

## ***Interactive comment on “The impact of observing characteristics on the ability to predict ozone under varying polluted photochemical regimes” by P. D. Hamer et al.***

**Anonymous Referee #1**

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Hamer et al. investigate how the characteristics of observations of ozone and its precursors affect their ability to support air quality forecasting and research. They use a photochemical box model and a Lagrangian 4D-variational data assimilation system to assess the impact of the choice of species to observe, of the observation noise, frequency and time during the diurnal cycle. The results are discussed according to the different photochemical regimes. This is an important point, not very often considered in such studies. Implications to emission inversion and GEO and LEO satellites are discussed highlighting the limitation of the numerical experiments conducted for this study.

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### General comments

The variety of numerical experiments conducted for this study constitutes consequent work and discussions and conclusions of these various experiments are of interest to well understand the implication between observations, emissions and air quality forecasting. The use of a simplified case (box model, idealized meteorology) allows the authors to draw instructive conclusions and they discuss them with regards to the limitations of their experiments. The manuscript is a consequent piece of work useful for the community. However, the presentation quality of the paper is often poor and major revisions are needed to improve this point.

1) The presentation quality needs to be improved especially concerning Section 2. It is very difficult for the reader to figure out what the various experiments are before reading Section 3 where one finally understands the different conditions used, in which cases and for what. In section 2, the information concerning the different experiments are provided at different places:

- page 4918, lines 7-12: first round of information given (changing the diurnal variability of emissions, ethane/ethane). This information is likely given too early in the text because the system has not yet been described.

- page 4920, from line 13 to the end: this paragraph is very difficult to read and the profusion of numbers within the text does not help to understand what the conditions of the experiments are for the emissions.

- page 4927, line 20: it is only in Section 3 the experiment conditions for the error are given.

Finally, it is confusing for the reader because the reader needs to build the puzzle of the various experiment conditions by himself. I would suggest to summarize the different experiment conditions in a table and to add a paragraph at the end of section 2, once the system, the theory and notations are defined, to discuss why these choices of

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experiment have been done.

I also wonder if Figs 2-4 are necessary in the manuscript. They are between schematic/illustrations of the method and results but the results are not clearly discussed. The reader does not know what conclude from these figures in terms of results. They are somehow more confusing than helpful for the reader.

2) Figures' quality needs to be improved. The size of the labels, numbers changes within a same figure, especially for the x and y axis. Improve the homogeneity within the figures would be good. It gives the feeling that the figures have been done very rapidly and not very carefully.

3) This comment is not related to the presentation quality of the manuscript. It is not clear for me the interest to include CO observations in the framework described here. If I well understood, the main focus here is to evaluate the impact of observations on forecasting capabilities of ozone (for air quality concern). The authors state that CO observations do not influence significantly the ozone forecast. So, why considering it in all the experiments? Does it help to constrain the background ozone? On the contrary, one of the main conclusions is that using O<sub>3</sub> and HCHO is valuable to improve ozone forecasting and emission inversion to properly cover the different chemical regimes but the authors do not propose any experiment including both O<sub>3</sub> and HCHO. It would be very interesting to have this kind of experiment in order to quantify the impact of using both O<sub>3</sub> and HCHO observations (more than having CO).

Specific comments

P 4912, line 25: the representativity of the measurement should also be discussed. It can bring some limitations when used for data assimilation.

P4914, lines 3-4: reference to Fu et al., ACP, 2013 and Cuesta et al., ACP, 2013 concerning multispectral retrievals (IR+UV) of ozone should be added.

P4923, references to Fig. 3 and eq. 12: the choice of E is not judicious as it is already

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used for the emissions. I am not sure this figure is very useful. One understands the process by the text.

P4923, line 10: It is not clear for me why the figure "demonstrates the mechanism by which ...". It seems quite obvious and well admitted for a secondary pollutant that the improvement of its precursor emissions will improve its concentrations.

P 4924, line 11: I do not understand what the authors mean by this sentence and what the interest is. They need the Jacobian to go through the error analysis, so it is not redundant.

P 4924, line 13-14: I would rephrase the sentence more like this: "Within our framework, each element of K represents the forward. ...".

P 4934, reference to Tab 5.: For the OCN scenario, 2 very large values are reported in the table for XNO=1.25 and 1.5. Are they correctly reported? IF yes, they should be discussed.

P4935, reference to Tab. 6: What about the ozone concentrations outside the ozone maximum? Is the influence similar?

Technical corrections:

P 4915, line 10: change "pre-cursor" to "precursor"

P4922, line 19: Is the notation  $\hat{x}$  within the gradient consistent with the notation use elsewhere in the text?

P4924, line 5: change "emissions" to "emissions estimates"

P4929, line 26: it should be "HCN scenario" and not "HCHO scenario"

P4935, line 1: change "varibility" to "variability"

P4945, line 27: change "may too be insufficient" to "may be too insufficient".

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