

***Interactive comment on* “The direct inversion method for data assimilation using isentropic tracer advection” by M. N. Juckes**

Anonymous Referee #4

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General comments - the overall quality of the discussion paper.

One is never in doubt of the high overall academic quality of the work behind this paper. Yet the average reader of ACP might be quickly lost in the vast mathematical mysteries of data assimilation. Despite the authors' qualified efforts to make the journey as easy and pleasant as possible the subject is indeed advanced. It calls for thorough introduction, clear aims and explanations in unusually small steps. All of this is fulfilled to a high degree in the present paper, though the clarity of the aim is challenged in the introduction. Still a normal human being, equipped only with a degree in chemistry or physics, not in mathematics, will need to dig deep into long forgotten knowledge to enjoy the full benefit of this work. It would be nice to have a reference to a gen-

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eral text about data assimilation. I tend to recommend "Eugenia Kalnay: Atmospheric Modelling, Data Assimilation and Predictability, from Cambridge Press, but any similar reference will do.

Specific comments - addressing individual scientific questions/issues.

Averaging kernels? In most applications of space borne atmospheric remote sensing, the data providers, i.e. the retrieval algorithm developers, keeps emphasising the need for understanding and utilising the effect of the averaging kernels. Can it safely be assumed that this is not necessary in this work?

Technical corrections - purely technical corrections.

8881,13 "extended" compared to what?

8881,14 Please introduce the concept of "a background field"

8881,15 Please give introduction or reference to "the Kalmann Smoother"

8881,18 Please introduce the concept of "control variables"

8881,20 "interesting" to whom?

8881,23 Please give introduction or reference to "a full Kalmann"

8881,29 "Optimal algorithms" opposite to "sub-optimal systems" is algorithm and system synonymous here? Please introduce the concept of "sub-optimal systems"

8882,6 Please explain "quasi-elliptic nature", or as minimum why it's worth preserving.

8882,12 "with 2 h" may be "within 2 h"

8882,13 "There is clearly more information in the field" How do I see that?

8882,16 "the advection equation" please provide a references for our convenience.

8882,22 "weak physical constraint" You never explain what's "weak" about this constraint?

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8882,24 Please explain “quasi-horizontal”

8883,18+19 What, how much, would be gained if these were included. How big is the error generated by leaving them out?

8884,5..9 Generally very unclear. What’s “a representative class”. What’s the “length scale” and “the autocorrelation length scale”

8884,9 “This is assumed to be the case here” I that a reasonable assumption, what’s the consequences?

8884,19 “random, value” may be “random, the value”

8884,13..15 “A small ... hyperbolic in nature” Is this a problem, why not?

8887,19+20 “but the effect ... not be tested”. Would you call for further studies of this or are you comfortable by leaving it out, why?

8888,4 a ‘the’ too many.

8888,8 “additional information” What other information?

8888,10..24 This entire section is largely unclear to me. May be a clarification of the terms “the delta-function” and “the solution” would help.

8889,15 “2, 5 and 2” Where do these values come from? Are they reasonable?

8889,16 .. 8890,6 Nice validation set up. Do you have a references on that or did you invent it yourself?

8890,15+16 “the streamer stretching over Australia” I can’t find that. What do you mean by ‘over’ is that North?

88891,3 a ‘the’ too many.

8891,14..8892,7 Generally very unclear. Please introduce the differences between “Kalmann Filter” and “Kalmann Smoother”. Please explain, in more details, about the

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concepts of e-folding.

8891,18 “Fig.2” may be “Fig. 4”?

8892,6 “0.23 ppmv” Where do you get this value?

8892,16 I can't find “Eq. (7d)”

8892,17 “The computations ... 2. Ghz processor” Hardly relevant to the reader, as you provide estimates in number of cycles. If you want it then move to Table 1. caption.

8894,4..8 These satellite sensors have significantly different ways of detecting the same atmospheric constituent. Some are UV some are VIS and they include both nadir, limb and occultation measurements. Is it reasonable to compare these results (fields) without considering the averaging kernels and other aspects of the retrieving techniques?

8894,11..17 What can be concluded from this? Is this as expected? Is it good (enough)?

8894,18 a 'the' too many.

8894,18 “means and variance” The figure caption states: Mean and RMS. Please be precise and consistent.

8894,24..27 Would including the averaging kernels help this?

8895,7..14 Very nice and clear paragraph.

8895,9 “6h and 2.5°” only relevant for fig.6. Fig.7 is 12h and 5°

8895,10 “far fewer” than what?

8895,11 “enough” for what?

8895,15..17 “firstly, ... sufficient accuracy” ??? Please explain this in more details.

8895,20 What “Figure 4a”

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8895,25 “this implies” How?

8895,26 “0.25 ppmv” Why 0.25 ?

8896,5 “10E and 50E” Please provide some sort of indication of this on the figures, I had to look it up.

8896,7..10 “resolution ... 7.5°” in contrast to “Neq=48 and 96” please use either one or the other.

8896,21..27 Does this explain the invariability? What does it explain?

8897,13 “weak constraint” remains unexplained...

8897,15 “much smaller than operational...” Can this method be used operationally, under what conditions?

8897,18..19 “control variables” remains largely unexplained...

8897,20,21 At what point (on what scale) do the the solution (to what) become independent of the resolution?

App.A. Good and clear.

App.B. Is this necessary?

App.C

8901,19 Please ref. to explanation of Ngrid.

8902,1 “equator”? Isn’t it “the last latitude where the number of points were reduced”

8902,3..6 What do “Sophistication” mean in this context?

8902,7 “The European Centre” is this ECMWF?

8902,12..14 The “effect” on what?

8902,16..17 “This suggests ... present purpose” No - Just that it is better than others.

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8902,19 Laplacian what?

8902,18..28 This paragraph is largely unclear.

App.D & E Is this necessary?

Table 5. An illustration/graphics showing the grid, or parts thereof might ease the understanding.

Fig. 4. Largely unclear, way too many points and colours. Two of the plates refer to 500K and two to 850K. Which is which? What's "(smoothed)" in the caption? Is fig. 4 referring to July 2003 only?

Fig. 5, 6 & 7. Slightly confusing in general. What, exactly, does the two shades of grey represent, respectively? In % of what? What's the units on the axis? Percent on x and km on y?

Fig. 8 & 9. The meaning of the lower, yellowish, line is not clear to me.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 8879, 2005.

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