National Data Buoy Center

NDBC's BuoyCAM and Anti-Vandalism

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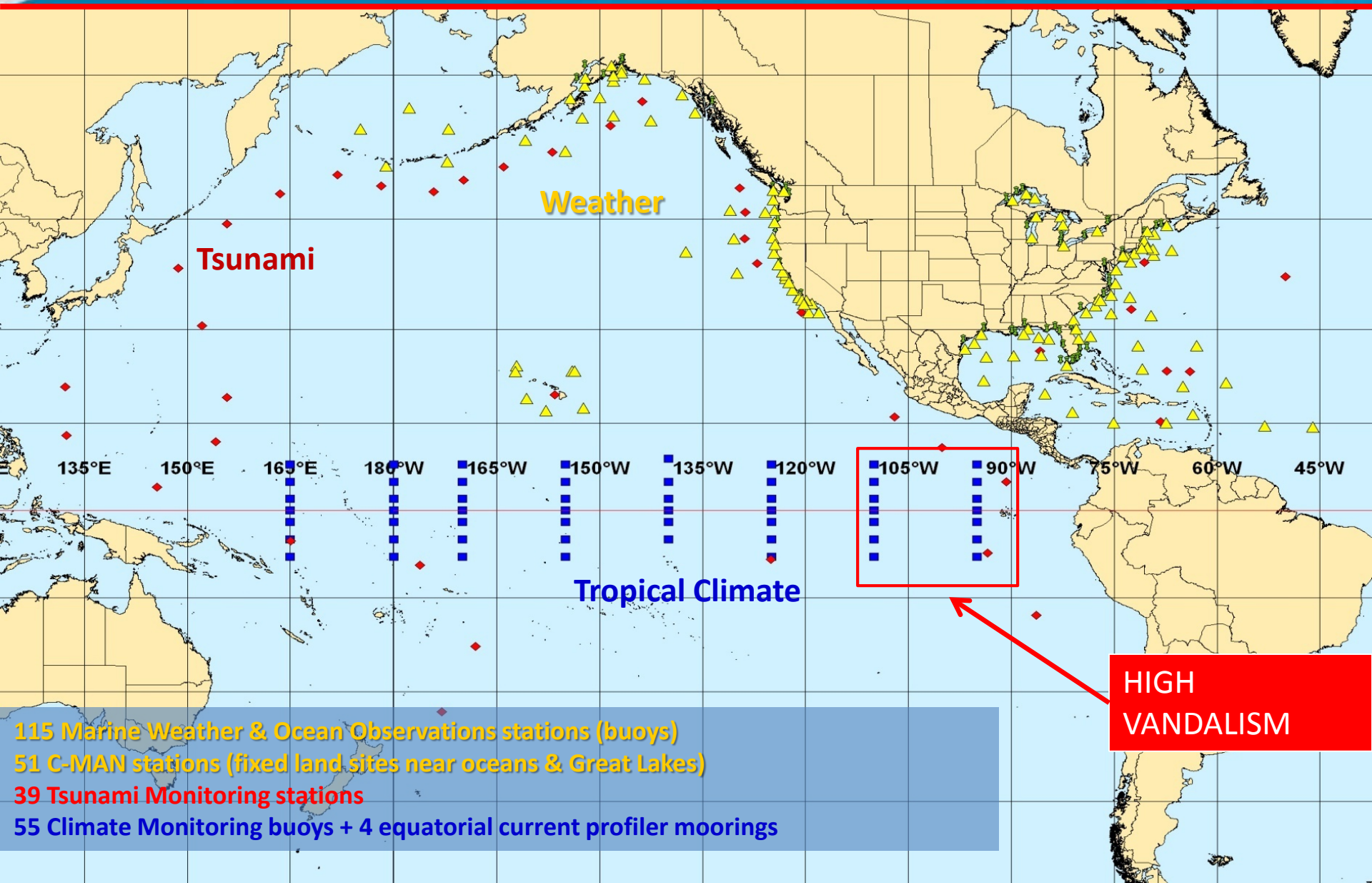
INMARTECH
11.20.2014

NDBC's Ocean Observing Networks



115 Marine Weather & Ocean Observations stations (buoys)
51 C-MAN stations (fixed land sites near oceans & Great Lakes)
39 Tsunami Monitoring stations
55 Climate Monitoring buoys + 4 equatorial current profiler moorings

NDBC's BuoyCAM and Anti-Vandalism

- Buoy Vandalism: interference, damage or theft to observing platforms by human action, whether that action is unknowing, incidental to reckless activity, or malicious.

- Vandalism disrupts the vital data collected and reported by moored buoys, which place lives, property, and economies in peril.

- Average cost of $100,000 per event

On ieeexplore.ieee.org
See OCEANS 2009, MTS/IEEE Biloxi - Marine Technology for Our Future: Global and Local Challenges

NDBC's BuoyCAM and Anti-Vandalism

Stolen Frame

NDBC's BuoyCAM and Anti-Vandalism

Mooring Cut

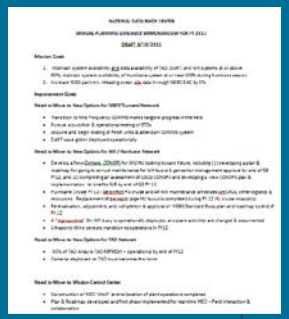
NDBC's BuoyCAM and Anti-Vandalism

Vessel Collision

NDBC's BuoyCAM and Anti-Vandalism

From Start to Success in 36 Months

NDBC Establishes Counter-Vandalism & *Buoy CAM* Objectives



Aug 10 2011

First Trail Cams Deployed on TAO

Feb 16 2012

First Trail Cam "Catch"

May 20 2012

First *BuoyCAMs* Deployed in TAO Jan 2013

The "Catch"

May 24 2013

Enforcement !

Fishing License Suspension & Crew Education

Aug 6 2014

2011 2012 2013 2014

NDBC's BuoyCAM and Anti-Vandalism

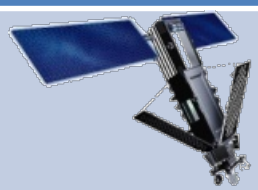
Trail Cams

1 Trail Cam Recovered

7 Confirmed Lost at Sea

NDBC's BuoyCAM and Anti-Vandalism

Challenges



Remotely Transmits Images

- Instant knowledge and immediate response

Low Power

- Long term unattended operation at sea

Wide View Angle

- Panoramic to catch all view points

Lens Fouling

- Lens free of distortion from sea spray and precipitation

NDBC's BuoyCAM and Anti-Vandalism

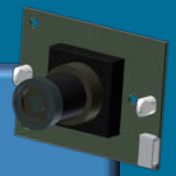
Enabling Technology: NDBC's Smart Module

Extremely low power

Compact	Wireless networking	32 GB file system	RS-232 serial ports
Low cost	Two way Iridium short burst	GPS	Analog ports

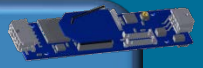
Smart Module Invention Disclosure Filed

NDBC's BuoyCAM and Anti-Vandalism



5 Cameras

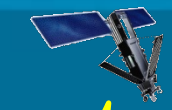
Linux



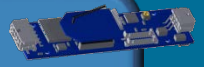
Smart Module

Images

Power



Iridium Modem



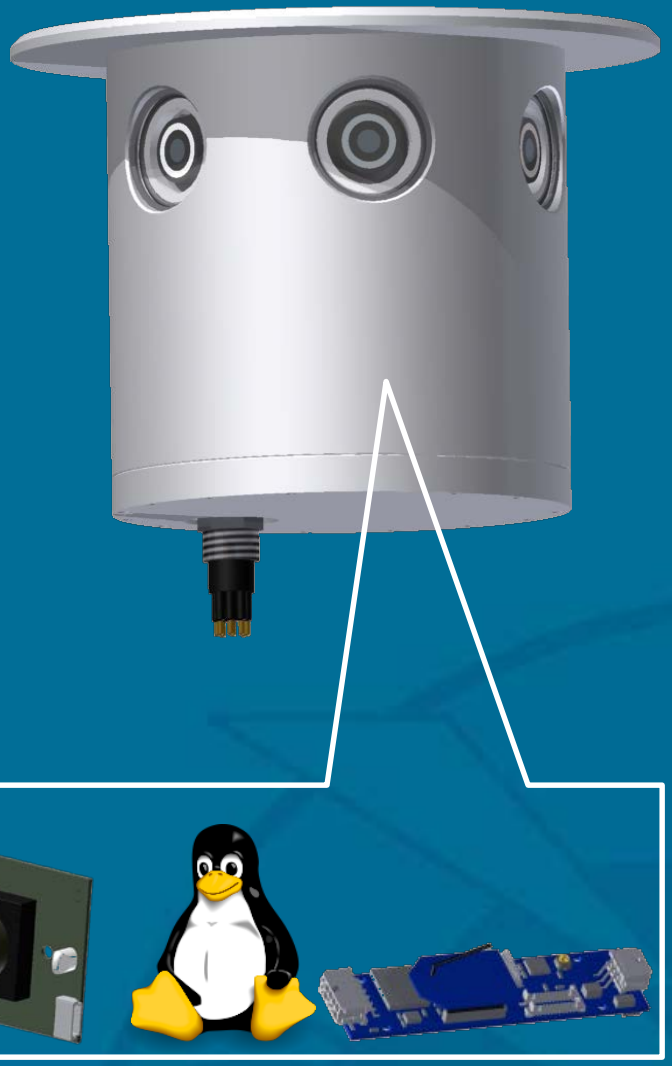
Smart Module

Batteries

NDBC's BuoyCAM and Anti-Vandalism

Submersion proof housing contains cameras, embedded Linux and NDBC Smart Module

- Linux
  - Uses "Angstrom" Linux that boots up in about 25 seconds
  - Runs NDBC software on boot up that utilizes OpenCV to take images and transfer them to Smart Module for transmission
- NDBC Smart Modules
  - Uses Wi-Fi to communicate with the Linux system
  - Extremely fast file transfers allow the system to shutdown after taking new images
  - Near zero sleep mode power



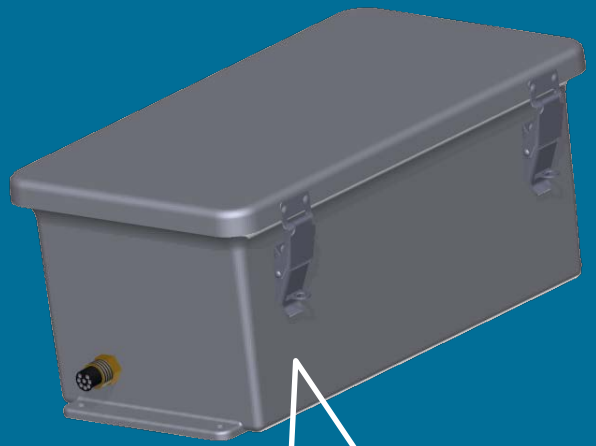
NDBC's BuoyCAM and Anti-Vandalism

Iridium

- Data rates about 300 bytes per second and it takes about 2 minutes to send 40 KB image
- Camera can send photos from anywhere in the world

Battery Power

- NDBC Smart Module technology aims to reduce time Linux system is powered up.
- Linux system is only powered up and running about 8% of the time



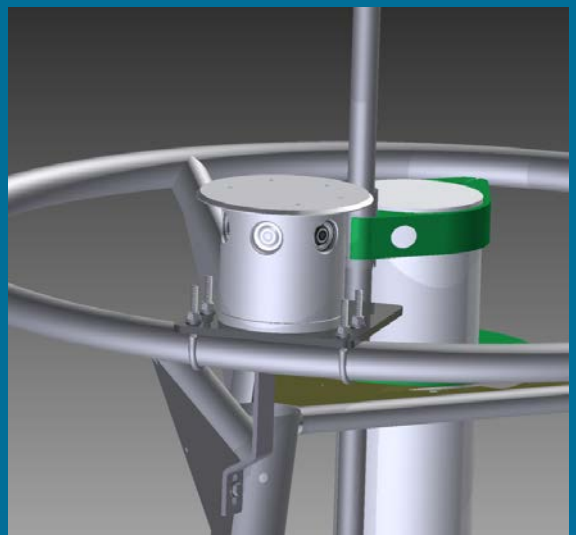
NDBC's BuoyCAM and Anti-Vandalism

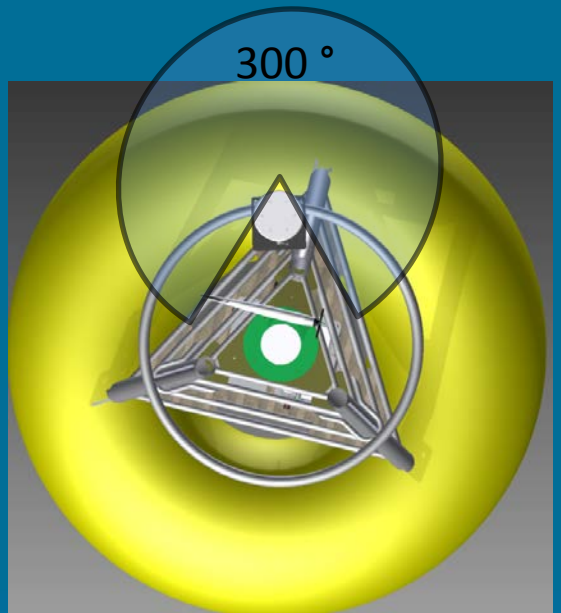
Generation 1 Capabilities

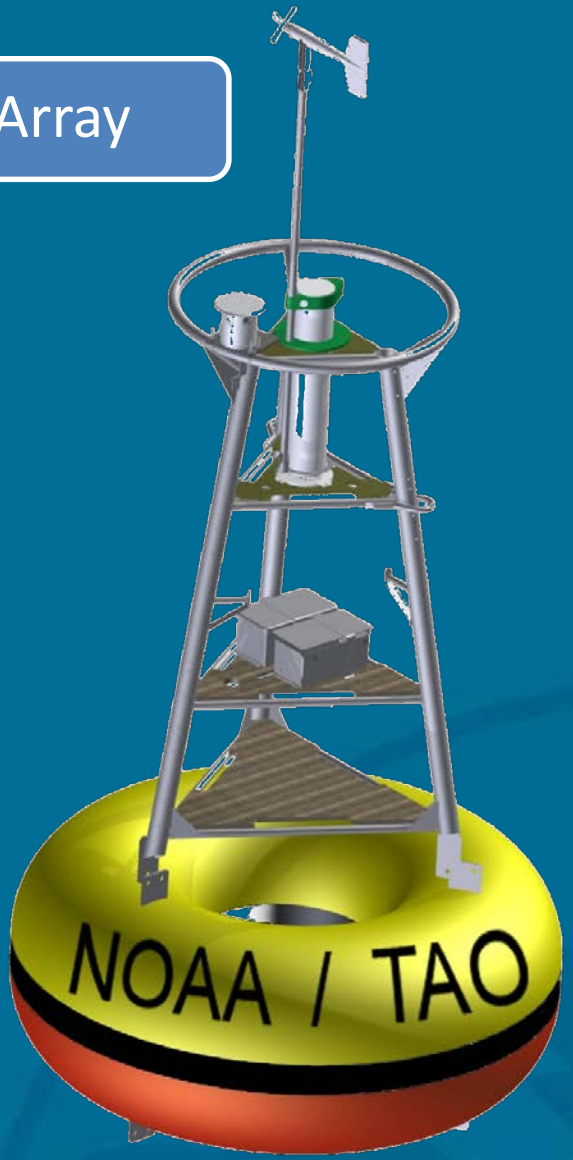
- 6 months of autonomous deployment
- 300° of vision
- Every 20 minutes: Take and store one image
- Every hour: Transmit one low resolution image
- Remotely request Hi resolution image

NDBC's BuoyCAM and Anti-Vandalism

Deployments in the TAO Array

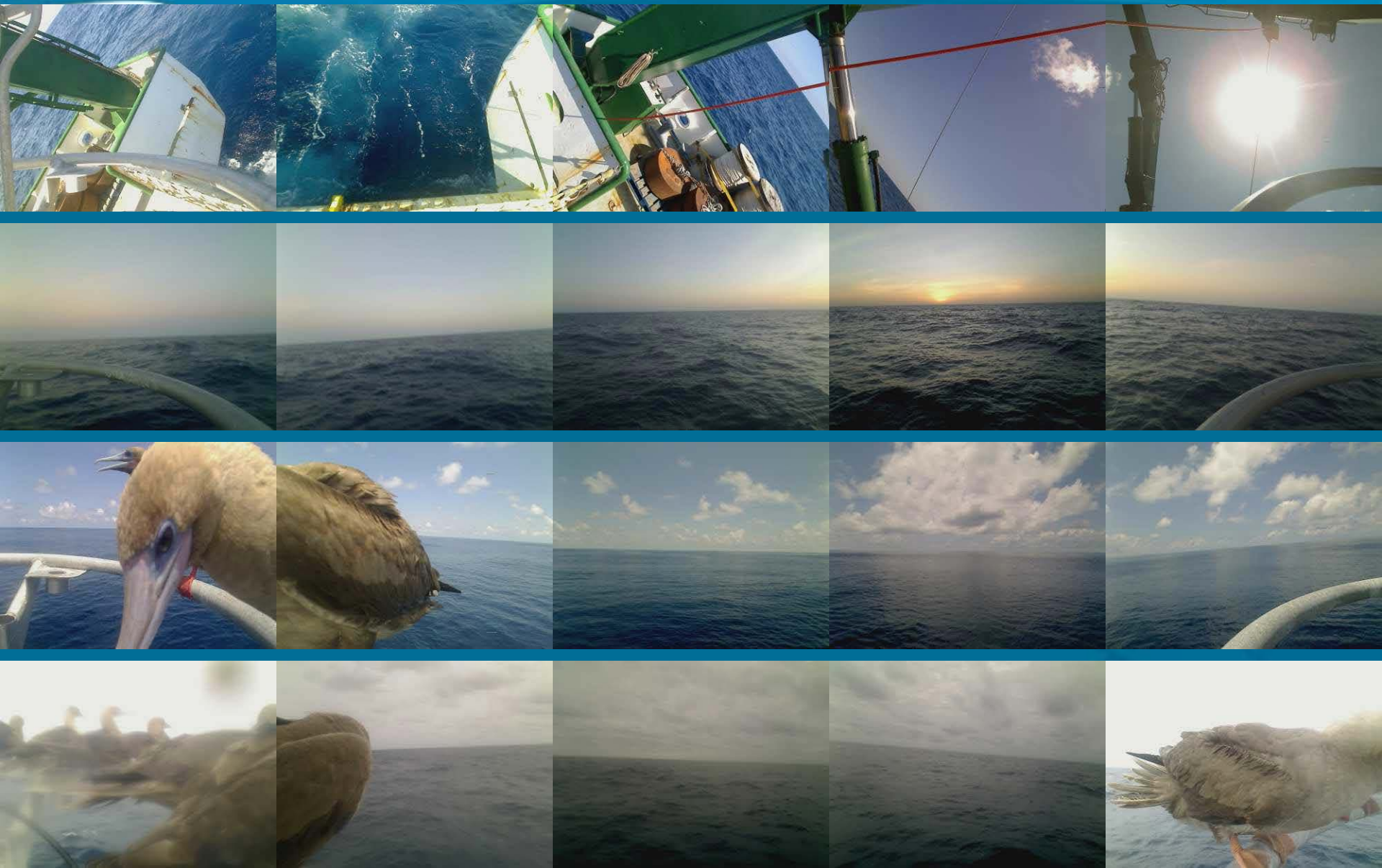






NDBC's BuoyCAM and Anti-Vandalism

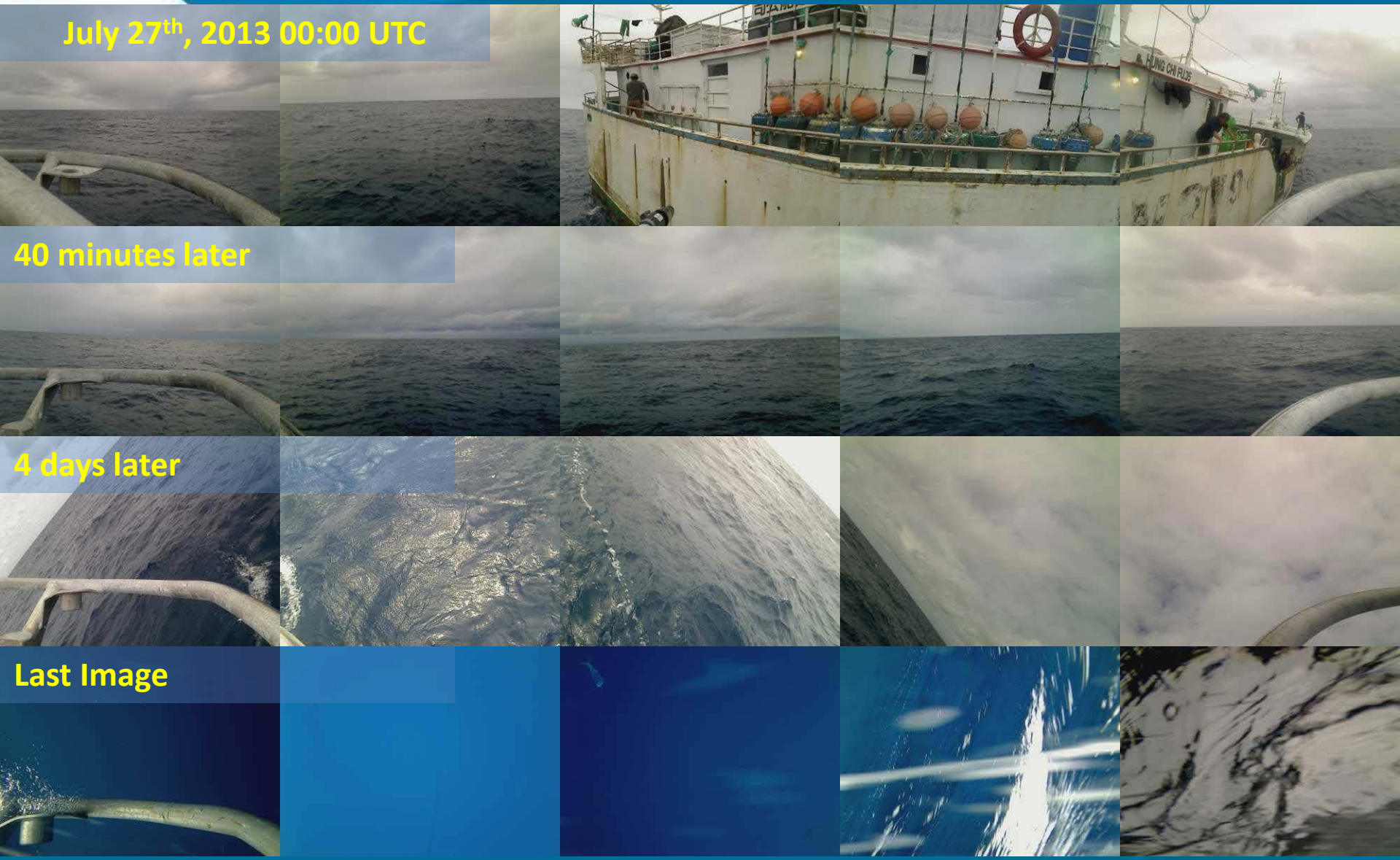
11:40 AM Local Time 25 March 2013



NDBC's BuoyCAM and Anti-Vandalism

NDBC Counter Vandalism Program in Action !

NDBC's BuoyCAM and Anti-Vandalism



NDBC's BuoyCAM and Anti-Vandalism

Station 46061 - Seal Rocks - Between Montague and Hinchinbrook Islands, AK picture taken at 07/08/2014 1501 UTC.

Station 44007 - PORTLAND 12 NM Southeast of Portland,ME picture taken at 07/08/2014 1501 UTC.

BuoyCAM "Snap Shots" –Morning on July 8, 2014

Station 46054 - WEST SANTA BARBARA 38 NM West of Santa Barbara, CA picture taken at 07/08/2014 1501 UTC.

Station 32304 - 5S 95W picture taken at 07/08/2014 1500 UTC.

Station 41009 - CANAVERAL 20 NM East of Cape Canaveral, FL picture taken at 07/08/2014 1500 UTC.

NDBC's BuoyCAM and Anti-Vandalism

22 Buoy Cameras deployed on climate, weather and tsunami buoys

Expanding Uses:

- Cloud study
- Wave height estimation
- Fog detection

Tsunami

Weather

NDBC's BuoyCAM and Anti-Vandalism

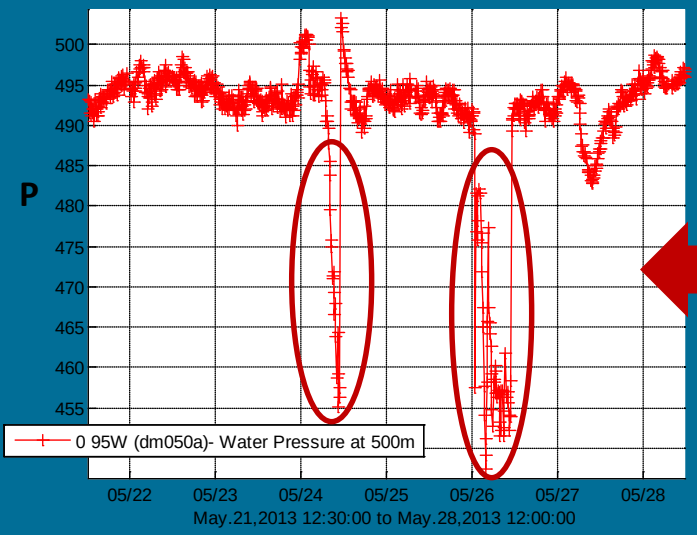
Generation 2 Capabilities

- Continuous autonomous deployment
- 360° of vision
- Every 5minutes: Take and store one image
- Every hour: Transmit one low resolution image
- Remotely request Hi resolution image
- Includes AIS receiver

[redacted] [redacted] Flag) Purse Seine Fishing Vessel Monitored in Real-Time Vandalizing a TAO Buoy

Working with NWS IA and U.S. State

095W TAO Pressure Sensor Shows "tugs" on Buoy



095W Camera captured events 5/24/13 & 5/26/13

2S95W Camera captured the same or nearly identical vessel 5/27/13 & 5/28/13

NDBC Multi-Agency Counter Vandalism Program

May 24 2013

The "Catch"

Via DBCP-30 Vandalism Form

Every "Event" Seen by NDBC Mission Control Center

Annual DBCP Report July 2013

Informational No Enforcement Action

High Confidence ***BV*** "Events"

ID ? Yes

No & Yes

LOC

Western Pacific

Eastern Pacific

International Regional Fishery Management ORGs

WCPFC

IATTC

Enforcement

IUU Fishing List

Via HLS Information Network

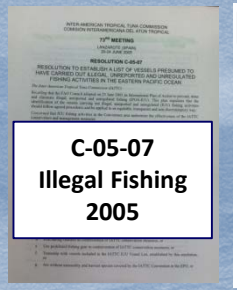
USCG Field INTEL Rpt

Influence

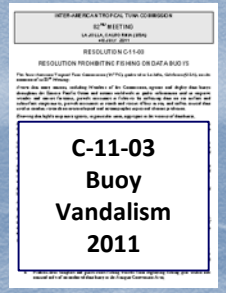
NDBC, NWS IA, NMFS, US STATE, DHS, USCG, INTERPOL

Inter-Agency Group

Policy Prohibiting Fishing on Data Buoys



C-05-07 Illegal Fishing 2005



C-11-03 Buoy Vandalism 2011

Aug 6 2014

Fishing License Suspension & Crew Education

NDBC's BuoyCAM and Anti-Vandalism

Thank You..Questions ?