NOAA
Pacific Marine Environmental Laboratory

Pacific Marine Environmental Laboratory: Innovative Marine Science for a Sustainable Future

Michelle McClure

Overview

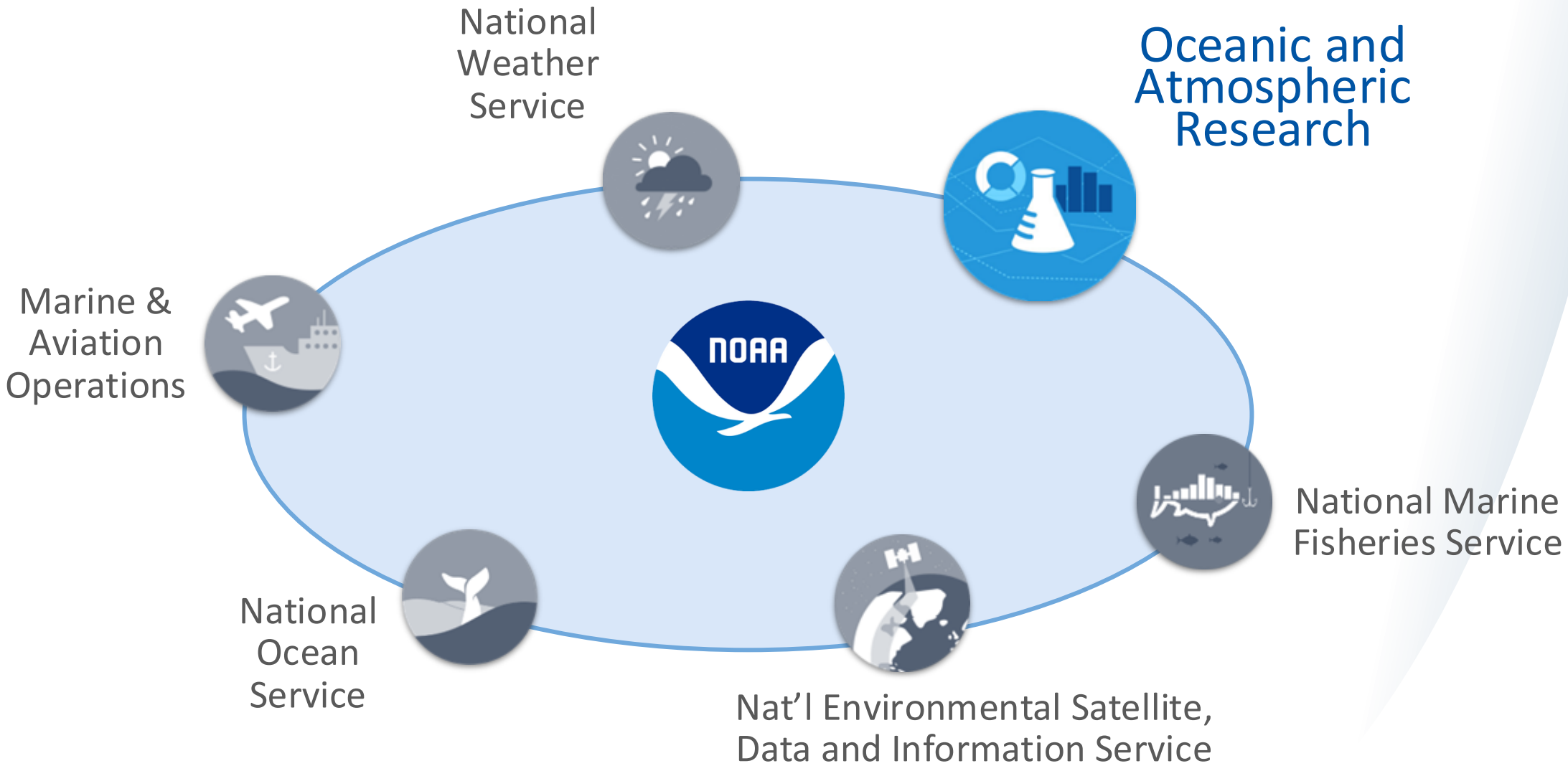
PMEL and NOAA: Who we are

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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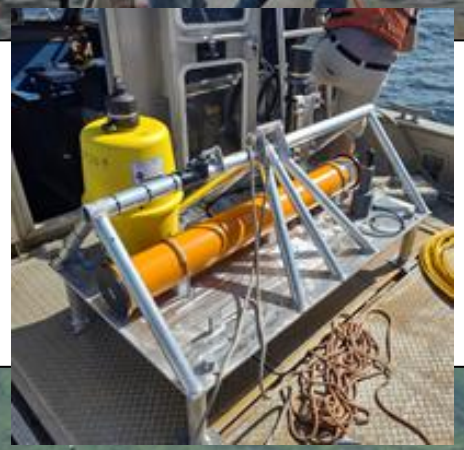
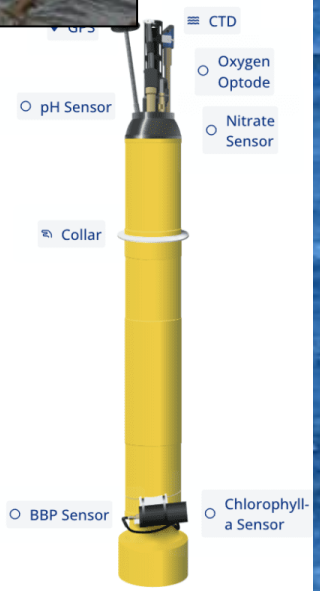
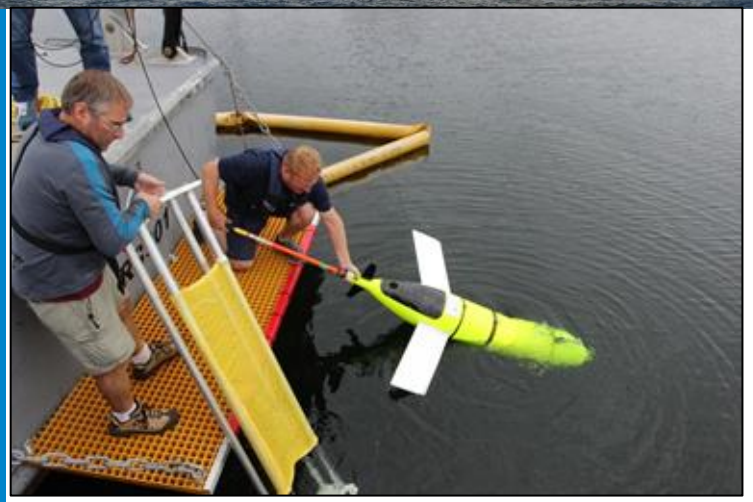


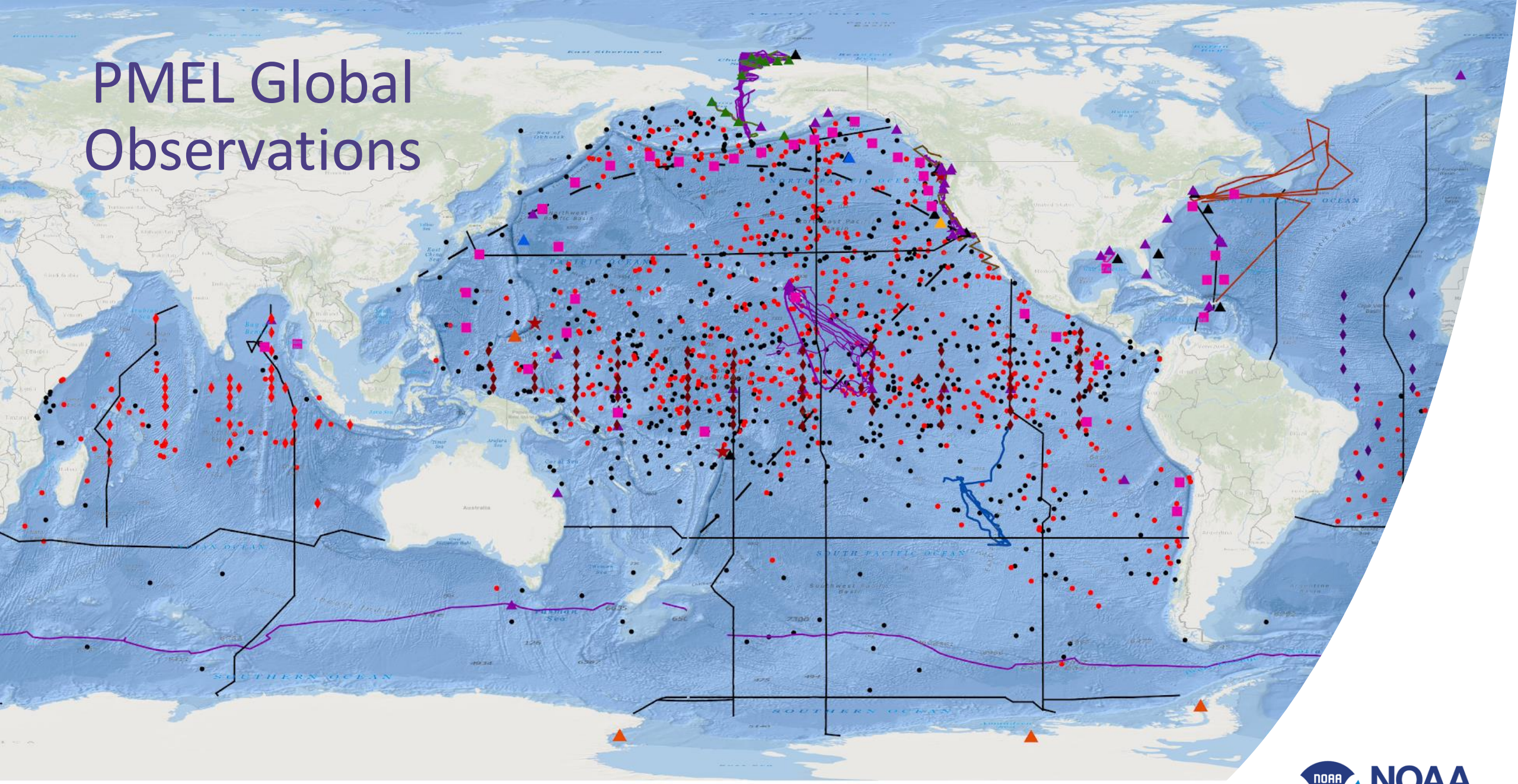


ic to Biogeochemical (BGC) Argo floats H



U.S. Department of Commerce | National Oceanic and Atmospheric Administration | Pacific Marine Environmental Laboratory

PMEL Global Observations



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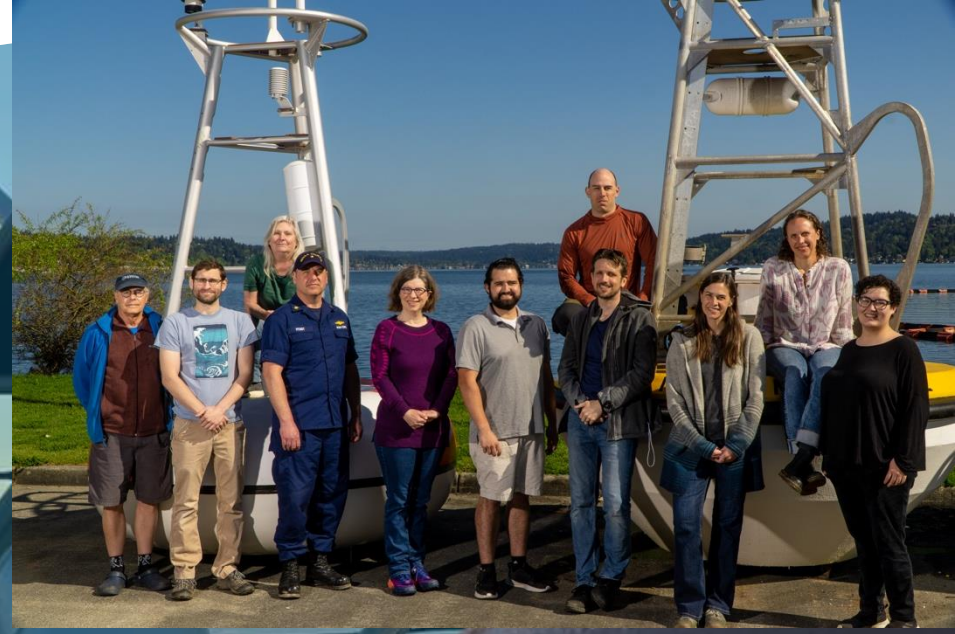


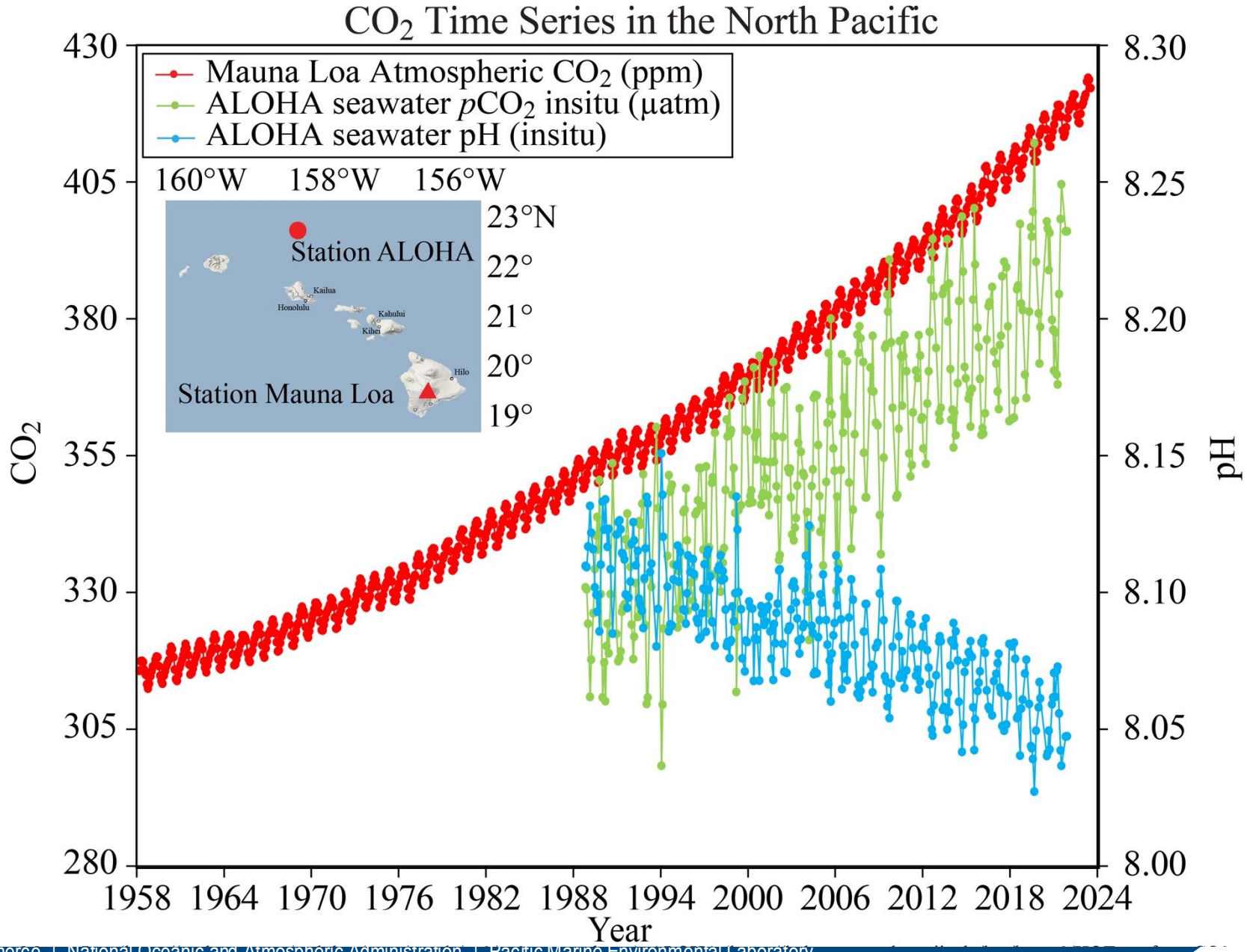
Our Big Questions:

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

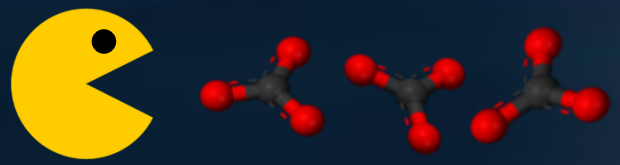
water

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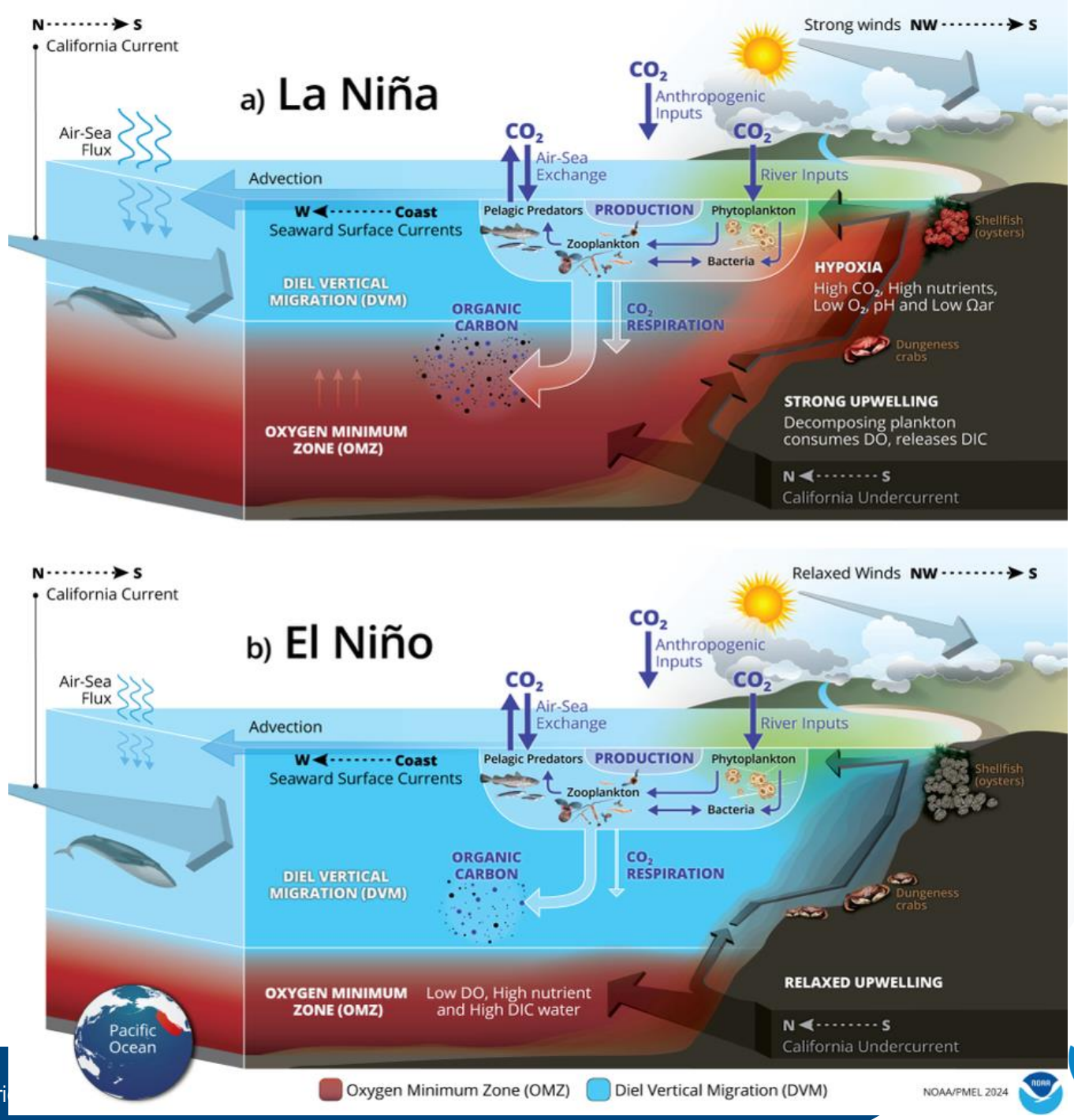
Upwelling brings corrosive waters to the surface along the Washington and Oregon coasts



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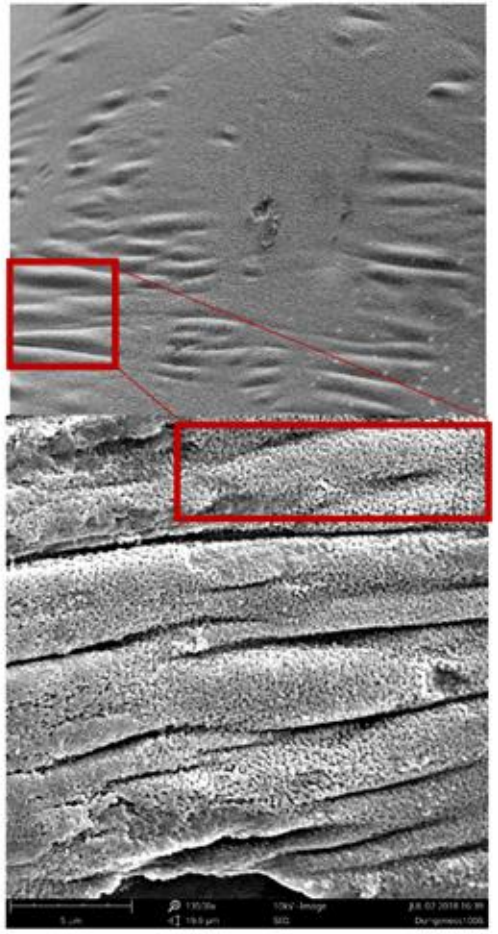
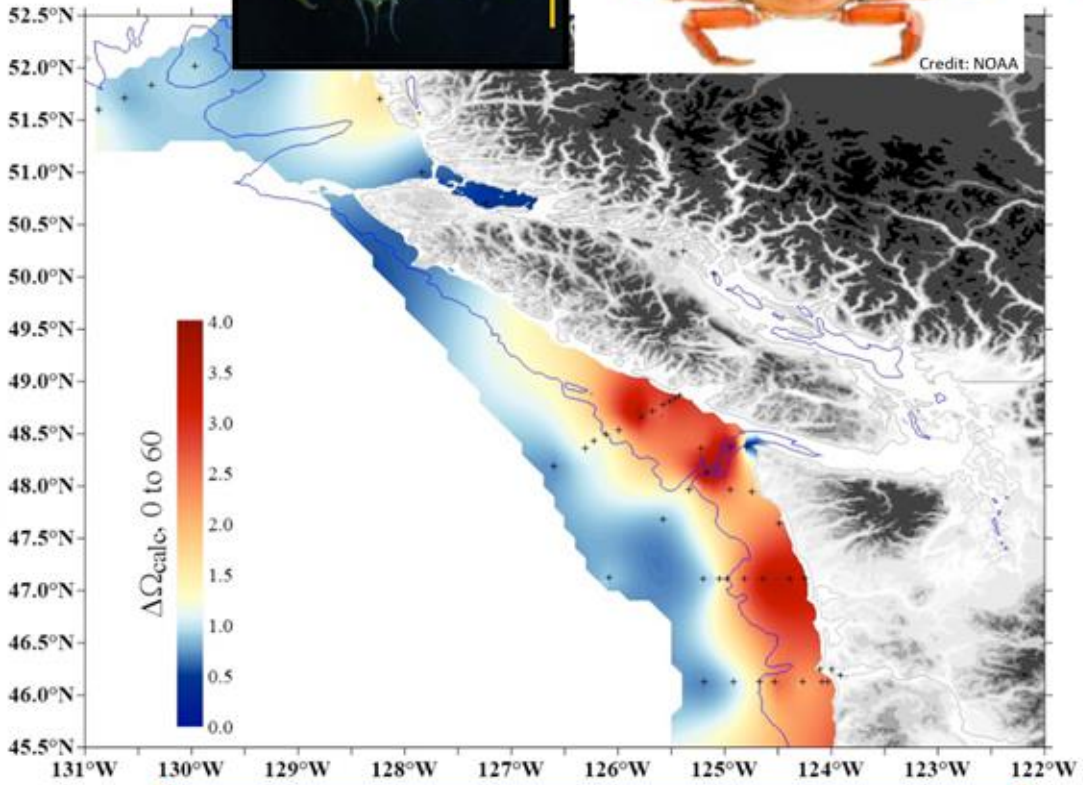
OA Impacts on the Organisms

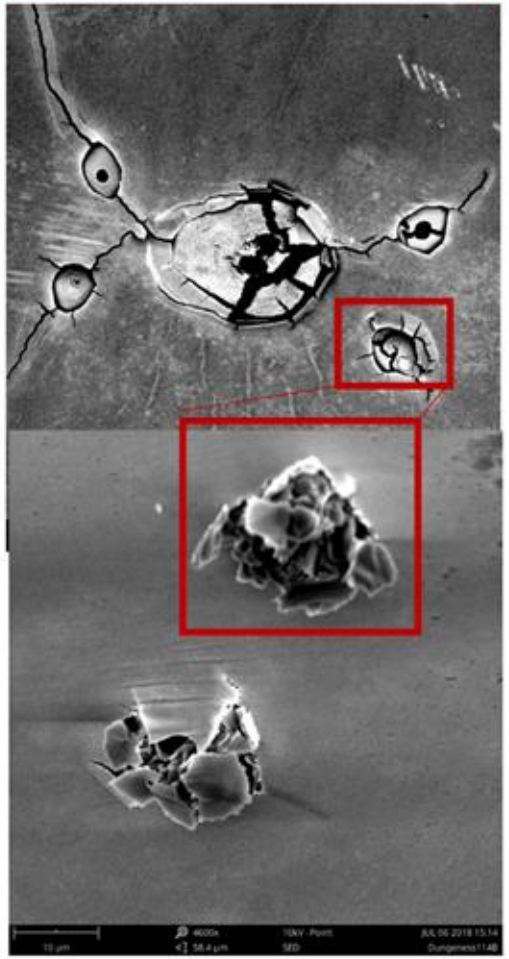
Exoskeleton dissolution of the larval Dungeness crab resulting in structural deformities



Credit: NOAA

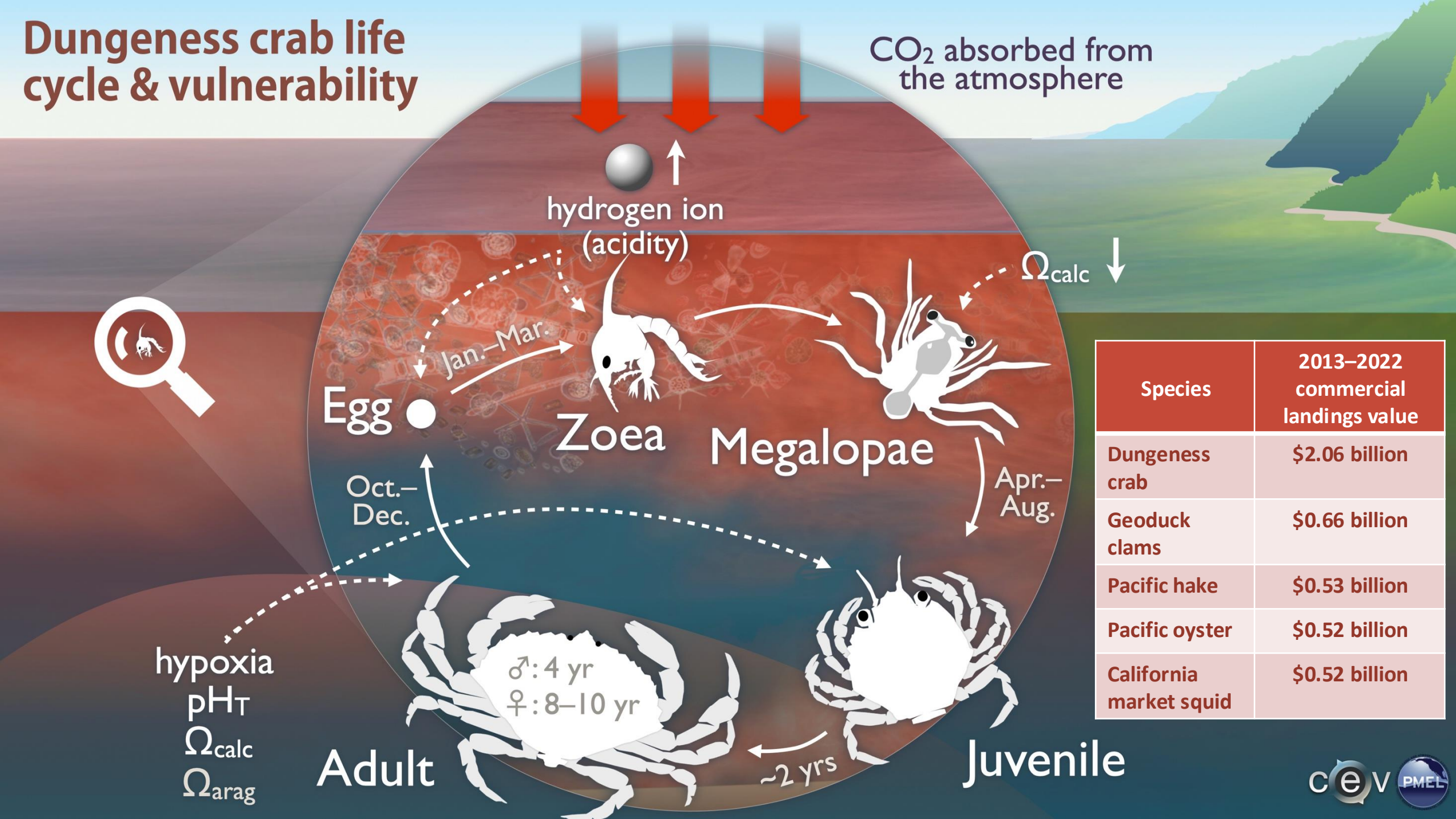


Dissolution also causes damaged or missing mechanoreceptors

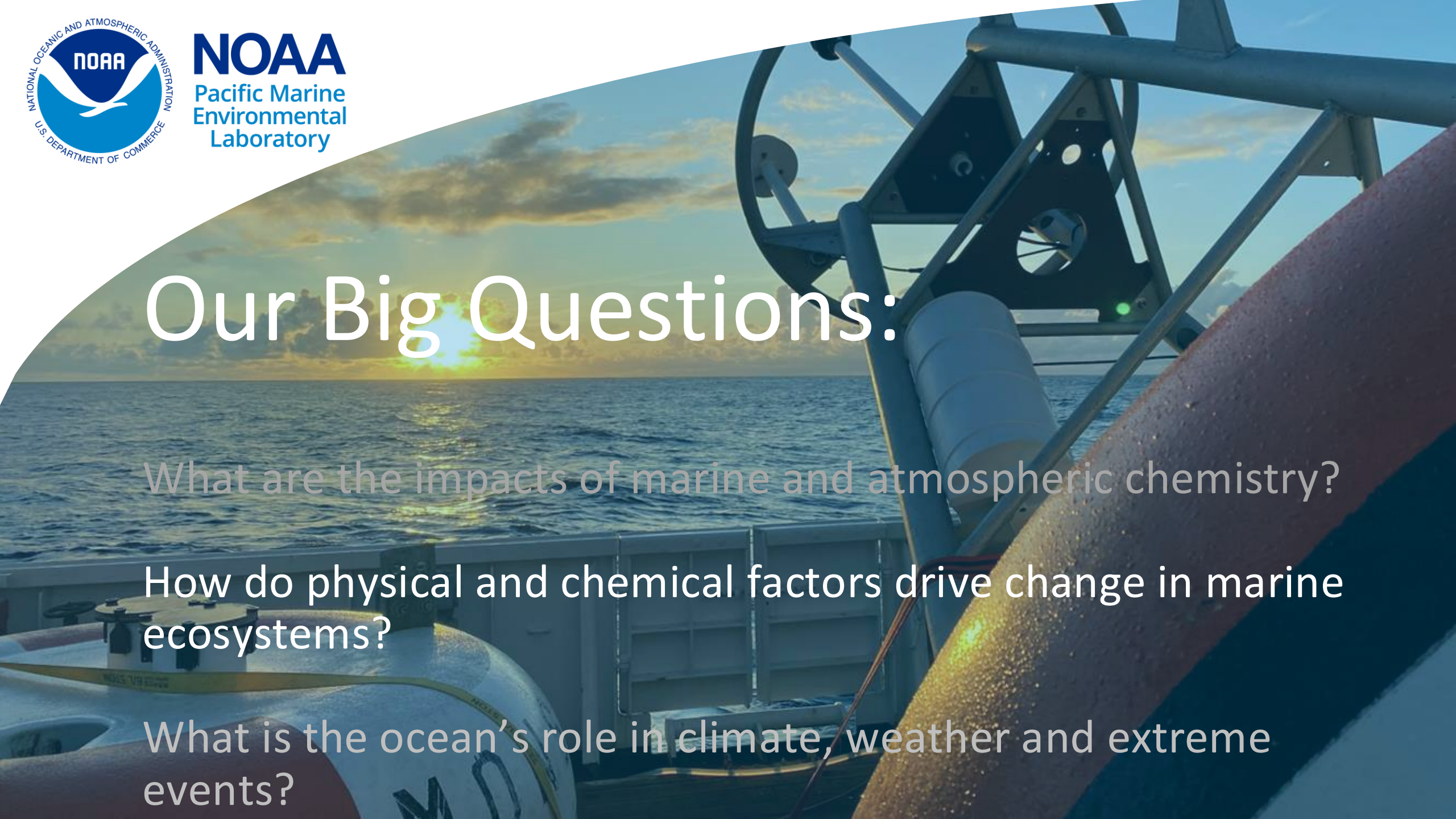


The ocean acidification hotspots, as defined by the steep calcite vertical gradients, where larvae Dungeness crab are most affected by dissolution

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



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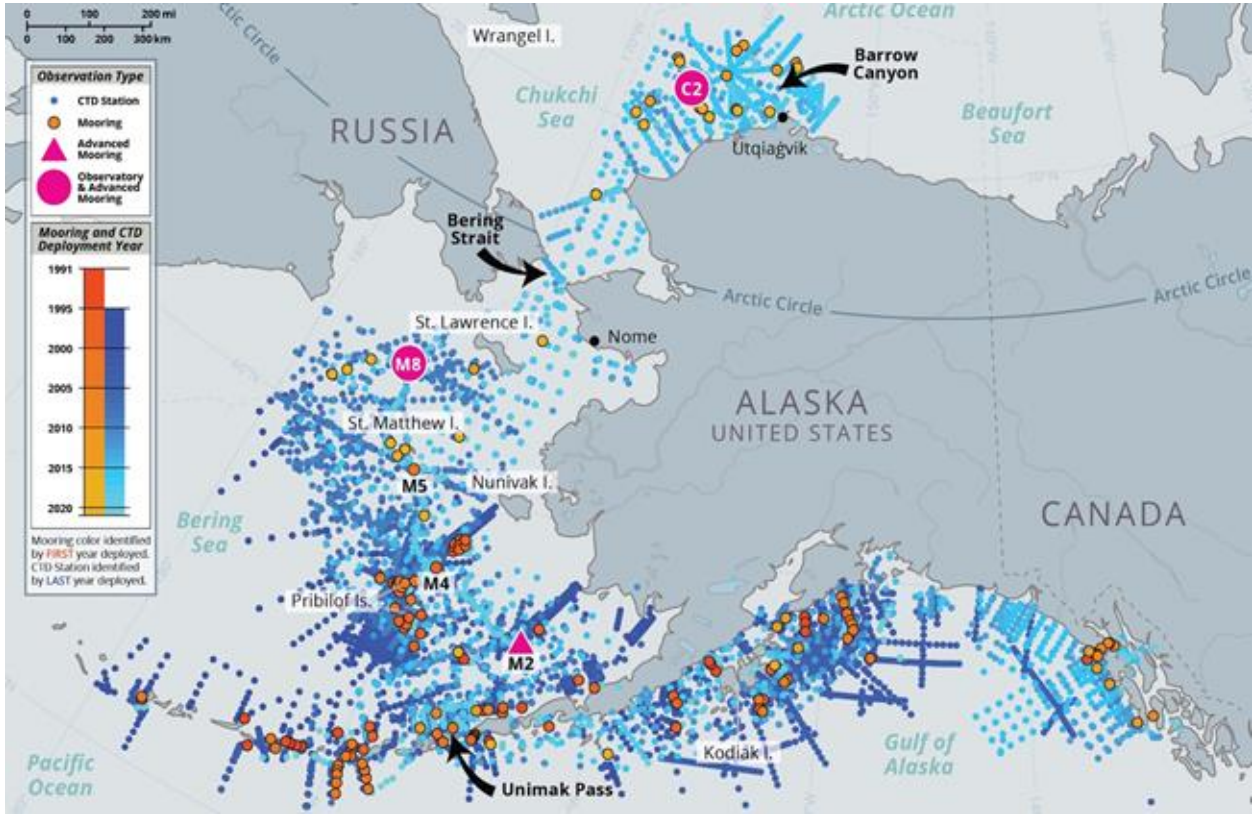
EcoFOCI Biophysical Mooring Network

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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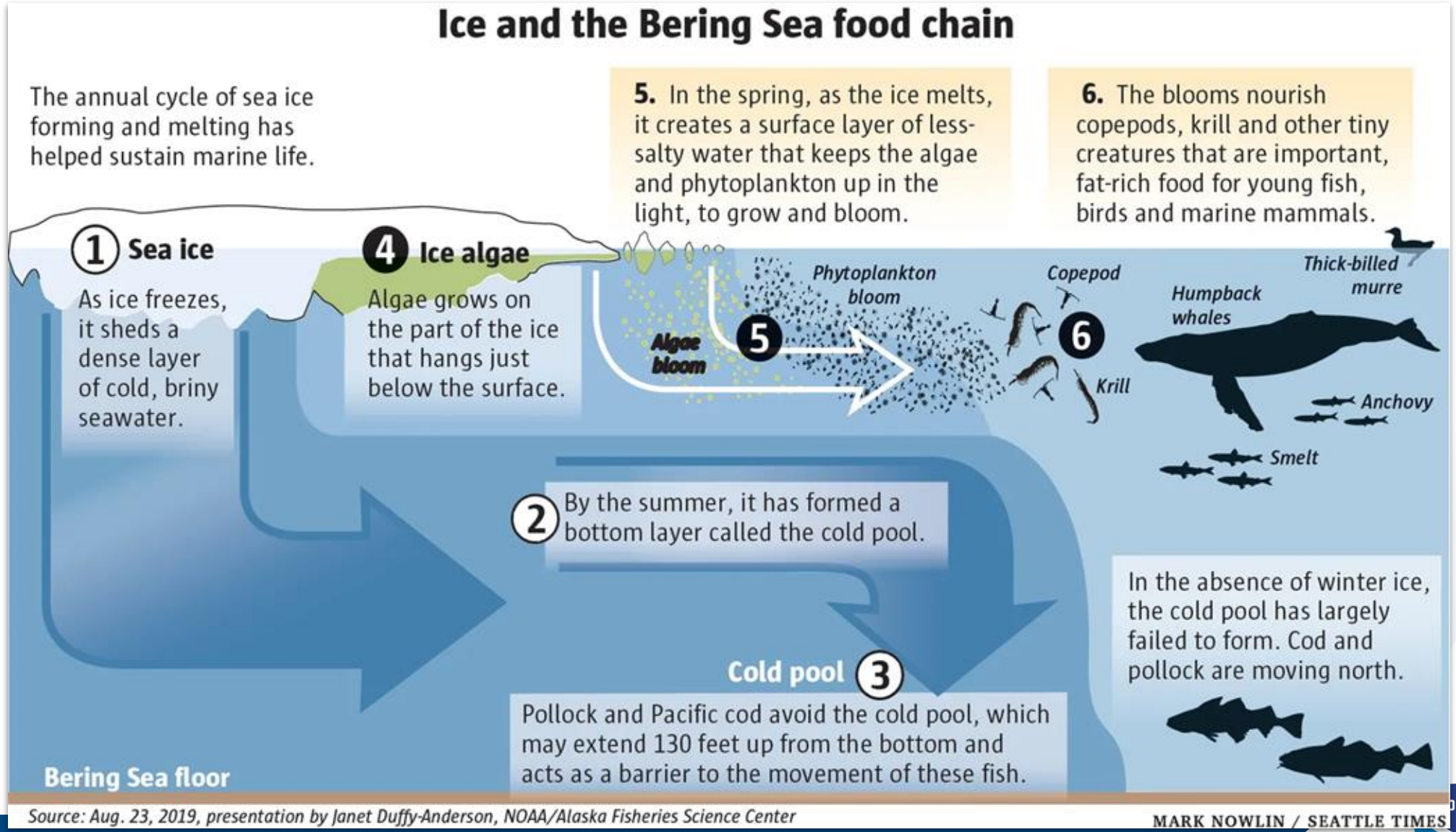
Sea Ice Structures the Bering Sea Ecosystem



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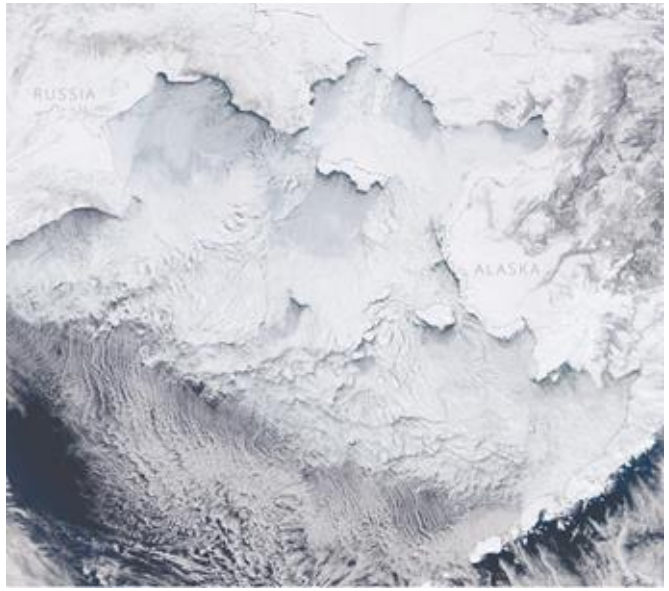
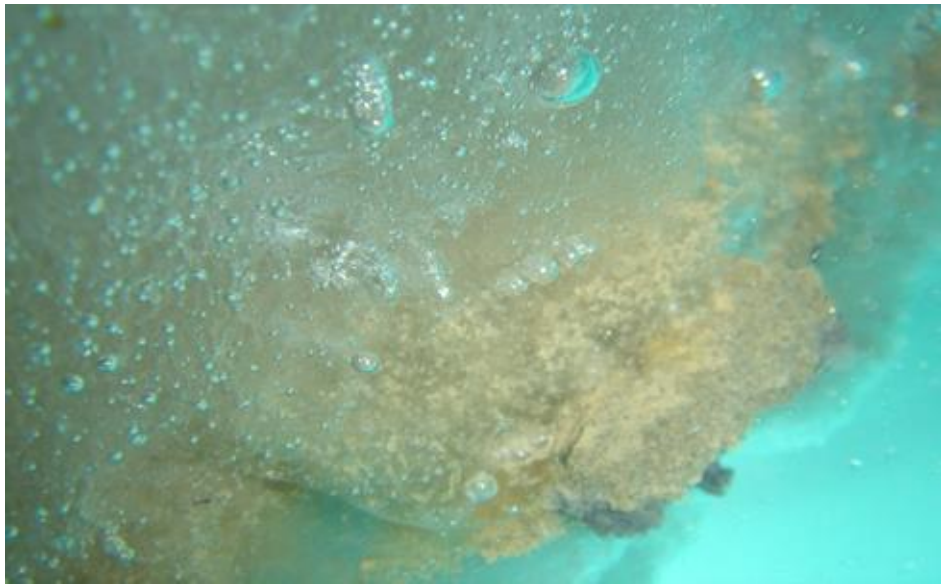
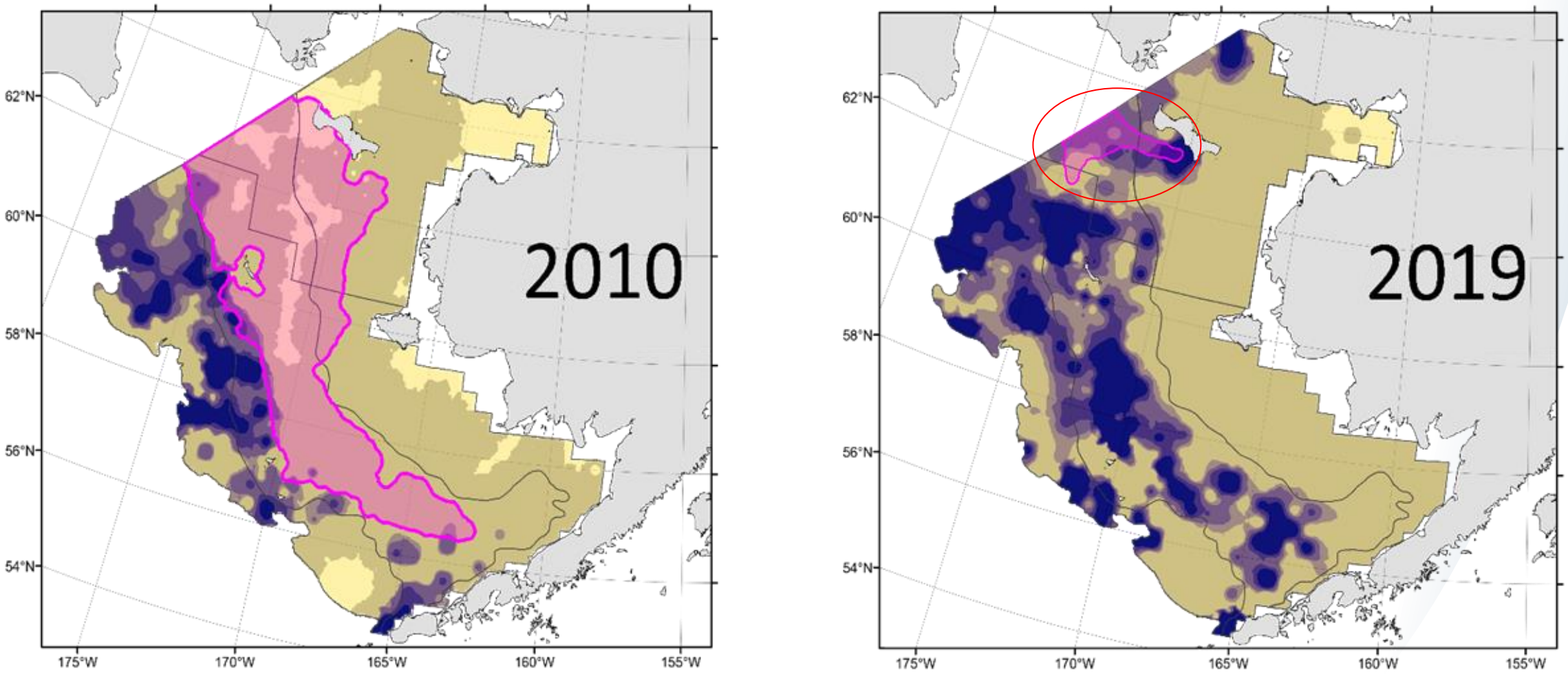




Stabeno et al., 2018

NOAA PMEL

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



Lyle Britt, NOAA AFSC

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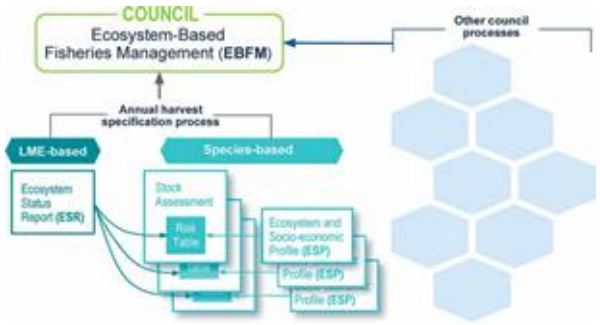
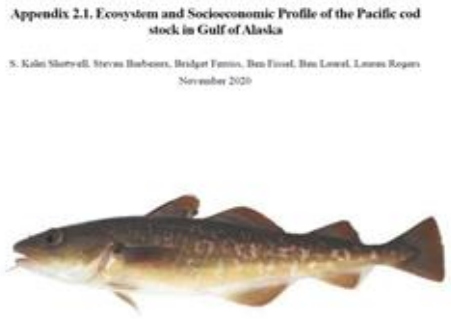
Rapid response delivery of data and model output to management.





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

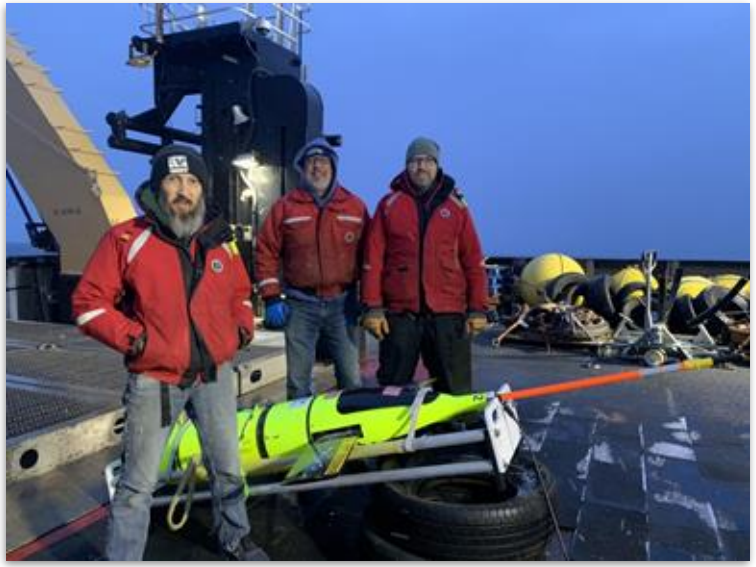
Databases, scientific publications, presentations, data synthesis products such as the Arctic Report Card, radio and news












The People

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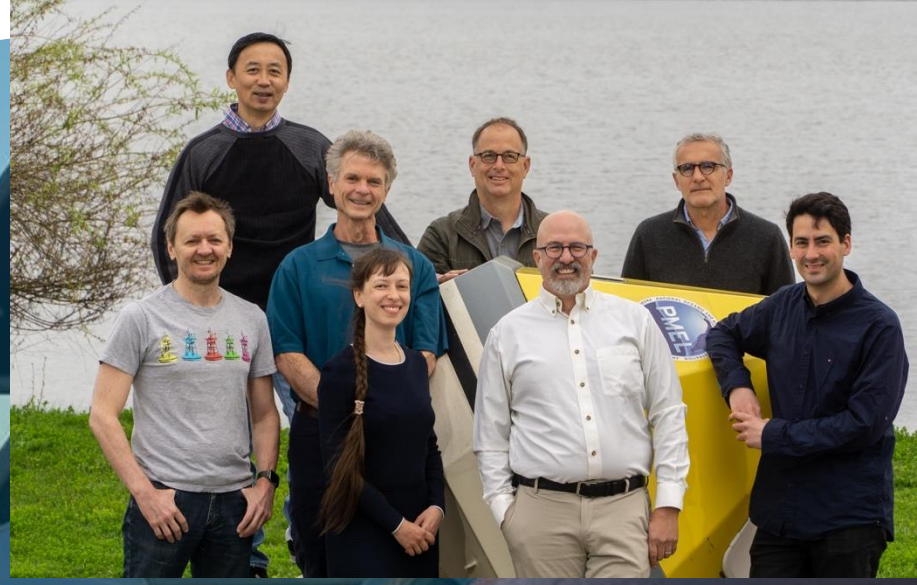

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Tsunami generation: Earthquake uplift estimate vs direct measurement

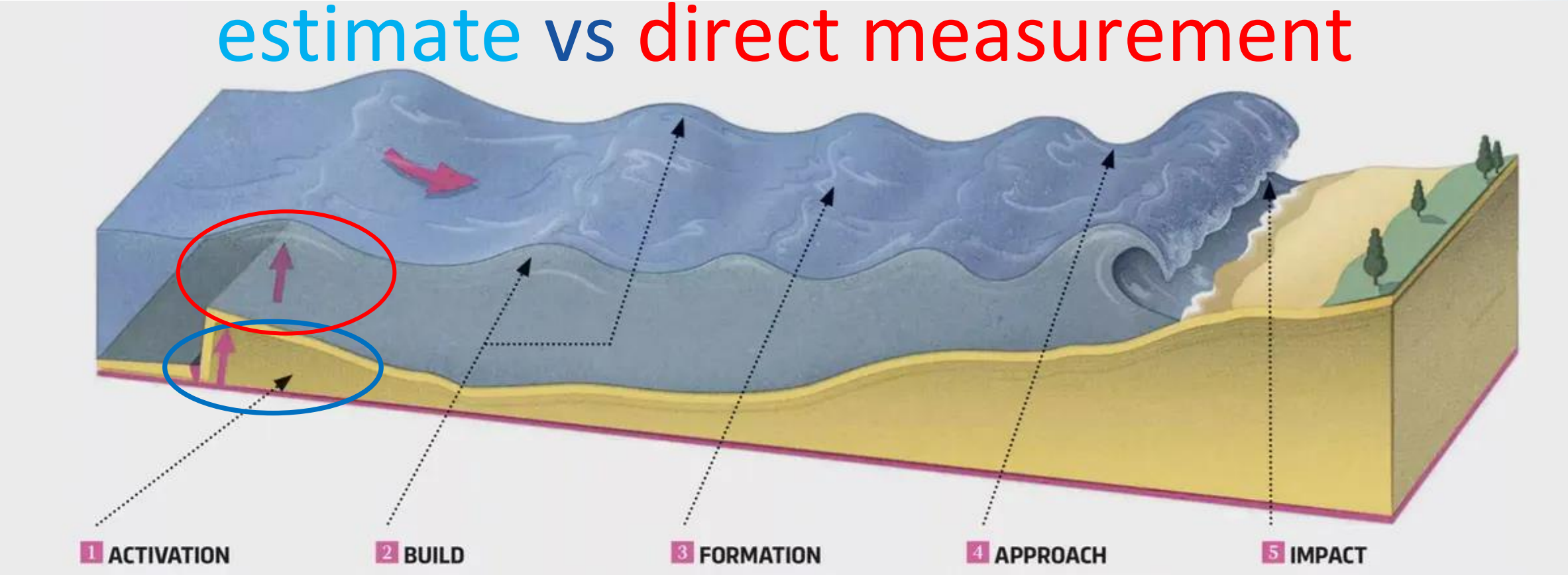
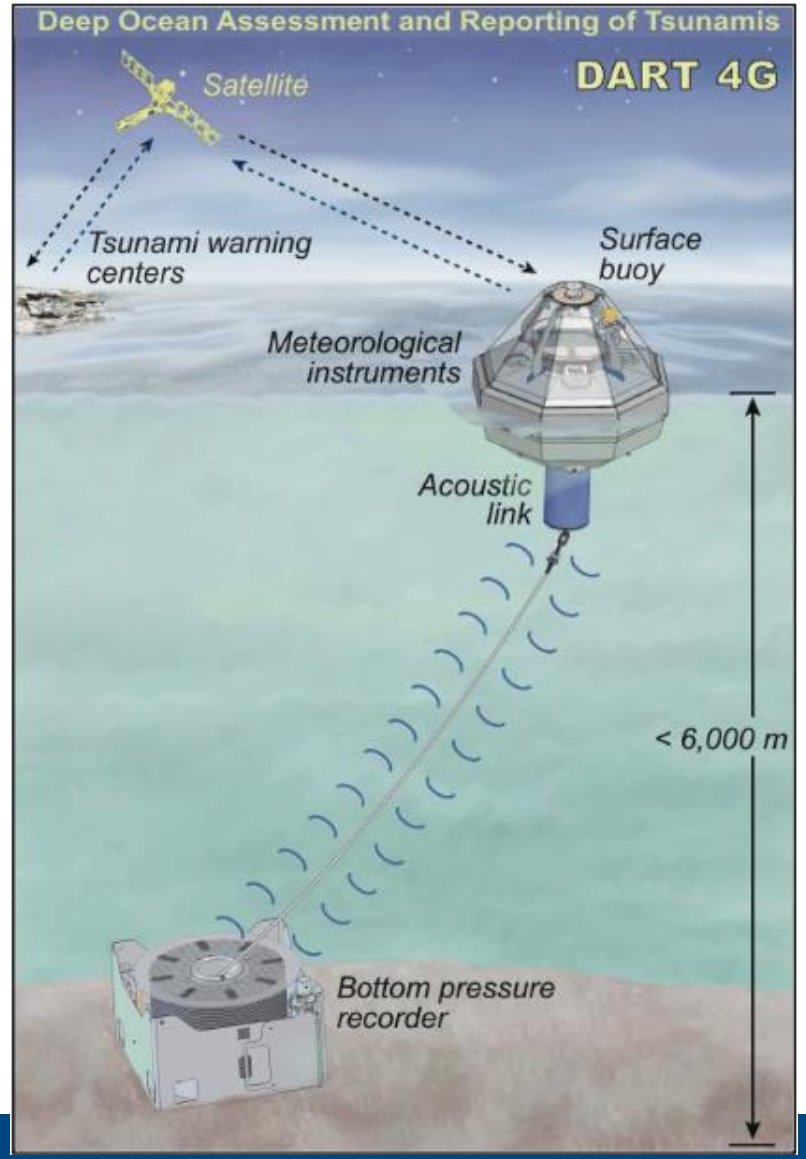
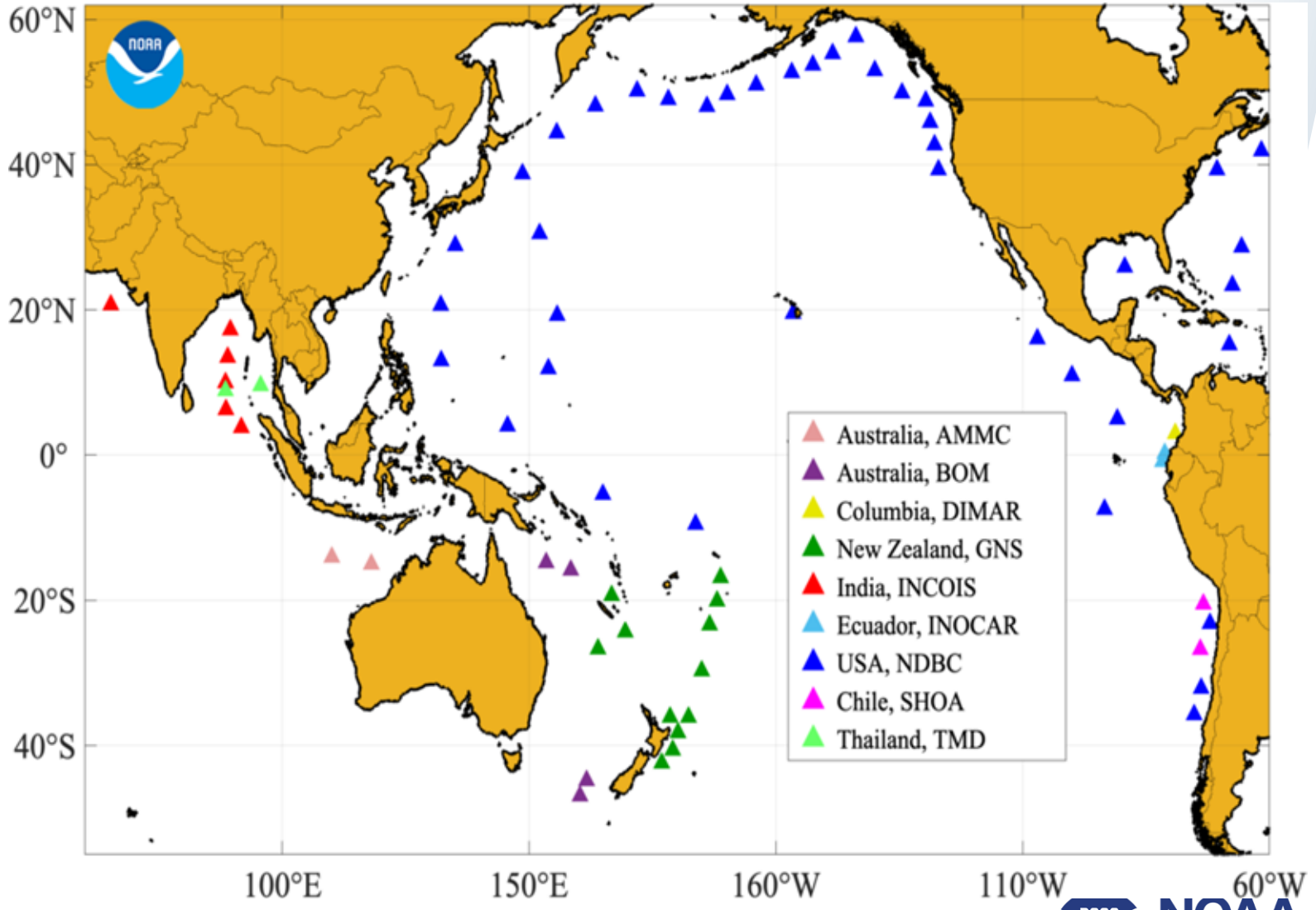


image from BBC Science

DART Observations





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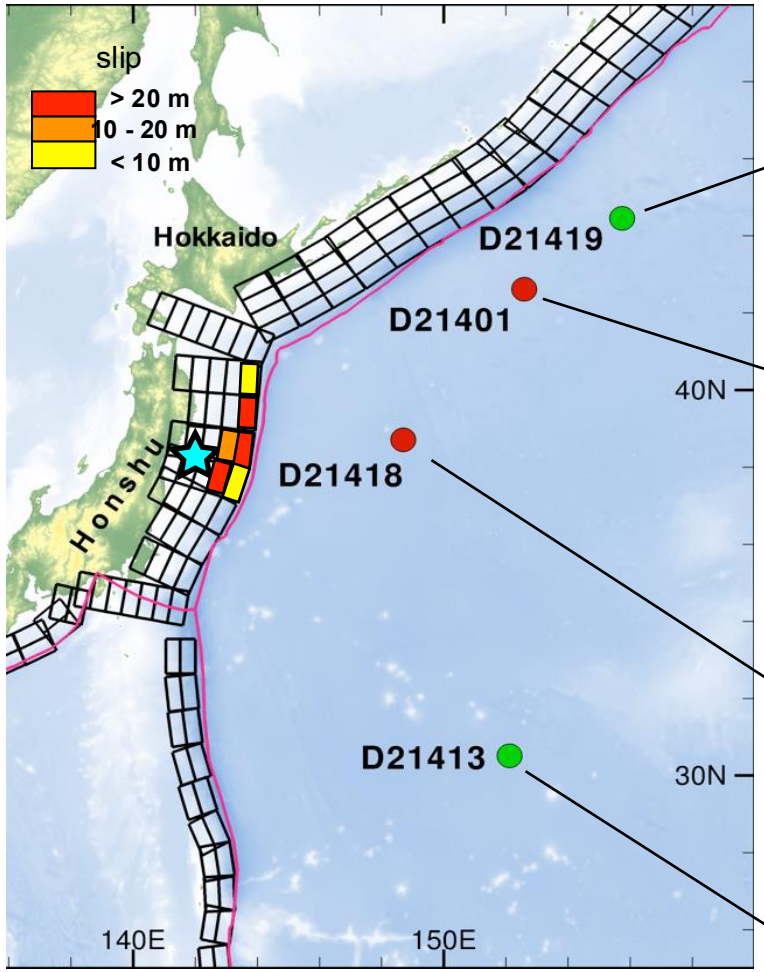
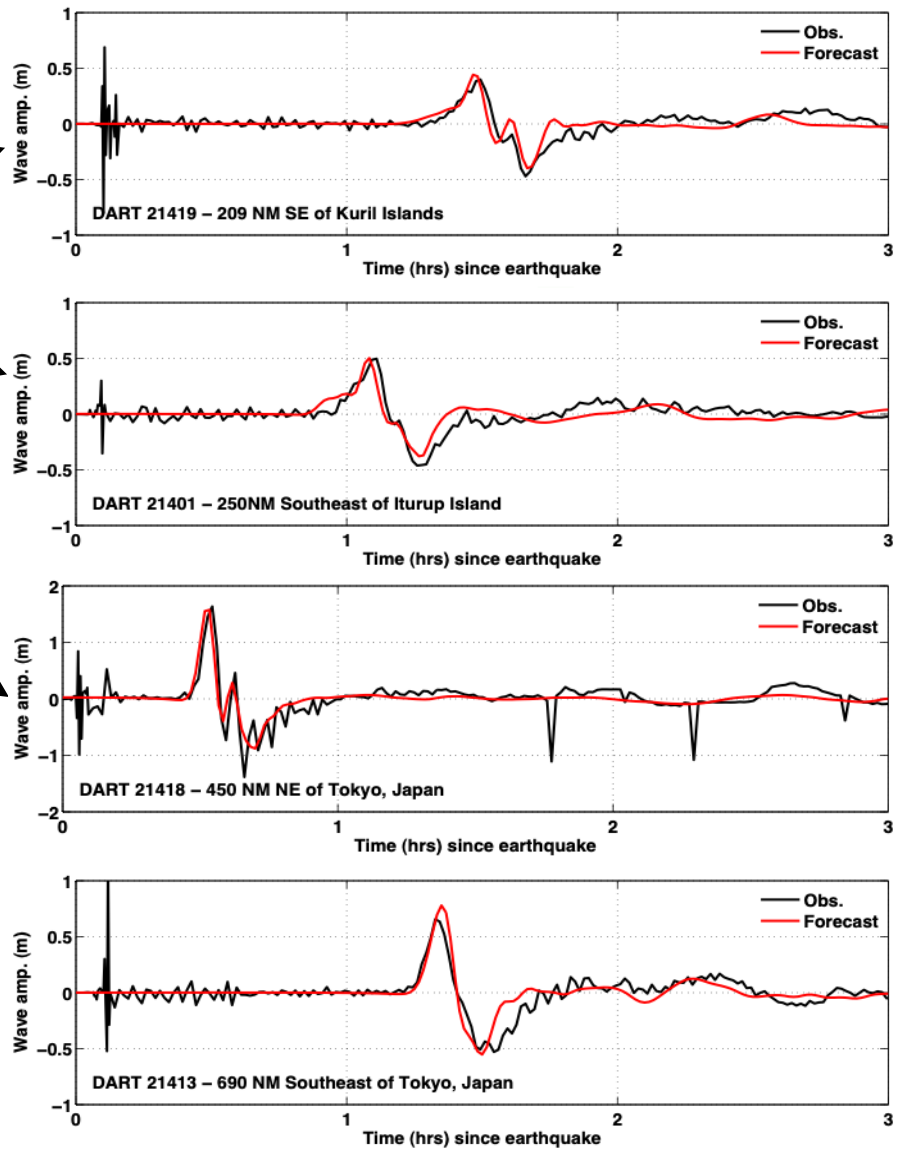
DART inversion method for initial tsunami shape



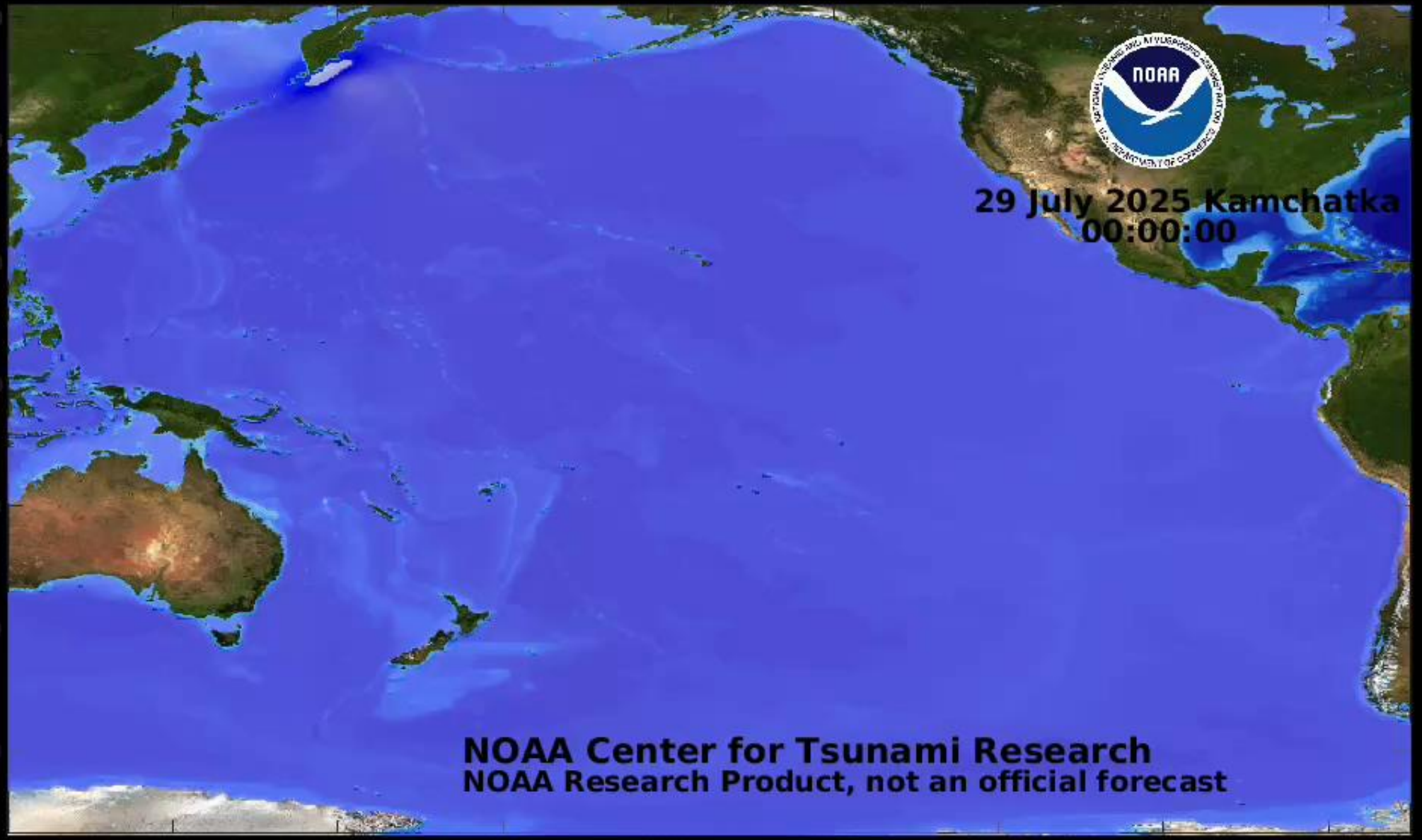


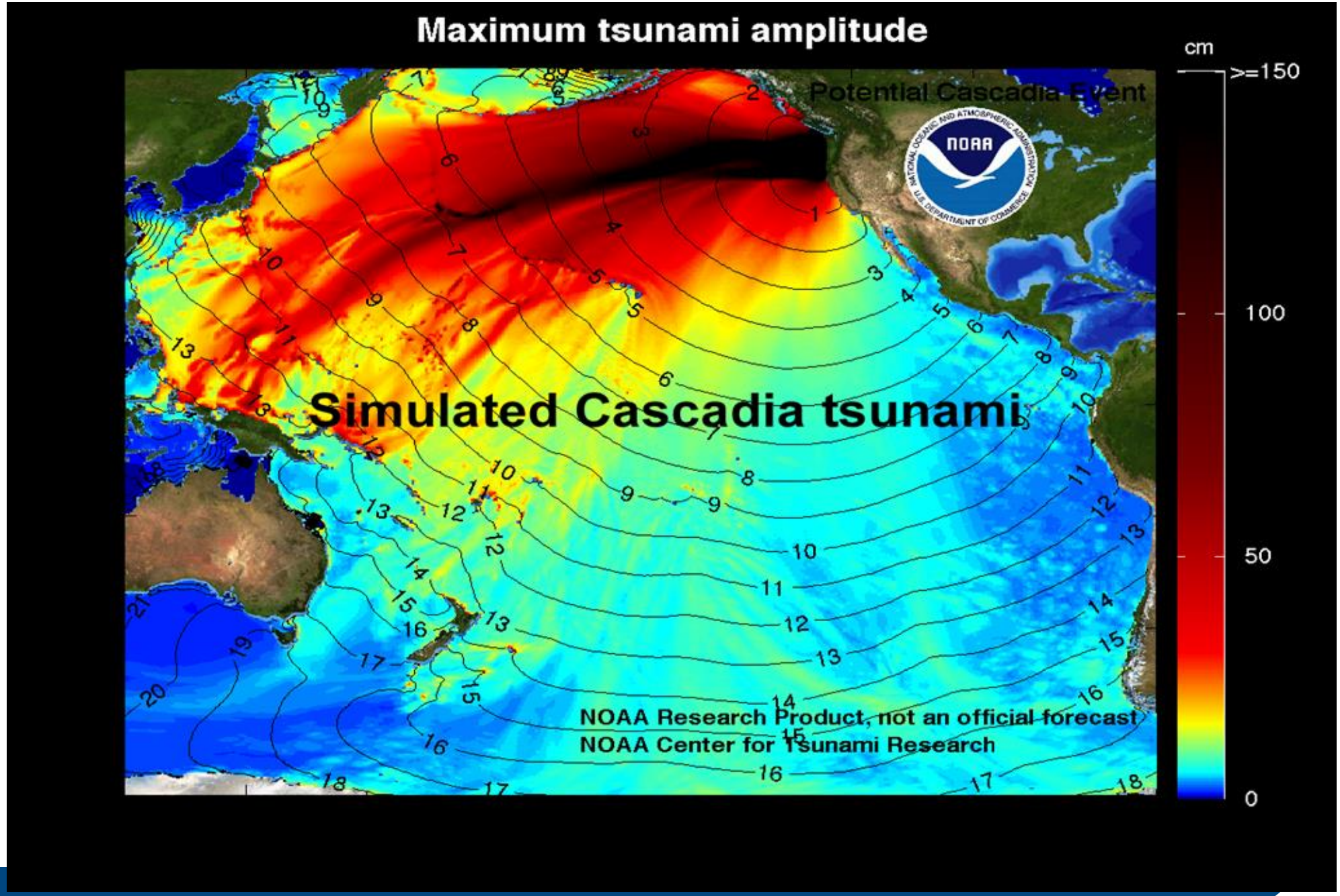
SIFT 2011 Tohoku Tsunami Forecast Results
Obtained in 1.5 hr after the EQ

Honshu (northeastern Taiheiyou) tsunami, 11 March 2011

NOAA Center for Tsunami Research

NOAA PMEL


60
40
20
0
-20
-40
-60
140
160
180
200
220
240
260
280
29 July 2025 Kamchatka
00:00:00
NOAA Center for Tsunami Research
NOAA Research Product, not an official forecast


Maximum tsunami amplitude
Potential Cascadia Event
Simulated Cascadia tsunami
NOAA Research Product, not an official forecast
NOAA Center for Tsunami Research
cm
>=150
100
50
0

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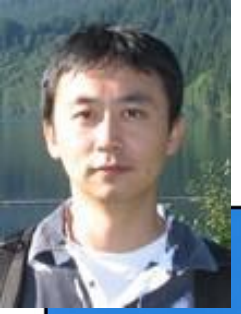
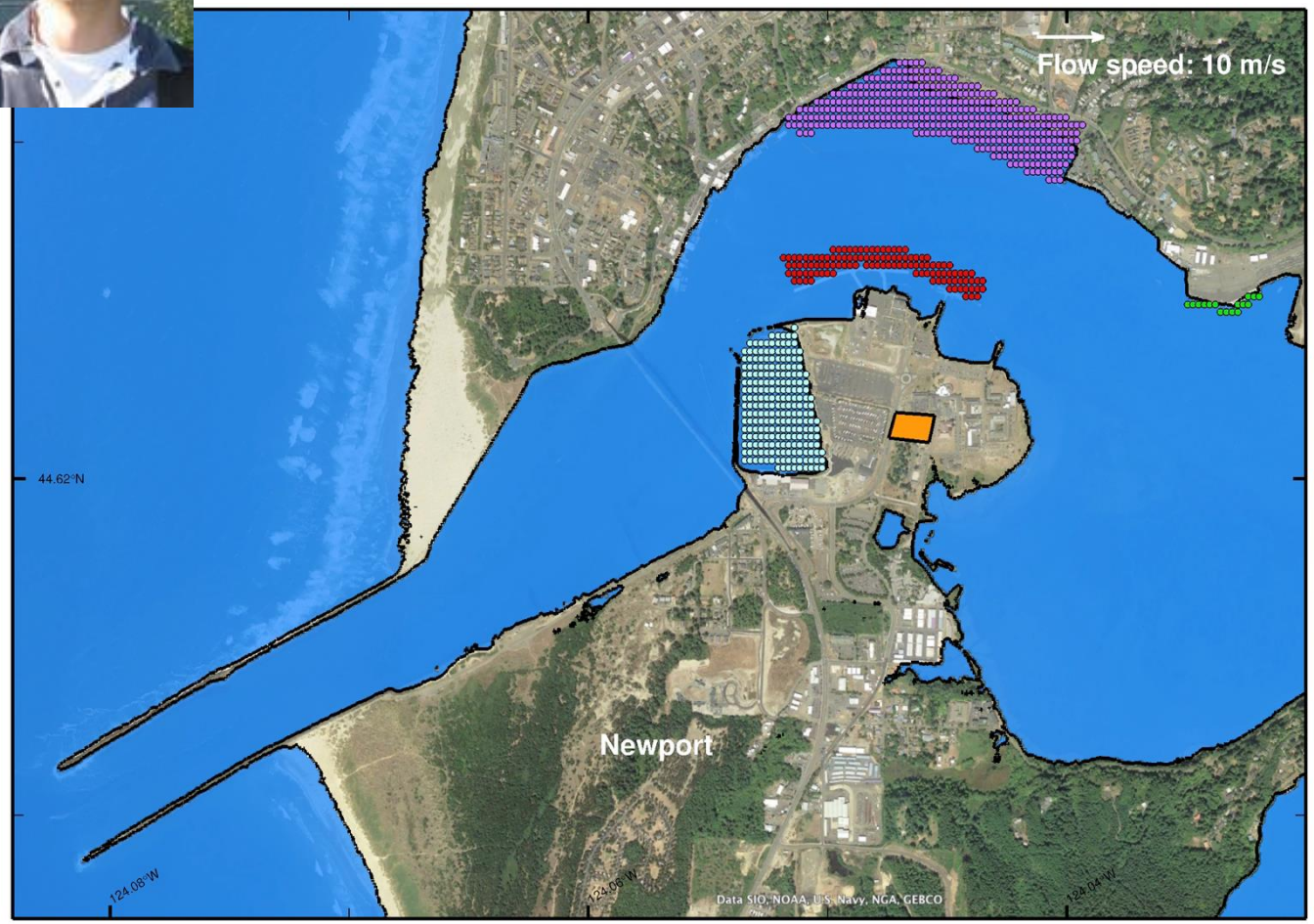


Tsunami Debris Forecasting and Vulnerability Assessment



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

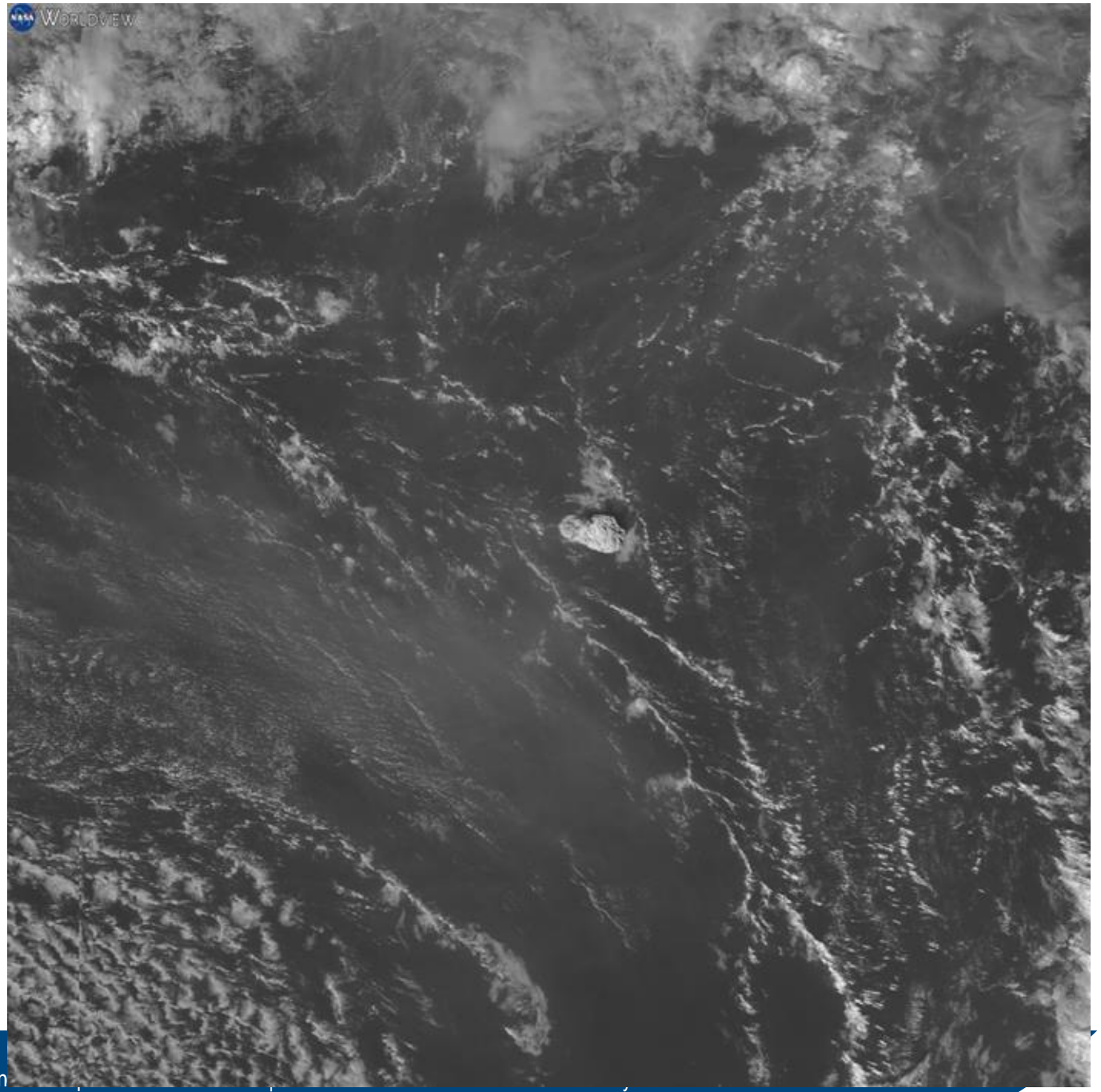
YOST GRUBE HALL ARCHITECTURE

kpff

UNIVERSITY of WASHINGTON

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

Hunga Tonga-Hunga Ha'apai Volcano Explosion and Tsunami



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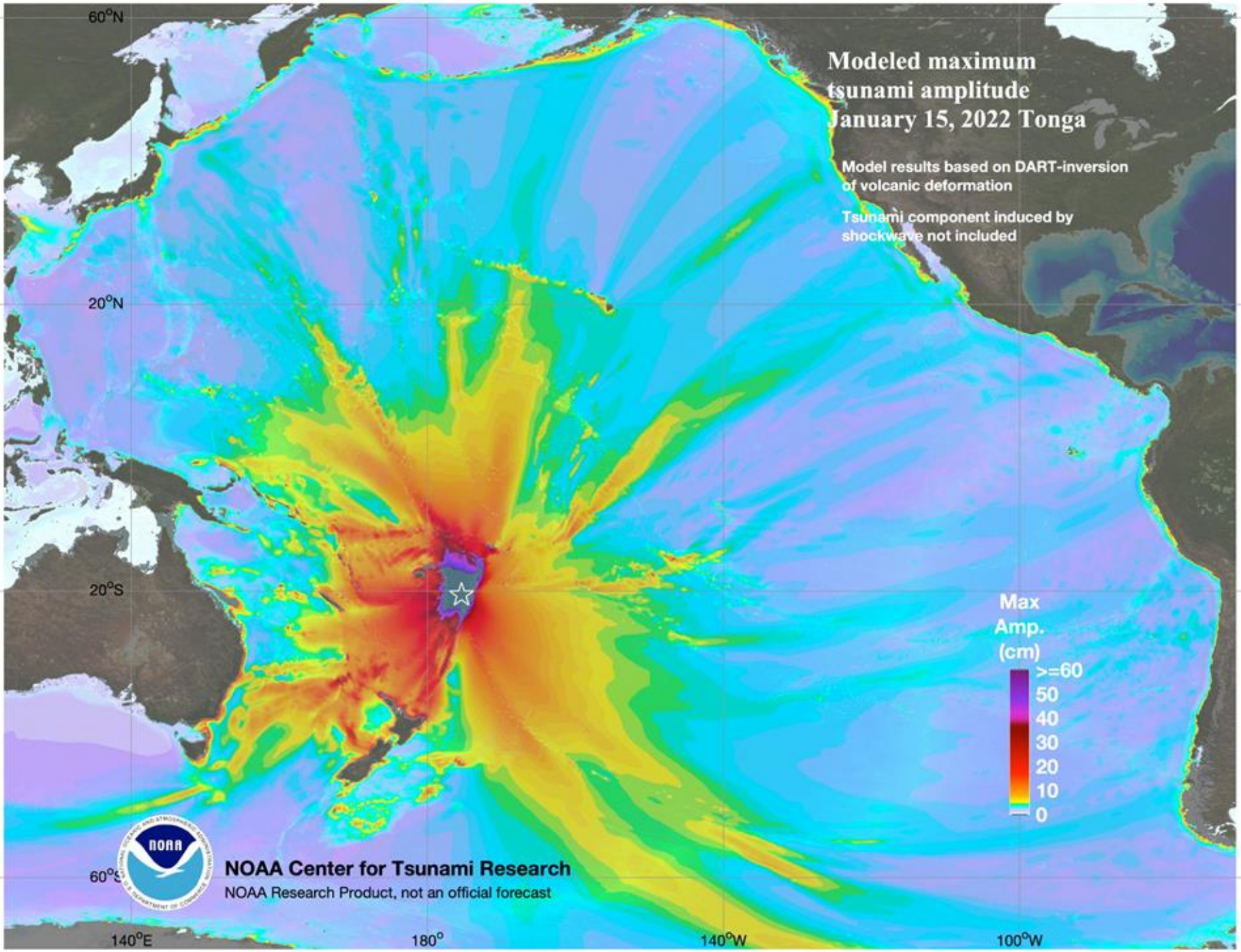
Modeled maximum tsunami amplitude January 15, 2022 Tonga
Model results based on DART-inversion of volcanic deformation
Tsunami component induced by shockwave not included
60°N
20°N
20°S
60°S
140°E
180°
140°W
100°W
Max Amp. (cm)
>=60
50
40
30
20
10
0
NOAA Center for Tsunami Research
NOAA Research Product,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

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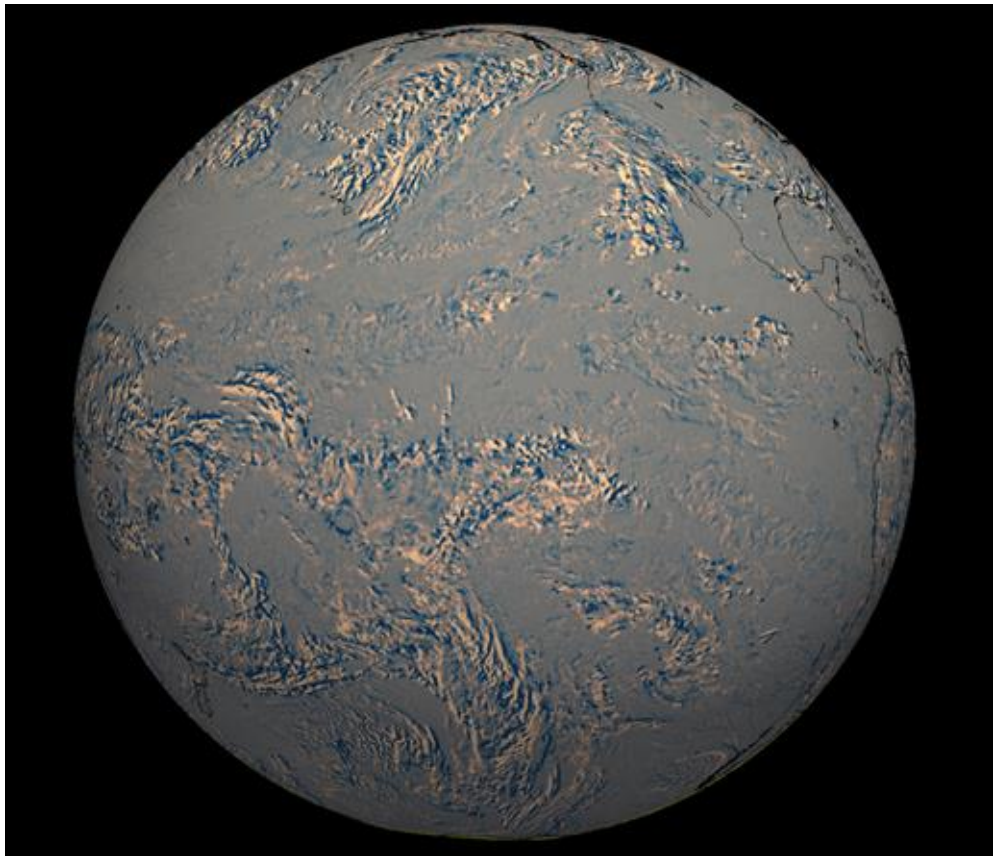
But Wait! That's Not All!

Atmospheric Response



Volcanic Tsunami (Jan 15, 2022 Tonga)

Modeled tsunami

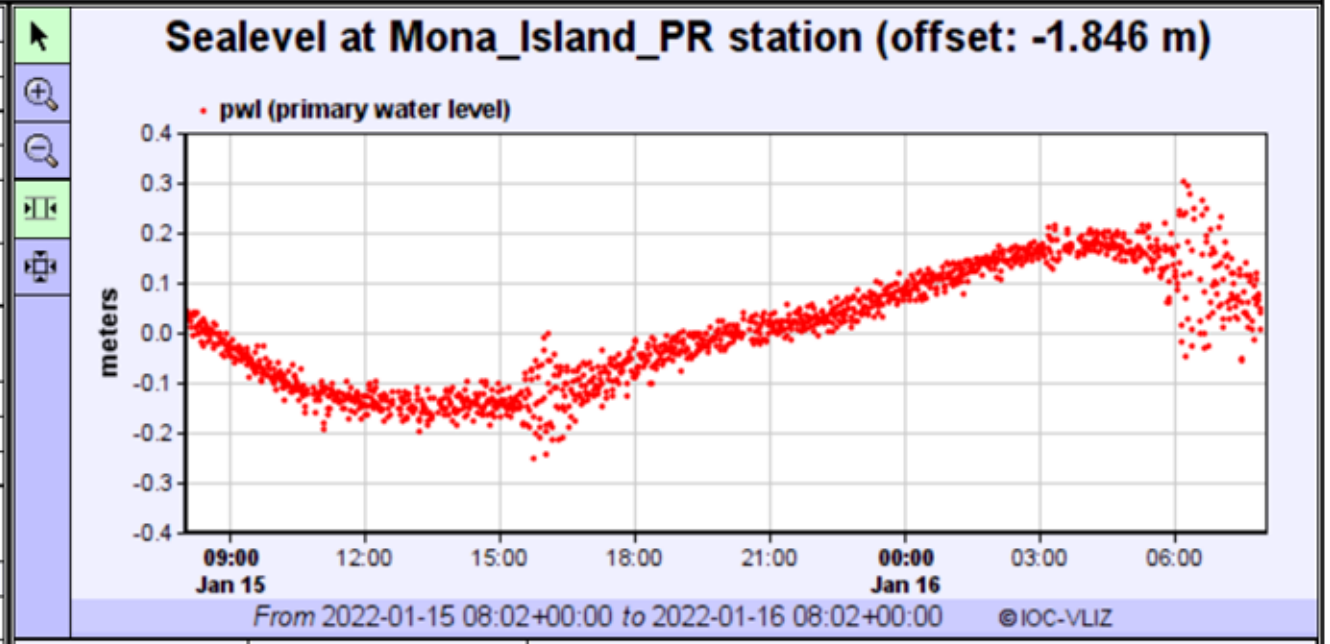
SEA LEVEL STATION MONITORING FACILITY

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

Site developed and maintained by VLIZ for UNESCO/IOC

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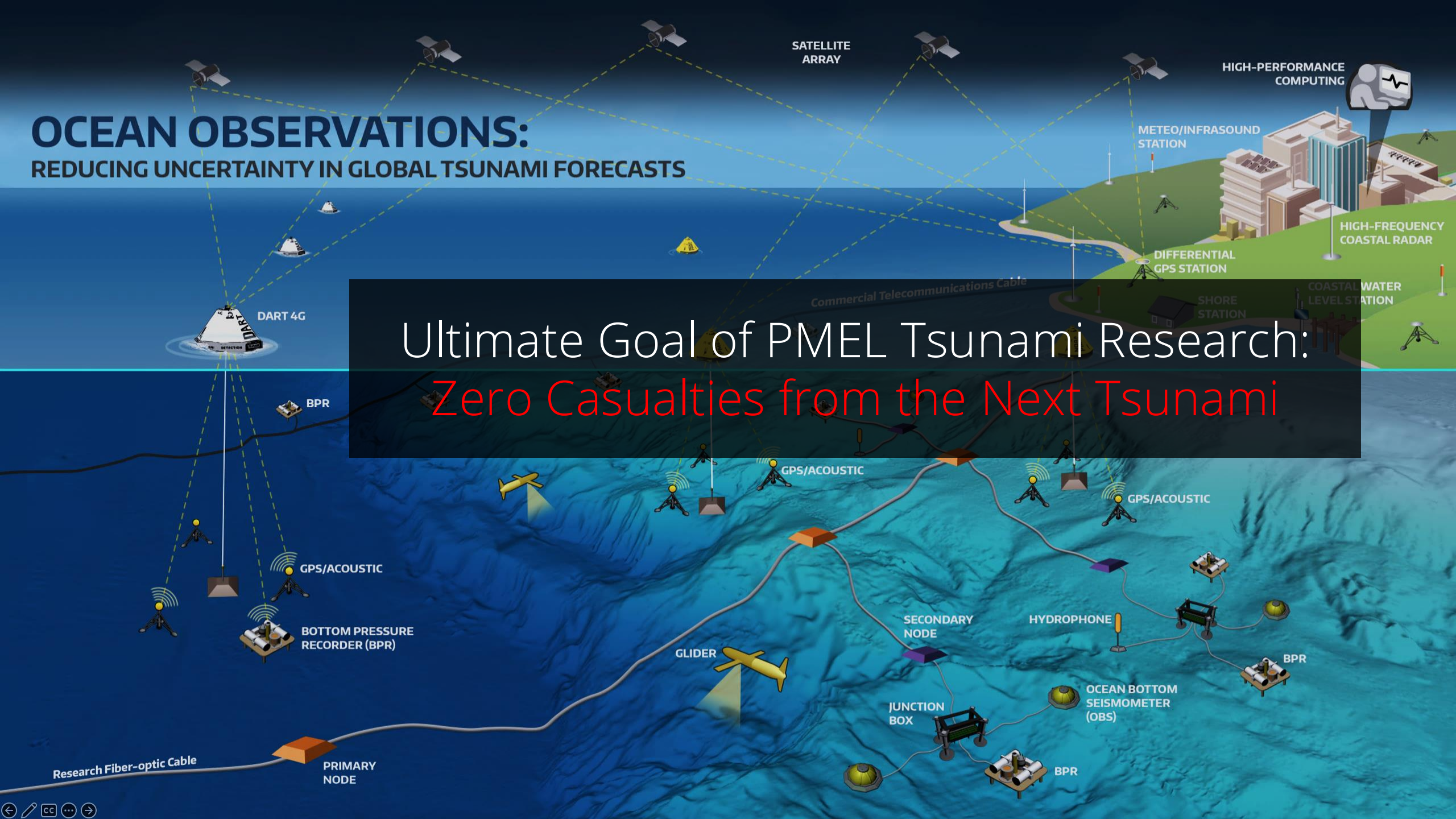


Ultimate Goal of PMEL Tsunami Research:

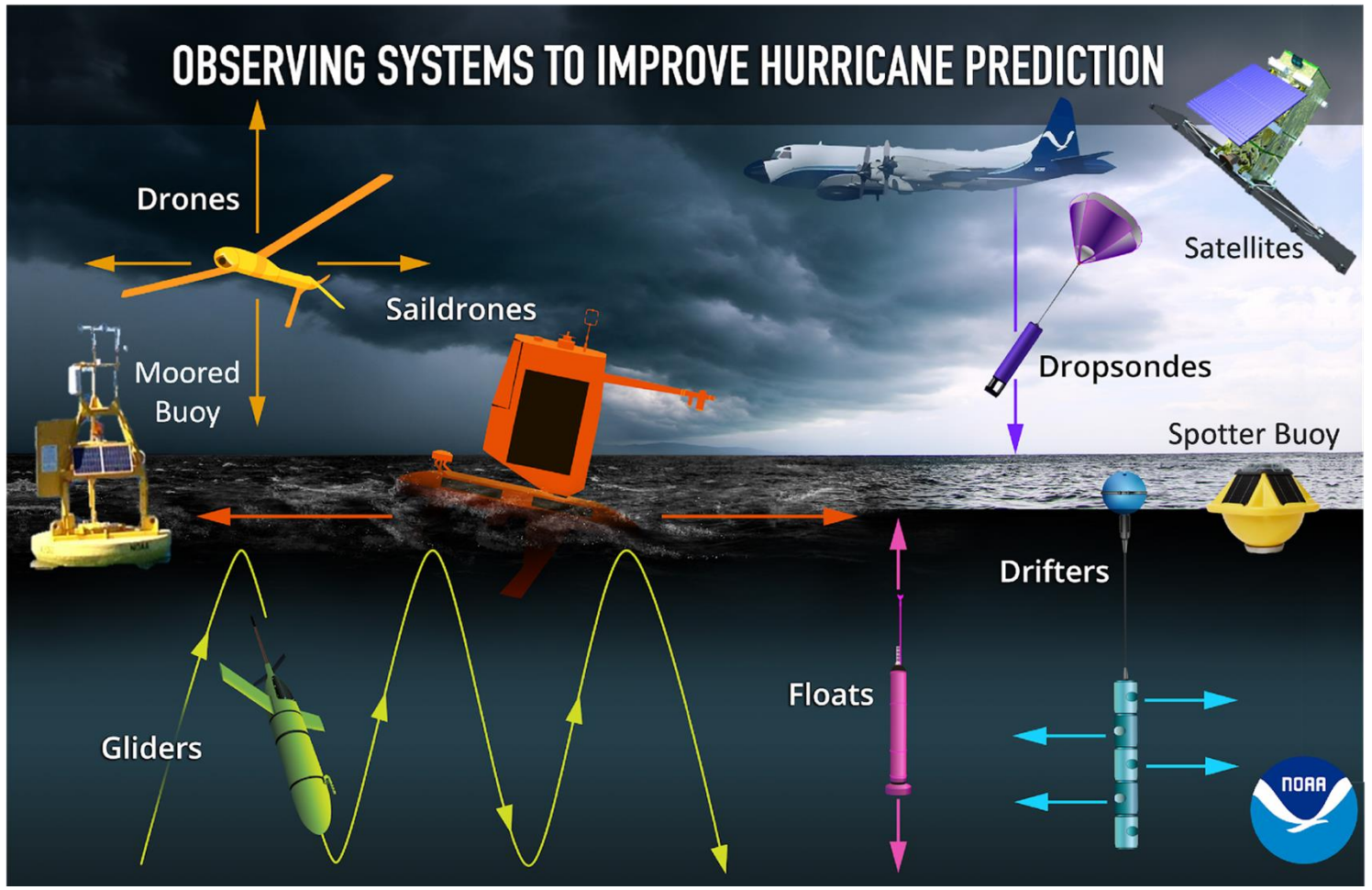
Zero Casualties from the Next Tsunami

PMEL Collaborations

NOAA PMEL


Thank you
and
Questions?

Observing inside hurricanes and tropical storms



2021–2024

36 saildrone deployed

20 hurricanes observed 46 times

Data used by international forecast centers and NOAA hurricane forecasters

Zhang et al., 2023
https://doi.org/10.1175/BAMS-D-21-0327.1

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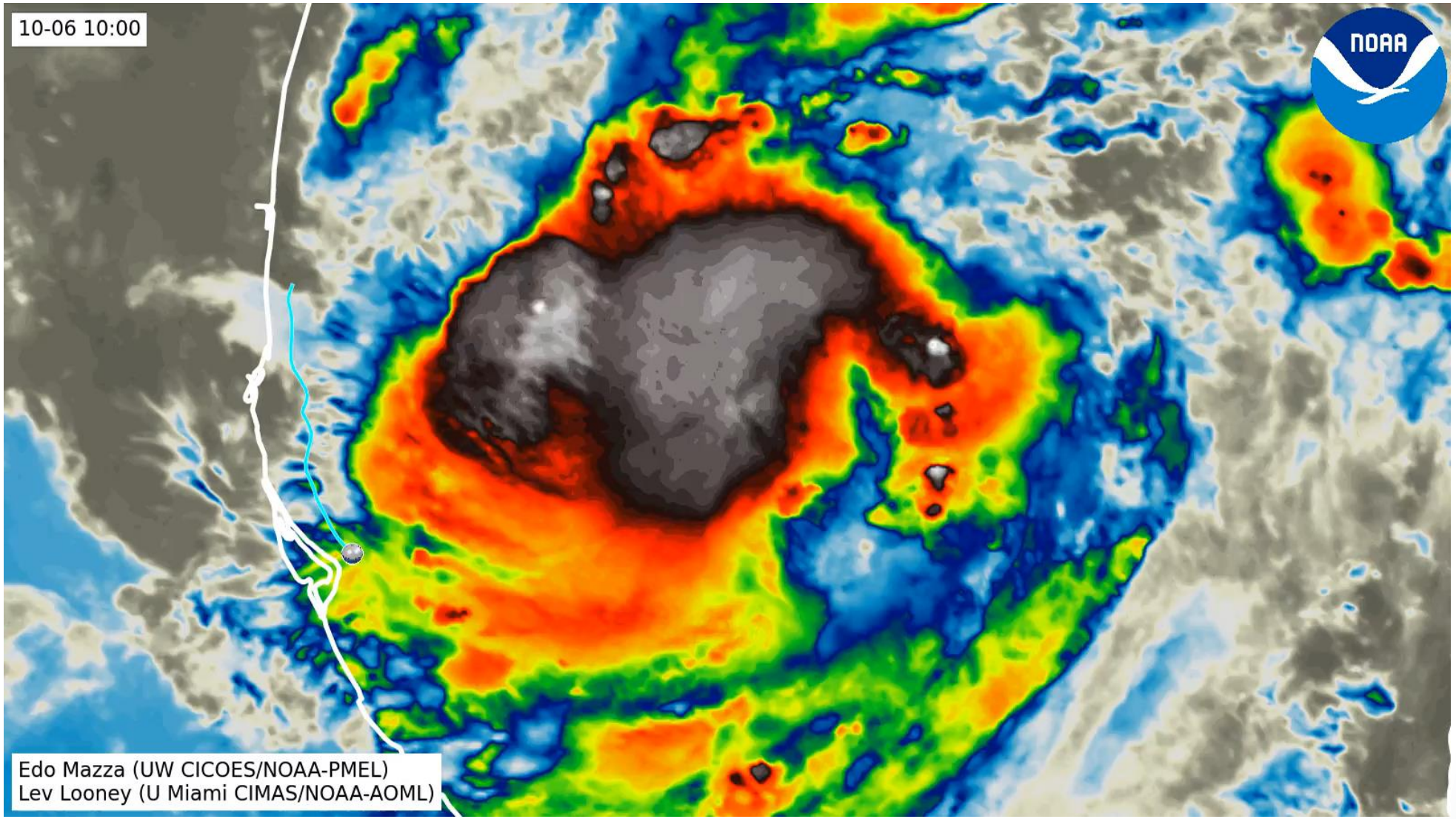
10-06 10:00
NOAA
Edo Mazza (UW CICOES/NOAA-PMEL)
Lev Looney (U Miami CIMAS/NOAA-AOML)

NOAA PMEL