



CEOS AC-VC-22
SRON, Leiden 2026-06-04

US GHG Missions Summary

Charles Miller



For required markings, please visit <https://mh.jpl.nasa.gov>

OCO-3 and OCO-3



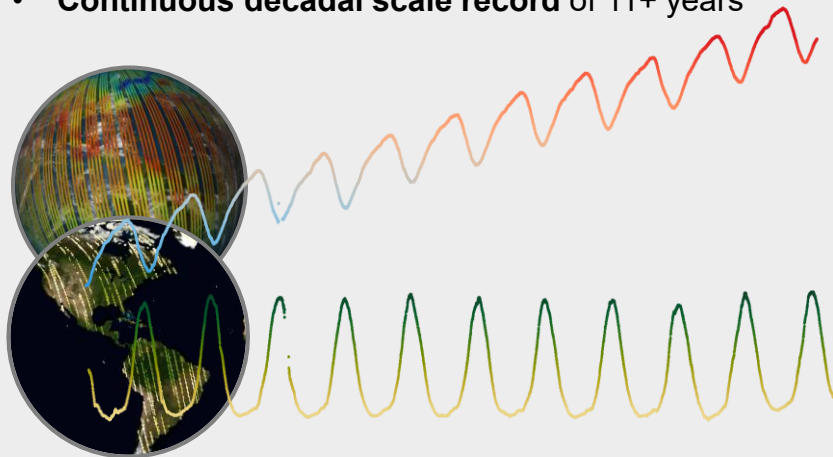
OCO-3 and OCO-2 Overview



OCO-2: Free-flyer in sun-synchronous orbit

OCO-2 provides a **decadal scale, Gold Standard baseline** for monitoring the **global** carbon cycle and vegetation health

- **Global** coverage from the tropics to the high latitudes
- **Repeated** observations at **fixed time of day** (1:30pm)
- **Continuous decadal scale record** of 11+ years



OCO-3: On the International Space Station

OCO-3 provides the **targeted**, high-resolution measurements of plant health and carbon over cities and ecosystems, **across different times of day**, offering insights into economic activity and resources

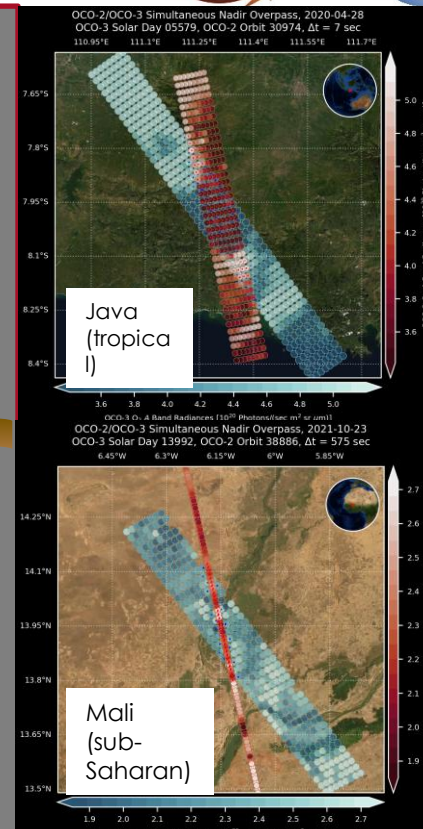
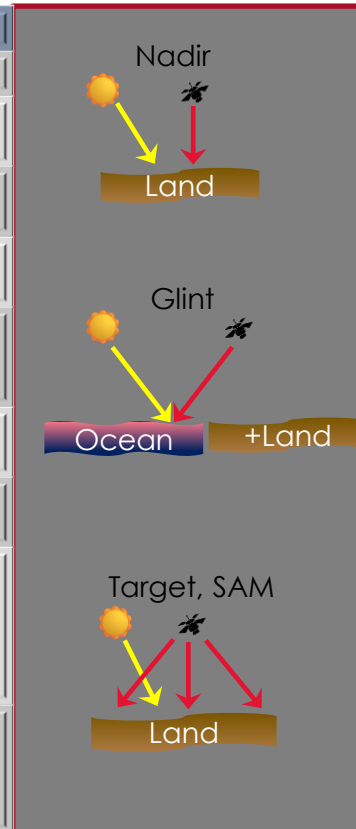
- Coverage between 52°N and 52°S
- Observations **across the diurnal cycle**
- Operational for 6+ years
- Agile high-resolution **snapshot area mapping**



OCO-2 vs. OCO-3 Instrument Overview



	OCO-2	OCO-3
launch	02 July 2014	04 May 2019
orbit	sun-synchronous, A-Train	precessing, ISS, 51.6° inclination
coverage	pole-to-pole, 1330h equator crossing	52°S – 52°N, variable
Swath width	~10 km (swath width varies along orbit)	~10 km
spectrometer	3 bands: 0.765 μm , 1.61 μm , 2.06 μm , 20,000 resolving power (OCO-3 was built as the OCO-2 spare)	
observed species	CO_2 dry-air column (XCO_2), total column H_2O solar-induced fluorescence (SIF)	
observation modes	nadir, glint, target	nadir, glint, target, SAM
off-nadir viewing	move spacecraft	pointing mirror assembly two mirrors: azimuth and elevation, moving independently
repeatability of observations	same local time every orbit; 16 days repeat (233 orbits)	none! local time a little earlier each day; day-by-day change in latitude coverage

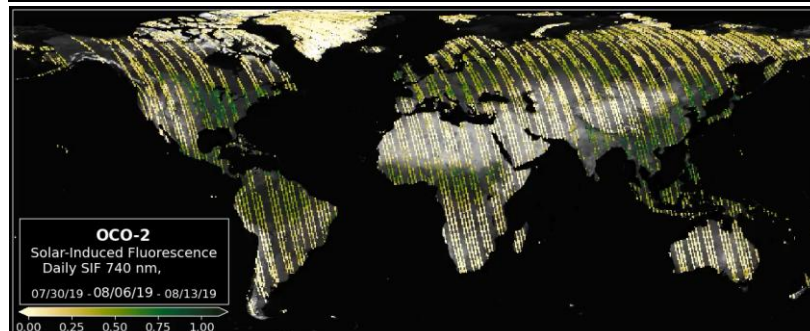
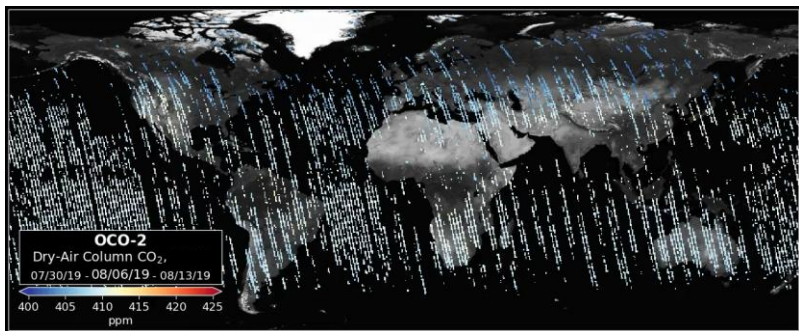
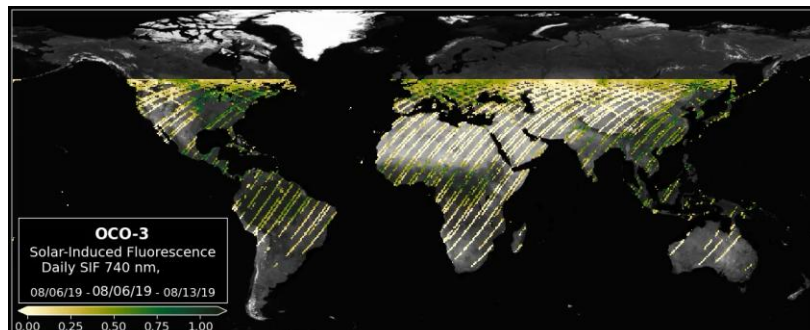
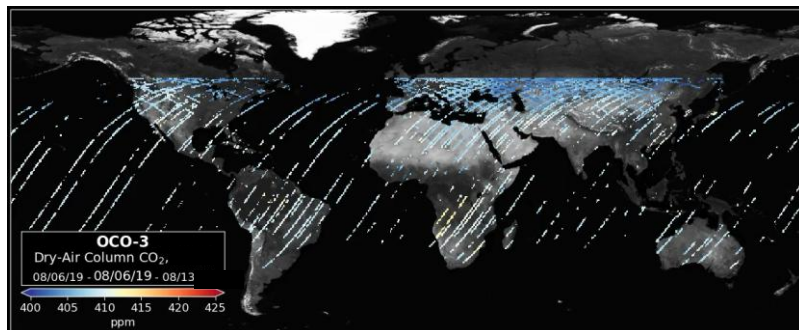


OCO Level 2 Data Products: XCO₂ and SIF



OCO-2 and OCO-3 data products are archived and made publicly available through the GES-DISC

- **“Forward”** processing stream. Subset of soundings, bias-corrected and filtered products with **2 day latency**
- **“Retrospective”** stream (refined calibration, process all cloud-free soundings) delivered at **monthly intervals**.

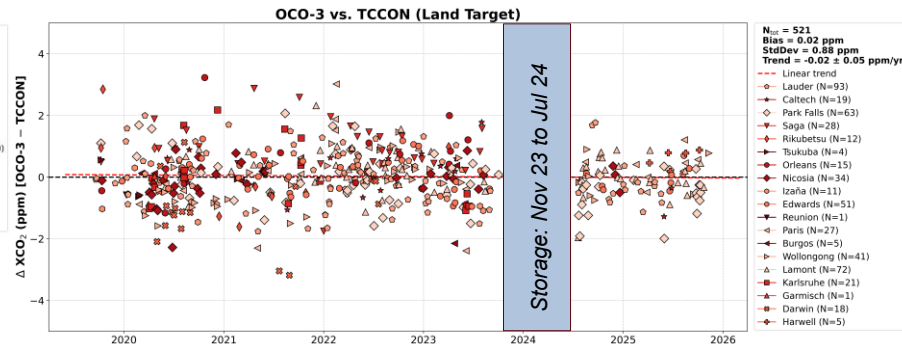
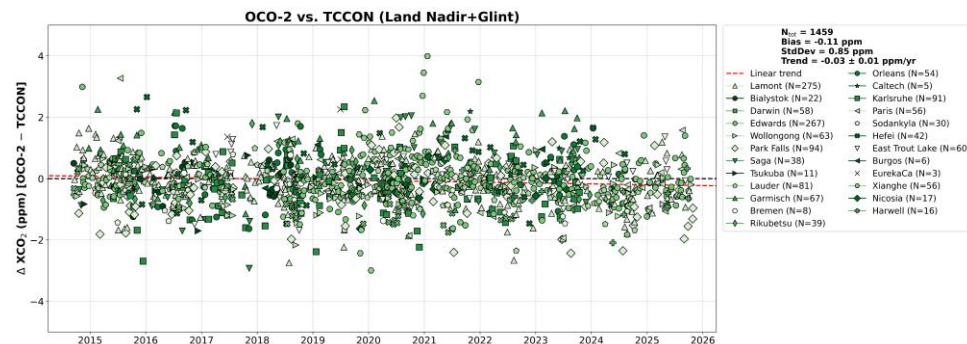


OCO-2 and OCO-3 XCO₂ values are carefully validated against TCCON reference



Figures: M. Kiel

Mission requirement: XCO₂ accuracy and precision < 1 ppm



- OCO-2 v11.2 and TCCON agreement < **0.85 ppm**
- Quality of the record is stable in time

- OCO-3 v11 and TCCON agreement < **0.9 ppm**
- Quality of the record is stable in time
- Post-storage data quality is excellent.**

The agreement between OCO-2 v11 and OCO-3 v11.2 is <0.5 ppm, better than the agreement of either sensor with the TCCON reference.

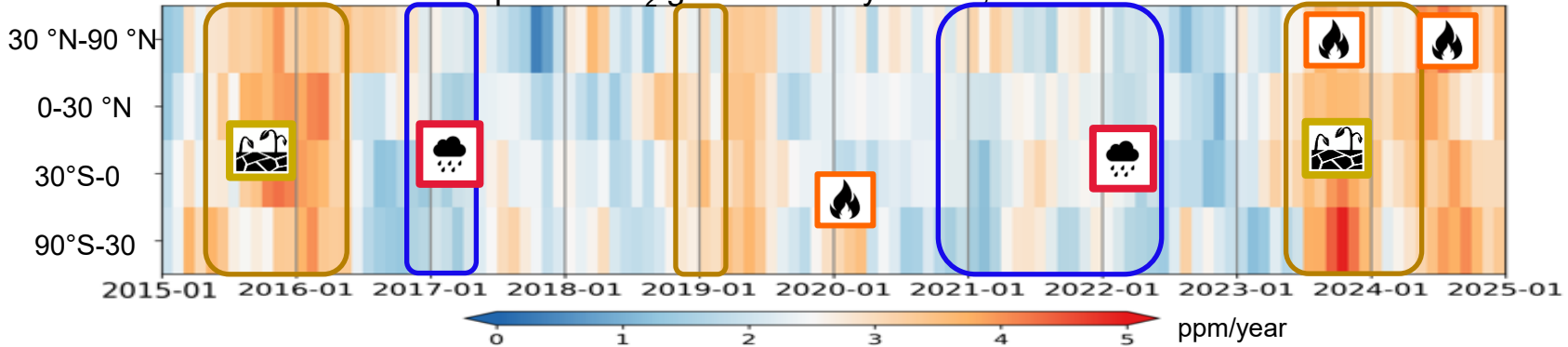


missions Update

OCO-2 reveals responses of natural carbon cycle to perturbations at global scale

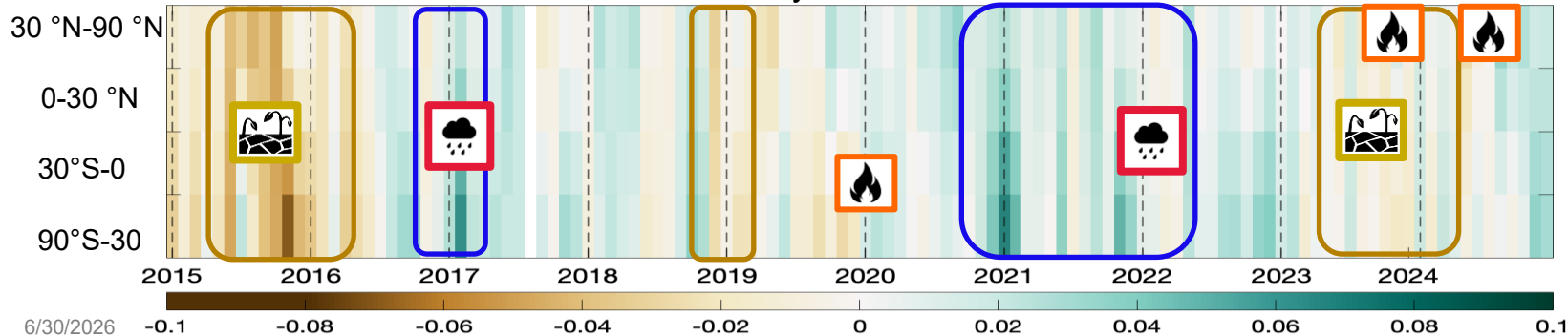



Atmospheric CO₂ growth rate by month, across latitudes



Pandey et al., 2025

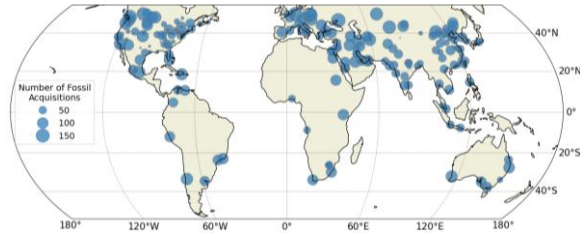
SIF anomalies by month, across latitudes



6/30/2026

Wm⁻²sr⁻¹μm⁻¹
7 JPL

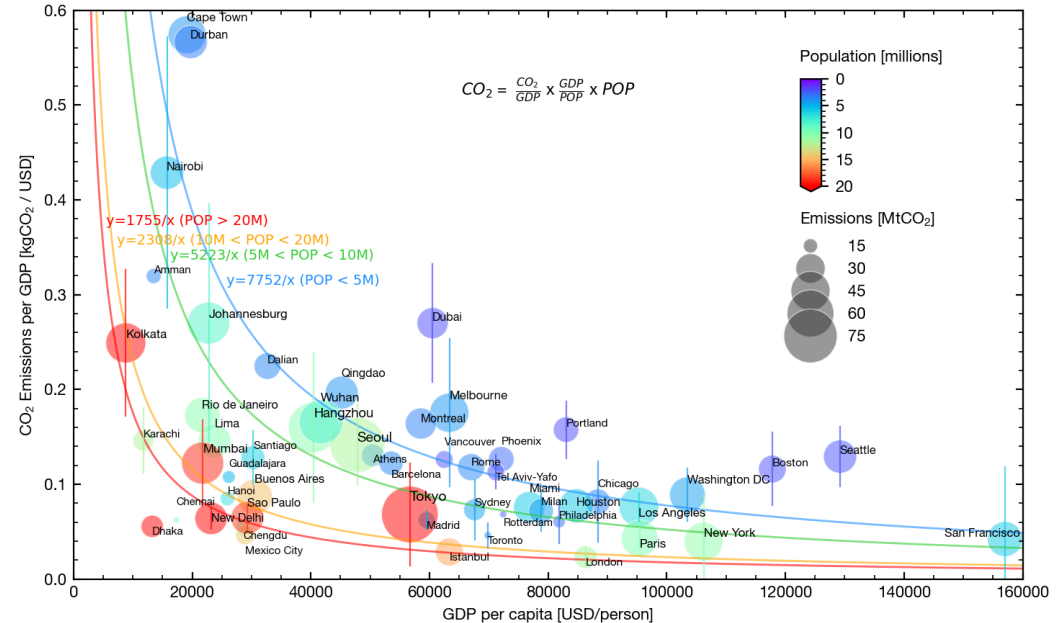
OCO-3 Measurements Characterize Economic Behavior and CO₂ Emissions



In partnership with

**C40
CITIES**

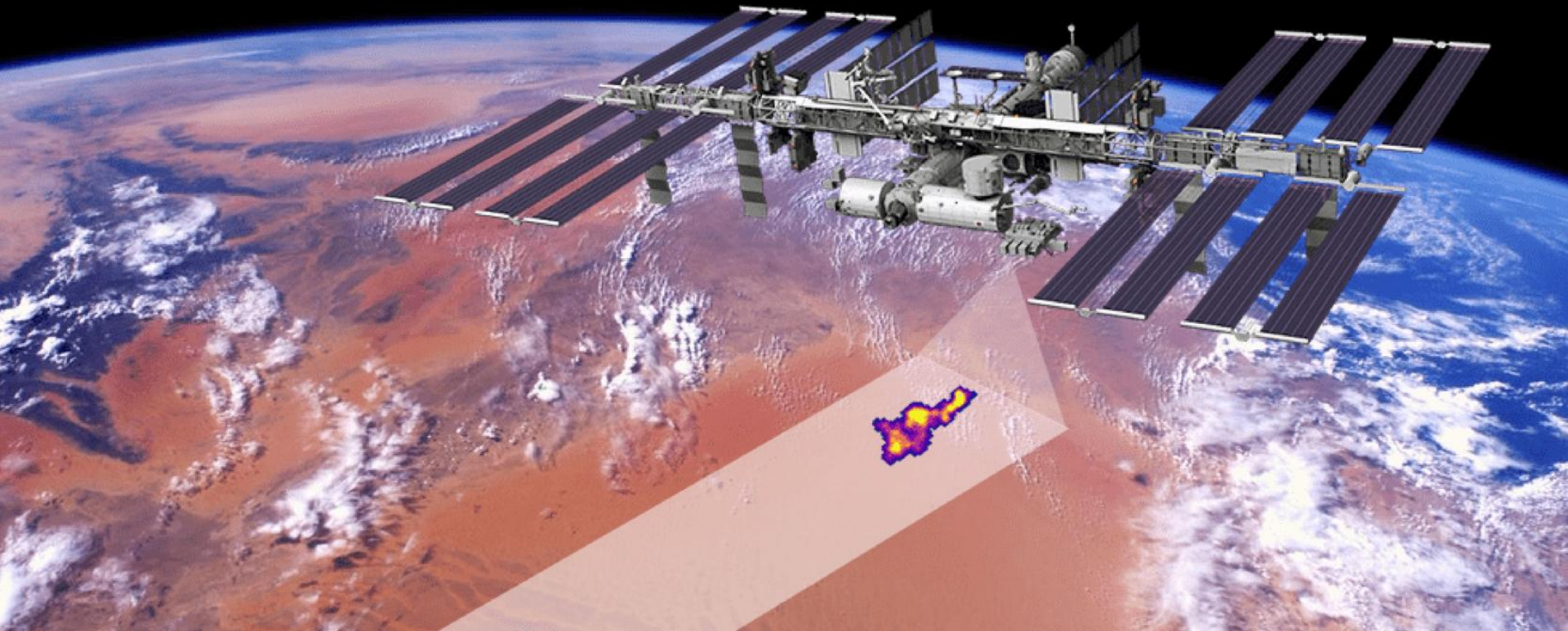
- **97 cities**
- **920 million people**
- **23% of the world economy**



- Energy intensity tends to be lower in higher-income cities
- Cities with larger populations generally exhibit greater energy efficiency

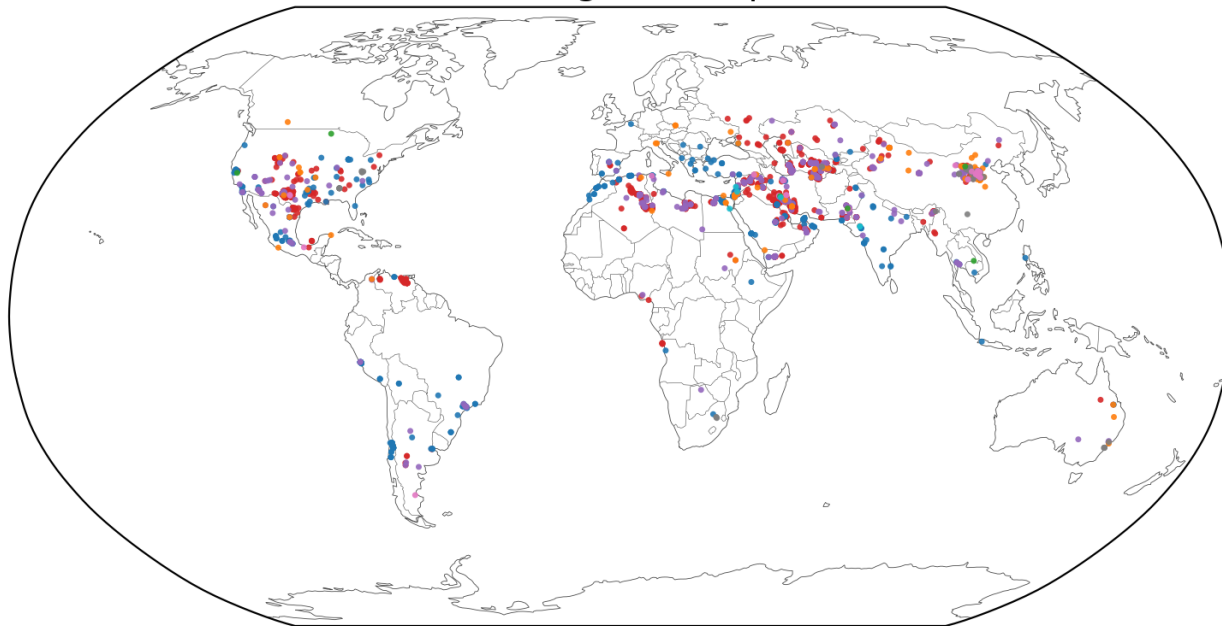
Ahn, D. *et al.* [2025]

EMIT on the ISS



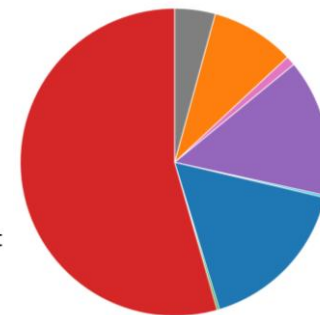
EMIT CH₄ point source observations

EMIT CH₄ (Aug. 2022-Apr. 2026)



- Sector
- agriculture
 - coal
 - industrial
 - oil gas
 - powerplant
 - unknown
 - waste management
 - water treatment

Plume count by Sector



Key
data
users



6/30/2024



KAYRROS



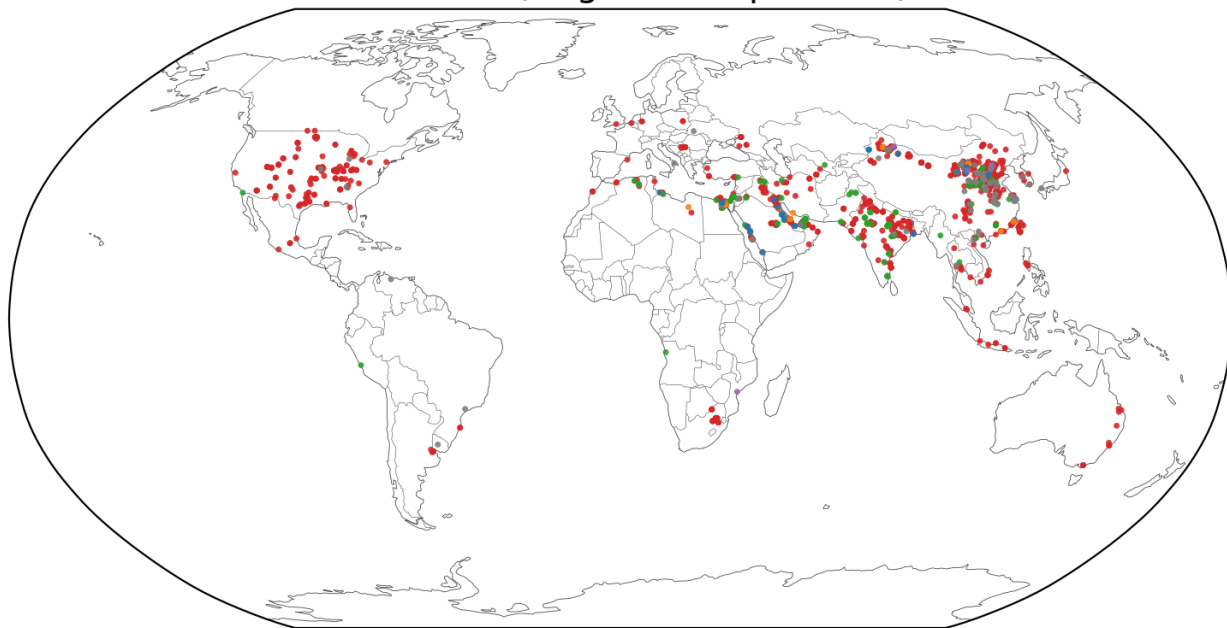
GHGSAT



CEOS AC-VC-22, Leiden NE

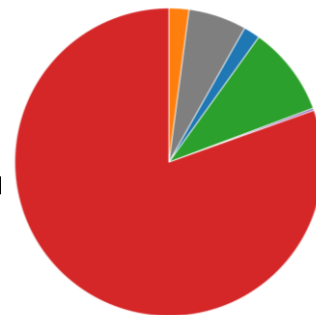
EMIT CO2 point source observations

EMIT CO2 (Aug. 2022-Apr. 2026)



- Sector
- cement p
 - industrial
 - oil gas
 - powerplai
 - refinery
 - unknown

Plume count by Sector



Key
data
users



6/30/2024



KAYRROS



GHGSAT



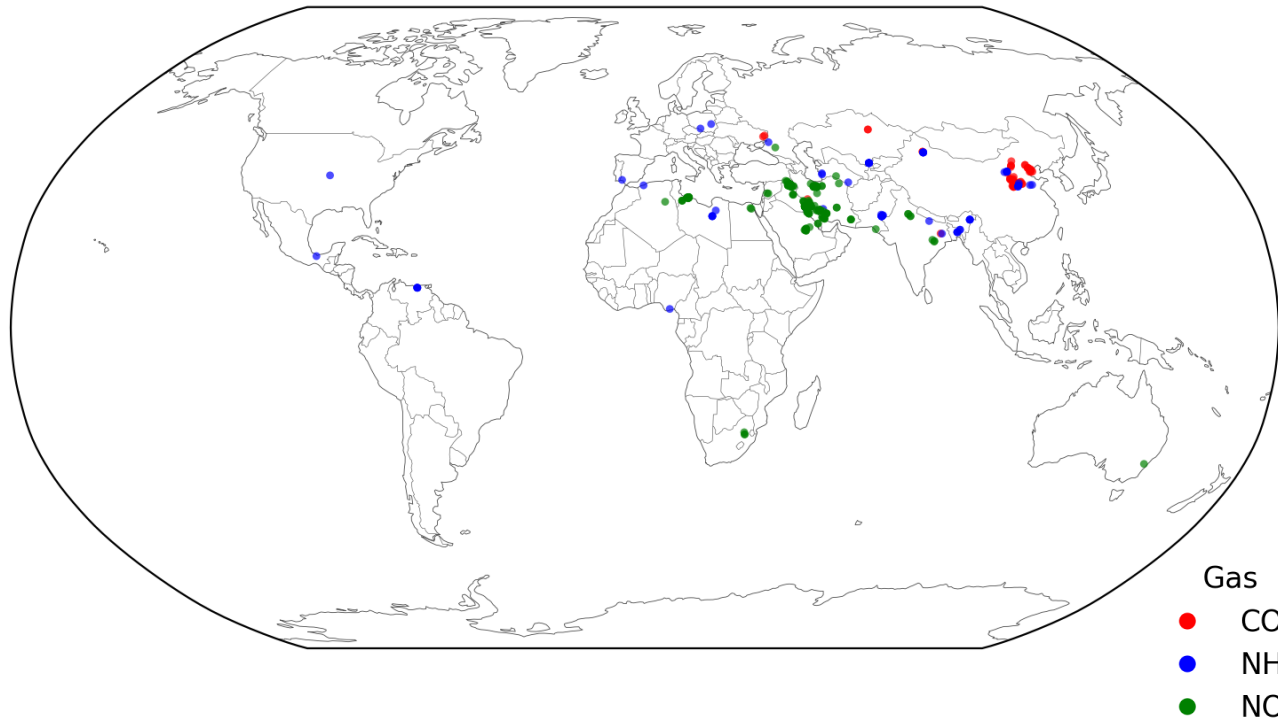
CEOS AC-VC-22, Leiden NE

11

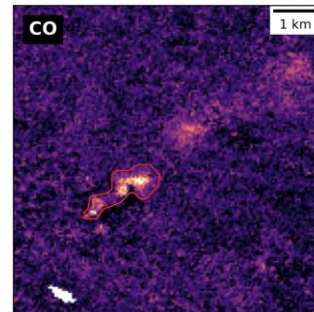


EMIT: New CO, NH₃, NO₂ capabilities

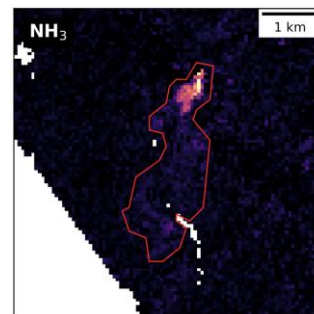
EMIT CO, NH₃, NO₂ (7K scenes)



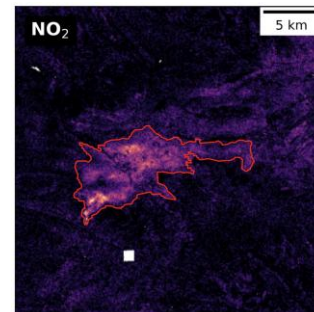
CO
from
metal
producti
on
facility
(China)



NH₃ from
fertilizer
plant
(Nigeria)



NO₂
from
power
plant
(Iran)

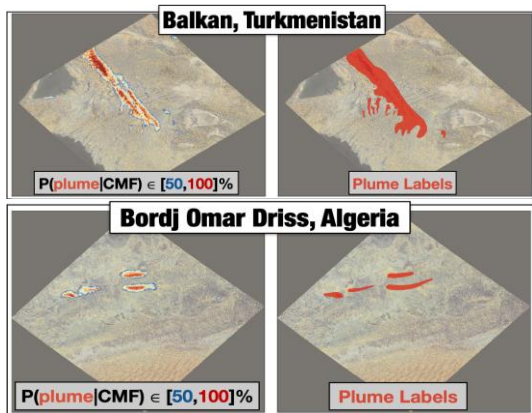


Advances in plume detection using Machine Learning

Towards operational automated greenhouse gas plume detection

AVIRIS & EMIT: Convolutional Neural Networks (CNNs) using GoogLeNet & U-Net architecture

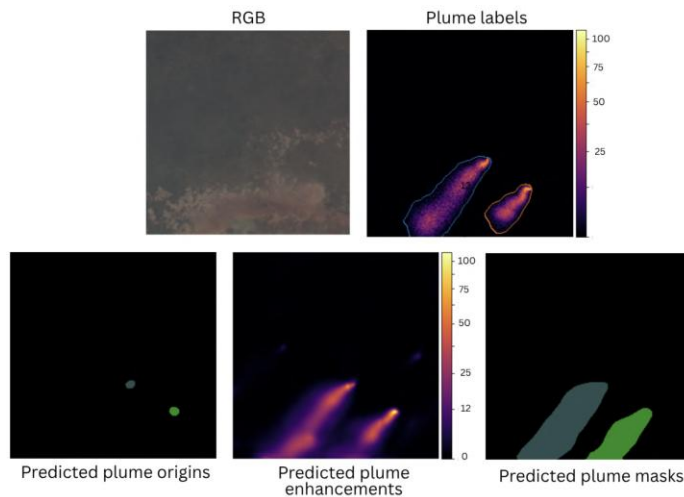
Brian Bue (JPL) et al. (in revision)



Global monitoring of methane point sources using deep learning on hyperspectral radiance measurements from EMIT

EMIT: End-to-end vision transformer framework

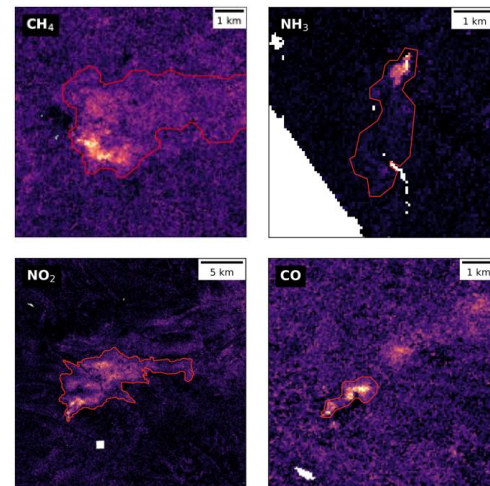
Vishal Batchu (Google) et al. (submitted)



Fully automatic trace gas plume detection

EMIT: CNN using U-Net architecture

Vit Ruzicka (JPL) et al. (submitted)

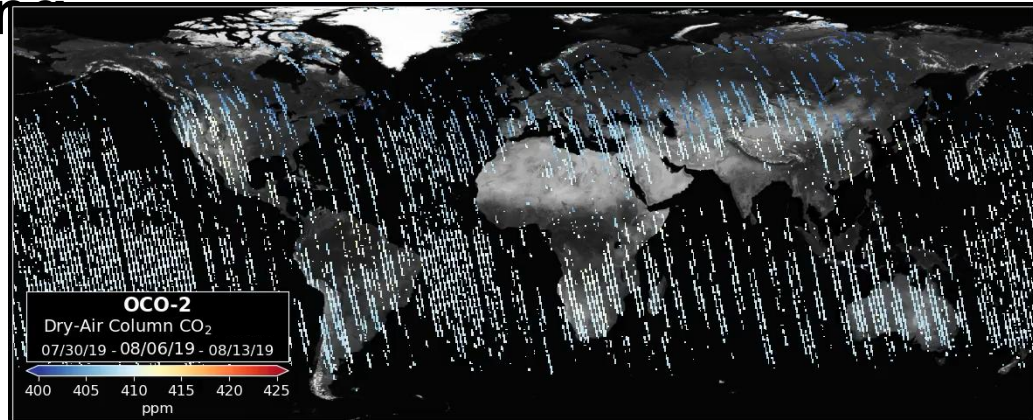




OCO-2 and OCO-3 each offer unique & complementary coverage, sampling XCO_2

OCO-2

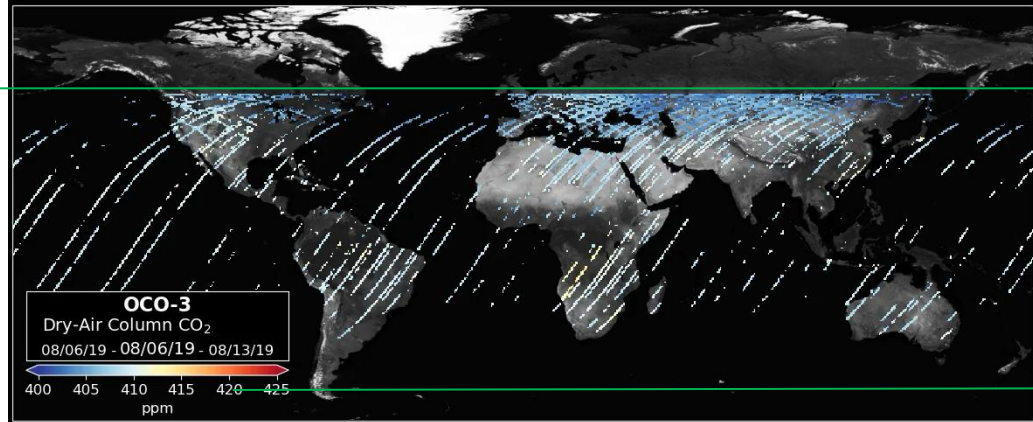
- "Pole-to-pole" coverage, depending on season;
- Fixed 1330h equator crossing time (and local overpass time)



OCO-3

- Coverage limited to $\pm 52^\circ$ latitude, changing with season;
- Observations span all times of day

Edmonton
Calgary



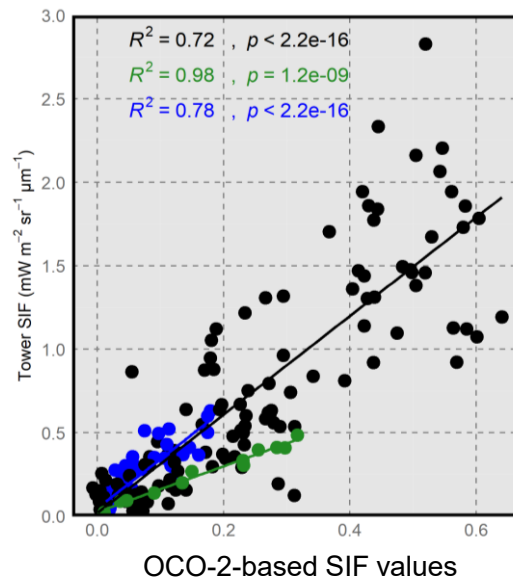
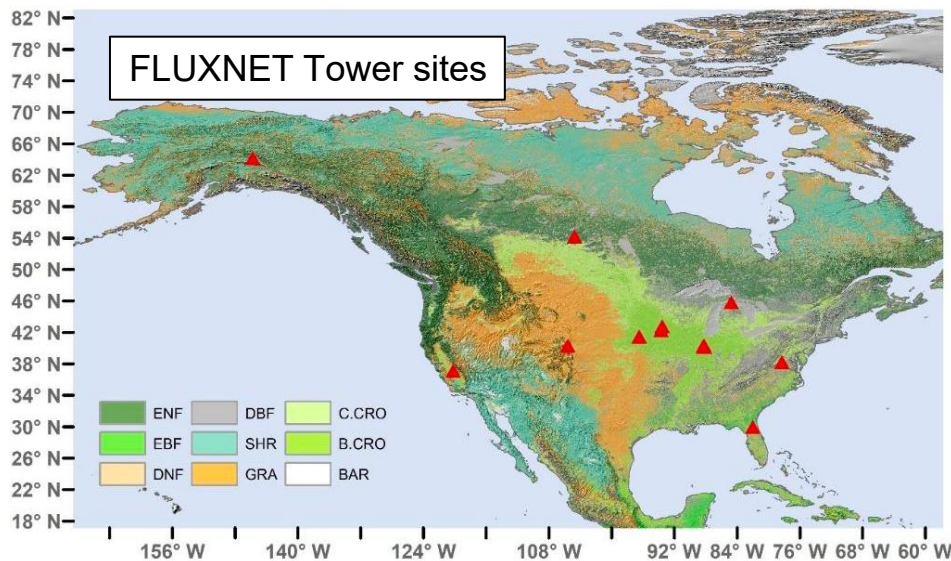
Amsterdam
Rotterdam
London

Rio Gallegos
Punta Arenas

OCO-2 SIF reliably tracks reference tower-based measurements



- OCO-2 SIF products reliably track tower-observed fluorescence across major North American ecosystems, supporting their use in large-scale photosynthetic monitoring and benchmarking of ecosystem models



Cropland

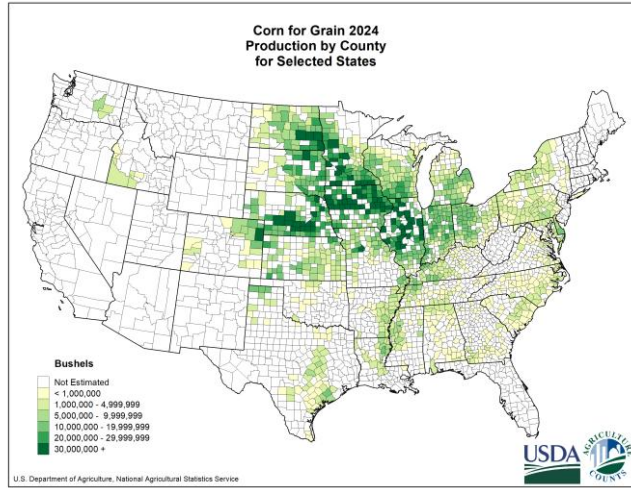
Deciduous
Forest

Evergreen
Forest

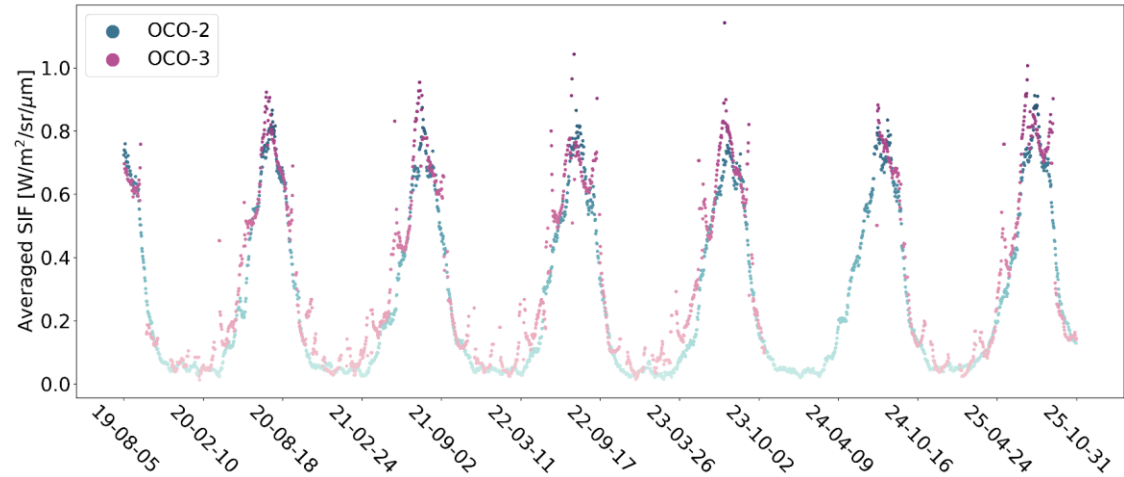
- The OCO-2 SIF record is stable across the record, thanks to the stability of the L1b radiances

OCO-3 SIF Is Stable in Time

History/Trend of Data Product Quality



OCO-2, OCO-3 Solar-Induced Chlorophyll Fluorescence Time Series
USDA Corn 15 Day Running Average



- OCO-3 SIF record is extremely stable over time
- OCO-3 and OCO-2 SIF show excellent agreement
 - Traceability to tower data