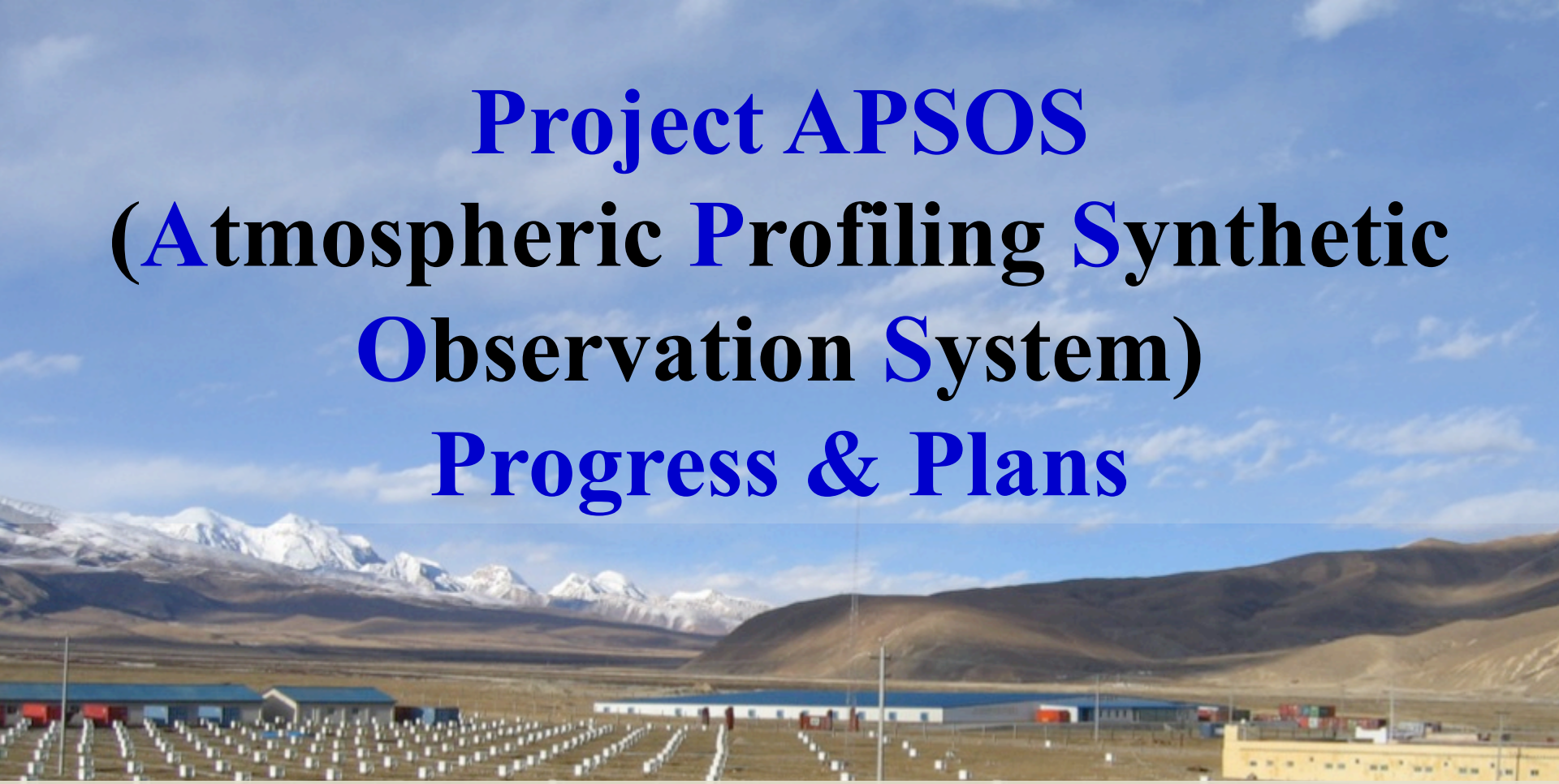


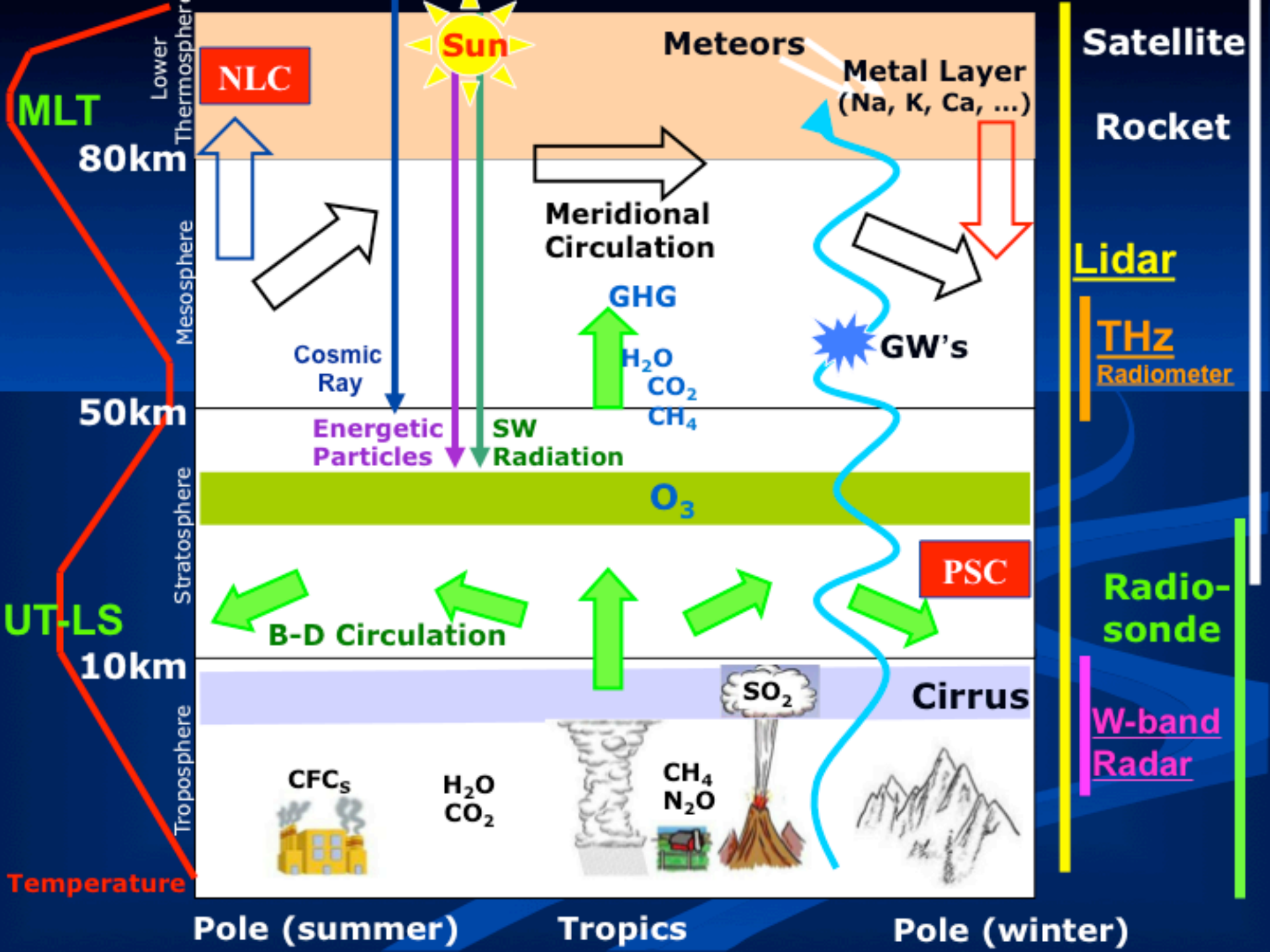
Project APSOS (Atmospheric Profiling Synthetic Observation System) Progress & Plans

Daren Lyu, Weilin Pan , Yuejian Xuan, Yinan Wang

(Institute of Atmospheric Physics, Chinese Academy of Sciences)

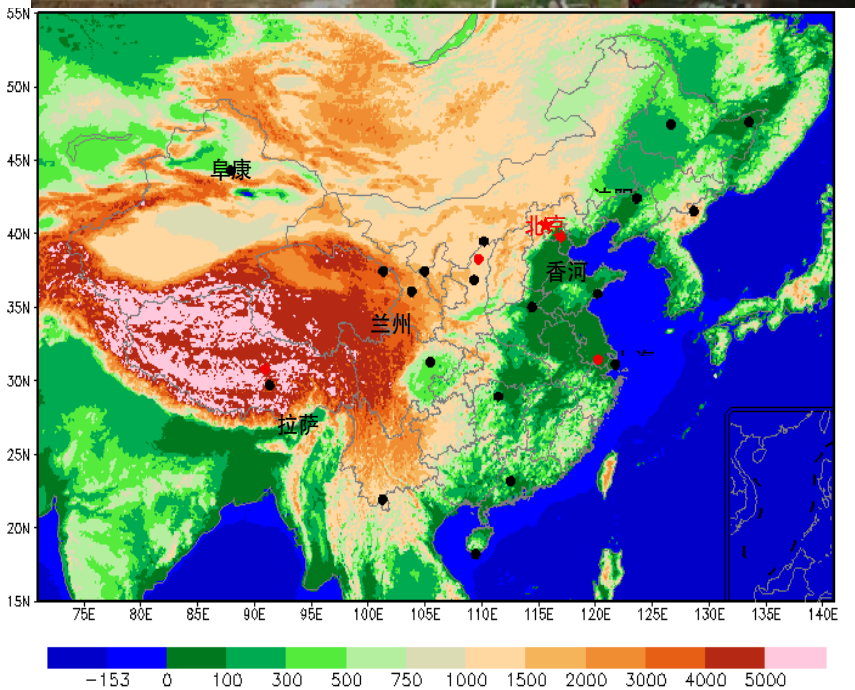
Shunsheng Gong, Faquan Li, Wei Gong, Tao Li, Shunxing Hu, Zhonghui Gao, Qijun Yao

(APSOS Team)


Lower Thermosphere
Mesosphere
Stratosphere
Troposphere
MLT
80km
50km
UT-LS
10km
Temperature
NLC
Sun
Meteors
Metal Layer
(Na, K, Ca, ...)
Meridional
Circulation
GHG
H_2O
CO_2
CH_4
Cosmic
Ray
Energetic
Particles
SW
Radiation
GW's
O_3
PSC
B-D Circulation
SO_2
Cirrus
CFC_S
H_2O
CO_2
CH_4
N_2O
Satellite
Rocket
Lidar
THz
Radiometer
Radio-
sonde
W-band
Radar
Pole (summer)
Tropics
Pole (winter)

Outline

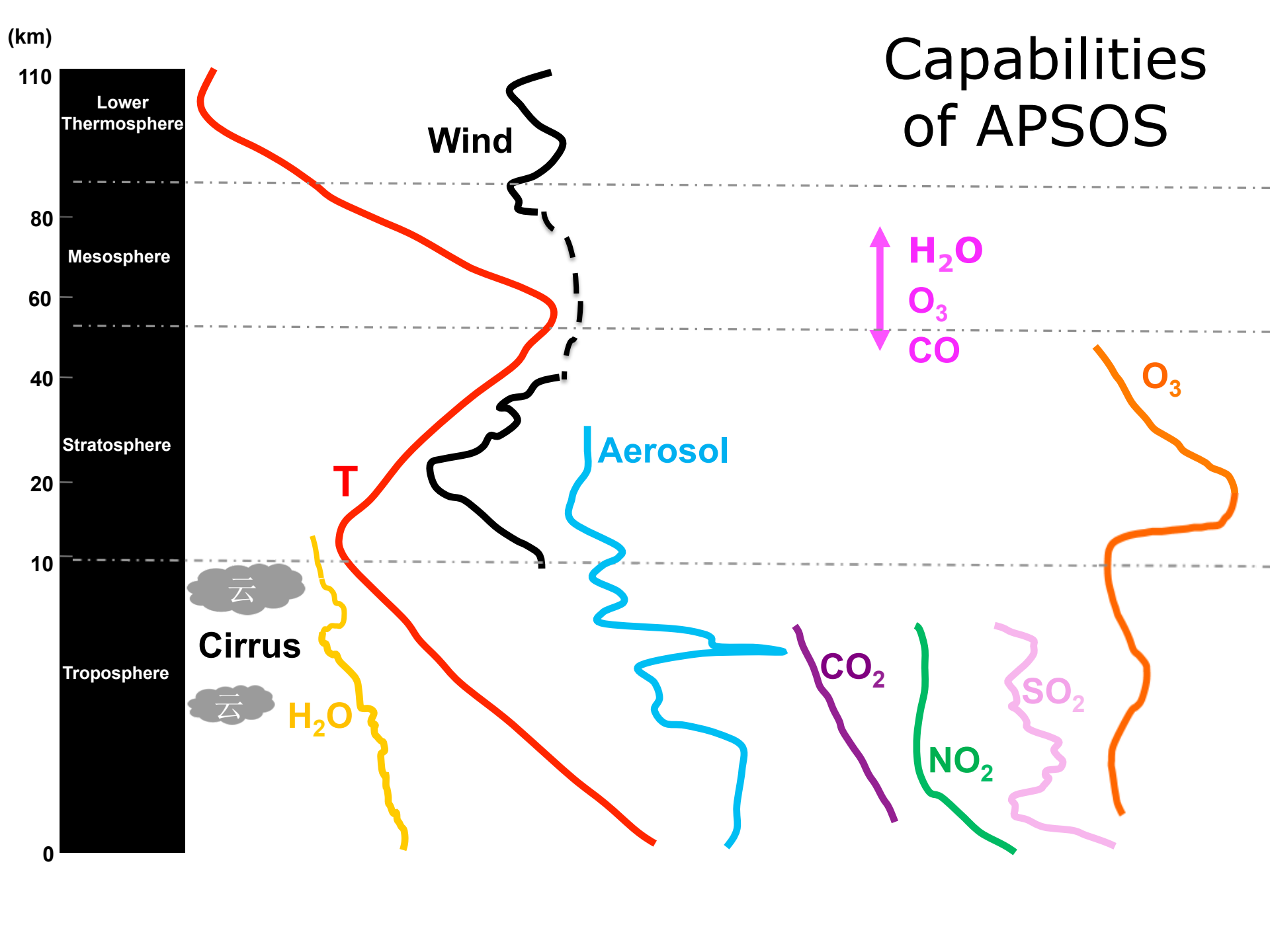
- Scientific Motivation
- Key Instruments
- Recent Progress
- Upcoming Campaigns
- Future Plans



Scientific Motivations

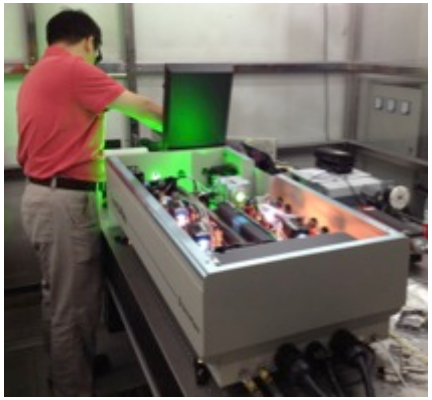
- **The challenges:**
  to understand the Dynamics-Physics-Chemistry processes and the driving forces in the whole (neutral) atmosphere

- **Measurement goals:**
  - **neutral atmosphere: 0 ~ 110 km**
  - **multi-parameters**
  - **high vertical resolution:** 10^1 **~** 10^2 **m**
  - **high temporal resolution:** 10^0 **~** 10^1 **min**
  - **variability (diurnal, seasonal, inter-annual, special events)**
  - **extend to global, regional, and local coverage**
  - **ground-based and space-borne**


Capabilities of APSOS
(km)
110
80
60
40
20
10
0
Lower Thermosphere
Mesosphere
Stratosphere
Troposphere
Wind
T
Aerosol
H_2O
O_3
CO
O_3
CO_2
NO_2
SO_2
H_2O
Cirrus
云
云

APSOS Team

- **Institute of Atmospheric Physics**
  Chinese Academy of Sciences
  PI: Daren Lu
  co-I: Weilin Pan



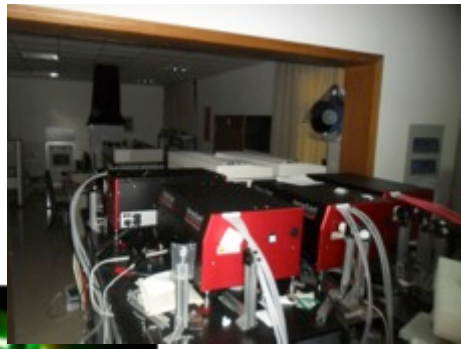
- **Wuhan Institute of Physics & Mathematics**
  Chinese Academy of Sciences
  co-I: Faquan Li

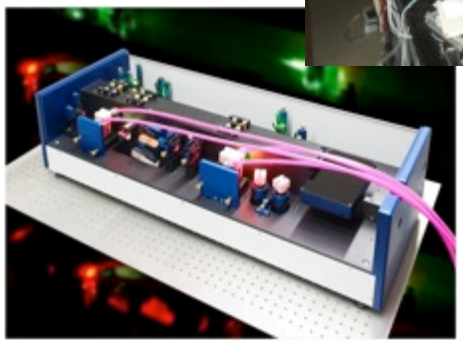
- **University of Science and Technology of China**
  co-I: Tao Li

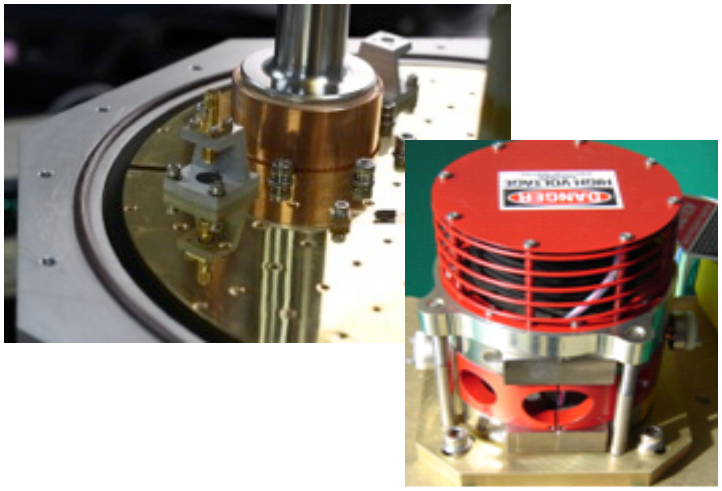
APSOS Team

- **Anhui Institute of Optics & Fine Mechanics**
  Chinese Academy of Sciences
  co-I: Shunxing Hu

- **Wuhan University**
  co-I: Wei Gong







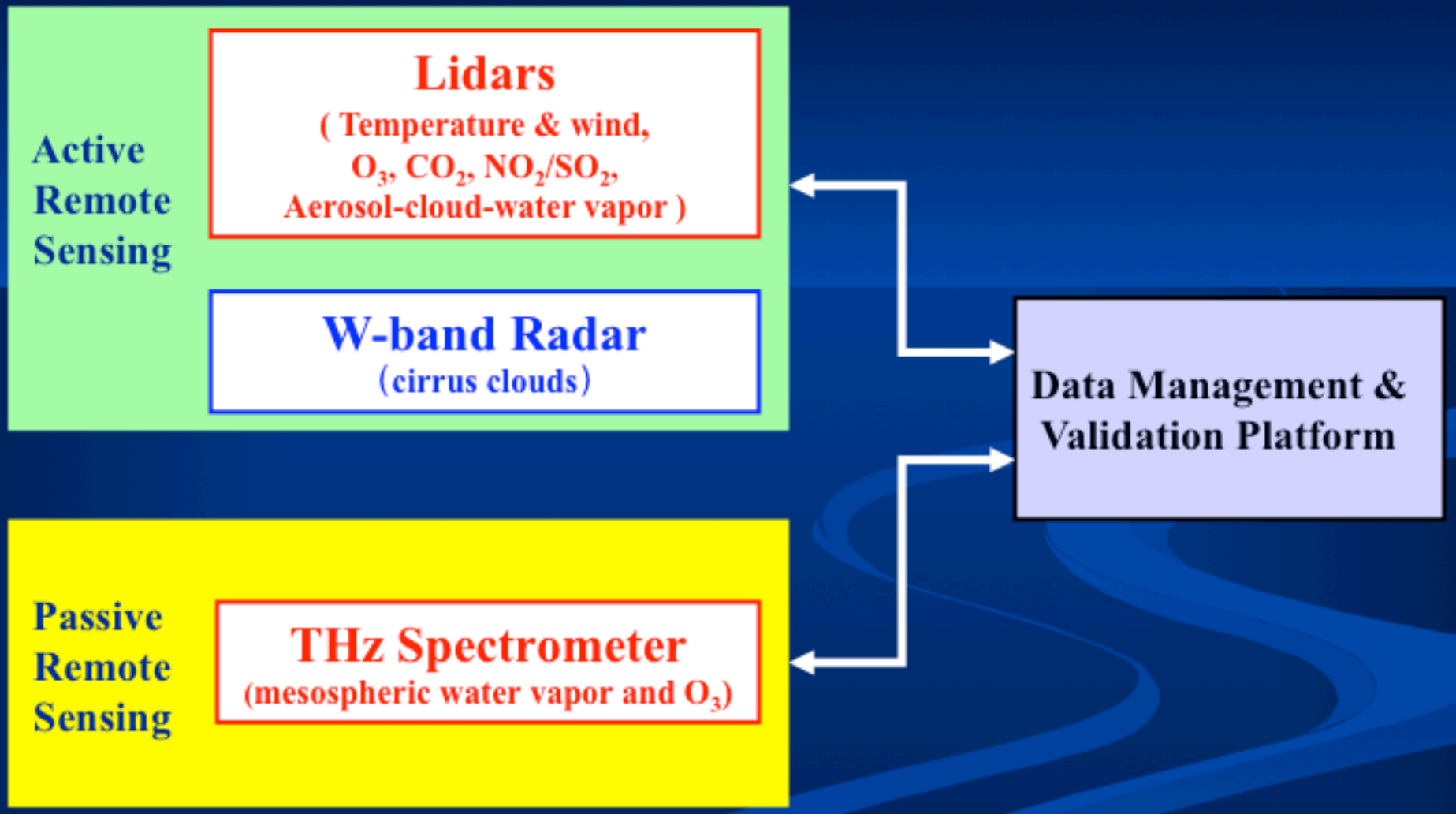
- **Purple Mountain Observatory**
  Chinese Academy of Sciences
  co-I: Qijun Yao

- **Anhui Sun Create Electronics**
  co-I: Zhonghui Gao

Project Objectives

- **To obtain the vertical profiles of atmospheric temperature and wind, greenhouse gases, pollution gases, clouds, aerosol, and water vapor;**
- **To characterize the greenhouse effects (warming in the lower atmosphere, and cooling in the upper atmosphere);**
- **To understand the two transition regions:**
  - **Upper Troposphere – Lower Stratosphere (UT-LS)**
  - **Mesopause and Lower Thermosphere (MLT)**
- **To provide ground-based measurements for satellite data calibration & validation;**
- **To monitor the solar activities, the cosmic rays, and their interactions with the Earth's atmosphere.**

APSOS System



APSOS Performance - Lidars

Detecting Target	Operating Wavelength	Sounding Level	Precision
Temperature, Wind	532nm 589nm	Temperature: 5-110km Wind: 10-40km, 80-110km	Temperature: <1K @ near surface, <3K @ 30km, <10K @ 50km, <4K @ 90km Wind: <3m/s @ 10km, <6m/s @ 40km, <4m/s @ 90km
O_3	289.1 nm, 299.1nm, 308nm, 355nm	5~50km	<20% @ 5~40km <30% @40~50km
NO_2,SO_2	446.6nm,448.1nm (NO_2)， 300.05nm,301.5nm (SO_2)	0.1~3km (night) scanning (orientation 0~360°，pitch 0~90°)	5ppb NO_2 2ppb SO_2
CO_2	1572nm	0.1~3km	<5%(night)
Aerosol，Cloud，Water Vapor	1064nm, 532nm, 355nm	Aerosol (near surface~30km) Cloud (near surface~18km) Water Vapor (near surface ~12km)	back-scattering ratio<20% water vapor<10% @ 5km water vapor<30% @12km

APSOS Performance - W-band Radar & THz spectrometer

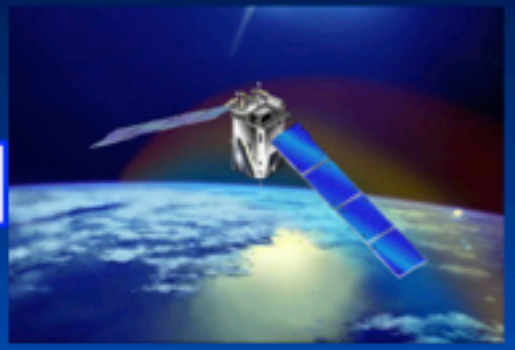
W-band Cloud Radar

Detecting Target	Operating Frequency	Sounding Level	Polarization Mode
Cloud(reflectivity, radial velocity, spectral width, depolarization)	94-95GHz	0.2-20km	Emitting horizontal linear polarization，receiving horizontal and vertical polarization

THz Spectrometer

Detecting Target	Operating Frequency	Sounding Level	Spectral Resolution
H_2O, O_3, CO, N_2O	325~380 GHz (Low)，448~488 GHz (High)	Mesosphere	<200K (Low frequency) <250K (High frequency))

Data Management & Validation Platform



Satellite Data

Radiosonde
Ozonesonde

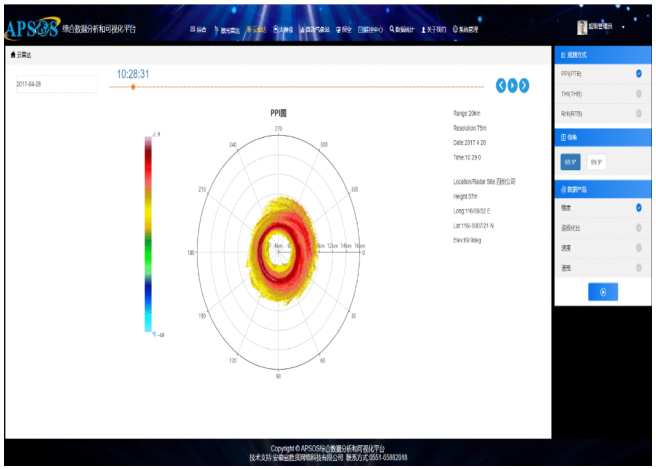
APSOS

Meteorological Tower

Stratospher ic Balloon

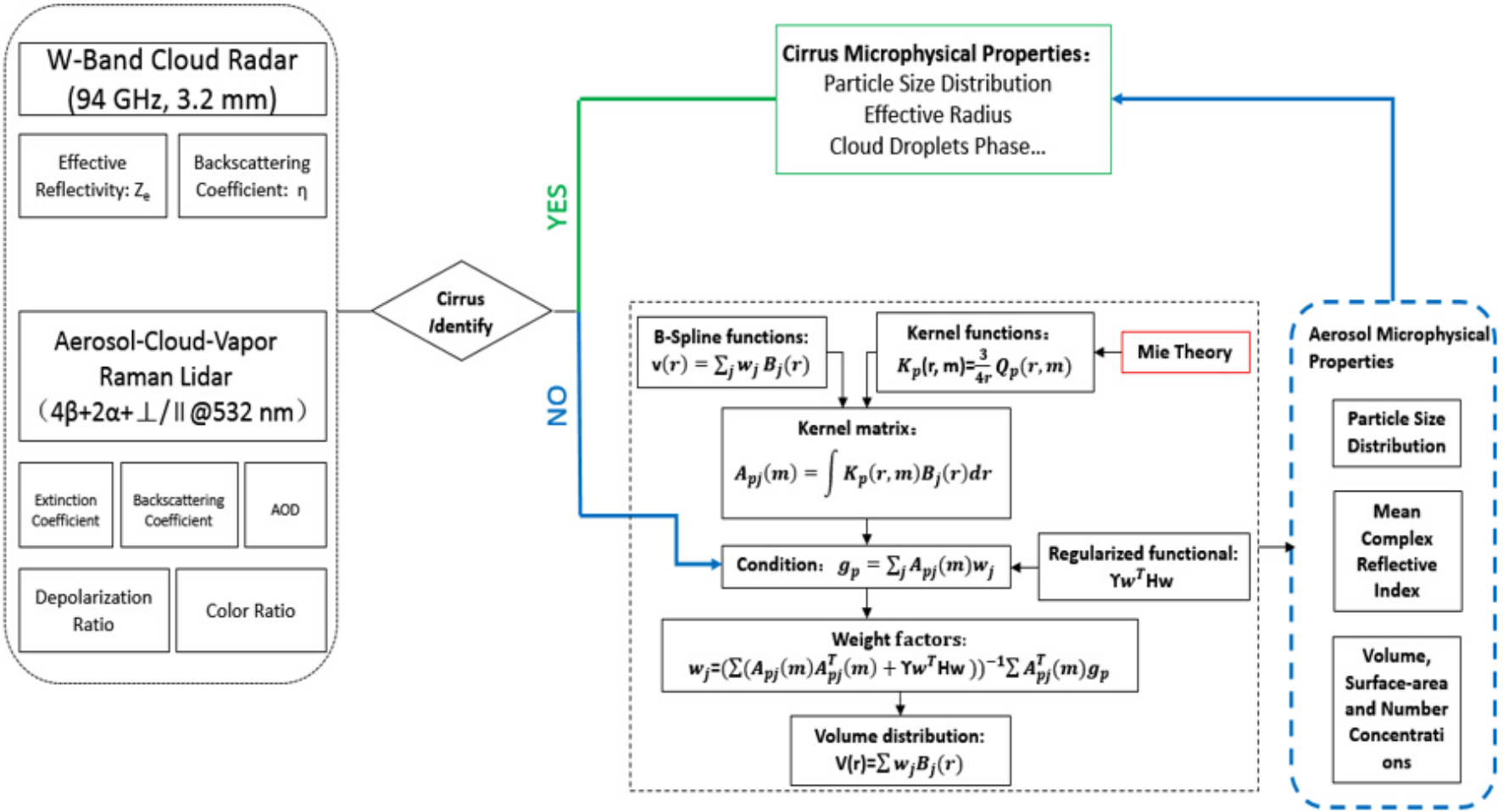
Data Management and Validation Platform

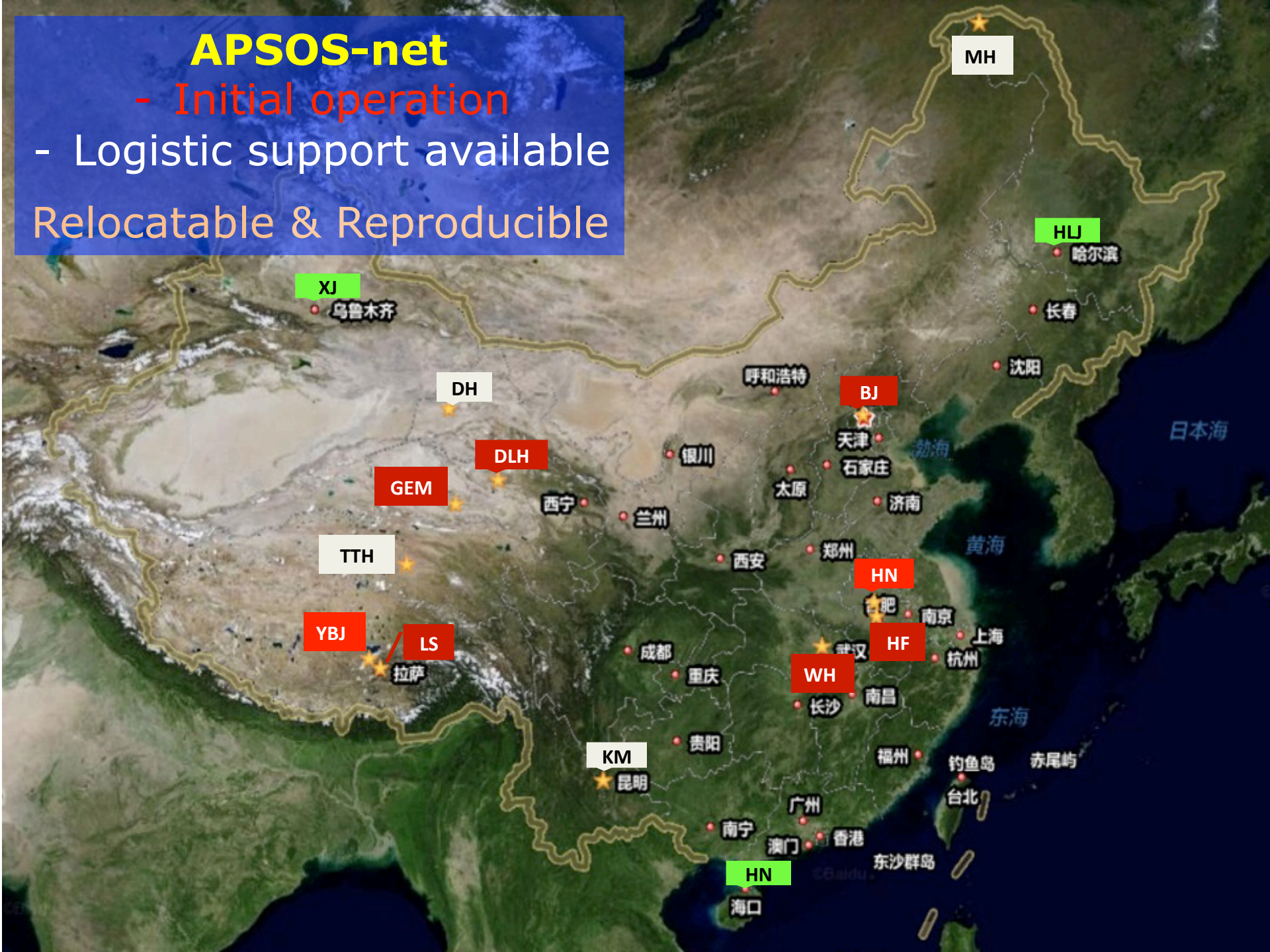
- APSOS UI
  - Synthesis
    - Synthetic Inversion
  - Lidar
    - Aerosol/Cloud/ Water Vapor
    - Wind/ Temperature
    - O3
    - CO2
    - SO2/NO2
  - Cloud Radar
  - THz Spectrometer
  - Monitoring Center
    - System Monitor
    - Environment Monitor
    - Video Monitor
  - Data Center
    - Initial Data Scan
    - Data Nodes Status
    - Database
  - System Management
    - Account
    - Menu
    - Authority
    - Shelter
  - Project Information
    - Progress
    - Dynamic Status
    - News



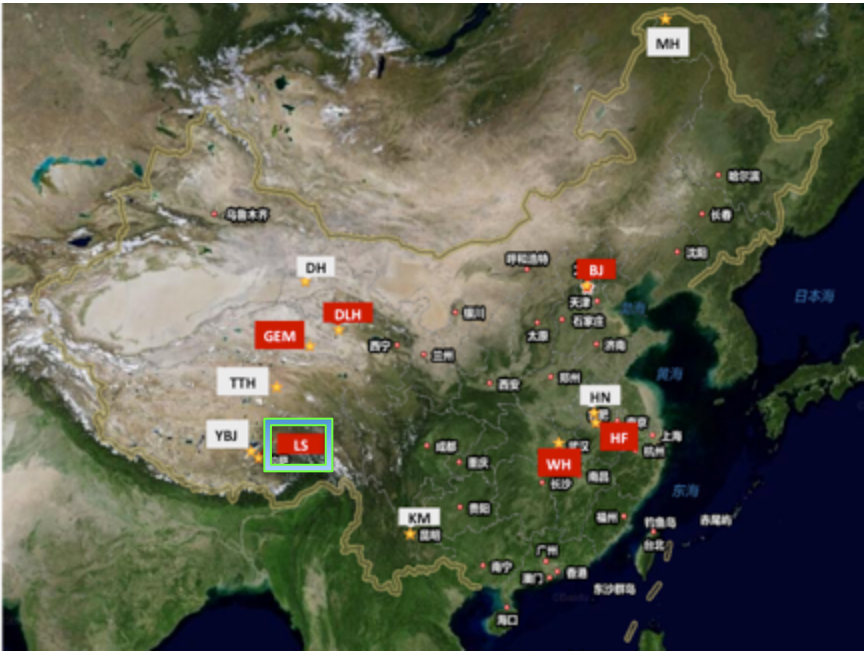
Synthetic Data Inversion System

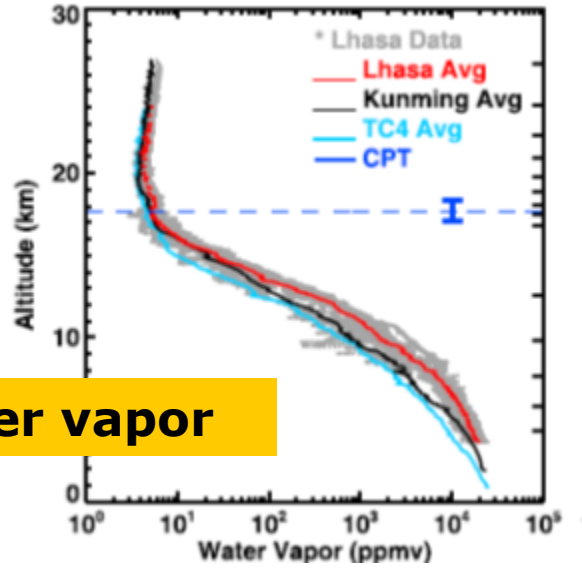
W-Band Cloud Radar & Multi-wavelengths Lidar



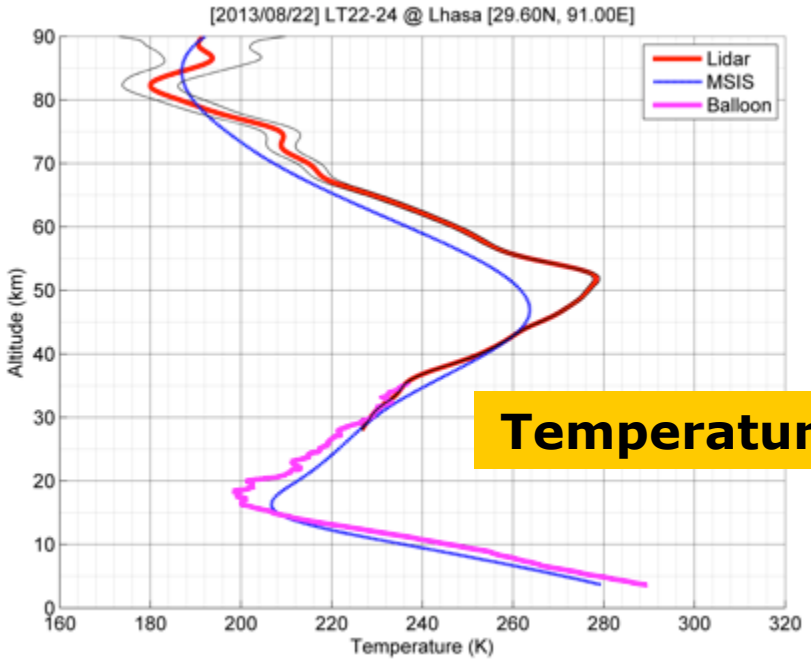

APSOS-net
- Initial operation
- Logistic support available
Relocatable & Reproducible
MH
HLJ
哈尔滨
长春
沈阳
XJ
乌鲁木齐
DH
呼和浩特
BJ
天津
石家庄
DLH
银川
GEM
西宁
兰州
太原
济南
TTH
西安
郑州
HN
合肥
南京
上海
YBJ
LS
拉萨
成都
重庆
武汉
HF
杭州
WH
南昌
长沙
贵阳
KM
昆明
福州
钓鱼岛
赤尾屿
台北
广州
南宁
澳门
香港
东沙群岛
HN
海口
日本海
渤海
黄海
东海

Lhasa 【N29°39′, E91°07′】

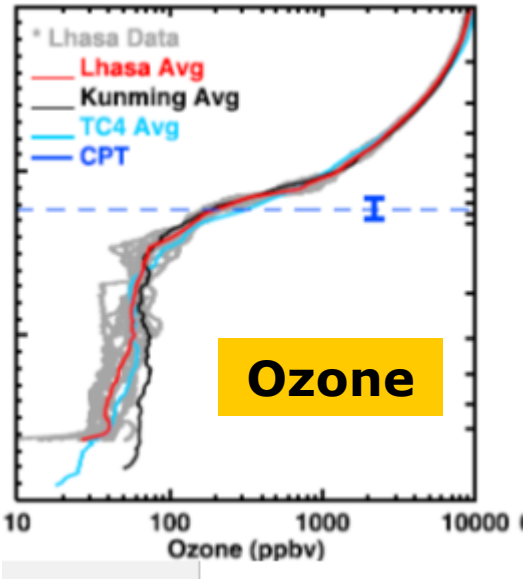




Water vapor

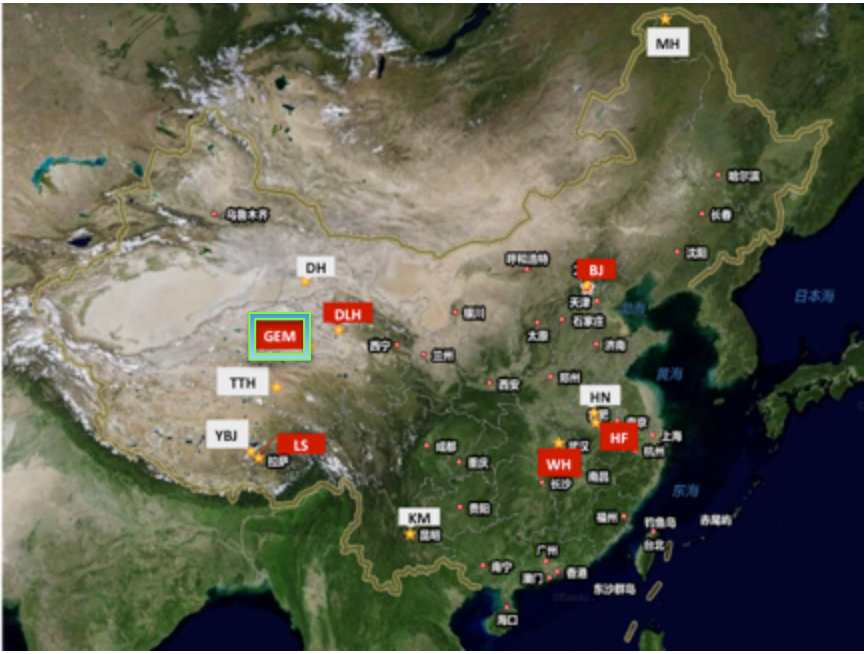


Temperature

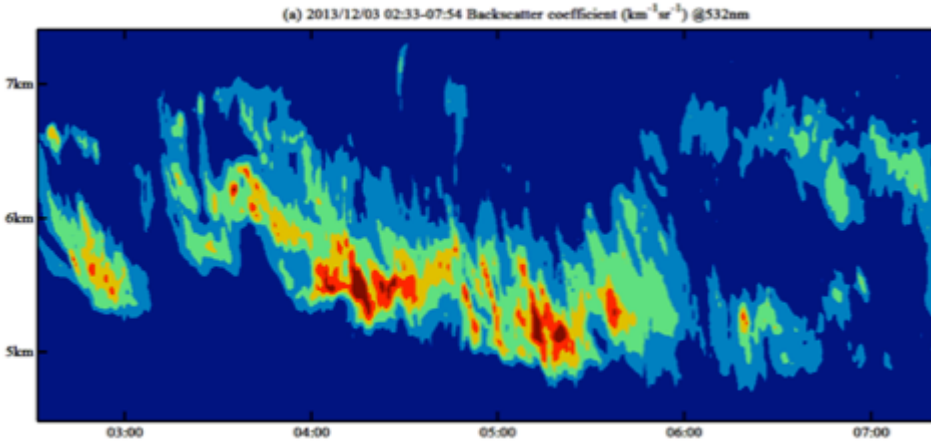


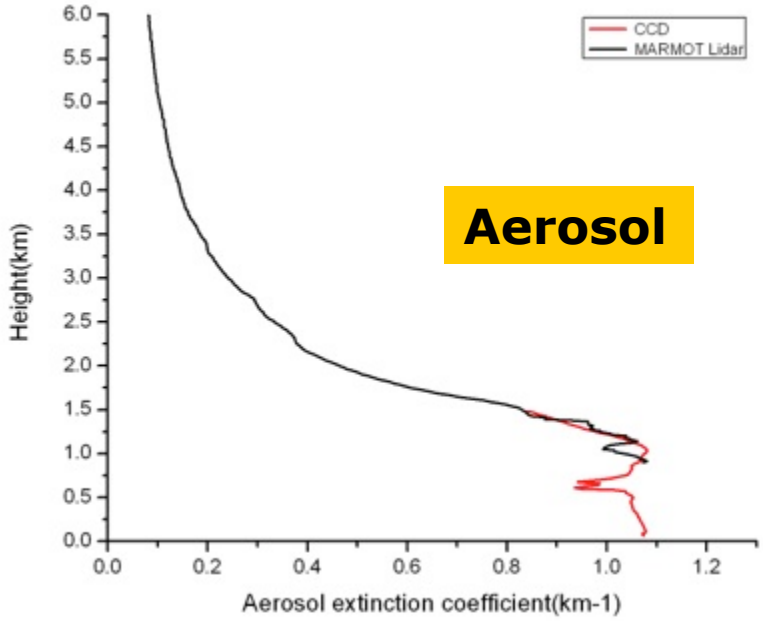
Ozone

Golmud 【N36°24′, E94°54′】

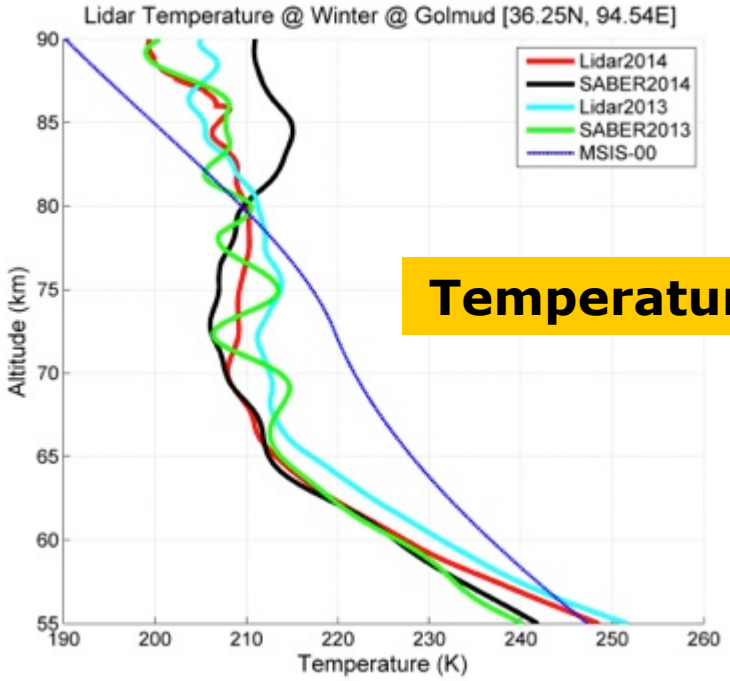


Cirrus



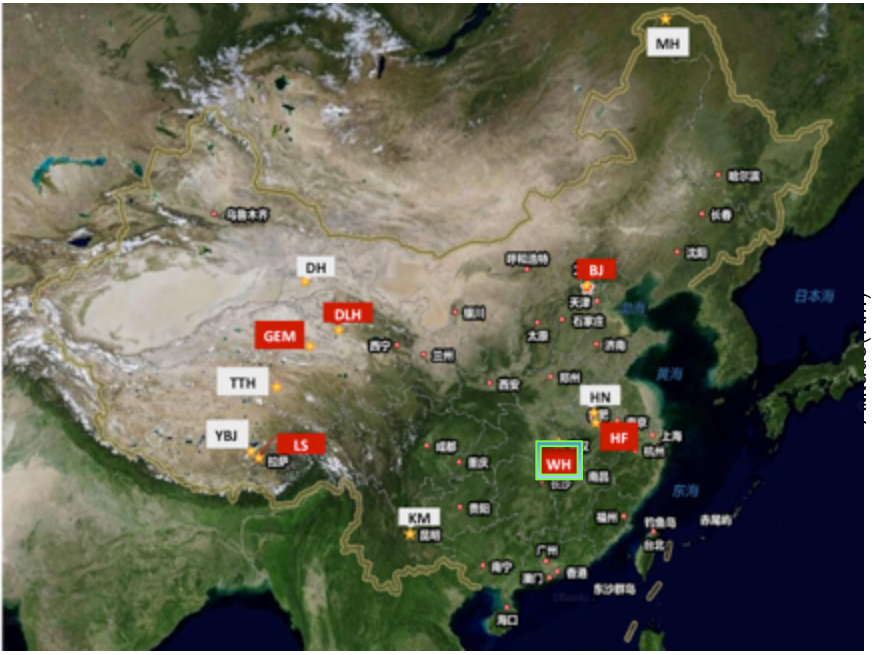


Aerosol

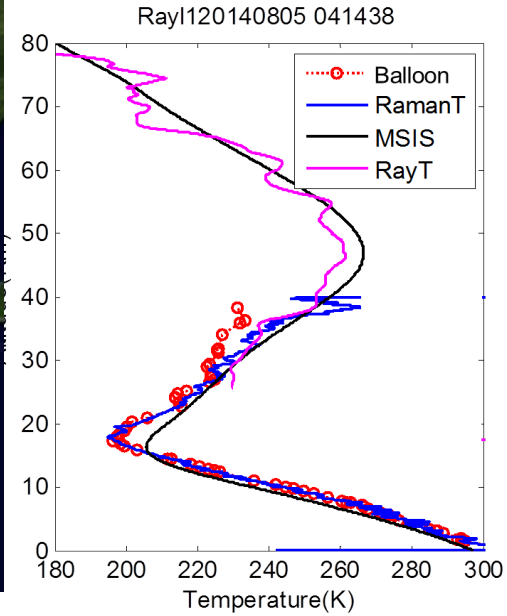


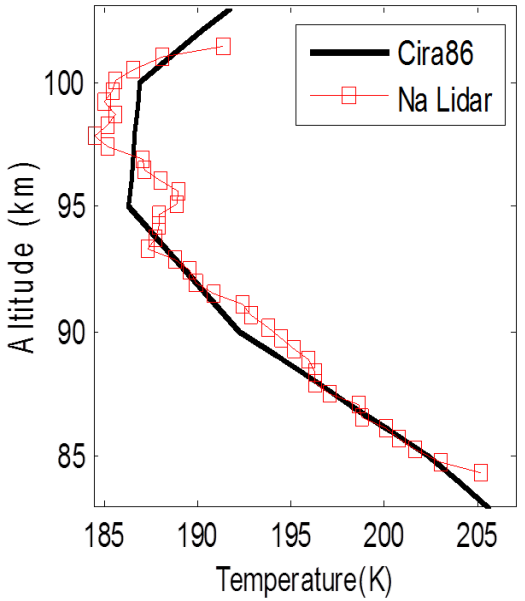
Temperature

Wuhan 【N30°36′, E114°18′】

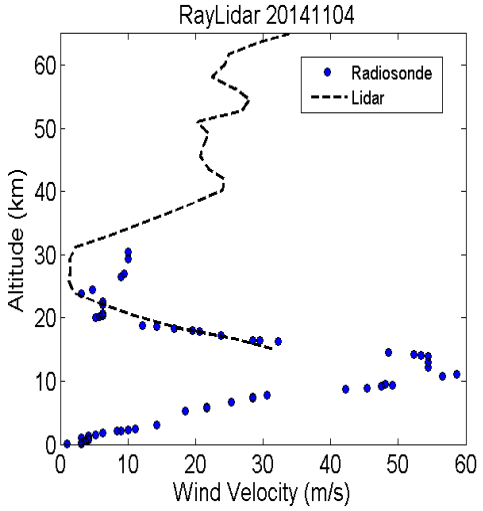


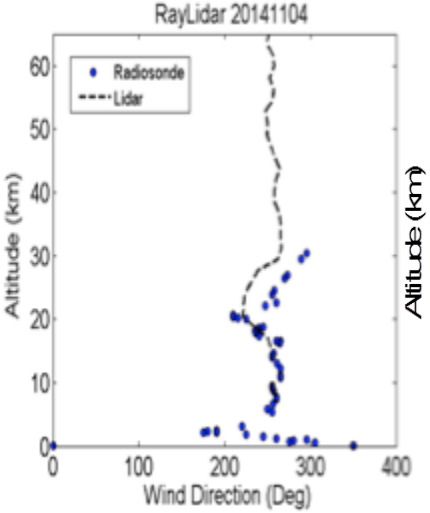
Temperature（5~110km）

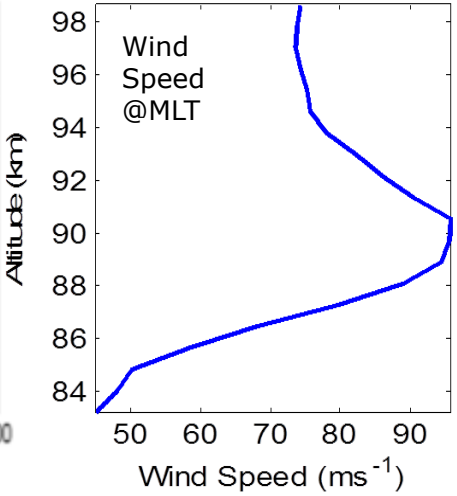


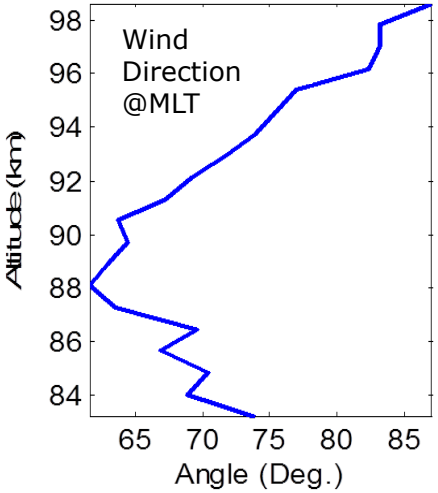


Horizontal Wind（10~60km，80~110km）

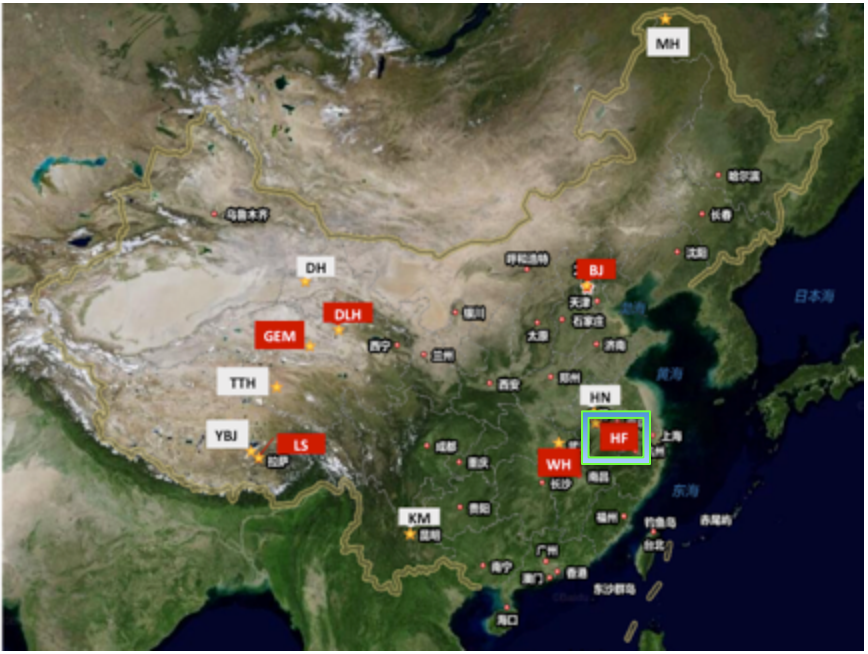


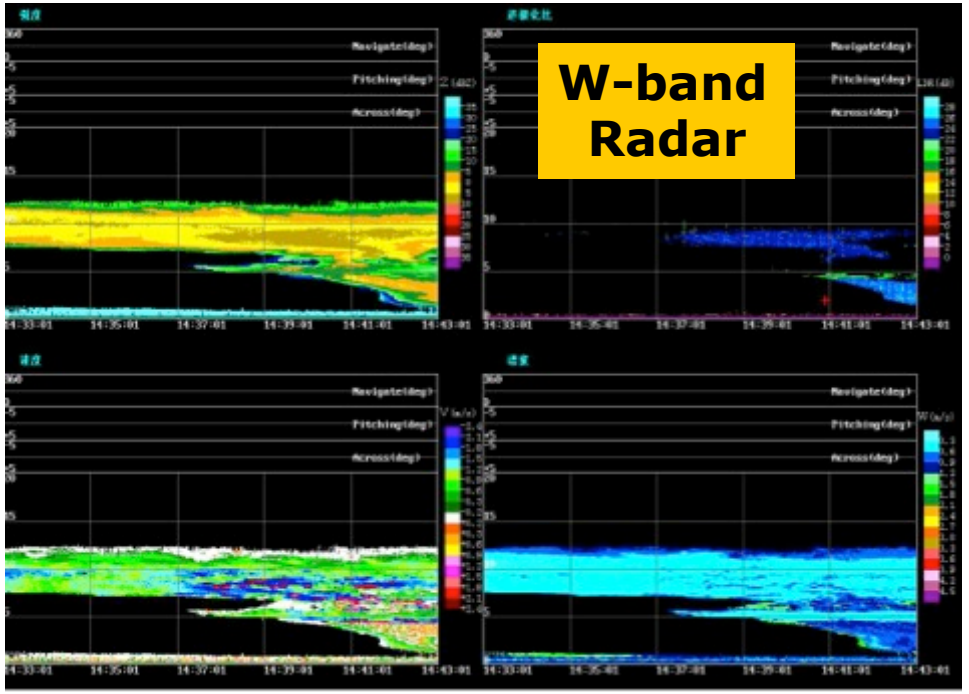




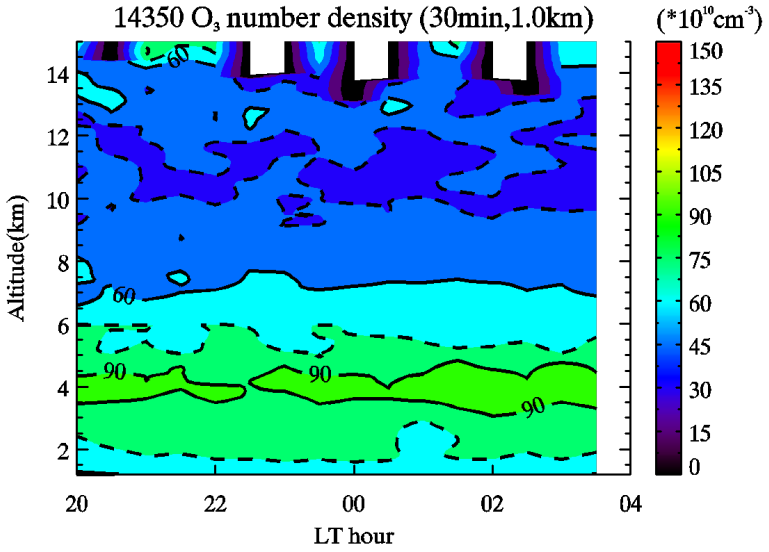


Hefei 【N31°49′, E117°13′】

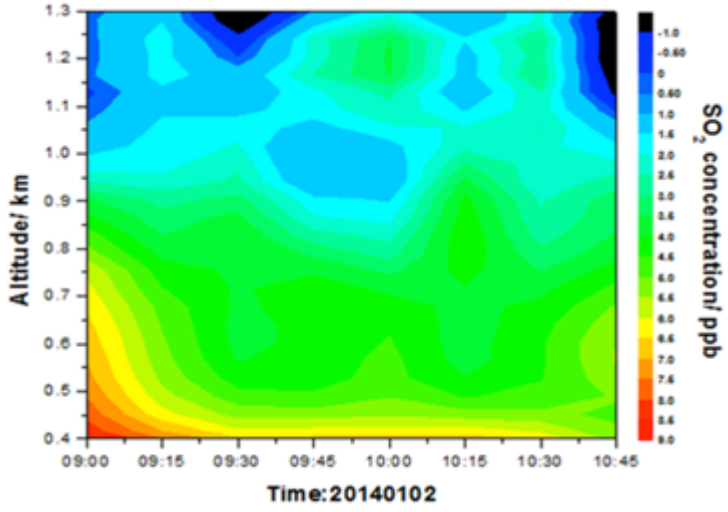




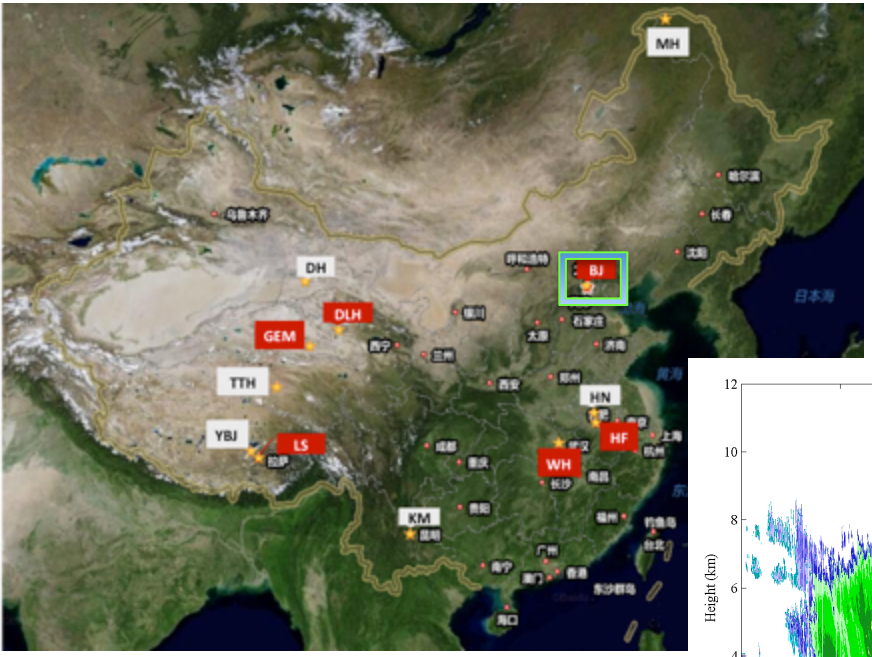
O_3（1~15km）



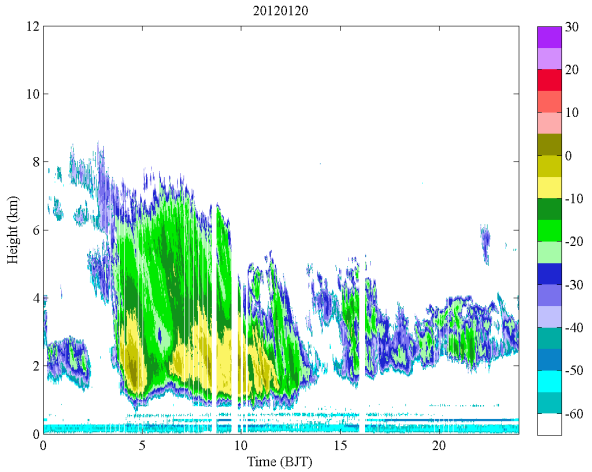
SO_2（0.4~1.3km）



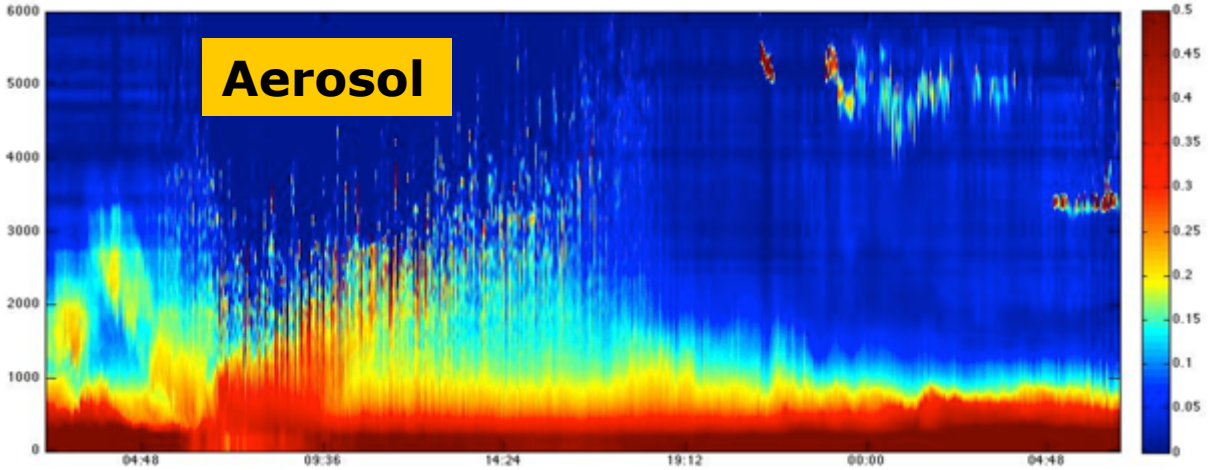
Beijing 【N39°56′, E116°24′】



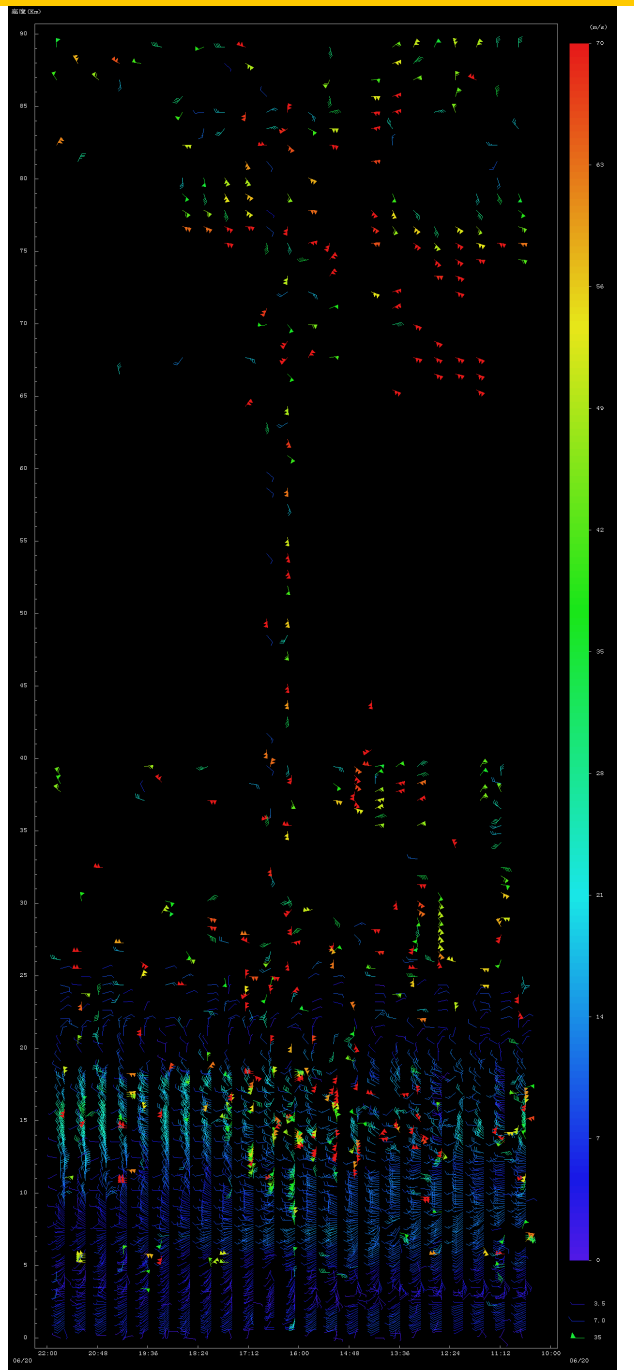
Ka-band Radar



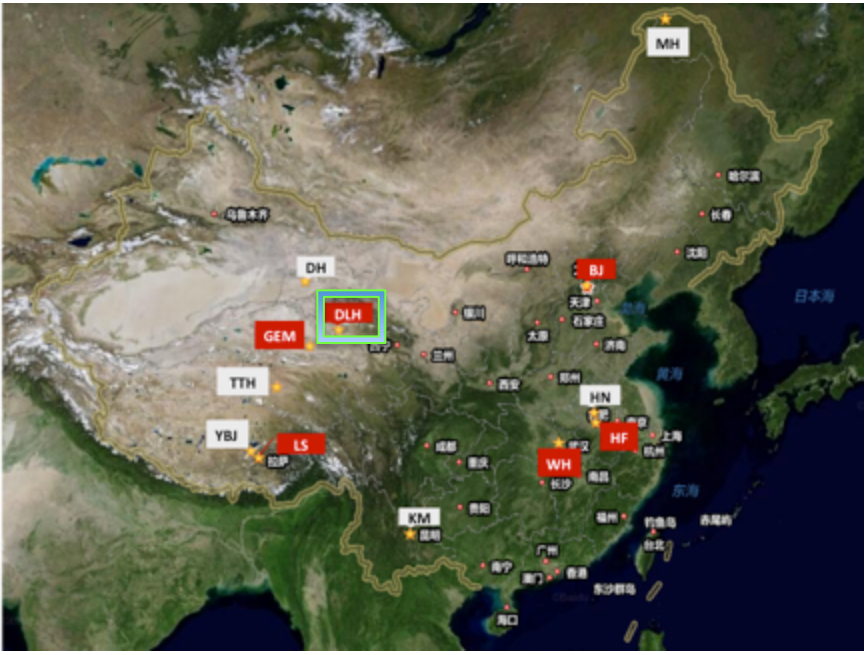
Aerosol

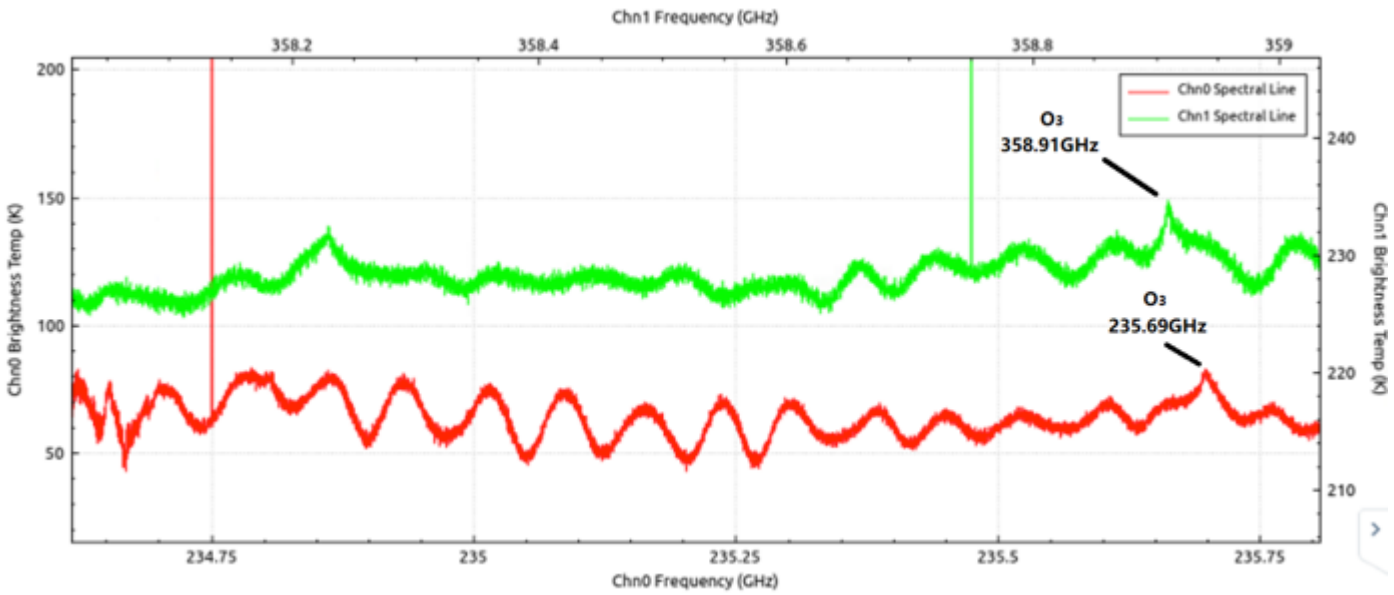


MST Radar wind (0~90km)

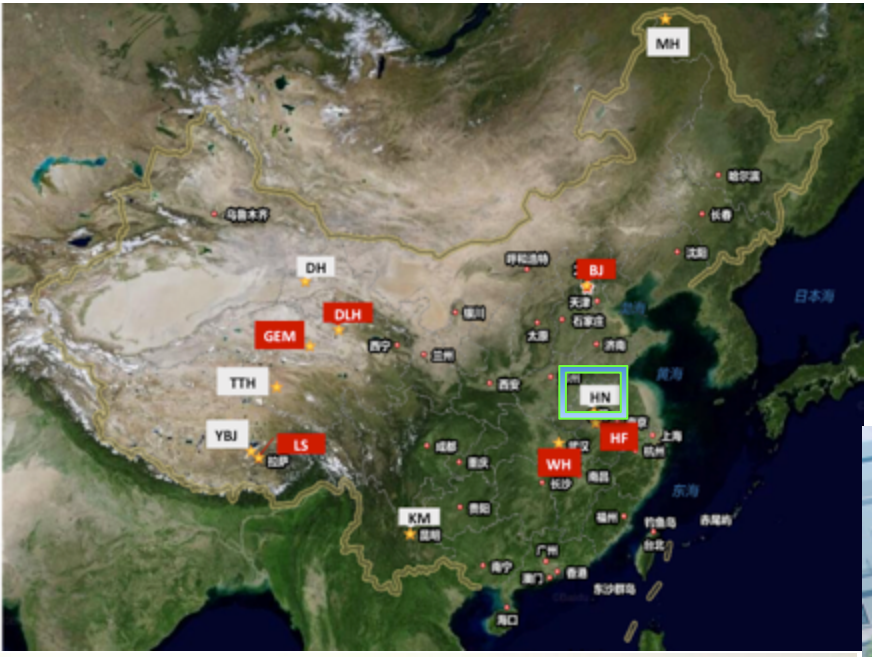


Delingha【N37°22′, E97°22′】



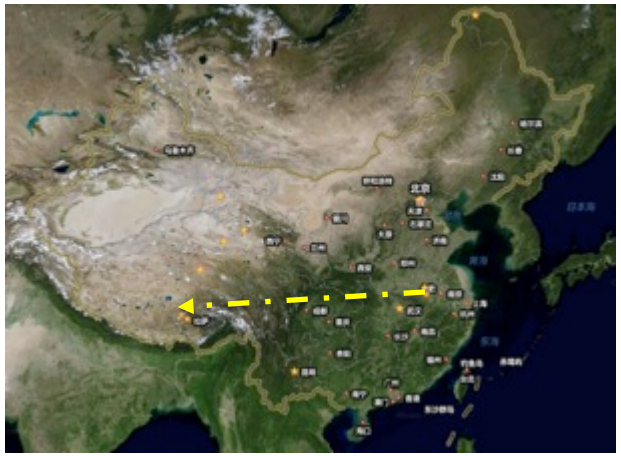


Huainan 【N32°38′, E117°0′】



Recent Progress

- **APSOS relocation journey**
  - **2017.09： from HuaiNan to YangBaJing**
  - **2017.10： System recovery**



Yangbajing【N30°05′, E90°33′】

Huainan 【N32°38′, E117°0′】

Tibetan Plateau

YBJ

Lhasa

YangBaJing International Comic Ray Observatory

4

2

3

1

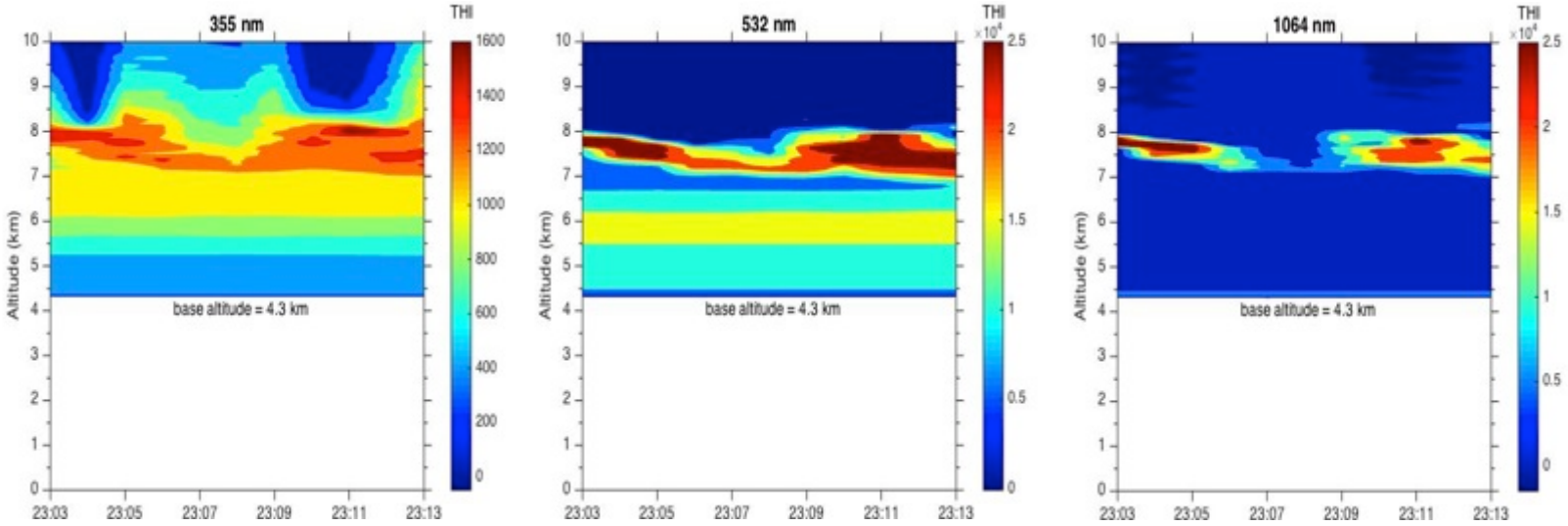
Elev. 4300 m 【N30°05′, E90°33′】

(1)	**ASγ Experiment**	**(China-Japan cooperation)**
(2)	**ARGO Project**	**(China-Italia cooperation)**
(3)	**Sub-millimeter Telescope**	**(China-Germany cooperation)**
(4)	**APSOS**	**(China)**

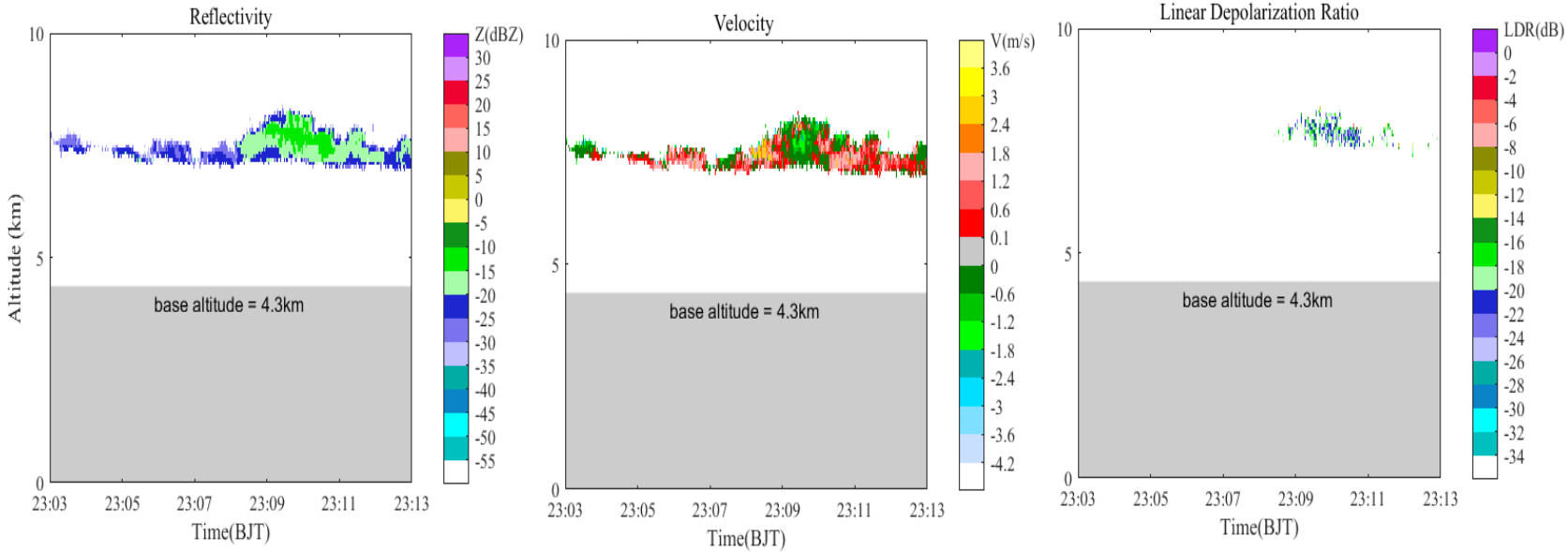
APSOS at YBJ

Initial Results at YBJ [2017.10.14]

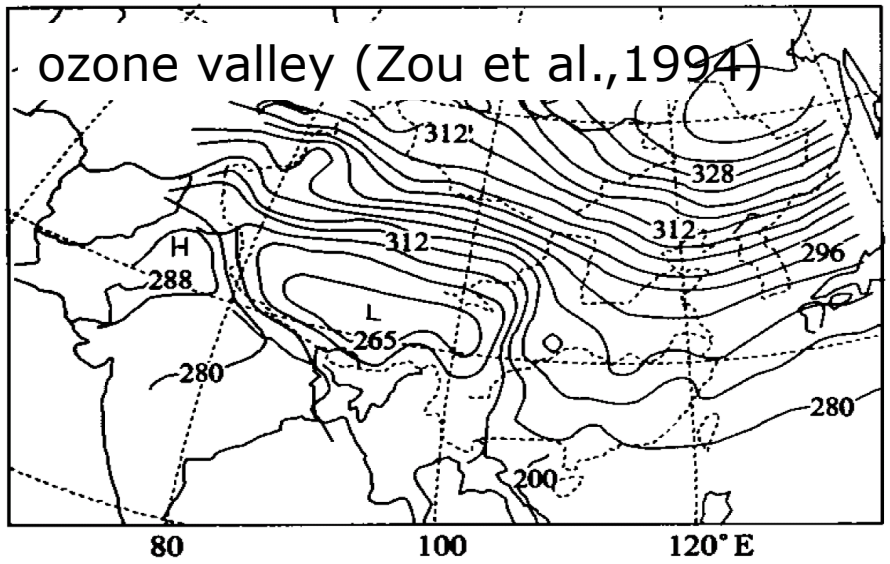
Lidar

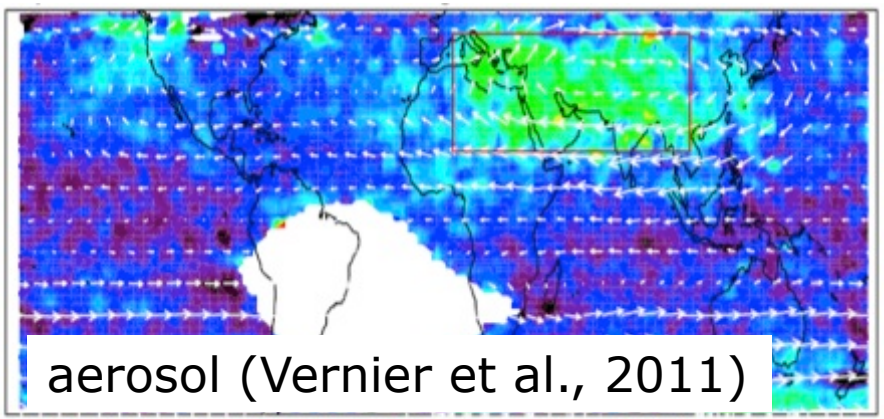


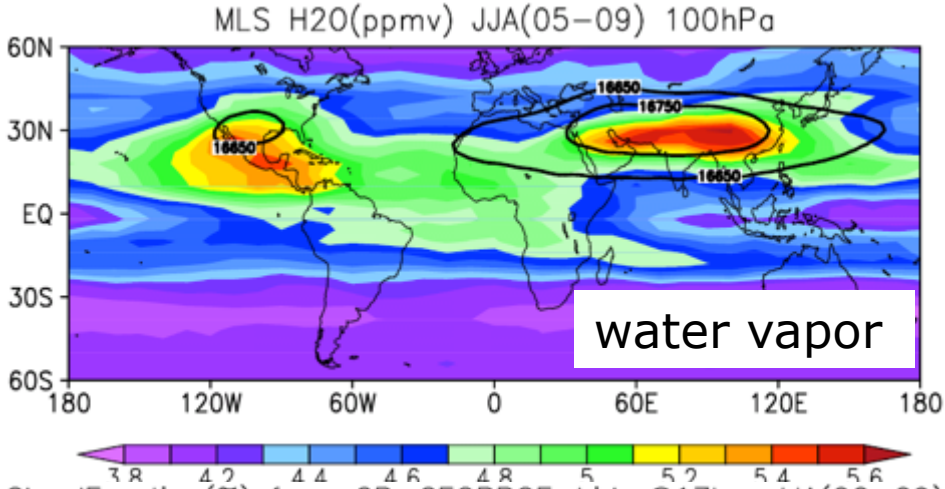
W-band Radar

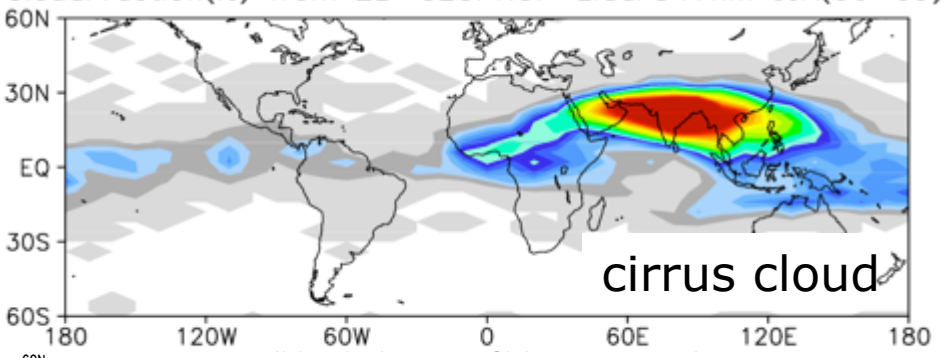


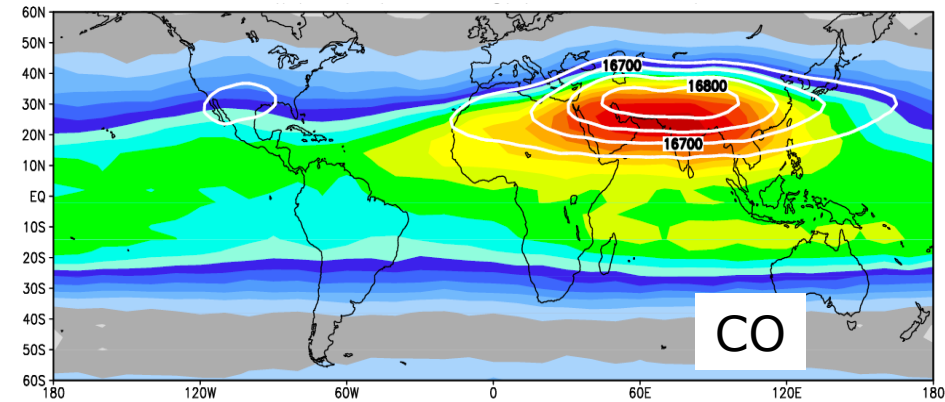
Summer Tropopause over Tibetan Plateau





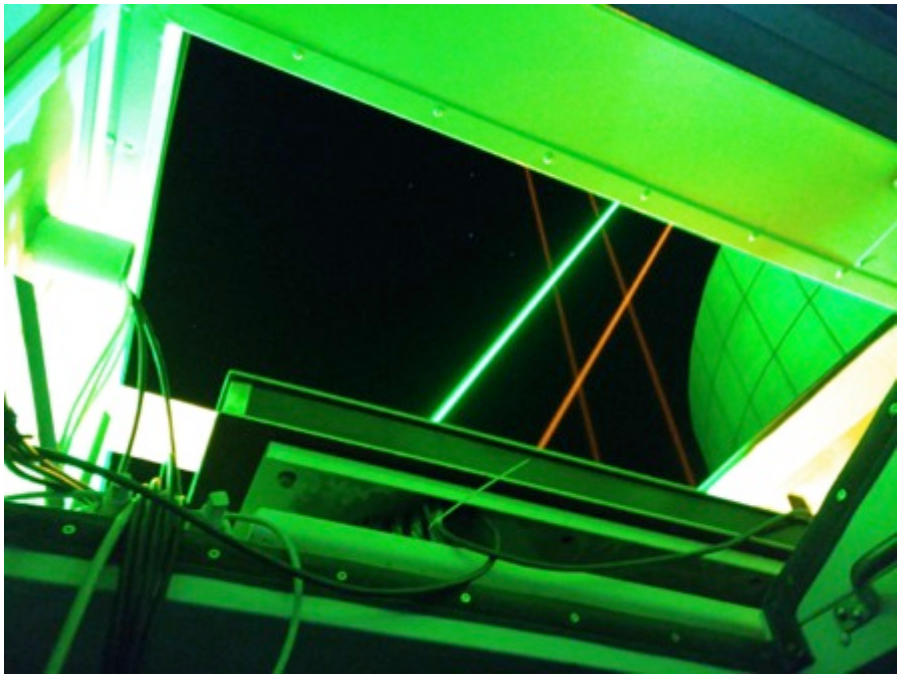






Future Plans

- **Upcoming Campaigns**
  - **2018：APSOS conventional operation-Scientific Observation**
  - **Future：Provide data product**
  - **International cooperation at YBJ**
- **APSOS-net**
  - **to expand regional coverage**
- **APSOS can make contribution to GEWEX**
  - **the transport of water vapor and pollution over the Tibetan Plateau**
  - **the Indian monsoon and severe convection**

Summary

- Current status of APSOS
- APSOS-net and its future