

Jacquet et al. present mesopelagic particulate organic carbon (POC) remineralisation fluxes in three different basins of the Mediterranean Sea using excess Barium ( $Ba_{xs}$ ) as a proxy. This tracer, through the transfer function relating  $Ba_{xs}$  to oxygen consumption, has been successfully used in different regions of the World Ocean (Southern Ocean, North Atlantic, North Pacific) and has also been shown to be relevant in the Mediterranean Sea (Jacquet et al., in reviews).

The study reveals interesting basinal variations in the magnitude of mesopelagic remineralisation (MR). Based on  $Ba_{xs}$  concentrations, greater 100-1000m MR fluxes are determined in the western basin (Algerian basin) compared to the Tyrrhenian and Ionian basins. This greater deep remineralisation could be due to different processes such as 1) a strong convection in the western basin leading to a strong particle injection pump, or 2) dust deposition event in the eastern basins leading to more efficient export of particles, thereby escaping mesopelagic remineralisation.

Overall the data is interesting and necessary for better understanding the biological carbon pump. The two possible explanations of greater MR fluxes (lack of dust depositions, water mass convection) are also interesting, but are unfortunately not detailed enough and, even not mentioned in the conclusion. Moreover, the authors do not provide enough arguments and evidences to support their interpretations. For example, there is nothing demonstrating the good quality of the presented data, no data on dust deposition, and no explanations/data evidencing a winter deep convection in the western basin. My review consists in a relatively long list of questions, highlighting the lack of details in the manuscript. After revision, the new manuscript should provide all the details answering these questions. This will make the manuscript more convincing as for now the reader must believe your interpretation only with words and not with facts. Finally, the comparison of  $Ba_{xs}$  data from the same station but at different visits deserves more attention as there are no many studies (or none?) investigating the  $Ba_{xs}$  evolution over time. The significant difference of DWA  $Ba_{xs}$  and MR flux between visits however brings another question about the  $Ba_{xs}$  proxy: Is the seasonal time integration proposed in earlier studies correct?

### **Major comments**

#### 1) Abstract

This section is too short in my opinion and should mention the context of this study (dust deposition), why this study is important and what is its goal. Also the possible influence of dust deposition on remineralisation fluxes, which is one of your main interpretation should be mentioned. Finally, the authors should explain what the particle injection pump is and how this process can drive greater remineralisation fluxes in the Mediterranean Sea.

#### 2) Material and methods

There should be more information about the sampling and the methods of both  $Ba_{xs}$  and prokaryotic heterotrophic production (PHP) parameters. As such, the reader cannot fully understand the methods if he is not specialist. Moreover, there is no evidence you correctly determine these parameters: please indicate the precision and accuracy of your analyses.

Lines 76-89: Is there more information relevant to your study in the literature about these three basins, ie. Primary production, bloom timing, dust deposition events, POC export fluxes? If yes, please include them as they will help the reader to better understand the study area.

Lines 93-94: Indicate how much time separates both visits.

Line 97: Are these filters cleaned? If yes, how were they cleaned?

Lines 100-101: Please give the blanks, the precision and the accuracy of your analyses.

Lines 103-105: Show the equation to illustrate how you determine  $Ba_{xs}$  concentrations. Moreover, which Ba/Al ratio do you use? From the UCC, from aerosols? Discuss about the relevance of the used ratio for this study.

Line 106: How do you calculate this uncertainty? By error propagation, taking into account the analysis error of Ba and Al?

Section 2.3: This section is really not clear, you need to give many more details and to reorganise the paragraph (maybe by depth layer: 0-200m samples, 200-800m samples and >800m samples?). Moreover, if you have data at depths >800m, please show them on Fig. 2 and 3.

Line 119: Did you sample the same stations than for  $Ba_{xs}$ ? How did you collect the samples, which sampling system did you use? How much volume did you collect?

Lines 121-123: Why are the sample from different depths incubated for different times? Why are the samples separated at these specific depths (ie., 0-200m; 200-800m and >800m)?

Line 124: 'Deep PHP' does it mean for samples from depth >800m?

Line 129: Is the protocol of Kirchman different from the one of Tamburini (line 125)? If yes, what is the difference? If no, combine both sentences at the end or beginning of the section.

Line 129: 'Epipelagic layers (0-250m)', why does it not correspond to the depth layer 0-200m described at the beginning of the section (line 122)?

Lines 131-134: With the information provided here, a reader who does not know about PHP analyses cannot understand how you estimate it. Please give more details: maybe an equation would help? Why do you mention isotope dilution here?

Section 2.4: Please mention you use DWA  $Ba_{xs}$  to determine POC remineralisation fluxes and explain briefly what the DWA calculation is.

### 3) Results

How do all these values compare to the literature?

Line 145: Why don't you show the PHP data at depths >800m?

Lines 154-155: What is a low lithogenic impact (give value please)? What does a >20% lithogenic fraction imply to your  $Ba_{xs}$  estimations. This comes back to the explanations of using a correct lithogenic Ba/Al ratio for this study area (see one of my comments above)

Lines 167-171: Do the PHP peaks occur at the same depths than the  $Ba_{xs}$  peaks (slightly above 100m)? Is there a link?

Lines 175-176: In both the 100-500 and 100-1000m depth layers?

Lines 177-179: The DWA  $Ba_{xs}$  values do not remain stable if they decrease over time. Please make it clear.

### 4) Discussion

You should give more details/more explanations supporting your interpretations.

Lines 185-187: How are Ca and Sr explaining the presence of ballasted phytoplankton-derived material? Do the Southern Ocean studies also report such high surface  $Ba_{xs}$  concentrations?

Line 190: ‘..Ba<sub>xs</sub> presents the characteristic maximum..’ Explain briefly what this characteristics maximum is. Someone who is not used to work on Ba<sub>xs</sub> concentrations cannot guess. For example, you could add: A typical profile of Ba<sub>xs</sub> shows a maximum in the mesopelagic layer (100-1000m) followed by a decrease of concentrations back to a background level, at deeper depths, usually below 1000m.

Lines 191-192: Please give average DWA Ba<sub>xs</sub> values for each basins and for both depth layers in order to directly compare the magnitudes.

Line 193-198: I suppose there a link between the dust event and the maximum Ba<sub>xs</sub> limited to the upper 500m in the TYR basin. Please find a transition/connection between both sentences. Moreover, compare average values of pAl concentrations (or %Ba<sub>xs</sub>) between Stations 4, 5 and TYR and other stations to illustrate the differences between basins (cite Fig. 2 as well). Best would also to show a figure of dust events in the ~15 days before the cruise (maybe on Fig. 1?).

Line 202: How does the relationship between Ba<sub>xs</sub> and PHP reflect the temporal progression of POC remineralisation?

Line 204: Fig. 3 only shows the upper 1000m of PHP values.

Line 212: Please add a transition between both sentences. Maybe “We can however note that some data points, characterized by low DWA Ba<sub>xs</sub> values, do not follow the trend (from KEOPS2 and #3, #5 and #Tyrr2) ’.

Lines 215-217: Can you demonstrate such temporal evolution? For example, satellite observations of surface Chl-a concentrations would show differences in bloom timing, which by taking into account a delay would suggest differences in remineralisation process.

Lines 279-219: The difference in DWA Ba<sub>xs</sub> content observed at the same station over time is very surprising to me. I thought Ba<sub>xs</sub> was a tracer integrating over a full season – how is it possible to observe such difference in only 2 days? Has this been discussed in earlier studies?

Line 229: ‘small increase in MR rates at station #Tyrr between the two visits’. There is an increase from 32 to 114 mg C/m<sup>2</sup>/d between both visits: this is a significant increase! Instead of focusing on this station, you could speak more generally, ie., averaging the all TYR basin.

Lines 227-233: Your hypothesis is convincing but how do you explain the restricted MR in the ION basin? Was there a dust deposition event there as well? A map of dust deposition averaging the ~15 days (or more?) before the sampling would give a good idea on how these basins were influenced by such events.

Line 237: Would you have an explanation for the low pAl concentrations in ALG basin while sampled just after a dust deposition?

Lines 238-242: This sentence is too long and not clear. Please re write.

Lines 243-252: This is one of your main conclusion and there is almost no explanation. You have to develop more: 1) is there a winter deep convection in the ALG basin (literature, data, how deep is the convection?)? Explain what the particle injection pump is and how this process can lead to greater MR rates?

## 5) Conclusion

Why do you not mention the impact of dust deposition and winter deep convection as possible explanations of the greater MR fluxes observed in the ALG basin? This is, to me, the most interesting part of your manuscript.

#### 6) Figures and Table

Line 282: You only show the upper 1000m of the PHP profiles. Also, change 'long' stations. You never use this description in the text.

Figure 1: Is it possible to add on the map where the dust deposition events occurred (surface colours maybe?), and where is the winter deep convection? Also what is the interest to show the T/S graph here if water masses are not discussed in the manuscript? What is the dashed line on the map?

Figure 3: Are the error bars shown?

Figure 4: The  $R^2$  is very confusing. Does it take into account all data points presented on the figure or only those of KEOPS2? If it is the one of KEOPS, please update the  $R^2$  by taking into account all data points shown here.

Figure 5: I am not sure it is necessary to show the MR fluxes of both depth layers below the figure, as they are indicated in Table 1.

Table 1: Can you please indicate the error in  $\text{mg C/m}^2/\text{d}$  and not in %.

#### **Minor comments**

Line 22: Please keep the same appellation for the ALG basin throughout the manuscript: either Algerian or Algero-Provençal basin.

Line 70: Remove 'and' in 'and (3) to determine...'

Line 86: the abbreviation LSW is confusing with the Labrador Sea Water. Is there a way to distinguish both abbreviations?

Line 122: remove the 'n' in the end of depth '..below 800m depth..'

Line 124: Use the abbreviation PHP.

Line 127: Remove the second 'at' in 'were incubated at in situ temperature'

Line 129: Remove 'detailed' in 'The protocol is also detailed in Kirchman et al. (1993)'

Line 129: Epipelagic layers: 0-250m or 0-200m (as mentioned line 122)?

Line 140: Mention you investigate here the 100-500m and 100-1000m depth layers.

Line 149: 'Such high  $\text{Ba}_{\text{XS}}$  contents..' instead of 'The very high  $\text{Ba}_{\text{XS}}$  contents..'

Line 150: What are the concentrations reached in the Southern Ocean?

Lines 152-153: This paragraph break is unnecessary.

Line 170: 'below 27'. Please give the exact value.

Line 172 and after: Why do you use the abbreviation DWAv instead of simply using DWA?

Line 206: Remove 'entire' in 'over the entire 100-500m depth interval'. This is confusing with Table 1.

Line 222: Add (100-500m) after '...for the upper ..' and (100-1000m) after '..the entire..'

Line 222: Precise for what depth layer is the MR range.

Line 224: 'This is especially salient at station #9'. Please give values to illustrate your sentence.

Line 249: Write PHP in full and indicate the abbreviation

Line 298: '...layer for the Algero-Provençal (ALG), Tyrrhenian (TYR) and Ionian (ION) basins.'