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12, C10481–C10492, 2016

Interactive Comment

Interactive comment on "Estimates of common ragweed pollen emission and dispersion over Europe using RegCM-pollen model" *by* L. Liu et al.

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Anonymous Referee #1

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Review of the article Estimates of common ragweed pollen emission and dispersion over Europe using RegCM-pollen model by Liu et al (2015) The study present a model developments and simulations with the RegCM model during the period 2000-10 with focus on ragweed pollen

Author's response: We would like to thank Referee #1 for the detailed comments and suggestions, which hopefully will help to improve the manuscript a lot. Please find the specific responses below and a revised version of our manuscript.

General comments: 1. The topic address a relevant scientific questions that is within the scope of Biogeosciences: Interactions within the biosphere-atmosphere system

Author's response: Thanks for the comment.

2. The manuscript presents the RegCM model and the pollen emission estimates. This modelling framework was previously presented by Hamaoui-Laguel et al. (2015) so there appears to be limited new knowledge with respect to concepts, tools and ideas. The study use 46 sites, but there is no information on the data from the sites except for a map (e.g. Fig 2) and scatter plots (e.g. Fig 4). This suggest that overall there is limited new information in this study.

Author's response:

a) Although it shares some common points with Hamaoui-Laguel et al., 2015, the modelling framework presented here shows nevertheless substantial differences:

In Hamaoui-Laguel et al. (2015), the pollen production is "externally" calculated from ORCHIDEE land surface model, in which a process-based phenological model (PMP) is used to simulate ragweed pollen season. The daily pollen production is then injected in CHIMERE and RegCM atmospheric model respectively to calculate the pollen release and dispersion.

In the RegCM-pollen modelling framework, plant distribution, pollen production, phenology based on biological day, flowering probability distribution, pollen release and transport are all calculated within the same RegCM system and using CLM45, which is the land surface scheme coupled to RegCM.

This on line approach allows for example for improved consistency between simulated pollen production, vegetation and climate, and a higher frequency of coupling between simulated meteorology, pollen release and transport. The methodology employed here shows also a different approach than the PMP developed by our colleagues working with ORCHIDEE. We believe that there is enough substantial new material in this re-

BGD

12, C10481–C10492, 2016

Interactive Comment

gard to justify a new publication.

Moreover, in this paper, we carried out a specific evaluation about ragweed pollen risk on a decadal time scale and discuss it in terms of statistics relevant to air quality and health impacts. This to our knowledge has not been specifically proposed for Ambrosia pollen over Europe. We believe this is a meaningful discussion, although there are of course uncertainties.

b) About observations, we fully agree with Referee #1' comments in this regard. We also believe that observations are of primary importance and included for any model development. As also detailed further, additional information are given about stations and measurements in the revised manuscript (new table + rewriting section 2.1).

3. The conclusion that are reached are substantial as they conclude that the simulations are possible with the RegCM model. However, as far as I know, then their approach on simulating pollen emission is not new. Similar methods are to my knowledge used in both European and American models such as COSMO-ART, CMAQ, SILAM, KAMM/DRAIS and a number of other models. So it would be good to be explicit on what is the difference with this method and e.g. the method published by Prank et al. (2014) or Helbig et al. (2004) and Sofiev et al. (2013), which they rely on.

Author's response: We agree with the Referee #1 that our model system is based on existing parameterisations which might be fully or partially used in other modelling framework. These precursor studies have been acknowledged by appropriates citations. The originality of our approach lies more in the modelling suite that we used and how we combined different parameterisations for different aspects of pollen modelling: Our general approach on simulating pollen emission is based on pollen flux formula presented by Helbig et al. (2004). This formula involves pollen production, flowering probability, pollen season, flux response to meteorological conditions. However, for the calculation of these different terms we proposed different approach than reported in Helbig et al. (2004), accounting for more recent studies. For example, we calculate annual pollen production based on the plant biomass according to Fumanal et al. (2007) instead of a constant one. For flowering probability distribution, we use the normal distribution function reported by Prank et al. (2013). But for pollen season, we adapt the mechanistic phenology model of Chapman et al. (2014), and for short term modulation of flux from meteorological conditions, we follow Solfiev et al. (2013). Technically, these parameterisations have also been adapted to match the CLM45 framework. In Sect. 2, we give a detailed description of model development and related reference. For improved clarity in our goal, we also rephrased introduction and conclusion sections.

4. The atmospheric modelling techniques are well founded by using established methods. However, the observational record that is used in this study is largely undescribed, except for a map and the number. As a minimum a list with names, coordinates and a basic description of the observations record is needed (e.g. start dates, pollen index etc).

Author's response: We fully agree with Referee #1' comment and suggestion. In the revised manuscript, we added Table 1 to give the general information about the observational records, including site name, coordinate, years available, annual pollen sum, pollen season, and simulation errors. We also modified the description of pollen observations. Please see the Sect. 2.1 observed pollen concentrations.

5. The conclusion appears to rely on a weak foundation as the observational data is not presented. Additionally, then the authors validate their results against the same calibration data set. A result of this approach is that the conclusion of the simulated pollen concentrations in Europe, are less well founded (page 17617, line 10 and onwards). As a minimum then the authors should have introduced an error estimate of their simulations (e.g. by using cross correlations) and probably, then the study should be limited to areas with a decent number of station coverage such as France and the regiona around Croatia.

Author's response:

We fully agree with Referee #1's comment. We hope that the additional information about stations will strengthen the manuscript. One should point out here that the availability of free public data for ragweed pollen is unfortunately limited. We try to use the best data sets available to us at the time. Ideally, we agree that model validation shall be conducted using another data sets. On the other hand, since we wanted to perform a risk assessment, we felt that it was important to do so by using a version of the model optimized with regards to the data we have. Nevertheless, estimation of the uncertainties and cross validation is certainly a very important point that we have now addressed in the revised version:

We implemented a 5-fold cross validation to estimate the error and sensitivity of our calibration method to the individual stations. The 44 sites are randomly divided into 5 groups. 5 calibration experiments are conducted each time with one group left and used for validation. The results of the 5 validation groups are then combined to assess the final performance. With this approach a model measurements Pearson correlation of 0.54 is obtained together with a normalized root mean squared error (RMSE) of 21%. Without surprise, this is less than when using the full data sets for calibration. In particular few stations with particularly high concentrations protruding from surrounding sites (for example, ITMAGE and ROUSSILLON) have a large impact on the results of validation. We compared our cross validation (8 or 9 sites left out each time) with three papers about ragweed pollen source estimation over the Pannonian Plain, France and Austria (Skjoth et al. (2010), Thibaudon et al. (2014), Karrer et al. (2015)). Their cross validations (one site left out each time) show corresponding correlations of 0.37, 0.25, 0.63 and root mean squared error of 25%, 16% and 3%, respectively. Our results are within this range. We agree that caution should be taken in areas without a decent number of station coverage where the calibration cannot be done. The revised manuscript includes this cross validation material and the text has been modified accordingly.

However, for the impact assessment section, we think it is justified to use the best

BGD

12, C10481–C10492, 2016

possible calibration based on all observations available to maximize the model performance. We should also outline that the full calibration is performed on the mean annual pollen sum while the model validation is performed on daily time series, relevant for impacts. Simulation of daily concentration evolution along the season, as well as pollen sum interannual variability are directly connected to model skills. Please see the modification in Sect. 3.1 and Sect. 4 Summary and conclusions.

6. The lack of data presentation makes it impossible to allow for a reproduction of their results. Without the calibration data it is not possible for me to assess the methods and verify the quality. The calibration data appears to be the most important component in the entire system(e.g. the substantial increase in correlations).

Author's response: We hope the additional information about data will help for the manuscript assessment. Please note that we also regret that data more easily and publically accessible.

7. I have the impression that the authors do not give credit to the work that provided the observational record. There is no description of the data sites, a limited description of the observational method and the data source is limited to the acknowledgement section.

Author's response: We absolutely respect the hard work and investment of the data providers. We are sorry for giving the reviewer, and the potential reader, such an impression. As mentioned before we modify the description of pollen observations and add a table to give the detailed information about observation records. Please see the Table 1 and the Sect. 2.1.

8. The title does not clearly reflect the contents of the paper. According to their results, then the observational record is the most important component (the large increase in correlations), but this is not reflected in the title

Author's response:

BGD

12, C10481–C10492, 2016

We thank Referee #1 for his/her comment. Please note that "calibration" is used in a modelling approach for bypassing a lack of constraints on important parameters for example ragweed density distribution (which should be probably a scientific priority, though very challenging).

Similar calibration methods have been used by Prank et al., (2013), Hamaoui-Laguel et al., (2015), Skjoth et al., (2010) and other authors. Our study is not about a new measurement method or pure statistical analysis of data, but about pollen modelling in regional climate model, calibration being one important aspect for its application to impact study. We can thus propose a new title which hopefully will reflect more the nature of our study:

"Ragweed pollen production and dispersion modelling within a regional climate system, calibration and application over Europe"

9. The abstract do to some degree cover the contents. However the parts on health risk appear to be unfounded as this require estimates against thresholds, which is not done in this study.

Author's response: We perform risk assessments estimations using explicit health related threshold in Sect. 3.4 of the initial and revised manuscript.

10. The overall presentation is clear and easy to follow.

11.The language is fluent and precise

12. The equations and symbols are well defined

Author's response: Thanks to Referee #1 for his/her comments.

13. The manuscript contain a lot of figures. Many figures could be removed if the authors used a few tables.

Author's response: Thanks for these suggestions. Figure 5 and the relative description in Sect.3.1 have been deleted. Figure 7 is deleted and the fit results of pollen season

BGD

12, C10481–C10492, 2016

Interactive Comment

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Interactive Discussion

Discussion Paper

are put into Table 2. Figure 8 is deleted and pollen season and simulation accuracy in Figure 8 are put into Table 1.

14. The used scientific literature is recent and relevant

Author's response: We added four references following the revision we made in the new manuscript.

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Thibaudon, M., Šikoparija, B., Oliver, G., Smith, M., and Skjøth, C. A.: Ragweed pollen source inventory for France – The second largest centre of Ambrosia in Europe, Atmos Environ, 83, 62-71, doi:10.1016/j.atmosenv.2013.10.057, 2014.

Minor comments:

a) The figure on initial guess and calibrated ragweed density map appear to have very little similarity with related regional maps published by Karrer et al. (2015), Smith et al. (2013), Thibaudon et al. (2014) in areas without a dense observational network. As an example then it shows that there is substantial infection in the UK even though it is well known that the UK has very few ragweed populations due to unfavourable ecology (Essl et al., 2015) and ragweed pollen are rarely found in the UK pollen counts (Pashley et al., 2015). This put a question to the foundation of the study and in which area the model results are usable. Also, their results leaves the impression that this study is an advanced way of developing an correlative model (although with an atmospheric model in between) where they have heavily tuned a model against a limited set of available observations and then validated their model against the same set of observations (e.g. Fig 7).

Author's response:

The difference between ragweed density maps presented by different authors could be related to the methods for estimating pollen source. The regional maps published by Karrer et al. (2015), Smith et al. (2013), Thibaudon et al. (2014) are based on annual pollen sum, plant ecology in relation to elevation, and land covers information that identifies the main ragweed habitats. Then ragweed density in areas without a dense observational network is mainly determined by elevation and land covers. The first guess density (without calibration against annual pollen sum) presented in this paper is based on infestation rate related to observed presence as reported in Bullock et al. (2012), suitable land use surface, and climate suitability index from Storkey et al. (2014). Bullock et al. (2012) (please see their Figure 3-29) collated records as far north as Scandinavia and still substantial presence in southern margin of UK, although most records are considered as casual. The climate suitability indexes in south UK are classed by Storkey et al. (2014) as established but less established compared with those of central EU. Accordingly our first guess density in southern margin of UK shows a bit substantial. The calibrated ragweed density in this part almost stays the same because of no observations nearby available. The site of Leicester or Derby in Pashley et al. (2015) is bit north than this area so ragweed pollens are rarely found. We acknowledge it is expedient to estimate the abundance of ragweed distribution from its presence without actual plant investigation.

BGD

12, C10481–C10492, 2016

Interactive Comment

We adapt the mechanistic phenology model of Chapman et al. (2014) to simulate the flowering season. We think the biological day (BD), which in relation to temperature, photoperiod and soil moisture, represent the ragweed pheonological evolution to some extent. But the parameters of this model are determined from controlled conditions and we still know little about how ragweed plant adapt to natural environment. So we have to adjust multi-year mean BD threshold of each site against observation to reflect its local adaptation. According to reviewer' comment, we validate phenology model using pollen observations of 2011 and 2012 (Table 2). Despite lower correlations, starting dates in both years and ending dates in 2012 are predicted reasonably well with 38.5, 28.7%, 26.1% of the explained variance. The model however fails in predicting central dates in 2012 with low correlations to experimetally determined dates. Even so the prediction errors of RMSE for all dates in both years are well controlled and the differences between fitting and prediction RMSE are kept within 1.6 days, which means degradation of model performance has limited effects on the prediction of pollen season. Extending the fitting to several years of observation may contribute to improve the stability and robustness of the fitted threshold and further improve the phenology modeling of ragweed. Please see the modification of Sect. 3.2

b) It is important that a number of relevant ragweed models are developed as it is unlikely that there will be one specific models that will be the overarching model that always perform the best. Due to this I consider it important that this study is fully published. However, based on the 14 points above as well as the minor comment, then it is my impression that major changes are needed in this manuscript.

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BGD

12, C10481–C10492, 2016

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BGD

12, C10481–C10492, 2016

Interactive Comment

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Author's response: We thank Referee #1 for his/her in depth review of the manuscript.

Interactive comment on Biogeosciences Discuss., 12, 17595, 2015.