

The New Progress of DQ-1 and Pre-research of DQ-2

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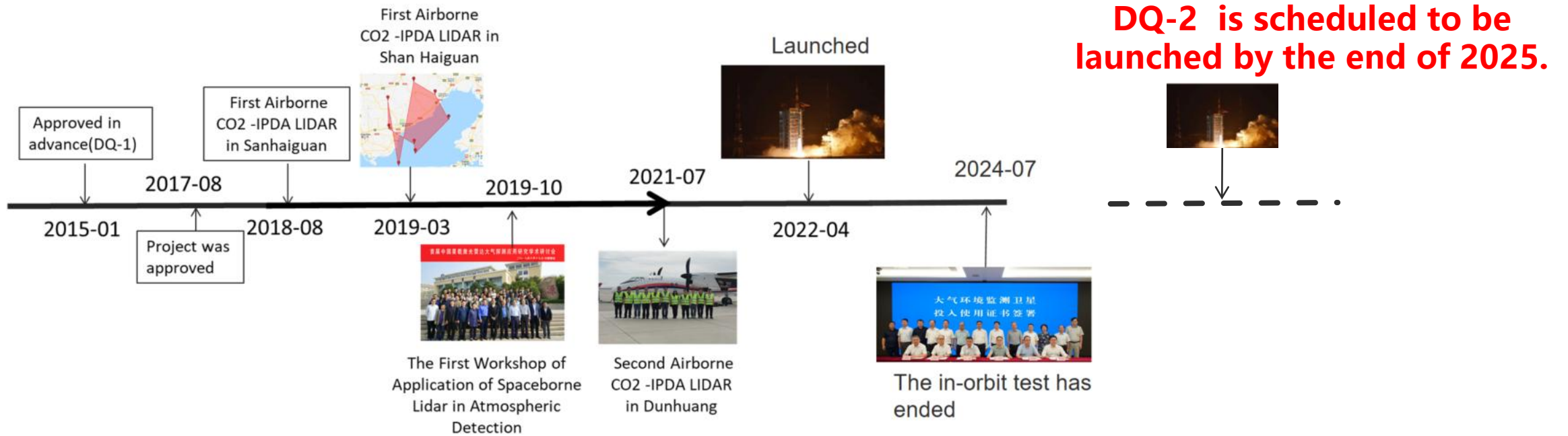
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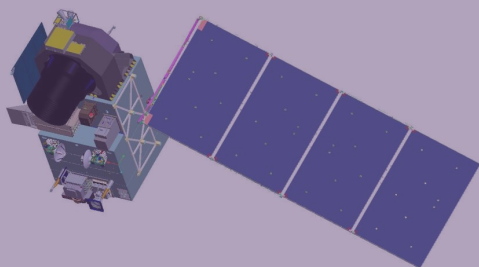
Introduction DQ-1 and DQ-2



Introduction DQ-1 and DQ-2

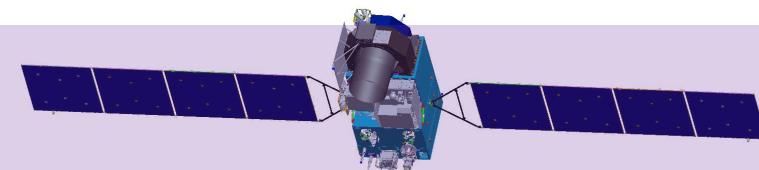
□ Satellite parameters

DQ-1



Specification	ACDL/DQ-1
Online wavelength	75mJ@1572.024 nm
Offline wavelength	75mJ@1572.085nm
Pulse width (on/off)	15ns
Field of view	100 μrad

DQ-2



Bands	central wavelength	spectral bandwidth	spectral resolution	SNR(0.05,60° solar zenith angle)	spatial resolution	field of view
GAS-II Parameter					≈3km	>100km
O2-A	765nm	>15nm	0.04 nm	350		
CO2	1610nm	>30nm	0.07 nm	340		
CO2,H2O	2060nm	>40nm	0.09 nm	230		
CO,CH4	2300nm	>50	0.1nm	200		
Bands	wavelength range(cm-1)			spectral resolution(cm-1)		spatial resolution
HIRAS-II						<14km
Long-IR	648.75~1169.375 (15.41~8.55 μm)			0.625		
Middle-IR	1167.5~1921.25 (8.56~5.20 μm)			0.625		
Short-IR	1919.375~2551.25 (5.21~3.92 μm)			0.625		

The Latest Progress of DQ-1

□ The progress of one year's work

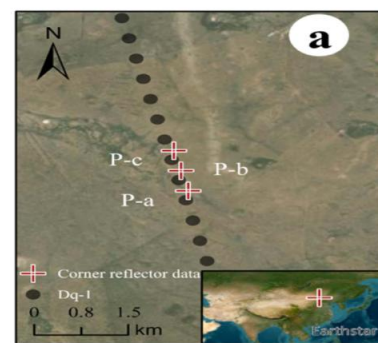
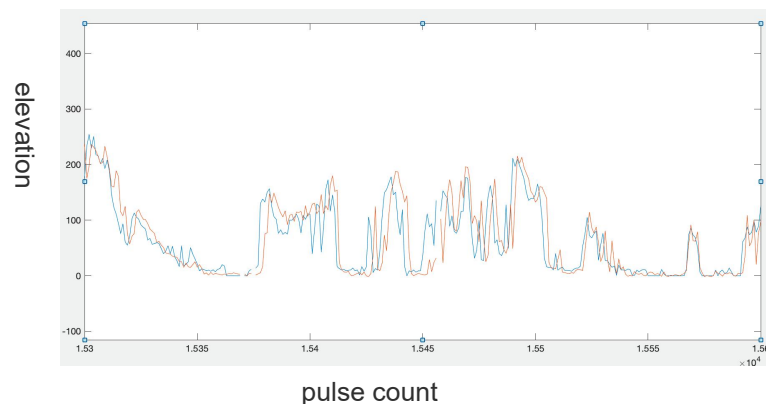
● Evaluated the impact of water vapor for XCO₂ measurement

1.The absorption cross-section of carbon dioxide

2.The differential optical thickness DAOD

3.The Weight function

● Completed the geometric calibration of DQ-1/ACDL



Chen C, Fan C, Wu Z, Xie Y, Hu J, Yang J, Zhu X, Zhang L, Wang Z, Liu S, Liu J, Chen W. Evaluating the impact of water vapor for aerosol and carbon dioxide detection lidar CO₂ measurement onboard the atmospheric environment monitoring satellite. Opt Express. 2024 Dec 30;32(27):48340-48352. doi: 10.1364/OE.546903.

The Latest Progress of DQ-1

□ The progress of one year's work

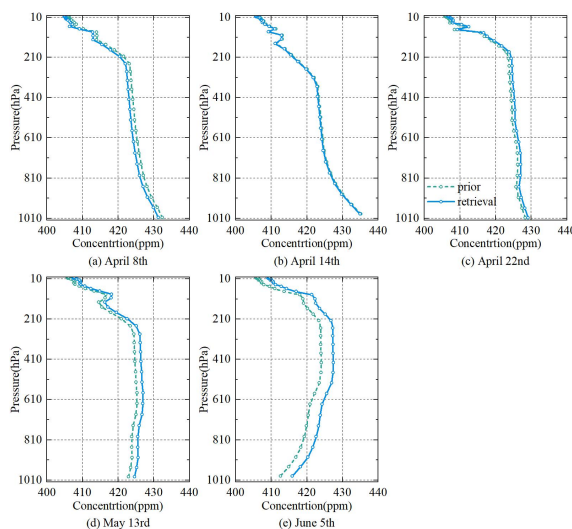
● Cal/Val

① Method

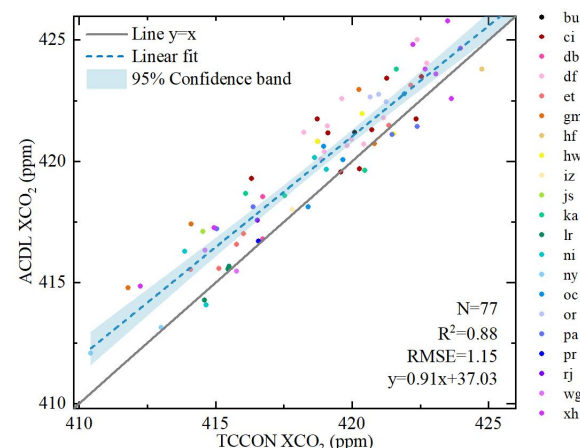
$$\frac{\int_{P_G}^{P_A} a \cdot \rho'_{CO_2}(p, T) \cdot WF(p, T) dp}{\int_{P_G}^{P_A} WF(p, T) dp} = \frac{1}{2} \ln \left[\frac{P(\lambda_{on}, R_A) \cdot P_0(\lambda_{off})}{P(\lambda_{off}, R_A) \cdot P_0(\lambda_{on})} \right]$$

$$\rho_{CO_2}(p, T) = a \cdot \rho'_{CO_2}(p, T)$$

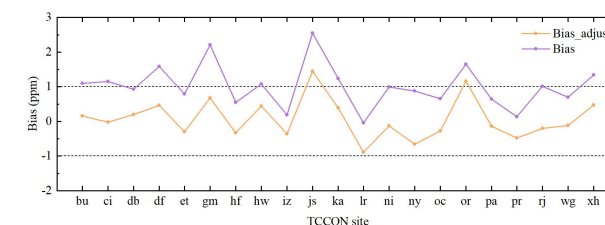
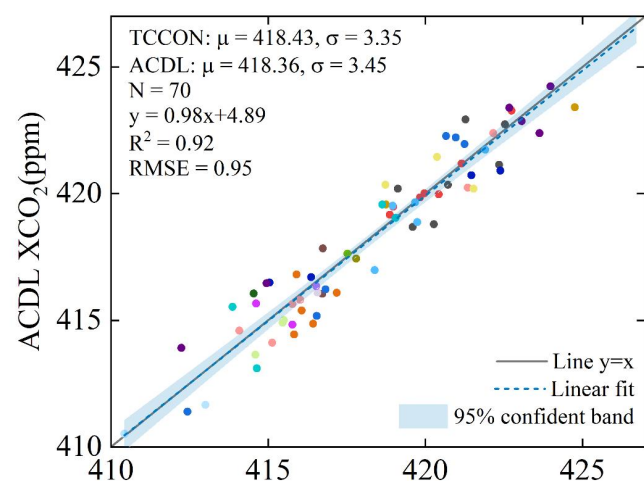
② Scaling the prior profile of CO2



③ Direct comparison with ground-based TCCON



④ after scaling prior profile, comparison with ground-based TCCON



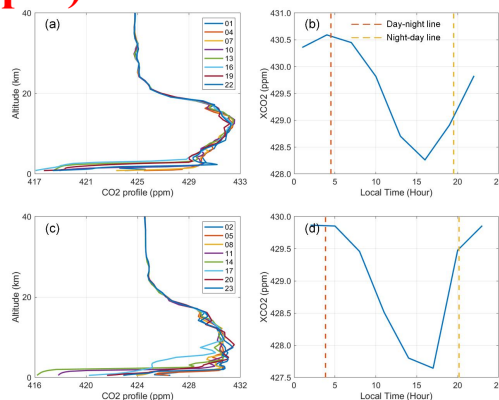
The R-Square (R2) between the ACDL and TCCON sites is **0.92**, and the Root Mean Squared Error (RMSE) is **0.95** ppm

The Latest Progress of DQ-1

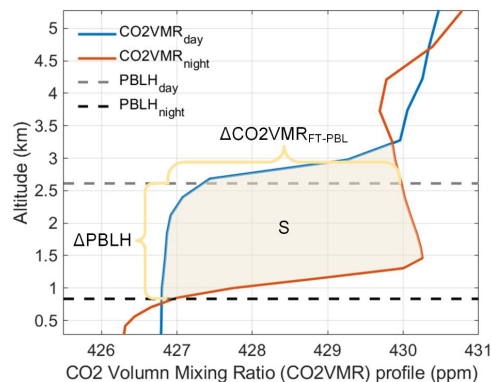
□ The progress of one year's work

● Day and night difference ΔXCO_2

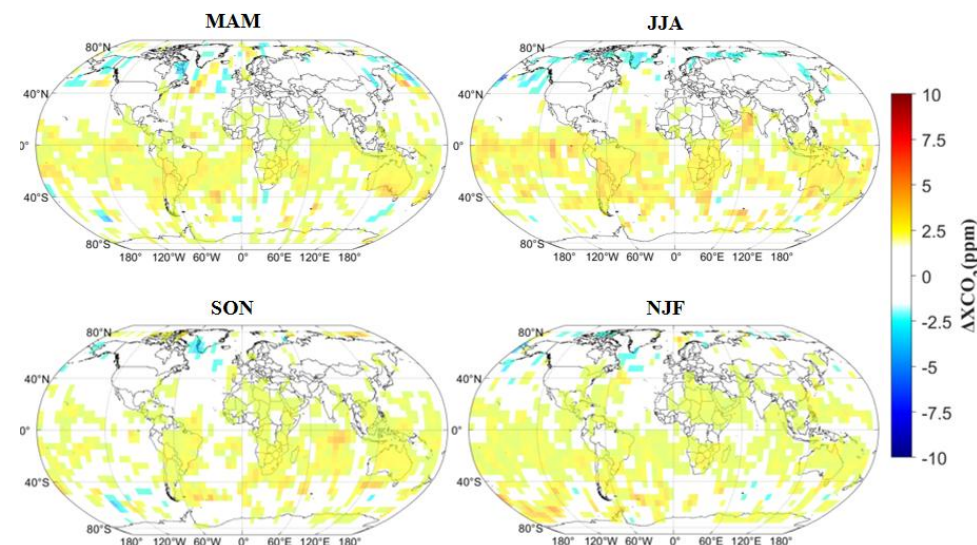
- ① The simulation demonstrates that the changes in near-ground CO₂ can be captured by the DQ-1 ($\Delta XCO_2 > 1\text{ppm}$)



- ② The boundary layer height (ΔXCO_2)



- ③ Preliminary result of ΔXCO_2



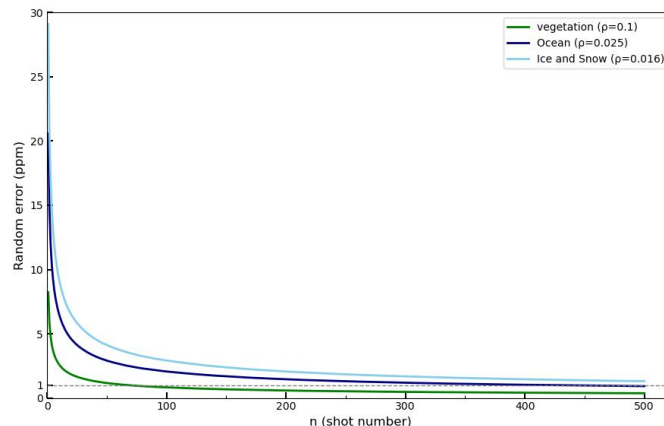
The ΔXCO_2 less than 1ppm was masked out

The Latest Progress of DQ-1

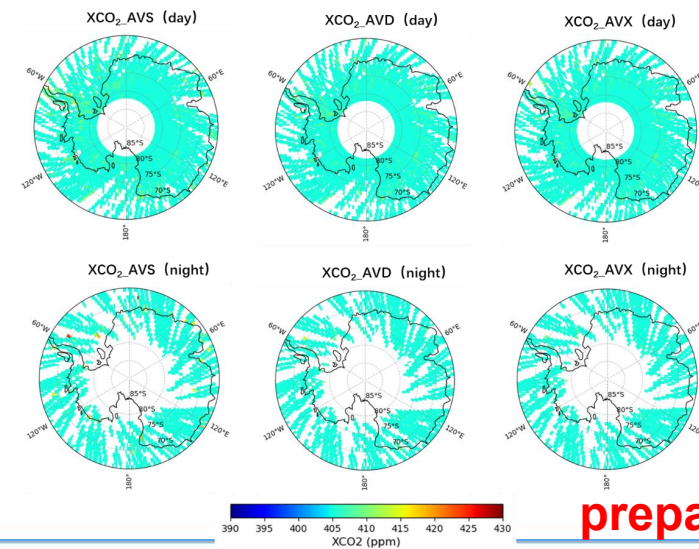
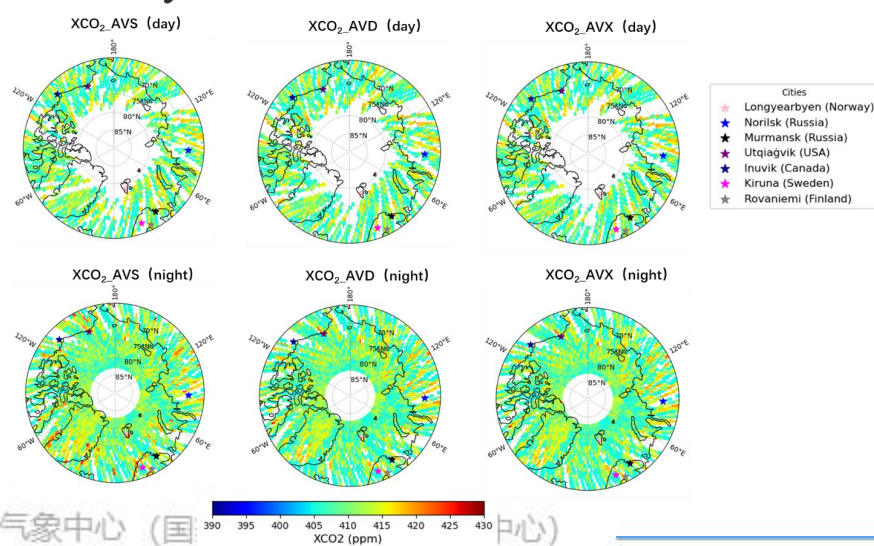
□ The progress of one year's work

● South and north pole XCO₂

① The surface of ice and snow has a low reflection at a 1.5 μ m, so we need more pulse for averaging (500s)



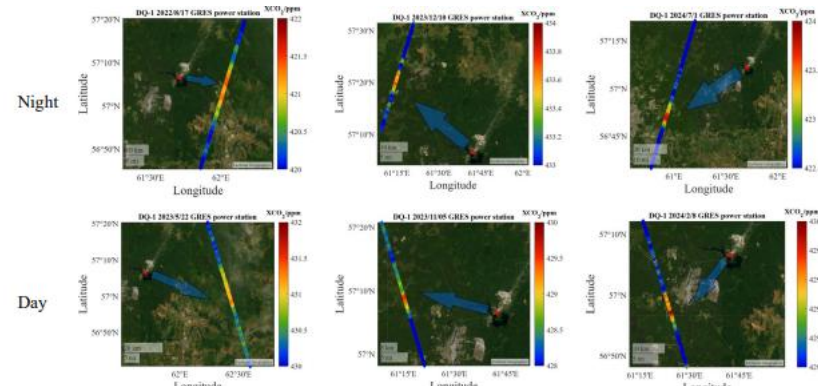
② Preliminary result



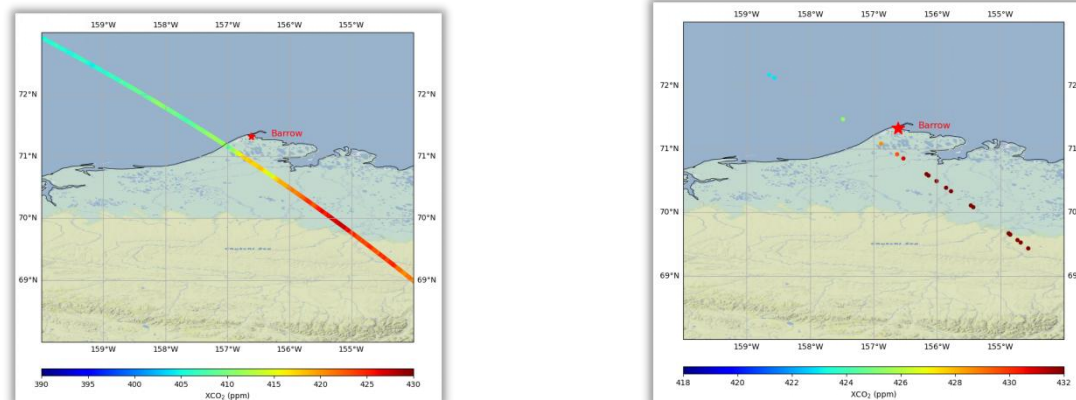
The Latest Progress of DQ-1

□ The progress of one year's work

- Emissions of CO₂ from power plants (high-latitude area)



- Measurement of CO₂ Column Concentration Above Cloud Tops
- Method for CO₂ Column Concentration in Sub-cloud area



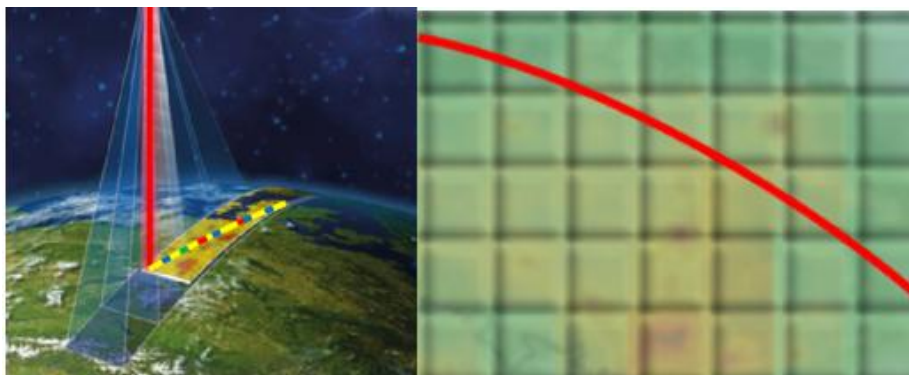
Zhang, X., Yang, H., Bu, L., Fan, Z., Xiao, W., Chen, B., Zhang, L., Liu, S., Wang, Z., Liu, J., Chen, W., and Lee, X.: Estimation of diurnal emissions of CO₂ from thermal power plants using spaceborne IPDA lidar, EGU sphere [preprint], <https://doi.org/10.5194/egusphere-2024-3152>, 2024

Zhihua Mao, Yang zhang, Lingbing bu, et al, Measurement of CO₂ column concentration above cloud tops with a spaceborne IPDA lidar. Geophysical Research Letters, 51, 2024

The Pre-research on DQ-2

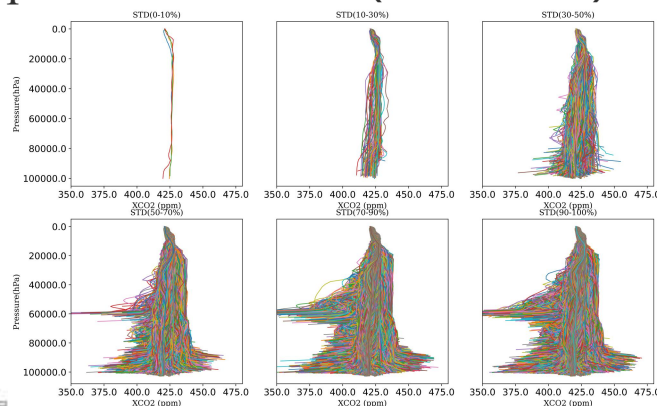
□ The differences between active and passive

- A very narrow observation bandwidth, as well as a very long observation range (for averaging)



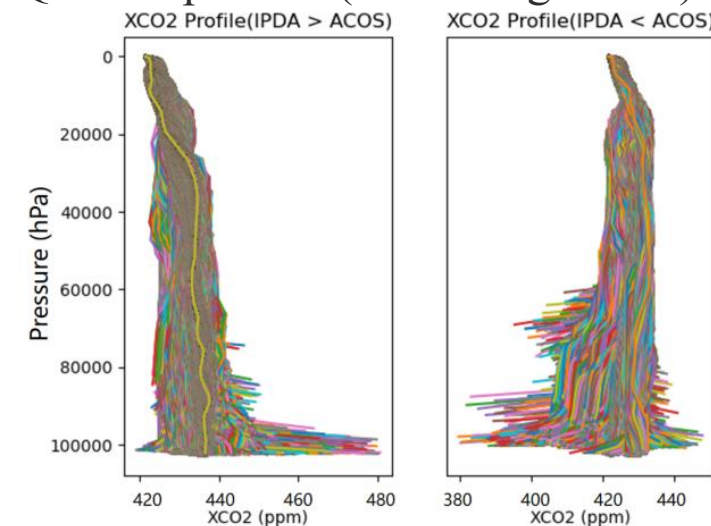
- Both are XCO2, but they are different.

The more vertical the profile is, the closer the active and passive states are (simulation) .



- Simulations of CO2 column concentration and profile

DQ-1 and passive (ACOS algorithm)



Weight function for DQ-1:

$$WF(p, T) = \frac{[\sigma(\lambda_{on}, p, T) - \sigma(\lambda_{off}, p, T)N_A]}{[1 + \rho_{H2O}(p, T)]gM_{dry}}$$

Weight function for Passive(ACOS):

$$c(p, T) = \frac{1}{[1 + \rho_{H2O}(p, T)]gM_{dry}}$$

Relationship: $WF(p, T) = c(p, T) \cdot [\sigma(\lambda_{on}, p, T) - \sigma(\lambda_{off}, p, T)N_A]$

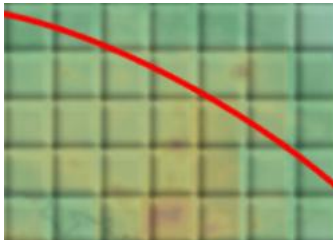
Summary

□ The data quality of DQ-1 is good

1. Cal/val
2. Day and night difference ΔXCO_2
3. South and north pole XCO_2
4. Emissions of CO_2 from power plants (high-latitude area)
5. Measurement of CO_2 Column Concentration Above Cloud Tops
6. Method for CO_2 Column Concentration in Sub-cloud area

□ The DQ-2 has active and passive payload

1. Different between Passive and active
The intensity of the sink can be measured?



Pay attention to the observation modes

□ More ground-based observations for Cal/Val

□ Data Open

It is expected that the one-year L2C DQ-1 data might be released by the end of this year.

THANKS

