NASA Carbon Monitoring System (CMS)
Multi-State Working Group Quarterly Meeting Report

Thursday, March 14, 2019

Meeting Focus: "Scaling Up the High Resolution Carbon Monitoring and Modeling Products to the Northeast U.S.: Discussion of Climate Action Plans, Current Carbon Monitoring Strategy, and Carbon Monitoring Needs and Interest for Stakeholders in the States of New York, Massachusetts, and Vermont"

26 Participants: **Edil Sepulveda Carlo**, SSAI/NASA GSFC; **George Hurtt**, UMD; **Maddie Guy**, UMD; **Jarlath O'Neil-Dunne**, UVT; **Andrew Lister**, USFS; **Elliott Campbell**, MD DNR; **Rachel Marks**, UMD; **Lelsey Ott**, NASA GSFC; **Suzanne Hagell**, NYS DEC; **Jeff Mapes**, NYS DEC; **James Wilcox**, NYSERDA; **Colin Beier**, SUNY ESF; **Hong-Hanh Chu**, MA EOEEA; **Robert O'Connor**, MA EOEEA; **Bennet Leon**, VT DEC; **Brian Woods**, VT DEC; **Collin Smythe**, VT DEC; **Keith Thompson**, VT DFPR; **Danielle Fitzko**, VT DFPR; **Don Strebel**, Versar, Inc.; **Rachel Riemman**, USFS; **Ritvik Sahajpal**, UMD; **Sabrina Delgado Arias**, SSAI/NASA GSFC; **Rob Feldt**, MD DNR; **Shannon Kennedy**, UMD; **Tom Chi**, Investor

I. Executive Summary

On March 14th, 2019, CMS scientists and invited stakeholders participated in the first Multi-State Working Group Quarterly Meeting of 2019. The objectives of the Multi-State Working Group Quarterly Meeting were:

- Provide stakeholders with the opportunity to discuss updates of policies, programs, and initiatives that could benefit from CMS carbon data products
- Determine how CMS can contribute science to inform policy
- Provide state officials with ideas on applications of the CMS data products in their respective states

Following an introduction and overview of the CMS data products produced by this team, as well as a data use-case discussion from the Maryland Department of Natural Resources, state representatives from New York, Massachusetts, and Vermont were asked to discuss their respective state's climate action plans, current carbon monitoring strategy, and carbon monitoring needs and interests. Key takeaways from the states' presentations were:

- Interest in forest carbon/carbon monitoring
- Need for better science information on current and potential future carbon stocks
- Desire to coordinate approaches to this topic

Information learned from this meeting was used to update a multi-state forest carbon science/policy table, appended at the end of this report. This draft table presents a summary of each state's policy framework, goal, science (land), and science needs (land), and will be updated

as discussions with more states continue. These discussions will be continued through additional meetings planned for later this year and next, to which participants of this call are encouraged to attend. A paper/report is also planned to be produced.

II. Welcome and Introduction

Edil Sepulveda Carlo, CMS Applications Coordinator at NASA Goddard Space Flight Center, gave a welcome and introduced participants to the objectives of the Multi State Working Group, as well as presented the goals and discussion topics and questions for this meeting. The Multi-State Working Group is comprised of NASA Carbon Monitoring System scientists and carbon data end users from the northeastern United States. The working group was originally created at the 2016 NASA-CMS & USFS Applications Workshop & Tutorial held at Newtown Square, Pennsylvania as the Tri-State Working Group.
The overarching goal of the new Multi-State Working Group is to share stakeholder perspectives and needs and relevant scientific advances for forest carbon monitoring and modeling. The working group provides a focused opportunity to continue and expand discussions on lessons learned, identify common needs and solutions, and make progress in incorporating science into policy and decision making. The objectives of the Multi-State WG Quarterly Meetings are the following:

- Provide stakeholders with the opportunity to discuss updates of policies, programs, and initiatives that could benefit from CMS carbon data products
- Determine how CMS can contribute science to inform policy
- Keep awareness of CMS updates

The focus of this meeting was to provide a science overview of the new products being developed for eleven northeastern states of the Regional Greenhouse Gas Initiative plus region (RGGI+), highlighting lessons learned from stakeholders in Maryland currently using CMS data products, and providing the opportunity to state officials from New York, Massachusetts, and Vermont to discuss climate change action plans and policies, as well as mandates and greenhouse gas reduction goals in their state. The expected outcome of this meeting was to provide new stakeholders from the northeastern United States with ideas on how to use the CMS data products for different applications in their geographic areas of interest.

III. Science Progress, Updates and Plans from NASA CMS Science Team

CMS scientists George Hurtt (PI, University of Maryland), Jarlath O'Neil-Dunne (University of Vermont), and Andrew Lister (US Forest Service) provided an over view of the CMS science and data products. The new multi-state project (Hurtt CMS-2016) aims to increase accuracy of high spatial resolution forest carbon monitoring and planning in the eleven state RGGI+ region, as well as develop a national prototype, using data from the NASA Global Ecosystem Dynamics Investigation (GEDI) mission [https://science.nasa.gov/missions/gedi]. The eleven state RGGI+ region consists of Maryland, Pennsylvania, Delaware, New York, Vermont, Massachusetts, New Jersey, Connecticut, Rhode Island, New Hampshire, and Maine.

The following products are being developed for 11 Mid-Atlantic and Northeastern states: 0.5 and 1m canopy cover maps (1km canopy cover at national level); 1m canopy height maps; 30m aboveground biomass maps with uncertainty; and 90m ecosystem modeling based maps of future carbon sequestration potential.

The USDA Forest Service is interested in the operational use of high-resolution carbon maps for monitoring purposes. Their interests include: identifying baseline carbon density at point locations using modeled carbon estimates; developing training data of carbon vs temporal profile indices; and developing machine learning models to estimate carbon loss at points based on temporal profile perturbations.

Elliott Campbell (Maryland Department of Natural Resources) presented an overview of how DNR has successfully implemented CMS data products into their workflow through close collaboration with the CMS team. CMS data are being used to inform to the state's Greenhouse Gas Reduction Act, which mandates the development of plan to reduce statewide emissions by 40% by 2030 and includes the land/forestry sector.

IV. Joint Quarterly Presentations: Discussion of Climate Action Plans, Current Carbon Monitoring Strategy, and Carbon Monitoring Needs and Interests from NY, MA, and VT

A. New York: "The role of forests in New York State's climate policy agenda"

Suzanne Hagell, Climate Policy Analyst in the Office of Climate Change at the New York State Department of Environmental Conservation, gave an overview of New York state's climate policy agenda and the role of forests in their climate action plans. New York State greenhouse gas (GHG) reduction goals can be found in the State Energy Plan and Executive Order 166. The long-standing goal is to reduce GHG emissions 80% below 1990 levels by 2050. The interim goal is to reduce GHG emissions by 40% below 1990 levels by 2030. The state does not monitor GHG emissions directly, with the exception of CO2 included as part of air pollution monitoring for specific sources. Progress towards reaching the GHG goals is approximated using activity data or scaling from the U.S. National GHG Inventory.

Based on the NYS GHG Inventory 1990-2015 seen in Figure 1, typically 80-90% of emissions are from fossil fuel combustion, however the proportion of non-combustion emissions is increasing as energy emissions are reduced and agriculture, waste, and HFC emissions stay flat or increase.

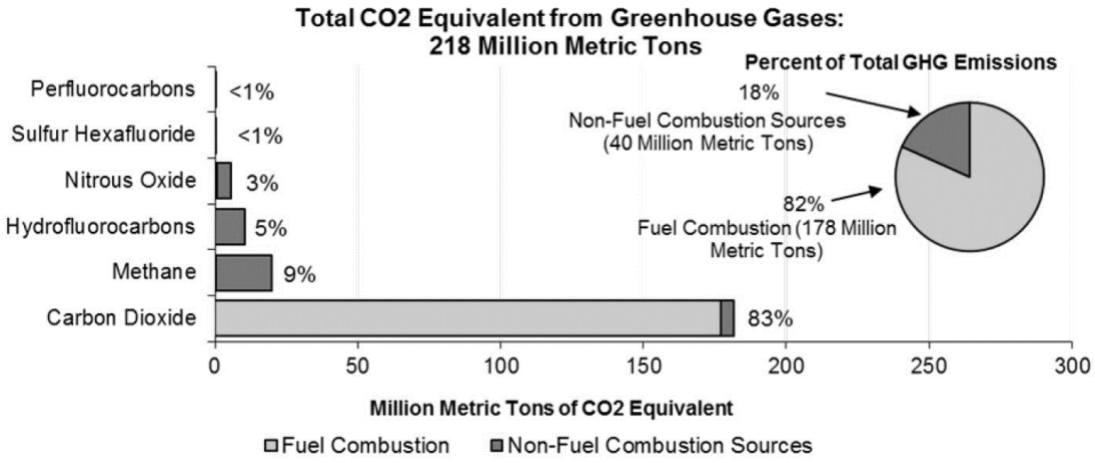

Figure 1: NYSERDA/DEC (2018) NYS GHG Inventory 1990-2015 (Source: Suzanne Hagell, NYS Office of Climate Change)

A challenge the state has is how to integrate carbon sequestration within the forest and agriculture sectors, which is currently not included in the GHG inventory. The state of New York has 19 million acres of forest, which equals 63% of the land area. The vast majority are privately owned (i.e. 14.4 million acres), and few of the private acres are under deliberate, professional forest management. Mostly indiscriminate harvesting that, among other detriments, does not allow the state to meet the potential for forests to sequester carbon.

Suzanne identified the following key issues and data needs for their state agency:

- Integrating forest sector into NYS climate strategy and GHG goals; and
- Developing NYS capacity to monitor and forecast net emissions
    1. Harvest modeling
    2. Model verification
    3. More progress for annual or decadal through 2050

B. Massachusetts: "Massachusetts Climate Law and its Related Forest Programs"

Hong-Hanh Chu, GWSA Implementation Program Manager, and Robert O'Connor, Forests and Land Policy Director, both at Massachusetts Executive Office of Energy & Environmental Affairs provided a detailed overview of the state's climate policies and forests programs that could be of interest for the NASA CMS efforts in the region. The Global Warming Solutions Act (GWSA) of 2008 is the landmark state legislation for Massachusetts relating to climate change mitigation efforts. It mandates a 25% reduction in statewide GHG emissions below 1990 baseline level by 2020, and at least a 80% reduction in statewide GHG emissions below 1990 baseline level by 2050.

They have a GHG Inventory 1990-2016, which tracks statewide GHG emissions from fossil fuel combustion, natural gas systems (CH4 leaks), industrial processes, agriculture, and waste, as well as tracks statewide carbon sequestration from forest land and GHG emissions from the loss of forest land. However, net carbon sink from natural and working lands are not currently counted toward GWSA compliance. The state Clean Energy and

Climate Plan for 2020 includes the intention to further analyze net carbon sink capacity and potential from natural and working lands for future climate policy development. The state agency is interested in analyzing the potential of existing natural and working lands to serve as net carbon sinks through 2050, factoring in projected population growth and development pressure.

Robert O'Connor listed and described a number of forest programs and resources in the state, including an urban tree planting program with energy efficiency funding, which has planted 20,000 trees in 12 cities since 2014. They indicated that having LiDAR capabilities and resilience of forests through imagery is something of great interest to them. The growth of dead trees in forests is an area of concern for them, and they finalized indicating their interest in implementing programs from the U.S. Climate Alliance.

C. Vermont: "Vermont climate and carbon monitoring overview"

A number of state officials from Vermont's Department of Environmental Conservation Air Quality & Climate Division, as well as the Department of Forests, Parks, and Recreation presented an overview of Vermont's climate and carbon monitoring strategies and plans. The group was led by Bennet Leon, an Environmental Analyst at Vermont DEC.

For the Department of Forests, Parks, and Recreation, much of their work has focused in climate change adaption recommendations. Setting precision targets and goals to reduce GHG emissions is a task which they are just beginning to work with. They want to promote forest health and sustainable forestry. They identified the following gaps and issues:

- Clearly establish carbon storage and sequestration goals;
- Information to support prioritization of efforts;
- Information to evaluate successes and failure of efforts;
- Lack of coordinated, collaborative plan; and
- The need for a dedicated forest carbon staff

The state of Vermont does not currently have a climate action plan/strategy. The state joined the U.S. Climate Alliance and will potentially be completing a deep decarbonization analysis to help inform a GHG reduction plan. They want to understand the benefits of forest land (well managed) and sequestration potential to help offset GHG emissions. Also, they are committed through the Climate Alliance to reach the Paris Agreement targets by 2025.

The Vermont DEC does not currently have a carbon monitoring strategy. The agency relies on estimates from FPR and FIA for their GHG inventory work. Current carbon estimates in inventory (see Figure 2) were from FIA using their updated methodology for the National Forest Carbon Inventory and values are for Forest Land Remaining Forest Land for Vermont used in the 2017 National Inventory Report (submitted by the USDA Forest Service to the EPA). Data incorporates aboveground biomass, belowground biomass, dead wood, litter, soil organic carbon. Sequestration estimates are included in inventory but are currently not subtracted from emissions estimates.

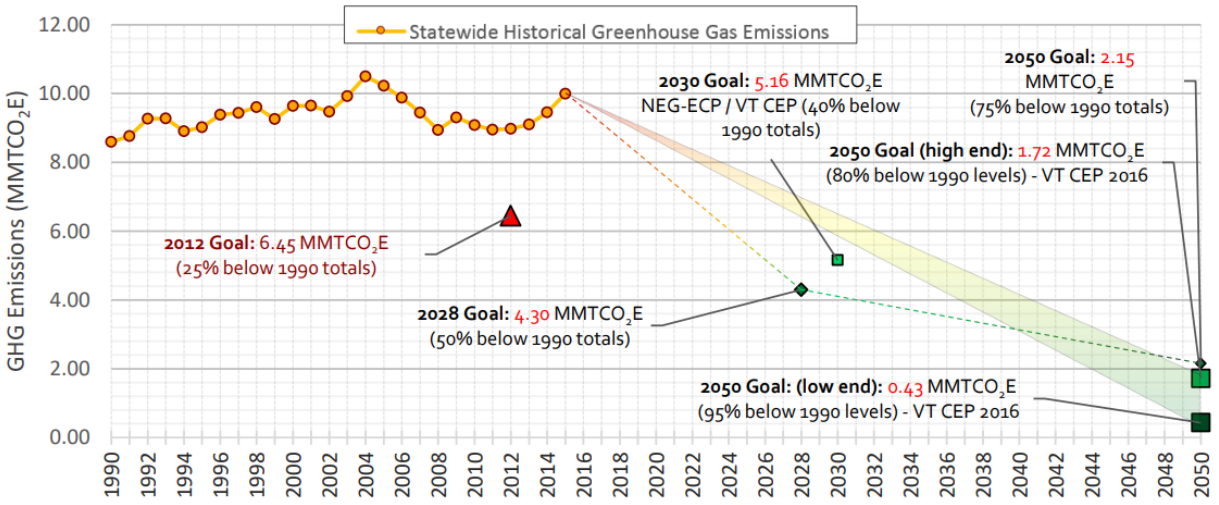

Figure 2: Statewide Historical Greenhouse Gas Emissions for Vermont (Source: Vermont Department of Environmental Conservation)

The state officials indicated the following data needs and interests:

- A more accurate inventory of forest carbon to determine carbon flux values for the state (and net sequestration totals);
- A method would need to be developed to account for (or model) annual changes in the carbon flux to incorporate into the inventory;
- In order to incorporate this sequestration value into the net emissions total, additional work would need to be done (and data quality ensured) in the other portions of the Land Use, Land-use Change portions of the inventory;
- Better understand the modeling of forest carbon/carbon flux and the movement of carbon between pools in the forest system; and
- Higher resolution, higher confidence estimates of forest carbon sequestration differences across stand types, land cover types, and soil types, which would then better inform GHG sequestration estimates and hopefully inform development decisions for energy and other projects.

V. Discussion & Next Steps

The CMS team is planning meetings with state officials from other Mid-Atlantic and Northeastern states (i.e. New Jersey, Connecticut, Rhode Island, New Hampshire, and Maine) in the coming months, and this will lead to an in-person stakeholder workshop in Spring 2020. The team is also continuing to develop a multi-state forest carbon science/policy table. A draft version of this table is appended to this report. Eventually, discussions, notes, and the summary table will evolve into a report/peer-reviewed paper that will be further discussed and elaborated during the stakeholder telecoms later in 2019 and 2020.

VI. Appendix

Multi-state Forest Carbon Science/Policy Table

The intent of this table is to provide an overview of each state's policy framework, climate mitigation goal, science (land), and science needs (land). This draft table is being developed in partnership between CMS scientists and state representatives/stakeholders, and will be continually updated as the CMS team learns more information about each state.

State Name	Policy Framework	Goal	Science (Land)	Science needs (Land)
Maryland	Greenhouse Gas Emissions Reduction Act (enacted 2009, updated 2016) Forest Conservation Act (enacted 1991, updated 2013)	40% below 2006 levels by 2030 80-95% below 2006 levels by 2050	NASA-CMS, USFS, *NLCD*	Annual flux monitoring
Pennsylvania	Climate Change Action Plan (Update 2018) State Forest Resource Management Plan (Update 2016)	26% below 2005 levels by 2025 80% below 2005 levels by 2050	USFS, *NLCD*	
Delaware	Climate Framework for Delaware (2014)	Recommended target of 30% below 2008 levels by 2030	USFS, *NLCD*	
New York	*New York State Energy Plan (2015)* *Executive Order 166*	*40% below 1990 levels by 2030* *80% below 1990 levels by 2050*	*U.S. National GHG Inventory*	*- Integrating forest sector into NYS climate strategy and GHG goals* *- Developing NYS capacity to monitor and forecast net emissions through: 1)*

				harvest monitoring, 2) model verification, 3) more progress for annual or decadal through 2050
Vermont	*Vermont Climate Action Commission Final Report (2018)* *Comprehensive Energy Plan (2016)*	*40% below 1990 levels by 2030* *80 to 90% below 1990 levels by 2050*	*FIA, National Forest Carbon Inventory*	*- More accurate inventory of forest carbon to determine carbon flux values for the state (and net sequestration totals)* *- Additional work needed (and data quality ensured) in other portions of the Land Use, Land-use Change portions of inventory* *- Develop method to account for annual changes in the carbon flux to incorporate into the inventory* *- Higher resolution, higher confidence estimates of forest carbon sequestration differences across stand types, land cover types, and soil types*
Massachusetts	*The Global Warming Solutions Act 2008 (GWSA)* *Clean Energy and Climate Plan for 2020*	*25% below 1990 levels by 2020* *80% below 1990 levels by 2050*	*Massachusetts Annual Greenhouse Gas Emissions Inventory 1990-2016*	*- Interested in analyzing the potential of existing natural and working lands to serve as net carbon sinks through 2050* *- Interest in LiDAR capabilities*

				- Increasing resiliency of forests through imagery
Connecticut		*45% below 2001 levels by 2030* *80% below 2001 levels by 2050*		
Rhode Island		*45% below 1990 levels by 2035* *80% below 1990 levels by 2050*		
New Hampshire	*The New Hampshire Climate Action Plan*	*20% below 1990 levels by 2025* *80% below 1990 levels by 2050*		
New Jersey		*80% below 2006 levels by 2050*		
Maine		*10% below 1990 levels by 2020* *75% to 80% below 2003 levels may be required*		