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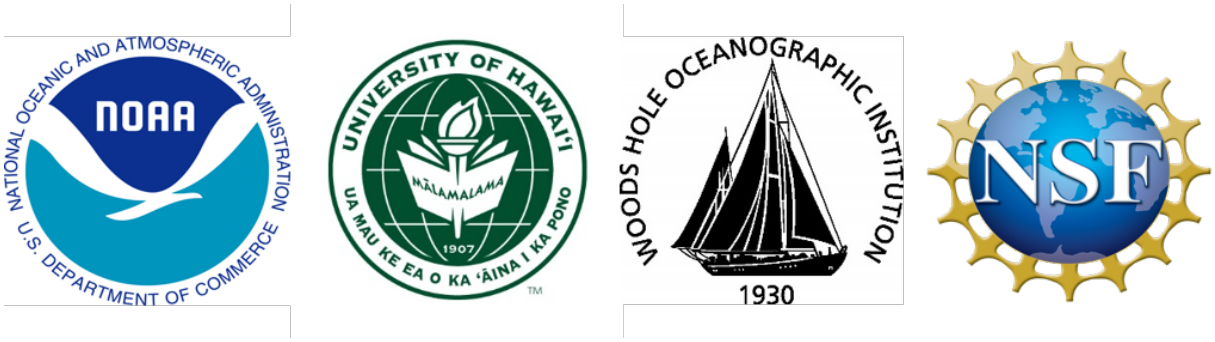

Hydrographic Observations At the Woods Hole Oceanographic Institution Hawaii Ocean Time-series Site: 2018 - 2019

by

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1 Introduction

In 2003, Robert Weller (Woods Hole Oceanographic Institution [WHOI]), Albert Plueddemann (WHOI), and Roger Lukas (the University of Hawaii [UH]) proposed to establish a long-term surface mooring at the Hawaii Ocean Time-series (HOT) Station ALOHA (22°45'N, 158°W) to provide sustained, high-quality air-sea fluxes and the associated upper ocean response as a coordinated part of the HOT program, and as an element of the global array of ocean reference stations supported by the National Oceanic and Atmospheric Administration's (NOAA) Office of Climate Observation.

With support from NOAA and the National Science Foundation (NSF), the WHOI HOT Site (WHOTS) surface mooring has been maintained at Station ALOHA since August 2004. This project aims to provide long-term, high-quality air-sea fluxes as a coordinated part of the HOT program and contribute to the goals of observing heat, freshwater, and chemical fluxes at a site representative of the oligotrophic North Pacific Ocean. The approach maintains a surface mooring outfitted for meteorological and oceanographic measurements at a site near Station ALOHA by successive mooring turnarounds. These observations are being used to investigate air-sea interaction processes related to climate variability and change.

The original mooring system is described in the mooring deployment/recovery cruise reports (Plueddemann et al. 2006; Whelan et al. 2007). Briefly, a Surlyn foam surface buoy is equipped with meteorological instrumentation including two complete Air-Sea Interaction Meteorological (ASIMET) systems (Hosom et al. 1995; Colbo and Weller 2009) , measuring air and sea surface temperatures, relative humidity, barometric pressure, wind speed and direction, incoming shortwave and longwave radiation, and precipitation. Complete surface meteorological measurements are recorded every minute, as required to compute air-sea fluxes of heat, freshwater, and momentum. Each ASIMET system also transmits hourly averages of the surface meteorological variables via the Argos satellite system and iridium. The mooring line is instrumented to collect time series of upper ocean temperatures, salinities, and velocities with the surface forcing record. This mooring includes conductivity, salinity and temperature recorders, two Vector Measuring Current Meters (VMCMs), and two Acoustic Doppler current profilers (ADCPs). See the WHOTS-15 mooring diagram in Figure 1

The subsurface instrumentation is located vertically to resolve the temporal variations of shear and stratification in the upper pycnocline to support the study of mixed layer entrainment. Experience with moored profiler measurements near Hawaii suggests that Richardson's number estimates over 10 m scales are adequate. Salinity is crucial to water mass stratification, as salt-stratified barrier layers are observed at HOT and in the region (Kara, Rochford, and Hurlburt 2000). Thus Sea-Bird MicroCATs with vertical separation ranging from 5-20 m were used to measure temperature and salinity. A Teledyne RD Instruments (TRDI) ADCP obtains current profiles across the entrainment zone and another in the mixed layer. Both ADCPs are in an upward-looking configuration, one is at 125 m, using 4 m bins, and the other is at 47.5 m using 2 m bins. To provide near-surface velocity (where the ADCP estimates are less reliable), we deploy two VMCMs. The simple mooring design is a balance between resolving extremes versus the typical annual cycling of the mixed layer (Plueddemann et al. 2006; Santiago-Mandujano et al.

2007).

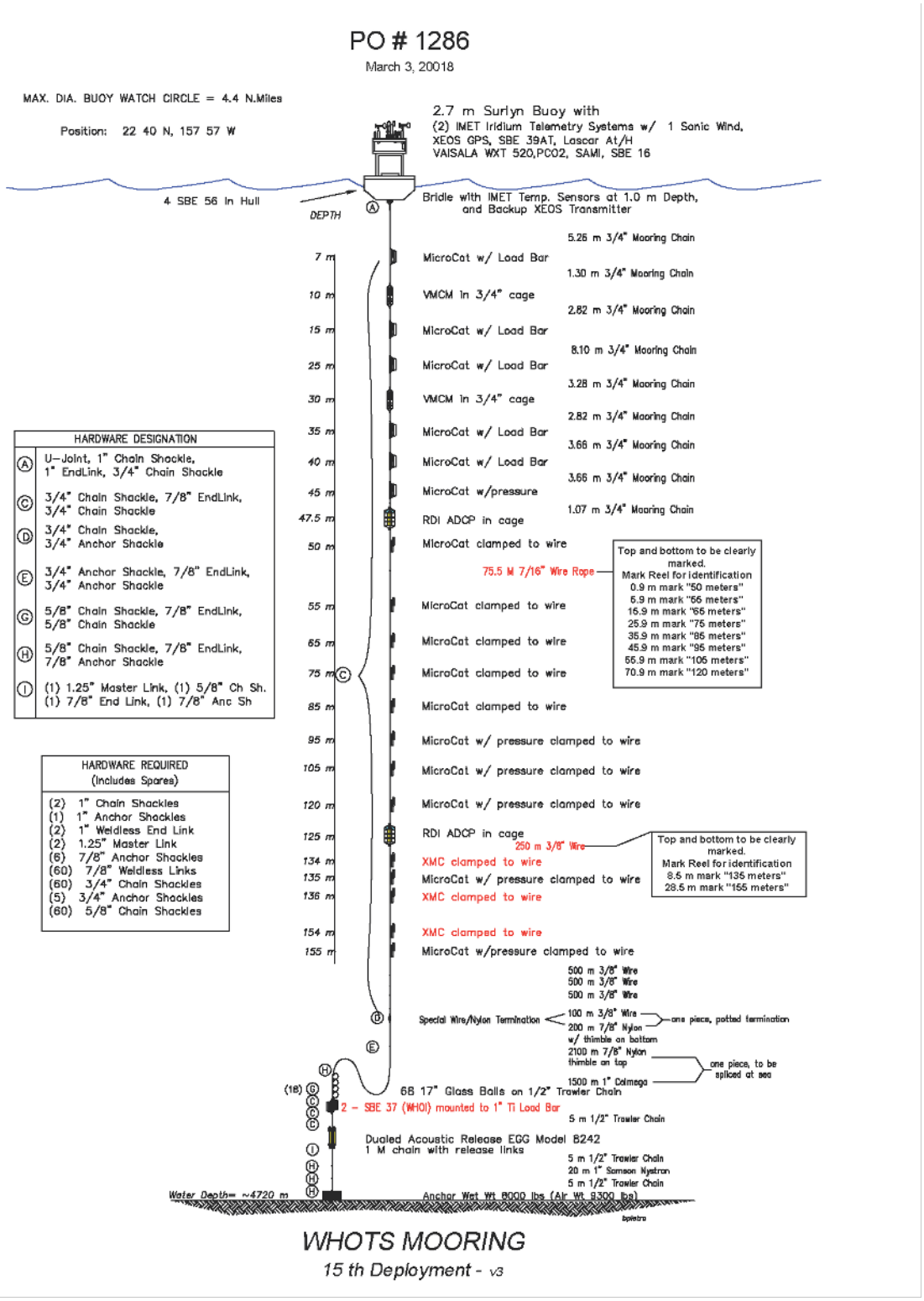


Figure 1: WHOTS-15 Mooring Diagram

The fifteenth WHOTS mooring was deployed on March 23rd, 2018 during an eight-day cruise (WHOTS-15 cruise) and was recovered on October 28th, 2019 during a nine-day cruise (WHOTS-16 cruise). The cruises were aboard the NOAA Ship Hi'ialakai and Oscar

Sette, respectively. A sixteenth mooring was deployed during the WHOTS-16 cruise; to be recovered in 2021.

This report documents and describes the oceanographic observations made on the 15th WHOTS mooring for nearly one year and from shipboard measurements during the two cruises when the mooring was deployed and recovered. Sections II and III include a detailed description of the cruises and the mooring, respectively. Sampling and processing procedures of the hydrographic casts, thermosalinograph, and shipboard ADCP data collected during these cruises are described in Section IV. Section V includes the processing procedures for the data collected by the moored instruments: SeaCATs, MicroCATs, VMCMs, and moored ADCPs. Plots of the resulting data and preliminary analysis are presented in Section VI.

2 Description of the WHOTS-15 Mooring Cruises

2.1 WHOTS-15 Cruise: WHOTS-15 Mooring Deployment

The Woods Hole Oceanographic Institution Upper Ocean Processes Group (WHOI/UOP), with the UH group's assistance, conducted the fifteenth deployment of the WHOTS mooring onboard the NOAA Ship Hi'ialakai during the WHOTS-15 cruise between September 21st and September 29th, 2018. The WHOTS-15 mooring was deployed at Station 50 on September 23rd, 2018, 01:17 UTC at 22° 45.94 'N, 157° 53.70 'W, and the WHOTS-14 mooring were recovered on September 27th. The scientific personnel that participated during the cruise are listed in Table II 1

Table 1: Scientific personnel on Ship Hi'ialakai during the WHOTS-15 deployment cruise

Name	**Title** or **Function**	**Affiliation**
Plueddeman, Albert	Chief Scientist	WHOI
Pietro, Ben	Senior Engineering Assistant	WHOI
Hasbrouck, Emerson	Engineering Assistant	WHOI
Greenwood, Ben	Research Associate	WHOI
Snyder, Jefrey	Marine Electronics Technician	UH
Santiago-Mandujano, Fernando	Research Associate	UH
Natarov, Svetlana	Research Associate	UH
Hebert, Garret	Undergraduate Volunteer	UH
Howins, Noah	Undergraduate Volunteer	UH
Maloney, Kelsey	Student Assistant	UH
Todd, James	Program Manager	CPO

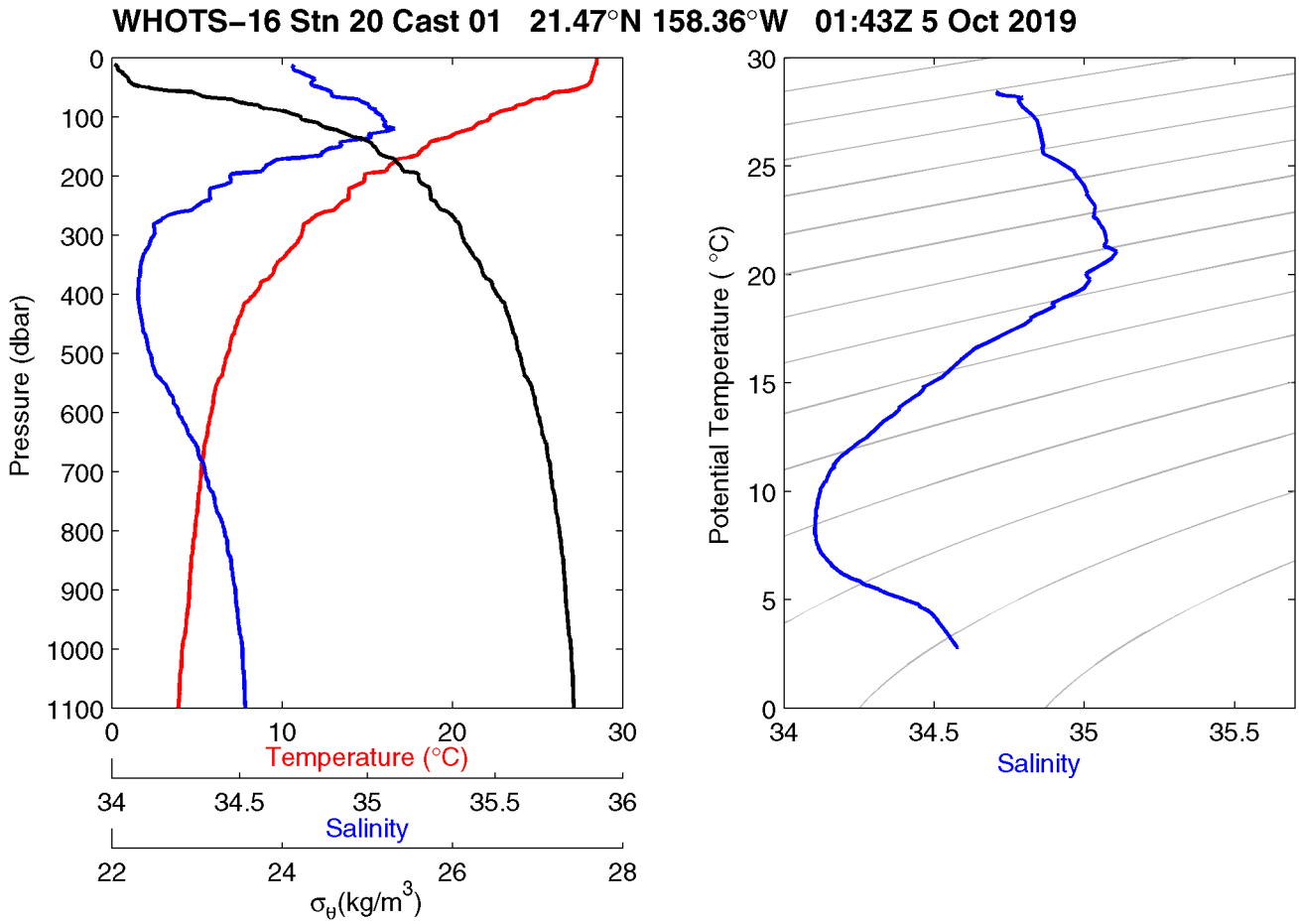
The UH group conducted the shipboard oceanographic observations during the cruise.

A Sea-Bird CTD (conductivity, temperature, and depth) system was used to measure T, S, and O2 profiles during CTD casts. The time, location, and maximum CTD pressure for each profile are listed in Table II 2. Twelve CTD casts were conducted during the

WHOTS-15 cruise. CTD profile data were collected at Station 52 (near the WHOTS-14 buoy) and Station 50 (near the WHOTS-15 buoy). A test cast was conducted at Station 20 (21°29.06'N 158°22.04'W) offshore of Makaha, HI, to an approximate depth of 1500 m to test three acoustic releases. Six CTD yo-yo casts were conducted to obtain profiles for comparison with subsurface instruments on the WHOTS-15 mooring after deployment, and five yo-yo casts were performed for comparison with the WHOTS-14 mooring before recovery. These casts were started less than 0.5 nm from the buoys with varying drift during each cast and consisted of 5 up-down cycles between near the surface and 200 m.

Table 2: CTD stations occupied during the WHOTS-15 cruise

Station/cast	**Date**	**Time UTC**	**Location (NMEA)**	**Max Pressure (dbar)**
20 / 1	09/22/2018	03:19	21° 29.06´ N, 158° 22.04´ W	1518



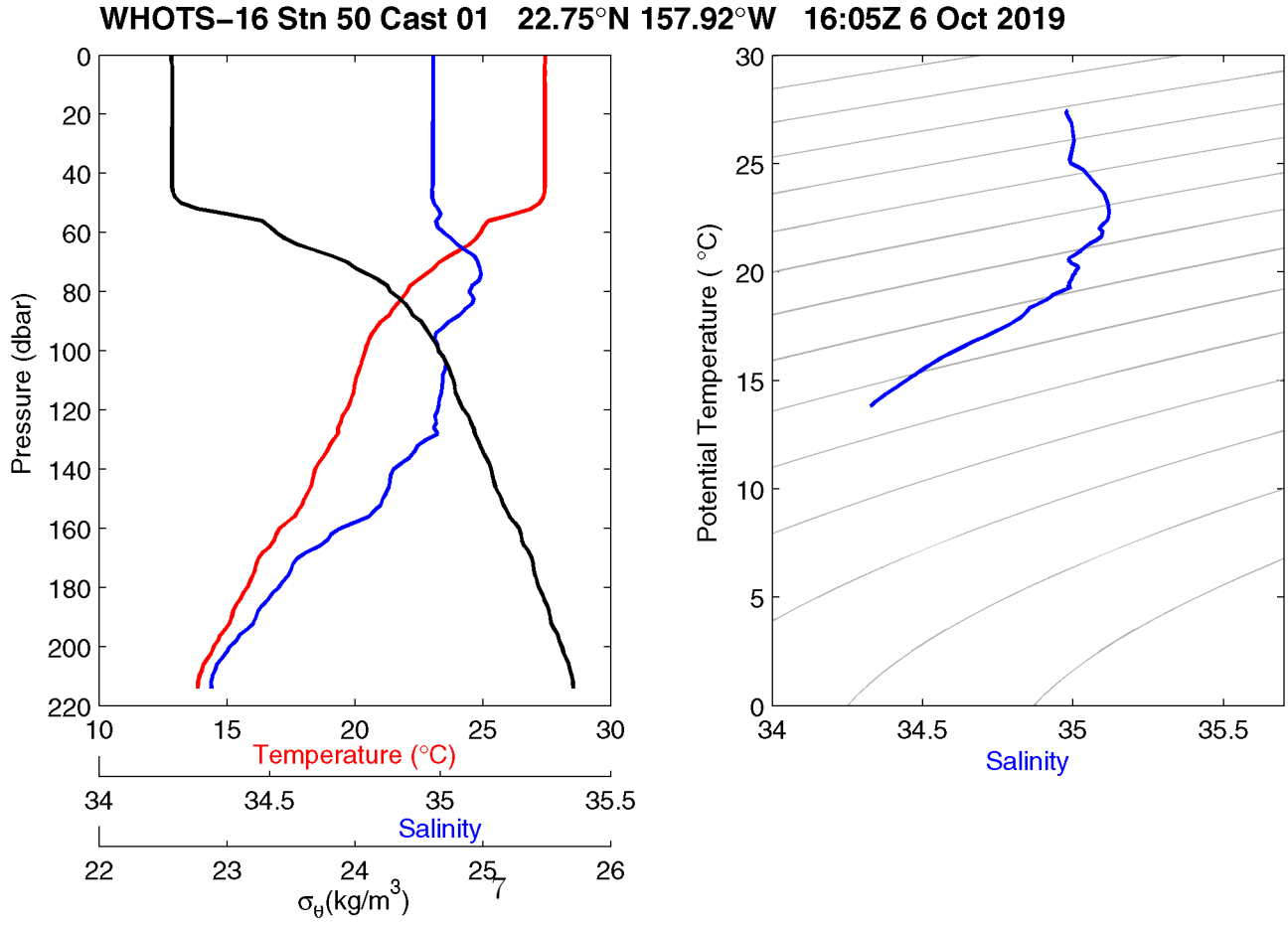


Figure 2: TEST on this one

References

References

Colbo, Keir and Robert A Weller (2009). "Accuracy of the IMET sensor package in the subtropics". In: *Journal of Atmospheric and Oceanic Technology* 26.9, pp. 1867–1890. ISSN: 1520-0426.

Hosom, David S et al. (1995). "The IMET (Improved Meteorology) ship and buoy systems". In: *Journal of Atmospheric and Oceanic Technology* 12.3, pp. 527–540. ISSN: 1520-0426.

Kara, A Birol, Peter A Rochford, and Harley E Hurlburt (2000). "Mixed layer depth variability and barrier layer formation over the North Pacific Ocean". In: *Journal of Geophysical Research: Oceans* 105.C7, pp. 16783–16801. ISSN: 0148-0227.

Plueddemann, Albert J et al. (2006). *WHOI Hawaii Ocean Timeseries Station (WHOTS) : WHOTS-2 mooring turnaround cruise report*. Tech. rep. DOI: 10.1575/1912/1074. URL: https://hdl.handle.net/1912/1074.

Santiago-Mandujano, Fernando et al. (2007). *Hydrographic Observations at the Woods Hole Oceanographic Institution (WHOI) Hawaii Ocean Timeseries (HOT) Site (WHOTS): 2004-2006*. Tech. rep. School of Ocean, Earth Science, and Technology, University of Hawaii. URL: http://uop.whoi.edu/currentprojects/WHOTS/docs/UH%7B%5C_%7DWhots%7B%5C_%7Ddata%7B%5C_%7Dreport%7B%5C_%7D1.pdf.

Whelan, Sean P et al. (2007). *WHOI Hawaii Ocean Timeseries Station (WHOTS) : WHOTS-3 mooring turnaround cruise report*. Tech. rep., p. 103. DOI: 10.1575/1912/1825. URL: https://hdl.handle.net/1912/1825.

Appendices