Development and Evaluation of the Urban Dispersion Model EPISODE

A contribution to subproject SATURN

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As a basis for modern air quality management work in urban areas, there is a need for urban scale dispersion models capable of estimating time-varying (hourly) concentrations at arbitrary receptor points within the urban area. Such models should be able to specify the time-varying pollutant gradients even close to sources. The air pollution dispersion model EPISODE has been developed at NILU over several years in order to meet these needs (Walker, 1997). In Oslo, the model currently forms part of NILU's Air Quality and Information System (AirQUIS), a modern PC-based system for air quality surveillance and management work. Earlier versions of the model have been applied in several places both in Norway and elsewhere (Larssen et al., 1994; Grønskei et al., 1993). Here we describe some results from the most recent evaluations of the model for NOx and NO2 at the Nordahl Brunsgt station in Oslo (Slørdal and Walker, 1997) for the period 1st October to 19th November, 1996.

Model description

The EPISODE model is a combined 3-D Eulerian/Lagrangian model for urban and local-to-regional scale applications (Walker, 1997). The Eulerian part of the model is based on the numerical solution of the atmospheric (mass) conservation equation of the pollutant species using a three-dimensional Eulerian grid. The Lagrangian part consists of Gaussian subgrid models for each of the three main source categories: area, line and point sources. The model also contains a module for calculating photochemical equilibrium between NOx, NO2 and O3 in all grid cells on an hourly basis. For Oslo, a 22 × 18 km² grid was defined using 3 layers with heights 20, 30 and 150 m. Background concentrations of ozone in Oslo was estimated on an hourly basis.
using measured values of ozone at the two regional background stations Birkenes and Prestebakke in southern Norway (maximum at the two stations).

**Emission data**

The emission database for Oslo (part of NILU's AirQUIS system) contains hourly emission data from different source categories such as domestic heating (area sources), road and ship traffic (area and line sources), and industry (point sources). Road traffic is the most important source of NO\textsubscript{x} (NO\textsubscript{2}) pollution in Oslo. The emission data from road traffic consists of about 2400 line sources with individual characteristics such as start and end position, road width and slope, daily and weekly variations in traffic load, amount of heavy duty traffic etc.

**Meteorological data**

Air temperature, vertical temperature gradient (stability), windspeed and direction were based on hourly measurements at the Valle Hovin station in Oslo (Fig. 1). The wind and stability data were used as input to a topographically oriented wind-field model. Atmospheric turbulence (\(\sigma_v\) and \(\sigma_w\)) were calculated for each grid cell using a meteorological preprocessor based on temperature and wind profiles and surface roughness.

**Results and discussion**

Overall, observed and model calculated concentrations corresponded fairly well during the evaluation period, 1st October to 19th November, 1996 (1198 hours). Correlation between observed and predicted values for NO\textsubscript{x} (NO\textsubscript{2}) was found to be 0.73 (0.68) with mean values of 88.8 \(\mu\)g/m\(^3\) (obs.) and 83.1 \(\mu\)g/m\(^3\) (pred.) for NO\textsubscript{x}, and 38.5 \(\mu\)g/m\(^3\) (obs.) and 35.9 \(\mu\)g/m\(^3\) (pred.) for NO\textsubscript{2}. Sensitivity analysis indicates that the deviations between observed and predicted concentrations can, to a large extent, be explained by the non-representativeness of using only the observed thermal stability \(\Delta T\) at Valle Hovin (outside of city centre) as a measure of the stability conditions at Nordahl Brunsgt. The build-up and weakening of pollution concentrations in the central parts of Oslo is probably a more complex process where mechanical turbulence, locally generated heat from buildings, and local turbulence from road traffic, influences the local wind- and turbulence-fields and the vertical exchange of pollution.
Fig. 1: The Oslo area showing the Nordahl Brunsigt and Valle Hovin stations.

Fig. 2: Observed and modelled hourly concentrations of NO\(_x\) at Nordahl Brunsigt in Oslo for a part of the evaluation period containing the highest concentrations.
Fig. 3: Observed and modelled hourly concentrations of NO$_2$ at Nordahl Brunsået in Oslo for a part of the evaluation period containing highest concentrations.

References
Grønskei, K.E., S.E. Walker, F. Gram; Atmos. Environ. 27B (1993) 105–120.
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