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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Parameterization of vertical diffusion and the atmospheric boundary layer height determination in the EMEP model" *by* A. Jeričević et al.

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Remark 1) In Eq.(13) the authors introduce a new bulk Richardson number, but its looks pretty standard. Explain the novelty in the new bulk Richardson number.

Reply: The bulk Richardson number method is the standard and widely used form for determination of the boundary layer height from the NWP output as it was stated in the Introduction of our paper, page 9600, line 18-22. We are stating that it is a new method that has been applied in the EMEP model. In order to be clearer we will point this throughout the paper.

Remarks under 2) and 3)... It should be checked if the difference in r is statistical sig-

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nificant (compare the two distributions). This exercise should be done for all predictions of chemical species throughput the manuscript.

Reply: Significance Fishers z-test has been conducted on correlation coefficients (r) determined between the measurements and the modelled data in order to find whether the change in r reflects the change of stochastic relation between the two data sets. However, the appropriateness of this procedure is questioned because initial assumptions for its application are not completely satisfied. The z-test has been used in practice, nevertheless it is found to be quite insensitive to establish whether two correlations have different strengths. Furthermore, it is based on the assumption that data from two samples are normally-distributed, while SO2, SO4 and NO2 are found to be log-normally distributed. In this test, as in many other standard statistical tests, an assumption of mutual independence is made. However, daily concentrations are not completely independent since they are time-correlated with the persistence of meteorological events (Fox, 1980; Chang and Hanna, 2003). Time correlation in data sets may affect significance tests in many different ways, and this makes estimation of degrees of freedom needed for level of significance determination impossible. Willmott (1982) argued that it is inappropriate to report r as statistically significant, not only because the magnitude of r and its associated significance level are not necessarily related to accuracy and rarely conform to the assumptions that are prerequisite to the appropriate application of inferential statistics, as it was also stated here. According to Fishers z-test (details in supplement material) there is a significant change in the correlation coefficients if determined variable z is greater than 2. For NO2 the differences in correlation coefficients are significant for NL10 and SE02 while for other stations condition $z > 2$ is not satisfied (Figure 1). Nevertheless, there are certain differences among analyzed stations showing that the level of significance is higher for stations in Germany, Ireland, Netherlands, Norway and Sweden. In Figure 2 results for SO2 are presented. Changes in the correlation coefficient are significant for Denmark and Spain and less significant at other stations. For SO4 (Figure 3) there is no significant change in the correlation coefficients with the change of the vertical diffusion scheme

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in the model. The same procedure has been applied on the correlation coefficients calculated between the H determined from the radiosoundings and Cabauw data and the corresponding H values estimated with the EMEP model with the two different ABL schemes. Although the change in correlation coefficient is not significant, based on the evaluation provided from the radiosounding data, the level of significance is improved for Gothenburg, Herstmonceuix, Zagreb, La Coruna and Madrid during January and for Stavanger, Copenhagen, Wroclaw, Meiningen, Vienna, Payerne and Practica di Mare in July (see Fig. 4). The change in correlation coefficient for Cabauw is significant during March and April; for other months the level of significance is satisfactory while for February and June the change in correlation is not significant (Figure 5). Concluding, the new parameterization schemes for K(z) and H gives slightly better results and improvement is evident although standard significance tests do not reflect it completely due to their own stated limitations in application at this particular data. However those results can be included in the paper.

Remark 4) It seems that the ability to predict the height of the marine boundary layer (Lisbon and Torshavn) is poor.

Reply: It is known that numerical simulations of the marine boundary layer are more complex involving e.g., a parameterization of the internal boundary layer which develops over land in coastal areas because of the temperature discontinuity between land and water (Stunder and Sethuraman, 1985; Batchvarova et al., 1999). Nevertheless, we find that the marine boundary layer height is reasonably well simulated in the EMEP model which is confirmed with the results from the other coastal stations i.e. Gothenburg, Stavanger, Oslo, Hemsby, Practica di Mare, La Coruna, Copenhagen and Izmir. Therefore, the suggested explanation in terms of specific positions of Lisbon and Torshaven stations in the model domain and coarse horizontal model resolution are the main reasons for the lower correlation coefficients between the modeled and observed H values at those stations.

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Figure caption

Figure 1. Results of z-test applied on the correlation coefficients (r) determined between the daily surface NO2 observations and the modelled data calculated with the two different K(z) schemes, the O'Brien and Grisogono, for analyzed stations in the EMEP domain in the year of 2001. The change in r is significant if condition z>2 is completed.

Figure 2. Same as Fig. 1 but for SO2.

Figure 3. Same as Fig. 1 but for SO4.

Figure 4. Same as Fig. 1. but for the H determined from the radiosoundings during January and July 2001.

Figure 5. Same as Fig. 1. but for the H determined from the Cabauw data in year 2001.

Please also note the Supplement to this comment.

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