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Circulation pathways and spreading rates of the Atlantic Water in the Arctic Ocean: Results from 25 years of tracer observations

Peter Schlosser (1), Angelica Pasqualini (2), Robert Newton (3), Tobias Koffman (3), Ronny Friedrich (4), and William M. Smethie (3)

(1) Columbia University, Earth Institute, Palisades, USA , (2) Columbia University, Dept Earth & Environmental Engineering, New York, USA , (3) Columbia University, Lamont-Doherty Earth Observatory, Palisades, USA , (4) Curt-Engelhorn-Zentrum Archaeometrie gGmbH, Mannheim, Germany

The Atlantic Ocean supplies heat to the Arctic Ocean along two pathways: one entering through Fram Strait (Fram Strait Branch) and one entering through the St. Anna Trough after seasonal modifications on the Barents Sea shelf (Barents Sea Branch). Although shielded from direct contact with the sea ice cover by the cold mixed layer and halocline, some of the heat reaches the sea ice via turbulent exchange and thus has impact on sea ice extent and thickness. This raises the question of the stability of the Atlantic Water circulation in the Arctic Ocean in a rapidly changing Arctic system and the consequences of potential changes in its position within the water column.
The presently accepted circulation scheme of Atlantic Water in the Arctic Ocean was first depicted by Rudels et al. (1994) based on hydrographic data and dynamical considerations and has been extensively discussed in the literature and widely used in many studies. Although the general circulation patterns seem to be robust, so far not all of its branches have been verified by direct observations such as current meter measurements or geostrophic flow estimates. Additionally, there are few direct measurements of the spreading velocities of the individual components of the overall circulation scheme. We present tritium/3He data and discuss how they add to our understanding of the circulation patterns and spreading velocities.
Specifically, we use 3H/3He and hydrographic data from 21 expeditions spanning 25 years of Arctic Ocean section work (1987-2013) to estimate spreading velocities and flow paths of both Atlantic Water branches on a pan-Arctic scale. Our tracer data corroborate and add a time dimension to previously estimated circulation schemes. The results confirm the presence of a well-organized boundary current that cyclonically flows along the continental slope and add insights on the other, typically topographically steered, circulation branches of Atlantic water, most notably those following the Lomonosov Ridge. The tracer data also show that within the limits of our method the current system has been stable over the 25 years of observation.