Response to reviewer #2

Thanks for the reviewer's helpful suggestions! The comments are addressed point-by-point and responses are listed below.

Comment: In my previous review, I suggested the authors to improve the English grammar and the organization of the manuscript (especially the description of the methods). They have worked on that, but not enough from my point of view. I suggest to introduce sub-sections for each method. In addition, apart from methods 1-4, they introduced γ-method and κsca-method. What is the difference between method 3 and κsca-method?

In line 156, the authors mentioned four campaigns, but Table 1 listed up to five campaigns. It is not clear to me if the data from Wuqing and Xianghe campaigns are used or not, and for what? Why the data is not corrected? To which corrections do the authors refer?

Response: Thanks for your comment. In the revised manuscript, each method is introduced in a sub-section. The method 3 is same with κsca-method, we have changed the term "κsca-method" to Method 3.

In this paper, datasets from five field campaigns are used. The following sentence is included in Sect.2 of the manuscript: "Dataset includes aerosol PNSDs at dry state, mass concentrations of BC and σ_{sp} values of different wavelengths from the following four campaigns which are listed in Table 1 are referred to as dataset D1: two campaigns conducted in Wuqing, Xianghe campaign, Wangdu campaign before 21 June, 2014".

Dataset D1 are used for simulating the look up table shown in Fig.6a of the manuscript. This information and the reason of using datasets from four field campaigns is included in the manuscript, and expressed as the following: "To better understand the relationship between $\kappa_{f(\mathrm{RH})}$ and κ_{sca}, all PNSDs at dry state (shown in Fig.3a) along with mass concentrations of BC from dataset D1 are used to simulate the relationship between $\kappa_{f(\mathrm{RH})}$ and κ_{sca} with Mie and κ-K*ö*hler theories. The aim of including PNSD and BC information from different campaigns is to simulate variations of R_k under different conditions". The reason that datasets from Gucheng campaign and Wangdu campaign during the period from 21 June, 2014, to 1 July , 2014 (the period when measurements from the humidified nephelometer system were available) are not used for producing the look up table is to make sure that the verification datasets are totally independent of the look up table.

In the revised manuscript, the type and reason about the correction is added and expressed as the following: "Note that measured σ_{sp} values of dataset D1 are not corrected for angular truncation errors. This is because that dataset D1 is used for producing the look up table of the newly proposed method, and it is expected that the Ångstr*ö*m exponent calculated from measured σ_{sp} values can be directly used as input for the newly proposed method".

Comment: One of my main concerns in my previous review was related with the error/uncertainties estimates of using the "new method" proposed in the manuscript. Although they have included a new dataset for testing the method, they do not quantify

the errors of using this method to estimate the hygroscopicity parameter. They should address this point if they expect their method to be useful for the scientific community.

Response: Thanks for your comment. We agree with the reviewer, it is best that we can fully quantify the uncertainties of using this method. Except for the measurement uncertainty of f(RH), uncertainties of this new method are arisen from the look up table shown in Fig.6a of the manuscript. With regard to uncertainties of the look up table, we can not conduct a thorough uncertainty analysis because that we can not know all possible conditions (PNSD, BC, and other factors). In processes of producing the look up table, we included as many datasets as possible from different field campaigns (conducted in different sites and seasons) for simulating this look up table to cover different PNSD and BC conditions as much as possible. In this light, we think uncertainty ranges of R_k under different conditions shown in Fig.6b which are based on the simulative results can be treated as the uncertainty analysis of this look up table to some extent.

Comment: Furthermore, the authors need to make clear that the method is valid for NCP aerosols. They stated in the abstract that the method is "applicable in different sites and seasons" but they have just tested the method in another site from the NCP (probably with similar aerosol characteristics…)

Response: Thanks for your comment. The following discussion is added in the revised manuscript: "The processes of simulating the look up table are independent of the size-resolved κ distribution, and used PNSDs are from four different field campaigns which were conducted in different sites and seasons of the NCP. The verification datasets from

two different field campaigns are totally independent of the look up table and from different sites and seasons of the NCP. These results demonstrate that the newly proposed method is applicable in different sites and seasons of the NCP. The results shown in Fig.6b demonstrate that if Ångström exponent and κ_{sca} are fixed, then R_k varies little. The maximum κ_{sca} of the look up table is 0.4, if R_k is 0.8 (close to the simulated highest R_k shown in Fig.5b), the corresponding $f(\mathrm{RH} = 80\%)$ is 2.6. According to the review of Titos et al. (2016), most of $f(\mathrm{RH} = 80\%)$ values for continental aerosols are lower than 2.6. The Ångström exponent range of the look up table is 0.4 to 2.0. Which demonstrate that the look up table shown in Fig.6a already covers large variation ranges of Ångström exponent and κ_{sca} and can be used under different conditions. Thus, the newly proposed method of deriving $\kappa_{f(\mathrm{RH})}$ might be also applicable in other regions around the world".

Titos, G., Cazorla, A., Zieger, P., Andrews, E., Lyamani, H., Granados-Muñoz, M. J., Olmo, F. J., and Alados-Arboledas, L.: Effect of hygroscopic growth on the aerosol light-scattering coefficient: A review of measurements, techniques and error sources, Atmospheric Environment, 141, 494-507, http://dx.doi.org/10.1016/j.atmosenv.2016.07.021, 2016.