# 25C6 AIRBORNE LIDAR AND RADIOMETRIC DETECTION AND ANALYSIS OF CHEMICAL PLUMES

Edward E. Uthe
Geoscience and Engineering Center
SRI International
Menlo Park, CA 94025 USA
(415) 859-4667

## ABSTRACT

Active and passive remote sensing techniques have been well demonstrated for measurement of concentration distributions of specific gas species over extended distances. Active techniques are well represented by ground-based differential absorption lidar (DIAL) and Raman lidar while passive methods are well represented by satellite radiometric analysis of water vapor and ozone global distributions. NASA has successfully applied these methods from large aircraft to characterize concentration distributions of climatically important gaseous species over large global areas. SRI has pursued the development of miniaturized remote sensors that can be operated on small aircraft of the type typically used on individual source, urban, and small regional measurement programs. Early studies concentrated on the use of relatively simple elastic scatter lidar and coaligned single-channel radiometers to investigate transport, diffusion, and optical properties of aerosol clouds and plumes. This paper reviews remote sensing measurements of chemical plumes conducted from the SRI Queen Air aircraft using $CO_2$-DIAL, UV-DIAL and passive FTIR, and presents plans for development and testing of future airborne remote-sensing systems.

The ALARM (Airborne Agent Remote Measurement) system employed two downward-viewing line-tunable multimode $CO_2$ TEA lasers producing pulses of about 500 mJ at aircraft altitude. ALARM was used in both range-resolved (atmospheric backscatter) and column-content (topographic scatter) modes of operation. Figure 1 illustrates ALARM measurements of the cross-plume distribution of $SF_6$ gas released at the surface level. The data show that little $SF_6$ was incident on the ground at 2.5 km downwind of the source and this was verified by surface sampling. Other data collected by ALARM will be shown.

A UV-DIAL was developed based on an excimer laser operating at a wavelength of 248 nm and an $H_2$ Raman cell to generate laser pulses at wavelengths of 277 and 313 nm. The Queen Air UV-DIAL was used to map the ozone plume across Lake Michigan downwind of the Chicago urban/industrial area (Figure 2). Other data show the effects of reactive gas plumes released from industrial sources on the large-scale ozone plume.

A downward-viewing passive FTIR has been flown on the Queen Air to evaluate the trajectory of an $SF_6$ puff released at the surface level. Figure 3 presents an example of its repetitive detection during flight segments across the puff.

Future plans are for development of an airborne 3- to 5-$\mu$m DIAL for measurement of industrial source emissions and evaluation of coaligned operation of FTIR and DIAL systems from the Queen Air aircraft.

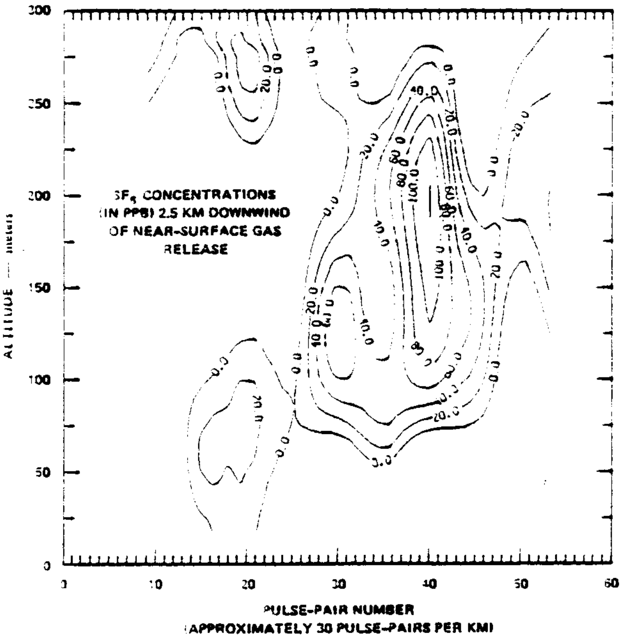


Fig. 1 Airborne IR-DIAL lidar mapping of cross-plume gas ($SF_6$) concentrations

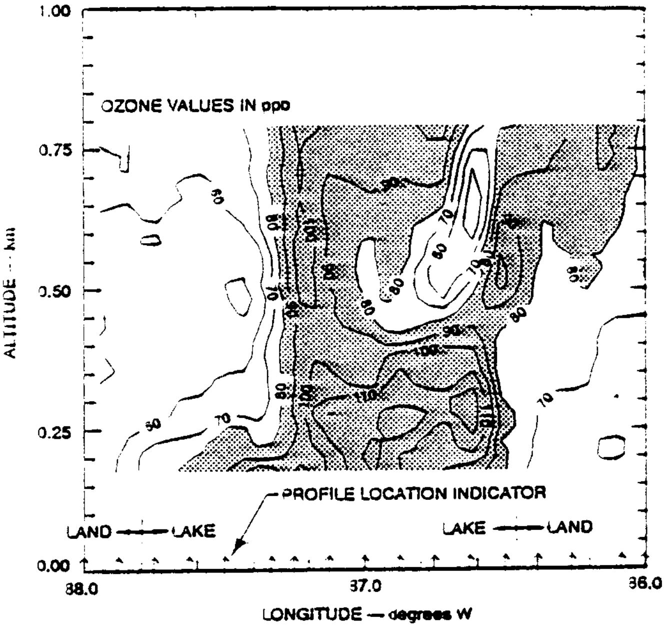


Fig. 2 Vertical ozone concentrations about 100 km downwind of the Chicago urban/industrial area as observed with the SRI airborne UV-DIAL

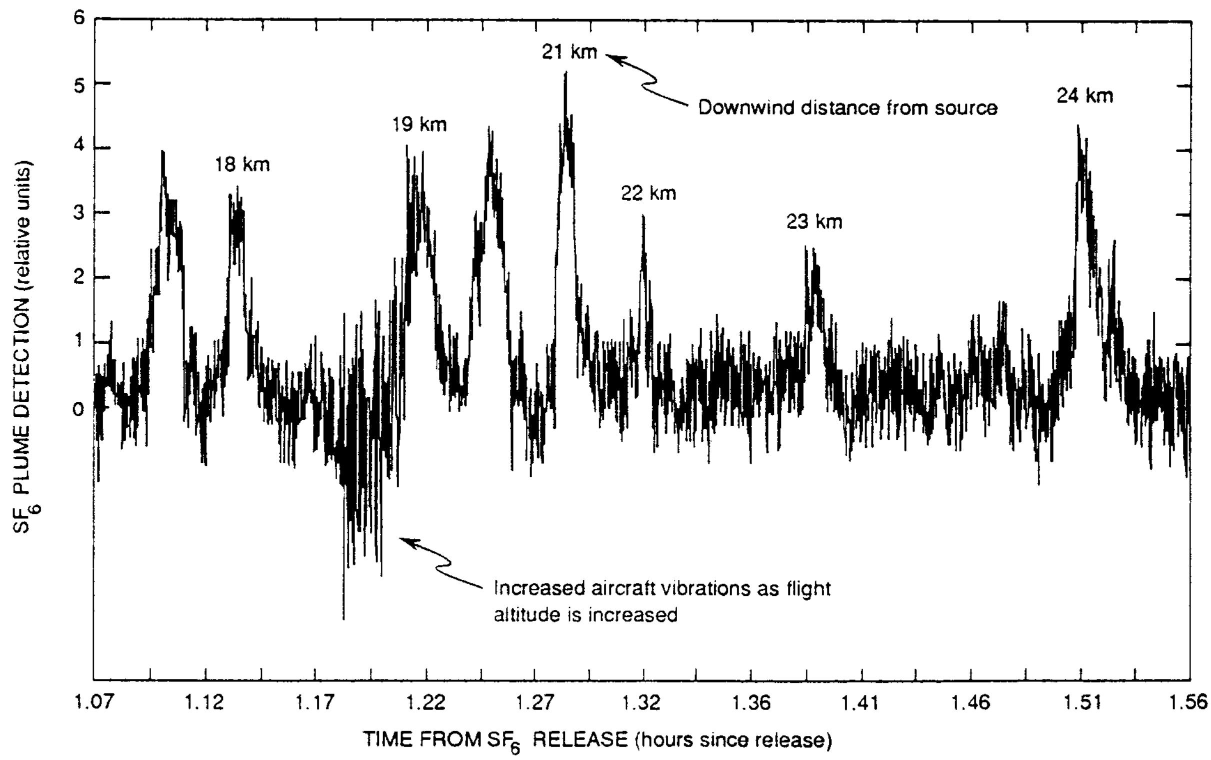


**Figure 3 $SF_6$ PUFF DETECTION USING AN AIRBORNE DOWNWARD-VIEWING FTIR**
Downwind distance from source is indicated above plume detection signal.