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The use of innovative pop-up floats to explore Arctic marine ecosystems

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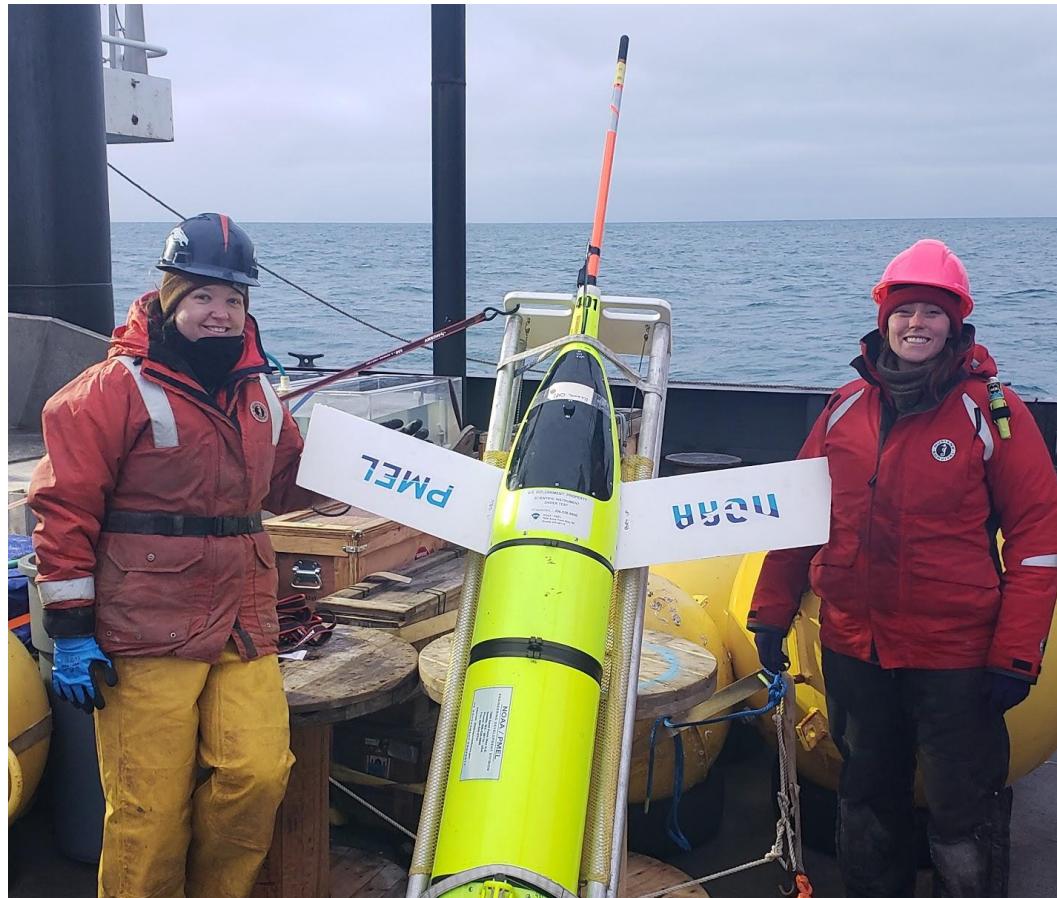
Pop-up floats fill a technology gap to collect data under sea ice in the Chukchi Sea

Sub-surface moorings measure bottom 30 meters



Recovering a sub-surface mooring aboard the NOAAS *Oscar Dyson* in August 2020 (pc Sarah Donohoe)

Gliders generally have to avoid sea ice



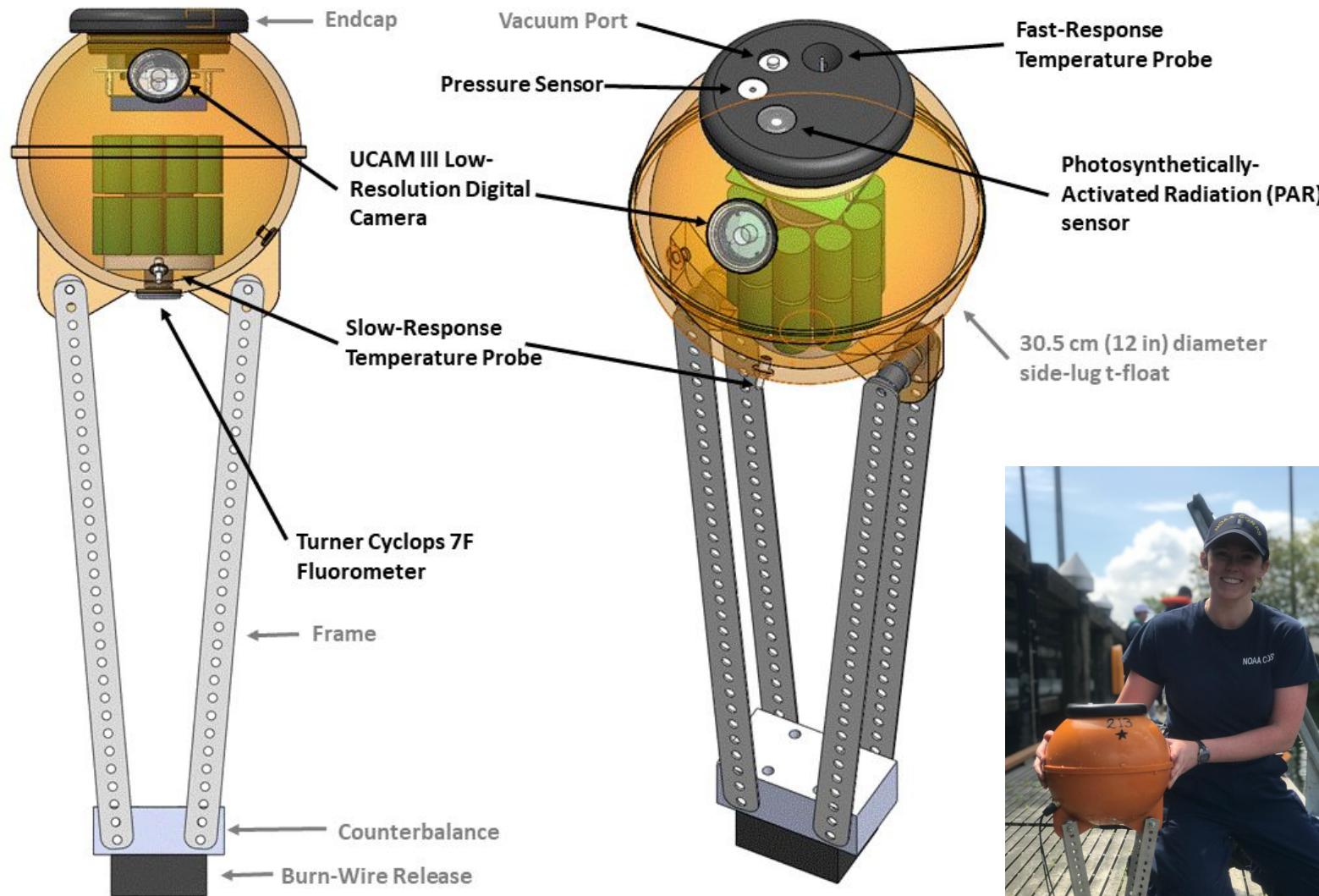
Stephanie Grassia(AFSC/MML) and Sarah Donohoe(PMEL/FOCI) with an Oculus Glider in October 2018 (pc Catherine Berchok)

Ice-Coring opportunities are rare



Ned Cockelet(PMEL/FOCI) and Matt Wilson(AFSC) with an Ice-Corer in 2006 (pc PMEL/FOCI) 2

Pop-up floats are autonomous, low-cost and provide oceanographic-quality data



LTJG Sarah Donohoe poses with a pop-up float after a test-deployment in Lake Washington (pc Heather Tabisola)



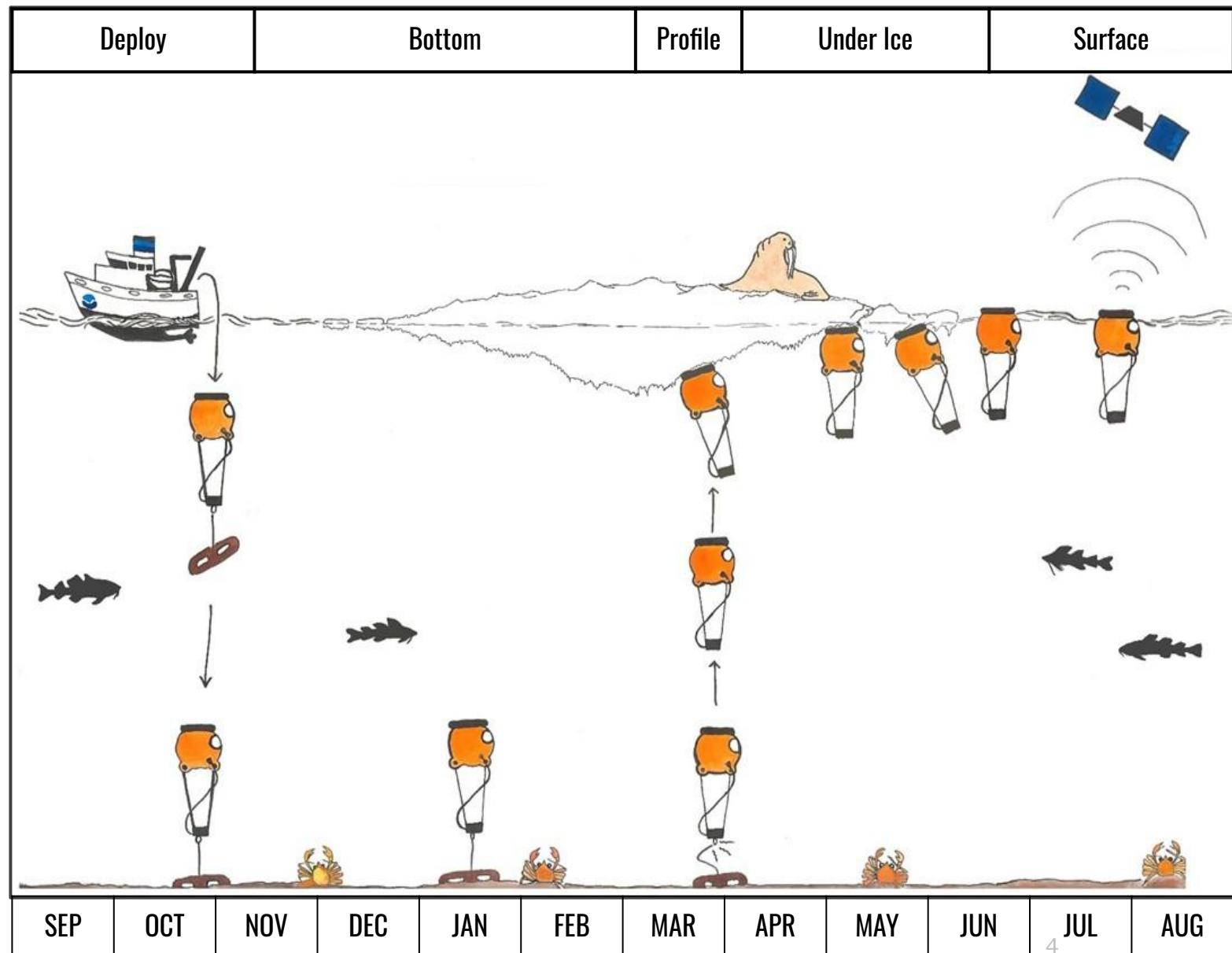
Two pop-up floats anchored at the bottom of a pool at the NOAA Western Regional Center (pc Sarah Donohoe)



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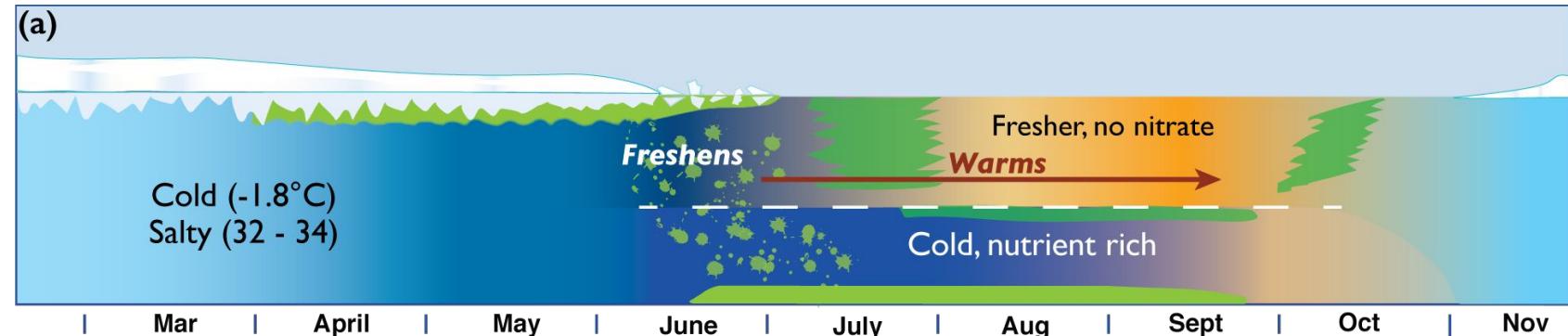
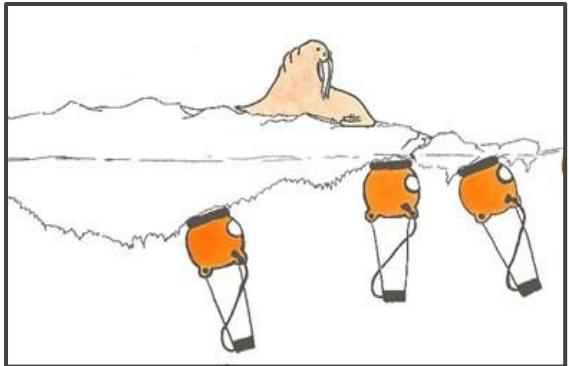
Pop-up floats function in 5 phases

1. **Deploy:** from ship in ice-free conditions
2. **Bottom:** logging measurements hourly
3. **Profile:** float rises after releasing the anchor, collecting measurements at 4Hz
4. **Under Ice:** logging measurements hourly and taking daily images
5. **Surface:** transmits logged data via Short-Burst-Data messages, then collects measurements every 3 hours until battery expires



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Pop-up floats measure under-ice production in the Chukchi Sea

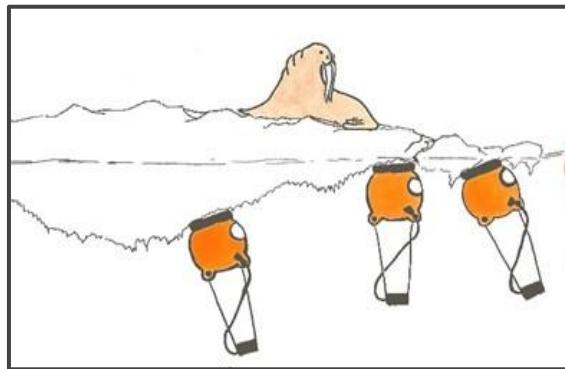


Under-Ice photos show ice algae, taken by NOAA Ship Miller Freeman Diver in April 2006 (pc Shawn Cimilluca)



Under-Ice photos show ice algae, taken by pop-up float 1240 in May and June, 2019 (pc PMEL/FOCI)

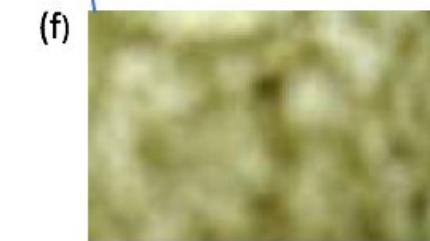
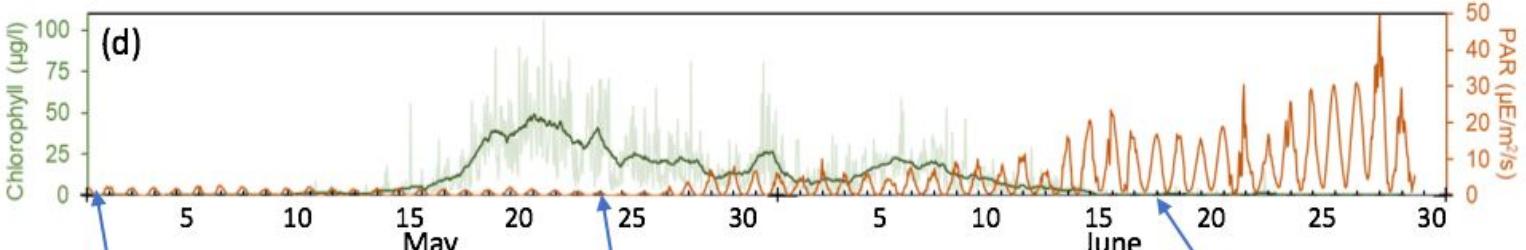
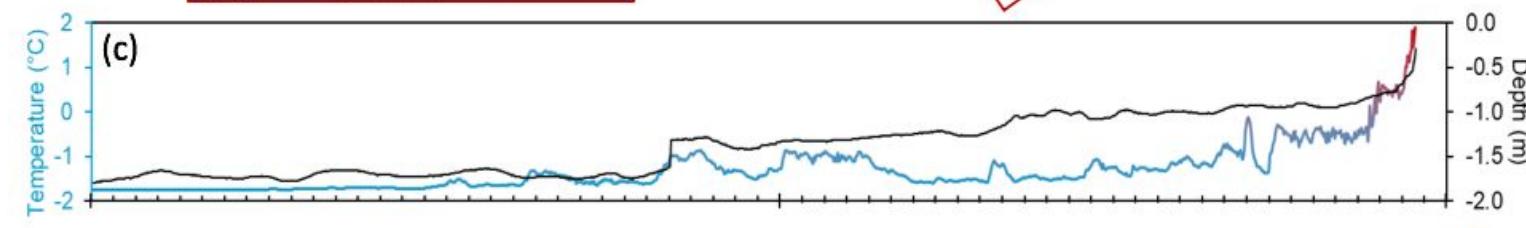
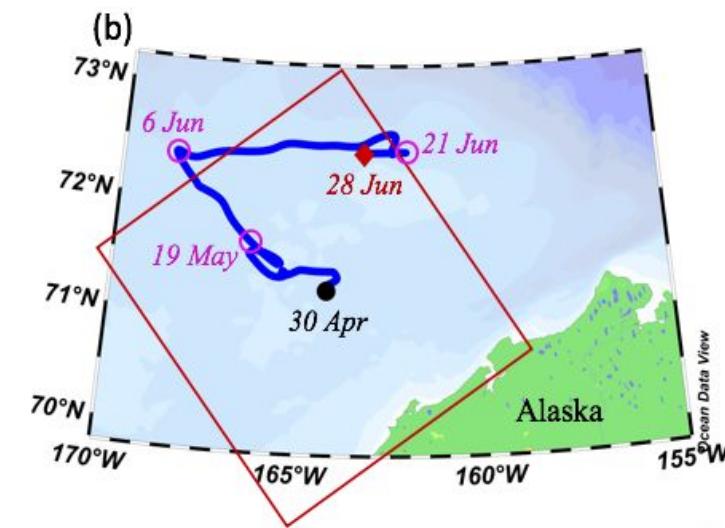
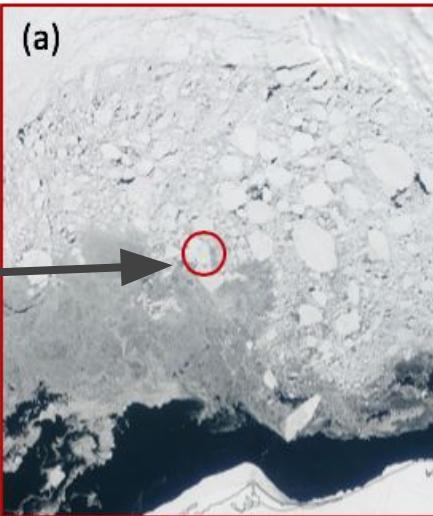
Under-ice data and satellite images tell the story of an ice-algae bloom in May 2019



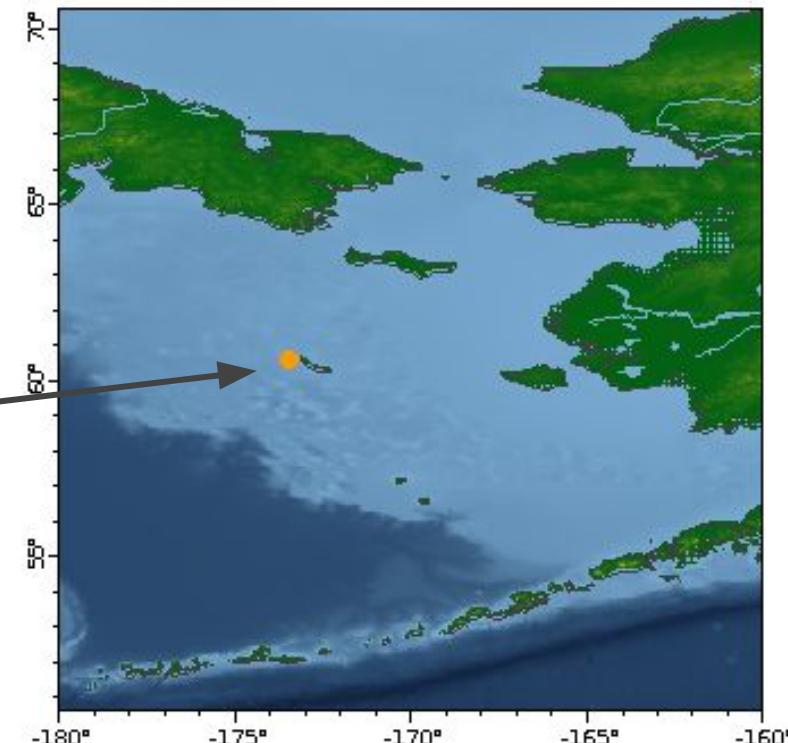
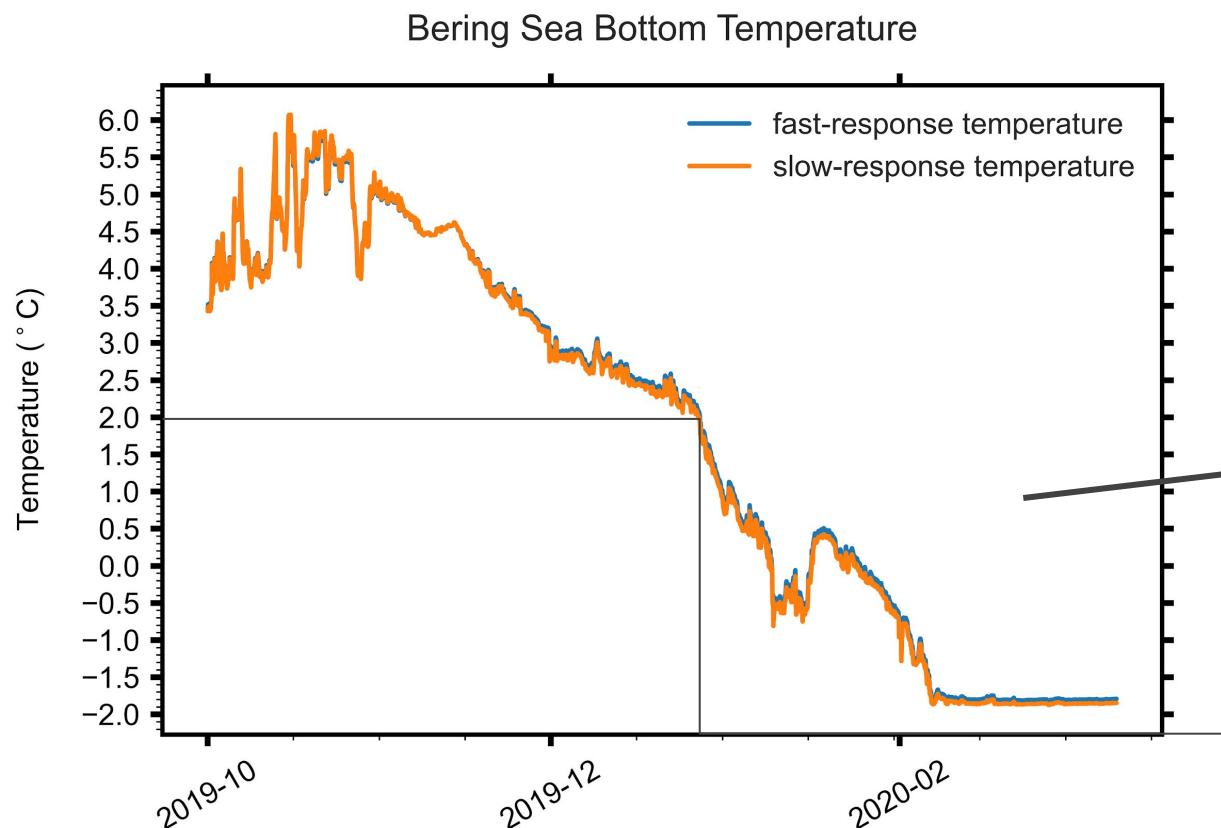
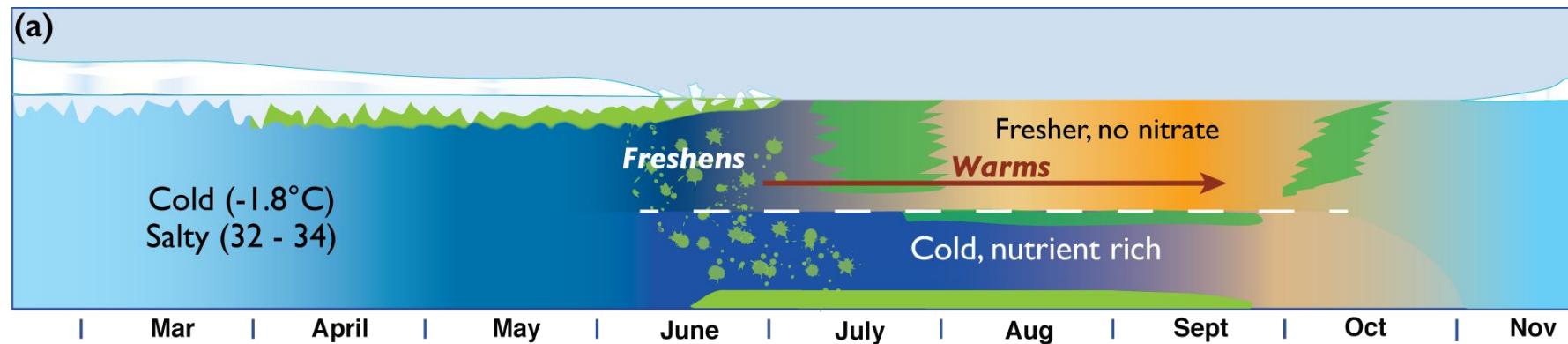
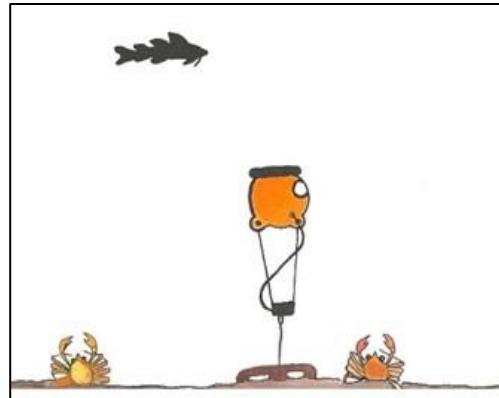
A pop-up float surfaced under a 2km long ice floe on April 30th, 2019

The floe was tracked with satellite imagery and followed the blue trajectory in figure b.

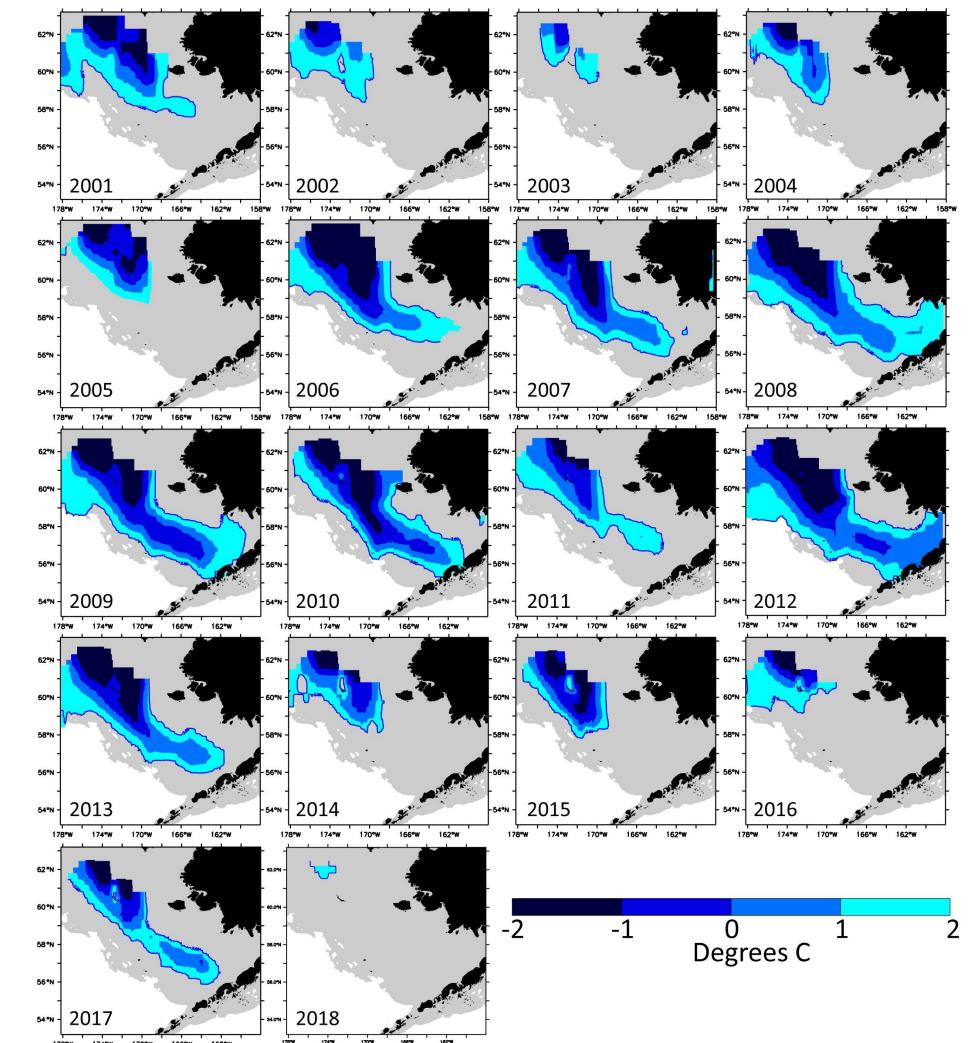
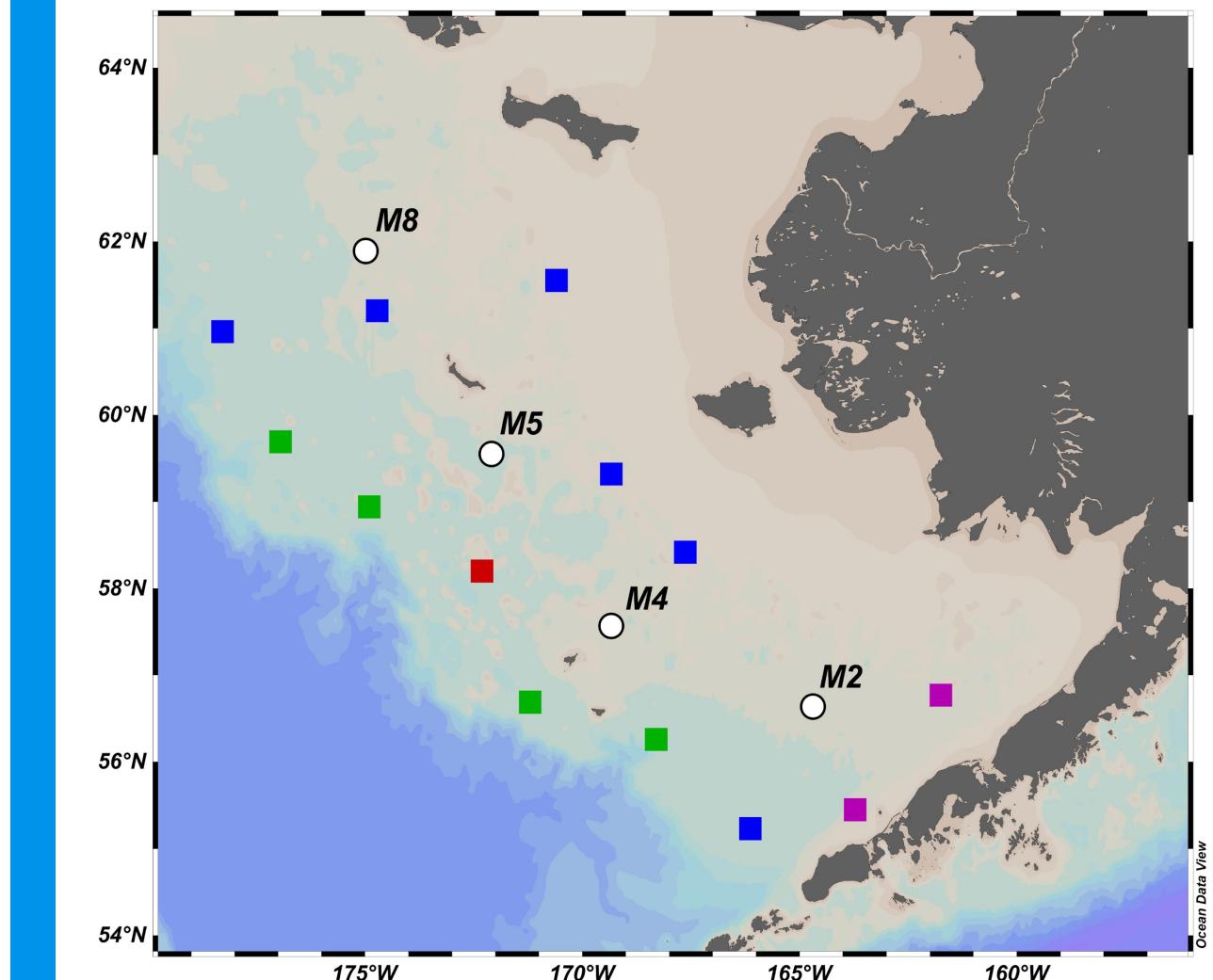
Fluorescence signal and ocean color images indicate an ice-algae bloom from May 15th to June 15th 2019



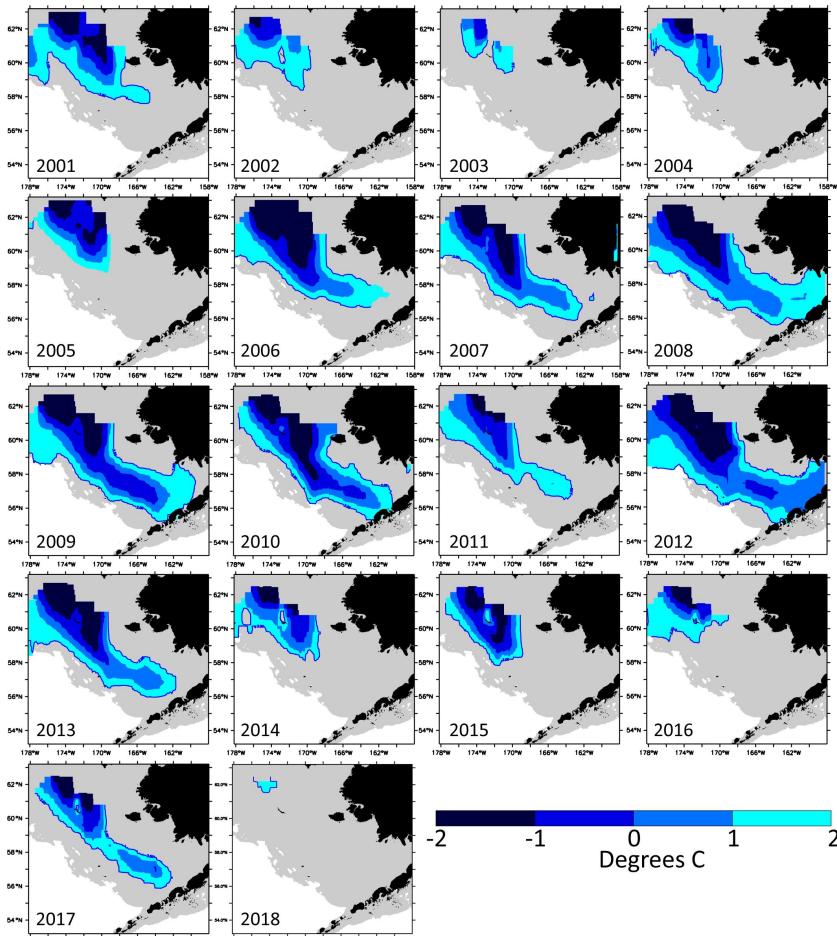
Pop-up floats measure bottom-temperatures to map Bering Sea cold pool ($<2^{\circ}\text{C}$)



Model of cold pool dynamics is fed by bottom-temperature time-series at M sites



Pop-up floats to improve ROMS model of cold pool dynamics



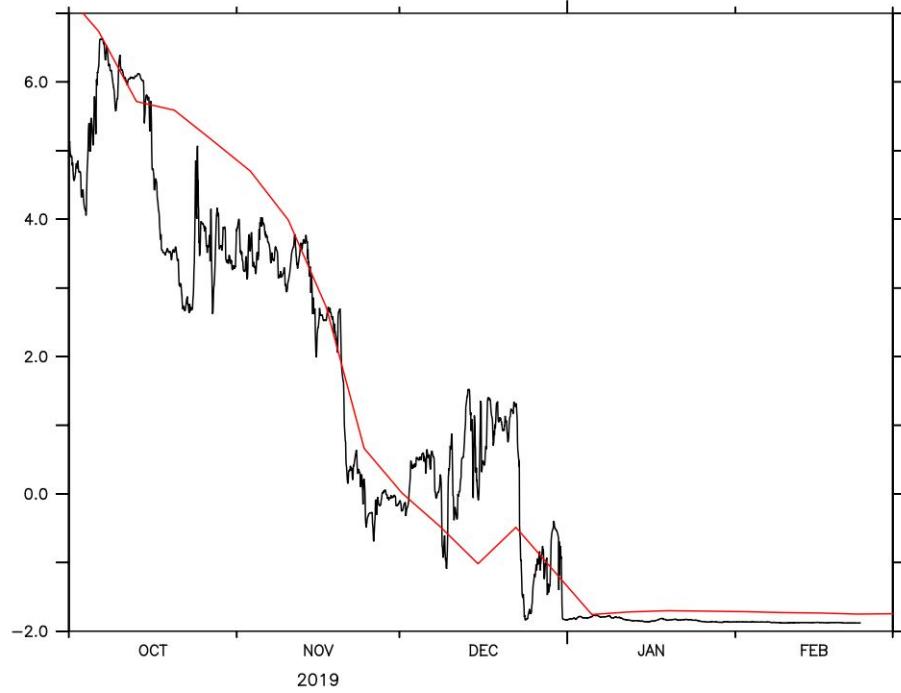
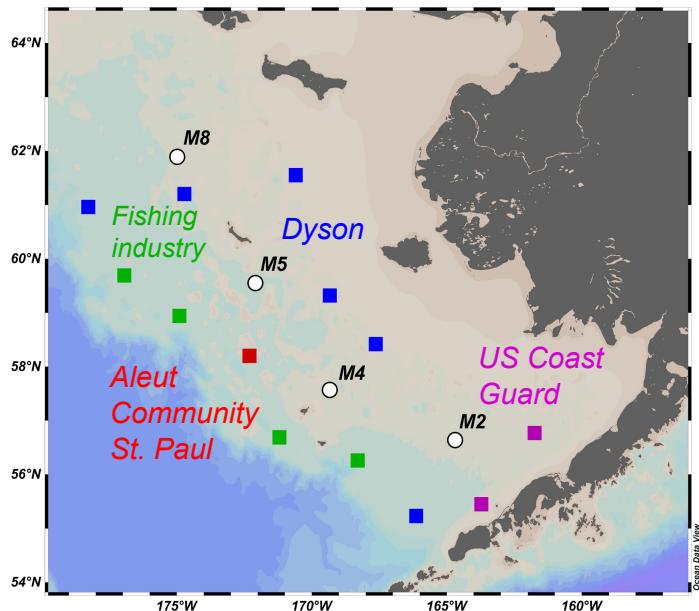
NPRB Ongoing Proposal, Rogers et al., 2020-2023



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Project Goals

1. **expand observations** of seasonal bottom temperatures across the EBS through deployment of PUFs
2. use those data to validate and assess **ROMS** model error and bias with respect to cold pool dynamics
3. formally assimilate new data into ROMS model for improved “hindcasts”
4. Use improved ROMS and known relationships between temperature and Pacific cod spawning success to characterize suitable habitat for spawning in the EBS
5. project the spatial distribution and timing of suitable spawning habitat under future climate scenarios
6. introduce this information into the management process for Pacific cod.



Pop-up floats deployed by the fishing industry, the U.S. Coast Guard and the Aleut Community of Saint Paul Island



C/P *Starbound*, August 2020

Left to right: Tylar Lowen ; Walter Miranda ; Reynaldo Pio ; Caleb Rodriguez. (pc Susie Zagorski)



U.S. Coast Guard Cutter *Fir*, October 2020
(pc U.S. Coast Guard Cutter *Fir*)



F/V *Karen Ann*, October 2020

Andronik Hanson. (pc President of the Aleut Community of St. Paul Island, Amos Philemonoff)

Thank you to co-authors and contributors!

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Pop-Up Float Takeaways

- inexpensive and autonomous
- useful for under-ice production studies
- useful for mapping the cold pool
- flexible for a variety of research interests
- partnership building platforms for local stakeholders

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