Impact of NASA Satellite Data and Models on U.S. Coast Guard's Decision Support Tool for Search and Rescue in the Northeastern Pacific Ocean

3-Year: Sept. 2008-Aug. 2011

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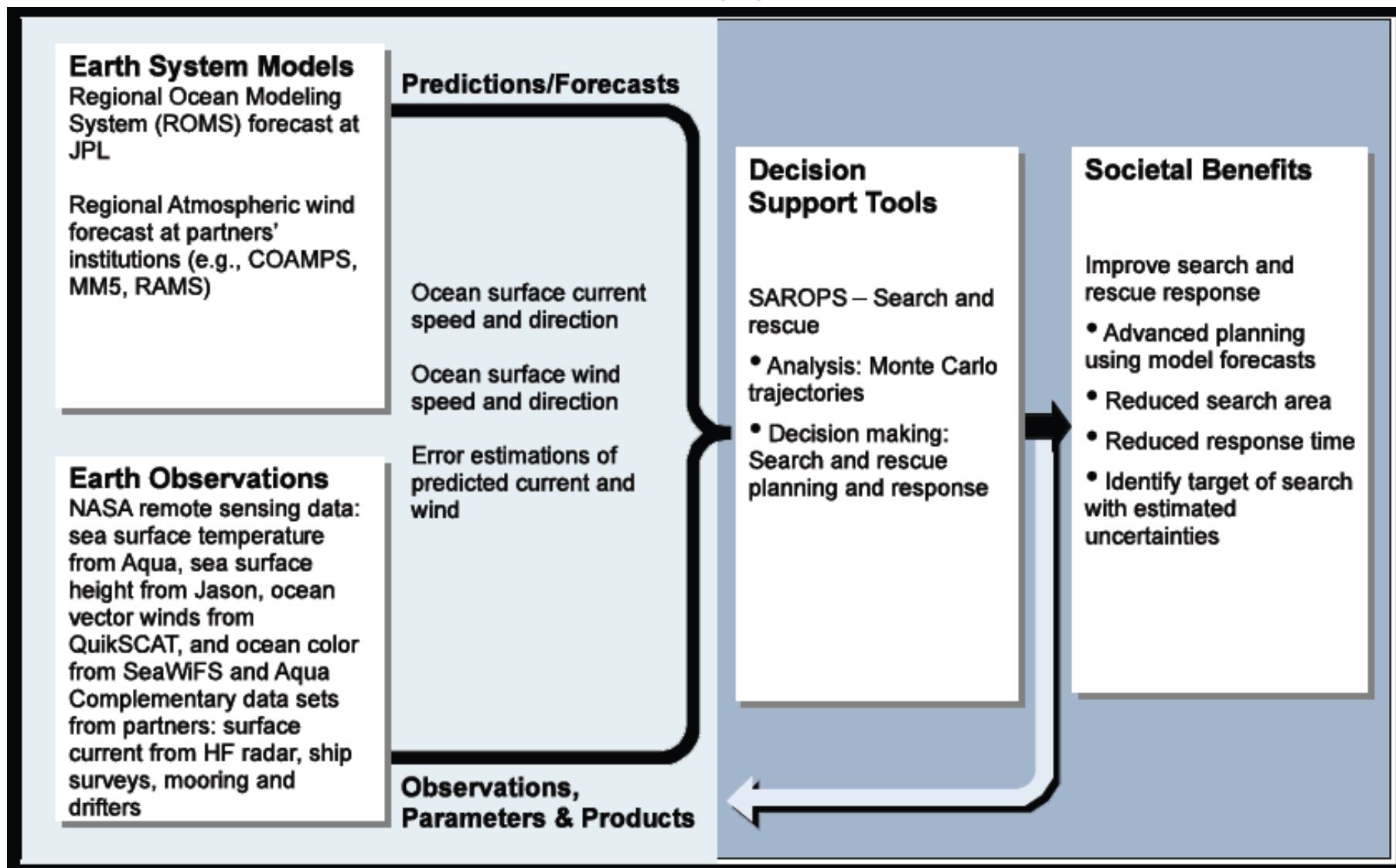Eoin Howlett, Applied Science Association (ASA)

Partner:

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Objective

- Our primary objective is to work with our U.S. Coast Guard (USCG) partner to provide improved real-time, high-resolution ocean current and wind observational data as well as ocean circulation forecasts with error estimates for inclusion in the USCG Decision Support Tool (DST) known as Search and Rescue Operations (SAROPS).

Proposed Architecture for the Search and Rescue Decision Support Tool

Earth System Models
Regional Ocean Modeling System (ROMS) forecast at JPL

Regional Atmospheric wind forecast at partners' institutions (e.g., COAMPS, MM5, RAMS)

Earth Observations
NASA remote sensing data: sea surface temperature from Aqua, sea surface height from Jason, ocean vector winds from QuikSCAT, and ocean color from SeaWiFS and Aqua Complementary data sets from partners: surface current from HF radar, ship surveys, mooring and drifters

Predictions/Forecasts

Ocean surface current speed and direction

Ocean surface wind speed and direction

Error estimations of predicted current and wind

Observations, Parameters & Products

Decision Support Tools

SAROPS – Search and rescue

• Analysis: Monte Carlo trajectories

• Decision making: Search and rescue planning and response

Societal Benefits

Improve search and rescue response

• Advanced planning using model forecasts
• Reduced search area
• Reduced response time
• Identify target of search with estimated uncertainties

NASA & Universities: JPL, UCSB, CU; Non-profit: AOOS; Industry: ASA; Partner: USCG

Search And Rescue (SAR) Problem

- Create a SAR case when alerted
- Gather information about case
- Get environmental data & uncertainties
- Use model to determine search area
- Estimate resource availability and capability
- Plan, promulgate & perform the next search
- Evaluate the completed search
- Repeat above until survivors are found and rescued
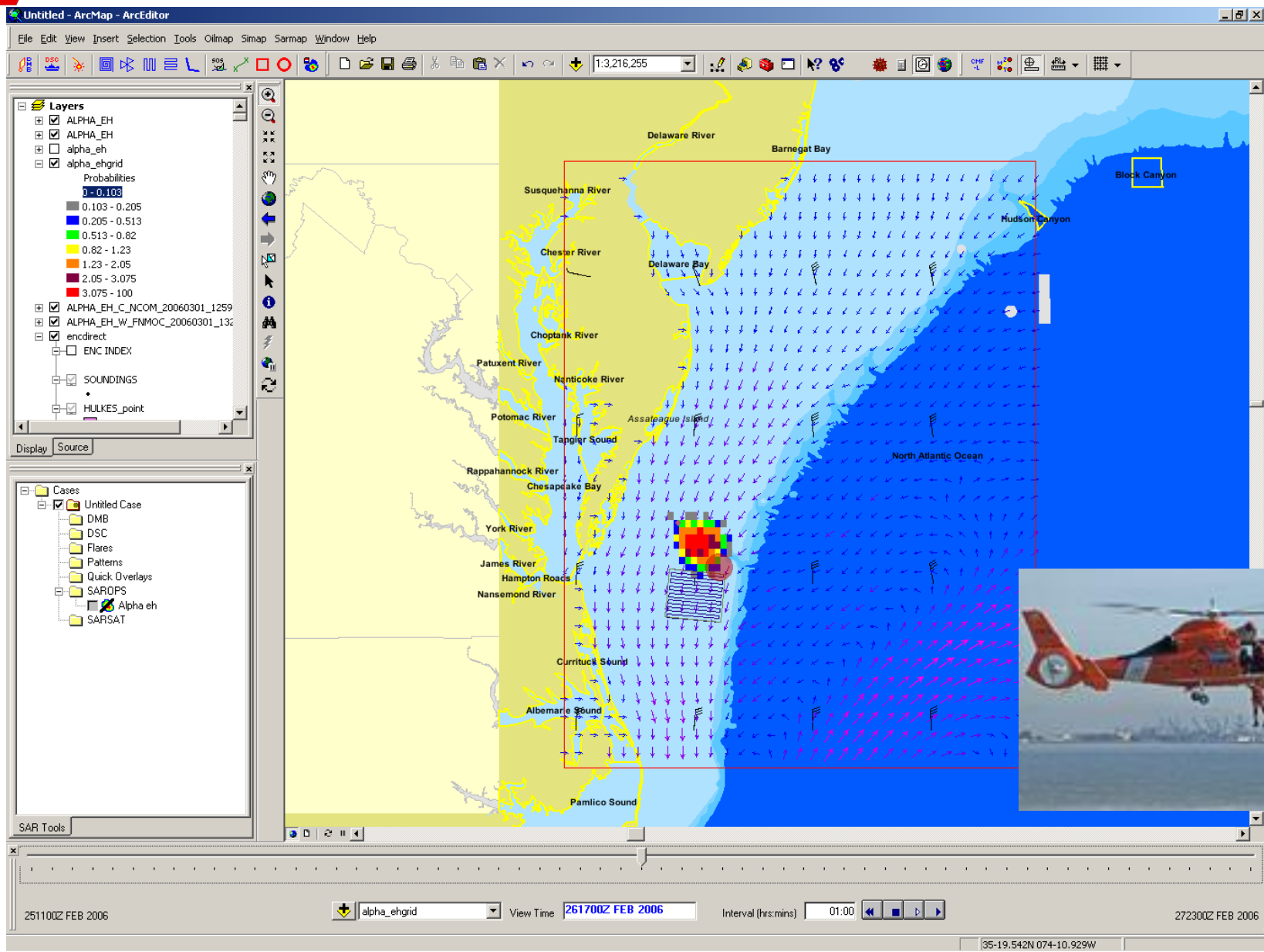
Find Jim in 2007

- This operational scenario was actually tested in the search and rescue effort for Jim Gray, a Microsoft engineer, in 2007; However, there is no integrated oceanographic information, and the local ocean model is not available at the needed spatial resolution; the U.S. coast guard ceased their operations after 5 days.

- It would help the U.S. coast guard tremendously if we have access to (1) a single portal to access all the ocean information, and (2) a well-calibrated ocean model forecast at the resolution required by the search and rescue operation (i.e., 1-km).

- Based on the realistic ocean forecast, the Coast Guard will estimate the search area over the next 24 hours, which will enable better planning the resources (e.g., ships, planes, people) needed to implement the research and rescue operation.

USCG SAR Statistics

FY	Cases	Lives Saved
2005	29,780	5,648
2006	28,323	5,290
2007	27,090	5,175

DST: SAROPS & improved EDS

Wind

Wave

Current

Temperature

Catalog Server

Catalog DB

EDS

THREDDS

OPeNDAP

Web Services

Operational since January 2007

SAROPS Client

Internet
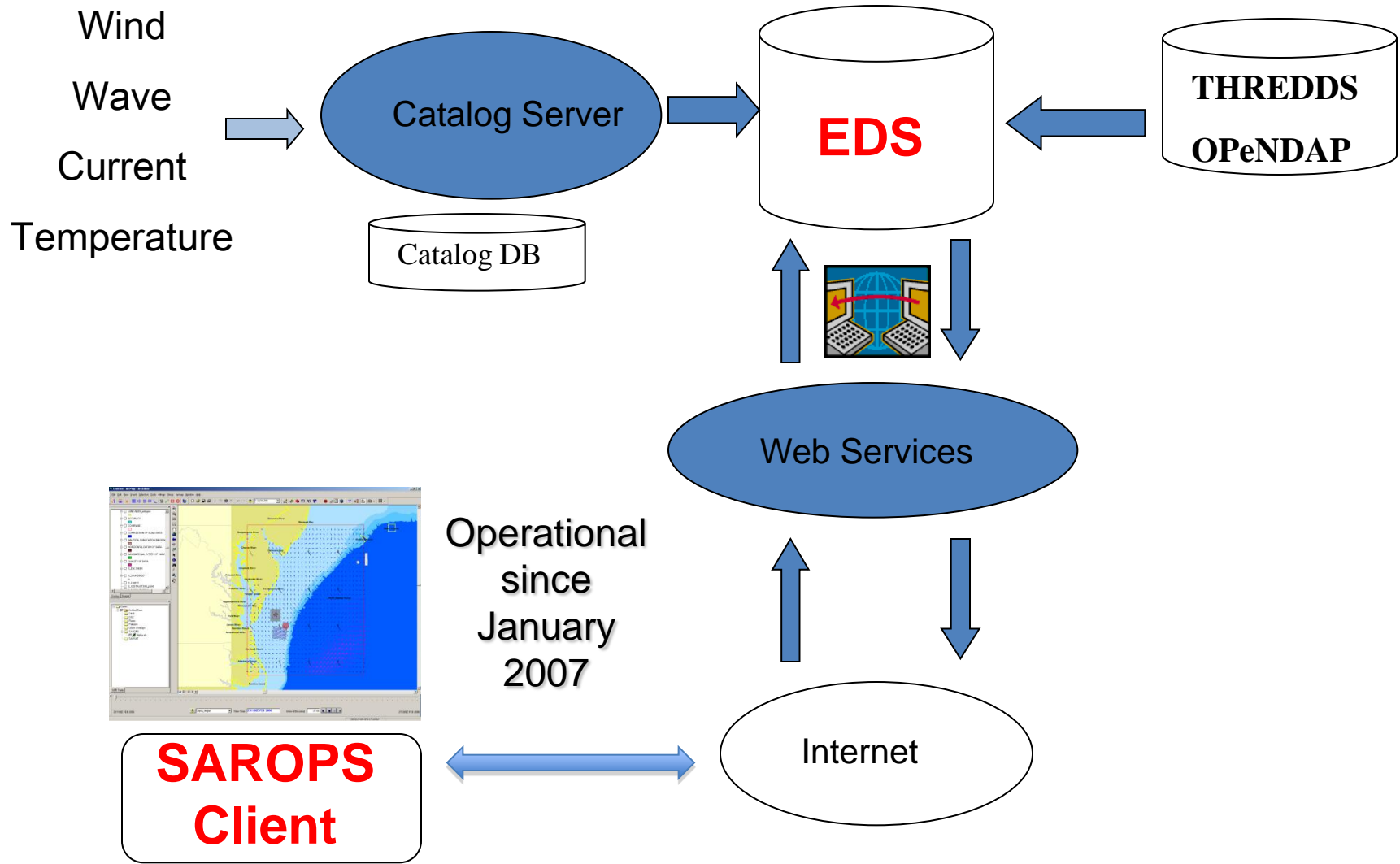
Year 1: Establish baseline performance

- IT/EDS server development: access data and model
- DST Benchmarking via FE-1

Prince William Sound

Prince William Sound (PWS) Field Experiment (FE) July 18-Aug 3

Location of Assets - Entire Field Experiment

- NDBC Buoy
- Ship SST
- CalPoly Remus
- CalPoly Glider
- Ship CTD
- HF Radar
- Thermosalinogr.

Open Ocean

SLDMB
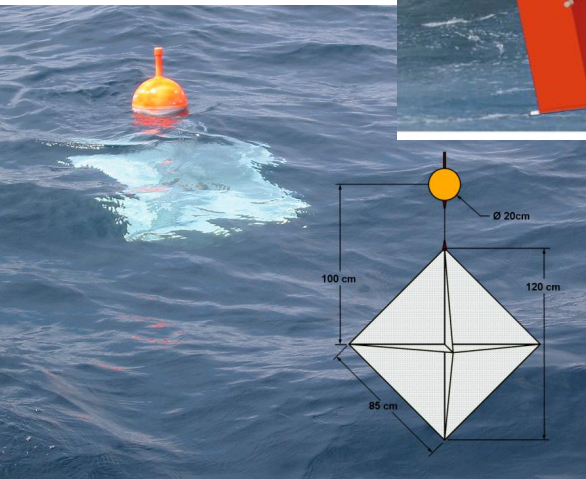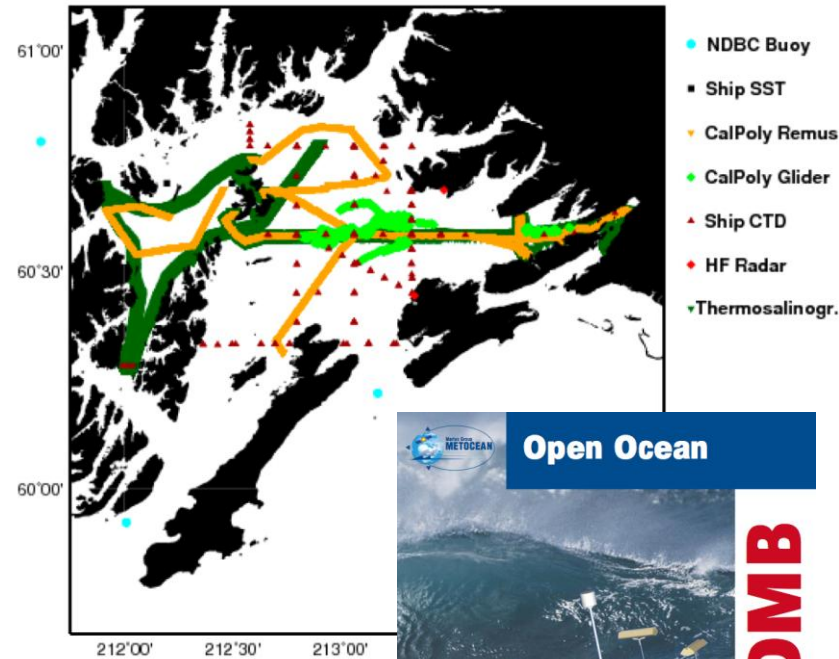
Co-sponsors: Alaska Ocean Observing System; Prince William Sound Science Center

July	2009

Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

`<<` `<` `>` `>>`

ROMS Nowcast
- Temperature
- Salinity
- Current
- Sea Surface Height

ROMS Forecast
- 3D Output

WRF
- Wind

ROMS vs. Data
- Tide Gauge
- Glider Profile
- Ship CTD
- REMUS
- HF Radar
- Sea Surface Temperature

Drifter Trajectory
- Observation
- Prediction
- Ensemble Prediction

Prince William Sound Field Experiment

The JPL OurOcean portal user guide

07/27/2009 - The dominant features on the weather scene today are a high pressure ridge extending northward along the east side of the GOA and a low pressure center rapidly approaching the Alaska Peninsula. Larger-scale forecast models are having difficulty with this low and as a result today's PWS-WRF run was not initialized especially well. In addition, as we enter a period of weaker winds, PWS-WRF is struggling a bit with forecasting wind direction. Winds today have decreased to between 5 and 15 knots over much of the PWS. For the most part, the wind direction continues to be from the east to southeast. PWS-WRF forecasts call for a general continuation of this moderate east to southeast flow through the coming 24 hours, but note that this is a relatively low confidence forecast due to difficulties handling the approaching low pressure center. The flow within much of the PWS as revealed by drifter trajectories and ROMS nowcasts/forecasts continues to be generally northward to northwestward. In addition, ROMS has been suggesting for several days that this flow - which enters through the Hinchinbrook Entrance - has been exiting through the Knight Island Passage/Montague Strait entrance. This flow pattern has been confirmed by recent drifter trajectories, including one released in the Knight Island Passage. The tidal range at all stations continues to slowly decrease from its recent peak. The ROMS ensemble forecast was delayed today, otherwise there were no significant operational issues.

Click *here* to view a more detailed PWS daily summary.

Location of Assets   20090727

- NDBC Buoy
- Ship SST
- CalPoly Remus
- CalPoly Glider
- Ship CTD
- HF Radar
- Thermosalinogr.
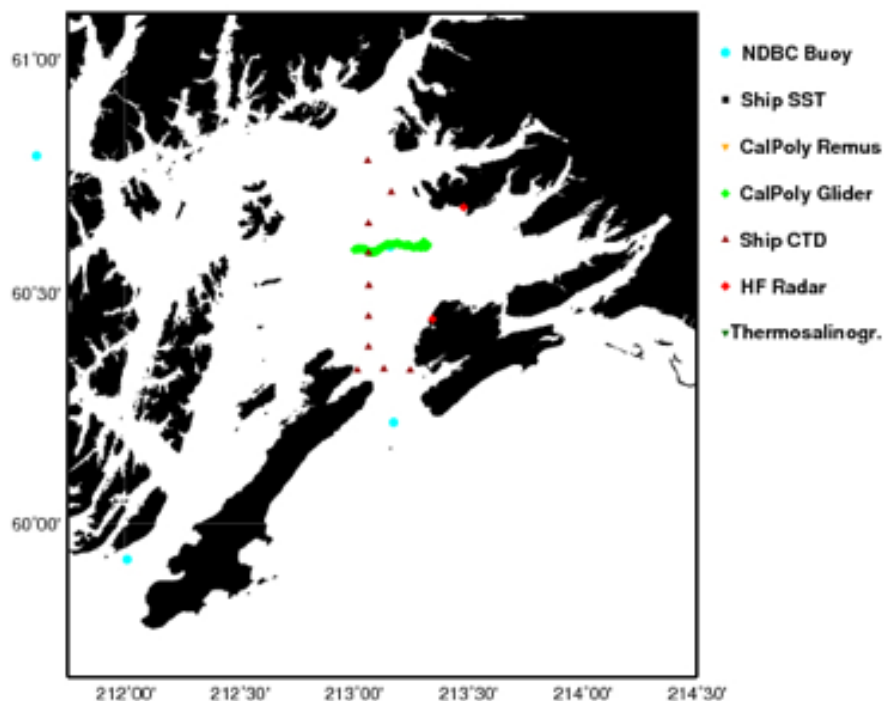
JPL ROMS Analysis & Forecast

End-to-End Integration for Data and Models

One-Stop Portal

http://ourocean.jpl.nasa.gov/PWS

PWS FE Daily Summary

- 08/01/2009

  - Winds have subsided to less than 10 knots over the PWS today and have become west to southwesterly. PWS-WRF forecasts indicate light winds (5 - 15 knots) from this direction will continue for the next 24 - 36 hours.

  - Overall, surface ocean currents throughout the PWS are weaker and more variable in direction than they have been. In the central Sound, currents are also weaker than yesterday with some indication that an eddy might be re-forming there. Today's ROMS forecast, however, does not show much tendency to develop an eddy.

  - The ROMS ensemble forecast was delayed today due to computer problems, otherwise there were no significant operational issues.

- Click here to view a more detailed PWS daily summary.

National Weather Service
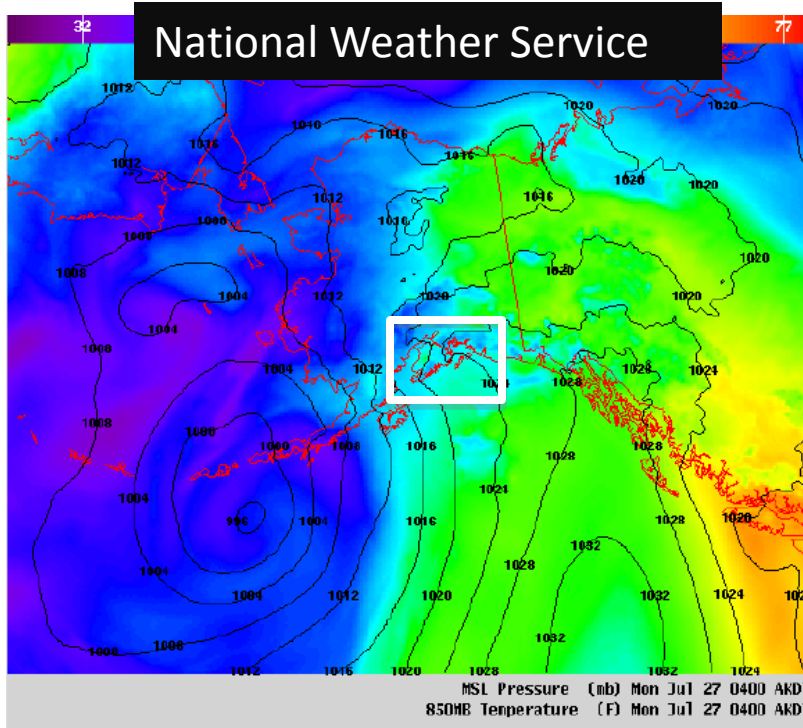
Regional WRF Forecast by UAA/UAF
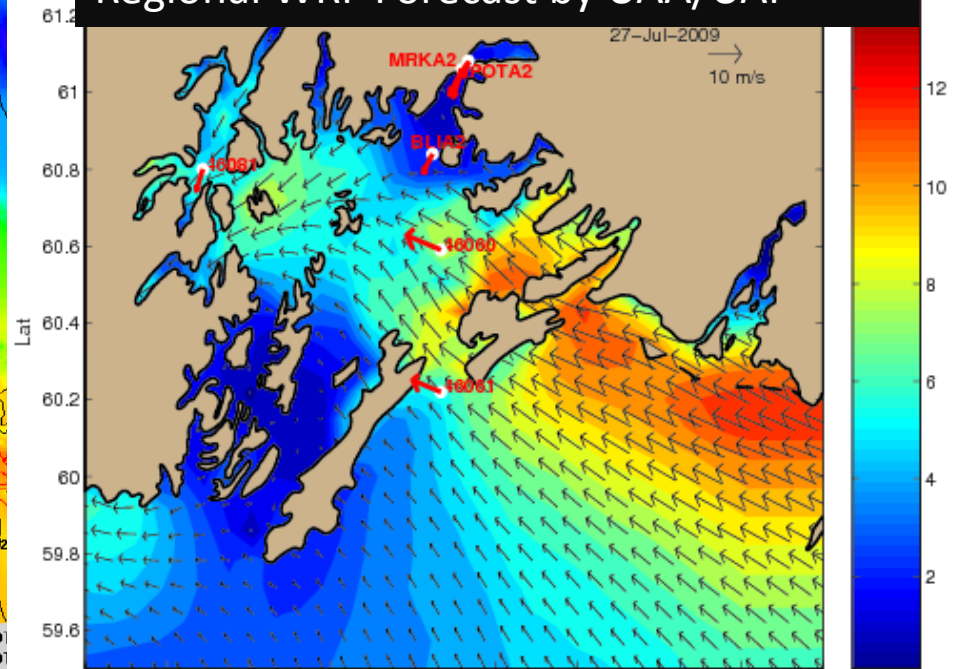
Wind Speed/Direction between WRF and Observation at station 46060

1-km
3-km
9-km
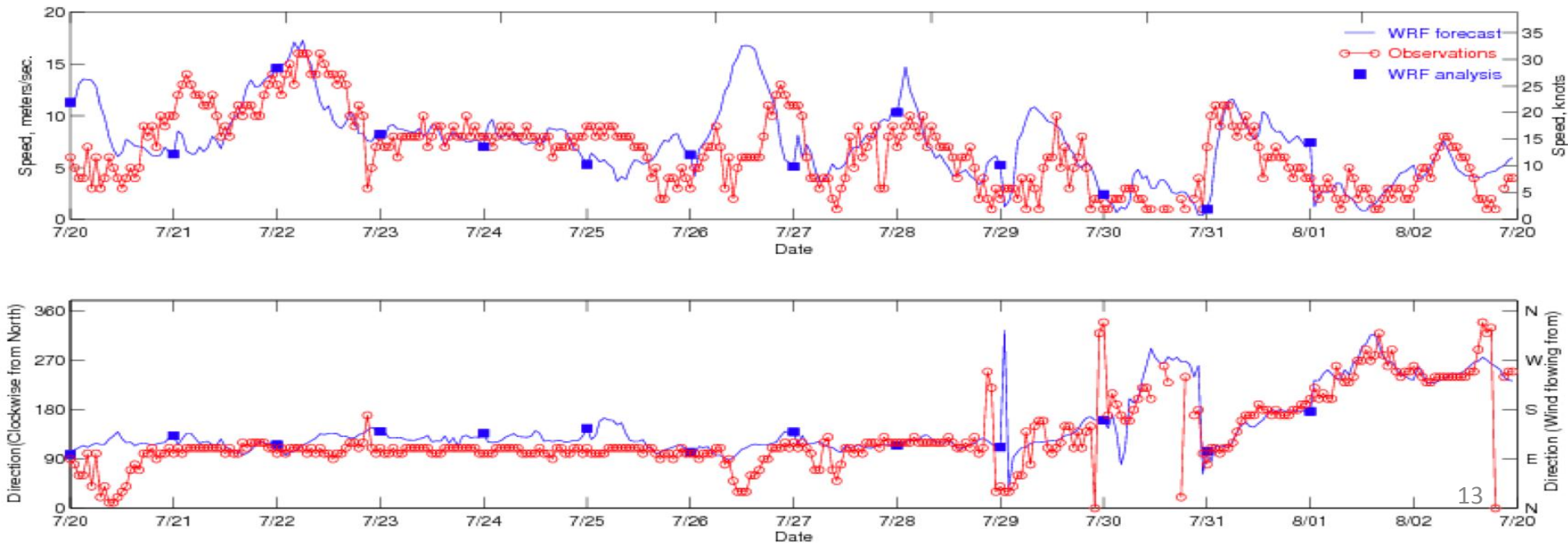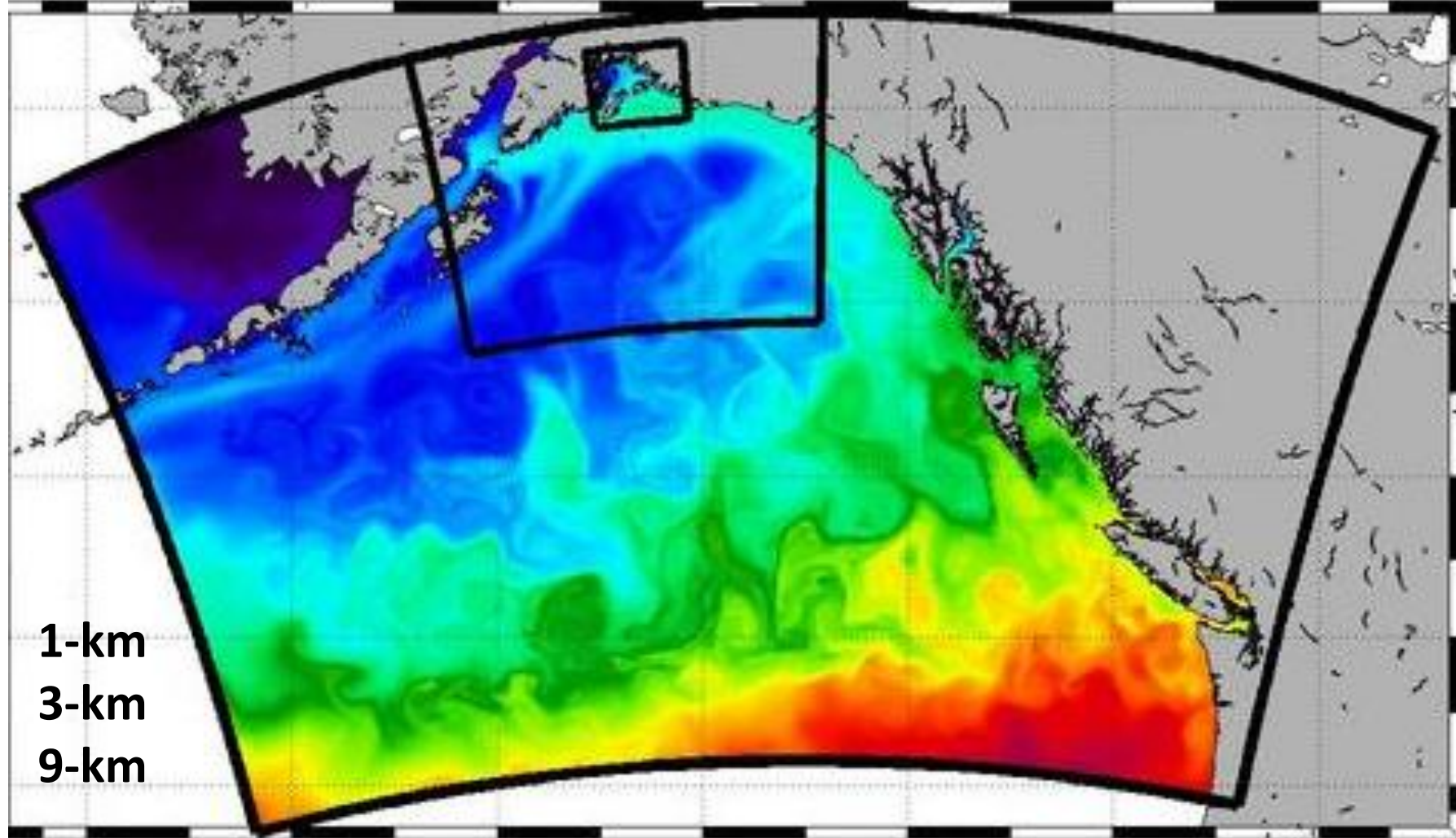
Longitude

168°W 160°W 152°W 144°W 136°W 128°W 120°W

2 4 6 8 10 12 14

14

Sea Surface Salinity

19.0   32.0
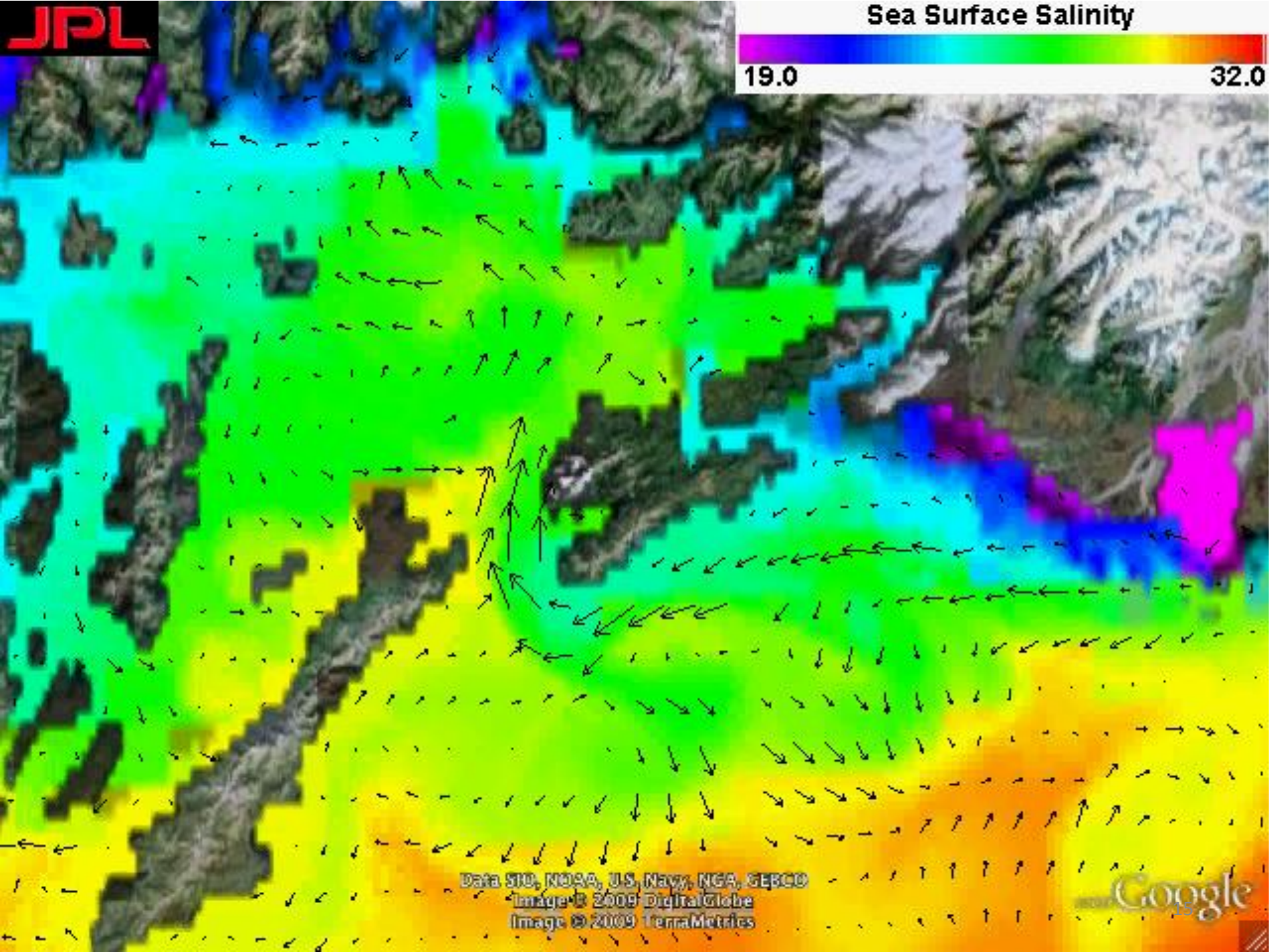
Data Assimilation & Model Initialization to enable better prediction

ROMS Forecast (Y^f)

$Min(Y^f-Y^o)^2$

Δy

Analysis/Nowcast Y^a

$Y^a=Y^f+\Delta y$

Observations (Y^o)

Ensemble Forecast & Error

True Ocean (Y)

Index (Y)

T_o T_o+6 T_o+48 Time
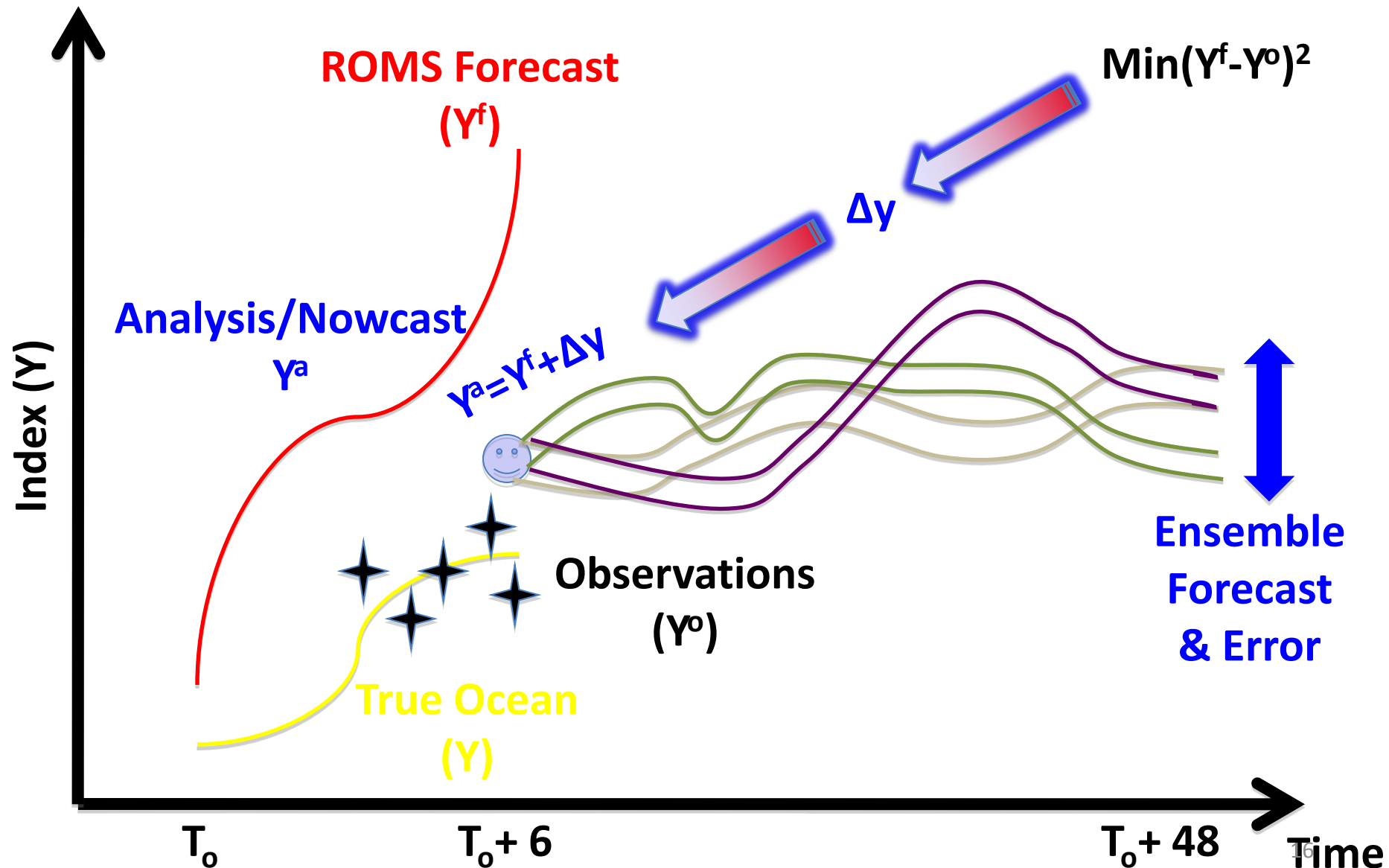
ROMS Daily Mean Surface Currents for July 26, 2009

Sample of four observed trajectories released at various locations within the PWS at different times on July 25. End times are mostly late July 26th

Current (cm/s) at 0 m for 24-hr Mean from 07/26/2009
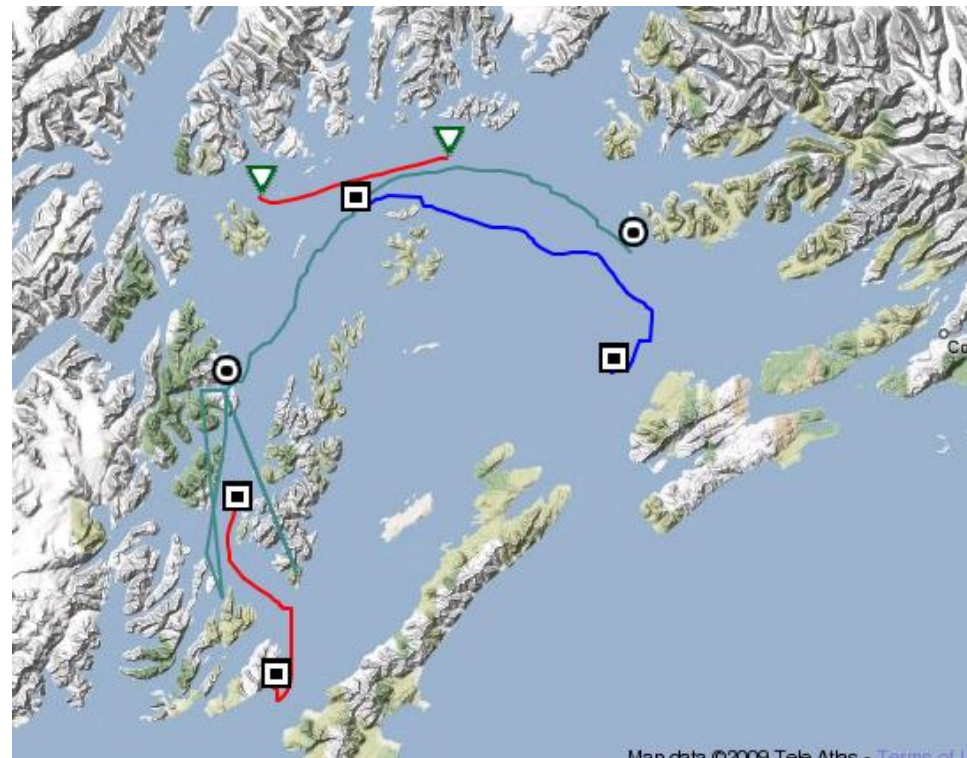
Ensemble Forecast
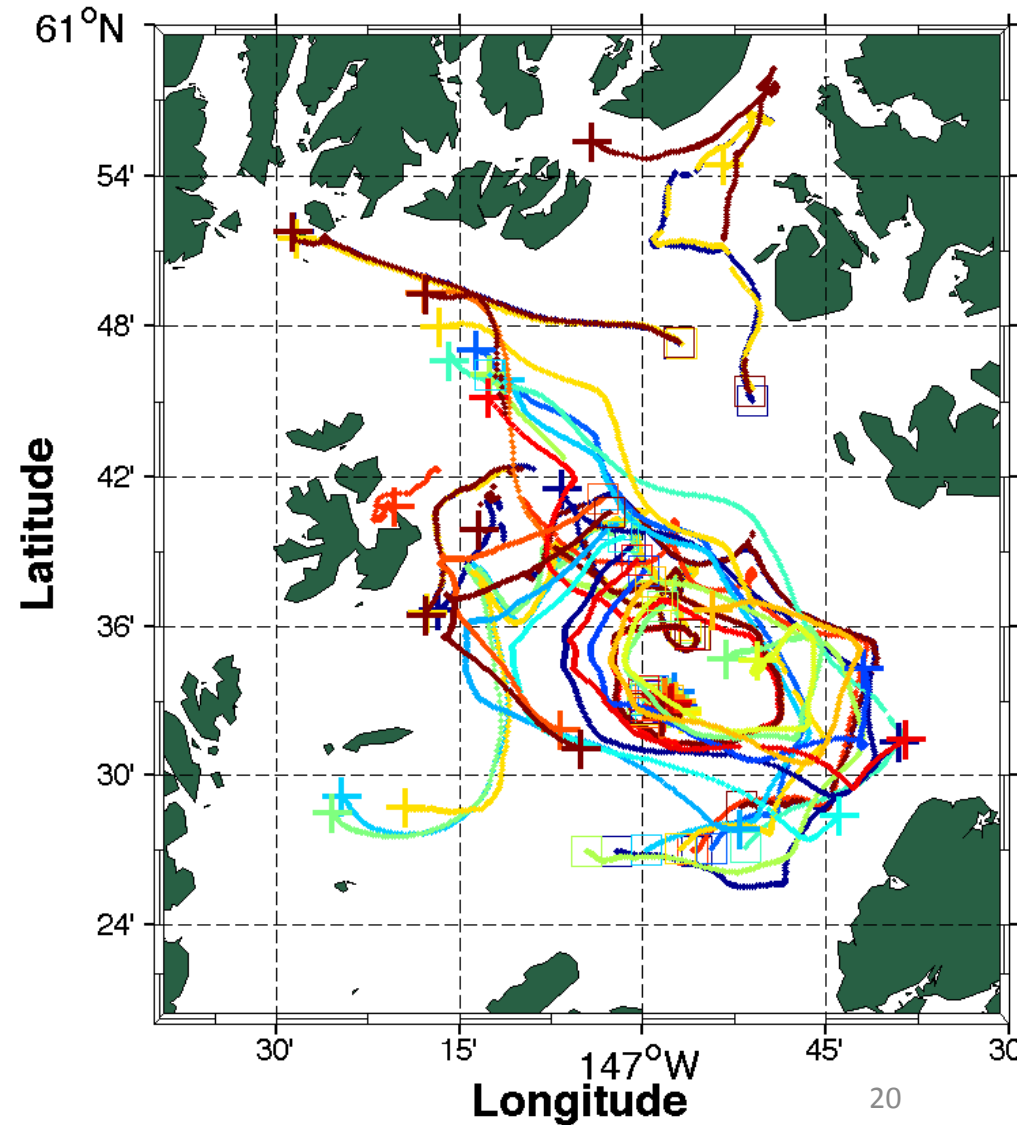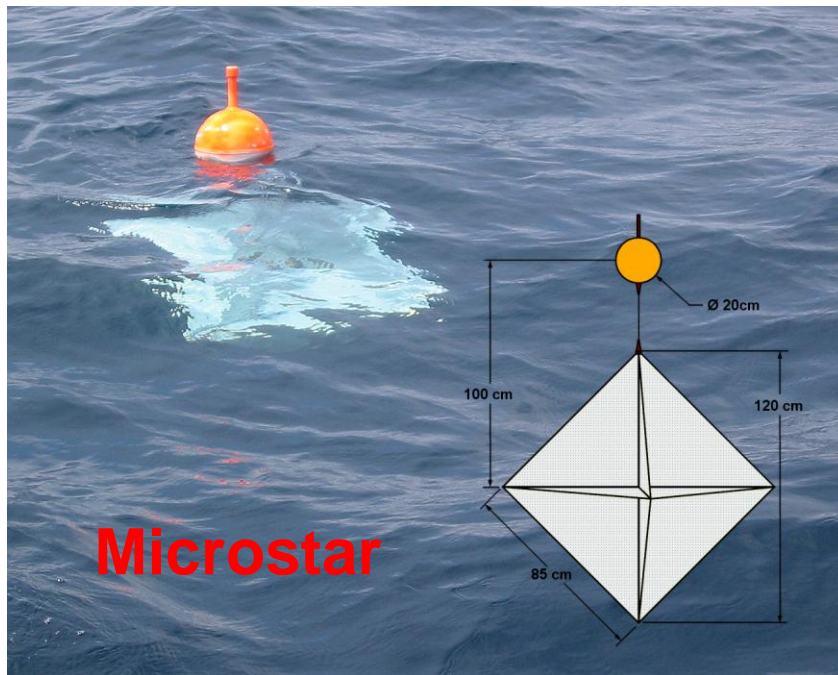# &
Error Estimation
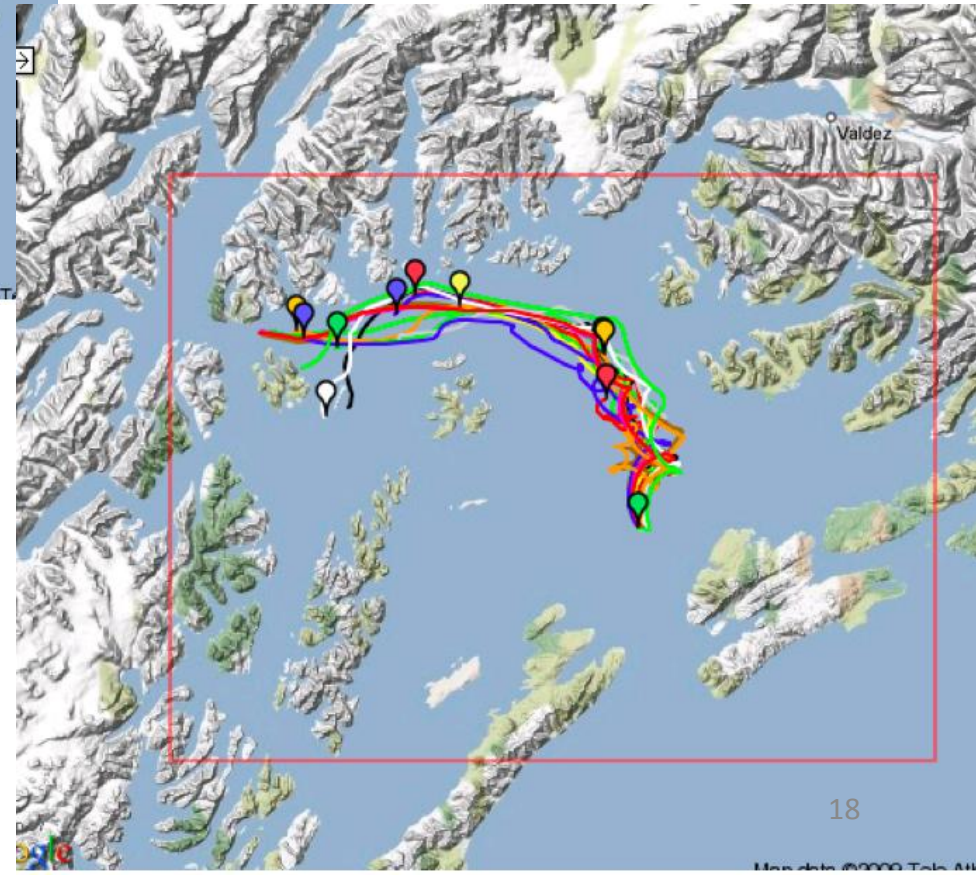
ROMS vs Data (Glider)
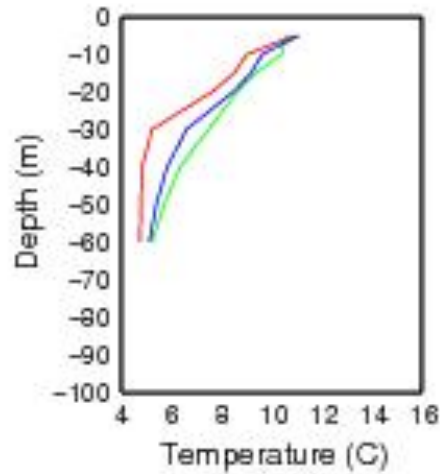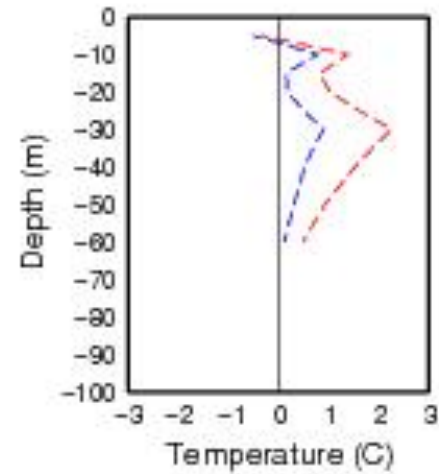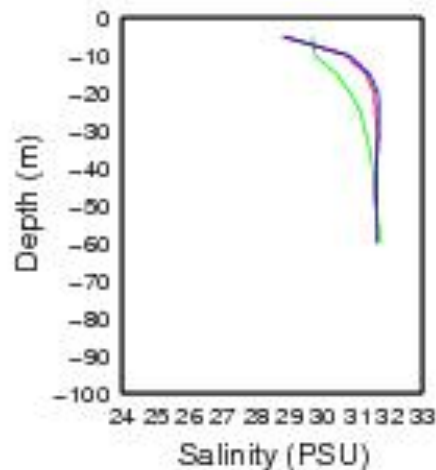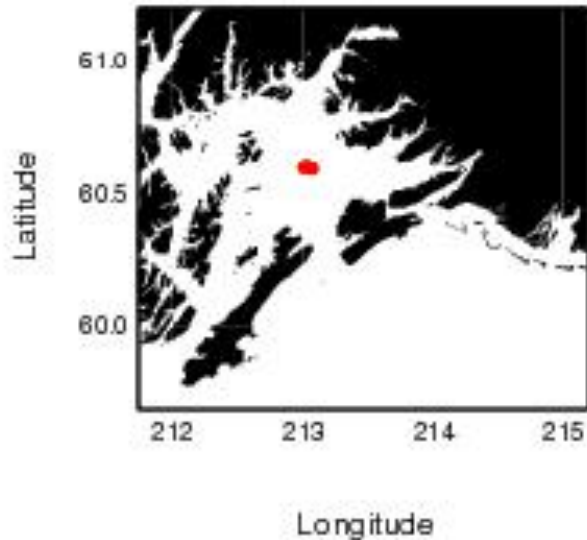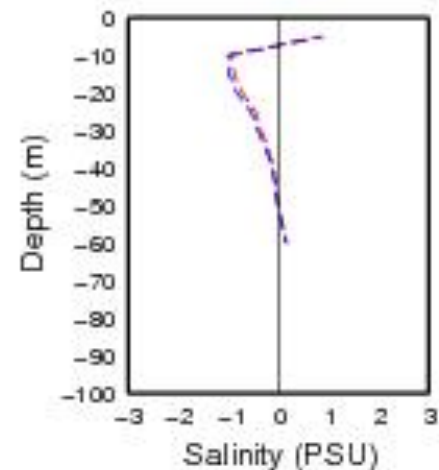
Field Experiment: July 18-Aug 3

Drifting Buoys

Microstar

Future Work Plan

- Year 2: Component refinement and integration
  - PWS FE reanalysis with publications
  - Improve data and refine model
- Year 3: Transition from research to operations
  - Quantify the improvements enabled by NASA data and model via FE-2