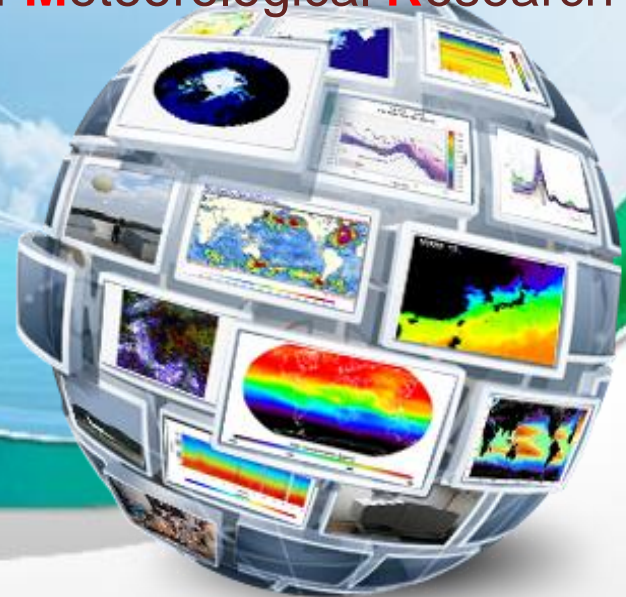


# Improved FTS Measurement for Remotely-based CO<sub>2</sub> Retrievals

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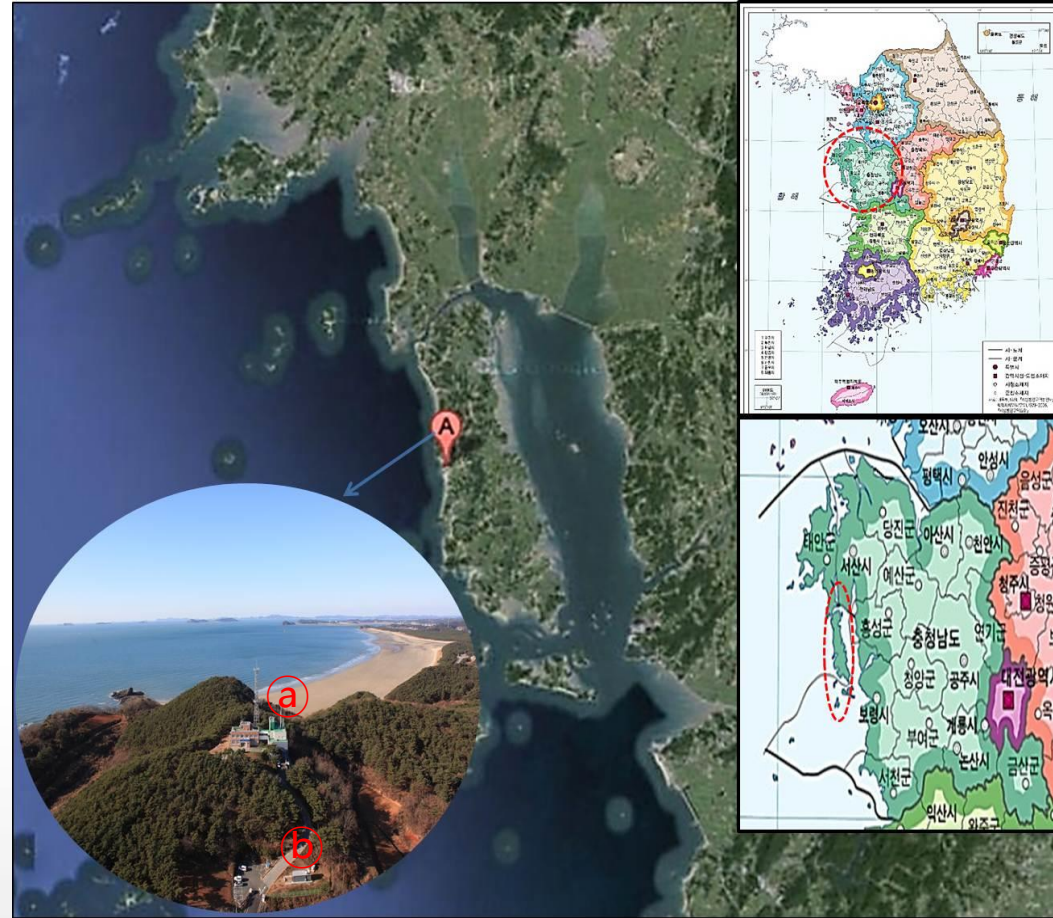


# Contents

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- 03 **Validation Results** ●
- 04 **Summary** ●

# Where is the site?

- ❖ Latitude:  $36^{\circ}32'N$
- ❖ Longitude:  $126^{\circ}19'E$
- ❖ Altitude: 25 masl
- ❖ WMO Regional GAW station of the KMA
- ❖ FTS station is an operational site of the **TCCON**



# What is the TCCON?

- ❖ Total Carbon Column Observing Network (26 sites over the world)
  - a network of ground-based Fourier Transform Spectrometers recording direct solar spectra in the near-infrared spectral region.
  - From these spectra, accurate and precise column-averaged abundance of CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CO, H<sub>2</sub>O, HF, and HDO are retrieved.
- ❖ TCCON provides an essential validation resource for the Orbiting Carbon Observatory (OCO), Sciamachy, and GOSAT.



# Overview of Instruments

Remotely-sensed Obs.

## ◆ FT-IR (Fourier Transform InfraRed)

- Model: AERI-003
- Manufacture: ABB (Canada)
- Period: 2010.6.~present
- Range: **550~3,000  $\text{cm}^{-1}$**
- Resolution: **1  $\text{cm}^{-1}$**
- Time Interval: 7~8 min.
- Measurement: Downward infrared spectra
- Retrievals: **T/q, CH<sub>4</sub>, CO**



## ◆ FTS (Fourier Transform Spectrometer)

- Model: IFS-125HR
- Manufacture: Bruker (German)
- Period: 2013.3.~present
- Range: **3,800~16,000  $\text{cm}^{-1}$**
- Resolution: **~0.0063  $\text{cm}^{-1}$**
- Time Interval: 2~3 min.
- Measurement: Solar absorption spectra
- Retrievals: **CO<sub>2</sub>, CH<sub>4</sub>**



Obs. for Validations

## ◆ Radio Sonde

- Manufacture: Graw (German)
- Period: 2010~present
- Num.: 72 launches so far
- Altitude range: ~30 km
- Measurement: **T, P, Humi.,** Wind dir. and speed
- Launch time: at the time of aircraft obs. and satellite overpassing

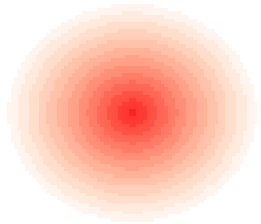


## ◆ Airborne CRDS

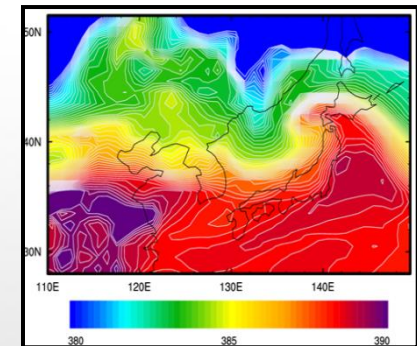
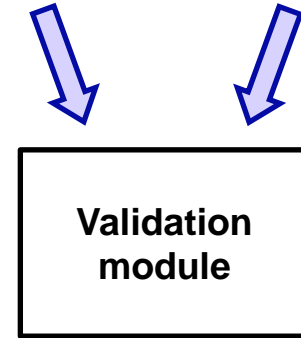
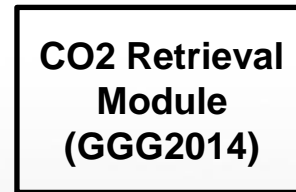
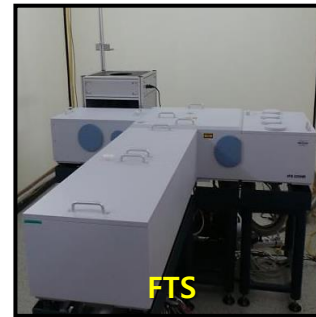
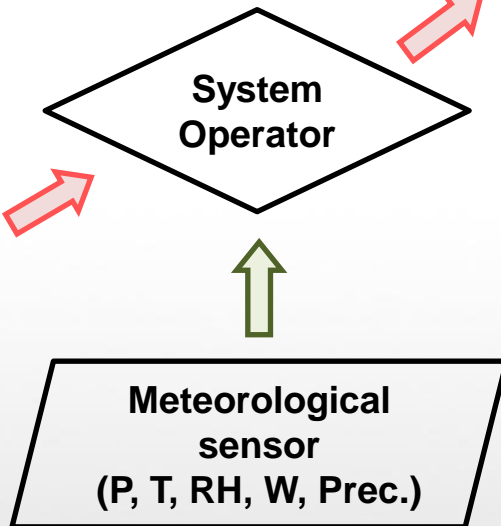
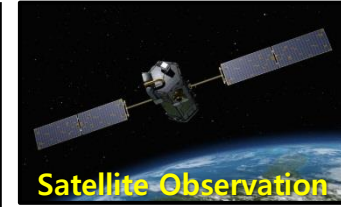
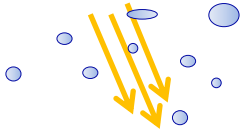
- (Cavity Ring-Down Spectroscopy)
- Manufacture: Picarro (USA)
- Period: 2012~present
- Altitude range: **~5 km**
- Measurement: **CO<sub>2</sub>, CH<sub>4</sub>, CO, H<sub>2</sub>O**
- Resolution: 0.3 sec.
- Aircraft Obs. 2010-2011
- Canister sampling(23 flights)
- CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, CO



# Flow Chart of FTS measurements



A variety of noise sources such as clouds, aerosols, bugs, birds etc.

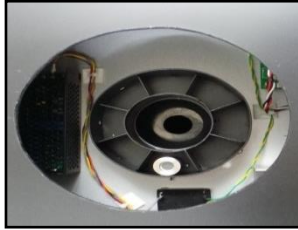


Carbon Tracker

# OASIS (Operational Automatic System on Intensity of Sunray)



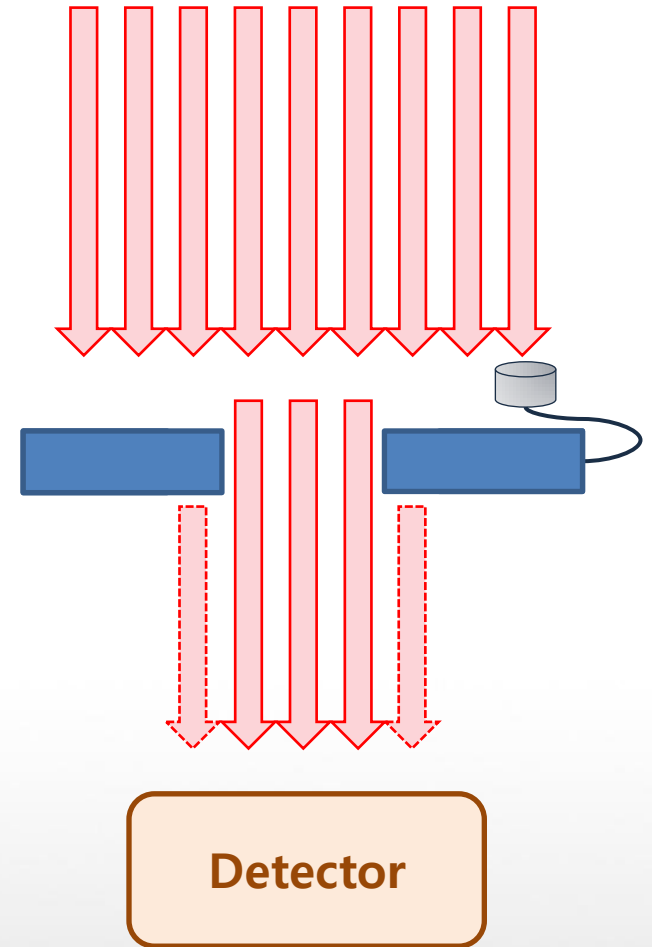
Photoelectronic Sensor



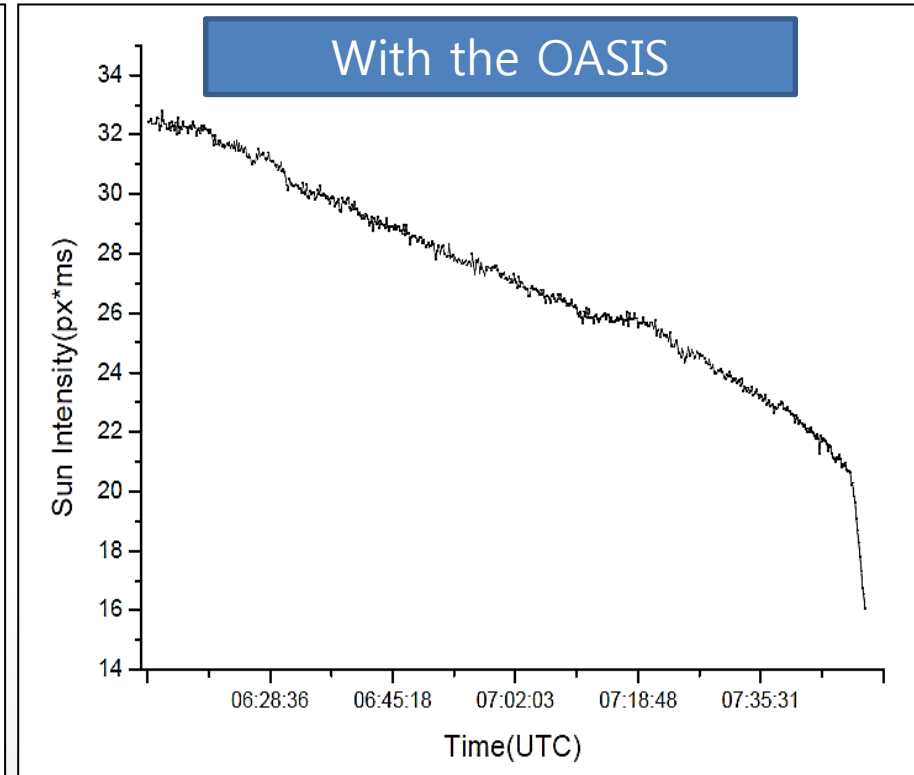
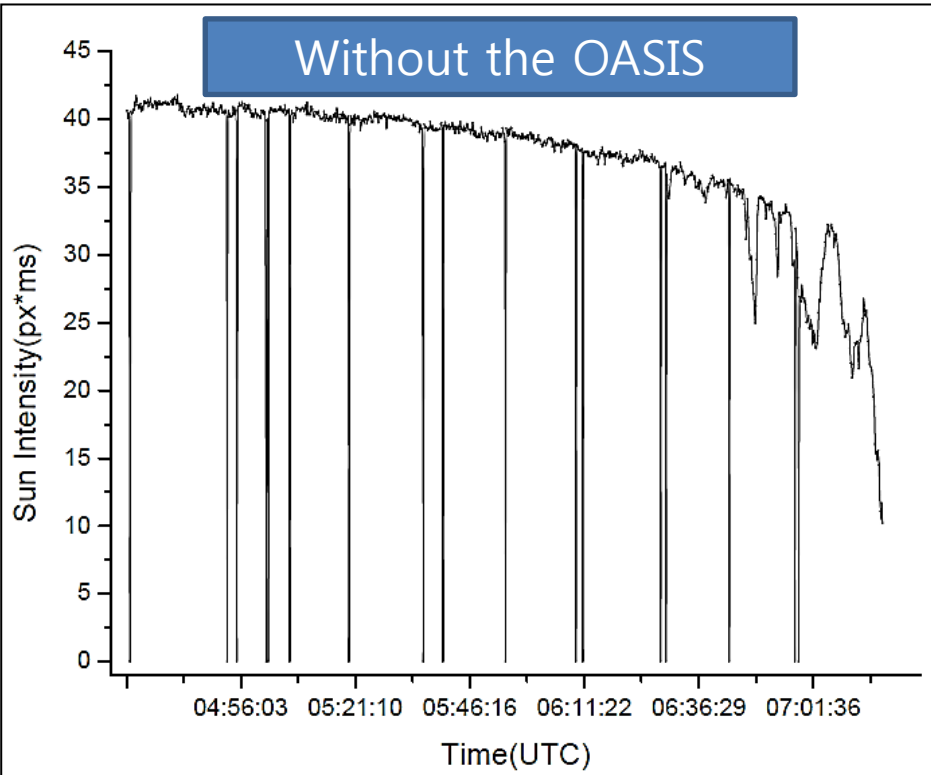
Circular Aperture



OASIS

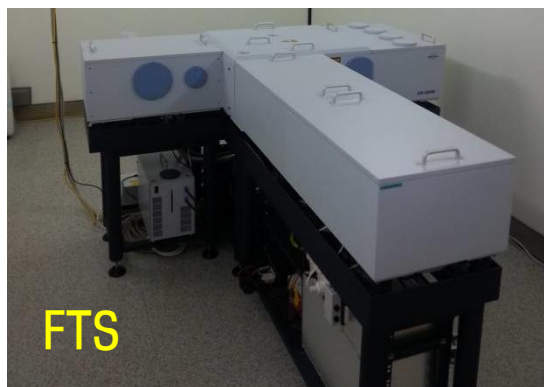


# OASIS Effect





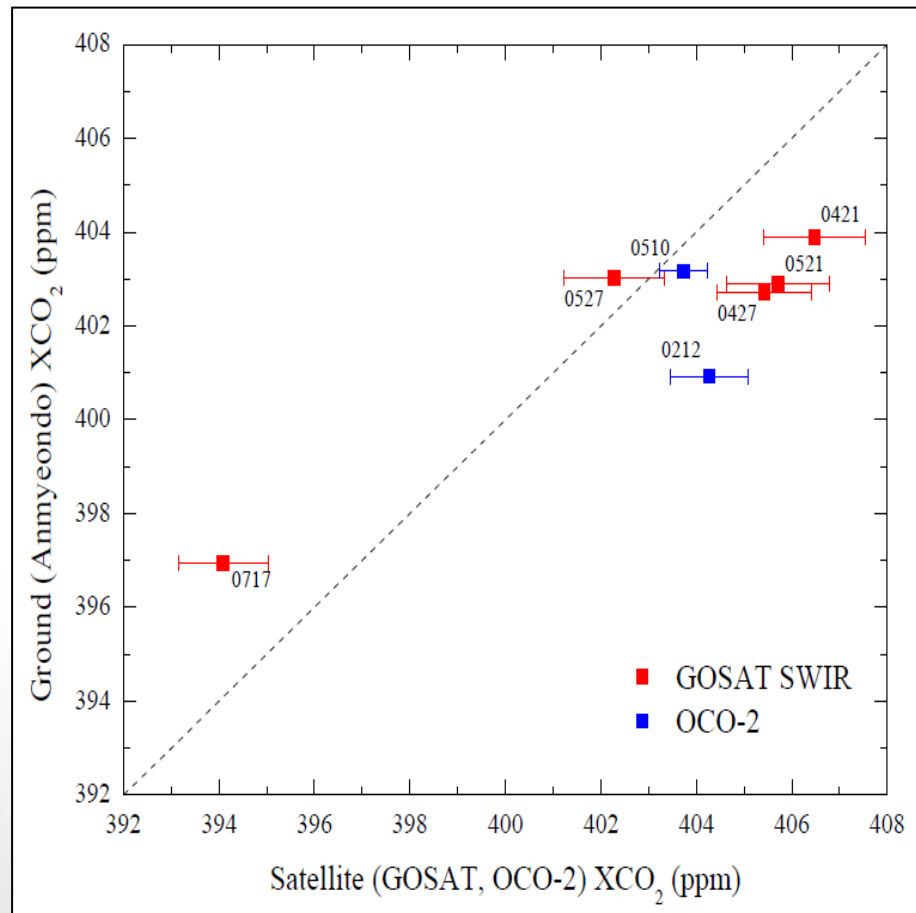
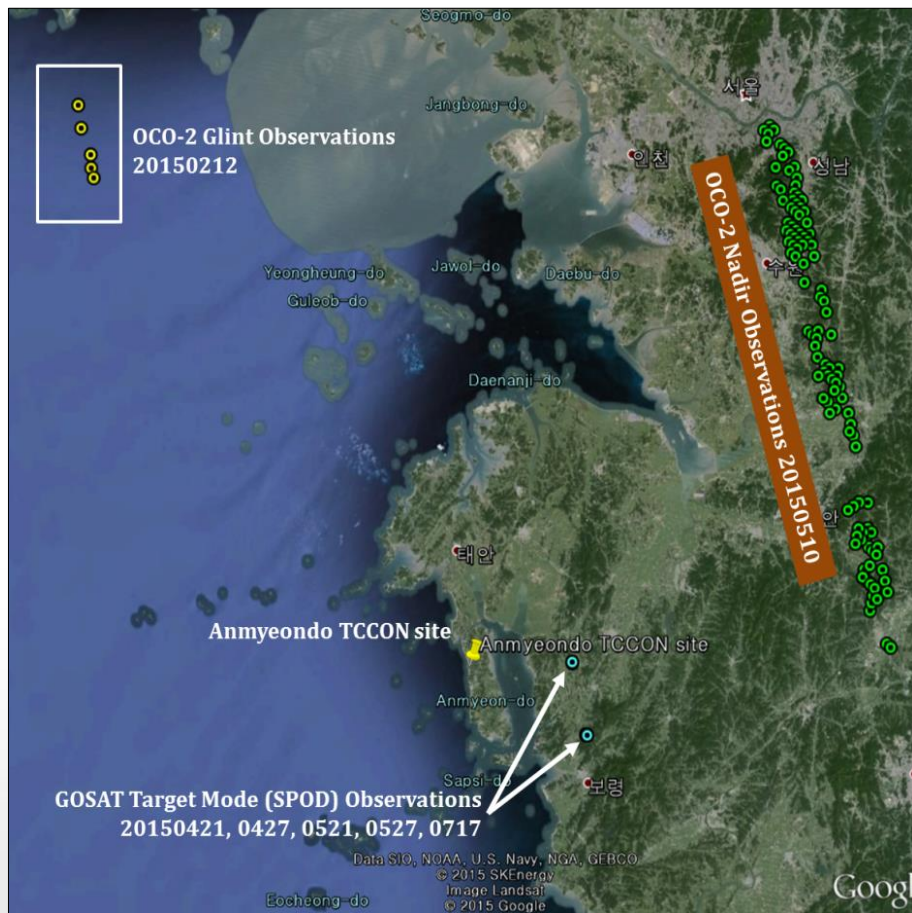
# Instrument Configurations



	FTS(IFS-125HR)	GOSAT-FTS	OCO-2 (grating)
Band	9000~16,000 $\text{cm}^{-1}$ (Si Diode Detector)	12,900~13,200 $\text{cm}^{-1}$ (Si Diode Detector)	12,953~13,210 $\text{cm}^{-1}$ (HgCdTe Detector)
	3,800~12,800 $\text{cm}^{-1}$ (InGaAs Detector)	5,800~6,400 $\text{cm}^{-1}$ (InGaAs Detector)	6,172~6,289 $\text{cm}^{-1}$ (HgCdTe Detector)
		4,800~5,200 $\text{cm}^{-1}$ (InGaAs Detector)	4,807~4,901 $\text{cm}^{-1}$ (HgCdTe Detector)
Spec. Res.	0.2 $\text{cm}^{-1}$	0.2 $\text{cm}^{-1}$	0.3 $\text{cm}^{-1}$
Time. Res.	Every 2~3 min.	Every 3 days	Every 16 days

# Validation of Satellite XCO<sub>2</sub>

- ❖ Period : Jan ~ September 2015
- ❖ Time window :  $\pm 5$  min.
- ❖ Domain window :  $\pm 1$  degree



# Summary

- In the spectrum measurement based on solar intensity, it is important to minimize spectrum noises due to aerosols, clouds and various disturbances.
- In this purpose, the OASIS has been developed.
- After operation of the OASIS, there has been remarkable improvement of accuracy and precision on FTS spectrum measurements.
- Although it is difficult to show a significant validation result on satellite XCO<sub>2</sub> against ground-based FTS XCO<sub>2</sub> because of insufficient sample size, it is found that the feature of high and low concentration in spring and summer, respectively, is well captured. It is also shown that satellite-based XCO<sub>2</sub> reasonably agreed with ground-based FTS XCO<sub>2</sub>.

## - Acknowledgements

This study was supported by “Development and Application of Methodology for Climate Change Prediction (NIMR 2012-B-2)” at National Institute of Meteorological Research.