Atmos. Meas. Tech. Discuss., 5, C3111–C3114, 2012
www.atmos-meas-tech-discuss.net/5/C3111/2012/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Cluster analysis of WIBS single particle bioaerosol data" *by* N. H. Robinson et al.

Y.-L. Pan (Referee)

yongle.pan.civ@mail.mil

Received and published: 30 November 2012

The authors applied hierarchical cluster analysis to the datasets measured by their WIBS system from laboratory generated calibrating PSL particles and atmospheric aerosol particles, tried to group the detected aerosol particles into different clusters according to their properties from three fluorescence band intensities (from UV to visible), scattering intensity size and asymmetric factors (AF) via two band UV wavelengths excitation (around 280 and 370 nm). No doubt WIBS is one of the best systems that are capable of real-time, in situ aerosol detection by supplying more information than most of the other commercially available systems such as UVAPS giving particle size, concentration, and fluorescence particle concentration via 355 nm laser excitation. By ap-

plying hierarchical cluster analysis, it allows to reduce the complexity of the measured data from WIBS and group the observed atmospheric aerosol particles into limited clusters for better characteristic understanding. The results are new and interesting, the writing is clean in scientific explanation, and it definitely should be accepted for publication. However, I would like the authors to take the following suggestions into considerations before print.

1. Is the PSL particles aerosolized by Sontics's, Collision's or other technologies? It is hard to produce total single particles from PSL suspensions for me, and it strongly depends on the suspension property and aerosol generation method and conditions. Therefore, is it possible that the particles in group C, Table 3 is dominated by the aggregates from 2 or 3 spheres the 1 um non-fluorescence PSL spheres, somehow they did not remain the singlet format, and that's why this group in tab 2 cannot be simply founded in Tab 3?

2. It is hard to understand how the 1 um fluorescence PSL spheres can be separated into two groups A and B via AF in tab 3? Looks they are not in aggregate format. How can all other similar to the orignal parameters like 1 um PSL, but in two groups of AF?

3. AF is a good parameter to extract information from elastic scattering of particles, and should greatly help distinguish particles when they are all in single "simple" particles, e.g. single spores vs single sphere. However, it does not maintain the same AF value for particles even they are formed from the same kind of "simple" particles. E.g. FA are different for PSL spheres in singlet, doublets, triplets, and big aggregates (AF will be similar to a sphere). Therefore, once the particles from the same materials, e.g. pollen spores in singlet, doublet, or aggregates will have different FAs, and the FA will confuse the cluster analysis and group them into different clusters even they are formed by the same materials. Therefore, I would like author to address this in the paper.

4. For non-polarized light illumination, AF should not dependent on particle size, so is there any explain for the AF difference in Tab 2?

5. As atmospheric aerosol particles are generally complex mixtures, particles from the same materials with different sizes should have the same fluorescence property (same spectral profiles and quantum efficiency but not the same absolute intensity for different size particles), these particles should below to the same grouped clusters if they are sorted by chemical properties of the aerosol particles. Here we have not count particles that contain the same fluorescent molecules but with different concentration of non-fluorescent materials. However, using the absolute fluorescence intensities, size, and AF as parameters will group the particles from the same materials into different groups. So I think it might be more meaningful to apply hierarchical cluster analysis to the dataset using fluorescence band ratios, and ratio of fluorescence to size, although the authors have claimed that the analysis in this paper is not for chemical and physical properties discrimination.

6. US Navy Research Laboratory uses 2 wavelengths excitation, a few fluorescence bands, and particle size to detect and characterize different aerosol and bioaerosol particles, it supplies similar information as WIBS via laser light sources without AF, I think cite their works may help readers understand better for how useful such a kind of detection system can be. E.g. Ref 1-2 below.

7. The authors claimed that "this is the first time cluster analysis has been applied to long term online PBAP measurements". However, the cited Ref 30 in this manuscript and Ref 3-5 below (works presented by a group of US Army Research Laboratory and Yale University) show that hierarchical cluster analysis have been used to analyze the measurements of atmospheric aerosol particles based on fluorescence and scattering (a few months span, 3 locations), so I am not sure if this claim is totally suitable. Cite Ref 3-5 may also help readers understand how the cluster analysis simply the data and supply useful information. The below Ref 3-4 show cluster template similarity via 263 nm and/or 351nm excitation in 3 different locations; Ref. 4-5 shows evolution of time series for different clusters from atmospheric aerosol particles.

Reference

1. Sivaprakasam V, Huston AL, Scotto C, Eversole JD, Multiple UV wavelength excitation and fluorescence of bioaerosols, Opt Express, 2004; 12(19):4457-66.

2. Sivaprakasam V, Lin HB, Huston AL, Eversole JD. Spectral characterization of biological aerosol particles using two-wavelength excited laser-induced fluorescence and elastic scattering measurements. Opt Express 2011;19:6191-208.

3. Pan YL, Pinnick RG, Hill SC, Rosen JM, Chang RK. Single-particle laser-induced-fluorescence spectra of biological and other organic-carbon aerosols in the atmosphere: Measurements at New Haven, Connecticut, and Las Cruces, New Mexico. J Geophys Res-Atmos 2007;112.

4. Pan YL, Huang H, Chang RK, Clustered and integrated fluorescence spectra from single atmospheric aerosol particles excited by a 263- and 351-nm laser at New Haven, CT, and Adelphi, MD, Journal of Quantitative Spectroscopy & Radiative Transfer, 2012; 113: 2213–2221.

5. Pinnick RG, Fernandez E, Rosen JM, Hill SC, Wang Y, Pan YL, Fluorescence spectra and elastic scattering characteristics of atmospheric aerosol in Las Cruces, New Mexico, USA: Variability of concentrations and possible constituents and sources of particles in various spectral clusters, Atmospheric Environment, 2013, 65: 195e204

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 6387, 2012.