An ingenious smog monitor

Invented by Graham Johnson, CSIRO's Airtrak air-monitoring system has proved an invaluable tool in studying Sydney's smog problems.

Prior to the CSIRO/Macquarie study, there were no data from the Hawkesbury Basin on the levels of the pollutants, reactive hydrocarbons and nitrogen oxides, that combine to form photochemical smog.

Indeed until recently it was not possible to measure the capacity of the air to produce photochemical smog. Ozone levels alone do not give an insight into the pollutants that cause ozone. It is even possible for one common pollutant, nitric oxide, to temporarily mask the ozone and allow photochemically polluted air to go undetected by a standard ozone monitor.

The Airtrak monitor dramatically changes the amount of information that can be obtained in real time. Developed in 1989 by CSIRO and the Australian company, MCI, the monitor can operate unattended and is suited to the routine requirements of the typical air-monitoring station.

Airtrak has three components: a photolytic chamber in which air is stirred and illuminated by ultraviolet lamps to trigger smog-forming reactions; a high-performance nitric oxide detector; and computer algorithms for interpreting data and predicting smog levels.

Air is continuously drawn into the instrument and split into three streams: A, B and C. Stream A is analysed by two methods for nitric oxide and other nitrogen oxides. Streams B and C are mixed with enough nitric oxide to consume whatever ozone may be already present. Stream B, which is used to determine the smog concentration of the air, is broken into two parts, in the second of which all the nitrogen oxides are converted to nitric oxide. Comparison of the amount of nitric oxide remaining in the first part with the total amount of nitric oxide in the second makes it possible to infer the level of smog.

Comparing the stream B concentrations with the nitrogen oxide levels in stream A gives the ozone concentration.

Stream C, which is directed to the photolytic chamber, is used to determine the speed of smog formation. The air is divided into two parts: one is exposed to UV light for 10 minutes to trigger the typical photochemical reactions that form smog; the second is maintained in darkness. The difference in the nitric oxide concentrations between the two gives a measure of the rate of smog formation.

The monitor also measures sunlight intensity and temperature. Combining all the data, the instrument can give accurate readings of the current ozone, nitrogen oxide and smog levels in the air. It also charts a 'time profile' for the air sample, estimating pollutant levels before and after sampling. If local wind patterns are well understood, the monitor can give an indication of the geographical source of the hydrocarbon emissions that feed the smog reactions.

In the CSIRO/Macquarie study, an Airtrak monitor was operated at Fleurs, in Sydney's South Creek Valley, west of the city. Data obtained helped the researchers track down an industrial source of nitrogen oxides about 4 km south of the monitor. Consistently high overnight levels of reactive hydrocarbons highlighted the importance of air flows in the Hawkesbury Basin that can trap emissions during the night.

Airtrak is being marketed in Australia and overseas. A network of instruments is currently being used to investigate the dynamics of smog production and transport in the Chicago/Lake Michigan area of the United States. The monitors are in use in Sydney and Melbourne and there are plans for installing Airtrak in other Australian cities.

Inside Airtrak