

Author answers to anonymous referee #1 are inserted in blue.

Anonymous Referee #1

Received and published: 12 July 2019

Dear editor,

I recommend that the manuscript be sent back for Major Revisions. The authors present and analyze unique observations of ocean properties during an open ocean polynya in the Lazarev Sea. However, the manuscript is not written very clearly and the results are presented in a confusing way. Moreover, the manuscript focuses exclusively on convection and various mixing processes but does not explore wind-driven advection, that may be constrained using reanalysis products. That is despite the fact that the title of the manuscript refers broadly to “dynamics” during the polynya. It seems that the authors do not present and test a hypothesis or a set of hypotheses about the causal chain of mechanisms that give rise to such open ocean polynyas.

Dear referee #1,

Thank you for reviewing our manuscript. We found the comments and suggestions useful, and we respond to them as indicated in our point-by-point answers below.

The aim of this work is to describe and create a temporal mixing map in the area that allows us to illustrate the ocean characteristics prior to and during the formation of the Maud Rise Polynya. Therefore, we would like to change the manuscript title to “Characterization of Ocean Mixing during the 2017 Maud Rise Polynya event”, eliminating the word dynamics.

We present our hypothesis in lines 94-98. In the next version of our manuscript, we will highlight thermobaric convection, and clarify any confusion regarding polynya dynamics.

Major issues:

1) The manuscript does not clearly present the observations and the analysis in the context of testing a hypothesis about the mechanisms behind a Polynya formation although it hints to such possible mechanisms in a very confusing manner. It seems that the authors are aware of ways in which their observations and analysis fit into the broader picture, but are not communicating this efficiently to the reader. I have not worked on the formation of open ocean polynyas, but my general understanding is that multiple processes with positive feedback mechanisms are at play, and this makes distinguishing cause and effect difficult. Could the authors' observations help disentangle the chain of events triggering and sustaining this open ocean polynya?

We are rewriting the confusing parts of the manuscript that you mentioned, and are clarifying our hypothesis to present more clearly the role of thermobaric convection in driving energy exchange at the thermal barrier. This process is just one component of the ocean preconditioning that forms part of the polynya formation puzzle. As we discuss in lines 499 – 510, wind and atmospheric effects are needed to open the polynya. Moreover, Francis et al., 2019, have confirmed that atmospheric events trigger the opening of the polynya. Therefore, we focus here on the ocean part, using rare measurements to describe the ocean preconditioning that occurs in this region.

2) The manuscript title refers broadly to dynamics but the analysis focuses exclusively on convection and mixing processes. The contemporaneous anomalies in wind-driven circulation are not given attention. Could the authors consider anomalies in the wind-driven circulation from reanalysis? Or alternatively, they could narrow down the scope of the paper, but be clear from the start that they are not fully exploring the dynamics of polynya formation.

Yes, it was a mistake to choose 'dynamics' for the title. We will change the title by deleting the word 'dynamics'. By doing this, we are not narrowing down our scope, just clarifying our focus subject: an assessment of the ocean conditions that make Maud Rise susceptible to a Polynya opening, based on a new and rare dataset.

3) The manuscript needs serious proofreading by the authors. This is not a minor issue because the text can be confusing at times. I may accept to review an updated version only if the quality

of the text is substantially improved! That is why I indicated that I am not willing to review this again.

We will check the full manuscript to make sure that the present tense is used consistently and to clarify our ideas as best we can. But we take your suggestions into account in our revision.

4) The introduction includes a broad overview but does not emphasize the important role of the halocline, the salt-stratification that allows a vertical temperature inversion (e.g., lines 59-65). Also, the introduction does not highlight differences between coastal and open ocean polynyas.

Thanks for the comments. In our introduction, we emphasize the role of the pycnocline in relation to the thermal barrier, which is why we focus on the thermocline rather than the halocline. We will rewrite this part to mention the important role of the halocline, but will give more emphasis to the thermohaline.

Minor issues:

Lines 16, 160, 163, 187, etc. You switch between present and past tense, but maybe you should stick to using present tense consistently throughout the text.

OK, we will check all tenses throughout the manuscript to check for consistency and will stick to the present tense.

Line 95 and others. You vaguely talk about “physical properties” when you can be specific that you mean density.

OK, we will check over the full manuscript and we will be more specific when we talk about physical properties.

Line 64, Line 368 and other instances – you talk about “production of sensible heat” when you mean “transport” and “release”

OK, we will change it.

Line 100 “providing” → “facilitating”

OK, we will change it.

Line 114 “within” → “during”

OK, we will change it.

Line 119 You do not have to keep the reader waiting. Briefly state what we should expect.

OK, we will add a sentence to conclude that thermobaric convection is an important driver of stability and exchange of fluxes in the thermal barrier.

Line 55 “by associated Ekman transport” – awkward phrasing

OK, we will change it.

176 “near to the surface” → “near the surface”

OK, we will change it.

Line 200. Diapycnal “diffusivity” is not “a process.” Diffusion is a process, while diffusivity is an inherent characteristic of the system.

OK, we will change it.

Section 3 title. Why do you refer to the following as “methodology?” It seems that you are doing an overview of theory.

This is the theory and steps we follow to quantify the variables in this work.

Lines 113, 137-140, 193-194, 202-206, 286, 289, 297, 325-326, 349-353, 394, 444, 450 – awkward or confusing phrasing

OK, we will rewrite this part.

Line 226 “quantified as” → “defined as”

OK, we will change it.

Line 271 expand the abbreviation ASW to explain what it stands for

OK, we will expand it.

Line 301 drop “a”

OK, we will change it.

Line 335 – if the isopycnals are steep, then there is both a lateral and a vertical component to isopycnal mixing. So I would not label diapycnal and isopycnal mixing as vertical and lateral.

The isopycnals are not steep. The isopycnals squeeze because of the steep slope of the Maud Rise in an area approx. ~100 km, to keep talking about isopycnal and diapycnal mixing.