National Aeronautics and Space Administration

NASA Carbon Monitoring System

Overview of CMS Applications Efforts

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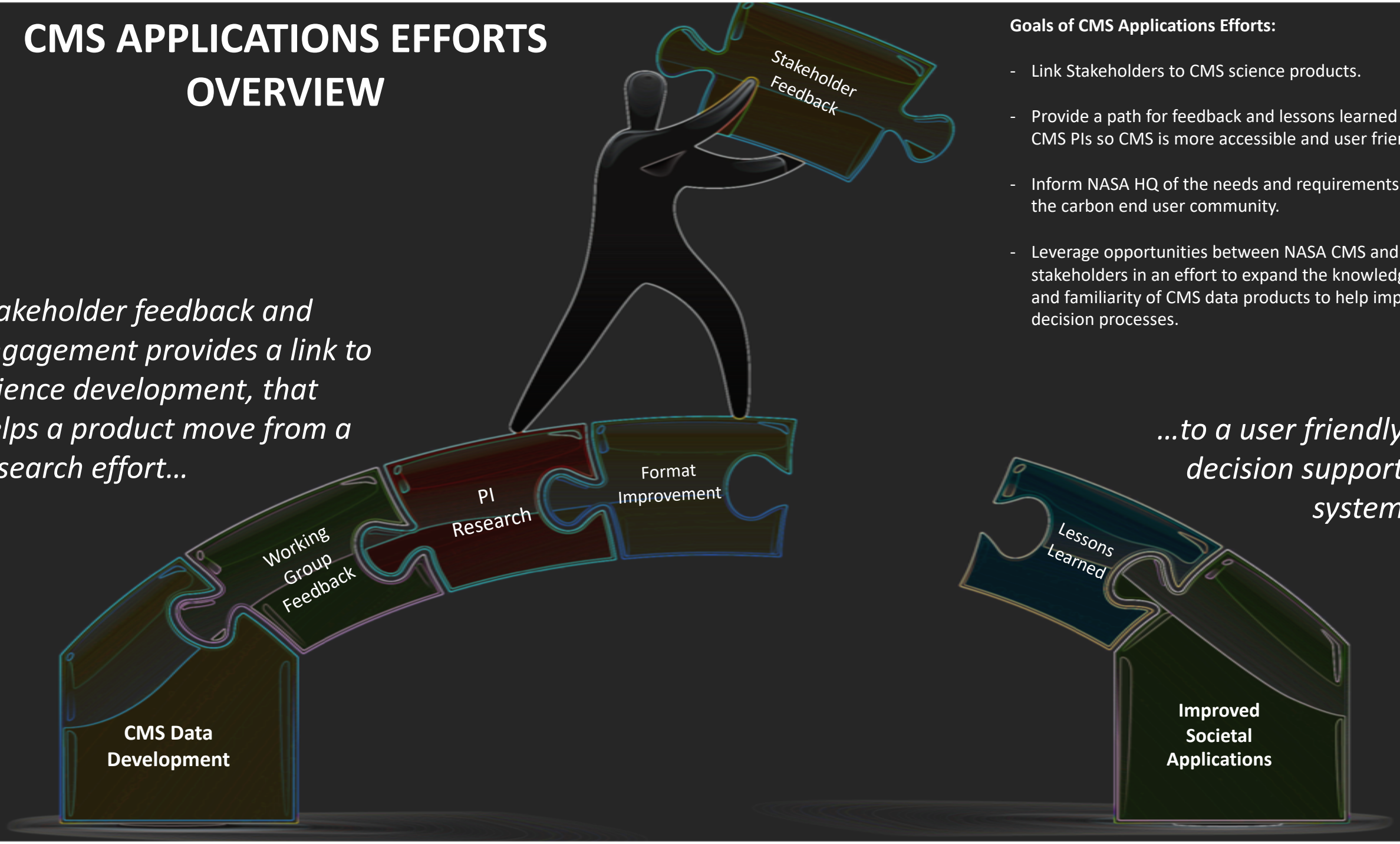
CMS Applications Workshop 2019 – La Jolla, CA
Tuesday, November 12, 2019

CMS APPLICATIONS EFFORTS OVERVIEW

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



…to a user friendly decision support system

Goals of CMS Applications Efforts:

- 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.

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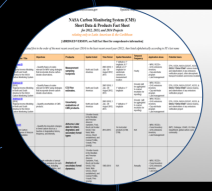
CMS Applications Program Framework

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

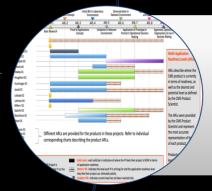
Annual event with CMS Science Team and end users for a better understanding of stakeholder uses, needs and challenges for carbon monitoring and MRV as well as lessons learned.



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.

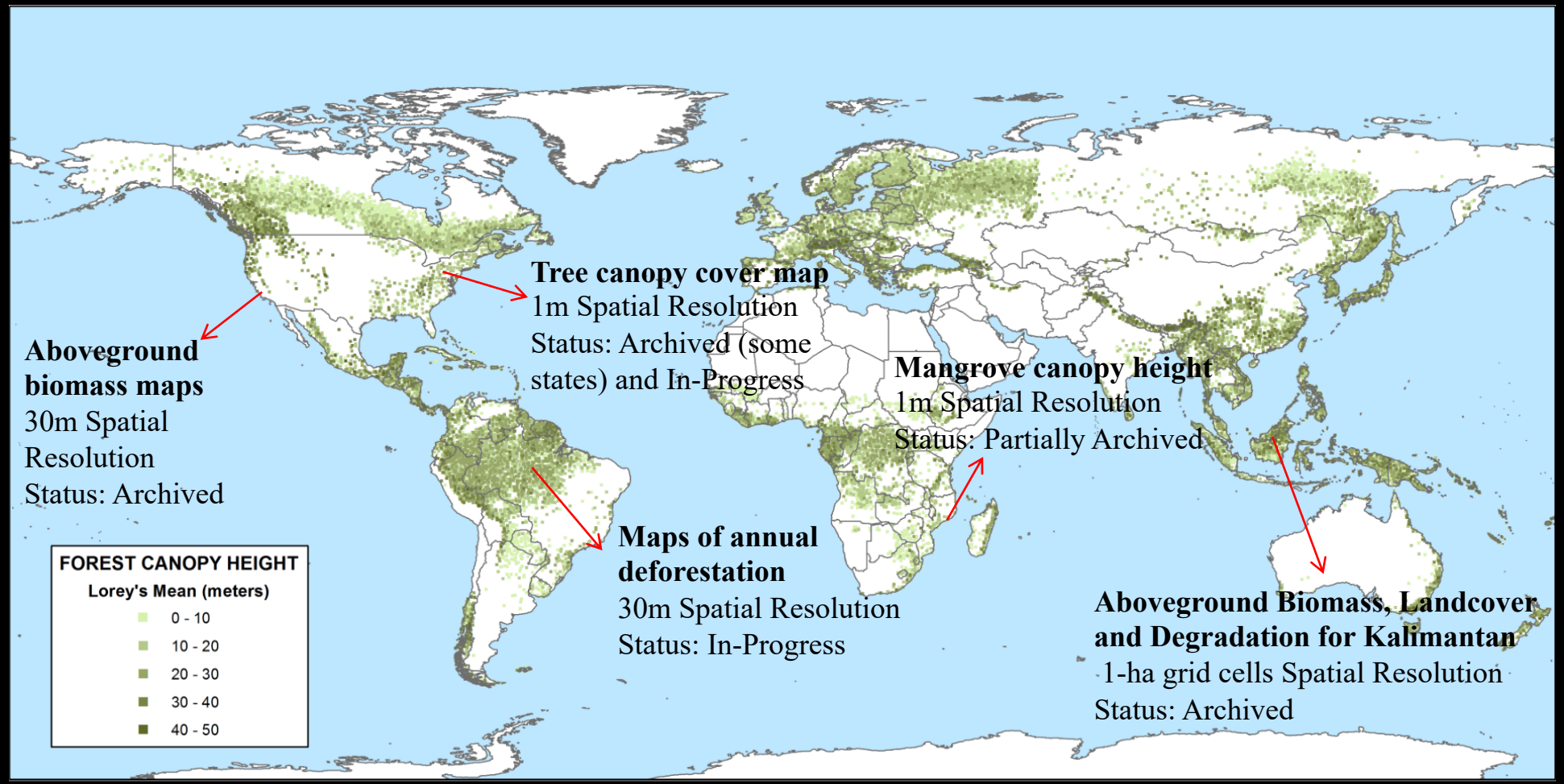
Socioeconomic Studies

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 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.

CMS Data Products

96 Projects
312 Data Products
Local to international scale



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

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

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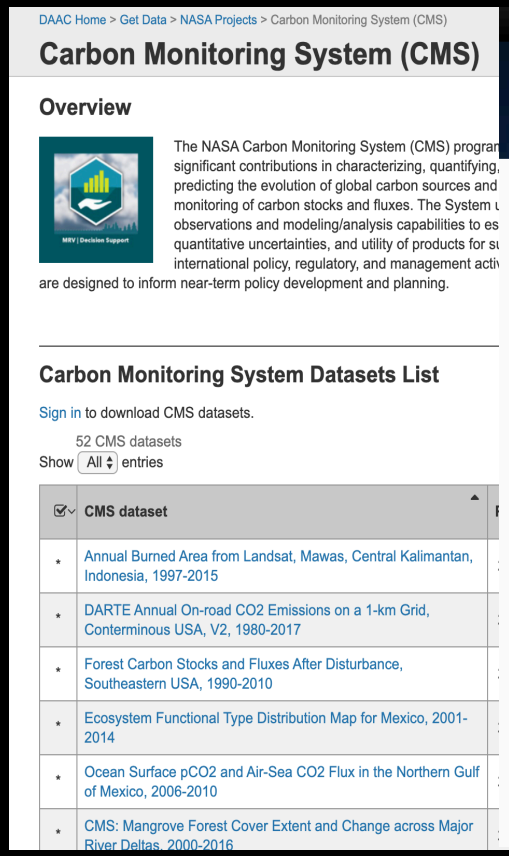
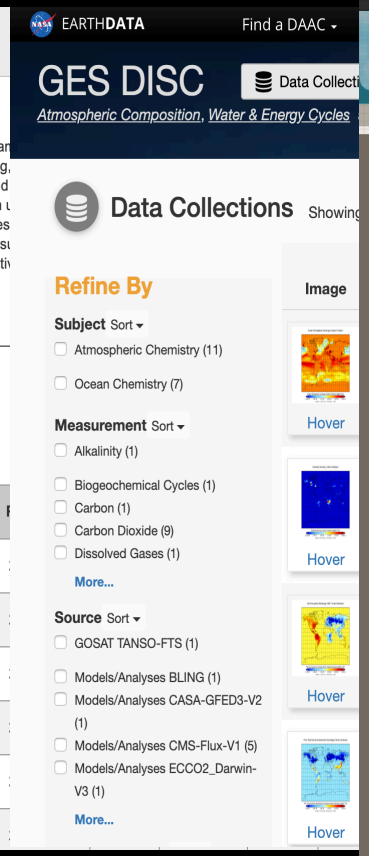
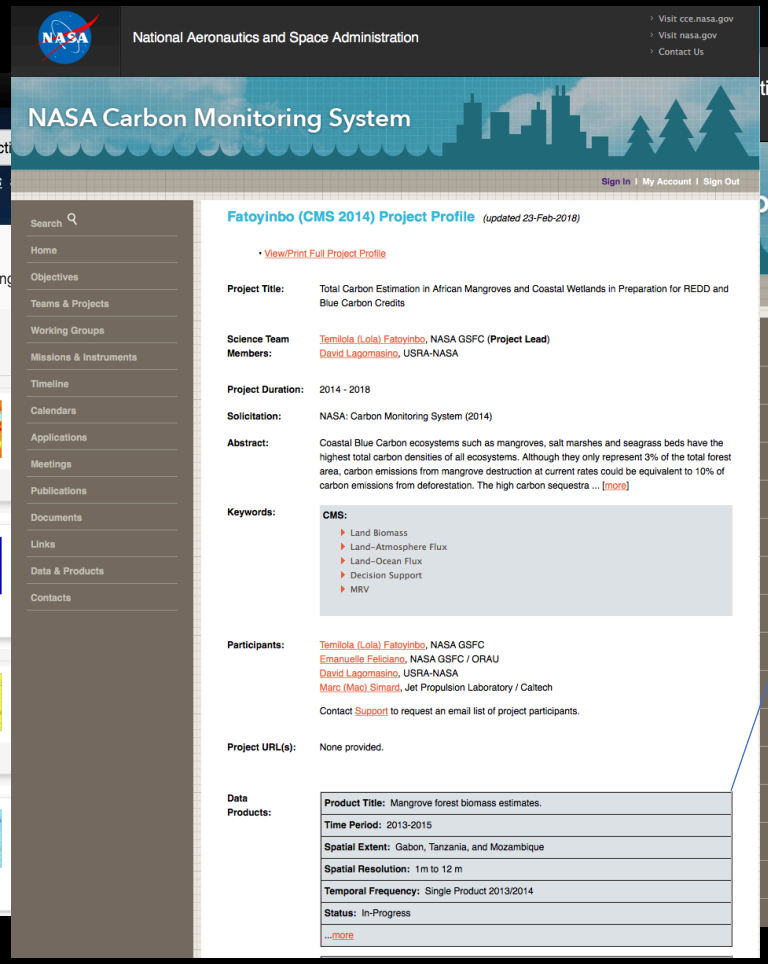
Overview of CMS Data Products

- Where can CMS datasets be found?







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 was 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. Detailed explanation. 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

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

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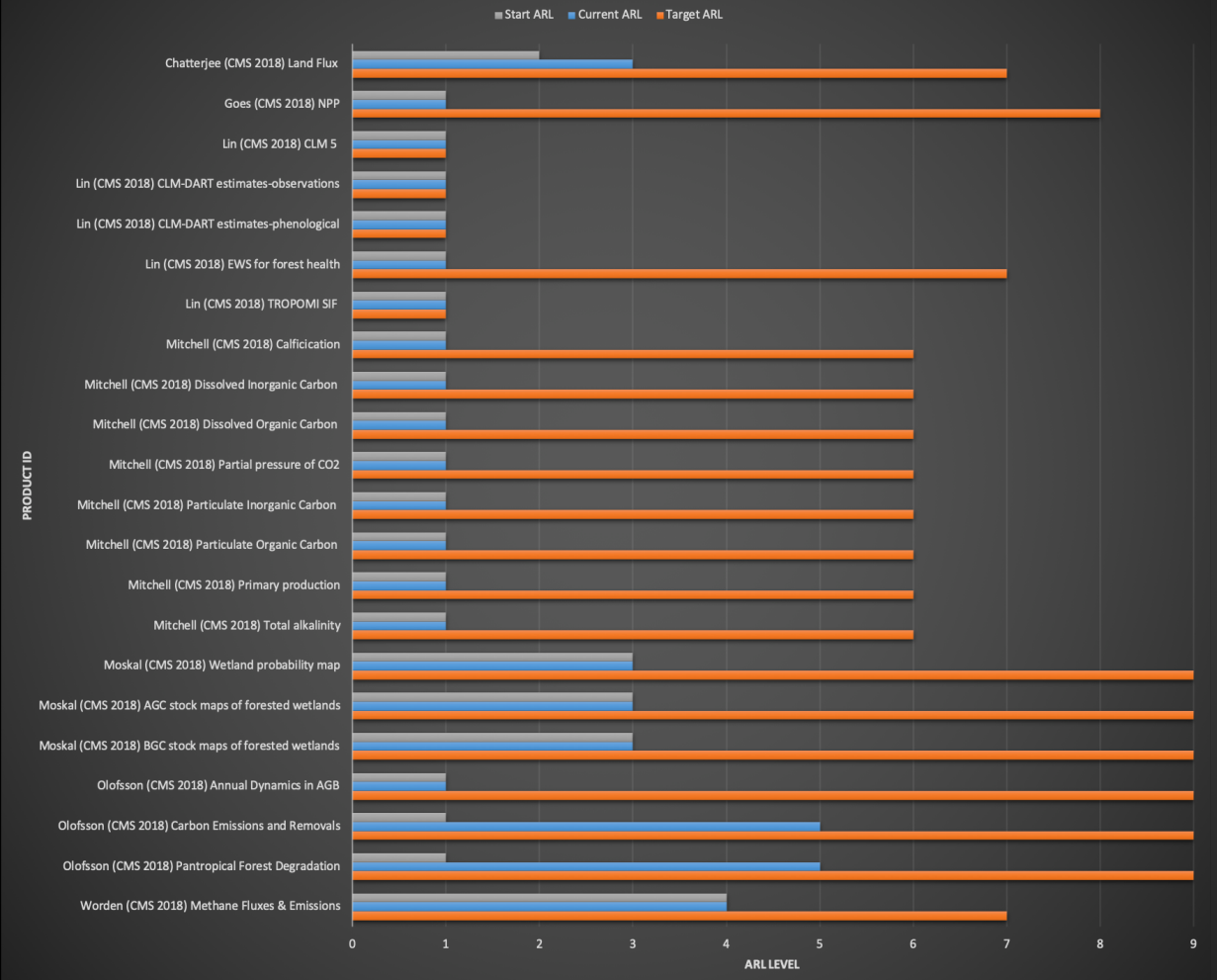
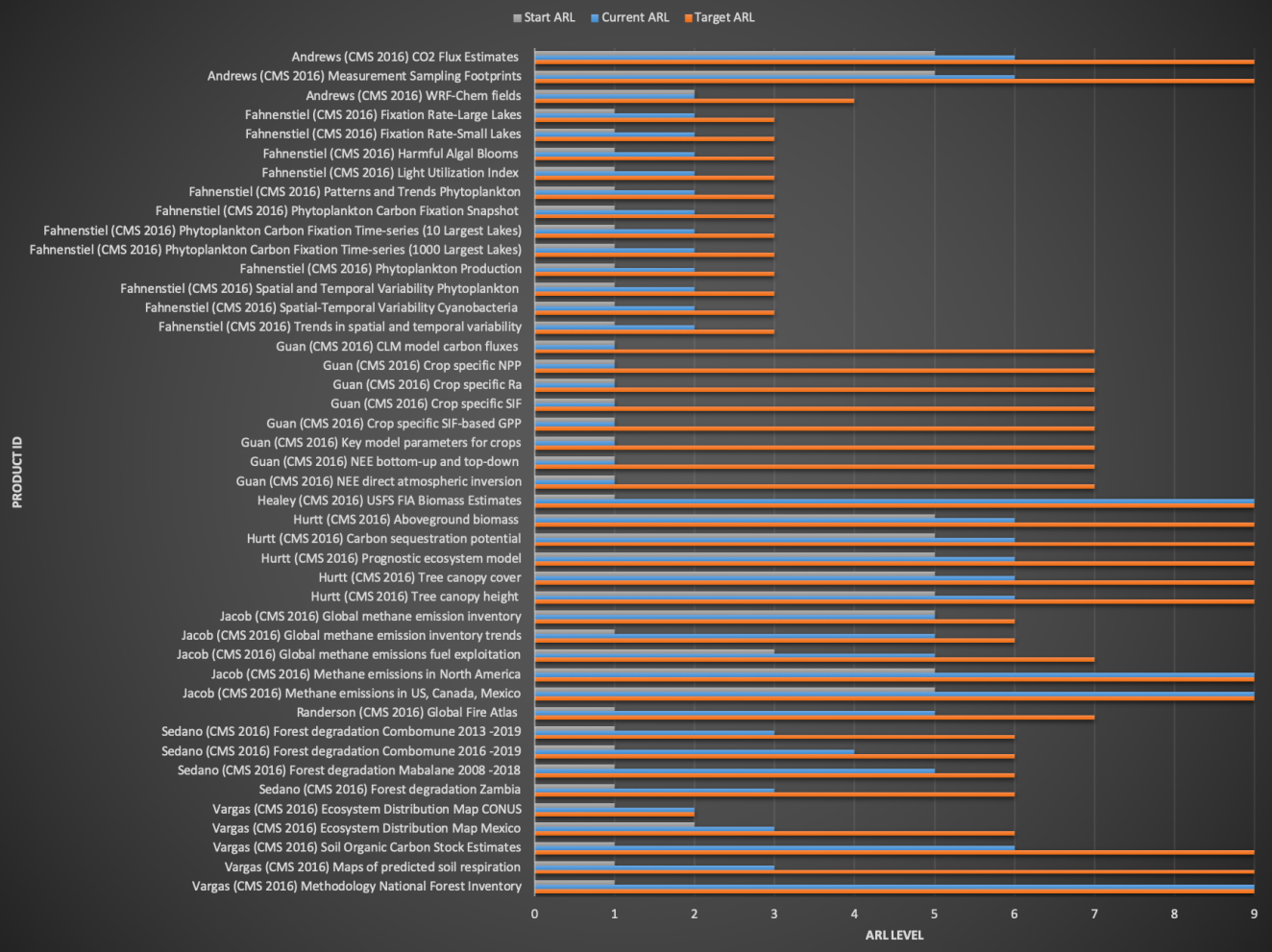
2018 Projects ARLs by Product

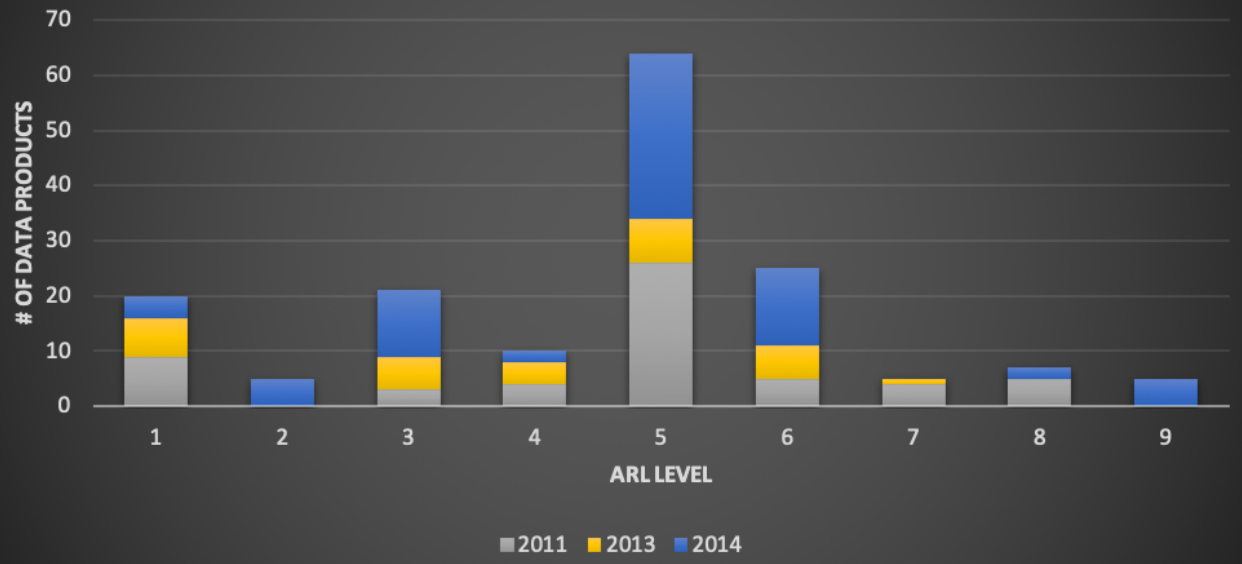


2016 Projects ARLs by Product

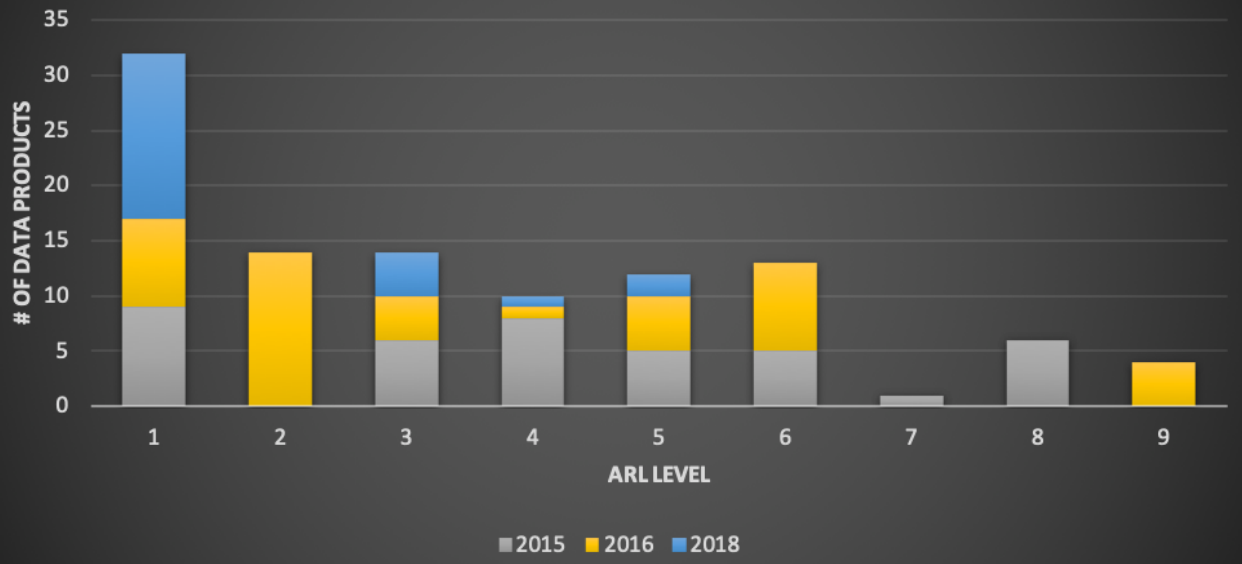


2011-2018 CMS Data Products by Current ARL

2011-2014 CMS Data Products by Current ARL

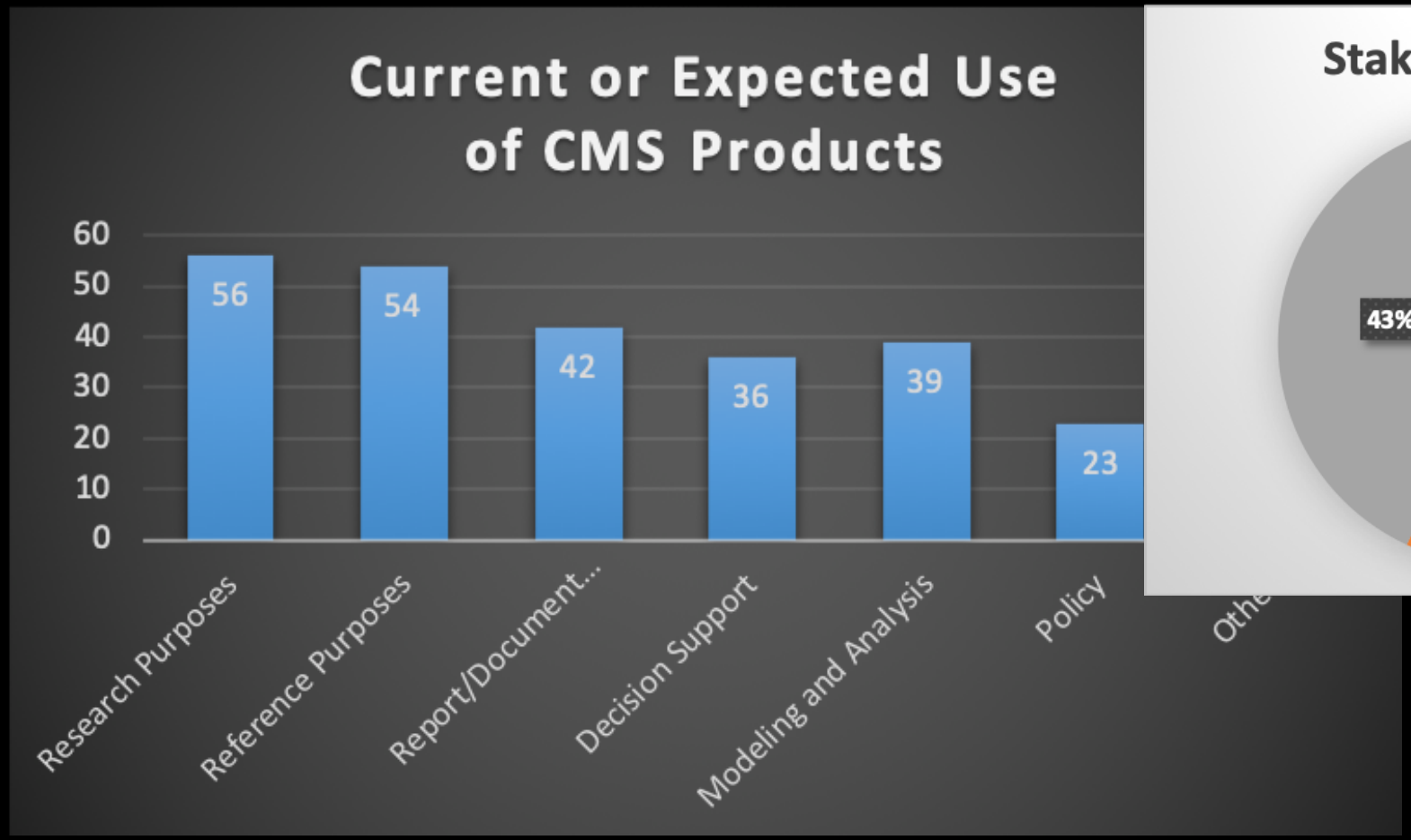


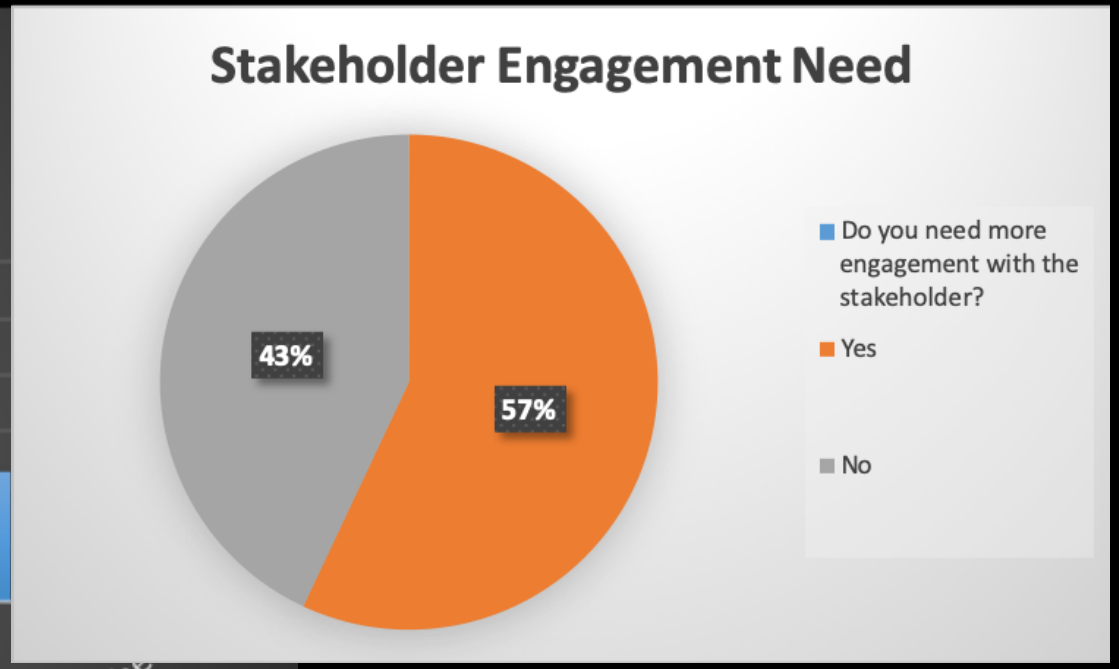
2015-2018 CMS Data Products by Current ARL



ARL LEVEL

2011 2013 2014 2015 2016 2018





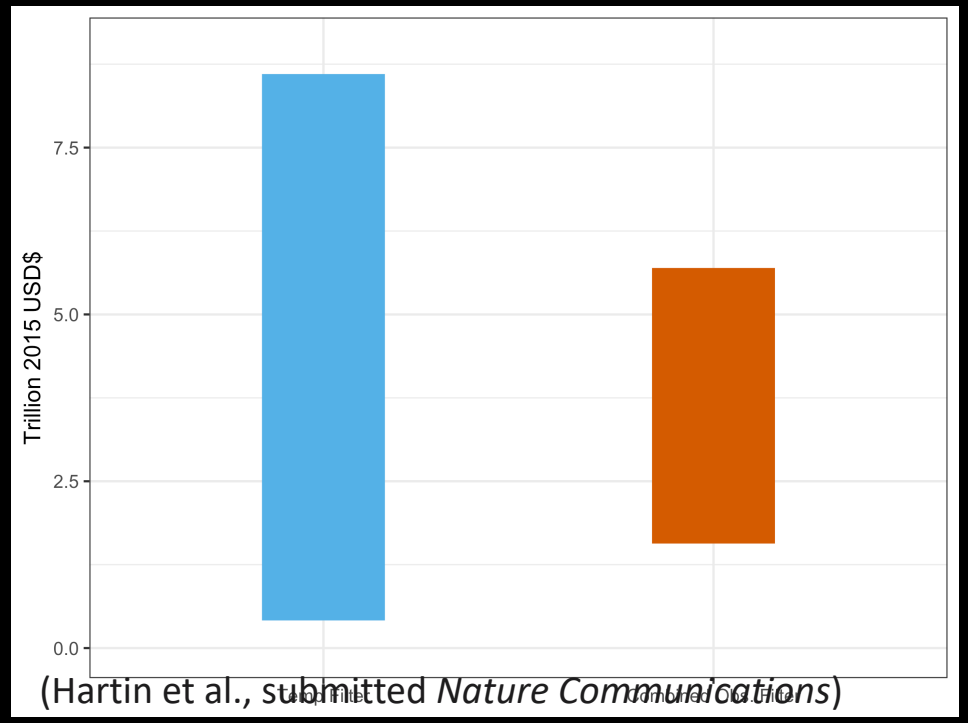
25 PIs responded
86 stakeholders identified

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

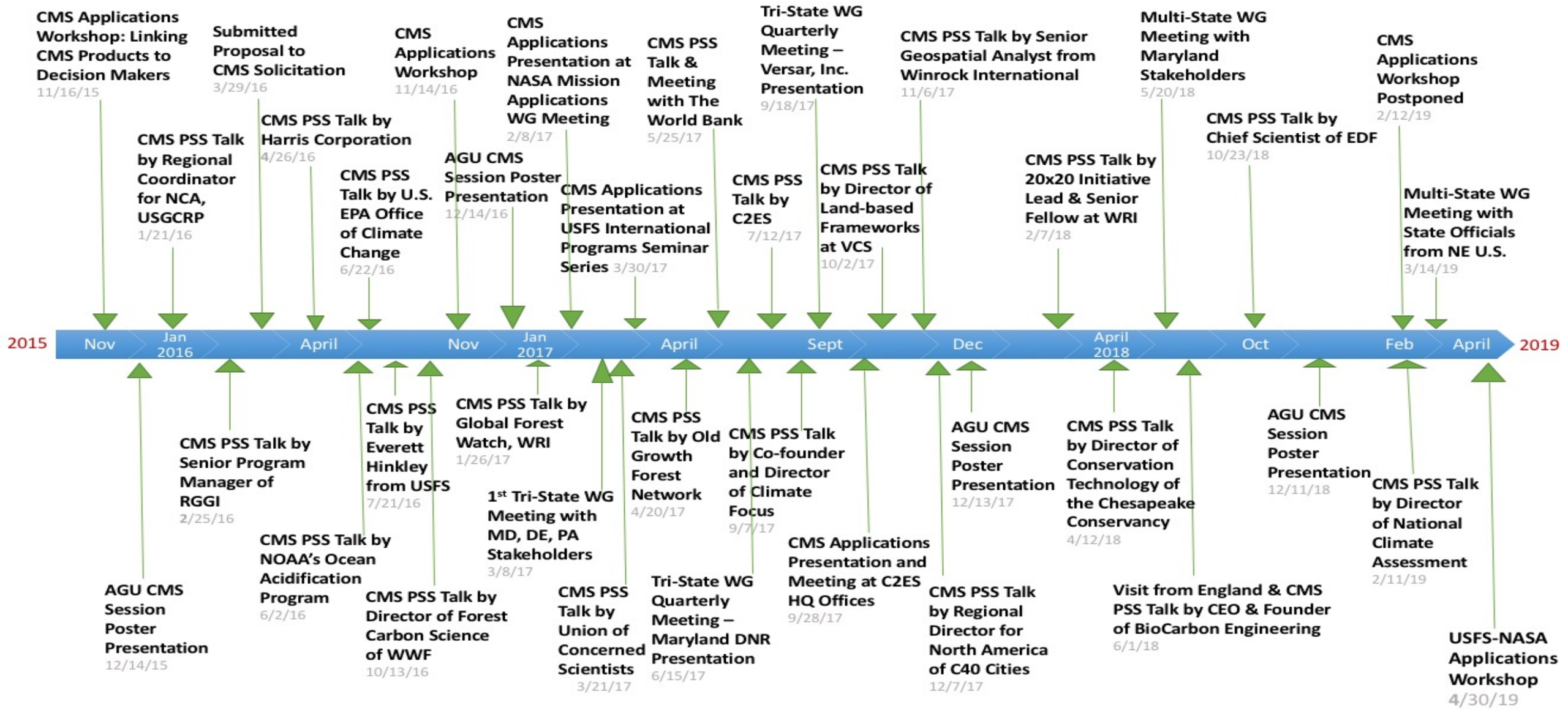
Evaluating the economic impact of improving uncertainty in the carbon-climate system

- 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



(Hartin et al., submitted *Nature Communications*)

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

Plenary Discussion: Stakeholder Engagement Efforts Moving Forward

Stakeholder Feedback

Principal Applications

GHG Inventories
Forestry
Ecological Forecasting
Air Quality & Public Health

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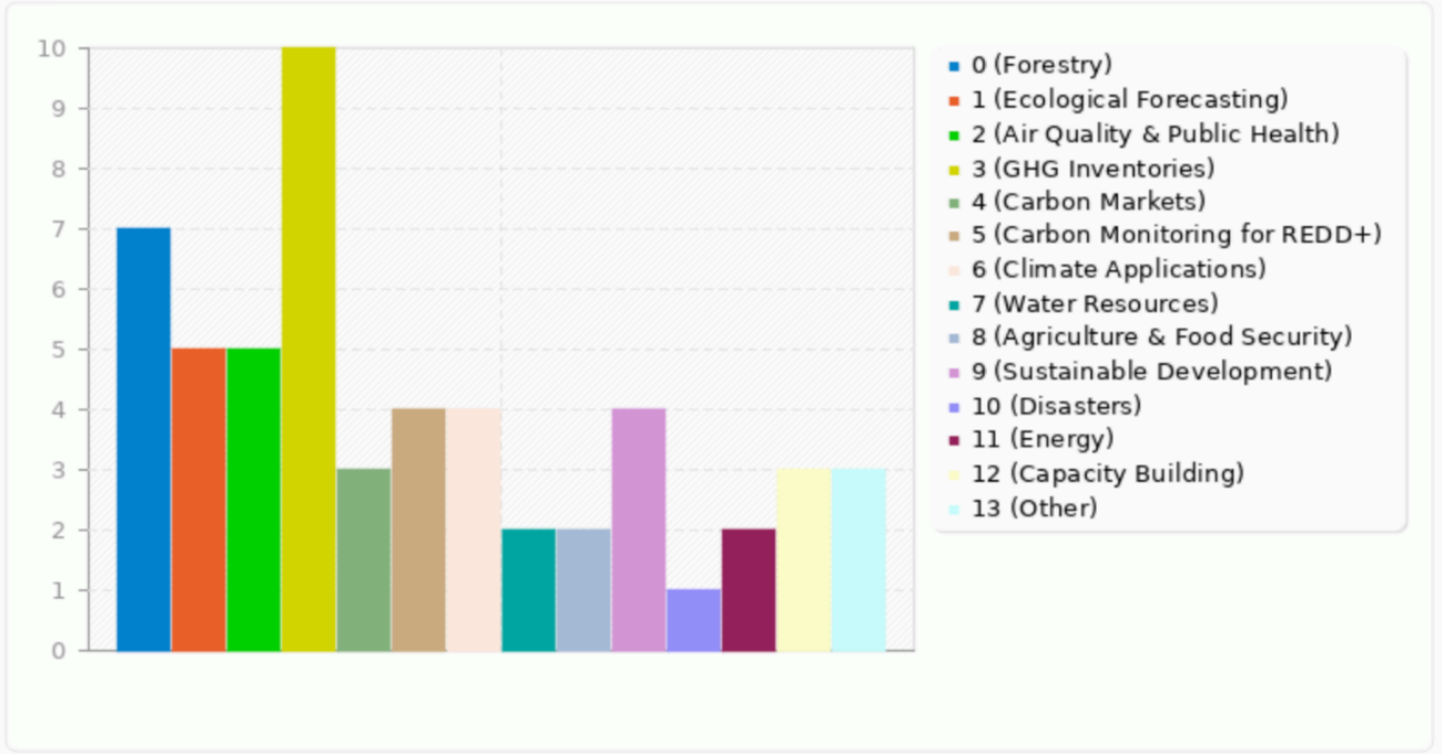
What are some of the applications you address with the carbon products?



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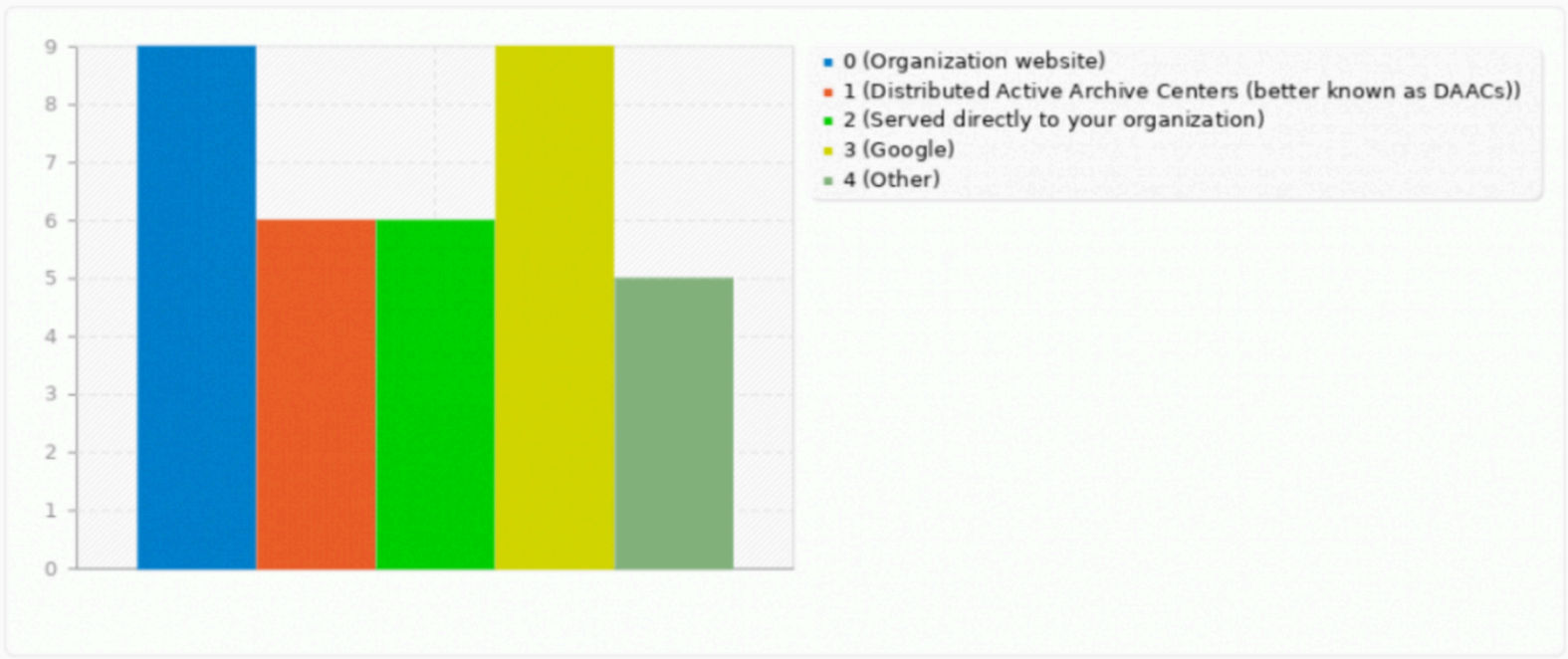
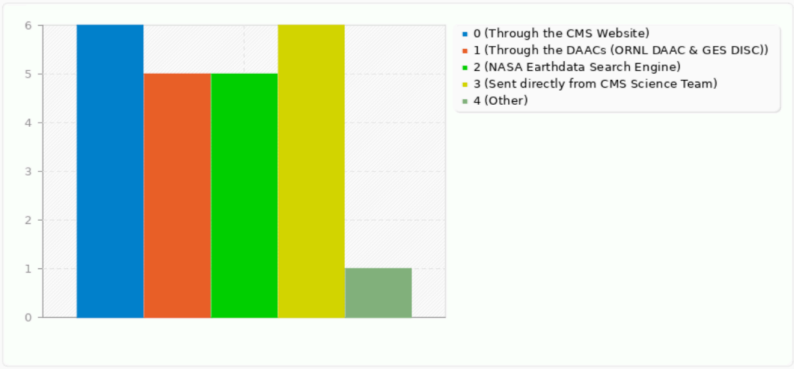
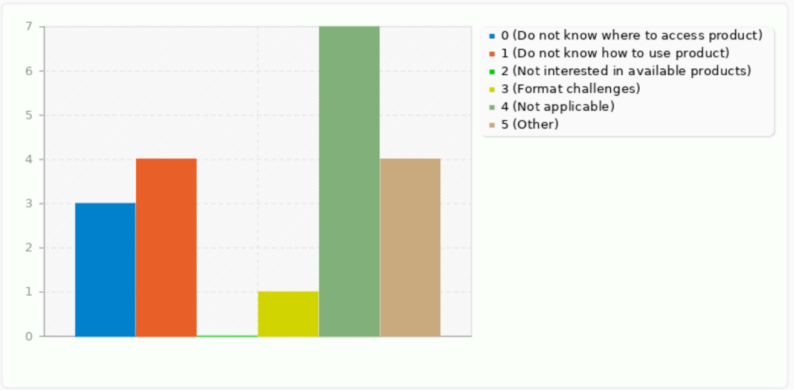
Where do you search for carbon data products?



How do you access the products?



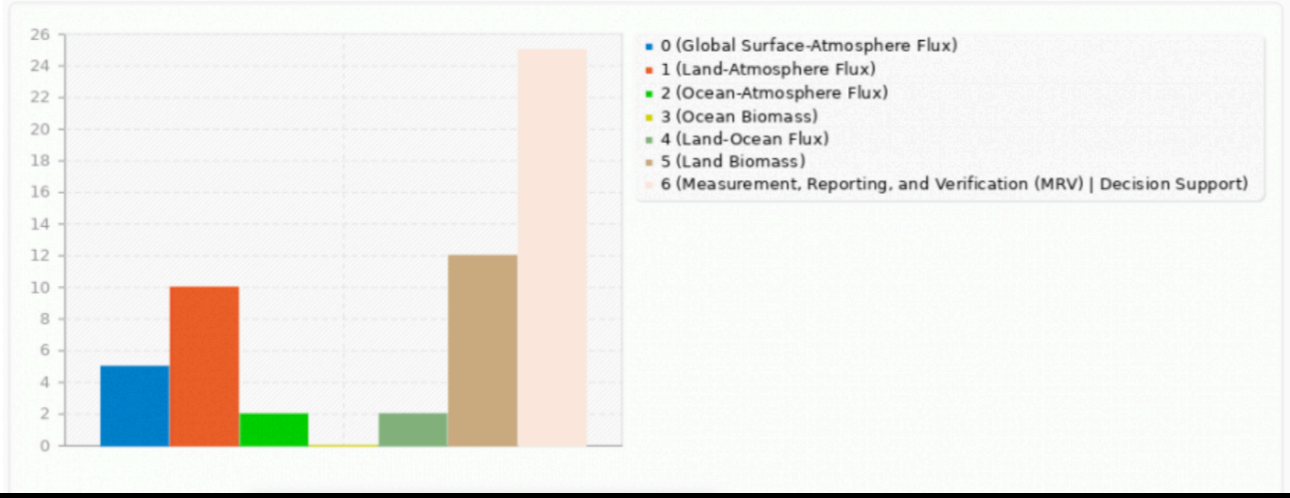
What prevents you from accessing CMS data products?



Stakeholder Feedback

CMS Science Theme

Which CMS science theme is most relevant to your work? (Check all that apply)



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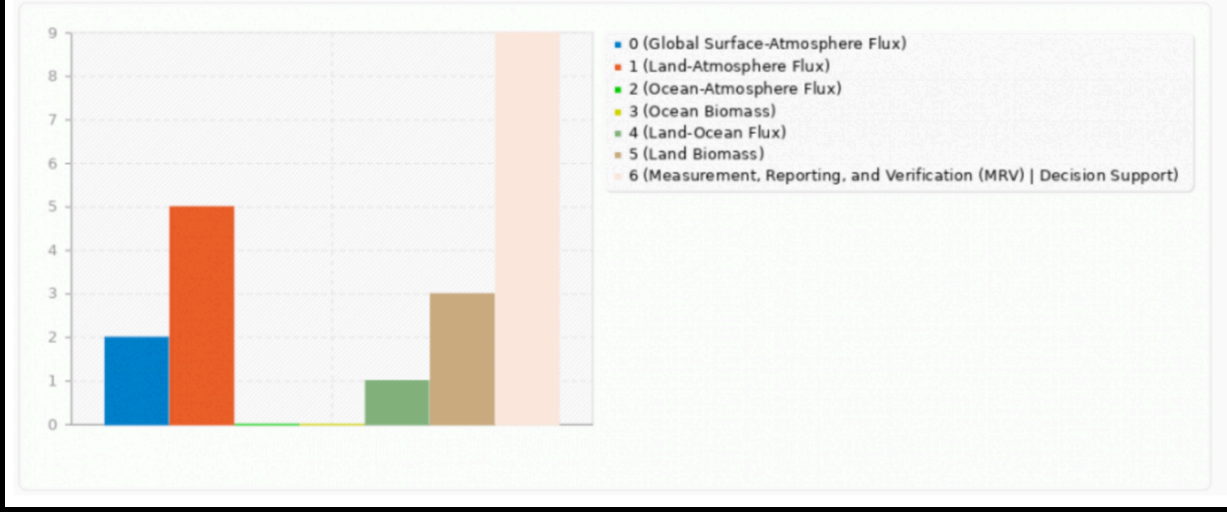
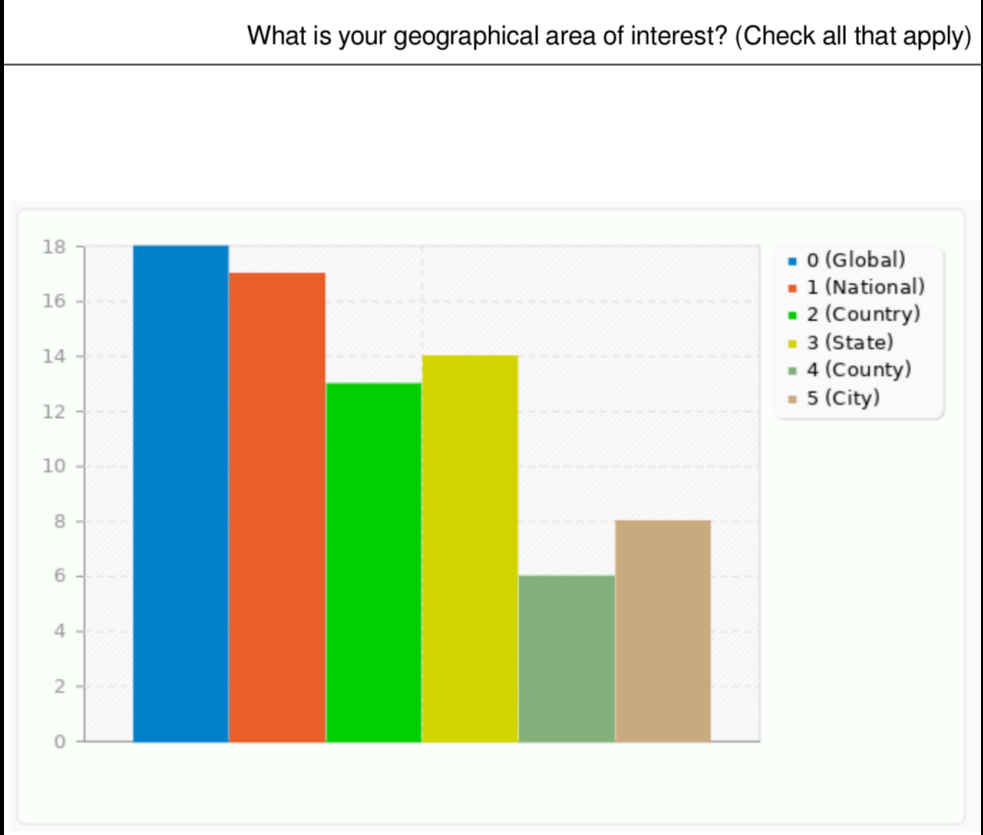
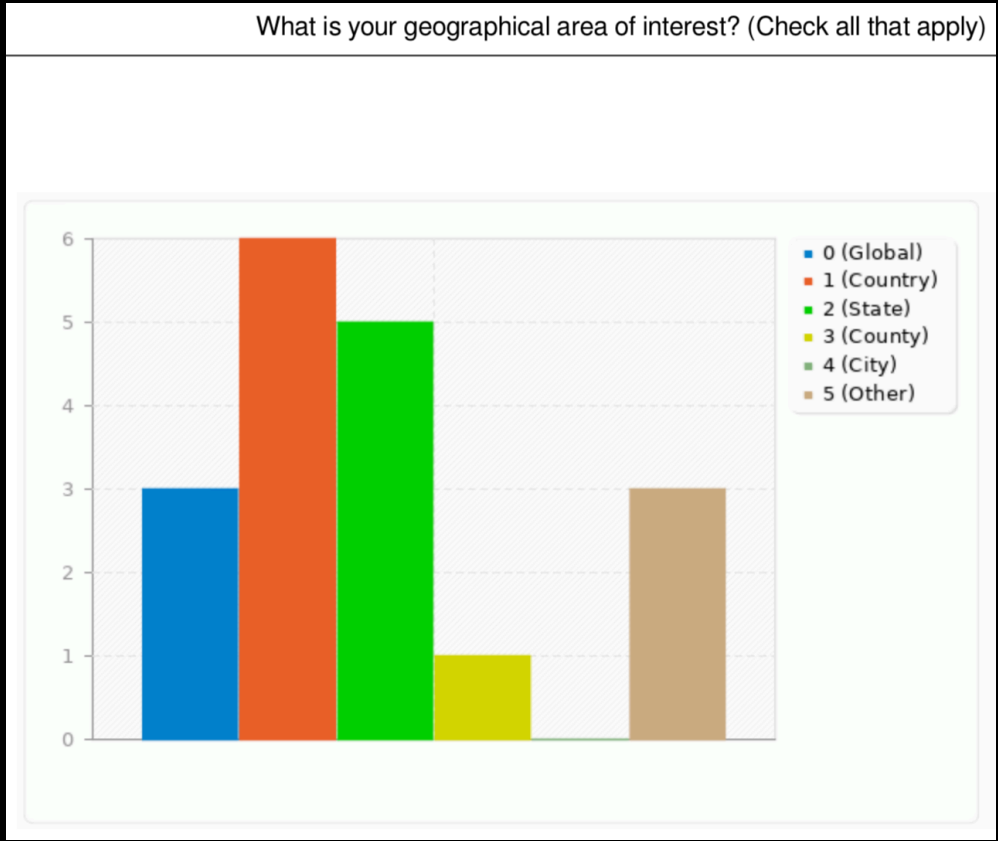


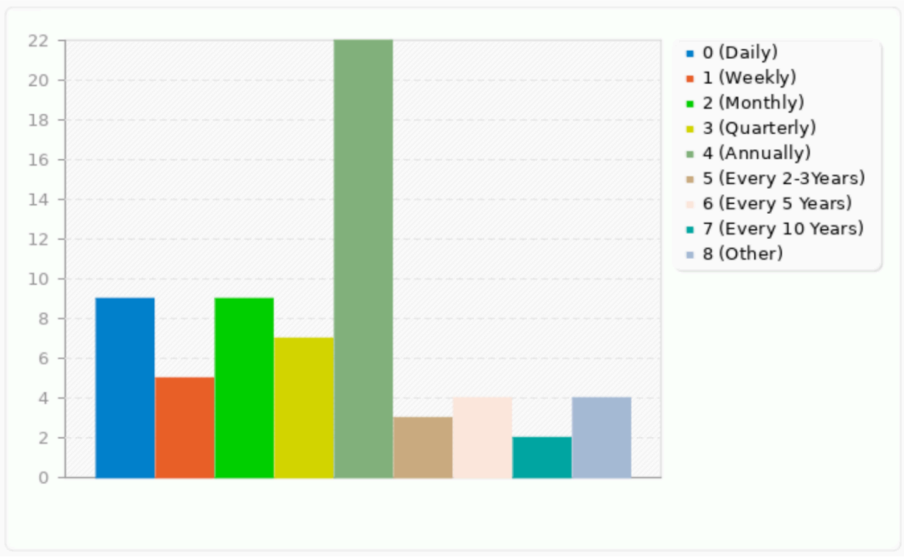
Spatial Extent





Temporal Frequency

What is the ideal frequency of carbon information updates that you need in your work? (Check all that apply)



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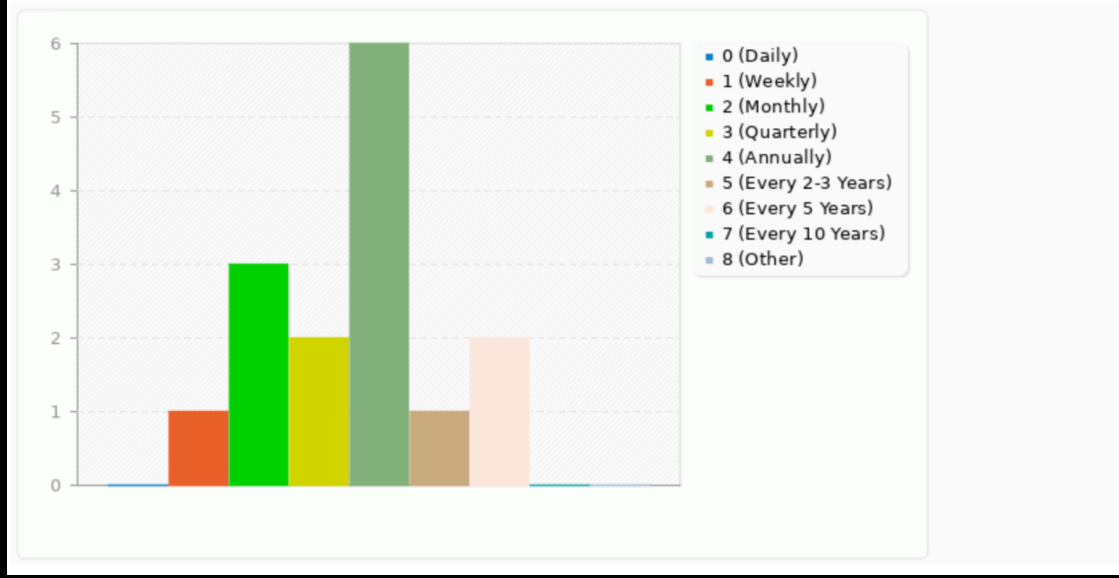
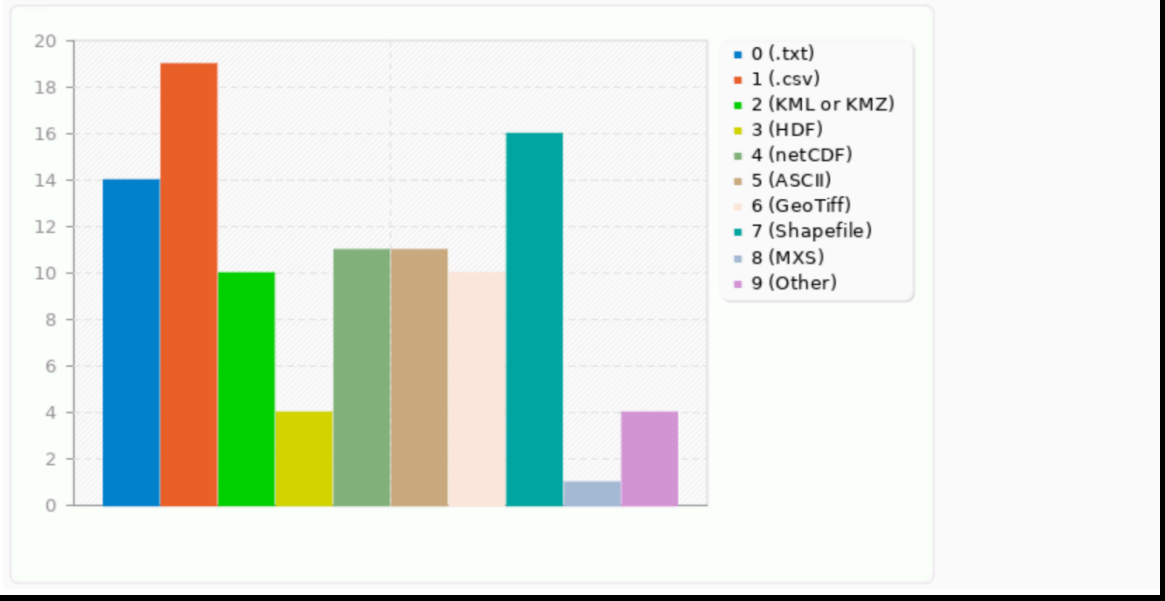


Data Format

With regards on data modeling and processing for your organization, what is the ideal data format for your work? (Check all that apply)



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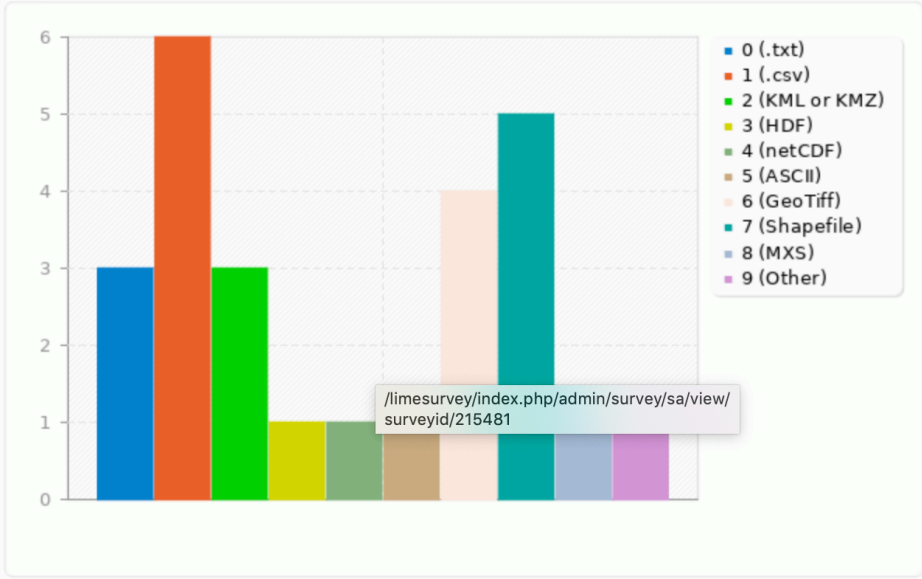

Plenary Discussion: Stakeholder Engagement Efforts Moving Forward

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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