New Tool to Predict Greenhouse Gas Fluxes & Potential Carbon Storage in Coastal Wetlands

The Coastal Wetland Greenhouse Gas Model 2.0 is a new user-friendly tool for predicting how greenhouse gas fluxes and potential carbon storage in tidal wetlands will change under different conditions. It allows northeastern and mid-Atlantic land managers, restoration practitioners and policymakers to better understand greenhouse gas fluxes in tidal wetlands of interest to them, and leverage advances in blue carbon science to support wetland management and restoration. The model can be used to help:

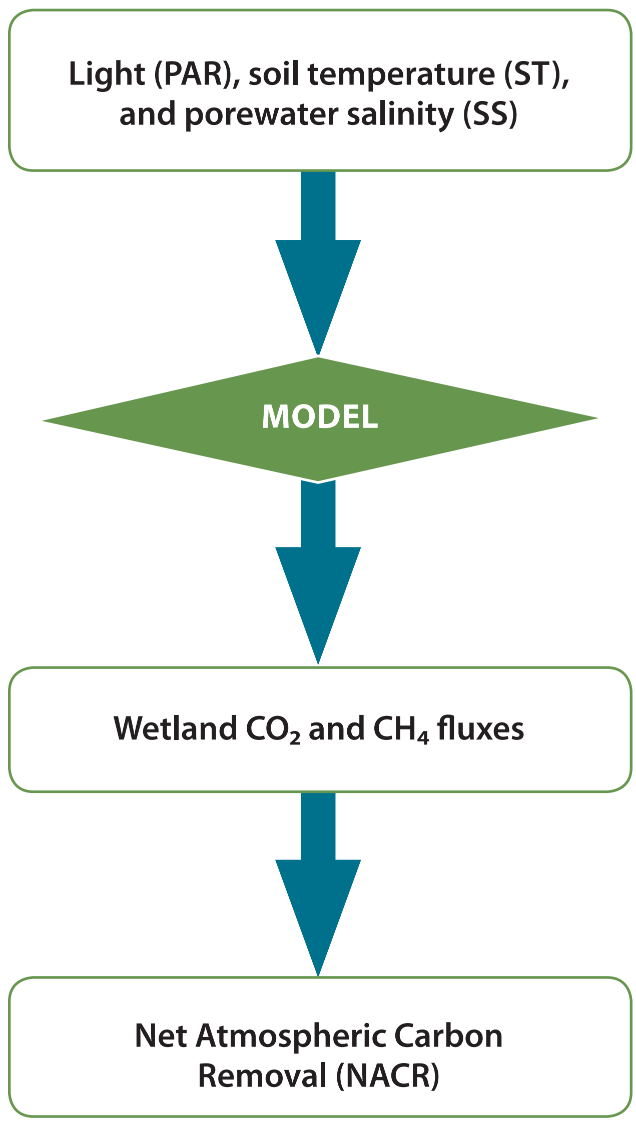
- ***Develop greenhouse gas offset protocols to guide the monitoring and verification of tidal wetland restoration and maintenance projects***
- ***Reduce the cost of monitoring greenhouse gas fluxes and carbon storage by estimating these from a small set of environmental variables for which data are more readily accessible***
- ***Predict greenhouse gas fluxes and potential carbon storage under IPCC climate change and restoration scenarios***
- ***Support wetland management and incorporation of coastal wetlands into carbon markets***

Why Do We Need This Tool?

Tidal wetlands play a critical role in the exchange of greenhouse gases between the soil and the atmosphere. Whether wetlands mitigate or contribute to global warming is determined by a delicate balance of environmental drivers, including climate, hydrology, sea level, and land use.

Understanding a wetland's capacity to capture and store potent greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) is important for supporting wetland conservation and restoration efforts, and integrating the role wetlands play in climate mitigation and adaptation into management and policy decisions.

To address this need, the Bringing Wetlands to Market team developed the Coastal Wetland Greenhouse Gas Model (CWGM) 2.0 model with data from 26 tidal wetlands along the mid-Atlantic and northeast coasts. Presented in an Excel spreadsheet, the model estimates a wetland's potential carbon storage by up-scaling and accounting for instantaneous predicted fluxes of CO_2 and CH_4 to the growing season. It is based on observations of photosynthetically active radiation (PAR), soil temperature (ST), and porewater salinity (SS). The CWGM 2.0 is a generalization of the CWGM 1.0 model originally developed for four salt marshes in the Waquoit Bay Reserve, MA.



Model Assumptions

This model is predicated on the assumption that mid-Atlantic and northeastern salt marshes are productive mainly during the growing season, from May to October. The net atmospheric carbon removal (NACR) presents the carbon ***removed*** from the atmosphere by the wetland, i.e, the difference between net CO_2 uptake and net CO_2 and CH_4 emissions. NACR represents the wetland's maximum possible carbon storage. The net ecosystem carbon balance (NECB) of a wetland can be calculated by subtracting the net lateral flux.

Model User Guide

1. Download the model here: http://waquoitbayreserve.org/research-monitoring/salt-marsh-carbon-project/expanding-blue-carbon-phase-2/model/
2. Enable the "macros" in the Excel file. If your version of Excel does not have "macros" enabled, you can enable them when you open the file and save it as an "Excel Macro-Enabled Workbook."
3. Input at least one set of data for PAR, ST, and SS to represent the growing period during May-October. Since this is a power-law based model, you should not give zero or negative values as inputs.
4. Input the number of days for which you want to estimate net atmospheric carbon removal (NACR).
5. To quantify the CH_4 emission fluxes and NACR based on IPCC recommended 20 or 100 year CO_2 equivalent global warming potential (GWP), select either 86 or 34, respectively, from the dropdown menu in "Enter CO_2 equivalent global warming potential (GWP) for CH_4". If GWP is not considered, select 1.
6. Click the RUN button to get the model outputs. The negative sign of predicted GHG fluxes and NACR indicates uptake (atmosphere to soil) and the positive sign indicates emissions.

Example (for a single set of variables)

Inputs (Reference baseline condition)
PAR = 1427.1 µmole/m^2/s
ST = 22.8 ºC
SS = 17.8 ppt
Number of days: 183, **GWP:** 34

Click the RUN button

Outputs
Net CO_2 flux = -869.5 gC/m^2
Net CH_4 flux = 143.6 gC/m^2
NACR = -725.9 gC/m^2 or -7.26 metric ton C/hectare

Climate Change Scenario: A community wants to know the potential changes in C storage of a wetland from the baseline conditions (see the above example) under a changing climate and rising sea level, where ST increases by 1ºC and SS rises to 20 ppt.

Analysis and Interpretation: Under this scenario NACR will be -736.0 gC/m^2 or -7.36 metric ton C/hectare. The potential carbon storage will increase by 10.1 g/m^2 or 0.10 metric ton/hectare from baseline due to the changing climate and sea level rise.

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Reference

Abdul-Aziz, O.I., Ishtiaq, K.S., Tang, J., Moseman-Valtierra, S., Kroeger, K.D., Gonneea, M.E., Mora, J., and Morkeski, K. (2018). Environmental controls, emergent scaling, and predictions of greenhouse gas (GHG) fluxes in coastal salt marshes. *Journal of Geophysical Research: Biogeosciences*, 123, 2234–2256.

Input Data Guide

SI	INPUT	DATA
1	Environmental variables (PAR, ST, and SS) during the growing period	**Minimum:** 1 set **Preferable:** 3 sets representing beginning (May), middle (August), and end (October)
2	Number of days for which you want to estimate NACR	Productive days in a year (e.g., 183, if growing perdiod is May-October)
3	CO_2 equivalent GWP for CH_4	1, 86 or 34 (recommended)

ABOUT BRINGING WETLANDS TO MARKET

This model was supported by the Bringing Wetlands to Market (BWM) project. The BWM project was led by the Waquoit Bay National Estuarine Research Reserve and a multidisciplinary team of partners. For nearly a decade, the BWM team has been at the forefront of blue carbon science, creating the knowledge and tools that communities need to leverage this science to support wetlands management, restoration, and conservation goals, and help facilitate the integration of coastal wetlands into carbon markets.

Support for the project was provided by the National Estuarine Research Reserve System (NERRS) Science Collaborative. By engaging decision makers in the research process, collaborative science projects directly address community needs. Through a national network dedicated to sharing tools and knowledge, local research strengthens all 29 NERR sites and the communities they serve, leaving them better prepared to manage our changing coasts.

To learn more about BWM and access other project resources, please visit: http://waquoitbayreserve.org/research-monitoring/salt-marsh-carbon-project/expanding-blue-carbon-phase-2/