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Interactive comment on "A low-order coupled chemistry meteorology model for testing online and offline data assimilation schemes" *by* J.-M. Haussaire and M. Bocquet

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We would like to thank the referee for his/her time, his/her useful input on the manuscript, and his/her interest in our work. Please find below the response to your comments and how the manuscript was modified accordingly.

- *1. For advection of the minor species the authors use a Godunov scheme. This scheme is usually found very diffusive, so the gradients are not very well conserve. I would have rather used a "slope scheme" or a PPM scheme, which can be easily implemented in a 1D framework. Have you any indications on the impact of your choice on the results of your assimilation experiments?*

The Godunov scheme is indeed very diffusive. It was chosen in Bocquet and Sakov, 2013, because it is very simple, conserves mass and positivity. It also accounts for the effective diffusion often present in chemical transport models at coarse resolution.

If the L95 model is exchanged for another meteorological model which is continuous, such as the Burgers equation or the Kuramoto-Sivashinsky model, the advection scheme would need to be revised and a more accurate, less diffusive scheme could be chosen (such as a direct space–time third-order scheme with a flux limiter, or a semi-Lagrangian scheme) as you have suggested.

We have included a short discussion about this issue in the conclusion, where we discussed the extension of the model to different meteorological models (in connection with the first referee's remarks).

- *2. As expected the impact of species assimilation on the coupled system is very different from one species to another. I would have expected more insight on that point and discussions on the relative role of dynamics and chemistry on the observed decoupling. This could certainly be done in comparing the time scales for dynamics and the lifetimes of the various species. A discussion around those ideas would certainly be of interest for future work using more complex models.*

The aim of the article is to introduce a new low-order model and demonstrate how it could stand for a rich playground for testing data assimilation schemes and the influence of various parameters. With this perspective in mind, we have introduced throughout the article several key parameters relevant to the physics, chemistry, coupling of models and to the observation of the system. We have even experimented on some of them, such as α, E or λ. But we believe it would be too far reaching in this paper to consider sketching a phase diagram depending on the value of these parameters and of the kinetic constants of the species.

We can nonetheless suggest additional experiments that we contemplate or that we have already partially studied but not reported. First of all, an experiment similar to the one in Sect. 3.3 (regime driven by the emission/deposition ratio) could have been carried out to compare the impact of the time scales on the result of data assimilation. Another experiment consists in assimilating observations of only a given set of species, instead of all of them, and witness which ones are necessary to avoid the filter's divergence. This requirement could probably be discussed from the time scales of the species which could affect observability. Another test that we have carried out was to study the impact of the α coefficient of the L95 model (Eq.(15)) on the data assimilation results, thus actually altering the time scale of the meteorology to possibly fit the time scale of the chemistry. Finally, some experiments on the decoupled L95-GRS, similar to the ones performed on L95-T could have been shown. These experiments present interesting results and raise challenging questions, many of them we have not satisfyingly answered yet.

In conclusion, we see this article as an invitation to such exploration of the phase diagram of the data assimilation system which depends on the many space and time scales set by the model. We hope to have provided tools for this exploration.

We have changed the conclusion of the manuscript to partially reflect this discussion.