The NOAA Portable Seagoing Air-Sea Flux Standard

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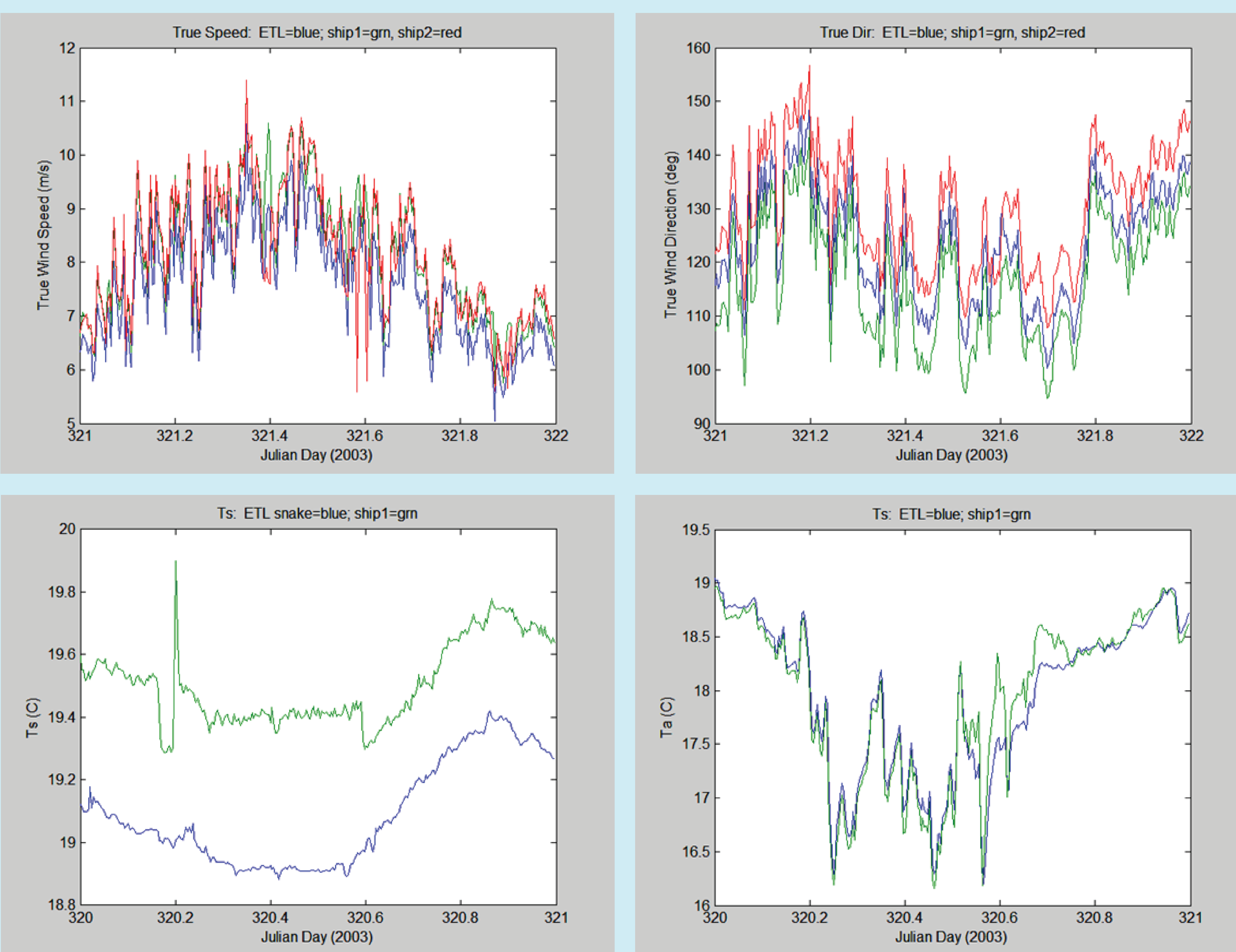
Relevant quantities:
Turbulent fluxes (stress, sensible and latent heat), radiative fluxes (solar and IR), precipitation, bulk meteorology.
Potential:
Present technology allows measurements of net heat input to the ocean from ships and buoys to an accuracy of about 10 W/m^2, but this accuracy is not being realized on most platforms.
Solution:
Implement a multi-faceted program of quality assurance, intercalibration, and data archiving.
- Research Vessels (NOAA, UNOLS, Navy, Coast Guard,..)
- VOSClim

Strategy:
Create a ship flux measurement group.
- Construct a state-of-the-art portable flux standard that can be installed on any ship to obtain best possible characterization of the relevant variables
- Construct a distributed set of sensors to be place with ship sensors for side-by-side intercomparison

Requirement:
There is a need for air-sea flux measurements of high accuracy and high time resolution.
- Intensive field programs
- Satellite retrievals
- NWP/Climate model products
- Climate monitoring
- Work with each ship operator to improve sensor suite, placement, connection methods, processing, etc
- Perform a computational fluid dynamics ICFD) assessment of the flow distortion effects for specific sensor locations
- Set up a web site with a Flux Manual detailing procedures and best practices for measurements from ships and flux estimation methods

Example:



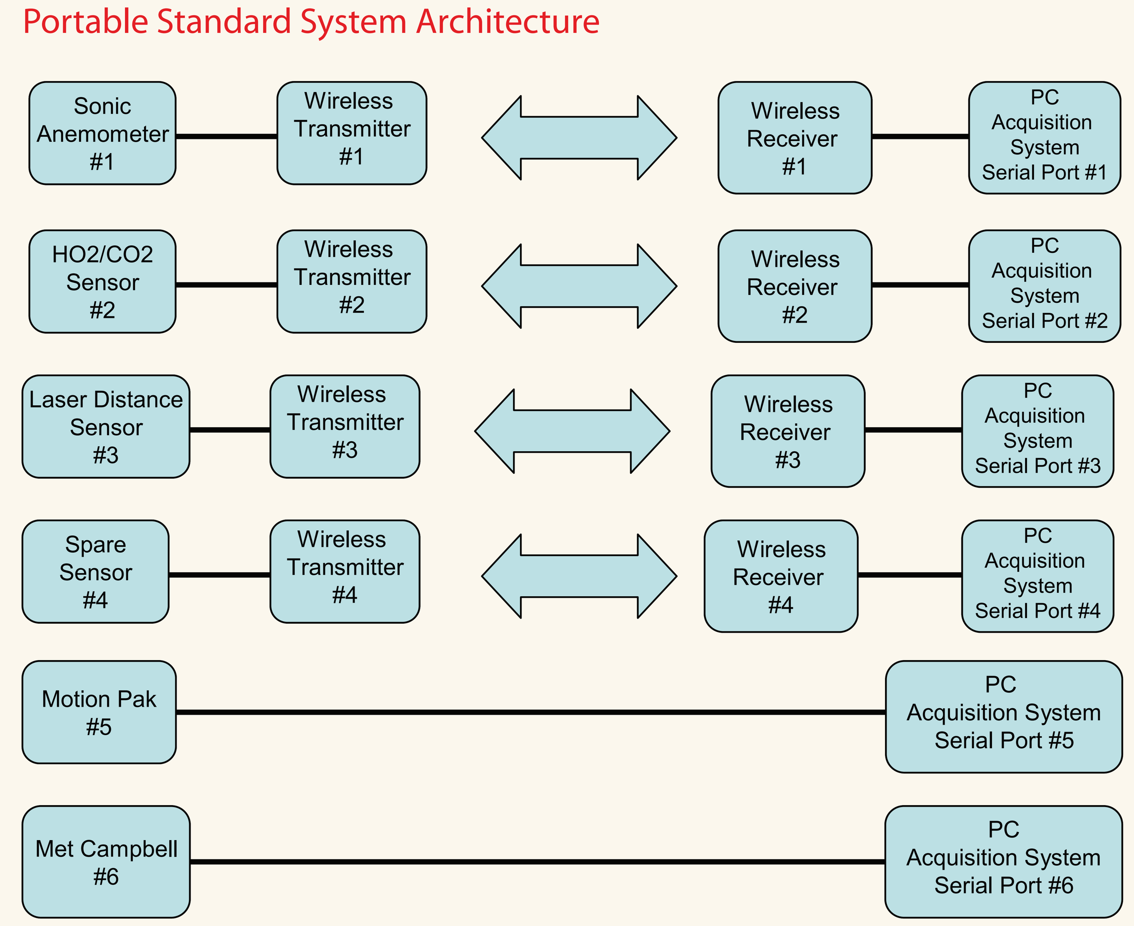
Recent sample comparison of ETL/PSD and Ship sensors from the *R/V Roger Revelle*: upper left, wind speed; upper right, wind direction; lower left, water temperature.; lower right, air temperature.

Accuracy Requirements

Table 1: Accuracy, precision and random error targets for SAMOS. Accuracy estimates are currently based on time scales for climate studies (i.e., ±10 W/m^2 for Q_{net} on monthly to seasonal timescales). Several targets are still to be determined.

Parameter	Accuracy of Mean (bias)	Data Precision	Random Error (uncertainty)
Latitude and Longitude	0.001°	0.001°	
Heading	2°	0.1°	
Course over ground	2°	0.1°	
Speed over ground	Larger of 2% or 0.2 m/s	0.1 m/s	Greater of 10% or 0.5 m/s
Speed over water	Larger of 2% or 0.2 m/s	0.1 m/s	Greater of 10% or 0.5 m/s
Wind direction	3°	1°	
Wind speed	Larger of 2% or 0.2 m/s	0.1 m/s	Greater of 10% or 0.5 m/s
Atmospheric Pressure	0.1 hPa (mb)	0.01 hPa (mb)	
Air Temperature	0.2 °C	0.05 °C	
Dewpoint Temperature	0.2 °C	0.1 °C	
Wet-bulb Temperature	0.2 °C	0.1 °C	
Relative Humidity	2%	0.5 %	
Specific Humidity	0.3 g/kg	0.1 g/kg	
Precipitation	~0.4 mm/day	0.25 mm	
Radiation (SW in, LW in)	5 W/m^2	1 W/m^2	
Sea Temperature	0.1 °C	0.05 °C	

Portable Standard System Architecture



Sensors

Anemometer
Open path Fast H2O/CO2 Analyzer
Laser Distance Wave Sensor
XYZ Angular velocity and linear Acceleration Sensor
Heading Gyrocompass
GPS
Met Campbell
- T/RH air temperature/humidity
- Optical Raingauge
- Pressure sensor
- PIR Longwave radiative flux
- PSP Solar radiative flux
- Surface water temperature

Instrument Specifications

- Sonic Anemometer – GILL instruments Ltd
  * Omnidirectional R3 Ultrasonic Anemometer - serial interface
- Open Path CO2 / HO2 Analyzer – LICOR Inc.
  * model #7500 – serial interface
- Laser Distance Sensor - RIEGL
  * model #LD90-3100VHS-FLP -serial interface
- XYZ Motion Sensor – Systron and Donner
  * model #MP-GDDDQBBB-100 – analog output
- Gyrocompass - Robertson Marine Electronics
  * model #RGC10 - serial interface
- Air T/RH - Vaisala
  * model #HMP-230 T/RH - analog output
- GPS Smart Antenna - GARMIN
  * model #35/36 TrackPak - Serial Interface
- Optical Sensor - Optical Scientific, Inc.
  * model #ORG-815-DA - analog output
- Precision Infrared Radiometer - Eppley
  * model #PIR - analog output
- Precision Spectral Pyranometer - Eppley
  * model #PSP - analog output
- Surface water Sensor - YSI Incorporated
  * Super-Stable Thermistor #46040 - analog output
- Cloud Ceilometer - Vaisala
  * model #CT25K - serial interface
- Air Pressure - Vaisala Pressure sensor
  * model PTB220

Wireless Communications:

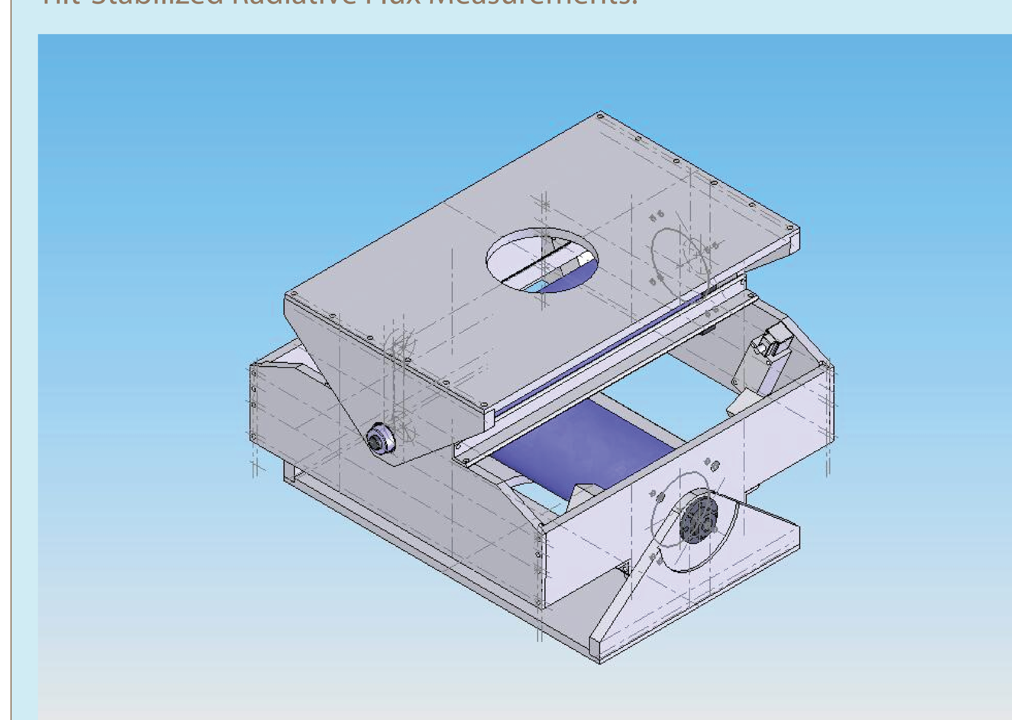
R/V Ronald Brown
Flux System.
Wireless transmitter are connected to :
Sonic
Licor
Laser wave gauge

R/V Ronald Brown Flux System
Wireless receivers and Interface box on 2nd deck starboard side

Wireless Specifications:

- Each serial interface instrument is connected in a point to point network topology with its own address identity.
- A standard 2.4 GHz transmit frequency with spread interfacing protocol.
- The radio modem are build by MAxStream with RS-232 PC interface.
- The interface is set for all set of instruments as 9600, 8,none,1 stop.
- The sampling rate are:
  * Sonic Anemometer 10Hz
  * Open Path CO2 / HO2 Analyzer 10Hz
  * Laser Distance Sensor 1Hz

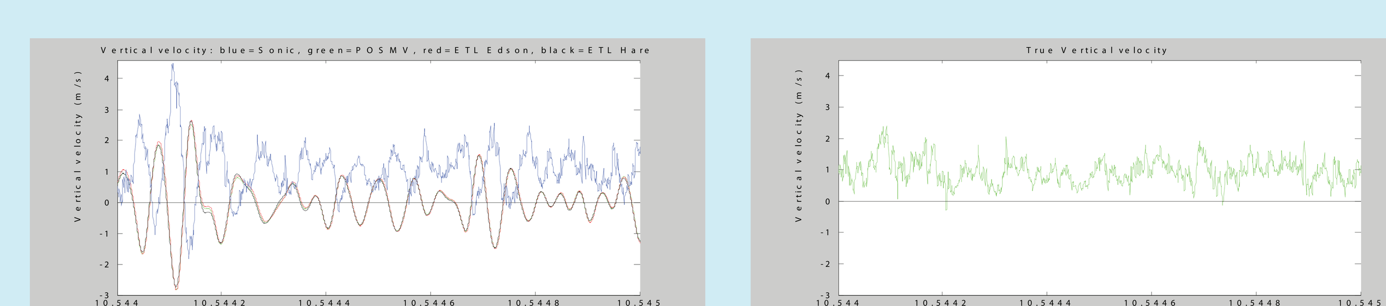
Tilt-Stabilized Radiative Flux Measurements:



The Stabilized stand alone system consists of:

* 2 axis motion controller from Galil model #DMC 2020
* Power Amplifier/ Interface from Galil model #AMP-19520
* Solid State Vertical Gyro from Crossbow model VG400MA-100
* Servo motors from Parker

Motion-Corrected Winds and Turbulence Example: Vertical Velocity



Plot of 86 s of data from the R/V Seward Johnson during RICO 2005: the upper panel shows the measured sonic vertical velocity (blue line) and the computed vertical velocity corrections from PSD (J.B.Edson and J.Hare routines) and the POS-MV ship system (red, green, and black lines). The bottom panel shows the true vertical velocity after removal of computed motion from the raw anemometer signal. The residual offset is a mean tilt of the flow caused by the ship structure.