

## ***Interactive comment on “Emission rate and chemical state estimation by 4-dimensional variational inversion” by H. Elbern et al.***

### **Anonymous Referee #1**

Received and published: 5 March 2007

Overall, it is an excellent paper that answered an important question in data assimilation. To our knowledge, it is the first paper that presents the details on 4D-Var chemical data assimilation that adjusts both initial concentrations and emission fields. In the paper, the results are thoroughly presented and discussed.

General: 1) There are some editing needed. a) Most figure numbers do not show up in text; b) Figure 5 does not match its caption; c) Caption of Figure 6 is missing; d) pp18,  $J_{\{m\}}$ in should be  $J_{\{min\}}$ .

2) In this paper, assimilation time window is chosen as 24 hours. Whether this is long enough for the adjusted emission rates to have effect on predicted chemical fields is questionable. This has been demonstrated by O<sub>3</sub> predictions in Figure 6. It is

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recommended that more explanation or discussion be given on this issue.

3). The results regarding the information content of various observations are of great interest. As we move forward in data assimilation the issue of what observations are most valuable is a key question. The results presented here show that the addition of a key precursor to ozone formation (i.e., NO<sub>x</sub>) did not improve the prediction skill. This is discussed in the paper and largely attributed to model resolution. Do you have results that might support this? can you comment on what is the value of assimilation of satellite observations on the regional predictions?

Specific: 1) pp.2, line 4: ", mapped to regular grids" It is not necessary to always map observation data to grid. Sometimes, it is impossible to do such a mapping, such as using the satellite column data.

2) pp.2, line 6: ", density, frequency" It is not clear what "density" means here.

3) pp.8, equation (9): It is better to indicate that Th, Tz, and Dx are operators that are performed with a half time step, unlike chemistry operator at a full time step.

4) pp 11, equation (17): How is '0.69' picked in the equation?

5) Figure 3 and 2nd paragraph on page 14: How are the correlation between different emitted species estimated?

6) pp. 16, 2nd equation: It seems that (L/Delta x) should read as (Delta x/L).

7) Figure 4 is difficult to read.

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 1725, 2007.

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