Cluster Analysis of ultrafine Particles Number Size Distribution Based on Long-term Measurement at SORPES in Yangtze River Delta of China

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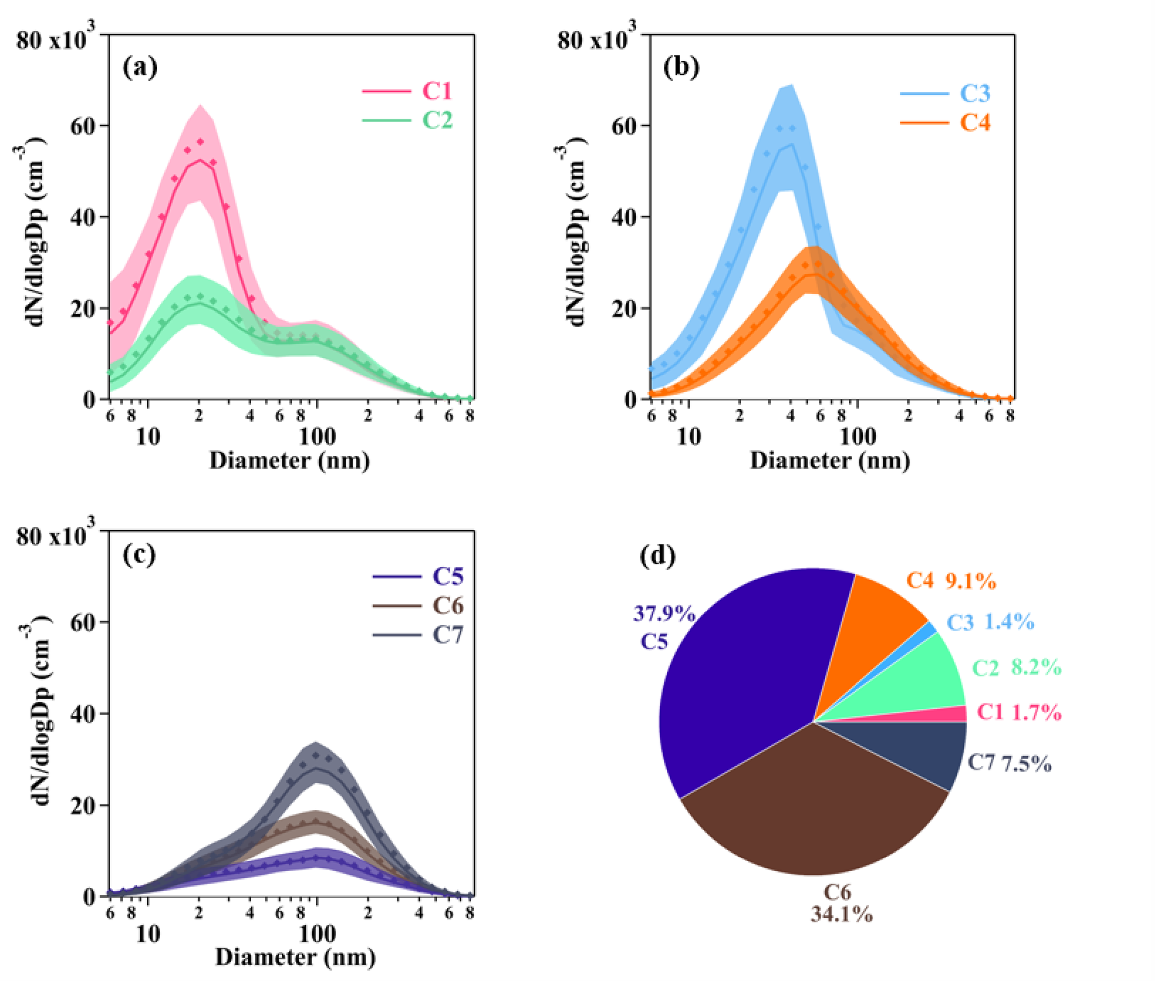
INTRODUCTION

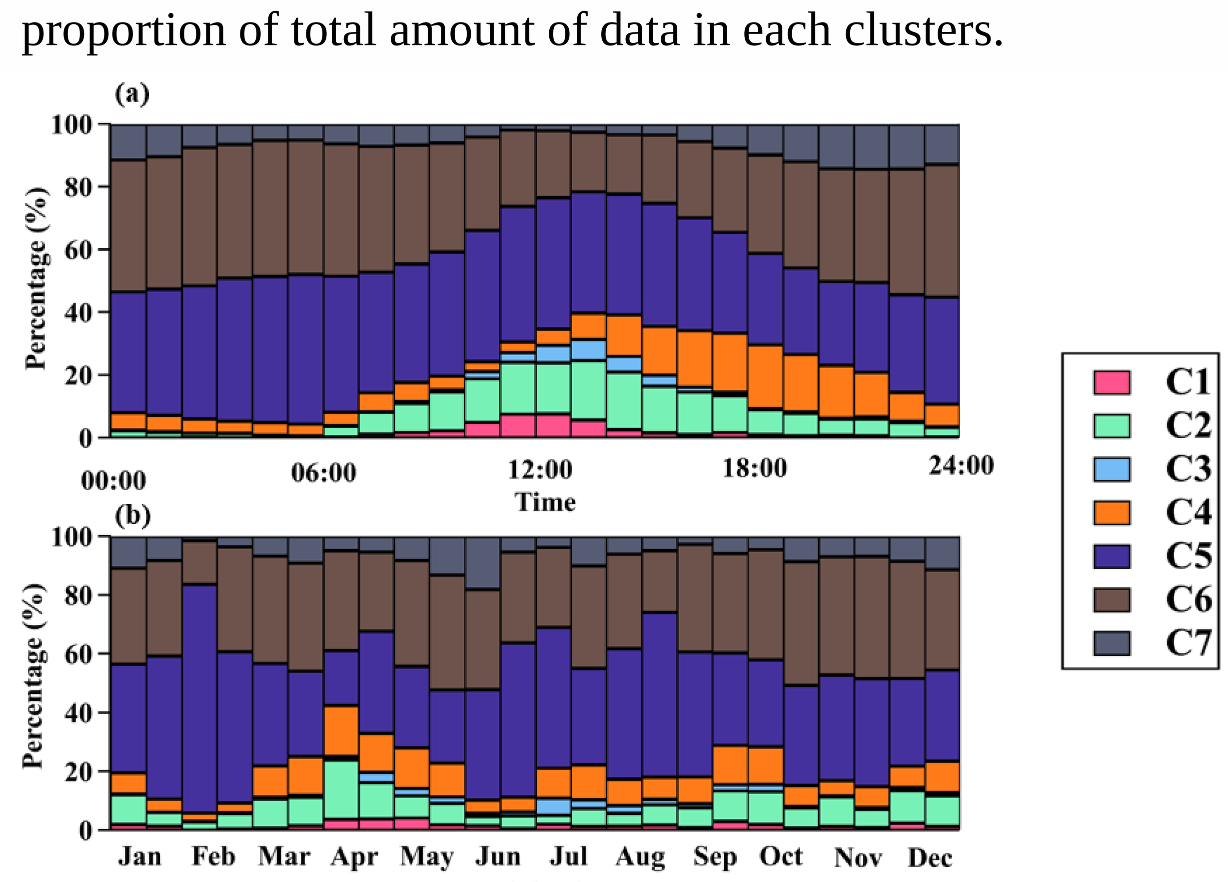
Atmospheric aerosols can affect climate, air quality and human health. This work presents an overview of long-term measurements of particle size distribution (PSD) measured by DMPS (differential mobility particle sizer) in the regional background site, the Station for Observing Regional Processes of the Earth System (SORPES). For purpose of understanding the sources, temporal and spatial trends of ultrafine particles, k-means cluster analysis was applied to reduce the amount and complexity of aerosol number size distributions in a three-year data set. Seven clusters were separated and defined. PSD patterns, concentrations of air pollutants, metrological variables, hourly and seasonal frequencies of occurrence, as well as water-soluble ions concentrations were used to support the interpretation of their origins.

RESULT



C1: *High intensity new particle formation, fresh vehicle exhaust emissions.*
C2: *Weak new particle formation, fresh vehicle exhaust emissions*
C3:*Intensive growth of nucleated particles.*
C4:*Further growth, aged vehicle exhaust.*
C5:*Humidity urban background cluster*
C6: *Pollution from fossil fuel combustion*
C7: *Heavy pollution from biomass burning*

Clustering results using DMPS data. Graph (a), (b) and (c) show the particle size distribution for each clusters. Bolt solid lines are the median values, diamonds show the averages and shadow represent percentiles of 25% and 75%; Graph (d) shows the proportion of total amount of data in each clusters.

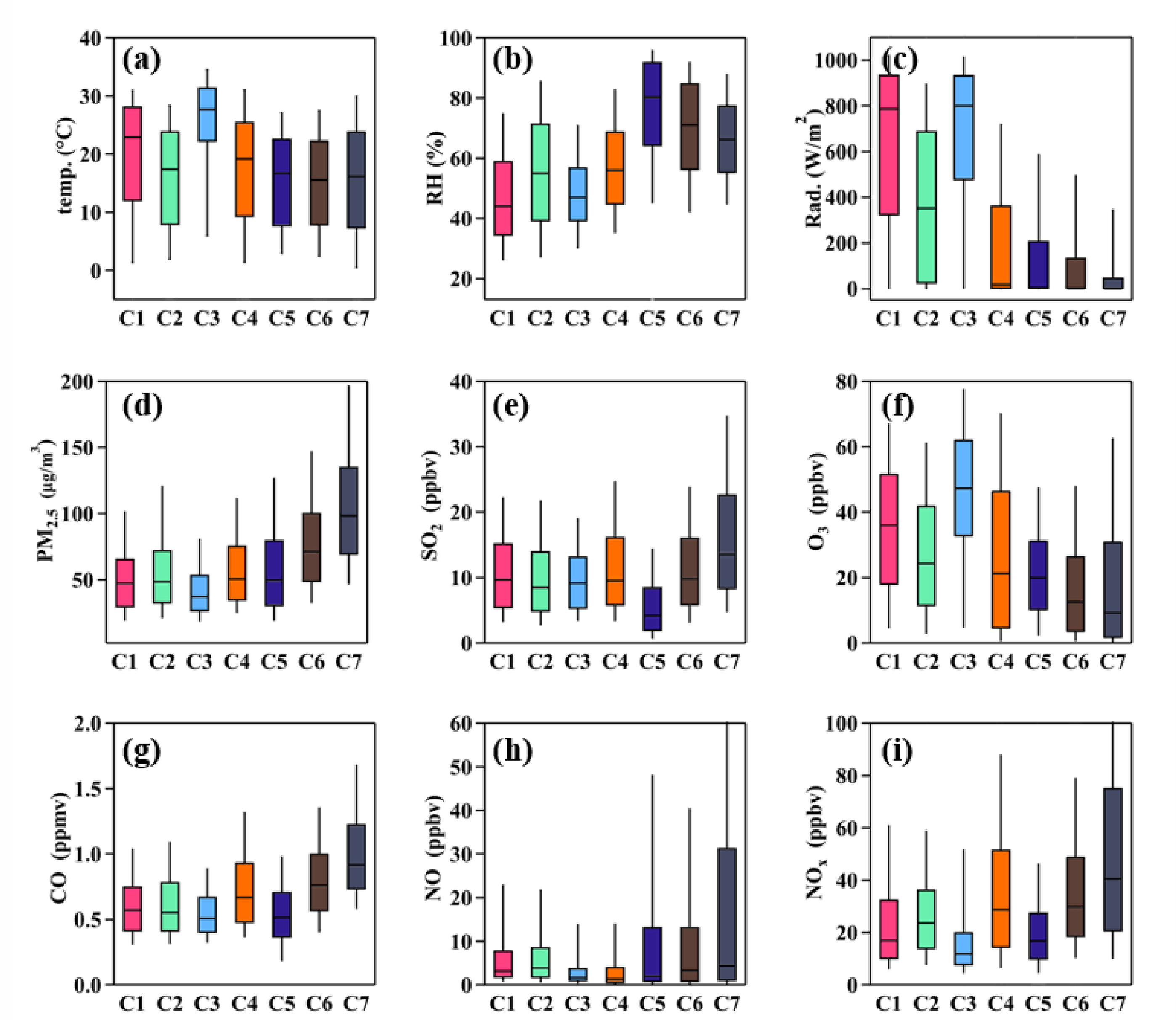


Graph (a) shows diurnal cycle of hourly counts for each clusters occurrence (b) shows seasonal cycle of monthly counts for each clusters and graph

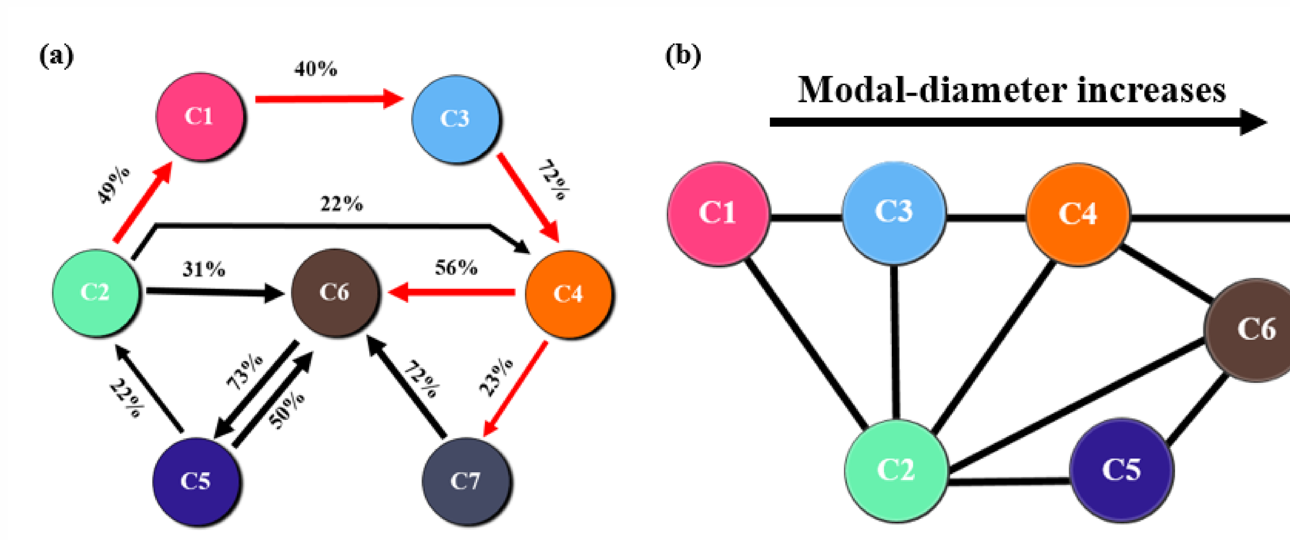
Table 1 Mean value of physical properties and chemical compounds of each clusters

	C1	C2	C3	C4	C5	C6	C7
Nucleation mode							
(6-25 nm)	24177	9855	13129	4347	1805	2274	2509
Aitken mode							
(25-100 nm)	13707	9113	25397	14922	4079	7674	11327
Accumulation mode							
(100-800 nm)	4603	4778	4792	6100	3494	6246	11306
GMD (nm)	26	38	38	56	69	74	85
Condensation sink	3.2E-02	3.2E-02	3.7E-02	4.2E-02	3.2E-02	4.7E-02	7.4E-02

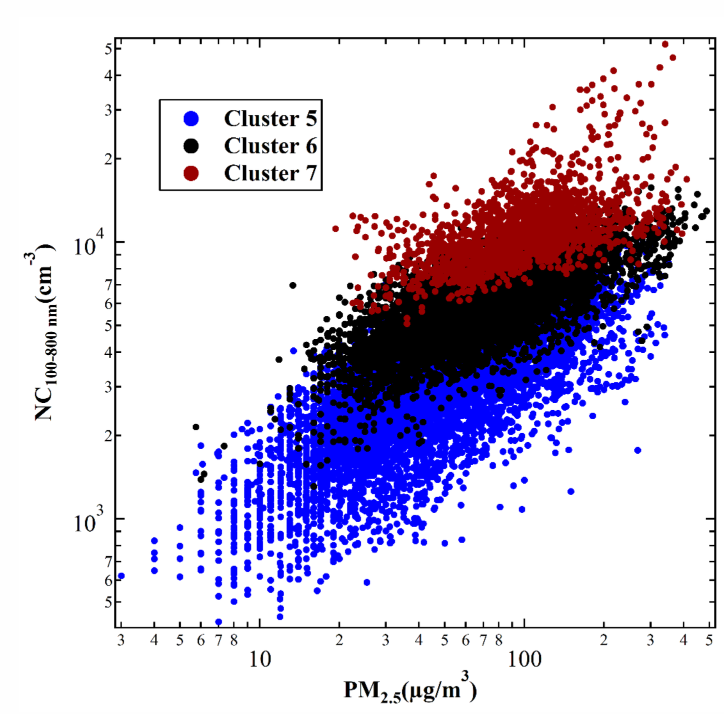
Time distribution, metrological parameters, concentration of pollutants, as well as water soluble ions like NO_3^- associated with each cluster were calculated to define seven characteristic particle size distributions.



Association between clusters, pollutants and meteorological data. (a) temperature;(b) relative humidity;(c) radiation; (d) $PM_{2.5}$; (e) O_3; (f) SO_2; (g) CO; (h) NO; (i) NO_x.



Cluster evolution diagram (a) and cluster proximity diagram (b). For graph (a), arrows show direction of transformation between clusters. According to the time series of cluster, The frequency of all non-self-cluster occurring after the certain cluster was calculated. To investigate the main conversion pathway, only the conversion pathways with the frequency larger than 20% were shown.



The scattering plot of PM2.5 concentrations and number concentrations of accumulation mode particles for three pollution clusters (i.e. Cluster 5-7). An interesting finding is that, the number concentrations can vary more than one magnitude even the $PM_{2.5}$ concentrations were same.

CONLUSIONS and SUMMARY

This study used long-term continuous measurement at regional background station in understanding the impact of emission sources, chemical mechanisms, and meteorological process on the change of aerosol particle size distribution.

(1) Seven clusters were identified: cluster 1 to cluster 4 were related with NPF events, accounting for 20.4% of all measurements which prefer to occurring at daytime with high intensity of solar radiation and high concentration of SO_2 and O_3. .

(2) We have found the relationship of mutual transformation within clusters. The steps of NPF and their contribution on pollution (C1→C3→C4→C5/C7), as well as pollutant scavenging (C6/C7→C5) or accumulation (C5→C6/C7) were seen clearly on the net of interrelationship of each cluster.

(3) C6 was caused mainly by fossil fuel burning in winter; while C7 was caused mainly by biomass burning happened during late May and early June. These two episodes both contribute heavy pollution, but the particle they produced were different in size distribution and chemical components.

References

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