

Ocean Sci. Discuss., referee comment RC2
<https://doi.org/10.5194/os-2021-48-RC2>, 2021
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Comment on os-2021-48

Emma Worthington (Referee)

Referee comment on "Role of air–sea fluxes and ocean surface density in the production of deep waters in the eastern subpolar gyre of the North Atlantic" by Tillys Petit et al., Ocean Sci. Discuss., <https://doi.org/10.5194/os-2021-48-RC2>, 2021

Dear editor and authors,

This interesting and well-written manuscript examines the effect of both buoyancy fluxes and the surface area of sub-polar mode water on the production of deep waters in the Iceland Basin, and makes a convincing attempt to quantify their inter-dependence. I recommend publishing the manuscript subject to minor revisions.

General comment

Overall, this manuscript is well-written, clear, and with few errors. I found the sensitivity experiment especially convincing visually but wondered if the authors had considered quantifying the results of the three experiments in some way?

I found the figures generally very good and clear, although some colourbar labels were very small.

Major comments

Figure 3: The captions and figures for (a) and (b) are mismatched - (a) is labelled Area on the x-axis but captioned buoyancy flux, and vice versa.

Minor comments

Figure 1(a): Labelling the isopycnals would help with identification. I assume that the darker shading is for greater sea surface density, but a greyscale colourbar would also help. Also, I assume that the black lines define the study domain described in lines 150--152 but stating this would be useful.

Figure 1(b): This is a nice, clear plot and the descriptive caption and colour matching with Fig. 1(a) makes it very easy to understand.

Figure 1(c): A little more description in the caption would be helpful, e.g, 'Surface area (m^2) between the 27.3 and 27.5 $kg\ m^{-3}$ isopycnals over the Iceland Basin in January'

Lines 150--160: I'd be interested to know what the area of the study domain is, and how

the surface area varies as a percentage of this domain.

Lines 164--166: Is the gyre boundary defined as the largest closed contour within a defined region?

Figure 2 (a):

- Isn't $W m^{-2}$ a unit of heat flux rather than buoyancy flux? I appreciate that it is common practice to map buoyancy flux to heat flux (see Figure 5.15 from Talley et al., 2011, see attached PDF) but if this is the case could it be stated explicitly.
- shouldn't positive heat/buoyancy flux lead to density loss (see Figure 5.15 caption)?
- The magnitudes of the buoyancy/heat flux seem very small, compared to those shown on this figure.

I understand what the plot is showing from the descriptions in the text, but I'm somewhat confused by the plot itself. Some clarification would be appreciated.

Lines 174--179: Saying buoyancy loss/gain rather than flux would be clearer.

Lines 177--201: The approach here is convincing, comparing both SPMW thickness and surface area to buoyancy forcing. I think stating an explained variance of less than 30% is fine and would strengthen the argument further, given that $R^2 = 0.27$.

Lines 201--203: It could be argued that 27% is sufficient contribution by buoyancy flux to surface density changes for them not to be regarded as independent, but I think the sensitivity experiments address this satisfactorily.

Figure 3: The (c-e) and (d-f) labels are a bit misleading, as (c-e) looks like (c, d, e) to me. I would prefer to see (c, e) and (d, f). Are these the same plots just zoomed in on the study domain and with slightly different scales? It might be helpful for the caption to say so.

Line 227: The almost inverse visual relationship of buoyancy flux and surface area variability within the study domain (Fig. 3 (e) and (f)) is interesting and supports the conclusion in 232--234.

Line 335: Isn't 'a large surface heat loss' another way of saying a large buoyancy flux? Would this suggest investigating the relationship between the buoyancy flux of the previous winter with the SPMW transformation of the current winter (i.e., a one-year lag) as an additional contributor?

Yours sincerely,

Emma Worthington

References:

Talley, L.D., Pickard, G.L., Emery, W.J. (Eds.), 2011. Descriptive physical oceanography: an introduction, 6th ed. ed. Academic Press, Amsterdam; Boston.

Please also note the supplement to this comment:

<https://os.copernicus.org/preprints/os-2021-48/os-2021-48-RC2-supplement.pdf>