Integrated Observation and Analysis System for Monitoring Anthropogenic and Natural Greenhouse Gas Sources and Sinks

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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 data and 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

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

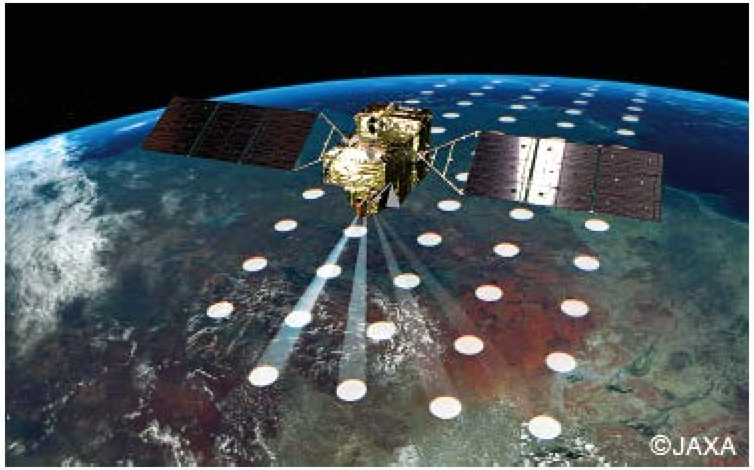
⇒Predict the effects of climate change mitigation measures in the near future

Progress in top-down analysis

Satellite-based Monitoring

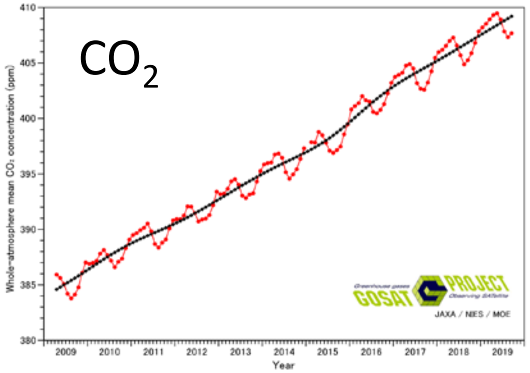
Data:
GOSAT Data Archive Service (GDAS)
https://data2.gosat.nies.go.jp/index_en.html
GOSAT-2 Product Archive
https://prdct.gosat-2.nies.go.jp/en/index.html

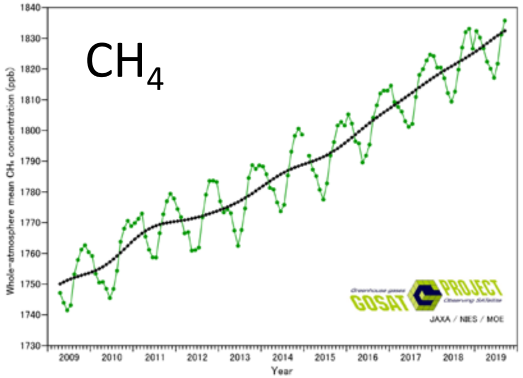
GOSAT

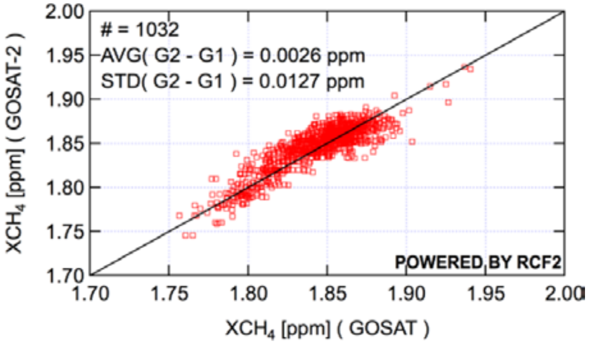


GOSAT-2

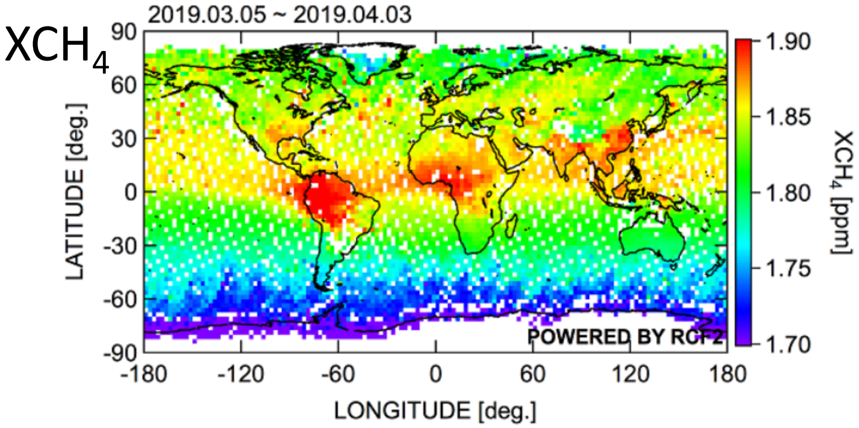
Whole-atmosphere monthly mean CO_2 and CH_4 concentrations based on GOSAT observations



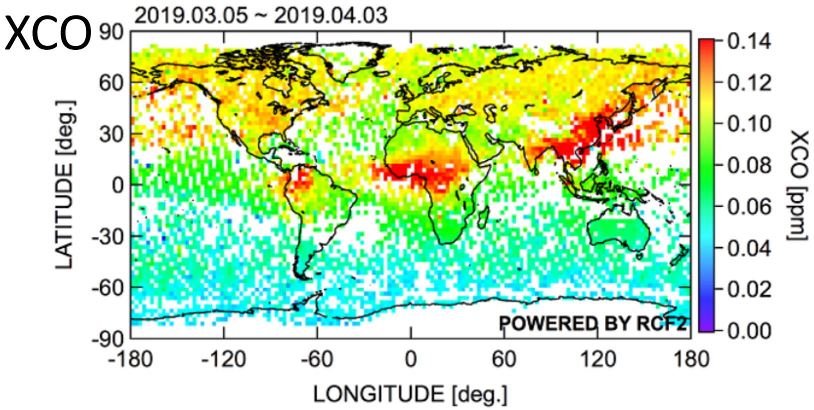




Comparison of methane column-averaged dry-air mole fraction (XCH_4) between GOSAT and GOSAT-2 data acquired on the same day.



Global distribution of methane column-averaged dry-air mole fraction (XCH4) retrieved by the proxy-method from FTS-2 data acquired from March 5 to April 3, 2019.

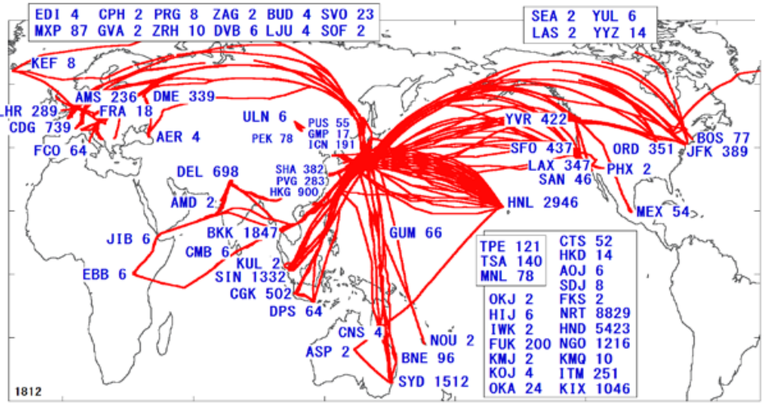


Global distribution of carbon monoxide column-averaged dry-air mole fraction (XCO) retrieved by the proxy method from the FTS-2 data acquired from March 5 to April 3, 2019.

Airborne-based Monitoring

CONTRAIL（Comprehensive Observation Network for TRace gases by AIrLiner）

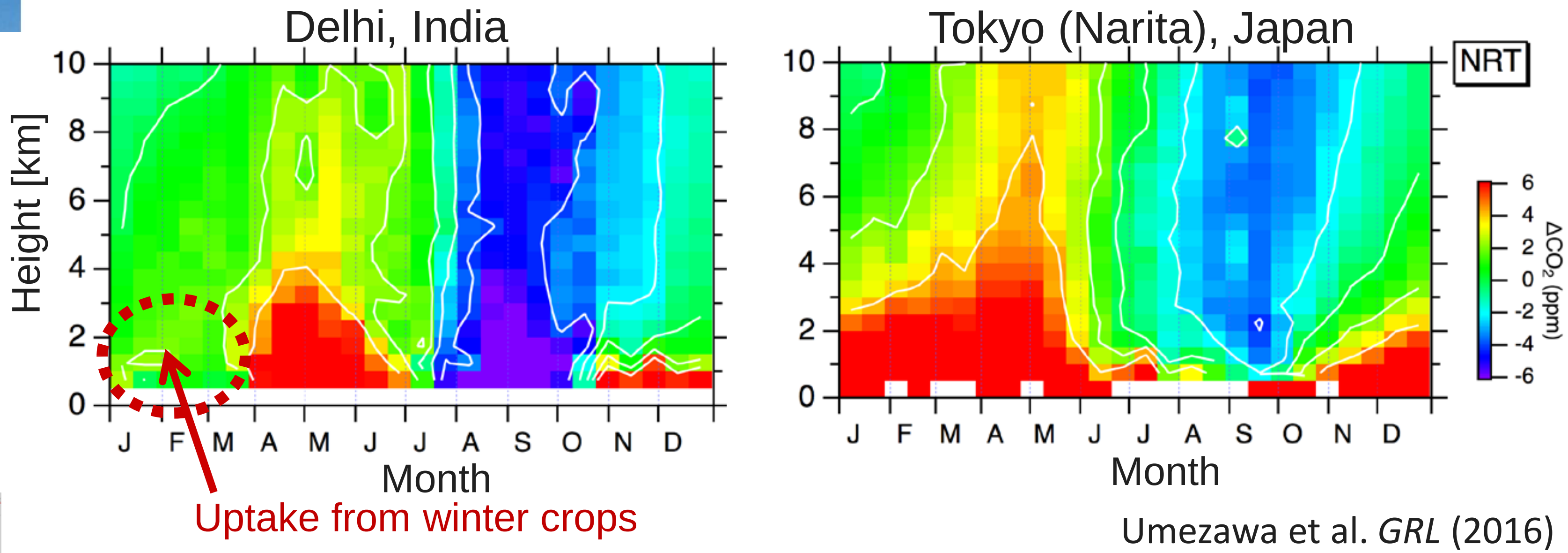
Boeing 777 aircraft and two research equipment



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

Powerful high-precision data for verifying models and satellite observations

Vertical distribution of CO_2 concentration and its seasonal change

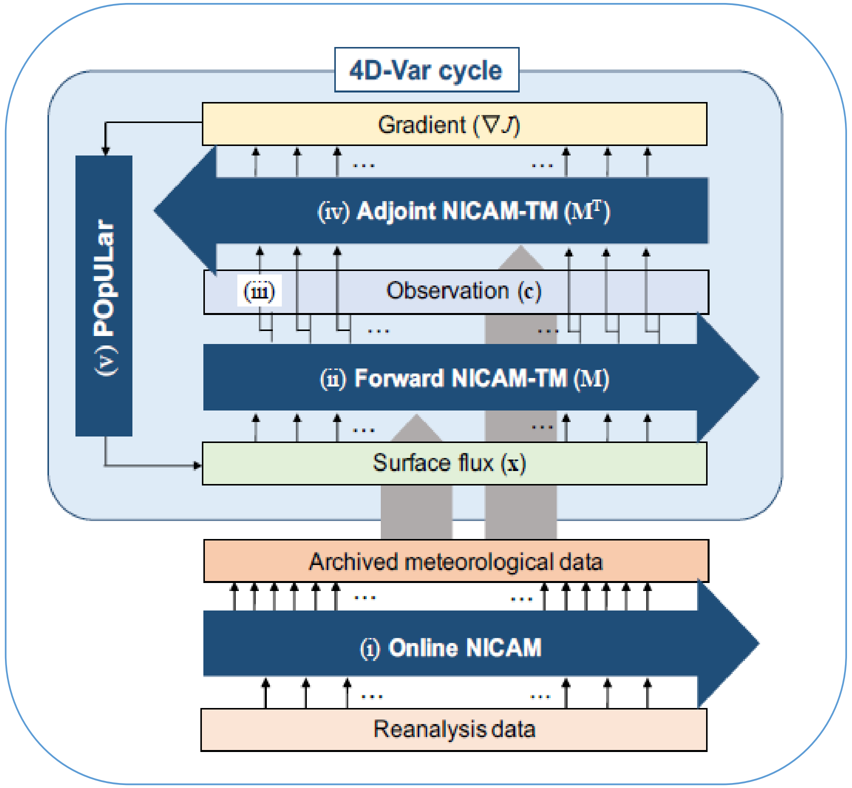


Umezawa et al. *GRL* (2016)
Umezawa et al. *ACP* (2018)

Data: Atmospheric CO_2 mole fraction data of CONTRAIL-CME:
http://www.nies.go.jp/doi/10.17595/20180208.001-e.html

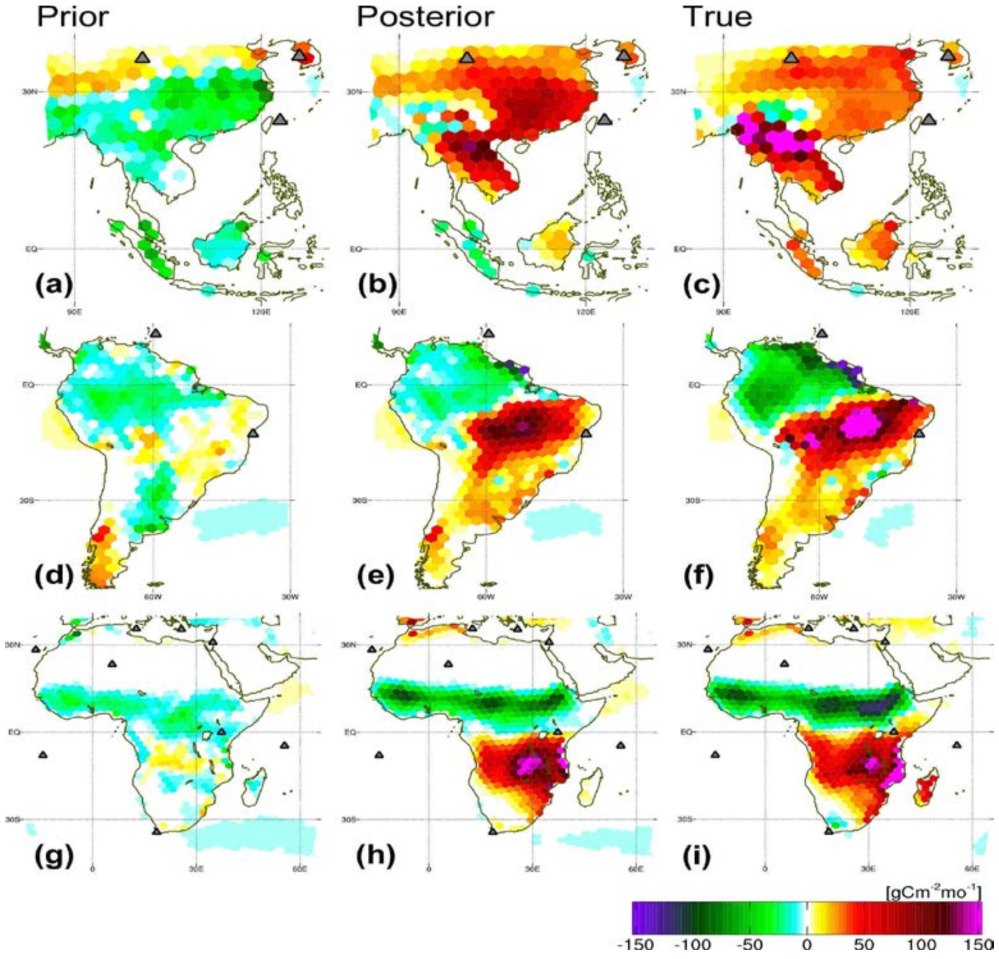
Data Integration and Inverse Model Estimation for GHG Sources and Sinks

NICAM-TM 4D-Var



NICAM-TM (Nonhydrostatic ICOsahedral Atmospheric Model-based Transport Model)

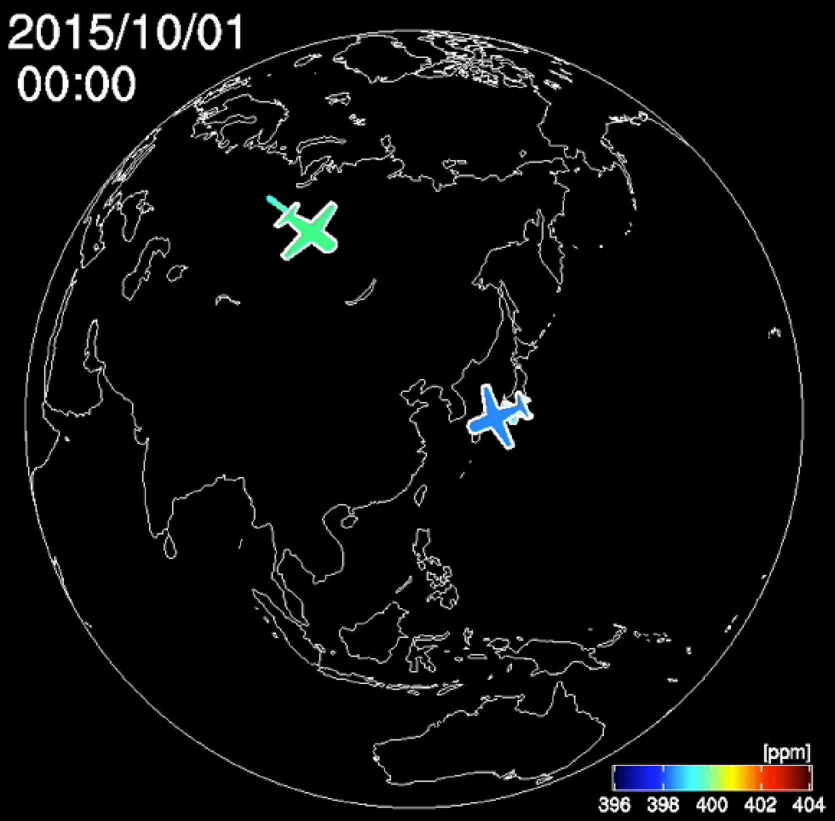
Results of the preliminary experiments for the detection of large-scale forest fires



Niwa *et al.* (2017a,b)

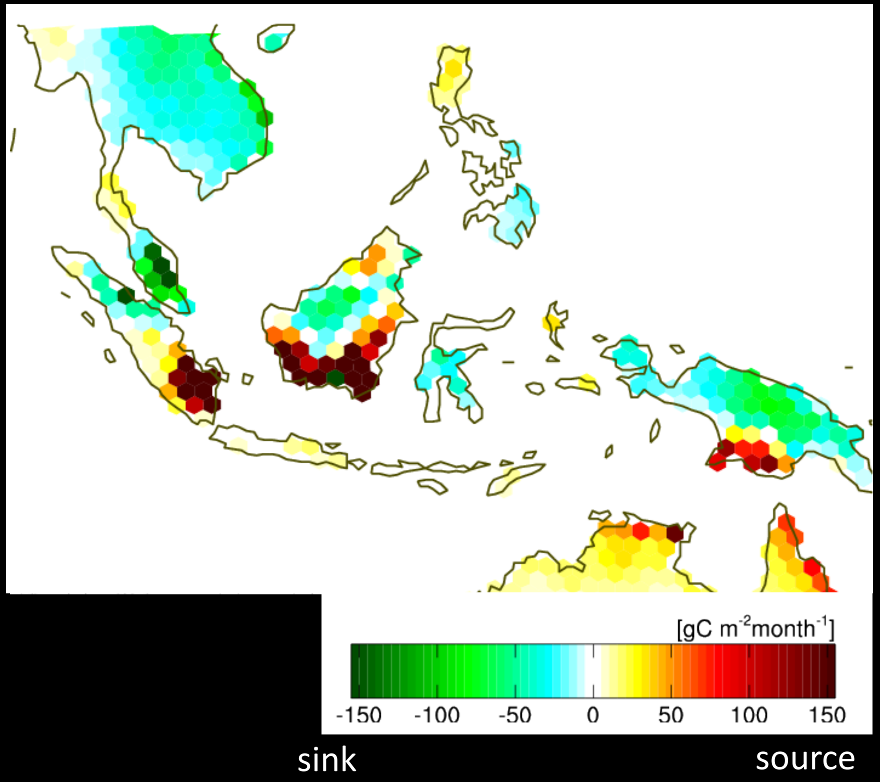
Data Integration and Inverse Model Estimation of GHG Sources and Sinks

CO_2 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.

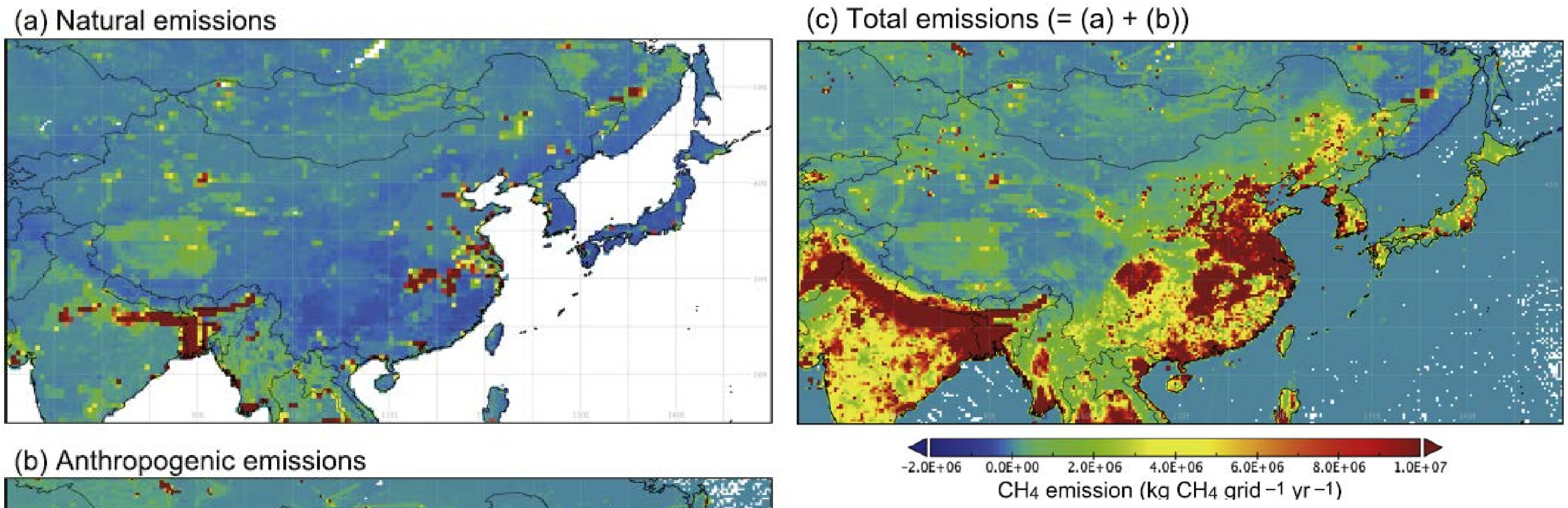


Slide provided by Niwa Y

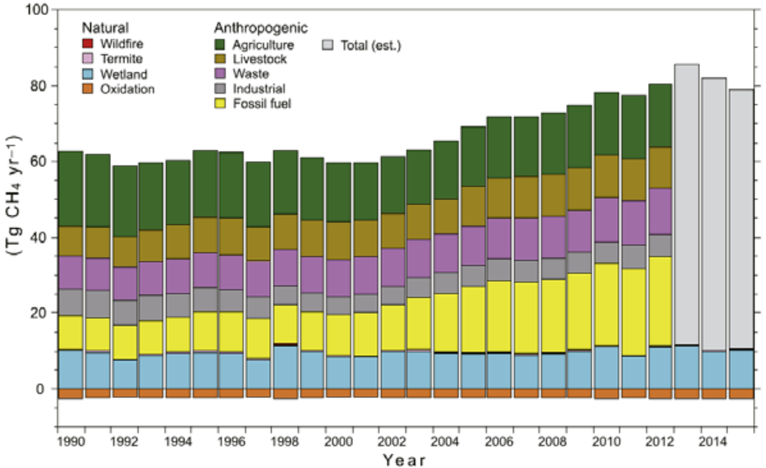
Bottom-up GHG Inventory

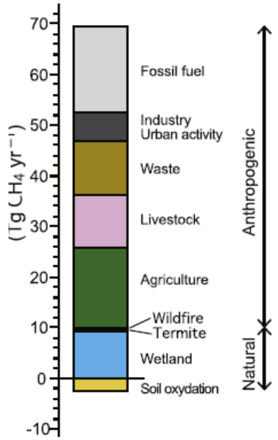
Methane budget of East Asia, 1990–2015: A bottom-up evaluation

Itoh *et al*. (2019)



Aggregated CH_4 budget (2000–2012).

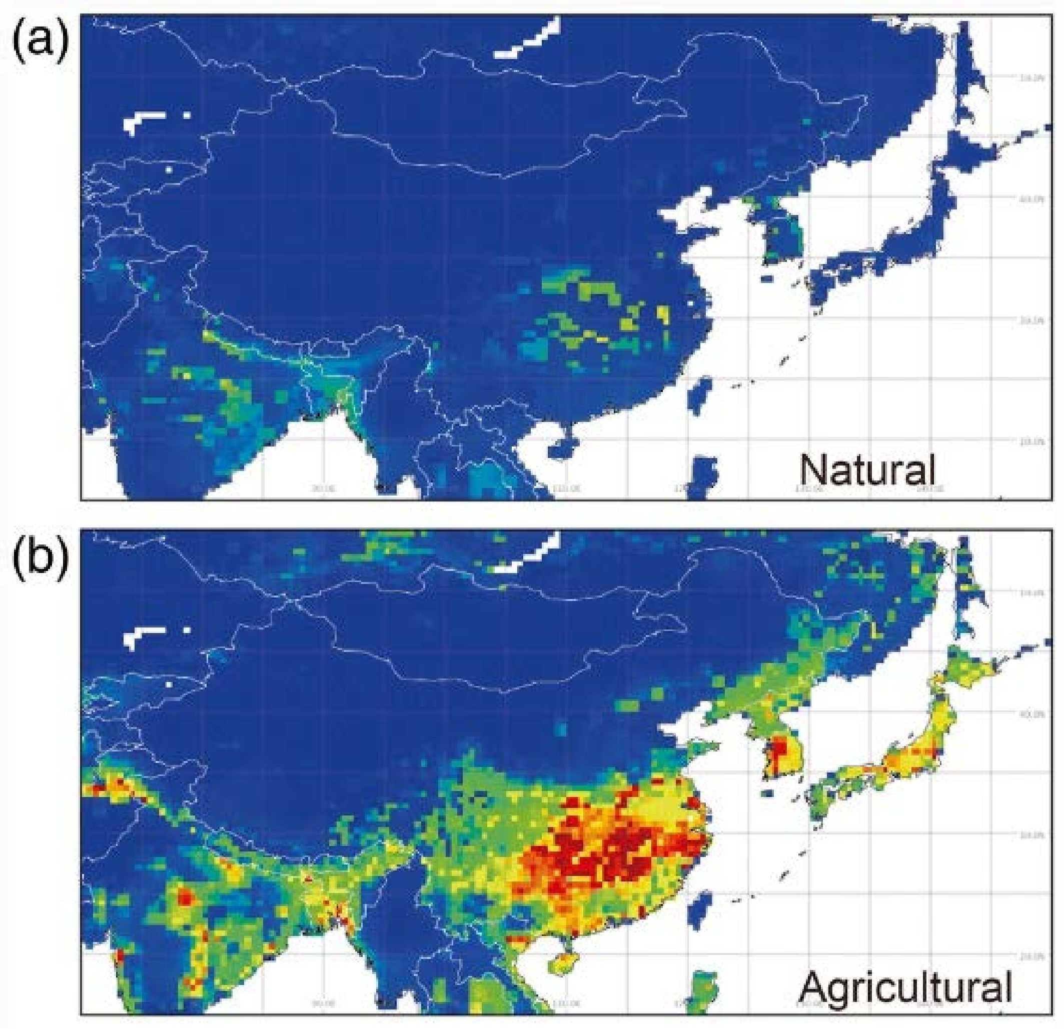


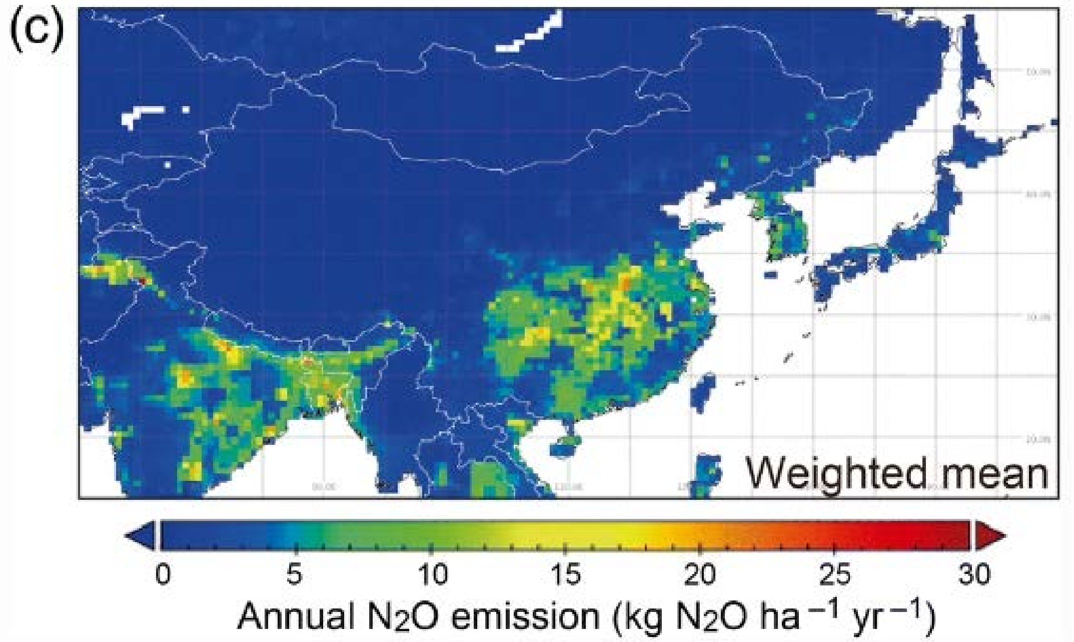


Time series of the CH_4 budget in East Asia (1990-2015)

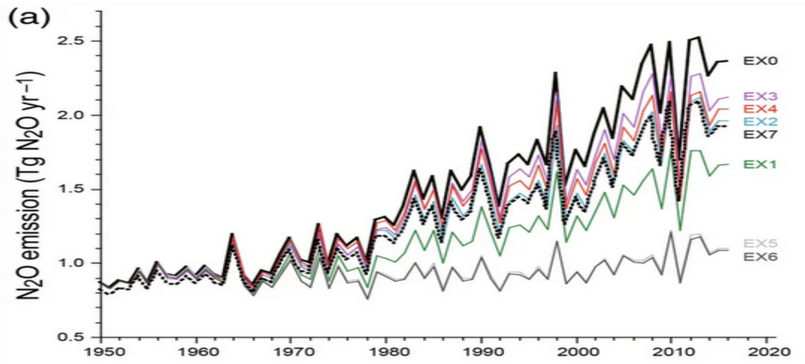
Emissions of nitrous oxide (N_2O) from soil surfaces and their historical changes in East Asia

Itoh *et al*. (2018)



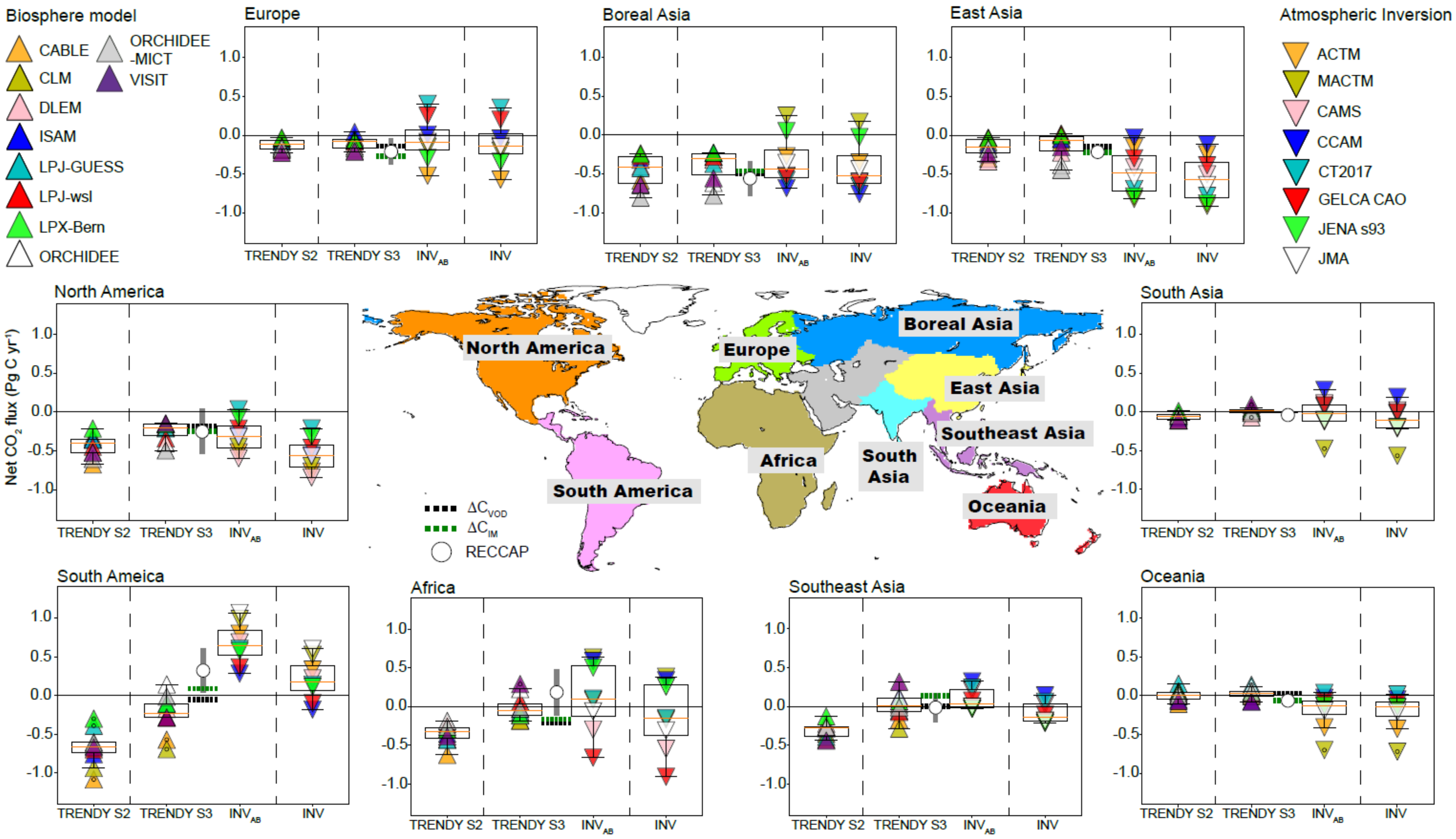


Emissions of N_2O in East Asia (2000–2009) simulated with the VISIT model.



Interannual variability of total N_2O emissions in East Asia simulated with the VISIT model.

Progress in both top-down and bottom-up approaches for terrestrial CO_2 budget



Terrestrial CO_2 budget estimations was much improved by reconciling top-down and bottom-up approaches.

Kondo, Patra, *et al*. (2019) Global Change Biology (in press)

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

ipcc | UNFCCC | Global Stocktake

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

WCRP | GLOBAL CARBON project

GAW WDCGG IG3IS | WMO

CEOS WG Climate GHG TT

GEO GROUP ON EARTH OBSERVATIONS

Data

Data and knowledge

Japan Platform

Data: Atmospheric GHGs & SLCPs, 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 (GHG Inventory Office) | JAMSTEC | Universities | MEXT

Other countries' efforts

City-scale and national emissions	EU	Global GHG emission
City-scale and national emissions	US	Global GHG emission
	…	

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 (anthropogenic and natural sinks and sources)
- Technological development is still required for
  - separation of anthropogenic and natural emission
  - near-future prediction of impacts of mitigation actions