

## ***Interactive comment on “Data assimilation of stratospheric constituents: a review” by W. A. Lahoz et al.***

**Anonymous Referee #2**

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This is an important, long overdue, and much needed review of the field of stratospheric constituent assimilation. The authors did a very thorough job with regard to the relevant literature and in addition to a comprehensive review paper provided the most complete references list up-to-date. I recommend this article for publication. I supplied several comments, which I strongly encourage the authors to consider taking into account. Yet none of the comments are critical to the core objectives of the manuscript.

1. Abstract, 2nd sentence. In my view there are many methods of data assimilation, not just one. For semantic reasons you may want to consider altering this sentence.
2. p. 9565, item 5. "Although the models available...". I think it is fair to state that all models embody physical laws that govern the system. I would suggest changing "a

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reasonable choice is a model that embodies" -> "all models to some extent embody"

3. p. 9565, Item 20, "Typically, prior or..." -> "Prior or.."

4. p. 9565, Item 25 "Nevertheless, in any..." -> "Nevertheless in many..."

5. p. 9566. Itemized items (15, 20 , 25, etc) are misaligned

6. p. 9567. I would add one more distinction – "The dimensionality of the state of the stratospheric chemical models is much higher than that of the NWP models. Assuming the same number of grid points, stratospheric constituent models need to track about 20-100 different species per grid point versus under a dozen variables for a NWP model"

7. p. 9571, first line "observation operator" -> "observation operator complex and non-linear". Once we take a log of concentration, the observation operator becomes nonlinear. The line-of-sight integrals make it even more complex. I would also add a sentence alluding to the fact that if we assume Gaussian error statistics for concentrations, logs of concentrations will have non-Gaussian error statistics.

8. p. 9590, top paragraph. I would change that entire sentence to "This behaviour is explained by a combination of two factors: 1. HERE GOES WHAT THE AUTHORS NOTED 2. Linear approximations were generated at every solver time step and matrices corresponding to such linear transformation were multiplied to obtain a matrix approximating evolution of the system at the end of the 10-day period . Due to the nature of the stiff solvers, these time steps vary by orders of magnitude and get very small when the changes in concentration for certain species are most rapid.

9. p. 9591, item 10. "... in comparison to 4D-Var" -> " 4D-Var as well as no requirements for an adjoint model"

10. p. 9568, item 5 ".. constituent distributions many months..." -> "...constituent distributions for many months..."

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