

Interactive comment on “Ensemble filter based estimation of spatially distributed parameters in a mesoscale dust model: experiments with simulated and real data” by V. M. Khade et al.

Anonymous Referee #2

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The manuscript “Ensemble filter based estimation of spatially distributed parameters in a meso-scale aerosol model: Experiments with simulated and real data” by V. M. Khade et al. deals with a demanding parameter estimation problem. Their task is to estimate fixed maps of soil erosion (a parameter called “erodibility”) which in part determines the desert dust aerosol emission. The problem is hard because the dimension of the problem is quite high as there is a specified value in each model grid point. This is contrast to many other model parameter estimation tasks concerning, say, model physics closure parameters where the problem dimension is low.

Given the hard estimation problem, I think this manuscript documents good progress,

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with a potentially significant impact in the field. I am glad to recommend its publication in ACP after just minor revisions.

Minor comments (in order of appearance in the manuscript):

- p. 28839, line 5-25: This introduction is a bit too general. Instead, you could concentrate to better explain the EAKF algorithm, which is used in the manuscript.
- p. 28845, line 22: “ensemble based estimation” → ensemble Kalman filter based estimation
- p. 28846, line 13: “meteorology” → atmospheric state
- p. 28847, line 10: “initial guess” → define in the context of EAKF (usually “prior state”, or “background”)
- p. 28847, line 17: Explain the lateral boundary condition for dust in the forecast model.
- p. 28847, line 24: Before c_m , write “dust concentration”
- p. 28847, line 28, and forwards: You state (here and in many places in the manuscript) that for parameters there is no dynamical equation. And yet you use one: $d\alpha/dt = 0$. In fact, for a well tuned forecast model this is an exact equation. Re-write here, and elsewhere, that this equation is applied although it is not exact for an imperfect (un-tuned) system.
- p. 28848, line 5: “The state variables (T, V, etc.)...” Please be more accurate here. What exactly are your state variables because the atmospheric state is given (not a state variable)!
- p. 28848, line 13: “Theory states ..” Which theory? Be more specific.
- p. 28849, line 13: A comment: 24-h interval is quote long implying low ratio of observations vs. parameters to be estimated.

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- p. 28851, line 11: "is the innovation" is repeated.
- p. 28853, line 11: "A cutoff radius is not imposed in the vertical". I do not understand, please clarify.
- p. 28853, line 22: "Arabia" →Arabian peninsula
- p. 28853: Figure captions are very long, and at places, duplicate the main text. Reduce captions for better readability.
- p. 28854-55: Experimentation provides material for clear understanding of parameters l and c on parameter recovery.
- p. 28857: You could say that spatial correlation in alpha effectively means reduction of the problem size (fewer degrees of freedom to resolve by estimation, and thus better parameter recovery).
- p. 28858, line 6 and 7: Fig.5i and 5g → Fig. 1i and 1g
- p. 28861, line 4: remove "in"
- p. 28861, line 13: Interestingly, "bad" values are near the boundaries.
- p. 28861, line 19: You could discuss the realism of the recovered parameter values here.
- p. 28864, line 21: Figure 12 is too small, and thus unreadable. Therefore, I have not been able to review any text text between p. 28864, line 21 and p. 28867, line 9.
- p. 28867, line 11: I wonder whether the term "trend" is adequate here?
- p. 28868, line 20-25: State clearly that in the OSSE, the alpha-map is the only model error.
- p. 28869, line 11: Yes, but with the additional complication that the temporal correlation time-scales need to be determined simultaneously.

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- p. 28869, line 26: Is this realistic knowing the surface type over there?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 28837, 2012.

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