

## ***Interactive comment on “Interannual variations of water mass properties and volumes in the Southern Ocean” by M. Tomczak and S. Liefvink***

### **Anonymous Referee #1**

Received and published: 20 June 2006

General Comments: The study by Tomczak and Liefvink describes and extension of a work published in Journal of Atmosphere Ocean in 2005 by the same authors under the slightly different title: 'Interannual variations of water mass volumes in the Southern Ocean' (in the following TL2005). The basic intention of the manuscript under discussion is (i) to apply a slightly different method to a part of the data used in TL2005 and (ii) to extend (compared to TL2005) the speculations about reasons why Circumpolar Deep Water and Antarctic Bottom Water properties (volume) may have changed between 1991/1993 and 1994-1998 along the SR03 section.

I think the weakest point on this paper (as in TL2005) is that no error analysis is presented and, considering all the assumptions the authors have made (explained in the present manuscript as well as in the TL2005), I do not see any evidence to interpret the

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

'variability' NOT as a product of 'noise' and methodical error or as a systematic error (e.g. leaving one SWT out which need to be included) or a mixture of both. Consequently, the 'speculations' about the physical mechanisms behind the 'variability' go far beyond the conclusions one can make from the analysis presented.

One main concern I have with this study is on the determination and use of the weights. I know from experience that the weights have profound influence on the results - for OMP analysis (TROMP) as for all system of linear equations. Therefore it is mandatory to not only to discuss the weighting procedure in more detail as it is done so far but to determine 'uncertainties' in weight AND showing how sensitive the results are in respect to the choice of weights. As a specific concern about the weights used for the present study is that the weights are not related to the SWT used. To my taste it was already a weak point in TL2005 to use only source water formation area variability for Central Water (I guess WSPCW and SSMW) and AAIW and only based on WOA98 data. For the analysis presented here still the weights are based on these two water masses (as explained in TL2005) although the water masses are NOT INCLUDED at all in the analysis presented!!! Consequently the weights are even less (zero) representative than in TL2005...

Another issue in respect to the technique: As I understood TROMP analysis includes an OMP analysis as an intermediate step during the minimization procedure (page 203, line11). Does this OMP analysis consider biogeochemical cycling ('alpha r') or not? On page 202 the matrix has an 'alpha r' included (although not explained in text) therefore I expect that they use 'alpha r'. For TL2005 it is clearly written that NO 'alpha r' was used. There is no doubt that the 'alpha r' is needed as explained by the authors, because we learned that e.g. AAIW along SR03 is composed from AAIW of different 'ages'. And furthermore, what is true for AAIW must be also true for the other water masses and 'alpha r' is a MUST for this type of analysis covering an area affected by water that enters on very different circulation pathways (and may even re-enter the section, as for the AAIW).

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

I suggest that uncertainties from at least the following model input: SWT, WEIGHTS, and OBERSAVTIONAL DATA should be considered in the analysis and in a consistent way. This would be at least possible during the 'intermediate OMP steps' of the TROMP.

In addition another possibility may exist: as far as I understood, TROMP considers uncertainties during it minimization. As I understood it seeks to find a 'better' SWT value but in certain boundaries only. Now one could determine from a Monte Carlo method approach other uncertainties of the system e.g. the fractions (x's). These uncertainties can be added to TROMP as an additional constrain.

Specific Comments:

- 1) (page 202, first paragraph) Please explain the meaning of 'alpha r' in chapter 2.
- 2) (page 202, frst paragraph or elsewhere) Clarify if 'alpha r' is used on not - if not, give at least an estimate on the influence when ignoring 'alpha r'.
- 3) (page 203, line 11) Does the OMP analysis used to solve the intermediate solution of TROMP include 'alpha r'?
- 4) (page 204, line 15) The SWT of the depth range 1500-4000m is used from TL2005. However, comparing table 2 and table 3 in TL2005 reveals that only SWT and weights from the southern part of the section are used. Does this mean the present study is limited to the southern part only? If YES, please correct table 1. If NO, please come up with a new SWT and weighting scheme that adequately represents either the whole section or split the analysis and add additional SWT and weight to table 2.
- 5) (page 204, line 18) In TL2005 we learned that the weights are determined using the Tomczak and Large 1989 technique based on source water formation area variability for Central Water (I guess WSPCW and SSMW?) and AAIW - these two water masses are not included at all in the analysis presented here and therefore the weights are even less (0) representative than in TL2005.
- 6) See Fahrbach et al. for a 'possible' variability of the source water types

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

7) (page 216, table 6) Although being a product mathematics only, the negative values look very strange as they are totally unrealistic.

8) (page 216, table 7) It is of more use to not show the absolute values but the change in residual after the iteration - here again the influence of the weight might be obvious as the relative changes: T S o2 phosphate nitrate silicate 60 % 1% 50% 4% 0.3% 900%

---

Interactive comment on Ocean Sci. Discuss., 3, 199, 2006.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper