SAILDRONE

SAILDRONE OVERVIEW

February 2022

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SAILDRONE, INC.

American Made | Owned | Manufactured | Operated

Saildrone is the world's leading collector of in situ ocean and climate data via uncrewed vehicles, above and below the sea surface.

Environmentally friendly | ML enabled | Secure data portal | Based in the USA

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WHY SAILDRONE?

The world's most capable, proven, and trusted Uncrewed Surface Vehicles (USVs)

SAILDRONE

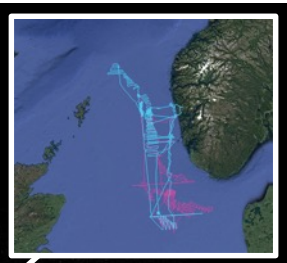
GLOBAL OPERATIONS

>750,000 nm sailed

>15,000 days at sea

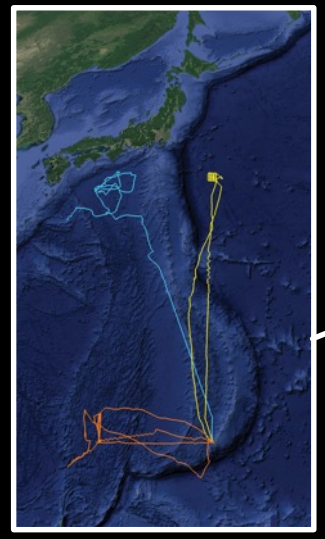
West Coast USA

Arctic



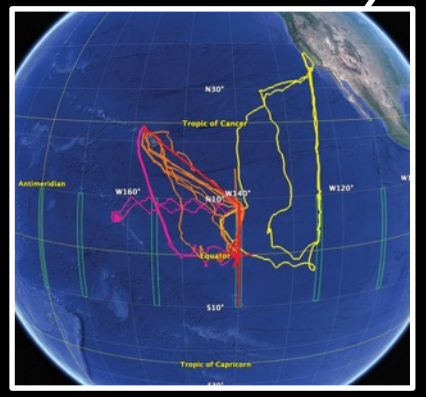
North Sea

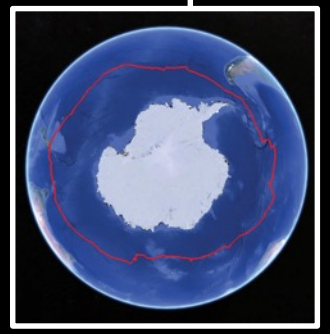
Transatlantic



Guam – Japan

Tropical Pacific





Antarctic

Barbados

Atlantic to Mediterranean

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OUR TECHNOLOGY
Vehicles | Data | Mission Portal

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A GLOBAL FLEET OF OCEAN DRONES

Wind and solar-powered, monitoring the planet in real time, above and below the surface.

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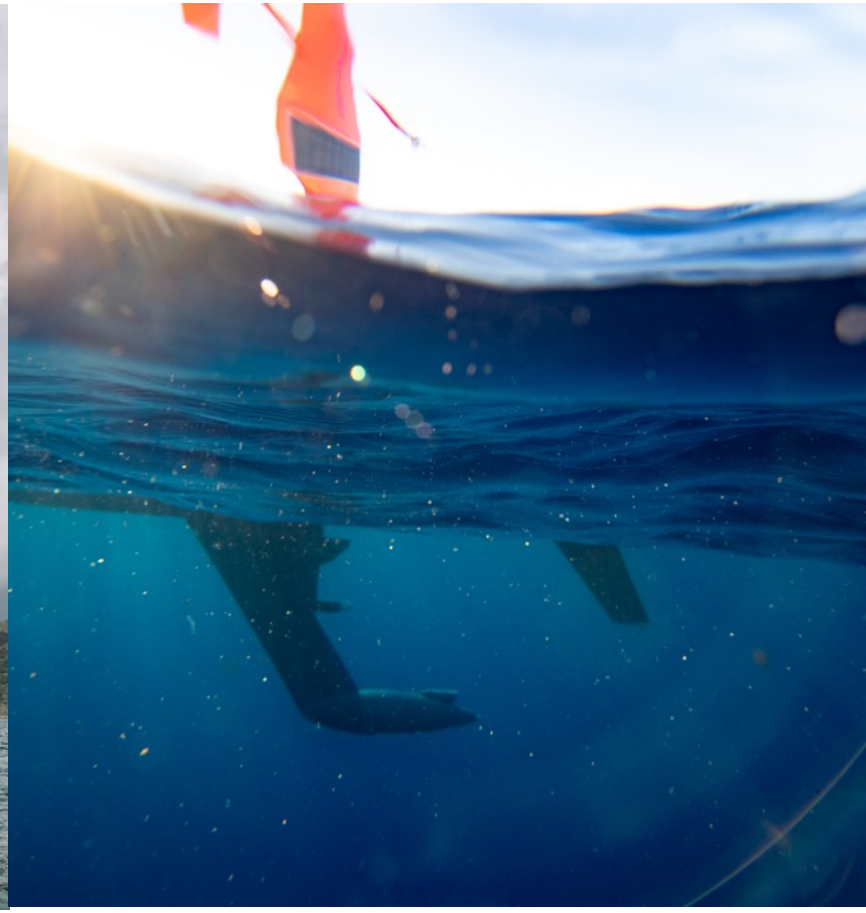

Maritime Domain Awareness

Intelligence, Surveillance & Reconnaissance (ISR)
Force Protection | Law Enforcement & Maritime Safety
Ecosystem Monitoring

Ocean Mapping

Single-beam and multibeam bathymetric data collection for navigation and charting, telecommunications, offshore energy, and physical oceanography to 23,000 feet (7,000 m) depth.

Ocean Data

Collecting essential ocean and climate variables.
Fisheries | Metocean Data Collection | Ecosystem monitoring | Satellite Calibration/Validation

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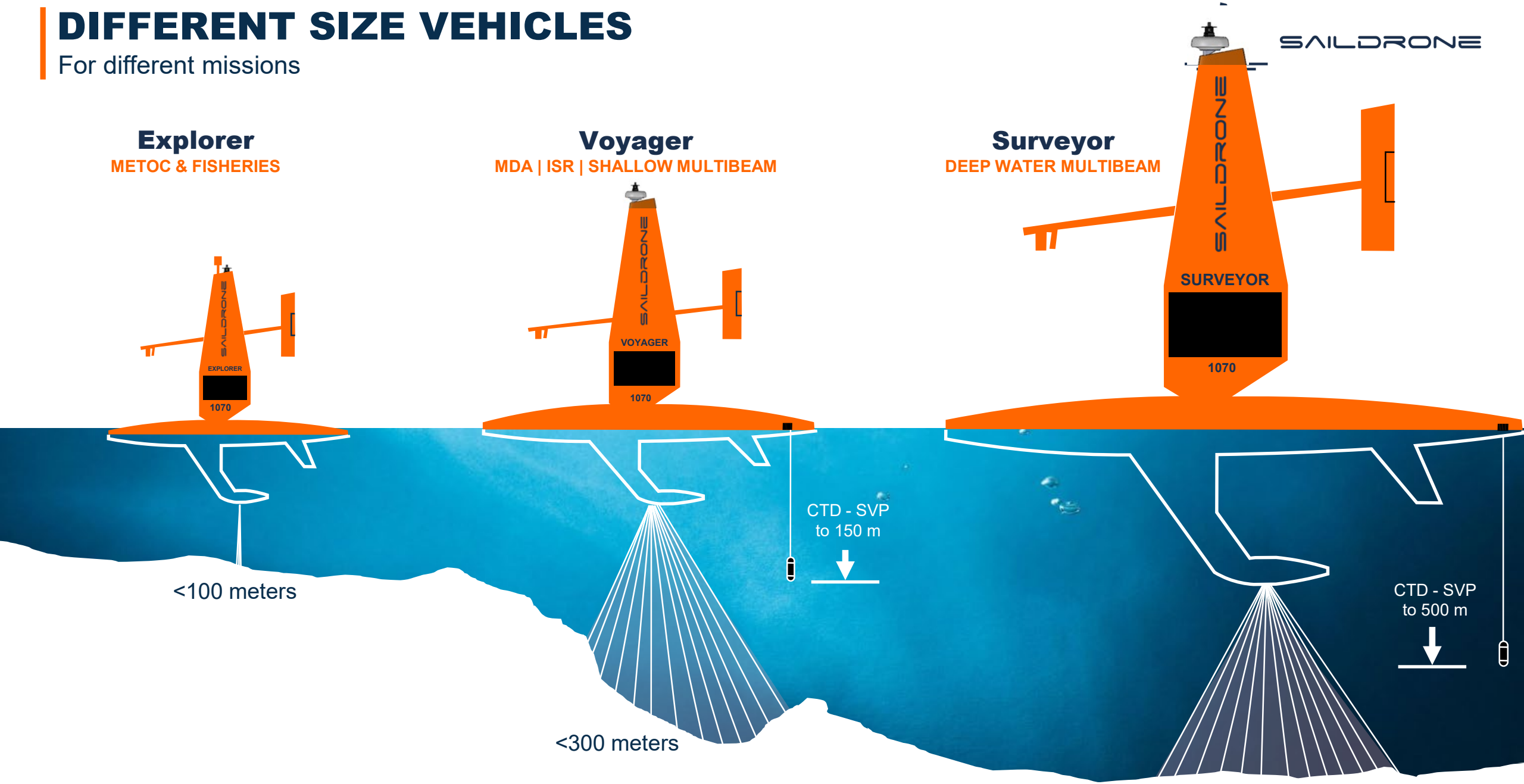
DIFFERENT SIZE VEHICLES

For different missions



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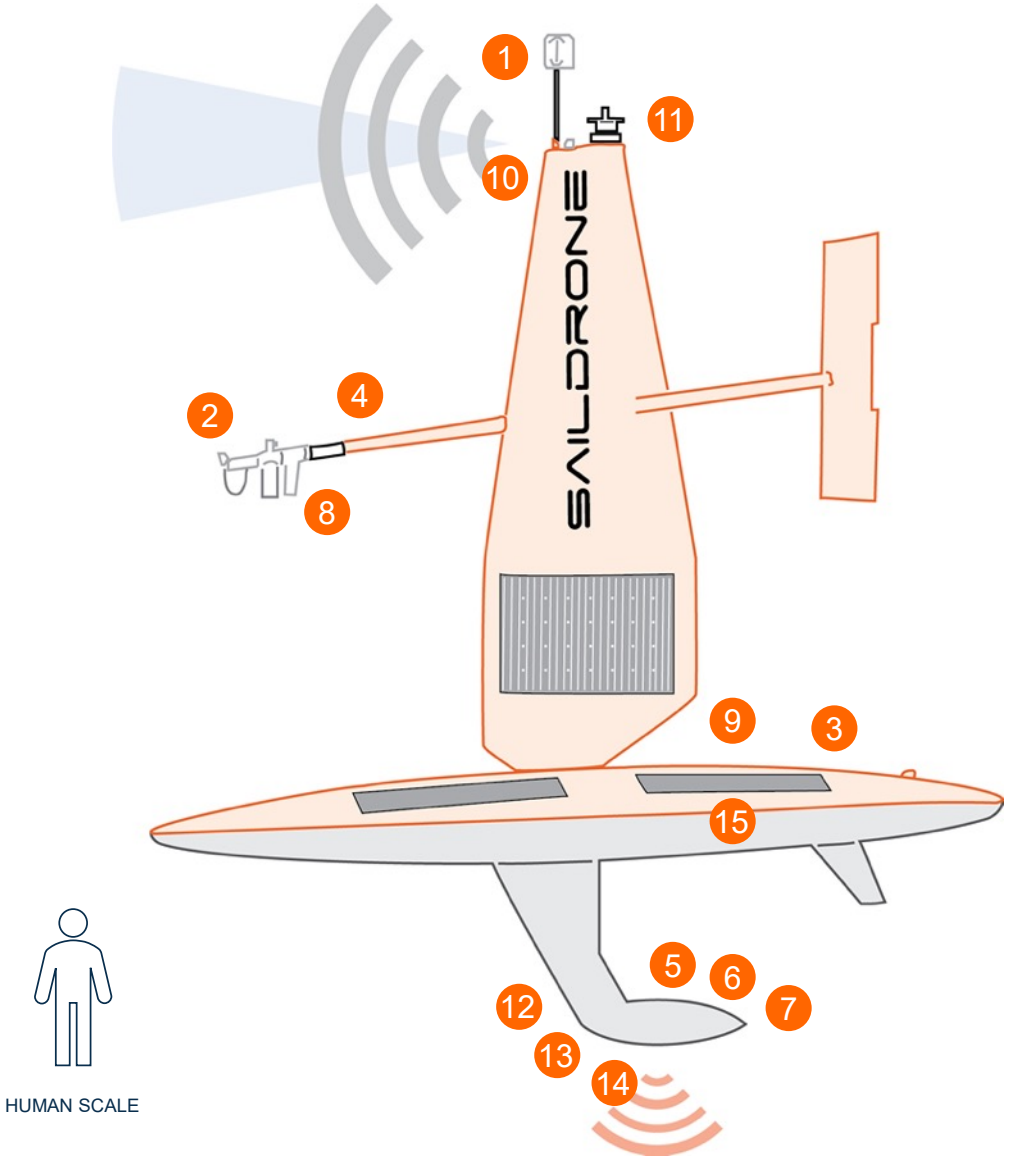
SAILDRONE EXPLORER – ALL SENSORS

Comprehensive sensor suite: Critical scientific data for understanding climate change



PAYLOAD OPTIONS

No.	Variable	Sensor	
1	Wind speed & direction	Gill Windmaster 3D Ultrasonic 20Hz @ + 5.2 m	ATMOSPHERIC
2	Air temp & humidity	Rotronic HC2 - S3 with rad shield @ + 2.3 m	ATMOSPHERIC
3	Barometric pressure	Vaisala Barocap PTB210 @ +0.2 m	ATMOSPHERIC
4	Photosynthetically active radiation	LI-COR LI-192SA @ +2.6 m	ATMOSPHERIC
5	Salinity & temperature	Seabird SBE 37 @ -1.5 m	OCEAN
6	Dissolved oxygen	Seabird SBE 37 ODO @ -1.5 m	OCEAN
7	Chlorophyll-a	Wetlabs ECO-FL-S G4 @ -0.5 m	OCEAN
8	Skin temperature	Heitronics CT 15.10 @ +2.3	OCEAN
9	Wave height & period	Dual GPS aided IMU	OCEAN
10	Carbon	NOAA PMEL ASVCO2 (pCO2) Atmospheric & dissolved pCO2	OCEAN
11	AIS transceiver		MDA
13	Smart camera array	360° High-resolution optical cameras with ML target detection	MDA
13	Ocean currents	Teledyne RDI Workhorse ADCP 300 kHz @ -1.9 m	ACOUSTIC
14	Bathymetry	Shallow single-beam: Airmar DT800 Deep single-beam: Teledyne Echotrac E20 Deep single-beam: Simrad WBT Mini	ACOUSTIC

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EXCEPTIONAL DATA QUALITY

Rigorously tested by external collaborators

> “Comparisons with shipboard measurements showed good agreement, inspiring confidence in these new instrument platforms.”

THE USE OF SAILDRONES TO EXAMINE SPRING CONDITIONS IN THE BERING SEA: INSTRUMENT COMPARISONS, SEA ICE MELTWATER AND YUKON RIVER PLUME STUDIES. OCEANS 2015

> “The saildrones performed well in the harsh conditions of the Bering Sea and demonstrated the potential of this innovative platform to advance ecosystem research.”

ADVANCES IN ECOSYSTEM RESEARCH: SAILDRONE SURVEYS OF OCEANOGRPAHY, FISH, AND MARINE MAMMALS IN THE BERING SEA. OCEANOGRAPHY 30(2):113–115

> “A platform that is ready for ocean research missions from the tropics to the Arctic.”

THE USE OF SAILDRONES TO EXAMINE SPRING CONDITIONS IN THE BERING SEA: VEHICLE SPECIFICATION AND MISSION PERFORMANCE. OCEANS 2015

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WHY SAILDRONE

Collaborating with the world's leading defense and civilian government and scientific organizations

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NOAA — USA	National Geospatial-Intelligence Agency — USA	University of Rhode Island — USA	BSFRF Bering Sea Fisheries Research Foundation — USA	SOCIB Balearic Islands Coastal Observing and Forecasting System — SPA	GEOMAR — GER
PMEL — USA	NASA — USA	University of Hawai'i — USA	Scripps Institution of Oceanography — USA	Copernicus Europe's eyes on Earth — EU	ICOS Integrated Carbon Observation System — NOR
NOAA Fisheries — USA	United States Coast Guard — USA	NOPP — USA	Woods Hole Oceanographic Institution — USA	SOOS — SWE	Institute of Marine Research — NOR
National Weather Service — USA	Defense Innovation Unit — USA	University of Washington — USA	Gulf of Mexico Research Initiative — USA	JAMSTEC — JAP	ECMWF — GBR
NCCOS — USA	University of New Hampshire — USA	The University of Southern Mississippi — USA	ECMWF European Centre for Medium Range Weather Forecasts — EU	CSIRO — AUS	Ifremer — FRA
COM Climate Observations and Monitoring — USA	MBARI — USA	ecogig — USA	The Nippon Foundation-GEBCO Seabed 2030	Schmidt Ocean Institute — USA	PLOCAN Consorcio — SPA

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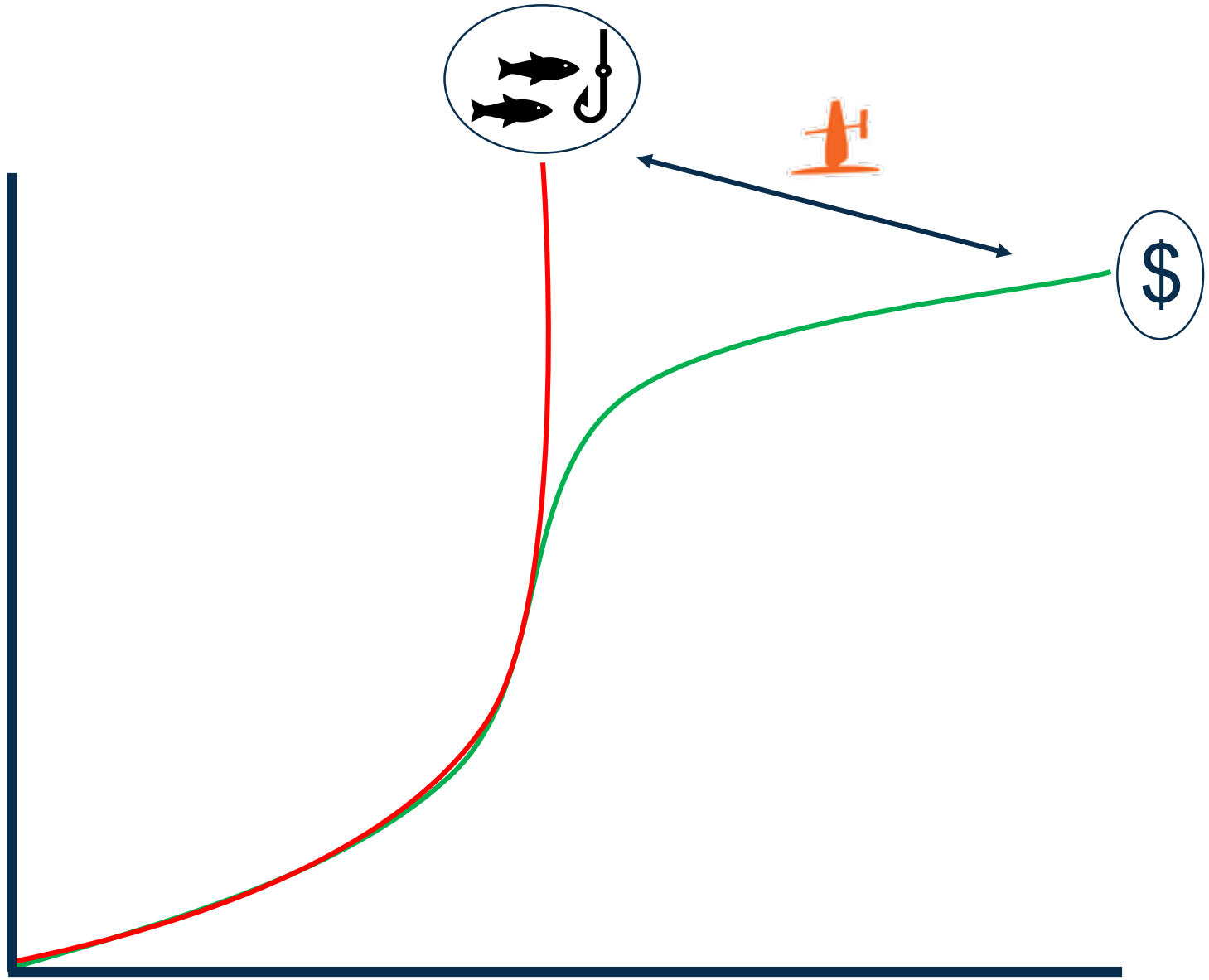
REQUIREMENTS vs. RESOURCES

Realizing Efficiencies to Close the Delta Between Requirements and Resources



- **Augment traditional survey efforts with long endurance, low impact (LELI) USVs.**
- **LELI USVs can be produced quickly, at a lower cost than a survey ship.**
- **Business model reduces cost and risk.**
- **LELI USVs are not going to replace ships; they will free those assets up for missions requiring crewed vessels.**
- **Let the robots mow the grass!**

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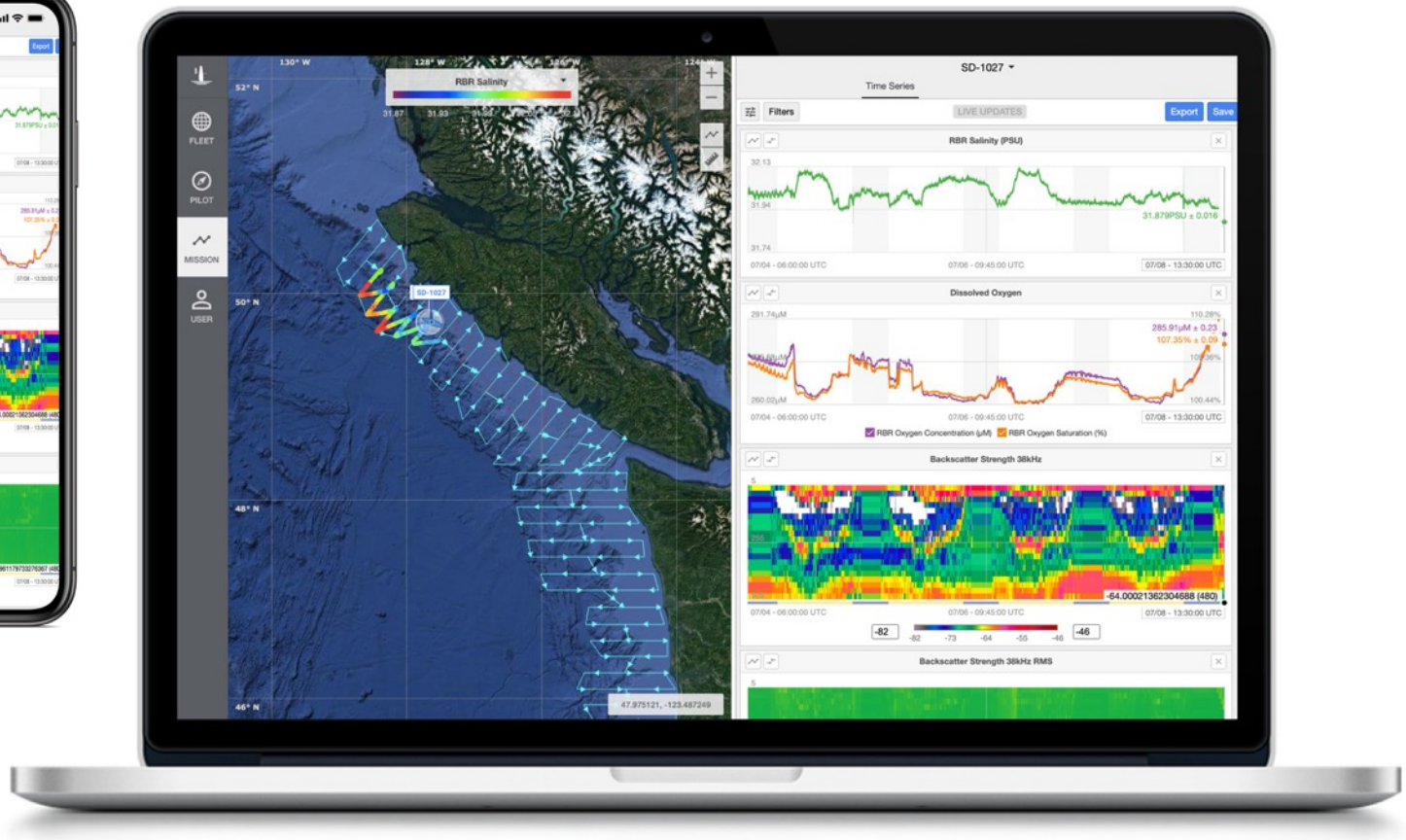
THE MISSION PORTAL

A fully managed ocean data service to keep you in control

Saildrone provides:

- A secure application for real-time data access and visualization with external data integrations
- The ability to manage your fleet
- A user-friendly secure web portal
- Advanced collaboration features
- Comprehensive mission planning tools.



On-the-fly Analysis

Adaptive sampling

Email-free collaboration

Your data your way

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OCEAN DATA
Critical Data for Managing and Protecting Natural Resources

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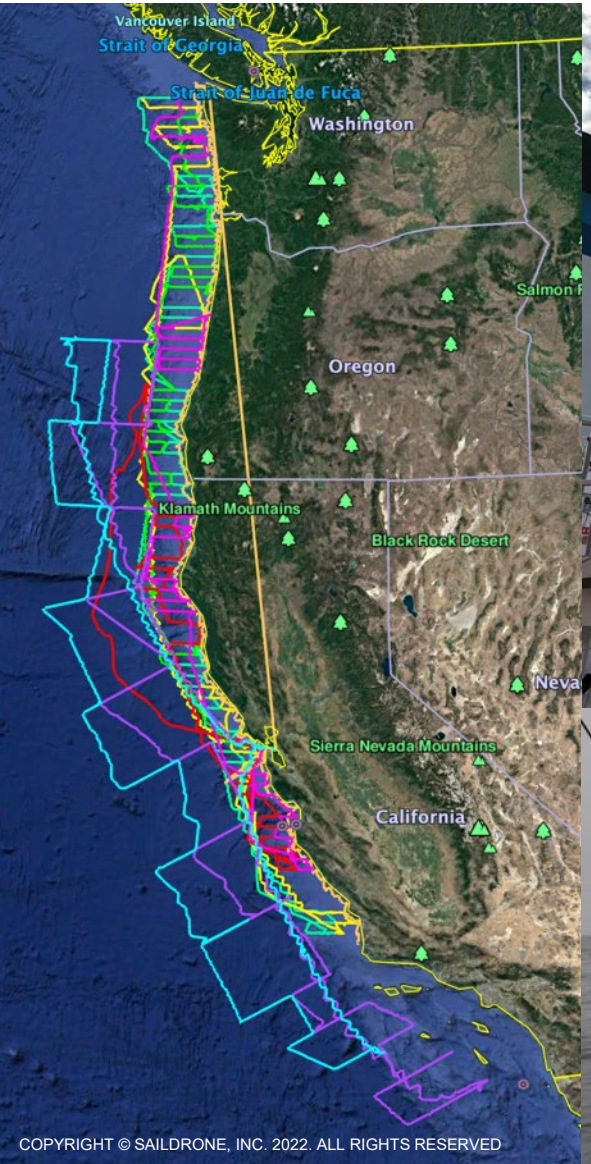
FISHERIES ACOUSTICS FOR NMFS

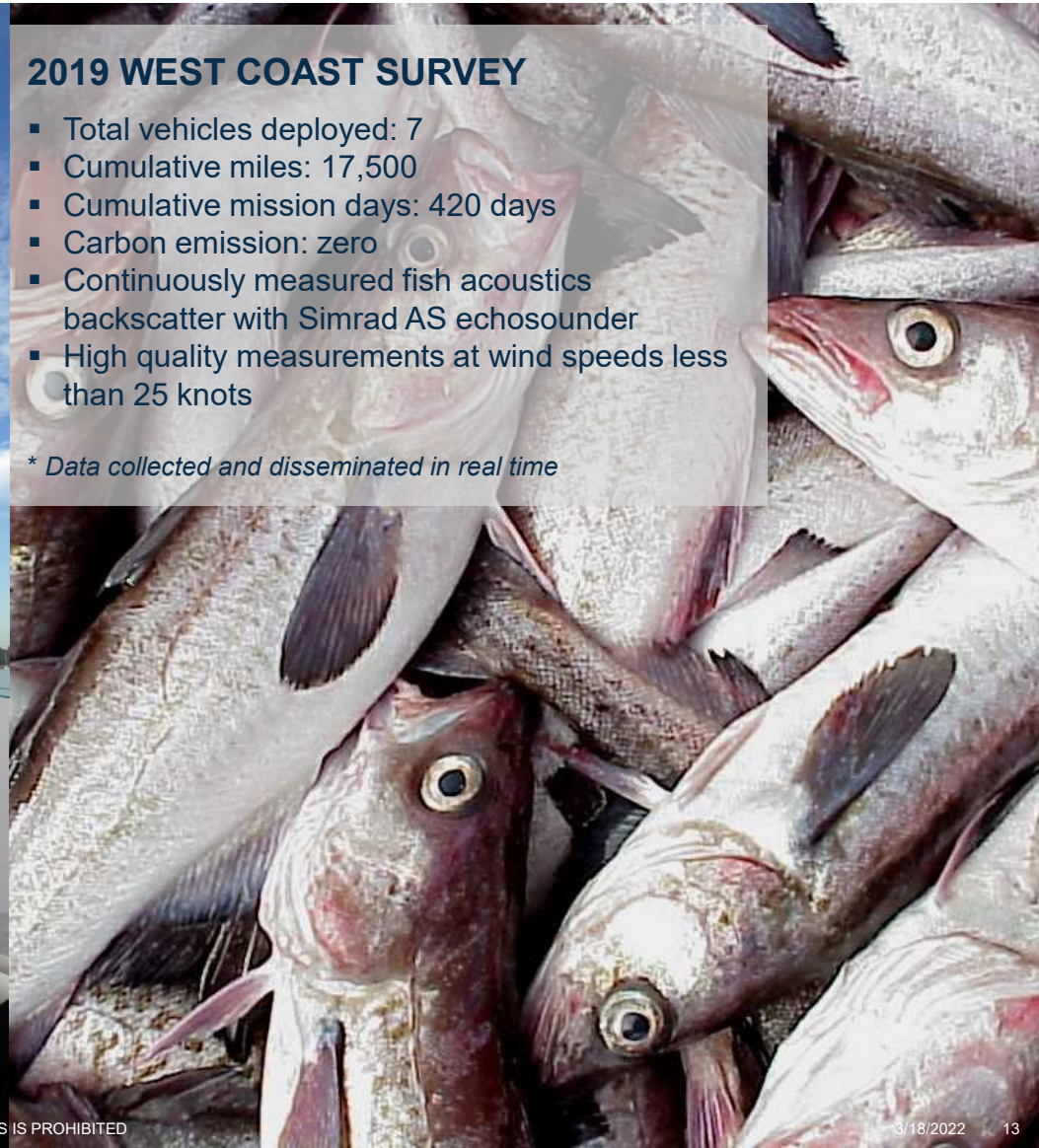
Saildrone successfully conducted a full uncrewed comparison with NOAA survey vessels for the 2019 hake and coastal pelagic species surveys



2019 WEST COAST SURVEY

- Total vehicles deployed: 7
- Cumulative miles: 17,500
- Cumulative mission days: 420 days
- Carbon emission: zero
- Continuously measured fish acoustics backscatter with Simrad AS echosounder
- High quality measurements at wind speeds less than 25 knots

** Data collected and disseminated in real time*



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FISHERIES ACOUSTICS

Comparisons with research vessel indicate shallow pollock react to ship noise

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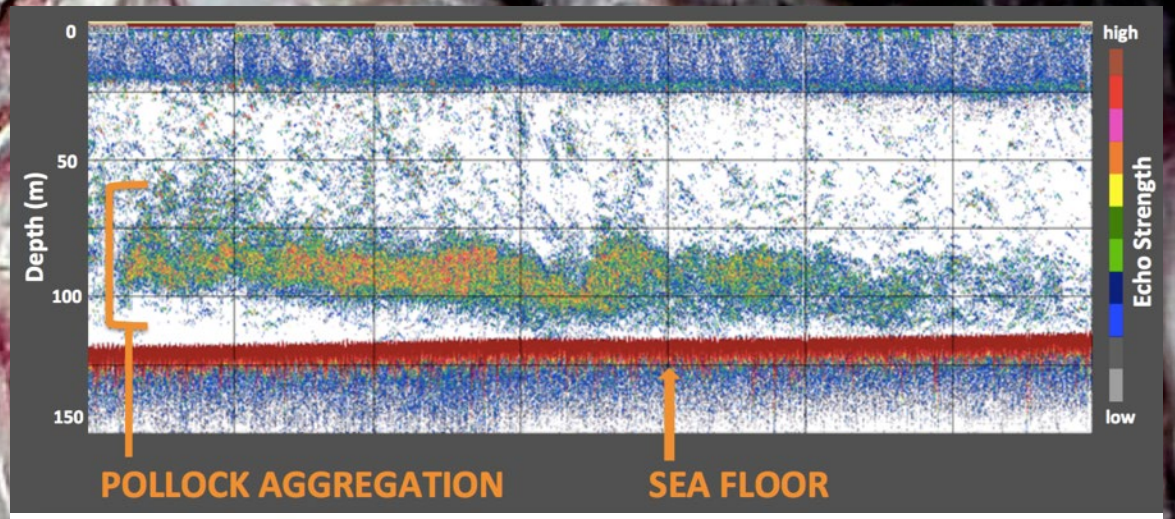
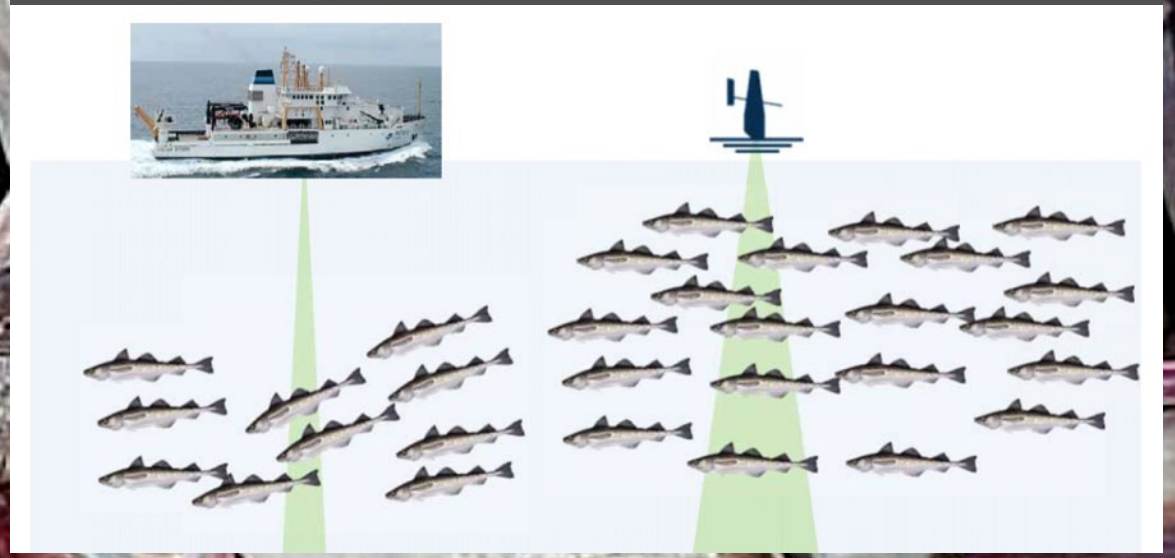
SAILDRONE HAS BEEN CONDUCTING POLLOCK SURVEYS IN THE BERING SEA SINCE 2015

- Total vehicles deployed in 2020: 4
- Carbon emission: zero
- Continuously measured fish acoustics backscatter with Simrad AS echosounder
- High quality measurements at wind speeds
- The 2020 mission was deployed from Alameda to the Bering Sea to conduct the annual survey, while COVID kept many traditional research vessels in their home ports

** Data collected and disseminated in real time*





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2020 POLLOCK SURVEY

First time data from uncrewed surface vehicles were used to help produce an annual estimate of abundance for a commercial fish stock

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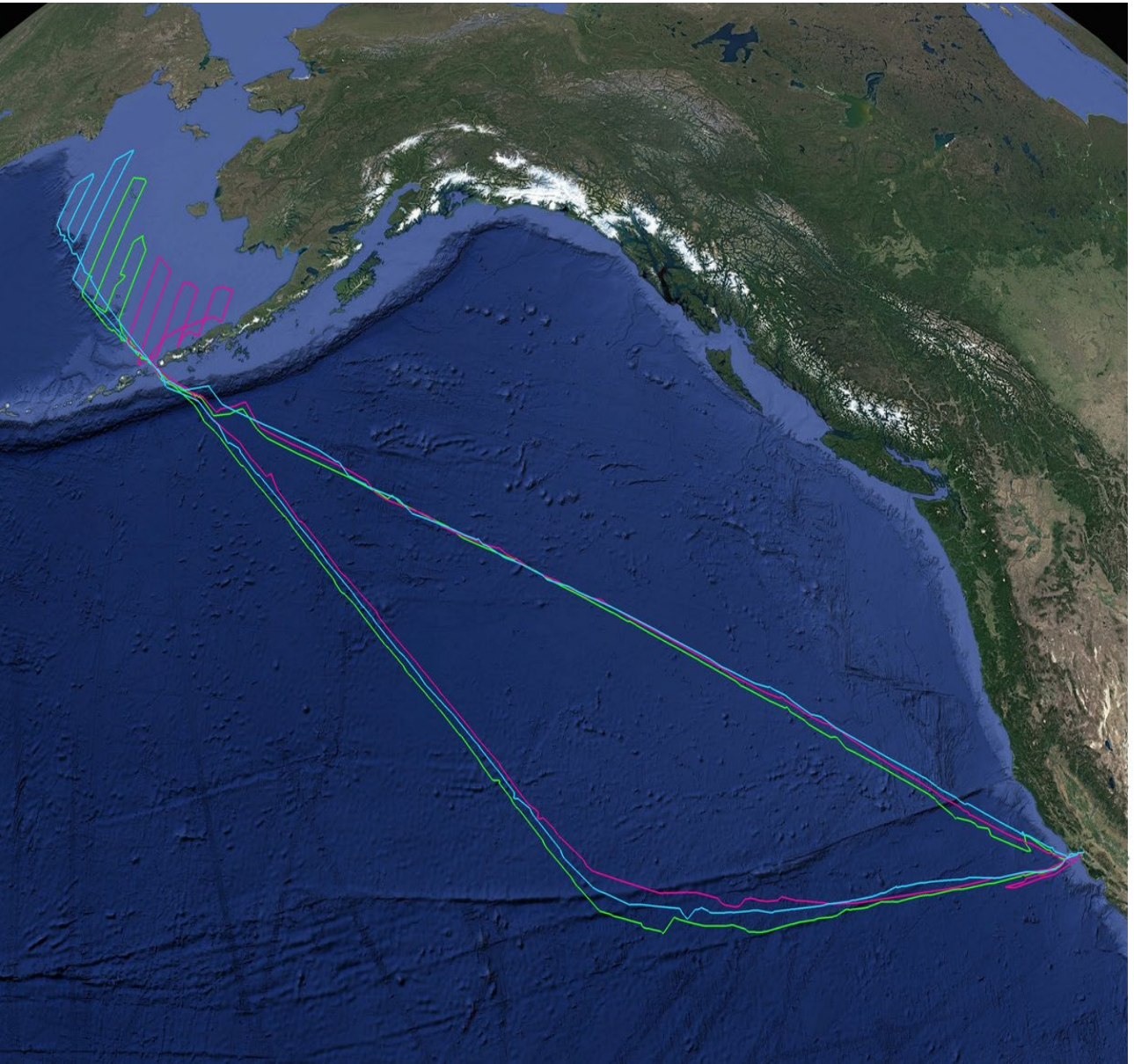
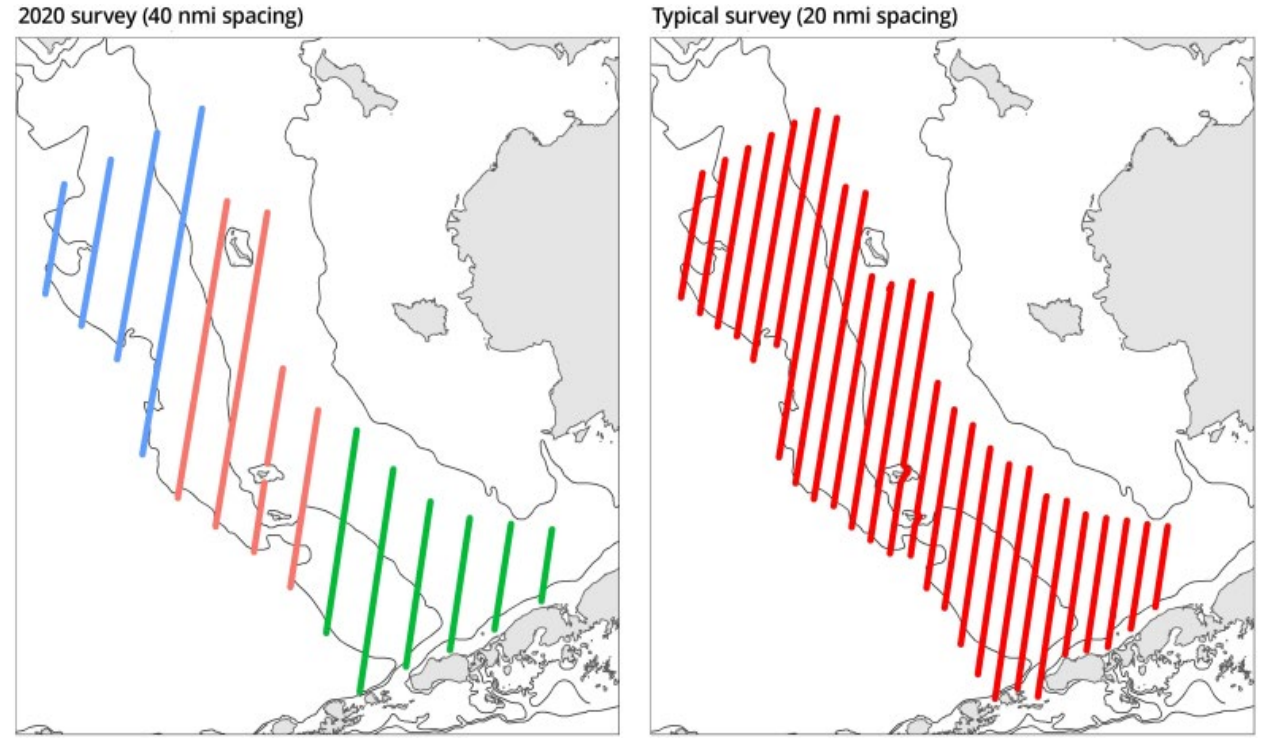
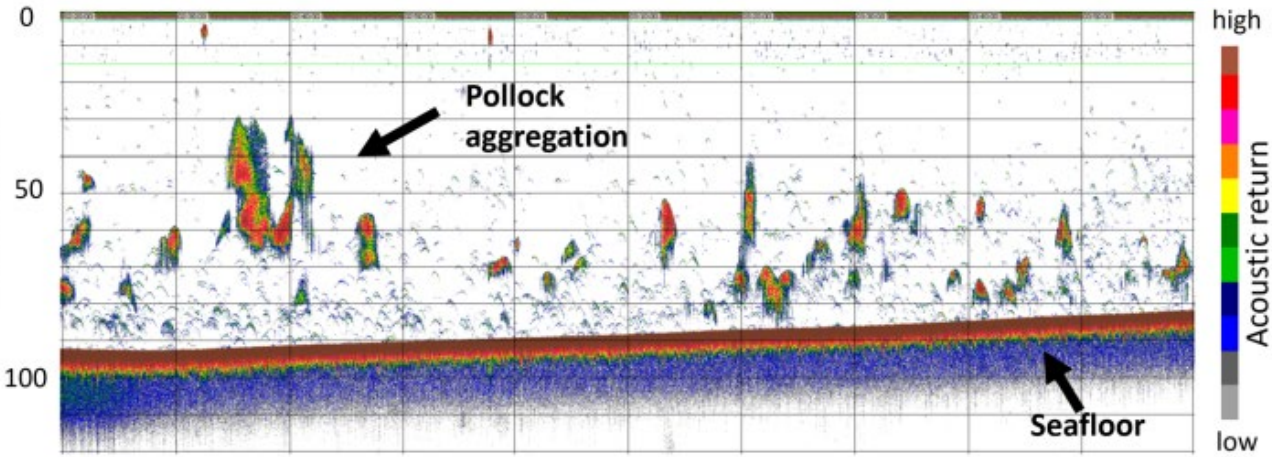
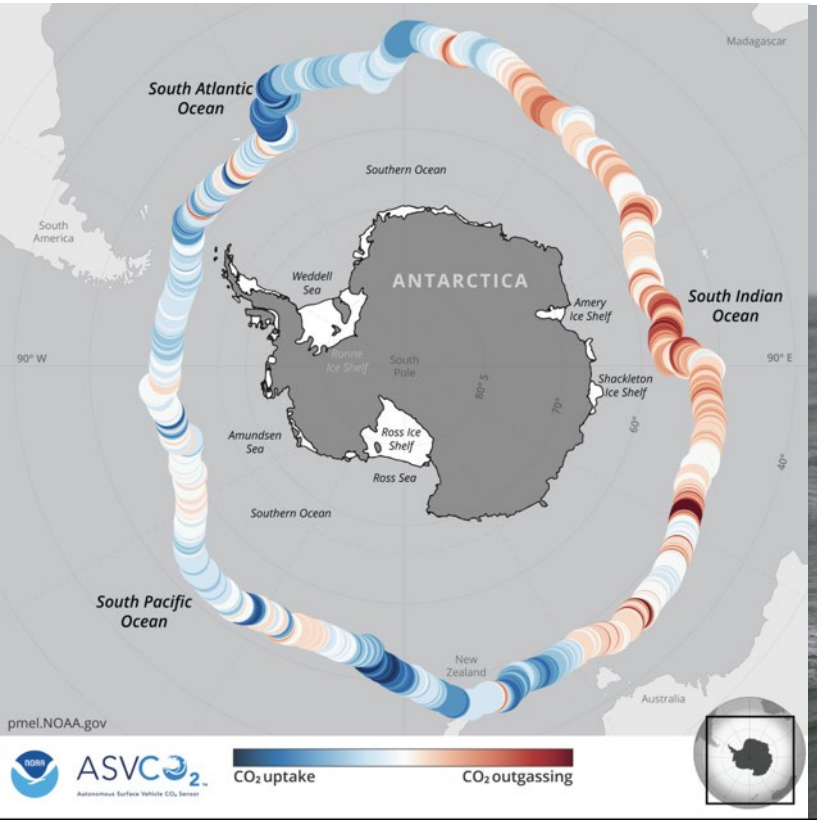






DISCOVERIES THAT IMPACT CLIMATE SCIENCE

Saildrone's 2019 circumnavigation of Antarctica to measure CO_2 in an under-sampled region demonstrated the role of autonomy in quantifying change



"The landmark accomplishment will ultimately increase observations and understanding of weather, climate, and ecosystem processes in remote, harsh, and rapidly changing oceanic regions. Preliminary results suggest that there is strong outgassing of CO2 in the austral winter; this finding upends out understanding of the Southern Ocean as a sink for atmospheric carbon."

2020 RON BROWN EXCELLENCE IN INNOVATION AWARD

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QUANTIFYING THE GULF STREAM

Improving global carbon budgets and global weather forecasting

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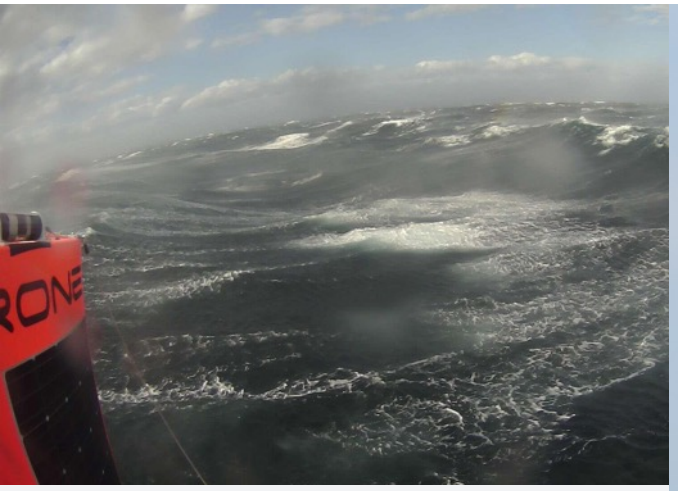

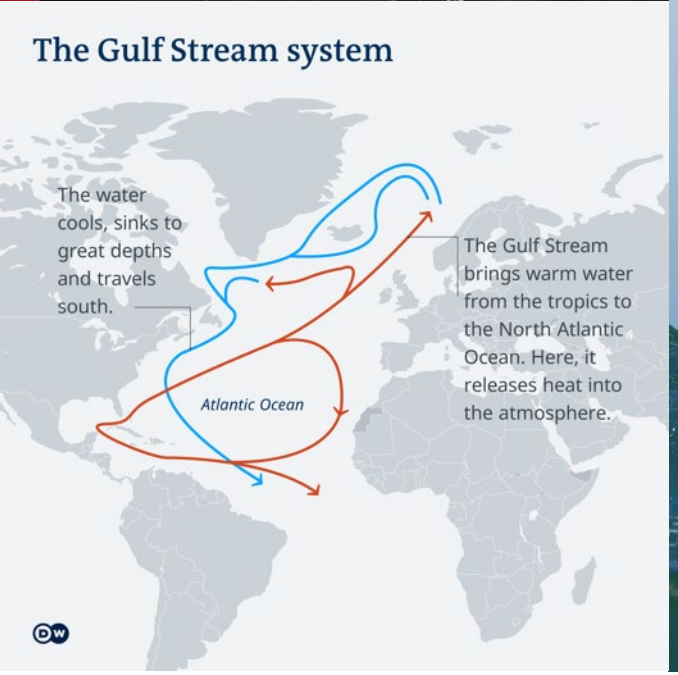

THE GULF STREAM HAS AN OUTSIZED IMPACT ON WEATHER FORECASTING AND IMPROVING UNDERSTANDING OF OCEAN CARBON EXCHANGE.

- Project length: 26 months
- Mission duration: 6 vehicles for 12 months
- Saildrone vehicles are designed to survive harsh conditions like those found in the Gulf Stream, from 15-meter (50-foot) waves to 130 km/h (80 mph) winds
- Partners: European Center for Medium Range Weather Forecasting and University of Rhode Island

“Weather is becoming more extreme, and as a society, we must get better and smarter at predicting it in order to protect our communities. We are enthusiastic about the potential for this project to leverage technology to contribute towards that goal.”

ROWAN BARNETT
HEAD OF GOOGLE.ORG FOR EMEA AND APAC

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2021 ATLANTIC HURRICANE MISSION

Improving intensification forecasting to mitigate hurricane damage in coastal areas

SAILDRONE

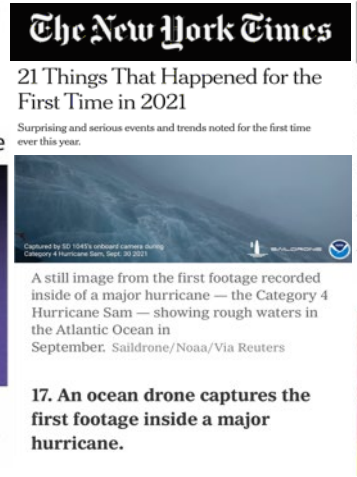
NOAA funded 5 vehicles for 90 mission days

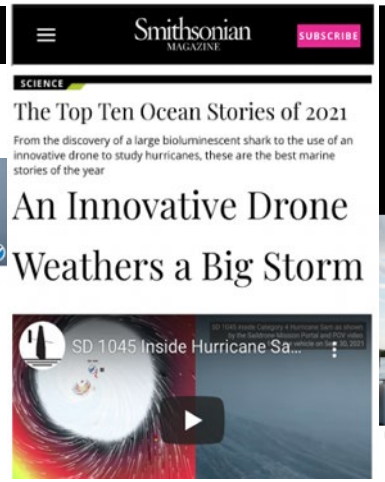
- Collecting data including air, surface, and water temp, humidity, barometric pressure, wind speed and direction, salinity, and wave height and period
- SD 1045 spent 24 hours inside Category 4 Hurricane Sam collecting real-time data and video
- All five vehicles contributed important insight into hurricane rapid intensification by sampling in or near tropical storms—Fred, Grace, Henri, Mindy, Peter
- Initial findings suggest salinity a key factor in rapid intensification

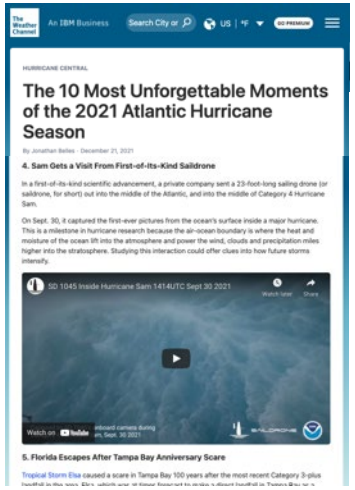
> “This mission has opened the door to a new era of how we study hurricanes… The point of the whole scientific mission was to measure the surface flux within hurricanes, especially around the eyewall—and we got it!”

CHIDONG ZHANG, DIRECTOR, NOAA PMEL
OCEAN CLIMATE RESEARCH DIVISION

Atlantic Hurricane Mission – recognized as one of the most important stories of 2021!







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MARINE MAMMAL RESEARCH

Tracking tagged northern fur seals – use of USV beyond ship capabilities

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ARCTIC / BERING SEA SURVEYS

- Cumulative miles: 161
- Cumulative mission days: 130
- Carbon emission: zero
- Tracked 30 satellite-tagged, adult-female fur seals as they foraged
- Followed and recorded behavior and prey field of 2 fur seals

** Data collected and disseminated in real time*

PMEL

NOAA

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OCEAN MAPPING
Cost effective IHO Compliant Bathymetry

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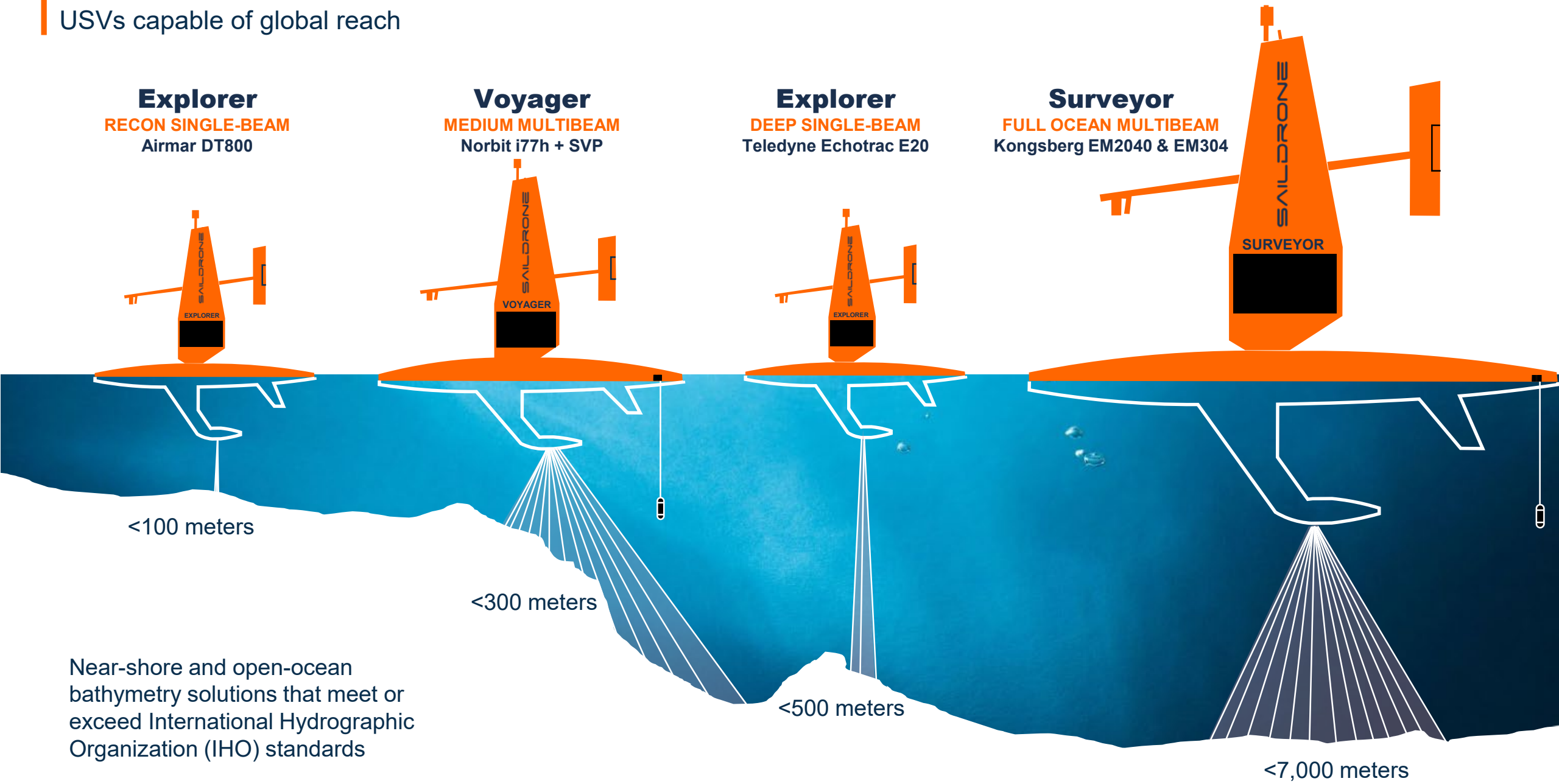
SAILDRONE BATHYMETRY PLATFORMS

USVs capable of global reach



Near-shore and open-ocean bathymetry solutions that meet or exceed International Hydrographic Organization (IHO) standards

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OCEAN MAPPING | BATHYMETRY

Purpose-built 24/7 autonomous IHO compliant ocean mapping solutions

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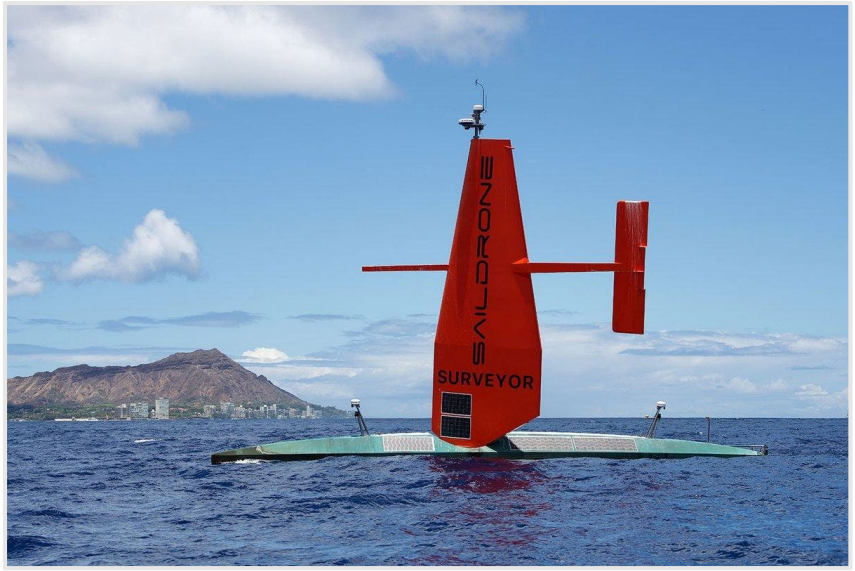
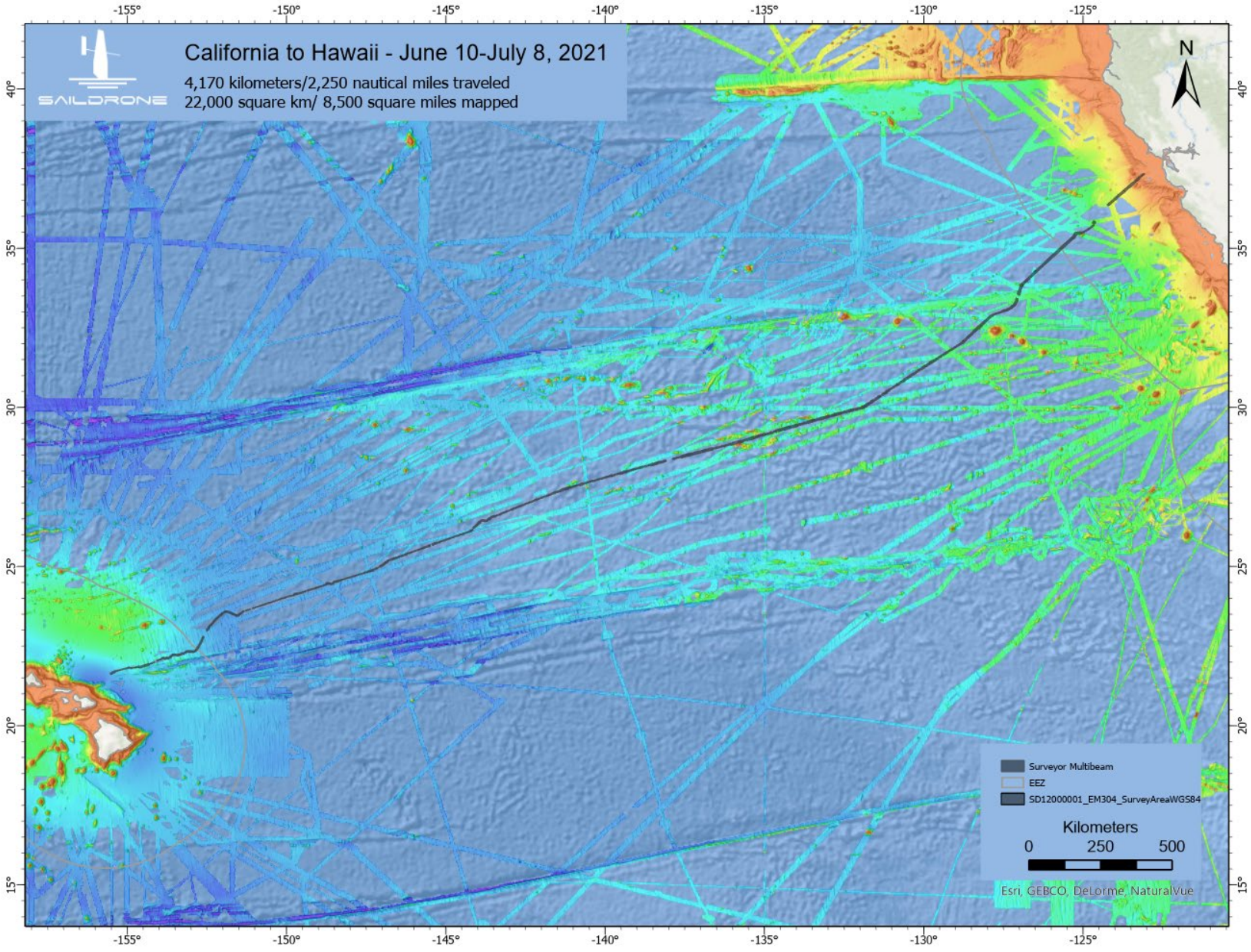
SURVEYOR FIRST MISSION

Alameda to Honolulu—mapping gaps!

- 28 DAS
- 4,170 line km mapped
- 22,000+ km^2 mapped
- 5500+ m in depth





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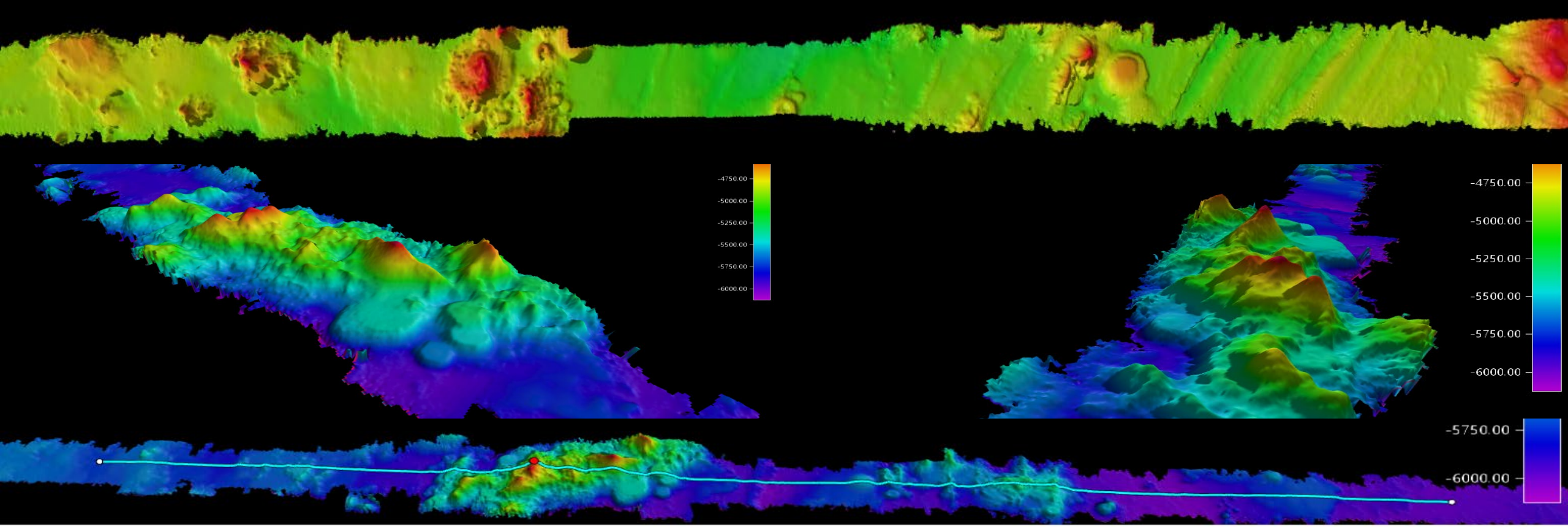

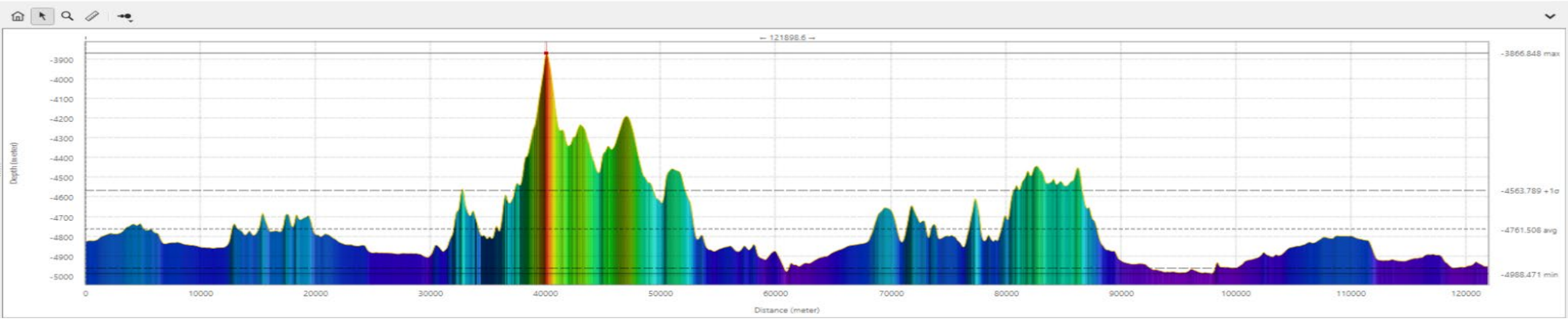

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MARITIME DOMAIN AWARENESS
Maximizing Information & Decision Advantage

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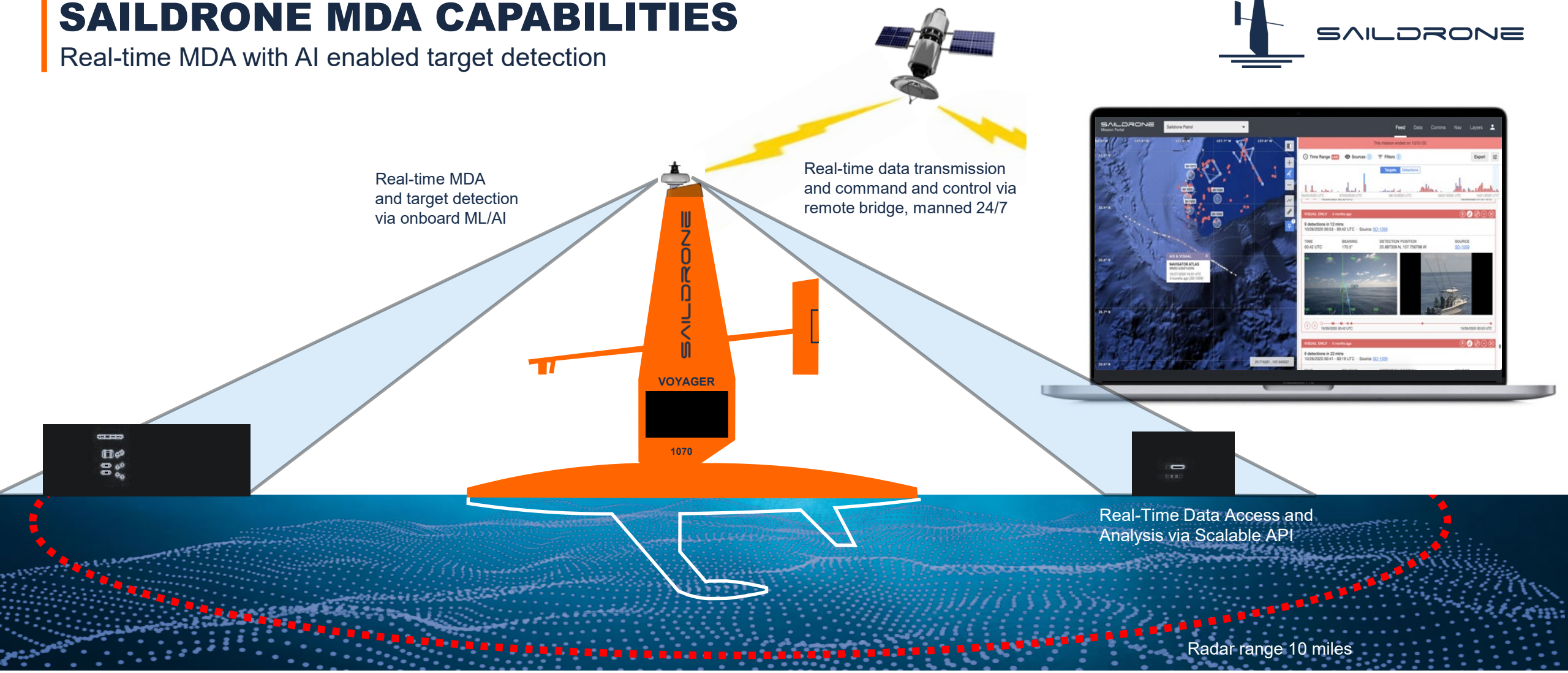
SAILDRONE MDA CAPABILITIES

Real-time MDA with AI enabled target detection



Proprietary onboard machine learning algorithm fuses sensor data, recognizes targets of interest, and alerts the end-user in near real-time—the “eyes” at sea. An advanced acoustics instrument package provides the “ears” at sea.

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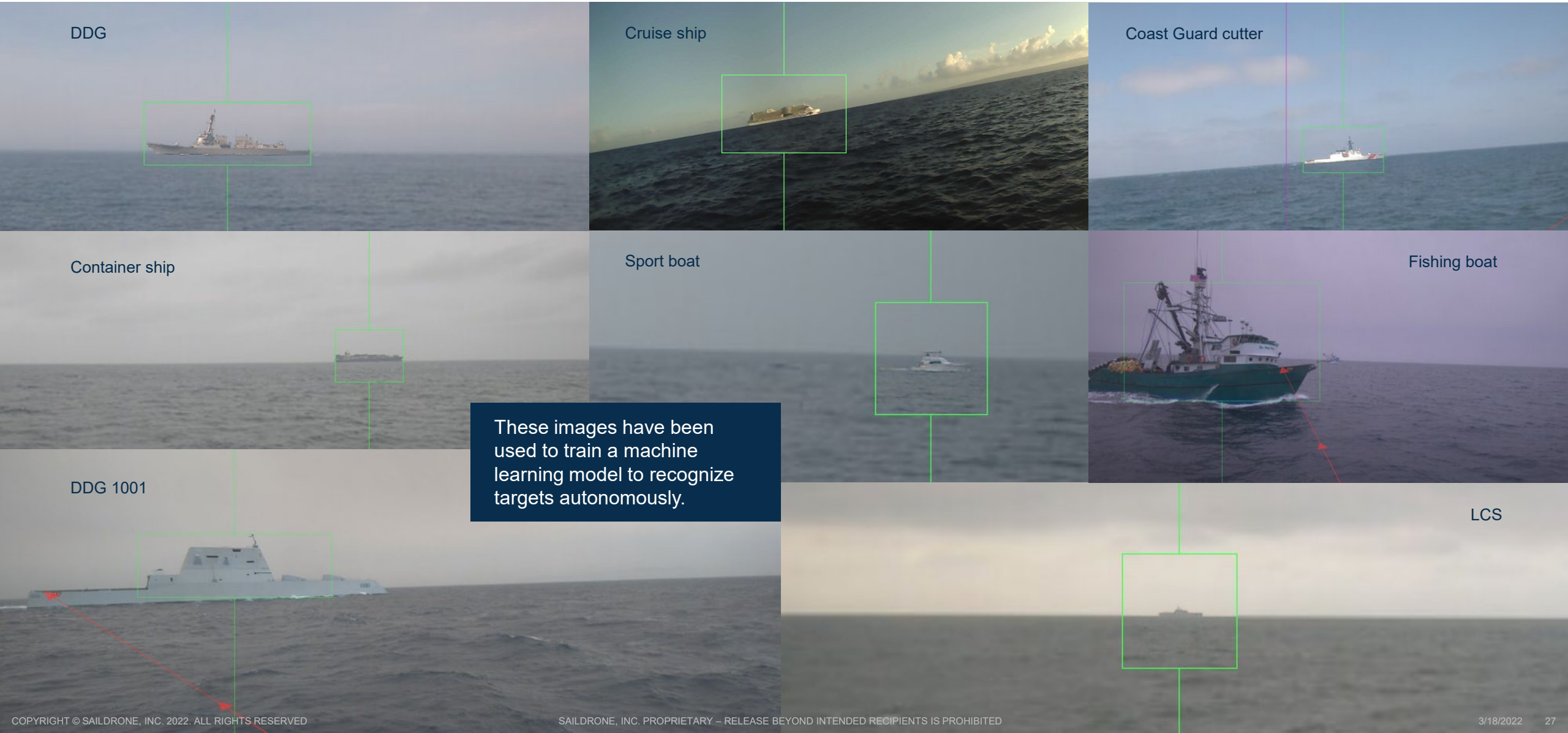
WORLD'S LARGEST DATABASE OF OCEAN IMAGES

Collected by Saildrone's own fleet



These images have been used to train a machine learning model to recognize targets autonomously.

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SAILDRONE VEHICLES
Vehicle Sensor Suites

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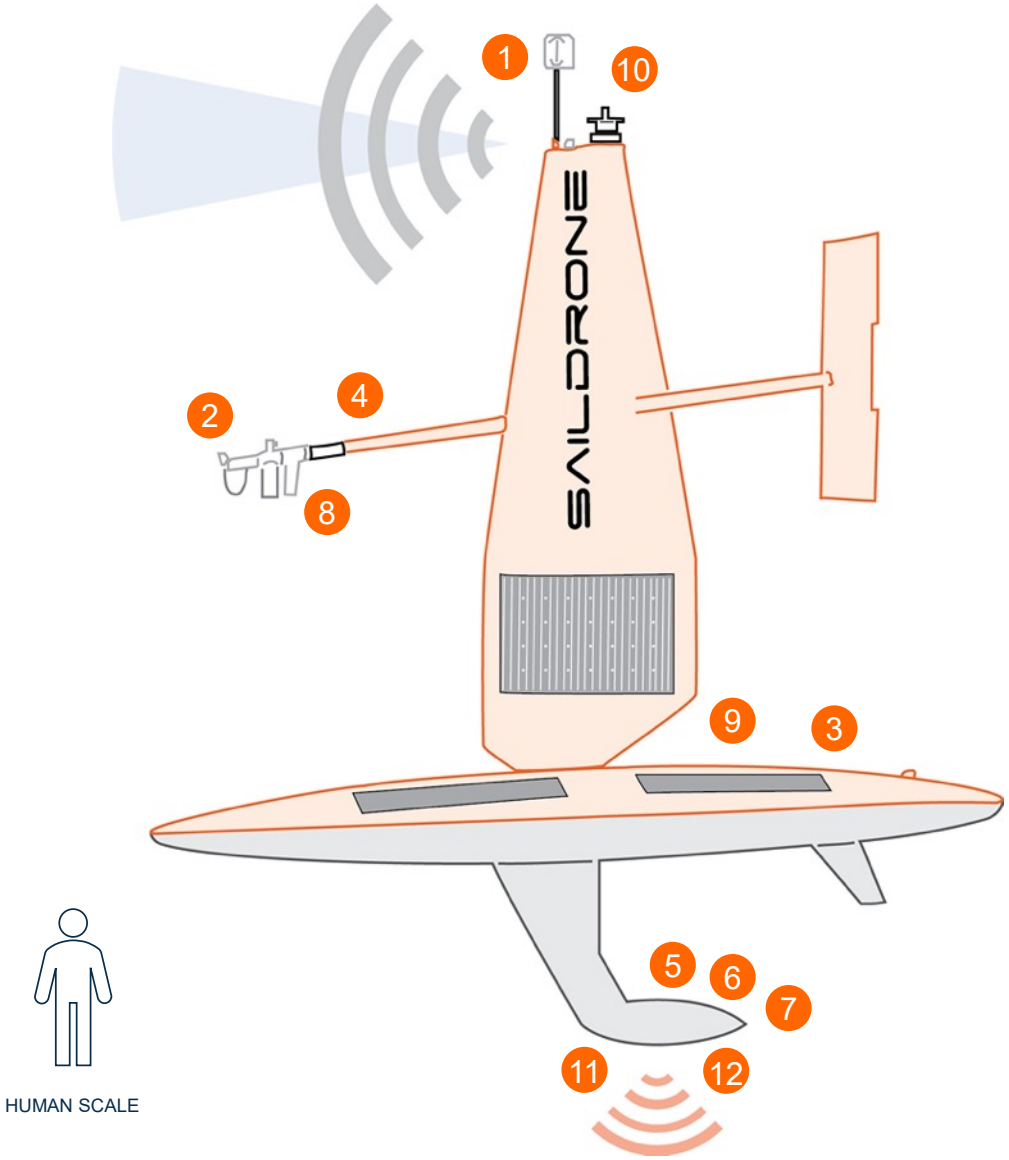
SAILDRONE EXPLORER – METOCEAN

Metocean sensor suite: Critical scientific data for understanding climate change



PAYLOAD OPTIONS

	No.	Variable	Sensor	
	1	Wind speed & direction	Gill Windmaster 3D Ultrasonic 20Hz @ + 5.2 m	ATMOSPHERIC
	2	Air temp & humidity	Rotronic HC2 - S3 with rad shield @ + 2.3 m	ATMOSPHERIC
	3	Barometric pressure	Vaisala Barocap PTB210 @ +0.2 m	ATMOSPHERIC
	4	Photosynthetically active radiation	LI-COR LI-192SA @ +2.6 m	ATMOSPHERIC
	5	Salinity & temperature	Seabird SBE 37 @ -1.5 m	ATMOSPHERIC
	6	Dissolved oxygen	Seabird SBE 37 ODO @ -1.5 m	ATMOSPHERIC
	7	Chlorophyll-a	Wetlabs ECO-FL-S G4 @ -0.5 m	OCEAN
	8	Skin temperature	Heitronics CT 15.10 @ +2.3	OCEAN
	9	Wave height & period	Dual GPS aided IMU	OCEAN
	10	Smart camera array	360° High-resolution optical cameras with ML target detection	OCEAN
	11	Ocean currents	Teledyne RDI Workhorse ADCP 300 kHz @ -1.9 m	OPTIONS
OR	12	Echo sounder	Simrad WBT Mini (EK80) @ -1.9 m 120 kHz or 38-200 kHz	OPTIONS

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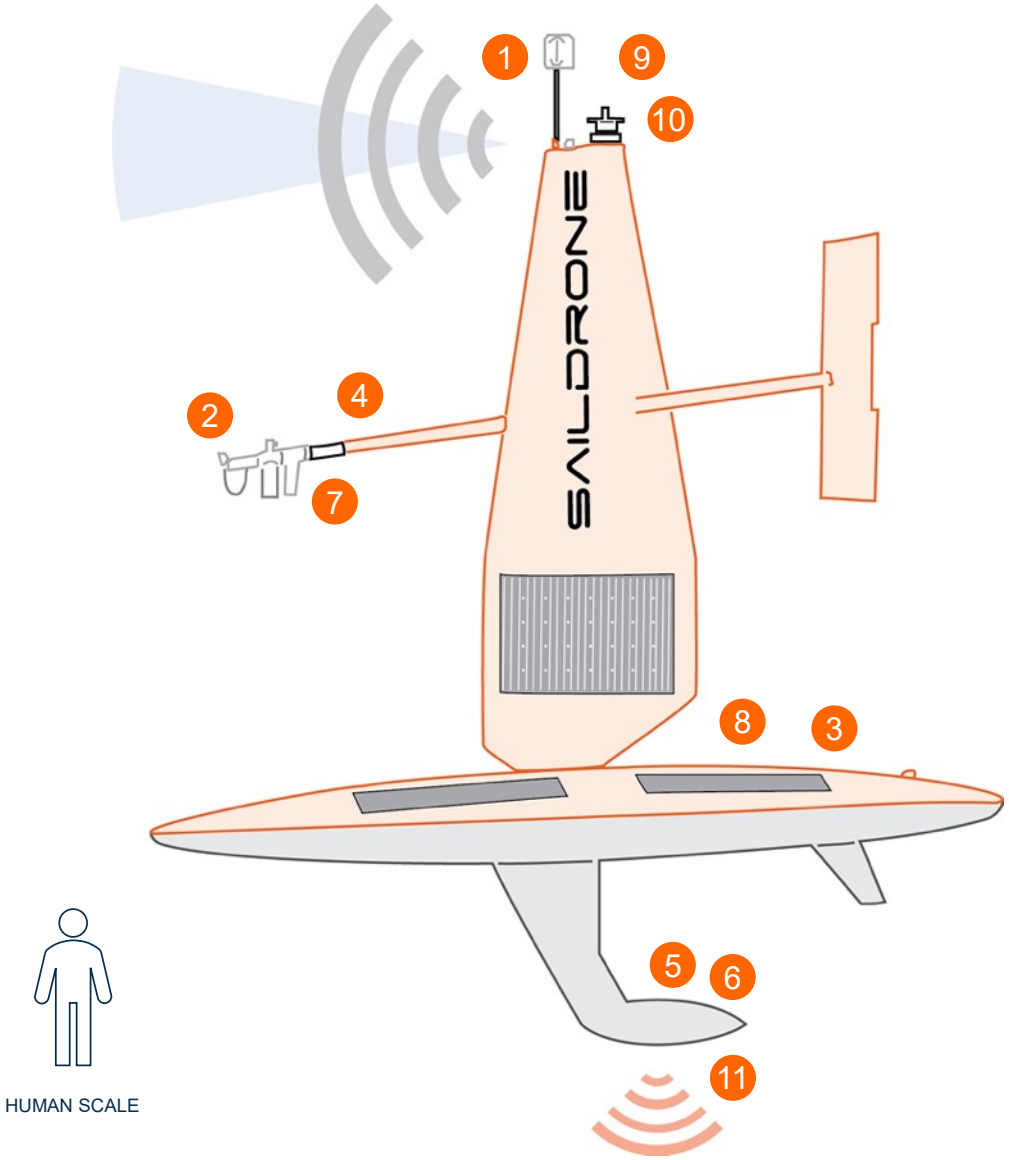
SAILDRONE EXPLORER – FISHERIES

Fisheries sensor suite



PAYLOAD OPTIONS

No.	Variable	Sensor	
1	Wind speed & direction	Gill Windmaster 3D Ultrasonic 20Hz @ + 5.2 m	ATMOSPHERIC
2	Air temp & humidity	Rotronic HC2 - S3 with rad shield @ + 2.3 m	ATMOSPHERIC
3	Barometric pressure	Vaisala Barocap PTB210 @ +0.2 m	ATMOSPHERIC
4	Photosynthetically active radiation	LI-COR LI-192SA @ +2.6 m	ATMOSPHERIC
5	Salinity & temperature	Seabird SBE 37 @ -1.5 m	OCEAN
6	Dissolved oxygen	Seabird SBE 37 ODO @ -1.5 m	OCEAN
7	Skin temperature	Heitronics CT 15.10 @ +2.3	OCEAN
8	Wave height & period	Dual GPS aided IMU	OCEAN
9	AIS transceiver		MDA
10	Smart camera array	360° High-resolution optical cameras with ML target detection	MDA
11	Fish biomass	Simrad WBT Mini (EK80) @ -1.9 m 120 kHz or 38-200 kHz	ACOUSTIC

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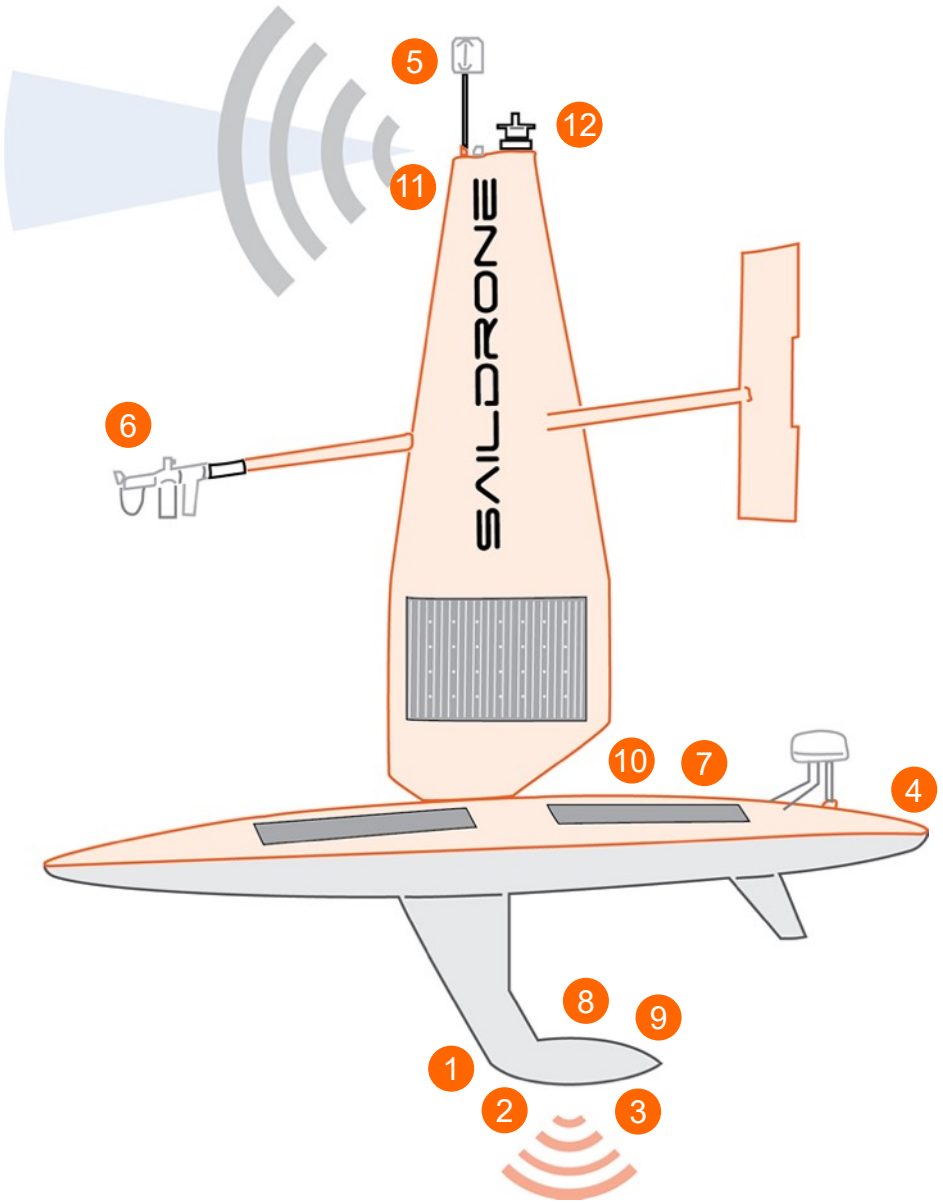
SAILDRONE VOYAGER – BATHYMETRY

Uncrewed shallow-water multibeam mapping vehicle



PAYLOAD OPTIONS

No.	Variable	Sensor	
1	Bathymetry	Norbit Winghead i77h 300 meters	ACOUSTIC
2	Positioning	Integrated POS MV OceanMaster	ACOUSTIC
3	Sound velocity	Integrated sound velocity profiler	ACOUSTIC
4	Sound velocity & winch	Integrated sound velocity profiler to 150 m depth	ACOUSTIC
5	Wind speed & direction	Gill 1405-PK-038	ATMOSPHERIC
6	Air temp & humidity	Rotronic HC2-S3 with rad shield @ + 6.4 m	ATMOSPHERIC
7	Barometric pressure	Vaisala Barocap PTB210 @ +0.2 m	ATMOSPHERIC
8	Salinity & temperature	Seabird SBE 37 @ -1.5 m	OCEAN
9	Dissolved oxygen	Seabird SBE 37 ODO @ -1.5 m	OCEAN
10	Wave height & period	Dual GPS aided IMU	OCEAN
11	AIS transceiver		MDA
12	Smart camera array	360° High-resolution optical cameras with AI/ML target detection	MDA

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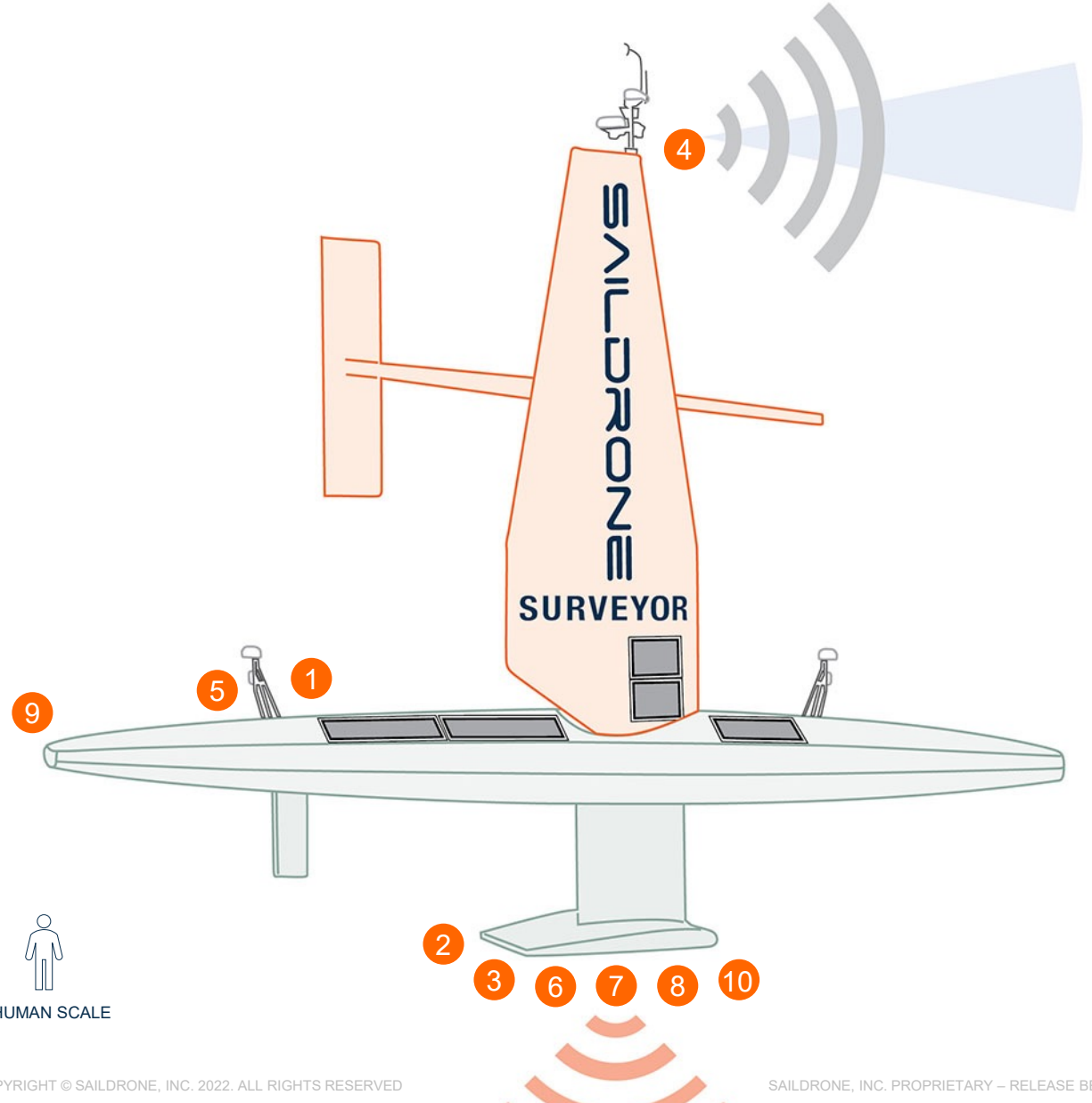
SAILDRONE SURVEYOR

World's largest and most advanced, uncrewed surface vehicle for ocean mapping and exploration



PAYLOAD OPTIONS

No.	Variable	Sensor
1	Positioning	Seapath 380+ GNSS/INS system
2	Deep-water bathymetry	Kongsberg EM 304 multibeam sonar
3	Shallow-water bathymetry	Kongsberg EM 2040 multibeam sonar
4	Wind speed & direction	B&G WS730S
5	Barometric pressure	Yacht Devices YDBC-05N
6	Ocean currents	Simrad EC150 ADCP
7	Ocean currents	Teledyne Pinnacle 45 ACDP
8	Fish biomass	Simrad EK80 echo sounder
9	Sound velocity profiler	Valeport sound velocity (cast depth: 500 m)
10	Surface sound	Teledyne SVP 70 (fixed on bottom of gondola)

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