Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-993-RC2, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hygroscopic growth study in the framework of EARLINET during the SLOPE I campaign: synergy of remote sensing and in-situ instrumentation" *by* Andrés E. Bedoya-Velásquez et al.

Anonymous Referee #1

Received and published: 9 February 2018

Hygroscopic growth studies with lidar are a valuable contribution to the field of research as they are operating at ambient conditions and allow us to study lofted aerosol layers and not only the situation near the ground. The accurate profile of the relative humidity is an important issue to tackle for this kind of studies. The present study uses a microwave radiometer for the temperature profile and the water vapor Raman channels of the lidar for the water vapor mixing ratio to provide the relative humidity with a high temporal resolution. This method is compared to a study where RH is used from a radiosonde only. It is a beginning, but the authors are in risk to miss the chance to

discuss the topic comprehensively. Therefore I have two major points to include in the manuscript (see more details below):

I. Take a modeled temperature profile, preferably from GDAS (Global Data Assimilation System), to compare your results obtained by the microwave radiometer (and the radiosonde). If it agrees well, this would extend tremendously the application of your method.

II. Try to deliver extinction enhancement or even scattering enhancement factors as they are reported frequently in literature. Use all your information from the lidar and the in situ sampling to give at least an estimate. Just reporting the backscatter enhancement factor limits the outreach of your study.

Considering the following comments, I recommend the manuscript for publication after major revisions.

Mayor comments

1. The key facts should be included in the abstract. At the moment, the abstract is too descriptive, and too few results are presented. For someone who only reads the abstract, the main findings should shortly be presented.

Here or in the introduction, you should mention that the method is tested against the results of Granados-Muñoz, AMT 2015.

2. The introduction is not well written. The main structure of an introduction should be clearer:

Why is it important?

What has been done in this field?

What questions remain open?

What is your contribution?

Furthermore, it is not clear, which aerosols are observed and how the publication is structured. Recent literature from the studied field should appear in the introduction. Some references are given later in the manuscript, but they could already appear in the introduction. Please revise carefully the literature.

3. In general, the reader is interested in which aerosols you are observing. Very late, in Table 1, you give an overview. Do you consider it as continental aerosol, urban pollution or biogenic particles? Please add a discussion about the aerosol type. In Granados-Muñoz, AMT 2015, sulfate, marine and mineral dust particles are discussed.

4. Section 2 is not well structured: first a description of the campaign (now Sect. 2.2), then a sub section to the valley station in Granada (now Sect. 2.1) and then a sub section to the hill station with the in situ instrumentation , where you explain which instrument measures which quantity.

5. A sketch of the location would be nice (maybe a vertical cut, showing the orographic profile with valley and hill station and the distance between them). And you mention several in-situ stations at different heights, an interesting fact, that is not used later on.

6. It is great to have a station on a mountain, almost 2000 m above the lidar and several stations on the mountain slope. Somewhere you should mention hygroscopic studies which compared remote sensing measurements with (meteorological) tower based in situ instrumentation, which only reach up to approximately 200 m above ground or the use of horizontal pointing remote sensing instruments to ground-based in situ observations; and the advantage of having a mountain slope for performing such experiments.

7. Another key point, you retrieve backscatter enhancement factors and you state, that it is difficult to compare them to values found in the literature. With your Raman signals, you can retrieve the extinction coefficient and determine the extinction enhancement factor or at least the lidar ratio. For the extinction enhancement factor, there are much more literature values to compare. Eventually, your in situ measurements allow you to determine the single scattering albedo and then you can derive the scattering en-

hancement factor, which can be compared to results obtained by in situ observations of hygroscopic growth. These conversions would add a lot of value to the paper.

8. As I understand it right, one idea of the paper is to perform hygroscopic growth studies using a calibrated Raman lidar system without having a radiosonde available. The Raman lidar delivers the aerosol properties and water vapor mixing ratio (if the calibration constant is known). In order to derive the relative humidity, the temperature profile is needed, which you derive from the microwave radiometer. Another option would be to use the temperature profile of the GDAS model output, as there are all available radiosonde ascends are included. I would like to see, how this even easier method compares to your results.

9. p4, l6-12 What about marine aerosol in Granada?

10. p6, l25 – p7, l3 At which temporal resolution do you derive the temperature profiles and the RH profiles?

11. p12, l6-21 and Fig. 4 Why the third moment of the vertical velocity and not the vertical wind velocity is shown? The vertical velocity would give valuable information about updrafts and downdrafts.

12. p14, l1-4 The statement is not convincing and needs more explanation. You can use a particle size distribution from the mountain station to show the influence of the large particles and how frequent they are. Furthermore you can use the 1064 nm backscatter to be more sensitive for the large particles.

13. Why don't you use the backscatter at 1064 nm? In Fig. 3 and 5 you can extend your study to include the near infrared. It would add value to your publication.

Minor comments:

1. Comma instead of dot in the list of affiliations (6 times)

2. The space after a symbol or a bracket is often missing throughout the manuscript.

3. Indices should not be written in italics, except in the sum formula (Eq. (4))

4. Units should not be written in italics.

5. Maybe you should consider slightly reducing the number of abbreviations to make the paper easier to read.

6. “upward wind”, better “upward wind velocity” throughout the manuscript.

7. In recent years the term ice nucleating particles (INP) is used for the aerosols which nucleate ice, see Vali et al., ACP 2015 (just for your information).

Vali, G., DeMott, P. J., Möhler, O., and Whale, T. F.: Technical Note: A proposal for ice nucleation terminology, Atmos. Chem. Phys., 15, 10263-10270, https://doi.org/10.5194/acp-15-10263-2015, 2015.

8. p4, l16-19 The instrument description is confusing, better “It emits laser pulses at . . ., and it receives backscattered photons at . . . in . . . mode”

9. p4, l21-22 What is the approximate overlap height of the system?

10. p9, Eq 4, What about rho? It is the density of which part?

11. p9, l31 and Fig. 1 Where does the lidar ratio of 65 sr come from?

12. p11, l26 “fine/coarse predominance” better “size”

13. p11, l28 “predominance of coarse particles”, better “predominance of larger particles”

14. p13, l26-27 Please indicate the uncertainty ranges for the 4 derived backscatter enhancement factors as it is done in the conclusion.

15. p14, l4 Please repeat the horizontal distance at this point.

16. Tab. 3 In the caption, be consistent with the date: 16th June 2016

17. Fig. 1+3 units should not be written in italics, see beta (. . .)

18. Fig. 1 d+h It is difficult to separate points and lines.

19. Fig. 2 Height range up to 4 or 6 km is sufficient to show. Could you please state (in the caption) the time of sunset as additional information?

20. Fig. 3 in the caption: backscatter at 1064 nm is not shown, but mentioned.

21. Fig. 4 It would be better to just show the same time interval as in Fig. 2 (1700-0000 UTC) to increase the number of details.

22. References:

- Kotchenruther et al., 1999 (not 1998)

- List, 1951, strange “f&”

- p13,l 17 no Titos et al. (2014b) only Titos et al. (2014)

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-993, 2017.