**Atmospheric
Chemistry
and Physics
Discussions**

Interactive
Comment

Interactive comment on "Using 3DVAR data assimilation system to improve ozone simulations in the Mexico City basin" *by* N. Bei et al.

Anonymous Referee #2

Received and published: 6 August 2008

This paper describes how ozone predictions are improved by assimilating meteorological observations into an air quality modeling system. While the paper is well written and organized, it lacks sufficient discussion on aspects of data assimilation that will influence the interpretation of the ozone predictions.

Major comments:

1) The paper lacks significant discussion of several issues related to data assimilation. A discussion section is needed (probably just before the conclusion section) that addresses the following issues:

a) Why is data assimilation necessary for air quality simulations? The authors fail to clearly articulate why data assimilation, particularly 3DVAR, is needed for air quality

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simulations. Presumably an improved description of meteorology will contribute to better air quality predictions, and therefore emission control scenarios can be conducted with more confidence in their predictions. This may be obvious, but some justification is warranted. For operational applications, data assimilation could be used to improve the initial conditions, but the effect of improved initial conditions is likely to be short-lived. Data assimilation has its place, but it does not get at the root cause of the uncertainties in meteorological predictions.

b) Why were experiments not performed with independent verification? Comparisons of 3DVAR results with observations that have been used in the assimilation are not an independent verification. This point needs to be made throughout the text. The paper could be greatly improved if another experiment was performed in which a portion of the observations were withheld and used as in independent data set for evaluation. If this experiment is not performed, the authors need to least discuss why this type of experiment is needed.

c) Why were improvements to the meteorology using 3DVAR incremental at best? Some discussion is needed to describe why the predictions still differ significantly from the observations. A variational approach is more mathematically sound than nudging, but it seems possible to achieve the same level of improvement using a simpler type of data assimilation. Despite the incremental improvement to the winds and temperatures, there were relatively larger impacts on mixed layer depths and ozone.

2) Why does the paper focus only on ozone? While ozone is important in terms of impacts to human health, ozone precursors should be examined as well. For example, it would be useful to quantify changes in CO and other primary emissions. Do other chemical species show similar improvements as ozone?

3) Since the performance of 3DVAR will depend significantly on the prescribed errors for the observations and background information, please describe in more detail why the NMC method (page 12535, line 11) and its 1-month data set would be applicable

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to the present study. Also include the possible impact of this assumption on the results in this study. The possible impact of the error covariance is only briefly mentioned in the conclusions.

Minor comments:

Page 12531, line 18: Please include a few sentences describing the differences between 3D and 4D variational approaches and what the advantages of 3DVAR are.

Page 12532, line 3: It would be useful to include any references that have used 3DVAR for air quality applications. If there are none, the authors should state so.

Page 12535, line 6: It would be useful to include a table listing the specific observations that are assimilated into the model results that depends on the domain.

Page 12536, lines 16-21: Unless, the VOC and NOx regimes are examined again with and without data assimilation, this paragraph is irrelevant to the present work and can be deleted.

Page 12537, line: Mark the positions of the high pressures systems in Figure 2 that are discussed in the text.

Page 12537, line 7: It is difficult to see significant differences in the profiles presented in Fig. 3. Perhaps the differences could be quantified better by plotting the observed profile in one panel and differences between the observed and simulated profiles in other panels.

Page 12538, line 3: I assume that the tethersonde observations were not assimilated into the model results, and thus present an independent data set to evaluate 3DVAR. The authors should include some text pointing this out.

Peg 12538, line 3: Please state why the mixed layer depths were changed significantly when assimilation was used. For example, was the surface temperature during the entire day too cool? Probably not, since the surface temperatures in Fig. 6 do not

seem to change much. Or was the stability changed that encouraged more vigorous boundary layer growth? Or was it something else?

Page 12538, lines 16-17: Even the 3DVAR simulations didn't capture the winds in the northwest part of the basin. Presumably they were assimilated into the model. Please comment on why 3DVAR failed to improve the model in this region.

Page 12543, line 25: Improvements to humidity is mentioned, but humidity is not described in the text.

Page 12549: The black squares in the right panel are not defined. What are they used for?

Page 12550: The coast of Mexico and the boxes need to have thicker lines to be legible.

Page 12553: Move labels from inside the panels to outside the panels to be more legible. It might be useful to draw in convergence lines at 20 LT so the reader can more quickly see the differences in the position of the convergence zone.

Page 12554: Gray shading has not been defined or discussed. Either describe or remove.

Page 12556: Gray shading has not been defined or discussed. Either describe or remove.

Page 12557: A 20 ppb contour increment seems too big for this time period. Suggest raising the minimum value to about 30 ppb and decreasing the interval to better illustrate the differences between the observations and predictions.

Page 12558: Include labels for the colors in the figure as well.

Page 12550: The arrows are far too small.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 12529, 2008.

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