Biological Transformations

Participants: Steve Lohrenz (lead), Sumit Chakraborty, Zack Johnson, Marc Kolodner, Liz Minor, Dan Tomaso, Noel Urban

I. What are the major biological transformations relevant to coastal carbon cycling?

A. Primary Production (includes NPP, GPP, DOM production, benthic vs. water column)

B. Net Community Production (NEP, NEM)

C. Respiration (Autotrophic, Heterotrophic, Ecosystem)

D. Secondary Production (grazing, microbial production, DOM production, DOM utilization)

E. Vertical fluxes (various forms)

F. Nutrient transformations (regeneration, nitrification, denitrification, annamox, uptake, new vs. regenerated)

G. DOM remineralization (degradation, photodegradation)

H. Important to define boundaries

II. What do we know and what don't we know?

A. Primary production

1. Numbers exist for most regions (discrete measurements, satellite-based, models)

2. Importance of satellite observations for improving estimates – past and future

a) Guide sampling and interpolation/extrapolation of measurements

b) Constraining coastal/river influence and boundaries

c) Importance of different assets/technology

(1) Continuity of observations (e.g., ocean color)
(2) Hyperspectral/multi-spectral
(3) Geostationary
(4) Airborne (imaging, lidar, etc.)
(5) High spatial resolution critical for terrestrial/coastal regions (Geostationary, Landsat, Worldview, IKONOS, Geoeye, Quickbird)

3. Large uncertainties – differences among methods

4. Challenge of extrapolating using modeling or satellite approaches, especially in higher latitudes (clouds, ice cover, limited data)

5. Need to account for different ecotypes – challenge in quantifying in heterogeneous environments

a) Tidal marsh/estuaries/inland waters/benthic vs. water column

b) Account for community structure/composition to improve models and algorithms

c) Importance of blue carbon – potential applications to carbon trading/carbon offsets

B. Respiration

1. **More limited observations– some regionally comprehensive**

2. **Critically important for carbon budget**

3. **Technological approaches provide improved assessment**
   a) ***Gliders/AUVs***
   b) ***Profiling floats***
   c) ***Moorings***
   d) ***Eddy/covariance (benthic subsurface as well as above water)***

4. **Progress in analytical approaches (triple oxygen isotope method, gas exchange methods)**

5. **Other methods (nitrogen methods, sulfate oxidation, etc.)**

6. **Need for better understanding of autotrophic and heterotrophic respiration**

7. **Factors contributing to uncertainty**
   a) ***Variations in respiratory quotient***
   b) ***Food quality/composition (nutrient content, stoichiometry, DOM lability)***
   c) ***Growth/transfer efficiencies – important for modeling***
   d) ***Role of different trophic groups (plankton, bacteria)***
   e) ***Challenges of scaling (system-wide vs. discrete, methodological differences, temporal coverage)***

C. Vertical flux/Export Production/New Production

1. **Sediment traps still major source of information, but with limitations**

2. **Other measurement techniques**
   a) ***^{234}Th***
   b) ***Optical proxies including satellite techniques***
   c) ***Modeling approaches***

3. **Importance of DOM as an export term**

4. **Coastal/nearshore systems difficult to quantify**
   a) ***Resuspension, "spiraling"***
   b) ***Conventional methods not applicable***
   c) ***High variability***

D. Other transformations

1. **Nutrient**

2. **DOM**

III. Community Structure and Composition

A. Importance of understanding length and complexity of food chain for carbon budgets

B. Models developed to account for community structure

1. Primarily regional
2. Understanding of basic processes/trophic level interactions
3. Some efforts to incorporate information into management approaches
4. Increasing model complexity can have diminishing returns

C. Satellite approaches for phytoplankton taxonomy, functional groups, size classes

D. Need for understanding long term (climate, eutrophication, ocean acidification) and event scale changes in community structure

E. Changes due to invasive species (e.g., mussels, HABs)

IV. What changes will most impact flux predictions?

A. Changing coastal environments (sea level, erosion, eutrophication, acidification, human activity, land use, terrestrial inputs)

B. Storm frequency and intensity

C. Mixing and stratification (wind stress, temperature dependence, freshwater runoff)

D. Ice cover

E. Changing habitat (invasives, habitat loss, shifts in community structure)

F. Lake phenology

G. Bioengineering and carbon sequestration efforts

H. Aquaculture

V. Variability in space, time, scaling and effects on uncertainties

A. Need to apply appropriate technology to integrate over relevant spatial and temporal scales (e.g., satellites, gliders, etc.)

B. Understanding subsurface processes beyond capability of remote sensing

C. Discriminating measurement uncertainty vs. natural variability

D. Challenge in extrapolation based on limited measurements

E. Need for adaptive sampling – response to episodic events, accounting for event scale phenomena (adaptive science, integrate into models)

F. Development of measurement proxies for critical variables/transformations