Atmospheric
Chemistry
and Physics

EGU
Open Access

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.

Anonymous Referee #2

Received and published: 27 March 2016

The Discussion Paper by Bonn et al. provides a very comprehensive assessment of a wide range of measurements conducted during the BAERLIN2014 campaign. It is very timely and relevant as it combines measurements using different mobile platforms and instruments to address key issues related to the spatial variability of urban air pollution.

In its current form, however, I see some shortcomings with regard to structure and presentation which I feel need to be addressed to make the paper accessible and relevant to a wider scientific audience. I hope that the following general and specific comments support this process, as I would like to see this paper eventually published due to its undisputed contribution to the current scientific discussion.

Structure The paper covers a lot of ground: 3 different mobile measurement platforms

(bike, van, aircraft) plus canister measurements; VOC speciation, particle number counts, atmospheric trace gases, both secondary and primary pollutants ... This is reflected by the structure and - not to forget - the length of the paper and is one challenge the authors need to address. Primarily in Section 4, it becomes obvious that a clear, concise structure to relate these different topics in an accessible way is difficult, which adds to the whole section being quite hard to read: structured by trace gases, then individual gases in 4.1.x, then Land use type influences (4.1.5), while in 4.2 addressing particulate pollution, the structure is done by type of measurement platform. There are different approaches conceivable, including splitting the paper up into two, either by method, pollutant or into approach/methods and application/results. Ultimately, the Results and Discussion section over 14 pages of length needs to be revised structurally to present a more clear pathway for the reader and to better highlight the important aspects. In addition, a suggestion would be to consider omitting the land use type classification and temperature sections, which could be moved to Suppl. Mat or dropped (see below).

Objectives The paper identifies the following objectives in Section 2, which it sets out to address: (1) What is the spatial and temporal heterogeneity of pollutants in the BBMA area with a focus on Berlin and Potsdam? (2) How do different vegetation types influence the levels of ozone, NOx and VOCs in Berlin? (3) What is the impact of different types of vegetated areas on urban environmental conditions i.e. temperature, humidity and particulate pollutants (number and mass)? (4) And finally what is the contribution of anthropogenic and biogenic organic compounds to secondary organic aerosol and the total particulate mass in the Berlin and Potsdam area affecting health, both directly and indirectly through ozone production?

In my opinion, these should be revised and are currently a bit too ambitious, as in the current version, the paper addresses (1) partially (to assess temporal heterogeneity, the duration of the measurements is too short in time and not sufficient in my view to adequately capture temporal variation in both space and across seasons, time of day,

day of week etc.). For (2), the use of the 100 m 2006 CORINE landcover maps are not sufficiently detailed, so I would suggest to either address this (see below), or omit this objective. (3) is addressed in the discussions , but does suffer a bit from the spatial resolution of the landcover mapping. (4) finally is well addressed and in itself a vital question to cover, as well as possible to discuss with the measurements undertaken to a large extent. Following from the objectives, the authors qualify these further, which I feel is not necessary once the objectives are clearly laid out and revised. One note, the "aim of this study is to identify hotspots of pollution" (P4L36), this is not really included in the objectives and given the obvious limitations of the spatial coverage, I would suggest to remove this. It is without doubt a valuable thing to do, but the value of this study is not in comprehensive spatial coverage of the city (or parts of it), but the addressing the variability of the pollution fields with different methods and measurement platforms.

Landcover As indicated above, my concern with using a 100m landcover map to derive robust classifications for urban land use/cover and how it affects local pollution levels at a very high resolution (both van and bike measurements allow for a very high temporal and thus spatial resolution of pollution variabiltiy) is not adequate. Street canyons and street vegetation, as well as local parks and green spaces in Berlin will likely affect the microclimate and pollutant dispersion at a spatial scale well below 100 m, so the uncertainties introduced by using this dataset have to be expected to be significant. Furthermore, the question in how far the 2006 LCM reflects the 2016 situation needs to be addressed, as the 2006 maps will be based on imagery that might be even older? To remedy this, I would advise to either drop this part from the paper (it is already substantive enough to stand alone without this analysis), or use a different, more up-to-date and spatially resolved resource to analyse the landcover in the area under investigation. Aerial photography and alternative land cover information (e.g. Open Street Map) on the one hand will likely be freely available through GIS resources, so this should not be a major issue. On the other hand, the use of the camera on the bikes would offer a more immediate resource to classify the immediate surroundings,

including density of buildings, street-canyon situations and other influencing factors not immediately available from land cover maps (construction sites, local changes in layout or buildings etc.). I appreciate that this would need more work, thus suggesting that the influence of land cover on the variability of pollution perhaps needing its own paper to be adequately addressed.

Uncertainties The paper addresses a range of measurements using different instruments, which is inevitable, but will require a discussion of uncertainties arising from the differences in instruments and measurement techniques. One aspect, which is not addressed currently, for instance is the issue of deriving (indicative?) particle mass concentrations from optical instruments (or has gravimetric analysis been done on the GRIMM filters, which would then obviously cover longer periods, not allowing easily for a detailed temporal allocation of particle mass?). In addition, the potential contribution from long-range vs local sources has been raised in the paper, with the conclusions seeming to contradict recent literature (e.g. Kiesewetter et al. 2015, doi:10.5194/acp-15-1539-2015; Vieno et al. 2016, doi:10.5194/acp-16-265-2016) identifying a substantial contribution of long-range transported ammonium nitrates and -sulphates for large parts of European PM2.5 and PM10 concentrations, so a discussion of chemical speciation of the aerosols measured would need to be included to justify and support this claim.

I hope these general comments support the revisions, together with the following specific issues: Abstract: -P1L19 ozone and particulate matter are specifically mentioned, but not other trace gases, in particular NOx, why? -P1L23 "between the June 2nd" - remove "the" -P1L26 "compounds and particulates and..." - suggest using a comma first, then 'and' -P1L33 "reduction of temperature" - specifically which, max, mean? -P1L36 "pointwise" unclear what you mean here, specify please -P2L1/2 "on the scale of one hundred metres" this is rather unclear, please elaborate your spatial reference -P2L3 "mass concentrations being local" - see comment under 'Uncertainties', not sure this claim is so far well supported by the paper as it stands. -P2L7 "facilities for sports and

leisure" how do these influence concentrations specifically? are you referring to open fields, or swimming pools and sports centres, which would likely have very different influence

Introduction P2L17 "are already causing" - looking at emissions of air pollutants in the Western developed countries, the peak of NOx and other pollutants was in the 1980-2000 period, so air pollution has been causing health effects for a while. Suggest to drop "already". P2L27-33 This is one long and complex sentence which I suggest to split into 2 or 3 parts. could you briefly introduce "oxygen capacity" for a more general audience P2L37 "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 ..." P3L3 space missing before "As a..." P3L6 "... can sue for an adjustment..." is rather German, perhaps better "can take legal action" or similar? P3L9 "In consequence ..." not a good start to a sentence, suggest to drop or reformulate P3L11 "respective" delete, not necessary here P3L11 "limit values continues to" - remove plural s from continues P3L12 "contained herein" reference is not clear, suggest to reformulate the phrase P3L15-18 another long sentence, suggest to break it up P3L18 "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 P3L23 "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 P3L36 "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 P3L36-37 "supporting authorities" is mentioned twice, so trying to support authorities by supporting authorities? check and revise, please P4L3 "and a hub for major transport routes" better "a major European transport hub" P4L7-9 "impact on pollution levels ... and thereby on pollution levels" please check, this seems a circular reference here P4L9 "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

C5

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? P4L12 "and transport of" better qualify this as "atmospheric transport" or "long-range transport" to distinguish from road transport activities P4L16-19 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. P4L23-30: 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. P4L38 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? P5L8 "aircrafts" - remove 's' P5L14-19 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? P5L28 "that cars cannot" reads a bit awkward, could you rephrase e.g. as "areas that cars cannot enter"? P5L32 "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? P6L2 "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 ..." P6L5 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? P6L8 "Please find the detail ..." I would skip this sentence, not needed P6L11 introduce IASS at first use P6L17 "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. P6L27 "Location data was collected via GPS" and camera, this could be a means to derive contextual in-

C6

formation, in addition to a time-activity diary? Was this considered? P6L29/30 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. P6L33 "a specific track was carried out", suggest to reformulate, e.g. "a pre-set route was followed" or similar P6L35-P7L5 the quantitative information would be better displayed in a table or graph than in the text here P8L3 "Method of relative parameters" not quite clear, suggest to rephrase e.g. "Method for deriving relative concentration parameters" or suchlike P8L29-32 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. P9L1-14 as indicated above, I am not convinced that at 100 m x 100 m the land use types can provide a meaningful basis for the analysis. My suggestion would be to remove section 3.5 entirely P9L15ff As indicated in the general comments, suggest to revise the structure of Section 4 overall. P9L29 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. P11L35-37 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. P12L15 "BLUME station" may have missed this earlier, but could not find another reference to this station name, so best introduce earlier P13L1 "if and only if" please avoid such phrasing, it is not needed here to emphasise P13L14 "diesel driven" ... "diesel consuming" remove driven/consuming, just "diesel passenger cars/LDVs" is sufficient. P13L16 "to the measured nitrogen dioxide mixing ratios" do you mean direct emissions of NO2 from diesel oxidation catalysts? I would then make this more direct and clear, it is a bit back-to-front else. P14L1ff as indicated above, I am not convinced by the results based on the coarse land use type resolution, and suggest to drop this.

P15L32-38 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? P16L3 referring to 'small scale variation' here, which I think is fine and relates to my comments on micro/mesoscale wording earlier P16L12 "mixed layer height" do you mean mixing layer? P16L23 "applied for the" applied to? was applicable to? P17L6 "Particle mass concentrations ..." see comment above, could you elaborate somewhere how mass was measured, in the context of optical instruments being used P17L15 "on the regional and local scale" see above, please use a consistent spatial reference for the different scales addressed P18L6 "particulate masses" please be more accurate and specific in referring to parameters, particulate matter mass concentrations (of PM10? 2.5?) or PNC? P18L28 "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 ..." P20L9ff see above, suggest to drop the section 4.2.4 P21L20ff "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? 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. P22L8 "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? P22L9 "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"? P22L17/18 "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. P22L27-32 could you quantify the 'significant' influence of vegetation on pollutant concentrations? Was it statistically significant? Contribution of isoprenes and terpenes to local ozone formation, was this quantified in the study, or is this derived from models/previous knowledge? The second half of this statement on urban vegetation is more robust and accepted. P22L33-37 again, the resolution of the land use maps considered makes this statement harder to justify, in addition, urban airflow patterns and complex terrain influences on wind and dispersion would need to be taken into account adequately, which is not within the scope of this study for good reason. Perhaps this section needs to be qualified a bit to reflect these caveats.

Figures: - general point, consider making the background maps slightly less vibrant to better bring out the colours of the measurements, in particular the orange and yellow shades are hard to see. - Fig 6: add more legible legends to the graph - Fig 8: what are the units for the upper graphs, please add to the legend

Tables: Table A1: formatting of the table makes it a bit hard to read, i.e. alignment and space between columns; time resolution is variable for the instruments, relating to the comments made above on time-synchronisation

ANNEX: A2L12 "All particle instruments except the instrument were ..." which 'instrument' are you referring to? Figure B1: add the unit to the legend in both cases Table C1: This table is rather dense and could considered to be more accessible as a bar chart? Figure C2: map zoom and focus is different, making a direct comparison between PNC and mass concentrations difficult, for no reason? suggest to make sure

that both maps show the same area

REFERENCES For a paper of this substance, some of the recent literature in particular with regard to urban PM seems to be missing, e.g. from the CLEARFLO project (http://www.clearflo.ac.uk/outreach/papers/), as well as those on long-range transport contributions and composition of urban PM (see specific comments).

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