# BOUNDARY LAYER INVESTIGATIONS USING A DOWN-LOOKING AIRBORNE LIDAR SYSTEM

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## ABSTRACT

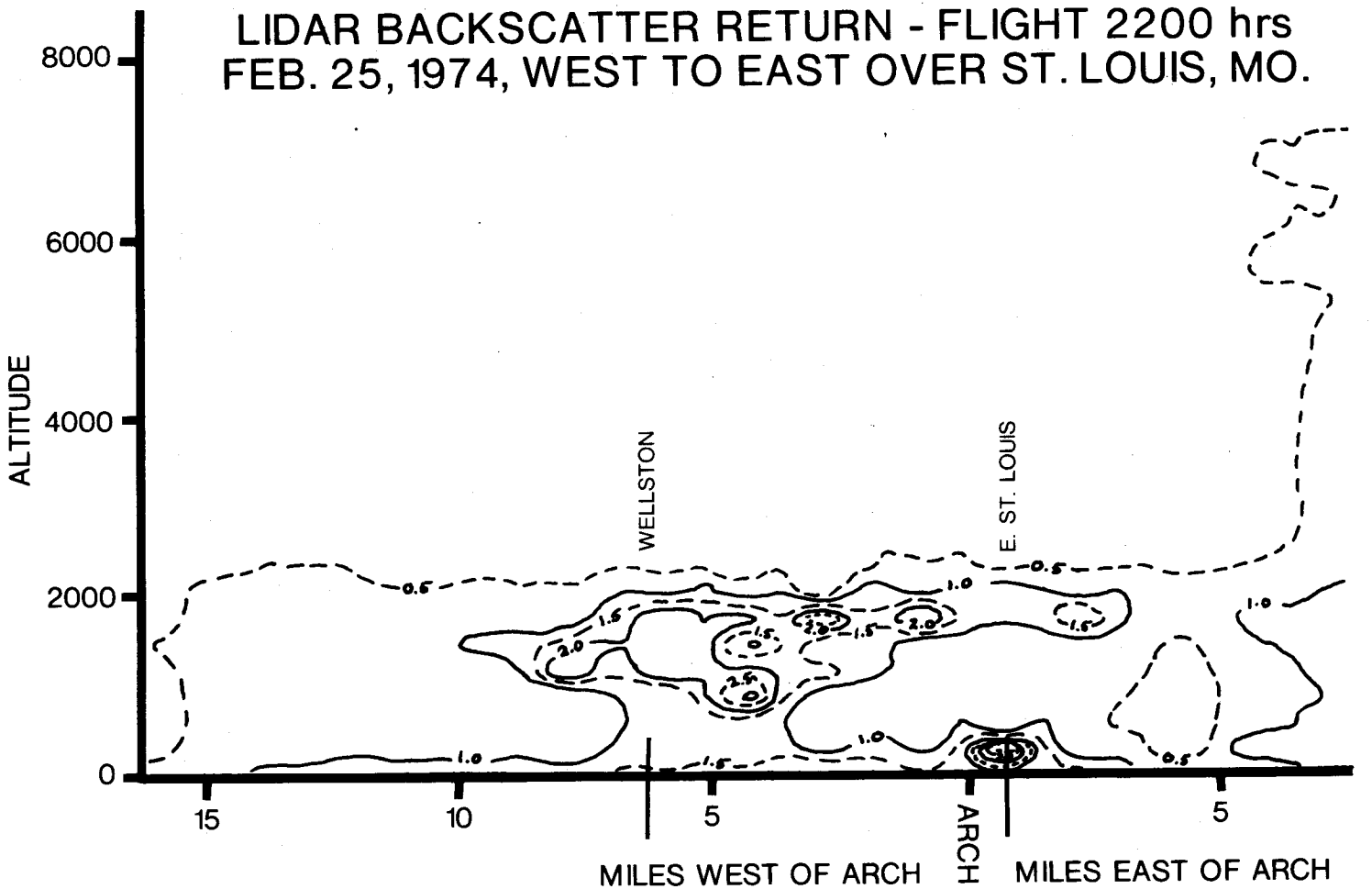
Airborne LIDAR studies were conducted in the St. Louis area to investigate mixing layer height and structure within the boundary layer. Simultaneous with the LIDAR flights, Pibal and radiosonde data were collected over the metropolitan area. In-situ monitoring was also performed using a small helicopter equipped with meteorological instrumentation, a nephelometer, and a $SO_2$ monitor.

The LIDAR system utilizes a Q-switched ruby laser with a pulse energy of one joule and a telescope with a 16 inch acrylic fresnel lens. The entire assembly is shock-mounted and positioned over an aerial camera port in a C-45 aircraft. The return signal, detected by a photo multiplier tube, was monitored using a high speed Analog to Digital Converter (ADC). The output of the ADC is recorded on a strip chart recorder. A sequencing camera was fired simultaneous with the laser to provide after-the-fact ground reference data. Firing interval was approximately 30 seconds, the time necessary for data output. Strip chart data was digitized by hand with $1/R^2$ correction and plotting performed on a CDC 6400 Computer system.

Measurements were taken on four separate flights over the St. Louis area. Three of the flights; an evening flight, early morning and mid-morning flight; collected data on the boundary layer transition period, whereas, the fourth flight collected data on the position and dimension of the urban plume. LIDAR data not only revealed the height of the mixing layer, but revealed considerable structure within the layer. Vertical profiles obtained with the use of the helicopter-mounted nephelometer and temperature monitor confirmed the measurements of mixing height obtained with the LIDAR system.

The laser was operated only after the aircraft reached its operational altitude of 10,000 feet. At this altitude, considering the 5 mrad beam divergence of the laser beam, the energy density of the beam at ground level is well below the BRH safe-limit for retinal damage.

An example of one series of LIDAR measurements is shown in the figure. The LIDAR data used to generate the figure consisted of 16 vertical profiles approximately one mile apart taken with the aircraft flying essentially from West to East over the St. Louis area. Significant ground features are noted on the abscissa. The contour lines connect areas of constant atmospheric scattering with relative values indicated. The figure shows a decrease in scattering at approximately 2200 feet which is interpreted as the height of a uniform mixed layer over the area. Also shown in the figure are two areas of relatively high scattering intensity; one over Wellston, Missouri, which extends to the mixing height and has a broad top, and the other located over East St. Louis, Illinois at a low altitude. Comparison of LIDAR data of this type with the independent meteorological data will be presented and discussed.


LIDAR BACKSCATTER RETURN - FLIGHT 2200 hrs
FEB. 25, 1974, WEST TO EAST OVER ST. LOUIS, MO.
ALTITUDE
8000
6000
4000
2000
0
WELLSTON
E. ST. LOUIS
0.5
1.0
1.5
2.0
2.5
15
10
5
ARCH
5
MILES WEST OF ARCH
MILES EAST OF ARCH