Publications from Ames Airborne Tracking Sunphotometers

Background. Since 1985 the NASA Ames Airborne Tracking Sunphotometers (AATS-6 and -14) have made extensive measurements of atmospheric constituents via their effect on the Sun's direct-beam transmission through the atmosphere. Constituents measured to date include O_3 [e.g., *Livingston et al.,* 2005; *Pitts et al.,* 2006; *Swartz et al.,* 2005], H_2O [e.g., *Ferrare et al.,* 2000b, 2006; *Livingston et al.,* 1998, 2000, 2003, 2007a, 2008; *Pilewskie et al.,* 2000; *Redemann et al., 2003*; *Revercomb et al.,* 2003; *Schmid et al.,* 2000, 2001; 2003a] and aerosols [see references below]. AATS measurements are used extensively to validate and supplement satellite retrievals of stratospheric and tropospheric constituents (e.g. Table 1), to validate airborne and ground-based lidar data products, to characterize horizontal and vertical distributions of gas and aerosol properties, to study closure (consistency) with in situ samplers aboard many aircraft, to test chemical-transport models, and to study the radiative effects of atmospheric constituents and Earth surfaces that are important to both climate and remote measurements. AATS hardware [e.g., *Matsumoto et al.,* 1987; *Livingston et al.,* 2005], measurements, analyses, and results are described in more than 100 peer reviewed publications. Example publications are listed below, grouped by selected field campaign (see Appendix for acronym definitions):

- **FIFE** [*Spanner et al.,* 1990; *Bruegge et al.,* 1992; *Wrigley et al.*, 1992]
- **AASE II** [*Russell et al.,* 1993; *Toon et al.,* 1993],
- **TARFOX** [*Hegg et al.,* 1997; *Hobbs et al.,* 1998; *Russell et al., 1999a,b; Tanre et al.,* 1999; *Veefkind et al.,* 1999; *Ferrare et al.,* 2000a,b; *Hartley et al.,* 2000; *Ismael et al.,* 2000; *Redemann et al.,* 2000a,b; *Gasso and Hegg*, 2003],

Table 1. Publications using AATS data to validate data products from satellite sensors or their airborne simulators

Sensor, Constituent	Publication	Sensor, Constituent	Publication
AIRS H_2O	*Livingston et al.,* 2007a	MODIS Aerosol	*Livingston et al.,* 2003; *Levy et al.,* 2003, 2005; *Schmid et al.,* 2003b; *Redemann et al.,* 2005, 2006a, 2009; *Chu et al.,* 2005; *Anderson et al.,* 2005; *Russell et al.,* 2007
ATSR-2 Aerosol	*Veefkind et al.,* 1999, *Schmid et al.,* 2003b		
AVHRR Aerosol	*Veefkind et al.,* 1999, *Durkee et al.,* 2000; *Livingston et al.,* 2000; *Schmid et al.,* 2000		
RSP Aerosol (Glory APS Simulator)	*Chowdhary et al.,* 2005; *Knobelspiesse et al.,* 2008, 2011; *Waquet et al.,* 2008	MODIS H_2O	*Livingston et al.,* 2007a
		OMI Aerosol	*Livingston et al., 2009*
GMS-5 Aerosol	*Wang et al,* 2003b	POAM Aerosol	*Russell et al.,* 2005
		POAM O_3	*Livingston et al.,* 2005
GOES-8 Aerosol	*Livingston et al.,* 2003 ; *Wang et al.,* 2003a	SAGE 2 Aerosol	*Russell et al*., 1986; *Livingston and Russell*, 1989
		SAGE 3 Aerosol	*Russell et al.,* 2005
		SAGE 3 O_3	*Livingston et al.,* 2005
GOME O_3	*Livingston et al.,* 2005	SeaWiFS Aerosol	*Hsu et al.,* 2002
MAS Aerosol	*Tanré et al.* 1999		
MISR Aerosol	*Schmid et al.,* 2003b*; Kahn et al.,* 2004; *Redemann et al.,* 2005; *Reidmiller et al.,* 2006;	TOMS Aerosol	*Livingston et al.,* 2003; *Schmid et al.,* 2003b
		TOMS O_3	*Livingston et al.,* 2005

- **ARM Water Vapor IOPs** [*Schmid et al.,* 1999, 2001; *Pilewskie et al.,* 2000; *Revercomb et al.,* 2003],
- **ACE-2** [*Livingston et al.,* 2000; *Schmid et al.*, 2000; *Collins et al.,* 2000; *Durkee et al.,* 2000; *Russell and Heintzenberg,* 2000; *Welton et al.,* 2000; *Gasso and Hegg*, 2003],
- **PRIDE** [*Colarco et al.,* 2003; *Livingston et al.,* 2003; *Reid et al.,* 2003; *Wang et al.,* 2003a],
- **SAFARI-2000** [*McGill et al.,* 2002; *Bergstrom et al.,* 2003; *Gatebe et al.,* 2003; *Kaufman et al.,* 2003; *Magi et al.,* 2003, 2008; *Pilewskie et al.,* 2003; *Schmid et al.,* 2003b; *Kuzmanoski et al.,* 2007c],
- **ACE-Asia** [*Wang et al.,* 2002; *Huebert et al.,* 2003; *Murayama et al.,* 2003; *Redemann et al.,* 2003; *Schmid et al.,* 2003a; *Wang et al.,* 2003b; *Bergstrom et al.,* 2004; *Kahn et al.,* 2004; *Anderson et al.,* 2005; *Chu et al.,* 2005; *Gasso and O'Neill*, 2006; *Kuzmanoski et al.,* 2007a,b],
- **CLAMS** [*Chowdhary et al.,* 2005; *Gatebe et al.,* 2005; *Jin et al.,* 2005; *Levy et al.,* 2005; *Magi et al.,* 2005; *Redemann et al.,* 2005; *Reidmiller et al.,* 2006; *Smith et al.,* 2005],
- **SOLVE II** [*Livingston et al.,* 2005; *Pitts et al.,* 2006; *Russell et al.,* 2005; *Swartz et al.,* 2005],
- **ARM Aerosol IOP** [*Andrews et al.,* 2006; *Ferrare et al.,* 2006; *Hallar et al.,* 2006; *Ricchiazzi et al.,* 2006; *Schmid et al.,* 2006; *Strawa et al.,* 2006],
- **EVE** [*Redemann et al.,* 2006a],
- **INTEX-A** [*Coddington et al.,* 2010; *Fehsenfeld et al.,* 2006; *Livingston et al.,* 2007; *Redemann et al.,* 2006b; *Russell et al.,* 2007; *Singh et al.,* 2006].
- **ALIVE** [*Knobelspiesse et al.,* 2008; *Waquet et al.,* 2008; Schmid et al., 2009]
- **INTEX-B/MILAGRO** [*Bergstrom et al.,* 2010; *Chowdhary et al.,* 2010; *Coddington et al.,* 2008; *Livingston et al.,* 2009; *Molina et al.,* 2010; *Redemannet al.,* 2009; *Russell et al., 2010; Schmidt et al.,* 2010].
- **ARCTAS** [*Lyapustin et al.,* 2010; *Shinozuka et al.,* 2011; *Shinozuka and Redemann*, 2011].

Other publications combine AATS results from different campaigns [e.g., *Russell et al.,* 1993a, 2002, 2004, 2010; *Durkee et al.,* 1998].

In several of the above field campaigns, AATS AOD measurements in the UV, visible, and near IR (out to 1 μm) have been extensively compared to ground-based AERONET measurements, yielding very strong correlations (r^2>0.99) and rms differences generally less than 10% [e.g., *Schmid et al*., 2003a; *Livingston et al.,* 2003, *Redemann et al*., 2005]. Measurements of AATS column water vapor (CWV) agreed with other suborbital CWV measurements at least to within 10% [*Schmid et al*., 2001; *Livingston et al.,* 2007, 2008].

AATS measurements have been used to characterize the spectral optical depth of oil- and forest-fire smokes and thin clouds [*Pueschel et al., 1988; Pueschel and Livingston*, 1990], to describe the impact of tropospheric haze aerosols on remote measurements of the Earth's surface [*Spanner et al.,* 1990; *Bruegge et al.,* 1992; *Wrigley et al.*, 1992; *Gatebe et al.,* 2003, 2005; *Knobelspiesse et al.,* 2008; *Coddington et al.,* 2008; *Lyapustin et al., 2010*; *Schmidt et al.,* 2010], and to document the effect of the 1991 Pinatubo volcanic eruption on global-scale stratospheric aerosol optical depth spectra [*Russell et al.*, 1993a,b, 1996; *Toon et al.,* 1993; *Pueschel et al.,* 1994].

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Appendix: Acronyms

AASE	Airborne Arctic Stratospheric Expedition
AATS	Ames Airborne Tracking Sunphotometer
ACE	Aerosol Characterization Experiment
AERONET	Aerosol Robotic Network
AIRS	Atmospheric InfraRed Sounder
AOD	Aerosol Optical Depth
ARCTAS	Arctic Research of the Composition of the Troposphere from Aircraft and Satellites
ARM	Atmospheric Radiation Measurement
ATSR	Along Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CLAMS	Chesapeake Lighthouse & Aircraft Measurements for Satellites
CWV	Column Water Vapor
DIAS	Direct beam Irradiance Airborne Spectrometer
EOS	Earth Observation System
EVE	Extended-MODIS-λ Validation Experiment
FIFE	First ISLSCP Field Experiment
GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellite
GOME	Global Ozone Monitoring Experiment
INTEX or INTEX-NA	Intercontinental Chemical Transport Experiment-North America
INTEX-A or -B	Phase A or B of INTEX-NA
IOP	Intensive Observation Period
ISLSCP	International Satellite Land Surface Climatology Project
ITCT	Intercontinental Transport and Chemical Transformation
J-31	Jetstream 31
LWV	Layer Water Vapor
MAS	MODIS Airborne Simulator
MILAGRO	Megacity Initiative: Local and Global Research Observations
MISR	Multi-Angle Imaging Spectroradiometer
MODIS	Moderate-resolution Imaging Spectroradiometer
MW	Multi-Wavelength
NIR	Near Infra-Red
OMI	Ozone Monitoring Instrument
PNNL	Pacific Northwest National Laboratory
POAM	Polar Ozone and Aerosol Measurement
ROSES	Research Opportunities in Space and Earth Sciences
RSP	Research Scanning Polarimeter
SAGE	Stratospheric Aerosol and Gas Experiment
SCIA-MACHY	SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SSA	Single Scattering Albedo
SSFR	Solar Spectral Flux Radiometer
4STAR	Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research
TARFOX	Tropospheric Aerosol Radiative Forcing Observational Experiment
TOMS	Total Ozone Mapping Spectrometer
UAS	Unmanned Aerial System
UV	Ultraviolet