

SCOOP

New Ocean Observing System for NDBC

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Self-Contained Ocean Observations Payload (SCOOP)

Background - Typical NDBC Buoy Met Data

Continuous Winds

TIME (HAST)	WDIR	WSPD
8:50 am	ENE (57 deg)	20.2 kts
8:40 am	NE (56 deg)	20.0 kts
8:30 am	NE (54 deg)	19.8 kts
8:20 am	NE (51 deg)	20.0 kts
8:10 am	NE (55 deg)	18.6 kts
8:00 am	NE (52 deg)	18.5 kts

Peak gust during the measurement hour

TIME (HAST)	GDR	GST
8:16 am	NE (50 deg)	25.3 kts

MM DD	TIME (HAST)	WDIR	WSPD	GST	Previous observations									
					WVHT	DPD	APD	MWD	PRES	PTYD	ATMP	WTMP		
			kts	kts	ft	sec	sec		in	in	°F	°F		
12 15	7:50 am	NE	21.4	25.3	12.8	13	7.4	-	30.07	+0.04	76.6	79.2		
12 15	6:50 am	NE	21.4	25.3	12.8	14	7.0	-	30.06	+0.03	76.5	79.2		
12 15	5:50 am	ENE	23.3	25.3	14.1	14	7.5	-	30.03	+0.00	76.6	79.2		
12 15	4:50 am	NE	23.3	27.2	11.8	9	6.9	-	30.03	-0.01	76.8	79.3		
12 15	3:50 am	NE	21.4	25.3	13.1	14	7.3	-	30.03	-0.02	76.6	79.3		
12 15	2:50 am	NE	21.4	25.3	13.5	14	7.6	-	30.03	-0.04	76.6	79.3		
12 15	1:50 am	NE	21.4	25.3	12.8	13	7.3	-	30.04	-0.03	76.6	79.3		
12 15	12:50 am	NE	23.3	29.1	13.1	15	7.4	-	30.05	-0.03	76.8	79.3		
12 14	11:50 pm	NE	21.4	25.3	12.8	14	7.3	-	30.07	+0.00	77.0	79.3		
12 14	10:50 pm	NE	21.4	27.2	13.8	15	7.5	-	30.07	+0.00	76.8	79.3		
12 14	9:50 pm	NE	21.4	27.2	13.5	15	7.6	-	30.08	+0.02	76.8	79.3		
12 14	8:50 pm	NE	21.4	27.2	12.8	14	7.5	-	30.07	+0.03	76.6	79.3		
12 14	7:50 pm	NE	21.4	25.3	13.1	14	7.1	-	30.07	+0.05	75.9	79.3		
12 14	6:50 pm	NE	21.4	27.2	12.5	15	7.4	-	30.06	+0.04	74.5	79.3		
12 14	5:50 pm	NE	21.4	25.3	11.5	15	6.9	-	30.04	+0.03	76.5	79.3		
12 14	4:50 pm	NE	23.3	27.2	13.1	15	7.2	-	30.02	-0.01	76.5	79.3		
12 14	3:50 pm	NE	21.4	27.2	12.5	15	7.4	-	30.01	-0.05	76.8	79.3		
12 14	2:50 pm	ENE	21.4	25.3	13.5	15	7.9	-	30.01	-0.08	76.6	79.3		
12 14	1:50 pm	NE	17.5	21.4	11.8	15	7.3	-	30.03	-0.07	76.8	79.3		
12 14	12:50 pm	ENE	17.5	21.4	11.8	15	7.3	-	30.06	-0.06	77.4	79.3		
12 14	11:50 am	ENE	17.5	21.4	12.8	15	8.0	-	30.09	-0.01	77.9	79.3		
12 14	10:50 am	ENE	17.5	21.4	11.2	8	7.3	-	30.11	+0.02	78.1	79.3		
12 14	9:50 am	ENE	15.5	17.5	12.5	15	7.9	-	30.12	+0.06	77.9	79.3		

Click on the graph icon in the table below to see a time series plot of the last five days of that observ

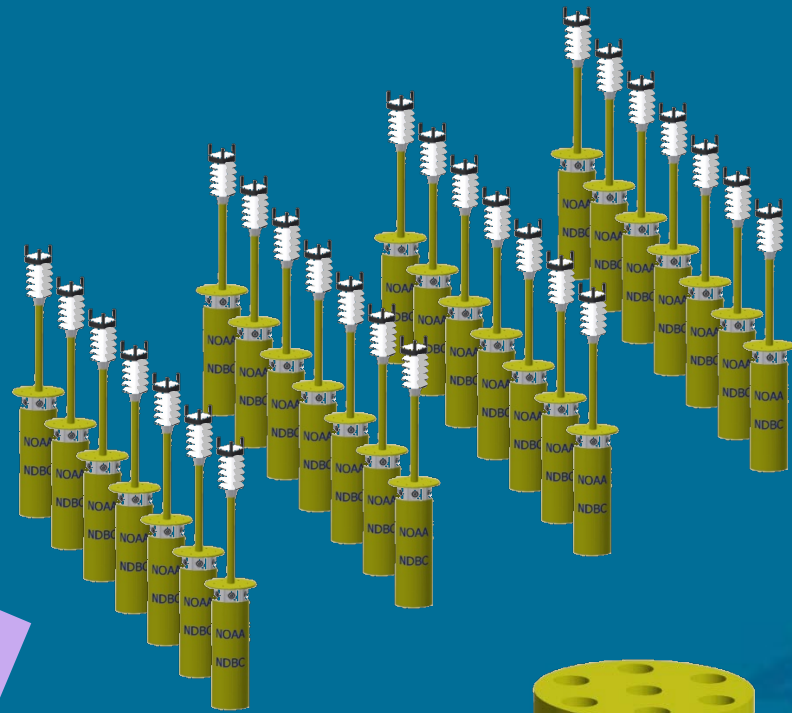
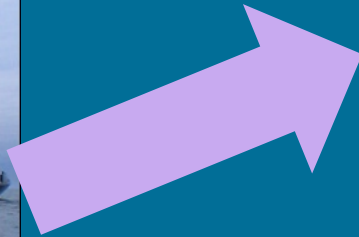
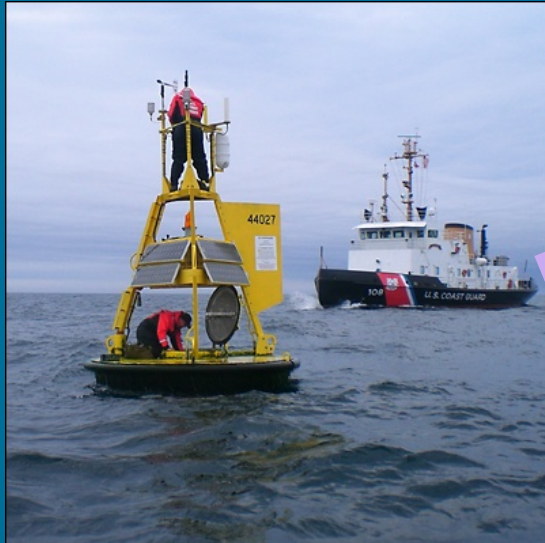
	Significant Wave Height (WVHT):	11.8 ft
	Swell Height (SwH):	8.5 ft
	Swell Period (SwP):	9.1 sec
	Wind Wave Height (WWH):	7.9 ft
	Wind Wave Period (WWP):	6.2 sec
	Wave Steepness (STEEPNESS):	STEEP
	Average Wave Period (APD):	7.2 sec

MM DD	TIME (HAST)	WVHT	SwH	SwP	SwD	WWH	WWP	WWD	STEEPNESS	APD	Previous observations	
											ft	ft
12 15	9:00 am	11.8	9.2	14.8	N/A	7.2	5.6	N/A	SWELL	7.1		
12 15	8:00 am	12.8	9.5	12.9	N/A	8.9	8.3	N/A	SWELL	7.4		
12 15	7:00 am	12.8	9.2	13.8	N/A	8.5	5.9	N/A	SWELL	7.0		
12 15	6:00 am	14.1	10.5	13.8	N/A	9.2	5.9	N/A	SWELL	7.5		
12 15	5:00 am	11.8	8.2	9.1	N/A	8.9	5.9	N/A	STEEP	6.9		
12 15	4:00 am	13.1	10.5	13.8	N/A	7.9	7.1	N/A	SWELL	7.3		
12 15	3:00 am	13.5	9.8	13.8	N/A	8.9	8.3	N/A	SWELL	7.6		
12 15	2:00 am	12.8	9.2	12.9	N/A	9.2	8.3	N/A	SWELL	7.3		
12 15	1:00 am	13.1	10.8	14.8	N/A	7.2	5.6	N/A	SWELL	7.4		
12 15	12:00 am	12.8	10.5	13.8	N/A	7.5	6.2	N/A	SWELL	7.3		
12 14	11:00 pm	13.8	9.8	14.8	N/A	9.5	6.2	N/A	SWELL	7.5		
12 14	10:00 pm	13.5	9.8	14.8	N/A	9.2	8.3	N/A	SWELL	7.6		
12 14	9:00 pm	12.8	9.5	13.8	N/A	8.9	8.3	N/A	SWELL	7.5		
12 14	8:00 pm	13.1	8.9	13.8	N/A	9.8	8.3	N/A	AVERAGE	7.1		
12 14	7:00 pm	12.5	8.9	14.8	N/A	8.9	8.3	N/A	SWELL	7.4		
12 14	6:00 pm	11.5	7.9	14.8	N/A	8.5	7.7	N/A	AVERAGE	6.9		
12 14	5:00 pm	13.1	8.9	14.8	N/A	9.5	7.7	N/A	AVERAGE	7.2		
12 14	4:00 pm	12.5	9.2	14.8	N/A	8.5	6.7	N/A	SWELL	7.4		
12 14	3:00 pm	13.5	10.5	14.8	N/A	8.5	7.1	N/A	SWELL	7.9		
12 14	2:00 pm	11.8	9.5	14.8	N/A	7.2	5.3	N/A	SWELL	7.3		
12 14	1:00 pm	11.8	8.5	14.8	N/A	8.2	6.2	N/A	SWELL	7.3		
12 14	12:00 pm	12.8	10.2	14.8	N/A	7.9	5.9	N/A	SWELL	8.0		
12 14	11:00 am	11.2	7.2	14.8	N/A	8.2	8.3	N/A	STEEP	7.3		
12 14	10:00 am	12.5	11.2	14.8	N/A	5.2	6.7	N/A	SWELL	7.9		

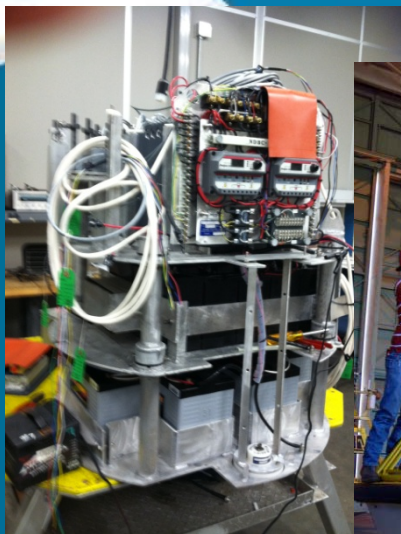
Self-Contained Ocean Observations Payload (SCOOP)

Future ...

Present



The Weather Buoy - Today



- 600 + hrs Labor to Construct
- Complex, Multiple Systems
- Weighs 3800 lbs
- Can't Field a 100% Tech Refresh in a Realistic Timeframe
- Vulnerable Electronics Opened in Field for Maintenance
- Requires Large, Expensive Ships to Service (≥ 175 ft)
- Minimum 6-8 hrs per Service Visit – Mission Aborts
- Lots of Opportunities for Mistakes & Failures

The *OceanOBS* Buoy - Tomorrow

SCOOP Payloads

MET-1



Waves



Sub-Surface



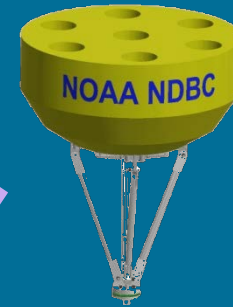
DART



Special



Aux Power



*Modular
"Empty"
Buoy*

*Basic Unit (NDBC MET-1) Includes
MET, Cameras, AIS, and SATCOM*

- ~ 40 hrs Labor to Construct
- Simple, Modular Sealed Systems
- Weight – One Person can Lift and Emplace on a Buoy
- Deploy Immediately on old & New Buoys – 100% Tech Refresh in a few Years
- Units Leave NDBC Sealed and Calibrated – Never Opened in Field
- With Smaller “Empty” Buoy Family – More Options for Deployment with Many Vessels
- Service Visit in Less than 30 min – Significant Reduction in Mission Aborts
- Lack of Opportunities for Mistakes & Failures – due to Sealed Units
- Same Unit goes Anywhere – on Legacy or New Buoys, C-MAN Towers, Ships, Land,.....

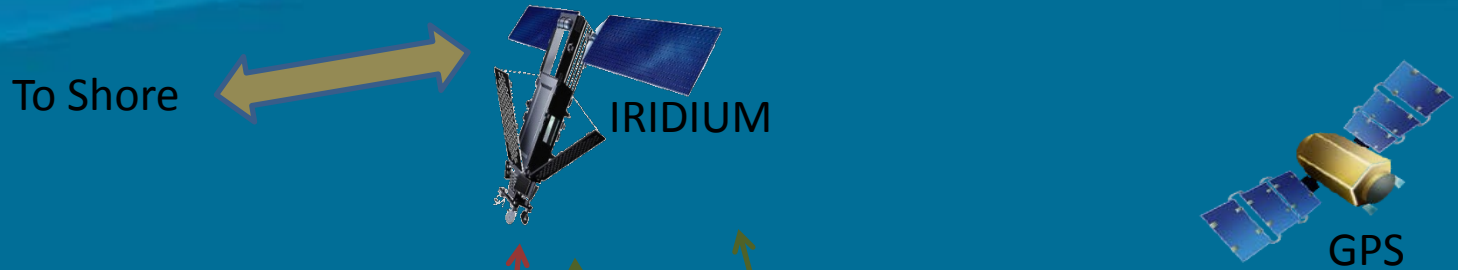
Legacy WX Buoy Electronics Payload vs SCOOP Prototype



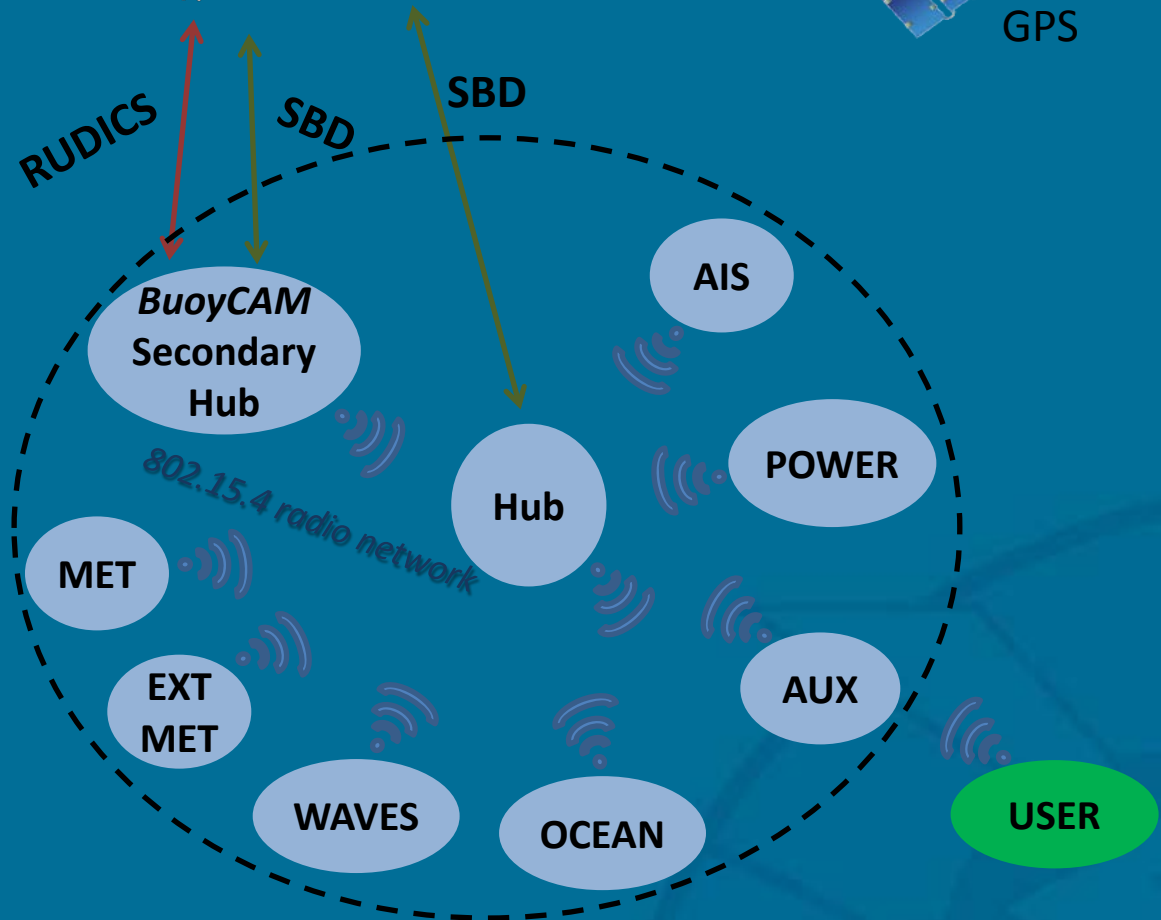
Legacy

SCOOP

SCOOP Architecture



- Star type network
- Hub:
 - Coordinates wireless network of modules
 - Interfaces to shore via Iridium SBD
- *BuoyCAM*:
 - Reports pictures by Iridium RUDICS
 - Iridium SBD modem for backup of wireless network
- Modules acquire, process, and send data to Hub(s)



Early Prototypes

*Generation 1 BuoyCAM
in Shipping Case*



*Generation 1 BuoyCAM
and MET on DART Buoy*



*One of First 15
SCOOP Units
In Lab
(Sept 2014)*



SCOOP Payload Mounted on a legacy 3m Weather Buoy Hull



**Need to add 1000 lbs ballast
In Hull to make Heavy enough**



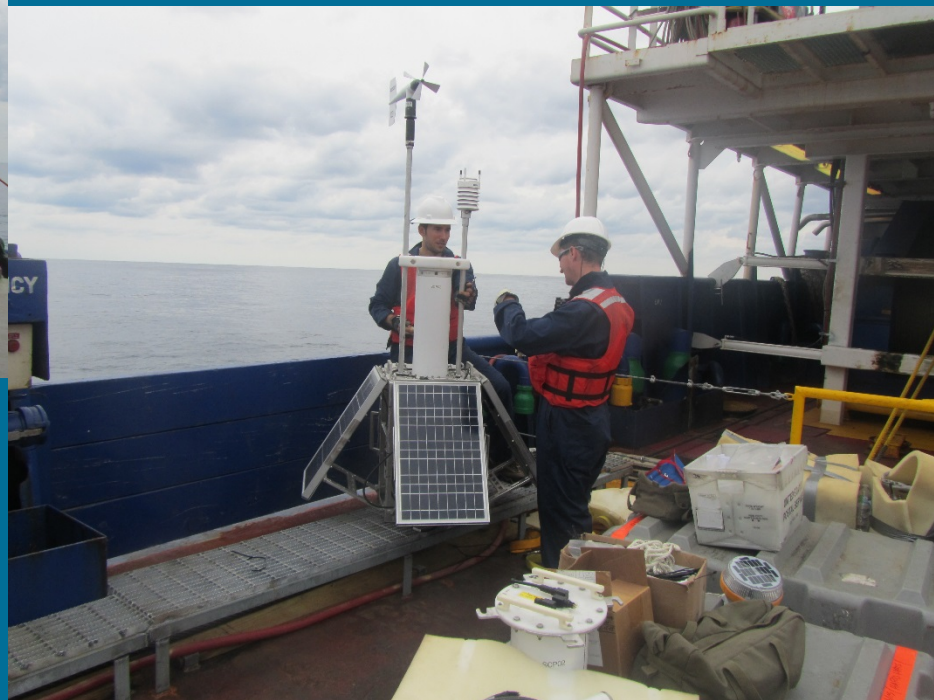
**Weights > 4000 lbs
& requires massive cranes**

Prototype Deployments – Nov '15

Stern A-Frame Recovery

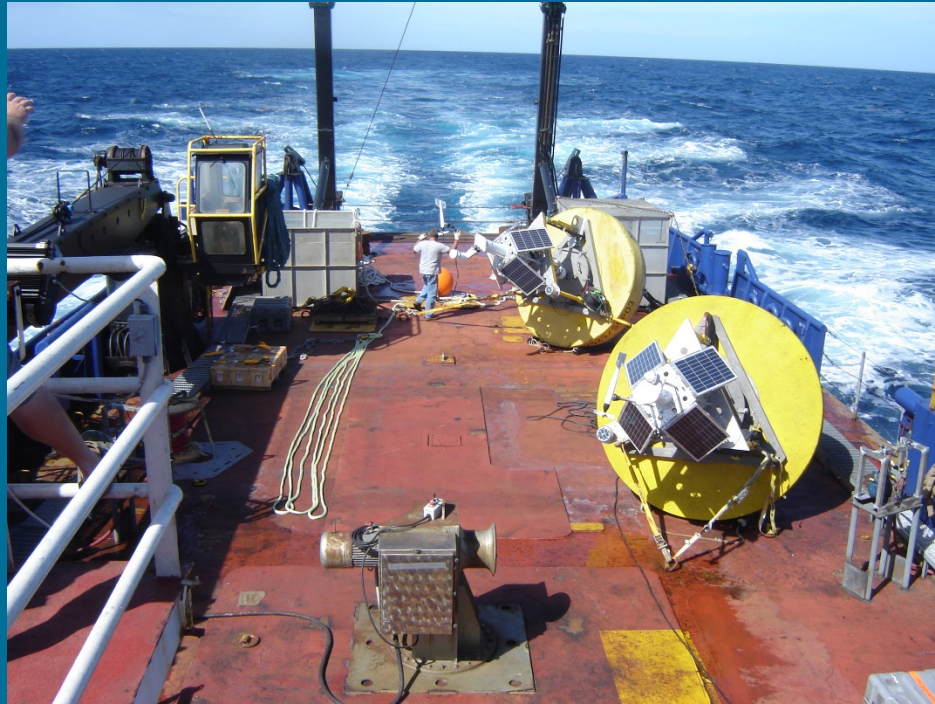


On-Deck Assembly

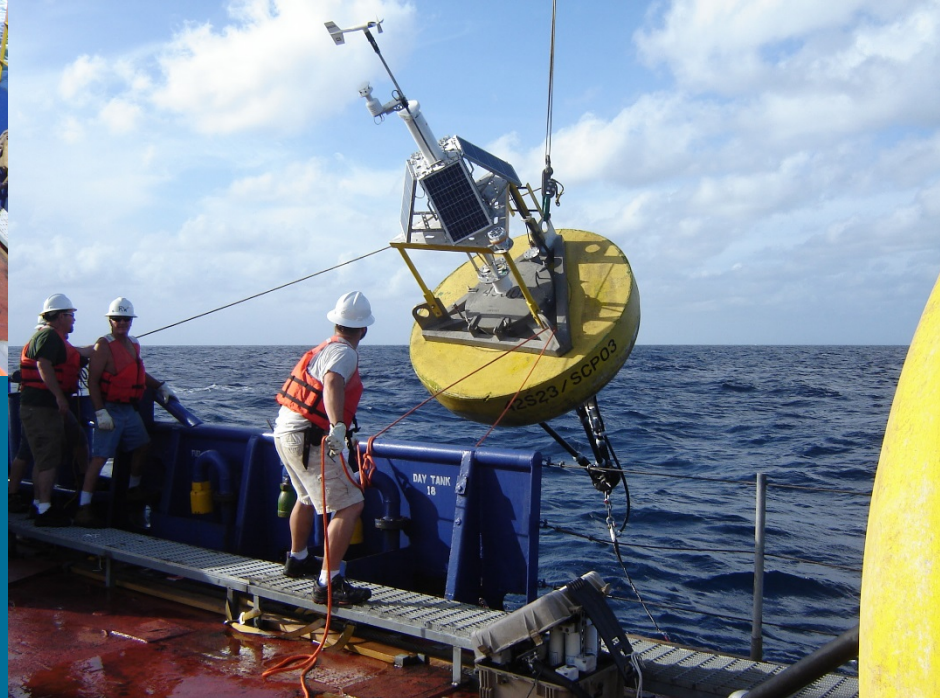


Prototype Deployments – Nov '15

Dockside Integrated Hulls

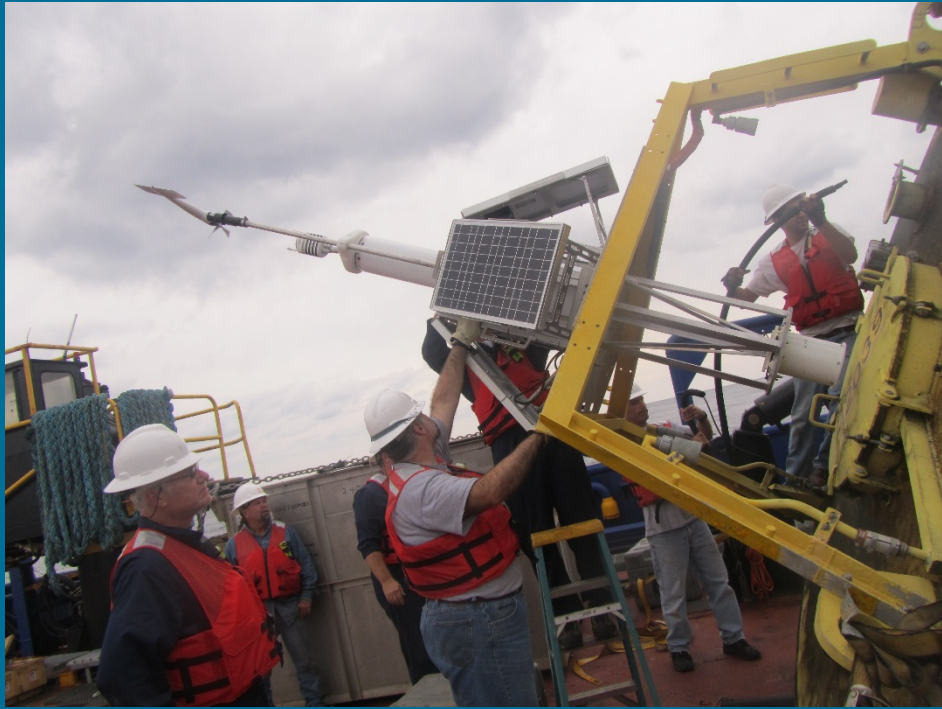


Port Crane Deployed



Prototype Deployments – Nov '15

SCOOP Retrofit



Stern A-Frame Redeployed



Eyes on the Ocean Environment

An Unanticipated Benefit of SCOOP

Ability to see images of waves, cloud cover, visibility, surface currents, ship traffic, fishing activities, and wildlife in the remote open ocean and coastlines promises to expand maritime domain awareness and environmental intelligence

EXAMPLES

- **Estimating Waves & Sea State from *BuoyCAM* Images**
- **Estimating Clouds & Visibility from *BuoyCAM* Images**
- **Estimating Surface Currents from *BuoyCAM* Images**

Estimating Waves & Sea State from *BuoyCAM* Images

 <p>Force 0: Wind Speed less than 1 knot Sea: Sea like a mirror.</p>	 <p>Force 1: Wind Speed 1-3 knots Sea: Wave height .1m (.25ft); Ripples with appearance of scales, no foam crests</p>	 <p>Force 2: Wind Speed 4-6 knots Sea: Wave height .2-.3m (.5-1 ft); Small wavelets, crests of glassy appearance, not breaking</p>	 <p>Force 3: Wind Speed 7-10 knots Sea: Wave height .6-1m (2-3 ft); Large wavelets, crests begin to break, scattered whitecaps</p>
 <p>Force 4: Wind Speed 11-16 knots Sea: Wave height 1-1.5m (3.5-5 ft); Small waves becoming longer, numerous whitecaps</p>	 <p>Force 5: Wind Speed 17-21 knots Sea: Wave height 2-2.5m (6-8 ft); Moderate waves, taking longer form, many whitecaps, some spray</p>	 <p>Force 6: Wind Speed 22-27 knots Sea: Wave height 3-4m (9.5-13 ft); Larger waves forming, whitecaps everywhere, more spray</p>	 <p>Force 7: Wind Speed 28-33 knots Sea: Wave height 4-5.5m (13.5-19 ft); Sea heaps up, white foam from breaking waves begins to be blown in streaks along direction of wind</p>
 <p>Force 8: Wind Speed 34-40 knots Sea: Wave height 5.5-7.5m (18-25 ft); Moderately high waves of greater length, edges of crests begin to break into spindrift, foam is blown in well marked streaks</p>	 <p>Force 9: Wind Speed 41-47 knots Sea: Wave height 7-10m (23-32 ft); High waves, sea begins to roll, dense streaks of foam along wind direction, spray may reduce visibility</p>	 <p>Force 10: Wind Speed 48-55 knots (storm) Sea: Wave height 9-12.5m (29-41 ft); Very high waves with overhanging crests, sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and shocklike, visibility is reduced.</p>	 <p>Force 11: Wind Speed 56-63 knots Sea: Wave height 11.5-16m (37-52 ft); Exceptionally high waves, sea covered with white foam patches, visibility still more reduced</p>

The Beaufort Scale & Guidelines for Visual Observations

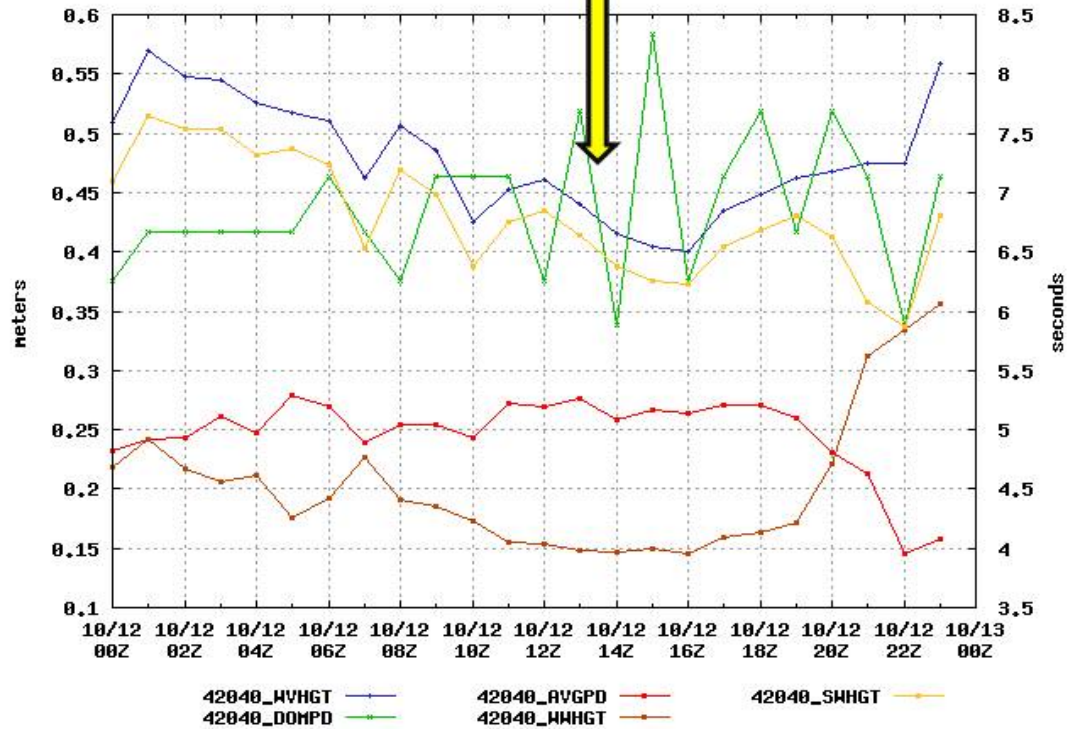
42040 10/12/14 1300 UTC

Wave acquisition takes place from minutes 20 to 40



National Data Buoy Center Station ID: 42040 10/12/2014 1300 UTC

NDBC Time Series Plots - Station 42040 vs 42040



Significant Wave Height:
0.44 to 0.415 meters

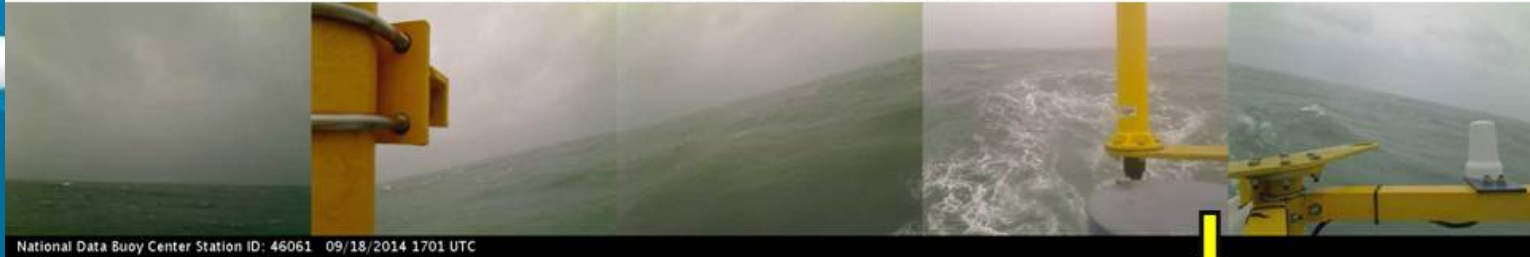
Mostly swell wave

Picture taken halfway between the 13:00
and 14:00 UTC wave acquisition periods.

BuoyCAM Images vs Instrumentation – Calm Seas

46061 9/18/14 1701 UTC

Wave acquisition takes place from minutes 20 to 40

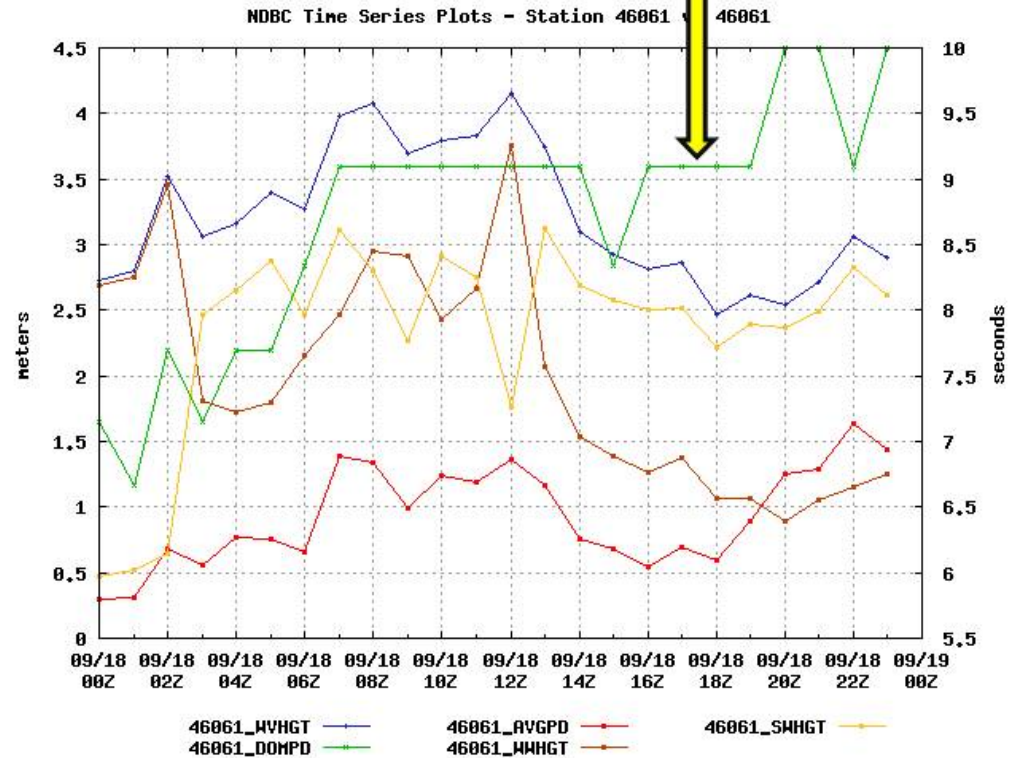


National Data Buoy Center Station ID: 46061 09/18/2014 1701 UTC

Significant Wave Height:
2.864 to 2.462 meters

Large wind wave component,
WSPD ~16.5 m/s

Picture taken halfway between the 17:00
and 18:00 UTC wave acquisition periods.



BuoyCAM Images vs Instrumentation – Rough Seas

Estimating Clouds & Visibility from *BuoyCAM* Images



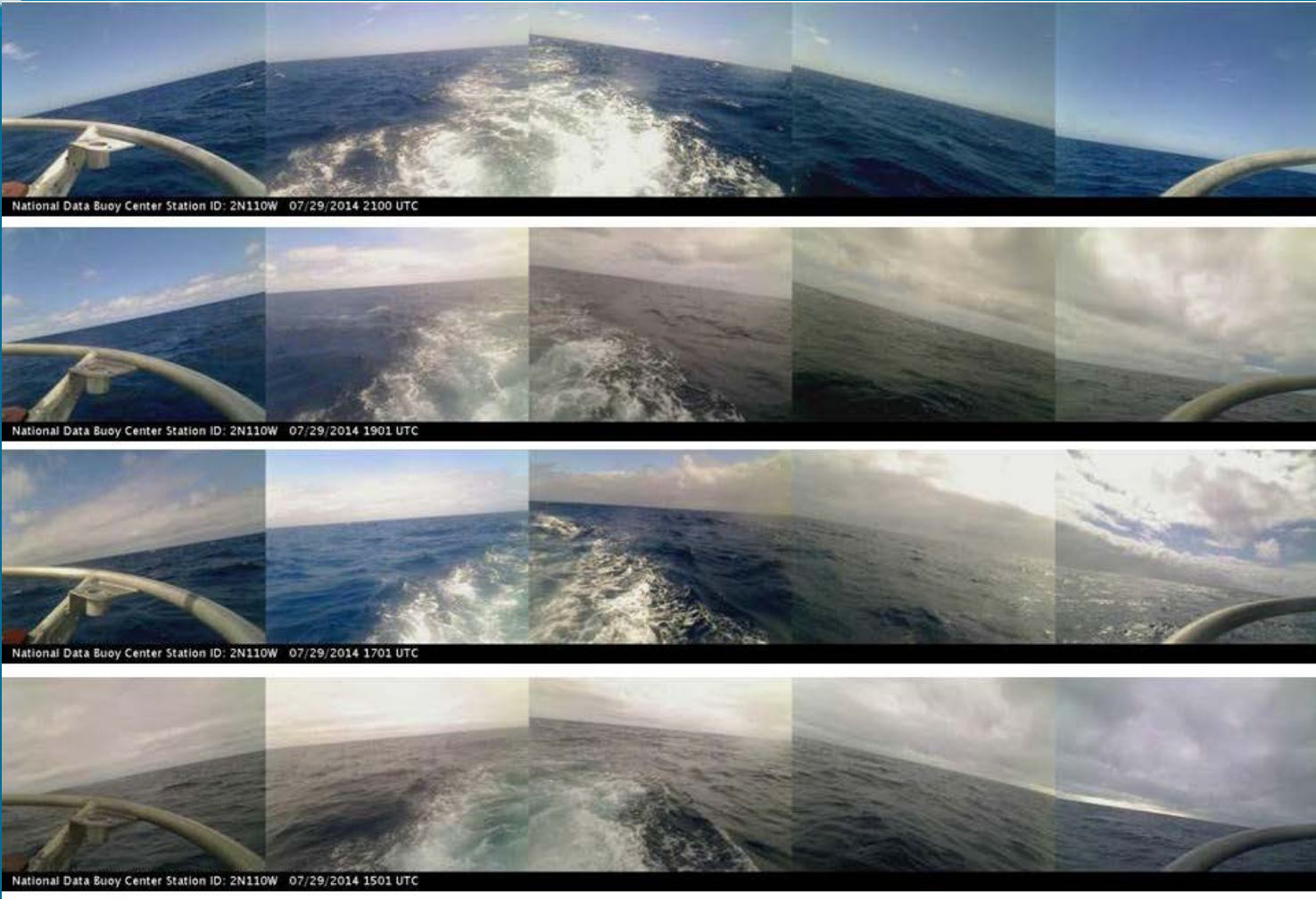
Variation of Ocean Color Vibrancy with small changes in Cloud Cover

Estimating Clouds & Visibility from *BuoyCAM* Images



Reduction of Ocean Color to Gray Scale with Overcast Skies

Estimating Surface Currents from *BuoyCAM* Images



BuoyCAM Images of a Fairly Strong Surface Current “Wake”

SCOOP New Ocean Observing System for NDBC



Thank You..Questions ?