Comparing MODIS C6 ‘Deep Blue’ and ‘Dark Target’ aerosol data

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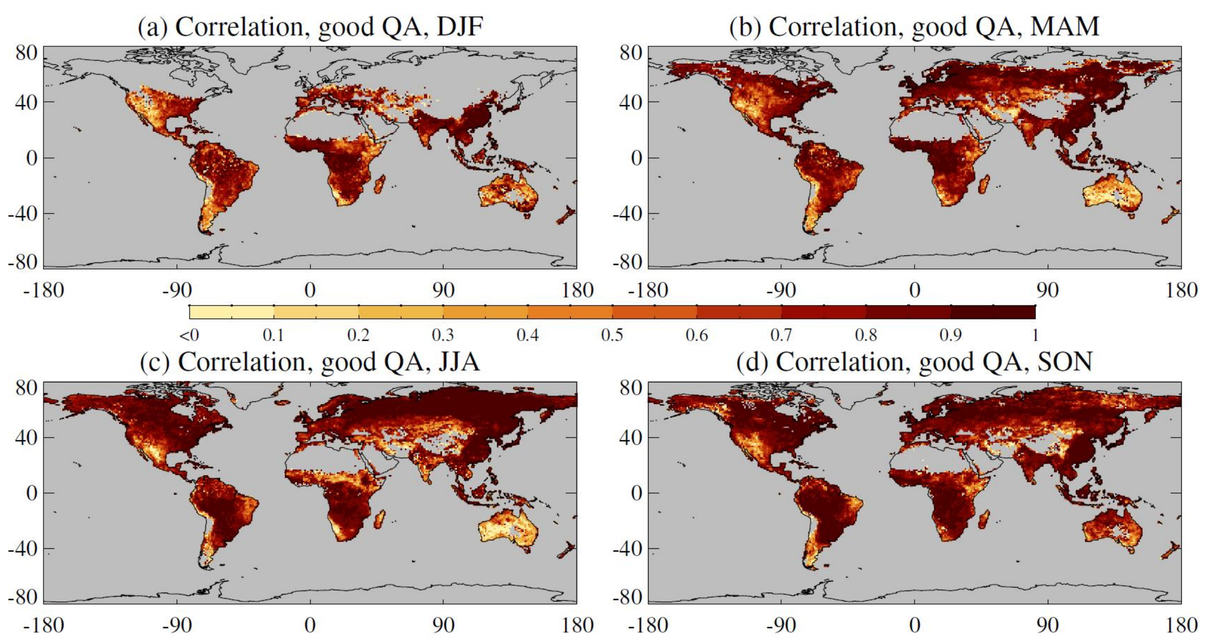
Introduction

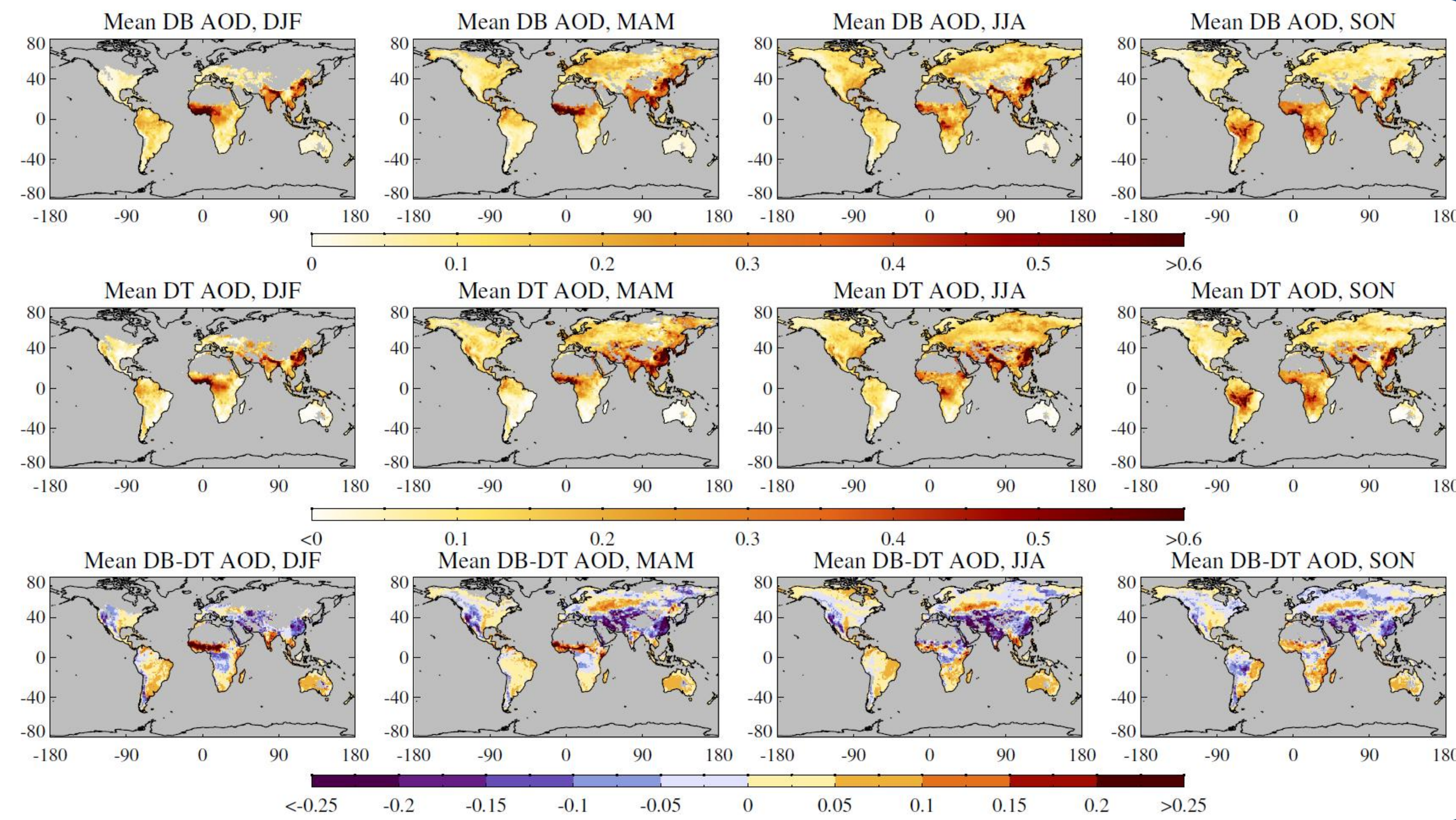
The MODIS Collection 6 Atmospheres product suite includes refined versions of both ‘Deep Blue’ (DB) and ‘Dark Target’ (DT) aerosol algorithms, with the DB dataset now expanded to include coverage over vegetated land surfaces. This means that, over much of the global land surface, users will have both DB and DT data to choose from. A ‘merged’ dataset is also provided, primarily for visualization purposes, which takes retrievals from either or both algorithms based on regional and seasonal climatologies of normalized difference vegetation index (NDVI).

This poster present some comparisons of these two C6 aerosol algorithms, focusing on AOD at 550 nm derived from MODIS Aqua measurements, with each other and with Aerosol Robotic Network (AERONET) data, with the intent to facilitate user decisions about the suitability of the two datasets for their desired applications.

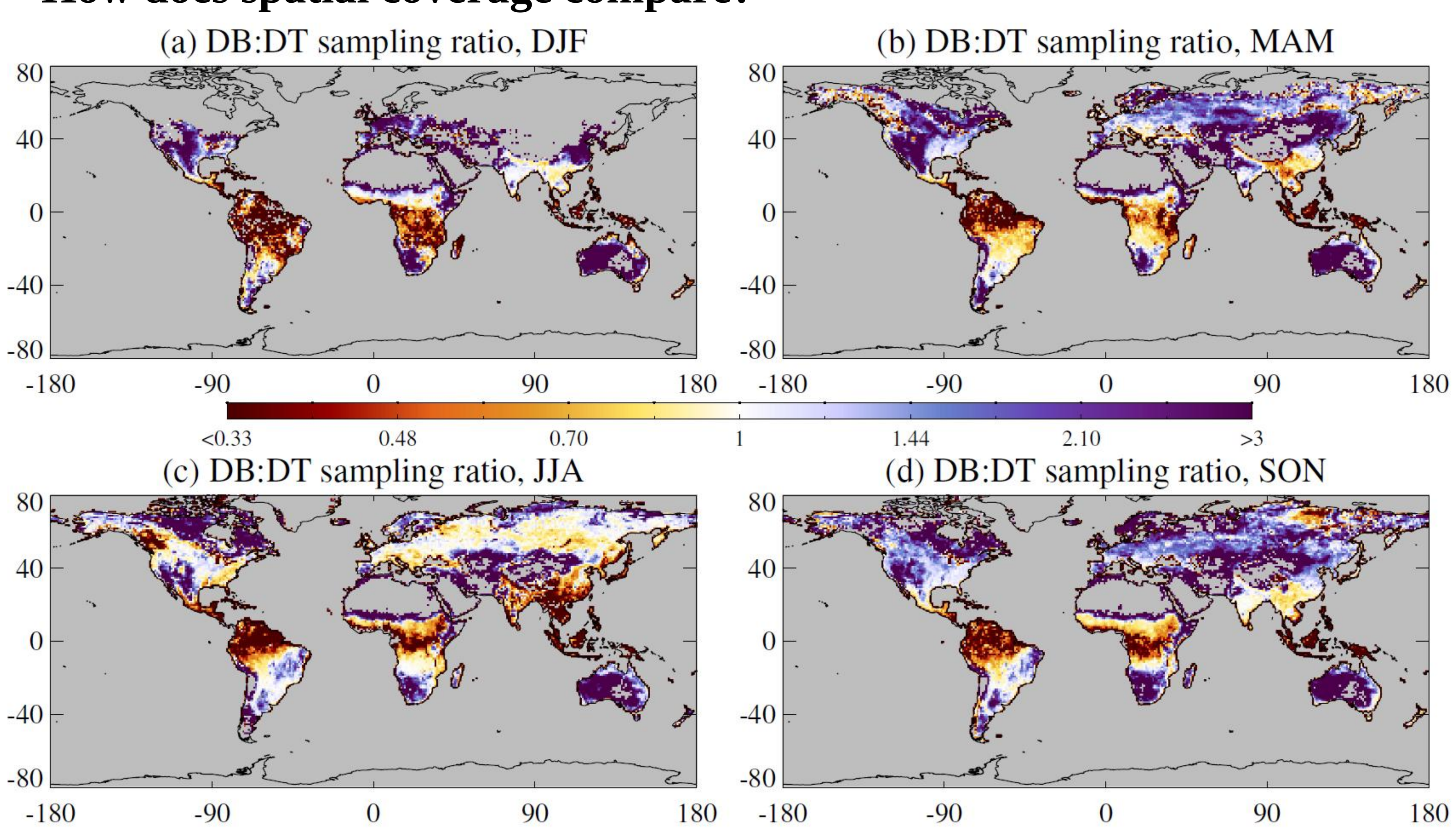
How similar are global aerosol fields?

- The figure to the right shows seasonal mean DB and DT AOD, and their difference, from collocated (on a level 2 basis) retrievals passing QA checks from 2006-2008.
- Similar global and seasonal patterns are evident, albeit with regional and seasonal relative biases between the two.
- The temporal correlation (below) remains high between the two at most locations, revealing these biases to be related to the peaks and troughs in AOD rather than differing seasonality.
- Low correlations are found in low-AOD regions such as Australia, where the magnitude of temporal variability of AOD is comparable to the uncertainty on the retrievals.





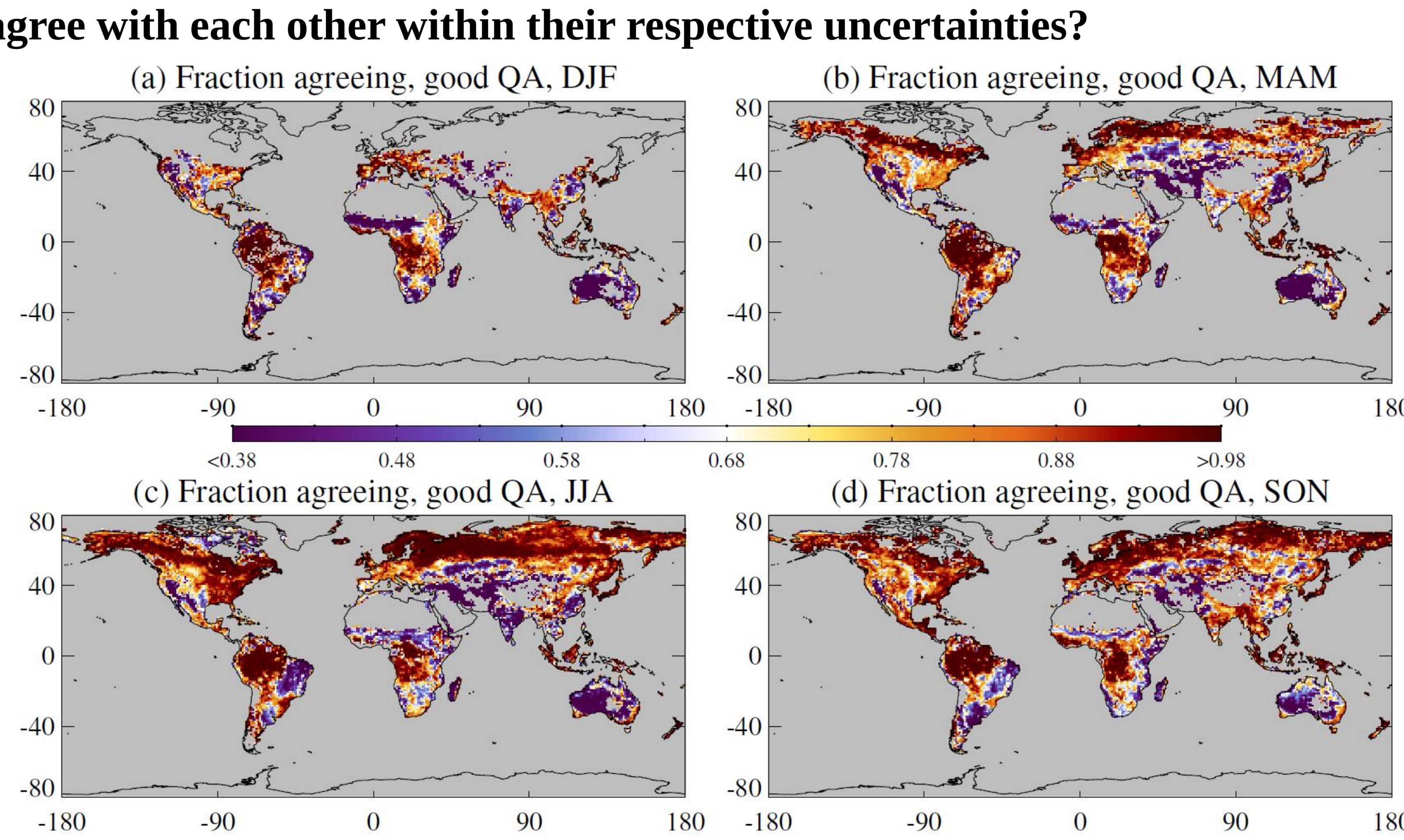
How does spatial coverage compare?



- The above shows the ratio of the number of good-QA DB retrievals to the number of good-QA DT retrievals, for grid cells where both datasets provide coverage.
- Grid cells in **red** represent areas where DT provides more retrievals. These are mostly forested tropical regions. In these areas, DB often has more conservative cloud screening.
- Grid cells in **purple** represent areas where DB provides more retrievals.
- On balance, there is more **purple** than **red**. DT may consider many areas not sufficiently ‘dark’ to retrieve AOD with high QA frequently, and/or have stricter cloud/QA checks in these areas.

How often do retrievals agree with each other within their respective uncertainties?

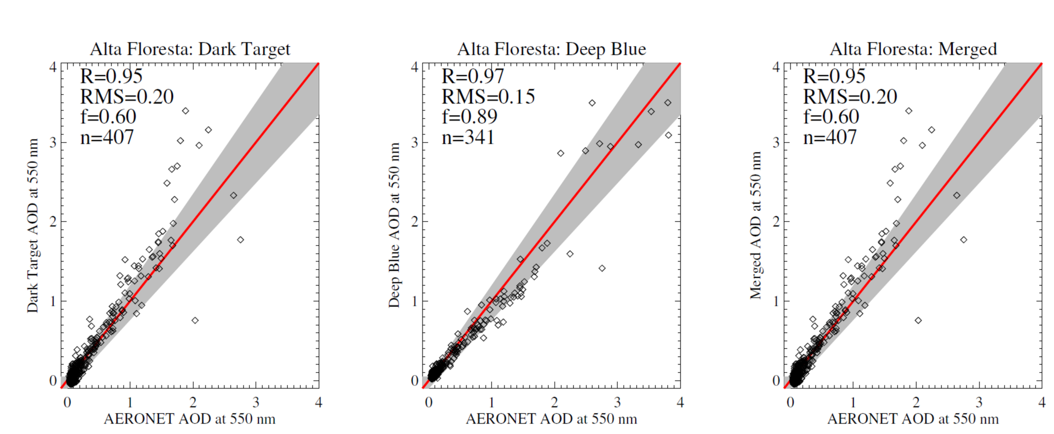
- This box assesses how often DB and DT AOD retrievals agree with each other, NOT how often they agree with AERONET.
- DT reports expected absolute AOD uncertainty, relative to AERONET, as 0.05+15%.
- DB provides per-pixel estimates (a function of AOD, geometry, and QA), of similar overall magnitude, defined relative to DB AOD.
- Both are taken to be one standard deviation confidence intervals against a ‘truth’. Assuming the DT data are unbiased, and the errors are independent, adding these in quadrature gives a combined confidence limit within which 68% of matched DB/DT retrievals should agree with each other.



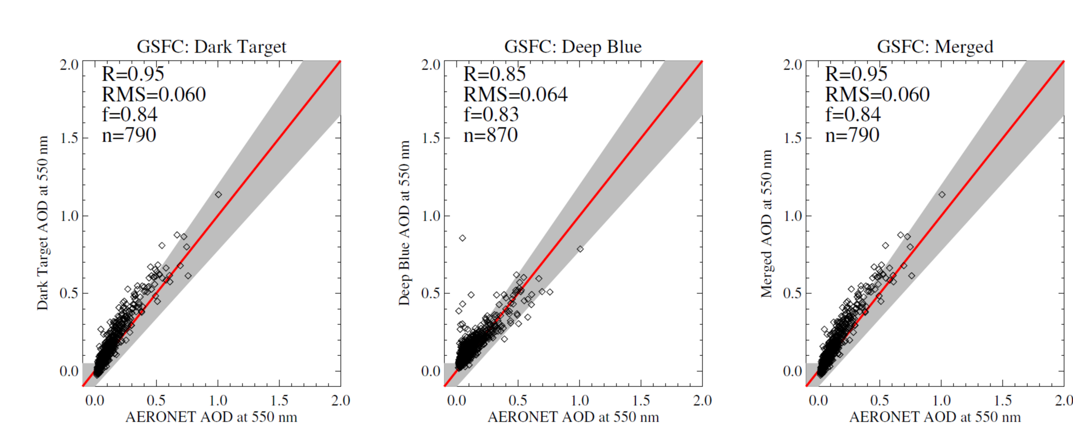
- Thus, maps of the fraction of retrievals in agreement with each other within this combined confidence limit tell us something about the error characteristics of the datasets.
- Over most land surfaces, the figure is well in excess of 68% (**red**). This indicates regions where the errors in the retrievals are correlated, and/or they are smaller than assumed.
- Over many semiarid regions, the figure is well below 68% (**purple**). This indicates regions where the errors in the retrievals are anticorrelated, and/or they are larger than assumed. DT often retrieves negative AOD in these areas, and DB a small positive AOD.
- Either way, these results imply that DT and DB cannot be considered as datasets with well-behaved Gaussian errors independent from each other.

What about comparisons against AERONET?

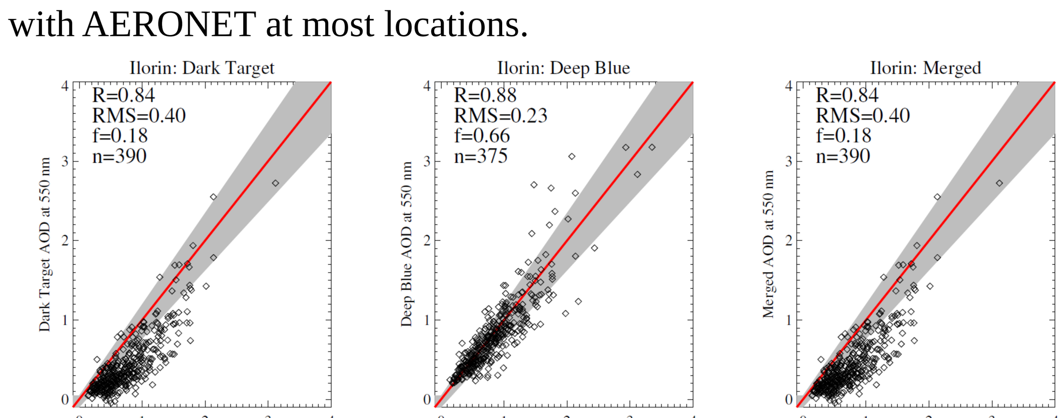
- This box shows comparisons between AERONET (direct-Sun level 2 version 2) and DT, DB, and the ‘merged’ AOD, at 550 nm from 2002-2011. All comparisons use only data passing QA checks and are aggregated spatiotemporally within 30 minute and 27.5 km radius windows. AERONET data were spectrally interpolated to 550 nm using the standard Ångström exponent method.
- Statistics presented include the linear correlation coefficient (R), root mean square (RMS) error, fraction (f) agreeing with AERONET within +/-(0.05+15%), which is shaded in grey in the plots, and data count (n).
- Neither algorithm outperforms the other at all sites, and on the whole performance is similar between the two. The merged algorithm is not superior to either DB or DT.
- DB fraction in agreement with AERONET is often better, but outliers in DT are often less extreme. DB also reports more matchups with AERONET at most locations.



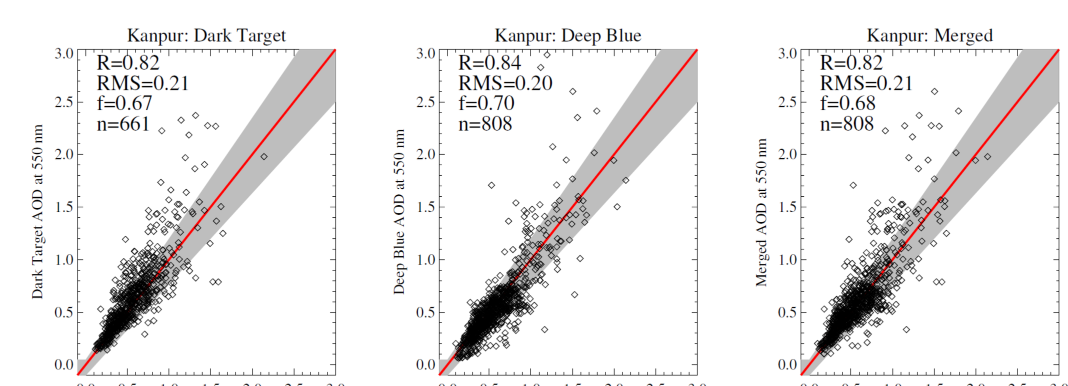
Alta Floresta, Brazil: Clean continental and biomass burning aerosols



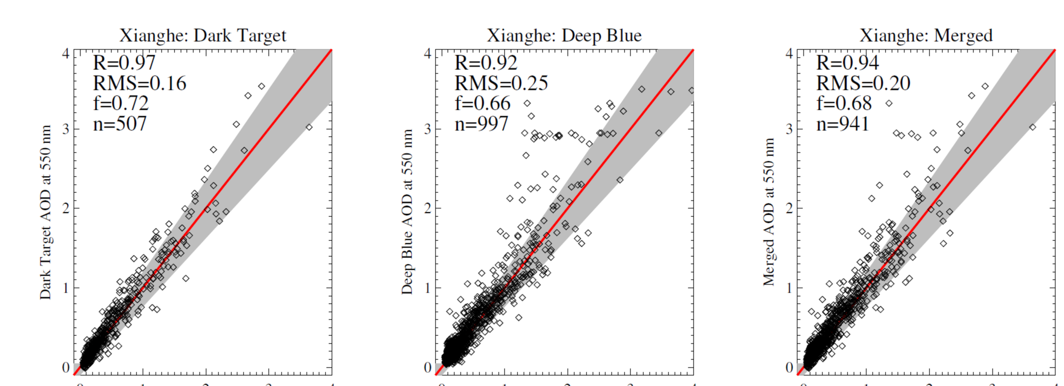
GSFC, USA: Continental and urban aerosols



Ilorin, Nigeria: Dust, biomass burning, and urban/industrial aerosols



Kanpur, India: Dust, biomass burning, and urban/industrial aerosols



Xianghe, China: Dust and urban/industrial aerosols

Comments

DB and DT provide similar views of the global aerosol system, with the same basic hotspots and seasonality on global and regional scales. Differences between them are generally smaller than their expected uncertainties, which is one of several reasons that the two should not be considered as entirely independent.

There is no clear ‘winner’ when it comes to comparisons against AERONET. The merged product does not appear to offer increased skill as compared to the individual datasets, and should not be considered a superior dataset, merely one with fewer gaps. More detailed evaluation is needed to determine those locations in which one algorithm may significantly outperform the other.

DB continues to be the only option for coverage over bright arid regions, while DT continues to provide the only over-ocean dataset. These are likely to be the main motivating factors in determining which dataset a user might choose. Where possible, we suggest users perform their analyses using both datasets separately, and their agreement (or lack thereof) may provide additional insight into the research questions asked.

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- Levy, R. C., S. Mattoo, L. A. Munchak, L. A. Remer, A. M. Sayer, F. Patadia, and N. C. Hsu (2013), The Collection 6 MODIS aerosol products over land and ocean, *Atmos. Meas. Tech.*, 6, 2989-3034, doi:10.5194/amt-6-2989-2013.
- Sayer, A. M., N. C. Hsu, C. Bettenhausen, and M.-J. Jeong (2013), Validation and uncertainty estimates for MODIS Collection 6 “Deep Blue” aerosol data, *J. Geophys. Res.*, 118, 7864–7872, doi:10.1002/jgrd.50600.

MODIS aerosol: modis-atmos.gsfc.nasa.gov/
AERONET: aeronet.gsfc.nasa.gov/

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