Sampling Strategies and Measurements on the East and West Coastal Environments of the US for Carbon Cycling

Date: Wednesday, Feb. 18 at 3pm
Conveners: Antonio Mannino and Burke Hales

Description of Breakout Session: Development of carbon budgets for coastal marine environments requires linking of land and ocean processes, measurements at the air-sea and ocean bottom interfaces, and measurements of in situ carbon cycling processes. The required measurements therefore encompass a wide range of approaches, techniques and processes. An additional consideration is providing measurements that can be used to inform, constrain and validate coastal carbon cycling models. The design of measurement programs that are adequate to this is the topic of this breakout session. The objective is to identify types of measurements, measurement approaches and needed data sets that will allow understanding of carbon cycling in US coastal waters. Discussions will have to address the range and variability of the hydrographic and biological regimes and major differences between the two coasts.
Objectives

• Define priorities for measurements and sampling strategies for the U.S. East & West Coasts towards development of carbon budgets.
• Generate report to funding agencies & scientific community describing these priorities.
• If necessary generate proposal or white paper requesting support for new or planned measurement programs.
Discussion Questions

• What are the measurement priorities for development of coastal carbon budgets?
• What are the critical measurements that modelers need to develop and evaluate carbon cycle models of the U.S. East and West Coasts?
• What sampling strategies/programs will help us achieve our measurement objective while maximizing our research investments?
• What additional resources and technology are needed to achieve NACP goals?
“The major unknowns seen as limiting the understanding of the carbon cycle in coastal waters could be summarized as an ignorance of net reactions in the water column and surficial sediments, and net fluxes across the important boundaries of the coastal ocean. These include the following:”

1. Net community water-column diagenesis
2. Net air-sea exchange of CO₂
3. Net chemical fluxes across ‘shoreline’ boundaries
4. Net exchange between coastal and open ocean

Workshop Recommendations:
“Make coastal carbon cycling research inclusive”
“Improve coastal carbon cycling observational capabilities”

1. Expansion of routine measurements in the coastal setting.
   - Optimize chemical and biological measurement technologies.
2. Refinement of remote sensing algorithms - specific areas of emphasis:
   - Better atmospheric corrections at continental boundaries.
   - Better resolution between CDOM, chlorophyll, and suspended sediments.
   - Increased spatial and temporal resolution of remote-sensing measurements.
   - Development of algorithms from remote salinity estimation.
3. Development of new technologies
   - Autonomous analysis systems.
   - In situ sensing technologies.
   - High-resolution automated sampling systems.
   - Cheap, fast, compact systems for deployment on coastal ships and moorings of opportunity.

“Synthesize and model existing datasets”.
“Objectively define the coastal oceans, and subregions, for targeted carbon cycle study”.
“Develop a plan for observational study and assimilative modeling of characteristic regimes ....
This work would have the following objectives:
1. Quantification of net carbon-relevant fluxes across key interfaces of the control volume, and net carbon-relevant reactions within the control volume, and detailing the processes that control these.
2. Determining relationships between the fluxes, reactions, processes above, and more extensively measurable parameters (e.g., meteorological and satellite data) such that detailed results can be extrapolated to unsampled times and locations of any given region.
3. Development of parameterizations of the above such that they can be readily implemented in models.
4. Detailed biogeochemical models of the regions would be an integral part of these studies. These would initially guide planning of the fieldwork, and ultimately assimilate the data generated in the field”.

# Measurement Priorities?

### Fluxes
- Air-Sea CO₂
- Sinking POC & PN
- Land-River-Estuary-Shelf DIC, POC, PN, DOC, DON & nutrients
- C burial
- Shelf/slope to open ocean POC, PN, DOC, DON, nutrients
- Upwelling nutrients, CDOM, DIC
- Downwelling DIC, DOC, DON, CDOM
- 3D advection, eddy diffusion, etc.
- Atmospheric N & Fe deposition
- Water-sediment C & N

### Processes
- NPP and GPP
- Benthic PP
- Respiration
- Net Community Prod. of DOC
- Grazing
- Photooxidation
- Denitrification
- Nitrification
- N₂ Fixation
- Turnover rates of POC, PN, DOC, DON, DOP & sediment C & N

### Discrete
- pCO₂ & DIC
- POC, PN, PIC
- DOC, DON, DOP
- Phyto. Biomass
- Pigments & Taxonomy
- Nutrients
- Alkalinity
- Semi-labile DOC & DON
- Temp., Salinity, Diss. Oxygen
- Susp. sediments
- IOPs & AOPs
Sampling Strategies

• Ship-based, in situ remote/autonomous, satellites and aircrafts
  – Where & when (regional and seasonal priorities)?
  – How? (random, grid, transects)
  – What’s lacking?
    • Ship time
    • in situ instruments
    • Satellite/aircraft data
    • Measurement techniques
    • Innovative approaches
Remote / Autonomous Technology

• Flow-through systems on ships, Moorings, Floats, Gliders, OASIS, other platforms …
  – CTD, dissolved oxygen, pCO₂
  – Air-Sea CO₂ flux
  – Chl-a & CDOM fluorescence
  – Inherent Optical Properties (absorbance, backscatter, beam attenuation, …)
  – Water-leaving radiances

• Satellite and Aircraft sensors
  – Development & launch of advanced sensors
  – Develop new remote sensing products
  – Improve existing algorithms
  – Improve access to and processing of data