Authors' responses to reviewer's interactive comment on "A Database of 10 min Average Measurements of Solar Radiation and Meteorological Variables in Ostrava, Czech Republic" by Marie Opálková et al.

Dear Anonymous Referee,

we thank you for your evaluation of our manuscript and valuable comments. We have taken each of your comments and suggestions into account. We brought answers and changes to text to satisfy your concerns. Below, we respond to each concern and comment. Your text is reported in this document in bold, our answer is in italics.

Yours faithfully,

Marie Opálková et al.

General comments: This paper presents a newly set-up database of solar radiation plus few meteorological and pollutants measurements carried in Ostrava, NE of the Czech Republic. This database has been built by scientists from the University of Ostrava in collaboration with French scientists which expertise in the area of solar radiation measurements and analysis is acknowledged. The sites, sensors used and their maintenance, and the quality checks performed on the raw data and their results are detailed. In particular authors propose a new procedure for checking the quality of irradiances in specific spectral bands which is an adaptation of procedures used for QC of total irradiances.

Specific comments: As I'm not an expert in solar radiation data QC I can not fully judge the validity of the new procedure proposed. I therefore mainly comment on other aspects as rationale, statistics, and form.

Rationale: The stress is put on the utility of the measurements set-up as a mean to understand the impact of variations in solar radiation, especially those related to atmospheric pollutants, on vegetation in Ostrava. Have the authors any idea of the surface of the city, presented as industrial, occupied by vegetation and if this is less, in the average or more than similar cities?

Yes, we have more information on the city of Ostrava, mostly found in bibliographical references listed at the end of this document.

Information about the public green areas in the Ostrava city was found in [1]. The Urban Atlas [2] published by the EEA contains detailed geographical data obtained from satellite. Using the special programme, each piece of land was assigned to a total of 21 categories (e.g. industry, agricultural land, roads, etc.). According to EEA, there could be two kinds of public green areas in the cities: either visibly maintained green areas and green areas used for recreational purposes (i.e. parks, but also zoological or botanical gardens), or higher vegetation without traces of recreational use (forests). Only green areas which were publicly accessible and at least ten meters wide were counted. Information about borders of 13 Czech county towns was added to these geographical data and the area of public green areas was calculated for each town. For Ostrava, the area of public green areas without forests was ca.

7% of the whole area of the Ostrava city and ca. 20% with forests. In comparison with other similar cities in the Czech Republic, Ostrava has a relatively high percentage representation of public green areas without forests (third best result among 13 cities), but a relative small percentage representation of public green areas with forests (ca. 20%, 9th best result among 13 cities). You can find more detailed information about results for four biggest cities in the Czech Republic in the Table 1. In comparison with cities in the world, Ostrava belongs to the cities with middle area of green public areas (51% for Vienna, 47% for Singapore, 46% for Sydney; 3% for Shanghai, 3% for Mumbai, and 2% for Istanbul [3]). There is also agricultural land in the area of the Ostrava city, but it was not counted to these numbers.

Table 1: Percentage representation of public green areas in selected cities in the Czech Republic (CZ).

City in CZ	*Area (km^2)*	*Public green areas without forests (%)*	*Public green areas with forests (%)*
Praha	*496.15*	*9.33*	*18.77*
Brno	*230.18*	*2.10*	*30.63*
Ostrava	*214.23*	*6.76*	*20.16*
Plzeň	*137.67*	*1.43*	*23.80*

Rather than impacting the vegetation in the city itself, don't the authors think that given air-mass movements, the neighbouring areas i.e. the gardening belt of the city might be impacted and your measurements if representative or extrapolable would be useful to assess also crops sensitivity to variations in PAR due to pollution.

Because of important ecological services of vegetation in the cities [4] and because the solar radiation is the crucial factor which influences plant photosynthesis and therefore growth and production of plants [5], it is important to understand transformations of radiation regime during different atmospheric conditions and this knowledge is important for both vegetation in public green areas (mainly trees and shrubs) and crop plants on fields. The sources of air pollution are concentrated in the area of the Ostrava city, concentrations of air pollutants are lower and air pollutants are more dispersed further from the city, expect the situation of locally specific geographic and atmospheric conditions (for example Věřňovice on the borders with Poland).

In another study that exploits these radiation and meteorological data and whose results will be sent to a scientific journal within the next months, the analysis of influence of air pollution on spectral composition of incident solar radiation (represented by ratios of the following spectral bands: Blue/PAR, Green/PAR, Red/PAR) has been performed. It was one of our main goals to find if air pollution significantly influences the visible part of the incident solar radiation. In addition, ratios of the spectral bands (Blue/Red, UVB/UVA, UVA/PAR, UVB/PAR, 660 nm/730 nm) were studied in dependence on the season of the year (spring, summer, autumn, winter), weather (cloudy vs. sunny days) and air pollution (categories were established according to the concentration of PM_{10}: very low, low, medium, high, very high). As these results are available, it will be possible to start with experiments on plants (spring barley and/or spruce will be probably used species) in growth chambers where the light

conditions during smog period will be simulated. So this would be the way for revealing crops sensitivity to variations in quality and quantity of PAR related to air pollution.

Lastly what might be the counter-effect of pollutants deposits vs increase in diffuse radiation on vegetation photosynthetic capacity?

Air pollutants can influence plants in direct way. For example, sulphur dioxide has a direct negative impact on vegetation, especially on coniferous trees, when productivity of plants is decreased by chronical damage. Nitrogen oxides can affect some plant species, especially with common influence of SO_2 and ozone. Ozone causes physiological and biochemical processes which cause damage at plants, and growth and crop yield are decreased. Acid rains cause increasing of hydrogen ions concentration in the soil and ions of some poisonous metals are better available for plants. Decreasing of pH influences soil fauna and microorganisms and also plant growth. Volatile organic compounds (for example peroxyacetyl nitrates) are directly toxic for plants, they cause a slowing down of plant growth and root system development [6]. Another direct effect is connected with a deposition of dust on plant leaves which reduces photosynthesis due to shading [7].

Direct and diffuse components of solar radiation appear to have different effects on the physiological processes within canopy. For example, diffuse radiation can be more efficiently used for canopy photosynthesis than the direct radiation. An increase of the blue/red radiation ratio during cloudy sky conditions and/or air pollution may lead to higher photosynthetic rates per unit leaf area, mainly due to blue-radiation-stimulated opening of the stomata [8].

Counter-effects of pollutants and increasing diffuse radiation look opposite mutually. The final effect is probably dependent on the amount and composition of air pollution. It is expected that negative effects of air pollutants would be stronger than positive effect of increased amount of diffusion radiation. However, the primary issue, that should be solved first, is the elucidation of the impact of air pollution on the spectral composition of incident solar radiation. This effect can be specific for individual air pollutants and can influence also other processes in plants (in addition to above mentioned effects on photosynthesis), which in turn can affect the direct impact of air pollutants on photosynthetic apparatus. Thus the aim of the following studies will be to elucidate the indirect effects of air pollution on plant photosynthesis which are related to changes in quantity and spectral quality of incident solar radiation.

Similarly, with regards to health issues what might be the balance between a lower exposure to UVA/UVB due to attenuation by pollution vs breathing these aerosols ...

Atmospheric pollutants influence human health, for example they cause respiratory diseases and some of air pollutants are cancerogenous (e.g. dioxins, heavy metals, volatile organic compounds [6]). Polycyclic aromatic hydrocarbons (c-PAHs) are connected with more often formation of micronuclei in dividing lymphocytes, which is associated with a higher risk of cancer. Number of micronuclei is higher in adult people than in children, indicating the negative effect of long-term exposures in environment with increased air pollution on human

genetic material [9]. But there are also influences of air pollutants on the children health. Significantly earlier asthma and other respiratory illnesses occur in children who live in the district Ostrava-Radvanice, where the highest concentrations of cancerogeneous c-PAHs were found in comparison with the other places in European Union [10].

Exposure of UVA and UVB radiation is not very dangerous in the Czech Republic. The maximum irradiance of UVA is 25 W m^{-2} in summer and 6 W m^{-2} in winter, and maximum irradiance of UVB is 2,3 W m^{-2} in summer and 0.25 W m^{-2} in winter (according to our own measurements). Also protection against UVA and UVB is easy – people can use clothes with long sleeves and legs, sunbathe creams, sunglasses and hats. Air pollution episodes in the Czech Republic occur mainly in winter months when solar irradiation is generally low, so breathing of pollutants is significantly more dangerous for human health than exposure to UV radiation.

I would like the authors to expand a bit their introduction considering these aspects to enhance the rationale of their in-situ measurements.

The introduction was expanded on the base of your and our comments in the text above, see P2, lines 30–34 + P3, lines 1–11.

Statistics: At the beginning of section 2.1, authors give mean values of sunshine duration air T◦ . . . first we don't understand if this is for Ostrava or the Czech Republic.

These values were related to the city of Ostrava. The paragraph (P3, lines 29–32; P4, line 1) was reworded to make it clear.

Second it would have been interesting to provide also these values as obtained from you in-situ measurements even if 3 years are available only.

We were able to calculate only annual mean of air temperature and the yearly sum of precipitation, because we measured neither duration of sunshine nor number of days with snow cover. Results of our measurements were added to the part 2.1 of the paper, see P4, lines 1–2.

In section 2.2 authors present additional pieces of information provided in the database, in particular the „type of weather". Yet they do not explain how they have assigned each day to one of the three type of weather. What are the statistics and distance metrics used? Supervised classification? Amplitude and variance of the diurnal cycles? This must be developed and explained.

We classified days into three weather type categories: cloudy, partly cloudy and sunny (P7, lines 13–18). They were determined by the analysis of the daily profile of the 10 min broadband irradiance, i.e. we checked the amplitude and the shape of the global irradiance curve for each day. An example is given in Fig. 2 in the manuscript (P8). Sunny days offer a bell-shaped profile, cloudy days have flat low profiles and partly cloudy exhibit large variability within the day.

For the information relative to the season I do not really understand the usefulness of it. Can you explain it a bit?

The information about season is given because of potential use of data by plant physiologist, it is necessary to be able to say what data were measured during vegetation season. This data could be easily filtered and used when information about season is given. What more, the differences among seasons (spring × summer; spring 2015 × spring 2016) could be also easily studied.

Maintenance: In section 2.2 authors also describe the way sensors are maintained and the frequency of these maintenances (each one or two month depending on the season). From the QC performed can you infer that this frequency is high enough?

We did not find any shifts in our data which might be caused by cleaning of sensors, so we can conclude that the frequency of maintenance was high enough.

How far the measurements rejected by the QC correspond to hours when the maintenance was operated? Have the authors the exact dates / hours of maintenance? If yes these dates / hours should be reported in the database in a dedicated column so that users can exactly know if the erroneous data (i.e. those not passing the QC) are due to maintenance (and maybe do interpolations from the hours preceding / following the maintenance) or an another failure.

Unfortunately, we do not have exact dates or hours of maintenance. Cleaning of the ensemble of sensors takes about 1 min for each station. Hence, cleaning a single sensor takes less time and the influence of this process on measured data is likely negligible in most cases, especially since data are stored as 10 min averages. We do not have enough information to assess the possible connection between maintenance and data rejection by QC.

Technical corrections

Abstract: lines 14-17: the authors should better stress there that they propose a new procedure for QC of irradiance in different spectral bands (cf beginning of section 3).

This is an excellent suggestion that we are glad to follow, see P1, lines 15–16.

Introduction: page 2 last sentence: This sentence is confusing: we don't understand if you propose to extrapolate the measurements or the procedure to other regions and which ones exactly (what are the regions similar to Ostrava?)? please reword.

The part of text which contained this confusing sentence, was completely changed, see P2, lines 30–34 + P3, lines 1–11.

Measurements sites: on the whole I find very difficult to follow / understand what are the sites you speak about along the whole paper. The way you name and call them is confusing. First starting from the map in figure 1 I would label the two sites "BGOU (S1, S2)" and "CHMI (S3)" than 1 and 2. This would be very very helpfull + add the coordinates on the map. Without these coordinates I can not figure out where is the PHI site (please if possible locate it on the map in figure 1 as well) which is important with regards to atmospheric dynamics and dominant winds ... Pictures of the sites – unless confidential - would be a nice supplementary material to provide on the PANGEA website

Figure 1 was improved according to your suggestions, including drawing of the point of the PHI site, see Fig. 1, P5.

For easing the review please do not present a same table on two different pages (a bit annoying) and number the lines with a step of two.

We were not sure if we could place the table at the separate sheet in the paper, there would be huge space between text and table. We guess this adjustment is not allowed by the template of ESSD. The text will be adjusted before publication in ESSD, current version is a draft. A step of five in lines of pages was given by the template of ESSD, we would like to leave this way of numbering of lines in agreement with the template.

P3, lines 26-27: I couldn't find any info about altitude in Tab1 or Fig 1 so delete (Tab1, Fig1)

This suggestion was accepted.

P4, line 13 (and elsewhere in the paper): please be more precise about dates: from the 1st of July 2104 + hour to the 31st of December 2016 + hour (since in some databases records are provided for non complete years).

Details about the exact starts and ends of measurements were added into the Tab. 1 (P4).

P5, Line 17: as the 2 stations were only 3m apart

This information was added into the chapter 2.1, see P4, line 4.

P6, Line 4: Within its network of X (? please provide this number) stations, the station the nearest of BGOU is located approximately at 1.7km (GPS coordinates)

Thank you for this suggestion. See P4, lines 21–22.

P6, Line 11: For the sake of simplicity → remove this sentence which is unnecessary here (explanations provided later in the paper)

Thank you for this suggestion. Done.

P6, lines 13 and 14: change "CHMI area in Poruba" for "CHMI station" and change "the location in Poruba" for "CHMI"

Thank you for this suggestion. See P7, line 8–9.

P6, line 19: broadband irradiance as exemplified in Fig. 2 which presents profiles. . .

Thank you for this suggestion. See P7, line 15.

P7, line 15: LibRadtran software (and not a package of software as R or Matlab. . .)

Thank you for this suggestion. See P8, line 13.

P8, line 1: for "BGOU and CHMI sites" (instead of both locations)

Thank you for this suggestion. See P8, line 20.

P9, line 7: add (BGOU) after S2 and (CHMI) after S3

Thank you for this suggestion. See P10, lines 1–2.

P9, line 13: change for „the station at CHMI (S3) had . . . than "stations at BGOU (S1, S2)"

Part of this text was changed, see P10, lines 3–4, 11.

P10, last sentence: use the plural form. Can these effects be neglected for your study purposes i.e. impact of SR variability on vegetation?

Thank you for this suggestion. See P11, lines 10–11. These mentioned effects of influencing of measured solar radiation can be neglected for our study purpose, because the differences and ratios between values of irradiation during different conditions are more important than the actual values of irradiation in studies about impact of solar radiation on vegetation. If all measured values were influenced by an arbitrary x%, the ratios would be unchanged.

P11: lines 6 – 15: move that in a table

Thank you for this suggestion. See P12, Tab. 6.

lines 16-18: delete a It means if it . . . minimum explanations given before in the paper.

This suggestion was accepted.

Line 19: are present + I couldn't find the figures in the files I uploaded. You should rather provide them as supplementary files just as the figure done from google earth which present the shading effect

Thank you for this suggestion. See P12, line 10. Supplementary material with requested figures was prepared as well, the link was added to the paper, see P4, line 17–18; Figs. 7–9 in Appendix.

Line 23-25: Data of "air pollutants and meteorological parameters" measured by ... "these" data.

Thank you for this suggestion. See P12, lines 12–14.

P12, line 5: for "modeling the" influence

This part of text was completely changed, see P13, lines 9–10.

line 9: studied in different environment conditions: please be more precise: meteorological and air pollution conditions I guess . . .

Thank you for this suggestion. See P13, line 6.

line 10: reword this sentence I don't understand what is a "correct function of microclimate"

This part of text was completely changed, see P13, lines 12–16.

line 11: spectral ratios? Do you really mean ratios or bands? If you mean ratio, please give example of bands you could use to compute ratios . . .

We really meant ratios, examples are given, see P13, line 13.

Tab 2: wonder if you should not split the table into two because it is confusing with regards to the sites where the instruments are implemented. For what I understand all

instruments belonging to OU are on sites S1, S2 and S3 whereas instruments belonging to PHI are on a site 1.7km from BGOU

New Tab. 3; you understood our information well, instruments owned by OU were used on sites S1, S2, S3 and instruments owned by PHI were used on the different site. We do not prefer a division of information in this table into two tables, but a description of Tab. 3 was improved, see P6, lines 20–22.

Tab 4: legend: numbering your columns would ease the reading of the table. You should also add BGOU and CHMI after S1/S2 and S3.

New Tab. 5; Thank you for these suggestions. See P10–11.

Fig2. Legend: please provide the dates of these three days of March 2015

Thank you for this suggestion. See P8, lines 2–3.

References:

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