Airborne Tropospheric Hydrogen Oxides Sensor (ATHOS) and OH Reactivity Measurement

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The overall goal is to gain a better understanding of atmospheric oxidation by deploying ATHOS and the OH reactivity instrument during ARCTAS.

Instrument Descriptions

ATHOS.

ATHOS is located in the forward cargo bay. It uses laser-induced fluorescence (LIF) to measure OH and HO_2 simultaneously. OH is both excited and detected with the $A^2\Sigma^+$ (v'=0) $\rightarrow$ $X^2\Pi$ (v"=0) transition near 308 nm. HO_2 is reacted with reagent NO to form OH and is then detected with LIF. The laser is tuned on and off the OH wavelength to determine the fluorescence and background signals. ATHOS can detect OH and HO_2 in clear air and light clouds from Earth's surface to the lower stratosphere. The ambient air is slowed from the aircraft speed of 240 m/s to 8-40 m/s in an aerodynamic nacelle. It is then pulled by a vacuum pump through a small inlet, up a sampling tube, and into two low-pressure detection cells - the first for OH and the second for HO_2. Detection occurs in each cell at the intersection of the airflow, the laser beam, and the detector field-of-view. ATHOS is absolutely calibrated in the laboratory and during the mission, as given in the table below. OH will be detected a second way with the periodic addition of perfluoropropene to remove all the OH while leaving a background signal. For INTEX-B, OH and HO_2 measurements are reported for more than 95% of the flight time.

OH Reactivity Measurement.

The OH reactivity is the sum of the product of the concentrations of all atmospheric constituents that react with OH and their reaction rate coefficients. It is measured directly by pulling the ambient air at a known velocity through a cylinder. An OH detection system, similar to the one used in ATHOS, protrudes into the cylinder near its end. A few pptv of OH is added to the ambient air through a probe that moves along the cylinder's axis. As the probe is pulled back, the reaction distance and time increases and the OH decreases as it reacts. The slope of the logarithm of OH versus time gives the OH reactivity (s^{-1}).

ATHOS and OH Reactivity Measurement Characteristics			
measurement	minimum integration time	limit-of-detection	accuracy (2σ. 1 minute)
OH	20 s	0.01 pptv	± 32 %
HO_2	0.2 s to 20 s	0.1 pptv	± 32 %
OH reactivity	20 s	about < 1 s^{-1}	about ± 15 %

Publications about ATHOS and the OH Reactivity Measurement.

Kovacs, T., and W. Brune, 2001: Total OH Loss Rate Measurement. *J. Atmos. Chem*., **39**, 105-122.

Faloona, I.C., D. Tan, R.L. Lesher, N.L. Hazen, C.L. Frame, J.B. Simpas, H. Harder, M. Martinez, P. Di Carlo, X.R. Ren, W.H. Brune, 2004: A laser-induced fluorescence instrument for detecting tropospheric OH and HO_2: Characteristics and calibration, *J. Atmos. Chem*., **47**, 139-167.

A schematic of ATHOS