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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Limitations of wind extraction from 4-D-Var assimilation of trace gases" *by* D. R. Allen et al.

Anonymous Referee #2

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The paper aims to examine the limitations of the wind extraction from trace gas measurements using a 4D-VAR assimilation system. However, there are different points which are not yet very clear. The authors must address the following points before accepting the paper for publication.

Major comments:

The paper is generally divided into two parts: the first part is more pedagogical and qualitative in which the authors used a 1D model to highlight the limitations of wind extraction from the assimilation of trace gas measurements. The second part is a more realistic application of the methodology using a 3D model with a more complete 4D-VAR system.

1) The first part uses a 1D model in an idealized case with many simplifications. The conclusions (page 32997, lines 22-29; and page 33000, lines 1-9) from this model study which constitutes an important part of the paper have been already reported in the literature (see for example: Daley, 1995; Riishøjgaard 1996; Peuch et al, 2000; Semane et al., 2009). I expected from this part an added-value from this model different from that reported in the literature. I am wondering what is the benefit of this part for the scientific community. I would like the authors highlight better that benefit if existing.

2) The second part constitutes the body of the paper and it is much more realistic because it uses a 3D model coupled with a 4D-VAR assimilation system. However, in this realistic case, the authors have used only ozone as a trace gas. Nevertheless, the title of the paper refers to all tracers! To give a meaning to the paper with respect to the title, it would be nice to use other tracers in the assimilation system and which are available from MLS instrument for example. This will confirm the hypothesis of the conclusion (page 33010, lines 7-8) which states that the assimilation of other tracers in addition to ozone may supplement the wind extraction.

3) In the same direction, note that no discussion concerning the effect of the trace gas vertical distribution is undertaken in the paper. I recommend that the authors address this issue and examine the impact of the analyzed wind as a function of the vertical structure of the tracer if existing. For example, is there a relationship between the vertical gradient of the tracer and the analyzed wind? Can we quantify this impact regardless to the tracers?

4) Again, the interpretation of the results in the paper is generally based on the RMS reduction which is statistically good. However, no comparisons are done in terms of wind before and after the tracer assimilation. it would be very useful that the authors make a direct comparison of the wind before and after the tracer assimilation with respect to the altitude. Figures showing the vertical distribution of the wind at different regions before and after the tracer assimilation will be welcome.

specific comments:

-Page 32987, Line 11 : ...extremely expensive. I suggest you provide a reference.

-Page 32990, Line 5 : Error variance diagnostics -> Error variance reduction diagnostics

-Page 32990, line 7-13 : What about IASI data onboard Metop-A and Metop-B ?

-Page 32991, line 7. Please remove the last sentence.

-Equation 2 : it seems that there is a missing term in the left-hand side : $u_{\mathrm{b}} \frac{\partial q_{\mathrm{b}}}{\partial \lambda}$. If this term is missing, please check the equation 3.

-Page 32992, line 15 : the non-dimensional wind U should be $\mathrm{U} = u\mathrm{d}t/\mathrm{d}\lambda$

-Page 32992, line 16 : in 1D approach, I don't know if: $\mathbf{M}_{t_{n-1} \rightarrow t_n} = \mathrm{d}x'(t_n)/\mathrm{d}x'(t_{n-1})$, please check?

-Equation 5 and in the following : Please replace σ_v by σ_u, otherwise what is σ_v ?

-Page 33004, line15 : I would suggest 'distributions' instead of 'conditions'.

- Another section dealing with the limitations due to the vertical structure of the tracer if existing will be welcome.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 32985, 2012.