

## ***Interactive comment on “Bayesian Dark Target Algorithm for MODIS AOD retrieval over land” by Antti Lipponen et al.***

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We thank the referee for the good and positive comments and questions. Below we have included the referee's comments in boldface font and our replies below each of the comments.

Referee comment:

**This manuscript presents a statistical method of aerosol (plus surface) retrieval from the multispectral satellite measurements, it is very well written with lucid explanations and convincing statistics. I have no objection if this paper is being**

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published in present form. The only suggestion I have is to make it clear that “the retrieval is carried out simultaneously in all the [dark land] pixels of a granule” (page 22 line 4). The average retrieval time of “one minute per granule” only applies to the subset retrieval of dark land pixels. That being said, I do have a general comment to make about such statistical approach (another recent example is Hashimoto and Nakajima, doi:10.1002/2016JD025698). Usually, this kind of approach involves a first-guess of the retrievals, constrains like spatial smoothness, error statistics of the involved variables/processes, and an iterative numerical solver. Once better retrieval is accomplished by such method, the question puzzles me is what is the key factor for this success – is it due to the accurate ancillary data used (like the first-guess of surface reflectance and aerosol parameters) or the power of the statistical approach (including constrains) itself? Is it possible that the non-statistical method would be as good as the statistical one if the same good a priori data (like the surface albedo) is used? Of course, applying a good first-guess is an integral part of the statistical algorithm, and I am not against using any better data if available (even the ones used for validation), but I am just not convinced that the statistical method is much better than the simple and independent non-statistical algorithm (like the MODIS Dark Target algorithm), given that much less ancillary data are required by the latter while few physics insights are added by the former. To me, getting a good estimate of the error statistics and a priori data is not easier than the retrieval itself, and the estimate of uncertainties is quite uncertain.

We thank the referee for the constructive comments and good questions.

Throughout the manuscript, we have added a mention of dark land pixels (instead of all pixels of a granule) to clarify that only the pixels with dark land are retrieved.

The use of statistical approach for retrieval as such does not make the algorithm per-

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fom better from the conventional approaches. Actually, in many cases the construction of the retrieval algorithm using a statistical approach leads to very similar practical solution of the retrieval problem than the deterministic approach. The biggest difference in statistical approach, in many cases, is the way of thinking (modeling all unknowns as random variables). This statistical way of thinking allows more straightforward processing of, for example, uncertainties related to the models used in the algorithm. Also this type of statistical approach directly allows the use of all possible data (prior information, measurements, more realistic noise and uncertainty models) that may improve the retrievals. We think that in this case the use of more realistic models and uncertainties, better surface information, and the use of observation data (more bands) in the retrieval are the keys for better performance of the algorithm. For more general introduction to statistical inversion methods, please see for example doi:10.1007/b138659

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-359, 2017.

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