A Long-term intercomparison between a Datawell Waverider buoy and an NDBC directional wave buoy: Part 1: the bulk sea state parameters

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Thanks to:

Tyler Hesser and Bob Jensen of US Army Corps of Engineers



Julie Thomas, Corey Olfe, Vicki Kellis CDIP/UCSD





The Southernmost Order of Flying Conchs (Bubba-tized Division) to LT RICHARD BOUCHARD

from .09. JUL 82... to 15 OCT 85



What Am I Doing?

- Comparing One NDBC deployment of a dual wave system in the vicinity of a Datawell Waverider MkIII
- NDBC Hull 3D68 (46042) deployed 10 January 2012 until 28 July 2015: Spans 31080 hours
- Hull 3D68 had:
 - (1) Datawell Hippy 40 with Directional Wave Processing Module (DWPM), version 2.0 and
 - (2) Microstrain 3DM-GX1® with Digital Directional Wave Module (DDWM) 2.03 (tilt correction to mitigate *Bender Effect*)
- Four Datawell Waverider MkIII deployments

Datawell Hippy 40 as Medium to Gage Accuracy of Candidate Systems to Accepted Standard

Datawell Hippy 40 "guts" of Waverider that can be used on an NDBC buoy



NDBC Accuracy Statements

http://www.ndbc.noaa.gov/rsa.shtml

		ARES	Payload		
PARAMETER	RANGE	FREQ.	AVG. PERIOD	RESOLUTION	ACCURACY
Wind Dir.	0 to 360	1.71 Hz	2/8 min *	1.0 deg	+/- 10.0 deg
Wind Speed	0 to 62 m/s	1.71 Hz	2/8 min *	0.1 m/s	+/- 1.0 m/s or 10% ***
Wind Gust	0 to 82 m/s	1.71 Hz	3 & 5 sec	0.1 m/s	+/- 1.0 m/s or 10% ***
Air Temp.	-40 to +60 C	1.71 Hz	2/8 min *	0.1 C	+/- 1.0 C
Pressure	800 to 1100 hPa	1.71 Hz	2/8 min *	0.1 hPa	+/- 1.0 hPa
Sea Surface Temp.	-5 to +40 C	1.71 Hz	2/8 min *	0.1 C	+/- 1.0 C
Rel. Humidity	0 to 100%	1.71 Hz	2/8 min *	0.1%	+/- 3%
Wave Height	0 to 35 m	1.71 Hz	40/20 min §	0.1 m	+/- 0.2 m
Wave Period	0 to 30 SEC	1. 71 Hz	40/20 min §	1.0 sec	+/- 1 sec
Wave Spectra	0 to 99 m*m/Hz	1.71 Hz	40/20 min §	0.01 Hz ¹	NA
Wave Dir.	0 to 360	1.71 Hz	40/20 min §	0.1 deg	+/- 10 deg
	001 00 0		A.A		

Bulk Parameters

Same Definitions for Datawell as NDBC; Primary products of NWS Forecasts

- Significant Wave Height (H_{m0})
 - NDBC = WHT
 - CDIP = Hs
- Average Period $((m_0/m_2)^{\frac{1}{2}})$
 - NDBC = APD
 - CDIP = T_z
- Dominant Period:
 - NDBC= DPD
 - Waverider = Tp
- Mean Wave Direction (at

the Dominant Period)

- NDBC = MWD
- CDIP = Dp

ZCZC MIATCDAT3 ALL TTAA00 KNHC DDHHMM TROPICAL STORM BARRY DISCUSSION NUMBER 3 NATIONAL WEATHER SERVICE MIAMI FL 10 PM CDT THU AUG 02 2001

WIND RADII HAVE BEEN REVISED ON THE BASIS OF AIRCRAFT DATA...AND 12 FT SEAS RADII HAVE BEEN REVISED ON THE BASIS OF BUOY DATA.

PZZ820-142345-

POINT ST. GEORGE TO POINT ARENA BETWEEN 60 NM AND 150 NM OFFSHORE-855 AM PDT WED OCT 14 2015

TODAY

N WINDS 15 TO 25 KT DIMINISHING TO 10 TO 15 KT...EXCEPT SE PORTION BECOMING SW TO W. SEAS 9 TO 11 FT SUBSIDING TO 7 TO 8 FT LATE.

TONIGHT

WINDS BECOMING N TO NW AND DIMINISHING TO LESS THAN 10 KT. SEAS BECOMING 6 TO 7 FT.







Bender (2010) Effect: Overestimates 26 – 56% Persistent Tilt Maps Horizontal Accelerations into Strapped-Down Accelerometers for Shallow-water, Small hulls



Effects of Tilt Correction

on Significant Wave Height

46042 (Monterey) Tilt Corrected DDWM Max 7.4 meters

46029 (Columbia River Bar) No Tilt Correction DDWM Max 9.5 meters



Bender Effect HIPPY-WAVERIDER DDWM- WAVERIDER

Mechanical Tilt Control

Tilt Correction



	Katrina Intercept Linear	Katrina Intercept Quad
Hippy-Waverider	-0.39 m/ -2%	-2.69 m/-15.9%
DDWM-Waverider	-0.54 m/ -3%	-2.42 m/-14.3%



plus ça change, plus c'est la même chose

- Karr, 1849

Today

Wang, 1995, Monterey Bay





Wave	rider	ND	BC		Wave	erider	ND	BC
Freq (Hz)	BW (Hz)	Freq (Hz)	BW (Hz)		Freq (Hz)	BW (Hz)	Freq (Hz)	BW (Hz)
0.0250	0.005	- 		9.1 s	0.1100	0.01	0.1100	0.010
0.0300	0.005	0.0005	0.005		0,1200	0.01	0.1200	0.010
0.0350	0.005	0.0325	0.005		0,1300	0.01	0.1300	0.010
0.0000	0.005	0.0375	0.005		0.1400	0.01	0.1400	0.010
0.0400	0.005				0 1500	0.01	0 1500	0.010
		0.0425	0.005		0.1600	0.01	0 1600	0.010
0.0450	0.005	2000 Biological Biological Biological Biological Biological Biological Biological Biological Biological Biologi Biological Biological Biological Biological Biological Biological Biological Biological Biologica Biological Biological Biological Biological Biological	27.5-34 G		0.1000	0.01	0.1000	0.010
		0.0475	0.005		0.1700	0.01	0.1700	0.010
0.0500	0.005				0.1800	0.01	0.1800	0.010
		0.0525	0.005		0.1900	0.01	0.1900	0.010
0.0550	0.005	an analyze the	Construction of the		0.2000	0.01	0.2000	0.010
		0.0575	0.005		0.2100	0.01	0.2100	0.010
0.0600	0.005				0.2200	0.01	0.2200	0.010
0.0650	0.005	0.0625	0.005		0.2300	0.01	0.2300	0.010
0.0050	0.005	0.0675	0.005		0.2400	0.01	0.2400	0.010
0.0700	0.005		0.000		0.2500	0.01	0.2500	0.010
		0.0725	0.005		0.2600	0.01	0.2600	0.010
0.0750	0.005				0 2700	0.01	0 2700	0.010
		0.0775	0.005	250	0.2900	0.01	0.2900	0.010
0.0800	0.005			3.3 S L	0.2800	0.01	0.2000	0.010
		0.0825	0.005		0.2900	0.01	0.2900	0.010
0.0850	0.005				0.3000	0.01	0.3000	0.010
		0.0875	0.005		0.3100	0.01	0.3100	0.010
0.0900	0.005				0.3200	0.01	0.3200	0.010
0.0050	0.005	0.0925	0.005		0.3300	0.01	0.3300	0.010
0.0950	0.005	0 4000	0.040		0.3400	0.01	0.3400	0.010
0 1012	0.0075	0.1000	0.010	hg and Forecasting Work	o 3500	0.01	0.3500	0.010
0.1013	0.0075			<u> </u>	0.0000	0.01	0.0000	0.010

Differences in Dominant Period (seconds) HIPPY-WAVERIDER

	Staggered Center Frequencies Waverider DPD > 9.1 s	Aligned Center Frequencies Waverider DPD <= 9.1 s
Ν	14155	4446
Bias	-0.61	0.46
RMSD	2.36	1.82
Mean	13.1	8.1
Range	9.9 – 22.2	3.5 – 9.1
RMSD /Mean	0.180	0.225







MWD degrees)	Hippy- WaveR	DDWM- Hippy	DDWM- WaveR
Bias	+4.9	-2.0	+2.9
RMSD	32.0	24.3	36.5
MAE	16.4	9.6	19.4

MWD error includes DPD error and directional errors

MWD RMSD

MWD (degrees)	Hippy- WaveR	DDWM- Hippy	DDWM- WaveR
All Measurements N = 18601	32.1	24.3	36.5
Δ DPD <= 1 s N = 12487	13.2	18.7	21.6
∆ MWD < 20 degrees in an hour N = 13533	17.7	7.1	18.7
Δ MWD < 20 degrees in an hour && Δ DPD <= 1 s N = 9841	9.9	6.6	11.7

Bulk Statistics of the Bulk Parameters

	Accuracy Requirement	HIPPY- WAVERIDER	DDWM -HIPPY	DDWM- WAVERIDER
WHT (m)	√0.2	0.1899	0.0429	0.1911
APD (s)	√1.0	0.5245	0.2127	0.5944
DPD (s)	Requires subsetting,	2.2399	2.2399	2.2135
MWD (deg)	or averaging	32.0	24.3	36.5

Conclusions

- NDBC Hippy 40 and DDWM 2.03 virtually indistinguishable for bulk statistics of the bulk parameters
- Can meet accuracy requirements for integrated parameters
- Tilt Correction appears to have reduced the Bender Effect in higher seas for this <u>limited range of seas</u>, perhaps now underestimating
- Hippy 40 DWPM always underestimated
- NDBC's contribution to JCOMM Wave Evaluation and Testing Pilot Project provides opportunity to test to a common reference
- More Work:
 - Outliers
 - Repeat for 46029

Thank-you

 More info: http://www.ndbc.noaa.gov/wavemeas.pd

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