University of Connecticut
Department of Marine Sciences

NERACOOS
NORTHEASTERN REGIONAL ASSOCIATION of COASTAL OCEAN OBSERVING SYSTEMS

Acoustic Modems for Controlling Wave and Turbulent Stress Measurements in Shallow Water

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University of Connecticut

IOOS® INTEGRATED OCEAN OBSERVING SYSTEM

Overview

- Array Status
- Rest of the stuff

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LONG ISLAND SOUND STUDY

A PARTNERSHIP TO RESTORE AND PROTECT THE SOUND

Overview

- Array Status
- Disposal of dredged material, Erosion of beaches etc. are important problems in the coastal zone
- Sediment erosion and transport is largely determined by the bottom stress and circulation
- The stress is determined by bottom structure, currents and waves
- Big waves are intermittent in estuaries
- Measurements are sparse – models dominate all practical applications

Station	Latitude (degrees north)	Longitude (degrees west)
1	41.2000	72.4000
2	41.1500	72.3700
3	41.2583	72.2422
4	41.1500	72.0000
5	41.1500	71.7500
6	41.2500	71.8000
7	41.2600	72.1000

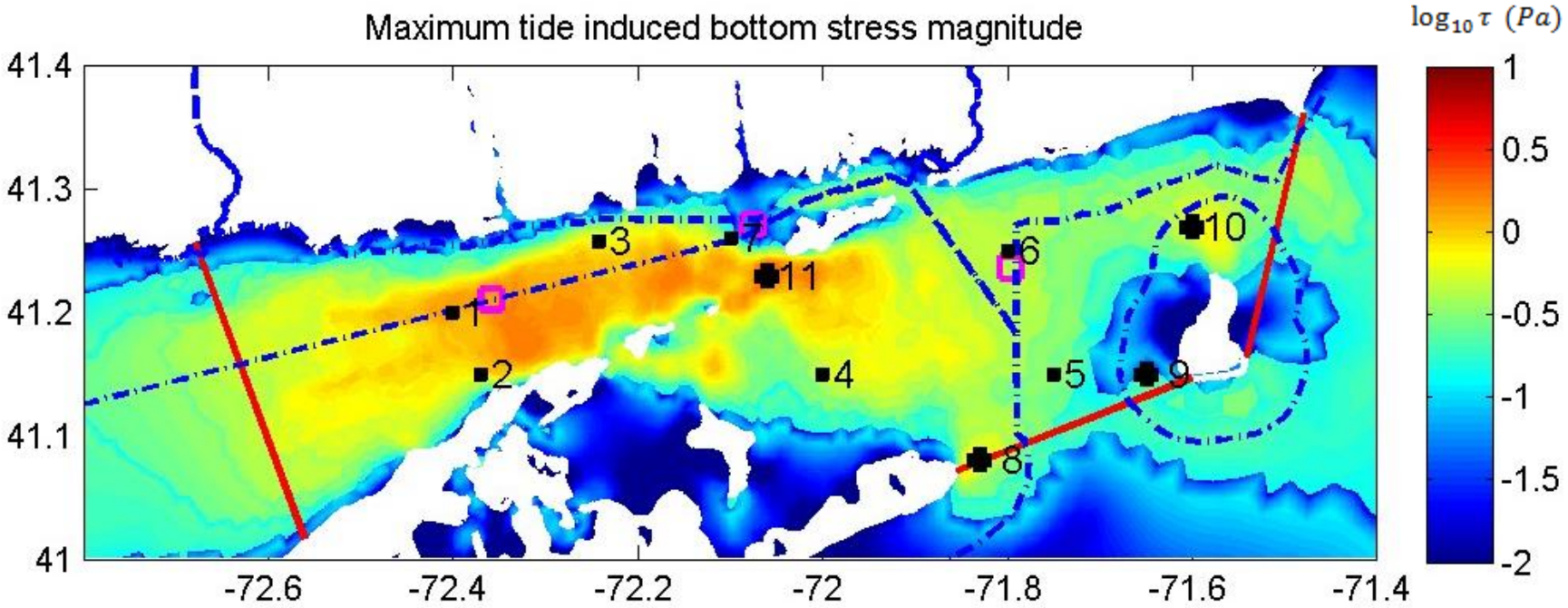
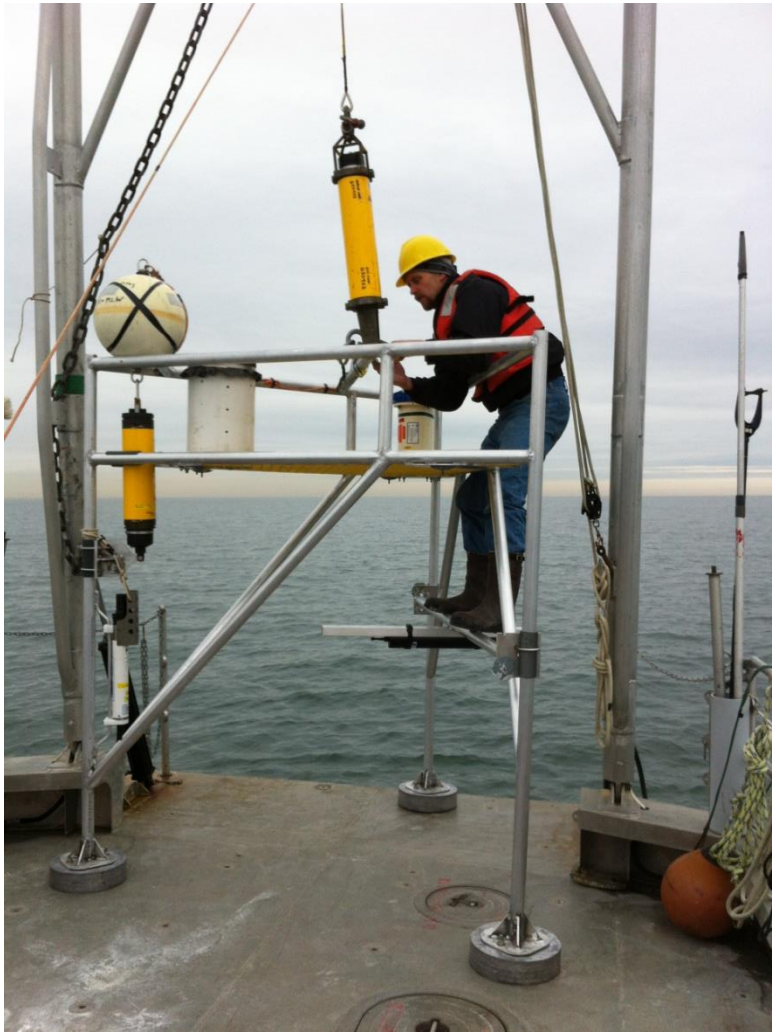


Figure 5. A map of the eastern end of LIS and the Block Island Sound with colors showing preliminary estimates of the distribution of the maximum bottom stress (N/m^2) produced by tidal currents alone. The red lines show the boundaries of the zone of siting feasibility (ZSF). The black squares show the proposed locations of moored current measurements. The open magenta squares indicate the location of existing or historical dredge material disposal sites.



Bottom Instrumentation

1. Upward looking RDI ADCP to measure profile (1-0.5m resolution) of current and wave statistics
2. Downward looking Nortek ADCP with 5cm resolution bottom to 75cm to measure stress and acoustic backscatter intensity
3. CTD to measure salinity, temperature and bottom pressure
4. Optical backscatter at .2 and .8 m to infer SPM concentrations

Overview - 2

- Wave and Stress observations require high resolution (1Hz and ~.1 m) measurements of current
- Since waves are intermittent, you need to do it for a long time.
- This requires a lot of power and bandwidth
- Getting that on a cable to the bottom in shallow water is awkward

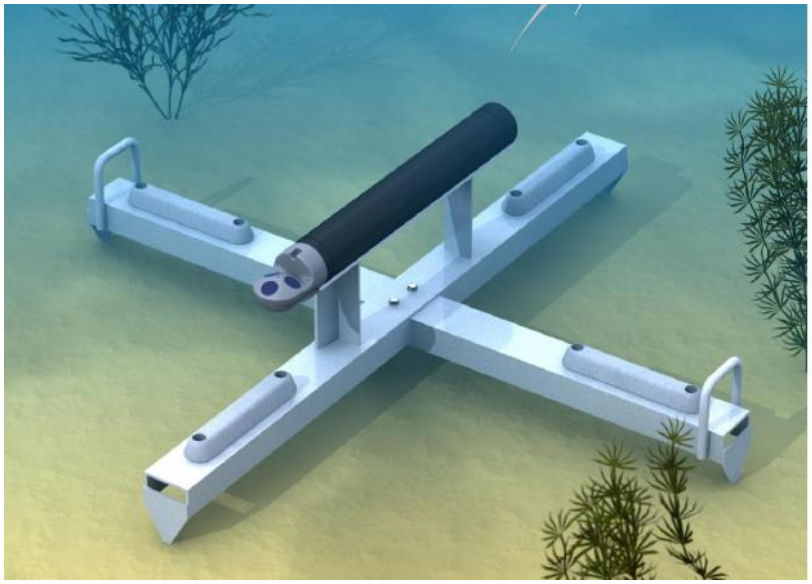
Nortek HR

- Operates at 2 Mz
- Three beams at 25 deg from axis
- PULSE COHERENT MODE

  http://nortek-as.com/lib/technical-notes/tn-027-pulse-coherent-primer.
- Extended Velocity Range Processing to reduce ABIGUITITY

  http://nortek-as.com/lib/technical-notes/tn-028-extended-velocity-range
- At 2Hz, 2048 pings every 20 minutes with 10 bins => 1.5 Gbytes ASCII /5 days

- Batteries fail and Memory full after ~20 days.

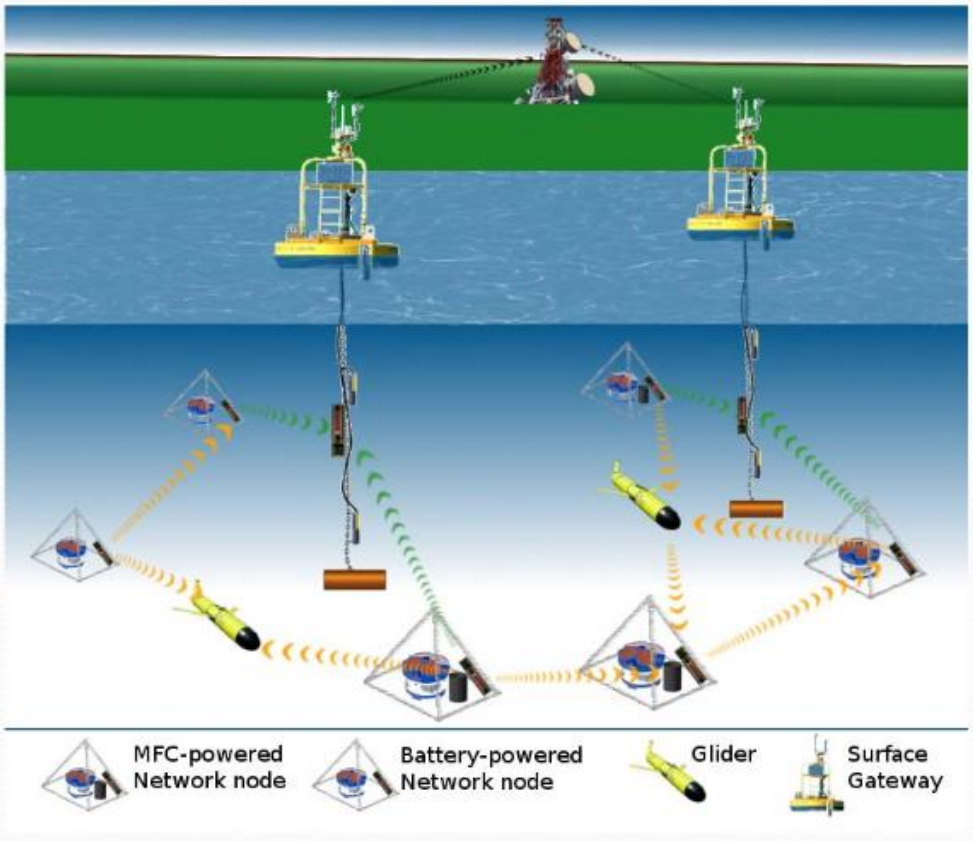


Overview - 3

Technology Solution- Put buoys with modems on the surface and instruments on a bottom frame.

- Control them from shore for efficient power, memory use

Ocean-TUNE: A Community Testbed



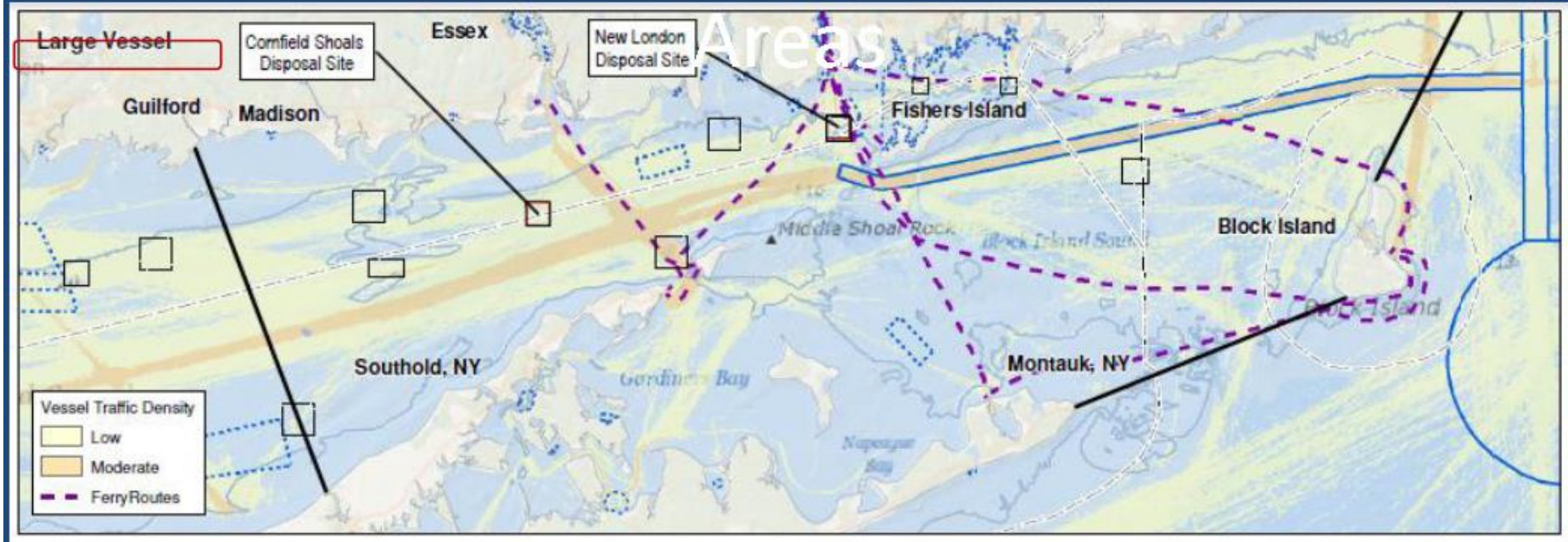
- Supported by NSF CRI
  - UConn (lead), UW, UCLA, TAMU
  - **$2,635,000 for 3 years**
- Sea Testbed with 4 sites
  - Long Island Sound, Hood Canal, Santa Monica Bay, Galveston Bay
- URL: **http://oceantune.org/**

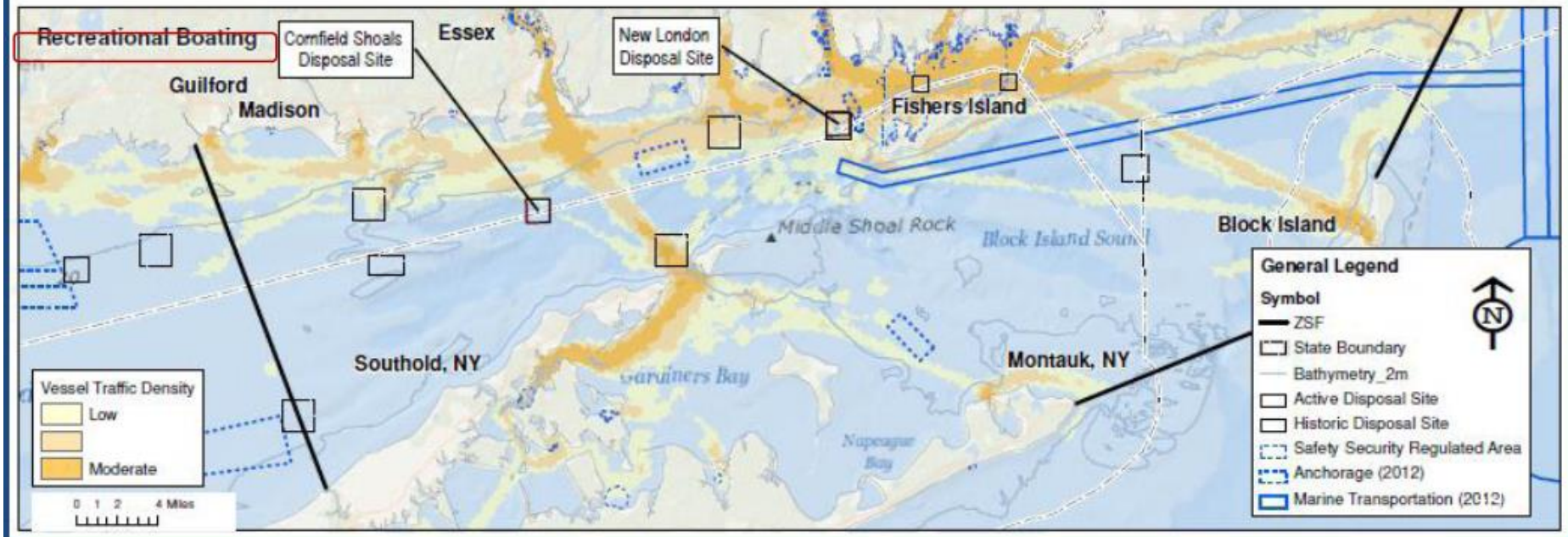
Jun-Hong (June) Cui

UnderWater Sensor Network (UWSN) Lab
http://uwsn.engr.uconn.edu

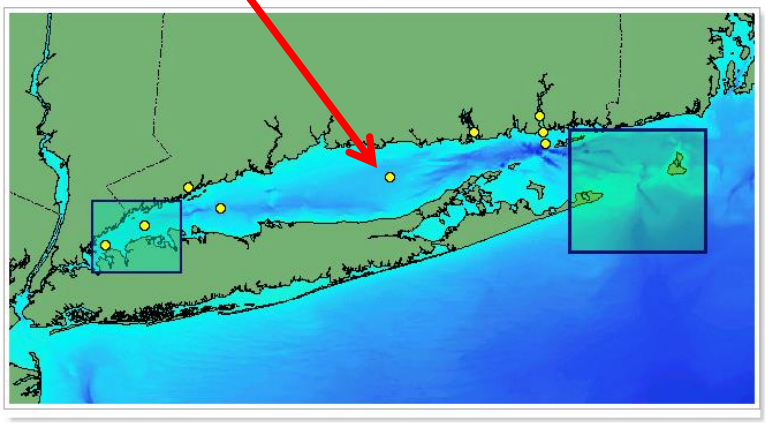
School of Engineering, University of Connecticut

Tier 1: Vessel Traffic Density, Anchoring





NERACOOS LISICOS – CLIS buoy



LISICOS mobile access: lisicos.uconn.edu/m/

Funding provided by NOAA in support of the U.S. Integrated Ocean Observing System:

IOOS INTEGRATED OCEAN OBSERVING SYSTEM

2. Time and Deployment

First deployment: Aug. 14, 2012
Experiment date: Aug. 22 to 27, 2012
Location: Near coast (see Fig.5)

Only OFDM modem was equipped on each node for underwater communication.

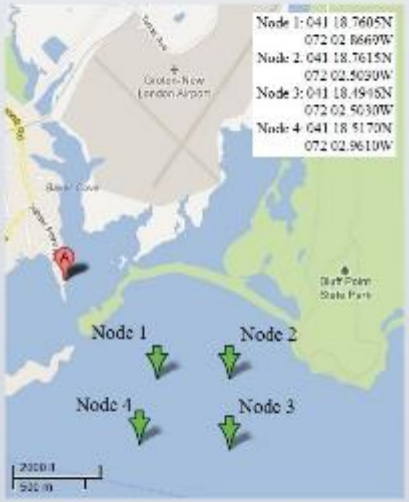


Fig.5 1st deployment locations

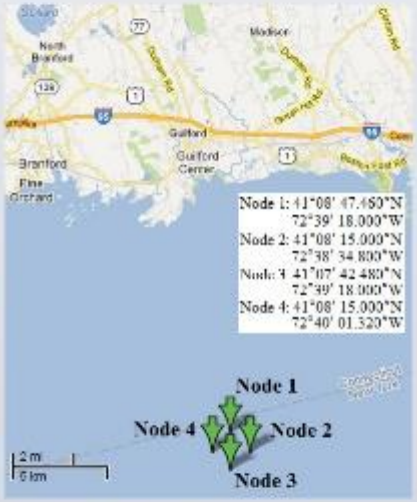
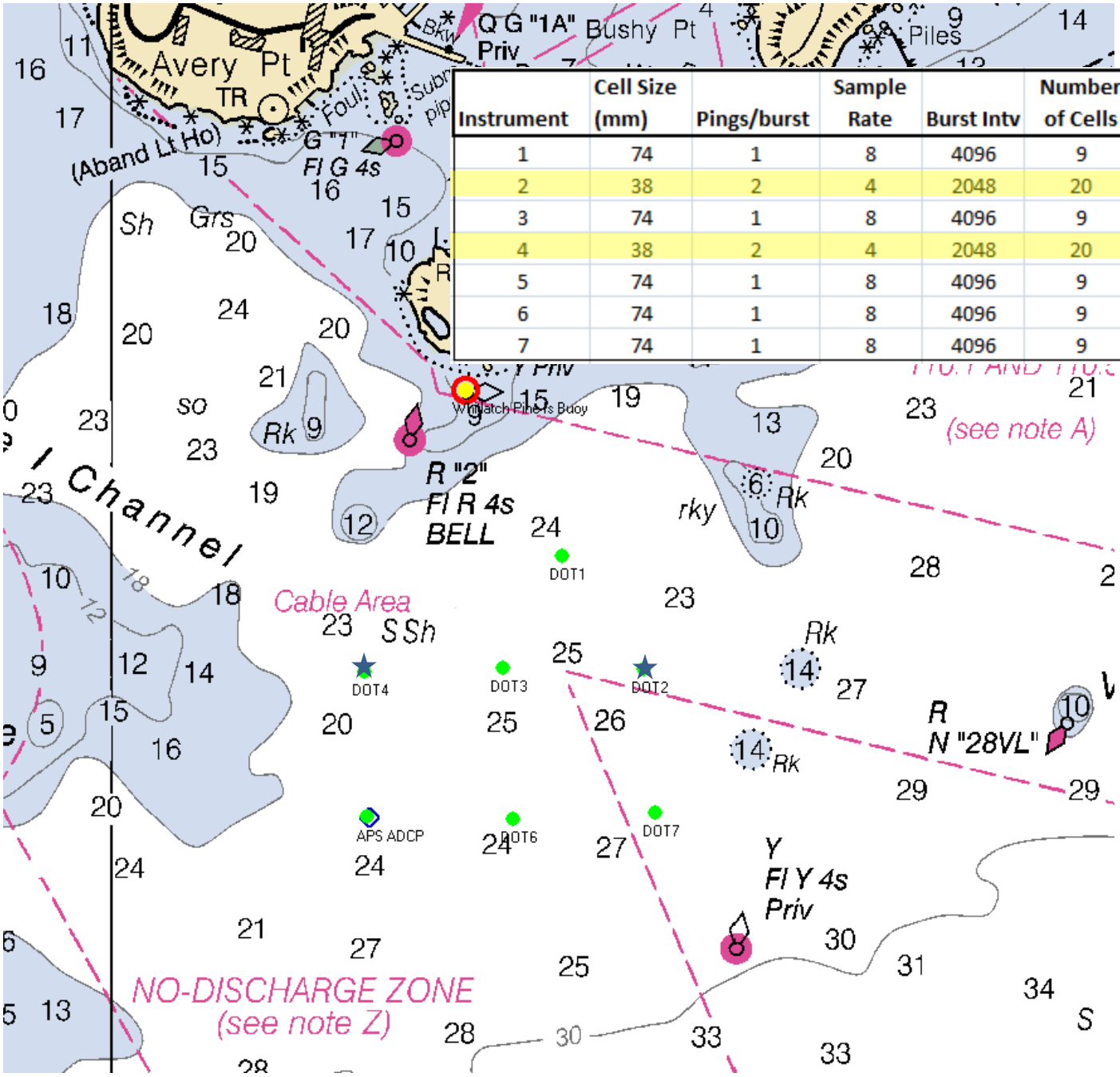


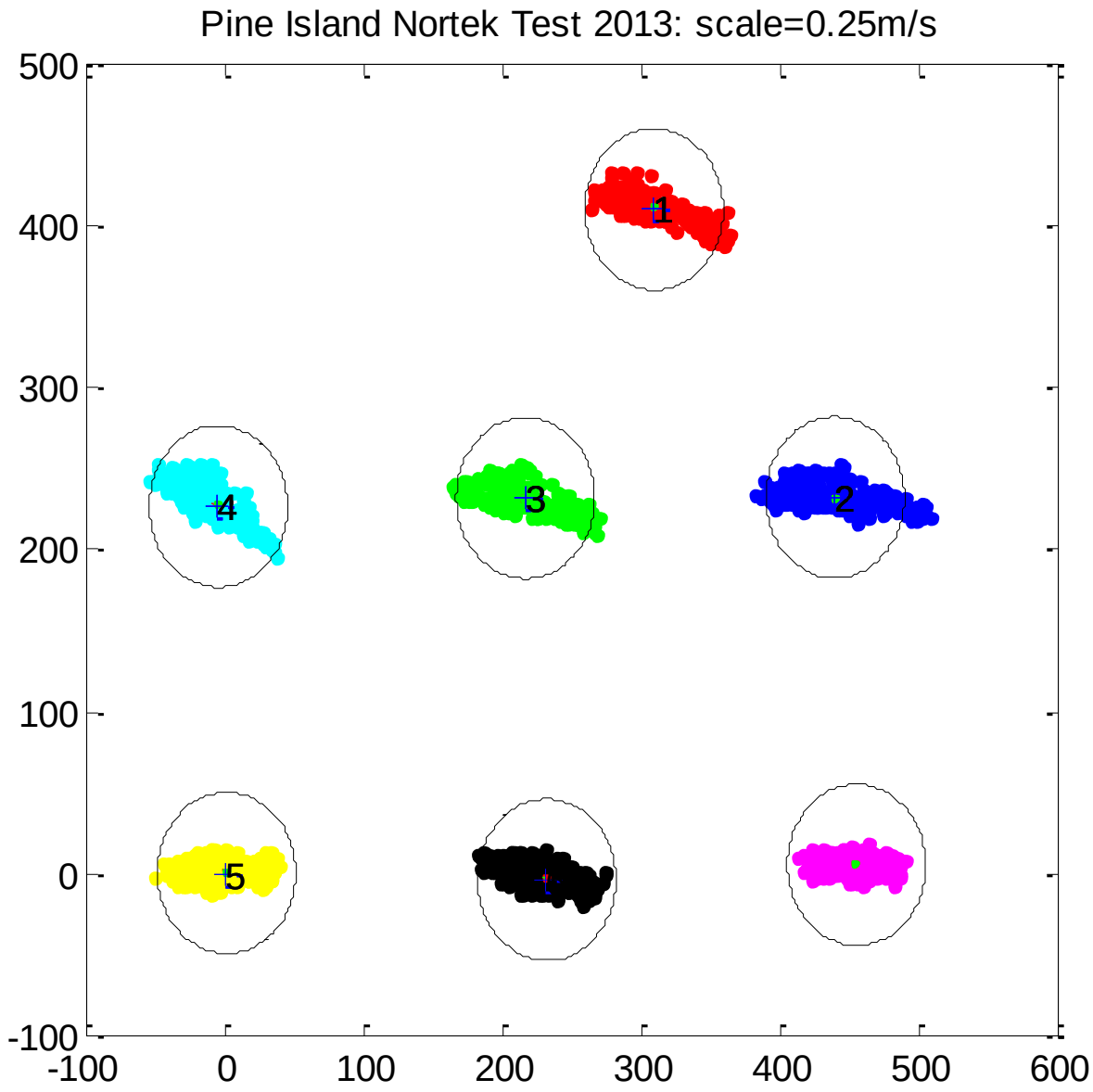
Fig.6 2nd deployment locations

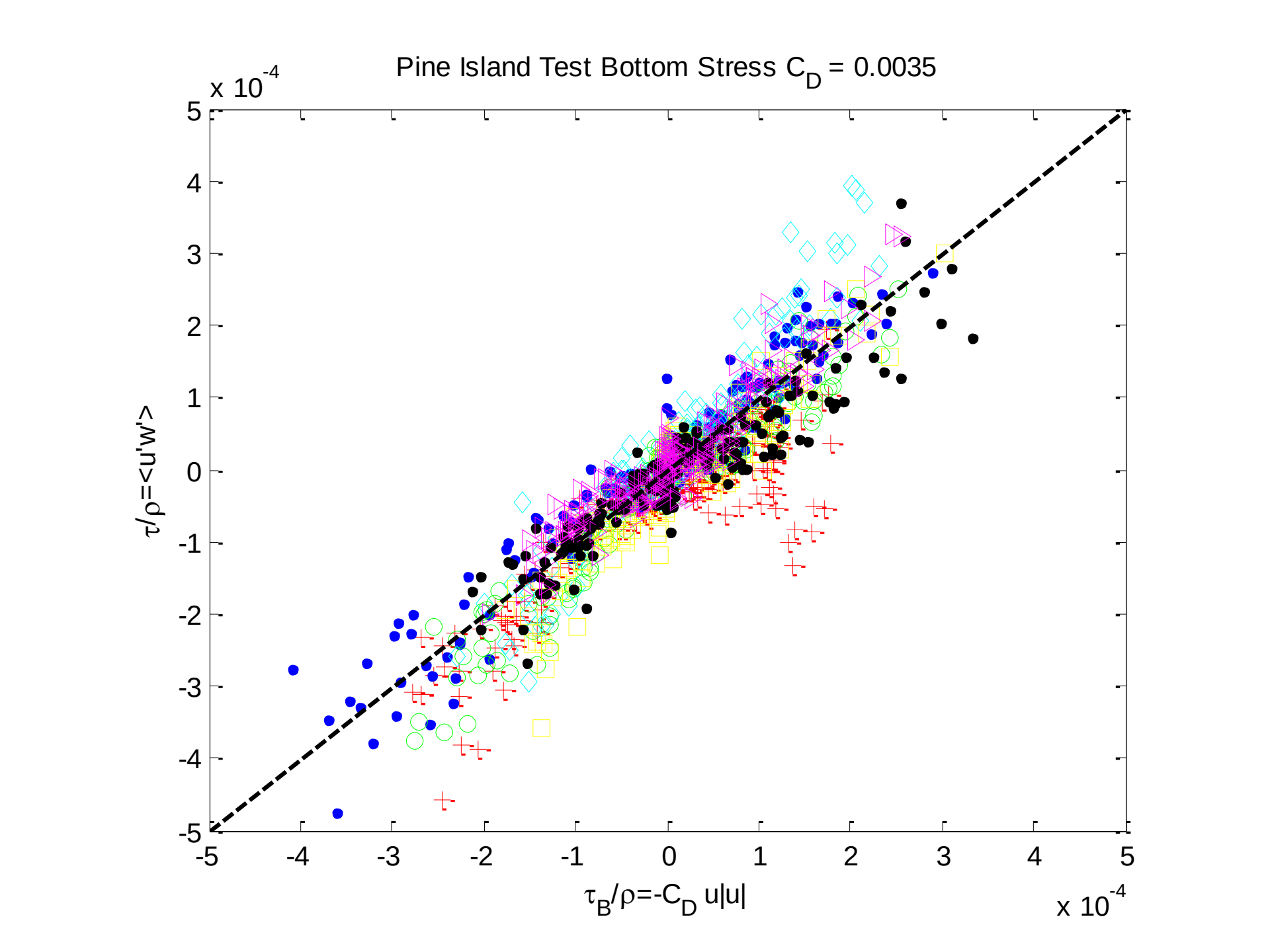
Second deployment: Dec. 20, 2012
Experiment date: Jan. 12 to Feb. 7, 2013
Location: 12km from coast (see Fig.6)

Node 1 was damaged due to sever weather condition in winter. Both Benthos modem and OFDM modem were equipped on the other nodes.



Instrument	Cell Size (mm)	Pings/burst	Sample Rate	Burst Intv	Number of Cells	EVR	Wrap
1	74	1	8	4096	9	ON	OFF
2	38	2	4	2048	20	ON	OFF
3	74	1	8	4096	9	ON	OFF
4	38	2	4	2048	20	ON	OFF
5	74	1	8	4096	9	ON	OFF
6	74	1	8	4096	9	ON	OFF
7	74	1	8	4096	9	ON	OFF


Pine Island Nortek Test 2013: scale=0.25m/s
500
400
300
200
100
0
-100
-100
0
100
200
300
400
500
600
1
2
3
4
5


Pine Island Test Bottom Stress C_D = 0.0035
x 10^{-4}
$\tau/\rho=<u'w'>$
$\tau_B/\rho=-C_D\ u|u|$
x 10^{-4}
5
4
3
2
1
0
-1
-2
-3
-4
-5
-5
-4
-3
-2
-1
0
1
2
3
4
5

Conclusions

- We used 7 Nortek HRs in a look-down configuration from ~0.75 above bottom in “Pulse Coherent Mode” to measure stress in a region of tides and waves
- We describe characteristics of the data quality and our methods of analysis
- We compared several “Log Law” fits methods and find that the method has a significant effect
  - The surface (Perlin approach) makes little difference to u_* but a substantial difference to z_0.
  - When fully turbulent, the z_0 should be constrained (Ling approach)
- We find good agreement when expected between u_*^2 and <u’w’> computed near the sensor
- The Nortek HR works for this application, but need long term deployment