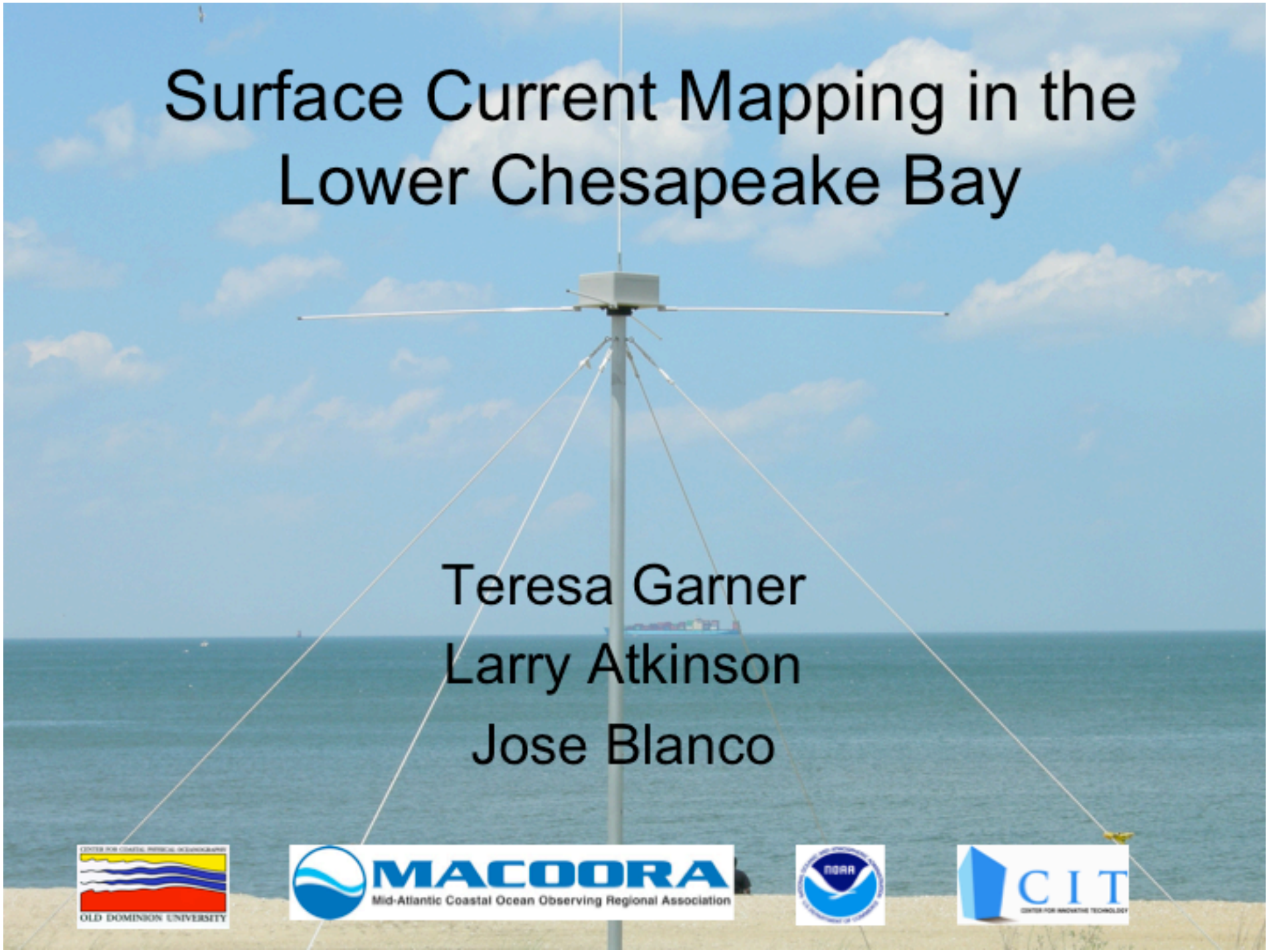
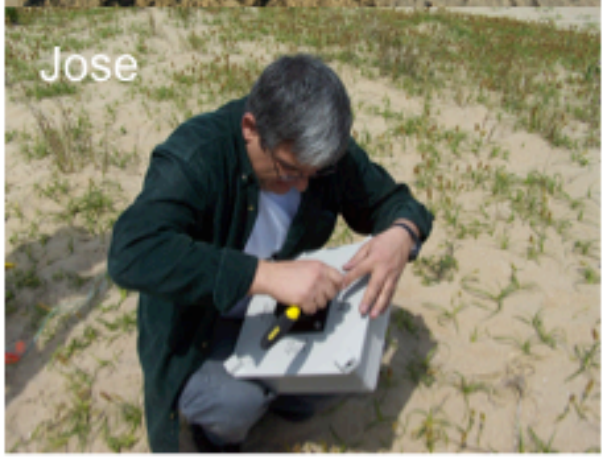

Surface Current Mapping in the
Lower Chesapeake Bay
Teresa Garner
Larry Atkinson
Jose Blanco
OLD DOMINION UNIVERSITY
MACOORA
Mid-Atlantic Coastal Ocean Observing Regional Association
NOAA
CIT

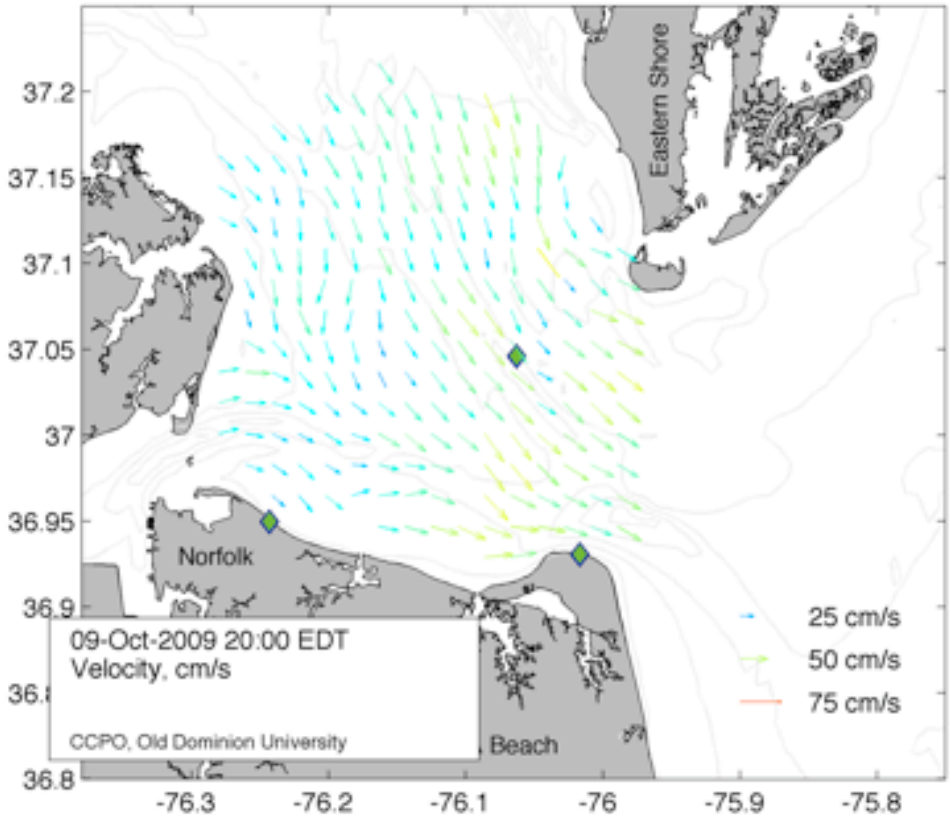


- Introduction to HFRADAR
- Local & Regional Data Coverage
- Applications
  - Data/Model Comparisons
  - Assimilation
    - Coast Guard Search & Rescue
    - Pollutant Tracking
- Validation
- Data Access
- Summary & Future Work

HFRADAR: Introduction

Basic operation of a CODAR system

HFRADAR Mapping: A Unique Perspective on Currents



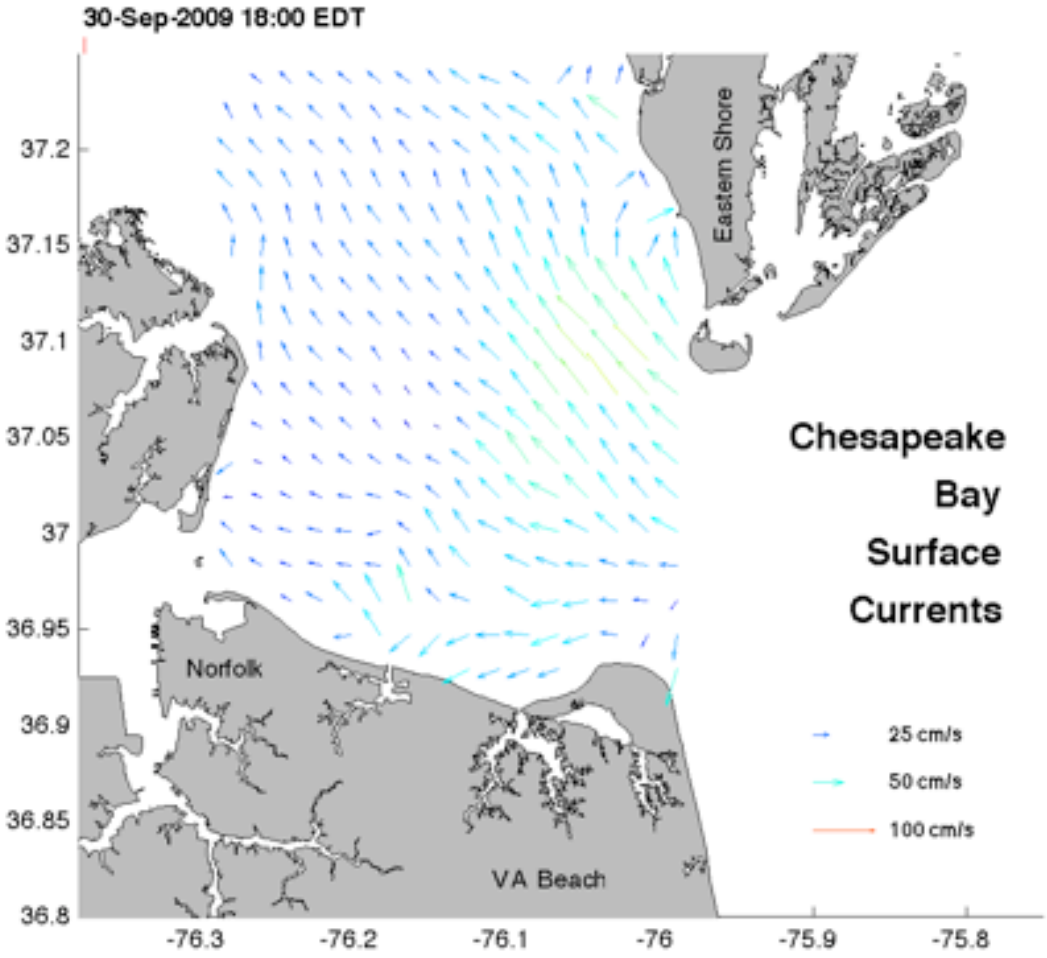
Land-based antennas

Use Doppler principles to observe surface velocities

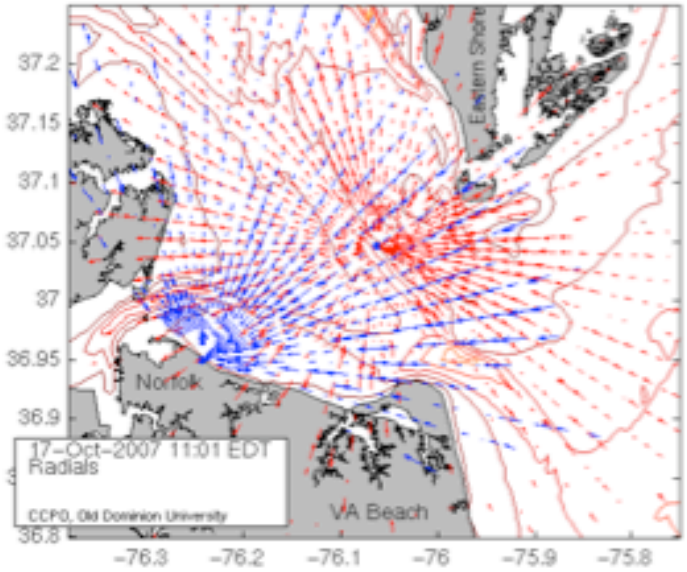
Sites normally set up to relay hourly output in near real-time.

Spatial coverage dependent on geometry / placement of antennas

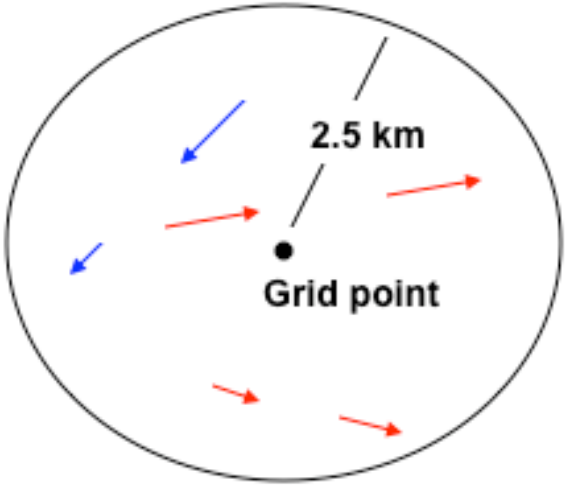
Ranges for single antennas:
Standard Range (25MHz): up to 40 km
Long Range (5MHz): up to 200 km


30-Sep-2009 18:00 EDT
Eastern Shore
Norfolk
VA Beach
Chesapeake
Bay
Surface
Currents
25 cm/s
50 cm/s
100 cm/s
37.2
37.15
37.1
37.05
37
36.95
36.9
36.85
36.8
-76.3
-76.2
-76.1
-76
-75.9
-75.8

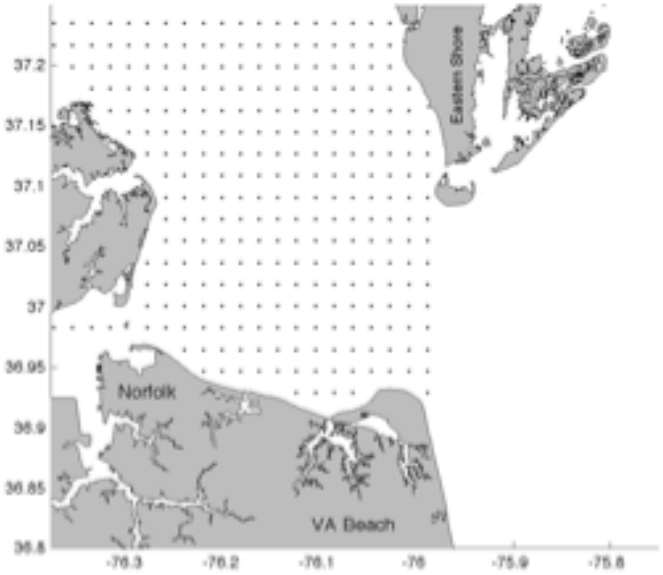
Radial Current Velocities



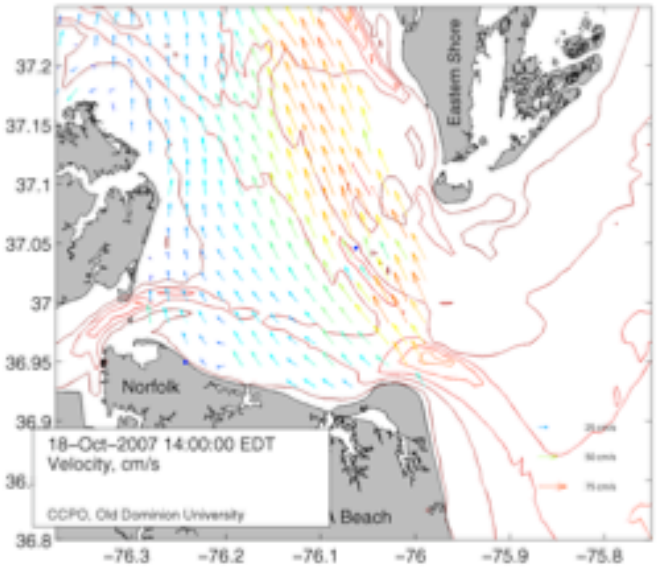
Around each grid point…
Combine Radial Vectors (Least Squares Average)



+ Grid



Total Current Velocities



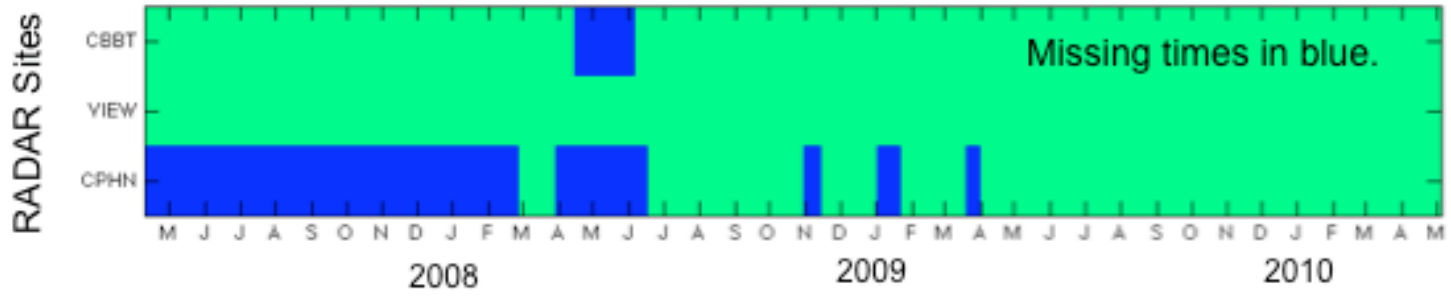
HF RADAR SITE LOCATIONS IN THE LOWER CHESAPEAKE

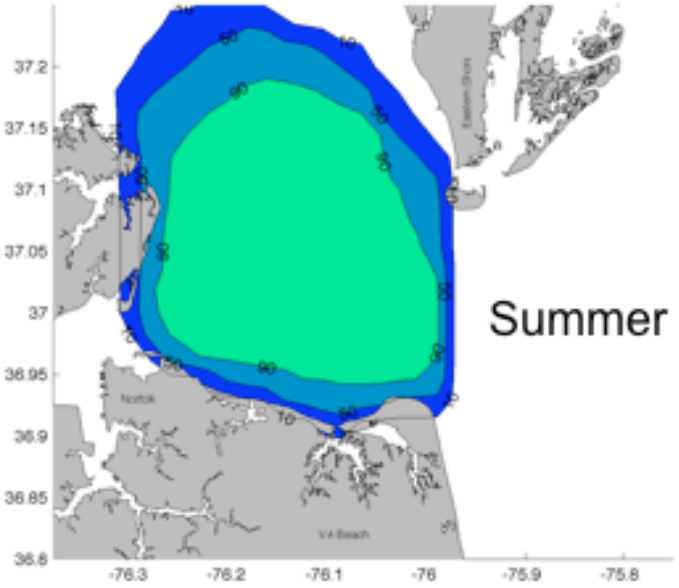
LOCAL FIELD SITES

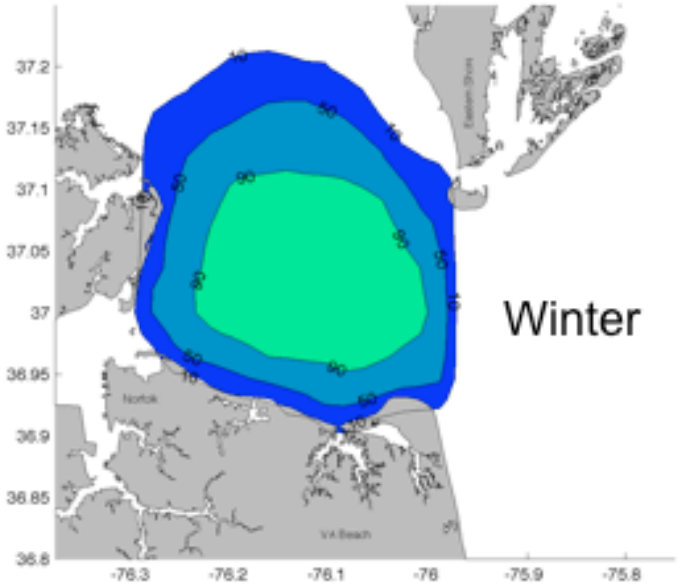
25.4 MHz CODAR Standard Range antennas with co-located Tx/Rx

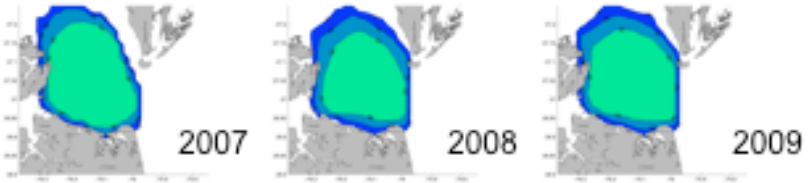
Cell phone modem connections

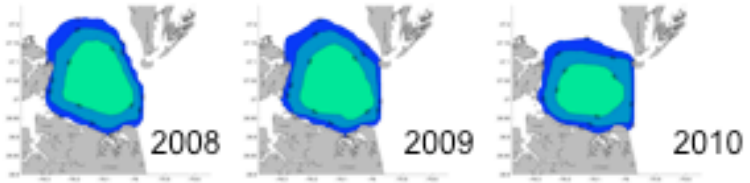
Chesapeake Bay Data Coverage





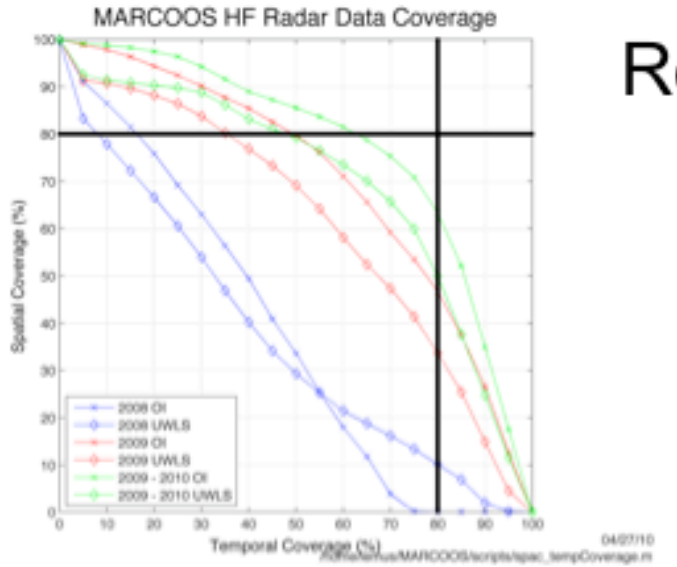


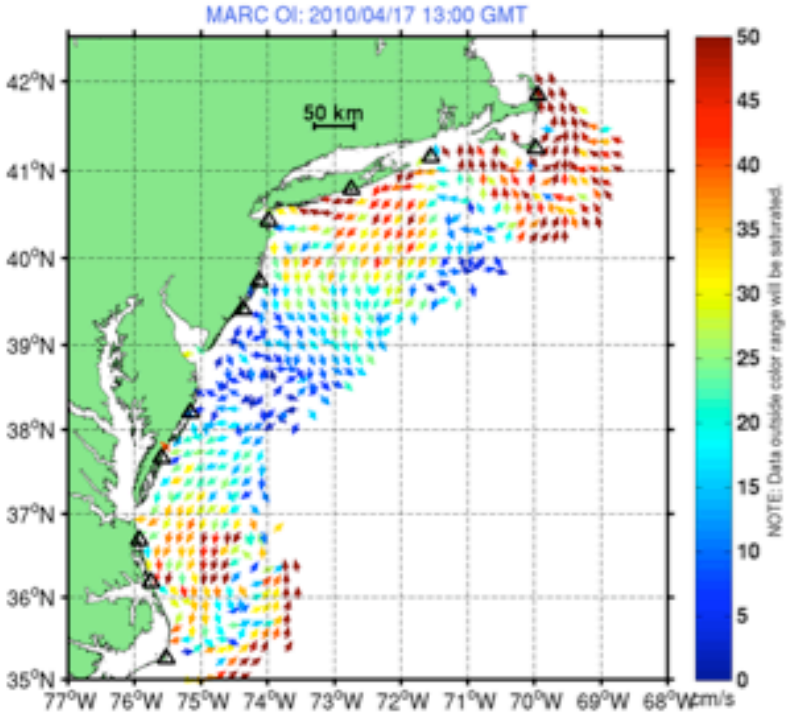




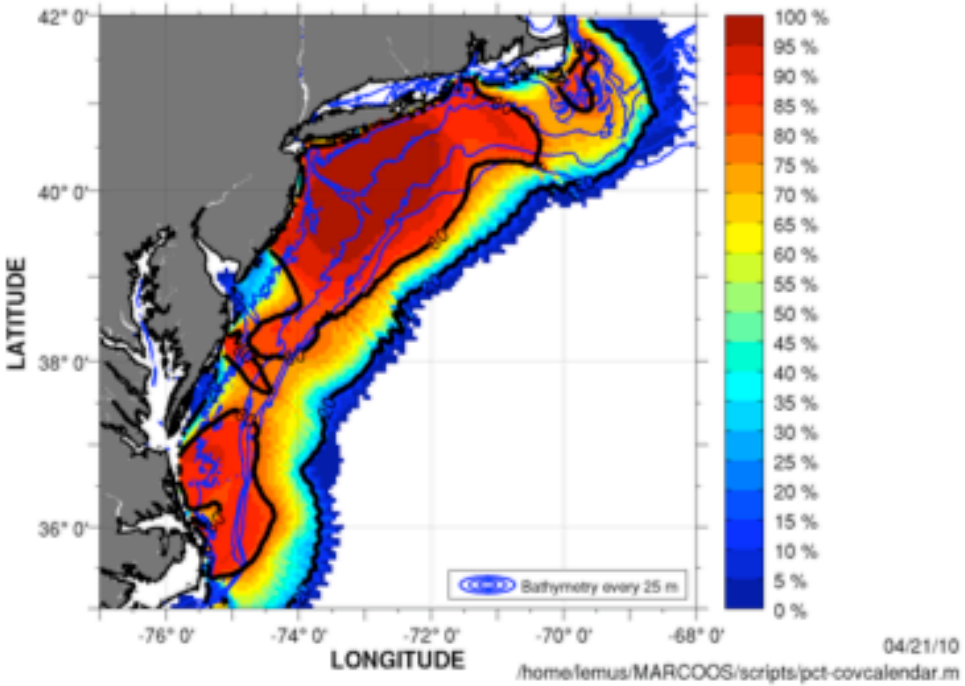
90% Coverage shown in green.

Regional Offshore Data Coverage





MACOORA HF Radar Network
OI Percent Coverage
Jan – Mar 2010

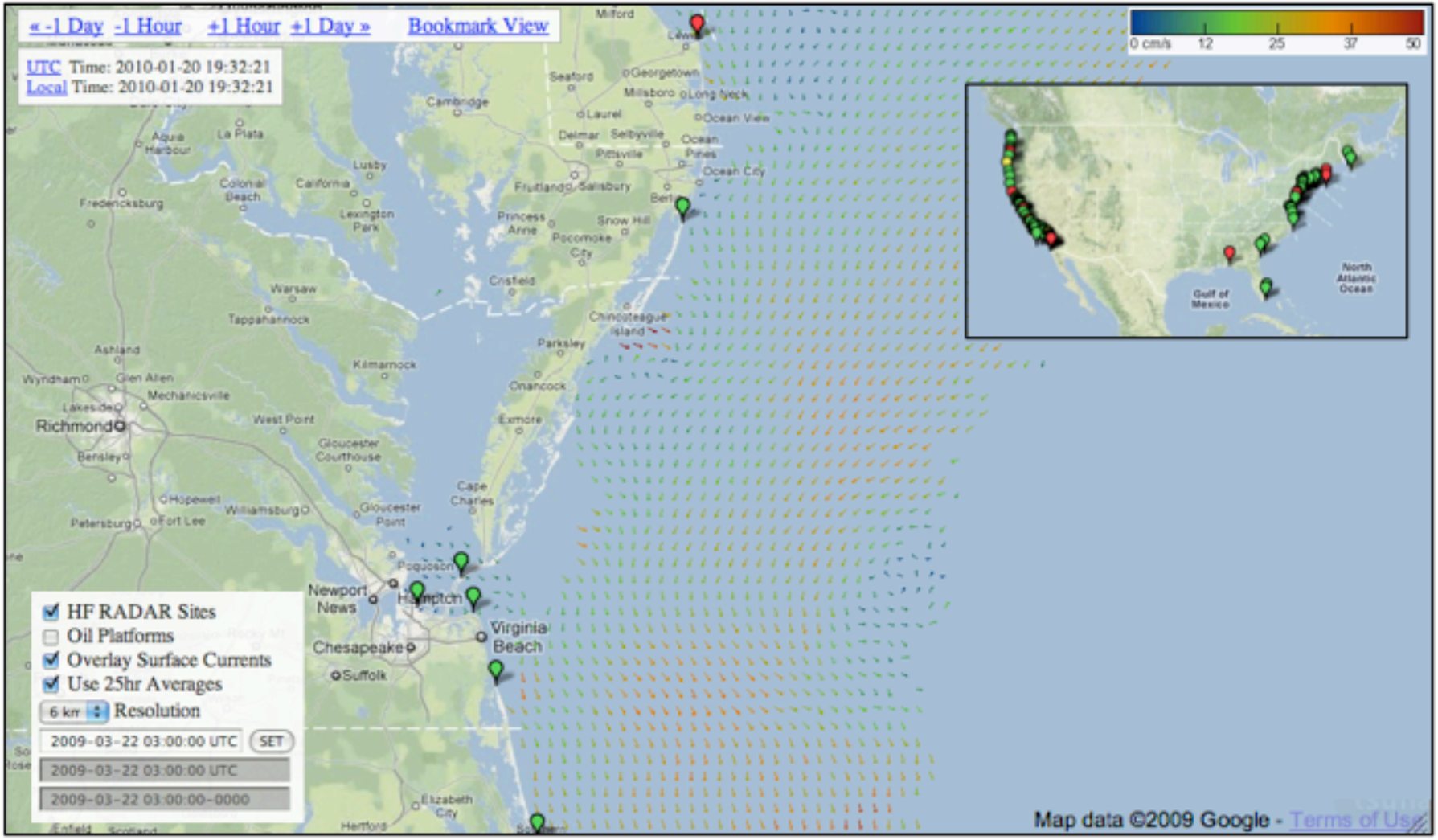


Rutgers University
Coastal Ocean Observation Lab
Institute of Marine and Coastal Sciences

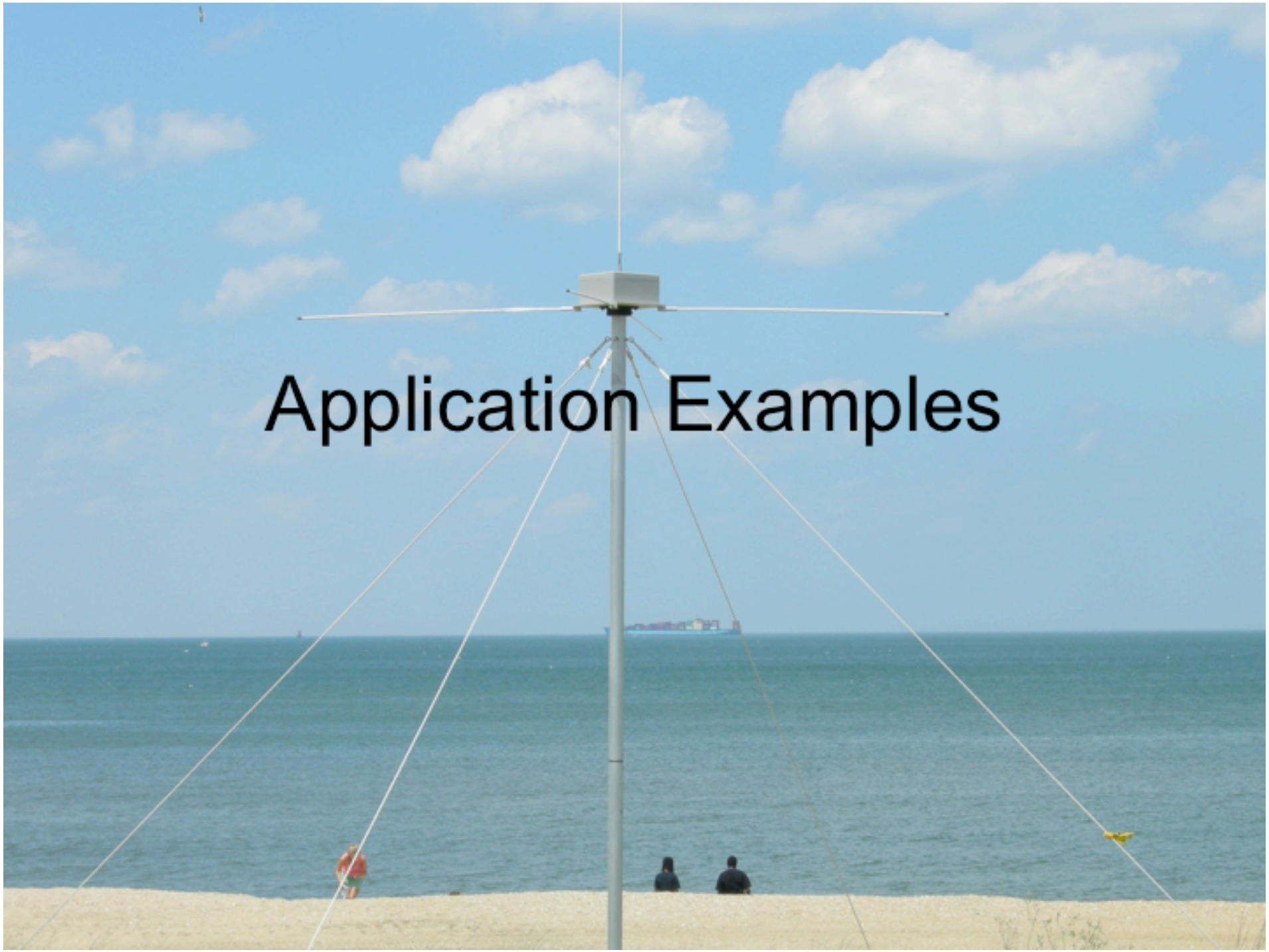
MACOORA
Mid-Atlantic Coastal Ocean Observing Regional Association

http://marine.rutgers.edu/~codaradm/hfr_viewer.php

HFRADAR National Network



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

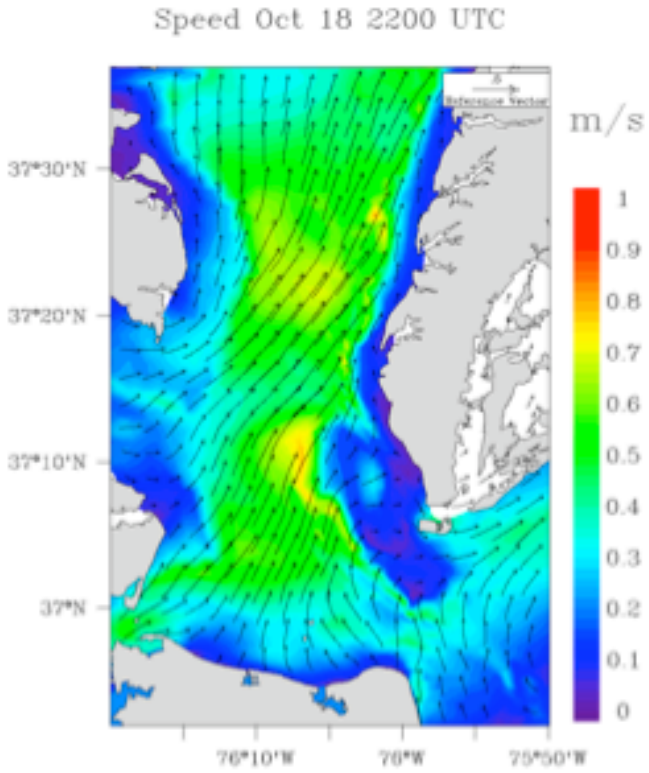

Application Examples

Modeling Applications

- Comparison of model output with current observations

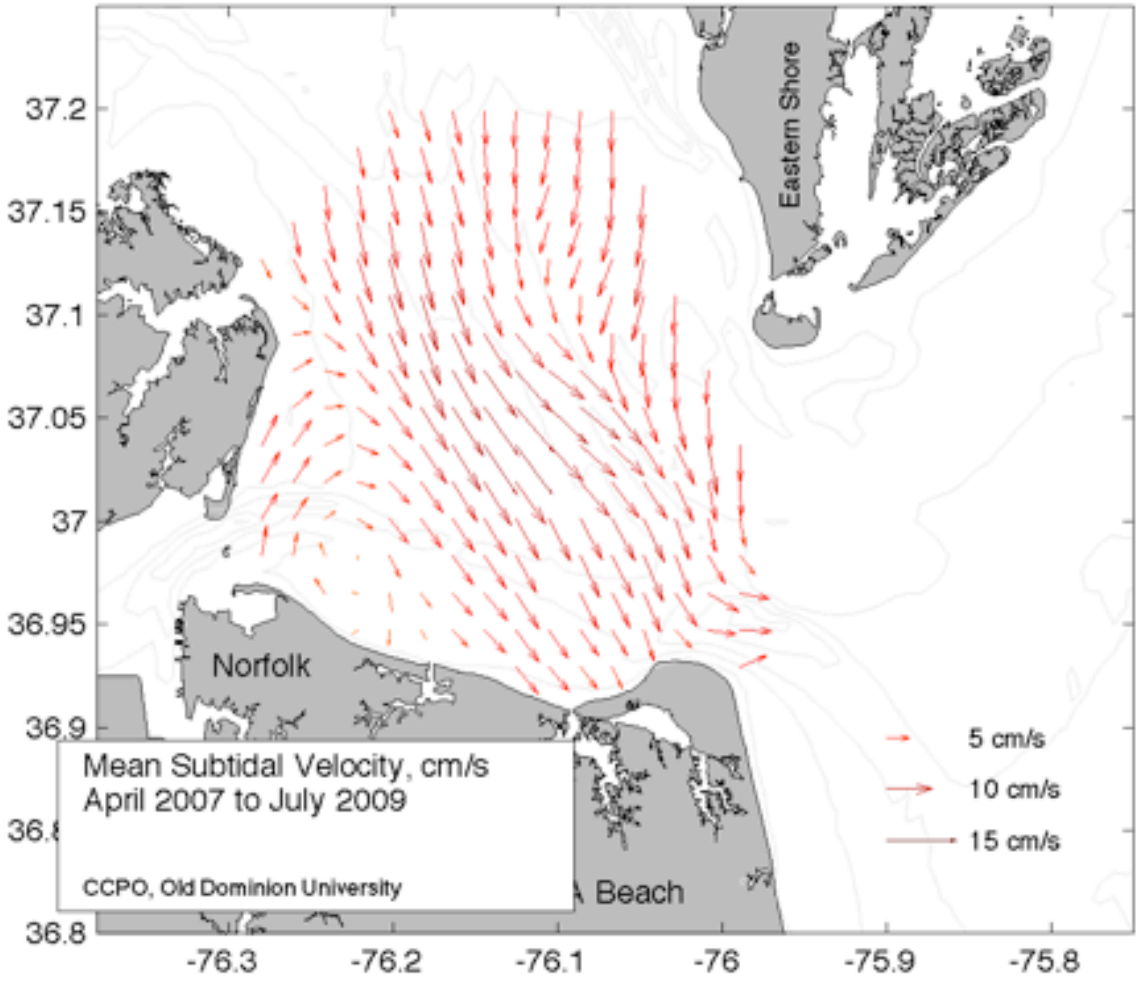
- Data Assimilation
  - Short Range HFRADAR data Steven Institute, NYHOPS
  - Long Range Totals

    Rutgers, ROMS

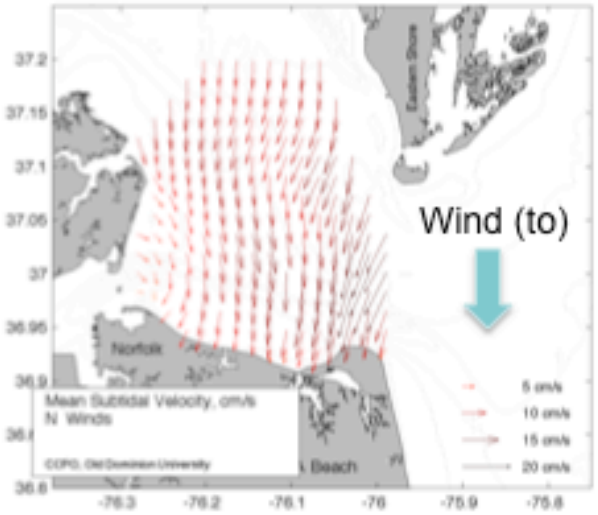


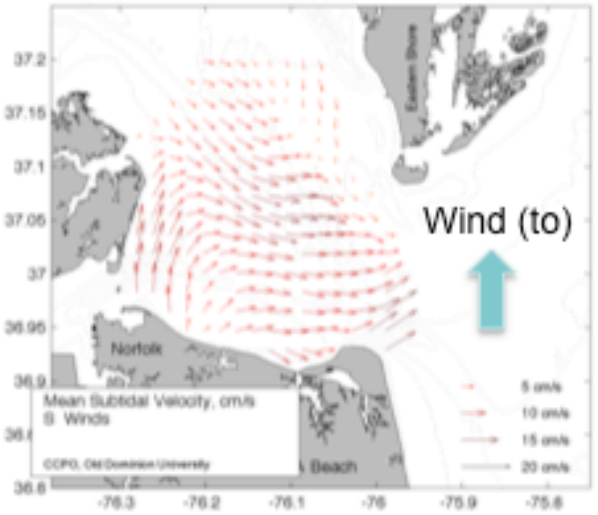
ChesROMS model output

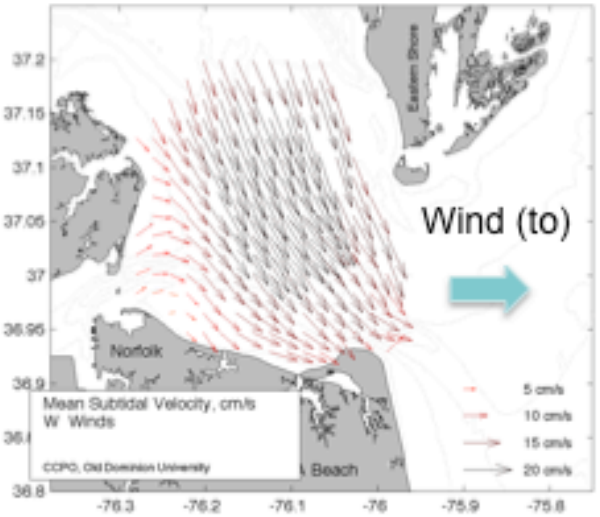
Mean Surface Circulation

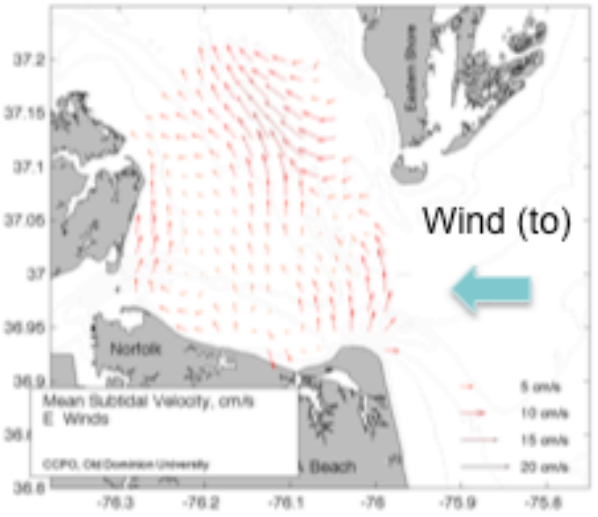


Wind Responses

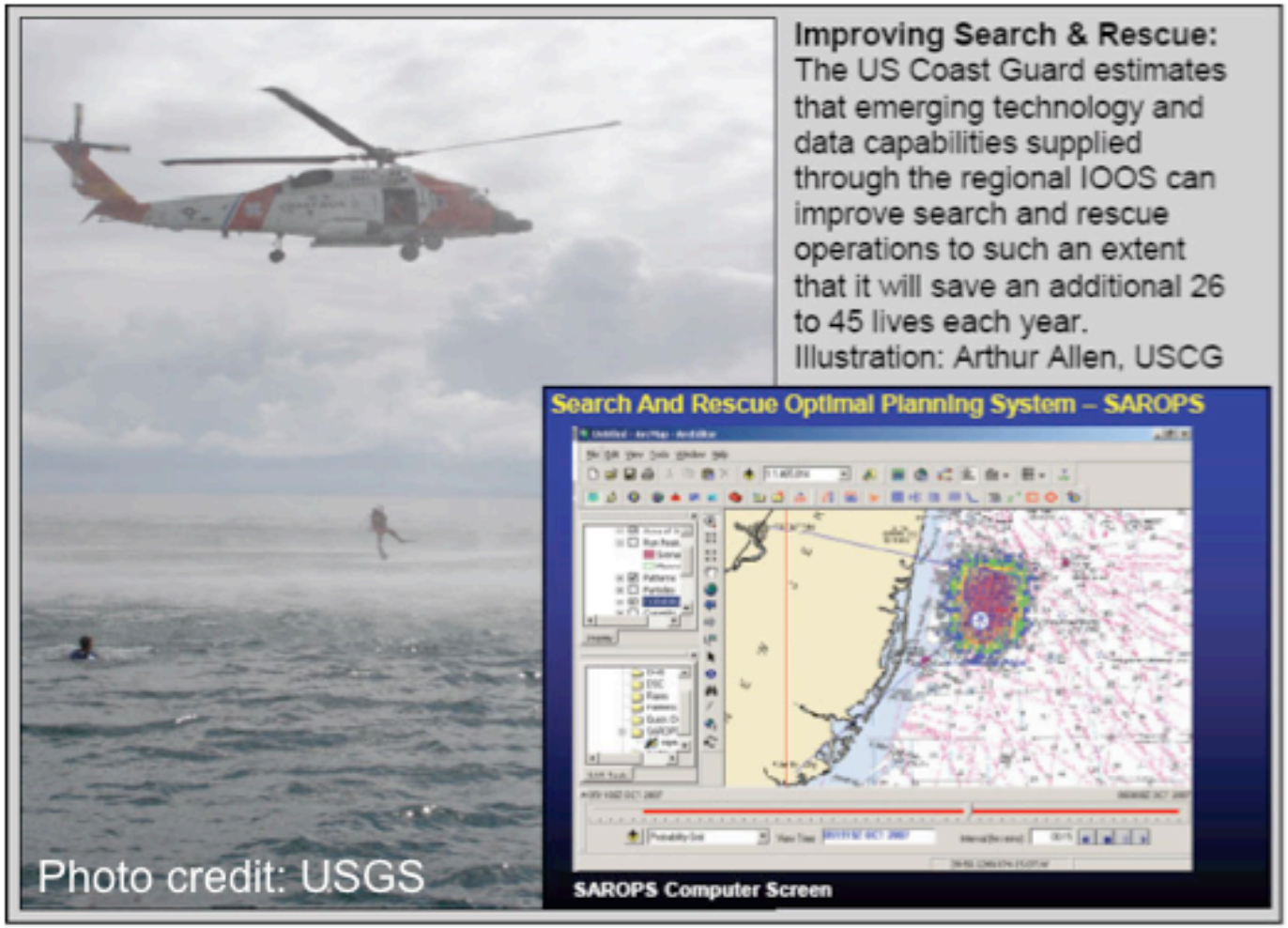








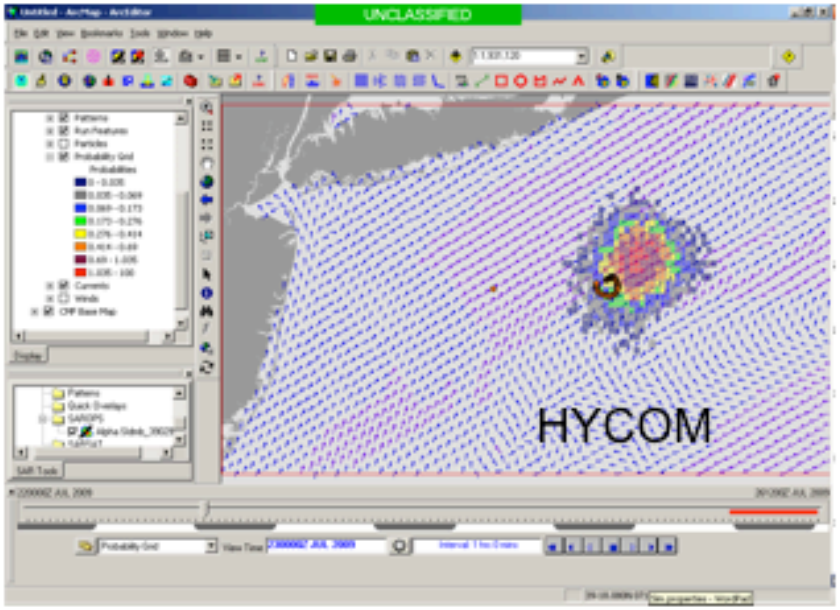
Coast Guard Search & Rescue

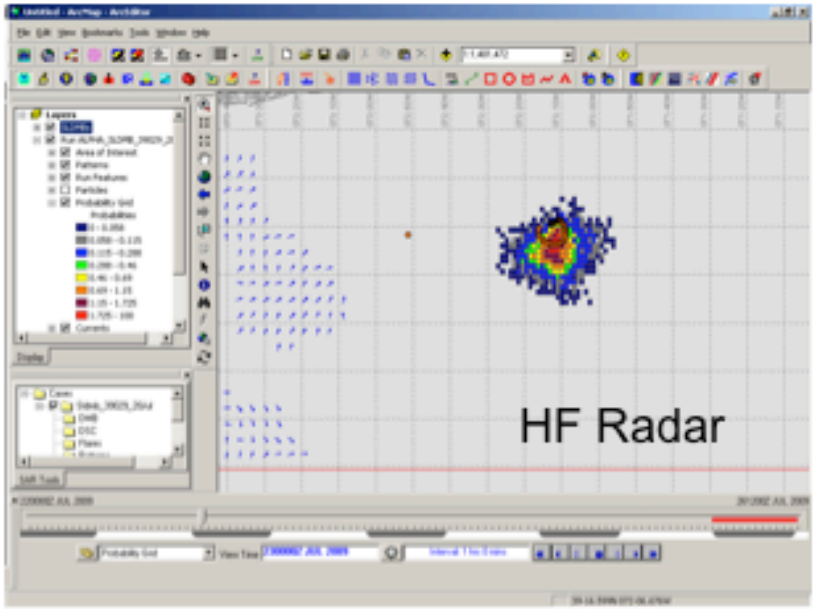


Improving Search & Rescue: The US Coast Guard estimates that emerging technology and data capabilities supplied through the regional IOOS can improve search and rescue operations to such an extent that it will save an additional 26 to 45 lives each year.
Illustration: Arthur Allen, USCG

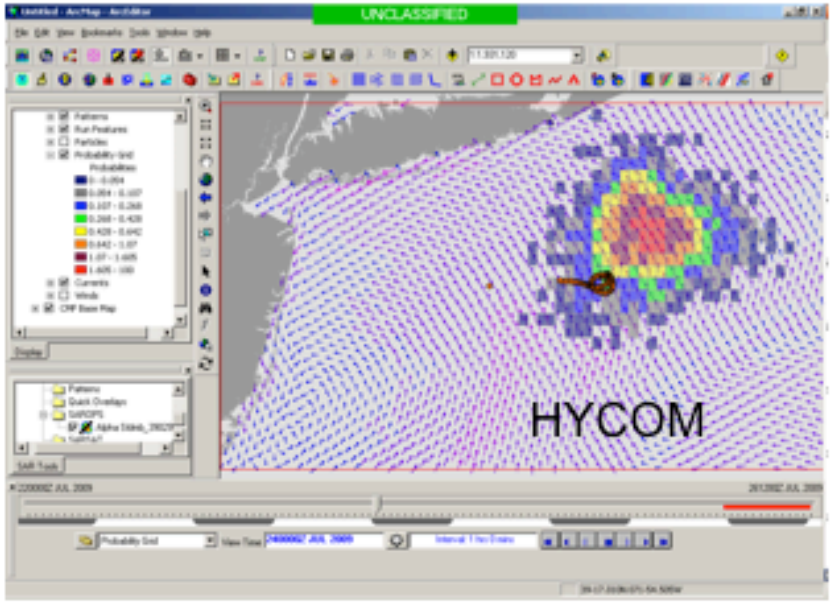
http://www.noaanews.noaa.gov/stories2009/20090504_ioss.html

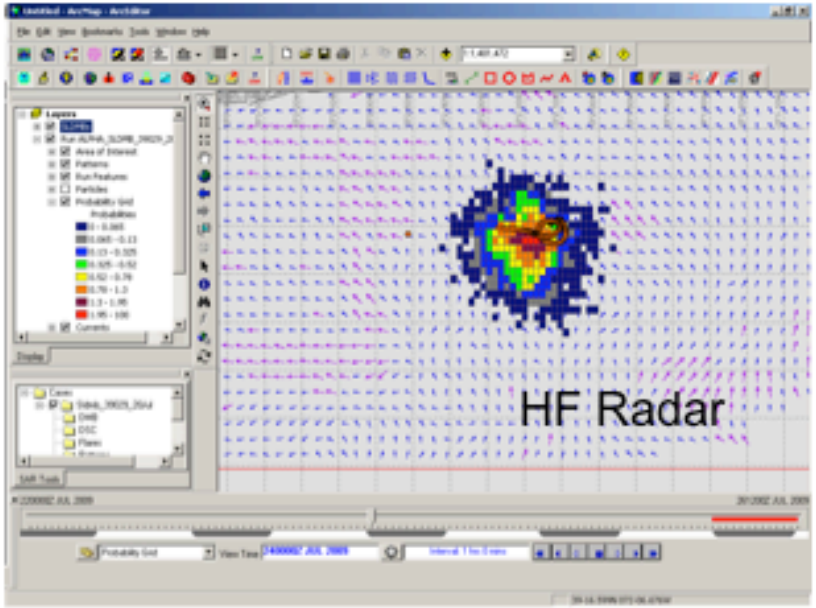
24 Hours Into Search



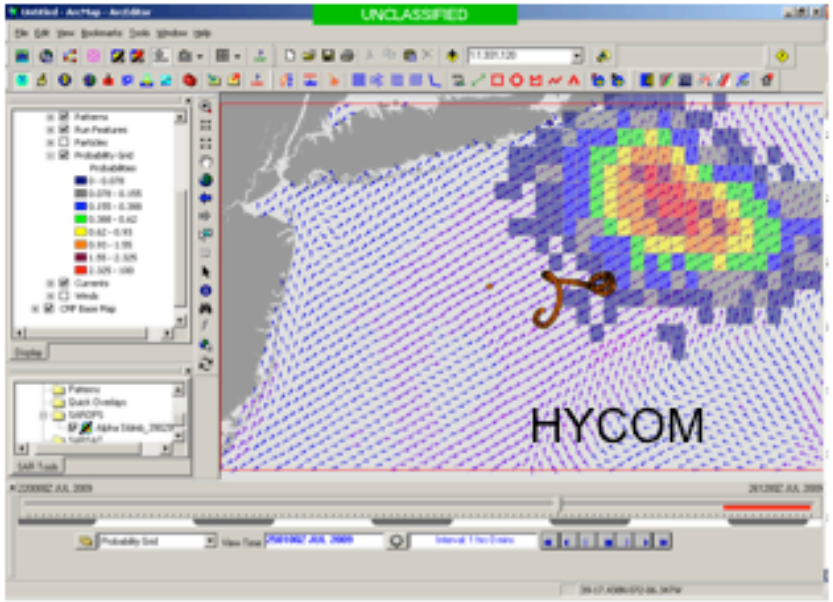


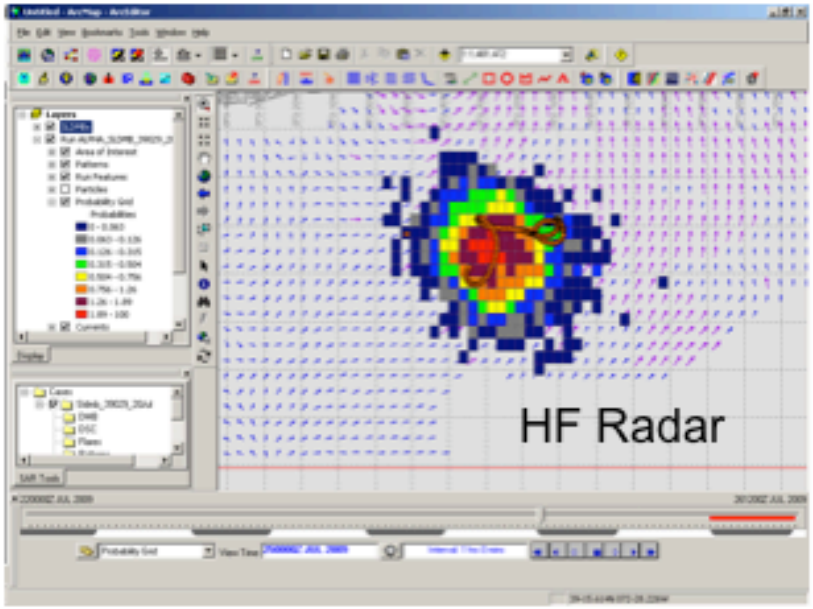
48 Hours Into Search



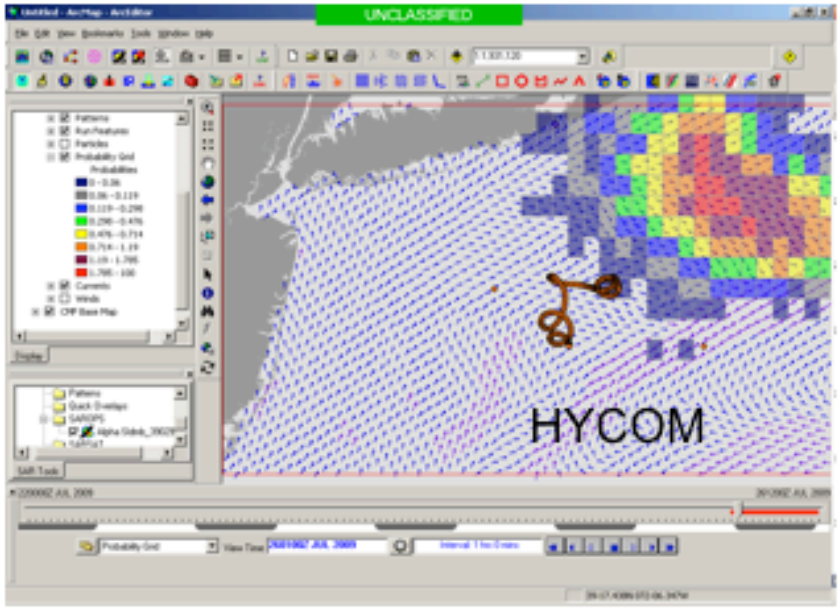


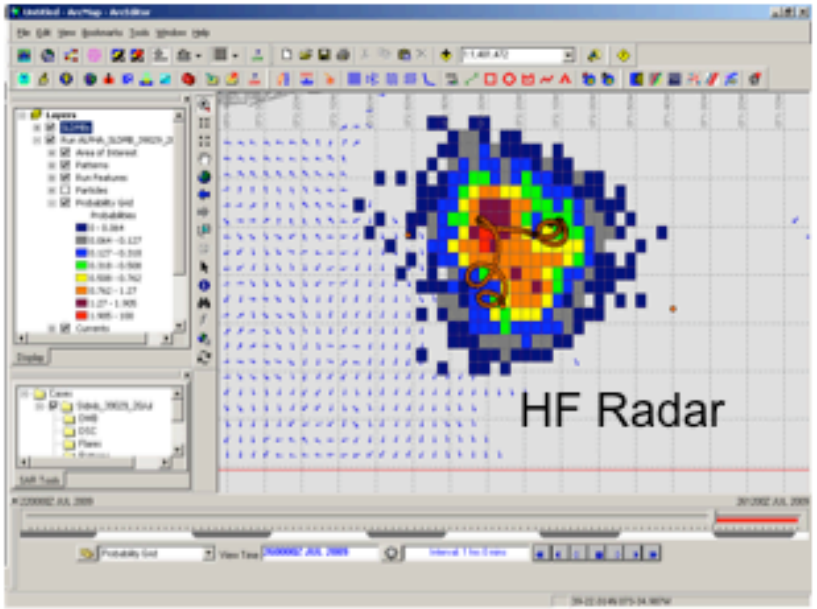
72 Hours Into Search





96 Hours Into Search



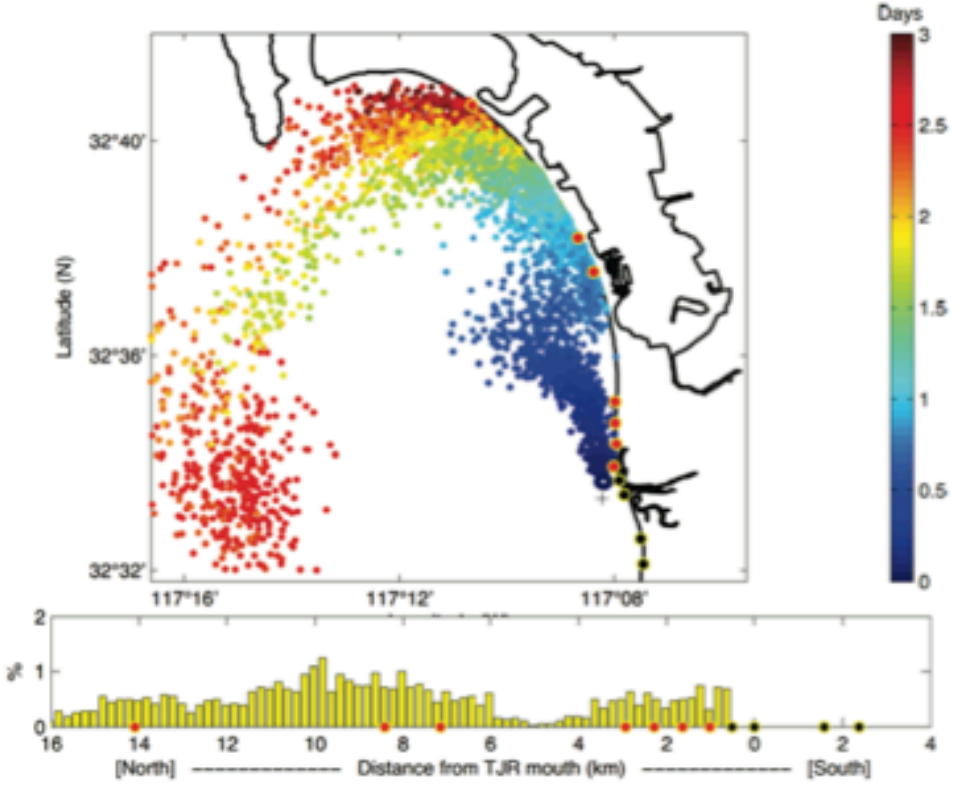


Water Quality Applications

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***



Sample of Publications

- Springer, S. R., R. M. Samelson, J. S. Allen, G. D. Egbert, A. L. Kurapov, R. N. Miller, and J. C. Kindle (2009), A nested grid model of the Oregon Coastal Transition Zone: Simulations and comparisons with observations during the 2001 upwelling season, J. Geophys. Res., 114, C02010, doi:10.1029/2008JC004863.
- 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, Hoboken, NJ
- Barth, A., A. Alvera-Azcarate, and R. H. Weisberg (2008), Assimilation of high-frequency radar currents in a nested model of the West Florida Shelf, J. Geophys. Res., 113, C08033, doi: 10.1029/2007JC004585.
- Barth, A., A. Alvera-Azcarate, and R.H. Weisberg (2008), Benefit of nesting a regional model into a large-scale ocean model instead of climatology. Application to the West Florida Shelf, Continental Shelf Research, vol.28, pp.561-573.
- Wilkin, J. L., H. G. Arango, D. B. Haidvogel, C. S. Lichtenwalner, S. M. Glenn, and K. S. Hedstrom (2005), A regional ocean modeling system for the Long-term Ecosystem Observatory, J. Geophys. Res., 110, C06S91, doi:10.1029/2003JC002218.
- Paduan, J., Shulman, I., "HF radar data assimilation in the Monterey Bay area", J. Geophys. Res., vol. 109, no. CO7S09, doi: 10.1029/2003JC001949, 2004.
- Erofeeva, S. Y., G. D. Egbert, and P. M. Kosro, Tidal currents on the central Oregon shelf: Models, data, and assimilation, J. Geophys. Res., 108(C5), 3148, doi:10.1029/2002JC001615, 2003.
- Kurapov, Alexander L., et al, The M2 Internal Tide off Oregon: Inferences from Data Assimilation, Journal of Physical Oceanography, August 2003, vol. 33, pp. 1733-1757.

* All of these are available at http://www.codar.com

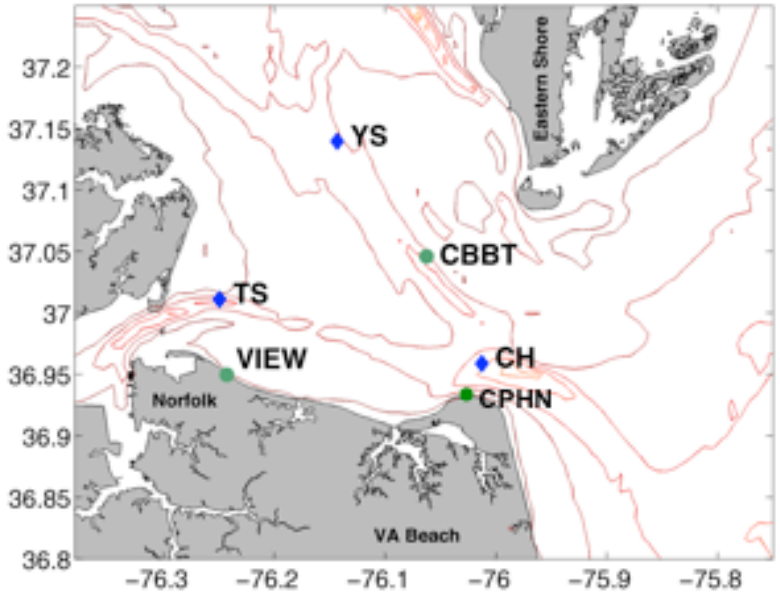

Data Quality

Data Validation

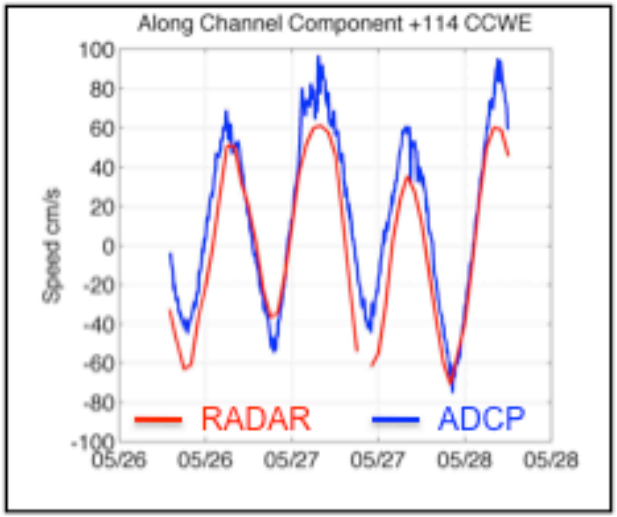
- Baseline (consistency between antennas)
- Tidal analysis
- ADCP Comparisons
  - Real-time using NOAA PORTS data
  - City of Norfolk mooring off of Ocean View beach

Photo Source: NOAA OSTEP report

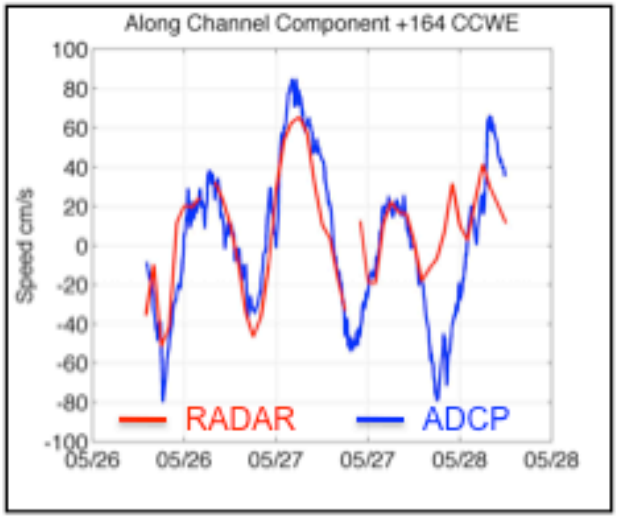
Comparisons with NOAA PORTS Doppler Current Profilers



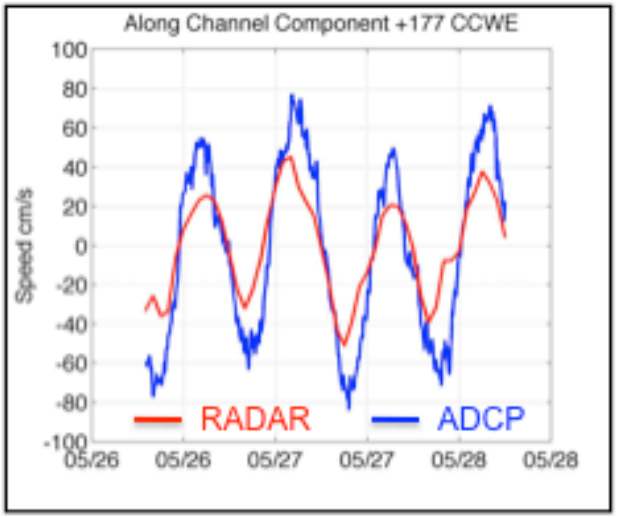
York Spit (YS)



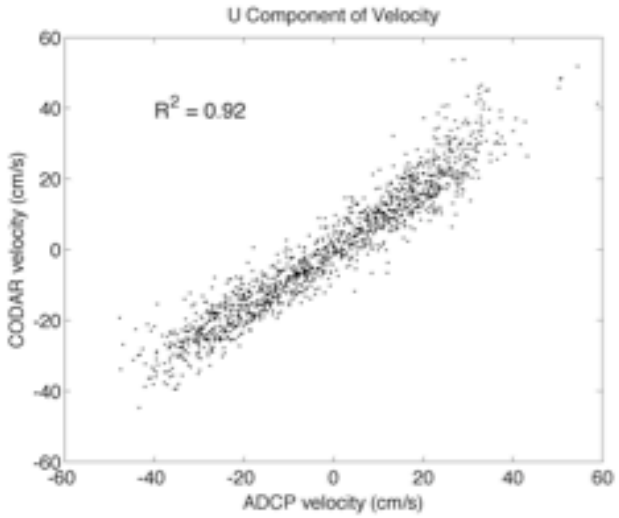
Cape Henry (CH)

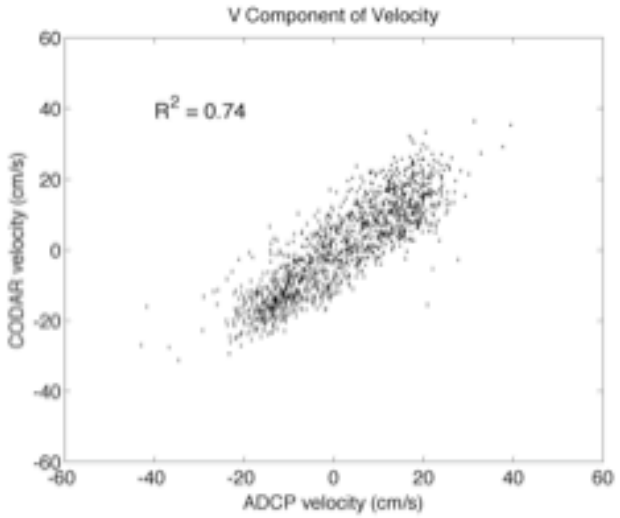


Thimble Shoals (TS)



Comparisons with AWAC Current Profile Data





Scatter plots of ADCP data versus CODAR data for U and V velocity components during AWAC deployment 7 (Nov 13 2007 19:00 - Mar 7 2008 12:00 UTC).

Deployment	**5**	**7**	**8**	**9**
Start Date	3/9/07	11/13/07	3/12/08	7/8/08
End Date	7/6/07	3/7/08	7/7/08	11/7/08
Npoints	1606	1345	659	2727
Mean (U)	-4.64	-1.04	-5.84	-5.01
Mean (V)	-0.29	1.21	-0.7	3.65
RMS (U)	10.57	6.19	13.09	11.74
RMS (V)	9.3	6.93	10.74	11.35

Mean and root-mean-square statistics for the difference in velocity between the Doppler profiler and CODAR in U and V components for four deployment periods.

Data Access

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

HFRADAR surface current data in the lower Chesapeake Bay (April 2007-present) are available through ODU and the data may be transferred in a variety of formats (i.e. text, MAT files, NetCDF).

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

National data including the lower Chesapeake Bay 2km grid are available via Thredds server in NetCDF format (OPENDAP,WCS,NetcdfSubset,WMS) :

http://hfrnet.ucsd.edu:8080/thredds/catalog.html

Regional offshore OI (optimal interpolated) data are also available via Thredds server in NetCDF format (OPENDAP) :

http://tashtego.marine.rutgers.edu:8080/thredds/cool/codar/cat_totals.html?dataset=macoora6km_codar

HFRADAR @ Old Dominion University

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

Quick Links to Most Recent Data

CBBT 1st Island 2nd Island 3rd Island 4th Island

A 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.

Ongoing & Future Work

- Collaborate with modelers to improve forecasting capabilities for various applications
- Continue QA/QC efforts
- Outreach to local groups
- Product development
- And?? We are open to input from the community!

Acknowledgements

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