Atmospheric
Measurement
Techniques
Discussions

Interactive comment on "Ground-based remote sensing scheme for monitoring aerosol–cloud interactions" *by* K. Sarna and H. W. J. Russchenberg

Anonymous Referee #1

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1   Main review points

The manuscript presents a statistical analysis of relationships between lidar attenuated backscatter and cloud properties as obtained from a combination of a cloud radar and a microwave radiometer. Two one-day cases are analysed. The manuscript's topic will be of interest for readers of AMT.

In my view, the following main review points require attention:

- While legible and understandable, details of English usage require attention. In

  particular, hyphenation and word order are frequently deficient. A thorough revision by someone fully proficient in English is required.

- The organization of the manscript is not ideal in many places – results, introduction and methods are frequently mixed.

- Descriptions of instrumentation and methodology are incomplete in some places (see details)

- It remains unclear whether correlation analysis, the central component of the methodology, was performed on normally distributed data. Tables 2 and 3 suggest a logarithmic transformation, but no mention of this is made in the text. Sample sizes are rather small (n in Table 2). Information on the statistical significance of the relationships (p values) is somewhat hidden and disjunct from the description of the correlation analysis.

- Overall, the manuscript in many places lacks precision, clarity and detail. Frequently, there are gaps in reasoning (see my 'why' questions below), and many non sequiturs (see below). In particular, it does not become clear to me on what basis previous and other approaches to quantifying aerosol–cloud interactions are discarded as not methodologically desirable.

2   Details

- Page 11954, line 10 (henceforth: 54-10 etc.): "We show the Pearson...." – this seems like too much detail for an abstract. Please abstract.

- 54-12: Can you find a positive way of saying this? I.e., we propose a new/improved way to represent aerosol-cloud interactions quantitatively.

- 54-16: low-level water clouds per se are not an uncertainty. Please specify what aspects about them are uncertain.

- 54-16 and elsewhere: "water cloud" is ambiguous. Please use "liquid water cloud" instead.

- 54-22: In view of AR5 cited just above, the terminology presented here seems outdated. Please use the terms used there ("aerosol-cloud interactions" etc.)

- 54-24: I do not consider this particular vertical order of aerosol and water layers to be part of the definition.

- 55-1: What do you mean by "impact of aerosol–cloud interactions"? Impact on what?

- 55-2: "some observational studies" – "some" seems a bit arbitraty. What criteria did you apply in choosing to present these particular papers?

- 55-1 to 55-9: The compilation of studies presented here seems slightly unfocused: Why did you choose the present these particular studies? What is the significance/importance of each particular perspective for the study of aerosol–cloud interactions (ACI)?

- 55-10 to 55-12: I don't follow this line of reasoning. Why would the absence of a common quantitative basis in different studies cast fundamental doubt on the (qualitative!) presence of an aerosol effect? I disagree with this conclusion and do not see material in this paragraph to support it.

- 55-13: While I agree that this is a necessary and valuable study, the need does not become clear in the transition between the previous and this paragraph. Please clearly identify the need for research and justify the particular research setup taken.

- 55-20: The meaning of 'spatial resolution' is unclear in the case of ground-based (point!) observations

- 56-14: The meaning of γ needs to be explained directly above or below the equation

- 56-18: sentence ending on "region": Please provide a reference.

- 57-1: The first sentence is confusing and possibly affected by circular reasoning.

- 57-7: If you choose to keep this equation, you may want to consider to exchange r_e and τ_d to more closely follow the reasoning in the text.

- 57-12: reference for equation 4 missing

- 57-17: I find the use of r and τ in this equation slightly confusing. Maybe substitute them by c for 'c'loud property or similar?

- 58-4: Please be more specific

- 58-8: What is meant by 'absorption optical thickness'?

- 58-12: As coagulation is defined as collision plus coalescence, the terms in this sentence are redundant.

- 58-16: I don't understand this sentence. How can there be a (meaningful) cloud-droplet concentration below the cloud base?

- 59-1: Unclear at this point: Are data sets tested for/transformed into normal distribution? Did you perform a log transformation? As normally distributed data are required for the application of the statistical methodology used, this has to be addressed explicitly?

- 59-11: How do you perform a t test for just one bin? The significance of what property do you test?

- 59-12: It seems that the remainder of this paragraph duplicates information already provided a few lines above.

- section 3.1: More detail is needed on the instrumentation used; e.g., what type radar, what frequency etc., ceilometer central wavelength, range, bin size, etc.

- 59-22: What do you mean by 'time scale'?

- 59-23: What is the problem with 'specific measurement campaigns'?

- 59-25: why are 'multiple locations' necessary?

- 60-1: It does not follow from the previous lines that remote sensing instrumentation is required.

- 60-6: What is a pixel in the context of this study?

- 60-6: How is this categorization performed? (scientific basis, method part of an existing product or performed by you?)

- 60-8: What do you mean by 'specific targets'?

- 60-13: peak of the Koehler curve = 'critical radius'

- Section 3.2 does not belong into the 'Methodology' chapter.

- 61-14: how are 'well-mixed conditions' determined?

- 61-15: What data are integrated?

- 61-15: At what altitude is the 'level of complete overlap'?

- 61-17: How did you determine a distance of 300m?

- 61-20: How did you find this?

- 61-20: What is the 'level of aerosol proxy'?

- 61-20: Is there a quantification for this dependence?

- 62-10: Do you actually perform the retrievals or do you use finished products? In the latter case, please cite the relevant publication(s) instead of presenting the details of the methodology.

- 63-1: robust in what respect?

- 63-2: What kind of 'observational errors'?

- 63-2: What kind of 'algorithm assumptions'?

- 63-8: Why did you chose 85 meters?

- Section 3.2.3 does not belong into the methodology chapter

- 63-25: why?

- 64-5: How exactly do you define a 'changing aerosol background' quantitatively?

- 64-8: I don't agree that both need to vary – if only aerosol varies, but not cloud, an effect of 0 size would be observed. If only cloud varies but not aerosol, other factors are obviously present.

- 64-10: How do you define 'good quality data' quantitatively?

- 64-13: daily basis → one-day case studies?

- 64-13: There can be transitions between meterological conditions even within one day (and much smaller intervals of time)

- 64-13: How are different meteorological conditions between days accounted for and how do they affect the validity of your findings?

- 64-24: What do you mean by 'regimes'?

- 64-26: What do you mean by 'method presented here' – so many different aspects are addressed in the previous paragraphs that it is hard to tell for the reader what the core of your own methodology is.

- 65-2: Based on what criteria are the case studies chosen?

- 65-9: What are the channels/central wavelengths/frequencies of these instruments?

- 65-11: How does the resampling affect the quality of the data?

- 66-22: Correlation analysis assumes normally distributed data. Droplet effective radius, at least, tends to be log-normal rather than normal. This means that a correlation analysis on the non-transformed data set is not numerically permissible or physically meaningful. Accordingly, the analysis in the following paragraphs is of very limited validity.

- 67-19: If precipitation started after 15:00, why did you discard data between 14:00 and 15:00?

- 67-26: Why is 30 chosen as the lower limit?

- 68-1: Why were these values excluded? What is the effect of excluding them?

- 69-13: New methodology should not be introduced in the last paragraph of the results chapter, but in the methodology chapter.

- 69-13: What is a "student's p test"?

- 69-13: All p values should be given explicitly or in terms of significance level markers (e.g. asterisks) together with r in the corresponding tables and text passages.

- 69-25: I think the data format is of little importance.

- 70-8: What do you mean by "statistical significance of every bin sample"? What property of the bin is tested for significance? What significance level is chosen?

- 70-8: I missed this explanation. Since this is the summary, can you repeat it in a few words, please?

- 70-10: "statistical parameters can be representative" – I don't understand this statement. Can you try re-wording it, please?

- 70-14: I agree that meteorological variation is an important factor. However, how can you draw generally applicable conclusions from your study?

- 70-16: How do you define "very similar"? Can you make a suggestion on quantitative criteria?

- 70-25: I don't think you can make inferences like this from the analysis of just one single case.

- 70-25: explain 'significant' in this case, please, or replace by a different word or phrase.

- 71-3: Widely available is relative: I think cloud radars are still fairly rare.

- Figures 5 to 8: p values of the regression should be given for each panel. Where the p value is larger than a pre-defined threshold (e.g., 0.01) no regression line should be shown.

3 Technical remarks and suggestions

- 54-12: aerosol–cloud interactions (mind the dash!)

- 54-12: way TO quantify

- 54-19: "contribute to the largest" – what do you mean by contribute here?

- 54-21: mainly impact

- 55-4: short lived → short

- 55-6: surface-based remote sensing

- 55-7: satellite-based remote sensing

- 55-18: upward-pointing

- No further comments on hyphenation, word order and other aspects of English usage beyond this point. Someone fully proficient in English needs to carefully proof-read the manuscript before publication

- 56-1: is as follows:

- 58-2: LOW optical thickness

- 59-11: period

- 61-1: First three sentences need lingual corrections.

- 61-17: telescope, Kovalev

- 61-13: ATB – please explain abbreviations when they are first used

- 61-15: data is a plural ('are' not 'is')

- 61-3: Cloud droplet size... (also in other places)

- 63-5: third and second momentS of

- 64-16: Its

- 65-11: these data are not grid data, so they cannot be re-gridded. re-sampled maybe?

- 68-9: Figure 6 shows the relationship between...

- 70-5: 10gm-2 WIDE.

- 70-6: remove "statistical parameters such as"

- 70-23: caseS, binS

- Table 1: Cloud droplet number concentration

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11953, 2015.