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Using tritium and helium-3 to study shallow ocean circulation and ventilation

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The distribution of tracers represent an integrated view of how material is transported in the ocean. As chemically and biologically conserved transient tracers, tritium (largely produced by atmospheric nuclear weapons testing) and its daughter isotope helium-3, behave in complementary fashion in the shallow ocean. Thus in tandem they offer useful information on the nature of fluid and material transport in shallow marine systems. The strong hemispheric contrast (north vs. south) in tritium delivery makes a potent tracer for cross-equatorial transport of shallow waters. Moreover, the longer term accumulation and subsequent loss helium-3 from the oceanic main thermocline provides very useful constraints on the magnitude and nature of thermocline ventilation. We have a more than 3 decade record of the evolution of these two isotopes in the North Atlantic, and their time evolution is potentially very useful in constraining our understanding of ocean ventilation and its variability over time. Finally, an added bonus with the helium-3 is the observed excess of this isotope in surface waters and the potential to use the gas-exchange loss of this tracer as a flux gauge for other biogeochemically important species. Perhaps the most compelling pictures of their joint distributions arise from the WOCE one-time survey, and the CLIVAR repeat sections. I present a number of clear examples of these pictures, along with simple example calculations that relate these features to what we learn about ocean circulation and ventilation.