SCOOP

New Ocean Observing System for NDBC

Craig A. Kohler, P.E.
Chief of Engineering, NDBC

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

Previous observations

MM	DD	TIME (HAST)	WDIR	WSPD kts	GST kts	WVHT ft	DPD sec	APD sec	MWD	PRES in	PTDY in	ATMP °F	WTMP °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

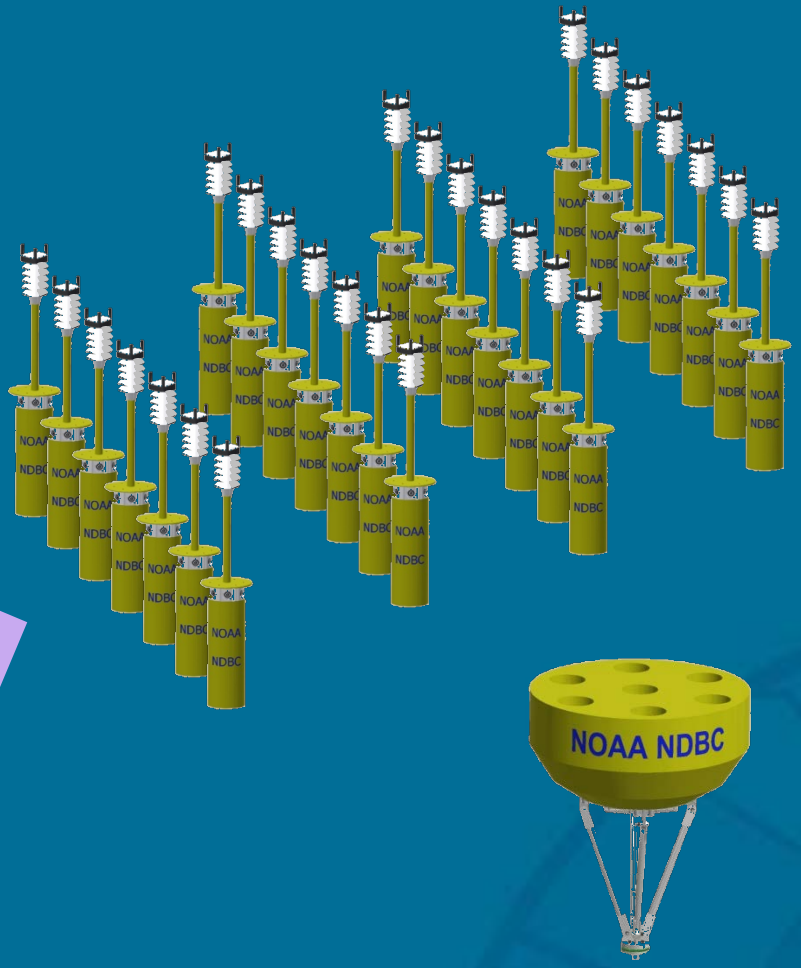
Previous observations

MM	DD	TIME (HAST)	WVHT ft	SwH ft	SwP sec	SwD	WWH ft	WWP sec	WWD	STEEPNESS	APD sec
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 …

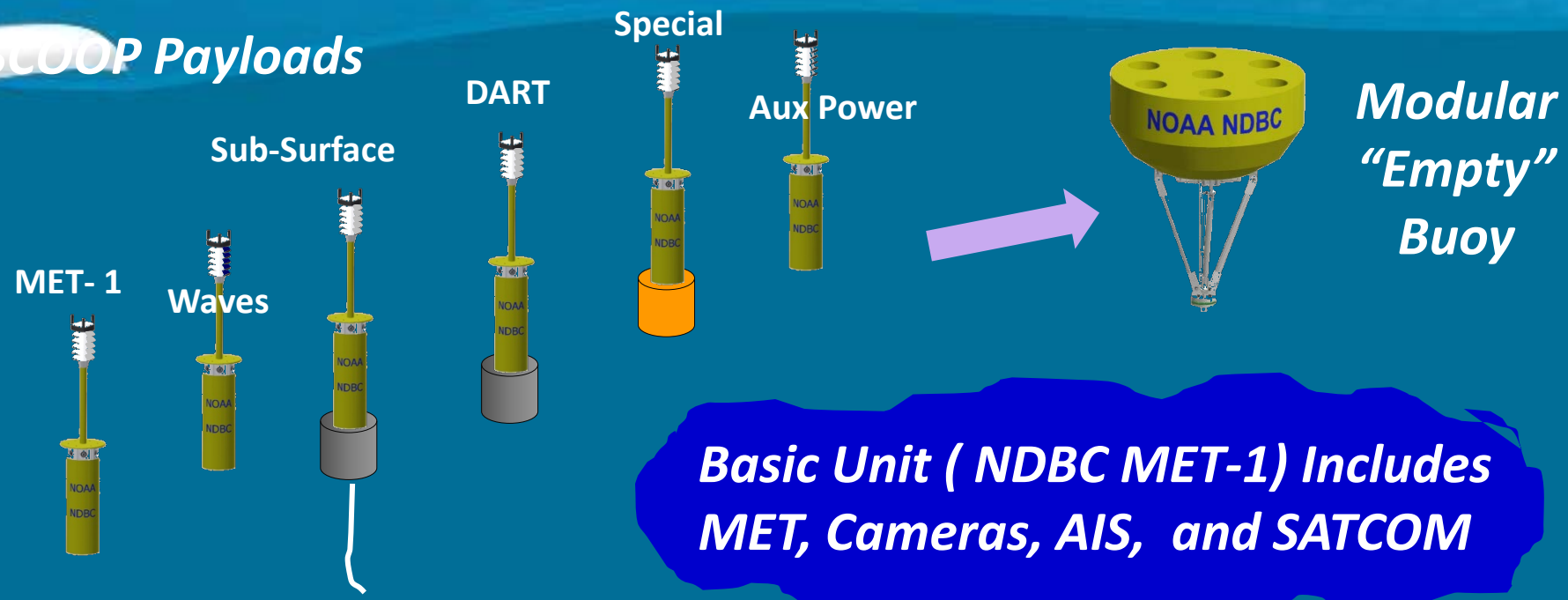
Present



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



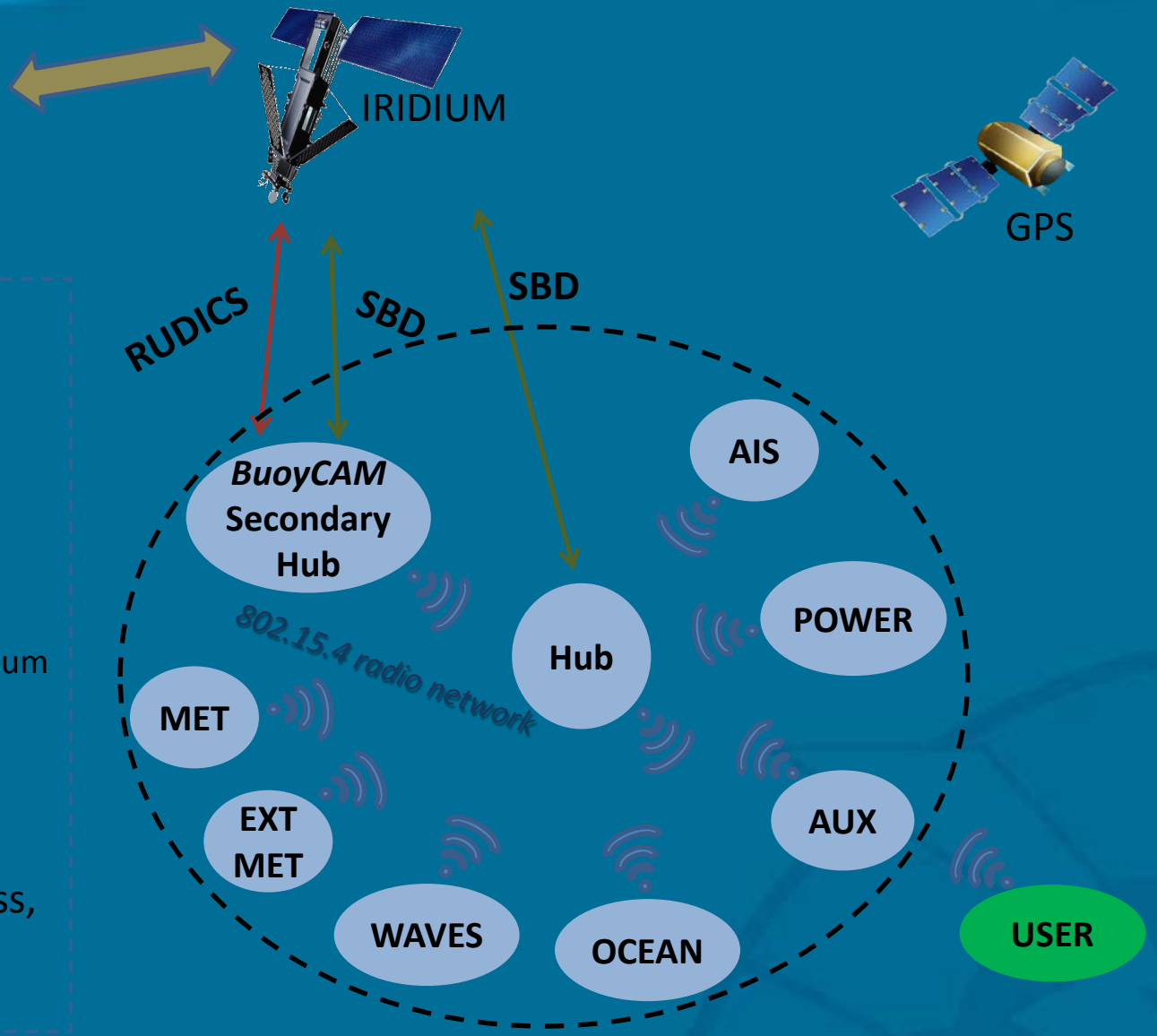
Basic Unit (NDBC MET-1) Includes MET, Cameras, AIS, and SATCOM

- ~ 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

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

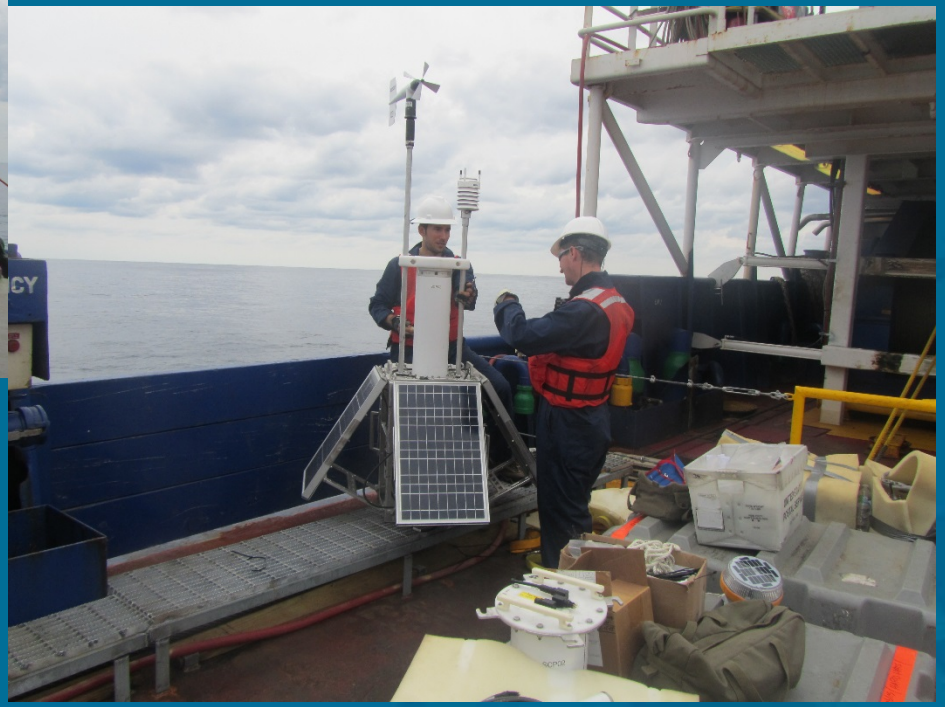
Need to add 1000 lbs ballast
In Hull to make Heavy enough

Weights > 4000 lbs
& requires massive cranes

Prototype Deployments – Nov ‘15

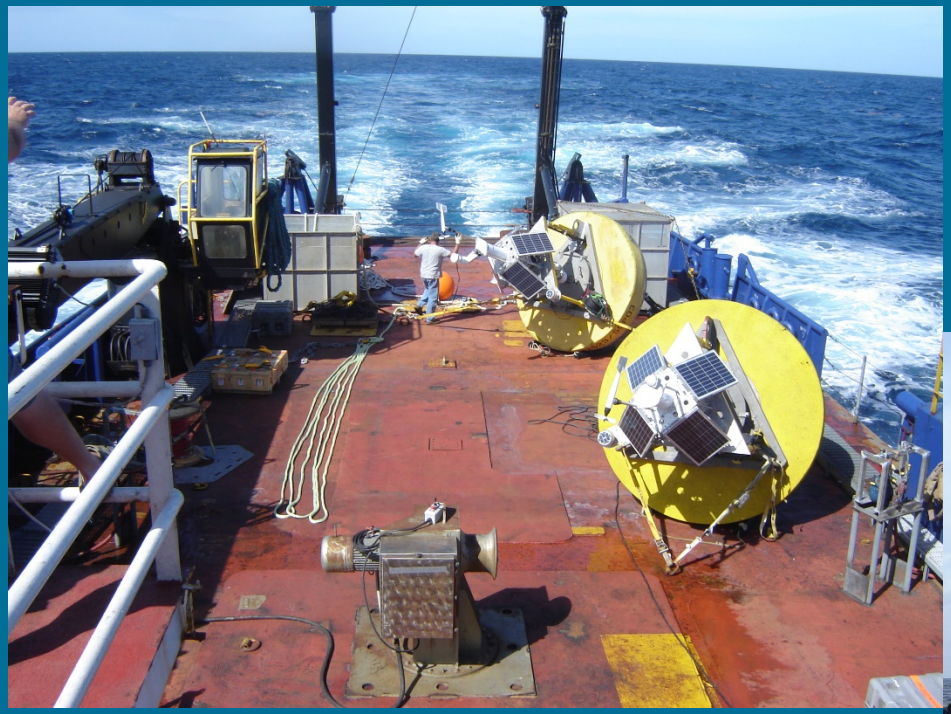
Stern A-Frame Recovery

On-Deck Assembly

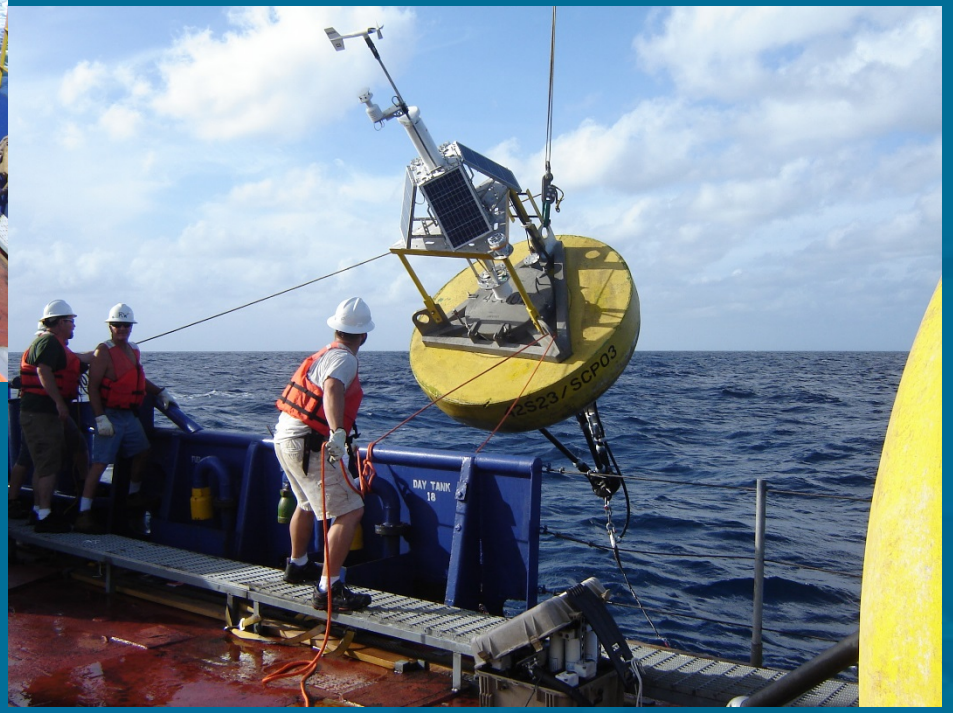


Prototype Deployments – Nov ‘15

Dockside Integrated Hulls

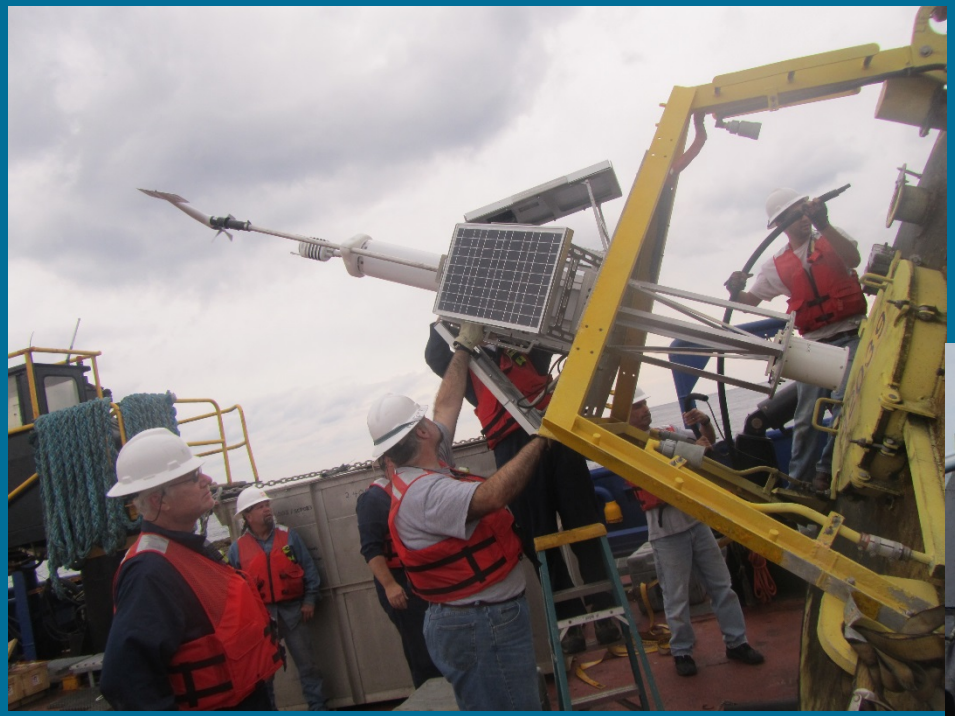


Port Crane Deployed



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

The Beaufort Scale & Guidelines for Visual Observations

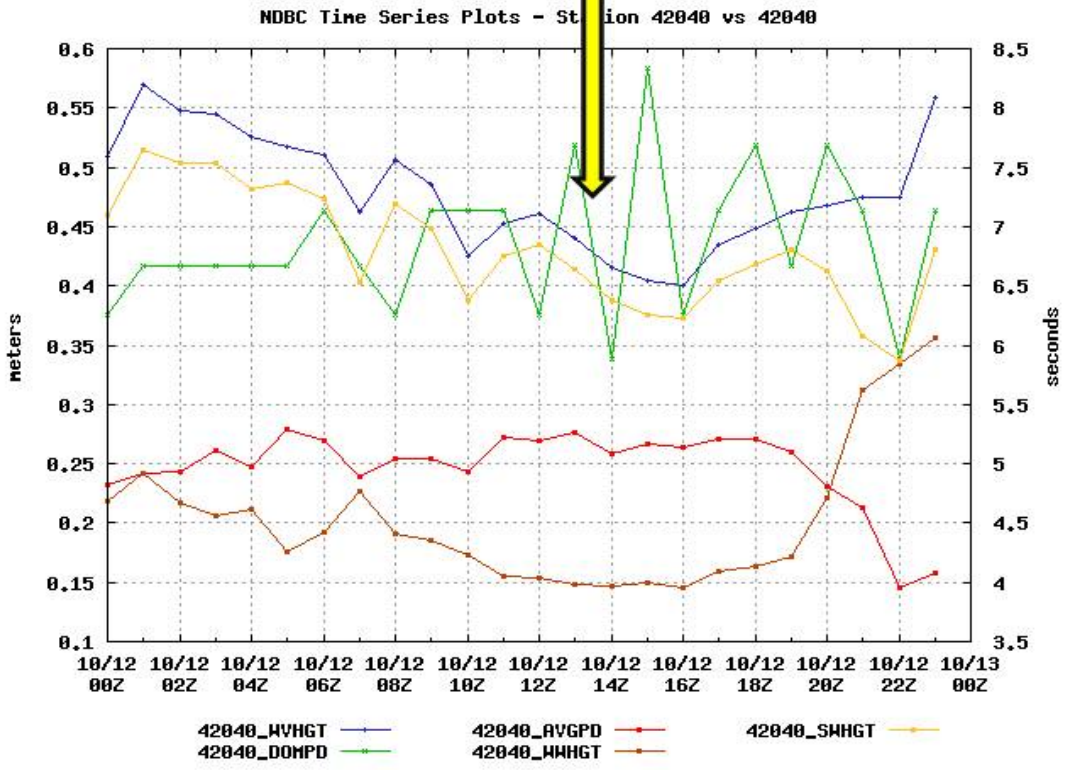
42040 10/12/14 1300 UTC

Wave acquisition takes place from minutes 20 to 40

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

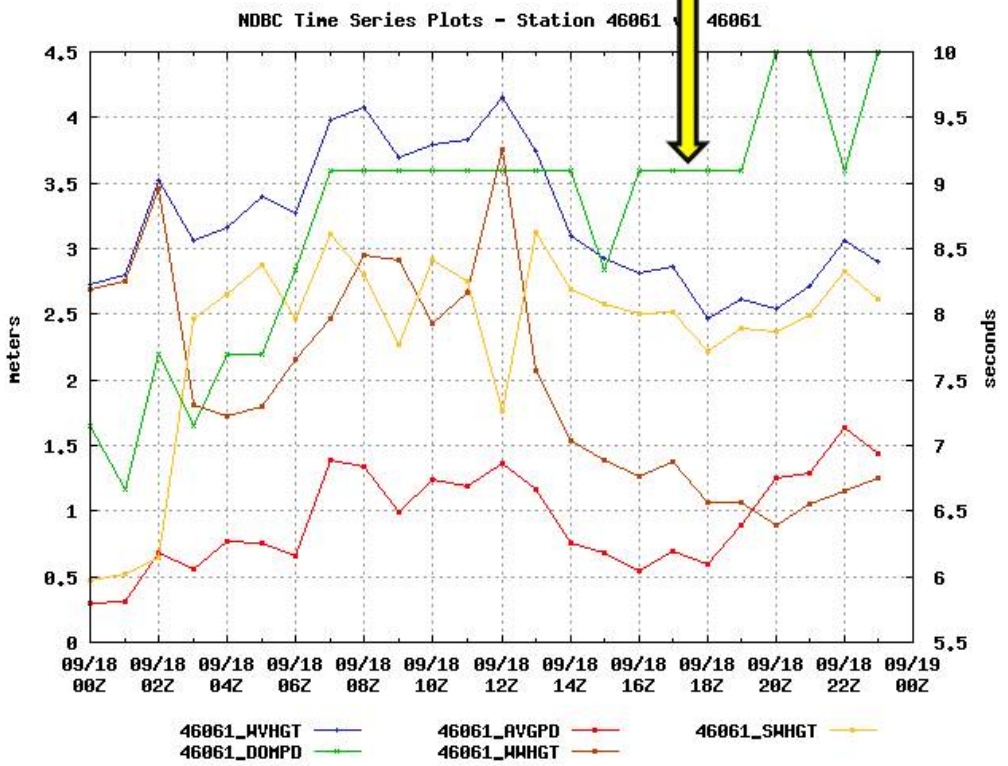
46061 9/18/14 1701 UTC

Wave acquisition takes place from minutes 20 to 40

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

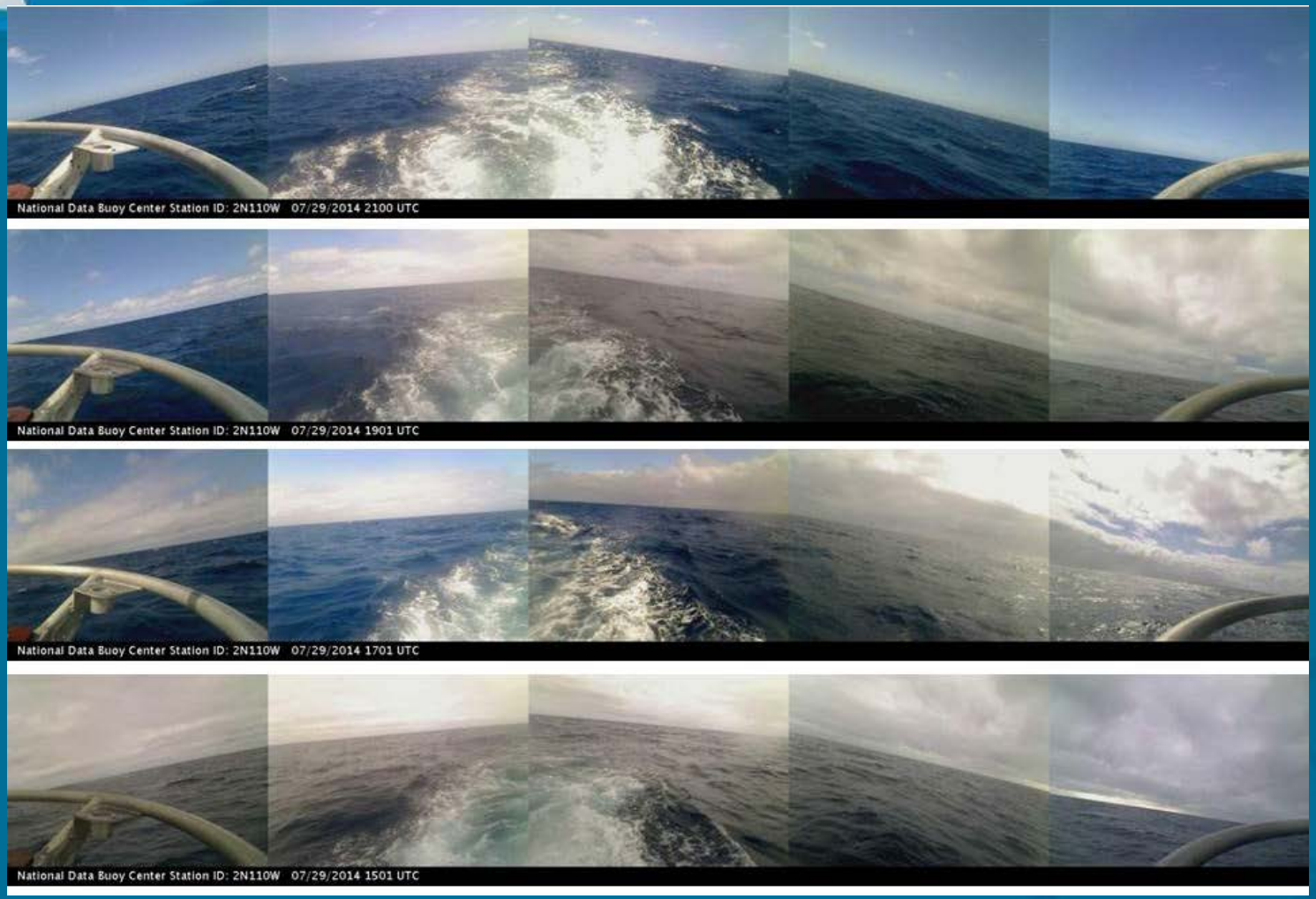
Estimating Clouds & Visibility from *BuoyCAM* Images

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 ?