Review Comments

General Comments

This manuscript presents glaciological observations conducted from the coast to the inland areas of Prudhoe Land, located in the northwestern Greenland Ice Sheet. The primary objective of the study is to enhance understanding of water and aerosol circulation in the North Water (NOW) region. Using surface snow and snow pit samples, the study investigates variations in water isotopic composition and ionic species concentrations. This research is a valuable preliminary step toward reconstructing past environmental changes in the NOW region using ice cores. A better understanding of historical environmental changes in this area is expected to improve future projections of marine environmental shifts in the region.

However, several aspects of the study's results require further consideration.

First, data from the ST9 snow pit indicate evidence of summer surface snowmelt. Such melting processes hinder the preservation of proxy records and introduce uncertainty in age-dating. As discussed in the manuscript (lines 164–165), water isotope records tend to become smoothed, and ion concentrations are altered due to refreezing of meltwater. Therefore, the interpretation of vertical variations in proxy concentrations should account for these site-specific characteristics.

Particularly in Section 3.2 ("Spatial and temporal variations in water isotopes and chemical species"), the interpretation of ST9 data should reflect the impact of summer melt on concentration variability.

The seasonal classification such as spring–summer vs. autumn–winter should be used consistently, and the discussion of concentration variability should be supported by statistical criteria due to no clear variability of proxies. For example, it is recommended to define peaks using either values above the mean or above the mean plus one standard deviation.

Second, additional evidence is required to substantiate some of the manuscript’s interpretations. For example, to support the discussion on atmospheric transport, the inclusion of backward trajectory modeling (e.g., frequency maps and cluster analyses) is recommended as supplementary information to identify source regions and air mass pathways.

Specific Comments

Introduction

- Lines 44–70: The necessity of studying past environmental changes in the NOW region is well presented. However, further explanation is needed on how the current study site differs from the nearby SIGMA-A site, especially in terms of meteorological conditions like prevailing wind directions.
- Line 68–69: Rephrase for clarity.

Methods

- Lines 104–105: Add information in the Supplementary Information regarding the design and cleaning procedures of the pre-cleaned stainless-steel tools used for snow pit sampling. Clarify the cleanliness specification of the Whirl-Pak polyethylene bags (e.g., part number, manufacturer).
- Because sample depth resolution varies (2 cm, 3 cm, 5–10 cm), figures such as Figure 4 should adopt a step-wise format for clarity, not dot and line format.
- Line 112: Provide details about possible contamination during snow sample melting and bottling. if possible, field blank should be provided.
- Line 117: Include specifications of the analytical column (e.g., length, diameter), model/manufacturer of standard materials, and detection limits for each ion.
- Line 122: Specify the standard material used for stable water isotope analysis.

Results and Discussion

- Line 139: Present snow density alongside depth.
- Lines 143–144: Ice layers below 0.96 m in the ST9 snowpack suggest summer melting, which may affect proxy preservation. This is appropriately and kindly described in lines 163–168.
- Line 172: Calculate annual accumulation rates using snow density for each depth interval and present average values.
- Line 183: Indicate the MSA detection limit as a line in Figure 4. Clarify dating below 3.4 m at ST9 (the conclusion mentions dating down to 4.5 m).
- Line 188: Include NO_3^- data.
- Line 196: Use nss-Ca^{2+} to interpret dust transport. Since nss-K^+ and nss-Mg^{2+} mostly show negative values, suggesting major marine influence, omit these from discussion and Table 1.
- Lines 197–209: Explain shortly the notable difference in $\delta^{18}O$ between the upper layer (0–0.7 m) and the deeper layer.
- Line 201: Present backward trajectory modeling results to support atmospheric transport path interpretations.
- Line 216: Interpretation in Figure 6c should align with the seasonal framework in Figure 6b.
- Lines 222, 232: Revise for clarity.
- Line 239: Provide supporting data for air mass transport.

- Line 278: Explain nitrate concentration increases due to melting/refreezing. if possible, explain shortly or provide references. Revise “positive peaks” to just “peaks.”
- Table 1: Replace nss-K^+ with K^+ and nss-Mg^{2+} with Mg^{2+} data.
-

Conclusion

- Avoid repeating earlier content. Summarize only the most significant findings and implications.