Atmos. Chem. Phys. Discuss., 5, S4609–S4613, 2005
www.atmos-chem-phys.org/acpd/5/S4609/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of very high-resolution simulations with thenon-hydrostatic numerical weather prediction model Lokalmodell for urban airpollution episodes in Helsinki, Oslo and Valencia" *by* B. Fay and L. Neunhäuserer

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Received and published: 20 December 2005

The authors gratefully acknowledge the received discussion and comments and try to answer all raised questions following the structure of each comment.

1. SC by R. Sokhi, following the numbering of the comment.

3): As suggested, recently performed urbanisation measures of LM and their results are already shortly described and referenced in the current conclusions. Investigations about improving inversion simulations at the DWD are intended (e.g. for all models: more vertical soundings and their data assimilation are needed). The problem is already stated in the conclusions, a short comment will be added about amelioration strategy.

7) ,10) and 14): The FUMAPEX investigations are the first LM applications for urban (episode) forecasting and to our knowledge also in the wider COSMO non-hydrostatic NWP-modelling consortium developing and using LM-versions. The topic has already received interest in this LM community and elsewhere, and it is the purpose of this paper to present the wealth of original LM results. Certainly, some reference to the urban modelling studies e.g. in former years or the US together with a reference to MM5 urbanisation (e.g. in US) would broaden the background and will be included. The well-known models MM5 and RAMS need no further introduction and are only briefly mentioned, but a remark about the similarities/differences to LM in design and applications will be added. A comprehensive literature review, nevertheless, is not intended and outside the purpose of this paper focussed on presenting LM results. Additionally, model inter-comparison results are/will be discussed in different reports/ publications. Despite these requested addenda, some shortening of the paper will be attempted but will be restricted in order to retain comprehensibility.

8): 1.1km resolution is not high from the viewpoint of local or microscale modelling, e.g. for urban or street canyon models. The ‘very’ in the title, however, was introduced from the viewpoint of and in relation to the mentioned NWP models were e.g. 5 to 7km horizontal grid resolution is already considered as high (‘very’ may be dropped).

13): The axes for figs. 12 and 13 will be explained in the fig. legends. Fig. 13 shows the 1.1km LM streamlines of 10m wind speed on a topographic map of the Valencia coastal region with 7 regional observation stations (black dots), coastline in white.

2.RC by anonymous referee, following the comment subtitles.

Specific comments: This is an interesting and helpful comment. The authors agree that diagnostic modelling is used to a large extent in small-scale air quality applications, especially for climatologic, longer-term evaluations in air quality assessments for all kinds of planning activities. The preference of prognostic or diagnostic models depends on many factors, especially the kind of application and required scale, but also available computer resources, requested simulation speed, personal preferences and experience etc. With the introduction of ever-increased and cheaper computing power and NWP models with higher resolution and improved and scale-adapted parameterisations, the applicability of NWP models is expanding to the smaller scale for air quality simulations as well. Thus, the main purpose and activity of this investigation were the evaluation of the potential and deficiencies of the current operational LM model in forecasting urban pollution episodes, to serve also as a basis for planned and implemented parameterisation improvements. Besides, due to model developments the proposed application definitions for prognostic/diagnostic models would be temporary or controversial, and also of little interest to NWP modellers. It rather seems helpful to stress to the latter the model improvements needed by air quality modellers other than convection parameterisation where some NWP communities tend to focus currently. We, therefore, prefer not to bring a discussion on diagnostic applications into this paper. The title of the paper will be changed accordingly from ‘simulations’ to ‘forecasts’ for better precision. The introduction will be re-formulated with special attention to evaluating forecasting applications and the increased applicability of advanced mesoscale NWP models in this area.

Some minor points: The vertical extent of the lowest layer for 35/45 layers vertical resolution is about 60/40m and the lowest model level at 30/20m in the Arakawa-C/Lorenz grid for scalars (incl. temperature and horizontal wind components) in LM. For the special conditions near the surface of the atmosphere, surface layer parameters like 2m temperature and 10m wind are derived diagnostically in NWP models by interpolating vertical profiles, based on MO similarity with the known restrictions to non-calm winds and respective validity restrictions for very stable conditions, very flat surface layers below the lowest model level, urban PBL... The new LM surface transfer scheme defines

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the surface layer between the surface and lowest model level, subdivided into a laminar sublayer (roughness layer) and a constant-flux layer. The MO stability functions are not derived empirically but generated directly from the LM Mellor-Yamada turbulence scheme and spatial interpolation schemes. Unfortunately, there is insufficient stability influence in cases of very strong stability, contributing e.g. to false interpolated 2m temp in these conditions as mentioned on p. 12 of the paper.

Episode characteristics: The emission sources for the Valencia episodes are also located in the coastal areas with pollutant re-circulation in many smaller and larger circulation systems in a region, e.g. in the Castellon conurbation (Millan et al. (2002), reference in paper). They are often urban but not local. The term 'resuspension' was used in the detailed episode description of the FUMAPEX city partners but does not appear in the episode classification in Kukkonen et al., 2005. Re-considering our paper concerning wind-driven resuspension, the phrasing was changed, partly for doubt about the suspension mechanisms (wind or tyres). Wood burning (mentioned on page 17 for Oslo) is negligible for Helsinki and dominant in Oslo only for wet winter ground surfaces when the traffic induced suspension of road dust is of minor importance (Kukkonen et al., 2005). The detailed episode description shows that the Oslo Jan 2003 episode (with low PM10) belongs to that type, while Nov 2001 (high PM10) with dry roads is also caused by suspended road particles.

Changing probability of larger model deviations (from observations) with higher model resolution: Agreement with comment, may also depend on other factors like available scale-adapted physiographic parameters and data assimilation etc..

Page 15: For determining mixing heights (MH) for stable boundary layers from turbulent kinetic energy (TKE), the TKE depletion approach determines MHs as the height where model TKE has fallen to 5% (not factor 5, will be corrected!) or 10% of its surface layer value (e.g. Fisher et al.(1998): COST710 Final Report).

Technical comments: Selected Kivenlahti mast level =91 m according to FMI

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FUMAPEX web page. Valle Hovin height should be 91.6=92m.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 8233, 2005.

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Interactive Comment