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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol optical depth trend over the Middle East" *by* K. Klingmüller et al.

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I would like to thank the authors (Klingmüller et al) for the offline discussions which we have had in response to my initial comment: I am very appreciative of the extra efforts they have taken to dig into the data, and together I feel we've been able to identify more conclusively the source of the artefact over the Aral Sea. Hopefully we will be able to ameliorate this in future versions of our satellite aerosol data products.

As noted the Aral Sea was not the main focus of the authors' study, so hopefully the Discussion here will serve to explain this anomaly in the data but not distract readers from the main discussions of AOD trends elsewhere.

I wanted to take the opportunity to share some more of the offline discussions I have had with the authors here, for the interest of the journal readership.

Although I had initially suspected that the high-AOD artefacts in the data would mostly

be coming from the side of the over-land retrievals, it turns out that the artefacts are mostly coming from retrievals over nominal water surfaces. Some pixels identified as water by the MODIS land mask are ephemeral (sometimes water-covered, sometimes not) and not really suitable for AOD retrieval from an algorithm assuming a dark water surface. While some of these are caught and eliminated by the algorithm's internal quality checks, a few are not, and lead to high-biased AOD retrievals. Additionally, pixels identified as water but which are not actually covered by water for a given observation are skipped by the over-land AOD algorithms. So the situation here is that there are some areas which should not have retrievals but do have them, and some areas which should have retrievals but do not. Thus, in the Level 3 aggregated data, these artefacts become magnified.

The underlying cause is that the MODIS data have a static land mask, which is used in the aerosol products to identify which algorithm processing path (i.e. land or water) should be used for a specific pixel. In areas where the surface cover changes by more than a pixel over the MODIS mission (the Aral Sea being the most prominent, but not only, example), this can lead to situations where the use of the land mask in this way breaks down. Work is underway here to better identify regions of variable land/water cover like this in future versions of the MODIS data products. In the meantime the authors' suggestion to look at histogram statistics to identify potentially anomalous grid cells seems to work well for Level 3 data.

I have attached images from an example MODIS granule from last week which illustrates this (it is the most recent day in which I saw the problem). Panel (a) is a true-colour image. You can see that the western end of the South Aral Sea basin (which still contains water) is dark, but the part nearer the centre (the remaining eastern lobe) is very shallow and definitely does not fit a 'dark water' assumption. Panel (b) shows which algorithm contributes in each pixel to the 'combined' MODIS AOD data set. Over land here it is always Deep Blue; over water it is always the water algorithm (since there is only one).

Panels (c)-(e) show the Deep Blue, Dark Target land/ocean, and Combined AOD fields for this day. You can see the artefacts in the central/eastern over-water retrievals (the AOD exceeds 4 in a few places, in fact) compared to the more reasonable values elsewhere. So, when these data are gridded to the level 3 1 degree resolution, these artefacts will strongly dominate the grid cells. This is because some of the fully dried out parts of the Aral Sea are still counted as 'water' by the MODIS land mask, so no land retrievals are performed there.

It is over these ephemeral (either very shallow water or at this point dry – hard to tell from the image) water surfaces where sometimes it is doing an ocean retrieval when it should not. As a result the retrievals in the Level 3 grid cells over here are dominated by retrievals which should not have taken place. Which is also why the authors' histogram tests work.

I've addressed this issue to the extent currently possible in our forthcoming VIIRS Deep Blue land and ocean AOD data set (so it should become much less of a problem) and it is being worked on here within the MODIS team as well. Interested parties can feel free to contact me for more information.

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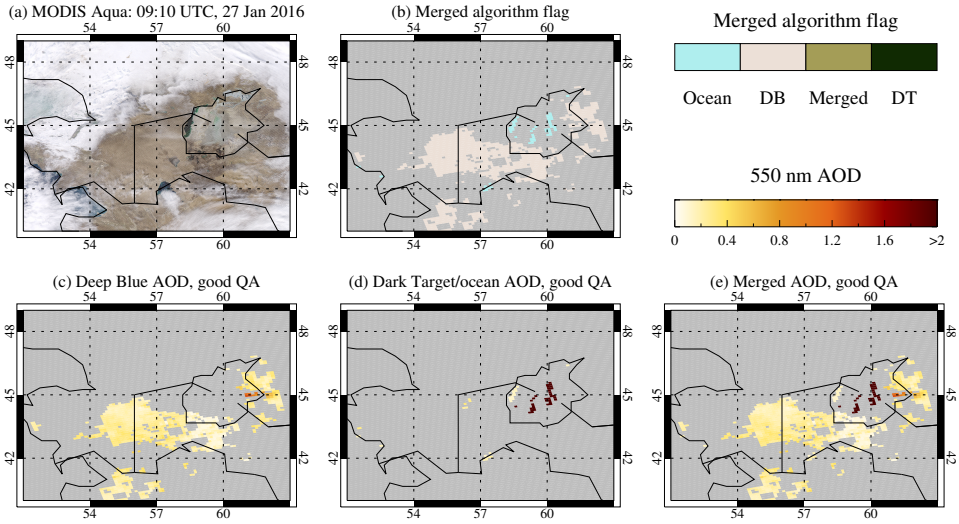

Fig. 1.