

Supplementary Materials

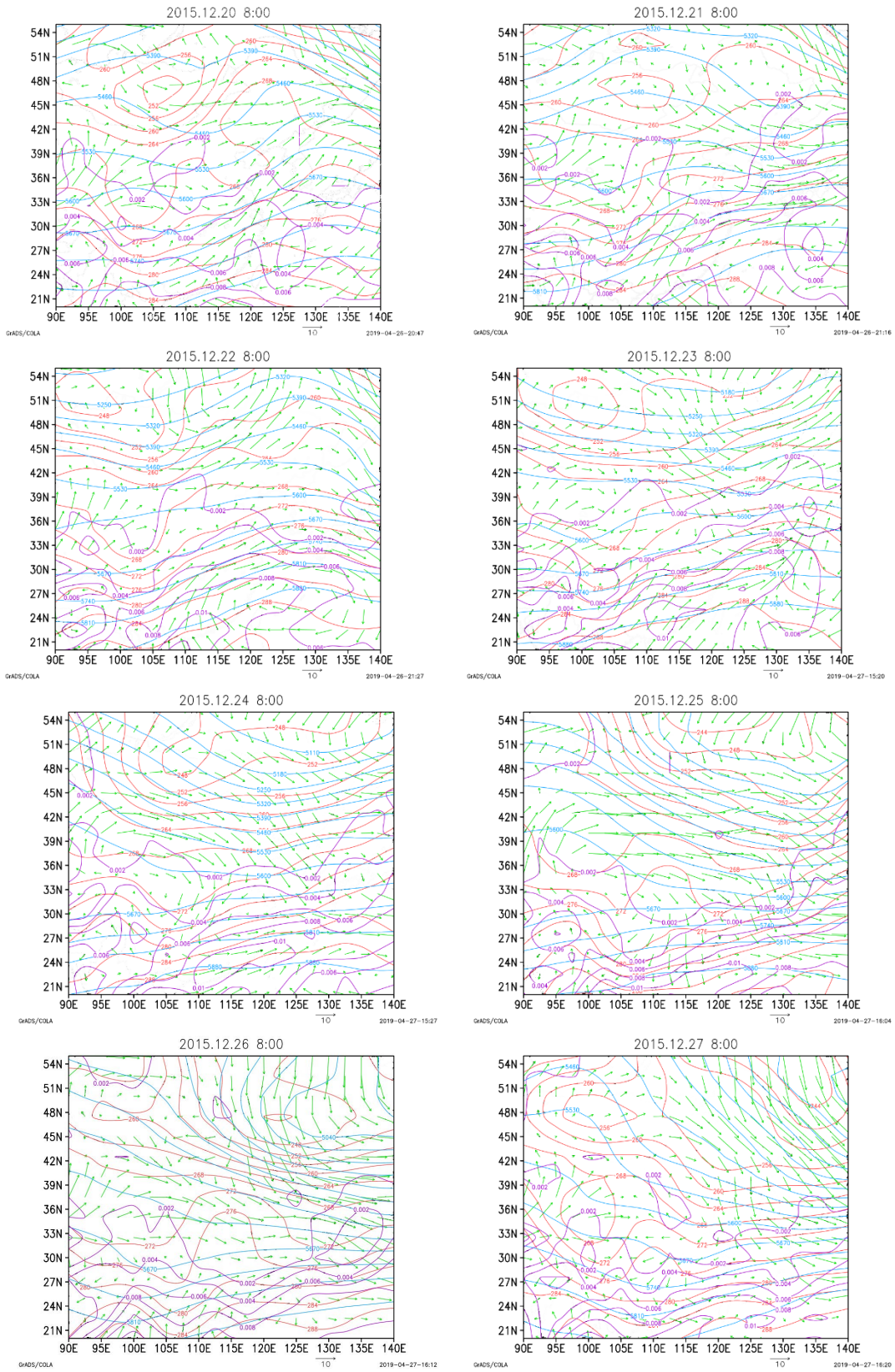


Fig. S1 Background atmospheric circulation during the persistent fog and haze event in December 2015

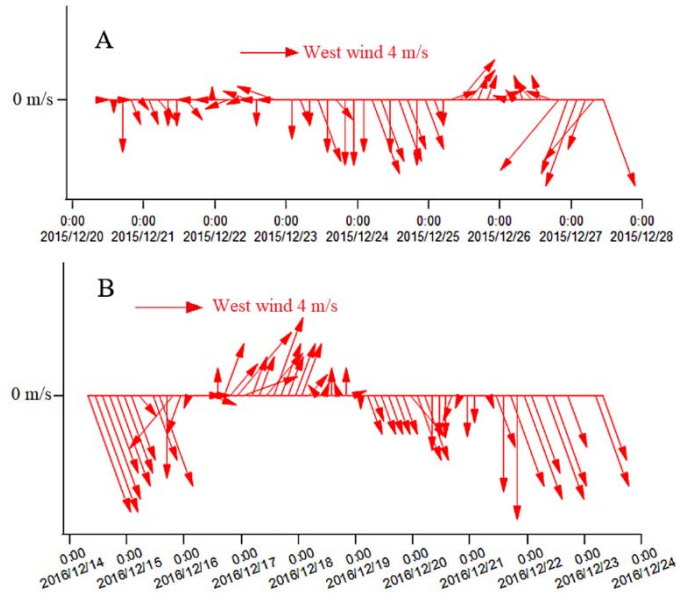


Fig. S2 Wind direction and velocity map during the persistent fog and haze events (every 3 hours) in December of 2015 (a) and December of 2016 (b)

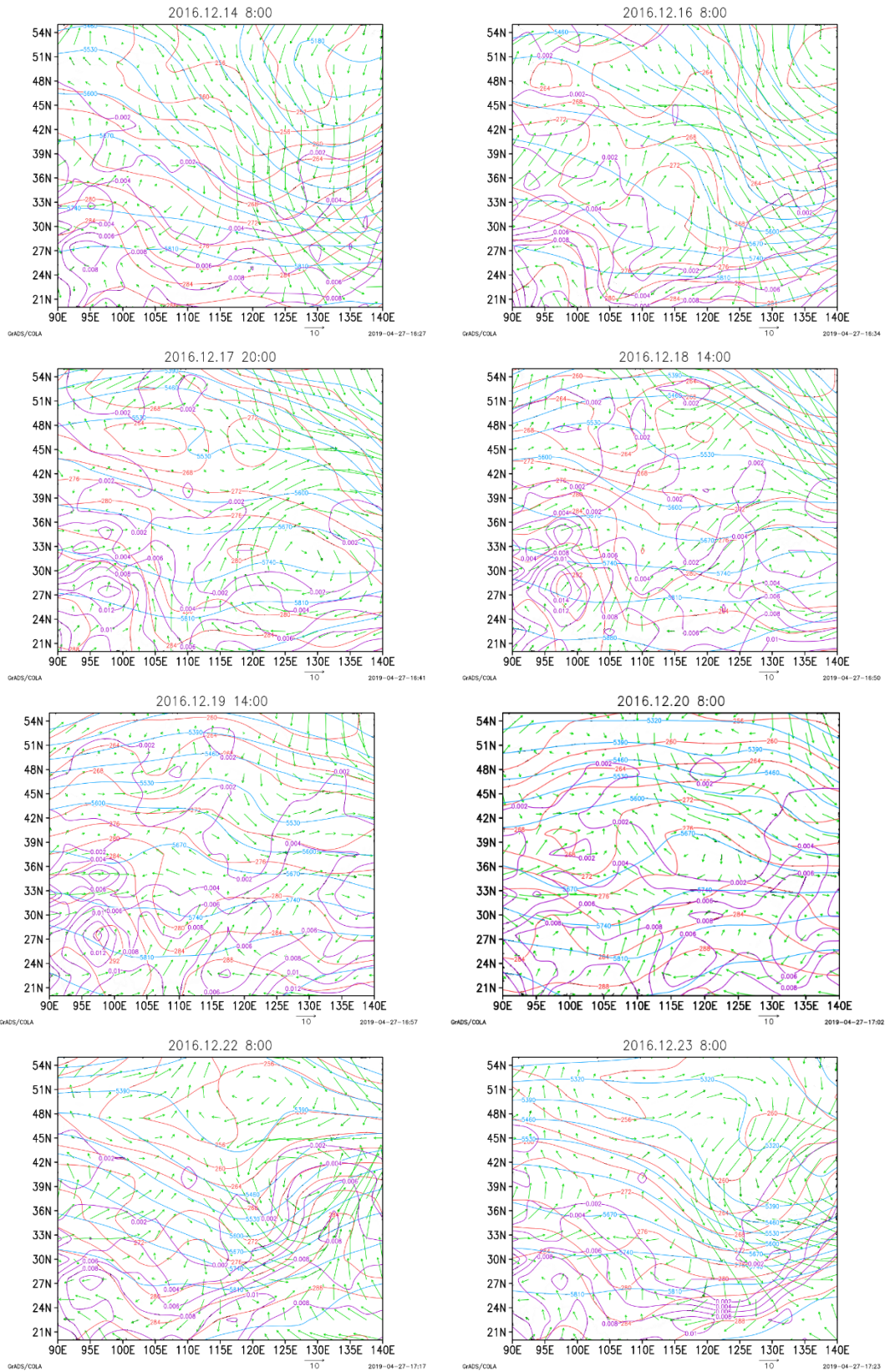


Fig. S3 Background atmospheric circulation during the persistent fog and haze event in December 2016

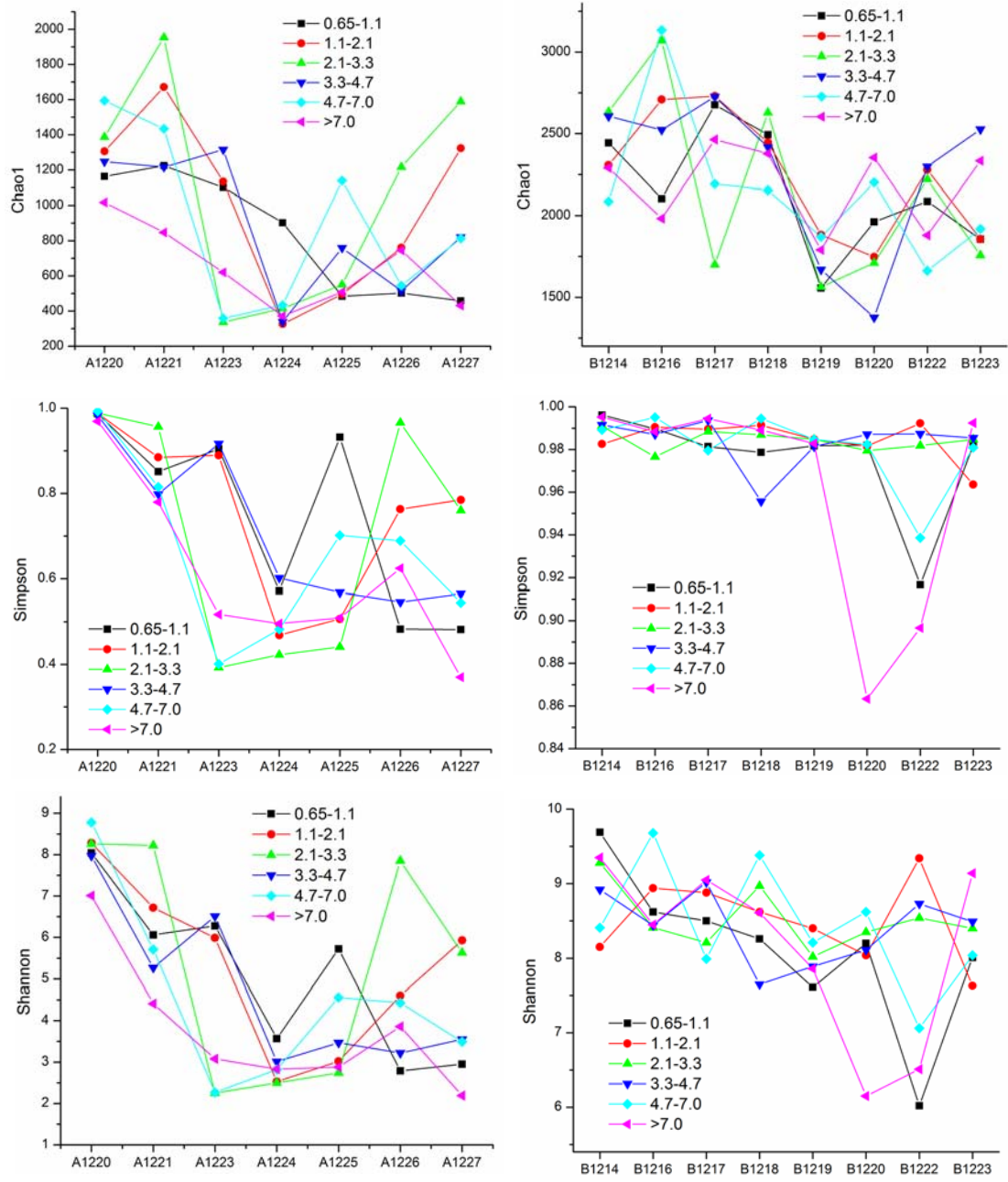


Fig. S4 Changes in bacterial community diversity for different particle sizes during persistent fog and haze events

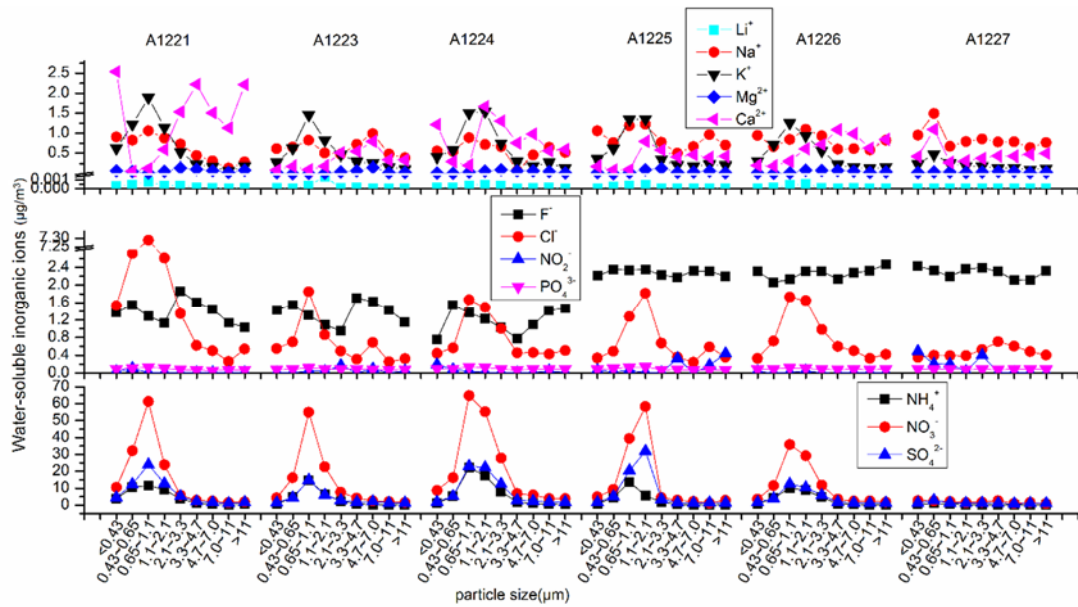


Fig. S5 Water-soluble ion concentration for different particle sizes during persistent fog and haze events in 2015 (The data was provided by Jianhua Qi, the co-author of this work, which can be seen in Xie et al., 2017)

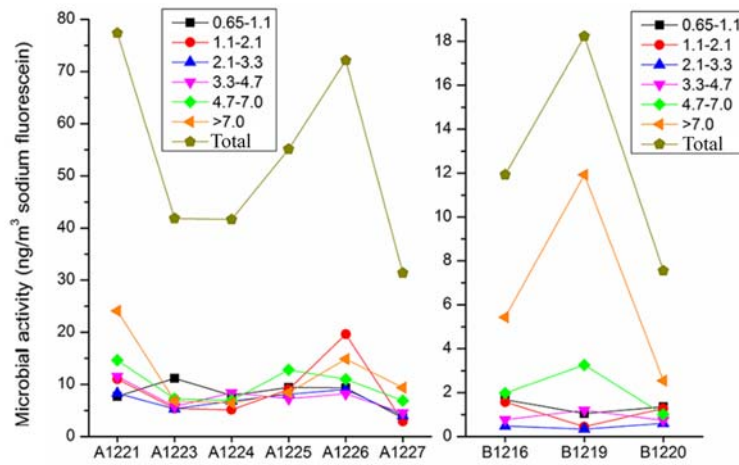


Fig. S6 Microbial activity for all (Total) and different particle sizes (The data was provided by Jianhua Qi, the co-author of this work, which can be seen in Meng et al., 2017; Li, 2018)

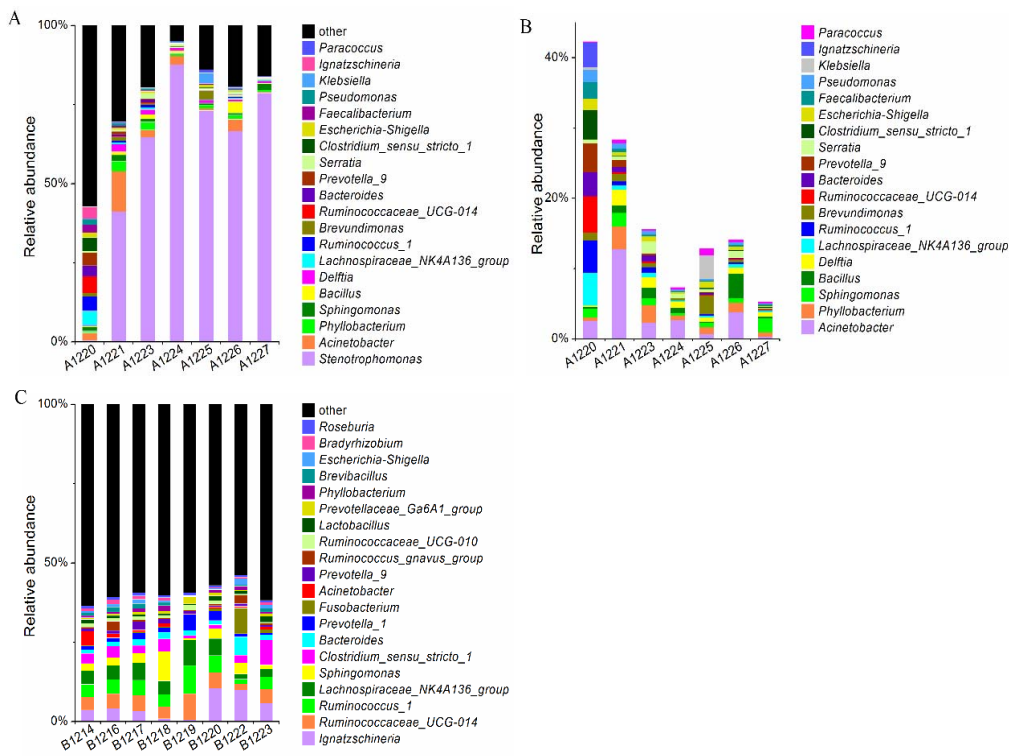


Fig. S7 Relative abundances of microbial groups in aerosols at the genus level in December 2015 (a), December 2015 (excluding *Stenotrophomonas*) (b) and December 2016 (c)

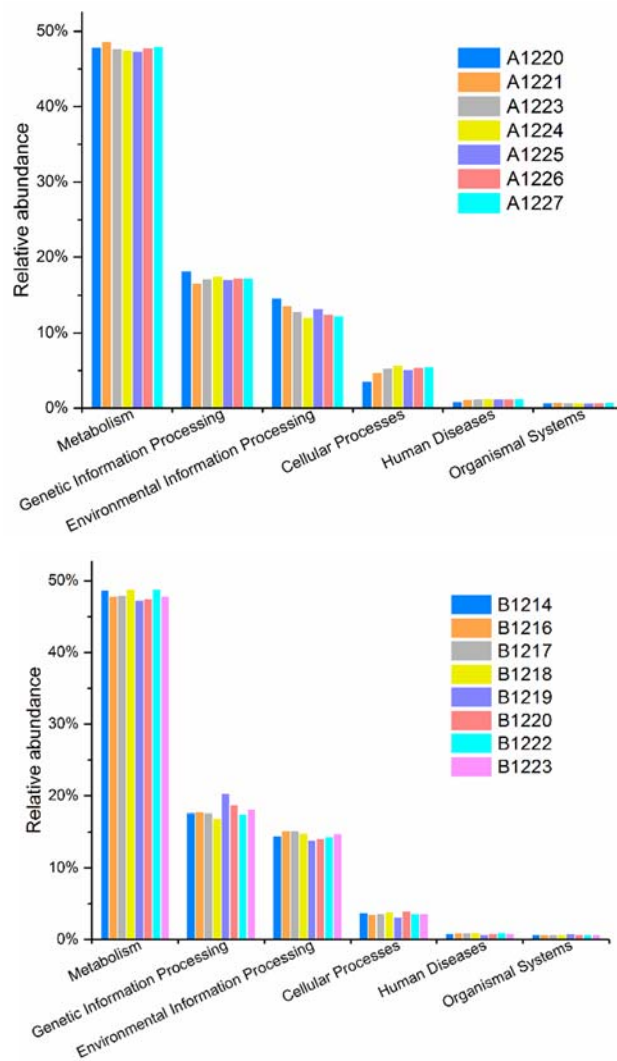
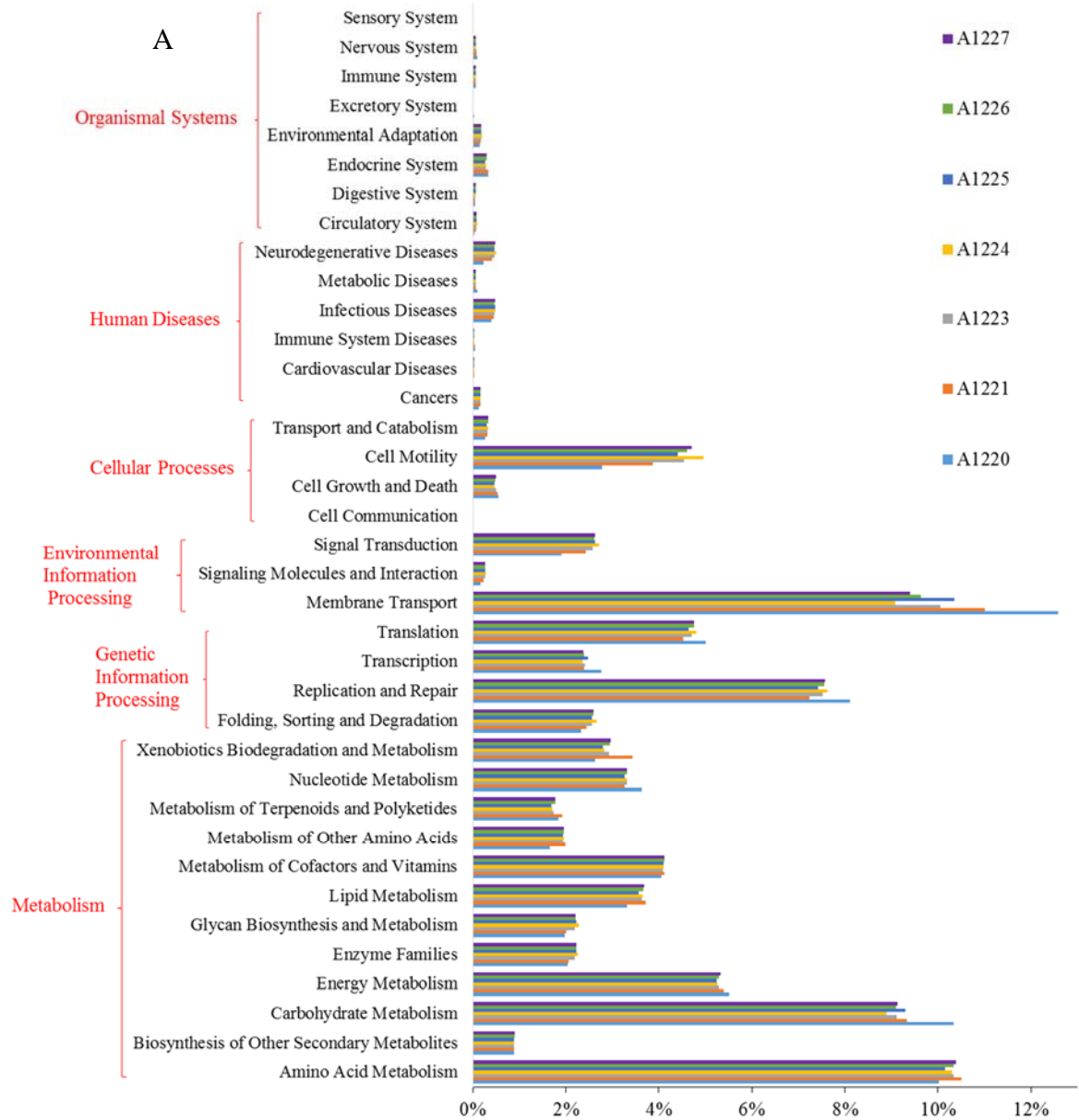


Fig. S8 Variation in bacterial biochemical metabolic pathways during persistent fog and haze events as analyzed by PICRUSt



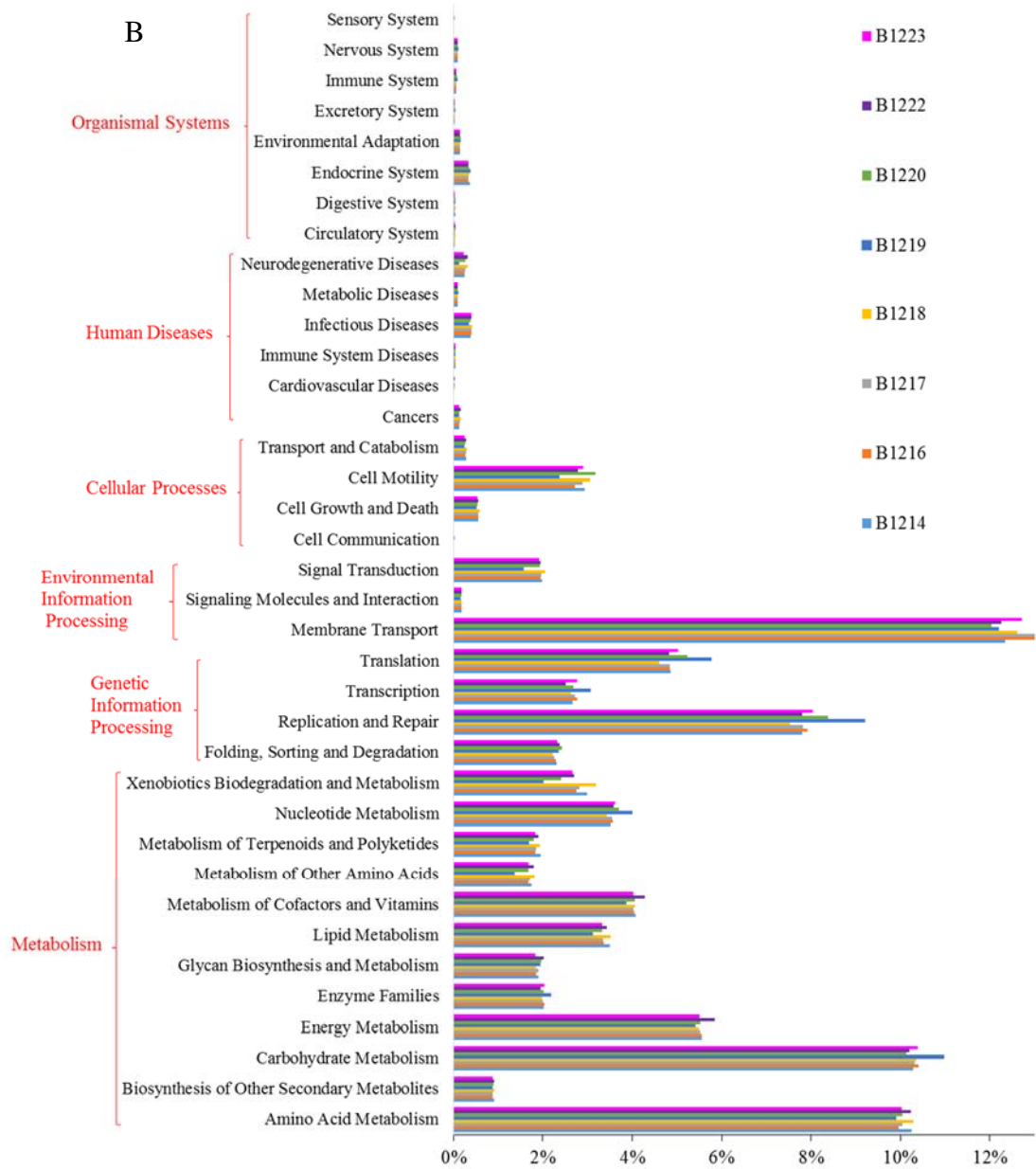


Fig. S9 Variation in bacterial functional profiles during persistent fog and haze events in 2015 (a) and 2016 (b)

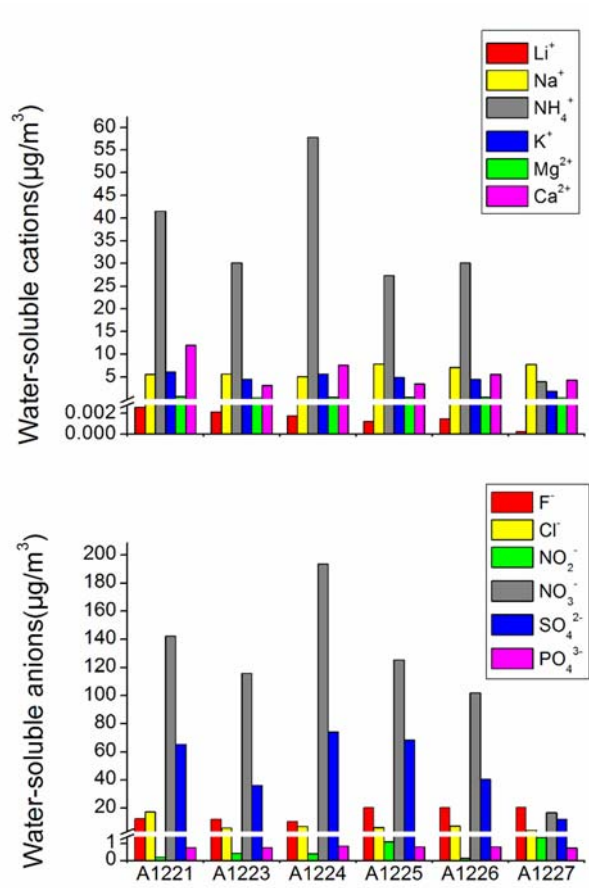


Fig. S10 Concentration of water-soluble ions during persistent fog and haze events in December 2015 (The data was provided by Jianhua Qi, the co-author of this work, which can be seen in Xie et al., 2017)

Table S1 Spearman's correlation coefficients calculated for each pairwise comparison of the top 10 genera and KEGG pathways in December 2015

Bacterial functional groups	Stenotropho monas	Acinetob acter	Phyllobacte rium	Sphingom onas	Bacillus	Delftia	Lachnospiraceae_ NK4A136_group	Ruminoco ccus_1	Brevundim onas	Ruminococcaceae_ UCG-014
Cell Growth and Death	-0.894**	0.595	0.350	0.639	-0.179	0.259	0.704	0.712	-0.038	0.679
Cell Motility	0.985**	-0.253	-0.018	-0.319	0.287	0.139	-0.917**	-0.922**	-0.294	-0.909**
Membrane Transport	-0.967**	0.266	0.091	0.286	-0.305	-0.082	0.876**	0.888**	0.402	0.865*
Signal Transduction	0.979**	-0.162	0.080	-0.298	0.268	0.230	-0.968**	-0.970**	-0.145	-0.960**
Replication and Repair	-0.547	-0.482	-0.667	-0.154	-0.203	-0.752	0.835*	0.819*	-0.162	0.852*
Cancers	0.857*	0.169	0.398	-0.027	0.253	0.559	-0.973**	-0.964**	-0.225	-0.981**
Cardiovascular Diseases	0.943**	-0.019	0.216	-0.150	0.238	0.376	-0.993**	-0.990**	-0.173	-0.989**
Immune System Diseases	-0.942**	0.568	0.304	0.548	-0.079	0.177	0.749	0.751	0.070	0.723
Infectious Diseases	0.984**	-0.287	-0.021	-0.385	0.185	0.116	-0.932**	-0.931**	-0.031	-0.916**
Metabolic Diseases	-0.941**	0.023	-0.202	0.222	-0.271	-0.353	0.994**	0.993**	0.089	0.989**
Neurodegenerative Diseases	0.971**	-0.108	0.129	-0.237	0.264	0.289	-0.977**	-0.977**	-0.197	-0.971**
Amino Acid Metabolism	0.468	0.565	0.642	0.398	0.359	0.772*	-0.714	-0.711	-0.466	-0.744
Biosynthesis of Other Secondary Metabolites	0.455	-0.461	-0.361	0.285	0.153	-0.319	-0.309	-0.331	-0.644	-0.297
Carbohydrate Metabolism	-0.940**	0.029	-0.192	0.242	-0.347	-0.358	0.957**	0.957**	0.308	0.959**
Energy Metabolism	-0.938**	0.334	0.031	0.539	-0.219	-0.072	0.868*	0.864*	-0.076	0.856*
Enzyme Families	0.929**	-0.597	-0.365	-0.548	0.194	-0.246	-0.717	-0.727	-0.182	-0.693
Glycan Biosynthesis and Metabolism	0.943**	-0.553	-0.318	-0.559	0.204	-0.195	-0.750	-0.759*	-0.155	-0.727
Lipid Metabolism	0.726	0.362	0.484	0.143	0.372	0.643	-0.906**	-0.907**	-0.346	-0.922**
Metabolism of Cofactors and Vitamins	0.717	0.256	0.277	0.279	0.274	0.451	-0.865*	-0.881**	-0.347	-0.864*

Metabolism of Other Amino Acids	0.830*	0.223	0.427	-0.008	0.297	0.577	-0.978**	-0.973**	-0.168	-0.987**
Metabolism of Terpenoids and Polyketides	-0.701	0.815*	0.542	0.720	0.019	0.500	0.407	0.406	-0.104	0.374
Nucleotide Metabolism	-0.802*	-0.213	-0.443	0.023	-0.231	-0.568	0.973**	0.964**	-0.026	0.979**
Xenobiotics Biodegradation and Metabolism	0.096	0.850*	0.823*	0.555	0.218	0.904**	-0.465	-0.455	-0.150	-0.498

Notes: * $P < 0.05$; ** $P < 0.01$

Table S2 Spearman's correlation coefficients calculated for each pairwise comparison of the top 10 genera and KEGG pathways in December 2016

Bacterial functional groups	Ignatzsch inertia	Ruminococcaceae _UCG-014	Ruminoco ccus_1	Lachnospiraceae_N K4A136_group	Sphingomo nas	Clostridium_sen su_stricto_1	Bacteroi des	Prevotell a_1	Fusobacte rium	Acinetob acter
Cell Growth and Death	-0.066	-0.669	-0.659	-0.433	0.902**	0.107	0.306	-0.550	0.176	0.149
Replication and Repair	-0.116	0.839**	0.861**	0.714*	-0.615	-0.425	-0.260	0.880**	-0.203	-0.387
Cancers	0.287	-0.824*	-0.798*	-0.614	0.774*	0.024	0.655	-0.547	0.564	-0.061
Cardiovascular Diseases	0.042	-0.792*	-0.795*	-0.610	0.829*	0.240	0.423	-0.688	0.313	0.155
Immune System Diseases	0.715*	-0.920**	-0.901**	-0.853**	0.267	0.300	0.408	-0.824*	0.495	0.229
Infectious Diseases	0.236	-0.877**	-0.893**	-0.784*	0.645	0.439	0.419	-0.853**	0.361	0.103
Metabolic Diseases	-0.339	0.912**	0.920**	0.807*	-0.524	-0.423	-0.291	0.918**	-0.293	-0.382
Neurodegenerative Diseases	0.420	-0.925**	-0.900**	-0.743*	0.696	0.192	0.473	-0.746*	0.449	0.168
Amino Acid Metabolism	0.112	-0.746*	-0.726*	-0.564	0.702	0.105	0.420	-0.541	0.380	0.479
Biosynthesis of Other Secondary Metabolites	0.052	-0.662	-0.635	-0.469	0.686	0.007	0.420	-0.426	0.378	0.487
Carbohydrate Metabolism	-0.686	0.840**	0.801*	0.693	-0.385	-0.155	-0.280	0.690	-0.347	-0.244
Energy Metabolism	0.663	-0.815*	-0.793*	-0.740*	0.081	-0.053	0.890**	-0.518	0.931**	0.027
Enzyme Families	-0.477	0.944**	0.927**	0.779*	-0.574	-0.219	-0.464	0.795*	-0.456	-0.240
Glycan Biosynthesis and Metabolism	0.594	-0.125	-0.046	0.000	-0.212	-0.690	0.628	0.349	0.691	-0.209
Lipid Metabolism	0.138	-0.827*	-0.819*	-0.648	0.693	0.264	0.243	-0.764*	0.216	0.553
Metabolism of Cofactors and Vitamins	0.651	-0.963**	-0.938**	-0.856**	0.341	0.108	0.770*	-0.700	0.806*	0.147
Metabolism of Other Amino Acids	0.343	-0.919**	-0.911**	-0.766*	0.653	0.316	0.361	-0.829*	0.342	0.322

Metabolism of Terpenoids and Polyketides	0.099	-0.833*	-0.843**	-0.695	0.574	0.325	0.298	-0.809*	0.273	0.629
Nucleotide Metabolism	-0.079	0.795*	0.813*	0.659	-0.640	-0.419	-0.150	0.856**	-0.100	-0.442
Xenobiotics Biodegradation and Metabolism	-0.133	-0.687	-0.712*	-0.544	0.699	0.407	0.081	-0.774*	-0.003	0.506

Notes: * $P < 0.05$; ** $P < 0.01$

References

Li M (2018). Level and size distribution of microbial activity in bioaerosols in Qingdao coastal region, China Sea and Northwest Pacific Ocean. Master dissertation. Qingdao: Ocean university of China (in Chinese)

Meng X B, Li M Z, Li H T, Gao D M, Qi J H (2016). Microbial activity in bioaerosols in winter at the coastal region of Qingdao, China. *Environmental Sciences*, 37: 4147–4155 (in Chinese)

Xie D, Qi J, Zhang R (2017). Formation and size distribution of the secondary aerosol inorganic ions in different intensity of haze in Qingdao, China. *China environmental science*, 38(7): 2667–2678 (in Chinese)