

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

William Brune: brune@ems.psu.edu; phone: 814-865-3286;
Jingqiu Mao: jzm145@psu.edu
Zhong Chen: zxc11@psu.edu
Xinrong Ren: xren@rsmas.miami.edu (University of Miami)
address: 503 Walker Building; Department of Meteorology; Pennsylvania State University; University Park, PA 16802; fax:814-865-3663.

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 HO₂ simultaneously. OH is both excited and detected with the A²Σ⁺ (v'=0) → X²Π (v''=0) transition near 308 nm. HO₂ 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 HO₂ 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 HO₂. 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. For INTEX-B, OH and HO₂ 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	about 1 to 240 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.

Faloon, 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 HO₂: Characteristics and calibration, *J. Atmos. Chem.*, **47**, 139-167.

A schematic of ATHOS.

