

CRUISE REPORT NEW PRODUCTION 2005

**CRUISE DATES:
FEBRUARY 15TH TO MARCH 15TH 2005**

**REGION OF STUDY:
NORTHWEST SARGASSO SEA**

**CRUISE PARTICIPANTS AND AFFILIATIONS:
(in alphabetical order)**

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1. Overview of Primary Research Objectives

Increasingly, biogeochemical studies are showing that event-scale phenomena, ~3-10 days in duration, have disproportionately large impacts on phytoplankton biomass and export production (e.g. Karl et al. 2001b, DiTullio & Laws 1991, Pesant et al. 2002). This is consistent with findings from mooring deployments that suggest the decorrelation time-scale for chlorophyll in the region of the Bermuda Atlantic Time-series (BATS) site is 5-10 days (Dickey et al. 2001). In this proposal, we seek to quantify the importance of event-scale destratification/stratification events during the winter convective mixing period (prior to the traditional spring bloom) to annual export production. As a necessary corollary, we propose to quantify the temporal relationship between *new* and *export production* during that time of year. To accomplish this goal, the dominant processes and mechanisms of nutrient input, consumption and loss from the surface ocean need to be studied on a time scale in line with that of physical forcing, that is days to ~2 weeks. Based upon a conceptual model described below (Figs 2 & 3) we present the following central hypothesis.

We hypothesize that the roughly bi-weekly passage of weather fronts during the period of winter mixing leads to an alternation between destratified and stratified water column states in the Sargasso Sea. The resulting episodic nutrient inputs, followed by short periods of water column stability, support increased new production well before the onset of seasonal stratification and give rise to a “bloom/bust” phytoplankton community dominated by rapidly growing forms such as diatoms. We further hypothesize that the nature of this physical/biological coupling leads to enhanced export production in subsequent destratification/stratification events during this time of year that has not been included in past geochemical new production estimates.

Short-term events of the type we hypothesize would be systematically missed or at least undersampled by the present BATS sampling schedule, because the ship does not leave port during rough weather. We therefore propose a continuous, 30-day field program designed to generate a mechanistic understanding of the event-scale (days to ~2-week) physical forcing and biological responses in this region of the Sargasso Sea. To successfully accomplish this sampling plan and integrate the findings into appropriate biogeochemical models, we have the following specific objectives.

1) Measure the daily time course of N input and uptake, within the euphotic zone of the Sargasso Sea, through several destratification/stratification events during the winter convective mixing period.

2) Quantify the main floristic changes (using a diversity of chemotaxonomic methods) and the size distribution change in the phytoplankton community during and after these destratification/stratification events.

3) Determine the fate of N (primarily particulate flux, DON export, non-gravitational flux or remineralization) that is detrained during destratification events in order to better understand the relationships between new production and export production.

4) Use the data collected to validate and enhance a 1-D model of the primary production and biogenic particle export cycle that has been developed for the BATS site, as well as increase the general robustness of biological/physical models for this and similar temperate latitude sites.

This research plan will provide much needed rate and stock measurements for understanding the controls on new production (**Objective 1**), and its subsequent fate following removal from the euphotic zone (**Objective 3**). In addition this study will provide valuable information on the response of the phytoplankton community composition to physical forcing and how this change impacts the fate of entrained N and C (**Objectives 2 and 3**). By assimilating

these data into a process-oriented biogeochemical model (Mongin and Nelson, 2002 a, b), we can expand the relevance of this work to other ocean environments that experience increased new production in the late winter and early spring prior to the traditional spring bloom (**Objective 4**). This work will complement the scientific objectives of the BATS program by providing information not currently available, yet absolutely necessary to evaluating productivity and export on an annual basis. *The importance of uninterrupted sampling during winter convection period is underscored by studies showing that the biweekly sampling scheme at BATS, although well designed for detecting seasonal and longer time-scale patterns, is not frequent enough to explain the dynamic processes that occur on shorter time scales (e.g. Dickey et al. 2001).*

2. Ancillary Projects Supported by NP2005

Several ancillary projects were supported on this research cruise, including thesis research of two additional graduate students. These projects were chosen for their synergy with the primary project scientific objectives and to help 'close potential gaps' in our knowledge with respect to rate processes and ecosystem function in the open ocean.

A. Tritium/NO₃ relationships in convectively mixed water (OCE – 0351396; Jenkins and Lomas) – Student Carolyn Walker, Advisors Mike Lomas & Bill Jenkins. On both NP2004 and NP2005 cruises, samples for Tritium/Helium levels were collected in connection with nutrient and dissolved oxygen concentrations. The purpose of these samples is to validate the Helium Flux Gauge Technique (FGT) as a measure of nitrate inputs to the euphotic zone, and therefore as a potential corroborative geochemical estimate of new production in the Sargasso Sea. This is a unique comparison for nitrogen inputs (FGT), uptake (15N rate measurements, and measured nitrogen export (PITs traps).

B. Microbial Community Diversity and Activity – Student Carrie Fraser, Advisor Lee Kerkhof. On both the NP2004 and NP2005 cruises, samples were collected to examine the prokaryotic diversity and to a limited extent the eukaryotic diversity based upon rRNA phylogenies. In addition to these estimates of diversity, experiments were conducted to examine bacterial productivity using the BrDU method, and rates of bacterial nitrogen and carbon assimilation based upon incorporation of heavy stable isotopes into microbial DNA (stable isotope probing techniques, Kerkhof et al.). These experiments are a great addition as they provide information on potential microbial uptake of nitrate and ammonium; uptake that could be attributed to autotrophs based upon bulk 15N incubations terminated on GF/F filters. In addition uptake of other DOM compounds is relevant to understanding DOM dynamics as they are a potential carbon export term.

C. Whole Community Enzyme Activity (Alkaline Phosphatase & Peptidase) – Student Brian Gaas, Advisor Jim Ammerman. On the NP2004 cruise we observed a very significant event with respect to carbon drawdown and enhanced export in the Sargasso Sea. The mixed layer during the time of this event was shallow enough to suggest that initial ratios of nutrient entrainment could be greater than the Redfield Ratio, and deficient in phosphorus. Despite this, the biological response was incredibly rapid (time scale of hours to day) and significant. An immediate question was whether or not dissolved organic phosphorus (DOP) was supporting some level of this enhanced production and export. Brian's work on the NP2005 provided additional insight to coupled carbon, nitrogen and phosphorus dynamics. This is an excellent

starting point for the newly funded project examining DOP dynamics in the Sargasso Sea (Lomas, Dyrhman & Ammerman OCE-0453023).

3. Summary of Cruise Operations

As the purpose of this project was to examine the role of convective mixing in the absence of additional physical forcing due to eddies or other physical anomalies, we worked closely with Dennis McGillicuddy at Woods Hole Oceanographic Institution (WHOI) to get sea level anomaly (SLA) maps in order to choose a research location not impacted by an eddy feature. That is we chose a region of the Sargasso Sea near to BATS where there was a near-zero value for the SLA and a minima in overall sea level gradients.

This tactic worked well in NP2004, but did not work as well in NP 2005 due to atypical (relative to the past few years) winter conditions. Storm events were not only stronger (in terms of mean wind speed) than typical, but also were much more frequent. Whereas in typical winters, frontal systems traveled over off the U.S. east coast every ~3 days, in the winter of 2005, frontal systems were forming nearly every day. This heavy cloud cover prohibits good satellite passes to determine SLA plots. As a result the image dated February 12, 2005 (Figure x.x), 3 days before we sailed, was used for the first 2.5 weeks of the research cruise. Throughout the remainder of the cruise we were able to get 2 additional SLA images to aid in our cruise operations.

At the beginning of the cruise we identified a region of low SLA gradients at 35°N 58°W, and we conducted a 'cross-patterned' survey grid prior to deploying the drogue. The drogue was deployed for a total of ~3 days before the decision to cease operations in this area. This decision followed from conducting the survey grid and the ~3 day drogue deployment under strongly adverse conditions (sea consistently in excess of 15' and winds in excess of 25kts often to 40kts.). The good news is that this was indeed an area of low SLA gradients as our drift following the drogue was clearly SW; the bad news is that the weather prevented us from conducting science. The PITs array was left in place to continue collecting samples as we steamed to Bermuda to pick up replacement equipment (D. Nelson's spectrometer and G. Tupper salinometer fan) and see if the weather would break. Upon return to Bermuda, we transited to the BATS site and conducted several CTD casts for ancillary investigators. Upon completion of these casts we steamed back to the location of the PITs array and retrieved them.

Based upon weather forecasts, and the seas when we arrived at PITs, it was believed that the weather would not in fact lay down and significant concern was raised about our ability to continue science in this region. As a result, we steamed South to 32°N 58°12'W in search of better weather. This was also a region of apparently low gradients in SLA, however after ~4 days, and after completing 3/4ths of a complete circle, it was clear we were in an anticyclonic eddy feature. At the beginning of hydrocast #39, at 0239 local, the CTD was pulled into the boom block, the wire parted and the CTD was lost. At first light we retrieved the PITs array and steamed for Bermuda once again. During transit, Marshall Swartz and Barrie Walden at WHOI arranged for a replacement CTD to be at the dock in Bermuda. The CTD did indeed arrive and after spending 24h in port, we steamed to complete the cruise.

We steamed to 31° 11.3'N 66° 56'W to begin the third and hopefully final drogue deployment for this cruise. The drift pattern for this particular deployment (see below) was very strange with several 'pig-tails', however there was no evidence that we were in an eddy feature. Indeed this was the most exciting of the drogue deployments as there was a clear increase in biomass, dissolved oxygen (representing net community production) in the face of a 300m mixed layer depth. In fact there was an increase in biomass before there was significant daily irradiance that might lead to even the slightest heating of the surface ocean. Details of the results from each drogue deployment are presented below.

4. Detailed Description of Core Cruise Measurements

Core project measurements are separated into stock and rate measurements. Details for sample collection/processing are as follows:

Stocks

NO₃⁻ and NH₄⁺ (Lipschultz/Lomas). NO₃⁻ concentrations will be determined using an Alpkem Nutrient Autoanalyzer, with a detection limit of ~0.05 μM using standardized procedures (Knap et al. 1997). To enhance our capabilities to measure low level NO₃⁻ and NO₂⁻ concentrations, we specifically request funds for purchasing a fiber-optic waveguide spectrophotometer. This method is based upon standard colorimetric chemistry, but the fiber-optic flow cell greatly increases the sensitivity of the method (~2nM) without losing precision (~0.8%; Zhang 2000). NH₄⁺ measurements are not a primary focus of the proposed research and concentrations remain very low during the winter mixing period (Lipschultz 2001), however, on several of the process-oriented casts we will make measurements of NH₄⁺ concentration and NH₄⁺ uptake rates (see below, Lipschultz 2001).

Dissolved Inorganic Carbon (Bates). DIC will be determined by highly precise and accurate gas extraction and coulometric detection methods used at BBSR (Bates et al. 1996b, Bates et al. 1996a, Bates et al. 1998, Carlson et al. 1999). New instrumentation at BBSR has improved the precision of the measurement from ~0.4 to 0.2 μmoles kg⁻¹ for metabolic measurements.

Dissolved Organic Carbon and Dissolved Organic Nitrogen (Lomas). Total organic carbon (TOC) sample collection and processing and analysis will be similar to that described in (Carlson et al. 1998), but with a new Shimadzu TOC-V Automated high-sensitivity TOC/total organic N (TON) analyzer. This system has the capabilities to perform simultaneous measurements of TOC via high temperature combustion and TON via chemiluminescence detection. The system response is standardized daily with a four point calibration curve of potassium hydrogen phthalate (for DOC) and NO₃⁻ (for DON; Bronk et al. 2000). Ampouled deep Sargasso seawater (provided by Dr. Dennis Hansell's certified reference material program) will be used as reference standards. Because the possibility is quite high that both particulate and dissolved organic matter will contribute significantly to the export flux, we will specifically measure suspended particulate organic matter concentrations and subtract them from the total organic matter concentrations in non-filtered samples to determine DOC and TDN (while minimizing the potential for contamination). TDN will be further corrected by subtraction of the DIN to yield DON.

Particulate Organic Carbon and Nitrogen (Lomas/Bates). Samples for POC and PON will be collected, processed and analyzed using the standard BATS methods (Knap et al. 1997) in the BATS analytical facility.

Biogenic Silica (Nelson). Diatoms dominate the biogenic silica (BSiO₂) signal at BATS (Nelson & Brzezinski 1997) and therefore can be quantified using estimates of biogenic silica

and compared to the fucoxanthin as an indicator of diatom abundance. Biogenic silica will be analyzed using the NaOH digestion method of Nelson and Brzezinski (Nelson & Brzezinski 1997), which have been successfully used in this region before.

Rates

¹⁴C and ¹⁵NO₃⁻ uptake (Lipschultz/Lomas). Rates of NO₃⁻ uptake will be measured by the procedures described by Lipschultz (Lipschultz 2001) while primary productivity measurements will be made using the standard BATS ¹⁴C protocol (Knap et al. 1997). Sample water from 8 depths over the euphotic zone will be acquired prior to dawn by Niskin cast and the Niskin bottles immediately emptied into 20 liter carboys to ensure the samples are entirely mixed and settling is minimized (Gundersen et al. 2001). Incubation bottles will be deployed on a standard BATS-style spar buoy for the duration of the daylight period. Initial (no incubation) and final bottles will provide filtrate for determination of the source enrichment and the isotope dilution after removal of the particulate fraction using GF/F filters for ¹⁵NO₃⁻ assimilation determination. These filters remove nearly all picophytoplankton (e.g. DuRand *et al.* 2001) but do allow ~50% of bacteria to pass (Gundersen *et al.* 2001) so Silver filters will be used occasionally to assess the bacterial component of ¹⁵NO₃⁻ assimilation. The measurement of ¹⁵N enrichment and mass of the particulates will use the CF-IRMS in Lipschultz's lab.

Analysis of the substrate ¹⁵N enrichment will use the protocols of Preston *et al.* (Preston et al. 1996, Preston et al. 1998). These protocols are essentially those used by Lipschultz (Lipschultz 2001), with the formation and extraction of dyes containing the ¹⁵N, but extended with further derivatization of the dye to form a volatile compound for analysis by GC-MS. Compared to direct combustion of the dye, the GC-MS requires less mass and hence less filtrate and, due to the specificity of the derivatization and GC-MS, the blank from organic contaminants is greatly reduced, improving the precision and accuracy of the analysis. BBSR has a GC-MS capable of this analysis; F. Lipschultz has considerable experience with the dye methods and with GC-MS. In addition, Richard Owen (see attached letter), who operates the GC-MS, is highly experienced with stable isotopes and the GC-MS and will assist implementing the method.

As mentioned above, profiles of NH₄⁺ uptake will be determined on selected casts using the protocols of Lipschultz (Lipschultz 2001). These measurements are necessary to validate the high *f*-ratio values that have been suggested for the Sargasso Sea during winter mixing.

Si(OH)₄ uptake (Nelson). We will measure these rates in incubation experiments using the radioisotope ³²Si, a β⁻ emitter with a half-life of 108 y (Elmore et al. 1980). We will collect 250-ml seawater samples from the same well-mixed samples used for ¹⁴C and ¹⁵N uptake. Samples will be injected with ~60,000 DPM (~0.03 μCi) of ³²Si(OH)₄ and incubated for the full daylight period on the spar buoy or the full night in the on-deck incubator with ¹⁴C and ¹⁵N samples. This will enable us to measure Si uptake, and estimate the contribution of diatoms to primary productivity and new production, on an integrated 24-hr basis. ³²Si stock solutions will be passed through Chelex cation exchange resin before use to remove possible trace-metal contaminants (Nelson & Brzezinski 1997). After incubation, samples will be filtered through Nuclepore filters (25-mm diameter, either 5.0 or 0.6-μm pore) under gentle vacuum (< 50 mm Hg), placed in 20-ml polyethylene liquid scintillation vials, allowed to dry at room temperature for ~48 h and returned to OSU for liquid-scintillation counting, which will be performed as described by Nelson *et al.* (Nelson et al. 2001). The rate of Si uptake (ρ, in nmol Si l⁻¹ h⁻¹) will be calculated from the measured ³²Si activity, and the specific uptake rate (V in h⁻¹) calculated from ρ and the measured biogenic silica using the exponential approximation described by Brzezinski and Phillips (Brzezinski & Phillips 1997). At all stations and depths where Si uptake rates are measured, the dissolved silicic acid concentration will be measured by the high-sensitivity manual method of Nelson and Brzezinski (Nelson & Brzezinski 1997).

Phytoplankton Community Structure

Particulate Inorganic Carbon (Bates/Lomas). The contribution of calcareous phytoplankton (e.g., *Emiliania huxleyi*) will be quantified using microscopic methods and will be further estimated by quantifying PIC concentrations (e.g., Wong et al. 1999, Haidar & Thierstein 2001, Wong & Crawford 2002). Haptophytes, of which *Emiliania huxleyi* is an important member at BATS (Haidar & Thierstein 2001), are a large component of the overall biomass at BATS and shows a clear maximum during the winter/spring. Several studies have shown that the importance of Haptophytes (Lomas and Bates, subm., Wong & Crawford 2002) is controlled to some extent by the physical regime and clearly methods to assess this particular component are very important.

Flow Cytometry (Lipschultz/Lomas). The use of flow cytometry as a means to rapidly distinguish and enumerate phytoplankton has become a powerful tool in oceanography (e.g. Frankel et al. 1990, Durand & Olson 1996, Durand et al. 2001), especially with regard to the picoplankton that cannot be identified easily using microscopy. Samples for flow cytometry will be fixed in para-formaldehyde, stored in liquid nitrogen (Sieracki et al. 1993) and analyzed at the J.J. MacIsaac Image Analysis Center (see attached letter). Flow rate and size calibration of cell size will be determined using standardized fluorescent microbeads. Data will be analyzed from two-dimensional scatter plots based on red or orange fluorescence and light scattering properties (Durand & Olson 1996). Based on these parameters, large red autofluorescent phytoplankton (e.g. diatoms), red autofluorescent nanoplankton (e.g., coccolithophorids and flagellates), red autofluorescent picoplankton (*Prochlorococcus*) and orange autofluorescent picoplankton (cyanobacteria) can be enumerated (Durand & Olson 1996, Durand et al. 2001).

CHEMTAX – An algorithm for relating algal pigment diversity to taxonomic diversity (Lomas). Phytoplankton pigment analyses by HPLC are a routine component of the BATS program (Bidigare 1991), and can readily identify the major indicator pigments of the dominant taxa in the Sargasso Sea (Goericke 1998). The BATS program in cooperation with this proposal will analyze HPLC samples in a timely manner, using all the same data quality control and assurance methods employed by BATS. Using the CHEMTAX algorithms (Mackey et al. 1996) phytoplankton taxon distributions can be estimated from the pigment profiles using appropriate pigment ratios (e.g., Goericke & Montoya 1998, Lochhead et al. 2002). CHEMTAX estimations of phytoplankton community structure will be ‘ground-truthed’ against a combination of the microscopic and flow cytometric estimates of phytoplankton community structure.

Microscopy (Lomas). As already mentioned, visual microscopy can provide more detailed taxonomic information but also is the most tedious and time consuming method, and is often unable to discriminate between picoplankton taxa which are morphologically similar. Consequently, this analysis is most useful for larger diatoms and dinoflagellates. Samples will be fixed in formaldehyde and settled for analysis taxonomic analysis on an inverted microscope (see facilities) or identified using epifluorescent microscopy. Lomas has experience in taxonomic identification and will oversee this aspect of the project.

Particulate Carbon Export

To quantify the gravitational flux of particulate material from the surface ocean, we will employ the Particle Interceptor Trap (PITs) design currently used at BATS (Knauer et al. 1979, Knap et al. 1997). As justified below, we request additional funds for building two (2) complete particle interceptor trap units for this project. In order to account for the probability that mixing depths will be >150m, we will use deeper trap depths, 200, 300 and 400m, to minimize the impacts of mixing events “mixing” particles past the traps, while still retaining shallow enough depths to allow for estimates of N and C remineralization, and insight into the importance of ballasted versus non-ballasted fluxes. In addition, as employed in the standard BATS PIT’s

array, a current meter will be positioned above the shallowest trap to monitor for periods of increase shear stress in the water column. Particle fluxes during these time periods will be corrected for this increased shear (and altered collection efficiency) based upon particle size distributions and the equations given in Gust et al. (Gust et al. 1992). Based upon a new 'low-volume' ²³⁴Th particle flux technique, we will collect additional selected samples for analysis by Claudia Benitez-Nelson (see attached letter), which will provide information to further constrain and understand the dynamics of particle export during winter mixing. A slight modification to the sediment trap design involves increasing the number of collection tubes at each depth to permit analysis of BsiO₂ (Nelson & Brzezinski 1997), PON, POC and PIC (on the same sample, see above), pigment analysis (Knap et al. 1997), and microscopic analysis at each depth.

The physical downward mixing of dissolved and particulate material will be determined using the methods discussed in detail by Hansell and Carlson (Hansell & Carlson 2001). Daily vertical profiles of DON/DOC and PON/POC will be integrated above (0 – 150m) and below (150-250m) 150m. Export of dissolved or particulate material will be determined by comparison of the inventories in each of these depth intervals over the course of a mixing event. A significant export to depth will be characterized by an increase in the 150-250m depth interval and subsequent decrease in the 0-150m depth interval.

5. Detailed Description of Cruise Activities

a. Northern Sargasso Sea (35°N 58°W) drogue deployment (Figure 1).

The short duration of this drogue deployment (due to weather considerations) makes it impossible to discern patterns. However, there are two short-lived increases in fluorescence (and presumably biomass). Both of these events appear to follow decreases in mixed layer temperatures (isotherms are nearly vertical), that are associated with comparable decreases in density. This suggests that these blooms might be in response to nutrient inputs from depth following convective overturn. Nutrient concentrations were very high (in excess of 1μM) during this time and it was difficult to see changes in concentration either due to biological uptake or replenishment from mixing. As an ancillary observation, the PITs traps, which were deployed through this time, did have a significant amount of material on them. This suggests that there was likely both gravitational and mixing-out of material that was collected in the traps.

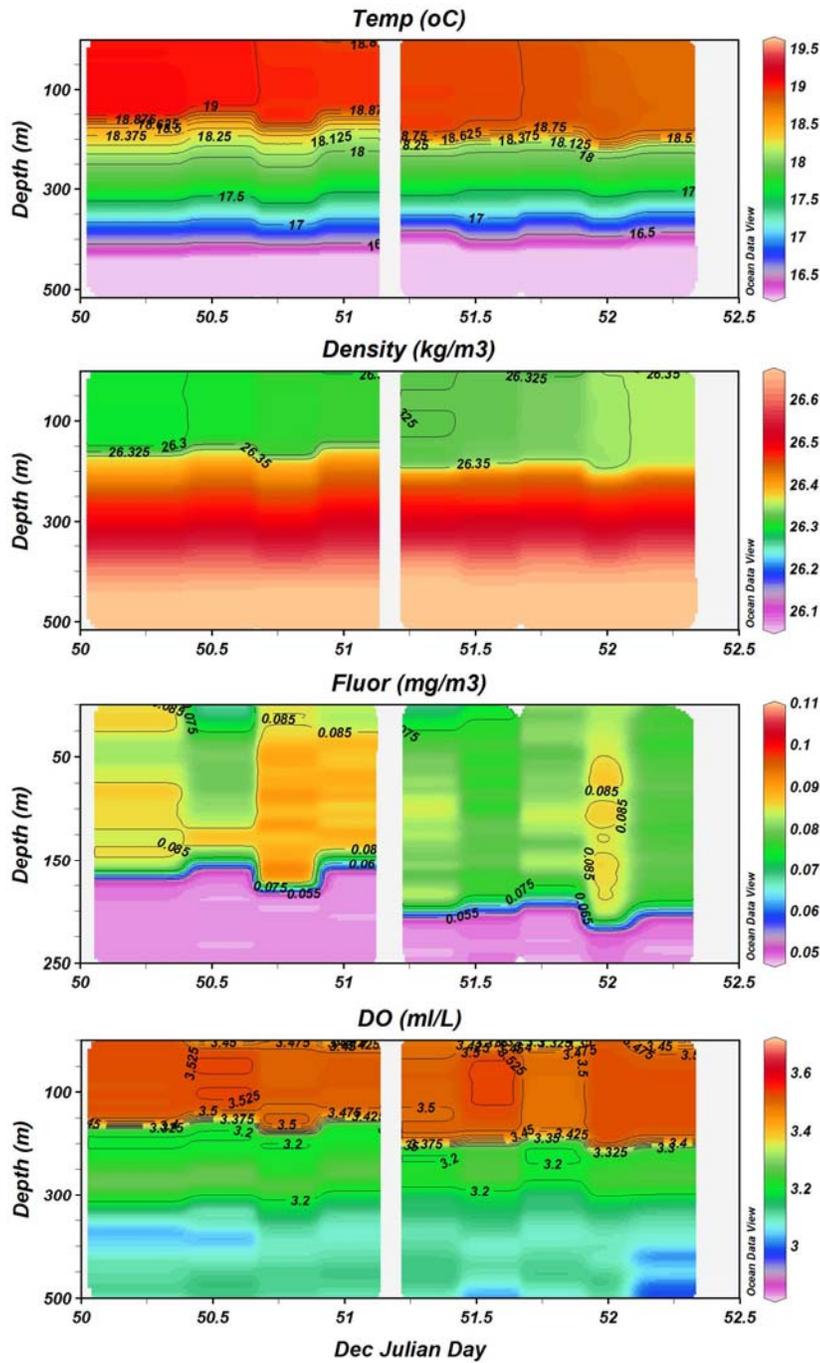


Figure 1. Temperature ($^{\circ}\text{C}$), density (kg m^{-3}), fluorescence (mg m^{-3}), and dissolved oxygen (ml L^{-1}) for the NE drogue deployment (35°N 58°W).

b. South Eastern Sargasso Sea (32°N 58° 12'W.) drogue deployment (Figure 2)

This drogue deployment was terminated early due to the drogue being entrained within an anticyclonic eddy feature. During this short duration experiment, there were no striking changes in the data parameters currently available.

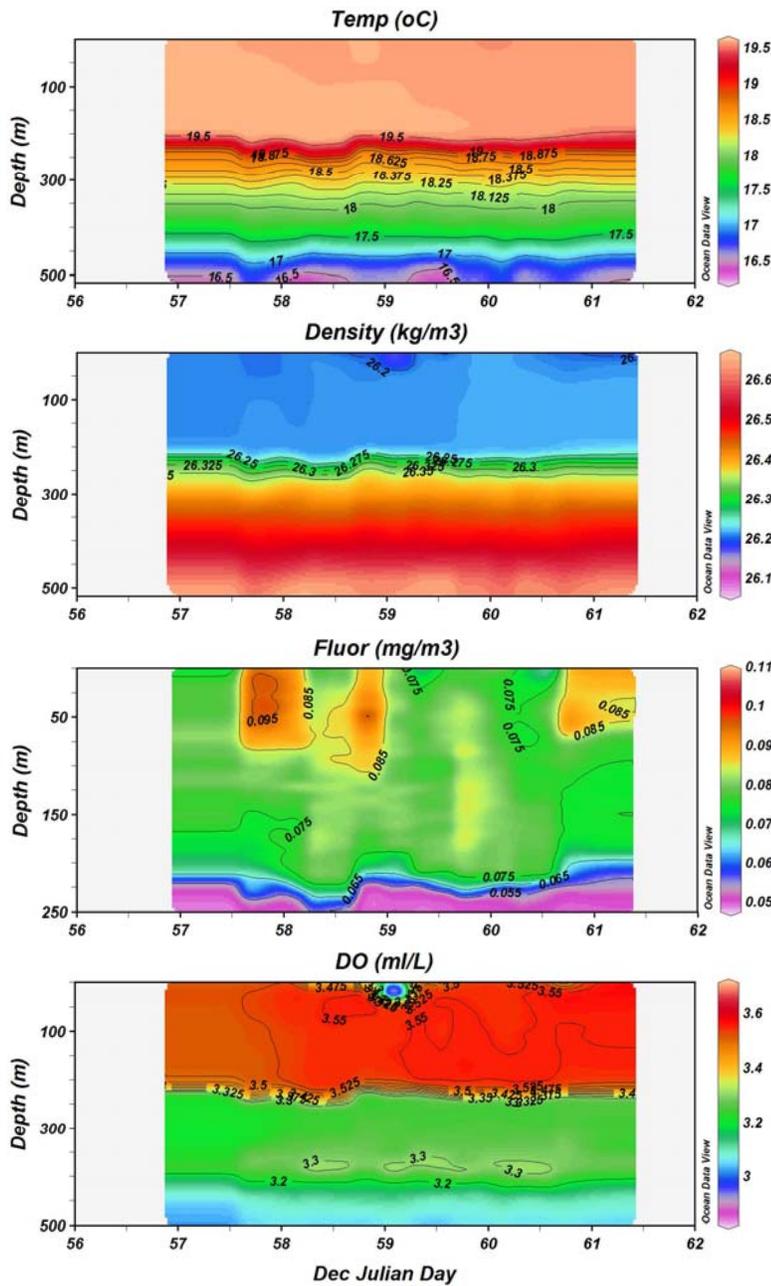


Figure 2. Temperature ($^{\circ}\text{C}$), density (kg m^{-3}), fluorescence (mg m^{-3}) and dissolved oxygen (ml L^{-1}) at the drogue deployment $32^{\circ}\text{N } 58^{\circ}12'\text{W}$.

c. South Western Sargasso Sea (31° 12'N 66° 56'W) (Figure 3)

This drogue deployment followed from the loss of the original CTD so note that the scales for some parameters may be different from the other two drogue deployments. There are several significant findings. First starting with the beginning of the deployment there was a significant increase in chlorophyll fluorescence (and assumed biomass) both within the euphotic zone and redistributed through the entire mixed layer. This accumulation of biomass occurred in the face of a nearly constant 300m mixed layer depth. It wasn't until the last 2 days when we had a significant amount of sunlight to show the beginnings of thermal warming and potentially a shoaling of the mixed layer. Associated with this significant increase in biomass was a drawdown in nutrients (preliminary data forthcoming), however, the drawdown was not as great as it probably should have been due to the deep mixed layer depth that continually replenished the nutrient concentrations. We also observed a very clear and consistent increase in euphotic zone dissolved oxygen. This will allow for estimates of net community production.

The second interesting observation during the duration of this drogue deployment is that observation of a diel export of 'fluorescence'. The decimal day on the x-axis is midnight. Note the increase in fluorescence shortly after midnight on days 67, 68, 70, 71 (missing a few casts so the interpolation is off a little bit) and 74. Some export events are clearer than others, but all appear to be significant. Additional support for this diel convective overturn comes from looking at the isopycnals and there is a really nice coherence between fluorescence export and the shallowing of higher density isopycnals; suggesting mixing up of deeper, denser water. Once we can validate the fluorescence values to real chlorophyll values, we can calculate biomass export. The good thing is that we have 2 PITs deployments during this time frame for comparative purposes.

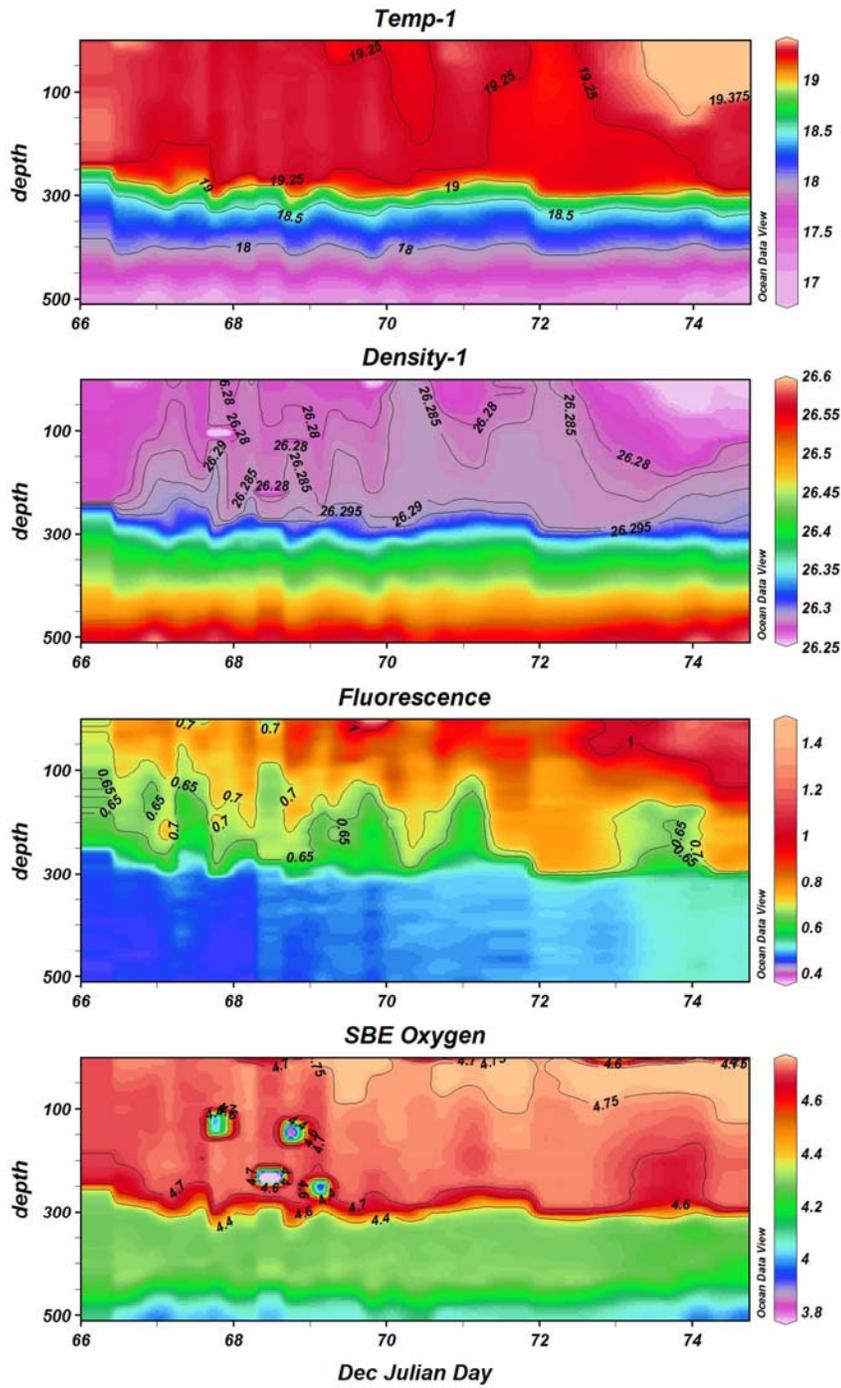


Figure 3. Temperature (°C), density (kg m⁻³), fluorescence (mg m⁻³) and dissolved oxygen (ml L⁻¹) at the drogue deployment 31°12'N 66°56'W.

d. Underway transects between northern Sargasso Sea and Bermuda (Figure 4).

Severe weather during the first week of the cruise limited our ability to conduct the 'routine' process-oriented measurements after several days and the decision was made to steam back to Bermuda to get Dave's spectrometer, the spare salinometer fan and a new liquid propane cylinder (to replace the one damaged by beam seas during the first week). During the transits to Bermuda and back to recover PITs, we monitored underway data and took discrete samples from the uncontaminated seawater system (the same one that Brian G. has been using for his AP activity) for nitrate, nitrite, phosphate, silicate and chlorophyll a. The chlorophyll a samples will be used for 'calibrating' the underway fluorometer system. The nutrient samples were collected purely for investigative purposes, but do indeed verify the passage through several eddies.

This activity provided some very interesting data as we transited through several cold and warm core features where there were clear coherence between fluorometer readings, sea surface temperature and surface nitrate/nitrite. This was very useful, in conjunction with SLA maps, in attempting to identify a location that wasn't impacted by physical anomalies. This is also a very nice data set that might be of use for Dennis McGillicuddy. Below are several graphs presenting this data from February 15th to February 26th.

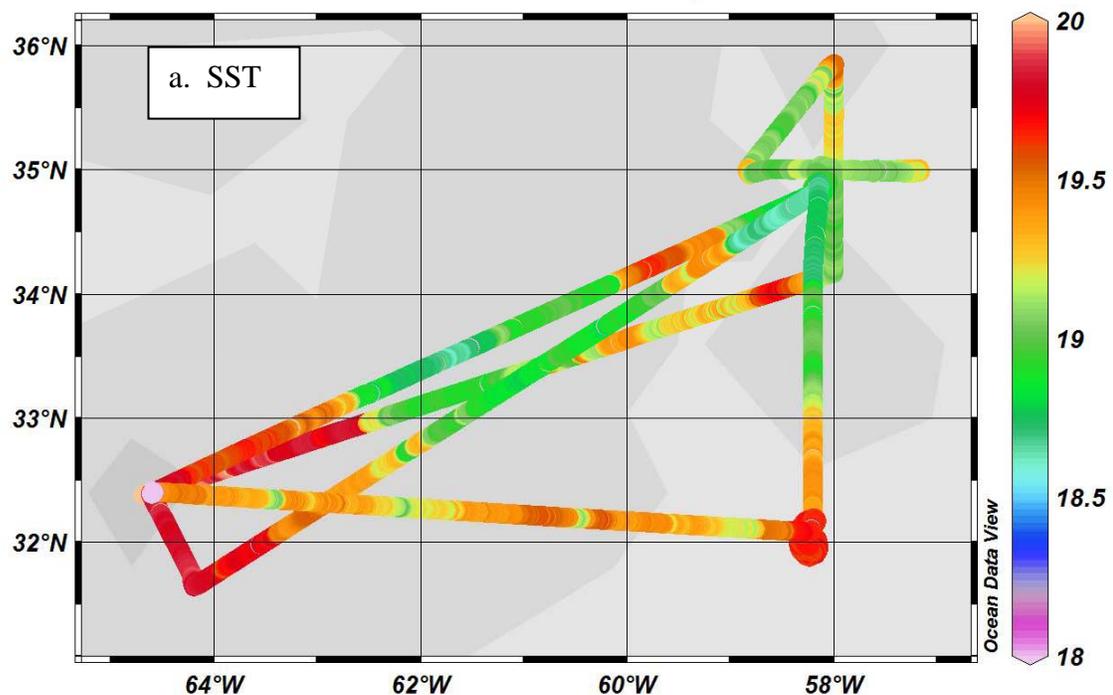


Figure 4a. Sea surface temperature ($^{\circ}\text{C}$) along the transits conducted between February 15th to February 26th. Note several important features that concur with the February 12th Sea Level Anomaly (SLA) image provided by Dennis McGillicuddy. A cold-core feature was centered around $33^{\circ}20'N$ $62^{\circ}0'W$, and two warm-core features were centered around $32^{\circ}45'N$ $63^{\circ}30'W$ and $34^{\circ}15'N$ $59^{\circ}30'W$. The transit ended at $32^{\circ}N$ $58^{\circ}12'W$, a region believed to be minimally impacted by eddies.

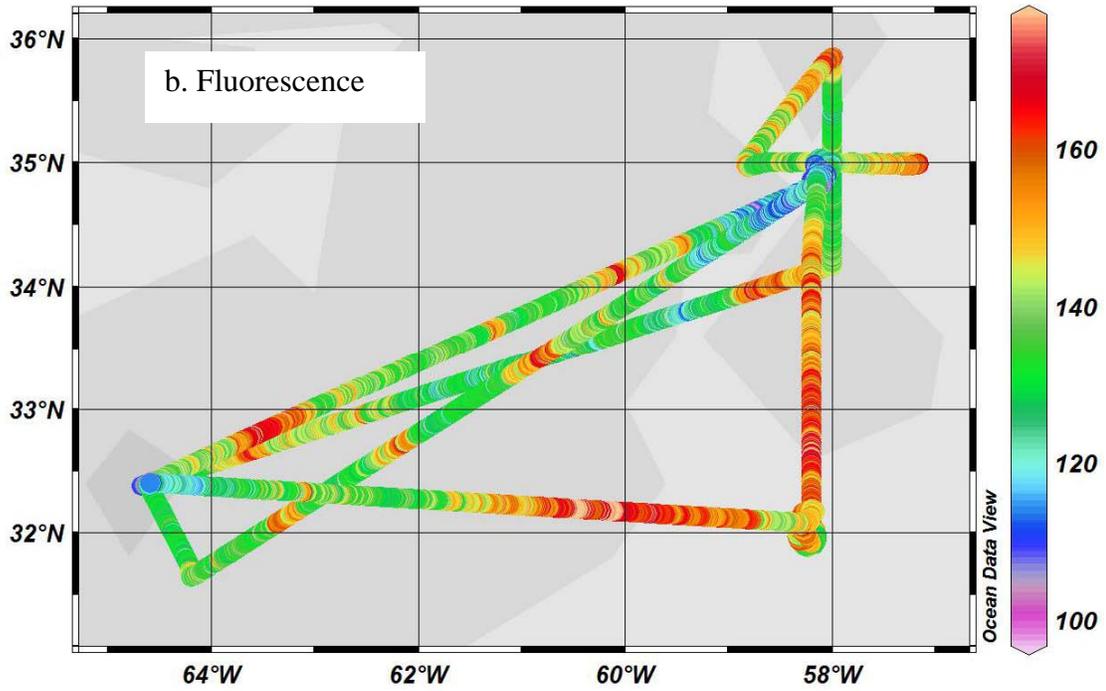


Figure 4b. Sea surface fluorescence. Rest of legend as in Figure Xa.

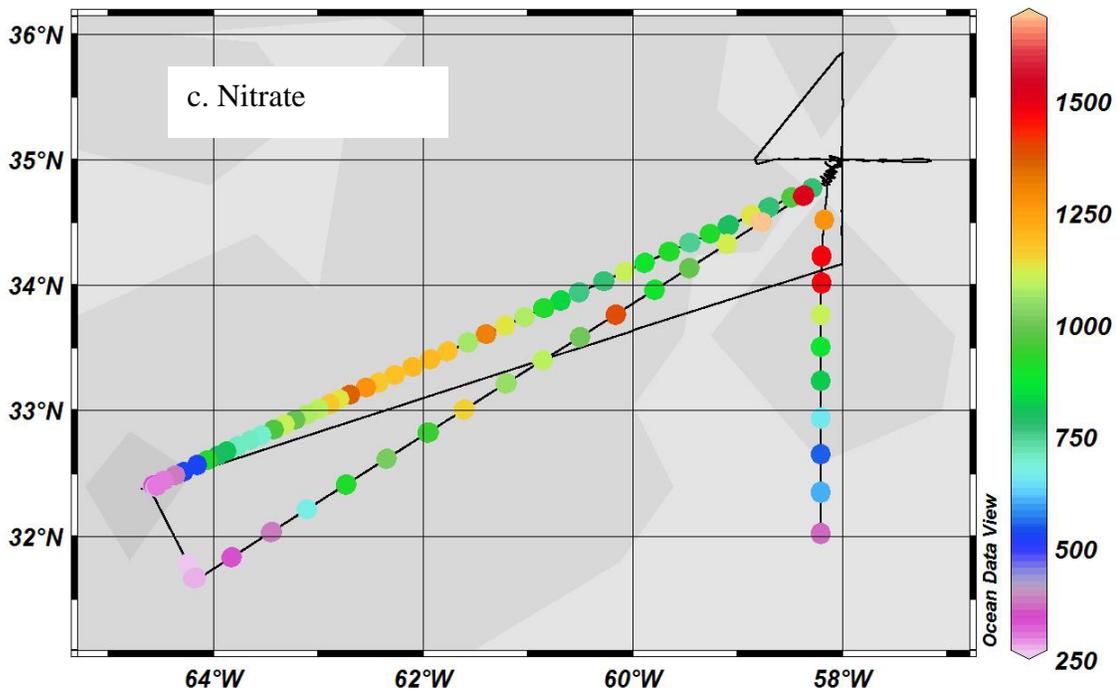


Figure 4c. Sea surface nitrate. Rest of legend as in Figure Xa.

APPENDIX A: Detailed Cruise Schedule NP2005. Includes cast information, samples collected and other relevant information.

Cruise Schedule – NEW PRODUCTION CRUISE 2005

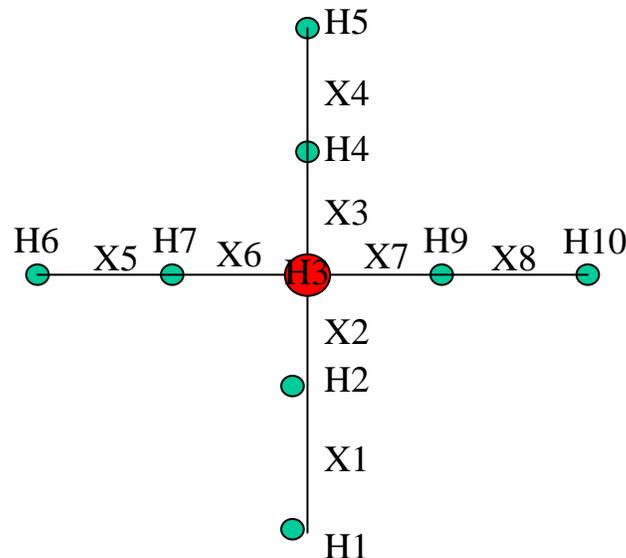
Day 1: Tuesday 15th February

(all times are local)

Sunrise: 0658 Sunset: 1804

1100 Depart St. George's for Survey Grid region

The survey grid will be done before and after the process work, including if we have to move away from the process site to avoid contact with eddies, etc. The sampling scheme is the same for each station.



Day 2: Wednesday 16th February

(all times are local)

Sunrise: 0657 Sunset: 1805

2130 Arrive at Survey Grid Station **H1**

(34° 10'N 58° 00'W)

2130 CTD Calibration Cast **CTD Cast #1**

2200 **CTD Cast #2**

(1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)

0-140m

evens: 3He/Tritium, D.O., DIC, TOC/N, Nuts, PIC/POC/PON

odds: HPLC, P*S*i, FCM,

160-500m

D.O., DIC, TOC/N, Nuts, PIC/POC/PON (500m), HPLC (250m),

2300 Depart for Survey Grid Station **X1**

Day 3: Thursday 17th February

Sunrise: 0656 Sunset: 1806

0000 Arrive Survey Grid Station **X1**

(34° 22.5'N 58° 00'W)

0000 **XBT #1**

0015 Depart for Survey Grid Station **H2**

0115 Arrive at Survey Grid Station **H2**

(34° 35'N 58° 00'W)

0115 **CTD Cast #3**

(1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
0-140m

evens: D.O., DIC, Nuts, PIC/POC/PON

odds: HPLC, PSi, FCM,

160-500m

D.O., DIC, Nuts, PIC/POC/PON (500m), HPLC (250m),

0215 Depart for Survey Grid Station **X2**

0315 Arrive Survey Grid Station **X2**

(34° 47.5'N 58° 00'W)

0315 **XBT #2**

0330 Depart for Survey Grid Station **H3**

0430 Arrive at Survey Grid Station **H3**

(35° 00'N 58° 00'W)

0430 **CTD Cast #4**

(1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
0-140m

evens: D.O., DIC, TOC/N, Nuts, PIC/POC/PON

odds: HPLC, PSi, FCM,

160-500m

D.O., DIC, TOC/N, Nuts, PIC/POC/PON (500m), HPLC (250m),

0530 Depart for Survey Grid Station **X3**

0630 Arrive Survey Grid Station **X3**

(35° 12.5'N 58° 00'W)

0630 **XBT #3**

0645 Depart for Survey Grid Station **H4**

0745 Arrive at Survey Grid Station **H4**

(35° 25'N 58° 00'W)

0745 **CTD Cast #5**

(1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
0-140m

evens: D.O., DIC, TOC/N, Nuts, PIC/POC/PON

odds: HPLC, PSi, FCM,

160-500m

D.O., DIC, Nuts, PIC/POC/PON (500m), HPLC (250m),

- 0845 Depart for Survey Grid Station **X4**
 0945 Arrive Survey Grid Station **X4** (35° 37.5'N 58° 00'W)
 0945 **XBT #4**
- 1000 Depart for Survey Grid Station **H5**
 1100 Arrive at Survey Grid Station **H5** (35° 50'N 58° 00'W)
 1100 **CTD Cast #5**
 (1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
 0-140m
 evens: 3He/Tritium, D.O., DIC, Nuts, PIC/POC/PON
 odds: HPLC, PSi, FCM,
 160-500m
 D.O., DIC, TOC/N, Nuts, PIC/POC/PON (500m), HPLC (250m),
- 1200 Depart for Survey Grid Station **H6**

Day 4: Friday 18th February*Sunrise: 0655 Sunset: 1807*

- 0000 Arrive at Survey Grid Station **H6** (35° 00'N 58° 50'W)
 0000 **CTD Cast #6**
 (1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
 0-140m
 evens: 3He/Tritium, D.O., DIC, TOC/N, Nuts, PIC/POC/PON
 odds: HPLC, PSi, FCM, salts
 160-500m
 D.O., DIC, TOC/N, Nuts, PIC/POC/PON (250m), HPLC (250m),
- 0130 Depart for Survey Grid Station **X5**
 0230 Arrive Survey Grid Station **X5** (35° 00'N 58° 37.5'W)
 0230 **XBT #5**
- 0245 Depart for Survey Grid Station **H7 (Really became XBT 6, file T&_00006)**
 0345 Arrive at Survey Grid Station **H7** (35° 00'N 58° 25'W)

NO SAMPLES TAKEN

- 0515 Depart for Survey Grid Station **X6 (Really became XBT 7, file T&_00007)**
 0615 Arrive Survey Grid Station **X6** (35° 00'N 58° 12.5'W)
 0615 **XBT #6**
- 0630 Depart for Survey Grid Station **H8 (Really became XBT 8, file T&_00008)**
 0730 Arrive at Survey Grid Station **H8** (35° 00'N 58° 00'W)

NO SAMPLES TAKEN

- 0900 Depart for Survey Grid Station **X7** (**Really became XBT 9, file T&_00009**)
 1000 Arrive Survey Grid Station **X7** (35° 00'N 57° 47.5'W)
 1000 **XBT #7**
- 1015 Depart for Survey Grid Station **H9** (**Really became XBT 10, file T&_00010**)
 1115 Arrive at Survey Grid Station **H9** (35° 00'N 57° 35'W)

NO SAMPLES TAKEN

- 1245 Depart for Survey Grid Station **X8** (**Really became XBT 11, file T&_00011**)
 1400 Arrive Survey Grid Station **X8** (35° 00'N 57° 22.5'W)
 1345 **XBT #8**
- 1400 Depart for Survey Grid Station **H10**
 1500 Arrive at Survey Grid Station **H10** (35° 00'N 57° 10'W)
 1500 **CTD Cast #7**
 (1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160,180,200,250,300,400,500m)
 0-140m
 evens: 3He/Tritium, D.O., DIC, TOC/N, Nuts, PIC/POC/PON
 odds: HPLC, P*S*i, FCM, salts
 160-500m
 D.O., DIC, TOC/N, Nuts, PIC/POC/PON (250m), HPLC (250m),
- 1645 Depart for Process Site
 2245 Arrive back at Process Site (35° 00'N 58° 00'W)

BEGIN PROCESS PORTION OF CRUISE

Note from this point on, all sampling will be done while following the 10m drogue unless otherwise decided.

Day 4: Friday 18th February (continued)

Sunrise: 0655 Sunset: 1807

- 2300 Deploy 10m drogue. (35° 00'N 58° 00'W)
 (Follow drogue and be sure that RDF, strobe and ARGOS are working)

Day 5: Saturday 19th February

Sunrise: 0654 Sunset: 1810

- 0230 *AM Production (CAST #8)*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 2 bottles/depth)
 Samples: 32*S*i, 14C, 15N, LK-rna; 15N; 13C (4depths?)
- 0600 **ON DECK INCUBATION, NO SPAR DEPLOYMENT!**
 Place samples in incubator

*Comm Structure cast cancelled due to weather*1200 *PM Profile (CAST #9)*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples:, DO, DIC, Nutrients, HPLC, PIC/POC/PON, P*S*i, microscopy, total autotrophs (Natalie's samples), Salts

1530 Deploy PITS Array

1800 Breakdown day incubation. NO SPAR RECOVERY.

1930 *PM Production (CAST #10)*

Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)

Samples: FCM, 32*S*i, 15*N*, LK-rna;15*N*; 13*C* (4depths),

2200 PM Production bottles in incubator

2300 *AM Profile (CAST #11)*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples: 3He/Tritium, D.O., Nutrients, TOC/*N*, Salts

Day 6: Sunday 20th February

Sunrise: 0653 Sunset: 1811

*AM Production cast cancelled for weather*0830 *Comm Structure (CAST #12)*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)

Samples: HPLC, PIC/POC/PON, P*S*i, FCM

1200 *PM Profile (CAST #13)*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples:, 3He/Tritium, DO, DIC, Nutrients, PIC/POC/PON

1530 Deploy PITS Array

1800 Breakdown day incubation. NO SPAR RECOVERY.

1930 *PM Production (CAST #14)*

Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)

Samples: FCM, 32*S*i, 15*N*, LK-rna;15*N*; 13*C* (4depths),

2200 PM Production bottles in incubator

2300 *AM Profile (CAST #15)*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples: ³He/Tritium, D.O., Nutrients, TOC/N, Salts**Day 7: Monday 21st February***Sunrise: 0652 Sunset: 1812*0230 *AM Production (CAST #16)*Depths: 1,20,40,60,80,100,120,140m (**N.B.** 2 bottles/depth)Samples: ³²Si, ¹⁴C, ¹⁵N, LK-rna; ¹⁵N; ¹³C (4depths?)*Comm Structure cancelled for weather**PM Profile cancelled for weather**PM Production cancelled for weather**AM Profile cancelled for weather*

Weather forecast looking worse, will stop science and steam to Bermuda to pick up several items of science gear while the weather is poor.

Arrived BDA at 0600h Wednesday 23rd, February. WBII dropped off our science gear on way to BATS.

Day 9: Wednesday 23rd February*Sunrise: 0650 Sunset: 1814*

0930 Transfer scientific gear from R/V Weatherbird II to R/V Oceanus

1000 Steam for the BATS study site (31° 40'N 64° 10'W)

SPECIAL NOTE: Stay at least 10 nm from the following science operations in the area

OFP Mooring 31° 50.01'N 64° 10.0'W

BTM Mooring 31° 42.7'N 64° 10.3'W

1500 Arrive BATS study site. We wish to compare several parameters being measured between both the WBII and the Oceanus. We should set up in way such that we are close, but not so close to the WBII that either ship will be compromised during CTD operations.

1630 ³H/He cast conducted for Rachel Stanley, 0-500m, (**CAST #17**)

Helium, DO, nutrients, salts

z= 1,5,10,15,20,25,30,35,40,50,60,70,80,90,100,120,140,160,200,250,300,400

Reps at 15, 60m

Tritium samples

z=1,50,100,140,200,250,300,400, reps at 1,150,300m

- 1930 Surface SW cast for Penny Chisholm and Deb Clougherty (**CAST #18**)
CTD to 500m, but all bottles fired just below the surface
- 2030 Bioassay Water Cast for Jeff Krause, Brian Gaas and Lee Kerkhof (**CAST #19**)
- 2230 Steam for latest PITS location to retrieve array.
(Chief Sci will provide Lat/Long's as they come in).

Day 11: Friday 25th February*Sunrise: 0648 Sunset: 1816*

- 0730 Retrieve PITs array at ~34° 42'N 58° 21'W
- 1000 *Hybrid Profile/Comm Structure (CAST #20)*
Depths: 1x2, 20x2, 40x2, 60x2, 80x2, 100x2, 120x2, 140x2, 160x2, 180, 200, 250, 300, 400, 500m
Samples: DO, DIC, Nutrients, HPLC (250m), PIC/POC/PON (250m), P*S*i, microscopy (250m), total autotrophs (250m; Natalie's samples), FCM (250m), Salts

1200 Steam for new process station. 32°N 58° 12'W.

SPECIAL NOTE: we will be monitoring chlorophyll biomass and surface NO₃ continuously and conducting XBT's every 40' of latitude along this S run to the new station.

| XBT Drops | | File Name |
|------------------|--------------------|------------------|
| #13 | 34° 10'N, 58° 12'W | T7_00022 |
| #14 | 33° 30'N 58° 12'W | T7_00023 |
| #15 | 32° 50'N 58° 12'W | T7_00024 |
| #16 | 32° 10'N 58° 12'W | T7_00025 |

Day 12: Saturday 26th February*Sunrise: 0647 Sunset: 1817*

- 0815 Arrive at new process station 32°N 58° 12'W.
- 0830 Deploy Drogue 32°N 58° 12'W.
- 0900 *Hybrid Profile/Comm Structure (CAST #21)*
Depths: 1x2, 20x2, 40x2, 60x2, 80x2, 100x2, 120x2, 140x2, 160x2, 180, 200, 250, 300, 400, 500m
Samples: DO, DIC, TOC/N, Nutrients, HPLC (250m), PIC/POC/PON (250m), P*S*i, microscopy (250m), total autotrophs (250m; Natalie's samples), FCM (250m), Salts
- 1300 Deploy PITs array near drogue

- 1930 *PM Production (CAST #22)*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: FCM, 32Si, 15N, LK-rna;15N; 13C (4depths),
- 2200 PM Production bottles in incubator
- 2300 *AM Profile (CAST #23)*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., Nutrients, Salts

Day 13: Sunday 27th February

Sunrise: 0646 Sunset: 1818

- 0230 *AM Production (CAST #24) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C
- 0300 Breakdown PM production samples
- 0600 Deploy Production Spar – **Dave, Lee, Jeff K., & Mike**
- 0830 *Comm Structure (CAST #25) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, PSi, FCM
- 1200 *PM Profile (CAST #26) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, DO, DIC, Nutrients, Heterotrophic FCM and Environmental DNA samples for Craig Carlson.
- 1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Lee**
- 1930 *PM Production (CAST #27) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C (4depths),
- 2200 PM Production bottles in incubator
- 2300 *AM Profile (CAST #28) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., Nutrients, FCM, Salts

Day 14: Monday 28th February

Sunrise: 0645 Sunset: 1819

- 0230 *AM Production (CAST #29) – CTD run by Dave & Lee*

Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

0230 Breakdown PM production samples

0545 Deploy Production Spar – **Dave, Lee, Jeff K., & Mike**

0830 *Comm Structure (CAST #30) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, P*S*i, FCM

1200 *PM Profile (CAST #31) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, 3He/Tritium, D.O., DIC, Nutrients, FCM, Salts

1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Lee**

1930 *PM Production (CAST #32) – CTD run by Jeff K. & Lee/Dave*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C

2200 PM Production bottles in on deck incubator

2300 *AM Profile (CAST #33) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 15: Tuesday 1st March

Sunrise: 0640 Sunset: 1820

0230 *AM Production (CAST #34) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

0230 Breakdown PM production samples

0545 Deploy Production Spar – **Dave, Lee, Jeff K., & Mike**

0830 *Comm Structure (CAST #35) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, P*S*i, FCM

1200 *PM Profile (CAST #36) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, 3He/Tritium, D.O., DIC, Nutrients, FCM, Salts

- 1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Lee**
- 1930 *PM Production (CAST #37) – CTD run by Jeff K. & Lee/Dave*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C
- 2200 PM Production bottles in on deck incubator
- 2300 *AM Profile (CAST #38) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 16: Wednesday 2nd March*Sunrise: 0639 Sunset: 1821*

- 0230 *AM Production (CAST #39) – CTD run by Dave & Lee*
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

At 0239 local the CTD was blocked and lost. Drogue and PITs recovered and sail set for Bermuda.

Day 17: Thursday 3rd March*Sunrise: 0639 Sunset: 1821*

Entire day transiting to Bermuda to pick up spare CTD rosette package.

Day 18: Friday 4th March*Sunrise: 0637 Sunset: 1823*

Arrived in Bermuda to take on new CTD rosette. All parts made it in and appear to be in order. Pat and George put it all together and we are good to go. Spent the night in port to give everyone a rest.

Day 19: Saturday 5th March*Sunrise: 0637 Sunset: 1823*

0800 Steam for new process station 31° 20'N 67° 0'W

NOTE: these XBT's are equidistant in time not space.

| | | | |
|------|----------|-----------|------------------------------------|
| 1200 | XBT drop | FILENAME: | T7_00026.rdf (really T7_00027.rdf) |
| 1500 | XBT drop | FILENAME: | T7_00027.rdf (really T7_00030.rdf) |
| 1800 | XBT drop | FILENAME: | T7_00028.rdf |
| 2100 | XBT drop | FILENAME: | T7_00029.rdf |

Day 20: Sunday 6th March*Sunrise: 0636 Sunset: 1824*

0000 CTD calibration cast 0-500m. Bottles fired at surface but no samples taken (**CAST #CTDcal1**) – **CTD run by Dave & Ivo**

0230 *AM Production (CAST #41)* – **CTD run by Dave & Ivo**

Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)

Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

NOTE: on this production cast we will do a comparison between on deck and in situ incubations. C, Si, and N will double on incubation bottles for this exercise.

0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**

0830 *Comm Structure (CAST #42)* – **CTD run by Jeff K. & Mike**

Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)

Samples: HPLC, PIC/POC/PON, PSi, FCM

1200 *PM Profile (CAST #43)* – **CTD run by Jeff K. & Mike**

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples:, D.O., DIC, Nutrients, FCM, Salts

1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**

Day 21: Monday 7th March*Sunrise: 0634 Sunset: 1827*

0230 *AM Production (CAST #44)* – **CTD run by Dave & Ivo**

Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)

Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**

Steam to drogue area and recover drogue.

Return to area where SPAR deployed and deploy drogue.

1530 Deploy PITs at Drogue location

1730 Hybrid Comm Structure/Profile cast. (**CAST #45**) – **CTD run by Jeff K. & Mike**

Depths: 1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160x2,180,200,250,300,400,500m

Samples:, DO, DIC, Nutrients, HPLC (250m), PIC/POC/PON (250m), PSi, microscopy (250m), total autotrophs (250m;Natalie's samples), FCM (250m), Salts

1830 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**

1930 *PM Production (CAST #46) – CTD run by Jeff K. & Lee/Dave*

Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)

Samples: 32Si, 15N, LK-rna;15N; 13C

2200 PM Production bottles in on deck incubator

2300 *AM Profile (CAST #47) – CTD run by Dave & Lee*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 22: Tuesday 8th March

Sunrise: 0632 Sunset: 1829

0230 *AM Production (CAST #48) – CTD run by Dave & Ivo*

Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)

Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**

0830 *Comm Structure (CAST #49) – CTD run by Jeff K. & Mike*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (N.B. 2 bottles/depth)

Samples: HPLC, PIC/POC/PON, P*S*i, FCM

1200 *PM Profile (CAST #50) – CTD run by Jeff K. & Mike*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples:, D.O., DIC, Nutrients, FCM, Salts

1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**

1930 *PM Production (CAST #51) – CTD run by Jeff K. & Ivo/Dave*

Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)

Samples: 32Si, 15N, LK-rna;15N; 13C

2200 PM Production bottles in on deck incubator

2300 *AM Profile (CAST #52) – CTD run by Dave & Ivo*

Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m

Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 23: Wednesday 9th March

Sunrise: 0629 Sunset: 1833

0230 *AM Production (CAST #53) – CTD run by Dave & Ivo*

Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)

Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C

- 0545 On deckboard incubator.
- 1200 Hybrid Comm Structure/Profile cast. (**CAST #54**) – **CTD run by Jeff K. & Mike**
 Depths: 1x2,20x2,40x2,60x2,80x2,100x2,120x2,140x2,160x2,180,200,250,300,400,500m
 Samples: DO, DIC, Nutrients, HPLC (250m), PIC/POC/PON (250m), P*S*i, (250m), ,
 FCM (250m), Salts
- 1930 *PM Production (CAST #55)* – **CTD run by Jeff K. & Ivo/Dave**
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C
- 2200 PM Production bottles in on deck incubator
- 2300 *AM Profile (CAST #56)* – **CTD run by Dave & Ivo**
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 24: Thursday 10th March

Sunrise: 0632 Sunset: 1829

- 0230 *AM Production (CAST #57)* – **CTD run by Dave & Ivo**
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C
- 0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**
- 0830 *Comm Structure (CAST #58)* – **CTD run by Jeff K. & Mike**
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (**N.B.** 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, P*S*i, FCM
- 1200 *PM Profile (CAST #59)* – **CTD run by Jeff K. & Mike**
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: D.O., DIC, Nutrients, FCM, Salts
- 1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**
- 1930 *PM Production (CAST #60)* – **CTD run by Jeff K. & Ivo/Dave**
 Depths: 1,20,40,60,80,100,120,140m (**N.B.** 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C
- 2200 PM Production bottles in on deck incubator
- 2300 *AM Profile (CAST #61)* – **CTD run by Dave & Ivo**
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 25: Friday 11th March*Sunrise: 0632 Sunset: 1829*

- 0230 *AM Production (CAST #62) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C
- 0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**
- 0830 *Comm Structure (CAST #63) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (N.B. 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, PSi, FCM
- 1200 *PM Profile (CAST #64) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, D.O., DIC, Nutrients, FCM, Salts
- 1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**
- 1930 *PM Production (CAST #65) – CTD run by Jeff K. & Ivo/Dave*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C
- 2200 PM Production bottles in on deck incubator
- 2300 *AM Profile (CAST #66) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 26: Saturday 12th March*Sunrise: 0632 Sunset: 1829*

- 0230 *AM Production (CAST #67) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 14C, 15N, LK-rna; 15N; 13C
- 0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**
- Comm Structure cast cancelled due to weather*
- 1200 *Comm Structure/PM Profile (CAST #68) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, D.O., DIC, Nutrients, FCM, Salts,

1430 Retrieve PIT's array NOTE: we will be re-deploying it at the location we retrieved it from, but we will need to change batteries on locator equipment. This only take 20minutes or less.

1800 Retrieve Production Spar – **Jeff K., Mike, Dave & Ivo**

Day 27: Sunday 13th March

Sunrise: 0630 Sunset: 1832

0830 *Comm Structure (CAST #69) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (N.B. 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, PSi, FCM

1030 deploy PITs traps near to the drogue

1200 *PM Profile (CAST #70) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: D.O., DIC, Nutrients, FCM, Salts, Environmental DNA and hetBact FCM samples for Craig Carlson.

1930 *PM Production (CAST #71) – CTD run by Jeff K. & Ivo/Dave*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 15N, LK-rna;15N; 13C

2200 PM Production bottles in on deck incubator

2300 *AM Profile (CAST #72) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 28: Monday 14th March

Sunrise: 0628 Sunset: 1832

0230 *AM Production (CAST #73) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 14C, 15N,
 Today is the second (and final) “on deck” vs. “in situ” productivity comparison.

0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**
 Set on deck samples in the incubator. Place rate measurement samples on top of bioassay bottles in the incubator for those two depths (#2 and #6) where they overlap. Be sure to put a line over the lids of the incubators to make sure they don't lift open.

0830 *Comm Structure (CAST #74) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (N.B. 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, PSi, FCM

- 1200 *PM Profile (CAST #75) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, D.O., DIC, Nutrients, FCM, Salts,
- 1930 *PM Production (CAST #76) – CTD run by Jeff K. & Ivo/Dave*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 15N just whole filtration.
- 2200 PM Production bottles in on deck incubator
- 2300 *AM Profile (CAST #77) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples: 3He/Tritium, D.O., TOC/N, Nutrients, FCM, Salts

Day 29: Tuesday 15th March

Sunrise: 0628 Sunset: 1832

- 0230 *AM Production (CAST #78) – CTD run by Dave & Ivo*
 Depths: 1,20,40,60,80,100,120,140m (N.B. 3 bottles/depth)
 Samples: 32Si, 14C (PP and calcification), 15N,
- 0545 Deploy Production Spar – **Dave, Ivo, Jeff K., Deb & Mike**
- 0800 *Comm Structure (CAST #79) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250m (N.B. 2 bottles/depth)
 Samples: HPLC, PIC/POC/PON, P*S*i, FCM
- 1100 *PM Profile (CAST #80) – CTD run by Jeff K. & Mike*
 Depths: 1,20,40,60,80,100,120,140,160,180,200,250,300,400,500m
 Samples:, D.O., DIC, Nutrients, FCM, Salts,
- 1530 Track down PITs and recover array.
- 1800 Recover production spar.

APPENDIX B: Summary of data collected and contacts.

| <u>Data Type</u> | <u>Contact</u> |
|---|--|
| Core Nutrients, HPLC Pigments, suspended POC/PON, Autotroph community structure (FCM, microscopy), Manual salt & dissolved oxygen, TOC/TDN, PITs, CTD data, 15N uptake rates, 14C productivity | Mike Lomas; mlomas@bbsr.edu ; 441-297-1880 x303 |
| Tritium/Helium | Carolyn Walker; cwalker@bbsr.edu ; 441-297-1880 x262 |
| DIC concentrations | Nick Bates; nick@bbsr.edu ; 441-297-1880 x210 |
| Silicate uptake rates, biogenic silica, manual silica Concentrations | Dave Nelson/Jeff Krause; danelson@coas.oregonstate.edu ; jkrause@coas.oregonstate.edu ; |
| Bacterial activity, compound-specific bacterial uptake | Lee Kerkhof/Carrie Fraser; |
| Whole community enzyme activity | Jim Ammerman/Brian Gaas; |

PRELIMINARY CRUISE REPORT

| | |
|---------------------------------|---|
| U.S. Dept. of State CRUISE No.: | 2004-108 |
| SHIP NAME: | R/V Oceanus |
| OPERATING INSTITUTE OR AGENCY: | Woods Hole Oceanographic Institution |
| PROJECT TITLE: | Enhanced New Production During Winter Mixing: A missing Component of Current Estimates |
| CRUISE DATES (INCLUSIVE): | February 15 to March 16, 2005 |

| | |
|------------------|--|
| CHIEF SCIENTIST: | |
| Name | Michael W. Lomas |
| Affiliation | Bermuda Biological Station for Research, Inc |
| Address | 17 Biological Lane, St. George's GE01 |
| Phone | 441-297-1880 x303 |
| Fax | 441-297-8143 |
| E-mail | mlomas@bbsr.edu |

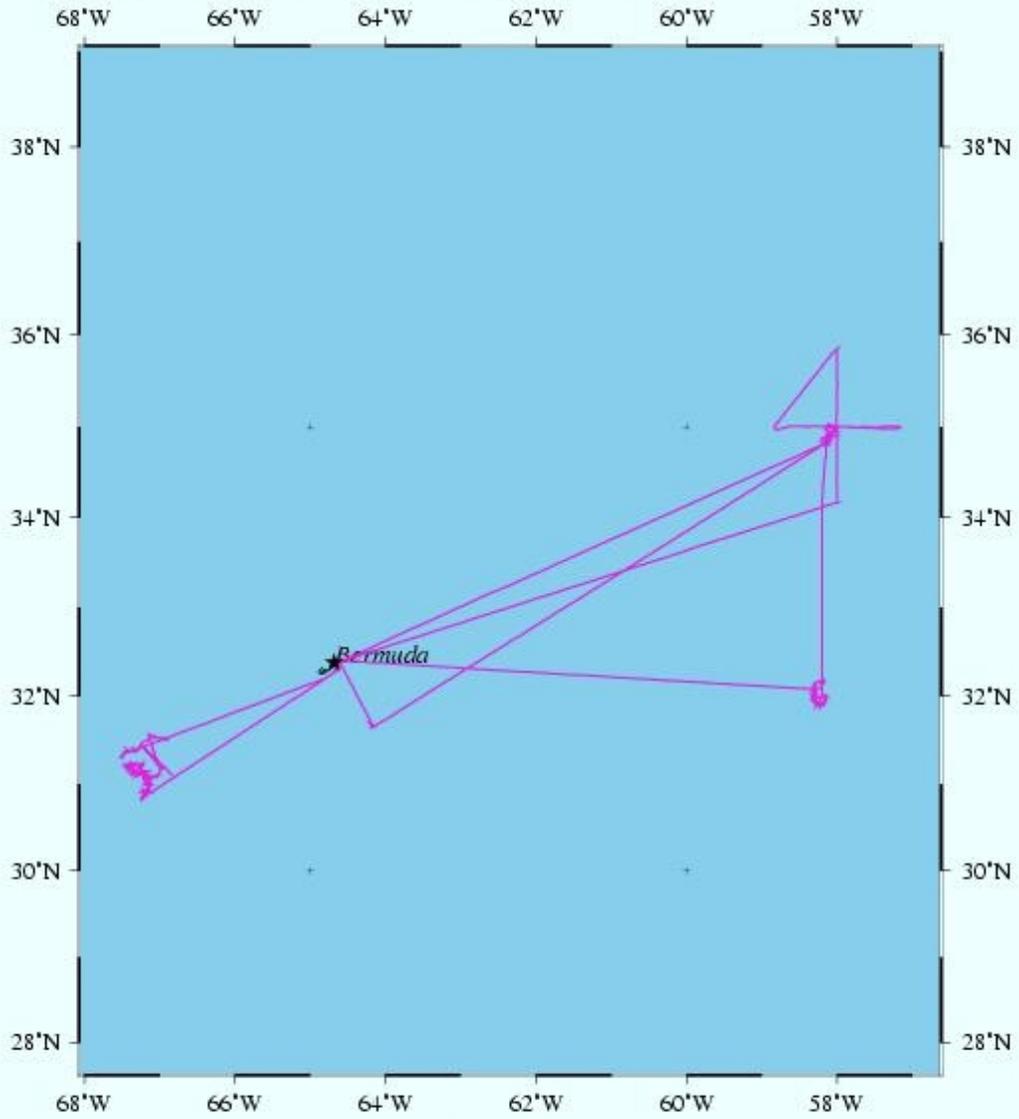
| | |
|-----------------------|---|
| CLEARANCE COUNTRIES: | Bermuda |
| FOREIGN PARTICIPANTS: | Dr. Ivaylo Grigorov, Southampton Oceanography Centre, UK. |

| |
|---|
| DESCRIPTION OF SCIENTIFIC PROGRAM(include page-sized chartlet showing cruise track): |
| The scientific objective of this research cruise was to characterize the biogeochemical response to the passage of storm fronts through the NW Sargasso Sea. Specifically we hypothesize that the passage of these storms results in the introduction of nitrate from depth due to deep convective mixing and subsequent carbon export. To assess these responses we employed a variety of oceanographic methods including CTD casts, in situ primary production arrays, and particle interceptor traps. This research was conducted over the course of a 30-day cruise. The cruise track for this research cruise is posted on the following page. |

| | |
|--|---|
| SCHEDULE OF DATA DELIVERY: | |
| Data Description | Date of Expected Delivery to Dept. of State |
| Conductivity, temperature and depth (CTD) data, rate process data (nitrogen, carbon and silicon uptake), stock measurements of phytoplankton biomass and diversity | Data will be delivered to Dept. of State within 2 years. This is the NSF guideline for data availability and will be employed here. |
| | |

R/V oceanus, cruise oc408-2

Last position: 32.38 N, 64.68 W at 17:59:56 gmt on 03/16/05



Last updated: Wed Mar 16 19:09:05 GMT 2005