A Novel Cryogenic Analyte Preconcentration Module for Trace Gas and Isotopic Analyses

B.R. Miller[1], D. Guenther[1], J. Winokur[2], B.H. Vaughn[2], S.A. Montzka[3] and P. Tans[3]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309; 303-497-6624, E-mail: ben.r.miller@noaa.gov
[2]Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO 80309
[3]NOAA Earth System Research Laboratory, Boulder, CO 80305

Many of the "minor" greenhouse gases (GHGs), ozone-depleting compounds (ODSs) and other substances involved in air quality (AQ) issues are present in the atmosphere at part-per-trillion (ppt) or part-per-quadrillion (ppq) mole fractions. In the gas chromatographic analysis of these analytes, it is often advantageous to perform a "preconcentration" step before chromatographic separation and detection. This step can greatly enhance the signal-to-noise ratios of the measurement, and also remove potential analytical interferences.

A novel preconcentration system is being developed in the Global Monitoring Division of NOAA/ESRL. This preconcentration methodology involves flowing an air sample (order 500 cc at STP, flowing at ~50 sccm) over a packed column (micro-trap) of chromatographic adsorbent at very cold temperatures (order -160 C). While bulk air components (N_2, O_2, Ar, etc.) elute quickly through this column and vent to waste, the trace GHGs, ODSs and AQ analytes show an affinity for the adsorbent and migrate slowly towards the end of the packing material. These preconcentrated analytes may now be desorbed at higher temperature (order +100 C) and moved under carrier gas flow to the chromatography column.

While the initial target suite of ~60 analytes includes halocarbons (e.g., hydrofluorocarbons, perfluorocarbons), hydrocarbons (C_2 through C_8) and certain sulfur-containing compounds (e.g., OCS, CS_2), this methodology should also find application in isotopic studies. The principle design goals of this system are: (1) reproducible preconcentration temperatures, (2) removal of interfering substances (e.g., CO_2), and (3) relatively fast cycle times (~30 minutes per analysis). While development continues, results to date will be described.

Figure 1. GMD's 3-channel GC system under development. Cold-end, vacuum chamber and dewar interfaced to a thermostated chromatographic valve (VICI) enclosure. Transfer lines between the valves and the cryotraps move analytes under helium carrier flow to separation columns in the GC (Agilent 7890) and detectors (MS, FID and ECD).