Surface Currents from High Frequency Radar (HFR): Central and Northern California

David M. Anderson, Central and Northern California Observing System

With:

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California has one of the best HFR arrays in the United States, owing to state support. Long range radar cover the entire coast with minimal gaps, and high resolution radar cover bays like San Francisco.
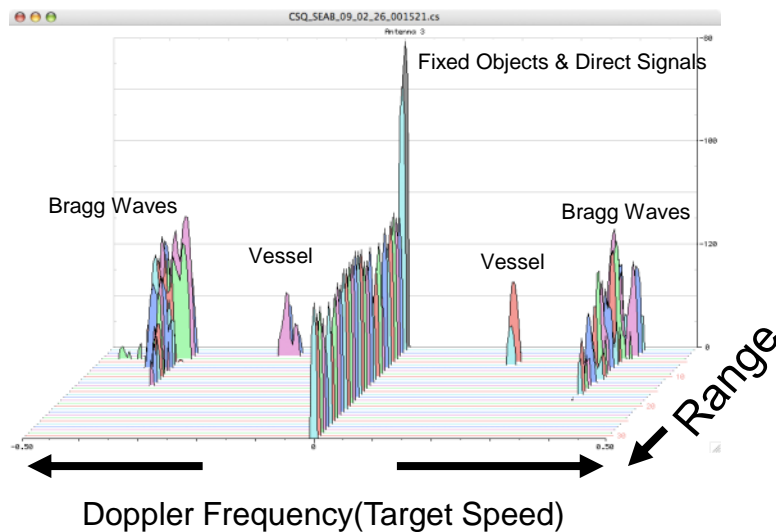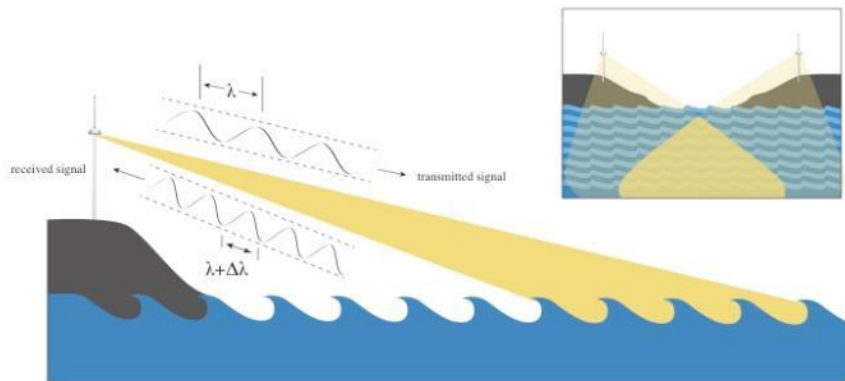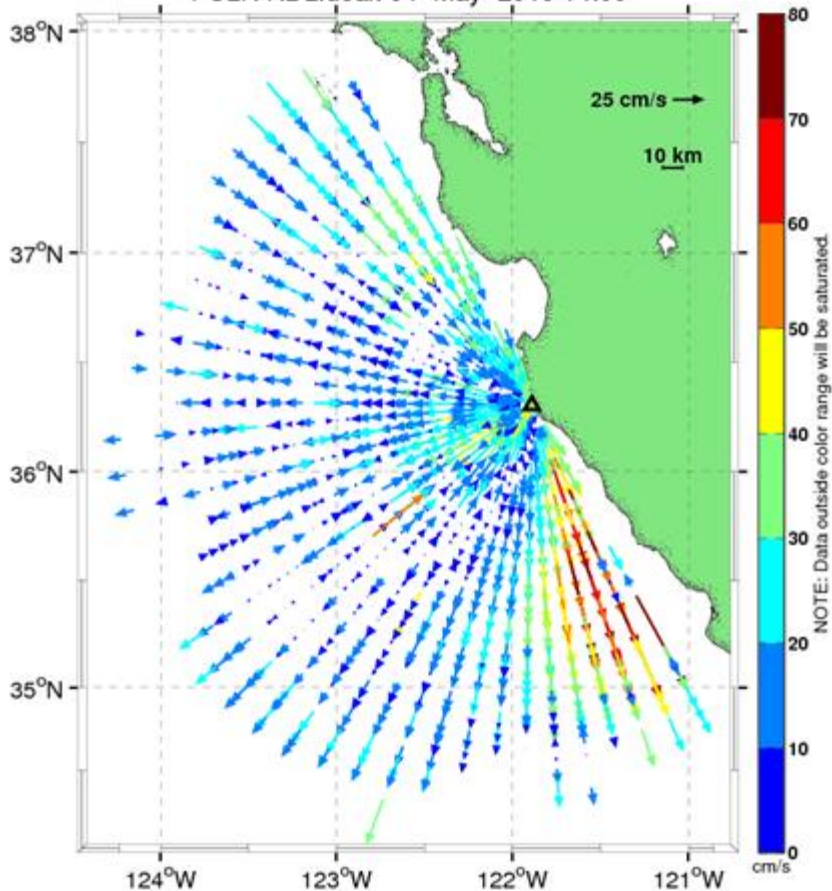
My message: Its not just about the hardware. Wise, dedicated, helpful people are engaged in this enterprise and can help!

Review: Currents from HFR (and limitations)

Assumption: Most of the audience is familiar with HFR as a data source; revisiting the method to understand some limitations
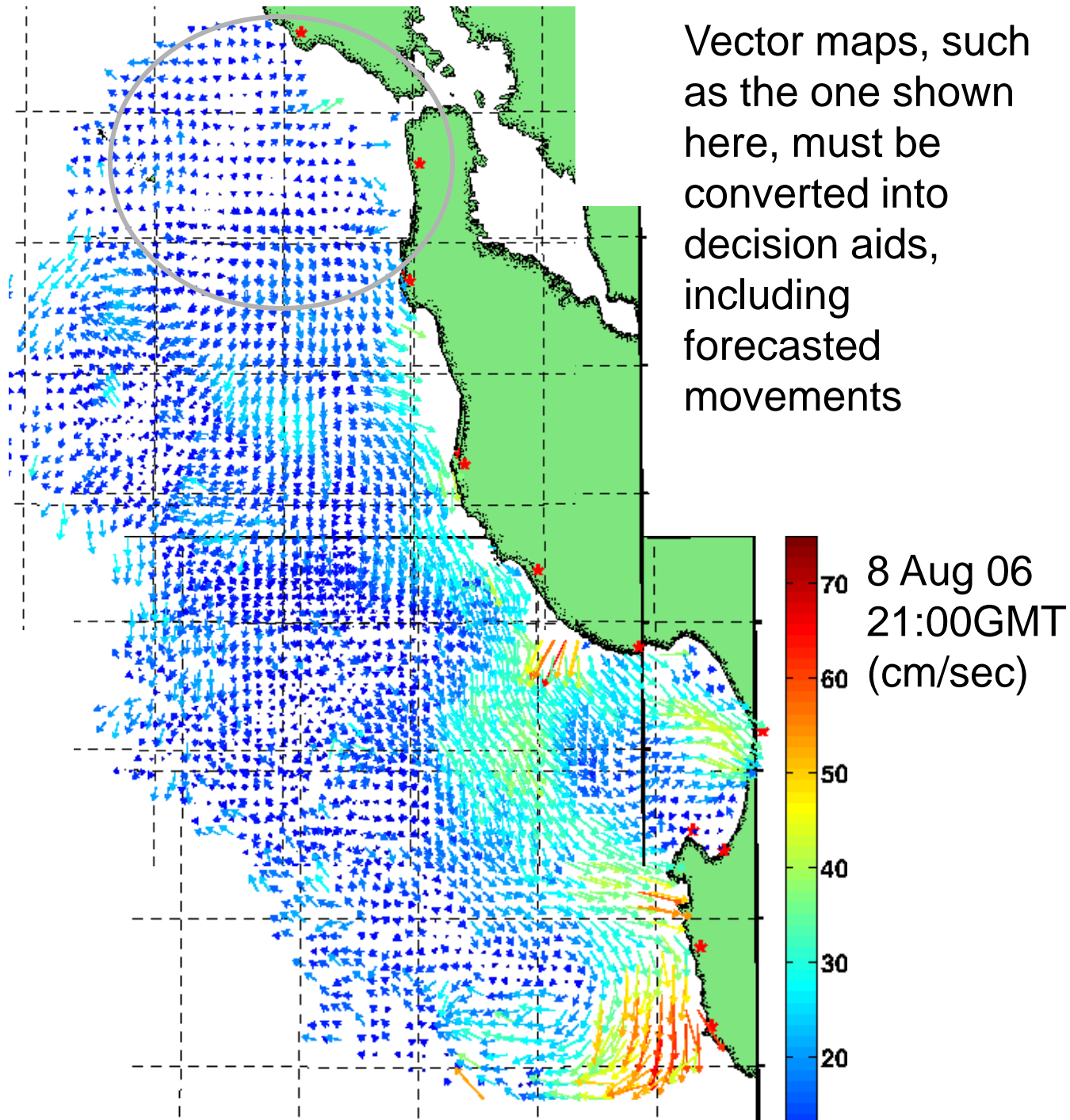

PSLR RDLIdeal: 04-May-2010 14:00

25 cm/s →

10 km

NOTE: Data outside color range will be saturated.

cm/s

Fixed Objects & Direct Signals

Bragg Waves

Bragg Waves

Vessel

Vessel

Range

Doppler Frequency(Target Speed)

Steps

1. Assemble hourly observations from many remote sites

2. Form map of vector surface currents

3. Fill spatial gaps

4. Estimate particle trajectories

5. Estimate tomorrow's currents

6. Produce netCDF file for GNOME model with 48 hr observations and 24 hr forecast

Vector maps, such as the one shown here, must be converted into decision aids, including forecasted movements

8 Aug 06 21:00GMT (cm/sec)

Filling and forecasting

Past 48 hour observed velocities plus 24 hour predicted velocities are packaged into a single 72-hour netCDF file every hour for ingestion into the tracking model GNOME
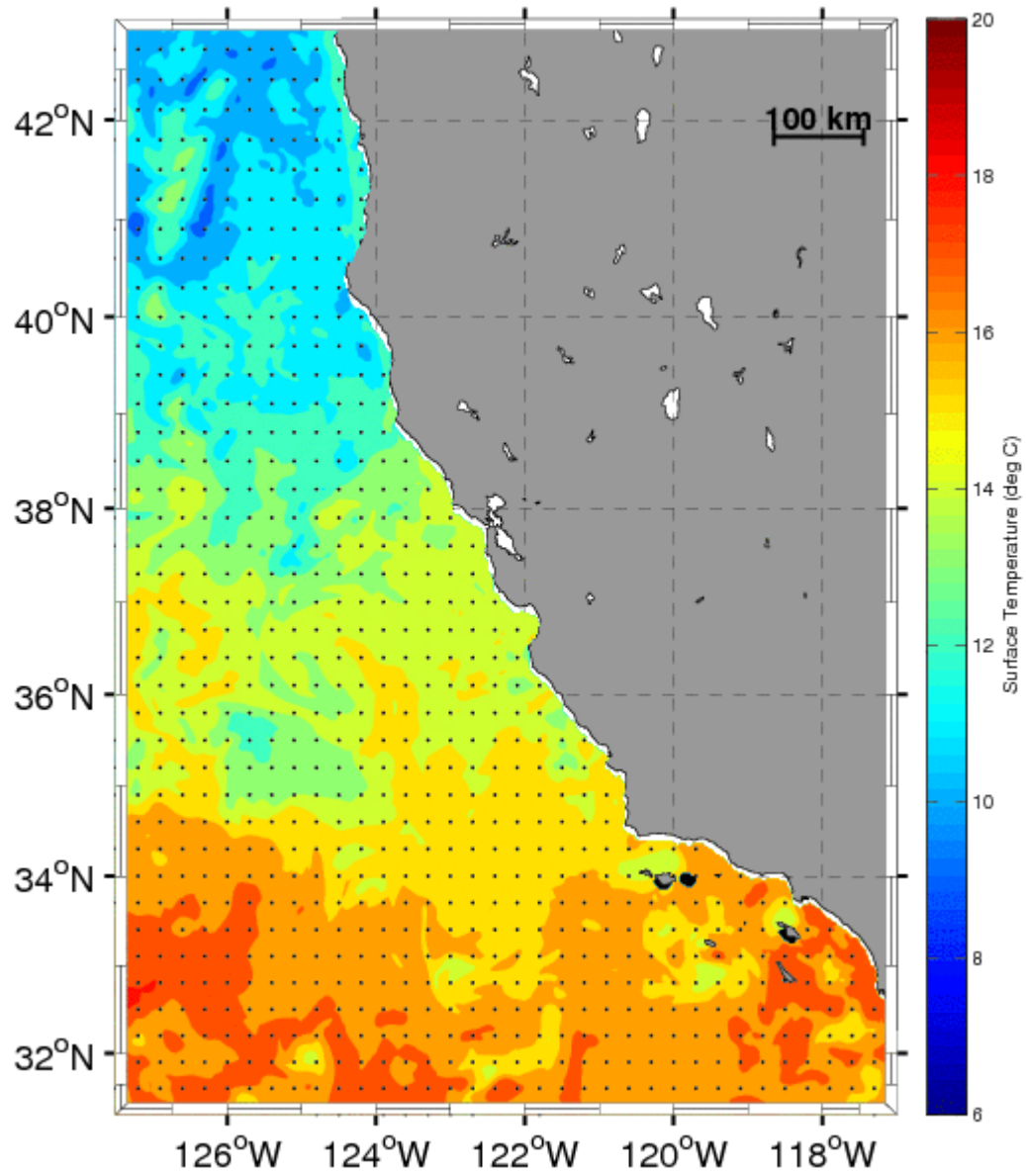
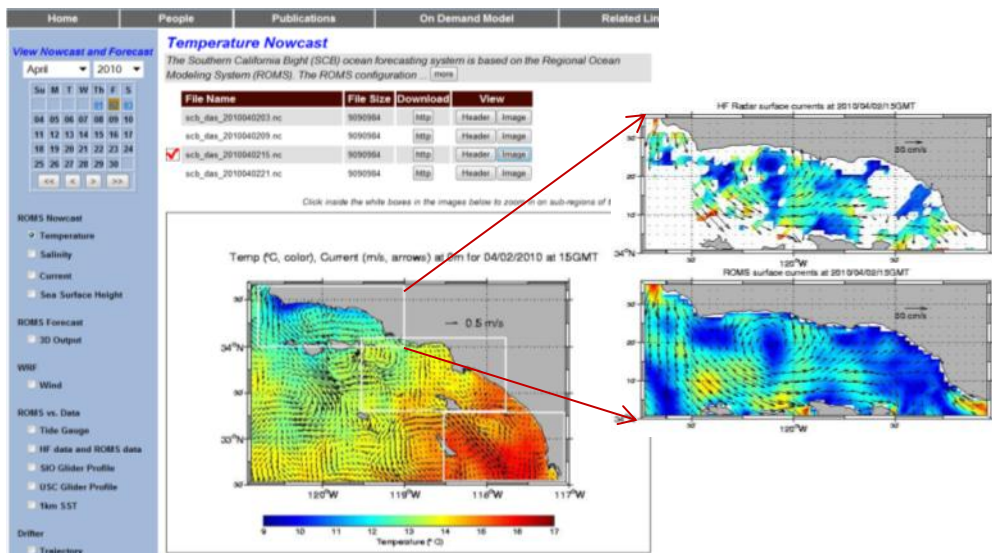The example here shows three simulated spills expanding and moving offshore with the observed flow
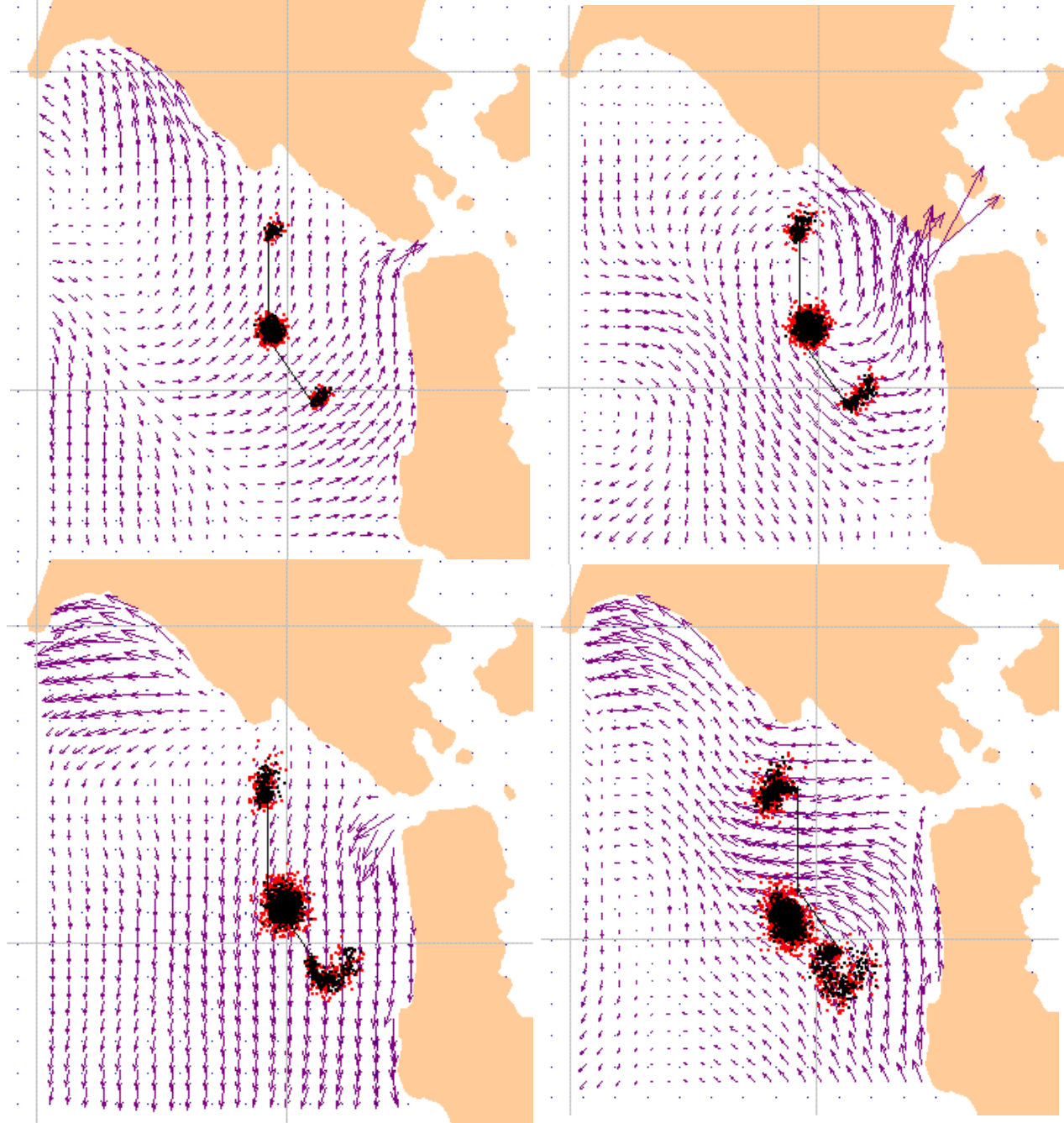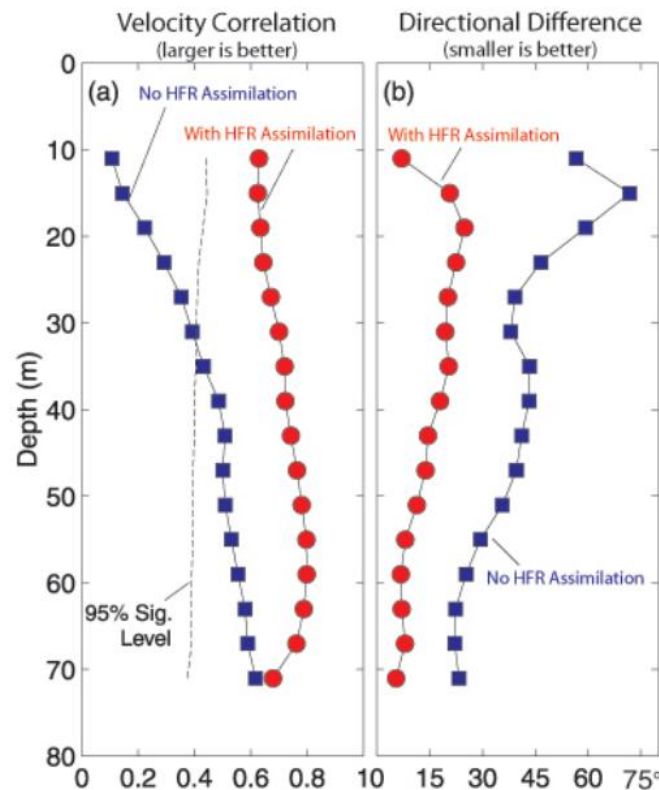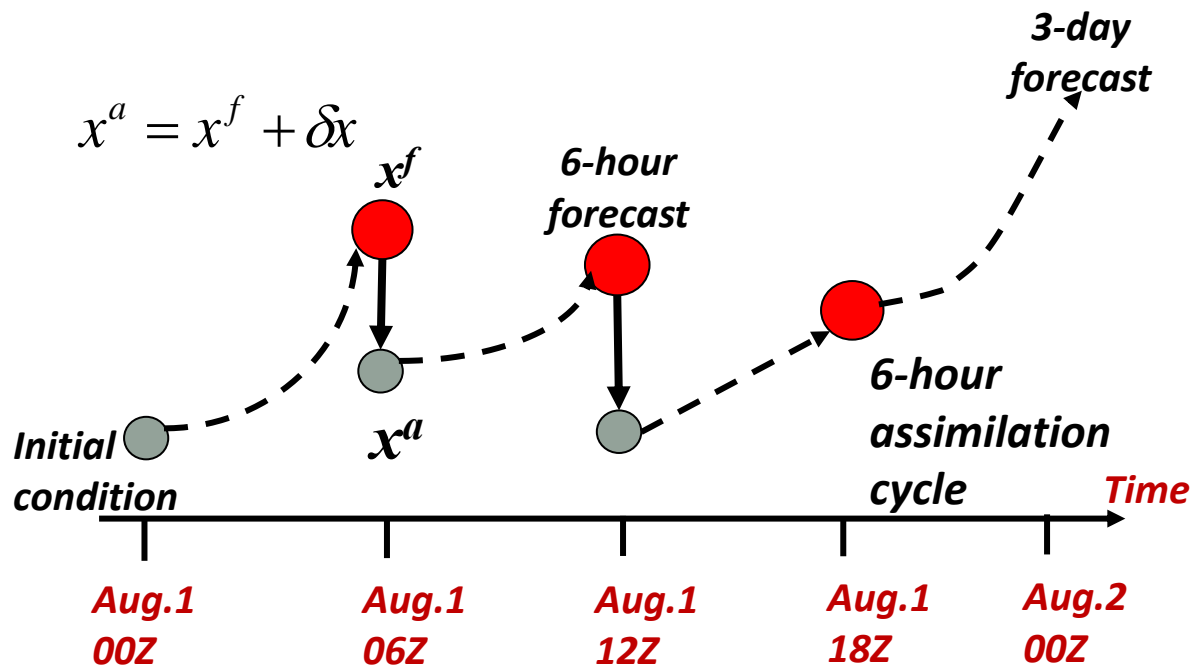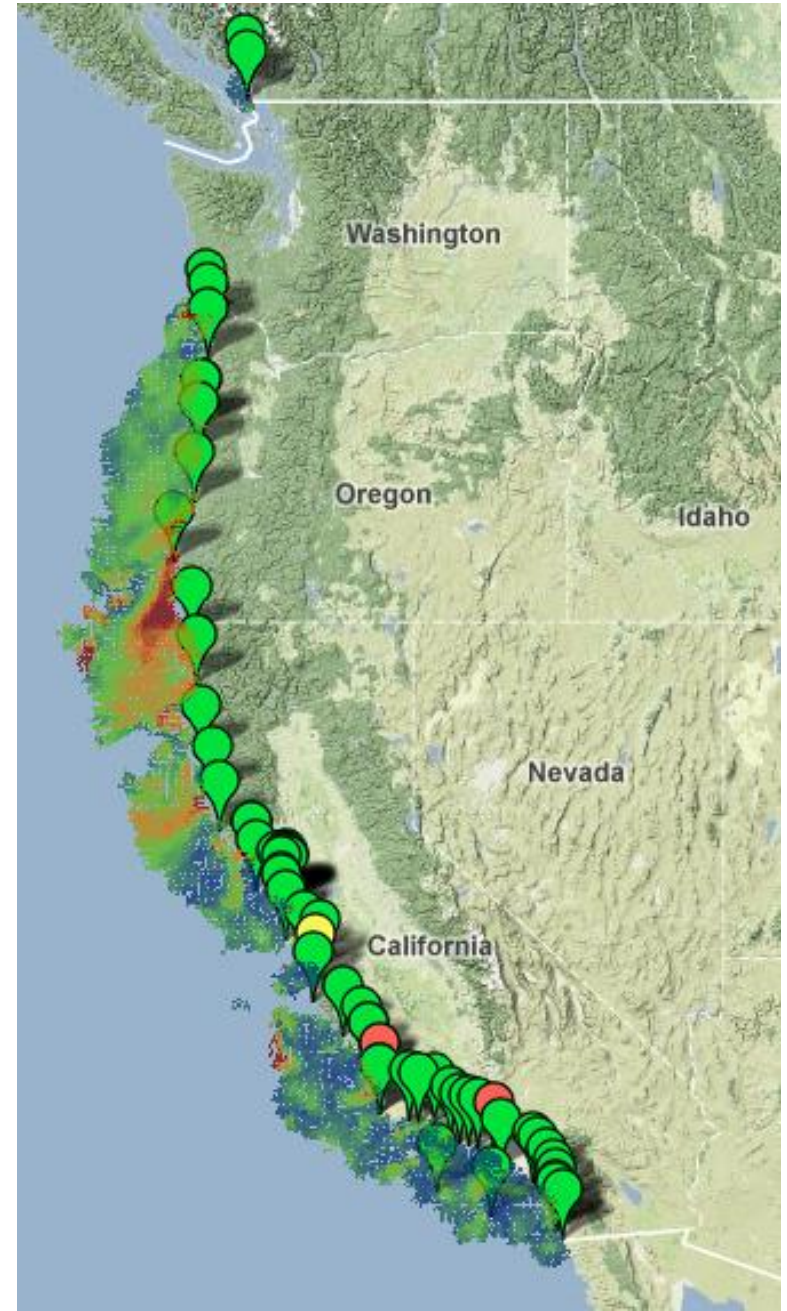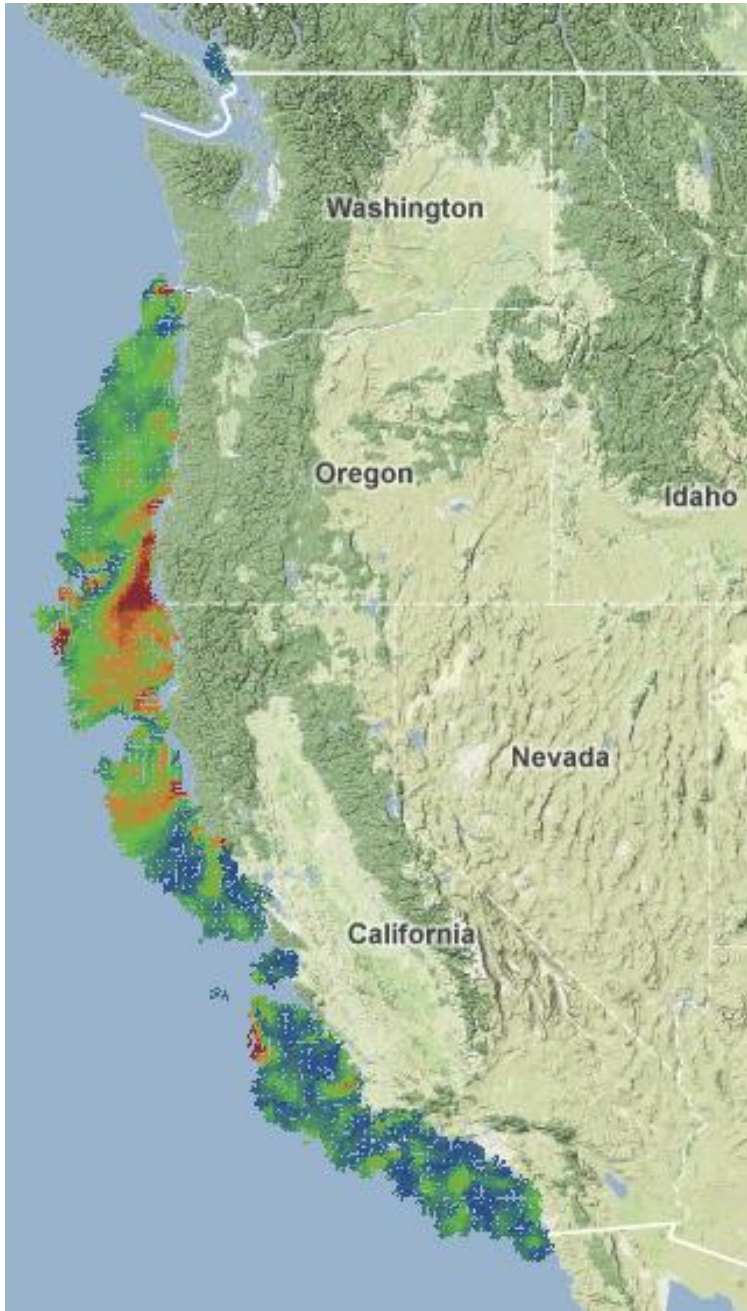
Regional ocean modeling ocean currents

Particle Trajectories From ROMS Surface
Currents at Thu Feb 19 16:00:00 GMT-08:00 2015

Future is modeling with Data Assimilation

$$x^a = x^f + \delta x$$

3-day forecast

x^f

6-hour forecast

6-hour assimilation cycle

x^a

Initial condition

Time

| Aug.1 00Z | Aug.1 06Z | Aug.1 12Z | Aug.1 18Z | Aug.2 00Z |

http://ourocean.jpl.nasa.gov

Yi, Chao; Oke et al 2002

California is fortunate: state built radar array in 2005

Sources of high frequency radar data (surface currents)

1. **SCCOOS and CeNCOOS (web sites, web services)**
2. CenCal Currents (Naval Postgraduate School
3. Bodega Ocean Observing Node
4. Coastal Observing Research and Development Center*
5. Rutgers Univ.*
6. National Data Buoy Center*
7. National Weather Service (AWIPS) coming soon
8. Ship display (AIS)
9. Trajectory Analysis Planner TAP (not intended for real-time)
10. General NOAA Operational Modeling Environment (GNOME)

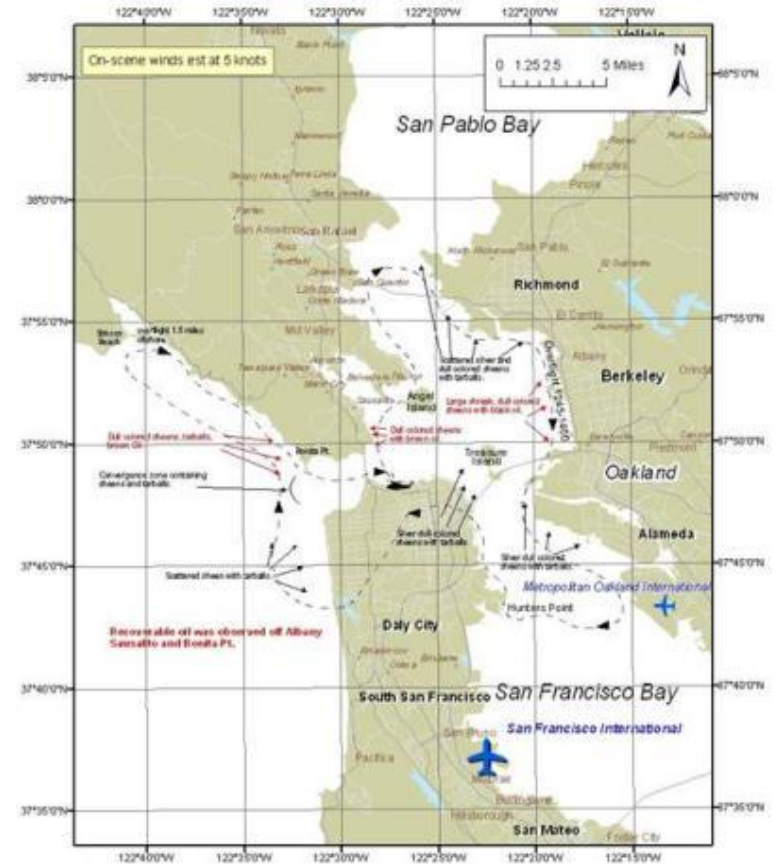*National integrating data archive

Case 1: Cosco Busan (2007)

Cosco Busan Oil Spill
+ Spill Site
— Affected Shoreline
■ Potential Area for Oil on Water

Hugh Roarty, Rutgers

Particle trajectories

HF radar observations in the Gulf of the Farallones were able to predict which beaches were vulnerable as the oil exited the Golden Gate

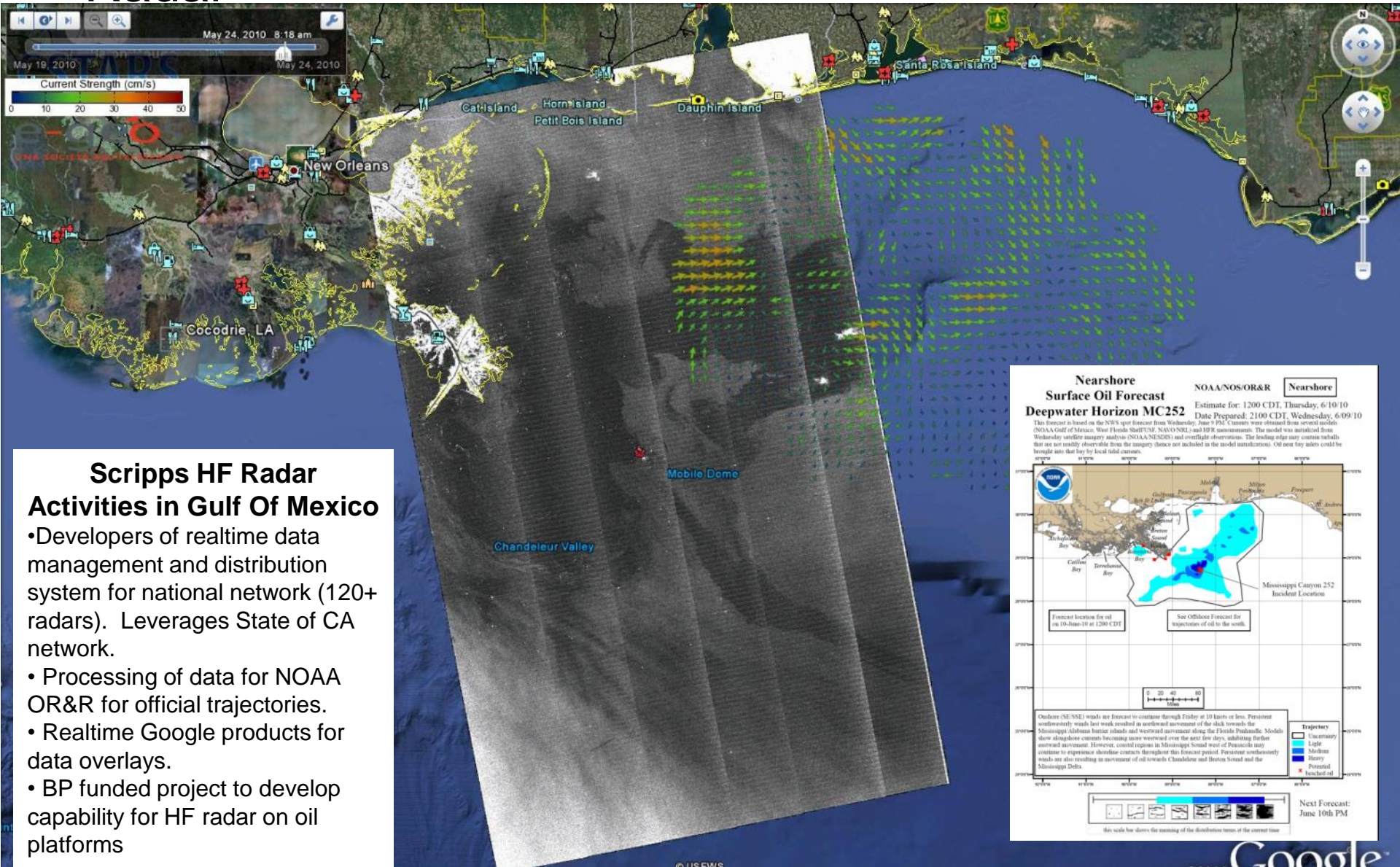Predictions allowed responders to focus assets effectively

Particle Trajectories From A Derived Currents at 15-Nov-2007

10 km

54'   48'   42'   36'

J. Paduan, NPS

April 20, 2010 – no systems operating

April 24, 2010 – USF systems online

May 1, 2010 – USM systems online
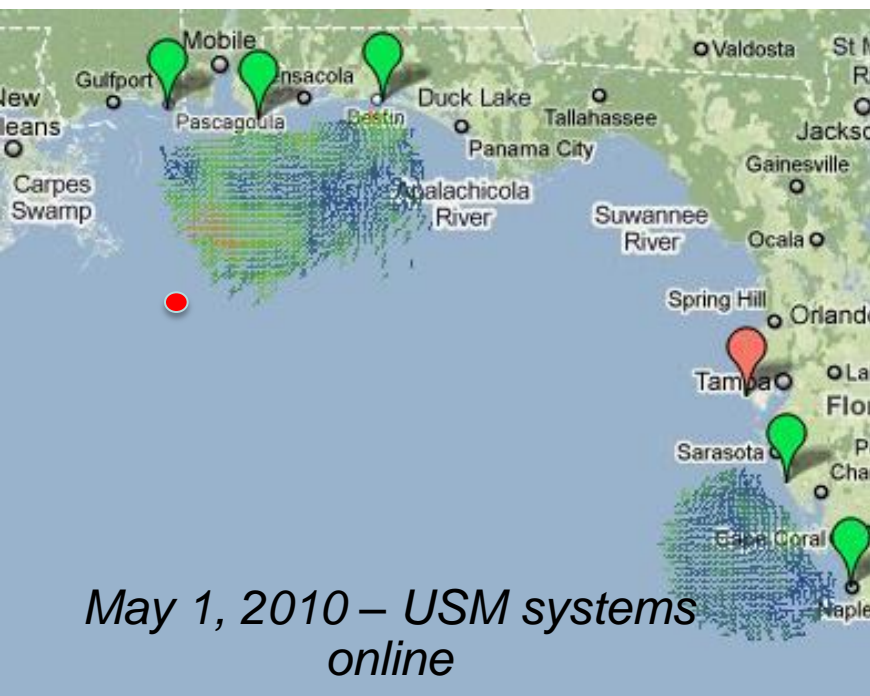
HF Radar National Network (HFRNet) – Coastal Observing Research and Development Center at Scripps Institution of Oceanography – PI Dr. Eric Terrill eterrill@ucsd.edu

• *British Petroleum (BP) Incident Command Center (ICC)*
NOAA IOOS liason: Dr. Jack Harlan jack.harlan@noaa.gov

• *Office of Response and Restoration (OR&R) Emergency Response Division (ERD)*
(formerly Hazardous Materials Response Division (HAZMAT))
Official NOAA forecasts for oil spill trajectories General NOAA Operational Modeling Environment (GNOME)

• *Office of Response and Restoration (OR&R) Assessment and Restoration Division (ARD)*
GIS shape files of HFR products and a data feed to the Environmental Response Management Application (ERMA)

• Near real-time currents available in various formats (NetCDF, GNOME NetCDF, Shapefile, kml): http://cordc.ucsd.edu/projects/mapping/
• Near real-time currents available via THREDDS at NDBC:
http://sdf.ndbc.noaa.gov:8080/thredds/catalog.html
• Ocean Observing assets and data availability:
http://rucool.marine.rutgers.edu/deepwater/

E. Terrill and H. Roarty

Mapping Surface Currents in Gulf of Mexico with HF Radar

**Scripps HF Radar Activities in Gulf Of Mexico**
- Developers of realtime data management and distribution system for national network (120+ radars). Leverages State of CA network.
- Processing of data for NOAA OR&R for official trajectories.
- Realtime Google products for data overlays.
- BP funded project to develop capability for HF radar on oil platforms
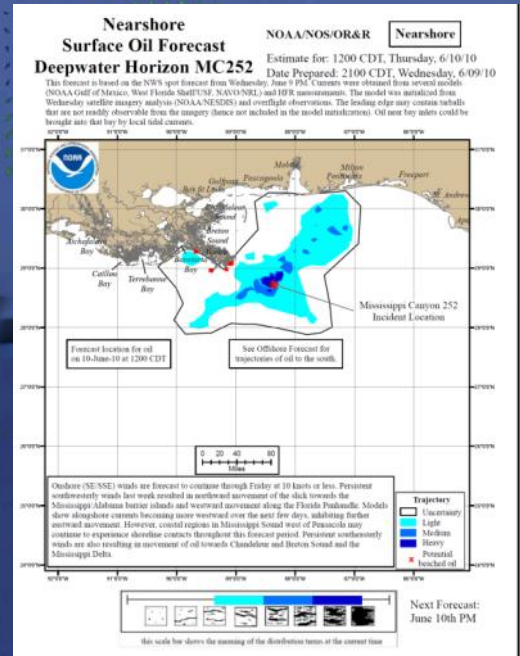
SAR imagery from CSTARS/UMIAMI. OI mapped HF Radar surface currents from CORDC/SIO. Radars operated by USM.

Integrated observations and model forecasts
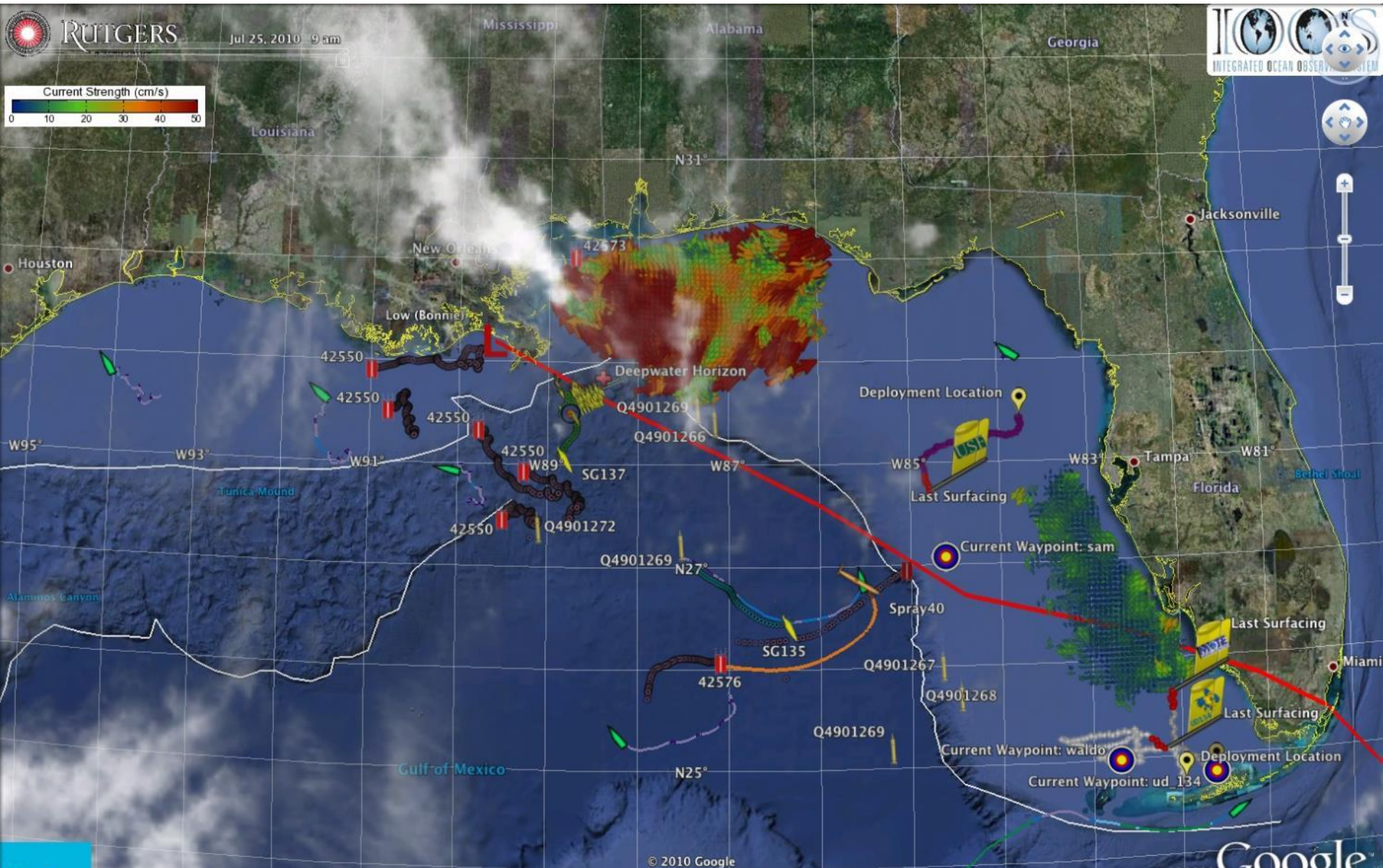
U.S. IOOS: DeepWater Horizon Portal -subsurface too!

Real-time IOOS Assets
- HF Radar
- Satellite
- Glider Fleet Positions
- Forecasts

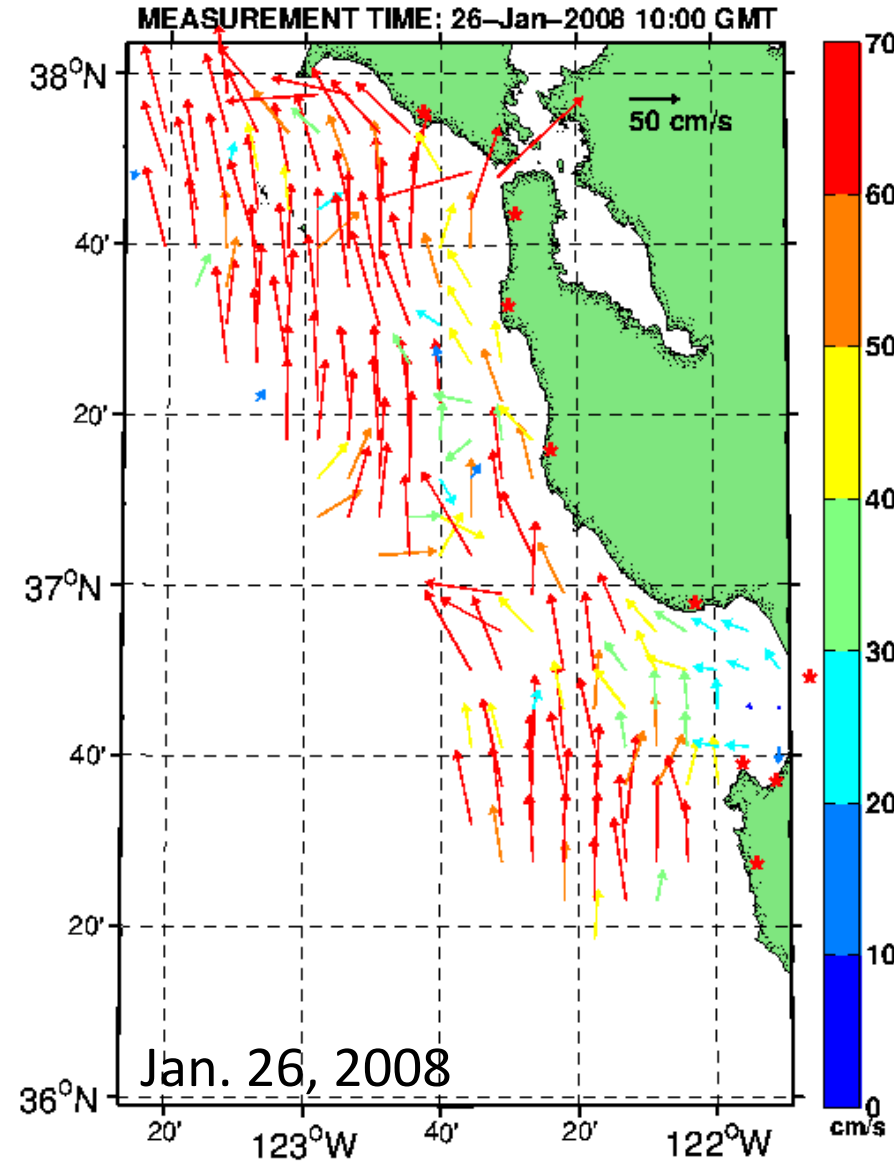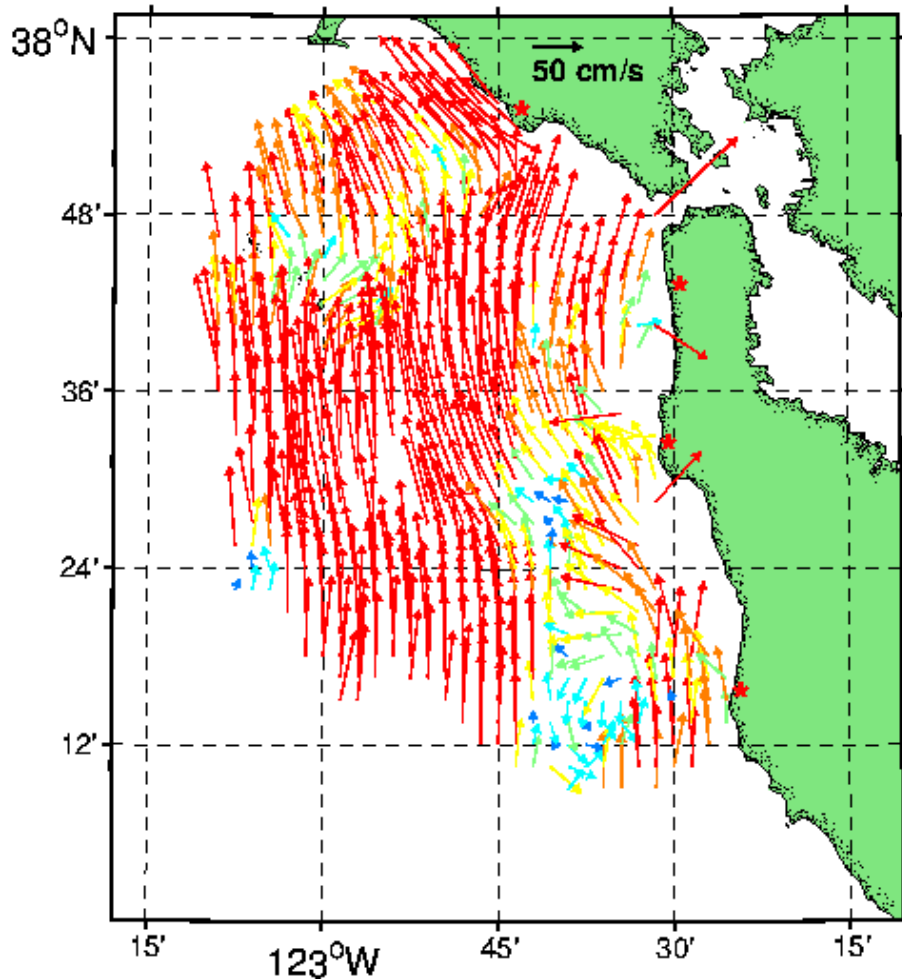http://rucool.marine.rutgers.edu/deepwater

Case 3: Tar balls in Central California

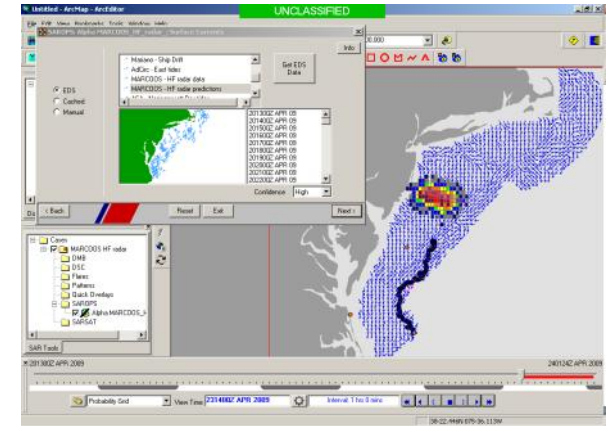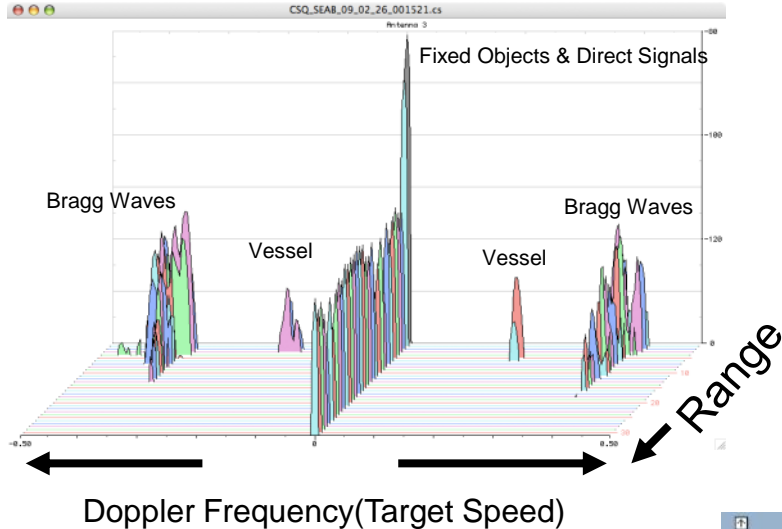Late January 2008, oil and tar balls washed up on beaches from Monterey to San Francisco

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Surface current measurements showed that the tarballs'
appearance followed a period of exceptionally strong flow from
the south

MEASUREMENT TIME: 26–Jan–2008 10:00 GMT

Jan. 26, 2008

J. Paduan, NPS

Other Uses of HFR

- Tracking ships

- Search and rescue

- Particle trajectories for larvae and other organisms, trash, lost at sea, water quality

Doppler Frequency(Target Speed)

SAROPS User Interface