Comments from Reviewer 1 and reply:

General comments from reviewer 1

General Comments:

By comparing the correlation between sampled grass pollen counts in three city sites of Aarhus, Denmark and one 'background' site 60km away using potential source map and wind direction sector analysis, the authors of this research paper examine the hypothesis that during intense flowing, the dispersion of grass pollen is a local scale phenomenon, which mirror the local source distribution. A new methodology based on remote sensing and management information through GIS for local grass area is proposed to build high resolution urban scale grass pollen source inventory. This study has the implication for pollen exposure assessment efforts by emphasizing the importance of the local dispersion behavior of grass pollen besides regional to long-range transport, especially during peak time. This manuscript is generally well written with a clear logic flow. The overall structure is well arranged and the statements are supported by using proper figures and tables. The discussion part is insightful. The reviewer recommends publishing this study on Biogeoscience after the following specific comments are addressed satisfactorily.

Answer to the general comment from reviewer 1:

We are pleased that reviewer 1 considers the manuscript to be of relevance to Biogeosciences and we are grateful for the constructive comments. We have to the best of our ability addressed all the specific comments raised by reviewer 1. Furthermore, the manuscript has been proof-read by a fellow scientist and we have therefore made additional changes with respect to specific formulations in the manuscript. Below we have answered each of the questions by reviewer 1 and also provided a full list of changes (from line 284) due to both the proof reading and the requests from reviewer 1.

Specific comments from reviewer 1

Specific Comments:

1. Page 14220. Line 17-19. 'Grass pollen grains from wild grass species ... only about 20um in diameter.' Citations are needed for this statement.

Answer to the specific comment from reviewer1:

We have added three references and changed the paragraph into

"Grass pollen grains from wild grass species usually have a size of 30-40 um in diameter (Brown and Irving, 1973) and about 50-60 for the crop rye (Durham, 1946), whereas birch pollen is only about 20um in diameter (Mäkelä, 1996)".

2. Page 14221. Line 2. 'The source emits 1 mio. Pollen grains'. Better use the full name of 'mio.'

Answer to the specific comment from reviewer1:

We have changed from " The source emits 1 mio. pollen grains" to "The source is set to emit 1 million pollen grains"

Specific comments from reviewer 1

3. Page 14222. Line 8-9. 'This site also includes measured metrological variables.' Please specific the measured variables. At least in your Figure 6, you compared with temperature, precipitation and wind.

Answer to the specific comment from reviewer1:

We have changed the sentence from "This site also includes measured meteorological variables"

Into

"This site also includes measurements of temperature, precipitation, wind speed and direction"

Specific comments from reviewer 1

4. Page 14233. Line 1-18. The overall arrangement of the paragraphs. Part (b)-(e) are the detail procedures for land cover classification to identify potential grass pollen areas. The author should delete the numbering (a) and start the numbering from 'Every band of 2.4 m GSD . . .'.

Answer to the specific comment from reviewer1:

On page 14223. Line 1-18, we have deleted the "a" so that the numbering goes from "a" to "d"

Specific comments from reviewer 1

5. Page 14233. Line 1-2. Please provide the citation for the 'dataset of six Quickbird satellite images'.

Answer to the specific comment from reviewer1:

On page 14223, line 1-2 we have added the reference and the year the picture have been taken. Another alternative to remote sensing pictures is instead to add the scene number such as "QuickBird scene 000000185959_01_P005". This information was not provided with the pictures we acquired. So page 14223, line 1-2 now reads:

Potential grass pollen source areas in the City of Aarhus are identified using a dataset of six Quickbird satellite images (DigitalGlobe, Corporate, 2008) that were taken during summer 2008.

Specific comments from reviewer 1

6. Page 14244-14245. Section 2.3. This section describe the methodology to indentify the grass management areas using GIS from different datasets (i.e. crop type from DGAR, parcel map of Denmark and public areas information in) and combine with NDVI map to constructed gridded inventory for grass pollen. Two questions may be need to be addressed in more detail: (1) The different datasets have different resolutions, how to combine them with 0.6m resolution NDVI map to build a gridded emission inventory 'with a resolution of about 14m'. (2) It seems to the reviewer that the criteria to determine managed or not-managed grass is a little bit arbitrary. For instance, roads above 6 m wide are considered not managed, public area with more than 12 cuts per year is assumed non-flowering. Can the authors give

some discussion on how uncertain of the choice of those empirical criteria to impact the final picture of emission source (i.e. Figure 8)?

Answer to the specific comment from reviewer1:

On page 14224-14225, section 2.3 with respect to question 1, we have used two data sets: a vector based data set (with the parcel map) and a grid based data set for the NDVI map. Here we have gridded the vector based data set to an identical resolution as the NDVI map and performed the actual calculations with 0.6 m resolution. Thereafter this calculation has been aggregated to 14.4m resolution for use in dispersion models.

With respect to question number to, more 12 cuts per year corresponds to two cuts per month or one cut every 14 day. The reason is that the typical growth period for crops and grasses in Denmark is from mid March to mid September. It is only during this period that grass areas are cut. So more than 12 cuts during a 6-7 month period will give at least 2 cuts a month or 14 day in between each cutting period. According to the management plans used by Danish agriculture (http://www.dlf.dk/upload/microsoft_word_-_fr_gr_ssernes_blomstring_og_modning.pdf) then it typically takes between 15(*Poa trivialis, Lolium multiflorum, Poa pratensis, Festuca pratensis* and *Lolium perenne*) and up to 20 days (*Phleum pratense, Dactylis glomerata* and *Festuca rubra*) for typical Danish grass species to evolve from immature flowers and into the stage of full flowering. It is therefore considered reasonable, that 14 days in between each cutting period will ensure that flowering is not happening. However, it is also recognized that if the management is not done according to the plan or of the grass areas have a faster growth rate than usual, then the grass areas will go into the flowering phase in between two cutting events.

we have therefore changed following on page 14225, line 11-13 from

"The management map is combined with the NDVI map (Fig. 3) to construct a gridded inventory with a resolution of about 14m (Fig. 8)"

into

"The management map is then converted to a raster data set with the same resolution as the NDVI map(Fig. 3). These two data sets are combined and afterwards aggregated to 14.4m resolution by using the mean value of all 576 pixels that are fully contained within each 14.4m grid cell (Fig. 8)"

Furthermore we have changed the sentence on page 14225, line 7-8 from

These public grass areas are cut either annually (1 time), seasonally (3 times), monthly (12 times) or more than 12 cuts per year.

Into

"These public grass areas are cut either annually (1 time), seasonally (3 times), monthly or more than 12 cuts per year, where 12 cuts per year roughly corresponds to a cutting frequency of 2 cuts per month during the grass growing season".

And finally we have expanded the discussion on page 14229, line 21 from

".. areas. The combined .."

Into

"..areas. The management map is here based on the assumption, that at least 2 cuts of grass areas per month is enough to prevent flowering. In Denmark, it typically takes between 15 days (*Poa trivialis*, *Lolium multiflorum, Poa pratensis, Festuca pratensis* and *Lolium perenne*) and up to 20 days (*Phleum pratense, Dactylis glomerata* and *Festuca rubra*) for typical Danish grass species to evolve from immature flowers and into the stage of full flowering. This information is provided through the management plans that are available for Denmark and in particular Danish agriculture (e.g. http://www.dlf.dk/upload/microsoft_word_-_fr_gr_ssernes_blomstring_og_modning.pdf). It is however likely that not all areas are strictly managed according to the management plan and special meteorological conditions are likely to advance grass growth and maturation so that small grass areas are able to enter the flowering phase. However, the general picture is that the majority of the managed areas do not release large fractions of grass pollen, especially if they are compared to non-managed areas. The combined .."

Specific comments from reviewer 1

7. Page 14225. Line 21-22. 'Wind directions were obtained for all available grass pollen counts (n = 1,644) within the pollen season'. In here, the analysis use all the raw 30-min resolution instantaneous wind direction during flowering season i.e. May 25 – Jul 29 (65 days, based on Table 1) or any other special dealing?

Answer to the specific comment from reviewer1:

We have changed the paragraph into "Wind directions were obtained from 30 minute average raw data for all available grass pollen counts (n=1,644) within the pollen season, i.e. from May 25 till July 29. "

Specific comments from reviewer 1

8. Page 14225. Line 26-27. 'The threshold are further used ..., where a level of 50 grains m-3 daily average . . .'. In here, the threshold value for pollen forecast service is for grass pollen only or for the total pollen including trees and grass pollen?

Answer to the specific comment from reviewer1:

The thresholds that were developed by Petersen and Munch (1981) and Weeke (1981) were specific at the species level for grass, mugwort and birch. We have therefore made this more clear by modifying line 25-26 on page 14225 from

"This threshold is based on clinical thresholds defined by Petersen and Munch (1981) and Weeke (1981)"

Into

"This threshold is based on clinical thresholds at the species level for grass (10 and 50 grains/m^3), mugwort (10 and 50 grains/m^3) and birch (30 and 100 grains/m^3) that were defined by Petersen and Munch (1981) and Weeke (1981) "

Specific comments from reviewer 1

9. Page 14226. Line 19-20. 'A secondary, . . . within a distance approximately 5 km . . .' should be 'with a distance radius approximately 5 km with the center in central Aarhus'.

Answer to the specific comment from reviewer1:

We have modified Page 14226, line 19-21 from :"A secondary, larger urban part within a distance of approximately 5 km shows a medium density of possible grass areas"

Into:

"A secondary, larger urban part within a distance of 5 km from the site in Central Aarhus shows a medium density of possible grass areas"

Specific comments from reviewer 1

10. Page 14227. Line 2. '(see Table 1)' should be '(see Table2)'.

Answer to the specific comment from reviewer1:

We have changed "Table 1" into "Table 2"

Specific comments from reviewer 1

11. Page 14229. Line 12-14. 'There was a high correlation . . . the three stations and operational trap in Viborg . . .'. Where is the geographic location of Viborg related with the city Aarhus? It should be marked in Demark map in Figure 2. It is helpful to understand the high correlation between Virborg and three urban sites based on wind direction sector analysis.

Answer to the specific comment from reviewer1:

The reviewer has a good point here. We have therefore modified both the text and the figure. We have changed p14222, line13-14 from:

"operational trap in Viborg, about 60km away"

into

"operational trap in Viborg, about 60km to the North-west"

Specific comments from reviewer 1

12. Page 14235. Line 20-24. 'The next step . . . develops a local scale dispersion model . . . explaining air movements transporting grass pollen on the local scale.' Just curious how to weight in other important meteorological factors besides wind information (temperature, precipitation) into local dispersion model. The urban scale grass emission source map developed in this study only gives the spatial distribution of grass pollen, but the day-by-day variation of pollen emission rate may also need in order to repeatthe observed pattern.

Answer to the specific comment from reviewer1:

This concern to large extend the complex conditions in urban areas where building obstacles highly affect flow pattern. This is currently described in advanced but also resource demanding Computational Fluid Dynamic models that are commonly used for studying air pollution dispersion in the vicinity of buildings, often with the aim of deriving parameterizations for use in operational street pollution models. An example

of this is the Operation Street Pollution Model (OSPM) that is developed at Aarhus University and currently applied in more than 17 countries around the world (e.g. Kakosimos et al., 2010). The development of OSPM revealed the importance of wind speed, wind direction and traffic induced turbulence for the dispersion in the urban streets, but also the crucial impact of what we term as the street configuration (building height, street width, orientation of the street, openings in the building façade as well as buildings of different heights). Grass pollen are released from ground level and if not released inside the street itself these need to be dispersed above buildings to enter urban streets. Local scale Gaussian models may be applied to describe dispersion from sources outside the urban area, but they cannot resolve the flow inside build-up areas. Tools for handling this have not according to our knowledge been developed for pollen, and they need to combine features from different types of models applied in air quality. Temperature and precipitation will generally play insignificant roles, whereas humidity may play a role for the settling velocity of the pollen grain. Concerning day-to-day variation – this will be affected by temperature and precipitation but here there is knowledge to build upon from ongoing dynamic emission modelling we have developed for ammonia (e.g. Skjøth et al., 2004; Skjøth et al., 2011) from agricultural sources and currently extended for the pollen area (Skjøth, 2009; Skjøth et al., 2010). We feel quite confident to have a powerful approach for this purpose and a key to this is the correct identification of the main grass species in Denmark as written earlier in this reply and a mechanistic description of the growth and flowering of these species. In order to make the remaining questions more clear with respect to modelling of grass pollen on the local scale we have therefore made following change on page 14232, line 28-29 from:

"..provided that they can be further developed to properly handling atmospheric dispersion of pollen. The use…"

Into:

"..provided that they can be further developed to describe atmospheric dispersion of pollen. In general this requires validated phenological models and a model that parameterises daily pollen release (e.g. Skjøth et al, 2010). Emission models for use by OML that take into account crop and grass growth are already developed for the Danish area (e.g. Skjøth et al, 2004, Gyldenkærne et al, 2005, Sommer et al, 2009, Geels et al, 2012). It has previously been shown, that these emission models can be extended to tree pollen (Skjøth et al, 2009, 2010). It is therefore likely that they can also be extended to grass pollen in order handle the main grass species such as *Poa trivialis, Lolium multiflorum, Poa pratensis, Festuca pratensis, Lolium perenne, Phleum pratense, Dactylis glomerata* and *Festuca rubra* and in particular their flowering. The use …"

<u>Specific comments from reviewer 1</u>

13. Page 14244. Table 1. Consider change the format of date from '25.5' to '25/05' , which is consistent with following Figures.

Answer to the specific comment from reviewer1:

We have modified Table 1 so that the date format is identical to the figures

<u>Specific comments from reviewer 1</u>

14. Page 14245. Table 2. (1) Need to adjust the position of the first column. Under the 'Classfication Data' should be the different land use type instead of black. (2) Need to give the full name of 'acc' as 'accuracy' or mark it as notation.

Answer to the specific comment from reviewer1:

We have modified the layout of Table 2 and expanded the caption with following lines:

"User accuracy (User acc.) and Producer accuracy (Prod acc.) are based on standard methodologies according to Lillesand and Kiefer (2007)."

Specific comments from reviewer 1

15. Page 14246. Figure 1. Remove the description title 'Release of 1 moi . . . near neutral weather conditions'. This is already covered in the caption of the Figure 1.

Answer to the specific comment from reviewer1:

We have re-drawn figure 1 so the head-line does not appear. Additionally, we have modified the layout slightly.

Specific comments from reviewer 1

16. Page 14248. Figure 3. The legends for '1000m distance' (white box with bold grey line) and 'no grass' (white box with grey line) is too close. Consider to change to differentiate them from each other (e.g. dash line for the legends of '1000m distance').

Answer to the specific comment from reviewer1:

We have redrawn Figure 3 so that the 1000m distance is made in black but with a dashed line

Specific comments from reviewer 1

17. Page 14250. Figure 5. The color of each site is not consistent with other figures, i.e. Figure 2-4, Figure 7-8. Site Rundhøjskolen should be blue, site TV2-Østjylland should be green while site Central Aarhus, NERI should be red.

Answer to the specific comment from reviewer1:

We have modified Figure 5, so that the layout, titles and colors of the time series are identical to those applied in the other figures. The colour representing the station Central Aarhus is changed from blue to red, and the colour representing the station Rundhøjskolen is changed from red to blue. The box around the legend is removed, and the x-axis title changed from "Day" to "Date".

Specific comments from reviewer 1

18. Page 14251. Figure 6. The format of x-axis is not consistent. Some of them is '25-05', some of them is '25/05'.

Answer to the specific comment from reviewer1:

We have modified figure 6, so that the dates on the x-axis are all identical.

Specific comments from reviewer 1

19. Page 14253. Figure 8. The zoom-in figure for vicinity of Site Rundhøjskolen should be also highlighted with bold blue line.

Answer to the specific comment from reviewer1:

We have modified Fig 8 so that zoom-in to Rundhøjskolen is also highlighted with bold blue

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258 **REFERENCES**

259

260 Brown, H. M. and Irving, K. R., Size and Weight of Common Allergenic Pollens - Investigation of Their
261 Number Per Microgram and Size Distribution, Acta Allergologica, 28**,** 132-137, 1973.

262 Durham, O. C., The Volumetric Incidence of Atmospheric Allergens .3. Rate of Fall of Pollen Grains in Still
263 Air, Journal of Allergy, 17**,** 70-78, 1946.

264 Kakosimos, K. E., Hertel, O., Ketzel, M., and Berkowicz, R., Operational Street Pollution Model (OSPM) ΓÇô
265 a review of performed application and validation studies, and future prospects, Environ. Chem., 7**,** 485-503,
266 2010.

267 Mäkelä, E. M., Size distinctions between Betula pollen types - A review, Grana, 35**,** 248-256, 1996.

268 Skjøth, C. A., Integrating measurements, phenological models and atmospheric models in Aerobiology -
269 creating new concepts within aerobiological integrated monitoring and forecasting Faculty of Science,
270 Copenhagen University, PhD thesis.

271 Skjøth, C. A., Geels, C., Berge, H., Gyldenkærne, S., Fagerli, H., Ellermann, T., Frohn, L. M., Christensen, J.,
272 Hansen, K. M., Hansen, K., and Hertel, O., Spatial and temporal variations in ammonia emissions – a freely
273 accessible model code for Europe, Atmos. Chem. Phys., 11**,** 5221-5236, 2011.

274 Skjøth, C. A., Hertel, O., Gyldenkærne, S., and Ellermann, T., Implementing a dynamical ammonia emission
275 parameterization in the large-scale air pollution model ACDEP, J. Geophys. Res. , [Atmos.], 109**,** 1-13, 2004.

276 Skjøth, C. A., Smith, M., Sikoparija, B., Stach, A., Myszkowska, D., Kasprzyk, I., Radisic, P., Stjepanovic, B.,
277 Hrga, I., Apatini, D., Magyar, D., Paldy, A., Brandt, J., Christensen, J. H., Frohn, L. M., Geels, C., Hansen, K.
278 M., Hedegaard, G. B., Milkovska, S., Simic, S., Uruska, A., Puc, M., Balwierz, Z., Chlopek, K., Piotrowska, K.,
279 Grewling, L., and Ianovici, N., An integrated assessment of ragweed dispersal from the Pannonian Plain, 9th
280 International Congress on Aerobiology, August 23-27, 2010, Buenos Aires, Argentina

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282

283

List of changes that have been made to the manuscript due to the requests by reviewer 1:

Page 14220, line 17-19: Changed from

Grass pollen grains from wild grass species usually have a size of 35–40 µm in diameter and about 80 µm for crops such as rye, whereas birch pollen is only about 20 µm in diameter.

Into

"Grass pollen grains from wild grass species usually have a size of 30-40 um in diameter (BROWN and IRVING 1973) and about 50-60 for the crop rye (Durham 1946), whereas birch pollen is only about 20um in diameter (Mäkelä 1996)".

Page 14221, line 3: Changed from " The source emits 1 mio. pollen grains" to "The source is set to emit 1 million pollen grains

Page 14222. Line 8-9: Changed from "This site also includes measured meteorological variables"

Into

"This site also includes measurements of temperature, precipitation, wind speed and direction"

Page 14222, line 13-14: Changed from ""operational trap in Viborg, about 60km away"

into

"operational trap in Viborg, about 60km to the North-west"

Page 14223, line 1-2: Changed from "Potential grass pollen source areas in the City of Aarhus are identified using a dataset of six Quickbird satellite images"

into

"Potential grass pollen source areas in the City of Aarhus are identified using a dataset of six Quickbird satellite images (DigitalGlobe, Corporate, 2010) that were taken during summer 2008."

Page 14223, line 1-18: Removed the numbering of the section "a" so that the numbering only contains four sections: from "a" to "d"

page 14225, line 7-8 from: Changed from "These public grass areas are cut either annually (1 time), seasonally (3 times), monthly (12 times) or more than 12 cuts per year.

Into

"These public grass areas are cut either annually (1 time), seasonally (3 times), monthly or more than 12 cuts per year, where 12 cuts per year roughly corresponds to a cutting frequency of 2 cuts per month during the grass growing season".

14225, line 11-13: Changed from "The management map is combined with the NDVI map (Fig. 3) to construct a gridded inventory with a resolution of about 14m (Fig. 8)"

into

"The management map is then converted to a raster data set with the same resolution as the NDVI map(Fig. 3). These two data sets are combined and afterwards aggregated to 14.4m resolution by using the mean value of all 576 pixels that are fully contained within each 14.4m grid cell (Fig. 8)"

Page 14225. Line 21-22: Changed from: "Wind directions were obtained for all available grass pollen counts (n = 1, 664) within the pollen season."

Into

"Wind directions were obtained from 30 minute average raw data for all available grass pollen counts (n=1,644) within the pollen season, i.e. from May 25 till July 29. "

Page 14225, line 25-26: Changed from "This threshold is based on clinical thresholds defined by Petersen and Munch (1981) and Weeke (1981)"

Into

"This threshold is based on clinical thresholds at the species level for grass (10 and 50 grains/m^3), mugwort (10 and 50 grains/m^3) and birch (30 and 100 grains/m^3) that were defined by Petersen and Munch (1981) and Weeke (1981)"

Page 14226, line 19-21 Changed from: "A secondary, larger urban part within a distance of approximately 5 km shows a medium density of possible grass areas"

Into:

"A secondary, larger urban part within a distance of 5 km from the site in Central Aarhus shows a medium density of possible grass areas"

Page 14227, line 2: Changed from "see Table 1" into "see Table 2"

Page 14229, line 21: changed from ""..areas. The combined .."

Into

""..areas. The management map is here based on the assumption, that at least 2 cuts of grass areas per month is enough to prevent flowering. In Denmark, it typically takes between 15 days (*Poa trivialis, Lolium multiflorum, Poa pratensis, Festuca pratensis* and *Lolium perenne*) and up to 20 days (*Phleum pratense, Dactylis glomerata* and *Festuca rubra*) for typical Danish grass species to evolve from immature flowers and into the stage of full flowering. This information is provided through the management plans that are available for Denmark and in particular Danish agriculture (e.g. http://www.dlf.dk/upload/microsoft_word_-_fr_gr_ssernes_blomstring_og_modning.pdf). It is however likely that not all areas are strictly managed according to the management plan and special meteorological conditions are likely to advance grass growth and maturation so that small grass areas are able to enter the flowering phase. However, the general picture is that the majority of the managed areas do not release large fractions of grass pollen, especially if they are compared to non-managed areas. The combined .."

Page 14232, line 28-29: Changed from: "..provided that they can be further developed to properly handling atmospheric dispersion of pollen. The use…"

Into:

"..provided that they can be further developed to describe atmospheric dispersion of pollen. In general this requires validated phenological models and a model that parameterises daily pollen release (e.g. Skjøth et al, 2010). Emission models for use by OML that take into account crop and grass growth are already developed for the Danish area (e.g. Skjøth et al, 2004, Gyldenkærne et al, 2005, Sommer et al, 2009, Geels et al, 2012). It has previously been shown, that these emission models can be extended to tree pollen (Skjøth et al, 2009, 2010). It is therefore likely that they can also be extended to grass pollen in order handle the main grass species such as *Poa trivialis, Lolium multiflorum, Poa pratensis, Festuca pratensis, Lolium perenne, Phleum pratense, Dactylis glomerata* and *Festuca rubra* and in particular their flowering. The use …"

Additions to the reference list:

Brown, H. M. and Irving, K. R., Size and Weight of Common Allergenic Pollens - Investigation of Their Number Per Microgram and Size Distribution, Acta Allergologica, 28**,** 132-137, 1973.

Durham, O. C., The Volumetric Incidence of Atmospheric Allergens .3. Rate of Fall of Pollen Grains in Still Air, Journal of Allergy, 17**,** 70-78, 1946.

Mäkelä, E. M., Size distinctions between Betula pollen types - A review, Grana, 35**,** 248-256, 1996.

Changes to figures and tables, including the changed figures:

We have modified Figure 1, so that the header is not present as the text also appear in the caption. Additionally we have removed some of the box-lines.

We have modified Figure 2, so that the location of Viborg appears on the map.

We have modified Figure 3, so that the grey line that was used as 1000m distance appear more clear on the map.

We have modified Figure 5, so that the colours of the time series are identical to the colours that are used in the other figures.

We have modified Figure 6, so that the titles and axis are identical to the other figures.

We have modified Figure 8, so that the zoom in to Rundhøjskolen is highlighted with bold blue.

We have modified Table 1 so that the date format is similar to the figures. We have also changed the name of TV2-East to TV2-Østjylland.

We have modified Table 2 with respect to layout and added additional text to the caption and corrected one typing error (Strees)

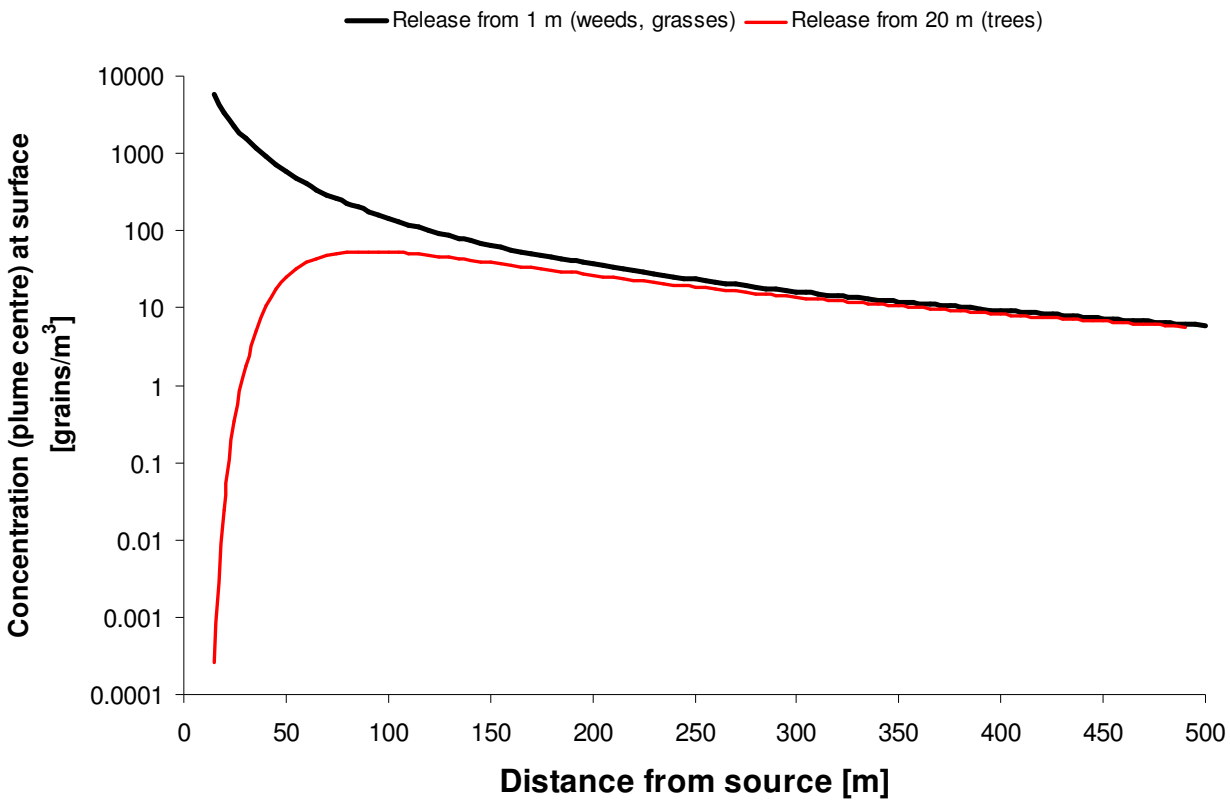
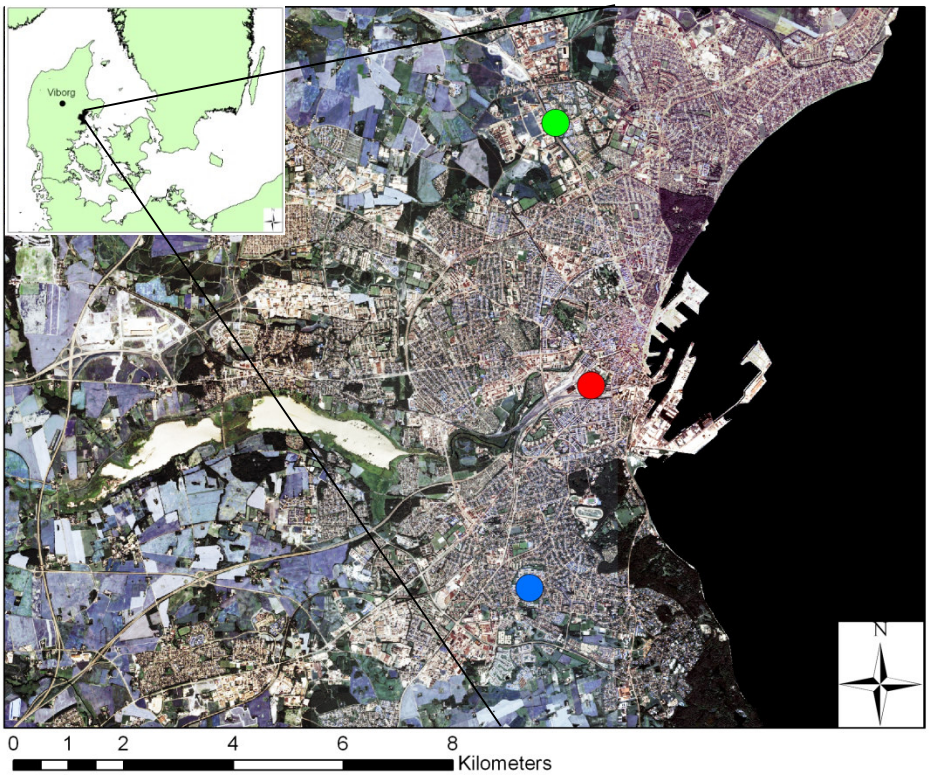


Fig 1. Local scale concentration profile of the pollen near the surface after the release of 1 mio pollen grains from trees (20 m) and weeds/grasses (1 m). Overall concentration is calculated using neutral meteorological conditions and a wind speed of 5 m/s.



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399 Fig 2. Municipality of Aarhus, Denmark and location of the three pollen traps in Aarhus and the operational
400 trap in Viborg (upper left).

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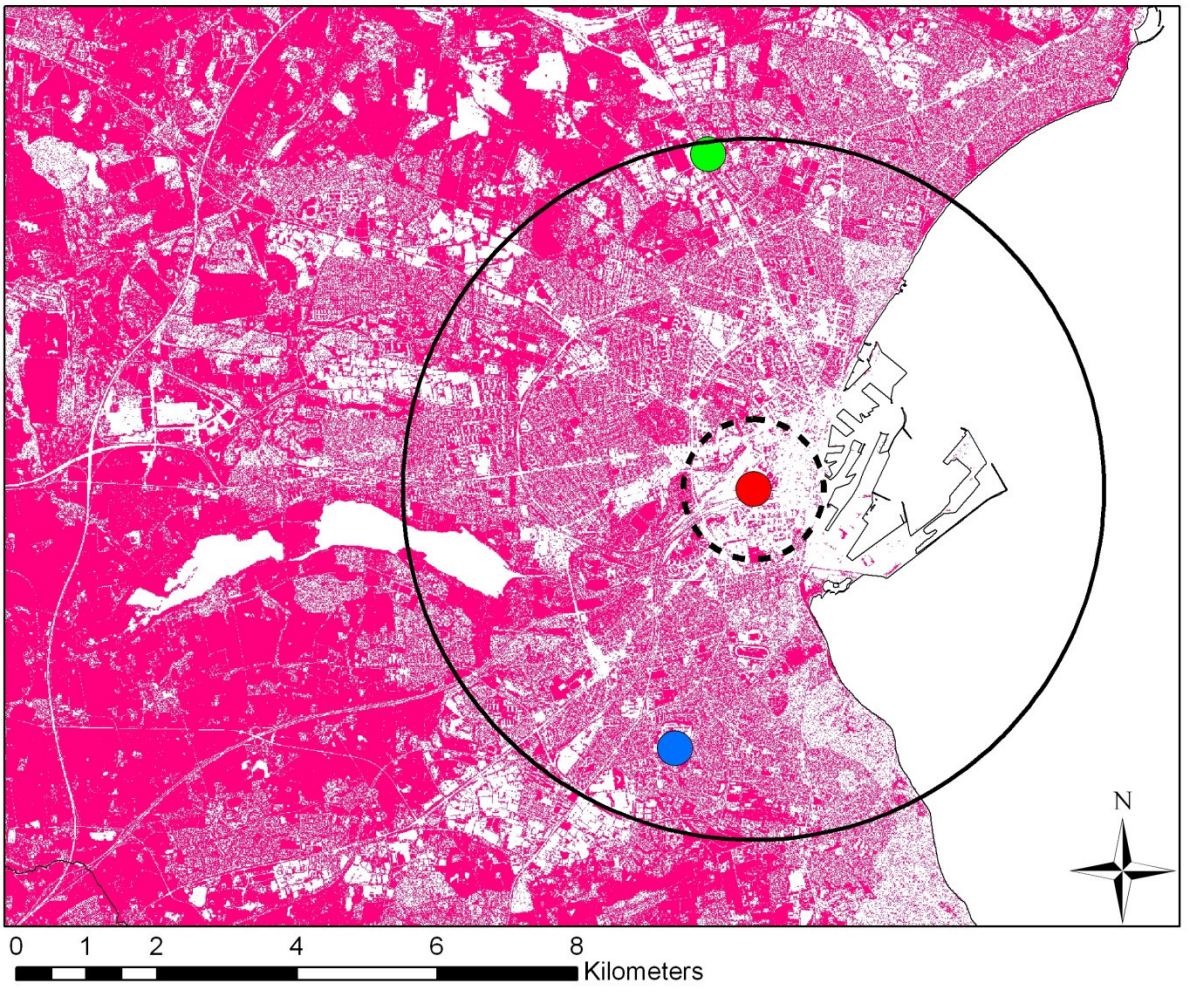

402

403 Fig 3. Possible grass areas in the city of Aarhus based on the NDVI classification methodology described in
404 Section 2.2 and a ground resolution of 0.6 m. High density grass areas will be displayed as large intense pink
405 areas and lower density areas as a more a mixture of pink and white pixels. Areas without grass are
406 completely white. Circles are distances from Central Aarhus at 1000 m and 5000 m, respectively.

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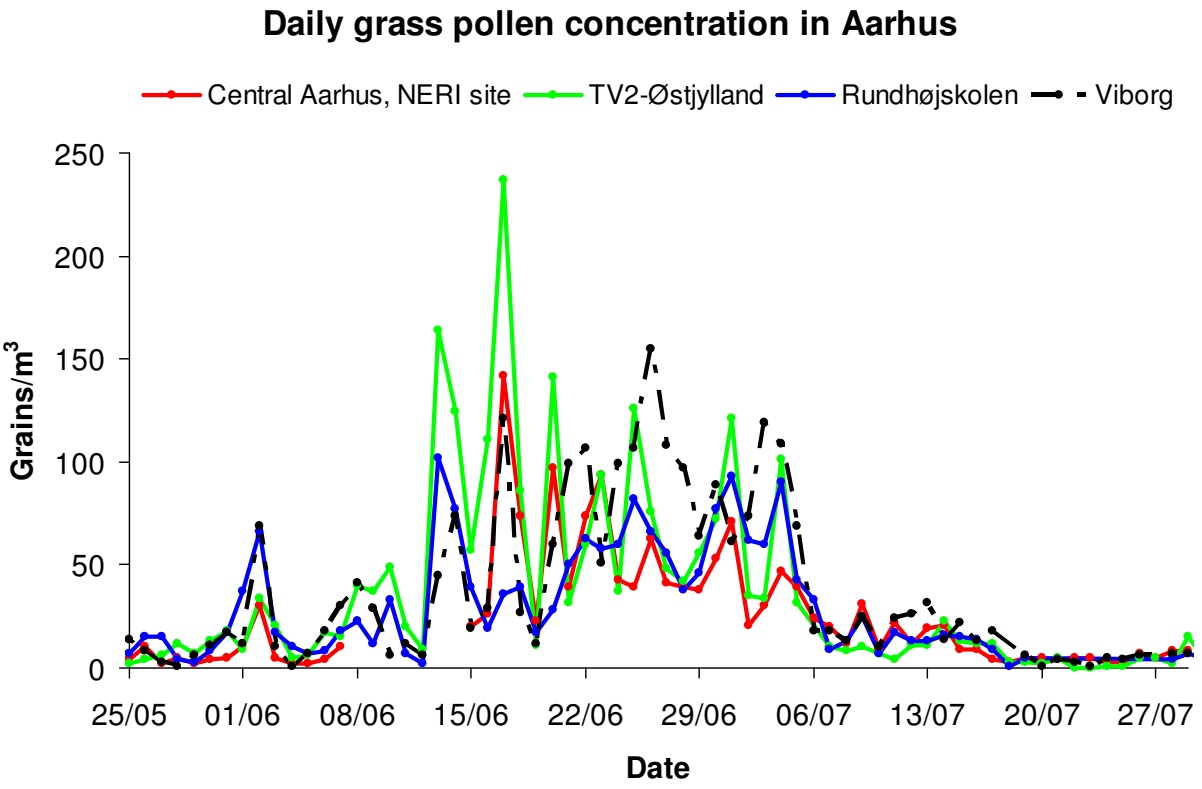

408

409 Fig 5. Daily grass pollen concentrations at the three monitoring sites in Aarhus and the operational pollen
410 trap in Viborg.

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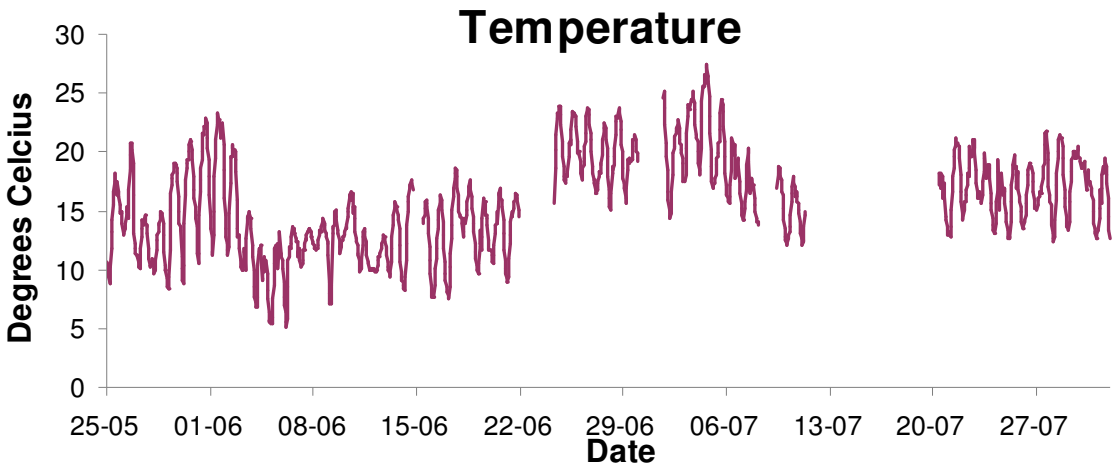

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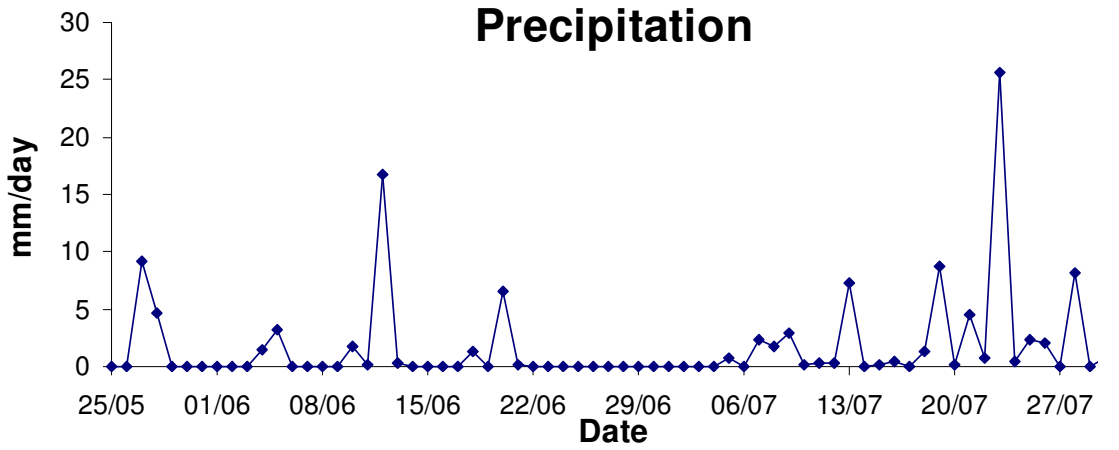

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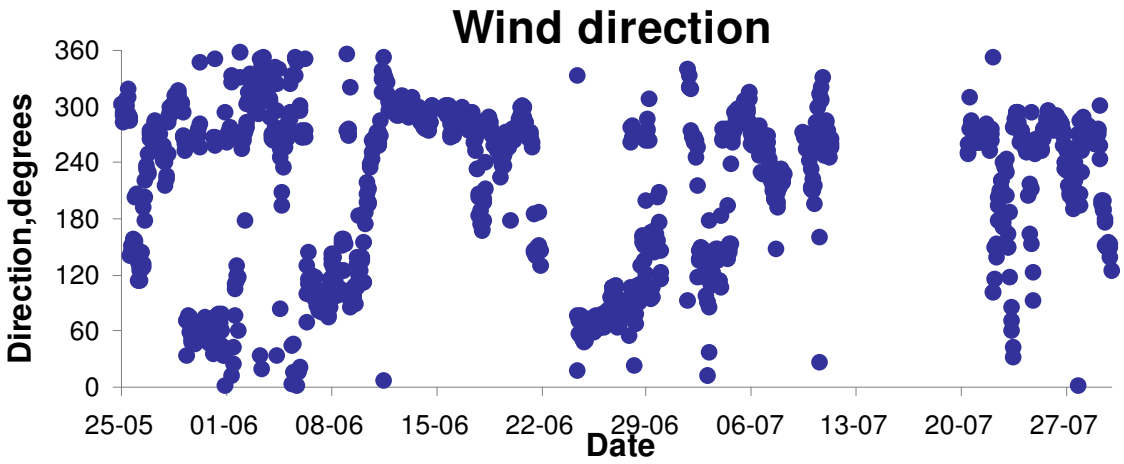
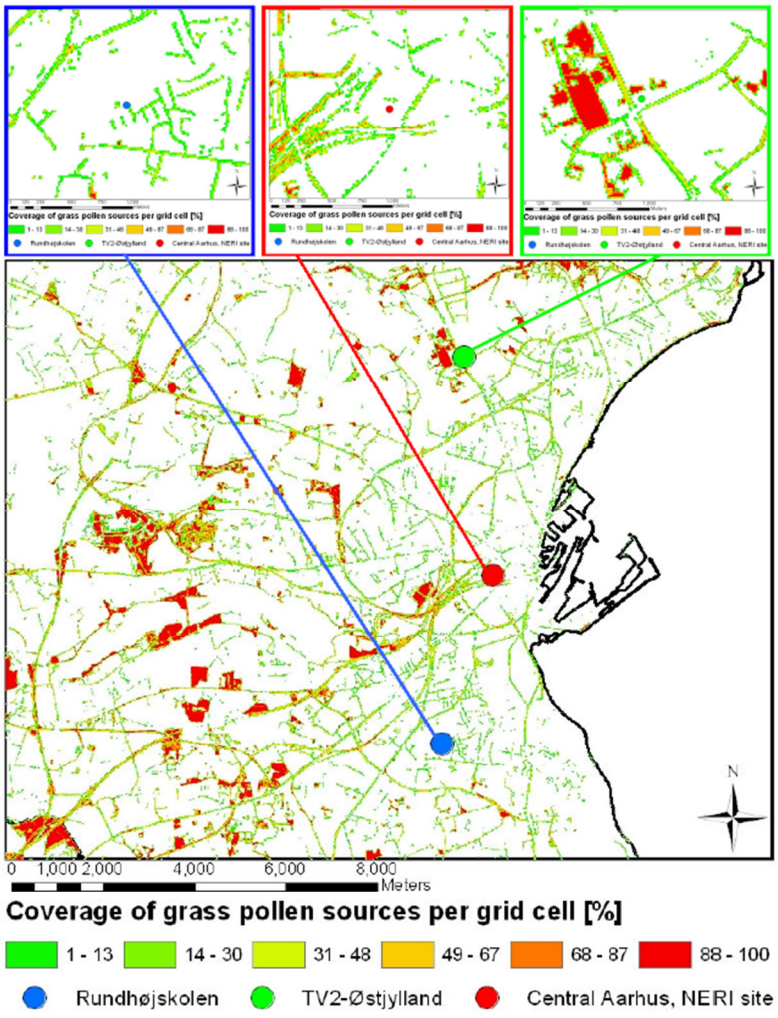


414

415 Fig 6. Meteorological observations of temperature, precipitation and wind direction at the

416 ENVS, AU monitoring site in central Aarhus.

417



418

419 Fig. 8. Inventory of high emitting grass pollen areas in the City of Aarhus (below) and zoom (top) that
420 provides the vicinity of the three pollen monitoring stations.

421

List of other technical corrections that have been made to the manuscript:

Page 14217: The name of the "Department of Environmental and occupational Medicine, School of Public health" has been changed to "Department of Public Health".

Page 14219, line 26: Changed from "… are in additional available in …" to "… are in addition available in …".

Page 14220, line 20: Changed from " … are near to spherical…" to "… are near spherical…".

Page 14220, line 25: Changed from "Grass pollen are released…" to " Grass pollen is released…".

Page 14220, line 26: Changed from " … of the birch pollen…" to " … of birch pollen…"

Page 14222, line 6-7: Changed from "… sampling was performed from Department of Environmental Science" to "… sampling was performed from The Department of Environmental Science, …" ....

Page 14222, line 8: Changed from "…monitoring station in Aarhus Ellermann et al 2007)." to ""… monitoring station in Aarhus , the former NERI station (National Environmental Research Institute) (Ellermann et al 2007)."

Page 14224, line 7: Changed from "the grass species does…" to " the grass species do…"

Page 14224, line 19: Changed from "… rye, (f) areas without…" to "… rye, and (f)areas without…"

Page 14224, line 22: Changed from "… map over Denmark." to "… map of Denmark".

Page 14224, line 27: Changed from "… structure and use." to " … structure and land use."

Page 14225, line 2: Changed from "… construction sites and un-managed…" to "… construction sites, un-managed…"

Page 14225, line 2: Changed from "…known to the parcel level…." to ""…known at the parcel level…."

Page 14225, line 18: Changed from "…. Science department…" to "… Science Department…"

Page 14226, line 7: Changed from "….and Fig. 5…" to"….and Figure 5…"

Page 14226, line 8-9: Changed from "… between the 2 June and the 5 July" to " … between 2 June and 5 July."

Page 14226, line 9: Changed from "… on the 2 June… locations on the 3 and 4 June" to"… on 2 June… locations on 3 and 4 June" Page 14226, line 12: Changed from "…. were measured at…" to " are measured at …"

Page 14227, line 3: Changed from " 3.3 Flowering or management map" to "3.3 Flowering map based on management".

Page 14227, line 10: Changed from "…and in absolute vicinity" to " and in the close proximity…"

Page 14227, line 20: Changed from "… until the 2 June" to " … on 2 June."

Page 14227, line 23: Added Figure referral : "… up to 27° C (See Figure 6). "

Page 14229, line 4: Changed from "… on the local scale." to " … on local scale"

Page 14229, line 8: Changed from "… are found in the direction of the high…" to " are found when winds are coming from the direction of the high…"

Page 14229, line 20-21: Changed from "This flowering…" to " The flowering".

Page 14230, line 1: Change from "…these concentrations will…" to "… the concentrations will…".

Page 14231, line 10: Change from "… resolution in their images such as …." to "… resolution images such as …."

Page 14231, line 11: Change from "… using other means of methods such as airplanes," to "… using other methods such as airplanes,".

Page 14231, line 23: Change from "… about 10 meter above ground level, according to traditional…" to "…about 10 to 20 m above ground level, and according to traditional…"

Page 14232, line 28: Change from "…developed to properly handling atmospheric …." to " … developed to describe atmospheric…"

Page 14234, line 27: Change from "… pollen from weeds-alone…" to "… pollen from weeds, alone…"

Page 14235, line 14: Change from "…assessments and forecast of pollen concentrations." To "…assessments and forecasts of pollen concentrations."