A model system for the assessment of ambient air quality conforming to EC directives

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Abstract

EC framework directive 96/62/EC and its daughter directives allow the use of models to evaluate ambient-air quality. The model system M-SYS has been developed for this purpose. M-SYS employs a hierarchy of mesoscale and microscale models for both, meteorology and chemistry, to calculate air quality metrics corresponding to the limit values of the EC daughter directives. Corresponding to the directives the model system delivers maps showing concentration distributions in different spatial resolution for the different subjects of protection. M-SYS results show the resolution dependence of maximum values. Concentration fields show a large variability on spatial scales smaller than the average spacing of air quality stations. These heterogeneities cannot be resolved by the operational air quality network. Commonly used interpolation techniques can also not capture these spatial patterns as long as they lack information on the small-scale variability of wind, turbulence, and chemical conversion. At traffic-orientated sites in the urban obstacle layer, particularly large heterogeneities are found which require the use of three-dimensional obstacle resolving models.

1 Introduction

According to the EC framework directive 96/62/EC (EUROPEAN COMMUNITIES, 1996) and its daughter directives (EUROPEAN COMMUNITIES, 1999; 2000; 2002), ambient air quality needs to be assessed throughout the territory of the member states. 13 pollutants are listed in the framework directive; their limit values, target values and alert thresholds are defined in the daughter directives. The air quality objectives are based on different statistics of concentration time series and depend on the pollutant and the subject of protection (ecosystems, vegetation, human health). The necessary statistical measures include simple measures like the concentration average over one calendar year, but also more involved metrics like AOT40 (accumulated ozone concentrations over a threshold of 40 ppb), maximum daily 8-hour running averages, and the number of hours per calendar year during which a limit value is exceeded. Manifold as they may be, the statistical measures are straightforwardly derived from an observational record with adequate temporal resolution and sufficient data capture. However, the robustness of some of the limit values remains an interesting problem: for example, the hourly mean concentration of nitrogen dioxide shall not exceed 200 $\mu$g/m$^3$ more than 18 times per calendar year, which is the equivalent of the 99.8th percentile. These values can hardly be derived from measured data, since short-time emissions (e.g. road works) may lead to (non-representative) threshold exceedances. This discussion, however, is beyond the scope of this article.

In general, air quality is controlled on the basis

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