

Interactive comment on “Long-term aerosol optical hygroscopicity study at the ACTRIS SIRTA observatory: synergy between ceilometer and in-situ measurements” by Andrés Esteban Bedoya-Velásquez et al.

Anonymous Referee #1

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The manuscript “Long-term aerosol optical hygroscopicity study at the ACTRIS SIRTA observatory: synergy between ceilometer and in-situ measurements” describes a strict procedure to specifically study events where hygroscopic growth led to the enhancement of optical properties. The study is based at the supersite SIRTA where several in-situ measurements are available and thus a comparison was possible between remote sensing data from Ceilometer measurements and chemical composition data as retrieved from an ACSM and Aethalometer. Two case studies are presented in more detail elucidating the reasons for the elevated enhancement factors. I recommend the

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paper for publication after the following comments have been addressed:

Major comments:

1) The paper lacks a clear description on how the in-situ data were retrieved. In Petit et al., 2015 the procedure of how to combine the ACSM and Aethalometer data is clearly denoted, mentioning correction factors (including the MAC value) for the Aethalometer and discussing collection efficiencies for the ACSM. It is not clear to me whether exactly the same dataset was used in this study or not? Although it is stated that it is a 4.5 year study I could not find what the exact starting and end dates were? In order to assess how well the contribution of BC is captured by this comparison with the ACSM, it is crucial to know how the data were combined.

2) There are several closure studies that combine chemical composition data to in-situ hygroscopic growth data. As this is also a main point in this manuscript, I strongly recommend to add a section on previous studies (although not from remote sensing) shortly describing how well these studies could find closure. Such studies are not mentioned so far.

General comments:

1) The results from case 8 are compared to previous findings associated with marine contributions (shipping emissions). Did the authors perform back-trajectory analysis using for example Hysplit to check whether the air masses were actually coming from marine environments? Or are there other instruments at the SIRTA site that are better suited to measure aerosols originating from the sea to support this hypothesis? The ACSM + Aethalometer combination is not well suited to characterize such air masses.

2) The methodology to identify the cases with enhancement due to water uptake in section 4 does not mention anything about days where the RH is 100% or close to it. How were such data treated / what was the max RH still used for analysis? Figure 2a for example shows RH very close to 100% just before the selected period.

3) The results section 5.1 should be rewritten as the results are presented twice, first in a summary and then in detail. This section should be more concise.

4) Section 3.1. - discussion of the RHref value: in line 16, page 7, the RHref is defined as “the lower value of RH in the atmosphere within the time-window of evaluation”. I expect that the minimum RH in this time-window is meant. How far were these minimum values of RH from the RH=40%? This information is important to get a feeling of how important the recalculation to RH=40% is.

5) The last paragraph in section 5.2 is based on very low correlation coefficients. I think the authors ought to be careful with the interpretation of such values and rather use terms like “these values suggest..”. Additionally, these results can be compared to previous studies of chemical composition and hygroscopicity. What is the additional information gained from calculating $F0=OA/(OA+SO4+NO3+NH4)$? Discussion is missing.

6) The whole manuscript has to be thoroughly checked for English spelling and grammar mistakes.

Specific comments:

Page 2, line 15: delete the word “effect”

Page 2, line 16: the water uptake changes both, the size and chemical composition thereby influencing the optical properties.

Page 2, line 18: the $f(RH)$ has to be explained here at the 1st instance, with all its suffixes.

Page 2, line 18: change “aerosol hygro. growth have. . .” to has

Page 2, line 19: give example of what such a aerosol optical/microphysical property would be

Page 2, line 20: be more specific in what kind of in-situ measurements have been

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done.

Page 2, line 24: add “a” in front of HTDMA

Page 2, line 26: nephelometers that measure (without “s”)

Page 2, line 27: change to “to quantify the enhancement factor”

Page 2, line 29: change Rosatti to Rosati

Page 2, line 30: rephrase sentence starting with “However, . . .” and be more specific what the tubing in in-situ sampling can affect

Page 3, line 7: be more specific in what “some limitations” are

Page 5, line 7: rather “resulting as”?

Page 6, line 15: rephrase “is water vapour number of concentration”

Page 6/7: combine Eq. 12 and 13

Page 7, line 3: missing “is” after σ_{wv} ?

Page 7, line 6: change to “An important fact shown in Eq. (15) is that the water vapour. . .”

Page 7, line 13: change to “ $f_{\beta}(RH)$ to be lower than 10%”

Page 7, line 24: Sentence starting with “As one step. . .” has to be rephrased. It is not clear when/how the uncertainty of $f_{\beta}(RH)$ was estimated. Was it part of the error calc. of γ ?

Page 8, line 6: change “derive” to “lead”

Page 8, line 25: switch order – “ ΔRH being the. . .”

Page 9, line 2: change to “. . . is not related to an increase in the aerosol mass concentration but due to an increase in RH .”

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Page 9, line 13: I think there is a problem in this sentence as you would like to select the cases with enhancement due to elevated RH and not as stated “disregard . . . cases in which . . . enhancement can be attributed to increase in RH.”

Chapter 5.1: as mentioned above a rephrasing of this paragraph is needed. There are also several grammatical errors. In line 19 (page 10) it states “case 1” that should be replaced by “case 3”. Also the discussion on where the aerosols came from (e.g. “anthropogenic and marine”) is quite unexplained here. Mention at least that more details can be found in the next section or leave out here.

Page 10, line 27-28: I am confused about the term “relative high” (which should read “relatively high”) and the percentage of 1% of NO₃-

Page 11, line 11: change to “cases 2, 4 and 6 present. . . of $f_{\beta}(RH,85\%)$. . .”

Page 11, line 15: delete the word “cases”

Page 11, line 17: change to “relatively high”

Page 11, line 23: change to “. . . of the aerosol particles. . . “

Page 11, line 24: maybe change to “temporal-change in RH”; beta is twice spelled in letters rather than the Greek symbol; I would recommend to restructure this sentence;

Page 11, line 26: delete the “but”

Page 11, line 30-31: rephrase sentence starting with “Therefore, results . . .”; what is meant by “linearization”? Extrapolation using a linear fit?

Page 12, line 5-6: change to “. . . values of $f_{\beta}(RH)$ ranging from xx to xx, while gamma lay between . . .”

Page 12, line 7-8: change to “can be well compared to reported ones found in in-situ . . . when they probed air-masses influenced by anthropogenic and marine aerosols.”

Page 12, line 12: state the definition of PM₁ at the first instance!

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Page 12, line 23: specify the “good agreement with...” and better rephrase the sentence, possibly making 2 sentences out of it for clarity.

Page 13, line 1: rephrase sentence; Do you mean “when NO₃ and NH₄ were added”?

Page 13, line 16: change to “strictly defined”

Page 13, line 27: change to “the relationship of OMF and IMF...”

Page 14, line 1: change to “detailed studies...”

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