**Biogeosciences
Discussions**

Interactive
Comment

Interactive comment on "Development of a regional-scale pollen emission and transport modeling framework for investigating the impact of climate change on allergic airway disease" *by* R. Zhang et al.

S. M. Burrows (Referee)

susannah.burrows@pnnl.gov

Received and published: 3 April 2013

This manuscript deals with an important and interesting topic: the simulation of regional-scale pollen dispersal in a highly populated region of Southern California.

Pollen allergies are among the most common respiratory allergies, and they are likely to become an even greater concern as the incidence of allergies rises. Studies such as this one could potentially be used to guide public health efforts to reduce exposure to allergens. In addition, such a model framework could be used to study the interactions

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

of pollen and air pollution, which may cause greater incidence of allergies.

The methods in the paper are generally sound, the study is clearly presented, and the authors have carefully treated several important sources of pollen. To my knowledge, there is not yet a well-established method for treating pollen emissions in regional forecasting models. This study represents a further development of a parameterization proposed by Helbig et al. (2004), where the pollen emission potential has been more explicitly modeled as a function of meteorological variables. There are large uncertainties in the emissions parameterization, but the authors have acknowledged this, and it can be expected that the emissions parameterizations can be improved with further research. Given the complexity of the problem, it is to be expected that an initial attempt to build such a model will have both failures and successes, and the authors have carefully discussed these and pointed out some promising avenues for potential improvements.

As a final note, this manuscript relies heavily on the STaMPS model for regional pollen production. The STaMPS model has been described in a paper that is listed in the References as "submitted". Since STaMPS is an important foundation of this manuscript, it would be preferable if at least a discussion paper describing it were already available before the final version of this manuscript is published.

I recommend this manuscript for publication in Biogeosciences after the authors have addressed the comments below.

General comments:

1. Pollen size and settling velocity: The settling velocity of a pollen grain may differ significantly from the velocity calculated from Equation 6, because pollen grains are not smooth spheres. Many have very distinctive shapes, some of which are adapted to the function of increasing the probability of lofting or the time aloft. From the text, it seems that the values for the settling velocity in Table 1 were calculated from Table 6, and that these values of the settling velocity were used to calculate dry deposition in

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

the model. Please clarify this, and please also discuss how large the differences are between pollen settling velocities as observed and as predicted from pollen grain size. Could pollen clumping also modify this relationship? If I understood correctly, pollen grains are assigned a single diameter in the model (they are monodisperse)? Please clarify.

2. Discussion of uncertainties: p. 3990, lines 8-12: How large (roughly) are the uncertainties in species composition and fractional vegetation cover expected to be? On p. 3980, lines 22-24, you state that the vegetation distribution maps are "subject to large uncertainties". Do you expect these to be larger or smaller than the uncertainties you investigated in your sensitivity simulations? What about uncertainties in the pollen grain size and/or settling velocity?

3. Influence of canopy/release height: p. 4001, lines 24-26: could the overestimation of grass pollen and the underestimation of walnut and oak perhaps be related to their canopy heights and the parameterization of the "escaped fraction" (i.e. Eq. 2)? I notice that grass pollen has the lowest canopy height and oak and walnut have the highest canopy heights of all genera considered in this study (Table 1). According to Eq. 2, the model calculates lower emissions for species with higher canopy height. The reasoning seems to be that a higher canopy will more effectively prevent emissions? But what if the opposite is the case: a higher canopy also means that pollen grains are released higher above the ground, and so they might have the potential to be transferred farther before settling or impacting onto a surface. A pollen grain released from the top of an oak tree surrounded by grass must travel farther than one released from the grass, but Eq. 2 predicts the opposite.

Technical and minor comments:

p. 3978, line 13: "representation of vegetation"

p. 3984, Eq. 2: is this equation applied per genus, i.e. $H_s is a genus - specific value here (average of the species - specific values?)$

p. 3985, lines 7-8: please rephrase sentence so that it doesn't begin with a symbol

p. 3985, lines 22-23: The authors write that "The dry deposition ... is treated by calculating the settling velocity", but dry deposition can also be influenced by factors such as surface roughness. Is this taken into consideration? I recognize that these processes are calculated in CMAQ and are not the main focus of this study, but a brief explanation would be helpful. Similarly, please briefly describe the wet removal processes (in particular, are these also size-dependent?) For pollen, dry deposition is likely the dominant loss process, but wet deposition could still play an important role, so I think it should be described a bit.

p. 3985, Eq. 5: maybe this is explained in Helbig et al., but it would help to have a brief explanation in a sentence or two of this equation. Why should it have this particular form, how is the value of $U10_e determined? I believe U10_e is a single constant value (the same for all plant types? Should it depend on canopy height?), but thi$

p. 3985, line 24: insert "the" before "slip" and "viscosity"

p. 3985, line 25: "The hourly ..."

p. 3986, line 12: "climate change on air quality"

p. 3987: "levels of 950 child participants..."

p. 3989, line 6: "while the horizontal"

p. 3990, line 2: "sensitivity runs" -> "sensitivity simulations" (here and wherever else this occurs)

p. 3990, lines 4-6: Does this refer to boundary conditions for the pollen concentrations? This is what I infer from Table 1, but it is unclear here.

p. 3990, line 19: "wind conditions"

p. 3990, line 25: please rephrase sentence so that it doesn't begin with a number or

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

symbol; "mean diameters"

p. 3991, line 28: "show" -> "shows"; perhaps delete "pretty"

p. 3992, line 16: "domain-wide" -> "domain-averaged" (I think this is what is meant?)

p. 3992, line 17: "tree"-> "trees"

p. 3993, line 1: "concentration" -> "concentrations", "single site, OALT,"

p. 3993, line 10: "level" -> "levels"

p. 3993, line 12: "a new species lumping scheme was developed" – new compared to what previous scheme? Are both schemes introduced in Duhl et al. (2013, submitted)? Would there be a more descriptive way of naming these schemes, something along the lines of "with and without separation of early bloomers" rather than "new and old"? (similarly in Fig. 4f-2).

p. 3994, line 24: "Due to the relatively short lifetime of pollen grains in the atmosphere..." – about how long are the simulated lifetimes of the pollens in this model?

p. 3997, lines 16-17: if there are spikes in the concentration due to a nearby source, wouldn't these influence the observations as well as the model?

p. 3999, line 19: "trend" -> "relationship"

p. 4000, line 1: "based on a dataset"

p. 4001, line 4: maybe "Pollens" -> "Pollen grains"

p. 4001, line 23: "maximums"-> "maxima"

p. 4002, line 3: "by the MEGAN/STaMPS model"

p. 4002, paragraph beginning line 14: here you discuss some limitations of the model and missing processes. It might also be appropriate to mention uncertainties in the

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

pollen size distribution more generally, not only the uncertainty arising from not considering pollen fragments. Since the dry deposition rate is quite sensitive to particle size and settling velocity, how much does it matter that you use only a single average value for each genus (and apparently a monodisperse aerosol)? Is pollen clumping a possible problem? This is addressed in part by your sensitivity tests, but I think it is worth adding a few sentences.

Also, it is worth mentioning wet removal here: rainfall location and timing is difficult to predict over uneven terrain such as the Sierra Nevadas, but a single rain event could effectively wash out most pollen from the air. So, uncertainties in rainfall prediction are another important limiting factor.

p. 4002, line 25: "trigger" -> "triggering"

Figures and Tables:

Several of the figures have labels that are very small and may be difficult to read, especially Fig. 4, Fig. 8, Fig. 9. This might be corrected simply by printing the figures in a larger format in the final typeset version, but please check this.

Tab. 1: as noted above, these seem to be quantities calculated from the diameter, but the actual settling velocity may differ. It might be worth noting in a footnote that this is the case, i.e. that these are calculated from the diameter.

Tab. 2: "compare"-> "compared" (four times in second column); there is a formatting problem in the third column which can be solved in LaTeX by using the command .

Fig. 10: Please provide more information about the back-trajectories in the caption (e.g. "three-day back trajectories from HYSPLIT"). I'd also suggest writing something like "with pollen concentration boundary conditions from outer domain simulation (BCOND) and without (BASE)". Also, the bars in the right panel are difficult to distinguish. A different choice of colors could help, but it might be simpler to use a line or point graph instead.

Interactive comment on Biogeosciences Discuss., 10, 3977, 2013.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper