This paragraph is not clear, could you maybe explain it in one or

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two more sentences.

Page 1040, Line 25 to Page 1041, Line 17: Taking into account that no carbonate dissolution should take place in the Mediterranean basin because of supersaturation, this paragraph should be revised.

Page 1041, Line 12-15: The sentence does not make sense to me, because above you said carbonate dissolution exceeds  $20 \mu\text{mol kg}^{-1}$  in the MOW. Additionally there are no data for the Strait of Gibraltar in Schneider et al.(2007).

Page 1045, Line 27 to Page 1046, Line 2: The comparison between the values sounds a bit strange. Suggestion: This value lies between the one given by Copin-Montégut (1993), who estimated a net alkalinity flux of  $77 \text{ kmol s}^{-1}$  into the Atlantic, that of  $60 \text{ kmol s}^{-1}$  provided by Santana-Casiano et al. (2002 ) and the latest assessment of  $25 \text{ kmol s}^{-1}$  reported by Schneider et al. (2007).

Page 1046, Line 4-5: Copin-Montégut (1993) did not use the water balance described by Béthoux (1979) for the alkalinity outflow estimate through the Strait of Gibraltar. She did an alkalinity balance and compared it to other results using different water flux estimates.

I found it hard to read all the rates and fluxes with the unit of  $\text{kmol s}^{-1}$ , because in most other references they are given in  $10^{12} \text{ mol yr}^{-1}$ . Furthermore I noticed some conversion errors, due to that problem (e.g. Page 1046, Line 18 -> 38 and  $48 \text{ kmol s}^{-1}$ ; Page 1047, Line 8 ->  $86 \text{ kmol s}^{-1}$ ; Page 1047, Line 15 ->  $30 \text{ kmol s}^{-1}$ ; Page 1048, Line 8 -> besides I think this should be the reference Copin-Montégut (1993),  $87 \text{ kmol s}^{-1}$ (?)).

Page 1047, Line 6-26: I cannot reconstruct this alkalinity balance. In my opinion the carbonate dissolution term appears twice and the calcification rate of  $16 \text{ kmol s}^{-1}$  is wrong. The paragraph should be structured more clearly and important terms should

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be emphasised.

Page 1048, Line 10-21: Again, this section seems not clearly written to me. Which data are used for the column inventory or how is the increase of  $0.7 \mu\text{mol kg}^{-1} \text{ yr}^{-1}$  calculated? Furthermore, I am not sure if the method used for calculating the Cant storage (with the MPD) is appropriate for the Mediterranean Sea, because we find relatively young waters in the deep basins (and therewith relatively high in Cant).

Are there shown any data from the stations 1-5 or where they used to do any of the calculations? If yes, it would be good to know, (because I only find data from the GIFT section) and if not, for simplification they could be left out in the method section and in Fig.1.

Figures: I think Fig. 6 does not show more details than Fig. 3a,b and Fig. 5 a-d. One of the two representations (profile or section plot) would be enough.

Fig.1:  $\text{Diamond}$ ; for station 7 is missing.

Fig.2, caption: If one looks at the figure it is clear which one shall be the solid line, but actually they are both solid. The plotted transport data are daily means? That should be in caption.

Fig.5a and b: For better comparison the colorbars should be scaled equally.

#### Technical Corrections

Page 1022, Line 17: It might be easier to use the same unit ( $25 \text{ Tg C yr}^{-1}$ ) as in line19 (or vice versa) (same on Page 1051, Line 6-7).

Page 1023, Line 3:  $\text{remain large uncertainties}$ ;

Page 1025, Line 2:  $\text{human pressure they (?) suffer}$ .

Page 1025, Line 27: A recent study has pointed $\text{}$ ;

Page 1027, Line 5: Water exchange through $\text{}$ ;

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Page 1027, Line 5-8: The sentence sounds a bit random: "strongly influenced; wide variety; diverse frequency of variability";

Page 1029, Line 3: In this study, ES station;

Page 1029, Line 5: "at this particular station";

Page 1029, Line 6: "subinertial flow"; needs to be explained here (happens later on line 16)

Page 1029, Line 27: "through the Strait and";

Page 1031, Line 3: Kind is not in the equation above.

Page 1032, Line 19: "Niskin bottles";

Page 1033, Line 16: I think I should be:  $\frac{1}{2}$ ; ( $\frac{1}{2}$ AT+AOU/RN), because later on line 17 you talk of  $\frac{1}{2}$ AT.

Page 1038, Line 13: There are direct measurements of dissolved inorganic carbon available at CDIAC database from Meteor cruise M51/2)

Page 1040, Line 28: (Fig. 5 c+d)

Page 1040, Line 29: (Figs. 5 c and 6e)

Page 1041, Line 5: (Figs. 5 c+d)

Page 1046, Line 13-15: In this sentence the word "is"; must be replaced.

Page 1048, Line 20: the last value has no unit.

Page 1050, Line 15: "a concentration of 27  $\pm$  7 kmol s<sup>-1</sup> of"; -> this is not a concentration.

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