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Comment on amt-2021-358

Anonymous Referee #2

Referee comment on "Estimating cloud condensation nuclei concentrations from CALIPSO lidar measurements" by Goutam Choudhury and Matthias Tesche, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-358-RC2, 2021

Review of 'Estimating cloud condensation nuclei concentrations from CALIPSO lidar measurements' by Choudhury and Tesche

This manuscript proposes a method to estimate cloud condensation nuclei (CCN) concentrations from space-borne CALIPSO lidar measurement. The article is corresponding to the scope of AMT. The CALIPSO-derived aerosol backscatter and extinction coefficient, depolarization lidar, and aerosol subtype information are put into the MOPSMAP package so as to obtain the number size distribution (then the values of $n_{j,dry}$) for five aerosol subtypes and further the CCN concentrations. The determination of CCN concentrations is crucial to study aerosol-cloud interactions, thus the authors' attempt is valuable, especially for the potential estimation of the global CCN concentration data set. The only case study compares the proposed method with in-situ measurement, suggesting that in the future more work focusing on method validation should be done. My major concern is: (1) the lack of basic information of data set used in sensitivity analysis and comparison with POLIPHON method; (2) weak motivation in the introduction section. The manuscript can be recommended for publication in AMT after addressing the following comments.

Specific comments:

- As mentioned in the general comment, after L48, it should be added another paragraph to state the motivation of proposing this new method for estimating CCN concentrations, which is different from the widely used POLIPHON method. To my point of view, the potential advantage for the proposed method is not necessary for calculating those region-varied conversion factors to obtain $n_{j,dry}$ (Ansmann et al. 2019AMT, He et al., 2021AMT), which cannot be obtained in the regions without sun photometer observations. Instead, CAMel and MOPSMAP package can solve this problem, making the global estimation of CCN concentrations possible. If so, add a new paragraph to state that.

- The basic information of the data set used in subsection 4.1 and 4.2 are absent, such as the location (global or a few sites) and period (a few months or year) of the selected data. This may confuse the readers, especially considering the large differences of conversion factors in the POLIPHON method. It is suggested to show some cases (after figure 5) that compare the CCN concentration profiles for five aerosol types with POLIPHON and OMCAM algorithms.
- The difference (or important improvement) between this method and Georgoulias et al. (2020) should also be stated.
- L26-27: "Quaas et al., 2008; Quaas et al., 2020" -> 'Quaas et al., 2008, 2020'
- L40: n_{280} has been modified to n_{250} in the followingpapers (Mamouri and Ansmann, 2016ACP; Ansmann et al., 2019ACP).
- L76: volume or particle depolarization ratio? It should be clearly stated.
- L92-93: What if CALIPSO level-2 aerosol subtype is misclassified (Ansmann et al., 2021 FENVS)? It should be mentioned and added some sentences to evaluate the related impact.
- L103: 'spheroids' -> 'non-spheroids'? please confirm.
- L116: define the α in equation (1) here. *x* is aerosol extinction exponent. The unit should be given for each parameter in equation (1). Besides, you should also cite when giving equation (1) (Shinozuka et al., 2015ACP).
- L124: Conversion factors vary from region to region. Therefore, as suggested before, it is better to choose a specific site (maybe the site in Limassol, where many target aerosol types can be observed) and give CCN profile comparison between POLIPHON and OMCAM algorithms.
- L127-134: This paragraph is logically confusing and should be rephrased to introduce the general content of section 3.
- L232: How can the conclusion 'fine mode as the primary contributor to the output aerosol number concentration' be drawn from figure 2?
- L312: Rephrase this sentence to more clearly state that conversion factors for marine aerosols are estimated from the Barbados AERONET site?
- L135 and Figure 5: There is a systematical factor of around 3-5 for marine aerosol types between the CCN concentration from two different methods. It would be better to try to give a more specific discussion, especially considering the proposed method is expected to extend to a global scale.
- Figure 6: The trajectory of the sub-satellite point should be added.
- Figure 7: It is great to see that CCN concentration profiles from POLIPHON and OMCAM are consistent with each other after hygroscopicity correction very well. It is expected to conduct more comparison with in-situ measurement in the future as reported in (Mamali et al., 2019AMT).

References

Ansmann, A., Mamouri, R.-E., BuÌ□hl, J., Seifert, P., Engelmann, R., Hofer, J., Nisantzi, A., Atkinson, J. D., Kanji, Z. A., Sierau, B., Vrekoussis, M., and Sciare, J.: Ice-nucleating particle versus ice crystal number concentration in altocumulus and cirrus embedded in Saharan dust: A closure study, Atmos. Chem. Phys., 19, 15087-15115. doi.org/10.5194/acp-19-15087-2019, 2019

Ansmann, A., Mamouri, R.-E., Hofer, J., Baars, H., Althausen, D., and Abdullaev, S. F.: Dust mass, cloud condensation nuclei, and ice-nucleating particle profiling with polarization lidar: updated POLIPHON conversion factors from global AERONET analysis, Atmos. Meas. Tech., 12, 4849-4865. doi.org/10.5149/amt-12-4849-2019, 2019.

Ansmann, A., Ohneiser, K., Chudnovsky, A., Baar, H., and Engelmann, R. CALIPSO Aerosol-Typing Scheme Misclassified Stratospheric Fire Smoke: Case Study From the 2019 Siberian Wildfire Season. Frontiers in Environmental Science, 9, 769852, doi: 10.3389/fenvs.2021.769852, 2021.

Georgoulias, A.K., Marinou, E., Tsekeri, A., Proestakis, E., Akritidis, D., Alexandri, G., Zanis, P., Balis, D., Marenco, F., Tesche, M. and Amiridis, V.: A first case study of CCN concentrations from spaceborne lidar observations. Remote Sensing, 12(10), p.1557, https://doi.org/10.3390/rs12101557, 2020.

He, Y., Zhang, Y., Liu, F., Yin, Z., Yi, Y., Zhan, Y., and Yi, F.: Retrievals of dust-related particle mass and ice-nucleating particle concentration profiles with ground-based polarization lidar and sun photometer over a megacity in central China, Atmos. Meas. Tech., 14, 5939–5954, https://doi.org/10.5194/amt-14-5939-2021, 2021.

Mamali, D., Marinou, E., Sciare, J., Pikridas, M., Kokkalis, P., Kottas, M., Binietoglou, I., Tsekeri, A., Keleshis, C., Engelmann, R., Baars, H., Ansmann, A., Amiridis, V., Russchenberg, H., and Biskos, G.: Vertical profiles of aerosol mass concentration derived by unmanned airborne in situ and remote sensing instruments during dust events, Atmos. Meas. Tech., 11, 2897-2910. doi.org/10.5194/amt-11-2897-2018, 2018.

Mamouri, R. E. and Ansmann, A.: Potential of polarization lidar to provide profiles of CCN- and INP-relevant aerosol parameters, Atmos. Chem. Phys., 16, 5905-5931. doi.org/10.5194/acp-16-5905-2016, 2016.

Shinozuka, Y., Clarke, A. D., Nenes, A., Jefferson, A., Wood, R., McNaughton, C. S., Ström, J., Tunved, P., Redemann, J., Thornhill, K. L., Moore, R. H., Lathem, T. L., Lin, J.

J., and Yoon, Y. J.: The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, Atmos. Chem. Phys., 15, 7585–7604, https://doi.org/10.5194/acp-15-7585-2015, 2015.