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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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We thank referee #2 for his/her kind comments.

We propose changing the title of this paper to, "Known and unknown unknowns: Uncertainty estimation in satellite remote sensing" to satisfy the comments of both reviewers. This should better represent the main purpose of the paper.

We appreciate that the entirety of this paper is not relevant to active remote sensing but,

from our experience with lidar, we feel several aspects of the paper are still important. The following discussion is now included in the conclusions,

> "This paper concentrated on passive remote sensing but the clear communication of uncertainty to users is still important in active remote sensing. The different definitions of active and passive measurands must be appreciated if they are to be compared. Active data are generally better constrained than passive and are often analysed with analytical equations, where approximations and system choices are substantially less important but still present (for example, the Ångström coefficient, the lidar ratio, and multiple scattering). These errors are minimised, in part, by selecting measurands closely aligned with the measurement (e.g. backscatter, extinction, reflectivity, depolarization). Approximation and system errors can become important when calculating more poorly constrained, physical parameters such as particle size or number. Resolution errors are more obvious with active sensing due to their narrow swath."

Minor comments:

- Data assimilation is now mentioned at the end of the second paragraph of the introduction. P8511, L8–10 have been replaced with, "The importance of quoting the uncertainty on any measurement and the thorough validation of both are well accepted, being essential for data assimilation (one of the primary uses of satellite data products). However, the. . . "
- We agree that this is an important point. On P8516, L28 "represented" has been replaced with "approximated" and on P8517, L22–24 have been replaced with, "The diversity in an ensemble of models (using different assumptions and simplifications) approximates the uncertainty in those models. This approximation

is limited (as it cannot sample uncertainty related to features that are neglected from all of the models) but can still be useful (Knutti, 2010)."

- We agree that single and multi-model ensembles provide different information and have clarified the distinction. P8517, L11–13 have been replaced with, "Non-linear error propagation in satellite remote sensing observations can be characterised via ensembles. Each member of the ensemble adds. . . " and L25 has been replaced with, "Such ensembles could be useful to asses the impact of a priori assumptions in poorly constrained retrievals (such as the selection of aerosol microphysical properties)."
- The sentence has been revised to, "This contrasts with laboratory-based measurements. . . ".
- "averaged" has been replaced with "aggregated".
- This reference has been included and thank the reviewer for bringing it to our attention.
- This has been clarified.