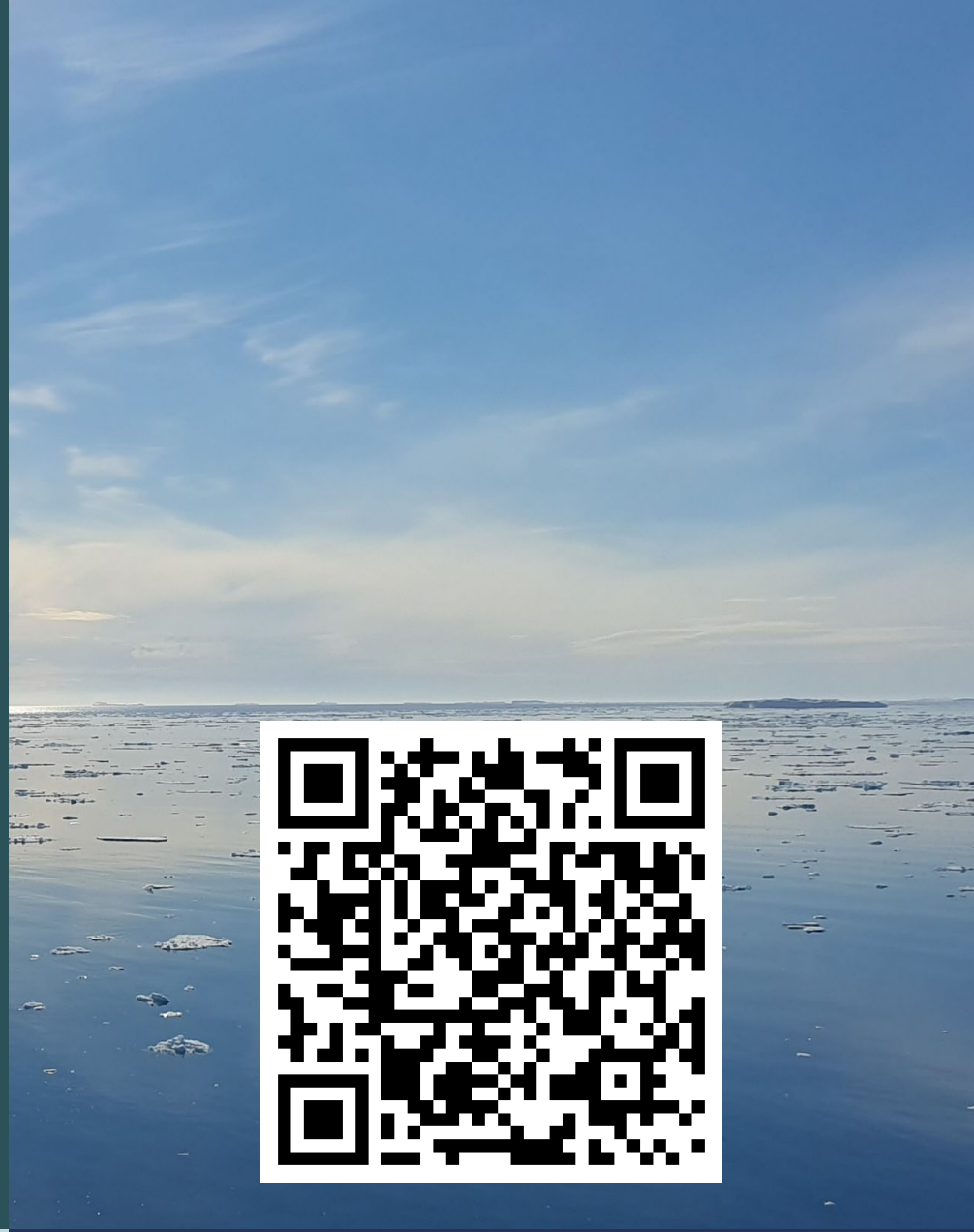
Changes in water mass composition and circulation in the central Arctic Ocean between 2011 and 2021 inferred from tracer observations

A.-M. Wefing, A. Payne, M. Scheiwiller, C. Vockenhuber, M. Christl, T. Tanhua, N. Casacuberta

EGU 2026 General Assembly



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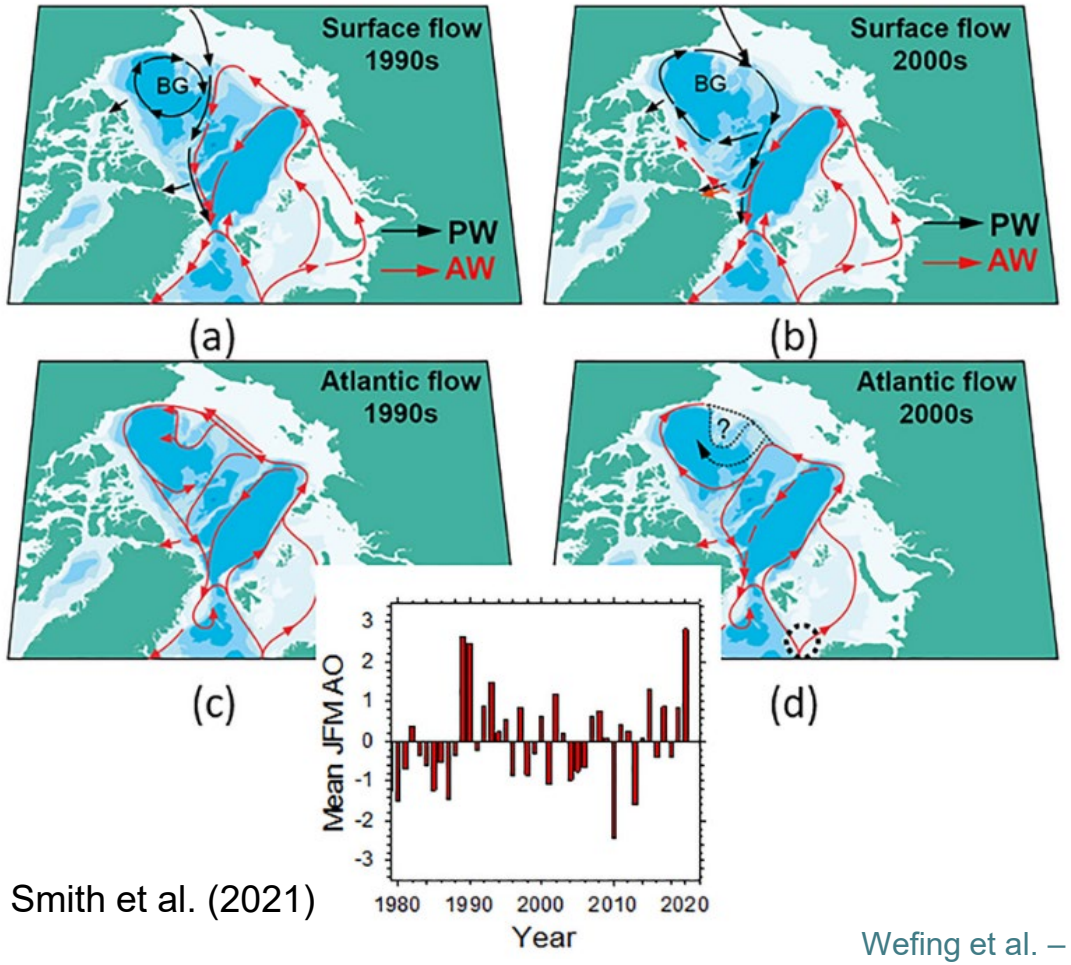
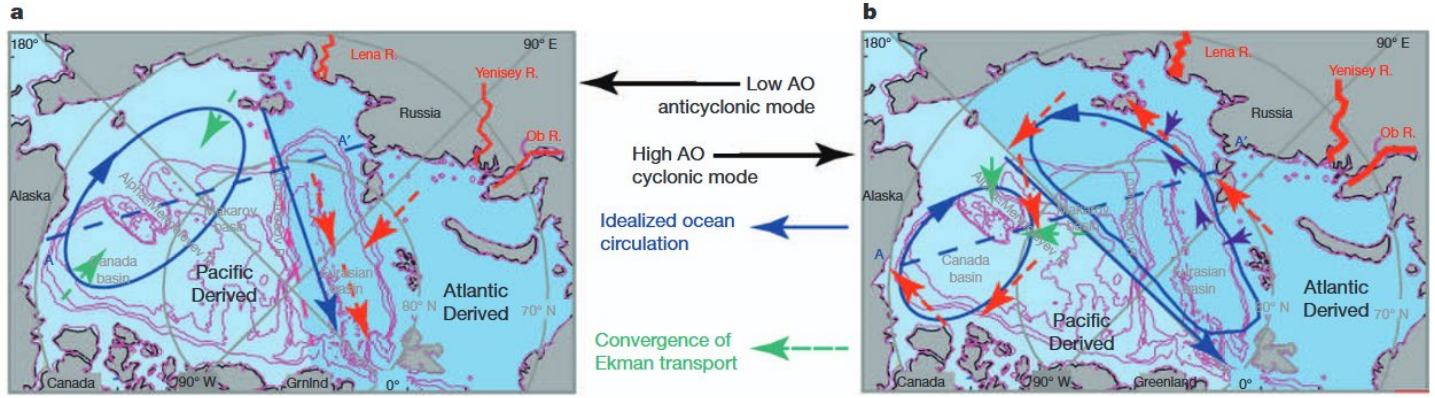
Wefing et al. (2025)
doi.org/10.5194/os-21-3311-2025

Circulation changes in the central Arctic Ocean?



Smith et al. (2021)

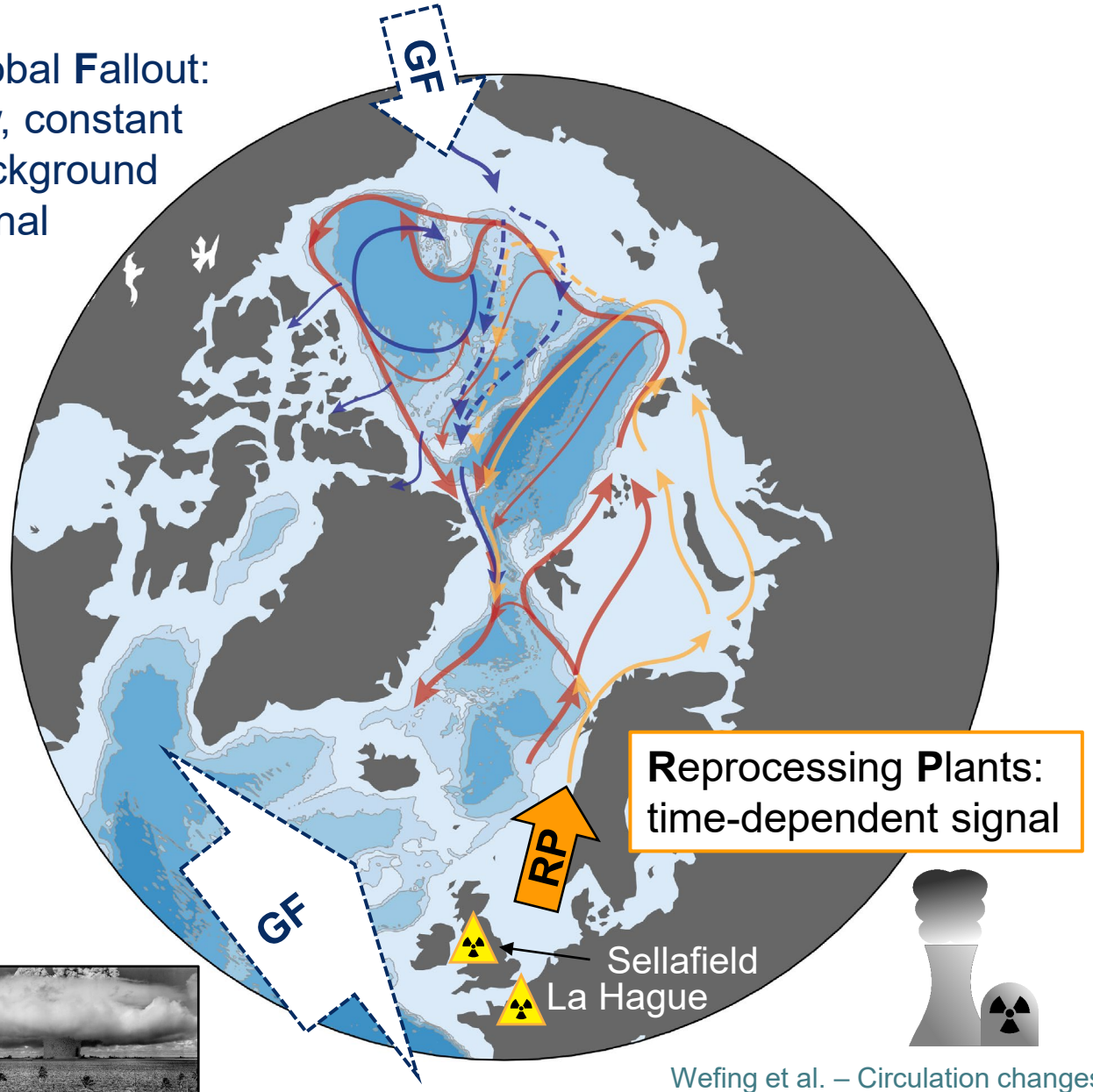


Morison et al. (2012)

- Surface layer circulation pattern in the Arctic Ocean is influenced by state of Arctic Oscillation (Morison et al., 2012)
- Large-scale circulation changes of surface waters and in the Atlantic layer occurred during shift of Arctic Oscillation state between 1990s and 2015 (Smith et al., 2021)
- Ventilation tracers showed an increase in mean ages in the intermediate layer of the Amundsen Basin between 2005 and 2021 (Gerke et al., 2024)

Tracers: Anthropogenic radionuclides I-129 & U-236

Global **F**allout: low, constant background signal

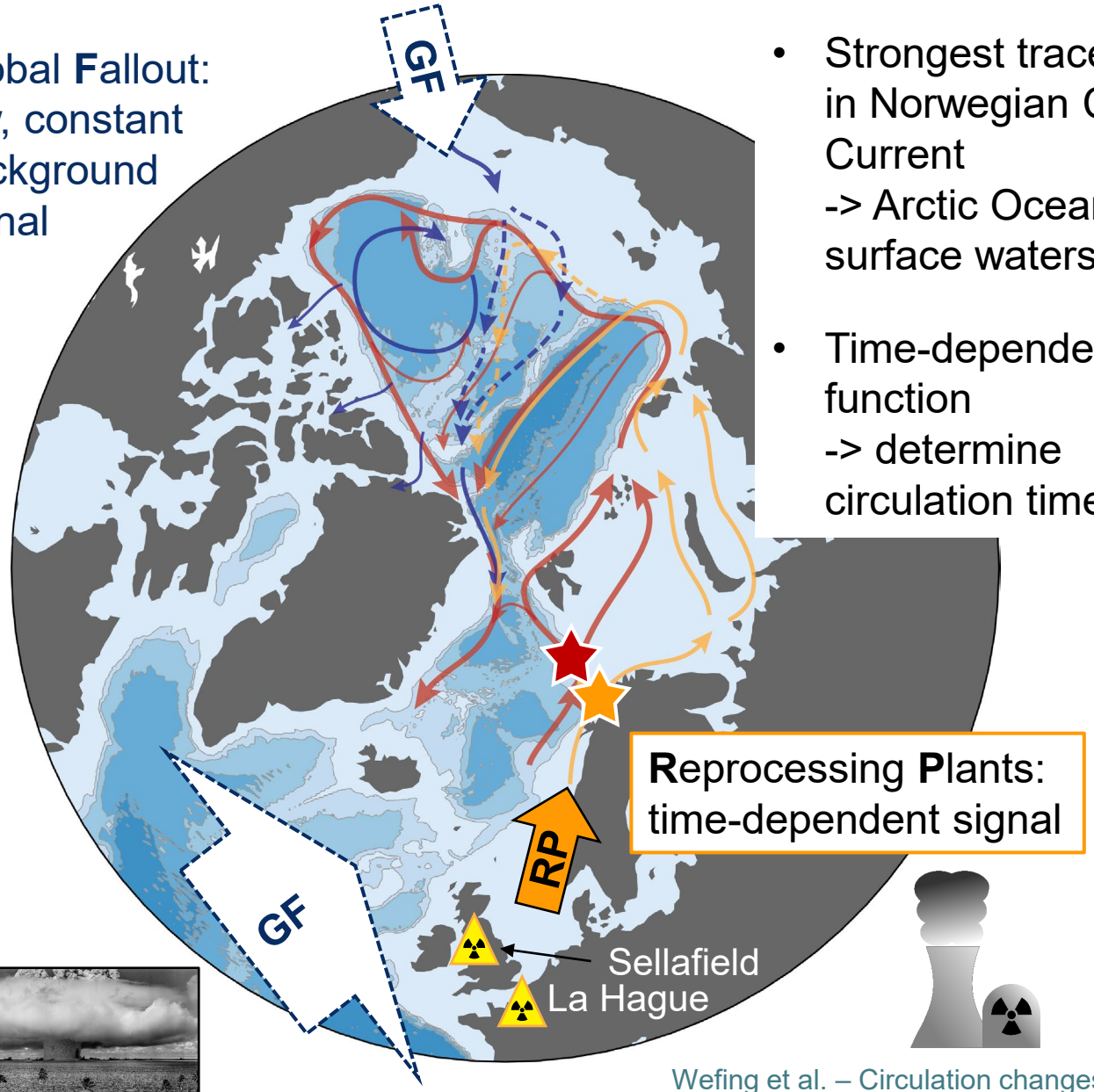


Reprocessing **P**lants: time-dependent signal

- Long-lived:
  $T_{1/2,\ I\text{-}129}$ = 16 million years
  $T_{1/2,\ U\text{-}236}$ = 23 million years
- Only anthropogenic sources:
  Atmospheric nuclear weapon tests
  Nuclear fuel reprocessing plants
- Conservative in the ocean

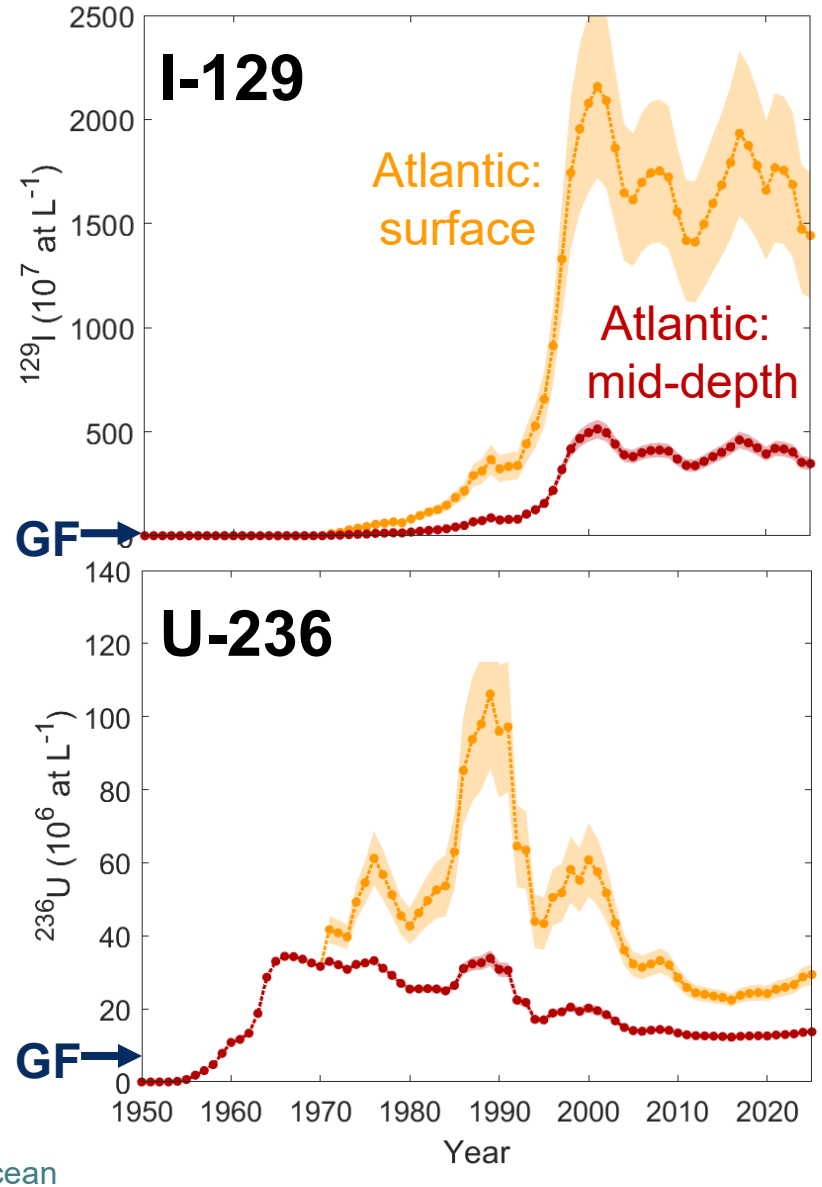
Tracers: Anthropogenic radionuclides I-129 & U-236

Global **F**allout: low, constant background signal

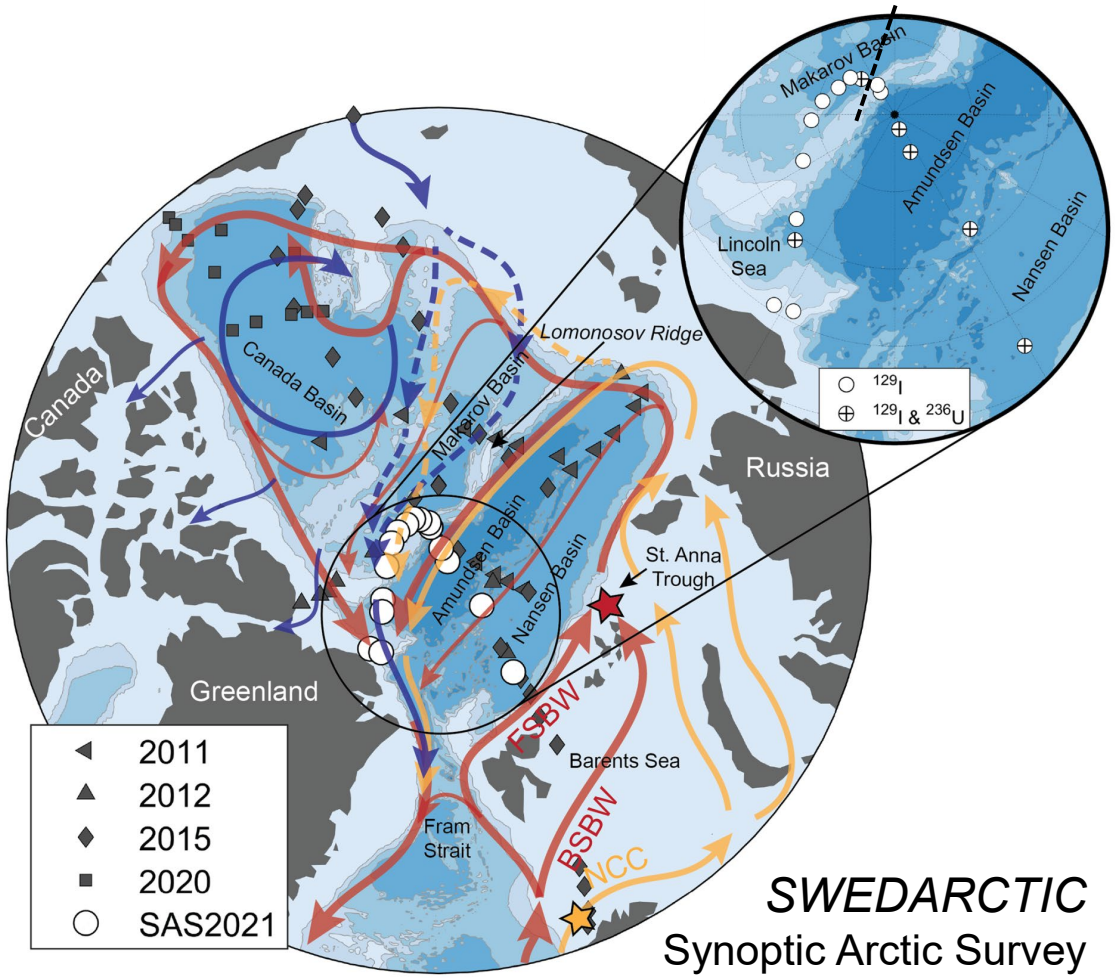


- Strongest tracer signal in Norwegian Coastal Current
  -> Arctic Ocean surface waters
- Time-dependent input function
  -> determine circulation timescales

Reprocessing **P**lants: time-dependent signal



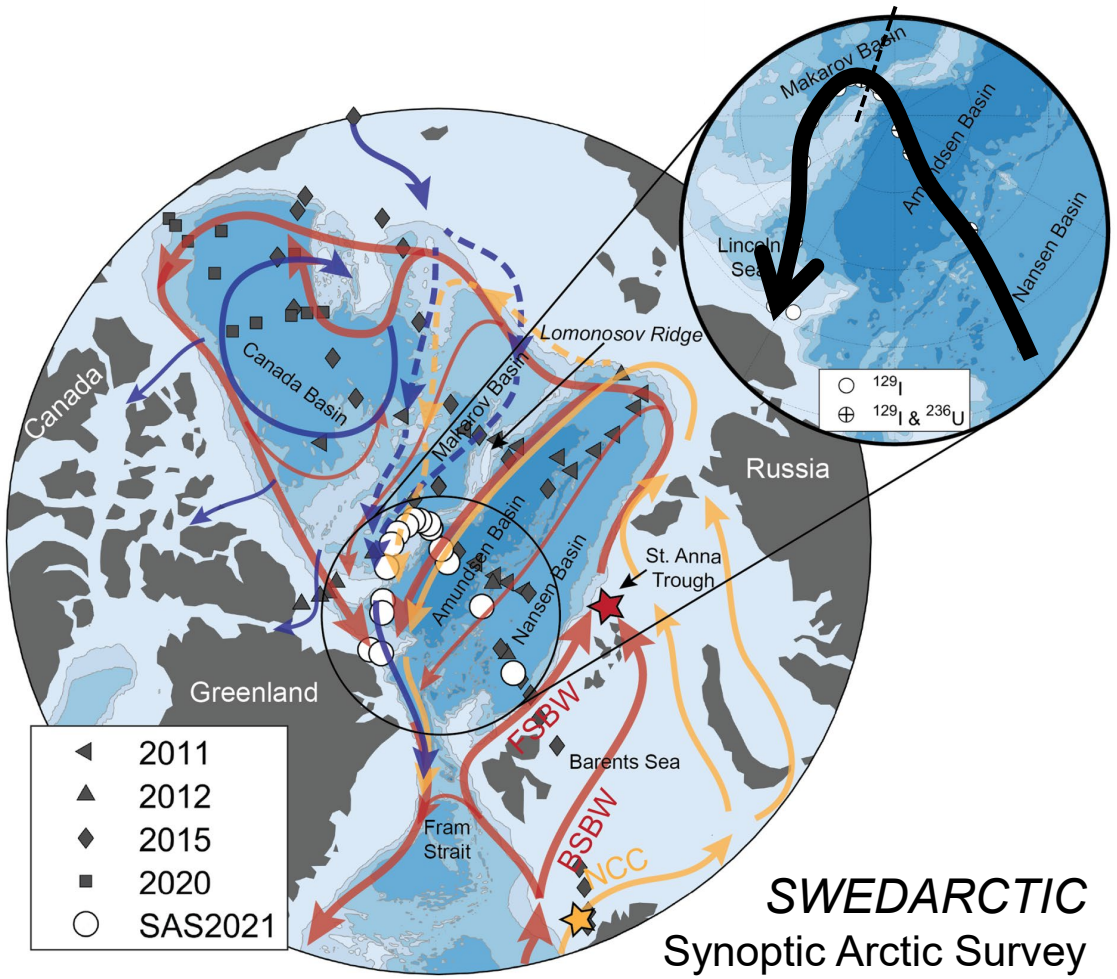
Data: SAS2021 expedition to the Arctic Ocean



SWEDARCTIC
Synoptic Arctic Survey
2021 with icebreaker Oden

doi.org/10.5194/os-21-3311-2025

Results: Cross sections of T, S, I-129

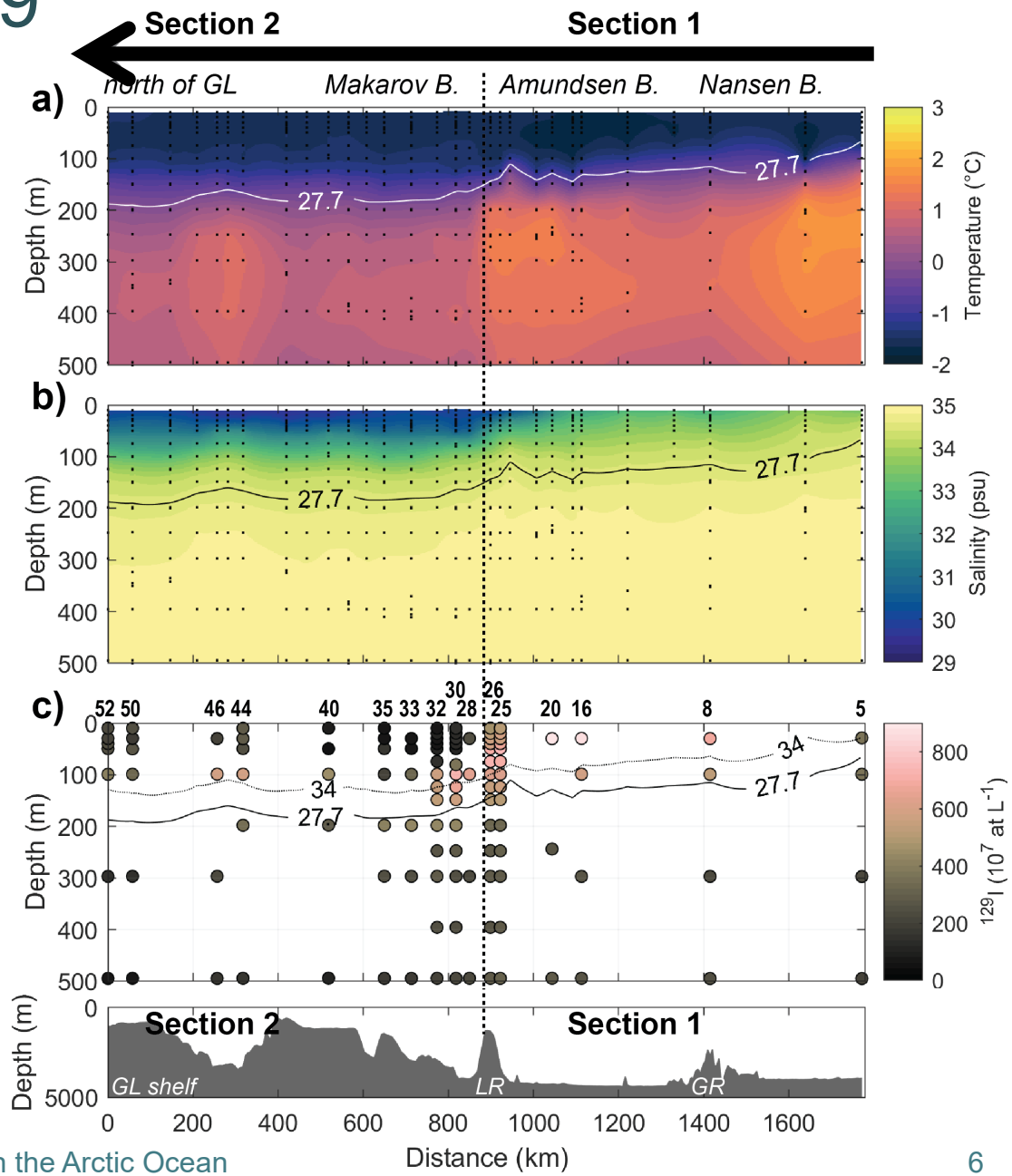


SWEDARCTIC
Synoptic Arctic Survey
2021 with icebreaker Oden

Temp.

Sal.

I-129



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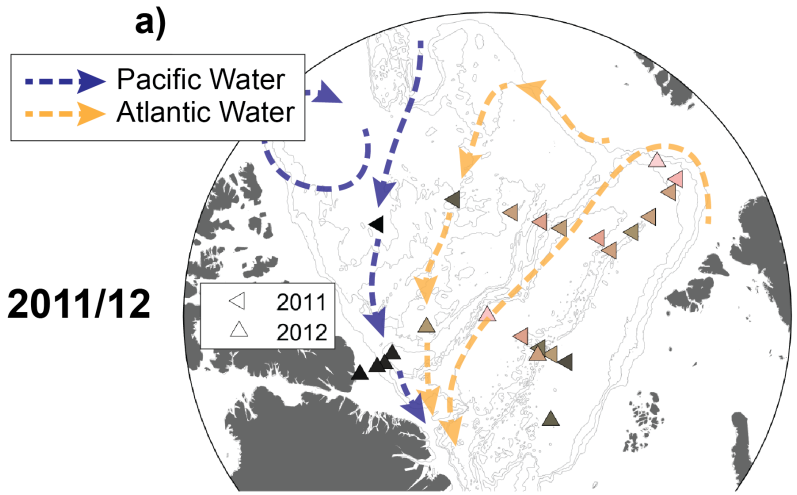
I-129 as a Pacific Water tracer in the surface layer

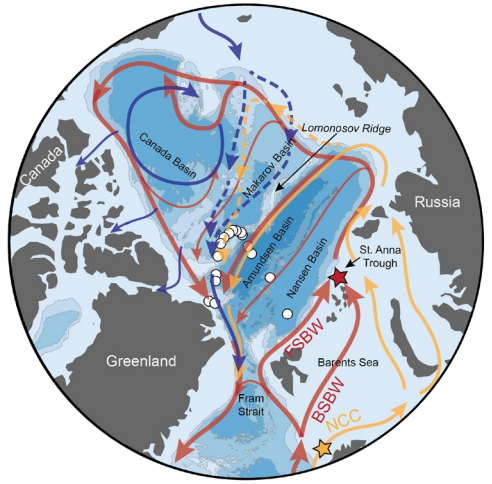


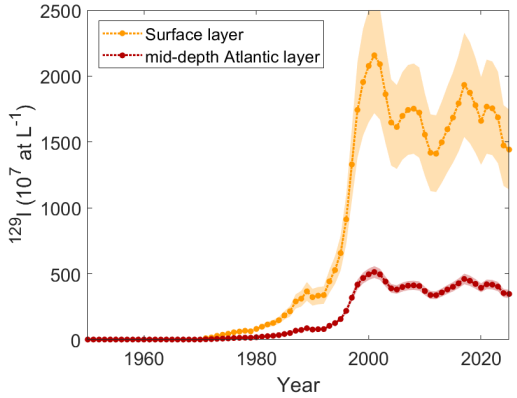
Surface layer:

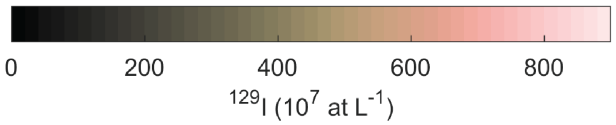
- I-129 high in Atlantic Water
- I-129 low in Pacific Water

➢ Use as **tracer for Pacific Water**

➢ Investigate **temporal changes** in the AW-PW front







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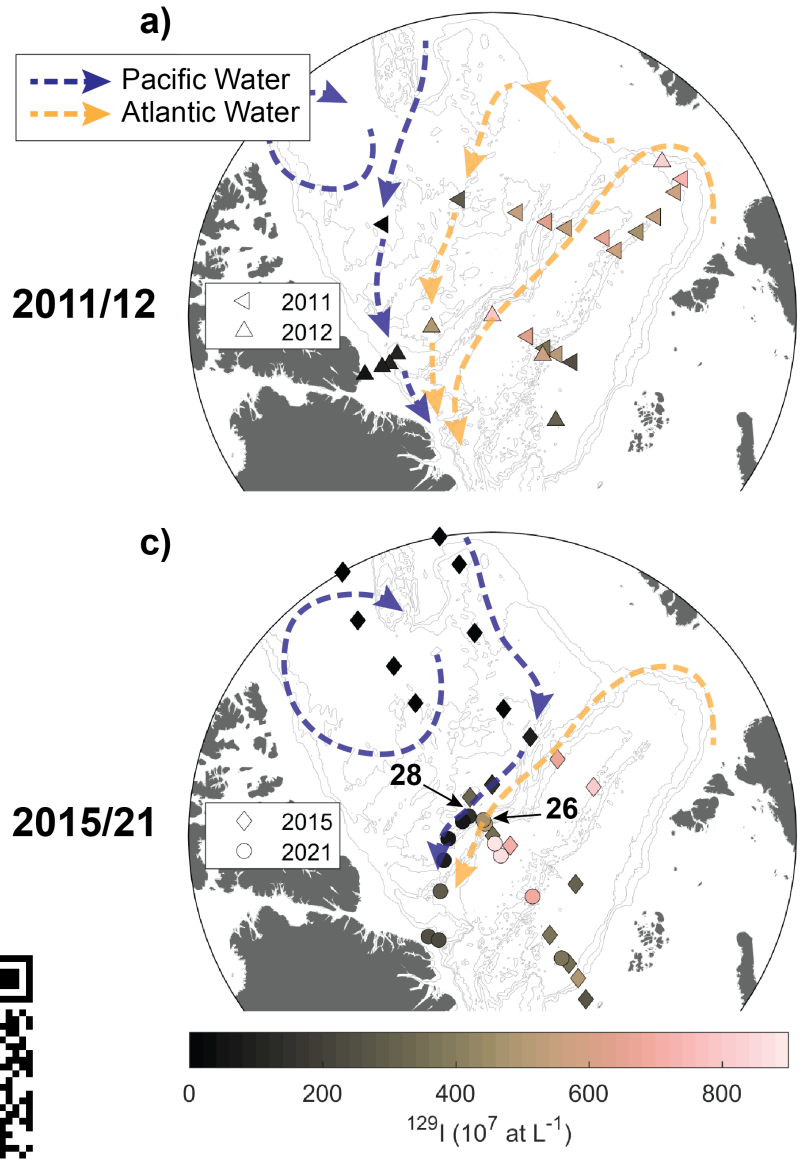
I-129 as a Pacific Water tracer in the surface layer



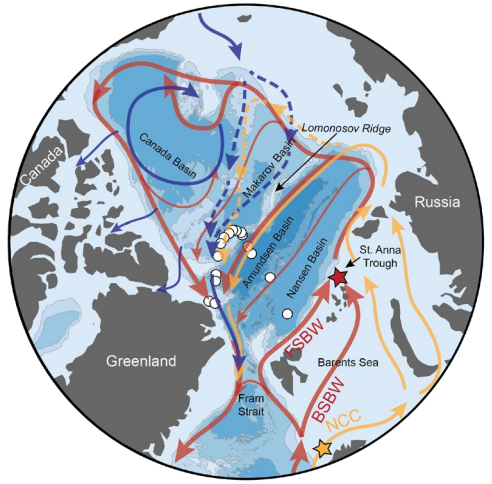
Surface layer:

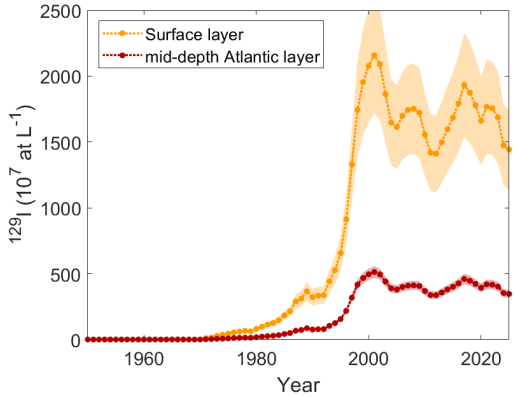
- I-129 high in Atlantic Water
- I-129 low in Pacific Water

➢ Use as **tracer for Pacific Water**

➢ Investigate **temporal changes** in the AW-PW front

➢ Pacific Water reached further towards the Eurasian Basin in 2015/21 compared to 2011/12





Sharing is encouraged

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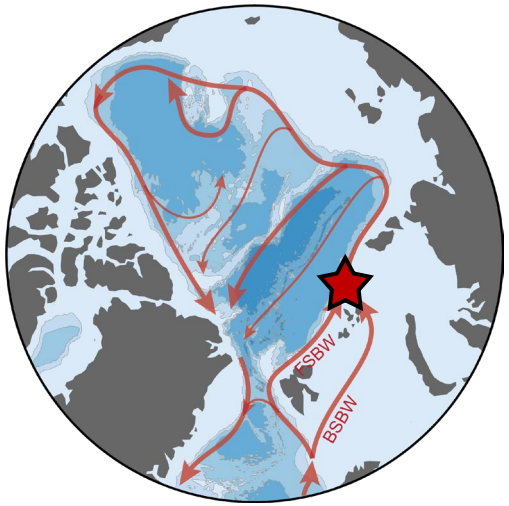
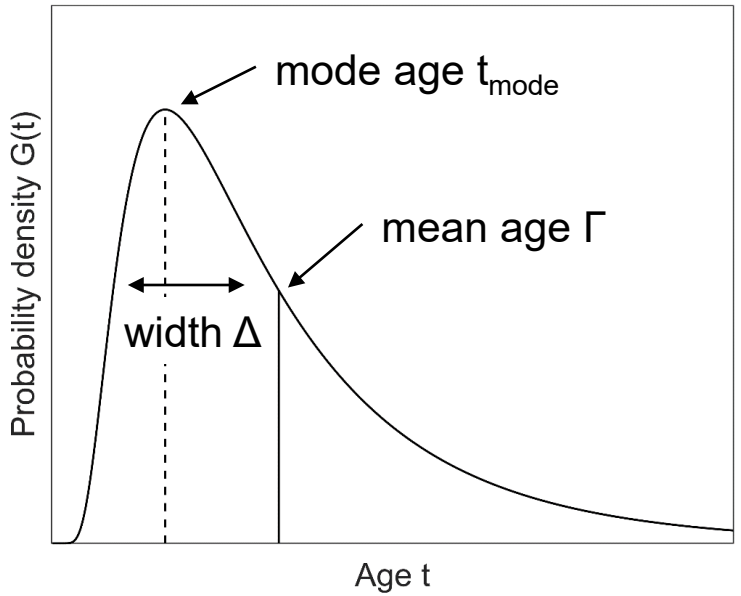
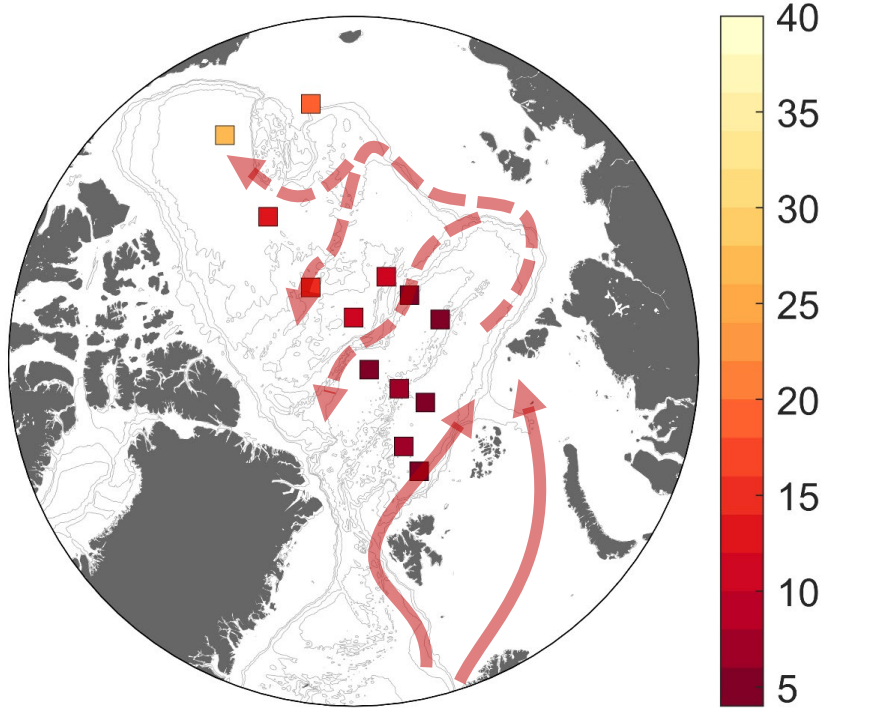
Atlantic Water circulation times from I-129 & U-236



Transit Time Distribution (TTD) method



2015, FSBW layer
(σ_Θ = 27.91)



Data from Wefing et al. (2021)

Atlantic layer:

- TTD method constrains distribution of ages
- Mode ages from TTD approach reflect circulation pattern of mid-depth Atlantic Water

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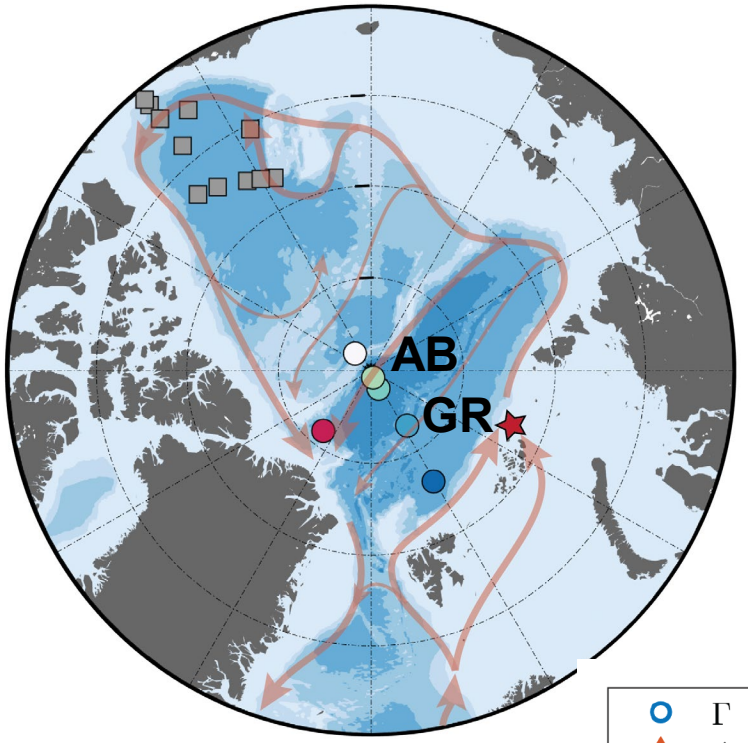
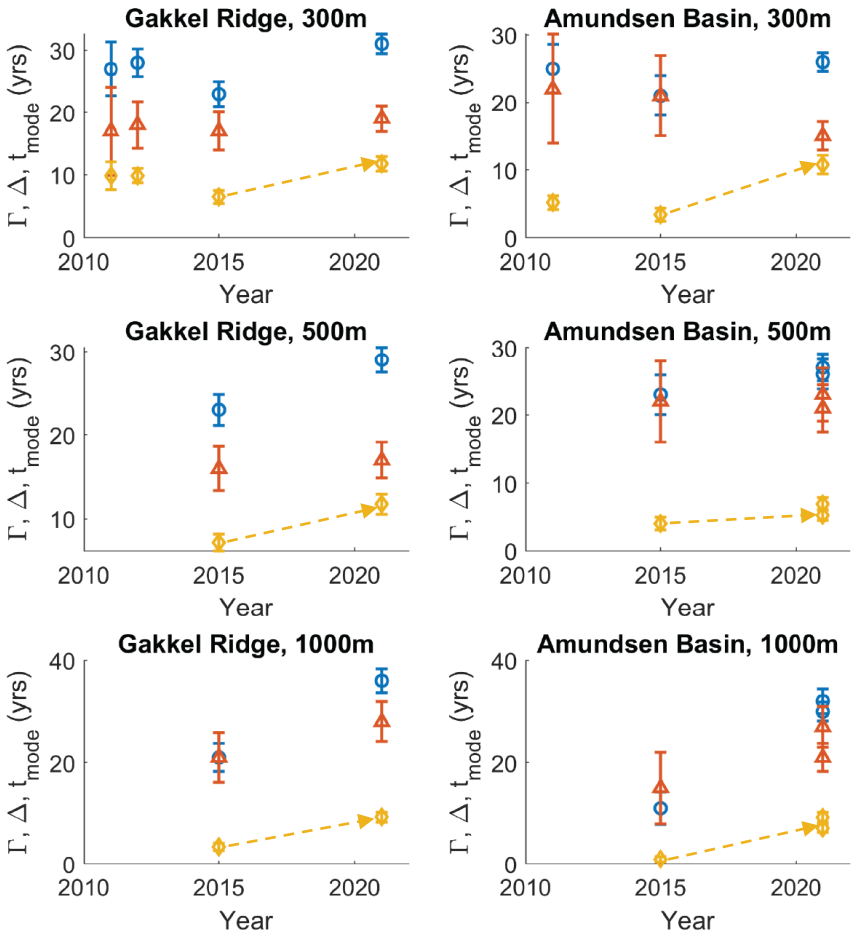
Atlantic Water circulation times – temporal changes?



Depth

Gakkel Ridge

Amundsen Basin



- Increase in mean and mode ages between 2015 and 2021
- Also observed by gas tracers CFCs & SF6 (Gerke et al., 2024)
- Changes in Atlantic Water pathways?
- Weakening of boundary current?
- Changes in inflow region?

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Conclusions

- Temporal changes in the distribution of I-129 in the surface layer suggest that Pacific Water reached further towards the Eurasian Basin in 2015/21 compared to 2011/12. Same pattern was observed in water mass fractions based on nutrient ratios.
- In the halocline layer, high radionuclide tracer concentrations across the entire transect suggest a common formation area around the Barents Sea.
- An increase in mid-depth Atlantic Water mean and mode ages between 2015 and 2021 suggests changes in the Atlantic Water circulation, in line with other tracer studies.

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Thanks!

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