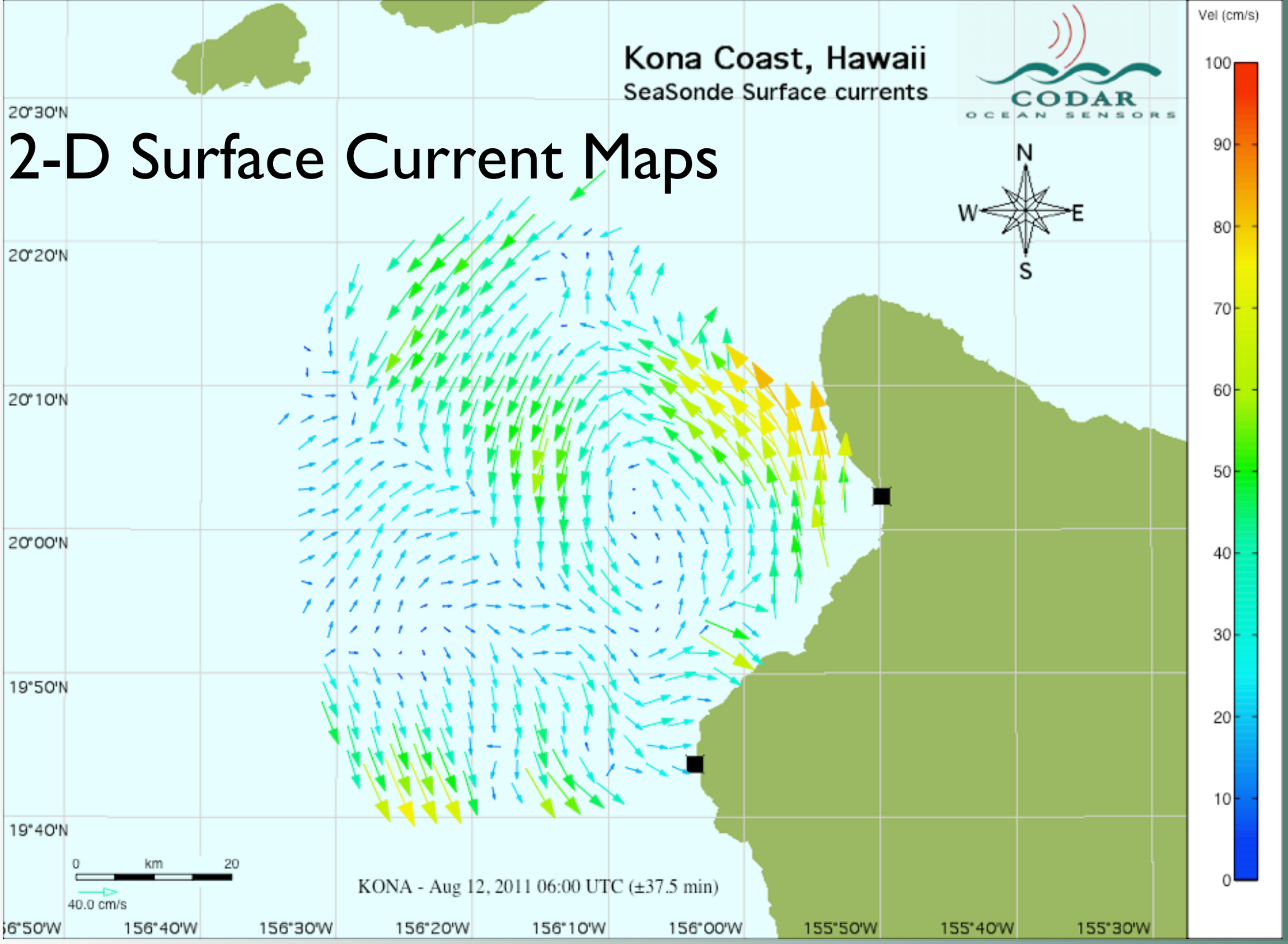
SeaSonde Ocean Surface Monitoring

Chad Whelan
Chief Technology Officer
CODAR Ocean Sensors

2-D Surface Current Maps



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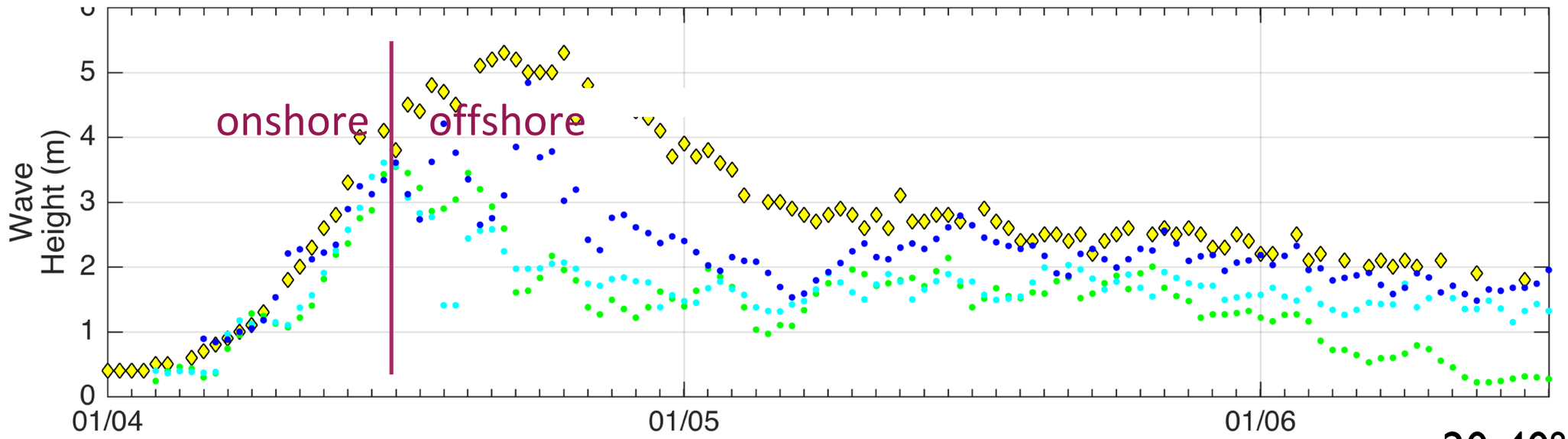
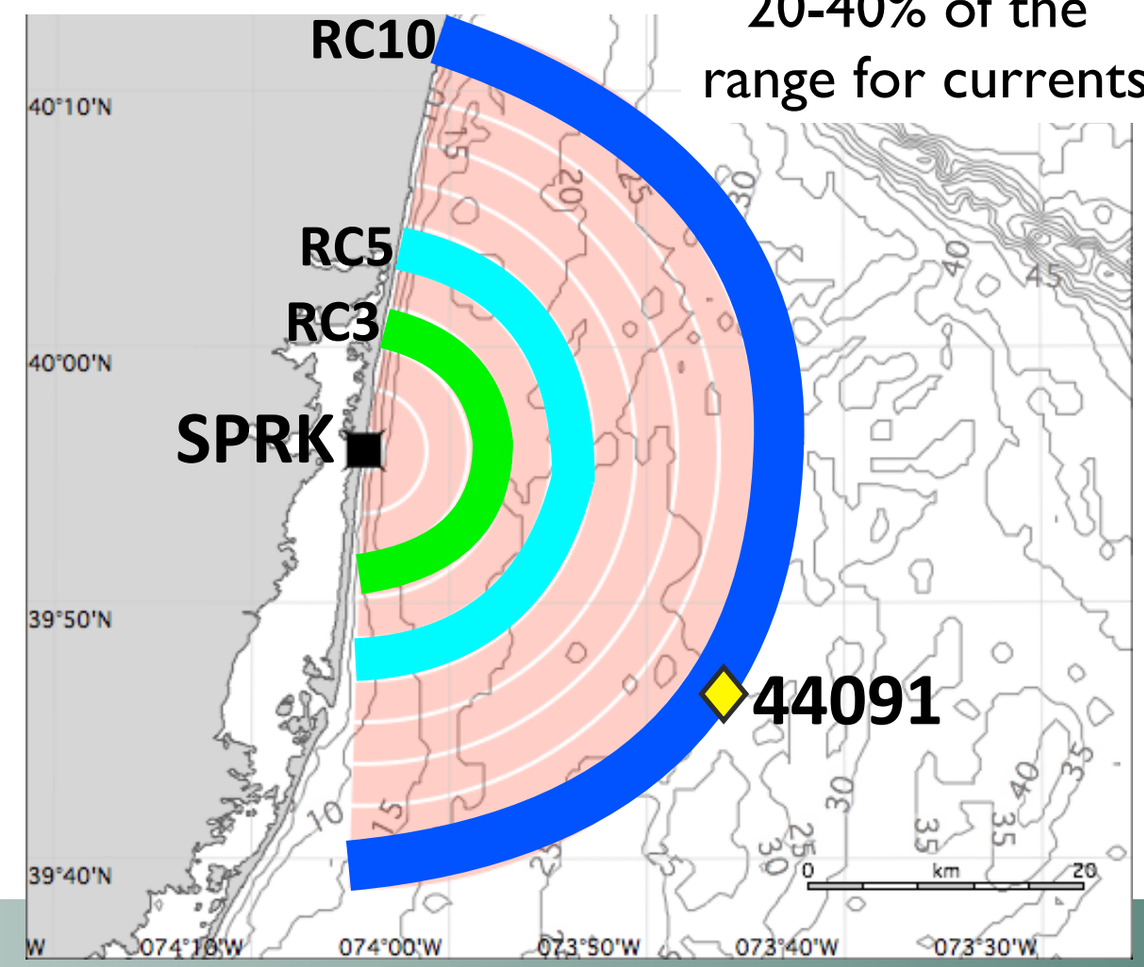
Wave Measurements





20-40% of the range for currents

CODAR Ocean Sensors

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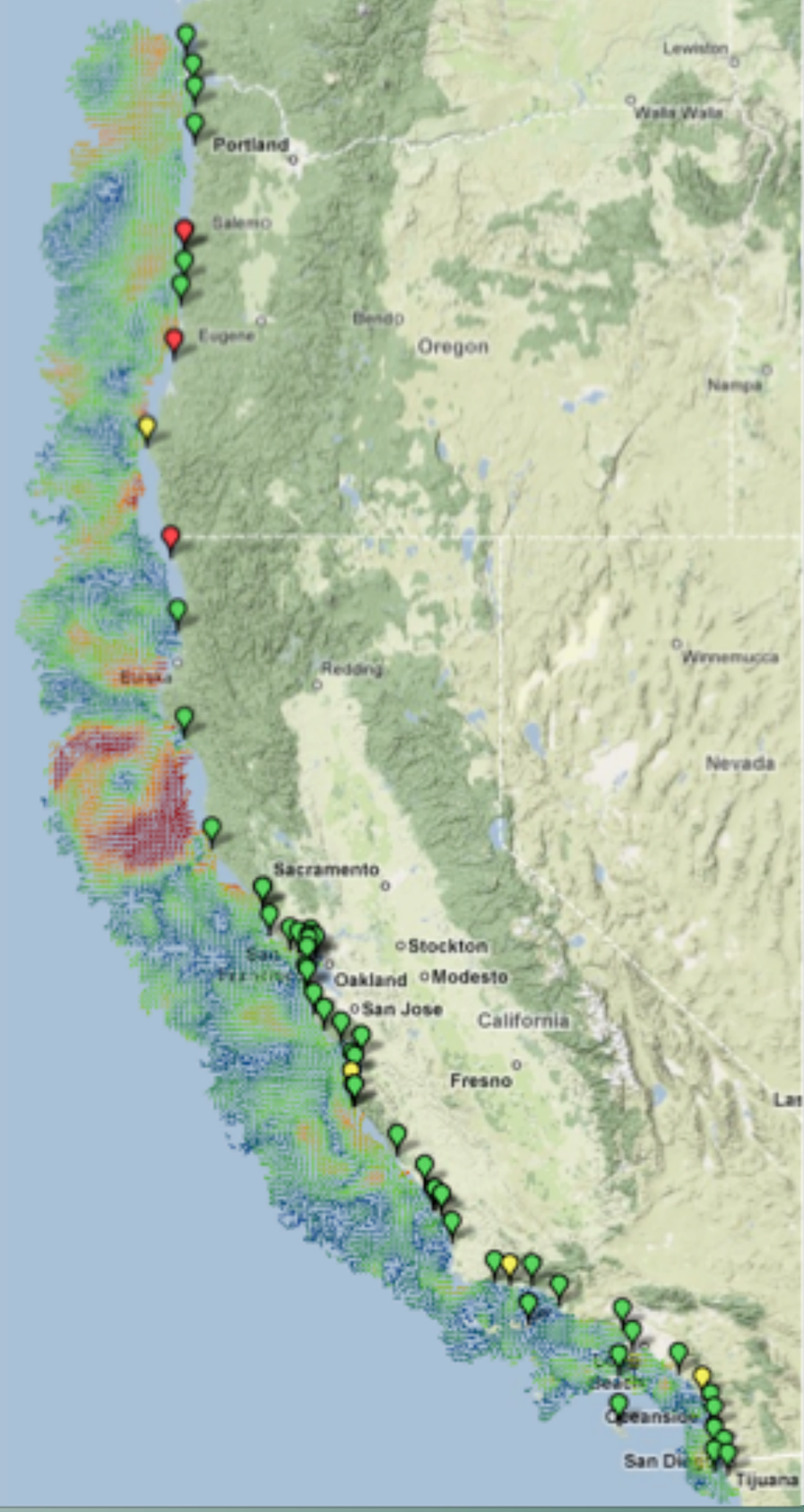
Over 500 SeaSondes Sold Worldwide

Ocean/Met Agencies Using SeaSonde

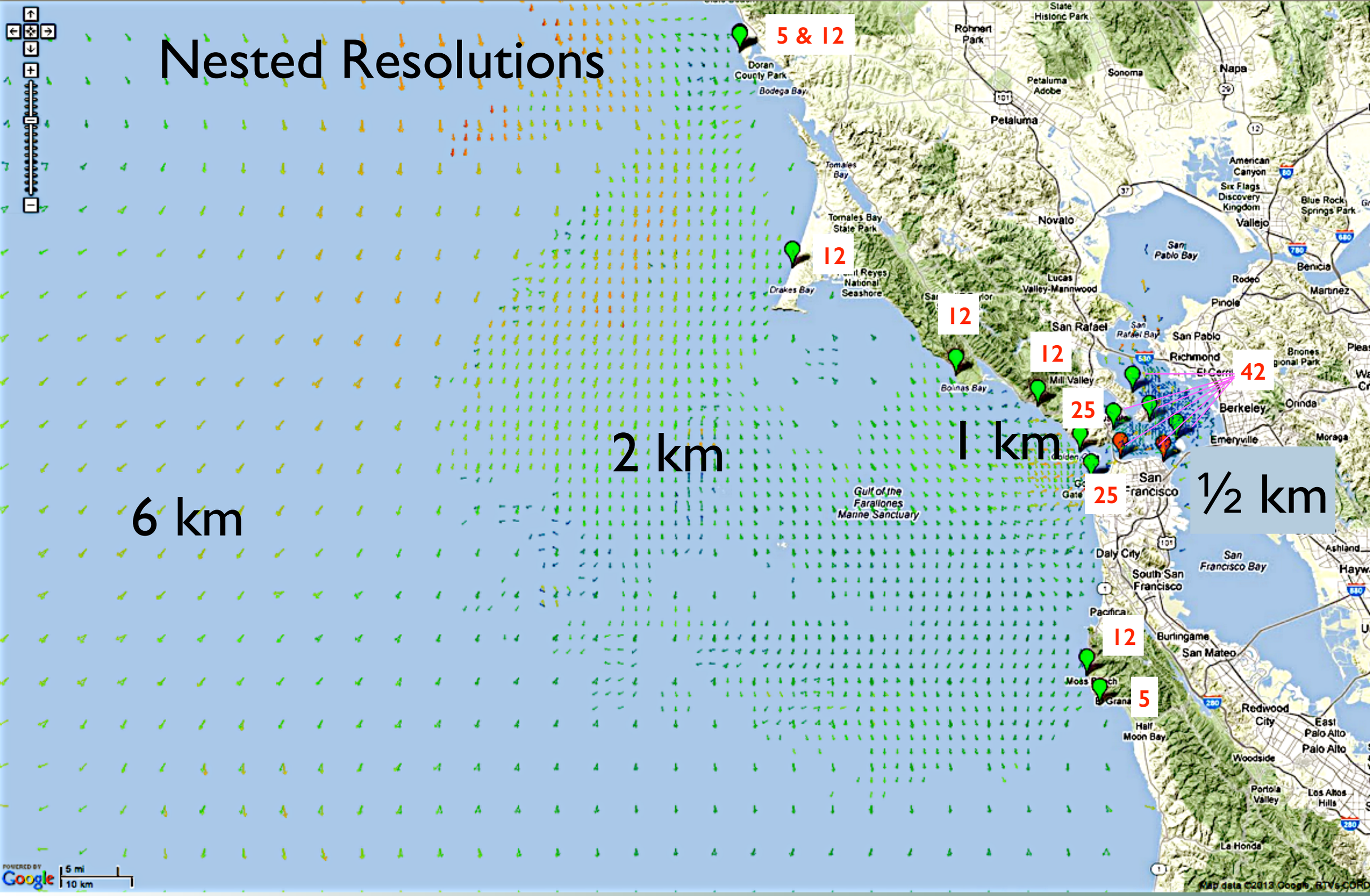
Regional/National Networks

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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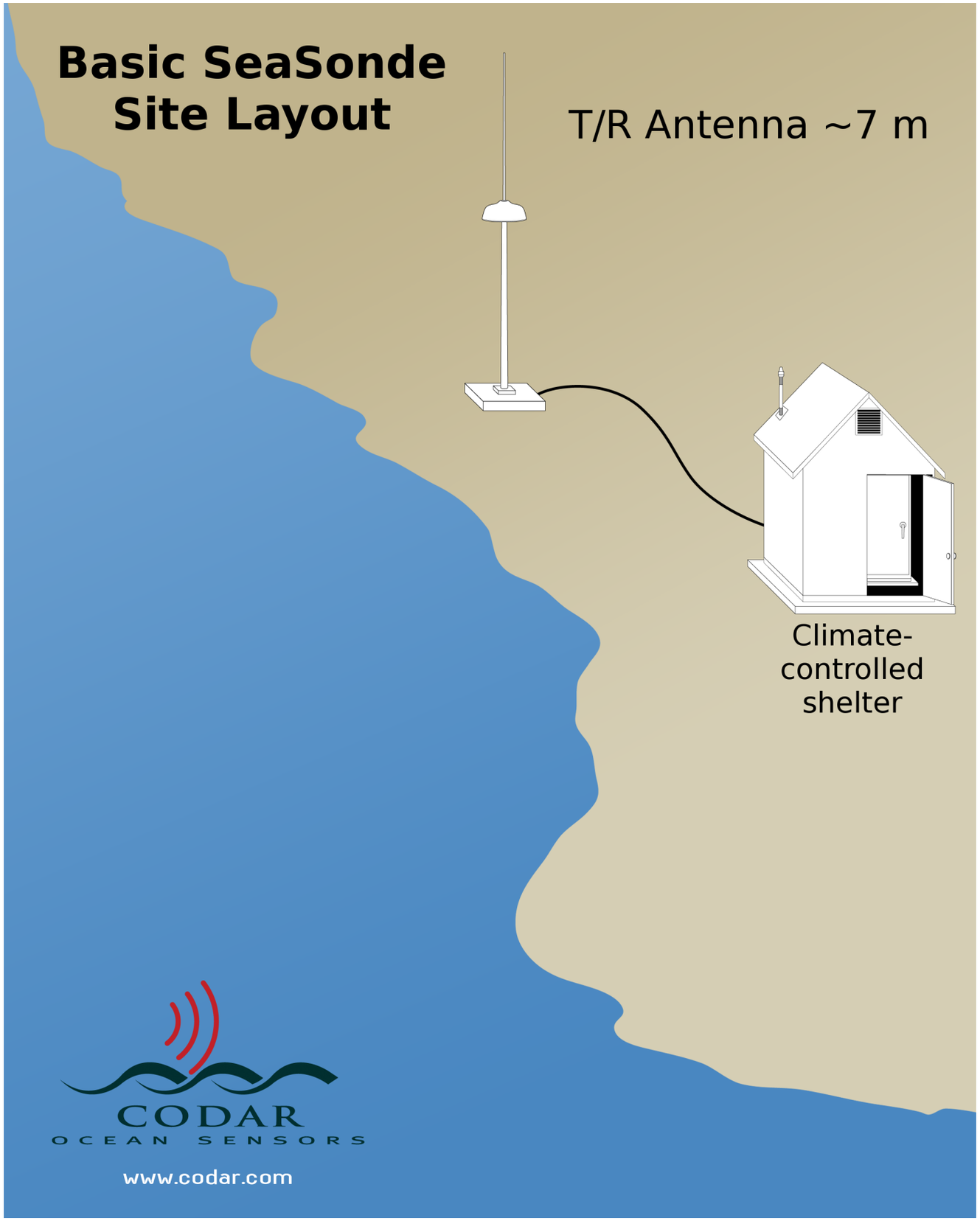
SeaSonde Site Layout

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:
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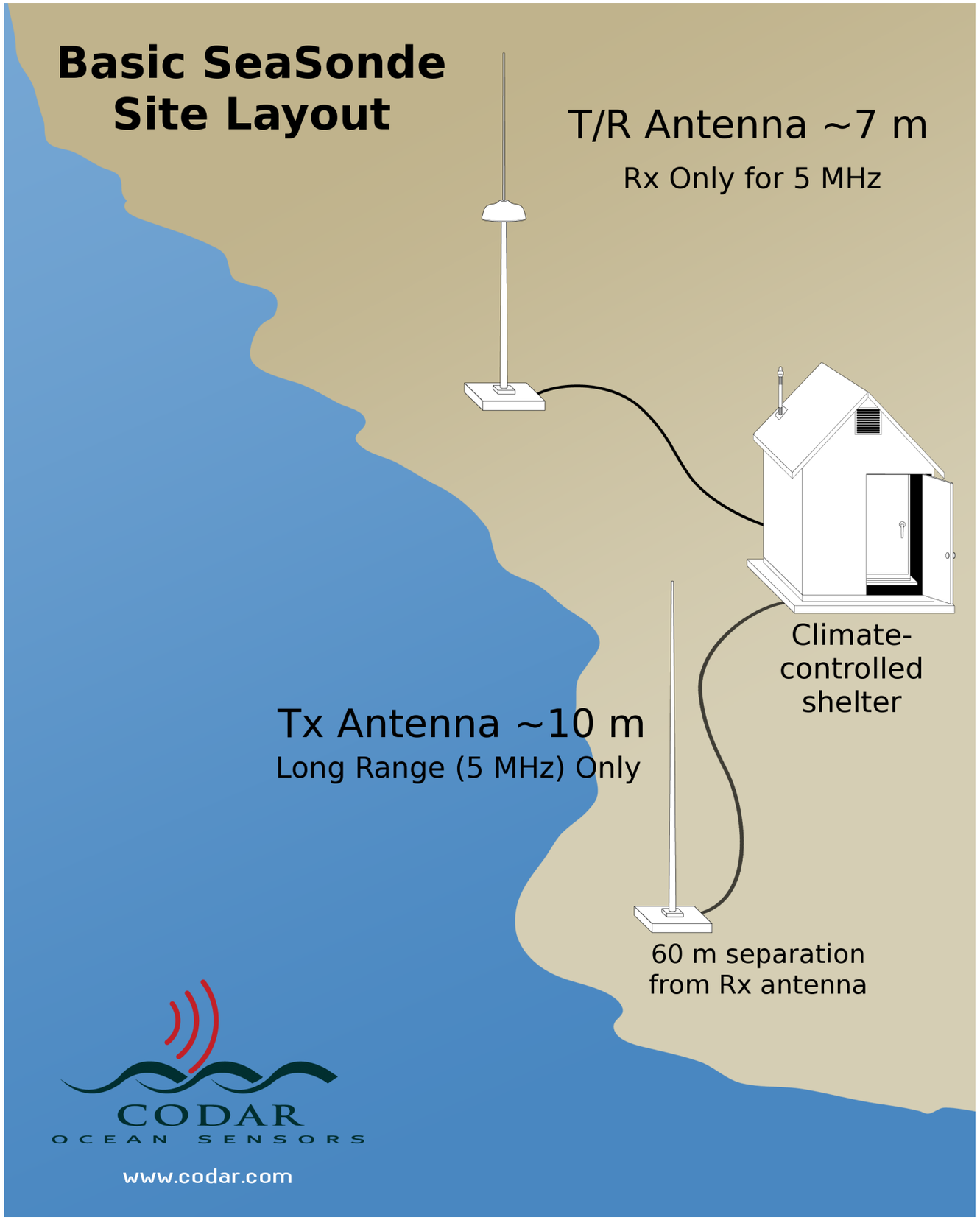
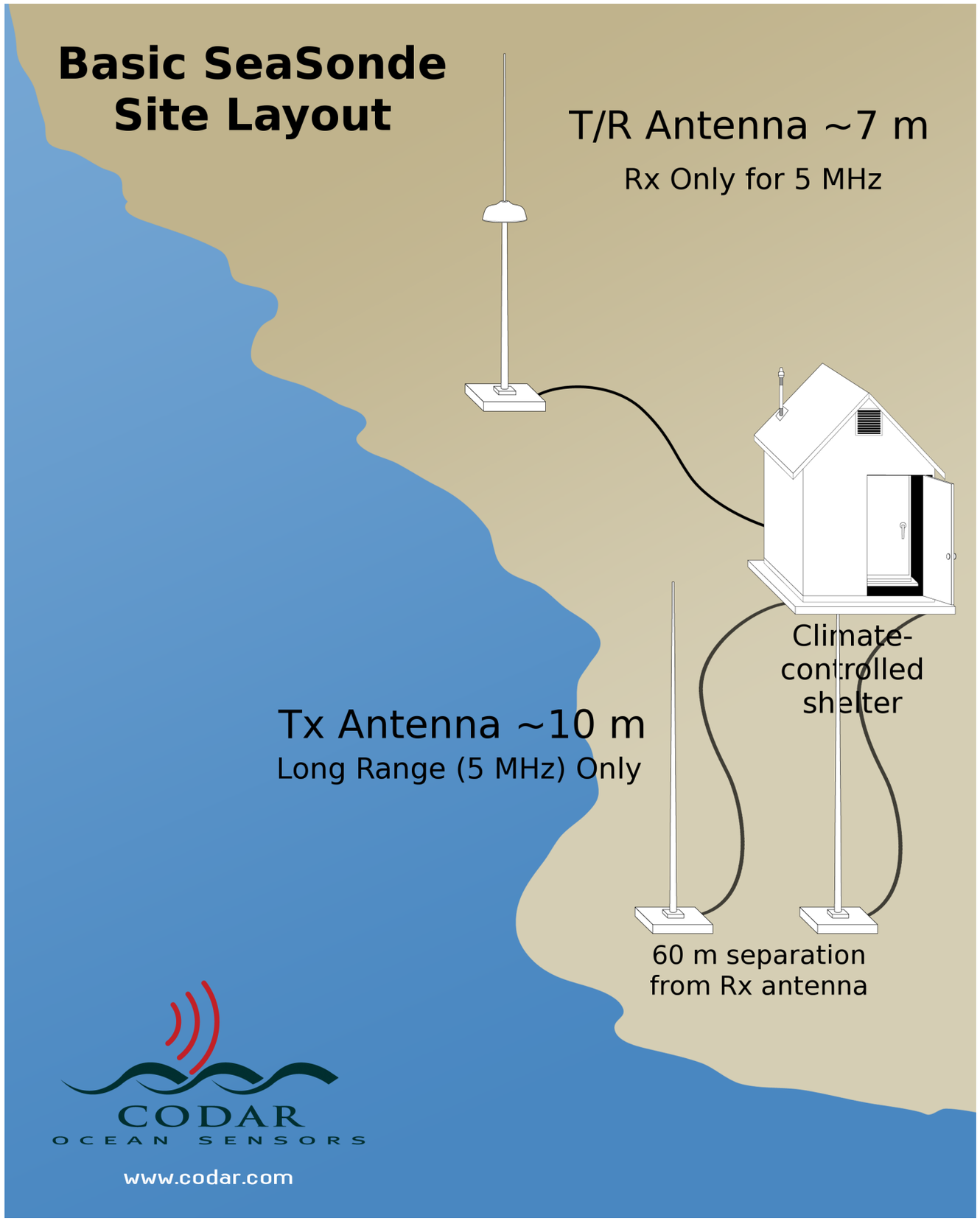


SeaSonde Site Layout

Climate-Controlled Shelter with Power, Communications

Transmit Antenna Configurations For Extra Range



Lightweight, Easy to Install

CODAR Ocean Sensors

www.codar.com

Small Footprint for Easier Siting

On Buildings

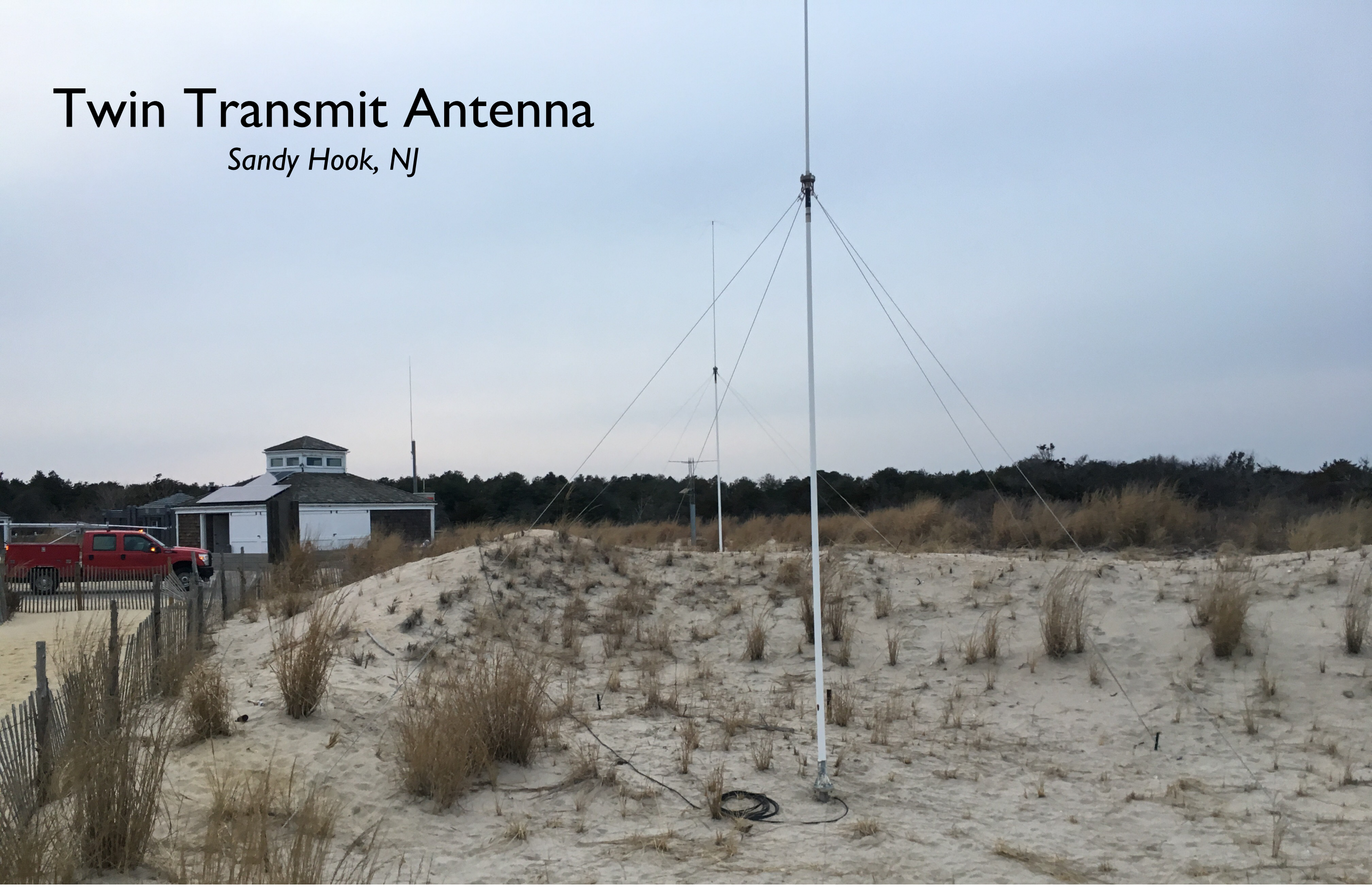

In urban areas &
on sensitive land

Phang Nga, Thailand

5 MHz Separated T & R

Twin Transmit Antenna

Sandy Hook, NJ



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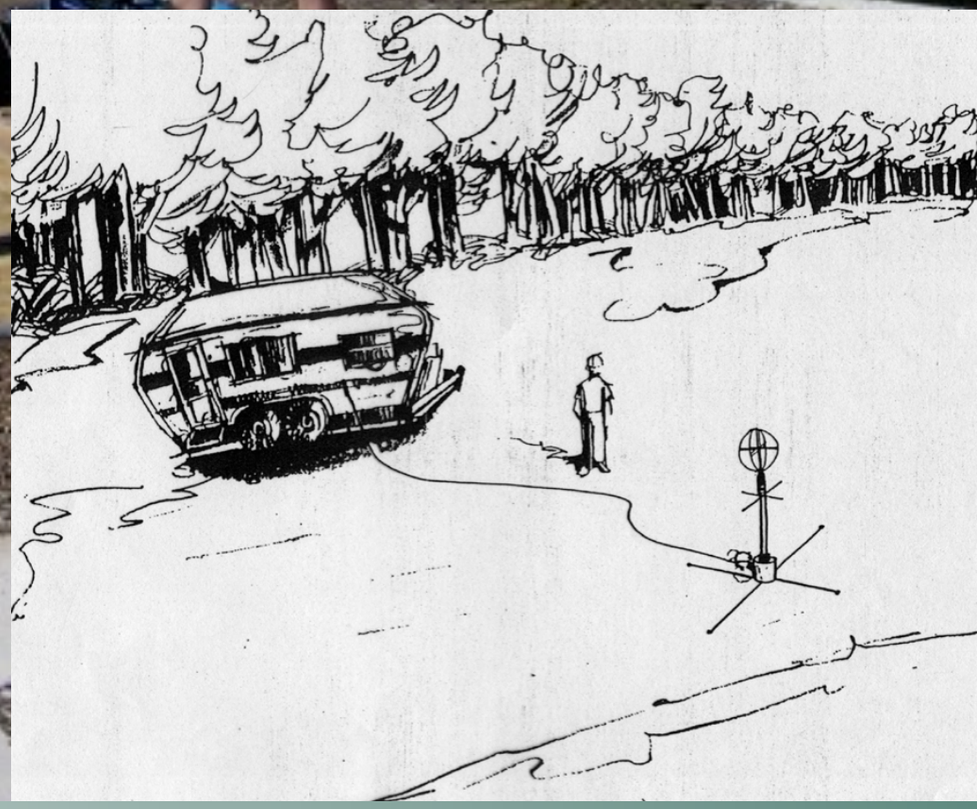
Rapid Deployment



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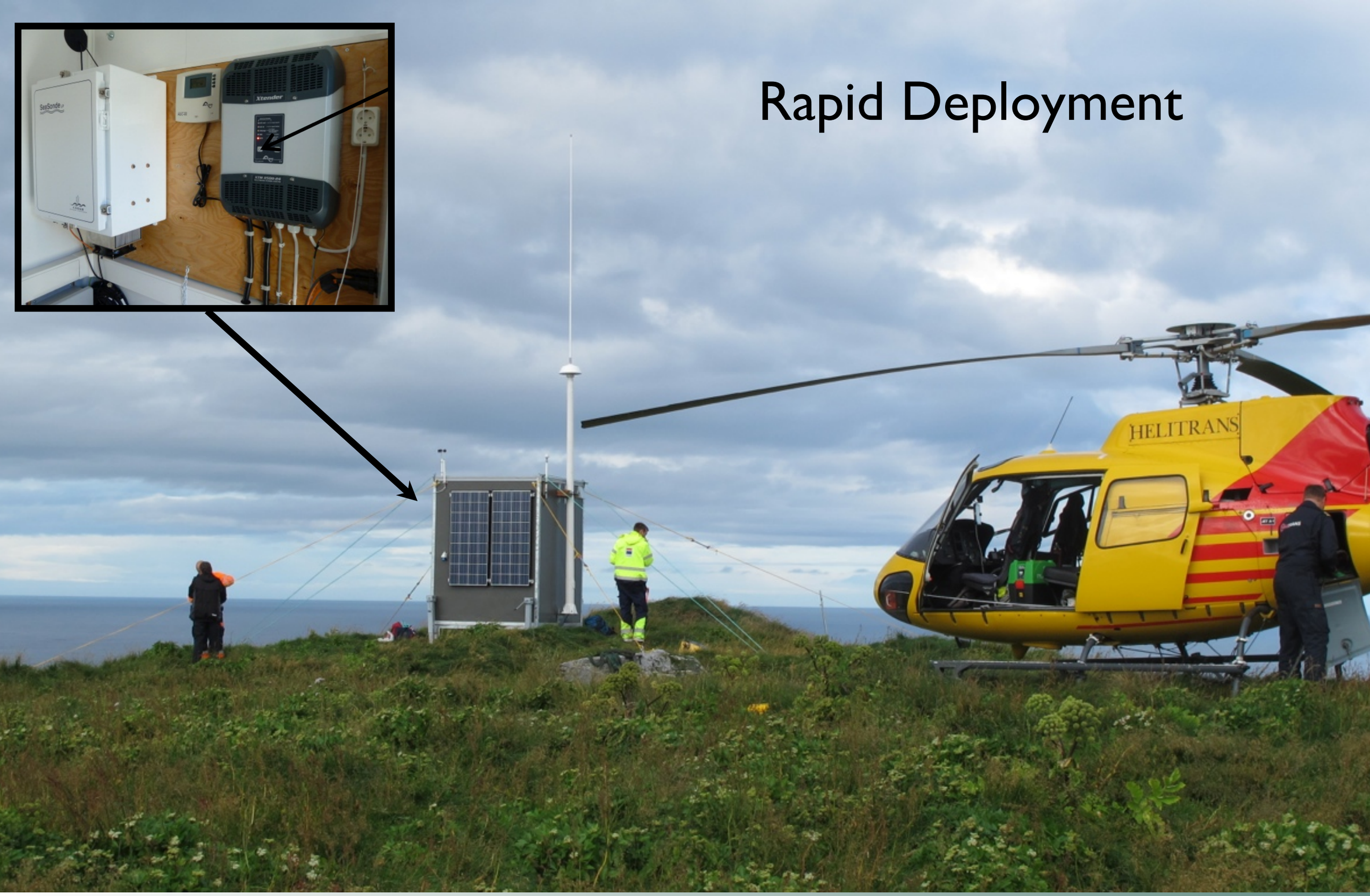
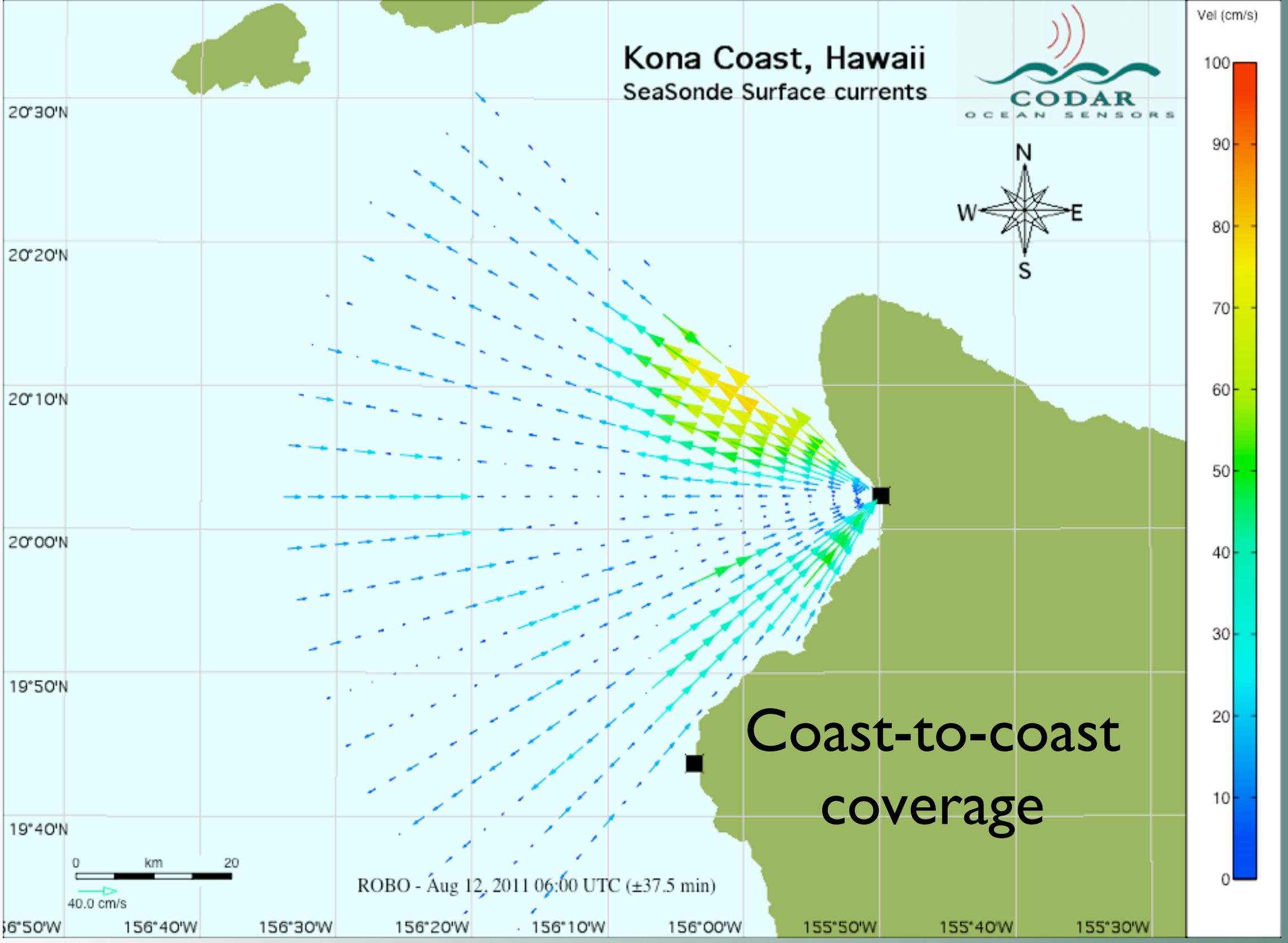
Rapid Deployment

Rapid Deployment





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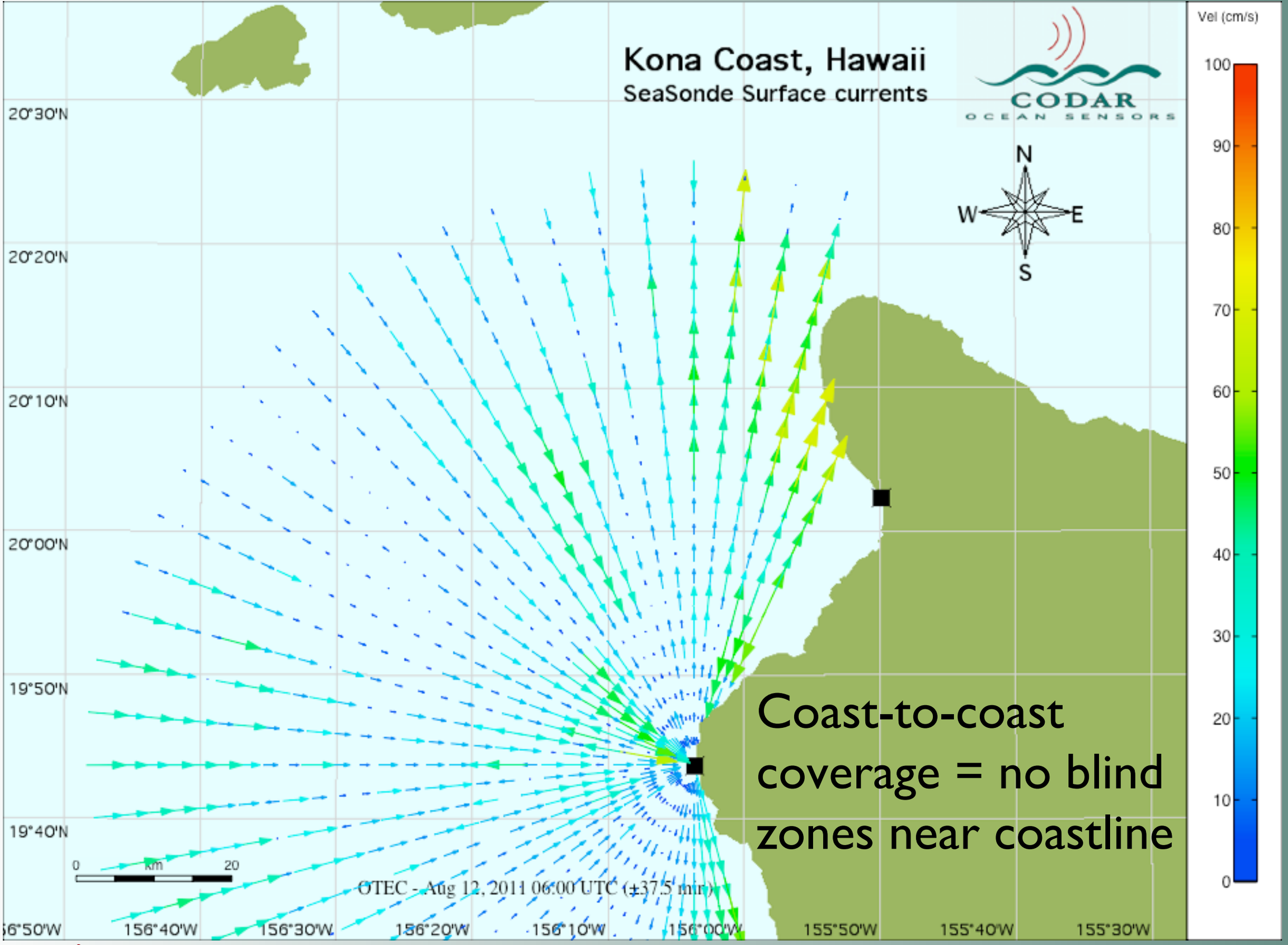

Coast-to-coast coverage = no blind zones near coastline

CODAR Ocean Sensors
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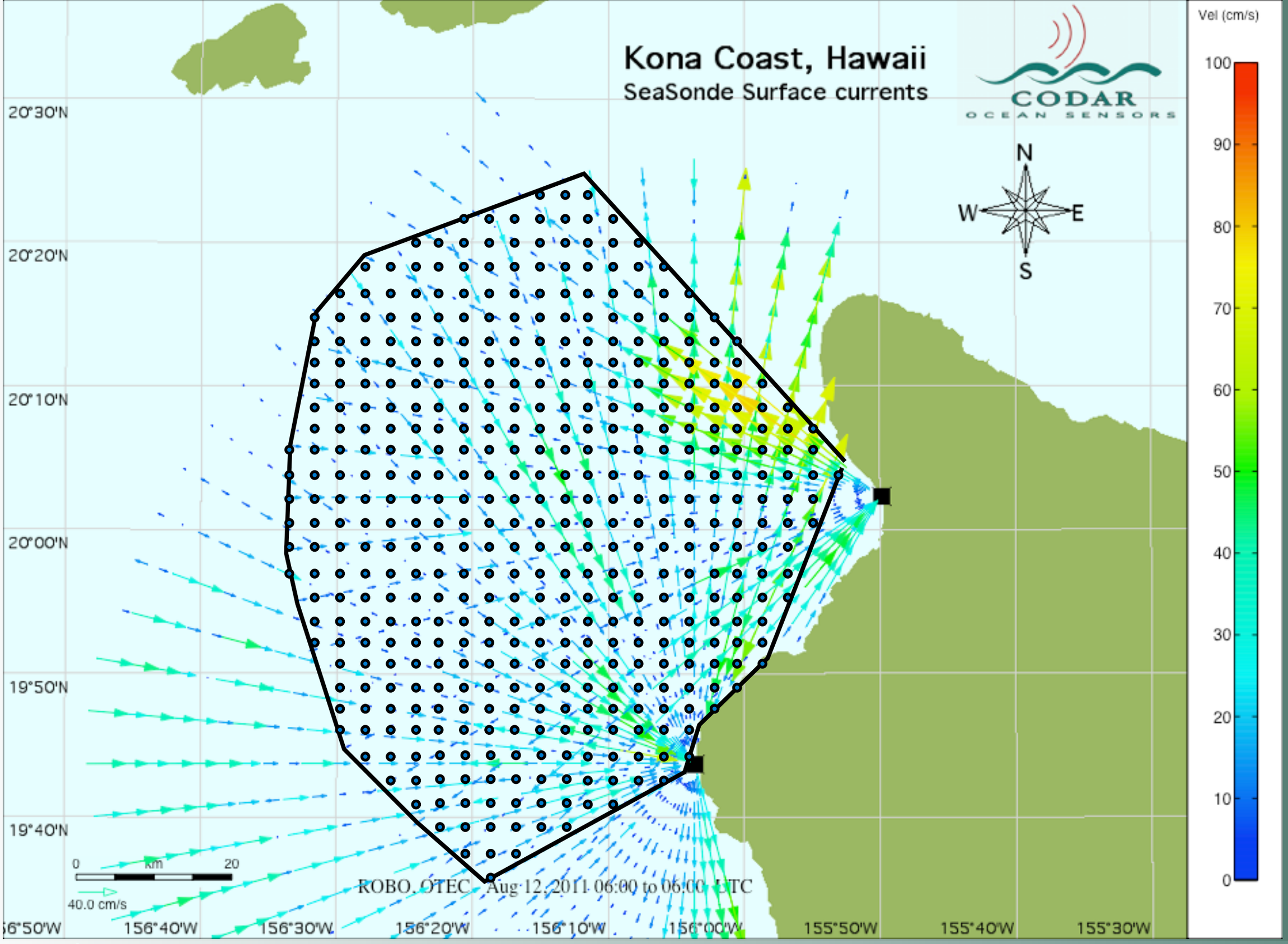

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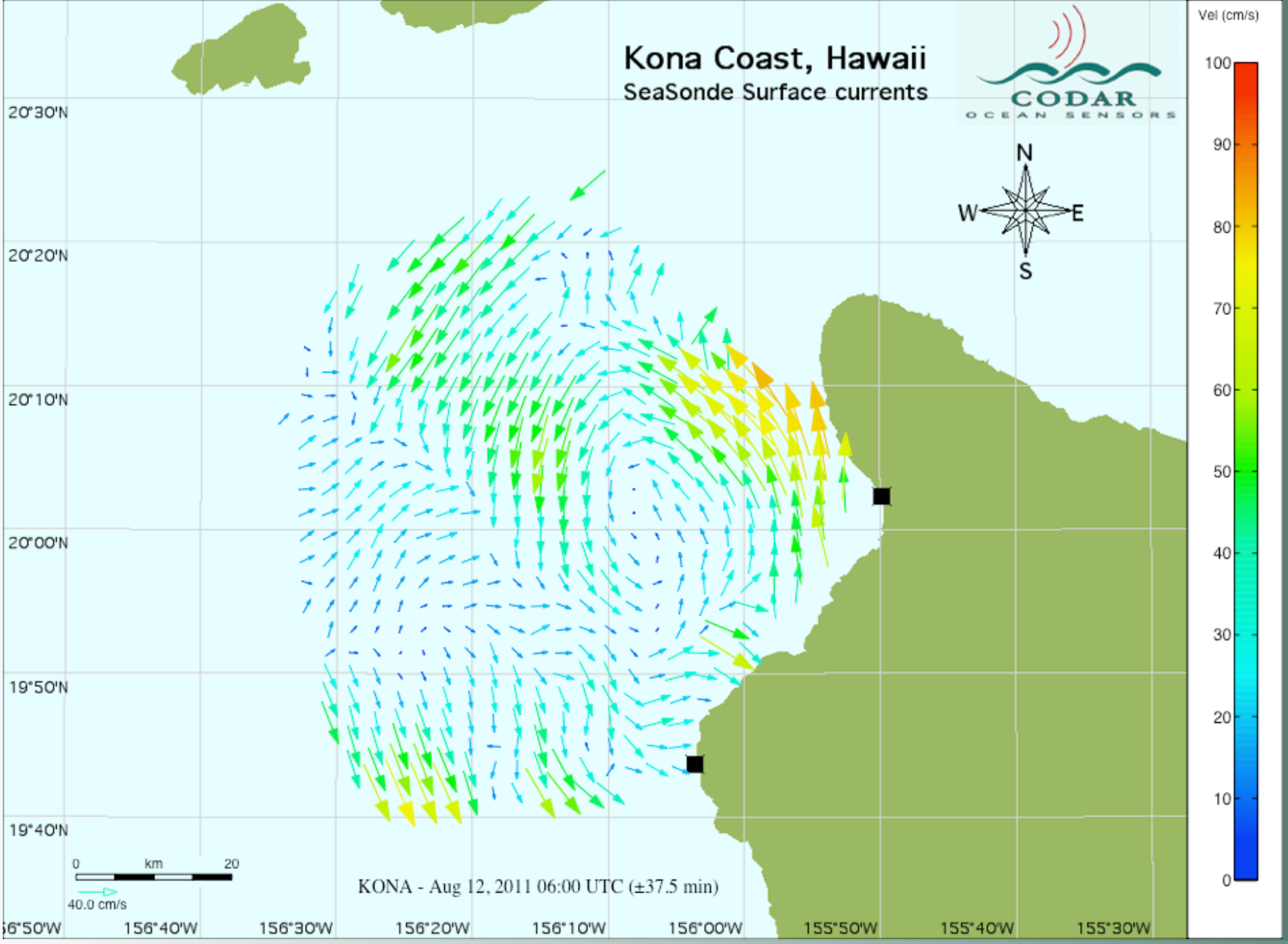

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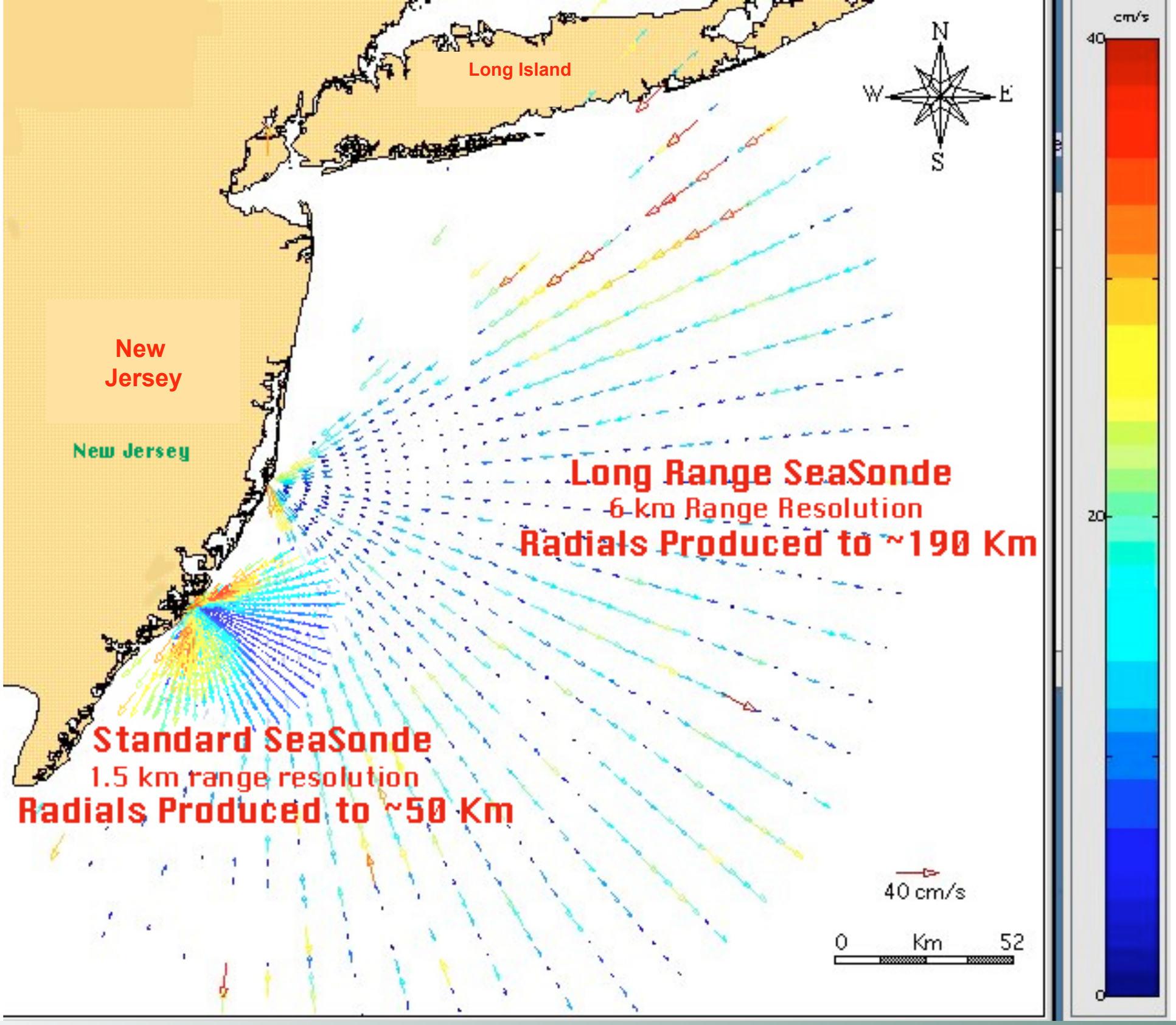

Long Island
New Jersey
New Jersey
N
W
E
S
cm/s
40
20
0
Long Range SeaSonde
6 km Range Resolution
Radials Produced to ~190 Km
Standard SeaSonde
1.5 km range resolution
Radials Produced to ~50 Km
40 cm/s
0
Km
52

Considerations for Choosing Frequency

Frequency (MHz)	Antennas	Radar λ (m)	Ocean λ (m)	Current Depth (m)	Max Speed (m/s)	Range (km)	Resolution (km)	Max Wave (m)
4.5	2	67.3	33.6	2.0	6.5	160-220	3-6	25
5.3	2	57.0	28.5	2.0	6.0	150-200	6	24
9.3	2	32.2	16.1	1.6	4.5	90-130	3-6	19
13.5	1	22.2	11.1	1.3	3.7	60-90	3	13
16.2	1	18.6	9.3	1.0	3.4	45-65	1.5	11
24.5	1	12.2	6.1	0.7	2.8	30-50	1	7
26.2	1	11.4	5.7	0.6	2.7	25-45	1	6
39.3	1	7.6	3.8	0.3	2.2	15-25	0.3	3
42.3	1	7.1	3.6	0.3	2.1	15-25	0.3	3

ITU Ocean Radar Frequency Allocations

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

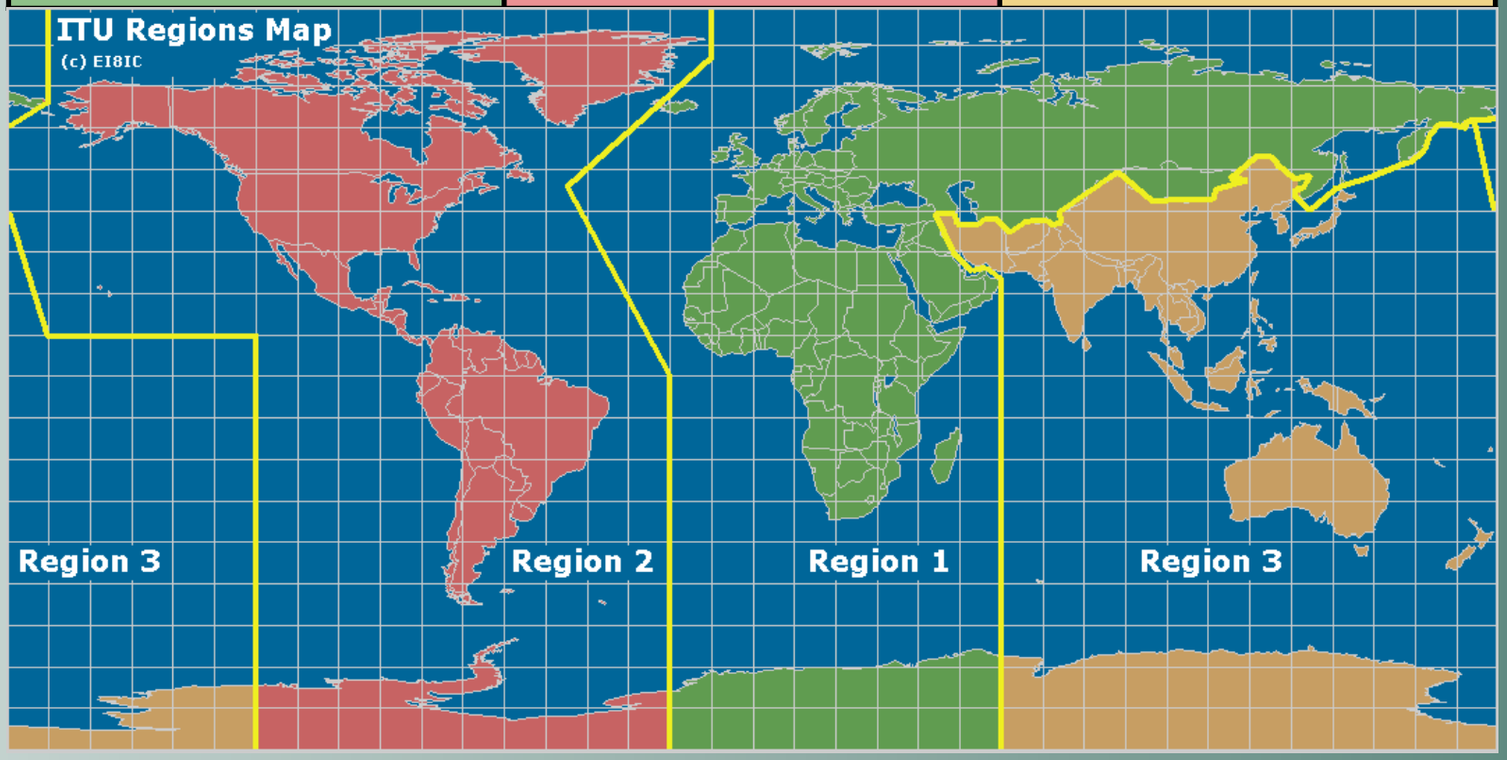
<u>Share Bandwidth</u>

Multiple Systems can sweep through same band without interfering

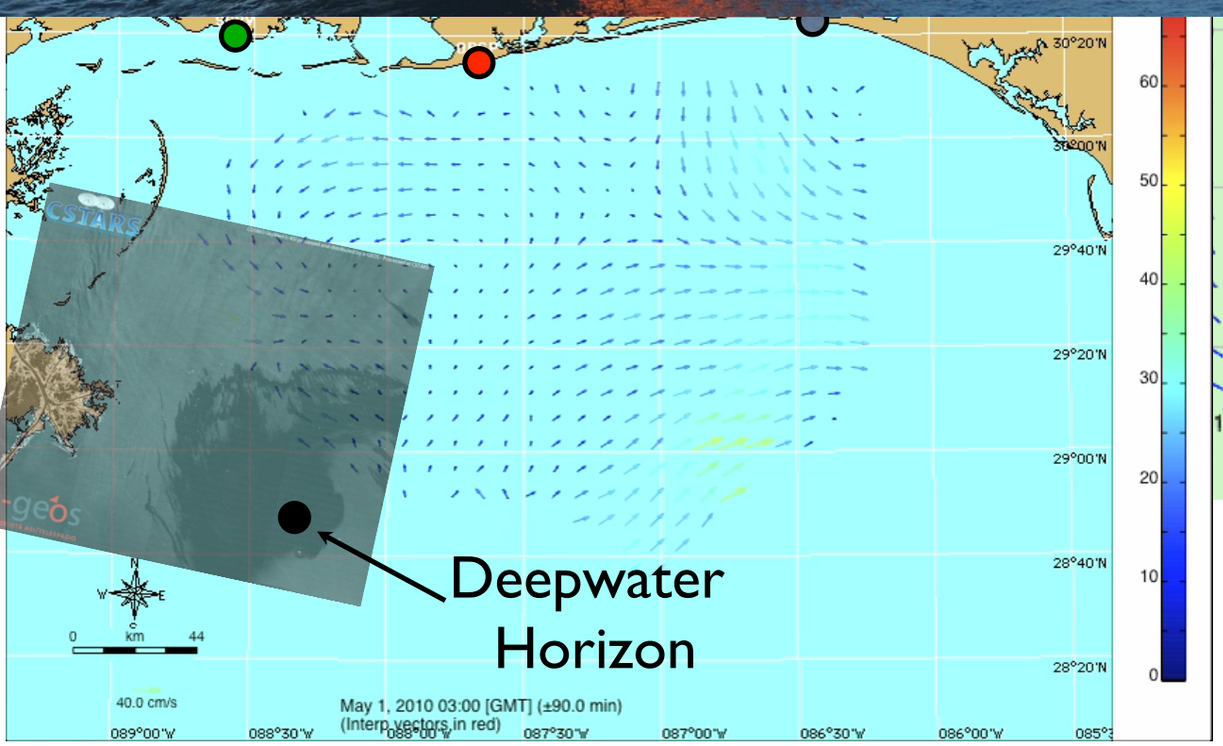
<u>Multistatic Network</u>

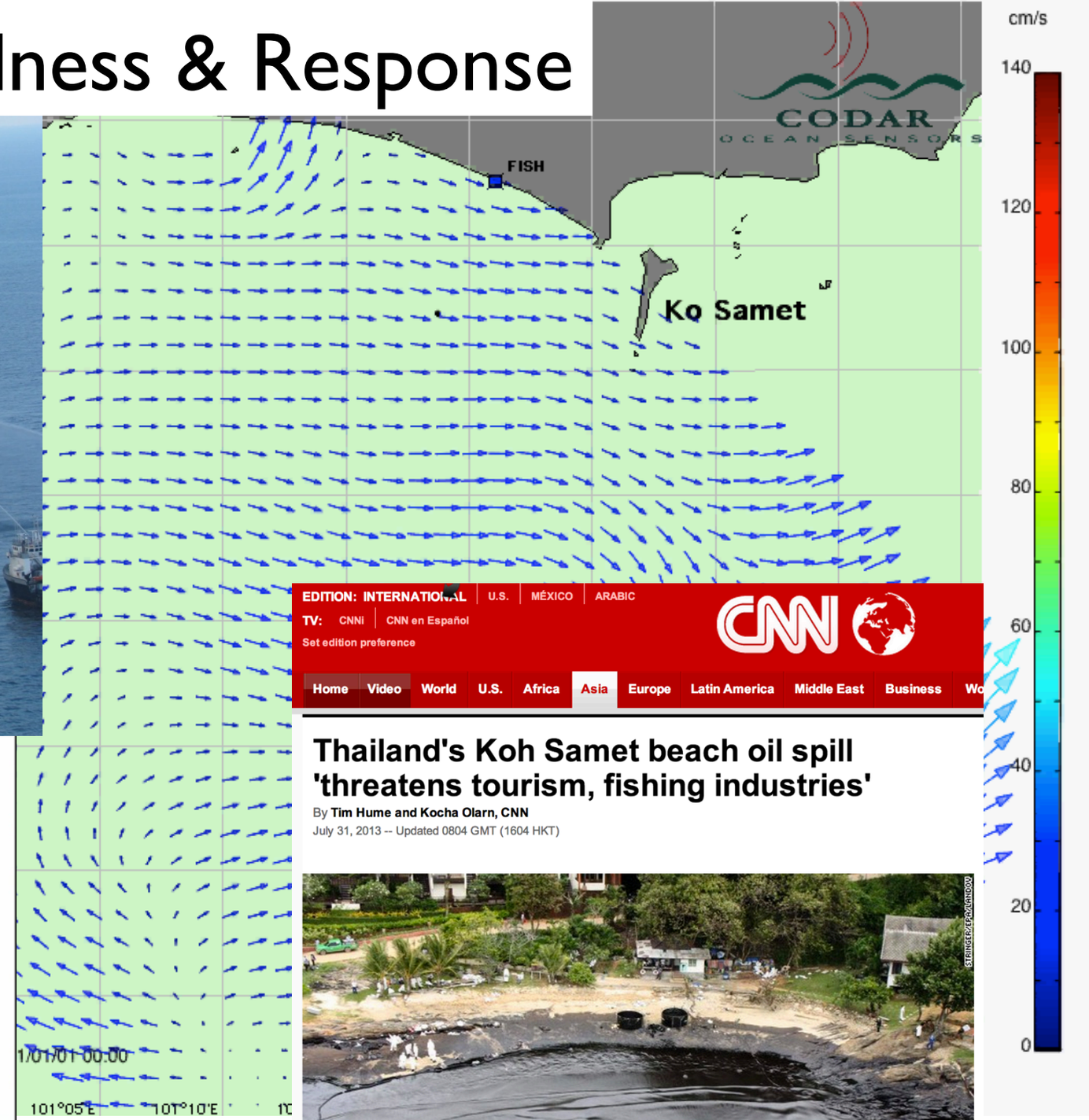
Collect Sea echo from another's site's transmission

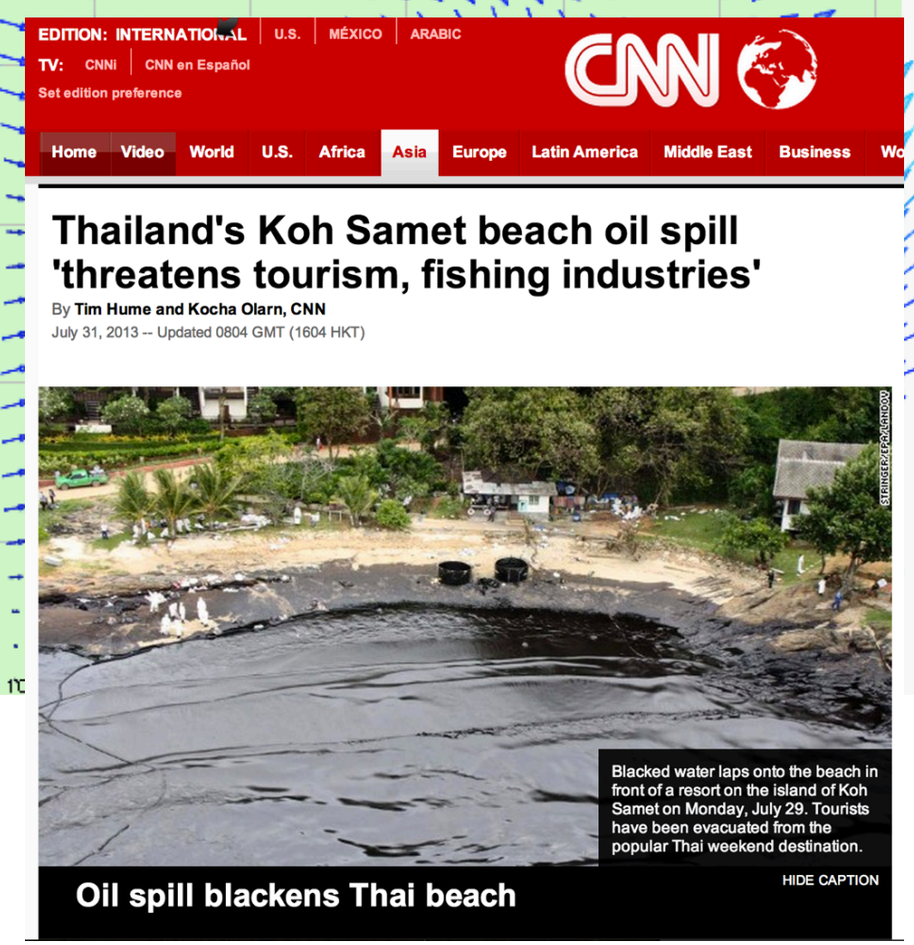
Region 1	Region 2	Region 3
4 438 - 4 488	4 438 - 4 488	4 438 - 4 488
5 250 - 5 275	5 250 - 5 275	5 250 - 5 275
9 305 - 9 355	No allocation	9 305 - 9 355
13 450 - 13 550	13 450 - 13 550	13 450 - 13 550
16 100 - 16 200	16 100 - 16 200	16 100 - 16 200
24 450 - 24 600	24 450 - 24 650	24 450 - 24 600
26 200 - 26 350	26 200 - 26 420	26 200 - 26 350
39 000 - 39 500	No allocation	39 500–40 000
42 000 - 42 500	No allocation	No allocation



Spill Preparedness & Response







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TV: CNNI | CNN en Español
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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 laps onto the beach in front of a resort on the island of Koh Samet on Monday, July 29. Tourists have been evacuated from the popular Thai weekend destination.

HIDE CAPTION

Oil spill blackens Thai beach

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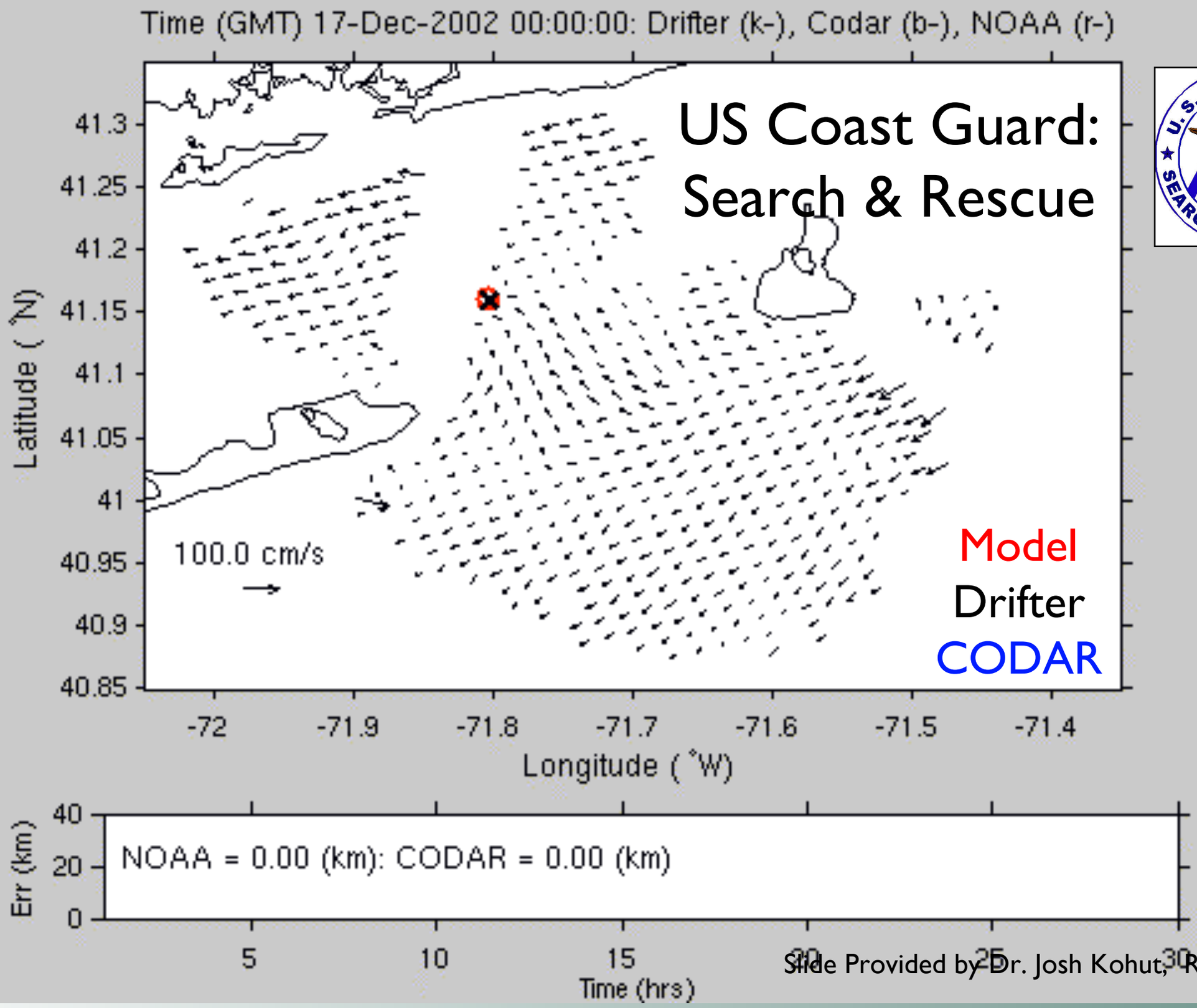
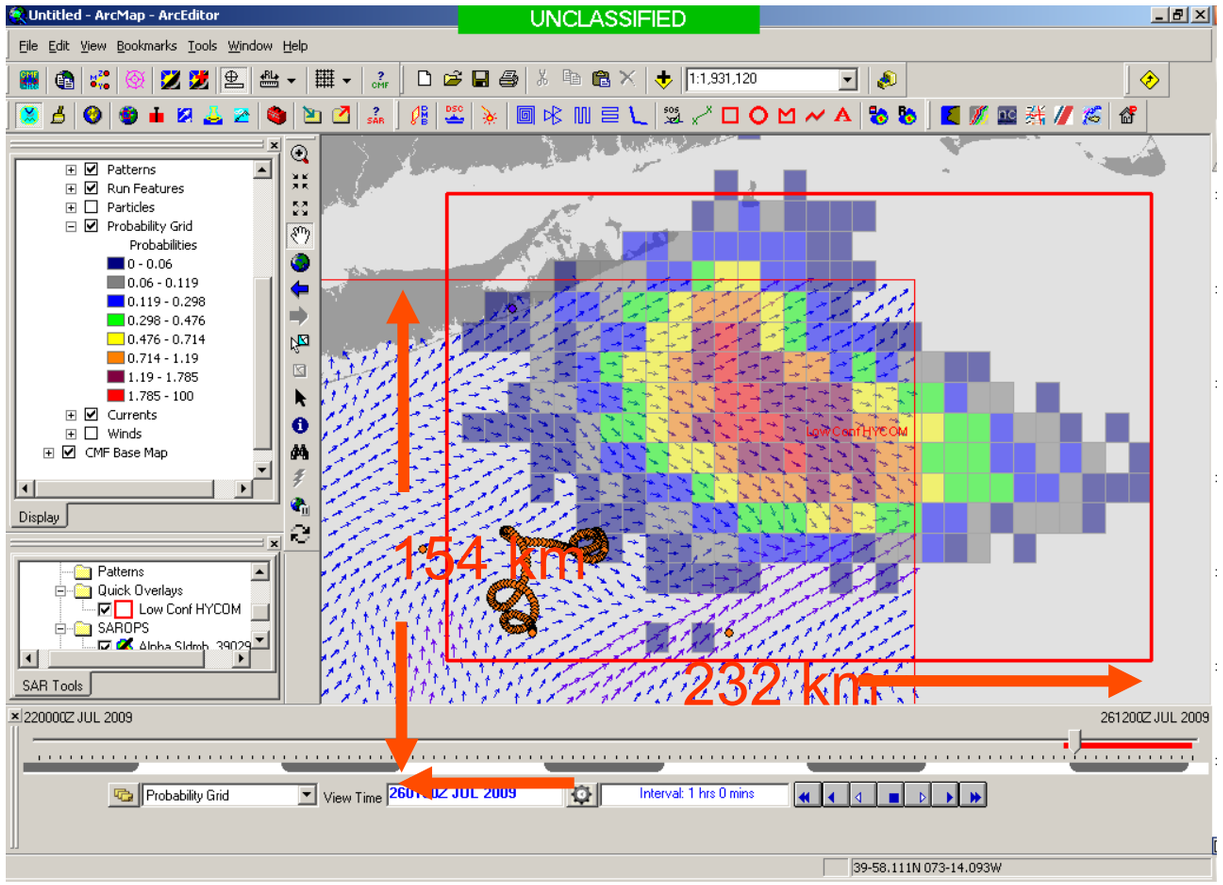
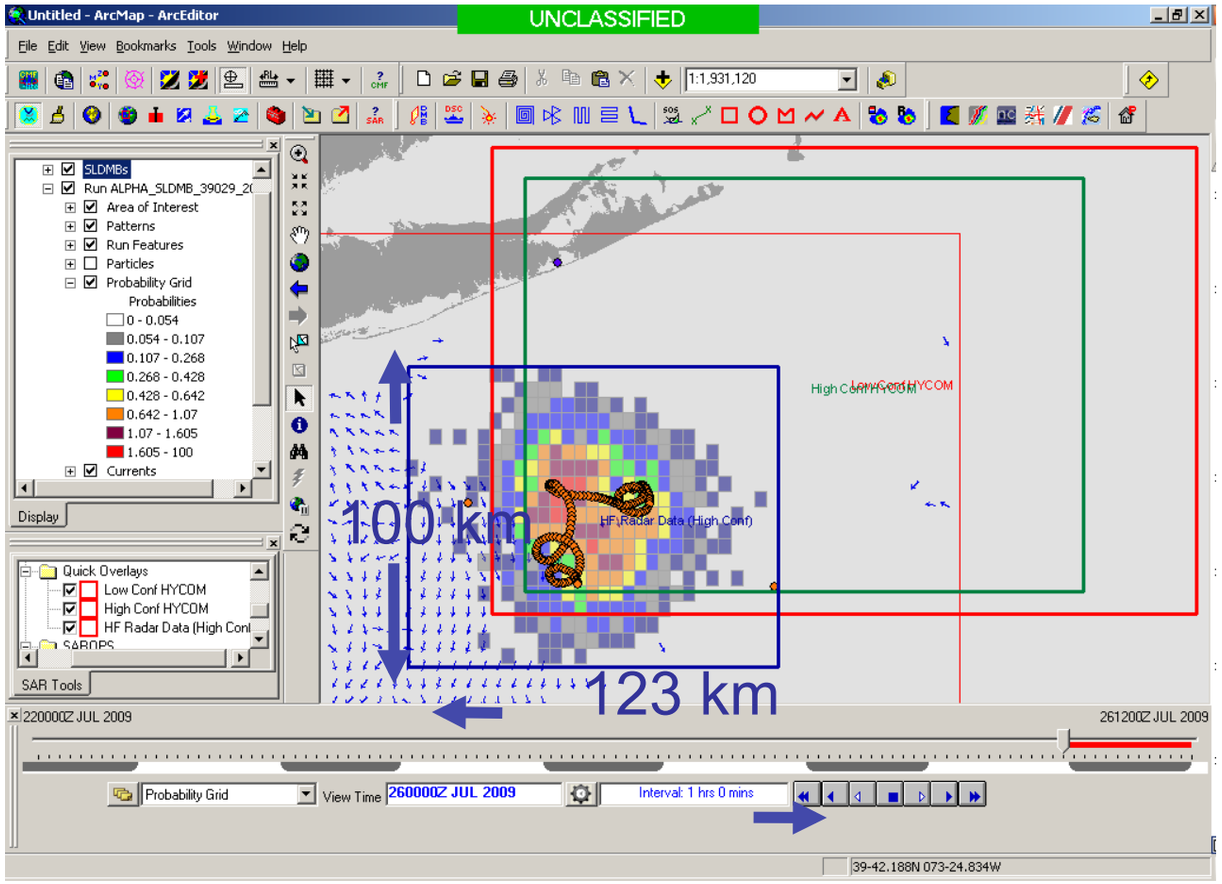


Slide Provided by Dr. Josh Kohut, Rutgers University

Search And Rescue: U.S. Coast Guards SAROPS

Search Area Greatly Reduced After 96 Hours



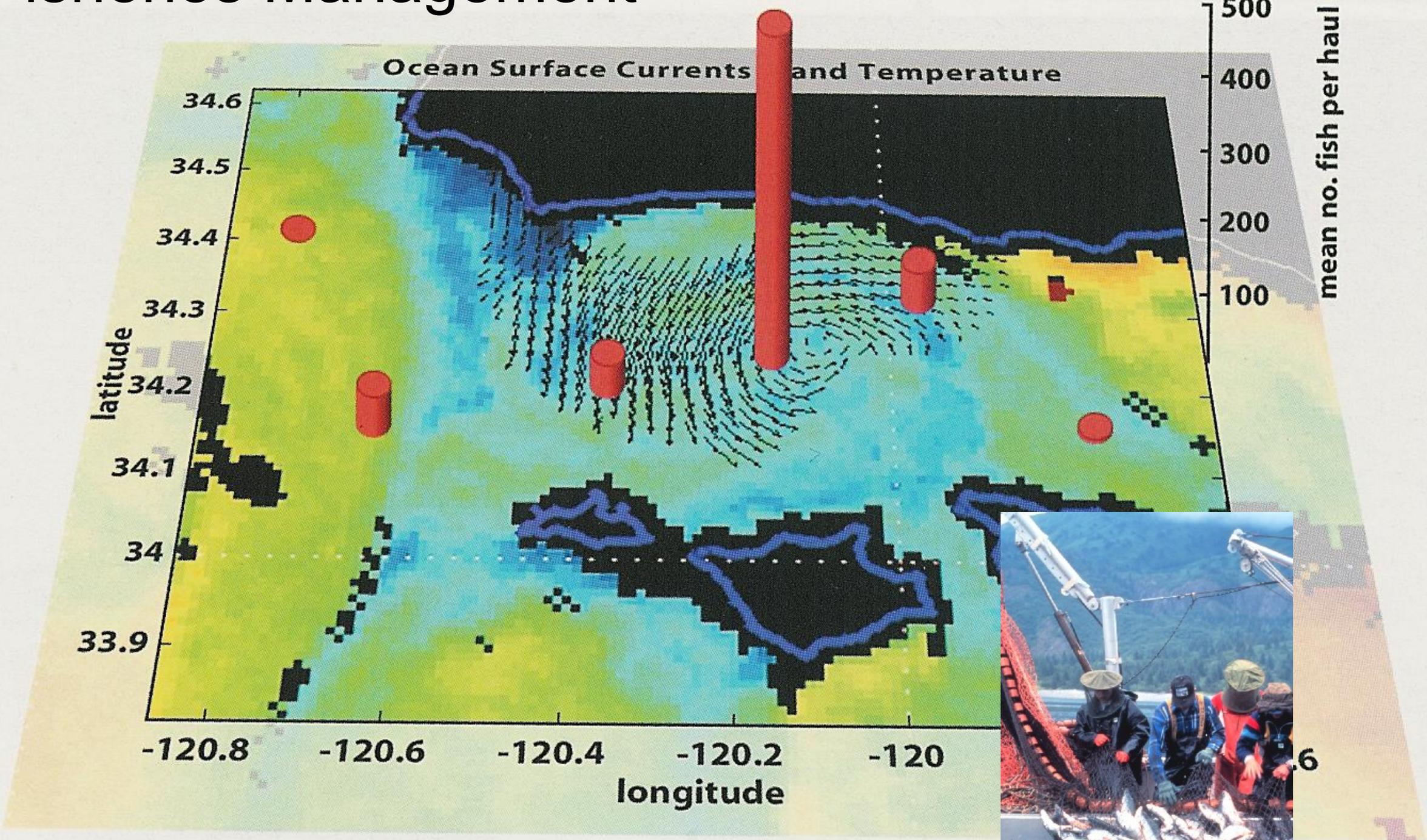


HYCOM 36,000 km^2

HF Radar 12,000 km^2

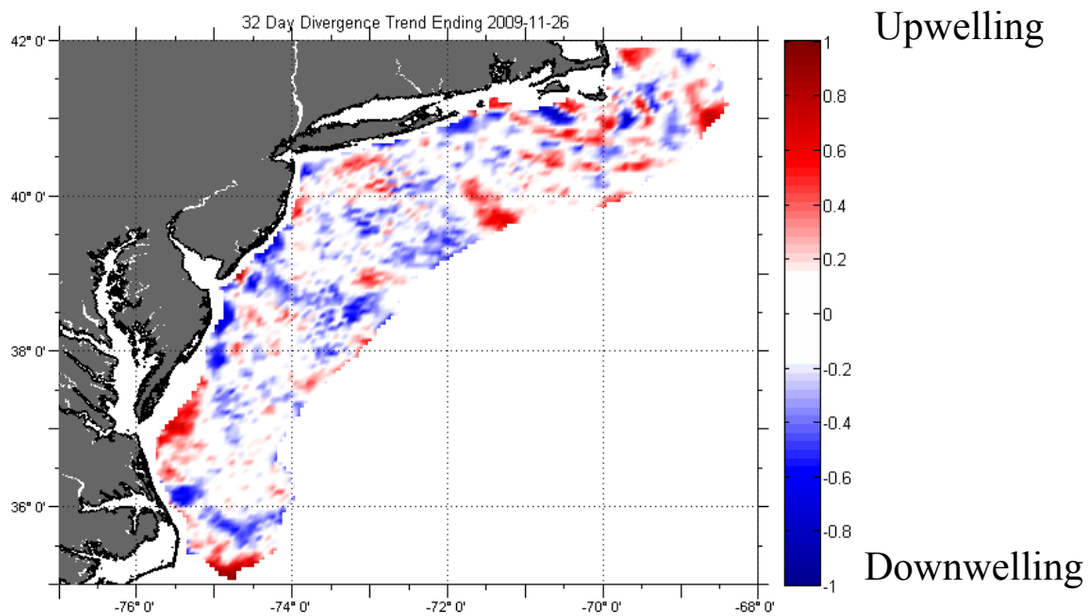
Slide Provided by Dr. Josh Kohut, Rutgers University

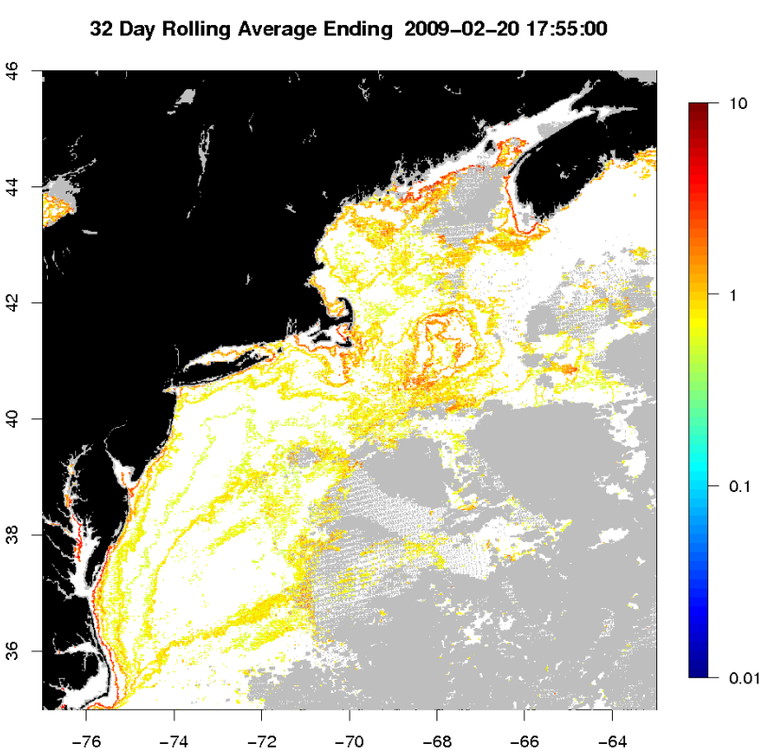
Fisheries Management

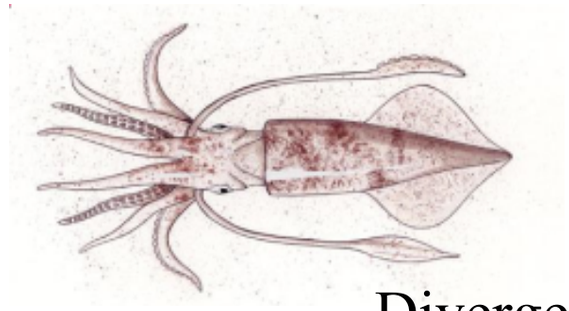


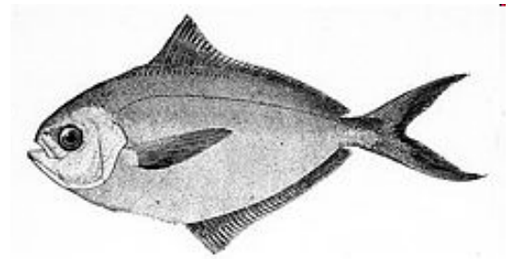
Slide Provided by UC Santa Barbara

Per Species Habitat Models

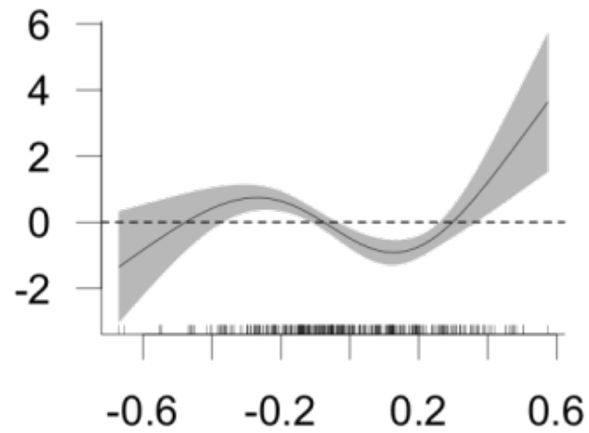


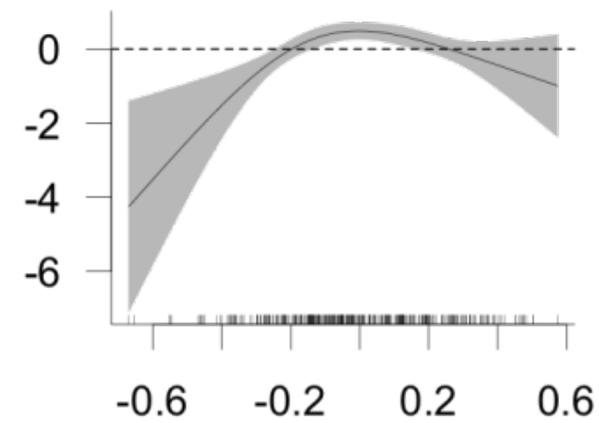






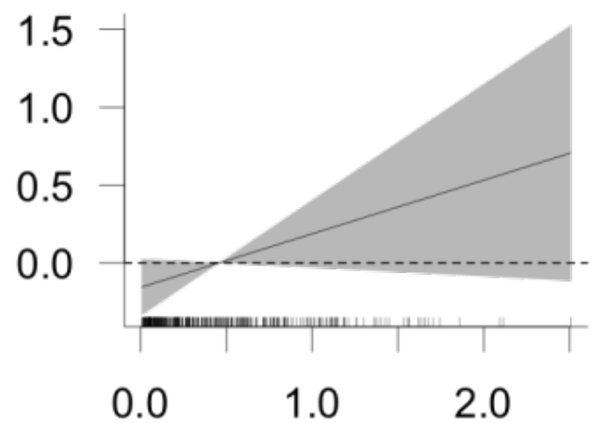
Divergence index

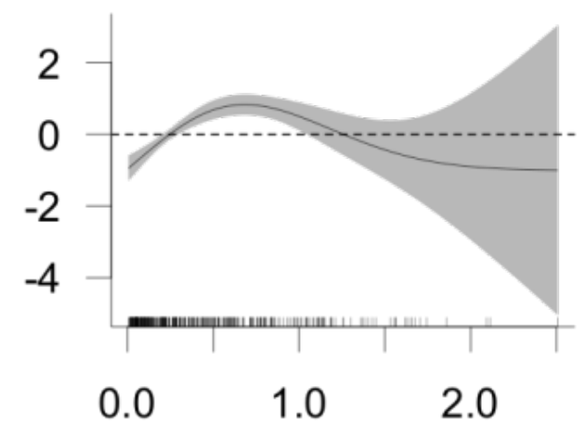




Downwelling Upwelling

Frontal index



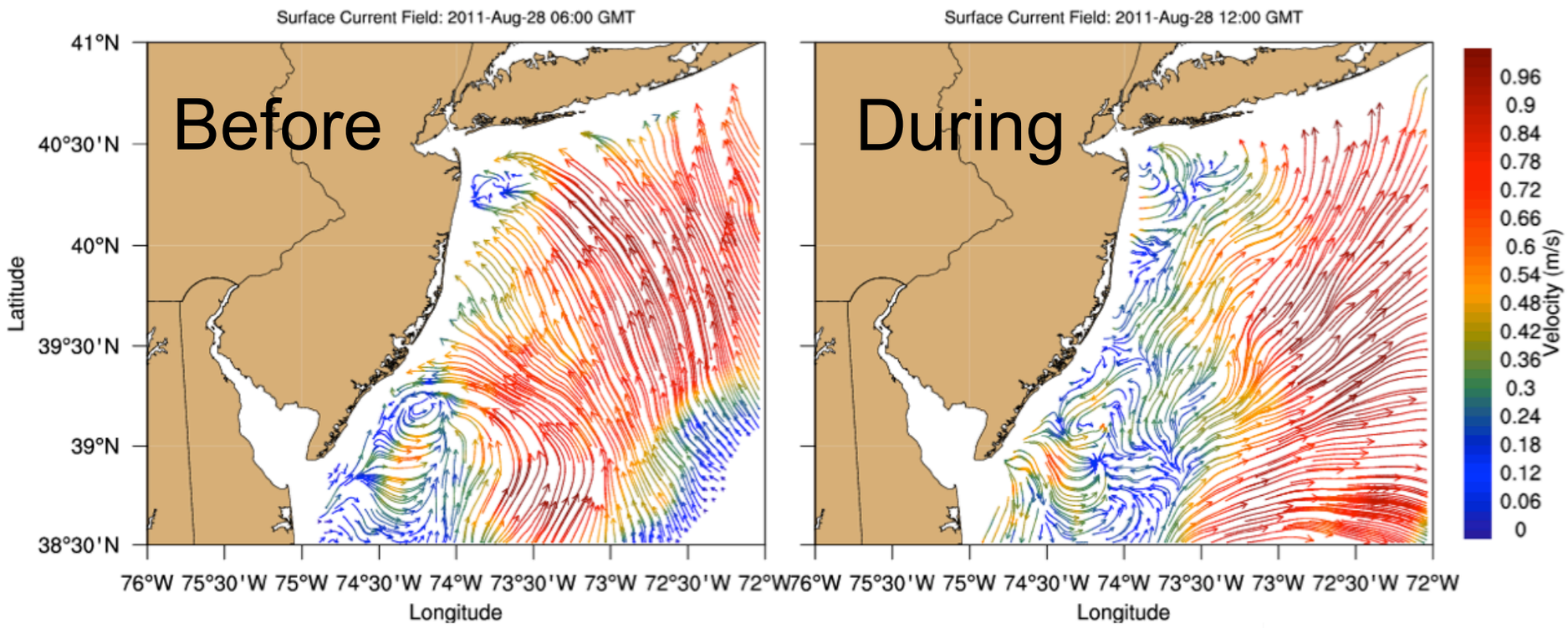


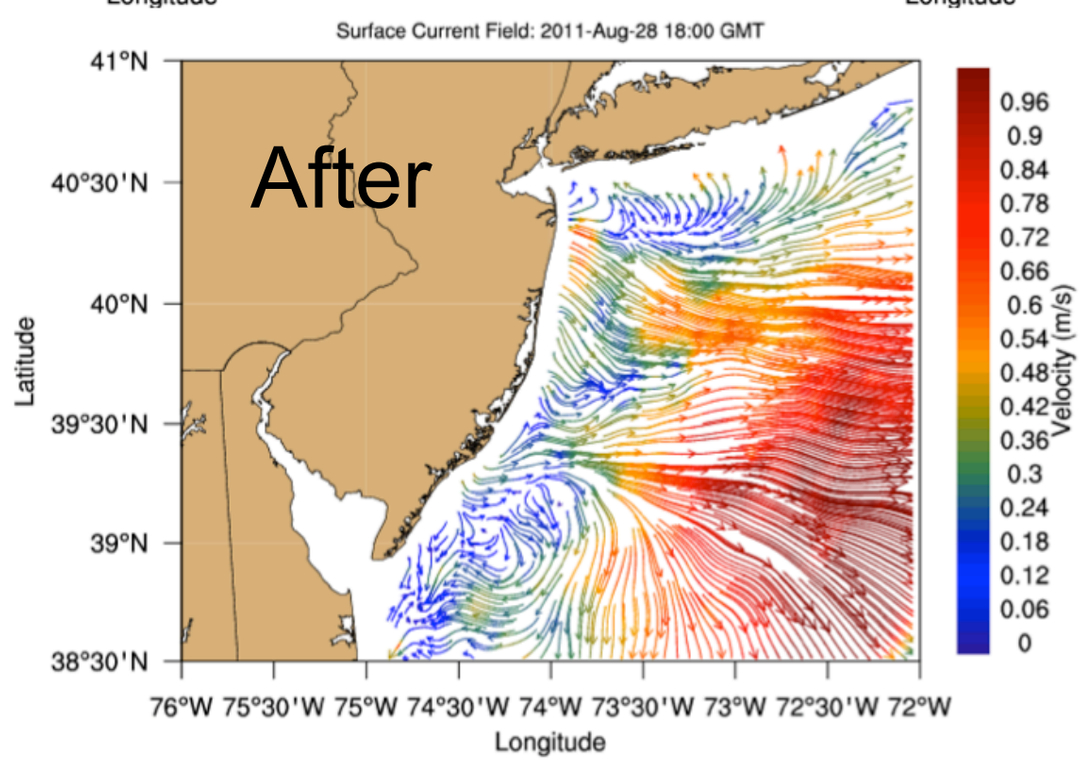
Distance: Far Close

Strength: Weak Strong

Slide Provided by Dr. Josh Kohut, Rutgers University

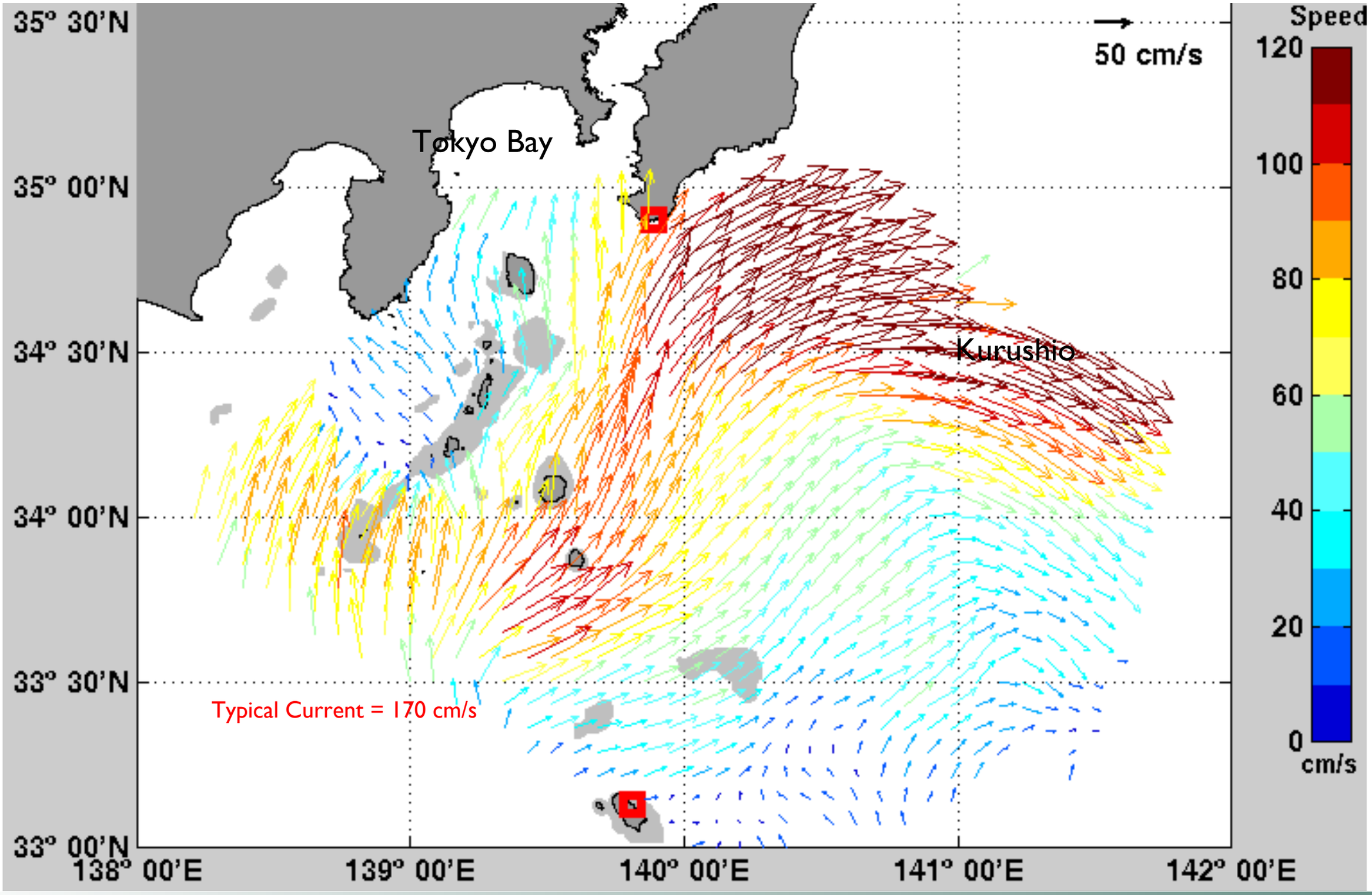
Storm Intensity Prediction – Currents during Irene





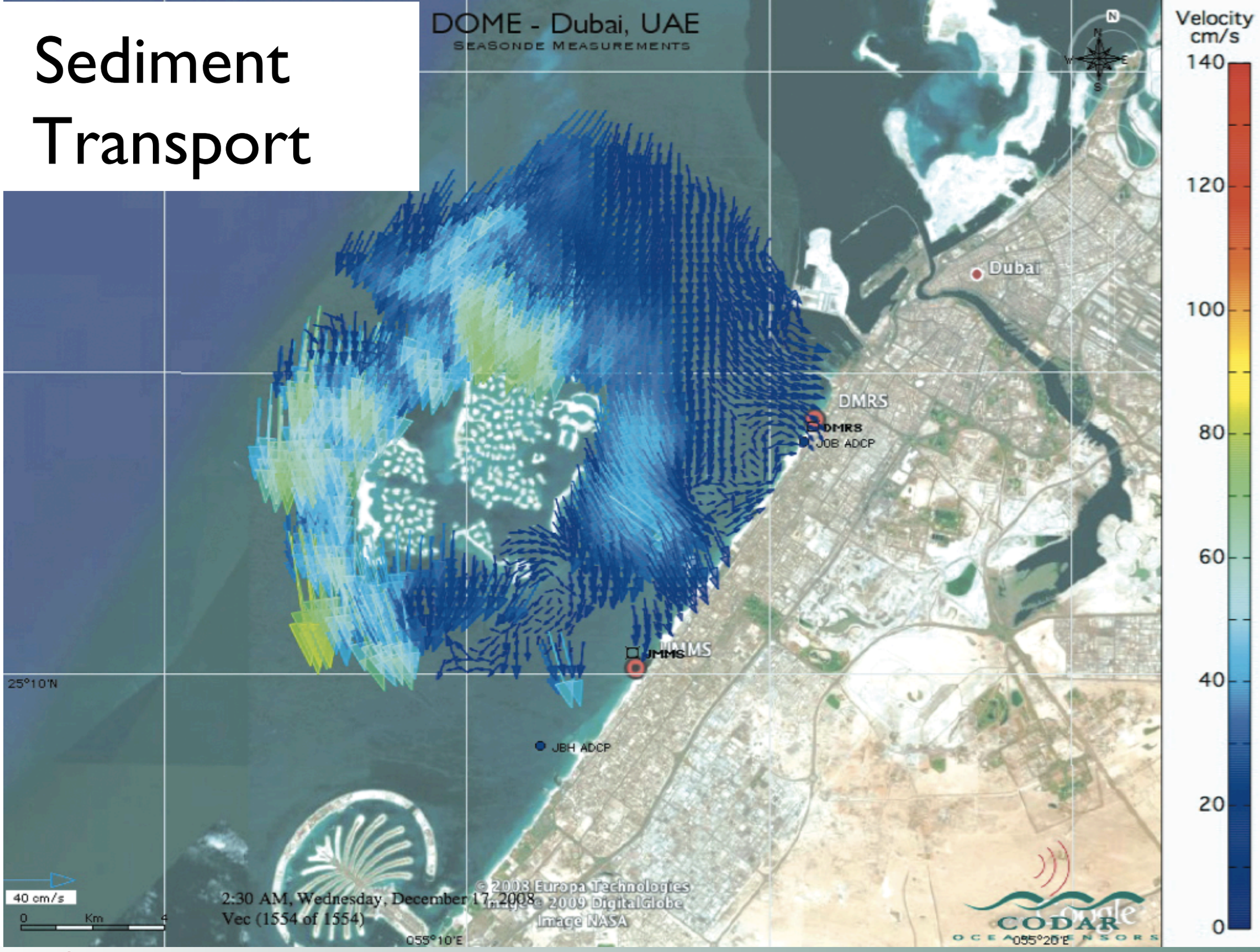
Images Provided by Rutgers University

Japan Coast Guard: Vessel Traffic Management



Data courtesy of
Japan Coast Guard

Sediment Transport



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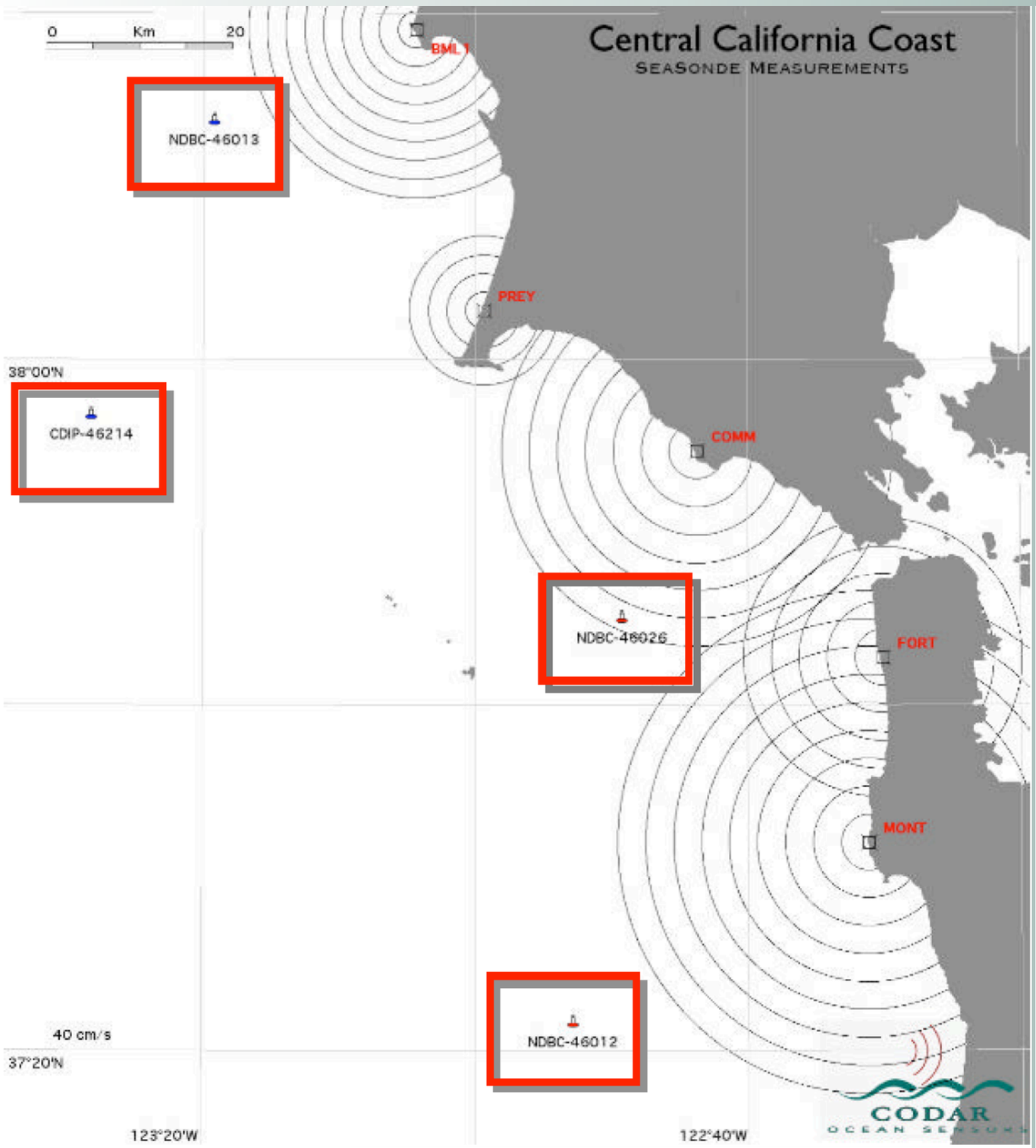
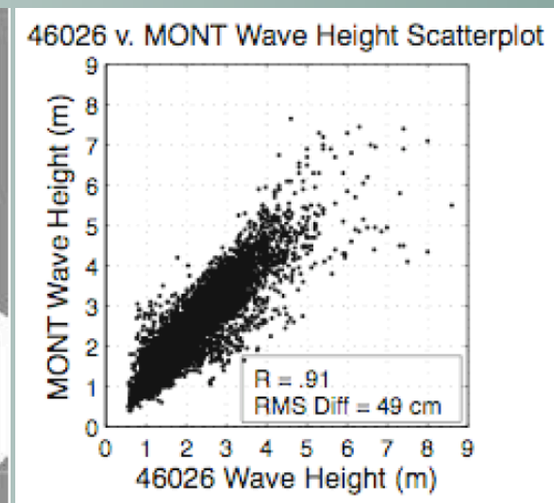
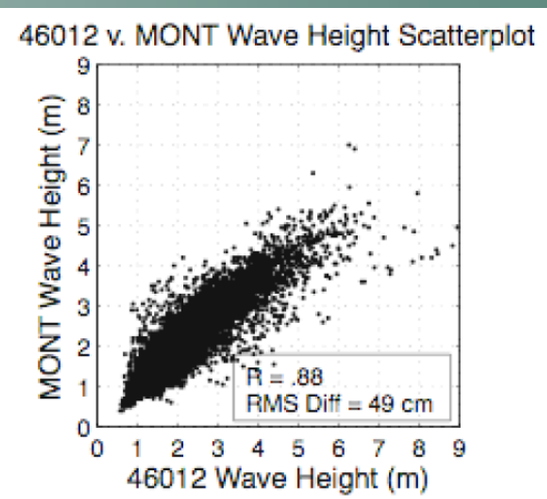
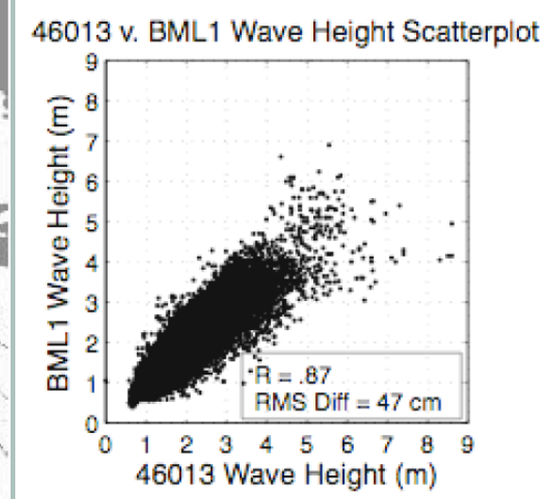
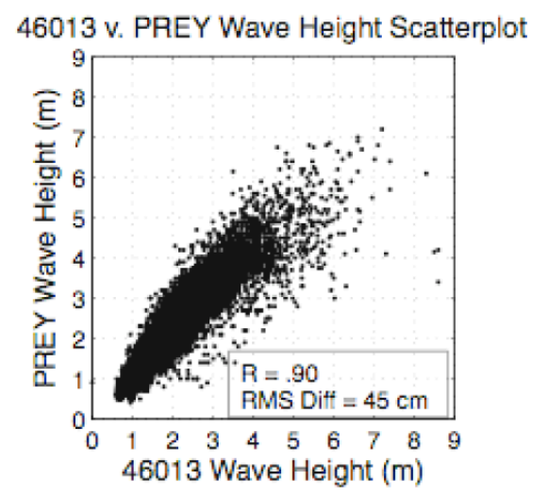
Waves vs Buoys – U.S. West Coast

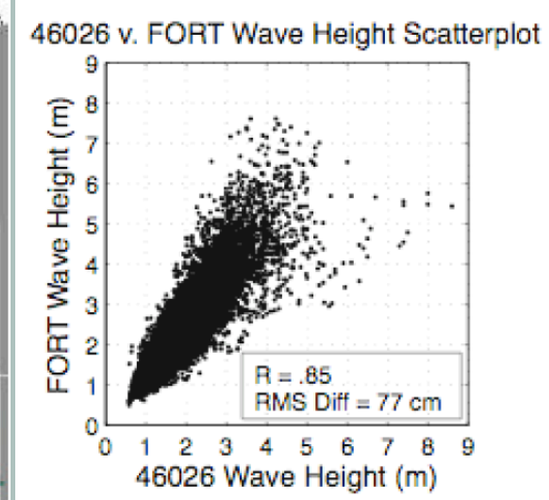


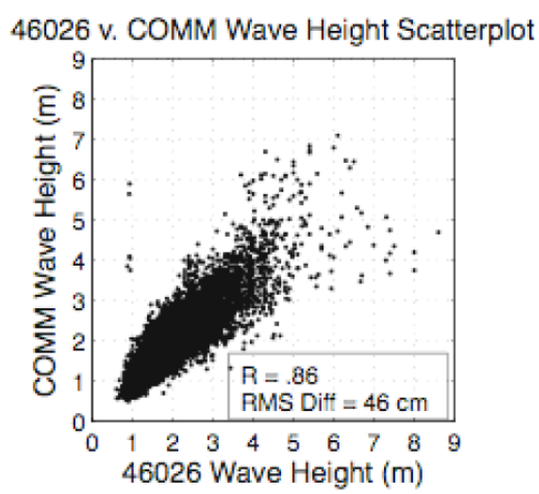




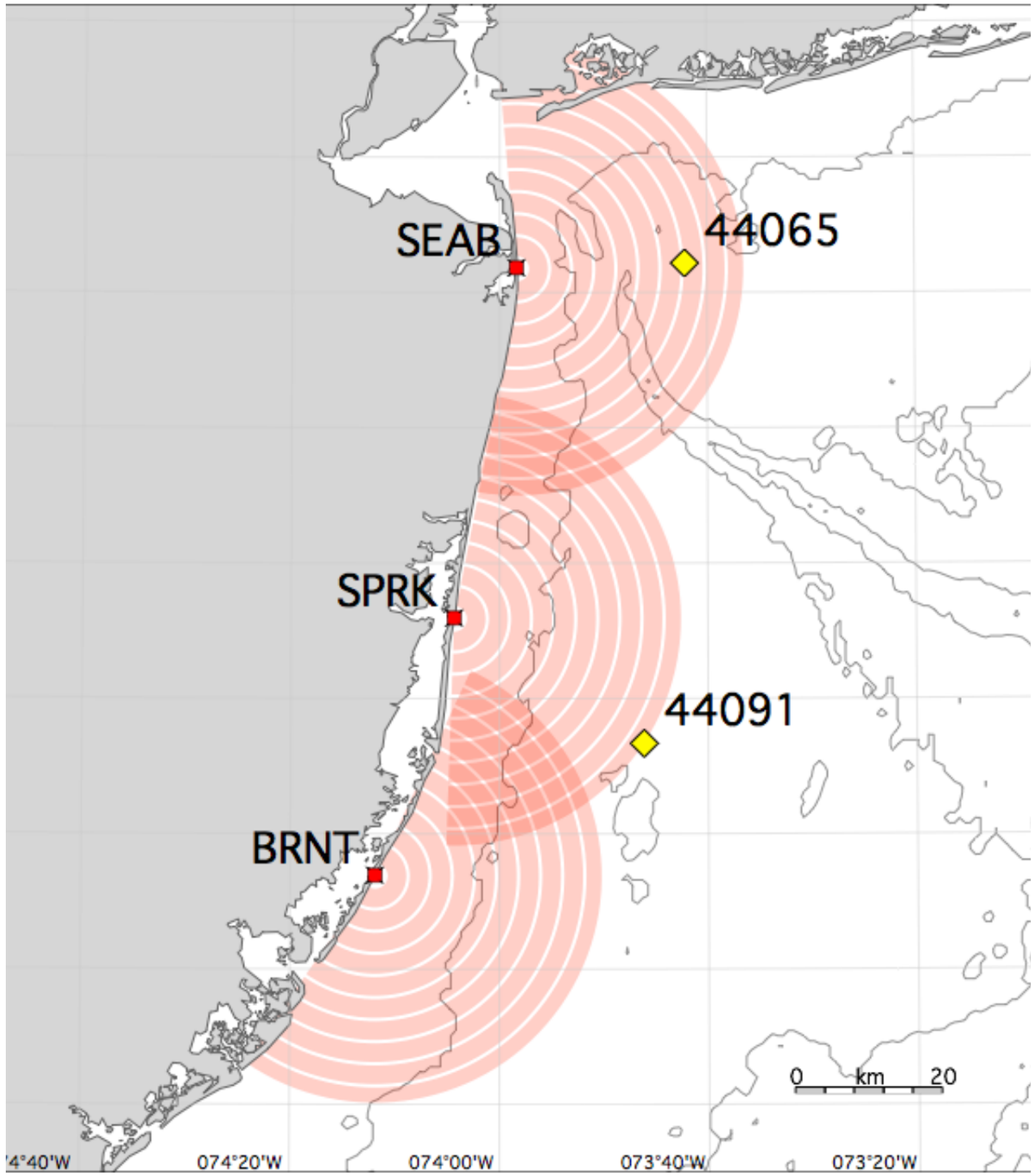








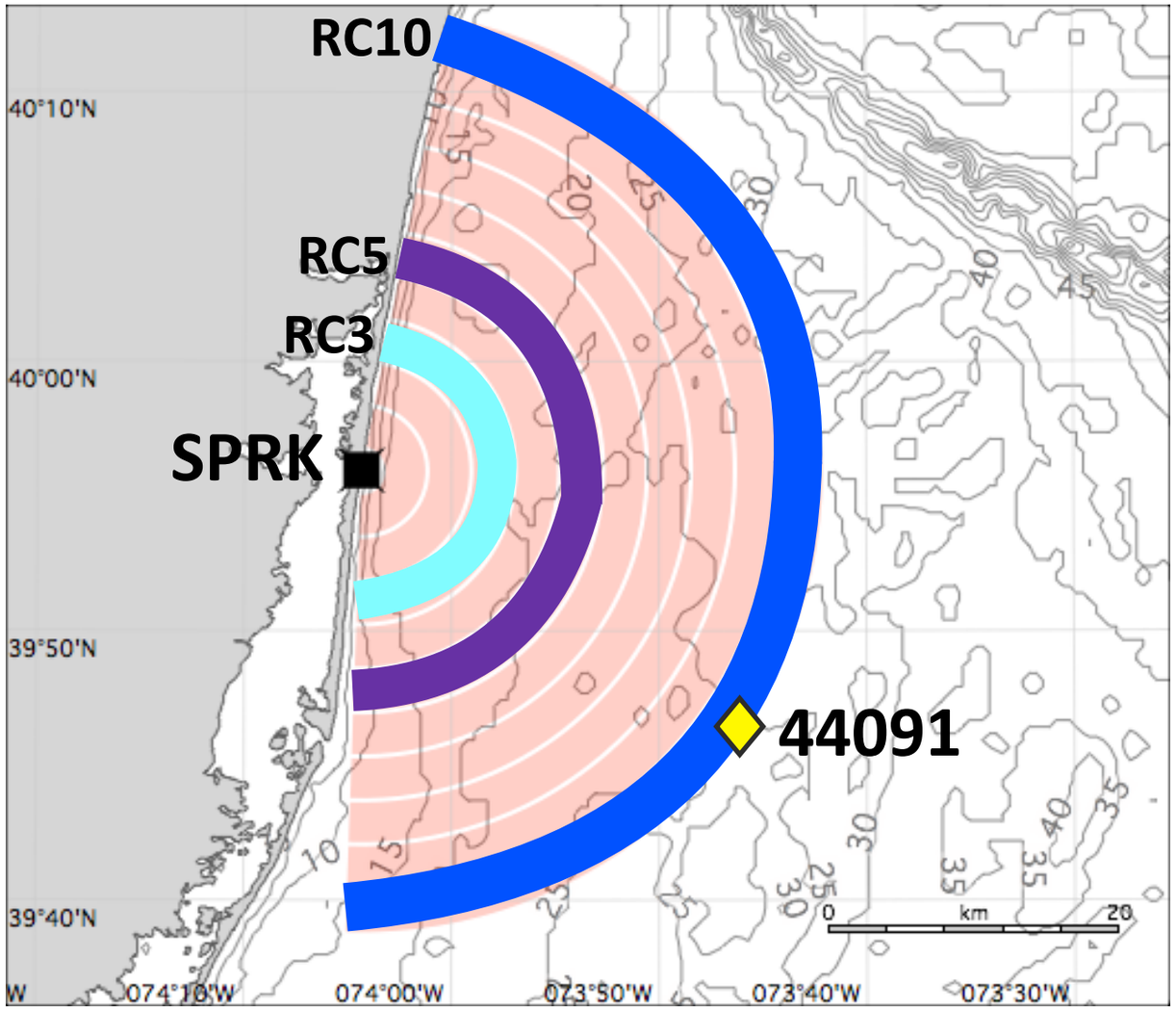
New Jersey Shore Waves Buoys

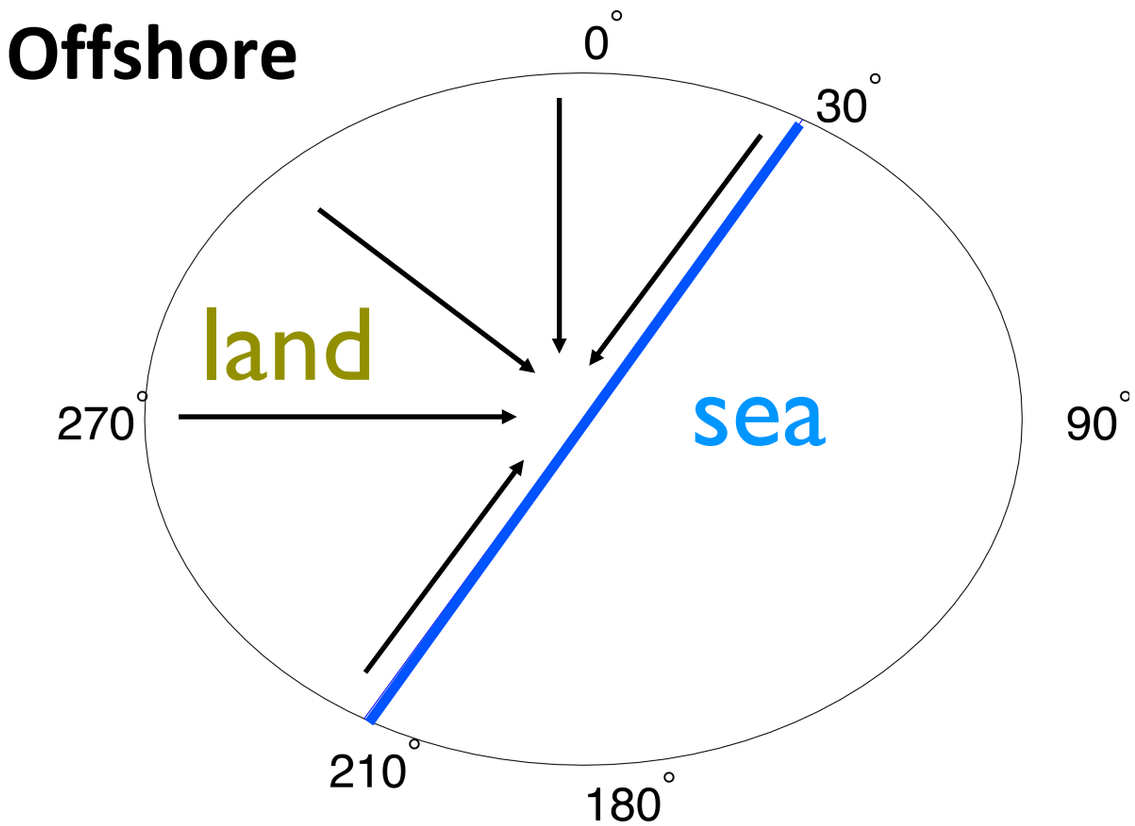


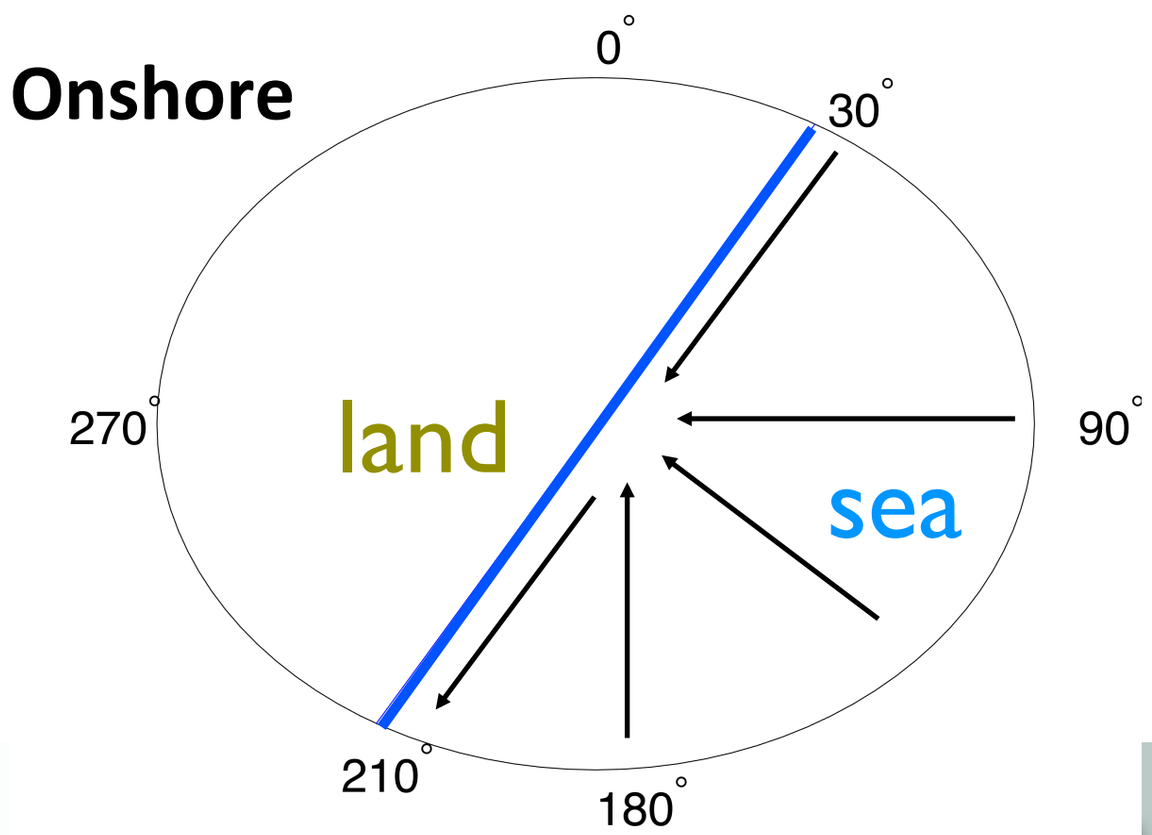
- Buoys obtain point measurement whereas SeaSondes obtain measurements from range cells (RCs).
- This map shows 10 RCs for each station. The first two RCs are not used to monitor waves.
- Because RCs extend across a wide patch of ocean surface, their measurements may reflect conditions that vary. These 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.







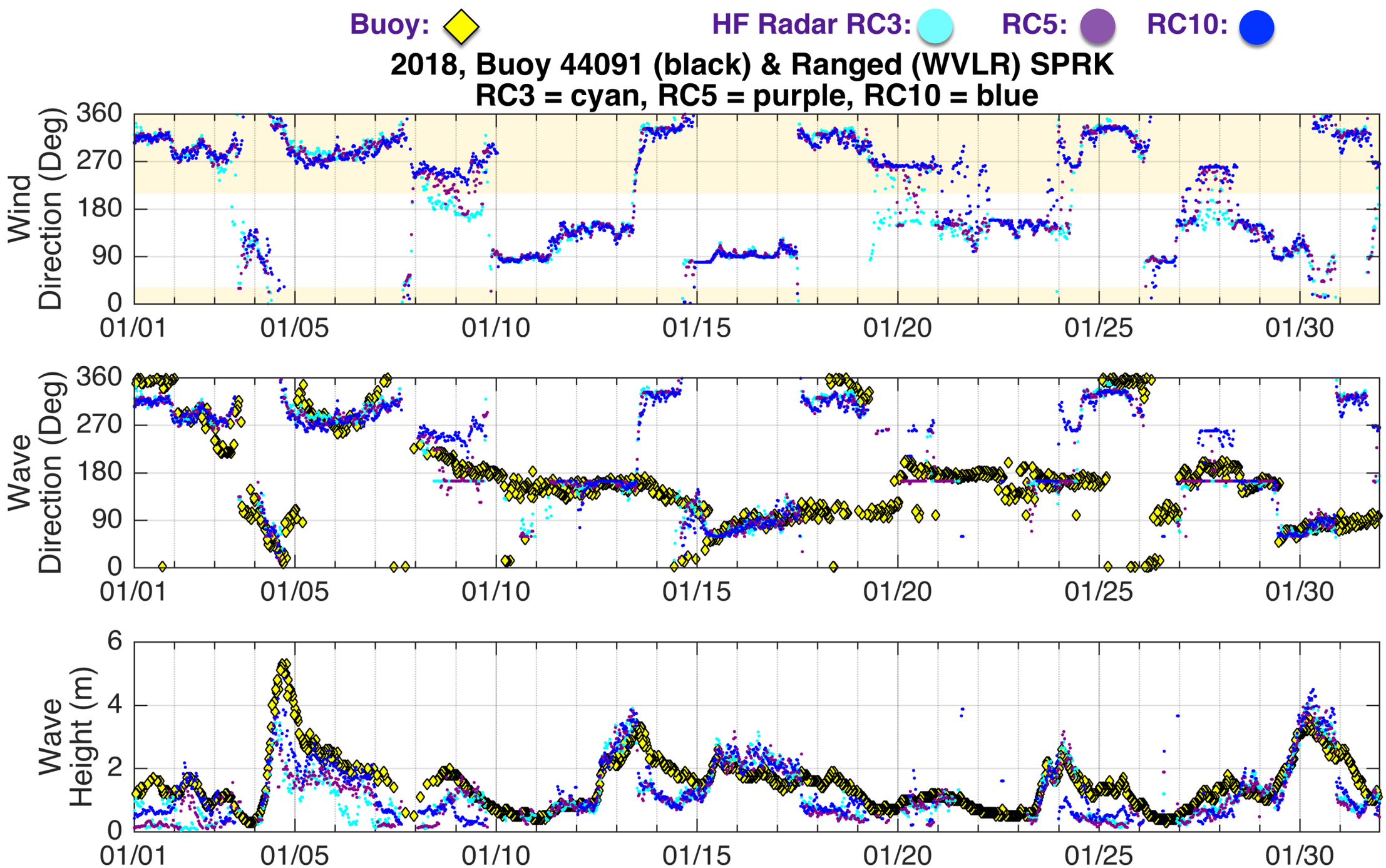
- Because the New Jersey coast is aligned at approximately 30°, offshore winds have directions between 210° and 30°.

- 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.

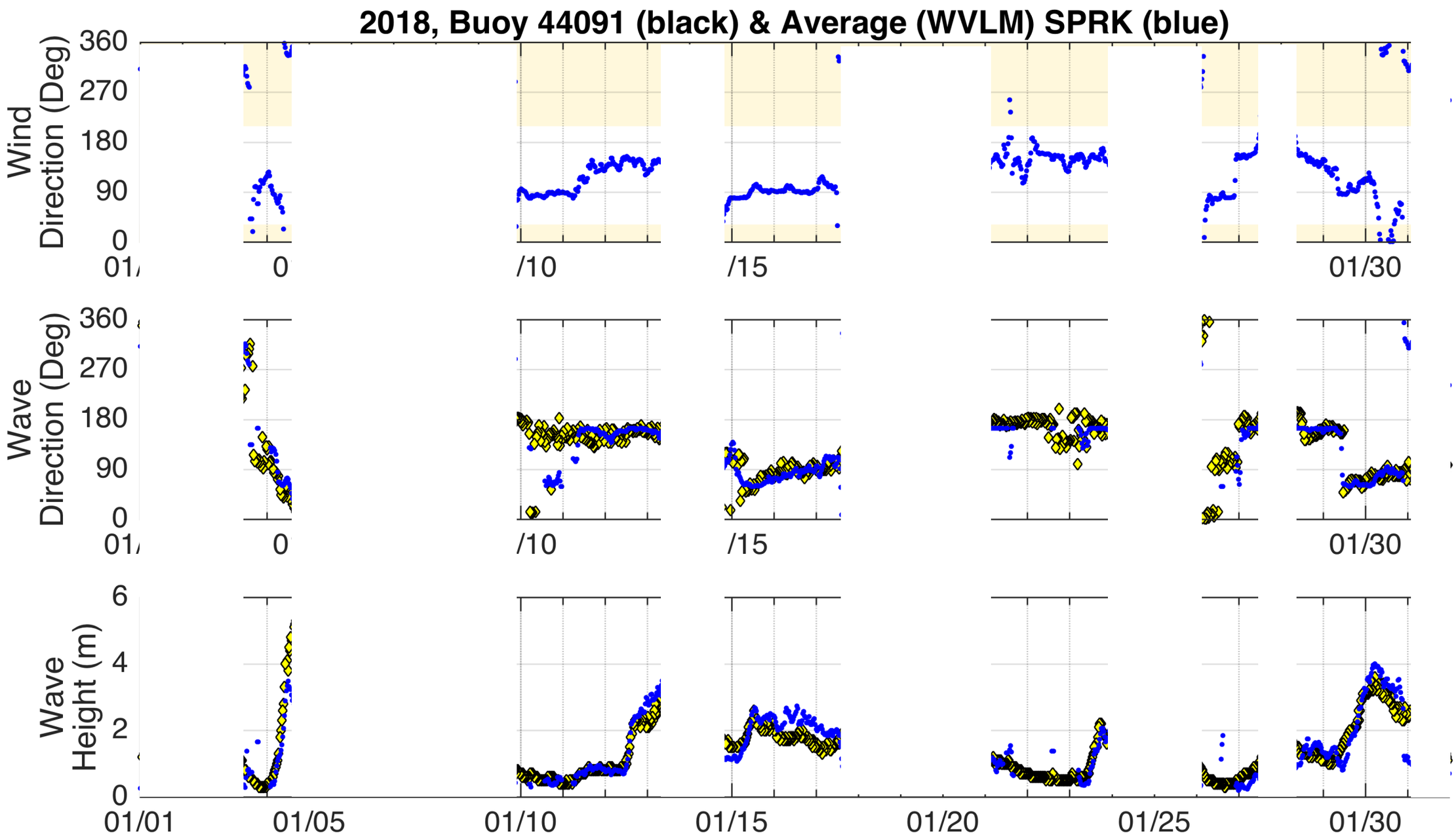
- Offshore winds produce wind waves that are barely developed nearest the coast. As the wave develops further from shore, wave height increases. Wind waves in various stages of development are observed in SeaSonde wave height data.

January 2018 Waves at Seaside Park (SPRK)



Onshore Waves approximately equal to buoy wave heights

Buoy: HF Radar RC3: RC5: RC10:



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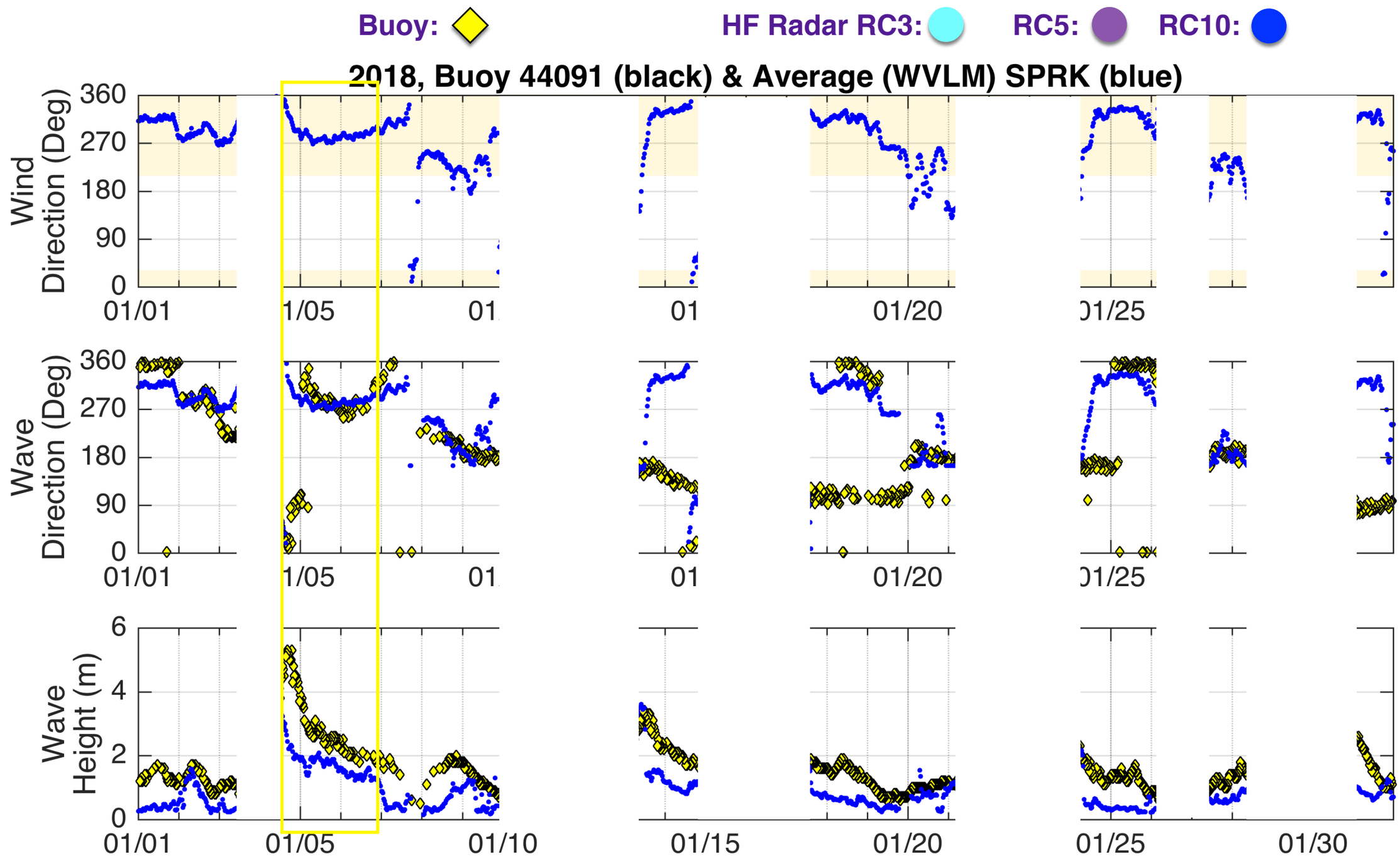
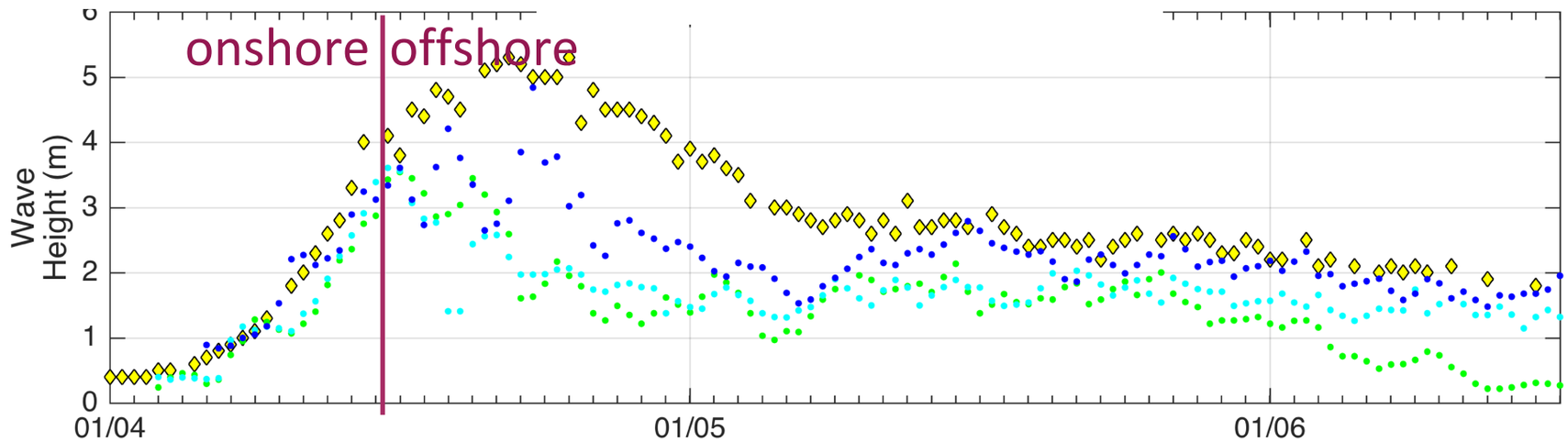
Offshore Waves lower than buoy wave heights due to Fetch-limited wave growth

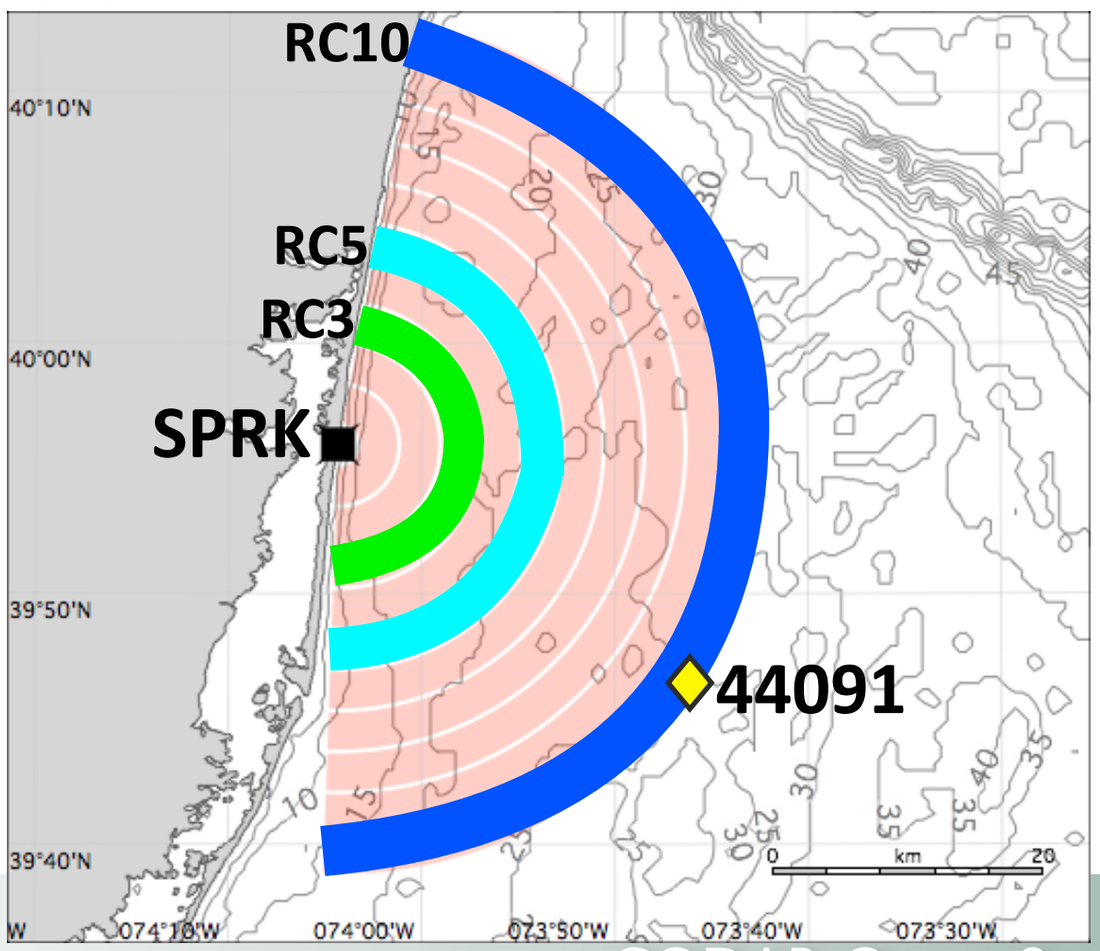


Significant Wave Height (m) Versus Time

January 4-6, 2018

Buoy 44091:◊ SPRK: RC10 ● RC5 ● RC3 ●



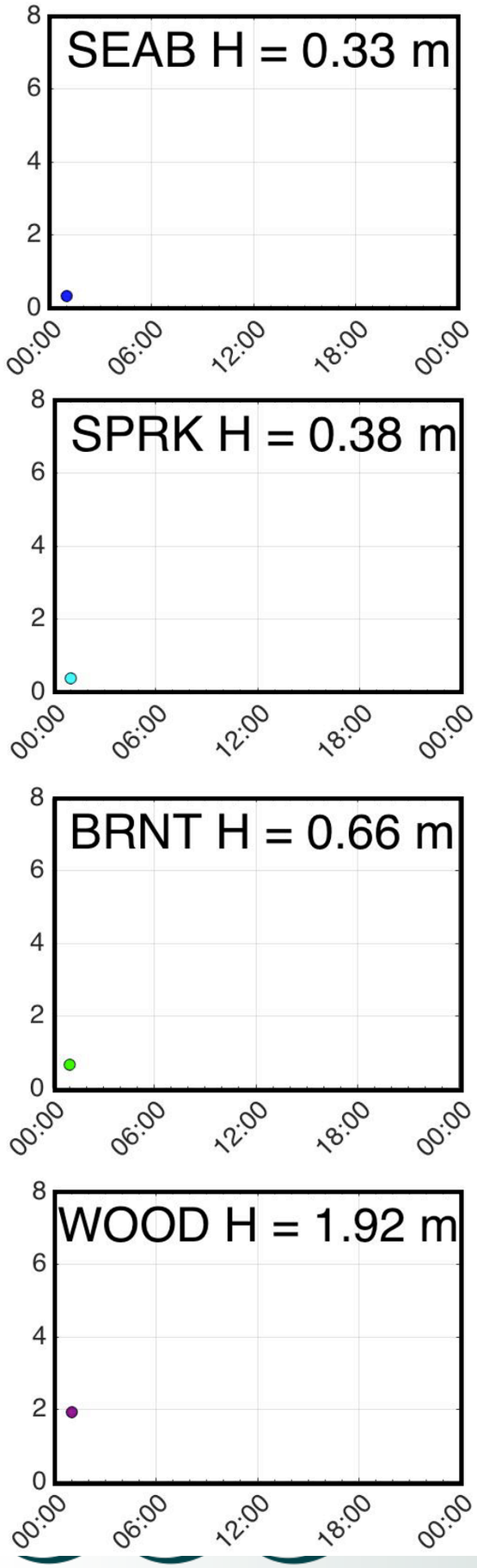


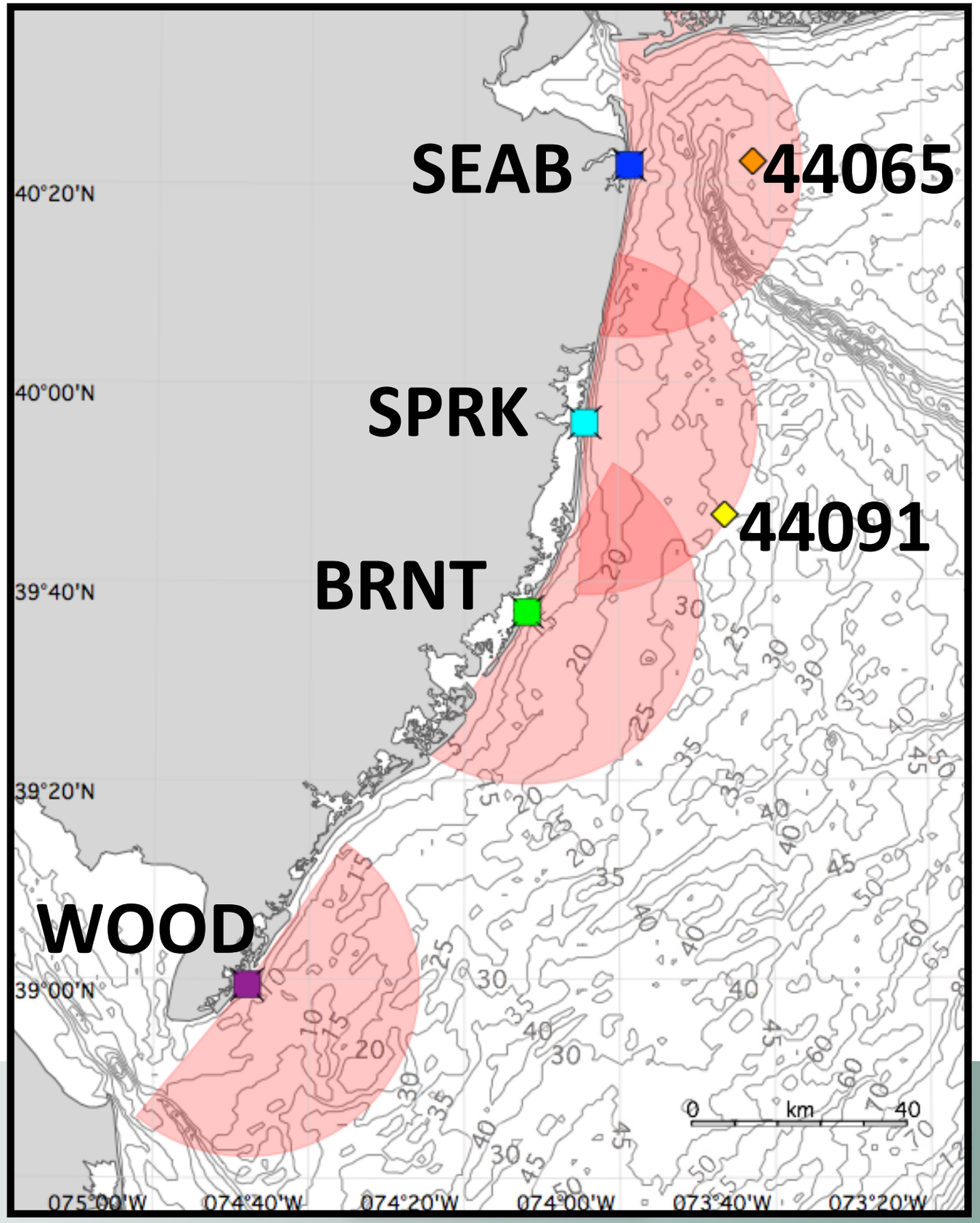
- **Significant wave height data are displayed for RC10, RC5, and RC3 and for buoy 44091.**
- **Offshore winds are reflected in an offshore increase in wave height extending through SPRK range cells and the buoy.**

Significant Wave Height (m) Versus Time

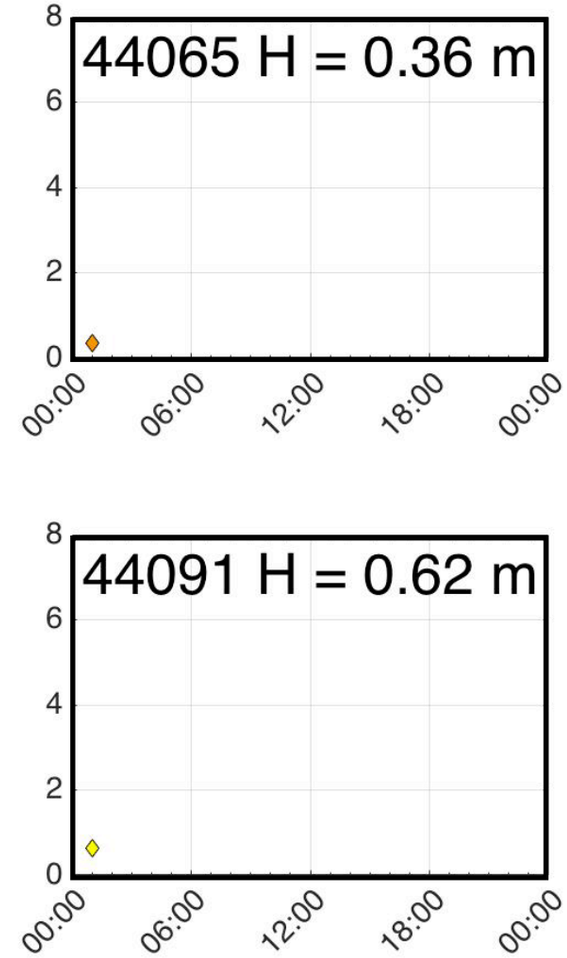
March 14, 2017

HFR RC10





BUOY

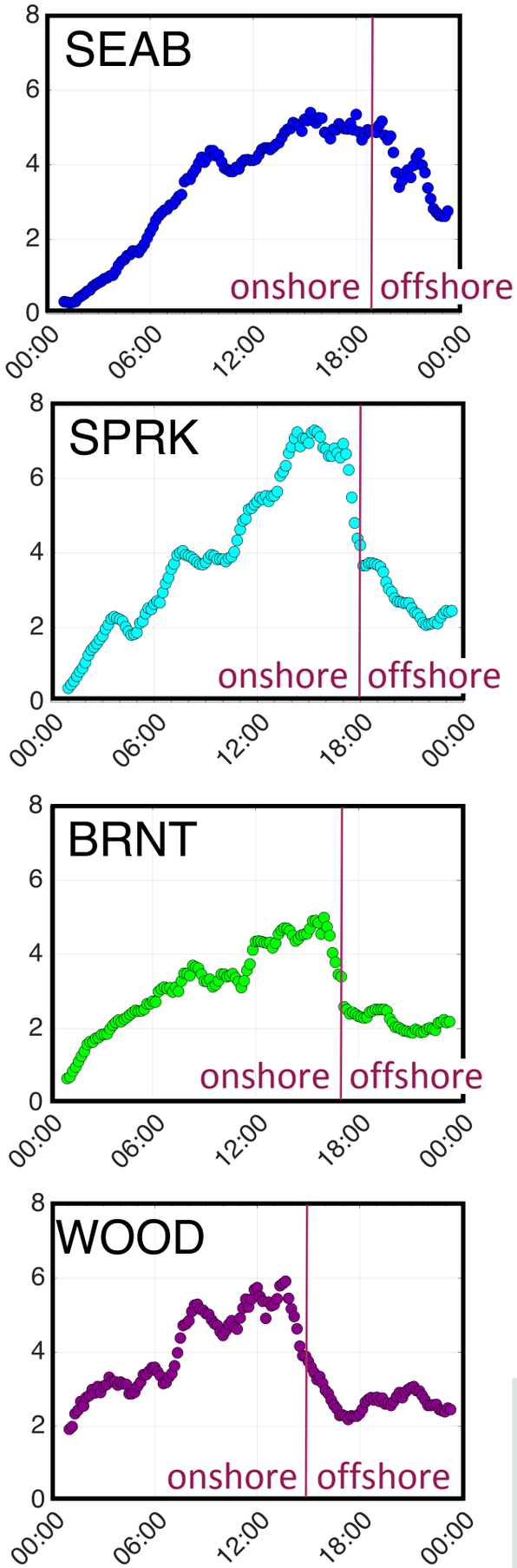


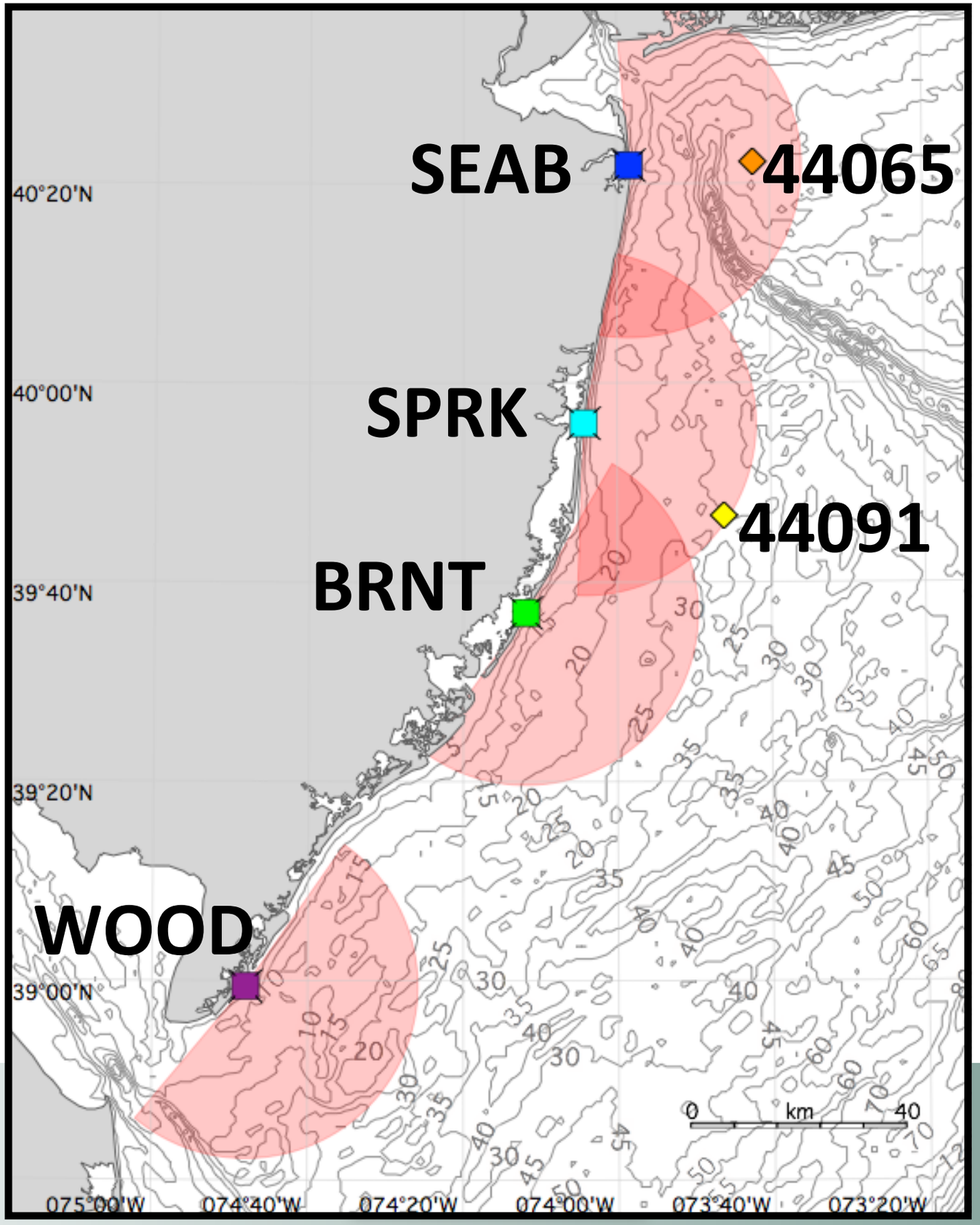
- **Significant wave height data are displayed for RC10 (left panel) and for buoys (right panel).**
- **Winds begin as onshore and transition to offshore**

Significant Wave Height (m) Versus Time

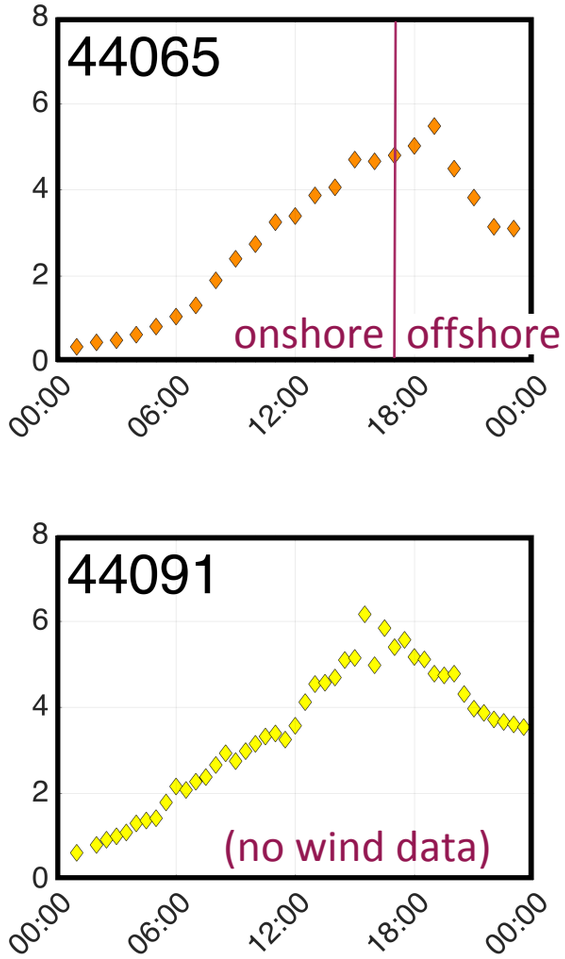
March 14, 2017

HFR RC10





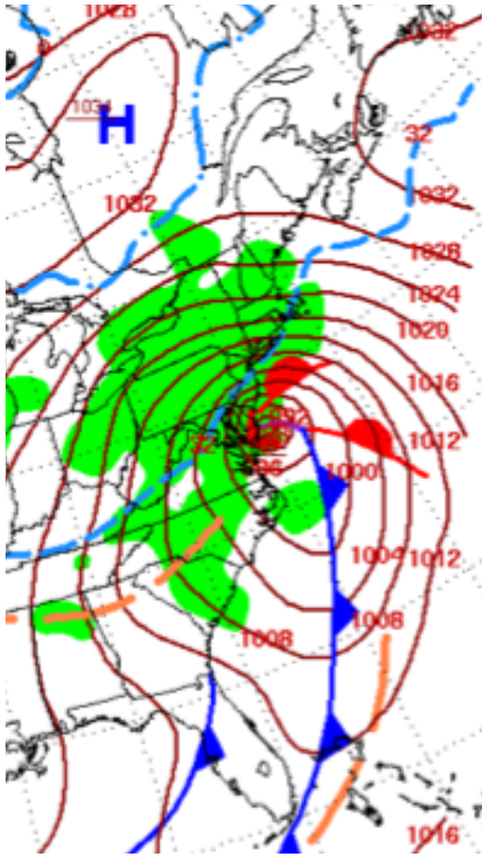
BUOY

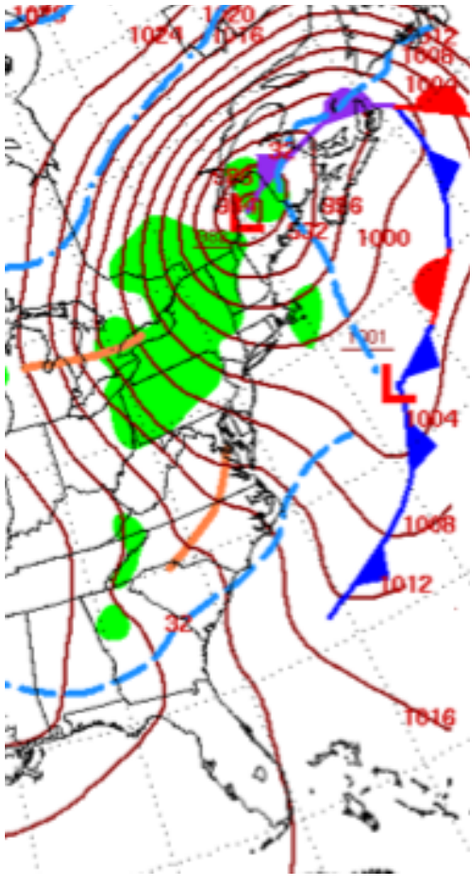


Winds become offshore at the vertical lines. The first transition occurs at WOOD and progresses northward.

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

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- Low power consumption
- Frequency sharing across large network

SeaSonde Ocean Surface Monitoring

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- Unrivaled manufacturer support
- Leverage many applications and stakeholders for one HF network

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