Introduction of Beijing weather modification center

Deping Ding

Beijing weather modification center

Beijing Key Laboratory of Cloud, Precipitation and Atmospheric Water Resources

Beijing weather modification center

Understanding the cloud – precipitation process and fasten

Cloud characteristics :

Field Observation:

1. Aerosol & cloud process observation. **Micro-properties**

2. Cloud and precipitation Remote Sensing. **Macro-properties**

Seeding mechanism quantify:

1. Laboratory study: BACIC chamber and wind tunnel (building).

2. Model simulation

Main objective:

Field Cloud seeding:

Hail prevention and **Precipitation enhancement**

Four groups:

Field observation :

aerosol and cloud

Remote Sensing:

cloud and precipitation

Model simulation:

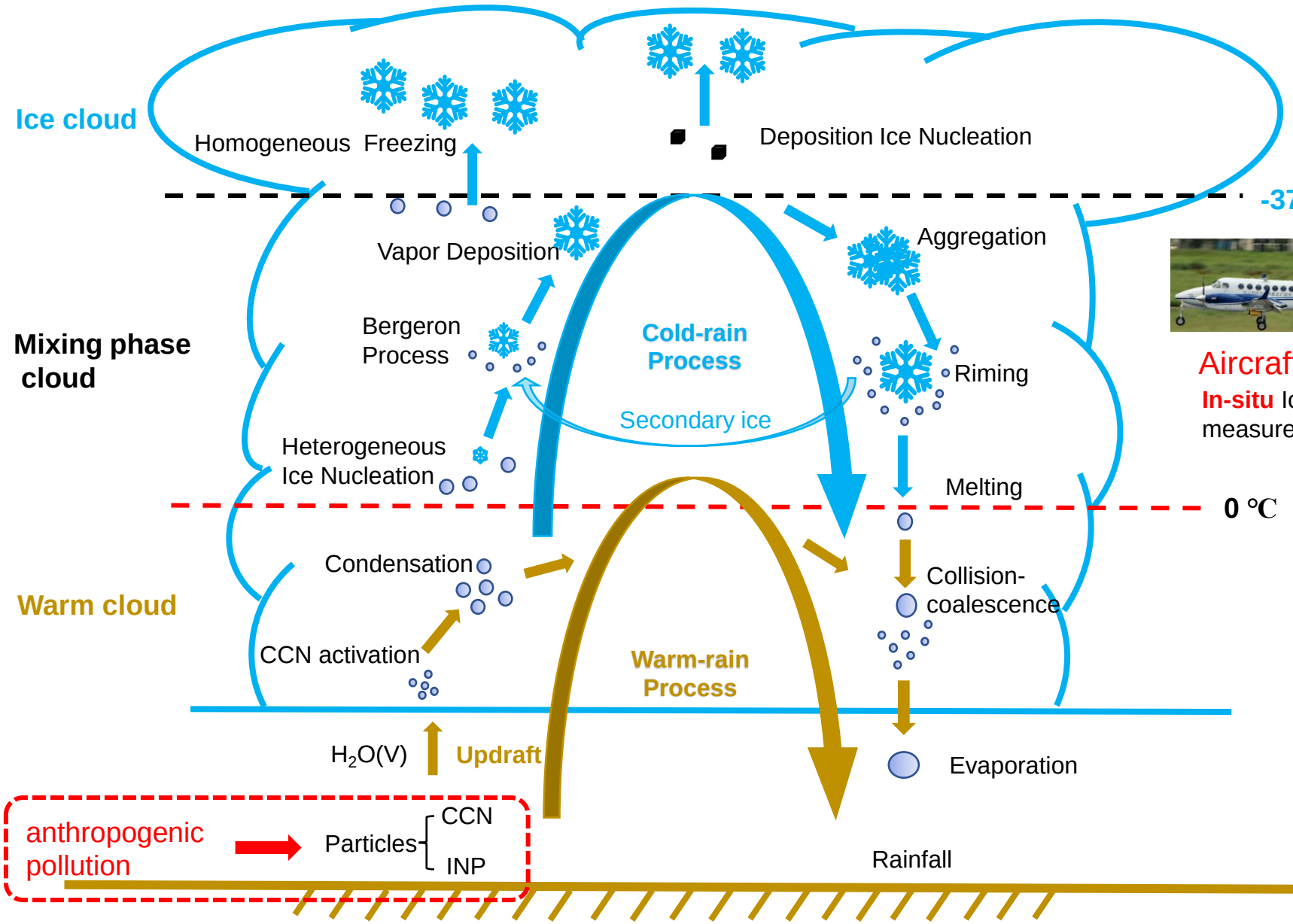
cloud process

Laboratory study:

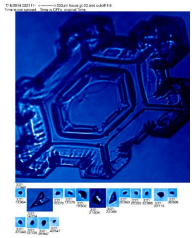
aerosol-cloud

BJWMO founded on 1990 and has 40 employees

What's the cloud characteristics under anthropogenic pollution influence?

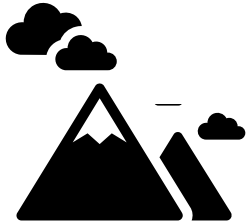


Observation System:



Aircraft observation

In-situ Ice crystals and cloud droplet size distribution measurement.



Mountain observation

In-situ and Long-term observation of orographic cloud and aerosol microphysics properties, and remoting measurement.

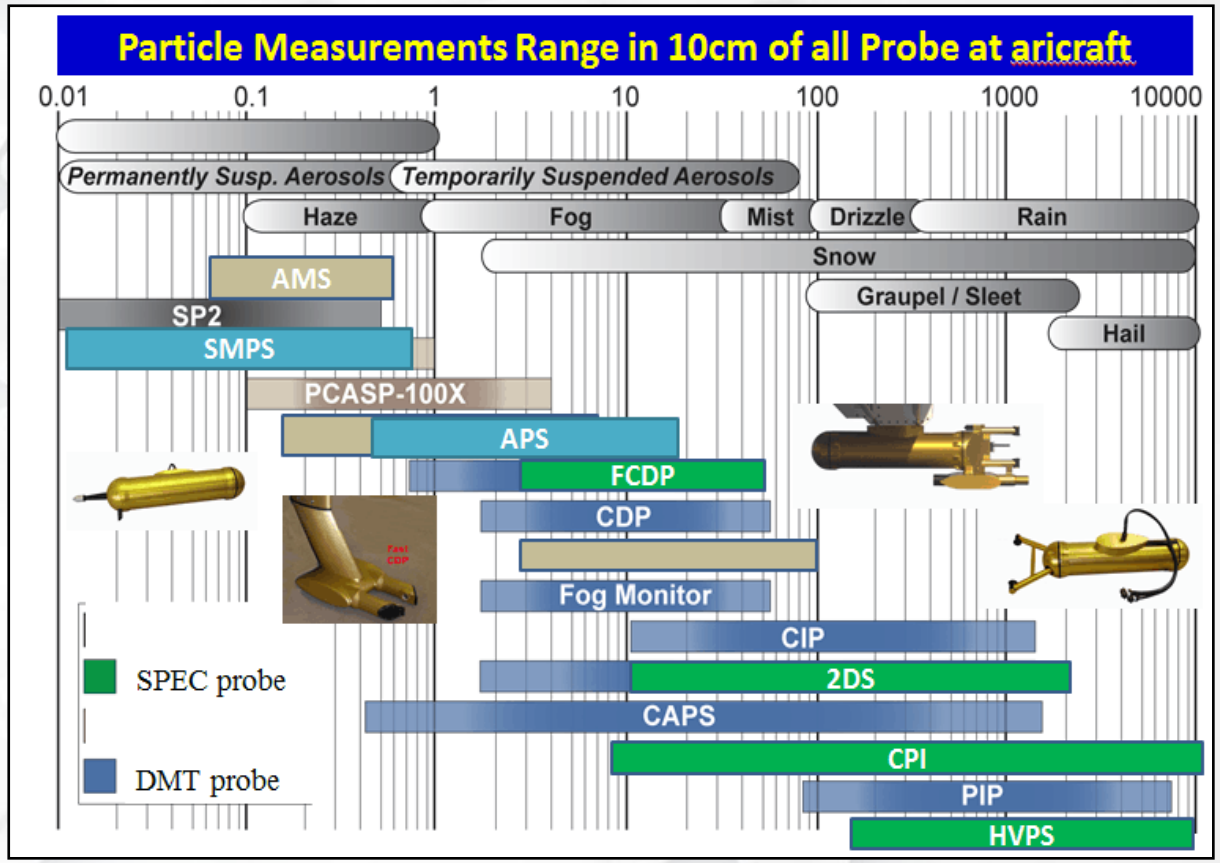
Ground observation

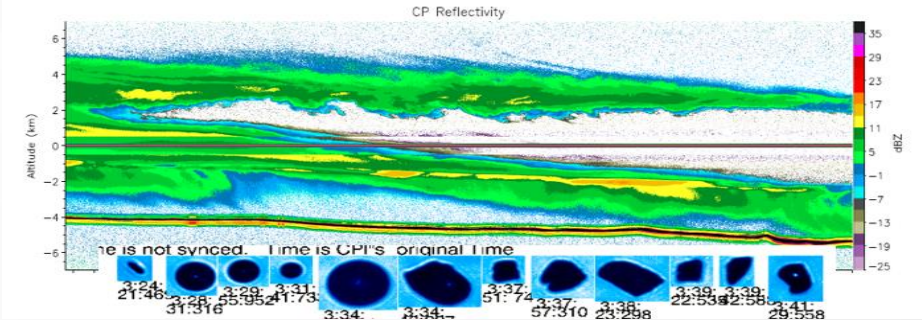
Urban and Suburb sites cloud and aerosol microphysics properties, and remoting measurement.

Aircraft observation platform

Object	Parameters	equipment
1.Meteorology	**T, P, RH, Td Wind$_s$ and wind$_d$**	AIMMS 20, DEW-point
2.Cloud micro-physics	**Droplet spectrum, liquid water, total water content, cloud particles phase**	FCDP, CIP, 3V-CPI, LWC, TWC, CCN、
3. Cloud macro-physics	**Liquid water path and cloud profiles**	KPR and GVR
4. Precipitation characteristics	**Precipitation particle spectrum, and phase states**	HVPS, PIP, 2DS
5. Aerosol physical and chemical	**Aerosol size distribution, aerosol components, Volatile organic compounds, and trace gases**	SMPS, PCAPS, HR-TOF-AMS, PTR-TOF, SO2, CO, O3, NOX

From 10nm to 10 mm





Vertical characteristic of aerosol over Beijing

clean:

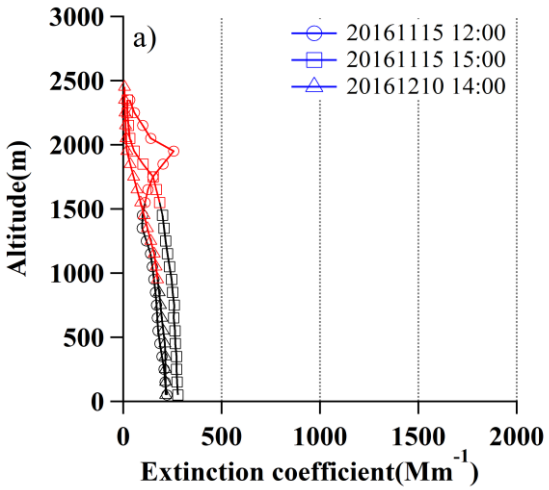
aerosol uniform inside the PBL

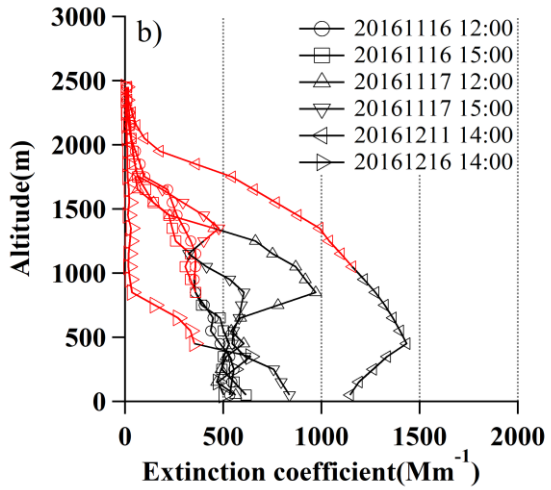
Transition:

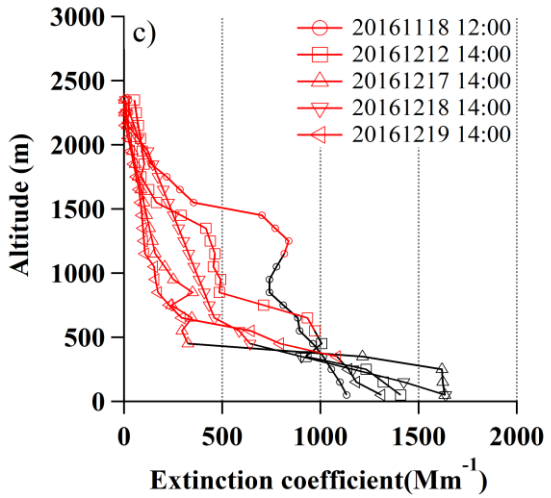
elevated layer usually found

Polluted:

aerosol suppress in the near surface



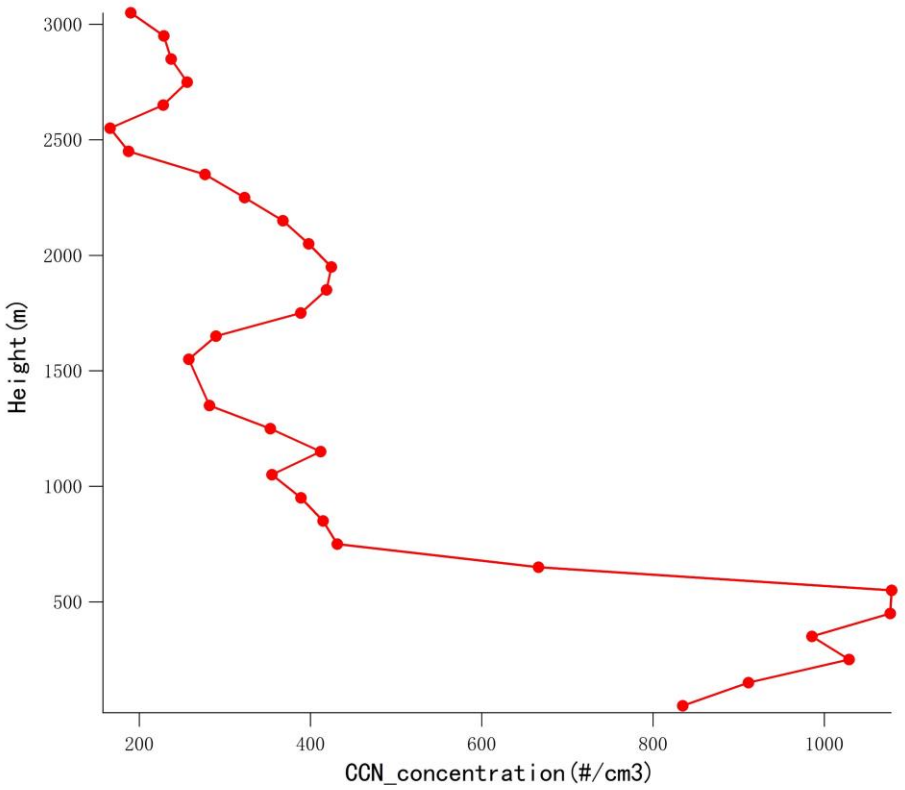




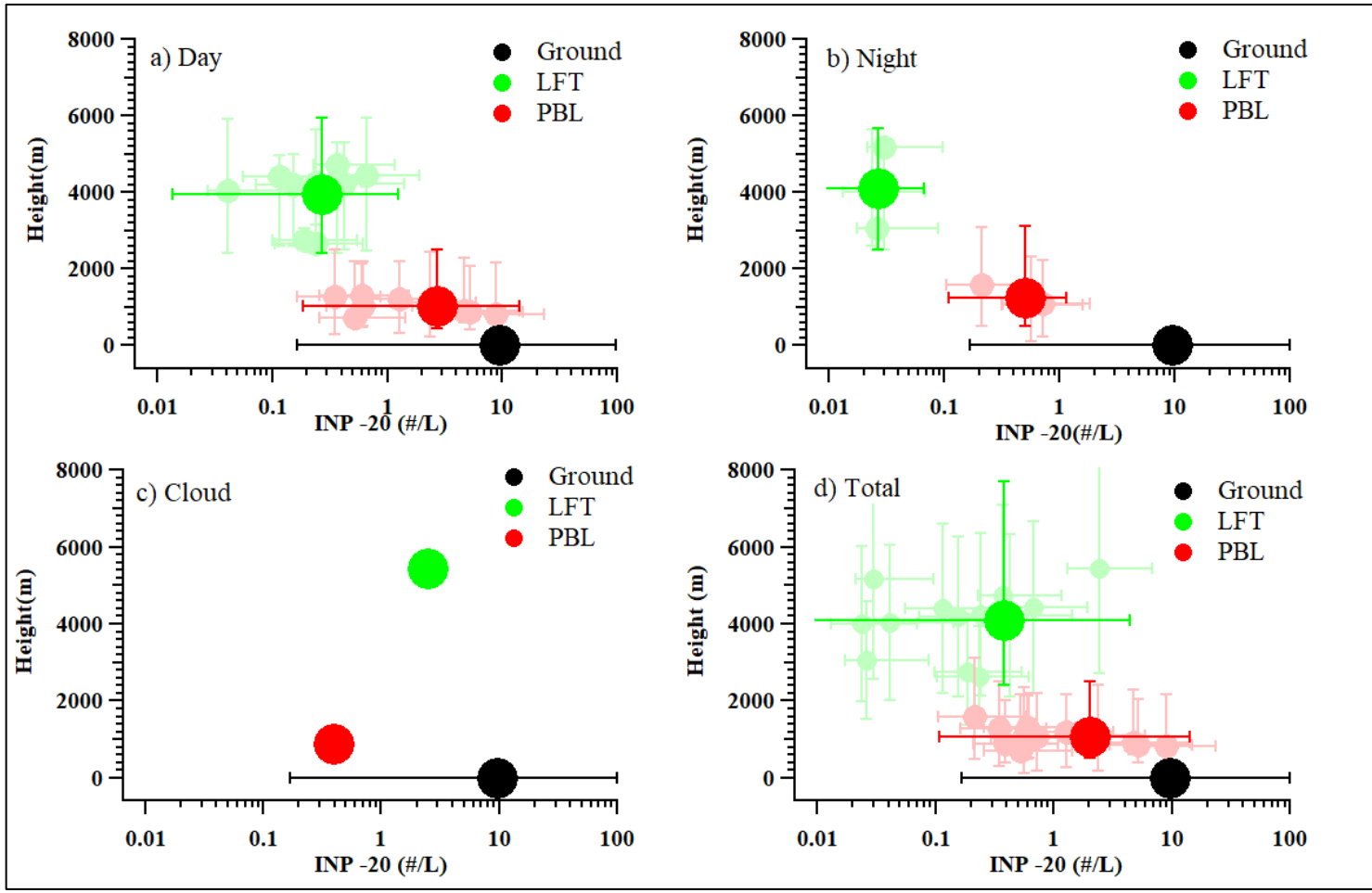
The vertical characteristic of aerosol under different condition.

Vertical characteristic of CCN and INP

CCN vertical distribution



INP vertical distribution



CCN (Model: CCN-200, DMT inc)

INP (filter sampling, analyze in KIT using INSEKT)

Support by
Ottmar Möhler

The surface observation of CCN and INP does not represent the troposphere

Microphysical properties of Warm clouds in Beijing area

Based on 75 times aircraft cloud observation in two years.

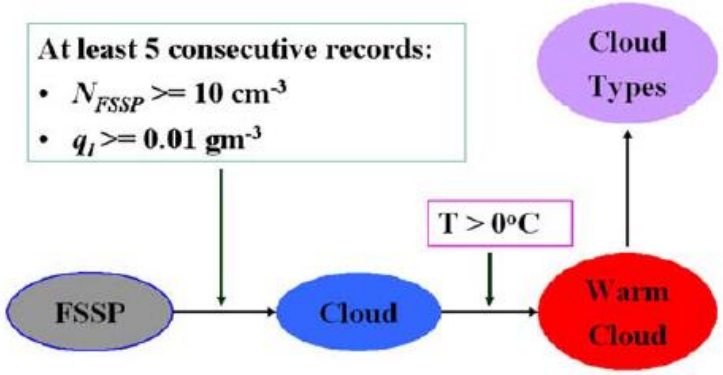
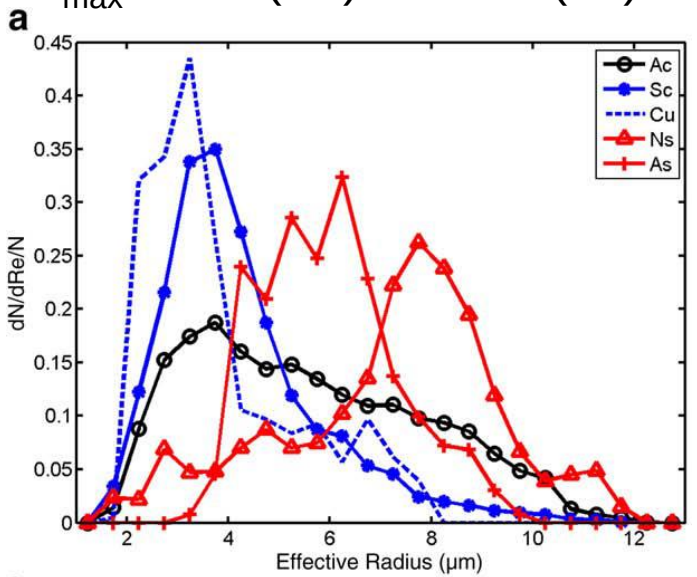


Fig. 1. Cloud determination scheme.

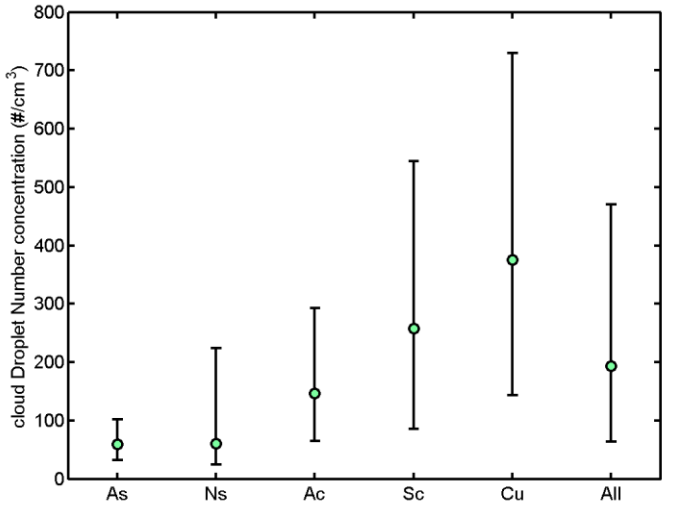
Smaller cloud droplet

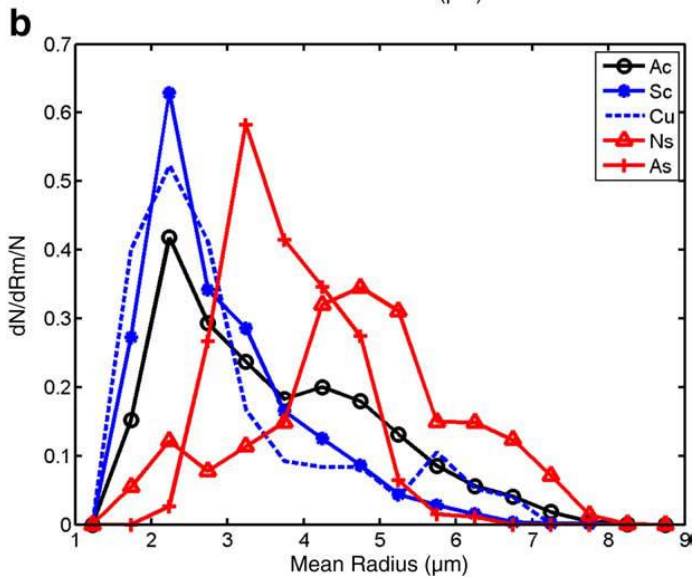
Nc_{max}: 1164 (Cu) & 1244 (Sc) #/cm^3

Rc_{mean}: 3.86 (Cu) & 4.27(Sc) μm

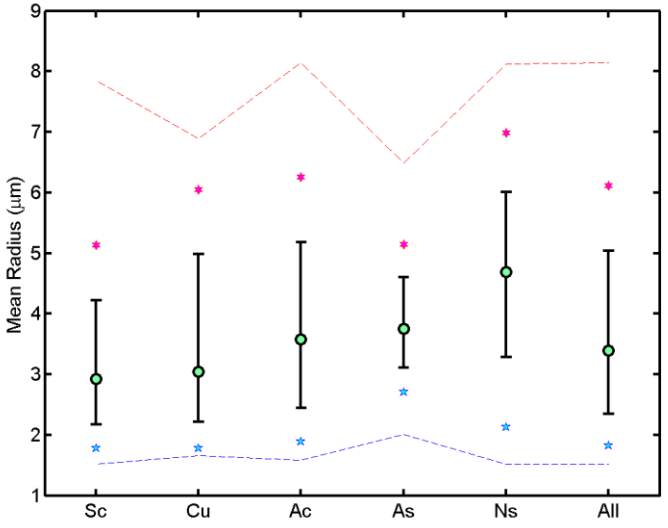


N_c





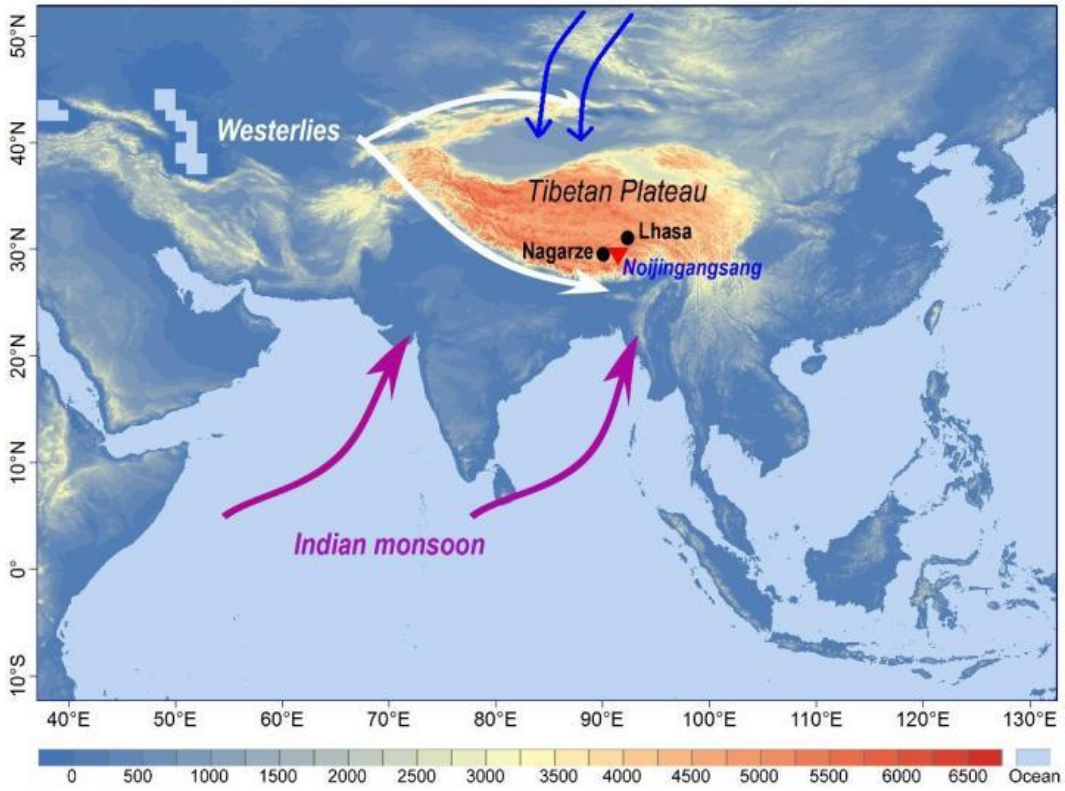
R_c

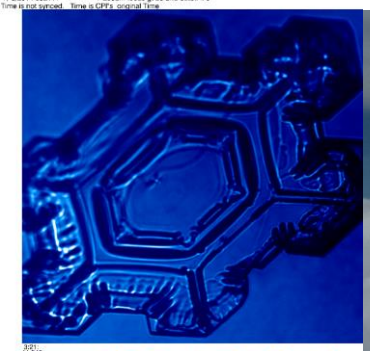


Deng et al. Statistical analysis of microphysical properties and the parameterization of effective radius of warm clouds in Beijing area, Atmospheric Research. 93, 888–896, 2009.

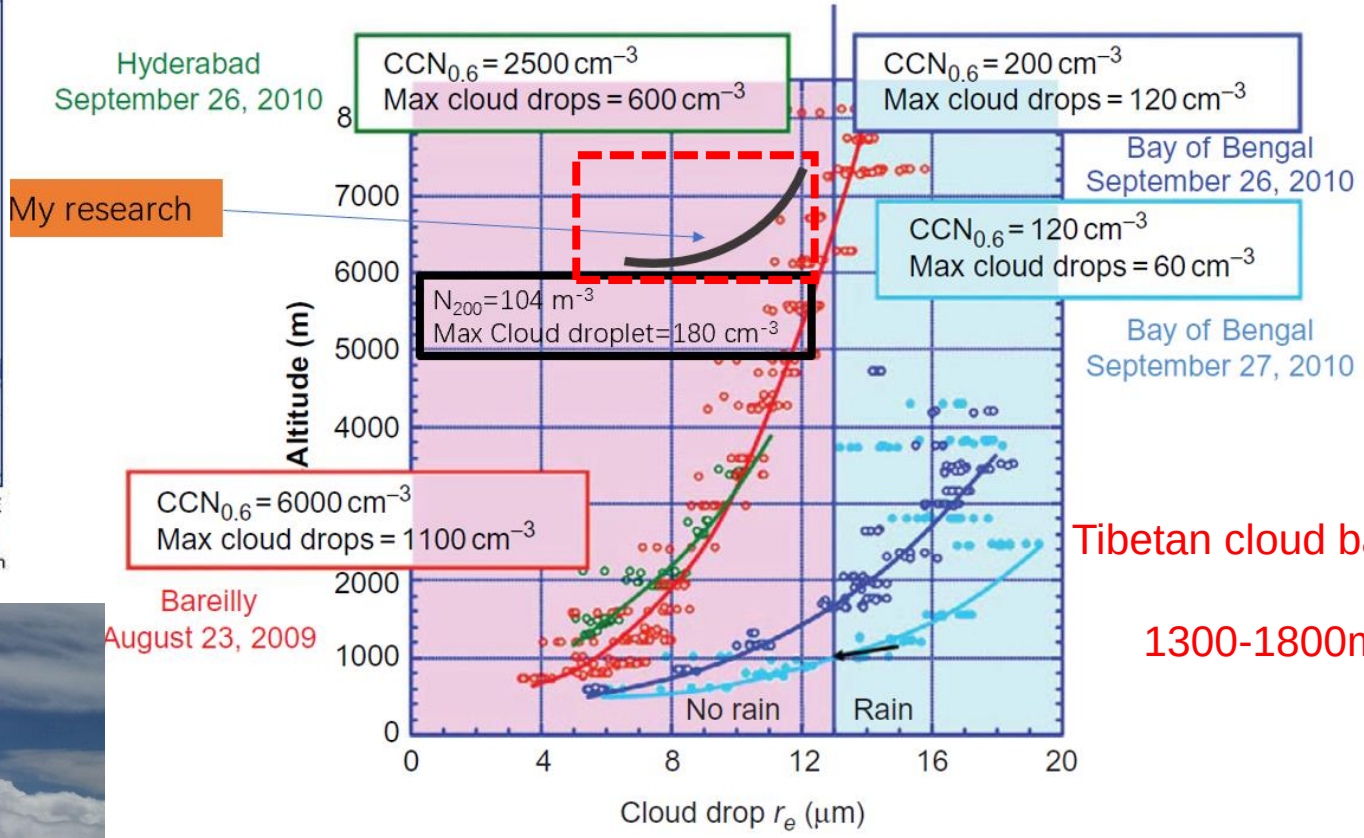
Qinghai-Tibetan Plateau Cloud Observation

altitude 4700m





How do the Tibet clouds compare to other clouds in the world, and how unique of a regime are they?



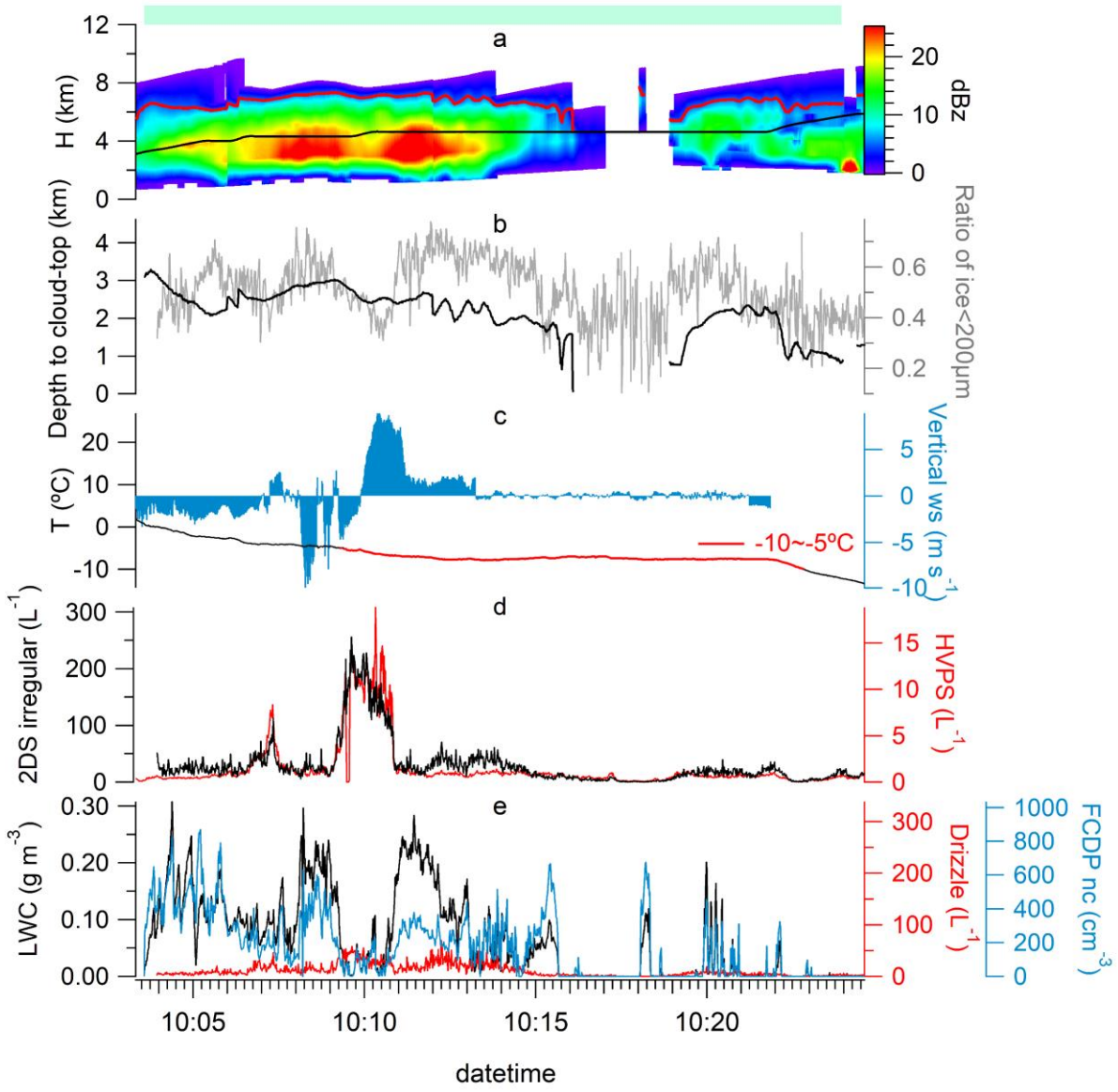
Tibetan cloud base :

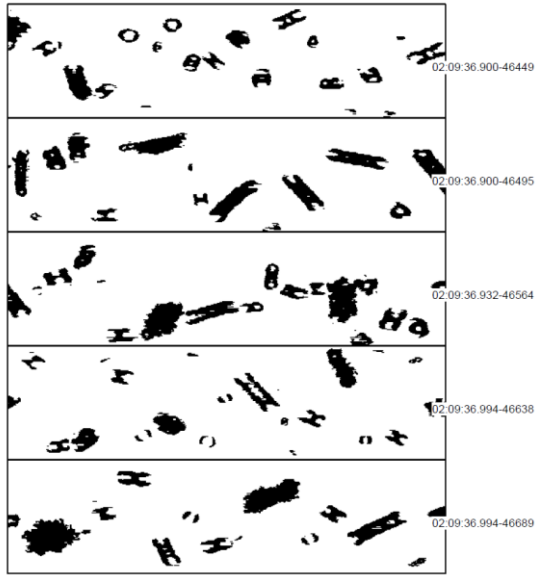
1300-1800m

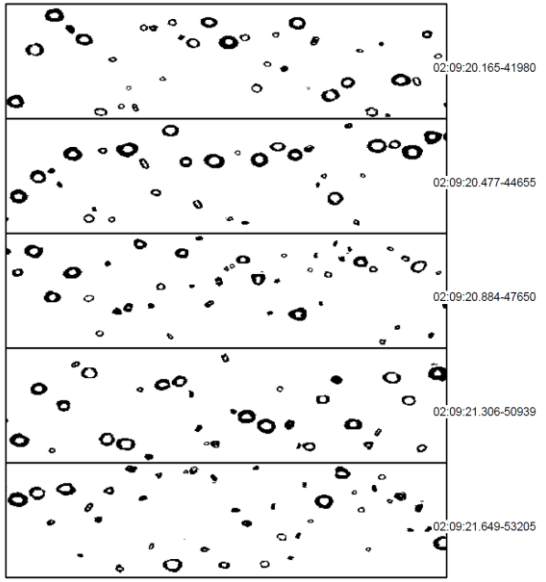
anthropogenic pollution delay the precipitation

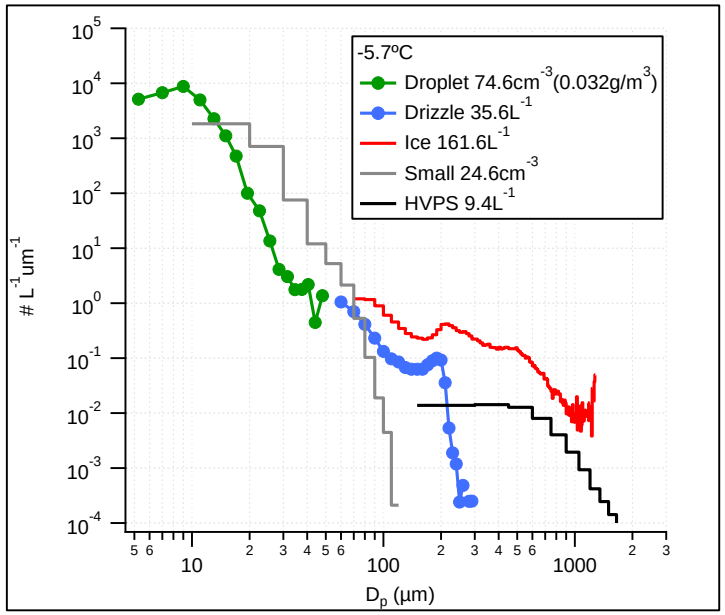
Tibetan cloud: smaller N_c and larger D_c

Secondary ice observation









-5 ℃

N_{ice}= 161.1 L^{-1}

Secondary ice is important for the precipitation over Beijing

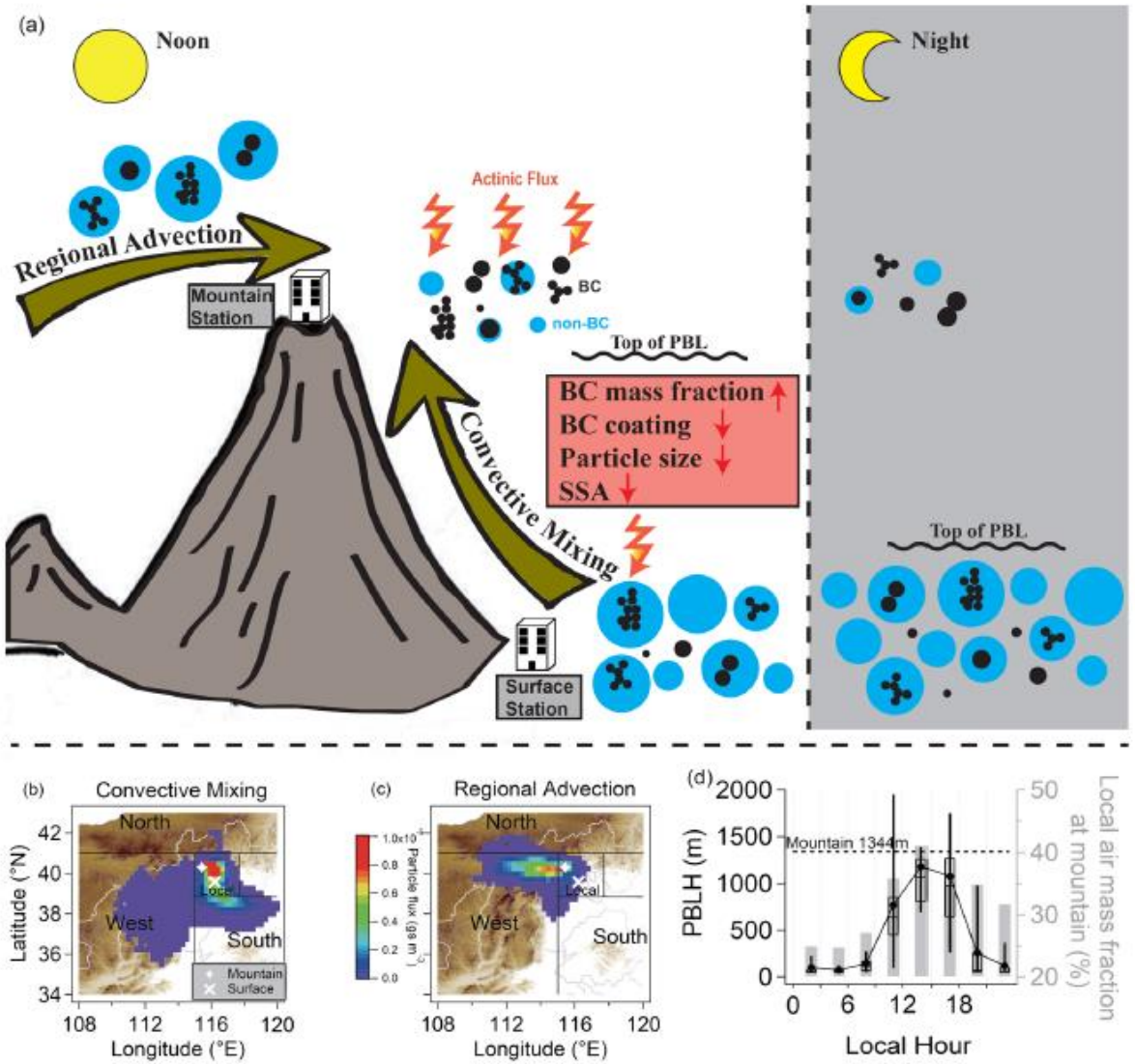
Mountain observation site

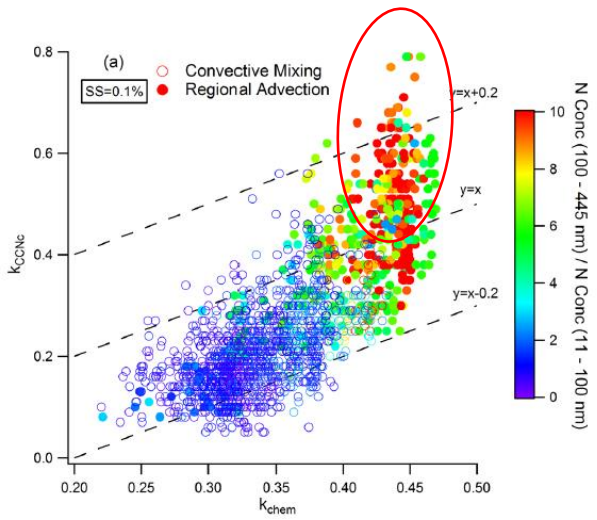
warm cloud

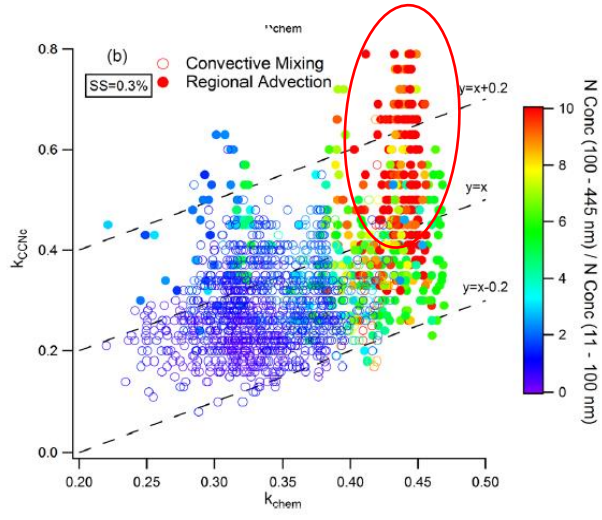
The mountain is above the PBL

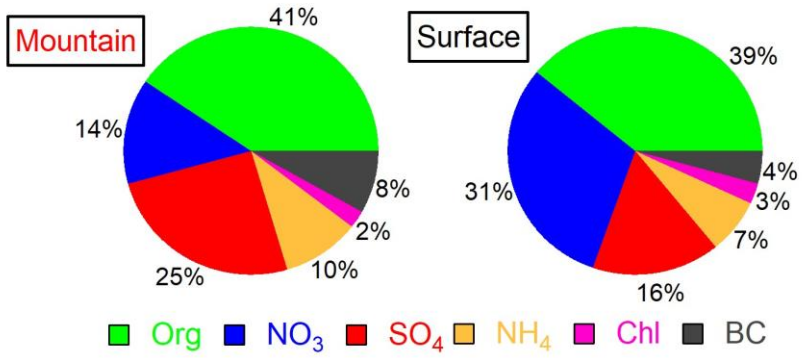
Long-term in-situ

CCN measured > CCN calculated based on ZSR









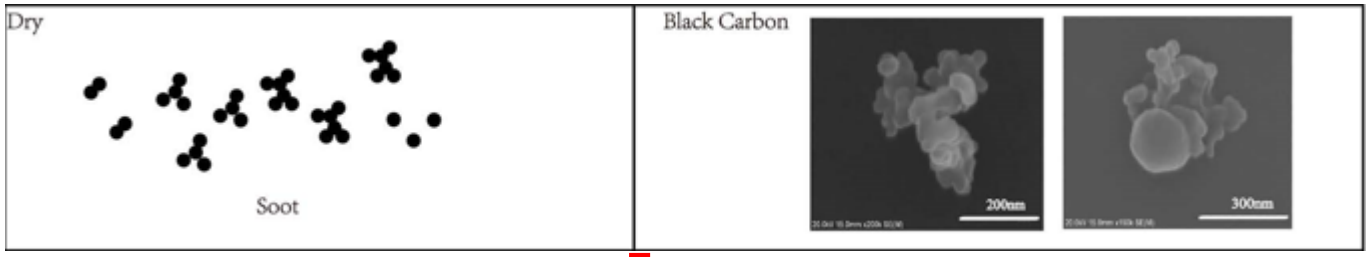
OC surface active decrease the surface tension

CCN may increase at higher altitude

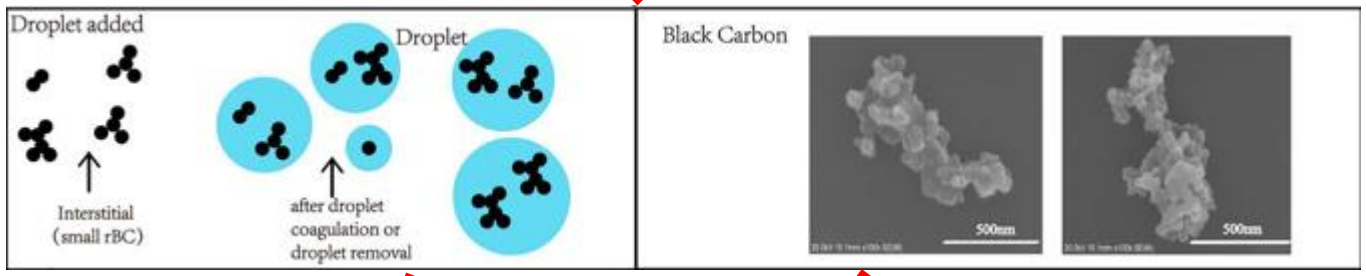
Mountain observation site

mixing phase cloud

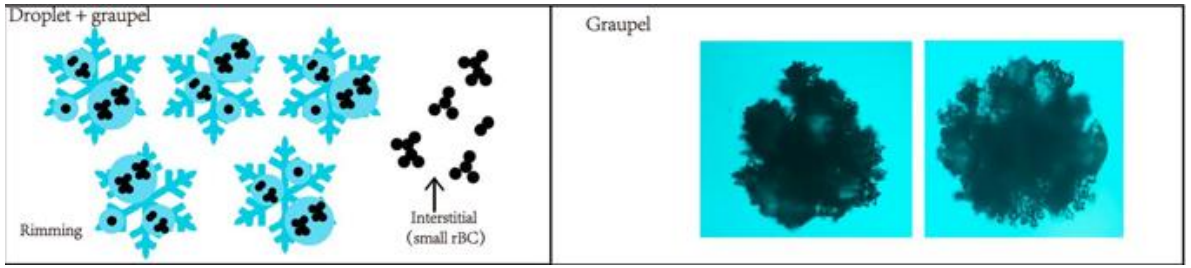
Direct measuring the Black Carbon (BC) release due to the WBF at the mountain site during snow period



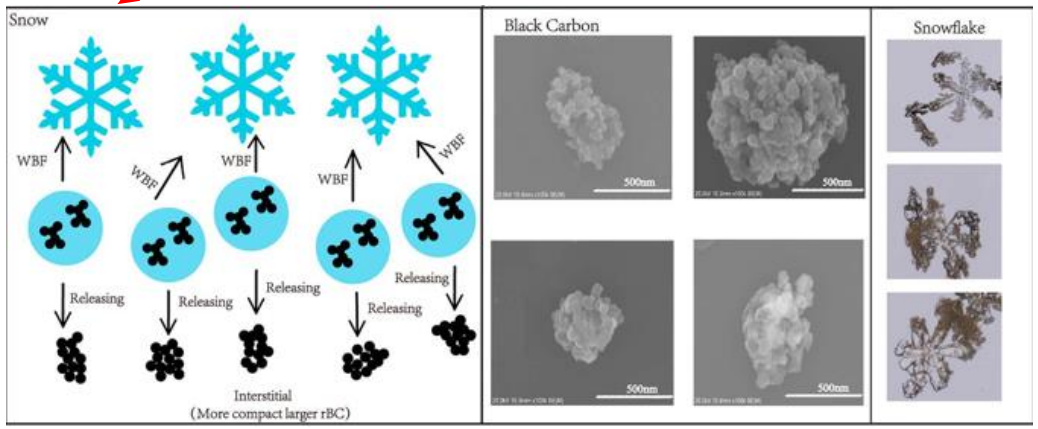
BC activate to cloud droplet



BC remove: Graupel - fast terminal speed



BC release: Snow - WBF

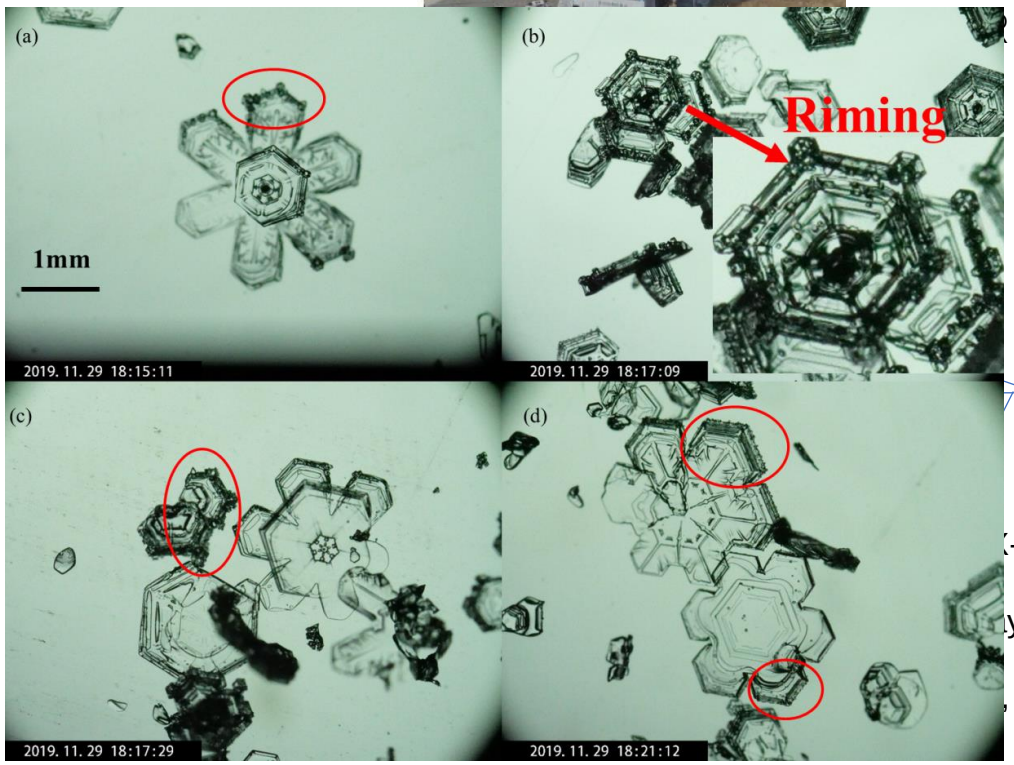


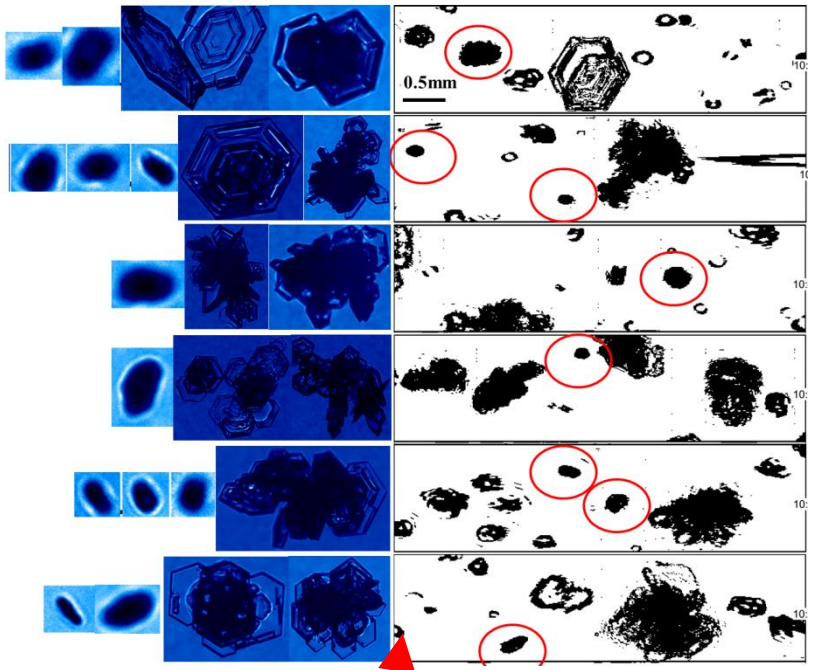
Remoting sensing of cloud and precipitation

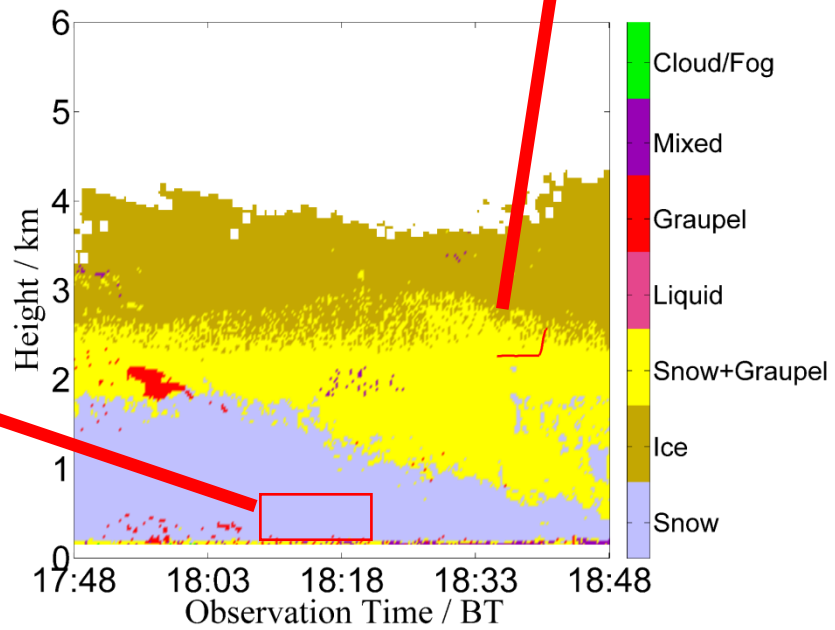
Hydrometeor Classification of Winter Precipitation Based on Multi-Platform Radar Observation System

3V-CPI
HVPS-3
AIMMS-20

1. MMCR





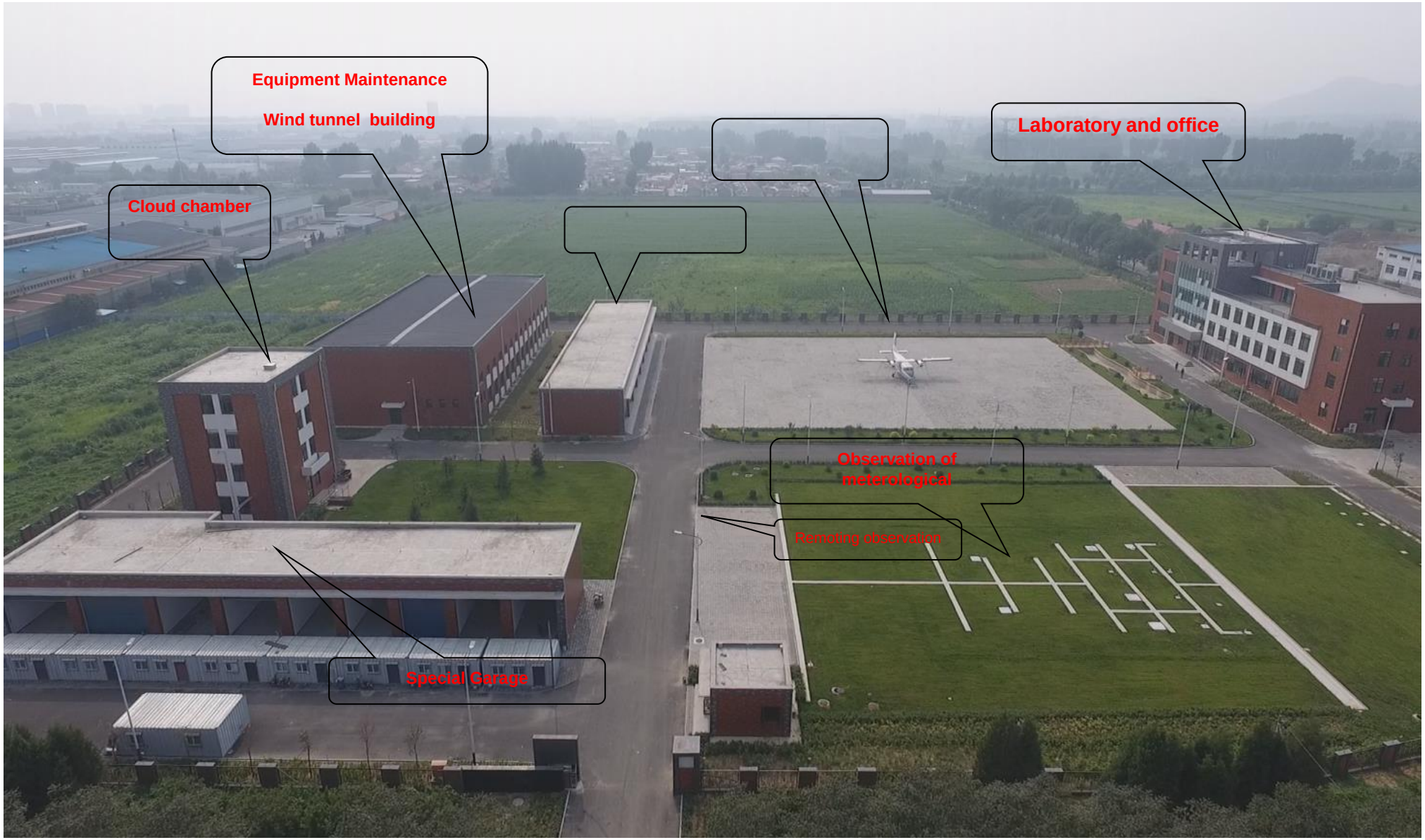


- and

yer

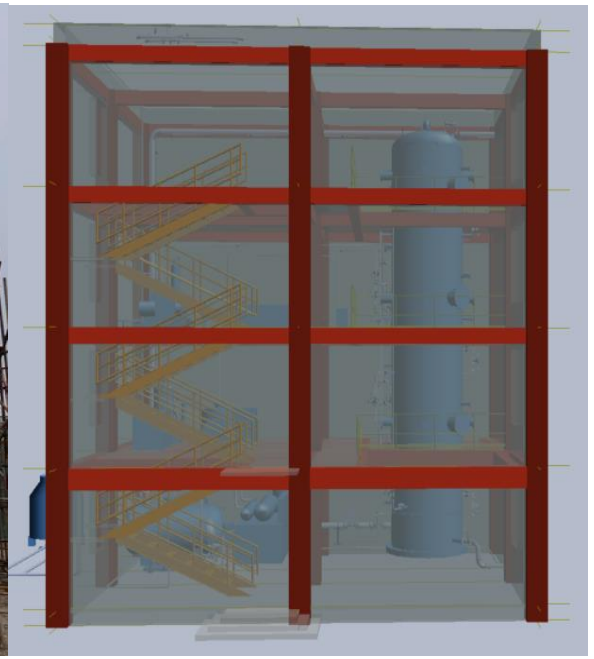
, and a

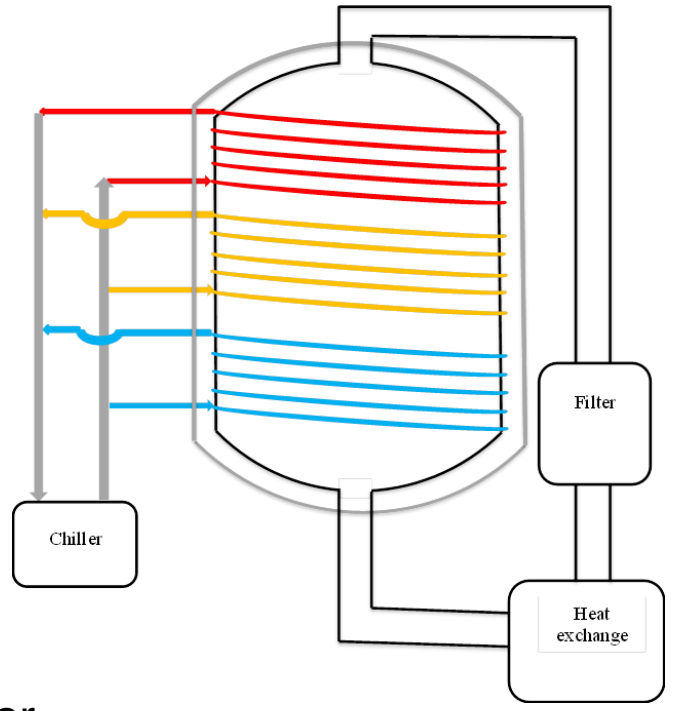
Cloud Laboratory and Observational Utilities Deployment Base (Cloud Base)



Laboratory

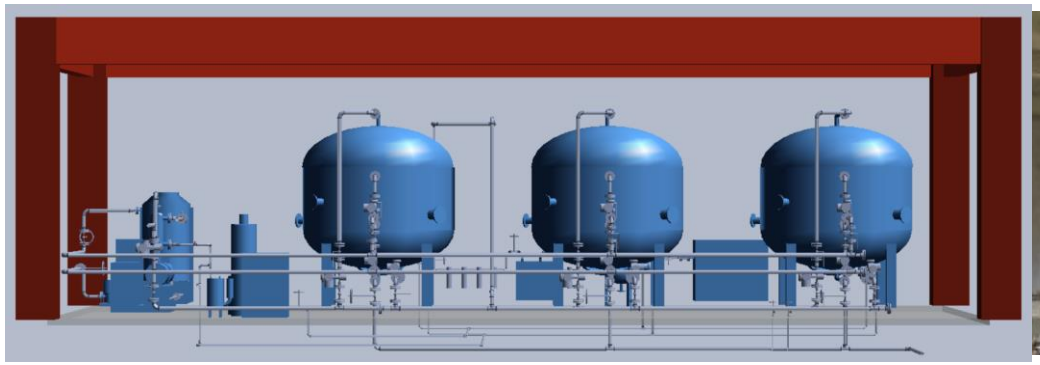
Beijing Aerosol and Cloud Interaction Chamber (BACIC)





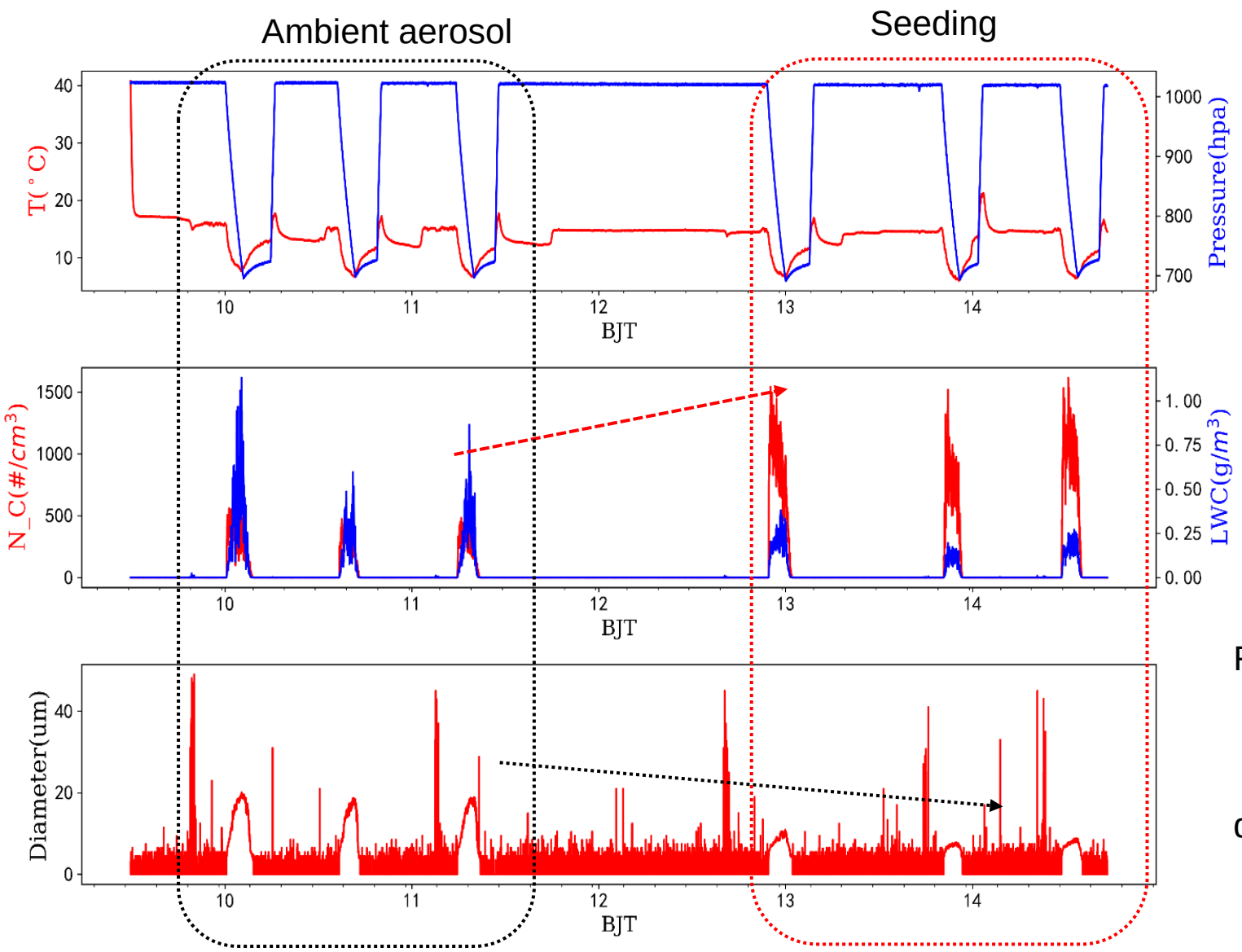
Parameters	
Shape	Cylinder
Size	Diameter: 2.6 m / Height: 14 m
volume / inner surface	70m^3 / 118.4 m^2
Surface to volume ratio	1.69 m
Wall material	Stainless steel
Temperature	223.5 K- 303.15 K
Operating Pressure	1 hpa – 1013 hpa

70 m^3 expansion cloud chamber



3 * 8m^3 cold cloud chamber

Seeding on natural warm cloud with hygroscopic material



N_a: 3000 #/cm^3
N_s: 2000 #/cm^3;
T: 10.8 ºC;
T_d: 8 ºC;

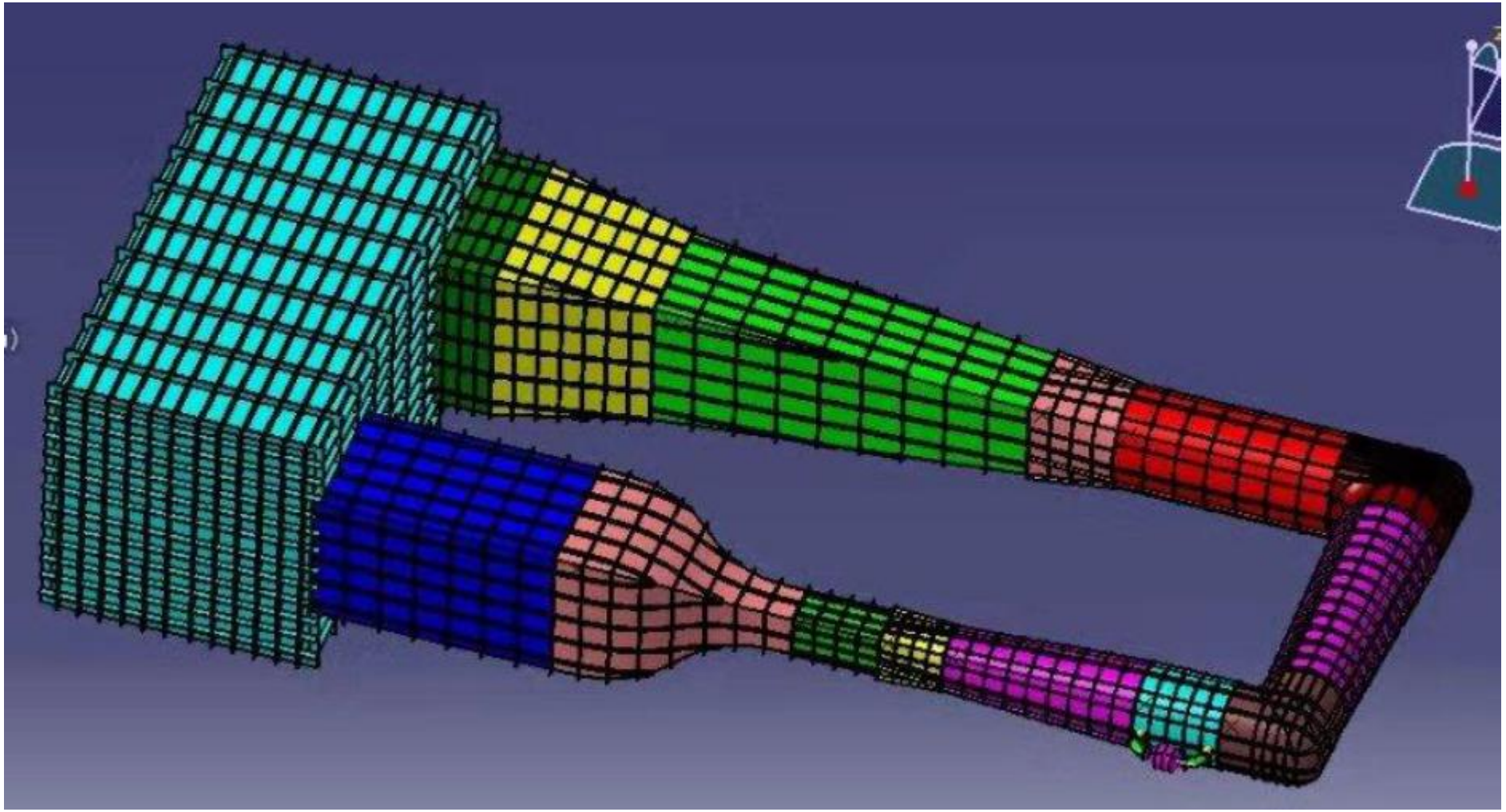
When the ambient aerosol concentration was lower, the number concentration of cloud was about 500#/cm^3,

Fixed water vapor concentration and updraft, :

(1) Increase of the number concentration of cloud, decrease the LWC;

(2) decrease of the MVD;

Wind tunnel



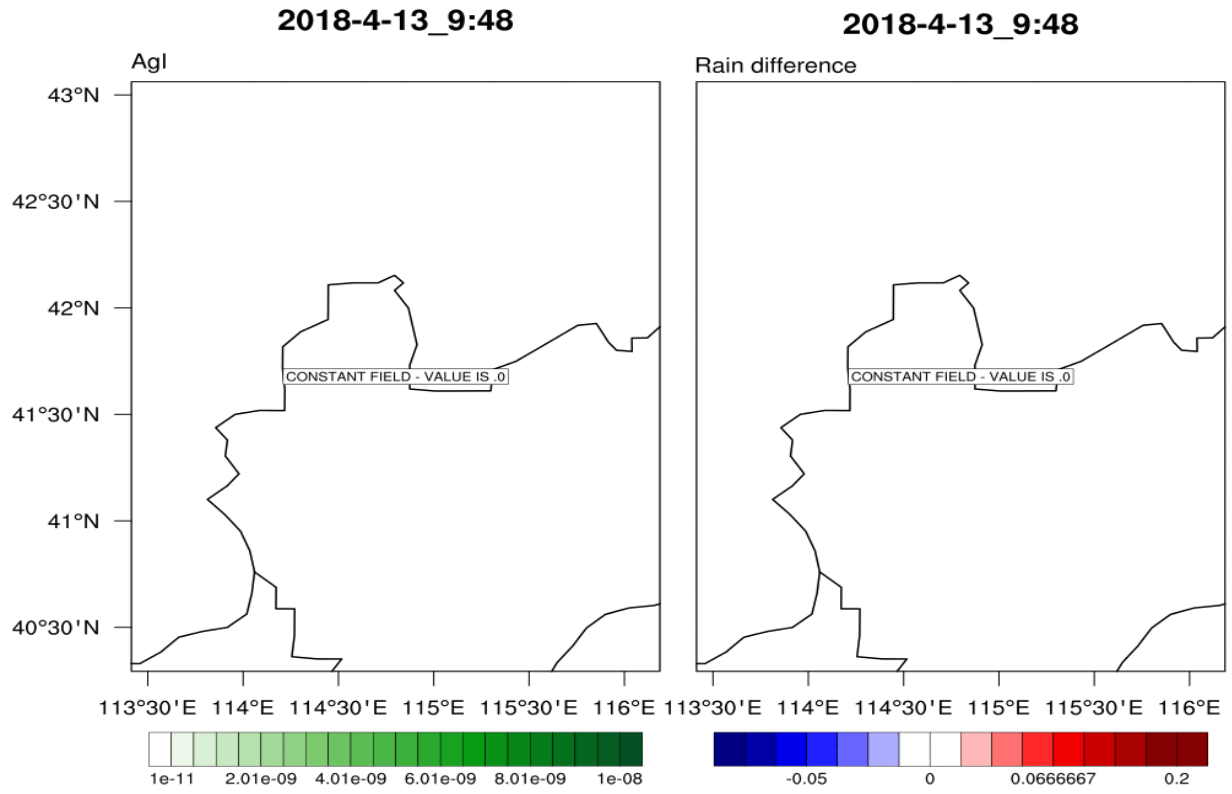
	Parameters
Shape	cycle
Size	1m*1m*2m
velocity	50~100m/s
Reynold number	> 4000
Wall material	Stainless steel
Temperature	-25 ℃- 35 ℃
Operating Pressure	300 hpa – 1013 hpa

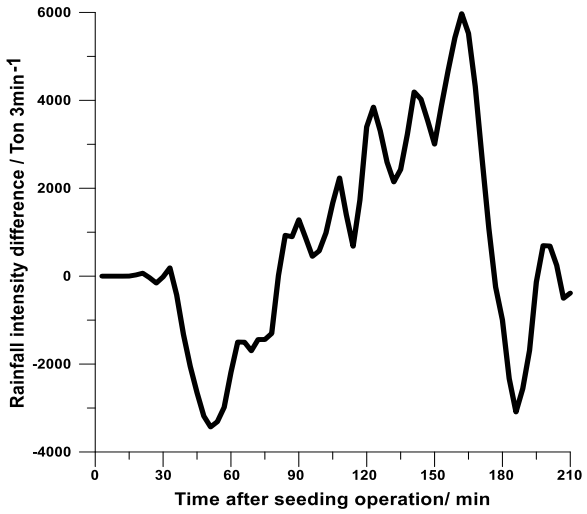
Building finish in 2022

Model simulation study

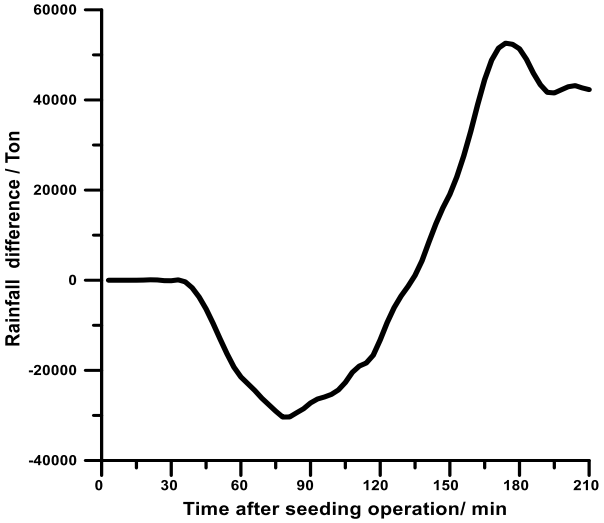
Cloud Seeding simulation

Based on the WRF model, AgI-seeding, LN(Liquid nitrogen)-seeding and salt-seeding scheme were developed to study the rain enhancement.





Temporal evolutions of the 3-min net surface rainfall increment



Temporal evolutions of the accumulated surface rainfall increment

Thanks for your attention