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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 #1

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Atmospheric correction is needed to create land surface albedo data sets, and requires AOD. For the CLARA-A2-SAL albedo data set created from AVHRR measurements, for the time period 1982-2014, there is no available AOD product. However, UV aerosol index (AI) is available. This study presents a method to relate AI to AOD, and therefore provide an atmospheric correction for use in CLARA-A2-SAL processing. This is an improvement over the last version of the albedo data set, which used a constant AOD, which would therefore introduce some regional/seasonal biases into the albedo.

The research is important and the basic premise is sound. However I have some concerns about some aspects of the analysis, and some parts are unclear. My scientific comments are as follows:

MODIS AOD is used to filter the OMI AI. However, from Table 2, it seems like 3 different versions of the MODIS AOD data were used for different parts of the time period. This is somewhat surprising to me since the current version, Collection 006, has been available for about 3 years now, and the differences between the data versions have been documented to be large in some versions. So this would potentially introduce some discontinuities in the data set. I can't think of a good reason for using multiple versions of the MODIS data since all the data are available freely and it should not be too much of a burden to obtain the latest versions. I therefore strongly recommend that the analysis is repeated using consistently the latest data version (C006), rather than a mixture of this and older obsolete versions.

It is also not quite clear to me what time period of MODIS data are used. Section 3 suggests that only the time period 2005-2008 was used, but Table 2 gives different data versions for different time windows. This should be clarified. Whichever period is used, the latest MODIS data should be used.

On a related note, the authors don't say which MODIS AOD data product they are using (Dark Target, Deep Blue, or a combination). This should be stated. Both have advantages and limitations. For example Dark Target gives no coverage over deserts (Deep Blue does), while Dark Target has better coverage over tropical forests. Collection 006 contains a combined data set from both algorithms, which may be optimal here. Otherwise there will be lots of data coverage gaps. However in Figure 9, there is data over deserts, so perhaps Deep Blue is used. But it is not stated anywhere in the manuscript. And if not, then how is the AOD-AI regression done without MODIS AOD data over these regions, since section 3.4 says the regression is pixel-wise?

In section 3.1 it is not clear exactly how the OMI 550 nm AOD is created – specifically, the paper does not say where the Angstrom exponent is obtained from. It sounds like the AOD is estimated from each wavelength (with an Angstrom exponent from an unknown source), and then the estimates from each of the 5 wavelengths propagated to 550 nm are averaged. Is that right? Would a better way not be to use all 5 wave-

lengths together with the Angstrom power law to derive AOD at 550 nm and Angstrom exponent in a self-consistent way?

Section 3.3, I don't think that deseasonalisation of the AOD and AI data makes physical sense, and I am concerned that this will in fact introduce regional and seasonal artefacts into the data. AI depends on aerosol composition (amount and degree of absorption), altitude, and the underlying surface. This can vary widely from season to season within a given location. For example, patterns of biomass burning and dust aerosol tend to be highly seasonal. Vegetation phenology gives pronounced changes in the underlying surface cover, and seasonal differences in temperature and aerosol sources affect the aerosol height. All of these will modulate the AOD-AI relationship, and so there will be seasonally-dependent relationships in many regions. Yet as the authors note, the deseasonalisation step produces a seasonally-independent relationship. This will therefore introduce artefacts. For example, it could be responsible for some of the discrepancies in Figure 21.

Equation 5, what exactly are the 'modified' AOD and AI here? I did not find a definition for how these are different from the normal AOD and AI. Or does this refer to the deseasonalised data? This should be made clear.

Table 2 also shows that the wavelengths that AI is calculated from differ between Nimbus-7 TOMS, Earth Probe TOMS, and OMI. Since UV aerosol extinction and absorption exhibit spectral dependence, these wavelength differences mean that AI calculated for the same aerosol would differ between the sensors. This effect was not really discussed but should ideally be quantified.

The UV AI is also only sensitive to aerosols which are light-absorbing in the UV. So weakly-absorbing or nonabsorbing aerosols, such as sulphates, will have no AI signal. Yet they will contribute to the AOD and so affect the atmospheric correction. The regression may account for this, to an extent – I suppose it will contribute to the term beta in Equation 5. However if the loading of nonabsorbing aerosols is variable in time,

then this variation can't be captured by beta. The partition between nonabsorbing and absorbing aerosols in the AOD to AI conversion could be discussed in a bit more detail. Or is the pixel just completely discarded if the AI is too low, and not used to estimate albedo at all? This is hinted at in sections 2.2 and 3.1, but could be stated more explicitly.

The presented method, whereby AOD is estimated from AI, is clearly a better assumption than taking a constant value of AOD as was done in the first version of the albedo data set. However, in light of the above issues, I recommend that the manuscript is revised and re-reviewed after the above aspects have been clarified. Then it will be easier to understand the subtleties of what is done.

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