

Report #2

Submitted on 07 Dec 2020

Anonymous Reference #1

Comment on «First validation of GOME-2/MetOp Absorbing Aerosol Height using EARLINET lidar observations» by Konstantinos Michailidis et al.

We would like to thank the Referee #1 for his/her comments that led to the improvement of the manuscript. In the update version the reviewer's comments have been taken into account, by improving the discussion of many sections and by further improving the figures. Below we report the changes included in the revised manuscript as a response to the comments of the reviewer. All comments have been extensively taken into account in the present form of the manuscript. In what follows, answers to comments are reported just below each related comment.

P1/L14: “from” → “from the”

REPLY: Changed as requested.

P1/L15: “with” → “using”

REPLY: Changed as requested.

P1/L23: “are” → “can be”

REPLY: Changed as requested.

P1/L27: “height” → “heights”

REPLY: Changed as requested.

P1/L30: cite papers here... Bougiatioti et al., Atmos. Chem. Phys., 16, 7389–7409, 2016 and many others.

REPLY: Done. We provide the references, according to reviewer comment. The full references have added to new manuscript. Add to the text: “... (Bougiatioti et al., 2016, Fanourgakis et al., 2019, Georgoulis et al., 2020)”

References:

Bougiatioti, A., Bezantakos, S., Stavroulas, I., Kalivitis, N., Kokkalis, P., Biskos, G., Mihalopoulos, N., Papayannis, A., and Nenes, A.: Biomass-burning impact on CCN number, hygroscopicity and cloud formation during summertime in the eastern Mediterranean, Atmos. Chem. Phys., 16, 7389–7409, <https://doi.org/10.5194/acp-16-7389-2016>, 2016.

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

P1/L31: Cite several papers here

REPLY: Done. We add the references, according to reviewer comment. The full references have added to new manuscript. Add to the text: “... (Seinfeld et al., 2016)”

References:

Seinfeld, J. H., Bretherton, C. S., Carslaw, K. S., Coe, H., De Mott, P. J., Dunlea, E. J., Feingold, G., Ghan, S. J., Guenther, A. B., Kahn, R. A., Kracunas, I. P., Kreidenweis, S. M., Molina, M. J., Nenes, A., Penner, J. E., Prather, K. A., Ramanathan, V., Ramaswamy, V., Rasch, P. J., Ravishankara, A. R., Rosenfeld, D., Stephens, G., and Wood R.: Improving our fundamental understanding of the role of aerosol-cloud interactions in the climate system, *P. Natl. Acad. Sci. USA*, 113, 5781–5790, <https://doi.org/10.1073/pnas.1514043113>, 2016.

P1/L32: Provide here papers published very recently e.g. 2019-2020

REPLY: Done. We provide the references according to reviewer comment. The full references have added to new manuscript. Add to the text: "... (e.g. Ansmann et al., 2019, Laaksonen et al., 2020)."

References:

Ansmann, A., Mamouri, R.-E., Bühl, 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 layers embedded in Saharan dust: a closure study, *Atmos. Chem. Phys.*, 19, 15087–15115, <https://doi.org/10.5194/acp-19-15087-2019>, 2019.

Laaksonen, A., Malila, J., and Nenes, A.: Heterogeneous nucleation of water vapor on different types of black carbon particles, *Atmos. Chem. Phys.*, 20, 13579–13589, <https://doi.org/10.5194/acp-20-13579-2020>, 2020.

P1/L33: Add "... still..."

REPLY: Changed as requested.

P1/L34: Add "... over several sites..."

REPLY: Changed as requested.

P2/L2: Here you have to cite several relevant papers.

REPLY: Done. We add the references, according to reviewer comment. The full references have added to new manuscript.

Add to the text: "... (e.g. Balis et al., 2016, Ansmann et al., 2018, Nanda et al, 2020, Sun et al., 2020)"

References:

Ansmann, A., Baars, H., Chudnovsky, A., Mattis, I., Veselovskii, I., Haarig, M., Seifert, P., Engelmann, R., and Wandinger, U.: Extreme levels of Canadian wildfire smoke in the stratosphere over central Europe on 21–22 August 2017, *Atmos. Chem. Phys.*, 18, 11831–11845, <https://doi.org/10.5194/acp-18-11831-2018>, 2018.

Balis, D., Koukouli, M.-E., Siomos, N., Dimopoulos, S., Mona, L., Pappalardo, G., Marengo, F., Clarisse, L., Ventress, L. J., Carboni, E., Grainger, R. G., Wang, P., Tilstra, G., van der A, R., Theys, N., and Zehner, C.: Validation of ash optical depth and layer height retrieved from passive satellite sensors using EARLINET and

airborne lidar data: the case of the Eyjafjallajökull eruption, *Atmos. Chem. Phys.*, 16, 5705–5720, <https://doi.org/10.5194/acp-16-5705-2016>, 2016.

Nanda, S., de Graaf, M., Veeffkind, J. P., Sneep, M., ter Linden, M., Sun, J., and Levelt, P. F.: A first comparison of TROPOMI aerosol layer height (ALH) to CALIOP data, *Atmos. Meas. Tech.*, 13, 3043–3059, <https://doi.org/10.5194/amt-13-3043-2020>, 2020.

P2/L5: Rephrase this phrase: “Which one is the dominant factor determining the aerosol vertical distributions depend on aerosol species”.

REPLY: The text was changed according to the reviewer’s suggestion.

The text was rephrased to: “...Lidar aerosol vertical profiles provide an important means of evaluating and improving aerosol models. Atmospheric aerosol models are generally sensitive in the vertical distribution of aerosols with large regional variability (Kipling et al., 2016).”

P2/L7: Correct to “... dust, biomass burning and ash particles...”

REPLY: Changed as requested.

P2/L8: Add more papers here like Soupiona et al., 2020, Adam et al., 2020

REPLY: Done. We add new references, according to reviewer comment. The full references have added to new manuscript. Add to the text: “(... Adam et al., 2020, Soupiona et al., 2020)”

References:

Adam, M., Nicolae, D., Stachlewska, I. S., Papayannis, A., and Balis, D.: Biomass burning events measured by lidars in EARLINET – Part 1: Data analysis methodology, *Atmos. Chem. Phys.*, 20, 13905–13927, <https://doi.org/10.5194/acp-20-13905-2020>, 2020.

Soupiona, O., Papayannis, A., Kokkalis, P., Foskinis, R., Sánchez Hernández, G., Ortiz-Amezcuca, P., Mylonaki, M., Papanikolaou, C.-A., Papagiannopoulos, N., Samaras, S., Groß, S., Mamouri, R.-E., Alados-Arboledas, L., Amodeo, A., and Psiloglou, B.: EARLINET observations of Saharan dust intrusions over the northern Mediterranean region (2014–2017): properties and impact on radiative forcing, *Atmos. Chem. Phys.*, 20, 15147–15166, <https://doi.org/10.5194/acp-20-15147-2020>, 2020.

P2/L8: Start a new paragraph here.

REPLY: It’s done. A new paragraph has been created.

P2/L15: Cited papers are strongly depended here

REPLY: Done. Citations are provided in the new manuscript. Add to the text: “... (e.g. Amiridis et al., 2015; Ansmann et al., 2018; Voudouri et al., 2019)”

References:

Amiridis, V., Marinou, E., Tsekeri, A., Wandinger, U., Schwarz, A., Giannakaki, E., Mamouri, R., Kokkalis, P., Biniotoglou, I., Solomos, S., Herekakis, T., Kazadzis, S., Gerasopoulos, E., Proestakis, E., Kottas, M., Balis, D.,

Papayannis, A., Kontoes, C., Kourtidis, K., Papagiannopoulos, N., Mona, L., Pappalardo, G., Le Rille, O., and Ansmann, A.: LIVAS: a 3-D multi-wavelength aerosol/cloud database based on CALIPSO and EARLINET, *Atmos. Chem. Phys.*, 15, 7127–7153, <https://doi.org/10.5194/acp-15-7127-2015>, 2015.

Voudouri, K. A., Siomos, N., Michailidis, K., Papagiannopoulos, N., Mona, L., Cornacchia, C., Nicolae, D., and Balis, D.: Comparison of two automated aerosol typing methods and their application to an EARLINET station, *Atmos. Chem. Phys.*, 19, 10961–10980, <https://doi.org/10.5194/acp-19-10961-2019>, 2019.

P2/L16: “profiles” → “aerosol profiles”

REPLY: Changed as requested.

P2/L25: “... sensing ...” → “... sensing techniques ...”

REPLY: Changed as requested.

P2/L25: “Active instruments” → “spaceborne lidars”

REPLY: Changed as requested.

P2/L31: Define ALH

REPLY: The text has been modified in the new manuscript accordingly.

P3/L9: What about section 3.

REPLY: The reviewer’s comment is right. A sentence for section 3 is missing. The text has been modified accordingly.

P4/L4: “... lidars...” → “...aerosol lidars...”

REPLY: Changed as requested.

P4/L9: Add citations for: Soupiona 2018, 2019, 2020

REPLY: Done. Citations are provided and added to new manuscript. Add to the text: “ (...Soupiona et al., 2018, 2019, 2020)”

References:

Soupiona, O., Papayannis, A., Kokkalis, P., Mylonaki, M., Tsaknakis, G., Argyrouli, A., and Vratolis, S.: Long-term systematic profiling of dust aerosol optical properties using the EOLE NTUA lidar system over Athens, Greece (2000–2016), *Atmos. Environ.*, 183, 165–174, <https://doi.org/10.1016/j.atmosenv.2018.04.011>, 2018.

Soupiona, O., Samaras, S., Ortiz-Amezcu, P., Böckmann, C., Papayannis, A., Moreira, G. A., Benavent-Oltra, J. A., Guerrero-Rascado, J. L., Bedoya-Velásquez, A. E., Olmo, F. J., Román, R., Kokkalis, P., Mylonaki, M., Alados-Arboledas, L., Papanikolaou, C. A., and Foskinis, R.: Retrieval of optical and micro-physical properties of transported Saharan dust over Athens and Granada based on multi-wavelength Raman lidar measurements: Study of the mixing processes, *Atmos. Environ.*, 214, 116824, <https://doi.org/10.1016/j.atmosenv.2019.116824>, 2019.

Soupiona, O., Papayannis, A., Kokkalis, P., Foskinis, R., Sánchez Hernández, G., Ortiz-Amezcuca, P., Mylonaki, M., Papanikolaou, C.-A., Papagiannopoulos, N., Samaras, S., Groß, S., Mamouri, R.-E., Alados-Arboledas, L., Amodeo, A., and Psiloglou, B.: EARLINET observations of Saharan dust intrusions over the northern Mediterranean region (2014–2017): properties and impact on radiative forcing, *Atmos. Chem. Phys.*, **20**, 15147–15166, <https://doi.org/10.5194/acp-20-15147-2020>, 2020.

P4/L28: Cite here recent papers even from ILRC conference 2017-2020.

REPLY: Done. Citations are provided in the new manuscript. Add to the text: “... (e.g. Pappalardo et al., 2004, Wandinger et al., 2016, Amodeo et al., 2018)”

References:

Amodeo A, D'Amico G, Giunta A, Papagiannopoulos N, Papayannis A, Argyrouli A, Mylonaki M, Tsaknakis G, Kokkalis P, Soupiona R, Tzani C (2018) ATHLI16: the ATHens lidar intercomparison campaign. In: 28th international laser radar conference, 25–30 June 2017, Bucharest, Romania, 176:09008. <https://doi.org/10.1051/epjconf/201817609008>

Wandinger, U., Freudenthaler, V., Baars, H., Amodeo, A., Engelmann, R., Mattis, I., Groß, S., Pappalardo, G., Giunta, A., D'Amico, G., Chaikovskiy, A., Osipenko, F., Slesar, A., Nicolae, D., Belegante, L., Talianu, C., Serikov, I., Linné, H., Jansen, F., Apituley, A., Wilson, K. M., de Graaf, M., Trickl, T., Giehl, H., Adam, M., Comerón, A., Muñoz-Porcar, C., Rocadenbosch, F., Sicard, M., Tomás, S., Lange, D., Kumar, D., Pujadas, M., Molero, F., Fernández, A. J., Alados-Arboledas, L., Bravo-Aranda, J. A., Navas-Guzmán, E., Guerrero-Rascado, J. L., Granados-Muñoz, M. J., Preißler, J., Wagner, E., Gausa, M., Grigorov, I., Stoyanov, D., Iarlori, M., Rizi, V., Spinelli, N., Boselli, A., Wang, X., Lo Feudo, T., Perrone, M. R., De Tomasi, F., and Burlizzi, P.: EARLINET instrument intercomparison campaigns: overview on strategy and results, *Atmos. Meas. Tech.*, **9**, 1001–1023, <https://doi.org/10.5194/amt-9-1001-2016>, 2016.

P5/L6: Delete “Absorbing Aerosol Index” from the phrase.

REPLY: Changed as requested.

P5/L11: Delete “Absorbing Aerosol Height” from the phrase.

REPLY: Changed as requested.

P5/L20: “...with...” → “...with the...”

REPLY: Changed as requested.

P6/L9: “(Regime)” → “(Regimes)”

REPLY: Changed as requested.

P7/L5: Here you have to put the full sentence “Many methods have been proposed...”. So first make a summary of the methods proposed (e.g. Kalman filter etc) to derive the PBL height (e.g. Banks et al., *Atmos Res.*, 176, 185-201, 2016; Kokkalis et al., *BLM*. 2020)

REPLY: The text was changed according to the reviewer’s suggestion and we provide additional references. The full references have added to new manuscript.

References:

Banks RF, Tiana-Alsina J, Baldasano JM, Rocadenbosch F, Papayannis A, Solomos S, Tzani CG (2016) Sensitivity of boundary-layer variables to PBL schemes in the WRF model based on surface meteorological observations, lidar, and radiosondes during the HygrA-CD campaign. Atmos Res 176–177:185–201. <https://doi.org/10.1016/j.atmosres.2016.02.024>

Kokkalis, P., Alexiou, D., Papayannis, A. et al. Application and Testing of the Extended-Kalman-Filtering Technique for Determining the Planetary Boundary-Layer Height over Athens, Greece. Boundary-Layer Meteorol 176, 125–147 (2020). <https://doi.org/10.1007/s10546-020-00514-z>

P7/L9: Here you have to cite all past papers on Haar wavelets e.g. Kalman, R. E. (March 1, 1960). "A New Approach to Linear Filtering and Prediction Problems." ASME. J. Basic Eng. March 1960; 82(1): 35–45; Rocadenbosch et al.,

REPLY: The text was changed according to the reviewer’s suggestion. The full references have added to new manuscript. Add to text: “... (e.g. R.E. Kalman, 1960, Rocadenbosch et al., 1999)”

References:

R. E. Kalman, “A new approach to linear filtering and prediction problems,” J. Basic Eng. 82(1), 35–45, 1960

Rocadenbosch F, Soriano C, Comerón A, Baldasano JM. Lidar inversion of atmospheric backscatter and extinction-to-backscatter ratios by use of a Kalman filter. Appl Opt. 1999 May 20;38(15):3175-89. doi: 10.1364/ao.38.003175. PMID: 18319906.

P8/L25: “...ground based...” → “...ground-based...”

REPLY: Changed as requested.

P8/L26: Start new paragraph.

REPLY: Changed as requested.

P9/L35: km should be separated from the number.

REPLY: Changed as requested.

P11/L21: “... signal is...” → “...signal, is...”

REPLY: Changed as requested.

P11/L23: “...from...” → “...from the...”

REPLY: Changed as requested.

P12/L1: “...mentioned above...” → “...previously mentioned...”

REPLY: Changed as requested.

P12/L29: “well spread” → “homogeneously-distributed”

REPLY: Changed as requested.

P12/L31: Rephrase this paragraph using better English language: “The first validation of the GOME-2/MetOp absorbing aerosol height (AAH) product against ground-based aerosol layer height (ALH) information, retrieved from the European Aerosol Research Lidar Network(EARLINET), lidar observations of backscatter profiles at 532 nm and 1064nm is presented”

REPLY: The text was changed according to the reviewer’s suggestion.

The text was rephrased to: “... we presented the first validation results of GOME-2/MetOp AAH product using lidar data from EARLINET database. For this scope, lidar backscatter profiles at 1064nm have been chosen primarily, and in some cases backscatter profiles at 532nm.”

P13/L1: “...of stations...” → “...of lidar stations...”

REPLY: Changed as requested.

P13/L24: Please rephrase this part using better English language: For this well-developed and spatially well-spread aerosol layer, most GOME-2 retrievals fall within 1km of the temporally collocated lidar observation for the entire range of 0 to 150km radius permitted.

REPLY: The text was changed according to the reviewer’s suggestion.

The text was rephrased to: “This validation effort shows that for all cases the target accuracy is achieved, and for well-developed and spatially well-spread aerosol layers, GOME-2 retrievals meet also the optimum user requirements for the aerosol layer height of 1km.”

P13/L30: “...on board Sentinel-5...” → “...on board the Sentinel-5P...”

REPLY: Changed as requested.

P13/L32: Add the “... were ...” after DB

REPLY: Changed as requested.

P13/L34: “...of automatic...” → “...of the automatic...”

REPLY: Changed as requested.

P14/L12: “...andfor...” → “...and for...”

REPLY: Changed as requested.