Temporal Variability in Net Community Productivity on a Coastal Shelf Site as Determined by High-Rate Oxygen and Nitrogen Data

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Introduction
Net Community Production (NCP) is Gross PP minus Community R
- Crucial factor in coastal carbon cycle studies
- Important in the study of eutrophication and fisheries biology
- Depends on myriad factors including temperature, solar radiation, dissolved nutrient levels, and community structure
- Several methods exist for estimating NCP in natural waters:
  - Light and dark bottles, C14 bottles
  - Remote sensing and ocean color
  - Ar:O2 saturation ratios using MIMS (flow through)
- We estimate timeseries NCP by two methods:
  - O2 mass balance
  - N2/O2 saturation ratio

Hypothesis
Dissolved O2 is impacted by both physical and biological processes
- Use O2 mass-balance, estimating physical processes:
  \[
  Z \frac{d[O_2]}{dt} = PP - R - F_s - F_p
  \]
  \[Z = \text{depth of integration (epi~topic zone)}\]
  \[\frac{d[O_2]}{dt} = \text{change in } O_2 \text{ departure from } O_2 \text{ saturation with time}\]
  \[PP = O_2 \text{ generated by Primary Production}\]
  \[R = O_2 \text{ consumed by Community Respiration}\]
  \[F_s = \text{Flux of } O_2 \text{ outward from ocean surface}\]
  \[F_p = \text{Vertical eddy flux of } O_2\]
- Rearranging,
  \[NCP = Z \frac{d[O_2]}{dt} + F_s + F_p\]
- If physical processes alone drive N2 saturation state, it can be used to track those processes:
  - Use changes in N2 to estimate expected O2 saturation from purely physical forcing
  - Biological processes account for the deviation of observed O2 from predicted

Results
O2 saturation spikes in the surface water around July 10
- Expected intense bloom
- Preliminary comparison with sediment trap data
- Dissolutes
- Mean NCP remains net positive throughout the summer months
- Begins to dip into the negative by the end of August
- Mean NCP remains negative throughout the winter deployment
- N2/O2 NCP estimates
  - Overestimates magnitudes at 5m
  - Tracks blooms well in time
- Future work
  - Improve N estimates of physical portion of O2 mass-balance (evaporation)
  - Measure N2 at multiple depths (multiple GTD's)
  - Improve N2/O2 estimation method to reflect real differences in physical characteristics

Date
Mean Air-sea
Value of O2 [mmol m^-2 d^-1]
Total Air-sea
Value of O2 [mmol m^-2 d^-1]
Mean NCP
Value of O2 [mmol m^-2 d^-1]
Total NCP
Value of O2 [mmol m^-2 d^-1]
Season
Mean Air-sea
Total Air-sea
Mean NCP Total NCP
Summer
59.132
5203.6
52.546
4624.02
Winter
-41.029
-4038.13
-43.122
-4839.04

Site and Methods
- UNH Coastal Carbon buoy located at 43°N, 70°W
  - Approximately 65m depth
  - East of Jeffery’s Ledge
  - Instruments at 1, 4, 5, 12, 24, 36, and 50 meter depth
  - Temporal resolution – 10 min
  - Two deployments: Spring and Fall 2009
- CTD - Salinity, Pressure, and Temperature
  - Optodes for O2 (Fig. 2)
- Gas Tension Device for N2 (Fig. 3)
  - Measures total dissolved gas pressure
  - Total Dissolved Gas
  - Dissolved O2
  - Dissolved CO2
- Wind speed for Air-Sea flux parameterization

UNH
1m: CTD, O2
4m: CTD, Chl-a
5m: CTD, GTD
12m: CTD, O2
24m: CTD, O2
36m: CTD, O2
50m: CTD, O2

Surface: T, P