First Institute of Oceanography, SOA
Qingdao - China

A "TAO" Hybrid for the Indian Ocean

Weidong Yu, Chunlin Ning and Staff
Rick Cole: RDSEA International, Inc
Jeffery Kinder: Down East Instrumentation, LLC
Yang Chao: Proteous Solutions, Ltd.

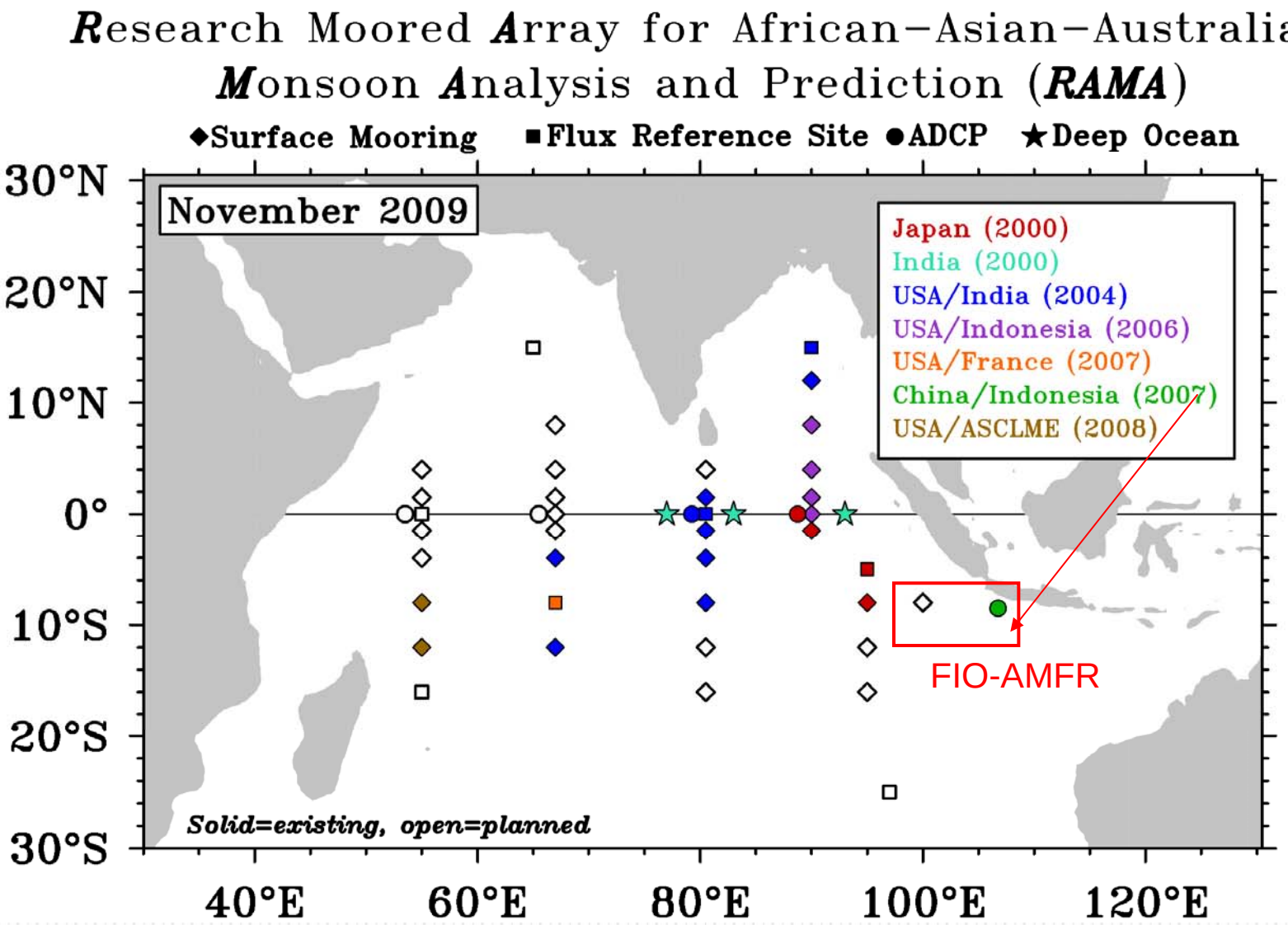
Discussion Outline:

- Introduction/Background
- Project
- The Buoy & Mooring
- Sensors
- Buoy Logger and Telemetry
- Deployment
- Base Station and Data

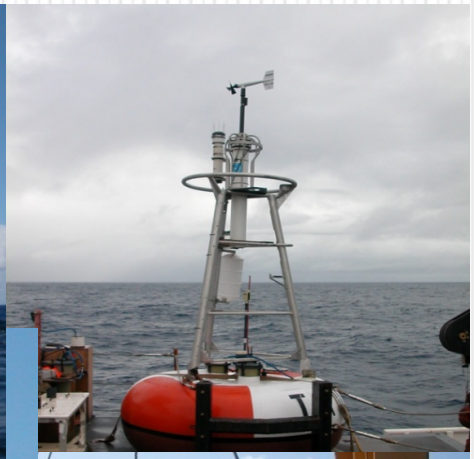
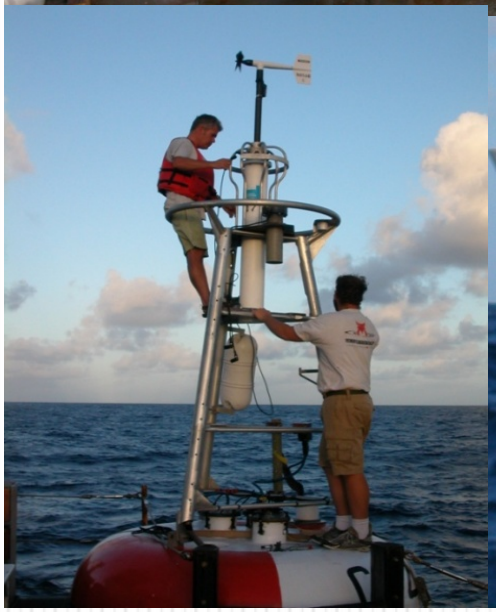
Dr. Weidong Yu and Staff
Ocean-Atmosphere and Climate Change Group - FIO

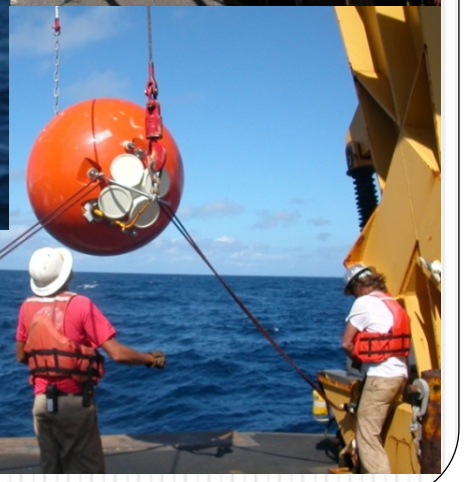
DEPARTEMEN KELAUTAN DAN PERIKANAN

Agency for Marine Fisheries Research, Jakarta


Research Moored Array for African–Asian–Australian
Monsoon Analysis and Prediction (RAMA)
◆Surface Mooring ■Flux Reference Site ●ADCP ★Deep Ocean
November 2009
Japan (2000)
India (2000)
USA/India (2004)
USA/Indonesia (2006)
USA/France (2007)
China/Indonesia (2007)
USA/ASCLME (2008)
FIO-AMFR
Solid=existing, open=planned
30°N
20°N
10°N
0°
10°S
20°S
30°S
40°E
60°E
80°E
100°E
120°E



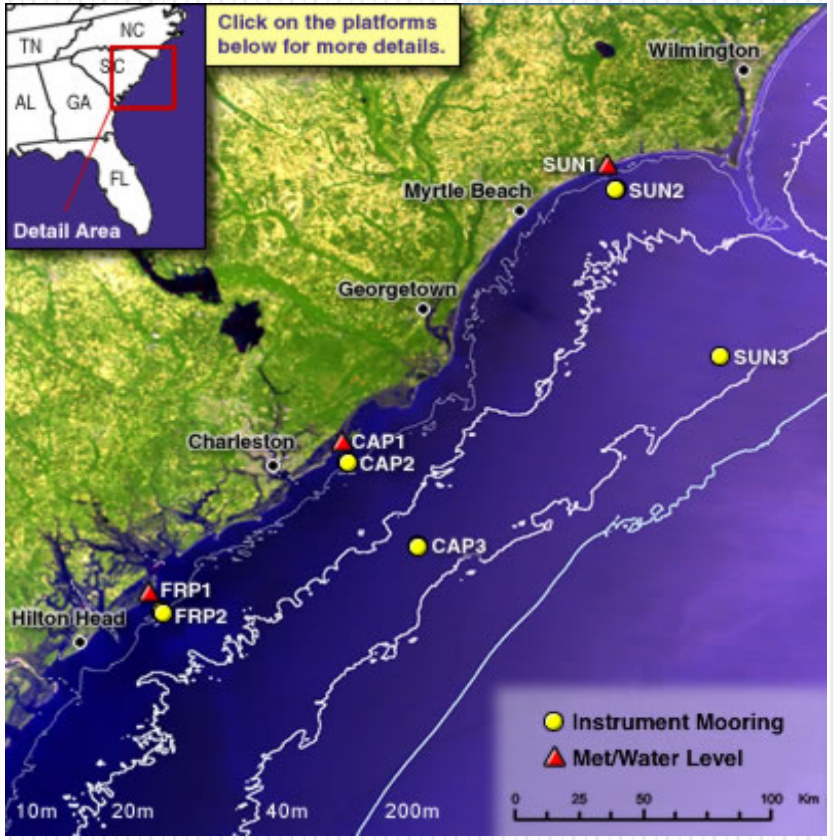



EPOCS, TOGA, TAO and WOCE

2010 DBCP Workshop, Oban, Scotland

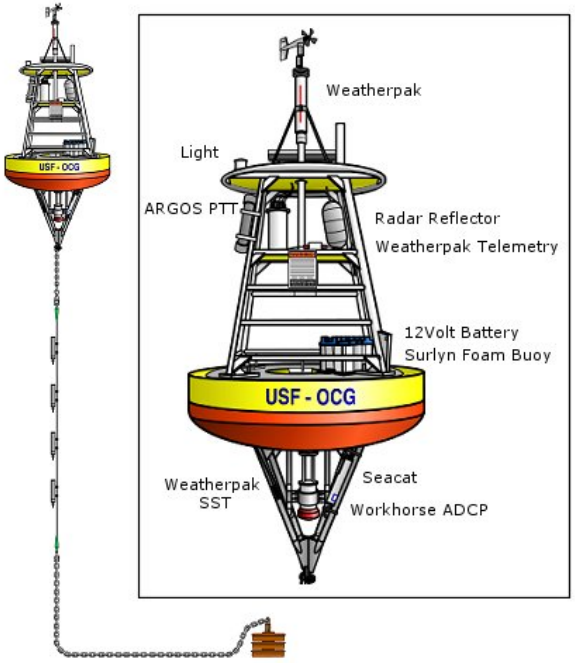
FIO-RAMA-BUOY System Ideas



FIO RAMA Buoy Evolution

NOAA – TAO

(Courtesy of NOAA-PMEL)



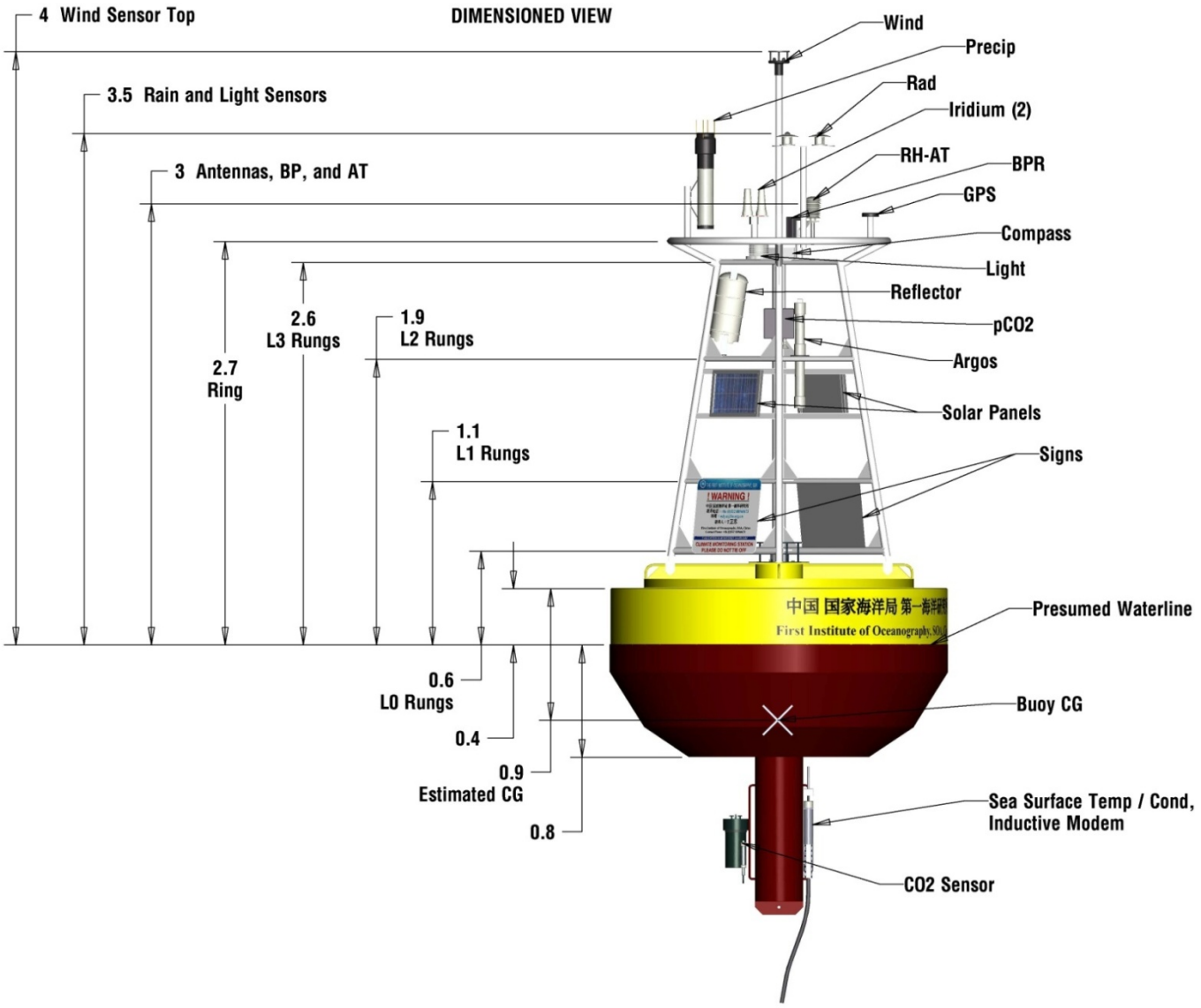
USF – COMPS

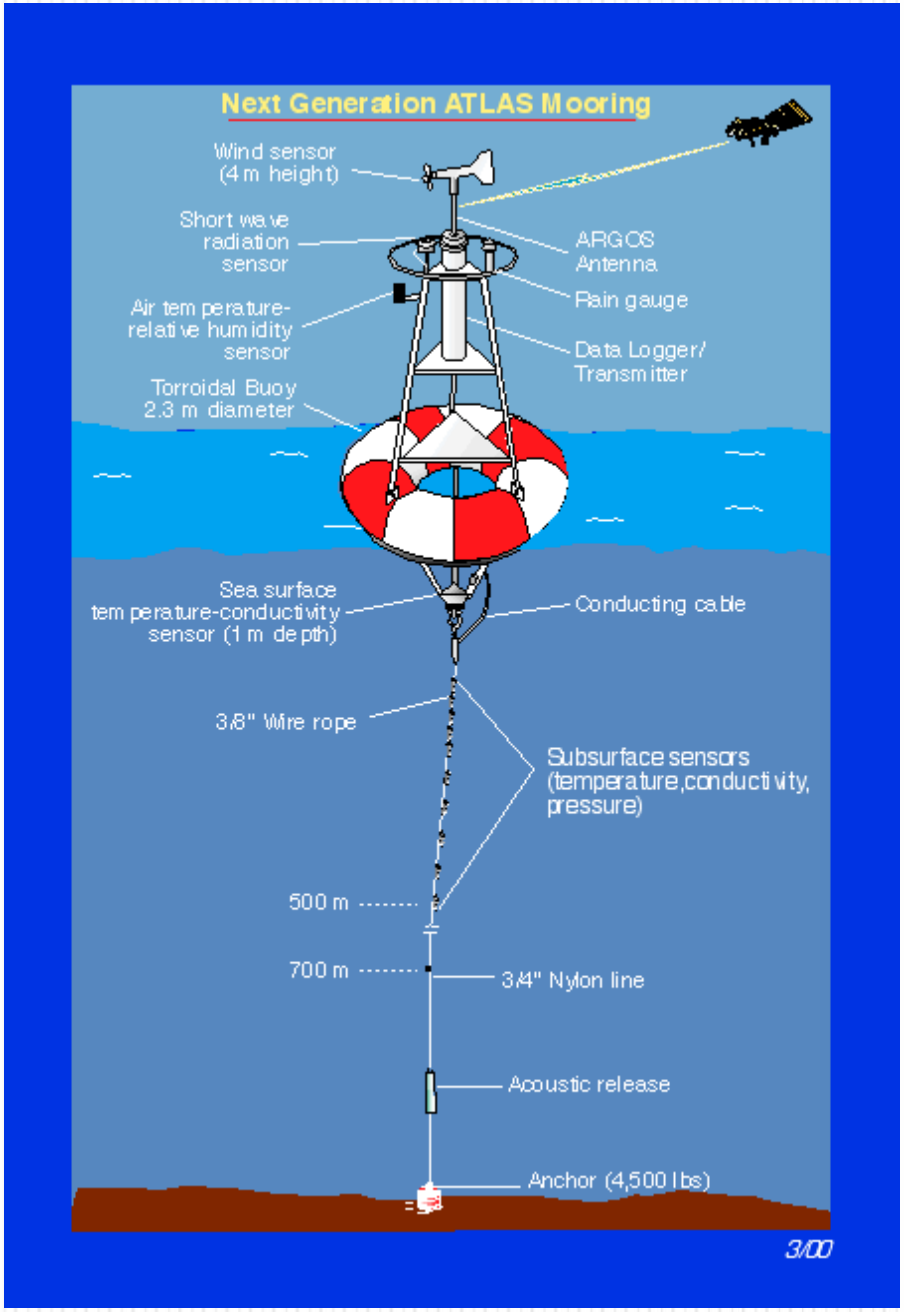
(Courtesy of USF)

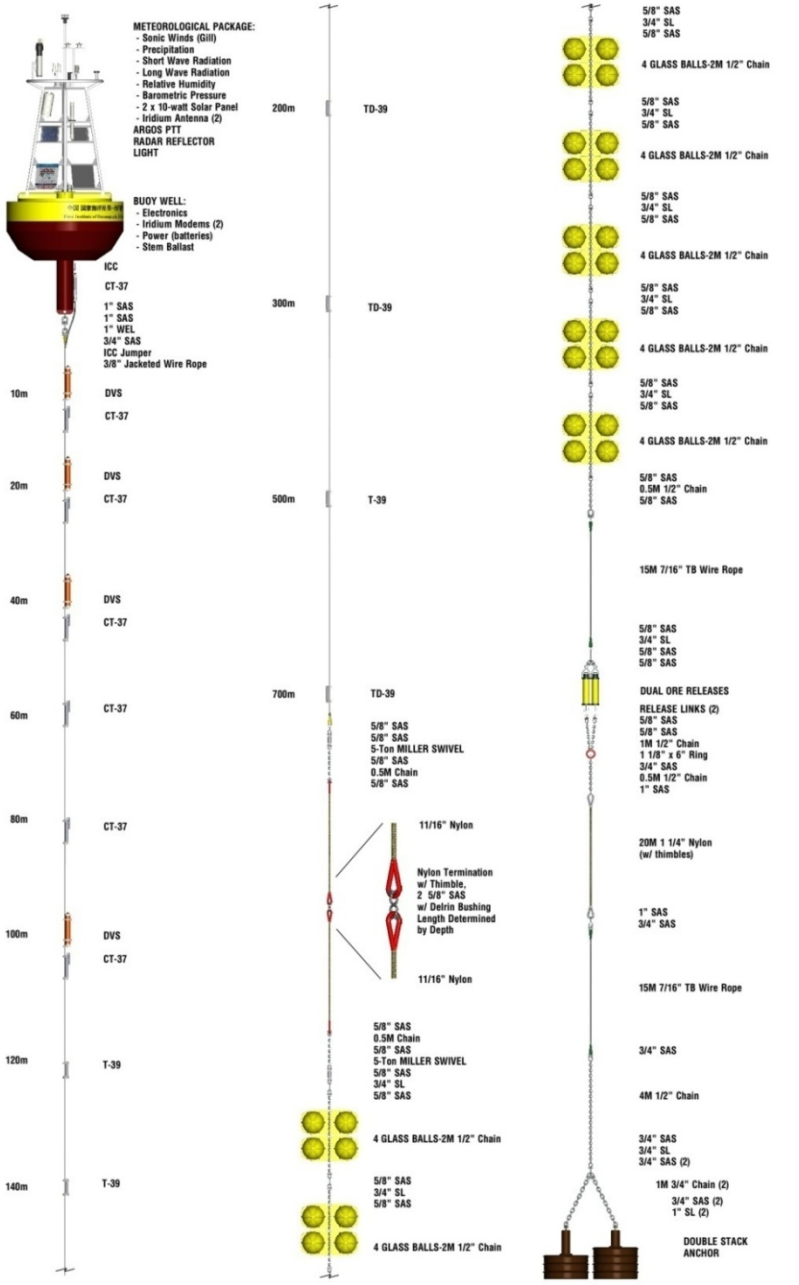
CaroCOOPS

(Courtesy UNCW)

FIO-RAMA-Buoy Configuration

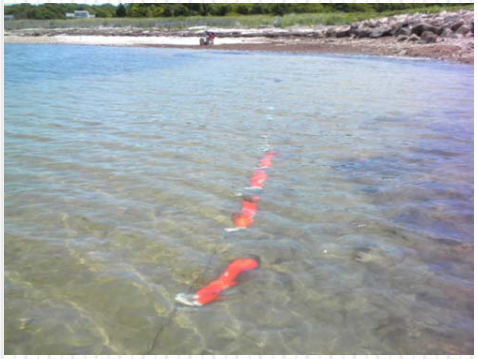



Next Generation ATLAS Mooring
Wind sensor (4 m height)
Short wave radiation sensor
Air temperature-relative humidity sensor
Torroidal Buoy 2.3 m diameter
ARGOS Antenna
Rain gauge
Data Logger/ Transmitter
Sea surface temperature-conductivity sensor (1 m depth)
Conducting cable
3/8" Wire rope
Subsurface sensors (temperature,conductivity, pressure)
500 m
700 m
3/4" Nylon line
Acoustic release
Anchor (4,500 lbs)
3/00

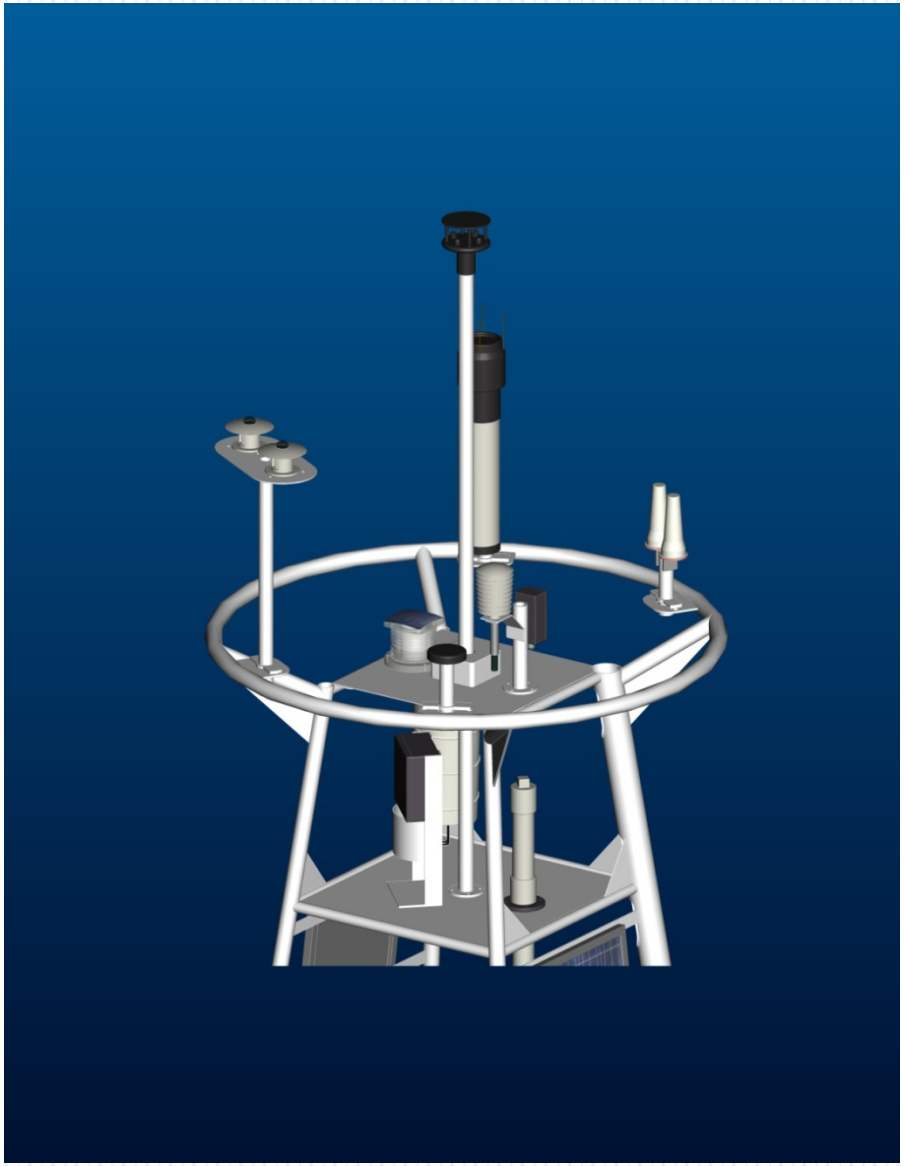

METEOROLOGICAL PACKAGE:
- Sonic Winds (Gill)
- Precipitation
- Short Wave Radiation
- Long Wave Radiation
- Relative Humidity
- Barometric Pressure
- 2 x 10-watt Solar Panel
- Iridium Antenna (2)
ARGOS PTT
RADAR REFLECTOR
LIGHT
BUOY WELL:
- Electronics
- Iridium Modems (2)
- Power (batteries)
- Stem Ballast
ICC
CT-37
1" SAS
1" SAS
1" WEL
3/4" SAS
ICC Jumper
3/8" Jacketed Wire Rope
10m
DVS
CT-37
20m
DVS
CT-37
40m
DVS
CT-37
60m
CT-37
80m
CT-37
100m
DVS
CT-37
120m
T-39
140m
T-39
200m
TD-39
300m
TD-39
500m
T-39
700m
TD-39
5/8" SAS
5/8" SAS
5-Ton MILLER SWIVEL
5/8" SAS
0.5M Chain
5/8" SAS
11/16" Nylon
Nylon Termination w/ Thimble, 2 5/8" SAS w/ Delrin Bushing Length Determined by Depth
11/16" Nylon
5/8" SAS
0.5M Chain
5/8" SAS
5-Ton MILLER SWIVEL
5/8" SAS
3/4" SL
5/8" SAS
4 GLASS BALLS-2M 1/2" Chain
5/8" SAS
3/4" SL
5/8" SAS
4 GLASS BALLS-2M 1/2" Chain
5/8" SAS
3/4" SL
5/8" SAS
4 GLASS BALLS-2M 1/2" Chain
5/8" SAS
3/4" SL
5/8" SAS
4 GLASS BALLS-2M 1/2" Chain
5/8" SAS
3/4" SL
5/8" SAS
4 GLASS BALLS-2M 1/2" Chain
5/8" SAS
0.5M 1/2" Chain
5/8" SAS
15M 7/16" TB Wire Rope
5/8" SAS
3/4" SL
5/8" SAS
5/8" SAS
DUAL ORE RELEASES
RELEASE LINKS (2)
5/8" SAS
5/8" SAS
1M 1/2" Chain
1 1/8" x 6" Ring
3/4" SAS
0.5M 1/2" Chain
1" SAS
20M 1 1/4" Nylon (w/ thimbles)
1" SAS
3/4" SAS
15M 7/16" TB Wire Rope
3/4" SAS
4M 1/2" Chain
3/4" SAS
3/4" SL
3/4" SAS (2)
1M 3/4" Chain (2)
3/4" SAS (2)
1" SL (2)
DOUBLE STACK ANCHOR

Buoy Build

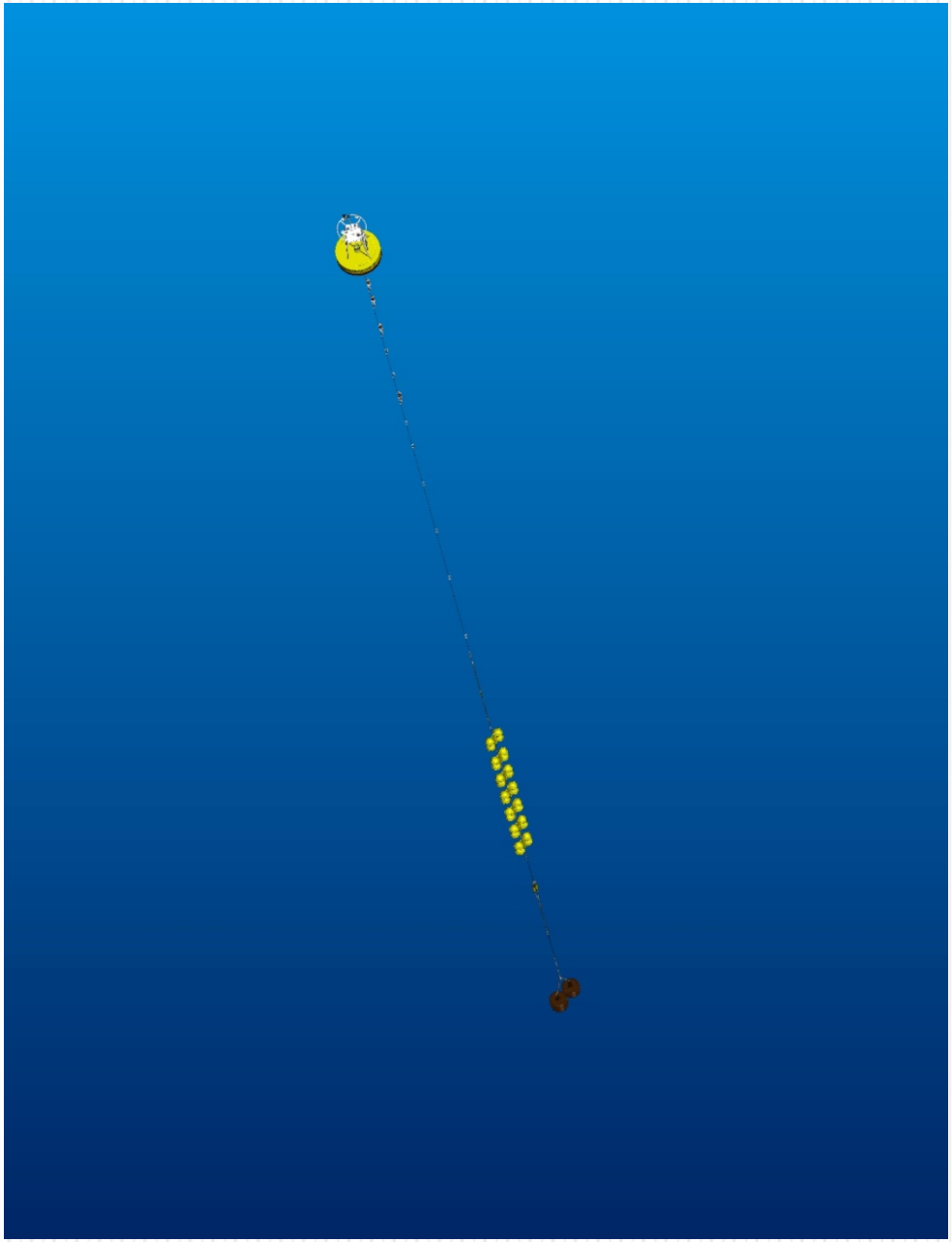
Complete Systems Test, In Air and Wet



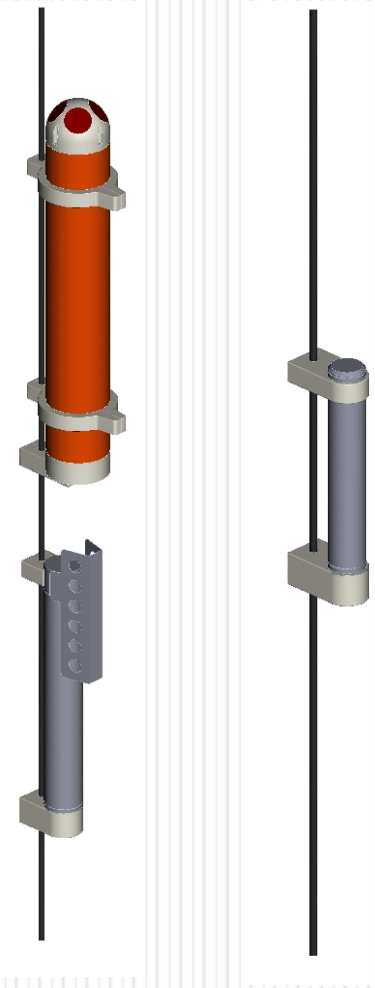
Surface MET: TAO Configuration



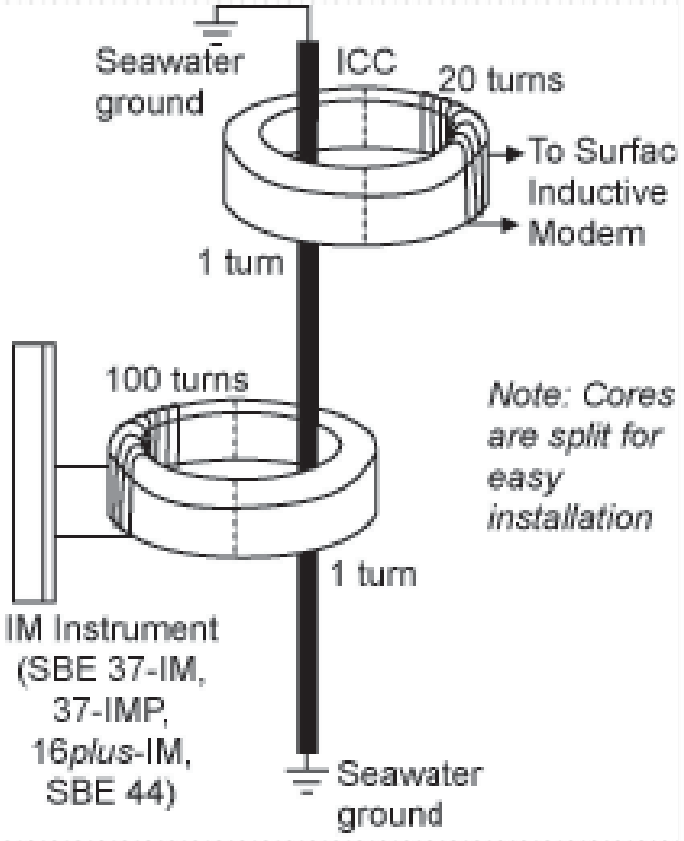
- Sonic Winds
- Air Temp
- Relative Humidity
- Barometric Pressure
- Short Wave Radiation
- Long Wave Radiation
- pCO_2
- Argos Beacon
- GPS Antenna
- Iridium Antennas

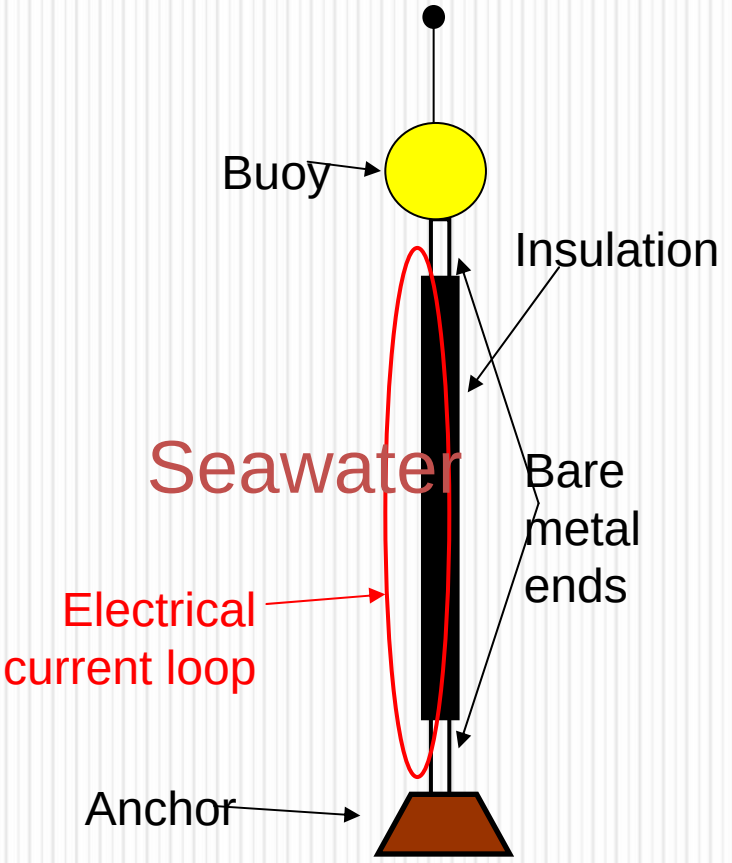


Doppler Volume Sampler (DVS)
SBE-37IM-MicroCat
SBE-39IM-MicroCat

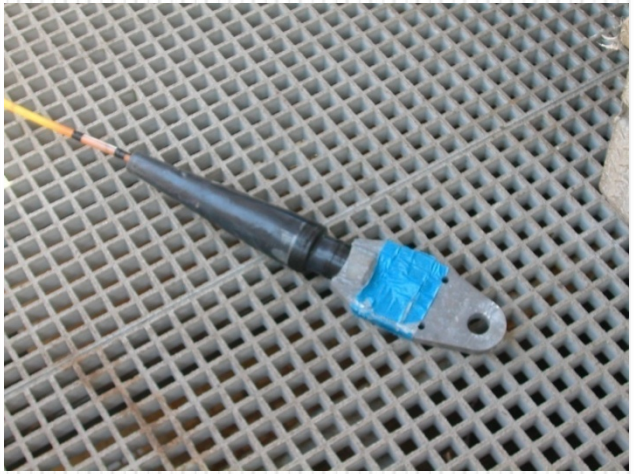


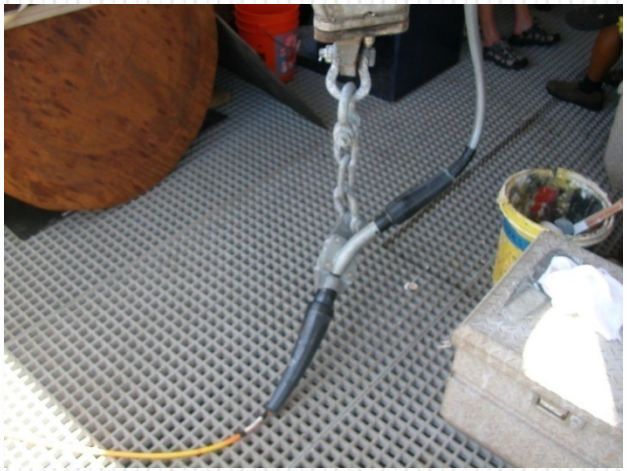
Each Instrument has It's Own Inductive Modem Module (IMM)





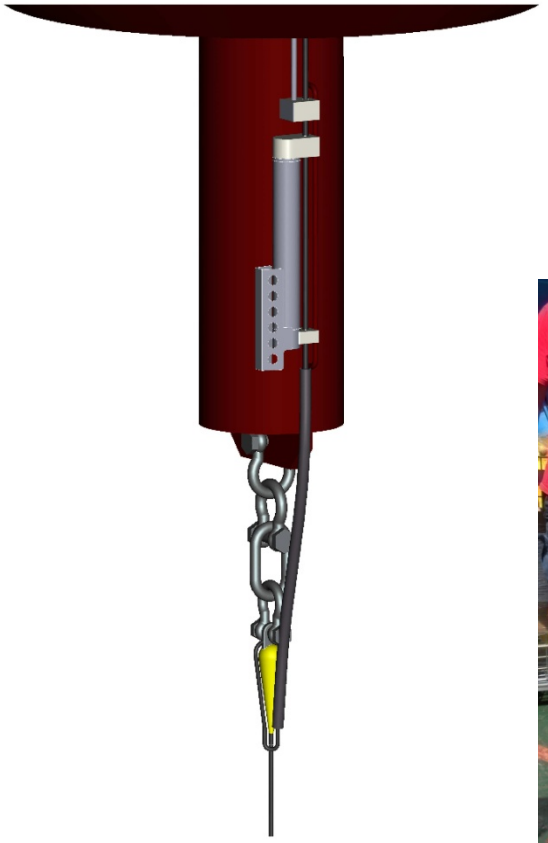
Inductive Coupling



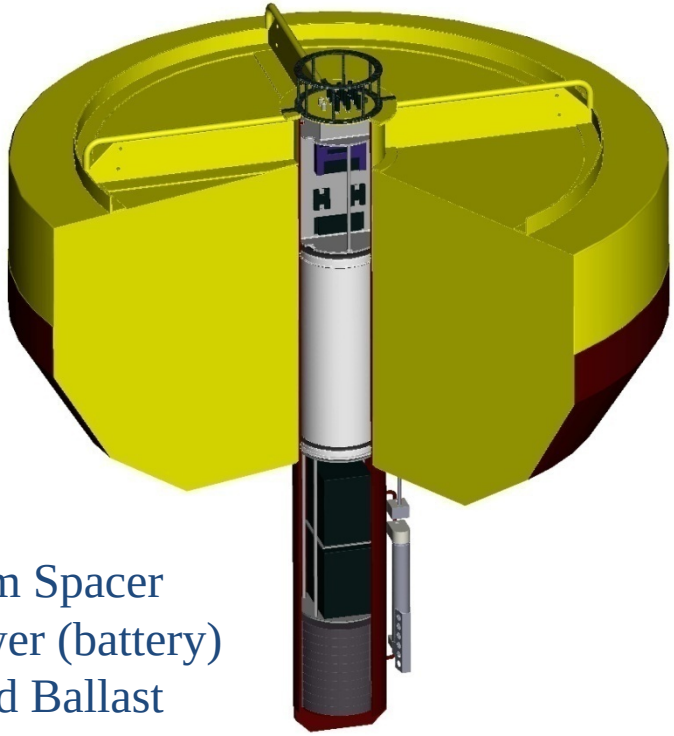


NOAA – PMEL Inductive Connection
Successful Since the Mid 1990's

ICC Connection (Jumper)



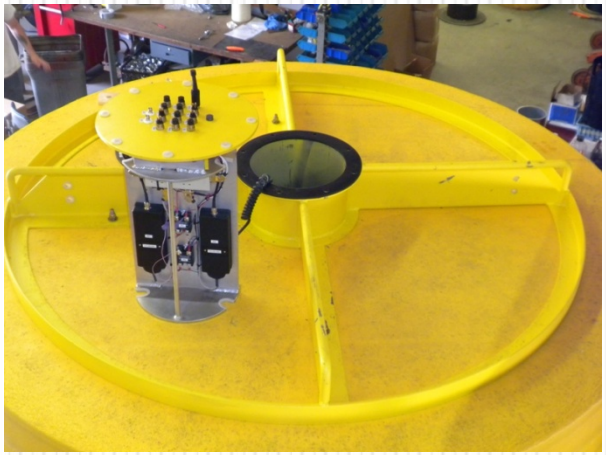
Data Logger and Telemetry



- Stem Spacer
- Power (battery)
- Lead Ballast

DataTaker
DT80G

Dual
Iridium
Modems



IMM Sensor ID Configuration

ID	Instrument	Depth
01	SBE-37	1 m
02	SBE-37	10 m
03	SBE-37	20 m
04	SBE-37	40 m
05	SBE-37	60 m
06	SBE-37	80 m
07	SBE-37	100 m
08	SBE-39	120 m
09	SBE-39	140 m
10	SBE-39 w/ pressure	200 m
11	SBE-39 w/ pressure	300 m
12	SBE-39	500 m
13	SBE-39 w/ pressure	700 m
14	DVS	10 m
15	DVS	20 m
16	DVS	40 m
17	DVS	100 m

Logger Control Strategy

SCHEDULE	DATA
C	10 minute interval – MET Suite, SBE
D	1 hour interval – Avg. MET, SBE
E	3 hour interval – CO2
F	DVS ID #14 – Most recent ensemble
G	DVS ID #15 – Most recent ensemble
H	DVS ID #16 – Most recent ensemble
I	DVS ID #17 – Most recent ensemble
X	8 hour interval - GPS

Ten Minute Schedule:

2009/06/04 15:12:15.4 18.61 1013.9 57.73 3.2 4.5 258.0 -0.23804 18.43 18.49 7.10756 24.0
0.0003 17.5457 332.0
0.0003 17.5480 308.0
0.0003 17.5450 308.0
0.0003 17.5588 308.0
0.0018 17.5450 431.0
0.0002 17.5718 404.0
0.0002 17.5693 402.0
17.5588 404.0
17.5320 404.0
17.4877 -0.006 450.0
17.4907 -0.016 407.0
17.5500 404.0
17.6150 0.057 404.0

One Hour Schedule:

All data values, with the exception of the DVSs, in the one-hour schedule represent the hourly means of the ten-minute measurements over the previous hour.

2009/06/10 12:00:11.9 12.7 6.78 -22 3.6 17.20 1013.1 63.84 3.2 4.1 270.0 -0.23804 16.81 16.83 7.10756
0.0003 16.7395
0.0003 16.7562
0.0003 16.7663
0.0003 16.7764
0.0018 16.7689
0.0002 16.7605
0.0003 16.7537
16.7406
16.7606
16.7762 -0.029
16.7815 -0.040
16.8067
16.8667 0.039

DVS Data Record

2009/06/10 12:00:12.3 7F8AA502063F81740000D907060A0B040A0100920400000122020 15E
5884FDEEA8E40080BC3F0000000000800300336200803900000000801F3200AEFF01008205
00800080008000800080008000800080008000800080008000800080008000800080008000
08038534354385343543853435438534354385343540606060B0606060B0606060B0606060B0
606060B000064000000640000006400000064000000640 0E221

2009/06/10 12:00:18.3 7F8AA502063F818D0000D907060A0B37000100BD0400000222020154E
68034EEA8E400805640000000000080050035600080 7A00000000801F3200AEFF01008205008
00080008000800080008000800080008000800080008000800080008000800080008000800
4C403F524C403F524C403F524C403F524C403F06070707060606060707070706060606060606
06000064000000640000006400000064000000640 0BA21

2009/06/10 12:00:22.2 7F8AA502063F81A10000D907060A0B3700010092040000012202015A
B98818F1A8E40080BC400000000008005002B6300803500000000801F3200AEFF01008205
00800080008000800080008000800080008000800080008000800080008000800080008000
08041514A4D41514A4D41514A4D41514A4D41514A4D06070706060606060707070706060
60707070700006400000064000000640000006400000064 00C421

2009/06/10 12:00:26.0 7F8AA502063F81740000D907060A0B02160100920400000122020 15D
F58BA3EEA8E400804140000000000800300325E00802A00000000801F3200AEFF01008205
00800080008000800080008000800080008000800080008000800080008000800080008000
08036504D4037504D4037504D4036504D4037504E4006060606060606060606060606060606060
60606060000640000006400000064000000640000006400 4721

Three Hour Schedule:

The three-hour schedule polls the pCO2 sensor for its most recent data record.

2010/01/08 03:00:33.1 47142 42483 661.90 54.4 20.8 28.3 1029

Where:

2010/01/08 03:00:33.1 – **DT**-80 Timestamp, YYYY/MM/DD HH:MM:SS.T
47142 – Raw zero counts
42483 – Raw CO2 counts
661.90 – CO2 in ppm
54.4 – Detector temperature, Celsius
20.8 – Water Vapor Pressure, mBars
28.3 – Humidity temperature, Celsius
1029 – Detector gas stream pressure, mBars

Eight Hour Schedule:

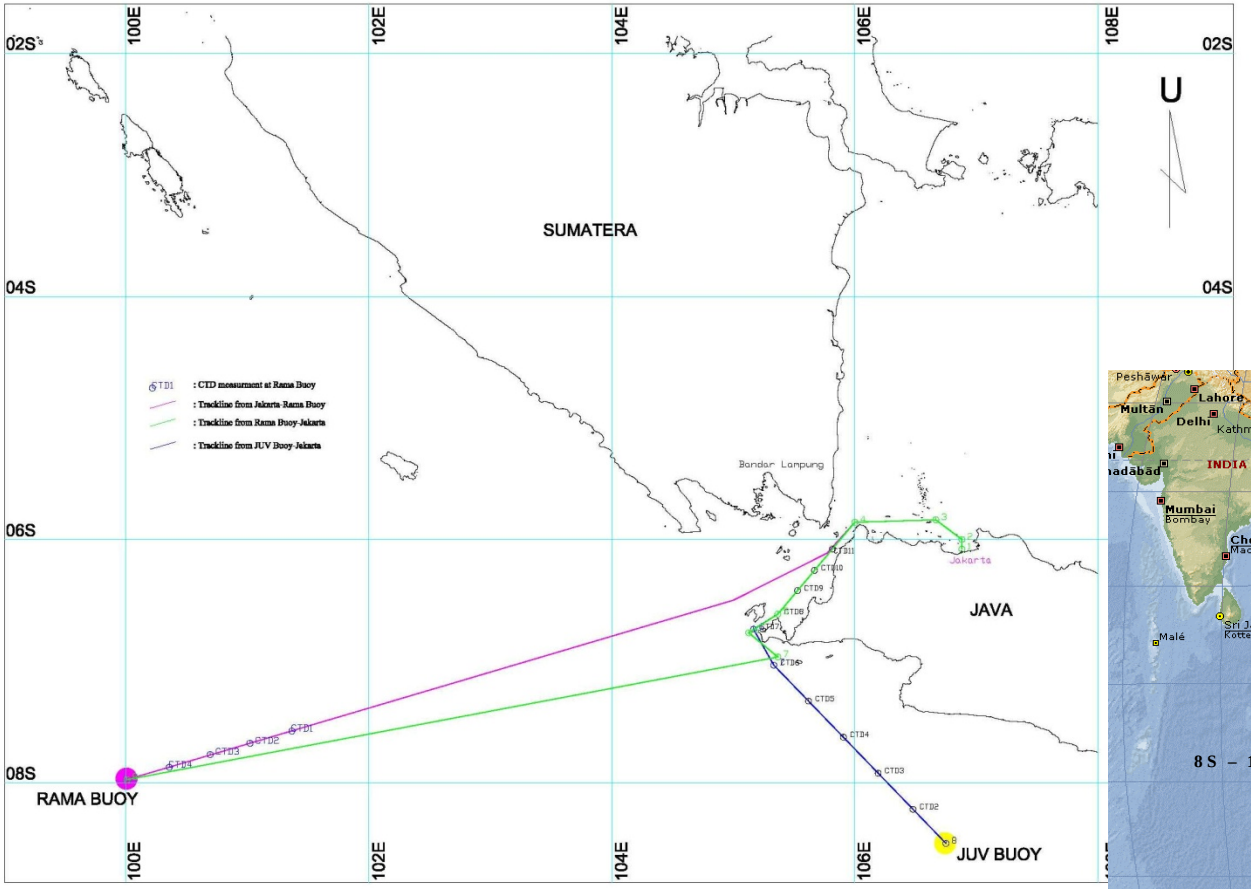
The eight-hour schedule collects latitude, longitude and UTC data from the on-board GPS receiver.

2009/06/10 12:02:26.0 3645.5537 N 08048.7260 W 12 02 26 A

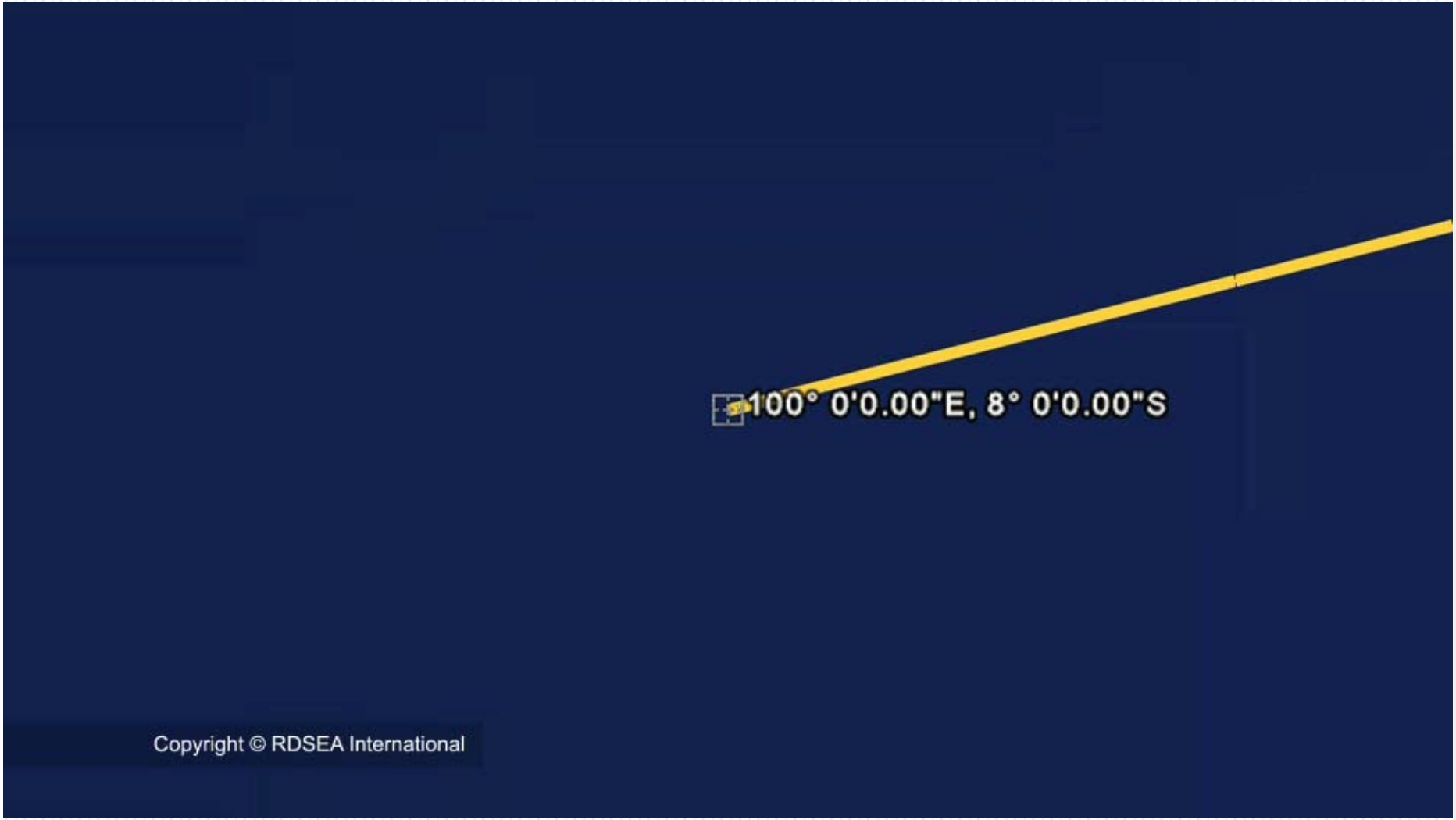
Where:

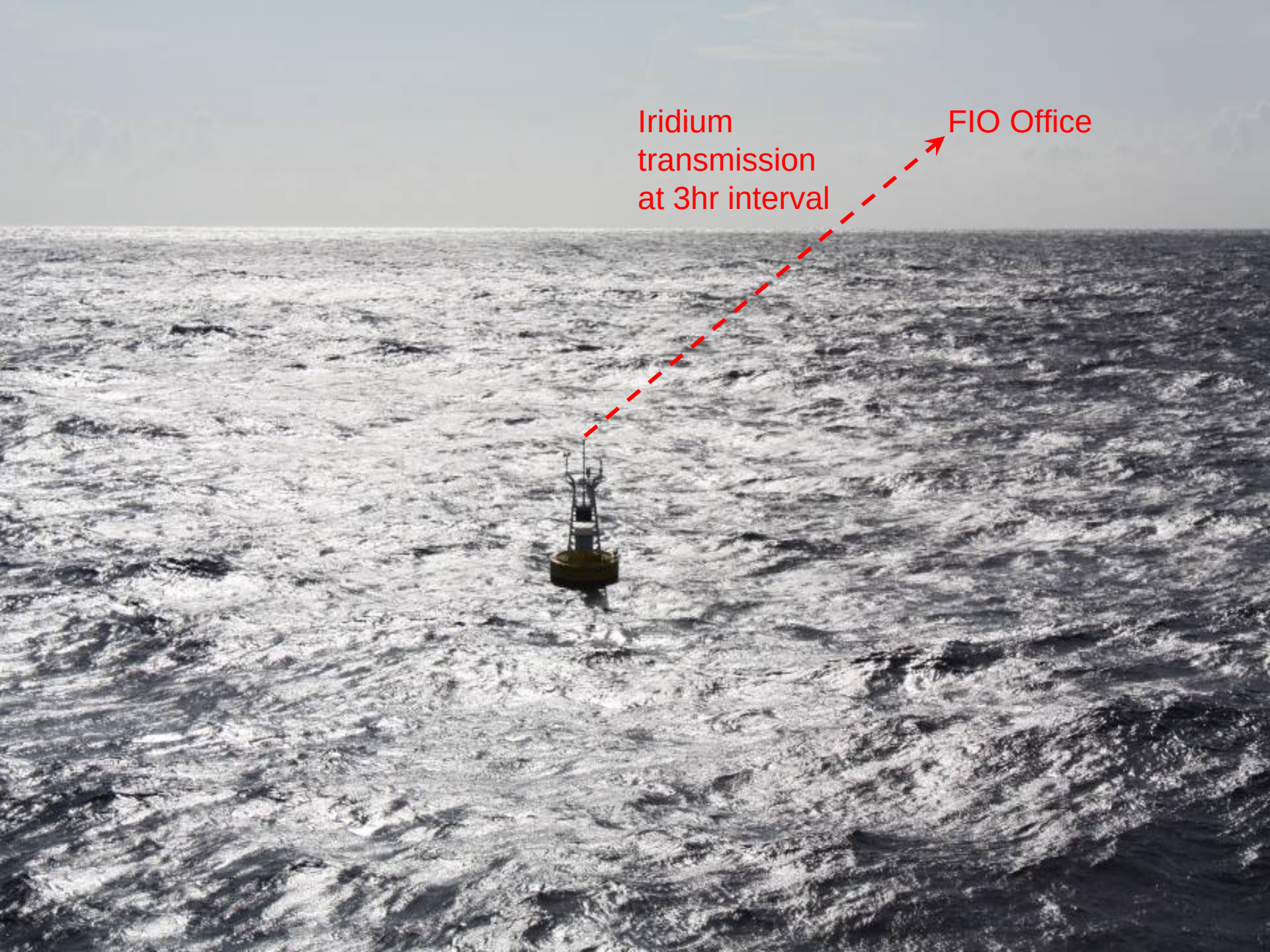
2009/06/10 12:02:26.0 – Timestamp, YYYY/MM/DD HH:MM:SS.T
3645.5537 - Latitude, ddmm.mmmm
N - Latitude Hemisphere
08048.7260 - Longitude, dddmm.mmmm
W - Longitude Hemisphere
12 02 26 - UTC Time, hh mm ss
A - Status, A = valid position, V = position warning

Deployment Location: 8S/100E – Indian Ocean



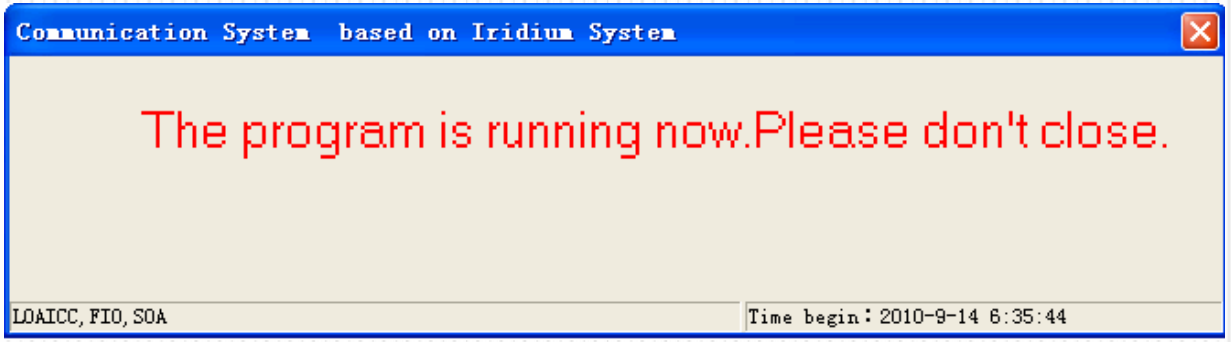
Deployment Procedures




Iridium
transmission
at 3hr interval
FIO Office

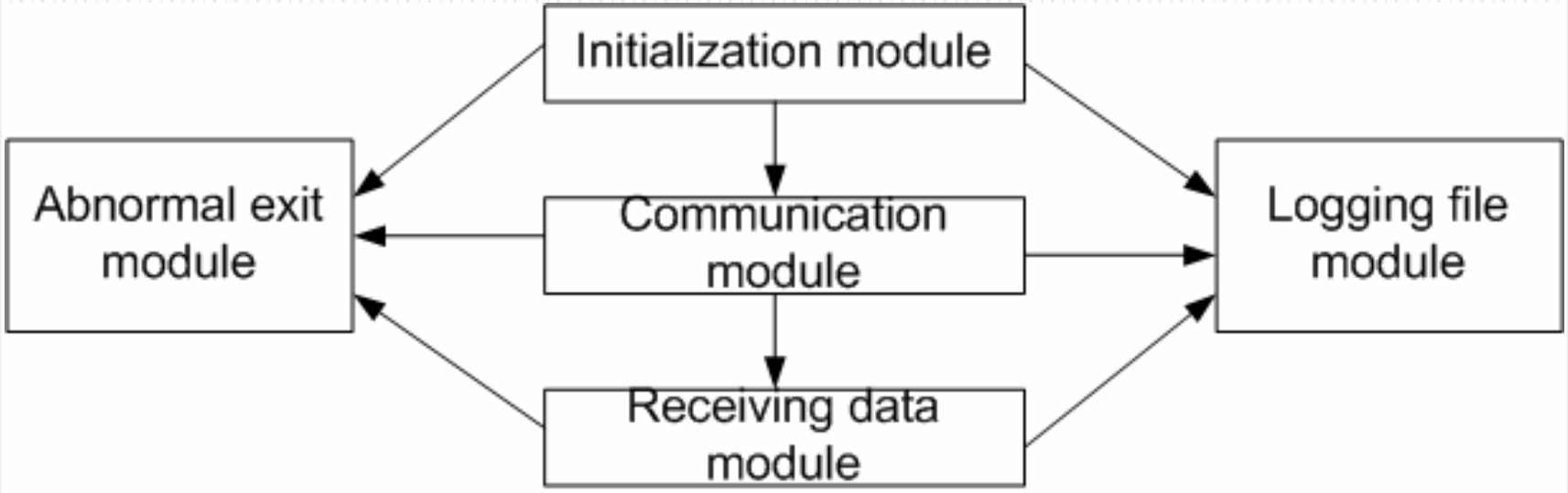
Hardware of the Communication System in Lab.

Software of the Communication System



1. Unmanned program
2. Auto create log files and data files

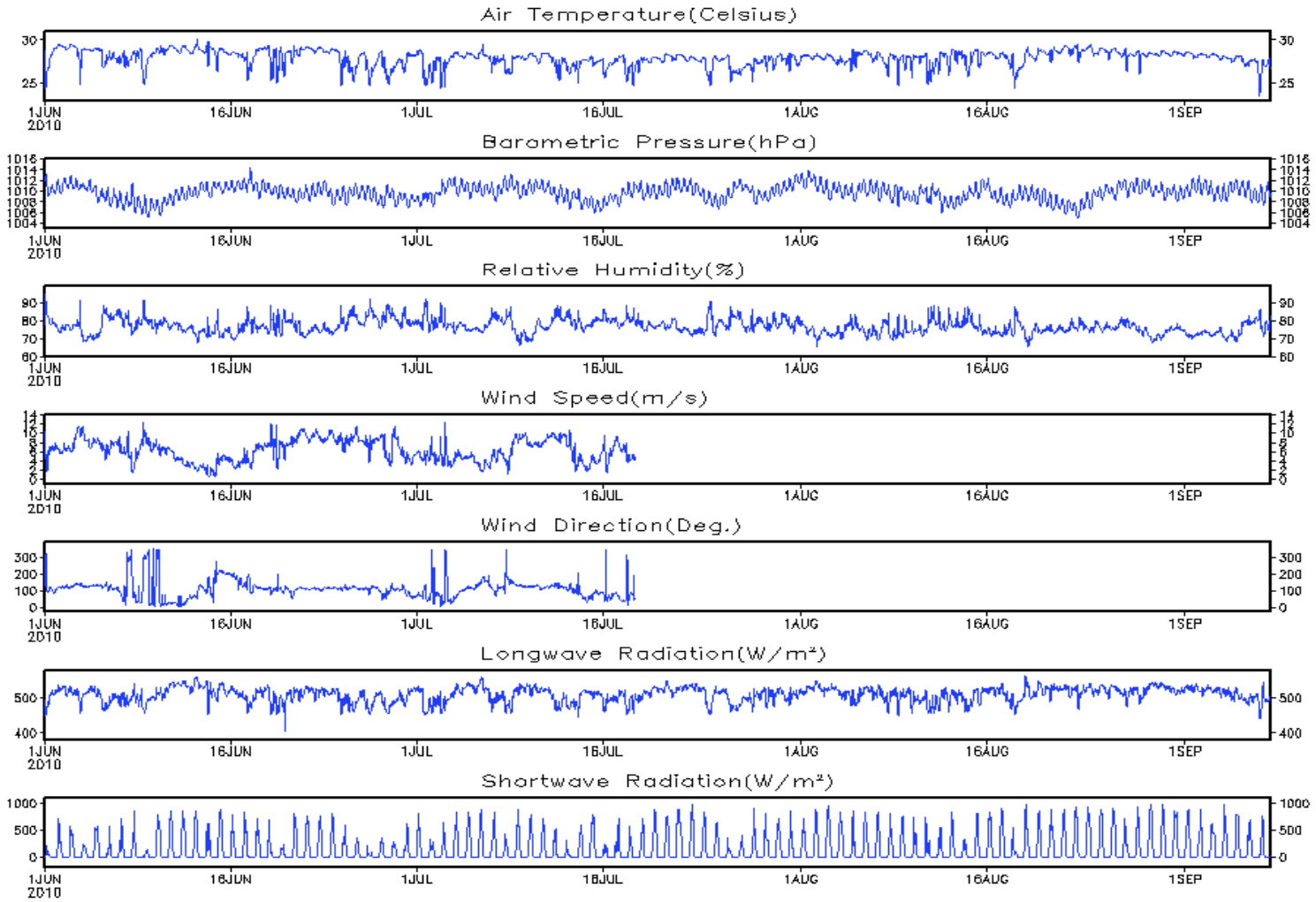
The Software's Construction



Communication Data:

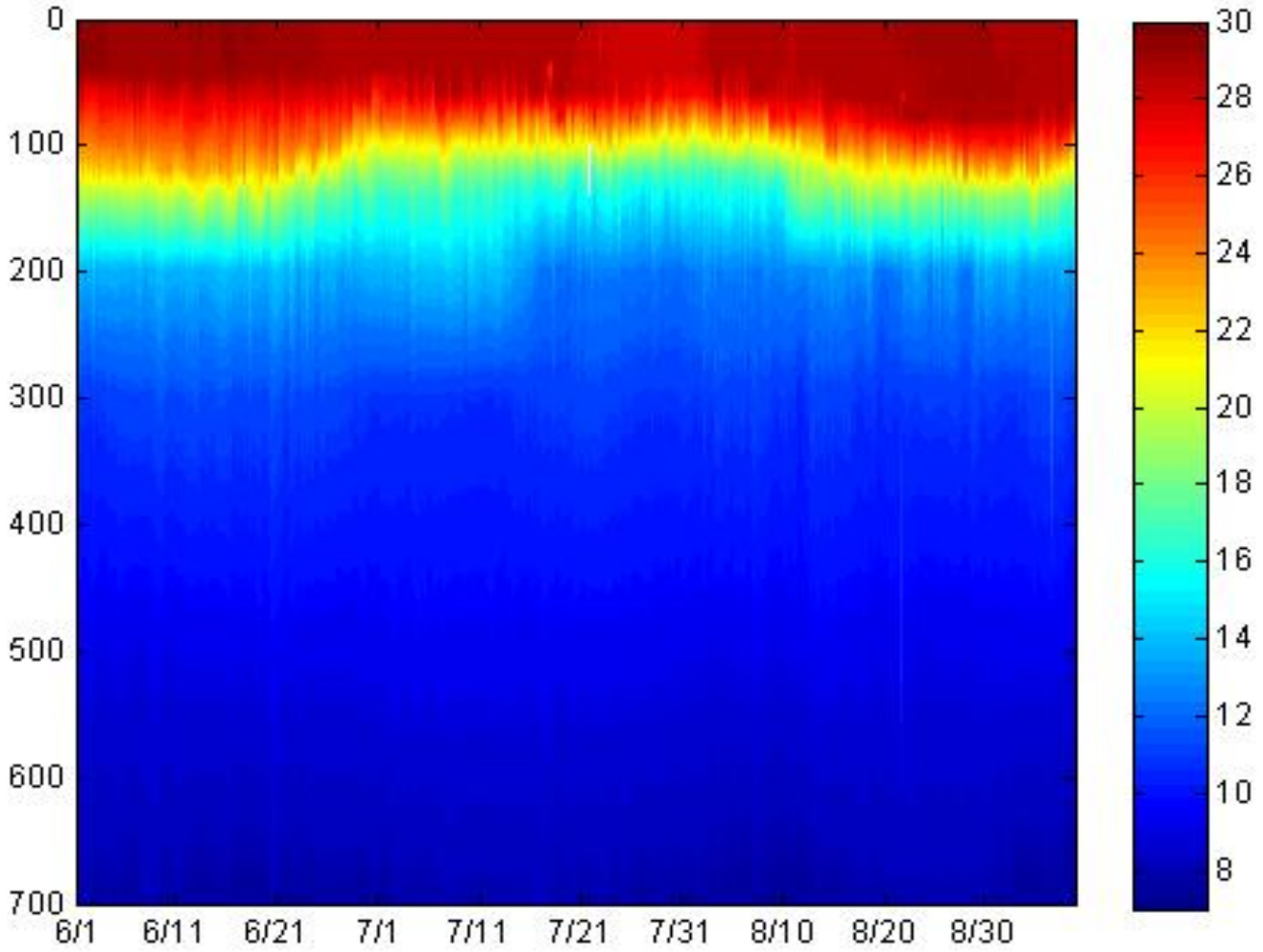
1. The data's website is ftp://ftp.fio.org.cn/
2 . The daily 24hr average data is provided
3 . The Data is updated every day.
4 . The data is then disseminated to the RAMA data website

Hourly Meteorological Data plots During June 1st – Sep. 7th 2010



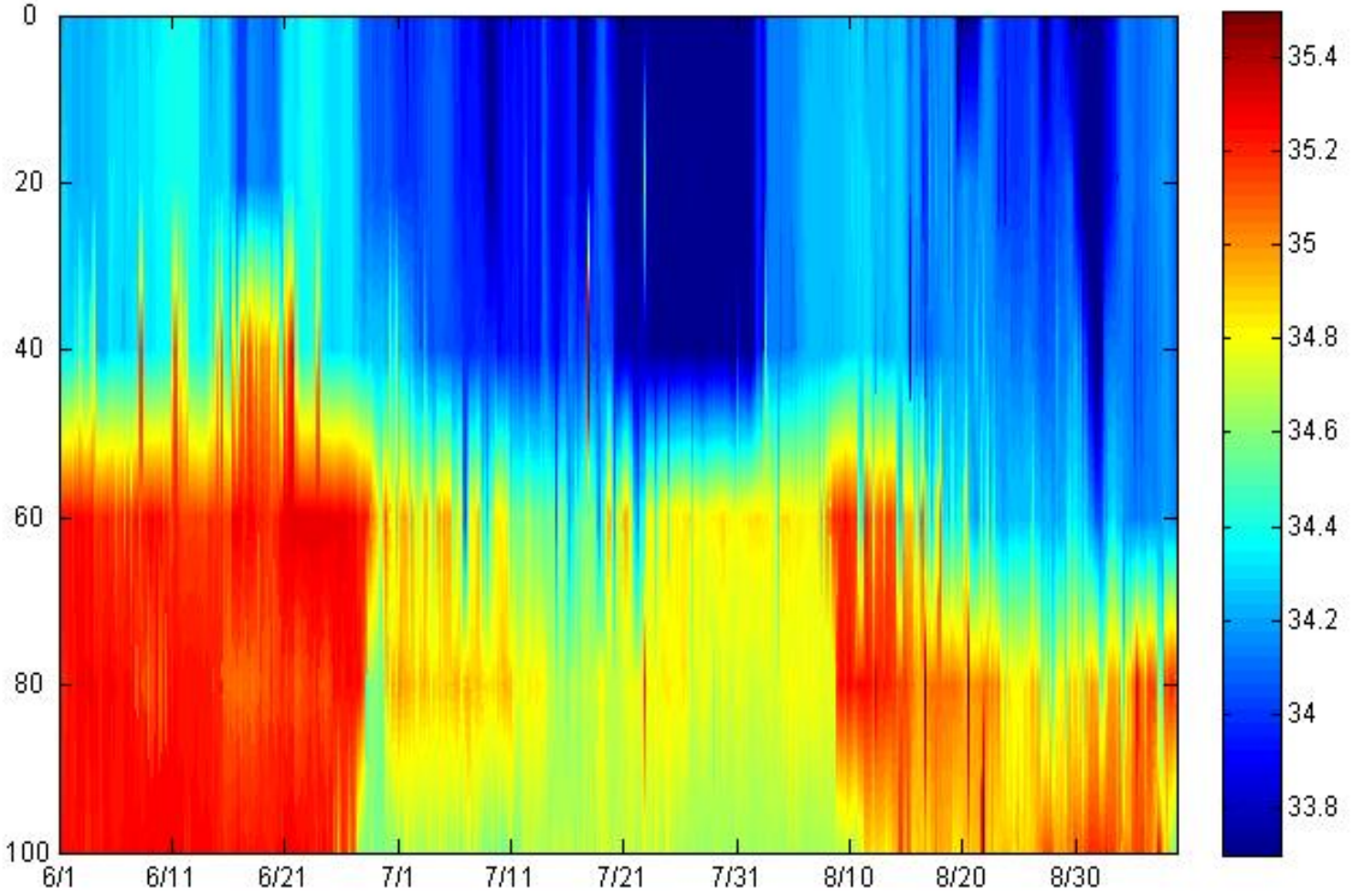
Hourly Temp-Profile: 0 – 700m

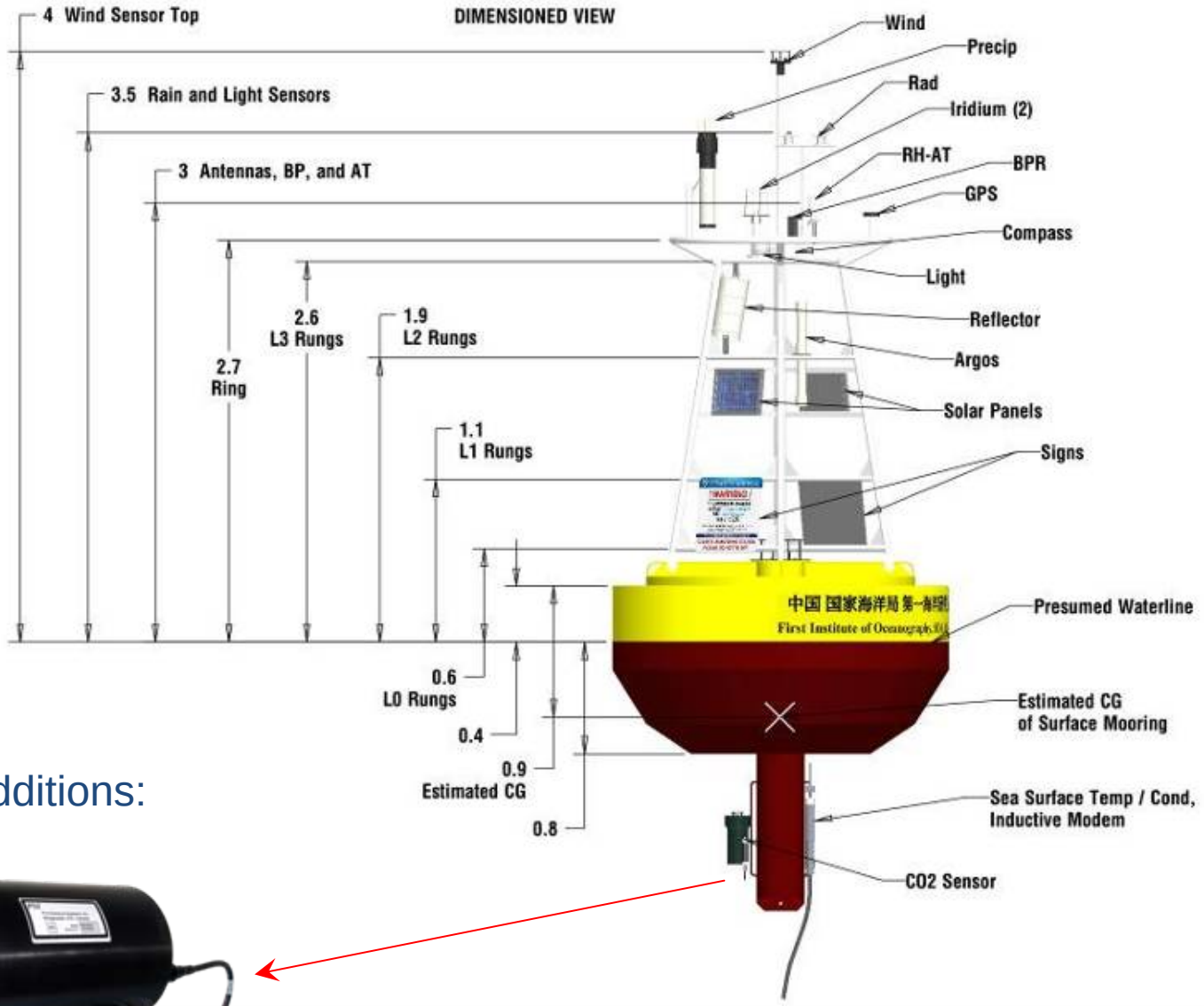
June 1 – September 1, 2010



Hourly Salinity Profile: 0-100m

June1 – September 7 , 2010



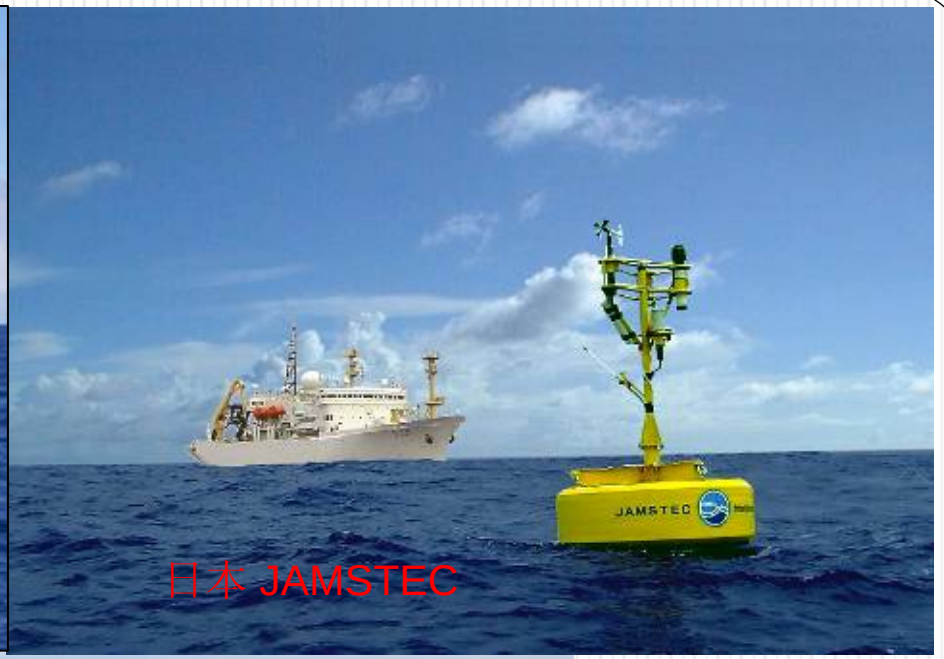


Future Additions:

PSI CO_2-Pro™: Pro-Oceanus System Inc., Canada

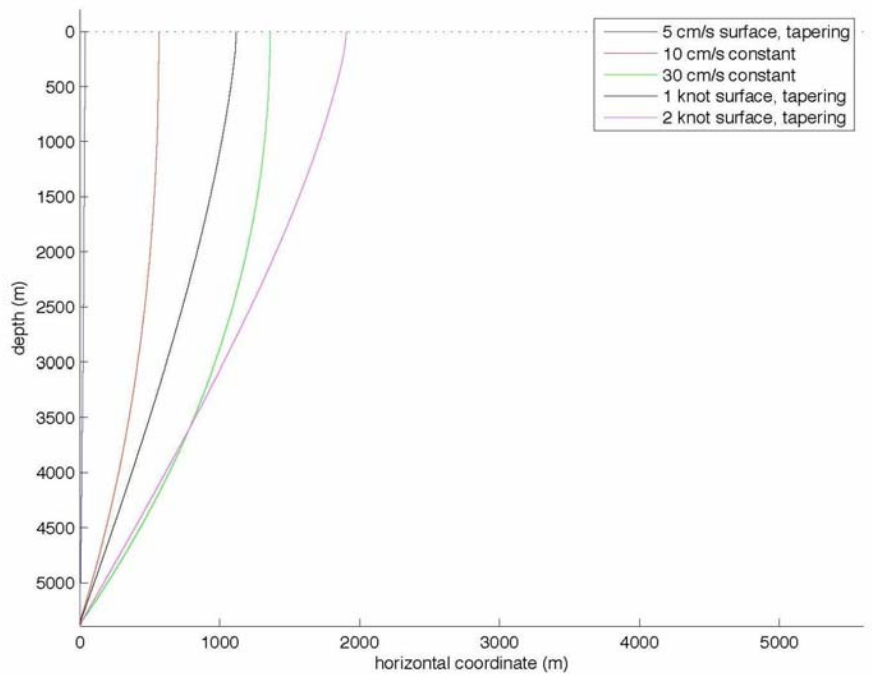
FIO Buoy with CO_2 sensor enhanced

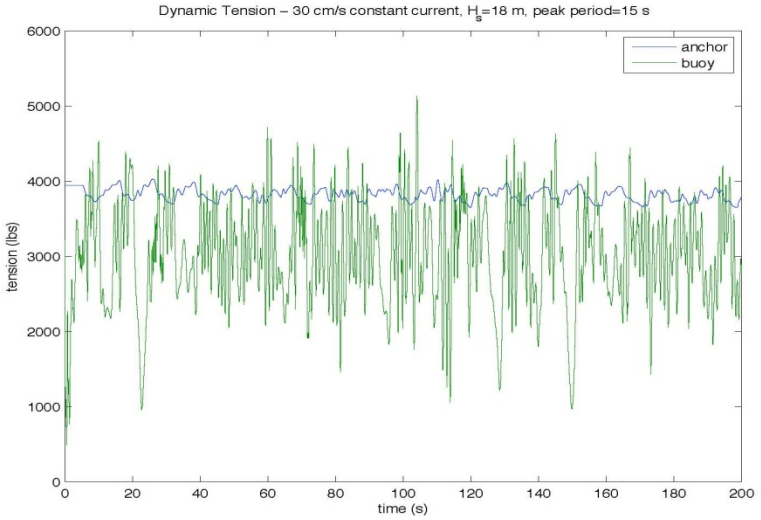

美国 NOAA


JAMSTEC
日本 JAMSTEC

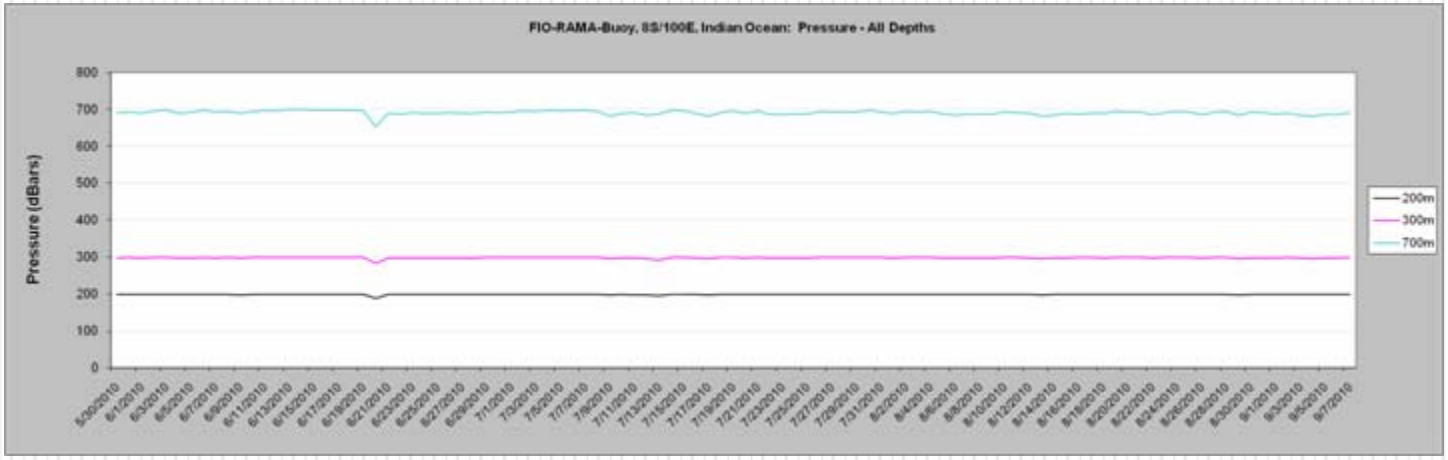

中国 海洋一所

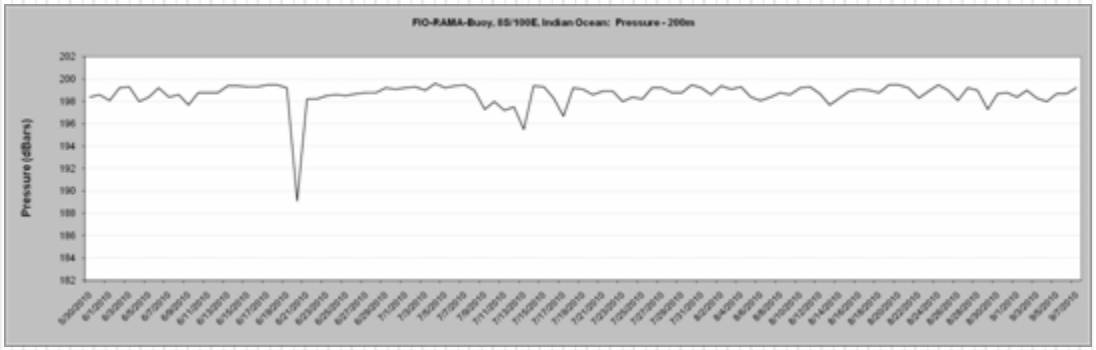
Mooring Performance



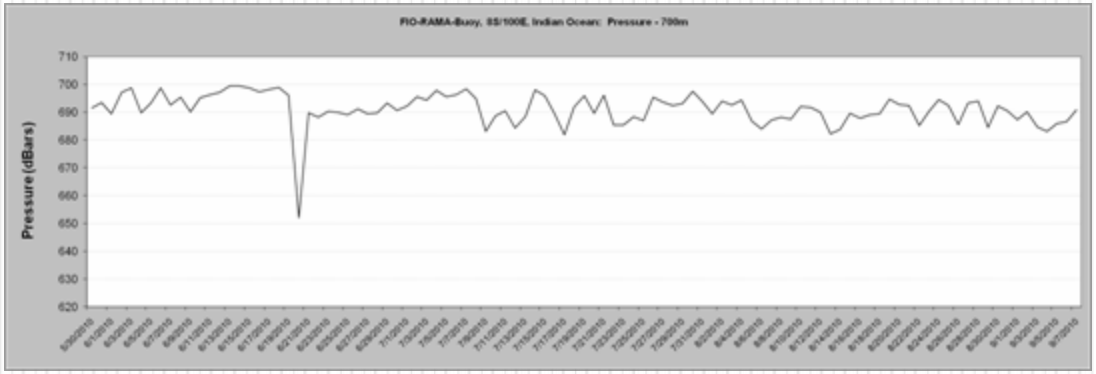


Pressure: 200m, 300m, & 500m





200m



700m

System No. 1 Travels

Thank You

wdyu@fio.org.cn rickcole@rdsea.com

RDSEA INTERNATIONAL

THE FIRST INSTITUTE OF OCEANOGRAPHY, SOA

2010 DBCP Workshop, Oban, Scotland

Down East Instrumentation, LLC