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Atmospheric Measurement Techniques Discussions

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

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This paper introduces an algorithm for the retrieval of aerosol optical depth and fine mode fraction from MODIS observations (τ and η, respectively). It utilises the same look-up tables, aerosol typing, and quality control as the Dark Target algorithm but (as pointed out in Dr. Sayer's comment) uses a different treatment of the surface. The most pronounced change is that it simultaneously retrieves the properties for multiple pixels, using a priori assumptions on the spatial correlation of τ and η alongside a characterisation of the observational and forward model errors to better constrain the retrieval problem. The algorithm is evaluated against the current Dark Target and Deep Blue algorithms by comparison to AERONET observations during 2015. The new algorithm exhibits superior correlation and bias while also providing useful pixel-level uncertainty

estimates.

I strongly recommend the publication of this paper. The presentation is clear and concise while the validation demonstrates that it is a compelling new technique to measure aerosol properties. Below, I include some thoughts that may benefit from consideration. There, P1L2 means line 2 of page 1. (I have declined to remain anonymous as, after reading the paper, I discussed it with the authors at a recent conference which addressed many of my initial concerns.)

P4L21 The retrieval of $\log x$ rather than x for positive variables is well documented. You retrieve $\log(1+x)$, which I have not encountered before. Could you further discuss this choice, maybe providing references to demonstrate it's use elsewhere? I am concerned that it permits $-1 \leq x$. Did you specifically wish to retain the small but negative τ from the original Dark Target algorithm or are the 'constraints that exclude non-physical solutions' (P5L23) hard limits that prevent this behaviour? If the latter, why not use the more common $\log x$ formulation? Have you considered how hard limits distort Gaussian uncertainty estimates near those limits?

§2 It's unclear from the text precisely how many pixels are processed at once. Is it an entire granule? Processing 50,000 pixels at once would be an impressive computational task!

I also recall that you only process pixels for which a DT retrieval was produced (implicitly adopting their cloud flag), but I don't find that mentioned in this text.

P6L17 Though the 50 km correlation length is widely used, you should cite something. doi:10.1175/1520-0469(2003)060<0119:MVOTA>2.0.CO;2 is quite common.

§3.1.3 This method contains a few surprising features. Why use blue sky albedo? Why seasonal averages? Why average the 3 closest values rather than do a bilinear or triangular interpolation? Was the technique overly sensitive to these choices (i.e. were these chosen at random and worked or did it take several attempts to find a stable solution)?

P8L7 What motivated the addition of coarse mode aerosol to the continental mode? Are the Dark Target team considering removing this step from their own processing?

P9L2-4 I don't understand what you mean by 'marginalize the posterior model'. Marginalize means 'to treat as insignificant' and you use posterior model to describe the cost function, (2). I would expect one to 'minimize the posterior model', but I fail to see why that is relevant to the approximation error approach.

P9L31 'Physical' may be a better word than 'true' here as there arguably is a 'true' FMF as defined by the Dark Target algorithm, but the point is that that value doesn't always mean something in reality.

Fig. 1 Could the urban sites (discussed in §5.4) be displayed in a different colour?

Figs. 2&3 For Angstrom exponent, could you use a colour bar that has grey at the centre so we can distinguish missing data from a value of 1?

App. B I broadly like this idea, and do something similar myself (though not yet in a published paper), but I'm curious about assuming the MODIS BRDF is accurate. It's a good retrieval but not without substantial uncertainty (of many forms - representational, approximation, etc.). Considering the dominance of the surface in aerosol error budgets, how accurate do you think these estimates of the approximation error are?

- Several references list a URL twice. Perhaps replace the BibTeX field url with doi?

I also include some proofreading recommendations.

P1L21 Hyphenate satellite-based.

P1L22 provides a means

P2L2 the oldest still operating

P2L4 An One algorithm to retrieve the aerosol properties, such as aerosol optical depth (AOD), is the Dark Target

P2L7 Comma after effect.

P2L19 be downloaded for example from

P2L21 MODIS is the Deep Blue

P2L26 Commas after useful and example.

P2L31-32 Hyphenate pixel-by-pixel.

P3L11 Comma after information.

P6L4 AOD values in a 1 degree

P6L17-18 correlation but on the other hand to allow while allowing for certain features

P6L18 Commas after features and plumes.

P8L2 we use a similar

P7L11 processing of a large

P7L19 average of the 3 closest

P8L23 In the statistical . . . model and take into account the uncertainties

P9L4-5 Use \citet rather than \citep for this reference to get rid of the brackets.

P9L9 Comma after uncorrelated.

P9L12 Hyphenate near-real-time.

P10L3 Hyphenate AERONET-based and size-distribution-related.

P10L9 Comma after the brackets.

P11L23 carried out is are selected differently in these algorithms. The DB

P12L6 Hyphenate all-pixel. Comma after reduced.

P12L7 the DT retrievals also in this case. This

P15L8 Comma after area.

P18L4 DT retrievals in at all but

P21L17 Hyphenate near-real-time.

P21L22 Comma after applications.

P22L1 Comma after retrievals. Hyphenate signal-to-noise.

P22L2 Comma after therefore.

P22L25 Comma after posterior distribution.

P23L4 Commas after usually and but.

P23L5 Comma after fixed.

P23L8 Comma after thus.

P24L2 The first L should be bold not italic.

P24L21 we use the median

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