The NASA Ames Airborne Tracking Sunphotometer, AATS-14, in ARCTAS: Instrument Description and Science Goals

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In ARCTAS the NASA Ames Airborne Tracking Sunphotometer, AATS-14 (see image below), will fly aboard the NASA P-3 aircraft during two three-week periods in April and July, 2008. AATS-14 measures direct solar beam transmission at 14 wavelengths between 354 and 2139 nm in narrow channels with bandwidths between 2 and 5.6 nm for the wavelengths less than 1640 nm and 17.3 nm for the 2139 nm channel. Additional instrument details are available at http://geo.arc.nasa.gov/sgg/AATS-website/AATS6_AATS14/AATS6_AATS14.html The transmission measurements at all channels except 940 nm are used to retrieve spectra of aerosol optical depth (AOD). In addition, the transmission at 940 nm and surrounding channels is used to derive columnar water vapor (CWV) [*Schmid et al*., 2001]. Methods for AATS-14 data reduction, calibration, and error analysis have been described extensively, for example, by *Russell et al*., [1993] and *Schmid et al*. [2001]. For ARCTAS, AATS-14 will be calibrated before and after the experiment at Mauna Loa Observatory (MLO) using the Langley plot technique.

AATS-14 measurements of spectral AOD and CWV obtained during aircraft vertical profiles can be differentiated to determine corresponding vertical profiles of spectral aerosol extinction and water vapor density. Such measurements have been used extensively in the characterization of the horizontal and vertical distribution of aerosol optical properties and in the validation of satellite aerosol sensors. For example, in the Aerosol Characterization Experiment-Asia (ACE-Asia), AATS measurements were used for closure (consistency) studies with in situ aerosol samplers aboard the NCAR C-130 and the CIRPAS Twin-Otter aircraft, and with ground-based lidar systems. In ACE-Asia, CLAMS (Chesapeake Lighthouse the Chesapeake Lighthouse & Aircraft Measurements for Satellites, 2001) and the Extended-MODIS-λ Validation Experiment (EVE, 2004), AATS results have been used in the validation of satellite sensors aboard various EOS platforms, providing important aerosol information used in the improvement of retrieval algorithms for the MISR and MODIS sensors among others (e.g., *Redemann et al*., 2006). Similar research using AATS data collected in INTEX-B (Intercontinental Chemical Transport Experiment – Phase B) is currently being pursued.

In ARCTAS, specific goals of AATS-14 aboard the P-3 are:

- an integrated analysis of the horizontal and vertical distribution of Arctic Haze aerosols and the emissions from boreal forest fires, with an emphasis on the immediate vicinity of clouds;

- the combination of AATS-14 AOD measurements with solar irradiance measurements on the same aircraft to determine aerosol direct radiative effects; and
- the use and validation of aerosol observations from MODIS, MISR, OMI, POLDER and CALIPSO in conjunction with AATS-14 measurements to address ARCTAS science objectives.

In addition to the AATS-specific goals above, we plan to combine AATS data with measurements collected by the other radiation sensors aboard the P-3, i.e., a pair of Solar Spectral Flux Radiometers (SSFR), a pair of broadband flux radiometers (BBR), the Cloud Absorption Radiometer (CAR), as well as a set of aerosol in situ measurements. Specifically, by combining AATS and SSFR data we intend to derive aerosol radiative forcing from simultaneously measured radiative flux and AOD gradients, to study the effect of AOD above cloud on cloud property retrievals by SSFR and satellites, to study the influence of aerosols on cloud radiative forcing, and to derive spectra of aerosol absorbing fraction (1-SSA) in thick polluted layers. Finally, AATS and CAR data will be combined to retrieve surface BRDF and aerosol optical properties.

For information and details of AATS measurements, including previous AATS-14 deployments on different aircraft in INTEX-A, INTEX-B and the ARM ALIVE program, please visit

http://geo.arc.nasa.gov/sgg/AATS-website/.

References

Redemann, J., Q. Zhang, B. Schmid, P. B. Russell, J. M. Livingston, H. Jonsson, and L. A. Remer (2006), Assessment of MODIS-derived visible and near-IR aerosol optical properties and their spatial variability in the presence of mineral dust, Geophys. Res. Lett., 33, L18814, doi:10.1029/2006GL026626, 2006.

Russell, P. B., J. M. Livingston, E. G. Dutton, R. F. Pueschel, J. A. Reagan, T. E. Defoor, M. A. Box, D. Allen, P. Pilewskie, B. M. Herman, S. A. Kinne, and D. J. Hofmann, Pinatubo and pre-Pinatubo optical-depth spectra: Mauna Loa measurements, comparisons, inferred particle size distributions, radiative effects, and relationship to lidar data, *J. Geophys. Res*., *98*, 22,969-22,985, 1993.

Schmid B., J.J. Michalsky, D.W. Slater, J.C. Barnard, R.N. Halthore, J.C. Liljegren, B.N. Holben, T.F. Eck, J.M. Livingston, P.B. Russell, T. Ingold, and I. Slutsker, Comparison of columnar water-vapor measurements from solar transmittance methods, *Applied Optics,* Vol. 40, No. 12, 1886-1896, 2001.