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Atmospheric Measurement Techniques
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# *Interactive comment on* "A review and framework for the evaluation of pixel-level uncertainty estimates in satellite aerosol remote sensing" *by* Andrew M. Sayer et al.

**Anonymous Referee #1**

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The authors discuss preliminary but very innovative work on prognostic (i.e. predicted) uncertainties in satellite retrievals. Although they focus on AOT (aerosol optical thickness), much of what they have to say is applicable to other properties (either related to aerosol or not). The paper has two major topics: the methodology of prognostic uncertainty estimates and the evaluation of those uncertainties. I believe prognostic uncertainties to be very important for at least two reasons. A practical reason is that data assimilation systems require uncertainty estimates for the observations they ingest. A philosophical/scientific reason is that good prognostic uncertainty estimates, if provided through formal error propagation, will advance our understanding of the strengths and weaknesses of remote sensing products. This paper is well written and



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Discussion paper

entirely suitable to AMT.

General comments:

As I started reading the paper, I felt that two major issues were not really touched upon: biases in observations and the Gaussian nature of errors. Fortunately, the authors spend quite some time discussing these at the very end of their paper. Maybe it would be good to refer to this alreday in the Introduction.

That said, I would like to hear the authors ideas on some aspects: - why would we expect errors to have a Gaussian distribution in the first place (other than for its ease of use)? - how will biases in real observations affect their analysis. E.g. Fig 9 shows that biases clearly present. (I believe Oleg Dubovik makes a very similar comment)? - how to interpret biases and uncertainty? The concept of uncertainty suggests random errors but at the same time the authors point out that calibration issues often result in biases. A similar issue is that a bias may be spatially varying (e.g. if related to surface relflectance estimates), and may present itself as more of a random error in a global dataset.

Minor comments:

p 19, l 3: "The reasons for identifying a particular site as complex" Can one be sure that "straightforward" sites are exactly that? It would be good if in future work, a number can be put on this so-called 'complexity'.

One thing that surprised me was that it seems that scene complexity has no systematic impact on errors/uncertainty. Maybe the authors can comment on that?

p 20, l 12: Did the authors verify that the standard deviation in AERONEt measurements was (statistically) the same for match-ups of different products (e.g. did different products see scenes of similar heterogeneity)?

p 21, l 5: "there is no objective way to determine universal optimal thresholds." I suspose the problem is not in finding an objective criterium but finding a universal criterium.

Objective criteria might be derived from e.g. model simulations at high spatial resolution or collocated surface measurements at high frequency.

Table 7: Why do land cases provide more match-ups? I would assume that over ocean, there are more valid retrievals?

p 29, l 1: "sites are grouped in triplets" I'm not sure what is meant by this. I see 6 sites in each figure and scene complexity is only denoted by the vertical order of the panels.

p 29, l 13: "This implies ..." Doesn't it also imply that the uncertainty of AERONET retrievals (mentioned in the previous sentence) is NOT an issue?

p 31, l 4 : "there is no clear single best technique" I'm rather impressed with the performance of DB. I understand DB uses an empirical approach which is maybe why the authors don't mention its success. Since its performance is so obviously better than the others, may be better to discuss this once more?

p 35, l 35: "the hard boundary of SSA=1 means that the Gaussian statistics on which many uncertainty estimates ..." Similarly AOD has a hard boundary of zero. Skewed MODIS DT error distributions can be found at low AOD (see e.g. Zhang & Reid 2006), which is why DT introduced negative AOD.

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