Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2020-33-RC1, 2020

Ocean Science
Discussions
Open Access

Interactive comment on "Subsurface Initiation of Deep Convection near Maud Rise" *by* René M. van Westen and Henk A. Dijkstra

Anonymous Referee #1

Received and published: 26 June 2020

Subsurface Initiation of Deep Convection near Maud Rise by René M. van Westen and Henk A. Dijkstra

Description: Model output from a 250-year high-resolution CESM simulation is analyzed to study Maud Rise Polynyas in the simulation. The authors try to use the Maud Rise Polynyas in the simulation to explain the difference between the observed Maud Rise Polynya events in 2016 and 2017 which were triggered by intense winter storms and offer an alternative explanation which is that subsurface convection triggers a Maud Rise Polynya.

The manuscript addresses some interesting questions - what is the preconditioning and triggering mechanisms of Maud Rise polynyas? Given the observed (2016-2017) polynyas over Maud Rise, it would be interesting to know why these did not lead to

a larger Weddell Sea Polynya. One of the obvious limitations in the study is that the authors do not define what subsurface convection is and do not provide a clear justification for using the Convective Available Potential Energy (CAPE) to indicate the onset of convective overturning in the Weddell Sea. They also do not investigate several previously suggested significant preconditioning processes that are relevant to the Maud Rise and the Weddell Sea, including the size of the sub-surface heat reservoir created by accumulation of Warm Deep Water, the strength of the Taylor column associated with the Maud Rise seamount, the strength of the impinging flow, and surface salinity anomalies. While I think this is an interesting problem, and the authors have looked into some of the possible processes, I am not convinced by the robustness of the results and do not suggest publishing at this time. There is a lot of inconsistency in the way the authors define Convective Available Potential Energy (CAPE) and also use results by Su et al (2016) to justify that CAPE indicates the onset of convection.

Reviewer Decision: I do not recommend publishing the article.

Major Issues:

1. In section 3.1, the authors show the accumulation of subsurface heat and salt prior to the onset of the polynyas but fail to relate it to the heat and salt content of a warm and salty water mass known as the Weddell Deep Water (WDW) which lies between 250-1500m in the Weddell Sea. A necessary but not sufficient condition for long-lasting, consecutive winter polynyas to occur is the heat reservoir at depth or the heat content of WDW (Martinson et al. 1981; Martin et al. 2013; Cheon et al. 2015; Dufour et al. 2017; Kurtakoti et al. 2018). If the main result in the paper is that the convection is initiated subsurface, a thorough and robust analysis of the stratification and water masses in and around Maud Rise is critical to the authors' justification and the readers' understanding.

2. Please define what is subsurface convection. How is it triggered and how is it maintained? Is this convection that only occurs within the WDW and if so how is it

initiated and how is this sustained?

3. One of the major scientific weaknesses of this study is the context in which CAPE is used. Ocean CAPE is defined for an ocean column as the maximal Potential Energy that can be released by adiabatic vertical parcel rearrangements, arising from thermobaricity (Su et al. 2016a,b). However, that alone does not indicate the onset of deep convection. Fig 3a. is used to indicate the onset of subsurface convection in early- mid July which is not accurate. Fig 3c clearly shows that the subsurface pattern repeats itself in the 2 years prior to the formation of the polynyas. This only indicated weakening subsurface stratification and not the onset of subsurface convection which is consistent with the accumulation of WDW heat content. If we could also see the Hovmöller of Temperature and Salinity time series that overlaps the time periods used in 3a and 3c, we can then confidently know for sure if convection does begin in the subsurface as claimed by the authors.

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