This remote-sensing technique allows elemental mercury mapping in the atmosphere at distances ranging up to 1000 m from the lidar position and also an evaluation of the mercury flux from a source if the speed and direction of the wind are known. The first study of atmospheric mercury emissions with the lidar technique was reported by Edner *et al.* (1989).

In addition to measurements carried out with the lidar system, point monitors were used for an accurate evaluation of the mercury levels in the atmospheric layers close to the ground and for a further comparison of the results obtained with the two analytical techniques, as has been reported elsewhere (Ferrara *et al.*, 1992).

EXPERIMENTAL

Atmospheric mercury measurements by the lidar technique

The lidar remote-sensing system employed in the present study has been extensively described by Edner *et al.* (1987, 1989). The system is housed in a van and can work autonomously by means of a 20-kV diesel generator towed by the van. This laser–radar system is capable of generating pulse energies of up to 5 mJ with a linewidth of 0.001 nm at the mercury resonance line (253.6 nm), and with a repetition rate of 10 Hz. The laser beam is transmitted into the atmosphere using quartz prisms and a large plane mirror which can be rotated around both the horizontal and the vertical axes. Back-scattered radiation is reflected by the same mirror and collected with a Newtonian telescope to reach the detection system. The laser is tuned on and off the resonance line of mercury every laser shot, allowing differential absorption measurements. A transient recorder performs A/D conversion of the signal with a time resolution of 10 ns, giving a range resolution of about 1 m. The digital signals are averaged on a computer and stored on floppy disks. A single scan is accomplished in a time that is considerably shorter than 100 ms; for a given measurement direction a few thousand scans are then averaged during a few minutes of integration time to obtain a satisfactory signal-to-noise ratio.

The detection limit is of the order of 2 ng m^{-3} of elemental mercury. The mercury compounds present in the atmosphere cannot be detected with the lidar technique, but these compounds do not represent the dominant fraction, constituting generally only 5–10% of the total atmospheric mercury.

Atmospheric mercury measurements by point monitors

The point monitors used by us in atmospheric mercury determinations have been described elsewhere (Ferrara *et al.*, 1992). Gaseous mercury is collected on gold traps at a flow rate of 1 ℓ min^{-1} by means of a battery-operated membrane pump, for a period of time set on a programmable timer. Mercury, electrothermally desorbed, is determined by atomic absorption spectroscopy or atomic fluorescence spectroscopy (detection limit 0.01 ng of mercury).

Determinations of atmospheric mercury levels carried out with the lidar system and with point monitors during an extensive field study provided comparable results (Ferrara *et al.*, 1992).

The speed and direction of the wind were measured by means of a weather station located near the electrolytic cells.

RESULTS AND DISCUSSION

A measurement campaign was performed at the Rosignano Solvay chlor-alkali complex from 19 to 21 September 1990. In Fig. 1 the mobile lidar system is shown against the background of the chlor-alkali complex.

A first horizontal screening carried out over the industrial scanning area allowed us to identify the main sources of atmospheric mercury.

In Fig. 2 a typical horizontal map of the mercury distribution over the study area is given. Data refer to a height of about 5–10 m above the ground and were obtained on 21 September from 4 p.m. to 7 p.m. with a wind speed of 7 m s^{-1} and a wind direction of 220°.

The highest mercury concentration (up to 903 ng m^{-3}) was measured over the electrolytic cell rooms

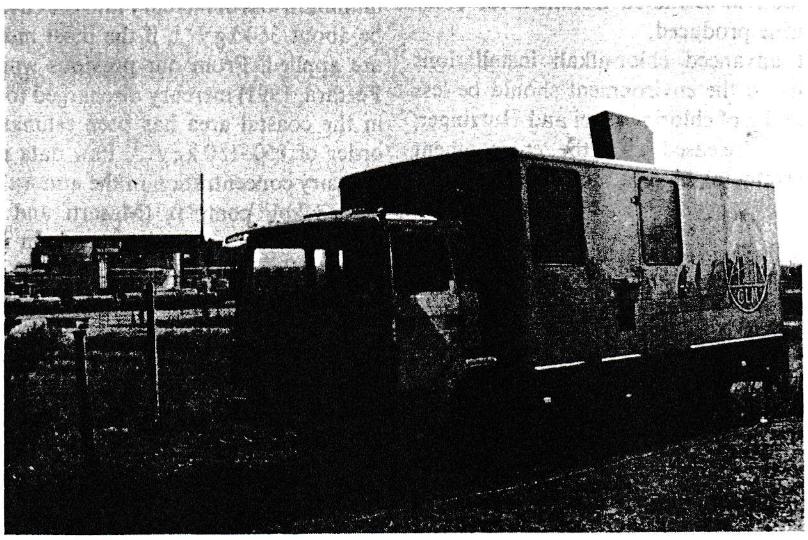

Fig. 1. The mobile lidar system against the background of the chlor-alkali complex of Rosignano Solvay (Livorno, Italy).