Tracking city air pollution

In assessing a city's air pollution problems, it is necessary to know where different winds take the pollutants. Tracing the movements of pollutants is difficult, especially when, like motor vehicle emissions, for example, they come from all parts of the city rather than from a few isolated sources such as particular factories.

To follow the progress of polluted air, scientists use tracers. If they are concerned with the fate of pollution from only one or a few sources, they can release easily tracked gases and see where these blow to.

However, this is impossible if they are dealing with pollutants emitted all over a city. What they can do then is use as a tracer some constituent of the pollution, chosen because it is relatively easy to track and because its movements give a good picture of the general air movement.

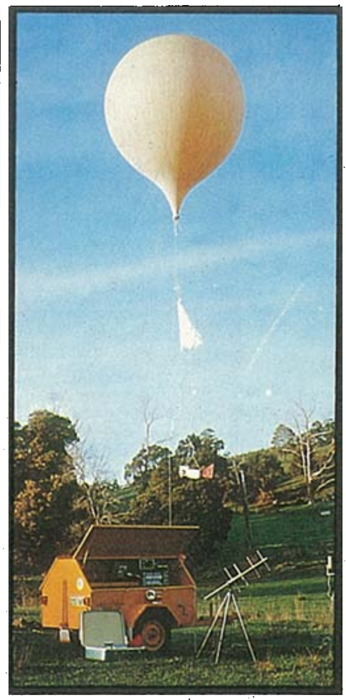
Dr Paul Fraser and two colleagues at the CSIRO Division of Atmospheric Physics, Dr Brian Sawford and Dr Peter Manins, recently monitored levels of the fluorocarbon F-11 above Melbourne to see if this gas could be used as a tracer of the city's polluted air mass. They found it works well.

One advantage is its inertness; unlike the ingredients of photochemical smog, for example, its movements are not masked by continuing chemical changes. Also, as background concentrations of the gas are low and relatively uniform, F-11 released from the city is quite easy to monitor. Another advantage is that it is possible to derive a reasonably accurate general representation of a city's F-11 emissions from data on production and use.

The scientists began their assessment of F-11 as a tracer by finding out from the aerosol and plastics industries how much of the gas is released in Melbourne and where centres of concentrated emissions are located.

It turned out that about 1000 tonnes are released in a year from spray cans, about 100 tonnes during loading of cans, and about 2000 tonnes in plastics manufacture. The scientists found that about 70 % of emissions could be represented as being spread over the Melbourne area in a contour pattern centred on the city, and the rest as coming from 12 point sources.

To test the validity of this picture of the sources, they used it to estimate the F-11 concentration that could be



The balloon and instruments used to trace F-11 movements.

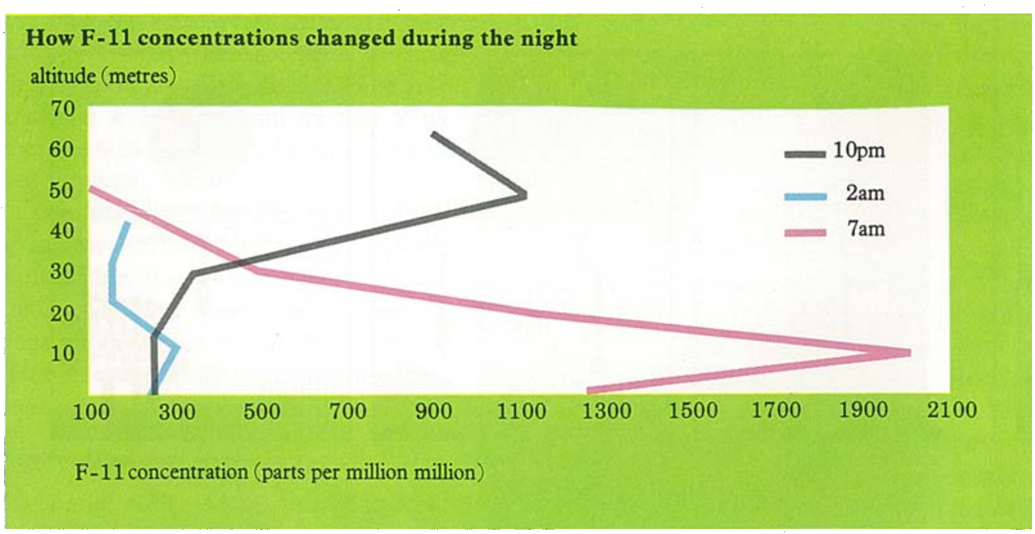
expected at the Division's Aspendale headquarters on a day when a north-easterly was blowing at 18 km per hour. The answer, 180–210 parts per trillion (p.p.t.) agreed well with measured concentrations, on such a day, of 130–90 p.p.t.

In another experiment, the scientists used air sampling equipment carried aloft by a balloon to follow changes in F-11 concentration at different altitudes during a winter's night at Aspendale. The balloon also carried equipment to measure wind speed, wind direction, temperature, humidity, and altitude.

Between 10 p.m. and 2 a.m., the low-level wind blew from the east-south-east, and F-11 concentrations in it were low (up to about 300 p.p.t.). At an altitude of 40–50 m, however, the wind came from the north and concentrations early in the night were much higher (up to 1100 p.p.t.). The scientists suggest that diffusion of F-11 from the city and suburbs through the easterly flow into the northerly produced these high concentrations.

After midnight, the concentration in the upper-level northerly fell to below 300 p.p.t. Then, between 2 and 4 a.m., the surface wind direction changed to northerly as cold air began to drain into the area from high ground to the north. The F-11 concentrations in this cold flow rose as the night wore on, reaching peaks of well above 1000 p.p.t.

The readings (see the diagram) show a complex variation in F-11 concentration with height, and it is safe to assume that concentrations of other pollutants vary in a similar manner. Dr Fraser points out that this shows ground-level measurements of pollutant concentrations can be totally unrepresentative of concentrations at only moderate heights, well below the height of many city buildings. He suggests that readings at a number of altitudes, up to perhaps 35 metres, would give a much better picture of the pollution situation at any location.



This graph shows the large variations in F-11 concentrations during the night and the unreliability of ground-level measurements as indicators of concentrations at even low altitudes.

CCl_3F (freon-11) as an indicator of transport processes in an urban atmosphere, a case study for Melbourne. P. J. B. Fraser, B. L. Sawford, and P. C. Manins. *Atmospheric Environment*, 1977, 11 (in press).