Interactive comment on "Development and evaluation of pollen source methodologies for the Victorian Grass Pollen Emissions Module VGPEM1.0" by Kathryn M. Emmerson et al.

Anonymous Referee:

General comments: I would like to thank Ms Emmerson and colleagues for submitting an interesting and detailed manuscript which describes a thorough assessments of the different prognostic approaches used in the grass pollen emission-source methodologies in their model (VGPEM1.0), applicable to Victoria, Australia. The publication also includes an excellent review of most of the relevant material on pollen emission modelling approaches to date, nicely summarising the limitations of regression versus statistical approaches. Whilst focussed on specific pollen type as might be expected and germane to this study region (*Poaceaea*) this is justified due to the significant health impacts, as highlighted by the thunderstorm induced asthma dispersal incident referenced, and the results produced are useful. The link to EVI is also useful. As discussed in section 3 of their manuscript the modelling approach does not include some of the more detailed mechanisms associated with pollen emission, that may impact pollen production and re-suspension etc. which may influence the variances discussed, but this is justified due to the lack of quantitative observational as well as modelling information for these mechanisms. The POD, FAR and ETS approach is well described although some context would be helpful.

Pollen types and sources can of course vary enormously across the globe but this work provides much needed evidence with good statistical analysis for different approaches and their applications to other regions and pollen types.

There will be many in the community who welcome this work as highlighting a growing need for pollen and other allergen/pathogen consideration in pollution modelling.

In my opinion the manuscript is worthy of publication. Only very small changes are needed in order to clarify certain areas (for the non-pollen experts) with answers to minor questions to help support one or two sections with occasional reflection in the conclusions.

Comments

1. There a couple of other studies that might be worth referencing to place this work in a more global context, e.g. Lake et al. (2017),and Pasken and Pietrowitz

2. Section 2 Observations and characteristics of grass pollen. You list the pollen risk categories specific to Victoria/Australia. How do these factors relate to international risk factor league tables e.g. in the USA (where other factors such as Pollen and Overall national Capital Risk Factors for individual cities are produced or clinical risk factors in the EU usually in terms of grains per year, e.g. Agnew et al. 2018, Int J Environ Res Public Health).

3. Section 3.1.6 Statistical Models. The limitation of the statistical models due to coarseness of the temporal training data (daily) is understood, however a sentence might be useful here explaining how this limitation is linked to the actual physical emission mechanism timescales via the gross timing function and day to day expected variation.

4. You show the non-linear relationships between VI, V2 model pollen responses and temperature, rainfall and relative humidity (Figure 4) – I assume the grayed areas represent the variances in each case? – So, can a brief sentence or two be included in this section to explain/summarise how these meteorological drivers actually physically relate to the pollen emission mechanisms please?

5. How representative are these responses, especially temperature, for Australia generally and for this pollen type in particular? I am thinking of the study by Viner et al, 2010, as also pointed out by the Editor regarding the timing response.

6. Can this statistical approach be robust enough to respond to inter-annual variations?

7. How representative might these relationships shown in Figure 4 be with respect to inter-annual variation (will the EVI approach take this into account)?

8. How do these dependencies, especially with temperature, compare to other pollen types described elsewhere in the literature as this obviously has implications for the risk factor analysis particularly if it is to be extended to other regions? A brief sentence on this might help with context.

9.Page 13, line 6. You state that "Transport of pollen from the productive grasslands in the west of Victoria to Melbourne would rely on the U wind vector being modelled accurately, however the model lifetime of these pollen grains is 6 hours over a height of 1 km; too short for pollen emitted near Hamilton to reach Melbourne.`'

You pose the initial question suggesting you will justify this but then ignore the point by assuming it is modeled correctly in order to justify the conclusion that these grasslands were not the source. Perhaps you could rephrase this sentence to make it less confusing?

10. Page 13, line 8. You state "We extracted the boundary layer height from the model (unavailable in the observations), which showed that the modelled grass pollen is more strongly correlated to atmospheric dilution (average r=0.61) than it is to temperature (average r=0.44). The model RH is more negatively correlated with grass pollen levels (average r=-0.52) than is observed." Now going back now to Page 10, where you state that, "This decline in concentrations may be due to increased boundary layer heights (and thus greater effective dilution) rather than a decrease in emissions."

The latter statement I agree with but is this consistent with your statement about that a growing boundary layer depth is accompanied by a sharp drop in temperature – is this correct? Have I read this correctly? One might expect that the concentrations are inversely related to the volume of air available for vertical mixing from the surface to the boundary layer top, or more precisely the mixed layer. So, increasing boundary layer height due to increasing convection during the day (and surface temperature)~ would lead to increased dilution due to turbulent mixing and dispersion in the lower boundary layer (unless in a zone impacted by strong recirculation from convective outflow or topographic influence). I believe this is generally observed in Melbourne. A drop in temperature response does not seem consistent?

As I understand it the impacts of summer versus winter boundary layer height development can significantly influence pollutant concentrations in Melbourne whilst the wind direction, e.g. from the local hills and vegetation sources in summer, influences the background tracer concentrations (Coutts et al. 2007, Atmos.Env.)? In addition sea-breezes can also be important in Melbourne and I understand the wind rose for Melbourne displays a very strong annual N-S bimodality with higher frequencies of average winds from the N but of course higher frequencies of much stronger winds from the ocean, S (BoM)?

Perhaps a sentence or two describing the known evolution of the boundary layer height with time of day in the measurement period specific to Melbourne would help put this section in context. It would also be useful for the general readers (even if only by reference to previous work. I note you state there were no contemporaneous observations)?

Although it is not necessary to reference this study the issue of significant variation of pollen concentrations with height may need to be discussed here, e.g. see Damialis, et al. (2017), Nature Scientific Reports. The latter compares surface, tower and aircraft measured pollen concentrations with altitude.

11. Perhaps you could include a brief summary of the wind climatology (your U and V components) as this is central to predicting wind pollinated species. This would also be helpful to place your wind thresholds in context, especially in terms of how these contribute to emission mechanisms and the correlation (or lack thereof`) you observe with these thresholds.

12. Section 5 Conclusions. How do your conclusions regarding the wind and RH correlations in particular compare with European and US studies?

13. Would it be helpful to include a statement concerning how much variation the smoothed statistical approach potentially might miss over and above the seasonal maxima?

References

Damialis, et al. (2017), Estimating the abundance of airborne pollen and fungal spores at variable elevations using an aircraft: how high can they fly? Nature Scientific Reports, 7, Article number: 44535.

Lake, IR, Jones, NR, Agnew, M, et al. Climate change and future pollen allergy in Europe. *Environ Health Perspect.* 2017; 125: 385- 391.

Pasken, R. and J.A. Pietrowiez (2005) Using dispersion and mesoscale meteorological models to forecast pollen concentrations, Atmos. Environ., 39, 2689-7701.

Viner, B.J., M.E. Westgate and R.W. Arritt, 2010: A model to predict diurnal pollen shed in maize. Crop Science 50, 235-245.