October 17, 2019

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

Tuesday, July 30, 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 Connecticut, New Jersey, and Rhode Island"

28 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; **Hong-Hanh Chu**, MA EOEEA; **Robert O'Connor**, MA EOEEA; **Bennet Leon**, VT DEC; **Daniel Warner**, DE Geological Survey; **Dena Gonsalves**, RI DEM; **Heidi Hales**, VT DEC**; Jennifer de Mooy**, DE DNREC; **John Callahan**, Univ of DE; **Cary Lynch**, CT DEEP; **Christopher Martin**, CT DEEP; **Margaret Valis**, NY DEC; **Mark Biddle**, DE DNREC; **Nathan Randolph**, TreeBaltimore; **Rachel Soobitsky**, Chesapeake Conservancy; **Shaun O'Rourke**, State of RI; **Susan Minnemeyer**, Chesapeake Conservancy; **Tee Jay Boudreau**, RI DEM; **Marwa Kamel**, NJ DEP; **Jorge Reyes**, NJ DEP; **Teresa Moore**, VPC; **Tom Chi**, Investor

I. Executive Summary

On July 30th, 2019, CMS scientists and invited stakeholders participated in the second 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 and a data need discussion from Delaware Department of Natural Resources & Environmental Control, state representatives from Connecticut, New Jersey, and Rhode Island 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
- LULC and forestry default data is not being used by some of the states (i.e. CT, RI) because the data is unreliable and questionable
- 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 continue updating 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 the end of this year and next, as well as an Applications Workshop planned for Spring 2020, to which participants of this call are encouraged to attend. A report/peer-reviewed publication is also planned and in preparation.

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, understand data needs and interests from stakeholders in Delaware already using or interested in using the available CMS data products, and providing the opportunity to state officials from Connecticut, New Jersey, and Rhode Island 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 overview 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 the 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/carbon maps with uncertainty; and 90m ecosystem modeling based maps of future carbon sequestration potential, gap to carbon sequestration potential, and timescale to achieve 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.

Jennifer de Mooy (Delaware Department of Natural Resources & Environmental Control) presented and overview of two related initiatives relevant to CMS scientists, where CMS data products could be used. The first one is the Natural and Working Lands initiative, an effort to develop a set of strategies for achieving carbon mitigation in the land use sector through carbon sequestration and storage in forestry, agriculture, and wetlands. The other is the development of a statewide climate plan, with climate mitigation actions identified and prioritized to meet Delaware's 2025 GHG emissions reduction goal. The statewide climate plan will include strategies developed in the Natural and Working Lands initiative. Recently, they began collaboration with Elliott Campbell (MD DNR) and his colleagues to learn from their work on monitoring forest carbon through remote sensing.

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. "Connecticut's Climate Strategy: Carbon Monitoring and LULC Change and Forestry Sectors"

Cary Lynch from the Office of Climate Change and Christopher Martin, Director of the Forestry Division, both at Connecticut Department of Energy and Environmental Protection gave an overview of the state's climate strategy and the role of forests in their climate action plans. Connecticut greenhouse gas (GHG) reduction goals can be found in the CT Global Warming Solutions Act (PA 08-98) and in An Act Concerning Climate Change Planning and Resiliency (PA 18-82). The short-term goal is to reduce GHG emissions 10% below 1990 levels by 2020, and as seen in Figure 1, the state is on route to achieve the goal. The long-term goal is to reduce GHG emissions 45% and 80% below 2001 levels by 2030 and 2050, respectively.

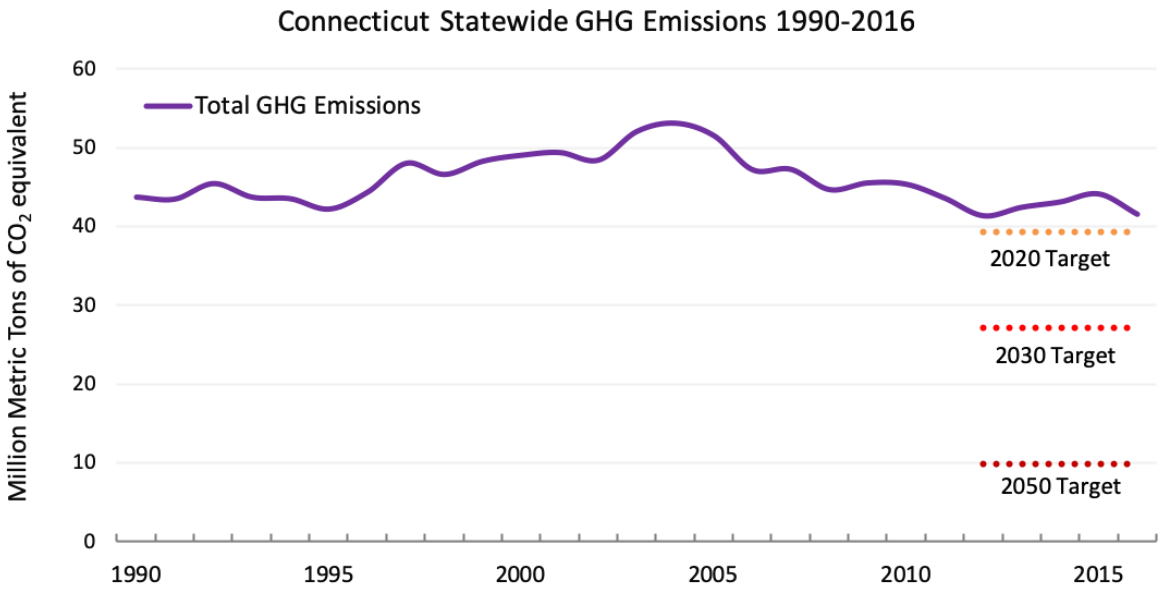

Figure 1: Connecticut Statewide GHG Emissions 1990-2016 (Source: Cary Lynch, CT DEEP)

The carbon monitoring method of the state is heavily based on the U.S. Environmental Protection Agency's State Inventory Tool (SIT). Default data is used for most sectors (transportation, residential, commercial, industrial, waste and agriculture), with some exceptions, particular noteworthy that LULC and forestry default data is not used because it is unreliable and questionable.

Forests cover 58% of the land area of the state, and there has been a 3.1% growth since 2012. However, the state does not currently account for GHG emissions from LULC Change and Forestry. There is pending research with the US Climate Alliance, Natural & Working Lands Challenge to assess carbon sequestration in the state forestry sector. Some forest conservation/protection initiatives mentioned by the stakeholder included: Connecticut Forest Action Plan, Current Use-Property Taxation (PA 490), and the Connecticut's Comprehensive Open Space Acquisition Plan, also called the Green Plan.

B. "New Jersey Climate Planning"

Marwa Kamel and Jorge Reyes from the New Jersey Department of Environmental Protection Division of Climate gave an overview of the state's climate strategy and the role of forests in their climate action plans. New Jersey's greenhouse gas (GHG) reduction goals can be found in the Global Warming Response Act (from 2007 and revised in 2019), and in the Clean Energy Act of 2018. The short-term goal is to limit GHG emissions in 2020 to 1990 levels or below. The long-term goal is to reduce GHG emissions 80% below 2006 levels by 2050. The Clean Energy Act from 2018 provides an electric generation emissions limit, with a goal of 100% clean energy by 2050. As seen in Figure 2, in 2018 the state of New Jersey issued several executive orders related to climate change, including reentering the Regional Greenhouse Gas Initiative (RGGI), joining the U.S. Climate Alliance to uphold the Paris Climate Accord, and advancing the state clean energy economy.

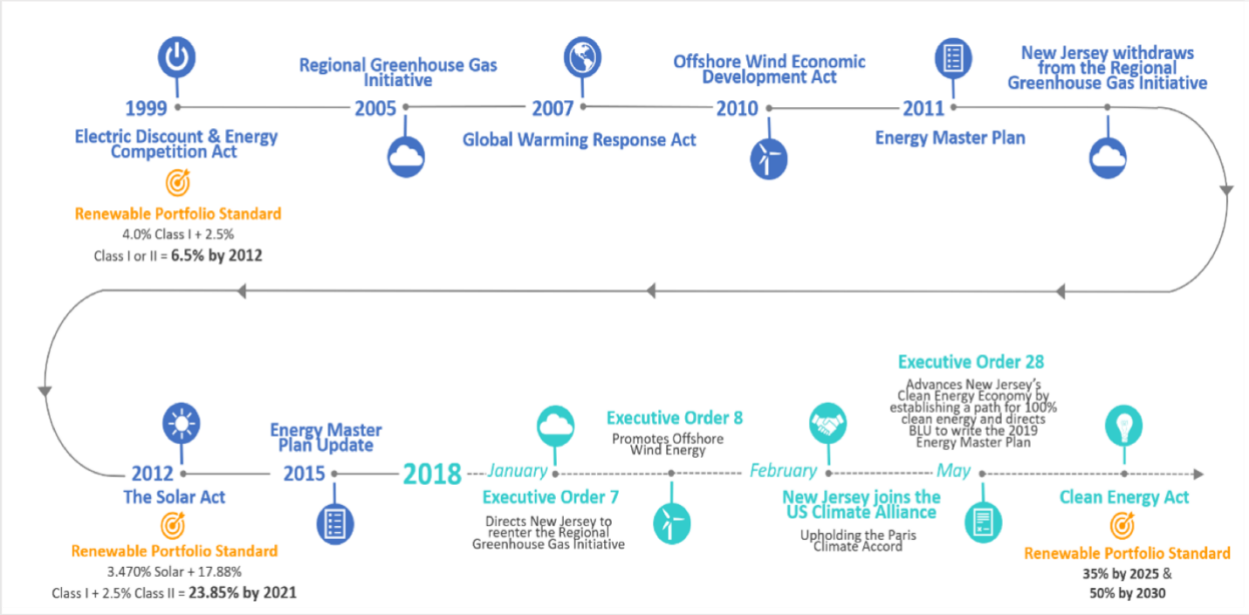

Figure 2: New Jersey's Energy and Climate Legislation (Source: Marwa Kamel, NJ DEP)

Terrestrial carbon sequestration represents a significant sink of greenhouse gases for the state. According to the 2016 estimated NJ GHG emissions inventory, terrestrial carbon sequestered 8.1 $MMTCO_2e$. For the GHG inventory the state utilizes NJDEP land use land cover data, which is updated every 5 years, with 2015 being the latest. The stakeholders listed the following data needs in which CMS scientists could contribute data:

- Updated New Jersey land-use data;
- Methane emissions from wetlands;
- Soil carbon data (such as, forest soil and urban soil carbon); and
- Improved monitoring, measurement and verification methods.

C. "Rhode Island Climate Action in the Forest Sector" '

Shaun O'Rourke, Chief Resilience Officer of the State of Rhode Island, provided an initial overview of "Resilient Rhody", an actionable vision for addressing the impacts of climate change in the state. Additionally, Dena Gonsalves and Tee Jay Boudreau from the Rhode Island Department of Environmental Management gave an overview of the state's climate strategy and the role of forests in their climate action plans. Rhode Island's greenhouse gas (GHG) reduction goals can be found in the Rhode Island Greenhouse Gas Emissions Reduction Plan (from December 2016). The short-term goal is to reduce GHG emissions by 10% below 1990 levels by 2020, and as seen in Figure 3, the state is on route to achieve the goal. The mid-term goal is to reduce GHG emissions by 45% below 1990 levels by 2035. Finally, the long-term goal is to reduce GHG emissions by 80% below 1990 levels by 2050.

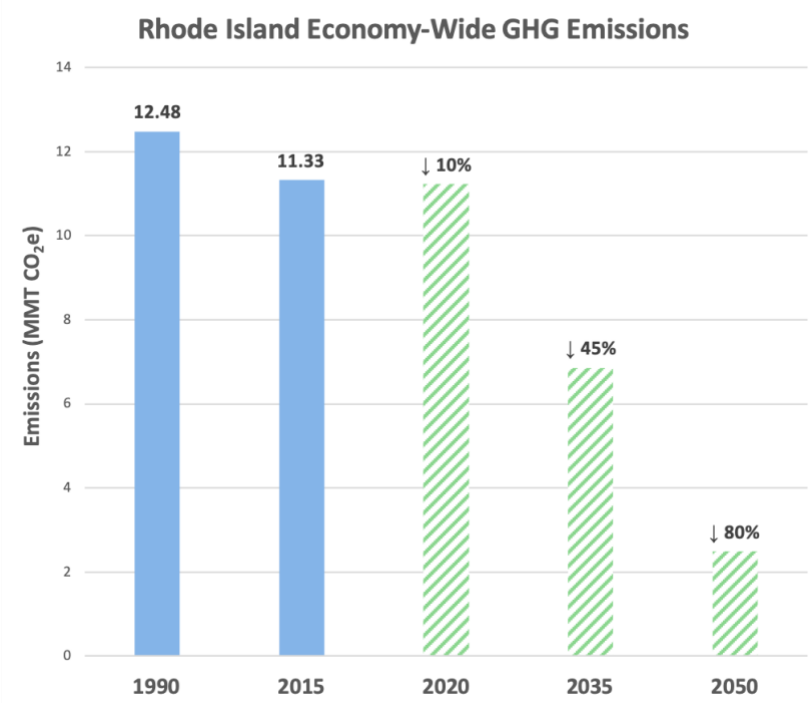

Figure 3: Rhode Island Economy-Wide GHG Emissions Goals (Source: Dena Gonsalves, RI DEM)

Rhode Island's forests are considered second growth, established on past agricultural lands. According to 2017 data, forests cover 55% of the total area of the state. As with the state of Connecticut, the land use sector data is unreliable, thus it is not included in the GHG inventory. One of the main challenges and concerns of state officials is the suburban spread and development on the state which contributes to forest fragmentation and shrinking forest ecosystems. In a 2014 statewide tree canopy assessment using the i-Tree Canopy tool, the monetary value of annual pollutant removal by trees was $38.5 million. The state has a particular interest in urban forests and urban greening to improve health through the *Resilient Rhody: Tree Equity for Climate and Health* Program. The main goal

of the program is to fully understand the mitigation potential of Rhode Island's urban forests, an important data need for the stakeholders.

V. Discussion & Next Steps

The CMS team is planning meetings with state officials from other Mid-Atlantic and Northeastern states (i.e. 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	Integrate forest sector, harvest monitoring, model verification

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	Annual changes in carbon flux values, high resolution carbon sequestration estimates
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	Existing natural and working lands as net carbon sinks, LiDAR capabilities
Connecticut	CT Global Warming Solutions Act (PA 08-98) An Act Concerning Climate Change Planning and Resiliency (PA 18-82)	10% below 1990 levels by 2020, 45% below 2001 levels by 2030, 80% below 2001 levels by 2050	EPA's State Inventory Tool (SIT)	More reliable LULC and forestry data
Rhode Island	Rhode Island Greenhouse Gas Emissions Reduction Plan (2016)	10% below 1990 levels by 2020, 45% below 1990 levels by 2035, 80% below 1990 levels by 2050	iTree Canopy Tool	Fully understand mitigation potential of urban forests
New Jersey	Global Warming Response Act (2007, revised 2019), Clean Energy Act (2018)	Limit to or below 1990 levels by 2020, 80% below 2006 levels by 2050	NJDEP land use land cover data	Updated land use data, soil carbon data, and improved monitoring and measurement methods
New Hampshire	The New Hampshire Climate Action Plan	20% below 1990 levels by 2025, 80% below 1990 levels by 2050		
Maine	Maine Legislature, 38 MRSA §576	10% below 1990 levels by 2020, 75% to 80% below 2003 levels may be required		