

North American Carbon Program

Status update and invitation to the Ocean Color Research Team

Galen McKinley, University of Wisconsin – Madison
for Peter Griffith, NACP Coordinator



What is the NACP?



Climate Change Science Program

Carbon Cycle Science Plan – Sarmiento and Wofsy (1999)

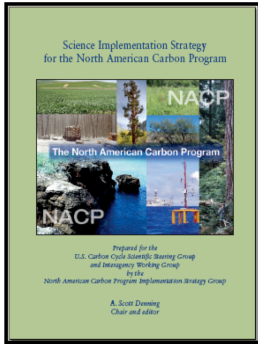
Carbon Cycle Interagency Working Group (CCIWG)

NACP Science Implementation Strategy – Denning et al. (2005)

NACP Office (NASA GFSC)

OCCC Implementation Strategy - Doney et al. (2004)

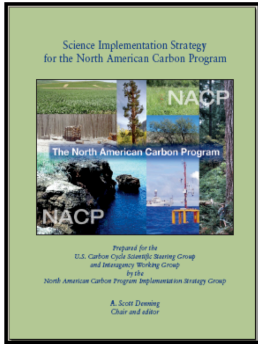
OCB Office (WHOI)



NACP Goals



- Develop quantitative scientific knowledge, robust observations, and models to determine the emissions and uptake of CO₂, CH₄, and CO, changes in carbon stocks, and the factors regulating these processes for North America and adjacent ocean basins.
- Develop the scientific basis to implement full carbon accounting on regional and continental scales. This is the knowledge base needed to design monitoring programs for natural and managed CO₂ sinks and emissions of CH₄.
- Support long-term quantitative measurements of fluxes, sources, and sinks of atmospheric CO₂ and CH₄, and develop forecasts for future trends.



NACP Science Questions

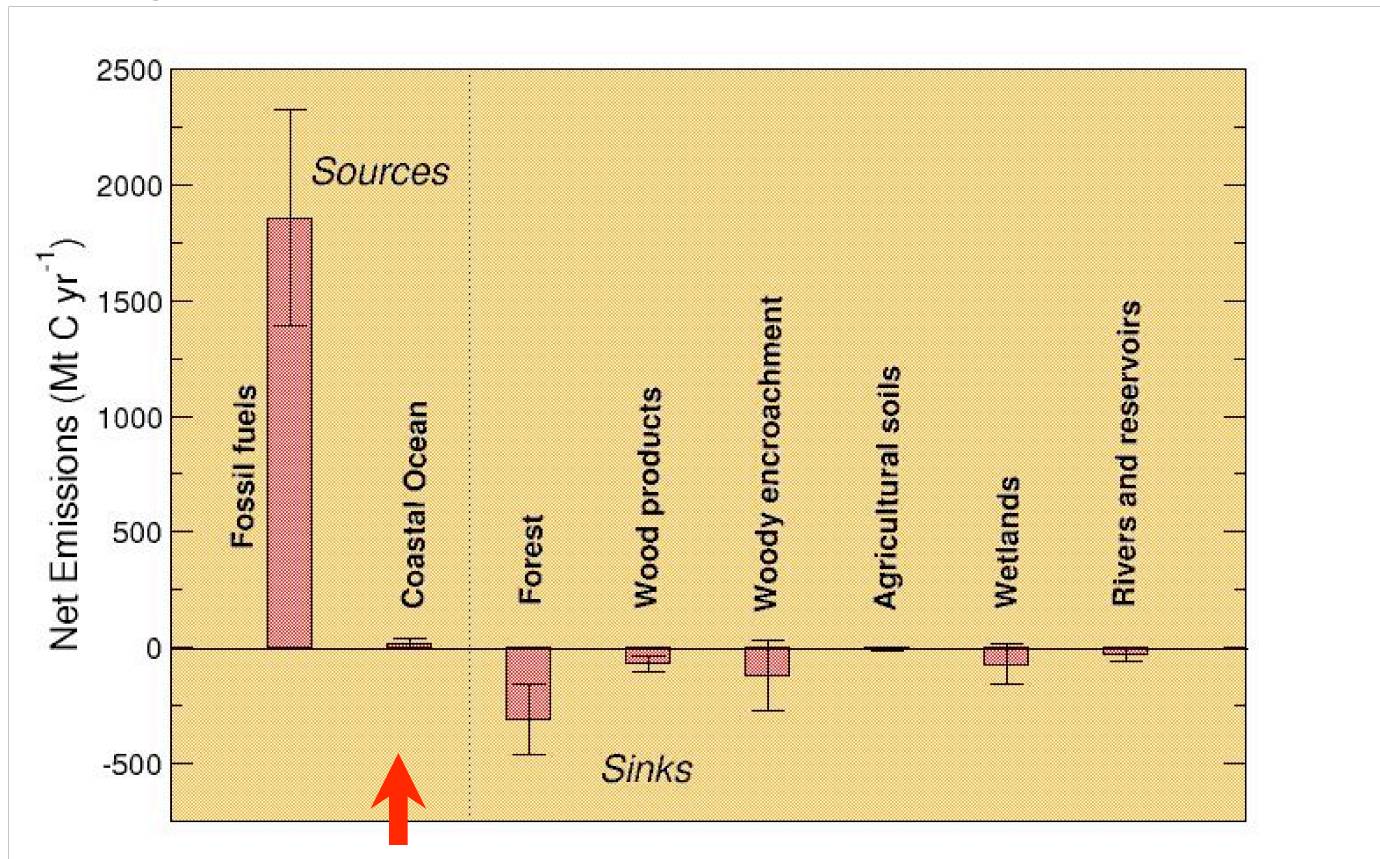


- **Diagnosis:** What is the carbon balance of North America and adjacent oceans? What are the geographic patterns of fluxes of CO₂, CH₄, and CO? How is the balance changing over time?
- **Process/Attribution:** What processes control the sources and sinks of CO₂, CH₄, and CO, and how do the controls change with time?
- **Prediction:** Are there potential surprises where sources increase or sinks disappear?
- **Decision Support:** How can we enhance and manage long-lived carbon sinks, and provide resources to support decision makers?

State of the Carbon Cycle Report, 2007



- SOCCR CCSP SAP 2.2 : North America is currently a net source of CO₂ (1264 Mt C yr⁻¹), with 30% of fossil fuel emissions (1856±464 Mt C yr⁻¹ in 2003) offset by a net terrestrial sink of 592±296 Mt C yr⁻¹.
- Coastal ocean estimate a result of adding large numbers of opposite sign and high uncertainties



NACP Interim Syntheses



- Site Interim Synthesis –Synthesis of modeled and measured carbon, water, and energy fluxes across North America; regional to continental upscaling of AmeriFlux data
- Mid Continental Intensive (MCI) Interim Synthesis –Synthesis of Tower CO2 Flux observations, inventory-based CO2 budget, atmospheric inversions, through 2005.
- Non-CO2 Greenhouse Gases Interim Synthesis
- Regional Interim Synthesis –NACP spatial model-data comparisons, inverse modeling, West Coast analyses
- **Coastal Interim Synthesis –carbon budgets for the East Coast, Gulf of Mexico, Pacific Coast, Arctic Ocean, and Great Lakes**
- Continental-scale Disturbance Interim Synthesis

2nd All Investigators Meeting

San Diego, February 2009

Programmatic Progress

courtesy of Ken Davis, NACP Co-Chair



- Nearing “success” at regional and continental diagnoses of the CO₂ budget (e.g. MCI synthesis, CarbonTracker, VULCAN).
- Yet, essential elements of continental observation and analysis system are endangered (flux towers, tall towers, CO₂ sampling, satellites).
- Need to engage whole-heartedly in research that is integrated with decision support. This will require new emphasis on prediction, model-data fusion, uncertainty assessment and greater focus on human emissions.
- Some program elements are mature, others far behind

2nd All Investigators Meeting

Coastal Oceans Reports and Activities



- Presentations (at http://www.nacarbon.org/meeting_2009/)
 - Carbon measurements on US continental margin (Sabine)
 - East Coast and the Gulf of Mexico synthesis activities (Lohrenz)
 - Pacific Coast synthesis activities (Alin)
 - Use of in-situ optical and remotely- sensed data (Vandemark)
 - Methodology to determine coastal acidification (Feely)
- Breakout sessions
 - Modeling the Coastal Carbon Cycle (Friedrichs, Hoffman, Najjar)
 - Measurements and Sampling for Coastal Carbon (Mannino, Hales)
 - Coastal Interim Synthesis Planning (Coble, Alin)

Coastal Ocean Interim Synthesis

Present Activities



- Phase 1: Regional Carbon Budgets
 - Develop carbon budgets given existing data and models
 - Groups for East Coast, West Coast, Gulf of Mexico and Great Lakes
 - Presentations at OCB summer workshop
- Phase 2: Community Modeling and Database Development
 - Model-data synthesis
 - Many details to be worked through – e.g. defining boundaries, units, internal processes
 - Proposals for workshops underway. Several to occur
 - First at OCB summer workshop or Fall 2009 AGU
- Organization through the NACP website www.nacarbon.org

Coastal Ocean Interim Synthesis



A CORE ELEMENT OF THE U.S. CLIMATE CHANGE SCIENCE PROGRAM

North American Carbon Program

CONTINENTAL CARBON BUDGETS, DYNAMICS, PROCESSES, AND MANAGEMENT

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NACP Synthesis Activities

NACP Investigators have organized several synthesis activities to evaluate and intercompare models and observations at local and regional scales. These activities are open to all investigators who have data or model results for North America.

Click on the [Email List](#) links below to subscribe to the email lists and join these syntheses activities being conducted:

Coastal Synthesis: [Learn More...](#)

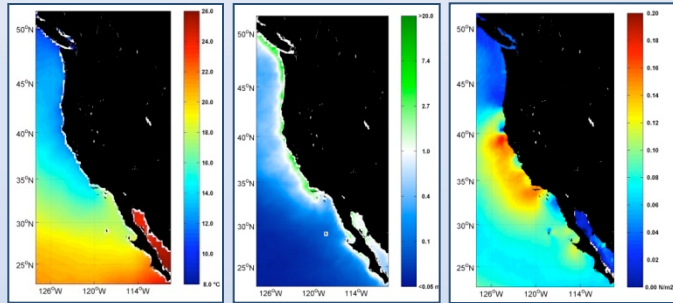
- **East Coast (including Gulf of Maine) Synthesis** [Email List](#) (join, view members and message archive)
Coordinator: [Wei-jun Cai](#)
- **West Coast (including Gulf of Alaska) Synthesis** [Email List](#) (join, view members and message archive)
Coordinator: [Simone Alin](#)
- **Gulf of Mexico Synthesis** [Email List](#) (join, view members and message archive)
Coordinator: [Paula Coble](#)
- **Arctic (including Bering, Chukchi and Beaufort Seas) Synthesis** [Email List](#) (join, view members and message archive)
Coordinator: [Jeremy Mathis](#)
- **Great Lakes Synthesis** [Email List](#) (join, view members and message archive)
Coordinator: [Galen McKinley](#)



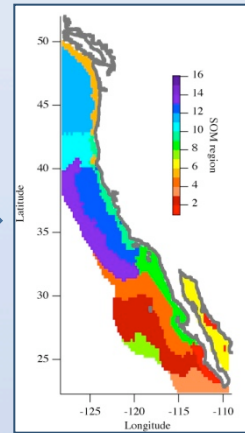
e.g. Pacific Coast Synthesis

Slides from Simone Alin

Extrapolation & Synthesis of CO₂ Observations

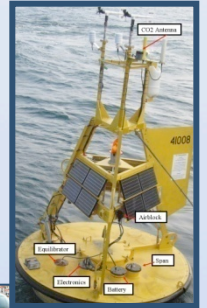


Remote sensing climatologies



SOM defines regions

Field CO₂ data



Non-linear model

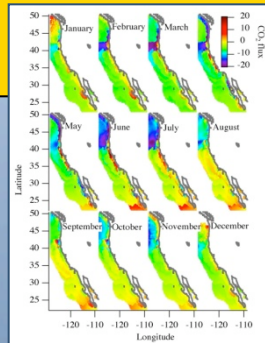
$$pCO_2 = f(Alk, TCO_2, T, S)$$

$$TCO_2 \approx TCO_{2,0} + \left. \frac{\partial TCO_2}{\partial T} \right]_{mix} \Delta T_{mix} + \left. \frac{\partial TCO_2}{\partial Chl} \right]_{bio} \Delta Chl_{bio}$$

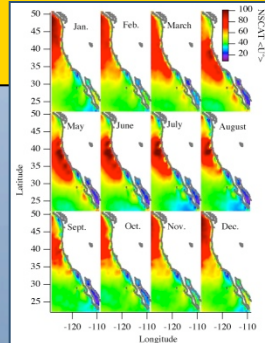
$$Alk \approx Alk_0 - 0.15 \Delta TCO_2$$

Flux = $k s$

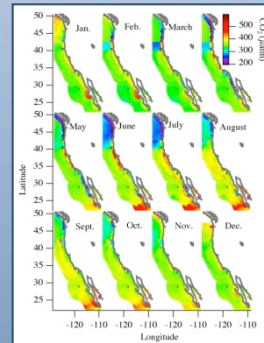
$k = f$



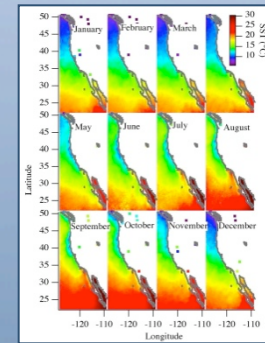
CO₂ flux



Wind speed



pCO₂



RS data

Hales et al., in prep

Estimates of West Coast CO₂ fluxes

Method	Latitude N	Annual flux (Tg C)	Source
Climatology	~8–55°	– 13 ± 26	Chavez et al. (2007)
SOM (U.S. West Coast–Baja)	22–50°	– 17	Hales et al. (2007)
SOM (Mexico– Panama)	5–25°	-0.5	Hales et al. (2008)
ROMS (U.S. West Coast)	24–48°	weak net source	Plattner et al. (2008)
SOM (U.S.– Central America)	5–50°	– 30	Alin et al. (2009)

Synthesis: challenges and opportunities

- 1. Consistency in area/units of outputs presents a challenge to study-to-study comparisons.**
- 2. Must define questions and products.**
- 3. Planning should allow for synergistic observational efforts.**

