How to Use Autonomous Underwater Vehicle Gliders to Make Your Oceanography Better

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- **Autonomous Underwater Gliders**
- **Describe some useful glider operations**
  - **Endurance**
  - **Footprint**
  - **Weather**

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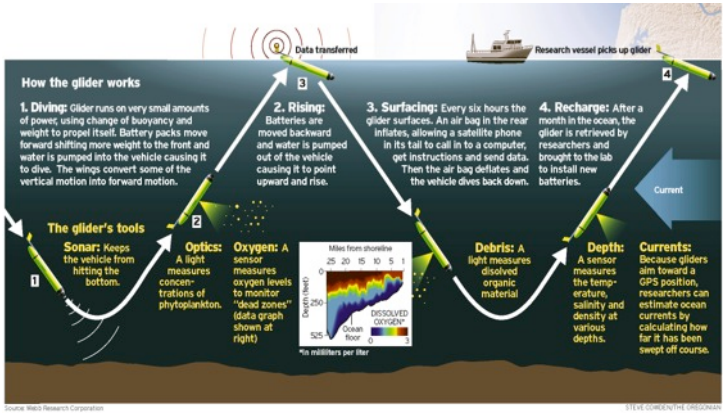
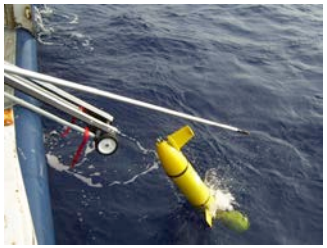
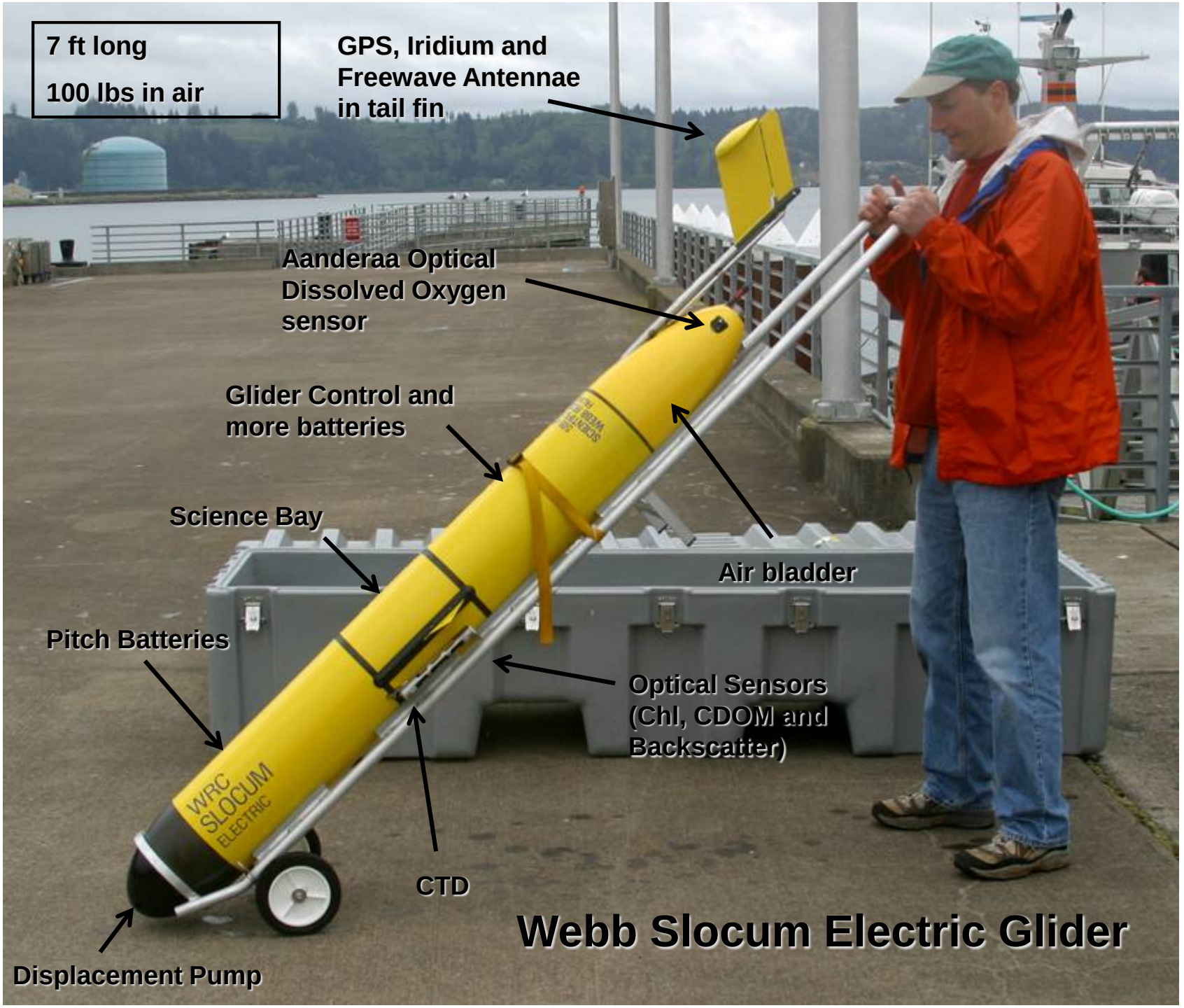
What's a glider?

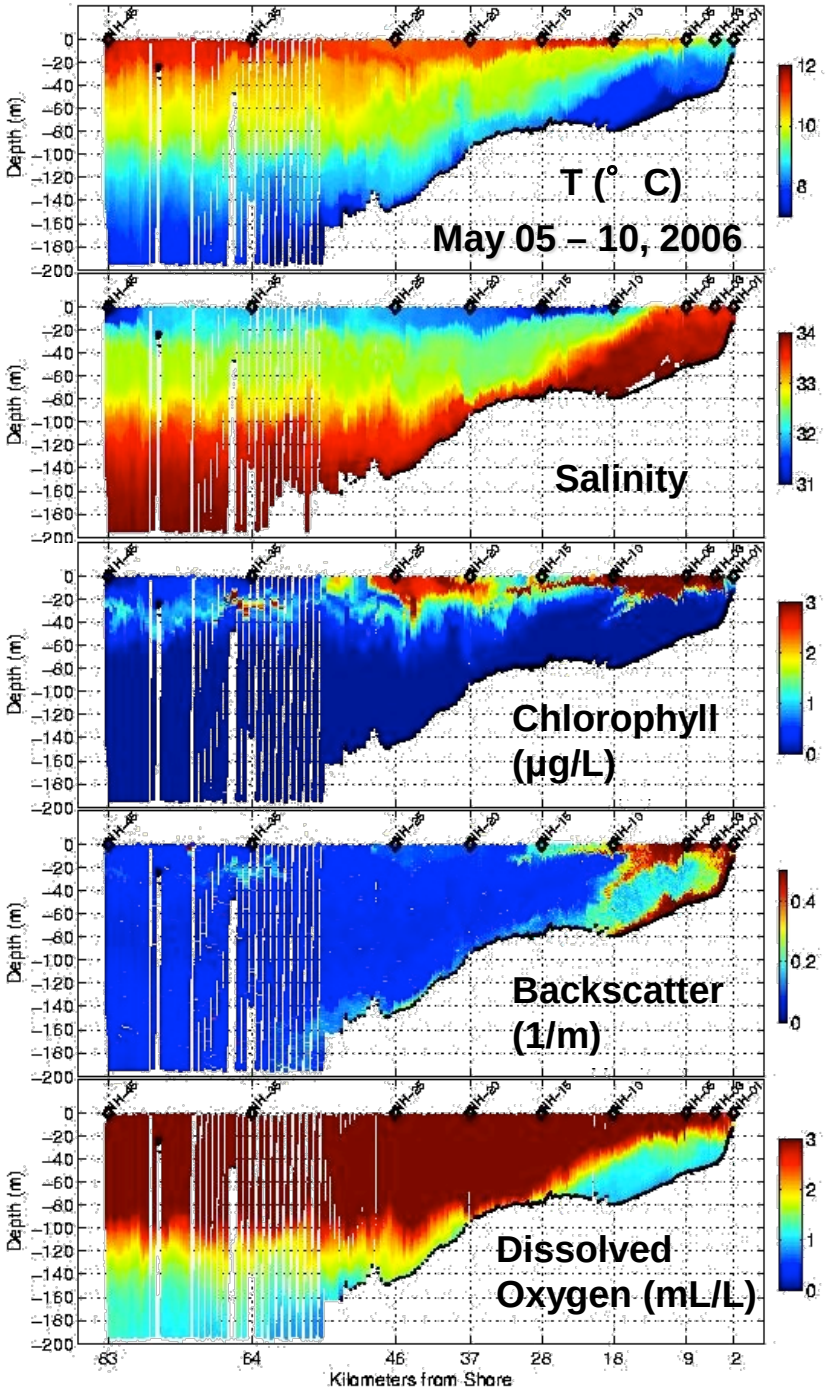
- **Autonomous underwater vehicle – a robot!**
- **Flies by changing its buoyancy**
  - takes on water, becomes heavy and sinks
  - wings turn vertical motion into forward motion
  - expels water, becomes light and rises
  - flies saw tooth pattern through the ocean
- **Slow, but can stay out a long time**
  - ½ knot
  - 3-4 week endurance



- **Collects same data you would on a research vessel at a fraction of the cost**
  - Research vessel: approx. $20K/day (fuel + crew)
  - Glider: $150K to buy + $200-1000/day (batteries + communications + techs)
  - 3500 days of glider operation:
    3500 days x $20K/day – 4 x ($150K+3500 days x $1000/day) = $55 million saved!




7 ft long
100 lbs in air
GPS, Iridium and Freewave Antennae in tail fin
Aanderaa Optical Dissolved Oxygen sensor
Glider Control and more batteries
Science Bay
Air bladder
Pitch Batteries
Optical Sensors (Chl, CDOM and Backscatter)
CTD
Displacement Pump
WRC SLOCUM ELECTRIC
Webb Slocum Electric Glider



Shelf Glider Sections

- ~20 km day (21+ day endurance)
- Very high spatial resolution
- Surface to Bottom coverage (200 m max)
- Surface every 1-6 hr to get GPS fix, download data and receive new instructions (via Iridium)
- Keep track via web:

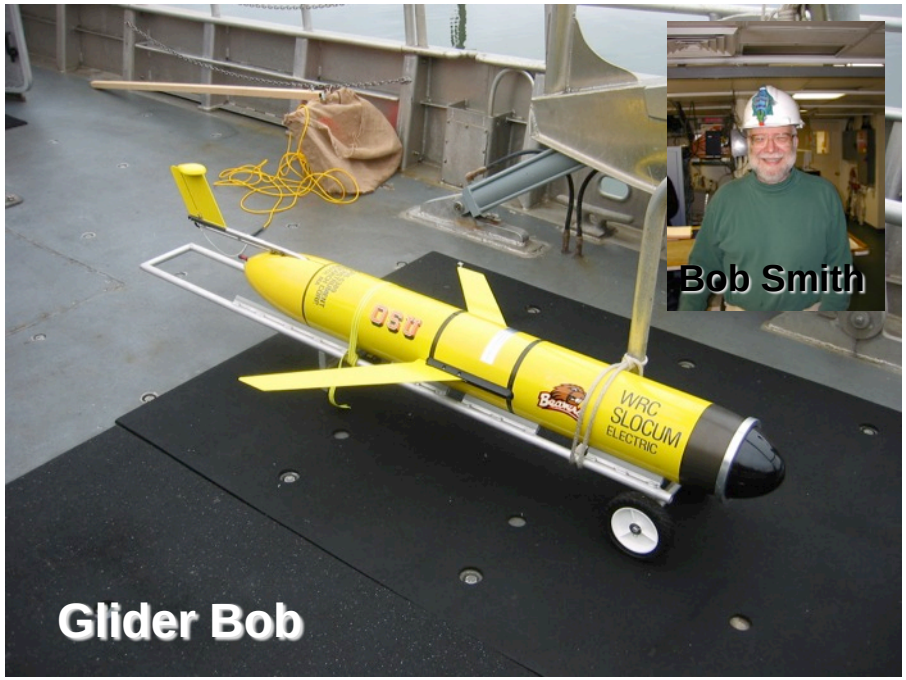
gliderfs2.coas.oregonstate.edu/gliderweb

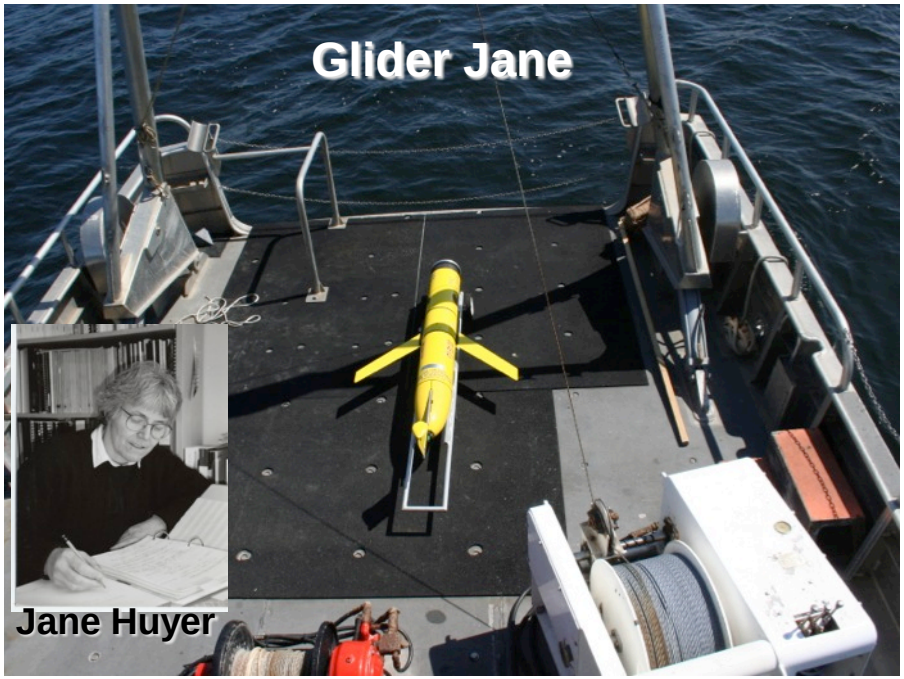
The OSU Glider Fleet

3 TWR Slocum 200 m
CTD, chl, bs, cdom, DO
CTD, microstructure

1 TWR Slocum 1000 m
CTD, chl, dye, bs, ADCP

5 UW/iRobot/Kongsberg Seagliders 1000 m
CTD, chl, bs, cdom, DO, PAR





Not true!

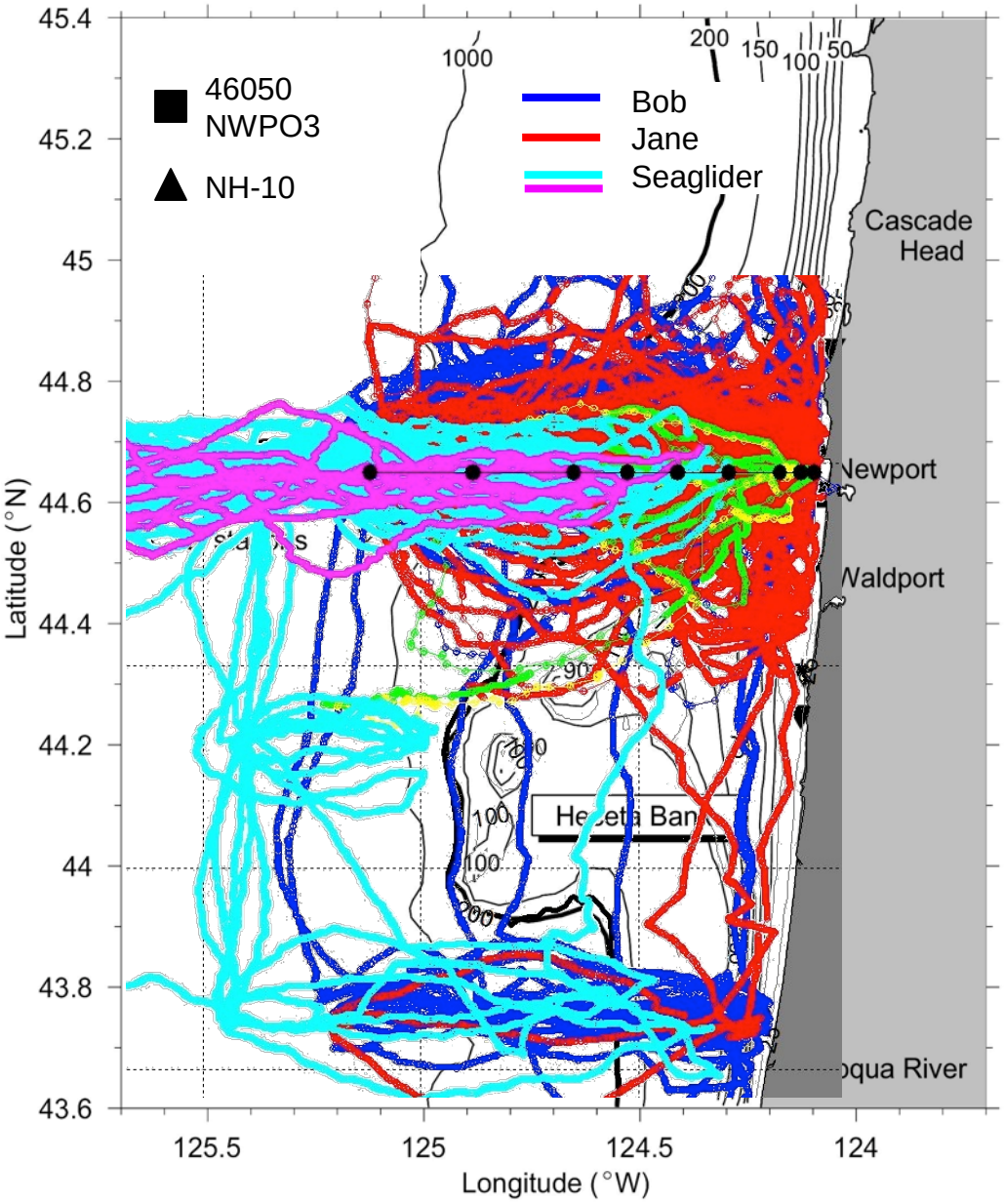
Just because it says autonomous, doesn't mean you get to sit around and do nothing …

Useful Glider Ops Versus Less-Useful Glider Ops

	vertical range	*vertical resolution*	*speed*	*horizontal resolution*	*endurance*	*cost factors*	*synopticity*	*unique advatages*
Ship w/towed profiler **$$$$**	0-400 m air-sea interface	high	8 knots	high	30 days	ship-based operations	medium	3D surveys at high speed large, flexible payload
Mooring **$$$**	full ocean depth air-sea interface	typically low	stationary	very low	1-2 years	ship for servicing	high (temporal)	long Eulerian time series
Gliding AUV **$$**	0-1000 m	high	0.5 knot	high	6 months	semi-expendable	low	endurance
Propeller AUV **$$$**	0-200 m	high	3 knots	high	1-2 days	intensive operations	medium	precise navigation
Float/drifter **$**	0-1500 m	high	drifts w/ currents	low	1-3 years	expendable	low	low cost Lagrangian nature
Ship w/ CTD **$$$$**	full ocean depth air-sea interface	high	10 knots	typically low	30 days	ship-based operations	low	extensive range of science operations supported

- All platforms have strengths and weaknesses
- Glider strengths are low cost, high resolution and long endurance
- Glider weaknesses are slow speeds, coarse navigation, and limited payloads

What we must avoid at all costs is the op where you deploy a glider and then follow it around with a research vessel …



Endurance

Newport Line

- **80 km cross-shelf**
- **Strong currents (50+ cm/s)**
- **Complex Bathymetry**
- **Historical Observations (1950s)**

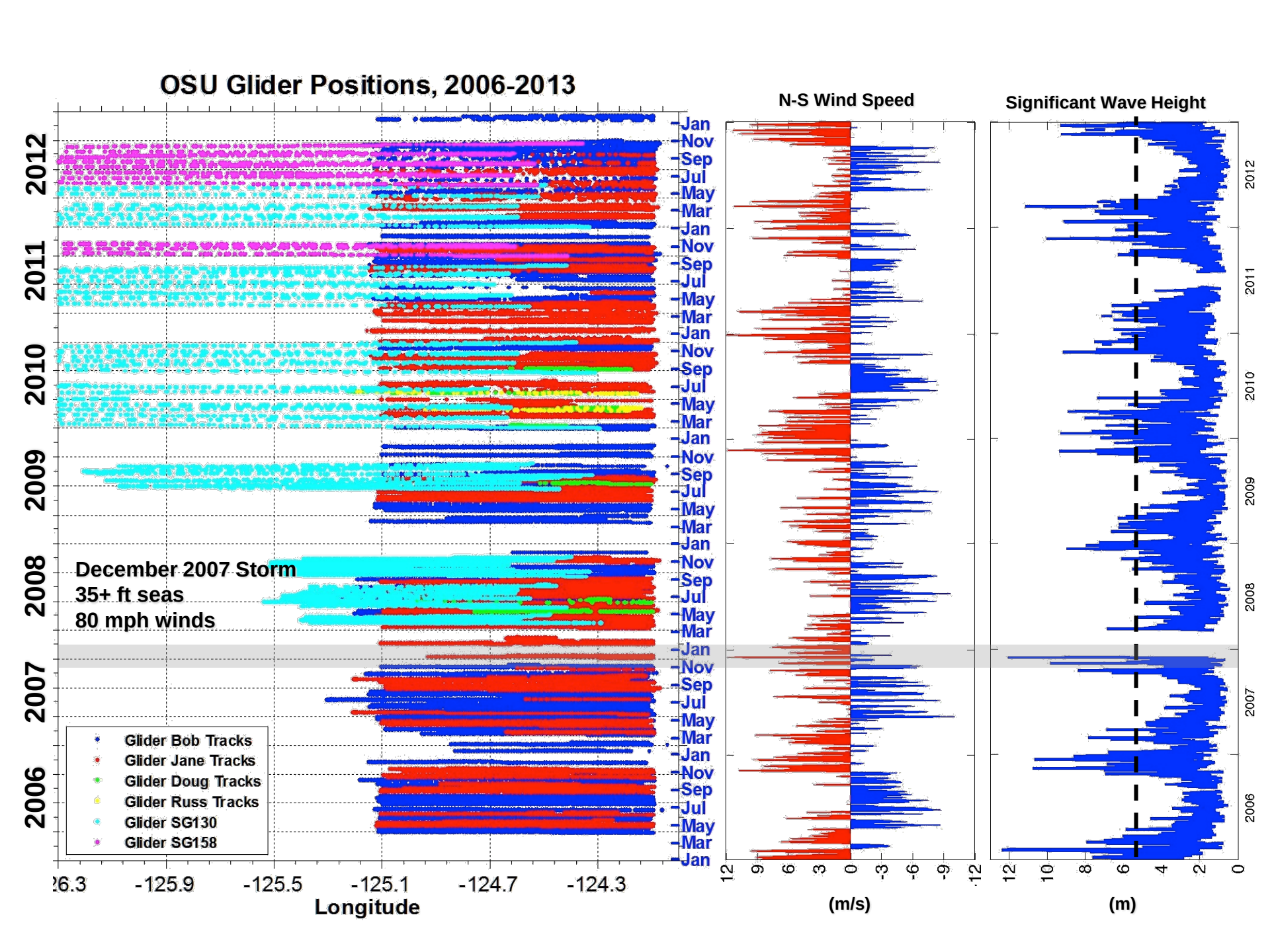
April 2006 – Nov 2014

- **3486 glider-days at sea**
- **187 deployments**
- **82,120 km**
- **260,190 vertical profiles**

Use a variety of ships to get the gliders in/out of the water

Be prepared for emergency recoveries

Don't assume piloting will be trivial

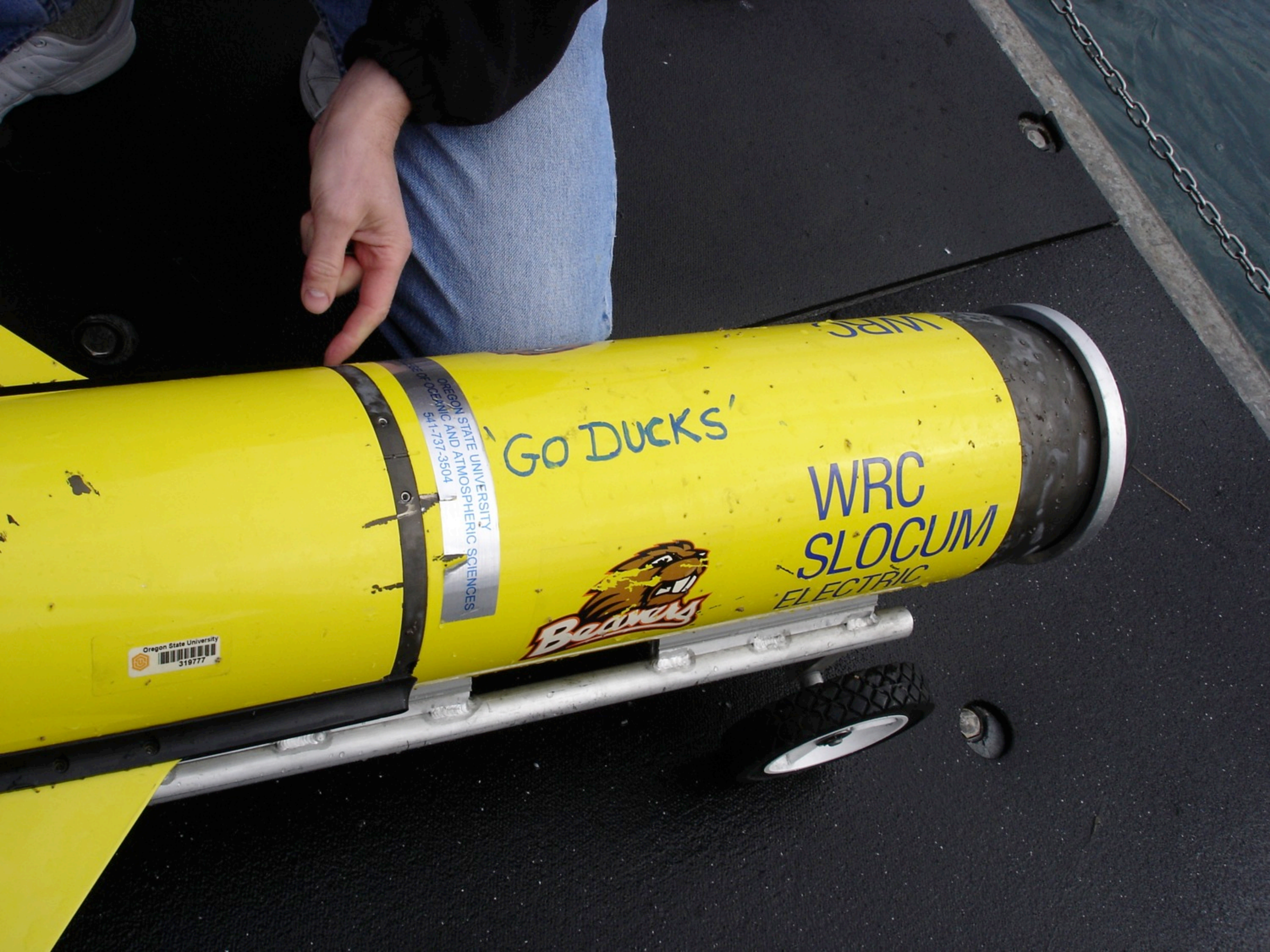

OSU Glider Positions, 2006-2013
N-S Wind Speed
Significant Wave Height
December 2007 Storm
35+ ft seas
80 mph winds
Glider Bob Tracks
Glider Jane Tracks
Glider Doug Tracks
Glider Russ Tracks
Glider SG130
Glider SG158
Longitude
-125.9
-125.5
-125.1
-124.7
-124.3
(m/s)
(m)
2006
2007
2008
2009
2010
2011
2012
Jan
Mar
May
Jul
Sep
Nov

Glider Stories: Jane is in a bit of a pickle …

Wow!!! You are the best glider pilots in the world!!! I bow to your precision!!! osc

Oscar Schofield, Rutgers U.

We're collaborating with local fishermen …


'GO DUCKS'
WRC
SLOCUM
ELECTRIC
OREGON STATE UNIVERSITY
OF OCEANIC AND ATMOSPHERIC SCIENCES
541-737-3504
Beavers
Oregon State University
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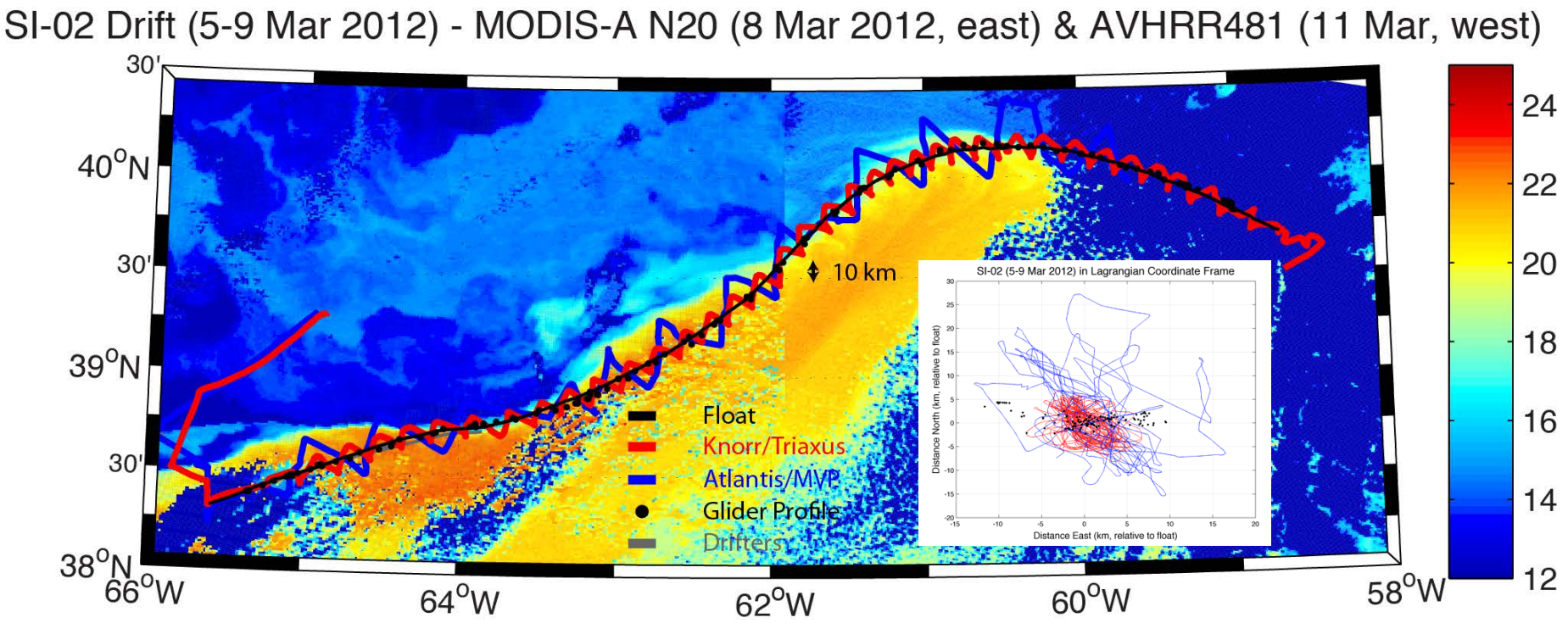
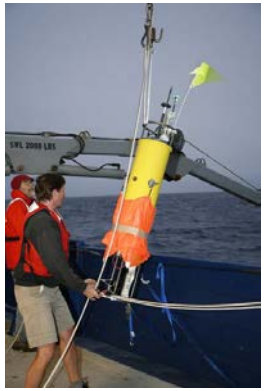
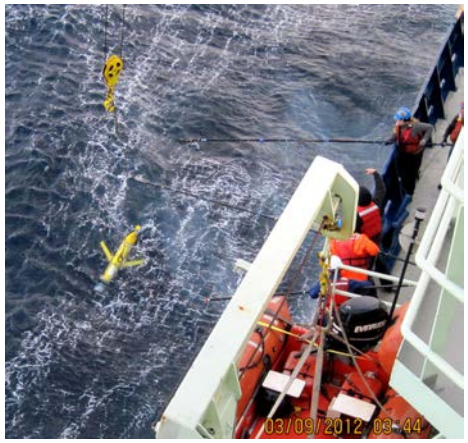
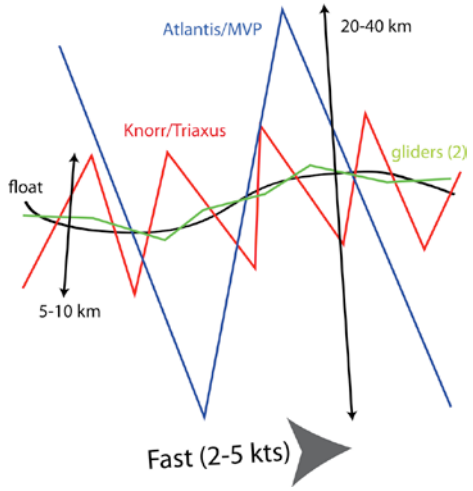
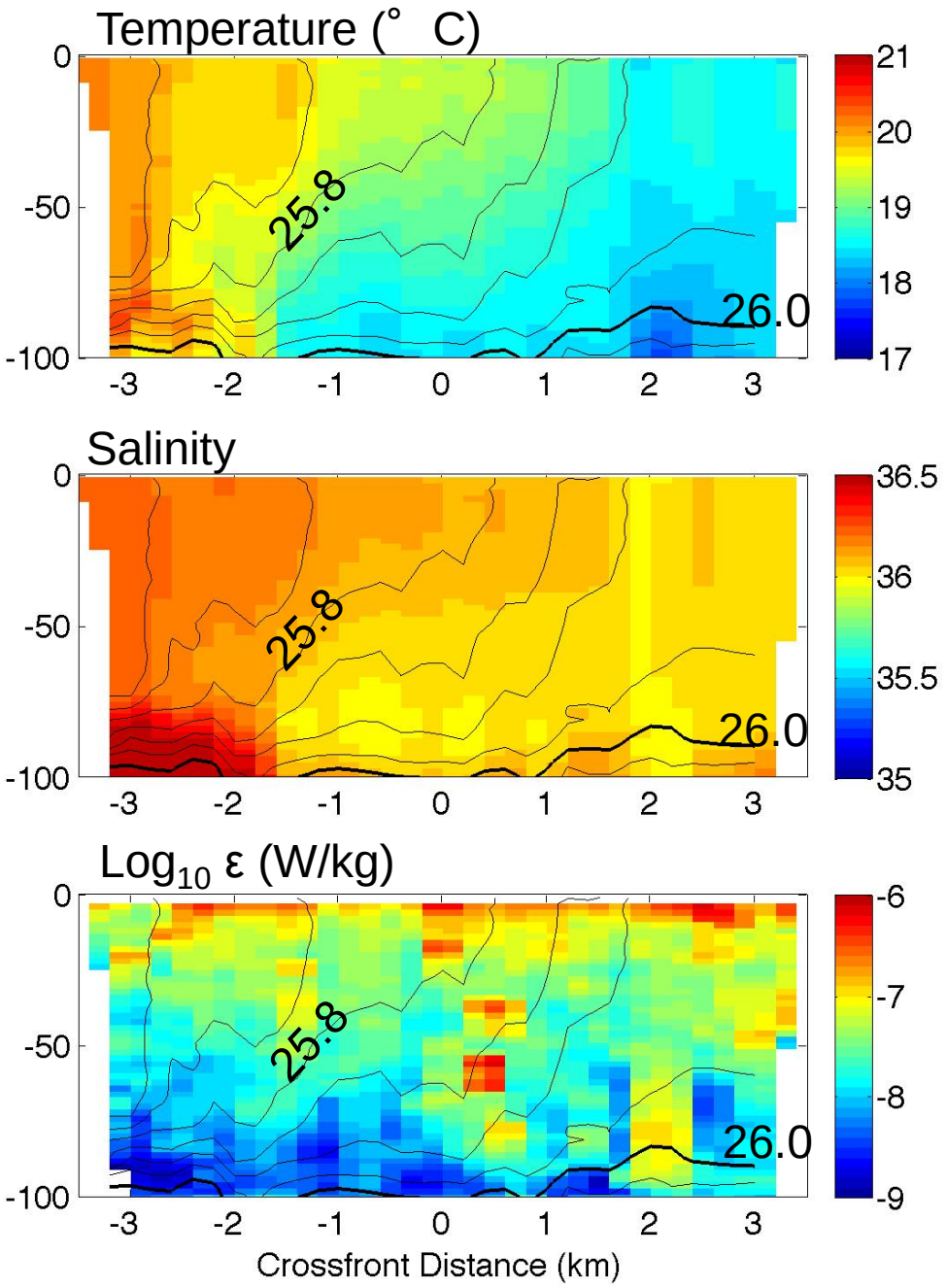
Enhancing Ship-based Survey Footprint









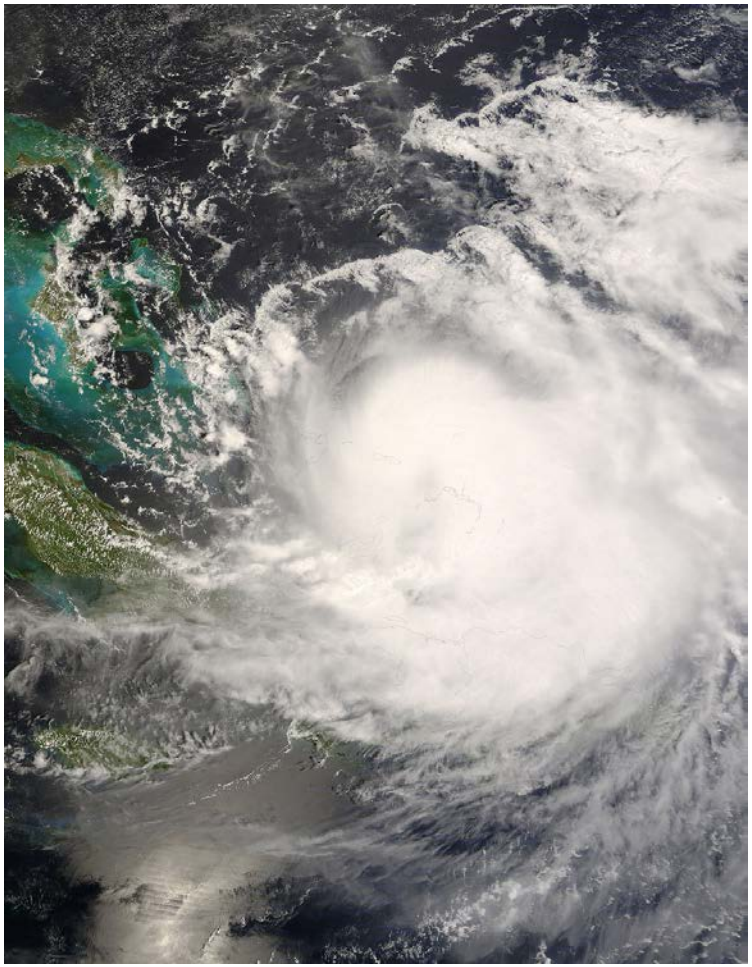


Average section

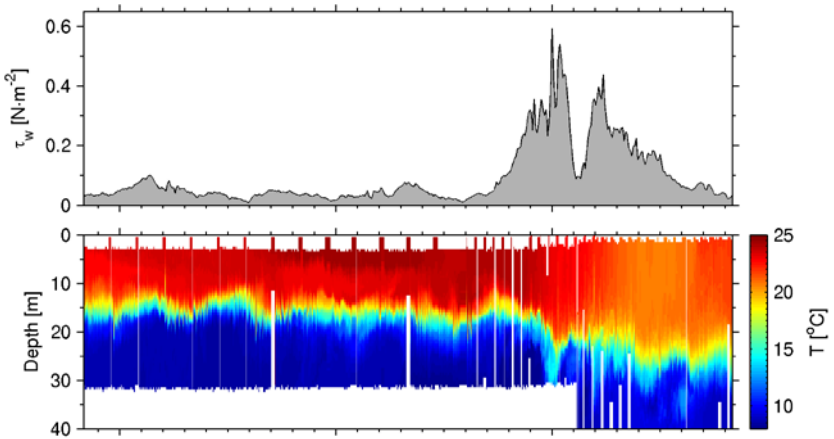
Vastly increased data and resolution at the front

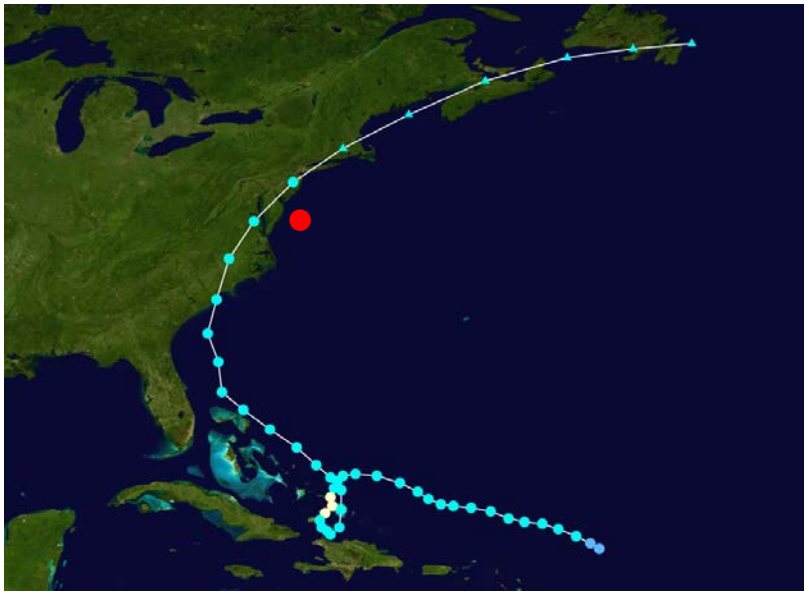
Better characterization of the structure on small scales

Continuous Sampling in Bad Weather



Tropical Storm Hanna Sep 2008





Autono-my-ass

- Autonomous Underwater Gliders
  - Slow, rough navigation & limited sensor payload
  - Cheap, high spatial resolution & long endurance
- Useful glider operations
  - Endurance, Footprint & Weather