Construction of an Expansion Cloud Chamber

Zhengjun SU

mailto: suzj@cma.gov.cn

Weather Modification Center of China Meteorological Administration

Chinese Academy of Meteorological Sciences

Address: 46, Zhong-Guan-Cun South Avenue Haidian District Beijing 100081, China

Zip code: 100081 Telephone:010-58995280

outline

- Some history regarding cloud chambers（CC） research of seeding agents in China

- Words on the new expansion cloud chamber（ECC）

- Some recommendations for future research needs the quality controls

Past history of cloud chambers in China

- As we all know that the beginning of the artificial weather modification in China was in 1958, it has a history of more than 60 years.

- While carrying out a large number of field experiments, we have also carried out a large number of experimental research in laboratory.

- Of course, the research results of our laboratory will in turn promote the improvement of the field operational level of weather modification.

Past history

Zhang J.H.

Feng D.X.
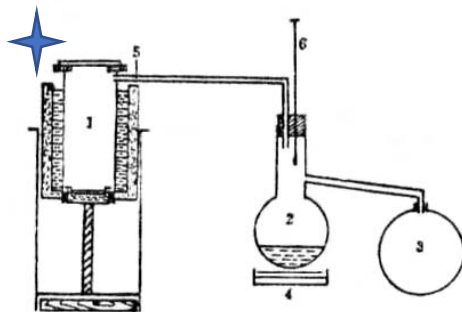
图1 冰核计数设备
1 云室 2 烧瓶
4 电炉 5 注射孔
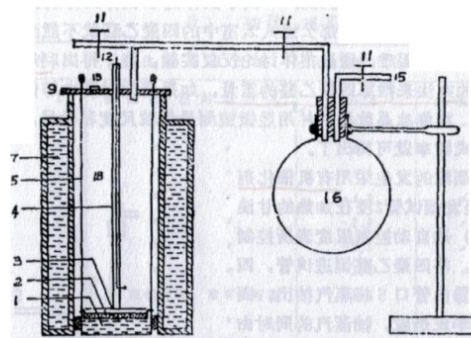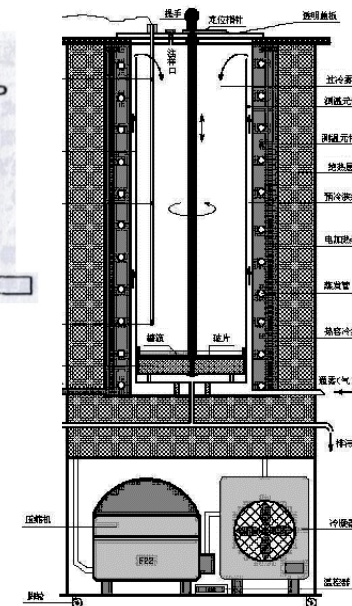
图4. 封闭式冰核计数器剖面图
2. 取样盘; 3. 取样盘盖; 4. 套管;
7. 冷冻液; 9. 有机玻璃盖; 11. 橡
12. 热电偶温度表; 13. 催化剂通
进气孔; 16. 气球; 18. 实验空间

CAMS-2m3-ICC

Portable Ice nuclei counter

15L mixed cloud chamber

Operational testing

CAMS-96m3 Medium cloud chamber

CAMS-1m3-ICC

1.2m3-ICC（Jilin）

2000L-ICC（Jilin）
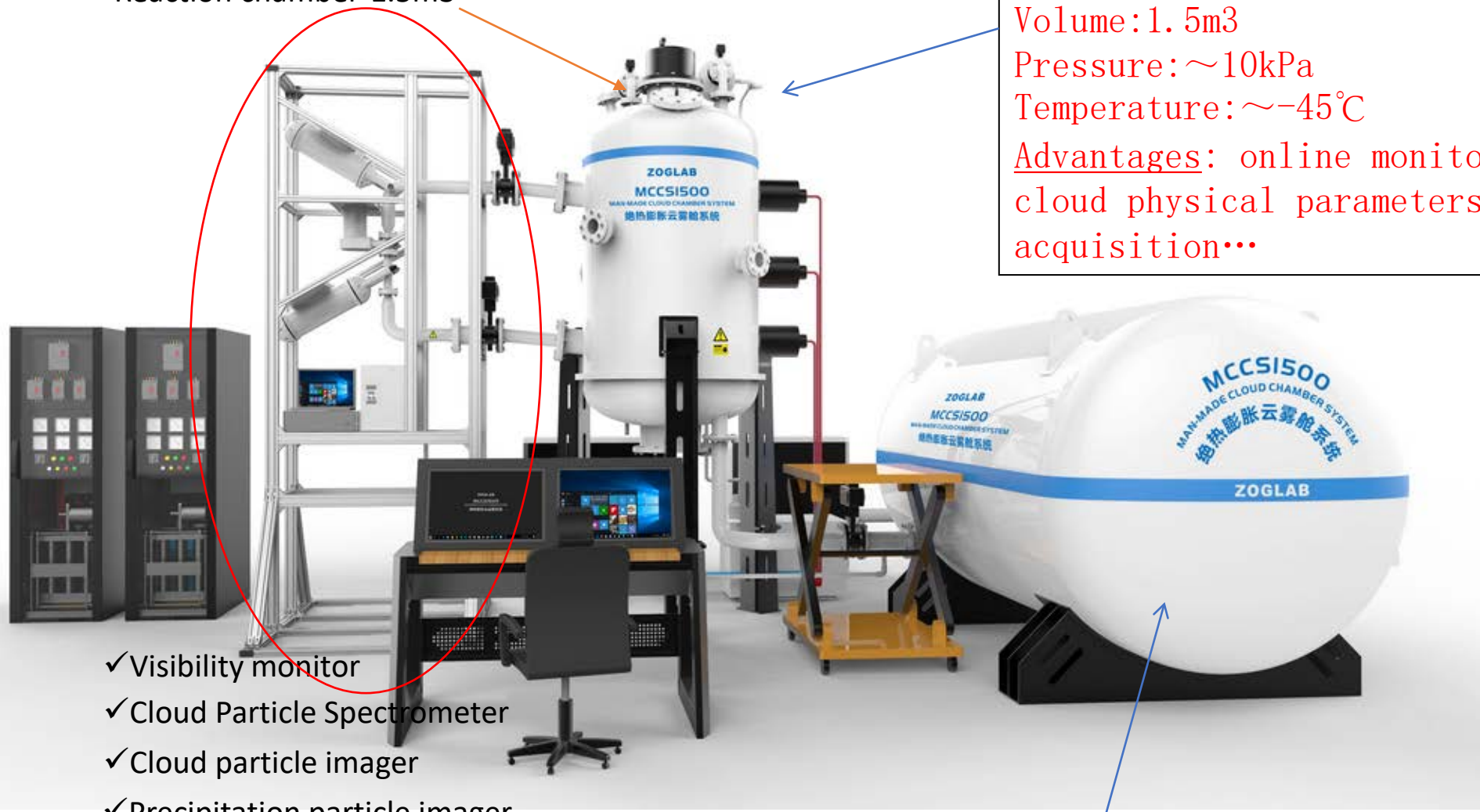
Reaction chamber-1.5m3

Volume:1.5m3
Pressure:～10kPa
Temperature:～-45℃
Advantages: online monitoring of cloud physical parameters; video acquisition…

✓Visibility monitor
✓Cloud Particle Spectrometer
✓Cloud particle imager
✓Precipitation particle imager
✓Aerosol spectrometer
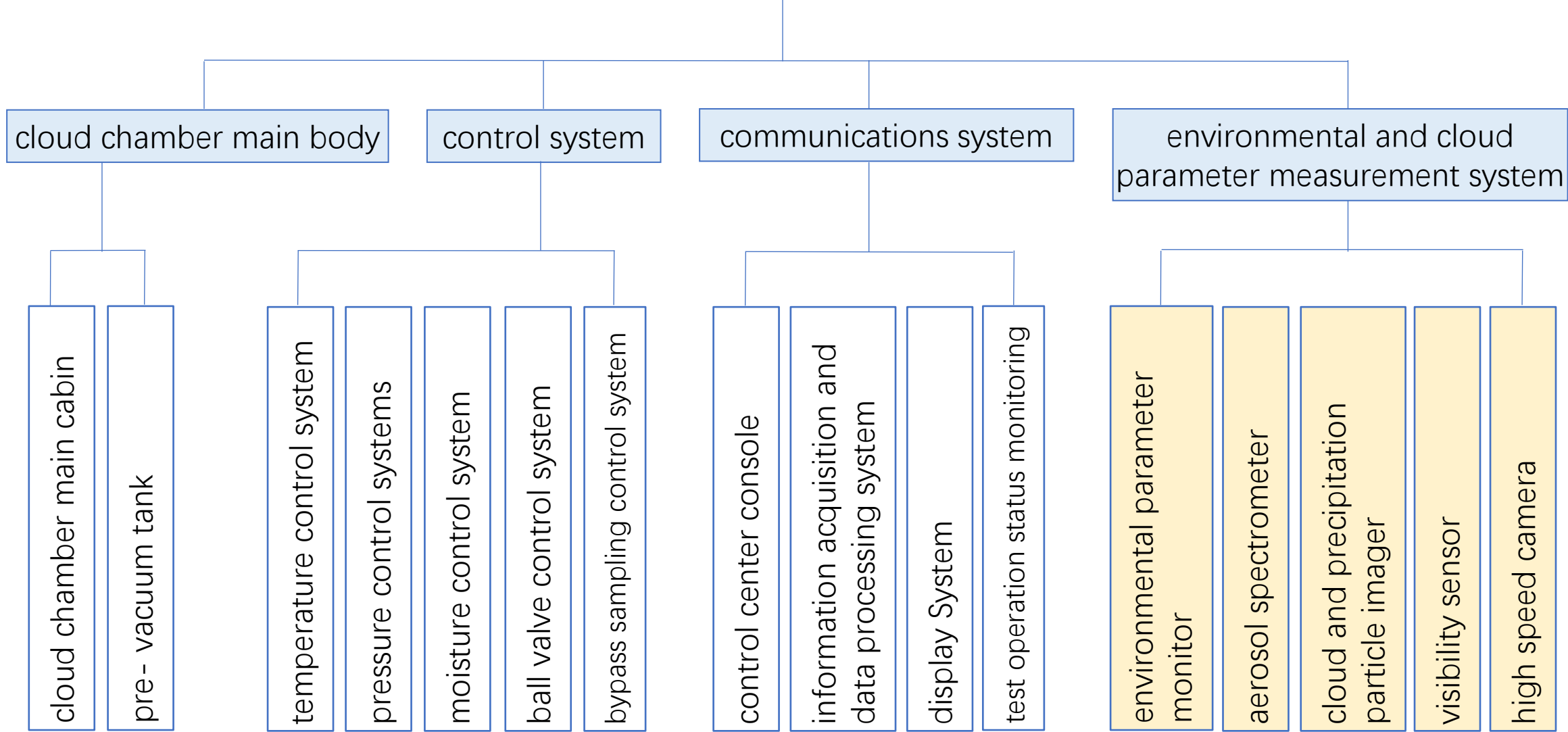✓High speed camera system

Pre-vacuum chamber- 9m3

"云微物理室内实验及模式研究"国际研讨，Beijing，20210922-25

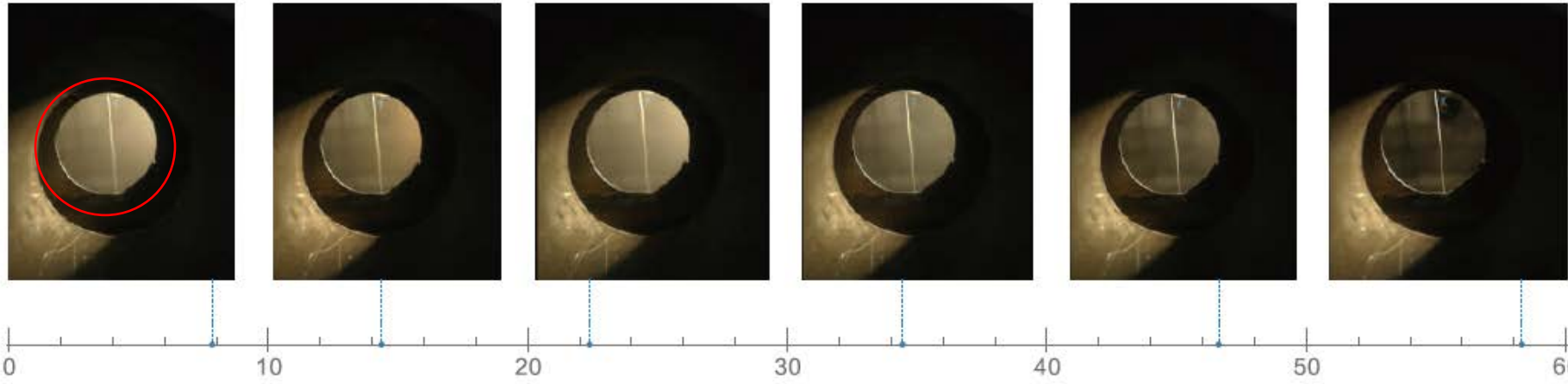Fig.3 The schematic diagram of expansion Cloud Chamber

Dr. Guo X.L.

Dr. Guo X.L.

Fig.5 Test scheme and comprehensive commissioning of expansion cloud chamber（ECC）

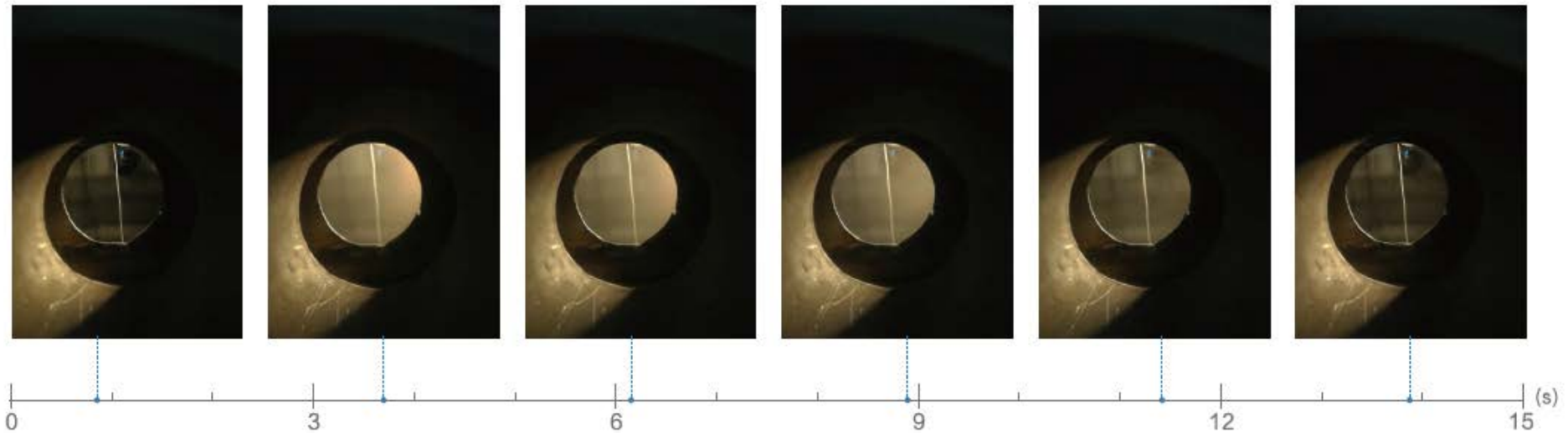# Expansion cloud forming test of the ECC

0℃造云　Produce cloud at 0℃
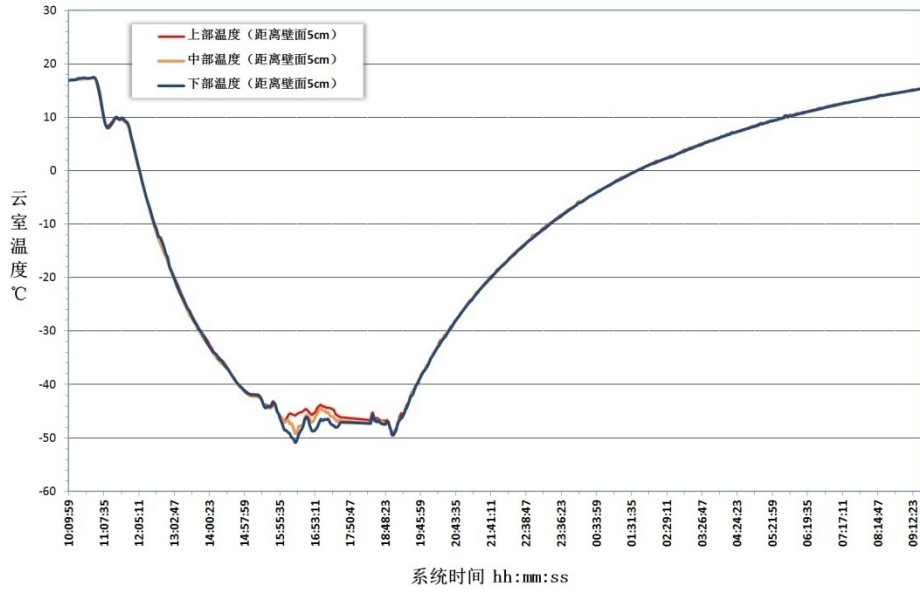

time (s)

低温造云　Produce cloud at the negative temperatures/below zero
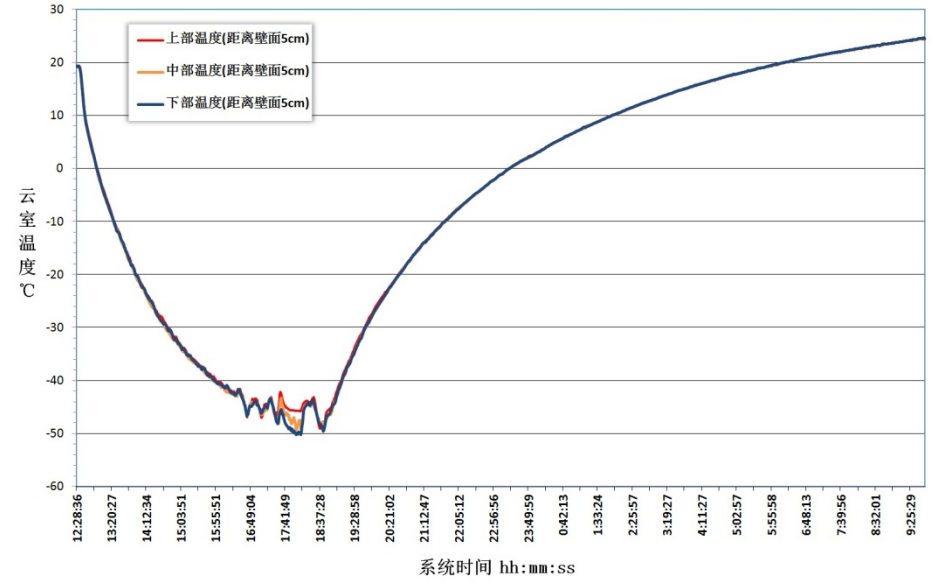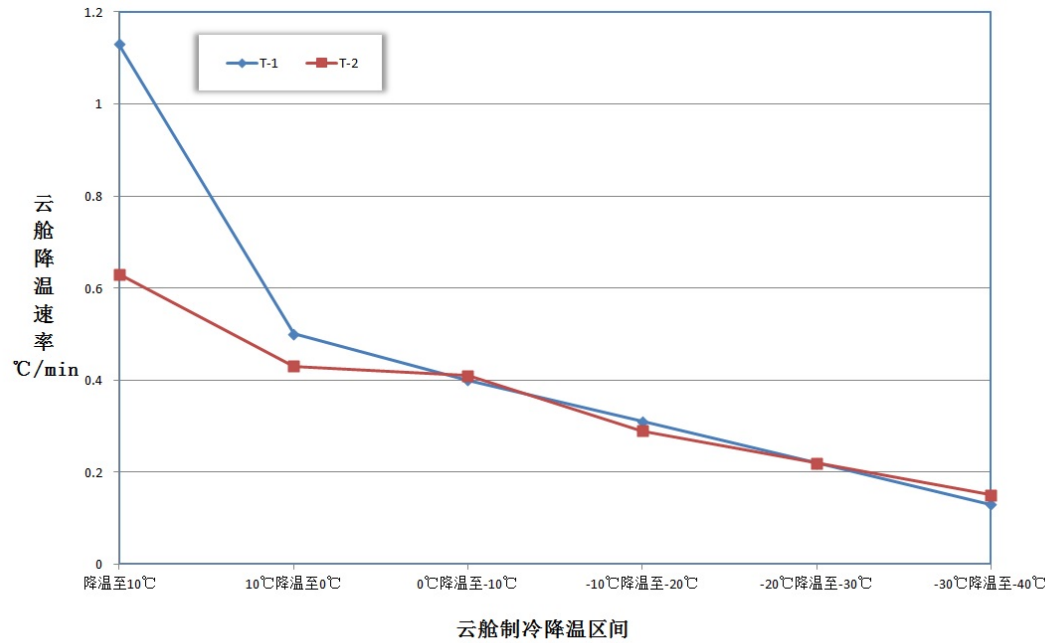

faster

time (s)

A

B

C

Tests show that the cloud chamber system has good temperature and pressure control ability. The average cooling rate can reach 0.25 ° C / min and temperature distribution in cloud chamber is uniform. In the chamber, the fog formed by expansion process lasts about four minutes. The maximum concentration of fog drops reaches 6.1 #/cm^3，the drop spectrum range is 3 μm～8 μm，average effective diameter is about 6.5 μm.

At the same time, we can get the clear cloud droplet images by high speed camera. It can achieve the control of the low-temperature environment from room temperature to -50 ° C, and pressure expansion cloud simulation and microphysical parameter monitoring capability.

Fig.7 Temperature curve during cooling in the chamber（a：T-1；b：T-2）

The cloud chamber has the ability to simulate pressure expansion，reaction chamber atmospheric pressure to 558.67 hPa. The expansion rate is 109.02 hpa/min. The maximum value of droplet number and concentration produced in the expansion process is 6.1 #/cm³. The droplet size is small, the droplet spectrum is narrow, and the PCO droplet image is clear.
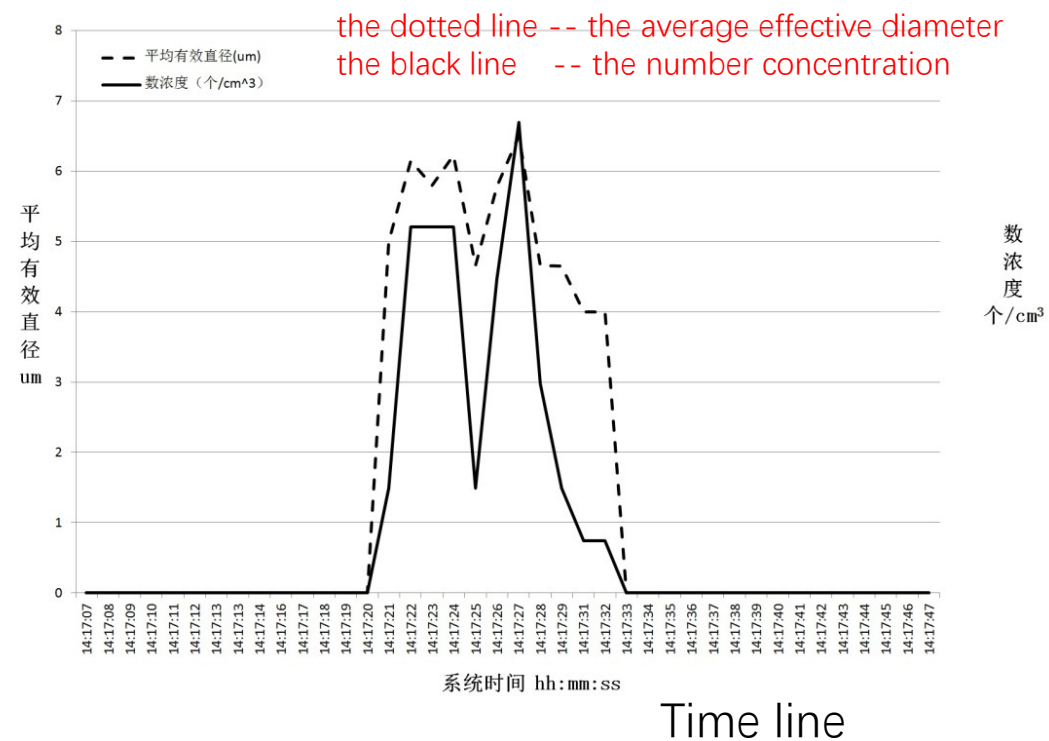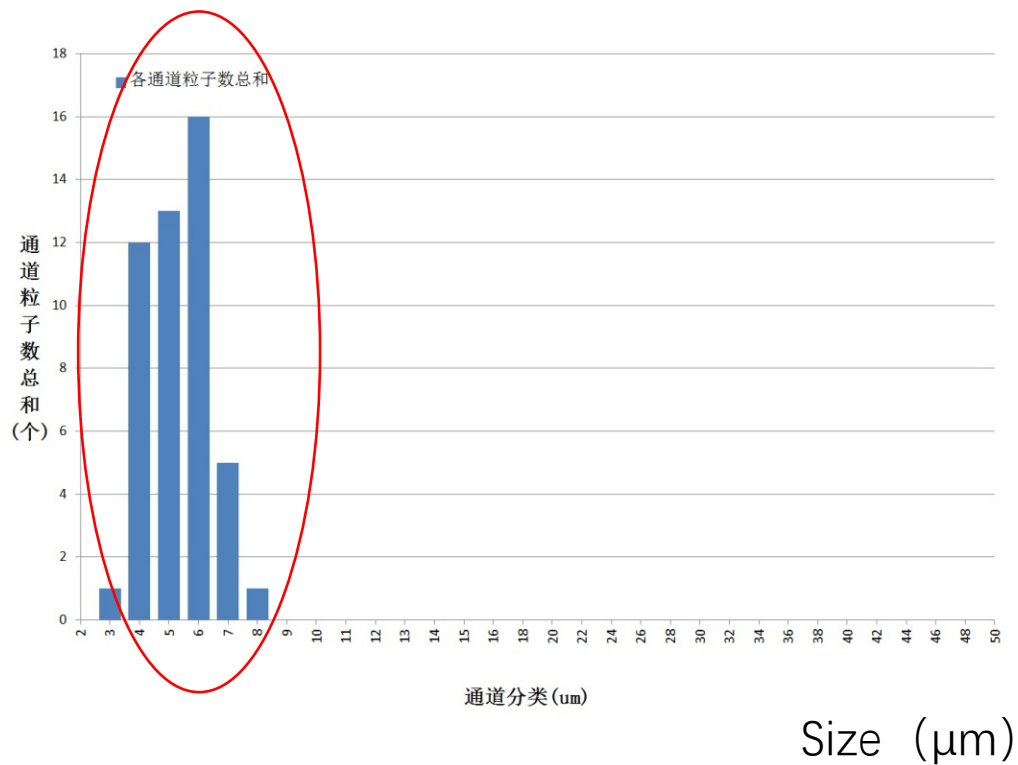

Fig.8 cloud droplets distribution characteristics formed by the expansion process

（a:cloud drop size distribution; b: variation characteristics of fog drop concentration）
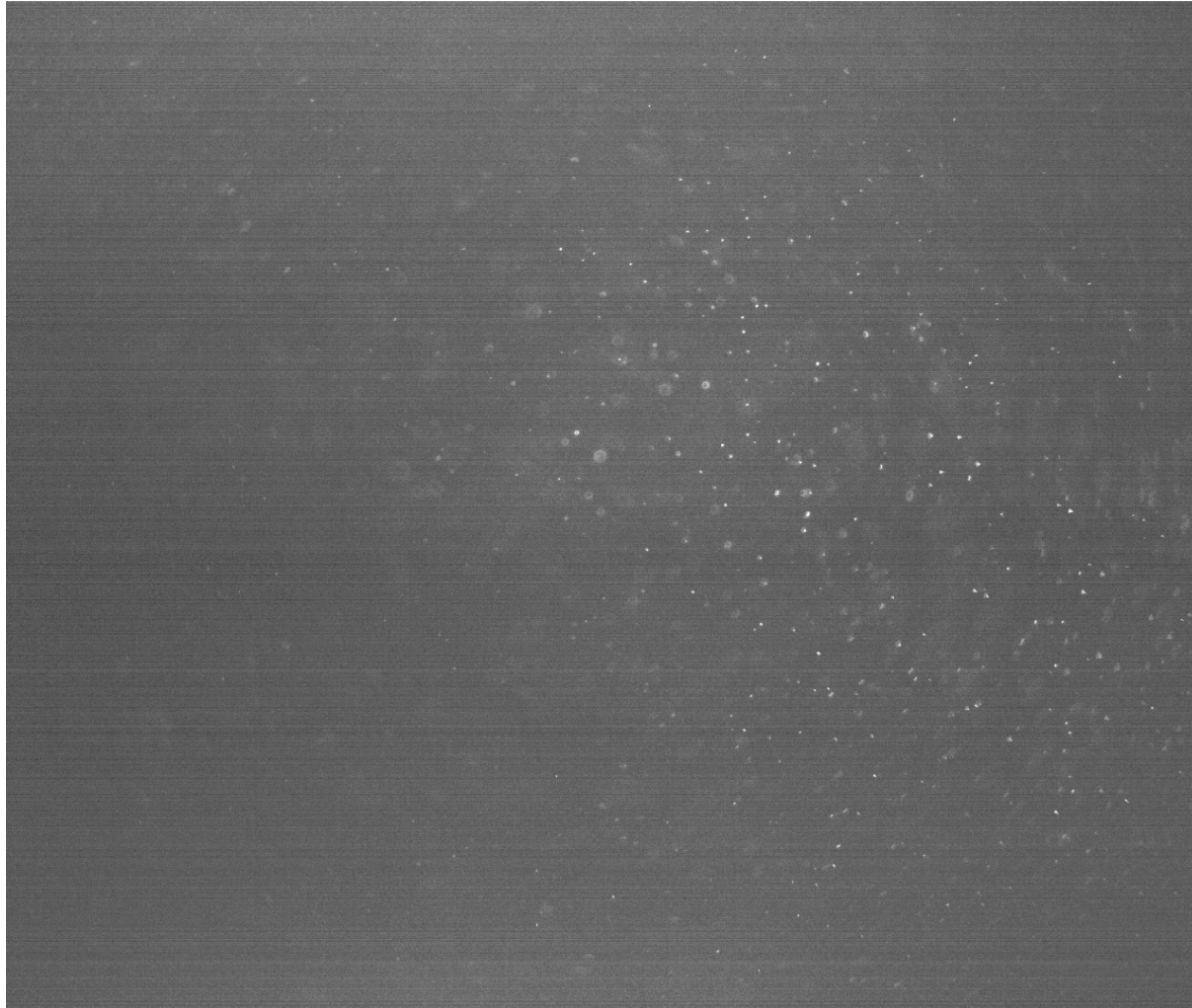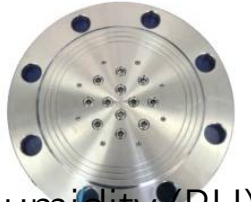
Fig.9 The Cloud droplet images by PCO after cloud formation

Several groups of expansion cloud forming tests were carried out.

When the pre- vacuum tank was set to 150hpa, the expansion tests were carried out in the cloud chamber with five different pressure differences(1000hpa、900hpa、800hpa、700hpa and 500hpa).

Here the test results are given in the table below.

initial pressure   pressure after expansion   temperature   relative humidity (RH)

	起始压力（hpa）		膨胀后压力（hpa）	膨胀时间（秒/s）	云室温度（℃）	云室湿度（%）
	Reaction chamber	pre- vacuum tank				
I	1000.28	140.78	490.08	1709	-37.06	43.47
II	905.78	140.58	490.57	1547	-39.02	36.90
III	802.77	146.77	490.25	1291	-38.76	23.92
IV	693.45	140.69	490.34	820	-36.46	14.23
V	514.01	137.51	490.96	1020	-38.15	16.91

| I	II	III
IV	V	

What do we want the expansion cloud chamber to do？

🌐 Carry out experimental research on seeding agents and technology, and carry out corresponding improvement and R & D；

🌐 Simulating the Key links in natural clouds and precipitation: including the hygroscopic growth, activation and condensation growth of aerosol particles（warm cloud…）

🌐 Simulate the formation of supercooled water in clouds and the Bergeron-Findeison process under various natural conditions(cold cloud…)

🌐 Simulate and study hot issues of social concern such as cloud, precipitation and atmospheric environmental problems(for example: haze, visibility, frost, freezing rain, etc)
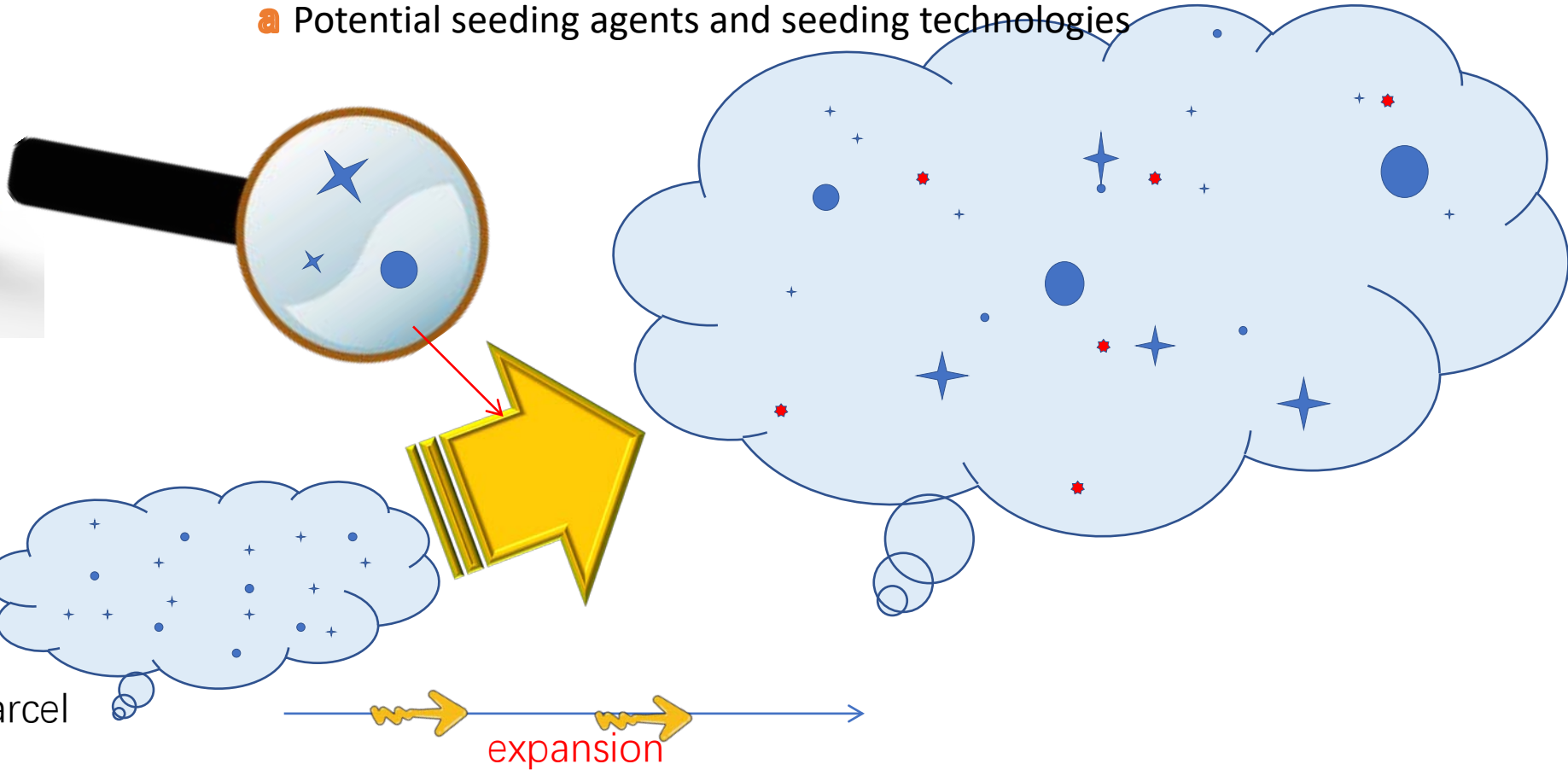
Experimental study on the effect of seeding agents on cloud expansion and rain formation processes

Future Needs and Recommendations

- Need to understand natural ice nucleation processes in order to place seeding in context

- Models should include detailed information on nucleation processes, so that seeding hypotheses can be tested（Provide key data through laboratory tests）

- More realistic testing of IN or INP behavior should be done

  --Lab tests designed to mimic generation conditions as well as considering all IN mechanisms

  --Detailed modeling of dynamics of aerosol generation like What has done for aircraft engines （maybe add to wind tunnel,,,)

- …

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Thank you for your attention!