# Blue Carbon Monitoring System

**Linking Satellite and Soil Data to Validate Coastal Wetland 'Blue Carbon' Inventories: Upscaled Support for Developing MRV and REDD+ Protocols**

**Lead PI:** Lisamarie Windham-Myers (18 Science PIS; October 2014-17)

## Federal

<table>
<thead>
<tr>
<th>Agency</th>
<th>Name</th>
<th>Agency</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>USGS</td>
<td>Brian Bergamaschi</td>
<td>U. South Carolina</td>
<td>Jim Morris</td>
</tr>
<tr>
<td></td>
<td>Kristin Byrd</td>
<td>U. Maryland/NOAA</td>
<td>Ariana Sutton-Grier</td>
</tr>
<tr>
<td></td>
<td>Judith Drexler</td>
<td>U. San Francisco</td>
<td>John Callaway</td>
</tr>
<tr>
<td></td>
<td>Kevin Kroeger</td>
<td>Florida Intl. U.</td>
<td>Tiffany Troxler</td>
</tr>
<tr>
<td></td>
<td>John Takekawa</td>
<td>Texas A&amp;M U.</td>
<td>Rusty Feagin</td>
</tr>
<tr>
<td></td>
<td>Isa Woo</td>
<td>Independent</td>
<td>Stephen Crooks</td>
</tr>
<tr>
<td>NOAA-NERR</td>
<td>Matt Ferner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smithsonian</td>
<td>Pat Megonigal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Don Weller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lisa Schile</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postdoc: James Holmquist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA-JPL</td>
<td>Marc Simard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Coastal Ocean: depth<200m

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pg C yr(^{-1})</th>
<th>% ocean total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Production</td>
<td>6.5</td>
<td>12</td>
</tr>
<tr>
<td>Export Production</td>
<td>2.0</td>
<td>21</td>
</tr>
<tr>
<td>Burial</td>
<td>0.67</td>
<td>86</td>
</tr>
</tbody>
</table>

*Sources: Brock et al. 2012; Nellesmann et al. 2009.*

**Figure 1 Blue carbon sinks**

- Mangroves: 0.2
- Seagrasses: 0.3
- Salt marshes: 1.8
- Estuaries: 6.5
- Deep sea: 26.6
- Marine habitat area, million square kilometres: 330

**Organic carbon burial rate, teragrams per year**

- Maximum: 17.5
- Minimum: 0.0002
- Average: 1.8
Can LULC data be used for national GHG inventory? IPCC Stock Difference (1990-2010)

Can we reduce uncertainty by refining wetland categories? (vegetation type, biomass, elevation, salinity, sediment)
1. IPCC Wetlands Suppl. 2013 (Ch.4 Coastal)

Mangrove and Tidal Marsh Activities:
- CO₂ Forest management
- Extraction
- Drainage
- CH₄ Rewetting/Revegetation/Creation

2. REDD+ and US agency policies (soil C)

3. Market Incentives (VCS, ACR)
Wetlands 23 M ha

Palustrine (Fresh)

Estuarine (Saline)

IPCC Default sed burial = 3.2 Tg
(2.3Mha x 1.4T ha⁻¹ y⁻¹)
“Blue” CMS - Approach

Product 1: National Scale stock-based 30m resolution C pool maps (1992-2010) via NOAA’s C-CAP (NLCD) linked with regional SLR and SSURGO 1m soil data
“Blue” CMS - Approach

Product 1: National Scale stock-based 30m resolution C pool maps (1992-2010) via NOAA’s C-CAP (NLCD) linked with regional SLR and SSURGO 1m soil data

Product 2: Sentinel Site stock-based and process-based maps, where

- Field and remote sensing data availability (abundance and quality)
- Within-site range of tidal wetland categories
  - Salinity
  - Vegetation types
  - Landuse (degradation, restoration)
- Between-site range of climate variables
Product 1: National Scale stock-based 30m resolution C pool maps (1992-2010) via NOAA’s C-CAP (NLCD) linked with regional SLR and SSURGO 1m soil data

Product 2: Sentinel Site stock-based and process-based maps, where
- Field and remote sensing data availability (abundance and quality)
- Within-site range of tidal wetland categories
  - Salinity
  - Vegetation types
  - Landuse (degradation, restoration)
- Between-site range of climate variables

Product 3: Price of Precision Error Analysis (30m v 250m, Tier 1,2,3, Algorithms)
**“Blue” CMS – Remote Sensing**

### Biomass (T ha⁻¹)

<table>
<thead>
<tr>
<th>Sensor</th>
<th>RMSE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat8 (marsh)</td>
<td>3.3</td>
<td>14</td>
</tr>
<tr>
<td>SRTM (mangrove)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>SSC (mg/L)</td>
<td>3.4</td>
<td>10</td>
</tr>
</tbody>
</table>

*Simulation and data provided by Simard et al 2006 and Boss et al (in prep)*
Once calibrated, relative elevation is used to estimate cumulative accretion, water depth, flooding frequency, aboveground and belowground biomass, and carbon stored.

**“Blue” CMS – Process-based Model**

From past and present, project future

Marsh Equilibrium Model (MEM 5.4):
mechanistic, annual cohort, 1D accretion

MEM-CH4: next version is methane capable
Synthesize validation data and metrics known to play a role in coastal carbon accretion. Evaluate what data sets, at what scale, are capable of improving C burial estimates.

GIS Model

Process-based Model

= verifiable protocol to support federal, international, and market incentives