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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratospheric age of air computed with trajectories based on various 3-D-Var and 4-D-Var data sets" *by* M. P. Scheele et al.

Anonymous Referee #1

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General comments

The paper tries a way to improve the representation of the age of air in CTMs and trajectory models driven by operational analyses. It assumes that a part of the problem comes from the unphysical perturbations due to assimilation of observations and suggests that the use of successive forecast series can improve the representation of the age of air.

The subject is relevant to ACP. The manuscript is compact and easily readable. My main critics are: (i) The issue of using discontinuous series of forecasts for trajectory calculation is not discussed at all. Such a procedure can have many possible side effects which might well invalidate the conclusions drawn in the paper. (ii) There is no

discussion on whether the reduction of the age of air seen when using longer forecast series comes from an improvement of the transport representation or whether it is a caveat of the method. The assumption is made implicitly that a larger age of air corresponds to a more realistic representation of the transport. An important lack obviously exists in the discussion.

To my opinion the paper needs major revisions.

Specific comments:

1. p4491 l15-l24: The calculation of trajectories with discontinuous forecast series needs further discussion here. You suggest to use stepwise trajectories, such as those calculated from discontinuous forecast series, as opposed to approximated trajectories calculated with assimilated data sets. Many questions arise here that are not at all addressed. For instance, it would be good to discuss what differences you expect between these two kinds of trajectory calculations, and also what problems the interpolation of fields between the end and the beginning of two independent forecast series may introduce.

2. p4491, l25-l28: Inconsistencies exist in the ERA40 due to changes in the observation instruments as well. But this discussion is confusing because you use only one year of data in your calculations anyway.

3. p4492 l6: Not sure what you mean in sentence beginning with "A trajectory model...". Does this statement still hold with a passive tracer in a CTM?

4. p4493 l13: Is this really a fit? You have two points and two variables in your guess function, so there is no fit optimization. To fit the expected function to the real curve, you need to minimize the sum of squared differences between the expected function and the real curve over T=3 and 5. The determination coefficient will then give you a measure of the quality of the fit. In addition, it would be nice to know the contribution of the extrapolated part to the age. Rough calculations give me 20-34%, which means

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that up to a third of the estimated age of air lies on pure speculative extrapolation. Can you invalidate/confirm this? Can you justify the shape of the extrapolation?

5. p4494 l2: This criterion has two arbitrary parameters: pressure 10% and residence time 1 day. Can you justify them?

6. p4494, paragraph 1 of Section 3: Why using two different years for operational (2000) and ERA-40 (1997)? The experiments would be much easier to compare if using the same year, as you seem not to be interested in inter-annual variability anyway.

7. p4495, paragraph 3: You seem to base your conclusions on the assumption that the less transport, the more accurate the representation of the transport. Can you justify this assumption? Can you still hold this statement in light of the variability showed on Fig. 4? In addition, to my opinion, the dependence of the age on the forecast period may come at least partly from the unphysical evolution introduced between two series of forecasts: Let's assume there are biases in the model's representation of some processes. This might lead to a horizontally biased distribution of trajectories at each end of forecast periods. These trajectories then might be redistributed vertically (e.g. systematical ascent) by the unphysical vertical winds resulting from the interpolation between the end of one forecast period (biased winds) and the beginning of the next one (unbiased winds). Can you invalidate this mechanism?

8. Table 1, and p4495: The conclusions about the effects of the individual change of year, resolution, etc... are based on the comparison each time of only two individual simulations (see point 6 above). A few words on how general you expect the results to be would be very useful.

9. p4496 first paragraph: Can you give somewhere a discussion of possible side effects of using consecutively the same year, such as the interpolated fields between the end of the year and the beginning of the year, the loss of any inter-annual variability,...

10. p4496 last paragraph: see point 4 above.

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11. p4497 first paragraph: Can you give a hint on how the age of air is diagnosed in the CTM? Can you give a hint on how the age of air was derived from observations and from which observations? What year/season?

12. p4497 last paragraph of section 4: Why don't you discuss the season dependence with the July run?

13. p 4498 paragraph 4: This result was not presented in the paper. Either state it explicitely here or discuss this point more thoroughly elsewhere in the paper.

14. p 4498 paragraph 5 - p4499 paragraph 1: The corresponding figures were not discussed in the paper. Add the discussions in the corresponding sections of the paper.

15. p 4499 paragraph 2: Refer to point 7 above.

16. Section 5: No conclusions are drawn for the trajectory experiments, although this was the main goal of the paper.

Technical comments:

1. p1192 l17: It is not clear here what you mean with "period". A small explanation or a better term would help.

2. p4492 l6: Can you give the reference of these two trajectory models.

3. p4492 l9: Change "including the vertical wind on the" -> "including the vertical wind, on the"

4. p4492 l13: In the sentence: "The fraction of the trajectories that has left the stratosphere after this period is a measure...", do you mean: "The fraction of trajectories that cross the tropopause is a measure..."? Do you make use of the criterion described in p4493 l24 - p4494 l2?

5. p4492 l17: Do you mean "model version" of "assimilation scheme"?

6. p4492 l19-l20: Change: "observations of the age of air" with "age of air as derived

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from observations"

7. p4493 l20: It would be useful here to introduce the unit PVU.

8. p4494 Section 3, paragraph 1: Do you mean: "In experiment 3 for instance, the forecast time steps 12, 18, 24, 30 are used to represent a 24h flow evolution (i.e. [12h,36h[). The trajectories are then computed by connecting together successively such 24h forecast periods."

9. p4494 l21: "The fraction of trajectories that has reached the troposphere at or before day 50..." Do you mean within the past 50 days preceding the starting time?

10. Table 1, footnote: change "*F(50)..." -> "**F(50)..."; and in "fraction (*100%)" make sure that the "*" is vertically centered; "at or before 50 days" see precedent remark.

11. p4495 l2: change "F(50)is" -> "F(50) is"

12. p4495 l6: change into: "In conclusion, our calculations suggest that the age of air in the tropical lower stratosphere, which is in a negative monotonic relationship with F(50), is larger for ..."

13. p4494 l10: remove ", implying increasing age,"

14. Fig. 4: Correct the contour labels (what does "TM3 4Dvar FG" mean ?) and homogenize the notation.

15. p4497 Title Section 5: Prefer "Conclusions" to "Discussion and conclusions" because no real discussions are present in the section.

16. p4498 l3: Change "we assumed an exponential fit with two parameters, which were determined..." into "we extrapolated the distribution with an exponential function which parameters were determined..."

17. p4498 l6: Change "uncertainty" in "inter-annual variability".

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 4489, 2004.