

## **Comments on *Direct measurement of warm Atlantic Intermediate water close to the grounding line of Nioghalvfjerdingsfjorden (79N) Glacier, North-east Greenland***

### **Global statement**

Interesting and timely results of Atlantic water close to the grounding line of 79N. I think this manuscript should be accepted after the comments of the two reviewers are addressed. I also have some minor comments that I believe would improve the manuscript.

***Many thanks for taking the time to look at this manuscript, and for your positive introductory comments. We address your specific comments and suggestions below.***

### **General comments**

Neither An et al. (2021), Lindeman et al. (2020), Mayer et al. (2018) or von Albedyl et al. (2021) present a full map of the ice shelf (glacier tongue) thickness. I feel since you are already using ArcticDEM for areas near the epishelf lake, you could present an ice thickness contour map of the ice shelf. That would not be too much work if you already have the grounded ArcticDEM data. Maybe that would help explain the weird circulation pattern outflowing through Dijnphna Sund.

***We will add a map of ice shelf thickness to Fig 1.***

I did not see any discussion about subglacial discharge. I think it is warranted to at least briefly discuss why it is not relevant in this study. You are really close to the grounding line and your CTDs are taken in summer, this is prime location and timing to see subglacial discharge. You mention that a “simple plume model would account for the thinning [...]”. Subglacial discharge is sometimes included in these plume models, maybe that’s a place to emphasize subglacial discharge does not matter so much in this case.

***See response to reviewer #1 where we note we will add an explanation of the different freshwater inputs to the lake***

I agree with reviewer 1 comment that using “water mass” is misleading.

I would add a few sentences on why “water mass 2” in the eastern basin is fresher than “water mass 3” in the Western basin. Isn’t the eastern basin more connected to the ocean than the western basin?

***See response to Reviewer 1 on the ‘layers’ or ‘masses’ point.***

### **Edits**

L36: “Unlike many other sectors of the Greenland Ice Sheet, NEGIS and the ice shelves that front it exhibited little response to atmospheric and oceanic warming for the decades immediately prior to the mid 2000s.” Maybe add the citation(s) to this statement directly at the end here instead of after the next sentence.

### **OK**

L46: “NEGIS flows at ~1200 m a-1 and upstream from the 79N Glacier grounding line (~600 m below sea-level) the basin floor deepens to ~1000 mbsl (Bamber et al., 2013)”. Is that velocity at the grounding line of 79N? Maybe divide this sentence in two, one about the velocity (with where the

1200 m a-1 velocity is taken) and one about the bathymetry.

**OK**

L56: "Humbert et al (submitted) also identify a recent shift in calving style and fracturing at the calving front of 79N Glacier." A shift from which style to which style? Maybe also add a sentence on the implications of this statement.

**OK**

L59: "Based on the rapid decrease in thickness of the ice shelf, to only 330 m within 5 km of the 79N Glacier grounding line ,..." To 330 m, ok, but from what thickness?

**Will be clarified by inclusion of along fjord profile in Fig 1**

L69: "There is only one measurement of AIW in the cavity, where it has been detected in a rift in the 79N ice tongue, located ~10 km behind the calving front" When was this measurement? Is this from the ITP? If so make this clearer.

**OK**

L96: "groundling" [typo]

**OK**

L98: "If AIW is circulating throughout the cavity beneath the floating portion of the 79N Glacier then this should have profound consequences for stability of the grounding line (An et al., 2021) and the ice shelf." Change "floating portion" by ice shelf or glacier tongue and be consistent throughout the paper, i.e. no alternating between both.

**See response to reviewer #1 on use of ice shelf.**

L112: "Where a source of freshwater feeds into the lake [add coma] a salinity-driven stratification forms with the more saline marine layer capped by a freshwater layer."

**OK.**

L138: "As part of a wider programme to characterise and sample water and sediments in Blåsø, to understand past changes in the 79N Glacier, the bathymetry of the lake was mapped and multiple CTD profiles were measured in different parts of the lake." Sluggish, maybe break into two sentences?

**OK**

L146: While at it, what's the sampling rate of the CTD and how fast was it lowered? How was the data averaged/binned?

**We will note these details.**

L175: Partially out of personal interest, but likely relevant to many others: did you compare bedmachine3 to your CHIRP survey? If so, one or two sentences on the comparison would definitely be relevant.

**Only where they intersect in Fig 5. The comparison of Fig 5 with the radar profiles can show that – at least close to the eastern entrance to Blaso - Bedmachine is not correct.**

L208-211: Use either just CTD or just CTD profile or water profiles, but be consistent.

**OK**

L227: "During bathymetric and CTD surveys [add coma] we observed ..."

**OK**

L308: "It is more likely that the difference is caused by internal waves which can be created where tidal currents drive water parcels, especially, on steep slopes (Munk and Warren, 1981)". You mean baroclinic tides? Any evidence of baroclinic tides in the ITM or other moorings record? This is a pretty big density jump, 5 m internal waves would be quite impressive. Could it be just that what you call water mass 2 is draining away? (making its way out through cracks and channel). Seasonal cycles of deepening and shoaling have been reported in Milne Fiord epishelf lake (Hamilton 2017, Bonneau 2021).

**See response to Reviewers #1 and #2 where we note we will include an expanded discussion on the potential explanations for the difference between CTD5 and 8. Thanks for the references.**

L316: Again, possible internal waves, but I would not conclude it is without a doubt based on two CTD profiles. High frequency internal waves in Milne Fiord epishelf lake have a maximum amplitude of 15 cm and a period of 50 min.

**See above.**

Figure 1A: Would it be possible to add some bathy contours from bedmachine3? Need a scale for the velocity arrows.

**We think this is beyond the dataset but will include an along-fjord profile**

Figure 1B: I think you have enough data to generate a decent bathy map of the lake. It would be nice see that. And overlay the data points?

**We do not think that we have sufficient spatial sampling to do this robustly and it risks generating spurious bathymetric features, highly dependent on kriging/interpolation methodology.**

Figure 3, 4: You say you are using conservative temperature and absolute salinity. These should be your labels.

**OK**

Figure 4: Are the dots your CTD data points and the lines just link the data points? If so I would remove the lines and make the markers a little larger, as it is usually done on T/S diagram.

**We will expand symbol size but we will keep the lines: they are helpful to show the depth relationship visually in T-S space and to separate the different profiles.**

Figure 5D: Check y axis, something is wrong.

**We will correct -100 and -200 m depth markers.**

Table 1: Not sure it brings something to the paper, could easily do without.

**We think these are important to show where the CTDs were taken.**