The *Medusa* Automated Cryofocusing Gas Chromatograph–Mass Spectrometer System for the Measurement of Atmospheric Trace Gases

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The *Medusa* automated gas chromatograph–mass spectrometer (GC-MS) instrument has been developed and deployed as part of the Advanced Global Atmospheric Gases Experiment (AGAGE) ground-based tropospheric measurement network. This instrument measures over 40 atmospheric trace gases ranging in concentration from 0.1 to 550 of parts-per-trillion (ppt), with emphasis on anthropogenic and biogenic trace gases which modulate stratospheric ozone and/or the radiative forcing of climate. The heart of the system is a programmable temperature trapping, distilling and cryofocusing system which concentrates these analytes from 2-liter air samples for injection into a customized Agilent 5973 GC-MS. More abundant interfering species are removed from the samples prior to injection onto the separating columns. Care is also taken to avoid chemical and bleed-through losses of analytes on the traps and co-elution interferences in the MS, and to quantify instrumental blanks. Instrument control and data acquisition are by custom computer software, which also provides important performance diagnostics and Internet data transmission and backup. Measurement time is 1 hour, and sample and standard injections are alternated. Measurement precisions range from about 0.1% above 100 ppt to a few percent below 1 ppt..

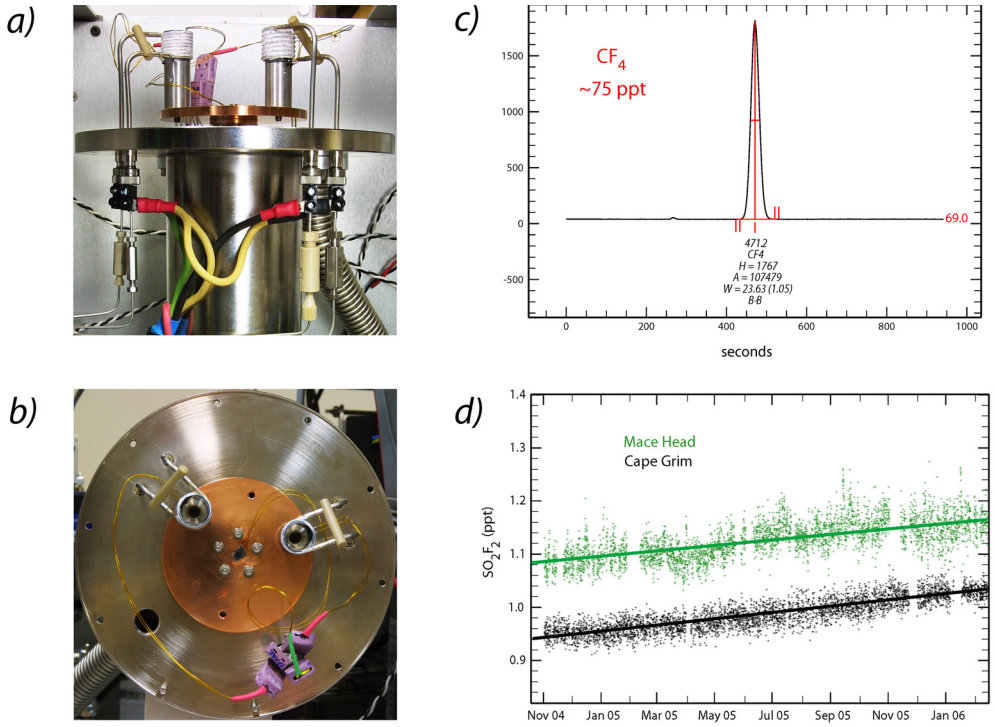

Figure 1. The AGAGE *Medusa* GC-MS instrument system employs custom-designed cryofocusing traps shown in plan view (***a***) and front view (***b***). These traps can be programmed individually at any temperature between −175°C and +200°C to trap, distill and cryofocus a wide range of trace gases from large air samples. Among the most difficult measurements made by the Medusa is the highly volatile carbon tetrafluoride (CF_4). Its chromatographic peak is well-resolved (***c***), and is measured with a typical precision of 0.15%. The anthropogenic fumigant sulfuryl fluoride (SO_2F_2) is present in the background troposphere at about 1 part-per-trillion (***d***). Its global distribution and trend are among the new discoveries made possible by the *Medusa*.