Interactive comment on "Mixing layer height as an indicator for urban air quality?" *by* Alexander Geiß et al.

Anonymous Referee #3

Received and published: 5 May 2017

This is an interesting manuscript as it discusses the relationship of the mixing layer height (MLH) and near surface pollutant concentrations. The authors perform correlations of the MLH and PM10, NOx, and O3, and found varying results. The authors believe that the effects of the heterogeneity of the emission sources, chemical processing and mixing during transport exceed the differences due to different MLH retrievals.

With regard to the use of the different MLH retrieval methods (Vaisala proprietary software, COBOLT), which are solely based on aerosol backscatter signal, I was wondering, if radiosondes have been used for a conclusive validation during the BAERLIN campaign. Also, I was wondering why other methods such as the Haar wavelet method or a cluster method have not been considered/discussed.

With regard to the relation of the MLH with air quality, it is well known that the local

change of any given pollutant is not only controlled by the MLH, but by a combination of emission, chemical transformation, removal, advection, convection and turbulent mixing. Also, it is known that at the microscale level urban structures cause flow disturbations and thus deviations from the mean air quality of a larger, representative fetch in an urban area. An example is the well-known wind rotor system in street canyons. Thus the relationship of the MLH with surface concentration critically depends on the fetch area representative for a given measurement site. These well-known processes are not properly addressed in the paper. Due to the rather flat larger area of Berlin, it can be expected that transport processes may play a dominant role in the distribution of pollutants, both at the mesoscale and microscale level. I am surprised to see that the authors did not consider any of the findings associated with the BERLIOZ experiment in 1998 (mostly published in Journal of Atmospheric Chemistry 42, 2002, but also others), which focused on the upwind-downwind conditions found for the Berlin case, as well as the pollutant concentrations within the boundary layer and aloft in the same area and the impact of long-range transport. I would not expect an unambiguous relationship between the MLH and surface concentrations at any given location and under any given meteorological situation in the Berlin area. Rather, I would only expect a dominant role of the MLH on surface concentration, when advection is at a minimum, i.e. under stagnant wind conditions. In its current form this paper neglects the discussion of the MLH with regard to different wind regimes, both with regard to wind speed as wind direction. It should also be mentioned that not only pollutants can be transported, but also physical properties of the boundary layer including the MLH depending on the history of air masses. This extended in-depth analysis is a crucial requirement for a potential publication in AMT.

This is a list of more specific, mostly minor issues, which need to be addressed:

Page 2, L25-28: The paper by Czader et al. (2013) should be added as it is one of the earlier examples to use ceilometer derived MLHs for validation in conjunction with comprehensive air quality modeling.

Czader et al. (2013): CMAQ modeling and analysis of radicals, radical precursors and chemical transformations, J. Geophys. Res., 118, 11,376-11,387, doi: 10.1002/jgrd.50807

Page 5, L18-19: I think both terms MLH and Hml mean the same. I suggest to use one term throughout the entire text.

Page 5, L22: Please define what "width" would mean exactly: horizontal or vertical?

Page 6, L9: Please define what is meant exactly by "secondary material"?

Page 7, L1-3: "These data....in whole Germany". Is this statement important in understanding the contents of the paper? I suggest to remove it.

Page 8, L4: What "information" is exactly meant?

Page 8, L6: Suggest to remove ", which is one hour different to UTC.", as UTC is not being used in the paper.

Page 10, L16: Please explain what is actually meant by "cross-platform" here, and why it would be helpful?

Page 15, L26: "Concentration measurements" of what?

Page 15, L30: "The latter...(Pappalardo et al., 2014)". Please explain the schedule of EARLINET and explain whether the BAERLIN approach was important for the EARLINET approach or the other way round (which is more likely).

Page 15, L32-33: Please mention that these specific COBOLT results refer to the entire campaign period.

Page 17, L11-12: What is exactly meant by "All measurements are performed under ambient conditions"? They way it is written it would mean that the air quality station was not air-conditioned.

Page 17, L18: I think this "significant horizontal heterogeneity" refers to surface mea-

surements here. Please clarify.

Page 17, L15-16: What is exactly meant by "inorganic species": gas-phase, particle bound or both?

Page 17, L17: The reference "von Schneidemesser et al., 2017" is still in preparation and therefore not citable.

Page 17, L17-18: "Here we do not discuss these topics...". In this case please remove the preceding L13-17 as they are not within the scope of this paper.

Page 18, L26-28: What is the justification for using these different correlations? The statistically most reliable quantity would be the median anyway, as it minimizes the impact of outliers. This is in particular true for such a quantity as PM10, which is mostly primarily emitted.

Page 20, L23: "...with a lot of vegetation, a high density of buildings...". This sounds like a contradiction: where there is high density of buildings how can there be lot of vegetation at the same time?

Page 20, L17-18: The authors mention aerosol formation. Would PM10 data provide any indication for aerosol formation? If so, please explain.

Page 20, L17: The authors mention that relative humidity may have an impact on PM10. Would PM10 concentration decrease or increase with relative humidity?

Page 21, L1-2: What classes in addition would the authors recommend?

Page 21, L2-4: This statement is obvious and has been considered in many urban air quality networks over many decades.

Page 21, L31 - Page 23, L5: It is well-known that O3 can be mixed from the residual layer into the convective layer, also for the case of Berlin (e.g. see BERLIOZ special issue in the Journal of Atmospheric Chemistry 42, 2002). The excellent correlation of the MLH with ozone in urban areas may not be surprising at all, as both processes are

ultimately driven by incoming solar radiation provided there are sufficient precursors for O3 formation available. In other words the relation between the MLH and O3 is apparent, but not causally determined. This should be mentioned.

Page 24, L7: "Whether ...studied". I suggest to remove this sentence. It is obvious that the potential impact of the MLH on ambient concentrations decreases with decreasing distance to the corresponding emission source.

Page 24, L13: As I remember Xu et al. (2011) do not report MLH observations and thus no correlation with primary or secondary pollutants.

Page 25, L10-12: I guess it is well-known that there is not one only parameter which controls surface concentrations.

Page 25, L27-28: In their paper the authors have tried to argue that MLH is not the only parameter which controls surface pollutant concentrations. Why then would it be of interest to perform a winter study in Berlin and why is it of importance that PM10 concentrations are 50% higher in winter compared to summer in Berlin. If there is no consistent correlation of MLH with PM10 in summertime why should it be different in wintertime?

Page 26, L4-6: The authors state that MLH data is beneficial for box-model calculations and validation of chemistry transport models. While I would agree on the authors' statement in this sentence I do not completely understand what the authors' justification would be for this, since according to their paper the authors largely argue that there is no consistent correlation of the MLH with air pollutants. This should be clarified.