Accuracy of Research Vessels as *in situ* Sources of Surface Flux Data from Recent PSD Cruises

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1.Introduction

For the last 10 years NOAA/ESRL has installed the PSD roving flux standard system onboard research vessels in support of Flux Reference buoy deployments and/or NOAA research field programs. Since 2002 we have evaluated 10 R/V's that contribute data to the SAMOS climate data archive. Data from 9 earlier cruises on NOOA R/V's are included in the statistics. Just for grins, five years of comparisons with TAO buoys are included. In this poster we will summarize the comparisons of PSD and R/V measurements from bulk meteorological variables and radiative fluxes.

2. Context

The PSD flux standard is one component of a strategy to create accurate gridded flux products as part of the ocean observing system. The PSD standard is the most accurate and dirct observing system and it forms the cornerstone for establishing the accuracy of the system.

Other components are:

**Ocean Reference Sites* (ORS): Buoys with climate-quality flux sensors (WHOI and PMEL)

*VOS observations in *the International Comprehensive Ocean-Atmosphere Dataset* (ICOADS): Volunteer ship observations.

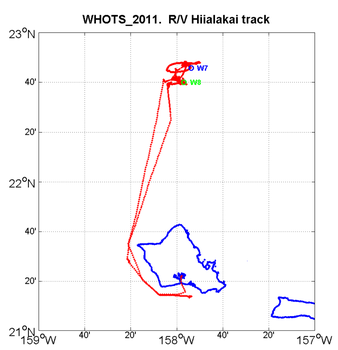
**Shipboard Automated Meteorological and Oceanographic System* (SAMOS): Archive of high quality observations from US and foreign research vessels at high temporal resolution.

**WCRP Surface Flux Analysis* (SURFA): A real-time archive of flux and bulk variables from operational NWP centers (ECMWF, DWD, JMA).

* *Objectively analyzed air-sea flux fields* (WHOI-OAFlux): Gridded flux field computed by blending select variables from different sources including NWP, satellite, and *in situ* variables.

3. PSD Flux Standard

The PSD flux standard represents two decades of development of sensors, techniques, software, and expertise. An example deployment on NOAA ship Hi'illikai for the WHOTS cruise (June 2011) is shown below.



Sensor	Sampling rate	Height (m)
Sonic Anemometer	10 Hz	18
Motion Pack 6-component	10 Hz	17.8
ORG	0.1Hz, averaged to 1 sample/min	16.4
T/RH	0.1Hz, averaged to 1 sample/min	16.1
Licor 7500 (CO2&H2O)	10 Hz	16.6
Radiometers	0.1Hz, averaged to 1 sample/min	14.5
Barometer	0.1Hz, averaged to 1 sample/min	12
SST	0.1Hz, averaged to 1 sample/min	-0.05 to -0.10
Lidar ceilometer	15 s, averaged to 10 min	15-7500 m

Ship	Ts C	Ta C	Qa g/kg	RH %	U m/s	Rl W/m^2	Rs W/m^2	P mb
RHB 99 - 03	-0.1	-0.1	-0.7		0.2			
KAI 00 - 02	0	0.2	0.4		0.4			
Revelle 03	0.2	-0.2	0		0.8		4	
RHB 04	-0.1	-0.1	-0.1		-0.2	-1	2	
Tao Buoys 99-04	-0.05	0.2	0.5		0.3	1	-12	
Knorr 08		-0.2	-0.2	-0.5	-0.3	0	5	1
RHB 08	-0.3	0.3	1.3	7	-0.2	0	6	-0.1
Kilo Moana 09	0.3	-0.8	-0.7	-1	0.4	2	-11	
RHB 10	-0.3	0	0.4	3	-0.7	3	-16	-0.1
Atlantis 10	0.1	0.4	0.4	-1	-0.7		-25	
Hi'Illikai 11	-0.4	1.7	0.9	2	0.4			-0.8
Revelle 11	-0.1	0.2	0.1	0	0.1	3	8	0.3
Mean	-0.07	0.13	0.19	1.36	0.04	1.14	-4.33	0.06
Sigma	0.2	0.6	0.6	2.9	0.5	1.6	11.8	0.7
Sigma/sqrt(N-1)	0.06	0.17	0.17	1.03	0.13	0.56	3.74	0.27
SAMOS target	0.1	0.1	0.15	1	0.2	3	3	0.5
PSD Standard	0.1	0.2	0.3	2	0.2	5	5	0.3

4. Analysis

The analysis presented here is for the basic observed variables (near-surface bulk meteorology, radiative fluxes, and pressure). The values in the table are the cruise mean of the Ship-PSD. Three NOAA and four UNOLS ships are included. Multiple cruises have been made on several ships. A value given in red denotes the difference exceeds the SAMOS guidelines. A few points to note:

*The mean of the ensemble difference is not significantly different from zero for all variables. Thus the PSD standard is accurate and there no apparent bias in the pool of R/V observations.

*The standard deviation of the ensemble exceeds the SAMOS targets for air temperature and humidity, wind speed, and solar flux. This means that on average the typical individual ship does not meet the standard for those variables.

5. Summary & Future Work:

*Analysis of 10 years of comparisons of the PSD roving flux standard with NOAA and UNOLS research vessel meteorological observations reveals inconsistent accuracy for some vessels.

*The analysis shows the R/V fleet taken as an ensemble has no significant bias in variables used to compute fluxes, although individual ships have accuracy problems

*SST, IR flux, and pressure are generally within guidelines.

*The PSD and SAMOS teams need to re-connect with R/V operational centers and ship tech programs to improve the observations.

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