CEOS Plenary Side Event

National Aeronautics and Space Administration

NASA

EXPLORE EARTH

Carbon Cycle and Applications: NASA's Perspectives and Contributions

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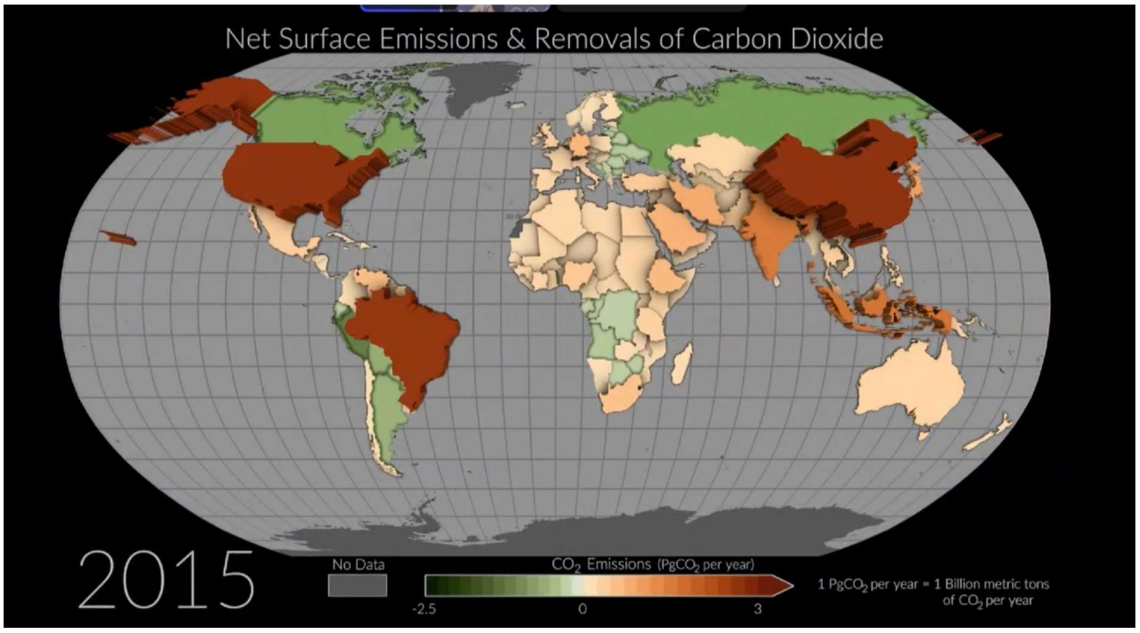
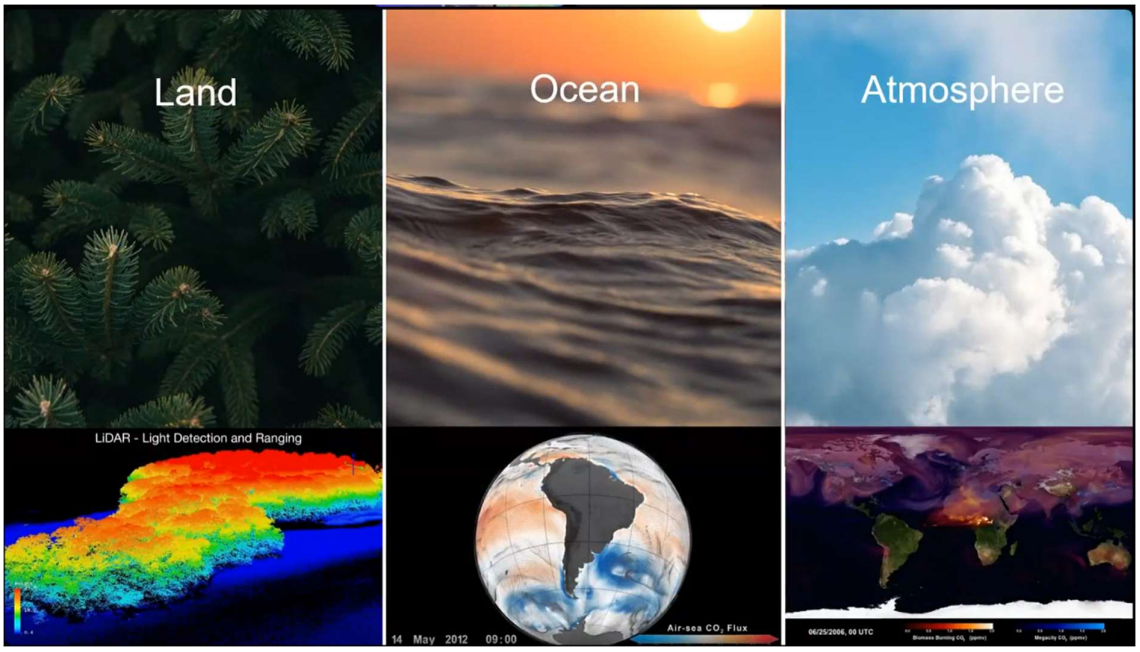
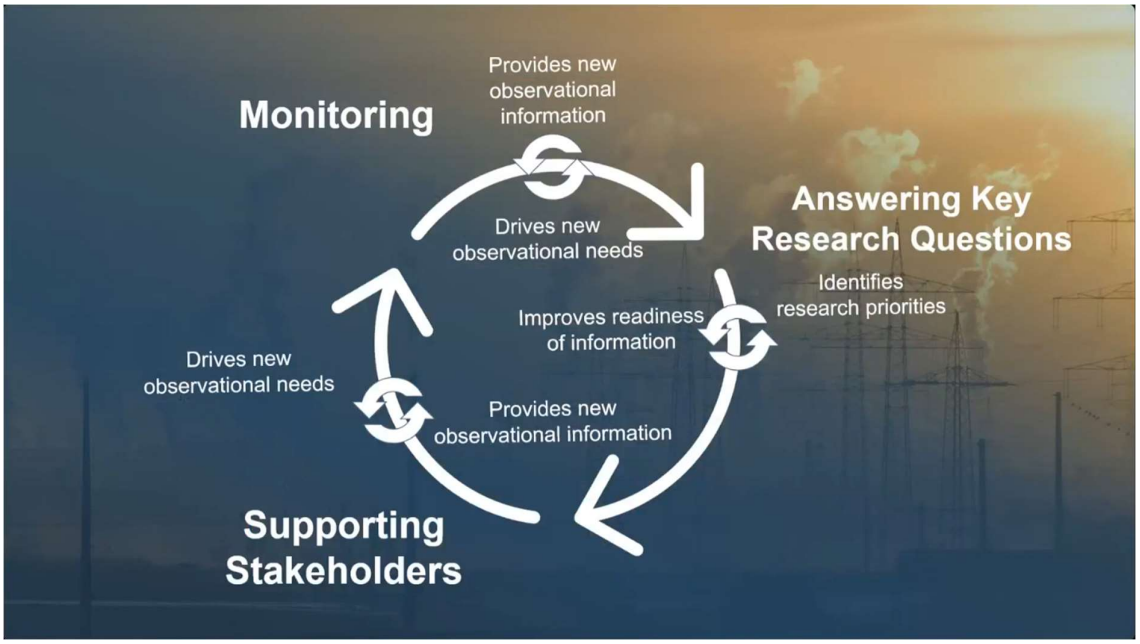
November 14, 2023



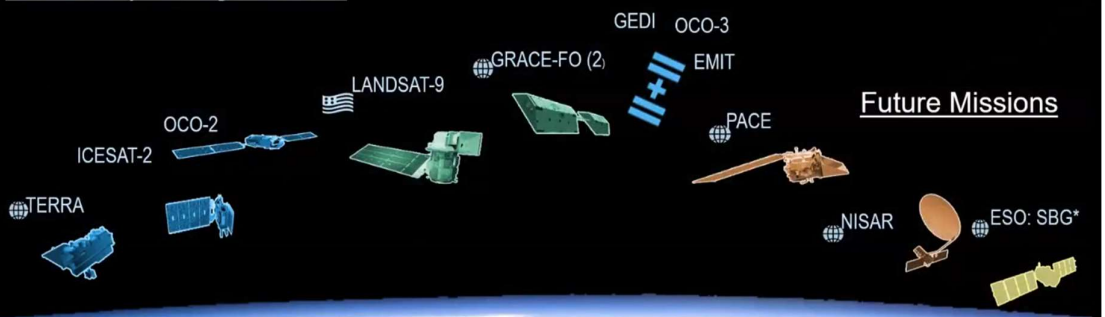

Land
Ocean
Atmosphere
LiDAR - Light Detection and Ranging
14 May 2012 09:00
Air-sea CO_2 Flux
06/25/2006, 00 UTC


Monitoring
Provides new observational information
Answering Key Research Questions
Drives new observational needs
Identifies research priorities
Improves readiness of information
Drives new observational needs
Provides new observational information
Supporting Stakeholders

Unique NASA Assets for Carbon Measuring and Accounting

KEY
- (PRE) FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED

Current Operating Missions



Future Missions

Airborne Visible InfraRed Imaging Spectrometer Next Generation (AVIRIS, AVIRIS-NG)

Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)

Land, Vegetation, and Ice Sensor (LVIS)

Goddard's LiDAR, Hyperspectral and Thermal (G-LiHT)

NASA's Carbon Monitoring System (CMS)

By leveraging satellite remote sensing resources, scientific knowledge, and modeling expertise, CMS develops usable products for a range of stakeholders who are involved with carbon monitoring and climate mitigation.

NASA CMS has produced one of the largest collections of applied carbon monitoring research to date. CMS has published 133 data products with 20 more in development.

- Ocean-Atmosphere Flux
- Land-Atmosphere Flux
- Land Biomass
- Ocean Biomass
- Land-Ocean Flux
- Global Surface-Atmosphere Flux
- MRV | Decision Support

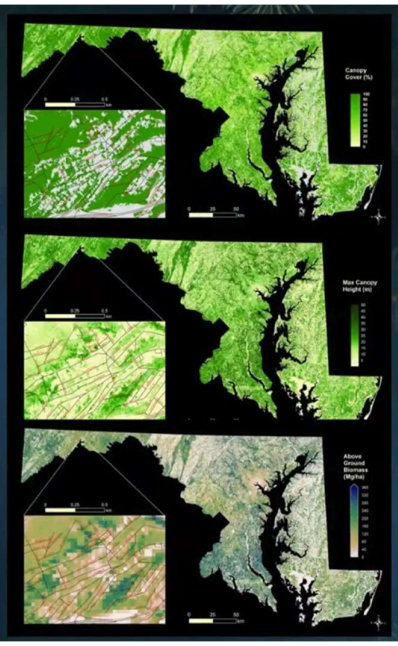
Forest Carbon Monitoring with NASA's CMS

The Maryland Department of Natural Resources engages with CMS-funded scientists and leadership to use high-resolution forest carbon monitoring and modeling products to inform the state's forestry sector.

Science Questions: What is the potential of forests to gain carbon in the future, and how long will that take? How and why are carbon stocks and fluxes changing over time?

Applications:

- Inform state's forestry and sequestration sector
- Support Maryland Forest Protection Act
- Help achieve goals of the GHG Reduction Act
- Monitor urban tree canopy goals
- Inform forest restoration projects



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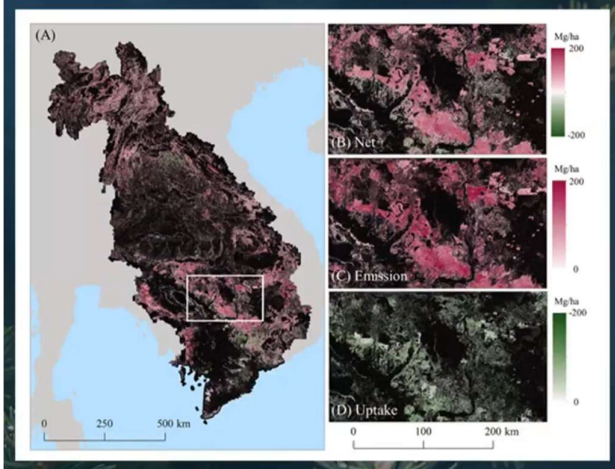
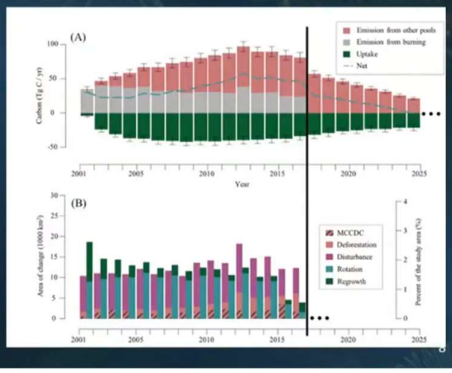


Mekong River Delta

Spatially explicit carbon bookkeeping



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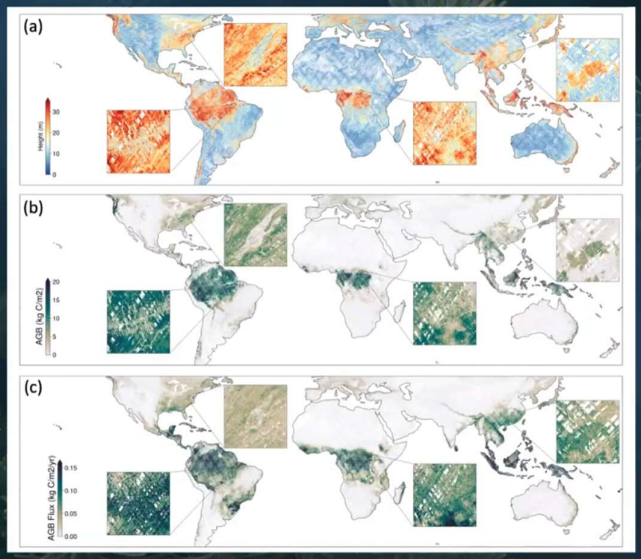
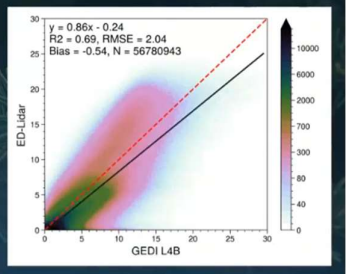
Global Carbon Model to Map Forest Biomass with GEDI

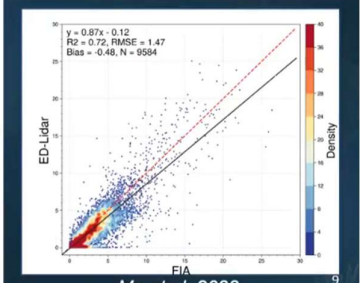
Height

AGB

AGB Flux







Ma et al. 2023

SERVIR Carbon Pilot (S-CAP)

The SERVIR carbon monitoring tool uses an ensemble approach to enable users to easily analyze and visualize carbon emissions through estimates of changing land use/ land cover and regional carbon stock.

Science Question:

How can we create reliable and transparent GHG methodologies that include the best available information for a wide range of regions?

Why:

- Countries need to monitor + report on CO_2 / GHG emissions
- Simple transition from LC data to GHG emission estimation
- Quantifying uncertainty

Potential Applications:

- RED++ Reporting
- National GHG Inventories
- Land-cover services and decision-making

S-CAP is being piloted in 15 countries now, with Ivory Coast, Colombia, and Bhutan being the most recent.

S-CAP and Blue Carbon Monitoring Mangroves

The Mangrove Monitoring Service was launched in July 2022 by SERVIR, a joint program of NASA and the U.S. Agency of International Development. Mangrove forests are one of the world's richest carbon sinks, sequestering more carbon than most inland rainforests.

This new monitoring effort is in collaboration with Guyana's National Agricultural Research and Extension Institute (NAREI) and the University of Guyana. It makes mangrove-related land-use change transparent and the resulting analysis publicly available for use by government and civil society to:

- Act on hotspots of deforestation and stop them on time
- Engage in land-use planning, policy-making and actions that protect mangroves from being converted to other land uses
- Plan mangrove protection efforts for farmers in low-lying coastal regions.

Maps showing loss of Mangrove area (red) in Guyana

SERVIR Southeast Asia Carbon Monitoring

Harmonizing for Carbon: Scalable Earth-Observation frameworks to facilitate REDD+ objectives in the Lower Mekong Basin

SERVIR's Applied Science Team (AST) Principal Investigator Robert Kennedy addresses issues in deforestation and carbon monitoring to aid forest management.

Objectives:

- Improve monitoring of forest loss by integrating an ensemble of forest disturbance algorithms
- Provide improved discrimination of forest loss events and scalable estimates of uncertainty in maps
- Improve estimation of forest carbon reference levels by integrating spaceborne lidar observations and developing enhanced biomass mapping tools

Impact:

More accessible, reliable, and scalable forest carbon-based management (REDD+)

SERVIR AST PI Robert Kennedy and the SERVIR Southeast Asia hub conduct a field visit in Cambodia.

Building Capacity in Carbon Monitoring through interagency partnerships like SilvaCarbon

GISTDA SilvaCarbon CEOS GFOI Global Forest Observations Initiative USGS

Global Datasets – February 23 – March 2, 2023

SilvaCarbon is a U.S. inter-agency technical cooperation program that builds worldwide capacity in the measurement, monitoring and reporting of carbon in forests. It is funded by the State Department and USAID.

It is the U.S.-led capacity building component of the GEO Forest Observation Initiative (GFOI).

Provides technical assistance for developing countries implementing the UN REDD+ framework

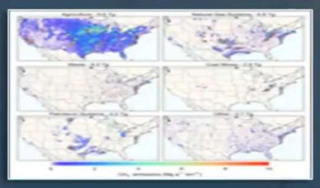
USAID USDA USFS USGS NASA

Active in 27 countries in four regions

What's Next: Greenhouse Gas Monitoring and Information Center

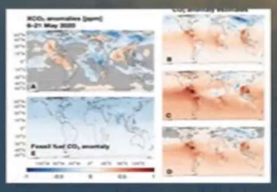
Mission: To extend accessible and integrated greenhouse gas (GHG) data and modeling capabilities from U.S. Government and non-public sources for scalable impact

Pilot Use Cases



Use Case 1. Improve access of gridded anthropogenic GHG inventory data to federal, state, local and tribal governments, and the general public.

Credit: Maasakkers et al., *Env. Sci. and Tech.*, 2016



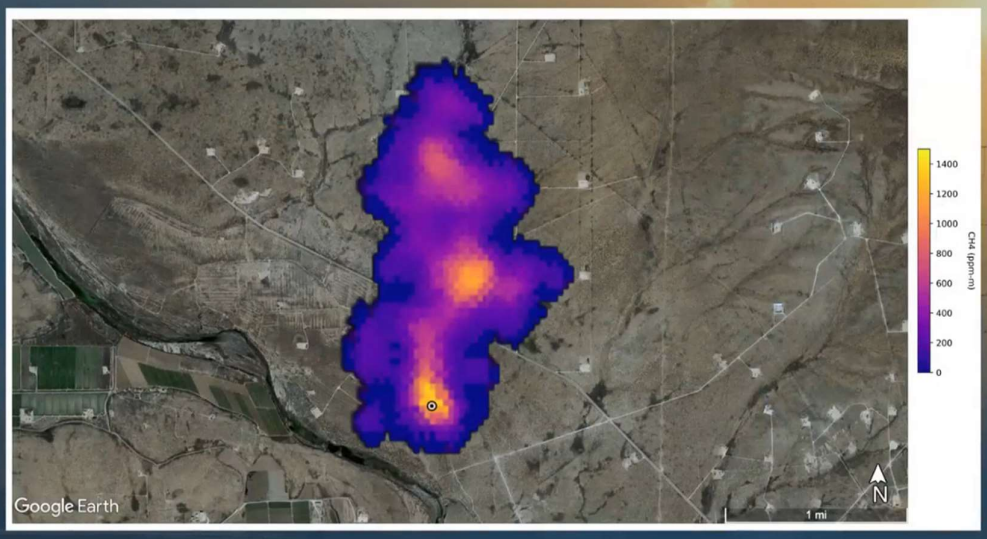
Use Case 2. Complement EPA's anthropogenic GHG emission data with up-to-date NASA data on natural GHG emissions and fluxes.

Credit: Weir et al., Env. Res. Lett., 2022,

Use Case 3. Identify, and quantify estimates from super emitting events, leveraging aircraft and satellite data.

Credit: Carbon Mapper, NASA Field Campaign Explorer,

Methane plume detection from EMIT



Challenges and Opportunities in Modeling and Accounting

Challenges in:

- Determining baseline and reference levels
- Characterizing leakage, measurement, and monitoring issues
- Standardization in terminology
- Better understand C-accounting process by practitioners
- Reconciling different in methods of C-accounting
- Addressing forest disturbance loss and recovery
- Blue Carbon Ecosystem accounting challenges due to unique habitat and biogeochemistry

- The key to current success with programs such as NASA's CMS has been exploitation of the remote sensing and modeling expertise, collaboration with other agencies, and the end-to-end focus on stake-holder engagement to meet societal needs.
- Success requires a strong foundation of ongoing relevant data, modeling, collaborations, and stakeholder engagement with improved remote sensing, multi-source integration, and robust ground-based measurements.