Validation of CALIOP Aerosol Backscatter and Extinction Profile Products Using Airborne High Spectral Resolution Lidar Data


NASA B-200 in Barrow, AK

Raymond R. Rogers[1], Chris A. Hostetler[1], Richard A. Ferrare[1], John W. Hair[1], Michael D. Obland[1], Anthony L. Cook[1], David B. Harper[1], Amy J. Swanson[2]

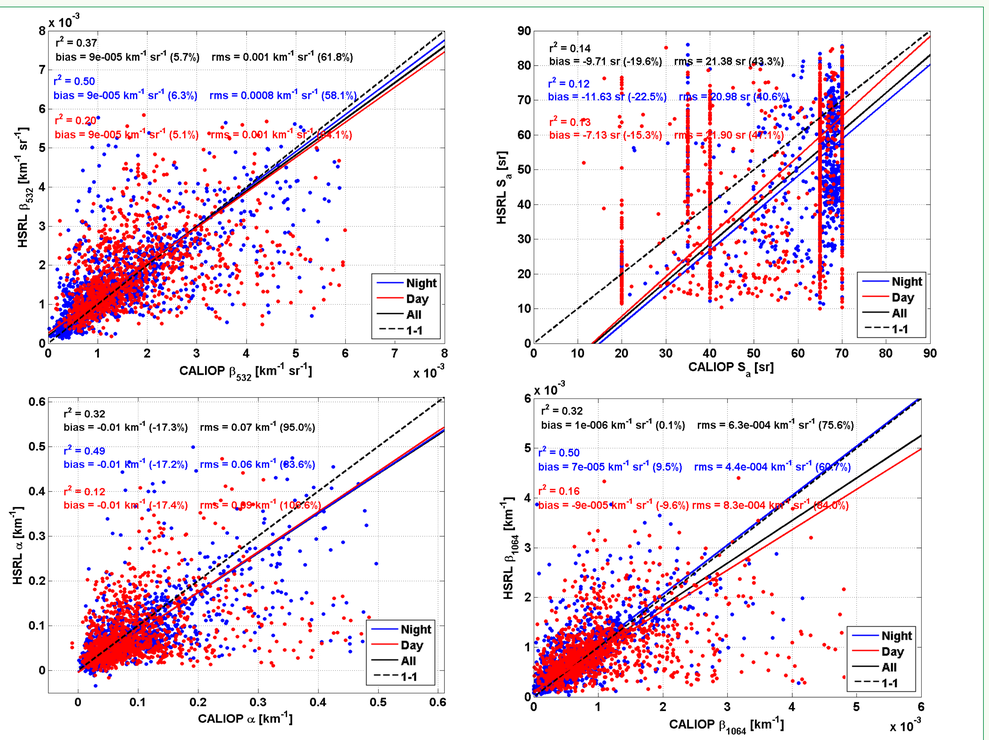
[1]NASA Langley Research Center, Hampton, VA

[2]SSAI/NASA Langley Research Center, Hampton, VA

Objectives and Flight Summary:

The NASA Langley airborne High Spectral Resolution Lidar (HSRL) has been deployed on 86 coincident underflights of the CALIPSO satellite, providing a unique, large validation database of well calibrated data products at 532 nm and 1064 nm: attenuated backscatter, backscatter, extinction, aerosol and total depolarization, and lidar ratio (532 nm only). These products have been used to assess CALIOP Level 2 backscatter, extinction, and AOD.

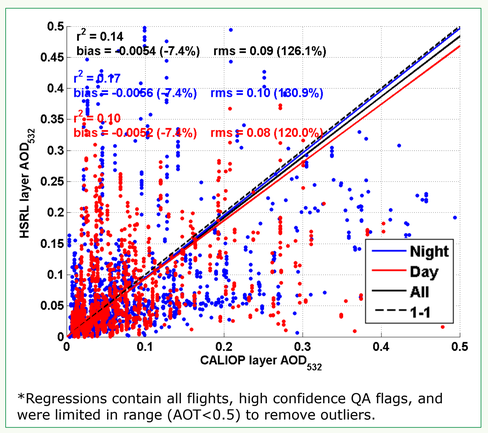
HSRL / CALIOP Aerosol Profile Regressions:



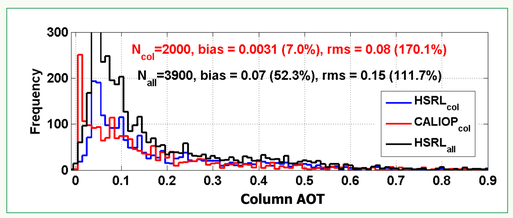
*Regressions contain all flights, high confidence QA flags, and were limited in range to remove outliers.

- Nighttime only (blue points) regressions generally show better agreement in extensive parameters than the noisier daytime only (red points) regressions.
- The lidar ratio scatter plot shows a large range of lidar ratios measured by HSRL for any given CALIOP lidar ratio.
- The 1064 nm aerosol backscatter also shows promising results given the uncertainty in channel calibration.

Aerosol Layer/Column Optical Thickness Study:



*Regressions contain all flights, high confidence QA flags, and were limited in range (AOT<0.5) to remove outliers.

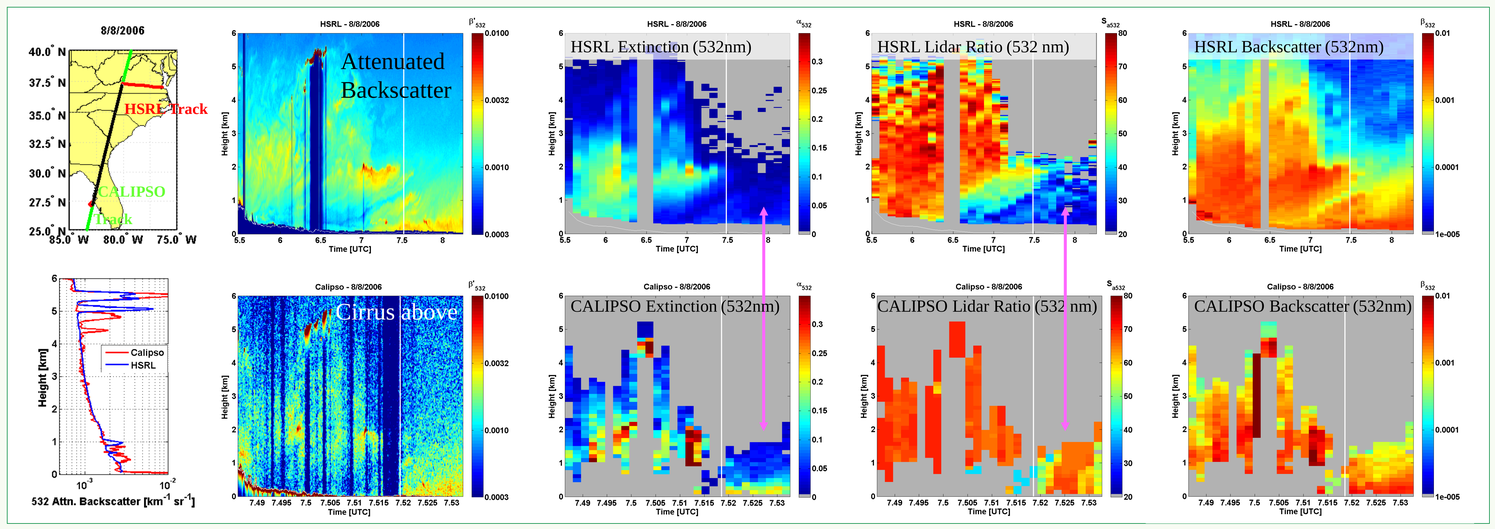


- CALIOP overestimates amount of low AOT (<0.04).
- Poor AOT correlation (daytime and nighttime).

Summary:

- Good overall HSRL/CALIOP statistical agreement for extinction, backscatter, and AOT, however on a profile by profile comparison the rms errors can be large (especially in the daytime). The errors in 532 nm extinction are larger than 532 nm backscatter, likely due to the lidar ratio selection.
- CALIOP misses thin aerosol layers which may be improved by longer averaging schemes in some regions (e.g. Arctic aerosols that were spread throughout troposphere).
- CALIOP AOT should be used with caution, especially for thin layers (AOT< ~0.04).

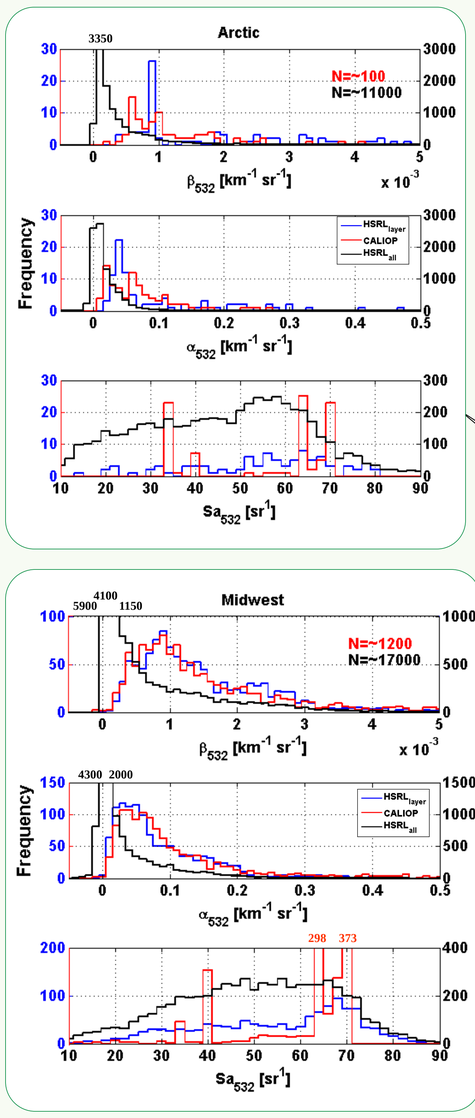
Example Flight: HSRL/CALIPSO Level 2 validation on 8/8/2006



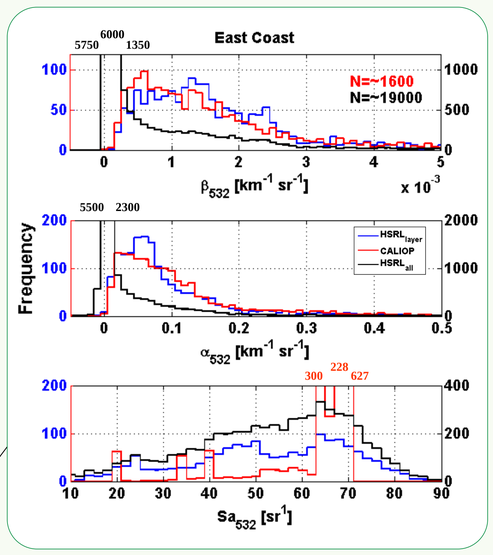
Qualitatively good agreement seen between CALIOP level 2 aerosol profile products and HSRL (averaged to 40km). CALIOP identifies the change in lidar ratio but misidentifies the type near 7.53 UTC, causing higher retrieved extinctions than measured by HSRL.

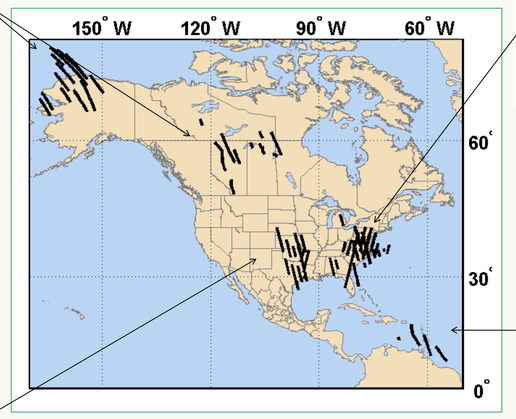
Statistical Aerosol Profile Comparisons:

There is good overall agreement between CALIOP and HSRL extinction and backscatter for a wide range of aerosol scattering and lidar ratios, though CALIOP does not detect all layers. Red/blue lines represent regions where both CALIOP and HSRL detected aerosols. Black lines show statistics where HSRL detected aerosols along the CALIOP track.

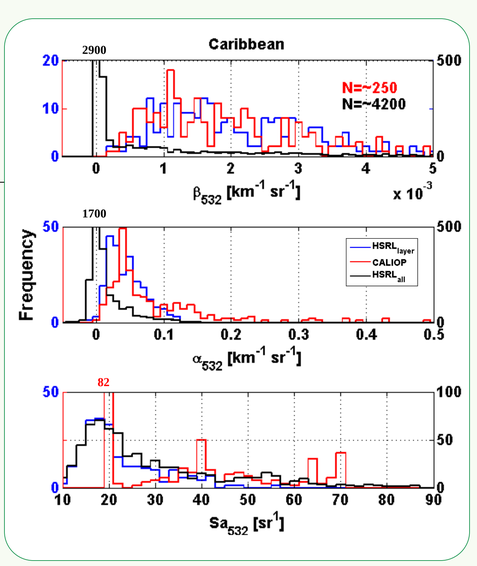


- Excellent backscatter and extinction agreement in the East Coast and Midwest regions (trimodal lidar ratio distribution)
- Thin aerosol in the free troposphere is often below CALIOP detection threshold (we estimate this to be ~0.3x10^{-3} km^{-1} sr^{-1}).





- Arctic aerosols are diffuse and primarily below CALIOP detection threshold.
- CALIOP captures maritime dominated lidar ratio in the Caribbean



Acknowledgements: We gratefully acknowledge the NASA Langley Flight Research Service Directorate for their support of B200 flight operations. Support for the HSRL and the analyses of these data was provided by: the NASA Science Mission Directorate, the NASA CALIPSO project, and the Office of Science (BER), U. S. Department of Energy (Atmospheric Science Program), Interagency Agreement No. DE-AI02-05ER6398