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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Implementation and testing of a simple data assimilation algorithm in the regional air pollution forecast model, DEOM" *by* J. Frydendall et al.

Anonymous Referee #1

Received and published: 4 May 2009

General comments:

The authors present a detailed comparison of various approaches to implement a simple data assimilation algorithm in an operational regional ozone forecast model. Both the data assimilation algorithm and the model evaluation focus on surface ozone. The analysis is sound and the results appear to support the hypothesis that data assimilation schemes may be beneficial for improving the forecast accuracy of operational models. The manuscript is generally well written and clearly structured. The quantity and quality of the tables and figures are appropriate and support the main conclusions. While I favor publication of a revised version of the manuscript, there are several ques-

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tions and issues that I would like to see addressed by the authors prior to publication:

- One of the main goals of air quality forecast models is to warn the public about potential exceedances of health-relevant pollutant thresholds. Therefore, the comparison of the reference run and the data assimilation runs should include categorical metrics such as false alarm rate, probability of detection, and critical success index for relevant ozone thresholds (e.g. 120, 180, and/or 240 micrograms per cubicmeter). This would provide additional evidence whether the data assimilation schemes investigated in this study can improve ozone forecasts. For a description of categorical metrics, please see Kang, D., B.K. Eder, A.F. Stein, G.A. Grell, S.E. Peckham, and J. McHenry, 2005: The New England air quality forecasting pilot program: development of an evaluation protocol and performance benchmark. J. Air Waste Manag. Assoc., 55, 1782-1796.

- In the introduction section, the authors may also want to include a discussion about postprocessing approaches (as opposed to data assimilation during model execution) that have been reported in the literature to account for model errors when issuing air quality forecasts. In these postprocessing approaches, model error often is estimated during a moving training period (e.g. the last seven days of forecasts) by comparing model output to observations. These bias estimates art then used to adjust the model forecasts for the current period after the model run is completed. For an example of such a postprocessing approach, please see Kang D., R. Mathur, S. T. Rao, S. Yu (2008), Bias adjustment techniques for improving ozone air quality forecasts, J. Geophys. Res., 113, D23308, doi:10.1029/2008JD010151.

- The data assimilation schemes described in this paper rely solely on updating ozone concentrations for the first layer with available surface ozone observations. Could the authors comment on the question how the lack of observations for other chemical species linked to ozone chemistry in the model as well as the lack of vertical data to adjust simulated vertical gradients affects the integrity and self-consistency of the modeled pollutant fields? This may be less of a concern when focusing only on the predicted ozone concentration but may become an issue when analyzing precursor

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species as well.

Specific comments:

Section 4.1, covariance determination: How sensitive is the determination of the correlation length and error covariances to the period used in the analysis (April – September in this study 1999)? Do the estimates for these parameters vary by month and/or for different years? If the analysis were to be performed for different regions of the domain, would there be sub-regional differences in the estimates, e.g. Southern Europe vs. Central Europe? How sensitive are the results of the data assimilation experiments described in Section 5 to the time period(s) and/or sub-region(s) used for estimation of the error covariances?

Page 7,656, lines 15-17: Please provide a reference for this statement. What is the typical spatial separation of the observation stations – is it equivalent to the typical transport distance corresponding to the temporal separation between assimilation time and evaluation time, i.e. approx. 4-6 hours? Why did the authors not consider an analysis approach that includes both spatial and temporal separation between observations used in the assimilation scheme and the observations used for evaluation?

Page 7,658, lines 5-6: Please clarify the design of experiment #6. In my understanding, experiments 4 and 5 use different correlation functions, so which correlation function was used in experiment #6?

Page 7,657, last paragraph: It might also be instructive to include maps of model performance as measured by bias, RMSE, etc. for the different experiments.

Page 7,658, lines 13-15: Was the ranking performed by month? The tables provide results by month but the description of the ranking system does not specify if the ranking was performed separately for each month.

Page 7,659, lines 4-6: How can continuous data assimilation be performed in a forecast setting where future observations are not available? For simulating historic periods,

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this statement is relevant, but I do not see how it is relevant for the forecast system analyzed in this study.

Page 7,659, lines 15-20: How sensitive is the conclusion that the optimal weights approach performs better than the equal weights approach to the training time period and/or spatial training domain used to determine the weights?

Page 7,659, line 25 – Page 7,660, line 2, Figure 2: Which hours are used for the analysis of daily mean values? In particular, do these hours include model values, pre- and post-assimilation periods, and the assimilated observations themselves during the 10:00 – 12:00 time period? In other words, there is a clear separation in time between assimilation period and analysis period for the daily maximum values, but it is not clear if there is also a separation for the analysis of the daily mean values.

Page 7,662, lines 12-13: Please specify how this different combination of experiments could be performed. In addition, this was not shown or discussed in Section 5 so probably this statement does not belong in the conclusion section.

Page 7,662, lines 24-26: What are the conclusions from this examination? Please specify.

Pages 7,679 – 7,680, Figures 9-10: Suggest including an additional panel showing the observed values.

Editorial comments:

Page 7,647, line 3: Suggest inserting “during initialization” after “assimilation of meteorological parameters”

Page 7,647, lines 6-7: Suggest defining “realistic emissions inventory” or removing the term “realistic”

Page 7,647, lines 7-9: Suggest replacing “validated” with “compared”. Also suggest changing the wording that the forecast “will be realistic and will probably also show

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good performance". How are "realistic" and "good performance" defined in this context? These terms are rather subjective. In addition, good emission and meteorological input fields are a necessary but not sufficient condition for good performance of the air quality model due to potential problems with the model formulation.

Page 7,647, lines 14 – 29: Please spell out NASA, EURAD, NILU, SMHI, and MATCH.

Page 7,648, line 3: Suggest replacing "great tools" with "valuable tools"

Page 7,648, lines 18-19: Suggest replacing "These data sets together gives" with "Potentially, these data sets together provide"

Page 7,648, lines 22-25: Suggest connecting these two sentences by inserting "but also for generating" between them and then modifying the sentence structure accordingly.

Page 7,649, line 26 – Page 7,650, line 9. This paragraph could be removed if the authors would like to reduce the length of the manuscript.

Page 7,653, line 9: Suggest replacing "essential thing" with "essential task"

Page 7,653, line 23: Suggest a more formal expression than "the good news is . . .". Please also elaborate why this is "good news".

Page 7,654, line 14: Suggest replacing "the departures from one" with "the departures at each"

Page 7,655, lines 18-20: Please provide a reference for this statement and elaborate which other parameter were considered when arriving at this conclusion.

Page 7,658, line 21: Please remove the "e" at the end of "determining"

Page 7,660, line 15: Please change the "!" to a "." after 0.68

Page 7,660, line 18: Suggest replacing "including mean values" with "showing seasonal mean values"

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Page 7,661, line 12: Suggest inserting “This is the case” before “Especially . . .”

Page 7,661, line 24: Please elaborate how this testing would be done. Also, please reword the expression “artificial artifacts”.

Page 7,662, lines 1-2: Suggest rewording the first sentence as follows: “This study reports the first results of a data assimilation routine that has been developed based on Statistical Interpolation for the DEOM model”

Pages 7,673 – 7,680, Figures 3 – 10: Please change “upper”/”lower” to “left”/”right” to reflect the arrangements of the panels.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 7645, 2009.