The Aerosol Lidar Validation Experiment – ALIVE

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Introduction

The Aerosol Lidar Validation Experiment (ALIVE), a collaborative effort between the Atmospheric Radiation Measurement (ARM) Program and National Aeronautics and Space Administration (NASA), took place in September 2005 at the Southern Great Plains (SGP) site. The major goal of the experiment was to collect airborne remote sensing data on atmospheric aerosols for validation studies of the SGP Raman lidar and micropulse lidars. The airborne data were collected by the NASA Ames Airborne Tracking 14-Channel Sunphotometer (AATS-14) flown aboard a Jetstream-31 research aircraft from Sky Research.

Before ALIVE, the 2003 Aerosol Intensive Operational Period (AIOP) at the SGP site provided one of the best measurement sets obtained to date for evaluating the scientific capability for measuring the vertical profile of ambient aerosol extinction in the lower troposphere (Schmid et al. 2006). However, validation results showed that an undetected loss of sensitivity of the SGP Raman lidar had occurred leading up to the AIOP, resulting in a significant high bias in derived aerosol extinction (Ferrare et al. 2006). Major upgrades were made to the Raman lidar in 2004 to restore and improve its data-gathering capabilities and sensitivity (Turner and Goldsmith 2005). To prove the integrity of the entire Raman lidar aerosol extinction record, data obtained by the AATS-14 during ALIVE are compared against the upgraded Raman lidar.

Measurements

Logging 20 flight hours between September 11 and 22, 2005, the Jetstream-31 conducted 12 flights over the SGP site (Figure 1). Five of these flights coincided with the flights by a new ARM in situ aerosol profile aircraft, the Cessna Turbo 206, to help evaluate the performance of instruments for collecting in situ aerosol profile measurements. Onboard the Jetstream-31, the AATS-14 obtained more than 40 vertical profiles at altitudes between 500 ft and 23,000 ft from spiral ascents and descents. Cirrus clouds presented a major obstacle for the radiation instruments aboard the Jetstream-31, although considerable efforts were made to minimize their effect through timing of the vertical profiles using various forecasting and nowcasting tools. The Research Scanning Polarimeter (RSP, Cairns et al. 1999)

Figure 1. Optical head of AATS-14 mounted external to the J-31 aircraft skin.

instrument from NASA's Goddard Institute for Space Studies also operated aboard the Jetstream-31 as a piggyback instrument, contributing an additional three flight hours to the ALIVE field campaign, and provided multi-spectral measurements of the upwelling polarization and radiance.

Results

Final calibrations are underway or have been completed for many of the instruments involved in ALIVE. As an example, the AATS-14 was calibrated before ALIVE at the Mauna Loa Observatory in Hawaii (11,000 ft above sea level) using a technique known as Langley plots (Schmid and Wehrli 1995). At the conclusion of ALIVE, it was sent there again for final calibration which is being refined further by inspecting the measurements taken at the highest altitude flight legs during ALIVE.

Instruments involved in ALIVE and their calibration and archival status are listed in Table 1.

Table 1. Calibration and archival status (as of 6/19/2006) of instruments involved in ALIVE.

Instrument	Calibration	Archival
Raman	Near Final	Prelim
MPL004	Prelim	Not yet
MPL102	Prelim	Prelim
RSP	Final	Prelim
AATS-14	Near Final	Prelim
J-31 Nav/Att	Final	Final
J-31 Met	Final	Prelim
USDA MFRSRs	Final	Final
MFRSR C1, E13	Final	Final
NIMFR	Instrument failed	No
RSS 105	Final	Prelim
Cimel	Final	Final
IAP C206	Final	Final

The 40 vertical profiles flown over the SGP Central Facility resulted in 29 AATS-14 aerosol profiles with collocated and concurrent micropulse and Raman lidar data. This is a major improvement over the situation in AIOP, where only 11 (Raman) and 19 (MPL) profiles were available for comparison.

Figure 2 shows a very preliminary comparison of aerosol extinction between AATS-14 and Raman and micropulse lidars during ALIVE (hatched bars). For comparison, results from the AIOP in 2003 (see Schmid et al. 2005) are shown as solid bars.

From Figure 2 it is obvious that the refurbishment of the Raman lidar led to a considerably better agreement with AATS-14. Note that the first and second bars from left use retrievals from the Raman lidar backscatter signals whereas the third bar from left uses the Raman shifted N2 returns. This latter retrieval technique was impossible to apply for the measurements with the much less sensitive Raman lidar during AIOP. The agreement between MPLARM and AATS-14 is also improved when compared to prior AIOP results.

The J-31 did not carry in situ aerosol sensors. However a comparison with such sensors carried by the Cessna 206 is planned for the coordinated flights.

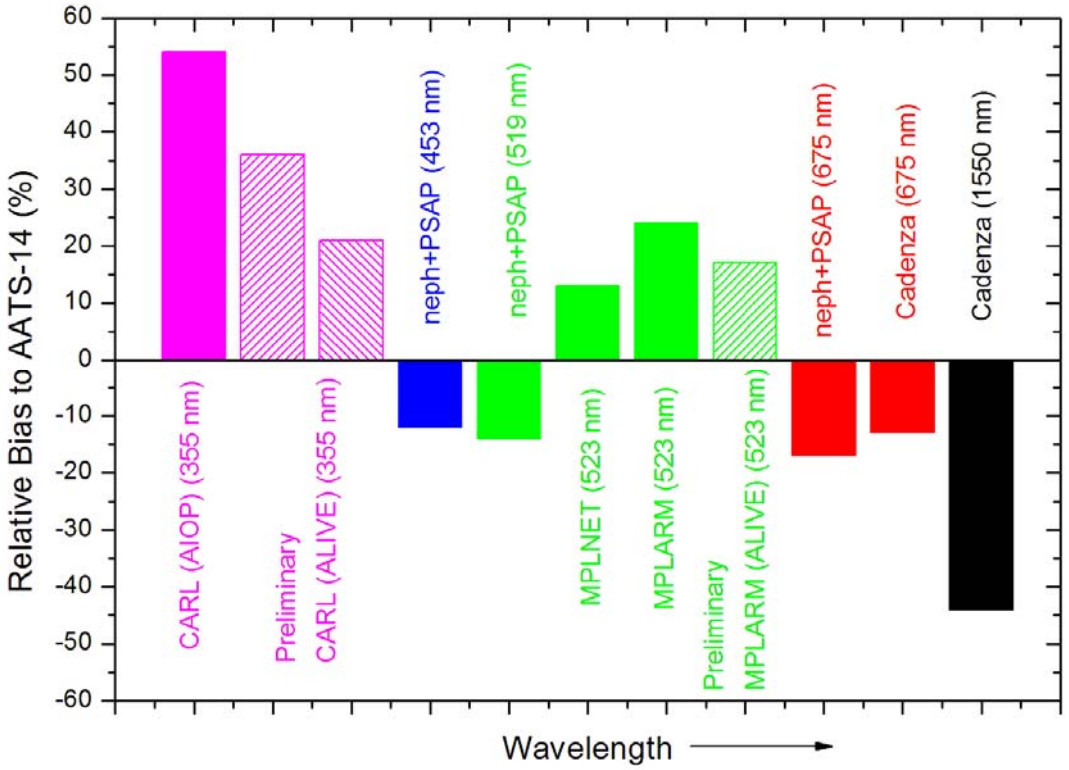

Figure 2. Preliminary comparison of aerosol extinction between AATS-14 and Raman and micropulse lidars during ALIVE (hatched bars). For comparison, results from the AIOP in 2003 (see Schmid et al. 2005 and 2006) are shown as solid bars. First and second bars from left use retrievals from the Raman lidar (CARL) backscatter signals whereas the third bar from left uses the Raman shifted N_2 returns.

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