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Lessons from a low-order coupled chemistry meteorology model and applications to a high-dimensional chemical transport model

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Atmospheric chemistry models are becoming increasingly complex, with multiphasic chemistry, size-resolved particulate matter, and possibly coupled to numerical weather prediction models. In the meantime, data assimilation methods have also become more sophisticated. Hence, it will become increasingly difficult to disentangle the merits of data assimilation schemes, of models, and of their numerical implementation in a successful high-dimensional data assimilation study. That is why we believe that the increasing variety of problems encountered in the field of atmospheric chemistry data assimilation puts forward the need for simple low-order models, albeit complex enough to capture the relevant dynamics, physics and chemistry that could impact the performance of data assimilation schemes.

Following this analysis, we developped a low-order coupled chemistry meteorology model named L95-GRS [1]. The advective wind is simulated by the Lorenz-95 model, while the chemistry is made of 6 reactive species and simulates ozone concentrations. With this model, we carried out data assimilation experiments to estimate the state of the system as well as the forcing parameter of the wind and the emissions of chemical compounds. This model proved to be a powerful playground giving insights on the hardships of online and offline estimation of atmospheric pollution.

Building on the results on this low-order model, we test advanced data assimilation methods on a state-of-the-art chemical transport model to check if the conclusions obtained with our low-order model still stand.

References

[1] Haussaire, J.-M. and Bocquet, M.: A low-order coupled chemistry meteorology model for testing online and offline data assimilation schemes, Geosci. Model Dev. Discuss., 8, 7347-7394, doi:10.5194/gmdd-8-7347-2015, 2015.