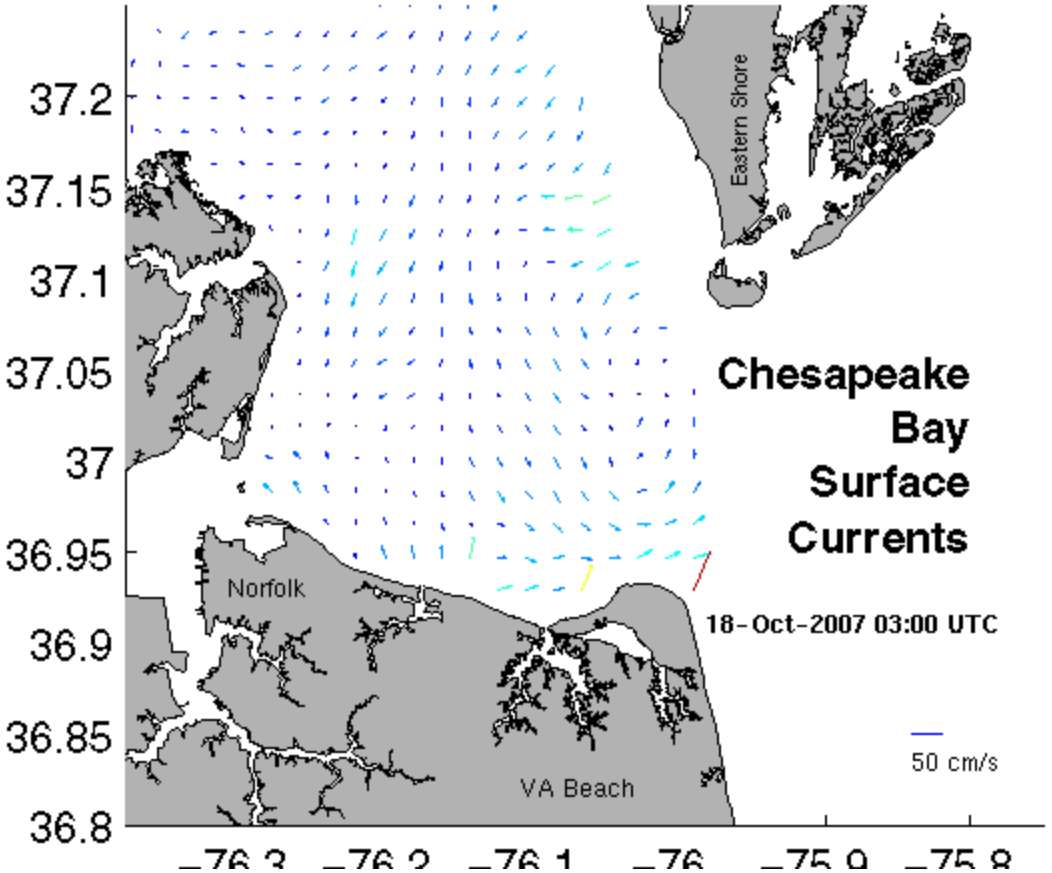
Surface Current Mapping with High Frequency RADAR

CODAR OCEAN SENSORS



CENTER FOR COASTAL PHYSICAL OCEANOGRAPHY
OLD DOMINION UNIVERSITY

MACOORA
Mid-Atlantic Coastal Ocean Observing Regional Association

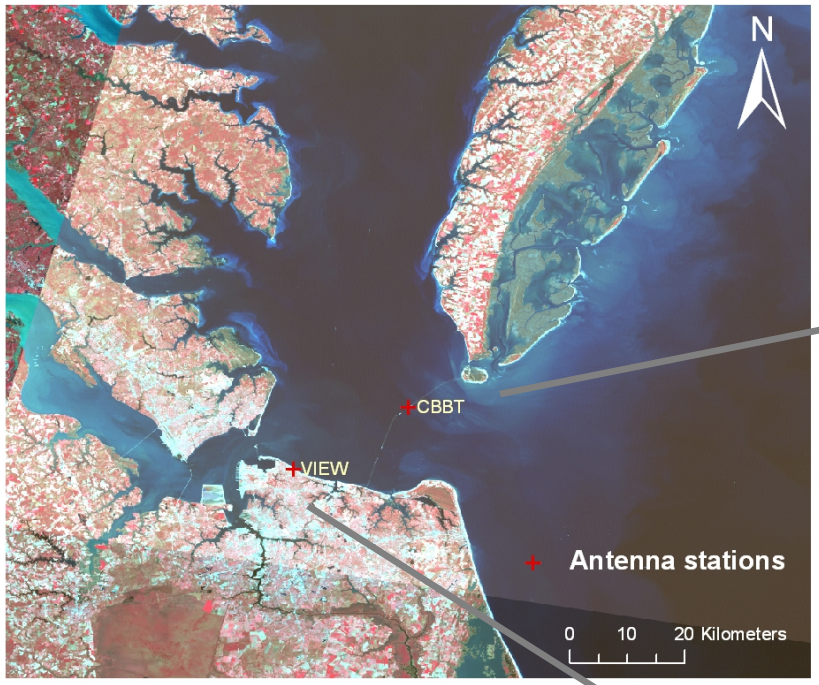
NOAA

CIT
CENTER FOR INNOVATIVE TECHNOLOGY

Applications

- Search and rescue
- Navigation
- Pollution tracking (Oil spills, red tides, …)
- Sediment transport
- Fishing & Recreational boating
- Assimilation into numerical circulation models to improve nowcast/forecast capabilities

Study Area & Antenna Sites



Source: U.S. Geological Survey
(www.seamless.usgs.gov/viewer)

Source: http://www.cbbt.com/

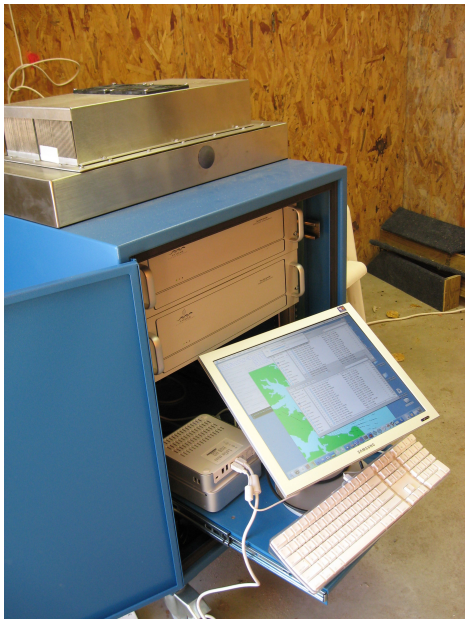
AT OUR FIELD SITES

25.4 MHz CODAR Standard Range

Antennas with co-located Tx/Rx

MiniMac Field Computers

Cell phone/Cable modem connections



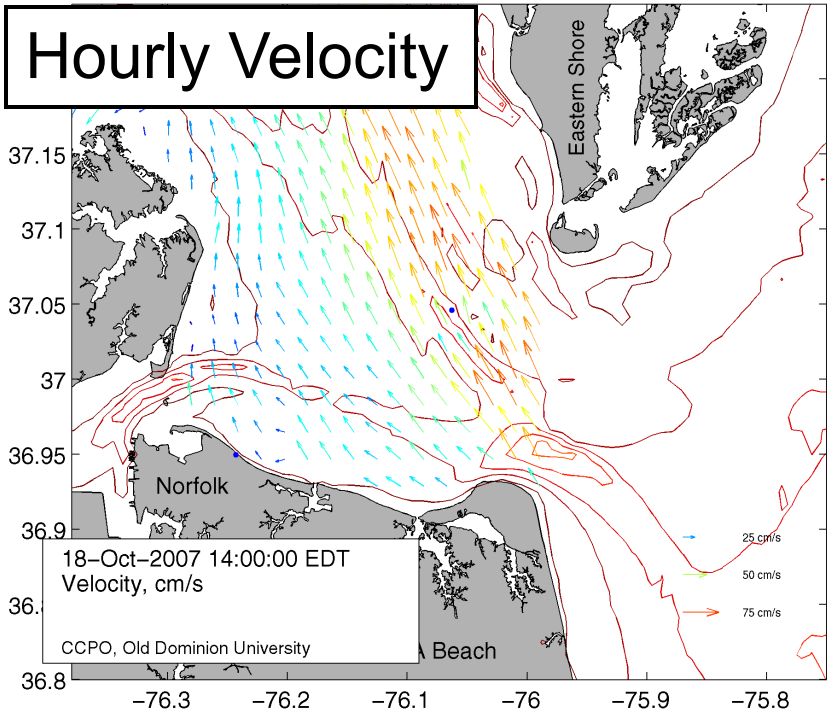
Operating Costs

- 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: Pattern measurements

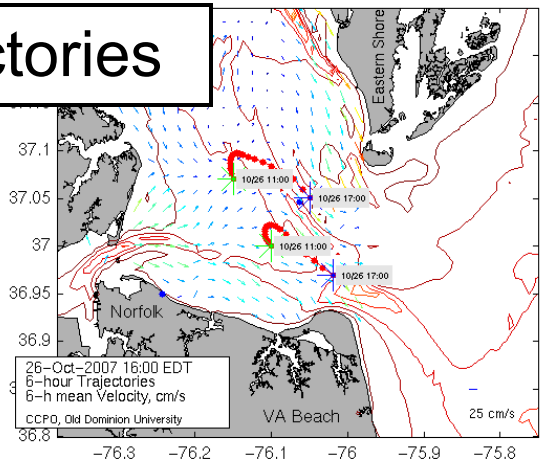
Data Products Updated Hourly

(http://www.lions.odu.edu/org/cbc)

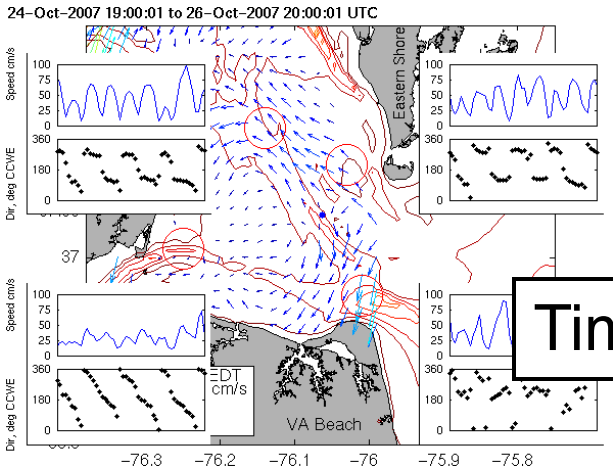
Hourly Velocity



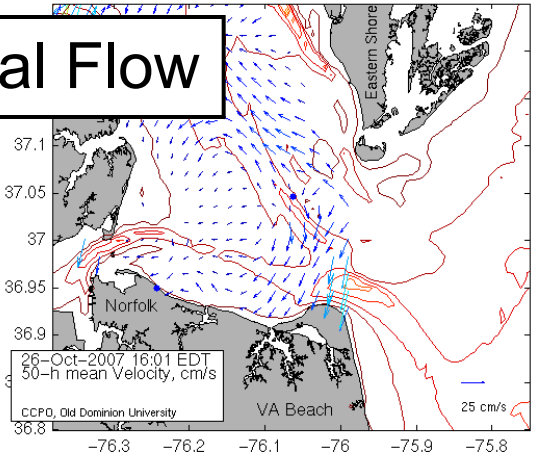
Trajectories



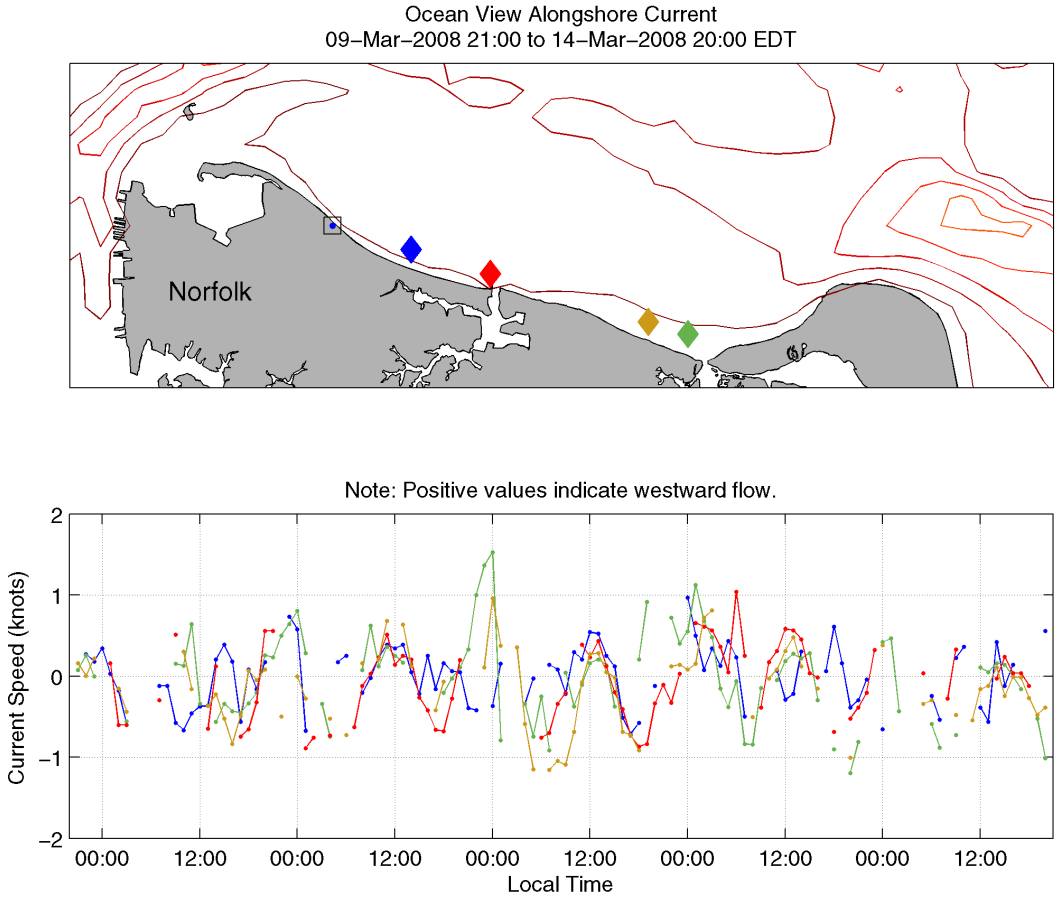
Time Series



Sub-tidal Flow



Ocean View Alongshore Currents



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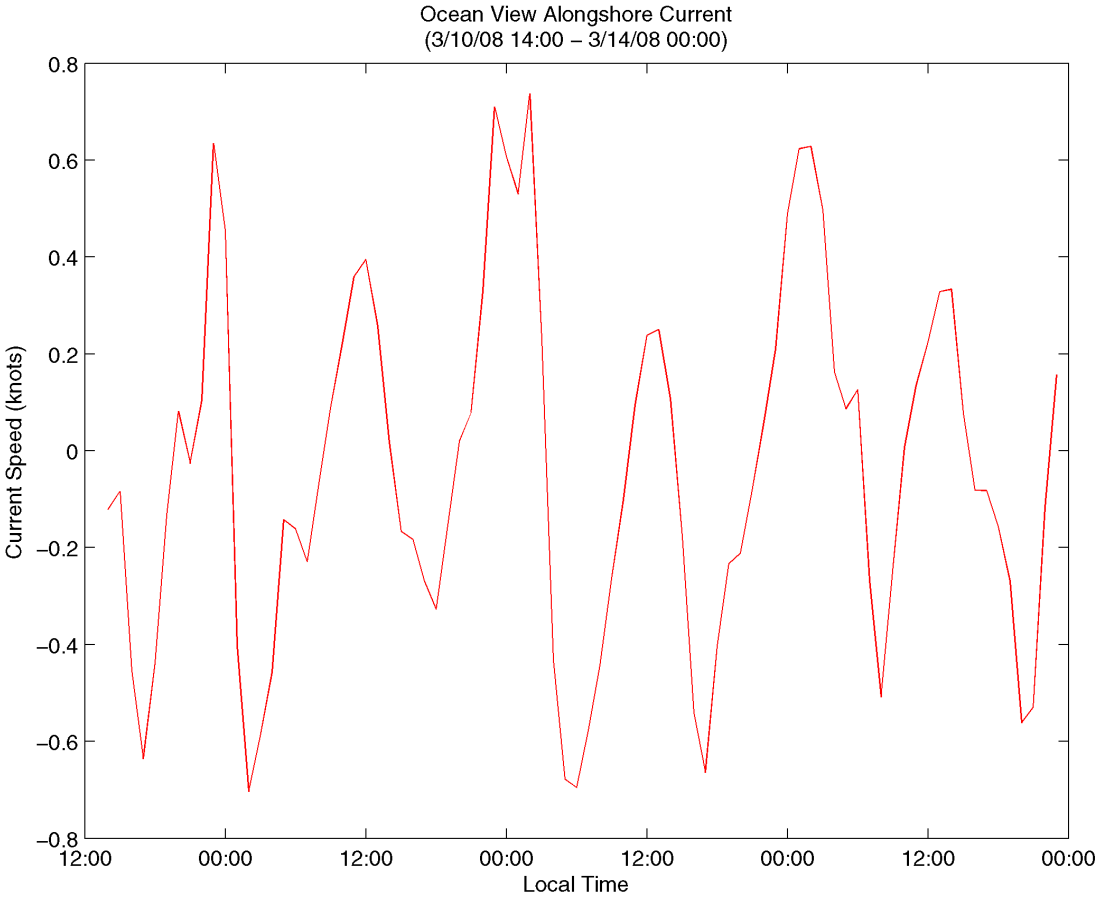
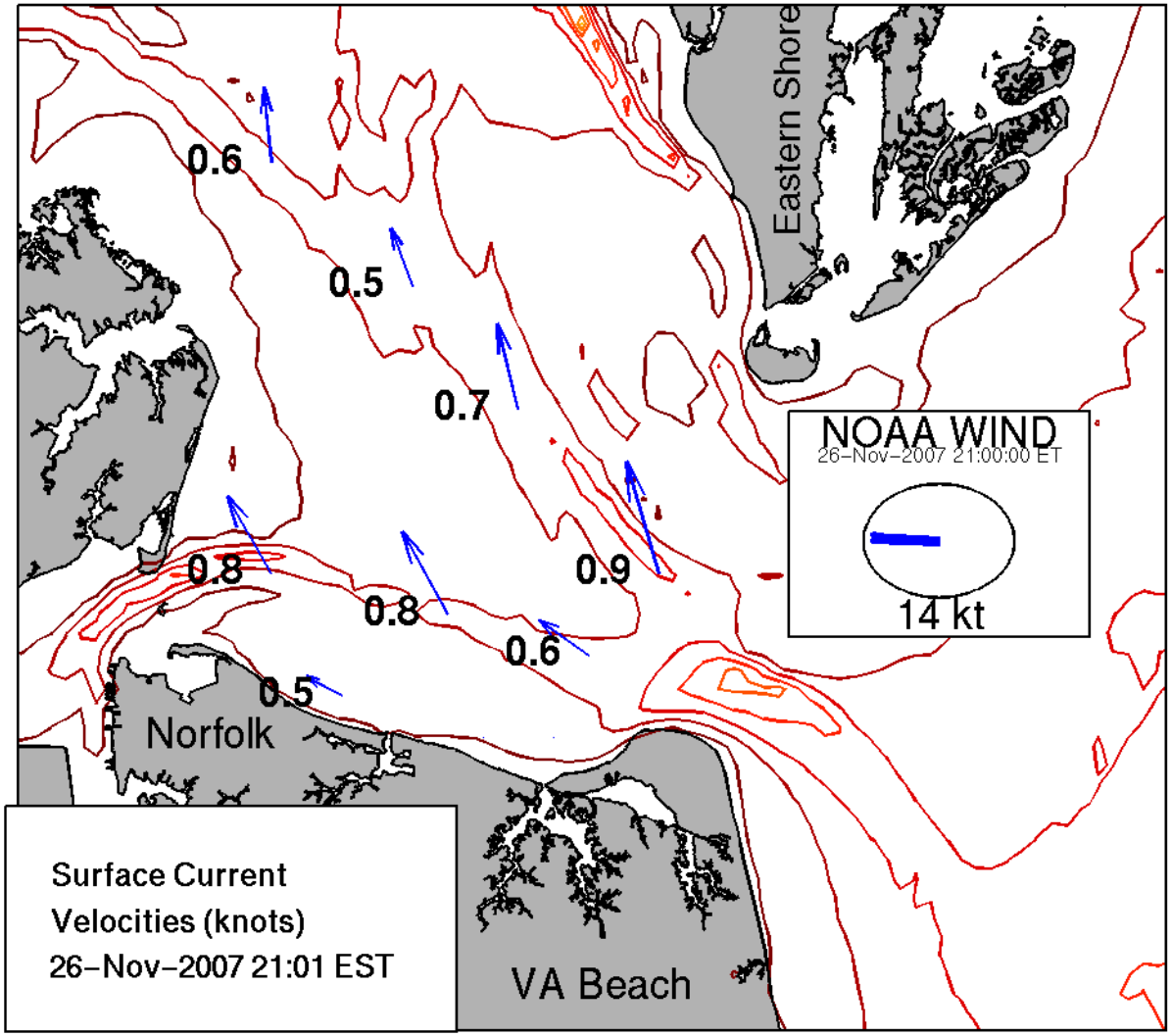
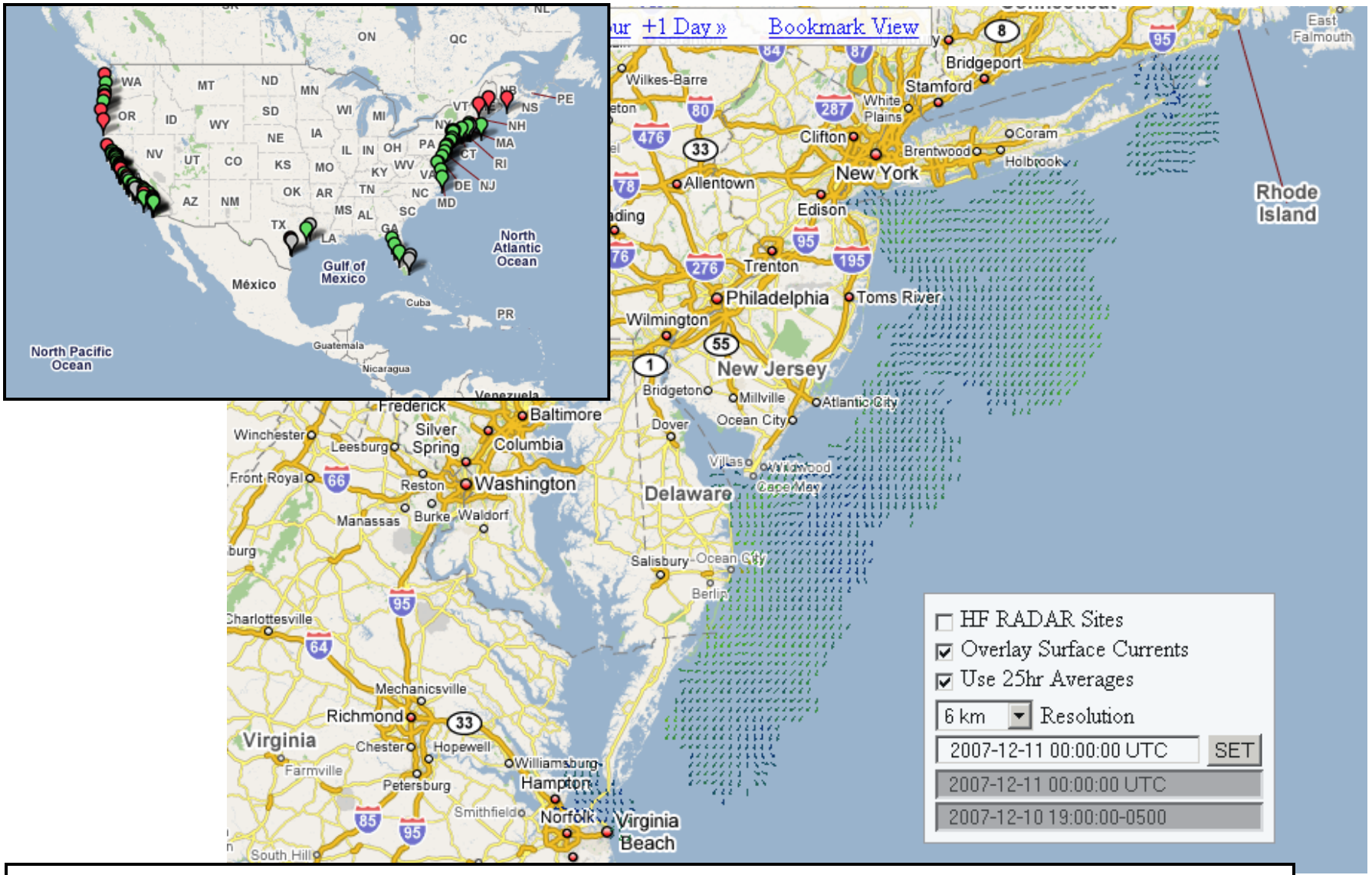


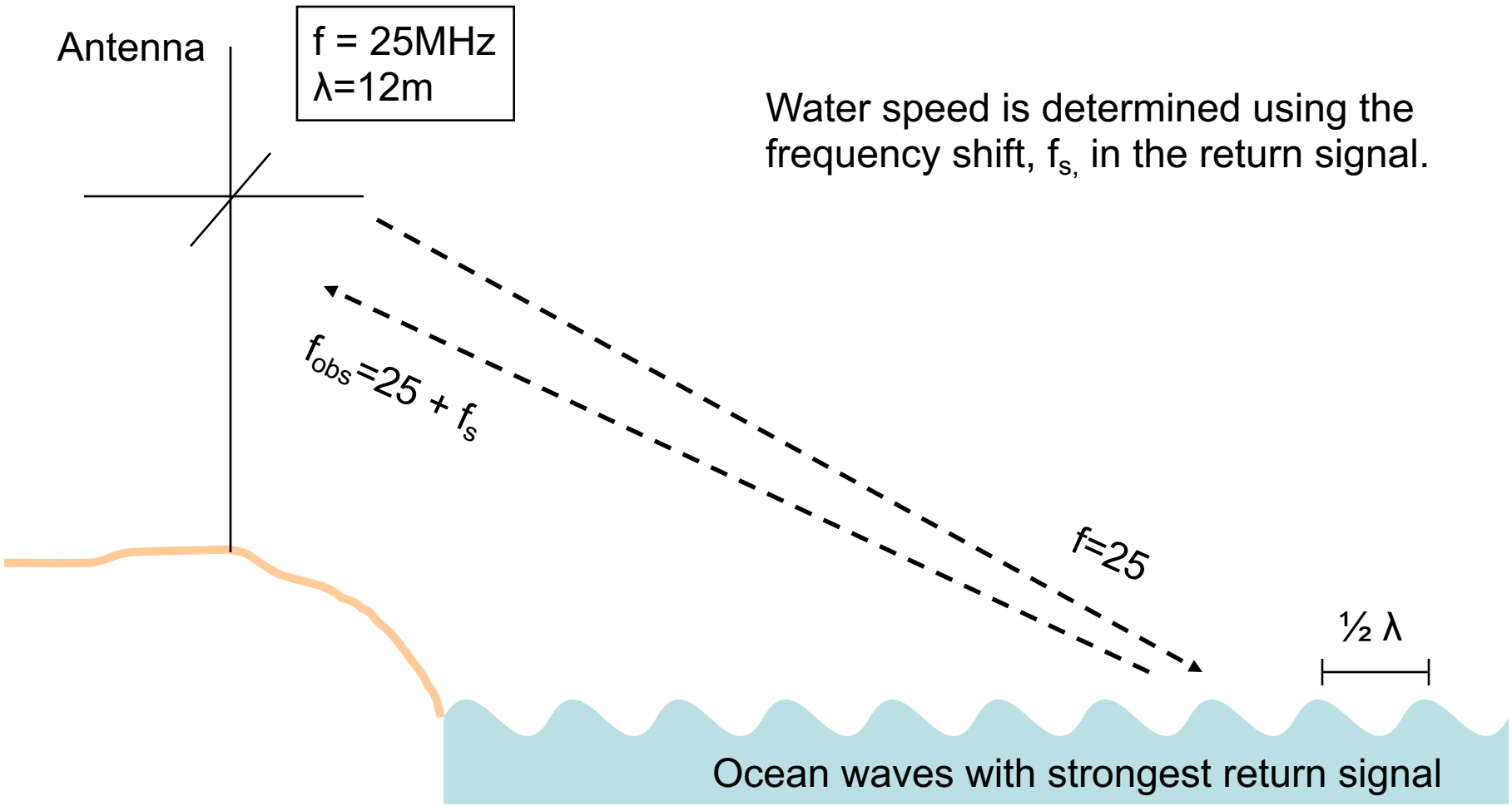
Shipping Channels



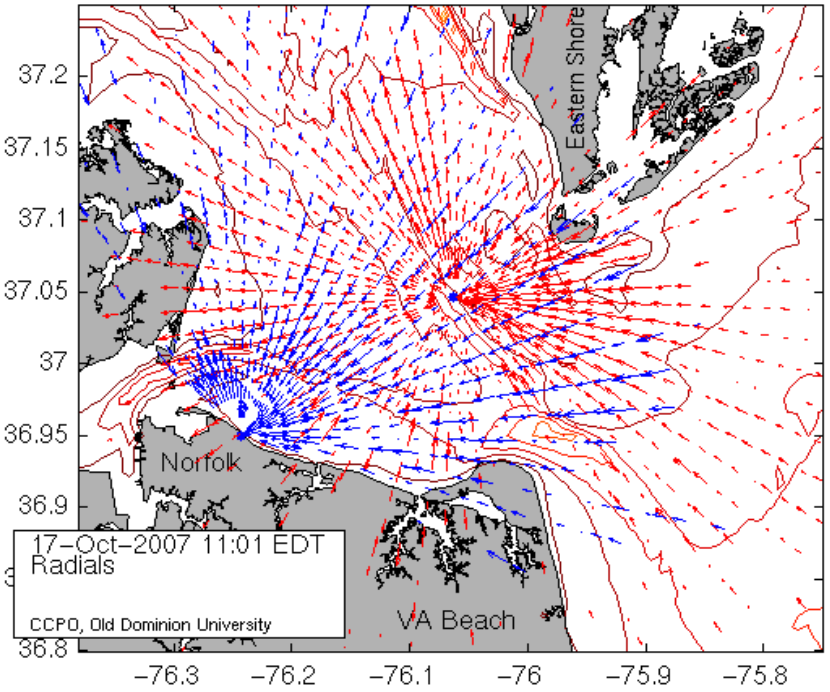
HF RADAR National Network



UCSD, Scripps Institute http://cordc.ucsd.edu/projects/mapping/maps


Antenna
f = 25MHz
λ=12m
Water speed is determined using the frequency shift, f_s, in the return signal.
$f_{obs}=25+f_s$
f=25
½ λ
Ocean waves with strongest return signal

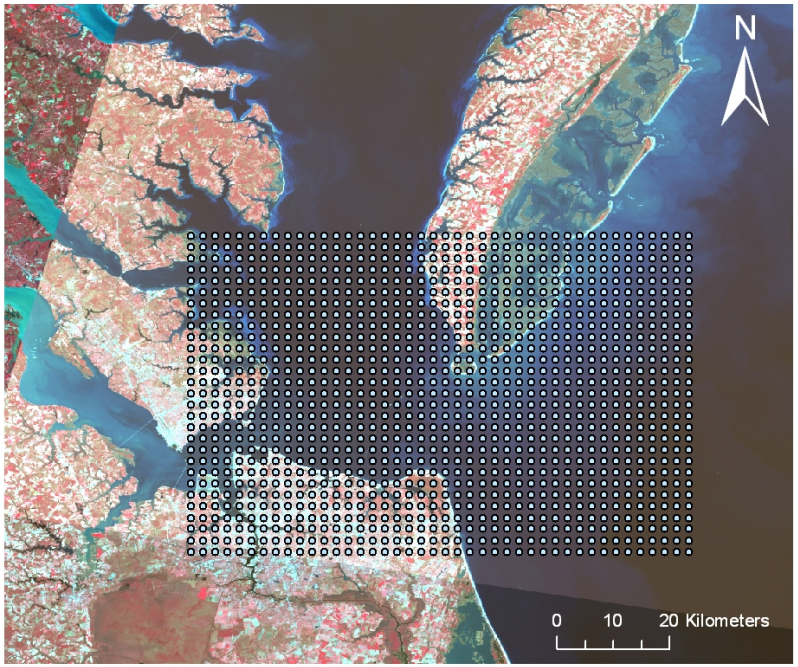
Radial Current Velocities…



A single antenna measures only one component of the water velocity, the speed of the water moving directly towards or away from it.

Radial vectors are output in range bins of 1.5 km and directional bins of 5 degrees.

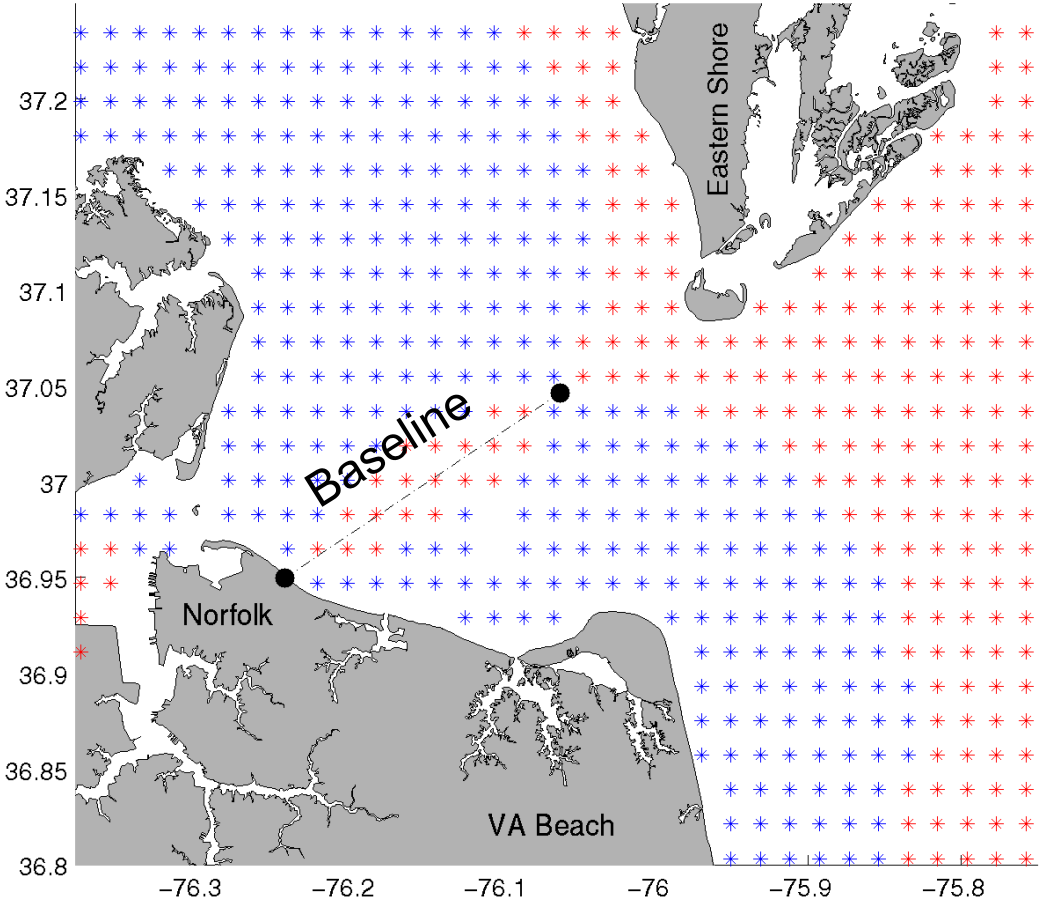
are combined on a grid



The grid is designed by the operator.

Mapping requires at least two antennas!

Grid for Total Current Vectors

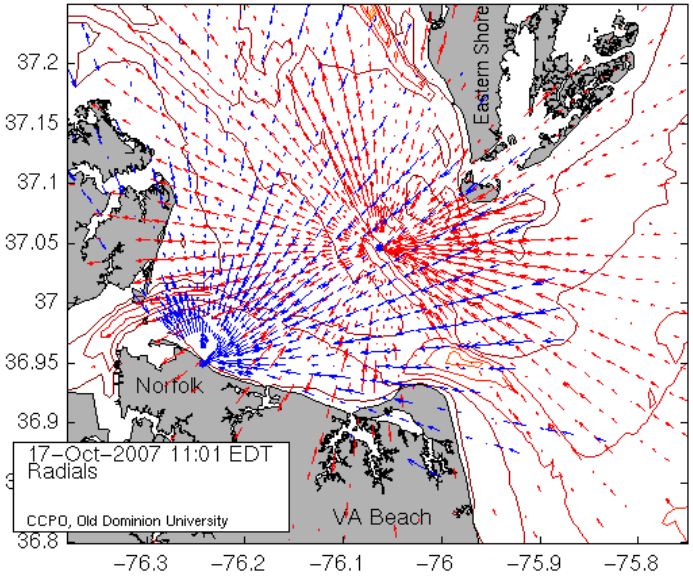


2 km Grid courtesy of CORDC National Network

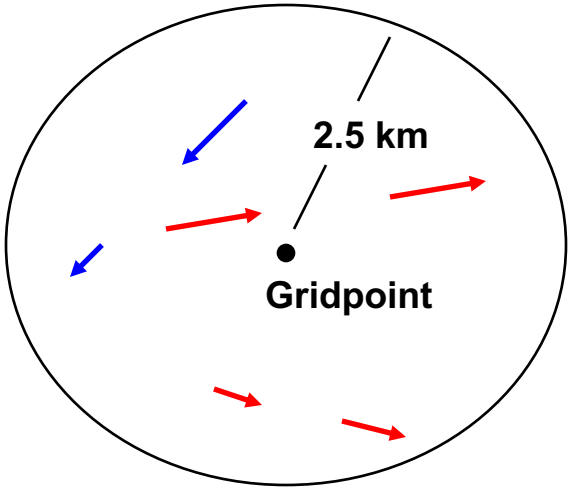
Preserves orthogonality

Red points fail stability angle requirements

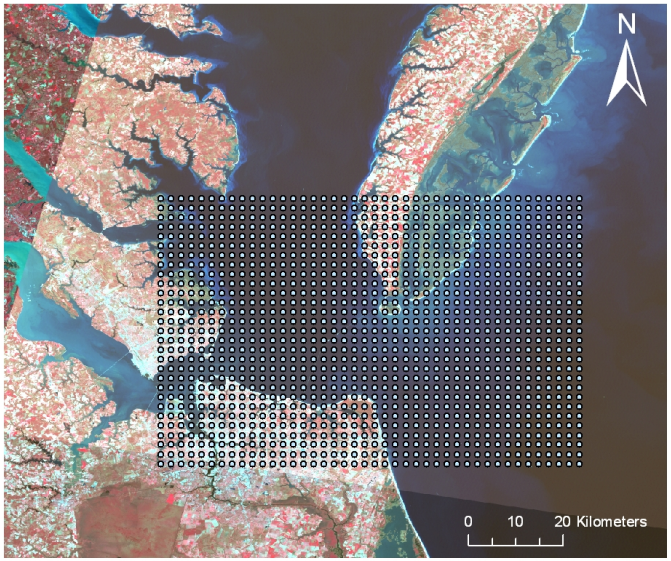
Radial Current Velocities



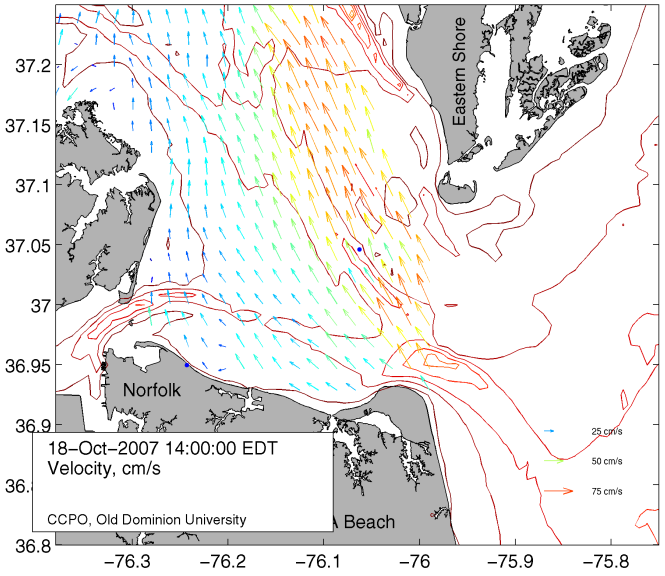
Around each grid point…
Combine Radial Vectors (Least Squares Average)



+ Grid



Total Current Velocities

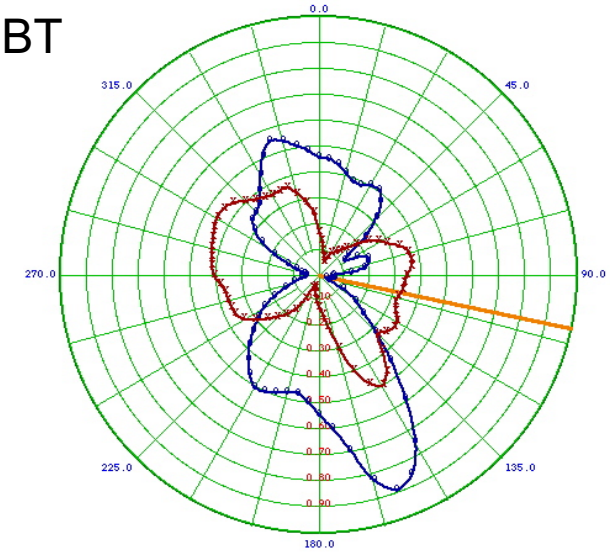


Data Quality

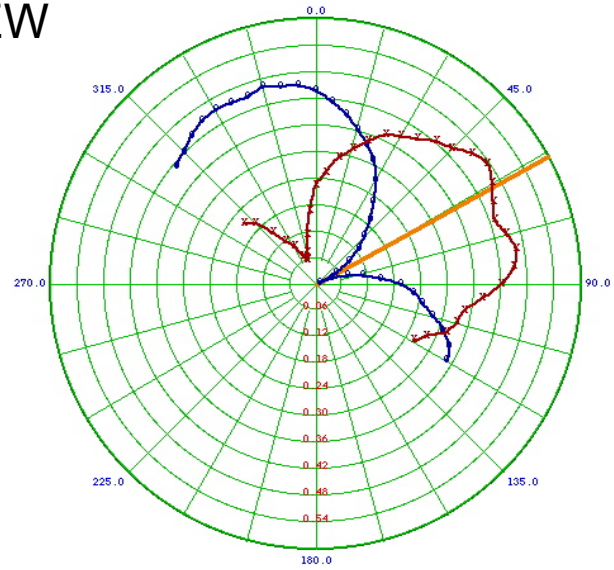
Calibration and Radial Coverage

Antenna Patterns

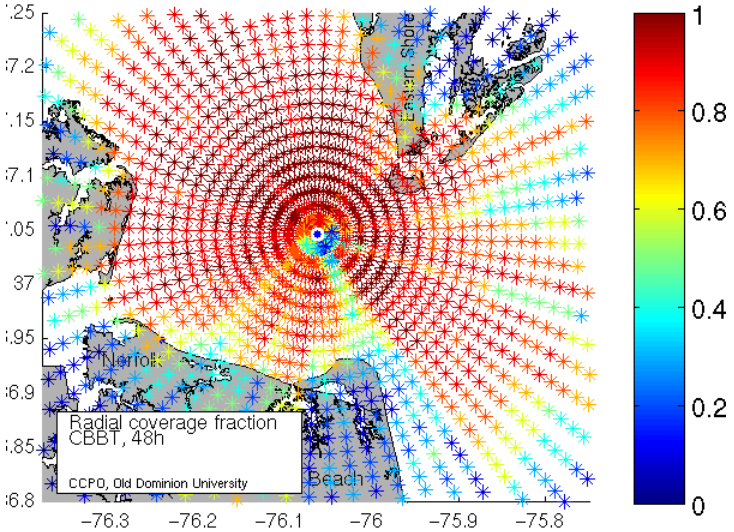
CBBT

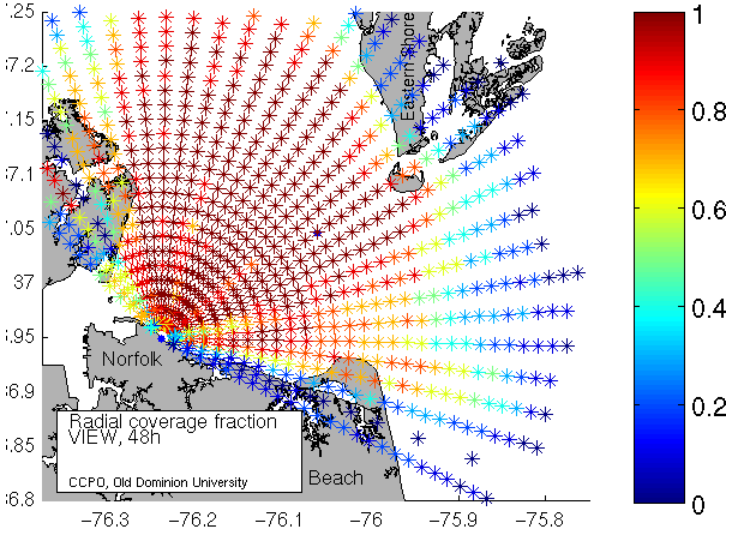


VIEW



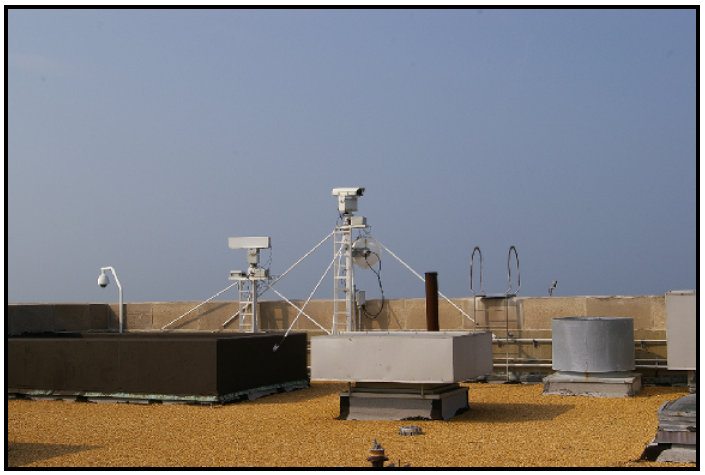
Radial Coverage





Challenges

- At a 360° site, antenna pattern measurement is essential
- Antenna isolation
- Summertime heat
- Interference (Natural & Man-made)

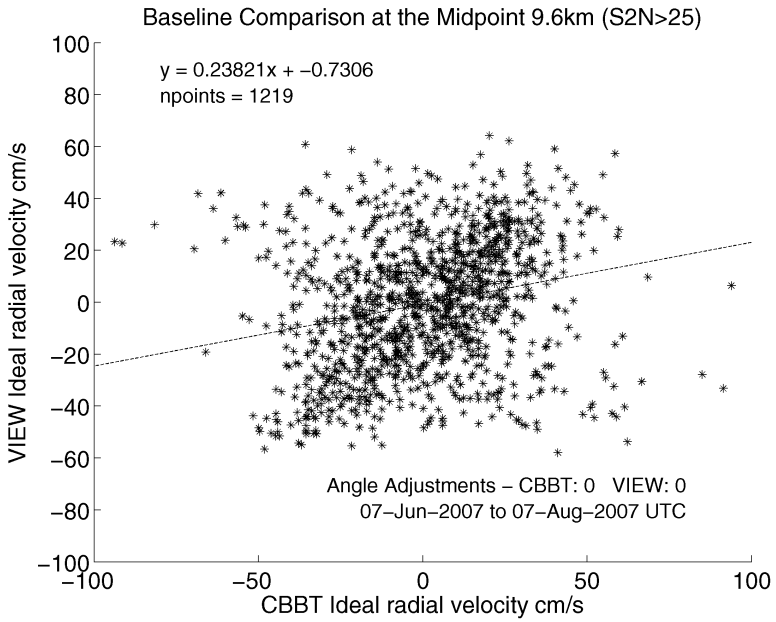


Data Validation by Comparison

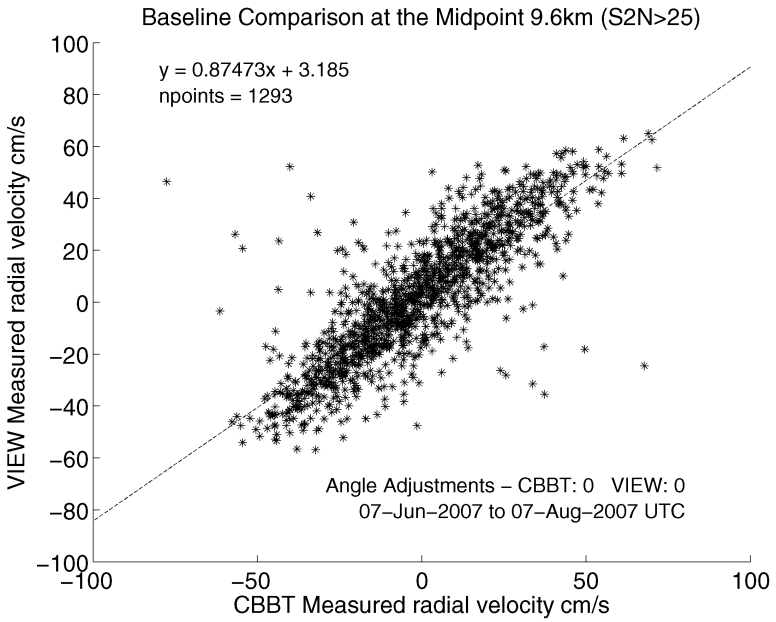
- Baseline (consistency)
- Tide
- Moored ADCP
- Towed ADCP

Photo Source: NOAA OSTEP report

Baseline Comparisons

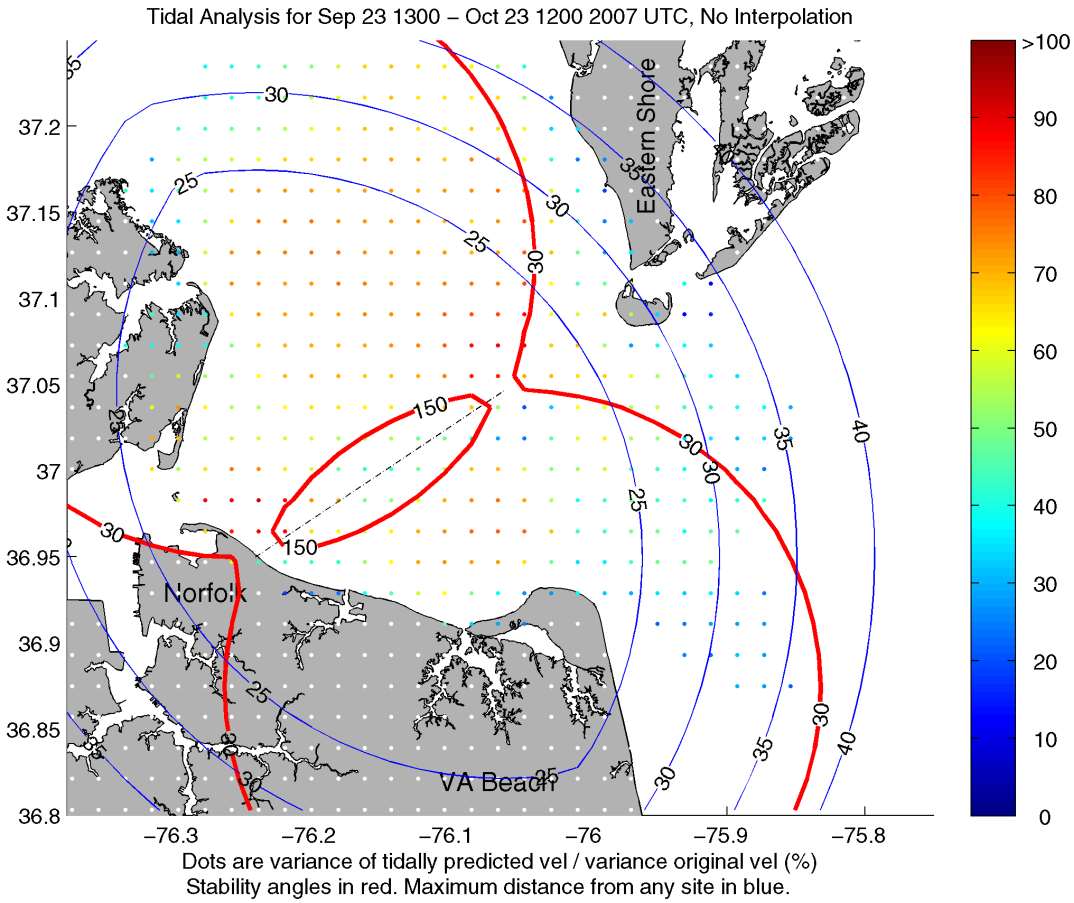


Ideal antenna patterns

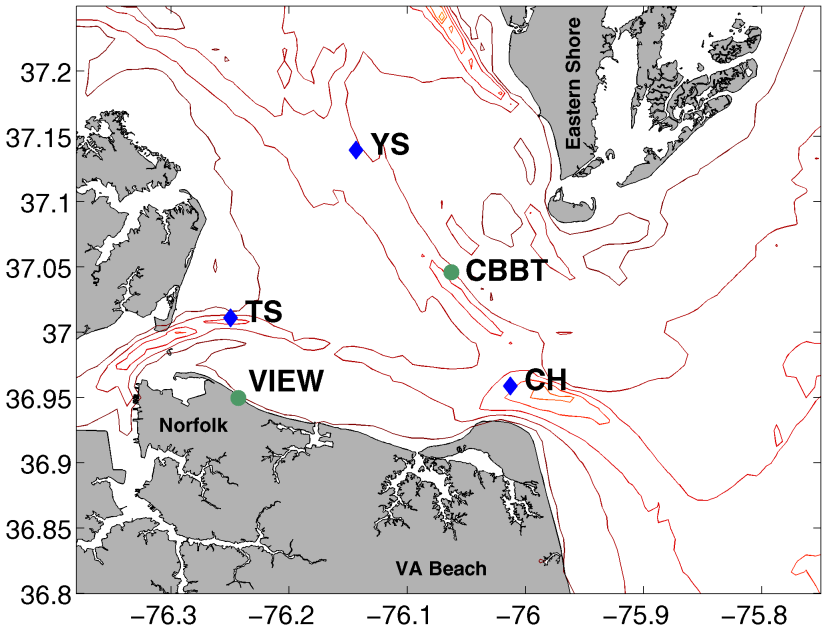


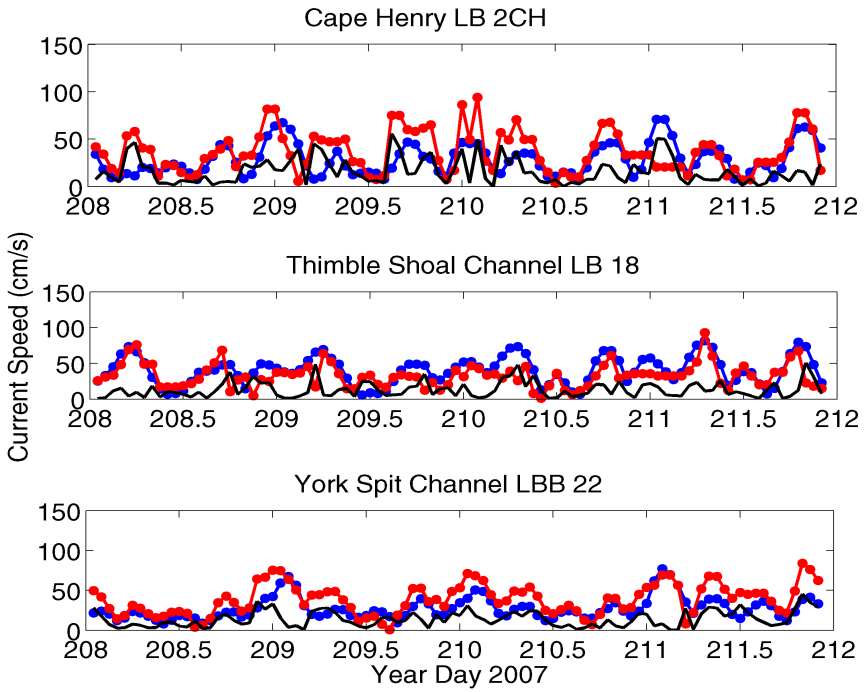
Measured antenna patterns

Tidal Analysis



Moored ADCP Comparison





Difference Statistics

Site	Mean	S.Dev
Cape Henry	16.2	14.0
Thimble Shoals	13.2	11.2
York Spit	13.9	10.0

Red line = CODAR
Blue line = NOAA ADCP
Black = |NOAA-CODAR|

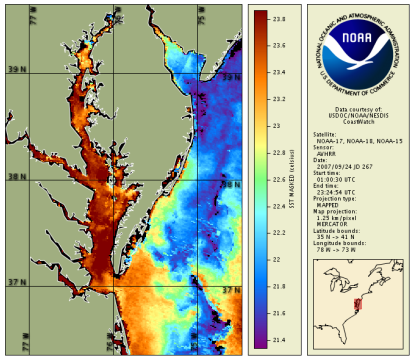
CODAR Current Research & Development

- Bistatic system: enhance coverage by using precise timing so that Rx can receive sea scatter from another transmitter (e.g. on a buoy)
- RiverSonde
- Ship detection
- Shallow water waves

Source: CODAR Research & Development poster

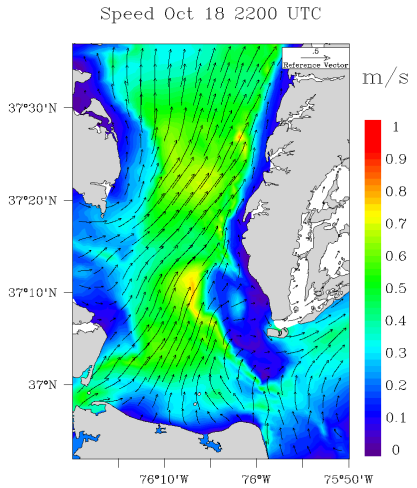
Our Future Plans

- Incorporate data into GIS; map with other regional spatial data
- Continue to work with trajectories/ plume tracking
- Model comparisons
- Outreach (VA Aquarium, education)
- Web page & product development
  - Shipping channels
  - Ocean View beaches



AVHRR SST Daily Composite, September 24, 2007

from NOAA Coastwatch



ChesROMS model output

Acknowledgements

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

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