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Evaluation of high-resolution forecasts with the non-hydrostaticnumerical weather prediction model Lokalmodell for urban air pollutionepisodes in Helsinki, Oslo and Valencia

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Abstract. The operational numerical weather prediction model Lokalmodell LM with 7\,km horizontal resolution was evaluated for forecasting meteorological conditions during observed urban air pollution episodes. The resolution was increased to experimental 2.8 km and 1.1 km resolution by one-way interactive nesting without introducing urbanisation of physiographic parameters or parameterisations. The episodes examined are two severe winter inversion-induced episodes in Helsinki in December 1995 and Oslo in January 2003, three suspended dust episodes in spring and autumn in Helsinki and Oslo, and a late-summer photochemical episode in the Valencia area. The evaluation was basically performed against observations and radiosoundings and focused on the LM skill at forecasting the key meteorological parameters characteristic for the specific episodes. These included temperature inversions, atmospheric stability and low wind speeds for the Scandinavian episodes and the development of mesoscale recirculations in the Valencia area. LM forecasts often improved due to higher model resolution especially in mountainous areas like Oslo and Valencia where features depending on topography like temperature, wind fields and mesoscale valley circulations were better described. At coastal stations especially in Helsinki, forecast gains were due to the improved physiographic parameters (land fraction, soil type, or roughness length). The Helsinki and Oslo winter inversions with extreme nocturnal inversion strengths of 18°C were not sufficiently predicted with all LM resolutions. In Helsinki, overprediction of surface temperatures and low-level wind speeds basically led to underpredicted inversion strength. In the Oslo episode, the situation was more complex involving erroneous temperature advection and mountain-induced effects for the higher resolutions. Possible explanations include the influence of the LM treatment of snow cover, sea ice and stability-dependence of transfer and diffusion coefficients. The LM simulations distinctly improved for winter daytime and nocturnal spring and autumn inversions and showed good skill at forecasting further episode-relevant meteorological parameters. The evaluation of the photochemical Valencia episode concentrated on the dominating mesoscale circulation patterns and showed that the LM succeeds well in describing all the qualitative features observed in the region. LM performance in forecasting the examined episodes thus depends on the key episode characteristics and also the season of the year with a need to improve model performance in very stable inversion

conditions not only for urban simulations.

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