16th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-16)
June 2 - 5, 2020

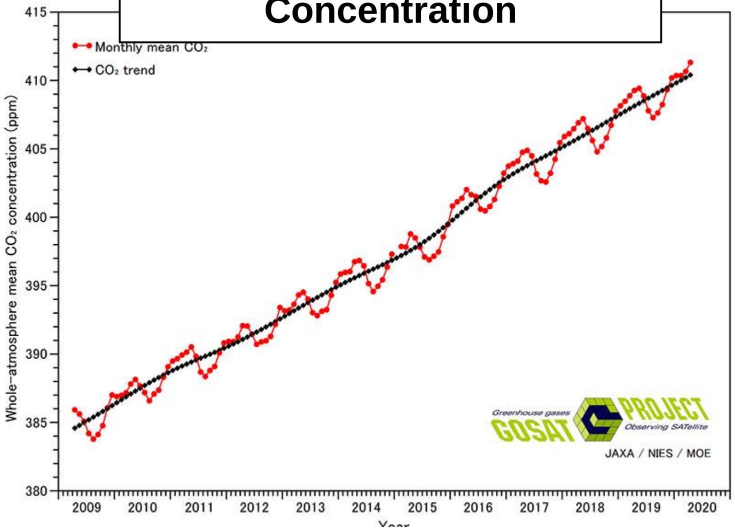
Overview of Recent Science Achievements, Related Activities, and the Future Direction of GOSAT Satellite Series

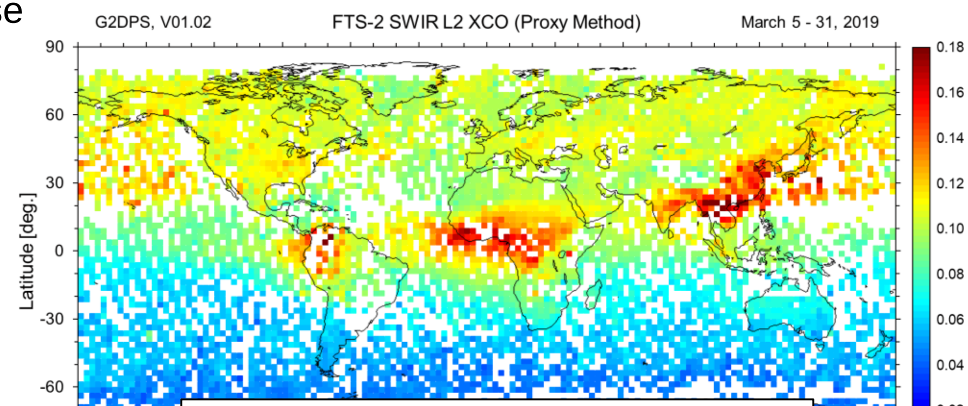
Tsuneo Matsunaga
National Institute for Environmental Studies (NIES)
Akihiko Kuze
Japan Aerospace Exploration Agency (JAXA)
and
Ryoichi Imasu
The University of Tokyo

Status of GOSAT and GOSAT-2

- **GOSAT (2009 -)**
  - FTS L1B — Current version = V220.220
    Next version = V230.230
  - FTS SWIR Level 2 — Current version = V02.81 / V02.75
    Next version = V02.90 / V02.95
  - Level 4 — CO2 flux, Current version = V02.06
    CH4 flux, Current version = V01.04
    CH4 flux, Next version = V01.05
- **GOSAT-2 (2018 -)**
  - FTS-2 Level 1 — V101.101
  - FTS-2 SWIR L2 Proxy — V01.02 (without SIF), RA release
    V01.03 (with SIF), RA Release
  - FTS-2 SWIR L2 Full physics — V01.01, RA Release
    V01.02, internal
  - CAI-2 L2 Cloud — V01.03, Public Release
  - Level 4 A/B — To be released in FY2020
- **Data download**
  (GOSAT) https://data2.gosat.nies.go.jp/
  (GOSAT-2) https://prdct.gosat-2.nies.go.jp/

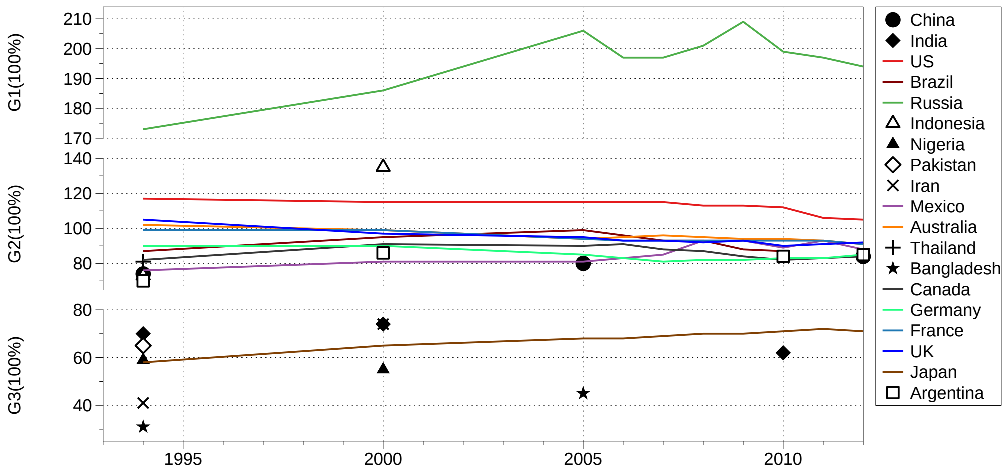
GOSAT Whole-atmosphere Monthly Mean CO2 Concentration





GOSAT-2 FTS-2 SWIR L2 Proxy CO Map (March 2019)

Methane Emission Estimates by the Global High-Resolution Inverse Model Using National Inventories (Wang et al., 2019)



UNFCCC / EDGAR v4.3.2 ratio.

- G1: Russia, 1.7 to 2-fold
- G2: US, China, France, Germany, UK, within 20%
- G3: India, Japan, 50%~70%

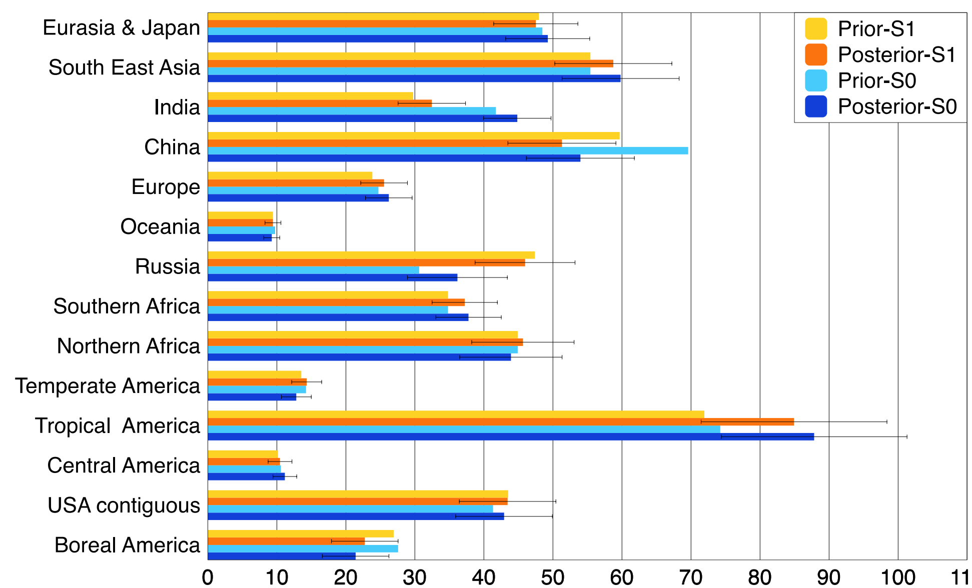
Inverse model

- NIES-TM-FLEXPART-VAR(NTFVAR)
- Reconstruct bi-weekly flux corrections, at resolutions of 0.1 deg

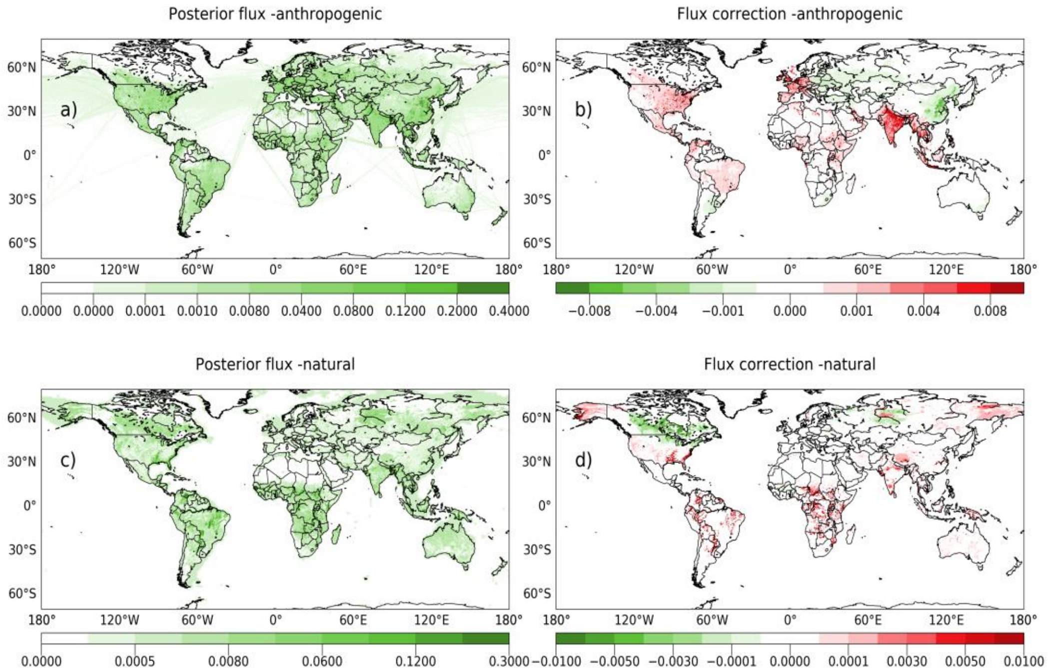
Optimized regional total CH_4 emissions using different priors

S0 = EDGAR prior, S1 = UNFCCC prior

- Russia increases by 27% from S0 to S1
- India decreases by 29%
- Temperate South America shows 12% higher posterior emissions
- Boreal North America increase by 6%
- Central North America decrease by 6%



Country-Scale Analysis of Methane Emissions with a High-Resolution Inverse Model Using GOSAT and Surface Observations (Janardanan et al., 2020)



Inverse model

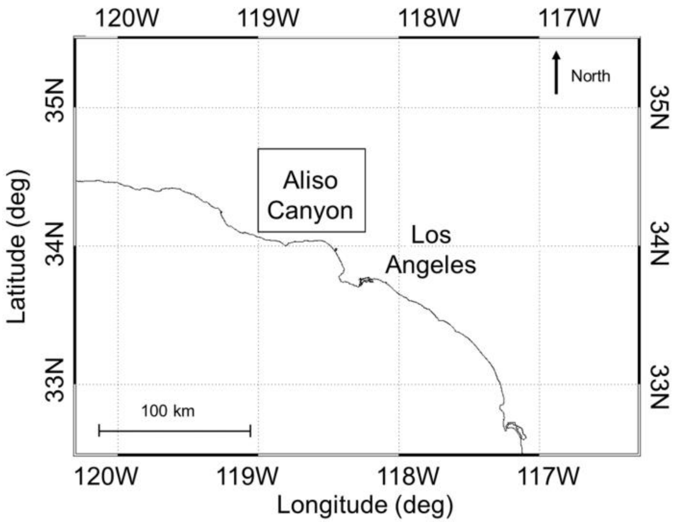
- NIES-TM-FLEXPART-VAR(NTFVAR)
- Reconstruct bi-weekly flux corrections, at resolutions of 0.1 deg

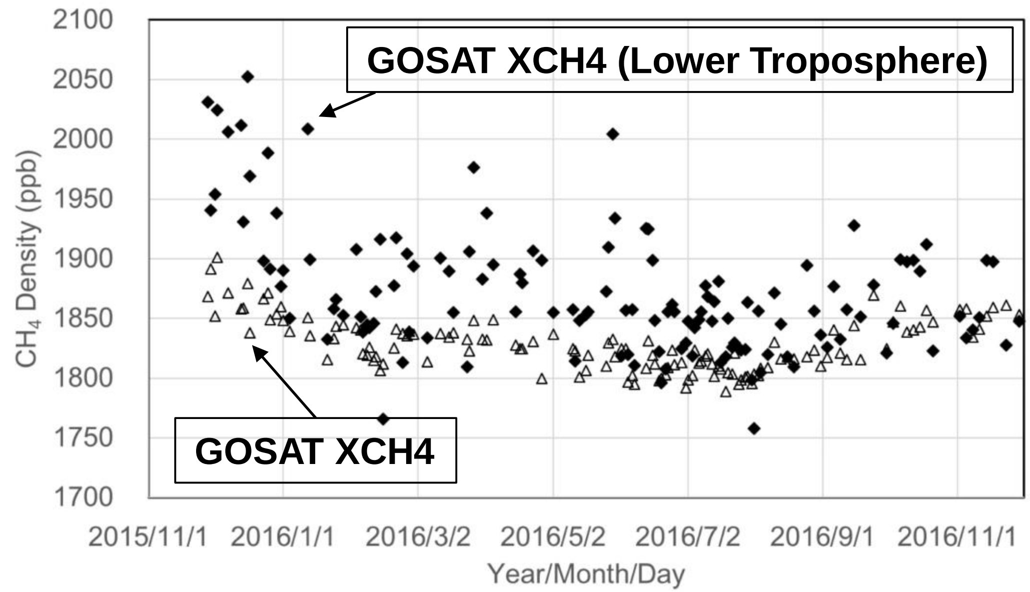
Posterior fluxes (**a** and **c**) and the corresponding flux corrections (**b** and **d**) by inverse model, averaged for 2011–2017, for natural (bottom panel) and anthropogenic (upper panel) categories. The units are in g CH_4 m^{-2} d^{-1}.

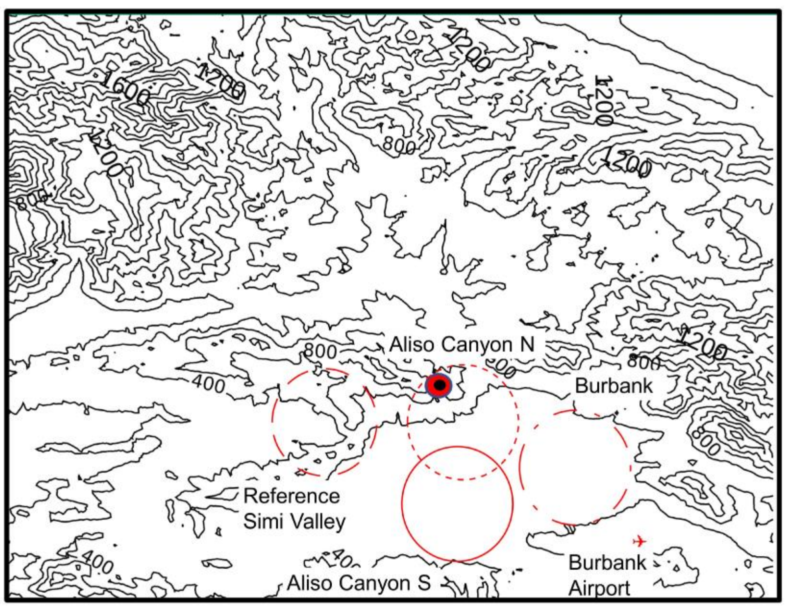
Country	total prior	total posterior	Percentage difference	natural prior	natural posterior	Percentage difference	Anthro-pogenic prior	Anthro-pogenic posterior	Percentage difference	Uncertainty (Tg)
CHN	60.1	52.0	-13.5	5.8	6.3	7.7	54.3	45.7	-15.8	8.6
USA	51.6	55.7	7.9	23.8	25.9	8.8	27.8	29.8	7.2	7.8
RUS	47.8	45.2	-5.5	13.6	13.2	-2.7	34.2	31.9	-6.6	7.8
BRA	45.6	56.2	23.3	29.2	39.8	36.1	16.4	16.5	0.6	10.0
IND	29.9	36.5	21.9	9.9	12.3	25.2	20.1	24.2	20.4	5.3
...	…	…	…	…	…	…	…	…	…	…
UKR	2.8	2.4	-14.5	0.2	0.2	-4.4	2.6	2.2	-15.8	0.4
PHL	2.8	2.8	1.5	0.2	0.2	4.6	2.5	2.6	1.2	0.4
POL	2.7	2.5	-5.3	0.0	0.0	0.0	2.6	2.5	-5.3	0.4
AGO	2.7	3.1	12.9	2.1	2.5	16.0	0.6	0.6	1.7	0.3
FRA	2.5	2.8	11.2	0.1	0.1	0.0	2.4	2.7	11.2	0.4
Global	551.7	573.4	3.9	209.2	232.5	11.2	342.6	340.9	-0.5	22.6

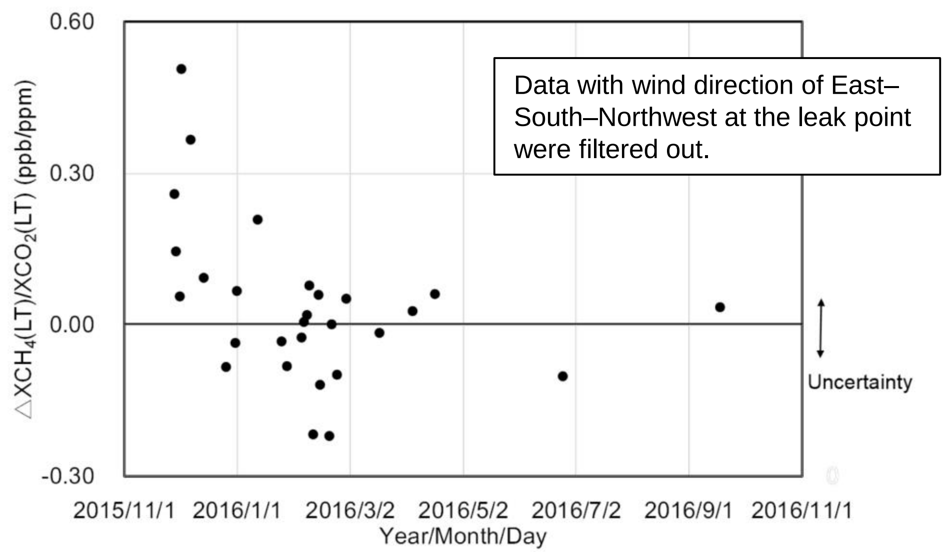
List of 39 countries with annual emission greater than 2.5 Tg CH_4.

Detection of Methane Emission from a Local Source Using GOSAT Target Observations (Kuze et al., 2020)





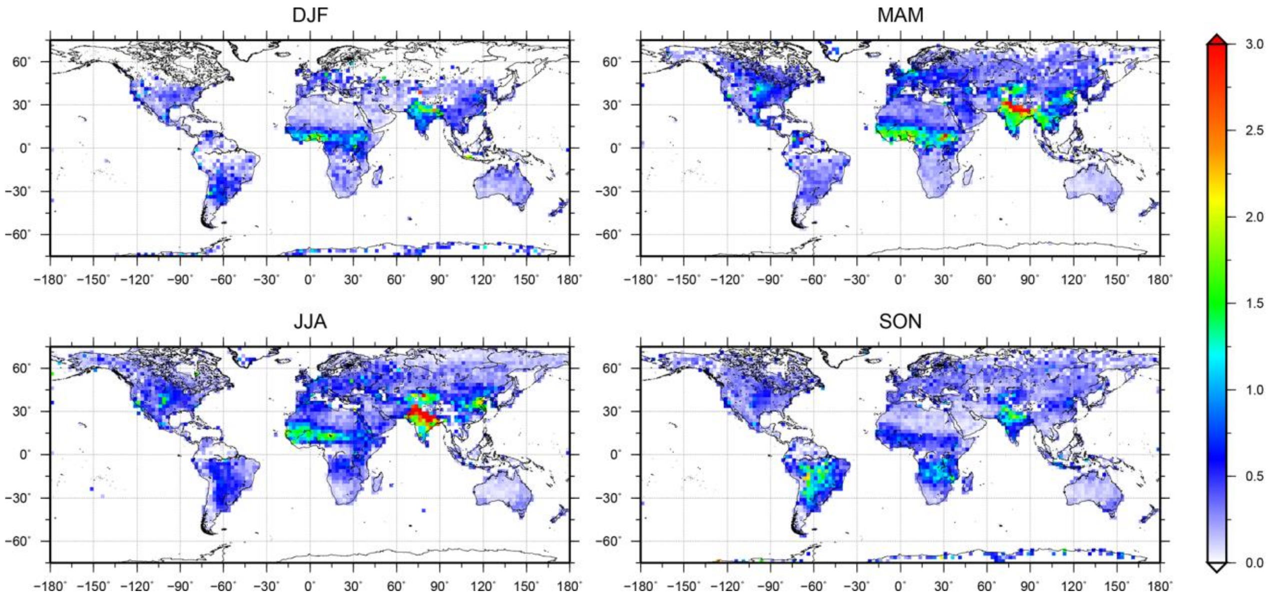


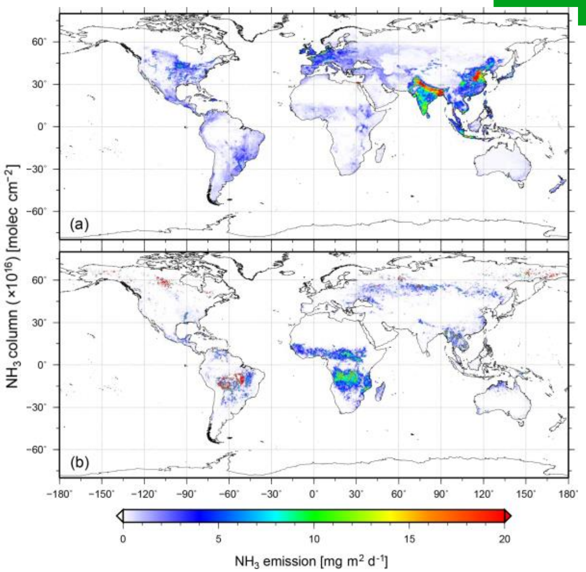


NIES
衛星観測センター
Satellite Observation Center

Tsuneo Matsunaga (matsunag@nies.go.jp), National Institute for Environmental Studies, Japan
16th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-16), 2-5 June 2020

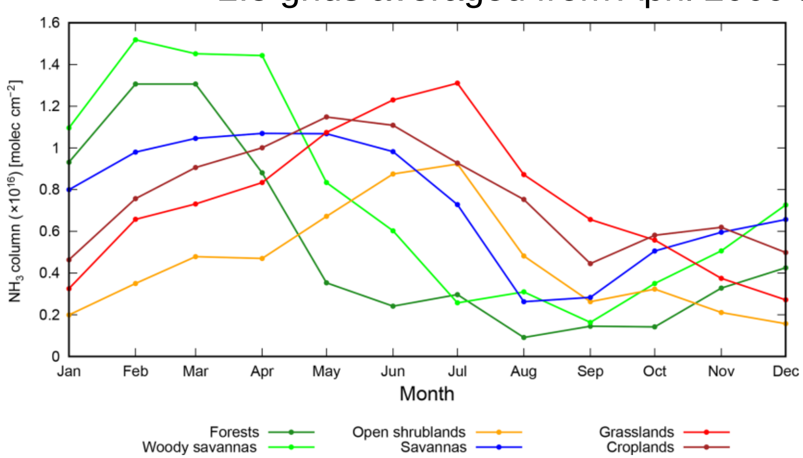
Atmospheric Ammonia Retrieval from the TANSO-FTS /GOSAT Thermal Infrared Sounder (Someya et al., 2020)





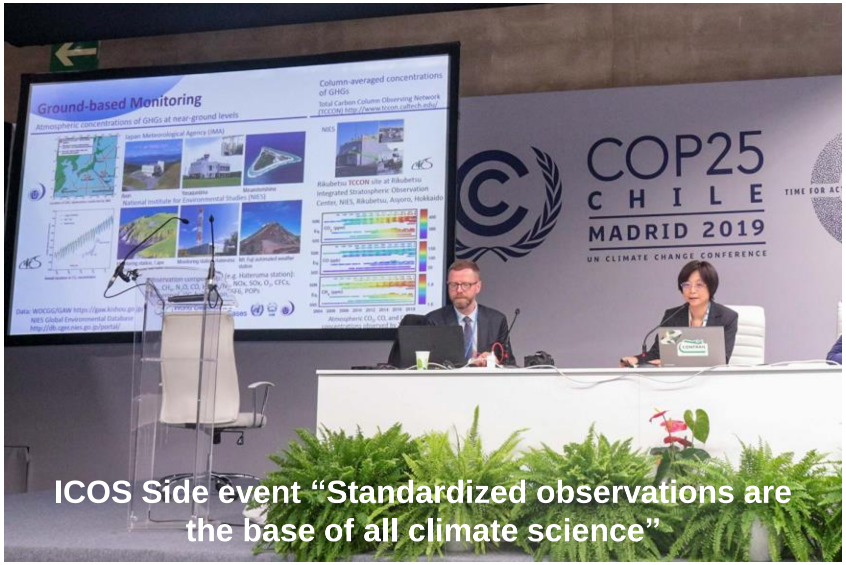
NH3 column amounts for each season retrieved from GOSAT over 2:5 2:5 grids averaged from April 2009 to May 2014.

Anthropogenic NH3 emissions in 2010 obtained from EDGAR-HTAP v2 (a) and the biomass burning emissions from GFED4.1s (b).



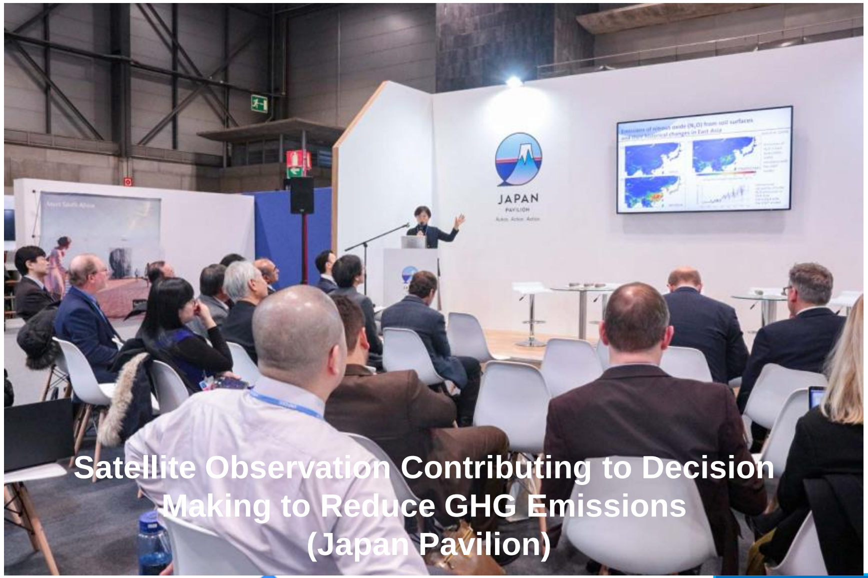
Monthly variations of ammonia column amount from GOSAT for the study period over forests, woody savannas, open shrublands, savannas, grasslands, and croplands classified by the MODIS product in Central Africa.

Presentations and Exhibit at UNFCCC COP25 (Spain, December 2019)

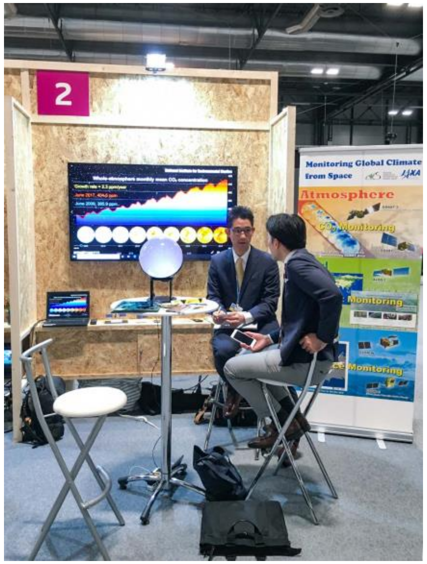


ICOS Side event "Standardized observations are the base of all climate science"

Satellites in Support of National Greenhouse Gases Reporting and Global Stocktake

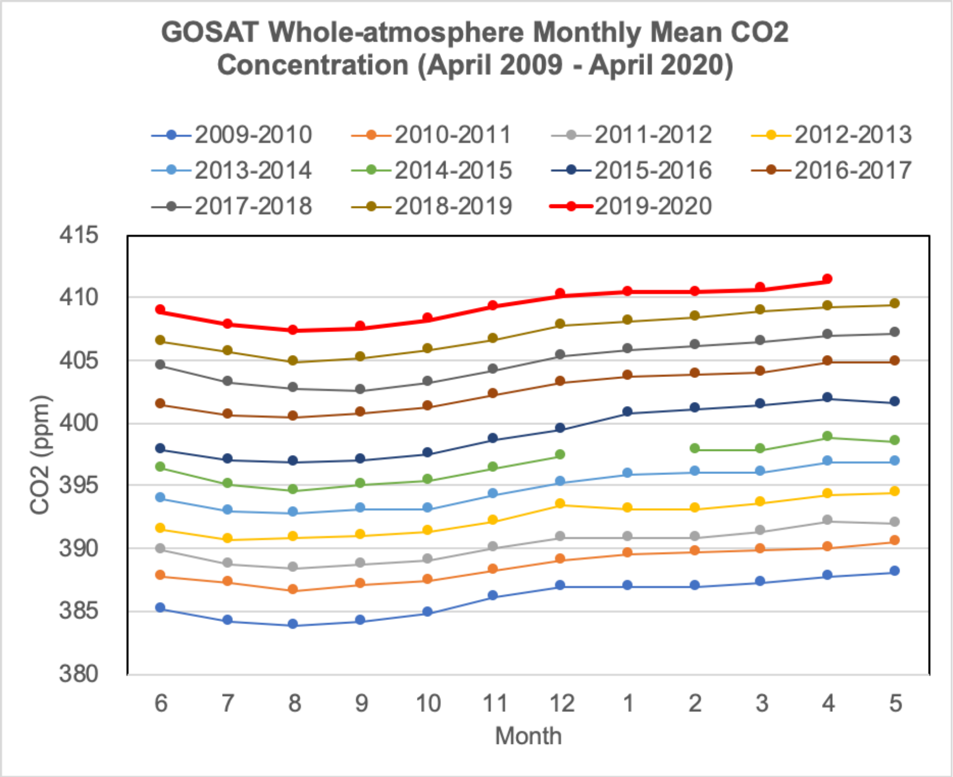


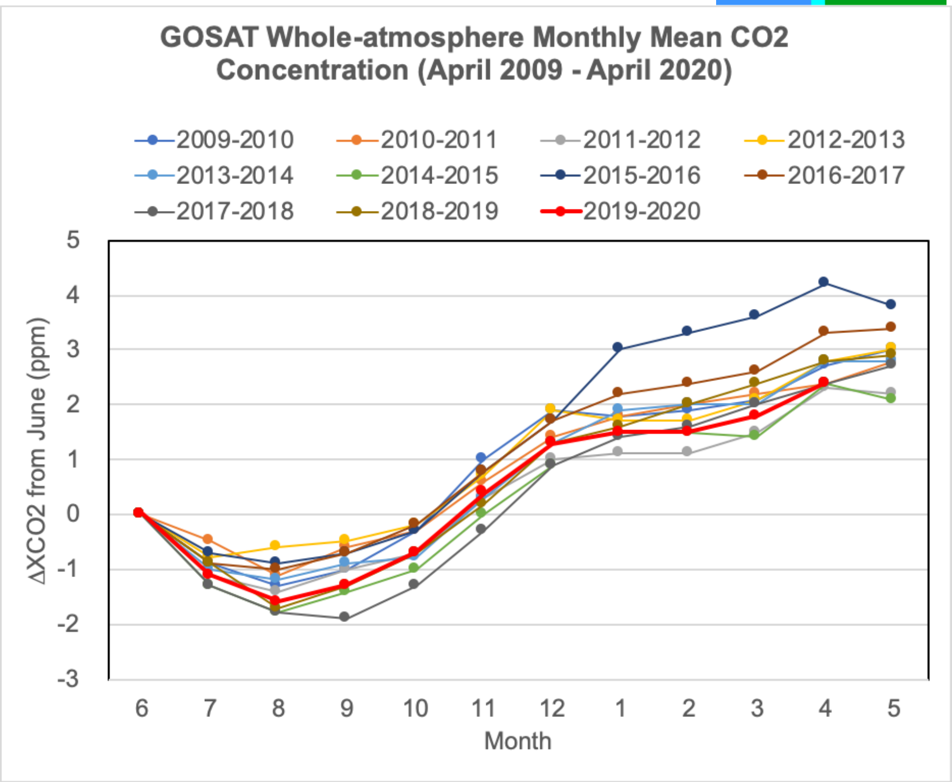
Satellite Observation Contributing to Decision Making to Reduce GHG Emissions (Japan Pavilion)



http://cger.nies.go.jp/ja/news/2019/191205.html

GOSAT Whole-atmosphere Monthly Mean CO2 Concentration (April 2009 – April 2020)





- (Annual increase) The growth rate of GOSAT whole-atmosphere monthly mean CO2 concentration is between 1.7 – 3.3 ppm / year since 2009.
- (Seasonal change) Every year, GOSAT whole-atmosphere monthly mean CO2 concentration increases monotonically from its lowest in August - September to its highest in April - May.
- CO2 increase from December 2019 to April 2020 is 1.1 ppm, the lowest in the last 7 years. But the fourth lowest in the last 11 years.
- The impact of reduced CO2 emission due to COVID-19 on global CO2 concentration is NOT clear.

http://www.gosat.nies.go.jp/en/recent-global-co2.html

NIES
衛星観測センター
Satellite Observation Center

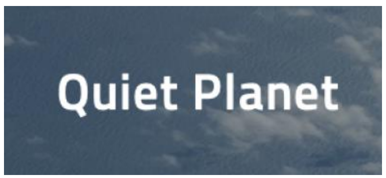
Tsuneo Matsunaga (matsunag@nies.go.jp), National Institute for Environmental Studies, Japan

Space Apps COVID-19 Challenge

https://covid19.spaceappschallenge.org

NASA SPACE APPS COVID-19 CHALLENGE

NASA, ESA and JAXA are inviting coders, entrepreneurs, scientists, designers, storytellers, makers, builders, artists, and technologists to participate in a virtual hackathon **May 30-31** dedicated to putting open data to work in developing solutions to issues related to the COVID-19 pandemic.

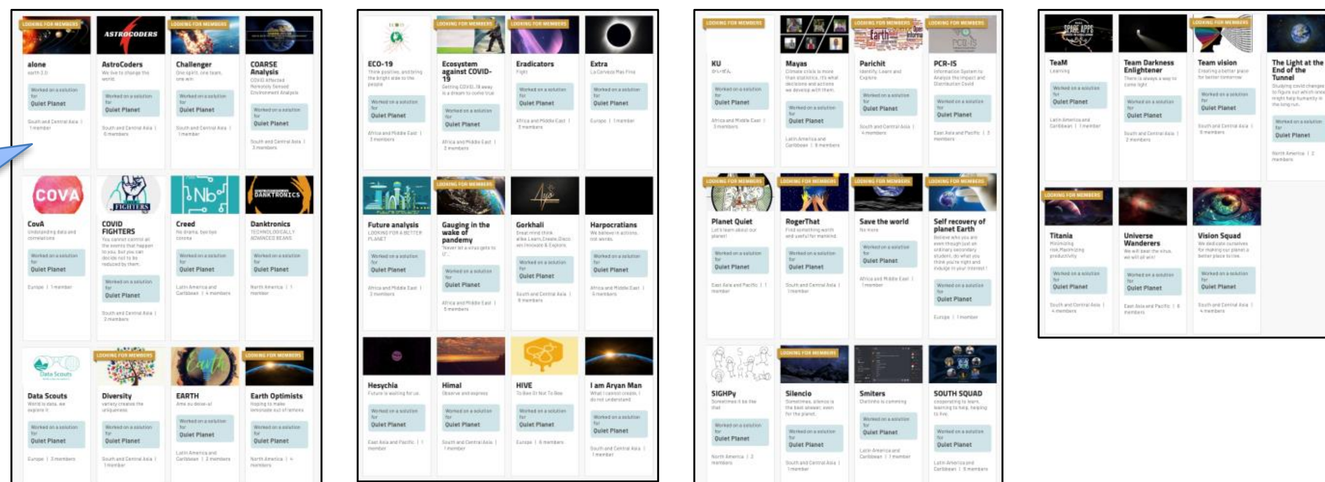


One of 12 Challenges : Quiet Planet

"The COVID-19 outbreak and the resulting social distancing recommendations and related restrictions have led to numerous short-term changes in economic and social activity around the world, all of which may have impacts on our environment. Your challenge is to use space-based data to document the local to global environmental changes caused by COVID-19 and the associated societal responses."

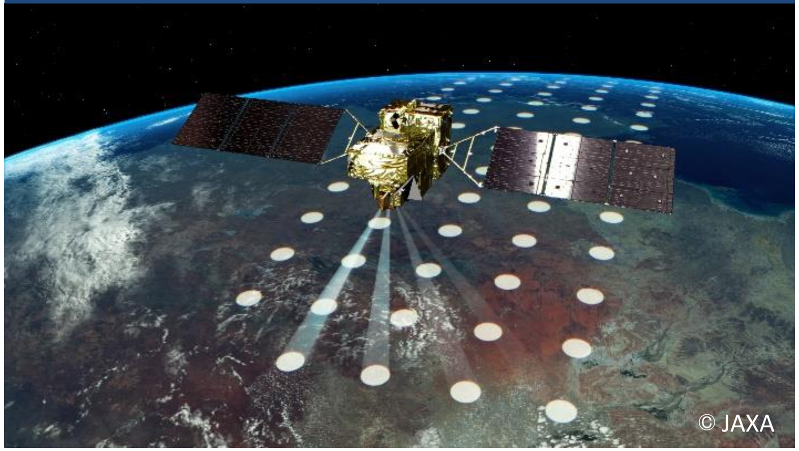
GOSAT data will be provided to Teams via JAXA GHGs Trend Viewer and NIES GDAS.

43 Teams from all over the world will tackle "Quiet Planet."



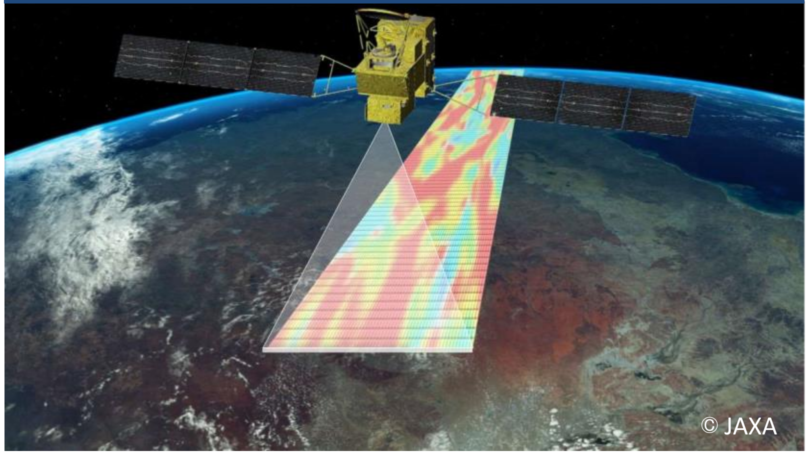
Global Observing Satellite - Greenhouse Gas and Water Cycle (GOSAT-GW)

GOSAT-2



Launch:	2018
Lifetime:	5 years
Mass:	1.7 t
Instrument:	FTS
Target:	CO_2, CH_4, CO
Bands:	0.7 / 1.6 / 2 µm + TIR
Swath:	Discrete, 5 points
IFOV:	≈ 10 km

GOSAT-GW



Launch:	FY2023
Lifetime:	7 years
Mass:	≈ 2.6 t
Instrument:	Grating Imaging Spectrometer
Target:	CO_2, CH_4, NO_2
Bands:	UV + 0.7 / 1.6 µm
Swath:	Continuous, two modes ≈ 1000 km or ≈ 90 km
IFOV:	≈ 10 km or ≈ 1 – 3 km

Thank you for your attention

GOSAT and GOSAT-2 standard products are freely available from
GOSAT Data Archive Service (L1B, L2, L3, L4)
https://data2.gosat.nies.go.jp
GOSAT-2 Product Archive (L1B, L2, L4**)**
https://prdct.gosat-2.nies.go.jp/

GOSAT L2 products can be downloaded from **WDCGG**
https://gaw.kishou.go.jp

Also visit **JAXA GHGs Trend Viewer**
https://www.eorc.jaxa.jp/GOSAT/CO2_monitor/

Highlighted Papers:

1. Wang et al., Methane Emission Estimates by the Global High-Resolution Inverse Model Using National Inventories, Remote Sens. 2019, 11(21), 2489, https://www.mdpi.com/2072-4292/11/21/2489/htm
2. Janardanan et al., Country-Scale Analysis of Methane Emissions with a High-Resolution Inverse Model Using GOSAT and Surface Observations, Remote Sens. 2020, 12(3), 375, https://www.mdpi.com/2072-4292/12/3/375
3. Kuze et al., Detection of Methane Emission from a Local Source Using GOSAT Target Observations, Remote Sens. 2020, 12(2), 267, https://www.mdpi.com/2072-4292/12/2/267
4. Someya et al., Atmospheric Ammonia Retrieval from the TANSO-FTS/GOSAT Thermal Infrared Sounder, Atmos. Meas. Tech., 13, 309–321, 2020, https://www.atmos-meas-tech.net/13/309/2020/