

## REVIEW of os-2013-40. REFEREE #2.

### The CO<sub>2</sub> system in the Mediterranean Sea: a basin wide perspective by Álvarez et al.

We would like to thank the reviewer for the suggestions and comments on our manuscript. Please find below a detailed answer to some specific comments and questions.

#### GENERAL COMMENTS:

This paper presents results from two cruises carried out in the Mediterranean Sea which provide a basin-wide dataset for the study of CO<sub>2</sub> parameters in the Mediterranean. The data treatment is sound and exhaustive and the authors perform an internal consistency analysis for the CO<sub>2</sub> system in the Mediterranean that can be useful for future studies. The data presented is of high quality and of interest to the science community. The paper provides a nice description of "this is what is observed".

We thank the reviewer for the compliments.

However, it would greatly improve if the authors also added some information explaining why and how those values are observed. Furthermore, if it is to be used as a staple reference for future studies it must include a comparison to previous studies, to put it in perspective.

In this manuscript, which in fact is intended to be the first one of a series of them based on the 2011 CO<sub>2</sub> data taken in the M84/3 cruise, we preferred to present just the chemical CO<sub>2</sub> characterization of the different water masses in the MedSea because there was no previous exhaustive and basin-wide description. The focus of previous manuscripts was mainly the CANT inventory / acidification (Schneider et al., JGR 2010; Touratier and Goyet, DSR I, 2010; Touratier et al., BGD, 2012).

We are not assessing the temporal changes in any physical or biogeochemical property in the MedSea because that would be the aim of a second manuscript part of H. San León's PhD. In order to do so, the first step is gathering all the published data, this is an extremely difficult task because the historical data are not archived and for the recent ones, only M51/2 is easily accessible. We are currently contacting all the PIs and gathering all the CO<sub>2</sub> and ancillary data in a common format. Then we will proceed with the quality control in the way of the CARINA group and finally the quantification of the changes. In section 4.1.1.1 Meteor M84/3 cruise data, we perform a coarse comparison between the 2011 and other cruises. But it is true that this is not the aim of the manuscript and we will not expand this discussion.

#### SPECIFIC COMMENTS:

My main concerns with this work are the following:

1) This is mostly a descriptive paper, it does little more than present the values measured in the cruise. The manuscript would greatly improve with some interpretation of the results.

We admit this is a descriptive manuscript; the literature is full of them about water masses in several oceans. We wanted to stress the peculiar CO<sub>2</sub> chemistry in the MedSea (internal consistency analysis) and its sensitivity to natural and anthropogenic changes (buffer factors section), and present the East to West evolution of the main water masses, Atlantic, Levantine and the deep and bottom waters. Particularly, deep and bottom waters show EMT and post-EMT differential characteristics that are discerned just with the vertical profiles.

2) The information obtained from the data, the actual science in the paper, is lost among the lengthy descriptions of the values measured. I would suggest shortening the descriptive part, e.g. eliminating station descriptions, and highlighting the interpretation of the measurements.

OK. We will try to shorten the description and focus on the differences and the interpretation of the measurements.

3) If this paper is to be used as a "benchmark" for future studies of CO<sub>2</sub> in the Mediterranean, like the authors claim, it should incorporate the results from all the previous studies in the area. I was surprised to find the authors think a comparison with previously available data is "out of the scope of the manuscript" (page 1459, line 20).

The term benchmark will be removed, it is conflictive. As commented to the other referee our intention was just to describe the post-EMT water mass characteristics with regard to three CO<sub>2</sub> variables. As previously said we are currently gathering the historical and recent data, which is not an easy task, and then proceed with the quality control and finally with the temporal study.

4) The descriptions of the water masses are often difficult to follow, with long, convoluted sentences. Apparently a more detailed description of the water masses is done in the paper by Hainbucher et al. (2013), but the reference is missing from the bibliography. In terms of the CO<sub>2</sub> parameters alone, I am not convinced that it makes sense to have that many water masses.

Due to health problems Hainbucher et al. (2013) was delayed in the submission to OSD, this ms is complementary to our manuscript. The reference is now included and hopefully the referee will have the opportunity to read it. Hainbucher et al. (2013) highlights the basin-wide evolution of Atlantic and Levantine waters and as well the pre-EMT, EMT and post-EMT temperature and salinity changes in the deep and bottom water masses in both eastern and western basins.

In our manuscript we do not define any new water mass in the MedSea. Them all have been previously defined, we just comment their evolution with regard to CO<sub>2</sub> variables but also supported by mainly Temp and salinity.

This section would benefit from a table summarizing all the water masses and their CO<sub>2</sub> characteristics, similar to table 2. It would also help to indicate the location of the water masses (or at least the main ones) in a plot.

We prefer to keep Table 2 as it is because it will be useful to compare with former studies like for example Rivaro et al. (DSR 2010) and historical ones as Millero et al. (DSR 1979). Acronyms for the water masses will be introduced in the vertical sections and the property-property plots.

Minor comments:

Page 1458, line 12: since the decrease in pH is hard to detect, is it significant?

This phrase is badly written and there are some wrong statements. We meant that there is a DIC increase below 3000 dbars of about 4  $\mu\text{mol/kg}$  that can be easily seen in the contours of Fig 6, but in the case of pH (Fig. 7), the color scale shows a 0.002 decrease (note the greenish color in the bottom) but the

contours do not. In the case of salinity (Figure not shown here) and TA (Fig. 5), both increase below 3000 dbars but in the vertical plots is difficult to detect either with the contours or the color shading as salinity decrease  $\approx 0.01$  units and TA  $\approx 4$   $\mu\text{mol/kg}$ . These changes are due to the arrival of newly formed, after 2002, deep water from the Adriatic Sea. The paragraph will be corrected in the manuscript.

Pages 1470 to 1472: Are the differences between stations so important that they merit almost a station by station description, even within the same sub-basin?

We rewrote these paragraphs and tried to reduce the wording, highlighting just the differences.

#### TECHNICAL CORRECTIONS:

There are some editing mistakes (punctuation, verb agreement, etc). These should be easy to correct upon going through the text with fresh eyes.

Thank you. We tried to improve the manuscript.

Section 4.1.1 has one section for Meteor data (mostly discussing water masses) and one for the Sardinia Sicily Passage. It would make more sense to either specify cruises or regions regardless of cruise. The section could be shortened or rewritten more clearly.

We decided to comment the two data sets because the cruises were designed to address different questions: the EF11 resolves the exchanges between the western MedSea and the Tyrrhenian Sea and the M84/3 data the basin-wide evolution of water masses in the MedSea. In this new version of the ms we tried to shorten section 4.1.1.

Page 1458, lines 9-10: Rephrase "...species in the through the center..."

Page 1461, Lines 10 to 20: very convoluted. please rewrite with shorter sentences.

Page 1466, line 10: the use of consequently indicates that there is more information to come: consequently, what happens? Rephrase.

Page 1466, line 19: correct figure number from 22 to 12.

Page 1468, line 8-10: "so deep waters from the Ionian..." this sentence is incomplete.

The former issues have been corrected in the new version of the manuscript.