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

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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 extrapolate 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 6 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/m^2/yr, but rates in US tidal wetlands range from 20-800 g C /m^2/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 Wetlands Supplement (2014) as requested to support the national report in 2017.

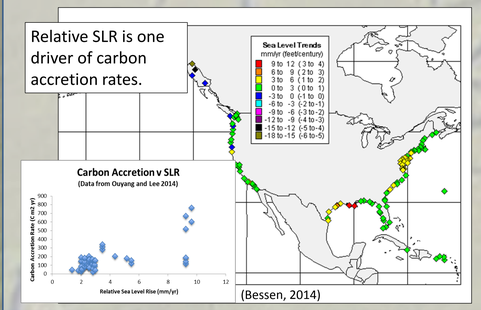
Methodology:

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

IPCC Level	Land Cover Classes: Marsh	Land Cover Classes: Mangrove	Carbon Accumulation Rate (CAR) Calculation (C density x accretion)	CAR Validation (field measured C density x accretion)
Tier 1- default	C-CAP Estuarine Emergent	C-CAP Estuarine Forested Estuarine Scrub-Shrub	Default	Soil CAR data (Dated cores using ^{210}Pb/^{137}Cs isotopes) ~500 pts
Tier 2 – National Scale	C-CAP Estuarine Emergent Palustrine Emergent, clipped to NWI tidal classes	C-CAP Estuarine Forested Estuarine Scrub-Shrub	SSURGO soil organic carbon x relative sea level rise from NOAA tide gauges	Same as above + short/med/long term data (surface elevation tables, marker horizons)
Tier 3 – Sentinel Sites	C-CAP+ Improved hierarchical classification based on multiple spatial and satellite-based datasets*	C-CAP+ Improved hierarchical classification based on multiple spatial and satellite-based datasets*	As above, plus Marsh Equilibrium Model (MEM5) hindcasts and forecasts of CAR and methane flux	Same as above + all available soil and biomass validation

Relative SLR is one driver of carbon accretion rates.

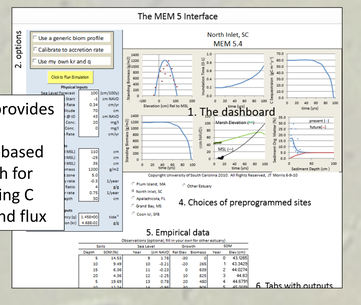


(Bessen, 2014)

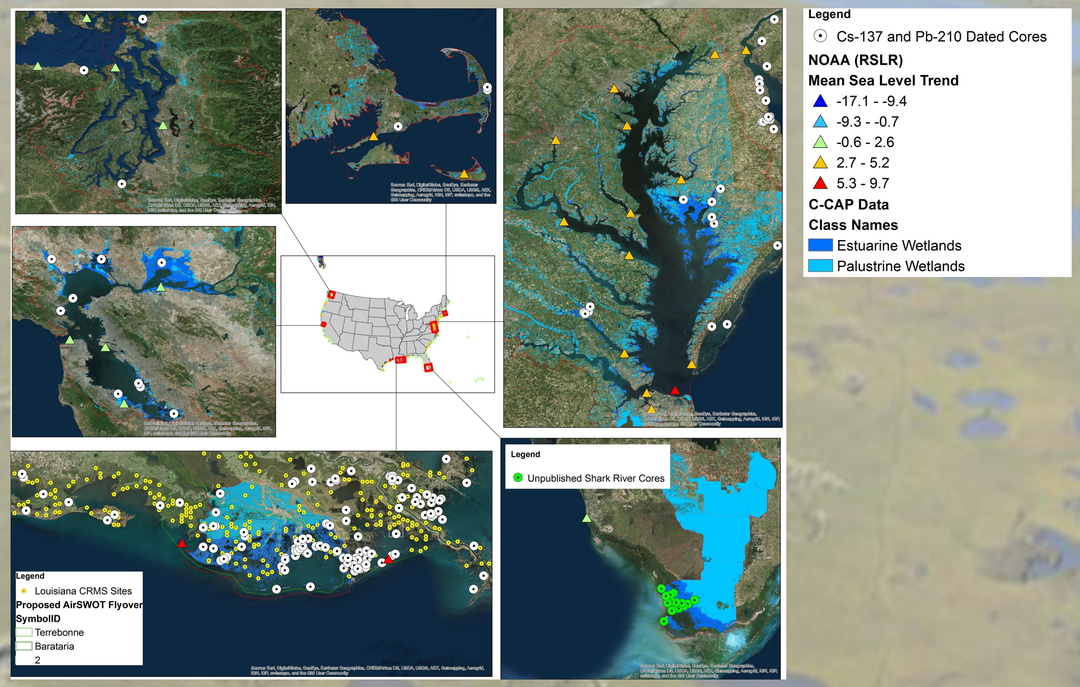
***Datasets for Tier 3 approach:**

- Tide gauges
- Soil cores
- RTK GPS, Surface elevation table data
- Salinity data
- Vegetation-corrected LIDAR DEMs
- Eddy covariance GHG flux data
- Suspended sediment concentration and maps
- Biomass maps from RADAR and spectral imagery

MEM5 provides a Tier 3, process-based approach for forecasting C stocks and flux



Six sentinel sites, clockwise from top left: Puget Sound, WA, Waquoit Bay, MA, Chesapeake Bay, MD, Shark River, FL, Terrebonne, LA, and San Francisco Bay, CA, plus key datasets for estimating and validating coastal wetland carbon accumulation rates and stock differences using IPCC Tier 2 and Tier 3 approaches



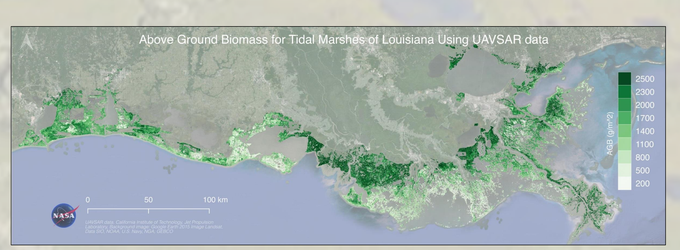
Products:

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

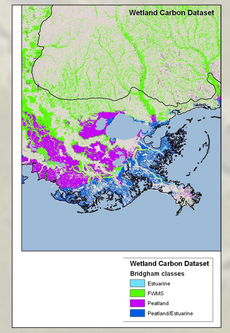
Product 2: Sentinel Site stock-based and process-based validated maps, based on

- Field and remote sensing data availability
- Within-site range of tidal wetland sub-classes
  - Salinity, elevation
  - 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)

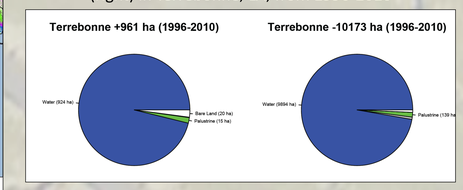


(Simard, 2015)



Peatlands in Louisiana tidal marshes, SSURGO data

C-CAP estuarine emergent marsh gains (left) and losses (right) in Terrebonne, LA, from 1996-2010



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