2009 WHOTS-6 cruise report from the PSD Flux Group

Field Program on the Research Vessel Kilo Moana

July 9 – July 17, 2009

Ludovic Bariteau, Anita D. Rapp, C. W. Fairall, Sergio Pezoa

NOAA Earth System Research Laboratory,

Cooperative Institute for Research in Environmental Sciences (CIRES)

Boulder, CO USA

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The Earth System Research Laboratory (ESRL) Physical Science Division (PSD) air-sea flux group collected surface meteorology, cloud, and rawinsonde observations during the Woods Hole Oceanographic Institute (WHOI) Hawaii Ocean Time-series Station (WHOTS) research cruise on board the University of Hawaii (UH) Research Vessel Kilo Moana. Instruments were deployed on the ship few days prior the departure date. The Kilo Moana departed from the UH Marine Center at Sand Island on 9 July 2009 and steamed to the WHOTS site at 22º 46.064' N, 157º 54.085' W for recovery of the WHOTS-5 mooring and deployment of a new mooring, WHOTS-6. The Kilo Moana returned to the UH Marine center on July 17, 2009. This report is intended to describe the various sensors used during that cruise.

1. Background on Measurement Systems

1.1. Flux system

A 30' tower was setup on the 01 deck of the portside bow of the ship (Figures 1-2). The fast turbulence system installed on the bow tower is composed of a GILL Sonic anemometer, a Li-Cor LI-7500 fast CO_2/hygrometer, and a Systron-Donner motion-pak. A mean T/RH sensor in an aspirator and an optical rain gauge were also mounted on the bow tower. To complete the PSD air-sea flux system, pyranometers and pyrgeometers (Eppley and Kipp&Zonen) were mounted on top of pole on the 03 deck. Finally, a near surface sea surface temperature sensor ('sea snake') consisting of a floating thermistor was deployed from the portside pontoon. A second sonic anemometer was also deployed on the bridge mast.

Slow mean data (T/RH, PIR/PSP, etc) are digitized on two Campbell dataloggers and transmitted via wireless as 1-minute averages. Inside the operation van (deployed on the portside pontoon of the ship, 01 deck), a central data acquisition computer logs continuously all sources of data via RS-232 digital transmission and wireless radio modem network.

1. Sonic Anemometers (two sonics)
2. Licor 7500, CO2/H2O
3. Slow means (two Campbell dataloggers)
4. Systron-Donner Motion-Pak
5. GPS
6. Heading and pitch/roll systems (two Crescent VS100)

The 10 data sources are archived at full time resolution. At sea, a set of programs are run in order to read the sonic anemometers (acquired at 10 Hz) and the mean measurement systems (sampled at 0.1 Hz and averaged to 1 min), and write daily text files at 1 min time resolution. The 1-min daily ASCII files are named as *proc_nam_DDD.txt* (nam='pc', or 'son'; DDD=yearday where 000 GMT January 1, 2009 =1.00). File structure is described in the readme accompanying these files. Further data analysis will include time matching the PSD met

data with the ship's various systems in order to create 5 and 30-min daily flux files.

Fig.1. View of the operation van deployed on 01 deck of the Kilo Moana. The bow tower can be seen on the background.

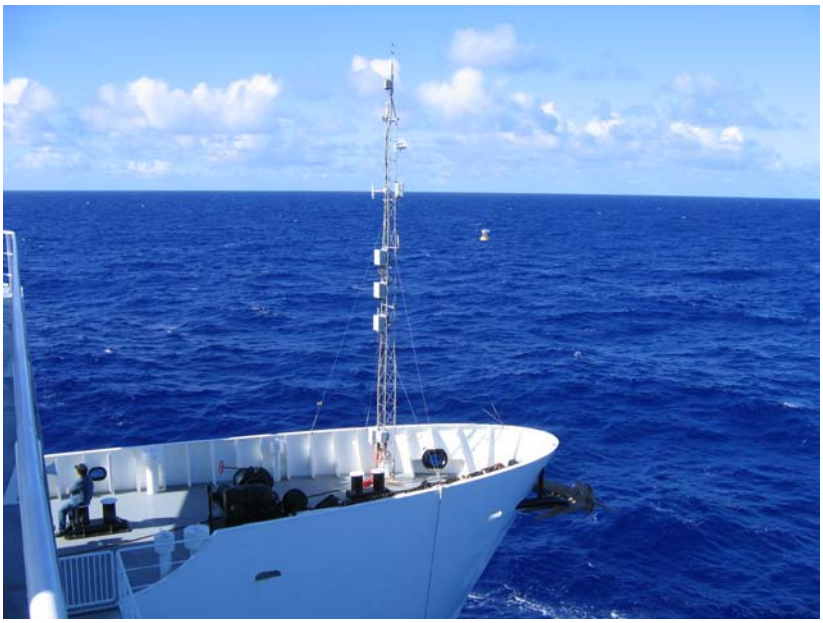

Fig.2. Flux tower deployed at the bow of the portside pontoon. The sea surface thermistor, i.e. 'sea snake', can be seen on the inboard side of the pontoon. It was moved on the outboard side later during the cruise.

1.2. CL31 cloud base ceilometers

The ceilometer is a vertically pointing lidar that determines the height of cloud bases from time-of-flight of the backscatter return from the cloud. The instrument was setup in front of the operation van on the 01 deck (Figure 3). The time resolution of the unit used during the WHOTS cruise is 30 seconds and the vertical resolution is 30 m. The raw backscatter profile and cloud base height information deduced from the instrument's internal algorithm are stored in daily files.

Fig.3. View of ceilometer and microwave radiometers at the operation van on 01 deck.

1.3. Microwave Radiometers

Two microwave radiometers (MWR) were deployed during WHOTS 2009 cruise (Figure 3). The two channel MWR (Mailbox) operates at 23.8 GHz and 31.4 GHz frequency, with a bandwidth of 0.4 GHz. The two channels allow one to retrieve water vapor (23 GHz) and liquid water path (31 GHz) estimate. A continuous automatic self-calibration developed by the Atmospheric Radiation Monitoring (ARM) program is implemented for this instrument. This

MWR was configured to get the retrievals at 90 degrees elevation angle, with a sample resolution of 48 sec. The 90 GHz MWR is another system sensitive to liquid water path. Manual tip calibrations are required with this system but were not performed during that cruise due to the lack of adequate clear sky periods.

1.4. W-band cloud radar

The PSD W-band cloud radar operated during WHOTS was installed in the operation van (Figure 4). The vertically pointing antenna is mounted on a mechanically stabilized platform to take out the pitch and roll of the ship. The cloud radar can be used to deduce profiles of cloud droplet size, number concentration, liquid water concentration, etc. and thus characterize clouds in the region. If drizzle (i.e., droplets of radius greater than about 50 μm) is present in significant amounts, then the microphysical properties of the drizzle can be obtained from the first three moments of the Doppler spectrum. Table 1 describes the characteristics of the W-band radar.

Fig.4. View of the W-band radar inside the operation van.

Application	Cloud Properties
Frequency	94.56 GHz
Peak/Avg Power	1750/6W
Antenna (beamwidth)	12 in Cassegrain (0.73 deg)
Pulse Width	167ns
Range Cell Size	25 m
Number of Range Cells	198
Range	~0.1 – 4.9 km
Velocity Resolution	12.3 cms-1
Max Radial Velocity	± 7.9 ms-1
Antenna Beam Positioner	Pitch-Roll Compensation
Pointing Directions	Vertical
Signal Processing	Average FFT, 0.33 s dwell time
Sensitivity (est)	-31 dBz (R = 2km)
Power (estimate)	120 VAC @ 8 amps

Table 1: Radar Characteristics during WHOTS 2009.

1.5. Radiosondes

44 Vaisala RS92-SGP radiosondes were launched on the WHOTS 2009 cruise starting on July 10, 06:00 UTC, and every 6 hours thereafter until July 17, 09:00 UTC. Radiosondes sample the atmosphere every 1 s and transmit observations to a Vaisala MW21 ground receiver unit (setup in Lab#1 on the main deck, Figure5). Helium gas was used to inflate the radiosonde balloons on the main deck (Figure 5). The radiosondes collect vertical profiles of temperature, relative humidity, pressure, and winds (calculated from GPS).

Fig.5. Left panel: view of the inflation site on the main deck with the Helium bottles on the 02 deck. Right panel: Vaisala radiosonde system deployed in Lab#1 of the Main deck.

2. PSD Data Cruise Archive

Selected data products were made available at the end of the cruise for the joint cruise archive. Further analysis will be done in order create the 5-min and 30-min daily flux files. After post processing, direct covariance, inertial-dissipation and bulk turbulent flux will be produced at 10 min and hourly average. This will include mainly momentum, sensible and latent heat fluxes. All data for this project will be put on an ftp site back in Boulder.

For access to the FTP site:

ftp voodoo.etl.noaa.gov

username anonymous

password (email address)

cd et6/cruises/ WHOTS_2009

3. Contact

Ludovic Bariteau / Anita D. Rapp / C. W. Fairall / Sergio Pezoa

NOAA Earth System Research Laboratory

325 Broadway

Boulder, CO USA 80305

303-497-4482 Ludovic.Bariteau@noaa.gov

303-497-4817 Anita.D.Rapp@noaa.gov

303-497-3253 Chris.Fairall@noaa.gov

303-497-6441 Sergio.Pezoa@noaa.gov