

Reviewer #2

Review of EGU sphere-2024-3436 paper: Effect of double diffusion processes in the deep ocean on the distribution and dynamics of particulate and dissolved matter: a case study in Tyrrhenian Sea by Xavier Durrieu De Madron and coauthors

General Comments

This study presents and discusses various marine data collected in the spring of 2020 during the PERLE-3 cruise, and sheds light on the relationship between double diffusion, in the form of salt fingers, and particulate and dissolved matter in the Tyrrhenian Sea. The authors present and analyze hydrological, hydrodynamic, particulate, and dissolved data covering a section of the south-central Tyrrhenian Sea. They then focus on two different stations, one with and one without staircases due to salt fingers. They find that the steps influence the size and distribution of particulate and dissolved matter, which in turn can affect biological activities.

This study makes an interesting contribution to the growing understanding of the role of double diffusion processes in the ocean. The data are well characterized, the methods are clearly presented and the conclusions are innovative and substantial. However, some improvements could enhance both the text and the figures to increase the overall quality of the presentation. Moreover, it would be beneficial to publish the data.

Specific Comments

Introduction

- The organization of the introduction is somewhat challenging to follow, as it shifts from discussing particulate matter to staircases, then to sedimentation and to staircases again.
- The fourth paragraph (starting from line 64) seems unnecessarily lengthy, as it discusses plumes while the focus is on the deep ocean.
- It would be beneficial to include a brief overview of the circulation of water masses in the area, as this would help explain the local salt finger processes. Additionally, all acronyms used later in the text should be defined in the introduction.
- The third paragraph (starting from line 50) on double diffusion presents only one reference. Please add more references, particularly in the definition of the process (e.g., Radko has published numerous papers on the theoretical aspects of double diffusion).

Material and Methods

- Section 2.1: The title would sound better as “Thermohaline and Optical Data” (consider adding “and Derived Index”). It should also include both shipborne CTD data and Argo float data, as they represent the same type of data collected using different probes.
- Lines 149-150: The majority of parameters described seem to be unused in the subsequent analysis. Please highlight where and if they are utilized, or consider removing them.
- Transmissometer Paragraph (lines 152-168): This paragraph could be better structured. Additionally, what about particles in the 10 to 80 μm range?
- Section 2.2. (from line 178): I suggest titling this paragraph simply “Acoustical Data” to match the style of the preceding paragraph. Moreover, please define both L-ADCP and S-ADCP at the beginning and use consistent terminology for each type of ADCP.

Results Section 3.1

- Please ensure consistent use of physical units throughout the manuscript. For instance, both μmol and μM are employed in the initial paragraphs. I have attempted to highlight every discrepancy in the text revision for your reference.
- As previously mentioned, it would be beneficial to include a brief discussion in the introduction regarding the circulation and names of water masses in the Tyrrhenian Sea. Defining these terms solely in the captions detracts from the overall fluency of the text.
- Regarding the figures, it would enhance their legibility to incorporate references in the cross-basin section figures. For example, I suggest utilizing a different color to highlight the isolines mentioned in the text or integrating the names of the water masses, similar to the TS diagram (Fig. 1). Ideally, figures in scientific papers should be self-explanatory, presenting all necessary information for the reader to comprehend them.
- Please provide specific references for the subfigures. For example: “The warmer, saltier, and oxygen-depleted core of the LIW is located at depths between 300 and 600 m, as illustrated in Fig. 2 (sections a, b, and c),” each time you describe the illustrated parameters.
- In Figure 3, the units are missing. Additionally, in Figure 2, incorporating colored lines, symbols, or labels within the section could facilitate quicker identification of eddies.
- At line 267, stations 09 and 20 are introduced for the first time. It may be beneficial to present these stations earlier in the document (perhaps in section 2.1) and

provide a brief explanation for their selection (presumably because they are the most representative). Furthermore, consider adding the station names within Figure 4 to enhance reading clarity.

- In Figure 5, acronyms must be defined in the text upon their initial use before appearing in the figures (for instance, LPM has not been defined). As with the other results figures, please consider adding visual references to the two selected stations, such as corresponding lines on the cross sections.
- Lines 289-290: Is this statement conjecture or a well-established fact? If it is the latter, please provide a citation to support the claim. Additionally, it would be prudent to include a brief definition of micronekton, as it has not been mentioned previously, and the intended scientific audience may include researchers in abiotic studies.

Results Section 3.2

- Lines 316-318: Could you please provide additional explanation for this highlight?
- Figure 6: I recommend enlarging the text size, as it may be challenging to read depending on the medium used by readers.
- Line 341: Did you intend to reference Figure 8 instead?
- Lines 343-346: Please rephrase this sentence for clarity, as it currently lacks precision.
- Lines 284-351: The temporal and spatial stability of Tyrrhenian staircases has been documented in several studies (such as Johannessen and Lee, 1974; Molcard and Williams, 1975; Molcard and Tait, 1977; Zodiatis and Gasparini, 1996; Falco et al., 2016; Durante et al., 2019; and Taillandier et al., 2020; and more). It would be advantageous to highlight this consistency with existing literature, or alternatively, to include this information in the Introduction section.
- Additionally, please consider incorporating the graphical positions of the two eddies in Figure 8 and adding titles to the maps, such as "Cruise" and "Floats."

Discussion 4.1

The content in paragraphs 382-393 contains qualitative speculation and should be rewritten, as it lacks sufficient adherence to the presented results.

It is important to distinguish between what constitutes a measured result (and where to locate it in the previous text) and what represents a conjecture. While I understand this paragraph relates to Results Section 3.2.2, both sections require restructuring and more substantive argumentation to enhance coherence. Consider these questions: Can you demonstrate a definitive influence of the eddies on staircase structures, or is it merely a qualitative correlation? Did you select station 20 due to its proximity to the 12 E° eddy, with the intention of investigating the relationship between the eddy and the potential

development of steps? If this is the case, please state it explicitly to clarify your speculative assertions regarding their interaction.

Additionally, you mention that vertical currents behave as expected (line 270). In what manner can they visibly alter the formation of staircases (line 387), particularly since there are no staircases present at the station nearest the eddy? Can you compare your cast in station 20 with other previous data of the same station? A potential approach could involve starting from the persistence of the center-basin staircases and hypothesizing that the absence of staircases at your station 20 (and possibly adjacent stations, are you able to show them for comparison?) may also be attributable to the presence of the eddies and their associated stronger currents. This interpretation reflects my understanding of this segment of the discussion.

For your reference, a relevant study examining the relationship between a Meddy and staircases is presented in Hebert (1988).

Discussion 4.2

Please consider including a description of the size classes presented in either the text or a table for clarity.

Discussion 4.3

Lines 488-489: Since you are comparing your results with those of Taillandier et al. (2020), it would be beneficial to also reference Durante et al. (2021) in this paragraph. The study analyzed heat and salt fluxes of staircases in a nearby area and over a broader portion of the water column, yet it found the strongest thermohaline fluxes occurring within a similar depth range (700 m – 1600 m) as the one you selected.

Technical Comments

Please refer to the attached paper. Consider these comments as a complement to Reviewer #1's feedback.