Frequency distributions of the mixing height over an urban area from SODAR data

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Abstract

The height of the mixing-layer (MLH) is an important parameter in the assessment of the dilution of primarily emitted or secondarily formed air pollutants in the atmospheric boundary-layer. A continuous measurement of MLH is possible only by remote sensing. Here, 17 months of SODAR data have been analysed automatically to derive the MLH over the city of Hannover in Northern Germany. In contrast to earlier studies the MLH has been determined from vertical profiles of the acoustic backscatter intensity and from the variance of the vertical velocity component. The results are presented in form of monthly frequency distributions and mean daily courses of MLH. These statistical evaluations of MLH show a clear annual course and interannual variability. The study shows the possibility to derive meaningful climatological information from long-term SODAR measurements for air quality issues.

1 Introduction

In order to run numerical and physical models that simulate urban air quality a priori information on vertical profiles of wind, temperature, moisture, and other atmospheric constituents is necessary to prescribe the initial and boundary values. A posteriori this information is needed to check the results. Likewise this information is needed to estimate the dilution of pollutants emitted or formed secondarily near the surface because temperature inversions and layers of low turbulence form a potential barrier for vertical dispersion. Similarly the information on vertical dispersion and dilution of particulate matter is important when inverting optical thicknesses measured from satellites into surface pollutant concentrations (DANDOU et al., 2002; SCHÄFER et al., 2002). The vertically resolved information is required at least for the vertical extend of the layer that is in direct contact with the surface. This layer is usually identified as the mixing-layer. The thermal stability and the height of the mixing-layer (MLH) exhibit a clear diurnal course, mainly driven by the radiation balance of the underlying surface. Its vertical extend varies between less than 100 m in very calm and clear nights and more than 2000 m with stormy weather or on clear and hot summer days. A dense data coverage on MLH can only be yielded by remote sensing techniques.

The definition and the methods of detection of the MLH have been discussed broadly in BEYRICH (1997) and SEIBERT et al. (2000). The derivation of MLH from radiosonde temperature profile data is the oldest method. Starting with HOLZWORTH (1964) various schemes have been proposed. An actual example for the application of his method, the monitoring of the annual variation of MLH from daily late-afternoon radiosonde ascents is presented in FREEDMAN et al. (2001). They find the maximum MLH in the Northeastern US in late spring just before the growing season starts. MLH frequency distributions for five months for Mexico City from two soundings per day can be found in SALCIDO et al. (2003). HOLZWORTH’ s method is only appropriate to find MLH for the time of the sounding but is...