IWGGMS-9 2013.5.29~31

The Status of Chinese Carbon Dioxide Observation Satellite (TanSat)

Yi Liu, Zhaonan Cai, Dongxu Yang, Minzheng Duan,,

Institute of Atmospheric Physics, CAS

ZengShan Yin

Shanghai Engineering Center for Microsatellites , CAS

Yuquan Zheng, Changxiang Yan

Changchun Institute of Optics, Fine Mechanics and Physics, CAS

ZhongDong Yang

National Satellite Meteorological Center, CMA

29 May 2013, Yokohama, Japan

TanSat 中国科学院大气物理研究所 IAP CAS microsat 上海微小卫星工程中心 中科院长春光机所 CIOMP NSMC

Outline

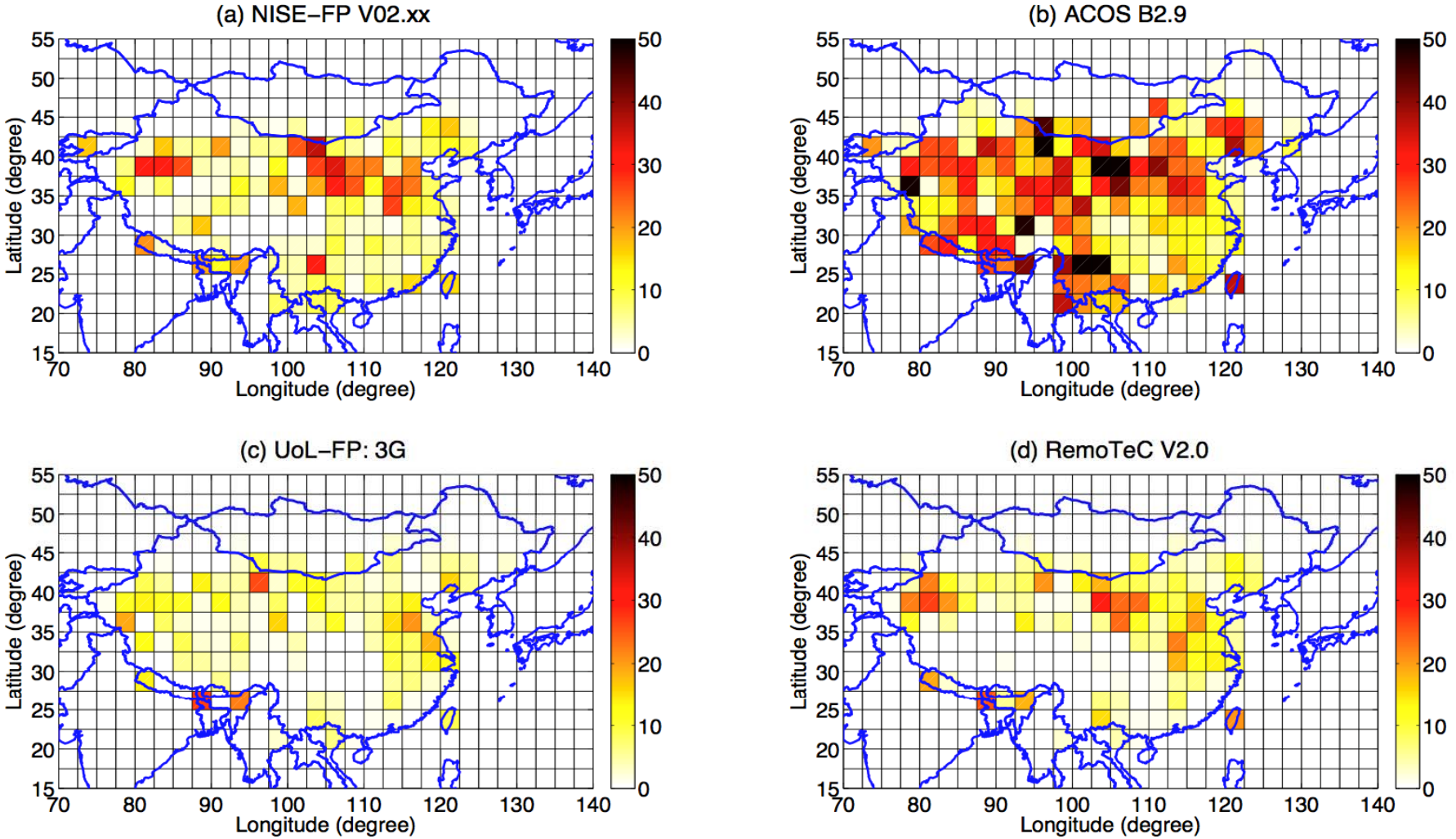
1. Introduction of TanSat Mission
2. Satellite platform
3. Payload & Calibration
4. Ground based validation network
5. Retrieval algorithm
6. Current Status and Schedule

Why should we start TanSat mission?

---China is large emission country

---CO2 flux observation from space need more satellites

---There are challenges (high aerosol …) over China



1. The TanSat Mission –Introduction

(1) National High Technology Research & Development Programs by Ministry of Science and Technology of China (MOST)

Term-1 (2011-2015)-SECM

Term-2 (2013-2015) – IAP

(2) Strategic Priority Research Program of the Chinese Academy of Sciences-Climate Change: Carbon Budget and Relevant Issue by Chinese Academy of Sciences (CAS) – (2011-2015) – IAP

Tagert

Term-1(2011-2015)

Measurement Goals

XCO2

1~4 ppmv

Monthly

500 x 500 km^2

Term-2(2013-2015)

Measurement Goals

Aircraft experiment

CO2 Flux

Monthly

500 x 500 km^2

Team of The TanSat Project-Term 1

Team Leader	Mission
Zengshan Yin **Shanghai Engineering Center for Microsatellites**	**Team leader and Satellite platform**
Yuquan Zheng **Changchun Institute of Optics, Fine Mechanics and Physics**	**Carbon Dioxide Spectrometer**
Changxiang Yan **Changchun Institute of Optics, Fine Mechanics and Physics**	**Cloud and Aerosol Polarization Imager (CAPI)**
Zhongdong Yang **National Satellite Meteorological Center, CMA**	**Data receiver, Calibration and Operational Process**
Yi Liu **Institute of Atmospheric Physics, CAS**	**CO2 Retrieval Algorithm, Science requirement and application**

TanSat Project Term-2 (2013-2015)

Content

1. CO2 flux inverse model system will be developed (ACPD paper will be available soon)
2. Airborne mode will be developed and aircraft experiment will be held during 2014
3. Application of TanSat product will be implemented over three regions of China.

2. Satellite Platform - Observation Mode

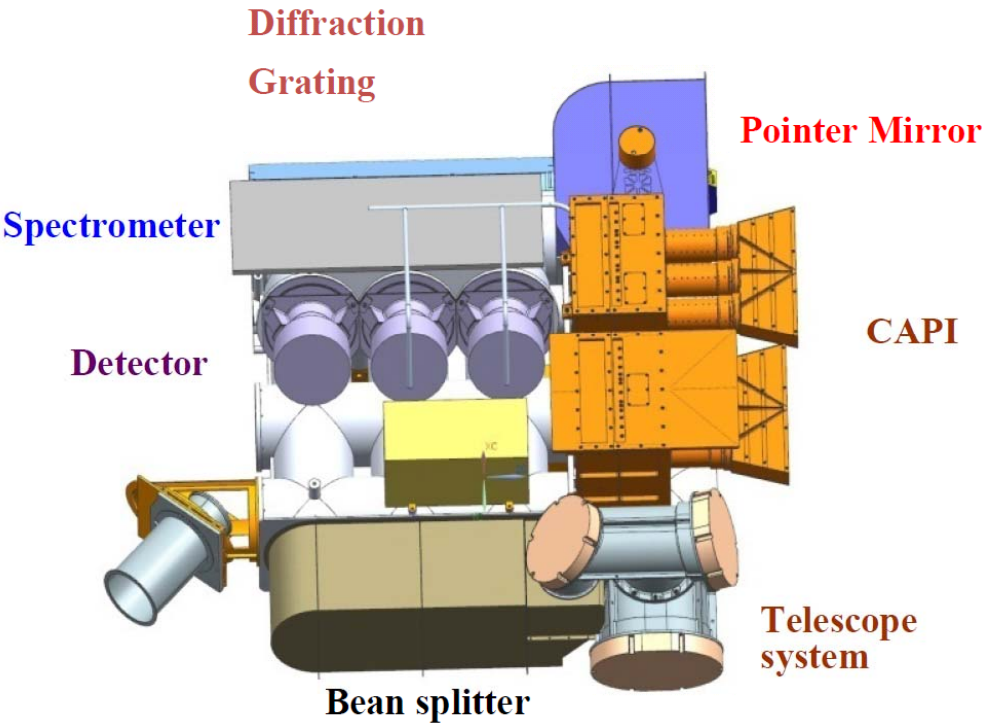
Name	Characters
Orbit type	sun-synchronous
Altitude	700 km
Inclination	98°
Local time	13:30 ±30min
Weight	500Kg

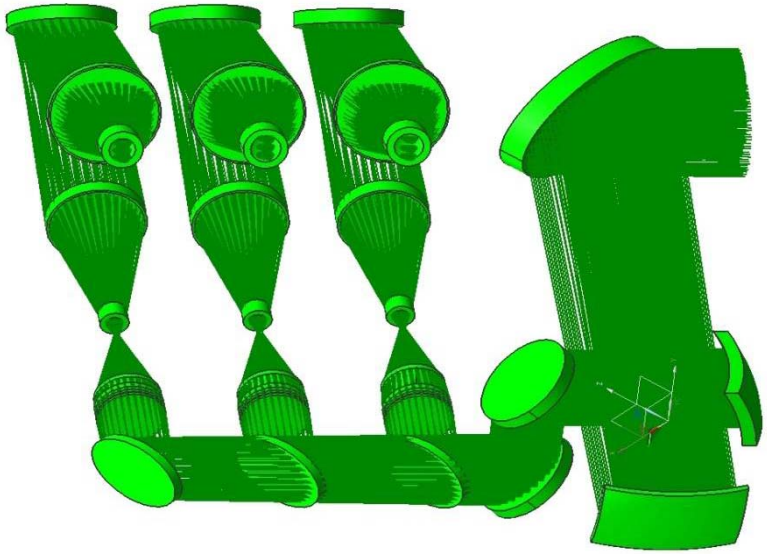
Nadir mode- Observation over land
- Push broom
- Principle plane track

Sun-glint mode- Observation over ocean
- Sun glint track
- Principle plane track

Target mode- Validation
- Surface target track
- Multi angles for one target

3. Carbon Dioxide Spectrometer





	O2-A	CO_2 weak	CO_2 Strong
Spectral Range (nm)	758-778	1594-1624	2042-2082
Spectral Resolution	0.044	0.081	0.103
SNR	360	250	180
Spatial Resolution	1km×2km, 2km×2km		
Swath	20km		

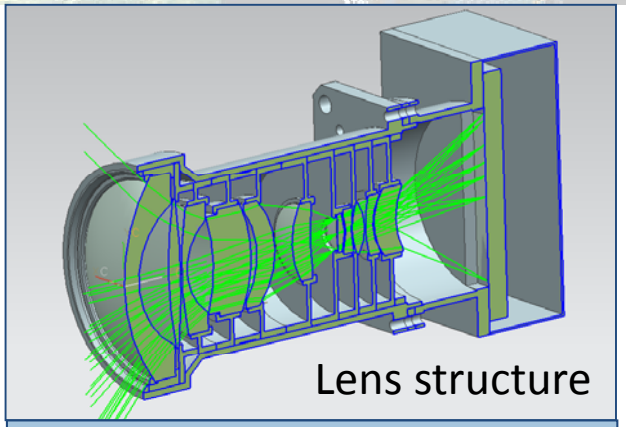
Cloud and Aerosol Polarization Imager - CAPI

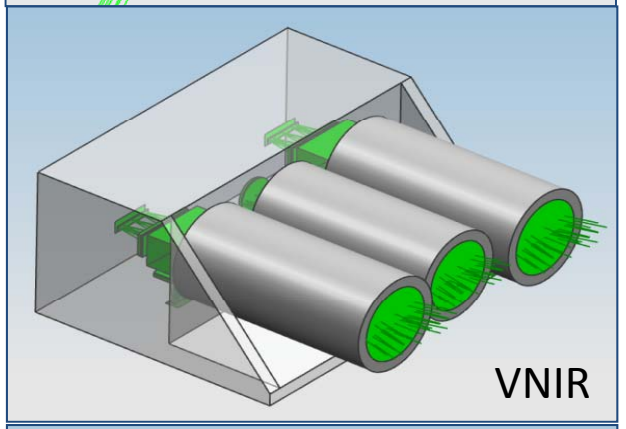
Instrument Specs of CAPI

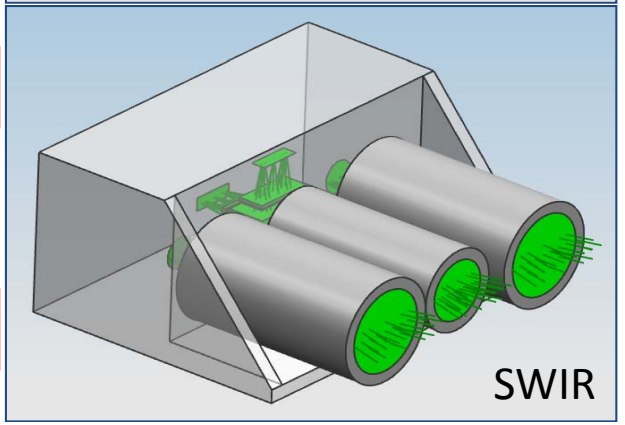
Name	Characters
FOV	400km
Spatial resolution	500m
VIS Samples	800
NIR Samples	800

Channel Specs of CAPI

λ [μm]	Range	SNR	polarization angle
0.38	0.365-0.408	260	-
0.67	0.66-0.685	160	0^0, 60^0, 120^0
0.87	0.862-0.877	400	-
1.375	1.36-1.39	180	-
1.64	1.628-1.654	110	0^0, 60^0, 120^0







Calibration

- Wavelength Calibration accuracy:
  - superior to 1/10 FWHM
- Radiometric calibration accuracy:
  - 3%(relative)
  - 5%(absolute) (Also for CAPI)
- On Board Calibrator (OBC) :

  CO2 Spectrometer : LED + solar Calibration

  CAPI : LED +lunar + Solar Calibration

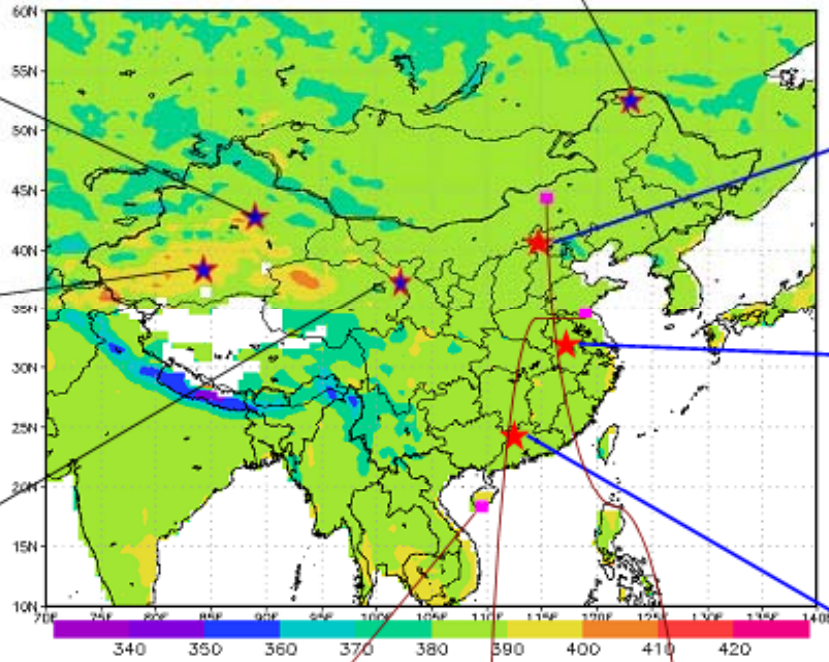
In-situ measurement sites in China for Tan Sat

4 GGA

Greenhouse Gas Analyzer

High-Lat site:

Mohe
(North-east of China)



Map: SCIAMACHY XCO_2 2003-2009 in China

3 IFS-125

Mid-Lat site:

Beijing
(East of China)

Mid-Lat site:
AnHui
(East of China)

Low-Lat site:

Guangzhou
(South of China)

3 OSA

Optical Spectrum Analyzer

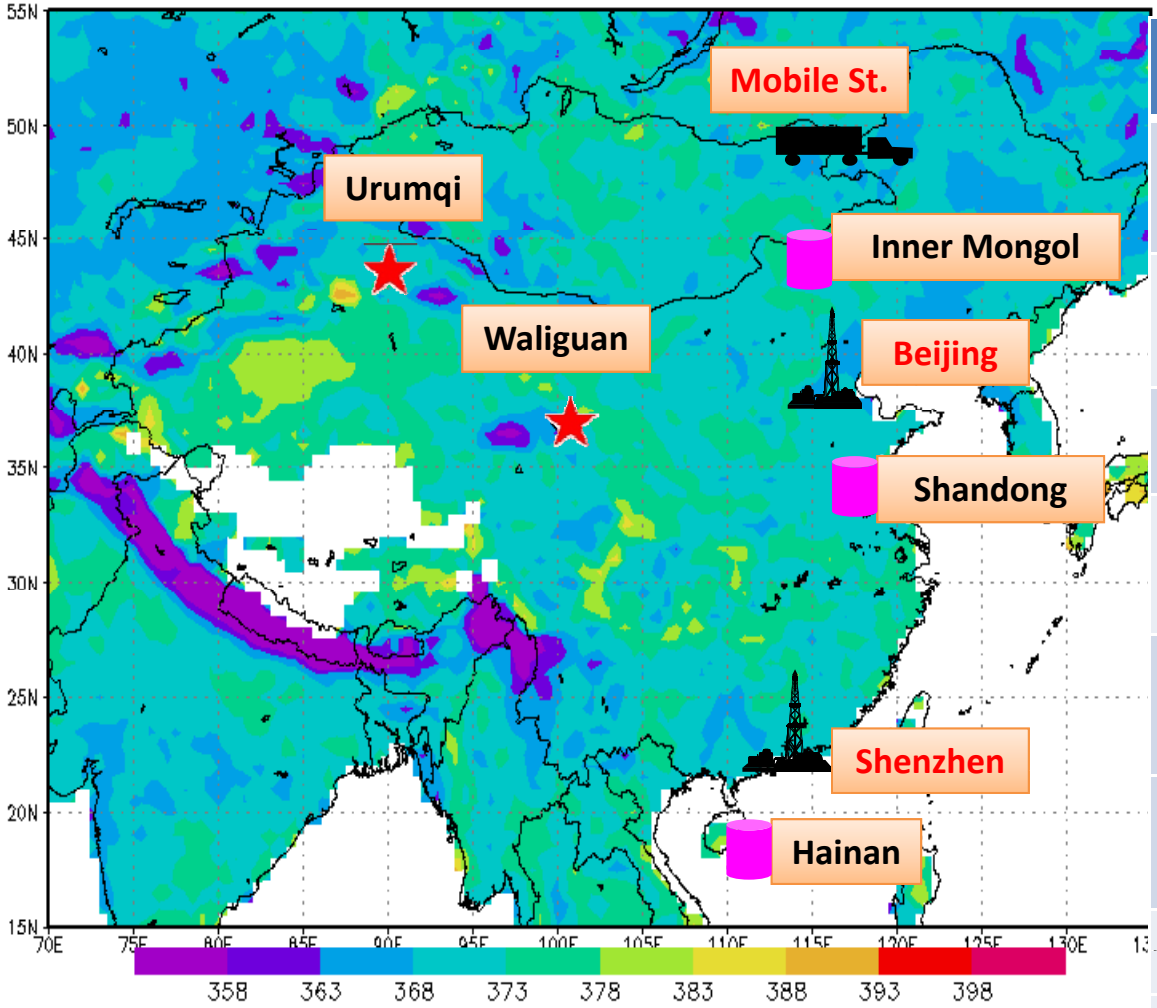
Hainan Island

Shandong

Inner Mongol

4. Ground based measurement network

Ground-based Measurement Sites in China



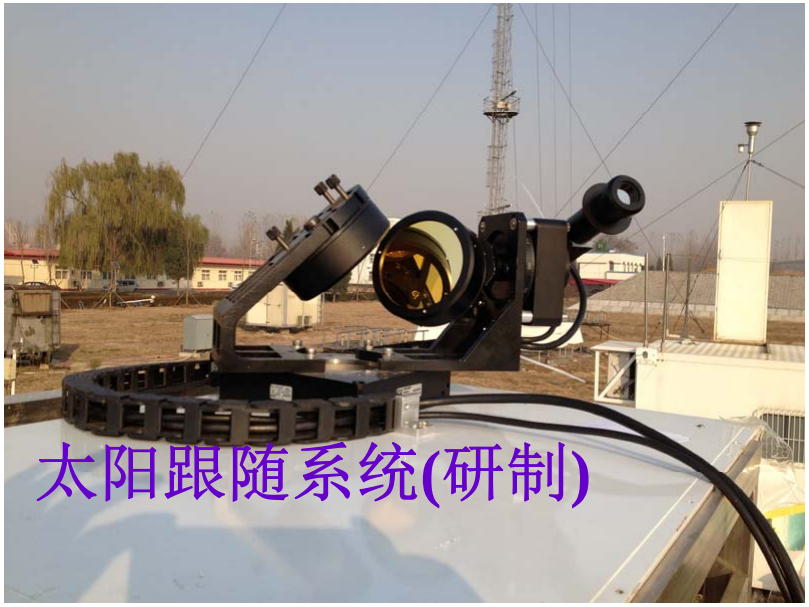
Calibration, Validation & priori data

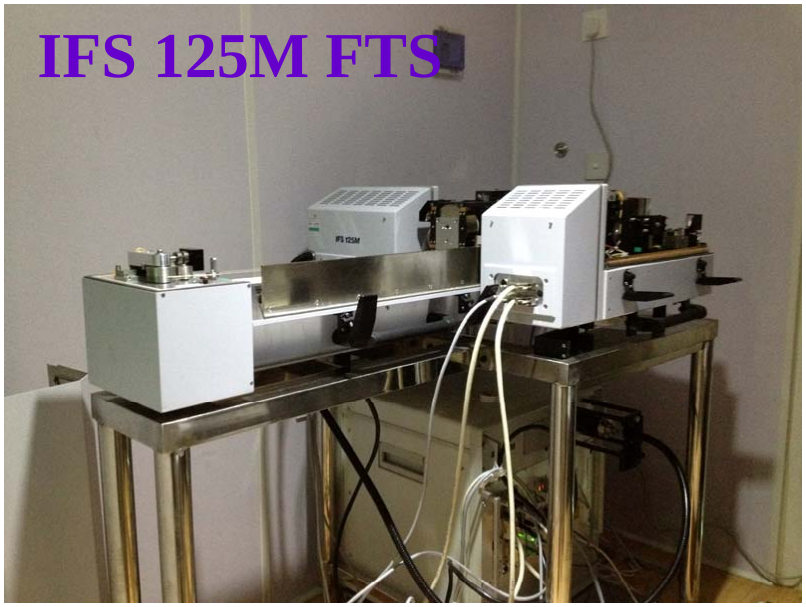
Ground sites

Site	Instrument
Beijing	IFS125/HR +325mTower+7 Licor
Shenzhen	IFS125/HR CIMEL+MWR
Mobile St.	IFS 125/M
Shandong	Optical Spectrum Analyzer(OSA)
Inner Mongol	Optical Spectrum Analyzer(OSA)
Hainan Island	Optical Spectrum Analyzer(OSA)
Urumqi	FGGA/LGR
Waliguan	FGGA/LGR

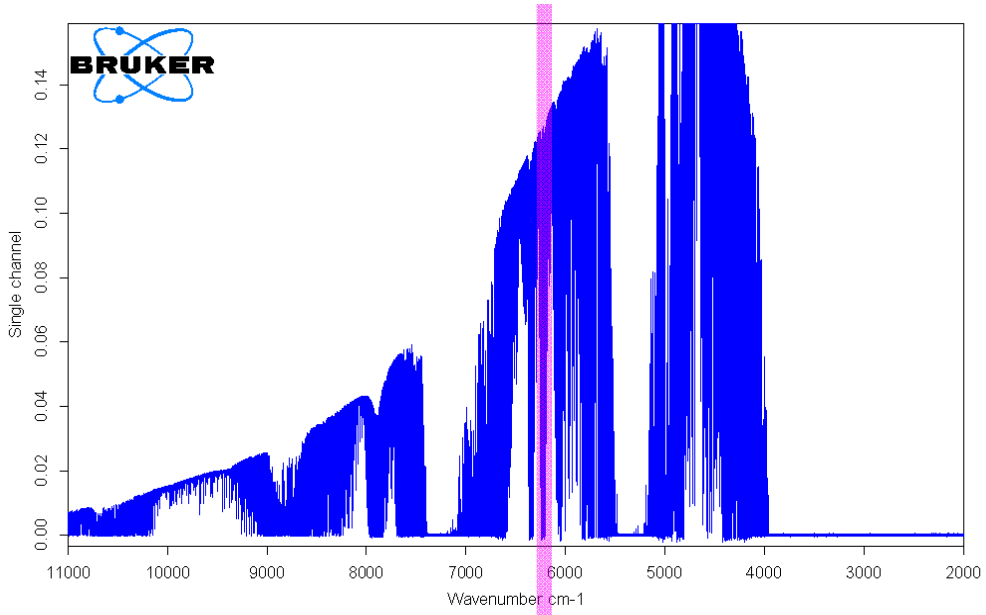
Instruments in stations

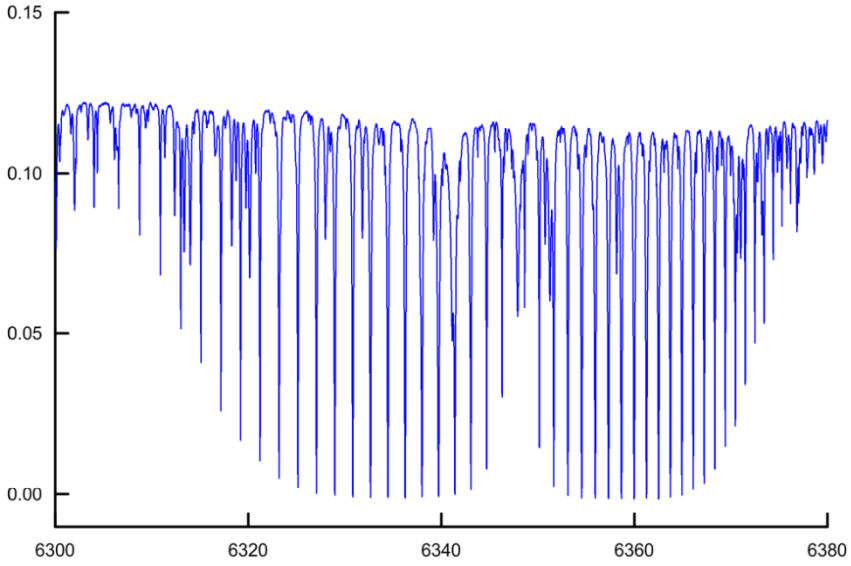
- OSA for total column CO2 ($\Delta\lambda$=0.05nm)
- Aerosol optical parameters(POM-02)
- Grimm aerosol spectrometer
- Licor 7500, CAST3 for surace CO2
- P, T, Rh, Radiation(LW, SW)
- Whole Sky imager
- Sounding (CO2 and P, T, Rh, Wind)





IFS/125M spectral resolution :0.0066 cm^{-1}，coverage：0.9~5μm





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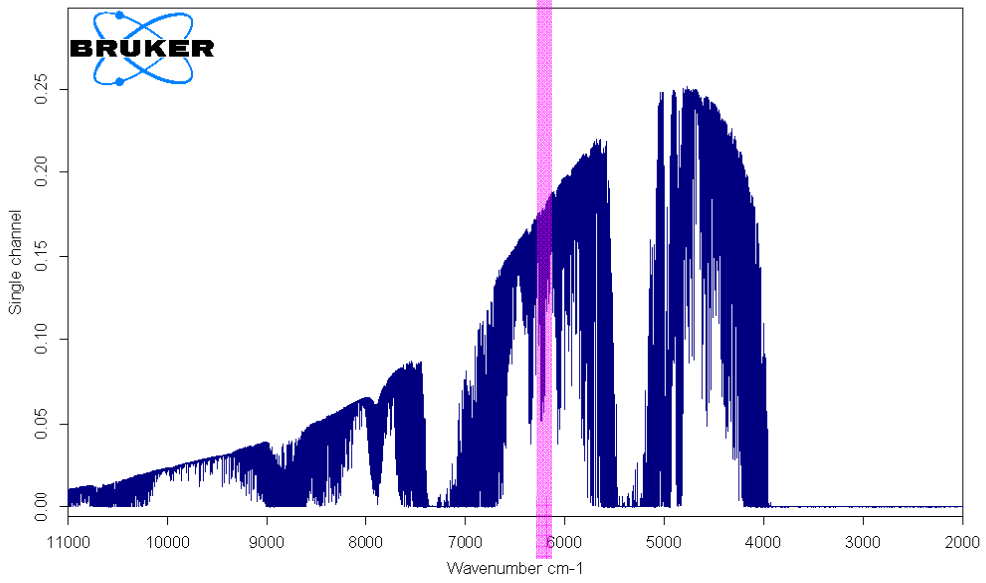

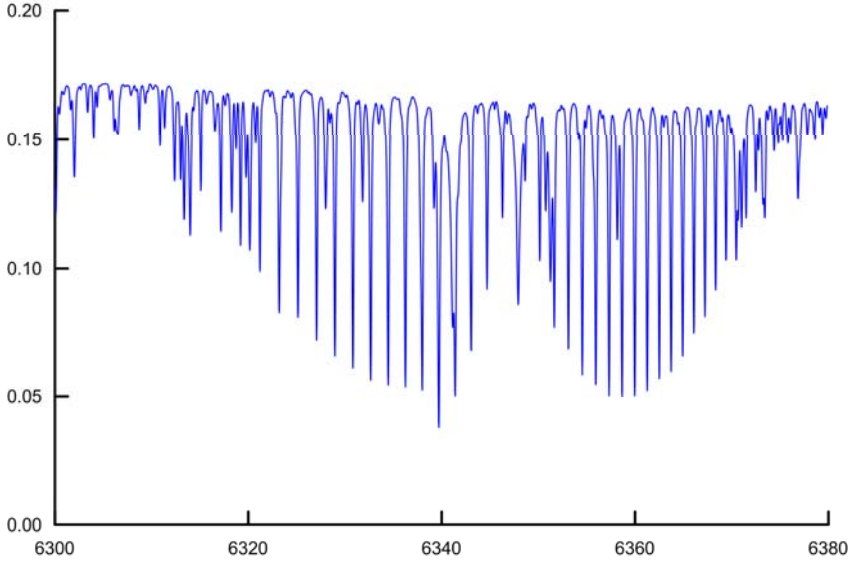

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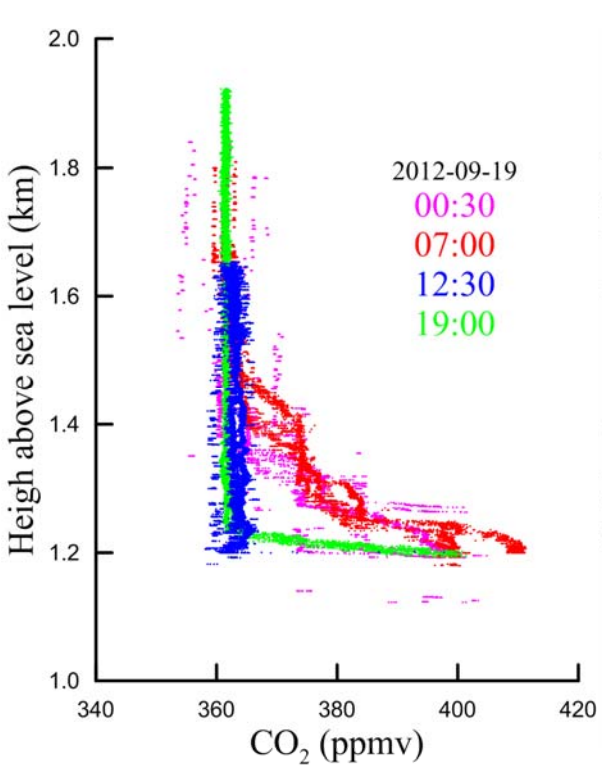
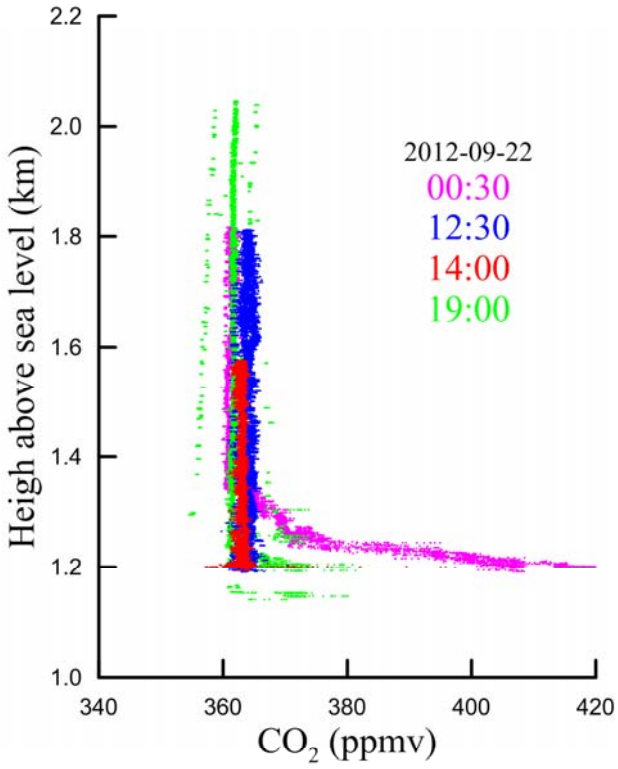
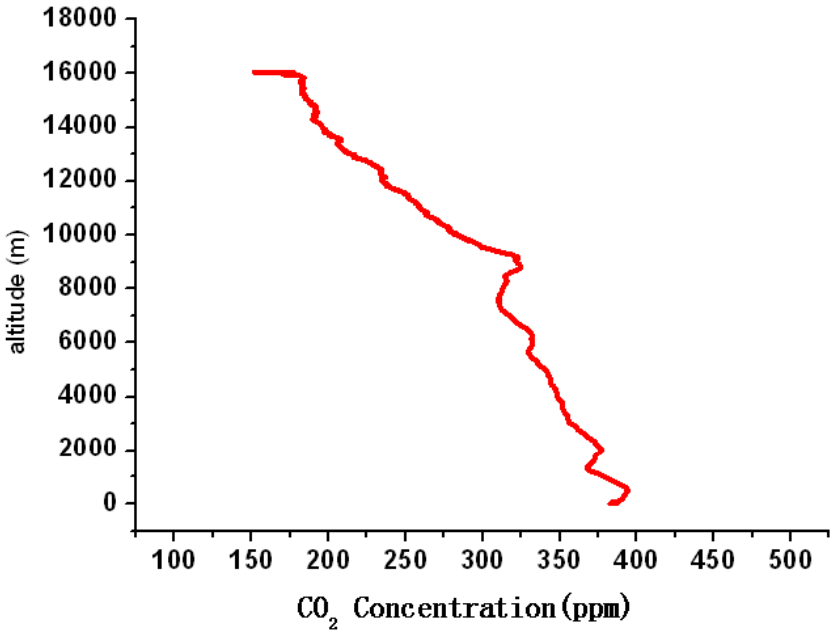
Balloon measurements.





2012, inner mongol， 0-800m CO_2 concentration

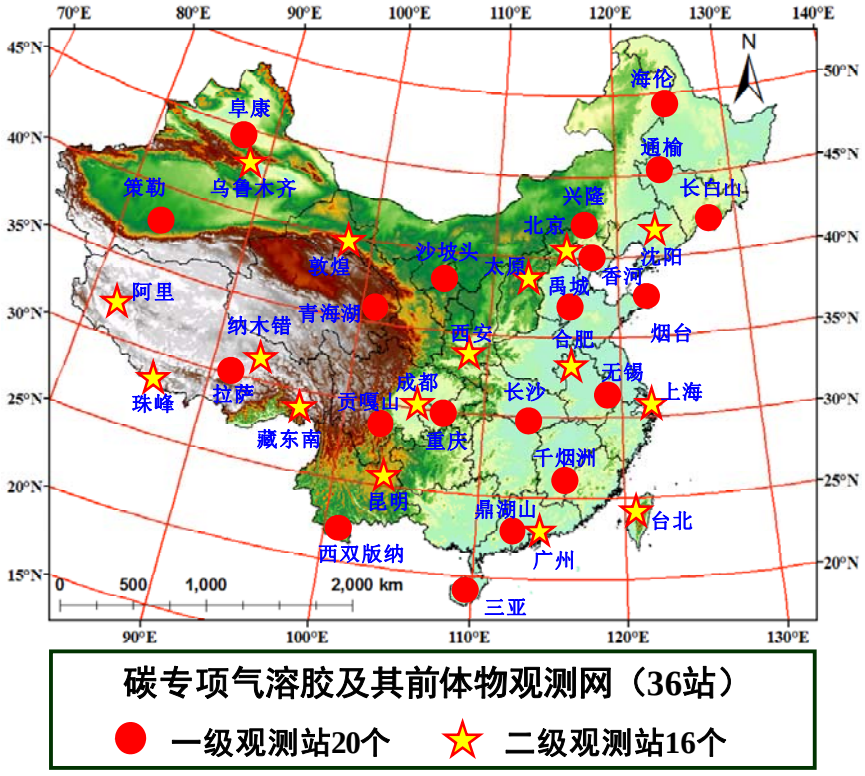

18000
16000
14000
12000
10000
8000
6000
4000
2000
0
altitude (m)
100
150
200
250
300
350
400
450
500
CO2 Concentration(ppm)

Aerosol observation network over China :

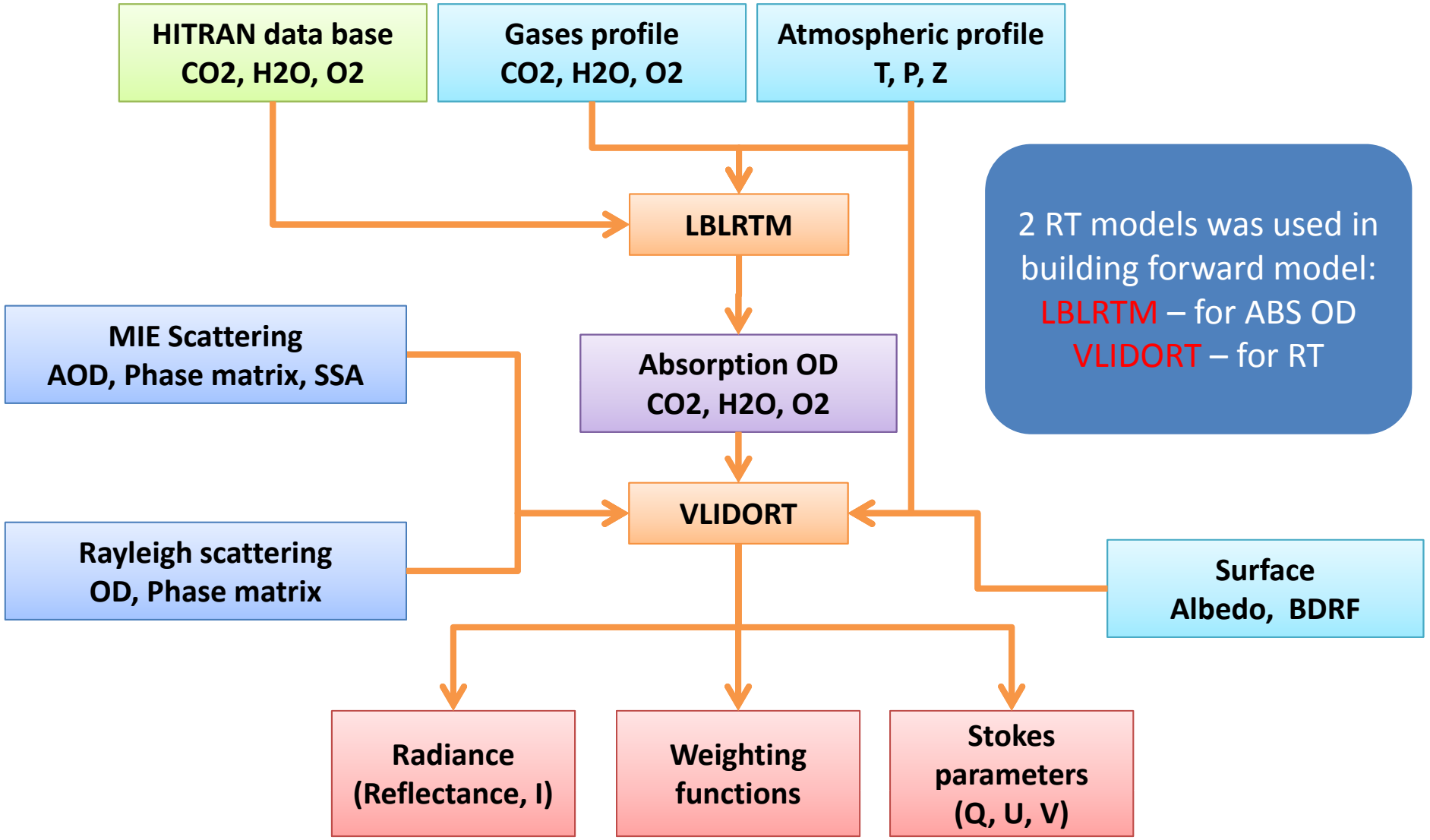
(“Carbon Budget and Monitoring in China”-CAS)

36 sites : total mass, size-resolved and speciated aerosols; and GHGs etc.

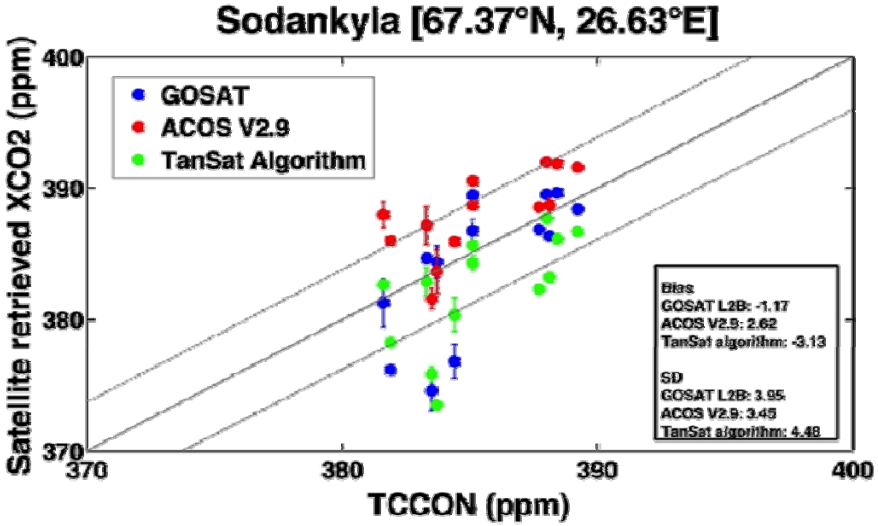
26 sites : aerosol optical properties; (10 sunphotometer +13 handing photometers + 3 laser stations)

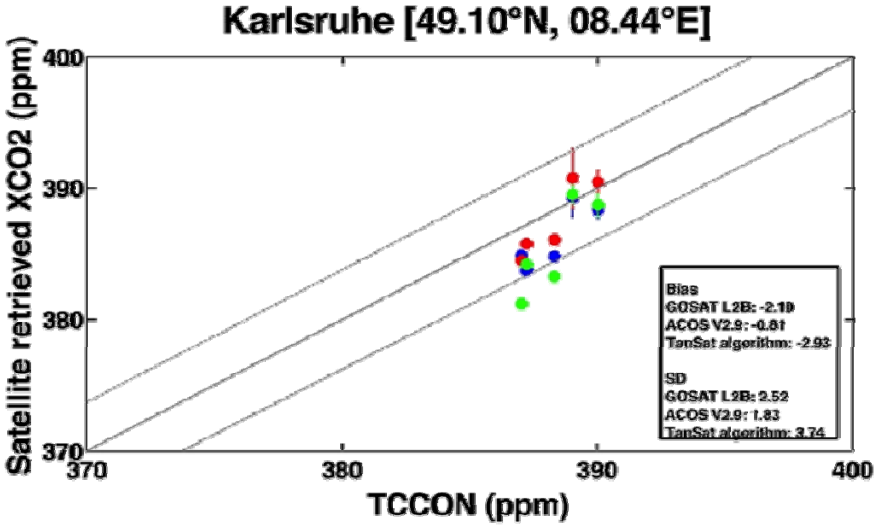


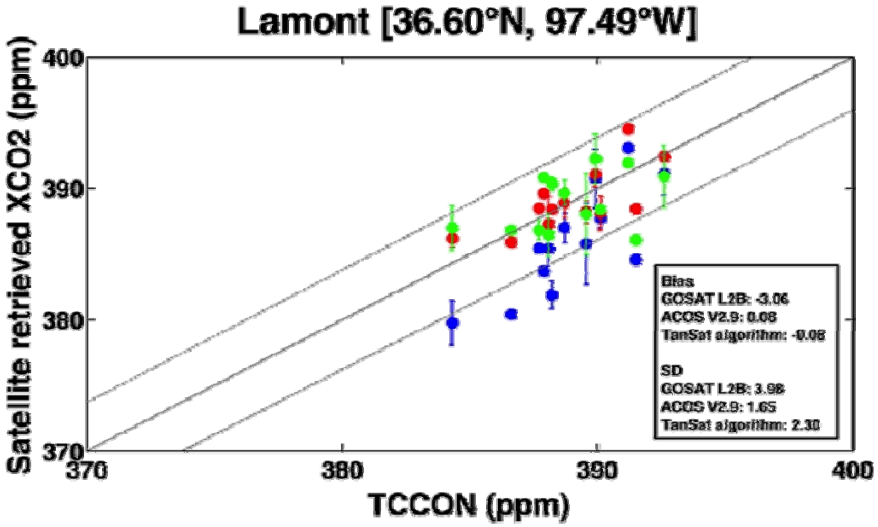
Forward Model Framework

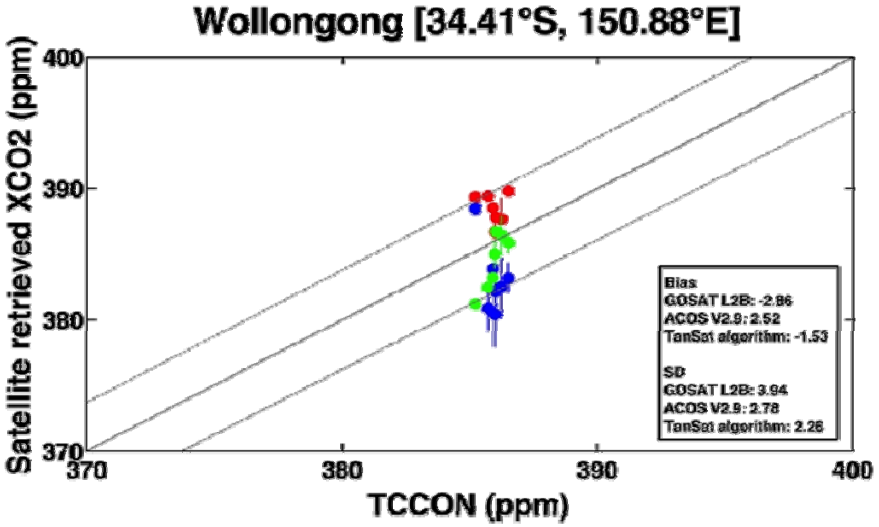


Preliminary retrieval - Validation studies



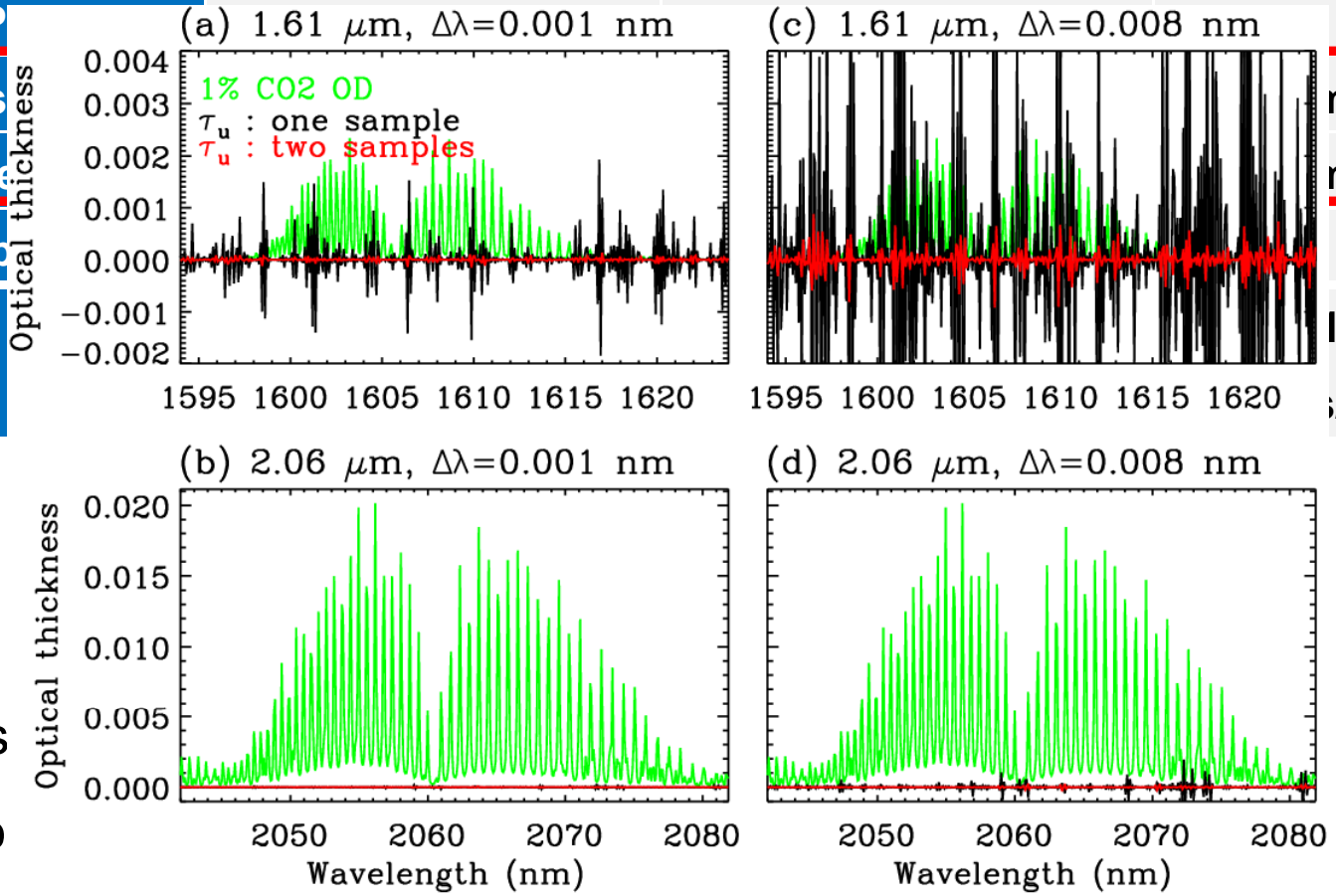






Current Status -1 TANSAT undersampling

TANSAT	O2A	Weak CO2	Strong CO2
Range	758-778nm	1594-1624 nm	2042-2082 nm
Resolving P			
Spectral res			
Spectral inte			
Number of p			
SNR			



n
=1
n

I.1×1012

s/s/cm2/sr/nm

Due to

whole s

(1) who

(2) **Part of spectrum**, high resolution, full-sampling

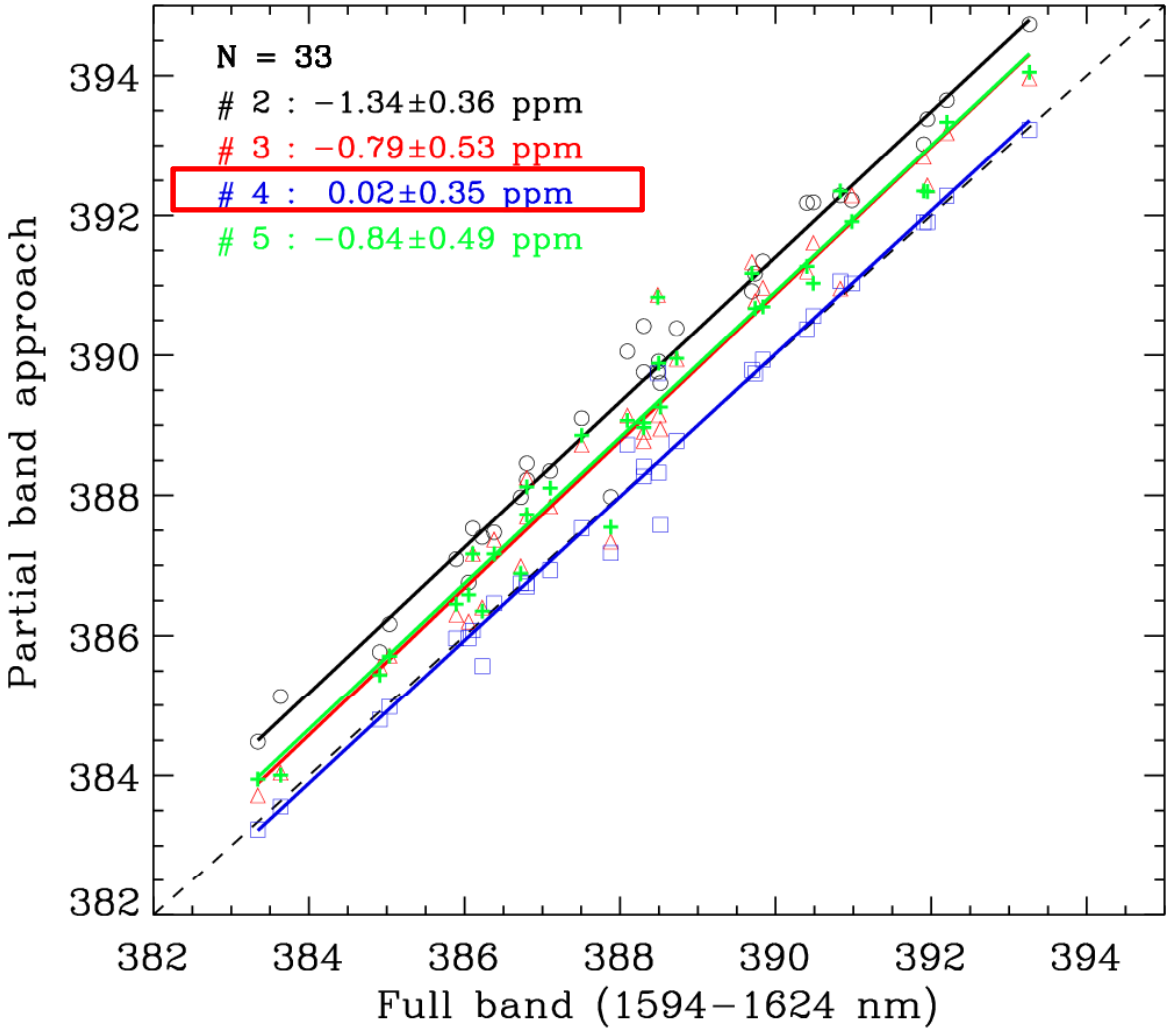
CO2 Band Select – by GOSAT data

1594-1614nm@0.081nm

is best

1594-1624nm@0.16nm

to improve SNR

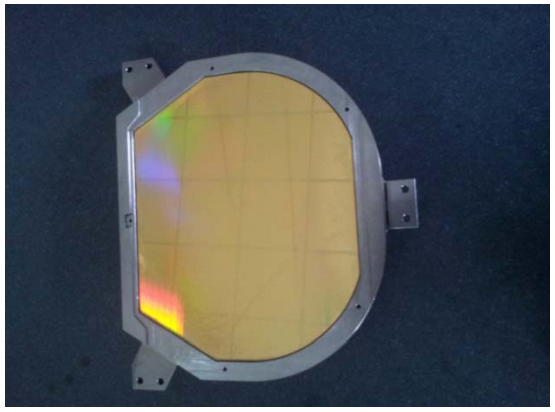


Current Status-2

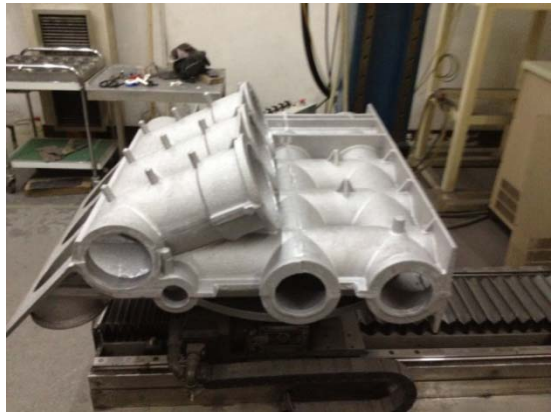
- Two prototype spectrometers are developed (760 and 1610 nm)
- Large-area diffraction grating is manufactured
- Prototype model and electrical interface test has been finished!

760nm Prototype

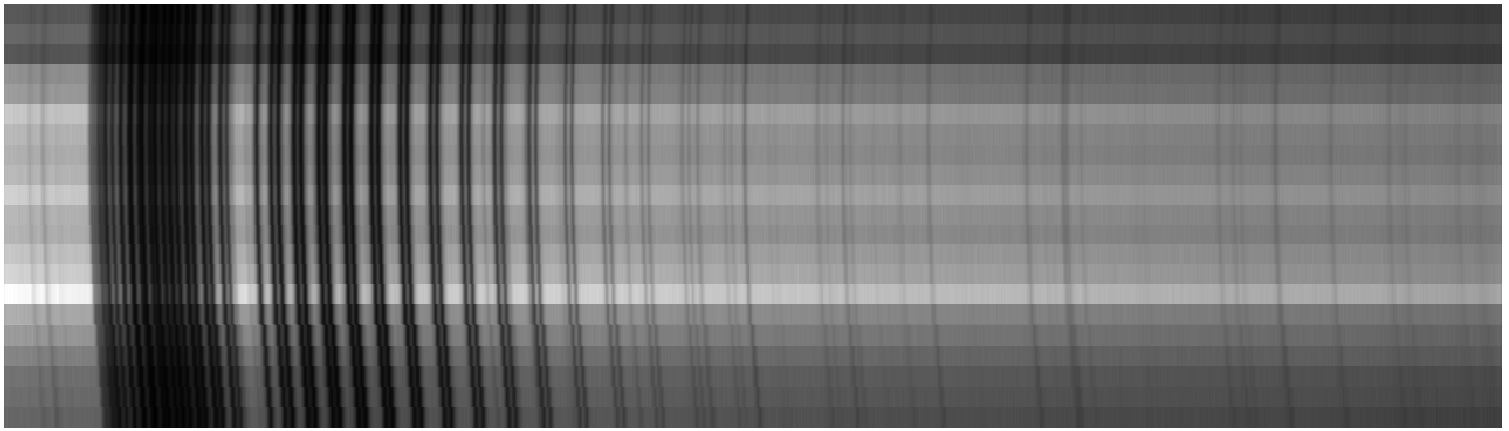
1610nm Prototype

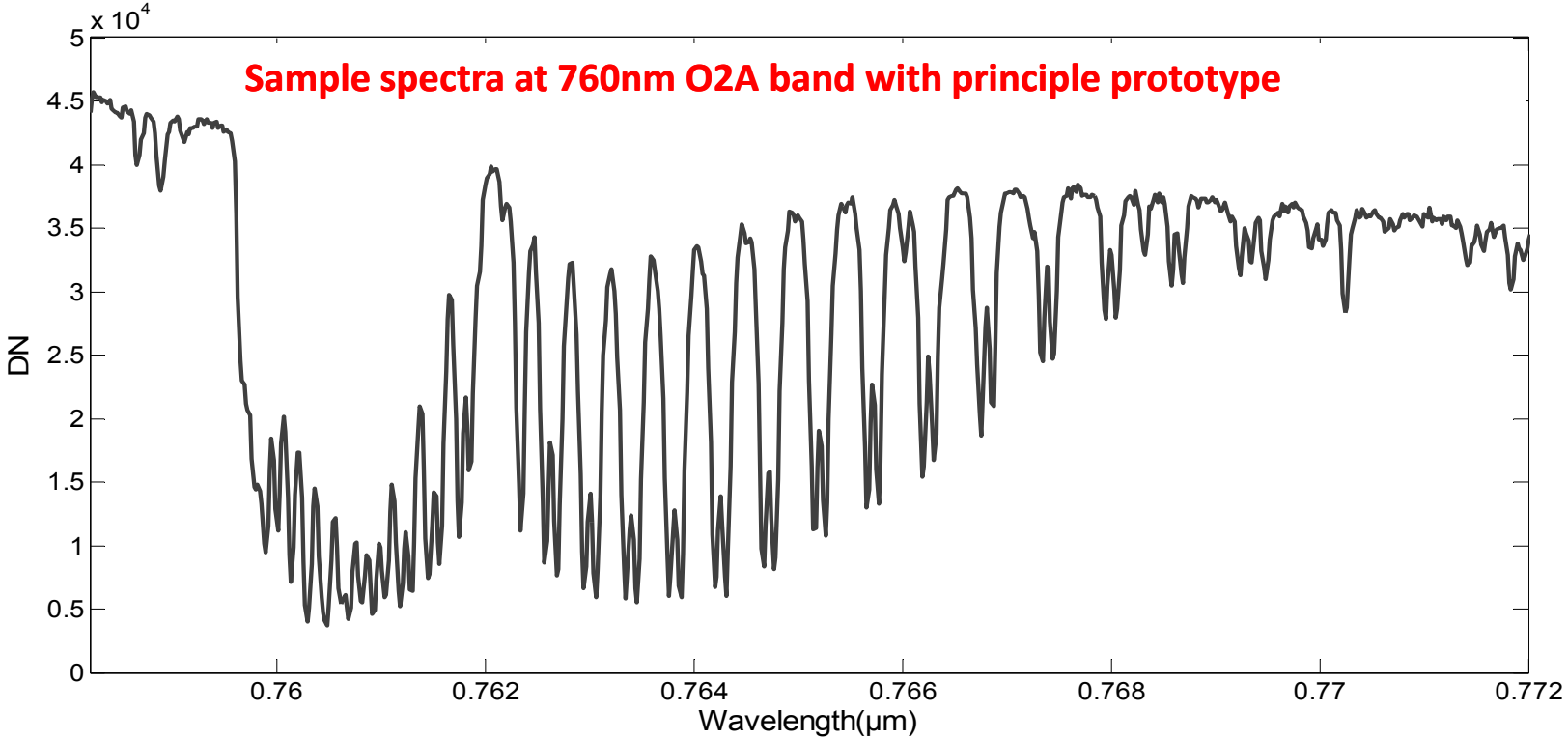


Large-area grating

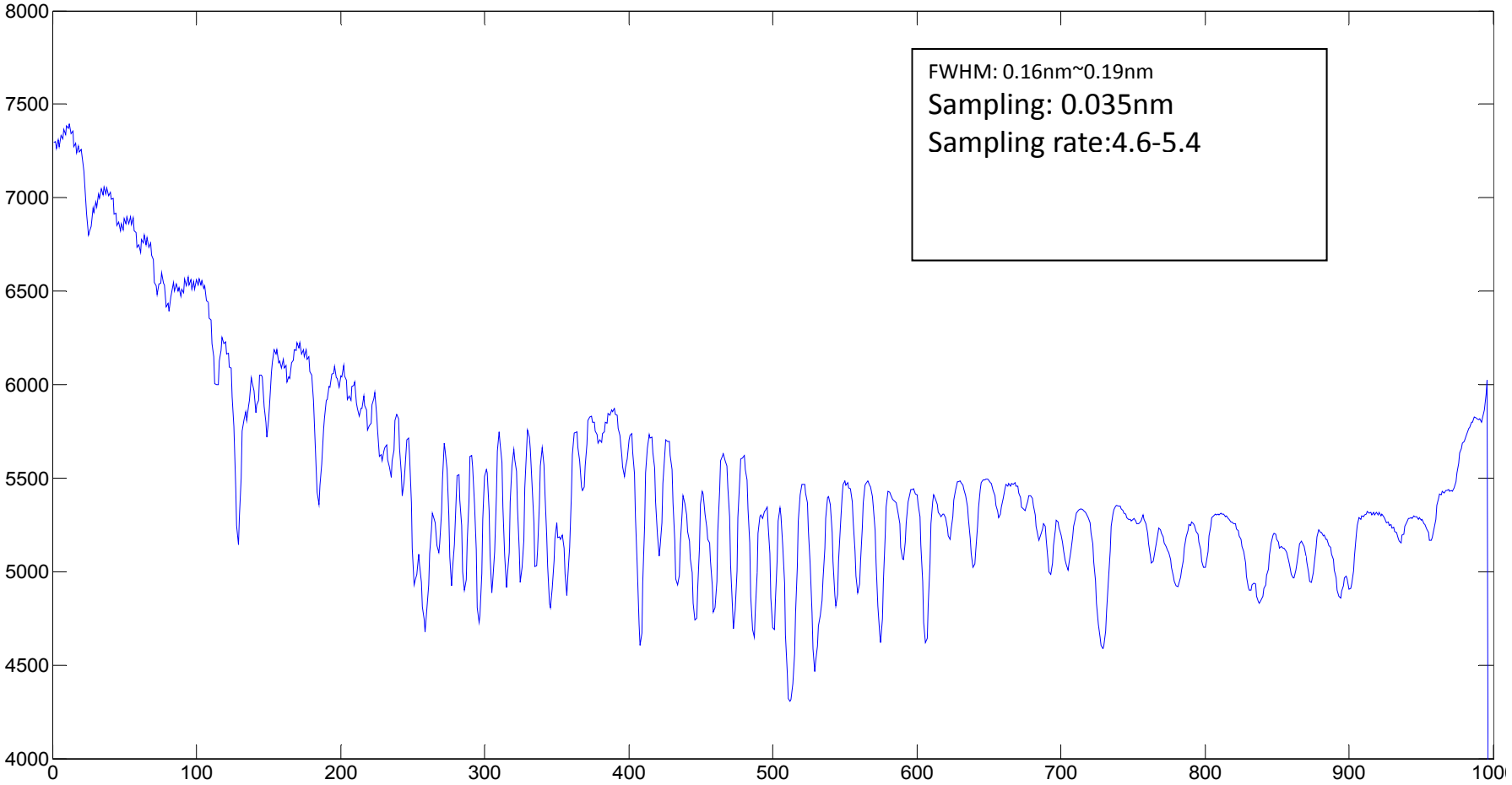


Payload Main frame



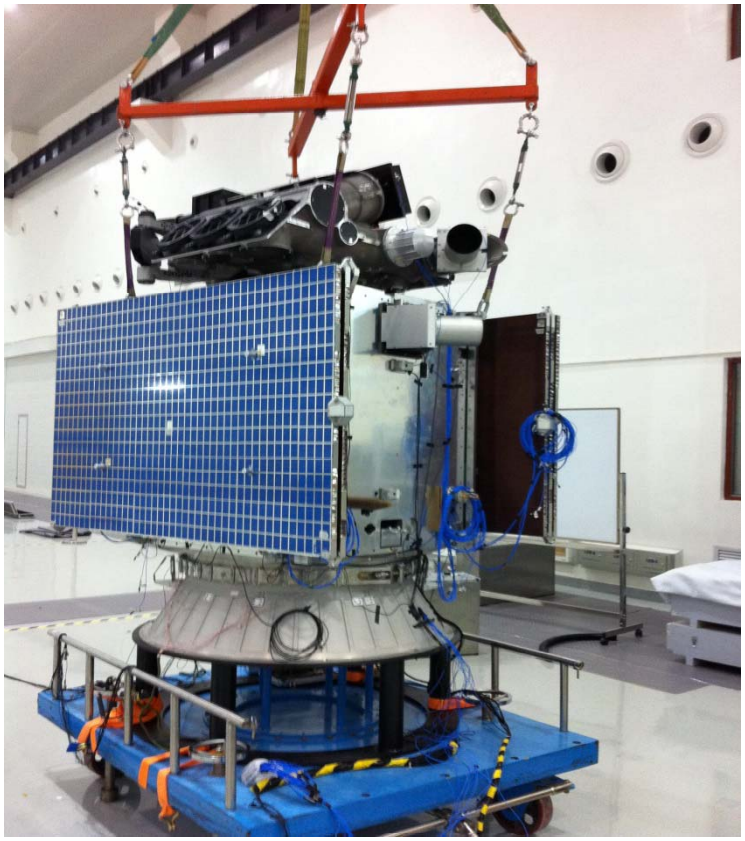

x 10^4
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
DN
Sample spectra at 760nm O2A band with principle prototype
0.76
0.762
0.764
0.766
0.768
0.77
0.772
Wavelength(μm)

Sampling spectra of 1.61um band



Current Status-2

CO2 spectrometer in thermal and mechanical experiment



TanSat in the vibration and mechanical experiment

TanSat Schedule

2011.2 kick off of project

2011.9 SRR-Science Requirement Review

2013.5 PDR-Preliminary Design Review

2013.6: Kick off phase C

2013.12 CDR- Crititcle Design Review

2014.12 SRR- Satellite Readyness Review

2015.6 Launching

The 1st TanSat International workshop-2012 Was held Oct. 15-18 in Beijing

The 2nd TanSat International Workshop will be in Shanghai this October, You are welcome to attend!

TanSat

IAP CAS

microsat 上海微小卫星工程中心

中科院长春光机所 CIOMP

NSMC