

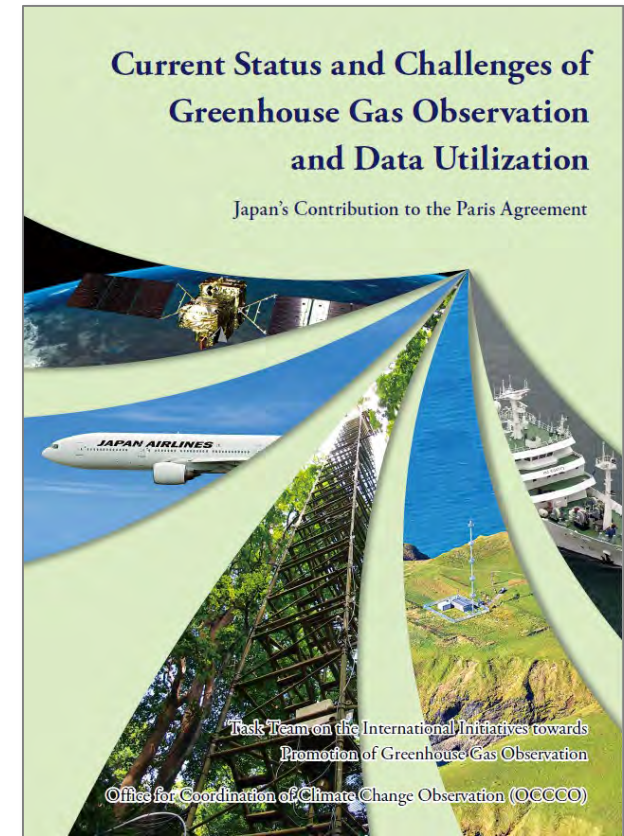
# Current Status and Challenges of GHG Observations:

## Japan's Contribution to the Paris Agreement

Nobuko Saigusa

National Institute for Environmental Studies, Japan

Pictures and figures by courtesy of  
Meteorological Agency (JMA) and  
Japan Aerospace Exploration Agency (JAXA)



# Concepts

To provide data and knowledge to stakeholders in time with the Global Stocktake Process under the Paris Agreement

To provide additional sources of information that can support estimating the **impacts of mitigation actions**

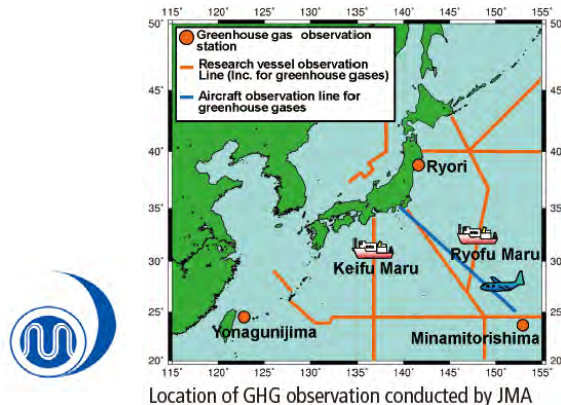
Relevant Japanese institutions and agencies for GHG observation and analysis will cooperate **to improve** up-to-date analysis systems and **data coverage particularly in Asia–Oceania** for better estimation of the **distribution of anthropogenic and natural sinks and sources** with sufficient accuracy

# Ground-based Monitoring

Atmospheric concentrations of GHGs at near-ground levels

Column-averaged concentrations of GHGs

Total Carbon Column Observing Network (TCCON) <http://www.tccon.caltech.edu/>



Japan Meteorological Agency (JMA)



Ryori



Yonagunijima



Minamitorishima

National Institute for Environmental Studies (NIES)



Monitoring station, Cape Ochiishi

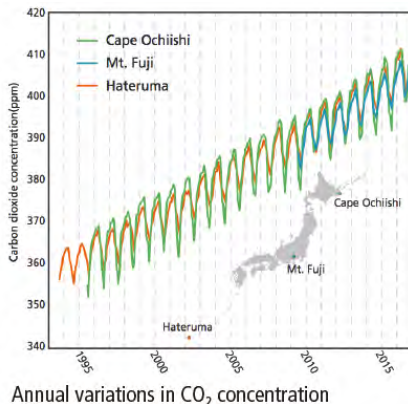


Monitoring station, Hateruma



Mt. Fuji automated weather station

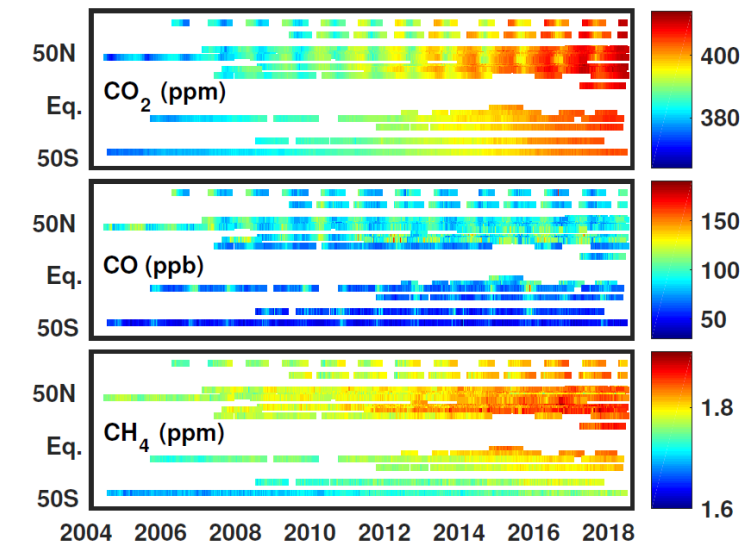
Observation components: (e.g. Hateruma station): CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CO, H<sub>2</sub>, O<sub>2</sub>/N<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub>, O<sub>3</sub>, CFCs, Rn, aerosol, <sup>14</sup>C, halocarbon, SF<sub>6</sub>, POPs



NIES



Rikubetsu **TCCON** site at Rikubetsu Integrated Stratospheric Observation Center, NIES, Rikubetsu, Asyoro, Hokkaido



Atmospheric CO<sub>2</sub>, CO, and CH<sub>4</sub> concentrations observed by TCCON

Data: WDCGG/GAW <https://gaw.kishou.go.jp/>  
NIES Global Environmental Database  
<http://db.cger.nies.go.jp/portal/>



World Data Centre for Greenhouse Gases

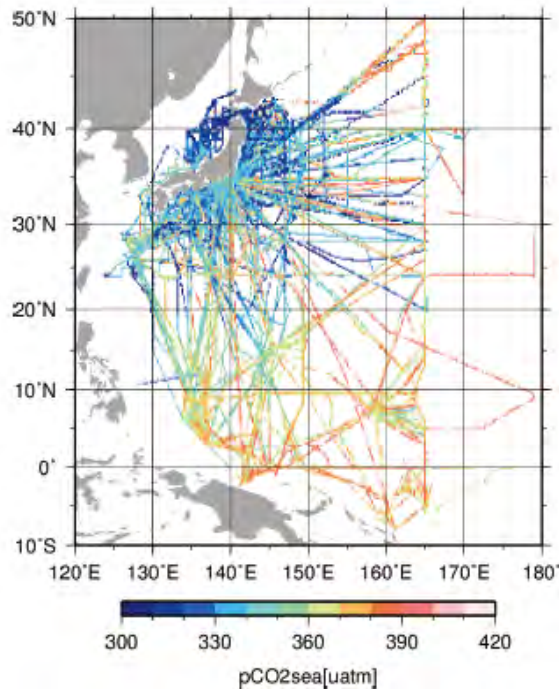




# Ship-based Monitoring

## GHG and ocean surface CO<sub>2</sub> monitoring

### Monitoring in the western North Pacific by Research Vessels (JMA)



R/V Ryofu Maru



R/V Keifu Maru

Observations of atmospheric and surface seawater pCO<sub>2</sub> by two research vessels from 1980s to the present



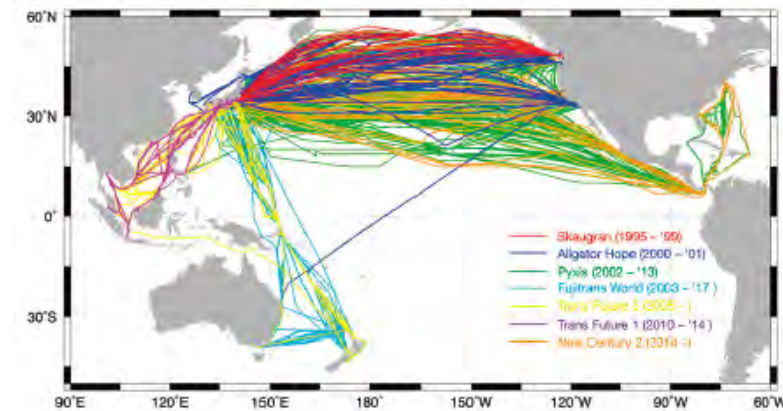
Data: JMA Observation Data/Oceanic Carbon Cycle Products

[https://www.data.jma.go.jp/gmd/kaiyou/db/vessel\\_obs/data-report/html/ship/ship\\_e.php](https://www.data.jma.go.jp/gmd/kaiyou/db/vessel_obs/data-report/html/ship/ship_e.php)

[https://www.data.jma.go.jp/gmd/kaiyou/english/oceanic\\_carbon\\_cycle\\_index.html](https://www.data.jma.go.jp/gmd/kaiyou/english/oceanic_carbon_cycle_index.html)

SOCAT <https://www.socat.info/>

### Monitoring in the western North Pacific by Volunteer Observing Ships (NIES)



Observation routes



Fujitrans World



Trans Future 5



New Century 2



# Airborne-based Monitoring

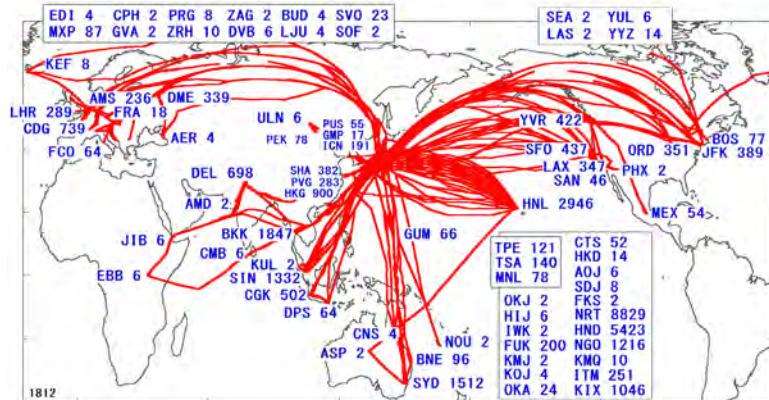
CONTRAIL (Comprehensive Observation Network for TRace gases by AirLiner)



Continuous CO<sub>2</sub> Measuring Equipment

Automatic Air Sampling Equipment

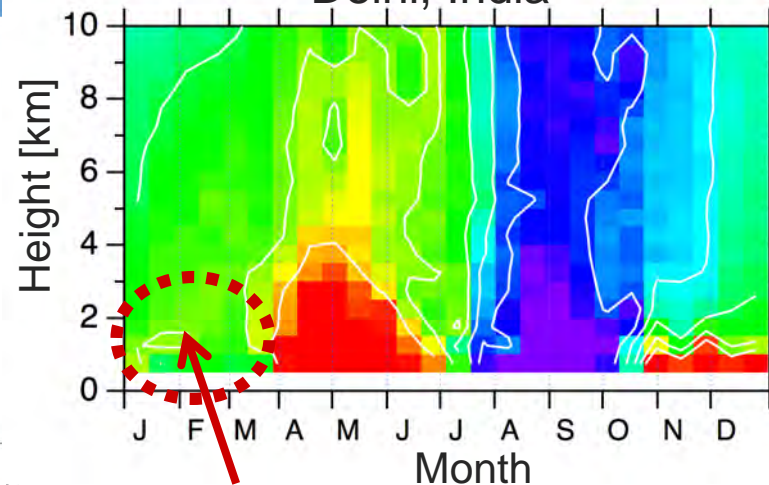
Boeing 777 aircraft and two research equipment



Powerful high-precision data for verifying models and satellite observations

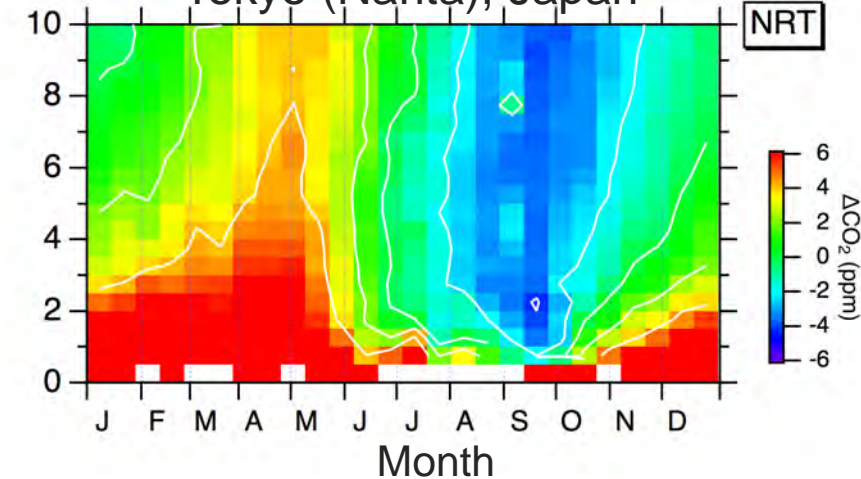
Vertical distribution of CO<sub>2</sub> concentration and its seasonal change

Delhi, India



Uptake from winter crops

Tokyo (Narita), Japan



Umezawa et al. *GRL* (2016)

Umezawa et al. *ACP* (2018)

← Flight paths and the number of vertical profile observations of CME

Data: Atmospheric CO<sub>2</sub> mole fraction data of CONTRAIL-CME:

<http://www.nies.go.jp/doi/10.17595/20180208.001-e.html>



# Satellite-based Monitoring

Data:

GOSAT Data Archive Service (GDAS)

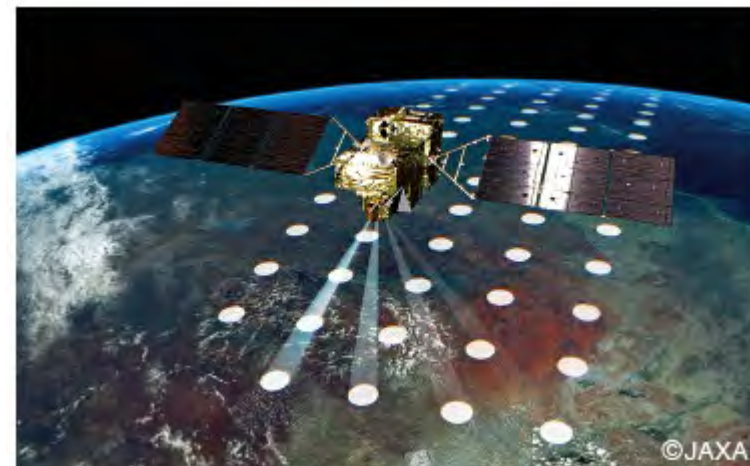
[https://data2.gosat.nies.go.jp/index\\_en.html](https://data2.gosat.nies.go.jp/index_en.html)

GOSAT-2 Product Archive

<https://prdct.gosat-2.nies.go.jp/en/index.html>

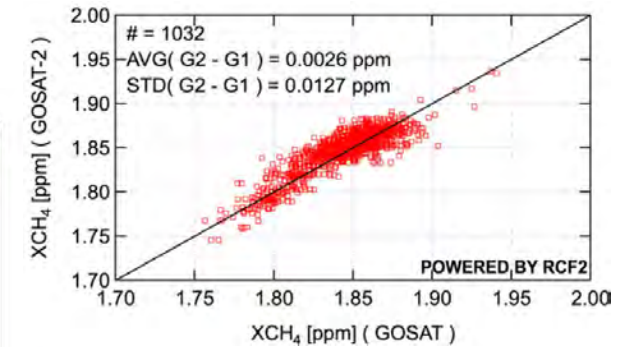
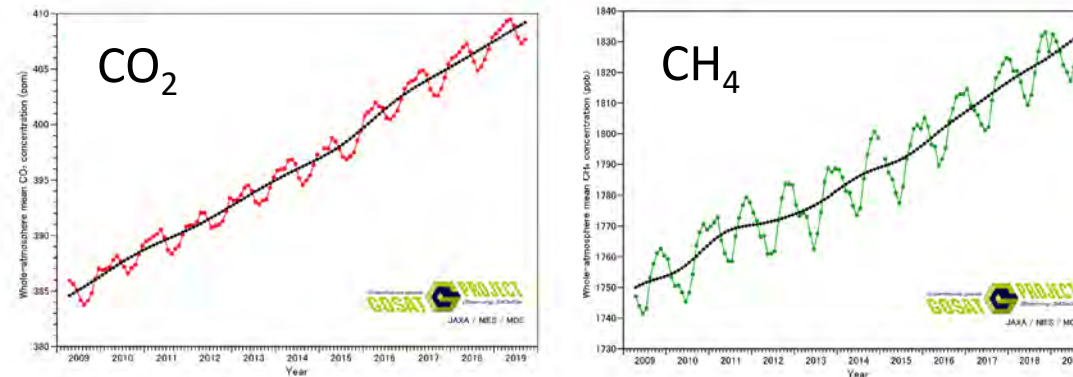


GOSAT

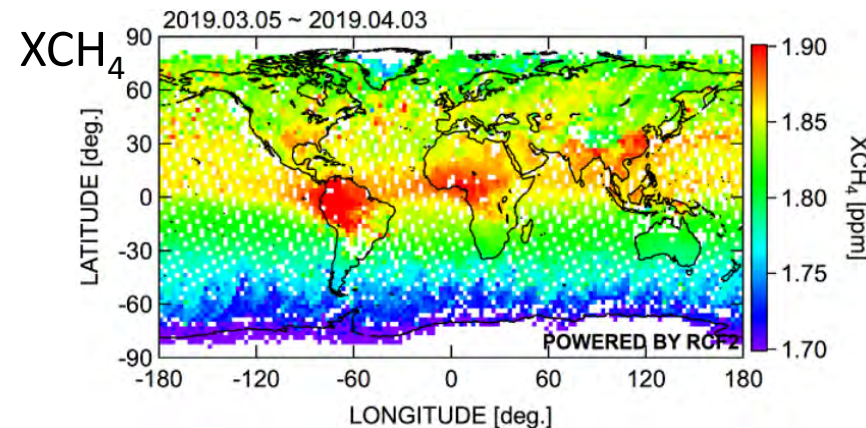


GOSAT-2

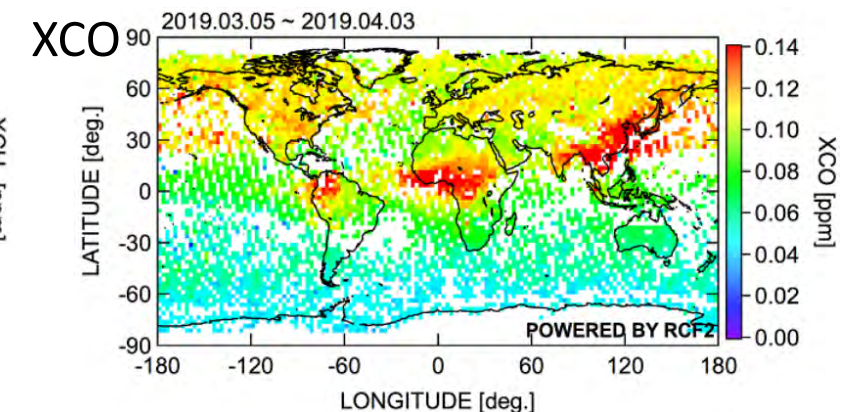
Whole-atmosphere monthly mean  $\text{CO}_2$  and  $\text{CH}_4$  concentrations based on GOSAT observations



Comparison of methane column-averaged dry-air mole fraction ( $\text{XCH}_4$ ) between GOSAT and GOSAT-2 data acquired on the same day.



Global distribution of methane column-averaged dry-air mole fraction ( $\text{XCH}_4$ ) retrieved by the proxy-method from FTS-2 data acquired from March 5 to April 3, 2019.



Global distribution of carbon monoxide column-averaged dry-air mole fraction ( $\text{XCO}$ ) retrieved by the proxy method from the FTS-2 data acquired from March 5 to April 3, 2019.



# Upscaling Terrestrial Carbon and GHG Fluxes

Terrestrial CO<sub>2</sub> flux monitoring network data in Asia and upscaling



Fuji-Hokuroku, Japan (NIES)



Teshio, Japan  
(Hokkaido Univ., NIES)



Takayama, Japan (AIST)



Sakaerat, Thailand (AIST)



Automated chambers for soil  
efflux monitoring at Pasoh,  
Malaysia (NIES)

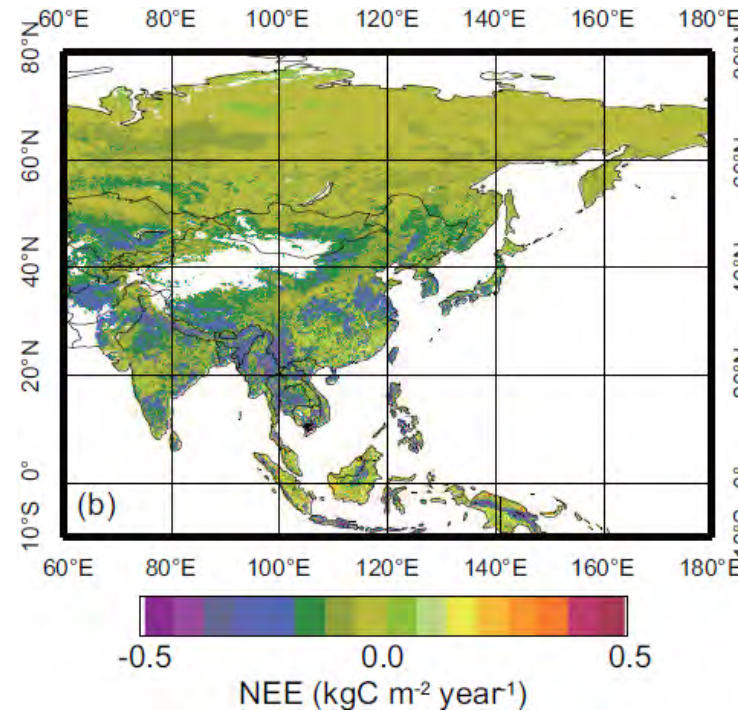


Mae Klong,  
Thailand (AIST)

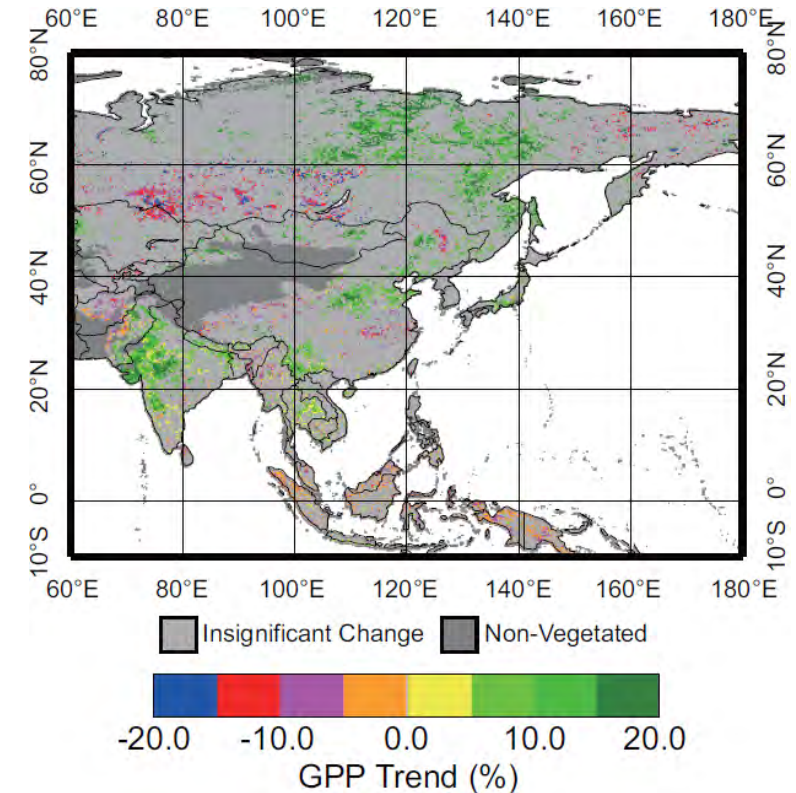


Poker Flat Research Range Flux  
Observation Supersite in Alaska, USA  
(JAMSTEC, IARC)

## Net Ecosystem Exchange



## GPP trend



(Ichii *et al.* JGR, 2017)



Data and Site Information:

AsiaFlux <http://asiaflux.net>

FLUXNET (Fluxdata) <http://fluxnet.fluxdata.org/>



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Poker Flat Research Range Flux  
Observation Supersite in Alaska, USA  
(JAMSTEC, IARC)

## AsiaFlux 20th Anniversary Workshop October 2-5, 2019, Takayama Japan



Data and Site Information:  
AsiaFlux <http://asiaflux.net>  
FLUXNET (Fluxdata) <http://fluxnet.fluxdata.org/>



# Collaboration Among Japanese Agencies and Institutions to Contribute to the Global Stocktake (tentative)

Expected Product/Data

Global GHG sources and sinks

GHG emission from Cities and Countries

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	Paris Agreement	Provide Gridded Data & Synthesis		★GST 1			Provide Gridded Data & Synthesis		★GST2



International research projects:  
WCRP, Future Earth, TranCom, SOCAT, FLUXNET, ....



Data and knowledge

GAW  
WDCGG  
IG33IS



WG Climate  
GHG TT



Data

Other countries' efforts

City-scale and national emissions

EU

Global GHG emission

City-scale and national emissions

US

Global GHG emission

...

Japan Platform

**Data:** Atmospheric GHGs & SLCs, ocean/terrestrial surface fluxes, GHG inventories

**Observation platforms:** Satellites, aircraft, ships, ground stations, ...

**Analysis systems:** Inverse models, flux upscaling, bottom-up inventories, ...

JMA

Global GHG sinks and sources

City-scale and National emissions

JAXA

MOE

NIES



JAMSTEC

Universities

MEXT

GHG Inventory Office

Discussion needed:

- Inter-comparison of global datasets?
- Separation of anthropogenic and natural emissions?
- Possibilities of near-future prediction



# Summary

- Japanese institutions and agencies for GHG observation and analysis cooperate to **improve up-to-date analysis systems and data coverage globally and in Asia–Oceania** for better estimation of the distribution of **anthropogenic and natural sinks and sources** with sufficient accuracy
- **International cooperation is essential to improve reliability** in the global datasets for GHG budget estimations
- **Uncertainty estimations are required** for anthropogenic and natural sinks and sources



# Methods

1. Top-down analysis
2. Flux upscaling
3. GHG Inventory

Improve their accuracy by identifying the cause of discrepancy



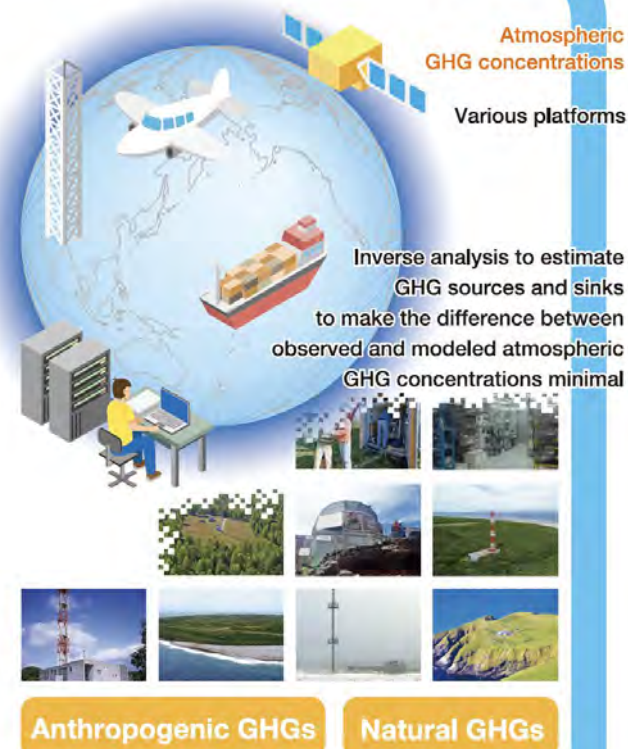
**Provide global gridded GHG sink/source data** to contribute to the Global Stocktake under the Paris Agreement by FY2021 and publish synthesis report by FY2022 (tentative)



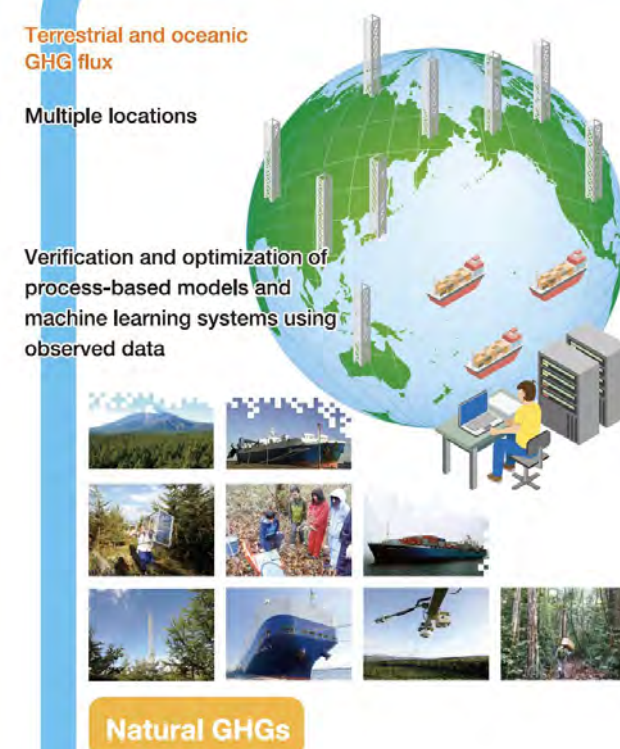
**Estimate long-term anthropogenic and natural GHG budgets** with high spatio-temporal resolution by FY 2023 (tentative)

- ⇒ Assess the **past** socio-economic scenarios used in the climate models
- ⇒ Predict the **effects of climate change mitigation measures** in the near future

## Top-down Analysis



## Flux Upscaling



## Evaluation of sources & sinks



Anthropogenic GHGs

## GHG Inventory

National GHG emissions

Estimating emissions based on atmospheric observations of GHGs has a potential for providing additional sources of information that can complement national inventories.