GEOS-Carb IV: Delivering low-latency carbon flux and concentration datasets in support of NASA's Carbon Monitoring System

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Motivation

Integrate all relevant space-based observations to better understand the processes that control both anthropogenic and natural influences on carbon dioxide concentrations.

Provide high quality, reliable information about greenhouse gases to researchers and stakeholders around the world.

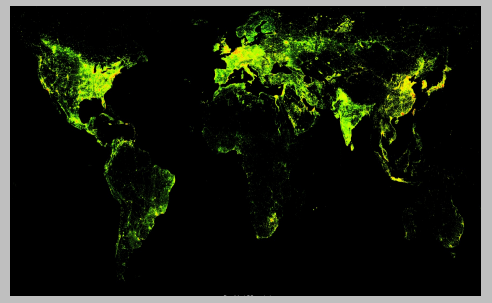
Increasingly, a broad range of users require timely information about global greenhouse gas fluxes and concentrations:

- Measurement and field campaign planning
- Commercial satellite retrievals
- Boundary conditions for regional models
- Monitoring and verification of emissions

Key objectives for GEOS-Carb IV: Emphasis on lowering latency of flux and concentration products through implementation of quasi-operational modeling systems

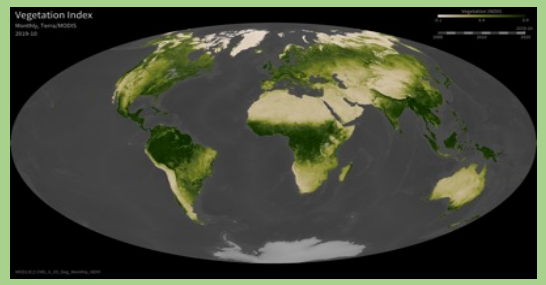
Observationally informed flux estimates

Fossil Fuel Emissions



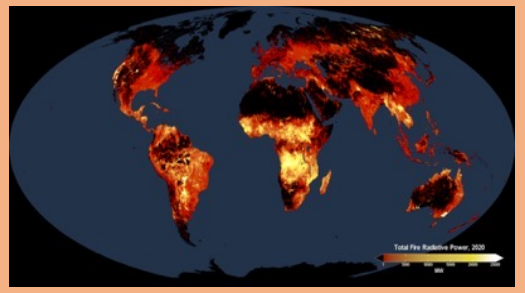
- Provided by the Open-source Data Inventory for Anthropogenic CO_2
- National emissions are redistributed using powerplant database, ***nighttime lights observations***
- http://odiac.org

Terrestrial Carbon Flux



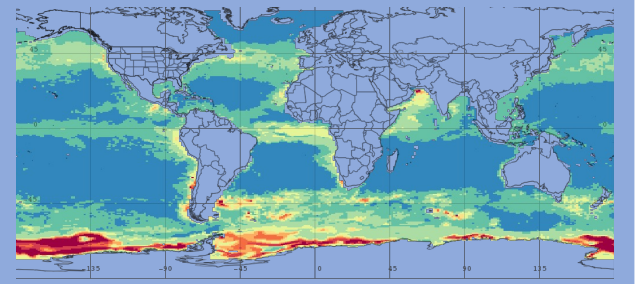
- Provided by the CASA-GFED3 vegetation model
- Driven by MODIS, AVHRR observations of **vegetation greenness, burned area**
- Data available from NASA GES-DISC

Fire Emissions



- Provided by the Quick Fire Emissions Dataset (QFED)
- Driven by MODIS **fire radiative power**, calibrated against GFED
- Data available from NASA GMAO

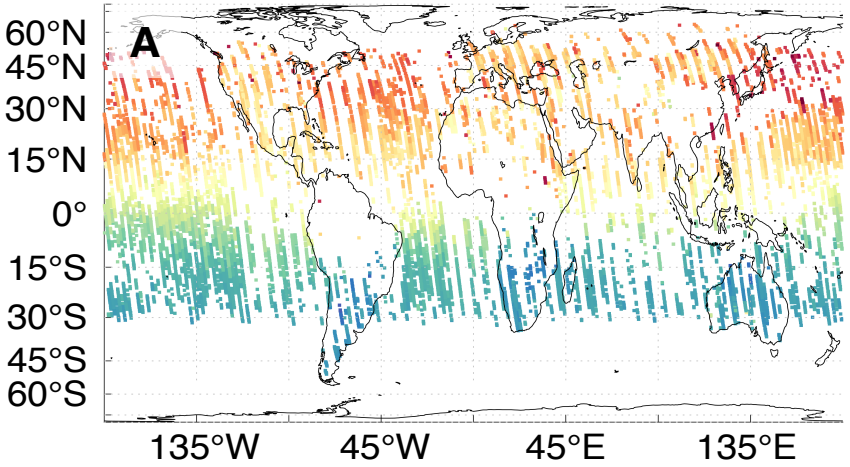
Ocean Carbon Flux



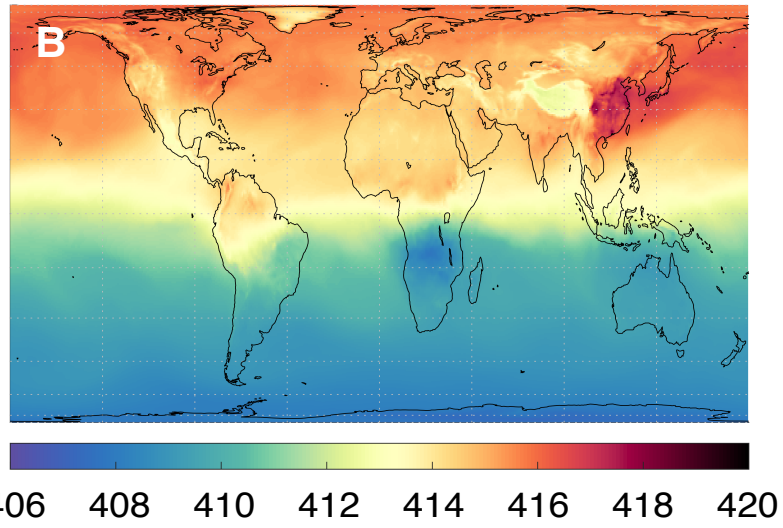
- Provided by the NASA Ocean Biogeochemical Model (NOBM)
- Driven by assimilation of ocean color data, MERRA-2 forcing
- Data available from GES DISC, Giovanni

Atmospheric concentration analysis for the most complete, data constrained view of atmospheric CO_2

16 days OCO-2 XCO_2 – 4/1-16/2020

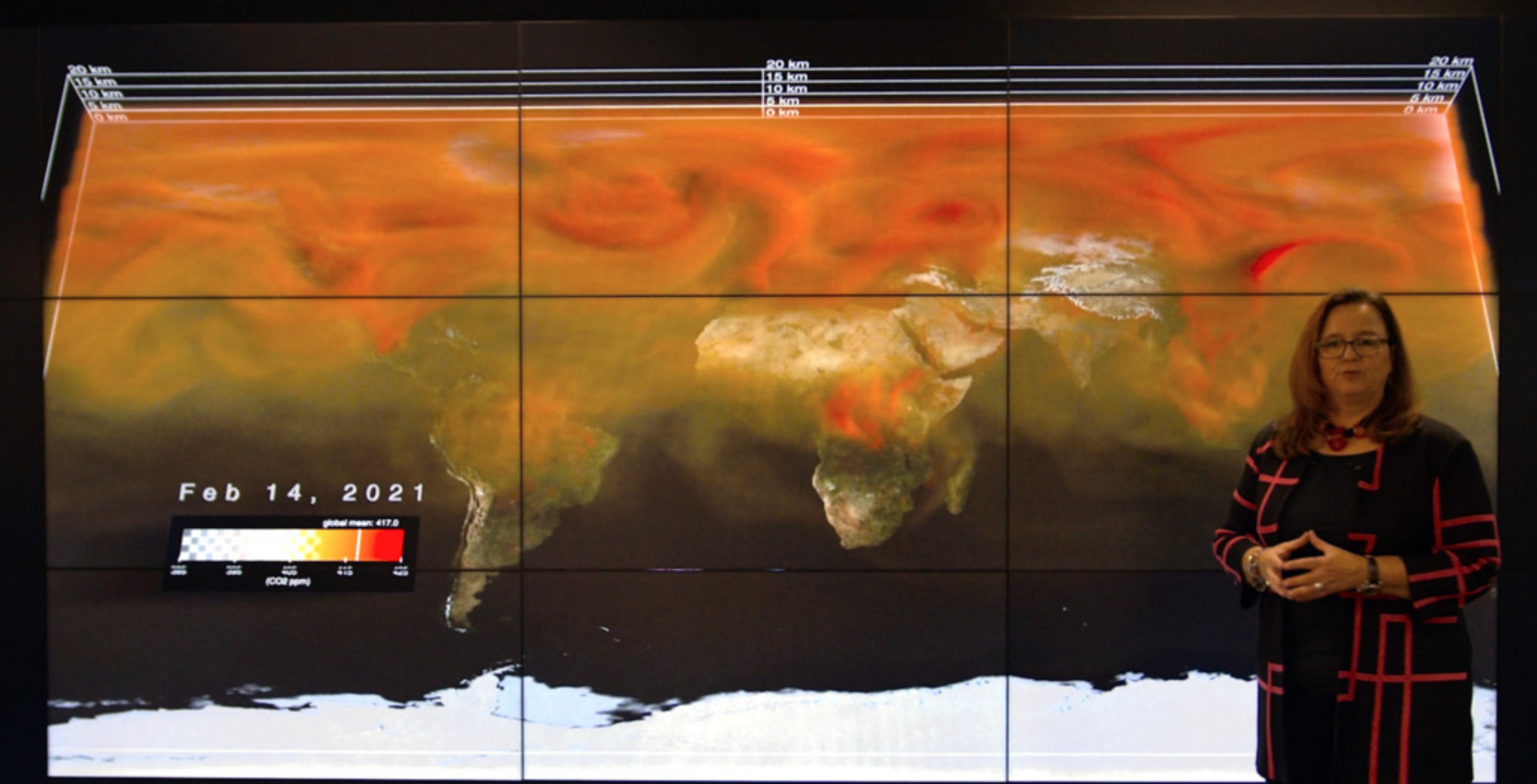


16-day average L3 XCO_2



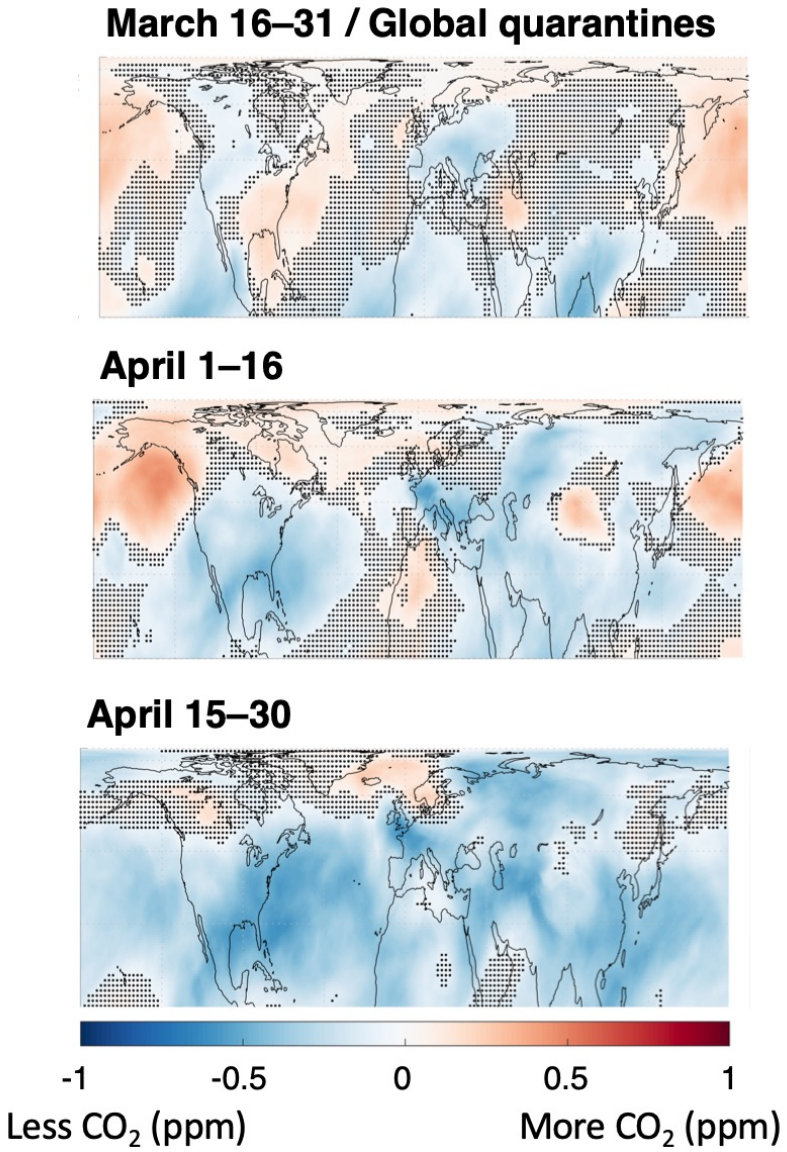
- NASA's OCO-2 satellite, launched in 2014, measures the column-averaged dry air mole fraction of CO2 (XCO_2) in sunlit, clear sky conditions.
- Bias-corrected OCO-2 retrievals are assimilated into the GEOS Constituent Data Assimilation System (CoDAS) to produce gap-filled 3-dimenstional CO_2 fields.
- When OCO-2 data are unavailable, gaps are filled using:
  - All previous good quality OCO-2 retrievals
  - MERRA-2 wind and atmospheric transport fields (~6M per 6-hr period)
  - Observationally-informed flux package (e.g. night lights, NDVI, FRP, surface growth rate)

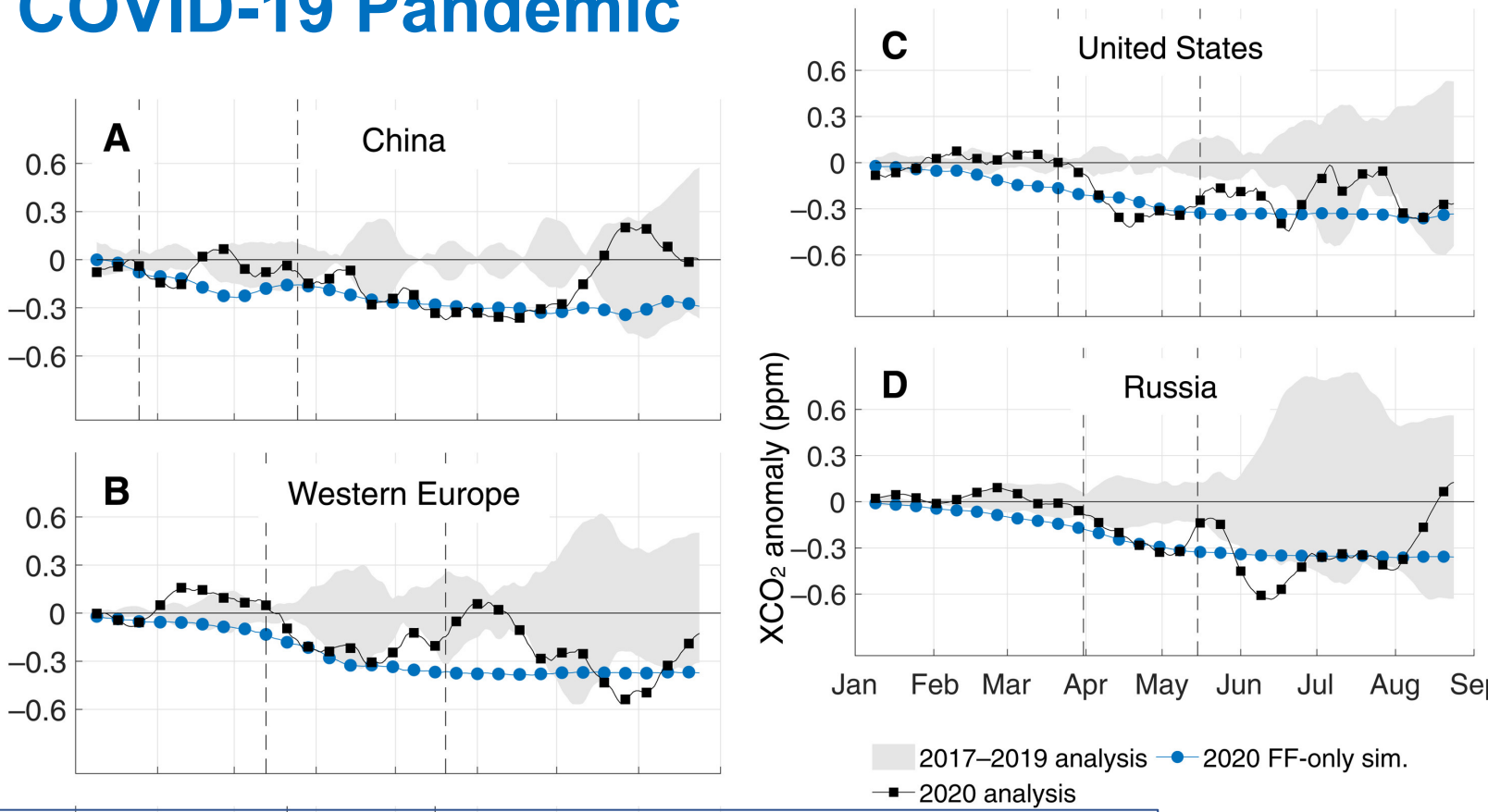
Currently supporting the OCO Science Team and beyond as a an L3 product



Check out a moving version at: https://svs.gsfc.nasa.gov/4983,
Karen's presentation at COP26: https://svs.gsfc.nasa.gov/31168

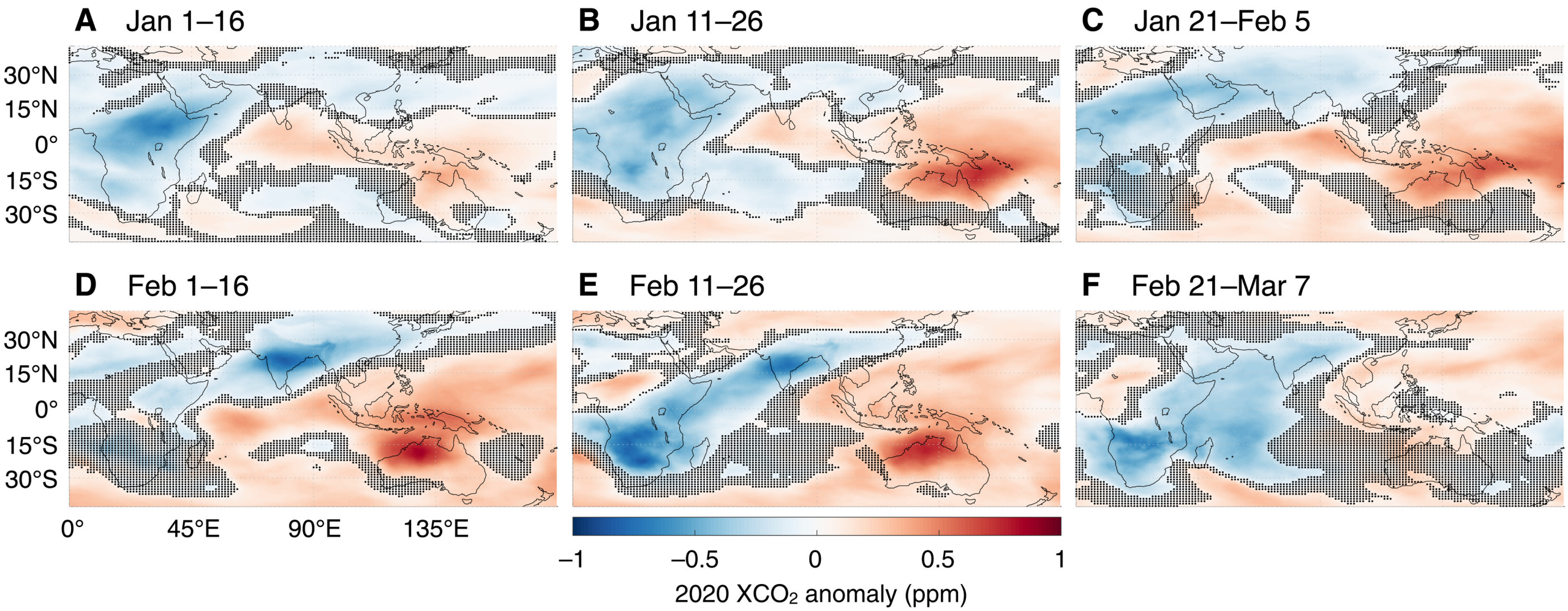
Progression of XCO_2 Anomalies in OCO-2-GEOS Data – COVID-19 Pandemic



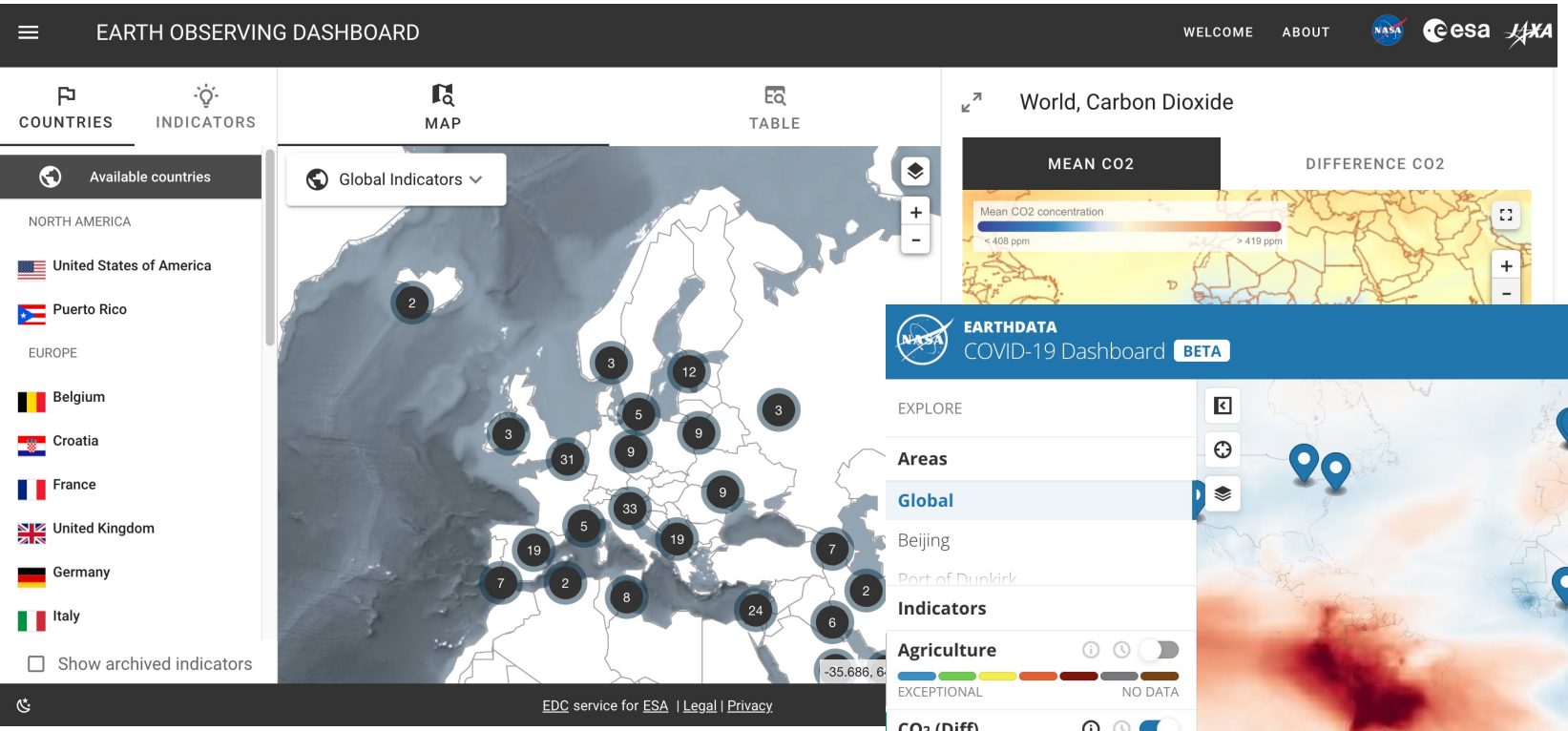


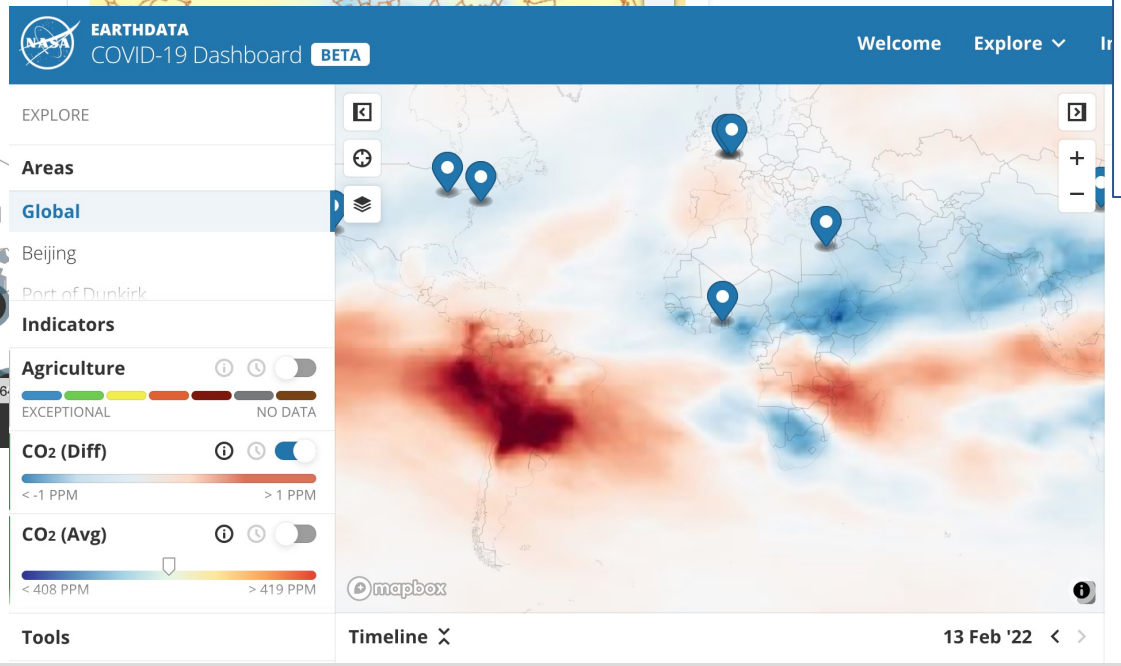
OCO-2-GEOS analyses were compared with **simulations using CarbonMonitor emissions**, demonstrating general consistency in NH winter-spring, and the growing influence of the land biosphere in summer

Progression of XCO_2 Anomalies in OCO-2-GEOS Data – Indian Ocean Dipole and Australian Fires



Data from OCO-2-GEOS monitoring system support multiple dashboards designed to make information on recent environmental changes more accessible





behavior in response to the spread of novel coronavirus, NASA satellites have observed associated changes in the environment.

Read more

There is no area of interest defined.

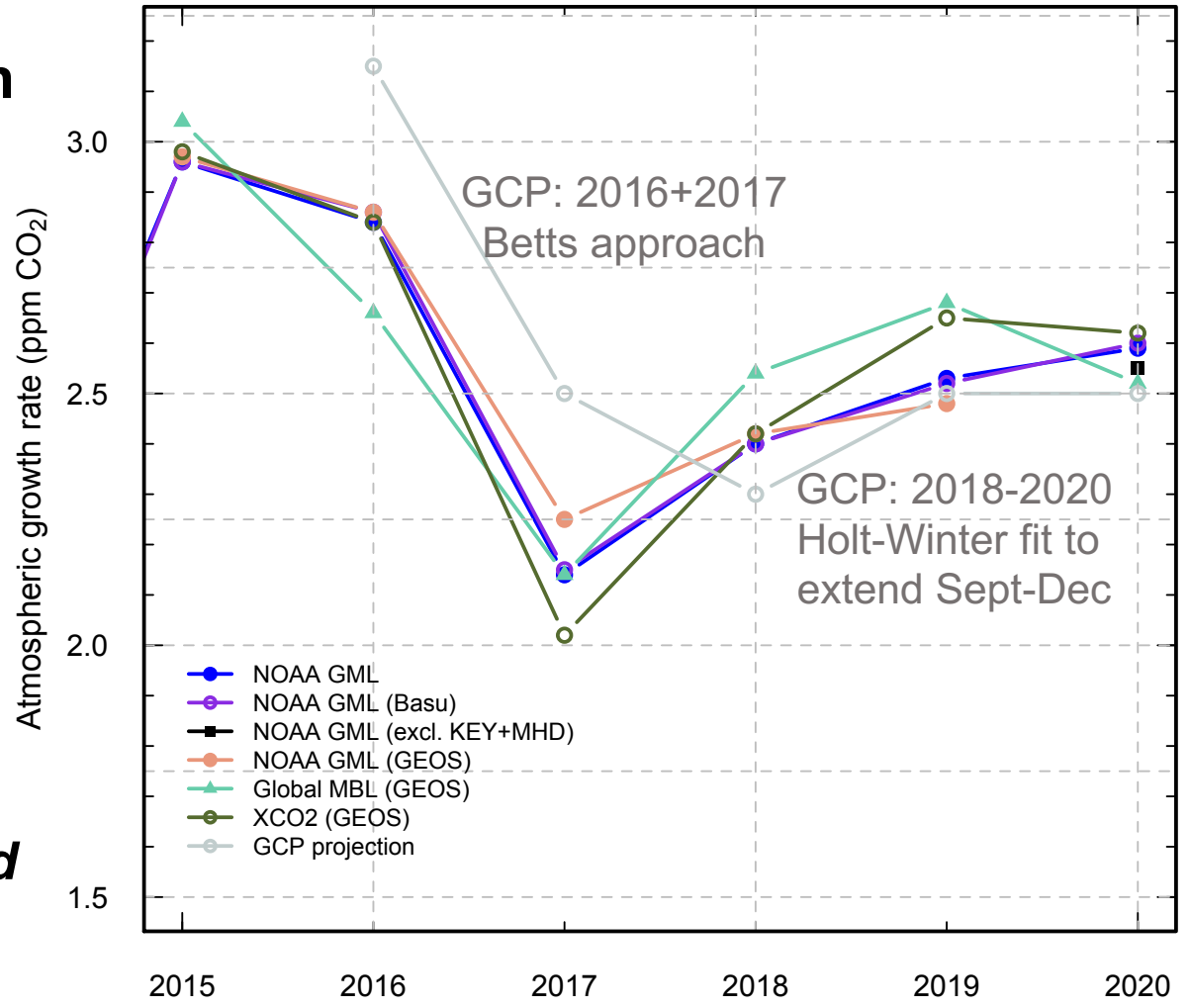
https://eodashboard.org/
https://www.earthdata.nasa.gov/covid19/
https://www.eodashboardhackathon.org/

Toward lower-latency atmospheric CO_2 growth rates

Agreement in growth rate estimates between ground networks and satellite-based methods

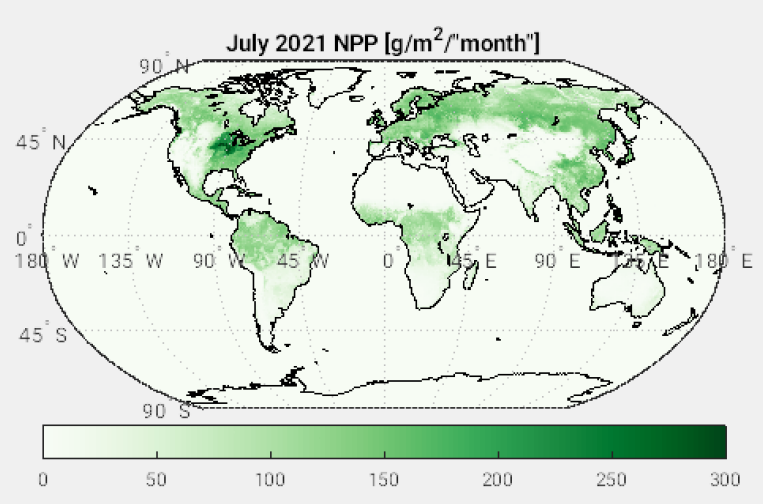
- Total XCO_2 is benchmark similar to NOAA MBL
- Agreement in IAV
- No systematic bias
- Approaches within the NOAA MBL uncertainty

OCO2-GEOS L3 products can support more rapid carbon budgeting efforts (2-3m latency)



Updates to Flux Components

Land



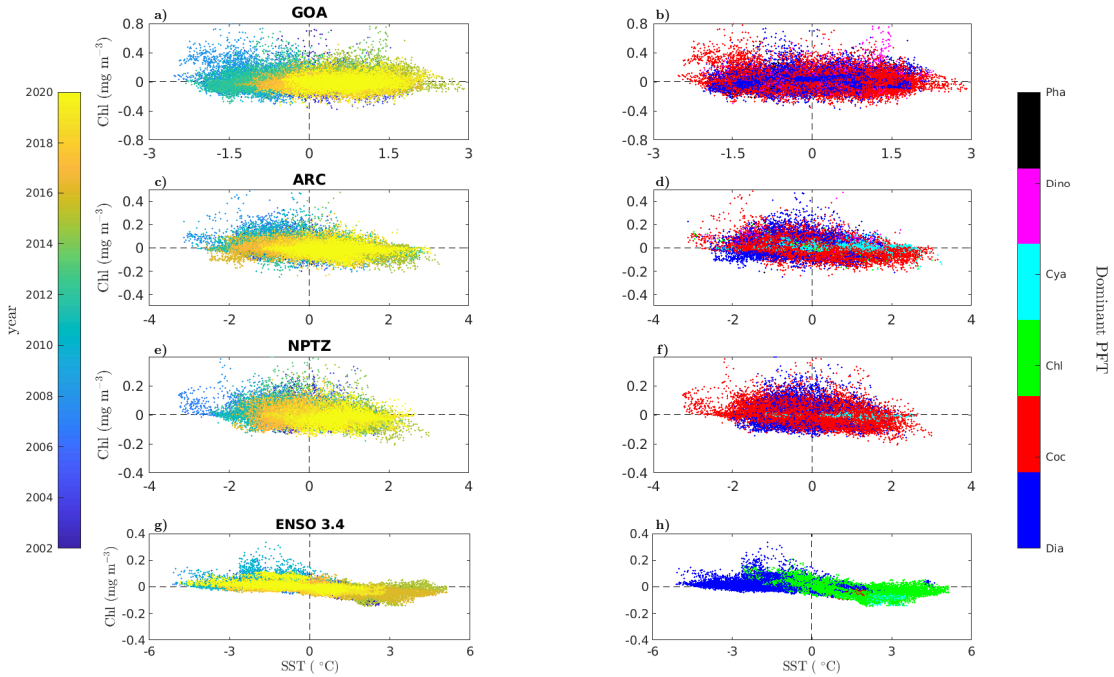
First look at new CASA-based land flux estimates:

- Ability to use MODIS reflectances for NDVI/fPAR (previously only AVHRR)
- Ability to run daily instead of monthly
- Finer spatial resolution

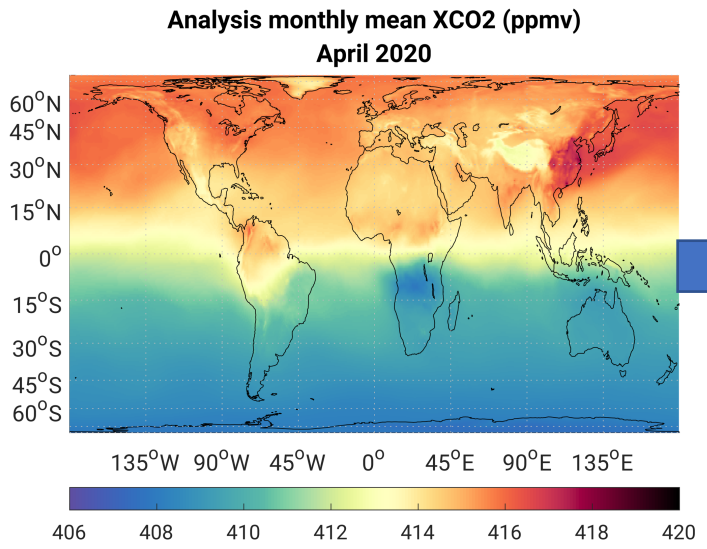
2001-2021 estimate completed, release pending analysis with atmospheric observations

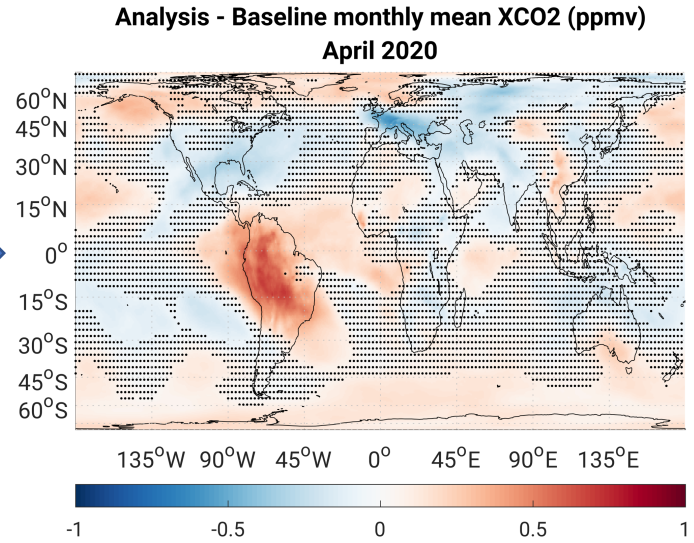
Ocean

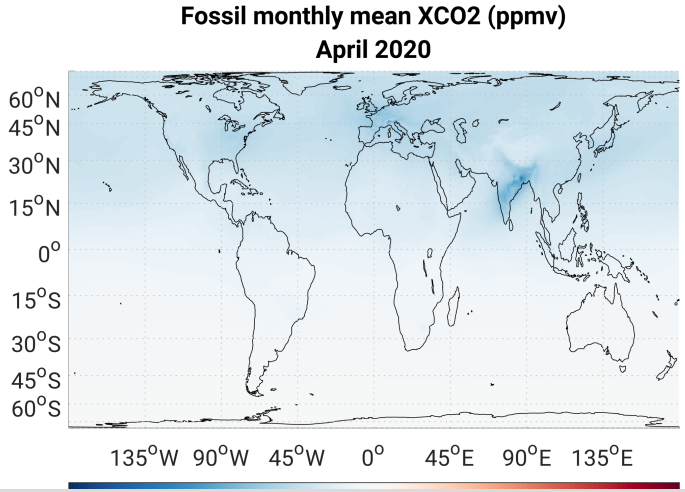
NOBM ocean fluxes updated through 2021.
NOBM used to examine changes in primary production, species composition, and carbon exports during heatwaves (Arteaga et al., in review)

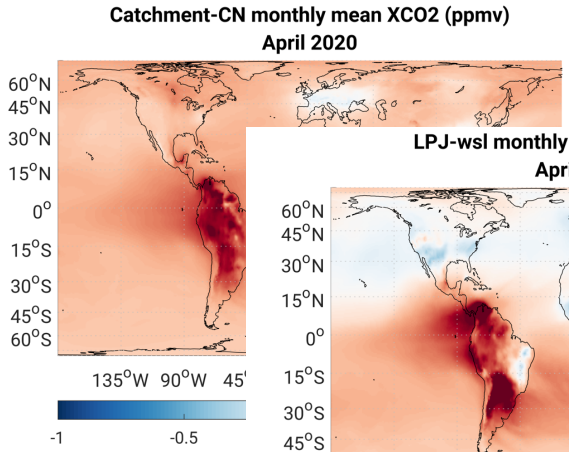


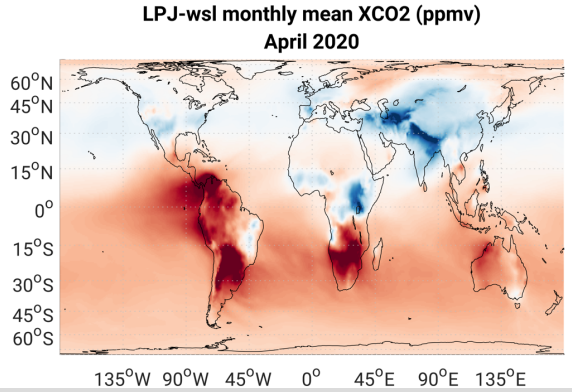
Future Direction: Example of low latency tagged tracers

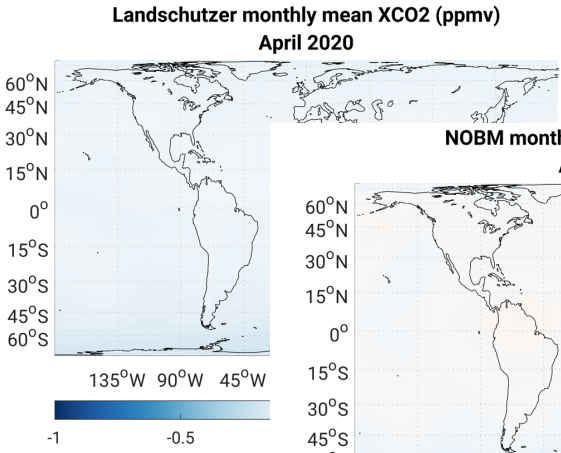


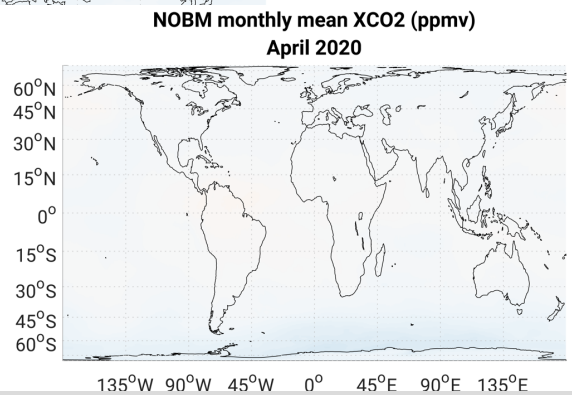






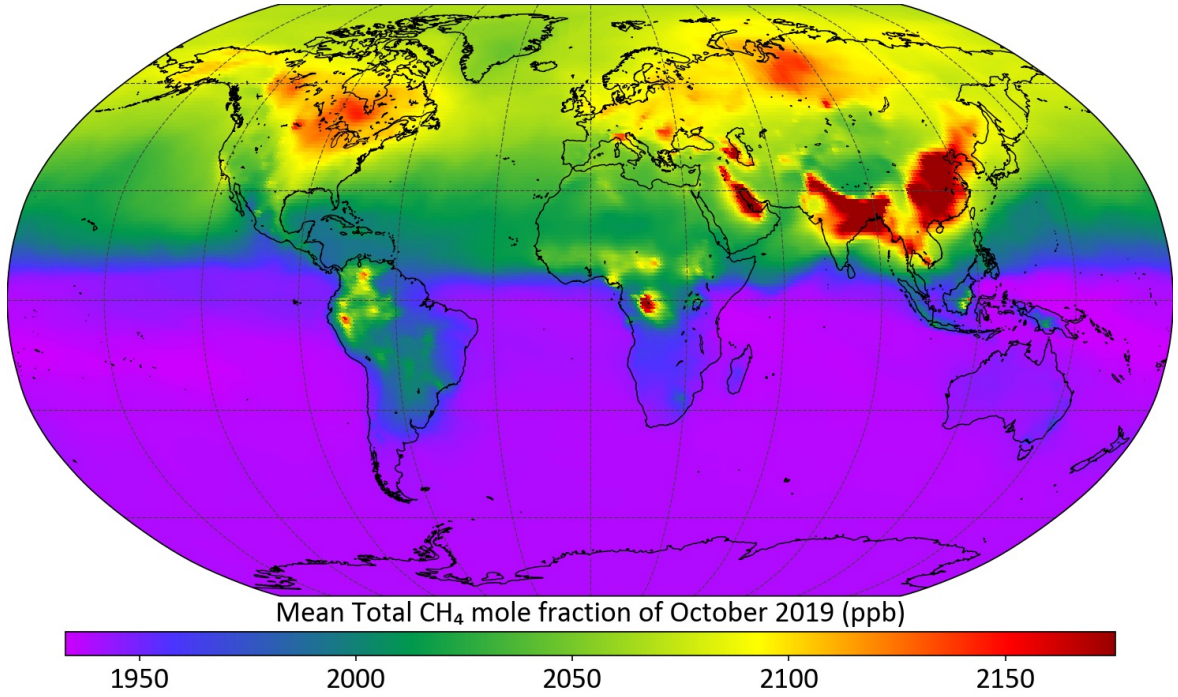






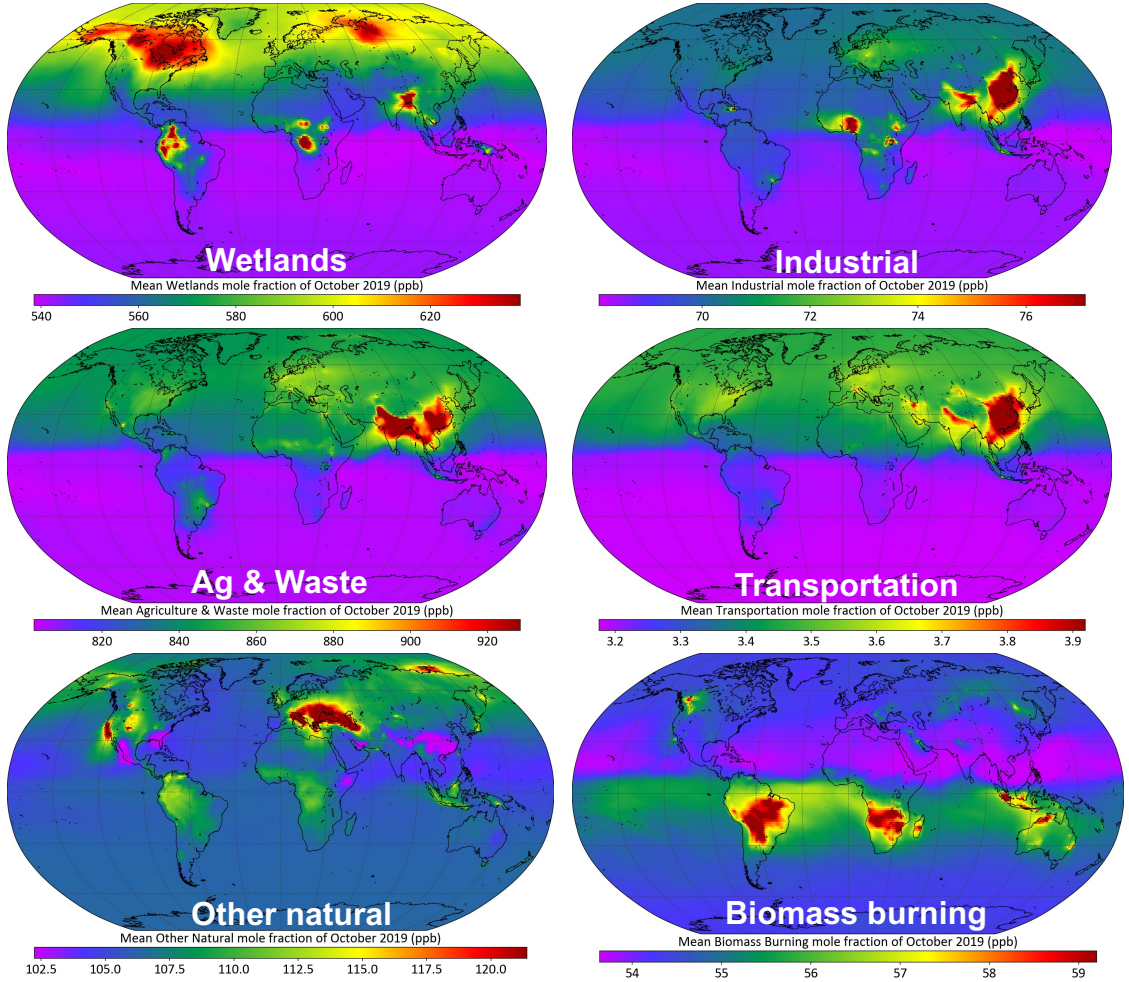
Future directions – quasi-operational CH_4 and CO_2 forecasts (leveraging MAP funding)

Monthly mean PBL CH_4 - 201910



Working to incorporate CO_2 and CH_4 into NASA's GEOS Composition Forecast (GEOS-CF) – will support field campaign planning, automated hot-spot detection, and satellite retrievals.

CH_4 tagged tracers



COP27 contributions – building toward a GHG themed hyperwall dashboard (more soon!)