U.S. GHG Center: Improving information on natural sources and sinks

Agency leads: Lesley Ott[1], Arlyn Andrews[2], Kenna Rewcastle[3], Anna Karion[4]

Contributions from: John Miller[2], Benjamin Poulter[4], Kevin Bowman[1], Colm Sweeney[2]

[1]NASA, [2]NOAA, [3]EPA, [4]NIST

Carbon Dioxide Budget
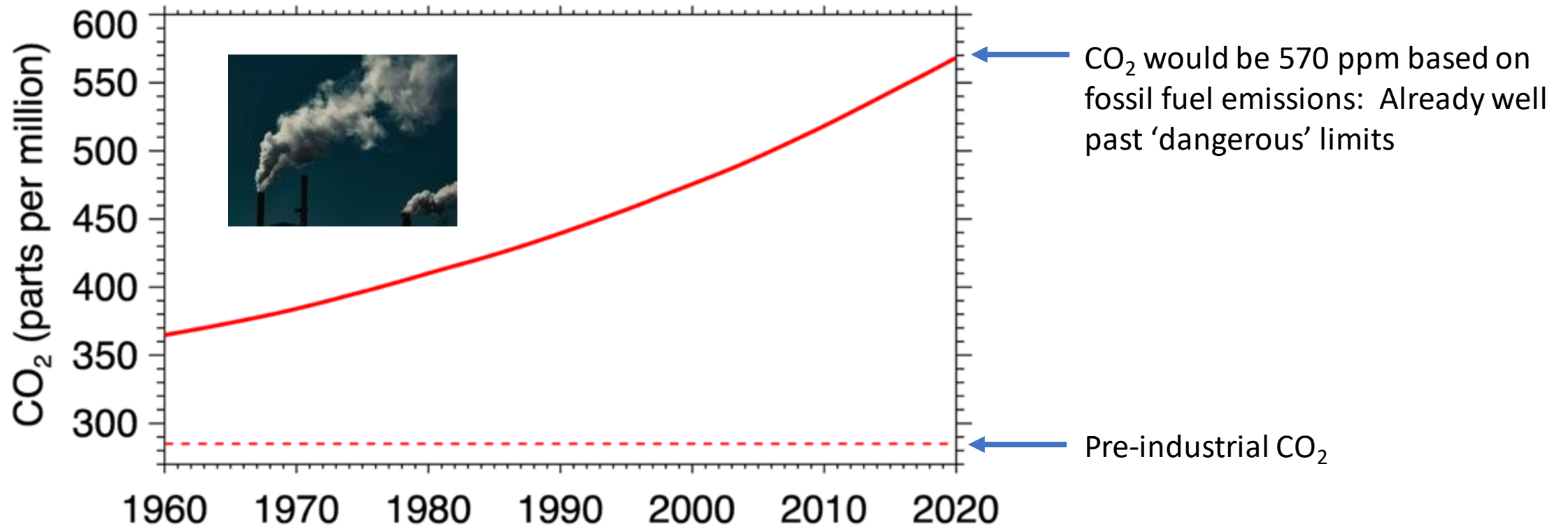
Atmospheric CO_2 would be much higher without land and ocean "sinks"

CO_2 would be 570 ppm based on fossil fuel emissions: Already well past 'dangerous' limits

Pre-industrial CO_2

Carbon Dioxide Budget

Atmospheric CO_2 would be much higher without land and ocean "sinks"

CO_2 would be 570 ppm based on fossil fuel emissions: Already well past 'dangerous' limits

Concentrations at 410 ppm
land and ocean sinks which absorb 50% of human emissions

Pre-industrial CO_2
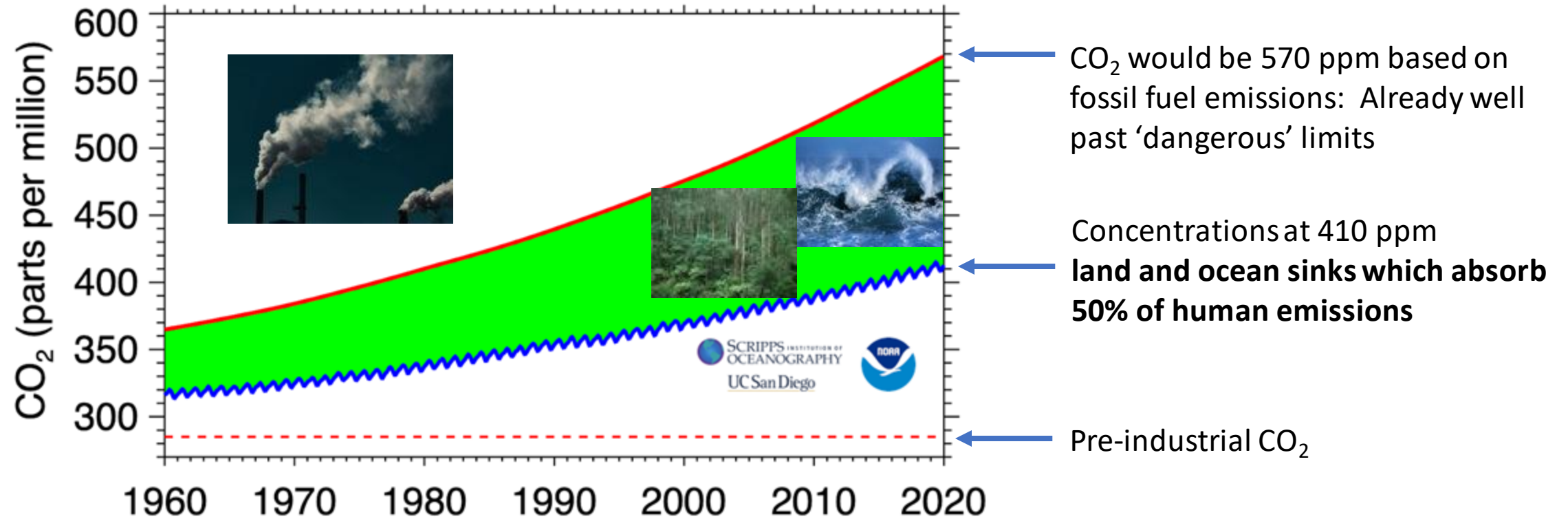
Global and US natural methane emissions are large

NOAA Global Average CH$_4$
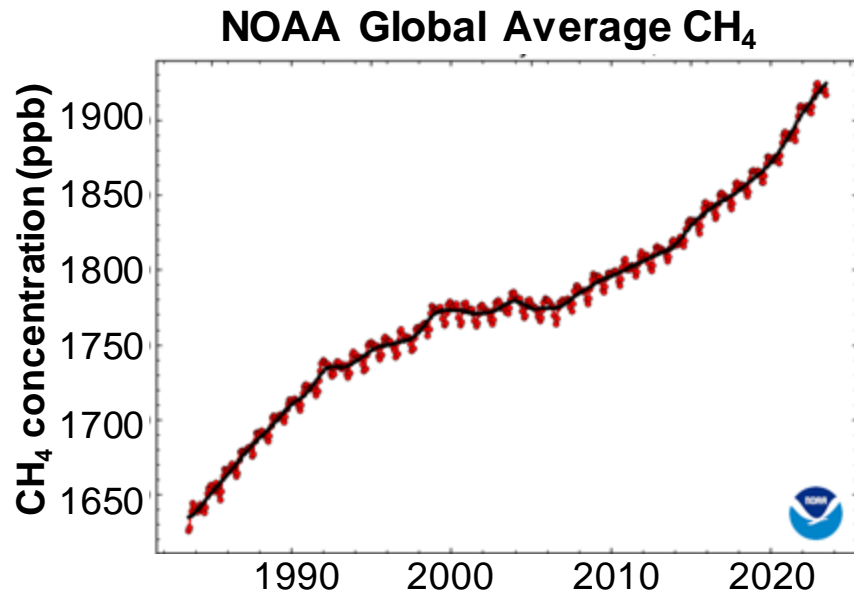
Global Methane Emissions (Tg/yr) (2008-2017)

- Other natural 21-50
- Fires 22-36
- Wetlands 159-200
- Oil & Gas 81-131
- Agriculture & Waste 207-240
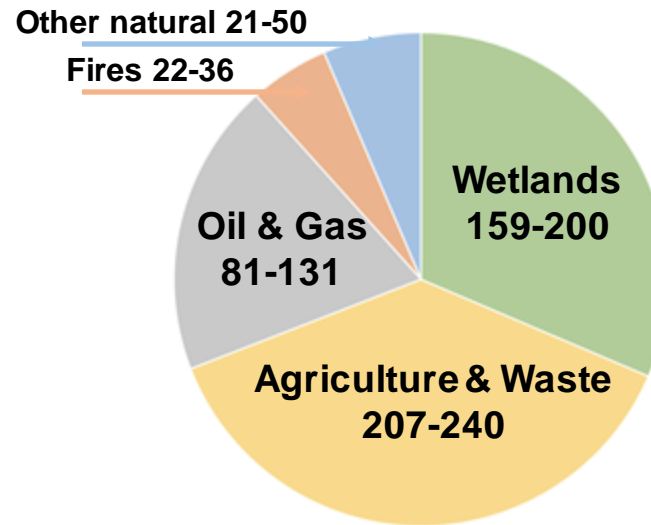
US Methane Emissions (2010-2019)

- Fires 0.2-0.4
- Other natural 4-9
- Wetlands 2.3-5.9
- Agriculture 9.1-9.7
- Waste 5.2-6.6
- Oil & Gas 10-17
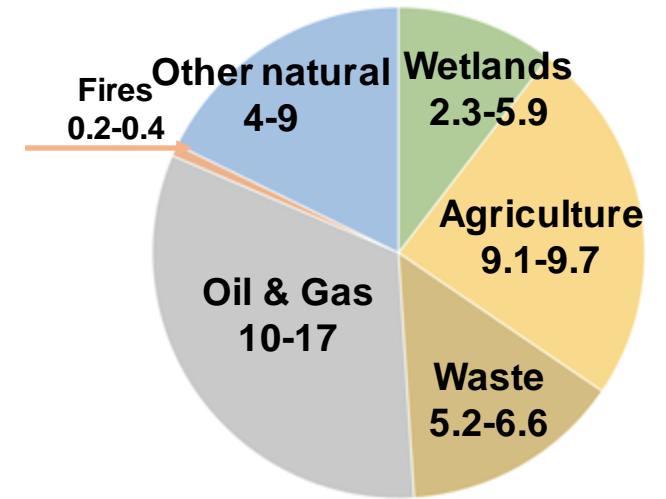
- The rapid rise in global CH$_4$ results from a complex mixture of natural and anthropogenic processes.
- CH$_4$ is removed from the atmosphere by atmospheric chemical reactions. These processes are not fully understood; they are controlled by climate variables and pollutant levels.

→ *Reducing uncertainty in global and US natural processes will better define mitigation targets.*

Climate change may undermine carbon sinks

MODIS visible imagery – Camp Fire, 2018   Soil moisture anomaly - USDA-NASA, 062021   Aerial imagery of coastal wetlands

Soil Moisture Anomaly

-70% -50% -30% -10% 0 10% 30% 50% 70%

Increases in fire frequency, severity, and length affect the ability of ecosystems to sequester CO_2
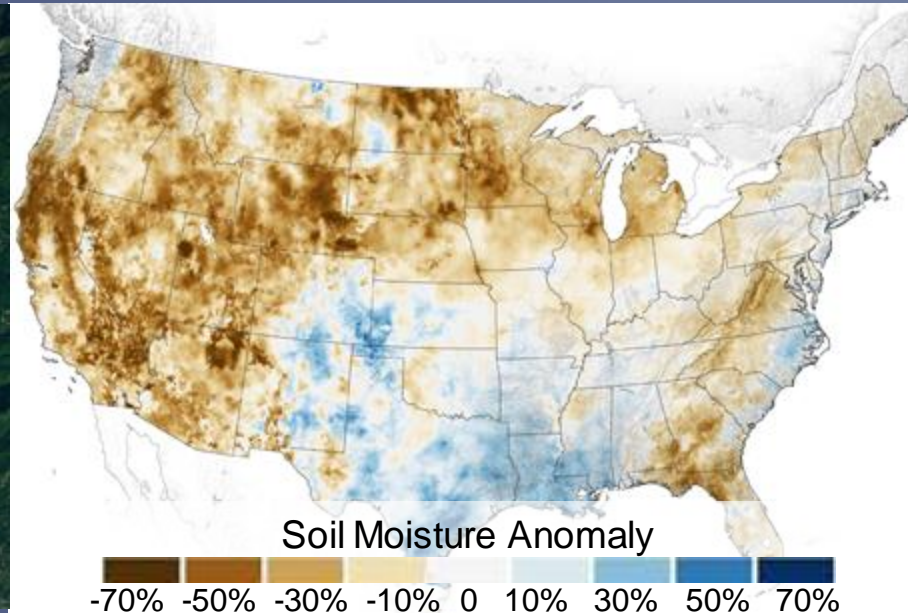
Changes in the frequency and severity of droughts affect the ability of ecosystems to sequester CO_2
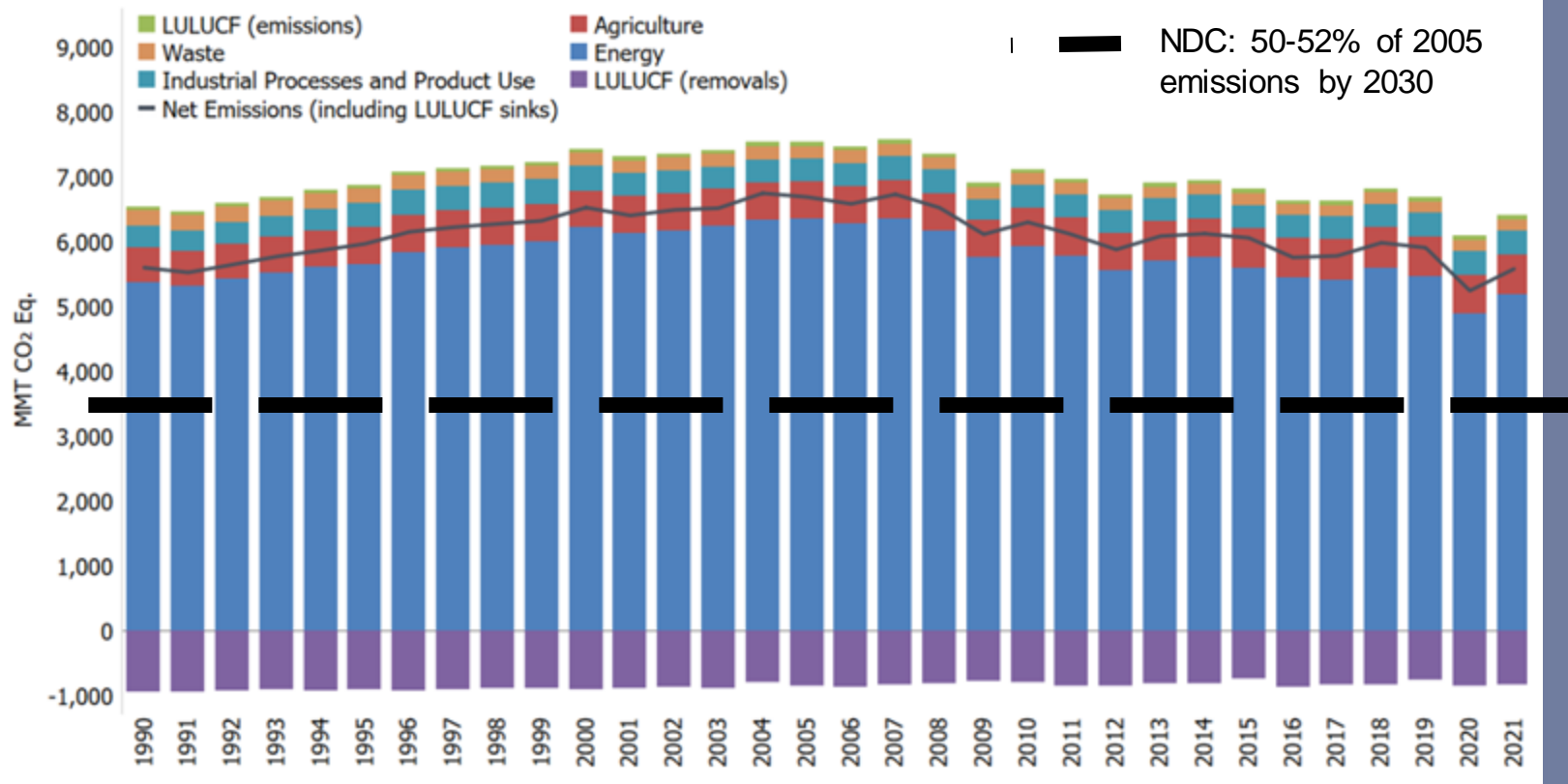
Sea level rise and tropical storms threaten the health of wetlands

Sources: NASA Earth Observatory, NOAA Fisheries

US GHG inventory estimates provide unique source/sink attribution

Figure ES-11: U.S. Greenhouse Gas Emissions and Sinks by IPCC Sector

- LULUCF offsets **~14% of total U.S. emissions** annually

- **Spatial and temporal variability** in flux estimates → improving accuracy is a priority

- Need **regularly-updated LULUCF activity data** that is **sensitive to mitigation measures** implemented in the sector

Source: EPA, 2023, *Inventory of U.S. GHG Emissions and Sinks 1990-2021*

Overview of planned GHG Center activities

GHG Center Focus on Natural Sources and Sinks

Improving and extending bottom-up estimates

Net Ecosystem CO$_2$ Exchange

kg CO$_2$ per 100 square m per month

-10 -5 0 5 10

Jun 2017
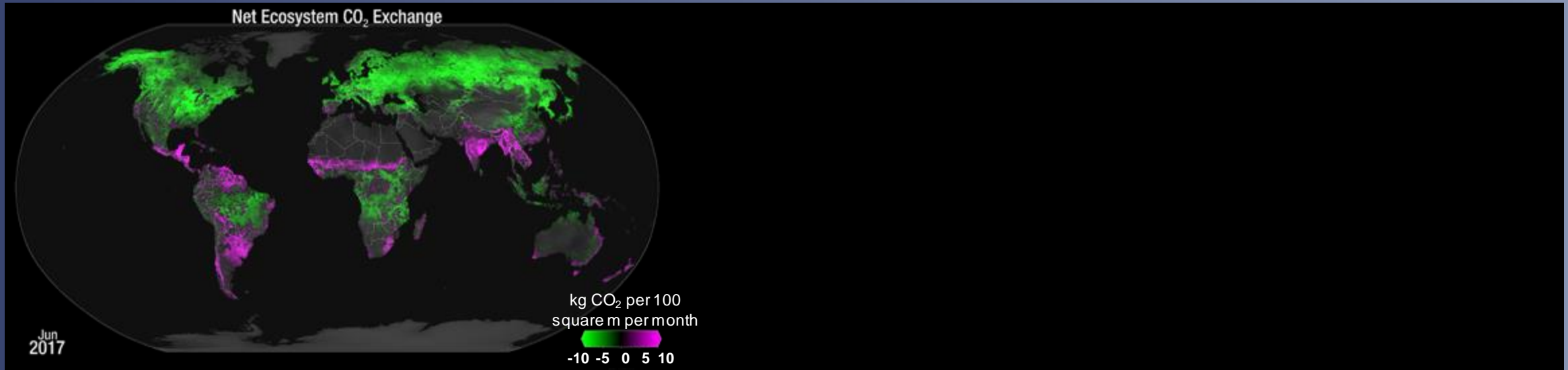
1. Improved delivery, quality, and resolution of natural source and sink estimates
- Routine delivery of land-atmosphere flux estimates lagging real time by a few months
- Implementation of open source cloud-based modeling tools
- Development of higher resolution approaches to better support needs for regional information
- Expanded dialogue on definitions of natural sources/sinks

GHG Center Focus on Natural Sources and Sinks

Improving and extending bottom-up estimates

Refinement with atmospheric data

Net Ecosystem CO_2 Exchange

kg CO_2 per 100 square m per month

-10 -5 0 5 10

Jun 2017
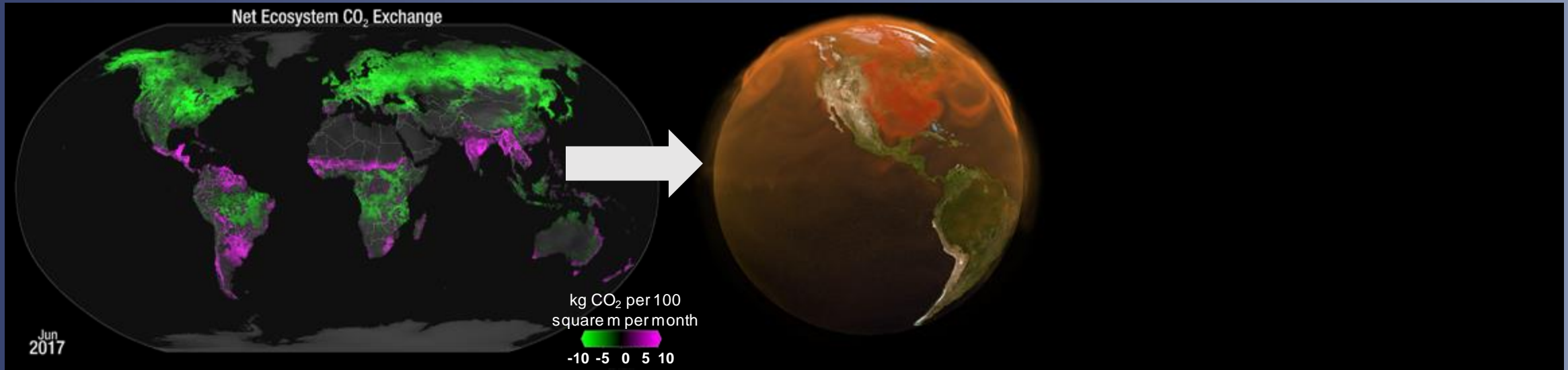
2. Monitoring and early warning of changes in sources and sinks
- Regular assimilation of GHG concentration data, delivery of information
- Detection and quantification of changes in emissions
- Enables regional modeling to further refine understanding of local sources/sinks
- Contributes to WMO's recently announced Global Greenhouse Gas Watch

GHG Center Focus on Natural Sources and Sinks

Improving and extending bottom-up estimates

Refinement with atmospheric data

Improved GHG budgets

3. Evaluation and refinement of source and sink estimates
- Comparison against independent estimates and budgets based on assimilation of atmospheric data
- Interagency coordination of results to provide consensus information and uncertainty
- Contribution to coordinated standards for model intercomparison and evaluation

GHG Center Focus on Natural Sources and Sinks: Workforce Development

Inaugural GHG Center Summer School hosted by CSU, summer 2024

- Develop future workforce to ensure sustainability of model-based products and evaluation tools
- Emphasis on helping prepare students with diverse backgrounds to support science needs of federal partners
- Open source lessons plans and training materials leverage investment in flexible data systems
- First summer school focuses on atmospheric 'top-down' methods