Technology Developments for Arctic Observations and Beyond

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PMEL
Pacific Marine Environmental Laboratory

NOAA FISHERIES

JISAO

ITAE
Innovative Technology for Arctic Exploration

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

MRV SYSTEMS

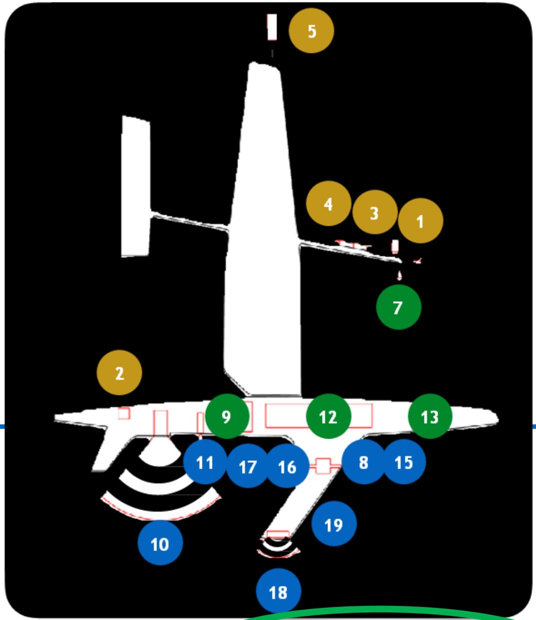
KONGSBERG

SAILDRONE

Outline

- Status and Challenges for Arctic Platforms
  - Saildrone
  - Profiling Floats (ALAMO)
  - New Coastal Underwater Glider (Oculus)

Saildrone Gen 4 Sensor Suite



Atmospheric Measurements

Measurement	No.	Sensor
Temperature / Humidity	1	**AT/RH @ +2.2m** Rotronic HC2 - S3 with rad shield
Pressure	2	**Barometric Pressure @ +0.2m** Vaisala PTB210
Radiation	3	**S & L wave Radiation @ +2.2m** Eppley PSP & PIR
	4	**Sunshine Pyrometer @ +2.2m** Delta-T Devices SPN1
Wind speed & Direction	5	**Anemometer @ +4.5m** Windmaster 3D ultrasonic 20Hz

Surface Measurements

Measurement	No.	Sensor
Skin Temperature	7	**SST IR Pyrometer @ +2.2m** Heitronics KT15 II
Wave height/period	9	**Dual GPS & IMU** Vectornav / KVH
Surface Currents	10	**ADCP @ -0.2m** RDI Workhorse 300 kHz
partial CO2 pressure	12	**pCO2 @ -0.5m / +0.3m** PMEL MAPCO2 system
Magnetic field	13	**Magnetometer @ 0m** Barrington MAG 648

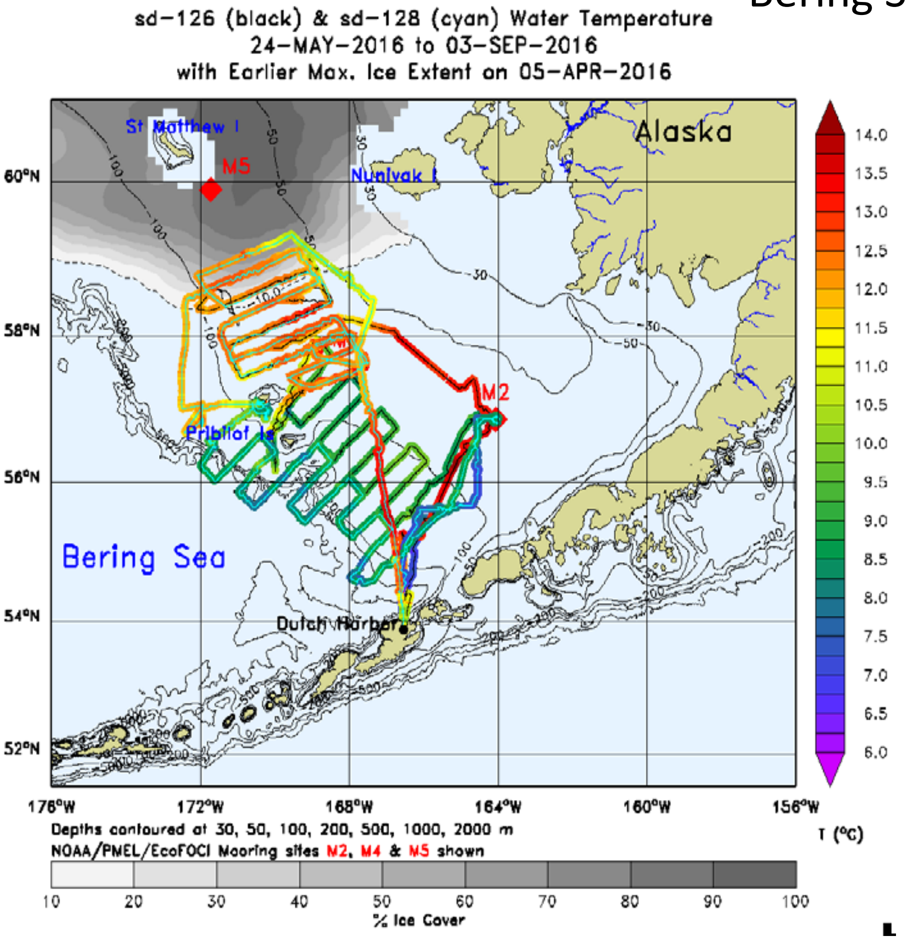
Sub-surface Measurements

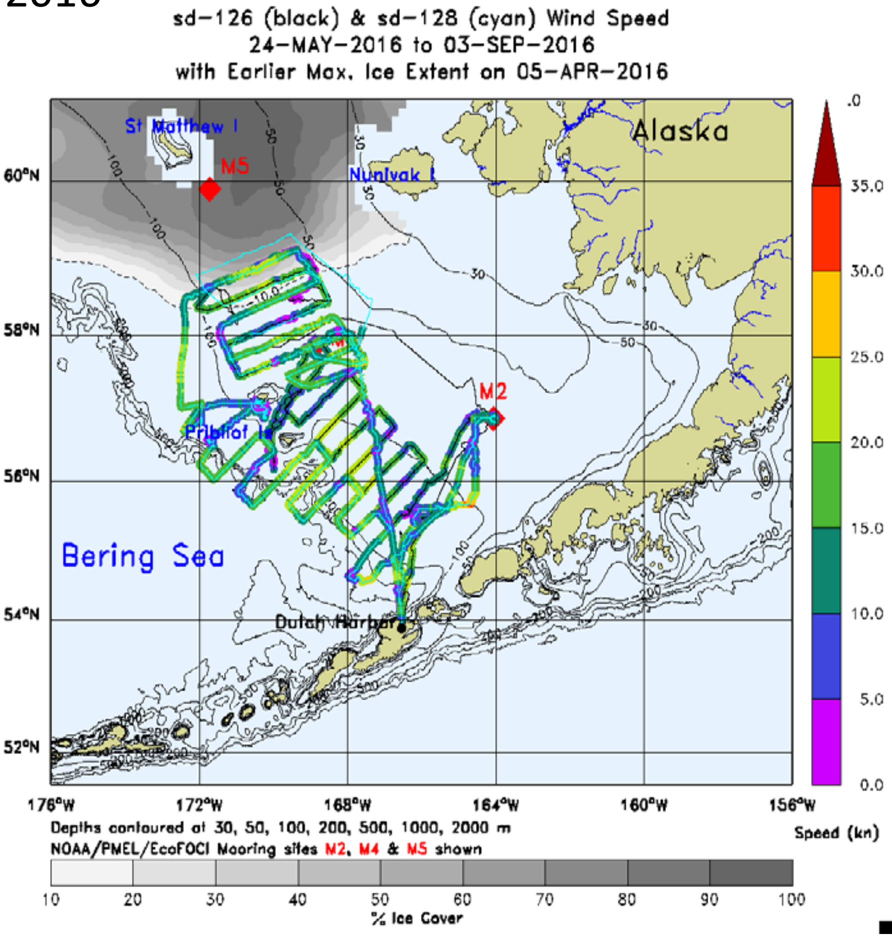
Measurement	No.	Sensor
Temperature & Salinity	15	**Thermosalinograph @ -0.5m** Teledyne Citadel
Currents	10	**ADCP @ -0.2m** RDI Workhorse 300 kHz
Bio markers	11	Chl, CDOM, **Red Backscatter** Wetlabs Fluro Triplet
Dissolved Oxygen	17	**Dissolved Oxygen @ -0.5m** Aanderaa 4831
Partial CO2	16	**pCO2 & pH @ -0.5m** PMEL MAPCO2 & Durafet
Biomass (fish)	18	**WBAT @ -2.5m** SIMRAD EK 80
Bathymetry	18	**Multibeam Sonar** Norbit
Acoustics (mammals)	19	**Passive Acoustics** Acousonde

Specifications

Length: 23'
Height: 15'
Depth: 7'
Weight: 1200 lbs, loaded
Speed: Transit ~ 3 Kt, Max ~ 8 Kt
Payload Power: 30w Steady state
Payload Capacity: 250 lbs
Max deployed duration; 12 months
Longest voyage: 10,000 miles

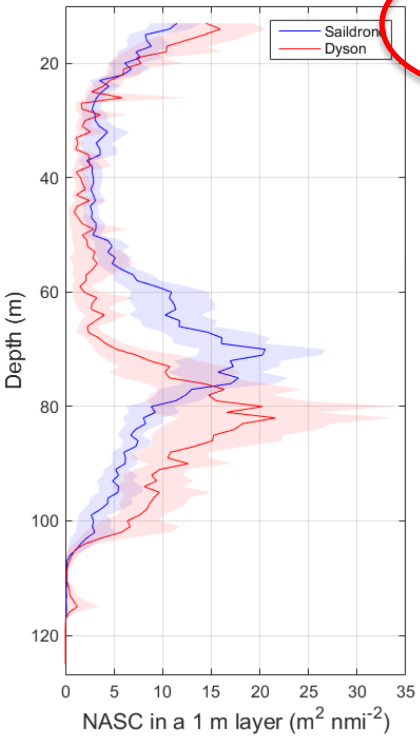
Bering Sea 2016





(N. Cokelet)

2016 Highlights: NOAAS *Oscar Dyson* -Saildrone Echosounder comparison

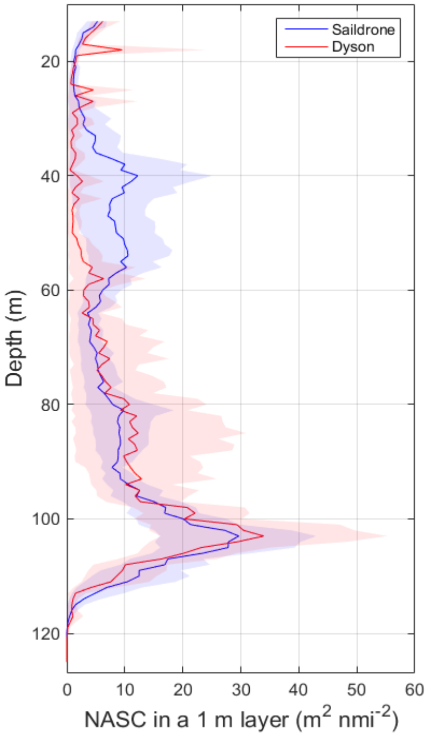


Day

SD 13% higher

SD 9.1 m shallower

shading is 95 % CI



Night

SD 38% higher

SD 8.9 m shallower

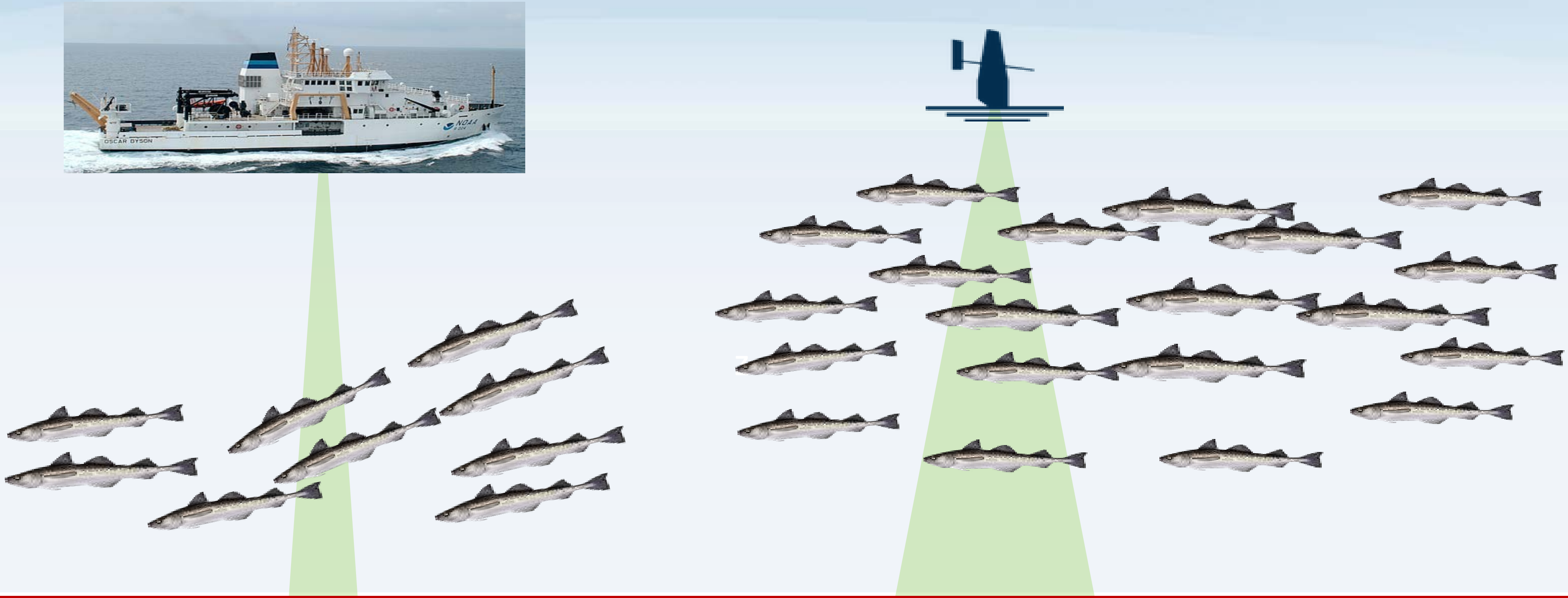
shading is 95 % CI

Saildrone observes higher, shallower backscatter

(A. De Robertis)

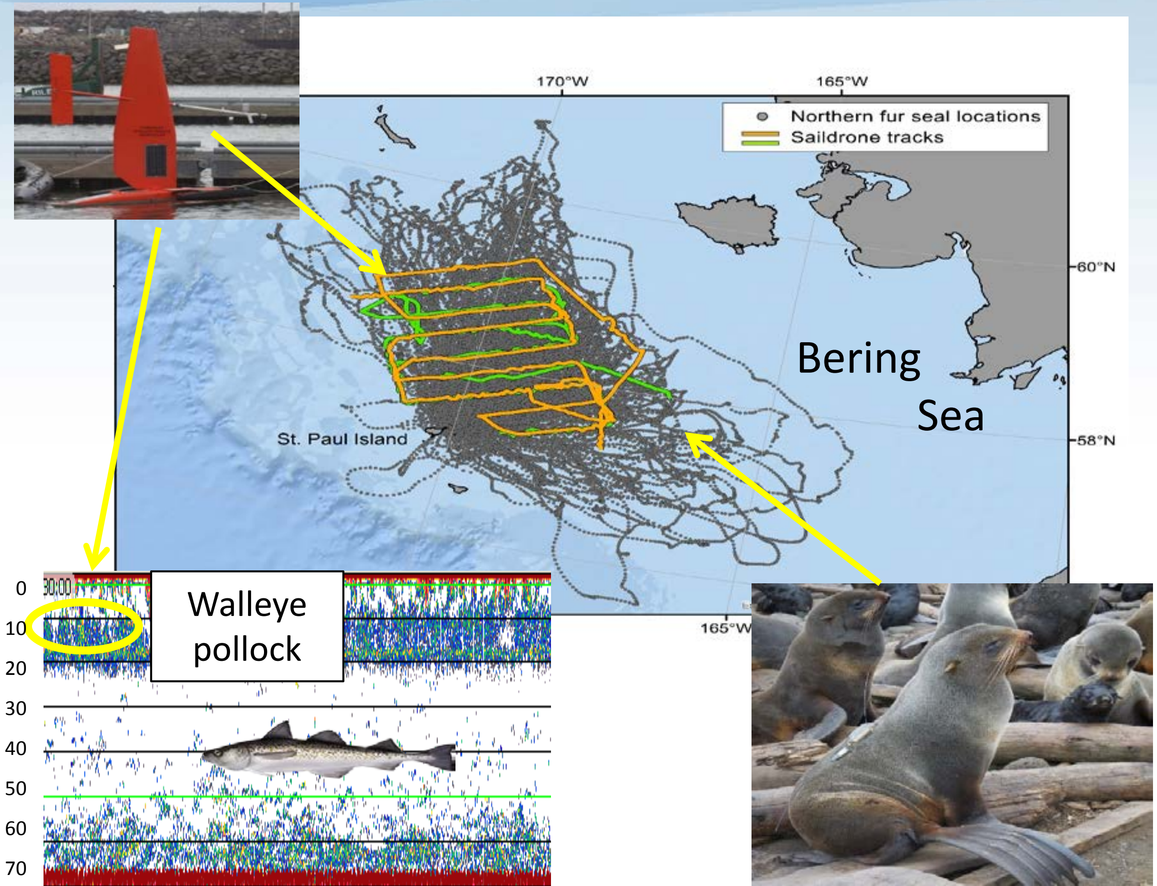
2016 Highlights: NOAAS *Oscar Dyson* -Saildrone Echosounder comparison

- Pollock are responding to Dyson (noise-reduced vessel)
- Larger response at night



(A. De Robertis)

2016 Highlights: Fish, fur seals, and Saildrones: using groundbreaking technology to understand predator-prey relationships



- Goal: Examine how the distribution and abundance of prey influence northern fur seal foraging behavior
- Tracked 29 fur seals as they foraged for ~70 days
- 65 Saildrone sampling days within the fur seals core use area (July-Aug)
- Echosounders used to map prey availability (walleye pollock)

(C. Kuhn)

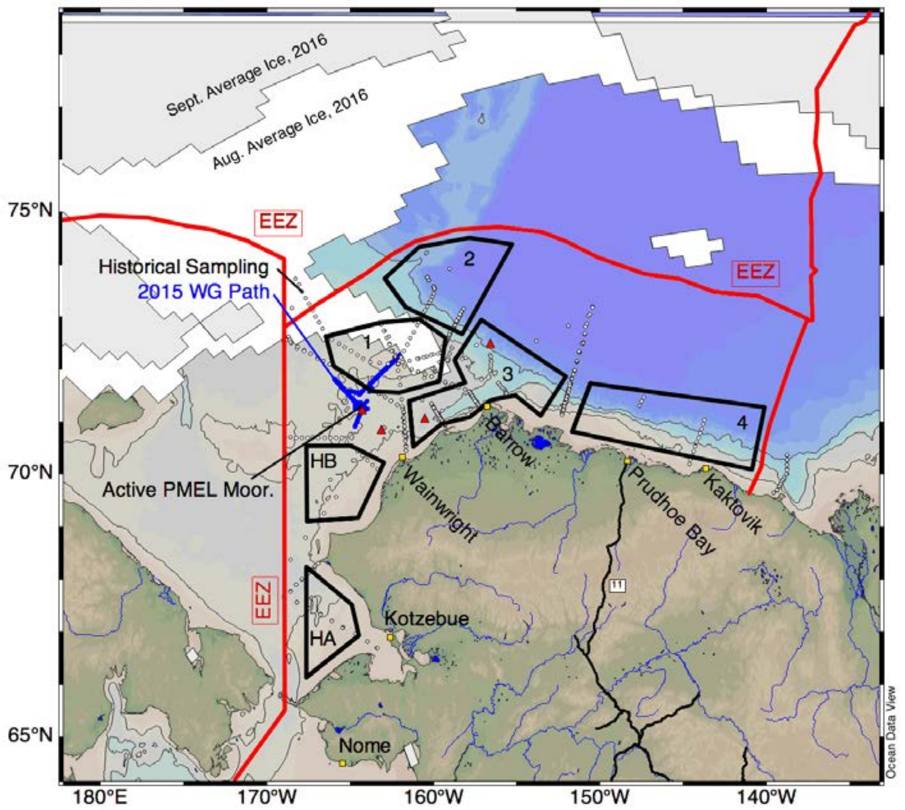
2017 Saildrone Bering Strait Transit & *p*CO2 Survey

Goals:

Launch 3 Saildrones from Dutch Harbor late June (1 Bering Sea-Ecosystems, 2 Chukchi-Carbon)

Challenges:

- Route Planning subject to ice conditions
- Transiting Bering Strait
- Solar conditions quickly deteriorate in mid-Sept (Chukchi)
- Potential recovery off North Slope dock. Special recovery options (difficult to find 8' harbor)



2017 Saildrone *p*CO2 Survey holding and priority regions.

North Slope Operations

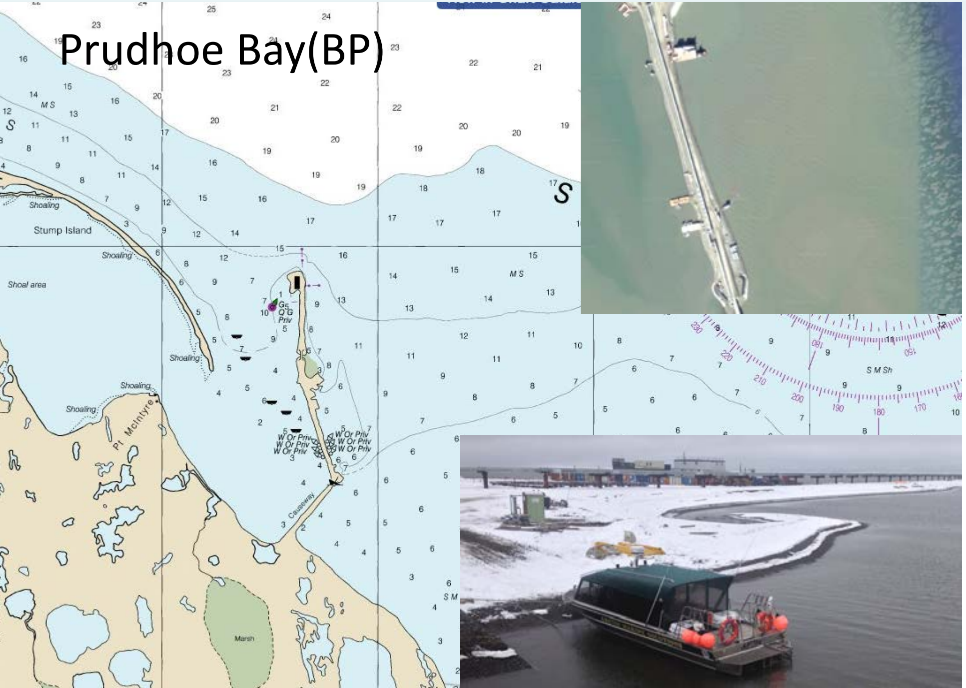
Considerations:

- Soundings are from a partial bottom coverage survey in 1950s with estimated accuracy of +- 160ft and +-3ft depth

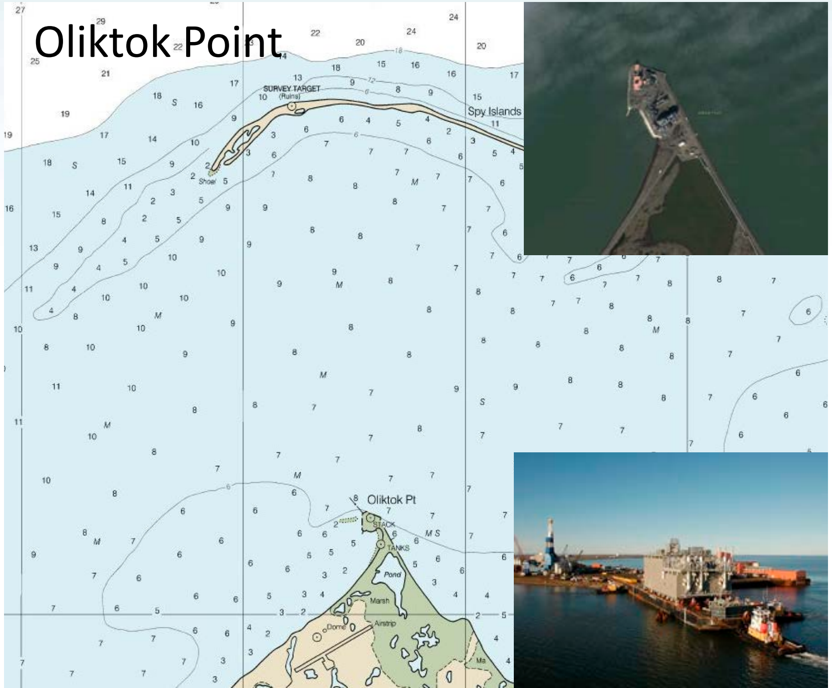
Considerations:

- > 4nm from Oliktok Pt to open water North of Spy Islands
- U of Alaska Research Station/Airfield

Prudhoe Bay(BP)



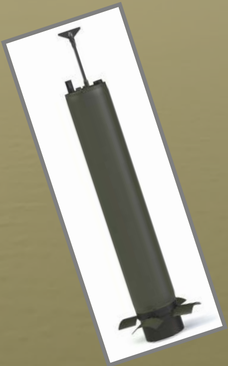
Oliktok Point



MRV ALAMO

Air-Launched Autonomous Micro-Observer

Characteristics

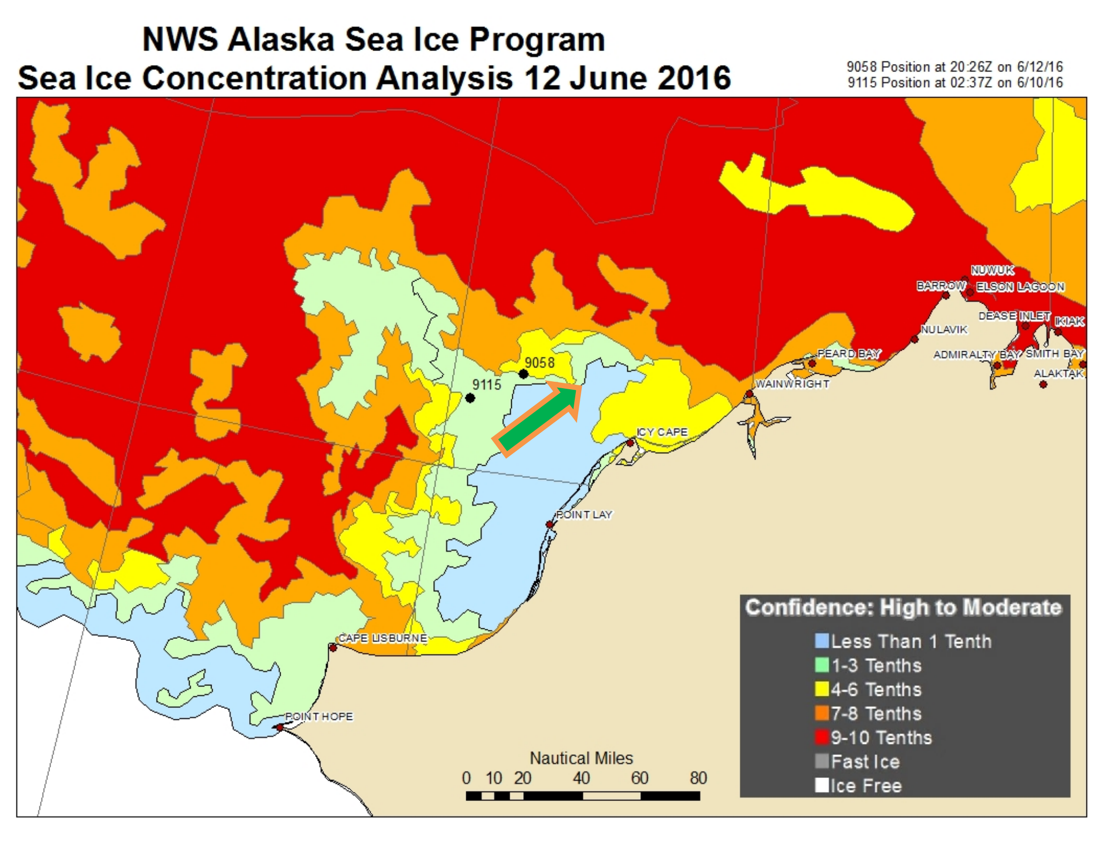


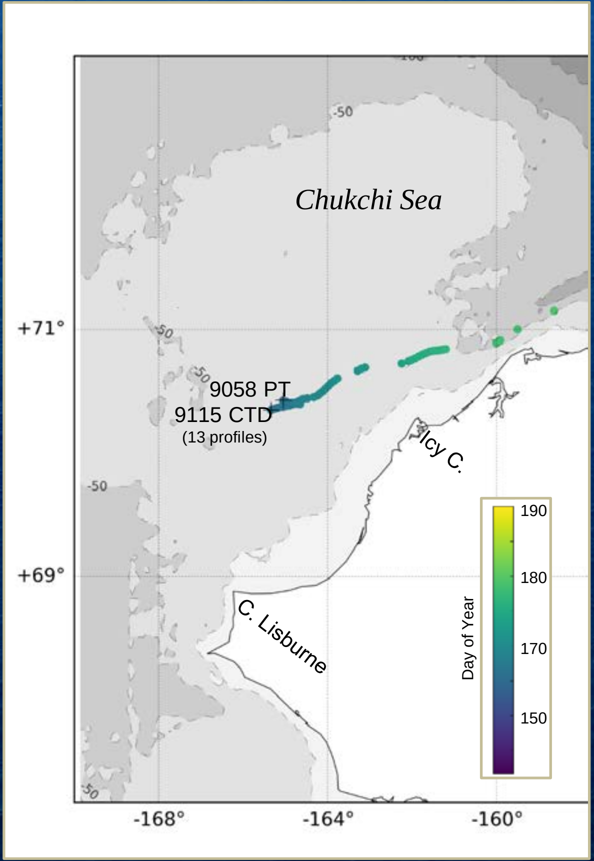
- Air or ship deployable
- Controllable profiles
- Multiple sensors
  - Pressure
  - Temperature
  - Salinity
  - PAR…
  - …others
- Near real-time data telemetry
- Bottom-following (or anchoring)
- Ice hardened antenna(in progress)
- Ice avoidance algorithm
- ~500 cycles

(K. Wood)

ICE CONDITIONS

Challenging drift of ALAMO 9058 and 9115

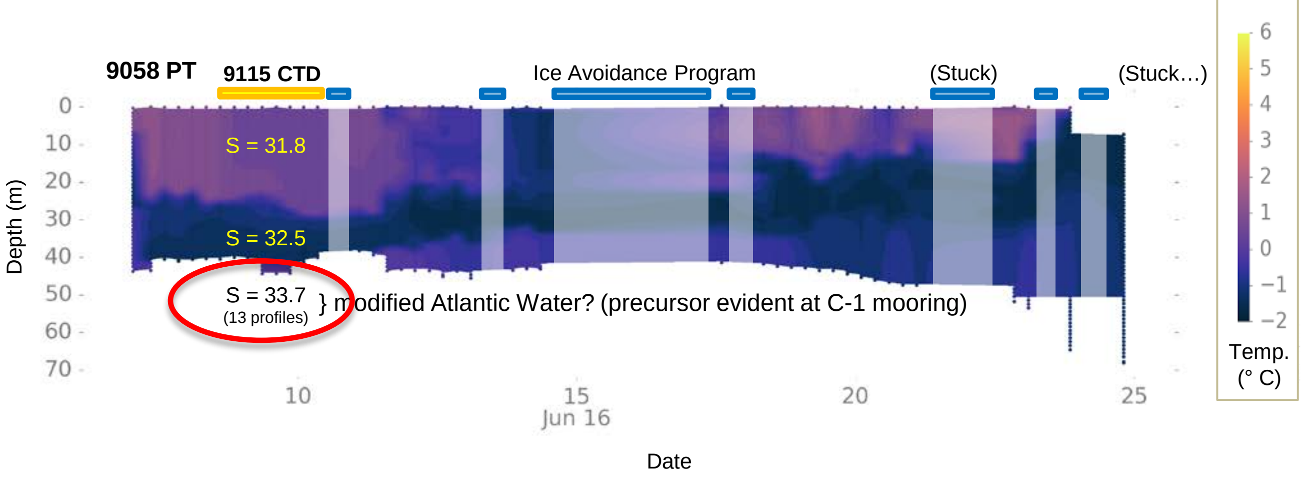


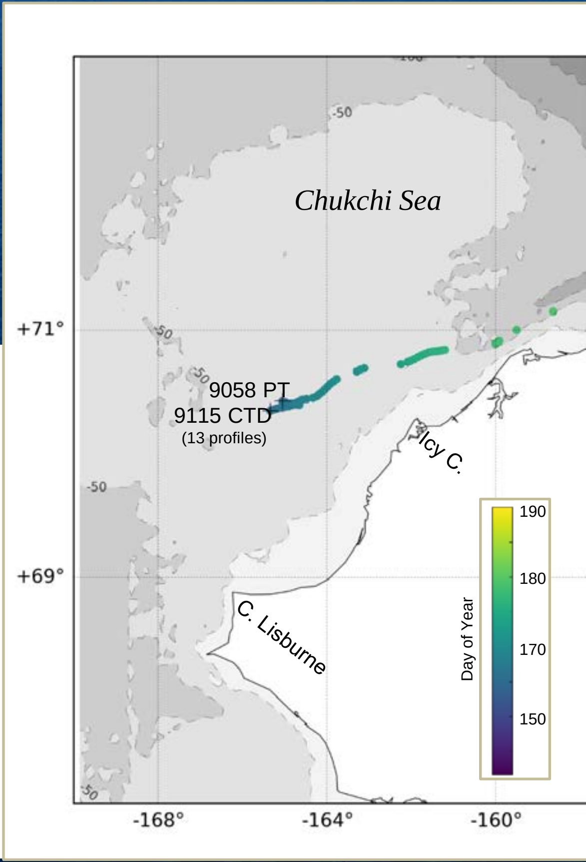


(K. Wood)

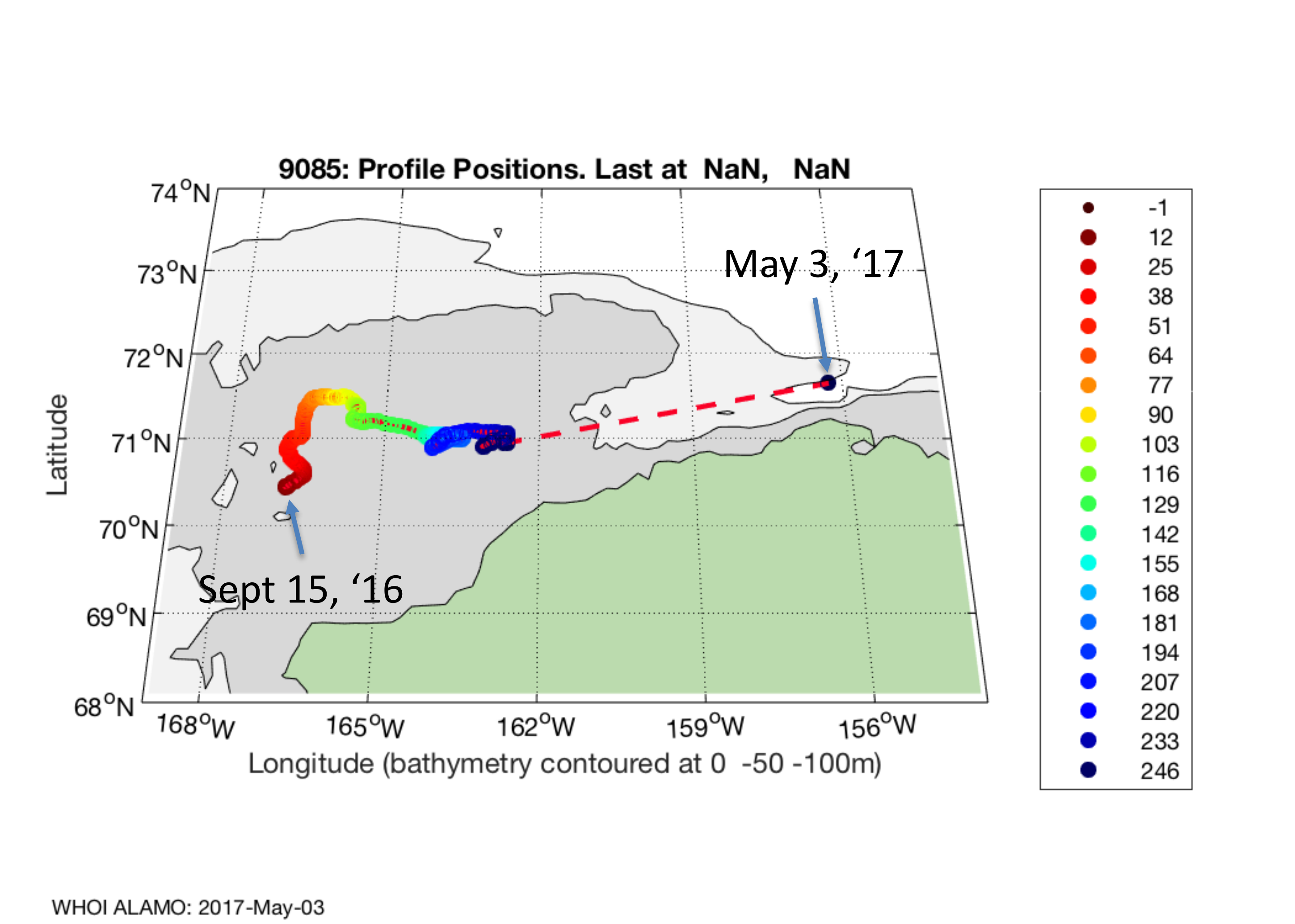
ALAMO 9058PT & 9115CTD

June 6 to June 25 – 55 profiles





(K. Wood)



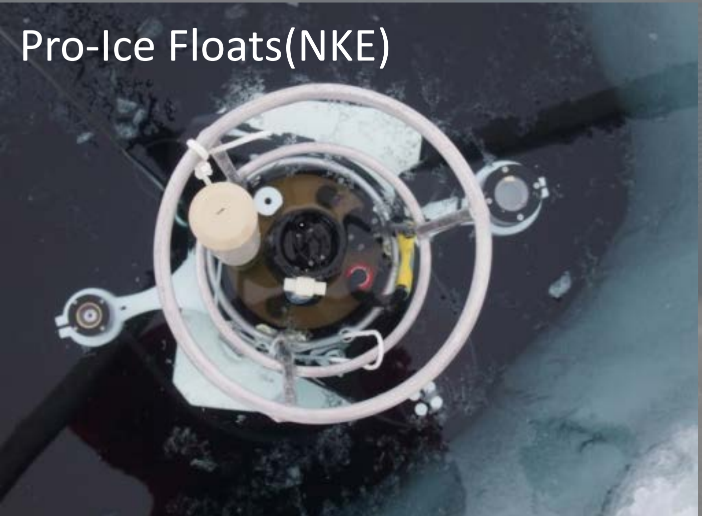
9085: Profile Positions. Last at NaN, NaN
74°N
73°N
72°N
71°N
70°N
69°N
68°N
Latitude
168°W
165°W
162°W
159°W
156°W
Longitude (bathymetry contoured at 0 -50 -100m)
May 3, '17
Sept 15, '16
-1
12
25
38
51
64
77
90
103
116
129
142
155
168
181
194
207
220
233
246
WHOI ALAMO: 2017-May-03

(K. Wood)

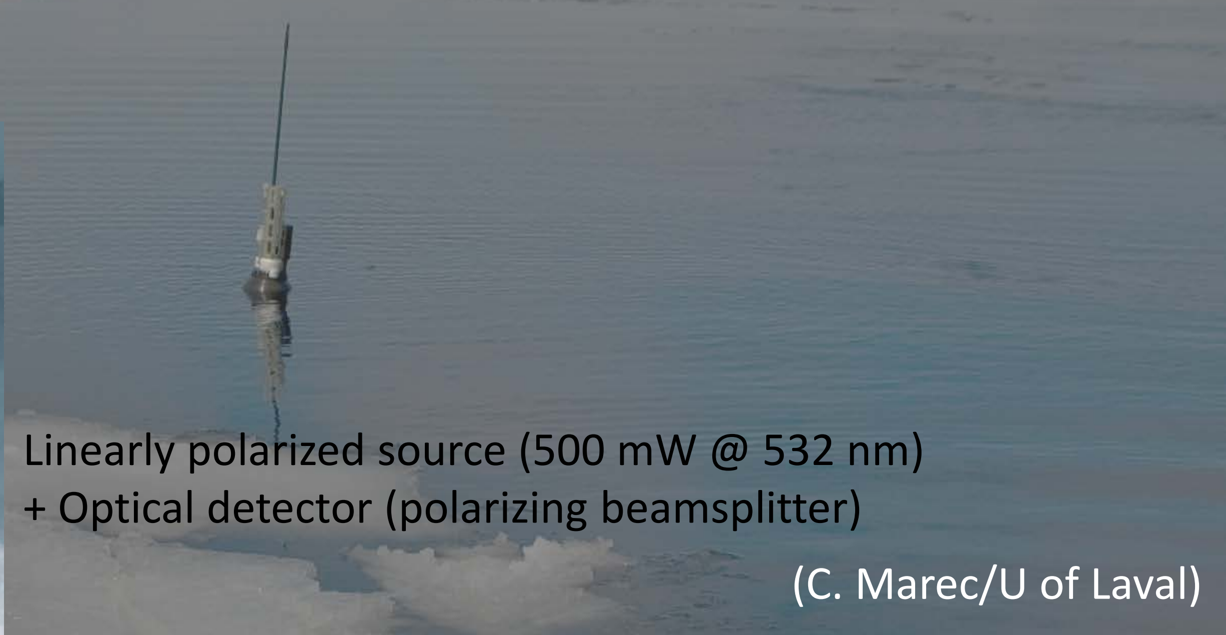
Challenge: Sea Ice Detection for Surfacing

Sea-ice detection techniques can be complementary, each contributing to different situations and ranges.

- ISA (Ice Sensing Algorithm), developed for S. Ocean [Klatt et al 2007]
- Active acoustic technique (~100m)
- Optical technique (~20m)
- Passive Acoustics (?)
- Mechanical (<1m)



Pro-Ice Floats(NKE)



Linearly polarized source (500 mW @ 532 nm)
+ Optical detector (polarizing beamsplitter)

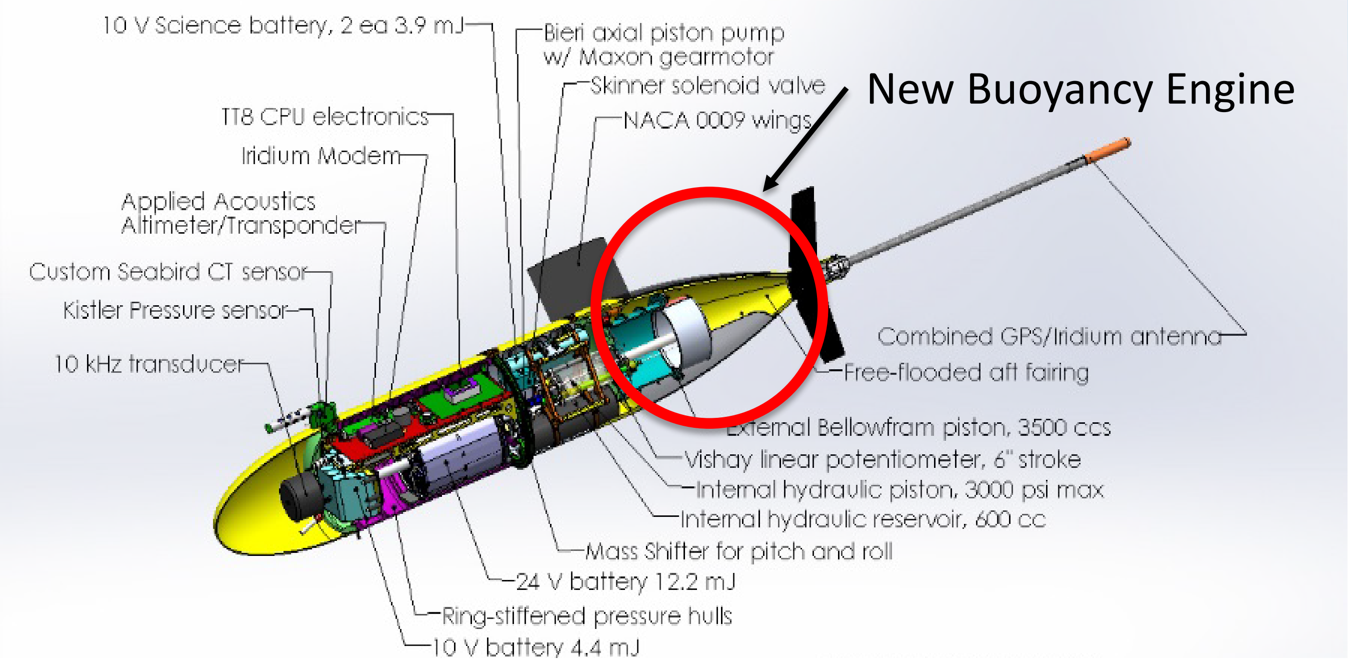
(C. Marec/U of Laval)

Oculus Underwater Glider

A new Coastal Glider (40-200m) based on U. of Washington Deepglider hardware and software

Arctic glider advantages:
-flexible, responsive
-scalable
-long endurance
-data shuttles

Challenges:
-under ice navigation
-logistics

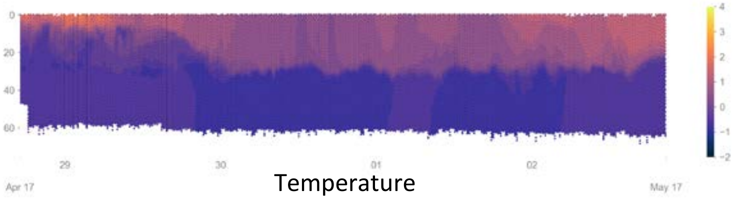


Oculus Underwater Glider

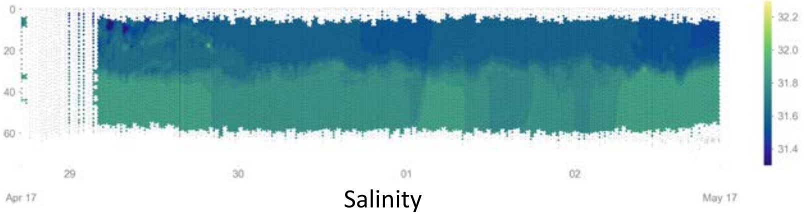
Advantages:

- Leverages Seaglider/Deepglider Technology for low cost/rapid development
- New buoyancy engine is 20X faster than a legacy glider, beneficial to minimize wind drift and surface hazards.
- High speeds of 100cm/s (2kts) when compared to legacy gliders
- Large scientific payload, carrying up to 6 kg of instrumentation
- Increased range with large wings that permit very shallow glide slopes and enable rapid turning.

Bering Sea
Test Mission
April/May 2017

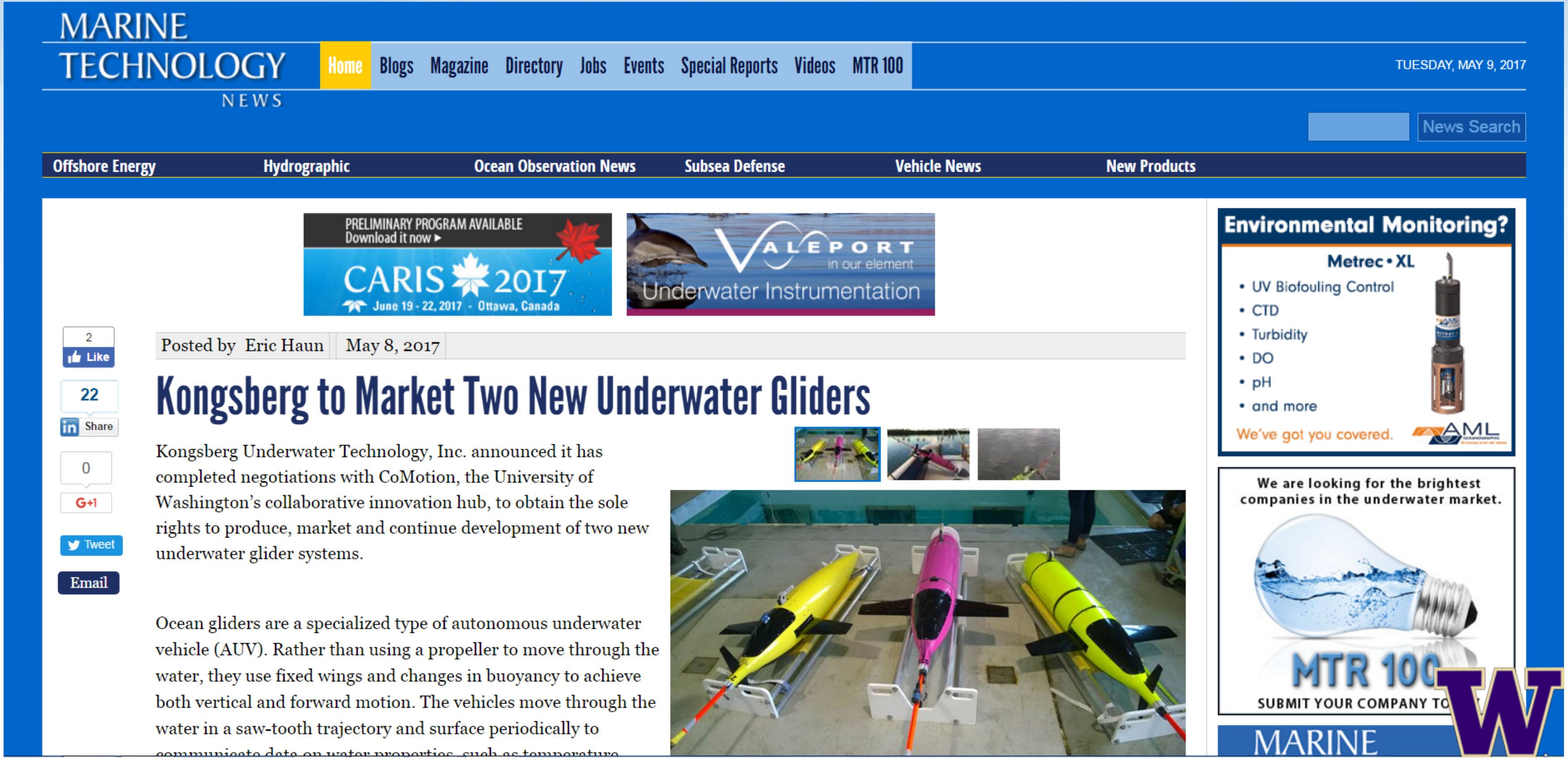


Temperature



Salinity

UW Tech Transfer to Kongsberg (May 8 '17)



Posted by Eric Haun | May 8, 2017

Kongsberg to Market Two New Underwater Gliders

Kongsberg Underwater Technology, Inc. announced it has completed negotiations with CoMotion, the University of Washington's collaborative innovation hub, to obtain the sole rights to produce, market and continue development of two new underwater glider systems.

Ocean gliders are a specialized type of autonomous underwater vehicle (AUV). Rather than using a propeller to move through the water, they use fixed wings and changes in buoyancy to achieve both vertical and forward motion. The vehicles move through the water in a saw-tooth trajectory and surface periodically to communicate data on water properties, such as temperature

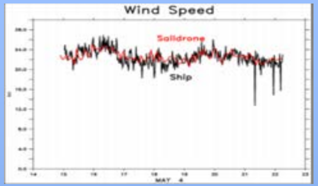
Summary

- Arctic observing technology is rapidly advancing and networks of platforms/sensors are practical
- ASVs, like Saildrone can carry many sensors for interdisciplinary studies in the Arctic, proving long endurance, flexible and scalable options
- 1st year echosounder field work has already shown promising science results
- New, smaller profiling ALAMO floats have been air-deployed and returned profiles after overwintering
- A new <200m coastal glider has been designed for arctic work

Innovative Technology for Arctic Exploration

ITAE

Research to Operations (R2O)



Systematic Science & Engineering Development

Platform Design and Sensor Integration

Operations and Field Test Planning

Data Validation

Integrated Research Missions

Transition to Operations