

Answer to referee #2

We thank the reviewer for your comment and suggestions on the manuscript „Ventilation of the Mediterranean Sea constrained by multiple transient tracer measurements“. The detailed review clearly point out necessary improvements and corrections.

“The paper is basically a descriptive analysis of different TTD-based approaches and respective outcomes. The results are certainly interesting and important for the scientific community, but I do find a major revision necessary. Section 6 presents the results where little effort is made to discuss these findings in the light of already published data. In my opinion, especially a comparison to the work by Schneider et al. (2013) is required who use the same data and a similar TTD-approach but only focus on the 1IG-TTD. In contrast to the present paper Schneider et al. used a fixed delta/gamma ratio = 1. The results presented in the present paper indicate that this approach is not applicable to all sub-basins of the MedSea. So, to what degree do the results of Schneider et al. still hold or need to be revised?”

Concerning the work by A.Schneider et al. (2014), we added several parts in the material and method section and in the results and discussion section as it seems like that the significant differences of both methods are not made clear to the reader. We have improved this in the new version of the manuscript. By using the same data set, and basically also the same TTD method, it might mislead to directly compare the results of both papers. However, the analysis of a time series, like Schneider et al. (2014) did for a time frame of 25 years, requires a model which can be applied to the various data sets of interest providing comparable results. Most of the older data sets do not allow for use of our model to constrain the TTDs due too few tracers being measured on several of the cruises. That is, it was not practical to apply the constrained method for the work of Schneider et al., (2014). However, the limitations of assuming a fixed Delta/Gamma ratio are thoroughly discussed by Schneider et al., (2014). Our work is focused on only one data set of only one cruise with a comprehensive transient tracer data set. None of the historic transient tracer data sets in Schneider et al., (2014) have more than two independent tracers (note that CFC-12 and CFC-11 are so similar that they are of little use for the constrained TTD model).

“The paper would benefit from providing uncertainties with respect to the estimated mean ages. Several separate figures could be merged into single figures with 2-3 subplots. The manuscript contains many typos and misspellings and occasionally entirely corrupt sentences.”

The material and methods section has been restructured, and an extra section of uncertainties has been inserted with information about data precision, accuracy and error sources as well as a figure of the mean age error function (absolute error). It is clear from our discussion that the measurement errors are small in comparison to possible biases by, for instance, unknown disequilibrium and assumptions of the shape of the TTD. This is now discussed in the paper.

“Detailed comments:

The "Introduction" mainly consists of detailed description of major circulation features. The motivation what the paper is all about is rather weak. Information to what extent contents differ from or build on the previous analyses of Schneider et al. (2013) is missing.”

We added an advanced description of ventilation analyses by using transient tracers in the introduction, where we also refer to already existing publications, describing the developments of the used methods. We have also specified our contribution to the field in the end of the introduction.

“There is a lengthy technical description about how parts of the tracer data were obtained. For non-tracer-experts, however, it remains unclear what particular technical system is used for what particular tracer. Information on data precision is not given. Instead, the reader is referred to an unpublished manuscript of the first author, which I, personally, do not find acceptable. Details on the analysis of helium/tritium of this particular cruise and respective data precisions/uncertainties etc. are entirely missing. Also the title of Section 2 is misleading, since also sections 4-5 basically contain descriptions of applied methods.”

The technical part was rewritten to better distinguish between the measurement systems / techniques of the transient tracers. The helium / tritium measurements and details about precision, accuracy etc., is given in the companion paper by Roether et al., (2013), to which we also refer. The measurement techniques and procedure of CFC-12 and SF₆ should be now clearly enough described in the belonging section. The master thesis (Stöven, 2011) with more details on the CFC/SF₆ analysis is publically available via the repository at our local library; the link is now in the reference list.

“Section 3.1: Is Eq. really required for the understanding of the remaining text ? If so, given parameters should be introduced.”

Thanks for this comment. Equation removed from the manuscript.

“Section 3.2: An earlier version of the TIF (Steinfeldt, unpublished) was shown by Steinfeldt (2004), who should be cited here as well. The benefit of using this instead of the one published by Roether et al. (2013) is not yet clear to me. Probably because of corrupt sentences it remains unclear what determines the correction factors. Since two regional TIFs are introduced I would expect more details on this topic.”

The tritium input function by R. Steinfeldt has no official reference yet (according to R. Steinfeldt) and citing an earlier version would not be correct. The tritium input function in Steinfeldt (2004) only extends to 1985; the version extended to 2011 is not published. However,

the publication by R. Steinfeldt et al. (2004) is cited several times in another context. The description of the determination of the two correction factors was rewritten for a better understanding.

“Section 4: please introduce alpha in Eq. 9”

Alpha is now introduced.

“Section 5: I would assume that this is not the first approach to constrain the 1IG- and 2IG-TTD models. One could expect a more thorough introduction concerning already established and different approaches considered here. Sections 5.1 and 5.2 do not point to respective publications.”

Correct, this is not the first time this has been attempted. We now discuss previous work in section 2.3.1.

“Section 6.2.1: please explain in more detail for what reason certain data points were considered as non-constrainable; how many were affected?”

We designed one table that provides a complete overview of the obtained data and the absolute values of constrained and non-constrained data points.

“Tables:

Please introduce at least in the caption of Table 1 parameters like alpha and gamma_1 and gamma_2. What does "n.a." mean here? Please, think of highlighting depth ranges pointing to relevant water masses. What are the uncertainties of the given mean ages?”

Thanks for the comment. Table changed accordingly.

“Figures:

Pressure should be reported in deciBar [dBar] and not in deciBel [dB].”

Changed.

“Figure 1: The TIF shown in Fig.1 and referenced as published by Steinfeldt (et al. ??) looks very similar to the TIF shown by Schneider et al. (2013), where it is claimed to be published by Roether et al. (2013); reference pointing to Stoeven et al. (2013) is missing”

There was a mistake in the discussion paper by Schneider et al. (2013). This is now corrected in the final version of the paper, Schneider et al., (2014).

“Figure 2: limited content of information since symbols and station labels are difficult to be identified/distinguished in parts of the figure; legend introducing colored contours is missing”

Figure has been improved according to recommendations.

“Figure 4: a colorbar should be given; use subscripts to distinguish between γ_1 and γ_2 ”

Colorbar is now given and different subscripts used.

“Figure 5: different longitudinal scales were chosen for a/b and c; (near-)bottom samples are not visible; colorbar should have label indicating displayed property and unit (same holds other figures showing section data)

Figures 9+10: could be merged into one figure; also see comments for Fig. 5

Figures 12+13: could be merged into one figure; also see comments for Fig. 5

Figures 14+15: please name considered stations in figure caption.

Figures 16+17: could be merged into one figure; also see comments for Fig. 5

Figures 12/16/22/26: there appears to be mismatch between the different figures concerning the number and spatial distribution of sampling depths, which is possibly related to the "reduced sectional interpolation quality" due to "non-constrainable data points". It remains unclear to me what determines the latter. Adding the δ/γ ratio = 1 as e.g. a black contour would be useful”

Figures updated accordingly.

“Figure 22: The displayed tracer age differences are either below or above 10 years. What is the maximum ?”

Maximum tracer age difference added in section 3.2.1