

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

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This is an well-written and interesting article that makes a useful contribution to our understanding of wind extraction in 4D-Var. The analytic solutions for the 1-D model form an important part of the paper and help to illustrate the nature of the wind extraction problem. However, the article does need to be careful when drawing conclusions from the 1-D examples. A few suggestions are given below, but it is necessary to remember that the 1-D examples are illustrative, and to be cautious when generalising from them. Otherwise, the article is largely ready for final publication.

Comments

1 - The conclusions drawn from the single-observation case in section 2.3, particularly

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from Fig.2, may be overly pessimistic. On P.32997, L.17 it is stated that increased measurement errors lead to "an increased probability that the analyzed wind is worse than the background wind". However, even in the worst case in Fig. 2 (background gradient = 0.2), if we were to take an ensemble of observations and an ensemble of analyses, many more of the analyses would benefit from improved winds than would suffer from degraded winds. Even if on some occasions the wind fields become slightly worse, the assimilation of tracer observations will on average improve the wind fields. Hence even in this case there is benefit to be gained from assimilating the tracer data.

The really important themes are the usual themes of data assimilation: (a) observation and background errors need to be correctly specified, and if that is true, even the noisiest observation can theoretically provide some benefit; (b) however, any uncorrected systematic differences between model and observations can wreak havoc.

2 - P.32998, L.20. "analyzed wind error reduces by 50% to 0.11". Is that not 0.09, rather than 0.11?

3 - P.32999, L.12. "assimilation of tracer observations has the potential to degrade the winds. A careful tuning of the background error covariances will be required to minimise this problem". Again I would suggest a slightly different interpretation. If the error covariances are correctly specified, the winds should not degrade in a statistical sense. And if the problem is a systematic error, then the ideal solution is bias correction, not error tuning. Of course there is plenty of error tuning done in the real world to deal with issues that are really bias problems!

4 - P.33000 L.7. "avoid spurious wind increments in the presence of noisy or sparse data". See point 1.

5 - P.33004 L.8-10. It might be worthy of comment that the wind error standard deviations are far too small for the NH, on the evidence of Fig. 4.

6 - P.33010 L.2. "correct tuning of the background and observational error characteris-

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tics". In a data assimilation system without systematic error, it should be "specification", not "tuning". This point is made a little further down the conclusion on lines 10-11.

7 - Figure 1. Would it be worth showing the true tracer distribution?

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