MESO-SCOPE 2017 cruise plan

Simons Collaboration on Ocean Processes and Ecology (SCOPE)

1. Cruise information

General information

Date:	June 26 - July 15, 2017
Research Vessel:	Kilo Moana
Cruise ID:	KM1709
Master of the vessel:	Greg Steele
Chief scientist:	Benedetto Barone
Co-chief scientist:	Tara Clemente
Marine technicians:	Sonia Brugger
	Rob Palomares

Phone numbers

Vessel:	808-587-8566 (in port)
	808-864-0065 (mobile)
	011-870-773-234249 (satellite)
Marine center:	808-956-0688
Science party:	808-389-9939 (Benedetto Barone)
	808-389-0544 (Tara Clemente)

Planned operation times

Crane operations:	June 23, 2017
Loading & lab set-up:	June 24, 2017 @ 0900
Departure:	June 26, 2017 @ 0800 (on board by 0700)
Arrival:	July 15, 2017 @ 1800

Useful documents & links

Waiver form	http://www.soest.hawaii.edu/UMC/cms_doc/KMWAIVERFORM2.pdf
Orientation and safety	http://www.soest.hawaii.edu/UMC/cms/kilo-moana-orientation/
Real-time tracks	http://hahana.soest.hawaii.edu/hot/trackmap/TrackMap.html

2. Scientific objectives and cruise structure

The MESO-SCOPE (Microbial Ecology of the Surface Ocean - Simons Collaboration on Ocean Processes and Ecology) expedition will conduct water-column observations in the region north of the Hawaiian Islands with the aim of identifying the impact of mesoscale eddies on the ecosystem of the North Pacific Subtropical Gyre. The area of interest for this cruise is centered on 23° North and 157° West and it extends within a circle having a radius of at least 300 km. The characteristics of the region of interest will be monitored using satellite observations of height, temperature, and chlorophyll. These observations will be used to choose the optimal study area to be targeted during the cruise. Considering the need to define a cruise schedule without prior knowledge of the mesoscale field at the moment of the cruise, we adopted a modular cruise structure whereby different cruise activities can be assembled together in several ways.

One module of the cruise will be the characterization of the area of interest with a horizontal survey using underway shipboard measurements, underway CTD deployments (3-4 km resolution), and a tow-fish. In this phase we will identify the optimal position of sampling stations at eddy centers and fronts, and we will deploy the SVP drifters near the center of mesoscale eddies to be later used to conduct Lagrangian sampling.

A second module will be a transect to characterize the horizontal variability using shipboard CTD sampling stations. Drifting profilers (Wirewalker, DMO) will be deployed at eddy centers to obtain high temporal resolution observations.

A third module will be the deployment of free-drifting sediment trap arrays in the mesoscale field to characterize the horizontal variability in particle export, and they will be recovered no later than 12 days after their deployment (maximum battery autonomy).

Two modules of the cruise will conduct diel Lagrangian sampling at two stations near the centers of mesoscale eddies. These two stations will be occupied for 97 hours each and they can be considered the most important part of the cruise. The activity at eddy centers will include CTD deployments, array deployments and recoveries, net tow deployments, bio-optical measurements.

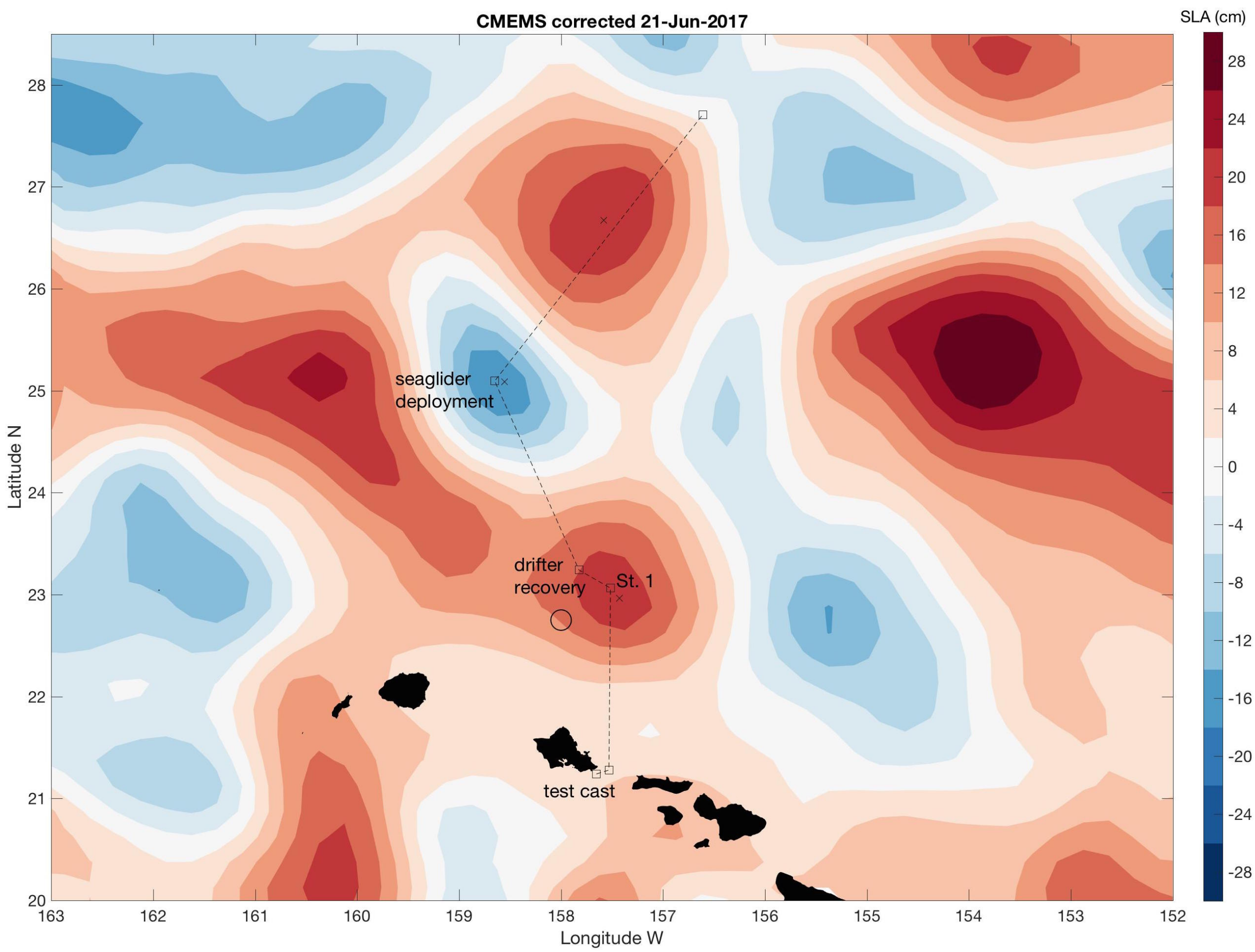
<table>
<tr><td>Jun 26</td><td>Jun 27</td><td>Jun 28</td><td>Jun 29</td><td>Jun 30</td><td>Jul 1</td><td>Jul 2</td><td>Jul 3</td><td>Jul 4</td><td>Jul 5</td></tr>
<tr><td colspan="3">Transit & horizontal survey</td><td colspan="3">Dipole transect</td><td colspan="2">ST deployments</td><td colspan="2">Diel 1: Lagrangian (97 hrs)</td></tr>
</table>

<table>
<tr><td>Jul 6</td><td>Jul 7</td><td>Jul 8</td><td>Jul 9</td><td>Jul 10</td><td>Jul 11</td><td>Jul 12</td><td>Jul 13</td><td>Jul 14</td><td>Jul 15</td></tr>
<tr><td colspan="2">Diel 1: Lagrangian</td><td></td><td colspan="4">Diel 2: Lagrangian (97 hrs)</td><td colspan="2">Equipment recovery</td><td>Transit</td></tr>
</table>

3. Main sampling schemes

The coordinated sampling of different groups will be organized around few activities:

A. Horizontal survey: we will characterize the region of interest with a high horizontal resolution hydrographic survey with the ship moving at 8 kts and using an underway CTD, underway surface seawater measurements, and a tow fish. The scheme below shows the survey track defined based on the altimetric map from June 21. In this phase, we will do: a first test cast for CTD deployments off the south shore of Oahu; sample at a Station close to the center of the anticyclonic eddy NW of Station ALOHA; recover a profiling float (White lab); deploy a Seaglider (Karl lab).

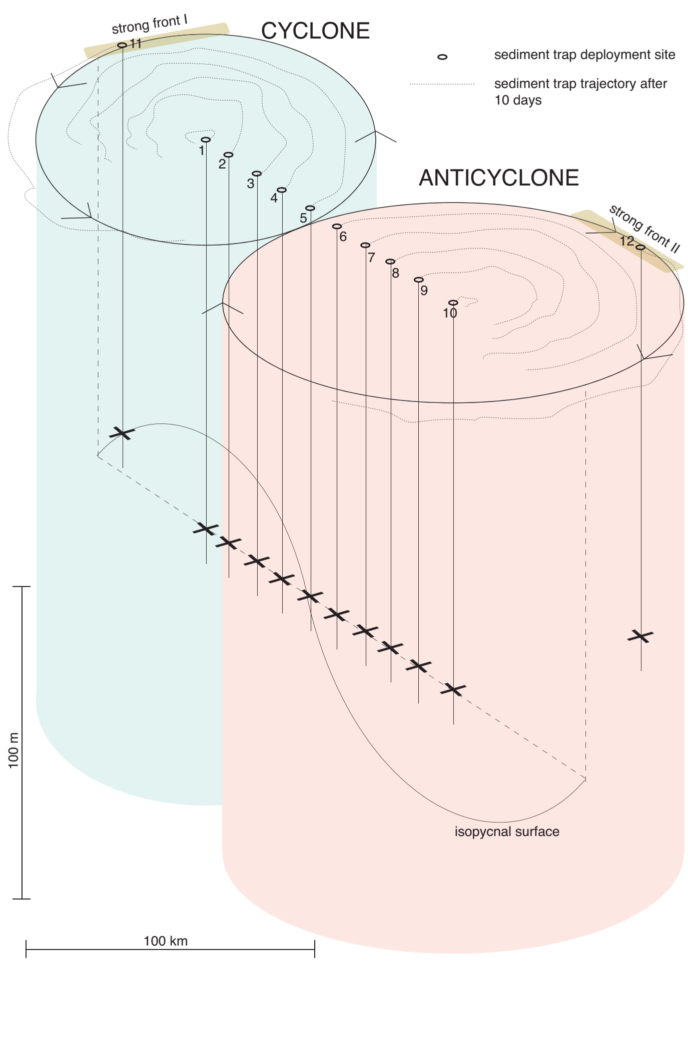


B. Dipole transect: 10-15 CTD stations (+ trace metal free rosette) will be used to define the main biogeochemical and ecological gradients within the mesoscale field. This module of the cruise is described more in detail in section 7 of this document.
During this phase, the ship should move at full speed when transiting from one station to the next one.

C. Diel Lagrangian sampling at eddy centers: two Lagrangian sampling periods will take place at eddy centers (or both in the same center in case of a single reliable eddy). We will sample at 15 m depth and at the DCM isopycnal with a 4-hour temporal resolution. The eddy center will be occupied for 12 hours before the start of the 72 hours diel sampling, so to identify the DCM isopycnal, and to deploy an array that will incubate water for 72 hours. The draft schedule in Section 8 shows timing and durations of the operations that will happen during the occupation of the eddy centers.

D. High-resolution vertical sampling: selected stations will be sampled at high vertical resolution (5 m) to characterize the transition in biogeochemical and ecological conditions that happens when crossing the deep chlorophyll maximum. We plan to sample at 15 depths (the DCM plus 6 depths above it and 8 depths below it) at 2 to 4 stations: 2 eddy centers and selected frontal stations. For sake of consistency, this sampling will take place around the same time of the day at all stations, ~8am.

E. Export variability in the mesoscale field: 12 sediment trap arrays will be deployed in different parts of the eddies and at the stronger fronts identified in the study area. The arrays will be in the water for about 12 days, and they will be recovered toward the end of the cruise. Each array will mount a cross with 12 PIT traps at a single depth of 150 meters.



F. In situ and on-deck incubations to characterize ecological responses of nutrient additions: both single-group and collaborative efforts are planned that will use incubations to characterize community response to changes in nutrient concentrations and ratios. Most of these efforts will target ecosystems from the eddy centers.

4. Science personnel

Participant	Gender	Citizenship	Title	Affiliation
Marianne Acker	F	France	Graduate student	WHOI - Repeta
Lydia Babcock-Adams	F	USA	Graduate student	WHOI - Repeta
Benedetto Barone	M	Italy	Postdoc	UH - Karl
Kevin Becker	M	Germany	Postdoc	WHOI - Van Mooy
Karin Björkman	F	Sweden	Research specialist	UH - Karl
Timothy Burrell	M	New Zealand	Research scientist	UH - SCOPE
Tara Clemente	F	USA	Research scientist	UH - SCOPE
Paul Den Uyl	M	USA	Research scientist	UH - DeLong
Mathilde Dugenne	F	France	Postdoc	OSU - White
Sara Ferrón	F	USA	Research specialist	UH - Karl
Katie Harding	F	USA	Graduate student	UCSC - Zehr
Matt Harke	M	USA	Postdoc	LDEO, CU - Dyhrman
Nick Hawco	M	USA	Postdoc	USC - John
Gwenn Hennon	F	USA	Postdoc	LDEO, CU - Dyhrman
Fiona Hopewell	F	USA	Undergrad. student	WHOI - Van Mooy
Rachel Kelly	F	USA	Graduate student	USC - John
Rachel Lundeen	F	USA	Postdoc	UW - Ingalls
Lisa Mesrop	F	USA	Research assistant	USC - Caron
Alex Nelson	F	USA	Research associate	UH - Church
John Ranieri	M	USA	Research associate	FHLBS, UM - Church
Eric Shimabukuro	M	USA	Research scientist	UH - SCOPE
Brittany Stewrt	F	USA	Technician	UCSC - Zehr
Alice Vislova	F	Russia	Graduate student	UH - DeLong
Ryan Tabata	M	USA	Research scientist	UH - SCOPE
Katie Watkins-Brandt	F	USA	Research associate	OSU - White
Qin Wei	M	China	Postdoc	UW - Ingalls

(26 participants: 10 males, 16 females)

5. Shipboard operations

5.1 Sediment trap arrays (Karl)
Twelve floating sediment trap arrays will be deployed in the first few days of the cruise, and recovered toward the end of the cruise. Sediment traps will be deployed from the stern, using the A-frame and Sea-Mac winch. Power requirement for the winch is 440 VAC, three phase at 10 amps. After deployment we request that the Bridge verify that the radio transmitters are functioning and directionally correct. The arrays will drift for about 10-15 days before recovery. Arrays are equipped with ARGOS satellite transmitters (platform #'s), strobe lights, and radio transmitters (channel , MHz). Daily positions of the arrays shall be transmitted by email directly to the ship (argosfix@satellite-email.com, password: argosfix), therefore the ship will not need to keep within site of the array until the time of the recovery. Assistance from the bridge is requested in plotting the drift track of the array. We request the use of the ship's radio direction finder for locating the array before recovery.

5.2 SVP Drifters (SCOPE)
We will deploy a Surface Velocity Program (SVP) drifters that comprise of a spherical surface float (equipped with a solar LED) and a "holey-sock" drogue centered at 15 m below the surface. The drifter transmits its position using iridium and drift along with the surface. We will sample alongside two drifters whose location is transmitted every 30 minutes. The positions are recorded at PacificGyre.com (username C-MORE, login microstar) and are transmitted via email to sdrifter@soest.hawaii.edu. They can also be forwarded to any email account that the UH Marine Center or the ships would like to receive them at.

5.3 CTD & rosette operations (SCOPE)
Vertical profiles of temperature, conductivity and depth will be made with an instrument package consisting of a Sea-Bird CTD attached to a 24-place rosette with 12 liter Niskin sampling bottles. We will need the ship's CTD winch and crane for these operations. Water samples for biogeochemical measurements will be collected on each cast. Additional CTD channels will be used for the following sensors: secondary temperature, secondary salinity, oxygen SBE43 sensor, Seapoint fluorometer, Wetlab fluorometer, c-star transmissometer, and scalar PAR sensor. These instruments are requested from the Ocean Technology Group.

5.4 Hyperpro (White):
Daily deployments of Satlantic radiometer to characterize irradiance and radiance. The Hyperpro is a profiling unit with one up-looking and one down-looking hyperspectral radiometer, a WET Labs ECO- BB2F triplet (measuring Chlorophyll-a fluorescence and backscattering in the blue and red wavelengths), temperature and conductivity sensors. This instrument also incorporates a ship mounted surface radiometer. The Hyperpro will be deployed from the stern through a small block hung from the A-frame. The instrument is hand-lowered and retrieved with assistance from the winch.

5.5 Underway CTD (SCOPE)
An underway CTD (Oceansciences) will be deployed from the stern of the ship during the cruise. The instrument uses a free-fall, internal-logging probe that is tethered to the ship by a high strength line that is loaded on a special tail spool before every cast. As the probe falls, the line on

the tail spool is paid out at the same time as line is paid out from the winch on the ship, similar to the operation of an XBT or XCTD, but with the probe being recovered after each cast.
The uCTD winch is used to recover the probe.

5.6 Net tows (Caron & Dyhrman)
Surface net tows are hand-deployed off the stern for 2-3 occasions during each day with deployments during between 40 minutes and 1 hour. We request that the ship remain stationary during these tows.

5.7 Seaglider deployment and recovery (Karl): one Seaglider (S/N 512) will be deployed during the cruise and survey the region of interest. It is possible that the glider will be recovered and deployed multiple times during the course of the cruise.

5.8 Drifting profiling systems (Karl): two wave-powered drifting profiling systems (Wirewalker, Del Mar Oceanographic) will be deployed in the first days of the cruise and recovered after 10-15 days. We request the use of the A-frame and the Sea-Mac winch for deployments and recoveries. Profiling systems are equipped with two ARGOS satellite transmitters (platform # emailing positions to argosfix@km.soest.hawaii.edu, password: argosfix), and a strobe light.

5.9 Incubation arrays (Church, John, Karl, Repeta, Zehr):
Free-drifting incubation arrays will be deployed multiple times during the cruise, for 12, 24 and 72 hours deployments. We request the use of the A-frame and the Sea-Mac winch for deployments and recoveries. Arrays are equipped with two ARGOS satellite transmitters (platform # emailing positions to argosfix@km.soest.hawaii.edu, password: argosfix), a strobe light and a radio transmitter (MHz).

5.10 Trace metal clean rosette (John): Vertical profiles will be conducted for trace metal analysis using a SeaBird CTD attached to a 12-place rosette with 8 liter Niskin sampling bottles with autonomous Auto Fire Module. The rosette is approximately 5 ft x 5ft x 4 ft and weighs 355/565 lbs in air empty/full. We will deploy the CTD rosette using a trace metal clean winch, delrin block and 1/4" Amsteel line using trace metal clean procedures.

5.11 Scripps Plankton Camera (Caron): this instrument is a submersible camera that collects plankton images in the water column. The camera is 120 cm x 18 cm and requires 30W max at 9-36VDC. It will be deployed in profiling mode either on the shipboard CTD/rosette system, or on a separate package lowered with the small capstan.

5.12 Surface towfish sampler (John): a custom built PVC towfish will be used to sample trace metal free water close to the sea surface. The towfish will be deployed up forward off from the starboard side of the ship and a 6 m long aluminum boom will be used to distance the sampler from the ship. The towfish will be deployed both while on station, during diel sampling, and while transiting.

6. Equipment

The science party will bring the following material:

1. One 20 ft. laboratory van (#24) for trace metal clean and general use
2. One 20 ft. laboratory van (#23) for radio isotope work and general use
3. All required chemicals and isotopes
4. Large vacuum waste containers
5. Liquid nitrogen dewars
6. 3 Big blue deck incubators + 3 small blue deck incubators + 1 x 3 chambered Frostie Incubator, 2-Temperature and light controlled Caron incubators, 1 dark incubator
7. Plankton nets
8. 12 x Sediment trap arrays,
9. 4 x drifting arrays
10. Hyperpro and other optical measuring instruments.
11. LI-190SA sensor and data logger
12. Oxygen titration system
13. Desktop and laptop personal computers
14. Assorted tools
15. Sampling bottles (various size)
16. Deck incubation system
17. Pertinent MSDS
18. Underway CTD & winch x2
19. Aandera O2 sensor
20. Trace metal free CTD and rosette system
21. Trace metal clean towfish sampler
22. 2 x drifting profilers (Wirewalkers)
23. 5 x SVP drifters

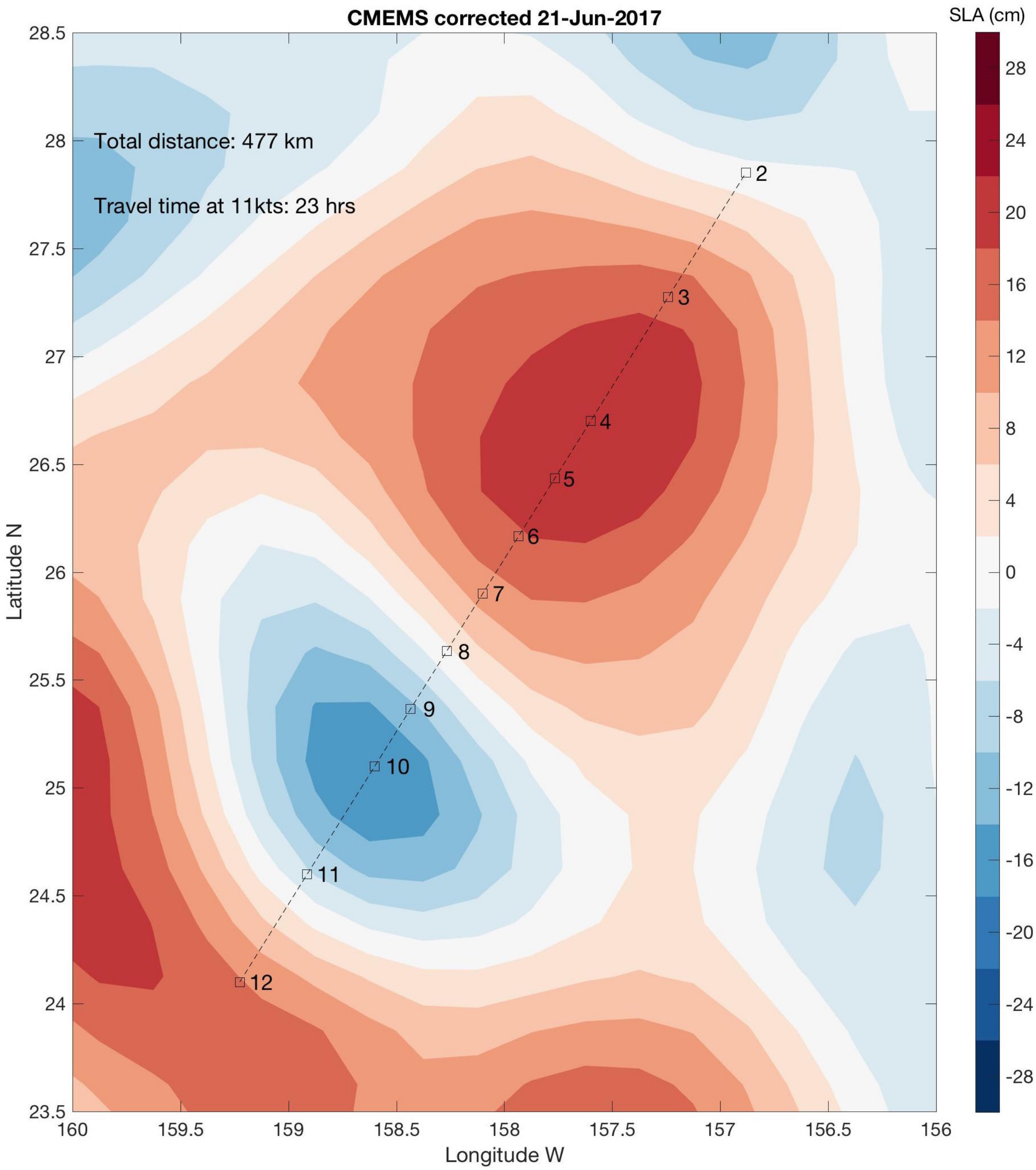
The following ship's equipment is requested:

1. One 20 ft. laboratory van (OTG van) for radioisotope work
2. OTG's 24-place rosette, and 24 12-l water sampling bottles
3. Second OTG's 24-place rosette, and 24 12-l water sampling bottles (to be used as spare)
4. 2 x CTD Instrument packages
5. A-frame
6. A-frame block assembly
7. Outrigger assembly for trace metal towfish sampler
8. Mount for the underway CTD
9. Trace metal clean winch (DSE winch) and line
10. Trace metal clean block assembly
11. Conducting wire for CTD
12. Electric power for winches (440 VAC, 3 phase, 60 Amp breaker) and vans (208 VAC single phase at 60 amps for lab van)
13. Deck incubation system with continuous seawater flow to 02 deck
14. Radio direction finder
15. Space on 01 deck for 3 vans (2 vans port (OTG van & Van #23), 1 van starboard (Van # 24))
16. Hand-held VHF transceivers
17. Precision depth recorder
18. Shackles, sheaves, hooks and lines
19. Quick Release

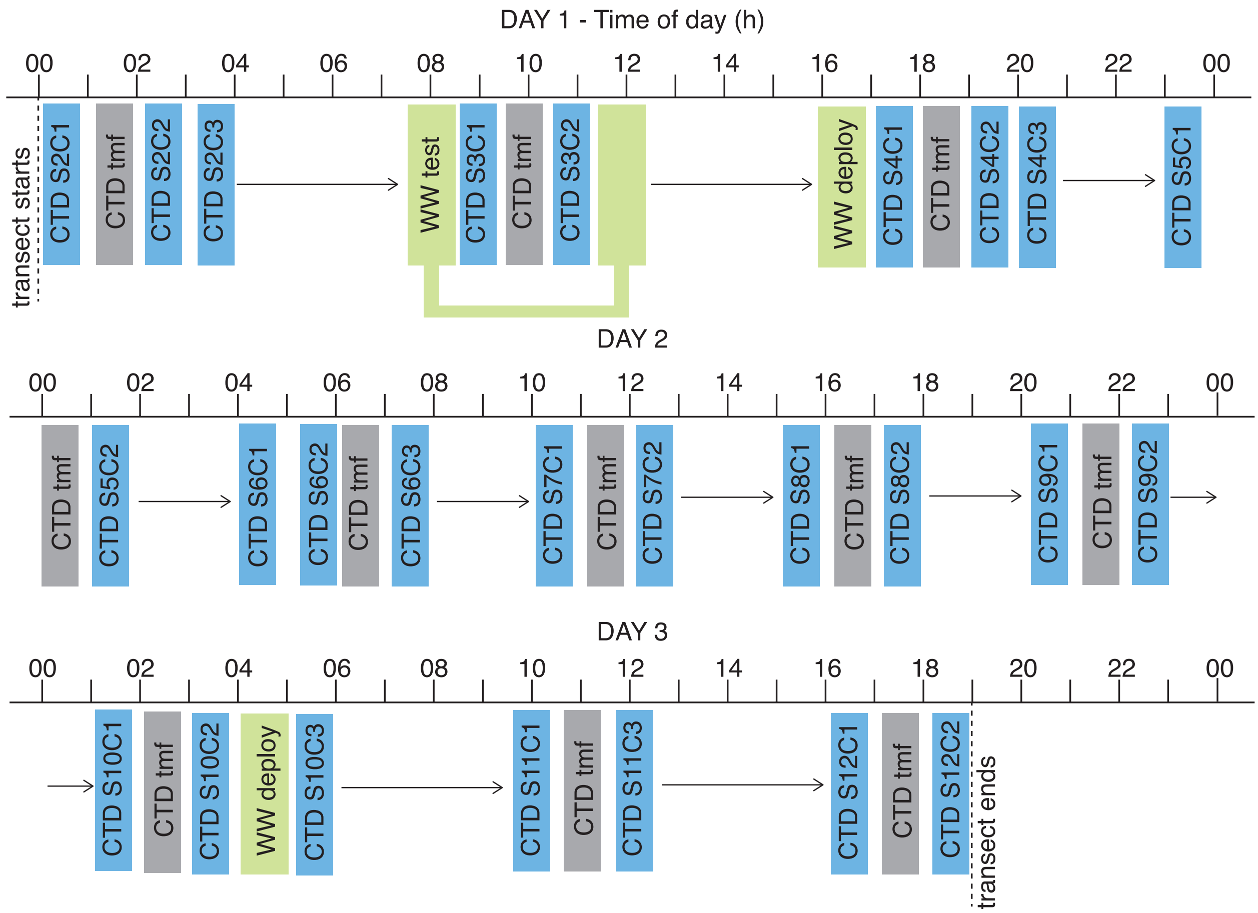
20. Grappling hooks and line
21. Shipboard Acoustic Doppler Current Profiler
22. Thermosalinograph, pCO2 system, and Fluorometer
23. Meteorological suite
24. Copy machine
25. Laptop with Nobeltec charting software and GPS feed
26. Running fresh water and seawater, hoses
27. Shipboard internet system
28. GPS system
29. Uncontaminated seawater supply
30. Small capstan (~ 10 m/min)
31. Underway/on-station data acquisition system for meteorological instruments, ADCP, thermosalinograph, fluorometer, pCO2 and access to real-time data through the network
32. 1000 lb weight
33. Large Sea-Mac winch (Mod. 1025 EHS). 60 Amp Hubbel plug/connector (440 VAC, 3 phase, 60 Amp breaker)
34. Monitor displaying ship's coordinates and GMT
35. Remote CTD dbar pressure display in winch operator area
36. 2 x C-star transmissometer
37. 2 x fluorometers (Seapoint or Wetlabs)
38. 3 x SBE43 Oxygen sensors
39. Refrigerator and Freezers (-20 and -80°C)
40. Deionized water production system

7. Dipole transect water budget by cast

The scheme below shows the sampling stations on the transect across the mesoscale dipole as present on June 21. In this scenario, we would move at full speed across the transect, and the operations would last 67 hours with 11 sampling stations.



The schedule for this module of the cruise is shown below:



The water budget for the different CTD casts is in the following table:

Cast	Day	Time	Depth	Water requests	Bott.
S2C1	1	0:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC,Chl,pH,DIC 7L@25,75,175,DCM; Ferron 3L@25m	24
S2C2	1	2:00	500	Caron 10L@25,75,DCM,500; Repeta 20L@25,175,250, below ML; nuts&DOM&SRP&FCM&PPO4 2L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	24
S2C3	1	3:30	200	White 55L@15m &10L@5,25,45m; Zehr 10L@5,25,45m; Karl 10L@15,DCM; Repeta 20L@below DCM, DCM;	18
S3C1	1	8:30	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy	24

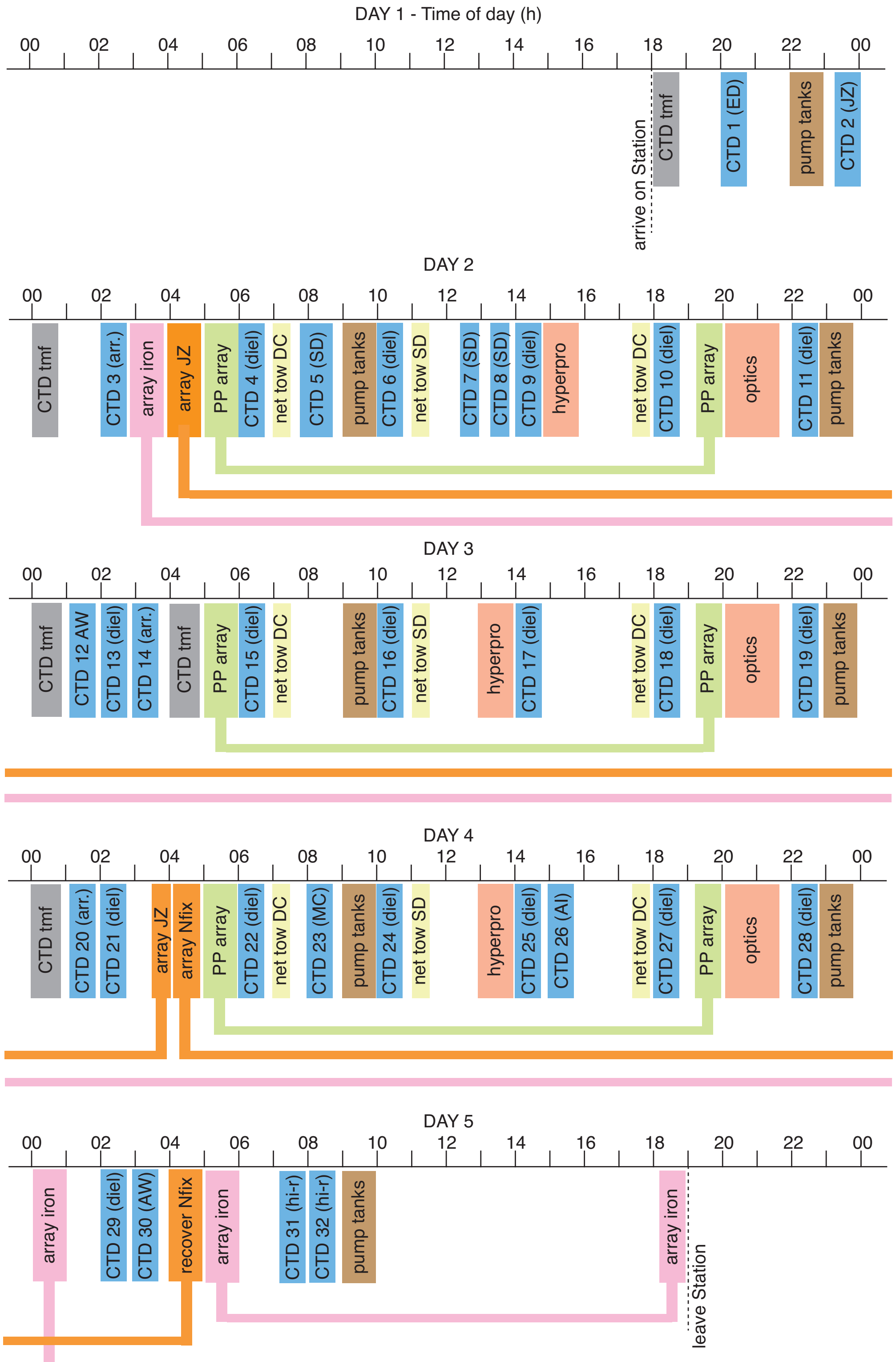
				6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC,Chl,pH,DIC 6L@25,75,175,DCM;	
S3C2	1	10:30	500	Repeta 20L@25,175,250, below ML, below DCM, DCM; nuts&DOM&SRP&FCM&PPO4 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM;	24
S4C1	1	17:00	500	Caron 10L@25,75,DCM,500; Zehr 80L@25m; nuts&DOM&SRP&FCM&POP 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM; O2 1L@5,25,45,75,100,125,250,500; Chl 1L@5,25,45,75,100,125,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	24
S4C2	1	19:00	200	Church 240L@150m	24
S4C3	1	20:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24
S5C1	1	23:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24
S5C2	2	1:00	500	Repeta 20L@25,175,250, below ML, below DCM, DCM; nuts&DOM&SRP&FCM&PPO4 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM;	24
S6C1	2	4:00	200	White 55L@15m &10L@5,25,45m; Zehr 10L@5,25,45m; Karl 10L@15,DCM; Zehr 100L@25m	24
S6C2	2	5:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24
S6C3	2	7:00	500	Caron 10L@25,75,DCM,500; nuts&DOM&SRP&FCM&POP 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	16
S7C1	2	10:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy	24

				6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM;	
S7C2	2	12:00	500	Repeta 20L@25,175,250, below ML, below DCM, DCM; nuts&DOM&SRP&FCM&PPO4 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM;	24
S8C1	2	15:00	500	Caron 10L@25,75,DCM,500; Dyhrman 60L@25m; nuts&DOM&SRP&FCM&POP 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	22
S8C2	2	17:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM;	24
S9C1	2	20:00	500	Repeta 20L@25,175,250, below ML, below DCM, DCM; nuts&DOM&SRP&FCM&PPO4 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM;	24
S9C2	2	22:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24
S10C1	3	1:00	500	Caron 10L@25,75,DCM,500; nuts&DOM&SRP&FCM&POP 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; O2 1L@5,25,45,75,100,125,250,500; Chl 1L@5,25,45,75,100,125,175,DCM; PPO4 5L@25,75,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	16
S10C2	3	3:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24
S10C3	3	4:30	200	White 55L@15m &10L@5,25,45m; Zehr 10L@5,25,45m; Karl 10L@15,DCM; Zehr 100L@25m	24
S11C1	3	9:30	500	Repeta 20L@25,175,250, below ML, below DCM, DCM; nuts&DOM&SRP&FCM&PPO4 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500;	24

				PPO4 5L@25,75,175,DCM;	
S11C2	3	11:30	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM;	24
S12C1	3	16:00	500	Caron 10L@25,75,DCM,500; nuts&DOM&SRP&FCM&POP 1.5L@ 5,25,45,75,100,125,150,175,200,DCM,250,500; PPO4 5L@25,75,175,DCM; gases 0.5L@5,25,45,75,100,125,150,175,200;	16
S12C2		18:00	200	DeLong 4L@25,DCM,175; Ingalls 30@25,DCM,175; Van Mooy 6L@25,75,100,125,175,DCM; Zehr 6L@25,45,75,100,125,150; PC, Chl,pH,DIC 6L@25,75,175,DCM; Ferron 3L@25m	24

8. Eddy center schedule and water budget by cast

The schedule below shows the timing of the operations planned while doing Lagrangian sampling at the eddy centers. The cast-by-cast water budget follows in the next page. Some of the operations will happen at different times in the two eddy centers.



Cast	**Day**	**Time**	**Depth**	**Water requests**	**Bott.**
1	1	20:00	400	DeLong/Ingalls 15L@20,40,60,80,100,120m	12
2	1	23:00	400	Zehr 120L@25,100m	24
3	2	2:00	400	Karl 30L@5,25,45,75,100,125,DCM; 1L@150m,175m	23
4	2	6:00	400	*Diel* 70L@15m,DCMiso; Caron 1.5L@15m, DCMiso;	14
5	2	8:00	700	Dyhrman 30L@700m; VanMooy 60L@15m	9
6	2	10:00	1000	*Diel* 70L@15m,DCMiso; *Biogeo* 8@5, 25, 45,75,100,125,150,175,300,700	24
7	2	12:30	25	Dyhrman 240L@25m	24
8	2	13:00	25	Dyhrman 240L@25m	24
9	2	14:00	400	*Diel* 70L@15m,DCMiso; Dyhrman 60L@25m	20
10	2	18:00	400	*Diel* 70L@15m,DCMiso;	14
11	2	22:00	400	*Diel* 70L@15m,DCMiso; Repeta 20L@175,250, below ML, below DCM, DCM;	24
12	3	1:00	25	White 165L@15m; Zehr 6L@15m	18
13	3	2:00	400	*Diel* 70L@15m,DCMiso; Church 6L@135,150,175,200,225,300m	20
14	3	3:00	400	Karl 30L@5,25,45,75,100,125,DCM; 1L@150m,175m	23
15	3	6:00	400	*Diel* 70L@15m,DCMiso; Caron 1.5L@15m, DCMiso;	14
16	3	10:00	400	*Diel* 70L@15m,DCMiso; White&Zehr 20L@5,25,45m	20
17	3	14:00	400	*Diel* 70L@15m,DCMiso; Dyhrman 60L@25m	20
18	3	18:00	400	*Diel* 70L@15m,DCMiso;	14
19	3	22:00	400	*Diel* 70L@15m,DCMiso; Repeta 20L@175,250, below ML, below DCM, DCM;	24
20	4	1:00	200	Karl 30L@5,25,45,75,100,125,DCM; 1L@150m,175m	23
21	4	2:00	400	*Diel* 70L@15m,DCMiso	14
22	4	6:00	400	*Diel* 70L@15m,DCMiso; Caron 1.5L@15m, DCMiso;	14
23	4	8:00	150	Church 240L@150m	24
24	4	10:00	1000	*Diel* 70L@15m,DCMiso Biogeo 8L@5, 25, 45,75,100,125,150,175,300,700	24
25	4	14:00	400	*Diel* 70L@15m,DCMiso; Dyhrman 60L@25m	20
26	4	15:00	200	Ingalls 100L@15m,DCMiso	20
27	4	18:00	400	*Diel* 70L@15m,DCMiso;	14
28	4	22:00	400	*Diel* 70L@15m,DCMiso	14
29	5	2:00	400	*Diel* 70L@15m,DCMiso	14
30	5	3:00	25	White 165L@15m; Zehr 6L@15m	17
31	5	7:00	400	Zehr&White 6L+2L@(DCM-30m):5m:(DCM+40m); Ingalls 30L@(DCM-20m):10m: DCM	24
32	5	8:00	400	Karl&DeLong 4L+4L@(DCM-30m):5m:(DCM+40m); Ingalls 30L@(DCM+10):10m: (DCM+30)	24

Diel: DeLong(4L),Ingalls(30L),Karl(16L),Repeta(0.1L),VanMooy(6L) @15&DCMiso;

Biogeo: O2 & Nut & DON/PP, SRP 1L@5, 25, 45,75,100,125,150,175,300,700 ; LLN 0.125@5, 25, 45,75,100,125; PC/PN & PPO4 8L@5, 25, 45,75,100,125,150,175