Vertically resolved aerosol optical properties over the ARM SGP site

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Abstract

In order to meet one of its goals - to relate observations of radiative fluxes and radiances to the atmospheric composition - the Department of Energy's Atmospheric Radiation Measurement (ARM) program has pursued measurements and modeling activities that attempt to determine how aerosols impact atmospheric radiative transfer, both directly and indirectly. However, significant discrepancies between aerosol properties measured in situ or remotely remain. One of the objectives of the Aerosol Intensive Operational Period (IOP) conducted by ARM in May 2003 at the ARM Southern Great Plains (SGP) site in north central Oklahoma was to examine and hopefully reduce these differences. The IOP involved airborne measurements from two airplanes over the heavily instrumented SGP site.

We show **preliminary** results from measurements aboard the CIRPAS Twin Otter and from two lidars at SGP along with aerosol transport modeling runs.

CIRPAS Twin Otter

SGP seen from Twin Otter

Twin Otter Payload

Available Measurement	Instrument	PI/Organization
Aerosol scattering	TSI Nephelometer (450, 550, 700 nm) (cabin)	D. Covert/R. Elleman U. Wash.
Aerosol absorption	Soot Photometer (PSAP, 467, 530, 660 nm) (cabin)	D. Covert/R. Elleman U. Wash.
Aerosol absorption	Photo-acoustic Instrument (675 nm) (cabin)	W.P. Arnott /DRI
Aerosol extinction **Aerosol scattering**	Cavity ring-down extinction cell (cabin) Cadenza II, 675 and 1550 nm Cadenza II, 675 nm	A. Strawa NASA Ames
Aerosol hygroscopicity	Humidigraph 3 RR Nephs (cabin) 540 nm, RH=20,60,85%	D. Covert/R. Elleman U. Wash
Aerosol optical depth, **water vapor**, **aerosol extinction** and **water vapor density** in feasible profiles	NASA Ames Airborne Tracking Sunphotometer (AATS-14, 354-2140 nm, 14 channels)	B. Schmid NASA Ames
Downwelling (on **stabilized platform)** and **upwelling solar and IR broadband irradiance**	CM-22 pyranometers CG-4 pyrgeometers (Kipp and Zonen, Sandia modified)	A. Bucholtz NRL
Downwelling (on **stabilized platform**) and **upwelling solar spectral irradiance**	NASA Ames Solar Spectral Flux Radiometer, Si, 300-1100 nm, 256 channels, InGaAs, 900-1700 nm, 128 channels	P. Pilewskie NASA Ames
Aerosol size distribution d=10 nm - ~0.7µm (2 RHs:15 -20%, 70%)	TDMA System (cabin)	J. Seinfeld, Caltech J. Wang, BNL
Aerosol size distribution d=0.5 µm - 5µm	TSI Aerodynamic Particle Sizer	CIRPAS/Caltech J. Wang, BNL
Aerosol/cloud size distribution d=0.1 -2.5 µm d=0.8 - 80 µm	PCASP CAPS	CIRPAS H. Jonsson
Aerosol/cloud size distribution d=2.5 – 50 µm	FSSP	CIRPAS H. Jonsson
Total **aerosol number** concentration	Condensation Nucleus Counter (CNC) (cabin)	CIRPAS H. Jonsson
Cloud liquid water content	Gerber PVM (borrowed from CSU) Johnson prob e on CAPS	CIRPAS H. Jonsson
Cloud condensation nuclei supersaturation spectrum	New Caltech CCN instrument (cabin)	Caltech VanReken/Rissmann Seinfeld/Flagan
Meteorological state parameters **Aircraft state parameters**		CIRPAS H. Jonsson

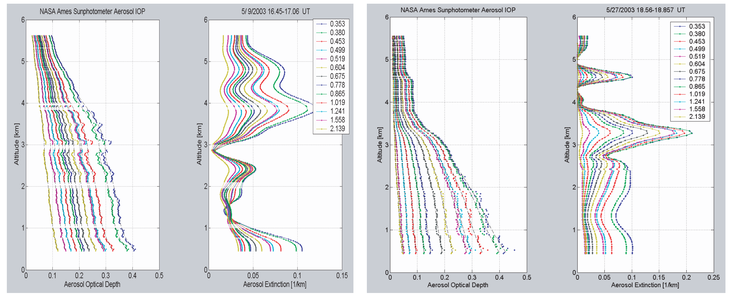
2 MicroPulse lidars at SGP

CART Raman Lidar at SGP

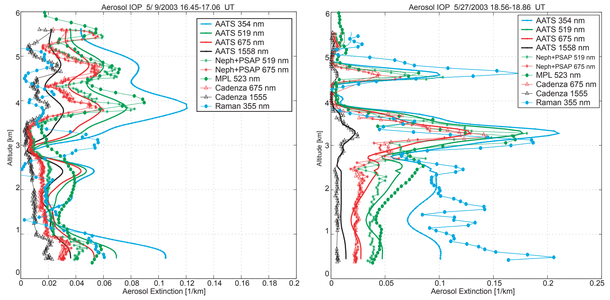
AATS-14 aboard the Twin Otter

Aerosol Extinction Profile Closure

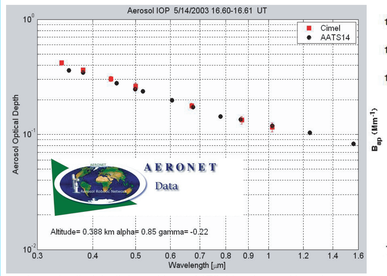
Aerosol optical depth and extinction vertical profiles derived from AATS-14. Wavelengths are in µm.



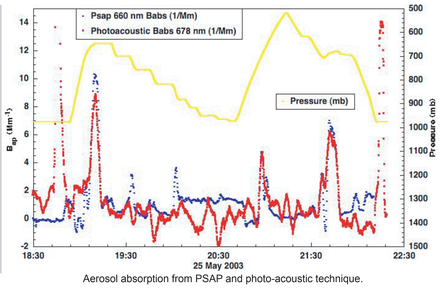
Aerosol extinction profiles measured by 5 different techniques. Curves of same color should fall onto each other.



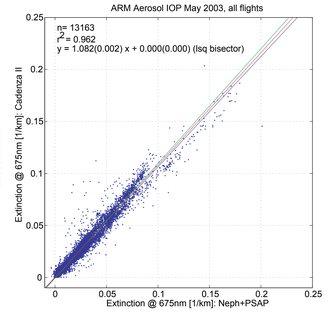
Intercomparisons



Aerosol optical depth from airborne AATS-14 and ground based AERONET instrument when flying low over SGP.



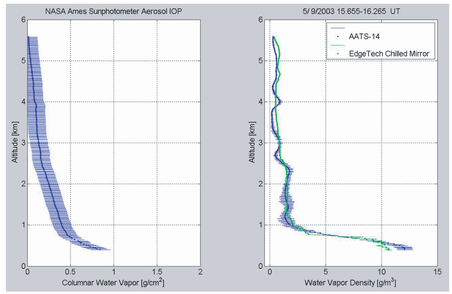
Aerosol absorption from PSAP and photo-acoustic technique.

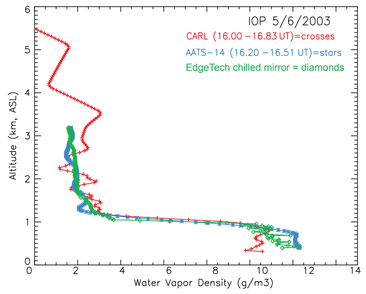


Aerosol extinction from Cadenza II vs. nephelometer/PSAP.

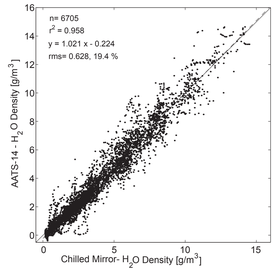
Water Vapor Profile Closure

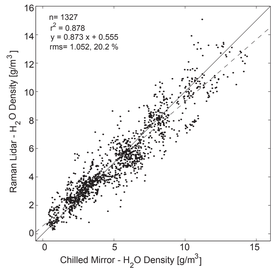
Columnar water vapor (left) and water vapor density (right) derived from AATS-14 and chilled mirror dewpoint sensor.





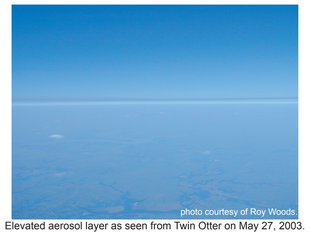
Water vapor density derived from AATS-14, Chilled Mirror dewpoint sensor and Raman lidar.



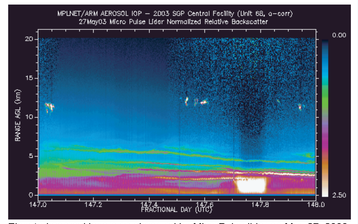


Comparisons of water vapor density. AATS-14 vs. Chilled Mirror and Raman lidar vs. Chilled Mirror.

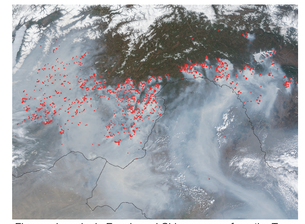
Elevated Smoke Layers from Siberian Fires?



Elevated aerosol layer as seen from Twin Otter on May 27, 2003.



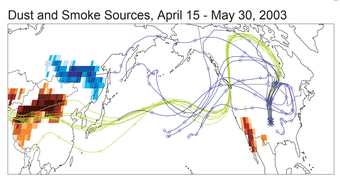
Elevated aerosol layers as observed by MicroPulse lidar on May 27, 2003.



Fires and smoke in Russia and China as seen from the Terra Satellite 05/14/2003 at 03:25 UTC (from http://rapidfire.sci.gsfc.nasa.gov/gallery/)

Rudolph Husar's community website.

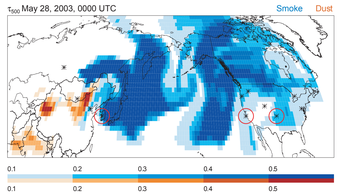
Modeling says "Yes!"



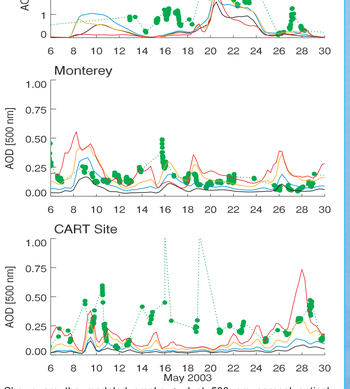
Smoke Emissions: 15.5958 Tg Dust Emissions: 177.925 Tg

0.01 0.02 0.05 0.1 02 0.5 10 20

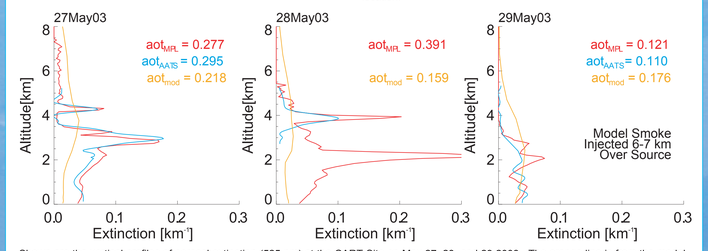
Shown are distributions of dust (red, from Ginoux et al., 2001) and smoke (blue, from FLAMBE, http://www.nrlmry.navy.mil/flambe/) aerosol sources used in the CARMA simulation. Also shown are 10-day back trajectories initialized over the CART Site at 3 km (blue) and 6 km (green) altitude.



Shown is the modeled smoke (blue) and dust (red) AOT (500 nm) over Asia, the north Pacific, and North America on May 28, 2003. Asterisks indicate locations of AERONET observations sites, with circled points indicating the locations of Anmyon Island, Monterey, and the CART Site. The model simulation shown is for smoke injected at 4 - 8 km over the source region. The same simulation is used in subsequent graphs.



Shown are the modeled smoke + dust 500 nm aerosol optical thicknesses (AOT) during May 2003 at Anmyon Island (Korea, 36N, 126 E), Monterey (California, 36 N, 121 W), and the CART Site (Oklahoma, 36 N, 97 W). Sensitivity of the modeled AOT to different assumptions about the smoke injection altitude are indicated with different colored lines. Also shown are cloud-screened AOT observations from AERONET (http://aeronet.gsfc.nasa.gov/) at each location.



Shown are the vertical profiles of aerosol extinction (525 nm) at the CART Site on May 27, 28, and 29 2003. The orange line is from the model, the blue line is from the AATS vertical profile, and the red line is from MPLNET.

The success of this IOP was due to the hard work and dedicated efforts from a large team of ARM and ACP scientists and investigators, CIRPAS Twin Otter and Cessna pilots, crew, and support personnel, SGP site personnel, ARM infrastructure support, weather forecaster, and support from Greenwood aviation at the Ponca City airport. We thank ARM for their support of this IOP.