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Atmospheric Measurement Techniques Discussions

Interactive comment on "An Aerosol Optical Depth time series 1982–2014 for atmospheric correction based on OMI and TOMS Aerosol Index" *by* E. Jääskeläinen et al.

Anonymous Referee #2

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The paper describes a method to produce a long-term aerosol optical depth (AOD) dataset reaching back to 1982. The purpose of this AOD dataset is its use for atmospheric correction of an AVHRR surface albedo time series 1982 - 2014. This is an important application and the AOD dataset is of high value, since no global AOD dataset suitable for this purpose exists over this long period. The title of the paper clearly states this specific limitation to one intended application of the AOD dataset. The final results for atmospheric correction prove the potential of the created dataset. However, the paper text is too short and needs to be extended to clearly describe the method used to produce the AOD dataset (e.g. snow / ice discrimination method, gap filling method, sub-class building, exclusion of low / high aerosol index, . . .). Many

figures need to be described in the text: what the reader can see, what conclusion is drawn from them, what statement shall be highlight with it. In addition, the discussion of the impact of assumptions and the results achieved needs to be largely enhanced (e.g. fixed AOD over snow and ice, impact of differences between morning and afternoon orbits, . . .). In particular the sensitivities of the AI to other parameters (foremost aerosol layer height, but also surface albedo, geometry, used UV wavelength pair) needs to be discussed. Additionally, the omission of non-absorbing aerosols as part of total AOD by the AI needs to be discussed. Furthermore, a conclusion section of only 7 lines is not suitable for a scientific paper. You need to summarize / discuss: impact of most critical assumptions, what have you achieved, what does a general reflectance increase mean, for which application is the mean validation on large aggregates sufficient, OMI AOD is not perfect - but taken here as truth... I therefore recommend a major revision of the paper. I recommend to start out from a discussion of the required accuracy for an AOD dataset to be used for atmospheric correction; this would then more clearly distinguish the atmospheric-correction AOD dataset from an AOD dataset for aerosol studies. In particular it should be stated which use of the AVHRR albedo dataset the authors have in mind (e.g. change detection of more qualitative and step-wise large differences over time, climate monitoring with small trends only to be detected in a noisy but stable time series), because this will determine the needed albedo accuracy and consequently the required AOD accuracy and stability. In the final discussion the achieved AOD accuracy can then be assessed in comparison to the assumption of a fixed AOD = 0.1. It needs to be discussed in how far the method does only correct for absorbing aerosols (excluding AI < 0) and how this will affect the AOD and albedo values. Also the impact of the difference between total AOD from MODIS and absorbing-aerosol AOD from AI in the regression of the method needs discussion. The evaluation is too much done with global / zonal and long-term averages – the added value of the AOD daily maps lies in the spatial and temporal patterns for the atmospheric correction. Also, providing those daily maps contains the risk of introducing additional noise into the datasets – this needs to be assessed, at least with exemplary studies. On what spatial and tem-

poral scales would one expect to reproduce realistic aerosol variability, where one you expect to smoothen them?

Further comments: To make up for longer text, some of the figures are not necessary and can be deleted or combined. The authors should consider reducing figures: 1 (describing the main stability over long time but regional seasonal cycles in the text will suffice), 2 (one of the two maps is sufficient, aren't they adding up to 100% ?), 3 (can be explained in text), 4 (better describe in text the principles for building the sub-classes), combine fig 8 and 10 into one flow chart with optional boxes; and tables: 5 (can be explained in 1 or 2 sentences in the text). The authors should make clearer in the title and text that they are discussing a time series of global maps (i.e. with regional AOD variability) to distinguish from a global averaged time series. This will then support the added value discussion of providing spatial information for the atmospheric correction. Spatial resolution of all datasets needs to be provided. English usage needs to be improved by involving a native English speaking person; e.g. articles are often missused, the word "manifolding" should be replaced (several times). Reword "TOMS-homogenize" (p. 7 / l. 13). There are a number of vague statements which should be made more precise / quantitative; e.g. "sufficient" (p.1 / l.7), "long enough (p. 1 / l. 16), "a little bit too coarse (P. 3 / l. 23), "by a little" (p. 4 / l. 15), "some local inspections" (P. 5 / l. 15), "not so much" (p. 5 / l. 23), . . .

Detailed comments: The last paragraph of section 1 (structure of the paper) should be shortened to only give one main heading for each section; further detail is not needed here. Section 2.1: EP-TOMS is not used and therefore needs not to be discussed at all. P. 3 / l. 17: MODIS AO is a retrieval, not an estimation (higher accuracy). P.3 / l . 21 -24: which land cover dataset do you use? Section 3.1: where do tau-UV and alpha come from? End of section 3.2 and later on: you mix up "areas" and "classes" – please be consistent to avoid confusing the reader. P. 5 / l. 15/16: I do not understand these statements – please explain what you mean. Section 3.2: this is very important to discuss the limitations / assumptions, but needs extension P. 5 /

l. 26: give minimum and maximum number of pixels; also l. 28 Fig. 6: better show results with AI * cos (theta), since you use this quantity; also better colour bar should be used to show variability where most data points lie (e.g. between 0.5 and 0.8) P. 5 / l. 29/30: Correlations of 0.5 are still quite weak – I would thus be more cautious and rather conclude, that the method can only be used for parts of the dataset to construct reliable AOD P. 6 / l. 10: I do not understand why you need the ordering – isn't this just the weighted average? P. 6 / l. 13: a vector of what? P. 6 / l. 18: explain "after additional restrictions" P. 6 / l. 22: explain how you divide them P. 6 / l. 28/29: I do not understand this sentence; is the simplest also the best one or at least equally good as others? I suggest to show one example time series over those steps to illustrate better what you do; also a map of regression coefficients could be illustrative Start of section 4: motivate, why you need two different approaches P. 7 / l. 30: how exactly do you treat cases with AI outside the range [0.5, 4.5]? omit, set to 0.5 and 4.5, respectively, . . . P. 7 / l. 29-31: why do you use two steps of spatial regridding? Fig. 9 needs discussion: many values too high (e.g. Scandinavia, California, Siberia, SouthEastAsia, Tibetan plateau, Himlaya, . . .), mountains come out, compare to OMI AOD retrieval map

P. 8 / l. 15-18: I am not convinced why you use 3 years before and after the gap – motivate and explain P. 9 / l. 8: if the annual cycle was the same over all years, then you could produce one long-term climatology dataset, but there are intra-annual variations, one potential strength of your dataset P. 9 / l. 9: Tropic of Capricorn is the Southern – you want to point to the Northern (sub-) tropical maximum over the Sahara latitude? P. 9 / l. 12-22: this is not very clear (why should the more accurate MODIS dataset have less seasonality) P. 9 / l. 26-28: a difference of 0.3 is very large (given mean global AOD over land of $\sim$0.2); also next paragraph: you should talk of large differences, but say better, that they are still smaller than with assuming a fixed AOD=0.1 P. 10 / l. 3 onward: please state in how far the 3 example classes are representative for your analysis of all classes. Do they show best, worst or typical results? P. 10 / l. 32: please add AERONET reference: Holben, B.N.; Eck, T.F.; Slutsker, I.; Tanr′e, D.; Buis, J.P.; Setzer, A.; Vermote, E.; Reagan, J.A.; Kaufman, Y.J.;

Nakajima, T.; et al. AERONETâĂŤA federated instrument network and data archive for aerosol characterization. Remote Sens. Environ. 1998, 66, 1–16. p. 11 top: typical satellite AOD validation uses a window of 50x50 km2 for spatial matching; you need to discuss whether you are not creating artificial variability on pixel level P. 11 / l. 10 onward and fig. 10+11: use more specific names, not the continents, where the small test regions lie in - this is misleading Fig. 22: better show absolute differences, not relative – otherwise you highlight larger relative errors over dark surfaces P. 12 / l. 14: can you draw a quantitative conclusion rather than saying that reflectances tend to be higher? Fig. 11: why do you not make a scatter plot of AODs? Add discussion in the text: El Nino Indonesia fires can be seen in 1997, lat 60N much too high, Sahara under-estimated/ biomass burning over-estimated, ... Fig. 12: why are there several curves for each category? Fig. 13: global mean AOD over land is $\sim$0.2 - so you cannot make it that crude - you have extreme differences + and - 0.7 or so; better show the range -0,25 to 0.25 and exclude the other regions Fig. 18: you show partly very large differences: peaks, distribution shapes, double peaks; how can AOD be >1 with your method? Use a better-suited x-axis (e.g. 0-1) Fig. 19 / text: discuss whether those 6 regions are suited to grasp all global variability of aerosol and surface conditions Fig. 21: state in text partly significantly wrong seasonality (thus limiting the capabilities for atmospheric correction to use for assessing seasonal changes) Fig. 22-24: which wavelength or band reflecances? Fig. 22: figure title should be “relative difference of corrected reflectance values” (“magnitude values“ is inappropriate terminology); better show scatter plots; I would prefer to see absolute values of reflectance differences; use better colour bar: large areas go from pale yellow to dark yellow (become worse, hard to be seen), some areas become better (from dark red to pale red); I would distinguish negative and positive values Fig. 24: why not again year 2010?

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