Reviewer 1 Marek Stibal

In this paper McCerery et many al sampled proglacial icings and accreted ice in the forefield of Isunnguata Sermia in SW Greenland to get an insight into their formations and the dynamics of the glacier's hydrological system. Using geophysical surveys they show water flow saturated sediment in the subsurface, feeding proglacial upwellings. Geochemical analysis revealed differences between the icings and accreted ice, suggesting different origins. Based on their results the authors contend that the icings are formed from winter discharge through both top-down and bottom-up processes, while the accreted ice features are the result of summertime upwelling of pressurised water. Given the importance of this site as a representative large catchment of the W GrIS these data and their interpretation are extremely interesting and useful for understanding the hydrological system of the ice sheet and can (and will) inform future research in the area and on the GrIS in general.

We thank the reviewer for taking the time to read and review our manuscript, and for their kind words on our work.

208-220 Please give your limits of detection and precisions and accuracies for your chemical analyses.

We have updated the methods section to include the LODs and precision percentages. *"Limits of detection (LOD) for both instruments was determined by standard regression on the intercept of the calibration curve and measured 0.02 mg L-1. Analytical precision was assessed as the relative standard deviation (RSD %) of triplicate measurements for each sample. RSD was below 3% for all analytes and across all run days for the ICP-OES and the IC, indicating good analytical reproducibility."*

Is there a way to quantify the uncertainty of your charge balance estimations of HCO_3^-?

The uncertainty of HCO_3^- is inherently tied to the propagated uncertainties of the measured cation and anion concentrations. We could add a statement noting that HCO_3^- values carry an uncertainty derived from the combined analytical uncertainties of all measured ions. *"HCO3- was then calculated using the charge balance error (CBE) method, where ε+ and ε - are total cation and anion equivalents. Uncertainty in HCO3- concentrations is derived from uncertainties of all measured cation and anion concentrations."*

Do you know the concentration of phosphate?

Phosphate was not reliably detected in any of our samples using our instruments. Given the low-nutrient glacial environment sampled, phosphate concentrations were expected to be at or below detection limits.

Did you measure TSS (particulates) at all?

TSS was not measured in this study; our sampling protocol focused on dissolved constituents following filtration through 0.45 µm membranes, meaning particulate material was not retained for analysis. We acknowledge this as a limitation of the current dataset, and therefore we can't comment on sediment transport and loading across the seasonal hydrological transitions.

263-271 Any idea what this yellow water was?

We assume this water has originated from a large upwelling eruption nearby, as its colour is distinctly similar to the sub-naled waters we sampled. This is an important observation, and we now discuss this further in the discussion section: *"Automatic camera footage in Figure 5 shows that naledi can also be built from unconfined waters, as ice layers accumulate from overland water flow (beside upwellings) and from local precipitation such as the snow event captured in the automatic cameras*

(Fig. 13). The cameras also captured the incorporation of yellow coloured waters originating off-camera. Due to the colour similarity with the waters collected below naled structures, we believe this overland flow originated from a large upwelling of overwinter waters at a nearby naled location. These camera-derived observations, combined with geochemical analysis help to explain some of the unique ice facies we observed in the naled ice cores."

Figures 7-9 Would it be possible to integrate the two bars (total ions and ion proportions) into one to make the differences between samples/layers clearer?

We thank the reviewer for this suggestion. We considered integrating the two panels into a single stacked bar chart, however, the wide range of TDS values across samples (~1 to 1,300 mg L^{-1}) would mean the bar heights on the low TDS samples would be so small relative to high-TDS samples that the ion proportion fills would become too difficult to see.

Figure 13 Is the subsurface water flow constrained by permafrost? I.e., is the depth of it determined by the permafrost table and/or distribution?

It is difficult to say with certainty either way. We've included the permafrost layer in our figure because it's an important feature of this system, but whether or not it contributes to the depth of the subsurface water flow is unknown.

555-557 If the accreted ice features were formed quickly during outburst events, could the samples be used as representatives of those outbursts? I would then expect them to contain more sediment than 'normal' accreted ice that forms during the melt season around the upwelling. Also, as per Livingstone et al 2026 JGlac I understand the October 2023 outburst was linked to lake drainage (primarily of an ice-marginal lake but potentially also secondarily of subglacial lakes)? Could the sediment in these features then be expected to come from these lakes?

Firstly, we agree that the accreted ice structures, given their inferred rapid formation during high-discharge outburst events, could serve as geochemical snapshots of those outbursts.

Secondly, regarding sediment content, we note that the accreted ice cores are indeed heavily sediment-laden relative to the naled ice, however, we did not see any differences in sediment content between the accreted cores. Lake-sourced sediments could plausibly contribute to the sediment load in accreted ice formed during such events as well. However, our dataset does not include sediment grain size analysis, so we cannot confirm or exclude a lake sediment source from our data alone. This would make for some interesting further investigations.

607 the correct year for this reference is 2026

Thank you for highlighting this. We will correct this.

Reviewer 2 Anonymous

There is much to like in this paper. First and foremost, there is not a sufficient literature on the types of physical, chemical and, perhaps, biological information that becomes stored in aufeis or naledi, and how this compares with that stored in icings. Second, there is precious little of this information on Greenlandic naledi/icings. Third, the interpretation of these data is far from straightforward, and it is great to see photogrammetry and water isotopes being used to help identify the processes controlling the accumulation of the ice and the chemicals stored in them. Overall, I am very supportive of the paper, but you know that the gripes always follow statements of reviewer's support.

We thank the reviewer for taking the time to read and review our manuscript, and for their kind words on our work. We have taken all of their comments on board and have responded in turn below.

1. Meltwater solute fluxes……. You simply cannot say you are contributing to studies of meltwater fluxes without quantifying the amount of solute stored in these types of ice relative to that exported in the meltwater over the rest of the melt season. A FLUX has fundamental units of mass per unit time, and often in meltwater solute studies, it becomes equivalent to concentration x discharge, summed over a period that is often a year. This work presents concentrations, period, and does not contribute to solute flux studies unless more quantitative analysis is included.

2. Nutrient fluxes…….. The same argument, but much worse. Only nitrate is measured, and although the figures purport to show nitrate concentrations, these are super difficult to make out. I'm comfortable that you say that this work could contribute to such studies, but not given the analysis you have provided. We've measured some big concentrations is not enough. Big concentrations in a small puddle of ice, relative to the small fjord that discharges from the ice sheet each year, does not necessarily sum up to a major contribution of solute and nutrient overall. My hunch is that if you can find a contribution of above a percent you will have done very well.

We thank the Reviewer for highlighting the two points above regarding fluxes, and we have reworded the manuscript throughout to ensure we are only referring to concentrations and solutes. What we detected here is orders of magnitude differences in solute concentrations between summer and winter icings, which is currently not considered when making geochemical inferences on weathering cycles and their downstream impacts on ecosystems. We focus on this in the discussion and conclusions section of the manuscript as follows: "Geochemical differences in ice samples also raise important questions for solute and nutrient release from the Greenland Ice Sheet. With pronounced peaks in TDS detected in the overwinter naled waters, year-round analyses of glacial waters are critical for capturing the full extent of foreland water flow and the impact of these waters on downstream ecosystems, particularly at the release of these solute-rich waters during the initial onset of the melt season. The seasonal changes in geochemistry we observe suggest that solute export in winter may be under-represented in existing literature, which should be considered for a thorough understanding of biogeochemical processes and wider ecosystem effects downstream (Hawkings et al., 2026)."

"These seasonal changes drive different geochemical outputs from the Greenland Ice Sheet. Our observations demonstrate the importance of seasonality in solute availability and show the importance of measuring glacier meltwater contributions to proglacial groundwater systems and downstream ecosystems over longer study intervals."

3. Overwinter fluxes of solutes and nutrients…… but you suggest that the solute is all retained in your frozen water. How does this get to the oceans?

The Reviewer is correct, we suggest that overwinter, all of this solute-rich water is stored in the naled icings and/or moving very slowly through the subsurface hydrological system. However, at the onset of the melt season this stored water will be mobilised, resulting in a pulse of solute-rich waters before the dilute summer melt enters the system. We have clarified this in the discussion section of the manuscript.

"With pronounced peaks in TDS detected in the overwinter naled waters, year-round analyses of glacial waters are critical for capturing the full extent of foreland water flow and the impact of these waters on downstream ecosystems, particularly at the release of these solute-rich waters during the initial onset of the melt season."

4. Flash freezing in icings shouldn't give you much of a chemical gradient in the ice overall (or does it?), in terms of vertical stratification in the ice and along the freezing water sheet. In principle, the di-valent carbonates will precipitate out first, then CaSO4 and then most soluble sulphates that contain monovalent ions and the nitrates and chlorides. Have to check the spatial variation of the icing chemistry to check for this patterning that is found in Svalbard? In principle, the waters should

become more concentrated and have a very different chemistry as they flow away from their source, so complicating your interpretation of subglacial/supraglacial chemistries.

The Reviewer is right, the flash freezing of summer icings shows no chemical gradient at all with consistent solute concentrations and isotopic signatures throughout all of the cores we collected here. In our naled samples we don't hypothesise flash freezing to occur, but we do present 'water packages' where there are some chemical and isotopic shifts within the cores but we base this on the isotope signature as opposed to the geochemical differences.

5. This pattern too should be found in your aufeis. You claim top down and bottom up freezing and it is unclear how much lateral water is occurring when this occurs. In principle, the first formed ice should be dilute (and so may not be supraglacial water), think of the purification of water by freezing, and you should get successive chemical layers building up that might be thick enough to measure these differences if there was an initial water column containing sufficient solute and sufficiently thick. Lateral flow of water during freezing can also give rise to an initial carbonate rich chemistry that evolves into a more sulphate rich chemistry. I think you need to acknowledge these types of caveats when you are claiming that the ice chemistry translates simply to subglacial water chemistry. It is very unlikely to unless there was a static water body that completely froze and through which you have sampled all the ice, from the initial dilute ice through to the last concentrated ice, without bias.

In our models we present the incorporation of 'other' sources of water to ice structures, whether that be from supraglacial, englacial or other overland flow sources.

I remain a big fan of the paper. Someone has to go out there and get the data, come up with the ideas and form a case for doing more work. I think you've done a good job overall.

We would like to thank both Reviewers again for taking the time to read and provide comment on our manuscript and we hope we have been able to clarify some of our interpretations.