Measurement of SF6 and CFCs on the US GEOTRACES North Atlantic section

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CFCs have been entering the ocean since they were first produced in the 1930s and 1940s and SF6 has been entering the ocean since the 1970s. The evolving CFC and SF6 distributions in the ocean provide information on circulation and ventilation pathways and time scales for the past half century. CFCs have been measured extensively in the ocean for the past 2 and a half decades as part of several large scale oceanographic programs (SAVE, WOCE, CLIVAR) as well as many smaller programs and SF6 has become a standard measurement on the CLIVAR cruises. Measurement of CFCs and SF6 on the GEOTRACES program places the GEOTRACES data in the context of large scale ventilation patterns established by CFC/SF6 measurements on these cruises and extensive CFC/SF6 measurements are planned for the future CLIVAR and other programs. This information will be useful in meeting several objectives of the GEOTRACES North Atlantic section.

The temporal information provided by the CFC/SF6 measurements can be used to estimate time scales of sources or sinks for the TEIs. This can be done in several ways. One way is to estimate water mass ages from the CFC and SF6 data and to plot TEI concentrations against age to obtain rates of production or degradation. Ages can be estimated from tracer ratios, tracer concentrations or transient time distributions estimated from the tracer distributions. Another way is model the transient tracers and the TEIs using the transient tracers to constrain the advection and mixing rates and the TEIs to constrain the rates of production or consumption of the TEIs. These methods can be used in most of the North Atlantic, which contains significant amounts of water with ventilation times less than 50 years.

In addition to information on ventilation time scales, there are two important objectives of this cruise that can be addressed with CFC/SF6 measurements. 1) TEI properties at the beginning of the Atlantic MOC deep circulation pathway, which includes several components of NADW. The most recently formed components of NADW can be readily identified as vertical maxima in CFCs and SF6 in the DWBC and the interior regions of the subtropical basin allowing the TEIs in the core of these water masses to be determined. CFCs and SF6 also provide information on the circulation pathways, advection time scales and exchange between the DWBC and the interior, especially when combined with measurements from other cruises in the region, which will be carried out as part of the CLIVAR repeat lines and Line W. 2) Understanding TEI distributions in the oxygen minimum zone off the northwest coast of Africa. The low oxygen water is produced by a combination of organic matter decomposition driven by primary productivity in overlying water and sluggish circulation, but it is not possible to determine the relative importance of each process from oxygen alone. CFCs and SF6 are affected only by circulation and mixing and will provide information on water residence time in the region of low oxygen.

I will propose to measure CFC-11, CFC-12 and SF6 at all depths on the full and shallow stations. The samples will be measured on board by gas chromatography and about 8 feet of bench space is required. Water samples will be taken from the regular rosette and 1500 ml of water will be required per sample, which includes rinses. Rinse water could be used for other parameters. One berth will be needed.