# *Comparison of GOSAT $CH_4$ measurements with in-situ measurements and model simulations —Application of GOSAT $CH_4$ data to Agricultural $CH_4$ emission in Asia—*

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**Contributors: AMASA* project team**

*Atmospheric Methane and Agriculture in South Asia

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*H. Araki and M. Nakazawa for their help of data analysis.*

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# Introduction

- Despite the importance of atmospheric $CH_4$ in global warming, the significance of individual sources of $CH_4$ remains highly uncertain.
- Asia is one of the most significant areas of $CH_4$ emissions.

Question

Where is the source of $CH_4$ in Asia, and how much?

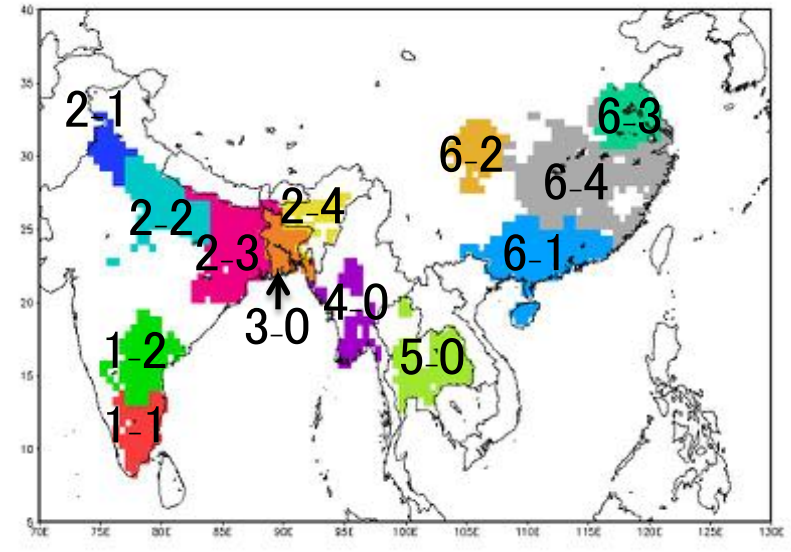
What are the effects that control methane emission?

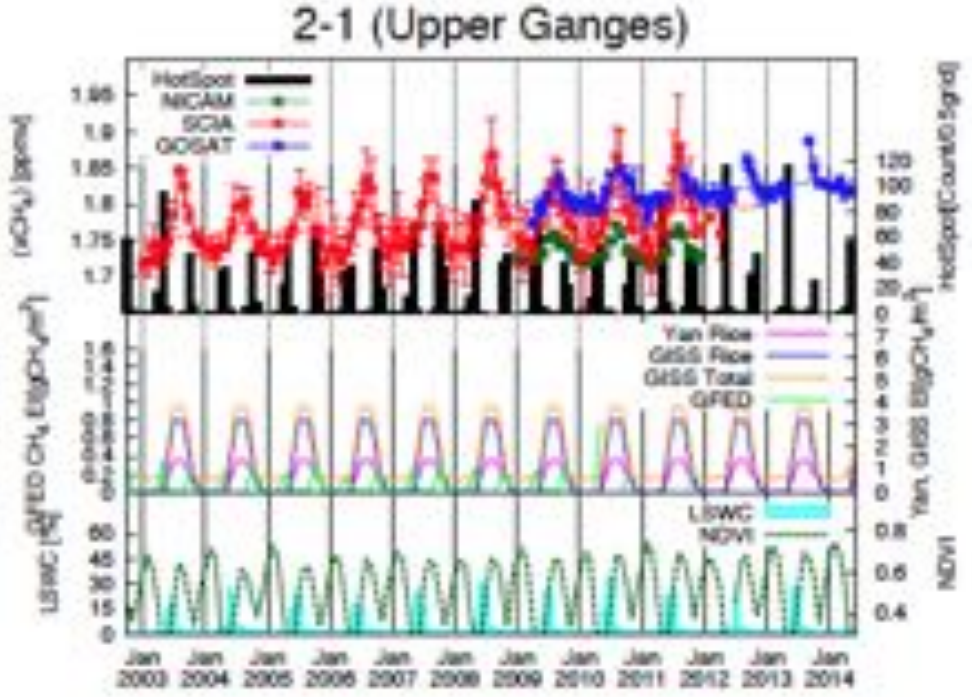
# Seasonal variation of $CH_4$ over rice paddies

updated from Hayashida et al., RSE, 2013

| Region name | Area code | Sub areas |
|---|---|---|
| India (south) | Area 1 | 1-1, 1-2 |
| India (north) | Area 2 | 2-1, 2-2, 2-3, 2-4 |
| Bangladesh | Area 3 | 3 |
| Myanmar | Area 4 | 4 |
| Thailand | Area 5 | 5 |
| China | Area 6 | 6-1, 6-2, 6-3, 6-4 |

- ✓ Regular seasonal variation of $XCH_4$ over rice paddy regions has been continuing.
- ✓ The long-term increasing trend is observed clearly.

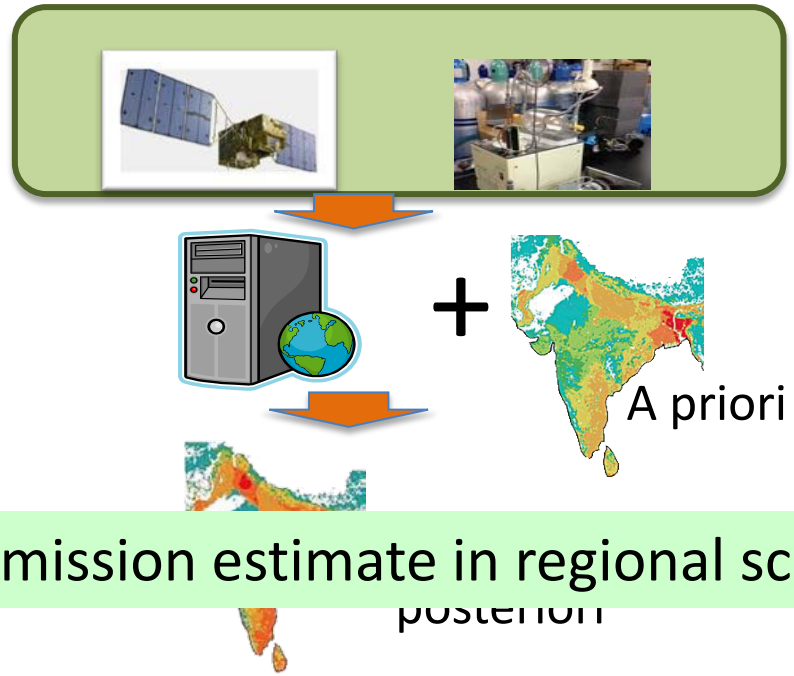


# Application of GOSAT $CH_4$ measurements to Agriculture

**AMASA**（Atmospheric methane from agriculture in South Asia）
a project sponsored by the Environment Research and Technology Development Fund (ERTDF a-1502) :
April 2015-March 2018 Leader: Sachiko Hayashida

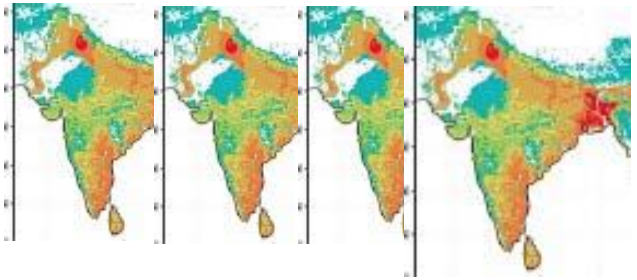
**Goal 1**: Improvement of Methane Emission Estimate from South Asia using GOSAT




Emission estimate in regional scale

**Goal 2**: Development of an Emission Mitigation Proposal

Mitigation scenarios from rice fields



by proper water management and/or fertilizer management

Evaluation:
realizable? detectable?

# Monitoring System toward Improvement of Emission Estimate


NIES

Flask air sampling

Nagoya Univ. (Y. Matsumi) &
Tokyo Univ. (R. Imasu)
Tokyo Gakugei Univ.

at Tamil Nadu

Continuous Measurements

Global scale

Regional scale

Data Input

Flux estimate in Regional Scale

**ACTM**
**Inverse analysis**
**(JAMSTEC)**

Simulation of CH4 distribution

**Goal 2**

Mitigation Potential Map

NIAES, Chiba Univ.

Mitigation Scenarios

# Collaboration in India and Bangladesh

Sonepat

Flux measurements at Mymensingh

Mymensingh

Comilla

R.Imasu

Flask sampling and Laser measurements at Sonepat

TRRI

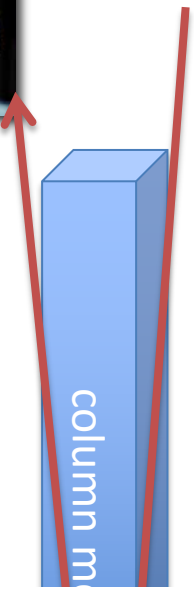
Hi !

Prabir Patra

Mitigation experiment at Tamil Nadu Rice Research Institute (TRRI)

# GOSAT/SWIR + GOSAT/TIR + in-situ measurement vs. ACTM over Indo-Gangetic plain

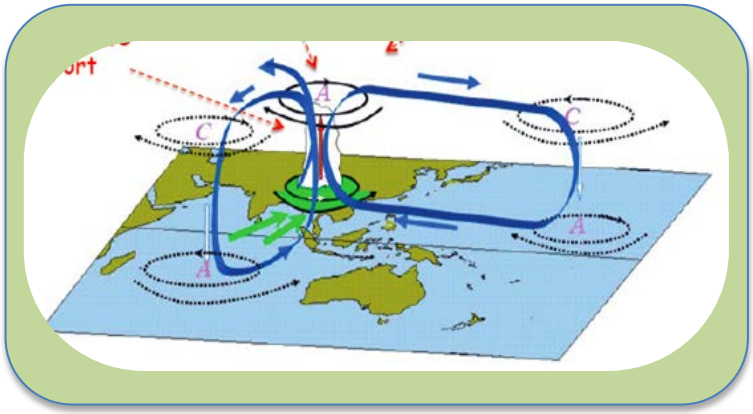
SWIR




SWIR measurements Involve information in the lower atmosphere

TIR (GOSAT)

under study



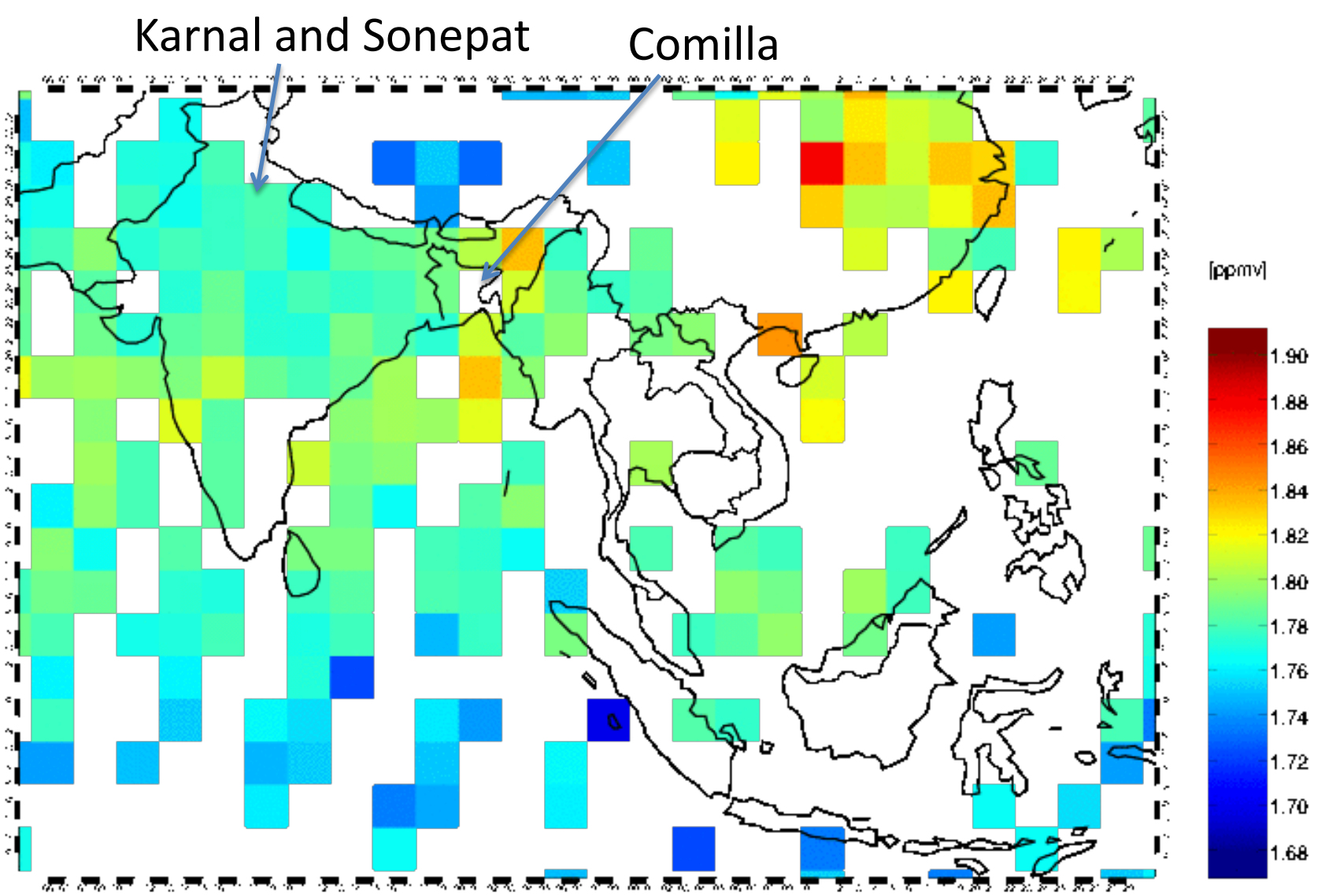
ACTM
JAMSTEC

Get information of $CH_4$ in the lower atmosphere

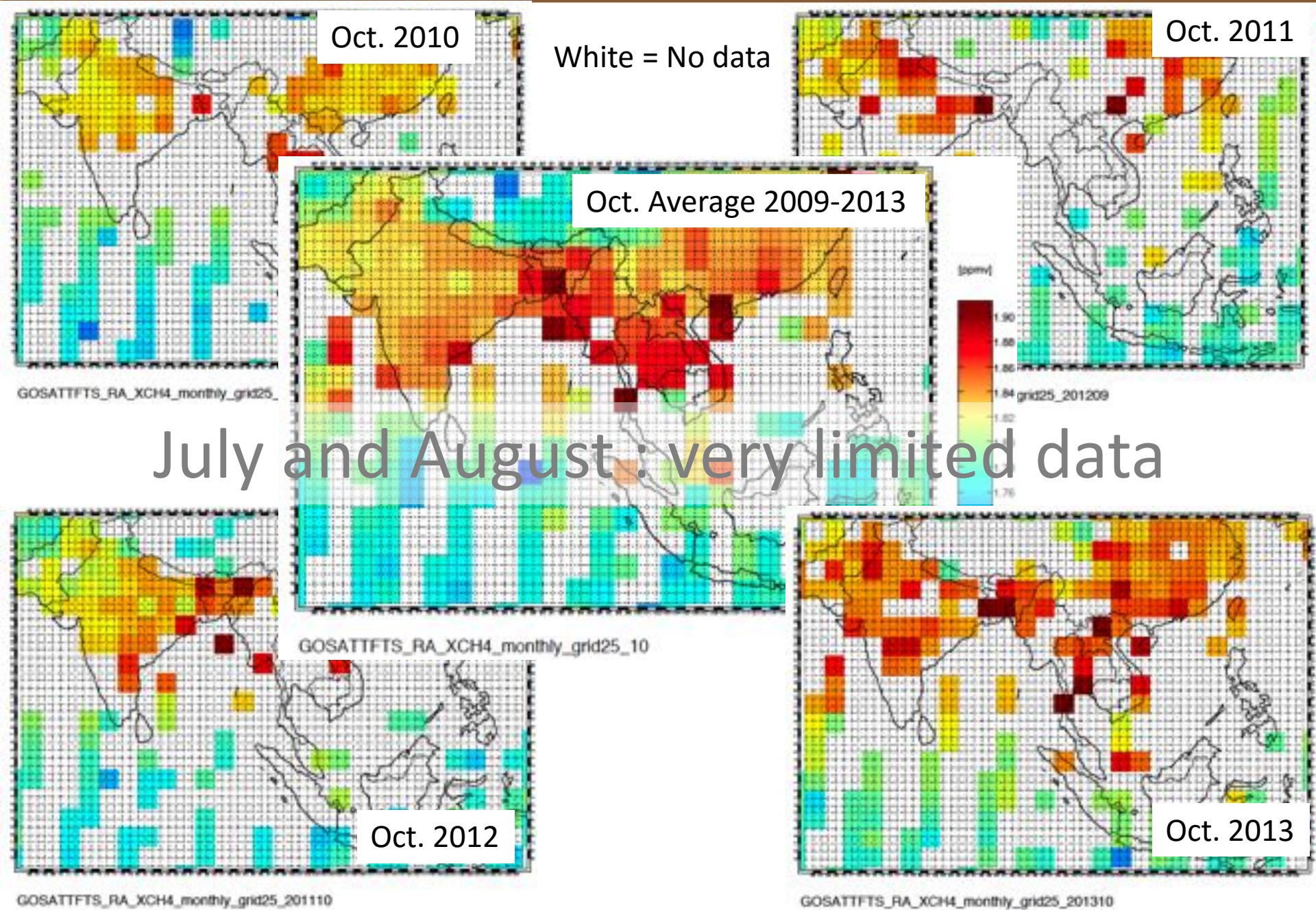
under study

In situ measurement
(Flask sampling)

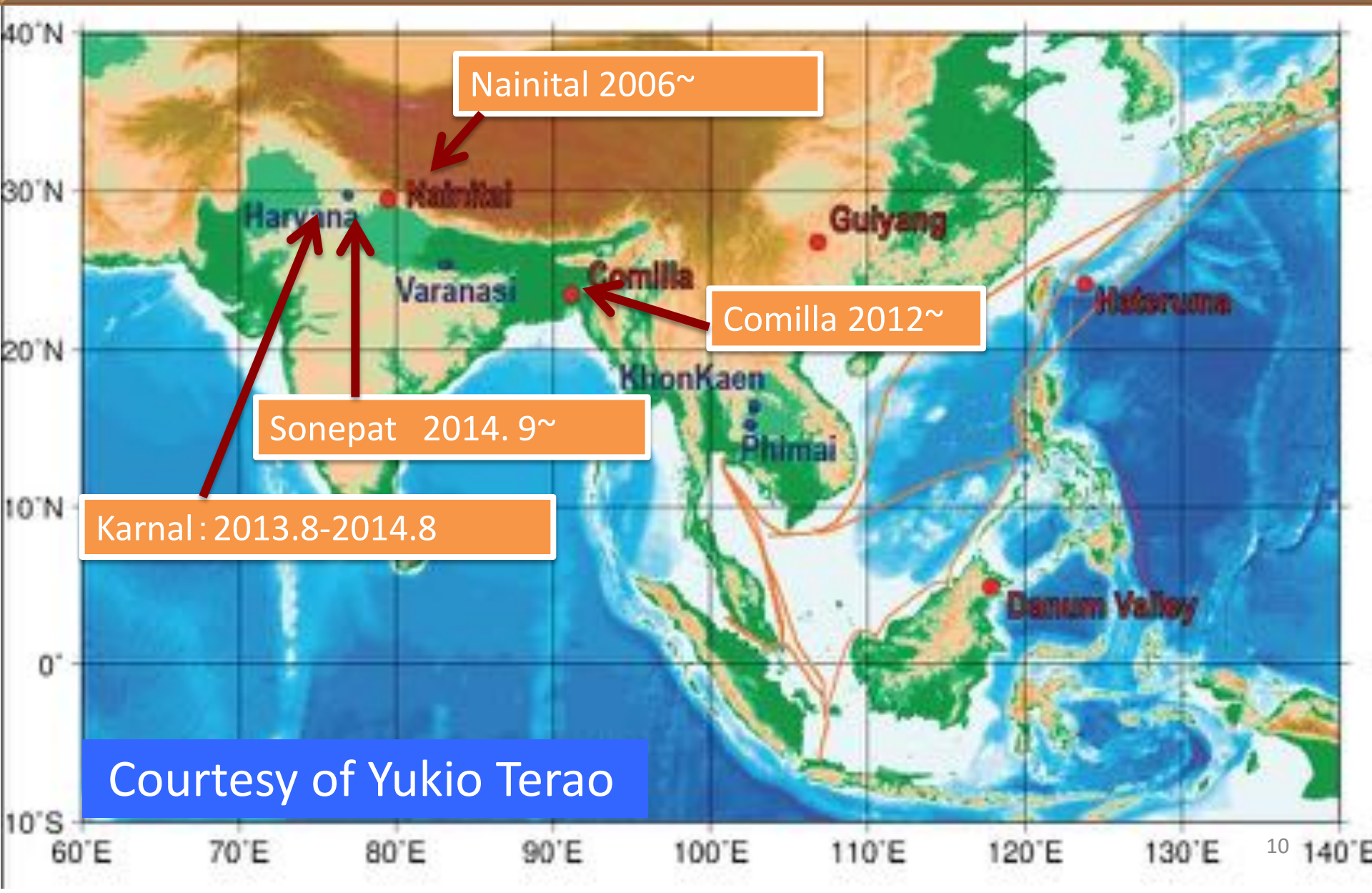
# GOSAT $XCH_4$ NIES V.2.x: Monthly average



# GOSAT $XCH_4$ NIES V.2.x: Monthly average

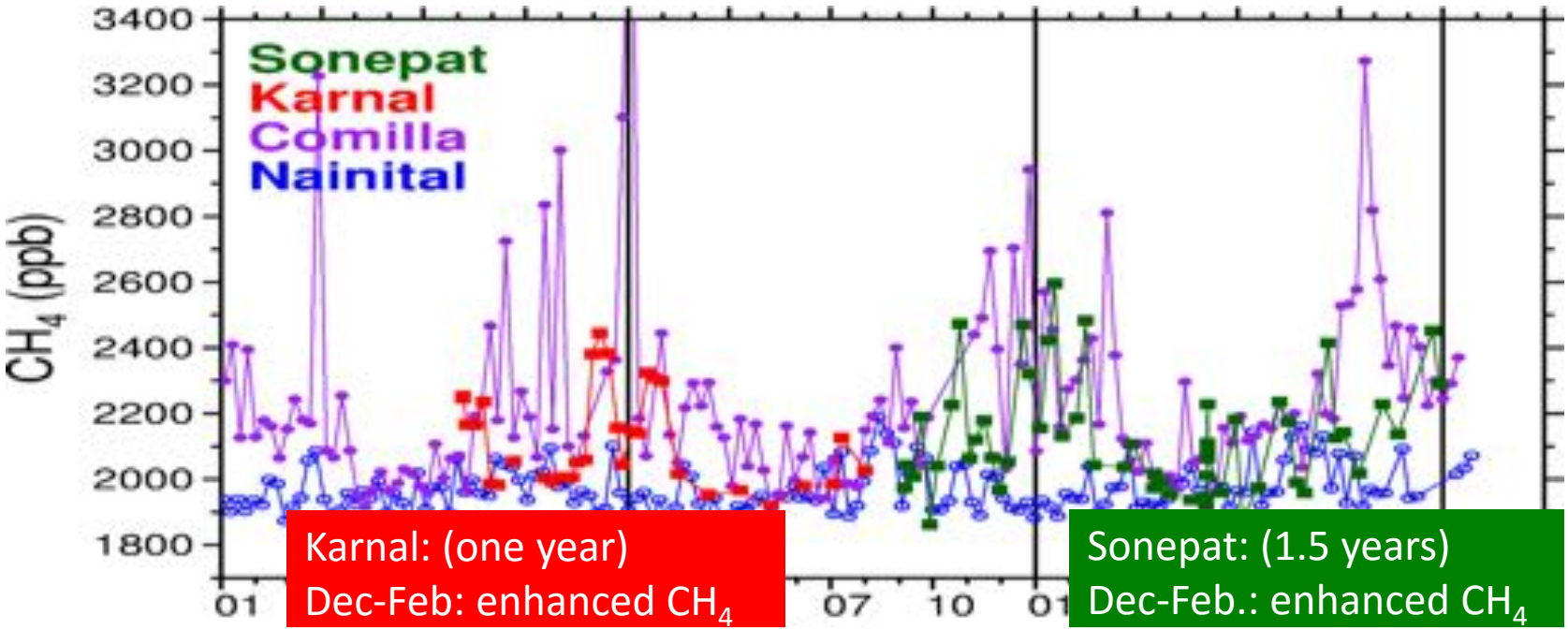


# Flask sampling network of NIES



# Air sampling vs. ACTM(P. Patra/JAMSTEC)

$CH_4$ in the sampled air

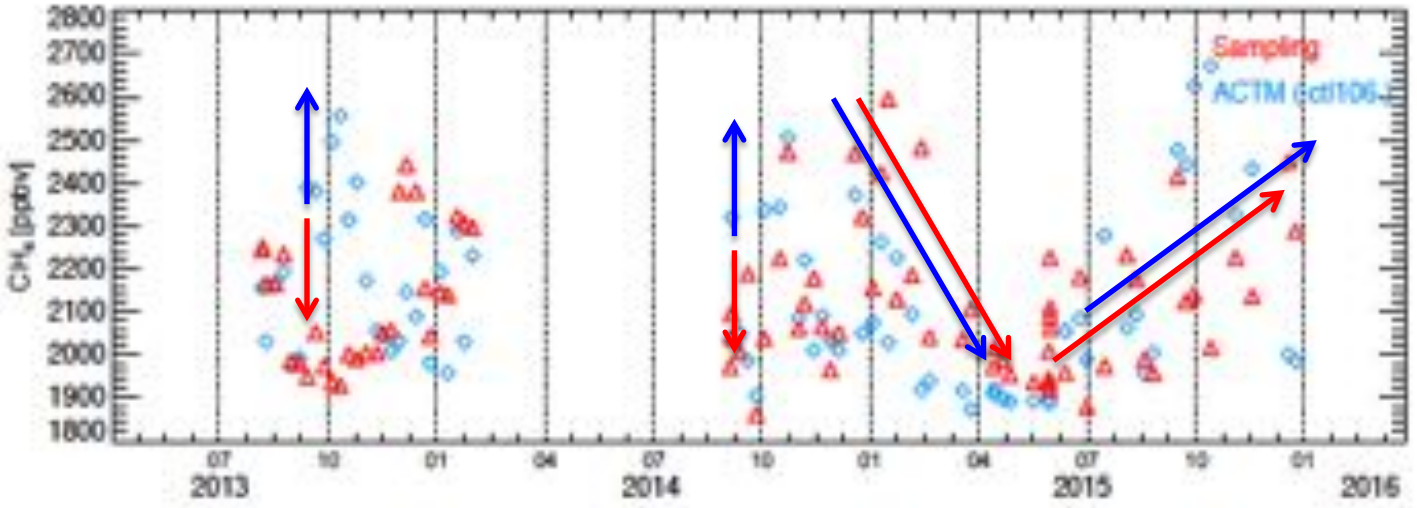



Karnal: (one year)
Dec-Feb: enhanced $CH_4$

Sonepat: (1.5 years)
Dec-Feb.: enhanced $CH_4$

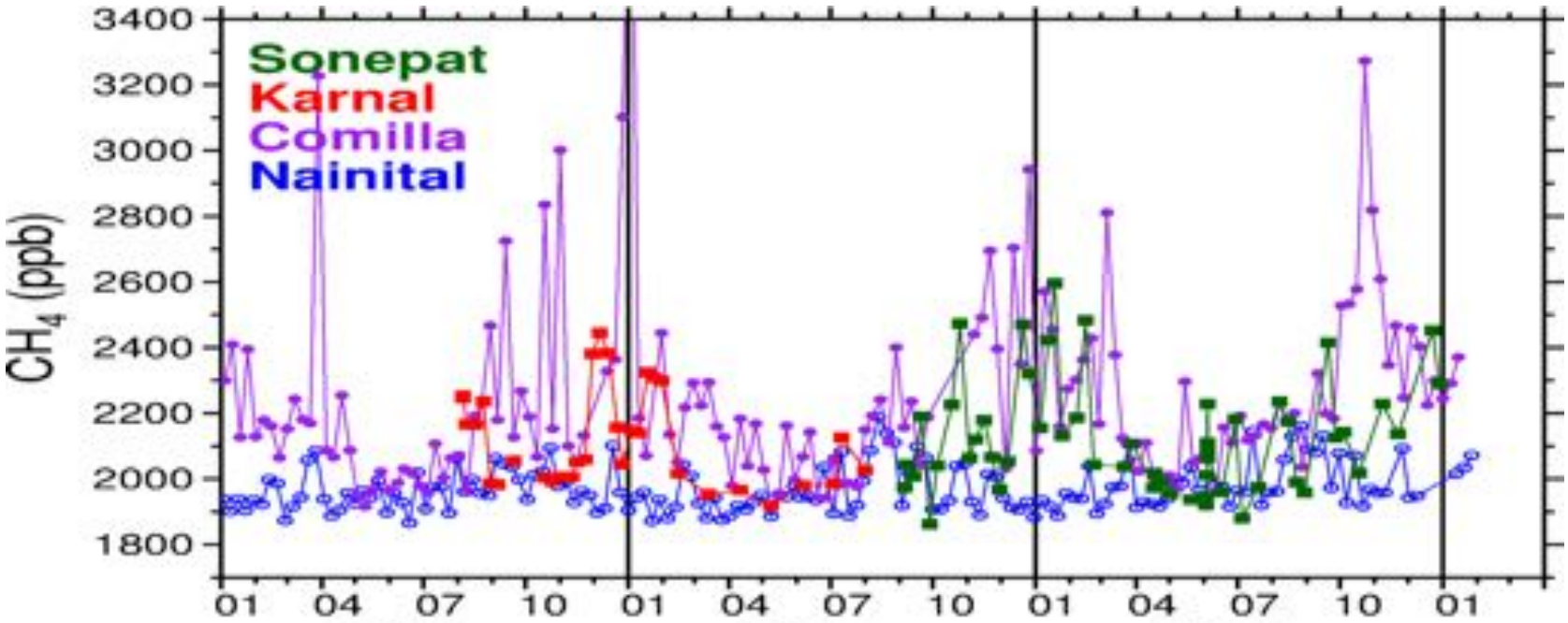
**Flask**

**ACTM T106**

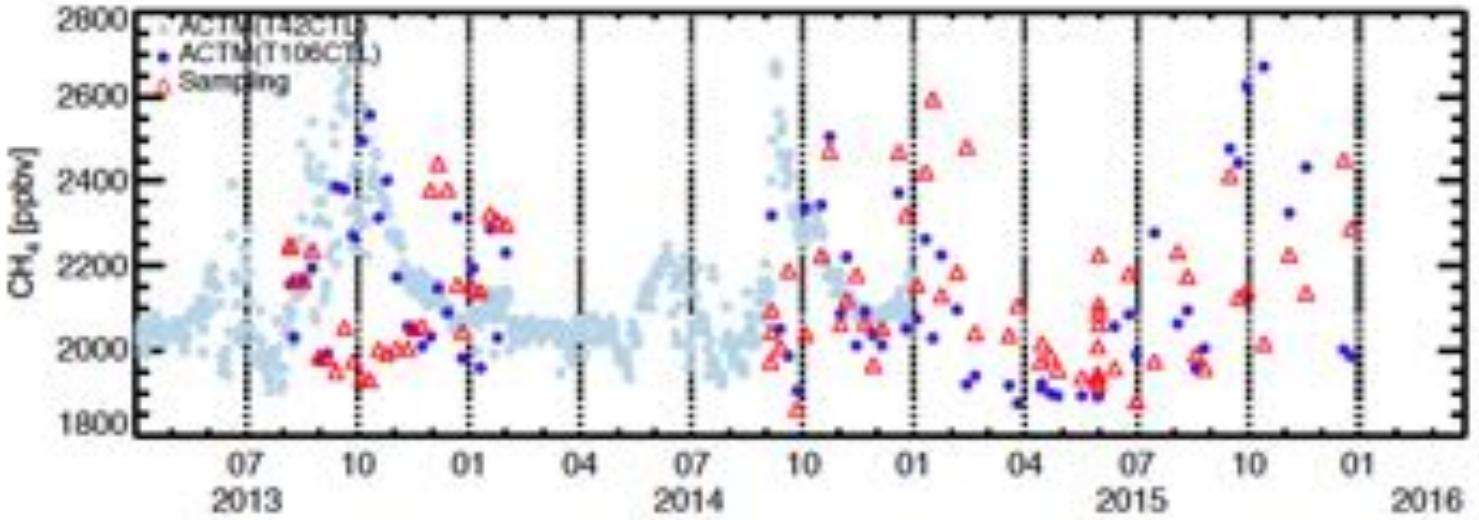


# Air sampling vs. ACTM(JAMSTEC)

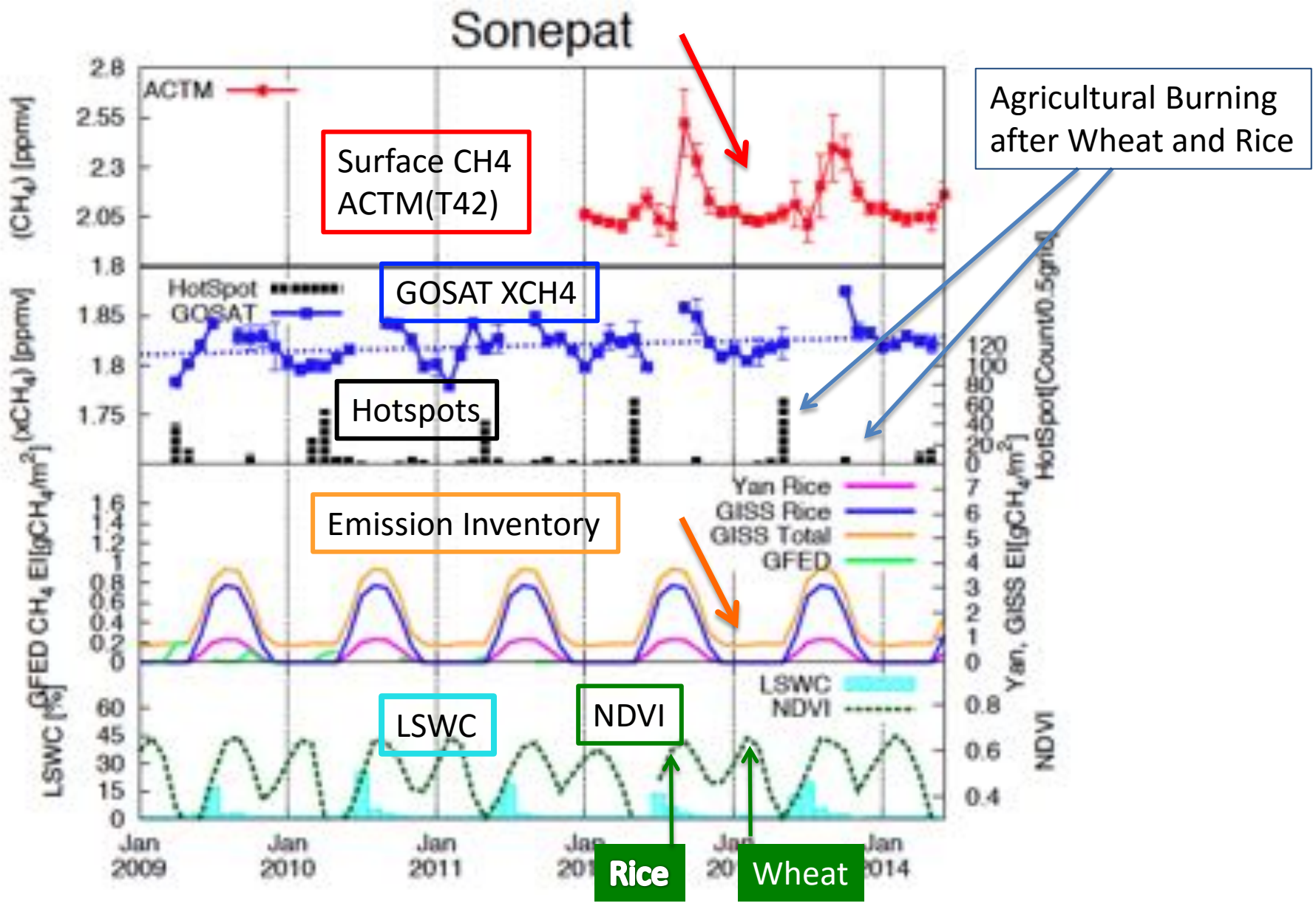
$CH_4$ in the sampled air



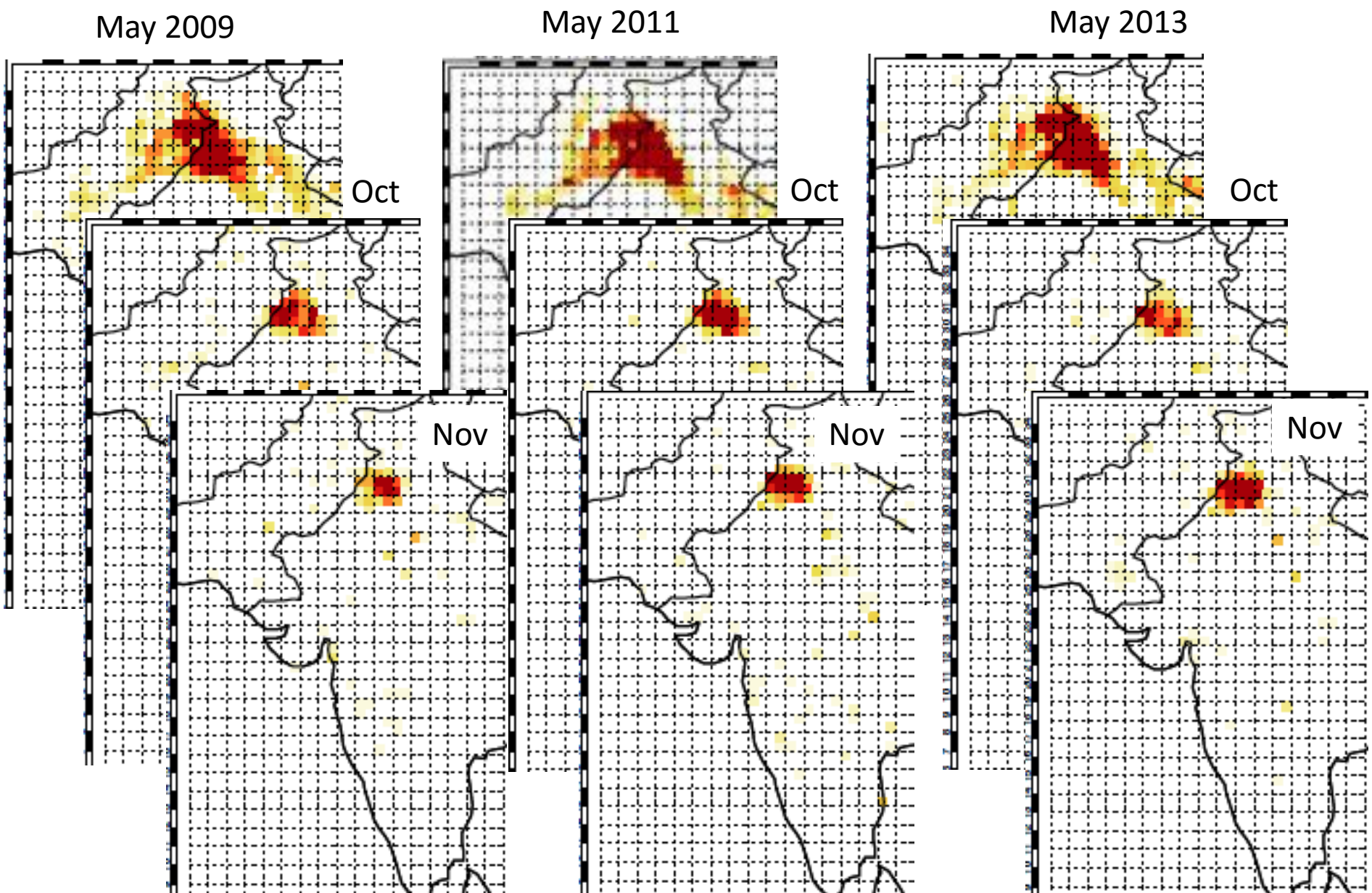

ACTM T42



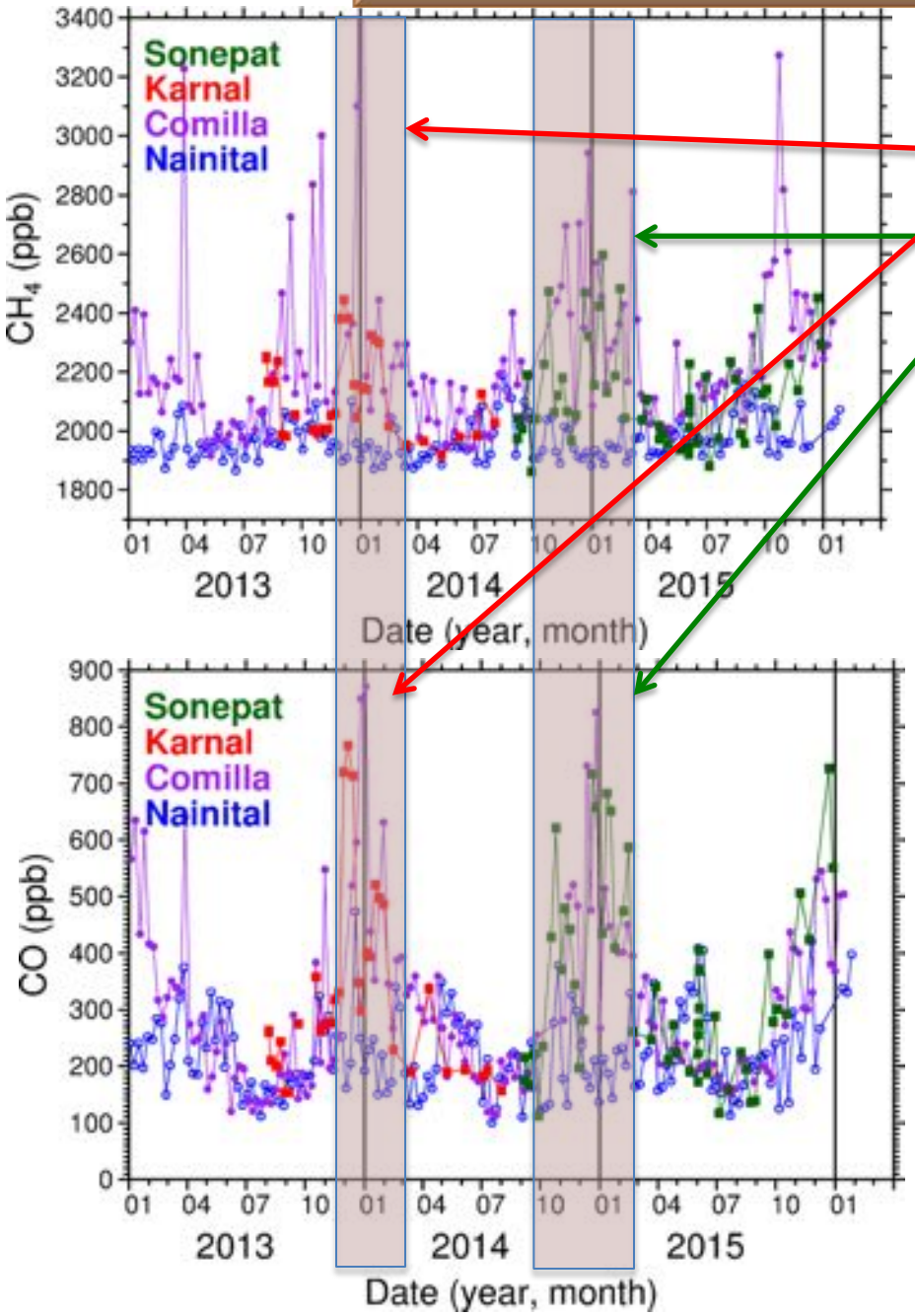
# Comparison of ACTM (T42:~2.8°), GOSAT, Hotspots, Emission Inventory, NDVI, and LSWC Monthly basis



# MODIS Hotspots in north India



# Discussion on winter maximum of $CH_4$

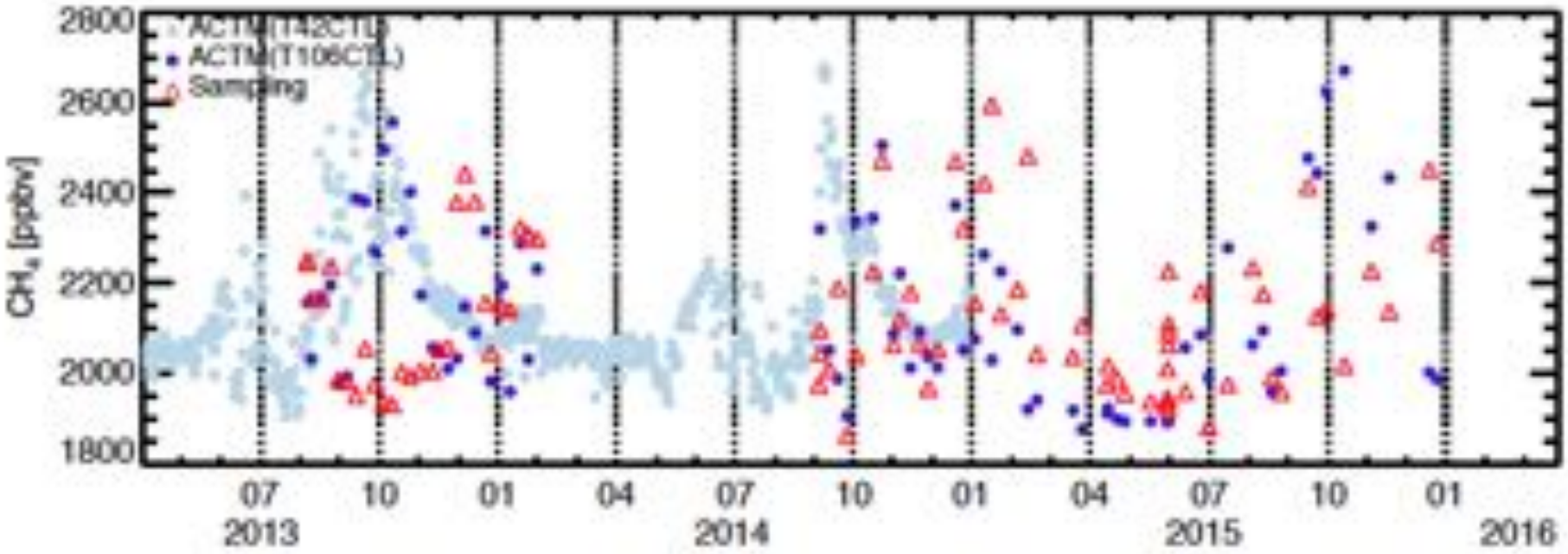



Both $CH_4$ and CO enhancement in late autumn to winter (Oct.-Feb.) over Karnal and Sonepat.

- ✓ ACTM T106 reproduced absolute values fairy well.
- ✓ Seasonal variation of ACTM T42 does not show winter maximum (Sep/Oct maximum).
- ✓ Over Comilla, Patra et al. (2016) described that the $CH_4$ build up at the surface during the winter because the loss of CH4 is at its seasonal low, and transport mechanism.
- ✓ Another agricultural burning after rice is effective? But the most active hot spots are found in Oct. and Nov.

# Summary

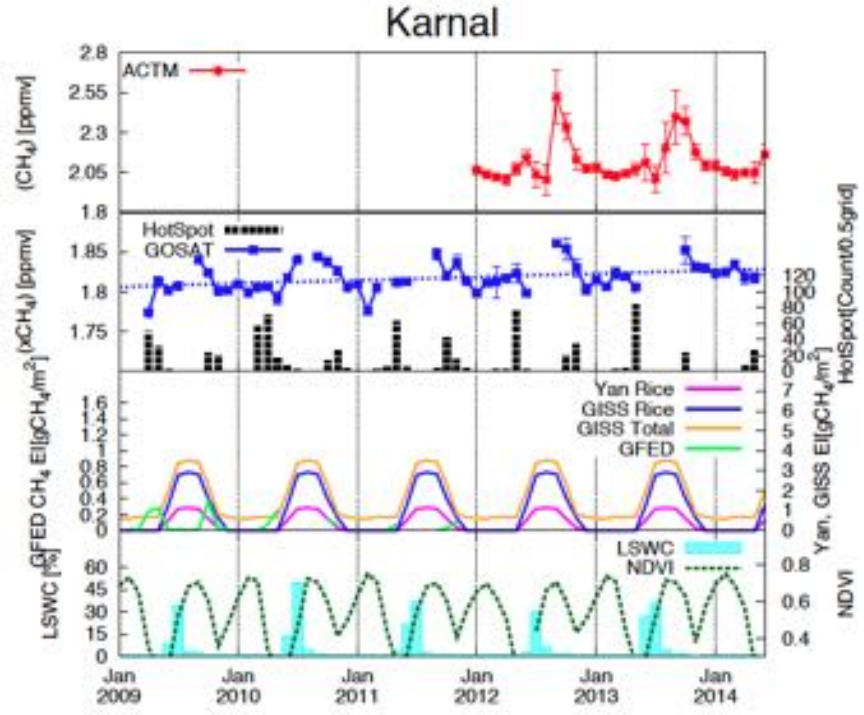
- Long-term record of GOSAT/SWIR $XCH_4$ over Asia
  - Regular seasonal variation is continuing.
  - Growth rate of GOSAT $XCH_4$ is comparable with SCIAMACHY
- GOSAT $XCH_4$ distribution
  - High in summer monsoon season over Indo-Gangetic plain
- Flask sampling in Karnal/Sonepat
  - Winter maximum for both CH4 and CO
- Comparison with ACTM/JAMSTEC over Karnal/Sonepat
  - ACTM(T106) reproduces flask sampling fairly well, when looking at day-by-day.
  - ACTM(T42) shows Sep/Oct maximum, corresponding to rice emission?
  - Patra et al., JMSJ, 2016: (over Comilla) the CH4 build up at the surface during the winter => the situation is different over Karnal/Sonepat?
  - Effect of BB in October/November?
- *Representativeness of measurements*
  - *Continuous measurement by LaserMethane instrument (by Matsumi） is important to follow the data gap of flask sampling (once a week)!*


ACTM(T42CTL)
ACTM(T106CTL)
Sampling
$CH_4$ [ppbv]
2800
2600
2400
2200
2000
1800
07
2013
10
01
04
07
2014
10
01
04
07
2015
10
01
2016

# MODIS Hotspot

Biomass burning :
Between rice and wheat cultivation periods

Agricultural burning after wheat in May, after rice in Oct/Nov.







MCD14ML_CF80_HOTSPOTCOUNT_monthly_grid05_200901