NOAA
Pacific Marine Environmental Laboratory

Innovative Marine Science for a Sustainable Future

Michelle McClure

Overview

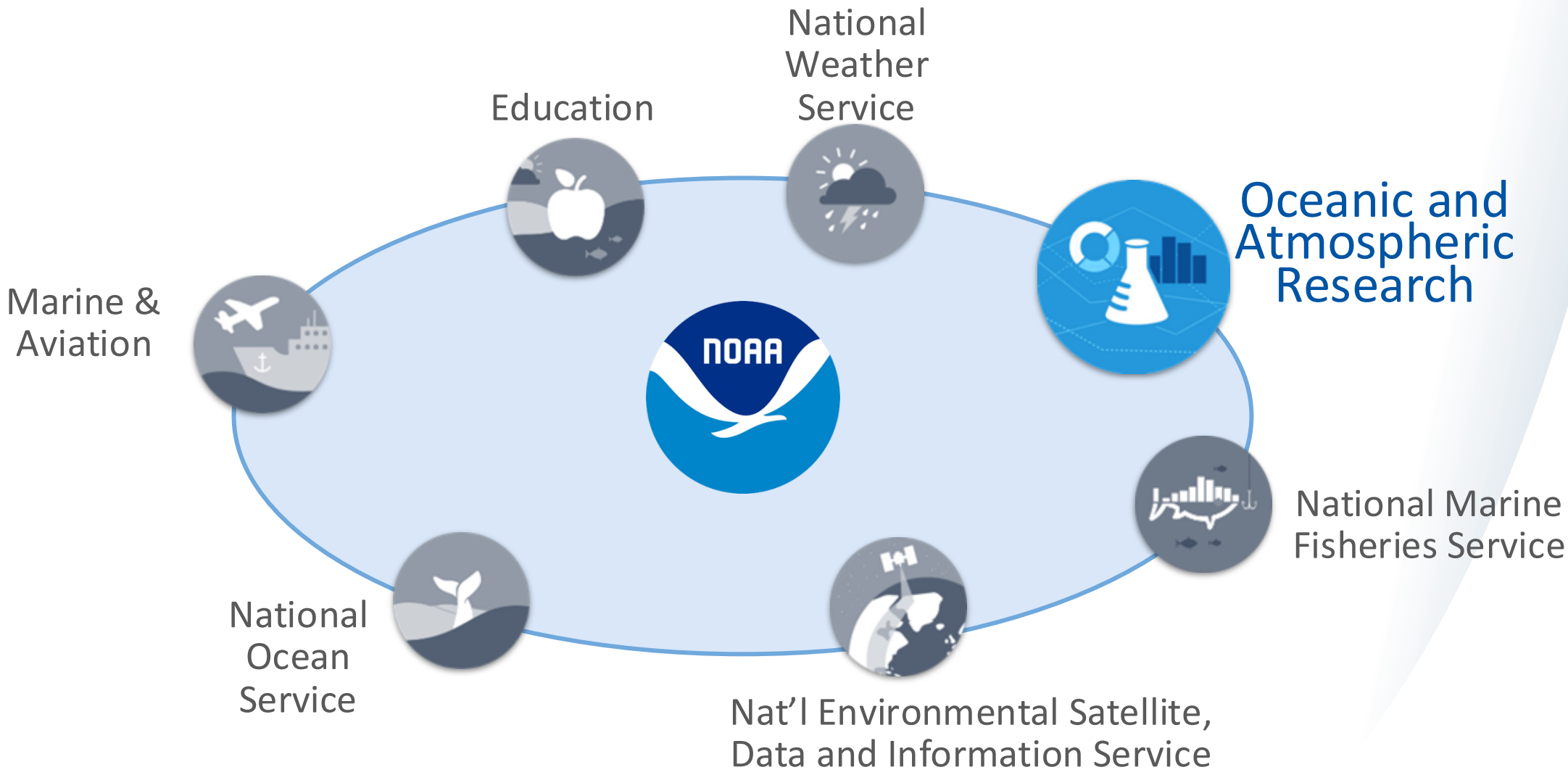
PMEL and NOAA: Who we are

Deeper Dives:

- Marine and Atmospheric Chemistry: Ocean Acidification
- Marine Ecosystems: Fisheries Oceanography in the Bering Sea
- Oceans and Extreme Events: Tsunami Detection and Forecasting

NOAA PMEL

About NOAA



NOAA PMEL

About PMEL

Our Vision:

Predictable, safe, and healthy oceans based on scientific knowledge and sustained for future generations as our planet changes.

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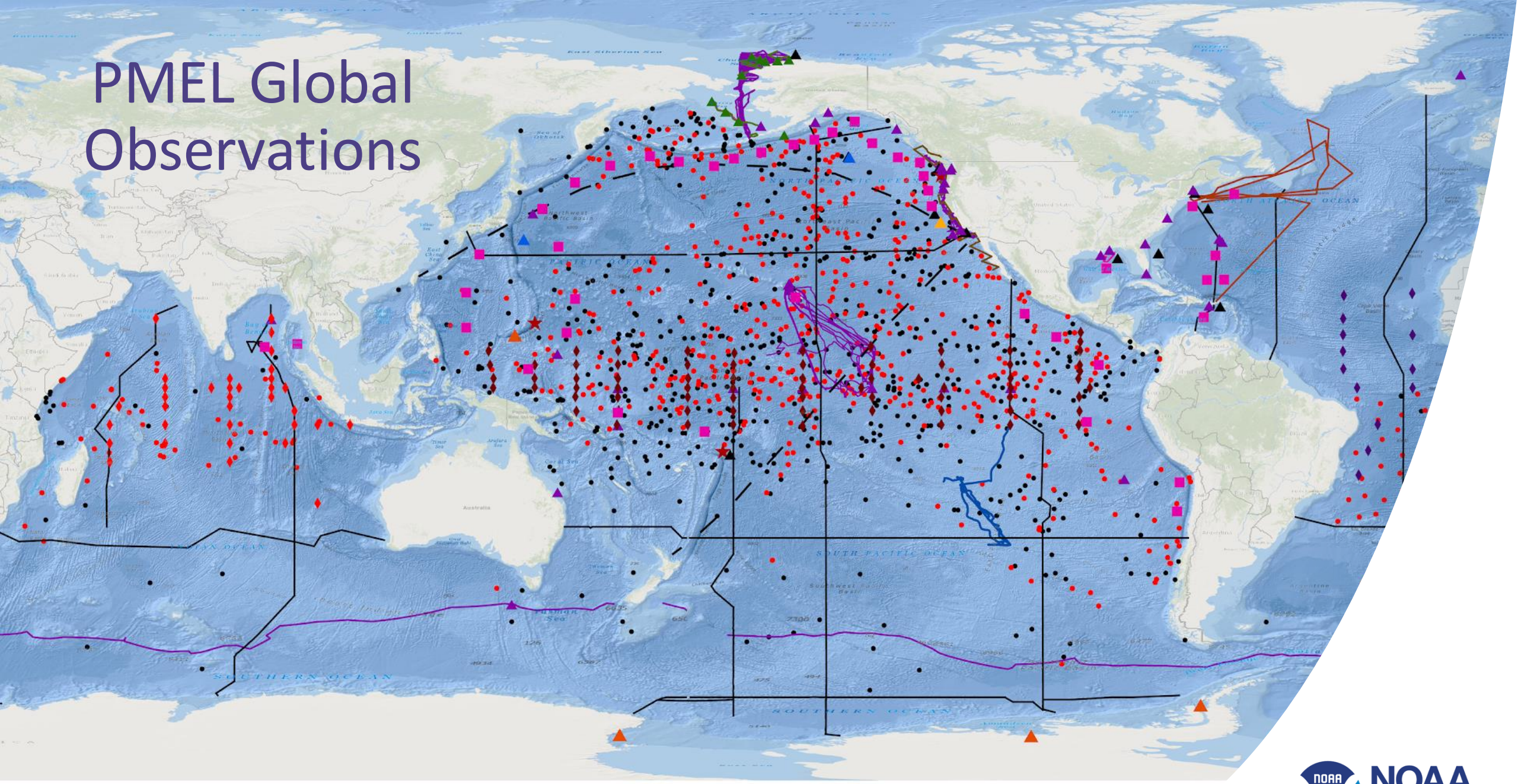
PMEL Global Observations



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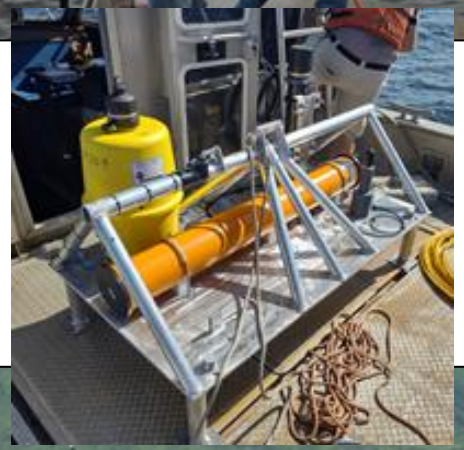
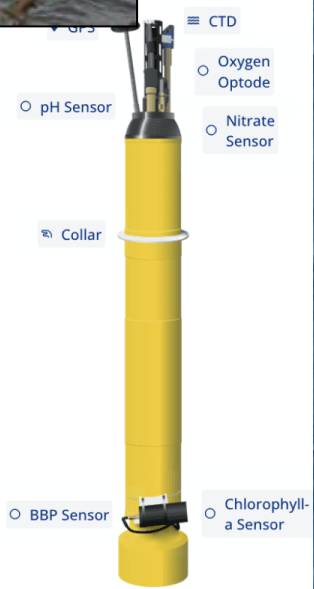
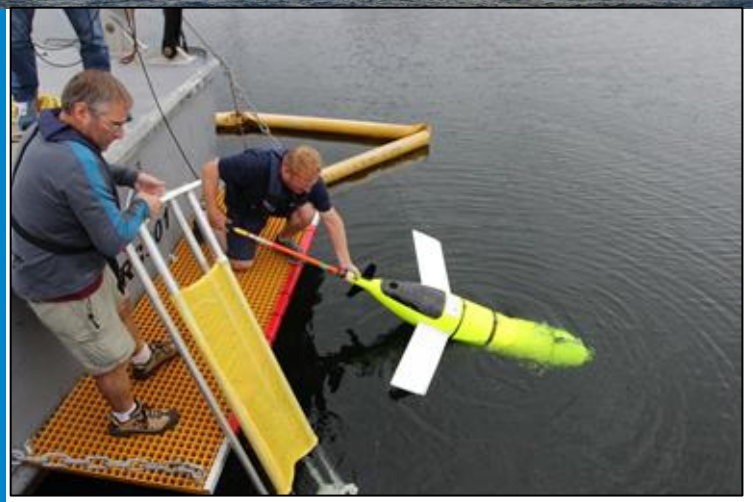




ic to Biogeochemical (BGC) Argo floats H



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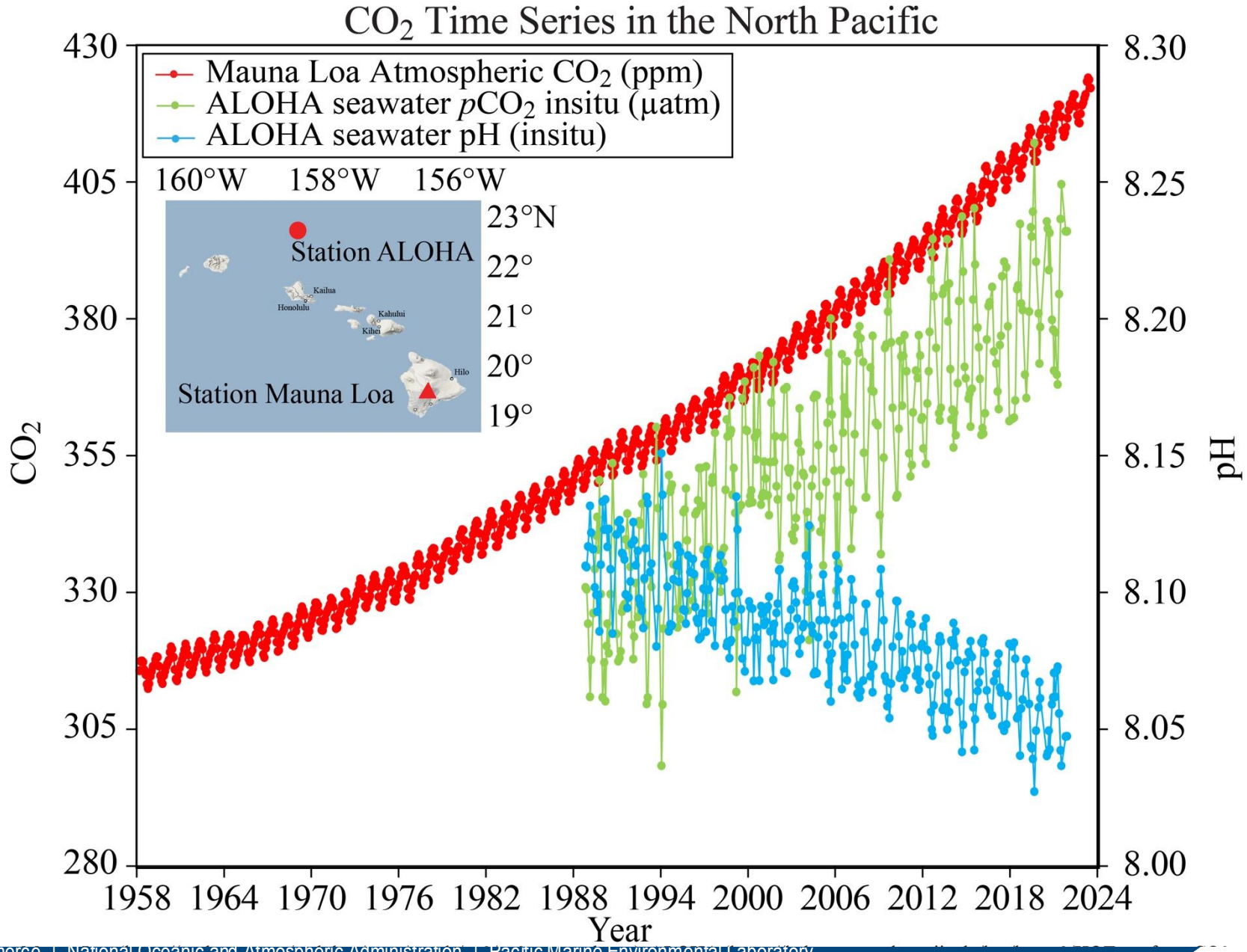
Our Big Questions:

What are the impacts of marine and atmospheric chemistry?

How do physical and chemical factors drive change in marine ecosystems?

What is the ocean's role in climate, weather and extreme events?

Global emissions increase CO_2 in the atmosphere ***and ocean***



Ocean Acidification (OA) Chemistry 101:

the many forms of CO_2 in seawater

CO_2

$CO_2 + H_2O \rightarrow H_2CO_3$ carbonic acid

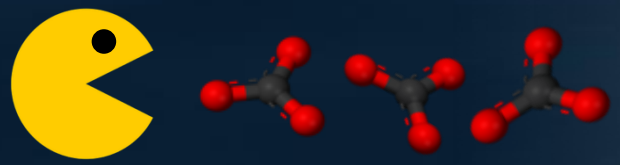
water

carbon dioxide

acidity (pH)

$H^+ + HCO_3^-$ bicarbonate

$H^+ + CO_3^{2-}$ carbonate



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Differences between beer and the ocean…

Scientists get concerned about exaggerated analogies, so…..:

- Beer has ~100 times as much CO_2 in it as seawater, and, it's basically all CO_2
- MUCH more of the other forms of CO_2 in seawater that *buffer* the effect of the CO_2 in seawater, preventing bubbles
- Consequently, beer is "acidic" (typically pH 4.0–4.5), whereas seawater is "basic" (usually pH 7.0–8.5)

Concerned scientist

Look: no bubbles!

Ultimately, increasing acidity can make shell-building harder by reducing the availability of building blocks or dissolving existing shells

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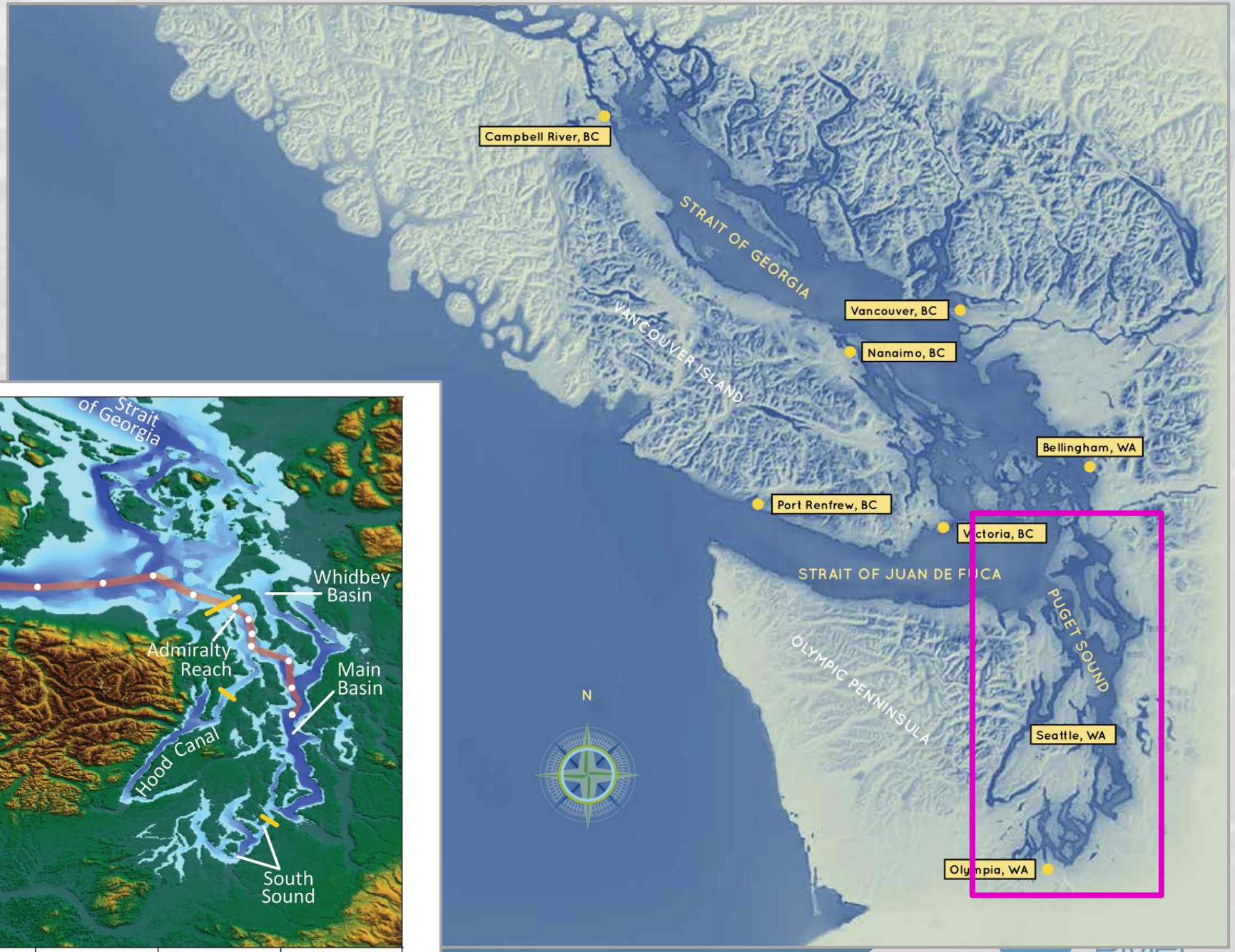
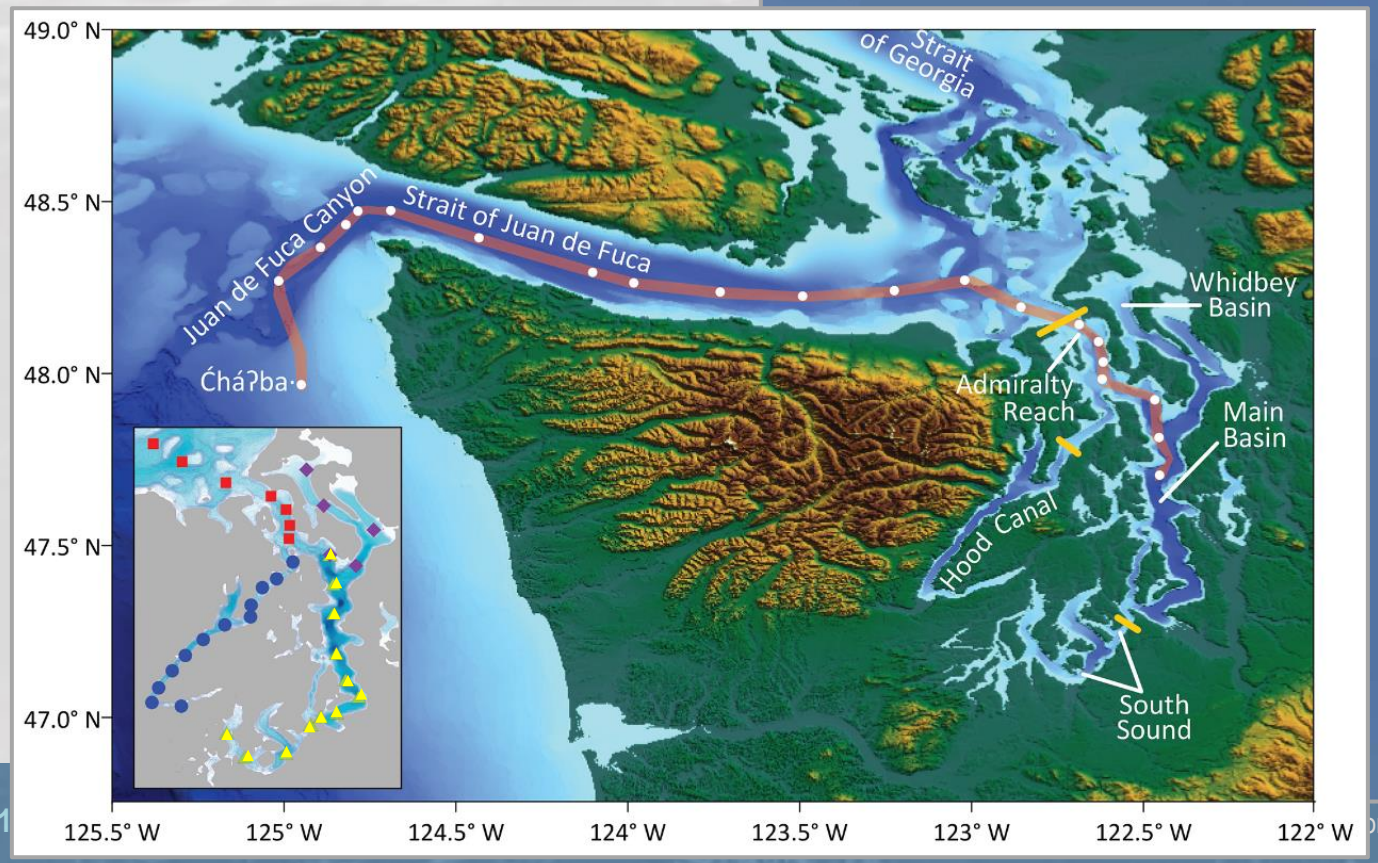
The Salish Sea

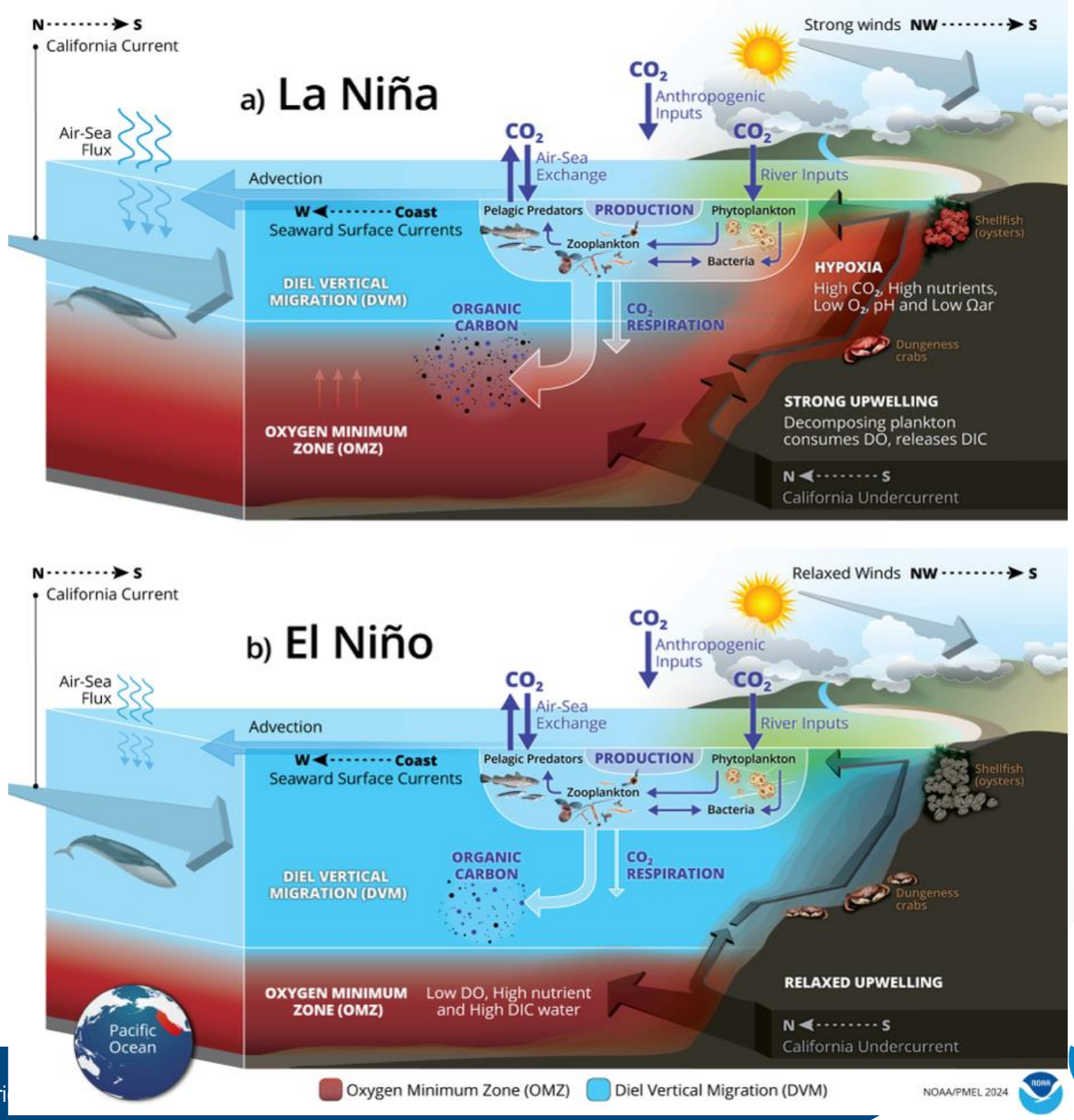
- **Seasonal Puget Sound cruises:** July 2014–July 2024 (30 cruises!)
- **Basins:** Admiralty Reach, Main Basin, South Sound, Whidbey Basin, Hood Canal
- **Surface to near-bottom**





Maps from: Sobocinski 2020, Alin et al. 20

Upwelling brings corrosive waters to the surface along the Washington and Oregon coasts



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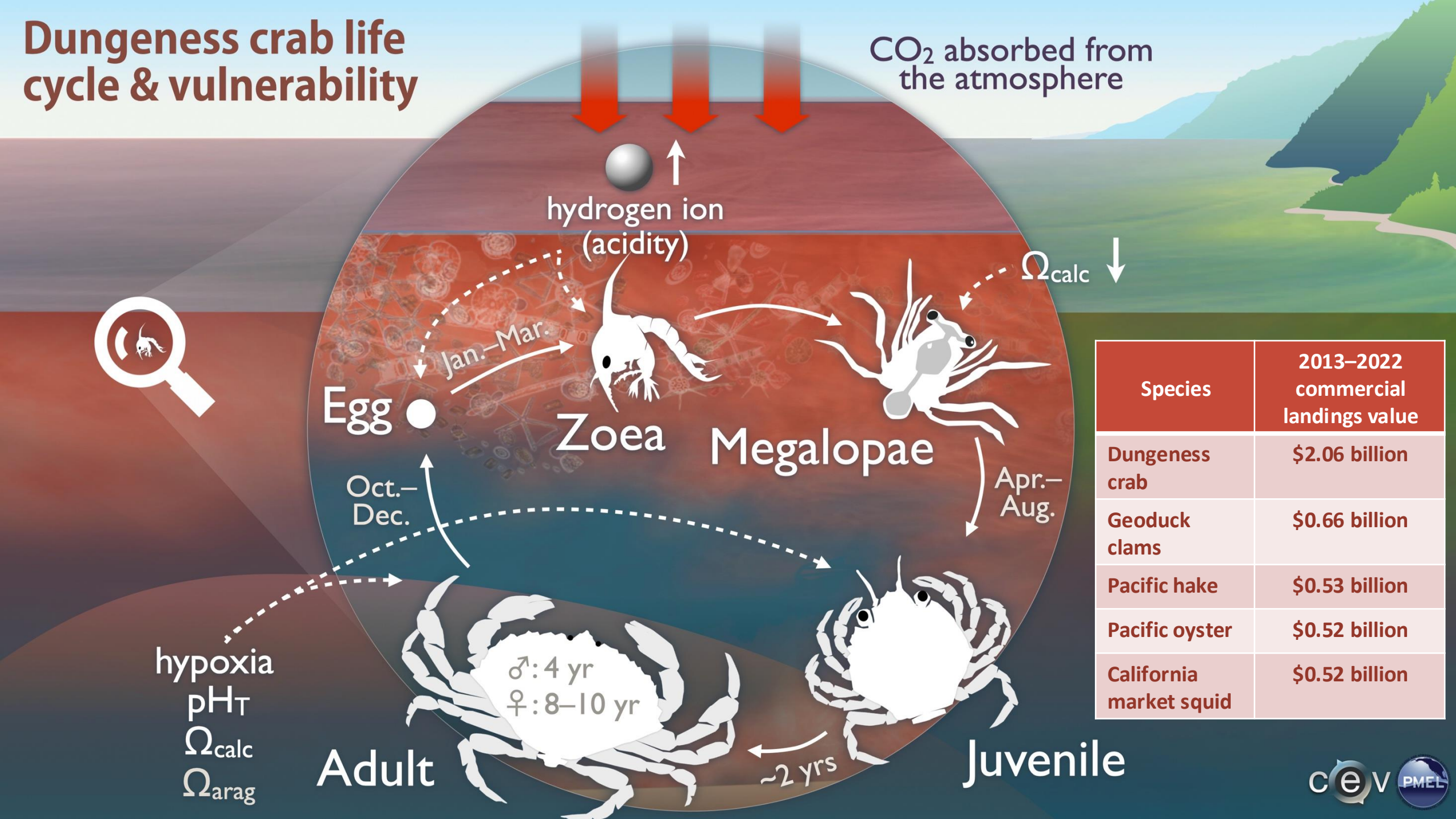
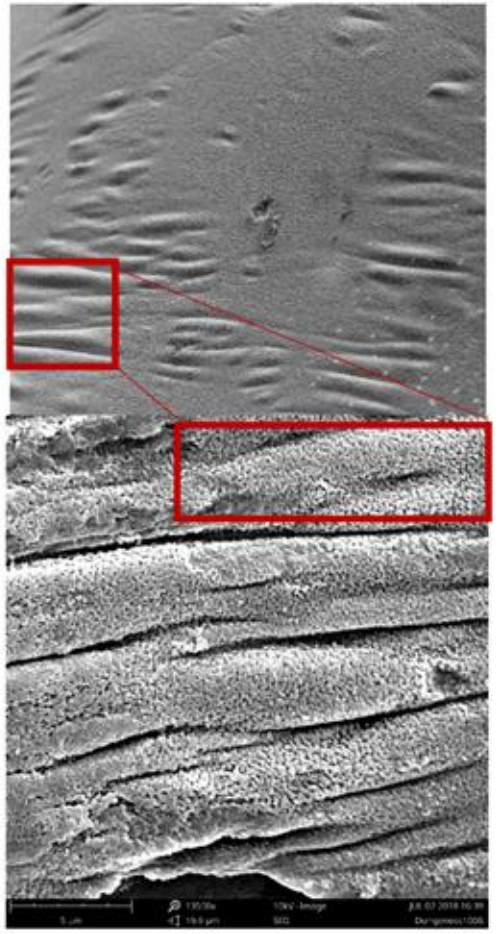
Dungeness crab life cycle & vulnerability

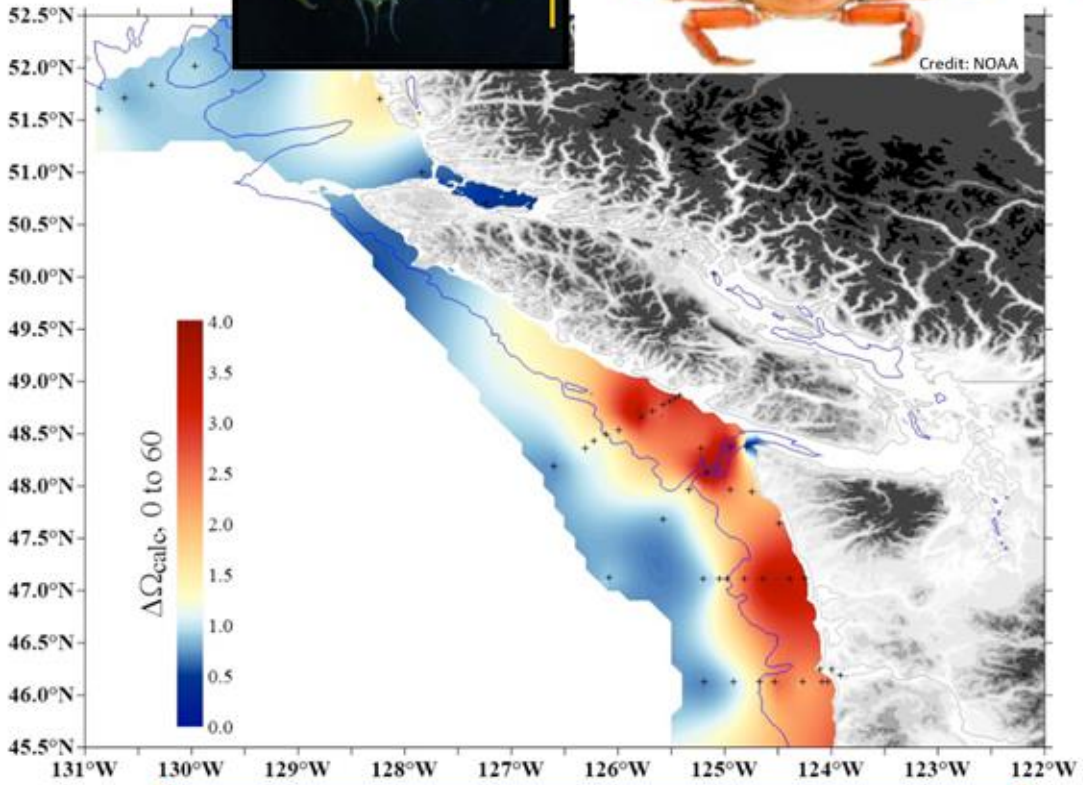


Species	2013–2022 commercial landings value
Dungeness crab	$2.06 billion
Geoduck clams	$0.66 billion
Pacific hake	$0.53 billion
Pacific oyster	$0.52 billion
California market squid	$0.52 billion

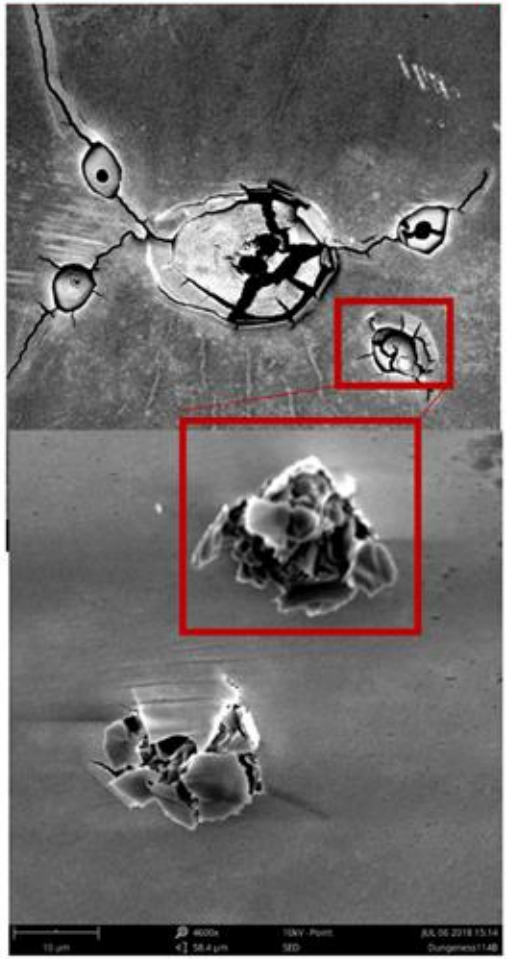
OA Impacts on the Organisms

Exoskeleton dissolution of the larval Dungeness crab resulting in structural deformities

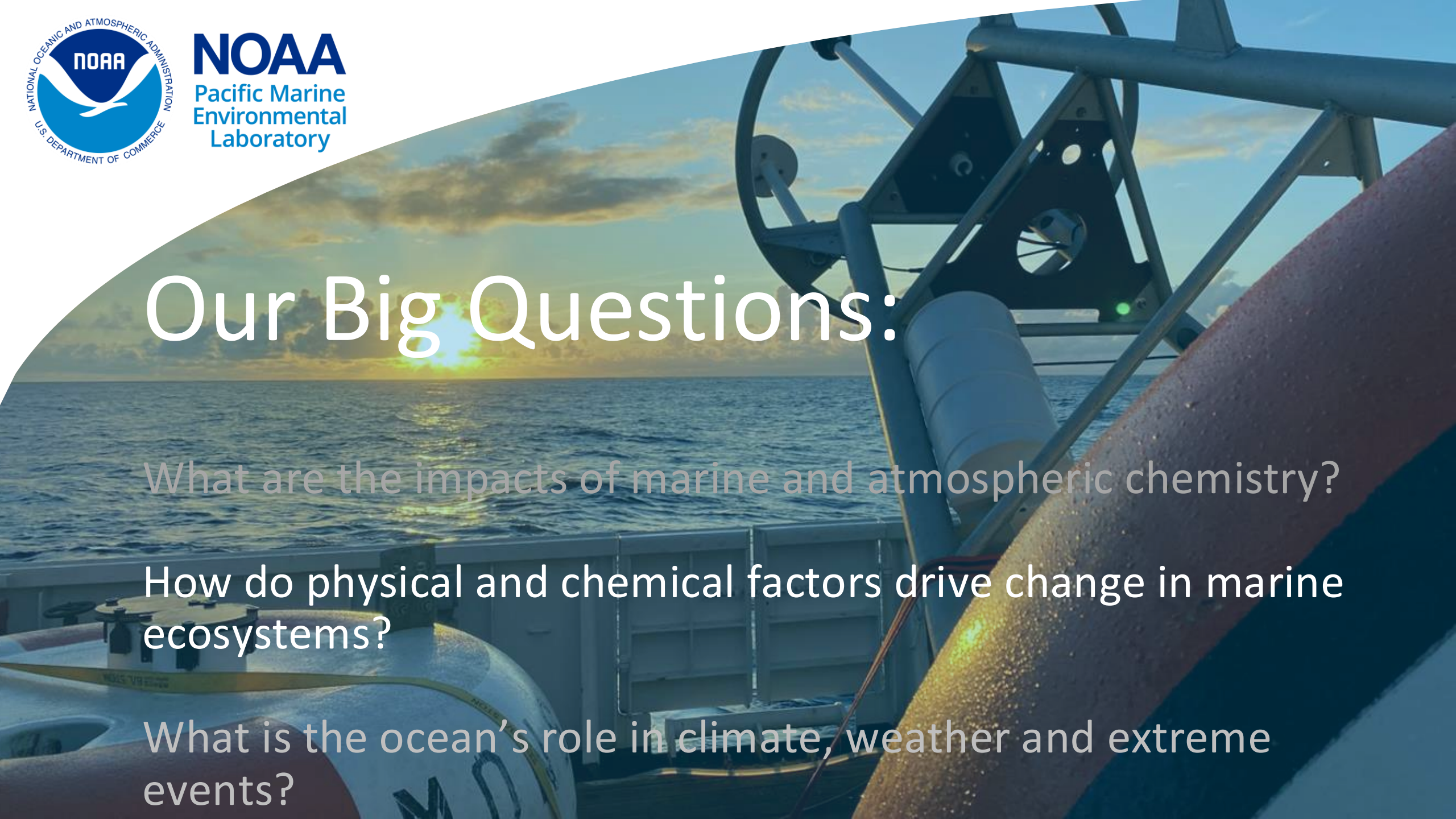




Dissolution also causes damaged or missing mechanoreceptors



The ocean acidification hotspots, as defined by the steep calcite vertical gradients, where larvae Dungeness crab are most affected by dissolution



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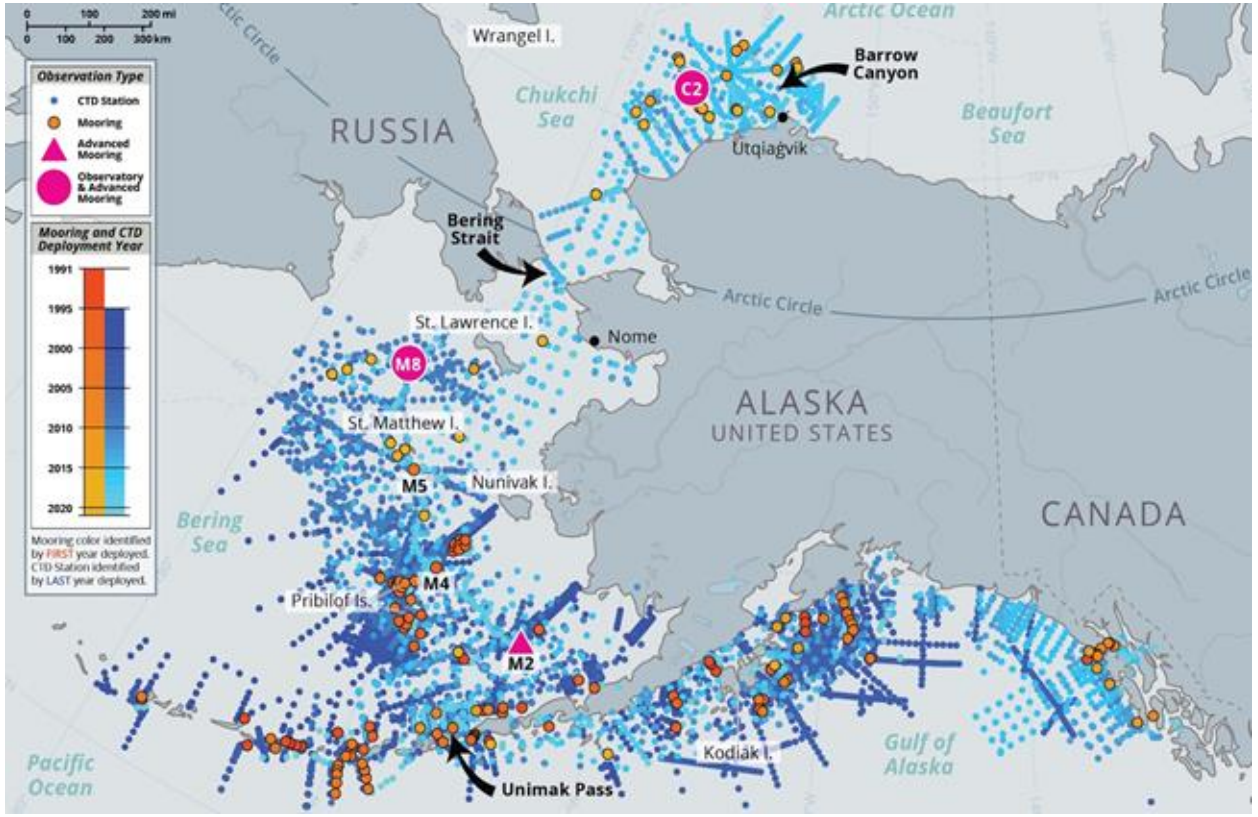
EcoFOCI Biophysical Mooring Network

Long-term biophysical moorings

EcoFOCI
Ecosystems & Fisheries-Oceanography Coordinated Investigations



- 30 years [M2]
- 20-29 years [Kodiak, M4, M5, M8]
- 15-19 years [Chukchi Sea, C2]
- 10-14 years [Chukchi Sea, C1, C3, C4, C5 (DBO5), C12 (DBO3)]
- 5 years [M14, Shumagin I.]

Immense Region:

- Alaska coastline accounts for 80% of total US coastline
- Over half of the US continental shelf is found here
- 40% of the US catch of fish & shellfish
- >100,000 people rely on subsistence hunting & fishing

All moorings measure: temperature, salinity, fluorescence, currents, passive acoustics (whales). At selected sites, PAR, O_2, nitrate, sediment trap, eDNA, CO_2, met data, ice thickness, bag sampler

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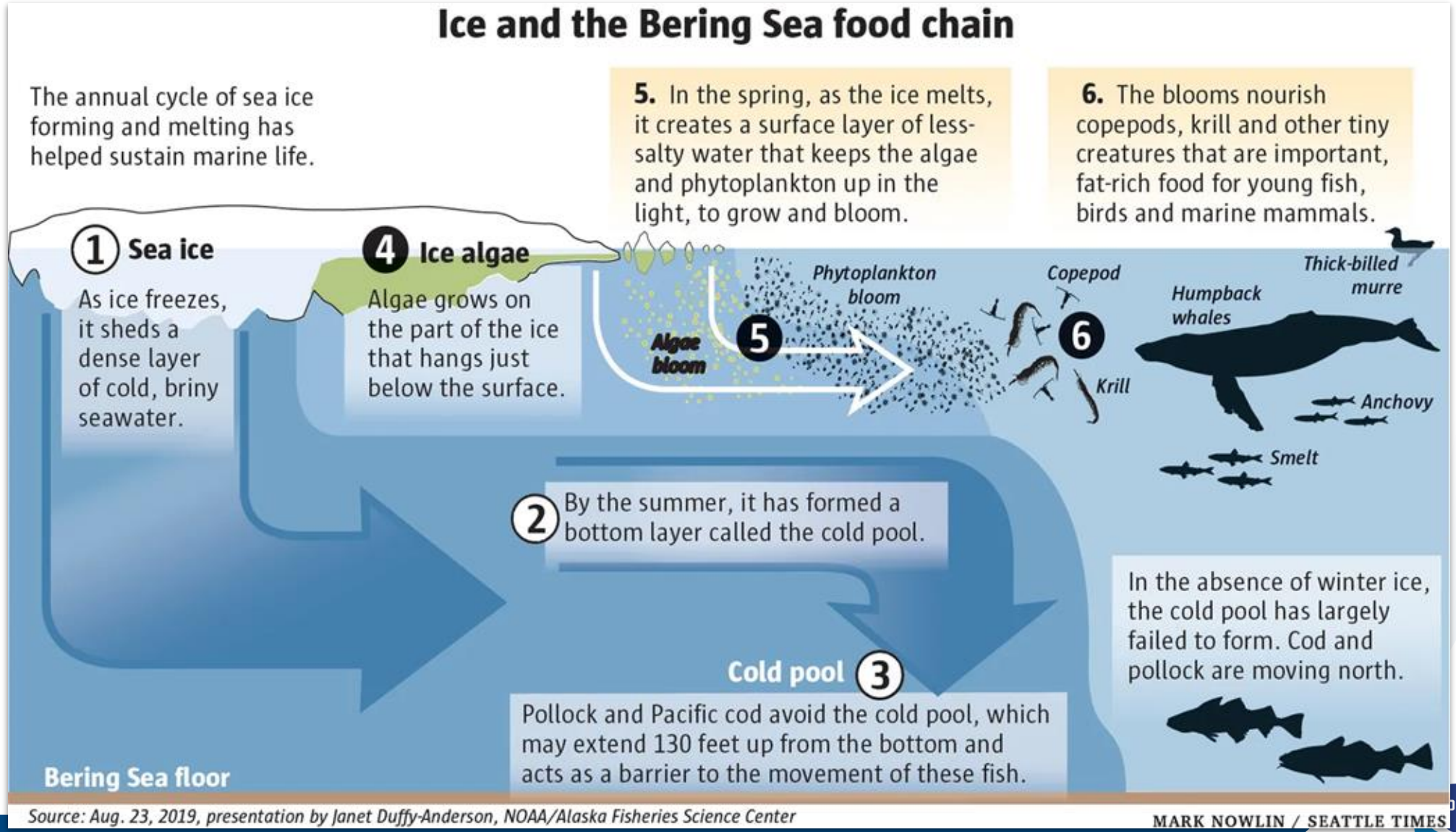
Sea Ice Structures the Bering Sea Ecosystem



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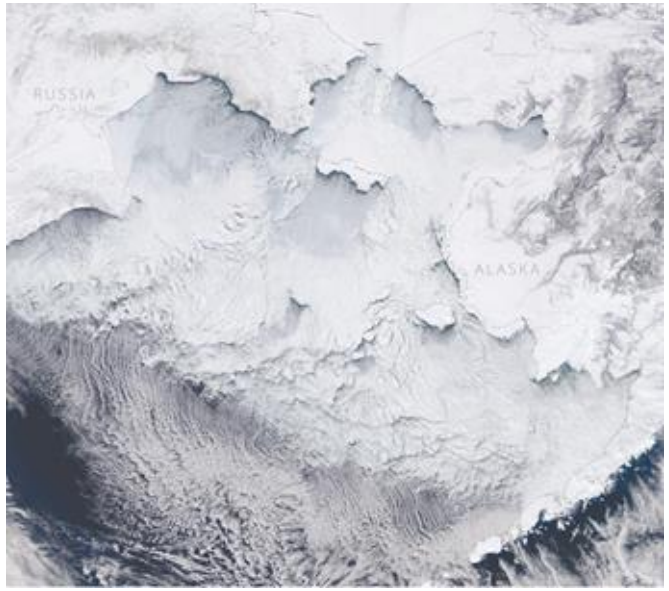

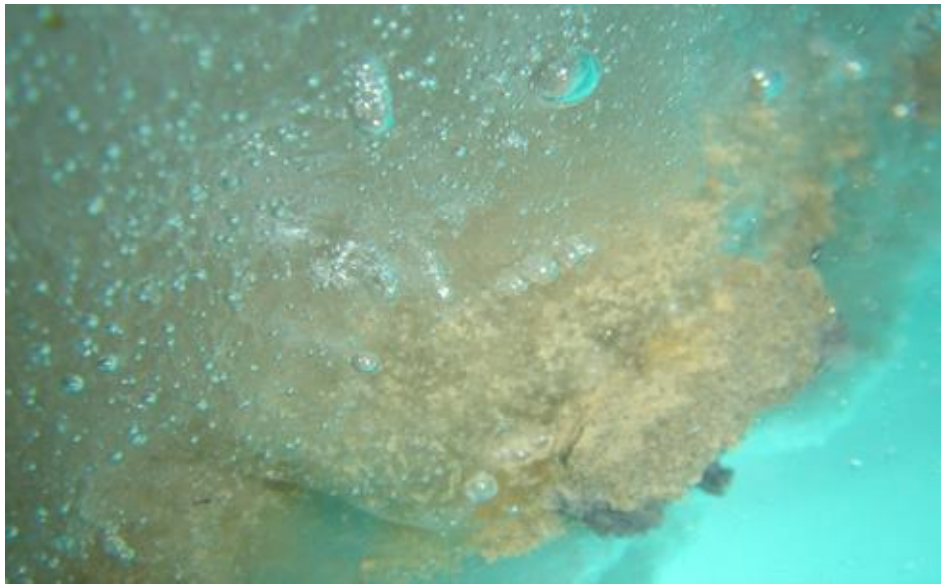

Stabeno et al., 2018

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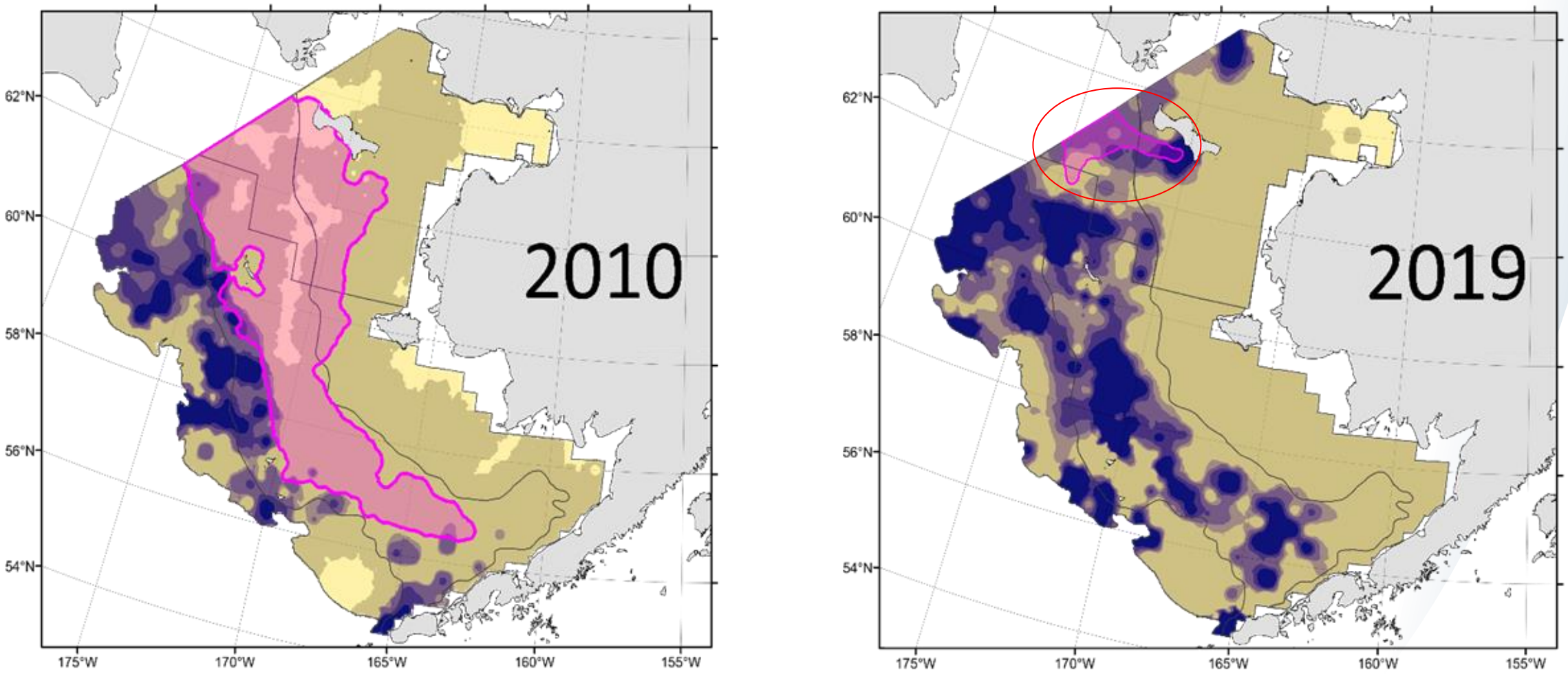
Cold Pool (Juvenile Sanctuary) **Adult Pollock**



Lyle Britt, NOAA AFSC

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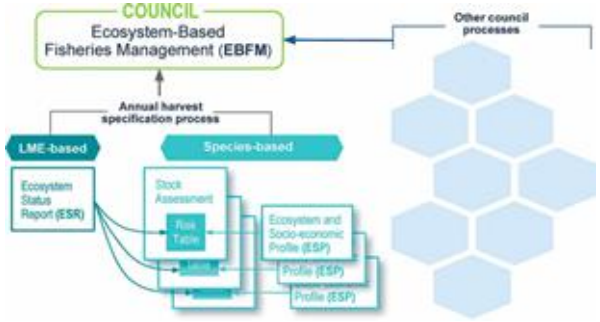
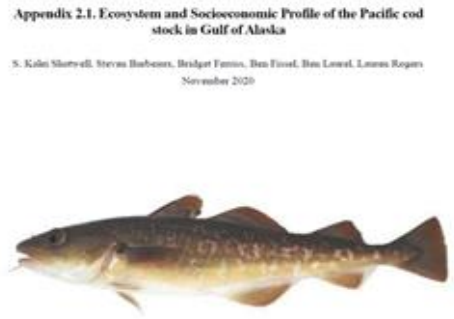
Rapid response delivery of data and model output to management.





How are our data and model output used in fisheries management?

MAY	AUG-OCT	SEP	OCT	OCT	NOV	DEC
PEEC	**ESR Contributions**	**Plan Team**	**Council Preview**	**Risk Tables**	**Plan Team**	**NPFMC Council Decision(s)**
Preview of Ecosystem and Economic Conditions meeting	Ecosystem Status Report contributions submitted	Groundfish Plan Team Climate Update	Council preview and early warnings	Stock Assessment Risk Tables with assessment authors	Groundfish Plan Team with Full ESR presentations	North Pacific Fisheries Management Council harvest specifications for Groundfish and Crab

Databases, scientific publications, presentations, data synthesis products such as the Arctic Report Card, radio and news

Three Bering Sea Scenarios:

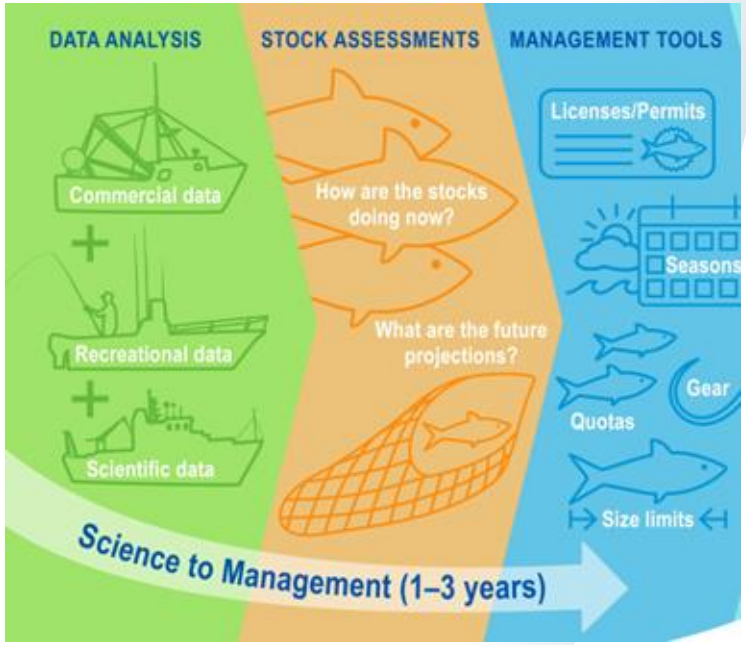
From Pacific Cod to Walleye Pollock

The Blob and Pollock

In 2016 and 2017, the southeastern Bering Sea warmed dramatically again — part of a recurring “warm stanza.” EcoFOCI found that young pollock could find cooler refuges in deeper layers, which helped some cohorts survive despite the heat.

Marine Heat Wave & Pacific Cod

In 2019, Pacific cod populations dropped so low that the fishery closed. EcoFOCI data provided information to managers that ultimately led to cutting catch limits by 40%.



Stock Assessment

A 2024 study by Rogers et. al found that warming waters made pollock spawn earlier — which meant survey timing missed part of the population. For the first time, EcoFOCI data on spawning timing were written directly into the stock assessment model.

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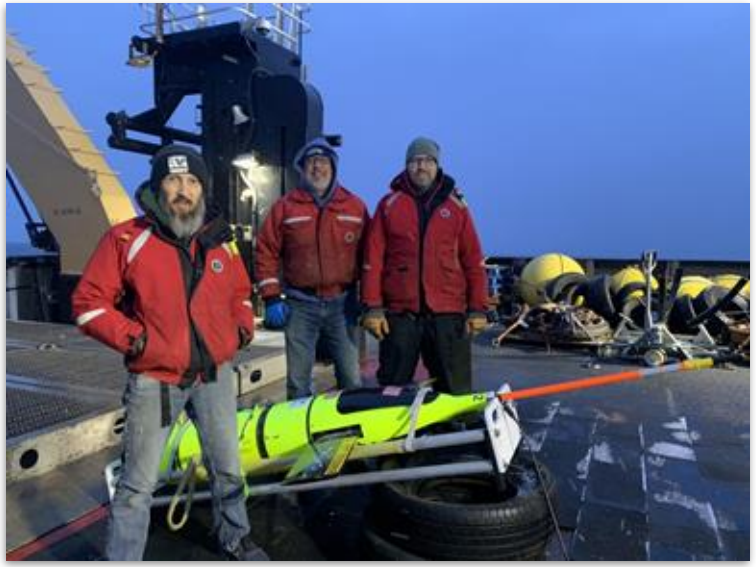


The People

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Tsunami generation: Earthquake uplift estimate vs direct measurement

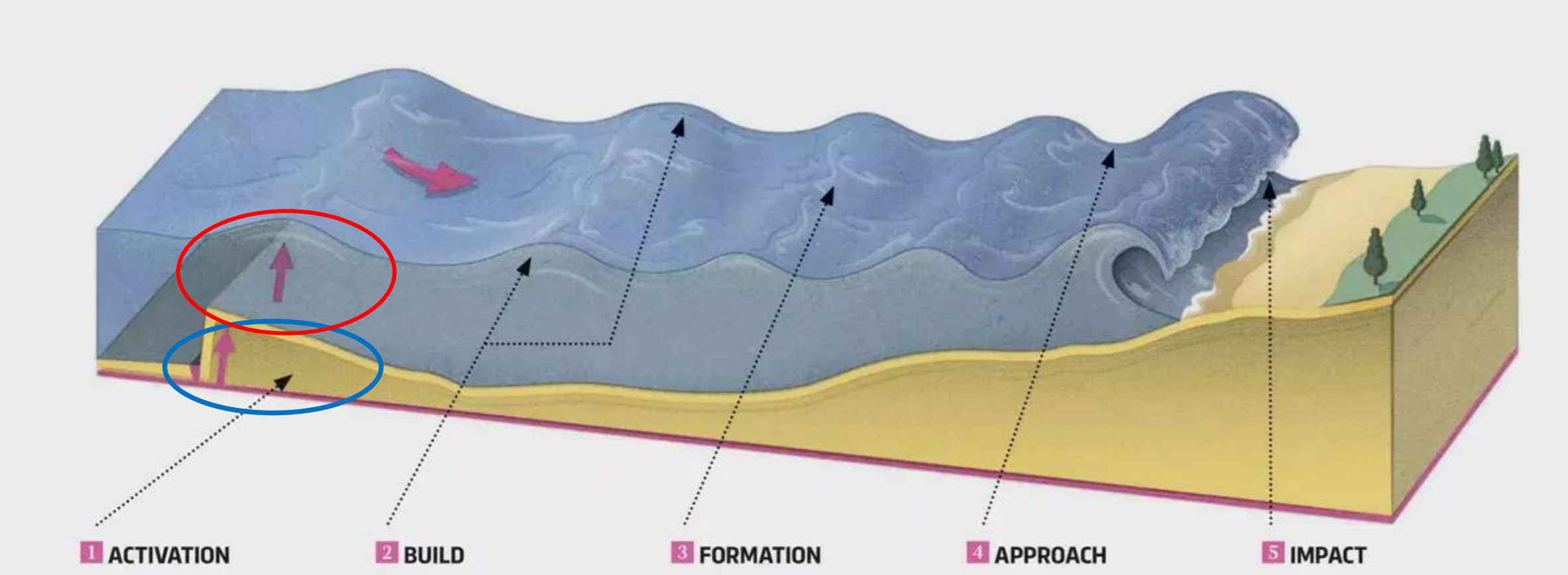
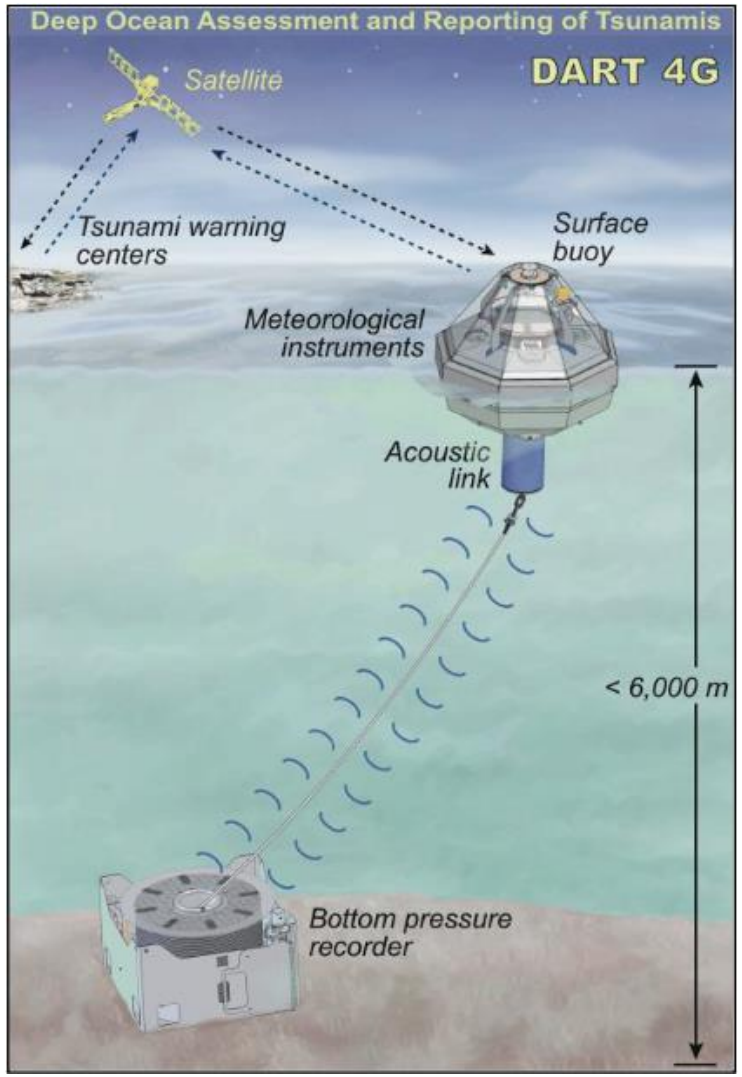
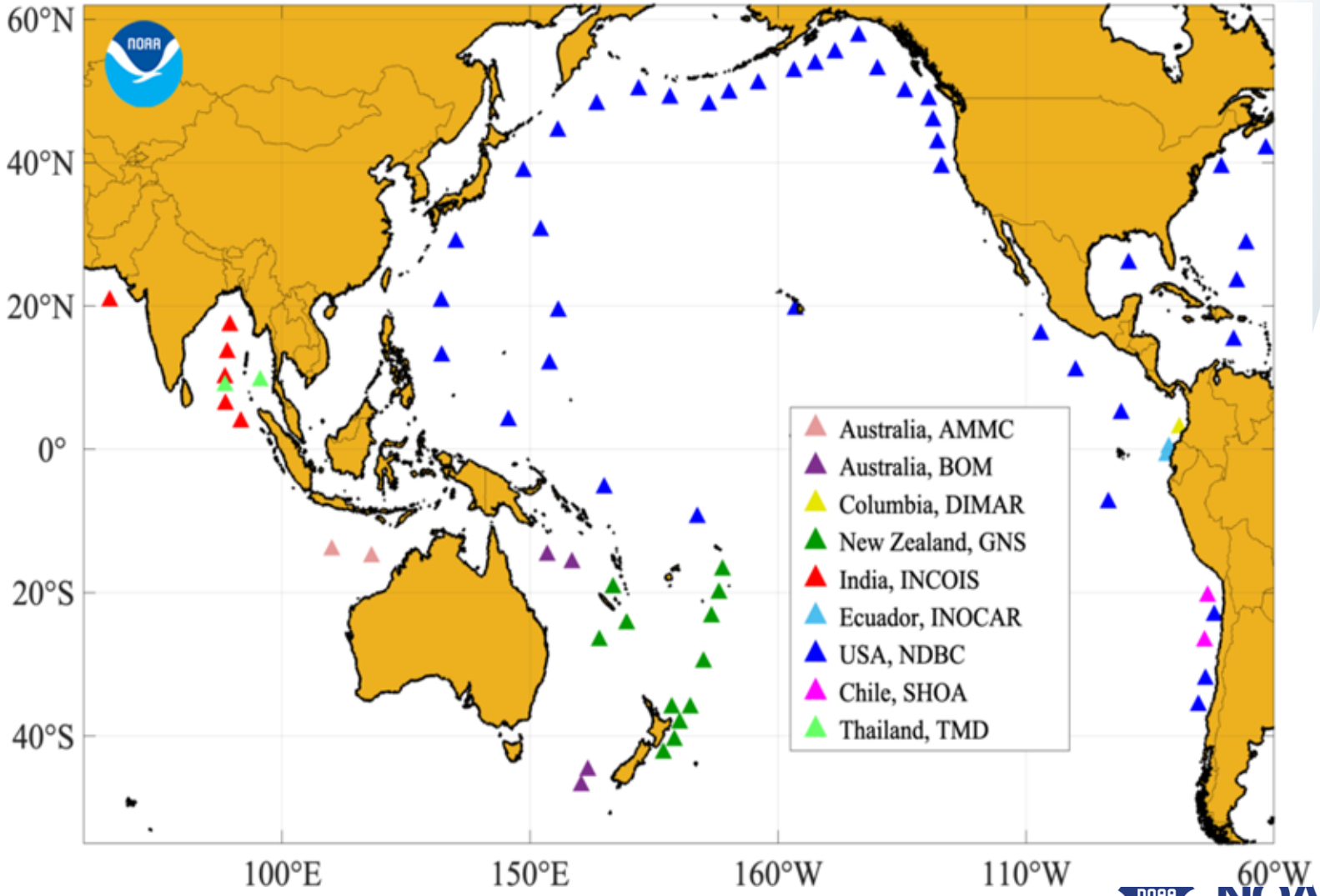


image from BBC Science

DART Observations





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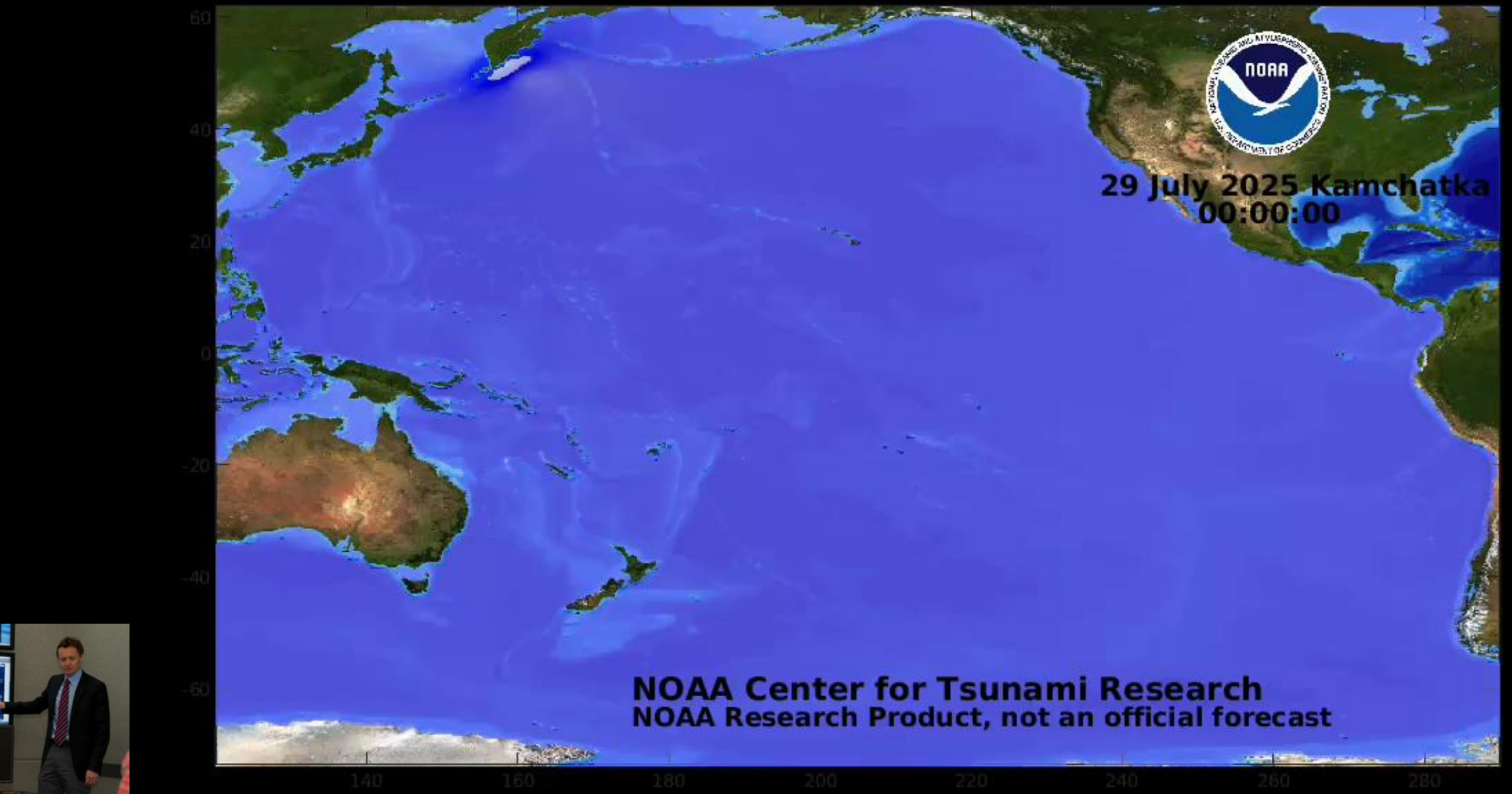
60
40
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-20
-40
-60
140
160
180
200
220
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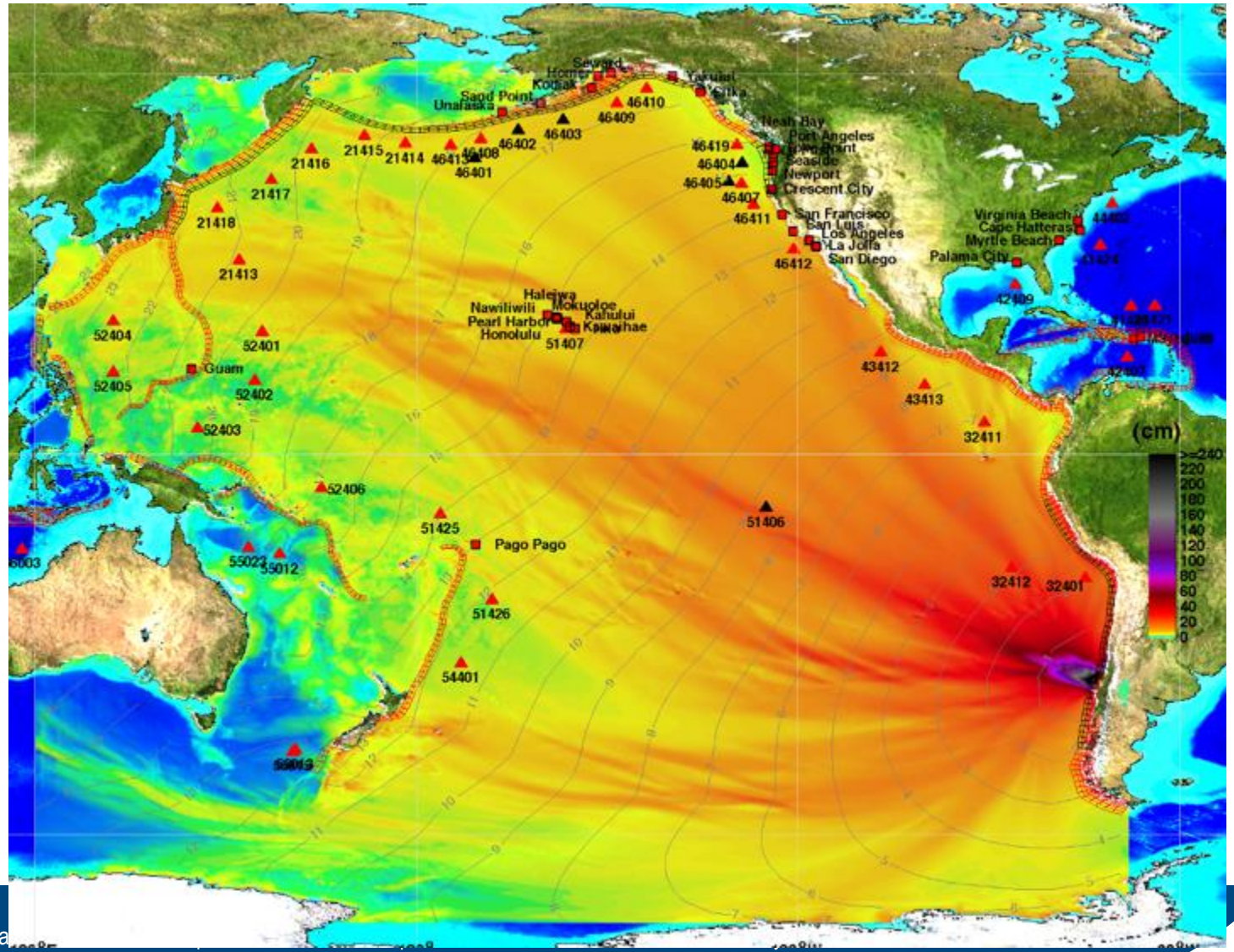
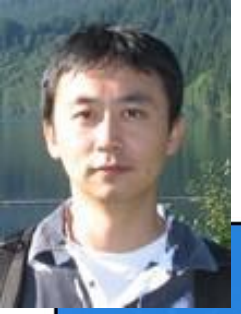
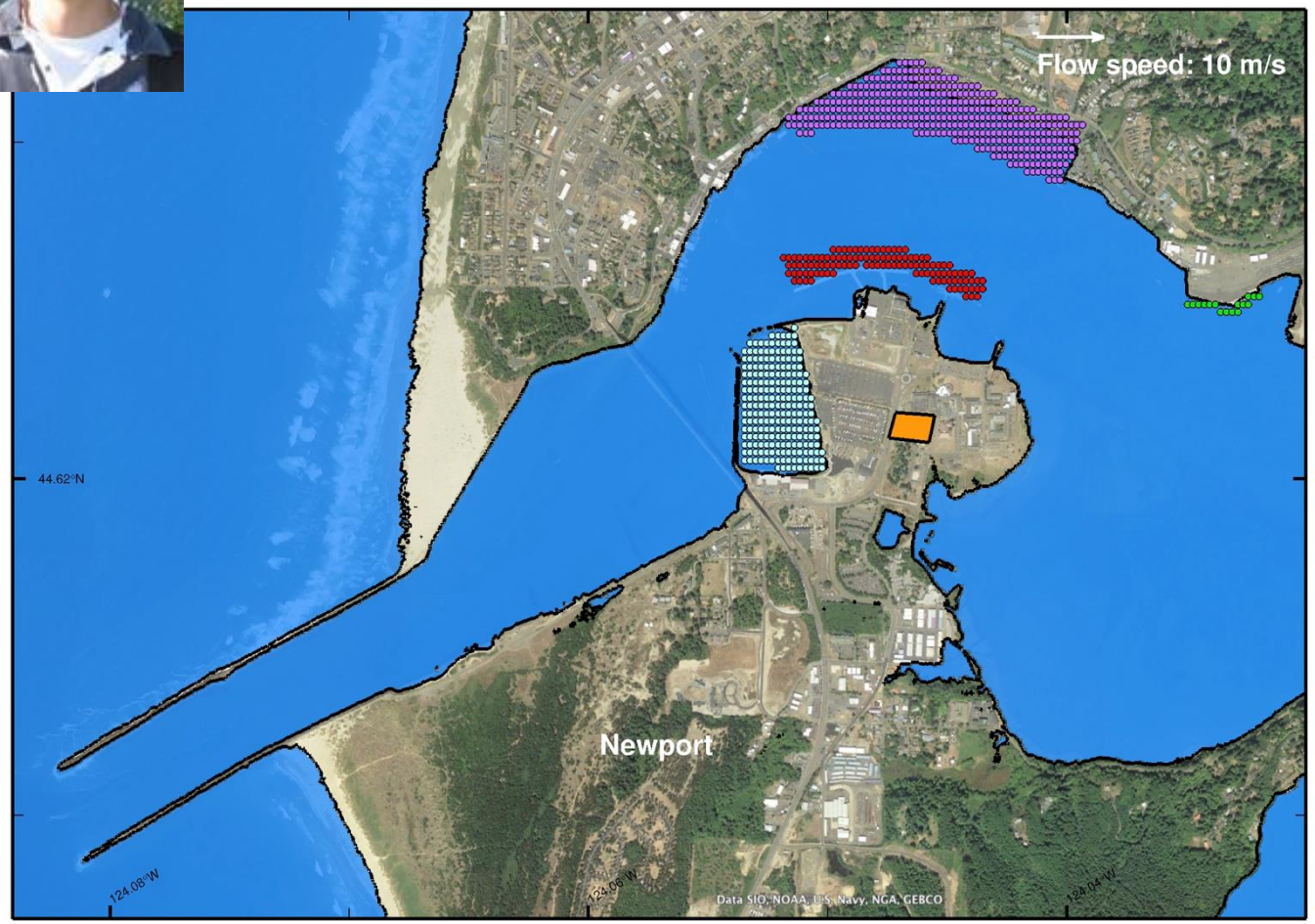
260
280
29 July 2025 Kamchatka
00:00:00
NOAA Center for Tsunami Research
NOAA Research Product, not an official forecast

Tsunami Amplitude Forecast





Tsunami Debris Forecasting and Vulnerability Assessment



Massless debris tracking of the XXL1 Cascadia Tsunami at the Newport OSU Building Site

Elapsed Time 00h 00m 06s

No. of debris impacting on the building: 0

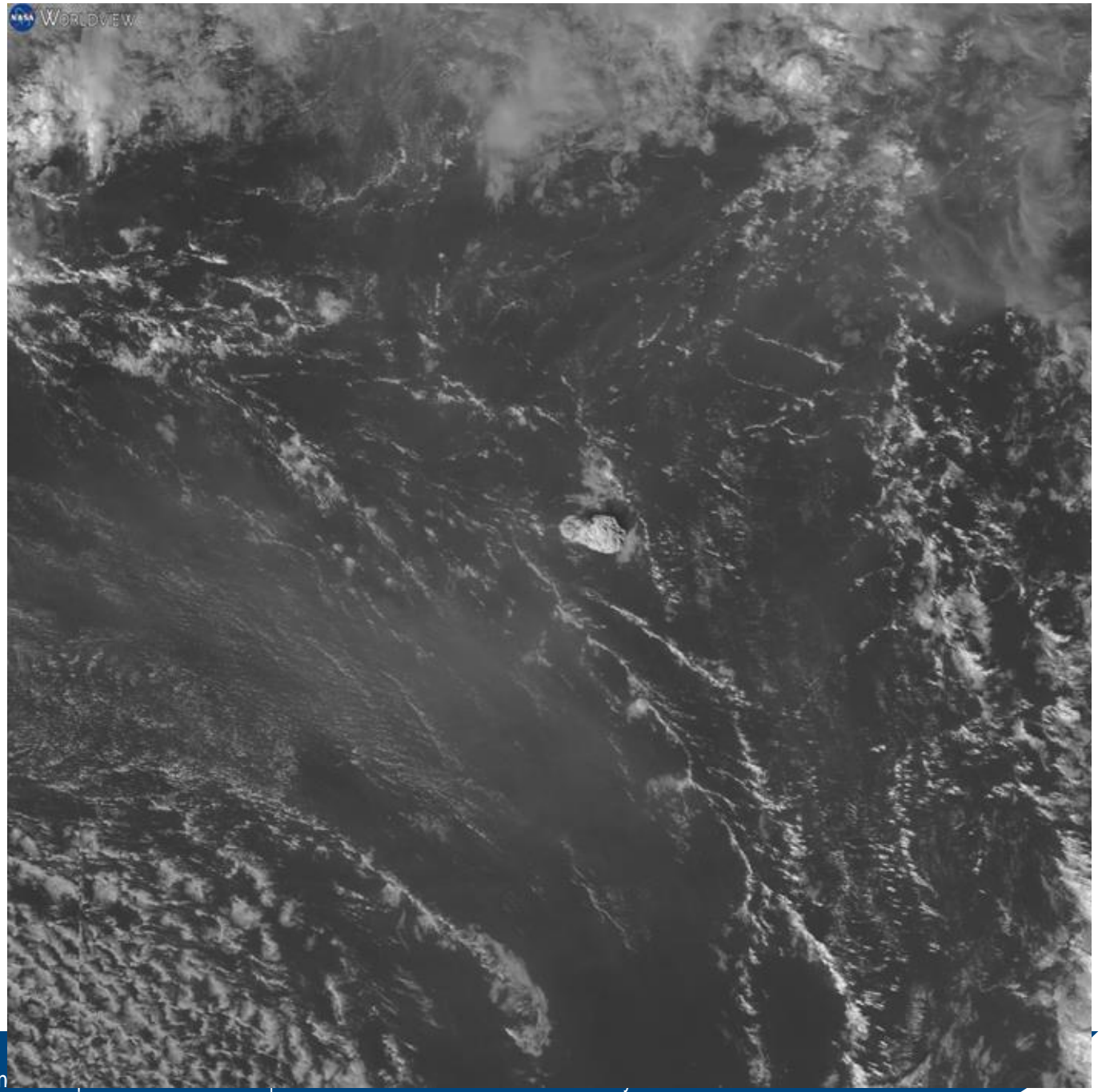
YOST GRUBE HALL ARCHITECTURE

kpff

UNIVERSITY of WASHINGTON

OSU Hatfield Marine Science Center: Vertical Evacuation Center for the community

NOAA PMEL



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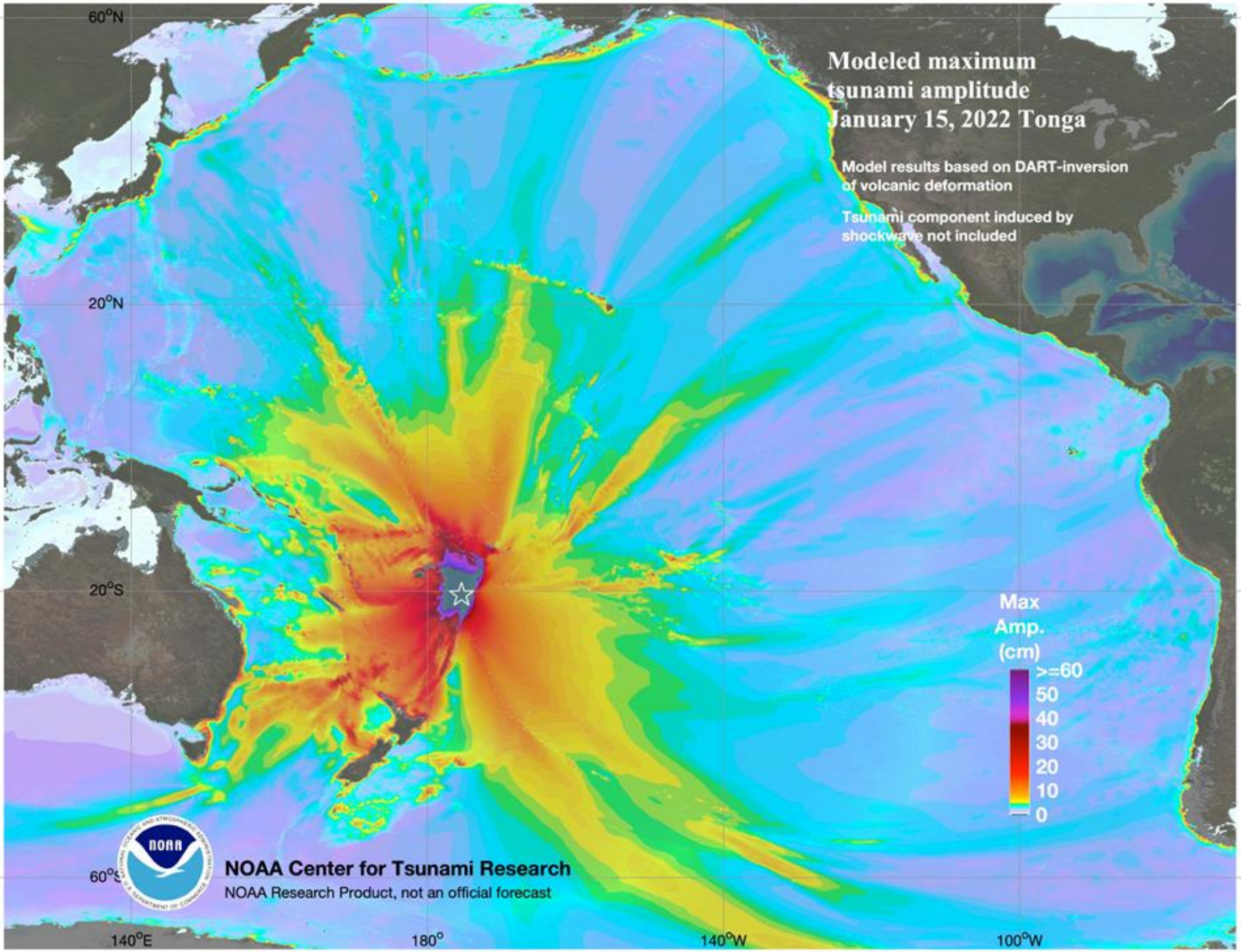
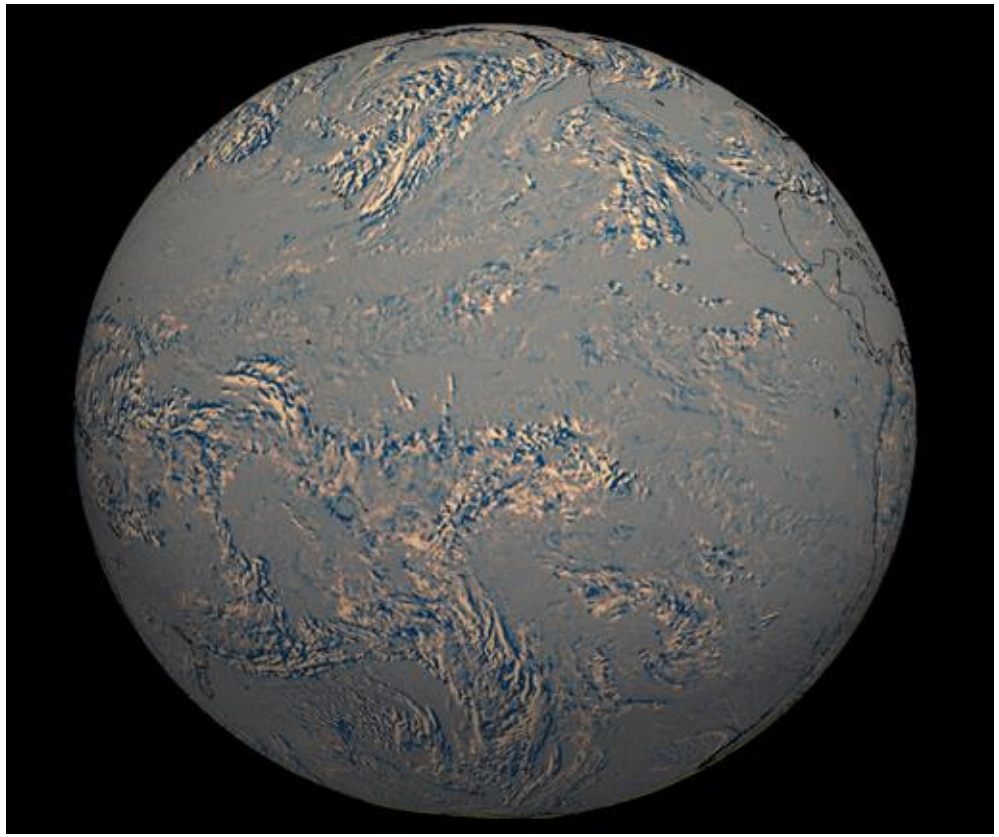

Modeled maximum tsunami amplitude January 15, 2022 Tonga
Model results based on DART-inversion of volcanic deformation
Tsunami component induced by shockwave not included
60°N
20°N
20°S
60°S
140°E
180°
140°W
100°W
Max Amp. (cm)
>=60
50
40
30
20
10
0
NOAA Center for Tsunami Research
NOAA Research Product, not an official forecast

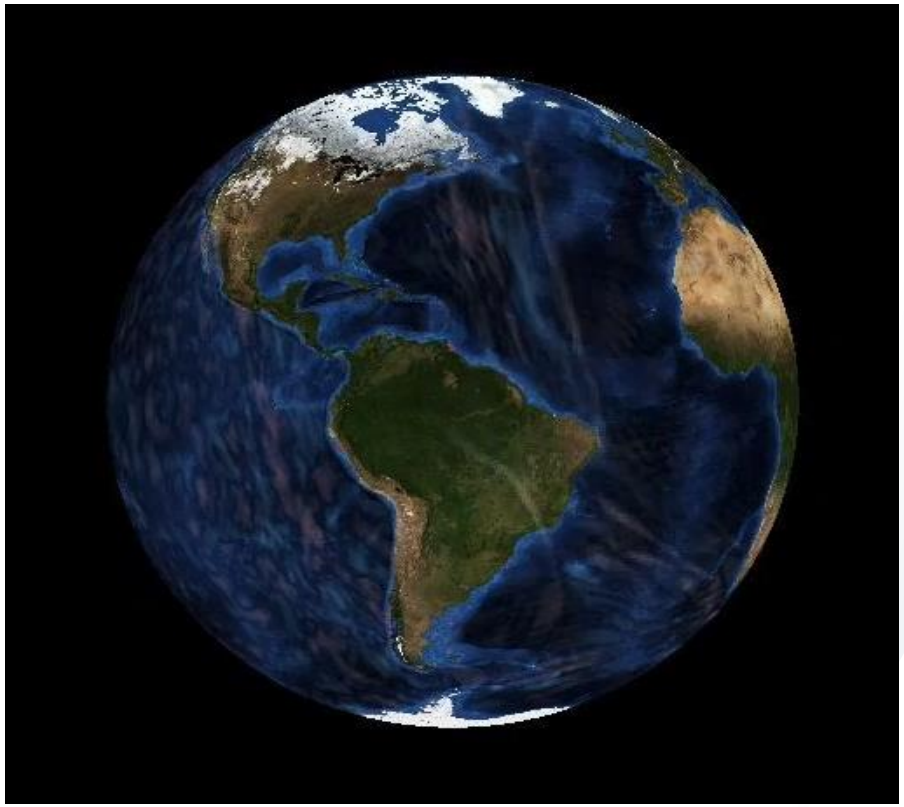
NOAA PMEL

But Wait! That's Not all!!

Atmospheric response



Modeled tsunami



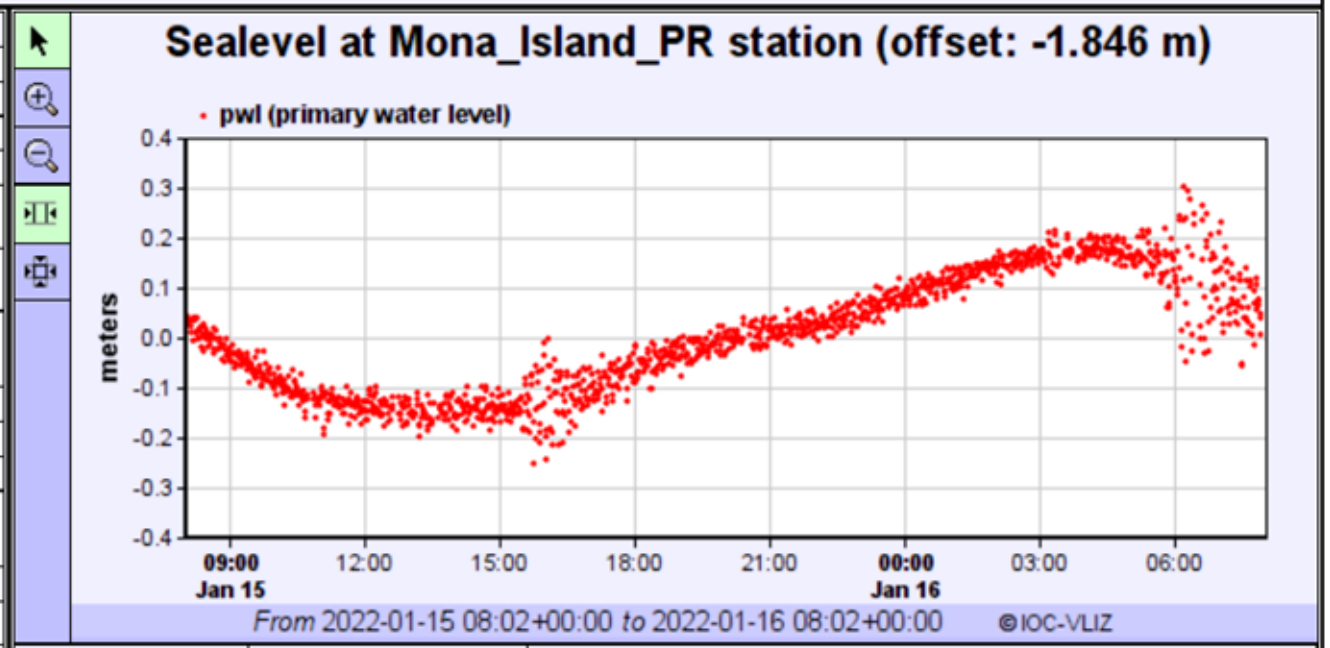
SEA LEVEL STATION MONITORING FACILITY

Intro | Map | Station lists | Station details | Services & FAQ | GLOSS | Catalog

[previous station] Station Mona_Island_PR at GMT [next station]

[more details] [GTS message] [show data] [show on map] [monitor]

Station metadata	
Code	mona2
Country	USA
Location	Mona_Island_PR
Status	Operational
Local Contact	National Ocean Service-NOAA (USA)
Other Contact	Caribbean Tsunami Warning Program (USA)
Long-term MSL data	UHSLC 267 (2006-2019) PSMSL 2122 (2006-2020)
Latitude	18.09
Longitude	-67.9383
Connection	GTS message
GTS message type	SXXX03
Sensor 1	
Type of sensor	pwl (primary water level)
Sampling rate (min)	1



Period	Signals	Data
12h / day / 7 days / 30 days	Remove outliers; Remove spikes	Relative levels= signal - average over selected period; Absolute levels= as received; Offset signals= relative signals + offset

Tip:use left icons to zoom & scroll

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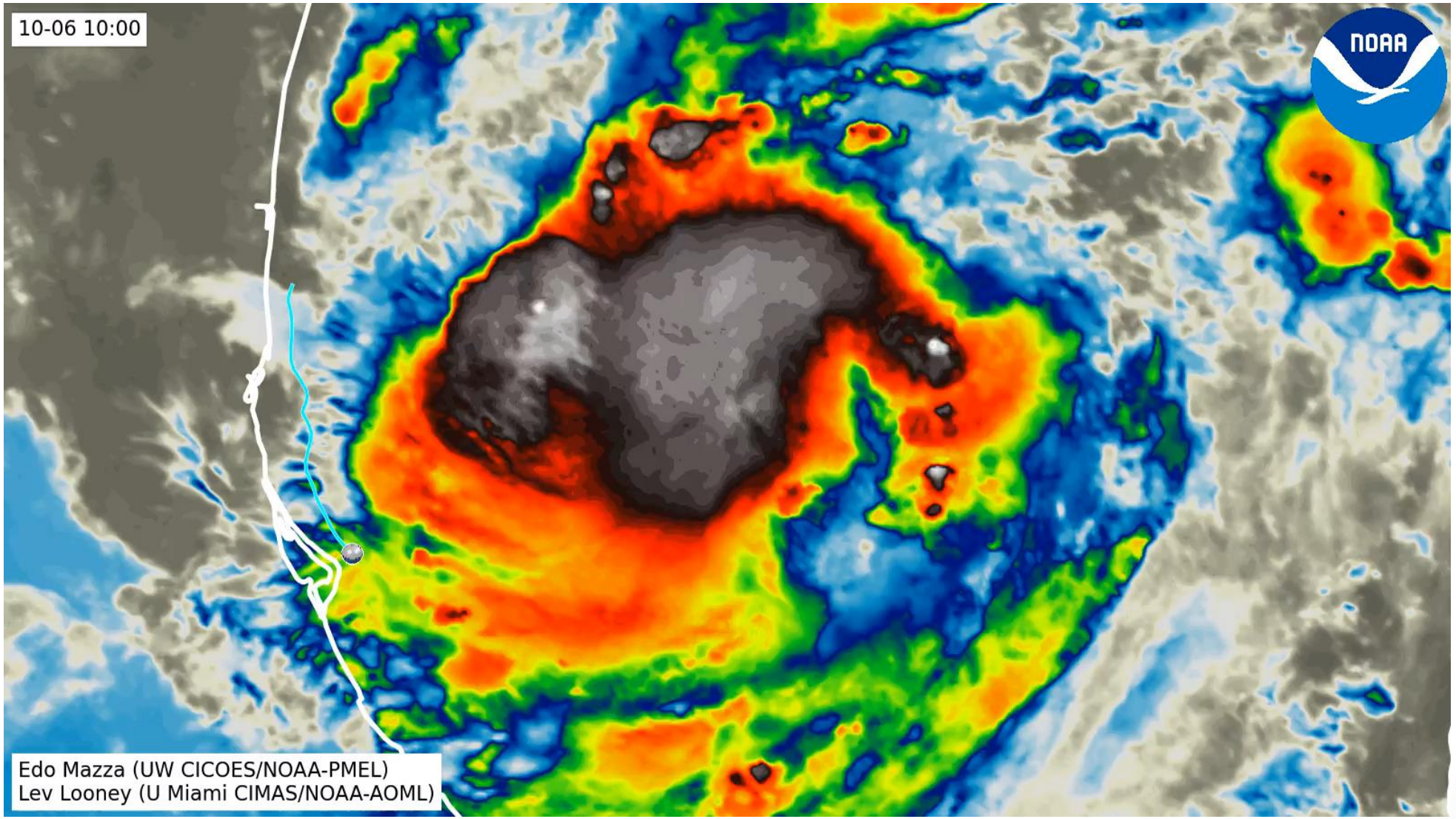
PMEL Collaborations

NOAA PMEL


Thank you
and
Questions?


10-06 10:00
NOAA
Edo Mazza (UW CICOES/NOAA-PMEL)
Lev Looney (U Miami CIMAS/NOAA-AOML)

Biophysical time series from moorings provide the status of the SE Bering Sea ecosystem

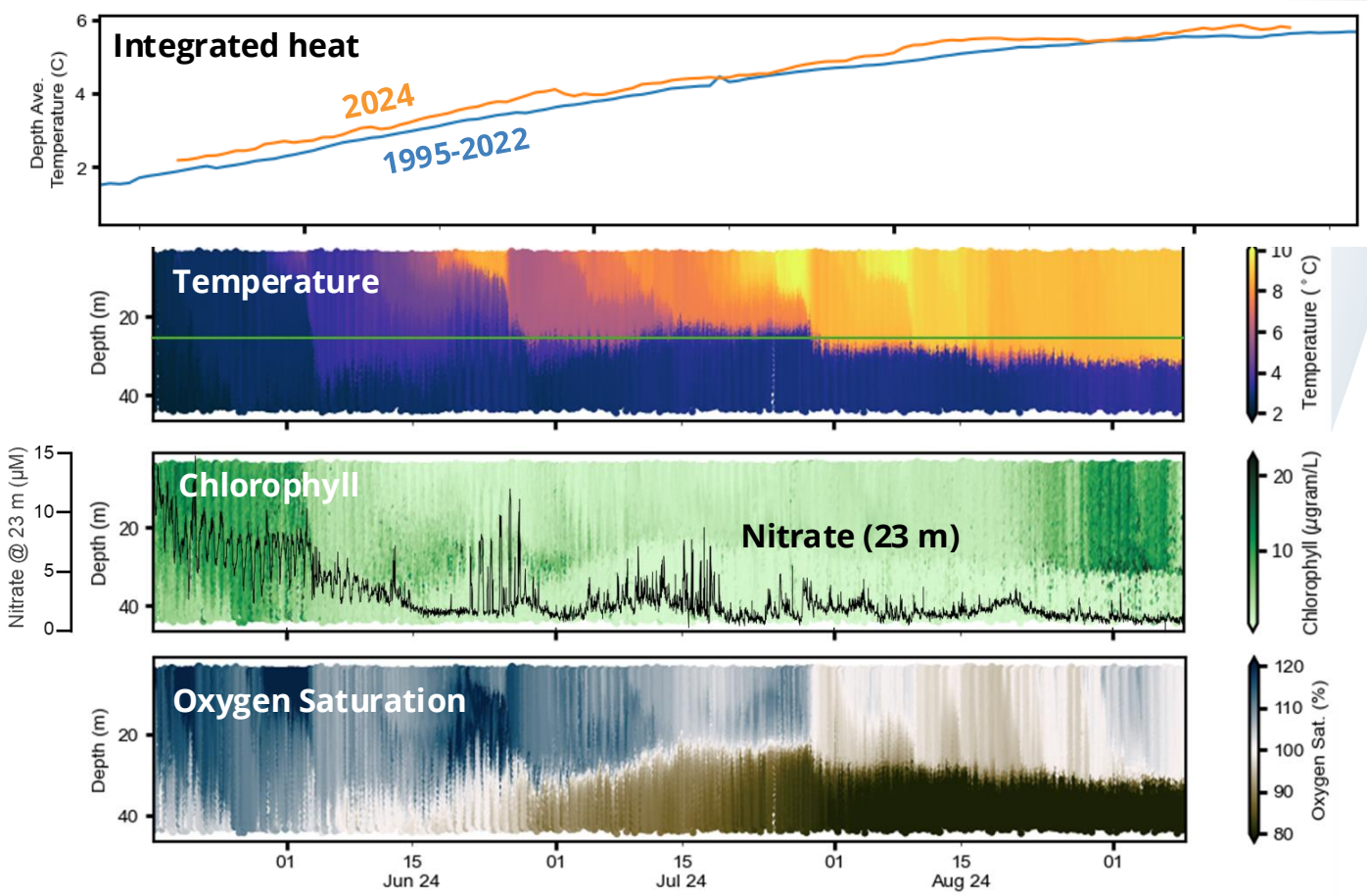
M2 Prawler: 2024

PMEL Nutrient Program

- Integrated heat was slightly above normal
- The intense thermocline in summer was disrupted by storms
- Nutrient drawdown was associated with the spring bloom
- An intense fall bloom was supported by a deepening mixed layer and injection of nutrients, and resulted in ~10 µM ammonium in the bottom layer

Oxygen and gas ratios will be used to estimate primary production

L. Juranek & H. Cynar (OSU) | J. Nielsen (UW) | C. Mordy (UW/PMEL)



EcoFOCI
Ecosystems & Fisheries-Oceanography Coordinated Investigations

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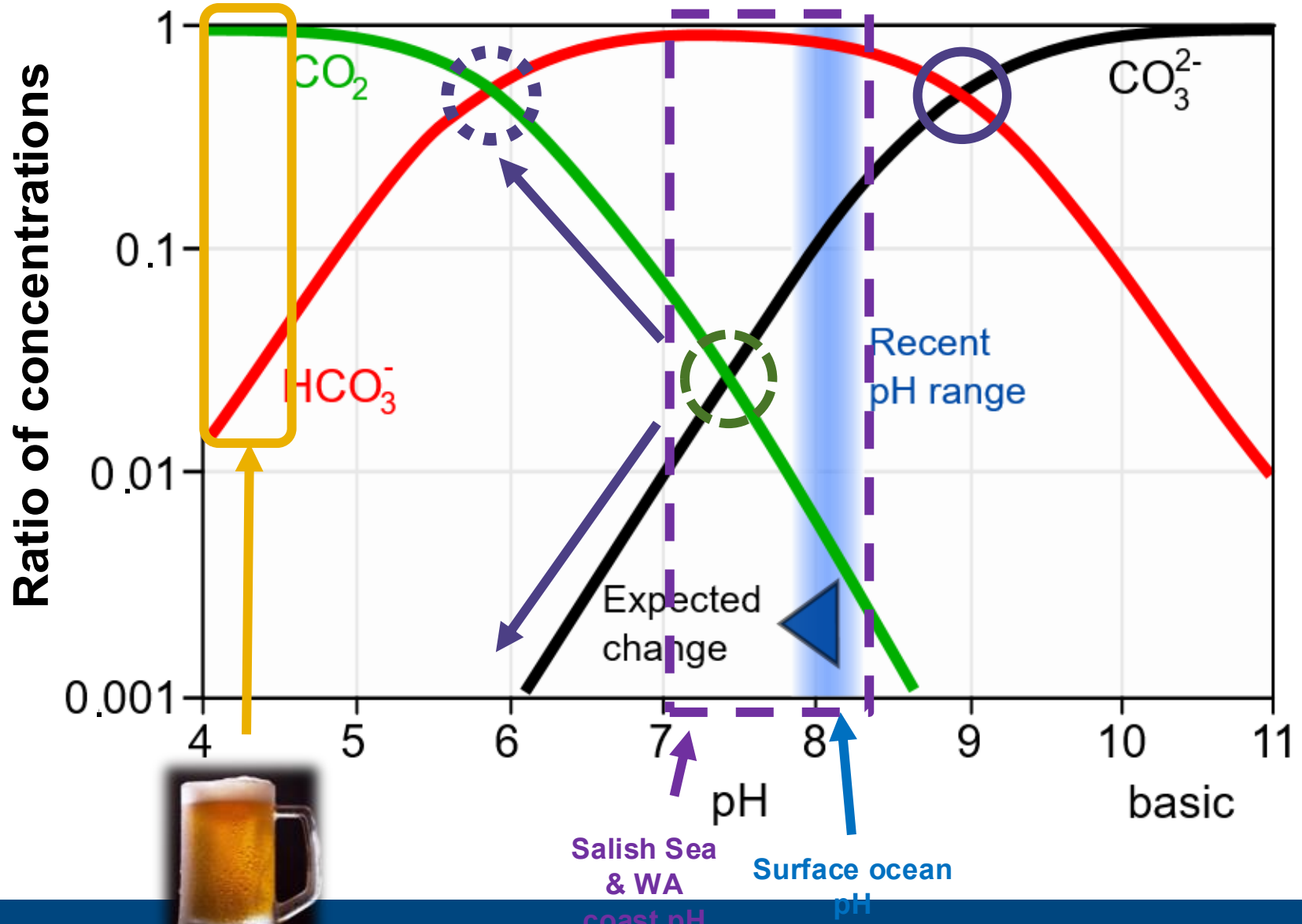
Buffering capacity and CO_2 in seawater



Carbonic acid can release two protons, depending on the pH:

- At pH 9, equal bicarbonate and carbonate concentrations, almost no CO_2.
- At pH 5.8, equal bicarbonate and CO_2 concentrations, almost no carbonate.
- At pH 7.5, we have maximum bicarbonate and equal parts CO_2 and carbonate.
- At pH values <7.5, calcifier impacts peak, but CO_2 increase and impacts should accelerate.
- *Salish Sea and WA coastal ecosystems see these pH values already*

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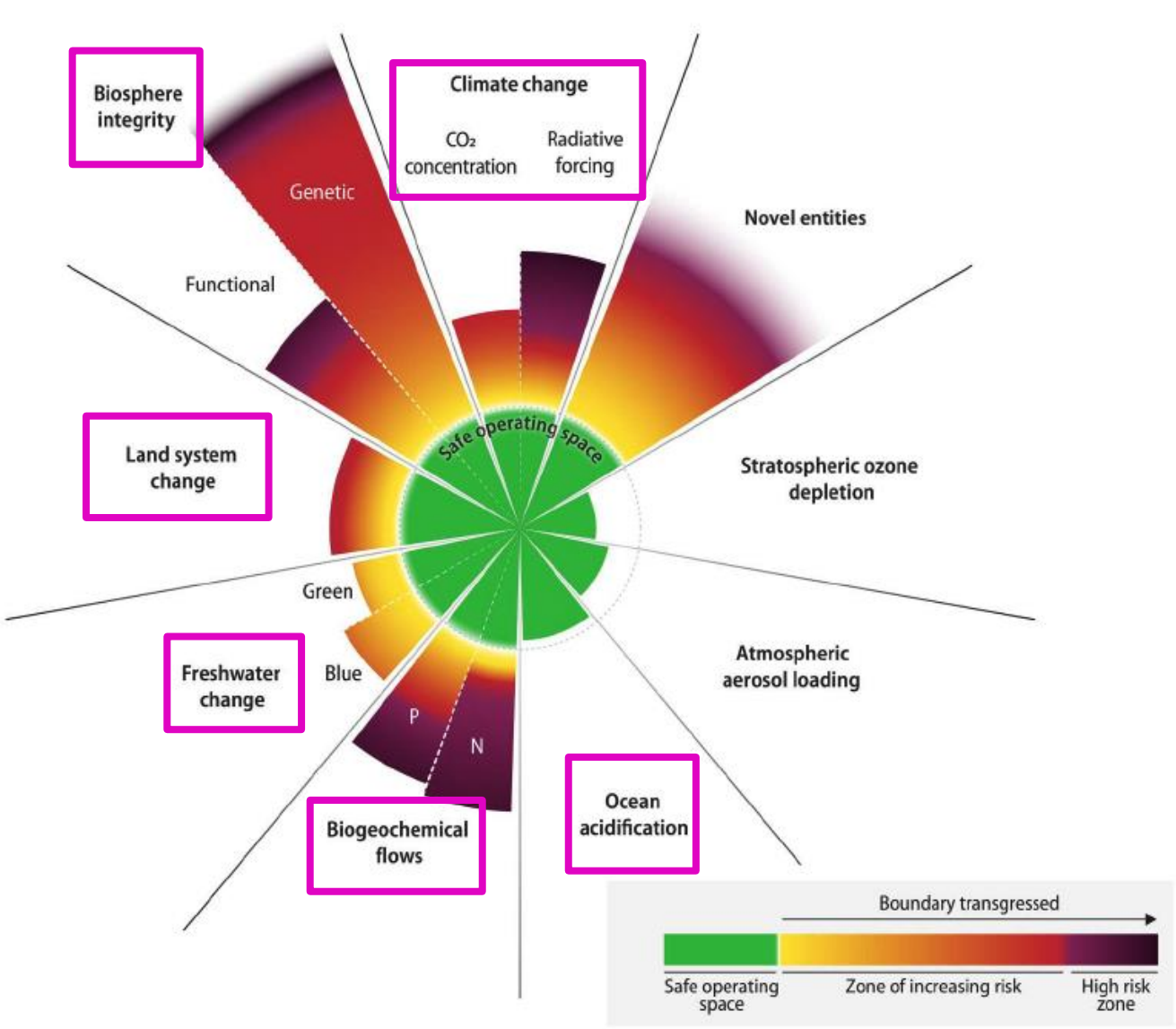
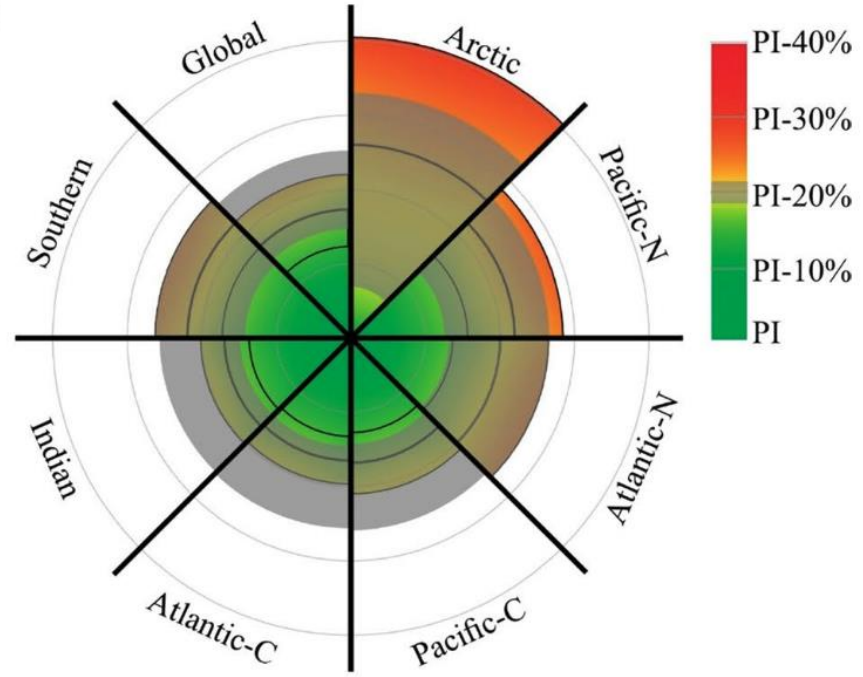
Global planetary boundaries & North Pacific–Arctic ecosystems





- PMEL research spans several of these Earth-system processes that are affected by ongoing CO_2 emissions.
- Arctic and North Pacific ecosystems are on the frontlines of ocean acidification and other climate impacts.
- PMEL scientists lead research on changing ocean conditions and ecosystems in the Bering Sea,

Fixing the problem: *emissions reductions can help within decades!*

- Water quality criterion of -0.2 pH change (Clean Water Act standards used by states).
- Some sites and months are at this level.
- ***But, emissions reductions could bend the curve!***