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Interactive comment on "Two superimposed cold and fresh anomalies enhanced Irminger Sea deep convection in 2016–2018" *by* Patricia Zunino et al.

Anonymous Referee #2

Received and published: 25 June 2019

This paper reports on a very interesting analysis of recent Argo data in the subpolar North Atlantic. They claim that deep convection in the Irminger Sea, which began in 2015, persisted through 2018 because of favorable preconditioning. They perform some novel analyses and the findings will be of great interest to the community. However, I agree with the review posted by Femke de Jong, which raises issues with the way that mixed layers are defined in the study. This is central to the interpretation and conclusions of the study, and I think that at the very least some major re-framing of the work is necessary. I recommend this work for publication after major revisions.

Major comments

I would like to echo de Jong's comments regarding the mixed layer depth derivation. In order to show that deep convection occurred in 2016-2018, they should show that all

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properties (including temperature and salinity) were homogeneous throughout, not just that a density threshold was exceeded at a very deep depth. Regardless of the method selected by the authors in their revision they should include much more detail on it in the text as it is a central calculation. They should also be clear about how sensitive their results are to the method used and to the thresholds that are selected. They should also detail how their methods relate to the methods used by previous studies in the region.

The authors should address how sensitive their results are to the Argo float coverage, and what portion of the Argo floats present have deep mixed layers. They report how many floats have mixed layers deeper than 700m, but not how many were present. Does the percentage of floats with deep mixed layers decrease over time? The authors should comment on why they think so few Argo floats have deep mixed layers. Is it consistent with their buoyancy forcing analysis? Does the sampling in time account for some of this: i.e. Are deep mixed layers seen more commonly late in winter?

The mixed layers reported in winter 2018 are almost all to the south of Cape Farewell, and not in the Irminger Sea. Further, the TS properties in 2018 are much more similar to Labrador Sea properties than Irminger Sea properties (Figure 3). This is consistent with the SCF box properties reported in Piron et al. 2017. Some of the properties in 2016 and 2017 may also fall in that category, I don't think the author's should be calling this "Irminger Sea convection".

The author's show a very interesting analysis of Labrador Sea properties which are advected into Irminger Sea and contribute to the deepening of the Irminger Sea halocline (Figures 7 and 9). Is this advection limited to the 1200-1400 range they consider? How does advection from the Labrador Sea in other depth ranges fit in?

The title is confusing, and I wonder if, in general, the author's should shift their focus from the Irminger Sea in particular and instead focus on the important connections between the intermediate waters in the subpolar North Atlantic. I think the authors have an opportunity here to clarify that intermediate waters are formed in many places and how the connections between these basins affect intermediate water mass properties. Their focus on salinity in addition to temperature would make this angle particularly interesting.

Minor comments

The link between anthropogenic forcing and the recent convection that is drawn in the first few sentences in the abstract and throughout the introduction is a bit of a stretch. The motivation could be made more direct and convincing, and this type of speculation could remain in the discussion where it is more relevant.

L109: "for the first time to our knowledge in this region" - this is a broad claim and not necessary.

Section 3.1: Please add significant detail on the mixed layer estimation method.

L222: The 2018 profiles with deep mixed layers are not in the Irminger Sea.

L237: "Water masses formed are very similar" It should at least be acknowledged that they are formed much closer to the Labrador Sea than in previous years.

L247: maybe instead: "heat alone" at the end of this sentence.

L248: This paragraph is confusing. Perhaps referring to Figure 4 earlier on would help?

L331: "despite they were also fresher" → "despite the fact that they were also fresher"

L340: Refer to figure 6.

L348: Clarify what happened here. These floats only profiled down to 1,100m?

L351: I was also confused by the fact that the author's claim to neglect advection, but cite advection of properties from the Labrador Sea as a reason for favorable preconditioning. Perhaps remove that claim. Additionally, the fact that the T and S properties are not homogeneous goes against the idea that deep convection is occurring locally.

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L370: hydrological → hydrographic

L370: anomalies relative to what?

L383: Why would only the properties in the 1200-1400 depth range be advected? Or are they the only ones that have a profound effect? See above. Please clarify.

L415/Figure 10: Not sure how this figure and paragraph are linked to the rest of the study.

L470: hydrological → hydrographic

Figure 4: Note the differences between the axis ranges in the caption. This figure could be featured earlier as it provides important context.

Figure 5: From Figure 5d, it appears that the thick density layers are actually below the densities that are being ventilated in the Irminger Sea (white areas). This supports the idea that they are being advected from the Labrador Sea.

Figure 6: Please clarify: are you using all Argo data within the box, or only the ones with deep mixed layers?

Figure 7: This is a very interesting figure! Could feature more prominently and be used to describe some key differences between the Labrador and Irminger Seas. Reddish → red. Bluish → blue.

Figure 8: missing a) b) c) labels on the figure.

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