

Interactive comment on “Post-processing to remove residual clouds from aerosol optical depth retrieved using the Advanced Along Track Scanning Radiometer” by Larisa Sogacheva et al.

Anonymous Referee #3

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The paper describes an improved post-processing method for the removal of residual clouds in aerosol retrievals using AATSR observations. The previous version of this technique has already been published by Kolmonen et al. (2015). The authors compare both versions by means of case study examples as well as discussing the AOD results w.r.t. seasonal and temporal changes.

From my point of view the paper is unnecessarily expanded, because the focus of this work is the presentation of the updated cloud post-processing scheme. The original scheme has already been published by Kolmonen et al. (2015). The authors failed at focussing on the description of the main improvements and associated changes in the

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aerosol retrieval results. The reader has to make a considerable effort to read through a lot of text until the point is reached, where the new work is being presented.

I recommend accepting the paper with major revision required. I expect that the authors perform a re-writing of the paper leading to a clear and focused manuscript.

In the re-writing, they should take into account:

Introduction:

The introduction is not very strong and does not arouse interest encouraging the reader to read to the very end of the work due to dispensable information and lack of the central theme. As a reader I would expect a clear structured introduction explaining the motivation, the state-of-the-art including challenges and the relevance of this work. In my opinion this introduction does not capture that.

P2L2: “Usually the retrieval is only made for cloud-free scenes, ...” Is there any aerosol retrieval that is capable to retrieve AOD in the presence of clouds? I would suggest removing the word “Usually” since the second part of that sentence contains “..., which implies that a very strict cloud detection scheme has to be applied to remove all cloudy pixels from the retrieval area.” This means a clear-sky conservative cloud screening is required for aerosol retrieval, which per se means cloud-free.

P2L18-26: The authors describe the general cloud screening approach, i.e. how clouds are characterized when looking from space. However, they do not mention the limitations, such as, bright clouds over desert and snow/ice covered areas, cold clouds over cold surfaces, extreme case: low clouds that are warmer than the surface. The description of ideal satellite sensors for the retrieval of aerosol and clouds are

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not relevant for this paper, thus, should be deleted. I would suggest writing a concise paragraph about cloud detection methods and their limitations with regard to spectral imagers, such as AATSR, referencing appropriate literature. Difference and threshold approaches are not the only methods that are being used for cloud masking, such as learning algorithms (e.g. neural network).

P2L27-P3L9: This paragraph is a mix of cloud tests being explained later in Section 4 (what is used in this work) and other techniques published by different groups. I would suggest writing a more general state-of-the-art summary of cloud detection methods rather than mixing it, because these cloud tests (“T1”, “T2”, etc.) are not relevant here, but the physics is. See previous comment P2L18-26.

Section 2:

P4L20: Change “and four in the mid- to thermal infrared” to “and four in the near- to thermal infrared”.

P5L2: Please explain in the text why the retrieval uses only 865 nm measurement over ocean?

P5L12-14: Superfluous, thus should be deleted.

Section 4:

Subsection 4.1 describing the cloud tests is difficult to read and tells only half of the story. I would suggest shortening the description using enumeration. Maybe a sketch/scheme illustrating the tests could be useful for the reader. Is the order of the applied tests unimportant for the thresholding used here for cloud detection? There are other thresholding approaches, where the order of the tests is important for the pixel classification. This might be not the case for a clear-sky conservative approach, but please mention it here or explain it.

The authors make general statements, such as “clouds are cooler than ..” or “clouds

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are brighter than the underlying surface ...”. However, there are cases where this might be not true and I wonder what the result would be in such cases in this study? Are there any checks for the cloud tests applied?

Since different threshold values over land and ocean are used, please mention which land/sea mask you are using. Is a DEM used?

What about sun glint or snow/ice and desert surfaces where clouds might be as bright as the underlying surface? What about sub-pixel clouds or cloud edges? Are they removed later by the CPP scheme? To summarize, cloud screening using spectral imager observations is not as simple as it is pictured here. The authors are mentioning on page 3 (L5-8) difficulties w.r.t. cloud masking, however, since the focus of this paper is the cloud detection used in by work, as a reader I am more interested in understanding the capabilities and limitations of the presented cloud detection.

P6L25: Why is only the forward view used in ASV and cloud detection, i.e. over ocean? Why not the nadir view or forward+nadir views?

Is it really necessary to discuss here the cloud screening and subsequent AOD results excluding the CPP method? Since the focus is the improved CPP method, why not discussing cloud detection and AOD results in Section 5 along with retrieval, old and new CPP? From my point of view the paper would benefit from merging 4.2 and 4.3 subsections (shortened!) into Section 5.

Section 5:

First of all, I agree with the second reviewer that the word “plume” should not be used in this context. Aerosol plumes are related to wildfire, volcanic, and desert dust events.

P8L6: “Each pixel is analyzed together with eight surrounding pixels.” How are borders

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treated, i.e. edges of an orbit? Subsection 5.2 describing the improved CPP method and limitation is difficult to read and to understand. I had to read it several times because I am not familiar with that work. Figure 6 is also very difficult to understand, it is not well explained in the subsection and is not helping at all to understand the text. I do not understand why the authors have chosen $N > 3$ and $A < 0.2$ as criteria when looking at Figure 6. The authors should explain in the text as well as in the figure caption why they have selected this combination of criteria for ImCPP.

In the lower panel of Fig. 6 (China) the blue dashed line for ExCPP is missing!

P9L18: "... for the Globe ...". The authors are using terms such as "Globe", "globally" and "the whole world" throughout the paper. Thus, a reader assumes that no region is excluded from the analysis. When looking at Fig. 9 obviously desert areas and Polar Regions are excluded from the retrieval. However, the authors do not mention this fact. Aerosol retrievals over bright surfaces are challenging but not impossible. In section 3 describing the algorithms the authors should be more precise what they mean with "over land" and "over ocean", excluding desert, snow/ice and sea ice? How are such pixels excluded from the retrieval? Is it done in the pre- or post-processing?

P9L25: "By lack of independent validation data, visual inspection is the main instrument to judge the cloud screening results." I do not agree with this statement. Visual inspection is one method. Validation data is rare. However, there are other well-known reference data sets, which are used for inter-comparison studies and for evaluating the cloud screening results. For instance, CALIPSO, MODIS/Terra, ARM sites, SYNOP data, etc. CALIPSO is in the A-train constellation and collocated pixels will be found only at higher latitudes. MODIS/Terra has the same equator crossing time as ERS-2 (ATSR-2) and has a 30 minutes difference with ENVISAT (AATSR). Please note, MODIS/Terra collection 6 cloud products should be not used after 2010 because band 29 detector crosstalk degradation results in artificially high cloud cover over tropical

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oceans. Thus, please re-write this sentence, for instance: "Visual inspection has been chosen to evaluate the cloud screening results."

P10L15-27: I am not sure if this subsection is really necessary because Fig. 3 and Fig. 4 are already demonstrating the aerosol retrieval, ExCPP and ImCPP results. Fig. 7 does not convey additional information. In my opinion, subsection 5.3 and Fig. 7 could be deleted.

Section 6:

P11L14-17: The evaluation of the new results should be focused on the inter-comparison between all retrievals vs. retrievals after ImCPP instead of focusing on old vs. new CPP results. This would highlight better the improvements, especially those for China. In the case of China the old CPP scheme removed too many pixels, while ImCPP provides more valid retrievals leading to a better correlation with AERONET. The scatter plots in Figure 8 demonstrate this very nicely. Thus, I would recommend swapping ExCPP and ImCPP columns and focusing on the improvements: all retrieval vs. ImCPP.

Fig. 8: The magenta dots and lines are hardly visible. Only when displaying on the screen and zooming into the plot I can recognize the dots and lines. Thus, I would recommend re-plotting those scatter plots (and increase them a little bit). Maybe it is better to choose another color bar for the scatter so that the binned AOD mean and standard deviations can be plotted using a distinct color.

Section 7:

Figure 11 is uninteresting since Figure 10 shows already the impact of ImCPP. Thus, this figure can be deleted.

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Section 8:

Figure 13: what is plotted in panel a, b, and c? Please specify it in the figure caption. The quality of the panels is insufficient. There are too many lines, regions and colors. It is pretty time-consuming and difficult to analyze and understand those panels. Combining 4 different seasons, multiple regions and two different results (old and new CPP) in one plot is too much!

When reading the section 8 along with Figure 13 I am confused. P12L25: "China and India (Fig. 13b) . . .", however there is neither China nor India in Fig. 13 b. Maybe the authors meant 13c? Why is the "Globe" plotted in each panel? Overall, Figure 13 and section 8 are very difficult to follow. Thus, I recommend re-plotting Figure 13, i.e. one or two regions per panel.

Figure 14 and associated paragraph should be deleted because there is no new information.

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