GOSAT and GOSAT-2 Level4 global surface flux estimates

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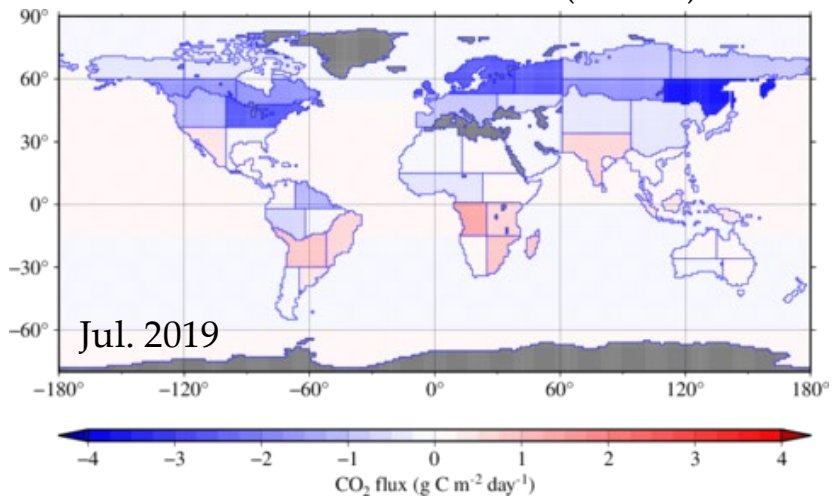
GOSAT Level 4 products

GOSAT: Jan. 2009 – (XCO_2, XCH_4)

GOSAT Level 4A CO_2 Product (V02.06)



Atmospheric observations:

GOSAT FTS SWIR Level 2 XCO_2 + ObsPack GV+

Atmospheric inverse model:

NIES-TM + Fixed-lag Kalman smoother
(Makyutov et al., 2013)

Prior information:

ODIAC (Oda et al., 2019): Fossil fuel CO_2 emissions

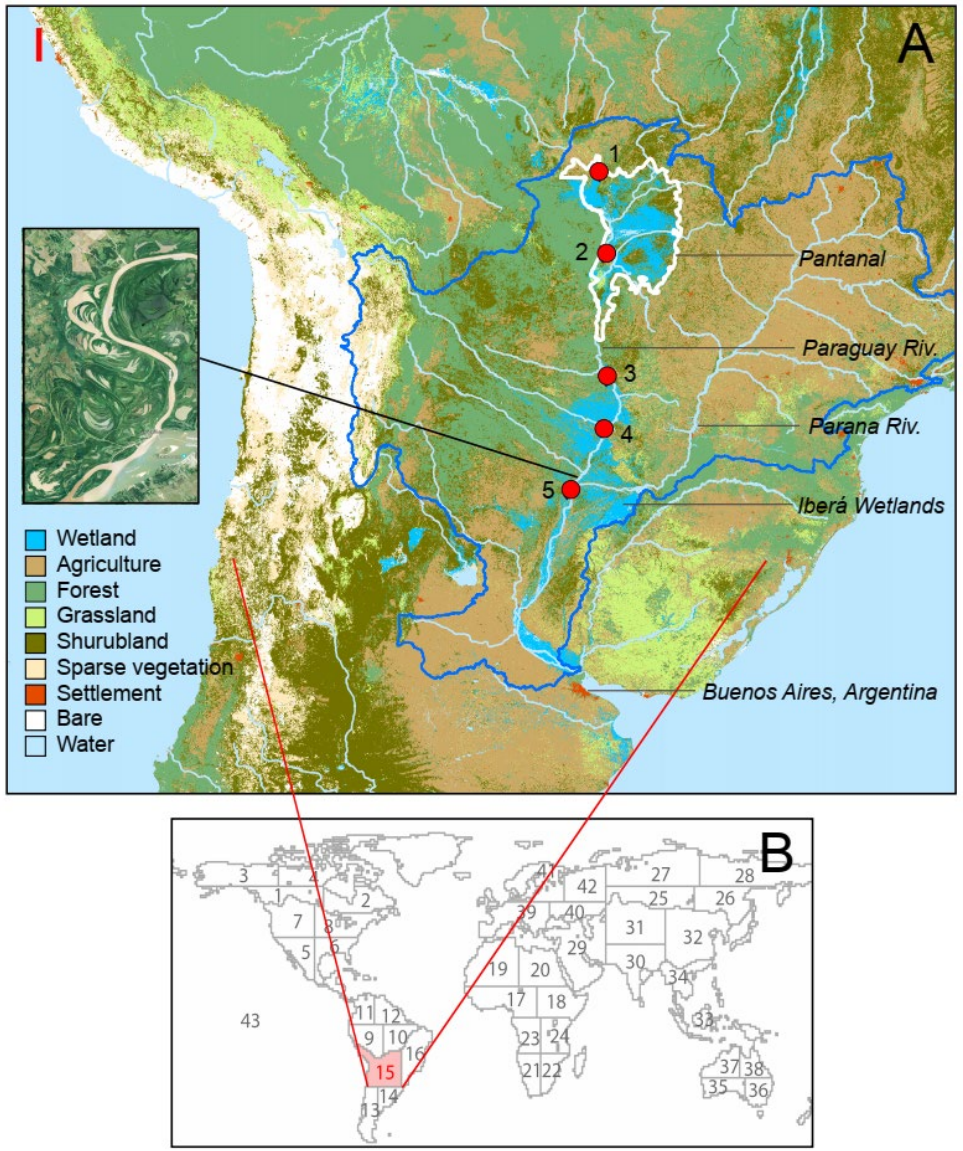
VISIT (Ito, 2010, Saito et al., 2014): Net ecosystem CO_2 exchange rate

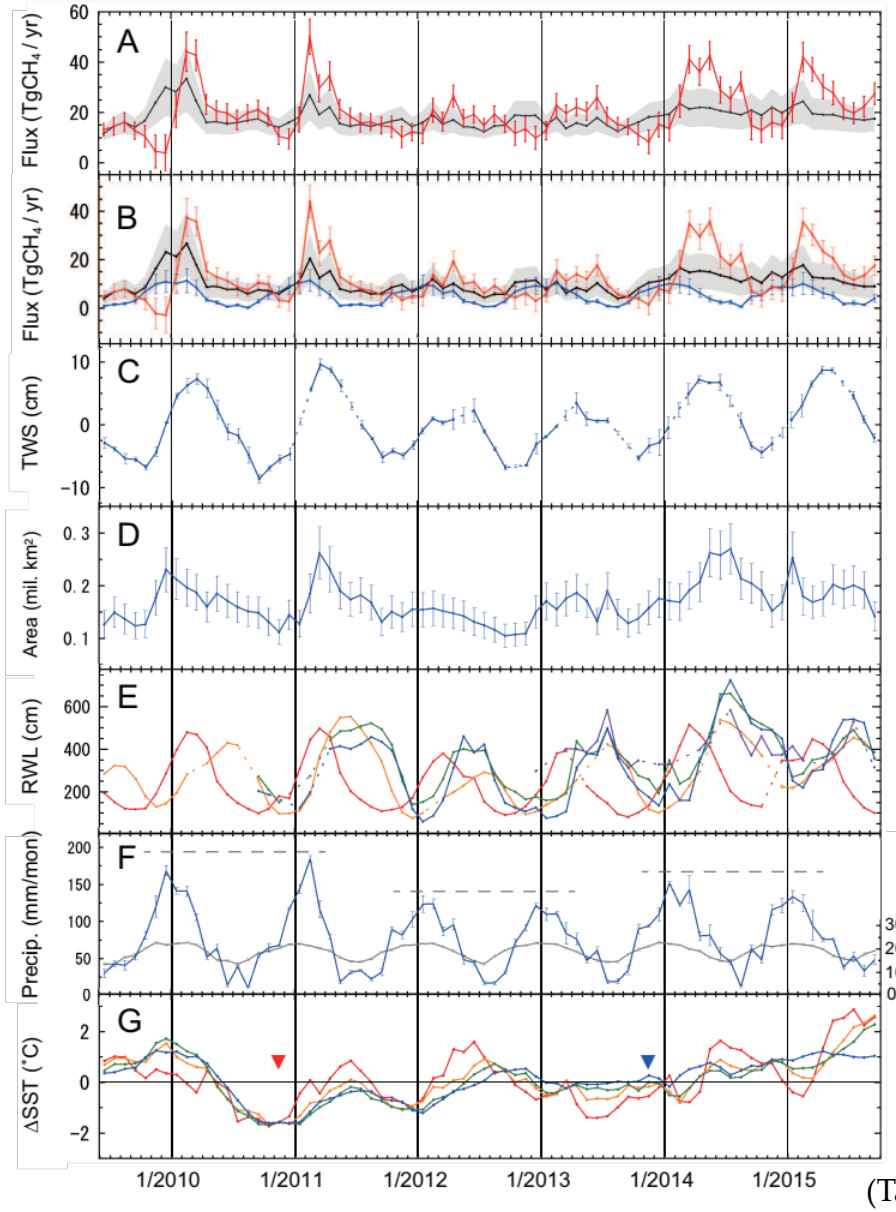
GFED (van der Werf et al., 2017): Biomass burning emissions

OTTM (Valsala et al., 2010): Ocean flux

Monthly global surface flux estimates in 64 (43 for CH_4) regions

Subtropical South America (SSA) CH_4 emissions using GOSAT observations





CH_4 flux

Wetland CH_4 flux

Terrestrial water storage

Inundated area

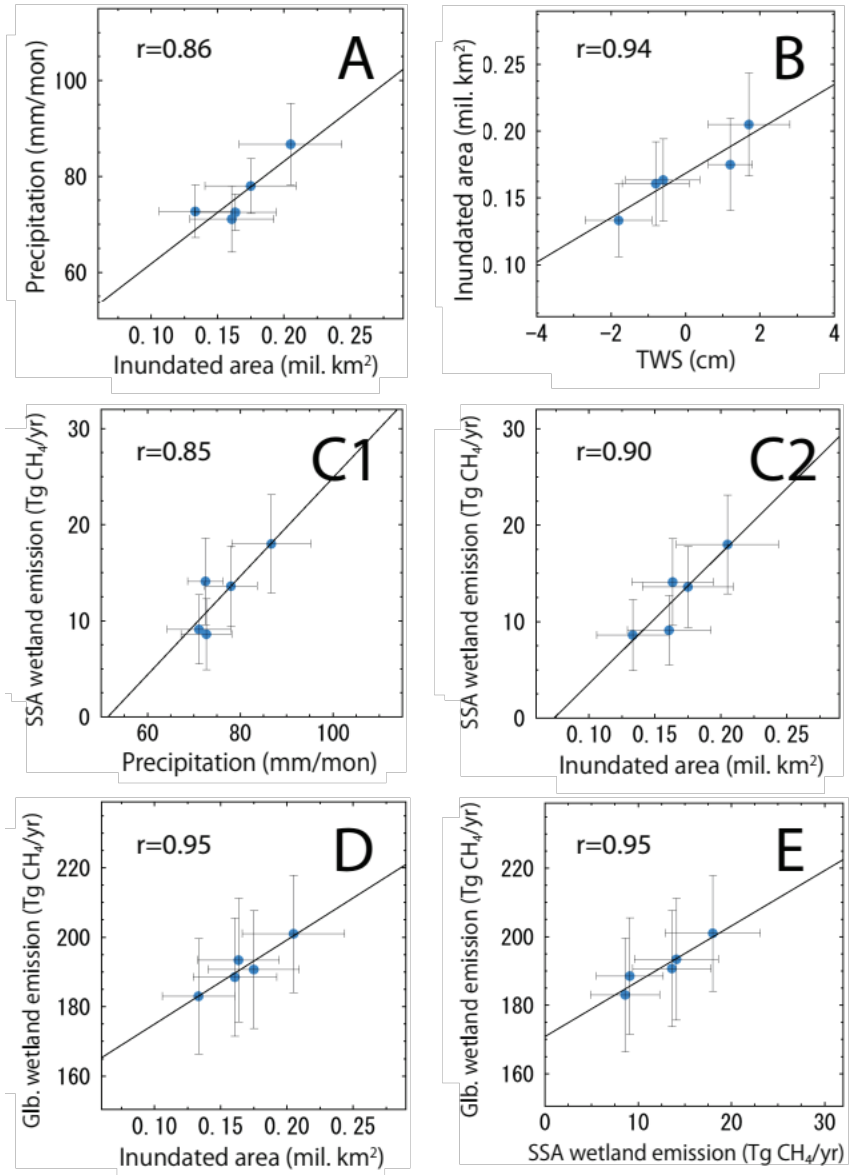
River water level

Precipitation and Temperature

Equatorial sea surface temperature anomalies

(Takagi et al., 2021)

Subtropical South America (SSA) CH_4 emissions using GOSAT observations



Consistent increase of the inundated area and TWS along with increasing precipitation.

Annual SSA posterior wetland emission increase with rising SSA precipitation amount and inundated area extent, showing strong correlations (r=0.85 and 0.90, respectively).

The global total posterior wetland emission increases with increasing SSA inundated area extent and SSA posterior wetland emission.

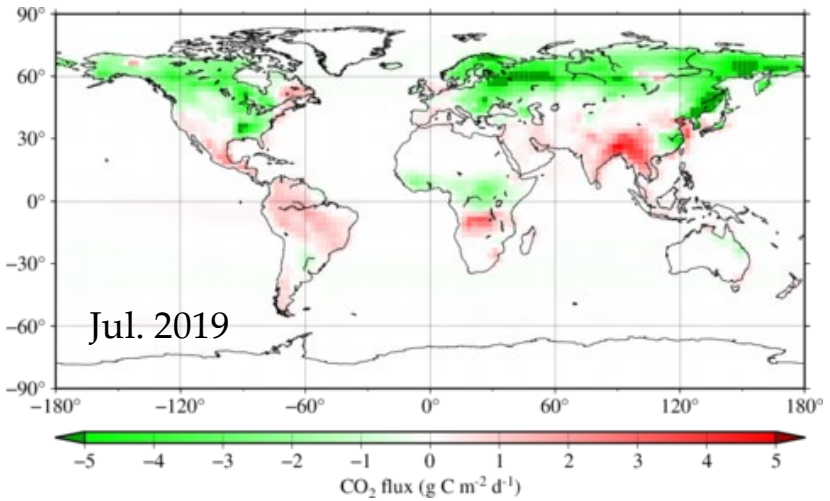
Our finding indicates that SSA CH_4 emissions are highly sensitive to rises in precipitation, TWS, and areal extent of inundation, and suggests that changes in SSA meteorology are an important factor driving the interannual variability of the region's wetland CH_4 emission and also have a potential of influencing the global total wetland emission.

Correlation between the annual values. A: SSA precipitation vs. SSA inundated area. B: SSA inundated area vs. SSA TWS. C1: SSA posterior wetland emission vs. SSA precipitation. C2: SSA posterior wetland emission vs. SSA inundated area. D: Global total posterior wetland emission vs. SSA inundated area. E: Global total posterior wetland emission vs. SSA posterior wetland emission.

GOSAT-2 Level 4 products

GOSAT-2: Oct. 2018 – (XCO_2, XCH_4, XCO)

GOSAT-2 Level 4A CO_2 Product (test version)



Atmospheric observations:

GOSAT-2 FTS-2 SWIR Level 2 XCO_2

Atmospheric inverse model:

NISMON (NICAM-TM 4D-Var; Niwa et al., 2017a,b)

Prior information:

ODIAC (Oda et al., 2019): Fossil fuel CO_2 emissions

VISIT (Ito, 2019): Gross primary productivity, Ecosystem respiration, Land use change

GBEI (Shiraishi et al., 2021): Biomass burning emissions

JMA Ocean CO_2 map (Iida et al., 2021)

Monthly global surface flux estimates with spatial resolution of 2.5 deg.

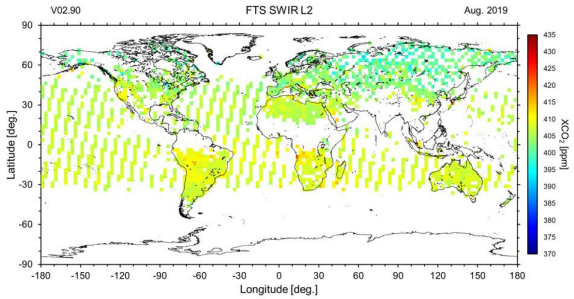
GOSAT and GOSAT-2 SWIR Level2 products

TANSO-FTS-2 (Thermal And Near infrared Sensor for carbon Observation (TANSO)- Fourier Transform Spectrometer (FTS)-2) features an Intelligent Pointing system that uses a high-resolution RGB infrared camera to identify cloud-free regions neat the target observation point.

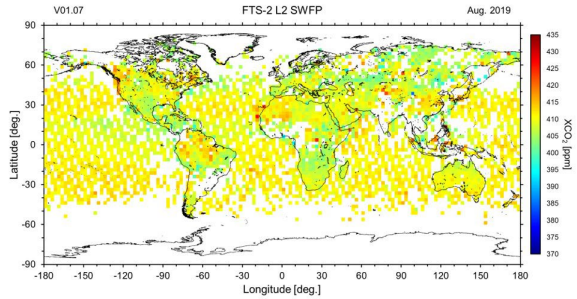
GOSAT Level2 XCO_2 (V02.97/98):
N = 277 391 (12 609/month)

GOSAT-2 Level2 XCO_2 (V01.04/07):
N = 582 756 (26 489/month)

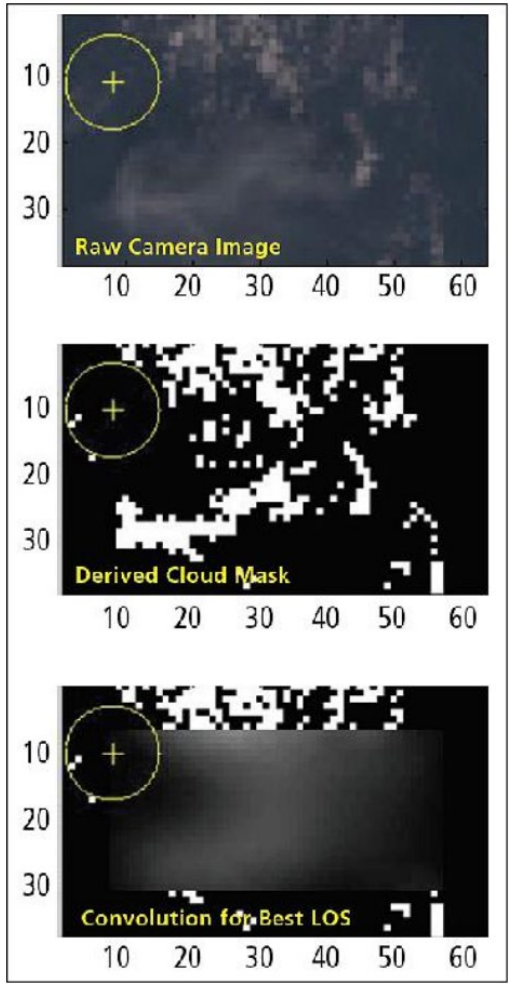
(22 months: Mar. 2019 – Dec. 2020)



GOSAT



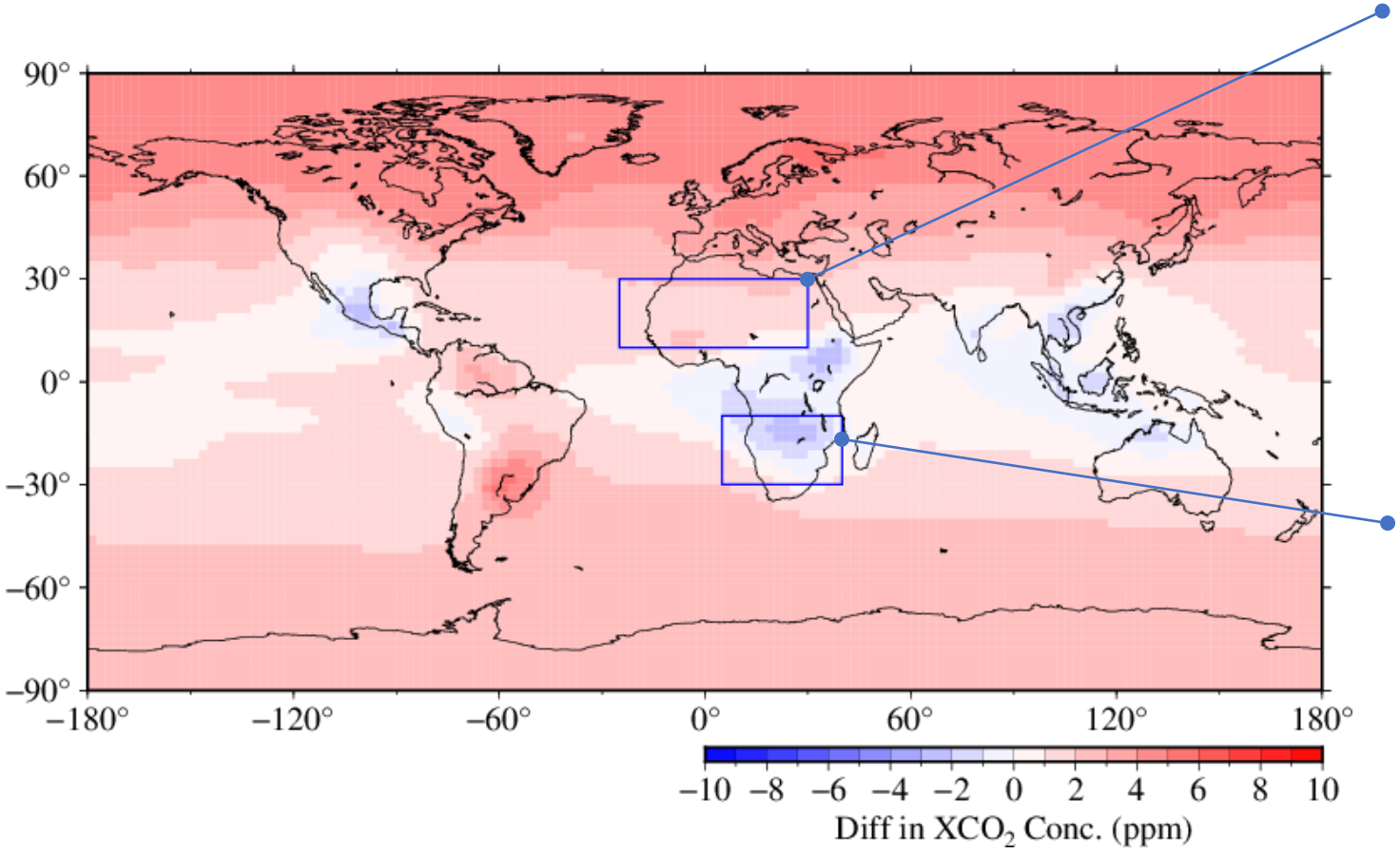
GOSAT-2



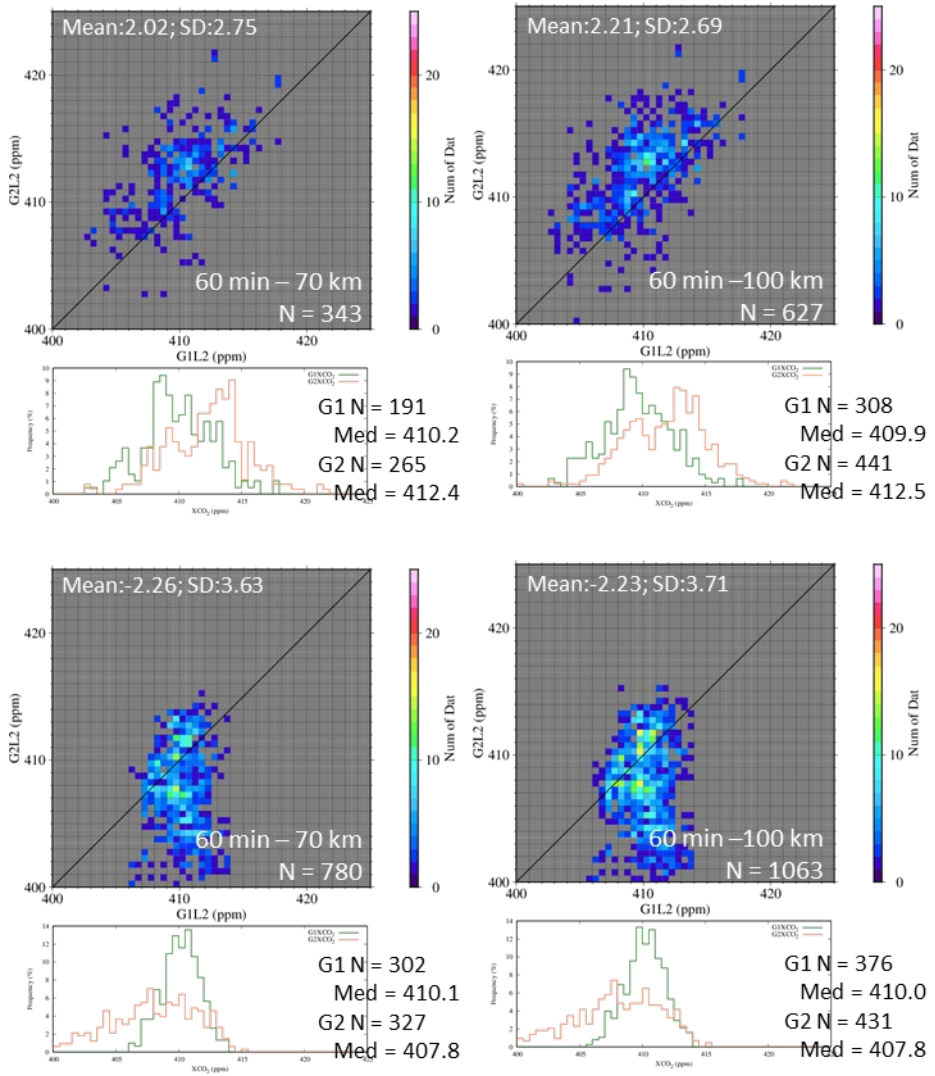
TANSO-FTS-2 cloud free region identification.

XCO_2: column-averaged dry air mole fraction of atmospheric CO_2

Biases in GOSAT-2 SWIR Level2 XCO_2



Difference of mean XCO_2 concentrations (ppm; Mar. 2019 – Dec. 2020) simulated using posterior fluxes derived from GOSAT XCO_2 (V02.97/98) and GOSAT-2 XCO_2 (V01.04/07).

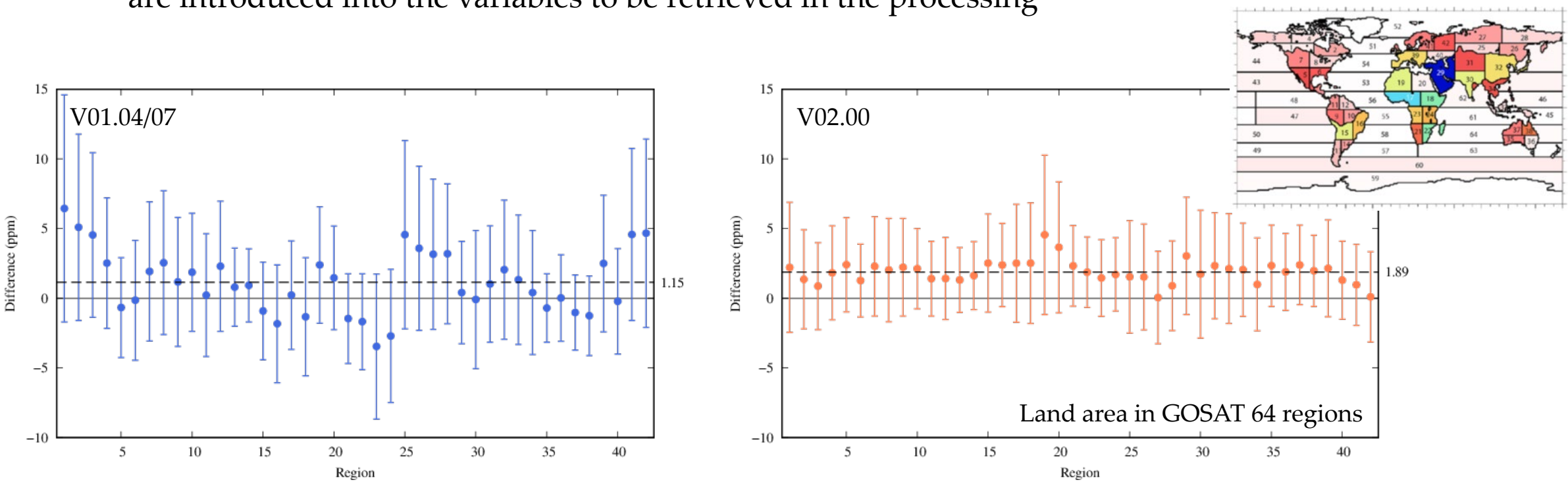


Comparison of GOSAT and GOSAT-2 XCO_2 data matching up to 60 min in the time direction and 70 or 100 km in the spatial direction.

GOSAT-2 SWIR Level2 product new version

GOSAT-2 SWIR XCO_2 product V02.00 was newly constructed by Y. Yoshida and is now open to the Research Announcement on GOSAT series (Jul. 4, 2022).
Difference of the new product from the previous one (V01.07) is

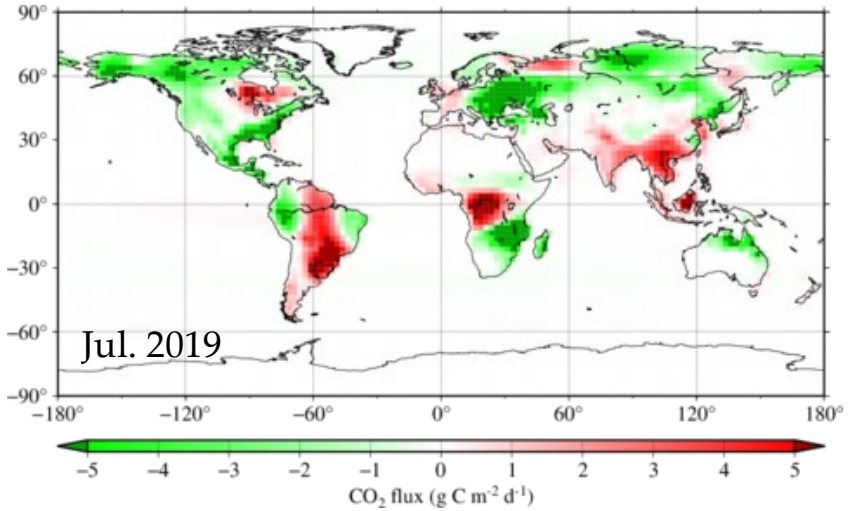
a zero-level offset and a stretch factor in instrument line shape function for each sub-band are introduced into the variables to be retrieved in the processing



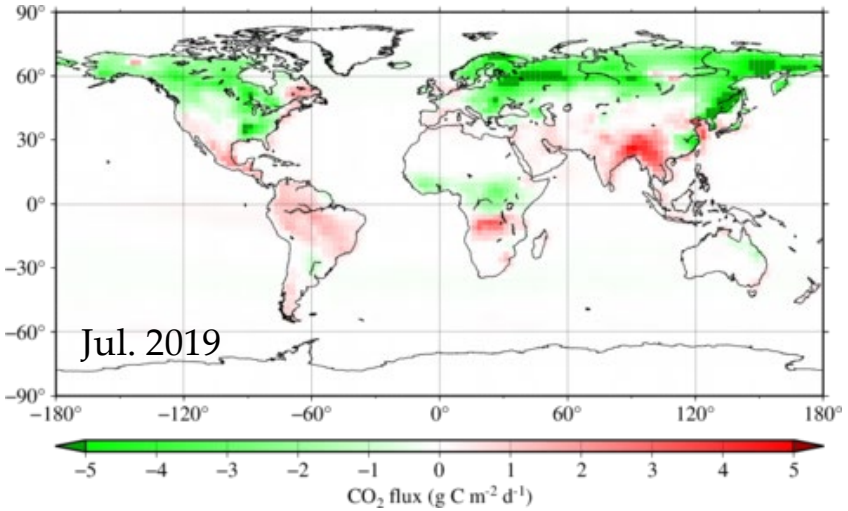
Distributions of mean XCO_2 bias and its standard deviation (ppm) for GOSAT-2 SWIR XCO_2 products of V01.04/07 and V02.00 in each land area region of GOSAT Level 4 classification (64 regions over the globe).

GOSAT-2 global surface flux estimates and Summary

using GOSAT-2 SWIR XCO_2 V01.04/07



using GOSAT-2 SWIR XCO_2 V02.00
with offset removal for land/ocean and
observation errors given for each point



Improvement of global surface flux estimates were seen in the simulation using GOSAT-2 SWIR XCO_2 product V02.00 with offset removal from the data and introduction of observation errors for individual observations based on the bias information on the XCO_2.

GOSAT Level 4 products have been publish every year by extending the analysis period. New products covering the period for 2009 and 2020 are being prepared.

The biases in GOSAT-2 XCO_2 product (V01.04/07) were substantially improved in the new version (V02.00), which also improve the global surface flux estimates.

GOSAT-2 Level 4 CO_2 product using the GOSAT-2 XCO_2 product V02.00 will be open soon.