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Atmospheric Measurement Techniques Discussions

Interactive comment on "Correcting for trace gas absorption when retrieving aerosol optical depth from satellite observations of reflected shortwave radiation" *by* F. Patadia et al.

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Anonymous Referee #1 Received and published: 5 February 2018 Important small detail for consistent climate data records The paper discusses corrections to mid-visible satellite aerosol retrievals for the impact of the small but non-negligible trace gas absorption. It rightfully states that this wellknown correction remains often at the side of publications on aerosol retrieval and not much detail is provided. The authors make a thorough quantitative assessment of the impact of different absorbing trace gases on window channels used in AOD retrieval. They relate the strength of absorption to typical AOD uncertainties and clearly show that while on global average trace gas

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absorption in window channels remains within AOD uncertainties, on regional scale it clearly does exceed them. The authors demonstrate the importance of such an accurate trace gas correction for consistent climate data records by assessing the consequences of tiny differences between similar spectral channels of two similar but not identical sensors MODIS and VIIRS which can be used to constitute a long-term AOD record. This fully falls into the scope of AMT and sheds detailed light on such a “small” but still important aspect of long-term climate quality data records. The paper is well written with clear arguments and conclusions supported by substantial data presented in appropriate tables and figures. Title and abstract summarize clearly the content of the paper and its essence. The scientific methods used are state of the art and clearly referenced where suitable.

I therefore recommend to accept the paper after some technical corrections.

Thank you very much for a thorough review and for suggestions that have improved the paper. We have incorporated all of them.

I have only three more general suggestions and a number of small issues (see detailed comments).

1) I recommend to consistently use the term “atmospheric gas correction” rather than “atmospheric correction” since the latter is commonly used when correcting surface observations for the impact of atmospheric scattering (molecules and aerosols) and trace gas absorption.

Done

2) Regarding references I suggest to add a few references for leading European aerosol retrieval algorithms, mainly in context of the ESA Climate Change Initiative CCI: a) In addition to the reference to Hollmann et al. 2013 (overview paper of the entire CCI program with its 13 ECVs) a paper on the Aerosol project in CCI should be added: “Popp, et al., Development, Production and Evaluation of Aerosol Climate

Data Records from European Satellite Observations (Aerosol_cci), Remote Sensing, 8, 421; doi:10.3390/rs8050421, 2016" or "de Leeuw, et al., Evaluation of seven European aerosol optical depth retrieval algorithms for climate analysis, Remote Sensing of Environment, 162, 295-315, doi: 10.1016/j.rse.04.023, 2015"

Added

b) When referring to the GCOS requirements, the latest GCOS implementation plan 2016 with its Annex A ECV Product requirement tables (aerosol on page 281) should be added: GCOS-IP 2016: GCOS Implementation Plan 2016. GCOS-200. Available at https://library.wmo.int/opac/doc_num.php?explnum_id=3417

Added

c) As leading algorithm for the AATSR instrument the Swansea algorithm should be added to the references: "Bevan, et al. (2012), A global dataset of atmospheric aerosol optical depth and surface reflectance from AATSR. Remote Sensing of Environment, 116, 119-210" and "North, et al., Retrieval of land surface bidirectional reflectance and aerosol opacity from ATSR-2 multiangle imagery, IEEE Trans. Geosci. Remote Sens. 1999, 37, 526– 537.

Added

3) Regarding figures, I suggest to increase axis legends of fig. 1, colour bar legends of fig. 6a

Done

Detailed comments: l. 82: "[MISR ATBD]" – please add http link, date and version to make a unique reference

Done

l. 111: please also add the width of VIIRS channels

Done

l. 178/ 179: two conflicting namings for Gi are made (airmass factor or path length), which could be confusing readers

Corrected

l. 270 ff: here ten gases are discussed, while in l. 169 only 5 are identified as relevant – please harmonize or explain (see also l. 346 and 462/463)

Done

l. 304 ff: I had to read this several times and found it confusing (my first impression was that liner relationship will do then is learned that it will not do) – maybe you can rearrange to start with the clear statement that a quadratic fit is needed Thanks for pointing this out.

Rearranged.

l. 310 ff: Can you state whether the H2O airmass factors include any effect of multiple scattering (since water vapour prevails in the lower troposphere)?

LBLRTM does not model multiple scattering. The only scattering effect modeled in LBLRTM is Rayleigh extinction.

l. 318: instead of “Gi“ and “gas i” it should be “GO3“ and “O3”

Corrected. Thanks.

l. 332: What is the temporal resolution of the NCEP analysis?

It is 6 hrs. Information in Line 374

l. 386: table 4 contains also another line on Rayleigh OD, which should also be mentioned and brought into perspective in the text

It has been edited out since this information is not relevant to this paper and was

inadvertently left in the table

l. 415: correct in the middle: “that that”

Done

l. 486: Another aspect of interest would be whether an overlooked longterm trend in water vapour or ozone concentrations (e.g. by using a static climatology) could create an artificial AOD trend – if you could add a statement on this (whether its relevant or negligible) based on an assumed possible decadal trend in concentrations, this would be very useful?

For H2O and O3, we almost never need to use climatology since we use NCEP data and that can account for trend from these gases. However, for the ‘dry gas’ we use climatology. For the DT algorithm, the important gases in category are CO2 (MODIS) and CH4 (VIIRS).

Over the lifetime of MODIS instrument, CO2 has increased from about 375 to 405 (i.e by $\sim$10%). A 10% change in CO2 amount = 10* 0.0163 = 0.00163 CO2 Optical depth at 2.12 μm (MODIS Channel impacted by CO2 absorption). Not accounting for this trend in atmospheric gas correction means that the DT algorithm would retrieve lower AODs and smaller trends. In separate work, we have also estimated the uncertainty in the retrieved AOD due to error in the water vapor data used by the DT algorithm. A 20% error in water vapor content results in AOD uncertainty of $\sim$0.002 (median) , $\sim$0.003 (mean). The uncertainty magnitude was similar for different months of global data we looked at. Therefore, we think that the impact of using climatological values for ‘dry gases’ would have an overall negligible impact on the decadal trends.

Fig. 7 legend vs. text in l. 427: differences are smaller than 0.08 (figure) or 0.07 (text) – can you harmonize?

Corrected.

Table 4 / Rayleigh OD, 2nd column: correct “Fiter” to “Filter”

Done

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