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Atmospheric Measurement Techniques Discussions

Interactive comment on "Known and unknown unknowns: the application of ensemble techniques to uncertainty estimation in satellite remote sensing data" *by* A. C. Povey and R. G. Grainger

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Uncertainty quantification of satellite products, particularly on the per-pixel level, remains a challenge for the remote sensing community. The authors provide a large scale view of uncertainty analysis, often beginning with internationally accepted definitions and techniques (i.e., Guide to Uncertainty in Measurements) and then explains how these definitions/techniques can or cannot be applied to remotely sensed measurements. I thought this paper was a reasonable overview of uncertainty and error analysis. The examples given are largely illustrative, but useful – I particularly enjoyed the bucket analogy shown in Figure 3.

My main critique is that based on the title, I expected a more in-depth discussion of the use of ensemble techniques to estimate uncertainty. Ensembles were only explicitly discussed in section 2.4. The focus of the paper is good, but the title of the paper needs to better reflect it. It may also make sense to limit the scope of the paper to passive sensors – many of the examples may not necessarily apply to active remote sensing.

This paper will hopefully serve as a first step to getting the cloud and aerosol community to agree upon a path forward to providing pixel level uncertainties. Although this paper is more of a "best practices" paper than a traditional research article, given the wide readership of AMT in the atmospheric community and the current need for uncertainty characterization in the satellite products of these communities, AMT is an appropriate venue for this work. This is a well-written paper with clear figures, and I only have a few comments to be addressed.

Minor comments :

Introduction: It may be worthwhile to mention that measurement uncertainty is essential for data assimilation (which in turn is one of the largest uses of satellite data products).

Section 2.4 : The authors also need to be careful in that multi-model ensemble techniques in the weather and climate communities represent model diversity, not uncertainty. These are not interchangeable! An excellent discussion of this can be found in Knutti, 2010.

Section 2.4 The authors seem to be lumping single-model (or algorithm) ensembles (running the same model/algorithm with perturbed inputs) together with multi-model ensembles (running several different models/algorithms once and examining the model diversity). Both techniques lend insight into uncertainty, but the two techniques will give different information.

For example, let us say that aerosol retrieval A includes wind speed and ocean color into their calculations of ocean surface reflectance while aerosol retrieval B does not. Performing a single-model ensemble technique to algorithm A will capture the uncertainty in ocean surface reflectance, but applying this same ensemble technique to retrieval B will not. However, the multi-model ensemble technique, adapted to remote sensing, (i.e. running both algorithms on the same reflectance input) will give insight on the error of leaving out some of the physics of the problem, but may not give better information on per pixel uncertainty for each independent algorithm.

Page 15, Line 8: Many branches of science do not have repeatable measurement, maybe better to rephrase "This is unusual in the sciences. . ." to something like "This is opposed to laboratory science. . ."

Line 17, Page 15 : Level 3 is more than just averages, it may be better to say that Level 3 is the statistics of aggregated Level 2 data.

Page 16, line 25: A good example of fair-weather bias is shown in Levy et al., 2009, particularly Figure 7.

Page 27: Line 25: C5 MODIS AOD low magnitude retrievals were assigned lower quality, this is no longer true in C6. Given that this example is largely illustrative, keep it, but just clarify that this is only for C5.

References : Knutti, R., 2010: The end of model democracy? Climatic Change, 102, 395–404, doi:10.1007/s10584-010-9800-2.

Levy, R. C., Leptoukh, G. G., Kahn, R., Zubko, V., Gopalan, A., & Remer, L. A.. (2009). A Critical Look at Deriving Monthly Aerosol Optical Depth From Satellite Data. IEEE Transactions On Geoscience And Remote Sensing, 47, 2942–2956. doi:10.1109/TGRS.2009.2013842

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