**NOAA / ESRL / PSD**

**Primary Turbulent Flux Data Acquisition System Ship-based**

**Rev 1.0**

**Technical Reference Guide for Turbulent Flux System**

**STRATUS Campaign 2015**



Turbulence Flux System setup Turbulence Flux System setup on

on R/V Knorr R/V Cabo de Hornos



Turbulence Flux System set up on R/V Moana Wave

**The PSD Turbulent Flux System**

The PSD Turbulent Flux Measurement System consists of six components:

* A fast turbulence system with ship motion corrections mounted on the jack staff.

The sensors are:

* Ultrasonic anemometer, Gill Wind Master model R3A.
* Systron Donner Inertia Div. Motion-pak unit with serial number 0681.

* Solar and IR radiation sensors are:
* Radiometers from The Eppley Lab, two pyranometers and two pyrgeometers mounted on the top of bridge or highest and unobstructed sky-see location.
* Bulk Meteorology-sensor are:
* Mean Vaisala T/RH (sensor s/n)sensor in aspirator,
* Near-Skin Surface Temperature (SST), SST measurement is made with a floating (YSI 46040) thermistor deployed off port side with outrigger.
* Optical Scientific Inc.-Optical Precipitation Sensor model ORG-815 DA.
* Li-COR 7500 fast CO2/H2Ogas analyzer - mounted on the top of bow tower.
* Two differential GPS heading, pitch and roll information – mounted on top of pilot house.

|  |  |  |
| --- | --- | --- |
| Item | System | Measurement |
| 1 | Air-sea flux system | Motion corrected turbulent fluxes |
| 2 | 3 Axis Motion system | Motion correcting for turbulent fluxes |
| 3 | Pyranometer & Pyrgeometer | Downward solar radiative, IR flux |
| 4 | Bulk meteorology | Tair, Relative Humidity, wind speed |
| 5 | Optical Rain gauges | Rain rate |
| 6 | Open Path LI-7500 Analyzer | CO2/H2O |
| 7 | Sea Snake | Sea surface temperature |

Table 1. Instruments used for air-sea interaction, cloud, and precipitation studies.

**Acquisition System Structure**

Two computes are used to log, archive and display instruments data sets; one computer is used solely as the data acquisition system while the other computer serves as real time display data and as the platform for daily diagnostics.

The instruments data is transmitted to the acquisition computer via a selected serial communication ports or via a selected wireless radio modems. The Data Acquisition System consist of three data loggers, six self contained instruments and two Microsoft Windows professional computer.

* Campbell CR1000 data logger, slow mean data MEAN1(1Hz)
* Campbell CR1000 data logger, slow mean data MEAN2(1Hz)
* Campbell CR1000 data logger, fast data Ship Motion(10Hz)
* Wind Master Pro Ultrasonic Anemometer Gill (10Hz)
* Open Path CO2/H2O Analyzer- LI-COR 7500 (10Hz)
* Motion Pak Systron & Donner model MP-GDDDQBBB-100 (10Hz)
* Crescent Hemisphere GPS-VS100 Heading, pitch (10Hz)
* PS3DAS04 Microsoft Windows XP professional computer.
* PS3DAS05 Microsoft Windows 7 professional computer.

PS3DAS05 computer collects real time data using a 8 serial port interface PCI device and a PSD developed sophisticated data acquisition software.

Ports COM3 thru COM10 are used for flux data acquisition instruments.

COM11 thru COM18 are available for other instruments to be included in the present study.

**Data Files**

All logged and archived data file names are formatted as follows:

aaabYYJJJHH\_raw.txt

aaa: Instrument identification

b: Index , default is 0 for one instrument

YY: last two digits of year

JJJ: julian day

HH: hour

Time stamp structure is as follows:

Timestamp: mmssmmm

mm: minutes

ss: seconds

mmm: milliseconds

Archived files have the following format:

* Combined Ship Data - scs0YYJJJhh\_raw.txt (optional, depending on ship data logging system)
* Ship Motion data – mot0YYJJJhh\_raw.txt
* Met Data logger – met1YYJJJhh\_raw.txt
* Met Data logger – met2YYJJJhh\_raw.txt
* 7500 Licor gas analyzer – lic0YYJJJhh\_raw.txt
* GPS Cresent VS100 – gps0YYJJJhh\_raw.txt
* Ship Heading& pitch - Crescent VS100– hed0YYJJJhh\_raw.txt
* Sonic anemometer – son0YYJJJhh\_raw.txt
* 7200 Licor gas analyzer – li00YYJJJhh\_raw.txt

**Instrument and data descriptions**:

* Gill Sonic Anemometer.

Data is acquired at 19200 baud rate and a sampling rate of 10Hz.

Data parameters are separated by a comma and file name format is:

son0YYJJJhh\_raw.txt

See bellow an example of the first and second lines of an hourly Anemometer raw data file.

4/19/2015 16:00 Generic with ASCII Output (SN: R3)

2409537 06,01,-06.28,+01.38,+00.72,+24.19, 0C

* Timestamp
* Status Address
* Status Data
* U (m/s)
* V (m/s)
* W (m/s)
* Sonic Temperature (deg C°)
* Check sum

B. LI-7500 Gas Analyzer.

Data are acquired at 9600 baud rate and a sampling rate of 10Hz.

Data parameters are separated by space and the file name format is:

lic0yyjjjhh\_raw.txt

See bellow an example of the first and second lines of an hourly Licor 7500 raw data file.

04/19/2015 00:00 Licor 7500 (SN: 1749)

0000022 249 15.6340 539.353 20.81 101.4

* Timestamp
* Diagnostic code
* CO2 (mmol/m3)
* HO2 ( mmol/m3)
* Temperature (deg C°)
* Pressure (kPa)

Temperature is in C, and Pressure is in kPa.

* Mean1 data logger.

Data is acquired at 9600 baud rate and a sampling rate of 1Hz

Rain Gauge Carrier and Sense, Temperature and Relative Humidity, Aspirator.

Data parameters are separated by commas the file name format is:

Met1yyjjjhh\_raw.txt

04/22/2015 03:00 Capmbell Datalogger (SN: 40295)

0059849 04/22/2015 03:00:00, 12.3,23.75,5.063,0.07700001,0,162.2,20.74,70.7,0,0.004,0, 0.001,0.001, 0,0.726,0.014,0.427,0

* Timestamp
* Date
* Datalogger time
* Datalogger Battery
* Datalogger temperature
* ORG Rain Gauge Carrier Voltage -average
* ORG Rain Gauge Sensing Voltage –average
* ORG1 mm/hr – average
* Aspirator air flow
* Air Temperature
* Air Humidity
* Water switch
* Battery std
* Datalogger Temp std
* ORG carrier std
* ORG sense std
* ORG mmhr std
* Airflow std
* Temperature std
* Humidity std
* Water switch std
* Mean2 data logger.

Data is acquired at 9600 baud rate and a sampling rate of 1Hz

Rain Gauge Carrier and Sense, Temperature and Relative Humidity, Aspirator.

Data parameters are separated by commas the file name format is:

Met1yyjjjhh\_raw.txt

See bellow an example of the first and second lines of an hourly Mean raw data file.

First line shows: Date, Hour, Instrument Description.

04/22/2015 00:00 Campbell Datalogger (SN: 58025)

0059091 04/22/2015 00:00:00,12.06,20.74,12406.32,19.7,12499.35,19.52,12653.07, 19.23, 12665.48,19.21,-0.059,-14.4,-0.012,-1.417,-0.033,-10.44,-0.009000001,-1.022, 3463.042, 21.74315,1014.027,21.1523,0.041,28.2824,0.054,0,0,0,0,0.002,0.536,0.001,0.101,0.001,0.435,0.003,0.36,0.446,0.003,129.9

* Timestamp
* Date
* Datalogger time
* Datalogger Battery
* Datalogger temperatu
* Case Resistance PIR1-average
* Case Temperature PIR1-avearage
* Dome Resistance PIR1-average
* Dome Temperature PIR1-average
* Case Resistance PIR2-average
* Case temperature PIR2-average
* Dome Resistance PIR2-average
* Dome Temperature PIR2-average
* PIR1 voltage
* PIR1 w/m2
* PSP1 voltage -average
* PSP1 w/m2 -average
* PIR2 voltage
* PIR2 w/m2
* PSP2 voltage -average
* PSP2 w/m2 -average
* Sea snake 4 wire resistance – average
* Sea snake 4 wire temperature – average
* Atmospheric pressure hpa
* Case1\_R\_Std
* CaseT\_1\_Std
* Dome1\_R\_Std
* DomeT\_1\_Std
* Case2\_R\_Std
* CaseT\_2\_Std
* Dome2\_R\_Std
* DomeT\_2\_Std
* PIR1\_V\_Std
* PIR1\_wm2\_Std
* PSP1\_V\_Std
* PSP1\_wm2\_Std
* PIR2\_V\_Std
* PIR2\_wm2\_Std
* PSP2\_V\_Std
* PSP2\_wm2\_Std
* Snake\_r4w\_Std
* SnakeC\_4W\_Std
* hpa\_Std
* Ship Heading Crescent VS100 s/n VS 0821-7117-0008

Data are acquired at 19200 baud rate and a sampling rate of 10Hz.

Data parameters are separated by commas and the file name format is: hed0yyjjjhh\_raw.txt.

04/18/2015 00:00 Hemisphere GPS (SN: 12345)

0000049 $PSAT,HPR,000000.10,318.49,3.76,,G\*31

1 Timestamp

2 $PSAT,HPR identifier

3 time UTC time (HHMMSS.SS)

4 heading in degrees

5 pitch in degrees

6 roll in degrees

7 type N for GPS, G for gyro

* Ship pitch, roll and yaw motion with

Motion-pak data logger.

Data are acquired at 38400 baud rate and a sampling rate of 10Hz.

Data parameters are separated by commas and the file name format is:

mot0yyjjjhh\_raw.txt

04/18/2015 00:00 Pen State (SN: 1234)

0000004 0.01774826,-0.009556756,-0.02457452,-0.07372354,-0.1460818,-3.563305

* Timestamp
* Rate-x
* Rate-y
* Rate-z
* Acceleration-x
* Acceleration-y
* Acceleration-z
* Ship position GPS Cresent VS100

Data are acquired at 19200 baud rate and a sampling rate of 10Hz.

file name format: gps0yyjjjhh\_raw.txt

Date, hour, instrument name and serial number are showed on every hourly file.

04/18/2015 00:00 Hemisphere GPS (SN: 123456)

0000046 $GPRMC,235847.65,V,2834.77694477,S,07646.67625776,W,12.24, 315.91,170415,4.9, E,N\*18

0000950 $GPVTG,315.91,T,311.00,M,12.24,N,22.67,K,N\*24

0000970 $GPZDA,000001.00,18,04,2015,00,00\*6C

$GPRMC coding

* Timestamp
* GPS code $GPRMC
* GPS time (HHMMSS.SS)
* Status ('A' = valid, 'V' = warning)
* Latitude in degrees, minutes and decimal minutes (DDMM.MMMMM)
* N or S latitude
* Longitude in degrees, minutes and decimal minutes(DDDMM.MMMMM)
* W or E longitude
* Speed-over-ground Z.Z in knots
* Track made good, reference to true north
* UTC date DDMMYY
* Magnetic Variation in degrees D.D
* Variation Sense v=E ;V=W
* \*CC check sum

$GPGGA coding

* Timestamp
* GPS code $GPGGA
* GPS time (HHMMSS.SS)
* Latitude in degrees, minutes and decimal minutes (DDMM.MMMMM)
* s=N or S=S latitude
* Longitude in degrees, minutes and decimal minutes(DDDMM.MMMMM)
* s=W or S=E longitude
* N quality indicator 0= no pos, 1=un-differentially corrected position, 2=diff corrected position
* QQ = number of satellites
* PP.P = HDOT = 0.0 to 9.9
* Antenna altitude SAAAA.AA
* M altitude, M=meters
* +/- XXXXX.XX geoidal separation
* M geoidal separation units, M= meters
* SSS= age of differential correction
* AAA= ref station
* \*CC check sum

$GPVTG coding

* Timestamp
* GPS code $GPVTG
* T
* True course over ground, 000 to 359 degrees
* Magnetic course over ground, 000 to 359 degrees
* M
* Speed over ground, 00.0 to 99.9 knots
* N
* Speed over ground, 00.0 to 99.9 kilometers per hour
* K
* Check sum

**Sensor Coefficient Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sensor** | **Calibration coefficient** | **Make / Model** | **Serial Number** | **Date of calibration** |
| Precision Spectral Pyranometer | 0.00851 | Eppley / PSP 1 | 28110F3 | May 12, 2014 |
| Precision Spectral Pyranometer | 0.00846 | Eppley / PSP 2 | 34290F3 | May 2, 2014 |
| Precision Infrared Radiometer | 0.00319 | Eppley / PIR 1 | 30433F3 | May 2, 2014 |
| Precision Infrared Radiometer | 0.00408 | Eppley / PIR 2 | 30558F3 | May 2, 2014 |
| Rain Gauge | Offset=0.058mV | OSI/ORG815DA | 8060281 | Apr 30, 2012 |
| Motion Pak ZERO xrate | 0.00828 | Sundstrand | n/a | May 15,2012 |
| Motion Pak ZERO yrate | 0.01728 | Sundstrand | n/a | May 15,2012 |
| Motion Pak ZERO zrate | 0.03569 | Sundstrand | n/a | May 15,2012 |
| Motion Pak Zero xaccel | 0.009 | Systron & Donner | n/a | May 15,2012 |
| Motion Pak ZERO yaccel | -0.0064 | Systron & Donner | n/a | May 15,2012 |
| Motion Pak ZERO zaccel | -0.008 | Systron & Donner | n/a | May 15,2012 |
| Sea Snake thermistor 0C to 40C | C4=0.001399937 | YSI 46040 series | n/a | May 9, 2012 |
| Sea Snake thermistor 0C to 40C | C5=0.00237854 | YSI 46040 series |  |  |
| Sea Snake thermistor 0C to 40C | C6=0.000000097 | YSI 46040 series |  |  |
| Temp / Humidity | n/a | Vaisala/HMT335 | C1110008 | Feb 22, 2014 |
| Class A Barometer | n/a | Vaisala/ PTB220 | E1350206 | June16, 2013 |
| CO2/H2O Analyzer | Available | Licor / LI-7500  In use | 75H-1749 | Zeroed Jul 19,2013  CO2 Zero=0.9190  H2O Zero=0.9023 |
| CO2/H2O  Analyzer | Available | Licor / LI-7500  spare | 75H-1397 | Zeroed Jul 16,2007  CO2 Zero=0.8652  H2O Zero=0.9113 |
| Wind Sensor | n/a | Gill / R3A | 138 |  |
| Wind Sensor | n/a | Gill / R3A | 137 | spare |
|  |  |  |  |  |