SeaSonde Ocean Surface Monitoring

Chad Whelan
Chief Technology Officer
CODAR Ocean Sensors
2-D Surface Current Maps

Kona Coast, Hawaii
SeaSonde Surface currents

KONA - Aug 12, 2011 06:00 UTC (±37.5 min)
Wave Measurements

Wave Height (m)

onshore  
offshore

20-40% of the range for currents
Over 500 SeaSondes Sold Worldwide
Ocean/Met Agencies Using SeaSonde
Regional/National Networks

Case Study: U.S. West Coast

- 60+ SeaSondes
- Mixed frequencies: 5, 13, 25, 42
- Nested Resolutions
- >2000 km of coastline covered
Nested Resolutions

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SeaSonde Site Layout

Climate-Controlled Shelter with Power, Communications

> 11 MHz: Single T/R antenna

< 11 MHz: Separate T & R antennas
SeaSonde Site Layout

Climate-Controlled Shelter with Power, Communications

> 11 MHz:
  Single T/R antenna

< 11 MHz:
  Separate T & R antennas
SeaSonde Site Layout
Climate-Controlled Shelter with Power, Communications
Transmit Antenna Configurations For Extra Range
Lightweight, Easy to Install
Small Footprint for Easier Siting
In urban areas & on sensitive land
Phang Nga, Thailand

5 MHz Separated T & R
Twin Transmit Antenna

*Sandy Hook, NJ*
Rapid Deployment

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Kona Coast, Hawaii
SeaSonde Surface currents

Coast-to-coast coverage = no blind zones near coastline

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Long Range SeaSonde
6-km Range Resolution
Radials Produced to ~190 Km

Standard SeaSonde
1.5 km range resolution
Radials Produced to ~50 Km
## Considerations for Choosing Frequency

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Antennas</th>
<th>Radar λ (m)</th>
<th>Ocean λ (m)</th>
<th>Current Depth (m)</th>
<th>Max Speed (m/s)</th>
<th>Range (km)</th>
<th>Resolution (km)</th>
<th>Max Wave (m)</th>
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</thead>
<tbody>
<tr>
<td>4.5</td>
<td>2</td>
<td>67.3</td>
<td>33.6</td>
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<td>3-6</td>
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<td>2</td>
<td>57.0</td>
<td>28.5</td>
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<td>6.0</td>
<td>150-200</td>
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<td>16.1</td>
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<td>90-130</td>
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<td>22.2</td>
<td>11.1</td>
<td>1.3</td>
<td>3.7</td>
<td>60-90</td>
<td>3</td>
<td>13</td>
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<td>18.6</td>
<td>9.3</td>
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<td>3.4</td>
<td>45-65</td>
<td>1.5</td>
<td>11</td>
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<td>12.2</td>
<td>6.1</td>
<td>0.7</td>
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<td>30-50</td>
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<td>7</td>
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<td>11.4</td>
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<td>25-45</td>
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<td>3.8</td>
<td>0.3</td>
<td>2.2</td>
<td>15-25</td>
<td>0.3</td>
<td>3</td>
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<tr>
<td>42.3</td>
<td>1</td>
<td>7.1</td>
<td>3.6</td>
<td>0.3</td>
<td>2.1</td>
<td>15-25</td>
<td>0.3</td>
<td>3</td>
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</tbody>
</table>
ITU Ocean Radar Frequency Allocations

CODAR-patented high-precision GPS-disciplined waveform (SHARE)

Share Bandwidth
Multiple Systems can sweep through same band without interfering

Multistatic Network
Collect Sea echo from another’s site’s transmission

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
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<td>4438 - 4488</td>
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<td>9305 - 9355</td>
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<td>13450 - 13550</td>
<td>13450 - 13550</td>
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<tr>
<td>16100 - 16200</td>
<td>16100 - 16200</td>
<td>16100 - 16200</td>
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<td>24450 - 24600</td>
<td>24450 - 24600</td>
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<td>26200 - 26350</td>
<td>26200 - 26420</td>
<td>26200 - 26350</td>
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<td>39000 - 39500</td>
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<td>39500–40000</td>
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<tr>
<td>42000 - 42500</td>
<td>No allocation</td>
<td>No allocation</td>
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</tr>
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</table>
Deepwater Horizon

Thailand's Koh Samet beach oil spill 'threatens tourism, fishing industries'
By Tim Hume and Kocha Olarn, CNN
July 31, 2013 – Updated 0804 GMT (1604 HKT)

Blacked water lapes onto the beach in front of a resort on the island of Koh Samet Monday, July 29. Tourists have been evacuated from the popular Thai weekend destination.

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US Coast Guard: Search & Rescue

Model Drifter CODAR

NOAA = 0.00 (km): CODAR = 0.00 (km)

Slide Provided by Dr. Josh Kohut, Rutgers University
Search And Rescue: U.S. Coast Guards SAROPS

Search Area Greatly Reduced After 96 Hours

HYCOM 36,000 km²

HF Radar 12,000 km²

Slide Provided by Dr. Josh Kohut, Rutgers University
Fisheries Management

Ocean Surface Currents and Temperature

latitude
longitude

mean no. fish per haul

34.6
34.5
34.4
34.3
34.1
34.0
33.9
-120.8
-120.6
-120.4
-120.2
-120

Slide Provided by UC Santa Barbara

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Per Species Habitat Models

Slide Provided by Dr. Josh Kohut, Rutgers University
Storm Intensity Prediction – Currents during Irene

Before

During

After

Images Provided by Rutgers University
Japan Coast Guard: Vessel Traffic Management

Typical Current = 170 cm/s

Data courtesy of Japan Coast Guard

CODAR Ocean Sensors www.codar.com
Sediment Transport
Waves vs Buoys – U.S. West Coast

CODAR Ocean Sensors

www.codar.com
New Jersey Shore Waves Buoys

- Buoys obtain point measurement whereas SeaSondes obtain measurements from range cells (RCs).

- This map shows 10 RCs for each station. The first two RCs are not used to monitor waves.

- Because RCs extend across a wide patch of ocean surface, their measurements may reflect conditions that vary. These include water depth, current speed, surface roughness, and wind direction.

- Buoy 44065 resides between SEAB’s RC7 and RC8. Buoy 44091 resides in SPRK’s RC10. 44091 does not monitor winds.

- Wave data from BRNT are plotted with 44091 buoy output.
HFR wave data can be also be viewed for each range cell.

SPRK range cells RC3, RC5, and RC10 are highlighted.
• Because the New Jersey coast is aligned at approximately 30°, offshore winds have directions between 210° and 30°.

• Onshore winds have directions between 30° and 210°. Offshore winds have directions between 210° and 30°.

• Onshore winds produce wind waves and swell. By the time swell reaches the shore, it is relatively uniform in wave length and height. Both swell and wind waves can be detected by SeaSondes and buoys.

• Offshore winds produce wind waves that are barely developed nearest the coast. As the wave develops further from shore, wave height increases. Wind waves in various stages of development are observed in SeaSonde wave height data.

Ocean Sensors
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January 2018 Waves at Seaside Park (SPRK)

2018, Buoy 44091 (black) & Ranged (WVLR) SPRK
RC3 = cyan, RC5 = purple, RC10 = blue
Onshore Waves approximately equal to buoy wave heights

2018, Buoy 44091 (black) & Average (WVLM) SPRK (blue)
Offshore Waves lower than buoy wave heights due to Fetch-limited wave growth

2018, Buoy 44091 (black) & Average (WVLM) SPRK (blue)
Significant Wave Height (m) Versus Time
January 4-6, 2018

- Significant wave height data are displayed for RC10, RC5, and RC3 and for buoy 44091.
- Offshore winds are reflected in an offshore increase in wave height extending through SPRK range cells and the buoy.
Significant wave height data are displayed for RC10 (left panel) and for buoys (right panel).

Winds begin as onshore and transition to offshore
Winds become offshore at the vertical lines. The first transition occurs at WOOD and progresses northward.

Northward storm progression is also seen in progression of wave height peaks.
Wave Results Match Northward Progression in Daily Weather Maps

3/14 7:00 AM EST 3/15 7:00 AM EST
SeaSonde Ocean Surface Monitoring

• Designed with national/regional networks in mind
• Compact, low footprint hardware
• Low power consumption
• Frequency sharing across large network
SeaSonde Ocean Surface Monitoring

- Omnidirectional measurements
- Built for resiliency
- Advanced QA/QC algorithms
- Unrivaled manufacturer support
- Leverage many applications and stakeholders for one HF network