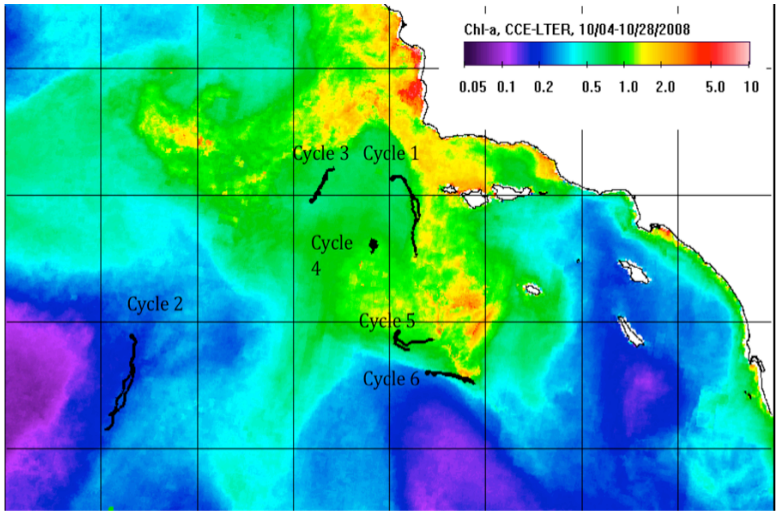
Cruise Report

California Current Ecosystem LTER Program
CCE-P0810, Process Cruise #3
R/V MELVILLE, 29 September - 28 October, 2008

Compiled and submitted by: Michael R. Landry, Chief Scientist
Scripps Institution of Oceanography, Univ. California, San Diego

Cruise ID: CCE-P0810, aka BOLT01MV
Depart: 29 September 2008 at 0800 (PST)
Return: 28 October 2008 at 0700
Vessel: R/V MELVILLE
Operator: Scripps Institution of Oceanography
Master: Captain Christopher Curl
Chief Scientist: Michael R. Landry
Marine Technicians: Jim Dorrance, John Calderwood, Kris Weeks



Contents

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A. Chekalyuk, Q. Li, A. Cawood, K. Roe, and C. Millsap disembarked in Santa Barbara after leg #1

Leg #2

1.	Mark Hafez	hafez@osb1.wff.nasa.gov	NASA Tech (Chekalyuk)
2.	Ryan Rykaczewski	rrykacze@ucsd.edu	SIO Grad Student
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SCIENCE OBJECTIVES

This was the third Process Cruise of the CCE LTER (California Current Ecosystem, Long-Term Ecological Research) Program, the objective of which is to understand the coupling of physical, chemical and biological dynamics in the California Current ecosystem and, ultimately, the system responses to long-term climate variability. The cruise was designed to investigate the relationships among water-column light, temperature, nutrients, thermocline and nutricline depths, phytoplankton and zooplankton standing stocks, phytoplankton and bacterial growth and production rates, micro- and meso-zooplankton grazing rates, and active and passive contributions to organic export. Our aim was to have this cruise earlier, during the late summer period of maximum stratification. However, the science agenda was adjusted to fit the fall, storm-mixed conditions encountered. The results from this cruise will provide an empirical basis for modeling of CCE late summer/fall dynamics and for comparison to previous cruise studies of spring conditions.

OVERVIEW OF THE SCIENCE PLAN

The science plan was based around 3 long and 3 short activity cycles for which water masses of differing initial characteristics were marked with a drogued drift array and followed over the course of 2-5 days. The cycle sites were situated along the axis of CalCOFI sampling line 80, which extends seaward off Point Conception, California and in the area of biomass accumulation south of the point. We used satellite-tracked drift array for in situ experimental incubations (recovered/redeployed daily) and a drogued drift array with sediment traps at 100 m to assess passive vertical export (sinking particulates).

Daily CTD sampling at 0200 was conducted to assess changes in water mass characteristics due to growth, mortality and associated changes in community composition. Measured variables included: temperature, conductivity, density, nutrients (dissolved inorganic N, P, Si), total organic carbon and nitrogen (TOC, TON), particulate carbon and nitrogen (POC, PON), stable isotopes of C and N, particulate biogenic silica (BSi), thorium-uranium disequilibrium, fluorometric Chla and HPLC accessory pigments, microscopical and flow cytometric assessments of microplankton community composition, and samples for molecular analyses. The same water collection was also used experimentally to assess taxon-specific rates of phytoplankton growth, 14C-primary production and microzooplankton grazing impact by a combination of dilution and pigment labeling approaches. These incubations were conducted for 24 hours in net bags attached on a line below the drift array (therefore incubated under in situ conditions of temperature and light).

Using the drift array as a moving frame of reference, additional CTD sampling was conducted at mid-day for bio-optical parameters, shipboard assessments of primary production, and microbiological studies (bacterial production, bacteria particle interactions, enzyme activities and viral mortality impact), and typically in the evening for additional shipboard experimental studies of mesozooplankton grazing and reproduction. The latter were accompanied by short bongo net tows to collect live animals.

An Underwater Video Profiling system, operated by guest researcher Marc Picheral (Ville-Franche-sur-Mer), was integrated into the CTD package for this cruise, providing a unique data set of video images and quantitative depth profiles of zooplankton and aggregate distributions to 500 m on most casts.

Go-Flo samples were taken for iron (Fe) analyses and for grow-out experimental studies of Fe- limitation. MOCNESS net tows were taken at mid-day and mid-night to determine the depth structure and day-night variability of the meso-zooplankton community. Sampling of mesopelagic fishes and invertebrates was conducted with a large (6 m2) mid-water trawl net to assess the contribution of actively migrating mid-water animals to organic export from the euphotic zone. Bongo net tows were also taken around mid-day and mid-night to get depth-integrated assessments of the zooplankton biomass structure and gut fluorescence in the euphotic zone. One side of the paired nets from these collections was formalin preserved for species identification. The other was size-fractioned on shipboard for biomass (dry weight, C, N) and gut pigment analyses. During each long cycle, bongo net collections were taken at 3-4 h intervals over 24-h to better resolve the diel periodicity in feeding (gut fluorescence) and migration into the euphotic zone. At least twice during each cycle, McLane pumps were used to collect large volume samples from below the euphotic zone an d 100 m for the C:Th ratios and the estimation of carbon export by the thorium disequilibrium method.

Daily activities also often included a 4-h bow-tie survey with a free-fall Moving Vessel Profiler (MVP) to determine the variability in water-column characteristics around the drift array, on a 10 x 10 naut mi pattern along and orthogonal to the direction of current flow. These surveys mapped to 200-m depth the 3-D fields of planktonic particles across a size spectrum of 150-6000 µm, Chl a fluorescence, temperature, salinity and density. The MVP was also used to identify major features of interest for the experimental cycles on 5 relatively long west-east sections, and on several crossings of a frontal system. In all, 700 MVP profiles were completed.

In summary, each cycle of activity was designed to follow the temporal evolution of a marked parcel of water for 2-5 days (i.e., the net rates of change in the ambient physical and chemical environment and the biological community) while conducting experimental studies to assess the contributions of phytoplankton and bacterial growth, micro- and meso-zooplankton grazing and active vertical migrations to particle export and net community change. In addition, we investigated a major frontal system that separated the water types studied on two of the shorter experimental activity cycles (5 and 6). This part of the science plan included several daytime crossings of the frontal system with the MVP and surface flow through systems operating, followed by slow speed (6 kts) crossings in daylight and nighttime conditions with the MVP, flow and multi-frequency acoustical systems operating, followed by nocturnal sampling of 9 stations across the front with vertical bongo tows and CTD profiles.

ALL planned science objectives were completed successfully, despite the loss of a little time for specific operations. Some initial site survey and transect work with the MVP were not possible due to equipment problems. We lost ~2 days

initially when the drifters were damaged by faulty battery packs, and we had to make an unplanned stop in Santa Barbara for repairs. In addition, the weather was too rough for about 1.5 days for anything except CTD and drifter work. All drifters and sediment traps were deployed and recovered on schedule, regardless of weather. Some time was saved in planning subsequent transits to optimize the experimental cycles and front study. In the end, one small cycle was dropped with negligible impact on the science program.

SHIP AND TECHNICAL SUPPORT

The Resident and Computer Techs, led by Jim Dorrance and Kris Weeks, were superb on this cruise -- just the right amount of lecturing/advising the science party on the fine points of shipboard procedures and safety, combined with their direct participation in all critical deck operations and acquiring and processing ship system data.

The crew was friendly and very supportive of the science. Captain Curl's ship handling was superb, providing tight daily recoveries/redeployment of the drifter array despite occasional poor weather conditions (35-40 kt winds). Chief Engineer Paul Bueren was a huge help in trouble shooting issues with the MVP system (it was necessary to re-do both the electrical and mechanical terminations at sea due to intermittencies in data communications), and 2nd A/E Sabrina Tataboletti did an amazing job putting a badly damaged bongo net frame back into round. Without prior notice of a problem, A/B Cletus Finnell spotted a distressed drifter at dusk that had lost its light strobe and satellite-GPS communication, which led to its successful rescue and redeployment. The drifter and its experiments would likely have been lost during the night without this timely intervention. Engineering also provided two winch operators (CTD and hydro) for the duration of the front study to help run the station operations at a fast pace.

We had a few occasions when the wire read out for the CTD winch did not work in the winch house, which slowed those casts considerably. This however had no measurable impact on the science objectives.

ADDITIONAL SCIENCE AND SUPPORT OPERATIONS

We had excellent satellite image support from the SIO photobiology group during the cruise, notably from Mati Kahru. On a daily basis MODIS-Aqua and/or SeaWifs images were posted on a web site accessible to us at sea, permitting us to identify larger-scale near-surface features and processes of interest for our experimental work. This near-real time imagery was valuable in permitting us to follow the evolution of the Chl a and SST fields.

In addition, a *Spray* glider along CalCOFI line 80 provided recent subsurface ocean structure (T, S, density, chlorophyll a fluorescence, acoustic backscatter). These up-to-date glider data, combined with satellite imagery and vertical profiling by MVP, enabled us to carry out our experimental cycles in specific, pre-identified ocean features.

INFORMATION MANAGEMENT

Information management activities by Karen Baker, Mason Kortz and James Conners facilitated data handling and communication, including deployment of an event logger, support for the education outreach, and preparation of the cruise materials in on-line community interactions.

An event logger was set-up to provide an authoritative listing of each research activity, with an assigned an event number, date time and location information. Pre-cruise preparations included incorporation of hardware/software updates on event logger laptops, set-up of logger stations on the bridge and in the lab, coordination of program decoding with the ship's GPS string, and logger training. A glossary of activity names incorporated as a configuration file serves as a controlled vocabulary list. Ship-to-shore communications permitted shore support for event logger issues that arose concerning display refresh, application restart, and latitude/longitude recording precision.

Infrastructure support was provided for a Teacher-at-Sea education/outreach activity. Preparations included evaluation, purchase, set-up, and testing of software and hardware to enable shipboard video recording and editing. Software was deployed and best practices were developed in support of a blog with input via the web shipboard that delivered text and associated photos daily. A configuration was established that allowed post-entry editing as well as input of comments by classroom participants.

Additional activities include input of cruise specifics to the information system study list and participant directory as well as upload of the cruise data CDs to a project shared disk. Since the event log serves as a key mechanism for post-cruise coordination of datasets, event log cleaning was initiated including checking for consistency and missing data. A web page was set up with cruise information and a dynamic mapper that makes station locations available visually and as a downloadable file. In addition, a Google earth mapping data file was produced to display the various activities by group and to animate the cruise track by time.

CCE-P0810 DAILY ACTIVITY SCHEDULE

30 September

0800	DEPART San Diego, various system tests in transit
1500	CTD test station
1600	Go-Flo bottle cast test/rinse
1730	MVP test
2000	Oozeki trawl test
2200	MOCNESS test

1 October

1900	MVP Bowtie survey to station, 33.64°N, 124.0°W

2 October

0200 CTD, setup *in situ* experiments (500 m)
0500 Deploy sediment trap array
0530 CTD, organics, bacteria, thorium (500 m)
0730 Recover sediment trap, station abandoned
0800 Begin transit to Santa Barbara for drifter repairs

3 October

0030 CTD, water for zooplankton experiments
0130 Bong tow (live), animals for experiments
0230 MVP deployed (2.5 h), transect sampling
0800 **Drifter repairs, Santa Barbara**
1700 MVP deployed (3 h), transect sampling to station
2200 CTD, water for evening experiments
2300 Net tows, animals for experiments

4 October

***** **Begin CYCLE #1 (34.13°N 120.97°W)**
0000 Deploy sediment trap array
0130 CTD, setup *in situ* experiments (500 m)
0400 Deploy *in situ* (drift) array
0430 CTD, organics, bacteria, thorium (500 m)
0600 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 CTD (^{14}C-PP, PvsE), 500 m; Radiometer off stern
1230 IOP cast (hydrowire)
1330 MOCNESS, zooplankton sampling (800 m)
1600 CTD, water for evening experiments
1800 Thorium pump, simultaneous surface pump
2000 Net tows, animals for experiments
2100 Bongo, zooplankton biomass & gut pig sampling
2200 MOCNESS, zooplankton sampling (800 m)

5 October

0130 CTD, setup *in situ* experiments (500 m)
0300 Go-Flo trace-metal sampling (deep)
0430 Recover/redeploy *in situ* array
0500 Go-Flo trace-metal sampling (shallow)
0600 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1100 Radiometer off stern

1130 CTD (^{14}C-PP, PvsE), 500 m
1230 IOP cast (hydrowire)
1330 Bongo, zooplankton biomass & gut pig sampling
1430 MOCNESS, zooplankton sampling
1730 Bongo, zooplankton biomass & gut pig sampling
1900 CTD, full dilution experiments & thorium
2030 Bongo, zooplankton biomass & gut pig sampling
2230 MOCNESS, zooplankton sampling

6 October

0030 Bongo/LOPC, zooplankton biomass & gut pig sampling
0130 CTD, setup *in situ* experiments (500 m)
0300 Bongo, zooplankton biomass & gut pig sampling
0430 Recover/redeploy *in situ* array
0600 Bongo, zooplankton biomass & gut pig sampling
0730 Oozeki trawl, deep (2 h)
1000 Bongo/LOPC, zooplankton biomass & gut pig sampling
1100 Radiometer off stern
1130 CTD (^{14}C-PP, PvsE), 500 m
1230 IOP cast (hydrowire)
1300 MOCNESS, zooplankton sampling
1500 Oozeki trawl, shallow (1 h)
1900 CTD, water for evening experiments & new prod
2100 Oozeki trawl, shallow (1 h)
2300 Net tows, animals for experiments
2400 Bongo, zooplankton biomass & gut pig sampling

7 October

0030 Oozeki trawl, shallow (1 h)
0130 CTD, setup *in situ* experiments (500 m)
0300 Go-Flo trace-metal sampling (deep)
0430 Recover/redeploy *in situ* array
0500 Go-Flo trace-metal sampling (shallow)
0600 MVP bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1230 IOP cast (hydrowire)
1330 Oozeki trawl, shallow (1 h)
1500 Oozeki trawl, deep (2 h)
1900 CTD, water for evening experiments & Morel incubations

2000 Thorium pump (deep cast), simultaneous surface pump
2100 Net tows, animals for experiments
2200 Bongo, zooplankton biomass & gut pig sampling
2300 MOCNESS, zooplankton sampling

8 October

0200 CTD, in situ exp, Th & organics (500 m, final samples only)
0300 Recover *in situ* (drift) array
0400 Oozeki trawl, deep (2 h)
0800 Recover sediment trap array; **End CYCLE #1**
0900 Transit – MVP Transect (10 h) to next station

9 October

***** **Begin CYCLE #2 (32.88°N 123.68°W)**
0130 Deploy sediment trap array
0200 CTD, setup *in situ* experiments (500 m)
0400 Deploy *in situ* (drift) array
0430 CTD, organics, bacteria, thorium (500 m)
1030 Bongo, zooplankton biomass & gut pig sampling (non-quant)
2000 Net tows, animals for experiments
2200 Thorium pump, simultaneous surface pump
WEATHER DAY – 30-45 kt winds, heavy seas

10 October

0130 CTD, setup *in situ* experiments (300 m)
0430 Recover/redeploy *in situ* array
1900 CTD, full dilution experiments & thorium
2100 Net tows, animals for experiments
WEATHER DAY – 30-35 kt winds, heavy seas

11 October

0130 CTD, setup *in situ* experiments (300 m)
0430 Recover/redeploy *in situ* array
0730 MVP test transect
1000 Bongo/LOPC, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1230 CTD (^{14}C-PP, PvsE), 500 m
1400 IOP cast (hydrowire)
1500 MOCNESS, zooplankton sampling
1800 CTD, water for evening experiments & new prod
1900 Go Flo cast, set-up incubation experiment

2000 Net tows, animals for experiments
2100 Bongo, zooplankton biomass & gut pig sampling
2200 MOCNESS, zooplankton sampling

12 October

0030 Oozeki trawl, shallow (1 h)
0130 CTD, setup *in situ* experiments (500 m)
0300 Go-Flo trace metal cast
0430 Recover/redeploy *in situ* array
0600 Go-Flo trace metal cast
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1400 Oozeki trawl, shallow (1 h)
1530 Oozeki trawl, deep (2 h)
1800 CTD, water for evening experiments
2000 Net tows, animals for experiments
2100 Bongo, zooplankton biomass & gut pig sampling
2200 Oozeki trawl, shallow (1 h)
2300 Oozeki trawl, deep (2 h)

13 October

0130 CTD, setup *in situ* experiments (500m)
0300 Go-Flo trace-metal sampling (deep)
0430 Recover/redeploy *in situ* array
0500 Go-Flo trace-metal sampling (shallow)
0600 MVP bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1400 MOCNESS, zooplankton sampling
1800 CTD, water for evening experiments
1900 Thorium pump (deep cast), simultaneous surface pump
2100 Net tows, animals for experiments
2200 Bongo, zooplankton biomass & gut pig sampling
2300 MOCNESS, zooplankton sampling

14 October

0130 CTD, in situ exp, Th & organics (500 m, final samples only)

0300 Recover *in situ* (drift) array
0400 Oozeki trawl, deep (2 h)
0630 Recover sediment trap array; **End CYCLE #2**
0800 Transit – MVP Transect (8 h) to next station
2300 Bongo net tow (live), animals for experiments

15 October

***** **Begin CYCLE #3 (33.95°N 121.81°W)**
0000 Deploy sediment trap array
0130 CTD, setup *in situ* experiments (500 m)
0400 Deploy *in situ* (drift) array
0430 CTD, organics, bacteria, thorium (500 m)
0600 Oozeki trawls, deep/shallow
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1300 MVP vertical profile (test)
1330 IOP cast (hydrowire)
1430 MOCNESS, zooplankton sampling
1700 CTD, water for evening experiments
1800 Thorium pump, simultaneous surface pump
2000 Net tows, animals for experiments
2130 Bongo, zooplankton biomass & gut pig sampling
2230 MOCNESS, zooplankton sampling

16 October

0130 CTD, setup *in situ* experiments (500 m)
0300 Go-Flo trace-metal sampling (deep)
0430 Recover/redeploy *in situ* array
0500 Go-Flo trace-metal sampling (shallow)
0600 Oozeki trawls, deep/shallow
1000 Bongo, zooplankton biomass & gut pig sampling
1100 Radiometer off stern
1130 CTD (^{14}C-PP, PvsE), 500 m
1300 IOP cast (hydrowire)
1400 Bongo, zooplankton biomass & gut pig sampling
1500 Oozeki trawl, deep (2 h)
1730 Bongo, zooplankton biomass & gut pig sampling
1830 CTD, full dilution experiments & thorium
2000 Bongo, zooplankton biomass & gut pig sampling
2100 Oozeki trawl, deep (2 h)

2330 Bongo/LOPC, zooplankton biomass & gut pig sampling

17 October

0030 Oozeki trawl, shallow (1 h)
0130 CTD, setup *in situ* experiments (500 m)
0300 Bongo, zooplankton biomass & gut pig sampling
0430 Recover/redeploy *in situ* array
0500 Bongo, zooplankton biomass & gut pig sampling
0600 MVP – small bow-tie survey
1000 Bongo/LOPC, zooplankton biomass & gut pig sampling
1100 Radiometer off stern
1130 CTD (^{14}C-PP, PvsE), 500 m
1300 IOP cast (hydrowire)
1400 MOCNESS, zooplankton sampling
1700 CTD, water for evening experiments & new prod
1800 Thorium pump (deep cast), simultaneous surface pump
2000 Net tows, animals for experiments
2130 Bongo, zooplankton biomass & gut pig sampling
2200 MOCNESS, zooplankton sampling

18 October

0100 CTD, in situ exp, Th & organics (1000 m, final samples only)
0300 Recover *in situ* (drift) array
0500 Recover sediment trap array; **End CYCLE #3**
0600 Transit – PERSONNEL TRANSFER, Santa Barbara
2230 MVP transect (3.5 h) to next station

19 October

***** **Begin CYCLE #4 (33.61°N 121.15°W)**
0300 Deploy sediment trap array
0400 CTD, setup *in situ* experiments (500 m)
0530 Deploy *in situ* (drift) array
0600 CTD, organics, bacteria, thorium (300 m)
0700 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1430 MOCNESS, zooplankton sampling
1600 Repair multi-freq sonar system
1900 CTD, water for evening experiments

2000 Thorium pump, simultaneous surface pump
2130 Net tow, animals for experiments
2230 Bongo, zooplankton biomass & gut pig sampling
2330 MOCNESS, zooplankton sampling

20 October

0230 CTD, setup *in situ* experiments (500 m)
0400 Go-Flo trace-metal sampling (deep)
0530 Recover/redeploy *in situ* array
0600 Go-Flo trace-metal sampling (shallow)
0630 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1430 Oozeki trawl, deep (2 h)
1730 Thorium pump (deep cast), simultaneous surface pump
1900 CTD, water for full dilution & evening experiments
2000 Oozeki trawl, shallow (1 h)
2100 Oozeki trawl, deep (2 h)
2300 Net tow, animals for experiments
2330 Bongo, zooplankton biomass & gut pig sampling

21 October

0030 Oozeki trawl, shallow (1 h)
0200 CTD, in situ & Th & organics (1000 m, final samples only)
0400 Recover *in situ* (drift) array
0430 Oozeki trawl, shallow (1 h)
0700 Recover sediment trap array; **End CYCLE #4**
0600 Transit to next station, MVP testing/repair enroute
2300 Bongo net, live animals for experiments

22 October

***** **Begin CYCLE #5 (32.90°N 120.93°W)**
0000 Deploy sediment trap array
0130 CTD, setup *in situ* experiments (500 m)
0300 Bongo net, live animals for experiments
0430 Deploy *in situ* (drift) array
0500 CTD, organics, bacteria, thorium (1000 m)
0600 Oozeki trawl, deep (2 h)
0900 Oozeki trawl, shallow (1 h)

1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1430 MOCNESS, zooplankton sampling
1600 Go-Flo trace-metal sampling
1730 Thorium pump, simultaneous surface pump
1900 CTD, water for evening experiments
2000 Net tow, animals for experiments
2130 Bongo, zooplankton biomass & gut pig sampling
2230 MOCNESS, zooplankton sampling

23 October

0200 CTD, setup *in situ* experiments (500m)
0430 Recover/redeploy *in situ* array
0500 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1430 Oozeki trawl, deep (2 h)
1730 Thorium pump (deep cast), simultaneous surface pump
1900 CTD, water for full dilution & evening experiments
2000 Oozeki trawl, shallow (1 h)
2100 Oozeki trawl, deep (2 h)
2300 Net tow, animals for experiments
2330 Bongo, zooplankton biomass & gut pig sampling

24 October

0030 Oozeki trawl, shallow (1 h)
0200 CTD, in situ & Th & organics (1000 m, final samples only)
0400 Recover *in situ* (drift) array
0430 Oozeki trawl, shallow (1 h)
0630 CTD profile & Chl a at sediment trap
0800 Recover sediment trap array; **End CYCLE #5**
***** **Begin MVP transects through FRONT STUDY area**
1000 MVP South transect through front 12 nm
1130 MVP North transect through front 24 nm
1400 MVP South transect through front 18 nm
1600 MVP slow (6 kts) North transect through front 12 nm
1830 MVP slow (6 kts) South transect through front 12 nm

***** **Begin A Front transect sampling, Bongo & CTD**
2100 Vertical bongo tow (100 m) – Stn AF1; 32.67°N, 120.71°W
2120 CTD (300 m)
2200 Vertical bongo tow (100 m) – Stn AF2; 32.70°N, 120.71°W
2220 CTD (300 m)
2300 Vertical bongo tow (100 m) – Stn AF3; 32.72°N, 120.71°W
2320 CTD (300 m)

25 October
0000 Vertical bongo tow (100 m) – Stn AF4; 32.75°N, 120.71°W
0020 CTD (300 m)
0100 Vertical bongo tow (100 m) – Stn AF5; 32.78°N, 120.71°W
0120 CTD (300 m)
0200 Vertical bongo tow (100 m) – Stn AF6; 32.80°N, 120.71°W
0220 CTD (300 m)
0300 Vertical bongo tow (100 m) – Stn AF7; 32.83°N, 120.71°W
0320 CTD (300 m)
0400 Vertical bongo tow (100 m) – Stn AF8; 32.85°N, 120.71°W
0420 CTD (300 m)
0500 Vertical bongo tow (100 m) – Stn AF9; 32.89°N, 120.71°W
0520 CTD (300 m)
0700 **End A Front sampling**; Transit south to CYCLE #6 area
1600 Go-Flo trace-metal sampling
1800 CTD, water for thorium, evening experiments
1900 Deploy sediment trap array
2030 Net tow, animals for experiments
2200 Bongo, zooplankton biomass & gut pig sampling
2300 MOCNESS, zooplankton sampling

26 October
***** **Begin CYCLE #6 (33.60°N 120.56°W)**
0100 IOP, Bio-optics cast
0200 CTD, setup *in situ* experiments (500 m)
0430 Deploy *in situ* (drift) array
0500 Oozeki trawl, shallow (1 h)
0630 Oozeki trawl, deep (2 h)
0900 Oozeki trawl, shallow (1 h)
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1300 MVP stationary vertical cast

1330 IOP cast (hydrowire)
1430 MOCNESS, zooplankton sampling
1730 Thorium pump, simultaneous surface pump
1900 CTD, water for full dilution & evening experiments
2000 Oozeki trawl, shallow (1 h)
2100 Oozeki trawl, deep (2 h)
2330 Bongo, zooplankton biomass & gut pig sampling

27 October

0030 Oozeki trawl, shallow (1 h)
0200 CTD, setup *in situ* experiments (500 m)
0430 Recover/redeploy *in situ* array
0530 MVP – small bow-tie survey
1030 Bongo, zooplankton biomass & gut pig sampling
1130 Radiometer off stern
1200 CTD (^{14}C-PP, PvsE), 500 m
1330 IOP cast (hydrowire)
1430 Oozeki trawl, deep (2 h)
1900 Thorium pump (deep cast), simultaneous surface pump
2030 Net tow, animals for experiments
2130 Oozeki trawl, shallow (1 h)
2300 MOCNESS, zooplankton sampling (1000 m?)

28 October

0200 CTD, in situ & Th & organics (1000 m, final samples only)
0400 Recover *in situ* (drift) array
0430 Oozeki trawl, shallow (1 h)
0630 CTD adjacent to sediment trap
0730 Recover sediment trap array; **End CYCLE #6**
0900 Transit – Head for the barn, sonar test speed, Oozeki trawls enroute
1300 Oozeki trawl, deep (2 h)
1500 CTD, water collection
2100 Live Bongo tow