Developing Policy-Relevant "Blue Carbon" Protocols for Monitoring and Verification - Linking soil and satellite data to reduce uncertainty in coastal wetland carbon storage fluxes for national GHG inventories and market incentives

Lisamarie Windham-Myers¹, Mark Bessen², Brian Bergamaschi³, Judith Drexler¹, Kristin B. Byrd¹, Matthew Ferner³, Patrick Megenigal⁴, Lisa Schile⁴, Donald Wellers⁴, Kevin Kroeger⁴, Stephen Crooks⁵, James Morris⁵, Ariana Sutton-Grier⁶, John Callaway⁷, Marc Simard⁸, Isa Woo⁹, John Takekawa¹⁰ & Tiffany Troxler¹¹

¹U.S. Geological Survey, ²Stanford University, ³SF Bay National Estuarine Research Reserve, ⁴Smithsonian Environmental Research Center, ⁵Environmental Science Associates, ⁶Belle Baruch Institute, ⁷University of Maryland, ⁸University of San Francisco, ⁹NASA Jet Propulsion Laboratory, ¹⁰Texas A&M University, and ¹¹Florida International University

Abstract:

Quantifying carbon fluxes in coastal and estuarine ecosystems has policy relevance both for documenting the carbon sink potential of "blue carbon" habitats, as well as for closing continental scale budgets. We seek to fill a gap in "blue carbon" accounting by providing a national-scale data framework to integrate and extraplate field measurements that support national GHG inventory requirements, and testing data needs for quantification of stock-based changes in coastal wetland sediments (soil) and vegetation for eventual REDD+ eligibility. Our project will develop a verifiable carbon (C) monitoring protocol appropriate for national policy and market-based interventions. Our approach is to refine Landsat-based land cover change data from NOAA's Coastal Change Analysis Program, with C-relevant attributes from finer scale NASA-derived spectral and RADAR data, as well as broadly available field data from partner agencies. Synthesizing previously-collected data for Sentinel sites along representative coasts of the U.S., we will refine and validate an IPCC-relevant, temporally-explicit (1996-2010) accounting method for coastal wetland C stocks and annual fluxes. Our approach leverages a recent surge in research on the key processes that regulate soil C accumulation in tidal wetlands, which we propose can be captured at large spatial scales using remotely sensed data and GIS modeling. Net annual C flux into tidal wetland soils is largely a function of vertical accretion due to organic accumulation with sea level rise, or C losses due to oxidation and erosion. The IPCC default value for soil C sequestration in tidal wetlands is 140 g/m²/yr, but rates in US tidal wetlands range from 80-200 g C/m²/yr. The greatest uncertainty in current "blue carbon" inventory-approaches arises from categorical upscaling, or distributing point data through the estuarine landscape. One goal will be to determine the "price of precision" or extent to which finer habitat classifications (hydrology, salinity, sea-level rise) continue to inform C accounting with greater accuracy. This project will provide a fundamental data platform to aid the U.S. in quantifying emissions and removals in response to the IPCC Tier 2-3 approaches for Ecosystems.

Methodology:

To create a hierarchical tidal wetland classification based on the NOAA Coastal Change Analysis Program (C-CAP) Estuarine (salinity > 0.5 ppt) and Palustrine (salinity < 0.5 ppt) land cover classes and carbon-relevant metrics (hydrology, elevation, salinity, biomass) derived from USDA SSURGO data, USFWS National Wetland Inventory (NWI) data, and multiple field and satellite-based datasets: Development of an improved hierarchical land cover classification will focus on 6 sentinel sites, with data compilation focused on model and policy relevance. The classification will be validated with in situ carbon accumulation rate data.

### IPCC wetlands GHG inventory: Rates or Stock Differences from 1996 - 2010

<table>
<thead>
<tr>
<th>IPCC Level</th>
<th>Land Cover Classes</th>
<th>Carbon Accumulation Rate (CAR) Calculation (C density x accretion)</th>
<th>CAR Validation (Field measured C density x accretion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1: default</td>
<td>C-CAP Estuarine Emergent</td>
<td>C-CAP Estuarine Forested</td>
<td>C-CAP Estuarine Scrub-Scrub</td>
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<tr>
<td>Soil CAR data (Dated cores using^{13}C/^{12}C isotopes) = 500 yrs</td>
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<tr>
<td>Tier 2: National Scale</td>
<td>C-CAP Estuarine Emergent, Palustrine Emergent, clipped to NWI tidal classes</td>
<td>C-CAP Estuarine Forested</td>
<td>C-CAP Estuarine Scrub-Scrub</td>
</tr>
<tr>
<td>Same as above + short/medium term data (surface elevation tables, marker horizons)</td>
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<tr>
<td>Tier 3: Sentinel Sites</td>
<td>C-CAP+ improved hierarchical classification based on multiple spatial and satellite-based datasets*</td>
<td>C-CAP+ improved hierarchical classification based on multiple spatial and satellite-based datasets*</td>
<td>As above, plus Marsh Equilibrium Model (MEM5) hindcasts and forecasts of CAR and methane flux</td>
</tr>
<tr>
<td>Same as above + all available soil and biomass validation</td>
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</tbody>
</table>

*Datasets for Tier 3 approach: Tide gauges, Soil cores, ATLAS, Surface elevation table data, Salinity data, Eddy covariance GNG flux data, Suspended sediment concentration and maps, Biomass maps from RADAR and spectral imagery

### Products:

**Product 1:** National Scale 30m resolution, validated map of tidal wetland C flux (rates or stock difference from 1996 to 2010) via NOAA’s C-CAP linked with interpolated SLR, SSURGO soil data, and mangrove biomass data

**Product 2:** Sentinel Site based and process-based validated maps, based on:
- Field and remote sensing data availability
- Within-site range of tidal wetland sub-classes
- Soil surface elevation tables, marker horizons
- Vegetation types
- Land-use (degradation, conversion, restoration)
- Between-site range of climate variables (relative sea level rise)

**Product 3:** Price of Precision Error Analysis (comparison of Tier 1, 2, 3 algorithms)

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