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Comment

# ***Interactive comment on “Tropospheric CO vertical profiles deduced from total columns using data assimilation: methodology and validation” by L. El Amraoui et al.***

## **Anonymous Referee #1**

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### General Comments:

This work presents a method to derive the vertical profile of CO from its total column using data assimilation. Comparison with model free run, the authors showed that the assimilation result with MOPITT column data significantly reduced the difference relative to that with the MOPITT CO profile data. This method can be extended to the chemical species that can only be measured as the total column. For better interpretation of the assimilation result, the authors should demonstrate whether their assimilation has enough vertical sensitivity. I recommend the paper for publication after consideration of the points below.

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## Specific Comments:

1: The zonal average degrees of freedom for signal (DFS) for the TIR-only MOPITT retrievals is typically about 1.5. When we use the column data, we only have 1.0 freedom, which will lead to the following question: do we have enough vertical sensitivity, or we are scaling the vertical profile uniformly?

Figure 15 shows the assimilation can reduce the zonal mean bias well. But the bias of zonal mean could be different with regional value and could also be affected by long-range transport. As a simple test, the authors can scale the vertical profile uniformly with ratio:  $\text{MOPITT\_column} / \text{Model\_column}$  in the assimilation process. It would be very interesting to see whether the method, presented in this work, is significantly better.

2: Page 6530, line 20-23: “The mean differences between both datasets are higher at 700 hPa than at 250 hPa. This could be explained by the reduced sensitivity of MOPITT measurements at lower levels.”

I cannot agree with this point. MOPITT V3 has weak sensitivity at surface but strong sensitivity in middle troposphere, from 700 to 350 hPa. I suspect that the difference between 700 and 250 hPa is due to the lost of vertical information by only using column data. This is why the authors need to check whether their assimilation has enough vertical sensitivity.

3: Page 6531, line 16-19: “These results are consistent with the results found by Emmons et al. (2009) comparing MOPITT CO profiles with aircraft measurements at 700 and 250 hPa. They found that the bias is larger at lower levels, being on average 25 % and 9 % at 700 and 250 hPa, respectively.”

This may not be an appropriate reference. Emmons et al. (2009) found the MOPITT CO profile is biased higher at 700 hPa. However, in this work, the MOPITT CO profile is used as true value and the objective is to reproduce the “true” CO profiles by using

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column data. The bias of MOPITT data itself has no relation with the bias showed in Figure 7.

4: In Figure 10, the deduced CO profile match very well with that from MOPITT retrievals. However, I am wondering whether it is because the regions, showed in Figure 9, are too big and thus the mean profile is strongly affected by the background CO. It would be helpful to define smaller regions, for example, over Southeast Asia monsoon or CO outflow regions to observe the assimilation effect.

Technical comments:

1: In Equations, vectors should be written with vector formats.

2: Page 6526, line 6: “p is the number of degrees of freedom”. Is it the best description? In 4DVAR, i should be the time step and p should represent the final time step.

3: The titles/descriptions of some figures are too small to read.

4: The description of “top” and “middle-left” in Figure 15 should be exchanged.

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 6517, 2013.

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