S. Mikkonen (Referee)

For clarity the referees comments are copied in black and our responses are offset in blue.

The paper uses Hierarchical Agglomerative Cluster analysis to classify the emissions of the bioaerosols. The article is well written and my recommendation is that it should be published after the questions below are answered.

We thank Dr Mikkonen for his helpful comments and recommendations which we address below.

General comments:

In the Introduction authors state that the temperature would also be a significant factor affecting to the concentration of biological aerosols. Did the authors test the effect of temperature or other meteorological factors in their data? Or did the classification of the data into "dry" and "wet" act as indicator for all meteorology?

We tested several meteorological parameters and found that RH and rainfall had the most pronounced effects. The segregation of data into dry and wet periods was necessary as the behaviour of the bioaerosol was distinctly different in each case suggesting a delayed/non-linear response. We feel that this simple segregation captured this behaviour well.

I would also like to see more proofs that the results from the two measurement points are really comparable. Even local meteorology may cause differences to the measurements. Wind conditions combined to some local source might be this kind of effect.

We reference and highlight this was previously done by Robinson et al. (2013) who intercompared the two instruments, both in the laboratory and it the Manitou site during this same experiment. They applied detailed cluster analyses to the time series from each instrument and showed very good agreement between the two locations. For the sake of brevity we have omitted duplicating this information in the data quality section and we refer the reader to Robinson et al. (2013) for further details. Differences in particularly the fungal spore cluster concentrations however might be expected as the majority of fungal plants (90%) are assumed to not contribute to the "escape fraction", Gregory (1962).

Specific remarks:

Page 2513: The authors discuss about the cluster solutions. The clusters should be introduced also in here, not just refer to Robinson et al. The results are hard to follow if the definitions of the clusters are not easily accessible. However, cluster analysis is a legitimate method for this kind of study.

We will introduce the clusters here for clarity as suggested, however again we also refer the reader to the previous technical work by Robinson et al.(2013) who discuss these in detail for the same data set.

Section 6.1: The polynomial fits

Reviewer 1 already asked for the physical justification of the polynomial fit but I would also like to know the goodness of fit of the function. In addition, I would like to hear the authors comment on the generalizability of the polynomials. Especially with small number of observations three or five order polynomials may fit perfectly to the measurements but will not fit any other similar data.

Instead of building an overfitting polynomial could it be possible to construct a multivariate nonlinear function with other meteorological parameters?

> For small numbers of observations polynomial overfitting can of course lead to significant biases and in addition tends not to elucidate further the underlying causal mechanisms, however, they can be useful in interrogating differences between behaviour and are often used in biogenic emissions parameterisations where laboratory studies have already identified the key meteorological drivers to controlling emissions mechanisms for investigation. In our case the number of observations within the selected variable range are extensive and in addition we have restricted the polynomial fit only to the domain where the returned fit is usable and meaningful. Beyond these ranges we would not of course recommend extrapolation, which is one of the problems with such approaches. We are preparing a further publication comparing the different approaches, including the one suggested by the reviewer in parallel with different cluster analysis techniques.

Page 2516, lines11-18: In fig 5 the scaling of the two plots somewhat misled me first. There seems to be decreasing trend in the concentration starting around the time of sunrise and ending few hour after noon. This clearly related to air temperature or solar radiation. This also relates my comment above: the effects of local meteorology should be discussed more

> Cluster C_3 is behaviourally consistent with bacterial aerosol as described by many laboratory studies. P. syringae has been demonstrated to be sensitive to UV radiation on the time scale of hours. Cazorla et al. (2003) showed the number of colony forming units of P. syringae to be significantly reduced after 4 hours exposure to UV radiation. Whilst we did recognise this the trend in fig. 5 is small, and so we were wary of over interpreting such analysis. However, we thank the reviewer and will include a discussion of the influence of UV radiation on the likely bacterial cluster in the revised manuscript. The trend would also be consistent with the concluding argument and linking references discussing the contribution by daytime convection to plant bacterial emission. In particular at this high altitude site it may be that this observed cluster trend represents a more UV resistant bacteria class, again consistent with the reference airborne measurements.

Page 2516, lines 19-23: What causes this diurnal variation? Is it a function of solar radiation?

> We are unsure of the biological origin of cluster D_3. Response to solar radiation and temperature would be consistent, but without knowledge of what this cluster actually is and hence known emission mechanisms, it is difficult to say and requires further study.

page 2520, lines 8-11: is RH a cause or indicator for this?

> RH is a cause. It is well known that relative humidity (and air velocity) influences surface emission rates of fungal spores although the emission rates are likely a complex combination of factors that may vary from species to species, e.g. wet discharge basidiospore and ascospore types. For the majority of species that adopt the wet-discharge mechanism, co-emitted fungal spore polyols such as mannitol and arabitol, also exhibit positive correlations with relative humidity, and organic carbon PM shows the same behaviour, Zhang et al. (2010).

Page 2521, Eq 5: I would like to see some goodness-of-fit estimate for this.

We will include a goodness-of-fit estimate in the revised manuscript.

Page 2522, lines 5-6: Is the correlation calculated or “visually observed”?

This correlation is visually observed.

Page 2526, line 25 onward: Does precipitation induce production or reduce sinks?

We believe that mechanical agitation caused by rain liberates bacteria from plant surfaces. In this sense it is an increase in production and not a reduction in sinks.

References:

Cazorla et al. (2003), Epiphytic Fitness of Pseudomonas syringae pv. syringae on Mango Trees is Increased by 62-Kb Plasmids, Pseudomonas syringae and related pathogens SE – 8, 10.1007/978-94-017-0133-4_8

Gregory, P H (1962), Pollen spores

Robinson et al. (2013), Cluster analysis of WIBS single-particle bioaerosol data, Atmos. Meas. Tech., 6, 337-347, doi:10.5194/amt-6-337-2013

Zhang, et al. (2010), Contribution of fungal spores to particulate matter in a tropical rainforest. Environ. Res. Lett. 5. doi:10.1088/1748-9326/5/2/024010