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Interactive comment on “Changes in ventilation of the Mediterranean Sea during the past 25 yr” by A. Schneider et al.

A. Schneider et al.

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We thank the reviewer for constructive comments.

General comments The paper presents an evaluation of changes in the ventilation of the Mediterranean Sea during the last 25 years, using a combination of several transient tracers, and different approaches to estimate water mass ages. In addition to the ventilation the study also discuss the different age-estimate approaches. The approach is rather novel, and the combination of different tracers give more robust results. The work is interesting and well written and with good figures, but some additional figure in the introduction would be helpful for the description of the area (see Specific comments below). The paper is well suited for Ocean Science, and should be published after minor revision. **Specific comments:** 1) The Introduction starts with a description

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of the circulation and water masses in the Mediterranean Sea. For any reader not familiar with the area it would be very helpful with some figure(s) showing the geographical features mentioned, e.g., all basins, and the main circulation, and possibly also some figure/table of the mentioned water masses. In addition, or at least, this could be helped by adding some information to the text in the introduction, such that, for example, “In the Levantine basin. . .” get some more location description (e.g., in the eastern Mediterranean). – Good advice! We included an additional figure and some changes in the introduction

2) To me the whole start of the Result section (p.1414, l. 21-27; p. 1415, l. 15) should be moved to the Method section since this describes the parameters and the approach. – Yes, we moved the paragraphs to the method section as: 2.4: Combination and comparison of nine cruises

3) Add some information about how the average profiles are calculated (p.1415). – The mean profile is calculated by first interpolating the individual profiles to standard depths using a piecewise cubic hermite interpolating method that do not allow too large vertical distances between data points, and then by taking the arithmetic mean of the interpolated profiles (e.g. Tanhua et al., 2010). This is now included in the manuscript.

4) The statement on p. 1415 that the profiles south of Crete are more homogeneous is not clearly supported by all parameters, when comparing Fig. 3 and 4. – That is true, thank you! We deleted this sentence.

5) Estimate and/or discuss the magnitude of the uncertainty from the assumption of 100% surface saturation in the TTD-based age estimates (p. 1415). Overall the paper lacks any quantification of the uncertainties, as far as I can find. This may be less critical since the aim is to detect relative changes more than quantify exact ages. Nevertheless, some discussion of this would be in place. – Paragraph added on page 1414: Under-saturation is possible in areas where surface water quickly cools and subducts before equilibrium with the atmosphere is reached (e.g. in the deep water formation

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areas). The assumption of 100% saturation would then lead to an overestimation of the water age. The assumption of 100% saturation would then lead to an overestimation of the water age. For instance Tanhua et al., (2008) suggest that the saturation of CFC-12 has increased over time as the atmospheric transient has decreased. Since we are analyzing the temporal variability of ventilation ages of water masses, temporal variability of the surface saturation would lead to a bias in our analysis. We do not have sufficient information to realistically address this question for the Mediterranean but assume that the surface saturation has remained constant over the last decades, bearing in mind that a potential overestimation of ages (due to under-saturation) during intense convection periods could bias our analysis.

Paragraph added in the method section (last paragraph): In this work we focus on relative changes in concentrations and ages over a time period of up to 25 years. This is the reason why we do not quantify the uncertainties, but only discuss biases affecting the relative comparison and not the absolute numbers. For a detailed discussion of the uncertainties of the cruise in the year 2011 see (Stöven and Tanhua, 2013)

Technical notes: p.1407, l. 12: "...in a view" is not clear to me; re-write. – Sorry, a typo: Changed to few

l.21: "preconditioning" should maybe be replaced by "preconditioner". – Right: Changed to preconditioner

l.25-26: change order of sentence: "..., a slowly ventilated water body is found between 1200 and 2600 m depth." – Done

p.1408, l.4: Consider rephrasing "...to have happened...". – Changed to: However, a cruise in 1995 noticed strong changes in the deep water formation and circulation compared to 1987

l.5-6: Consider rewriting sentence "Enhanced salinities..."; not very clear presently. – Changed to: Enhanced salinities of subducting surface water in the Aegean Sea had

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led to water flowing out of the Aegean Sea that was dense enough to sink down to the bottom of the main eastern basin.

l.17: The depth of the Sicily Channel is already mentioned at p. 1407 and can be removed. – Thanks: removed

p.1409, line 12: WMT is here referred to as Western Mediterranean Transient, but should be “. . .Transit” to be consistent. The same goes for p.1419, l.13. – Consistently corrected to WMT=Western Mediterranean Transition (not Transient or Transit)

p.1410, l.4: Edit the location of the parenthesis at the reference. – Done

l.9: Is it correct to refer to the transient tracers as “conservative”? – Good point; we changed to “chemically inert”.

l.26-27: Order the references chronologically. – Done

p.1411, l.19-20: Edit the parenthesis at the references. – Done

p.1412, l.9: Order the references chronologically. – Done

p.1416, l.12: typo on “the TTD-based. . .” – Thanks

p.1417, l.6: “. . .profiles do not.” – Thanks

p.1423, l.3: Either remove “it” (in the end of the line), or maybe add something, like “shows” after “also” on the next line. – Removed “it”

p.1427, l.25: Two of the authors are missing on the reference Waugh, “Relationships among tracer ages”, 2003. – Hall and Haine – Sorry! Corrected!

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