Design and Performance of LITE

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The Lidar In-space Technology Experiment (LITE) was developed by NASA Langley Research Center as an experiment to demonstrate applications of space lidar to remote sensing of the Earth's atmosphere. LITE was flown as part of the STS-64 mission September 1994. Observations of clouds and aerosols were acquired between 57N and 57S on 10 days of the mission.

The LITE instrument is built around a 1-meter diameter telescope and a Nd:YAG laser. The laser primary wavelength is doubled and tripled and the return signals at all three wavelengths are sampled simultaneously. Photomultiplier tube (PMT) detectors are used at 355 nm and 532 nm, and an analog avalanche photodiode detector at 1064 nm. On orbit, the lidar was observed to have a higher than expected capability to penetrate cloud. While more than 70% of the profiles detected clouds, the return signal was able to penetrate to the surface about 60% of the time.

The LITE mission plan was carefully designed to take the best advantage of a limited duration mission. Operating times and instrument configurations were chosen to optimize observing opportunities, within the constraints imposed by other components of the STS-64 mission. Part of the mission plan was an international correlative measurements campaign, which included extensive participation of the European and Japanese lidar communities. This campaign has provided a large number of observations from groundbased and airborne lidars, as well as a variety of other types of instruments, with which to validate LITE.

References:

D. M. Winker, R. H. Couch, and M. P. McCormick, 'An overview of LITE: NASA's Lidar In-space Technology Experiment', Proc. IEEE 84, 164-180, 1996.

D. M. Winker, Observations of the vertical distribution of cloud using space lidar. Proceedings of the 9th AMS Conference on Atmospheric Radiation, p422-425, 1997.

D. M. Winker, LITE: Results, performance, characteristics, and data archive. in Laser Radar Ranging and Atmospheric Lidar Techniques, U. Schreiber, C. Werner, Eds. (European Symposium on Aerospace Remote Sensing, London, UK, 22-26 Sept 1997), Proceedings of SPIE vol. 3218, 186-193, 1997.

D. M. Winker, Application of space lidar to the remote sensing of clouds and aerosols. Proceedings of IGARSS '97 Singapore, August 1997.

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Science Objectives

- Clouds
  - vertical distribution
  - vertical structure and overlap of multilayer clouds
  - optically thin clouds
  - optical properties
- Aerosols: troposphere and stratosphere
  - sources and transport
  - optical properties
- Planetary Boundary Layer: height and structure
  - study the role of PBL in the transfer of heat, moisture, and momentum between ocean and atmosphere
- Stratospheric Density and Temperature
- Surface Reflectance
  - ocean: surface roughness, winds
  - land: calibration, lidar vegetation index

Figure 1. Science objectives of the LITE mission.

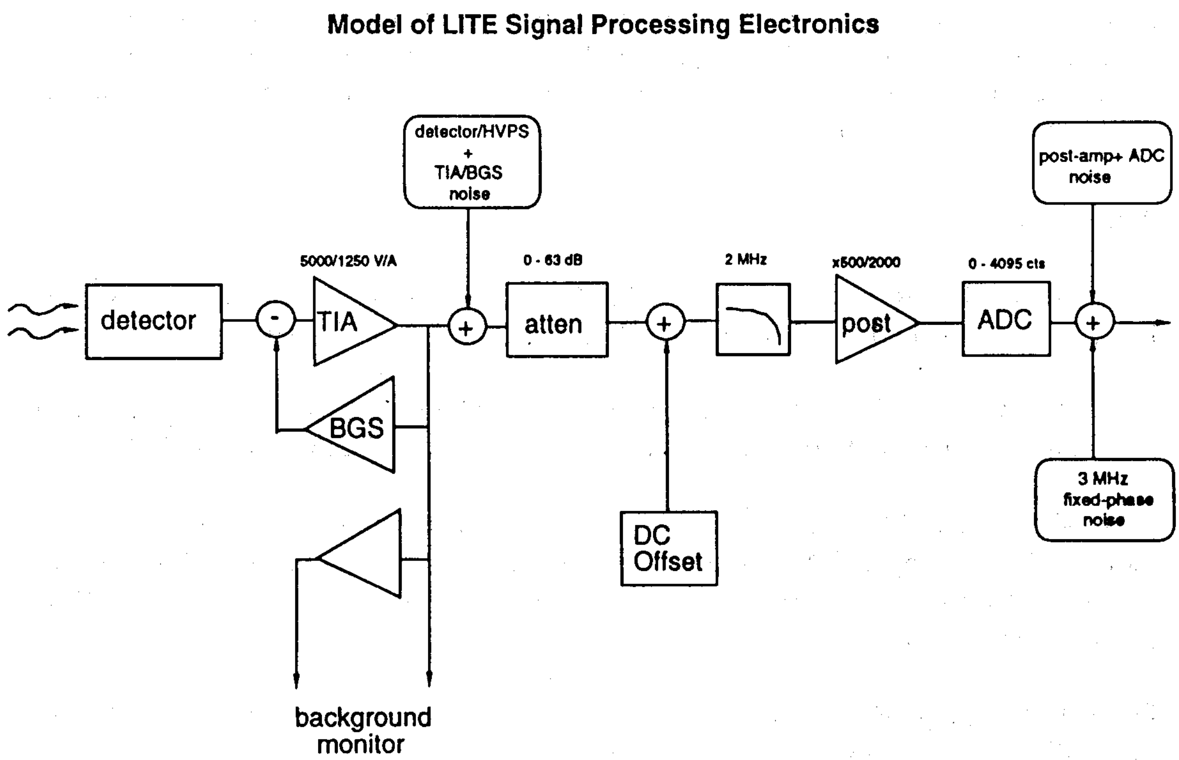

Figure 2. Model for the simulation of the LITE receiver electronics. The major signal conditioning and acquisition components are indicated, as well as the noise soures which were modeled.

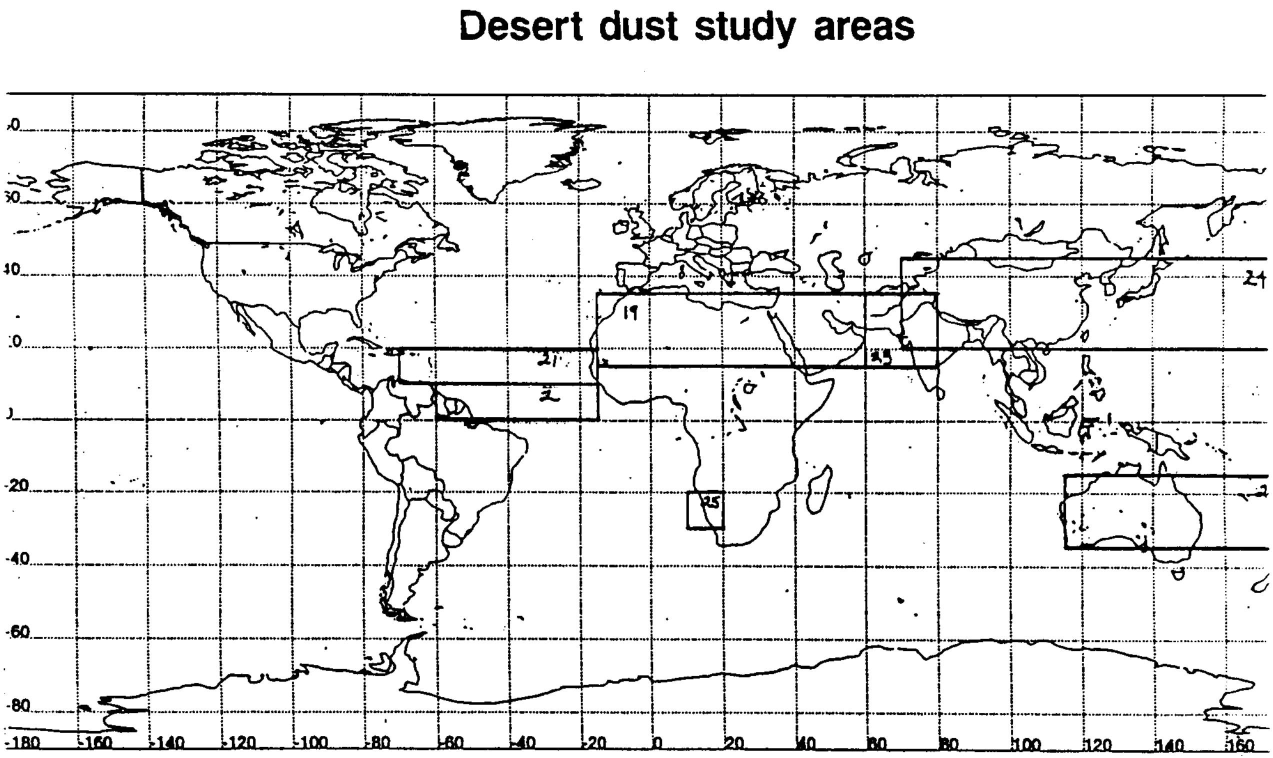

Figure 3. Areas identified as interesting for the study of desert dust sources and transport. Developed as part of the LITE pre-mission planning.

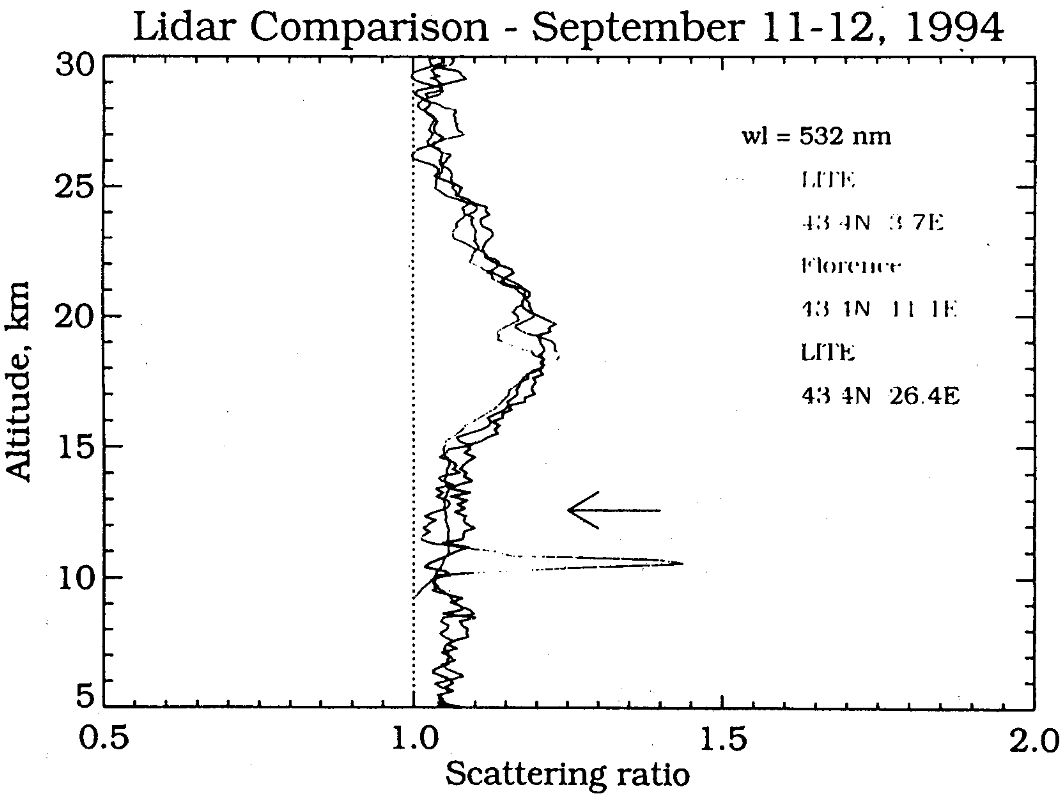

Figure 4. Validation of LITE stratospheric aerosol retreival at 532 nm: comparison of groundbased measurement from Florence, Italy with observations from two nearby LITE overpasses. Agreement is within the spatial variability of the aerosol.

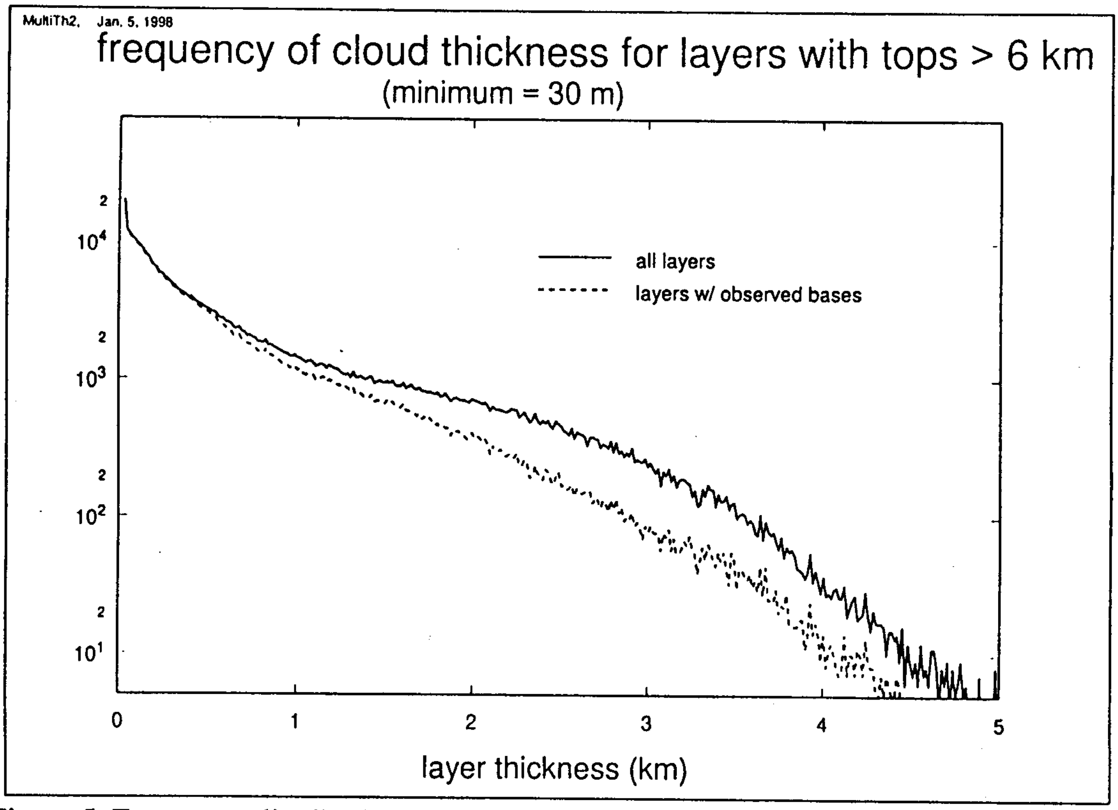

Figure 5. Frequency distribution of cloud layer thickness derived from LITE data using a simple thresholding algorithm. The solid line includes opaque layers which were not fully penetrated by the lidar pulse. The dashed line includes only those layers whose bases were definitely identified and shows a more nearly log-normal distribution.

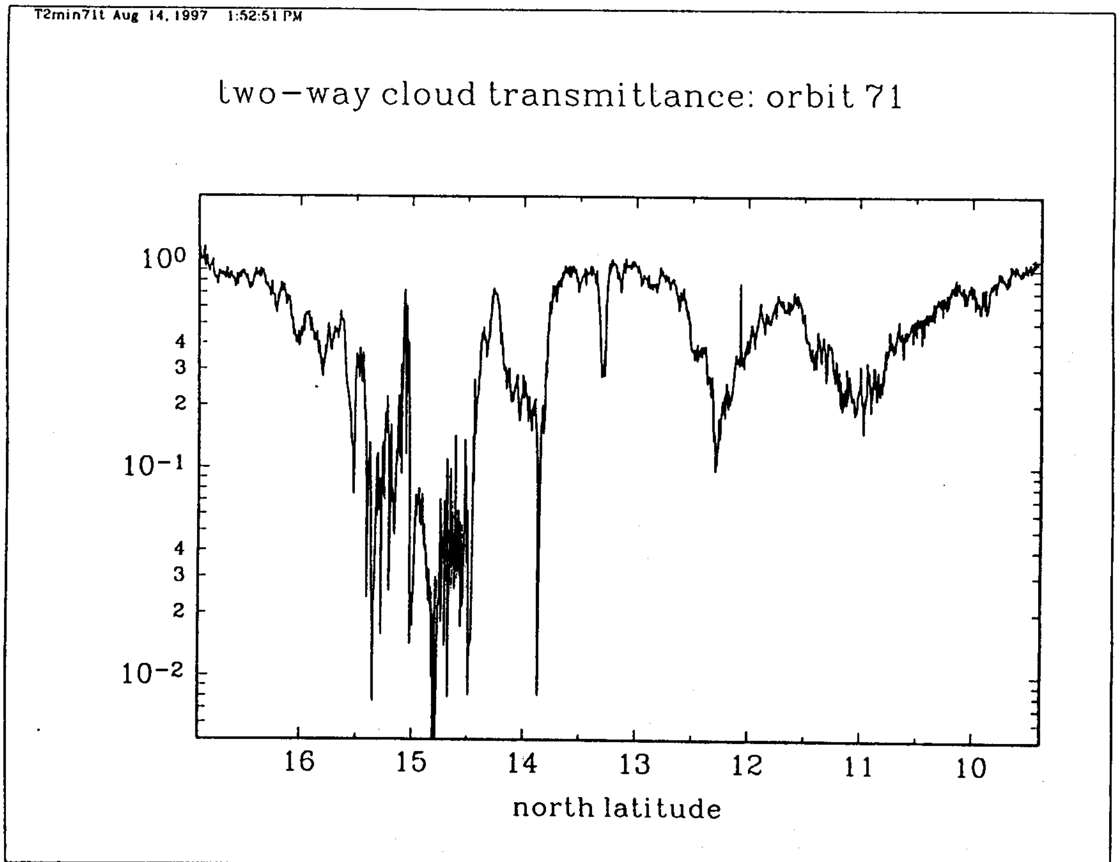

Figure 6. Two-way transmittances of a tropical cirrus anvil measured from the clear-air returns above and below the anvil.