

Manuscript: Circulation timescales of Atlantic Water in the Arctic Ocean determined from anthropogenic radionuclides

Response to RC1

(comment posted 04 June 2025, commented pdf of the manuscript)

Dear RC1,

Thank you for your review and helpful suggestions.

This response letter includes responses to the comments in the pdf and the corresponding changes made to the manuscript. We would like to point out that following the suggestions by RC2, the manuscript has been substantially restructured and large parts have been moved from the discussion to the introduction, methods, or results part. Furthermore, figures and corresponding text have been changed to refer to practical salinity instead of absolute salinity throughout the manuscript.

On behalf of all co-authors,

Anne-Marie Wefing

Note: Reviewer comments in black (lines refer to the original manuscript), response in blue

This study represents an important contribution to our understanding of Atlantic Water distribution and circulation in a region marked by the complex confluence of multiple water masses. The scientific approach is robust, and the organization of material and quality of figures are both excellent. Most of my comments are stylistic in nature, with a few minor typographical corrections.

Introduction: several references suggested

We thank the reviewer for suggesting many helpful references. The references in the introduction have been revised and several have been added. Note that the introduction has been partly rewritten following suggestions from RC2.

Line 100: suggested to add the Lincoln Sea in Figure 1. Has been added.

Line 221: typo has been corrected.

Line 224: “Considering” has been substituted by “At”

Line 228-229: has been changed to "Above 100 m, the decline in I-129 and U-236 in Section 2 (left half of the section) was clearly evident and coincided with a decrease in

practical salinity from around 32.5 g kg⁻¹ to around 30.5 g kg⁻¹ at 50 m depth.” as suggested.

Lines 235-237: temperature values and differences have been included and the sentence has been changed to: “PSW from Section 2 had slightly higher temperatures (difference around 0.5°C) compared to Section 1, for salinities above 32 (see also Section 4.2). In AAW and below, the opposite was observed, with Section 1 stations showing higher temperatures (difference up to 1°C) compared to Section 2 (Fig. 5b). Highest AAW temperatures of about 1.5°C (conservative temperature) were observed at station 5 in the Nansen Basin, closest to the Atlantic Water inflow region.”

Lines 244-245: stylistic suggestions have been incorporated.

Line 253: concentrations range has been added and stylistic suggestions incorporated.

Line 263: the range of differences has been stated.

Line 266: sentence has been changed to “Along Section 2, [...]” as suggested.

Line 279: To me “Atlantic Water Circulation” feels little narrow given the scope of the subsections. Suggesting changing 4.1 title to something more broad in scope (Arctic Ocean Water Mass Circulation in 2021, Water Mass Provenance? Pathways, and Ventilation Timescales in 202

Following the suggestions by RC2, the results and discussion sections have been restructured and titles have been changed accordingly.

Line 301: sentence has been removed and the discussion about the Nansen Basin has been integrated with section 4.1

Lines 304-305: see comment above. The publication year has been added to Perez-Tribouillier et al. (2025).

Line 313: sentence has been removed and the global fallout tracer signal has been included in section 2.2 instead.

Line 315: has been changed to “... meteoric water (net precipitation and river runoff) ...” as suggested.

Line 317-320: stylistic suggestions have been incorporated, suggested references have been added.

Line 321: consider adding depth level (e.g. highest in the upper x meters) and spatial distribution

Has been added, the sentence now reads: “Meteoric water fractions were up to 0.12, highest in the upper 50m in the Amundsen and Makarov Basins.”

Line 326: “Consider being consistent in the use of either fractions or percentages when discussing water mass composition. I realize this is a pedantic point—apologies”

Thank you for pointing that out, we now report the results of fractions instead of percentages.

Line 326: “consider adding a note on brine rejection (negative SIM)”

Has been added in line 417.

Lines 329-331: sentence has been changed to “Pacific Water fractions have been estimated using various parameters (e.g., silicate, nutrient ratios, gallium), each with its own strengths and limitations. These methods remain debated and carry large uncertainties (e.g., Alkire et al., 2015, 2019; Whitmore et al., 2020), however, they still serve for an overview of the spatial distribution of Pacific Waters across the sampling area.” as suggested.

Line 332: values have been added as suggested.

Line 337: uncertainty levels have been added.

Lines 352-355: This has been rephrased and moved to section 3.3.

Lines 357-359: sentence has been changed to “... which in the Eurasian Basin is formed through repeated winter convection cycles north of the Barents Sea, as well as by advection of low-salinity shelf water, primarily from the Laptev Sea ...” as suggested.

Line 362: reference Anderson et al. 1994 has been added

Line 369: sentence has been changed to “Based on I129 and U236, we conclude that...”

Line 372: has been changed to “large variability” as suggested.

Lines 376-377: this has been rewritten and mentioned in the methods already.

Line 381: might be helpful to specify this refers to the boundary current flow ie along the continental slope.

This has been specified (line 544).

Lines 389-390: sentence has been changed to “The TTD parameters Γ and Δ , the Δ/Γ ratio, and the mode age t_{mode} derived for SAS21 and JOIS 2020 (Canada Basin) are presented in Fig. 7.” (line 340-341).

Line 421: stylistic suggestions have been incorporated (line 350).

Lines 430-432: sentence has been simplified to: “Samples from station 46 (dark red) plotted close to or directly on the mixing lines.” (line 354-355).

Line 434: has been changed to “(Eq. (4))” according to journal convention.

Line 436: consider moving this sentence up to where you introduce the bimodal TTD.

Sentence has been moved to subsection 2.5.

Lines 439-446: this part has been rewritten and partly moved to subsection 3.4.

Lines 454-456: sentence has been simplified to “The I129 distribution in surface waters (approximately 10-30 m, depending on sample availability) was characterized by higher concentrations in the Amundsen Basin compared to the Makarov Basin and north of Greenland (Fig. 9a).” as suggested.

Line 464: stylistic suggestion has been incorporated.

Line 495: "ongoing shift" might suggest that the AW/PW front continued advancing into the EB but the following sentence clarifies that it remained stable. Maybe: the front has not regressed back towards the Mendeleev Rise..

Sentence has been changed to “Our analysis of I129 concentrations between 2011 and 2021 indicated that the position of the front still changed between 2011 and 2015, but remained stable between 2015 and 2021”.

Line 498: maybe TPD should be briefly described here on in the intro

The TPD is now introduced in section 1.2.

Lines 530-531: parts of this section have been moved to the introduction and rewritten.

Line 546: has been changed to study region.

Line 563: “lateral” has been added as suggested.

Lines 732-733: check out <https://doi.org/10.1175/JPO-D-20-0190.1>

Thank you for the suggestion. The reference to Morison et al. 2021 was included in section 1.1 and 1.3, about the relation between a strong boundary current and a positive AO index.