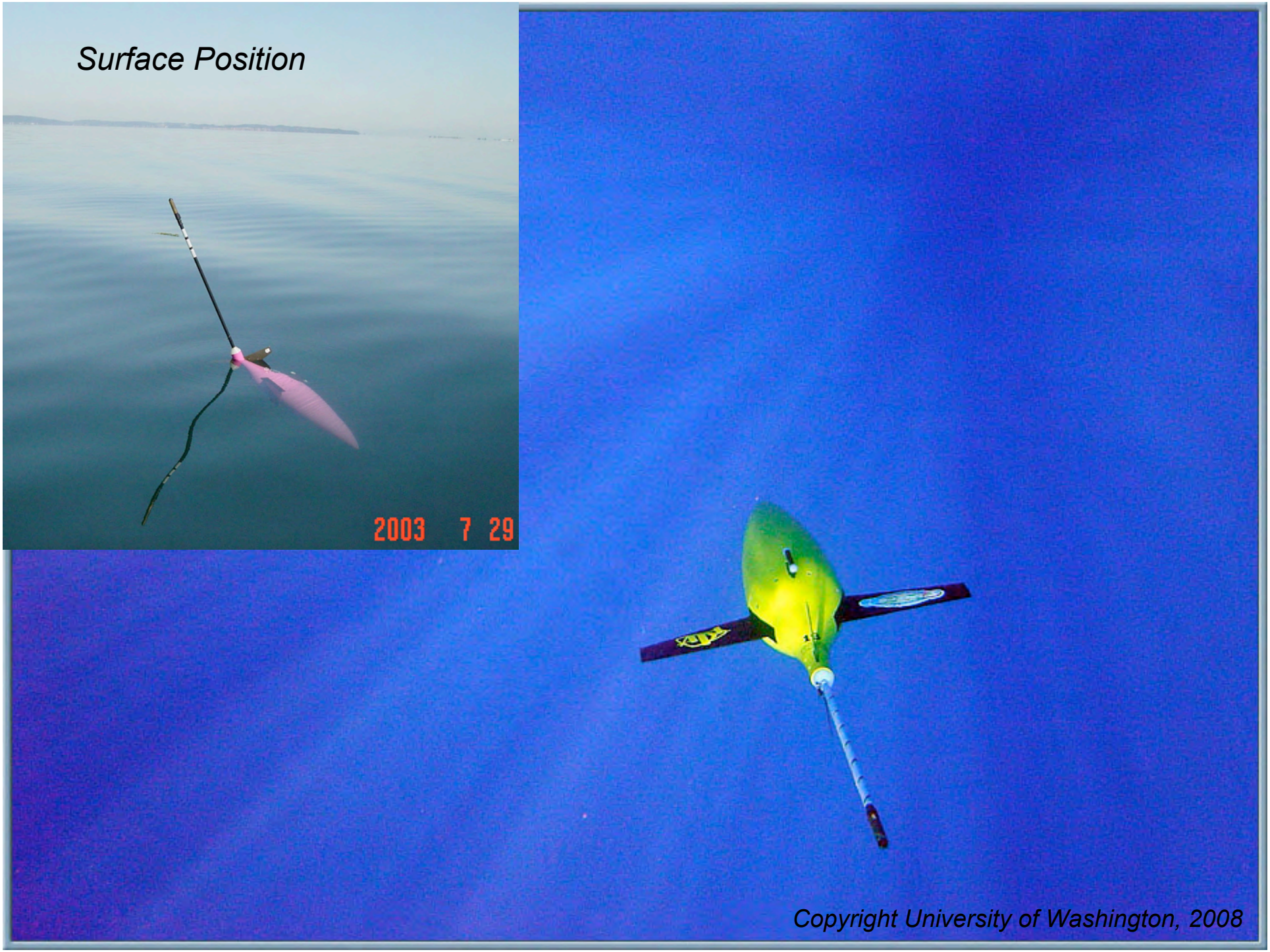
Seaglider -

Some projects, data, and results from Univ. of Washington and collaborators

Fritz Stahr
School of Oceanography
University of Washington


Surface Position
2003 7 29
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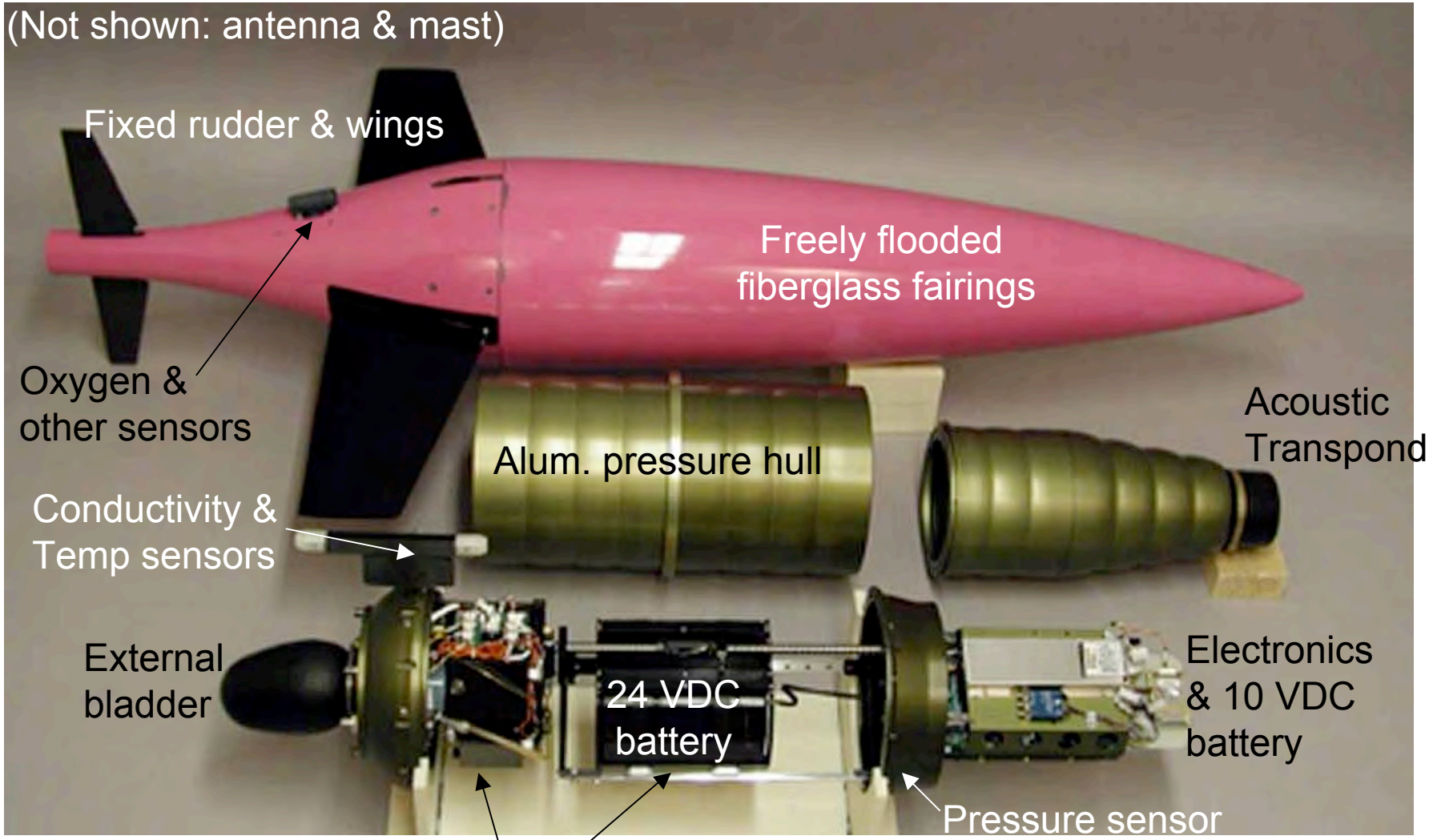
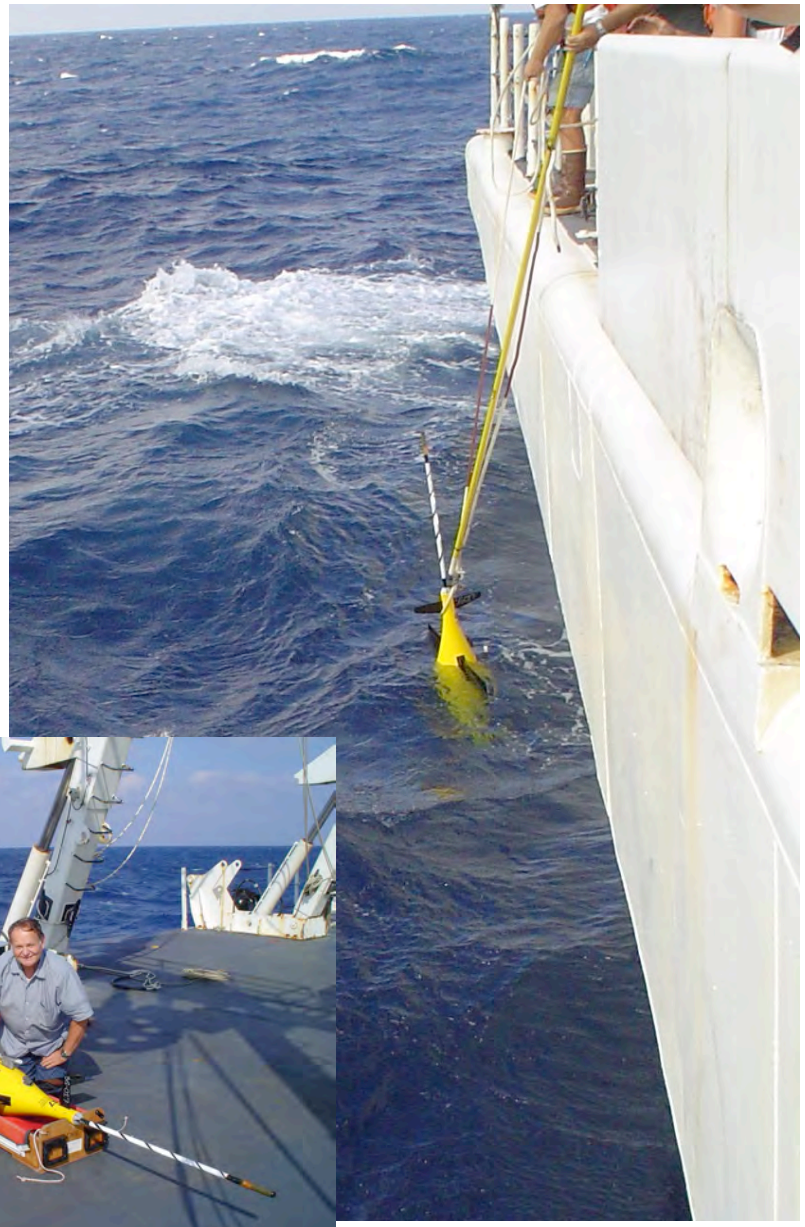
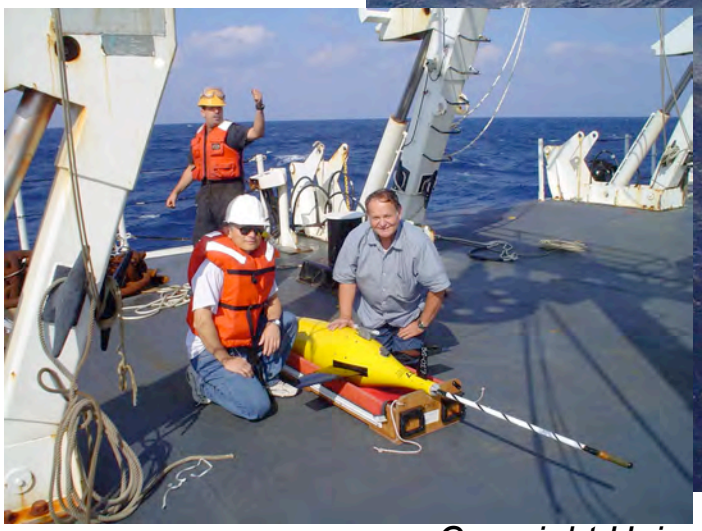
Seaglider - main systems & parts

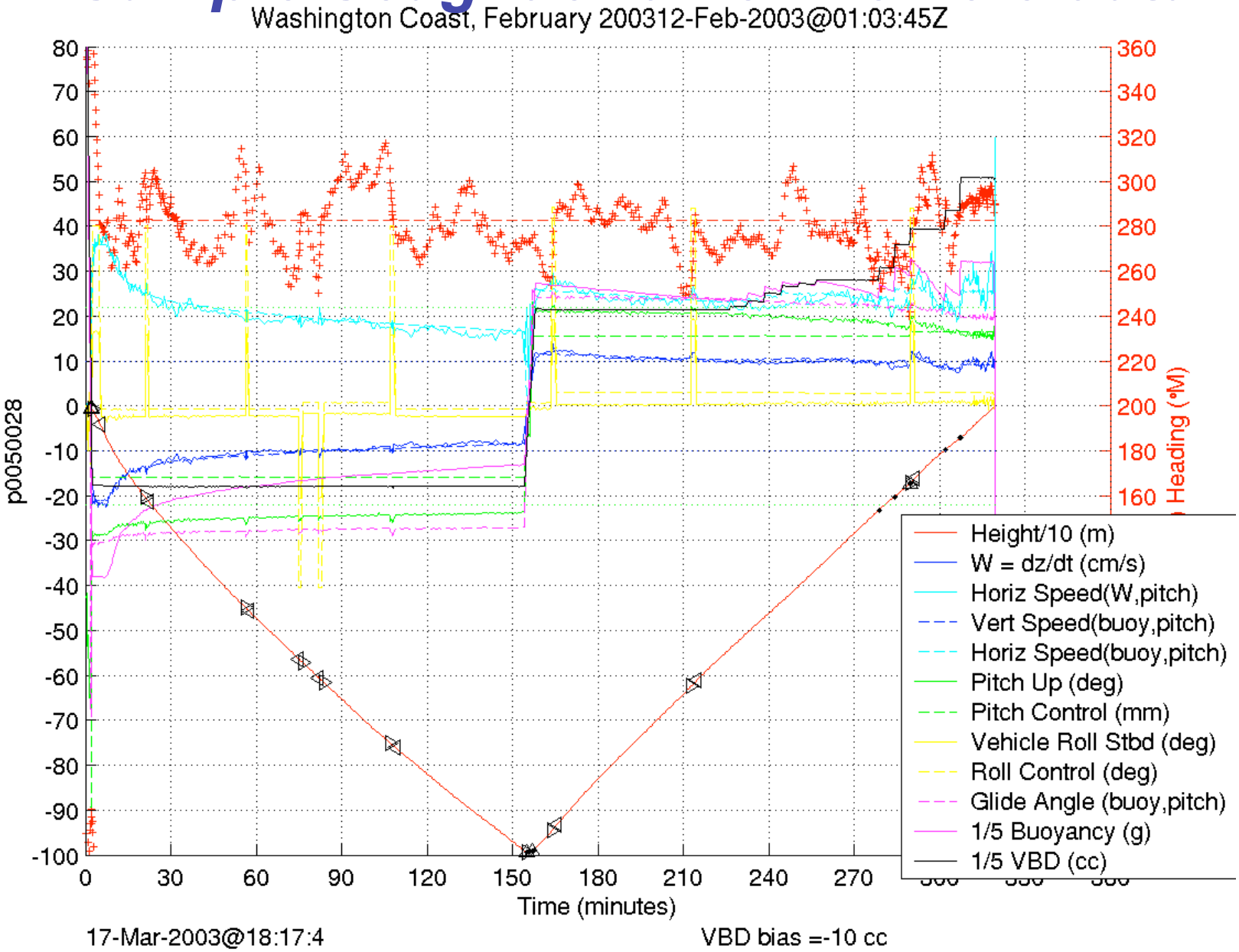


Launch & recovery from small or large ships





Sample Seaglider dive - vehicle data

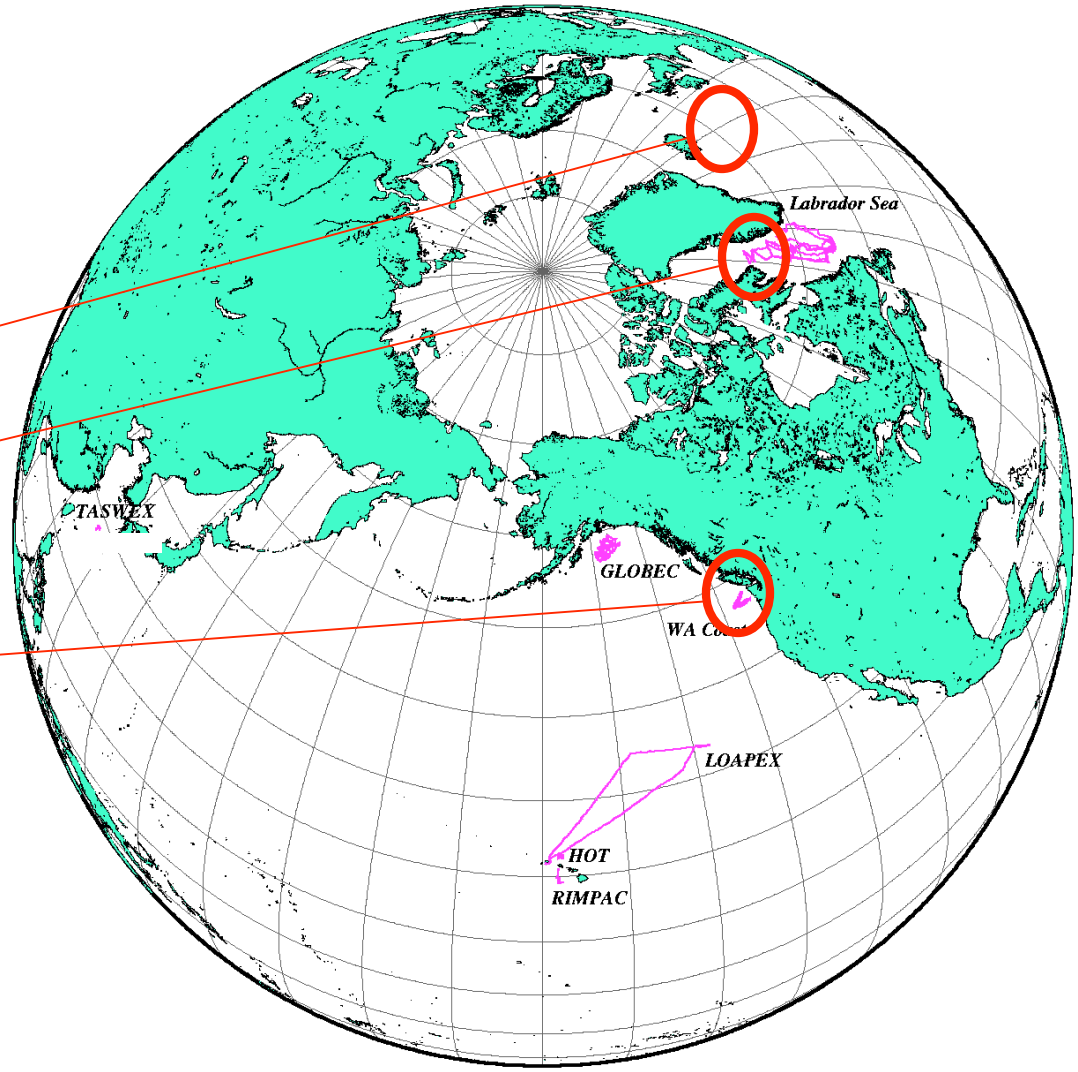


Seaglider Operations Worldwide

Seaglider Deployments 21 August 2003 - 21 April 2005

A wide variety with UW scientists:

- Winters (2) in Labrador Sea
- Gulf of Alaska - GLOBEC
- North Atlantic Bloom '08
- Hawaii Ocean Time-series (HOT)
- Davis Strait
- Kuroshio Current
- WA coast time series
- Various Navy exercises (RIMPAC, TASWEX, etc.)



University of Washington School of Oceanography & Applied Physics Laboratory

Cascadia - Washington Coast

A time-series study

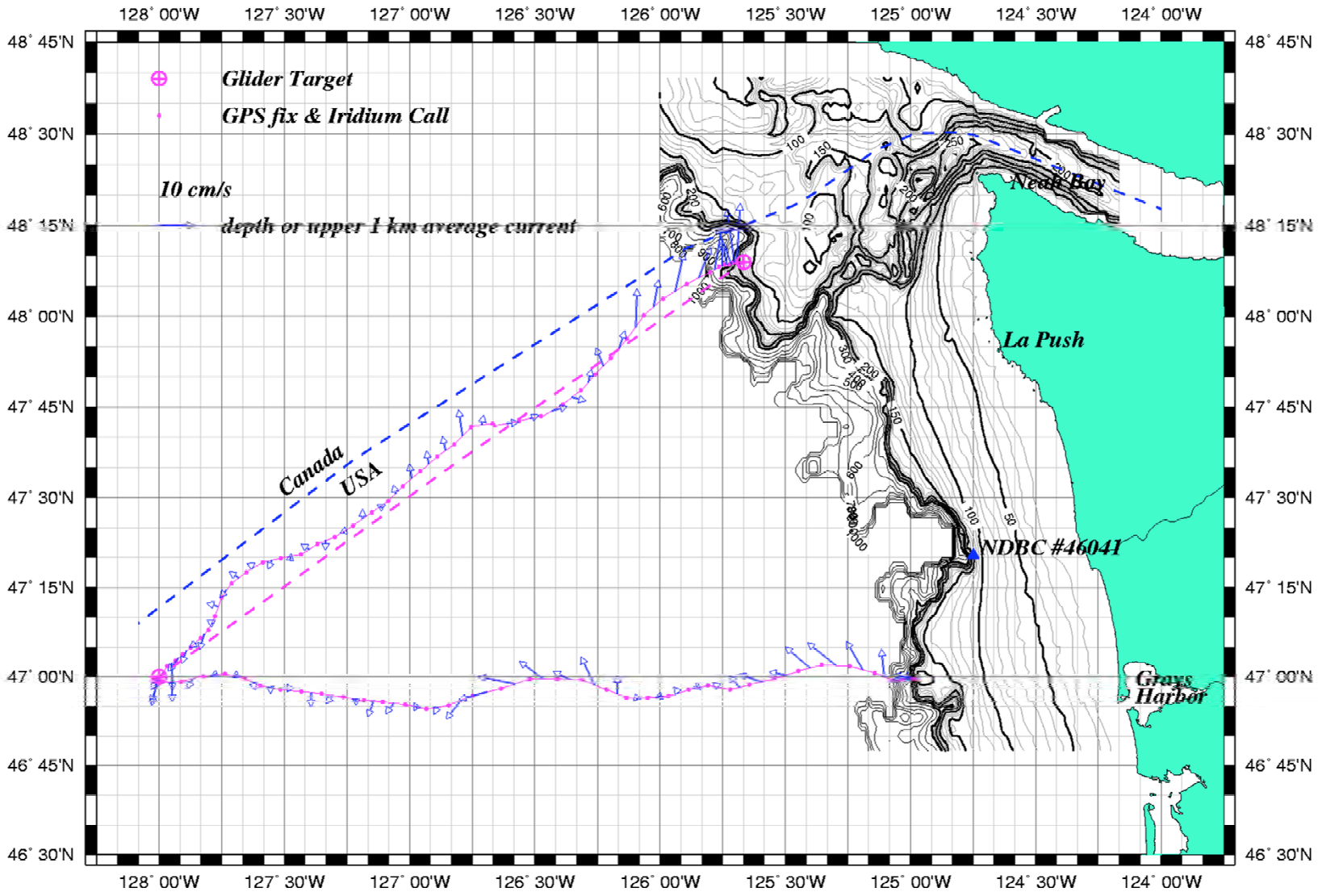
PIs: Charlie Eriksen (UW), Craig Lee (UW), Mary Jane Perry (U. of Maine)

Recent Publication: *Seaglider observations of subsurface bloom and chlorophyll maxima off the Washington coast*, Perry et al, Limnol. Oceanogr., 53(6), 2008

Duration: September 2002 to present, nearly continuous

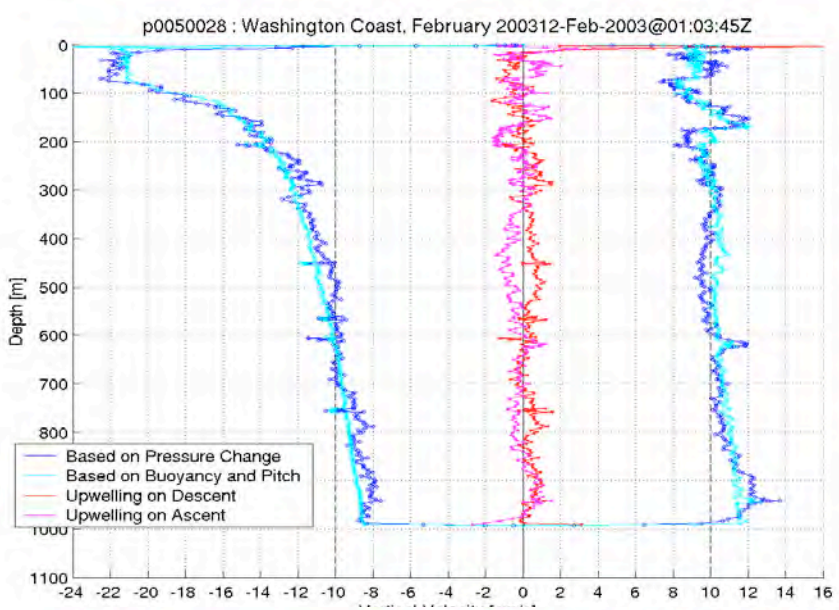
Results: "…4 yr of sampling within 25 km of the vertex demonstrate the value of gliders in ocean observing and their capability to carry out multiyear, fully autonomous operations under any sea state. The **true power of glider programs will be realized in combination with other measurement platforms**, **includin**g larger spatial coverage by **satellites** and more comprehensive biogeochemical measurements from **moorings** and occasional **ship-based sampling**.

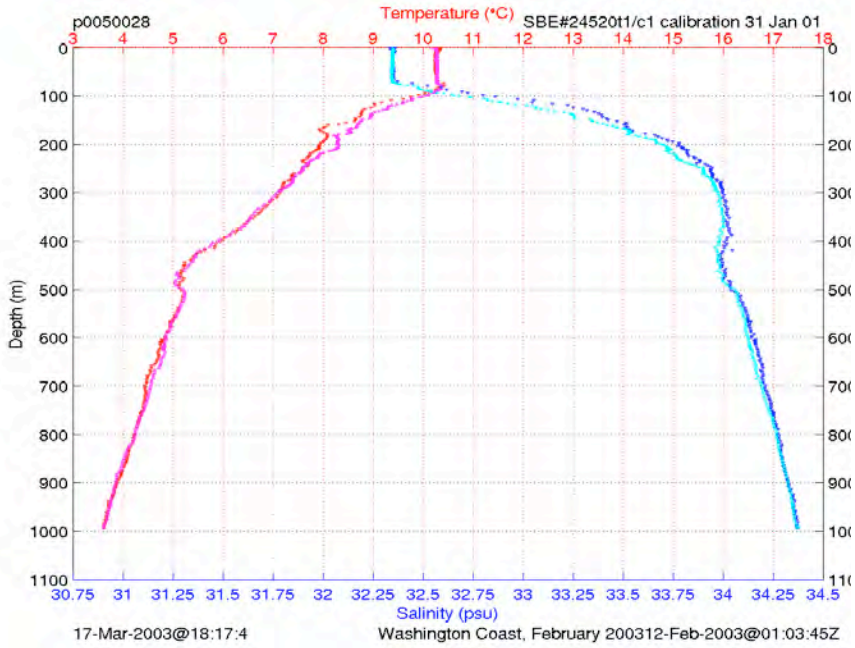
Seaglider #005 18 September 2003 - 13 October 2003

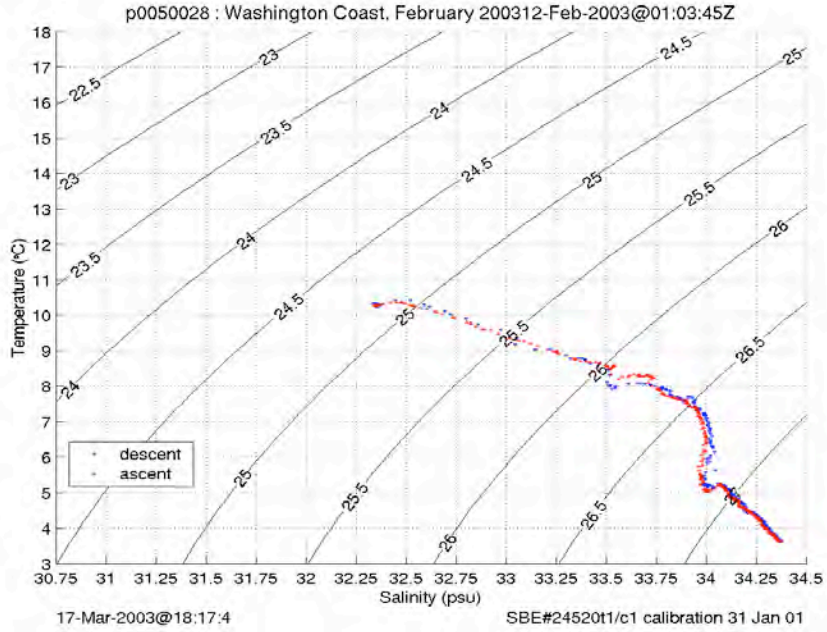


U.W. School of Oceanography / Applied Physics Laboratory

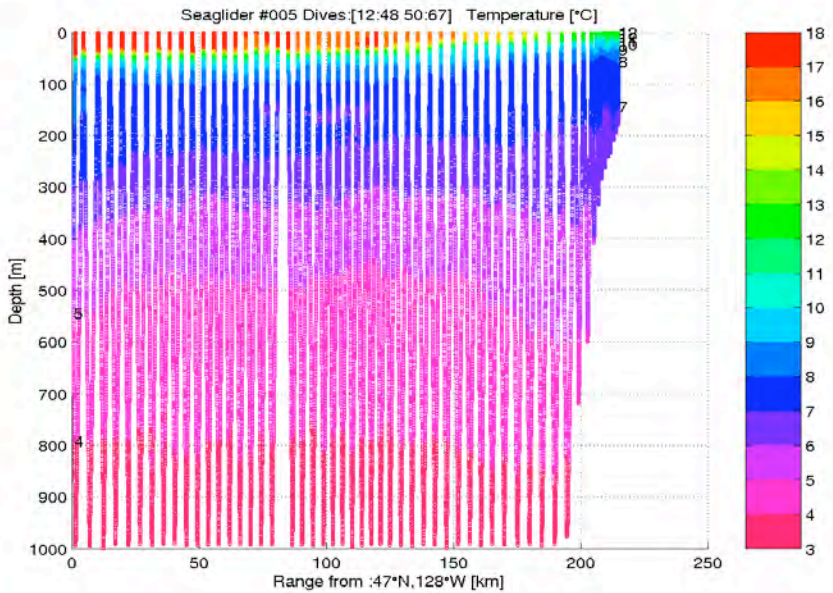
Single dive - Seaglider sensor data

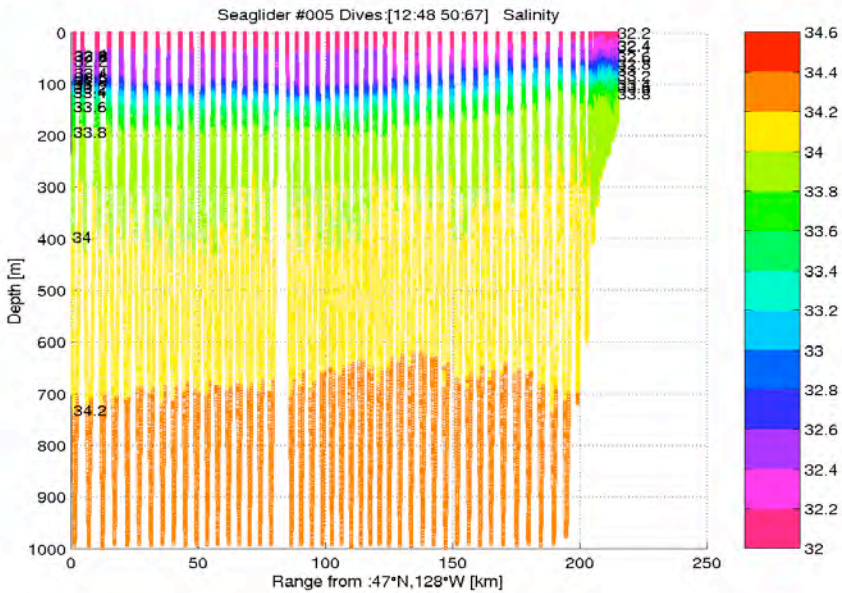


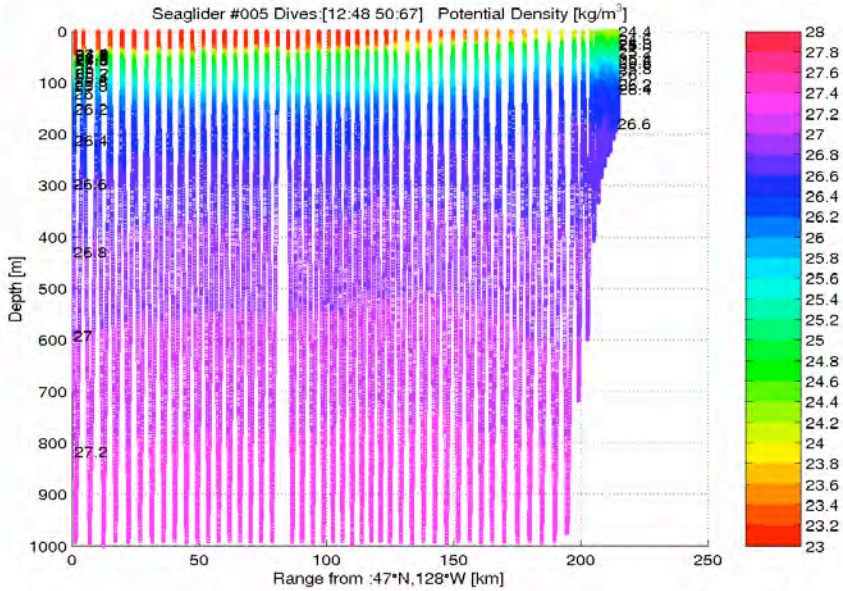


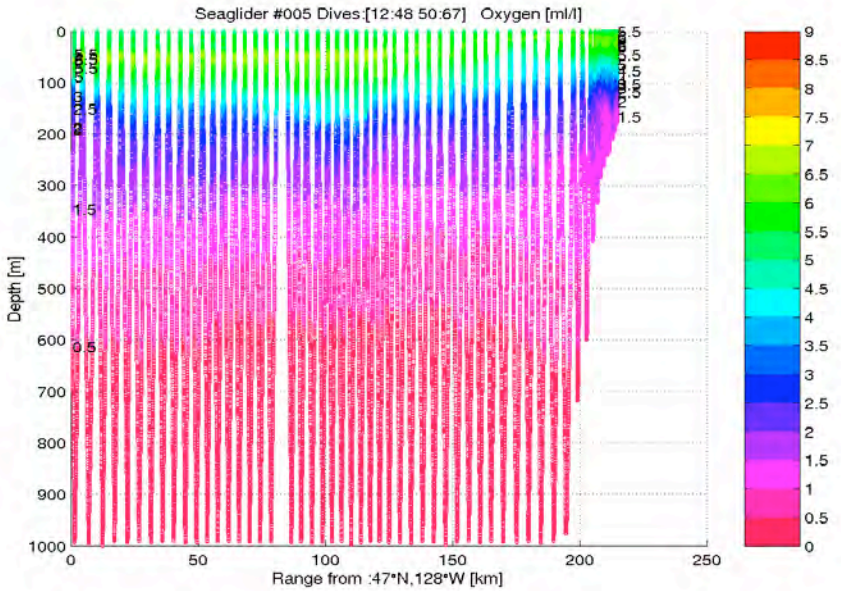


Single transect - Seaglider data



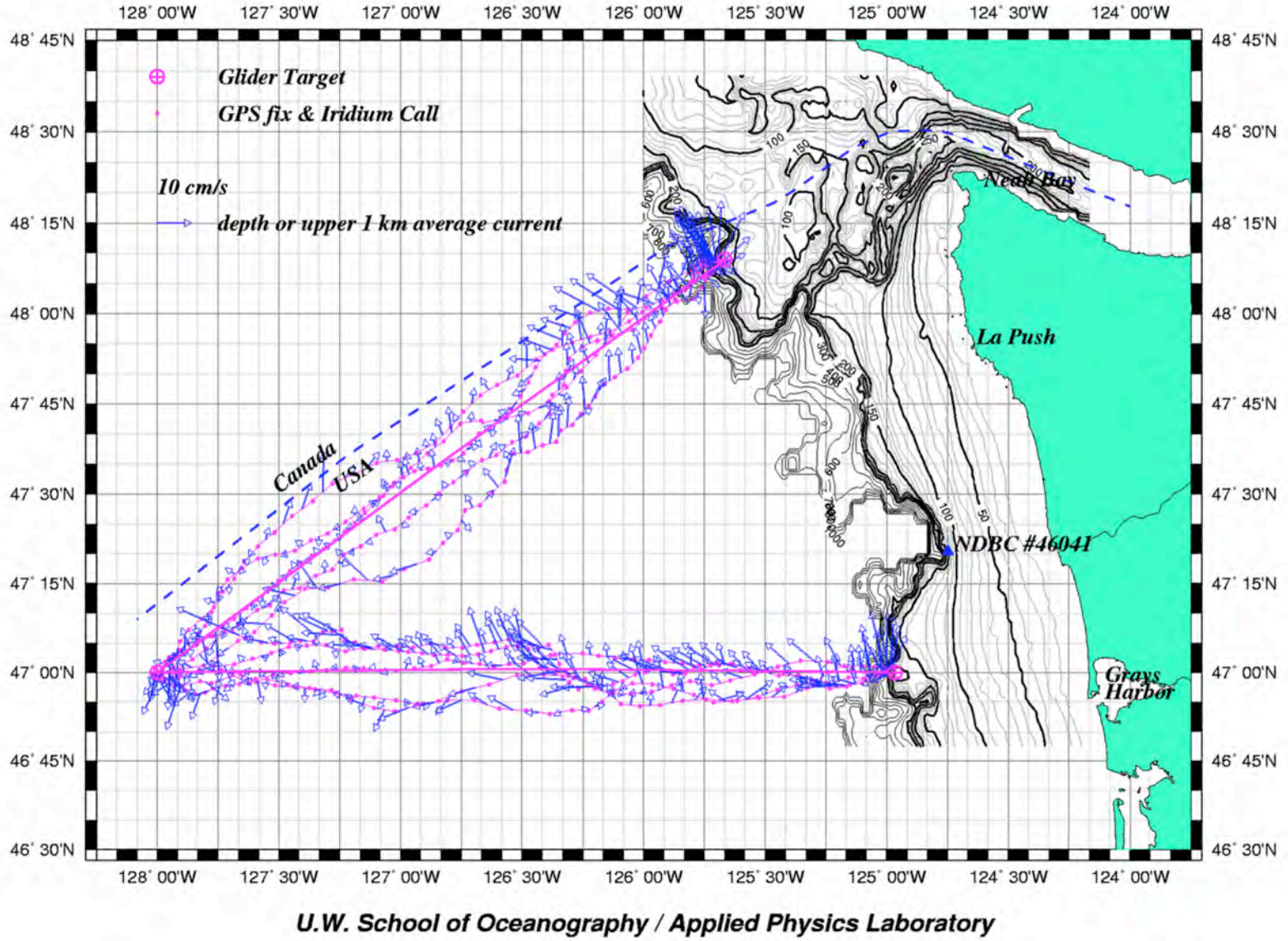




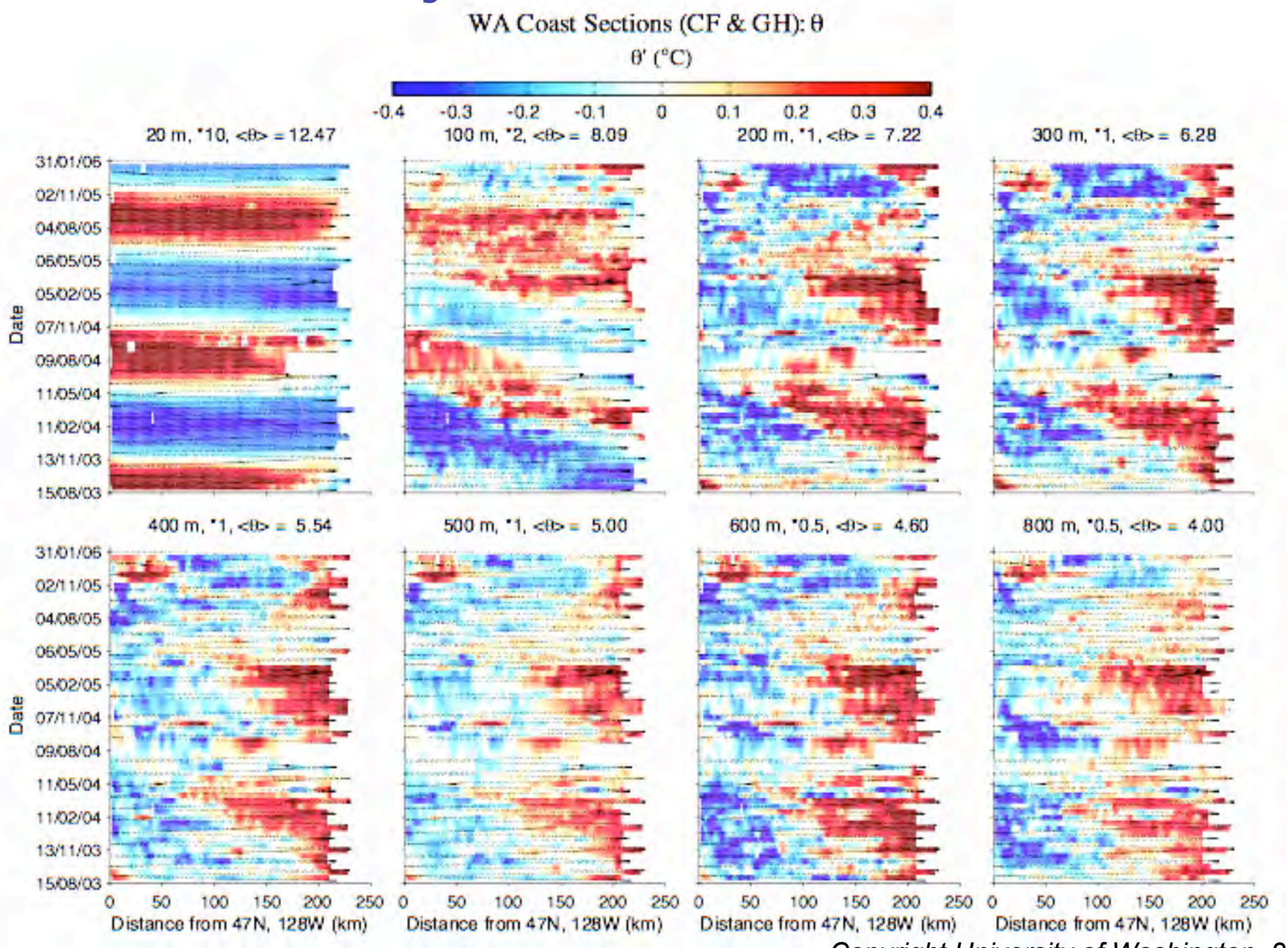


Single Seaglider - 5-6 mo. each

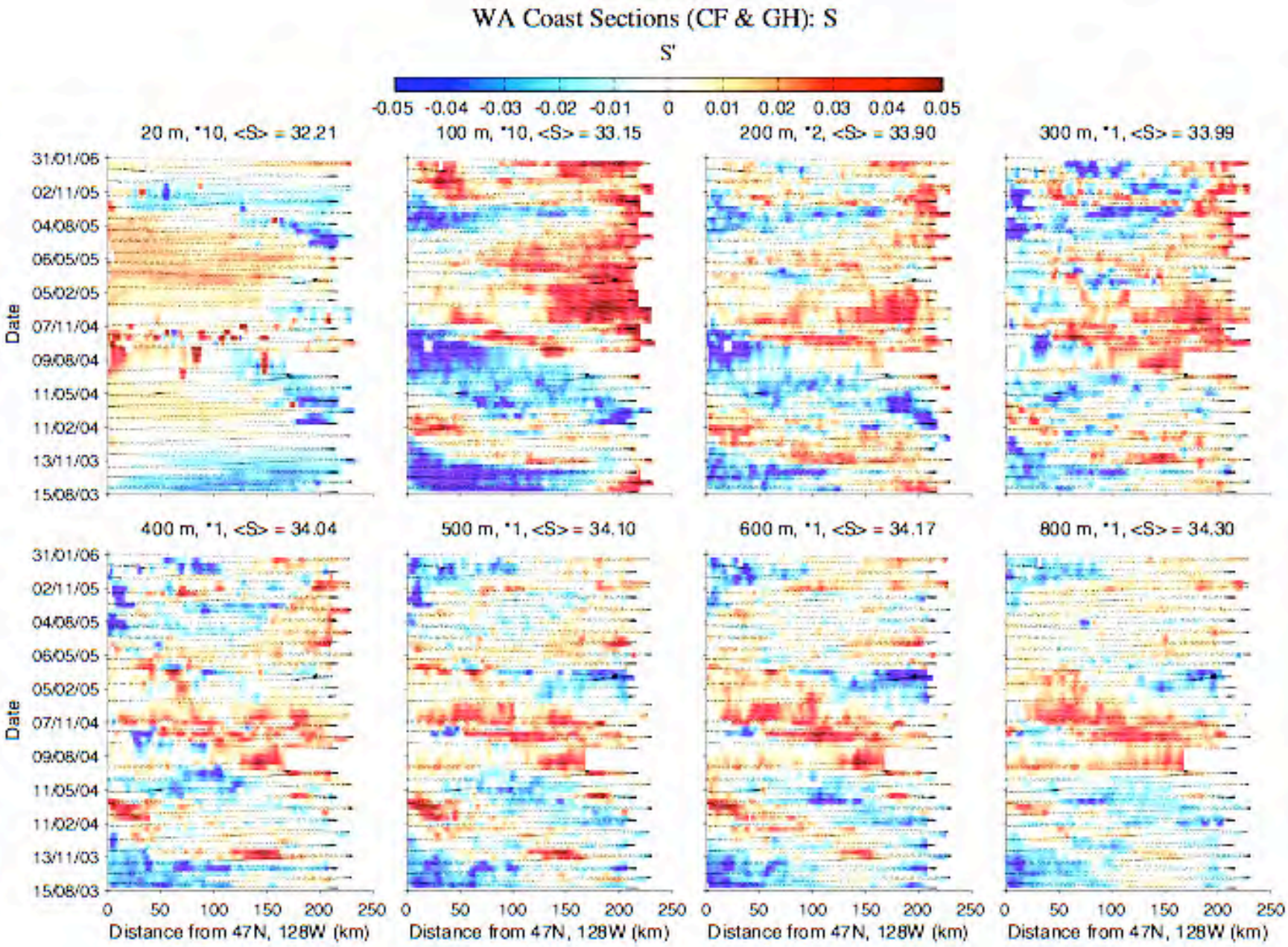
Seaglider #005 22 August 2003 - 17 January 2004



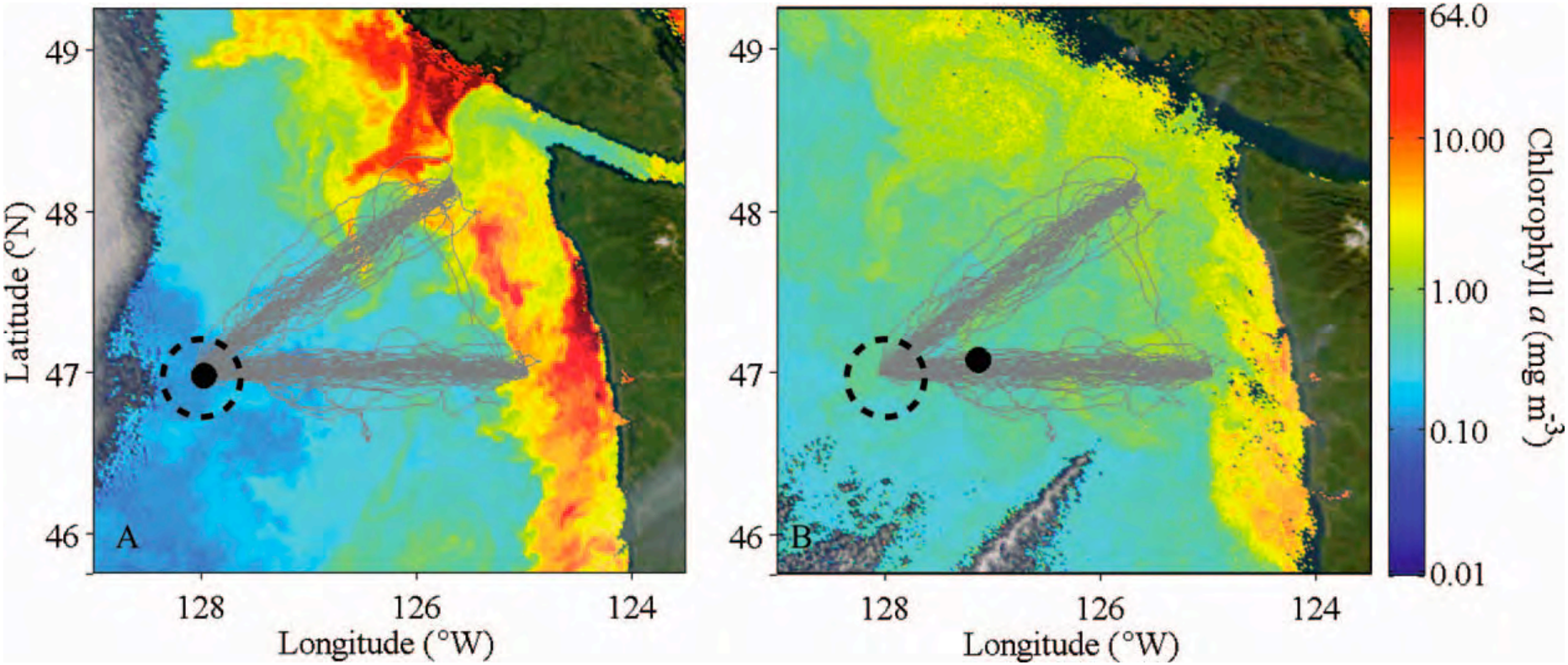
Multi-year data - Cascadia



Multi-year data - Cascadia



All Seagliders - Sept. 2002 to Dec. 2007



SeaWiFS satellite ocean color images of chlorophyll *a* concentration (mg/m^3) with color bar; (A) 02 September 2003 and (B) 31 October 2003; closed circle represents Seaglider position on these dates. Seaglider transects between Sept. 2002 and Dec. 2007 are shown as gray solid lines; dashed circle highlights region analyzed in the text.

University of Washington, 2008

Davis Strait

Understanding Arctic change - watermass exchange

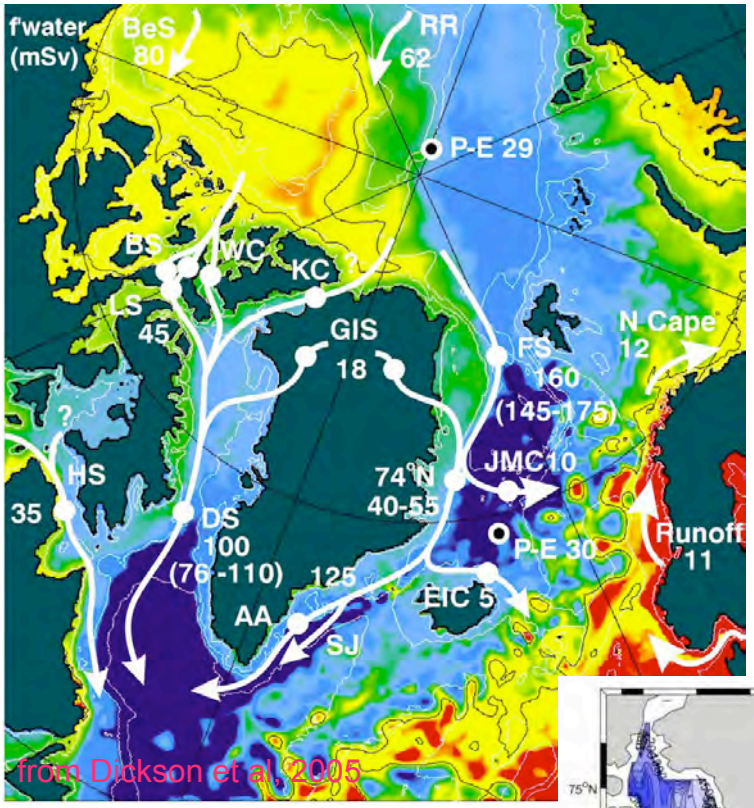
PIs: **Craig Lee**, Jason Gobat, Richard Moritz, Kate Stafford - *APL-UW;* Brian Petrie - *Bedford Inst. of Oceanography*

Duration: 2004 to present

Summary:

- W. Greenland (Irminger) water warming, extent increasing.
- **South-flowing Arctic water extent shrinking**.
- Baffin Shelf, W. Greenland slope & shelf: OPA and observed along-strait velocities compare well.
- Central Strait and Baffin Slope: OPA and observed along-strait velocities compare poorly.
- OPA and observed transports compare well- boundaries play larger role than mid-Strait.
- **Observed (and modeled) transports (2004-2006) smaller than those reported in previous studies**.
- Wind forcing appears to control OPA shelf variability… does wind forcing dominate the true response?
- **First under-ice glider operations- successful test of complete system (navigation, autonomy, operations near ice-ocean interface).**

Critical Arctic Gateways

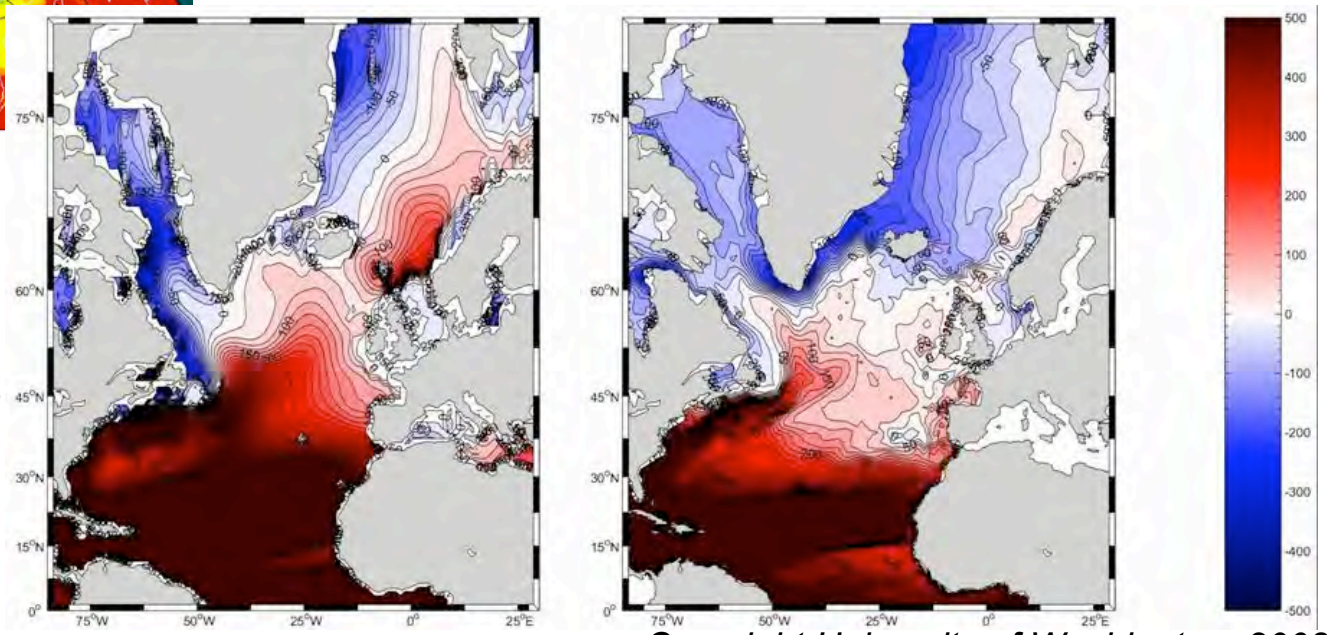


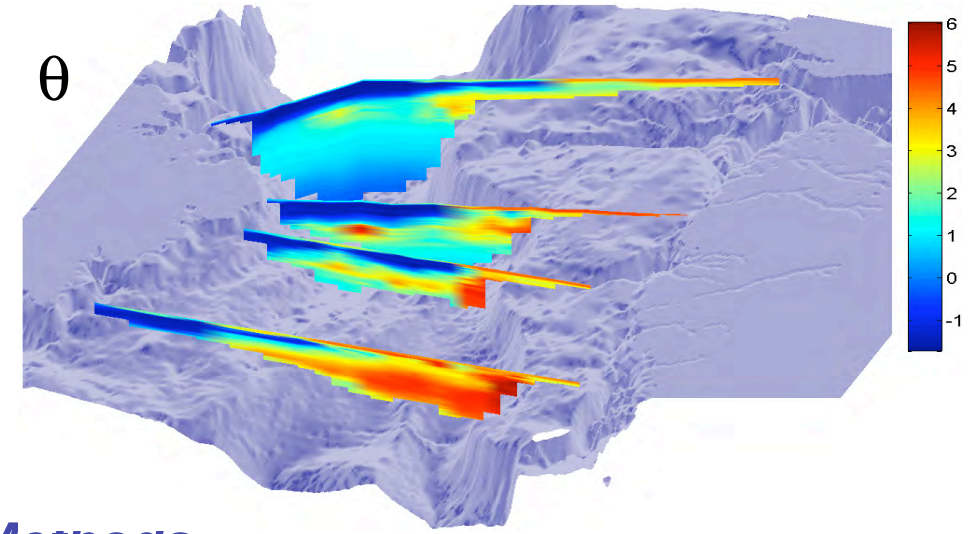
Freshwater fluxes- major ocean gateways

- Understand partitioning between FW exchange west and east of Greenland, impacts on deep water formation and meridional overturning circulation.
- Davis Strait integrates the CAA outflow with all terrestrial, atmospheric and oceanic transformations prior to entering the N. Atlantic.
- Relative impact of West Greenland Current, Baffin Island Current on Labrador Sea stratification?
- CAA/Davis Strait + Fram Strait captures nearly all of the Arctic FW discharge.

Barrier to Convection (Bailey, Rhines & Häkkinen)

- 0-500m *difference* between thermal and haline components of dynamic height (blue: S, red: T)
- *Transport and fresh over-capping of the subpolar gyre and Nordic Seas modulates MOC*





Challenges

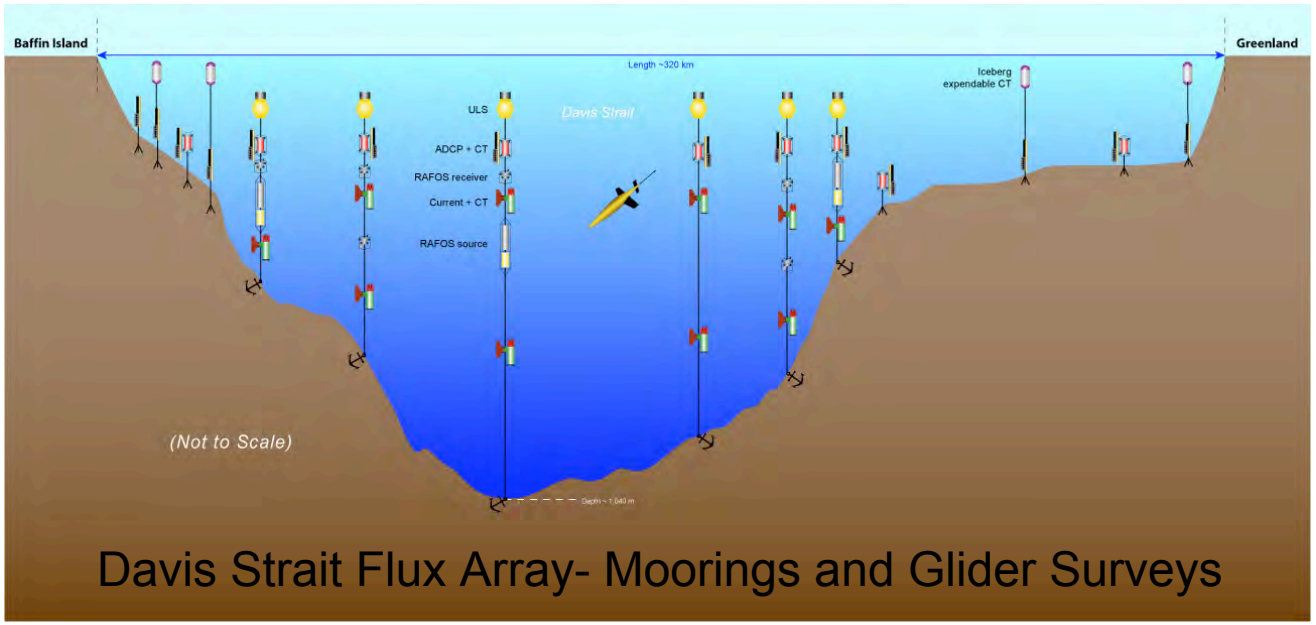
- Small internal deformation scale- dynamically wide strait.
- Broad West Greenland shelf.
- Ice cover & icebergs.
- Freshwater moves in thin (~50 m) surface layer.
- Quantify liquid & ice contributions at monthly to inter-annual time

Methods

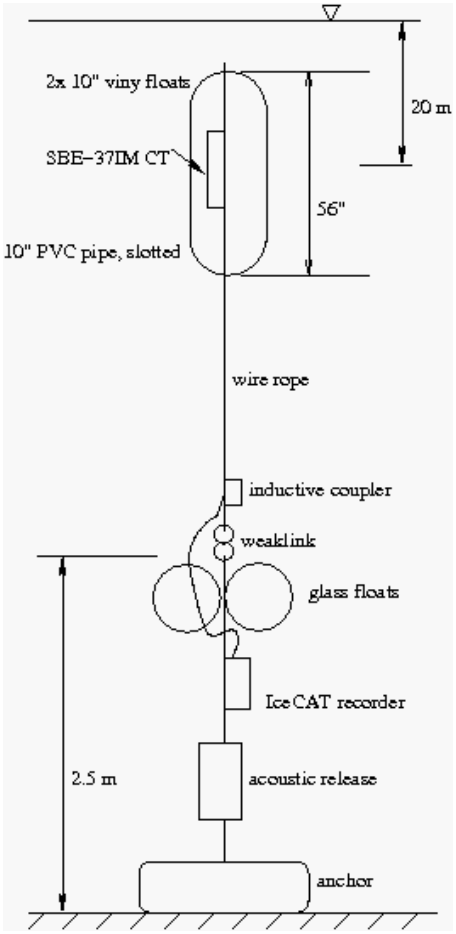
Moorings: Ice draft/velocity, absolute geostrophic velocity, low-mode u, T, S structure, marine mammals (‘06-’08)

Shelf Moorings: Low-cost (~$10k) ICECAT for T-S near ice-ocean interface, upward looking acoustic current profilers and bottom-mounted T-S

Acoustically-navigated gliders: Repeated sections (5 km, resolves deformation scale) at O(week) timescales between 500-m isobaths. Samples at ice-ocean interface. Temperature, salinity, dissolved oxygen



Ship-based Hydrographic Sections: Autumn. Biogeochemical tracers (nutrients, trace metals, TOC, TAlk, CFCs, oxygen isotopes. Spans broad region from S. Baffin Bay to N. Labrador Sea.

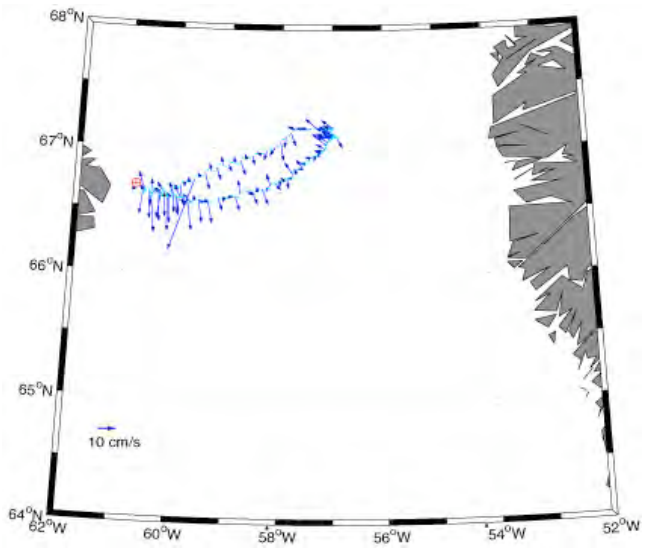


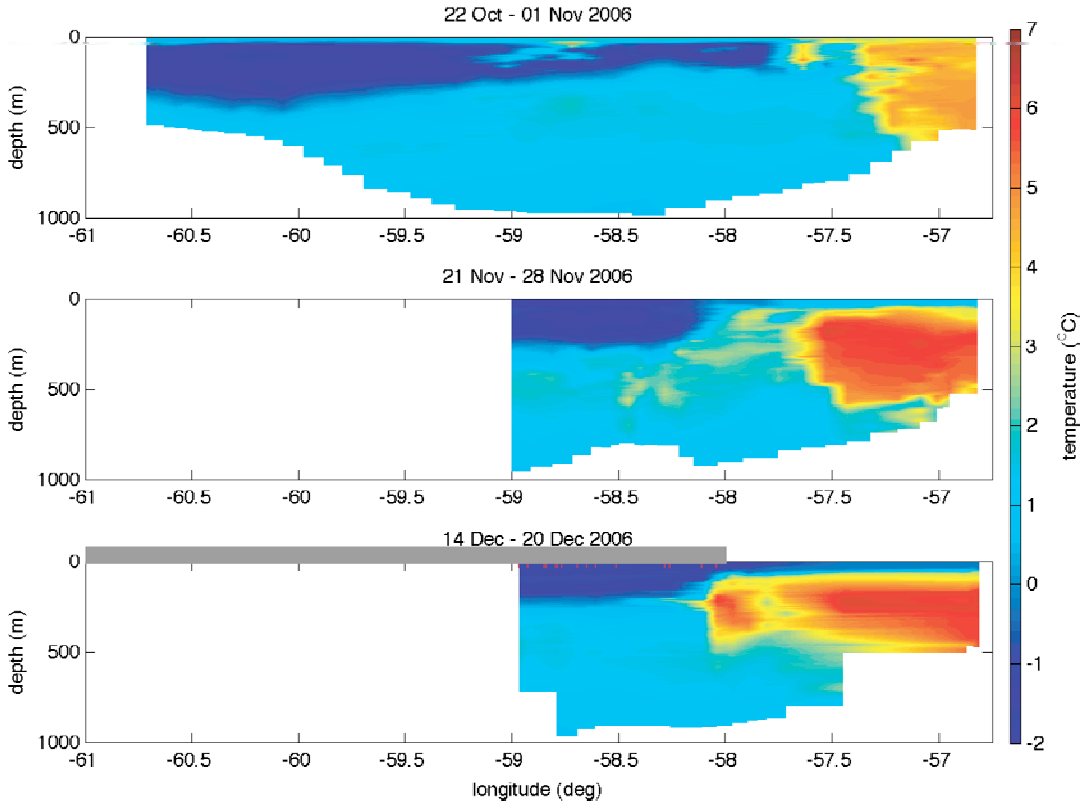
ICECAT moorings

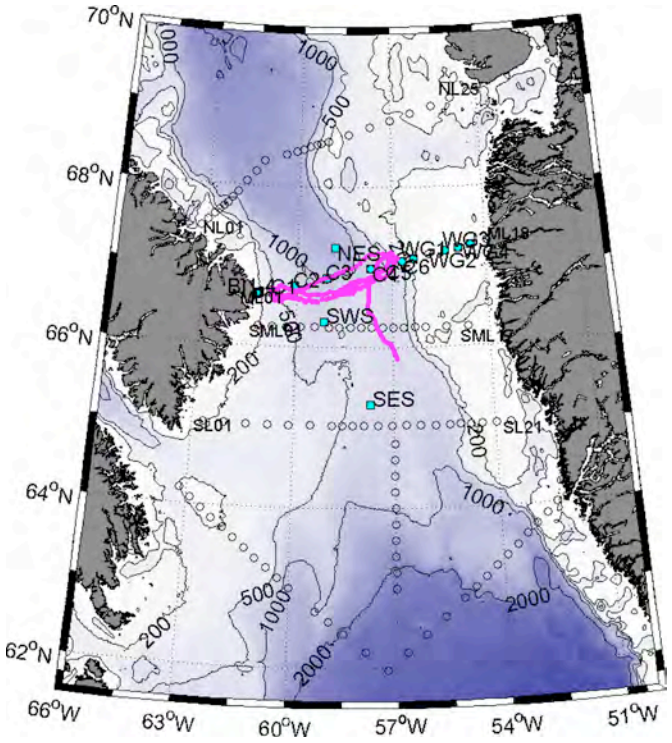
- Samples in ice-threatened near-surface layer.
- Shallow element expendable, data logged below.
- Inexpensive (~$10k), deploy many.
- 2004(1), 2005(2), 2006(4), 2007 (5+)…
- Contributing this technology to Bering Strait, other projects.

Seaglider

- Operation below ice requires acoustic navigation (RAFOS), advanced autonomy.
- Acoustic data upload desirable for ‘insurance’.
- IPY/AON dev. include refining under-ice glider system, implementing moored ‘data depot’ for periodic data offload while under ice

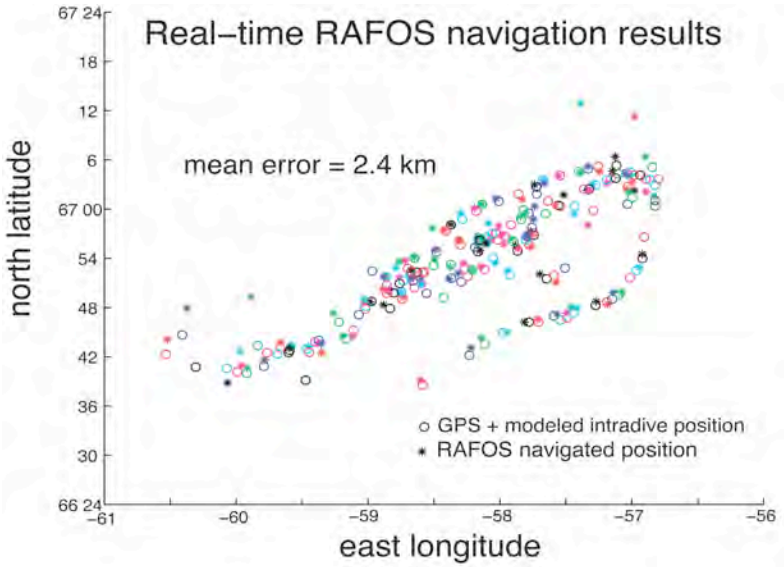






First glider-based section under the ice: December 2006

- Fully navigated using RAFOS array.
- Fully autonomous operation - glider decided where to go and when to attempt to surface without human intervention.
- Under-ice glider system works, but some setbacks associated with platform reliability.
- Observations to within a few meters of ice-ocean interface, roughly 5 km horizontal resolution. Resolved south-flowing, surface-trapped Arctic outflow from CAA.



North Atlantic Spring Bloom - NAB08

A biogeochemical process study in Lagrangian frame

PIs: **Mary Jane Perry**, Eric D'Asaro, Craig Lee, Katja Fennel,

Students and Collaborators: Witold Bagniewski, Nathan Briggs, David Checkley, Giorgio Dall'Olmo, Amanda Gray, Kristinn Gudmundsson, Emily Kallin, Richard Lampitt, Patrick Martin, Nicole Poulton, Eric Rehm, Katherine Richardson, Ryan Rykaczewski, Tatiana Rynearson, Michael Sauer, Brandon Sackmann, Michael Sieracki, Toby Westberry

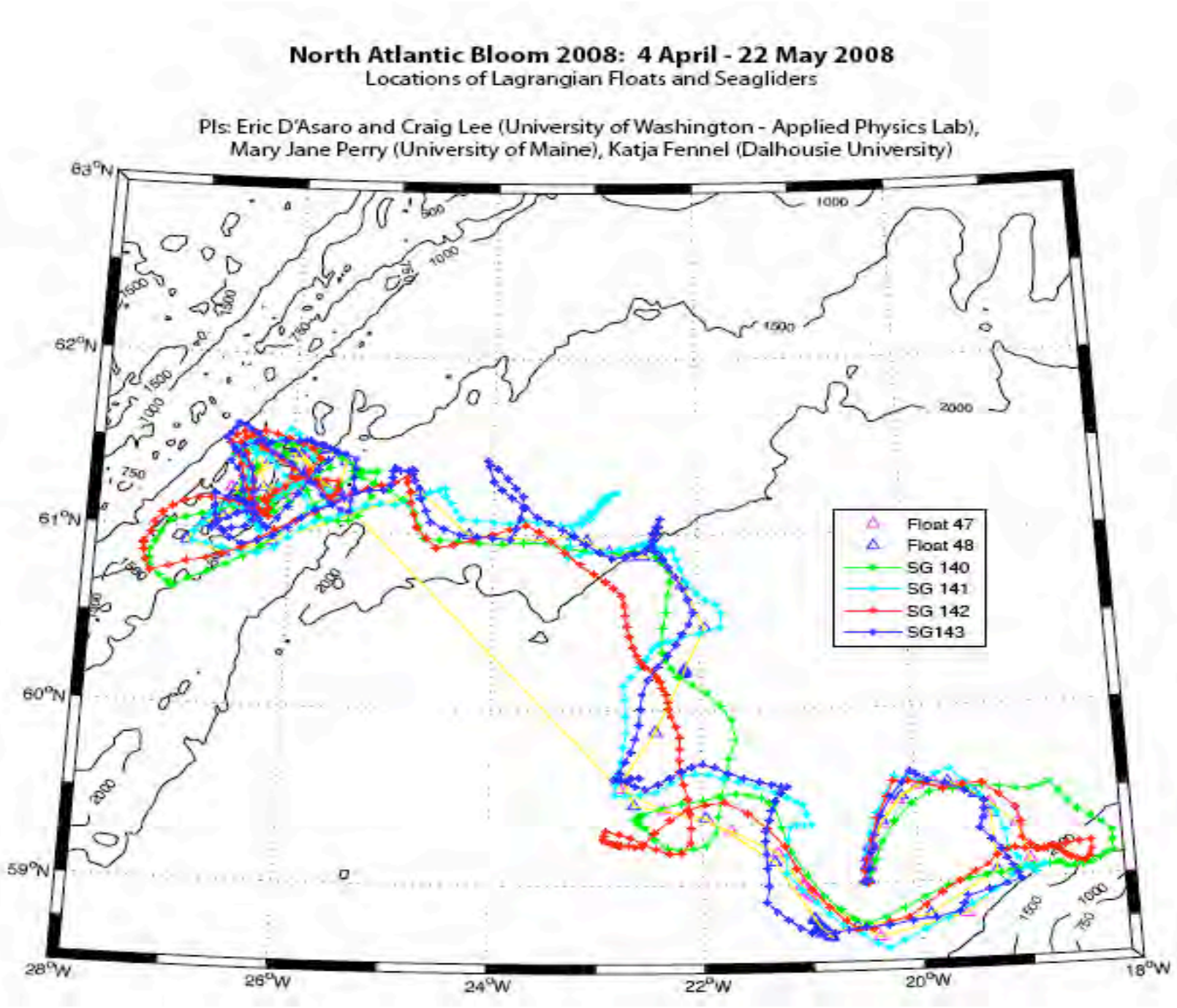
Duration: April to June 2008

Goal: Measure carbon flux in full-cycle of NA spring bloom near 60ºN

Motivation: Need more complete temporal & spatial coverage of bloom and improved resolution of mixed-layer dynamics and lateral processes.

Approach:

- Autonomous 4-D sampling April–June using 2 heavily-instrumented floats and 4 Seagliders with proxy sensors for carbon-cycle components
- Deploy all before bloom starts & retrieve after ends
- Gather ancillary data on 3-week process cruise in middle - (*e.g.*, floating sediment traps)
- Add satellite data and ecosystem model



Two Lagrangian bio-heavy floats

Followed water

Sensors

- T, C (2 each)
- O_2 (2 types)
- Transmission (c)
- Chl fluorescence
- Backscatter (2λ)
- Ed (λ) and Lu (λ)
- PAR
- ISUS NO_3^-

Four Seagliders

Followed floats

Sensors

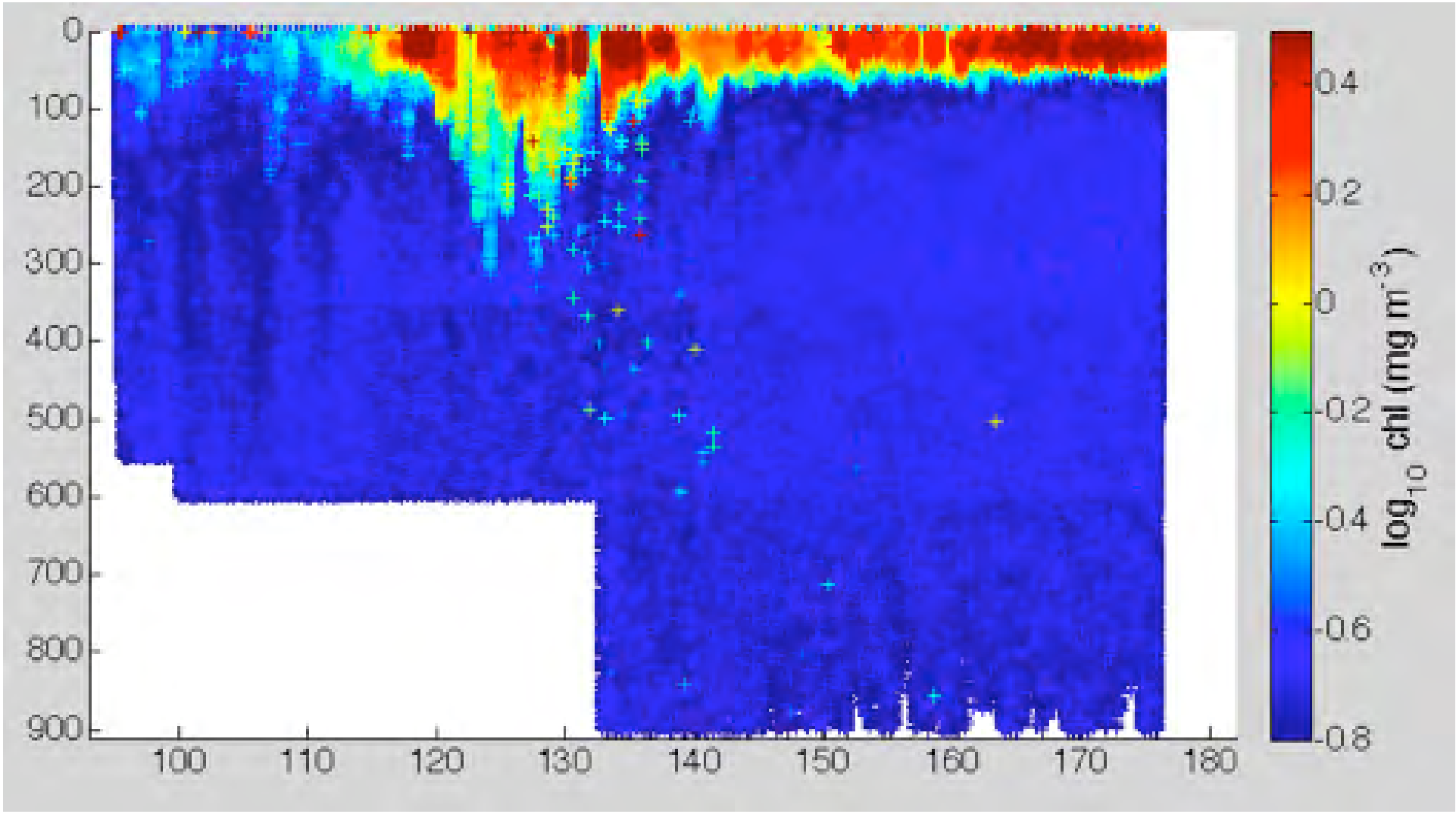
- T, C
- O_2 (2 types)
- Chl fluorescence (2)
- Backscatter (3λ)
- CDOM fluorescence

Typical early April seas in North Atlantic

University of Washington, 2008

Seaglider data triggers cruise May 2 after start of bloom

Access to data from region of study in real time extremely useful



Conclusions

- Seagliders bring new capacity to many types of studies - persistence is key
- Using Seagliders with other platforms provides much more complete spatial & temporal coverage
- Seagliders have long track record - many gliders, one ocean