Chemical Tracers and the Development of Understanding of Arctic Ocean Circulation

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The use of chemical tracers to infer qualitative aspects of the circulation of the upper layers of the Arctic Ocean (AO) commenced with measurements of nutrients and oxygen from Drift Station Alpha and the T-3 ice island during the International Geophysical Year (1957) and again in the late 1960's. More detailed insight, including into the AO's deeper circulation and rates, commenced with the more extensive suite of tracers measured from the early Canadian ice camps LOREX (1979) and CESAR (1983). In contrast to most other basins, most of our fundamental knowledge of circulation patterns and rates in the AO developed at the same time as a diverse toolkit of chemical tracers became available. Understanding has benefitted from measurement of naturally-occurring tracers, the fallout-derived tracers from bomb-testing, anthropogenic gases and source-specific radiotracers (e.g. from waste reprocessing and nuclear accidents). I will attempt to extract lessons from this history, by comparing inferences from early, highly-restricted sampling of multiple tracers to our present state of knowledge which is based on icebreaker-supported surveys since the late 1980's, and much more data. For comparison, I will briefly review the extent to which chemical tracers have guided development of numerical models of AO circulation. On the basis of the (debatable) assumption that history is a guide to the future, I will make suggestions for future developments in AO tracer oceanography.