

Anonymous Referee #1

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Review

This paper describes the data assimilation tool BEATBOX. This open source tool should be very useful to the scientific community working with data assimilation in the area of atmospheric chemistry, both for research and teaching. The description of the tool is comprehensive and the examples illustrative. Thus, this paper will be of great interest to the scientific community. The paper is suitable for publication once the authors address the comments below. They mainly concern providing further important details about OSSEs, and clarification of points made. The style of the language, including ensuring that the English is clear, is also a concern that needs addressing.

We thank the reviewer for his/her positive review and helpful comments. Please find our responses to the comments below.

P. 2

L. 21: Avoid subjective terms like "interesting".

We have updated the manuscript on several occasions to avoid subjective terms.

L. 23: Do you mean Lorenz?

Yes, we do. Thanks for spotting this typo. Fixed.

L. 28-29: Do you need "In fact"? Avoid needless words. Do this elsewhere in the paper, e.g., consider omitting the form "in order". Consider omitting "suspicious" in L. 19 of P. 17.

Removed.

P. 3

L. 2: Indicate what you will do in each section of the paper.

The last sentence of the introduction now reads: "In section 2 we present in detail the structure of BEATBOX and its algorithms, exemplified through case studies which we discuss in section 3."

L. 14: Perhaps comment that the space agencies, e.g., ESA, now support the use of OSSEs to inform on the performance of proposed missions. The authors could refer to the concept of scientific readiness level.

We added the following sentence:

[...] OSSEs allow assessing the benefit of a potential new type of instrument for environmental predictions using a data assimilation system and are of crucial importance to define requirements of a given instrument. Space agencies such as the National Aeronautics and Space Agency (NASA) or European Space Agency (ESA) hence support OSSEs as tools to proof scientific readiness levels for proposed space missions. Also, the model [...]

L. 22: Somewhere in this section, the authors should mention issues with OSSEs to take into account in their design: the cost; the “incest” or twin problem when the models producing the Nature Run and performing the assimilation experiments are the same; interpretation of results.
We clarify the text by adding the following sentences: [...] sets of ODEs (chemical schemes in our case).

A number of issues regarding the OSSE technique should be mentioned as well. Performing an OSSE could be costly in terms of setup and design as well as computationally. Numerical integration of the most state of the art representation of the earth system for sampling observations and benchmarking with could be intensively costly and requires highly skilled staff and extensive collaboration between research entities. Approximations are often required to make experiments possible (e.g. the “identical twin” problem) necessitating careful diagnosis of the results and could limit scientific conclusions. Ultimately an OSSE should be used to highlight model deficiencies and inaccuracies [...]

P. 7

Eq. (3): I think a superscript “-1” is missing after the brackets.
Corrected.

P. 9

L. 26: I am not sure what you mean by clamping. Should it be “clumping”?

No, it meant forcing these members to zero instead of becoming negative. The sentence has been revised and now reads: “[...] Finally, to conserve the positive definite nature of the ensembles and also prevent forcing ensemble members to zero that would otherwise be inflated to negative values we reduce the inflation factor iteratively on every value of the state such as: [...]”

P. 10

L. 9: Do not anthropomorphize the data assimilation system. I suggest you use a word other than “tell”. See also P. 15, L. 5; P. 17, L. 27. There are more instances.

We have gone through the text and corrected a number of instances.

P. 11

L. 14: What transition? P. 14

From the VOC- to the NO_x-limited regime. We have updated the text accordingly.

Fig. 5: I suggest that the caption includes the description of the line styles. Do this also for similar figures.

We have amended the figure captions to include the line styles shown.

P. 15

L. 2: Which same experiments? Identify them here.

The sentence has been rephrased and now reads: “[...] We repeat the experiments presented in 3.2.1, but assimilate CH₂O observations instead of NO₂. [...]”

P. 17

L. 30-31: *Rephrase and correct typos (this is an example of what to avoid). Check carefully the English language throughout the paper.*

We have again gone through the manuscript to correct typos. As none of us is an English language native and Copernicus offers English copy-editing upon publication we defer the final language check to their expertise.

P. 20

L. 13: *I suggest you replace “probably” with “likely”.*

Done.

P. 24

L. 33: *The Lahoz et al. reference is not in the main text. Please address.*

Referenced now in section 2.2.1.