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Atmospheric Measurement Techniques Discussions

Interactive comment on "Improved real-time bio-aerosol classification using Artificial Neural Networks" *by* Maciej Leśkiewicz et al.

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We would like to thank the Reviewer for evaluation of our manuscript. The detailed answers to the questions are as follows:

Reviewer #1

This manuscript details the use of an Artificial Neural Network, or ANN, to attempt to better identify bio-aerosol. Bio-aerosol has been a topic of contemporary interest in the atmospheric sciences and neural networks have gained prominence as a data reduction and analysis technique. This is therefore a paper that could be of interest to the AMT readership. There are however several large missing sections, e.g. aerosol justification and characterization, that should be addressed before it is publishable.

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Discussion paper

1. The writing of the paper is a bit too familiar and there are many unquantifiable terms, e.g. “Society is awaiting anxiously for system that could inform them in real-time about a real danger that is suspended in the air.” – this would be a rather improved paper if this type of writing could be toned down as in “There is a need for real-time information about ambient particulate matter.”

- The sentence was corrected.

2. In addition, the paper could benefit from a through read from a native English speaker with a focus on removal of incorrect and non-scientific terms. Examples, but by no means comprehensive: “really promising”, “very high performance”, past tense of grind is ground, not grinded, etc.

- The language correction was performed.

3. The name of the technique to which the ANN is applied, BARDet, should be stated in the abstract.

- The name of the device was added to the abstract.

4. The central issue with this paper is there needs to be a description of the aerosol generation method and the produced size distribution of each sample; some are solids, some are liquids. Were sizes comparable? Concentrations? Ideally this is a sub-section of 3.1.2.

- All aerosols were generated from powders only as it was described in section 3.1.2. The sizes depend on dimensions of particles. An information about particle’s sizes was added to the table 2.

Going farther, why were these samples chosen? Some seem rather important e.g. pollens, while others are unclear. Paper towel? Multiple broths? It is upon the authors not to simply present so may aerosol types but instead (1) care-fully and completely characterize the aerosol investigated – not only what they look like to the BARDet - and (2) to argue why they are being investigated (do they have any atmospheric importance

which is the theme of the paper)?

- The following explanation was added to the 3.1.2 section: “In order to achieve reliable aerosol classification the ANN’s needs to be trained using possibly large number of measurement data. Therefore, various particle types, that can be easily aerosolized, were tested. Samples like pollens, fungi, bacteria, spores and leaves scraps are present in the atmosphere. Biofluorophores like riboflavin, cellulose, aminoacids and proteins were also characterized since they are components of biological materials. The group of bacterial growth media was investigated due to their strong influence on bacteria fluorescence especially if they are not sufficiently washed. This can occur in case of intentionally released bacterial aerosols. Due to technical limitations the other than pharmaceutical samples could be aerosolized in this study. The aerosols of flours, and fluorescent non-biological substances like paper dust, AC fine Test Dust and talc were analyzed since they can occur especially in indoor and public places. The non-fluorescent particles were not a subject of the research since they can be automatically discarded as non-biological applying given fluorescence threshold.”

5. Going a step further, although there are 48 aerosol types suggested, in practive the confusion matrix says the separation is based on 7 broader classes. If this is indeed the case (as it appears) then (1) the abstract should reflect separation of 7 classes, not the 48 stated (2) Table 1 should state what fits into each class, since this is the central concept.

- In the manuscript we have stated as follows: “It is difficult to present confusion matrices and ROC graphs for all neural networks in this paper, so only the most interesting one has been discussed.” - In practice separation is done not by one confusion matrix (ANN) but by all of them in sequence (22 ANN’s combined in a decision tree). For example, if ANN classifies unknown substance into any of 22 groups it means that decision process is not ended but from that moment another ANN classifies this substance. That’s why there are substances which only needs one ANN to make a classification (e.g. FM7), but there are also such which needs 6 ANN (e.g. BWF) to complete the

task. The main difference between this two examples is that 98.5% of all FM7 particles are classified correctly, but BWF has only 54.8% detected particles. However in both cases system recognize aerosol type every time with no mistake.

6. The statistic in Table 4 need to be placed in the abstract and repeated in the summary, these are the central results.

- Table 3, previously Table 4 do not represents the central result. It is only 1 of 22 nodes of a decision tree. The most important fact is that each one aerosol type can be recognized. In the abstract we added as follows: “In both cases the system recognized aerosol type with no mistake.”

For example, in Tables 4 and 5 it appears that there can be confusion on the 50th centile level. This is not altogether great separation and should be explicitly stated for the reader from the outset.

- It was stated in the text. However, we hope that modified explanation will be helpful (Lines 451-456).

The 48 types and 114k number of spectra, which are the data set, belong only in the methods section; while these seem rather impressive they are not results. The authors should therefore replace the sentences which repeat these values in abstract and summary with the separation ability.

- We are agree with reviewer that number of data are not a result. Therefore they were removed from the abstract and summary.

7. Table 3 is overly simplistic for a table; this can be stated in a single sentence. Please remove.

- The sentence was added and the table was removed (Lines 382 – 384).

8. In the summary : “This study proved that it is possible to create a tool for a highly effective analysis of bio-aerosols using multiple ANNs combined into decision tree.” –

this is again an unquantified statement. It is also at odds with “Tests revealed that only several substances have such characteristic fluorescence spectra that allows correct classification of almost each particle. However, in all other cases the system was able to recognize a particular aerosol cloud.” Please provide the separation ability and then let the reader judge is this is a highly effective analysis.

- We provided for the reader only two examples that shows good and poor separation in accordance for individual particle within only these two groups (group 0 and group 21). Probably it was not emphasized clearly enough in the manuscript that system recognize aerosol type (all of them) with no mistake every time and that was main goal to achieve in presented analysis. - In the lines 581-583 we added as follows: “However, in all other cases the system was able to recognize a particular aerosol accurately with no mistake, but a representative number of several dozens of particles in a cloud was necessary.”

9. Why weren’t non-biological materials tested?

- The materials and methods section was improved. We justified the use of tested samples. We also changed confusing title in 3.1.2 “Bioaerosols” for “Aerosols” - The non-biological materials were tested: Fluoromax microspheres 7 um Nivea talc Printer paper dust Paper towel dust AC Fine test dust (This one can contain also biological particles) - The most of non-biological materials like gypsum, syloid, desert sand are non-fluorescent and there is no any problem to differentiate them from biological particles.

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