

Surface Current Mapping in the Lower Chesapeake Bay

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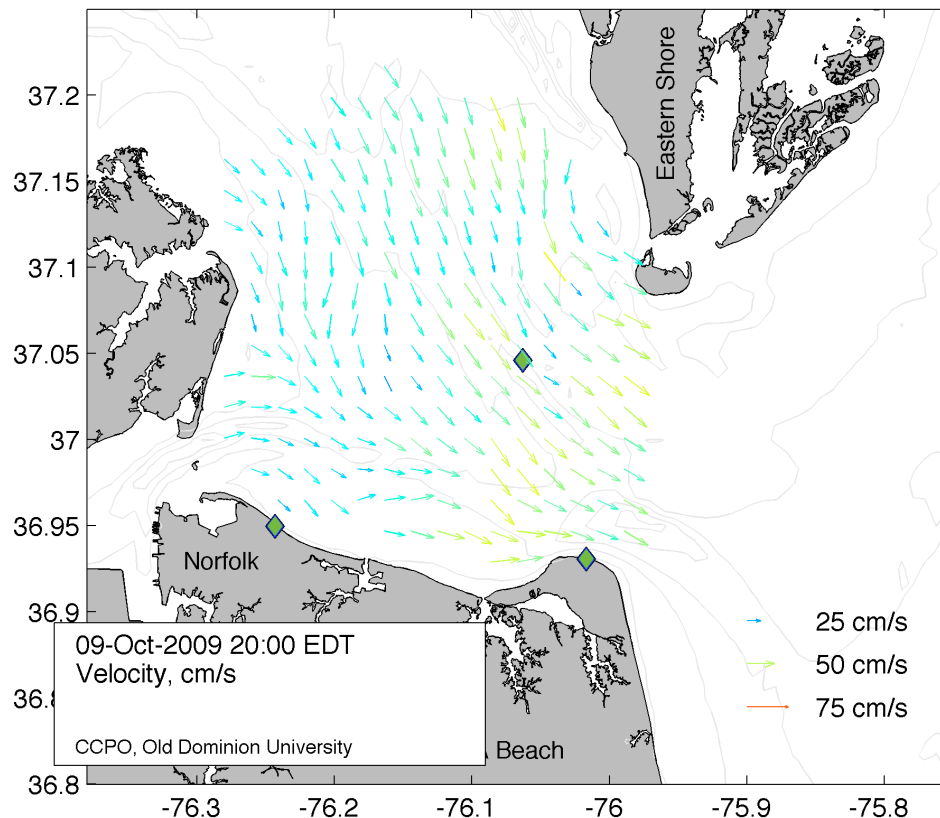
- Introduction to HFRADAR
- Local Sites & Data Access
- Products & Applications
 - Search & Rescue
 - Oil Spill/Pollution Tracking
 - Input into Numerical Models
 - Inform Sampling Strategies
 - Navigation
- Validation
- Summary & Future Work

A photograph of a coastal radar station. A tall, grey metal pole stands on a sandy beach, supporting a white rectangular radar antenna at the top. The antenna has several thin, horizontal metal rods extending from its base. Four white guy wires are attached to the pole and extend diagonally to the ground, forming a wide triangle. In the background, the ocean stretches to the horizon under a blue sky with scattered white clouds. A few people are visible on the beach: one person in a red shirt is on the left, and two people in dark clothing are sitting on the right. A large container ship is visible on the horizon line.

HF RADAR: Introduction

Basic operation of a CODAR
system

HFRADAR Mapping: A Unique Perspective on Currents



Land-based antennas

Use Doppler principles to observe surface velocities

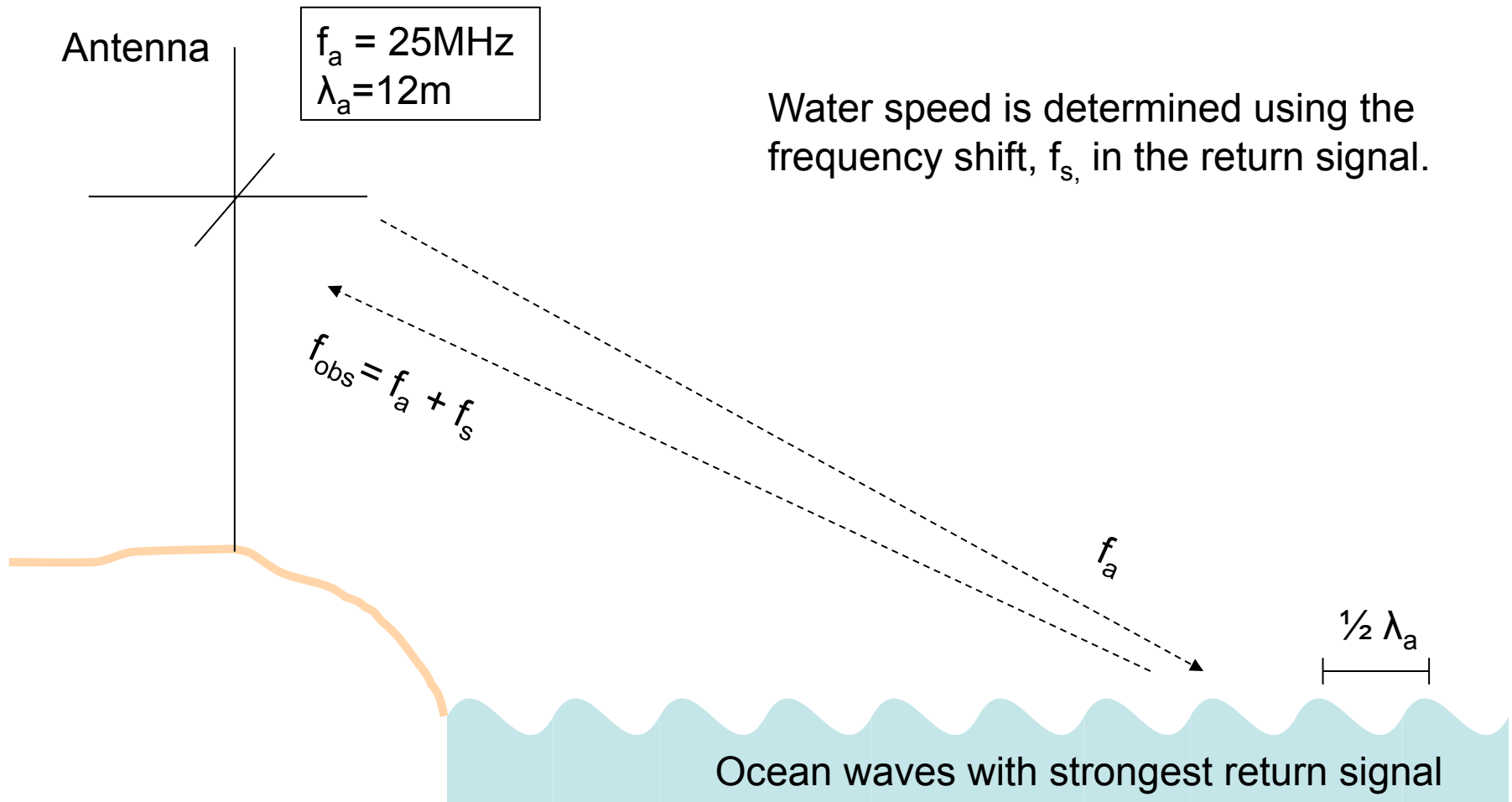
Sites normally set up to relay hourly output in near real-time.

Spatial coverage dependent on geometry / placement of antennas

Ranges for single antennas:

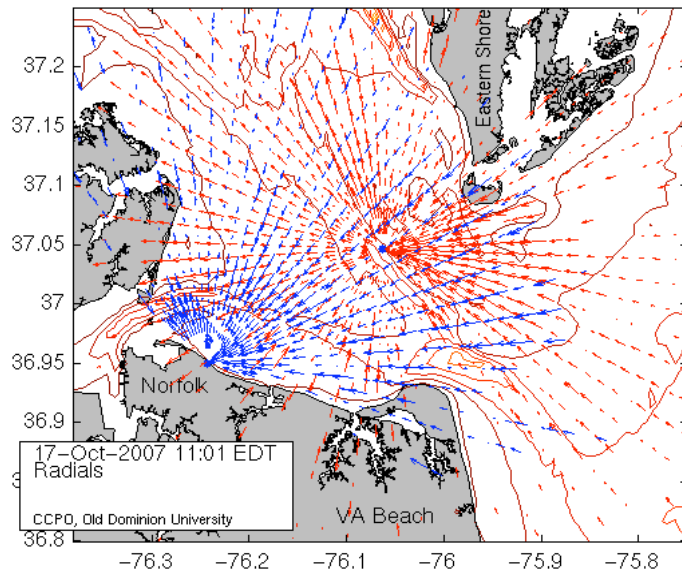
Standard Range (25MHz): up to 40 km

Long Range (5MHz): up to 200 km

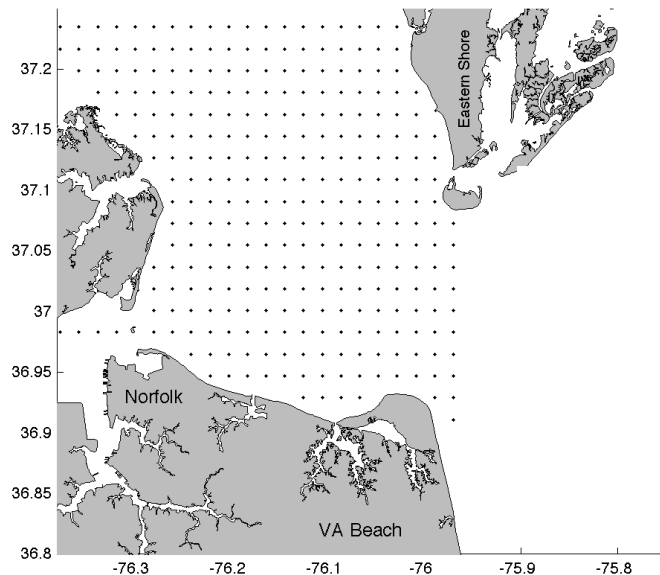


observed wave speed – theoretical wave speed = current speed

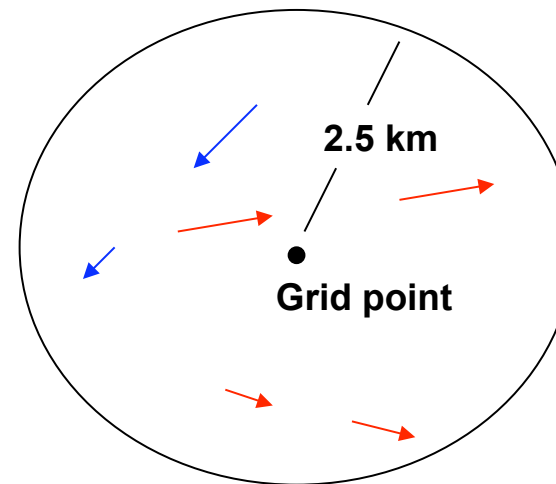
Radial Current Velocities



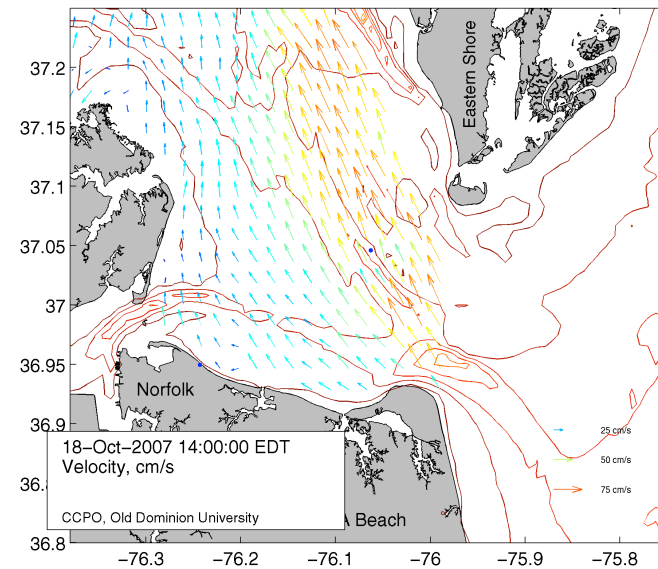
+ Grid



Around each grid point...
Combine Radial Vectors (Least Squares Average)



Total Current Velocities





HF RADAR SITE LOCATIONS IN THE LOWER CHESAPEAKE



AT OUR FIELD SITES

25.4 MHz CODAR Standard Range
antennas with co-located Tx/Rx

Cell phone modems connections

Ocean View Community Beach (VIEW)



Chesapeake Bay Bridge Tunnel (CBBT)



Operating Costs

- Equipment (antenna, computer, electronics enclosure, software) roughly 150K / site
- Power / network connections / access to the site
 - CBBT \$220/ month
 - VIEW \$100/ month
- Technician
- Additional costs: Calibrations, repairs

HFRADAR @ Old Dominion University

<http://www.ccpo.odu.edu/currentmapping>

Surface Current Mapping in the Lower Chesapeake Bay

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Data Products

[Latest Velocity Map](#)
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[Sample Trajectories](#)
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Diagnostics

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[50 Hr Radial Coverage](#)
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External Links

[NOAA Winds & Tides](#)
[NOAA Marine Forecast](#)
[Wunderground Forecast](#)
[CODAR](#)
[National Network](#)
[MARCOOS](#)
[ROWG](#)
[Rutgers](#)
[Southern California](#)

Quick Links to Most Recent Data

CBBT [1st Island](#) [2nd Island](#) [3rd Island](#) [4th Island](#)



project of the Center for Coastal Physical Oceanography, Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University.

Funding by the National Oceanic & Atmospheric Administration through the Center for Innovative Technology and MARCOOS (Mid-Atlantic Regional Coastal Ocean Observing System). Special thanks to the City of Norfolk and the Chesapeake Bay Bridge Tunnel Authority for providing sites for the antennas.

Data Products Updated Hourly

<http://www.ccpo.odu.edu/currentmapping>

[Latest Velocity Map](#)

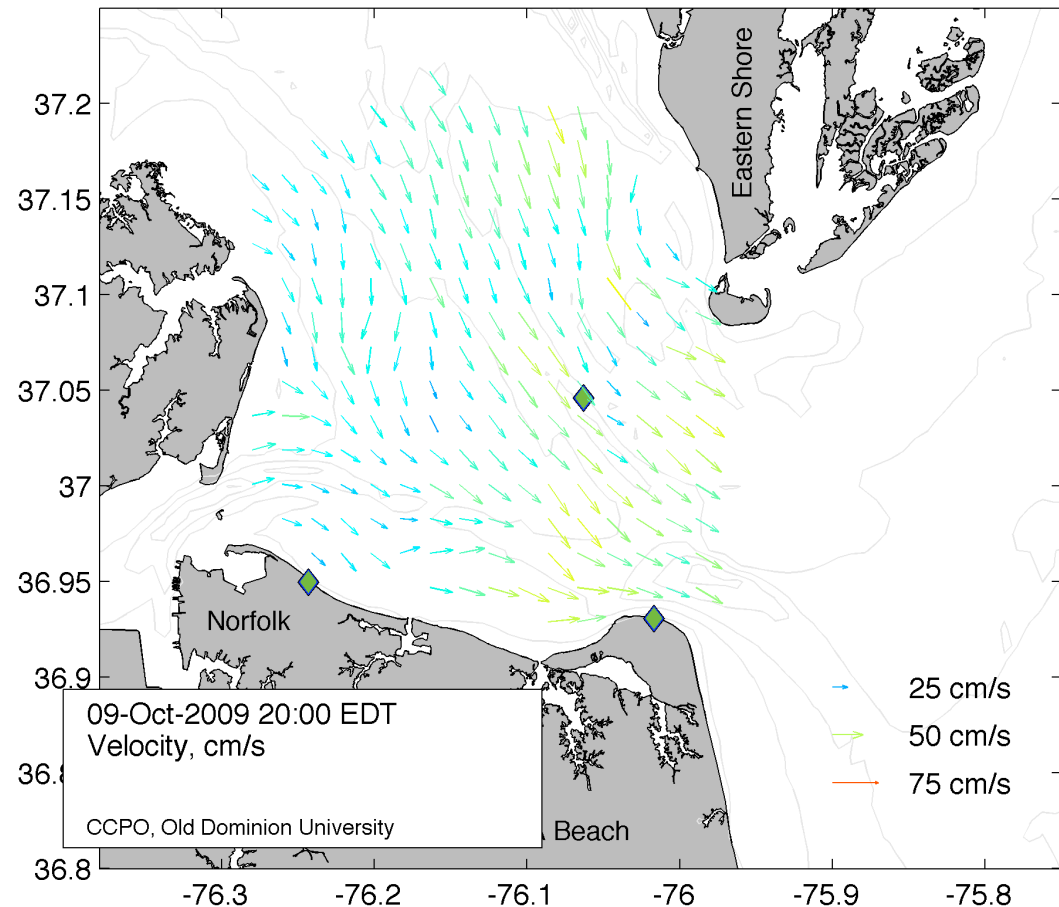
[12 Hour Movie](#)

[Sub-tidal Flow](#)

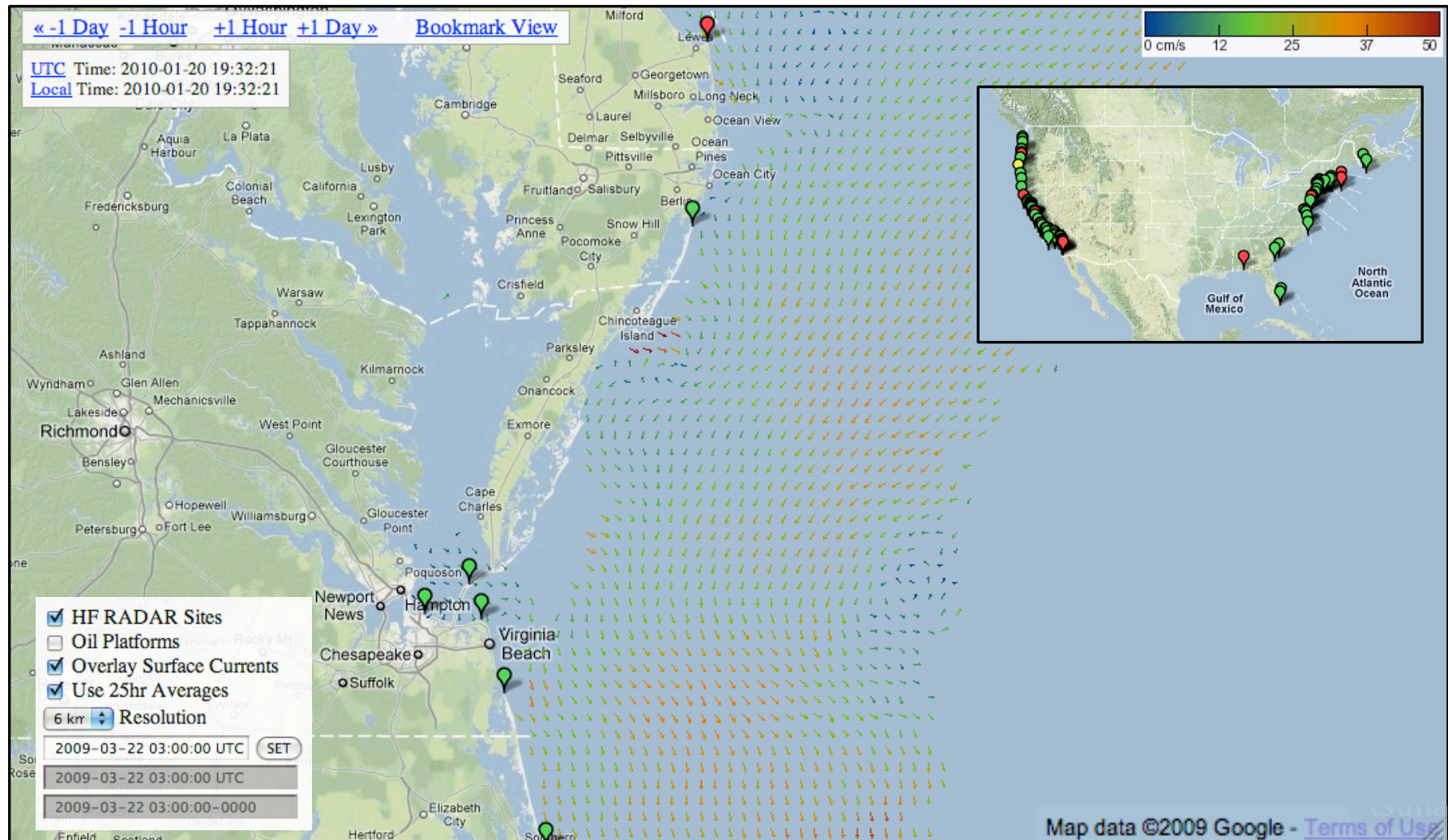
[Time Series](#)

[Alongshore Currents](#)

[Sample
Trajectories](#)

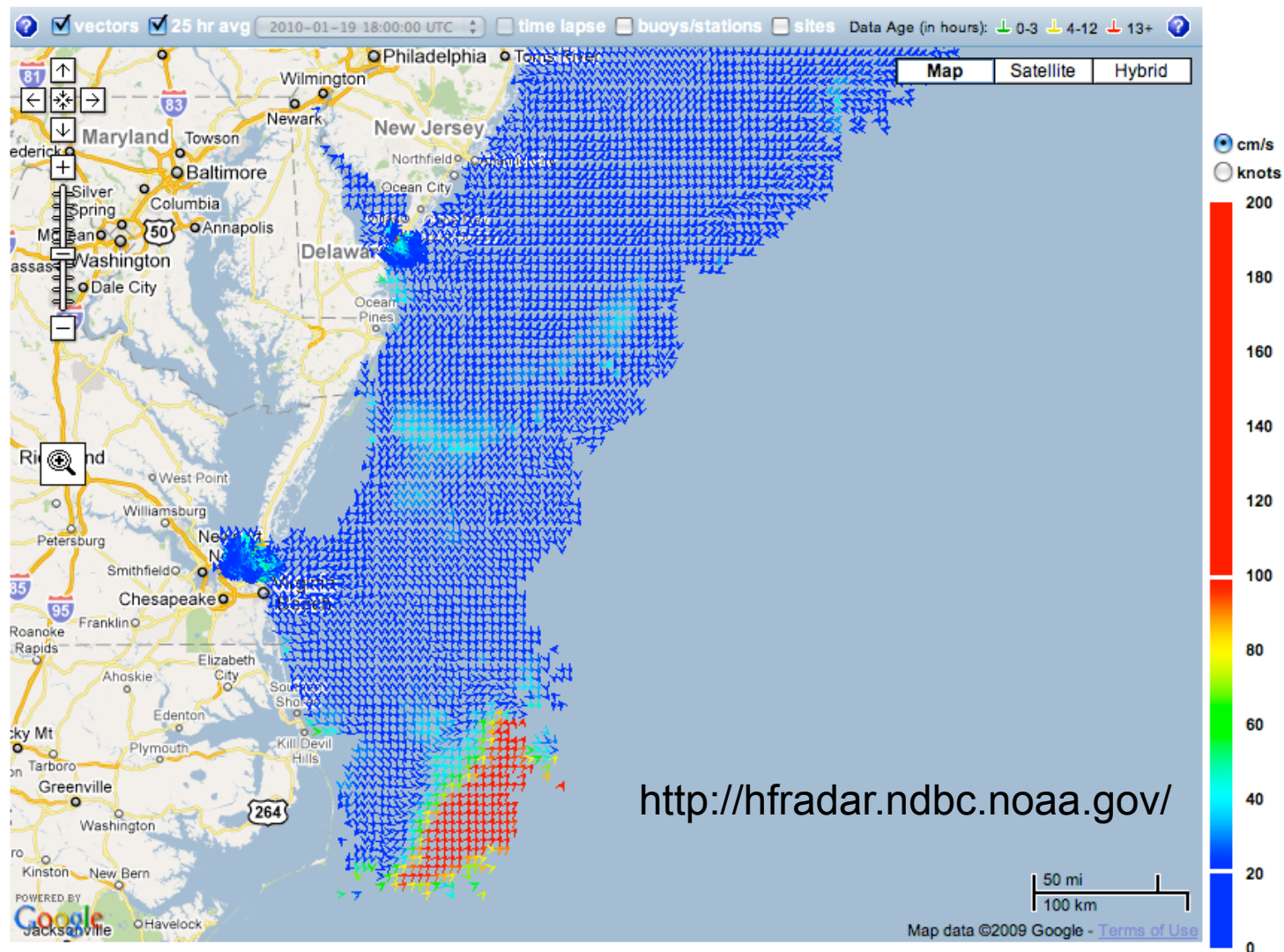


HFRADAR National Network

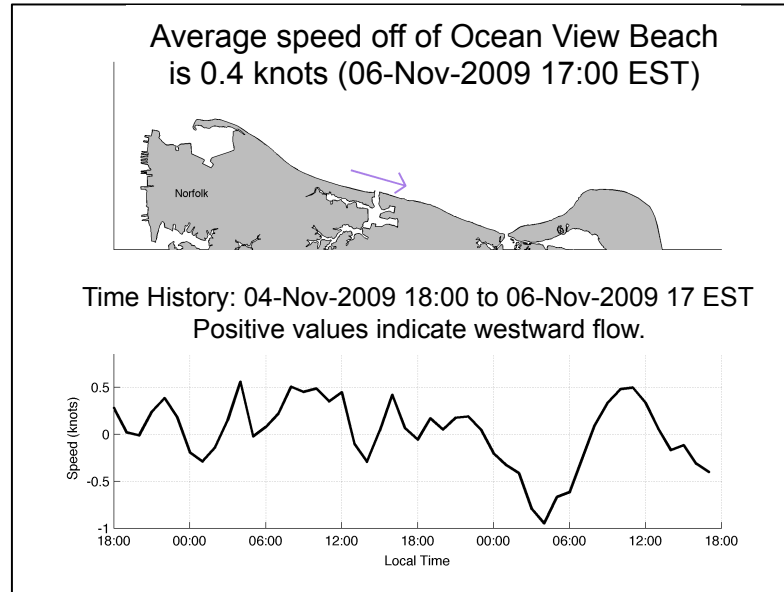


<http://cordc.ucsd.edu/projects/mapping/maps>

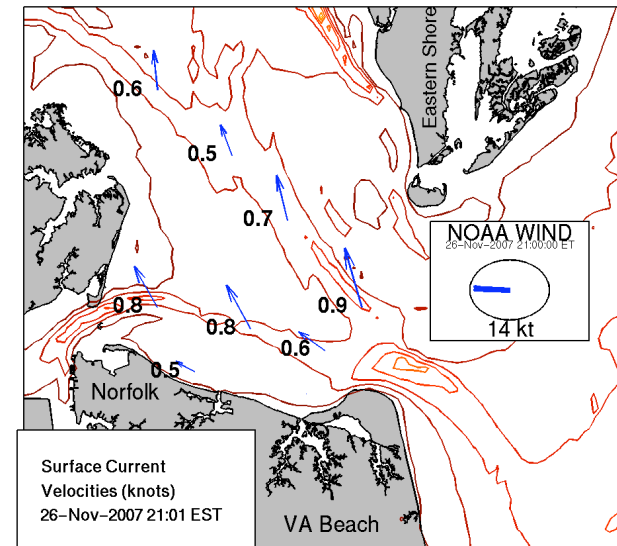
NOAA HF Radar National Server and Architecture Project



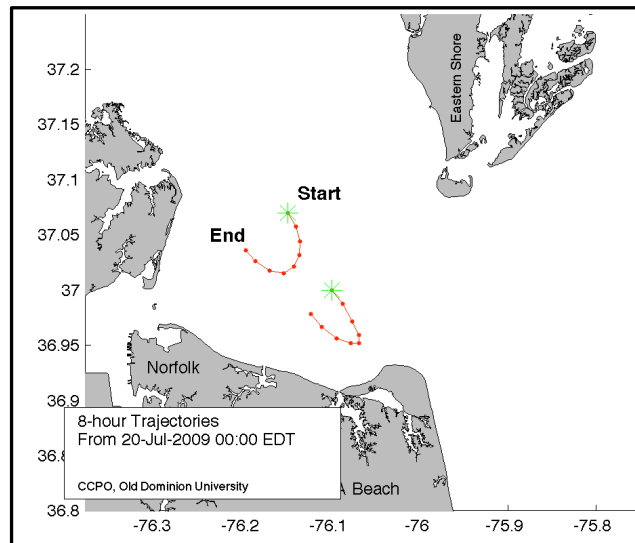
Alongshore Currents



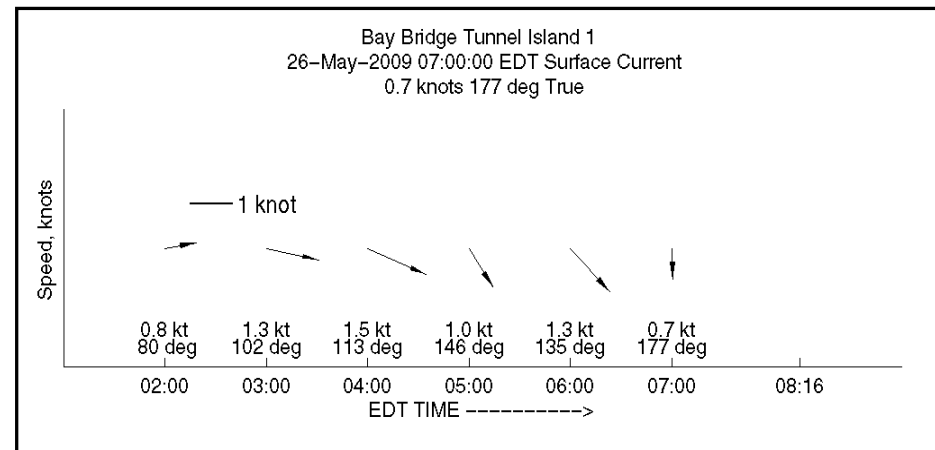
Shipping Channels



Trajectories



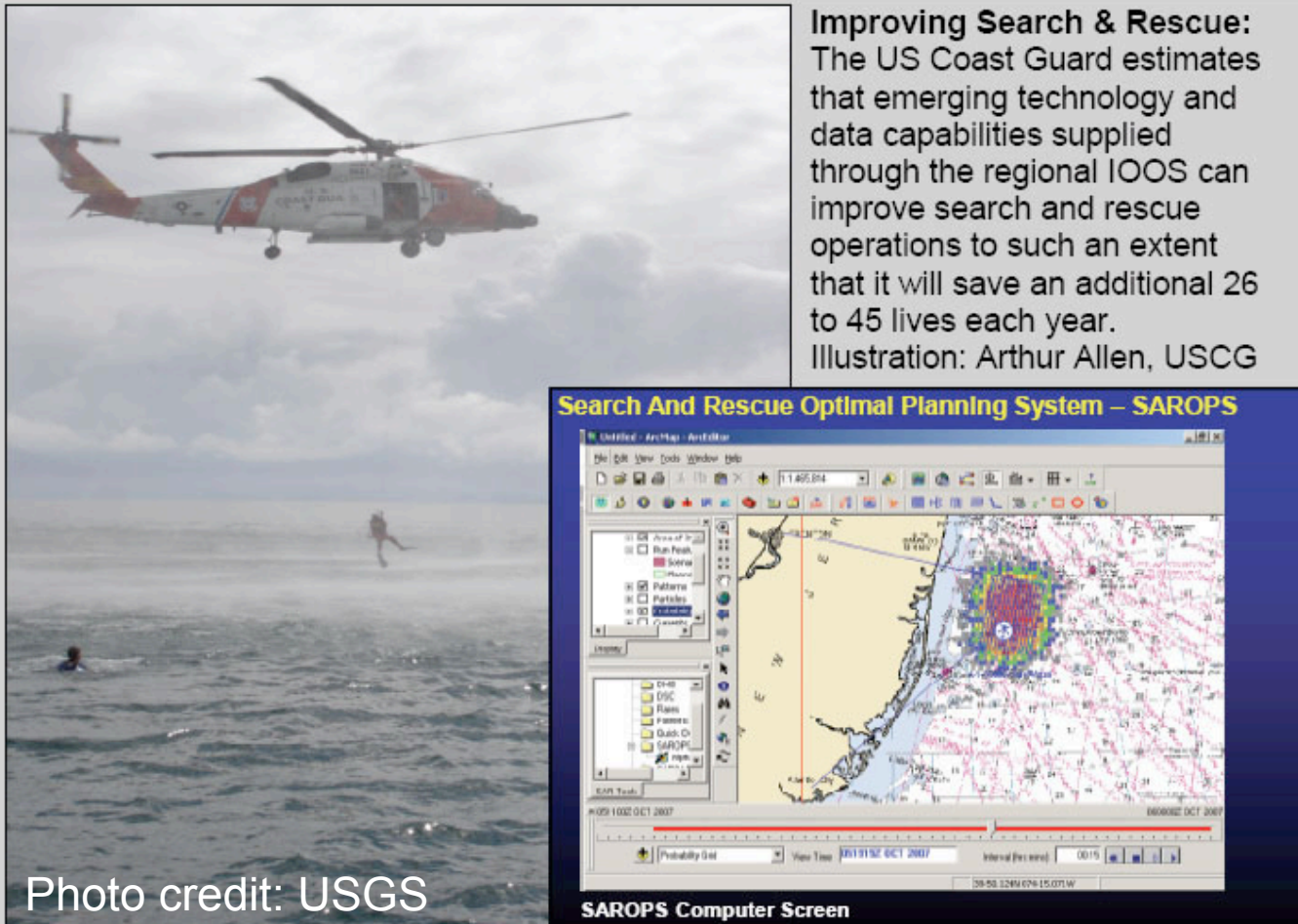
Times Series



Application Examples



Coast Guard Search & Rescue



The image is a composite. The left side features a photograph of a Coast Guard helicopter, a Sikorsky HO4S, flying over a choppy sea under a cloudy sky. In the distance, a person is visible in the water. The right side of the composite contains a screenshot of the SAROPS (Search And Rescue Optimal Planning System) software interface. The SAROPS screen shows a map of a coastal area with a search area highlighted in red and yellow. The interface includes various toolbars, a legend, and a timeline at the bottom. The text 'Photo credit: USGS' is located at the bottom left of the composite image.

Improving Search & Rescue:
The US Coast Guard estimates that emerging technology and data capabilities supplied through the regional IOOS can improve search and rescue operations to such an extent that it will save an additional 26 to 45 lives each year.
Illustration: Arthur Allen, USCG

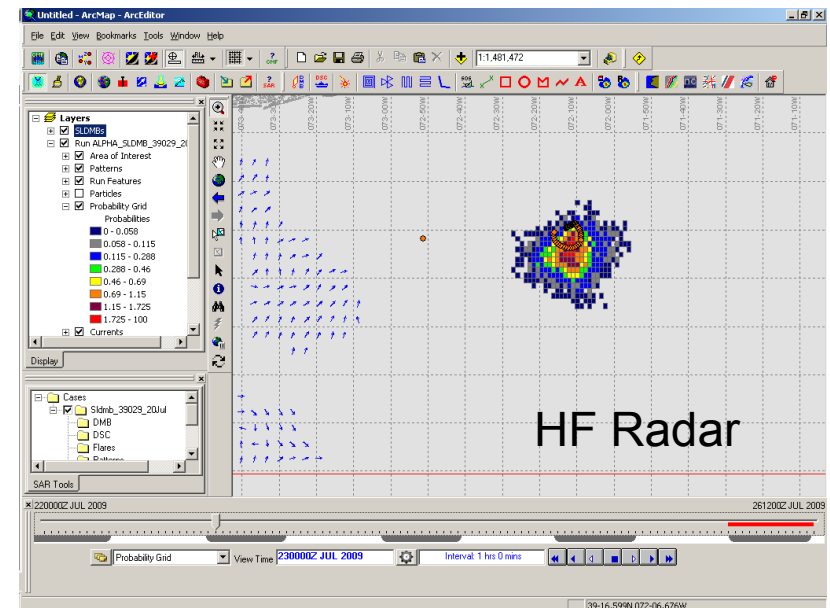
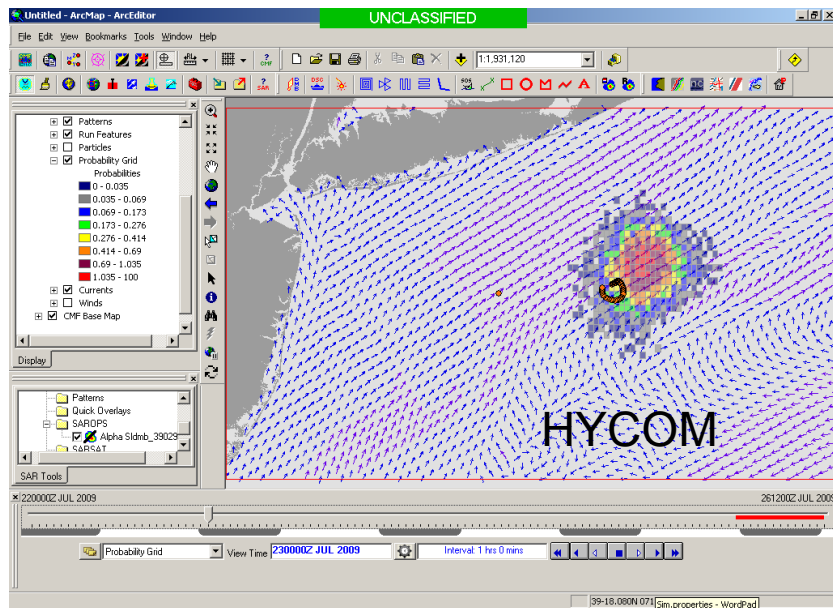
Search And Rescue Optimal Planning System – SAROPS

Photo credit: USGS

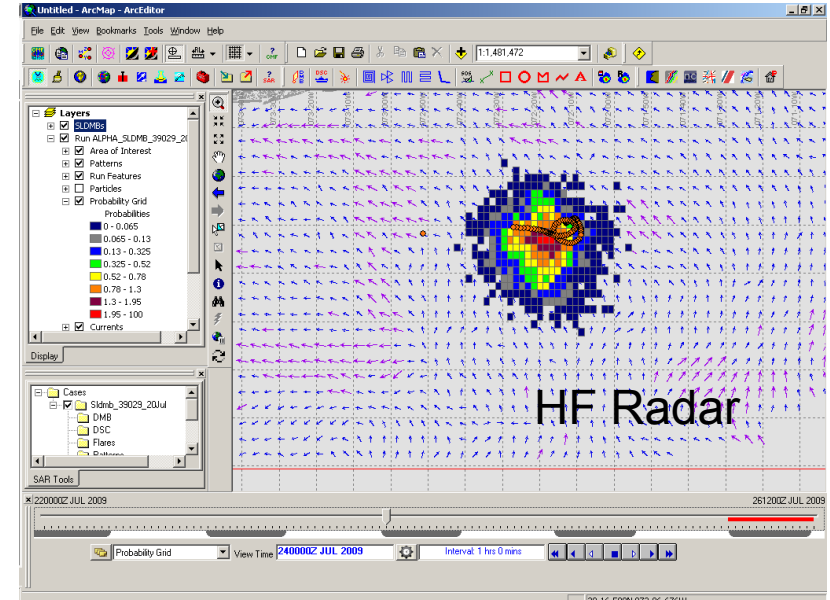
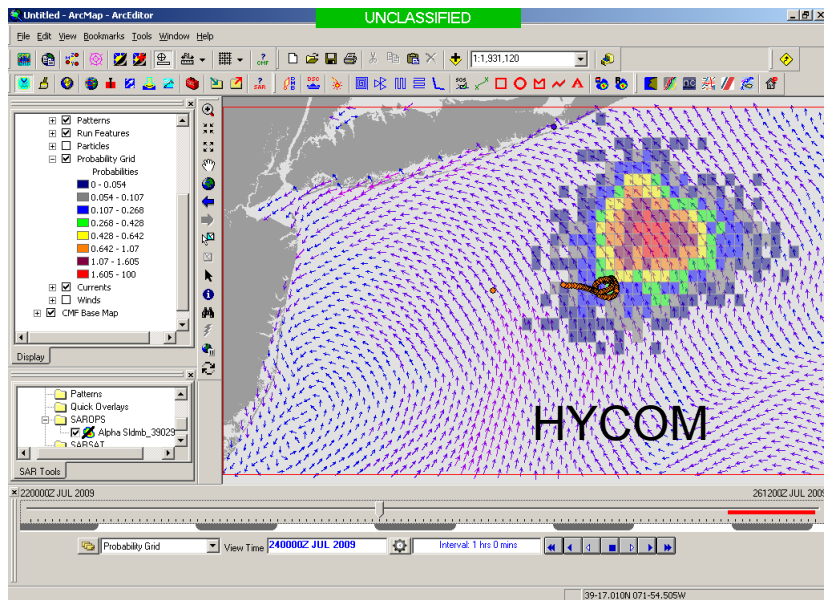
SAROPS Computer Screen

http://www.noaanews.noaa.gov/stories2009/20090504_ious.html

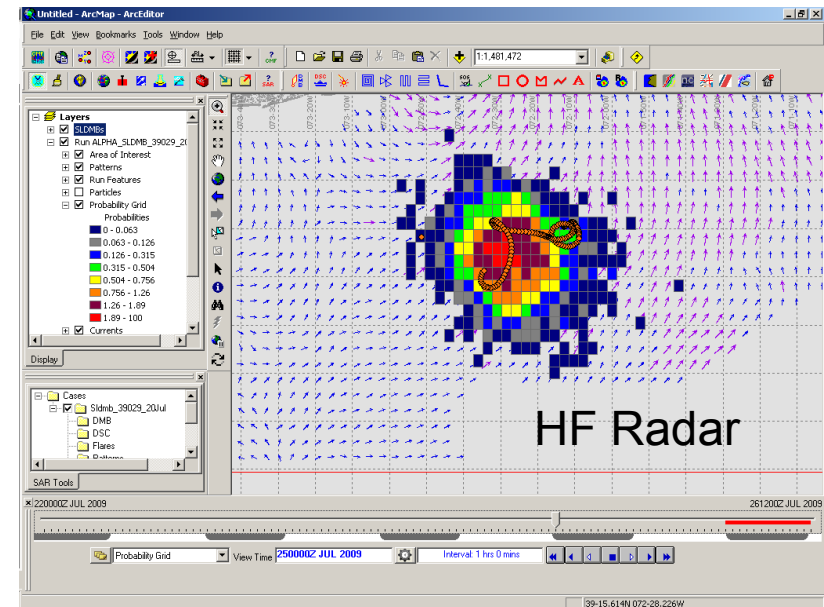
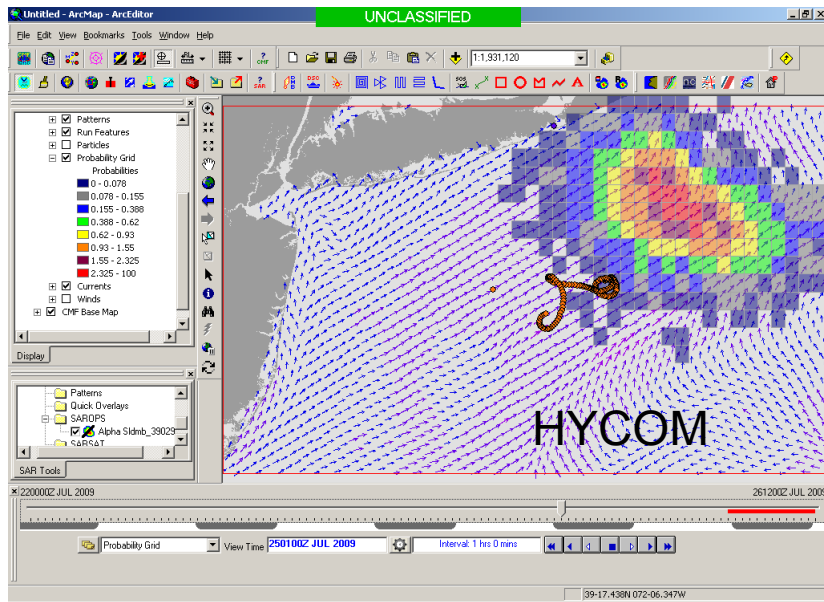
24 Hours Into Search



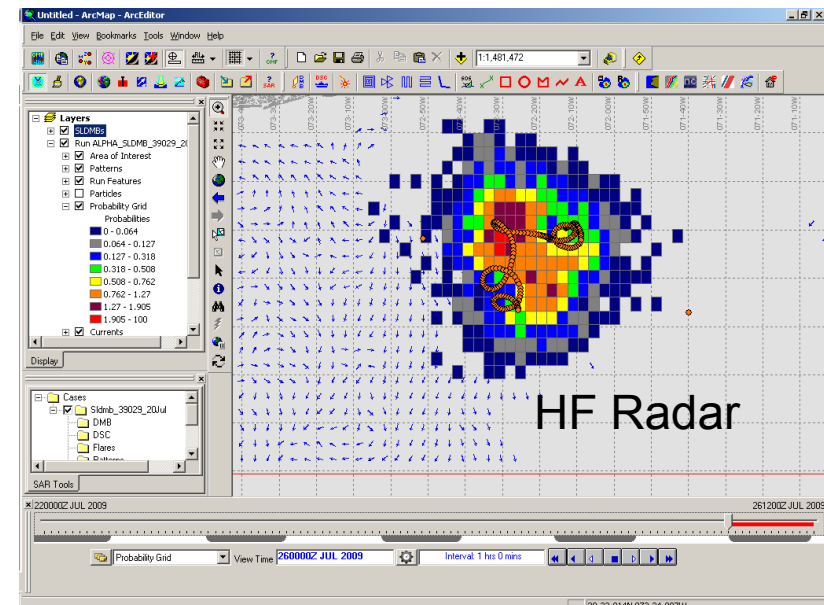
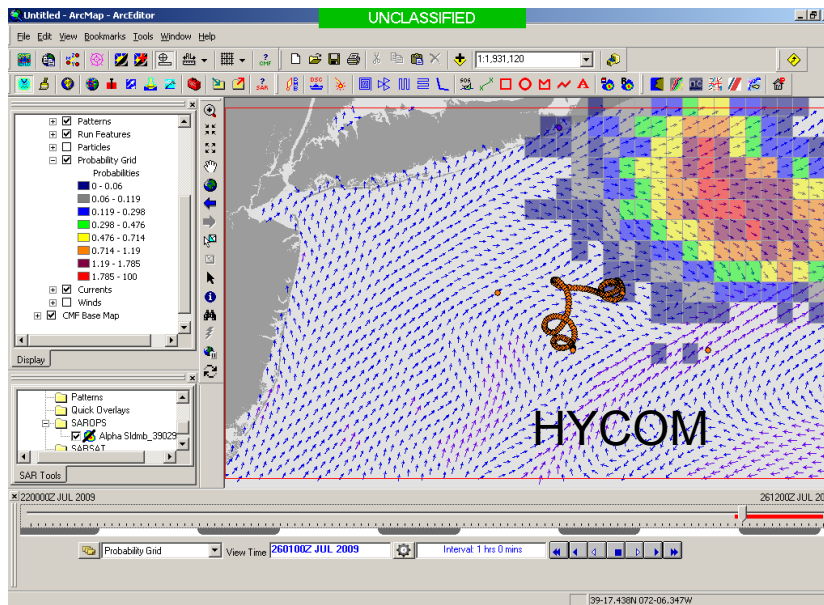
48 Hours Into Search



72 Hours Into Search

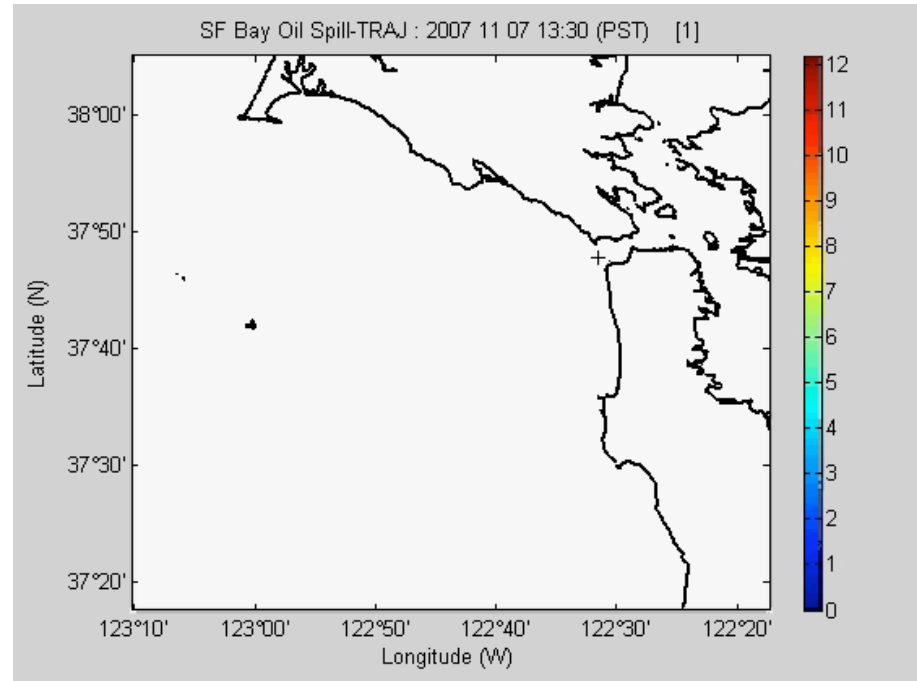


96 Hours Into Search



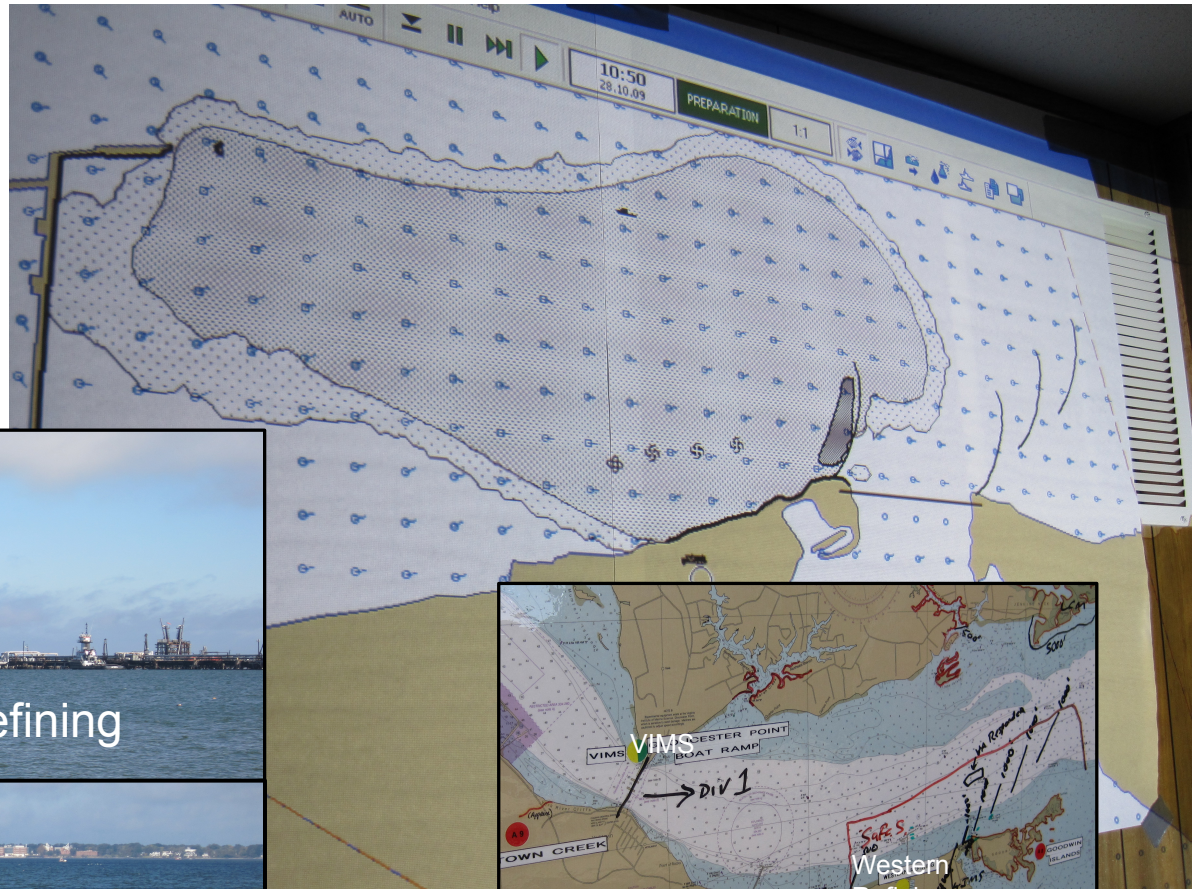
San Francisco Bay Oil Spill

- November 7, 2007 8:27am
The *Cosco Busan* hit the Bay Bridge and spilled 58,000 gallons of bunker fuel
- 70 miles of shoreline were affected
- 40% of oil was recovered or evaporated
- Cost: \$3M/day



http://cordc.ucsd.edu/about/docs/sfoilspill_20071107/sfbaytrajsub2_outside.mov

Oil Spill Training Exercise at Western Refining

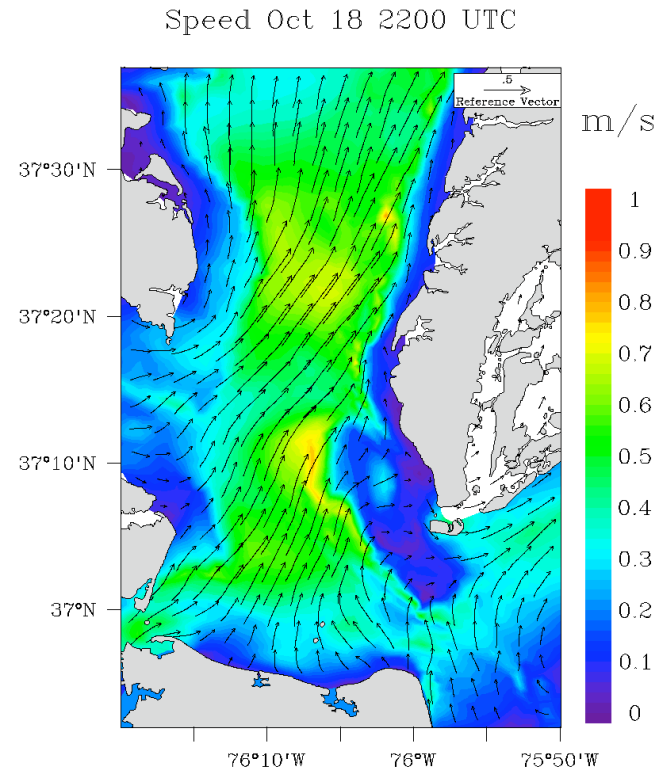


Numerical Modeling

The HFRADAR community hopes to improve model forecasting through

- Comparison of model output with current observations
- Data Assimilation
 - HFRADAR data has been assimilated into NY/NJ models

Gopalakrishnan, G. (2008), Surface current observations using high frequency radar and its assimilation into the New York Harbor observing and prediction system, Ph. D. Thesis, Stevens Institute of Technology



ChesROMS model output

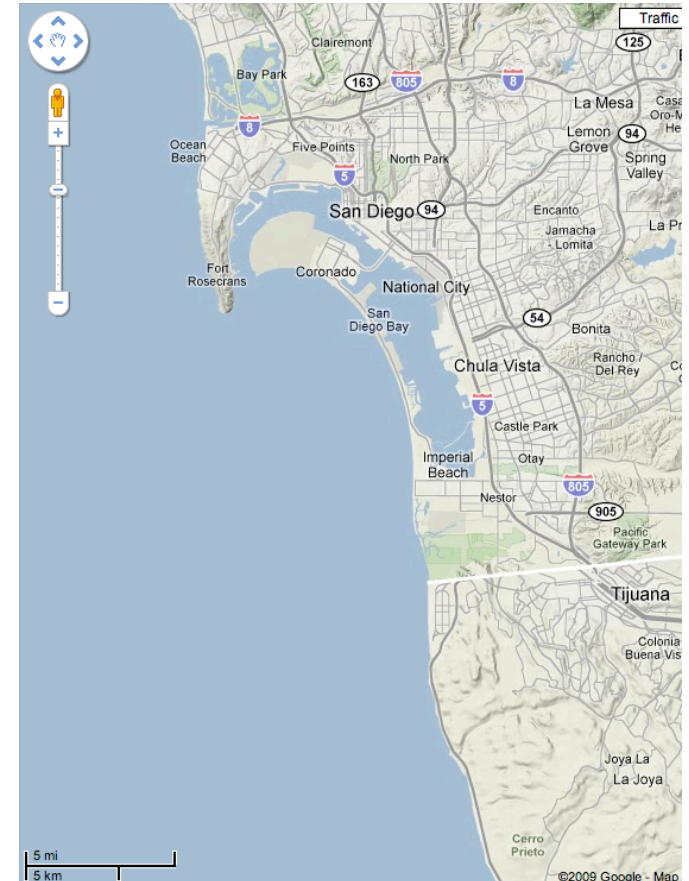
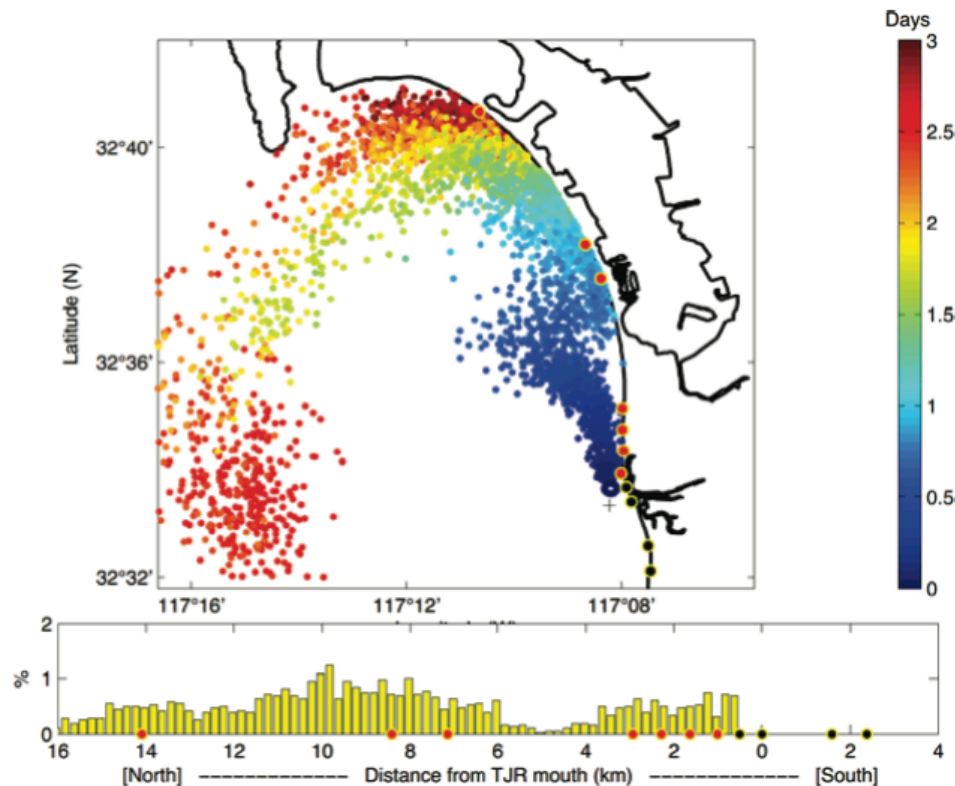
Water Quality Applications

Investigate sources of bacteria and pathogens that lead to beach closures

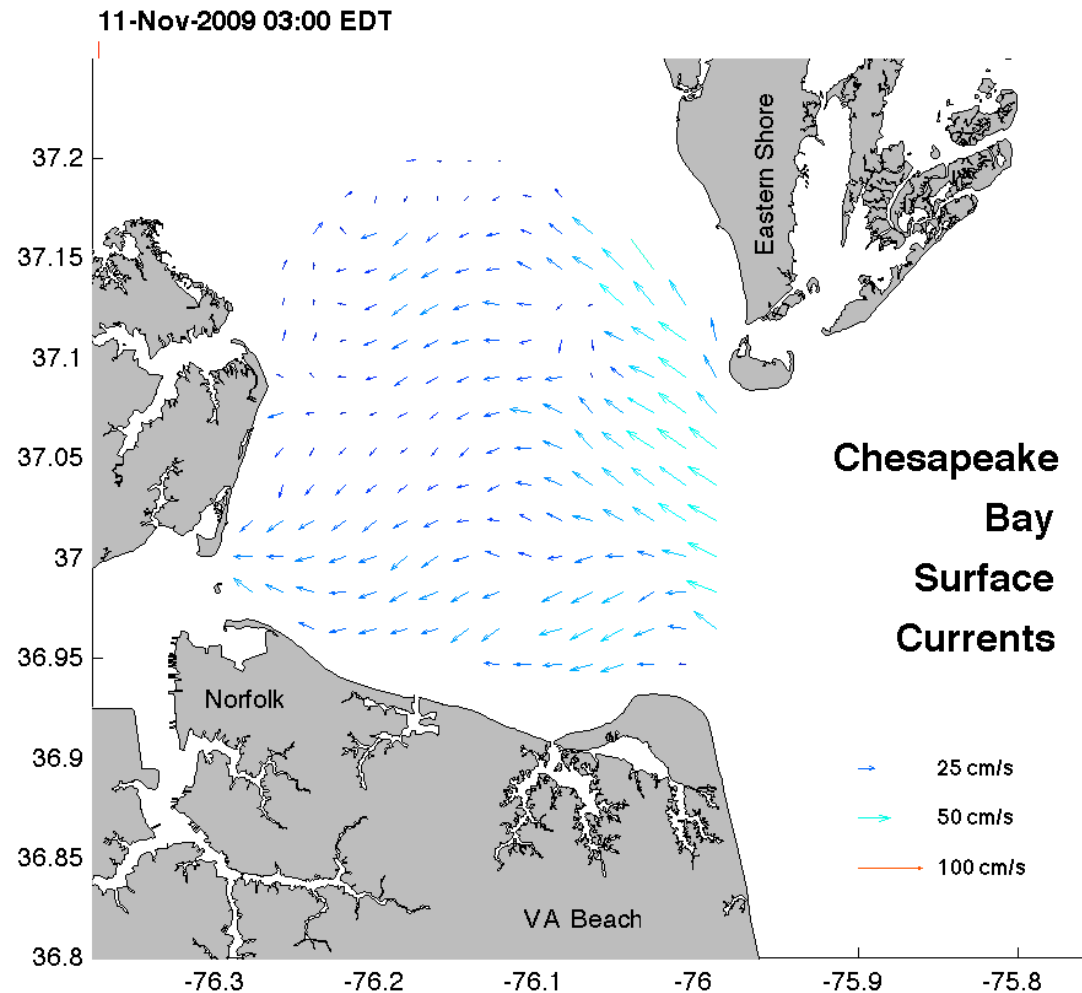
Assessing Coastal Plumes in a Region of Multiple Discharges: The U.S.

–Mexico Border Sung Yong Kim, Eric J. Terrill and Bruce D. Cornuelle

Environ. Sci. Technol., 2009, 43 (19), pp 7450–745



November 2009 storm event



Data Quality



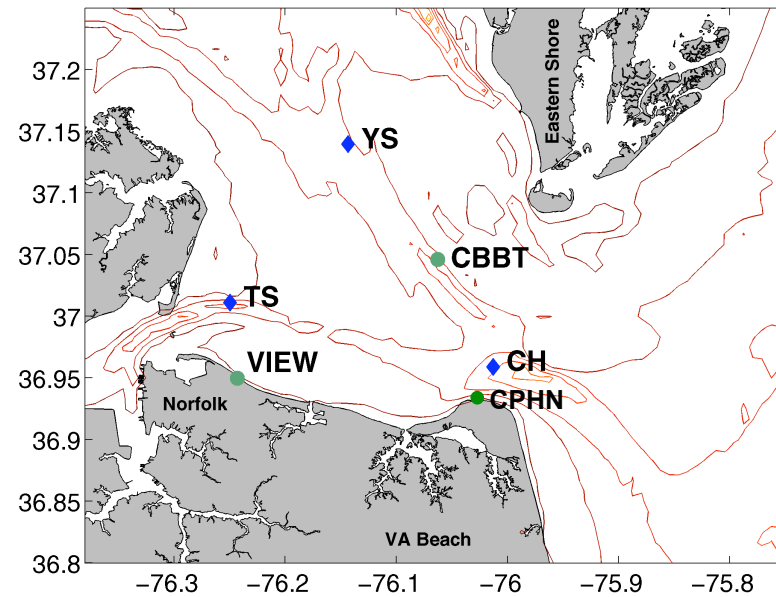
Data Validation

- Baseline (consistency between antennas)
- Tidal analysis
- ADCP Comparisons
 - Real-time using NOAA PORTS data
 - City of Norfolk mooring off of Ocean View beach

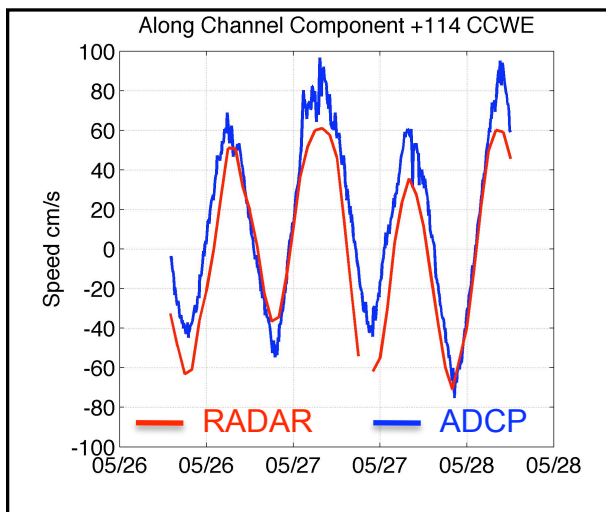


Photo Source: NOAA OSTEP report

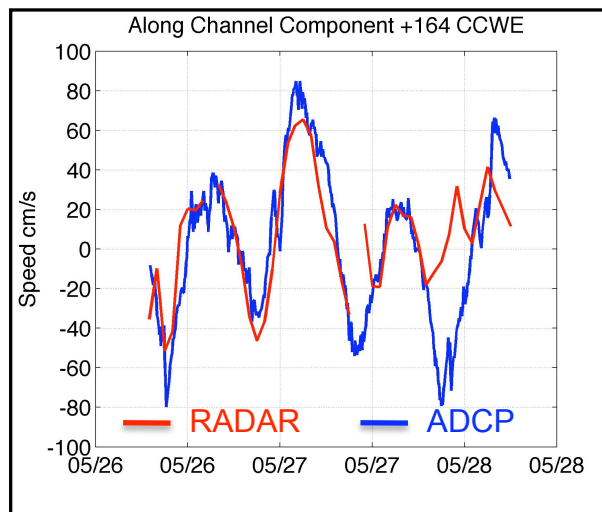
Comparisons with NOAA PORTS Doppler Current Profilers



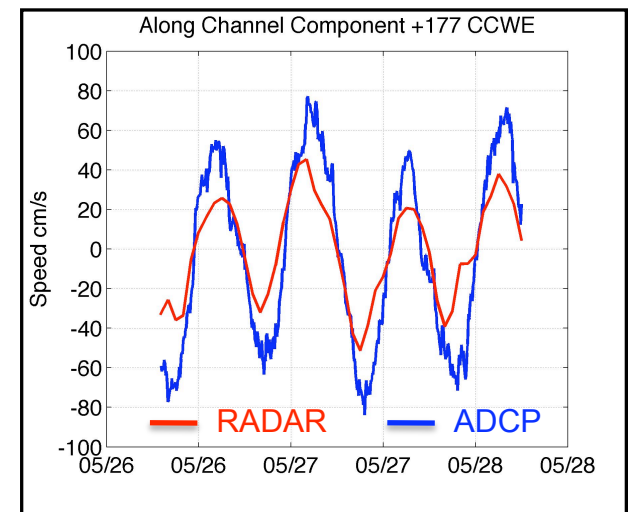
York Spit (YS)



Cape Henry (CH)

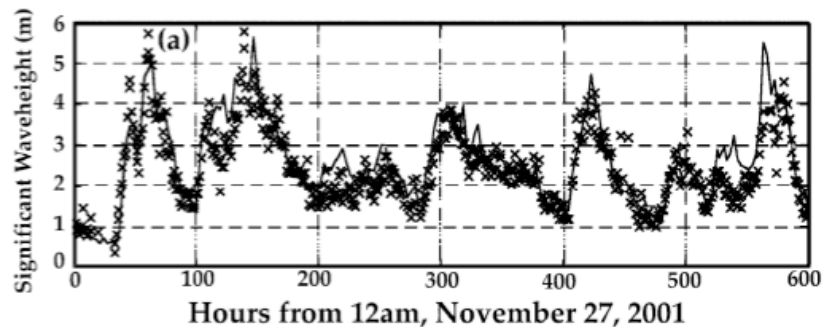


Thimble Shoals (TS)



More HFRADAR Products

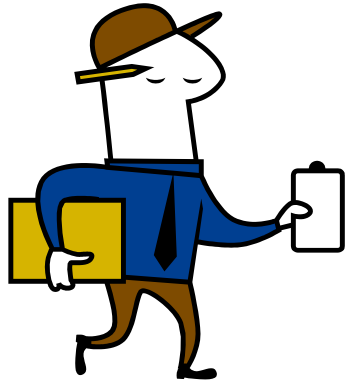
- **Water velocity in rivers** (product available)
- **Waves** (available for long range, not in shallow water)
- **Ship detection/tracking** (under development)



Lipa, B.J., B. Nyden (2005), Directional wave information from the SeaSonde, IEEE Jour. Ocean. Eng., vol 30, no. 1, pp 221-231.



RiverSonde



Data Access

Teresa Garner
garner@ccpo.odu.edu
757-683-4816



HFRADAR surface current data in the lower Chesapeake Bay (April 2007-present) are freely available.

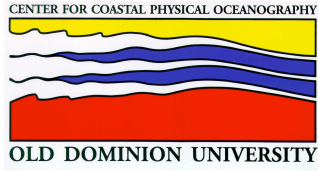
The data may be transferred in a variety of formats (i.e. text, MAT files, NetCDF).

We can help facilitate the development of new products and we welcome suggestions on how to best display the data to suit particular needs.

Ongoing & Future Work

- Outreach to local groups
- Web page & product development
- Incorporate data into GIS and map with other regional spatial data
- Data analysis to answer basic research questions and improve current forecasting capabilities
- Model comparisons
- And?? We are open to input from the community!





Acknowledgements



- Larry Atkinson and Jose Blanco
- CIT, MACOORA, NOAA
- CODAR support
- Advice and assistance from numerous other HF RADAR operators

