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Interactive comment on "Sensitivity of chemical transport model simulations to the duration of chemical and transport operators: a case study with GEOS-Chem v10-01" *by* S. Philip et al.

Anonymous Referee #1

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Review of paper Sensitivity of Chemical Transport Model Simulations to the Duration of Chemical and Transport Operators: A Case Study with GEOS-Chem v10-01 by S. Philip, R. V. Martin, and C. A. Keller

This study presents sensitivity simulations designed to understand the variability of simulated concentrations to the model spatial resolution and the temporal integration. These simulations are done using the chemistry-transport model GEOS-Chem v10-01, a state of the art model. The main goal is to determine the best compromise between computational expense and simulation accuracy.

The main motivation for this work is clear and certainly one major concern for atmo-

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spheric modellers, often searching for more accuracy and less computational time at the same time. But the methodology exposed in this paper is very simple and the main conclusions are difficult to understand and thus to consider as robust and acceptable.

In fact, the question could be: is there really an optimal couple between computation and accuracy? This couple exists and a sensitivity study is not needed:

1. for the transport, the CFL must be respected
2. For the chemistry (faster), some error criteria exist and have to be apply. see for examples all papers about the stiff solvers, as one you are citing: Mallet et al 2007, among many others.

Also, obviously:
http://acmg.seas.harvard.edu/education/jacob_lectures_ctms_chap3.pdf (section 3.2)

If you consider that you need to have 1 ppb as maximal numerical error, you can use solvers criteria to calculate it. If the criteria is not respected, you just have to automatically increase your time step and rerun until the required precision is reached.

The main concerns are:

- the conclusion is to invite modellers to prioritize the fine spatial resolution before the temporal resolution. This conclusion is clearly false. As presented in the paper (introduction), the CFL is the most important limiter for the computational time. In a chemistry-transport model, when increasing the spatial resolution, the time-step will automatically increase too. These two considerations are thus not independent and there is no priority to give between the two. Note that the CFL has to be expressed in Δt and Δx (and not the absolute value t and x).
- the bibliography is not sufficient: a lot of citations are old (25/72 are used to explain how CTMs are working but are before 2000). Numerous sensitivity studies

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currently exist to examine this problem and it would be necessary to refresh this bibliography and then the arguments used in the paper.

- A lack of measurements: In this paper, there is one simulation with a specific accuracy and considered as the reference. How can you be sure this is a 'good reference'? Are you sure that the difference between measurement and the reference is lower than between the sensitivity simulations? i.e that your reference is really good? If this is not the case, the study is not very useful, because you are just calculating differences all far from the reality.
- The conclusions about the mass variability of aerosols or the concentration variability of gaseous species is very strange. The main goal of a parameterization is to be conservative in mass whatever is the spatial resolution. If the model has results significantly different when the resolution is 1, 2 or 4 degrees, it means there is a real problem in a scheme (chemistry? deposition?).
- All conclusions are probably valid only for this specific CTM, its strengths and weaknesses. The sensitivity study is not done in a way that some results could be used in another context.

Details:

- p.9590, l.8: why tracers? in the paper, the study examines chemically active species and not tracers.
- p.9591, l.4: CTM stands for chemistry-transport model (and not chemical).
- p.9591,l8: why "a" mass continuity equation. Is there different equations? Does it mean that some simplifications are done in the case of GeosChem. If yes, what simplifications?

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- p.9594, l2: the Firts level is very high (130m ASL) and probably not adaptated to fast chemistry as above urbanized areas.
- p.9594: Reference to (Fairlie et al., 2007): More a sensitivity study than a mineral dust production scheme.
- p.9595, l.11: How this influence is reduced? Is it significant compared to the other variabilities studied here?
- p.9596, l.19: To make the sum of the SIA may hide a very high variability due to a chemistry badly solved if the time-step is not correct.
- p.9597, l.20: "a factor of 4" this means there is no impact of the CFL, but only the impact to have four times more cells. This "linearity" is difficult to understand.

Interactive comment on Geosci. Model Dev. Discuss., 8, 9589, 2015.