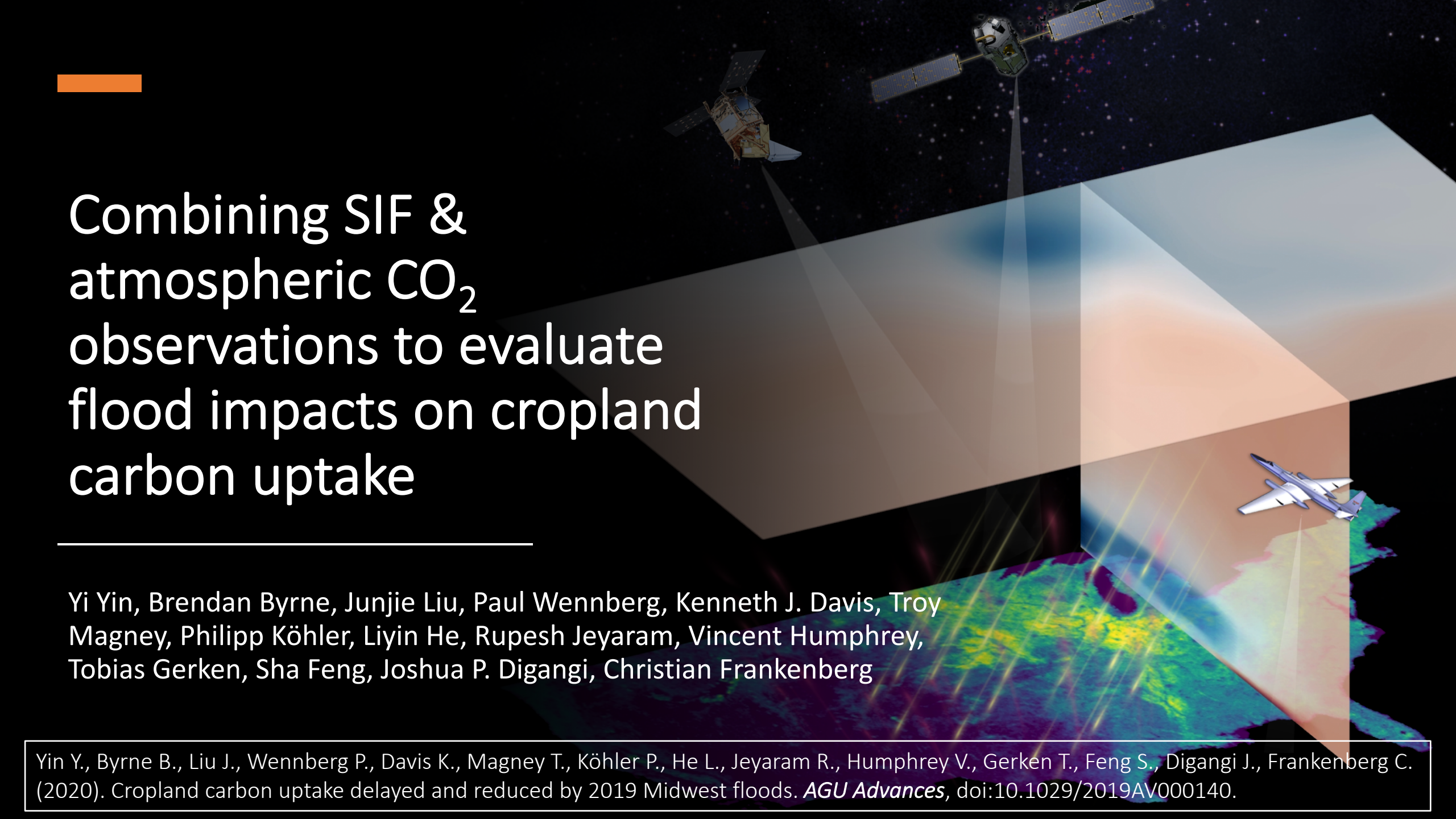
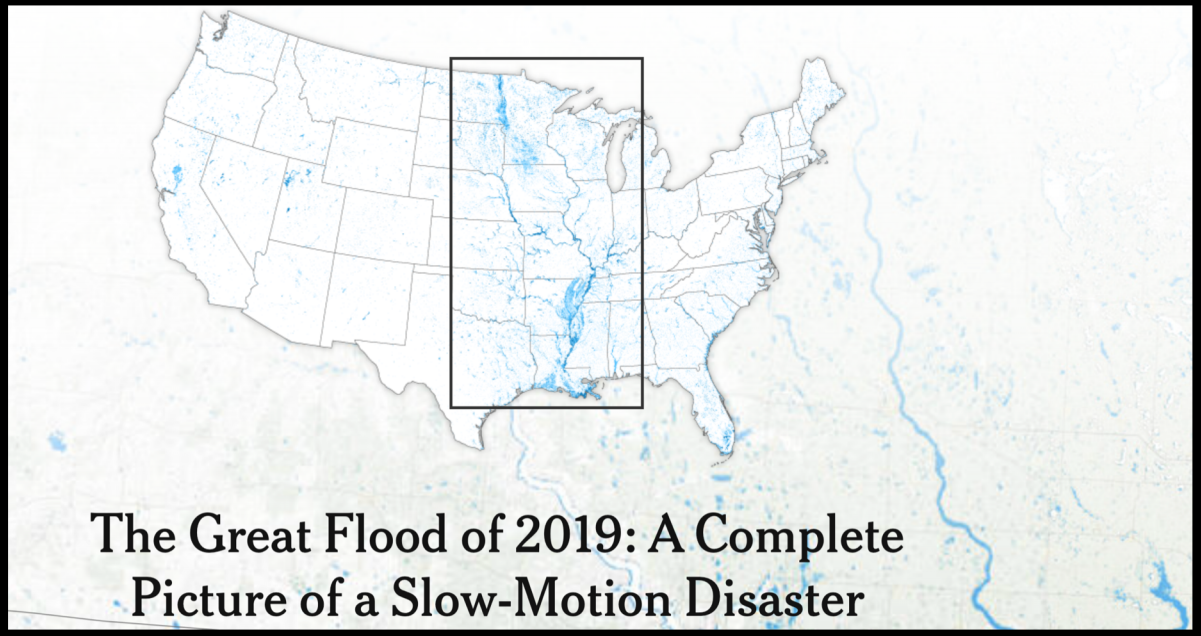


Combining SIF & atmospheric CO_2 observations to evaluate flood impacts on cropland carbon uptake

Yi Yin, Brendan Byrne, Junjie Liu, Paul Wennberg, Kenneth J. Davis, Troy Magney, Philipp Köhler, Liyin He, Rupesh Jeyaram, Vincent Humphrey, Tobias Gerken, Sha Feng, Joshua P. Digangi, Christian Frankenberg

Yin Y., Byrne B., Liu J., Wennberg P., Davis K., Magney T., Köhler P., He L., Jeyaram R., Humphrey V., Gerken T., Feng S., Digangi J., Frankenberg C. (2020). Cropland carbon uptake delayed and reduced by 2019 Midwest floods. ***AGU Advances***, doi:10.1029/2019AV000140.

Can we quantify carbon cycle impact of 2019 Midwest floods?



The Great Flood of 2019: A Complete Picture of a Slow-Motion Disaster

2019 Midwestern U.S. floods

From Wikipedia, the free encyclopedia

The Midwestern United States has been experiencing major floods since mid-March 2019, primarily along the Missouri River and its tributaries in Nebraska, Missouri, South Dakota, Iowa, and Kansas. The Mississippi River has also seen flooding, although starting later and ending earlier. The 2019 January-to-May period was the wettest on record for the U.S., with multiple severe weather outbreaks through May in the Midwest, High Plains, and South exacerbating the flooding and causing additional damage.[1][2][3] Throughout late May and early June, rain in Iowa, Illinois, and Missouri caused every site on the Mississippi River to record a top-five crest.[4] At least three people in Iowa and Nebraska have died.[5]

Nearly 14 million people in the midwestern and southern states have been affected by the flooding, which the New York Times has called "The Great Flood of 2019".[6]

2019 Midwestern U.S. floods

March 2018 and March 2019 side-by-side

'So much land under so much water': extreme flooding is drowning parts of the midwest

Midwest flooding is drowning corn and soy crops. Is climate change to blame?

This year's constant deluge of rain has led some to wonder if farmers are finally feeling the predicted impacts of a warming world.

The severe floods soaking the Midwest and Southeast are not letting up

Forecasters predicted the massive floods months ago.

By Umair Irfan | Jun 11, 2019, 11:50am EDT

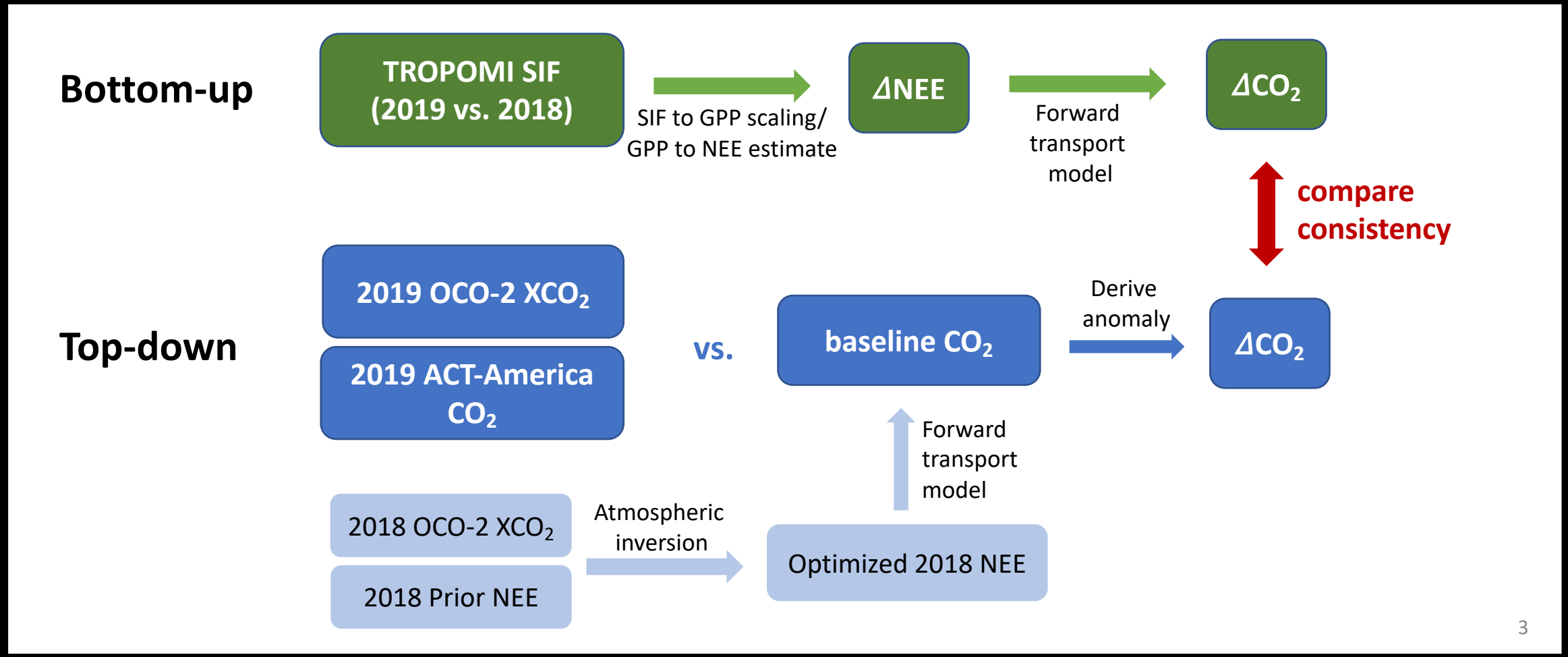
No End in Sight for Record Midwest Flood Crisis

High waters continue to swamp towns and agricultural fields throughout the Mississippi basin

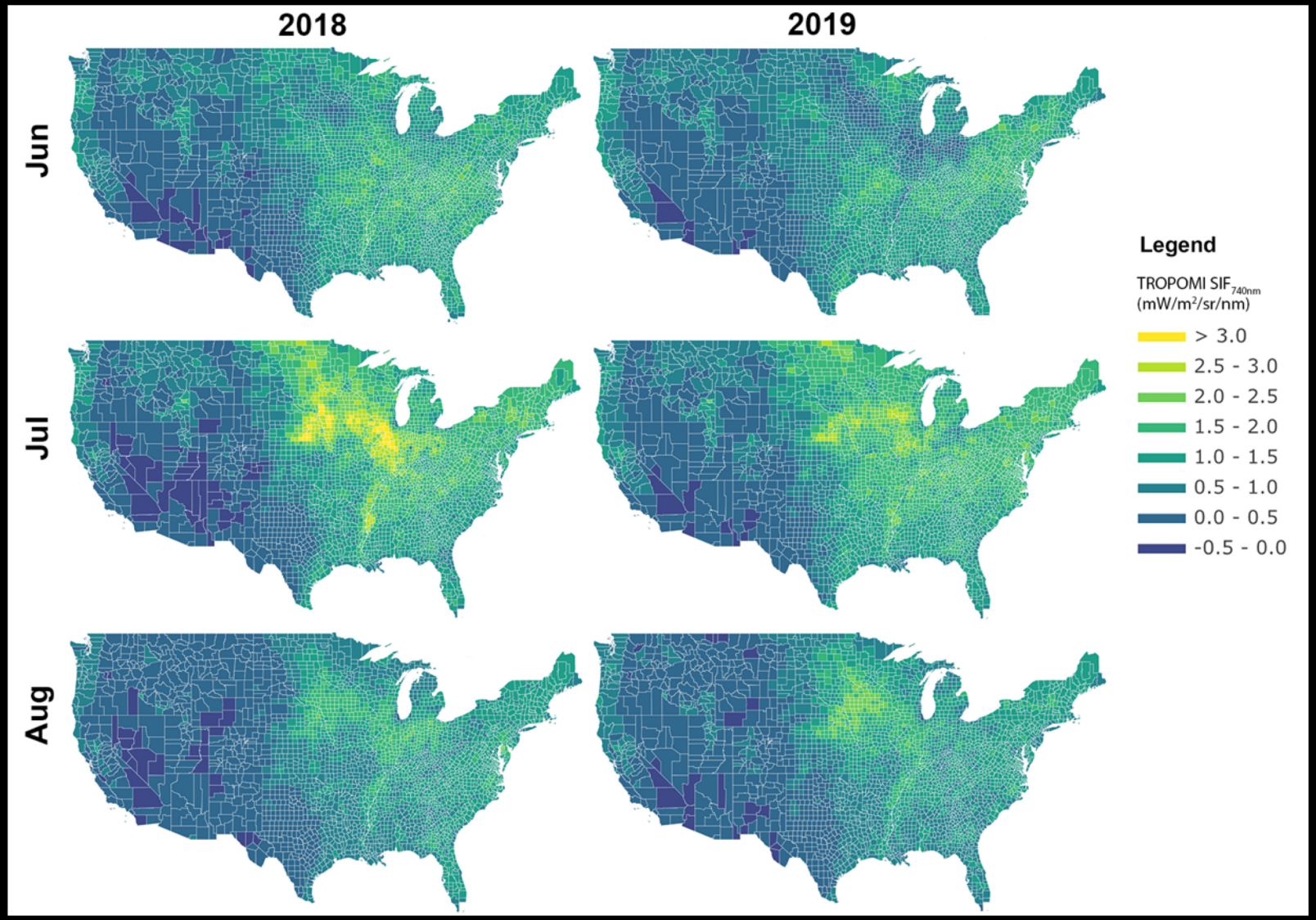
By Daniel Cusick, E&E News on June 26, 2019

Quantify carbon cycle signal

- Estimate carbon budget anomaly in atmospheric CO2
- Compare independent top-down and bottom-up estimates



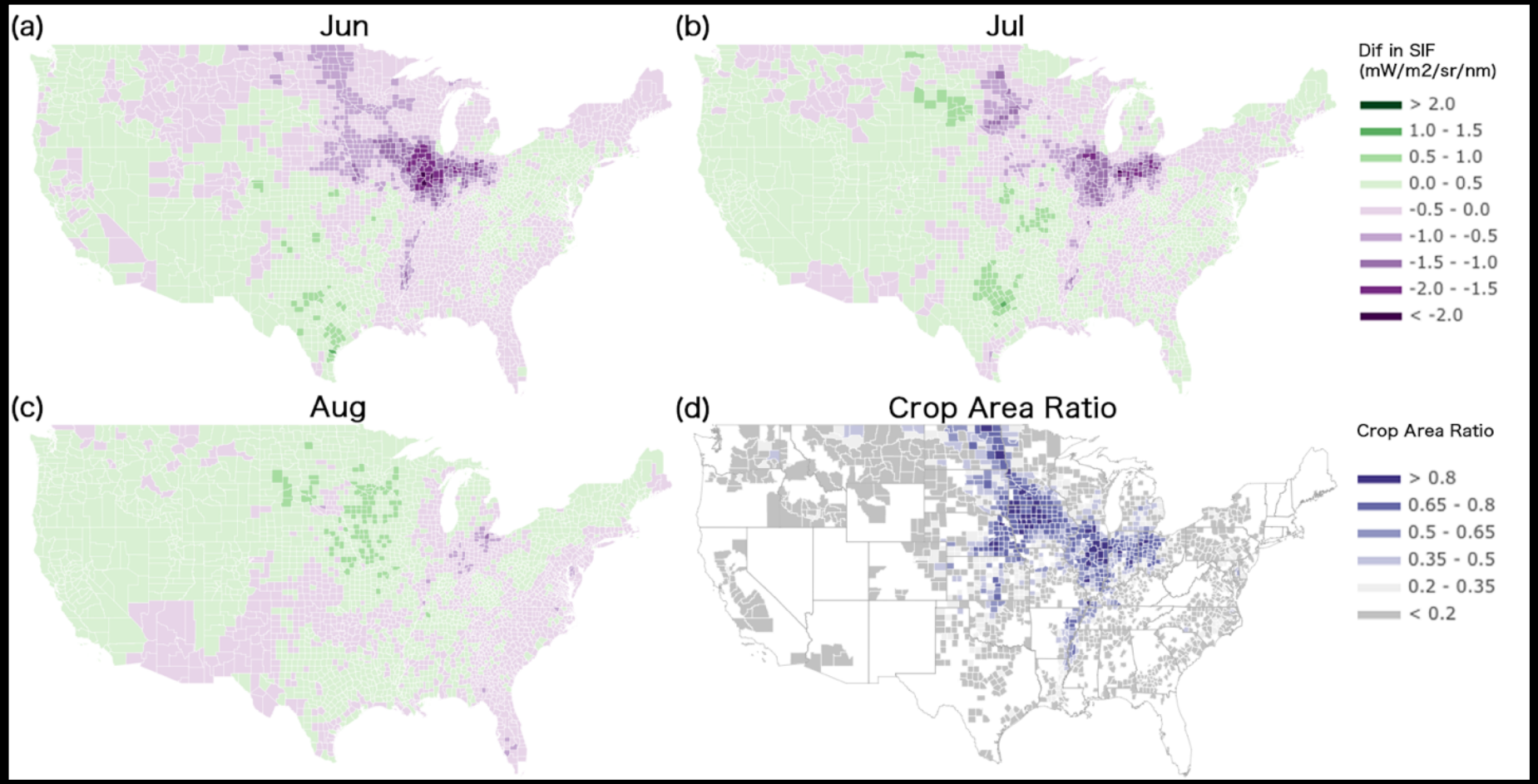
SIF from TROPOMI per county



TROPOMI SIF measurements track GPP across the growing season

Differences between 2018 and 2019 are largely due to flooding in the Midwest

2019-2018 SIF difference & Bottom-up ΔCO_2



2019-2018 TROPOMI SIF differences can be used to estimate ΔNEE due to flooding

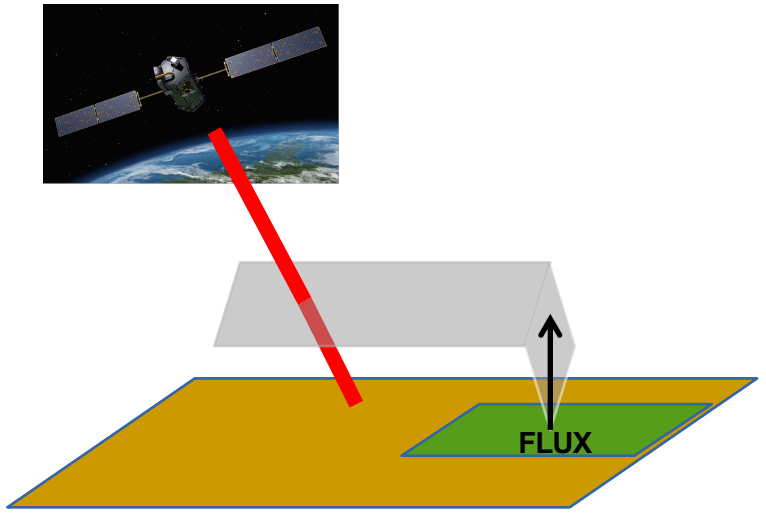
Using a chemical transport model, ΔNEE is employed to simulate ΔCO_2

Bottom-up

TROPOMI SIF (2019 vs. 2018) → SIF to GPP scaling/ GPP to NEE estimate → **ΔNEE** → chemical transport model → **ΔCO_2**

Top down NEE and ΔCO_2

Atmospheric CO2 flux inversion



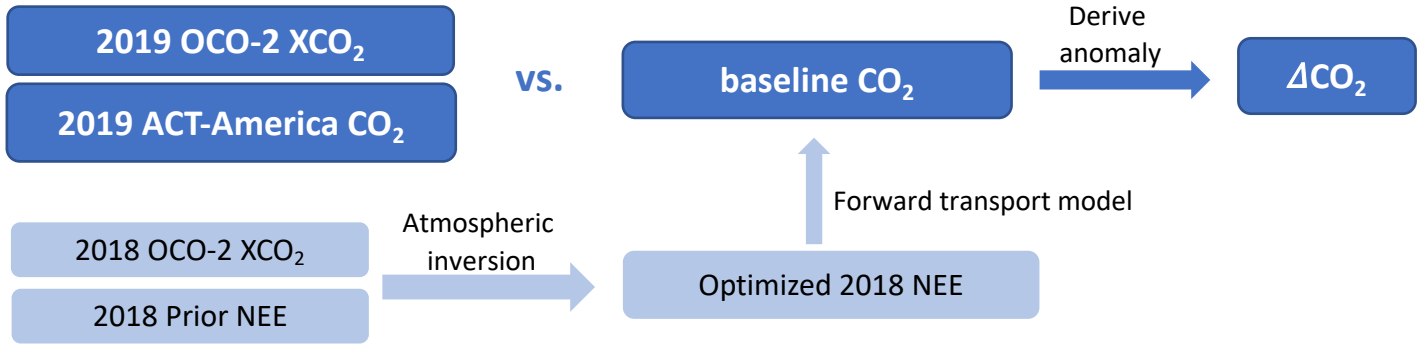
$CO2 = f(NEE)$

Estimate NEE

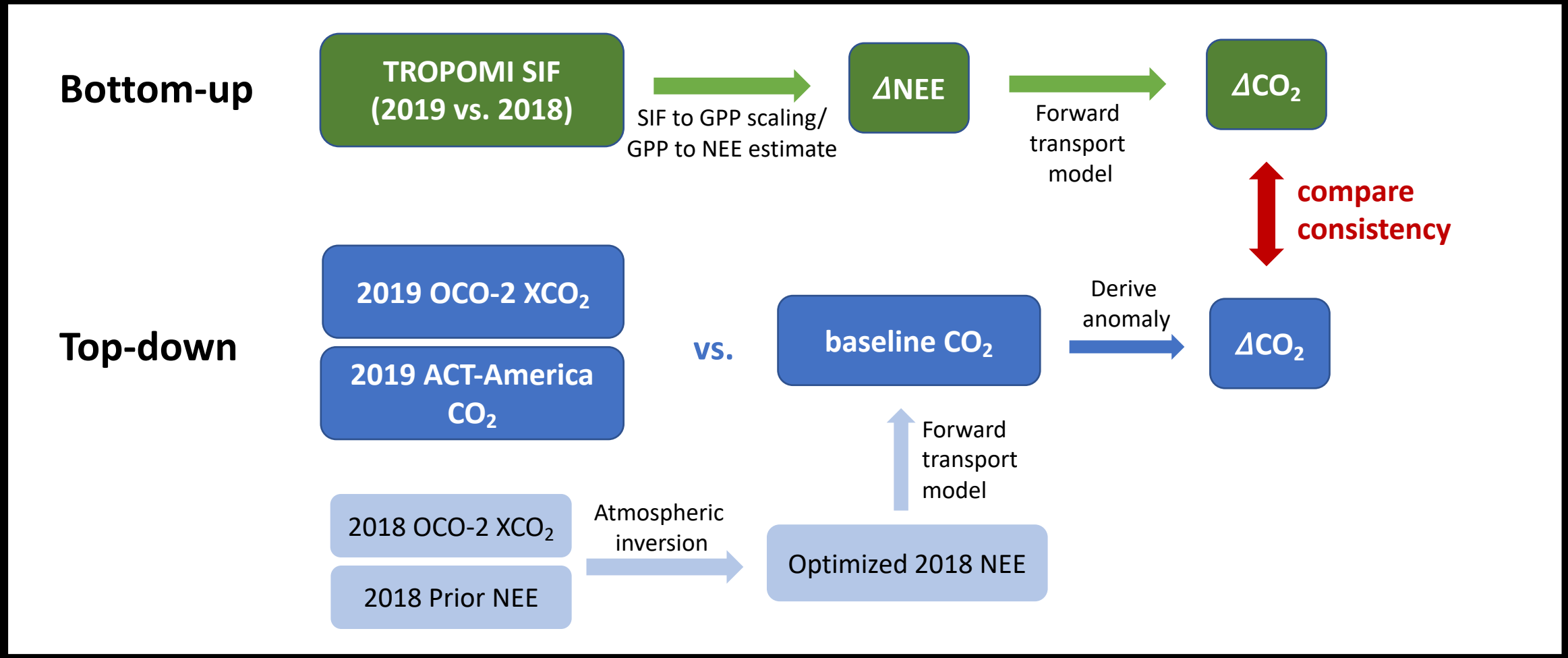
Measure atmospheric CO_2

- CO2 flux inversion assimilating OCO-2 XCO2 provides an estimate of NEE fluxes for 2018.
- These optimized 2018 NEE fluxes are repeated for 2019 to simulate 2019 CO2 fields.
- The difference between 2019 CO2 measurements and simulated measurements using 2018 NEE can be attributed to differences in NEE for 2019.
- Provides top-down estimate of ΔCO_2

Top-down

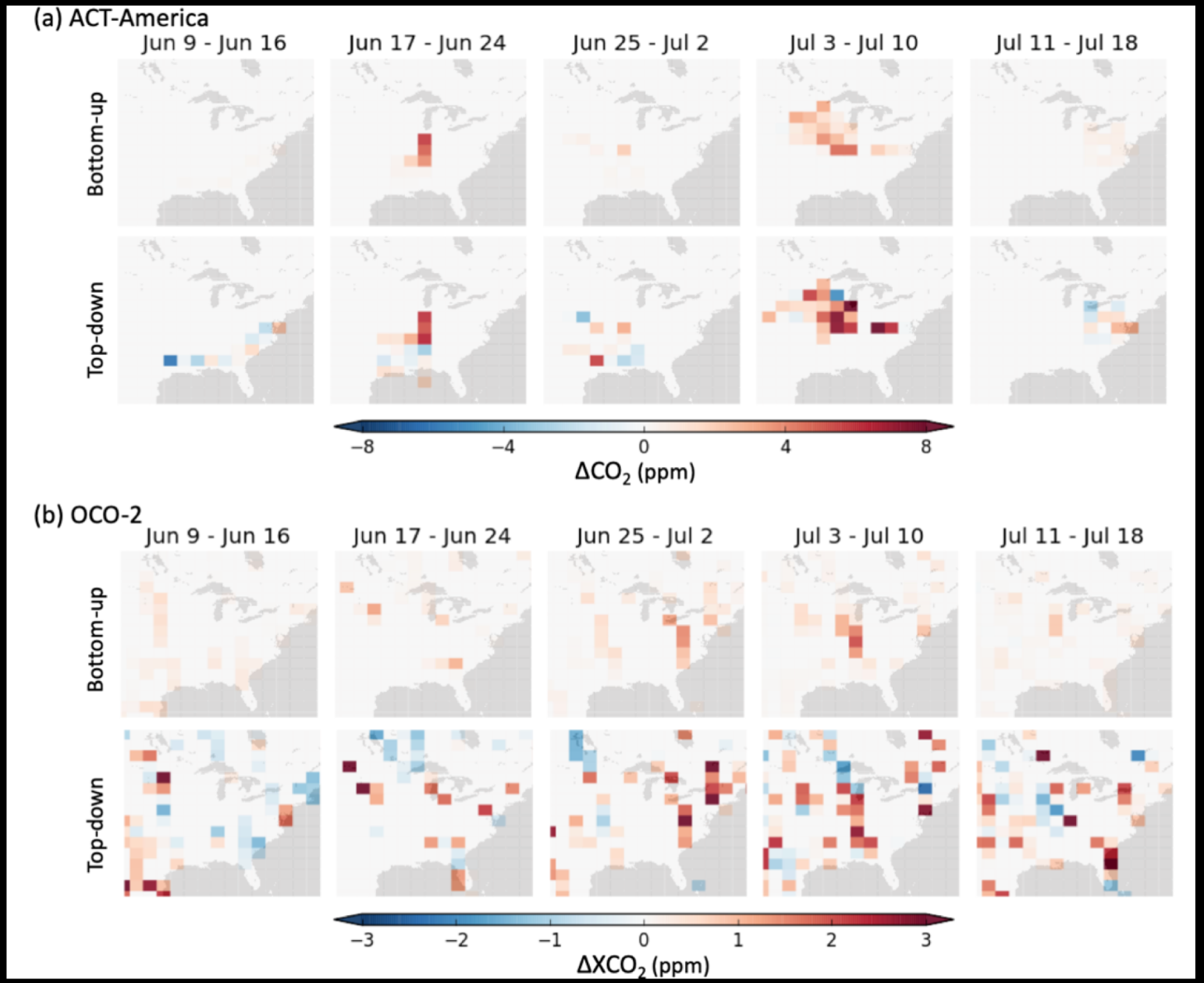


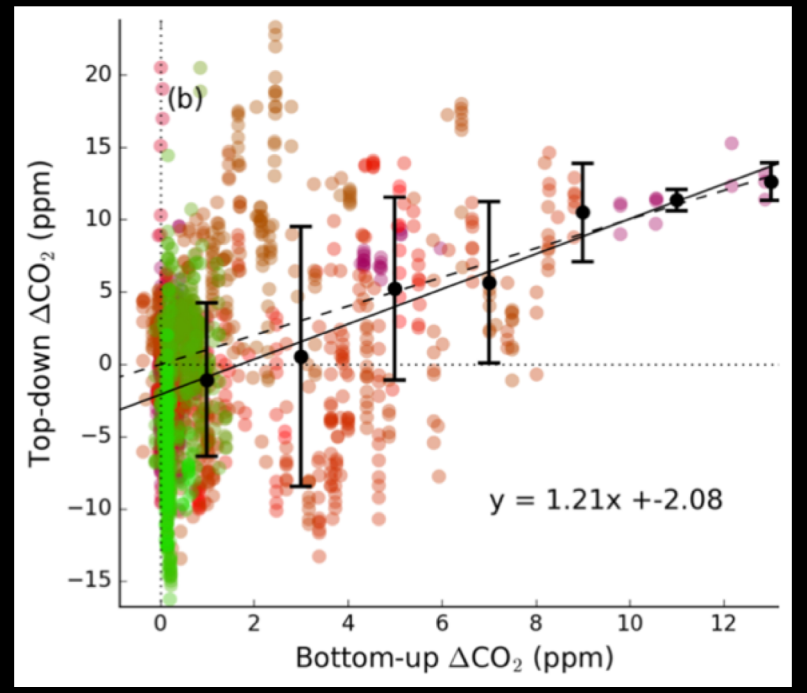
Compare bottom-up (SIF-based) and top-down (CO2 based) estimates of the carbon cycle anomaly

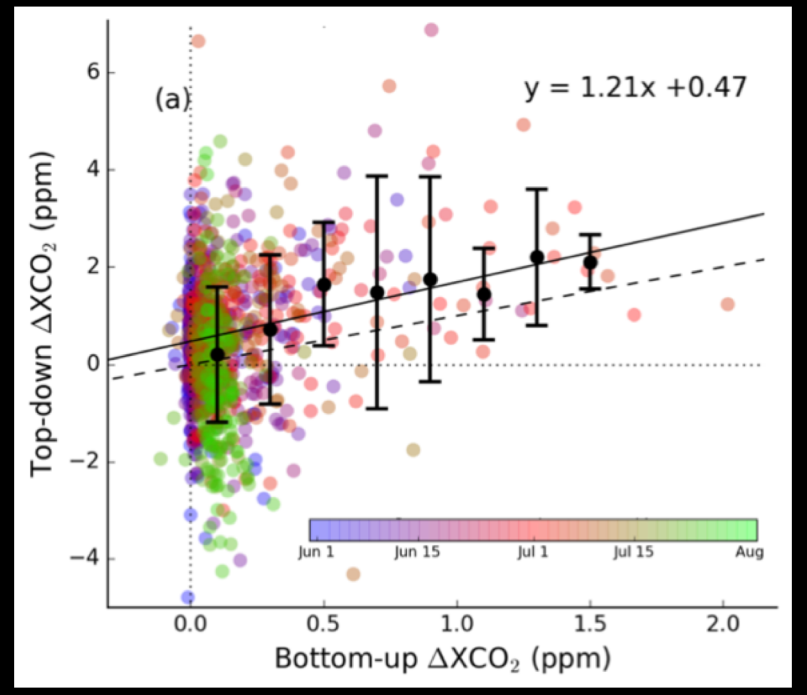


Comparing SIF- and CO_2-based signal

ΔCO_2 signal is correlated (P<0.01) between methods







Summary

- This study demonstrates a method to reconcile SIF-based and top-down CO_2-based estimates of large-scale carbon cycle anomalies and suggests our capability in monitor carbon cycle anomalies in near-real-time.

- A ~0.1 PgC reduction in net ecosystem uptake during June and July (equiv. to 35% of US fossil fuel emissions at the same time) is consistent with observed atmospheric CO_2 enhancement from both OCO-2 and ACT-America.

Yin Y., Byrne B., Liu J., Wennberg P., Davis K., Magney T., Köhler P., He L., Jeyaram R., Humphrey V., Gerken T., Feng S., Digangi J., Frankenberg C. (2020). Cropland carbon uptake delayed and reduced by 2019 Midwest floods. ***AGU Advances***, doi:10.1029/2019AV000140.

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