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Supporting Information for

Particle Number Size Distribution of Wintertime Alpine Aerosols and Their Activation as Cloud Condensation Nuclei in the Guanzhong Plain, Northwest China

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Text S1

In briefly, the NH_3 in the optical cavity will absorb the laser light of a fixed wavelength, thus causing a decrease in the amount of light. The CRDS setting measures the time it takes for light to fall to a certain percentage of its original intensity due to the laser light pass back and forth between a pair of mirrors and enhance the absorption optical path length. This "decay time" is used to calculate the volume concentration of the absorbing gas ammonia in the cavity (Martin et al., 2016; Wentworth et al., 2016).

In order to avoid some uncertainties as much as possible and improve the accuracy of the observation data, some actions were taken to avoid them during the experiment. These actions included adding copper alloy tube (1/4 inches inner diameter (ID), approximately 1.0 m) to prevent the NH_3 absorption, reducing particles with a filter at the front of sampling inlet, and changing the filter every 2 weeks to 1 month, depending on air conditions (He et al., 2020).

Figure S1. Detailed terrain features around the sampling site on Mt. Hua (image from © BigmapGIS Software)

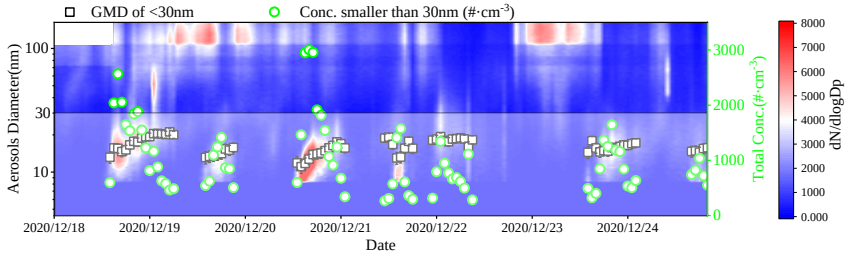

Figure S2 The contour of particle number size distribution was from Dec. 18th to. 24th, 2020. The color bar is for the d*N*/dlogD_p. The black frame dot with error bar is for the geometric mean diameter and standard deviation of particles with diameter less than 30 nm. And the green circle stands for the total concentration of particles with diameter less than 30 nm

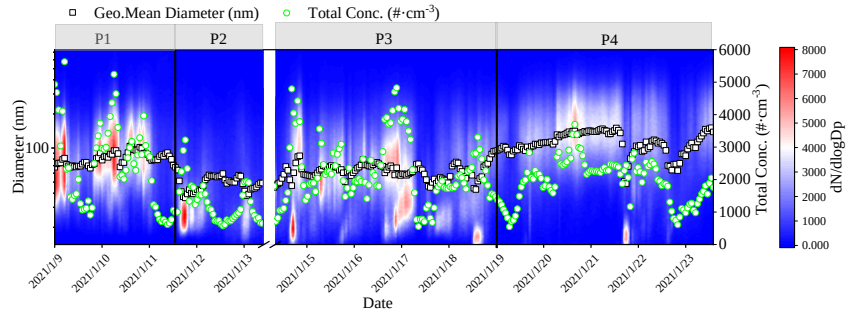

Figure S3 The contour of particle number size distribution was from Jan. 9th to 23rd, 2021. The color bar is for the d*N*/dlogD_p. The black frame dot with error bar is for the geometric mean diameter and standard deviation of particles. And the green circle stands for the total concentration of particles.

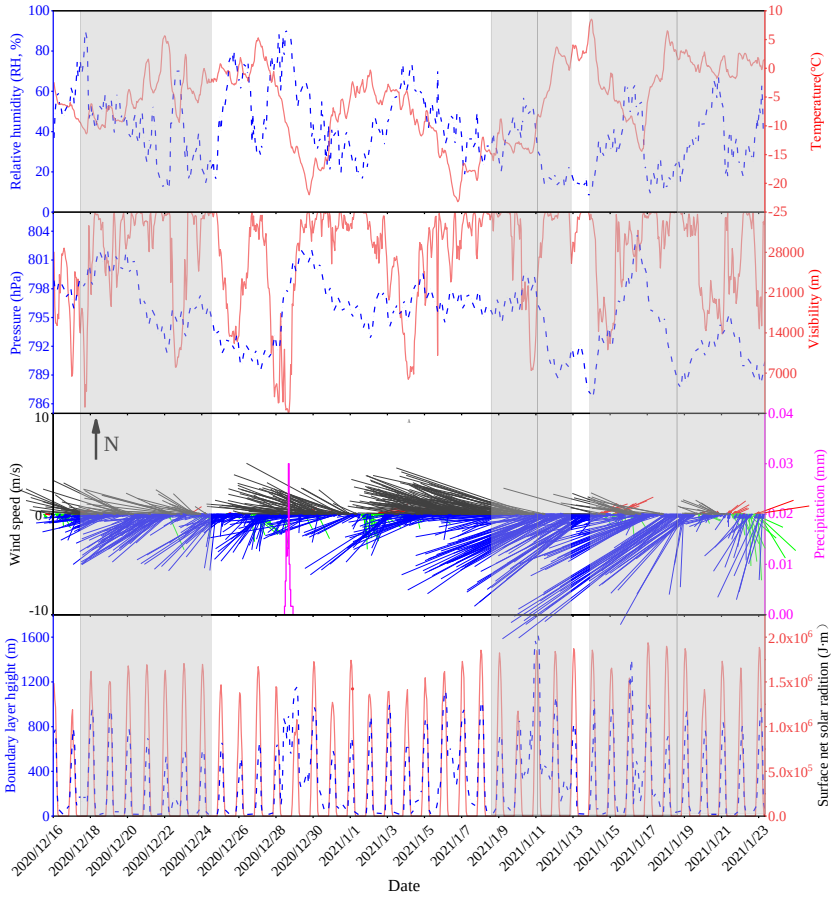

Figure S4 The meteorological parameters on the summit of Mt. Hua, include the real-time relative humifity, temperature, pressure, visibility, Wind speed and direction, and precipitation parameters, and ERA5 reanalysis database for boundary layer height and surface net solar radiation.

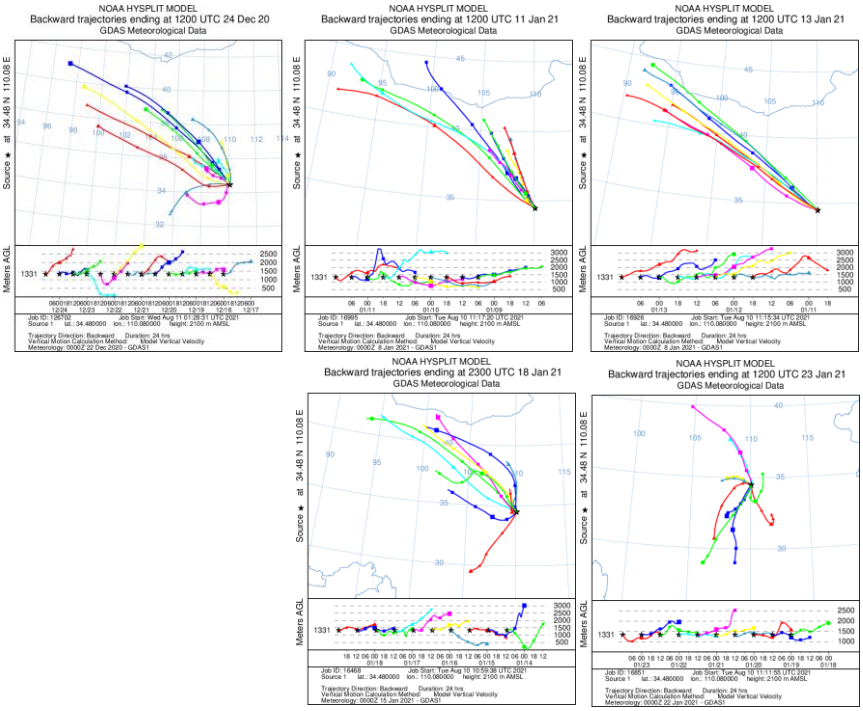

Figure S5 the air mass backward trajectories for five period.

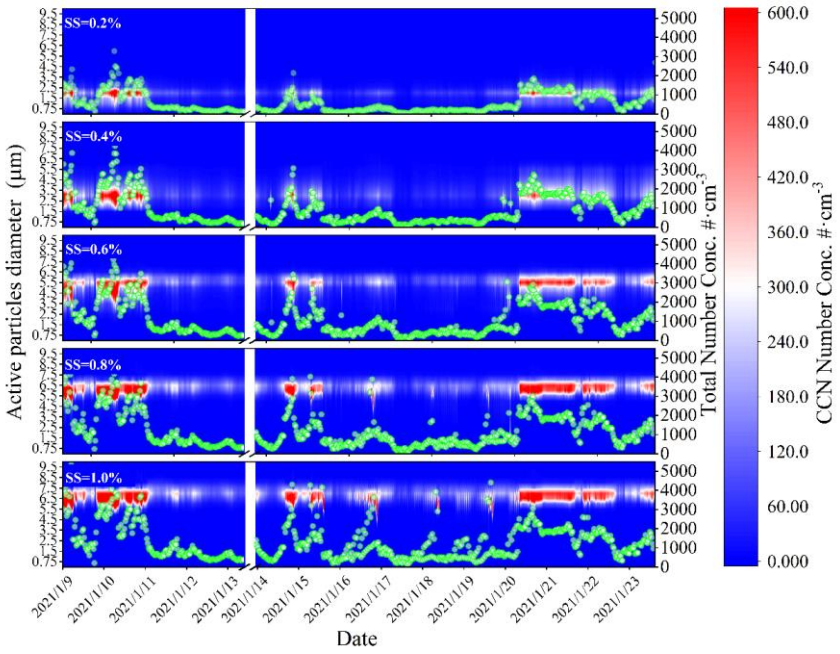

Figure S6 The contour of CCN number concentration was from Jan. 9th to 23rd, 2021. The color bar is for the dN/dlogD_p.

Table S1 the diameter division of nucleation mode particle from published literature and this study

Number	Site	Altitude	Nucleation mode	Reference
1	Remote Pacific and Atlantic oceans.	0.2-12km	3-12nm	(Williamson et al., 2021)
2	Mt. Saraswati, Hanle Valley	4520 m a.s.l	10-16nm	(Gogoi et al., 2014)
3	Mt. Huang 30.03°N, 118.09°E NUIST 32.21°N, 118.72°E	493m a.s.l 62 m a.s.l.	10–20 nm	(Wang et al., 2014)
4	PKU, Beijing	15m, a.s.l	3-20nm	(Yue et al., 2009)
5	Resolute Bay, Nunavut 74°41'N, 94°52'W	--	5-20nm	(Willis et al., 2016)
6	Helsinki, Finland	--		(Okuljar et al., 2021)
7	Cyprus, CAO-AMX 35.04°N, 33.06° E	532m a.s.l	3-25nm	(Baalbaki et al., 2021)
8	Beijing and surrounding areas			(Chen et al., 2017)
9	Thiruvananthapuram, 8.55°N, 76.97°E	3 m a.s.l.	15-25nm	(Babu et al., 2016)
10	Trivandrum 8.55°N, 76.97°E, Hanle 32.78◦ N, 78.96◦ E;	3m a.m.s.l. 4520m a.m.s.l	<25nm	(Kompalli et al., 2014)
11	Ranichauri, Uttarakhand 30.2°N, 78.25°E;	1,930 m amsl		(Sebastian et al., 2021)
12	Lai Chi Kok Road; Kowloon Tong, HongKong	--	<30nm	(Zhang et al., 2017)
13	UNIFESP, São Paulo 23◦43'8"S,46◦37'40"W,	769m a.m.s.l		(Monteiro dos Santos et al., 2021)
14	WFRS, Kyoto University, Japan 34.07°N, 135.52°E	750 m m.s.l	14-30nm	(Han et al., 2013)
15	Nanjing 118°57'10"E, 32°07'14"N,	40m a.g.l.	6-30nm	(Qi et al., 2015)
16	Mt. Hua, Shaanxi 34.48'N, 110.08' E	2060 m a.s.l,	<30nm	In this study

Table S2 the growth rates (GRs) of particle from different sites in published literature and this study

Number	Site	Altitude	GRs	Reference
1	PKU, Beijing	15m a.s.l	1.2-5.6	(Yue et al., 2009)
2	BUCT, Beijing	~20m a.g.l	0.4−8.8	(Deng et al., 2020)
3	Xigu Petrochemical District, Lanzhou 36.13°N, 103.69°E	1631m a.s.l	1.3-16.9 (4.4)	(Gao et al., 2011)
4	Taicang City	20 m a.g.l	3.6-7.4	(Gao et al., 2009)
5	Mt. Huang 30.03°N, 118.09°E	493m a.s.l	6.5–9.0	(Wang et al., 2014)
	NUIST 32.21°N, 118.72°E	62 m a.s.l.	4.8–5.6	
6	Ranichauri, Uttarakhand 30.2°N, 78.25°E	~1,930 m a. s.l.	6.2–11.2 (7.5) 3.3–10.7 (4.2)	(Sebastian et al., 2021)
7	SPC 44°39'N, 11°37'E	11m a.s.l.	3.0 (Zeppelin) 2.8 (Ground)	(Lampilahti et al., 2021)
	HTL 61°51'N, 24°17'E	181m a.s.l.	2.4 (Zeppelin) 2.1 (Ground)	
8	north (sub)tropical Pacific area (NSP)	--	0.5-1.8	(Ueda et al., 2016)
	south subtropical Pacific area (SSP)	--	0.6-2.7	
9	Thiruvananthapuram, 8.55°N, 76.97°E	3 m a.s.l.	7.4±2.9	(Babu et al., 2016)
10	India Habitat Centre	15 m a.s.l.	11.6– 18.1	(Mönkkönen et al., 2005)
11	IITM, Pune 18.53°N, 73.85°E	573m a.s.l.	6.5 ± 1.2	(Kanawade et al., 2014)
	IIT, Kanpur 26.46°N, 80.32°E	125m a.s.l.	8.7 ± 3.2	
12	WFRS, Kyoto University, Japan 34.07°N, 135.52°E	750m a.s.l.	5.0-15.7 (9.2)	(Han et al., 2013)
13	Xinken 22°37'N, 113°35'E	6m a.s.l	3.1-19.8	(Liu et al., 2008)
14	Nagoya, Japan	--	7.6-14.7	(Minoura and Takekawa, 2005)
15	Mt. Hua, Shaanxi 34.48'N, 110.08' E	2060 m a.s.l,	0.83	In this study

Table S3 the mean of meteorological parameters during five different episodes

Mean value	T1	P1	P2	P3	P4
Wind direction (°)	253.2±33.2	272.9±12.1	251.0±8.8	221.5±69.0	194.4±67.7
Wind speed ($m \cdot s^{-1}$)	4.9±2.4	8.5±2.6	12.6±2.4	6.6±4.5	5.5±5.6
Relative humidity (%)	41.5±17.5	39.8±8.8	18.4±4.7	30.8±16.0	37.0±12.9
Pressure (hPa)	797.4±2.9	797.0±1.4	791.6±2.5	795.1±4.2	791.3±2.0
Temperature (℃)	-4.9±4.1	-13.3±1.6	-1.5±4.0	-3.4±5.9	0.9±1.4
Visibility (km)	28.6±8.2	27.7±9.3	33.1±3.0	28.2±7.1	26.5±7.2

Table S4 the parameters of C and k from this study and published literatures

Site	Period	Altitude (long., lat.)		C(#·cm^{-3})	k	Reference
Mt. Hua	2021.01.09-2021.01.11	2060 m a.s.l, (34.48°N, 110.08° E)		2283	0.45	In this study
	2021.01.11-2021.01.13			655	0.67	
	2021.01.14-2021.01.18			1139	0.71	
	2021.01.19-2021.01.23			1488	0.35	
Mt. Huang	2014.06.30-2014.07.17; 2014.07.24-2014.07.28	1840m a.s.l (30.08°N, 118.09°E)		1596	0.46	(Miao et al., 2015)
India CAIPEEX	2011.10.26	Clean	Ground	4068	0.46	(Varghese et al., 2016)
			Cloud base	631	0.25	
	2011.10.02	Polluted	Ground	5179	0.53	
			Cloud base	1612	0.30	
	2011.10.08	Highly polluted	Ground	5649	0.37	
			Cloud base	2132	0.72	
Ponmudi	2016.07.19-2016.09.30	Hill station, 960m a.m.s.l (8.8°N, 77.1°E)		474	0.65	(Jayachandran et al., 2018)
Thumba	2013.08-09	Coastal station, 3m a.m.s.l (8.5°N, 76.9°E,)		2096	0.54	
	2014.07-09			-	0.64	(Jayachandran et al., 2017)
SORPES, China	2016.06.01–2017.05.31	40m a.s.l (32°07' N, 118°56' E)		7573	0.82	(Shen et al., 2019)
PGH, India	2011.11.01–2013.03.25	1936m a.s.l (29°22' N, 79°27' E)		4677	1.18	
Lucknow	2016.06.11-2016.07.11	126m a.s.l. (26.84° N, 80.94° E)		5981(PM)	2.07	(Manoj et al., 2021)
				1396(M)	1.46	
Jaipur/Jodhpur		431m a.s.l. (26.91° N, 75.78° E)		677 (PM)	0.81	
				735(M)	0.93	
Bhubaneswar		58m a.s.l. (20.29° N, 85.82° E)		1931(PM)	1.25	
				430(M)	0.43	