Hawaii Ocean Time-series
HOT-313 Cruise Plan

Cruise ID: KM 19-12
Vessel: R/V *Kilo Moana*, University of Hawaii
Master of the Vessel: Captain Joey Daigle
Chief Scientist: Dan Sadler, University of Hawaii
Marine Technicians: Jeff Koch and Patrick A'Hearn

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Pre-Cruise Meeting: June 24, 2019 at 1330 in the Moore Conference Center, C-MORE Hale.
Loading: June 29, 2019 at 0900, Pier 35.
Departure: June 30, 2019 at 0900 (**Science personnel on board by 0800**).
Arrival: July 4, 2019 at 0800
Post-Cruise: July 4, 2019 at 1000 in KM Conference Room

1.0 SCIENTIFIC OBJECTIVES

The objective of the cruise is to maintain a collection of hydrographic and biogeochemical data at the Hawaii Ocean Time-series (HOT) stations. Four stations will be occupied during the cruise, in the following order:

1) Station 1, referred to as Station Kahe, is located at 21° 20.6'N, 158° 16.4'W and will be occupied on June 30th for about 2 hours.
2) Station 2, referred to as Station ALOHA, is defined as a circle with a 6 nautical mile radius centered at 22° 45'N, 158°W. This is the main HOT station and will be occupied June 30th – July 3rd.
3) Station 50, the site of WHOTS-15 Mooring (anchor position 22° 46.045'N 157° 53.888'W) will be occupied for about one hour on July 3rd.
4) Station 6, referred to as Station Kaena, is located off Kaena Point at 21° 50.8'N, 158° 21.8'W and will be occupied on July 3rd for about 2 hours.

1.1 SCIENTIFIC OPERATIONS

Station	Activities
Kahe (Sta. 1)	Weight Cast, Hyperpro cast, CTD cast (1000 m)
ALOHA (Sta. 2)	Sediment traps, Gas array, Wirewalker, Net tows, CTD operations, Primary productivity measurements, Optics casts, Misc. experiments.
WHOTS mooring station (Sta. 50)	One CTD cast (yo-yo to 200 m), surface instrument intercomparisons.
Kaena (Sta. 6)	One near-bottom CTD cast (~ 2400 m)

Underway/continuous	ADCP, thermosalinograph, fluorometry, meteorology, SeaFlow, C-Star, Imaging FlowCytobot (IFCB)

2.0. SCIENCE PERSONNEL

Participant	Title	Affiliation	Citizenship
Kendra Babcock	Research Associate	UH	USA
Ryan Tabata	Research Associate	UH	USA
Tim Burrell	Research Associate	UH/SCOPE	New Zealand
Dan Fitzgerald	Research Associate	UH	USA
Carolina Funkey	Research Associate	UH	USA
Tully Rohrer	Research Associate	UH/SCOPE	USA
Dan Sadler– Chief Scientist	Research Associate	UH	USA
Fernando Santiago-Mandujano	Research Associate	UH	USA
Blake Watkins	Marine Engineer	UH	USA
Jeff Koch	Marine Technician	OTG	USA
Patrick A'Hearn	Marine Technician	OTG	USA
Karin Björkman	Scientist	UH	Sweden
Jinchun Yuan	Scientist	ECSU	USA
Kelsey Maloney	Student Assistant	UH	USA
Dylan Boeman	Undergraduate Student	UH	USA
Nathaniel Harmon	Graduate Student	UH	USA
Andres Salazar Estrada	Graduate Student	UH	Chile
Hayley Schiebel	Scientist	UH	USA
Wendell Waters	Scientist	Brown	USA
Mathieu Caffin	Scientist	UH	France
Erik Hakansson	Volunteer	UH	Sweden
Mary Parker	Journalist	M.L. Parker Media	USA
Peter Vissers	Engineer	Hawbolt Ind.	Canada

3.0. SUMMARY SCHEDULE

24 June	Pre-cruise planning meeting 1330 hrs, Moore Conference Center, C-MORE Hale.
29 June	Equipment loading at 0900 hrs, Pier 35.
30 June	Depart from Pier 35 at 0900 hrs. **Science personnel on-board by 0800.**
30 June	Station 1 Kahe Pt. operations.
1-3 July	Station 2 ALOHA operations, Station 50 CTD yo-yo cast. Station 6 CTD cast.
4 July	Arrive back to Pier 35.
4 July	Post-cruise meeting at 1000 hrs. KM Conference Room.

4.0. OPERATIONAL PLANS

4.1. Station Kahe (21°20.6'N, 158°16.4'W)

A 1300 lb. weight-test cast to 500 m, a Hyperpro cast (Sect. 4.2.8), and one CTD cast to 1000 m (4.2.6) will be conducted at this location on June 30th. The ships A-frame and Dynacon winch will be needed for these operations. After the operations are satisfactorily completed, the ship shall proceed to Station ALOHA.

4.2. Station ALOHA (22°45'N, 158°W with 6 nm radius)

4.2.1. Upon arrival to Station ALOHA, the Wirewalker will be deployed (Sect. 4.2.2). Once the Wirewalker is deployed, the Sediment Traps will be deployed (Sect. 4.2.3). After these operations are completed, one 1000-m cast will be conducted to collect water for the Primary Production Array. Following this, the Primary Production array will be deployed (4.2.4). These operations will be followed by a near-bottom CTD cast and the start of the 36-hour water column observations at Station ALOHA.

NOTE: Array tracking is facilitated through the SOEST Cruise and Drifter Tracks tool found at http://hahana.soest.hawaii.edu/nowcast/loctable.html

4.2.2 Wirewalker deployment

Upon arrival to Station ALOHA a Wirewalker (Del Mar Oceanographic) will be deployed to take hydrographic and optical observations in the upper 400 m of the water column. The instrument is approximately 1.5 m long and 0.6 m wide and weighs approximately 30 Kg. The instrument will be deployed on a wire with a 40 Kg bottom weight and a surface buoy with strobe light and Pacific Gyre positioning system (ID: DMO-GLBCN-0003 or DMO-GLBCN-0004), Xeos 51020, Iridium (platform #: 704320).

The Wirewalker will be deployed at a location within Station ALOHA, to be determined by observed local and forecasted currents to avoid possible entanglement with the WHOTS mooring. The instrument will stay in the water for approximately 56 hours. Deployment and recovery will be conducted from the back deck through the A-frame and using the SeaMac winch, each operation will take 30 to 60 min. Two ABs will be required to operate the A-frame and winch respectively. Blake Watkins will be in charge of this deployment.

After deployment of the Wirewalker, the ship shall prepare to deploy the sediment trap array.

4.2.3. Sediment trap array deployment

The floating sediment traps will be deployed in close proximity to the Wirewalker, so the two arrays drift in a similar direction. The array will be deployed from the back of the deck thru the A-frame and using the SeaMac winch. After deployment we request that the bridge verify that the radio transmitters are functioning and directionally correct. The Sediment Trap array will consist of one cross with 12 particle interceptor traps (PIT) at 150m.

The array will drift for about 56 hours before recovery. The array is equipped with 1 ARGOS satellite transmitter (platform #: 85857), 1 Novatech Iridium beacon (platform #: 200), strobe lights, a radio transmitter (channel 72: 156.625 MHz). Daily positions of the array shall be transmitted by email directly to the ship (argosfix@km.soest.hawaii.edu , 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. Blake Watkins will be in charge of this deployment.

After deployment of the sediment trap array, one 200 m CTD cast shall be conducted and the ship shall prepare to deploy the Primary Productivity Array.

4.2.4 Primary production experiment

Samples for the primary productivity experiment will be collected from the rosette. Before dawn (Sunrise 0551 hrs on July 1st), a free drifting incubation array will be deployed from the back of the deck thru the A-frame and using the SeaMac winch. The primary production incubation array will be deployed at a location within Station ALOHA, to be determined by observed local and forecasted currents to avoid possible entanglement with the WHOTS mooring. The array is equipped with ARGOS satellite transmitter (platform # 60484), Xeos 50030, strobe lights and a radio transmitter (channel 74: 156.725 MHz). Positions of the array will be emailed to argosfix@km.soest.hawaii.edu, password: argosfix. The **ship shall keep within site of the array** while performing CTD operations for the last 6 hours of the approximately 12-hour time the array will be in the water unless the array drifts outside of the ALOHA circle. If the array drifts out of the circle, the ship should return inside the circle to conduct CTD casts, and the monitoring of the array will be coordinated with the watch leader. The array will be recovered just at sunset (1921 hrs). CTD operations shall continue after

recovery. All radioactive waste generated by the experiment shall be returned to the University of Hawaii. Only qualified personnel shall handle radioactive material. Blake Watkins will be in charge of this deployment.

After deployment of the Primary Production Array, the ship shall transit to the center of the station circle to conduct a bottom CTD cast, S2C2 (approximately 4740 m).

4.2.5. Water column measurements

Vertical profiles of temperature, conductivity and dissolved oxygen will be made with an instrument package consisting of a Sea-Bird CTD attached to a 24-place rosette with 12 liter Bullister sampling bottles. We will need the ship's CTD winch and A-frame for these operations. Water samples for biogeochemical measurements will be collected on each cast. The cast after the deployment of the Primary Productivity Array shall be made to the near bottom (approximately 4740 m). Following this cast, a series of 1000-m casts shall be made continuously every 3 hours for a 36-hour period, ending with a second near-bottom cast. It is highly desired that this burst sampling be done without interruption and we request the ship to maintain position within the study area for that period of time, and repositioning to the center of the Station before each cast whenever possible.

Whenever pumping of the ship's tanks is needed, it must be conducted outside the circle that defines station ALOHA (Sect. 1.0). To avoid disruptions in the schedule, this operation should be coordinated with the chief scientist or the watch leaders **(Karin Björkman and Dan Fitzgerald)**.

4.2.6. Gas Array deployment

A free drifting incubation array will be deployed the third day of the cruise at Station ALOHA. Samples for the gas array will be collected from Station 2 CTD cast 8. The gas array will be deployed from the back of the deck thru the A-frame and using the SeaMac winch. The gas array be deployed at a location within Station ALOHA, to be determined by observed local and forecasted currents to avoid possible entanglement with the WHOTS mooring. The array is equipped with ARGOS satellite transmitter (platform # 60484), Xeos 50030, strobe lights and a radio transmitter (channel 74: 156.725 MHz). Positions of the array will be emailed to argosfix@km.soest.hawaii.edu, password: argosfix. The ship will **not** need to keep within sight of the array until the time of the recovery, approximately 25 hours after its deployment. Assistance from the bridge is requested in plotting the drift track of the array. B. Watkins will be in charge of this deployment.

4.2.7. Hyperpro

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. Around 1400 on the first, second and fourth days, the Hyperpro will be deployed from the stern through a small block hung from the A-frame. The instrument is lowered and retrieved by hand. Each deployment will consist of two profiles and one yo-yo (5 x 20m) before the instrument is retrieved.

4.2.8. Optics

An optical package including a SeaBird Seacat with temperature, conductivity, and pressure sensors, a Wetlabs ECO triplet measuring g backscatter, chlorophyll fluorescence, and CDOM fluorescence and a LISST particle size and distribution analyzer will be deployed during the cruise. Each deployment will consist of three up and two down profiles to a target depth of 200 m at a constant speed of 10 m/min during both the downcast and upcast. An instrument soaking period at just below the surface will be required between the two profiles. The A-frame and capstan will be needed for this operation.

4.2.9. Zooplankton Net Tows

A plankton net will be deployed from the stern and shall be towed for half-hour periods. Half-hour periods are scheduled around noon and midnight on the second, third, and fourth days (see schedule) for a total

of six slots. The A-frame and small capstan will be needed for this operation. B. Watkins will be in charge of these operations.

4.3. Gas Array, Sediment Trap Array and Wire Walker recovery

In the morning of July 1st, after the optics cast has been completed, the ship shall transit for the recovery of the Gas Array. The A-frame and the Sea-Mac winch will be needed to retrieve the sediment trap array. After the Gas Array is recovered, the ship shall transit to recover the floating sediment trap array. On completion of sediment trap array recovery, the ship shall transit to recover the Wirewalker. Blake Watkins will be in charge of these operations. After the Wirewalker is recovered, the ship shall transit to Station 50. Upon arrival at Station 50 a Hyperpro cast, one 200 m CTD yo-yo cast and ADCP inter comparisons will be conducted.

4.4 Station 50 - WHOTS-15 Mooring

The anchor position of the WHOTS-15 mooring is 22° 46.045'N 157° 53.888'W. The watch circle of the buoy is about 2 nautical miles. Generally, the buoy stays on the edge of the watch circle. The buoy can be detected via radar in good weather conditions but is harder to detect with larger sea states.

4.4.1 CTD yo-yo cast (subsurface instrument intercomparison)

One 200-m CTD yo-yo cast with at least 5 full cycles will be conducted near the WHOTS mooring on July 3rd for subsurface instrument intercomparison. This cast should be conducted downwind, down current, and about 200 m from the mooring.

4.4.2 Surface instrument intercomparison

While on station, the ship's meteorological system shall be in operation for surface instrument intercomparisons with the WHOTS mooring. Once the yo-yo cast is completed, ADCP intercomparisons will be run between the shipboard ADCP system and the moored instrument on the WHOTS-15 mooring line. These comparisons should also be conducted downwind, down current, and about 200 m from the mooring.

After operations at Station 50 are completed, the ship shall transit to Station Kaena.

4.5. Station Kaena (21° 50.8'N, 158° 21.8'W)

A near-bottom CTD cast (~2500 m) will be conducted at this location in the evening of July 3rd. Once the CTD cast is complete, the ship shall return to Pier 35.

4.6. Acoustic Doppler Current Profiler

The ship's acoustic Doppler current profilers (ADCP) will be in operation during the duration of the cruise. The OTG technicians will be in charge of the ADCP system.

4.6.1. Lowered Acoustic Doppler Current Profiler

The HOT rosette configuration includes a Teledyne Workhorse Mariner Model 600 kHz lowered-ADCP (LADCP) for current measurements on down- and up-cast. The LADCP, operating in single ping mode, will record measurements internally at a rate of 4 Hz. These measurements will then be downloaded after each cast via an RS232-to-ethernet connection. This will require direct connection to the ADCP after each cast, with data download before the next cast.

4.7. Thermosalinograph, Fluorometer and pCO_2

The ship's thermosalinograph, fluorometer and pCO_2 sampling the uncontaminated seawater supply system will be in operation during the duration of the cruise while the ship is outside of Honolulu Harbor. Salinity samples to calibrate the thermosalinograph will be taken from the intake hose at 4-hour intervals throughout the duration of the cruise by the science personnel. The ship's meteorological system shall be in operation throughout the cruise. Access to real-time underway data through the ship's network will be required. The OTG technicians will be in charge of the thermosalinograph, Fluorometer, and meteorological suite operations.

4.7.1 SeaFlow, Inline C-Star Transmissometer and Imaging FlowCytobot (IFCB)

In addition to the continuous thermosalinograph and fluorometer sampling, the SeaFlow, an inline C-Star Transmissometer, and the IFCB will sample continuously from the uncontaminated seawater supply system throughout the duration of the cruise while the ship is outside of Honolulu Harbor. Access to real-time underway data through the ships network is required. The SCOPEOps technicians and UH personnel will be in charge of these instruments and operations.

4.8 Aerial Drone Operations

An aerial drone equipped with chemical sensors will collect atmospheric profiles each day for about 20 minutes. Launch and recovery is requested from an open deck area determined in consultation with the captain and OTG technicians. A licensed individual will operate the drone according to all applicable regulations.

4.9 ARGO Float Deployment

An ARGO float will be deployed off the stern on July 3rd after operations at WHOTS. Blake Watkins will be in charge of this operation

5.0 EQUIPMENT

5.1. The HOT science party shall be bringing the following

1. Seabird CTD system, all sensors, deck boxes and computer CTD acquisition systems
2. Rosette and 24 12L Bullister sampling bottles, and all associated spare parts
3. Lowered Acoustic Doppler Current Profiler (LADCP)
4. One 20 ft. laboratory van (#23) with assorted equipment for radioisotope and general use, and one 10 ft. blue storage van (PO) for equipment and spare storage.
5. Distilled, deionized water and all required chemicals and isotopes
6. Large vacuum waste containers
7. Liquid nitrogen dewars
8. Drifting sediment trap array with strobe lights, satellite and radio transmitters, floats, weights, line, sediment traps and crosses.
9. Drifting primary production array with strobe lights, satellite and radio transmitters, floats, weights, line primary production bottles and spreader bars.
10. Drifting gas array with strobe lights, satellite and radio transmitters, floats, weights, line, 4 L bottles and short mounting bars.
11. Drifting Wirewalker array with surface buoy, strobe lights, satellite transmitters, floats, weights, 400m and cable.
12. Oxygen titration system
13. Plankton nets and towing lines
14. Desktop and laptop personal computers
15. Assorted tools
16. All required sampling bottles
17. Pertinent MSDS
18. Wirewalker
19. SeaFlow
20. Inline C-Star Transmissometer
21. Imaging FlowCytobot (IFCB)
22. Incubators

5.2. We will need the use of the following ship's equipment:

1. A-frame
2. A-frame block assembly
3. CTD winch
4. Electric power
   -440/480 VAC, 3 phase 60Hz, 60amp for winches
   -208 VAC single phase at 60 amps for lab vans
5. Space on upper 01 deck port side for one 10 ft van **(Blue Equipment van)**
6. Space on upper 01 deck port side for one 20 ft van **(#23)**
7. Space on 02 deck for incubators
8. Space on deck for ~4 deck baskets of array gear
9. Small capstan (~ 10 m/min)
10. SeaMac Winch
11. Radio direction finder
12. Hand-held VHF transceivers
13. Shackles, sheaves, hooks and lines
14. Precision depth recorder
15. Shipboard Acoustic Doppler Current Profiler
16. Thermosalinograph, pCO_2 system, and Fluorometer
17. Meteorological suite
18. Grappling hooks and line
19. Navlink2 PC or equivalent
20. Running fresh water and seawater, hoses
21. Uncontaminated seawater supply
22. -80°C Freezer
23. 4°C Refrigerator and -20°C Freezer
24. Distilled, deionized water system
25. Electronic mail system
26. GPS system
27. Underway/on-station data acquisition system for meteorological instruments, ADCP, thermosalinograph, fluorometer, SeaFlow, inline C-Star transmissometer and IFCB and access to real-time data through the network.
28. OTG's 24-place rosette, and 24 12-l water sampling bottles (to be used as spare)
29. ~1300 lb weight
30. Remote CTD dbar pressure display in the winch operator area.
31. Monitor in CTD Lab displaying ship coordinates, bottom depth and GMT.
32. OTG's transmissometer (preferably SN 1366)

Ship: R/V *Kilo Moana* **HOT 313 CTD CASTS** **Date: June 30 - July 4, 2019**

Cast		Samples	#Bottles
Kahe Pt.			
s1c1	1000 m	O_2, Temp, DIC/Alk, pH, Nuts, LLN, LLP, Chl a, Salts	15
Station ALOHA			
s2c1	200 m	Primary Production, Chl a, FCM, **SF-S**(pb 3@ 5, 25, 45, 75, 100, 125) and O2(1@15), Salts	24
s2c2	4740 m (PO-1)	O_2, Temp, DOC, DIC/Alk, pH, Ref Si, Nuts, Salts	24
s2c3	1000 m (PO-2)	O_2, Temp, DOC, DIC/Alk, pH, Nuts, Ref Si, Salts	24
s2c4	1000 m	PC/PN, DNA(1@5,25,45,75), Salts	18
s2c5	1000 m	PPO4, **SF-S**(1@5, 25) and O2(1@15),Salts	17
s2c6	1000 m (BEACH)	O_2, Temp, DIC/Alk, pH, Nuts, LLN, LLP, DOC, Keeling, Quay, Salts, **SF-S** (1@5,pb@25)	24
s2c7	1000 m	**SF-S**(1@5, 25), DNA(1@,100,125,150,175), Salts **MCA**(1@5,25,45,75,100,125,150,175,250,500)	22
s2c8	1000 m	Gas Array(3@5,25,45,75,100,125), **SF-S**(1@5, 25), Salts	22
s2c9	1000 m	DNA(1@200,225,250,275), **SF-S**(1@5, 25) and O2(1@15), **MC** (1@5, 25, 45, 75, 100, 125, 150, 175), Salts	17
s2c10	1000 m	PSi, **SF-S**(1@5, 25), **MCA**(4@5,75,125),Salts	24
s2c11	1000 m	**SF-S**(1@5, 25), **PO**(6@1000), Salts	15
s2c12	1000 m	ATP, DNA(1@300,400,500,770), **SF-S**(1@5, 25), Salts	17
s2c13	1000 m	**SW**(1@5,25,45,75,100,125,150,175, 200, 300, 400, 600, 800) **SF-S**(1@5, 25) and O2(1@15),Salts	18
s2c14	1000 m	HPLC, Chl a, **MCA**(1@5,25,45,75,100,125)Salts	17
s2c15	4740 m (PO-3)	Oxygen, DNA(1@1000,2000,3000,4000),salts	18
WHOTS Mooring			
s50c1	200 m yo-yo	DIC/TA(1@5)	1
Kaena			
s6c1	2400 m	Chl a, Salts	13
Underway Samples			
		CF (20 L)	

MC=Matt Church, **SW**=Sam Wilson, **SF-S=**Sara Ferrón-Smith, **MCA**=Mathieu Caffin, **CF**= Carolina Funkey

Ship: R/V *Kilo Moana* HOT 313 Date: June 30 - July 4, 2019

TIME	Sun. 6/30	Mon. 7/1	Tue. 7/2	Wed. 7/3	Thu. 7/4
0000		Deploy WireWalker	Transit to pump tanks		
0100		Deploy Sed Trap			
0200		S2C1 PP	S2C8 Gas		
0300				Optics	
0400		Deploy PP Array	Deploy Gas Array		
0500		S2C2 PO-1(Deep)	S2C9 Open	Transit Gas Array	
0600		322 Wire Assessment		Recover Gas Array Transit Sed Traps	
0700				Recover Sed Traps	
0800	All Sci. Aboard		S2C10 PSi	Transit WireWalker	Arrive Pier 35
0900	Depart Pier 35		Transit to pump tanks	Recover WireWalker	
1000				Transit St. 50	
1100	Arrive Kahe(11:30) Weight Cast	S2C3 PO-2 (Begin 36 hr)	S2C11 Open	HyperPro	
1200	HyperPro	Net Tow	Net Tow Net Tow		
1300		HyperPro	Aerial Drone Ops	S50C1 WHOTS	
1400	S1C1 Kahe	S2C4 PC/PN	S2C12 ATP	ADCP Inter-comp	
1500	Aerial Drone Ops	Transit to pump tanks		ARGO Float	
1600	Transit ALOHA	Aerial Drone Ops		Aerial Drone Ops	
1700		S2C5 PPO4	S2C13 Open	Transit to Kaena	
1800			Transit to pump tanks		
1900		Recover PP array			
2000		S2C6 BEACH	S2C14 HPLC		
2100				S6C1 Kaena	
2200		Net Tow Net Tow	Net Tow		
2300	Arrive ALOHA	S2C7 Open	S2C15 PO-3 (Deep) (end 36 hours)		

July 1st: Sunrise 0551, Sunset 1921

6.0 HOT-312 Watch Schedule

0300-1500

Carolina Funkey – Water Boss
Tim Burrell– Alt Tag
Kelsey Maloney – Tag
Dan Fitzgerald – Console, Watch Leader
Dan Sadler – Chief Scientist – Tag
Andres Salazar Estrada – Alt Tag
Nathaniel Harmon

1500-0300

Kendra Babcock – Water Boss-Alt. Tag
Karin Björkman – Watch Leader
Ryan Tabata –Tag
Fernando Santiago-Mandujano - Console
Tully Rohrer – Tag
Dylan Boeman

0900-2100

Erik Hakansson

At Large

Blake Watkins
Jinchun Yuan
Andres Salazar Estrada
Mathieu Caffin
Hayley Schiebel
Mary Parker
Peter Vissers
Wendell Waters

OTG

Jeff Koch
Patrick A'Hearn