Bjerknes Fast Track Initiative 2024

Report on the BCCR FTI project: Characterizing the Transport of the Atlantic Water in the Nordic Seas and Arctic Ocean by Radioactive Tracers

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Background:

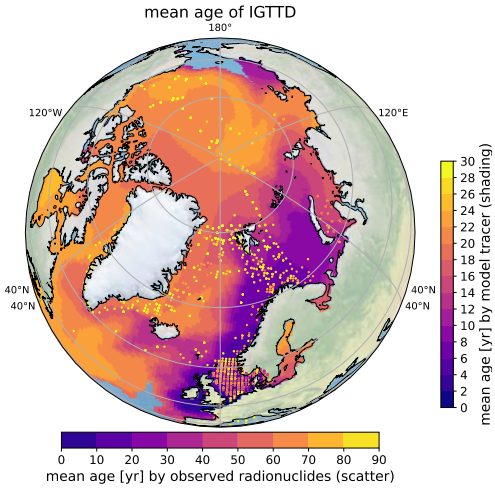
Since the 1960s, anthropogenic radioisotopes from the European nuclear fuel reprocessing have been contaminating the Atlantic Water (AW) as it entrains and mixes with the contaminated coastal waters. The AW is thereby imprinted by the unique reprocessing tracer signature through its way northward into the Arctic Ocean (AO) and back southward to the deep North Atlantic. We applied the 1D advective-diffusive transport model (IG-TTD) on the observed radioactive tracers, supported by model output, to analyze the transit-time distribution of the AW in the Arctic Ocean. The outcome highlights AW's horizontal transport patterns, complementing ventilation rate estimates from SF6 and CFCs, and will facilitate the use of radioisotopes to validate OGCM in tracing the northward flow of AW and return to North Atlantic.

Activities:

1. Collected radioisotope observations and model outputs for the North Seas, Nordic Seas and the Arctic Ocean..
2. Validate model simulations with observations, and derived source functions for transit-time estimation in the next.
3. Analyzed advective (mean) and diffusive (spread) transport of AW using idealized and observed tracers (I-129, Tc-99, U-236).
4. Compared AW transit times derived from CFC-12 and SF6 with radioisotope-based estimates.
5. Organized meetings and individual discussions with project participants.

Outcomes:

1. Compiled datasets of radioisotopes, input data and protocol for simulating radioisotopes, toolbox for validating model outputs and calculating transit-time distribution.
2. Estimated AW transit times: ~10 years to Fram Strait and ~30 years to the deep central AO (model tracers, as shown in the figure), with observed radioisotope ages 2-3 times older. CFC-12-based ages (~9±10 years) align well with model results, while observed radioisotopes indicate significantly older ages.



Budget:

1. Y. He got 2PM and E. Jeansson 1 PM support.
2. The other partners contribute in-kind.

Outlook:

1. These datasets and tools are hosted on GitHub, and will be made public after peer-reviewed publication.
2. The point discharge of radioisotopes has a strong dilution effect and likely breaks the fundamentals of the 1D IG-TTD method. A modified scheme of the IG-TTD with dilution effects considered will be further explored with idealized model tracer simulations to improve the fidelity of the application of the IG-TTD method on radioisotopes.