Toward Improvement of Methane Emission Inventory of South Asia from GOSAT

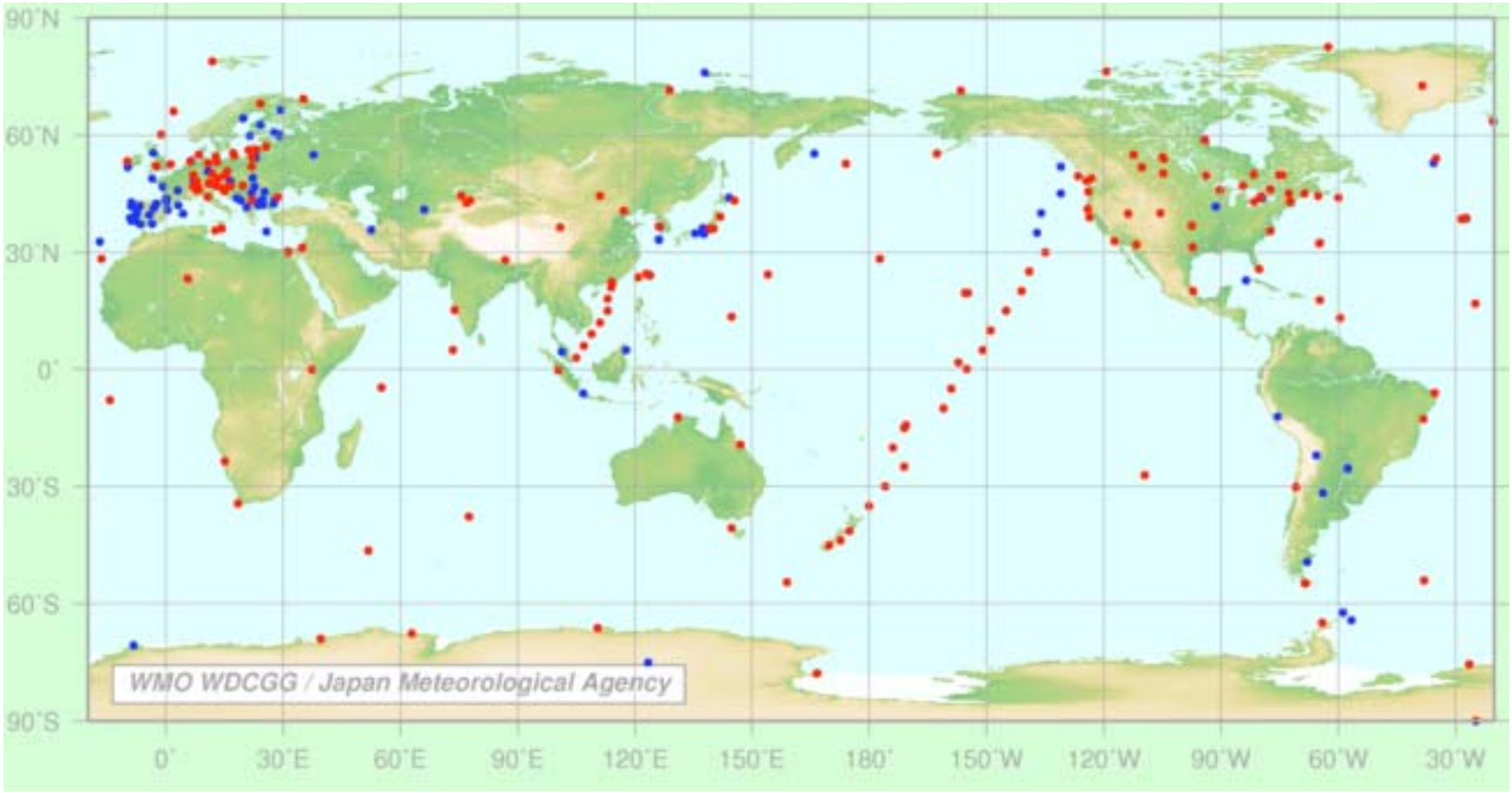
Sachiko Hayashida

Nara Women's University

Background: Methane

- Methane is the second most important anthropogenic green house gas after carbon dioxide.
- Most of methane emission are biogenic origin and their emission estimate have large uncertainty.
- Methane is one of the SLCPs: mitigation measures is an urgent issue.

The current observational network: insufficient coverage

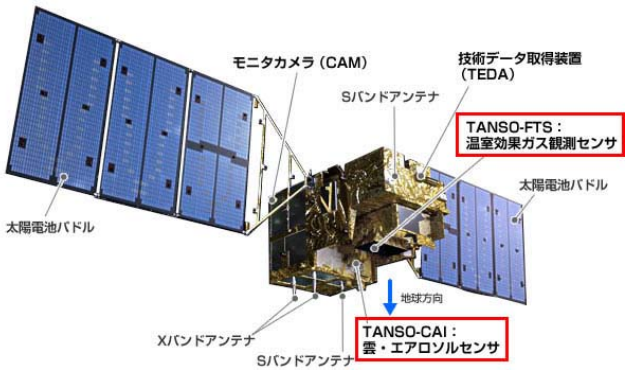


WDCGG http://ds.data.jma.go.jp/gmd/wdcgg/

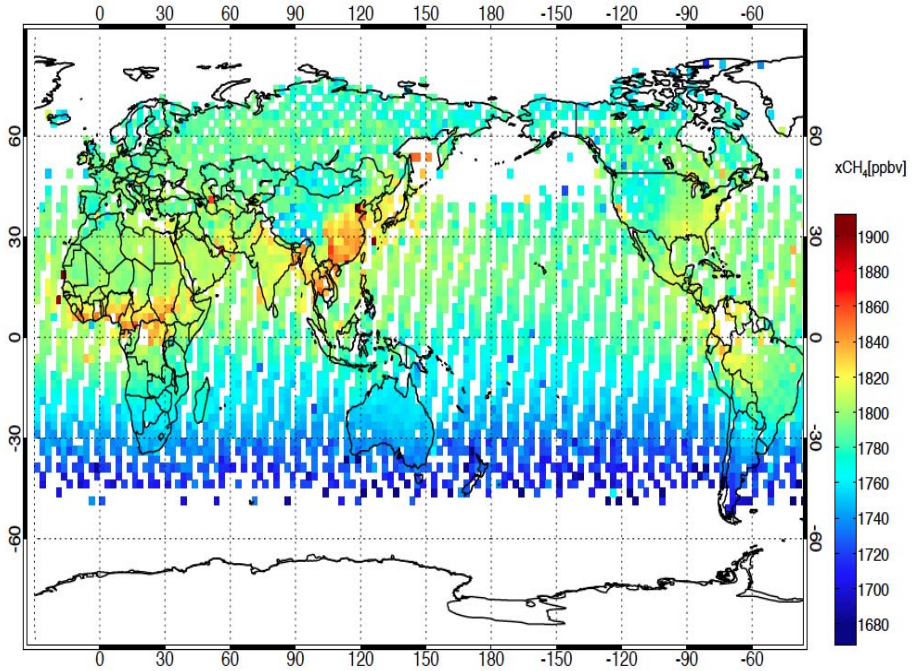
Recet Development: Satellite observation of CH_4

SCIAMACHY

(Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY)
onboard ENVISAT (2005~)



GOSAT CH4 Global Average of 2012 (NIES Ver. 02.21)



TANSO-FTS/GOSAT

Greenhouse gases Observing SATellite “IBUKI”

The first/only satellite dedicated to greenhouse-gas-monitoring.

GOSAT was developed by JAXA: launched on January 23, 2009

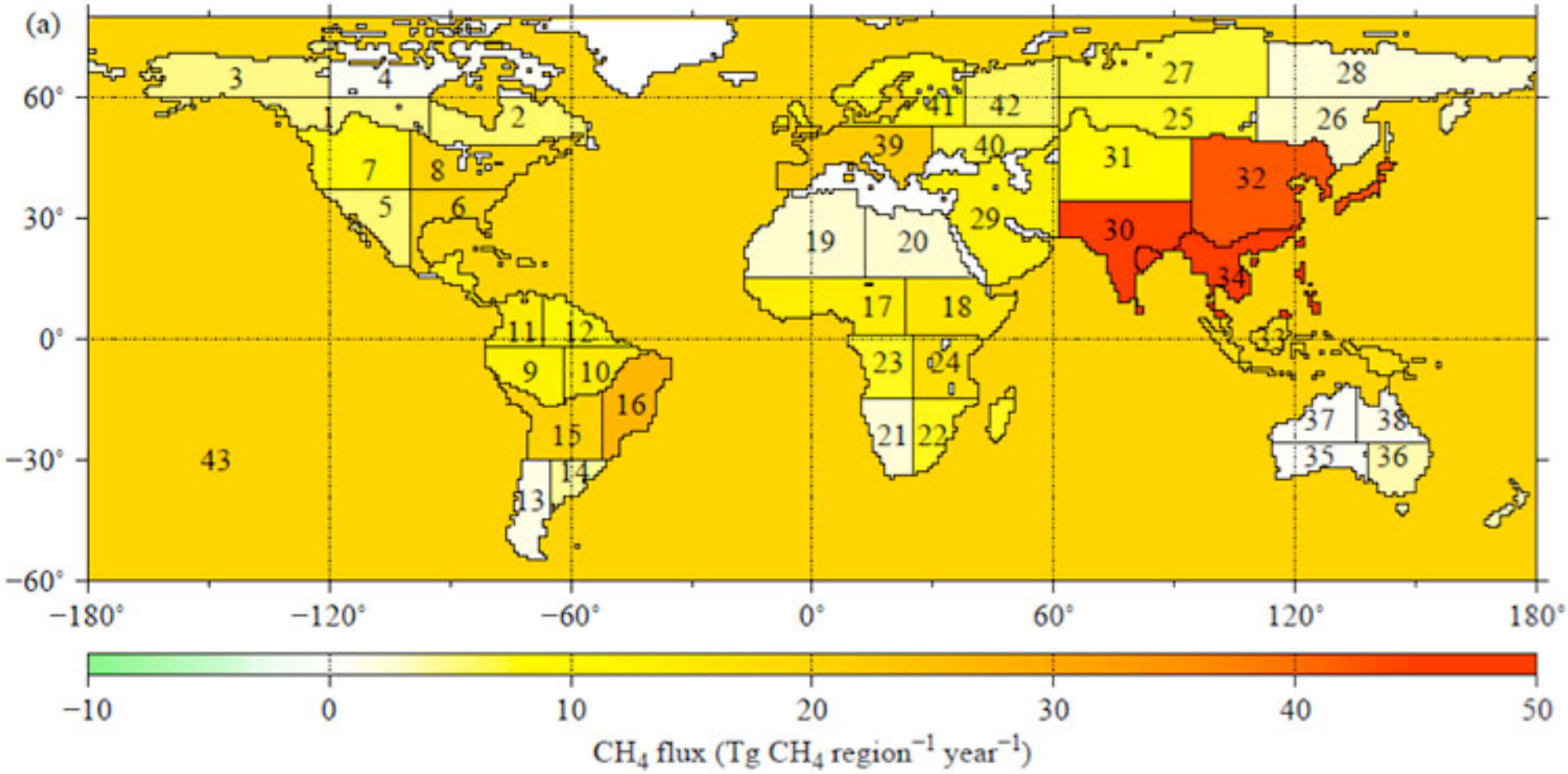
TANSO-FTS Sensor

- –Target: CO_2, CH_4
- –IFOV: 10.5km in diameter

Inverse analysis by NIES model with the GOSAT NIES product

from press release by NIES, March, 2014

Asia is a big source of CH4

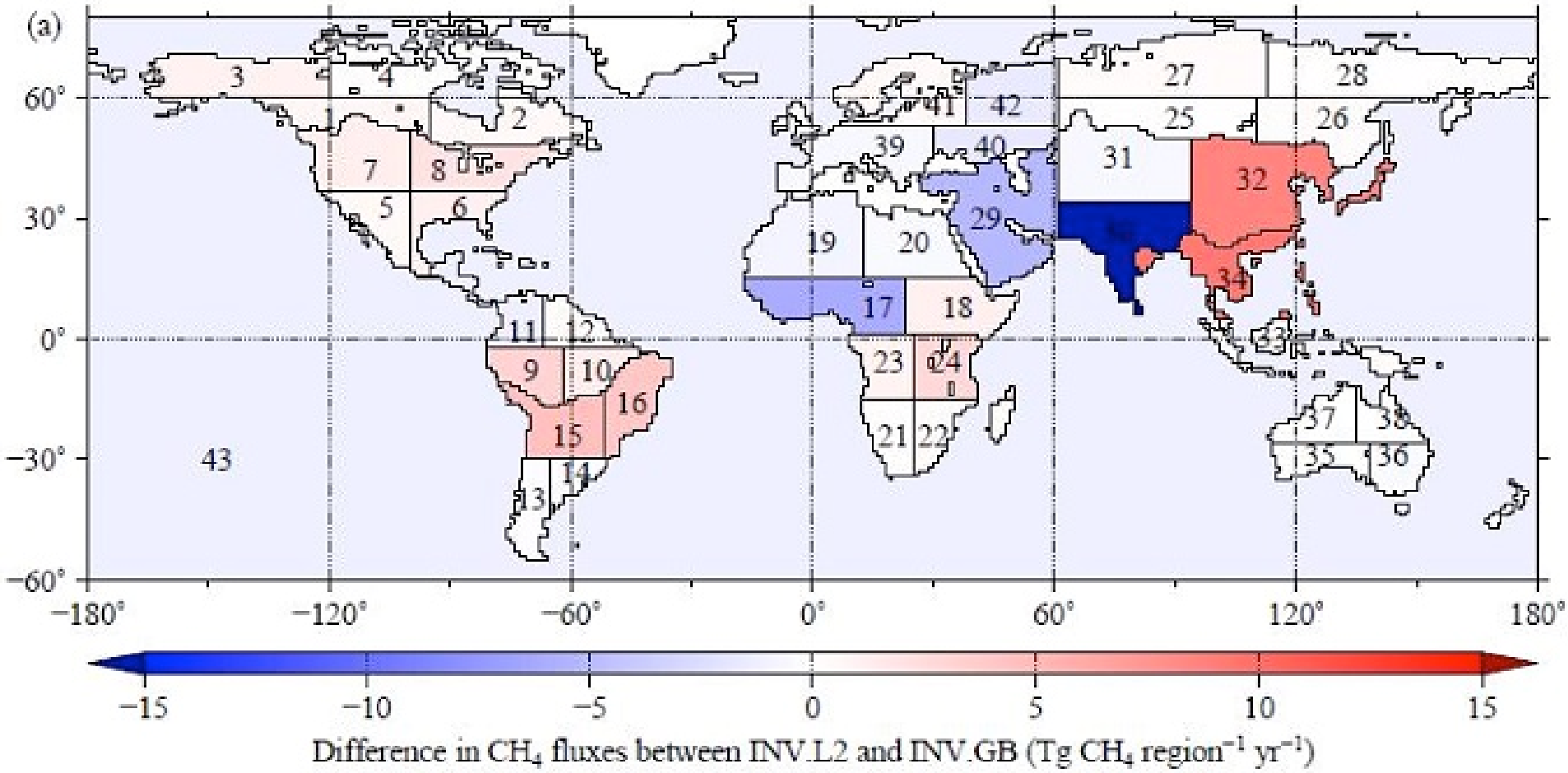


H.-S. Kim and S. Maksyutov (NIES)

Inverse analysis by NIES model with the GOSAT NIES product

from press release by NIES, March, 2014

Diff. with and w/o GOSAT data



Difference between INV L2 and INV.GB Is large: negative in India, positive in China

H.-S. Kim and S. Maksyutov (NIES)

Strategy to overcome : GOSAT insufficiency -1

SWIR

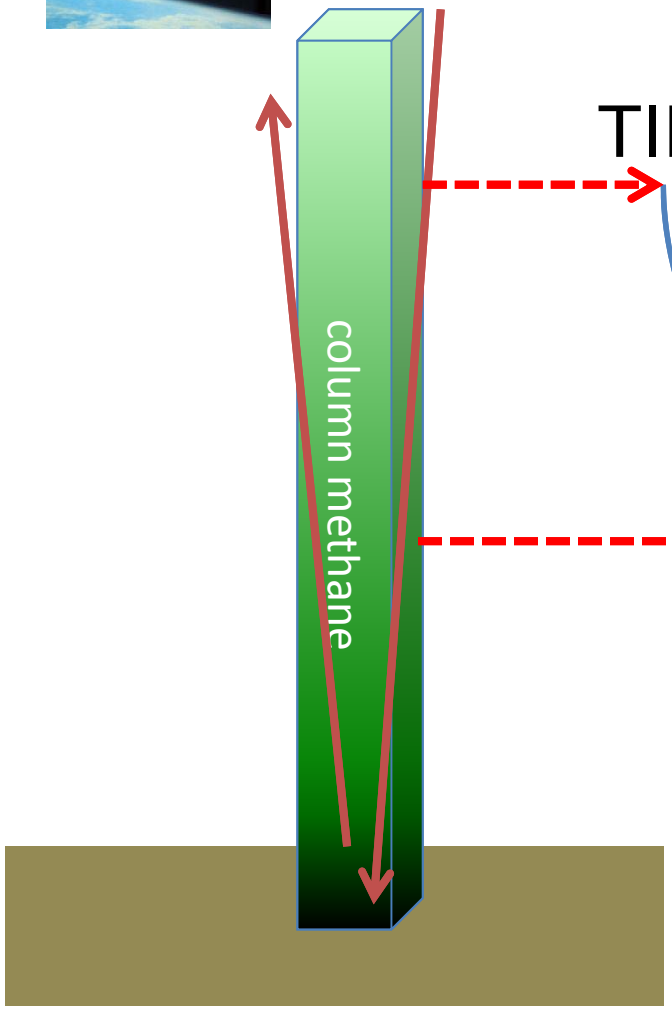
Strategy to overcome : GOSAT insufficiency -1

SWIR Column Amount

Strategy to overcome : GOSAT insufficiency -1

SWIR Column Amount

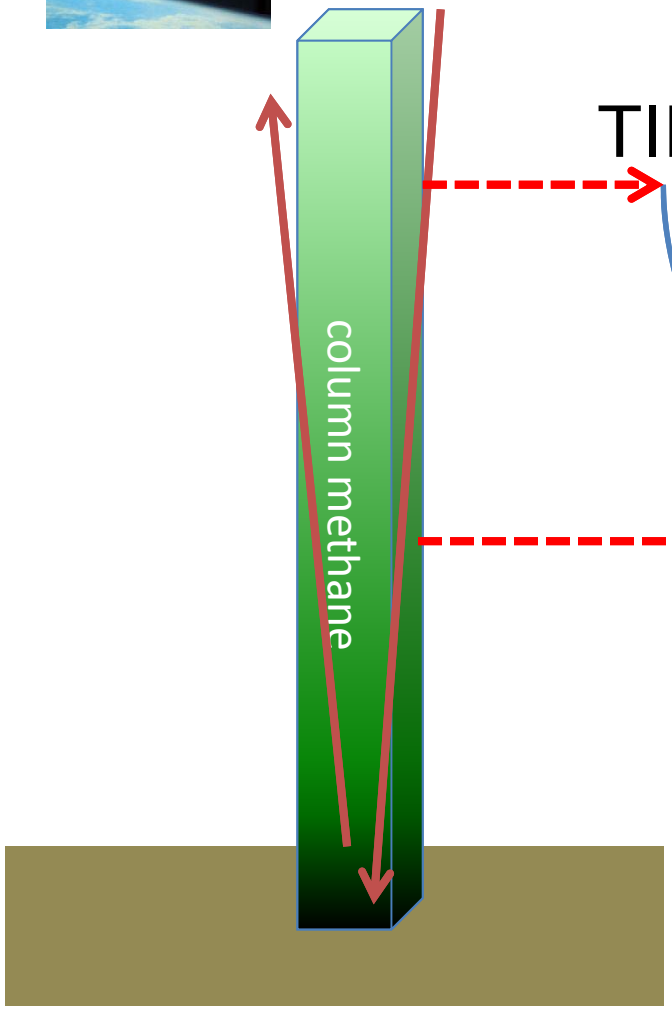
TIR Profile of Upper Tropospher/ and Lower Stratosphere



Strategy to overcome : GOSAT insufficiency -1

SWIR Column Amount

TIR Profile of Upper Tropospher/ and Lower Stratosphere

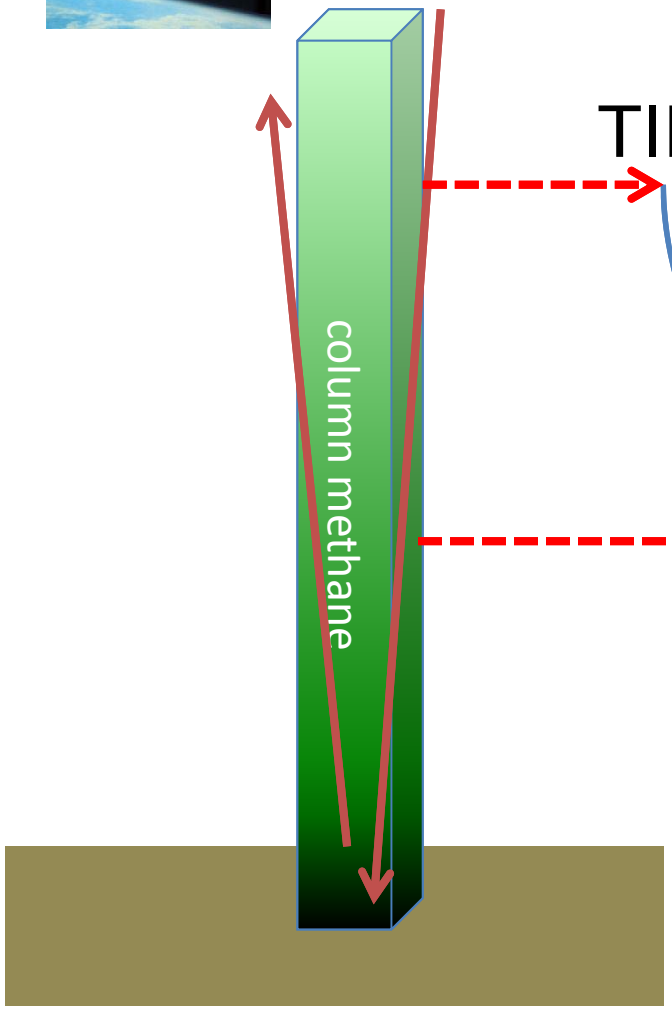


Information of CH4 in the lower atmosphere

Strategy to overcome : GOSAT insufficiency -1

SWIR Column Amount

TIR Profile of Upper Tropospher/ and Lower Stratosphere

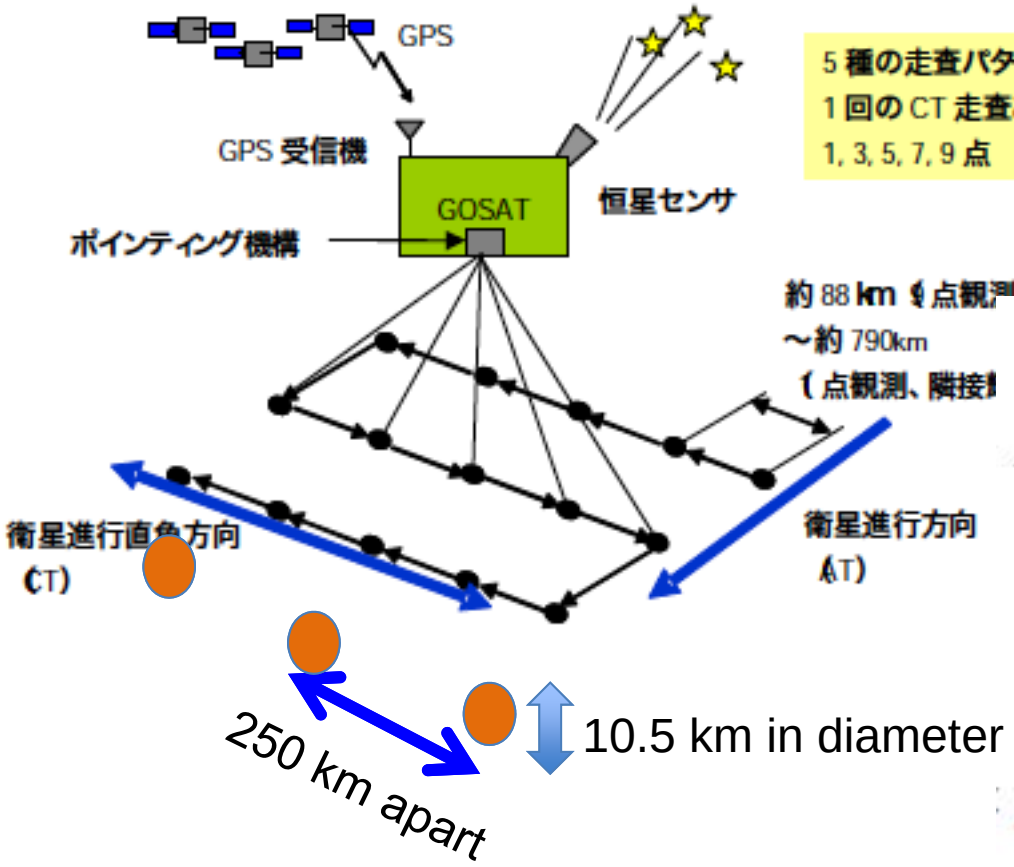


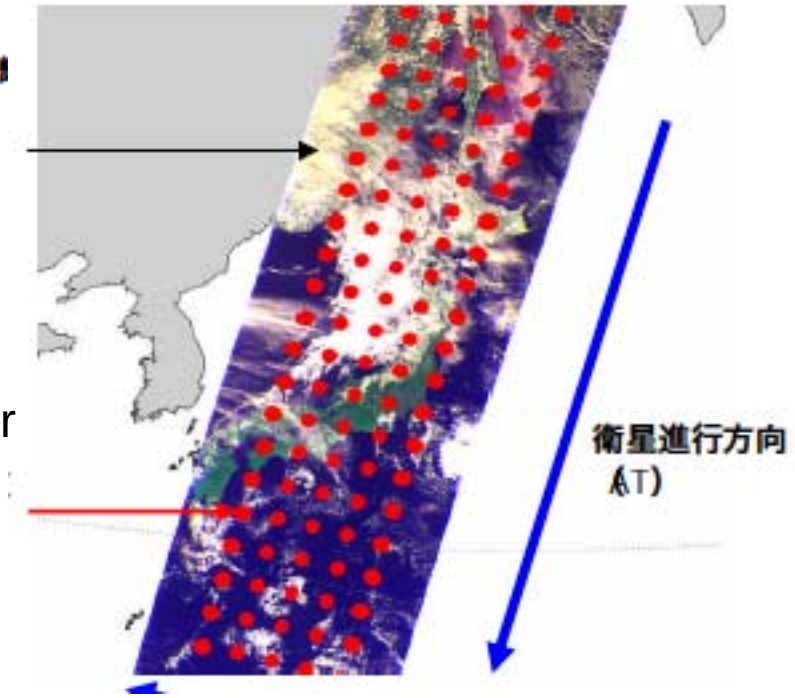
Information of CH4 in the lower atmosphere

Surface Measurements (e.g. Air Sampling)

GOSAT insufficiency -2

3 points mode with 3-day revisit orbit

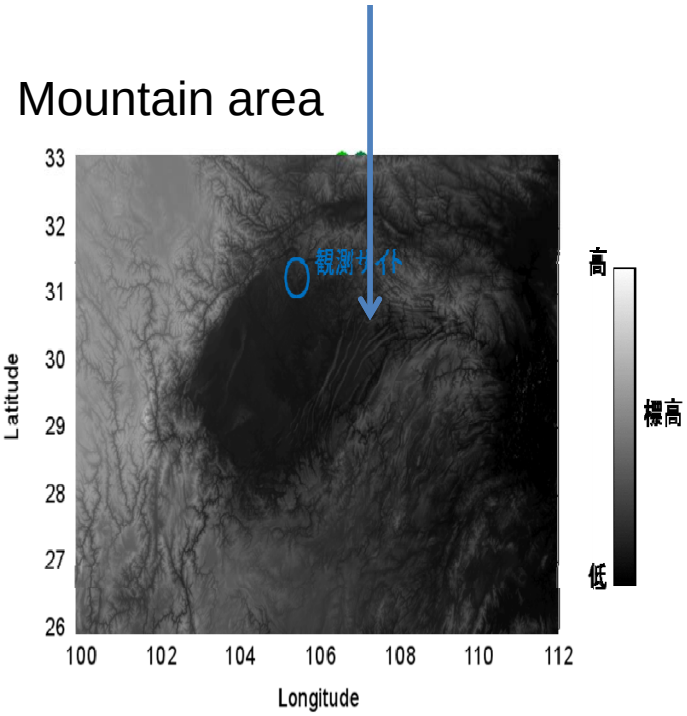




After cloud screening, the number is much less

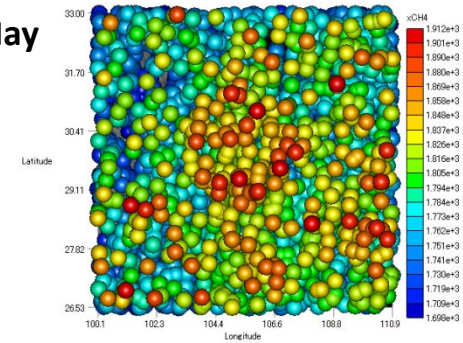
Example in Sichuan basin

Mountain area

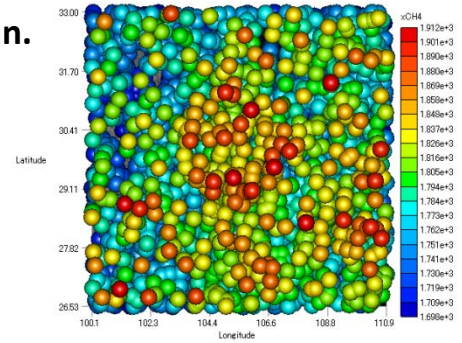


▽ SCIAMACHY xCH_4

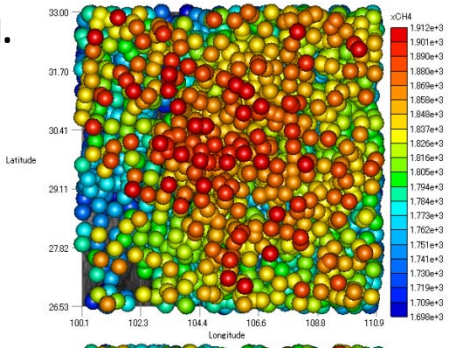
May



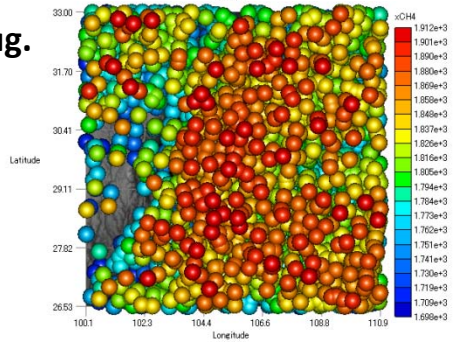
Jun.



Jul.

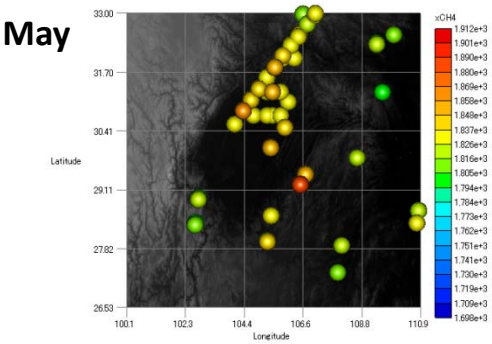


Aug.

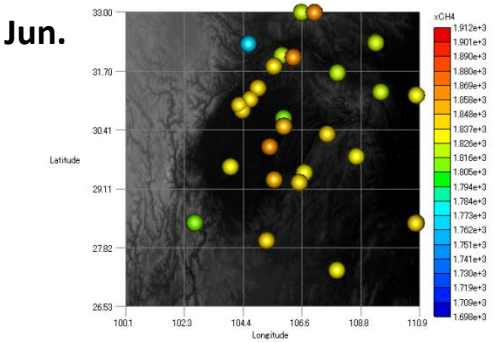


▽ GOSAT xCH_4

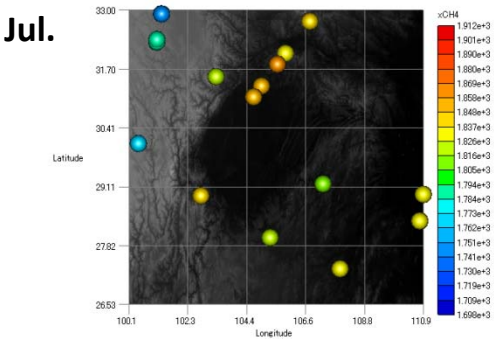
May



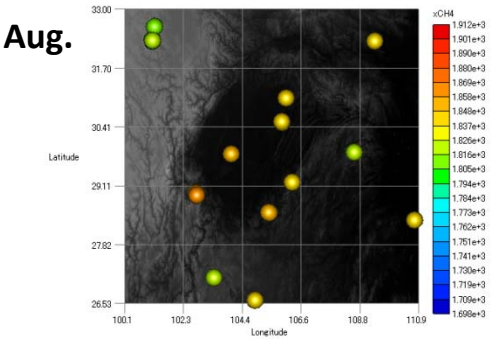
Jun.



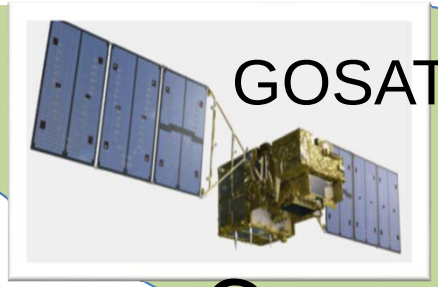
Jul.



Aug.

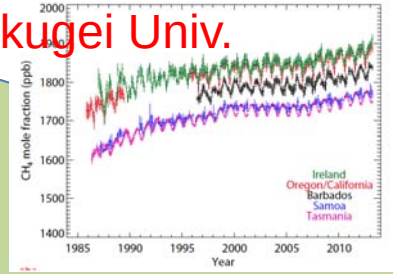


Next Step : Monitoring System toward Improvement of Emission inventory



NIES

Nagoya & Tokyo Gakugei Univ.



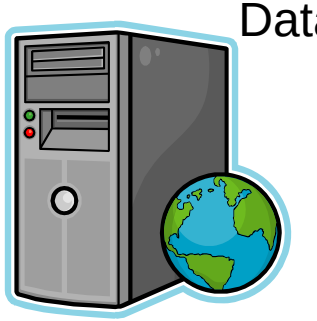
Global scale

Flask air sampling

Continuous Measurements

Regional scale

Data Input



Flux estimate in Regional Scale

Mitigation Potential Map

with NIAES

Transport model
Inverse analysisl (JAMSTEC)

Simulation of CH4 distribution

Mitigation Scenarios

Bottom-up estimate of CH4 emission in India

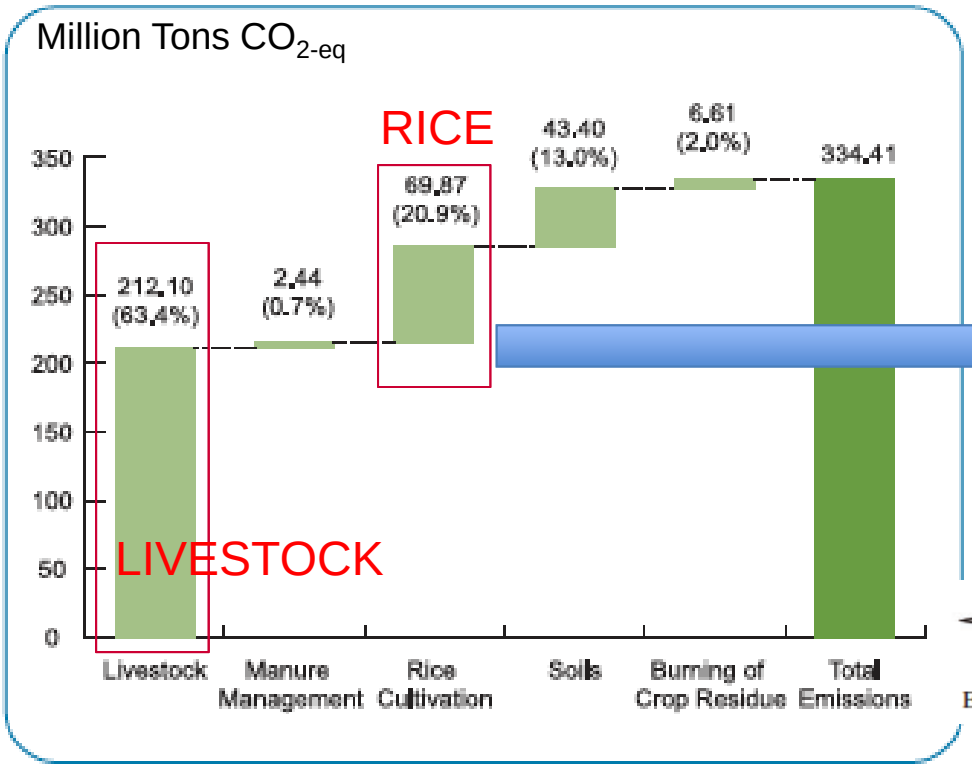
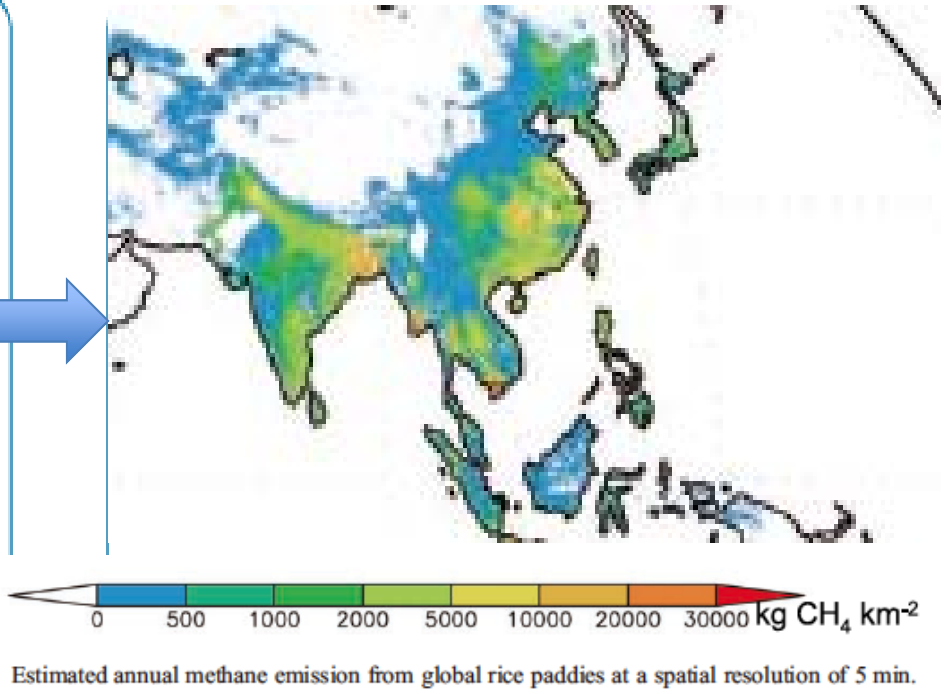


Figure ES6: GHG emissions from Agriculture Sector (million tons of CO_2 eq).



Estimated annual methane emission from global rice paddies at a spatial resolution of 5 min.

: Yan et al., GBC,2009

出典：INCCA Indian Network for Climate Change Assessment 2007

Environment Research & Technology Development Fund

Ministry of the Environment
Government of Japan

The Environment Research and Technology Development Fund (ERTDF)
Sonsored by MOE

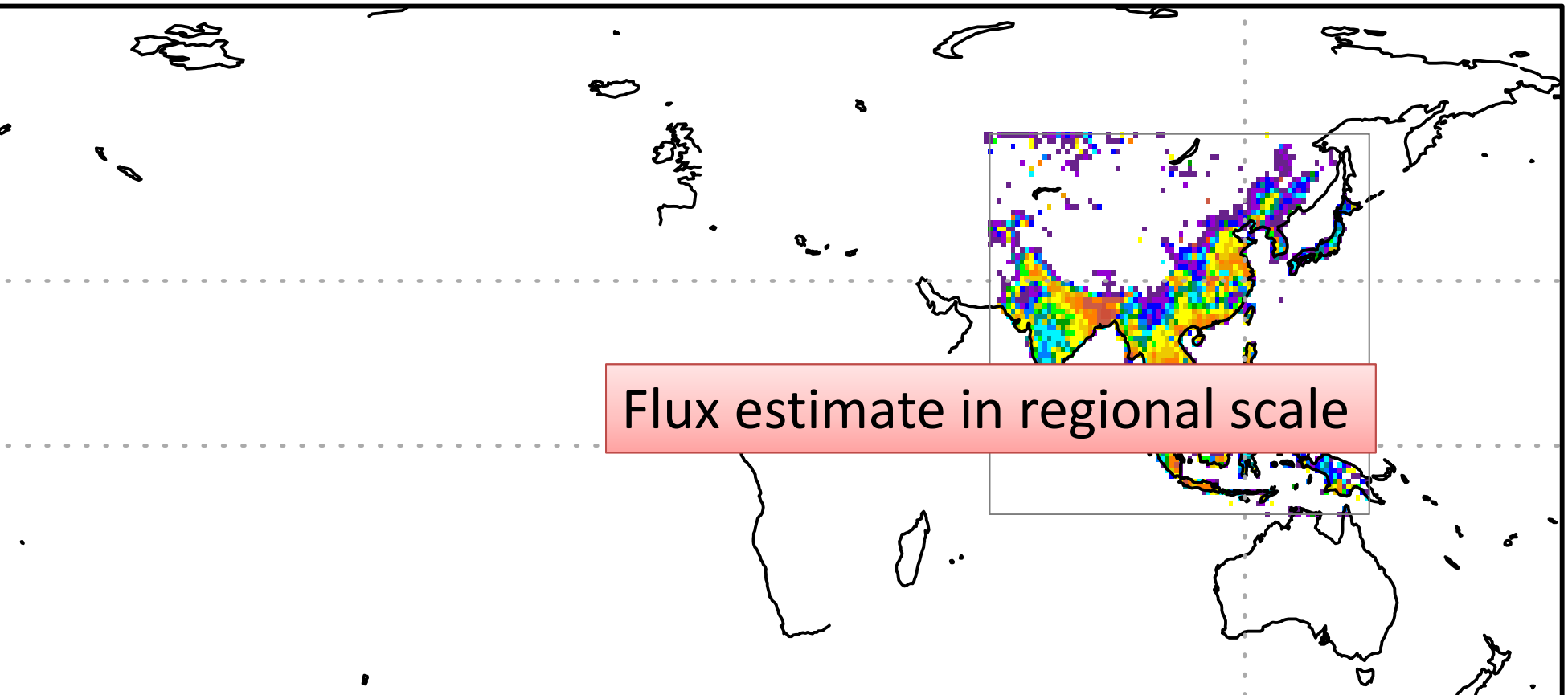
Improvement of Methane Emission Estimate from South Asia using GOSAT and Development of an Emission Mitigation Proposal FY 2015-17

Members: S. Hayashida (PI), M. Kuji (Nara Women's Univ.), Y. Terao (NIES), S. Sudo (NIAES), K. Inubushi, M. Mano (Chiba Univ.), A. Yamamoto (Tokyo Gakugei Univ.), and Prabir Patra (JAMSTEC)

Also supported by GRENE-ei, MEXT: Carbon Circulation FY 2011-2015
R. Imasu (PI), Y. Matsumi, W. Takeuchi, S. Hayashida, N. Saitoh

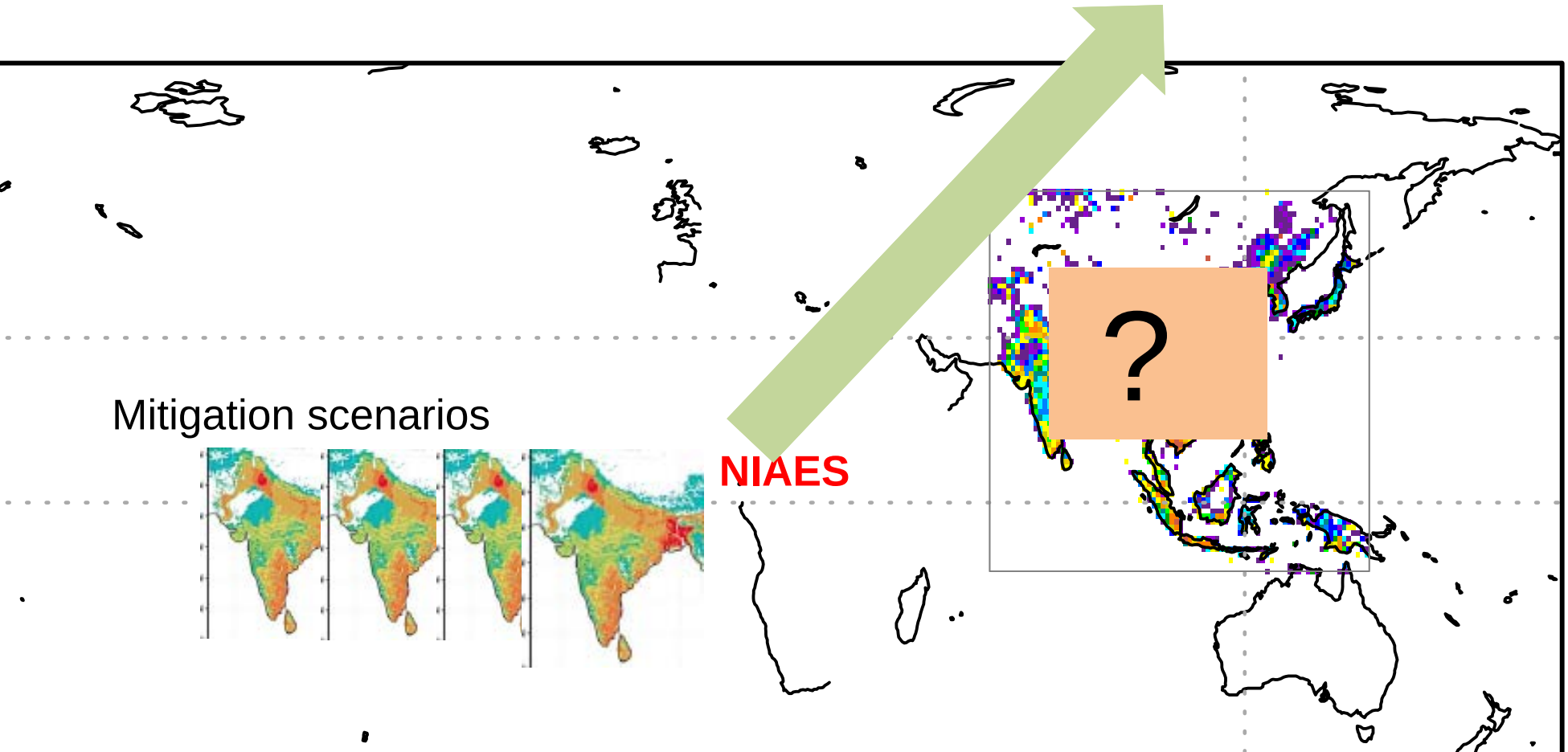
Improvement of Methane Emission Estimate from South Asia using GOSAT

Inverse analysis by ATM



Emission Mitigation Proposal

Inverse analysis by ATM



Environment Research & Technology Development Fund

Ministry of the Environment
Government of Japan

The Environment Research and Technology Development Fund (ERTDF) Sonsored by MOE

Improvement of Methane Emission Estimate from South Asia using GOSAT and Development of an Emission Mitigation Proposal
FY 2015-17

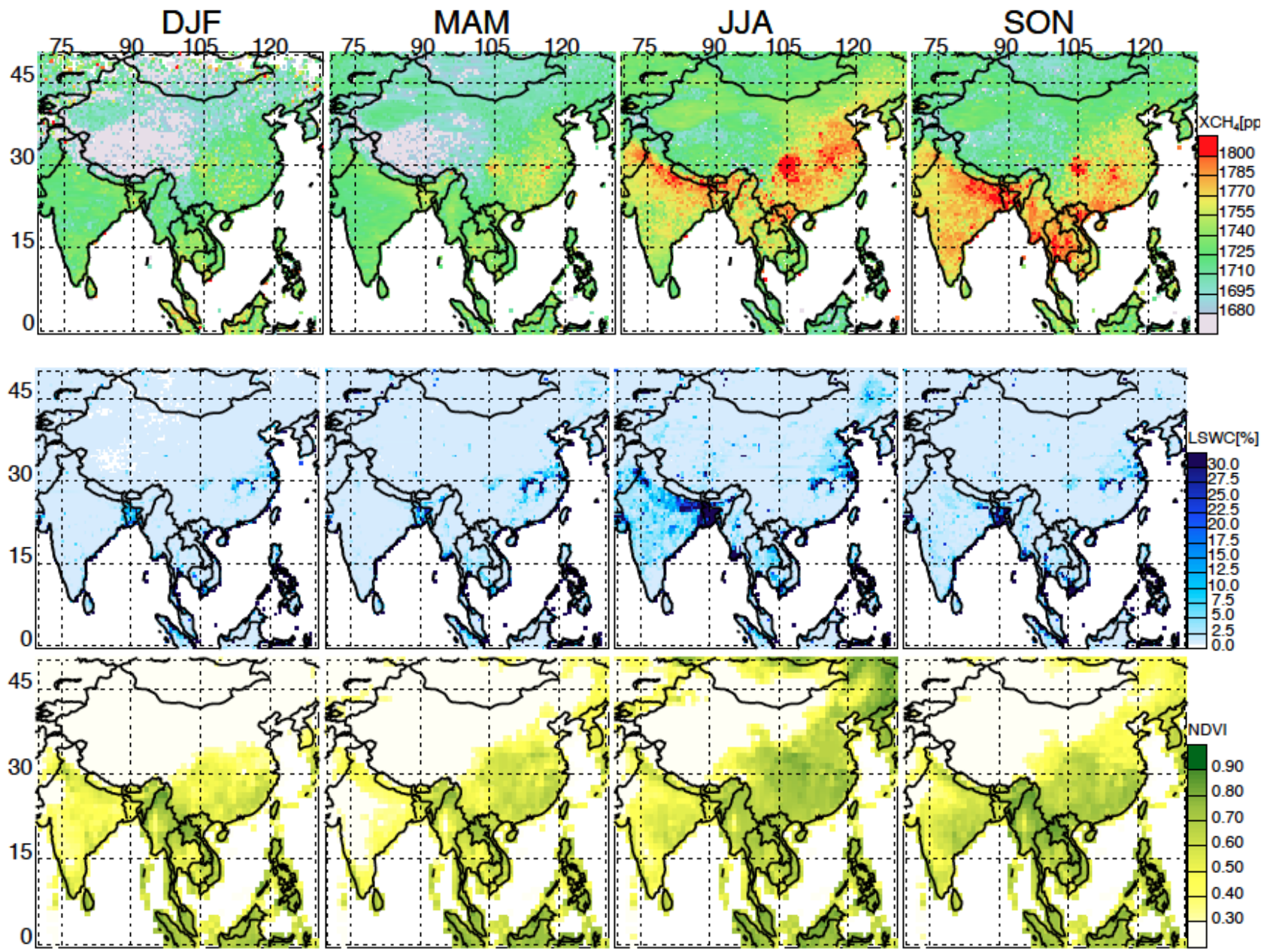
Preliminary results and future plan

Distribution of xCH_4 (SCIA), LSWC , and NDVI

xCH4
(SCIA)
Climatology
2003-2009

LSWC

NDVI



Hayashida et al., RSE, 2013

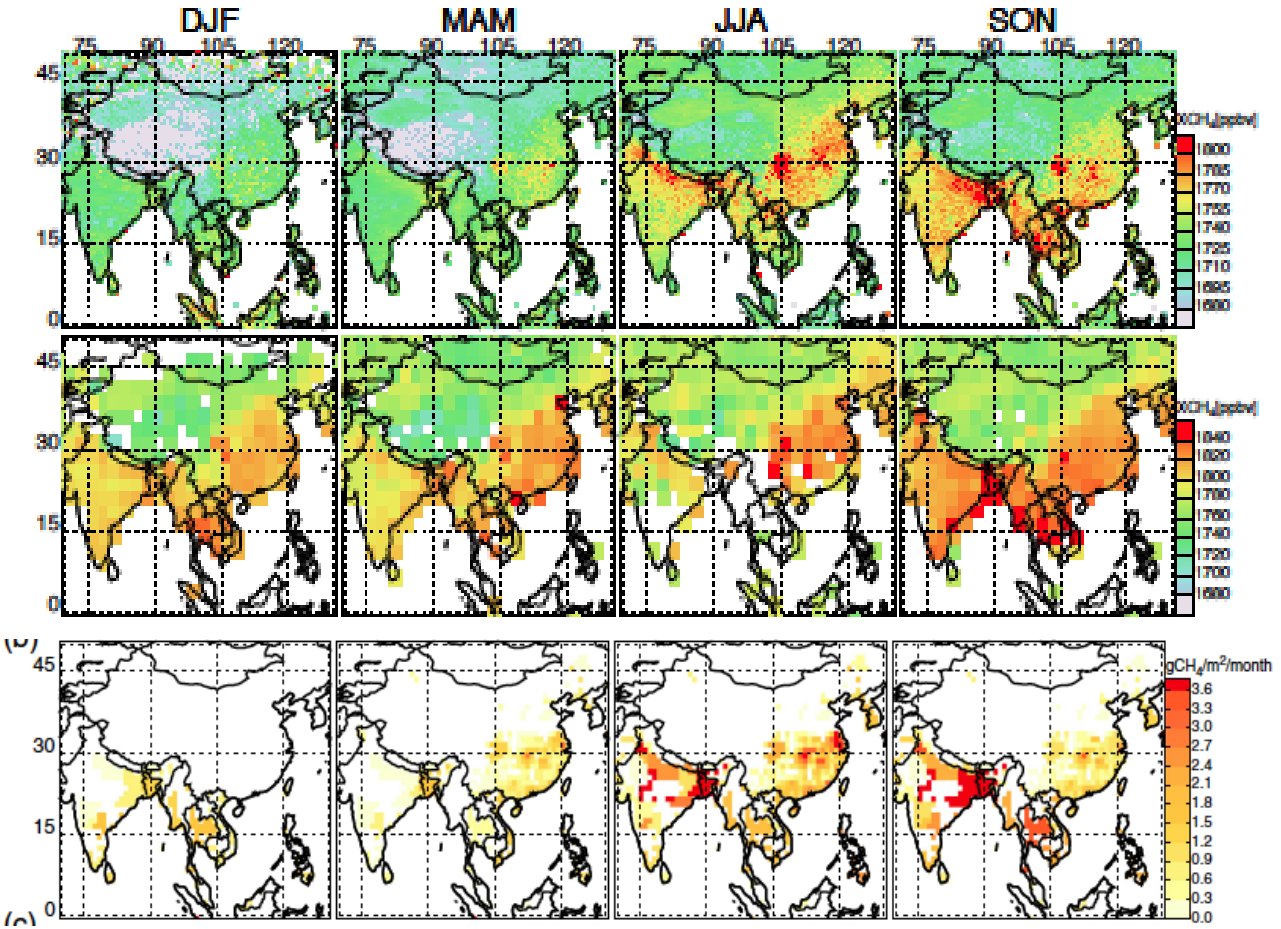
Challenge to approach to better understanding of CH_4 emission from Asia using GOSAT

- The geographical distribution of high CH4 values obtained from SCIAMACHY corresponds to strong emissions from regions where rice is cultivated, as indicated in the inventory maps.

SCIAMACHY
2003-2009

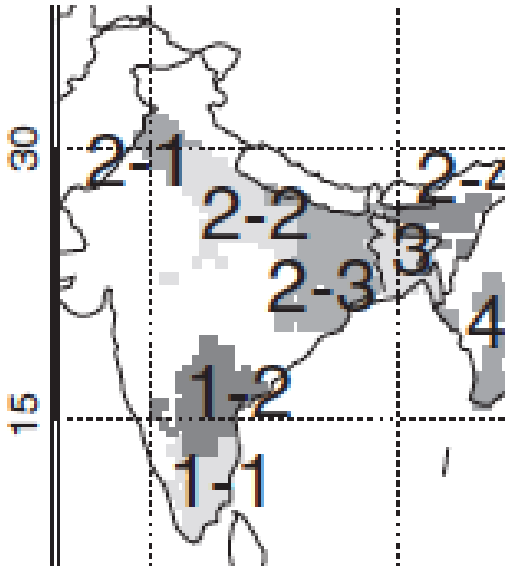
GOSAT NIES V2

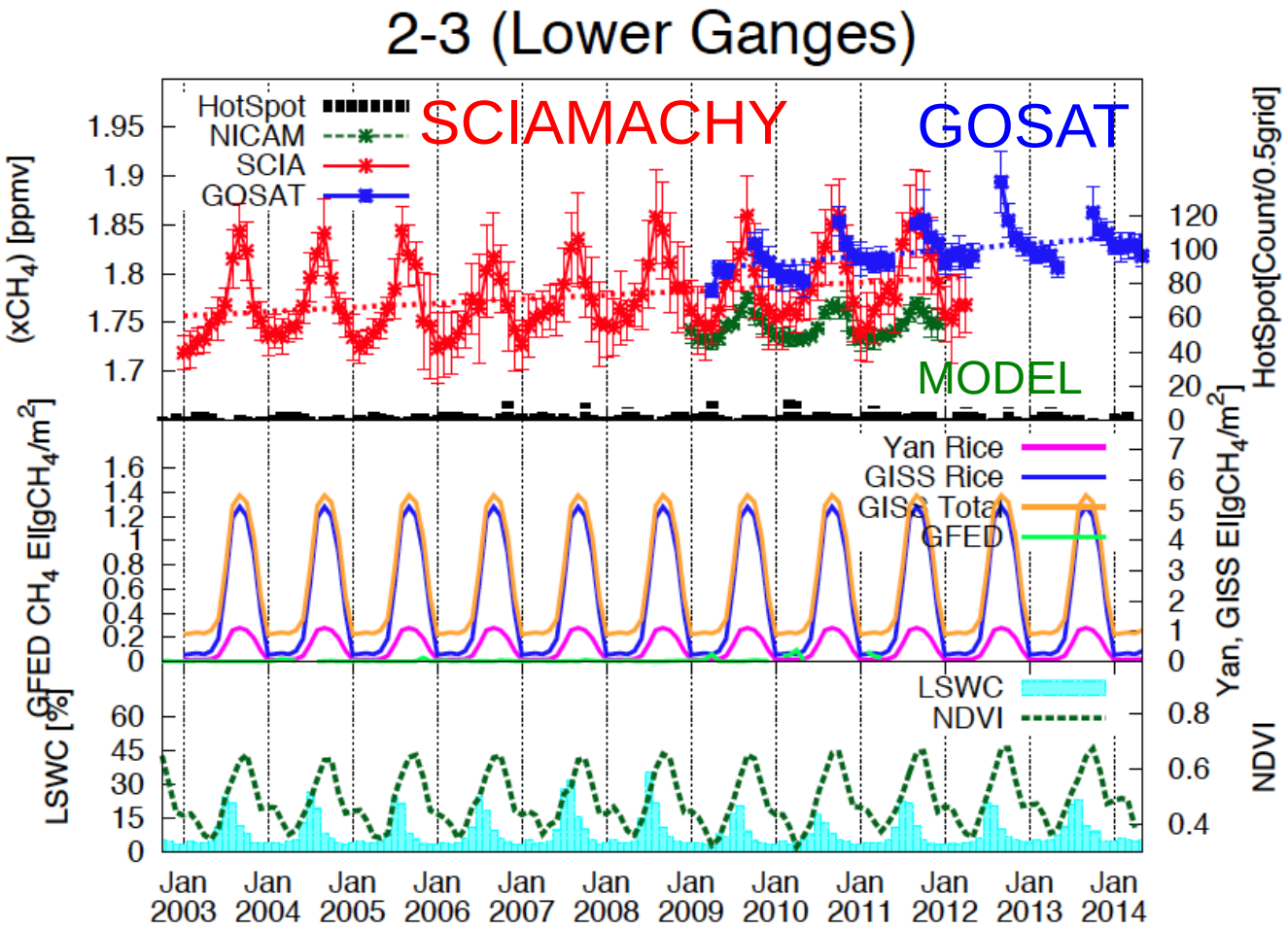
GISS rice emission



Time series of xCH4, bottom-up emission inventory, LSWC, NDVI

Rice paddies

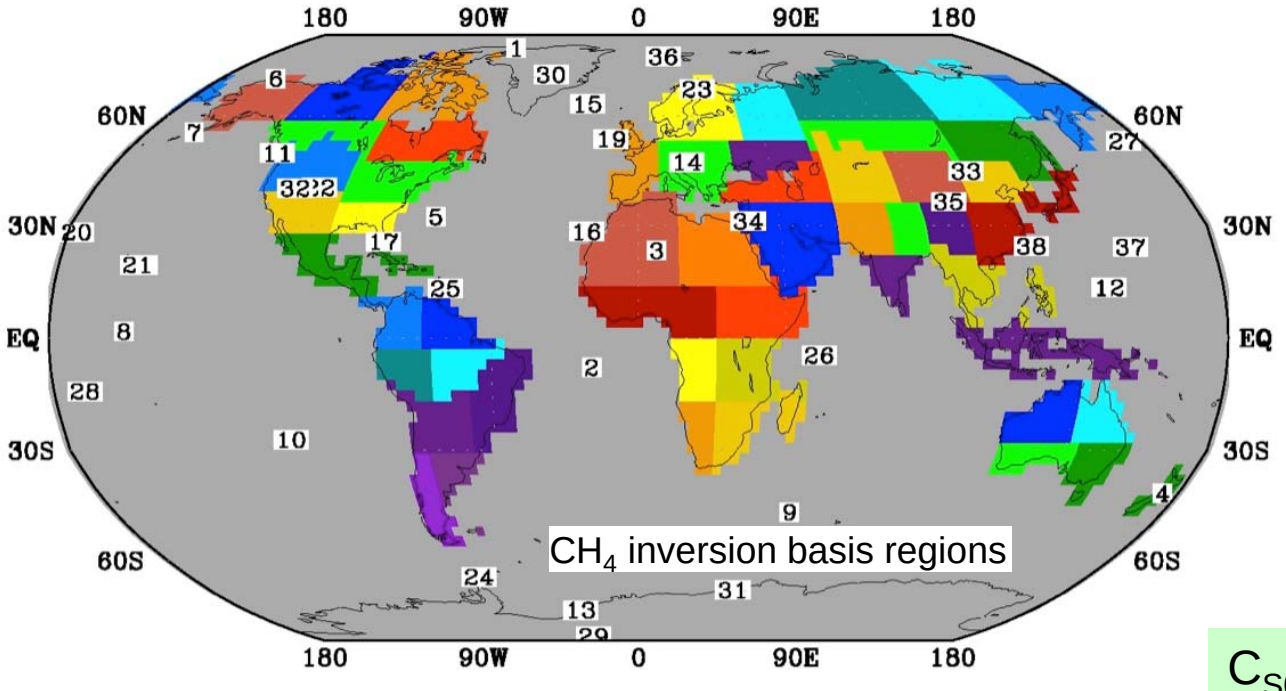




We are doing….

- comparison of GOSAT time series and spatial distributions with model simulations
- comparison of L4B (assimilated) and GOSA_TIR

Inverse system has already been set-up by Prabir Patra (JAMSTEC)

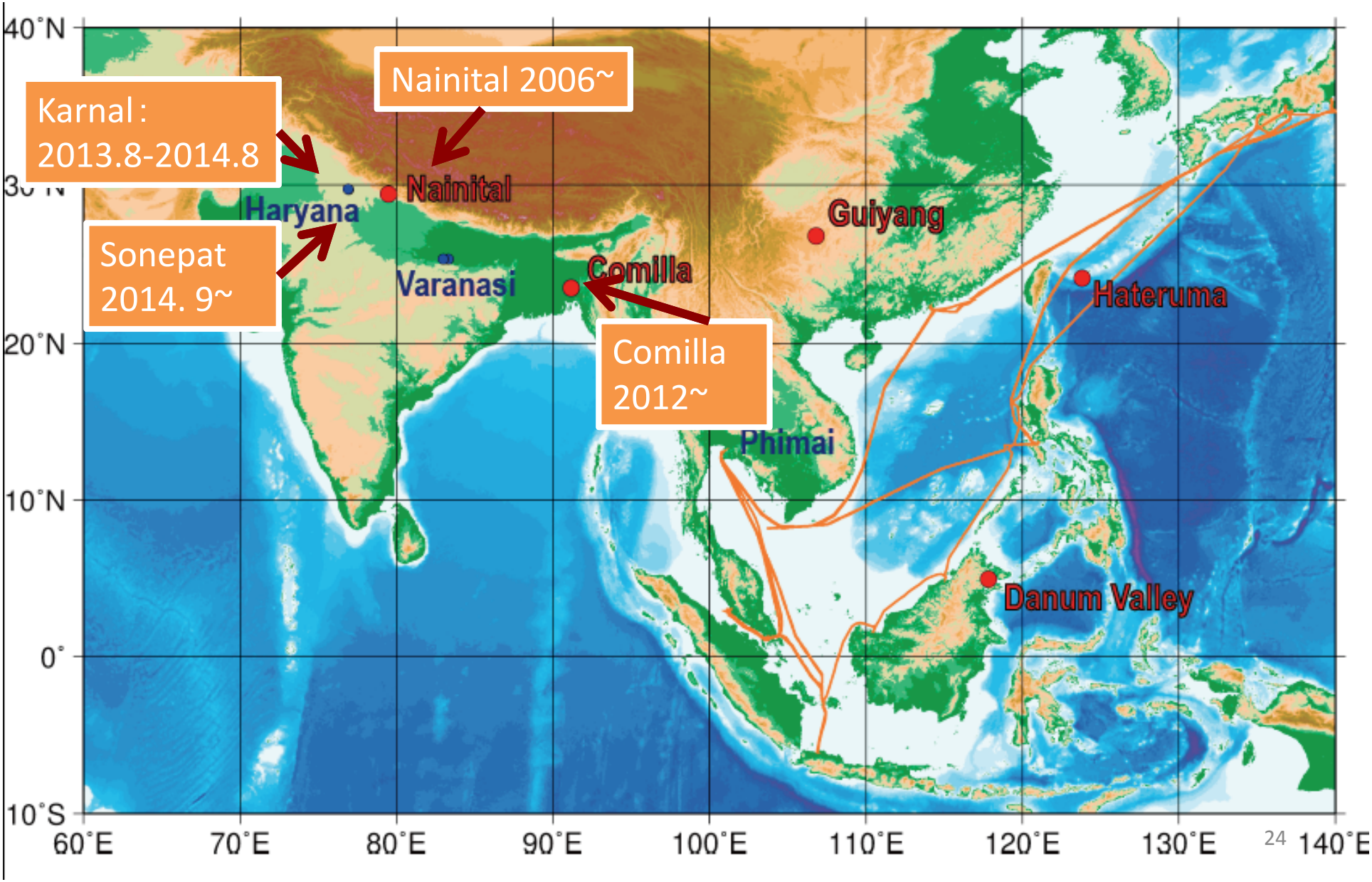


C_{S0} = 50% of regional total emission

$$C_S = (G^T C_D^{-1} G + C_{S_0}^{-1})^{-1}$$

$$S = S_0 + \left(G^T C_D^{-1} G + C_{S_0}^{-1}\right)^{-1} G^T C_D^{-1} (D - D_{ACTM})$$

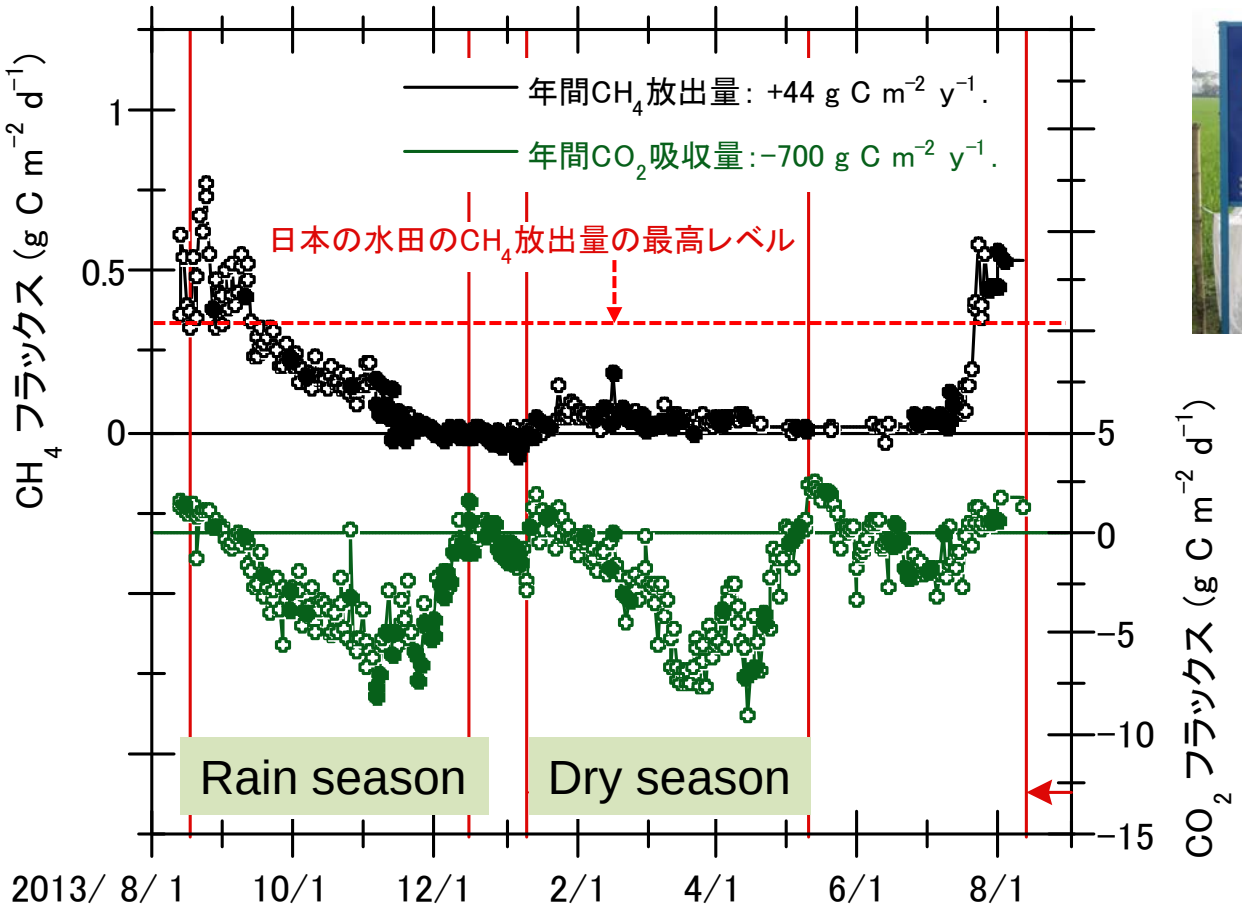
Flask Sampling: NIES Monitoring Network courtesy of Dr. Terao (NIES)



Eddy Covariance Measurement at Bangladesh Agriculture Univ. in Mymensingh, Bangladesh

Continuous Measurement of CO_2 and CH_4 eddy flux

Courtesy of Dr. Mano (Chiba Univ.) and Dr. Miyata and NIAES team



Visit to India and Bangladesh

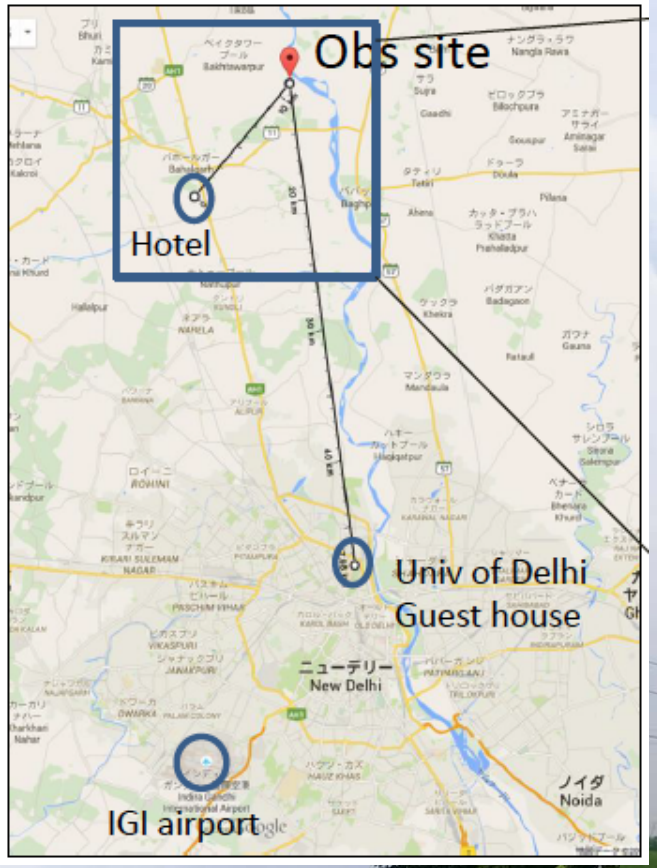
- July 26- August 3, 2015 with the project members
- Purpose of the visit is to decide appropriate observation sites in India and Bangladesh

Juy 28, with farmers family in Sonepat

July 30, at Tamil Nadu Rice Reserch Institute

Sonepat

open in Sep. 2014
under agreement
between Tokyo Univ
and Delhi Univ.

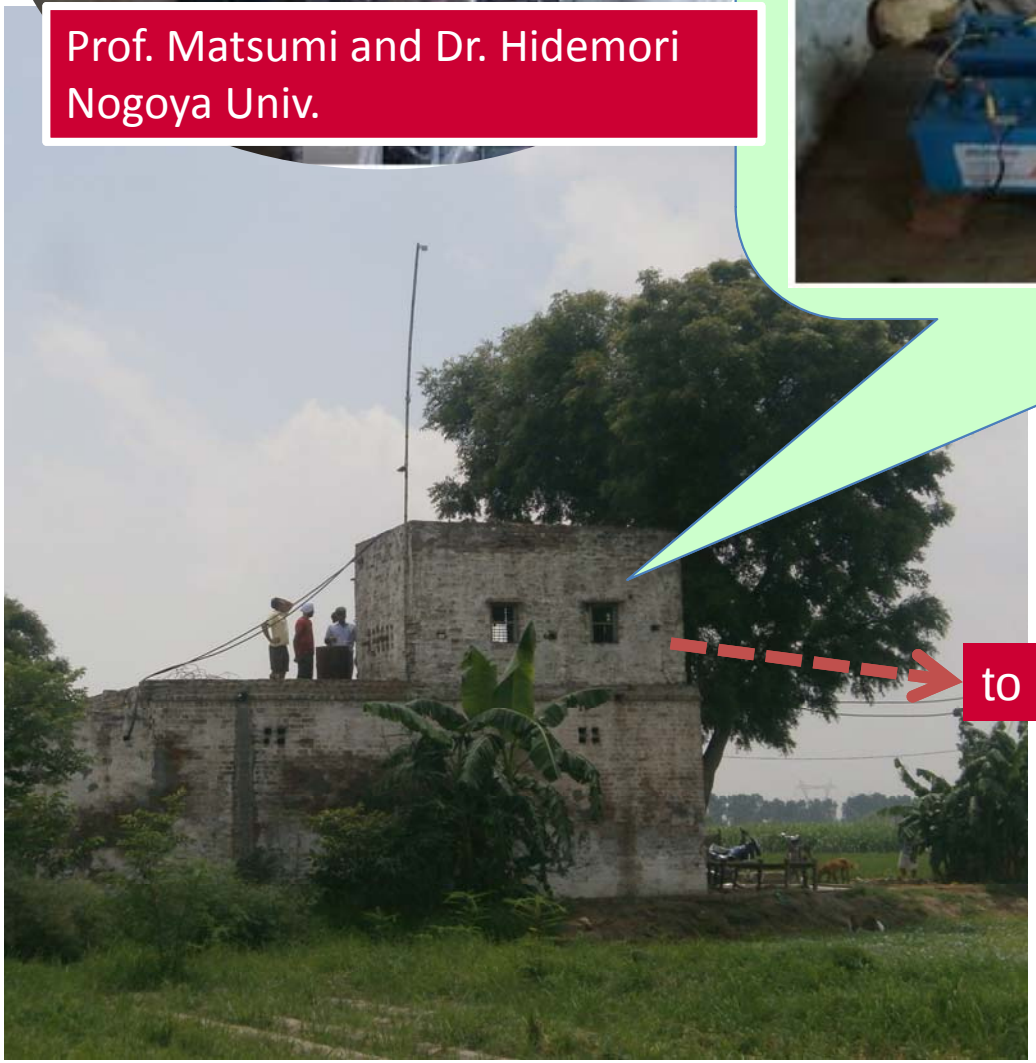


Field rooter including
wind, humidity, soil moisture,
and camera that can be
monitored in Japan

Flask Sampling

Gas flask sampling in the pomp house in the middle of farming areas in Sonepat
Gas sampling started in Sep. 2014
sampled once a week by Jagmohan
analyzed in NIES (Terao and Nomura)

Prof. Matsumi and Dr. Hidemori
Nogoya Univ.



to a reflector

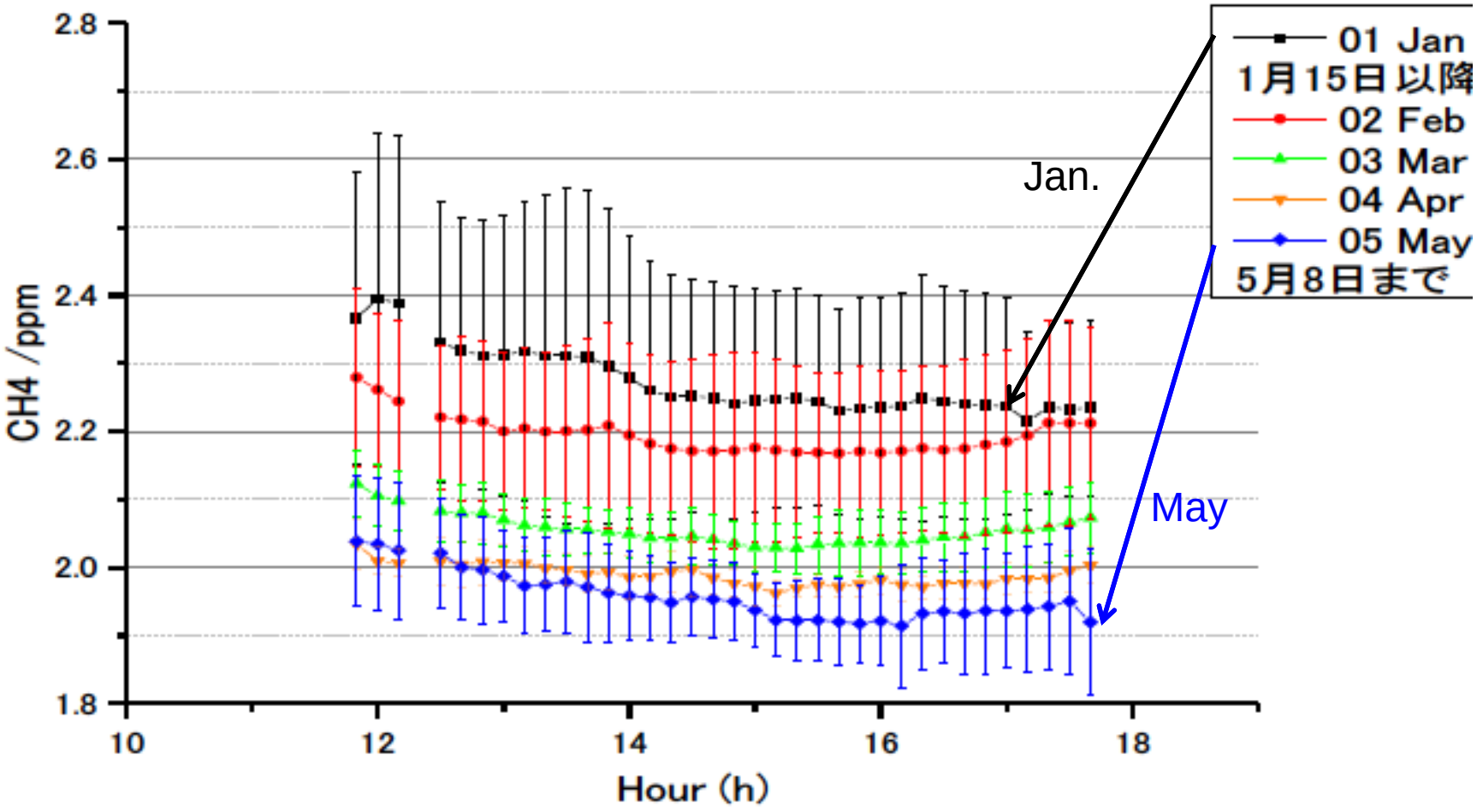
The Laser methane instrument
is installed in a storage barn.
24hrs. continuous measurement

Supported by GRENE-ei project,
and Tokyo Univ. and Delhi Univ.

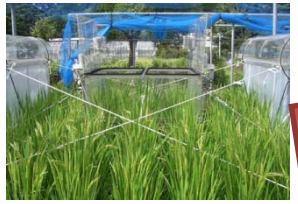
Laser Methane instrument: Diurnal Variation

Courtesy of Dr. Hidemori and Prof. Matsumi (Nagoya Univ.)

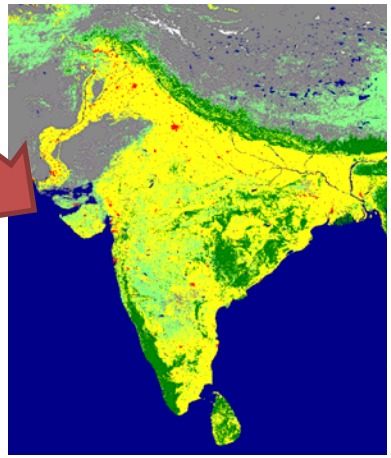
supported by GRENE-ei project



Mitigation Potential Scenario (NIAES)

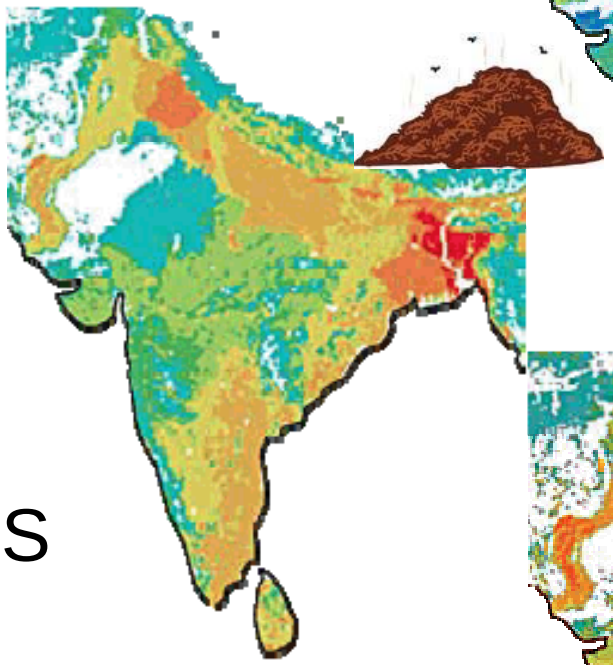


(image of process)

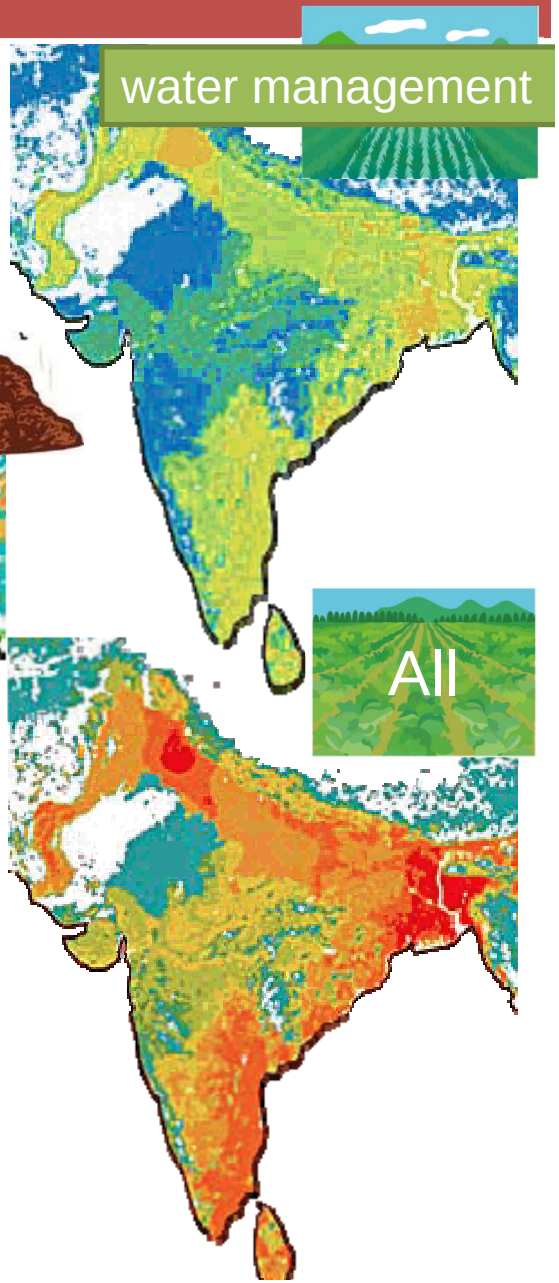


+GIS

fertilizer management



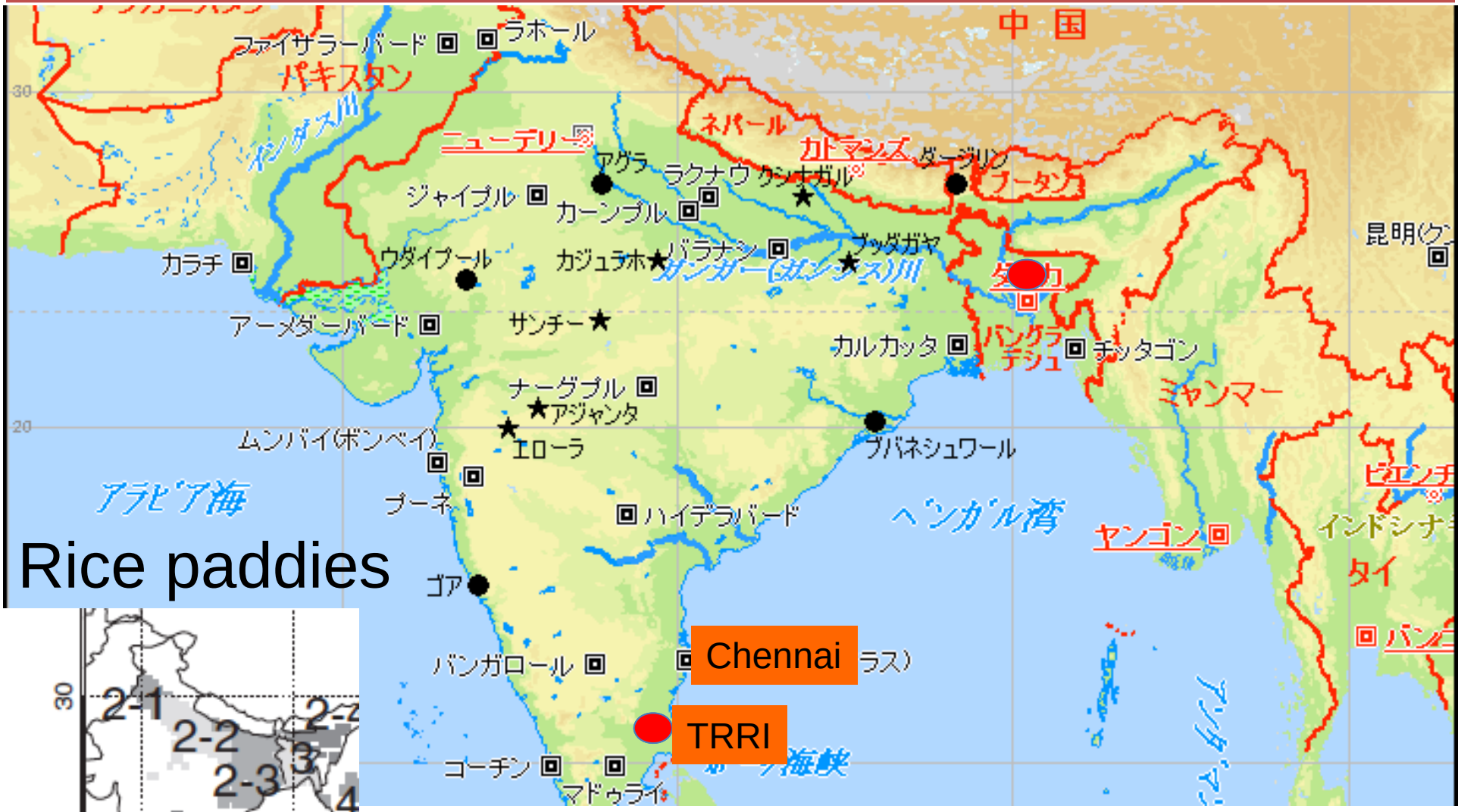
water management



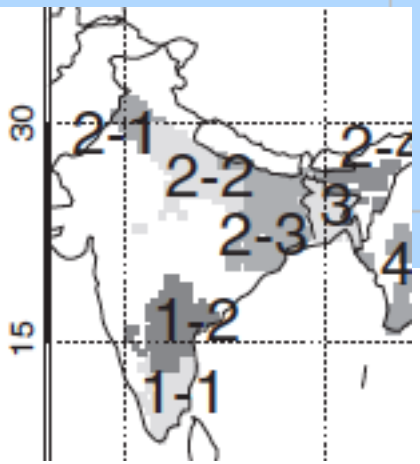
All

NIAES

Experiments for Mitigation

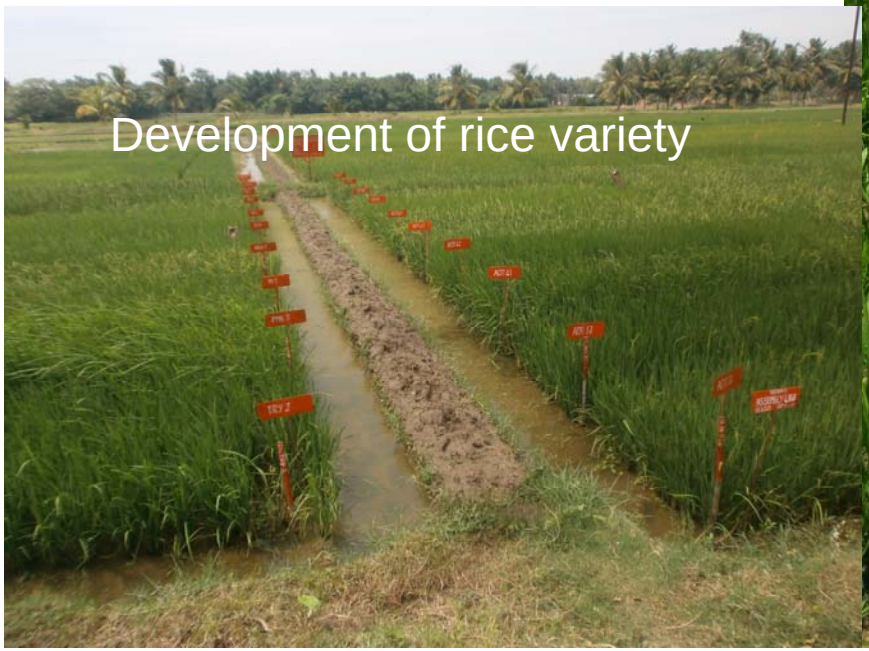


Rice paddies



Tamil Nadu Rice Research Insutitute, Aduthral, on July 30, 2015

Tamil Nadu Rice Research Insutitute

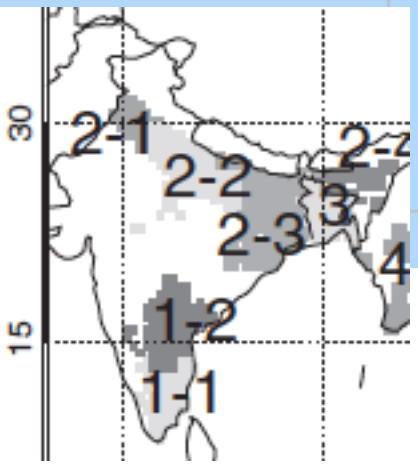


Tamil Nadu, Soil and Water Manageent Research Institute on July 30, 2015

Experiment of water management

Flux measurements

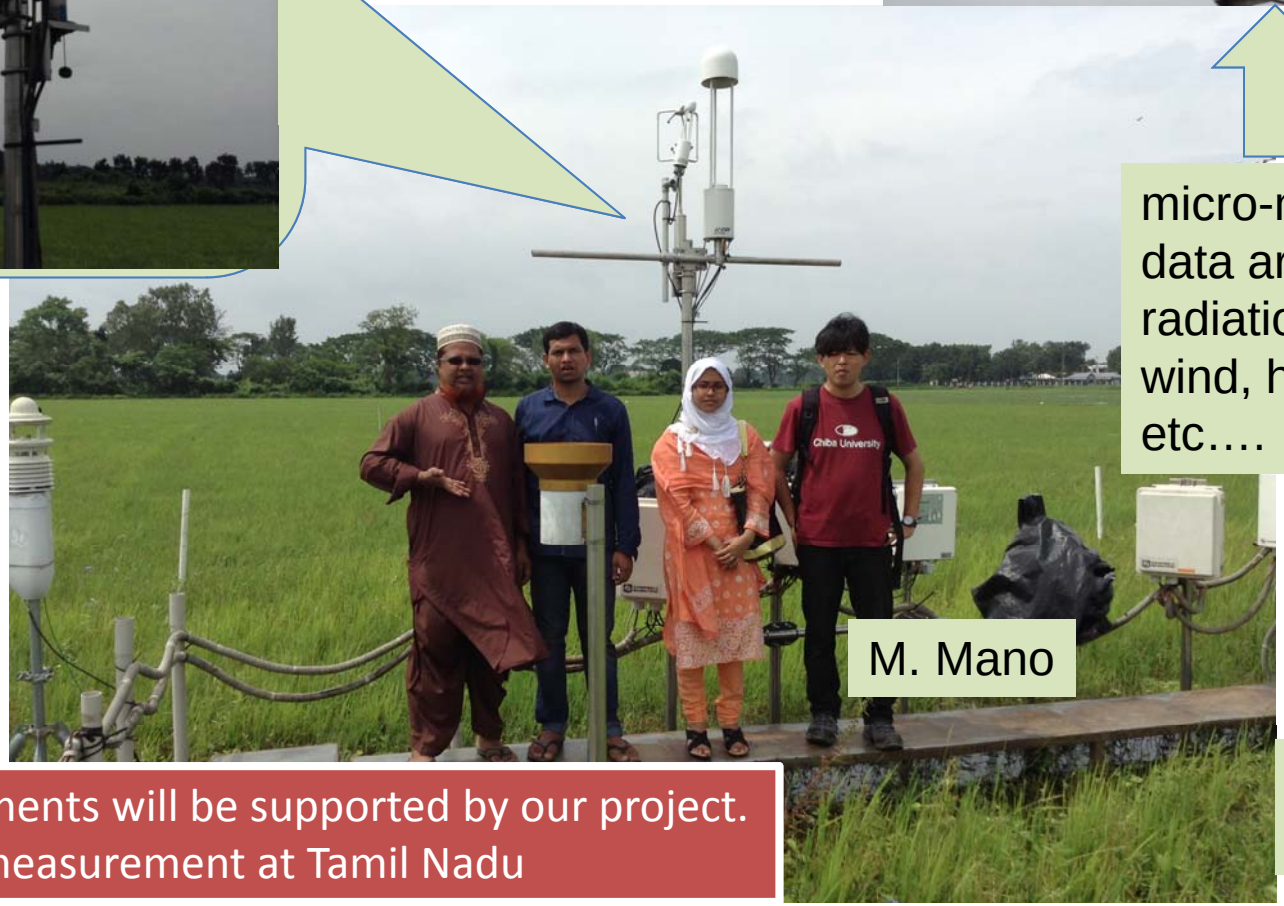
Rice paddies



Visit at Bangladesh Agricultural Univ., August 2-3, 2015

Bangladesh Agricultural Univ. Mymensingh, Bangladesh

Eddy covariance
flux measurement
of CO_2 and CH_4



M. Mano

micro-meteorological
data are obtained,
radiation, PAR,
wind, humidity, temp.
etc….

soil water
content…

Flux measurements will be supported by our project.
We will start measurement at Tamil Nadu

Summary

- We have started a new project “Improvement of Methane Emission Estimate from South Asia using GOSAT and Development of an Emission Mitigation Proposal” under ERTDF sponsored by MOE in June 2015.
- The project includes: Satellite data analysis and in situ measurements of methane, and flux measurement.
- From July 26, we visited India and Bangladesh to survey new sites that are fit to our project purpose.

On August 2, at BAU

http://www.ics.nara-wu.ac.jp/lab/ertdf/
(English page is now under construction)
Sachiko Hayashida
sachiko@ics.nara-wu.ac.jp

Thank for your attention!