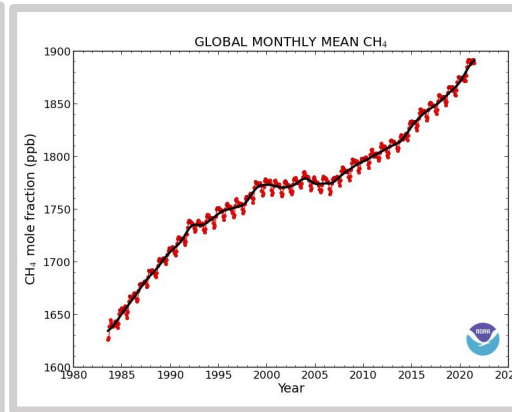
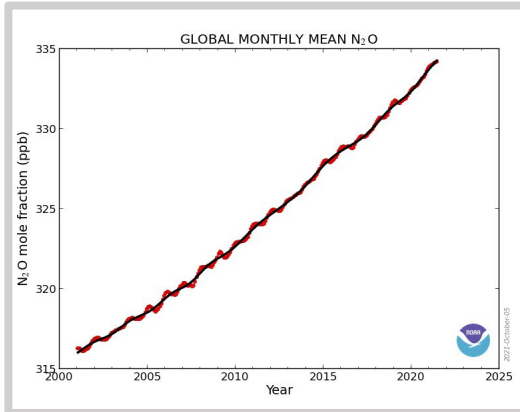
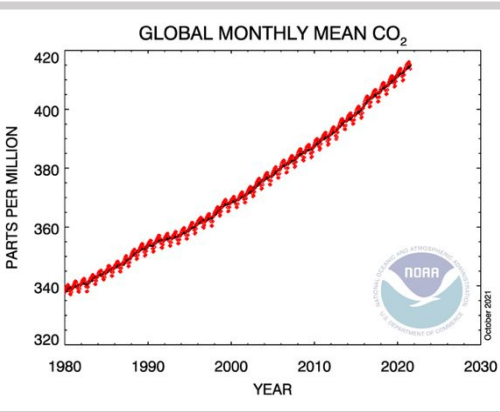


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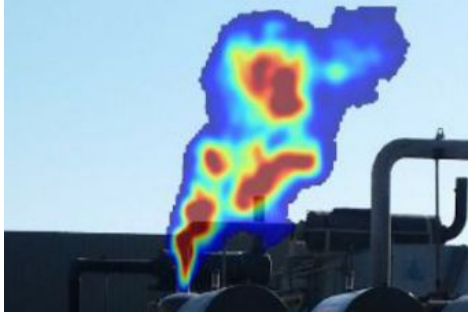
An Interagency Greenhouse Gas Information and Analysis System

Ben Poulter¹, Arlyn Andrews², Lori Bruhwiler², with Kevin Bowman³, Abhishek Chatterjee³, Dave Crisp³, Grant Domke⁴, George Hurtt⁵, David Lawrence⁶, John Miller², Douglas Morton¹, Lesley Ott¹, Sasha Reed⁷, Dave Schimel³, Gyami Shrestha⁸, Margaret Torn⁹, Chris Williams¹⁰, Lisamarie Windham-Myers⁷, John Worden³



*Presentation to Steering Committee on Earth
Sciences and Applications from Space Fall
Meeting 2021*

Aim: Integrate and expand existing interagency capabilities within a GHG observing system



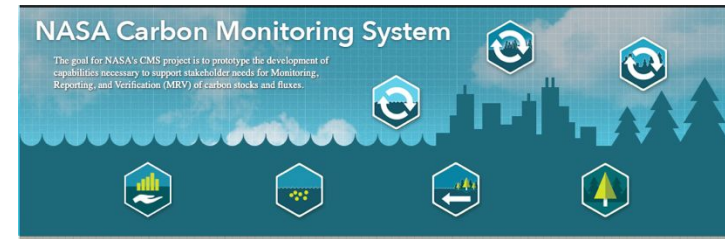
- Detection and attribution of climate-carbon feedbacks
 - *Strategic monitoring*; optimize and sustain observing networks
 - *Multi-scale data integration*; ground networks, aircraft, and space-based obs.
 - *Earth system perspective*; assess both anthropogenic and natural emissions
 - *Robust forecasts and projections*: seasonal-to-subseasonal to multi decadal
 - *Inform policy*; monitor efficacy of climate mitigation and CO₂ removal (CDR)
- Enhance National Greenhouse Gas Inventories (NGHGI)
 - *New technologies*; remote sensing of biomass and GHGs
 - *Advances in modeling*; spatially explicit gridded emissions and removals
 - *Lower latency activity data*; improved observations of emissions and removals
 - *Build global capacity*: 128 countries have no reported national inventory

USGCRP agencies are poised to integrate existing networks into a sustained and strategic greenhouse gas observing system

Two-decades of research laid groundwork for operational Interagency Greenhouse Gas Information System



The North American Carbon Program (NACP) is a USGCRP Interagency effort initiated in 2005 to track carbon stocks, emissions, and removals and to improve understanding of key processes and drivers.

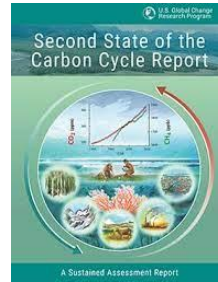
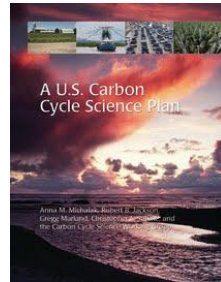


NASA responded to Congressional direction starting in 2012 to develop a prototype Carbon Monitoring System. They have engaged researchers from other Agencies via a competitive research process.

These [research efforts](#) have demonstrated new observational capabilities and data services that are ripe for transition to sustained operations:

- Improved mechanisms to support long-term planning and interagency coordination are needed (i.e., sustained and directed funding).
- A [continuum from research to sustained operations](#) should be maintained to ensure measurement compatibility over decades while allowing for innovation.
- Ongoing engagement with academic researchers and opportunities to develop public:private partnerships are crucial.

Sustained operations of GHG observations



- *There is no long-term plan in the United States to support monitoring of greenhouse gases and carbon stocks, or to transition to sustained operations*

- **The Status of the Global Climate Observing System 2021: *The GCOS Status Report*, (GCOS-240), WMO, Geneva.**

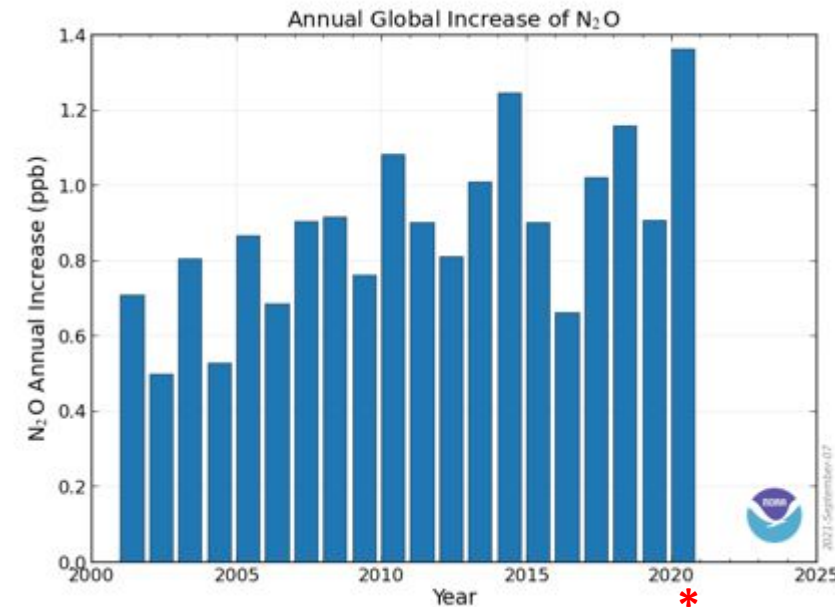
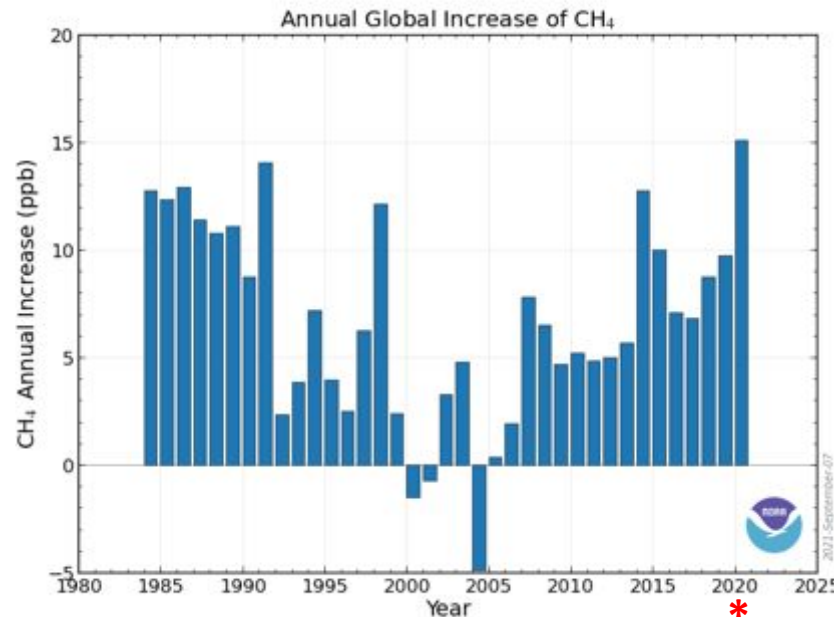
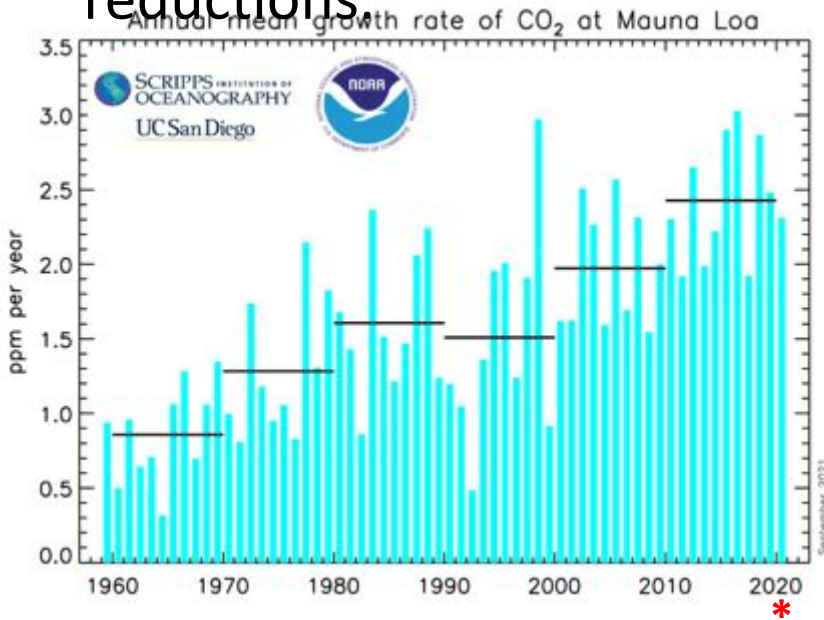
- Ensuring the sustainability of observations,
- Addressing gaps in the system,
- Ensuring permanent, free and unrestricted access to the observations,
- Increasing support for policies driven by the UNFCCC Paris Agreement.

- **NACP National Science Implementation Plan (NSIP)**

- Establishment of an interagency National Carbon Monitoring System
- Strategic investments to further develop and expand in situ measurements to address critical gaps in the current carbon observing system
- Guidance from the science community to design an integrated and sustained carbon observing system
- Routinely updated, high resolution, national and global gridded estimates of anthropogenic emissions and ecosystem fluxes for CO₂ and CH₄.
- New coordinated intensive measurement activities to address key uncertainties identified in SOCCR-2
- Continued and expanded coordination with international partners (e.g., ICOS, Copernicus)

The COVID-19 Earth system 'experiment'

- Despite a 5-7% drop in CO₂ emissions, growth rates of atmospheric greenhouse gases (CO₂, CH₄ and N₂O) increased rapidly in 2020^{1,2}.
- ***Immediate need for integrated system to contextualize natural variability and carbon-climate feedbacks to*** enable monitoring, reporting, and verification of emission reductions.

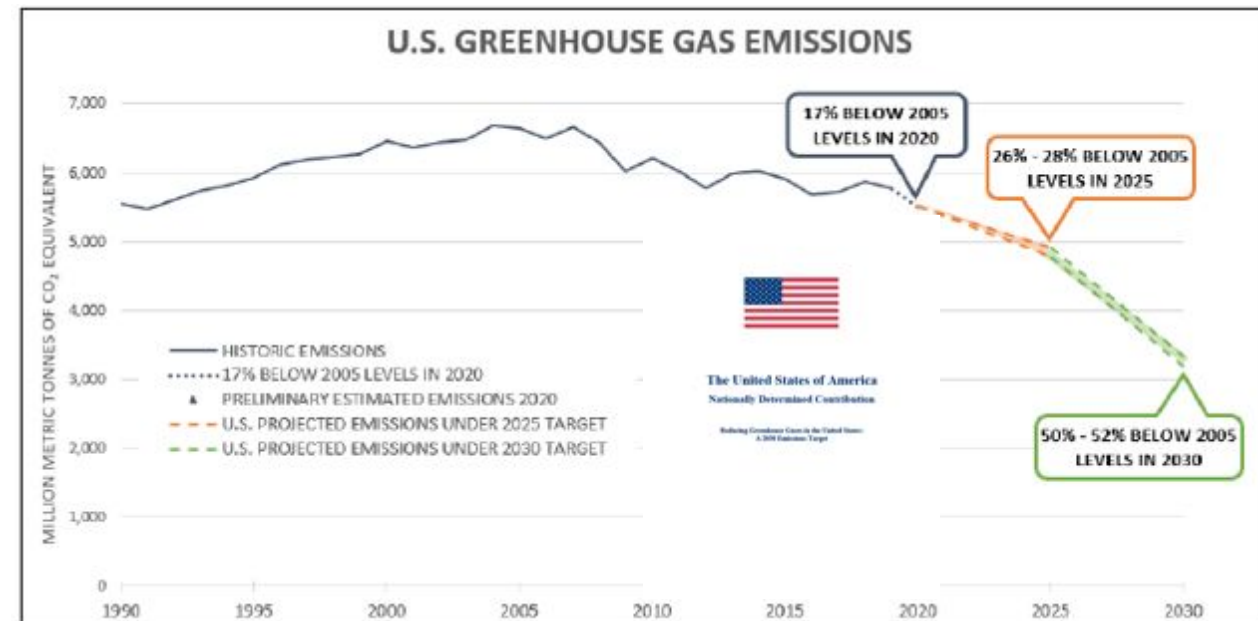
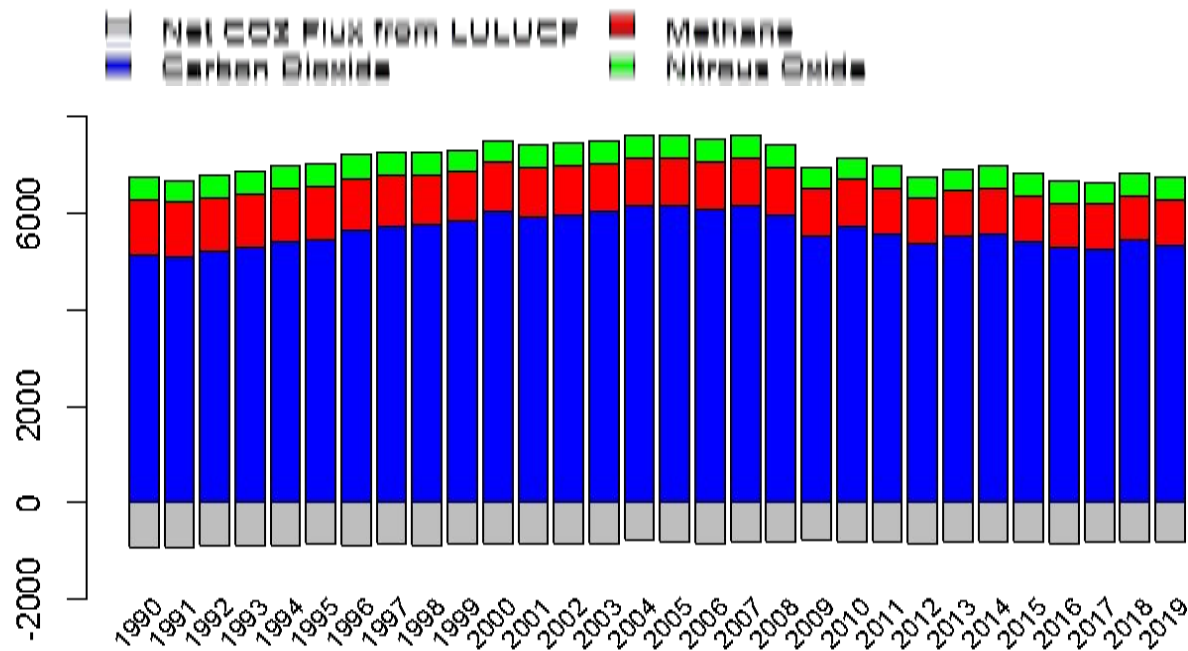


¹Laughner et al., PNAS (2021)

²Weir et al., Science Advances (2021)

Policy Basis: Observing needs to inform the Paris Agreement

- US Government Nationally Determined Contribution (NDC) aims for 50% reduction of GHGs by 2030¹ & Global Methane Pledge will reduce CH₄ emissions by 30% by 2030²
- The Global Stocktake requires an accurate summary of emissions and removals consistent with Article 4.1 of the Paris Agreement aiming for net zero emissions

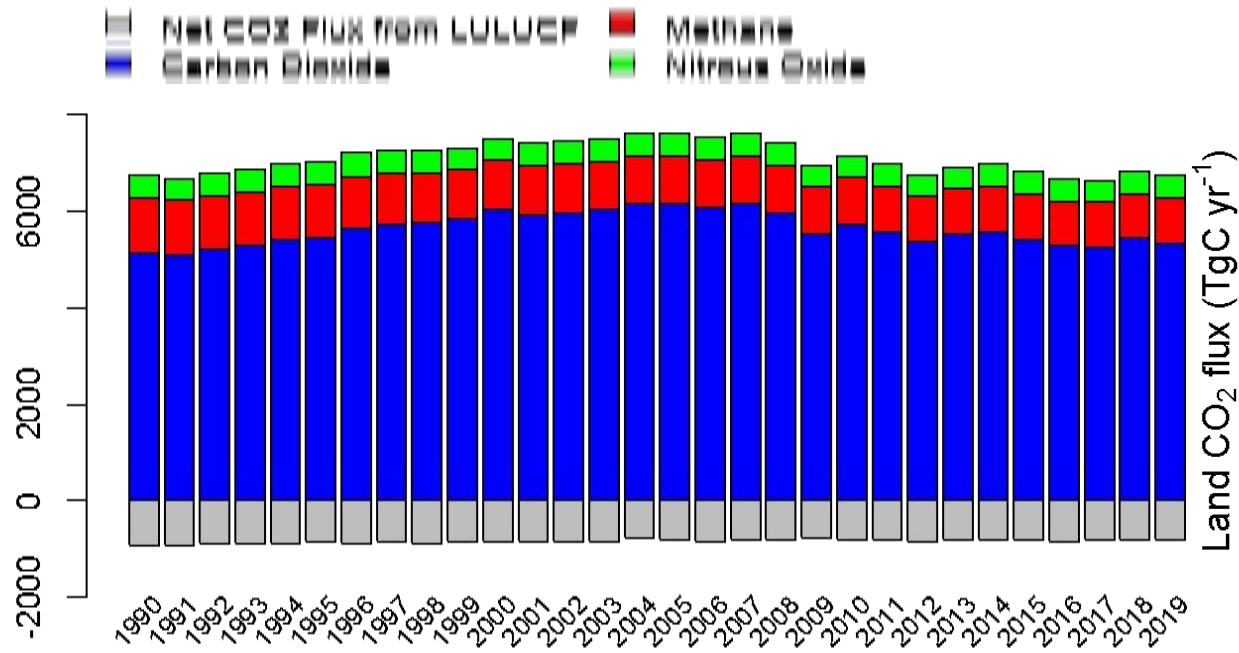


¹From 2005 levels

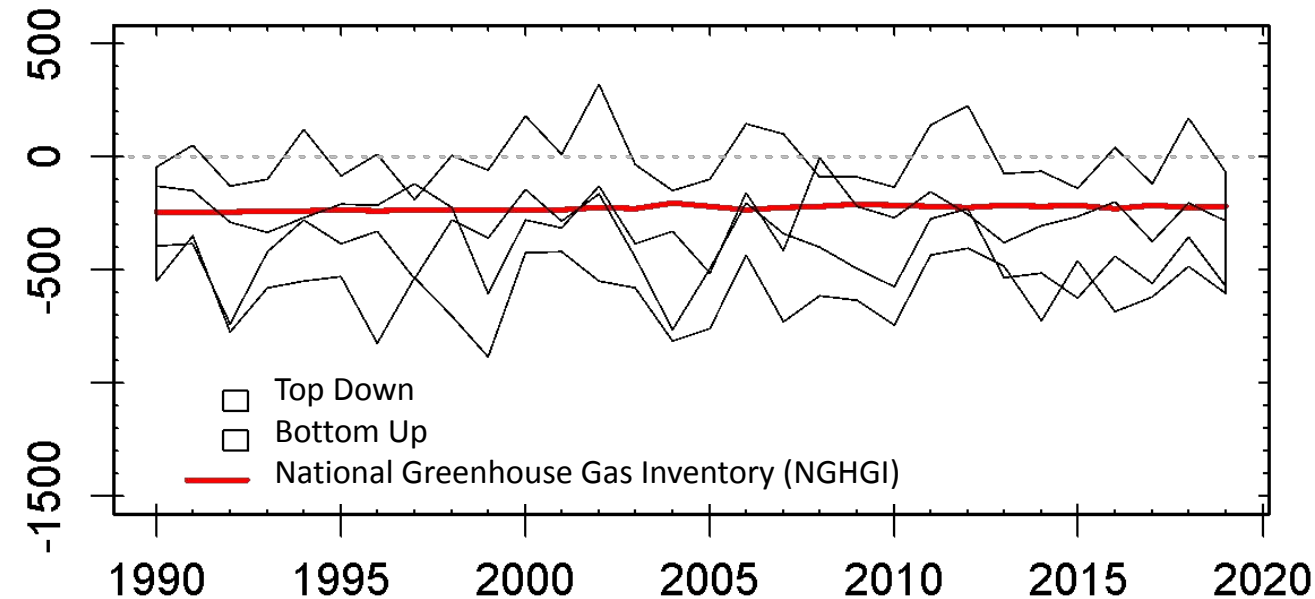
²From 2020 levels

The Global Stocktake will require coordinated and integrated GHG observations

- Land and oceans remove about half of CO₂ emissions and large year-to-year variability is not included in UNFCCC National Inventory Reports.
- Ground, air, and spaceborne GHG observation networks integrated within data assimilation systems can provide needed framework for MRV.



Comparing USA land fluxes with inversions, process models, and the NGHGI



Timeline for formation of Interagency Greenhouse Gas Information and Analysis System

Domestic

2008/2009: GHGIS Workshop recommendation

April 2017: OSTP task force recommendation for Greenhouse Gas Observations and Analysis Working Group (GGOAWG)

January 2021: US rejoins Paris Agreement

March 2021: NACP public comment on National Science Implementation Plan

April 2021: NASA Earth System Observatory

May 2021: OSTP to USGCRP 'science acceleration' public letter

June 2021: CCIWG recognizes interagency operational GHG workstream

International

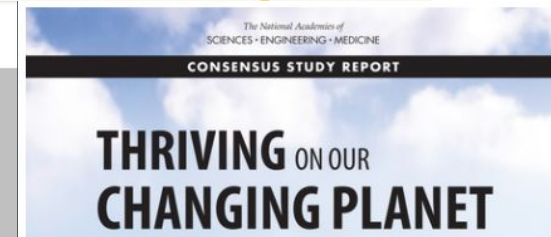
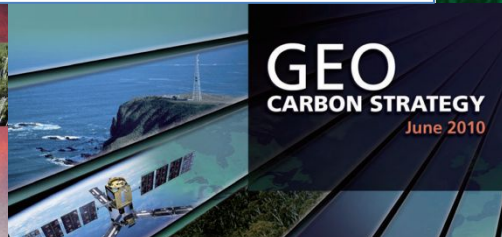
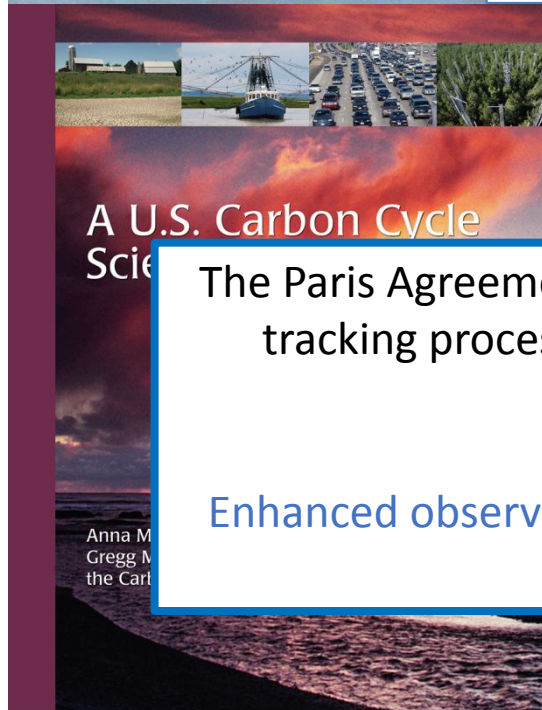
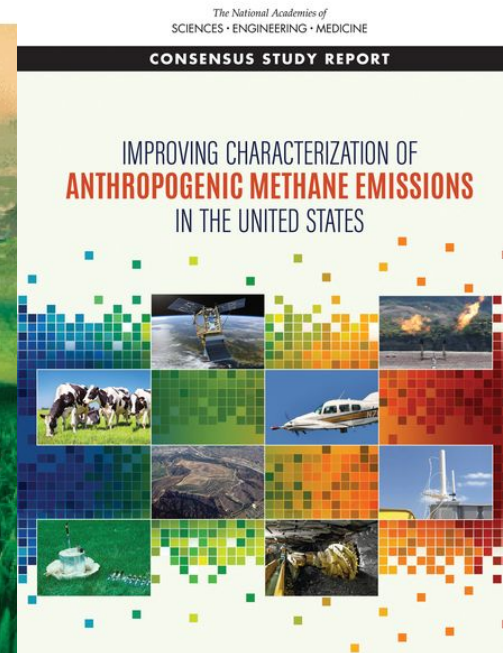
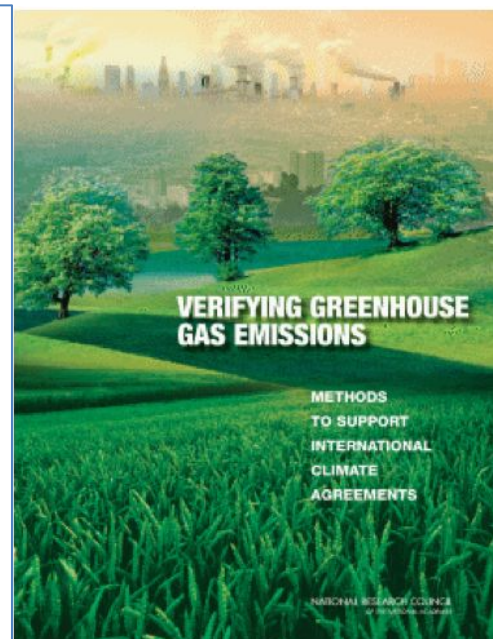
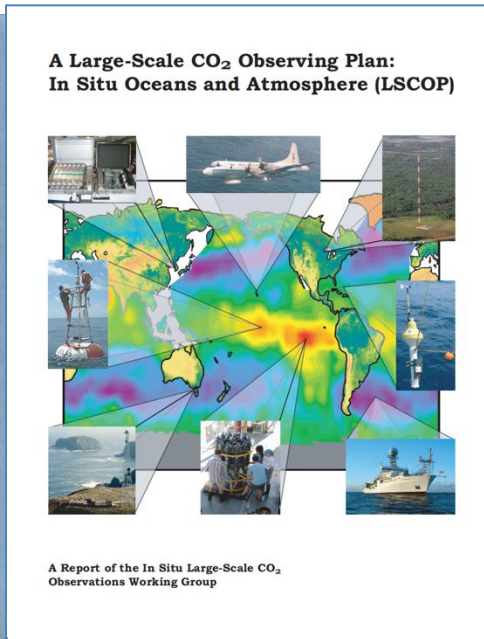
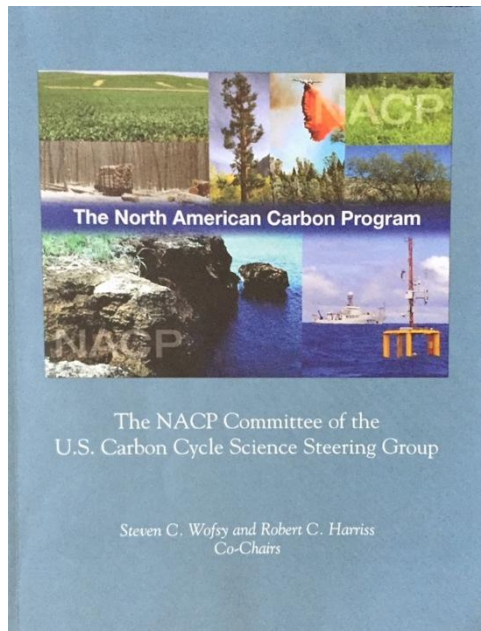
2016: Integrated Global Greenhouse Gas Information System (IG3IS), urban focus

2020-ongoing: CEOS Global Stocktake GHG and AFOLU activities

January 2021: EU Prototype system for a Copernicus CO₂ service (CAMS) CoCO2 kick off (CO₂M, MERLIN)

March 2021: UNEP establishes International Methane Emission Observatory

August 2021: IPCC WGI releases 6th Assessment Report



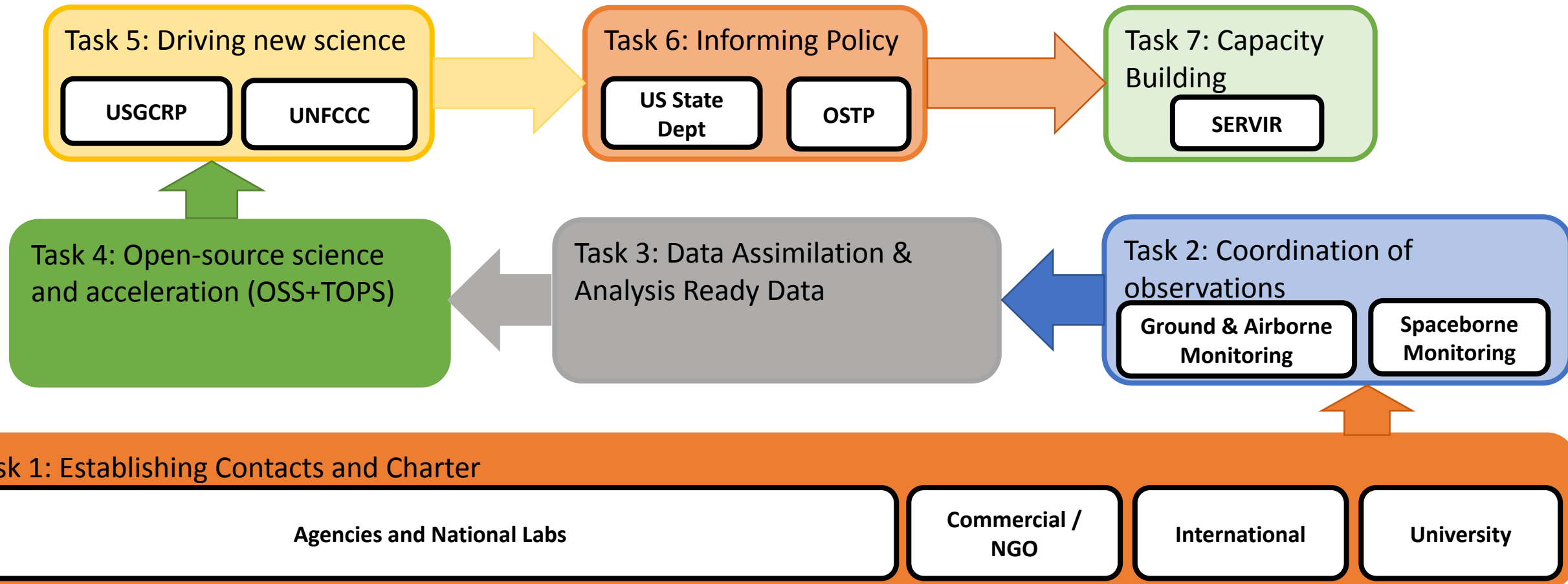
The Paris Agreement doesn't fundamentally change the existing, well-documented requirements for tracking processes responsible for greenhouse gas emissions and removals. It could provide a mandate for implementation and sustained operations.

Enhanced observations to support/improve the IPCC process provide the foundation for supporting the Global Stocktakes.



Framework for an Interagency GHG Information and Analysis System

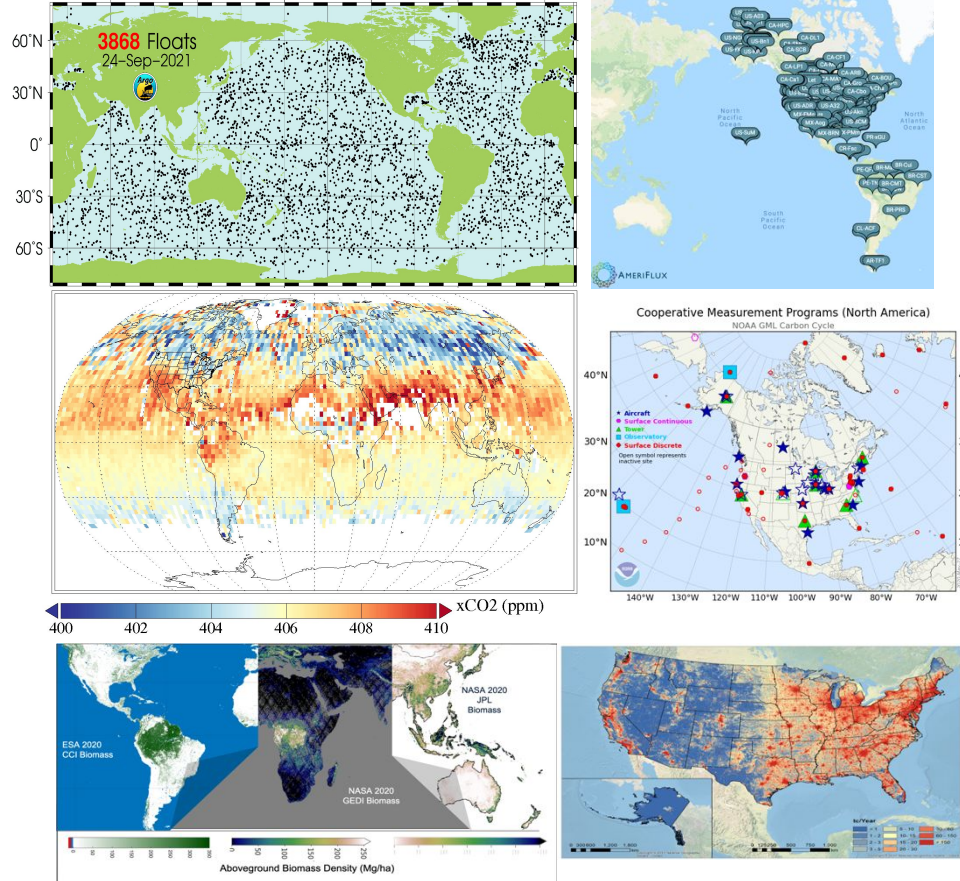
- Many of the components necessary for an interagency GHG information system exist and a mandate is needed to initiate integration



Expanding and sustaining strategic observing networks, enabling low-latency science

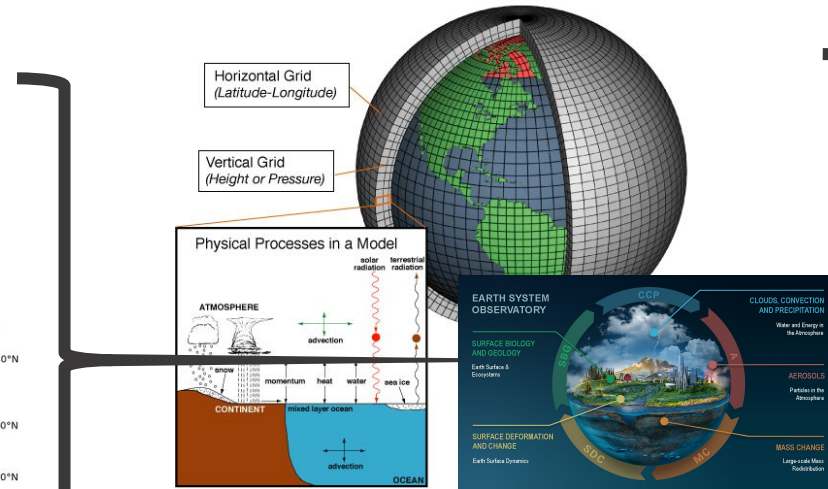
Observations

[e.g., atmospheric CO₂ + other GHGs, ocean carbon, terrestrial biomass, etc.]



Modeling & Data Assimilation

[GEOS, CarbonTracker, CLM, SOCAT, CMS-Flux]

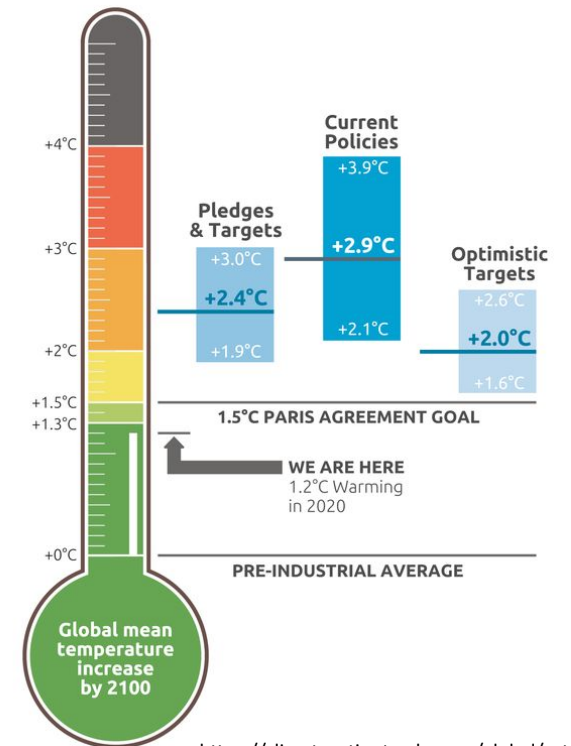


Open Source Science

[EIS, MAAP,]

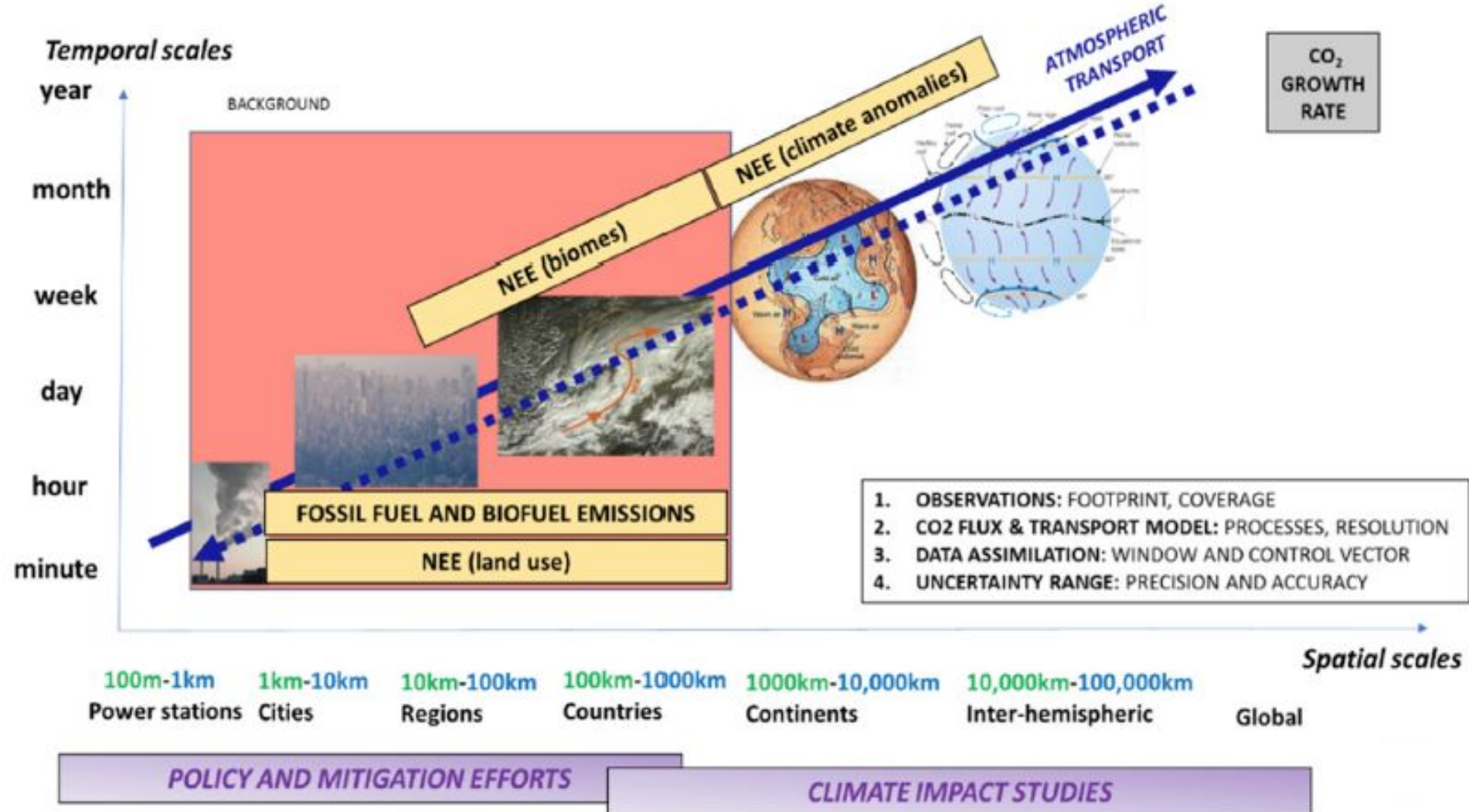


Accelerated and Actionable Science [GISS Model-E, IAMs, NDCs, IPCC, NCA]



<https://climateactiontracker.org/global/cat-the-rmometer/>

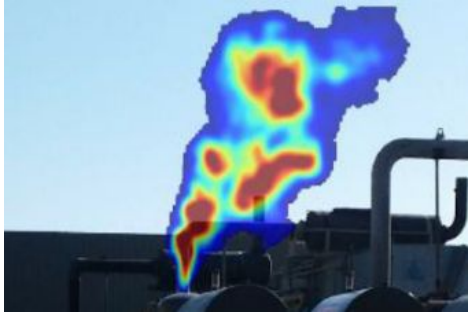
Informing stakeholder needs across multiple time and space scales



Near and long-term actions

Action	
Near term 2021-2022	Socialize and develop concept • AGU Town Hall (CCIWG, ObsIWG, CAMS) • AMS presentation • Invest in National Academies consensus study (2022)
	Develop more detailed plan and budgets • Infrastructure needs (sites, isotopes, aircore, aircraft) • Continuity of space-based measurements • Modeling needs • Organizational and communications structure
	Pilot study • Demonstrate low-latency and forecasting capabilities
	<i>Integration with IG3IS, ClimateTrace, CarbonMapper, Emissions Information System, NASA Earth System Observatory (ESO)</i>
Longer-term 2023-2028	Implementation of observation and modeling strategy w/ Tiered budgets
	Coordination with Copernicus Atmospheric Monitoring Service and IMEO
	Operational readiness for climate mitigation and future climate assessments

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Backup

Interagency and International Context

- The [US Global Change Research Program \(USGCRP\)](#) coordinates research across 13 federal agencies
 - *Thirteen Agencies, One Vision: Empower the Nation with Global Change Science*
 - Congressionally Mandated
 - US Carbon Cycle Science Program, Interagency Groups
- The [US Group on Earth Observations \(USGEO\)](#) coordinates Federal Agencies' civil Earth observations activities.
 - Subcommittee under the White House National Science and Technology Council's (NSTC) Committee on the Environment (CE).
 - Coordinates participation in the international [Group on Earth Observations \(GEO\)](#), an international voluntary partnership in which the United States is a member and leader
- The [Global Climate Observing System \(GCOS\)](#) aims to provide systematic observations to support the UNFCCC. Related WMO efforts include [Global Atmosphere Watch](#) and [Integrated Global Greenhouse Gas Information System \(IG3IS\)](#).

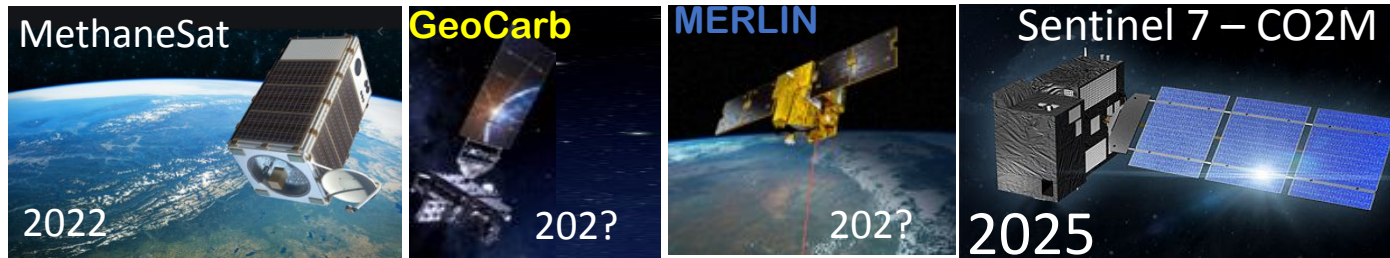


International Atmospheric Carbon Satellite Measurement Capabilities

NEAR-IR: Present



Near-IR: Coming soon



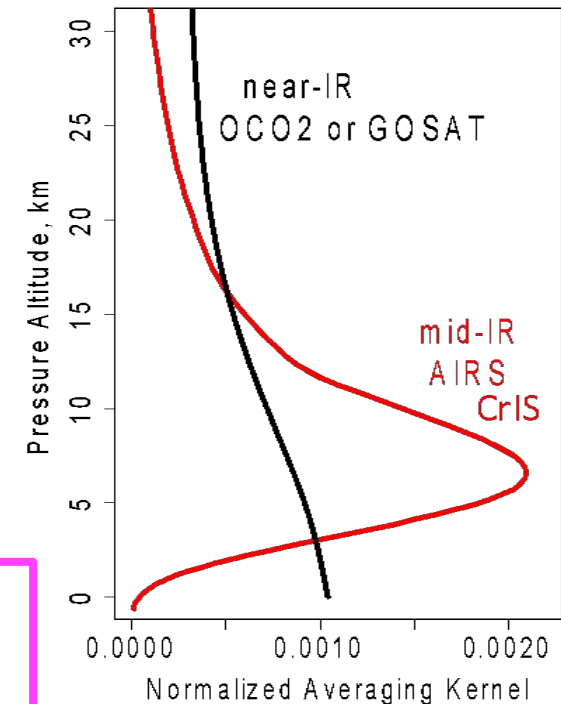
Thermal-IR: Measurements of Opportunity



Combined thermal-IR and near-IR satellite measurements theoretically enable separation of boundary layer versus free-troposphere signals with rigorous [data assimilation](#) techniques.

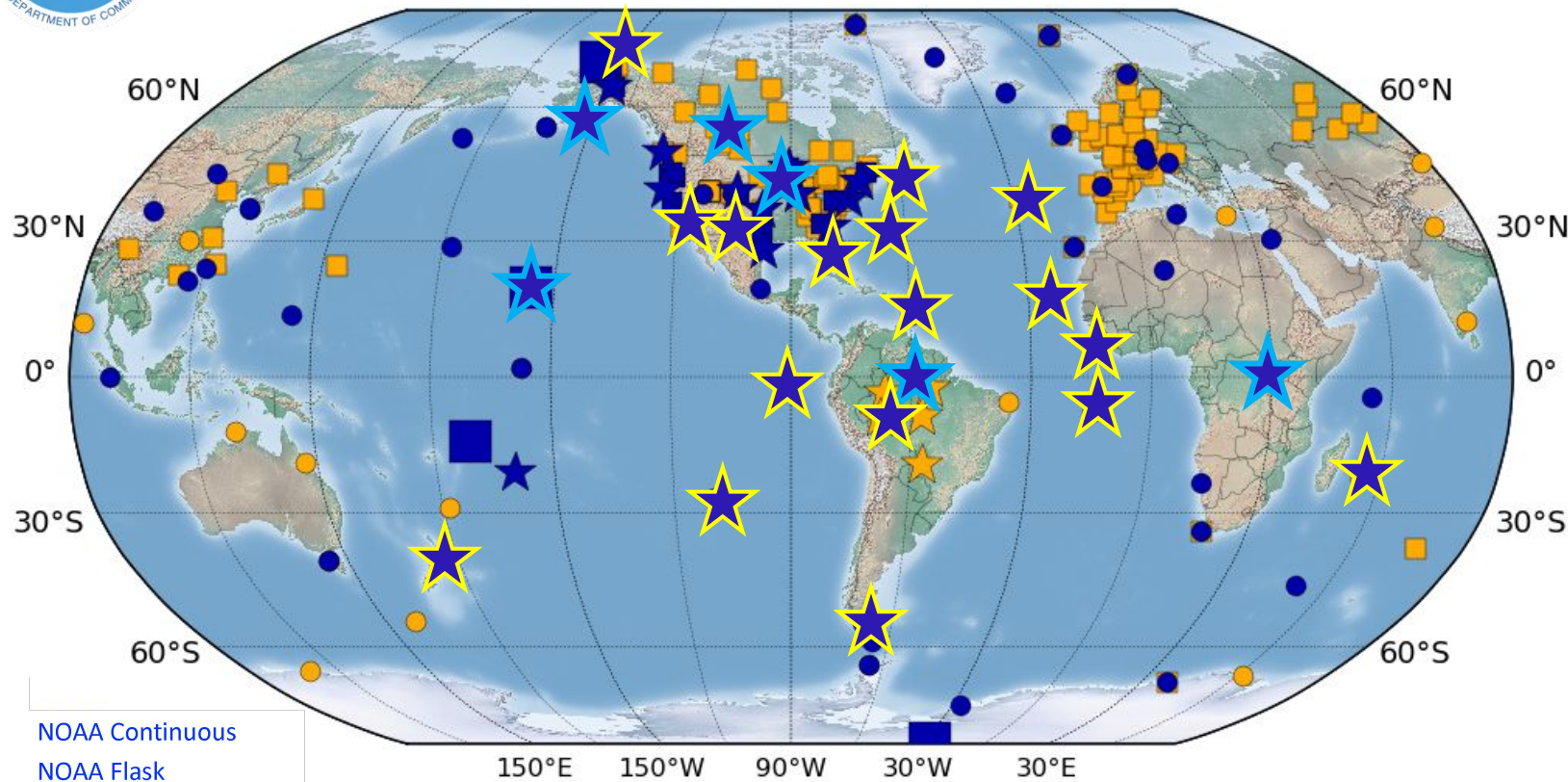
Sufficiently dense, well-calibrated, [in situ vertical profile data](#) are [urgently needed](#) to reliably detect and [correct systematic biases](#) in retrievals so that data from current and future satellite sensors can be confidently combined.

The US lacks a long-term strategy for satellite greenhouse gases monitoring. A NASA/NOAA plan for sustained atmospheric GHG measurements is needed.

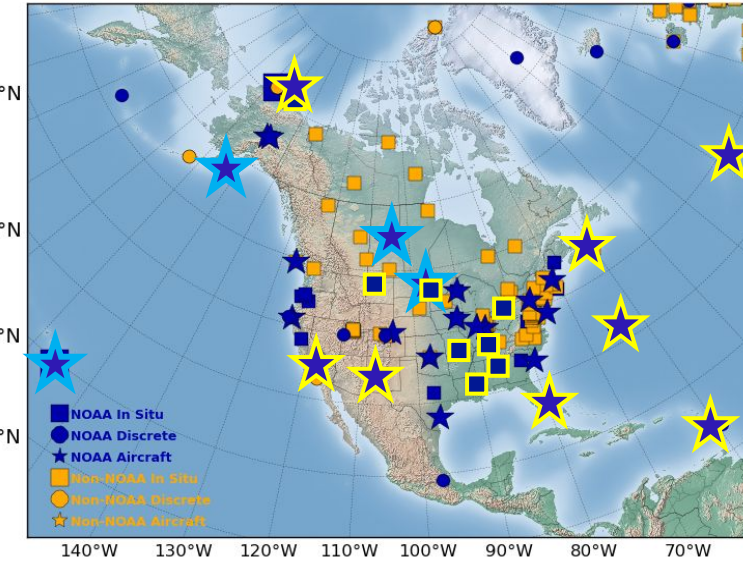




GGGRN: Restoration and Expansion



NOAA Continuous
NOAA Flask
NOAA Aircraft
Non-NOAA Continuous
Non-NOAA Flask
Non-NOAA Aircraft



Proposed Enhancements in NOAA's FY22 budget:

- 20 new Aircraft sites
- 8 new tall tower sites



NOAA GHG Measurements on
Boeing/Alaska Airlines
ecoDemonstrator

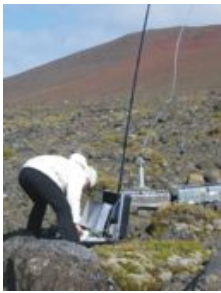
Transformative Opportunity: Commercial aircraft GHG measurements are “shovel ready”:

- Unprecedented 4-D resolution
- Identify and correct biases in satellite datasets

Towards an International Integrated Greenhouse Gas Observing System



FUTURE



NOAA GGGRN

Note: Not a comprehensive depiction of all current measurement programs!

Interagency GHG system would complement the Copernicus Atmospheric Monitoring Service (CAMS)

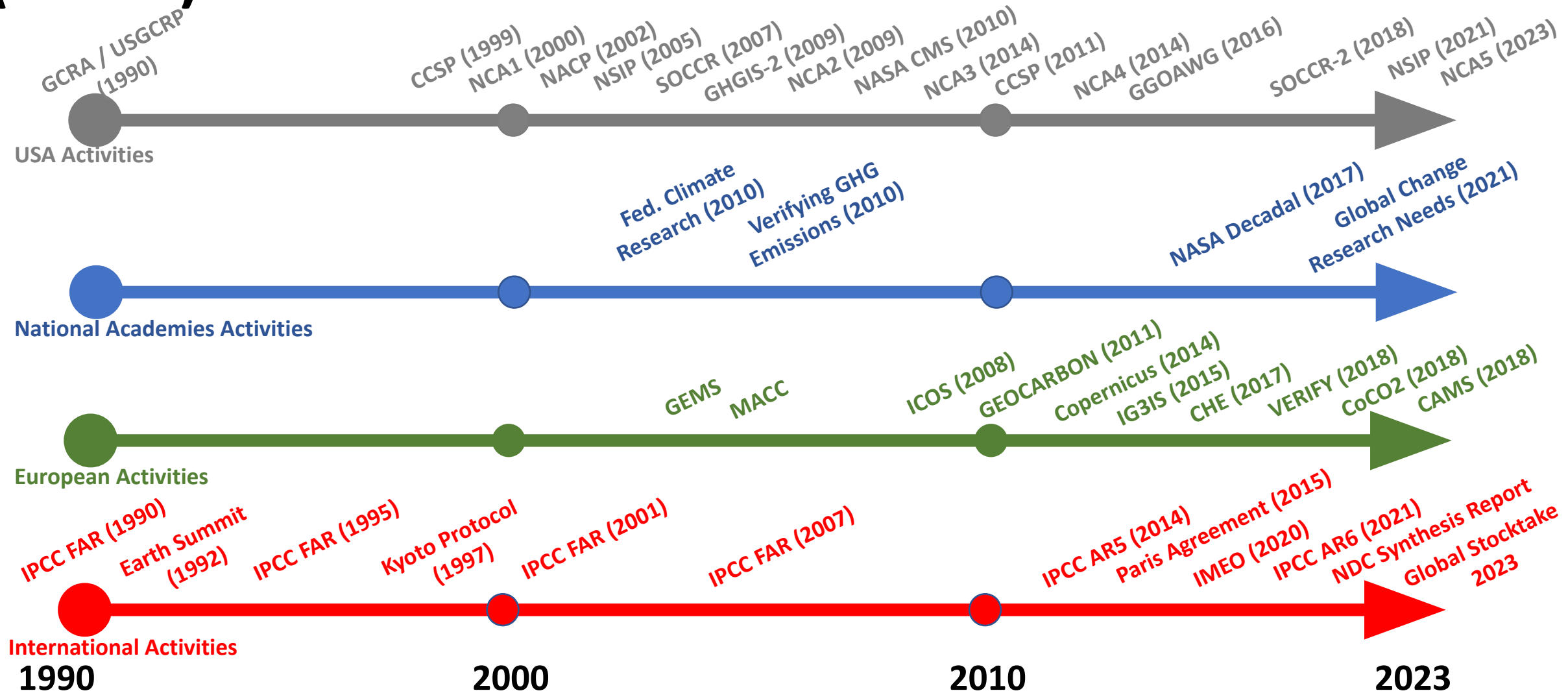


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 - nasa.gov image of Earth
- Slide 2 and 13 (photos):
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