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Geoscientific Model Development Discussions

Interactive comment on "Novel estimation of aerosol processes with particle size distribution measurements: a case study with TOMAS algorithm" *by* Dana L. McGuffin et al.

Anonymous Referee #3

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Review of "Novel estimation of aerosol processes with particle size distribution measurements: a case study with TOMAS algorithm"

The authors employ an inverse modeling technique on an aerosol microphysical model in order to scale uncertain simulated aerosol processes (nucleation, emissions, and growth) to improve simulated aerosol properties (N3-6, N10, Vdry) compared to observations. As an initial step, the authors test the inverse modeling technique on synthetic data with and without noise as well as observed aerosol size distributions in Europe. The approach is novel, interesting, and has potential towards broader applications (as noted in the manuscript). The manuscript is well written and the results are convinc-

ing. I believe the manuscript is suitable for publication after consideration of the minor comments outlined below.

General Comments:

I believe the manuscript would benefit from further discussion on the limitations of applying this approach to ambient size distributions which may be influenced by many uncertain aerosol processes that are not being scaled in the inverse technique. As aerosol processes are often non-linear, how sensitive is this method to potential errors in the representation of other aerosol processes? The authors do introduce this issue in Section 4.2 (and I agree a full exploration of the problem is beyond the scope of this paper). What are the implications of the assumption that the other modeled aerosol processes are correct? If a given aerosol process is drastically misrepresented in the CTM, will this inverse approach overcompensate (attempting to get the correct answer for the wrong reason)?

How generalizable is this approach in terms of choosing the scale factors and inventory variables? Would it be relatively straightforward for future studies to choose different aerosol processes to scale (for instance, if I wanted to assume nucleation rates are accurate but instead scale dry deposition rates)?

How is the exponential error decay factor (Kc) tuned? Is it kept constant across the simulations using the synthetic and observed data or is it tuned in each simulation?

Specific comments:

1. Line 2-13 could be rephrased as there are other processes that could contribute to aerosol growth not considered here.

2. What is the normalized error for the aerosol properties simulated with the a priori TOMAS model in Figure 8? How does this compare when using the inverse method?

3. I think Figure 9 could benefit from a legend or additional annotation. I found it hard to remember each color representation.

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