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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Will a perfect model agree with perfect observations? The impact of spatial sampling" *by* N. A. J. Schutgens et al.

Anonymous Referee #1

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In this study, the authors use high-resolution modelling of aerosol distributions to build two datasets, one representative of typical observations and the other of typical global aerosol model simulations. Comparing the two datasets statistically quantifies the errors due to spatial sampling. The authors find that those errors are large, and explore different ways of minimising them, from temporal averaging to model interpolation.

This paper is very interesting and very clearly written. I very much enjoyed reading it. The figures illustrate the discussion very well. I agree with the authors that the lack of previous study of those sampling effects is surprising, given that model/observation comparisons are now a mandatory aspect of most modelling papers and research proposals. That situation strongly suggests that comparisons are often not made carefully, and that observational constraints have often been misleading.

I recommend publication after minor revisions to address the main comments below. The first comment asks for a clear explanation of why errors should increase with distance to the grid-point, a fact that I find difficult to comprehend fully. The second comment requests a more separate discussion of differences of behaviour between observables.

1 Main comments

- Sections 4 and 9: I may not be as clever as the average *Atmos. Chem. Phys.* reader, but I have difficulties understanding why errors increase with distance to the grid-point of the 210x210 box. If I understand section 4 and Figure 2 correctly, if $w = 1$, all observations (the 10x10 boxes) within a model 210x210 gridbox are compared to the same value. That value is the average of all observations in the 210x210 gridbox, as calculated by Equation 2. So it should not matter where the 10x10 box is within the 210x210 gridbox, since the value being compared against is always the same. Where do I go wrong here?
- The difference in behaviour between observables is fascinating. Looking at figures 2 and 3, one does not see an essential difference between AOT and BC that could explain the different error statistics (Figure 6) and different responses to temporal sampling (Figure 5, page 7 line 15). Yet they differ. The authors offer hints at possible causes throughout the paper, especially in section 6 where they discuss the narrowness of BC plumes. I recommend adding a more self-contained discussion in the conclusion. That discussion could also be more quantitative. In data assimilation, where they encounter very similar problems, they characterise distributions with correlation length scales. The results of the present paper suggest that AOT, for example, has a longer correlation length scale than BC concentrations, although this is not obvious from looking at Fig-

ure 2. Collins *et al.* (2001) use a correlation length scale of 200 km for AOT, which sounds large compared to what the authors imply here. Correlation length scale would also inform the model/observation comparison strategy, with distributions with shorter correlation length scales requiring greater caution and a more adapted distribution of observations.

2 Other comments

- Page 4, lines 1–2: SPRINTARS can diagnose number concentrations, but that facility was not used in this study. Is that correct?
- Page 4, lines 12–20: The authors seem to worry about the impact of hygroscopic growth on number concentrations, but I do not understand what the problem is in the context of the study. Can that point be clarified?
- Page 21, caption of Figure 2: The meaning of “at 10 days, 00 hours" is unclear. I suggest “at T+10 days”.
- Page 11, section 10.1: Even if I fully understood the reason why errors increase with distance to the grid point, wouldn’t that fact be an artifact of the methods used, where model data are regridded versions of observations? In the real world, the two are independent, so distance to gridpoint might be less relevant, undermining the strategy of using only observations close to the gridpoint.
- Page 11, line 30: The distance at which errors are zero in the case of a linear weighting function looks to be two thirds of the gridbox size. Is that expected mathematically, or is it a coincidence?

3 Technical comments

- Page 3, line 20: Repeated word “from”
- Page 4, lines 18–19: Reference is wrongly formatted.
- Page 23, Figure 5: It would help if the blue line were thicker.
- Page 7, line 32: Typo: “quite a bit”
- Page 8, line 22: large -> larger
- Page 12, line 16: Typo: “a more localised weighting function”

4 References

Collins, W.D., P.J. Rasch, B.E. Eaton, B.V. Khattatov, and J.-F. Lamarque: Simulating aerosols using a chemical transport model with assimilation of satellite aerosol retrievals: Methodology for INDOEX. *J. Geophys. Res.*, 106, 7313–7336, 2001.

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