

NASA Carbon Monitoring System



# Overview of CMS Applications Efforts

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CMS Applications Workshop 2019 – La Jolla, CA Tuesday, November 12, 2019

### **CMS APPLICATIONS EFFORTS OVERVIEW**

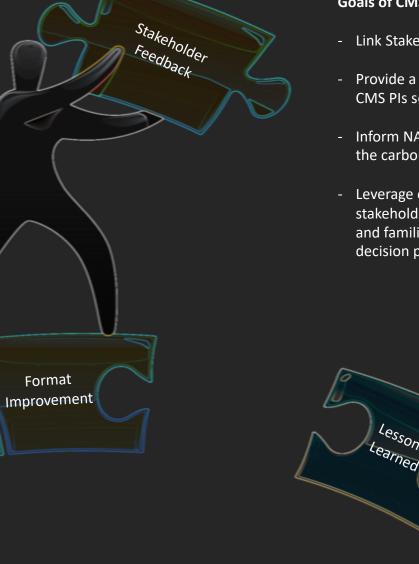
Working

Group Feedback PI

Research

Stakeholder feedback and engagement provides a link to science development, that helps a product move from a research effort...

> **CMS** Data Development



#### **Goals of CMS Applications Efforts:**

Lessons

- Link Stakeholders to CMS science products.
- Provide a path for feedback and lessons learned for CMS PIs so CMS is more accessible and user friendly.
- Inform NASA HQ of the needs and requirements of the carbon end user community.
- Leverage opportunities between NASA CMS and stakeholders in an effort to expand the knowledge and familiarity of CMS data products to help improve decision processes.

...to a user friendly decision support system

Improved Societal Applications



#### **Policy Speaker Series**

Brings stakeholders to NASA to explain how carbon science data are applied to specific policies. Informs CMS science community of specific stakeholders data needs and collaboration opportunities.



#### **Applications Workshops**

Annual event with CMS Science Team and end users for a better understanding of stakeholder uses, needs and challenges for carbon monitoring and MRV as well as lessons learned.



#### **Data Products Fact Sheet**

Collection of CMS metadata and policy data for each product (e.g. spatial extent, resolution, uncertainty, application areas, relevant policies), Integrated into CMS website database.

Feedback to CMS Science Community and NASA HQ ESD

#### Application Readiness Levels (ARLs)

Provide transparency to HQ and user community on the maturity of each CMS product. Used as a communication tool for stakeholders to assess product maturity.

#### Surveys & Community Assessments

Evaluate thematic user challenges within the CMS. Assess impact of CMS data products for end user organizations.

#### Socioeconomic Studies

Development of socioeconomic case study addressing the social value of CMS Lidar in MD DNR policy, and an ongoing assessment of the contribution of CMS flux products to the reduction of uncertainty in the carbon cycle.

### CMS Applications Program Framework

NASA Carbon Monitoring System



#### **CMS** Applications

Efforts Examples. Tri-State Area Applications Workshop & Tutorial in Newtown Square, PA: CMS Application workshops and tutorials provide an opportunity for CMS Science Team members and stakeholders to engage on thematically detail objectives that help advance CMS science into appropriately scaled policy arenas.



#### NASA Carbon Monitoring System

### CMS Data Products

96 Projects 312 Data Products Local to international scale

Tree canopy cover map 1m Spatial Resolution Status: Archived (some Aboveground Mangrove canopy height states) and In-Progress biomass maps 1m Spatial Resolution 30m Spatial Status: Partially Archived Resolution Status: Archived Maps of annual FOREST CANOPY HEIGHT deforestation Lorey's Mean (meters) Aboveground Biomass, Landcover 30m Spatial Resolution 0 - 10 and Degradation for Kalimantan Status: In-Progress 10 - 20 1-ha grid cells Spatial Resolution 20 - 30 30 - 40 Status: Archived 40 - 50

> **Global forest canopy height** (Healey, 2015) Archived at ORNL DAAC

Available at: https://doi.org/10.3334/ORNLDAAC/1271



### **Overview of CMS Data Products**

#### • Where can CMS datasets be found?

#### Carbon Monitoring System (CMS) Overview The NASA Carbon Monitoring System (CMS) program significant contributions in characterizing, quantifying, predicting the evolution of global carbon sources and monitoring of carbon stocks and fluxes. The System u observations and modeling/analysis capabilities to es

quantitative uncertainties, and utility of products for su international policy, regulatory, and management activ

are designed to inform near-term policy development and planning.

DAAC Home > Get Data > NASA Projects > Carbon Monitoring System (CMS)

#### Carbon Monitoring System Datasets List

Sign in to download CMS datasets

52 CMS datasets Show All \$ entries

<b>*</b> ~	CMS dataset
*	Annual Burned Area from Landsat, Mawas, Central Kalimantan, Indonesia, 1997-2015

DARTE Annual On-road CO2 Emissions on a 1-km Grid. Conterminous USA, V2, 1980-2017

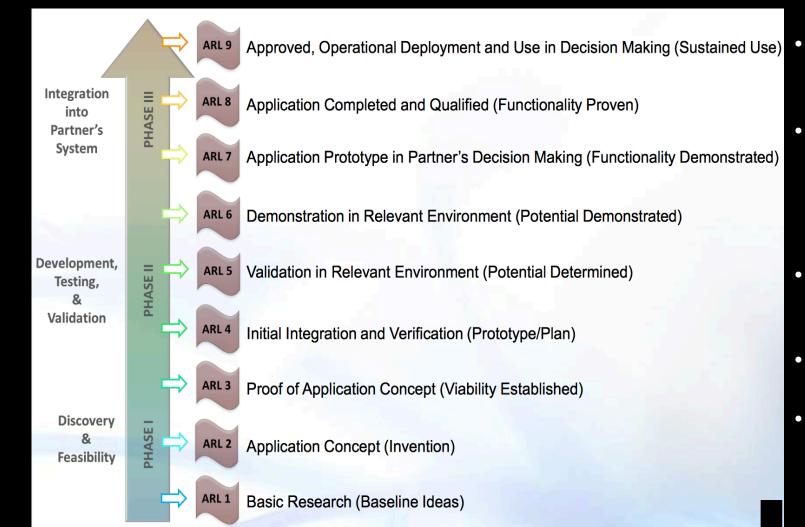
- Forest Carbon Stocks and Fluxes After Disturbance. Southeastern USA, 1990-2010
- Ecosystem Functional Type Distribution Map for Mexico, 2001-2014
- Ocean Surface pCO2 and Air-Sea CO2 Flux in the Northern Gulf of Mexico, 2006-2010
- CMS: Mangrove Forest Cover Extent and Change across Major Deltas 2000 201

		NASA	National Aeror	nautics and Spa	ce Administration	<ul> <li>Visit cce.nasa.gov</li> <li>Visit nasa.gov</li> <li>Contact Us</li> </ul>
EARTH <b>DATA</b> Find a		A REAL PROPERTY.				
GES DISC E Data Collecti Atmospheric Composition, Water & Energy Cycles		NASA Carbon Monitoring System				
				Fatoyinbo (C	MS 2014) Project Profile (updated 23-Feb-2018)	
Data Collections showing		Home		ViewPrint Full Project Profile  Project Trite: Total Carbon Estimation in African Mangroves and Coastal Wetlands in Preparation for		paration for REDD and
		Teams & Projects			Blue Carbon Credits	aration for REDD and
Refine By Image		Missions & Instruments		Science Team Members:	Temilola (Lola) Fatoyinbo, NASA GSFC (Project Lead) David Lagomasino, USRA-NASA	
Subject Sort -		Timeline		Project Duration:	2014 - 2018	
Atmospheric Chemistry (11)	Sec.			Solicitation:	NASA: Carbon Monitoring System (2014)	
Ocean Chemistry (7)		Applications		Abstract:	Coastal Blue Carbon ecosystems such as mangroves, salt marshes and seagrass beds have the	
	-	Meetings			highest total carbon densities of all ecosystems. Although they only represent 3% of the tot area, carbon emissions from mangrove destruction at current rates could be equivalent to 1	
Measurement Sort -	Hover				carbon emissions from deforestation. The high carbon sequestra [more]	
<ul> <li>Alkalinity (1)</li> </ul>	-			Keywords:	CMS: Land Biomass	
Biogeochemical Cycles (1)	1000				Land -Atmosphere Flux     Land-Ocean Flux	
Carbon (1)	3. 6. 6				Decision Support	
Carbon Dioxide (9)	and the second s				► MRV	
Dissolved Gases (1) Hover More Source Sort ▼						
				Participants:	Temblak (Lula) Fatiynbo, NASA GSFC Emanuelle Feliciano, NASA GSFC / ORAU David Lagomasinu, USRA-NASA Marc. (Mac), Simard, Jet Propulsion Laboratory / Catech	
GOSAT TANSO-FTS (1)	- to the				Contact Support to request an email list of project participants.	
Models/Analyses BLING (1)				Project URL(s):	None provided.	
Models/Analyses CASA-GFED3-V2 Hover						
(1)				Data	Product Title: Mangrove forest biomass estimates.	
Models/Analyses CMS-Flux-V1 (5)	-			Products:	Time Period: 2013-2015	
Models/Analyses ECCO2_Darwin- V3 (1)					Spatial Extent: Gabon, Tanzania, and Mozambique	
					Spatial Resolution: 1m to 12 m	
More	Hover				Temporal Frequency: Single Product 2013/2014	
					Status: In-Progress	
					<u>more</u>	

Metadata Fields	Explanation			
Award Year	The year the funding was granted			
Project ID	Principal Investigator's last name and project #			
Objectives	Goals that the project seeks to attain by developing data and products			
Science Theme	Type of data and products, according to components of carbon cycle research that are most relevant: Global Flux, Ocean-Atmosphere Flux, Land-Atmosphere Flux, Land- Ocean Flux, Land Biomass, Ocean Biomass, Lake Biomass, MRV, and Decision Support			
Products Keywords	Keywords that will help stakeholders identify data and products appropriate to their needs. See below for a table that explains each product keyword.			
Data Products	A description of output data and products that will be publicly available upon completion of the project			
Spatial Extent	The geographical area that the data and products cover			
Coordinates	Coordinates can be approximate. They can be the center of Spatial Extent or study sites. Shape files are welcome.			
Time Period	The time period that the data and products cover			
Spatial Resolution	Finest spatial resolution of data and products			
Temporal Frequency	Time intervals of data products			
Input Data Products	Any satellite, airborne, field, and modeled data products used. If airborne Lidar data wa used, please indicate where, when, which instruments, and how much data (area, dimensions, or number and length of lines).			
Algorithm/Models Used	Any algorithm or models used to develop data and products			
Evaluation	Any efforts to evaluate the accuracy, robustness, and/or performance of data and products			
Intercomparison Efforts/Gaps	Any key intercomparison effort(s) that have been undertaken or gaps where future intercomparison efforts are warranted			
Uncertainty Estimates	Plans to quantify data uncertainty, if any			
Uncertainty Categories	1. Ensemble (e.g. stochastic), 2. Deterministic, 3. Model-Data Comparison, 4. Model- Model Comparison, and/or 5. Data-Data Comparison			
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			
Stakeholders	End users engaged with CMS PIs who are using or plan to use data and products in the future			
Application Readiness Level (ARL)	The NASA index that assesses applications potential of data and products in operational settings. <u>Detailed explanation</u> . Principal Investigators specified the ARLs of their own projects			
Future Developments	Future plans to engage stakeholders, share data and products, and raise awareness of the product development efforts			
Limitations	Any shortcoming of data and products that users must be aware of			
Date When Data/Product Available	The date (MM/DD/YY - if possible) on which data and products will be made publicly available			
Data Server URL	The URL address where a user may access data and products			
Metadata URL	The URL address where a user may access metadata			
	Award Year         Project ID         Objectives         Science Theme         Signal Extent         Coordinates         Spatial Extent         Coordinates         Time Period         Spatial Resolution         Temporal Frequency         Input Data Products         Algorithm/Models Used         Evaluation         Intercomparison         Efforts/Gaps         Uncertainty Estimates         Uncertainty Categories         Akeholders         Stakeholders         Level (ARL)         Future Developments         Limitations         Date When Data/Product         Available			



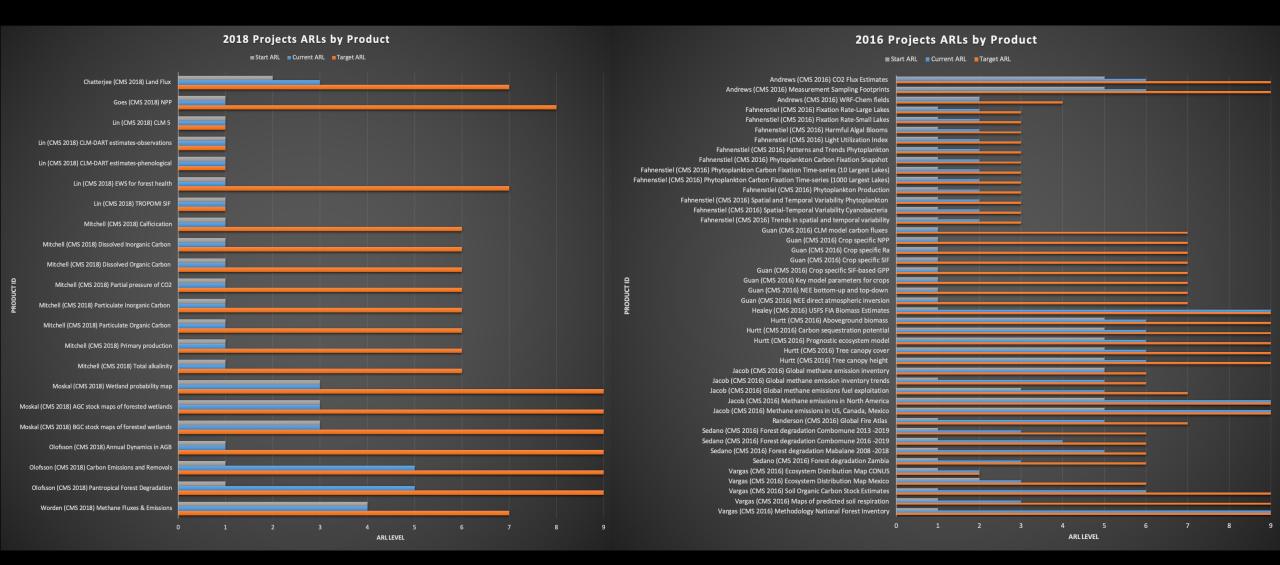
### ARL Refresher



- Serve as a guide to user community
- Set expectations to user on how to use products and what feedback to provide
- ARL designated by the CMS PI
- Update as needed
- Intended to guide HQ and user community on the maturity of products

#### NASA Carbon Monitoring System

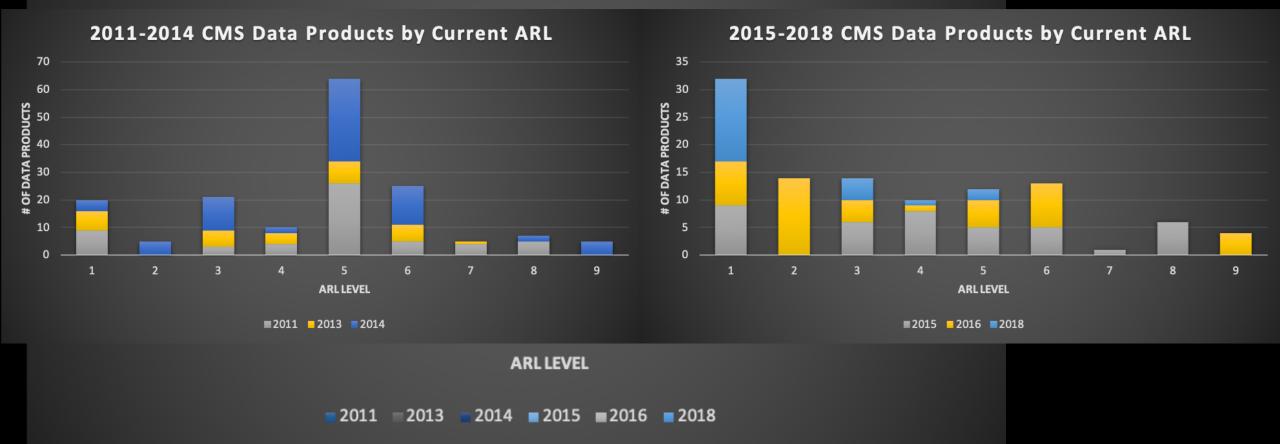
#### National Aeronautics and Space Administration





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#### 2011-2018 CMS Data Products by Current ARL





60

50

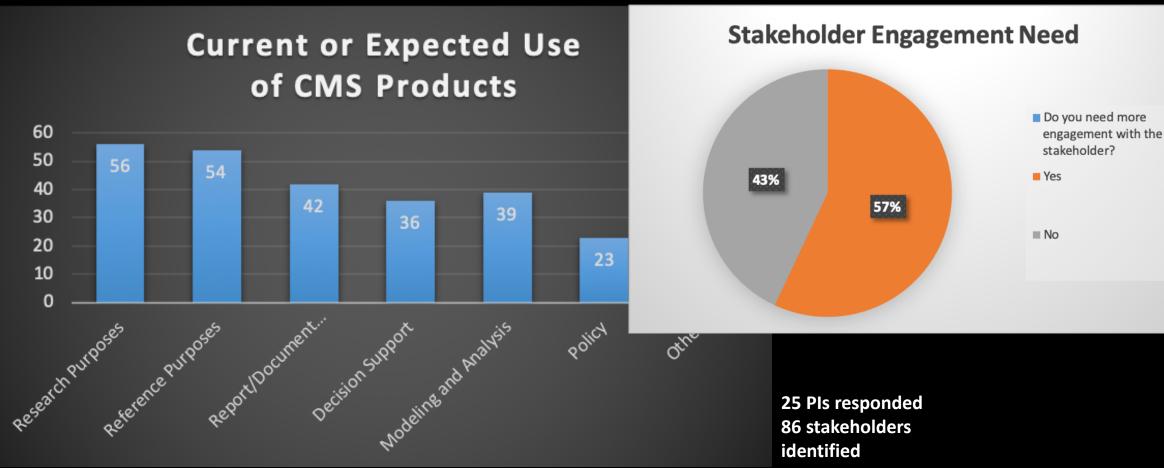
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30

20

10

0



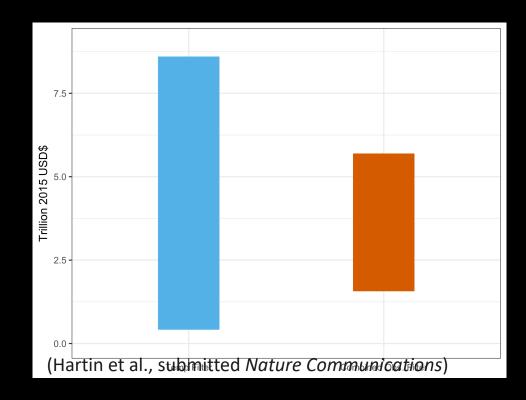
### CMS Stakeholder Survey for Science Team

- Main stakeholders: USDA Forest Service, US EPA, NOAA, CA ARB
- Not all stakeholders are using CMS data products at this moment
- All products, be research or operational products, have feedback potential



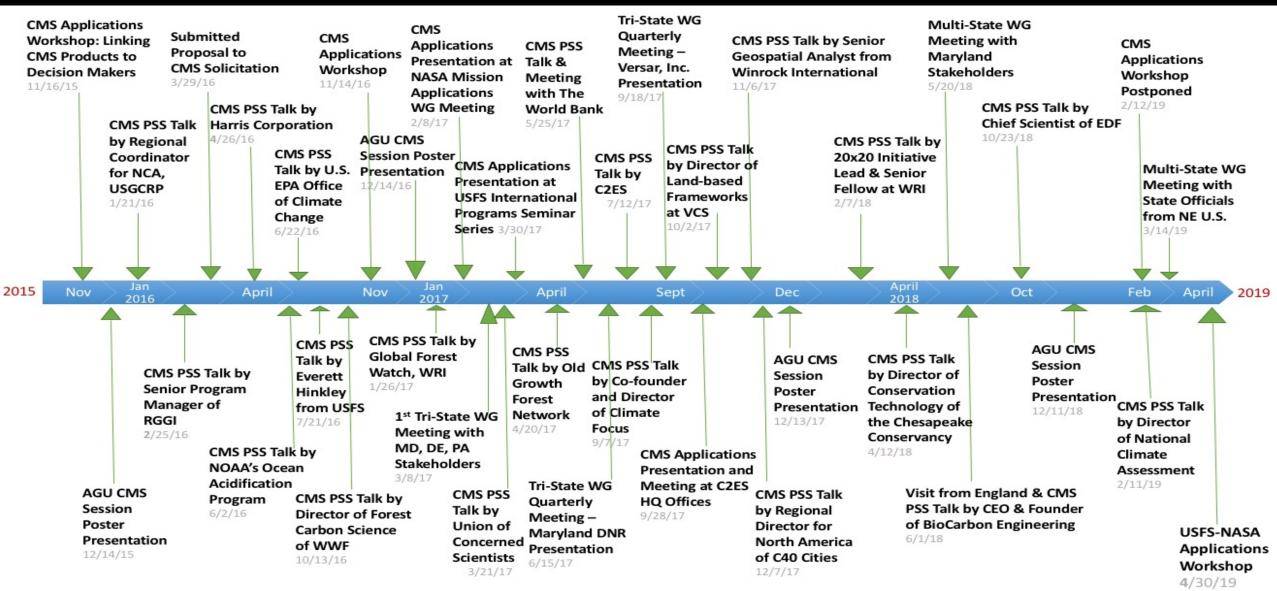
# Evaluating the economic impact of improving uncertainty in the carbon-climate system

- Coupled an economic model (GCAM) and simple climate model (Hector) together
- Three observational products (CO2, Temp, NPP) were used to narrow uncertainty in the climate system in reaching an RCP2.6 2100 target
- This translates to \$3 trillion USD
- Future plans will incorporate CMS data products





### Timeline of CMS Applications Efforts & Activities 2015-19





#### Stakeholders engaged by CMS Applications Efforts through Applications Workshops, Policy Speaker Series, and other engagement activities

The overarching objective of the applications effort is to broaden and strengthen the knowledge and engagement of the research and applications communities within the Carbon Monitoring System (CMS) Initiative.





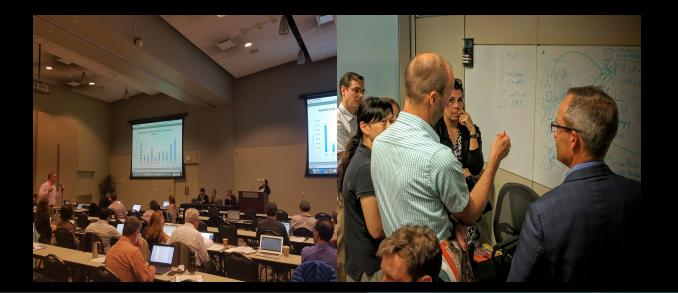
### **Discussion Questions for Workshop**

- How are you using the CMS data products?
- What application areas are been targeted?
- What are your decision making timelines?
- What are your carbon data needs and interests?
- What are some positive aspects of CMS data for your work?
- What scientific advancement(s) could contribute to your work?
  - What data do you need? When? Be as specific as possible.
- Are there any improvements that can be made short term? Accessibility, time domain, spatial scale, and frequency of data updates?
- What are other success stories you can share from partnerships/collaborations with CMS or other NASA missions?

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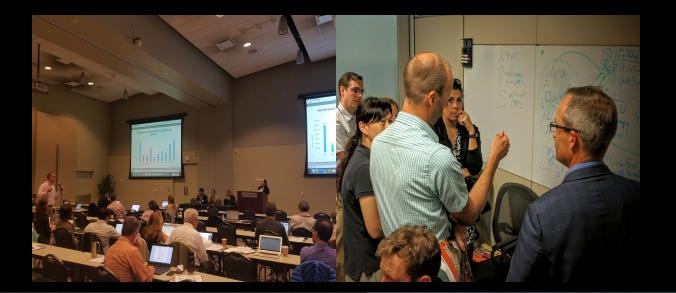
# Questions & Discussion Panel





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# Plenary Discussion: Stakeholder Engagement Efforts Moving Forward





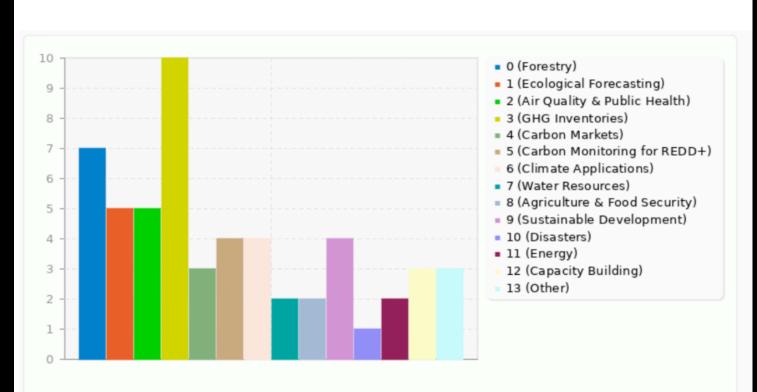
National Aeronautics and Space Administration NASA Carbon Monitoring System

### Stakeholder Feedback

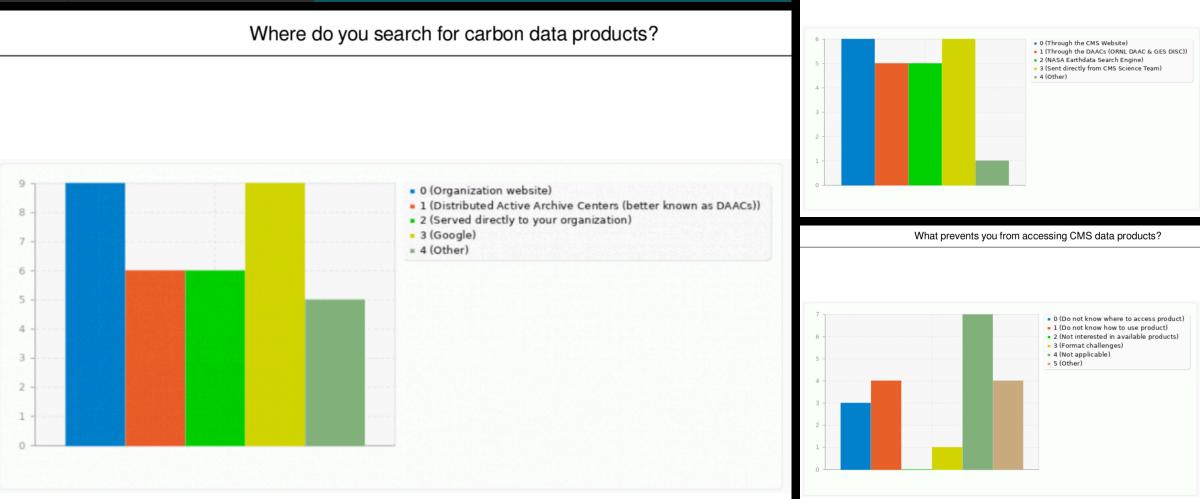
**Principal Applications** *GHG Inventories Forestry Ecological Forecasting Air Quality & Public Health* 



#### What are some of the applications you address with the carbon products?





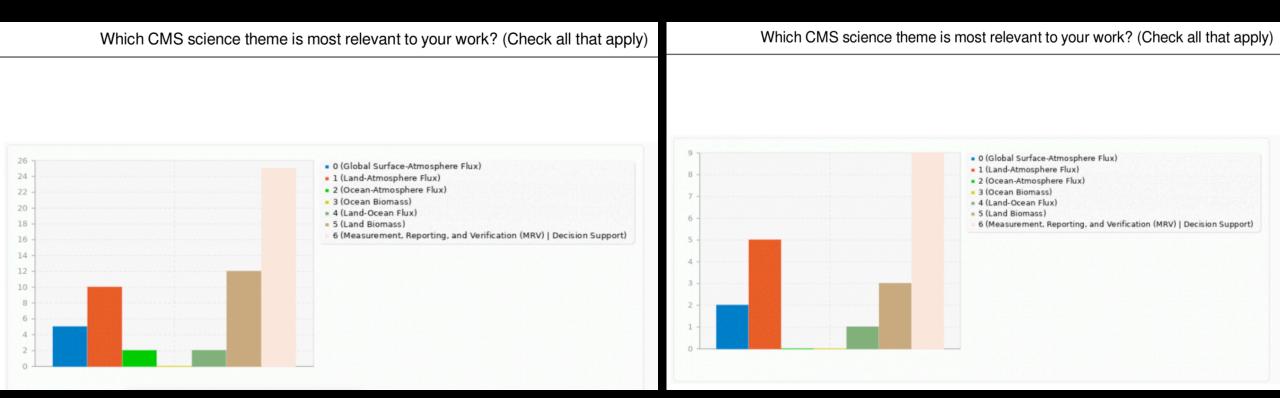


### Stakeholder Feedback



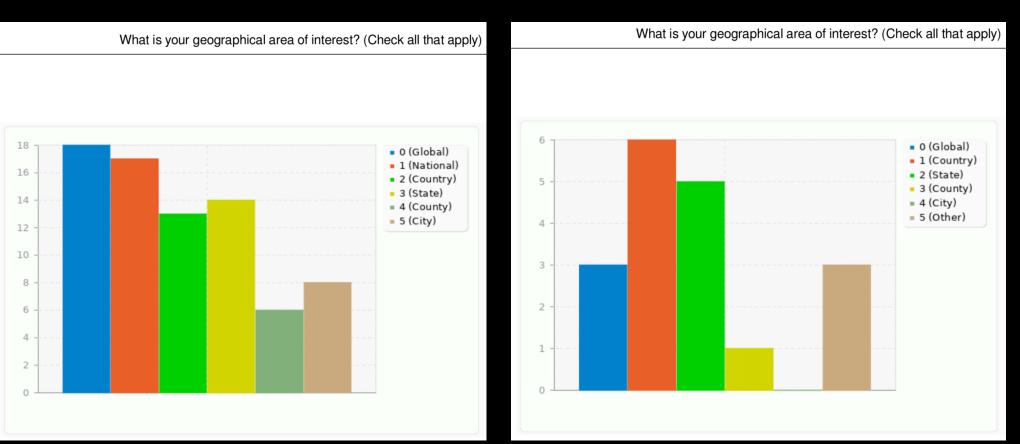
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## CMS Science Theme





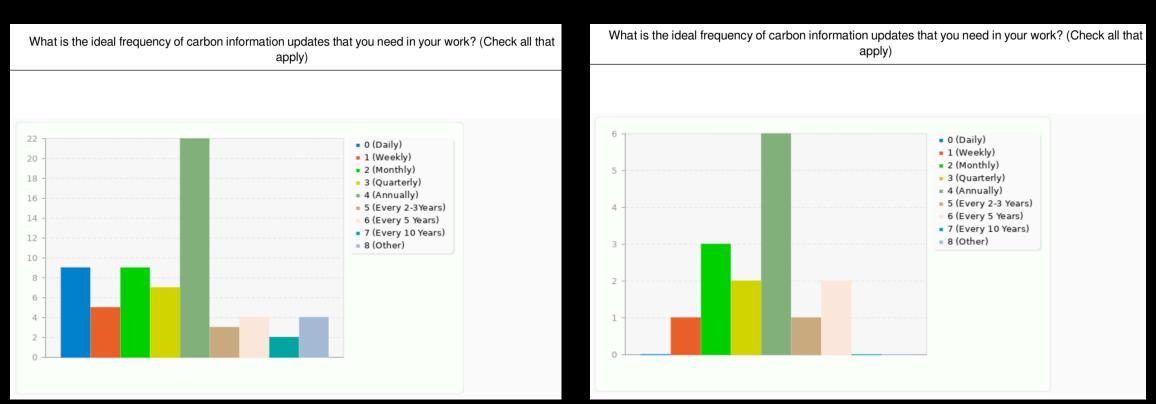
# Spatial Extent





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# Temporal Frequency



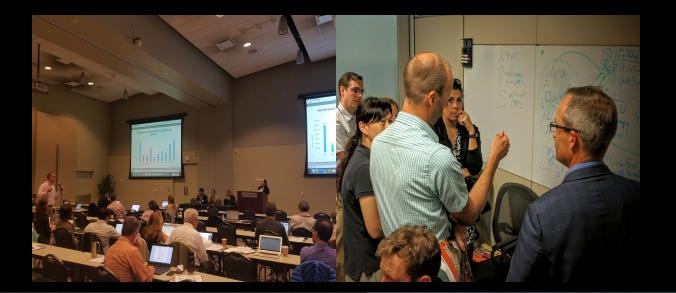


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### Data Format



# Plenary Discussion: Stakeholder Engagement Efforts Moving Forward





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### Outcomes & Actions Moving Forward

- Workshop Summary for The Earth Observer Newsletter and CMS Quarterly Newsletter January 2020
- CMS Applications Workshop Report/Proceedings February 2020
  - Stakeholders Interested in Contributing as Coauthors?
    - Provide Short Summary of Presentations
- CMS Stakeholder Fact Sheets with information about stakeholder organization, uses and applications, impact, and data needs – Spring 2020
- Agenda, Slides, Recording, and Report to be Published in CMS Website
- Potential Creation of CMS Stakeholder Working Group & Possible MoU with Stakeholder Organizations

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### Upcoming Events 2019-2020

- Oral and Poster Presentations at 2019 AGU Fall Meeting
- CMS Policy Speaker Series in 2020 at NASA GSFC
  - CMS PIs are welcome to provide recommendations
- CMS Thematic Workshops: Climate Restoration Workshop in Spring 2020
- Stakeholder Workshops for CMS Projects {e.g. Hurtt (CMS 2016)} March 2020
- Joint Workshops: NASA-USFS Applications Workshop April 2020
- More Data Tutorials for CMS Stakeholders in 2020
  - How to use CMS datasets and scenario-based exercises (DAACs & ARSET)

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