LITE Correlative Measurements and Multiple Scattering Estimates Using Airborne Lidar Systems

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As the first atmospheric lidar in space, LITE provided the opportunity to demonstrate the advantages of making active remote measurements from space as well as to uncover some of the aspects of these measurements that will allow for the improvement of future space-based lidar systems. This paper discusses the importance of using airborne lidar measurements to validate spaceborne lidar measurements; results associated with comparisons of airborne lidar and LITE aerosol measurements; and the contribution of multiple scattering (MS) to increasing the optical depth of aerosol layers measured by LITE.

For the LITE correlative measurements program, the NASA Langley airborne UV DIAL (Differential Absorption Lidar) system was reconfigured to generate the same laser wavelengths as LITE, and it was flown on the NASA Electra aircraft over the eastern U.S. and the Caribbean during four LITE overpasses. In addition, the LASE (Lidar Atmospheric Sensing Experiment) system was also being flown on the NASA ER-2 aircraft in the vicinity of Wallops Island, Virginia, and it was flown under LITE on orbit 117. The aerosol and cloud measurements from both the airborne lidar systems showed that the LITE measurements were nearly identical to them except for the additional signal with penetration into the aerosol layers coming from MS.

The underflight for LITE orbit 117 afforded the best opportunity to investigate the magnitude of the MS in the PBL, and significant (50%) MS was found at optical depths of 0.4. These results are somewhat higher than was calculated for a similar lidar measurement geometry by Spinhirne [1982]. Implications for future space-based lidar experiments are discussed.

References:

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Spaceborne Lidar Correlative Measurements for Tropospheric Aerosols

- **Simultaneous multiple-wavelength lidar measurements of major tropospheric aerosol types--requires airborne lidar measurements in remote regions not covered by ground stations.**

- **Measurements are required of aerosols over important ecological regions & phenomena impacting large atmospheric regions.**

Figure 1. Requirement for airborne lidar measurements of tropospheric aerosols in spaceborne lidar validation program.

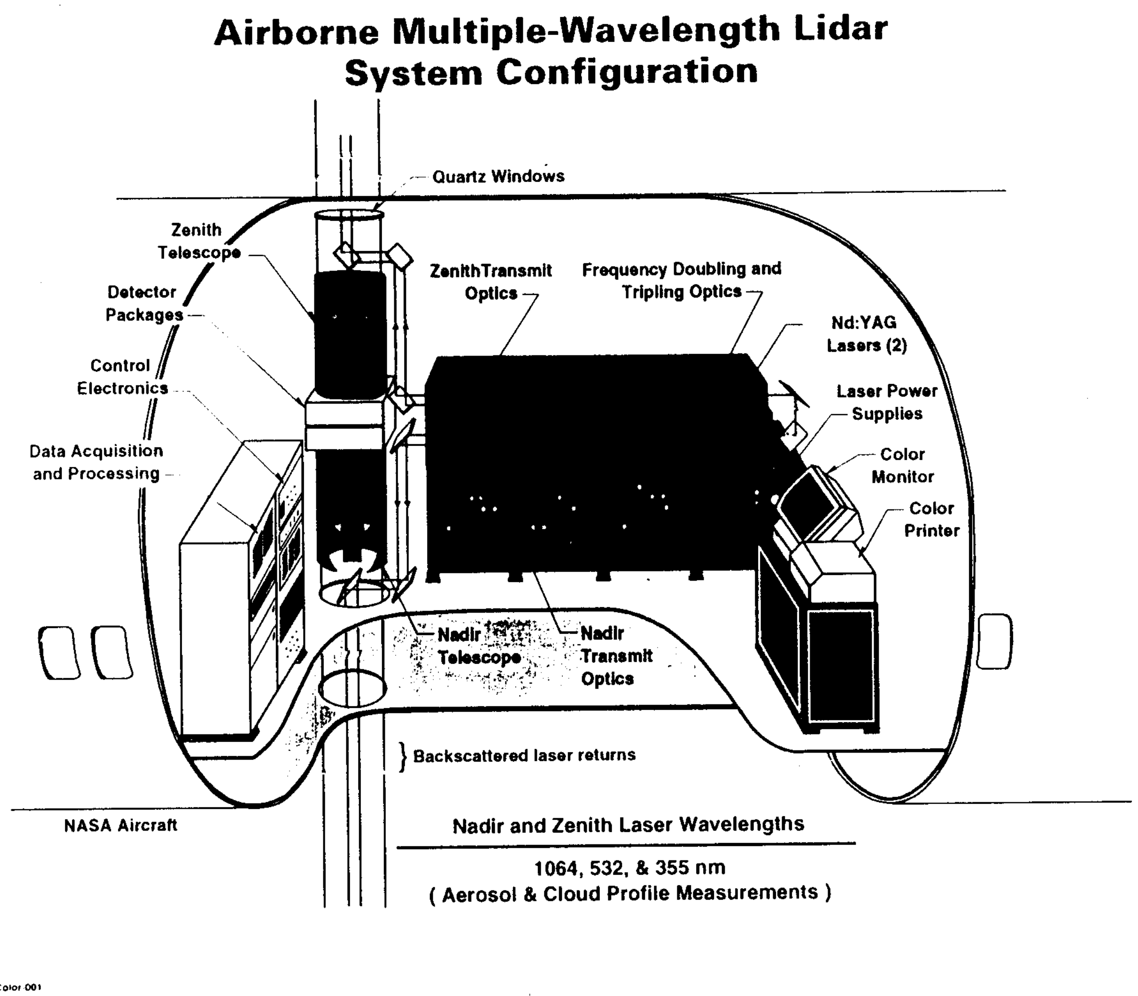

Figure 2. Modified configuration of UV DIAL system for nadir and zenith lidar measurements of aerosols and clouds at the same wavelengths as LITE.

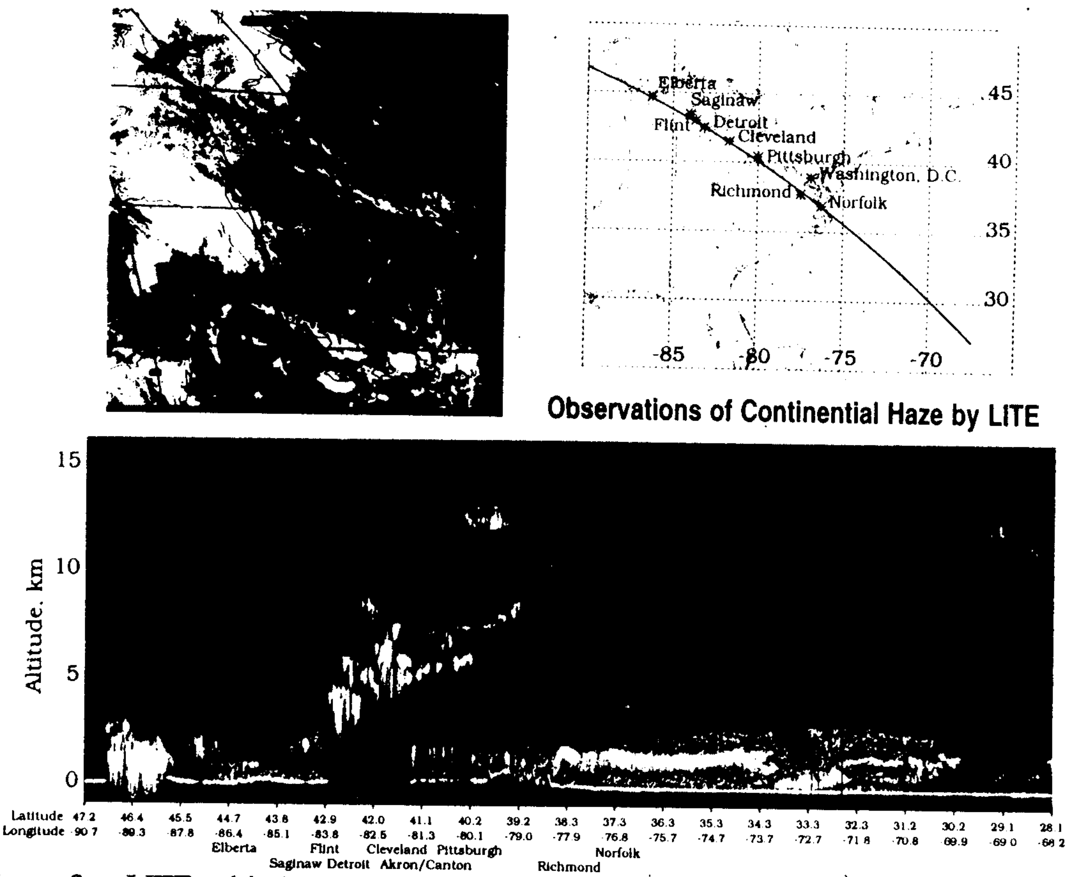

Figure 3. LITE orbit 117: LITE orbit track (top right), GOES cloud image of same region (top left), and LITE aerosol and cloud backscatter measurement along ground track.

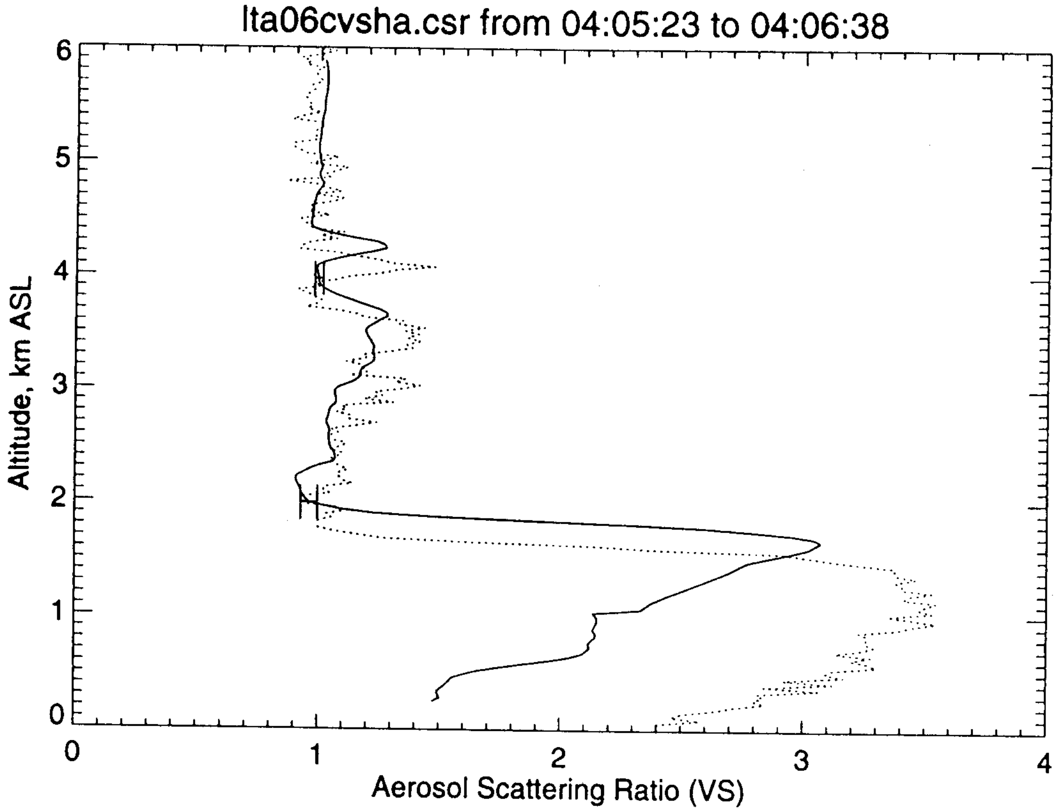

Figure 4. Comparison of UV DIAL aerosol scattering ratio profile (solid line) at 532 nm and the coincident LITE aerosol scattering ratio profile (dashed line). The profiles need to be adjusted by about 200 m to correct for relative altitude error between the profiles. The higher level of scattering in the PBL is due to MS in the LITE measurement due to a large field of view.

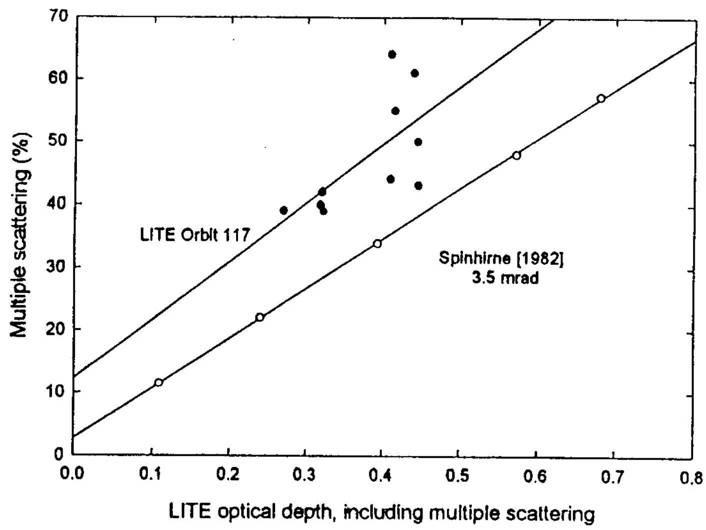

Figure 5. Initial estimate of LITE MS derived from comparison of LITE and UV DIAL 532 nm data. MS estimates as a function of optical depth for orbit 117 is given as solid circles. A regression line is also shown through the data. An estimate of the LITE system MS derived from the results of Spinhirne [1982] is also shown.

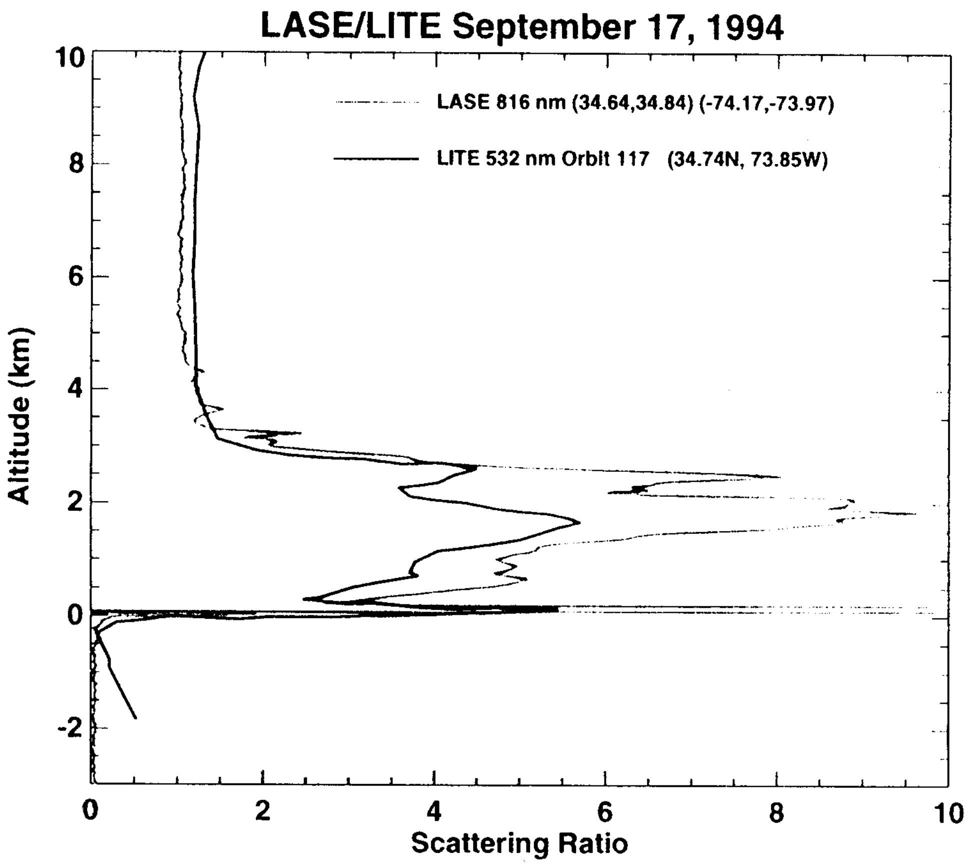

Figure 6. Comparison of LASE and LITE atmospheric scattering ratio profiles. The LASE measurement is at 816 nm while the LITE measurement is at 532 nm. Thus, because LASE is at the longer wavelength, it has a higher scattering ratio across the aerosol layer. While the aerosol feature compare well between the two measurements, there is still evidence for MS in the LITE data below 2 km (LASE data has more attenuation in this region with no MS; while the LITE data shows less attenuation due to MS effect.