Validation of CALIPSO Lidar Observations Using Data From the NASA Langley Airborne High Spectral Resolution Lidar

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Overview

This poster focuses on preliminary comparisons of data from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument on the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) spacecraft with data acquired by the NASA Langley Airborne High Spectral Resolution Lidar (HSRL). A series of 20 aircraft validation flights was conducted from 14 June through 27 September 2006, under both day and night lighting conditions and a variety of aerosol and cloud conditions. This poster presents comparisons of CALIOP measurements of attenuated backscatter at 532 and 1064 nm and depolarization at 532 nm with near coincident measurements from the Airborne HSRL as a preliminary assessment of CALIOP calibration accuracy.

Note that the CALIOP data presented here are the *pre-release* version. These data have known artifacts in calibration which have been corrected in the December 8 CALIPSO data release which was not available at the time the comparisons were conducted for this poster. The HSRL data are also preliminary. No artifacts are known to exist; however, refinements in calibration and algorithms are likely to be implemented before validation comparisons are made final.

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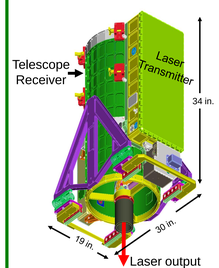
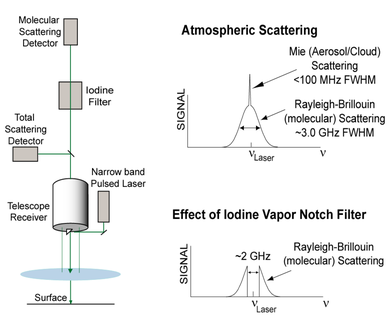
Airborne High Spectral Resolution Lidar

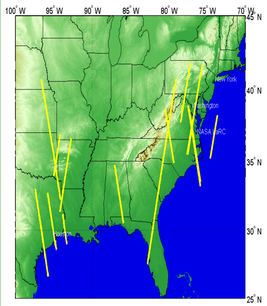


- Independently measures aerosol/cloud extinction and backscatter at 532 nm
- Includes
  - Backscatter channels at 1064 nm
  - Polarization sensitivity at 532 and 1064 nm
- Measurement capabilities
  - Extensive measurements
    - Backscatter at 532 and 1064 nm
    - Extinction at 532 nm
  - Intensive measurements
    - Color ratio (or Angstrom coeff.) for backscatter (β_{1064}/β_{532})
    - Extinction-to-backscatter ratio at 532 nm
    - Depolarization at 532 and 1064 nm

HSRL via Iodine Vapor Filter Technique



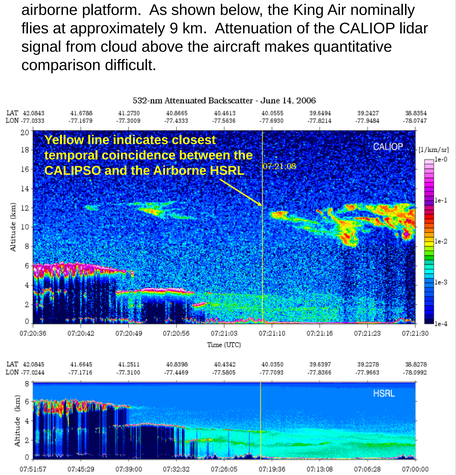
Validation Methodology



- 20 CALIPSO validation flights conducted between June 14 – Sept 27, 2006
  - –8 night flights
  - –12 day flights
  - –5 flights coordinated with other platforms on TexAQS/GoMACCS
- Validation Instrument: Airborne High Spectral Resolution Lidar
- Aircraft Platform: NASA Langley King Air B-200

Quantitative CALIOP-HSRL Comparisons

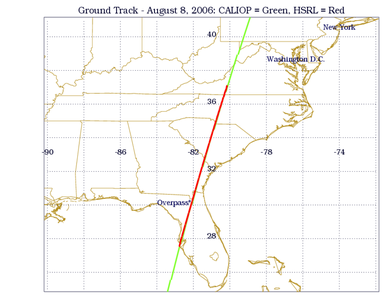
Quantitative HSRL-CALIOP data comparisons are possible only for portions of flight tracks that are cloud-free above the airborne platform. As shown below, the King Air nominally flies at approximately 9 km. Attenuation of the CALIOP lidar signal from cloud above the aircraft makes quantitative comparison difficult.

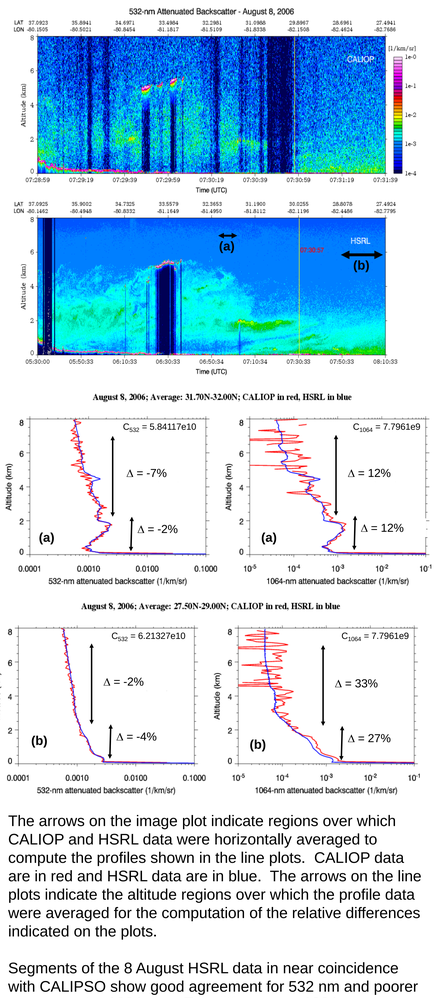


To provide a preliminary assessment of CALIOP calibration, we present comparison of *attenuated* backscatter coefficients as defined by the Level 1B CALIOP data product. The CALIOP data are calibrated at 30 km, and the Level 1B attenuated backscatter coefficient computed for any altitude includes an attenuation factor accounting for the two-way transmittance from 30 km to the altitude of the sample. The Airborne HSRL is flown nominally at 9 km and internally calibrated at a point just below the aircraft. To put HSRL data on an equal footing with CALIOP, the HSRL data must be converted to include attenuation from 9 to 30 km. This is accomplished by factoring in the attenuation of the lidar signal estimated from a clear air model atmosphere.

HSRL attenuated backscatter + HSRL true aerosol backscatter + Density Profile → Attenuated total backscatter with attenuation referenced to 30 km as per CALIOP

8 August 2006 Nighttime Comparison

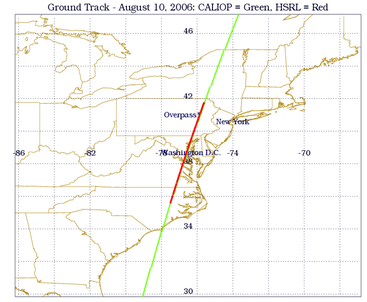


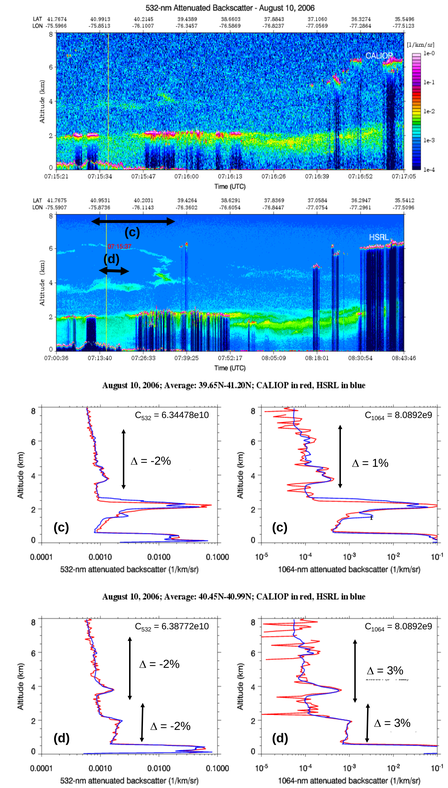


The arrows on the image plot indicate regions over which CALIOP and HSRL data were horizontally averaged to compute the profiles shown in the line plots. CALIOP data are in red and HSRL data are in blue. The arrows on the line plots indicate the altitude regions over which the profile data were averaged for the computation of the relative differences indicated on the plots.

Segments of the 8 August HSRL data in near coincidence with CALIPSO show good agreement for 532 nm and poorer agreement for 1064 nm. The difference at 1064 nm will be investigated when after the CALIOP data are reprocessed to fix known calibration artifacts.

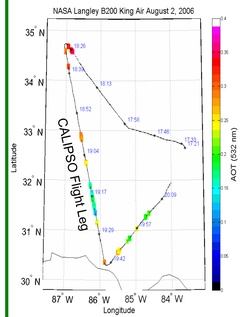
10 August 2006 Nighttime Comparison



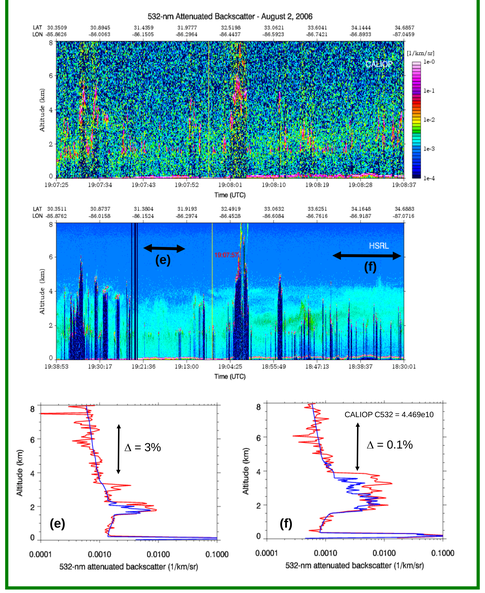


The selected segments of the 10 August HSRL data in near coincidence with CALIPSO show excellent agreement at both the 532 and 1064 nm wavelengths. In the top line plot figure, the quantitative comparisons were limited to regions above boundary layer clouds. Because of the rapidly varying nature of boundary layer clouds and the unavoidable temporal mismatch between the satellite and aircraft based measurements, boundary layer clouds provide a poor target for calibration assessment.

2 August 2006 Daytime Comparison



CALIOP data have significantly higher noise under day lighting conditions as seen in the image plot from the 2 August flight over Alabama. The CALIOP calibration constant is determined during the night portion of the obit and interpolated across the day side. The HSRL data indicate that the interpolated CALIOP 532-nm calibration constant was very accurate for this case.



Future Plans

- Quantitative comparisons for all validation flights
  - Incorporate cloud clearing into both CALIOP and HSRL data set for more accurate calibration comparisons
- CALIOP Calibration assessment
  - 532 and 1064 nm total backscatter
  - Depolarization ratio
- Assessment of CALIPSO Level 2 products
  - Cloud-aerosol discrimination
  - S_a selection
  - Aerosol backscatter
  - Aerosol extinction
  - Aerosol depolarization
  - Layer base/top altitudes
  - Recalibration below layers
- Assessment of new algorithms using HSRL data for test cases