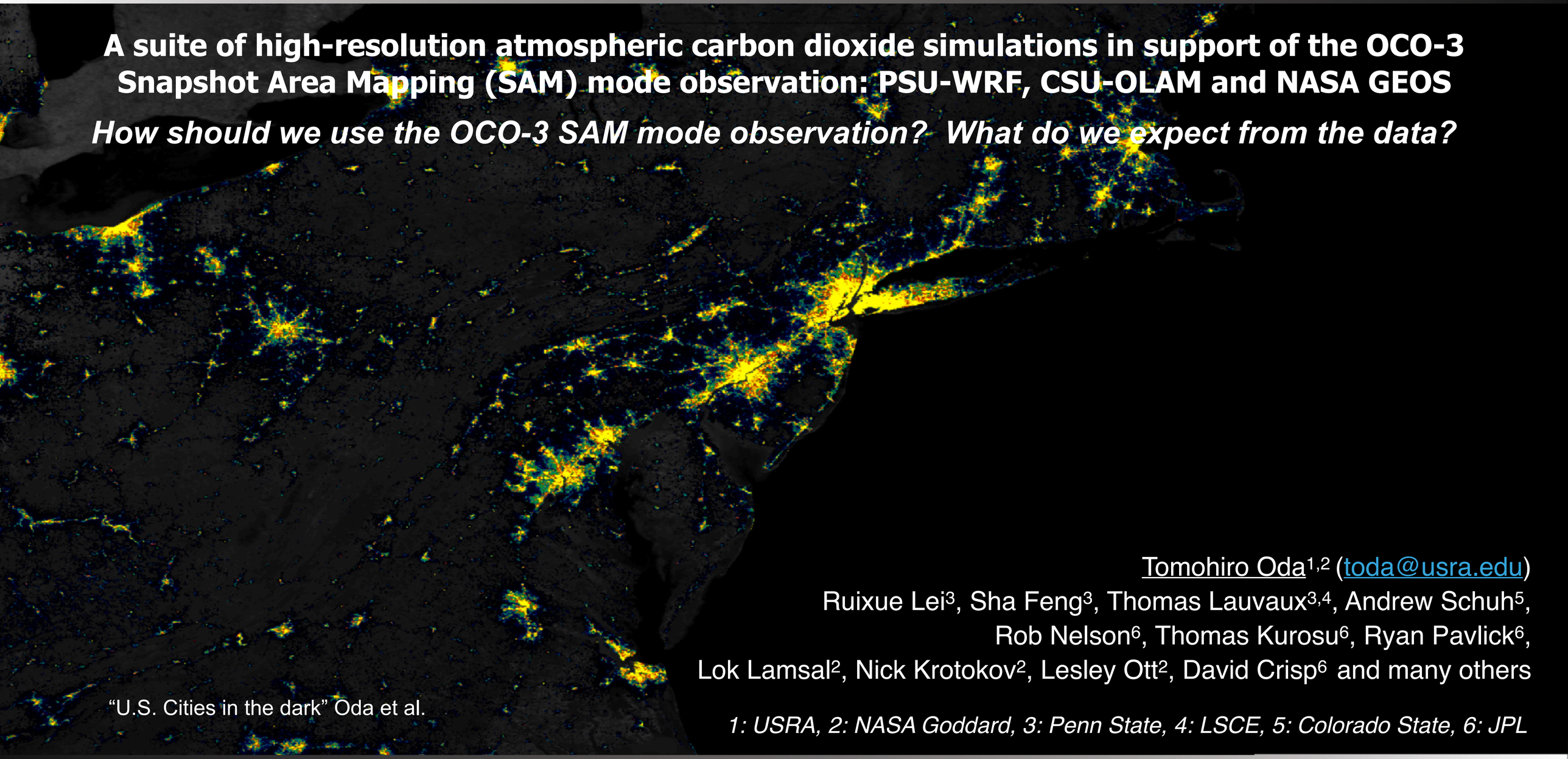
A suite of high-resolution atmospheric carbon dioxide simulations in support of the OCO-3 Snapshot Area Mapping (SAM) mode observation: PSU-WRF, CSU-OLAM and NASA GEOS

How should we use the OCO-3 SAM mode observation? What do we expect from the data?



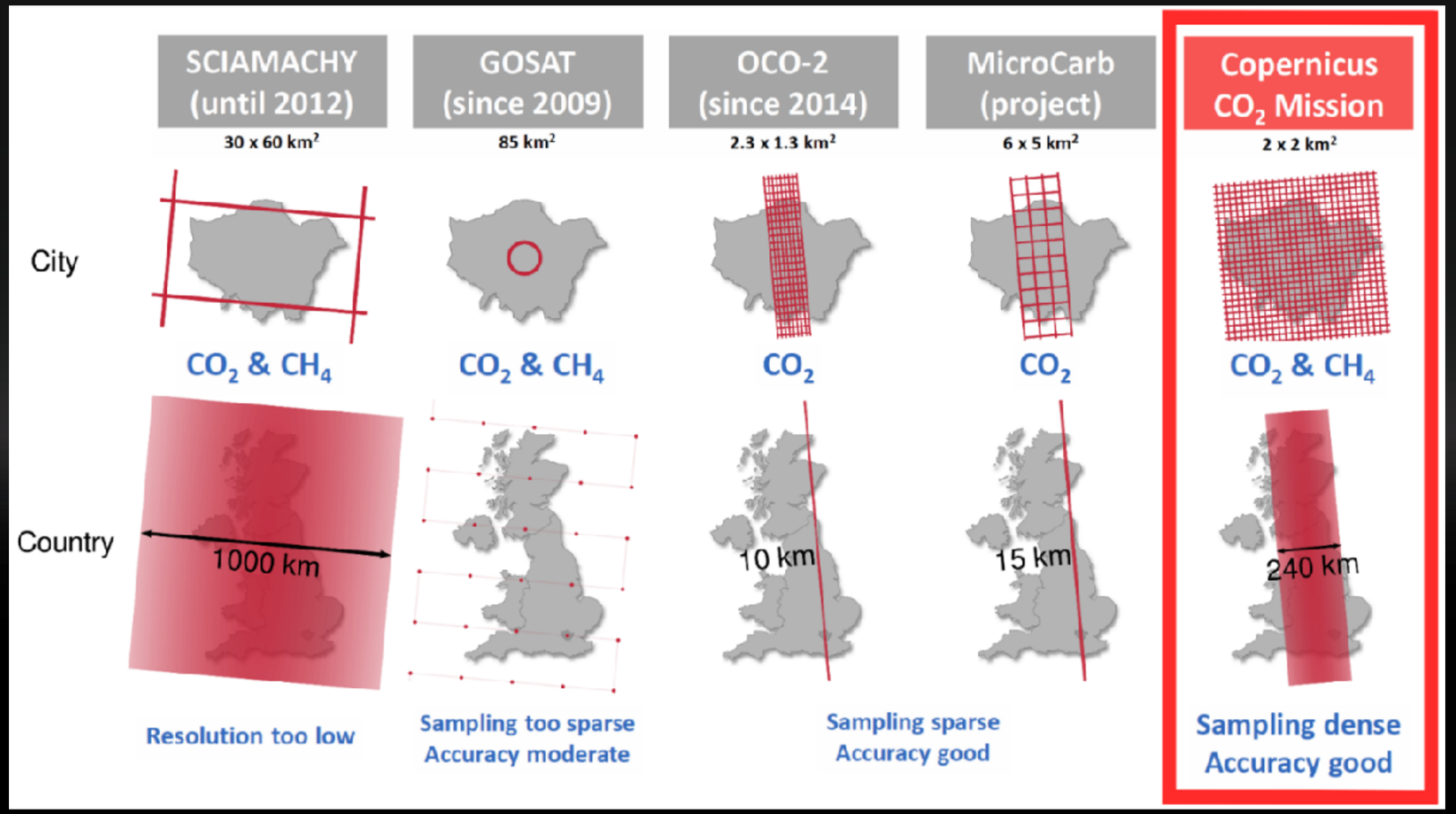
"U.S. Cities in the dark" Oda et al.

Tomohiro Oda[1,2] (toda@usra.edu)
Ruixue Lei[3], Sha Feng[3], Thomas Lauvaux[3,4], Andrew Schuh[5],
Rob Nelson[6], Thomas Kurosu[6], Ryan Pavlick[6],
Lok Lamsal[2], Nick Krotokov[2], Lesley Ott[2], David Crisp[6] and many others

1: USRA, 2: NASA Goddard, 3: Penn State, 4: LSCE, 5: Colorado State, 6: JPL

Supposed by NASA grant #80NSSC18K1313

Evolution of carbon observing satellite emissions

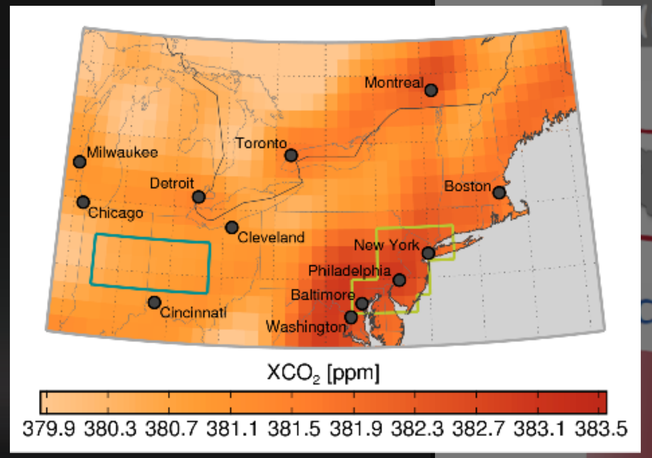


Courtesy of Dr. Michael Buchwitz (U. Bremen)

Time

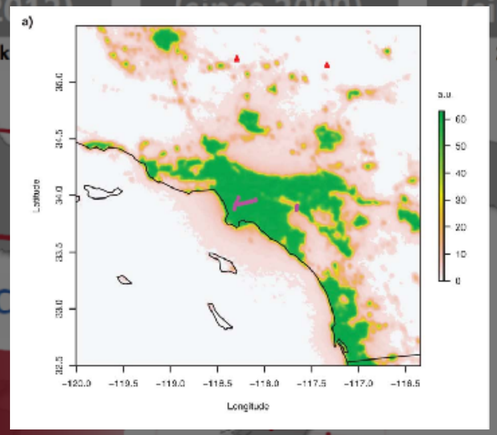
Evolution of carbon observing satellite emissions

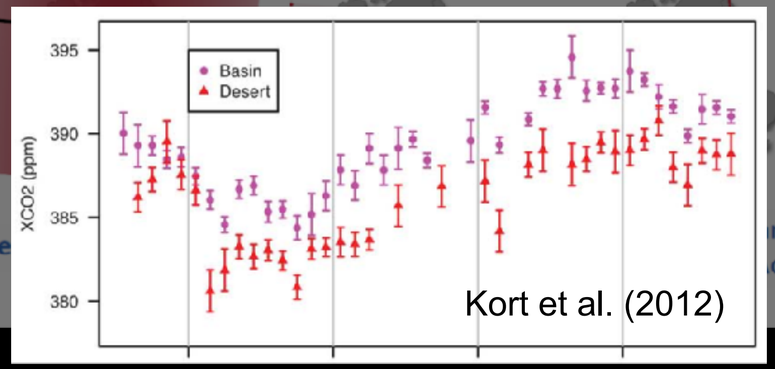
SCIA



Schneising et al. (2013)

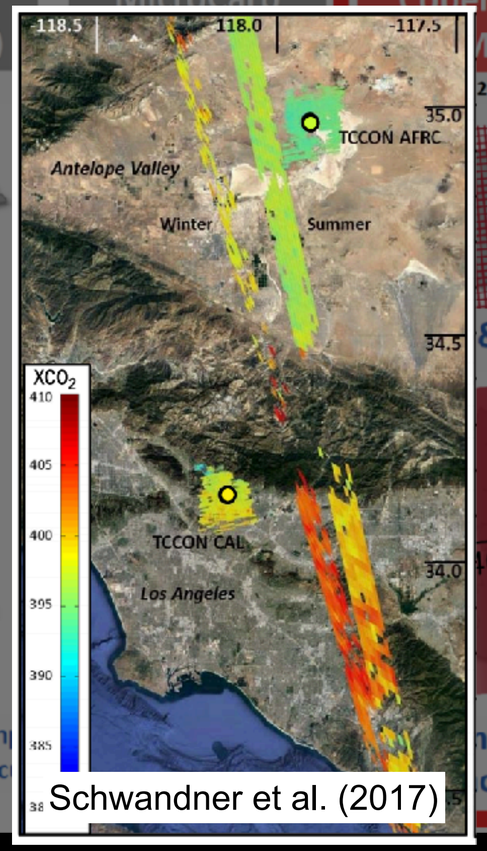
GOSAT





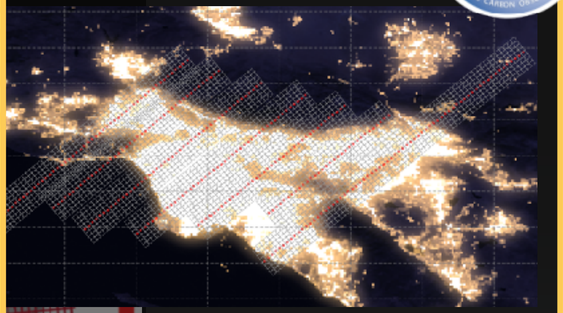
Kort et al. (2012)

OCO-2



Schwandner et al. (2017)

OCO-3 SAM



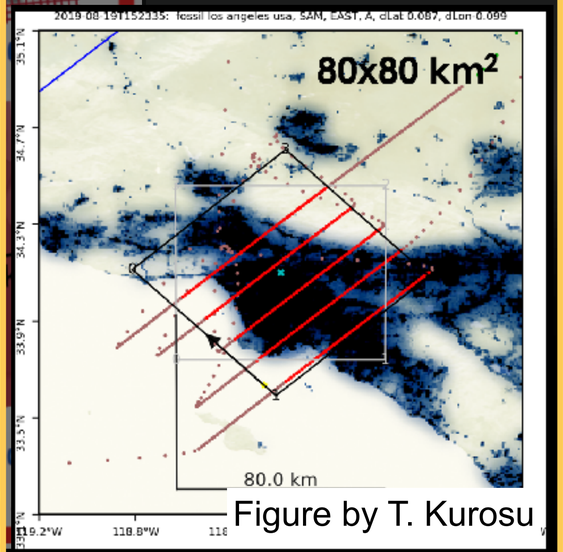


Figure by T. Kurosu

Time

Urban carbon problems with OCO-2 data

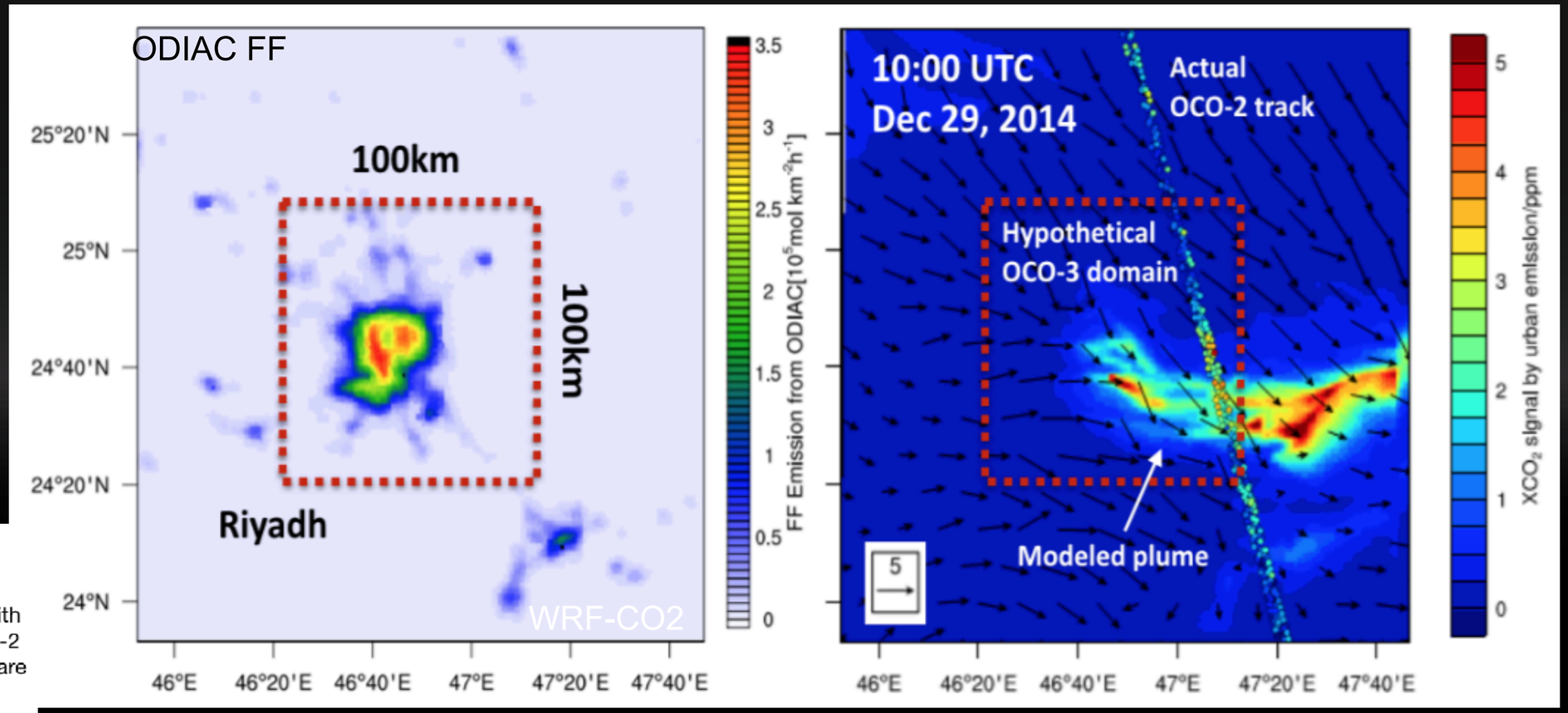
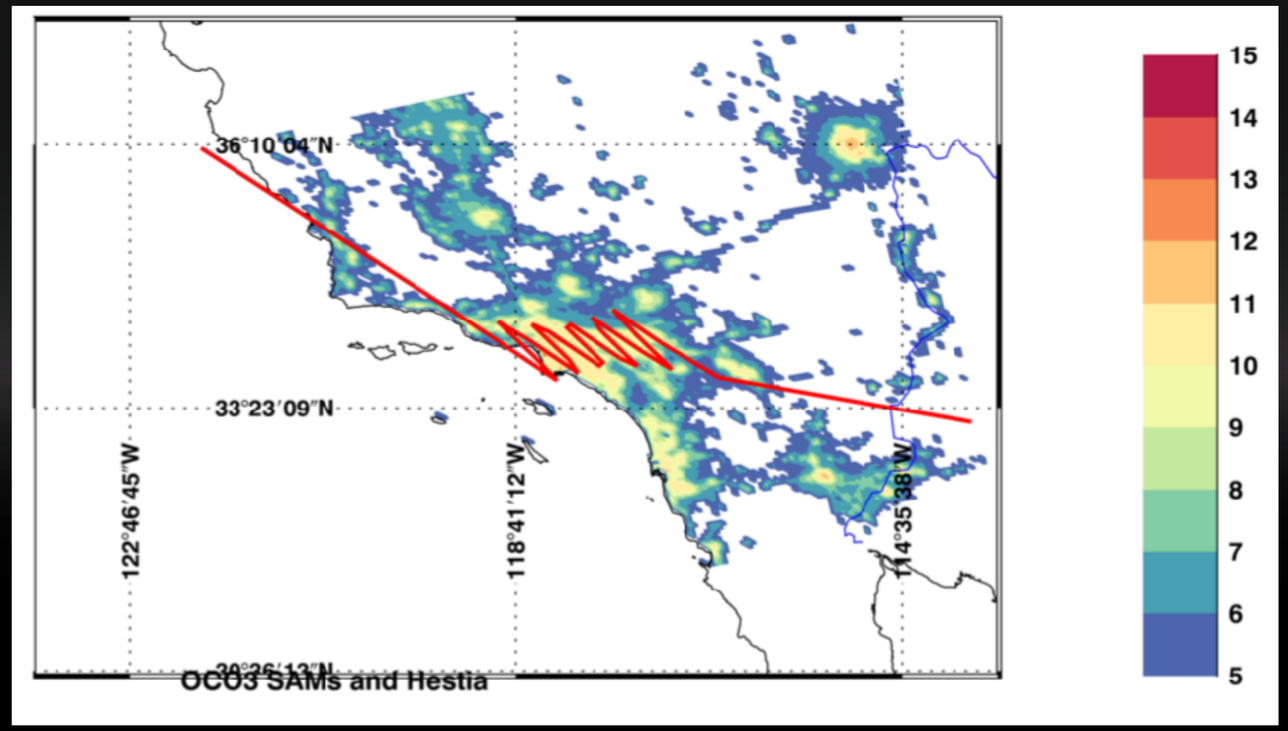


Figure 2. ODIAC CO_2 emissions over Riyadh (right) and X_{CO2} plume simulated using WRF with 10-m wind and an OCO-2 track (right). Both plots are on 1x1 km domain. The red box indicates a hypothetical OCO-3 observation domain (Ye, Lauvaux et al., in prep modified).

Modified from Ye, Lauvaux et al. in review

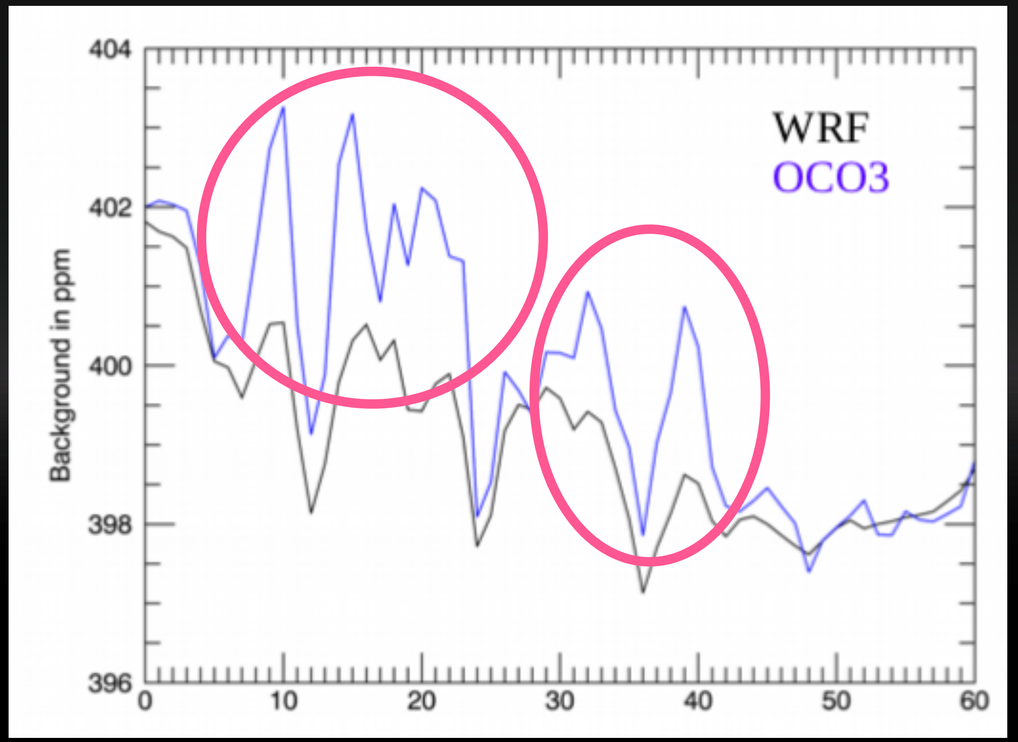
High-resolution CO_2 simulations in support of OCO-3

A simple observing simulation simulation experiment (OSSE)



Simplified SAM over Los Angeles used to extract WRF-CO2 simulations of XCO2 (coupled to Hestia)

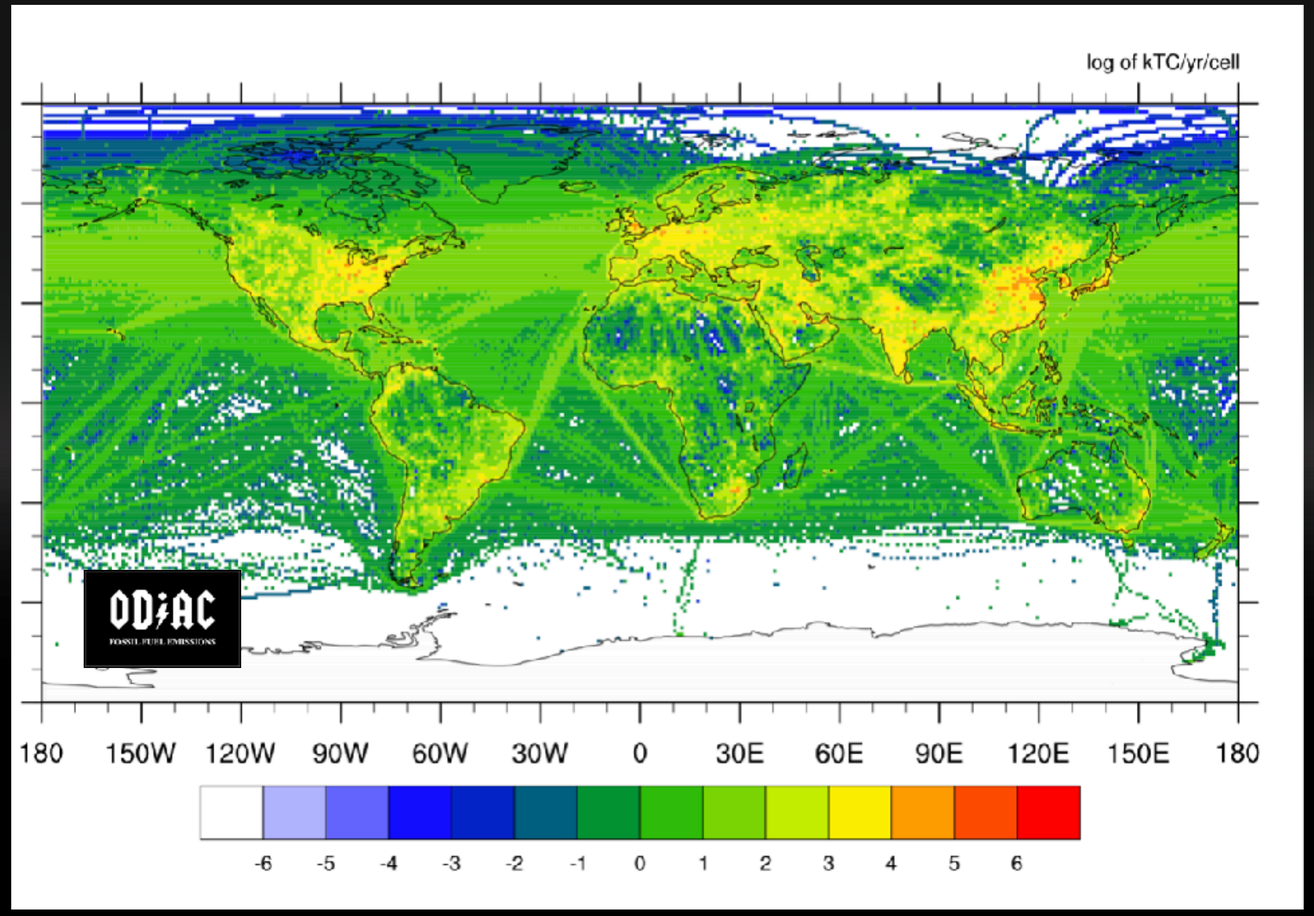
Potential overestimation of the background CO2



Background XCO2 values from the entire domain (WRF) and from the OCO-3 SAM for 60 different days

Thomas Lauvaux

An up-to-date, global high-resolution picture of fossil fuel emissions



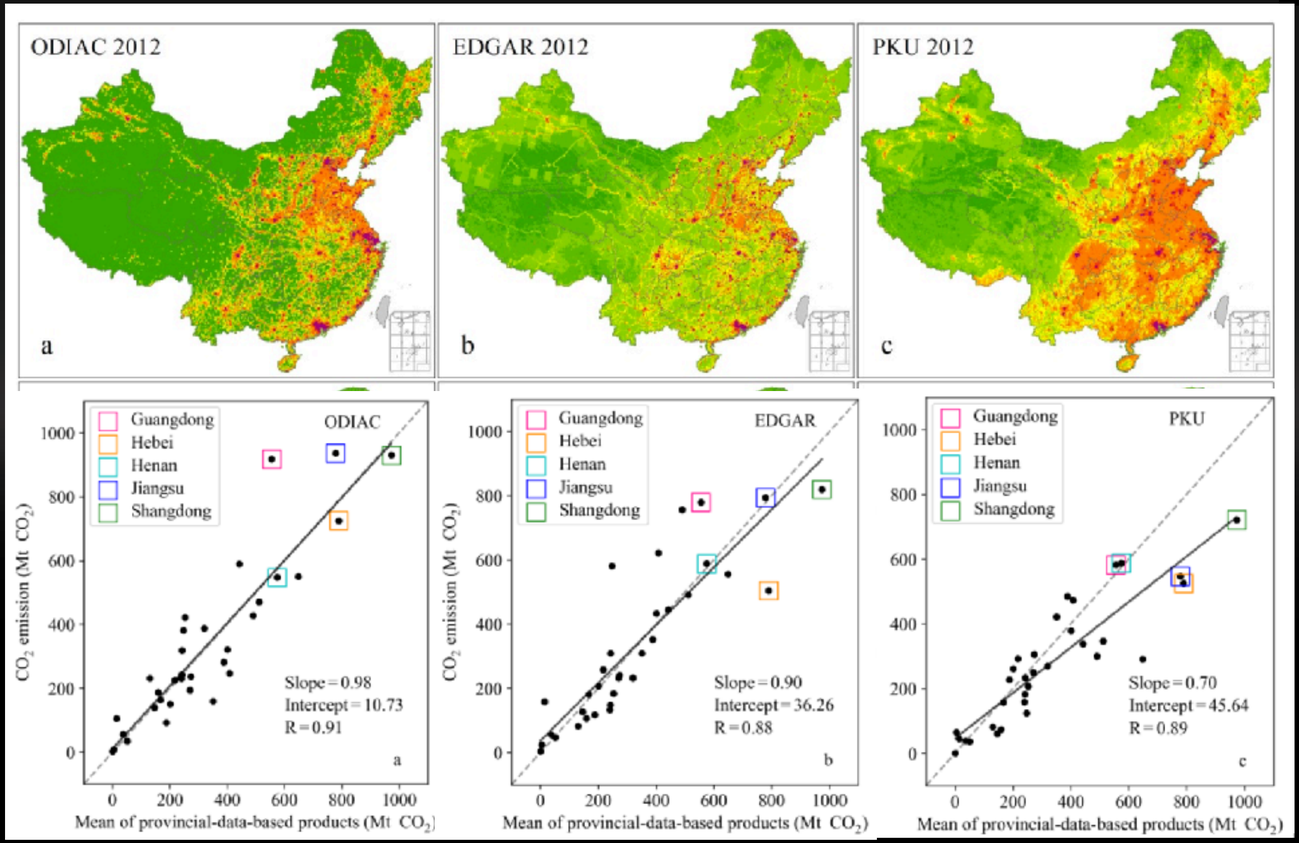
- ODIAC is a global high-resolution (1x1km) monthly FFCO2 data product
- Based on spatial disaggregation of the latest CDIAC fuel-based emission estimates
- Used to prescribe CO2 transport models from global to urban scales.
- Used for the satellite fossil target selection (e.g. GOSAT, OCO-2, and…).
- Updating/improving the power plant emission information.
- Improving the emission modeling approach using NASA's Black Marble nightlight data.

ODIAC2019 (2000-2018) is now available for download

Oda and Maksyutov (2011) ACP ; Oda et al (2018) ESSD

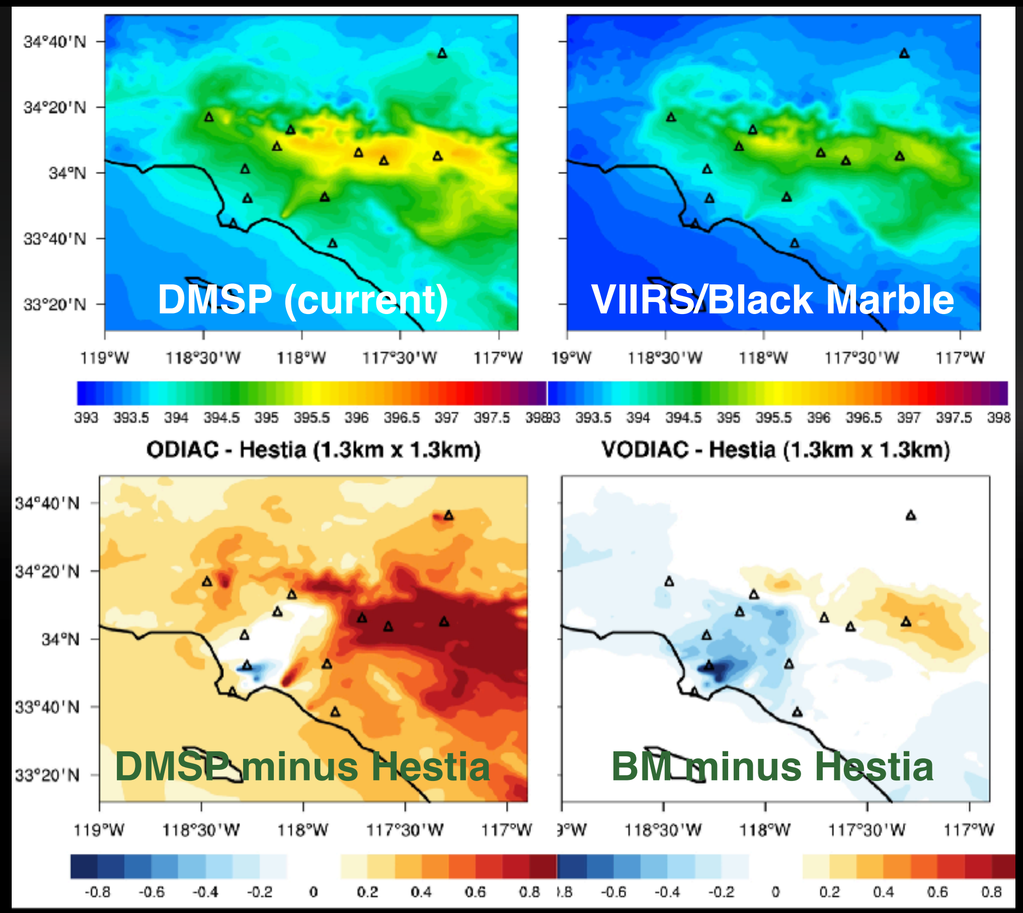
Mapping urban CO_2 emissions using observations from space

Emission downscaling error < 30-40%



Han, Zeng, Oda et al submitted.

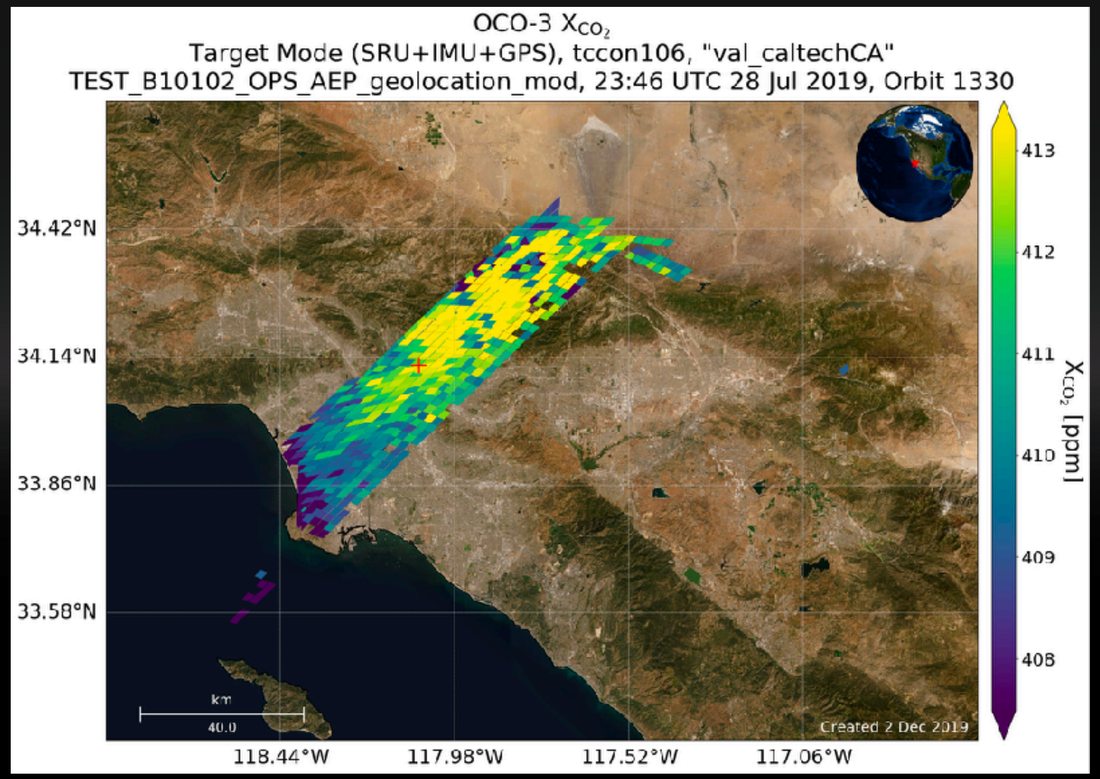
Emission representation error in XCO2



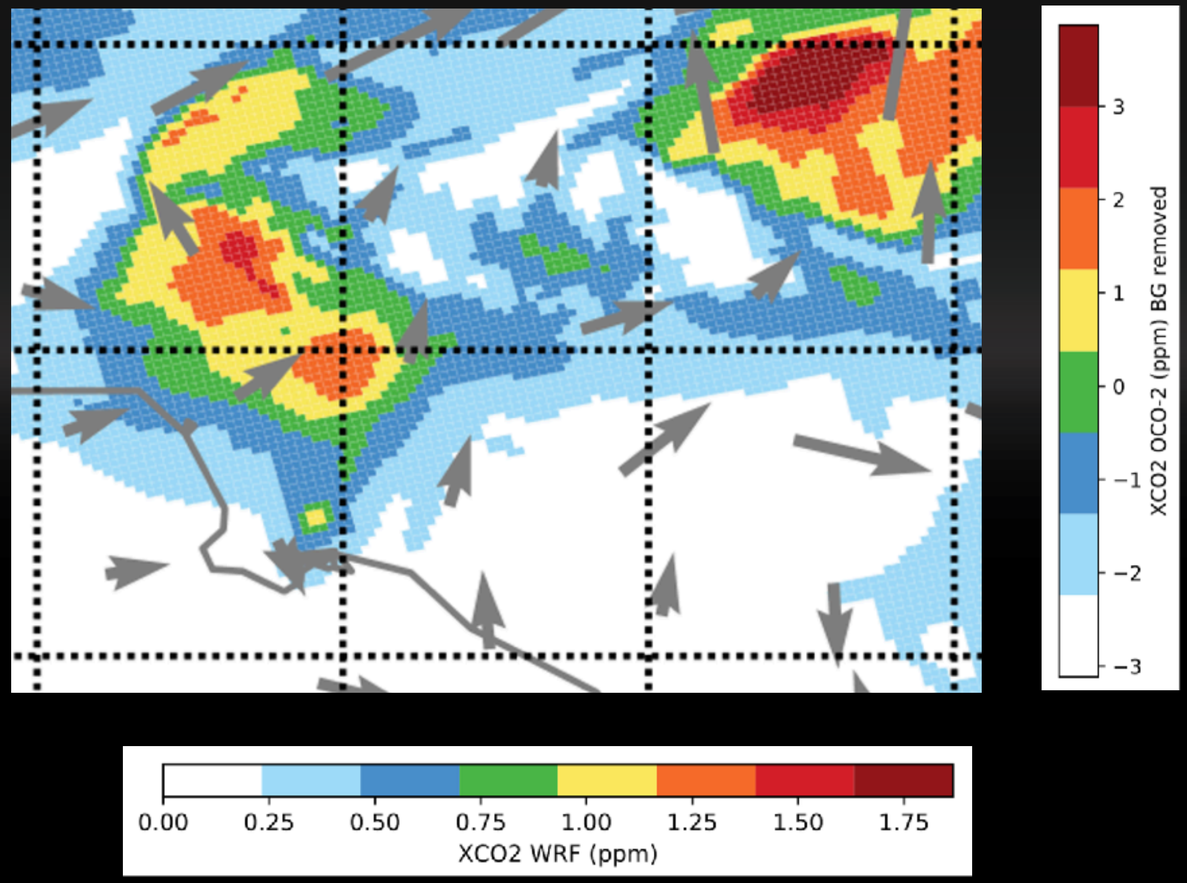
Oda, Roman, Wang, Feng et al.

OCO-3 SAM@LA 2019-07-28 23:46 UTC

OCO-3 XCO2 (Preliinary)



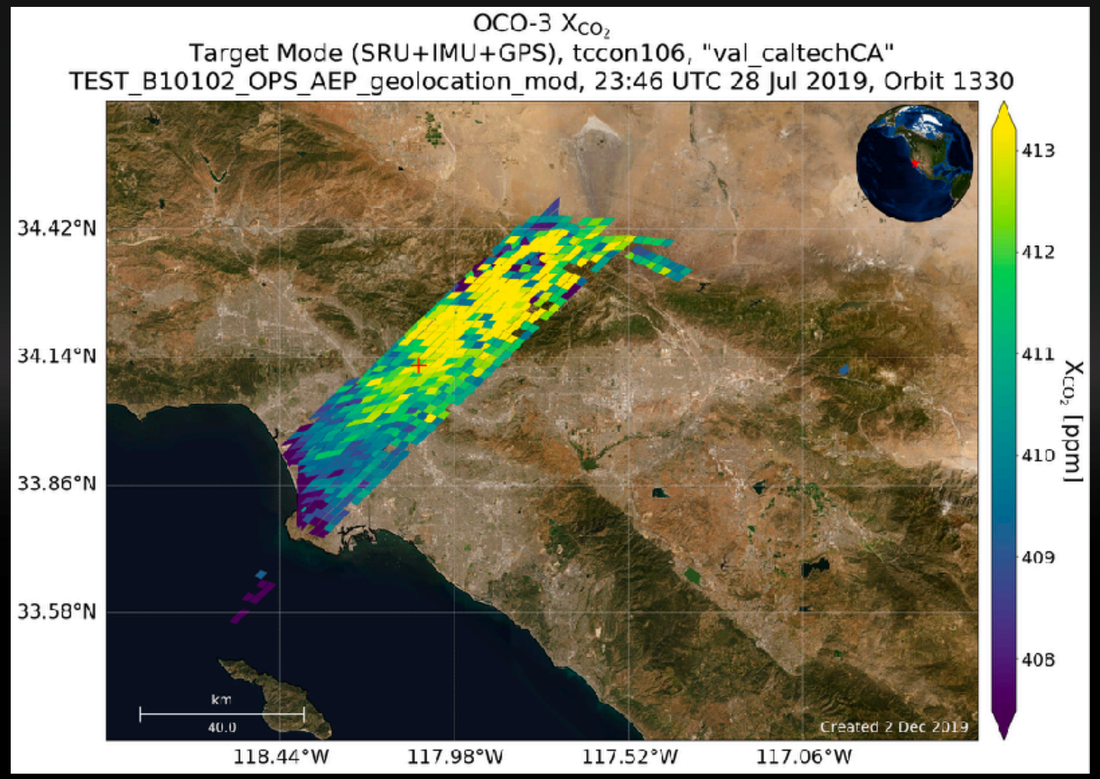
Modeled XCO2 (WRF-ODIAC)



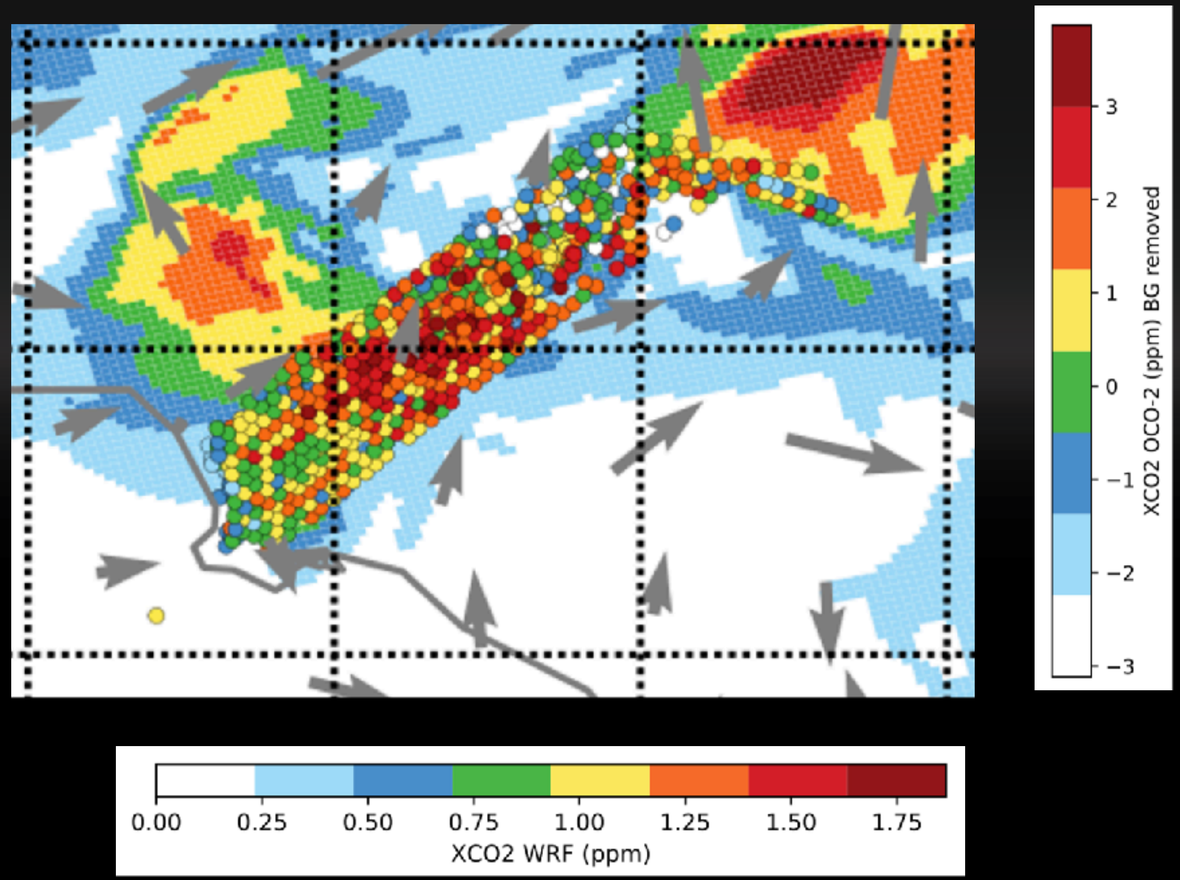
Ruixue Lei

OCO-3 SAM@LA 2019-07-28 23:46 UTC

OCO-3 XCO2 (Preliinary)



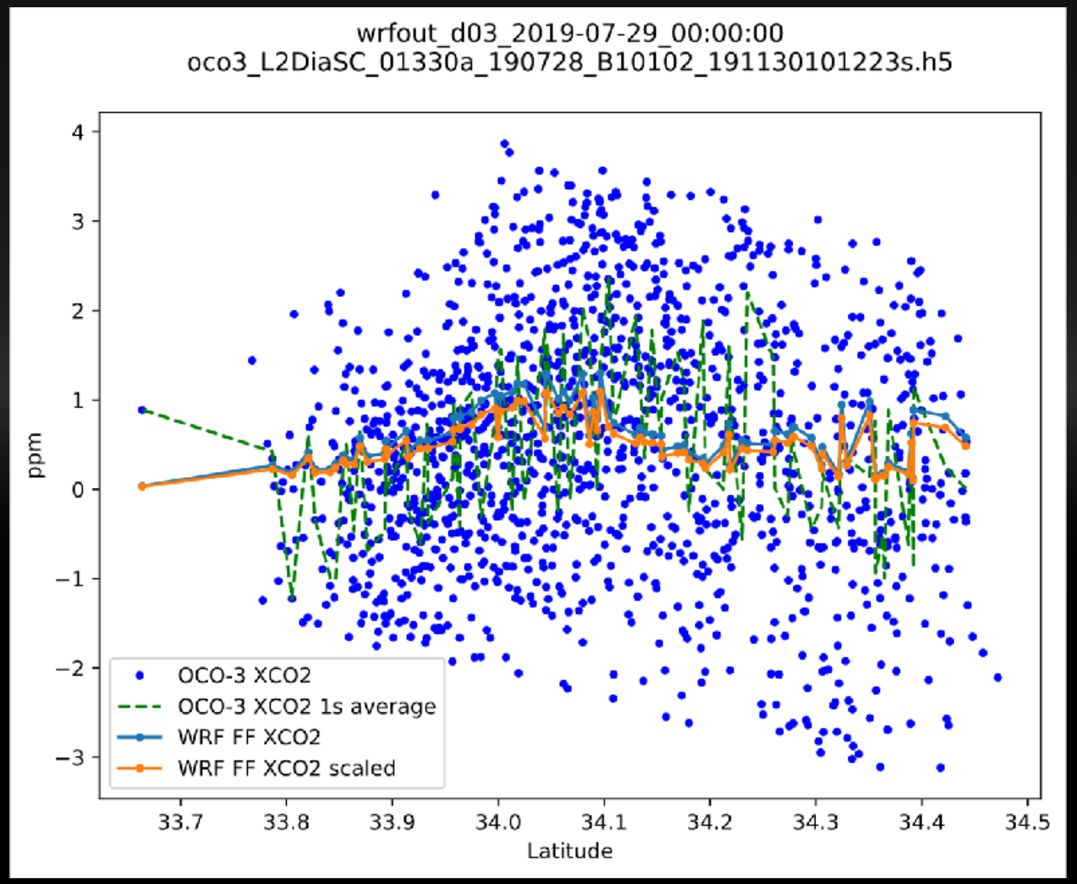
Modeled XCO2 (WRF-ODIAC) + SAM



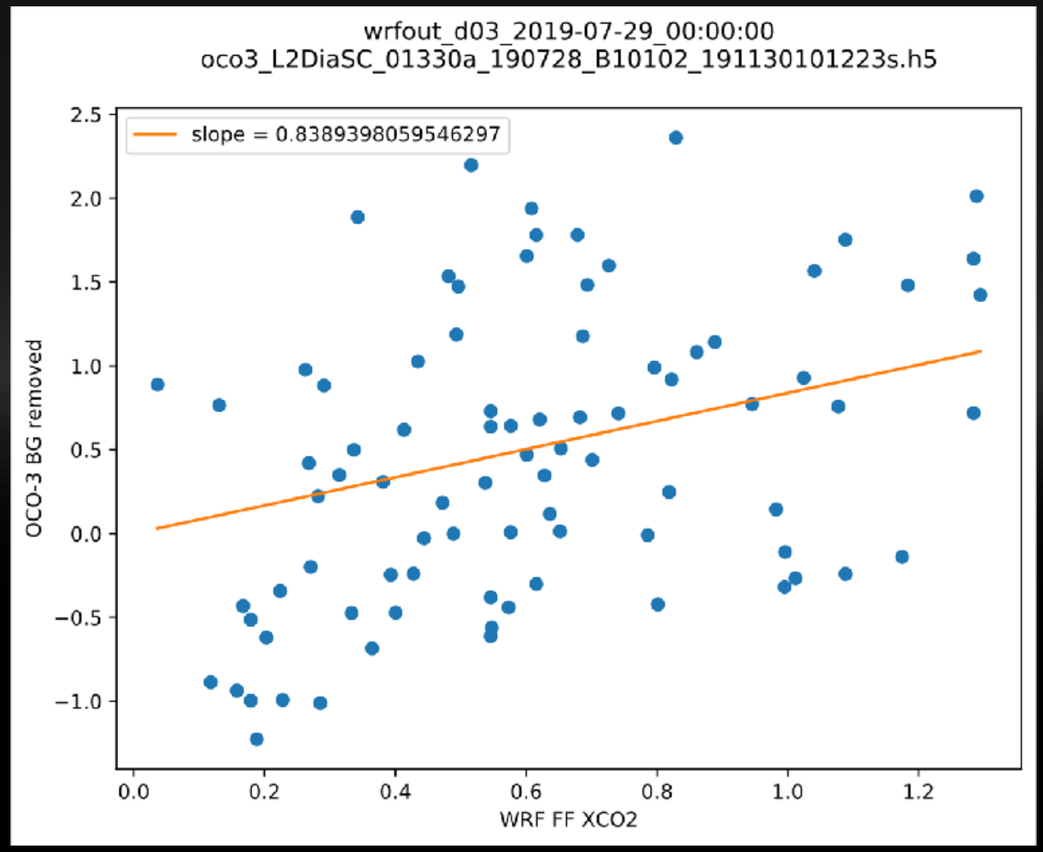
Ruixue Lei

OCO-3 SAM@LA 2019-07-28 23:46 UTC

OCO-3 (background removed) + WRF XCO2



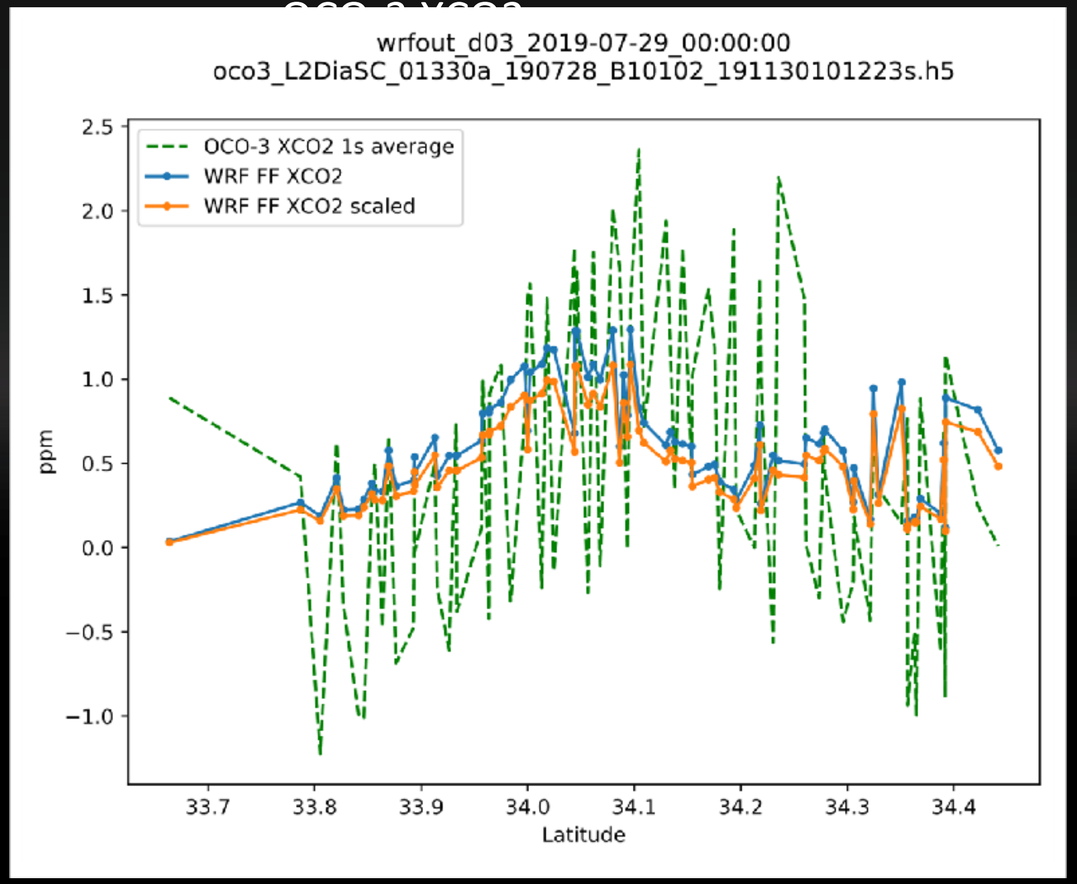
WRF-ODIAC (only FF) vs. OCO-3 SAM (1 sec avg)



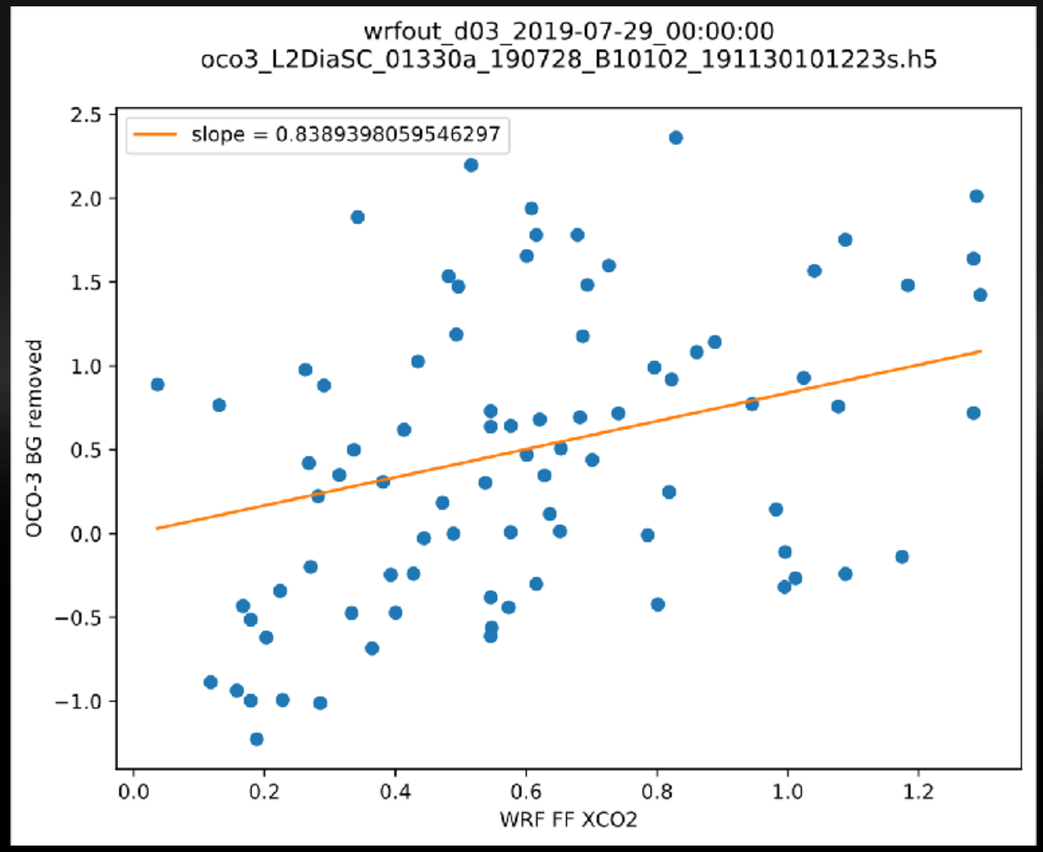
Ruixue Lei

OCO-3 SAM@LA 2019-07-28 23:46 UTC

OCO-3 (background removed, 1 sec avg) + WRF XCO2



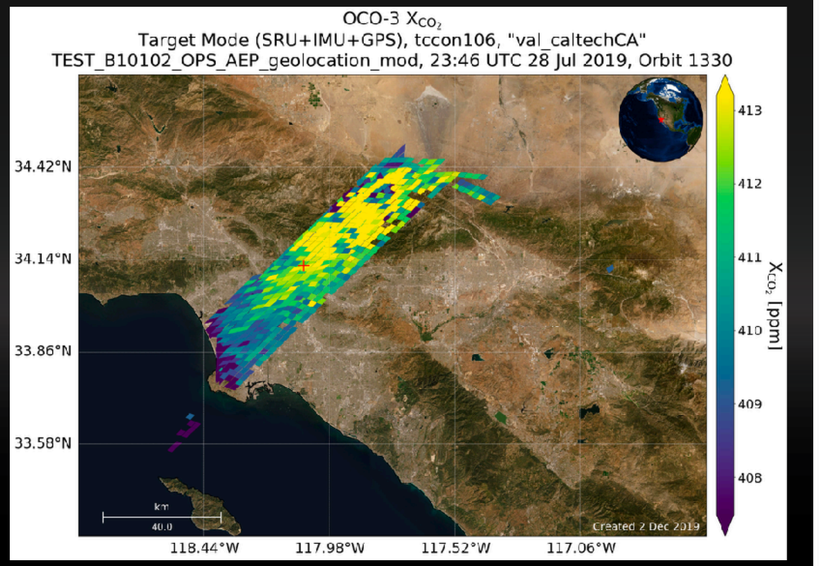
WRF-ODIAC (only FF) vs. OCO-3 SAM (1 sec avg)



Ruixue Lei

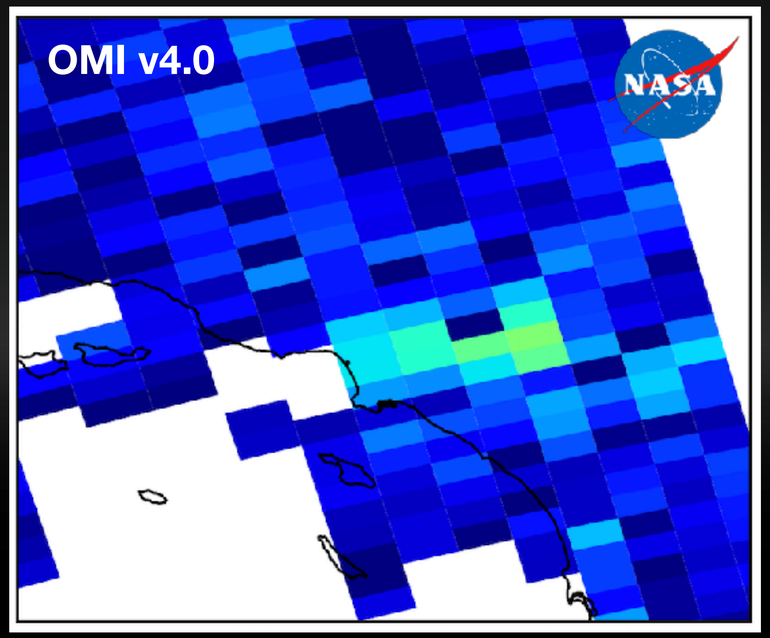
OCO-3 SAM XCO2 and NO2@LA

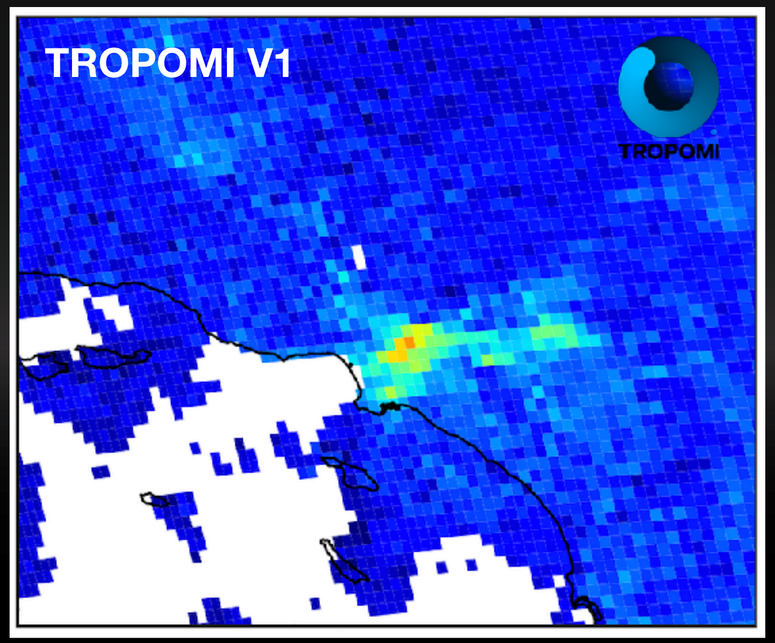
OCO-3 XCO2 (Preliinary)



3:46pm Local time

NO2 - indicator for FF CO2



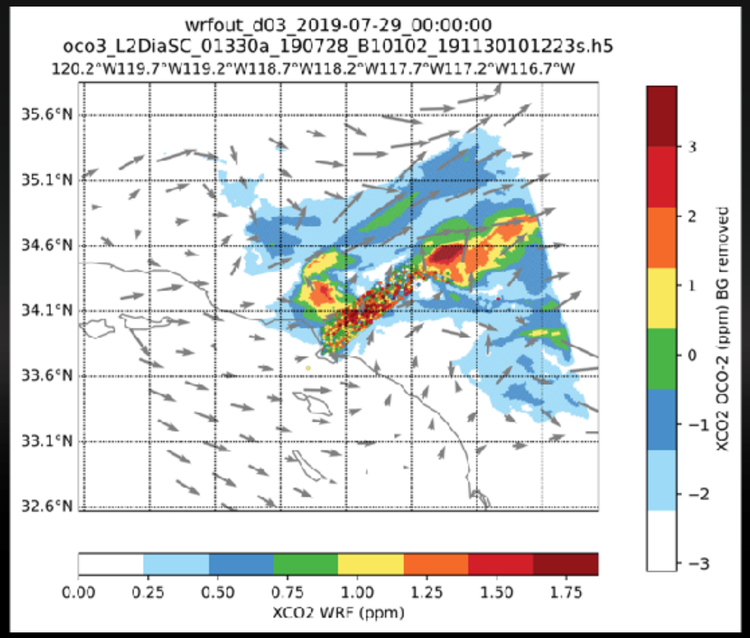


1:30pm or so Local time

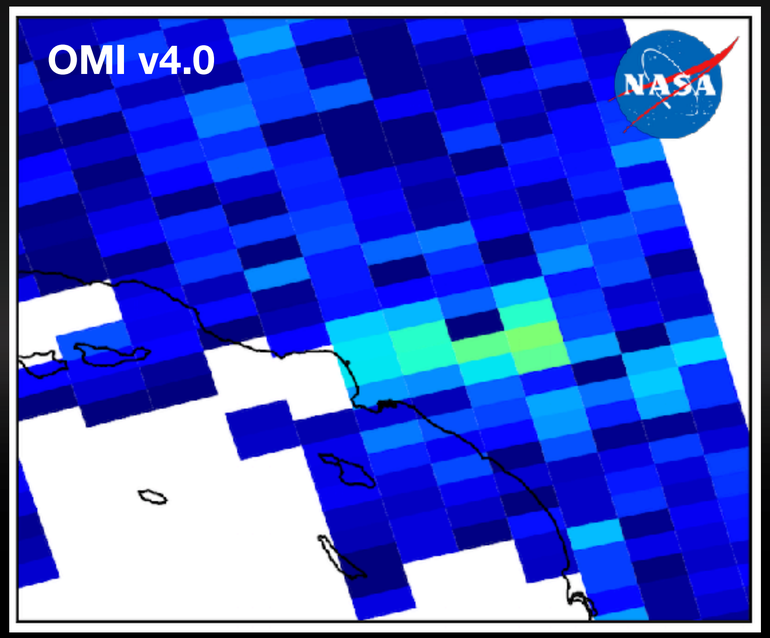
NO2 data: Lok Lamsal, Nick Krotokov

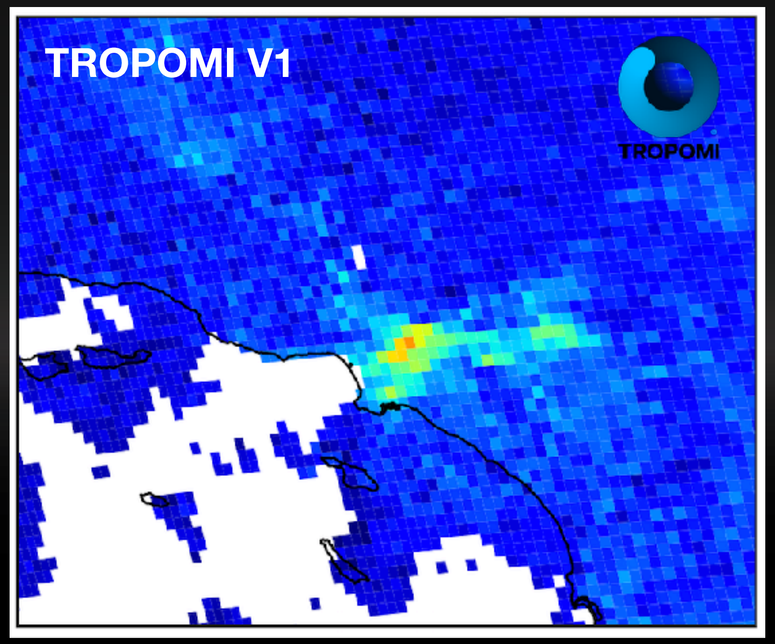
OCO-3 SAM XCO2 and NO2@LA

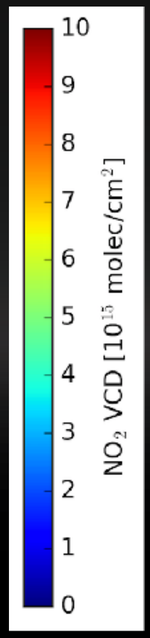
Modeled XCO2 (only FF)



NO2 - indicator for FF CO2







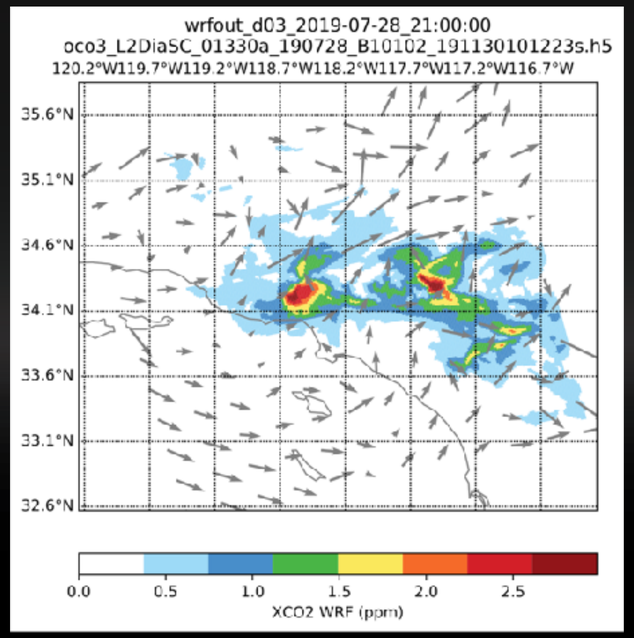
4:00pm Local time

1:30pm or so Local time

NO2 data: Lok Lamsal, Nick Krotokov

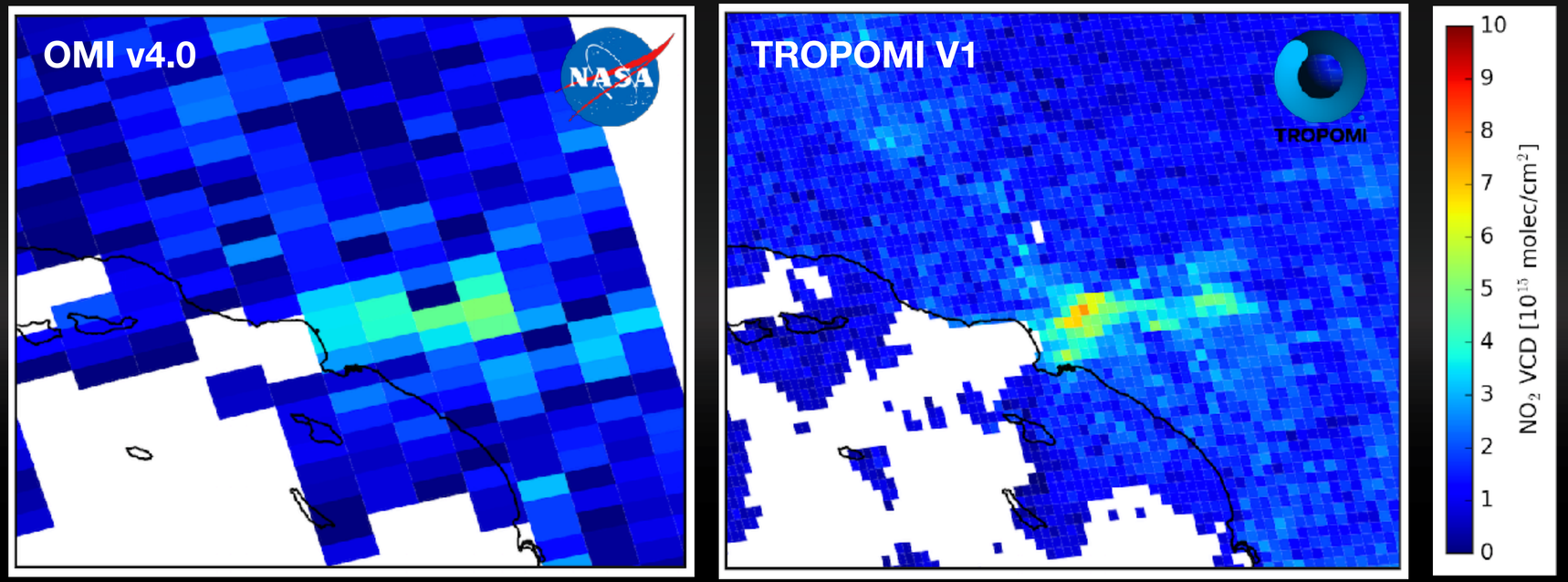
OCO-3 SAM XCO2 and NO2@LA

Modeled XCO2 (only FF)



1:00pm Local time

NO2 - indicator for FF CO2

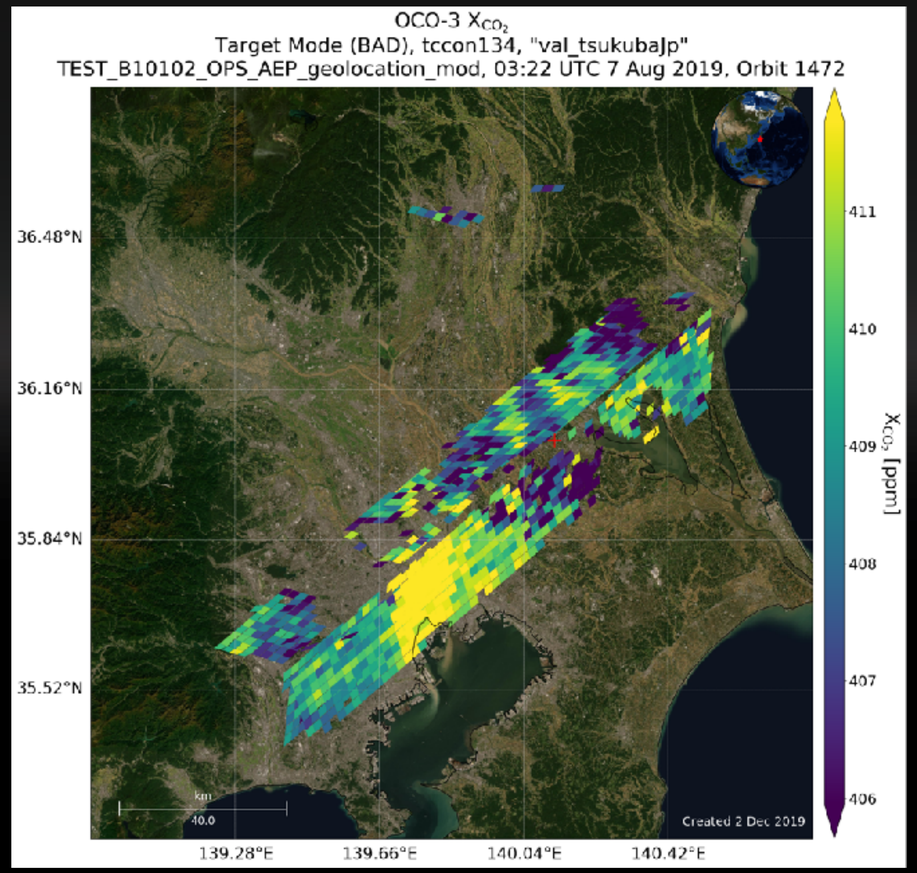


1:30pm or so Local time

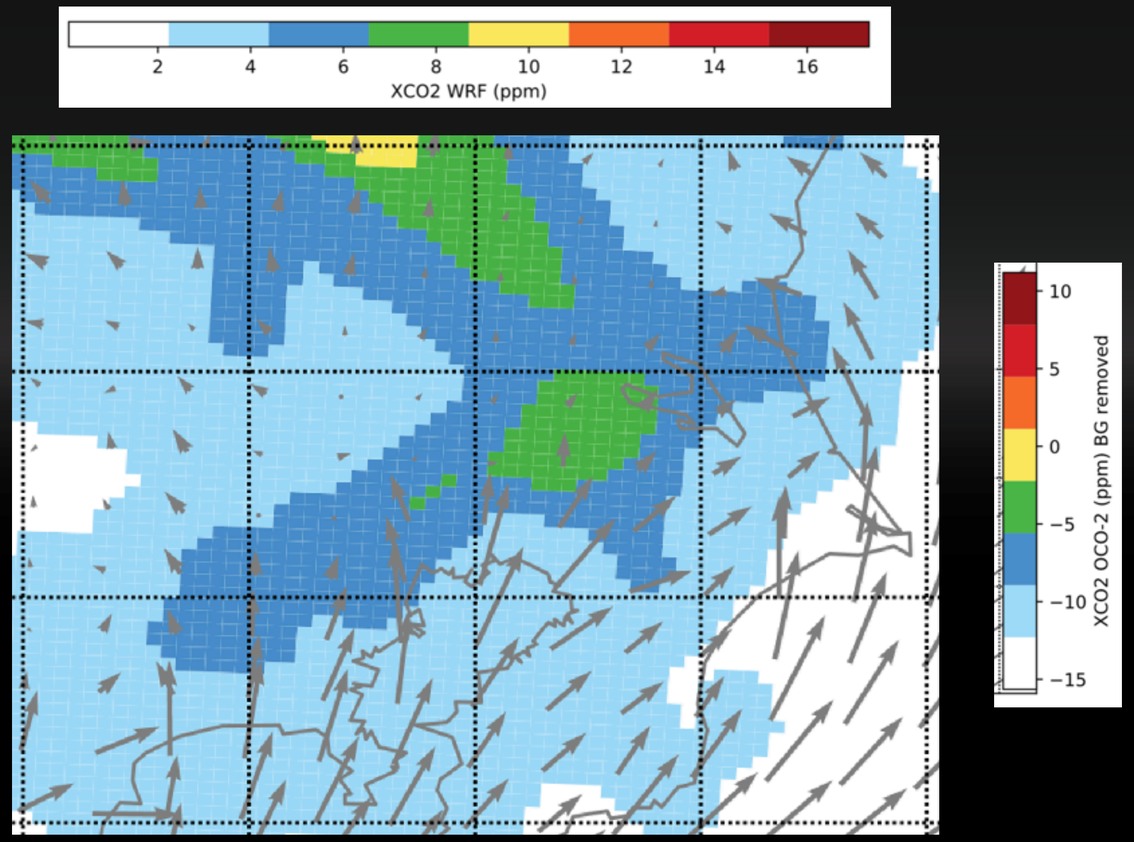
NO2 data: Lok Lamsal, Nick Krotokov

OCO-3 in Target mode@Tokyo 2019-08-07 03:22 UTC

OCO-3 XCO2 (Preliminary) @12pm local time

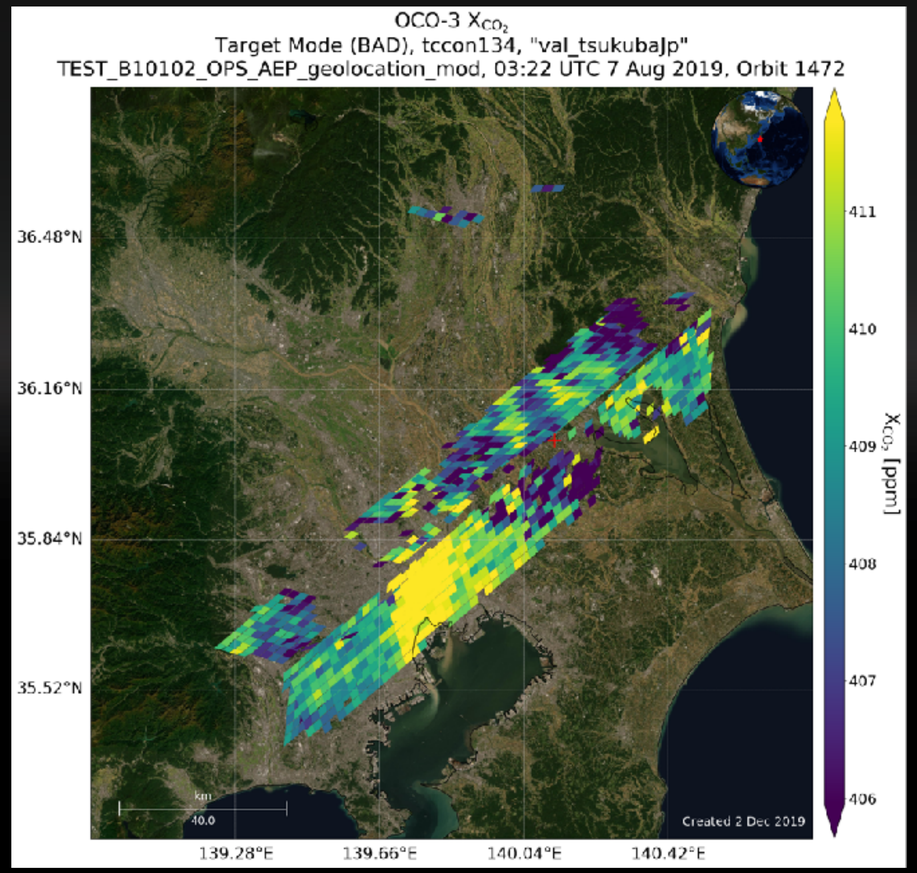


WRF XCO2 (only FF)

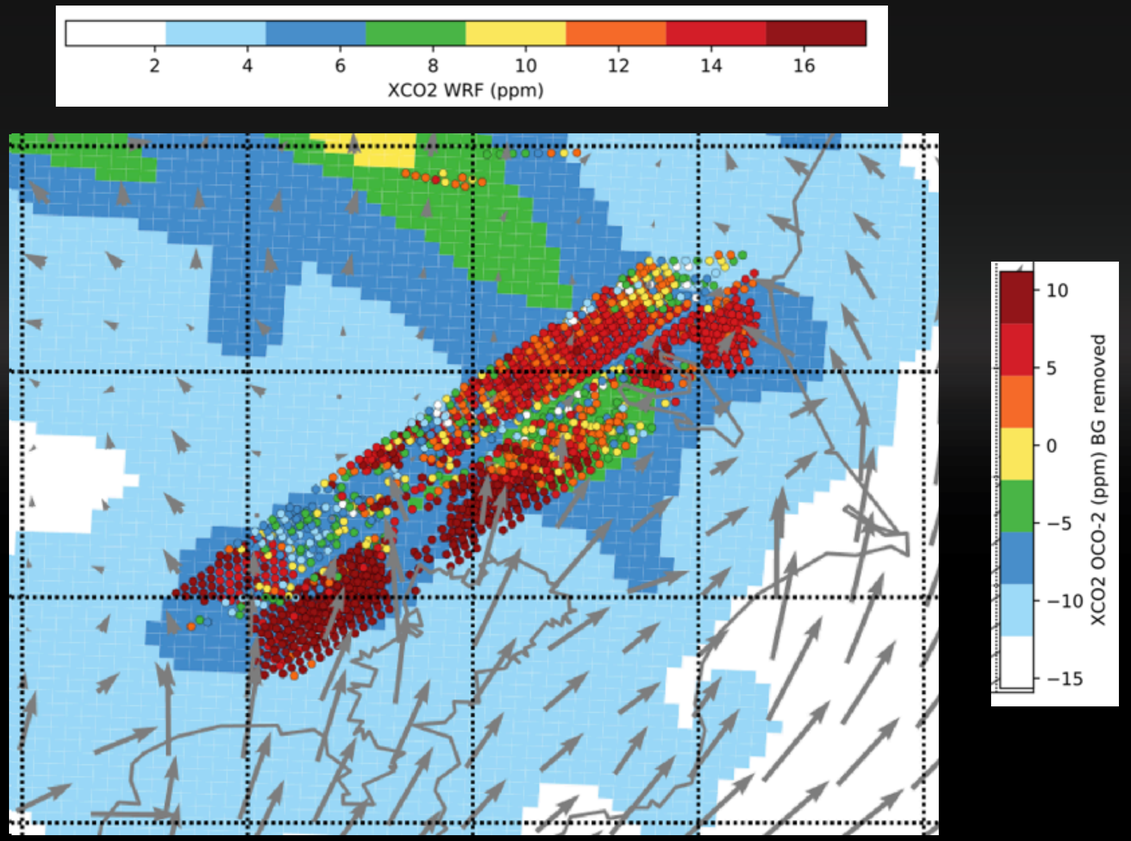


OCO-3 in Target mode@Tokyo 2019-08-07 03:22 UTC

OCO-3 XCO2 (Preliminary) @12pm local time

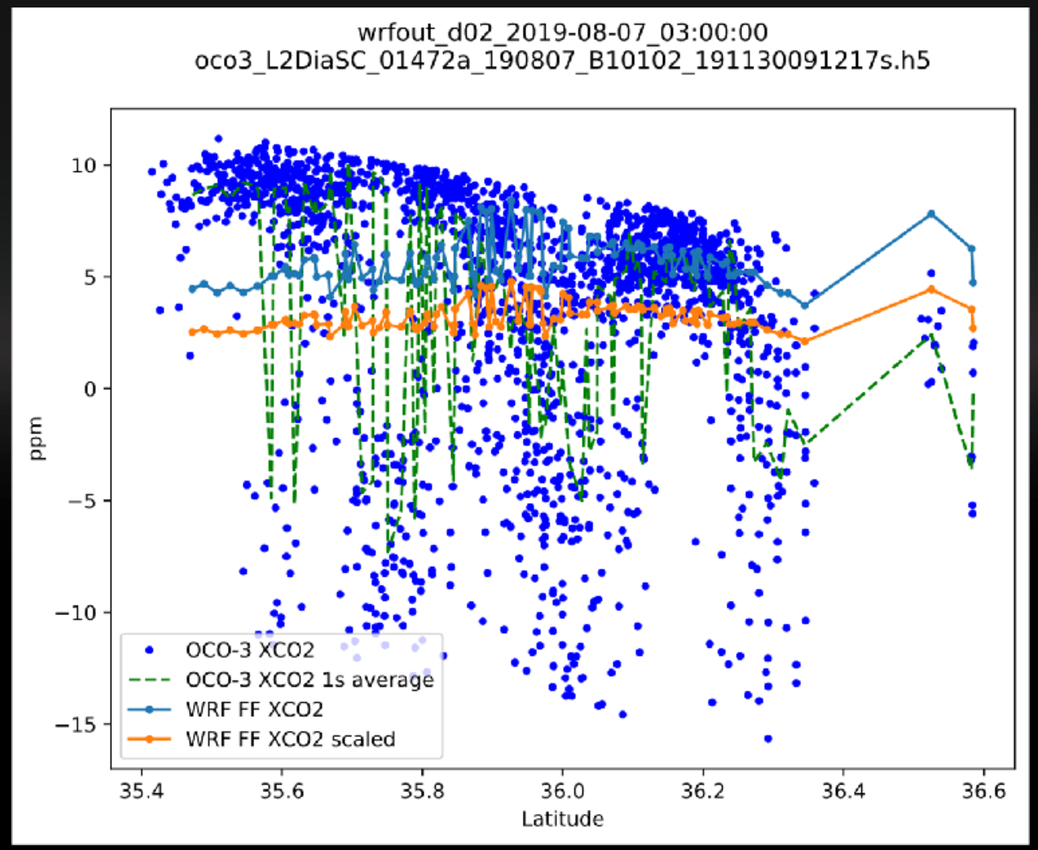


WRF XCO2 + OCO-3 (Background removed)

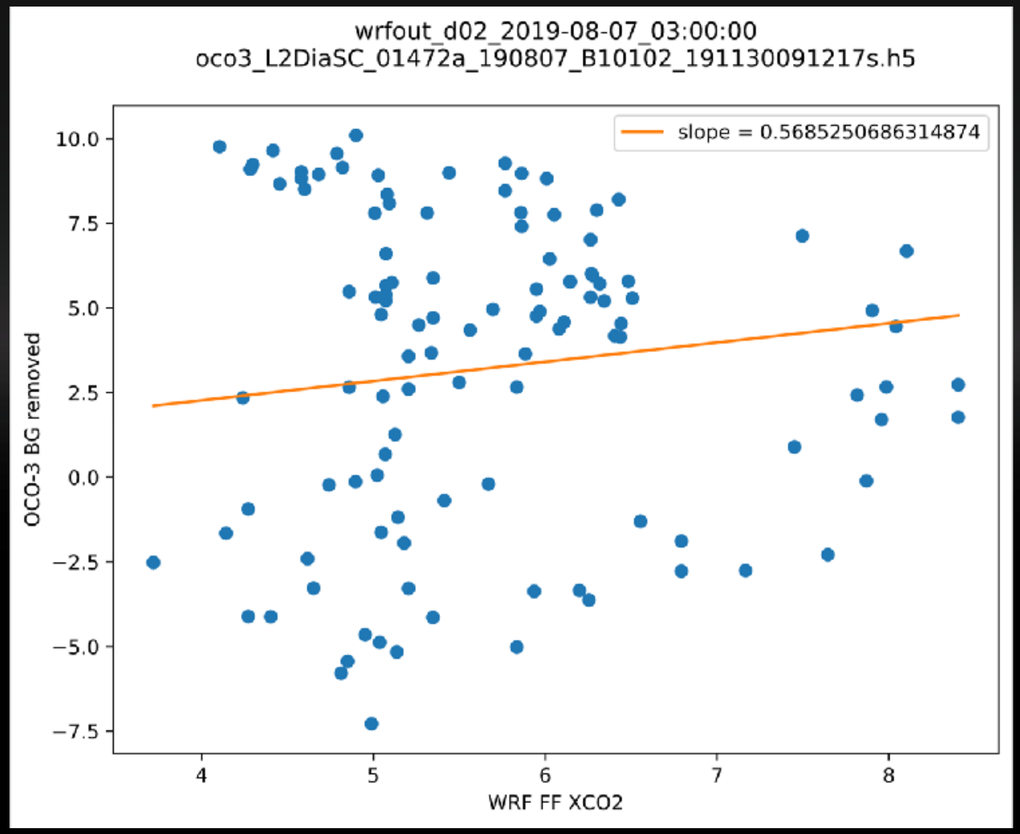


OCO-3 in Target mode@Tokyo 2019-08-07 03:22 UTC

OCO-3 (background removed) + WRF XCO2

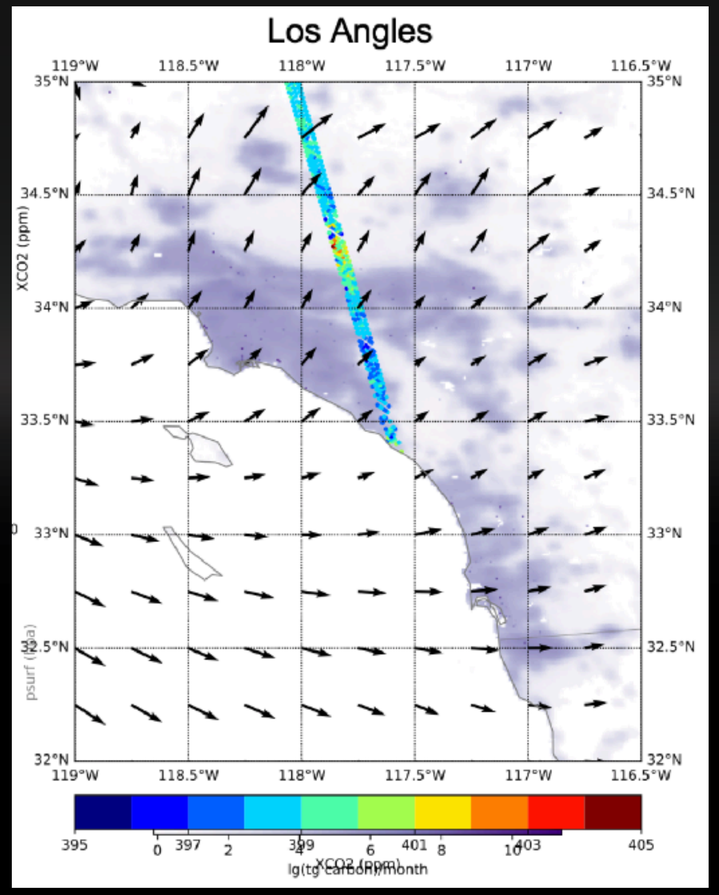


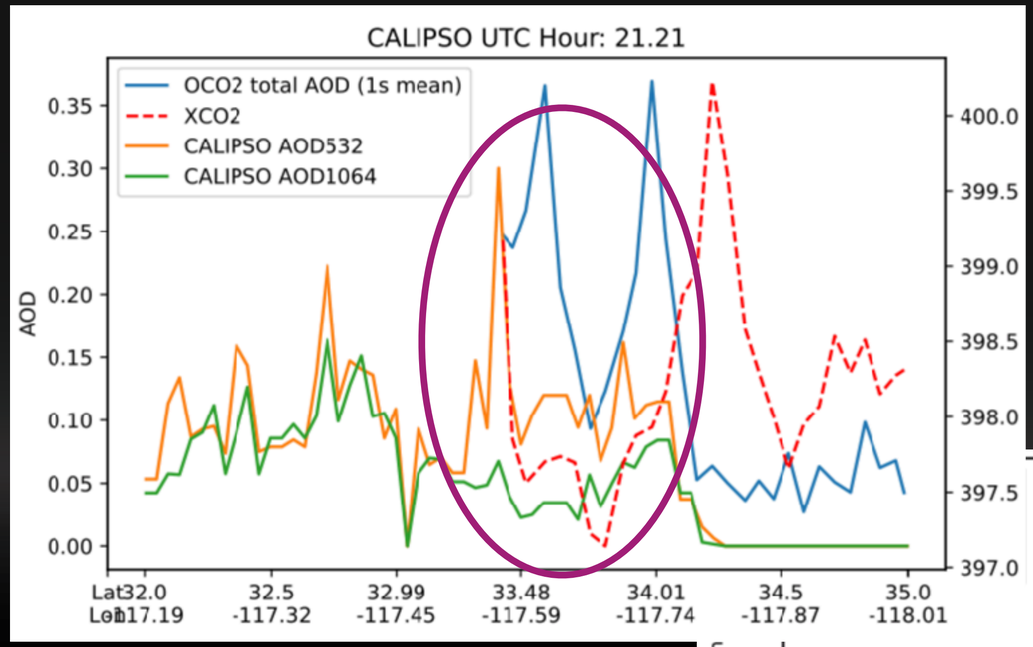
WRF-ODIAC (only FF) vs. OCO-3 SAM (1 sec avg)

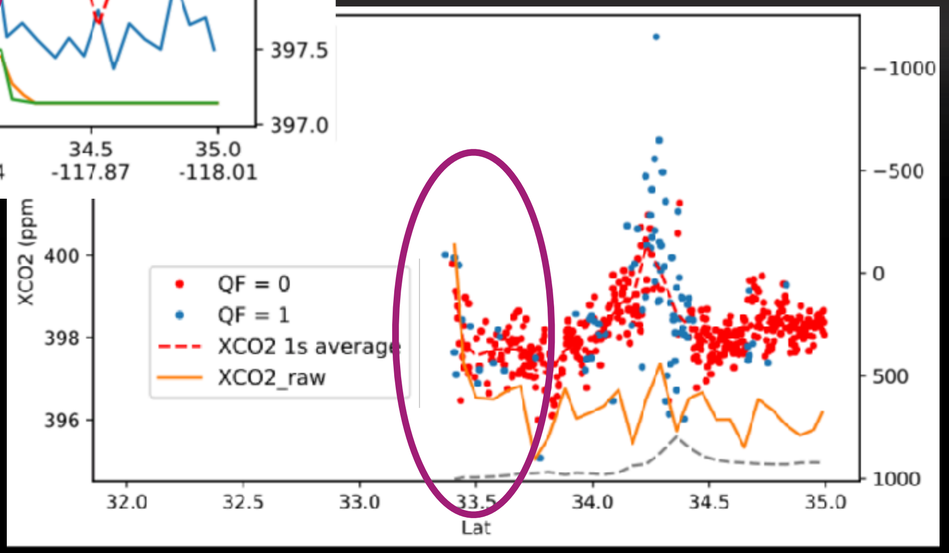


Characterizing possible errors in urban soundings

OCO-2 Aug 7, 2015





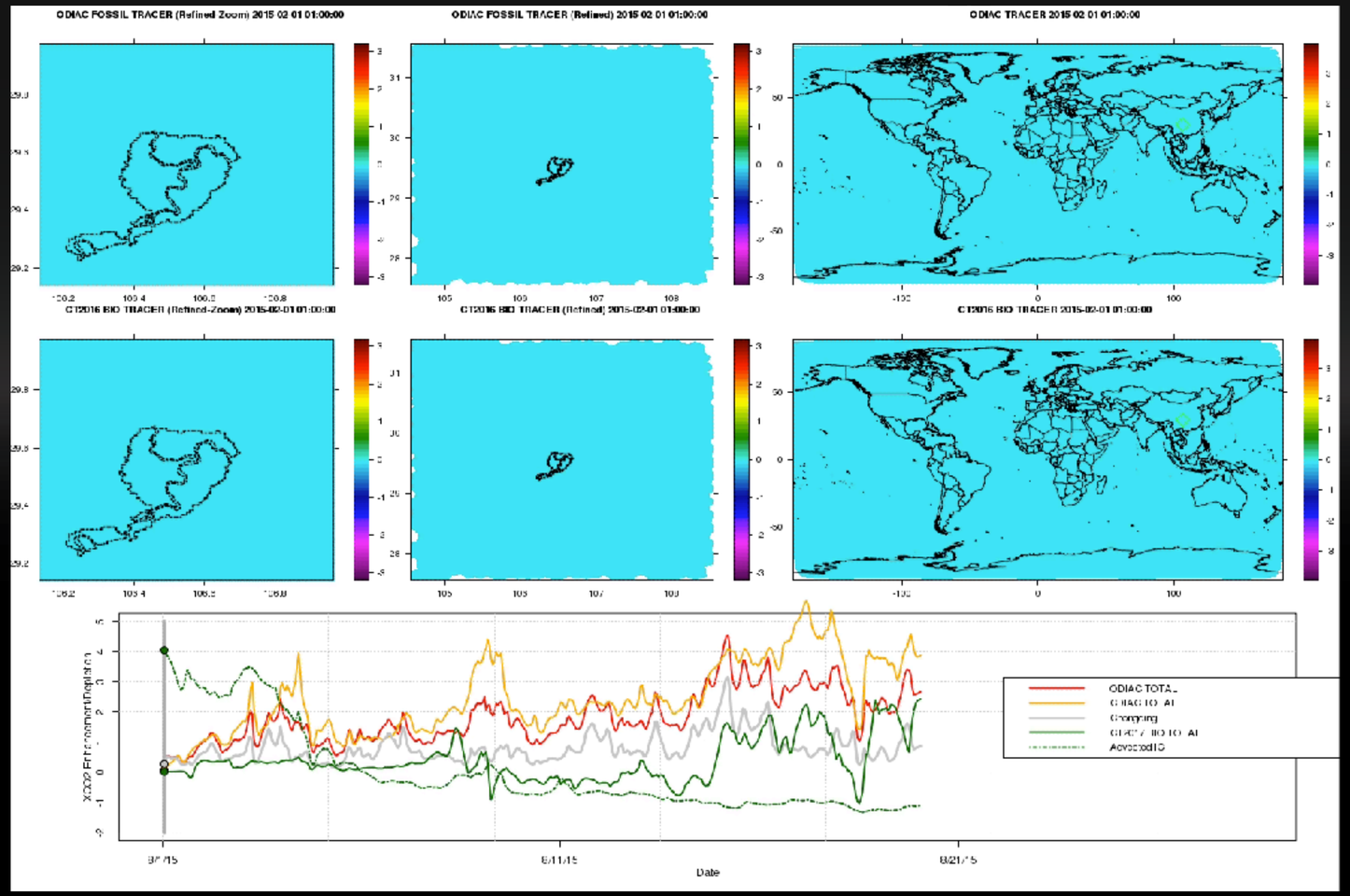


Some High AOD and XCO2 match well…

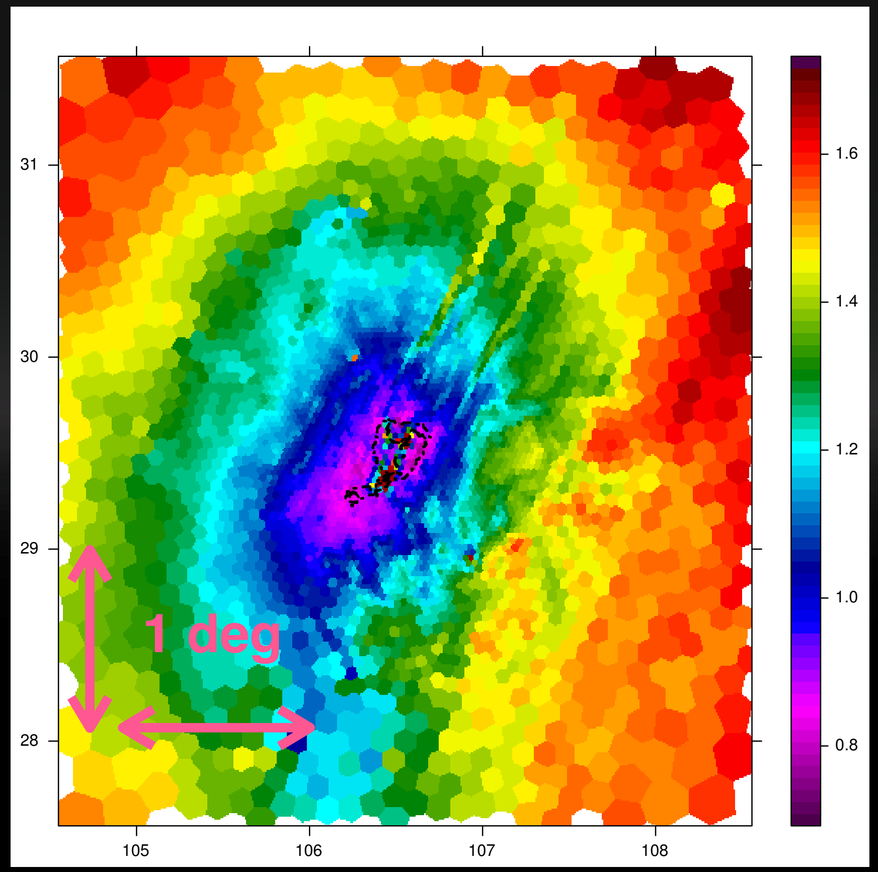
Lei, Feng, Lauvaux working progress

Simulating CO_2 from global cities with a single model (CSU-OLAM)

Chongqing, China



“Halo city” RMSE analysis



Andrew Schuh working progress

Summary (knowing the SAM data are preliminary) and future plans

- ***Models in support of OCO-3:*** *We are developing a suite of high-resolution atmospheric CO_2 models that allows us to examine the potential observation strategies for collecting useful urban soundings and then evaluate the CO_2 retrievals.*
- ***First look at SAM****: Compared to our model simulations, the major spatial feature recoded in the preliminary SAM data look plausible. We expect do more comparison exercise as data become available.*
- ***NO2 data look promising:*** *Two NO2 data are consistent despite of the different spatial resolutions. The reasonable spatial correspondence between the WRF model and NO2 data is encouraging from both modeling and observation perspectives.*
- ***Upcoming challenges:*** *We will attempt to characterize potential errors and biases in urban soundings using model simulations and independent observations (e.g. aerosols). The impact of the biospheric contributions (local and lateral inflow) needs to be examined, and then the optimal observation strategy need to be studied.*
- ***Synthetic OCO-3 data development:*** *A Synthetic OCO-3 data product (including aerosol and cloud information!) baed on NASA's GEOS-5 is being developed (Ott et al. working progress). The product includes all types of observation modes, not just for SAMs.*

Questions/Comment/Collaboration? Tomohiro Oda (toda@usra.edu)