Referee 2

> ***The manuscript addresses source apportionment using a Bayesian statistical approach. This is a departure from standard source apportionment techniques and the approach has some conceptual merit in that it reduces reliance on measurement uncertainty matrix inputs and therefore facilitates the inclusion of additional parameters. The generation of a test dataset and the analysis using established positive matrix factorization and the novel Bayesian approach is helpful in move the science forward in this area.***

Thank you for the review. Please see our responses to specific comments below and in the answers to referee 1.

> ***For the wider application of this approach, it would be useful to understand what the computational speed is when compared to PMF.***

We added a consideration regarding the computational speed to the manuscript:

"Another area of development is computational speed, for the dataset sizes discussed here running BAMF takes few hours on a modern computer (Intel Xeon Silver 4110), but the time increases as the data size increases."

> ***For PMF, alternative factor solutions below and above that chosen should be reported and discussed at least in the SI***

The alternative factor solutions are already reported in Figures 7 & 8 as well as Table 2 and discussed in section 4.3 "Resolving an unknown number of sources", which was expanded due to a similar comment from referee 1.

> ***Fig 3 and associated analysis and discussion - it would be useful to have a statistical analysis of these comparisons (t-test, Kruskal-Wallace) to show whether the difference were statistically different***

Even though we acknowledge the reviewer's concern about the statistical significance of the differences, the main point here is that the distributions are very similar and all within limits that we consider acceptable.

> ***Fig 4 – there is a large over-estimation of HOA compared to the other approaches. It is not obvious where this mass is allocated in comparison and is worthy of some discussion.***

We added a sentence stating that it is probably taken from OOA (notice the order of magnitude difference in scales):

"All models slightly underestimate OOA, which results in overestimating the other components (Table 1)."

> ***Fig 5 – please keep the fig sub title (a,b,c) in the same location. The reason for the large variability in CCOA for BAMF in b needs to be discussed in more detail.***

We adapted the figure labelling as suggested by the reviewer.

We added a discussion about the mixing between BBOA and CCOA. The correlation of F is easily influenced by the removal and addition of mass between the two components. We added Appendix A and the sentence:

“Figure 5a, shows that BAMF can over- and underestimate both BBOA and CCOA depending on the dataset.”

First sentence of conclusion (326) is not true.

We removed the first sentence of the conclusion.

other comments:

Line 20 – formalism – what is this? Could an alternative word be used?

We reformulated the sentence, which now reads:

“The idea is to use the variation in the chemical composition of a set of measurements, such as outputs from mass spectrometers, to decompose the measurements into “source terms” using non-negative matrix factorization.”

Line 66 - Dirilecht is spelt incorrectly I believe

We corrected the spelling.

Line 166 – Sofi only finds local optima for unconstrained PMF, where an a-value is used this is not the case

To our best knowledge, using a-values does not change the nature of the optimization problem. It changes the pool of possible solutions.

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