CARBON FLUX THROUGH THE TWILIGHT ZONE – NEW TOOLS TO MEASURE CHANGE

Poster #1502

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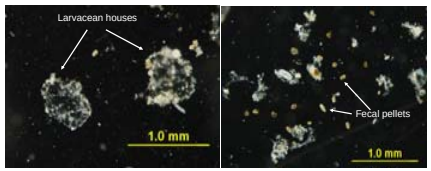
ABSTRACT

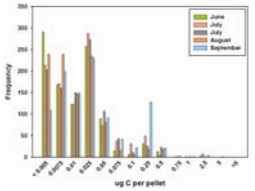
We have started a project to develop the next generation of particle flux collectors to answer key science questions associated with fluxes of sinking particles at the Bermuda Atlantic Time-series Study (BATS) site. We show new flux data using neutrally buoyant sediment traps (NBSTs) as part of the BATS time-series. These data will include the fluxes of major elements- POC, PON, bSi, PIC and mass, as well as different particle types. We will also show designs for the "Twilight Zone Explorer" (TZEX), a new NBST that is under development. The TZEX will be capable of collecting multiple samples on longer deployments using anti-swimmer controls to inhibit zooplankton from entering the traps, and with on board sensors to characterize water column properties. These flux data will be interpreted in context of BATS plankton community structure and variability in production and ocean properties determined using remote sensing. We are also interested in engaging additional scientists in collaborations to augment our studies of the ocean's twilight zone (depths below the euphotic zone to about 1000m).

FECAL PELLET FLUX



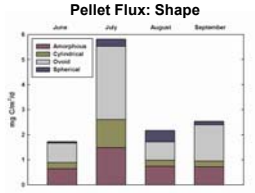
Typical particles found in BATS sediment traps. Left panel shows two larvacean "houses" (discarded mucous feeding webs). Right panel shows abundant small fecal pellets originating from larvaceans and small copepods, as well as pieces of larvacean houses and other unidentified detritus.

Normalized Pellet Size Frequency Distribution

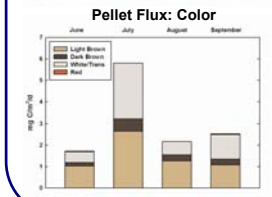


- **Most of the fecal pellet flux at BATS is in the small size classes, reflective the dominance of small copepods in the euphotic zone.**
- **The dominance of smaller, slower sinking pellets is consistent with the low export ratios seen at BATS.**
- **Fecal pellet flux increased from June to July due to an increase in small, ovoid pellets (produced by small copepods and larvaceans), which then leveled off in August and September.**
- **In September, large, brown, ovoid pellets (from unknown herbivore or omnivore) account for the increase in the size frequency distribution in the 0.25-0.5 µgC/pellet range.**
- **Red pellets produced by carnivorous zooplankton also appeared in traps in September.**

Pellet Flux: Shape



Pellet Flux: Color



SAMPLING PROTOCOL

2 x

Swimmer removal methods

Trap 1 → Filter through screen

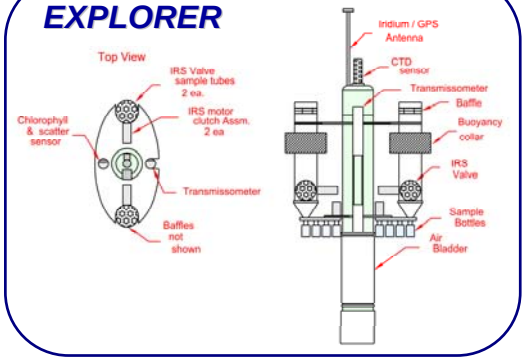
Trap 2 → Wet-pick swimmers or filter through screen

→ Split sample 8-ways, a-g

- a, d, g → Th-234 → CHN (½) bSi (¼) P (¼)
- b. e. h → Mass → b, e → PIC; h → ICP-MS
- Screen/ Swimmers → CHN (¼) bSi (¼) P (¼)

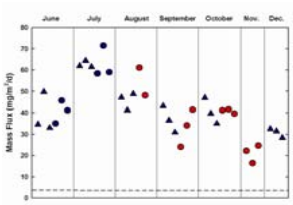
Combine 4 out of 5 tubes – 5th is for microscopy (VIMS)

TWILIGHT ZONE EXPLORER

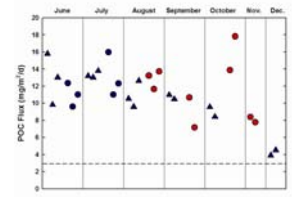


MAJOR PHASES AND MASS FLUX

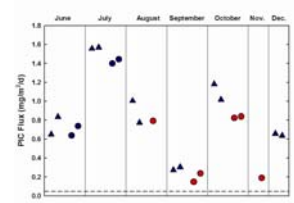
Mass Flux



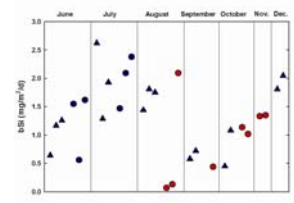
Particulate Organic Carbon (POC) Flux



Particulate Inorganic Carbon (PIC) Flux



Biogenic Silica (bSi) Flux

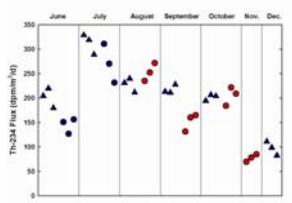


Shown are mass, POC, PIC, bSi, and ^{234}Th fluxes as collected by NBSTs at 150m at BATS between June and December 2007

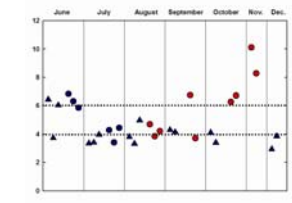
- **Replicate fluxes between splits and between two NBSTs (circle vs. triangle) are generally consistent.**
- **The use of screens (blue) or wet picking (red) methods to remove swimmers resulted in similar fluxes.**
- **Mass, POC, and PIC fluxes are corrected using the "effective flux" from a NBST tube containing brine and formalin that remains onboard the ship during the flux collection period.**
- **For mass, POC, and ^{234}Th, there is a trend to lower flux in November and December.**
- **The correlation between fluxes is tightest for mass and ^{234}Th, though POC flux shows a similar trend, as evidenced by relatively constant POC/^{234}Th ratios.**
- **POC is on average 26% of the total flux (58.4% POM). PIC and bSi are consistently a small percentage of the total flux, on average, 1.7% and 3.0% respectively (14.3% $CaCO_3$, 6.5% Opal). The monthly fluxes of PIC and bSi show a different pattern than the total flux, due to changes in phytoplankton assemblages (pigment and food-web data not yet processed).**

Screened Trap 1
Screened Trap 2
Wet-picked Trap 2
"Effective flux" from blank tube
Typical POC/Th values

^{234}Th Flux



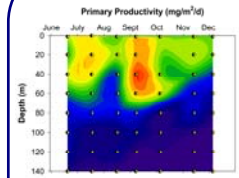
POC/^{234}Th Ratio



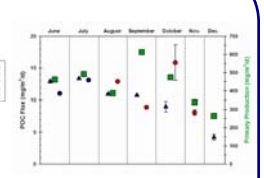
TWILIGHT ZONE EXPLORER

PRELIMINARY FINDINGS & FUTURE WORK

Primary Productivity (mg/m²/d)



Primary productivity (mg/m²/d) vs. depth and time as measured by the BATS program shows a peak in September at 40m and general decrease towards November and December cruises.



POC flux (mg/m²/d – left x-axis) shown as the average and standard deviation from the NBST time-series (same symbols as in figures to left). Also plotted is the integrated primary production rate (■ mg/m²/d – right x-axis) for the same time period.

Ongoing field work and analytical work

1. **Continued NBST time series through 2008**
2. **New analyses for flux components and plankton community structure (ICP-MS for trace elements, P, HPLC pigments)**
3. **Comparison to PITS and other BATS data to investigate causes of changing export ratios**
4. **Comparison to assessments of sea surface color and particle source funnels (Siegel) to place monthly single-point results in context of larger mesoscale patterns of surface chlorophyll and eddies**

New studies in 2008 and beyond

1. **Two additional traps at 300 and 500m to resolve flux vs. depth (Apr, Jun, Jul, Sept, and Nov) in order to parameterize the transport efficiency of particles through the mesopelagic zone**
2. **Particle abundance and size profiles of upper 500m using Video Plankton Recorder (collaboration with Gallager, Ashjian, and McDonnell) to relate particle size and abundance changes in flux vs. depth and to quantify changes in the zooplankton size and abundances**
3. ***In situ* O_2 respiration (collaboration with Boyd and McDonnell) to study changes in remineralization rates of sinking particles vs. depth and season**
4. **New developments with swimmer avoidance using rotating IRS technologies (Valdes) as part of the development of a time-series, swimmer avoidance, neutrally buoyant sediment trap (TZEX – Twilight Zone Explorer – see schematic above)**

As part of our continued efforts to study processes that control particle flux and remineralization in the upper ocean and mesopelagic zone, ***we welcome new collaborators*** *for 2008 for additional analyses of flux materials we are collecting already and/or for participation with additional experiments on the 2008 cruises.*

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