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Interactive comment on "Dissolved Inorganic Nutrients in the Western Mediterranean Sea (2004–2017)" *by* Malek Belgacem et al.

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On behalf of all authors, we would like to thank the reviewer for their thorough reading of the manuscript and their constructive remarks and suggestions. Your comments provided valuable insights to refine and clarify the manuscript. We have taken into consideration all suggestions. In the following, we try to address all issues raised as best as possible.

R : The dataset is complete, with most required metadata, and provided in a user-friendly format. However, the adjusted dataset does not follow exactly WOCE QC flags: missing values are not flagged, while they should be flagged 9 (no data).

A : We did follow the WOCE QC flag during the 1st QC in the original dataset, "flag 9"

for missing or non-measured values. As for the adjusted product, we added flags based on the results of the crossover analysis excluding the non-measured one, so there is no "flag 9" in the adjusted product, there is only "flag 2 : adjusted and acceptable" and "flag 3 : adjusted and recommended questionable", this based on 2ndQC recommendation in section 4.4. We did clarify it better in table 3 and in the supplementary Materials (Supplementary material – Part 2 (A2)).

R : The dataset can provide a valuable contribution to the main European initiative in charge of assembling and giving access to marine data of the European seas, namely the European Marine Observation and Data network (EMODnet) (see Giorgetti et al., 2018). Surprisingly, there is no reference to the large availability of data in the Western Mediterranean provided by European data infrastructures such as SeaDataNet (https://www.seadatanet.org/) and EMODnet Chemistry (https://www.emodnet-chemistry.eu/).

A : We are aware about the large availability of data in the Western Mediterranean provided by European data infrastructures such as SeaDataNet (https://www.seadatanet.org/) and EMODnet Chemistry. We have now added a reference to the well-known existing nutrient datasets or data products. However, the main purpose of the paper is to make available the CNR data set. In our future studies, we aim at updating and adding other data sources from SeaDataNet and the MOOSE observing network, like Dr. Coppola suggested (Coppola et al., 2019; Tintoré et al., 2019), and integrating the Eastern Mediterranean as well, as far as possible.

R : I am concerned with the choice of the 5 cruises as reference to perform the secondary quality control and the adjustments, given the well known mesoscale dynamics of the Western Mediterranean, the seasonal variability detected also in the deep layers and the changes observed in the deep waters reported in the same period (Manca et al., 2004; Schroeder et al., 2008; Schroeder et al., 2016). It is recommended to compare the profiles of the reference cruises with the outcomes of the extensive analysis of over 40 years of biogeochemical data collected

in the Mediterranean and the resulting climatological vertical profiles (Manca et al., 2004) and the full set of spatially averaged vertical profiles available to downloaded at http://nettuno.ogs.trieste.it/medar/climatologies/medz.html), provided for different Mediterranean regions defined according to general circulation patterns. Giorgetti et al., 2018 EMODnet Chemistry Spatial Data Infrastructure for marine observations and related information. Ocean and Coastal Management 166 (2018) 9–17 Manca et al., 2004 Physical and biochemical averaged vertical profiles in the Mediterranean regions: an important tool to trace the climatology of water masses and to validate incoming data from operational oceanography; Journal of Marine Systems 48, 83–116 Schroeder et al. (2008) An extensive western Mediterranean deep-water renewal between 2004 and 2006, Geophys. Res. Lett., 35, L18605, doi:10.1029/2008GL035146.

A : Reference cruise data were chosen according to a number of criteria: they are independent from our CNR dataset, they have a large spatial distribution and different time span (we added information about number of observation per reference cruises table 2), Besides, nutrient analysis followed the recommendation of the World Ocean circulation experiment (WOCE) , the GO-SHIP protocols (Hydes et al., 2010; Tanhua et al., 2013) and have undergone rigorous quality control following GLODAP routines, along with cruises that were carried out in the framework of the MedSHIP programme (Schroeder et al., 2015). Observations of these cruises are highly reliable. Based on that, the 5 reference cruises were selected to perform the 2nd QC analysis, as explained in section 2.3. We have added additional details in the text explaining our choice of reference cruises. This work is a starting point for a living data product, the original data collection is available to improve the method/make updates. We have added a section comparing our results to the Manca et al. (2004) vertical climatological profiles in section 4.5, thank you for the suggestion, which we think is a great addition to the paper.

R : To improve the logical sequence of the information, some sections should be reorganized. The Introduction is not logically organized, there are several citations which

are listed, but the connections are not clear. Many important concepts are introduced (eg. Biological pump, N:P ratio) but not introduced and some sentences are not clear or vague (eg. Lines 57- 60).

A : The text has been revised for structure and flow. We thank the reviewer for suggesting the additional references which have now been included.

R : Reference should also be made to the Mediterranean Sea – Eutrophication and Ocean Acidification aggregated datasets 1911/2017 v2018 provided by EMODnet Chemistry (https://doi.org/10.6092/89576629-66d0-4b76-8382- 5ee6c7820c7f) (line 71)

A : Done

R : The use of citations should be revised: some citations do not seem to be appropriate or are not correctly inserted in the text as there are cases of quite vague statements linked to citations (eg. line 57 Boyd; Line 171: Muniz et al 2001)

A : The text has been proofread to ensure proper citation throughout.

R : Reference to published climatologies of biogeochemical properties available for the Mediterranean is missing (eg. Manca et al., 2004; MEDAR/MEDATLAS Climatology)

A : Done, by comparing the product to Medar/MEDATLAS Climatology

R : Section 2.2 should be moved after 4.1. Section 3 should follow 2.1, after the description of sampling protocols for nutrient measurements.

A : The sections have been modified accordingly.

R : Line 47: the latter: do you mean validation? Can you please explain what you mean?

A: We meant data collection and monitoring, and there are still gaps in the Mediterranean Sea, this is now explained better in the text and refer to dataset and data prod-

uct previously done.

R : Lines 83-88: there is a not correct comparison among different terms: datasets, databases and large European data infrastructures such as SeaDataNet and EMODnet Chemistry are different things. Throughout the manuscript: check the consistency between the terms dataset and data set.

A : we have made the necessary changes.

R : Is the description at lines 123-130 innovative? If not, the citation to the already consolidated method is enough and the whole part can be removed.

A : It is a summary of the analysis description done in laboratory.

R : On the other hand, a table summarising the laboratories, the instruments, the respective detection limits, together with sample storage and freezing duration used for the different cruises would facilitate the understanding.

A : A table of the sample storage and freezing is added in the revised supplementary materials (Table 1S).

R : Section 4: deals with Quality Assurance rather than QC

A : The section title has been modified accordingly

R : Section 4.1 should be reorganized to clearly explain how primary QC has been carried out; lines 169 – 172: please explain how were QF assigned to data and the relationships between flagging and CV Lines 176-179: this sentence is not very clear. Please rephrase it.

A: Section 4.1 has been reorganized as requested. The CV compares the degree of variation between surface and deep observations and how we can proceed with the flagging. The upper layer (nitrate CV=1.16, phosphate CV=1.005, and silicate CV=0.75) imposed a check of outliers per depth range, here we name it as standard depths (or class of depth) at 0-10, 10-30, 30-60, 60-80, 80-160, 160-260, 260-360, 360-

460, 460-560, 560-1000 m. Per cruise, a Median absolute deviation was computed by class of depth, atypical observation was flagged as questionable, in the upper layer we did not strictly follow the criteria of flagging as bad the values higher than three median absolute deviations. The deep observation is relatively less variable (nitrate CV=0.15, phosphate CV=0.22, silicate CV=0.14).and the flagging was based on a check of nitrate to phosphate (N:P) and nitrate to silicate (N: Si) ratios. We considered as outlier any value that departs from the median ratio (below 1000db) by more than three median absolute deviations. We did highlight that the primary QC can be subjective depending on the expertise of the person flagging the data, thus flagging could bring in some uncertainties.

R : Lines: 187-206: As shown in fig. 9, most cruises (even cruises #1, 5 and 16) cover different parts of the West Mediterranean basin, which are influenced by heterogeneous physical and biogeochemical processes, different water masses, which are characterised by different nutrient concentrations. The relationship between standard deviation of data collected in different water masses and data precision is not so straightforward. Therefore, the assessment of “precision of each cruise measurements” based on cruise CV is questionable.

A : In order to have a first assessment of the precision of each cruise measurements, the standard deviation of data deeper than 1000db was calculated (Table 4). When the time span between different cruises is one month or less, then the temporal variation can be excluded below 1000db, and the standard deviation is interpreted as the effect of the natural variability and the precision of the observations. We compared standard deviations of cruises having similar spatial coverage. We add statistics per subregion as an overview of the overall content in nutrient layer (Table 4).

R : The authors use 5 reference cruises carried out in different seasons between 2001 and 2016 to adjust data obtained during a total of 24 cruises carried out between 2004 and 2017. Reference cruises cover a large area but sometimes with just 1 station per sub-area. The use of single stations sampled during a specific season as reference is

questionable. Even though only data below 1000 m are involved in the Secondary QC and deep waters are less variable than upper and intermediate waters, seasonal as well as long term variability in nutrient concentrations in deep waters cannot be ruled out, as also stated by the authors. It is not clear how this is taken into account (lines 226-230).

A: A valid crossover with the reference cruises should consider at least three stations for the computation to get a valid statistic. If there are not enough stations, there is no crossover. The computational approach takes this into account if there is a change, weights are given according to the “confidence” in the determined offset of the compared profiles not necessarily the variance of the profiles themselves, i.e. the weighted mean offset of a given crossover-pair is weighted to the depth where the offsets of all compared profiles have the smallest variation, which is the case in deep regions. The summary plot coming out of the 2nd QC toolbox is a function of year. The reason for that is to be able to assess whether a long-term trend exists (it becomes very obvious when the offsets are plotted as a function of time). So long-term trends are taken into account when deciding on an adjustment. Seasonal variability is an issue though, but this is why we go deep.

R : Section 5.4: why only a sub-set of cruises is described?

A : The section has been expanded to discuss all cruises.

R : Line 373: Apart from old MEDAR/MEDATLAS database, reference should be made to the harmonized, aggregated and validated Mediterranean regional dataset of parameters related to eutrophication provided by EMODnet Chemistry (https://doi.org/10.6092/89576629-66d0-4b76-8382-5ee6c7820c7f)

A : We did add it in the revised version.

R : Line 326-327: r2 do not match those in the figures, Line 577: N:P does not match those in the figures

A : We checked it and corrected it in the revised version.

R : A plot showing temporal distribution of cruises and of reference cruises could be appreciated

A : Table 1 is the cruise summary table where cruises were sorted in chronological order and plotted against the reference in Figure 1. Same as table 2 detailing the reference cruises and plotted in figure 2.

R : Fig.1 Map: difficult to identify the different (Blue and red) cruises. The use of larger and filled/open symbols may help.

A : We improved the map.

R : Fig. 8: Numbers in figures do not match with captions. Has the adjustment been done on the whole Profile or only to data > 1000m? This is not clearly described in the paper.

A : The proposed adjustment factor was estimated from observation deeper than 1000db, and we applied it to the whole profile. We clarified it in the revised version (section 3.2).

R : References: The first reference is not complete (journal? Pages?)

A : Done.

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