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Interactive comment on "Ecosystem–atmosphere exchange of microorganisms in a Mediterranean grassland: new insights into microbial flux through a combined experimental-modeling approach" *by* Federico Carotenuto et al.

Anonymous Referee #3

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General comments

Carotenuto et al. investigated the ecosystem-atmosphere exchange of microorganisms in a Mediterranean grassland using flux-gradient measurements and a model that simulates biological production of microorganisms and the meteorological drivers of their emissions into the atmosphere. The presented research is of great interest because while concentration measurements of bioaerosols are getting relatively common, flux measurements are much rarer. Further, they designed an emission model to estimate the net flux of microorganisms from the phyllopshere to the atmosphere, which simulates the biological production of microorganisms and the meteorological divers of their emission. However, I have a number of serious concerns with the model that should be addressed before the paper can be considered for publication.

Specific comments

Some equations contain errors and units are missing or incorrect for a number of parameters, see the specific comments below. There are also a number of inconsistencies between the equations in the MS and in the code. I am puzzled most by the formulation for microbial population growth: is it assumed to respond instantaneously to changes in driving variables (temperature)? If so, is that a valid assumption on the 30 min. time step that you applied here, and at which time step would this assumption brake down? Or are the dynamics of the microbial population calculated transiently? Moreover, the formulation and units of eq. 8 are inconsistent, which is where most of my confusion comes from.

Why is only gravitational settling considered as removal mechanism? Other dry deposition mechanisms can be relevant for particles of the assumed size (3.3 um). How sensitive are the calculated dry deposition fluxes to assumptions on the particle diameter?

The title promises new insights into microbial fluxes, but I do not see them in the abstract or conclusions. What are for instance the 'underlying driving forces (P12,L25)' of microbial emissions? What new insights has the combination of the flux measurements and the emission model yielded into these driving forces? Could you highlight these findings in the abstract and conclusion?

I would like to see some more discussion on which types of microorganisms are sampled. The MS mentions viable microorganisms. Does that include both bacteria and fungal spores? Besides, can you say something about the size range of the observed particles? This will be important to eventually evaluate the role of the emitted bioaerosols on climate.

P2,L21: in addition to these papers, (Crawford et al., 2014) measured PBA fluxes using the flux-gradient method, and (Ahlm et al., 2010; Whitehead et al., 2010) measured fluxes of coarse aerosol in tropical forests (presumably PBAs) using eddy-covariance

P5,L2: competition is mentioned here as a driver of the microbial dynamics, but I don't think it is actually included in the model. Please limit this description to processes that are included in the model.

P5,L30: why is only gravitational settling included? For supermicron particles, also inertial impaction is important.

P6, eq8: I have some serious concerns regarding this equation, both as presented in the MS as in the code; this equation has microbial population size in the same units as the microbial growth and emission flux, which cannot be true. Should it read dN/dt=rN-Fn? In that case, it would represent exponential growth of the microbial population and loss due to emission. In the code, it is implemented as N(t)=N(t-1) + N(t-1)*r + Fn, in which units are also inconsistent. It could be solved by multiplication of the 2nd and 3rd term on the RHS by the timestep, which would yield a discretization of the equation for exponential growth.

P6,L24: it is unclear what is meant here: 'kmin, which is the point at which all process find an equilibrium'

P7, L14: can you discuss how this choice has affected your results? This number seems to be important in determining the upper and lower bounds of the modeled microbial population.

P9,L28-31: strictly spoken, the Burrows et al 2009a study does not discuss the effect of PBAP on precipitation, which is what this sentence seems to imply

P9,L32: I would add transport to 'emission-deposition process' (e.g. Wilkinson et al., 2012)

P10,L28: what does it mean if the 95% confidence intervals include 0 and 1 or not?

P11,L2-12: I miss a discussion here on the use of online detection of PBAs using fluorescence measurements (e.g. Gabey et al., 2010; Huffman et al., 2010) or single particle mass-spectrometry (Zawadowicz et al., 2017). These techniques measure concentrations, but could in principle be used in combination with micrometeorological techniques to measure fluxes (e.g. Crawford et al., 2014).

P11,L18: it is unclear what is meant here: 'it is not to underestimate the long-term importance of evaluating the viable fraction of said fluxes'. Please rephrase

P12,L9-10: is rain rate given in mm/hour here?

Fig. 6: with half-hourly observations and model data available, why are only daily average fluxes given? In addition, it would be interesting to see time series of observations and model data.

Technical issues

P4,L15: unit is missing for z0

P5, eq 2: in the code, Nk_max is given as N/k_max, which seems correct to me, as it would express the population scaled by the carrying capacity, and judging by the units. Besides, the values of m1-m3 differ slightly from those in L19. What are the units of m1-m3? They cannot all be unitless (as mentioned in Table 1 and 2) when Fe is in CFU m-2 s-1.

P6, eq 9: this equation seems to be missing an exponent ((Topt-Tmin)/(Tmax-Topt)), which is included in the code. What is the unit of r? Based on eq. 8 it should be s-1. Then also c should have this unit, and not none, as mentioned in Table 1 and 2. Please check these and other units throughout the MS.

P9,L9: won't -> will not

P10,L23: remove 'it'

P10,L24: the Planet -> Planet

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Discussion paper

P11,L1: a scaling -> scaling

P11,L14: transmit -> transmitting

P11,L15: represents -> represent

P11,L16: the atmospheric -> atmospheric

P12,L6: acting -> act

P12, L32: which is nested -> which it is nested

P12,L14: has-> have

P12,L24: suggest adding a comma between ‘precipitation and’

P12,L32: which is -> which it is

Fig. 3 and 5: Data within years are plotted as if they represent time series (with continuous lines), but this is not always the case. This makes the plots hard to interpret. Besides, time labels are placed at irregular intervals. Pls update these figures to make them easier to understand.

In the code at L305: in the Cc calculation, a factor of 2 is missing in the exponent

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