

GHG Analyzing Platform using Ground Sites, Aircraft, Ships, and Satellite-based Data

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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**

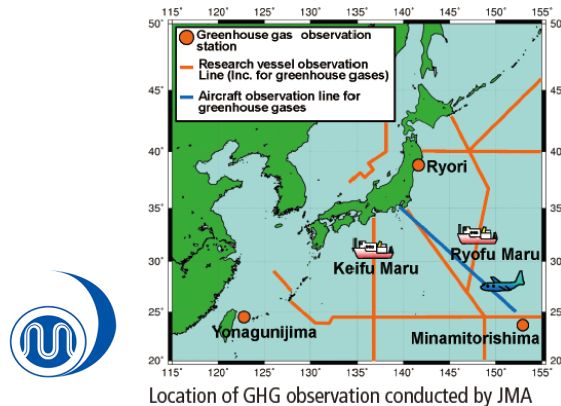
Relevant Japanese institutions and agencies for GHG observation and analysis will cooperate to improve up-to-date analysis systems and data coverage particularly in Asia–Oceania for better estimation of **the distribution of anthropogenic and natural sinks and sources** with sufficient accuracy

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

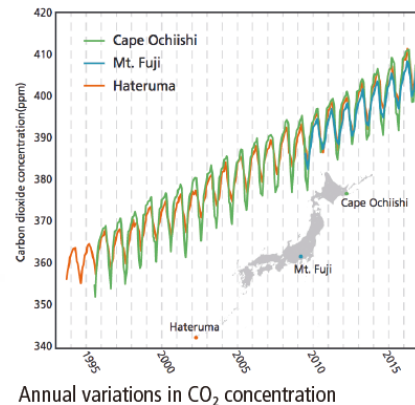


Monitoring station, Hateruma



Mt. Fuji automated weather station

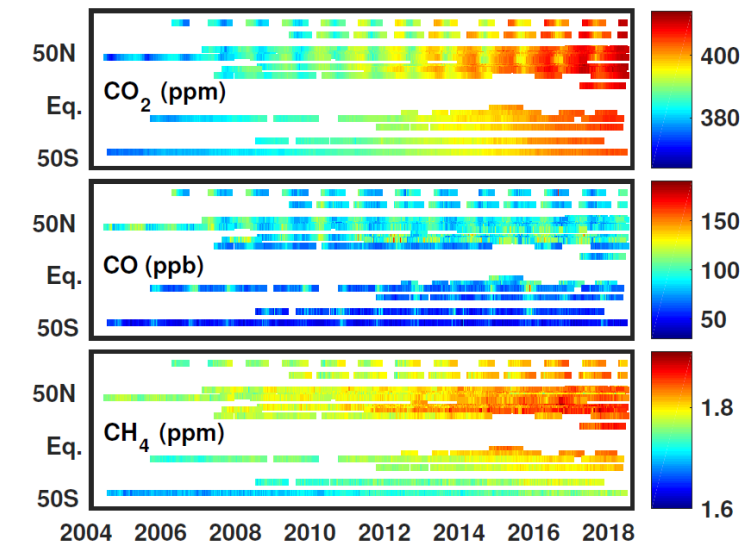
Observation components: (e.g. Hateruma station): CO₂, CH₄, N₂O, CO, H₂, O₂/N₂, NO_x, SO_x, O₃, CFCs, Rn, aerosol, ¹⁴C, halocarbon, SF₆, POPs



NIES



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



Atmospheric CO₂, CO, and CH₄ concentrations observed by TCCON

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



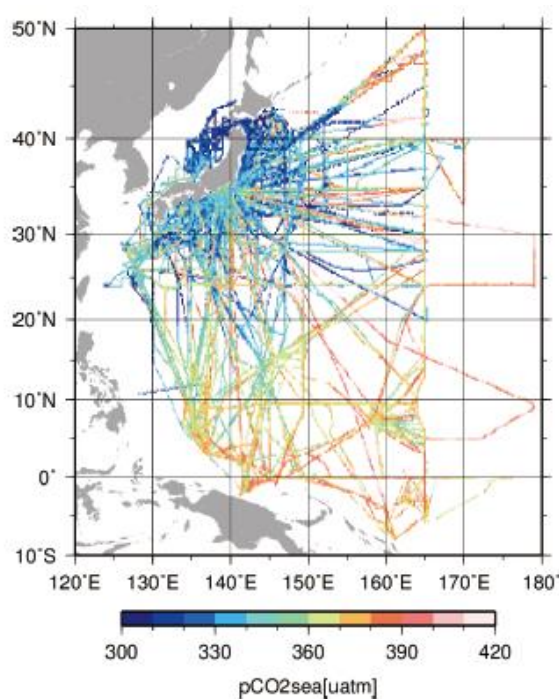
World Data Centre for Greenhouse Gases



Ship-based Monitoring

GHG and ocean surface CO₂ monitoring

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



R/V Ryofu Maru

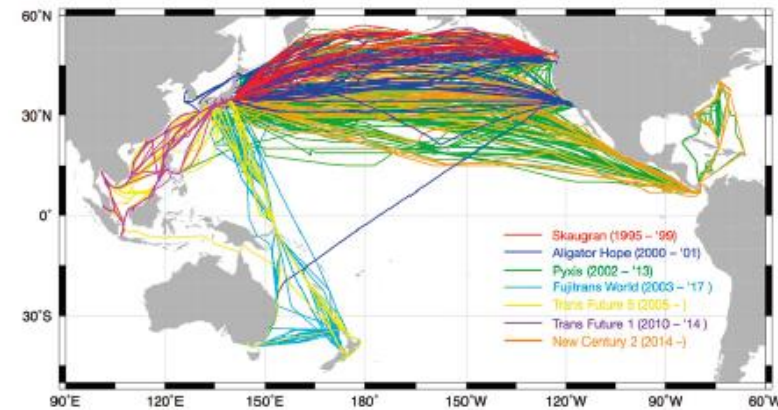


R/V Keifu Maru

Observations of atmospheric and surface
seawater pCO₂ by two research vessels
from 1980s to the present



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



Observation routes



Fujitrans World



Trans Future 5



New Century 2

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/english/oceanic_carbon_cycle_index.html

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

Airborne-based Monitoring

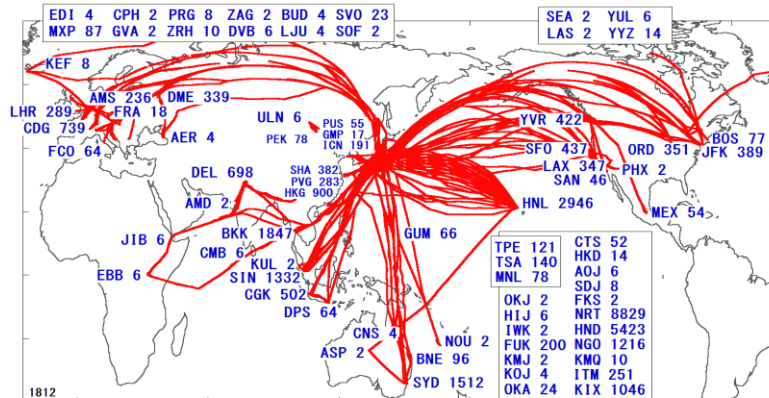
CONTRAIL (Comprehensive Observation Network for TRace gases by AirLiner)



Forward Cargo Room
Continuous CO₂ Measuring Equipment

Aft Cargo Room
Automatic Air Sampling Equipment

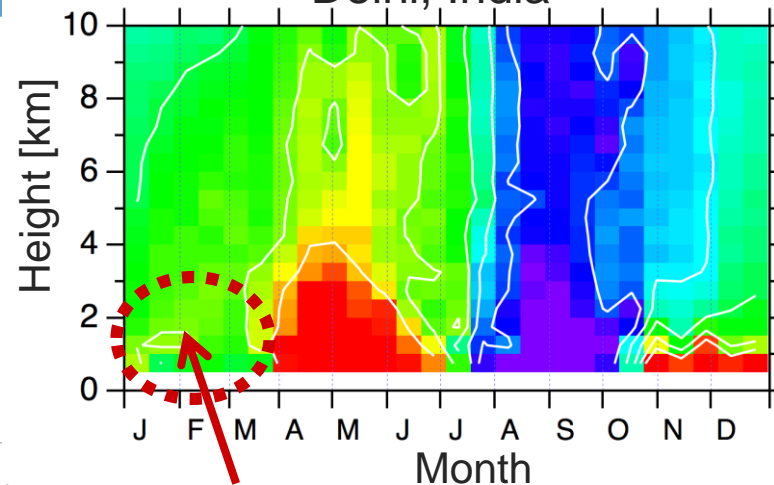
Boeing 777 aircraft and two research equipment



Powerful high-precision data for verifying models and satellite observations

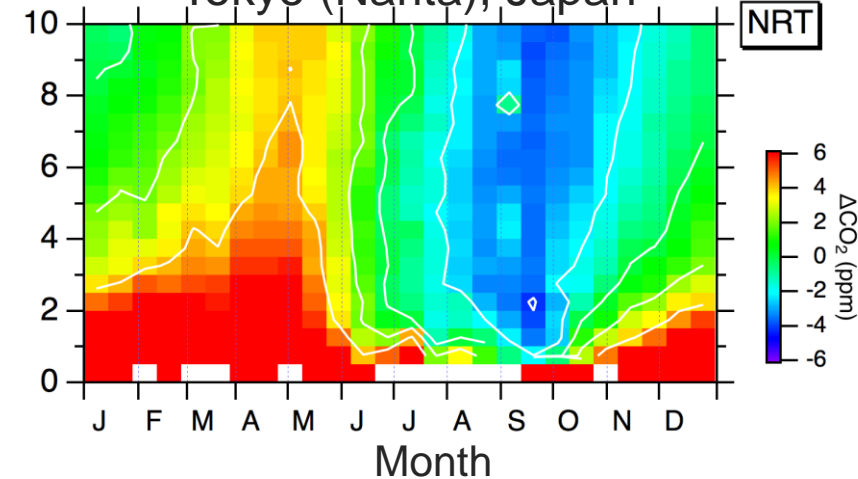
Vertical distribution of CO₂ concentration and its seasonal change

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 CO₂ 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)

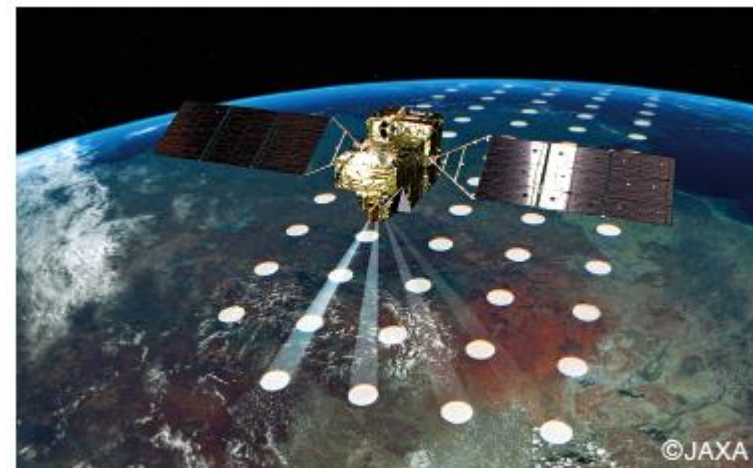
https://data2.gosat.nies.go.jp/index_en.html

GOSAT-2 Product Archive

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

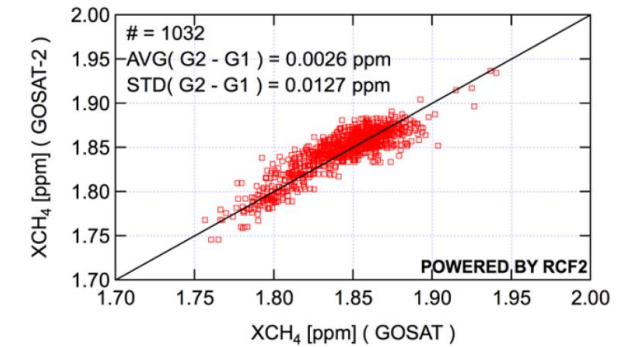
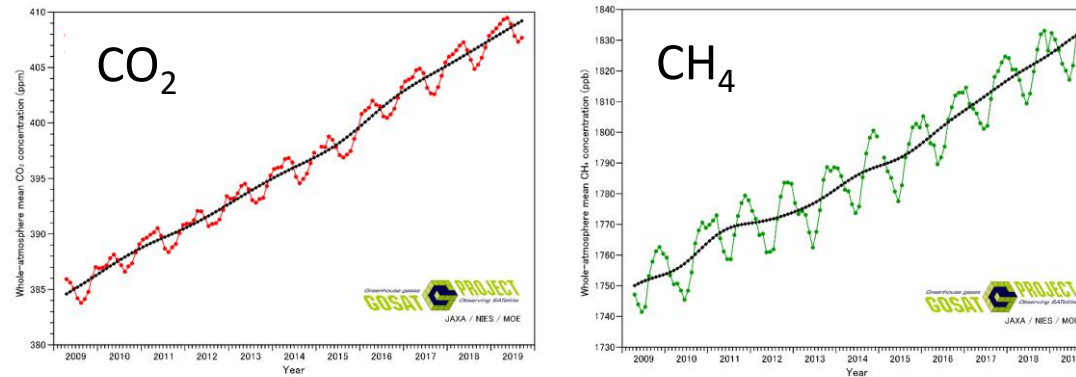


GOSAT

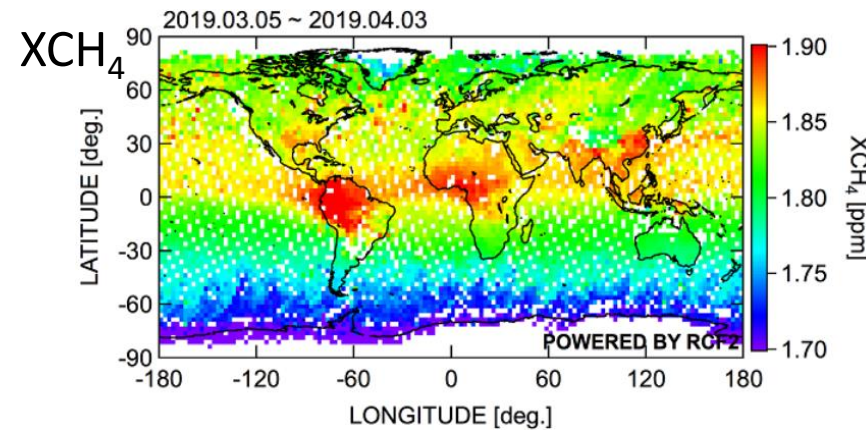


GOSAT-2

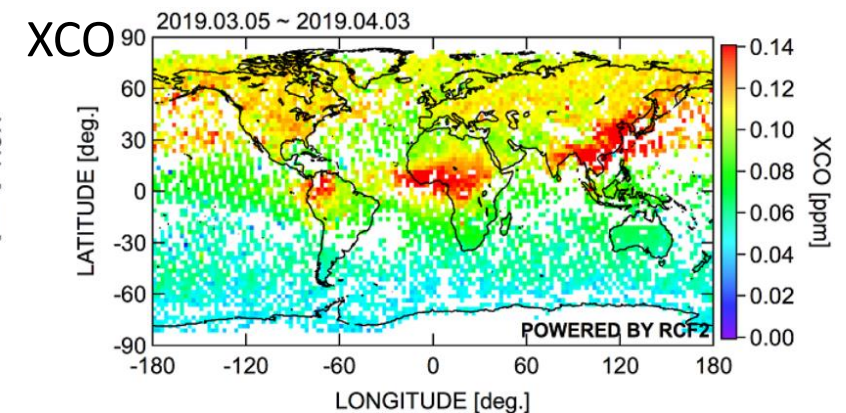
Whole-atmosphere monthly mean CO_2 and CH_4 concentrations based on GOSAT observations



Comparison of methane column-averaged dry-air mole fraction (XCH_4) between GOSAT and GOSAT-2 data acquired on the same day.



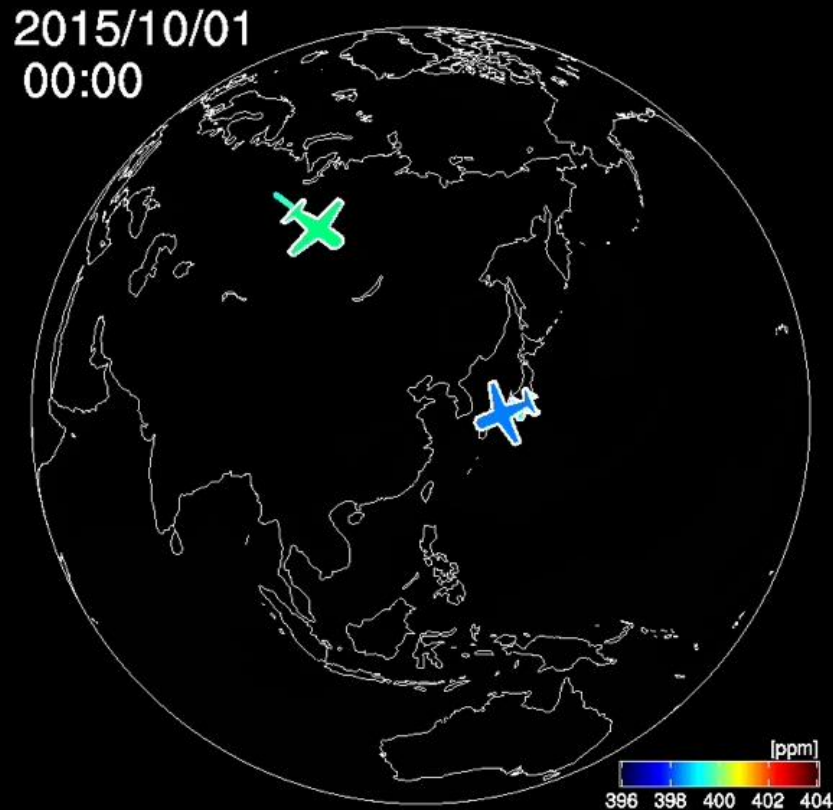
Global distribution of methane column-averaged dry-air mole fraction (XCH_4) retrieved by the proxy-method from FTS-2 data acquired from March 5 to April 3, 2019.



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

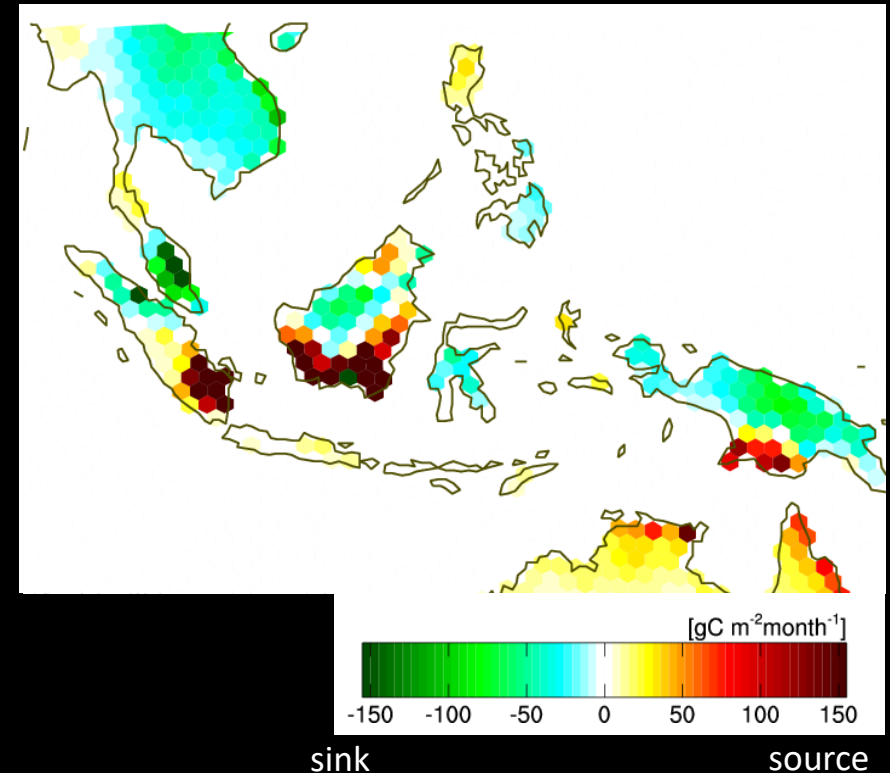
Data Integration and Inverse Model Estimation of GHG Sources and Sinks

CO₂ concentration distribution at 10 km (250 hPa)
estimated using NICAM-TM and CONTRAIL flight data



Southeast Asia for Oct 2015

Inversion analysis with CONTRAIL data improved the reliability of the results. Strong sources, likely related to biomass burning, and also some sinks, were retrieved.

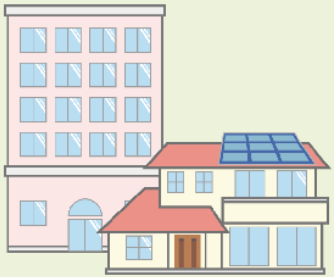


Quantifying Combusted Carbons from Megacity

Measurements of GHGs and related tracers ($^{14}\text{CO}_2$ and O_2) in Tokyo

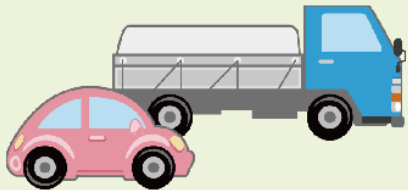
CO_2 from natural gas

$^{14}\text{CO}_2 = \text{zero}$, $\text{OR}^* = 1.97$



CO_2 from gasoline

$^{14}\text{CO}_2 = \text{zero}$, $\text{OR} = 1.5$



*Oxidative Ratio; $-\text{O}_2/\text{CO}_2$ (mol/mol)

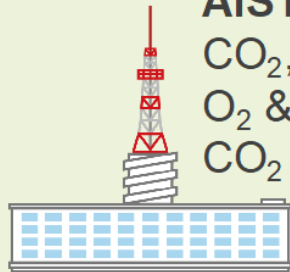
Yoyogi site (52m)

AIST, NDA, NIES

CO_2 , CH_4 , CO , ...

O_2 & $^{14}\text{CO}_2$

CO_2 & heat flux



Biospheric CO_2

$^{14}\text{CO}_2$ included, $\text{OR} = 1.1$
(plants) & 1.25 (human)



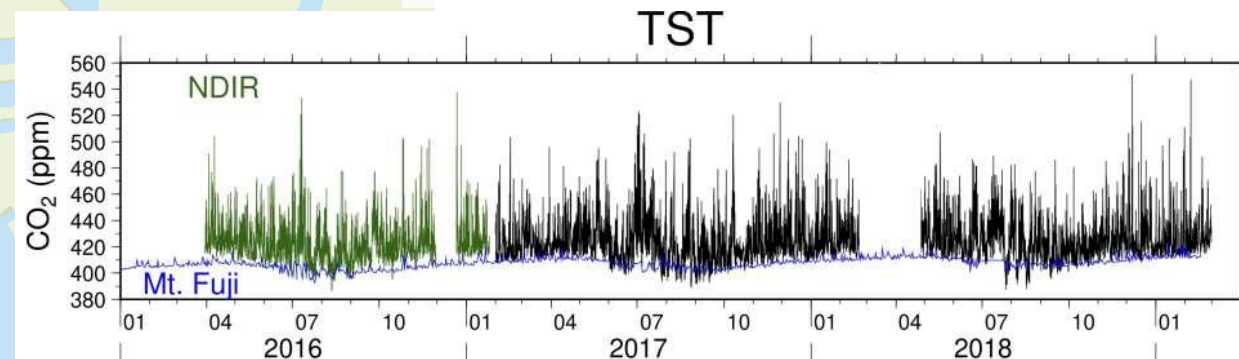
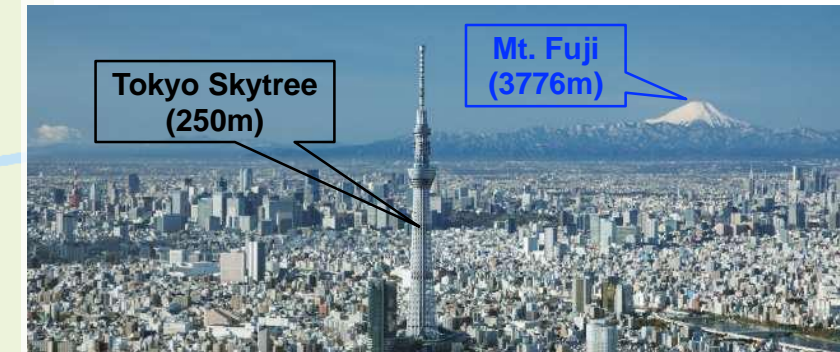
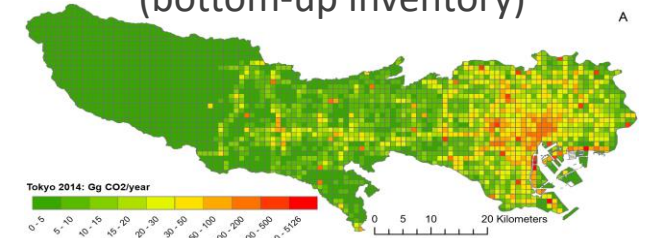
NIES Tokyo Skytree observatory (250m)

CO_2 , CH_4 , CO , ...

O_2 & $^{14}\text{CO}_2$



Anthropogenic CO_2 emission from Tokyo
(bottom-up inventory)



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



CEOS
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
- Urgent international cooperation is needed to improve reliability in the global datasets
- Technological development is still required for
 - separation of anthropogenic and natural emission
 - near-future prediction of impacts of mitigation actions