NASA Carbon Monitoring System (CMS) Data & Products Fact Sheet

Regional Domain:
- U.S. Sub-National (States, Counties, & Cities)
- North America
- Global or Outside of North America

Regional Domain: U.S. Sub-National (States, Counties, & Cities)

Project ID [*Award Year*]	**Science Theme**	**Spatial Extent {*Time Period*}**	**Data Products**	**Spatial Resolution {*Temporal Frequency*}**	**Application Areas**	**Potential Users**[1]	**Application Readiness Level**
Cook-B-01 [*2012*]	Land Biomass	Mid-Atlantic and New England regions of the eastern U.S. (from Maine to North Carolina) {*2008-2012*}	Forest biomass maps and associated uncertainties. The maps feature physical characteristics of trees such as crown dimensions, crown area weighted height, and stem density.	10 – 20 m (plot-scale) {*Every 5 years for Maine and sampling snapshots for other sites*}	• Forest inventory • Land management	**U.S. Department of Agriculture Forest Service (USFS)** and **private timber firms *Weyerhaeuser Corporation*** that are interested in productivity and biomass estimates	Achieve ARL 4 from ARL 1 Current ARL: 4
Dubayah-03 [*2012*]	Land Biomass	Maryland (all 24 counties) {*2004-2012*}	1) Canopy height and forest/non-forest maps. 2) Aboveground biomass with associated uncertainty maps for all Maryland counties and Addison County of Vermont. 3) Prognostic ecosystem model (ED) based maps of carbon stocks and flux. 4) ED based maps of carbon sequestration potential. 5) Single photon Lidar[2] canopy height and derived biomass maps for only Garrett County, Maryland. 6) Web-based data visualization and query system.	1) 1 m and 30 m 2) 30 m 3) 90 m 4) 90 m 5) Canopy height at 1m and biomass at 30 m 6) Not Applicable (N/A) {*N/A*}	• Land management • Forest inventory	**Maryland Department of Natural Resources (DNR) Forest Service**, U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), private landowners, **county GIS departments**, national and global entities that want to validate top down products	Achieve ARL 8-9 from ARL 5 Current ARL: 8-9
Dubayah-04 [*2013*]	Land Biomass	Sonoma County, California	1) Canopy height, ground digital elevation model (DEM), and forest/non-forest maps – and	1) 1m and 30 m 2) 30 m and 1 ha [3] 3) 90 m 4) 90 m	• MRV [4] • Land management	Habitat preservation groups (i.e. **Sonoma County Agriculture & Open Space Preservation District**, The	Achieve ARL 8-9 from ARL 6 Current ARL: 6

[1] **Bold** indicates existing communication between the CMS product developers and the end users. Specific points of contact for these end users are listed between asterisks.

[2] Lidar is a remote sensing technology that uses a laser to illuminate a target and analyze distance by analyzing the reflected light. Single photon Lidar is a high-resolution aerial imaging technology that generates 3D topographic maps.

[3] 1 hectare (ha) = 10,000 square meters, or 100 m x 100 m.

[4] MRV = Measurement, Reporting, and Verification of carbon emissions reductions, as part of REDD+ and other climate treaty agreements.

Project ID [*Award Year*]	Science Theme	Spatial Extent {***Time Period***}	Data Products	Spatial Resolution {***Temporal Frequency***}	Application Areas	Potential Users[1]	Application Readiness Level
		{*2013*}	associated point cloud data. 2) Aboveground biomass and associated uncertainty maps. 3) ED based maps of carbon stocks and flux. 4) ED based maps of carbon sequestration potential.	{*N/A*}	• Forest inventory	Conservation Fund, The Nature Conservancy), nutrient trading & hydrology groups (i.e. city wastewater treatment facilities, California Department of Environment), commercial agriculture groups (precision agriculture and yield productivity consultants, fertilizer companies providing variable rate application services), wildfire fuels modeling groups (California Department of Forestry and Fire Protection, USFS in California), forest management companies (Mendocino Redwood company), national and global entities that want to validate top down products.	
Graven-01 [*2013*]	Land-Atmosphere Flux	California {*May and November of 2014*}	Fossil fuel and biospheric CO_2 flux estimates.	Statewide, sub-state regions of greater than 100 km^2 {*Monthly*}	• MRV • GHG emissions inventory[5] • Cap-and-trade program • Land management	California Air Resources Board, California Resources Agency, California Energy Commission	Achieve ARL 4-5 from ARL 3 Current ARL: 3
Kennedy-01 [*2012*]	Land Biomass	Washington, Oregon, and California {*1990-2010*}	1) Forest biomass maps. 2) Maps of forest disturbance by agent, severity, and timing.	30 m {*1) Annually 2) Annually*}	• Fire management • Forest inventory • Land management • Invasive species • Air quality protection	**USFS**, Oregon Department of Forestry, Oregon Department of Fish and Wildlife, Washington State Department of Natural Resources, California Department of Forestry and Fire Protection, California Clean Air Resources Board	Achieve ARL 6 from ARL 1 Current ARL: 3-4
Loboda-02 [*2012*]	Land Biomass, Land-Atmosphere Flux	Interior Alaska {*2001-2010*}	Terrestrial carbon stocks estimates and changes in carbon stocks in the boreal forests of Alaska.	60 m {*Annually, Individual pixel has daily time stamp*}	• Fire management • Forest inventory • Land management	Federal land management agencies in Alaska (i.e. USFS, Bureau of Land Management (BLM), Fish and Wildlife Service, Department of Defense, National Park Service, and EPA)	Achieve ARL 1 from ARL 1 Current ARL: 1

[5] GHG = Greenhouse Gas

Project ID [*Award Year*]	**Science Theme**	**Spatial Extent {*Time Period*}**	**Data Products**	**Spatial Resolution {*Temporal Frequency*}**	**Application Areas**	**Potential Users**[1]	**Application Readiness Level**
Lohrenz-04 [*2012*]	Ocean-Atmosphere Flux, Land-Ocean Flux	Mississippi River Watershed and Gulf of Mexico, including continental margins of Florida and the South Atlantic Bight {*1904-1910, 2004-2010*}	1) Land-ocean fluxes of carbon and nitrogen. 2) Ocean-atmosphere fluxes of carbon dioxide. 3) Continental shelf-ocean exchanges of carbon and nitrogen. 4) Associated uncertainties.	5 km {*Monthly*}	• Land management • Global carbon budget calculations • Watershed protection plans • Ocean acidification mitigation	EPA (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force), National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Service (USGS), US Global Change Research Program, **CMS terrestrial flux teams**	Achieve ARL 4 (if more funding, ARL 6) from ARL 1 Current ARL: 4
Nehrkorn-01 [*2013*]	Atmospheric Transport, Land-Atmosphere Flux	Boston-DC urban corridor {*mid-2013 to present*}	1) Measurements of CO_2 concentrations. 2) CO_2 flux estimates. 3) Meteorological (atmospheric transport) modeling outputs.	1) N/A (point measurements) 2) At least 0.5°, higher resolution for some components 3) Nested grids with grid spacing between 1-30 km, finer than 10 km over area of interest {*1) Hourly 2) Biospheric & Anthropogenic: 3-hourly or higher 3) Every 10 minutes to hourly, depending on horizontal resolution of the nested grids*}	• MRV • Urbanization policies • Cap-and-trade program • GHG emissions inventory • Land management	USFS, Baltimore Washington Forest Stewardship Partnership, Maryland Department of Natural Resources, EPA (Regions 1, 2, & 3)	Achieve ARL 3 from ARL 1 Current ARL: 1
Nelson-03 [*2013*]	Land Biomass	Tanana Forest Management District of Interior Alaska {*July and August of 2014*}	Maps (pixel-level) and statistical estimates (stratum-level) of carbon stocks, and their associated uncertainties.	30 m {*1 sampling snapshot*}	• MRV • Forest inventory • Land management	**USFS in Alaska**	Achieve ARL 9 from ARL 6 Current ARL: 6

Regional Domain: North America

Project ID [*Award Year*]	**Science Theme**	**Spatial Extent {*Time Period*}**	**Data Products**	**Spatial Resolution {*Temporal Frequency*}**	**Application Areas**	**Potential Users**[6]	**Application Readiness Level**
Andrews-02 [*2012*]	Atmospheric Transport, Land-Atmosphere Flux	North America {*July 2009 – December 2010*}	1) CO_2 flux estimates. 2) Estimated CO_2 profiles corresponding to GOSAT XCO_2 observations.[7]	1) 1° x 1° [8] 2) N/A {*1) 3-hourly 2) N/A*}	• GHG emissions inventory • Cap-and-trade program • Land management	EPA, U.S. Department of Agriculture (USDA), NASA (GOSAT, ACOS, & **OCO-2** ***Chris O'Dell**** science teams), and stakeholders of any emissions verification project	Achieve ARL 9 from ARL 1 Current ARL: 1
Cohen-02 [*2013*]	Land Biomass	CONUS [9] (Maine, Pennsylvania, New Jersey, South Carolina, Minnesota, Colorado, & Oregon) {*1990-2014*}	Maps and estimates of: 1) Disturbance. 2) Aboveground biomass.	30 m {*Annually*}	• MRV • Fire management • Forest inventory • Land management • Invasive species • Air quality protection	IPCC Task Force on National Greenhouse Gas Inventories (TFI), **USFS**, EPA, US State Department, USGS, **White House Council on Environmental Quality *Chris Woodall***, SilvaCarbon	Achieve ARL 7 from ARL 1 Current ARL: 2
French-04 [*2012*]	Land Biomass, Land-Atmosphere Flux	CONUS and Alaska {*Wildland: 1984-2012* *Agricultural: 2010-2012*}	Maps of emissions from wildland and agricultural fires. Emissions include CO_2, CO, CH_4, NMHC, $PM_{2.5}$, PM_{10}, and total carbon.[10]	1 km {*Monthly*}	• Fire management • Forest inventory • Land management • Air quality protection	**EPA**, **USFS**, BLM, carbon accounting researchers, state agencies that prescribe burning and/or monitor air quality	Achieve ARL 5 (if more funding, ARL 7) from ARL 4 Current ARL: 5
Jacob-01 [*2012*]	Atmospheric Transport, Land-Atmosphere Flux	North America {*2009 - present*}	Estimates of methane emission fluxes.	1/2° x 2/3° (~50km x 50km) {*Monthly*}	• Fire management • Air quality protection • GHG emissions inventory • Land management	Air quality agencies at both state and national levels (e.g. **EPA, Iowa Department of Natural Resources**), industry groups (e.g. **American Petroleum Institute**), U.S. State Department	Achieve ARL 9 from ARL 1 Current ARL: 5

[6] **Bold** indicates existing communication between the CMS product developers and the end users. Specific points of contact for these end users are listed between asterisks.
[7] GOSAT = Greenhouse gases Observing Satellite, a product of which is column-averaged dry air mole fractions of atmospheric carbon dioxide (XCO_2).
[8] Latitude x Longitude; 1 degree at equator is 111.32 km, at 23°N is 102.47 km, at 45°N is 78.71 km, and at 67°N is 43.50 km.
[9] CONUS = Contiguous United States, 48 states below Canada and above Mexico.
[10] CO = carbon monoxide, CH_4 = methane, NMHC = non-methane hydrocarbon, $PM_{2.5}$/PM_{10} = particulate matter sized 2.5 or 10 micrometers or smaller.

Project ID [*Award Year*]	Science Theme	Spatial Extent {***Time Period***}	Data Products	Spatial Resolution {***Temporal Frequency***}	Application Areas	Potential Users[6]	Application Readiness Level
Lauvaux-01 [*2013*]	Atmospheric Transport, Land-Atmosphere Flux	North America {*2010*}	Estimates of the sensitivity of NASA CMS-Flux inversions to uncertainty in atmospheric transport.	4° x 5° {Monthly}	• Global carbon budget calculations	**Certain CMS projects**, EPA, **NOAA** Carbon Tracking group	Achieve ARL 7 from ARL 1 Current ARL: 1
Saatchi-02 [*2012*]	Land Biomass, Land-Atmosphere Flux	CONUS (all carbon pools) and Alaska (only aboveground biomass and belowground biomass) {*2000-2010*}	Maps of all forest carbon stocks (aboveground biomass, belowground biomass, coarse woody debris, forest floor, and soil) and net fluxes.	100 m {*Forest cover – 2000, 2005, 2010; Aboveground biomass – 2000, 2005; Other carbon pools – 2000, 2005; Flux – 2000-2005, 2005-2010*}	• MRV • Forest inventory • Land management	USGS**, USFS,** EPA**, President's Interagency Climate Change Adaptation Task Force**	Achieve ARL 8-9 from ARL 3 Current ARL: 6-7
Shuchman-01 [*2012*]	Lake Biomass, Ocean Biomass, Ocean-Atmosphere Flux	Laurentian Great Lakes {*1980-2014*}	Lake-wide primary production estimates for all five Great Lakes in the U.S.	1 km {*Annually – time series for Lakes Michigan, Superior, and Erie: 1980-1985, 1998, 2000, 2005, 2010-2011, and 2014* *Monthly – seasonal analysis for all five Great Lakes: 2011}*	• Watershed protection plans • Global carbon budget calculations • Coastal land management	**Michigan Department of Environmental Quality**; **Great Lakes Observing System (GLOS)**; **US National Park Service; USGS; NOAA**; US Coast Guard; **EPA** Regions 2, 3, & 5; Illinois, Indiana, Michigan, Pennsylvania, New York, Wisconsin, Minnesota, & Ohio Departments of Natural Resources or equivalent agencies; Environment Canada; Great Lakes Fishery Commission	Achieve ARL 5 (if more funding, ARL 7-8) from ARL 2 Current ARL: 4-5
Vargas-01 [*2013*]	Land Biomass	Mexico {*2000-2015*}	Methodologies for upscaling carbon stocks and dynamics from forest inventories to regional scale, and their associated uncertainties.	5 km {*Monthly*}	• MRV, REDD+[11] • Forest inventory • Land management	USFS, **Mexican National Forestry Commission**, Canadian Forest Service	Achieve ARL 3 from ARL 1 Current ARL: 1

[11] REDD+ = United Nations – Reducing Emissions from Deforestation and forest Degradation program, included under Application Areas for only projects with geographical focus on countries participating in the UN-REDD+ program.

Regional Domain: Global or Outside of North America

Project ID [*Award Year*]	**Science Theme**	**Spatial Extent {*Time Period*}**	**Data Products**	**Spatial Resolution {*Temporal Frequency*}**	**Application Areas**	**Potential Users**[12]	**Application Readiness Level**
Balch-03 [*2012*]	Ocean Biomass, Ocean-Atmosphere Flux	Western Arctic Ocean {*June and July of 2011*}	Measurements of: 1) Calcification rate (including total primary productivity). 2) Particulate inorganic carbon and biogenic silica concentrations. 3) Coccolithophore/ phytoplankton abundance.	Not Applicable, involves direct biological samplings along km-scale transects {*Daily*}	• Fisheries regulations • Ocean acidification mitigation • Global carbon budget calculations • Coastal land management	NOAA, EPA, Global Carbon Project (GCP), NASA	Achieve ARL 1 from ARL 1 Current ARL: 1
Behrenfeld-01 [*2012*]	Ocean Biomass	Tropical Pacific and Atlantic Oceans {*2012*}	Measurements of phytoplankton carbon.	Not Applicable, involves direct biological samplings along km-scale transects {*3-4 times a day when sampling*}	• Fisheries regulations • Ocean acidification mitigation • Global carbon budget calculations • Coastal land management	Any researcher who develops algorithms that relate optical properties to field data of ocean carbon stocks	Achieve ARL 2 from ARL 1 Current ARL: 1
Bowman-01 [*2012*]	Land-Atmosphere Flux, Ocean-Atmosphere Flux, Global Flux	Global {*2010-2011*}	Spatially gridded, temporally resolved estimates of: 1) Terrestrial biospheric CO_2 fluxes. 2) Oceanic CO_2 fluxes. 3) Fossil fuel emissions. 4) Biomass burning. 5) Atmospherically constrained terrestrial biospheric CO_2 fluxes. 6) Vertically resolved CO_2 concentrations. 7) Total CO_2 fluxes. 8) Associated uncertainties.	1) 0.5° 2) 18 km 3) 0.1° 4) 0.5° 5) 4° x 5° 6) 4° x 5° 7) 4° x 5° {*1) Monthly and 3-hourly* *2) Monthly and 3-hourly* *3) Monthly and 3-hourly* *4) Daily* *5) Monthly* *6) 3-hourly* *7) Monthly*}	• GHG emissions inventory • Forest inventory • Land management • Watershed protection plans • Global carbon budget calculations • Ocean acidification mitigation	Group on Earth Observations (GEO), Regional Greenhouse Gas Initiative (RGGI), **CMS flux teams**, **EPA**, **NOAA *John Miller***, DOE Integrated Assessment (IA) and Climate and Earth System Modeling groups	Achieve ARL 2 from ARL 1 Current ARL: 1

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Project ID [*Award Year*]	Science Theme	Spatial Extent {***Time Period***}	Data Products	Spatial Resolution {***Temporal Frequency***}	Application Areas	Potential Users[12]	Application Readiness Level
Cochrane-01 [*2013*]	Land Biomass, Land-Atmosphere Flux	Central Kalimantan, Indonesia {*2007-2011 and 2014* *Land cover changes and burned area: 1997-2016* *Timing of fire activity: 2000-2016}*	Estimates of peat[13] fire-related emissions, including land cover changes, burned area, and timing of fire activity.	30 m {*Annually*}	• MRV, REDD+ • Fire management • GHG emissions inventory • Forest inventory • Land management • Air quality protection	**Indonesian government's Forestry Research and Development Agency**, Indonesia National Aerospace Institute (LAPAN), IPCC TFI, Australian Agency for International Aid, **U.S. Agency for International Development (USAID), USFS**	Achieve ARL 6 from ARL 1 Current ARL: 1-2
Collatz-02 [*2013*]	Land Biomass, Land-Atmosphere Flux	Global {*2003-2014*}	1) Estimates of terrestrial carbon fluxes: Gross Primary Productivity (GPP)/ Net Primary Productivity (NPP), Net Biome Production (NBP), Ecosystem Respiration (RE)/ Heterotrophic Respiration (RH), and fire emissions. 2) Maps of above- and below-ground biomass live and above- and below-ground biomass detritus. 3) Associated uncertainties for both fluxes and biomass.	1) 0.5° x 0.5° and 1° x 1.25° 2) 0.5° x 0.5° {*1) Monthly at 0.5° resolution and 3-hourly at 1°* x 1.25° *resolution* *2) Annually*}	• Fire management • Global carbon budget calculations • Land management • Air quality protection	**CMS atmospheric modeling groups (i.e. Bowman-01, Pawson-01, Andrews-02, Nehrkorn-01)**	Achieve ARL 5 from ARL 1 Current ARL: 3-4
Dubey-01 [*2013*]	Land-Atmosphere Flux	Global, with focus on developing countries in Asia (China & India), South America, and Africa {*2014-2015*}	Evaluation of a new off-the-shelf, low-resolution MRV technology, which includes measurements of regional total column XCO_2 and XCH_4 observations.	10 km {*Every 5 minutes during daytime sampling*}	• MRV, REDD+ • GHG emissions inventory • Global carbon budget calculations • Land management	DOE, EPA, certain CMS projects, Total Carbon Column Observing Network (TCCON), Orbiting Carbon Observatory-2 (OCO-2) science team, U.S. Global Change Research Program	Achieve ARL 4-5 from ARL 3 Current ARL: 3

[13] Peat is an accumulation of partially decayed vegetation.

Project ID [*Award Year*]	Science Theme	Spatial Extent {***Time Period***}	Data Products	Spatial Resolution {***Temporal Frequency***}	Application Areas	Potential Users[12]	Application Readiness Level
Hagen-01 [*2013*]	Land Biomass, Land-Atmosphere Flux	5 provinces of Kalimantan, Indonesia {*2010-2015*}	Maps of forest carbon stocks and fluxes, and an uncertainty tracking system.	100 m {*Stock: only one map for 2010* *Flux: Annually*}	• MRV, REDD+ • Forest inventory • Land management	**Indonesian Ministry of Forestry *Dirk Hoekman***, **Indonesia REDD+ Office of President *Heru Prasetyo***, Indonesian government's Forestry Research and Development Agency, **LAPAN**, IPCC TFI, **US State Department, USFS, USAID**	Achieve ARL 7 from ARL 3 Current ARL: 3
Healey-01 [*2012*]	Land Biomass	Global {*2005*}	Statistical estimates – derived consistently across countries and with well-defined confidence intervals – of country-level mean forest biomass values and mean canopy height, and associated standard errors.	N/A {*N/A*}	• MRV, REDD+ • Forest inventory • Land management	**UN Food and Agriculture Organization (FAO)**, **USFS**, **SilvaCarbon**, and any country that needs the baseline data in order to improve its forest inventory system	Achieve ARL 9 from ARL 3 Current ARL: 7
Houghton-02 [*2012*]	Land Biomass, Land-Atmosphere Flux	Global Tropics {*2000-2012*}	Maps of gross and net carbon fluxes in tropical forests due to deforestation, reforestation, growth, and degradation.	500 m {*Annually}*	• MRV, REDD+ • Forest inventory • Land management • Forest inventory • Global carbon budget calculations	Developing countries who are seeking to reduce emissions in the tropics (Brazil, Indonesia), Brazilian National Institute for Space Research (INPE), LAPAN, FAO, USAID, **GCP**	Achieve ARL 7 from ARL 3 Current ARL: 5
Huntzinger-01 [*2012*]	Land-Atmosphere Flux	Global {*2009-2010*}	1) New prior land flux estimates, and their associated uncertainty, for CMS and other atmospheric CO_2 inversions. 2) Updated estimates of terrestrial net CO_2 fluxes inferred from the CMS inversion and informed by these new land flux priors. 3) Atmospheric CO_2 signals generated from 10 terrestrial biospheric models.	2° x 2.5° {*Sub-daily to monthly*}	• GHG emissions inventory • Global carbon budget calculations • Land management	Process-based and inversion modeling communities participating in **MsTMIP**, **NASA CMS**, and elsewhere, IPCC Task Force on National Greenhouse Gas Inventories (IPCC TFI), GEO, USFS	Achieve ARL 6 from ARL 1 Current ARL: 5
Imhoff-West-04 [*2013*]	Land Biomass, Land-Atmosphere Flux	Global {*2005-2010*}	Estimates of carbon stocks and fluxes for agricultural lands, including vegetation and soils.	0.05° {*Annually*}	• GHG emissions inventory • Land management	**USDA**, **EPA**, FAO, U.S. State Department	Achieve ARL 6 from ARL 3 Current ARL: 3

Project ID [*Award Year*]	Science Theme	Spatial Extent {***Time Period***}	Data Products	Spatial Resolution {***Temporal Frequency***}	Application Areas	Potential Users[12]	Application Readiness Level
Keller-01 [*2013*]	Land Biomass, Land-Atmosphere Flux	Paragominas, Brazil {*2012-2015*}	Maps of aboveground carbon stocks, changes in carbon stocks, and associated spatially explicit uncertainties.	100 m {*2 sampling snapshots: 2012 and 2014*}	• MRV, REDD+ • Forest inventory • Land management	Municipality of Paragominas, State of Para, Brazilian Ministry of the Environment, Brazilian Space Agency, Instituto Floresta Tropical, Imazon	Achieve ARL 3 from ARL 1 Current ARL: 1
Kellndorfer-03 [*2013*]	Land Biomass, Land-Atmosphere Flux	Peru, Colombia, and Mexico {*1996-2014*}	Estimates of carbon flux from deforestation, forest degradation, and forest regrowth – and associated uncertainties.	1 ha {*Annually*}	• MRV, REDD+ • Forest inventory • GHG emissions inventory • Land management	**Peruvian Ministry of Environment**; **Colombian Ministry of Environment**; **Colombian Institute of Hydrology, Meteorology, and Environmental Studies**; **Mexican National Commission for Knowledge and Use of Biodiversity**; **Mexican National Forestry Commission**; USAID	Achieve ARL 6-7 from ARL 2 Current ARL: 3
Miller-J-01 [*2012*]	Atmospheric Transport, Land-Atmosphere Flux	Global {*2009-2011*}	A comparative evaluation of observed CO_2 fluxes and a posteriori modeled CO_2 fluxes from a CMS Bowman-01 flux.	Variable {*Weekly to Monthly*}	• MRV, REDD+ • GHG emissions inventory • Land management	**CMS Bowman-01 Flux Product team**	Achieve ARL 1 from ARL 1 Current ARL: 1
Pawson-01 [*2012*]	Land-Atmosphere Flux, Ocean-Atmosphere Flux, Global Flux	Global {*1) 2003-2013* *2) 1998-2013*}	1) Estimates of net terrestrial biospheric CO_2 fluxes, including biomass burning. 2) Estimates of net oceanic CO_2 fluxes. 3) Uncertainties associated with terrestrial and oceanic fluxes. 4) Assimilated 3D atmospheric fields of CO_2 concentrations. 5) Characterization of size and location of regions that impact the ACOS observations.[14]	1) 0.5° x 0.5° and 1° x 1.25° 2) 1° and 1.25° {*1) Monthly for 0.5°* resolution and 3-hourly for 1° 2) Daily}	• GHG emissions inventory • Global carbon budget calculations • Land management	**CMS flux teams**, USGS, EPA, NOAA, GCP, and others who want to run carbon cycle models.	Achieve ARL 5 from ARL 1 Current ARL: 3-4
Stehman-01 [*2013*]	Land Biomass	Global {*N/A*}	Sampling design and analysis methods to quantify and reduce uncertainties associated with carbon monitoring systems.	N/A {*N/A*}	• MRV, REDD+	**Certain CMS projects** and any REDD+ project that seeks to use remote sensing data to quantify impacts from land cover changes.	Achieve ARL 3 from ARL 1 Current ARL: 1

[14] ACOS = Atmospheric CO_2 Observations from Space Task

Project ID [*Award Year*]	**Science Theme**	**Spatial Extent {*Time Period*}**	**Data Products**	**Spatial Resolution {*Temporal Frequency*}**	**Application Areas**	**Potential Users**[12]	**Application Readiness Level**
West-03 [*2012*]	Land Biomass, Land-Atmosphere Flux	Global {*2005-2010*}	Estimates of carbon fluxes for agricultural lands: gridded data carbon uptake by crop, carbon release by livestock, carbon release by human, and combination of all three mentioned above.	0.05° {*Annually*}	• GHG emissions inventory • Land management	**EPA, USDA Farm Service Agency**, **CMS flux teams**, United Nations Environment Programme – Global Environmental Facility, UNFCCC, FAO, NGOs: World Wildlife Fund, The Nature Conservancy, & Natural Resource Defense Council	Achieve ARL 6 from ARL 3 Current ARL: 5
Verdy-01 [*2012*]	Ocean-Atmosphere Flux	1) California coastal ocean 2) Global {*1) 2007-2010* *2) 1973-2013*}	1) Ocean biogeochemistry state estimates. 2) Global Ocean Data Analysis Project version 2 (GLODAPv2) data product.	1) 7 km 2) 1° {*1) Monthly* *2) N/A*}	• Global carbon budget calculations • Watershed protection plans • Ocean acidification mitigation	NOAA, EPA, White House Council on Environmental Quality, any oceanographer or modeler who needs to know the global ocean 3-D distribution of carbon system parameters and tracers that are not commonly cataloged by National Oceanographic Data Center	Achieve ARL 5 from ARL 3 Current ARL: 4

Key: Fact Sheet Categories

Category	Explanation
Project ID	Principal Investigator's last name and project #
Award Year	The year the funding was granted
Science Theme	Type of data and products, according to components of carbon cycle research that are most relevant
Spatial Extent	The geographical area that the data and products cover
Time Period	The time period that the data and products cover
Data Products	A description of output data and products that will be publicly available upon completion of the project
Spatial Resolution	Finest spatial resolution of data and products
Temporal Frequency	Time intervals of data updates
Application Areas	Areas with policy or societally relevant decision processes, which may benefit from the usage of data and products
Potential Users	Possible end users of data and products once fully developed
Application Readiness Level (ARL)	A NASA index that assesses applications potential of data and products in operational settings. Principal Investigators specified the ARLs of their own projects.

Acronyms List

ACOS	Atmospheric CO2 Observations from Space Task
ARL	NASA Application Readiness Level
BLM	U.S. Bureau of Land Management
CA-AB32	California Assembly Bill 32: Global Warming Solutions Act
CAA	U.S. Clean Air Act
CAP	President Obama's Climate Action Plan of 2013
CarboNA	Carbon North America, formerly the Joint North American Carbon Program (JNACP)
CH4	Methane
CO	Carbon monoxide
CO2	Carbon dioxide
CONUS	Contiguous United States, 48 states below Canada and above Mexico
CMS	NASA Carbon Monitoring System Initiative
CWA	U.S. Clean Water Act
DOE	U.S. Department of Energy
Doha/Kyoto	Doha Amendment to the Kyoto Protocol
EPA	U.S. Environmental Protection Agency
FAO	Food and Agriculture Organization of United Nations
FIA	Forest Inventory and Analysis of the U.S. Forest Service
FLPMA	U.S. Federal Land Policy and Management Act
FOARAM	U.S. Federal Ocean Acidification Research and Monitoring Act
FPP	Carbon Monitoring System Flux Pilot Project
GCP	Global Carbon Project
GEO	Group on Earth Observations
GO-SHIP	Global Ocean Ship-based Hydrographic Investigations Program
GOSAT	Greenhouse gases Observing SATellite
ICESat-2	Ice, Cloud, and land Elevation Satellite-2
INCAS	Indonesian National Carbon Accounting System

Acronyms List

IOCCP	International Ocean Carbon Coordination Project
IPCC	Intergovernmental Panel on Climate Change
IPCC GPG	IPCC Good Practice Guide for Land Use, Land-Use Change, and Forestry
IPCC TFI	IPCC Task Force on National Greenhouse Gas Inventories
LAPAN	Indonesia National Aerospace Institute
MRP	Mega Rice Project
MRV	UN-REDD+ Measurement, Reporting, and Verification of carbon emissions reductions
MsTMIP	Multi-Scale Synthesis and Terrestrial Model Intercomparison Project
NACP	North American Carbon Program
NALS	North American Leaders' Declaration on Climate Change and Clean Energy
NASA	U.S. National Aeronautics and Space Administration
NFMS	National Forest Monitoring System
NGHGI	National Greenhouse Gas Inventory
NMHC	Non-methane hydrocarbon
NOAA	U.S. National Oceanic and Atmospheric Administration
OCO-2	Orbiting Carbon Observatory-2
PM2.5 (or PM10)	Particulate matter sized 2.5 (10) micrometers or smaller
REDD+	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RGGI	U.S. Regional Greenhouse Gas Initiative
UNFCCC	United Nations Framework Convention on Climate Change
US-Indonesia Partnership	U.S.-Indonesia Partnership on Climate Change and Clean Energy
US-Mexico Bilateral	U.S.-Mexico Bilateral Framework on Clean Energy and Climate Change
USAID	U.S. Agency for International Development
USCCSP	U.S. Carbon Cycle Science Program
USDA	U.S. Department of Agriculture
USFS	U.S. Department of Agriculture Forest Service
USGS	U.S. Geological Survey
XCO2 or XCH4	Column-averaged dry air mole fractions of atmospheric CO2 or CH4

NASA Application Readiness Level Index

Notes:

1. The NASA Application Readiness Levels (ARLs) is an index adapted from the NASA Technology Readiness Levels (TRLs) in order to track and guide application efforts of NASA funded projects such as those under the Carbon Monitoring System initiative.
2. The project teams are asked to assess at which ARL the project started, is currently, and strives to reach upon completion.
3. Not all projects will start at ARL 1 and end at ARL 9, and the ARL index may not be applicable to some projects that are primarily focused on furthering the scientific understanding.
4. For detailed description of each ARL, see http://www.nasa.gov/sites/default/files/files/ExpandedARLDefinitions4813.pdf