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Tracing Atlantic Waters in the Arctic Ocean by means of long-lived radionuclides (I-129 and U-236)

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Atlantic inflows have recently been recognized to have an increasing role in reducing the sea-ice extent in the Arctic Ocean at a rate now comparable to losses from atmospheric thermodynamic forcing. Yet the transport of Atlantic waters into this polar region is not well constrained and further research is needed to understand their exchange at mid-depths between the Canada and Eurasian Basin. Chemical tracers, in addition to other hydrographic parameters and models, are key tools to understand and quantify such water exchange. Anthropogenic compounds and isotopes such as CFCs and artificial radionuclides produced during man's industrial/military activities are used as transient tracers that provide crucial information on pathways, time scales and processes of key water masses that cannot be obtained from hydrographic properties alone. Among these tracers, the artificial radionuclides produced during the atmospheric weapon tests and/or released from the two European Nuclear Reprocessing Plants, have proven to be particularly useful to trace the circulation of Atlantic water into the Arctic and sub-Arctic oceans. This is the case of ^{129}I ($T_{1/2}$=15.7 $\cdot$ 10^6 y) and ^{236}U ($T_{1/2}$=23.4 $\cdot$ 10^6 y), two long-lived radionuclides that given their conservative nature in open ocean, are now key tools to identify Atlantic waters inflow in the Arctic Ocean, providing information on the sources of water masses and their transit times circulation along their path through the Arctic Ocean. Here we will present the results obtained during a suite of expeditions carried out in the last 8 years. The combination of ^{129}I and ^{236}U allows identifying the different Atlantic branches entering the Arctic Ocean. Due to the uneven mixing of ^{129}I and ^{236}U from the two European Reprocessing Plants of Sellafield and La Hague in the North Sea, each branch brings a different ^{129}I/^{236}U ratio. This allows the identification of a third branch evolving from the Norwegian Coastal Current, that stays on the upper Polar Mix Layer (upper 200m) and carries a significantly larger proportion of ^{129}I and ^{236}U releases from European reprocessing plants compared to the Fram Strait Branch Water and the Barents Sea Branch Water. The new input functions defined for the different Atlantic branches entering the Arctic Ocean shall be used to calculate the transit time distribution of Atlantic Waters in the Arctic Ocean. A revision of the state-of-the art of these tracers in the Arctic Ocean will be done and the advantages and caveats will be discussed.