

Ocean Sci. Discuss., referee comment RC2
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Comment on os-2021-40

Anonymous Referee #2

Referee comment on "Defining Southern Ocean fronts using unsupervised classification"
by Simon D. A. Thomas et al., Ocean Sci. Discuss.,
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The authors propose a new method to quantitatively define the Southern Ocean fronts. The new metric, I-metric, searches boundaries of water masses in the space spanned by the principal components of the Southern Ocean hydrography. The water masses are classified by the Gaussian mixture modelling. When applied to the output of the Southern Ocean State Estimate (B-SOSE), the newly defined fronts correspond well to the traditional definitions of fronts both in monthly snapshots and in 5-year average.

I find the definition of the I-metric (equation (3)) is intuitive and natural, and am convinced that the new method has an advantage over the traditional front definitions in its ability to allow "for a wider variety of transition types between regimes" (ll.198-199). The paper is well written except for a few places where exact meanings of technical terms are not obvious (see below). I think only a minor revision is needed before acceptance.

l.95: Doesn't B-SOSE also solve the salt conservation equation?

Table 1. It is stated that "a state estimate ... the changes in ... mixing parameter" (l.90). Are the mixing parameters listed in Table 1 the initial values? Or are they fixed? Or are they after adjustment?

l.120: Explain the use of the word "normalise" in more detail. Did you calculate the spatial standard deviation at each depth at each time step in the entire region south of 30S and divide temperature with the standard deviation? Or the standard deviation includes the time dimension?

l.180: I believe this term "posterior probability" is used in the Bayesian probability. If this

is the case, it would be helpful to explain what is the prior probability here.

ll.183, 190, etc. also equation (3): Is "maximum" right word here? The word "highest" (l.185) sounds more appropriate since all Gaussian are "maximum" (l.165) in the sense of minimum mode-data misfit.

l.246: By "central" and "eastern" export pathways, I interpret the former corresponds to the equatorward path around the dateline and the latter along the 120W meridian. If the "eastern" means the I-metric blob off the South America coast, more detailed explanation is needed to clarify the ambiguity.

ll.277-278: I do not understand what is meant by "correlation coefficient between G_x and x gradient." Is this the correlation between the result of G_x operator and the result of d/dx applied to the gridded PC data?

l.283: What is "*" operator? How is it defined? Convolution in space?

Equations (B4)(B5)(B6): c_n seems undefined. μ in the 1st line of (B6) should be in bold face.

Equation (B7): Is k defined?

L.450: What is w here?

Appendix A1.

(A2) and (A5) are identical. The content is very elementary and can be found in any textbook. I do not think this appendix is necessary. I found Appendix A2 is very informative.