VARIATION OF THE URBAN NO_2 CONCENTRATION DURING A GROUND INVERSION SITUATION

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In February 1985 the NO_2 concentration over Göteborg, a major Swedish city, was monitored during two inversion situations. The differential absorption technique was employed and the results show the build-up of the concentration.

A ground inversion is a situation that occurs mostly in cold weather. During a cloudfree night the temperature radiation from the surface to the air above may be sufficient to cool the ground. The surface will then be colder than the air above it, fig 1. If there, in addition, is no wind, the situation will be a stable one and no stirring of the air will occur. When the surface gets heated during daytime, the temperature gradient characteristic of the inversion will gradually vanish. An inversion layer is formed, under which the air is trapped. Finally, the layer is destroyed and convection stirs the system. During these stable conditions pollutants that are emitted will not be blown away or be removed by convection. They will remain around the sources or under the inversion layer. Very high concentrations resulting in extremely poor air quality will follow. The studies of NO_2 during these episodes can give information about the dangerous areas and sources that exist. Metereological models can be tested. Dial measurements have previously been performed on NO_2, Ref 1.

In this experiment the laser beam was scanned horizontally over Göteborg. The results were presented as maps over the NO_2 concentration distribution, see for example fig 2. For security reasons the beam was not parallell to the ground , which gives a height gradient in some measurements. During the measurement period the NO_2 concentration build-up from the morning to the afternoon was monitored. Great concentration variations were seen. Later the mixing below the inversion layer, resulting in a more uniform, high concentration was seen. The breakdown of the inversion when stronger winds start was also seen.

Comparisons with a traditional point-measuring chemiluminiscence instrument and an optical method, DOAS (Differential Optical Absorption Spectroscopy), were made (Ref 2). The results are discussed. Strong spatial concentration variations are shown by the lidar measurements. They are averaged out in the DOAS measurements. For a point-measuring system, the instrument must be very carefully placed since its location will strongly influence the values it gives.

References:

1. K. Fredriksson and H. M. Hertz, "Evaluation of the DIAL technique for studies on NO_2 using a mobile lidar system.", Applied Optics 23, 1403 (1984).

2. B. Galle, A. Sunesson, L. Unéus, S. Wallin, and W. Wendt, "A comparison between different techniques for urban monitoring of NO_2", to be submitted to Atmospheric Environment.

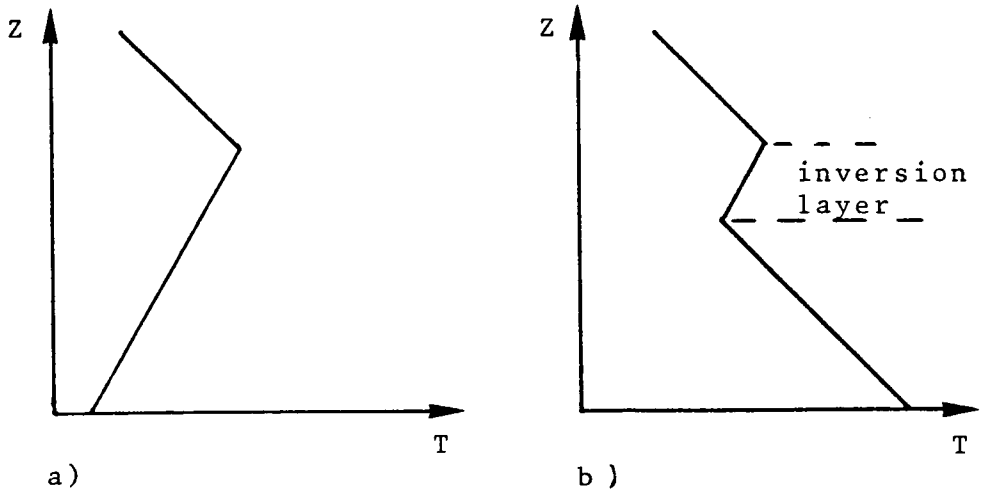

Figure 1. Schematic temperature profiles in an inversion
a) at the start
b) after the ground has been heated and an inversion layer has formed.

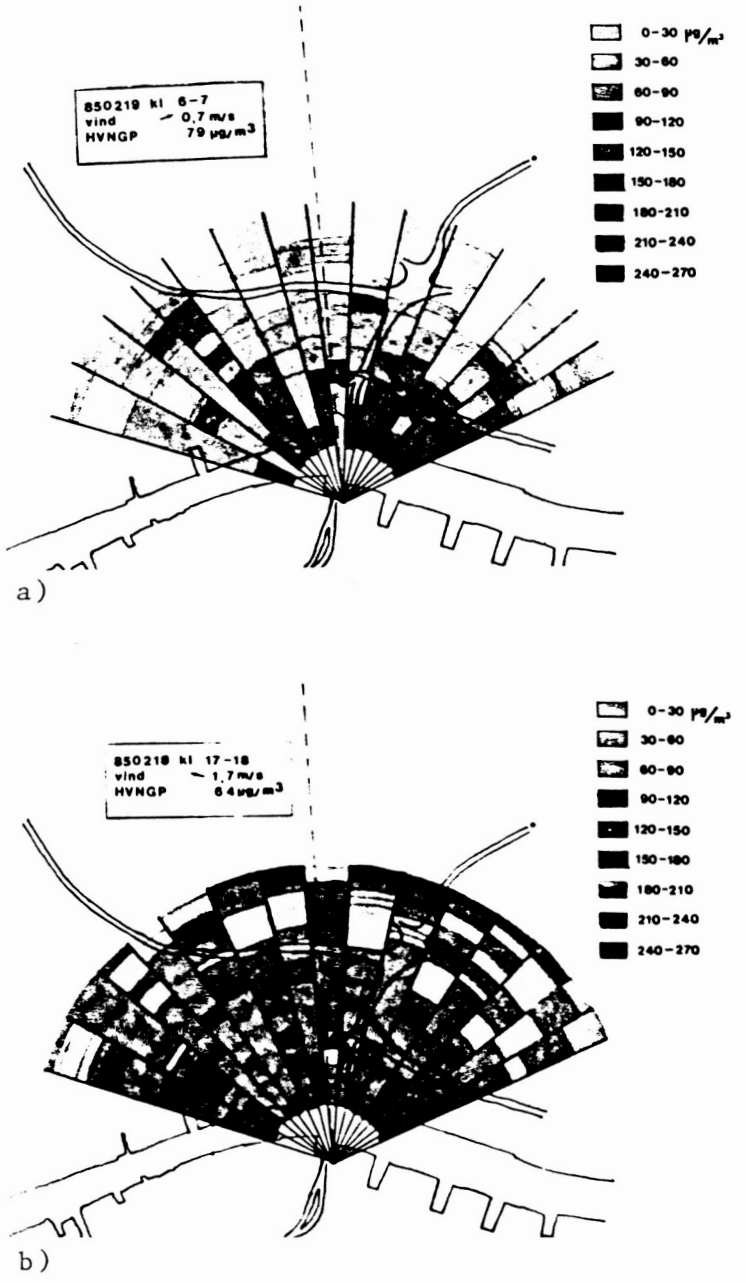

Figure 2. Horizontal mapping of the NO_2 concentration
a) early in the inversion
b) after some stirring of the system
The concentration map overlaps a map where greater roads and a river are indicated.