

Recent Progress on Greenhouse Gas Measurement at Lulin Atmospheric Background Station (LABS, 2862m MSL) in Central Taiwan and Dongsha Island (Pratas Island) in South China Sea

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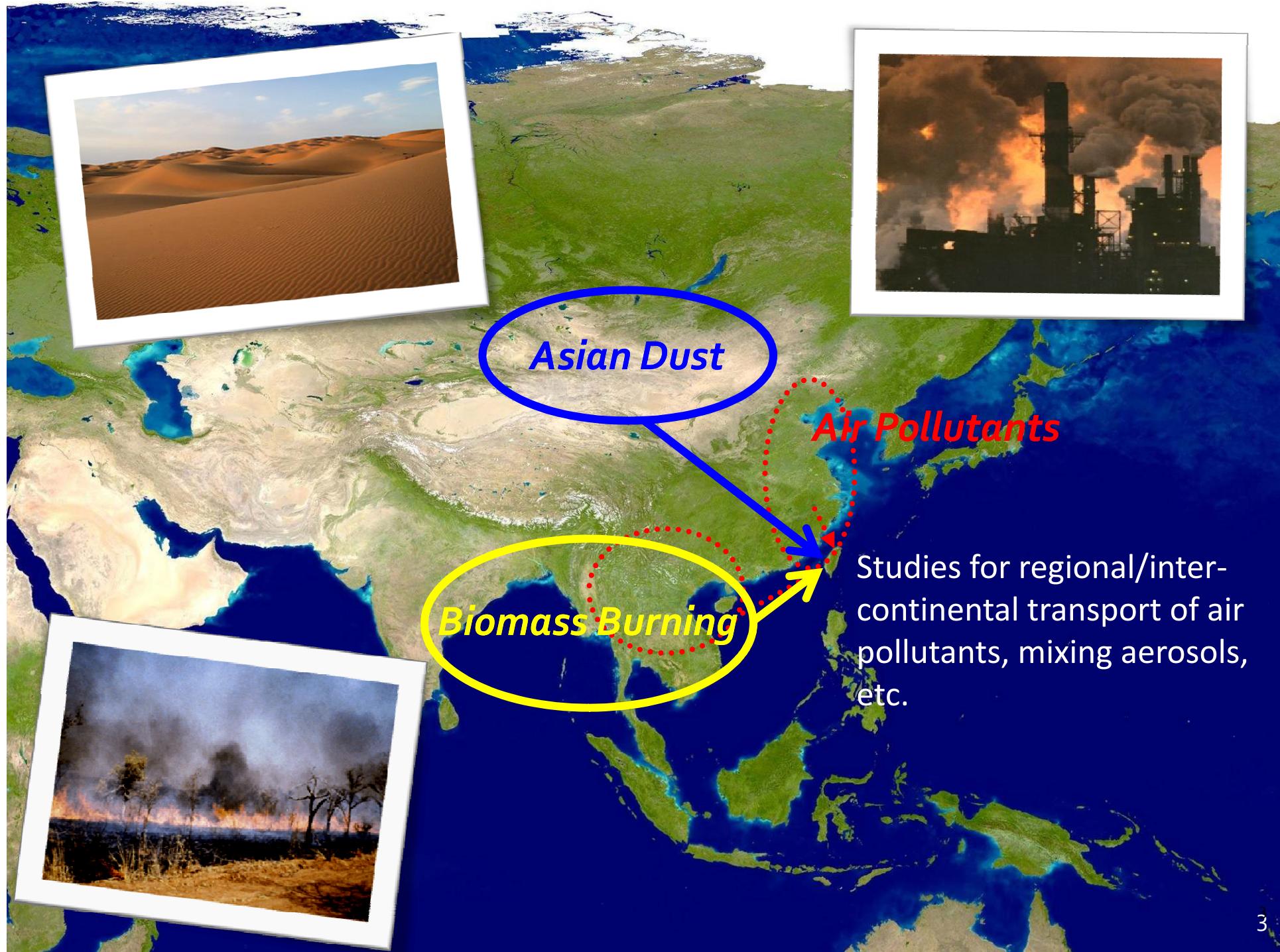
National Central University
Chungli, Taiwan



Last time I have been to Jeju Island...



EAREX 2005 Gosan Experiment

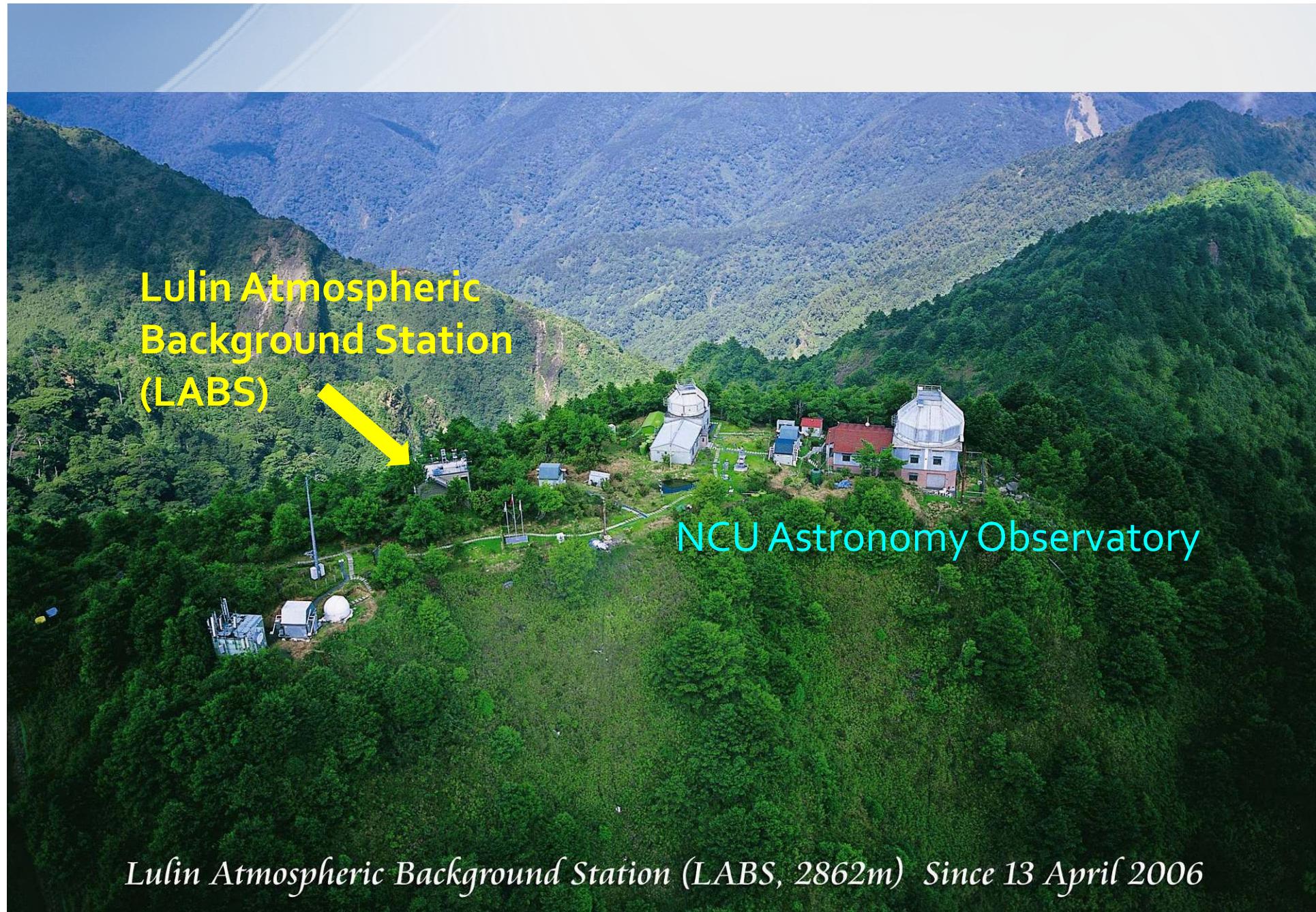


Where is Mt. Lulin?



Lulin Atmospheric Background Station
- LABS (23.47N, 120.87E, 2862m)







Grand Opening on 13 April 2006



Operating under WMO-GAW/NOAA protocols



Instrument, Manufacturer, Model	
Aerosols	Model
Particle mass concentration	TEOM Particulate mass monitor, R&P 1400 (PM ₁₀ , PM _{2.5})
aerosol chemical components	Aerosol sampling, R&P, 3500
	Aerosol sampling, R&P, 2025D
NOAA CPD aerosol system	PSAP, TSI 3010 CPC, TSI 3563 integrating nephelometer
Radiation	Model
7 spectral channels	Sunphotometer, Cimel, CE-318
6 spectral channels	Shadow band, Yankee, MFR-7
UVA	UVA, Solar Light, MODEL 501
UVB	UV-Biometer, Solar Light,
	Solar radiation sensor, MetOne, 96-1
Total flux	Kipp&Zonen CMP-21 pyranometer
	Kipp&Zonen CGR-4 pyrgeometer
Direct sun radiation	Kipp&Zonen CH-1 pyrheliometer
Gas	Model
O ₃	Ozone analyzer, Ecotech, ML9810B
CO	TraceAnalytical, TA-3000R
CO ₂ and CH ₄	Horiba, APMA-360
NOy	Picarro
NH ₃	Ecotech EC9843
CFCs	Ecotech EC9842
Air sampling	Modified GC, Agilent, HP6890N
	NOAA/ESRL/GMD CCGG PSU
Mercury	Model
Gaseous Elemental Mercury	Cold Vapor Atomic Fluorescence Spectrometry, Tekran,
Reactive Gaseous Mercury	Mercury Speciation Unit, Tekran, 1130
Particulate Mercury	Particulate Mercury Unit, Tekran, 1135
Precipitation chemistry	Model
Rainwater sample	Rain sampler
Met.	Model
Visibility	Present Weather Detector, VAISALA, PWD22
Meteorological Monitoring System	MetOne (Temp., Humidity, Press., Rain, Wind)

Participate in NOAA/CCGG sampling network at Mt. Lulin since August 2006

Lulin, Taiwan [LLN]

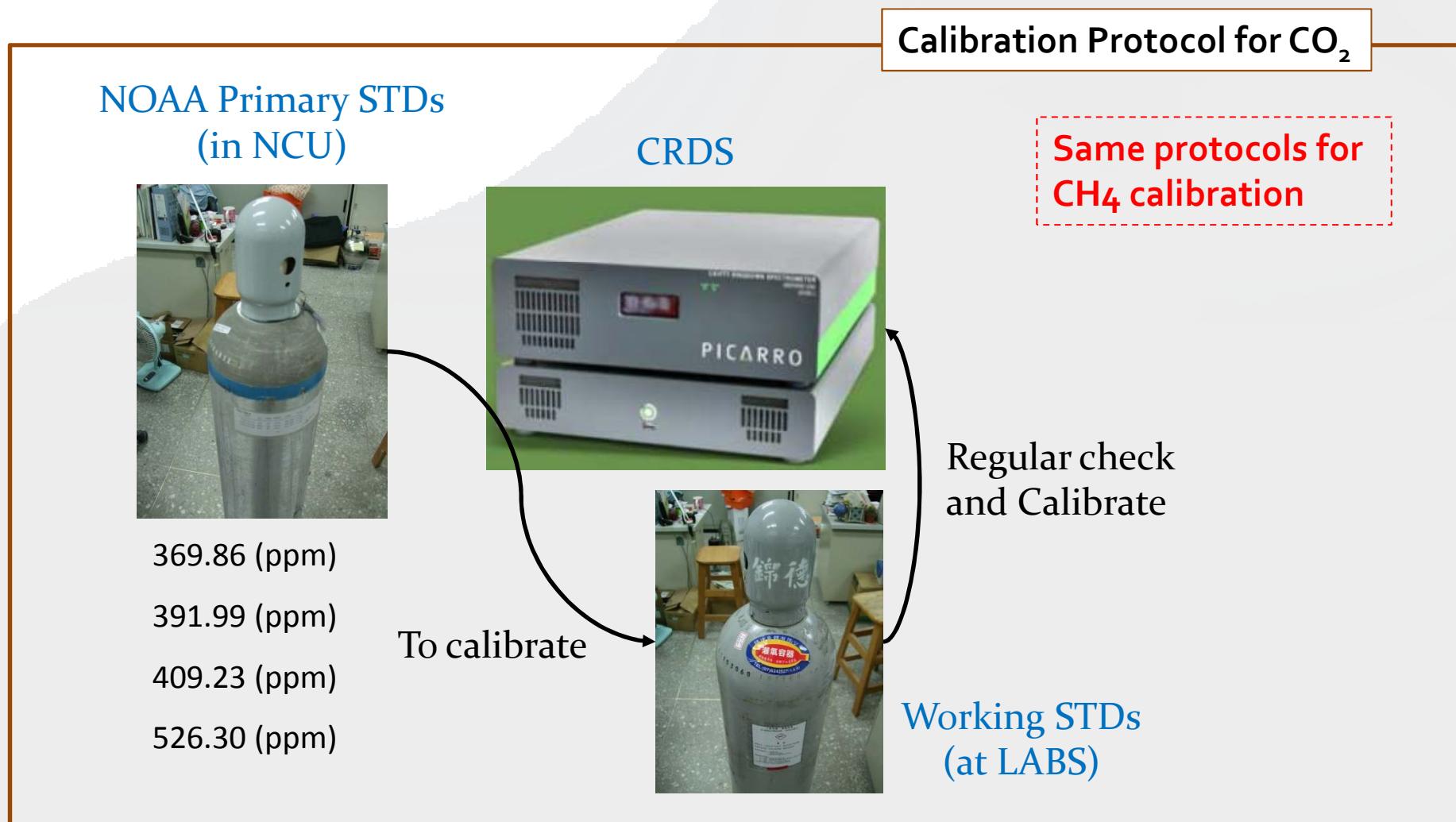


Location

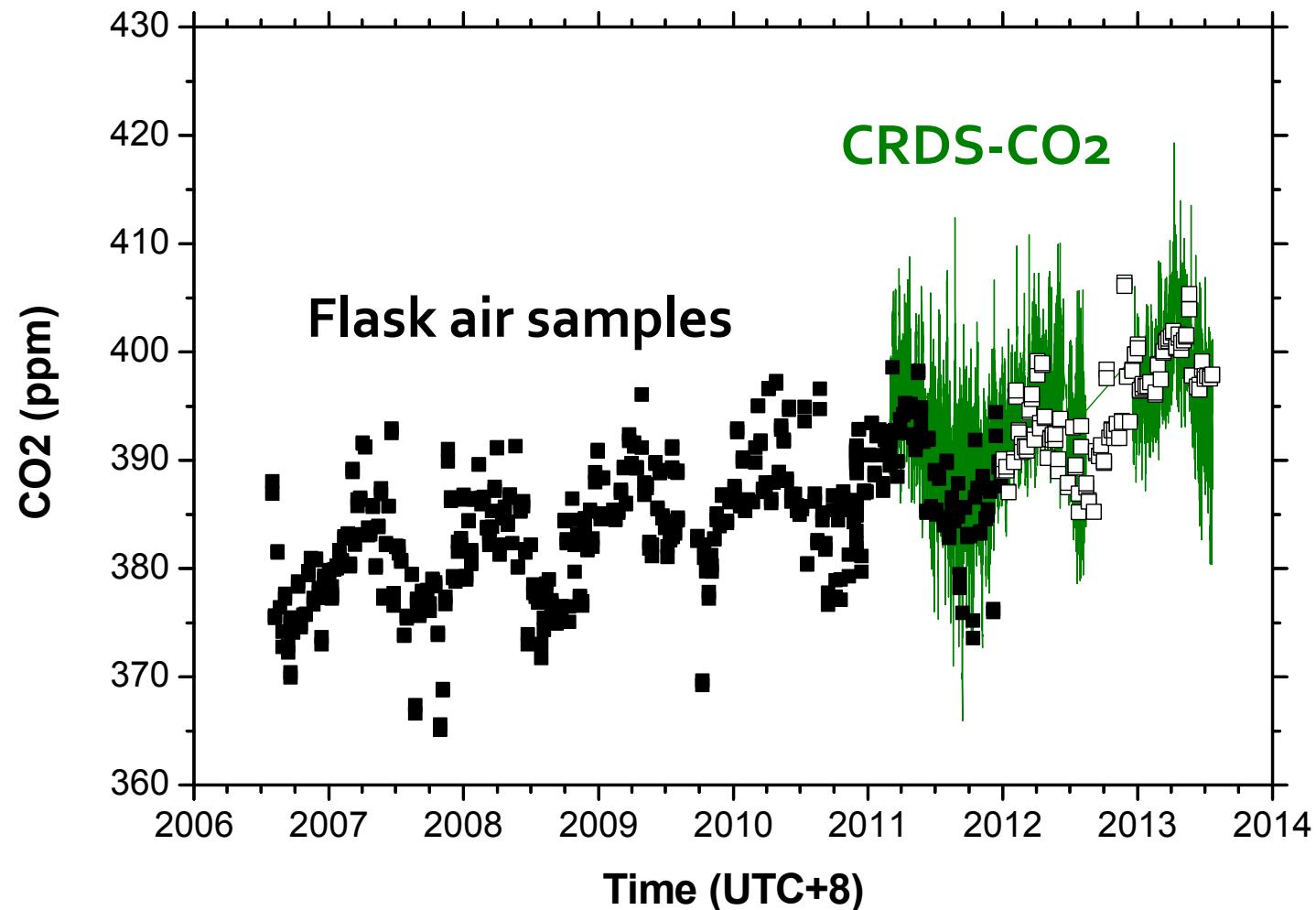
- » Country: Taiwan 
- » Latitude: 23.4700° North
- » Longitude: 120.8700° East
- » Elevation: 2862.00 masl



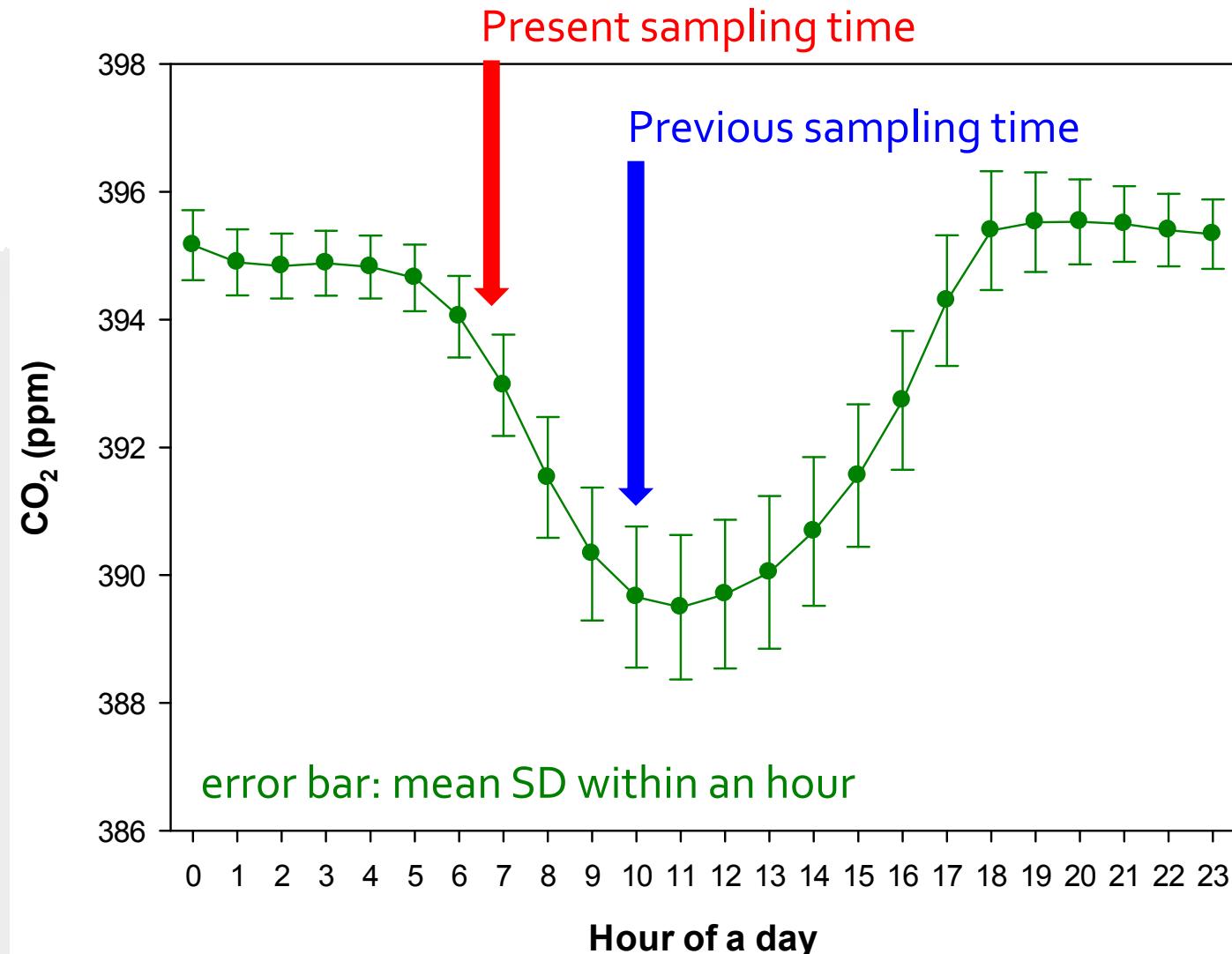
Cavity ring-down spectroscopy (CRDS) for CO₂ and CH₄ measurement at LABS



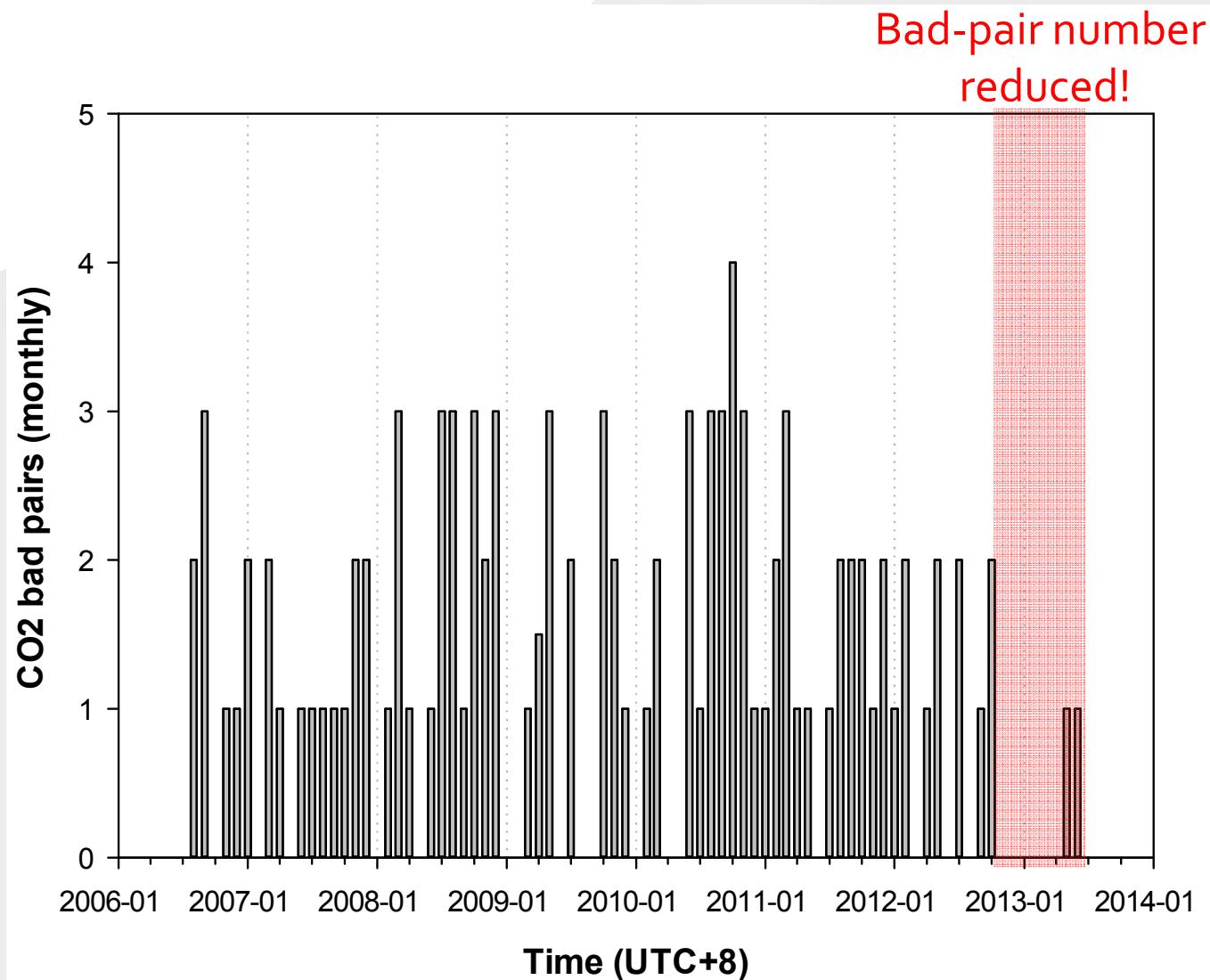
Measurement of CO₂ at Mt. Lulin



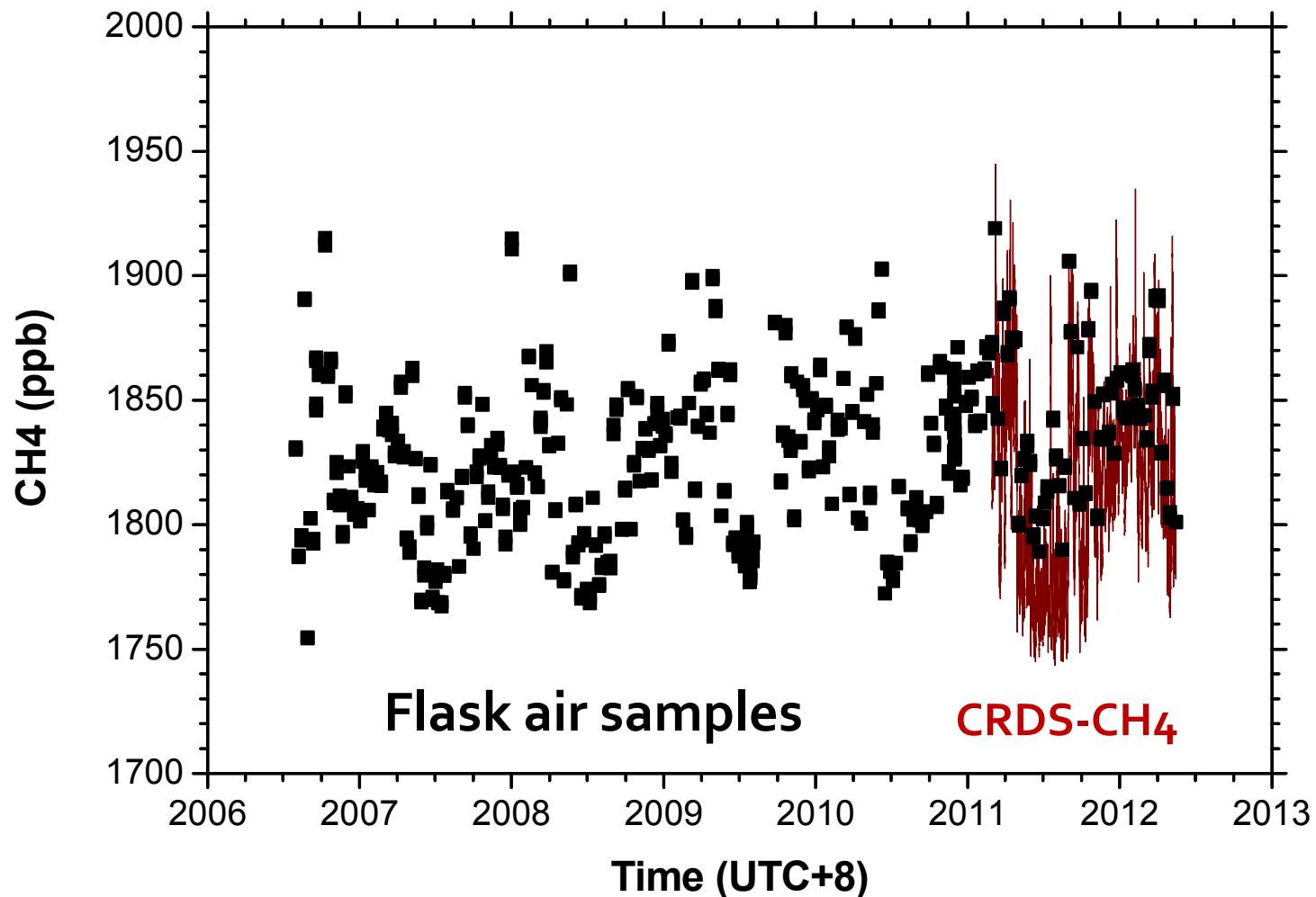
Averaged CO₂ daily cycle by CRDS



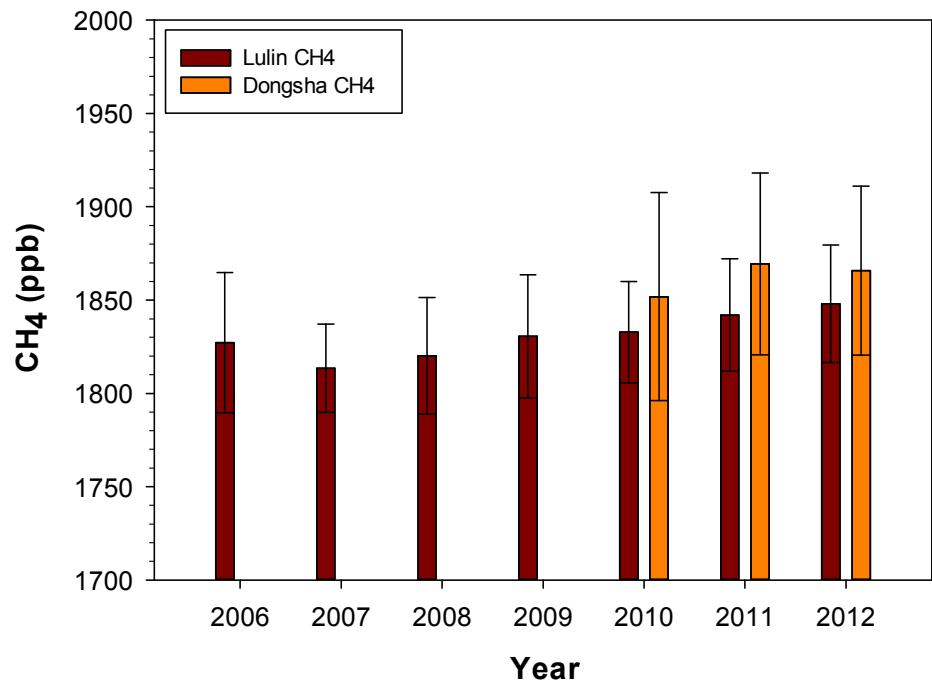
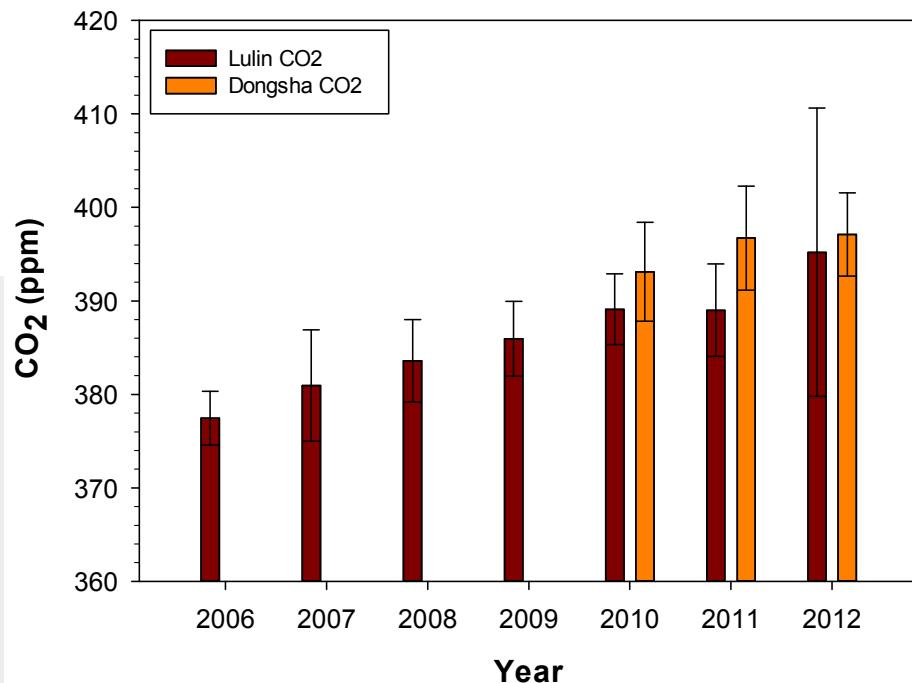
CO_2 bad pairs (difference > 0.5 ppm)



Measurement of CH₄ at Mt. Lulin



CO_2 and CH_4 flask air samples

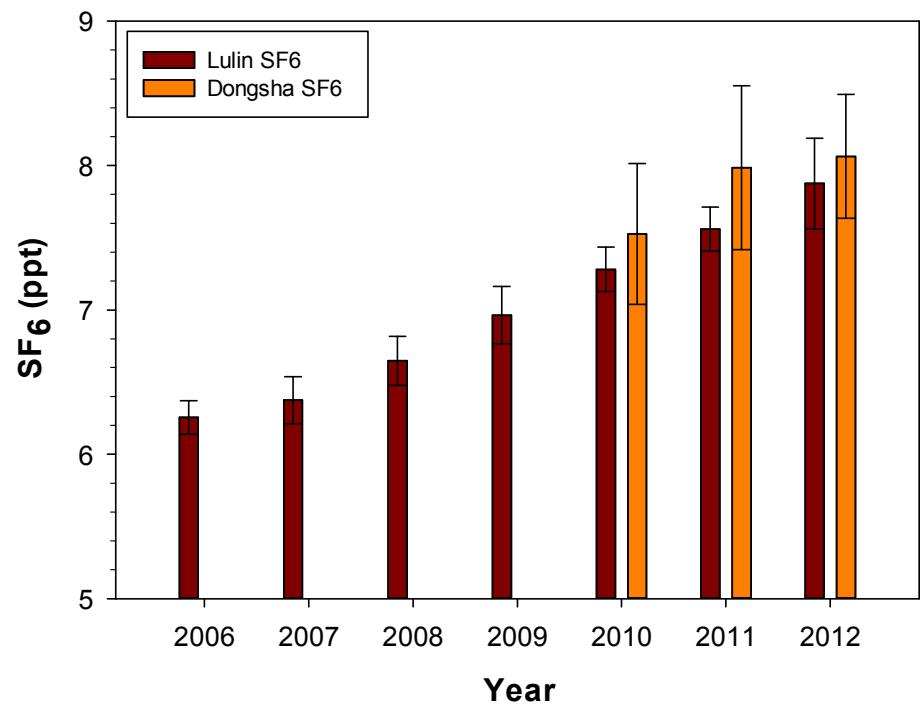
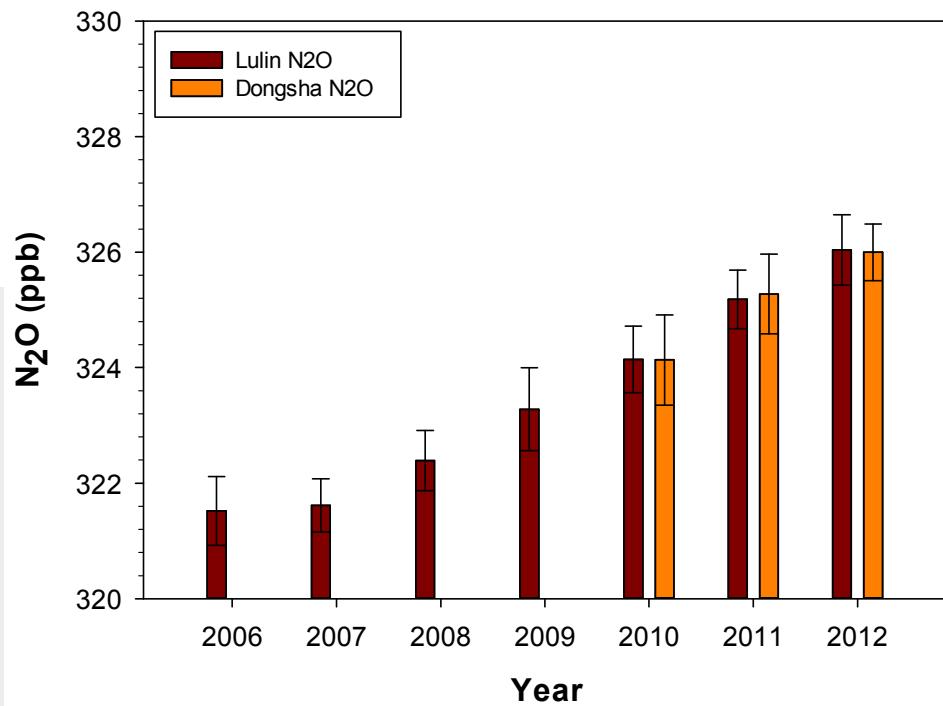


Growth rates (2006-2012) of greenhouse gases at Lulin:

CO_2 : +2.68 ppm

CH_4 : +4.7 ppb

N_2O and SF_6 flask air samples



Growth rates (2006-2012) of greenhouse gases at Lulin:

N_2O : +0.80 ppb

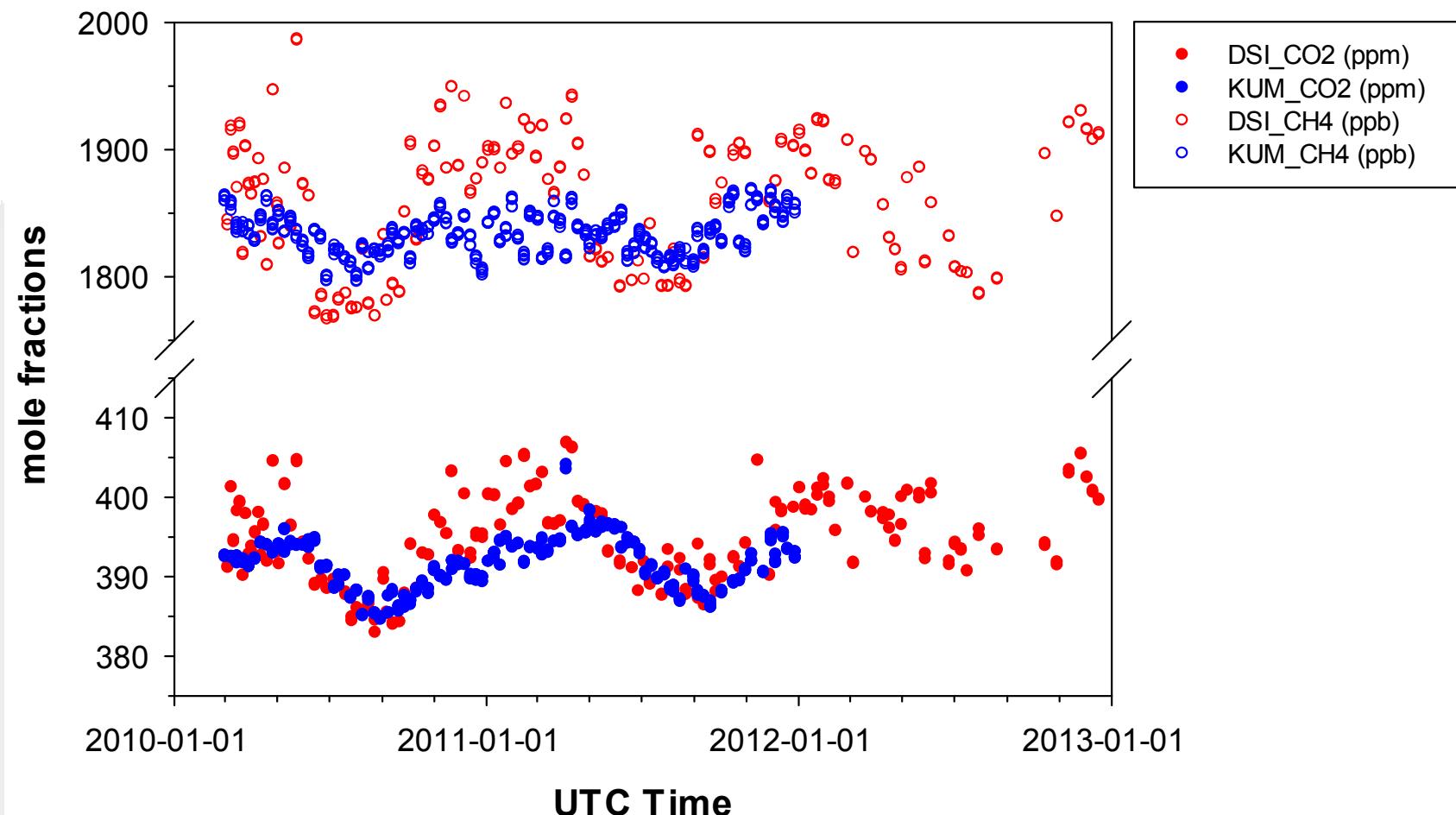
SF_6 : +0.28 ppt



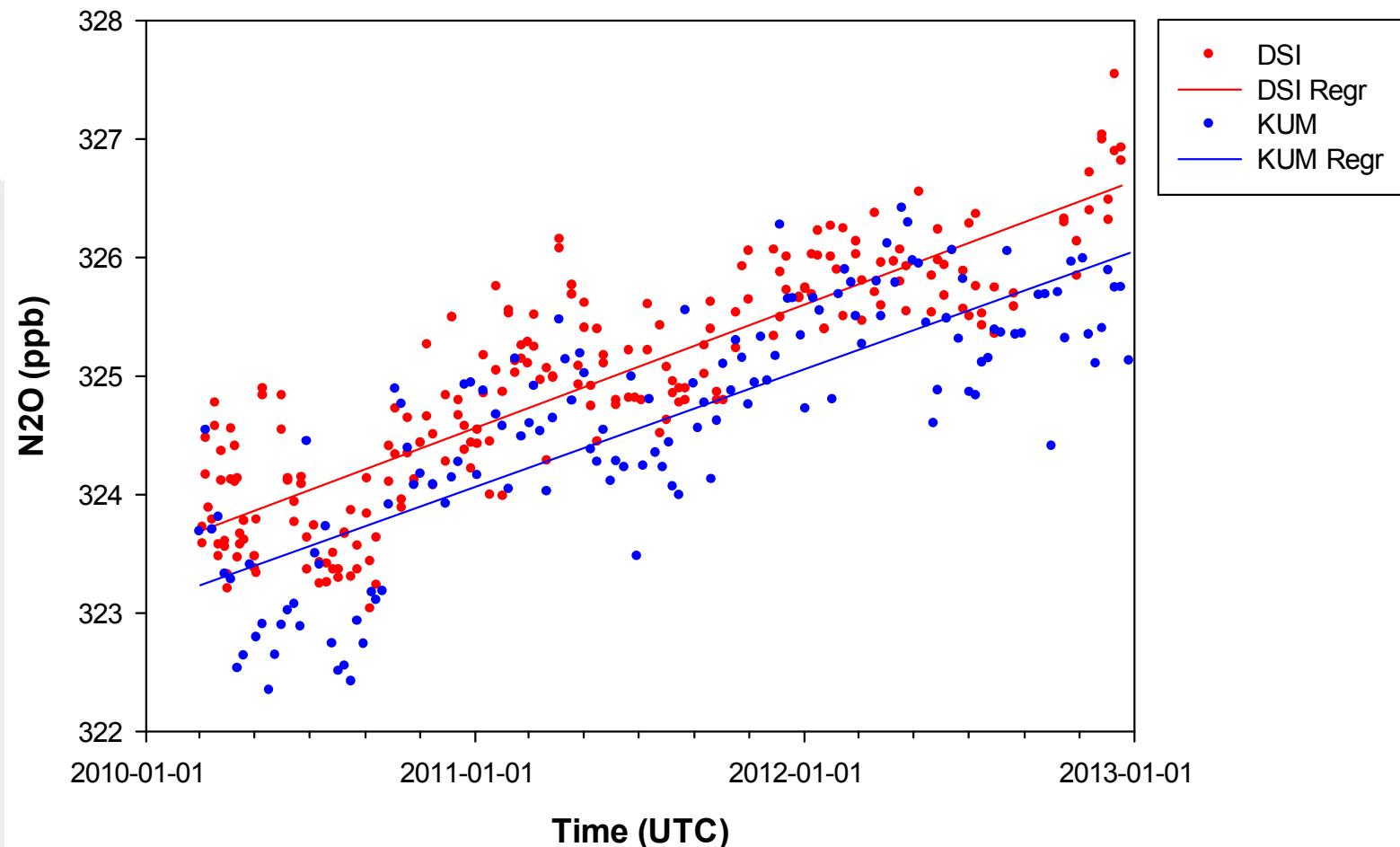
Map of western Pacific



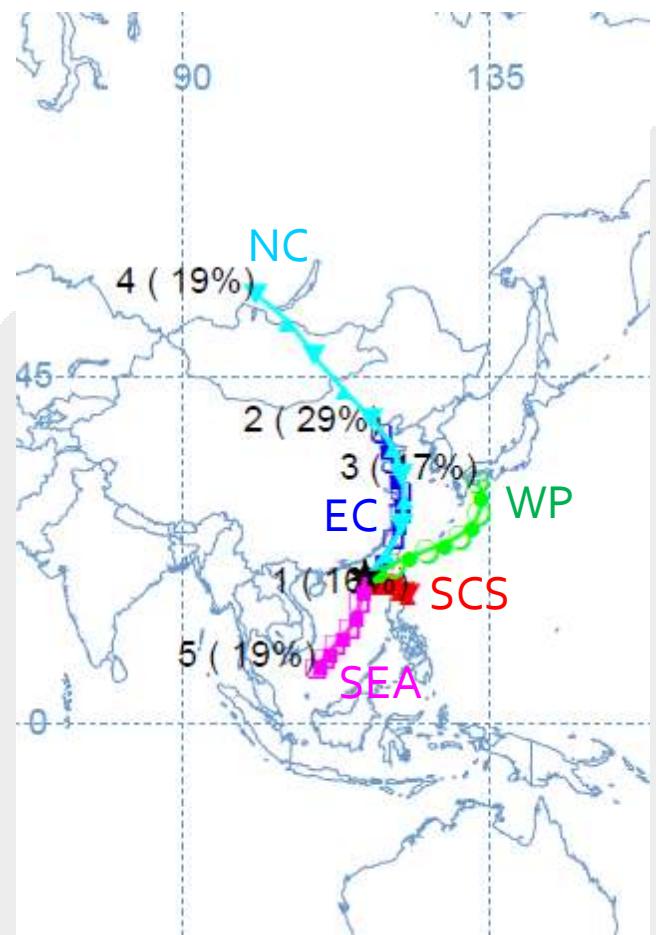
CO_2 and CH_4 at Dongsha



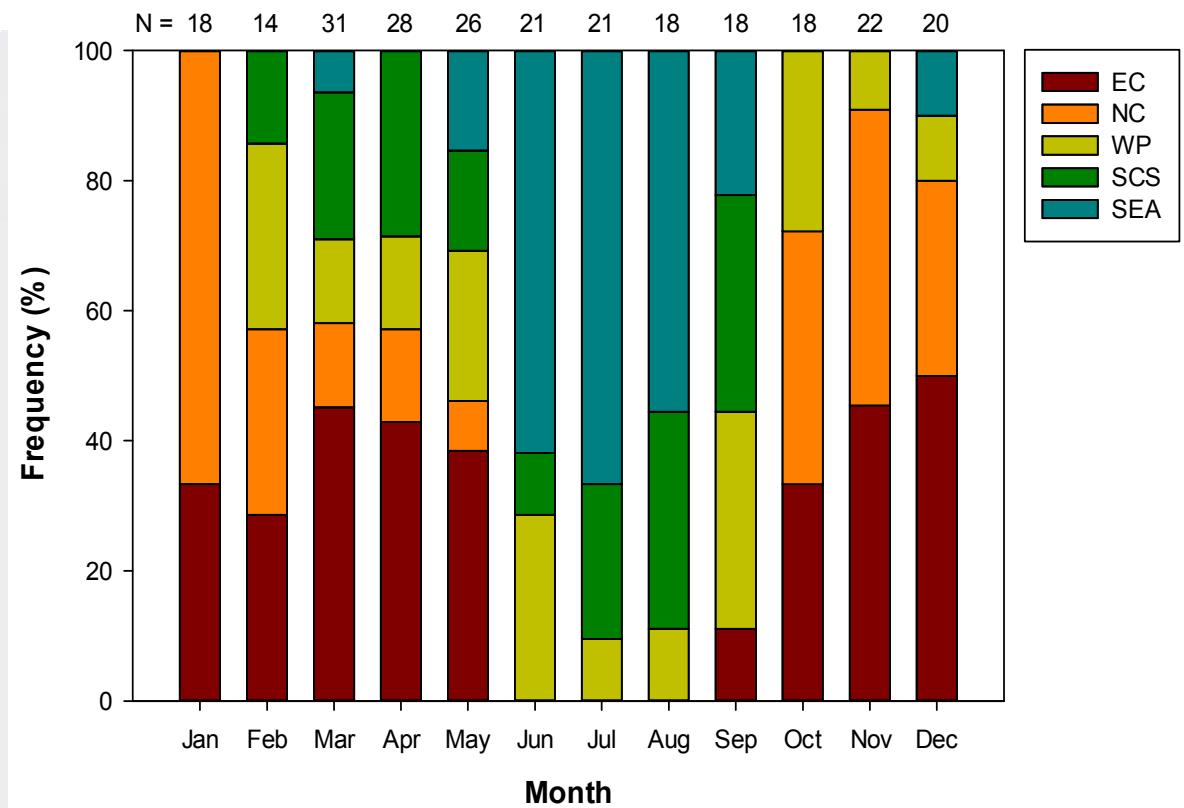
N_2O at Dongsha



Cluster analysis of 5-day backward trajectories



Monthly frequencies of respective clusters

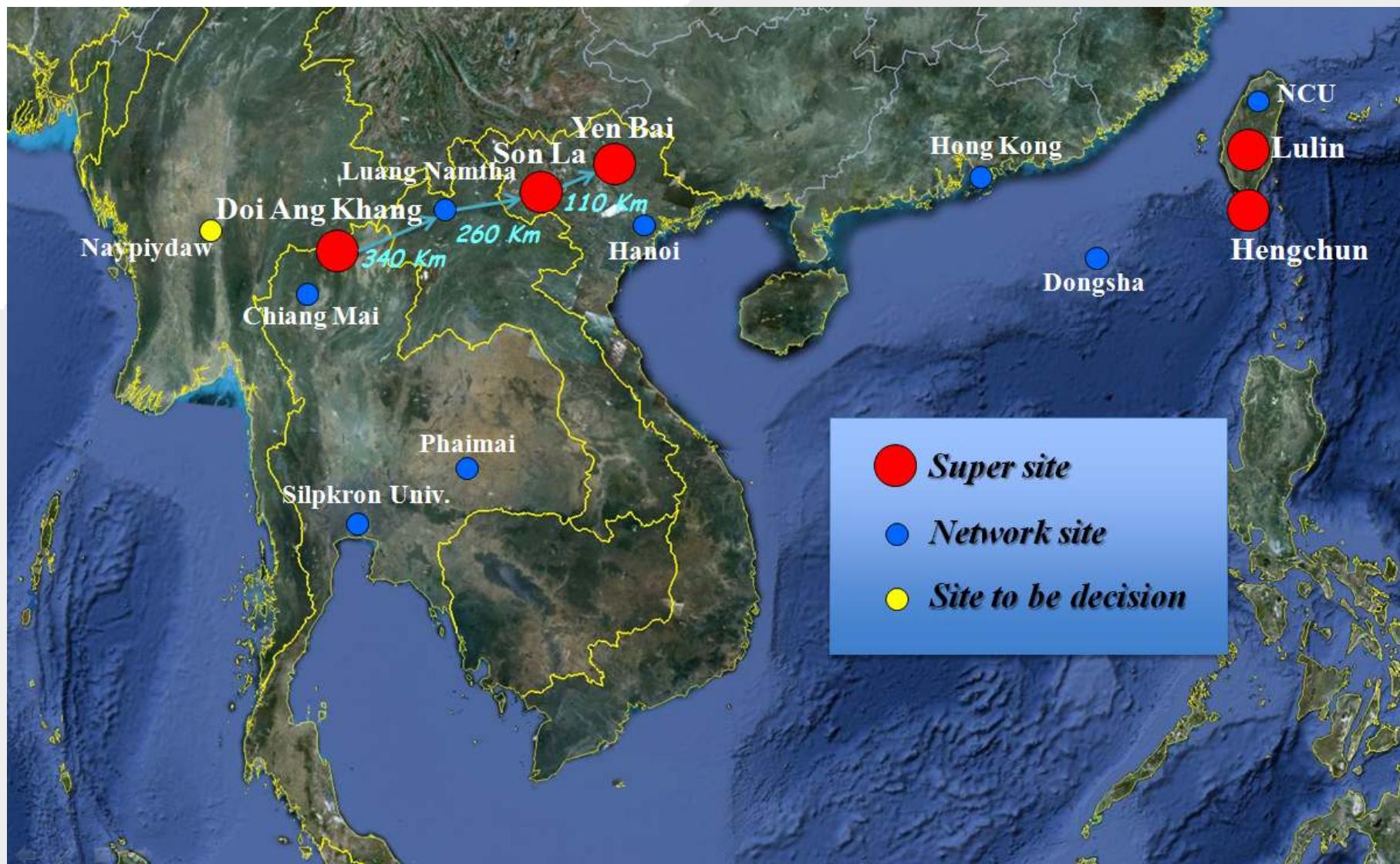


Mean concentrations of respective GHGs in each cluster

Data: March 2010 – December 2012

Cluster ^a	Number ^a	% ^a	CO (ppb) ^a	CH ₄ (ppb) ^a	CO ₂ (ppm) ^a	N ₂ O (ppb) ^a	SF ₆ (ppt) ^a
EC ^a	74 ^a	29.0 ^a	275.0±93.4 ^a	1900.4±33.0 ^a	398.5±4.0 ^a	325.1±0.8 ^a	7.87±0.39 ^a
NC ^a	49 ^a	19.2 ^a	251.7±70.9 ^a	1899.9±20.1 ^a	398.5±4.4 ^a	325.2±1.0 ^a	7.97±0.40 ^a
WP ^a	43 ^a	16.9 ^a	166.0±58.4 ^a	1848.7±28.4 ^a	393.0±4.4 ^a	324.8±1.0 ^a	7.65±0.30 ^a
SCS ^a	40 ^a	15.7 ^a	137.8±53.2 ^a	1822.0±33.8 ^a	392.8±4.0 ^a	325.0±0.8 ^a	7.55±0.27 ^a
SEA ^a	49 ^a	19.2 ^a	110.0±57.5 ^a	1805.0±37.5 ^a	390.0±4.6 ^a	324.4±1.1 ^a	7.29±0.49 ^a
Total / Average ^a	255 ^a	100 ^a	199.5±97.7 ^a	1860.5±50.7 ^a	395.0±5.5 ^a	324.9±1.0 ^a	7.67±0.45 ^a

Recent Activities: 7-SEAS Project



International Collaborations

- NOAA CCGG and Aerosol
- NASA AERONet and MPLNet
- US NADP Hg Network
- EU Hg Network
- Mt. Fuji in Japan
- Univ. of Tokyo
- Univ. of Munster



Welcome to visit the LABS! Just bring your instruments here!



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Thank You!