

## A review of “Water Masses in the Atlantic Ocean: Characteristics and Distributions” by Mian Liu and Toste Tanhua [version 5].

This is a second review after revisions of the previous manuscript “ Characteristics of Water Masses in the Atlantic Ocean based on GLODAPv2 dataset” [version 4].

This paper uses an inverse-model to define water masses in the Atlantic Ocean. I think it is much better than the previous version. Results and figures are clear, writing is clear, and order is logic. The main thing to do is to add a more details about the method used, and some furthermore minor changes. This paper is almost ready for publication.

### Method

The paper uses a least square analyses, equivalent to an inverse method without any weights or constraints, but with prior choices. Hence, normally one would write an inverse method including prior constraints as (McIntosh and Rintoul 1997, Menke 1984, Groeskamp et al 2014 [from which this equation is copy pasted]):

$$\mathbf{x} = \mathbf{x}_0 + \mathbf{W}_c^2 \mathbf{A}^T (\mathbf{A} \mathbf{W}_c^2 \mathbf{A}^T + \mathbf{W}_r^{-2})^{-1} (\mathbf{b} - \mathbf{A} \mathbf{x}_0).$$

The results are this sensitive to weighting of both the equations ( $\mathbf{W}_r$ , now all equally weighted), weighing of the unknowns ( $\mathbf{W}_c$ , also equally weights), and choice of prior knowledge ( $\mathbf{x}_0$ ). In this paper, the prior knowledge is inputted by the SWT's. Hence, the results can be sensitive to this, and no such sensitivity is currently explored. Regardless I'm reasonably convinced that the results are fine because it looks good. But with an inverse method, you have to explore the sensitivity to the input variables that we choose. Long story short: you might want to either study this sensitivity or otherwise mention that this is not been looked at.

- McIntosh, P. C., and S. R. Rintoul, 1997: Do box inverse models work? J. Phys. Oceanogr., 27, 291–308, doi:[10.1175/1520-0485\(1997\)027<0291:DBIMW.2.0.CO;2](https://doi.org/10.1175/1520-0485(1997)027<0291:DBIMW.2.0.CO;2).
- Menke, W., 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press, 260 pp.
- Groeskamp, S., J. D. Zika, , B. M. Sloyan, T. J. McDougall, and P. C. McIntosh, 2014: A thermohaline inverse method for estimating diathermohaline circulation and mixing. J. Phys. Oceanogr., 44, 2681–2697, doi:[10.1175/JPO-D-14-0039.1](https://doi.org/10.1175/JPO-D-14-0039.1).

More minor comments can be found annotated in PDF of the paper.