Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-21-RC2, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Method to retrieve cloud condensation nuclei number concentrations using lidar measurements" *by* Wangshu Tan et al.

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Received and published: 26 March 2019

General

The paper deals with an important topic of atmospheric research: The retrieval of CCN from multiwavelength backscatter and extinction lidar observations. New aspects are integrated (e.g., using the increase in backscatter and extinction coefficient with relative humidity, humidogram approach). This is an excellent idea!

However, the paper has to my opinion almost no structure. Although one gets an idea how the method may work, a well-elaborated and well-structured description of the methodology is completely missing. A huge amount of information on microphysical and chemical particle particle properties, simulated related optical effects, dependence of optical effects from increasing humidity (growth factors), etc. and respective experimental data from field observations in the North China Plain (NCP) are just ac-

cumulated in different sections, but the reader must already be an expert in this field to get an idea how all this may fit together.

So, the manuscript is far from being acceptable. To be short: to my opinion it cannot be published in the present version and must be rejected. In the following, I will give more detail so that the authors may get an idea how to change the structure of the manuscript and then resubmit it.

A manuscript with clear goals, clear structure, an easy-to-follow methodology, plus uncertainty analysis, and also some convincing but simple case studies are required.

An important issue is also: Please do not consider NCP aerosol only. It would be nice to have a general methodology that can be applied to anthropogenic haze and smoke, to dust aerosol, and may be to aerosols dominated by marine sea salt. All the required kappa values and growths factors are available in the literature. You do not need to focus on NCP aerosol!

Details

P3, L8-9: . . . The new method to retrieve CCN . . . is proposed based on kappa Koehler theory. . .... There are many examples of such 'isolated' phrases, not further explained. So, often the reader is confronted with a lot of information and then with the question: What do they want to say? How will that be used? Only experts know what the message behind probably is.

Section 2: As a motivation it is mentioned: Section 2 introduces the measured and simulated data sets. Ok. But why do you introduce these data, why do you need these data, what is the goal, do you need them as input? All this is not explained. Nothing is clear. As a reader one wants to know the motivation for every section, before the content of the section is presented.

And after reading of section 2 and all the subsequent sections it becomes more or less clear: This method obviously only holds for North China Plain (NCP) pollution aerosol.

But is that then a useful method, for all the lidar scientists around the globe?

As a reader I expect a well elaborated algorithm applicable to all relevant aerosol types: What about pure marine conditions, what a about desert dust scenarios, what about forest fire smoke in the free troposphere? How does the method work in these cases? All this is not considered in this paper. Only NCP aerosol.

The BC mixing state is introduced. ... size resolved chemical composition all come from campaign C2. . .. . . and after transforming the ambient wet aerodynamic diameters into dry volume-equivalent diameters, size resolved kappa distribution were derived from measured size resolved chemical composition. Twenty five typical size-resolved kappa distributions in the NCP are computed and later used. . ... in the simulations. Who can follow? Why do you present all this? The methodlogy is still not presented yet! The paper is to more than 50% just an acccumulation of information, like in a laboratory book . . .. Section 2.2.

P4, Eq3 is introduced, taken from another paper, D is introduced as particle/droplet radius (but it is obviously the droplet radius). The equation contains: RH = 1 + SS with SS in %, so what is the unit of RH?

P4, L29: Then Mie theory is used with all the parameters introduced before including the confusing 25 kappa distributions. It is impossible to check the simulations in detail. We are forced to read another paper (Zhao et al, 2017). So, as a reader I am totally confused by the accumulation of all the information from field campaigns, simulations, partly explained in another paper. All particles are spherical which may make sense for North China pollution close to cloud base but what about aerosol mixtures with a lot of mineral dust, practically 75% of the aerosol in China) probably contains dust, what do we do in these cases?

P5, In Section 3, among the discussion of another set of new aspects (useful or not) the authors 'jump' to a new topic: Size-resolved enhancement contributions of backscatter and extinction are calculated to discuss hygroscopicity sensitive size of optical en-

hancement factor measurement. Ok!?! . . .strong oscillations are found in size enhancement contributions of backscatter coefficients. OK! But what is the message behind all this? Where is the methodological concept? Where is all the mentioned information used?

P6: Now equations describing light scattering enhancement factors are introduced, no word about aerosol types and related differences in the enhancement factors. So, here it became finally clear to me the authors only develop their method for North China Plain pollution aerosol.

In conclusion, the authors accumulate and accumulate information . . . from field campaigns, from papers, from own simulations, but leave the reader alone. . . with the question: Why do you present all this? Where is the flow chart with all input parameters needed to compute CCN from backscatter and extinction coefficients at several wavelengths, including uncertainty bars? We are already at the end of page 6, and no methodological concept is presented yet. Section 5 (Summary) comes close (given on page 11).

Now the methodology section starts, Sect. 3.3.

P7 L6: The equation provides the basic relationship between lidar information (backscatter and extinction coefficient) and N-CCN.

P7 L4: you write backscatter/extinction coefficient, but I believe you want to write backscatter and extinction . . .., and not to use the ratio (backscatter/extinction). All this is confusing!

P7, Eq.7 and Eq.8, again new parameters are introduced, new discussion and uncertainty sources, but no clear flow chart what to do with all this information in detail (step byr step).

P8, L4-6: Here the entire method is summarized within three lines! We need to study Figure 3 that shows a flow chart. This is a SKTECH! . . . and helps to understand the

method. But a clear set of equations with all input parameters needed in the first step and all the output parameters, which are again input for the next step and so on, is missing. All this is needed for five optical properties (3 beta and 2 ext). All this is not presented. What about uncertainties in the retrieval? How can we get a convincing opinion on the potential (and especially the limits) if we have only Fig 3 and then the correlation plots in Figure 4. Figures 6 and Figure 7 are useful. But we need to see the overall concept (equations, including uncertainty computation approaches.) And we need it for other aerosol types (dust, haze, marine..), not only for NCP aerosol which is of course an important aerosol mixture.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-21, 2019.