

Development of a Cryogen-Free Concentration System for Measurements of Volatile Organic Compounds

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An innovative cryogen-free concentrator system for measurement of atmospheric trace gases at the parts per trillion level has been developed with detection by routinely used gas chromatographic methods. The first-generation system was capable of reaching a trapping temperature of $-186\text{ }^{\circ}\text{C}$, while the current version can reach $-195\text{ }^{\circ}\text{C}$. A Kleemenko cooler is used to create liquid nitrogen equivalent trapping conditions and eliminate the use of solid absorbents, a potential source of artifacts. The method utilizes dual-stage trapping with individual cold regions. The two stages are cooled to -20 and $-175\text{ }^{\circ}\text{C}$ for water management and sample enrichment, respectively. Both stages house a Silonite-coated stainless steel sample loop; the second stage loop is filled with 1-mm-diameter glass beads, which provide an inert surface area for analyte concentration. In our application, the complete system employed four channels utilizing two flame ionization detectors, one electron capture detector, and a mass spectrometer. The system was automated for unattended operation and was deployed off the New England east coast on Appledore Island to measure a suite of ambient non-methane hydrocarbons, halocarbons, alkyl nitrates, and oxygenated volatile organic compounds during the International Consortium for Atmospheric Research on Transport and Transformation field campaign in summer 2004. This robust system quantified 98 ambient volatile organic compounds with precisions ranging from 0.3 to 15%.

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