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## ***Interactive comment on “Distributions of the carbonate system properties, anthropogenic CO<sub>2</sub>, and acidification during the 2008 BOUM cruise (Mediterranean Sea)” by F. Touratier et al.***

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We are sorry to see that the major comments of M. Alvarez do not concern the main objectives or interesting conclusions of our paper.

Her first goal is apparently to discredit the TrOCA approach and also the MIX method simply because the latter produces very similar results. We do remind here that several inter-comparison exercises have been published during the last decade to compare the results of the approaches in different areas of the world ocean (TrOCA and MIX were often among the selected methods). Both methods are known to provide realistic estimates. However, we agree on the fact that such inter-comparison exercise should

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be done specifically for the Mediterranean Sea. As explained in our paper, this cannot be done with the BOUM 2008 dataset since measurements of some key properties required by other approaches are missing.

Our responses to the comments (see below) suggest that M. Alvarez is probably not fully aware of some key papers published specifically for the Mediterranean Sea. They also reveal that she probably missed to read some important paragraphs/sections of our paper.

The two main comments given by M. Alavarez are 1) that our paper is ‘another claim supporting the advantages of the TrOCA method’; 2) that we ‘advocate for its benefice ... in a very subjective way’. She then recommends ‘to perform a careful assessment of the caveats and advantages of the TrOCA method specifically applied to the Med Sea’.

We suggest that M. Alvarez should provide objective and concrete scientific proofs. Contrary to the affirmation of M. Alvarez, a careful assessment of the TrOCA method has been realized in many different areas of the world ocean. Concerning specifically the Mediterranean Sea, two papers (Touratier and Goyet 2009, 2011) assess in details the caveats and the advantages of the TrOCA approach using several dataset or databases (DYFAMED, MEDATLAS, and the 2001 METEOR 51 cruise). Both papers are referenced into the present work and we recommend M. Alvarez to read carefully these published papers.

The next comment of M. Alvarez is that ‘TrOCA is only compared with the MIX approach, which is also proposed by the same authors’. The reasons of this choice are clearly explained in the paper (Section 3, last 2 paragraphs):

“The use of another approach to estimate CANT is of importance to validate/invalidate the previous estimate. Unfortunately, among the five methods tested during the inter-comparison exercise of Vázquez-Rodríguez et al. (2009), the three methods TTD,  $\Delta C^*$ , cannot be applied since CFCs were not measured during the 2008 BOUM cruise.

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Apart from the TrOCA approach, the only potential candidate is the method proposed by Lo Monaco et al. (2005). However, this approach overestimates the computation of the CANT concentration since its CANT total inventory reached the highest value of 67 Pg C for the Atlantic Ocean (Vázquez-Rodríguez et al. 2009) ... The MIX approach developed by Goyet et al. (1999) has been shown to be very persuasive to estimate the distribution of anthropogenic CO<sub>2</sub> in the northern Indian Ocean using the WOCE I1 high quality dataset. Its results have been compared to those computed from the  $\Delta C^*$  and the TrOCA approaches (see the papers of Coatanoan et al., 2001; and Touratier et al., 2007). The conclusion of this inter-comparison exercise was that the CANT distributions computed from MIX and TrOCA were much more correlated to those of three measured anthropogenic tracers (CFC-11,  $\Delta^{14}\text{C}$ , and 3H) than the one computed from the  $\Delta C^*$  approach. The use of the MIX approach is particularly recommended for regional studies where the distribution of water masses can be clearly defined (this is the case for the Mediterranean Sea). Other arguments like its accuracy and its independence from the TrOCA approach (the hypotheses used and the computation are radically different) further justify our choice to use the MIX approach as a second approach to estimate CANT in the present paper.”

M. Alvarez first recognizes that regional estimates computed with the TrOCA approach are supported by other approaches like  $\Delta C^*$ , TTD, . She then affirms that ‘our paper clearly avoids to comment on the Yool et al. (2010) paper that evaluates the caveats of the TrOCA approach in an objective way’.

This is not true since in Section 7 we clearly comment on the Yool paper:

“Yool et al. (2010) used a multidisciplinary 3D model (OCCAM) in order to assess the TrOCA approach applied to the world ocean (marginal seas like the Mediterranean are ignored). Their strategy consists in the utilization of the outputs of their model (which is able to simulate the properties of the carbonate systems and many others) and to use them as input parameters for the TrOCA approach. CANT estimated with TrOCA by this way is then compared to the CANT computed (considered as the ‘true’ field of

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CANT) with the 3D OCCAM model. This approach would be valid only if the OCCAM simulated TrOCA input variables (CT, AT, O<sub>2</sub>, and  $\theta$ ) could be fully validated with the corresponding measured properties. Despite the availability of these measurements from databases like GLODAP (Key et al., 2004), these validations are not presented. In fact, the attempt of validation of OCCAM is only based on a crude comparison between the measured and the simulated concentration of CFC-11. They also try to validate the OCCAM simulated results with those of another model (CANT from OCCAM is compared to CANT simulated with the  $\Delta C^*$  method). Why Yool et al. (2010) do not use the numerous measurements available for nutrients, carbonate system properties, salinity, temperature, and many other parameters to objectively validate OCCAM? This appears to be an unavoidable step before publishing any unbiased assessment of the TrOCA approach.”

We clearly do not think that the Yool paper provides a valuable and an objective approach to assess the TrOCA approach since a full validation of their 3D model is still missing. Moreover, why Yool et al. (2010) did not apply their approach to assess other approaches like the  $\Delta C^*$ , TTD, in a similar way? In another paper, Alvarez et al. (2009), using data from the subtropical Indian Ocean, compared the results of the 3D OCCAM model to those of four approaches ( $\Delta C^*$ , TrOCA, TTD, and IPSL). One of their conclusions (p.693) was that the TrOCA approach provides very coherent estimates of anthropogenic CO<sub>2</sub>.

In summary M. Alvarez criticisms seem to concentrate on the methods TrOCA and MIX (both approaches were actively debated in published inter-comparison exercises) rather than on the new and interesting information revealed by the 2008 BOUM cruise.

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