Interactive comment on "A model for the Artic mixed layer circulation under a melted lead: Implications on the near-surface temperature maximum formation" *by* Alberto Alvarez

Anonymous Referee #2

Received and published: 23 February 2021

This paper presents an idealized simulation of ice-ocean interactions within a lead, with focus on the fluid dynamics below the ice. The study finds the daily generation of convection cells in response to shortwave-driven sea ice melt. I find the approach and results interesting and worthy of publication, but there are a number of issues related to the presentation of the study and the approach that I feel need to be addressed first.

Major

Introduction: -The introduction includes a very nice discussion of observational studies on leads, but what about other numerical studies? Ramudu et al., 2018 discusses NSTM specifically and might be a good starting point, but I imagine there are many

other numerical/fluid dynamics studies. -There is a very nice and thorough discussion of the seasonal evolution in a lead, but then the study focuses on the diurnal cycle. I suggest the author motivate this choice and perhaps focus the discussion on the time of year he is focusing on. -L68: The objective is stated here but it is very broad. Possible to be more specific on the question that is answered ? -It is mentioned in the methods that the ice will be assumed as motionless. This is okay but really needs to be stated up front that you are *only* considering thermodynamic drivers from sea ice melt/formation. This needs to be properly motivated in the introduction too.

Methodology: The NSTM seems like an important part of the research question (and is stated in the title). As far as I know, NSTM is mainly discussed in the context of the Canada Basin (and the references in the intro are all for the Canada Basin too). So why is the initial profile used from the Eurasian Basin? The Canada Basin is fresher, has a shallower mixed layer, and has a stronger halocline that is closer to the surface. This will likely change a lot. I strongly suggest the author consider downloading observations from a few ITPs in the Canada Basin, get a sense of what the halocline looks like there, and go from there. Alternatively, they could hunt for a representative profile in papers like Toole et al., 2010; Jackson et al., 2010; Timmermans 2015.

Results: -Validation: Once the model is spun up, are the T,S profiles still realistic? I think this needs to be included somewhere to know if we can trust the analysis that follows. -Sensitivity to parameters: How sensitive are the results to the choice of initial conditions and other parameters? One particularly interesting question that might be worth looking into is the sensitivity of the convection cells to the initial stratification (observations indicate that this is changing and having an impact on NSTM).

Minor

L39: heat flux from the ocean and the atmosphere? L40: although → even though? Despite? L45: Earlier studies that showed this: Morison 1978, Lemke 1983 L46: progress → progresses L46: to → and? L47: "Leads constitute then" ? L49: Add

comma after "In addition: L57: Maybe add Timmermans 2015 too L78: What is meant by lead spacing *below* 500m? Fig 1: What is meant by "ground values"? Fig 2: How do you choose what time periods to use (a-f), and what time of the year to use? L148-149: What is Qm exactly? It just says its "the linear relationship found by Perovich." But what is the equation? Fig. 6: Add legend for the colors. Please also add time of day/ heat flux in corner of each panel so we don't have to flip back to Figure 2. Fig. 7: How are the bulk coordinates and characteristic sizes defined? Average? Note: There appeared to be many grammatical errors/typos, I do not list them all here.