# Diagnosing GHG Emission Through GOSAT Over Indonesian Area

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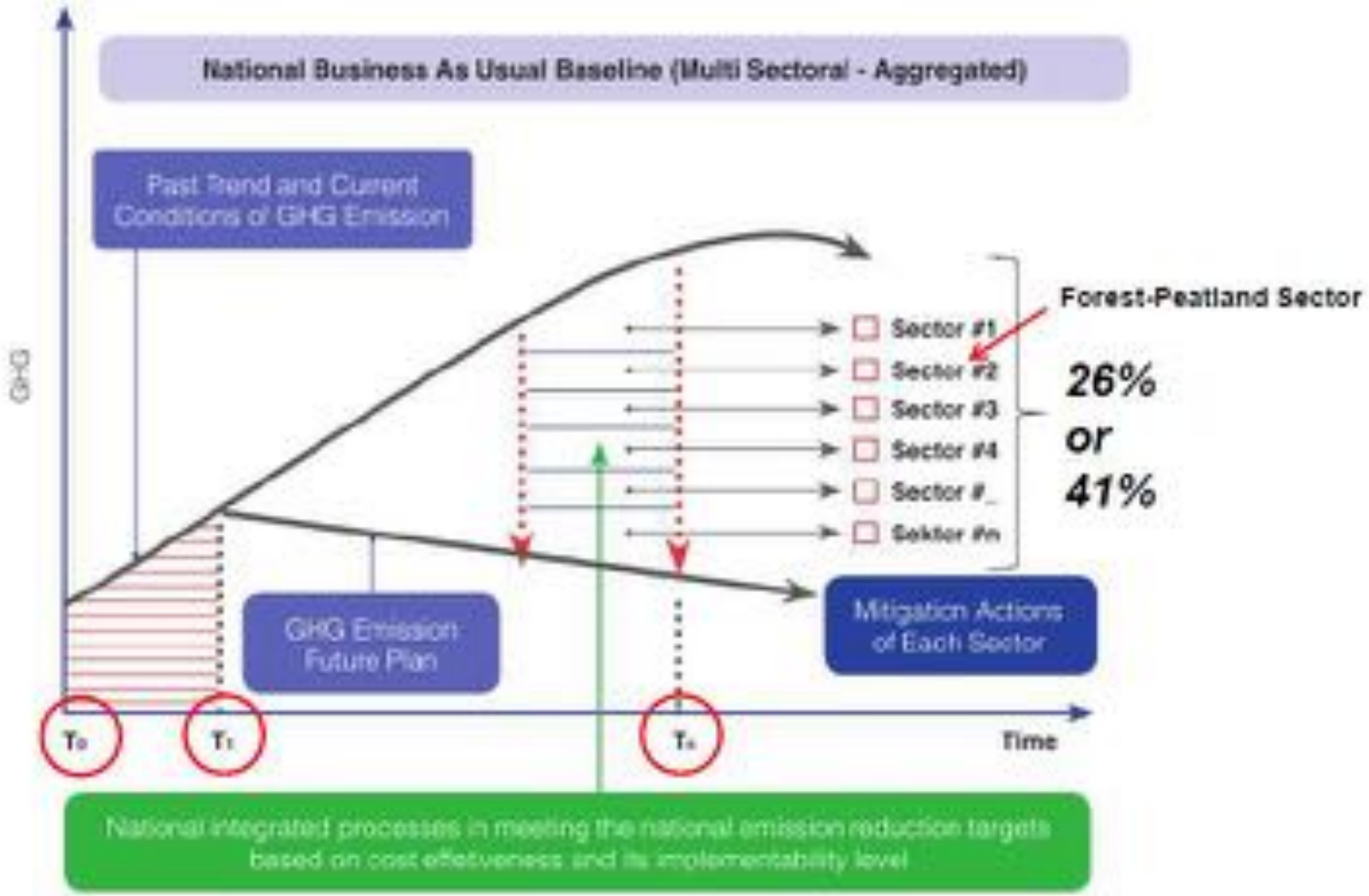
# Talk Outline

- Peat Forest and climate change issue
- MRV (Measurement – Reporting – Varification)
- GOSAT Tanso-FTS analysis
- Assimilating and visualization GOSAT with meteorological data
- FES (Fibre Ethalon Solar) or “Nafas Bumi”
- New Idea : Inversion Layer Trapping Method

# SATREPS Project (JST-JICA)
# 2008 - 2013
# “Wild Fire and Carbon Management in Peat-Forest”

# GHG Reduction Action Plan




**Only remote sensing data can be used for past land cover change on baseline (REL/RL) assessment**

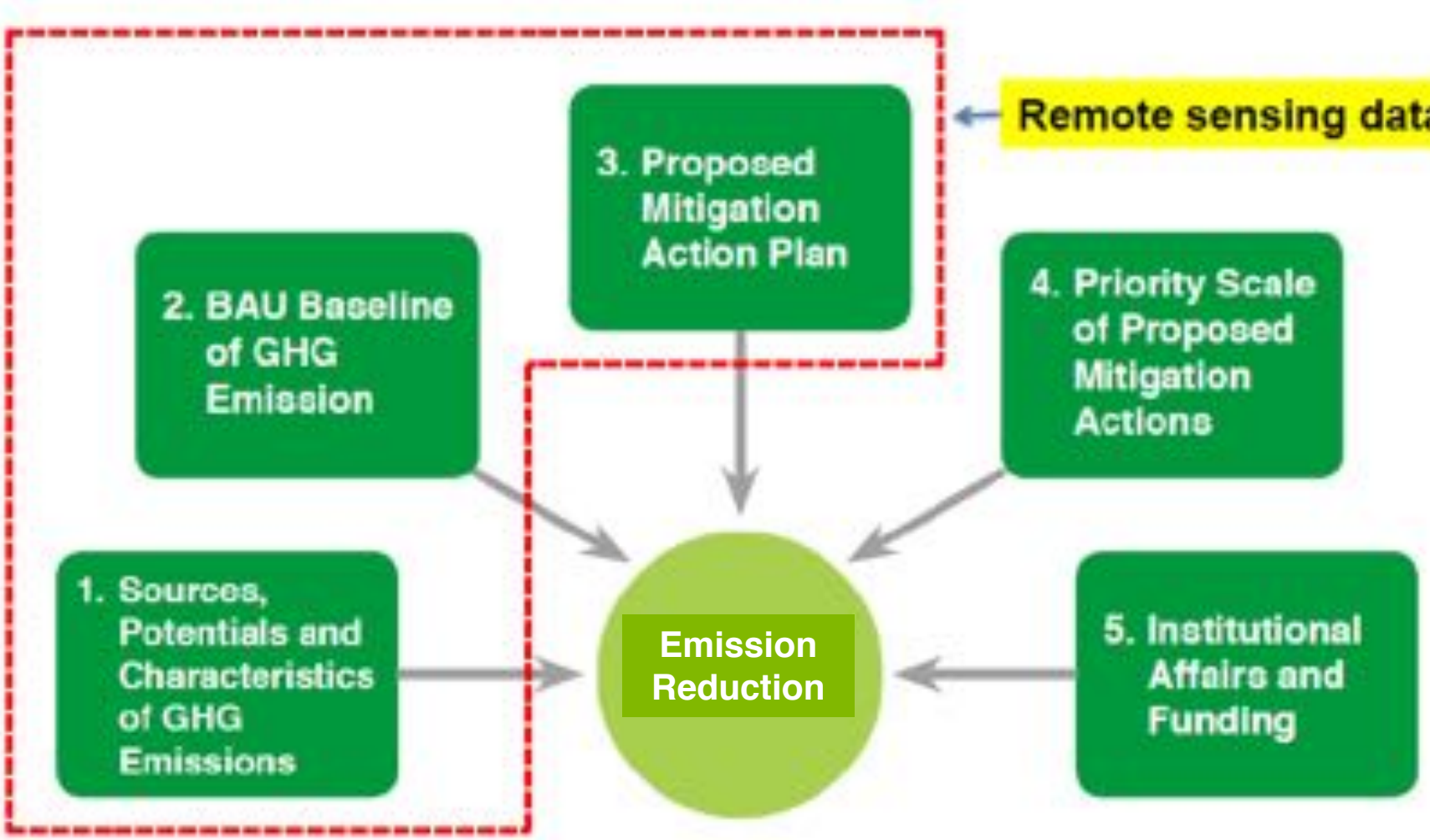
# Contribution of Satellite Data

2009: **COP15** at Copenhagen

To establish…, robust and transparent national forest monitoring systems … that:.(i) Use a combination of ***remote sensing and ground-based forest carbon inventory approaches*** for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes (FCCC/CP/2009/11/Add.1)

# Contribution of Satellite Data

## Emission Reduction Plan




**Key Subtances for emission reduction**

# Global Carbon Dioxide ($CO_2$)

- The average global $CO_2$ concentration in 2010 was 389 ppm (World Data Center for Greenhouse Gas), which is 11.9 ppm greater than 2004
- $CO_2$ concentration has increased 39% from pre-industrial global level of 280 ppm
- Terestrial and marine environments are able to absorb approximately one-half to three-quarter of the emitted $CO_2$
- Observation of GHG in the atmosphere are important for predicting global climate change

# Emission Sources

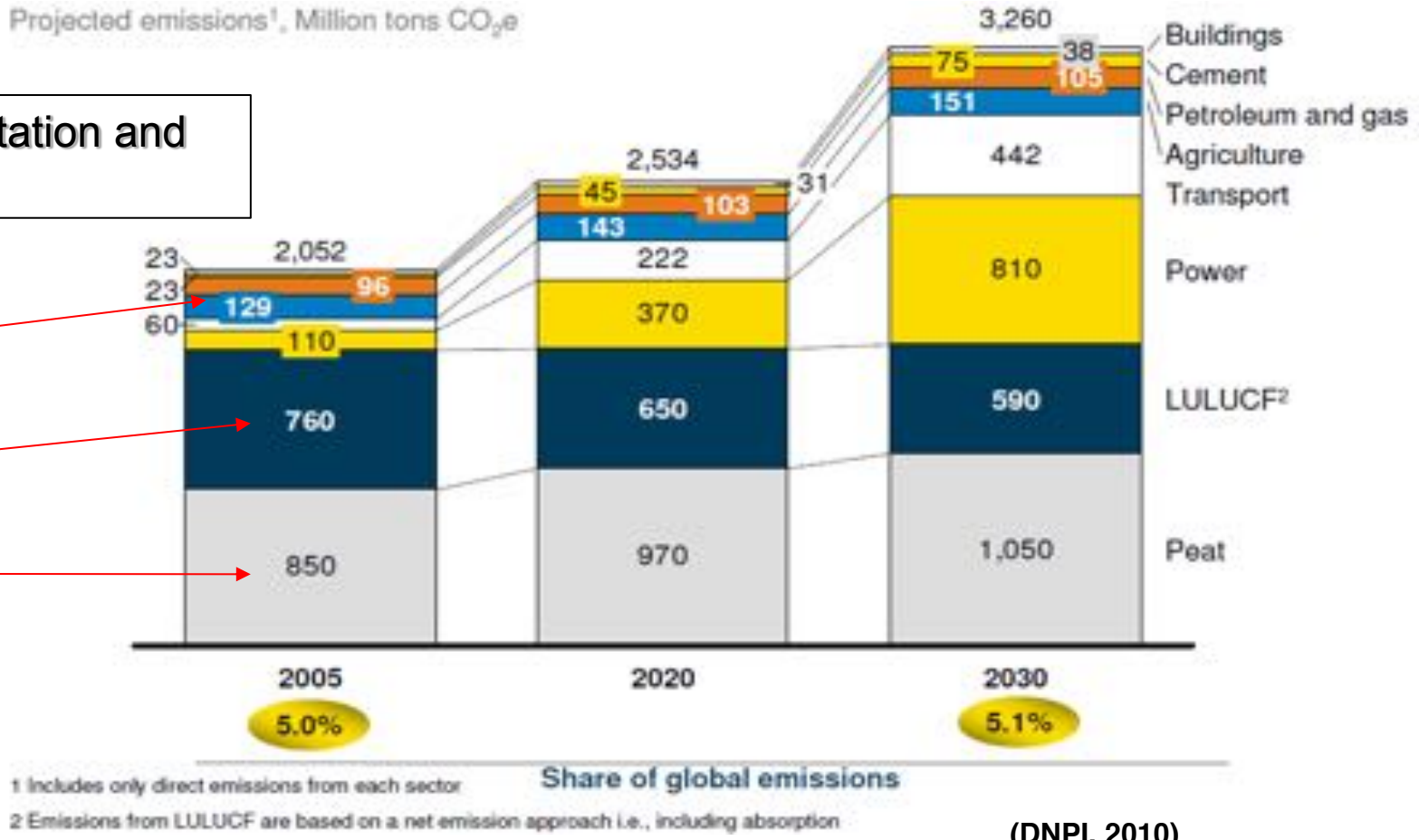
Emission estimated to grow from 2.1 to 3.3 $GtCO_2e$ between 2005 and 2030

85% from Deforestation and Degradation

Agriculture: 6%

LULUCF: 37%

Peat : 41%




(DNPI, 2010)

# Worldwide peatland

Yakutia, Russian Federation

Kyrgystan

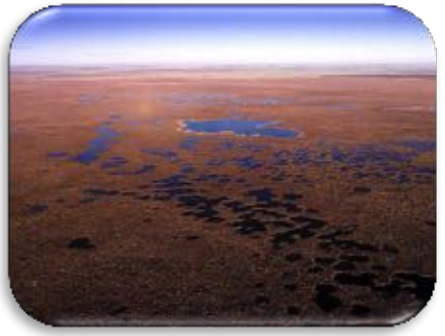
Northwest Territories, Canada

Sichuan, China

Ruaha River Tanzania

Archangelsk, Russian Federation

Tierra del Fuego Argentina



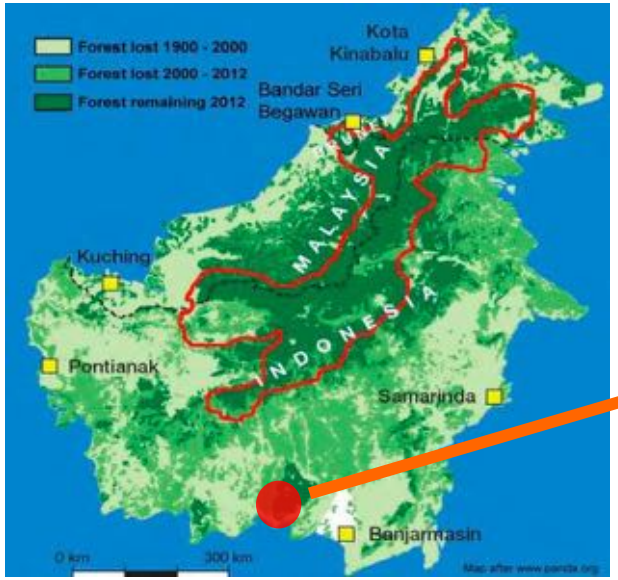
Flow Country, Scotland

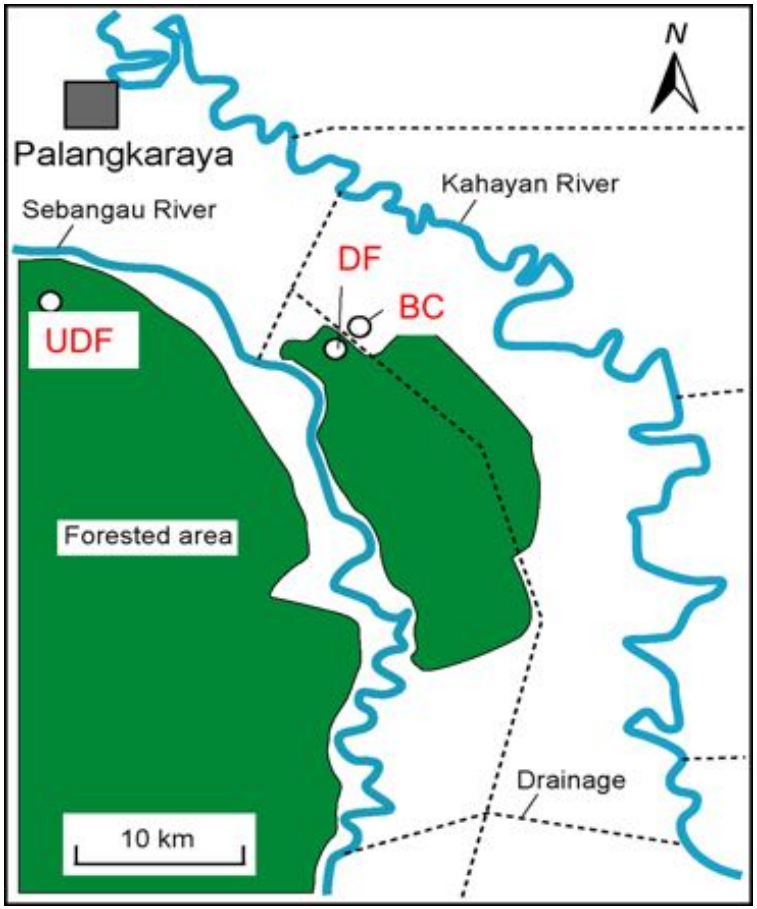
Berbak National Park, Indonesia

# Worldwide peatland

# Worldwide peatland

## Central Kalimantan




**$CO_2$ observation towers**

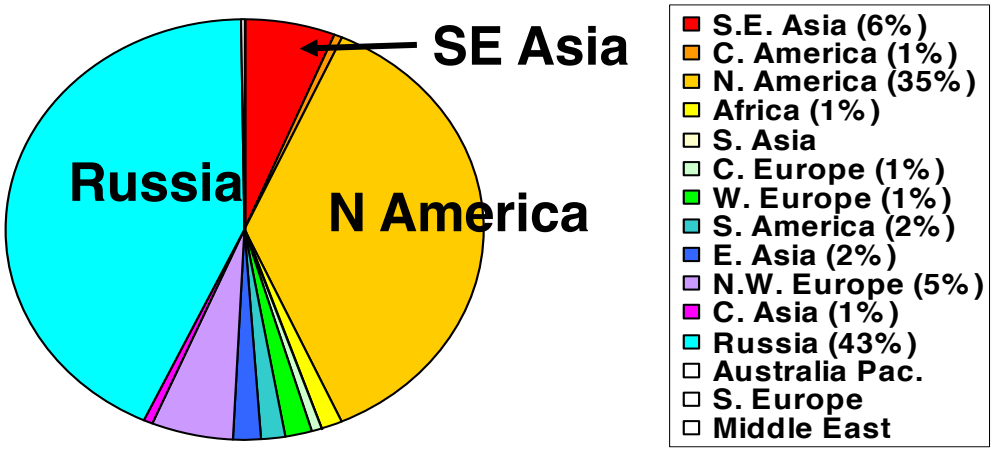
**UDF : (Un-drained Peat)**

**DF : (Drained Peat )**

**BC : (Burnt Carbon Peat)**

# Worldwide peatland

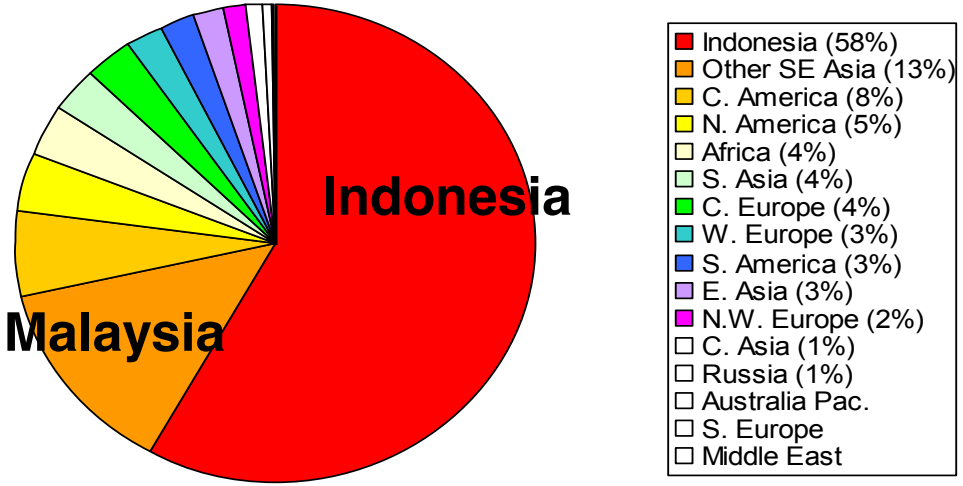
**Peatland extent by region**
**(global total: 381 Mha; source: PEAT CO2)**




**6%** **of global *peat* area**

**50-70% of global peat emissions**

**$CO_2$ emissions from oxidation in drained peatlands (fires excluded), by region**
**(global total: 887 Mt/y; source: PEAT-CO2)**




**< 0.1%** **of global *land* area**

**5-8%** **of global $CO_2$ emissions**

Source : Wetland International

# Peatland Issues

- Deforestation
- Degradation
  - Drainage
  - Fires

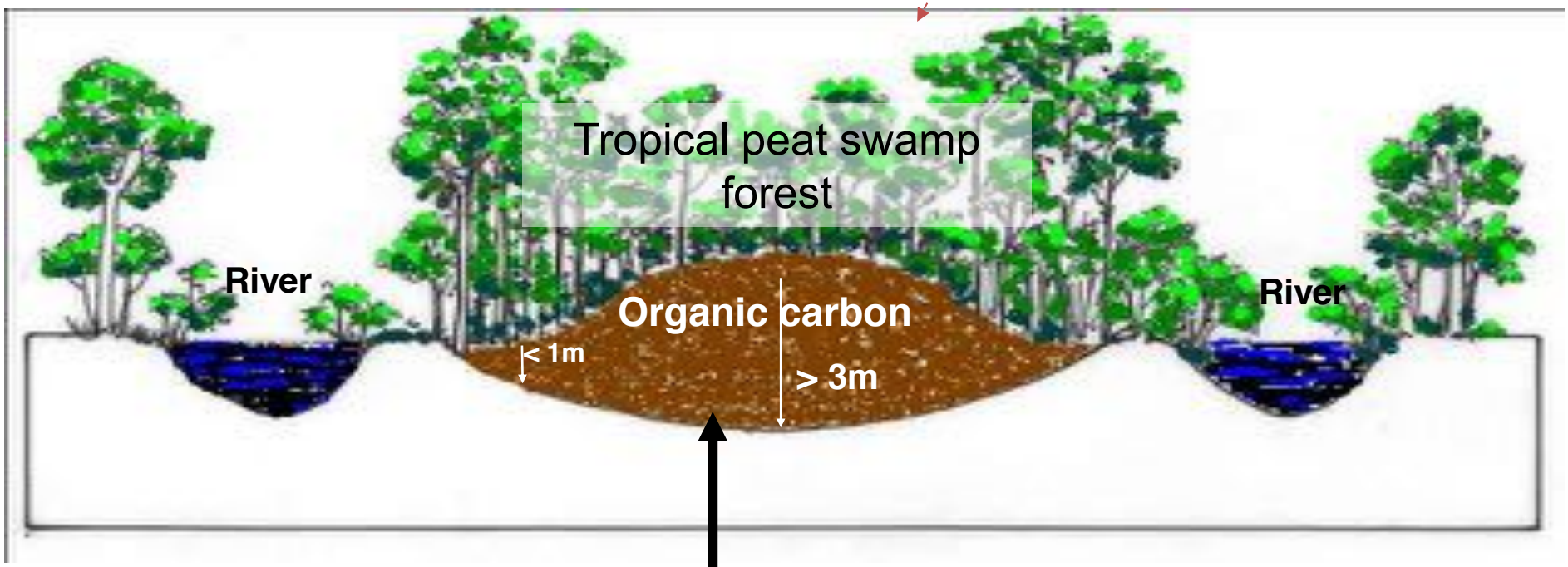
# Peat Forest

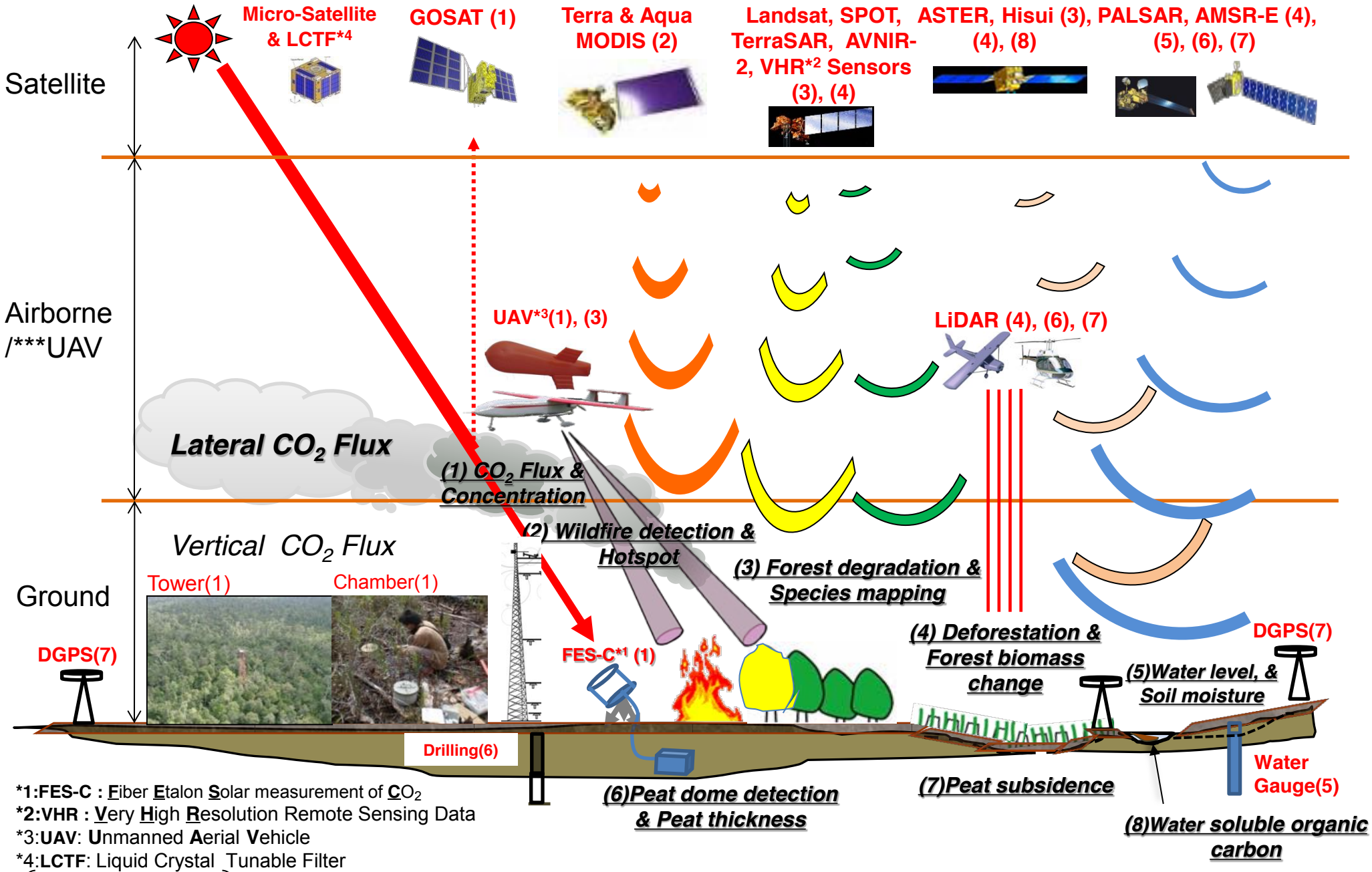
**Peat**

Organic matter accumulated over thousands of years, storing concentrated carbon in thick layers

**Tropical Peat swamp forest** is formed mainly from rain forest tree

**The peat bog is rain water fed**

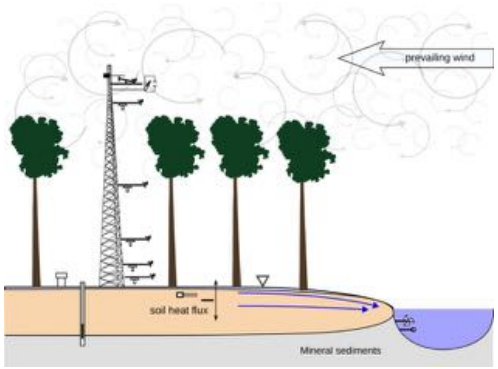





*1:**FES-C** : **F**iber **E**talon **S**olar measurement of **C**$O_2$
*2:**VHR** : **V**ery **H**igh **R**esolution Remote Sensing Data
*3:**UAV**: **U**nmanned **A**erial **V**ehicle
*4:**LCTF**: Liquid Crystal Tunable Filter

**Red: Instrument**
**Black: Target**

# Key Elements of Tropical Peatland Carbon Assessment System



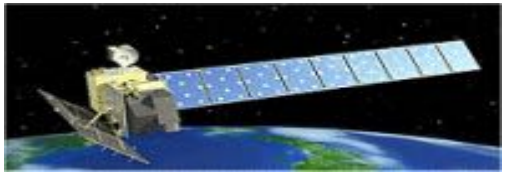

Eddy Cov-Flux tower

Tethered Balloon


Optical Spectometer Analyzer (FES)

Unmanned Air Vehicle

LIDAR

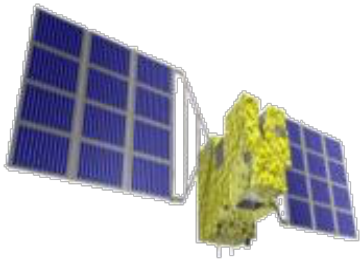


ALOS/PALSAR



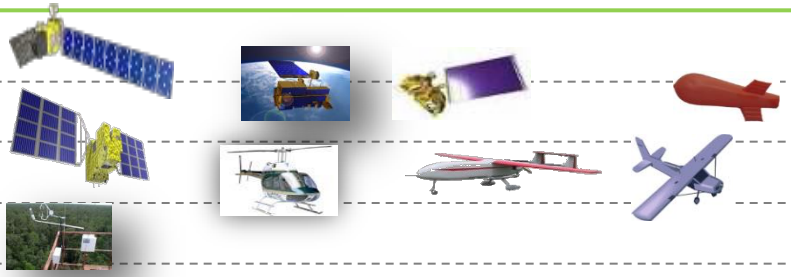
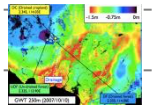
Hyperspectral sensor (HyMAP)

ASTER

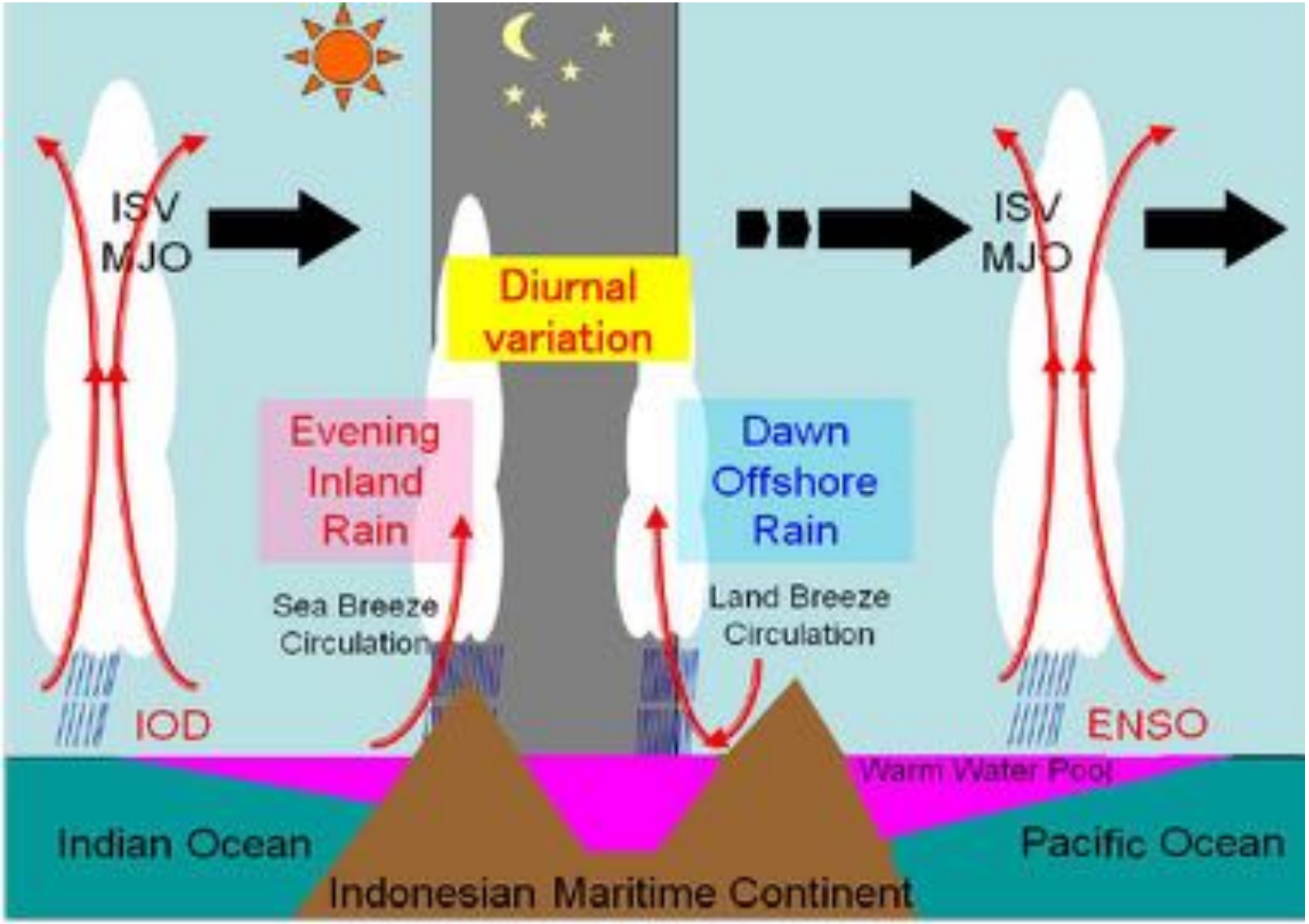


GOSAT

# MRV and Instruments

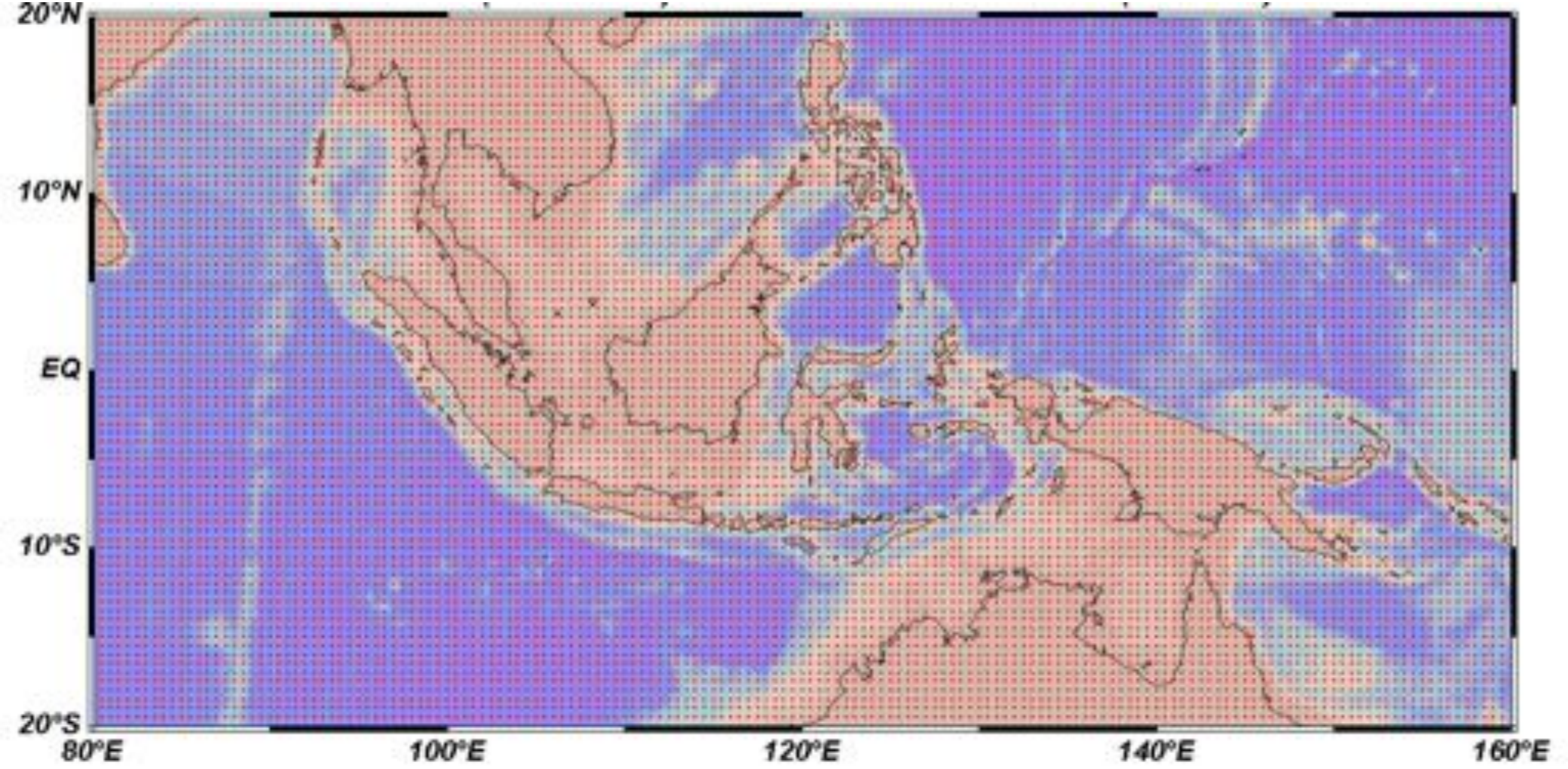
| | Tasks | Instruments |
|---|---|---|
| M | ▪ Land use/land use change<br>▪ Land cover/land cover change<br>▪ Degradation<br>▪ Emission (fire), carbon flux |  |
| | ▪ Biomass above ground<br>▪ Biomass below ground<br>▪ Dead wood<br>▪ Litter<br>▪ Soil/peat |  <br>  <br>  |
| | ▪ Forest conservation<br>▪ Carbon enhancement<br>▪ SFM<br>▪ Compile inventory |  <br>  |
| R | ▪ International | |
| | ▪ Domestic | ▪ MRV agency |
| | ▪ Donor | ▪ MRV agency |
| V | ▪ QA | ▪ Independent partner |
| | ▪ Independent ver. | ▪ Independent partner |

# Maritime Continent

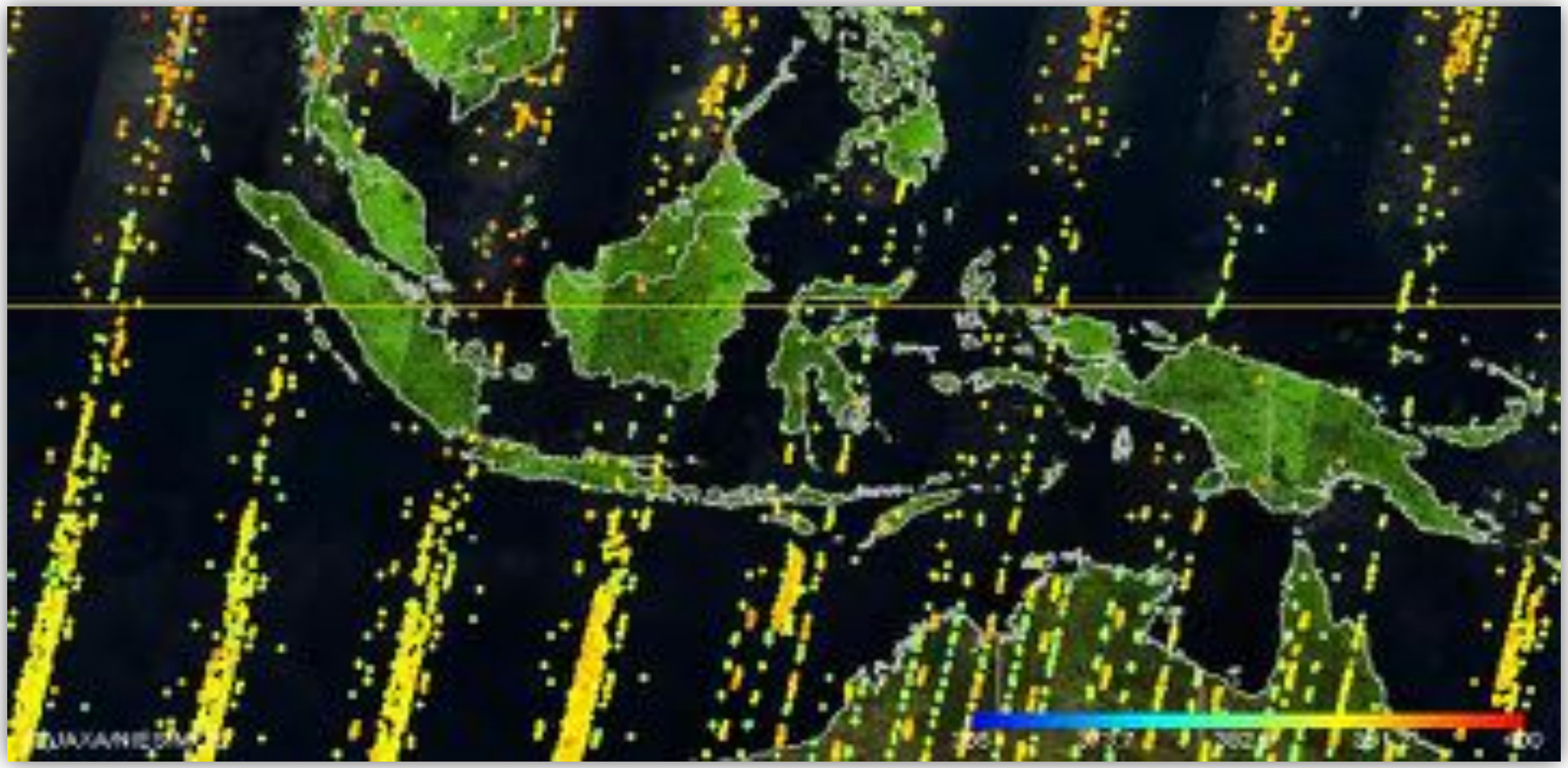


# Grid MAP of GOSAT

Grid Map of GOSAT Data over Indonesia ( 0.5$^{o}$ x 0.5$^{o}$)



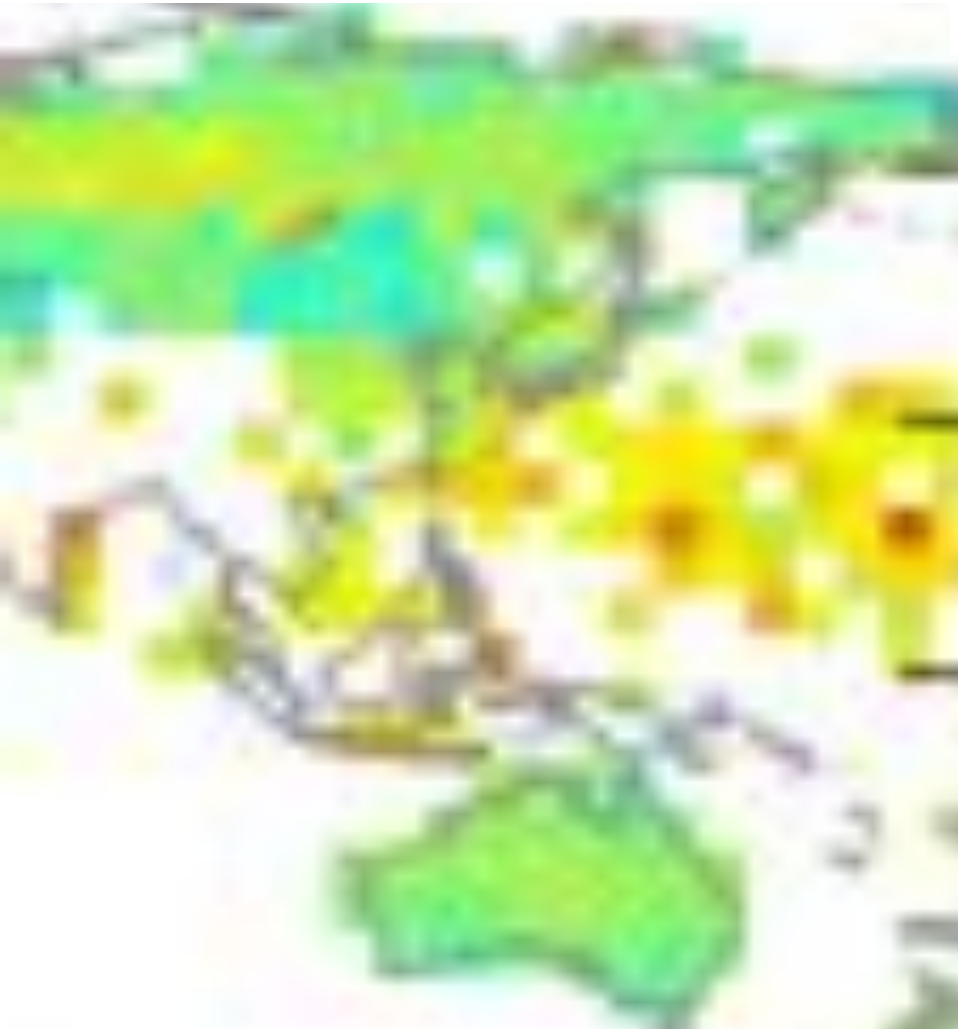
# GOSAT Footprint over tropical Area

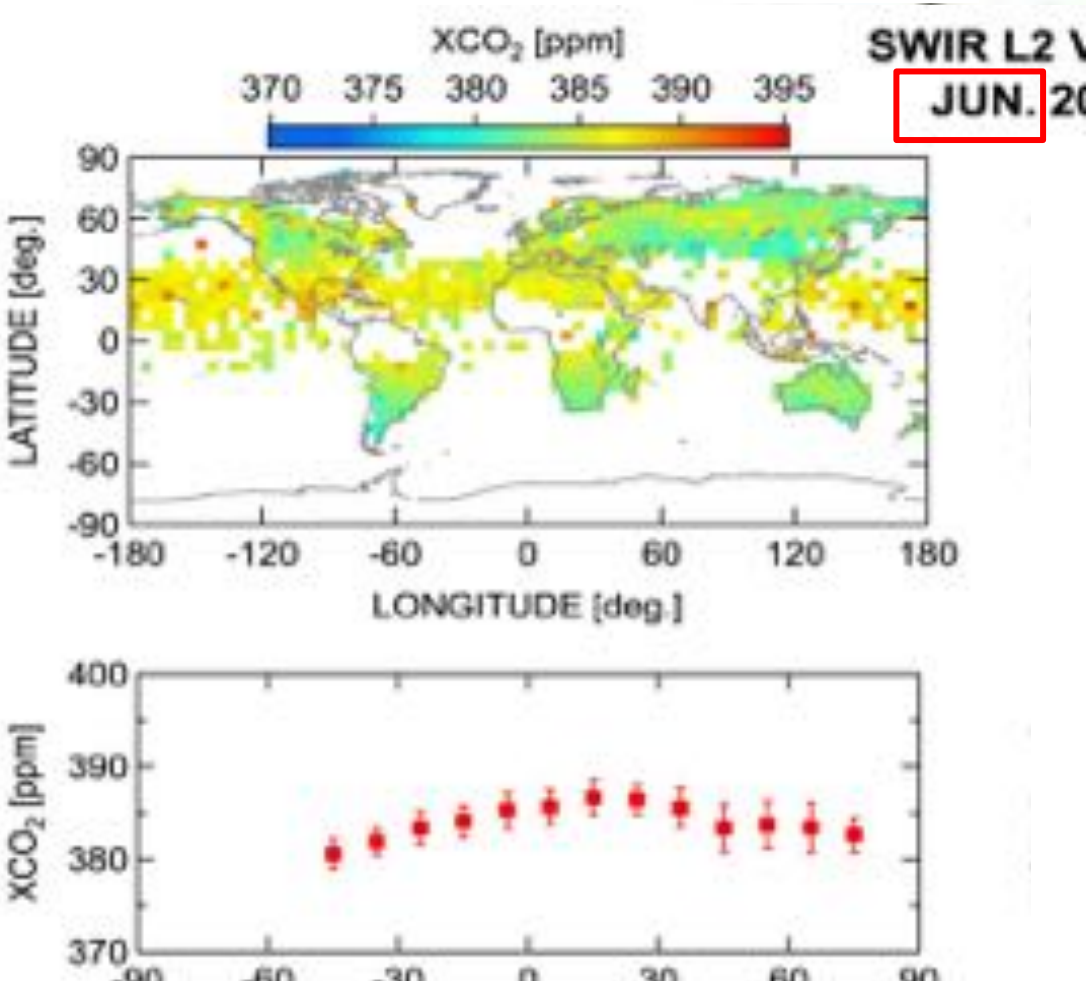


GOSAT covers tropical area with limited data as the cloud cover

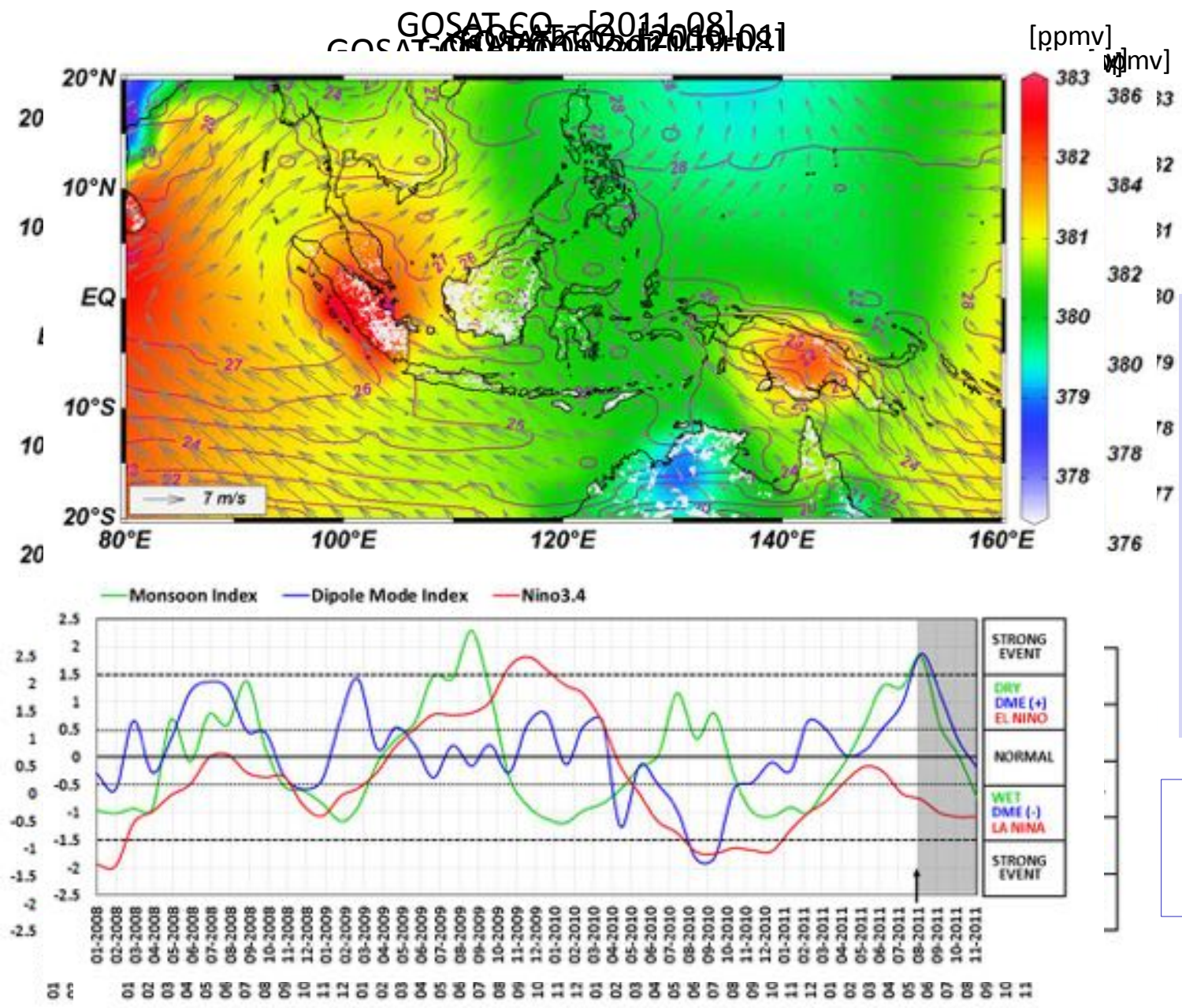
# JUN. 2009

## GOSAT DATA





# GOSAT $CO_2$ and Hot Spot

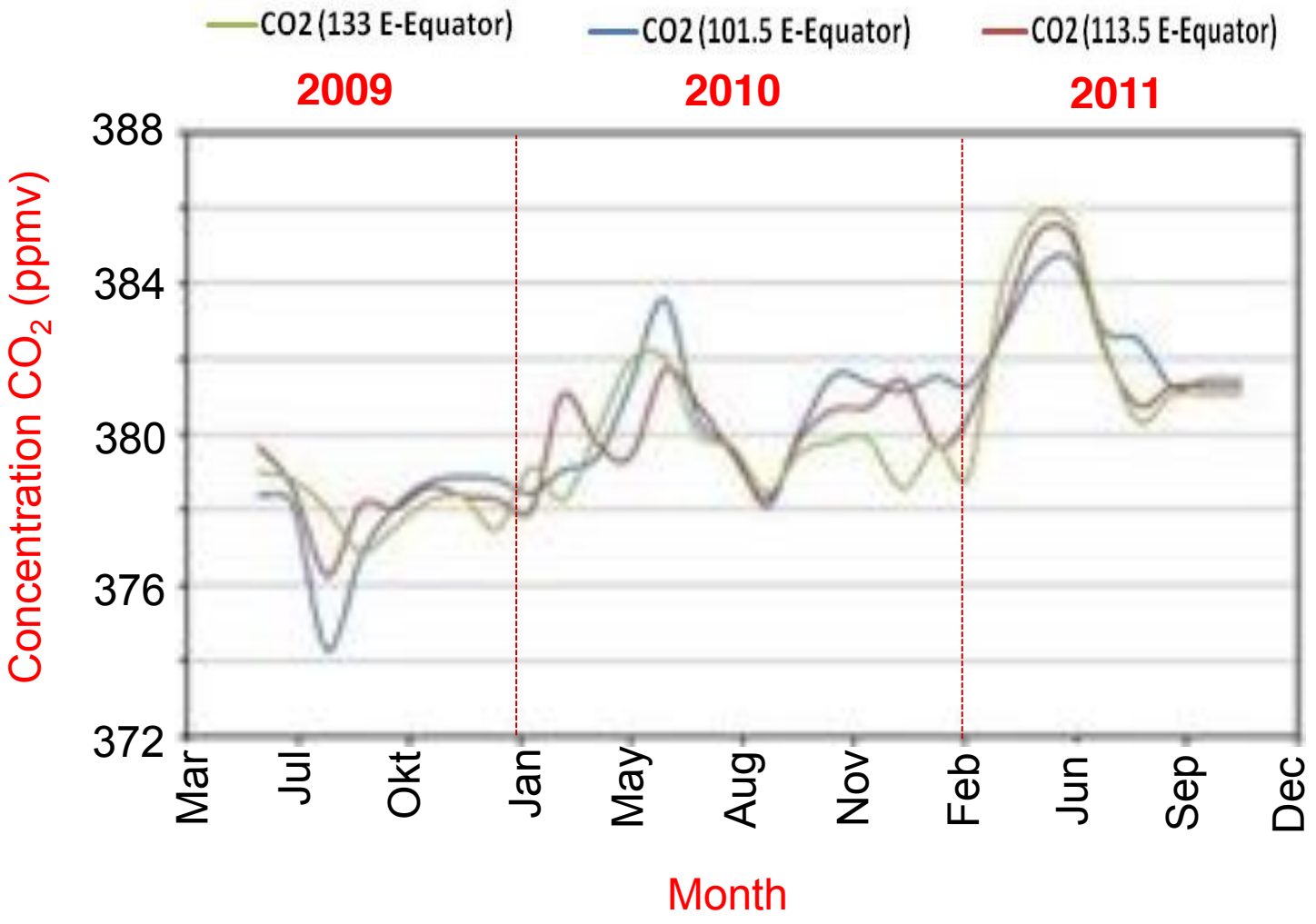



Data Source

- GHG : GOSAT
- Atmospheric parameter and wind : ESRL-NOAA (Earth System Research Laboratory)
- Hot Spot : FIRMS-EOSDIS-NASA (Fire Information for Resource Management System)
- El Nino/La Nina : NOAA
- Monsoon Index : JMA
- DME : Modeling (JAMSTEC)

TANSO FTS SWIR level 3 (Global $CO_2$ distribution), from June 2009 – November 2011

# Seasonal Variations of $CO_2$ Concentration



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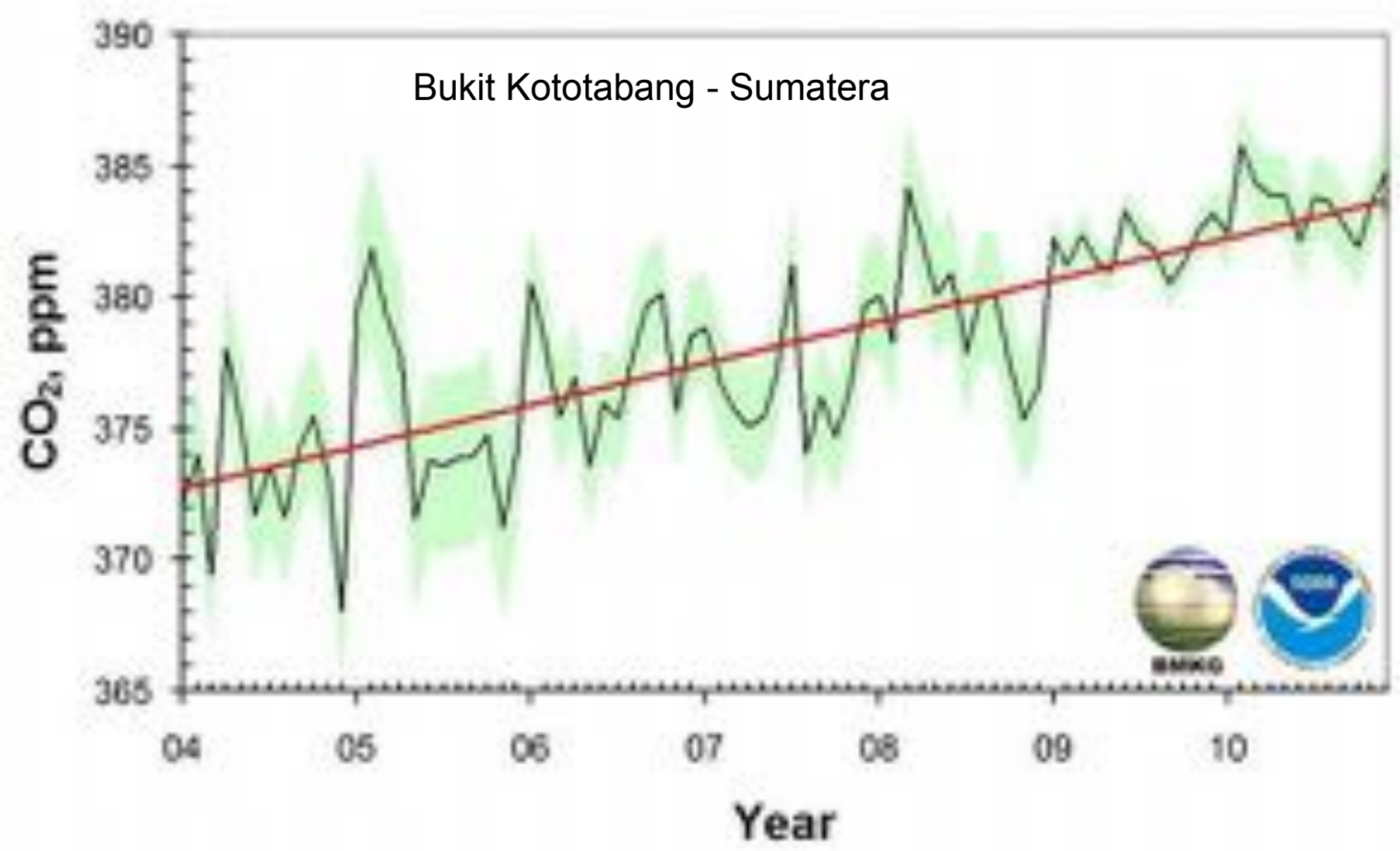

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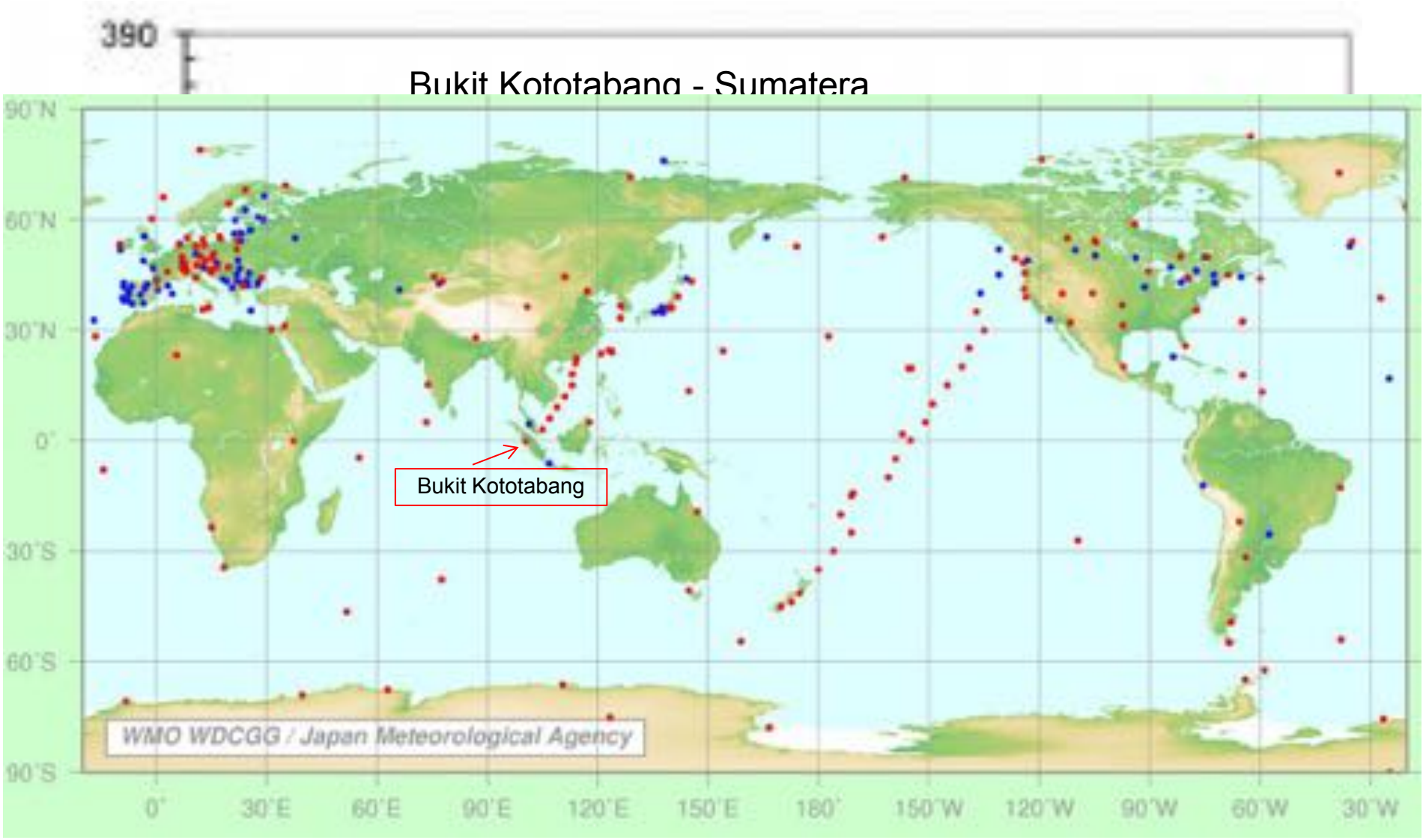
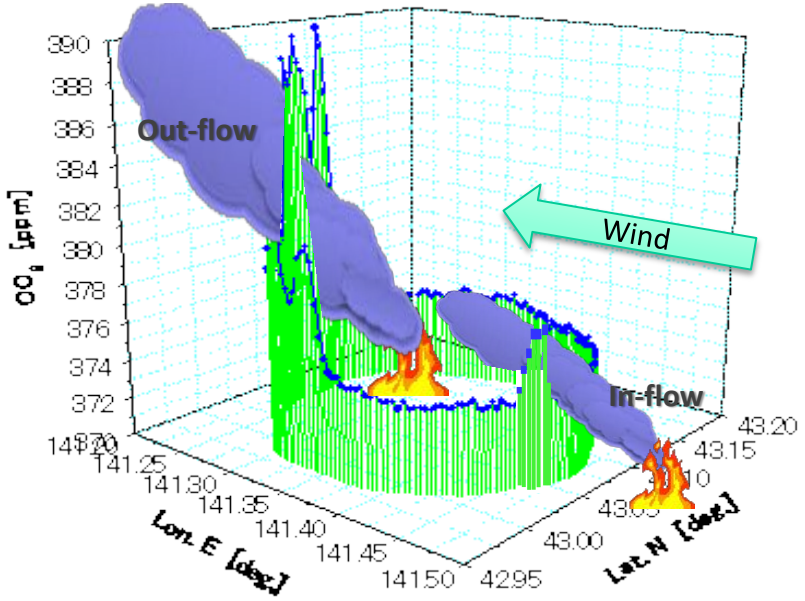
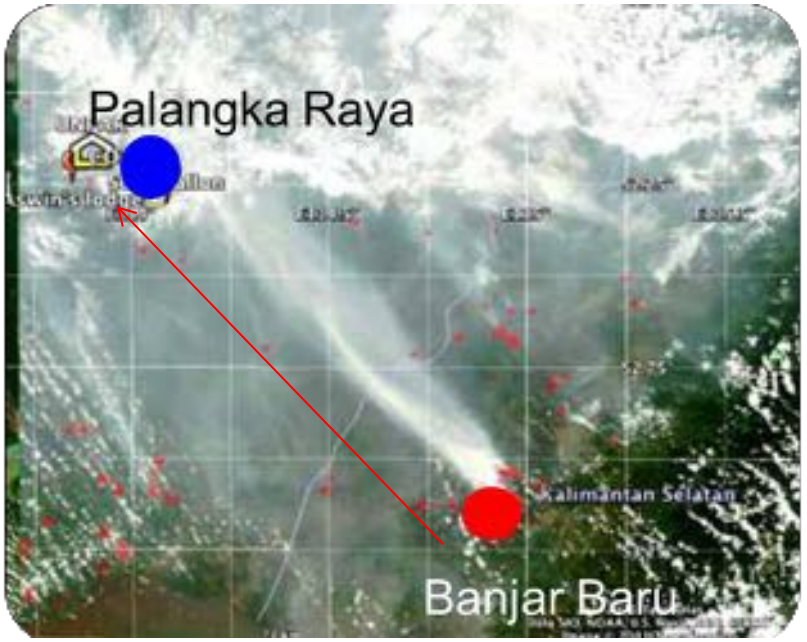


# FES Observation 2011

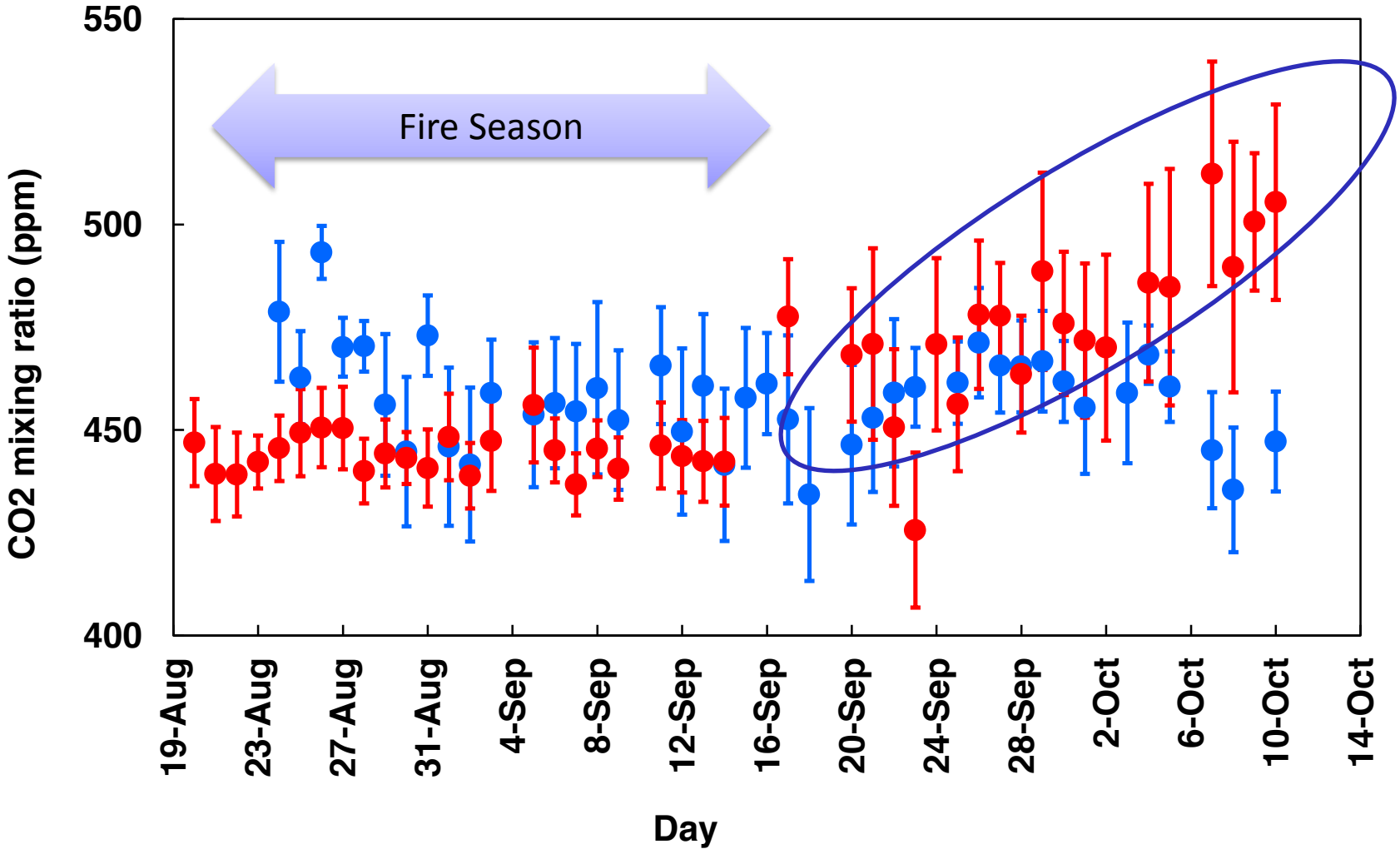

Notable difference in the $CO_2$ mixing ratios (ppm) between the out-flow point of Palangka Raya (central Kalimantan) and the in–flow point of Banjar Baru (South Kalimantan) (August , 2011).



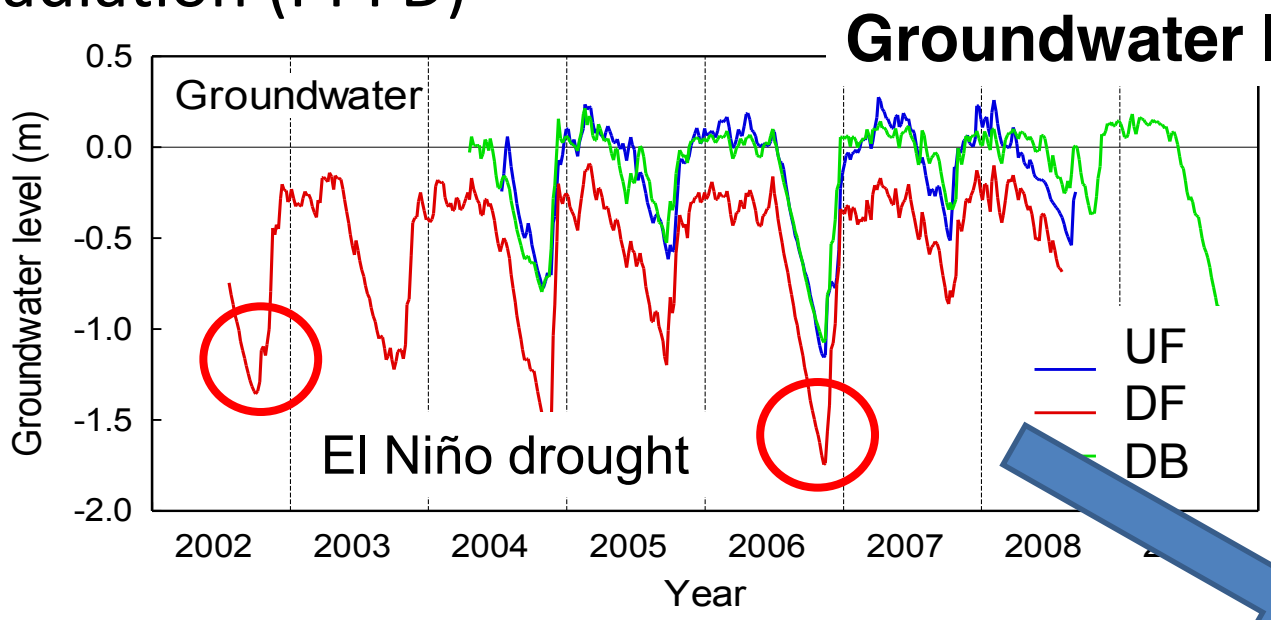



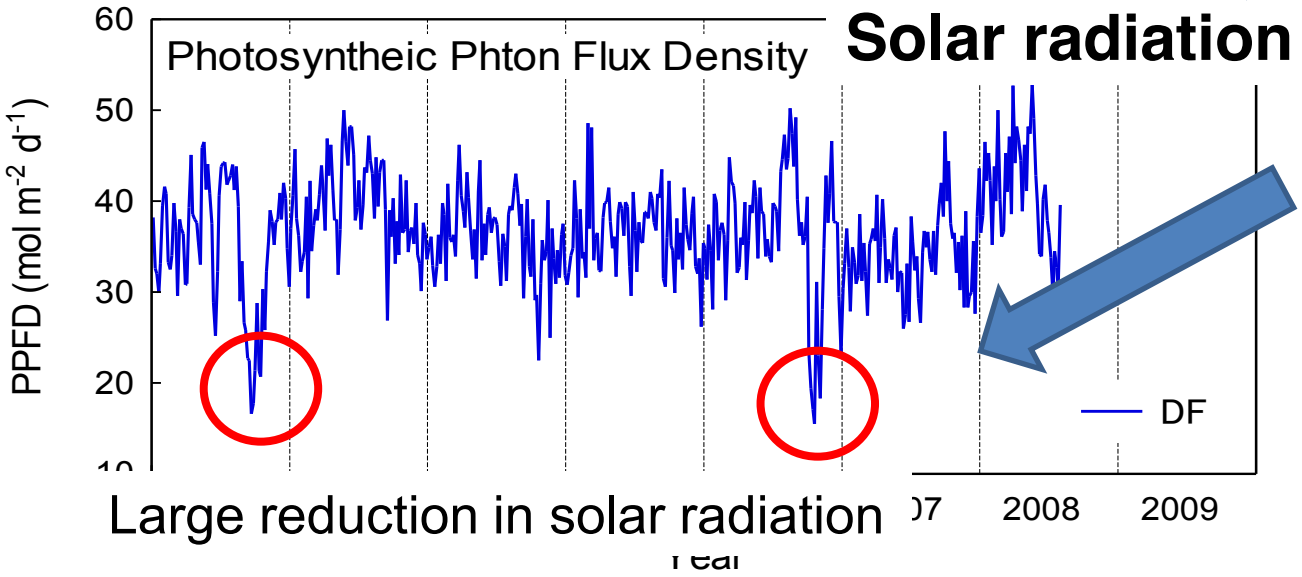
# FES Observation 2011

**Blue**: Palangka Raya (Central kalimantan), **Red**: Banjar Baru (South kalimantan)



# Seasonal variations in groundwater level (GWL) and solar radiation (PPFD)



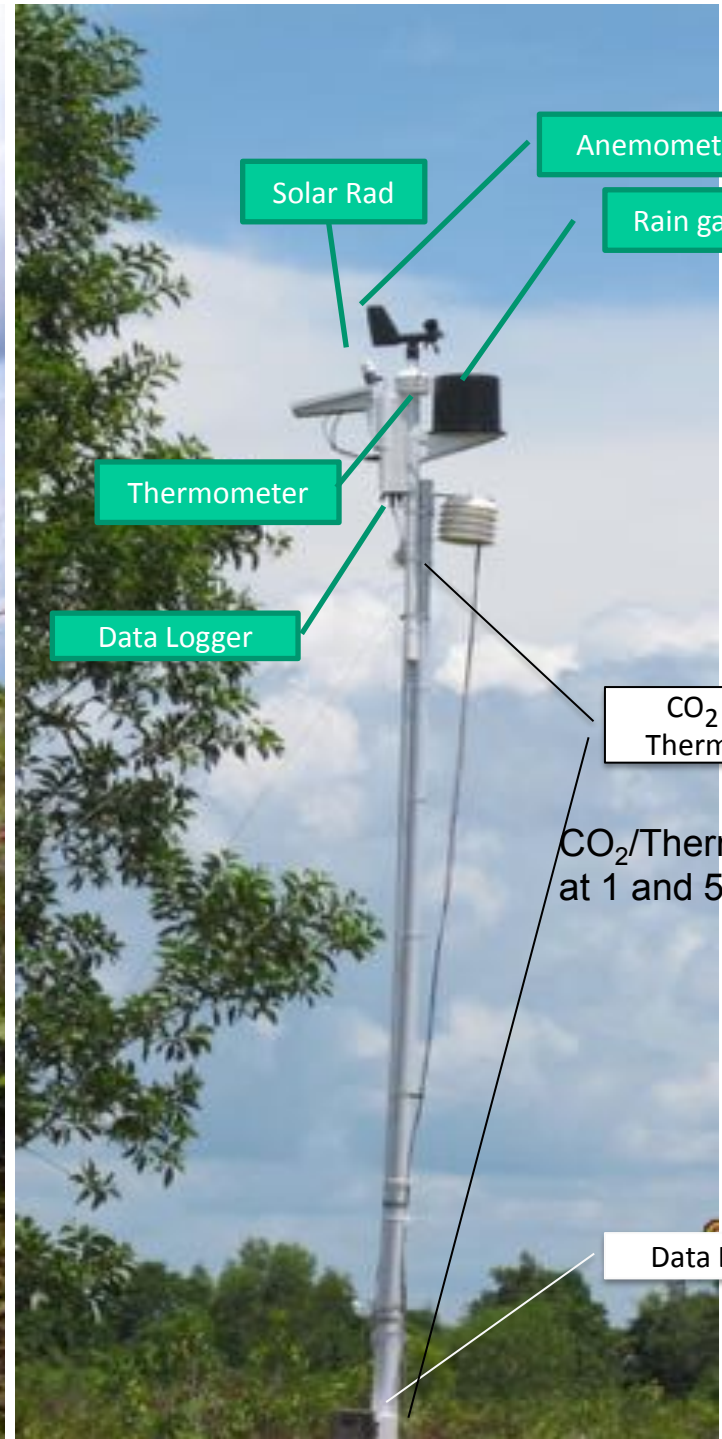

Large reduction in solar radiation

Large-scale fires


To: M. EVRI
In appreciation for
your support of the
Wyoming Air National Guard
Jakarta, Indonesia
1997
Col
Mission
Commander
1997 - 08

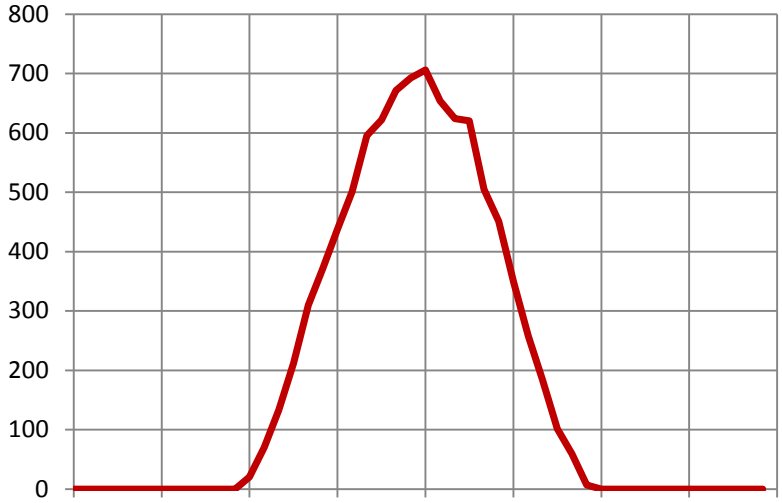
# $CO_2$ Flux measurement by Temperature Inversion Layer Trapping Method

Meteorological sensor installed in February 2012
Wind speed at night time < 4m/s ( selected 13 days).

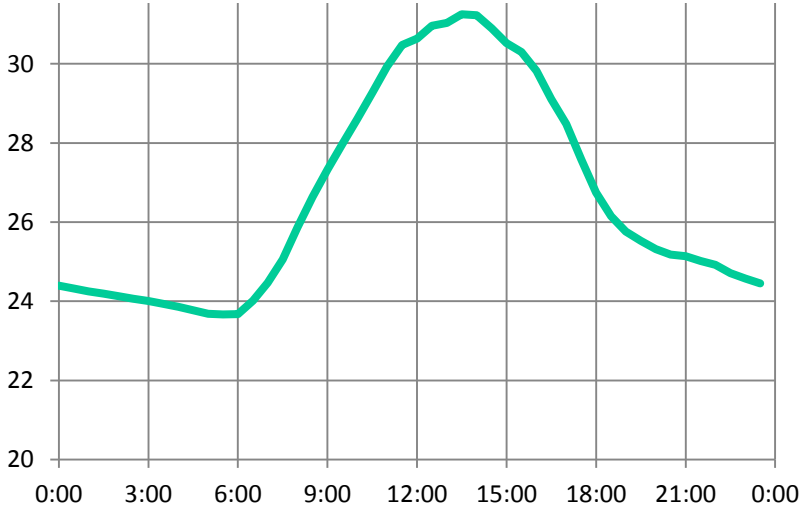


# Typical meteorological parameters averaged over calm days

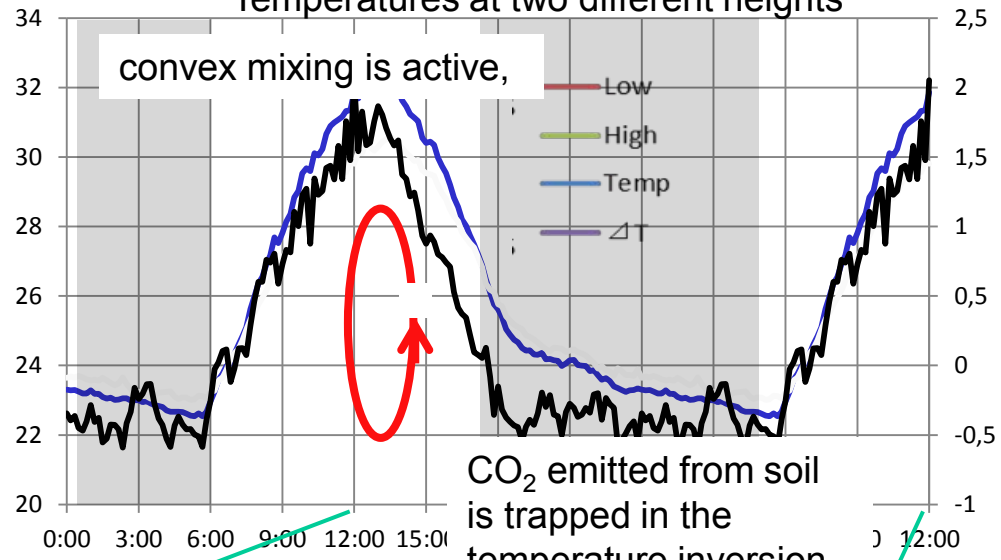
Solar radiation (red) and Temperature (green)



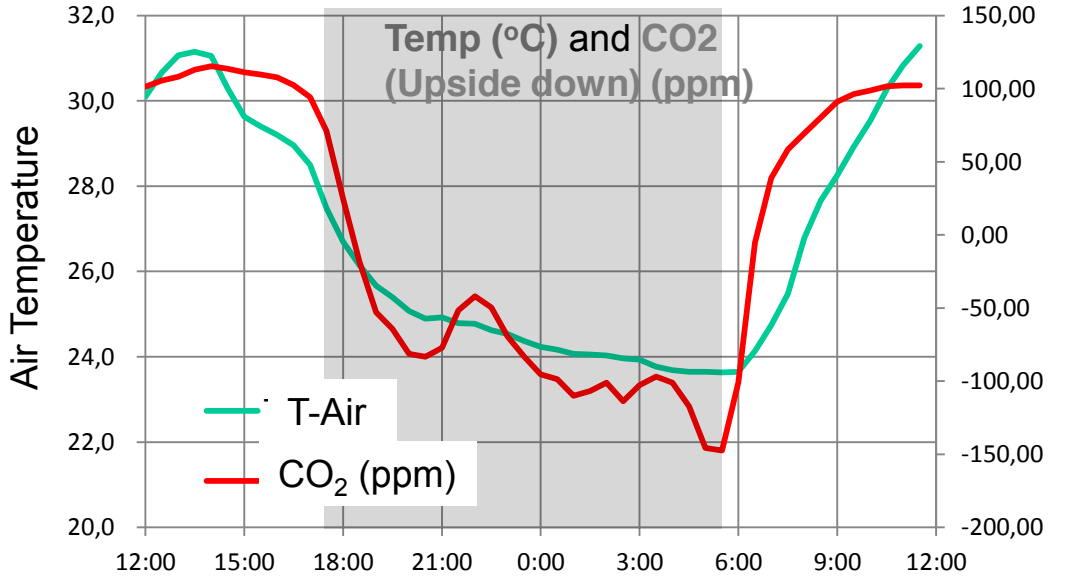

The solar radiation measured from 6 am to 6 pm. Air temperature decreases slowly and night-time cooling is obviously observed.




Temperatures at two different heights

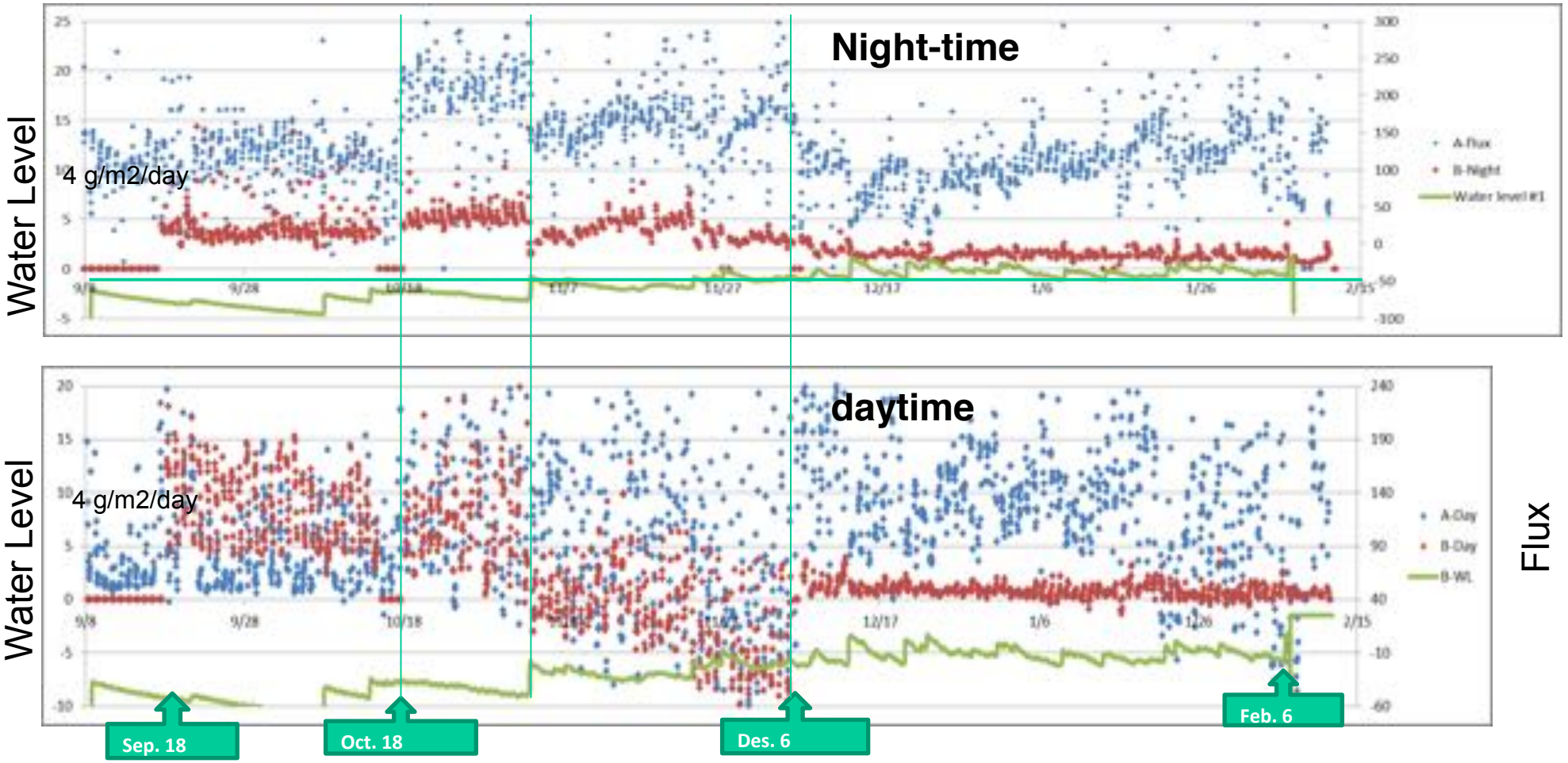



$CO_2$ emitted from soil is trapped in the temperature inversion




Note: $CO_2$ concentration is plotted upside down

# $CO_2$ Flux measurement using chamber method

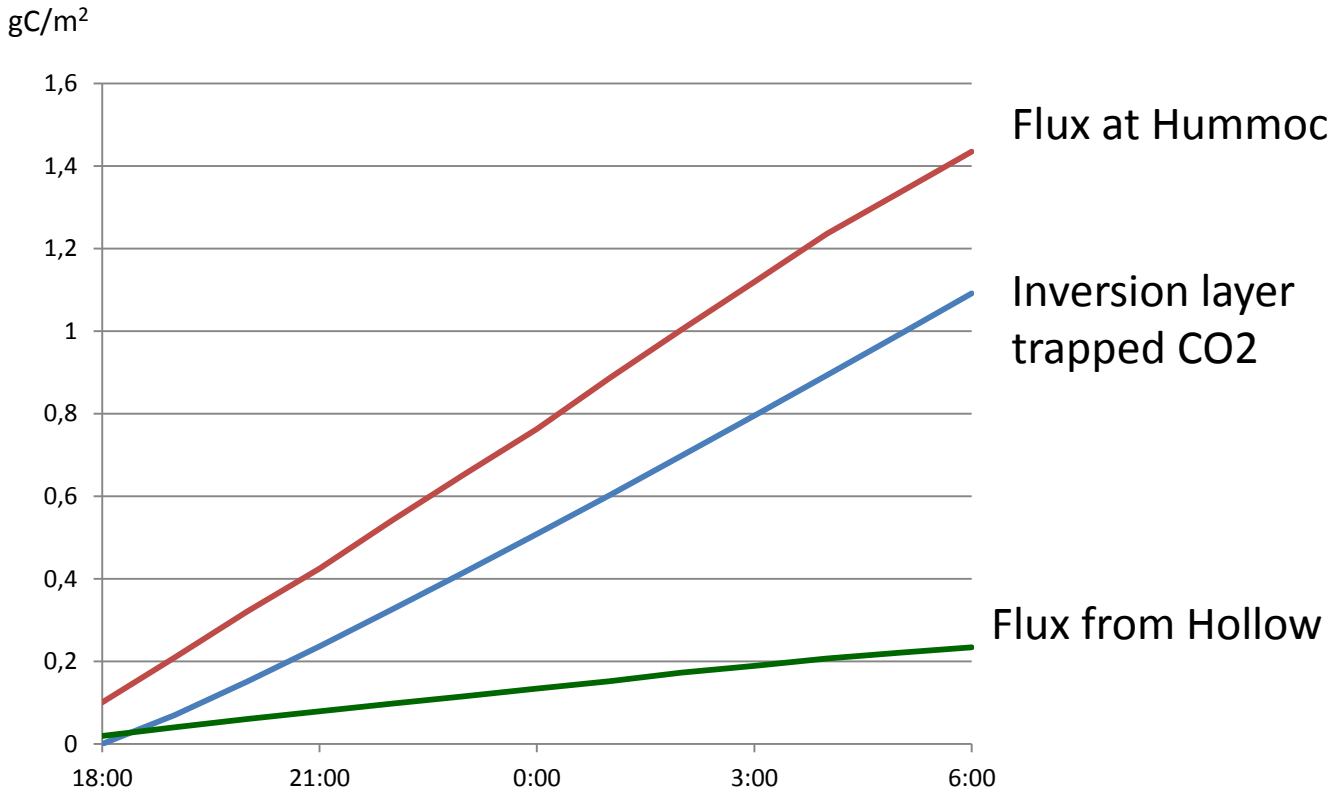



Flux measurement by Chamber method at hammock and hollow, and nighttime (upper) and daytime (lower) for Sept., 2012 – Feb., 2013

Arrows with date show the timing of maintenance and removing of fern

# $CO_2$ trapped in the inversion layer

Accumulated CO2 from chamber measurements (gC/m2 vs s after sunset; 18:00)

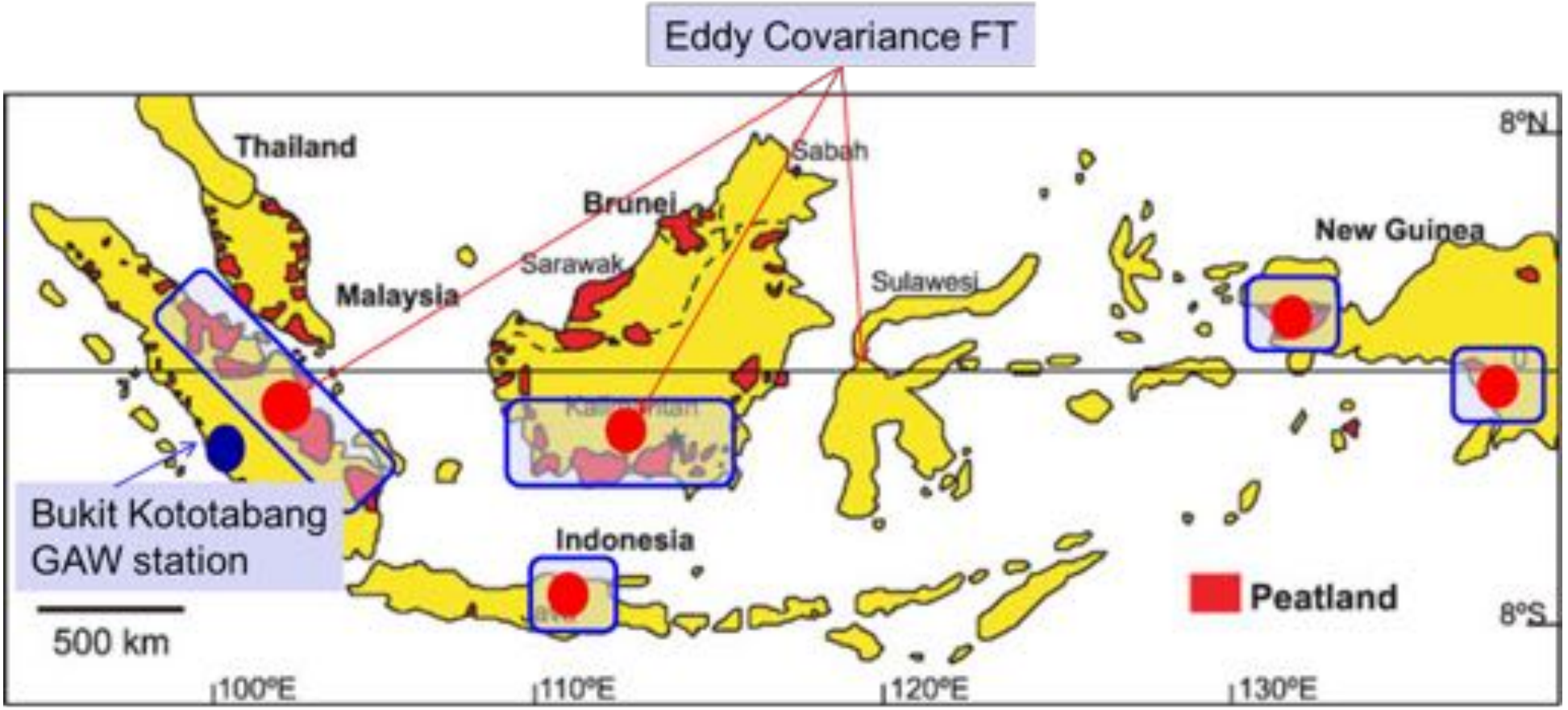



Accumulated CO2 taken from chamber data and inversion trap from sunset to sunrise : 1.06 and 0.23～1.43 gC/$m^2$, respectively.
(corresponds to the total flux in half a day).

# Conclusions

- Monitoring GHG emissions over tropical area using GOSAT spatially shown varied results associated with the treatment of data source and physical evidents
- Validation for GOSAT in tropical area needs plenty of field observation data (station) such as column concentration measurement
- Global and regional GHG emissions estimation still needs more efforts to deal with the large spatial and temporal variations

# Future Plan




FES (OSA)

- GAW station (present)
- Potential site : GAW, EC, FES, TCCON

# Don’t Miss it !!

## The 34th Asian Conference of Remote Sensing (ACRS)

## Bali-Indonesia, 20 – 24 October 2013

www.acrs2013.com