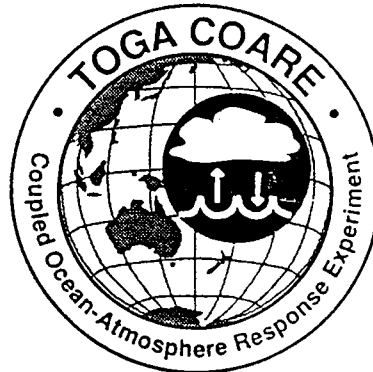


Technical Report

May 1993



**TOGA COARE Mooring Deployment,  
Mooring Check-out and Mooring Recovery Cruises**

*R/V Wecoma* 7 October – 1 November 1992

*R/V Le Noroit* 2 December – 15 December 1992

*R/V Wecoma* 27 February – 11 March 1993

A.J. Plueddemann

R.P. Trask

W.M. Ostrom

R.A. Weller

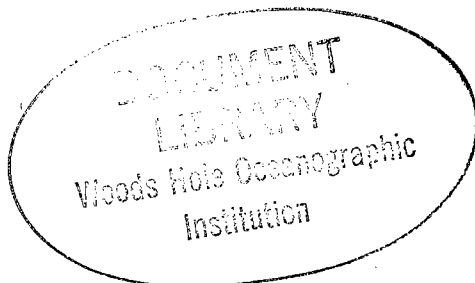
B.S. Way

S. Anderson

N. Bogue

J. Shillingford

S. Hill



**Upper Ocean Processes Group  
UOP Technical Report 93-5**

**WHOI-93-30  
UOP Report 93-5**

**TOGA COARE Mooring Deployment,  
Mooring Check-out and Mooring Recovery Cruises**

**R/V *Wecoma* 7 October – 1 November 1992  
R/V *Le Noirt* 2 December – 15 December 1992  
R/V *Wecoma* 27 February – 11 March 1993**

A.J. Plueddemann  
R.P. Trask  
W.M. Ostrom  
R.A. Weller  
B.S. Way  
S. Anderson  
N. Bogue  
J. Shillingford  
S. Hill



**Upper Ocean Processes Group**  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts 02543

May 1993

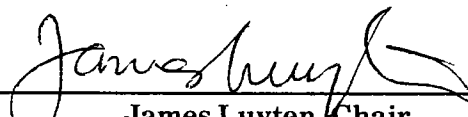
**Technical Report**

Funding provided by the National Science Foundation under grants OCE-9110554 and OCE-9110559.

Reproduction in whole or in part is permitted for any purpose of the United States Government. This report should be cited as:  
Woods Hole Oceanog. Inst. Tech. Rept., WHOI-93-30.

Approved for publication; distribution unlimited.

**Approved for Distribution:**

  
\_\_\_\_\_  
**James Luyten, Chair**  
Department of Physical Oceanography



## **Abstract**

The Tropical Ocean - Global Atmosphere Coupled Ocean - Atmosphere Response Experiment (TOGA COARE) was conceived in order to improve understanding of the principal processes responsible for coupling of the ocean and atmosphere in the western Pacific warm pool region. Field work for TOGA COARE was concentrated in an Intensive Flux Array (IFA) and included a variety of atmospheric and oceanic platforms. The Upper Ocean Processes Group (UOPG) was involved in TOGA COARE through the preparation, deployment, and recovery of a heavily instrumented surface mooring for the observation of air-sea fluxes and oceanic temperature, salinity, and currents in the upper 300 m. The mooring was deployed at 1<sup>o</sup>, 45.27' S, 155<sup>o</sup>, 59.73 E on 21 October 1992 in 1744 m of water. An instrument check-out cruise was undertaken in December of 1992 in order to evaluate the meteorological systems on the buoy. The mooring was recovered on 4 March 1993. This report describes mooring deployment operations, the instrument check-out cruise, and the mooring recovery. UOPG personnel also assisted with the deployment and recovery of five other moorings as a part of the COARE IFA and these operations are discussed.

## Table of Contents

	page
List of Figures	3
List of Tables	4
<b>Part 1: Mooring Deployment Cruise - R/V Wecoma WE92-10A</b>	
Section 1-1: Introduction	5
Section 1-2: Preparations	8
Section 1-3: Transit Leg	12
Section 1-4: Mooring Deployments	12
References	24
Acknowledgments	24
Appendix 1-1: Personnel	25
<b>Part 2: Mooring Check-out Cruise - R/V Le Noroit</b>	
Section 2-1: Introduction	26
Section 2-2: Mooring Work	26
Addendum	28
Acknowledgments	28
<b>Part 3: Mooring Recovery Cruise - R/V Wecoma WE93-02A</b>	
Section 3-1: Introduction - R. Weller	29
Section 3-2: The Mooring Program	32
A. UOP mooring - W. Ostrom	32
B. PCM array - N. Bogue and J. Shillingford	34
C. ELSI mooring - S. Hill	37
Section 3-3: Instruments and Sensors - B. Way, S. Anderson and S. Hill	38
Section 3-4: Wecoma - manual met sensor intercomparison - S. Anderson	42
Section 3-5: VAWR - Wecoma sensor intercomparison - S. Anderson	42
Section 3-6: CTD Survey - N. Bogue	49
References	49
Acknowledgments	49
Appendix 3-1: Personnel	50

## List of Figures

	page
<b>Part 1. Deployment</b>	
Figure 1-1. Mooring Array	6
Figure 1-2. TOGA COARE IFA	7
Figure 1-3a. UOP Mooring Schematic	9
Figure 1-3b. Upper 25 m UOP Mooring Schematic	10
Figure 1-4. ELSI Mooring Schematic	11
Figure 1-5a-j. Meteorological Comparison	14
Figure 1-6. ELSI Steve Hill drawing	21
Figure 1-7. Anchor position for UOP Mooring	22
Figure 1-8. Anchor position for ELSI Mooring	23
<b>Part 3. Recovery</b>	
Figure 3-1. Cruise Track and Mooring Array	30
Figure 3-2. Recovered IFA Moorings	31
Figure 3-3. Discus Deck Bail Configuration	33
Figure 3-4. PCM Schematic	35
Figure 3-5a-e. Manual - shipboard Meteorological Comparison	43
Figure 3-6a-f. VAWR-Shipboard Meteorological Comparison	46

## **List of Tables**

	<b>page</b>
<b>Part 1. Deployment</b>	
Table 1-1. Sensor table for UOP Mooring	19
<b>Part 3. Recovery</b>	
Table 3-1. IFA Mooring Positions	31
Table 3-2. Subsurface Instrumentation	40

# **Part 1: TOGA COARE Mooring Deployment R/V Wecoma Cruise Report WE92-10A**

## **Section 1-1: Introduction**

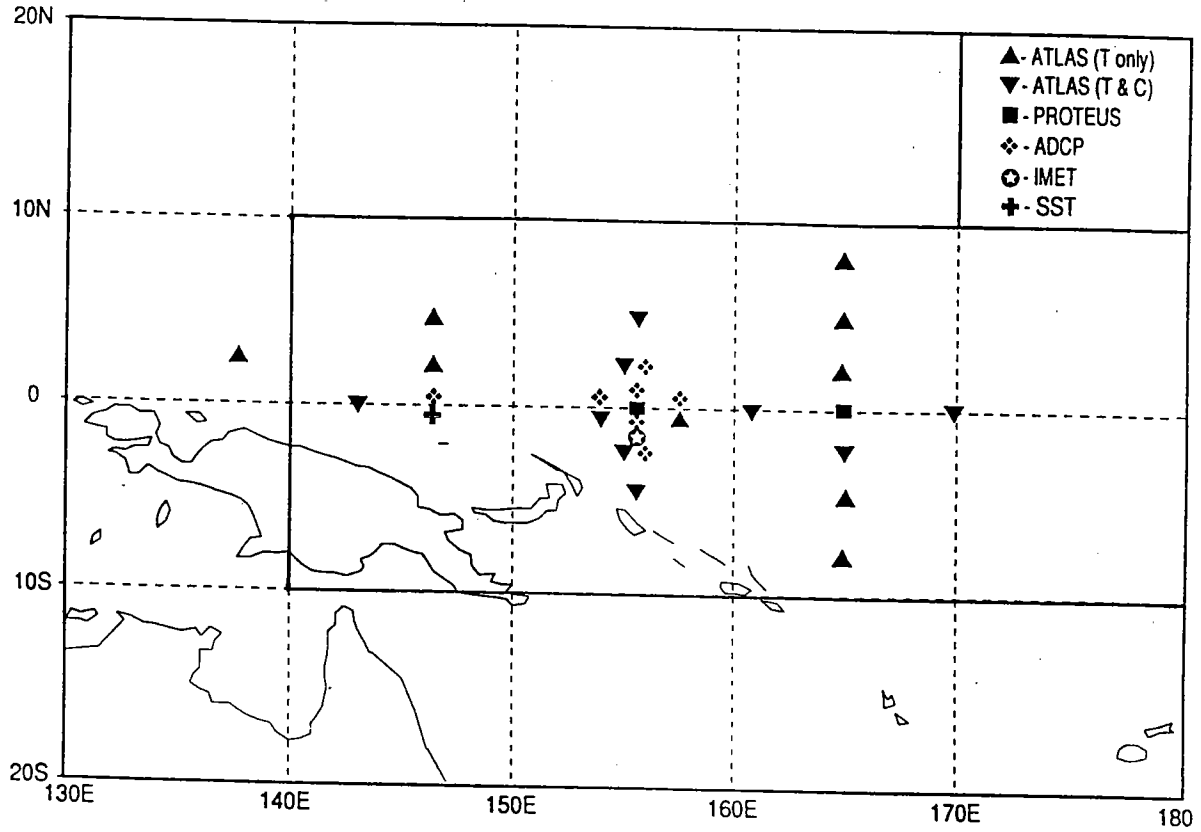
During evaluation of the progress in the Tropical Ocean - Global Atmosphere (TOGA) program, it became clear that the complexity of the coupled ocean-atmosphere system in the western Pacific warm pool region warranted further study. The Coupled Ocean - Atmosphere Response Experiment (COARE) was designed to fill this need. The principal scientific objective of COARE was to improve understanding of the processes responsible for coupling of the ocean and atmosphere in the warm pool region (WCRP, 1990). Field work for TOGA COARE included a variety of atmospheric and oceanic measurement platforms in the COARE domain (figure 1-1). The methodology for the experiment was to concentrate the measurements in an Intensive Flux Array (IFA; figure 1-2) which was intended to produce a high quality heat, moisture, and momentum flux data set for the ocean-atmosphere system. A thorough discussion of scientific motivation and experimental design of COARE is given by Webster and Lucas (1992). Many more details on experimental logistics and implementation are given in the TOGA COARE Operations Plan (TCIPO, 1992)

The Upper Ocean Processes Group (UOPG) was involved in TOGA COARE through the preparation, deployment, and recovery of a heavily instrumented surface mooring in the IFA for the observation of surface meteorology and oceanic temperature, salinity, and currents. The goal of the project was to make high quality observations of the air-sea fluxes and detailed measurements of the temporal evolution of the vertical structure of the upper 300 m of the ocean. The measurements from the UOP surface mooring were complemented by sub-surface measurements from five other moorings within the IFA, and UOPG personnel assisted in the preparation and deployment of these moorings. The goals of the analysis effort will be to develop an improved understanding of the role of the air-sea fluxes and near-surface oceanic processes in determining the sea-surface temperature and vertical structure of the warm pool. Of particular interest is the oceanic response to atmospheric forcing events ranging in scale from small (5-50 km) convective elements to westerly wind bursts (1500 km zonal and 500 km meridional).

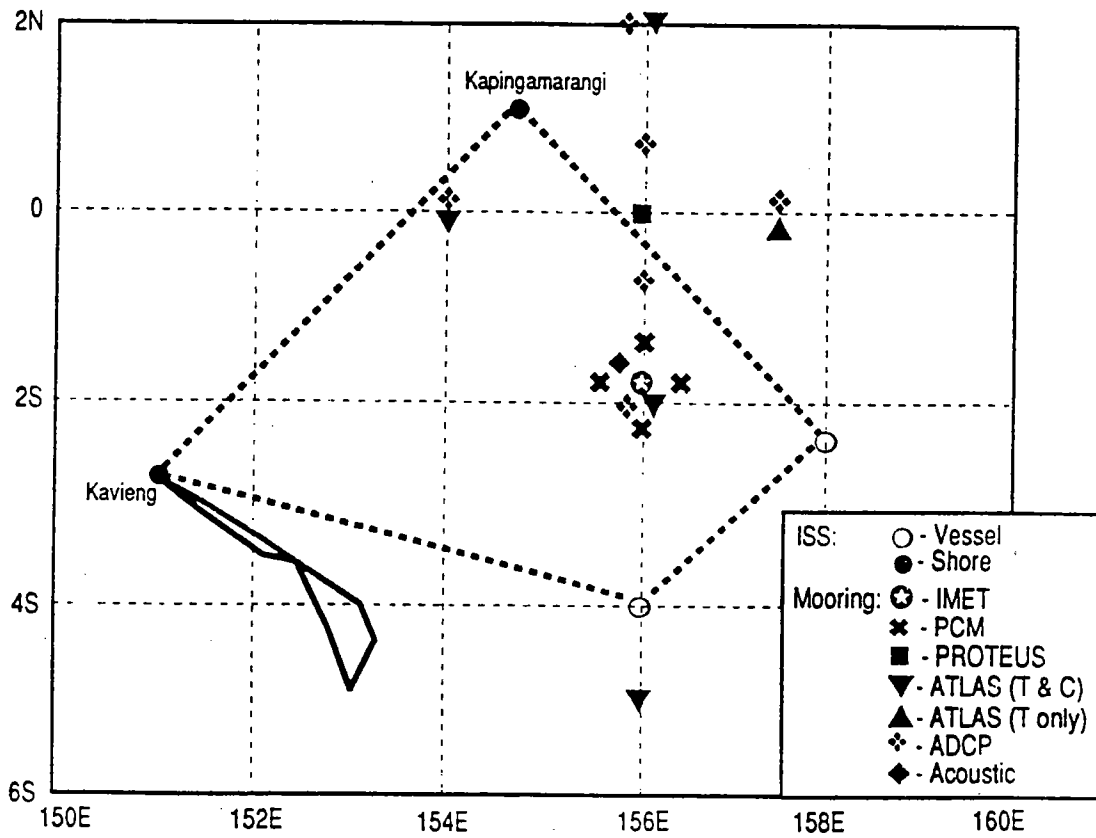
The purpose of the cruise aboard the R/V Wecoma was the deployment of six moorings in the COARE IFA. The deployment cruise was initiated from Honolulu, Hawaii on 7 October 1992, made a brief port call in Pohnpei to take on scientific personnel, and continued on to the IFA site for mooring operations. The Wecoma sailed for Guam upon completion of the mooring deployments on 27 October, arriving there on 1 November. The science party for the first leg of the cruise consisted of four people from the Woods Hole Oceanographic Institution (WHOI) with A. Plueddemann as Chief Scientist. The second leg of the cruise was conducted jointly with the University of Washington (UW). A party of five from UW joined the ship in Pohnpei, with C. Eriksen serving as Co-Chief Scientist. Also joining the ship in Pohnpei was a party of two from the Institute of Ocean Sciences (IOS), B.C., Canada, representing the interests of D. Farmer.



**Figure 1-1. Moorings in COARE Domain**



**Figure 1-2. Mooring Array in COARE IFA**



## Section 1-2: Preparations

The tasks to be accomplished on this cruise were the deployment of six moorings: A meteorological and oceanographic surface mooring developed by the UOPG (denoted the WHOI-UOP mooring, figure 1-3a,b), a subsurface mooring containing an acoustics instrument known as ELSI developed by Farmer (figure 1-4), and four subsurface Profiling Current Meter (PCM) moorings developed by Eriksen. This report is principally concerned with the activities of the contingent from WHOI who were responsible for the deployment of the UOP mooring and ELSI.

The advance party from WHOI (Simoneau, Bouchard, Grant) arrived in Honolulu on 26 September followed two days later by the remainder of the group (Plueddemann, Allsup). A total of 11 days were spent in Honolulu engaged in cruise preparation. Accomplished during this time were:

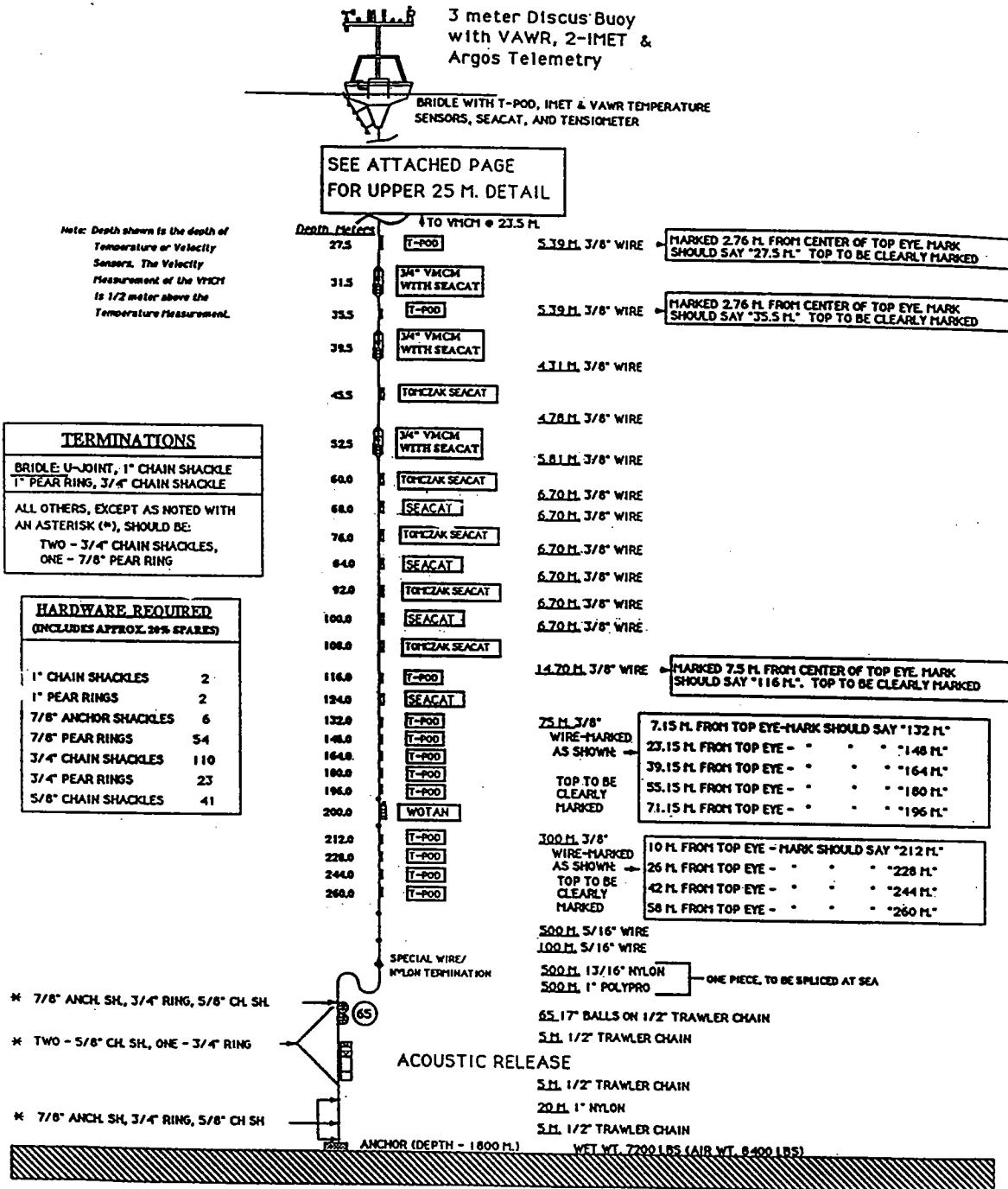
- construction of the UOP buoy tower
- installation of VAWR and IMET sensors on the tower
- buoy spin
- preparation of 9 VMCMs including compass spins
- preparation of 13 WHOI Seacats
- acquisition of 5 Tomczak Seacats
- 3 releases checked
- near-surface Brancker string assembled
- tensiometer checked
- Edson sonic anemometer mounted on Wecoma
- Wecoma deck and lab loaded

A series of tests were performed comparing handheld meteorological observations to those of VAWR and IMET. Both Argos data and IMET optical disk data were processed and plotted for various test periods. At one point these comparisons showed that the IMET longwave (LW) radiation was consistently  $50 \text{ W/m}^2$  higher than that of the VAWR. Some discussion with Woods Hole was initiated with regard to possible Argos contamination, but it was finally argued that the spare IMET LW should be tried. The original sensor was replaced with the spare on 6 October, and from that point on the IMET and VAWR LW values agreed to within  $5\text{-}10 \text{ W/m}^2$ . All other met comparisons indicated properly functioning sensors.

A series of minor difficulties were encountered during the mechanical preparation of the buoy tower. Much of the hardware supplied seemed inappropriate, necessitating many trips to the local hardware store. Some of the construction details had to be modified. The mounts for the solar panel above the buoy pick-up point were found broken upon arrival. Both mounts were re-constructed using a heavier gauge bracket.

One VMCM (S/N 051) had a problem writing a tape during an overnight test. The tape transport in this instrument was replaced with a spare, and no more problems were encountered. One WHOI Seacat (S/N 927) would not respond to RS232 interrogation by the computer. It was later found that one of the chips in the electronics board had worked loose. Another Seacat (S/N 995) did not have the battery pack modification. It was decided to deploy the instrument with the factory battery pack installation. The tensiometer did not register properly upon initial connection to the buoy. It was later found that the connector for the tensiometer cable in side the LOPACS was bad. This was repaired and the tensiometer performed as expected.

Figure 1-3a. UOP Mooring Schematic



**TERMINATIONS**

BRIDLE U-JOINT, 1" CHAIN SHACKLE  
1" PEAR RING, 3/4" CHAIN SHACKLE

ALL OTHERS, EXCEPT AS NOTED WITH AN ASTERISK (\*), SHOULD BE:  
TWO - 3/4" CHAIN SHACKLES,  
ONE - 7/8" PEAR RING

**HARDWARE REQUIRED**  
(INCLUDES APPROX. 20% SPARES)

1" CHAIN SHACKLES	2
1" PEAR RINGS	2
7/8" ANCHOR SHACKLES	6
7/8" PEAR RINGS	54
3/4" CHAIN SHACKLES	110
3/4" PEAR RINGS	23
5/8" CHAIN SHACKLES	41

- \* 7/8" ANCH. SH, 3/4" RING, 5/8" CH SH
- \* TWO - 5/8" CH SH, ONE - 3/4" RING
- \* 7/8" ANCH. SH, 3/4" RING, 5/8" CH SH

TOGA / COARE  
W.H.O.I. DISCUS MOORING

Upper Ocean Processes  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts USA 02543  
(508) 548-1400 x 2508

G. TUPPER 14 MAY 92  
1ST REVISION 29 JUN 92

Figure 1-3b. UOP Mooring Upper 25 m Schematic

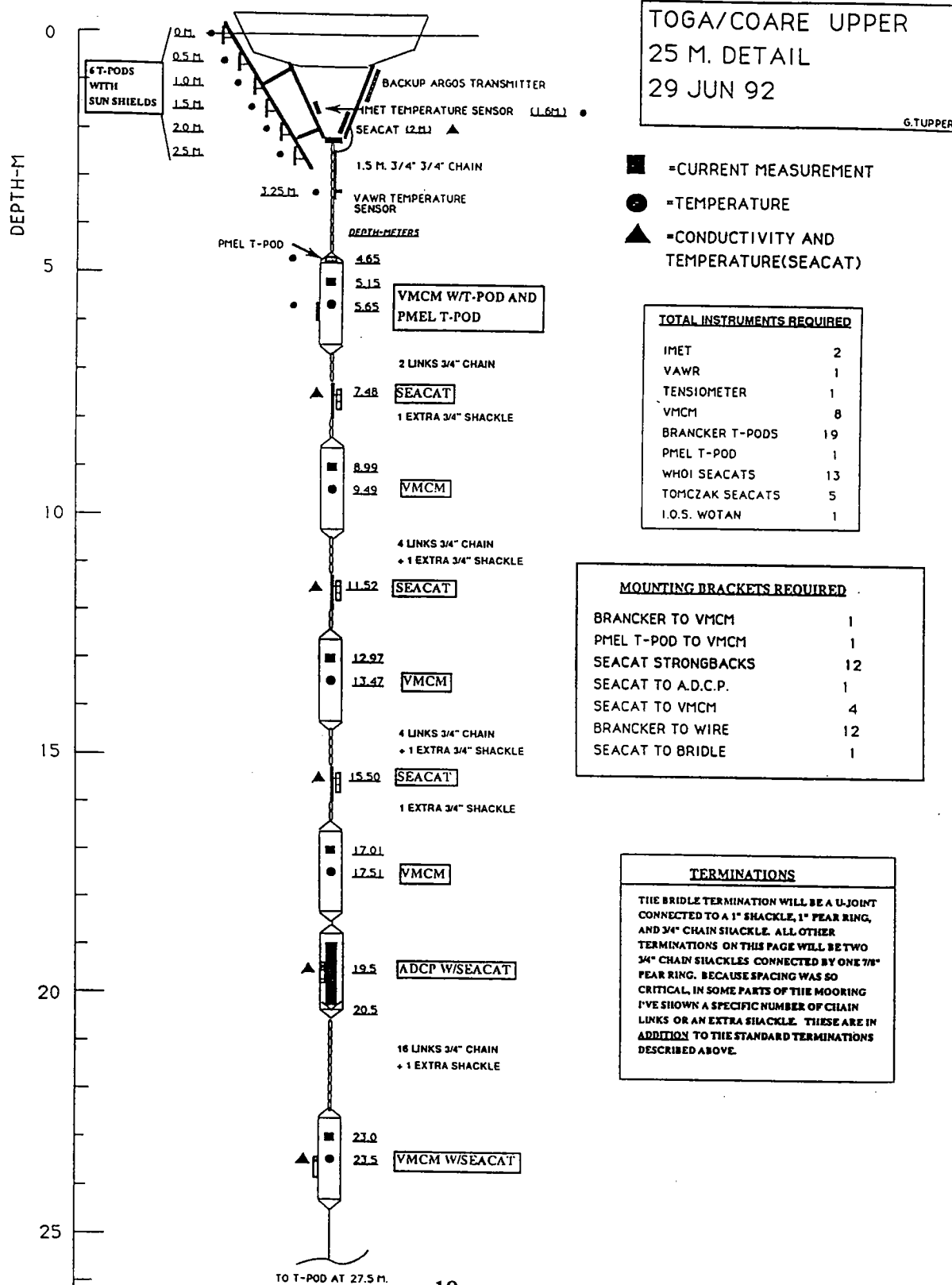
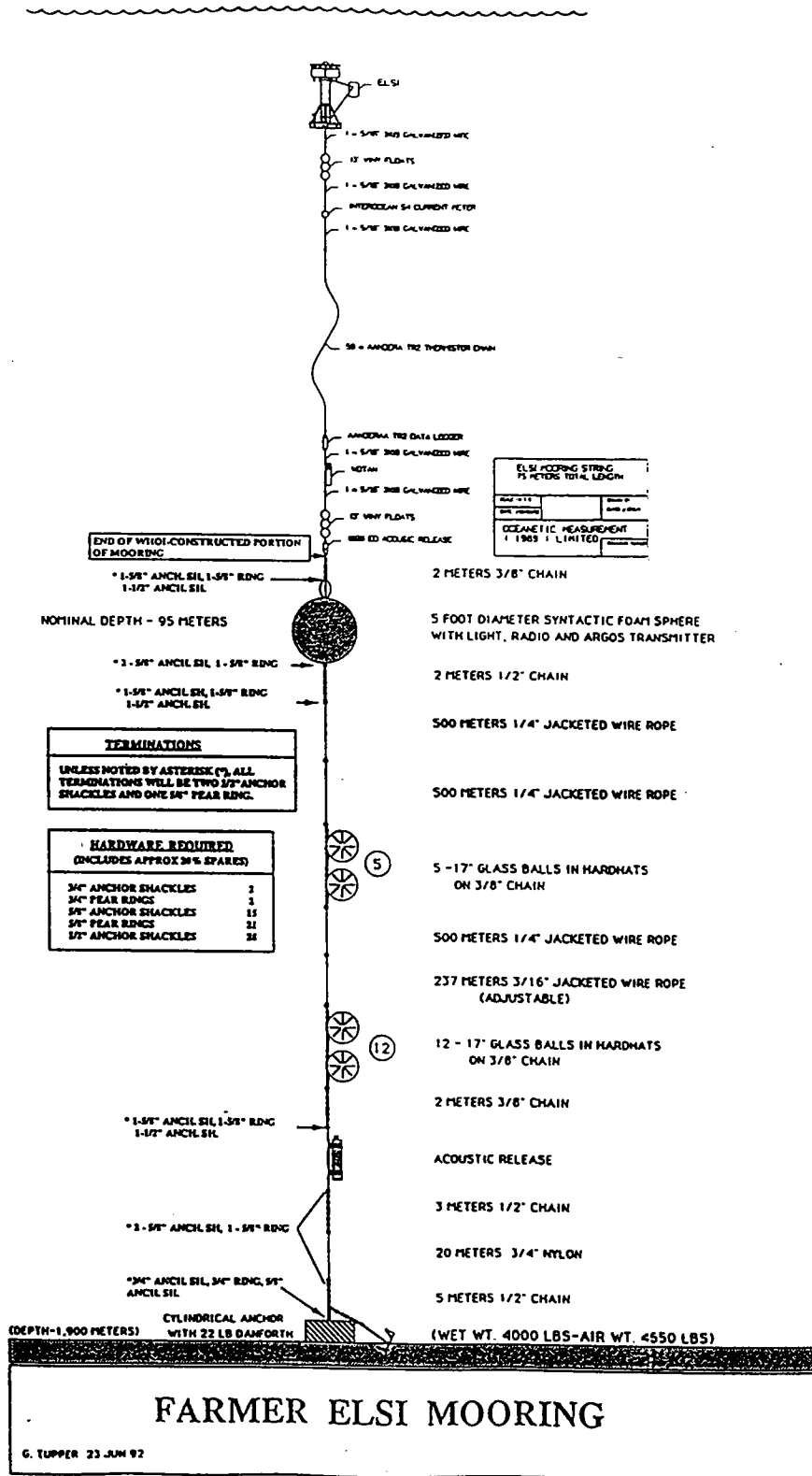


Figure 1-4. ELSI Mooring Schematic



FARMER ELSI MOORING

G. TUPPER 23 JUN 92

Problems with two of the AMF acoustic releases necessitated an emergency shipment of spares from WHOI. The first release would transpond, but would not shut off when put into time-ping mode. The second would not respond at all in any mode. The spare units, BACS releases from Scott Worriow's lab, arrived at approximately 5 AM on the morning of our scheduled departure after difficulty getting transferred from San Francisco onto a flight to Honolulu. Without the efforts of G. Tupper and K. Adams these would not have arrived in time and the departure would have been delayed.

### **Section 1-3: Transit Leg**

The R/V Wecoma, operated by Oregon State University, arrived in Honolulu on schedule, the morning of 3 October. By 7 October, she was loaded and ready for departure. The deck load was near capacity, and difficulties were encountered attempting to fit the 3-meter discus buoy (the last item aboard) on deck. It became clear at this time that the deck load would have to be rearranged and that a new methodology would have to be worked out in order to lift the buoy safely. Wecoma sailed for Pohnpei on 7 October with Plueddemann, Simoneau, Grant, and Bouchard aboard. Allsup returned to Woods Hole from Honolulu.

During the transit leg, instrument preparation was completed, including the remaining 14 Branckers, the ADCP, and three BACS releases. The broken Seacat was fixed by refitting one of the chips to the electronics board. The sonic anemometer electronics was set up and logging started. It was noticed that the high frequency shuddering of the ship while underway was causing substantial "shaking" of the buoy tower. The R.M Young wind sensors were removed and the VAWR vane blocked in order to minimize possible wear on the moving parts. An interesting quirk was discovered in the IMET system by Butch. If the UTC "midnight reset" of LOPACS occurs during a period when the aspirators are on, they will come back on line in off position. Thus it will take at least 10 min (10 counts of SW > 150) before they will turn on again. Trickle charging was done during most of the transit to keep the IMET battery pack fully charged.

Instrument work was nearly complete by 13 October, and a 24 hr met watch was started in order to independently monitor the met sensors and to develop confidence (or lack of same) in ship's sensors. Wecoma was outfitted with only minimal meteorological instruments, since the "special" met package had not been requested for our cruise. We found the only useful information from the ship to be GPS position, wind speed and direction, and barometric pressure. Handheld instruments were used to provide the remaining observations (air temperature, sea surface temperature, and relative humidity). From this monitoring several problems were found: Failure of the secondary IMET system due to a cracked stuffing tube nut, erroneous values from the VAWR relative humidity sensor due to water in the endcap (Paul suggests that this resulted from the sensor being "upside down" from its typical installation), and failure of the secondary IMET wind sensor due to a shorted pin. The stuffing tube nut and shorted wind sensor pin were fixed while underway. The VAWR RH sensor was replaced with the spare.

### **Section 1-4: Mooring Deployments**

Upon arrival in Pohnpei on 17 October, we met up with the remainder of the scientific party. Joining the ship were Charlie Eriksen, Neil Bogue, Bob Reid, Carmen Martorella, and Chaz Wichman from UW, and Steve Hill and Don Lapishov from IOS. The morning of the next day, still in Pohnpei, we re-arranged the deck load, attached the

bridle leg to the IMET buoy and took the opportunity to test the stability of the buoy during pick-up with the crane. Lifting from the designated pick-up point resulted in the buoy nearly falling over onto the sensor tower. It was determined that a special sling would be needed to make the crane lift safe and manageable, and that this sling would stay on the buoy after deployment, to be recovered via a small boat operation later. We departed Pohnpei 18 October without incident.

Three days of steaming brought us to the COARE IFA region. The UOP buoy was the first to go in, but we were worried by strong winds and rough seas the day and night before the scheduled deployment on 21 October. These conditions were the result of a succession of tropical storms, some strong enough to be typhoons, passing to the north of our position. The morning of the deployment showed some moderation of conditions, and we decided to proceed. We were very concerned with the methodology of attaching the VAWR temperature sensor on the chain between the bridle and the first VMCM and rigged up a mount which would allow the sensor to remain on the bridle if attachment to the chain was not feasible. The buoy was lifted from the (very crowded) fantail and over the starboard rail without incident, at which time the VAWR temp sensor was attached to the chain while the 4000 lb buoy took several large swings over David and Paul, held only by the release hook and tag lines. After this tense moment, the remainder of the deployment went relatively smoothly, finishing by about 1500 local.

Four hours of intensive (15 minute interval) meteorological observations were done immediately following the deployment as well as a CTD cast to 300 m. The shipboard and handheld met observations agreed well with both IMET and VAWR sensors on the buoy (figure 1-5a-j). Conditions of heavy rain during the observation period made independent of air temp and relative humidity difficult, and may have resulted in strong near-surface temperature gradients. A possible processing problem with the IMET barometric pressure was brought to light (figure 1-5f), but not considered serious. It was decided that it would be necessary to re-survey the ELSI site since the deployment was very depth-sensitive. This, in addition to general exhaustion, left no window for the IMET anchor survey, which we postponed until later. A compilation of sensors on the mooring was made (table 1-1) and forwarded to WHOI for use in securing insurance.

After a follow-up survey of the ELSI mooring site during the night, we began deployment of the mooring on 22 October. Steve Hill provided a new drawing of the upper portion of the mooring (figure 1-6), and indicated that the target depth for ELSI should be 25 m, not 20 m. The expected water depth was 2078 m, and the mooring length was adjusted accordingly. Some difficulties were encountered in setting the upper portion of the mooring due to lengths which could not be wound on the winch and could not be stopped off. The remainder of the deployment went smoothly. Pressures to survey the PCM sites meant foregoing the anchor survey. No CTD cast was done at this time.

Following the ELSI deployment on 22 October, four PCM moorings were set on four successive days. The weather was better, and these deployments went mostly without incident. After each PCM deployment, the anchors were surveyed, and a CTD cast was done at the time of the first PCM profile. During the transit from the East to North PCM sites, we stopped at the IMET site and completed the anchor survey (figure 1-7). After the last (West) PCM was deployed, we moved to the ELSI site, completed the anchor survey there (figure 1-8), and made a CTD cast.



**Figure 1-5a,b. VAWR, IMET, ship and GTS sensor comparison  
wind speed and direction**

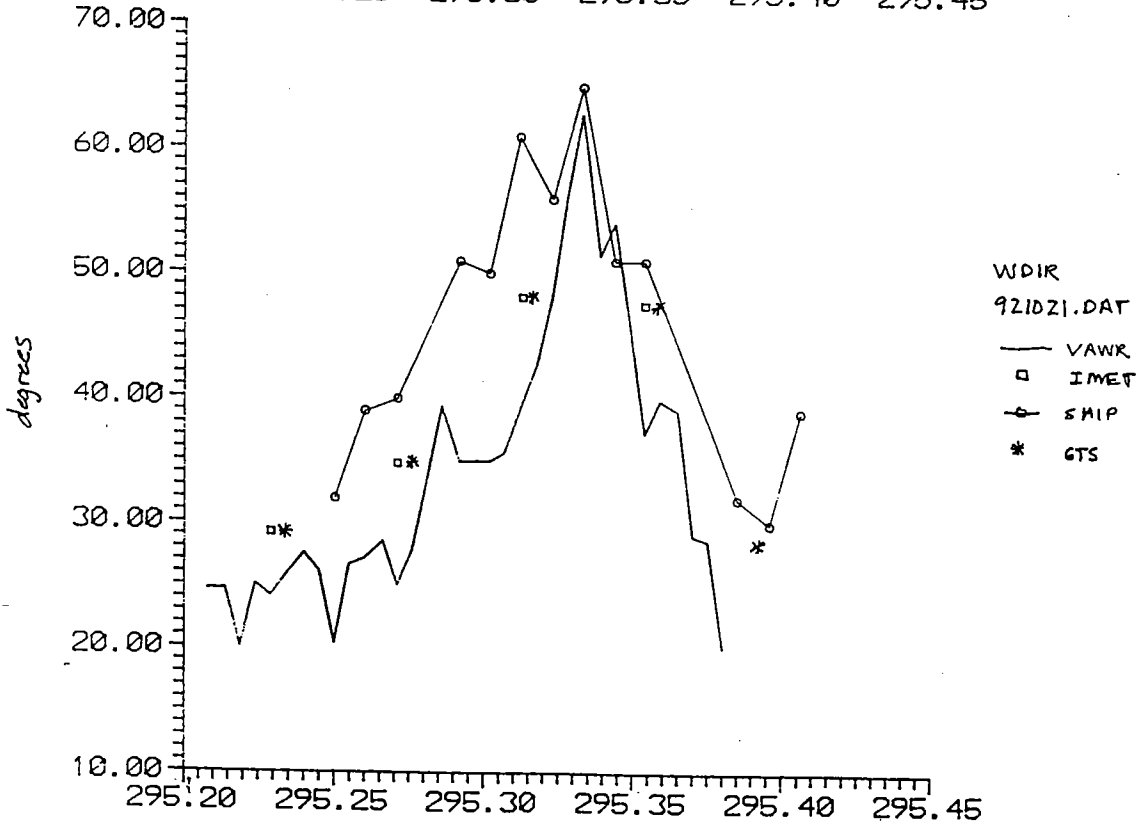
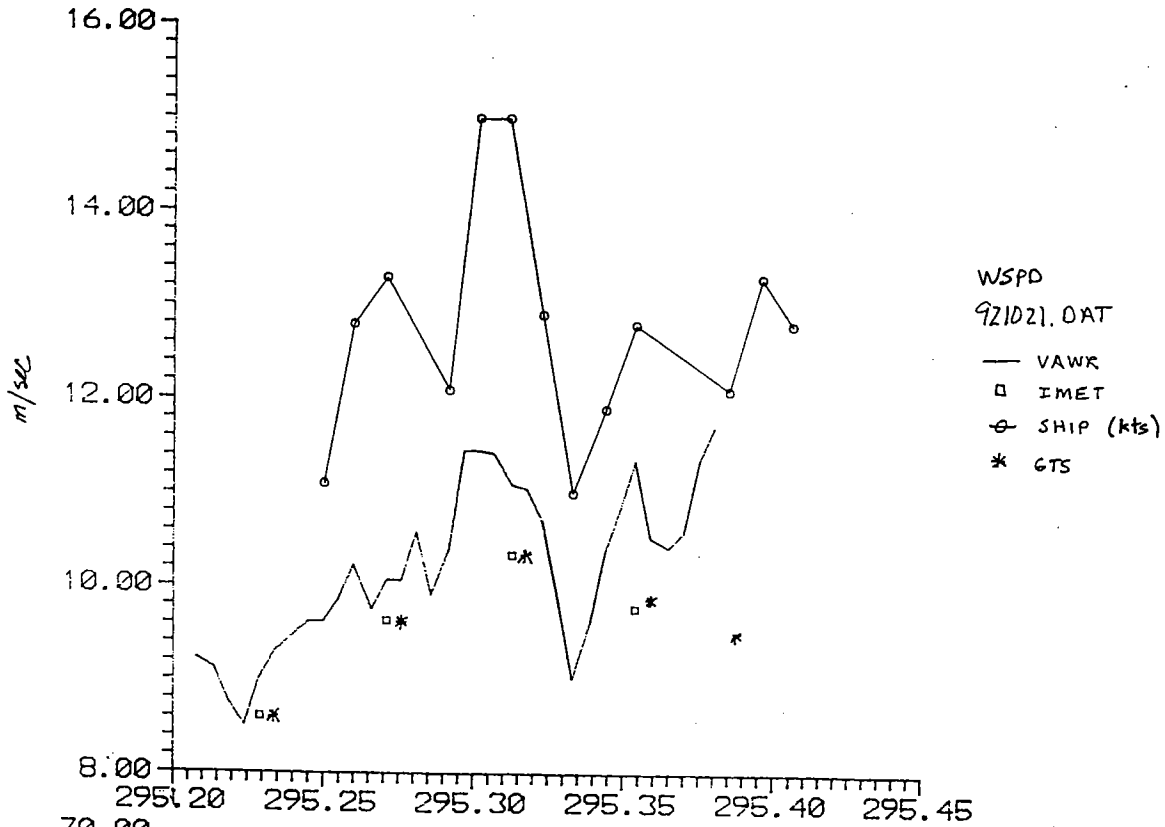
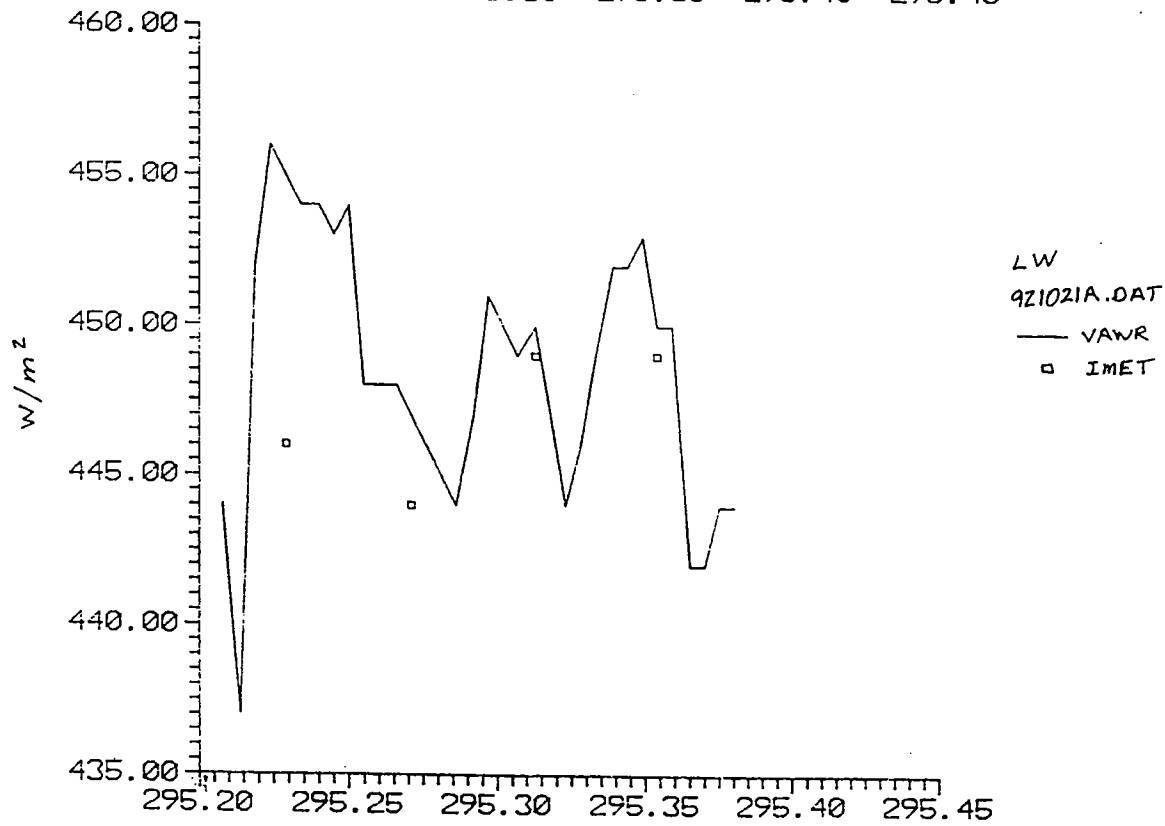
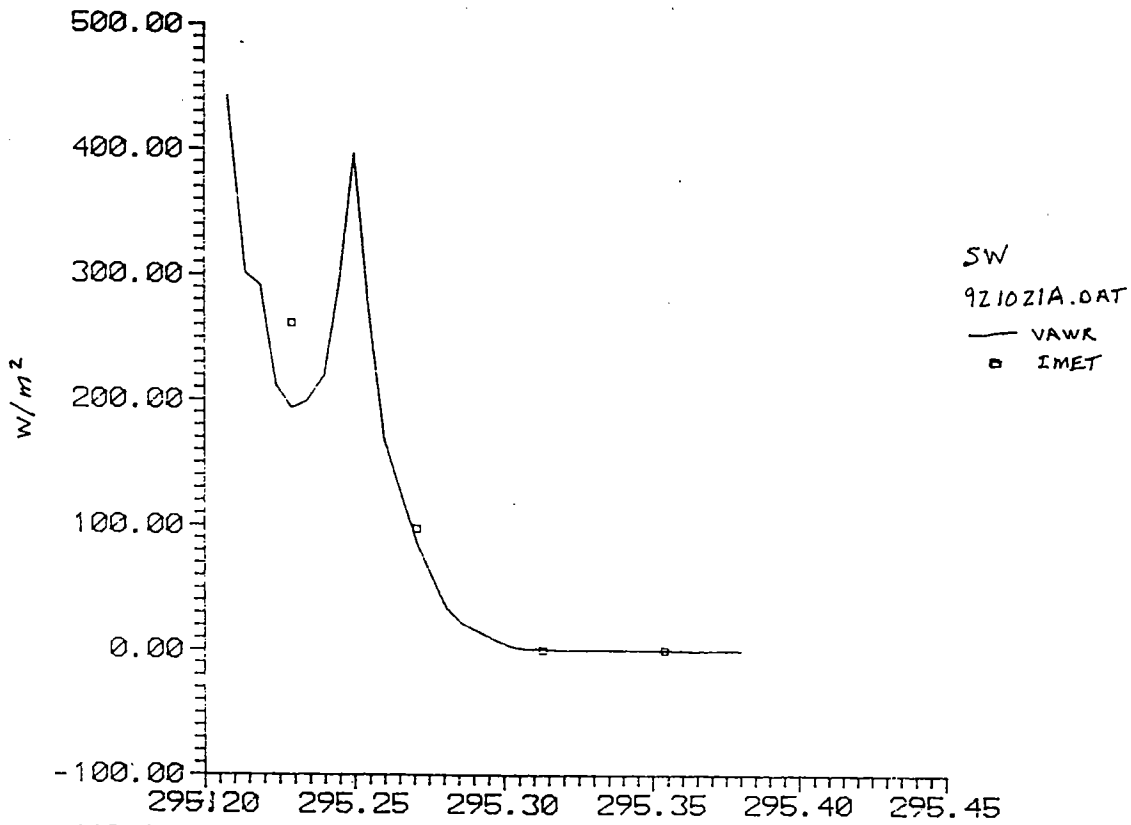


Figure 1-5c,d. VAWR, IMET, ship and GTS sensor comparison  
shortwave and longwave



**Figure 1-5e,f. VAWR, IMET, ship and GTS sensor comparison  
relative humidity and barometric pressure**

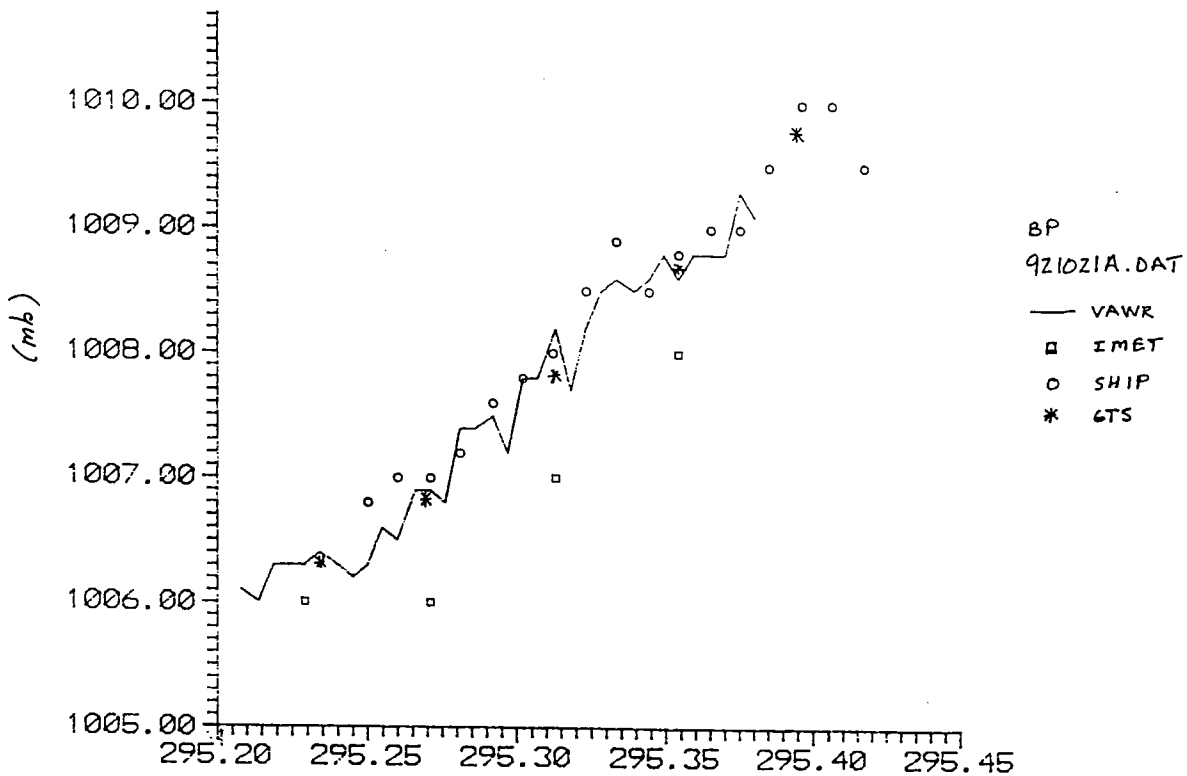
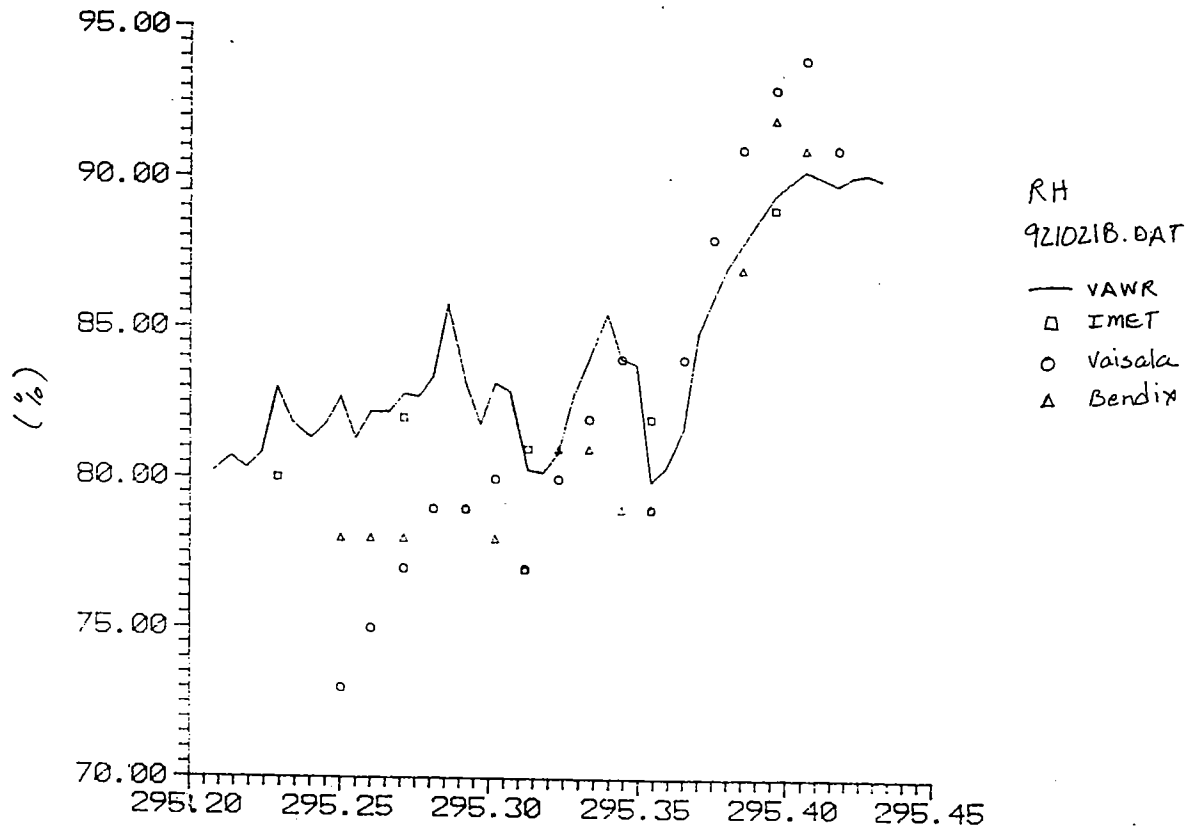


Figure 1-5g,h. VAWR, IMET, ship and GTS sensor comparison  
sea temperature and air temperature

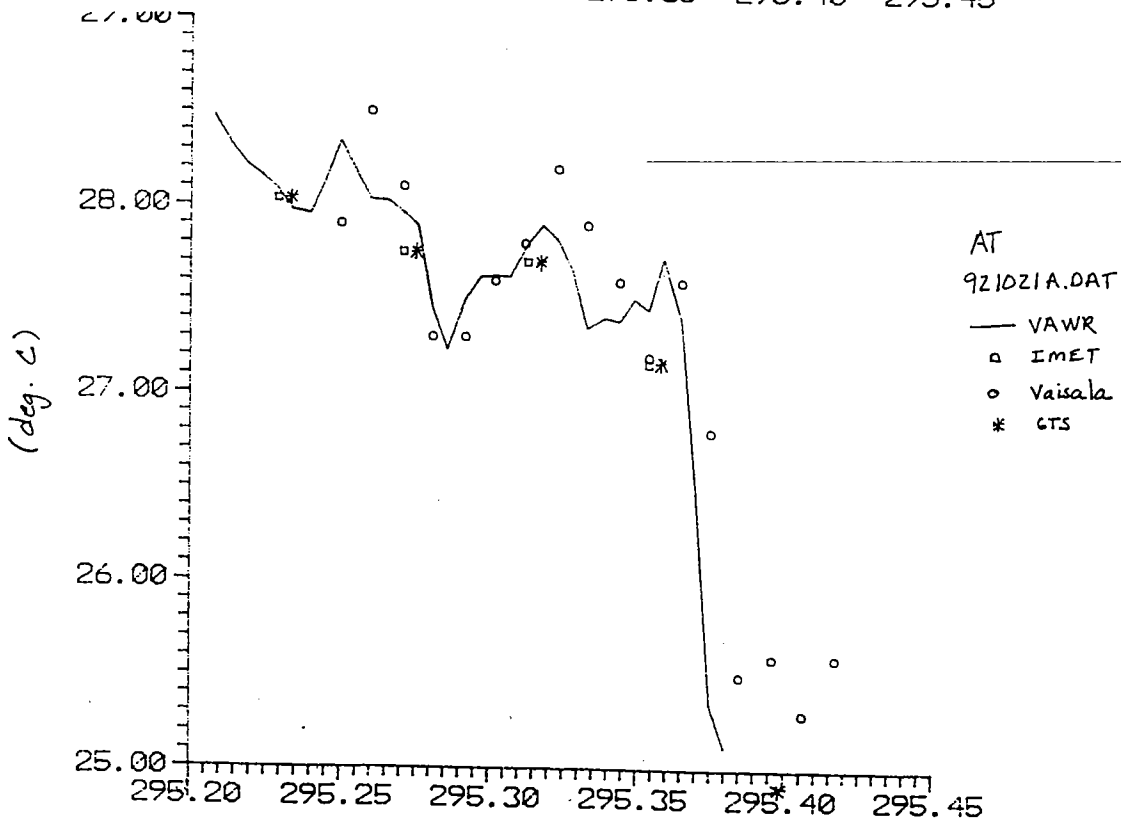
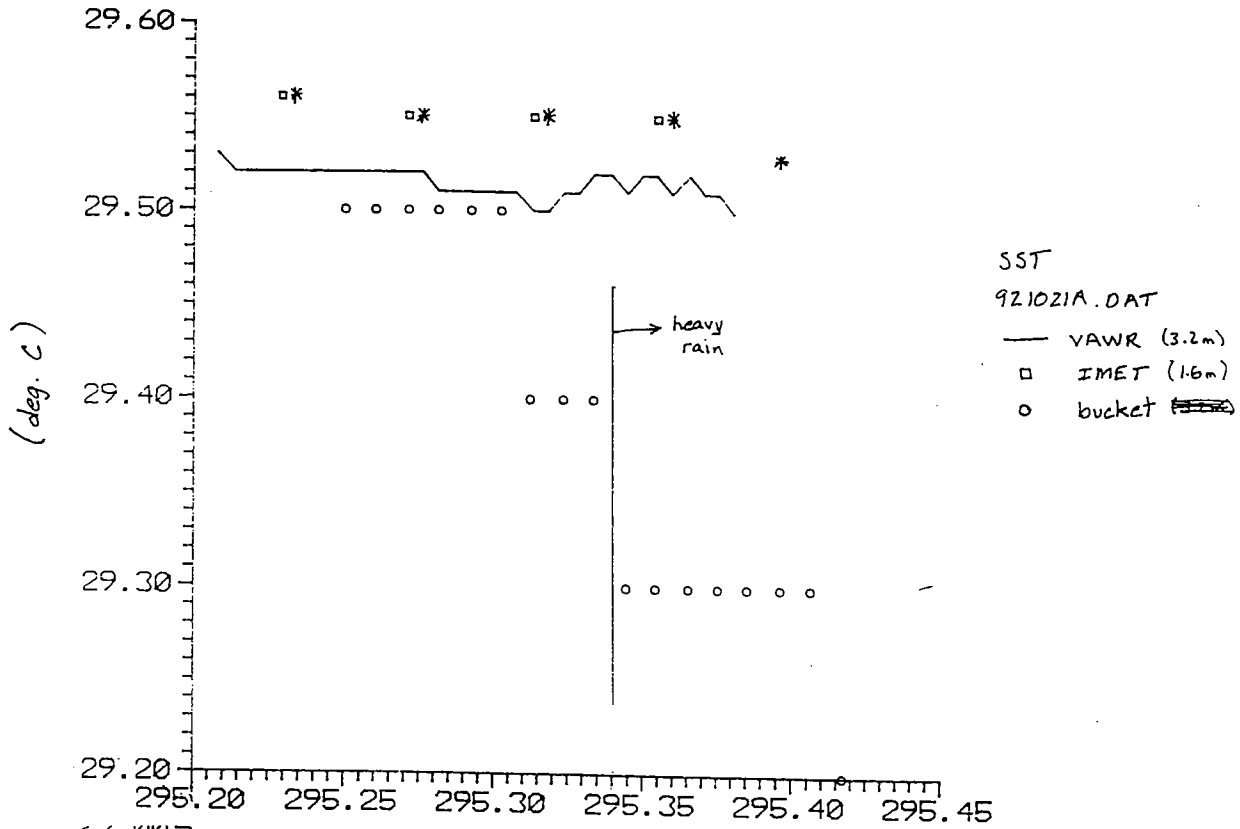
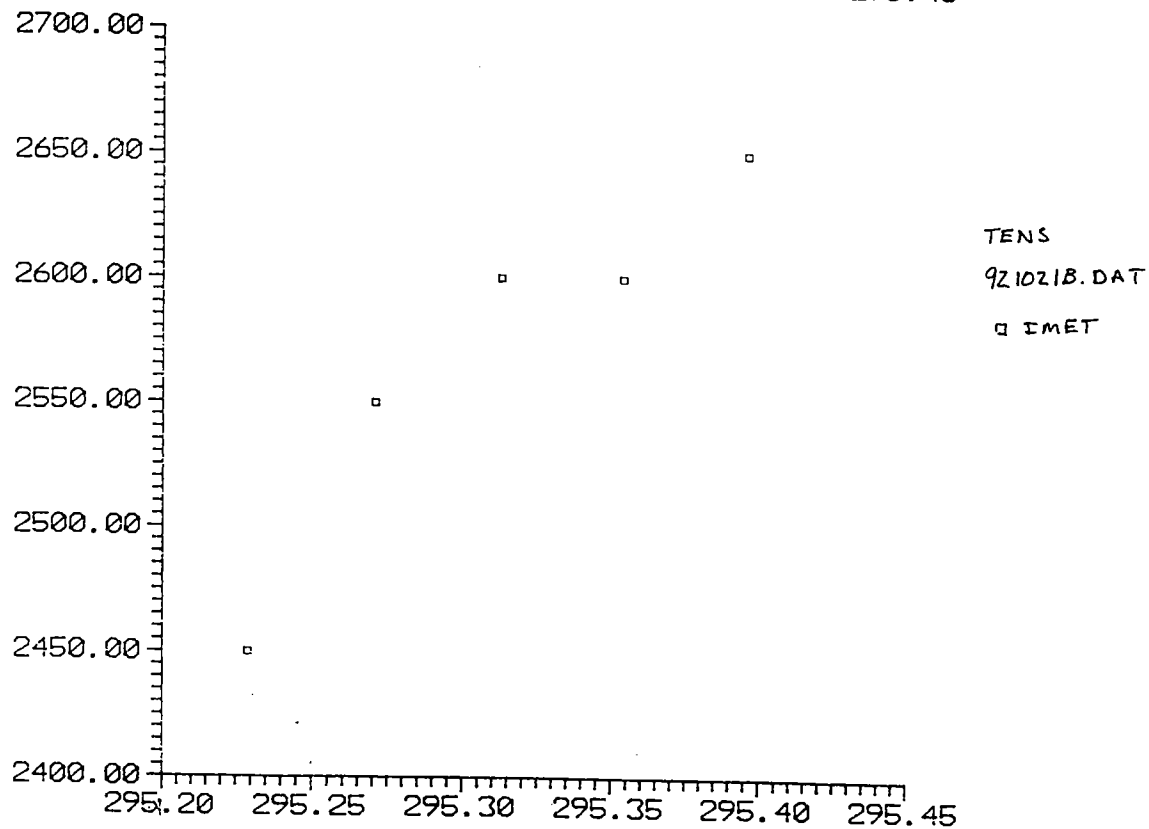
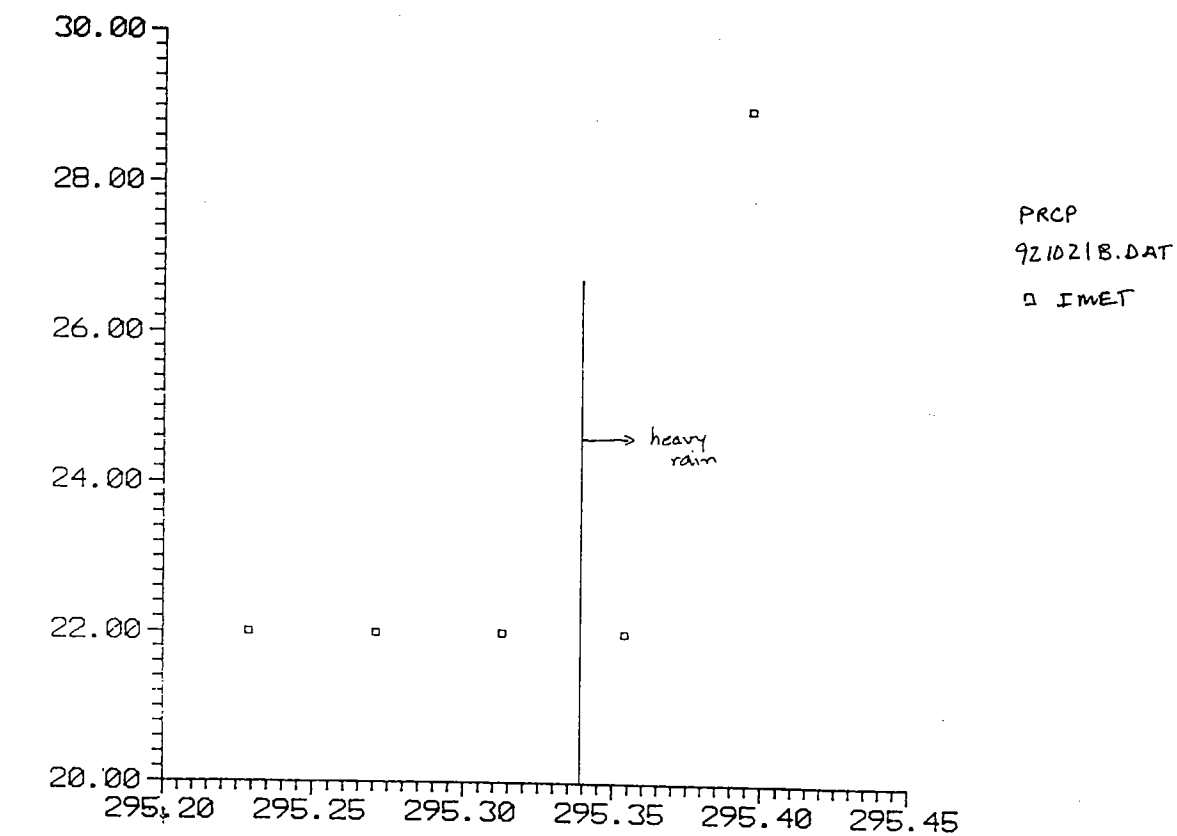


Figure 1-5i,j. VAWR, IMET, ship and GTS sensor comparison precipitation and tension



**Table 1-1. UOP TOGA COARE Mooring Instrumentation**

Time of deployment: 0430 UTC 10-21-92

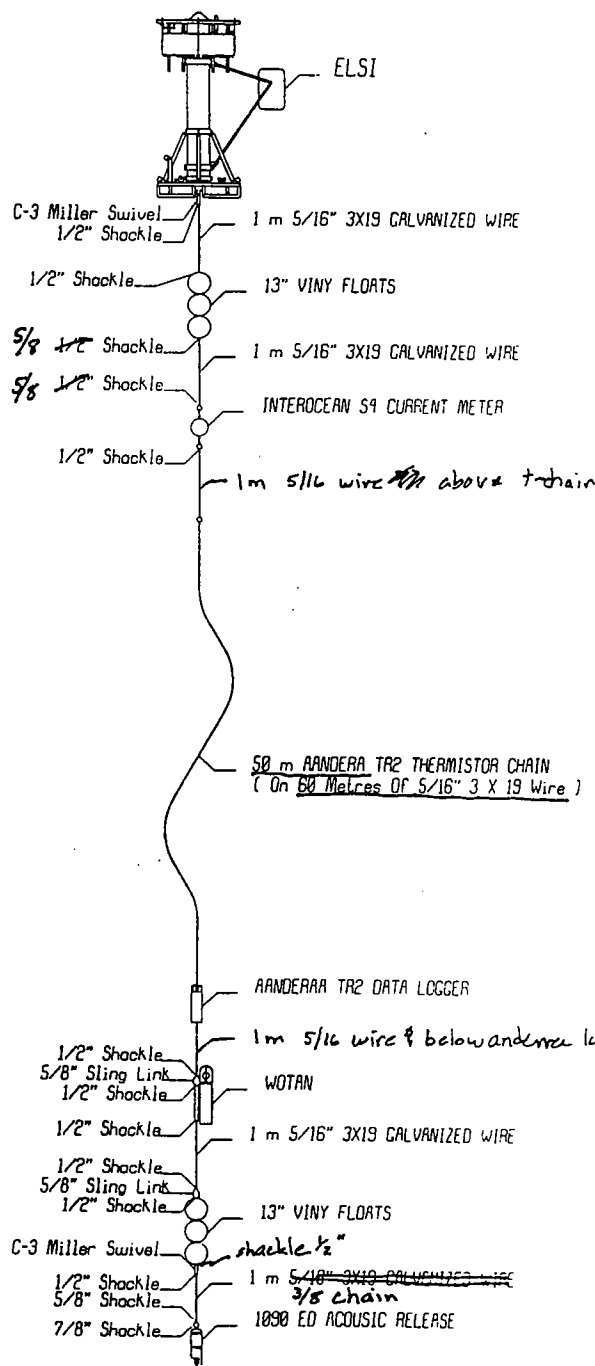
Position: 1° 45.27' S, 155° 59.73' E

Water depth: 1744 m

Instrument	Serial No.	Depth
VAWR	723	-2.5
VAWR WIND	na	-2.5
VAWR SW	28315	-2.5
VAWR LW	27237	-2.5
VAWR RH	V-029	-2.5
VAWR BP	44149	-2.5
VAWR AT	T5850	-2.5
IMET WND01	111	-2.5
IMET WND02	112	-2.5
IMET SW	103	-2.5
IMET LW	003	-2.5
IMET AT01	110	-2.5
IMET AT02	106	-2.5
IMET RH01	110	-2.5
IMET RH02	102	-2.5
IMET BP	110	-2.5
IMET PRCP	109	-2.5
IMET PTM	001	-2.5
IMET PTT	107	-2.0
3-m discus buoy	na	0.0
Brancker T-pod	3667	0.4
Brancker T-pod	3705	0.5
Brancker T-pod	3838	1.0
Brancker T-pod	3832	1.5
Brancker T-pod	3699	2.0
Brancker T-pod	3839	2.5
IMET SST	109	1.6
Seacat	142	2.0
Tensiometer	43845	2.4
VAWR SST	T5502	3.2
PMEL T-pod	2011	4.65
VMCM	203203	5.15
Brancker	3308	5.65
Seacat	143	7.48
VMCM	401105	9.0
Seacat	928	11.5
VMCM	401004	13.0
Seacat	929	15.5

Instrument	Serial No.	Depth
VMCM	051	17.0
Seacat	991	19.5
ADCP	448	20.5
VMCM	203304	23.0
Seacat	992	23.5
Brancker	3761	27.5
VMCM	202803	31.5
Seacat	993	32.0
Brancker	3834	35.5
VMCM	202002	39.5
Seacat	994	40.0
Seacat (Tomczak)	1069	45.5
VMCM	203504	52.5
Seacat	995	53.0
Seacat (Tomczak)	1065	60
Seacat	141	68
Seacat (Tomczak)	1066	76
Seacat	144	84
Seacat (Tomczak)	1067	92
Seacat	927	100
Seacat (Tomczak)	1068	108
Brancker	3835	116
Seacat	146	124
Brancker	3301	132
Brancker	3762	148
Brancker	3701	164
Brancker	3763	180
Brancker	3836	196
WOTAN (Farmer)	8846	200
Brancker	3702	212
Brancker	3703	228
Brancker	3387	244
Brancker	3764	260
AMF Release	130	1714

Figure 1-6. ELSI Mooring Schematic modified 10/21/92



ELSI MOORING STRING 75 METERS TOTAL LENGTH		
SCALE : M T S		DRAWN BY DAVID J. SPEAR
DATE : 08/01/92		
OCEANETIC MEASUREMENT ( 1989 ) LIMITED		DRAWING NUMBER



Figure 1-7. UOP Mooring Anchor Position

