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Atmospheric Chemistry and Physics Discussions

Interactive comment on "BAERLIN2014 – The influence of land surface types on and the horizontal heterogeneity of air pollutant levels in Berlin" *by* B. Bonn et al.

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We thank reviewer 2 for the time spent and the encompassing and supportive comments to improve the presentation a lot. As done for the other review, the reviewer's comments will be discussed below and our changes to address the comments in the manuscript are described below.

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General

The reviewer points out that the length of the study and its presentation structure should be modified, i.e. shortened and condensed to make it relevant for a larger community and number of readers. This is certainly true.

Structure

The general comments are reflected in this paragraph. I agree with the reviewer that results and discussion section of 14 pages may be too long and should be shortened. So we'll do that. The structure of "Results" shall be focussed on and condensed to (individual) gases, particles (number concentration and mass) and land use types. Different measurement platforms won't be separated anymore and will be part of "individual gases" and "particle properties". Because this article is supposed to be on overview presentation on the "mobile" campaign part, which was designed to elucidate the effect of urban vegetation on pollution levels, the individual sections can and will be cut down to focus the text, concentrating on the major findings. However, we find that the key features, i.e. the influence of different land usage types on pollution and the horizontal heterogeneity, should be kept. In relation to later comments regarding the land use classifications and how they are applied, we will lump certain land surface usage types to more general classes.

Objectives

There is probably a misunderstanding in the word "objectives" as the four aspects listed were named as parts of the objectives not as all-encompassing. No project can

do so. "Objectives" is meant more in terms of big picture research questions. To avoid this confusion, we suggest reducing the present list to three points, making their focus more specific and add one specific that was requested in the comments later on:

1. *"Heterogeneity of* ***particle number and mass concentrations throughout the city characterized by different sources and sinks including green areas.***

   This will be extended by a further study dealing with the bicycle measurements and their classification by the camera, which is in progress since some months due to the large amount of video material acquired.

2. Influence of green spaces/areas on urban pollutants (NO_x, VOCs, ozone and particles) levels;

3. *Contribution of anthropogenic and biogenic organic compounds on particulate levels and on ambient ozone;*
   and

4. **Provide support for the city authorities for future action plan development to improve air quality.**"

   The present study is one of two overview articles on the BAERLIN2014 campaign addressing the mobile observations and analysis, while the second (von Schneidemesser et al., in prep.) will focus on the stationary measurements and source apportionment. The investigation of the link between NO_x, different VOCs and SOA was split off to a box model study and will be described in a further article."

Hopefully this would make things easier to follow and better tracked by the current and potential future papers planned from the study. In order to do so point (1) will be

addressed exemplarily by selected single bicycle and van measurement tracks with a reference to the future bicycle study. This was the aimed at so far previously but will be concretized focused to make it more clearly. Point (2) is being covered in the section about VOC-canister samples at distinct characteristic sites as well as by mobile van measurements of NO_x and ozone with consideration of bicycle, van and air-borne measured particle concentrations. Point (3) is discussed as noted by the reviewer in the "Results and discussion" section already. Although this could be more extensive, the further analysis details are expected to be presented in a further particle focused study. A further change because of the newly shaped foci of this study will be the structural change (see above comment) (a) observations of pollutants and (b) discussion not separated but combined. Based on our three different objectives the observations will be presented and discussed: (1) Differences of pollutants in green and non-green areas/spaces including the heterogeneity, (2) Influence of green areas/spaces on particulate pollutants and its heterogeneity in space and time as well as (3) a conclusion the contribution of anthropogenic and natural sources to particulate levels.

Landcover

The comment on skipping or improving the landcover analysis is a critical issue that has been discussed among the co-authors significantly, including the investigation of a variety of alternatives for more than a year and is worth discussion. While the resolution is fairly low (100m x 100m), which is critical for more detailed analysis, it is the only data directly accessible, reliability checked and including the information needed for analysis of the datasets obtained. In addition, it is used in other applications (Statopoulou and Cartalis, 2007; Janssen et al., 2008; Tomaselli et al., 2013). Geographical street maps (e.g. www.openstreetmap.org) were accessed but were lacking much of the information on green spaces that was available in CORINE, i.e. the one used, despite the lower resolution and year. The format (polygons) was found incompatible with the

database of GPS coordinates created. As the land cover refers to the major point of this study, i.e. the influence of green spaces, which change more slowly than buildings, we chose this map however with notable care not to interpret aspects beyond the range of significance and discuss where evidently overlapping effects occur and affect the results. The significance of the effect of individual land cover types would certainly increase the higher the resolution and the better the distinction between different types. But so far this is not possible. While the land usage type classification was done for 2006, i.e. 8 years before the project start, some changes will have occurred (buildings, building areas etc.) but much less so in green spaces, and even less so in large green spaces, such as Grunewald, a large forest area where many of the bike routes passed through. Those require substantially more time and small effects will become more obvious in the analysis of the bicycle data and its video files recorded. For this reason, the CORINE map classification was determined to be sufficient for an initial analysis.

1 Uncertainties

*Uncertainties are always a key aspect of the reliability of data. Again we would like to stress that we (i) listed all the available measurements with instruments and their corresponding range of uncertainty and that we (b) have performed different calibration actions to exactly elaborate this aspect. As mentioned in the text on p. 37, l.12-13 all particle instruments except the DiSCmini were calibrated a priori at the Leipzig Institute for Tropospheric Research, i.e. the World calibration centre for aerosol measurement calibration. The DiSCmini instrument was checked and calibrated at UBA in Langen. This latter "instrument" mentioned in the text without DiSCmini will be corrected and "**DiSCmini**" pasted in as it got accidentally dropped as the text was rearranged during the writing. In line 12 all particle instruments will we named in brackets: "**(GRIMM 1.108 (2x), GRIMM 5.403, GRIMM 5.416 and TSI 3550 NSAM)**". Some measurement techniques and instruments were calibrated by chemical standards (PTR-MS, canister*

sampling with GC-MS analysis) and cross-checked with the local continuous measurement of the BLUME network at Berlin-Neukölln (benzene, toluene). The DiSCmini, which was the only particle instrument not calibrated in Leipzig but in Langen, and the GRIMM 1.108 were compared regularly during the stops at the station in Neukölln with stationary measurements by GRIMM 5.416 and the stationary GRIMM 1.108 for about 20 min. The later comparison was operated by two calibrated instruments i.e. the stationary GRIMM 1.108 and the mobile GRIMM 1.108 (bicycle) that were calibrated a priori in Leipzig and checked thereafter, which no significant difference. Furthermore van and bicycle measurements were cross-checked in two joined tracks i.e. cyclist ahead and van following. Comparison figures (temporal lines and scatter plots with identical averaging time slots) will be provided in the supporting online information (SOI). We agree that different particle measurement techniques (gravimetric and optical) for particulate mass provide different results is based on the assumptions that a certain aerosol particle composition, used for calibration and applied for anywhere else in future usage, implies. We will insert a sentence on this in the "methods" and "results and discussion" sections each, when dealing with the particle instruments as results of both techniques are used in here. With respect to the source speciation of the aerosol particle mass we agree to include a discussion about the results from Kiesewetter et al. (2015), which are not contradicting completely but focus on a broader approach with similar assumptions for entire Europe and on the entire seasonality. Please note that we focussed on experimental studies at a single location and not on model challenges in here. We mentioned that a substantial particulate mass contribution is deriving from local sources for the time of study (June to August 2014), while the Kiesewetter et al. (2015) study investigated entire Europe on the seasonal scale and averaged. Other studies such as Kerschbaumer (2007) indicated remarkably contributions of PM from the industry of Southern Poland during winter time. This was probably not found because of a different meteorology during summer (westerlies) compared to winter time (easterlies). An accompanying study (von Schneidemesser et al., in prep) on the stationary measurements will deal with a principal component analysis on sources even

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further, for which a reference will be set in this study in order not to overstretch the length.

Specific points

Abstract, p.1, l.19:
Ozone and particulate matter were referred to because of the aim of this project, which was focused on the role of green spaces in ozone production. NO_x is certainly important especially in areas affected by traffic, industry and burning processes, and was measured but not the main focus of the study.

p.1, l.23 30: *OK.*

p.1, l.33: *We are not really sure about the comments meaning, i.e. "max, mean", which were not used there. The temperature and particulate levels measured by bicycle platforms displayed significantly lower i.e. reduced values in vegetated areas. This can be classified by mean+/-standard deviation as well as median, which was done in the boxplots provided later on. We will reformulate this particular sentence to rule out misunderstanding.*

p.1, l.36: *'pointwise' addresses the measurement method by canister samples and analysis later on in the lab. As this particular method could not be applied all the time representative points were selected and during the tracks one or several samples were taken.*

p. 2, l.1/2: 'scale of one hundred meters':

The individual measurements were compared to other measurements in the surrounding area for a radius of 100 m. Therefore, for any data point sampled the observations in a spatial area of 100 m distance and time within ±1 min were extracted individually and correlated. We'll change the current form to 'For example, ***moving average*** *concentrations of the traffic related chemical species CO and NO varied by more than ±20% and 60% over the distance of one hundred meters* ***around any measurement location****, respectively.'.*

p.2, l.3: *Regarding the particulate mass observations and uncertainty of observations we refer to two identical observations, i.e. the calibrated GRIMM 1.108 as stationary and mobile instruments. Both applied spectroscopy as measurement method, no gravimetric methods. While the different methods can certainly cause differences in absolute numbers, this does not apply for relative measures as given in this sentence with two identical measurement instruments.*

p.2, l.7: *'facilities for sports and leisure' refers to the CORINE classification. Of course this includes a variety of different surfaces with different impacts. Thanks for the remark. Any classification type, i.e. based on meteorology, biology or productivity will cause a shortcoming in one of the other areas. As noted above we suggest lumping the individual types to more general types with less information but a larger set of data. Furthermore, to address issues with the method, we are removing this category as it has fewer data points and is less robust than some of the other categories.*

Introduction, p.2, l.17: *Skipping 'already' is OK.*
p.2, l.27-33: *Yes we can and will. The sentence got too long and will be split into two. An additional sentence, explaining 'oxygen capacity' as '****the maximum quantity of oxygen that will combine chemically with the hemoglobin in a unit volume of blood [free medical dictionary, accessed April 25th 2016] and that can be used***

***by the body for brain and physical working**' will also be added.*

p.2, l.37, ' 'As held by the ...' this formulation is a bit awkward, could you rephrase the sentence, best switch it around to start with "Establishing such air quality programs ...': *Will be changed to 'Establishing such air quality programs is a subjective right of any person directly concerned and can thus be claimed by citizens in court (Janecek v. Bayern, ECJ, 2008).'.*

p.3, l.3: *Missing space will be added. Thanks.*

p.3, l.6: 'Correct, the expression derives from German to English translation.': *This will be corrected.*

p.3, l.9, "In consequence ...' not a good start to a sentence': *The expression 'in consequence' will be dropped and the sentence shall start with 'Berlin, like every. . .'.*

p.3, l.11, 'suggest to drop or reformulate 'respective' delete, not necessary here': *Will be changed to 'The Senate of Berlin **thereto** adopted a **clean air** program for 2011-2017 (Berlin Senate, 2013b).'*

p.3, l.11, "limit values continues to' - remove plural s from continues': *Will be done*

p.3, l.12, "contained herein' reference is not clear, suggest to reformulate the phrase': *Will be changed to '. . ., it is questionable whether the **intended** measures are sufficient*

to enable Berlin to comply with this obligation.'

p.3, l.15-18, 'another long sentence, suggest to break it up':
*Changed to 'This measure was **intended** to lower traffic related emissions and the **annual** number of critical threshold exceedances according to EU law for NO_x and PM (see Table 1) in Berlin. **It** resulted in an emission reduction by 20% for NO_x and 58% for soot by diesel engines (Berlin Senate, 2011).'*

p.3, l.18, "has been claimed to' ... by whom? where? only one 2007 reference is provided, but long range transport contributions to PM10/2.5 have been subject to a lot of most recent literature, which should be referenced and acknowledged': *Agree. But this study was focussed on the Berlin-Brandenburg area, for which only this particular study was available so far. Oher studies using coarser resolved models may not be easily transferable. However, we will reformulate the particular sentence and add the following information to that: 'The study by Kerschbaumer (2007) has claimed a substantial contribution to NO_x and particulate matter (PM) by long range transport from Polish industrialized areas. Several studies (Kiesewetter et al., 2015; Amato et al., 2016) conducted elsewhere supported this claim, while others (Petit et al., 2014; Mancilla et al., 2016) contradicted and identified local sources to be dominant.'*

p.3, l.23, "Due to their provision...' this sentence does not logically follow from the previous, I suggest to introduce a new paragraph here, or link it better':
Will be done as follows: We will start a new paragraph and improve the link of both sentences. 'These vegetative areas are supposed to have notable effects on temperature and air quality. Therefore, increasing green areas such as parks and forests are often considered as measures to counteract urban heat island effects (Fallmann et al., 2014; Grewe et al., 2013; Schubert and Grossman-Clake, 2013) and air pollution problems (Irga et al., 2015; Janhäll et al., 2015).'

p.3, l.36, ”the presented study tries to support city authorities’ - does this refer to the paper, then it is yet another objective not introduced before, but if it refers to BAERLIN2014, this needs to be clarified’:
Thanks. The support is provided as expertise to the collaborating partner ’Senate of Berlin’ and is basically included in the foci mentioned. In order to clarify this we will be named in the list of foci of this study. But please note this study in one of two overview articles on the BAERLIN2014 project, with the second one (von Schneidemesser et al., in prep.) dealing with the stationary results. This latter study will be of most interest for the Senate as it was bound to a monitoring station. The present one will provide information about the differences across the urban area, effects of green areas/spaces and sources.

p.3, l.36-37, ”supporting authorities’ is mentioned twice, so trying to support authorities by supporting authorities?’:
? We’ll clarify that by reformulating the sentence: ’The aim of this study was to identify hotspots of pollution, the variability of basic air pollution trace gases, to quantify the impact of green areas and to exemplarily identify dominant VOC sources to support future development of action plans by the Berlin Senate with improved success.’

p.4, l.3 ’and a hub for major transport routes’ better ’a major European transport hub’:
Will be done.

p.4, l.7-9 ’impact on pollution levels ... and thereby on pollution levels’ please check, this seems a circular reference here’:
Indeed. Corrected. Thanks.

p.4, l.9 ”generally meet the EU limit values’ - how does this relate to the adverse health effects outlined in the introduction before? I do not challenge the fact, but it would better be explained a bit more to the audience, as a reader could feel that if limit values are widely attained, why is there a problem to investigate?’:
Will be done in more detail.

p.4, l.12 ”and transport of’ better qualify this as ’atmospheric transport" or "long-range transport’ to distinguish from road transport activities’:
Will be changed to ’regional and long-range atmospheric transport of’.

p.4, l.16-19 ’why is this text set in italics? is this a quote, then by which source, or is this a key statement, then it is not founded anywhere in the current text. Suggest to remove, put in a box and explain, or add further reference.’:
This was used to emphasize. We will remove the italics.

p.4, l.23-30: ’I take it these are the objectives of BAERLIN, but it is somewhat confusing, so I would suggest to make these rather explicit and refer them to the overall study objectives of BAERLIN, which could e.g. be put in suppl. mat., otherwise it may confuse the reader quite a bit.’:
Yes, they are. See as suggested above in the ’Objective’ part.

p.4, l.38 ’the reference to identifying dominant VOC sources to support action plans for the Senate seems to be a bit unrelated to the overall paper, with the exception of the canister studies, so wondering if this needs to be here, or should rather be in the conclusions as one potential area that the results of this paper could be used for¿:
We will add a sentence to the conclusion section as this VOC speciation affects ozone, PNC and PM production. The relevance of certain species with respect to those

aspects will be named in a short sentence.

p.5, l.8: 'aircrafts' - remove 's': *OK.*

p.5 l.14-19 'I would suggest not to use 'mesoscale' here, which in my view is not quite right with the scales addressed by the different studies? Or explain what you explicitly mean by the terms in this context?':
We will explicitly describe the resolution of observations expressed by the different scales and the major focus for using that particular platform. Thus when 'mesoscale' is used so far a suburb or city area is meant (resolution of hundreds of meters to tenth of kilometres), while microscale expresses street canyon and finer resolution (meters to tenths of meters). This will be named accordingly in the future version of the text.

p.5, l.28 "that cars cannot' reads a bit awkward, could you rephrase e.g. as 'areas that cars cannot enter'?':
Done.

p.5, l.32 "particulate values' here and subsequently, could you make sure to be very precise what 'values' you are referring to, as both PNC, PM mass and other parameters are used in the study?':
Sure. Two brackets including the individual parameters for the bicycle measurements have been added to the text: "...quantifying meteorological ***(temperature, relative humidity)*** *and particulate values* ***(number, mass and lung deposable surface area concentrations)*** *are listed...:*

p.6., l.2 "Applied as well was ...' not a good start to the sentence, try to activate as much as possible, e.g. 'The optical particle counter GRIMM 1.108 () was applied for

...':
*Changed to '**We deployed** the optical particle counter ....'.*

p.6, l.5 'can you elaborate on the setup here, if the instrument was covered in a backpack or pannier, how was uninhibited constant airflow guaranteed? Perhaps add a picture of the instrument setups in the suppl. mat?':
Yes, both will be done. 'Backpack or pannier' expressed that instruments were provided to cyclists with different bicycles and they got the setup for either storing it inside the backpack (provided too) or in a pannier of the cyclists own equipment. An introduction how to set-up the equipment and which aspects to take special attention for was given to each participant. This will be noted in the supplementary material and added in a single sentence to the text: '... were transported in a backpack or pannier. ***The inlets of the instruments were kept as short as possible (50cm each) and were mounted non-flexed at the top of the backpack or pannier, for which an explicit loss correction factor was derived before the start of the campaign.****'*

p.6, l.8, "Please find the detail ...' I would skip this sentence, not needed':
Those details are essential and we would prefer including the details of the instruments because of their methods and time resolution used for the results presented and discussed.

p.6, l.11, 'introduce IASS at first use':
This has been changed.

p.6, l.17, "while the sampling frequency ... was relatively high' how did you match time scales/steps for all the measurements and the GPS? This should be introduced somewhere early on as it will be rather variable across instruments and methods.':

Excellent remark. Will be done. The instrument with the highest time resolution was the GPS sensor (Garmin camera) and so an easy match was accessible for the range of individual measurement points. For comparing different instrument results the instrument with the higher time resolution was averaged for the same period as the time resolution of the coarser resolution.

p.6, l.27, "Location data was collected via GPS' and camera, this could be a means to derive contextual information, in addition to a time-activity diary? Was this considered?':
Yes. Especially for classifying the environment tested this needed to be taken into account. Time was always provided for the end of each measuring interval. However, for the match of GPS (1s) and instruments ($\geq$1s) this didn't matter much for the bicycle observations.

p.6, l.29/30, 'how was aerosol mass measured in real time, can you elaborate on this here, as it is rather crucial for the interpretation of the results, and not trivial to achieve.':
For real time measurements of the particle size distribution and the particle mass concentration an electrical low pressure impactor (ELPI, Decati Ltd., Finland) was used. A corona charger charges the particles which are then classified in a 12 stage low pressure impactor. The particle mass is then calculated for the different size bins (Keskinen et al. ,1992). To calculate the local background concentrations a 5% percentile filter with a time constant of 180 s was used (Bukowiecki et al., 2002; Pirjola et al. 2006; Urban, 2010; Ehlers, 2014)

p.6, l.33, "a specific track was carried out', suggest to reformulate, e.g. 'a pre-set route was followed' or similar':
Done.

p.6, l.35-p.7, l.5, 'the quantitative information would be better displayed in a table or graph than in the text here':
OK. Shifted to Table 4 and referenced in the text. Other table numbers renamed accordingly.

p.8, l.3, "Method of relative parameters' not quite clear, suggest to rephrase e.g. 'Method for deriving relative concentration parameters' or suchlike":
*Will be rephrased to '**Method for deriving comparable** relative **concentrations**'.*

p.8, l.29-32, 'again, time steps are mentioned here, but it is not clear how temporal resolution of the measurements has been harmonised/addressed, suggest to add a paragraph earlier on to address this.':
*In order to prevent further misunderstanding a small paragraph will be added explaining how the different temporal resolutions are harmonized according to the reviewers comment: '. . . at the corresponding time. **In order to harmonize the different time resolutions of stationary and mobile measurements the urban background measurements (reference) were averaged for 30 min intervals to exclude short term local effects. The corresponding stationary data point was selected in that way that the mobile time was assorted to the data point, in which 30 min time interval the mobile data point was included**. . ..'*

p.9, l.1-14, 'as indicated above, I am not convinced that at 100 m $\times$ 100 m the land use types can provide a meaningful basis for the analysis. My suggestion would be to remove section 3.5 entirely':
We partially agree on that and would have appreciated a better surface resolution map with the information needed. But contrary to the reviewers suggestions we want to have this part included and will reduce the number of surface usage types in order to investigate the difference between urban green spaces and areas covered sealed

surfaces (buildings, streets). Please see our feedback to some of the earlier comments regarding changes and adjustments we have made to revise the application of the method.

p.9, l.15ff: 'As indicated in the general comments, suggest to revise the structure of Section 4 overall.':
Correct. As noted above, we will condense this part and split results and discussion into two sections. This will be structured around the three aspects highlightened in the 'Focus' section.

p.9, l.29, 'the part on the leaf blower seems to be marginal and not related to the objective to derive more general insights into the spatial variability. Could you explain better why this is important, or remove that part? It does seem to be a rather specific issue.':
Indeed we have discussed about this aspect for long. Leaf blowers are meanwhile used in Berlin rather frequently and the results from measurements in its vicinity during running were such that a substantial influence of local air quality is to be expected. As those instruments were and are used in the context of removing biogenic material i.e. leaves etc. those are related to the indirect influence of the biosphere on air quality and pollutants although driven by mankind. Because of that we shifted it to the supporting online information document and will discuss it briefly in the discussion part to unravel potential origins of certain VOCs and PM, which sometimes display a strange behaviour. This seems likely to be caused by these kind of instruments.

p.11, L.35-37, 'first sentence on CO is giving a generic statement about similar patterns for all gases, I would suggest to carefully check the paper and remove these, as they are repetitious and generic. Furthermore, in the results and discussion, I would not go into as much detail to explain the general sources of CO and its formation in

urban environments, as done here, it just adds more text distracting from the valuable findings of this study.':
Will be done.

p.12, l.15, "BLUME station' may have missed this earlier, but could not find another reference to this station name, so best introduce earlier':
Thanks. Will be introduced at first notice. It refers to the 'Berliner Luftgütemessnetz' in English "Berlin Air Quality measurement network". An overview can be found at http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/de/messnetz/index.shtml unfortunately only in German.
p.13, l.1, "if and only if' please avoid such phrasing, it is not needed here to emphasise':
OK. Will be changed to 'if'.

p.13, l.14, "diesel driven' ... 'diesel consuming' remove driven/consuming, just 'diesel passenger cars/LDVs' is sufficient.':
Done.

p.13, l.16, "to the measured nitrogen dioxide mixing ratios' do you mean direct emissions of NO_2 from diesel oxidation catalysts? I would then make this more direct and clear, it is a bit back-to-front else.':
At least from diesel cars, yes. The study referred to was done 13 years ago and the techniques changed meanwhile so that the results published 2003 cannot be taken as quantitative but qualitative.

p.14, l.1ff, 'as indicated above, I am not convinced by the results based on the coarse land use type resolution, and suggest to drop this.':
As mentioned above, we would prefer keeping this in but reduce the number of surface

types and the length of the subsection. Again, see responses to previous comments.

p.15, l.32-38, 'again, a rather generic basic introduction to particulate matter, which I suggest to skip as it is not really necessary here, perhaps add one reference in a short sentence to introduce this?':
OK.

p.16, l.3, 'referring to 'small scale variation' here, which I think is fine and relates to my comments on micro/mesoscale wording earlier':
We will change the scale variations to physical dimensions 'from several meters to kilometres in spatial resolution'.

p.16, l.12, "mixed layer height' do you mean mixing layer? ':
Yes, actually 'mixing layer height' was measured in Berlin-Neukölln and the text will be changed in the text accordingly.

p.16, l.23, "applied for the' applied to? was applicable to?':
Excellent suggestion. Thanks.

p.17, l.6, "Particle mass concentrations ...' see comment above, could you elaborate somewhere how mass was measured, in the context of optical instruments being used':
OK. The text will be shortened to 'The observed PM10 and PM2.5 ***at flight level*** *were identical to concentrations observed at the city boundaries* ***at the surface*** *in Grunewald (west) and in Friedrichshagen (southeast) with concentrations between 9 and 10 μg/m3 (BLUME, von Stülpnagel et al., 2015).'*

p.17, l.15, ”on the regional and local scale’ see above, please use a consistent spatial reference for the different scales addressed’:
Will be changed to distances: ’Next we focus on surface bound measurements ***by van in Berlin and its surrounding area (radius of about 65-70 km)****.’*

p.18, l.6, ”particulate masses’ please be more accurate and specific in referring to parameters, particulate matter mass concentrations (of PM10? 2.5?) or PNC?’:
In this case this was used on purpose. PNC was not meant as it expresses particle number but not mass concentration. The observations applied not only to a certain PM group but were made for the different groups in a similar way. PM1, PM2.5 and PM10 displayed similar behaviour but the magnitude changed. We will change this to “Similar patterns but much more moderate increases have been seen for the different particulate masses (PM1, PM2.5 and PM10). As remarkable fractions of the PM10 particle mass are of secondary organic origin. . .”.
p.18, l.28, ”Please take into account ...’ I would suggest to drop such formulations, they just add words and no substance, rephrase to ’The measurements with the van were conducted by following ...’:
Good point. Will be done.

p.20, l.9ff, ’see above, suggest to drop the section 4.2.4’:
See comments made with respect to the land use types earlier. We agree on the challenge of 100m $\times$ 100m resolution. But there is currently no trustworthy usable digital map available to use and even that resolution allows some important findings, however to be applied carefully. An improved map is an important aspect for future investigations.

p.21, l.20ff, ”For most of the land use type classifications the differences between the van and bicycle measurements agree within the associated uncertainty’ what is the

associated uncertainty and how is it derived?':
*The uncertainty is treated as statistically uncertainty expressed in the boxplots by the notches made with R. Those represent the range of ±1.58 the interquartile range divided by the square root of the number of observations. They match approximately the 95% confidence interval (Chambers et al., 1983) and are independent of the underlying distribution (normal, Poisson etc.). No overlap of two boxplots within the range of the corresponding notches represents a significant difference between both measurements. We will add three sentences to the methods section 3.5 about this to make it clear: 'A significant difference in the medians of two different categories is determined at confidence interval of 95% using the approach by Chambers et al. (1983) of ±1.58*IQR/ïČŰn. IQR is the interquartile range and n stands for the number of data points considered. This formulation is independent of the underlying statistical distribution and is provided in the figures as notches.'.*

'Due to the short term of the measurement campaigns, the conclusions on the heat island effect would likely need more supporting work. Not sure if a discussion of the heat island effect here in this paper is necessary, and the caveats are outlined already in the text following on the same page. Consider shortening or removing? For a more thorough comparison, looking at the share and distribution of green space areas in different cities would be essential, in my opinion.':
We will provide a plot in the supplementary material but will skip it from the article itself.

p.22, l.8, "characterise air quality on multiple scales' I think this is a bit of a leap, the study very well demonstrated the capability of mobile measurement platforms to quantify specific air pollutant concentrations, in a one-off campaign based mode, so perhaps better stick to this in the formulation?':
OK. Let's take that: 'The mobile measurements with bicycle, van and air plane/glider as part of the BAERLIN2014 measurement campaign has demonstrated the ability of

integrated measurement platforms to characterize air quality in the presented one-off campaign mode.'

p.22, l.9, "large geographical area' related to earlier comments on consistent reference to spatial scales, 'large' is relative and best quantify here 'an area covering X square km'?':
Yes. Will be changed to 'Van-based measurements were used to cover a circular area of about 65 km in radius in and around the city of Berlin, while. . .'.

p.22, l.17/18, "elevated air pollutant concentrations found in Berlin were most likely produced in the vicinity of the observation and originated from local pollutant sources" – while I accept this for NOx and CO, I am yet to be convinced by the findings presented here that this is the case for PM2.5, which would require a discussion of the chemical composition of the PM observed and a look at the regional-scale atmospheric transport processes; previous material presented by the Senate of Berlin indicated a substantial amount of PM originating from long-range transport, and recent literature has shown this for Europe in general and several European cities, so the role of ammonia and secondary inorganic aerosols should be more thoroughly assessed before this claim can be substantiated.':
Disagree to a certain extent. If particulate mass values increase from 8 $\mu g/m^3$ at the city boundaries to 17.2 or 31.8 $\mu g/m^3$ for the van measurements as smoothed baseline or all values during the passage throughout the city, we can draw the conclusion of elevated pollution levels to be caused locally during the time of observation. The latter should and will be emphasized. The chemical composition is nice to know but not necessarily needed for general conclusion. Detailed investigations would be favoured but were out of the scope of the presented project. We would be very keen on learning more about this in a future study. Anyway, we will add the additional phase 'during the period of observations elevated air pollution levels were found to be very likely

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originating from local sources.'.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-57, 2016.

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