APRECON-TOF-MS: A new state-of-the art instrument for the analysis of halogenated greenhouse gases

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Halogenated organic trace gases are strong greenhouse gases and deplete the stratospheric ozone when containing chlorine and bromine. Measurements of these compounds at atmospheric background sites started in the 1970s by gas chromatography-electron capture detection (GC-ECD) (Lovelock, 1971). These data were used for showing the ubiquitous abundance of halogenated long-lived substances in the global atmosphere and were key to the subsequent detection of the origin of the ozone hole of the Antarctic continent. Subsequently, detection by mass spectrometry became the predominant analysis technique for continuous measurements of these gases. In the global AGAGE network, halocarbons have been measured by the Adsorption Desorption System (ADS, Simmonds et al., 1995) since 1997, which has been followed by measurements from the further developed Medusa system (Miller et al, 2003) in 2003. With the APRECON-TOF-MS we present a newly developed system, which combines a fundamentally redesigned preconcentration unit with a new, powerful detection system for measurements of halogenated trace gases.

At the core of the APRECON (Advanced Preconcentration system) is a copper plate which is cooled to -180 °C by means of a Stirling cooler. Two copper cones are fixed on this copper plate on which the preconcentration traps are mounted on detachable hats (adopted from a design by NOAA/ESRL/GMD). Halocarbons from 2 liters of air are sampled on these traps during the cold phase. For the subsequent heating phase, the hats can be removed from the base plate for desorption of the analytes. This design allows fast switching of the traps between heating and cooling cycles.

First results will be shown of measurements down to the fmol/mol (ppq, 10^{-15}) range, using both an established quadrupole mass spectrometer (QP-MS) and a new time-of flight mass spectrometer (TOF-MS) for detection. The latter is superior because of its ability to detect the exact mass and because it allows the simultaneous analysis of all ions. APRECON-TOF-MS has, therefore, major advantages over earlier systems and may well become the standard measurement technique for atmospheric halogenated organic trace gases.

References

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