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

Chris Hostetler1, Johnathan Hair2, Zhaoyan Liu3, Rich Ferrare1, David Harper1, Anthony Cook1, Mark Vaughan2, Chip Trepte1, David Winker1

(1) NASA Langley Research Center, MS401A Hampton, Virginia, 23681-2199, USA. Email Chris.A.Hostetler@nasa.gov (2) National Institute for Aerospace (3) Science Systems and Applications Inc.

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.

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.

Validation Methodology

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 aircraft altitude. The airborne HSRL is flown nominally at 9 km and is 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.

The arrows on the image plot indicate regions over which the profiles shown in the line plots. CALIOP 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 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 uncorrelated temporal mismatch between the satellite and aircraft based measurements, boundary layer clouds provide a poor target for calibration assessment.

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 assessments
    - 532 and 1064 nm total backscatter
    - Inclination ratio
    - Assessment of CALIOP Level 2 products
    - Cloud-aerosol discrimination
    - Aerosol backscatter
    - Aerosol extinction
    - Aerosol depolarization
    - Cloud and aerosol properties
  - Assessment of new algorithms using HSRL data for test cases

Airborne High Spectral Resolution Lidar

- Independently measures aerosol/cloud extinction and backscatter at 532 and 1064 nm
- Includes backscatter channels at 1064 nm
- Inclination sensitivity at 532 and 1064 nm
- Measurement capabilities
  - Extensive measurements
  - Backscatter at 532 and 1064 nm
  - Detections at 532 nm
- Intensive measurements
  - Cloud (or aerosol) size
  - Backscatter (true signal)
- Total extinction coefficient at 1064 nm
- Depolarization at 532 and 1064 nm

HSRL via Iodine Vapor Filter Technique

- Atmospheric backscatter
  - Hygrometer (uncalibrated)
  - Water Vapor
- Effect of Iodine Vapor Filter
  - Dry Air
  - Humid Air
- Attenuated total backscatter with attenuation referenced to 30 km as per CALIOP

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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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