Two years under Sail for Science

Igor Shkvorets

Presentation at the CMOS Ottawa Centre meeting on 15th January 2026

Citizen science project “Sail for Science”

www.sailforscience.com

Our mission:

- To collect high-quality oceanographic data using a CTD measuring system aboard a low-carbon, wind-powered sailboat, ensuring rigorous quality control and submitting these data to recognized ocean data repositories.
- To empower the global cruising-sailor community to participate in ocean observation by sharing knowledge through our website, public presentations, and onboard workshops.

The activity of the Sail for Science project was endorsed by the UN Decade of Ocean Science for Sustainable Development

Who we are

We are Igor Shkvorets and Iryna Troshyna — a couple of retired Oceanologists who have been sailing through life together since our university days. We both graduated from the Odesa Hydrometeorological Institute (Ukraine, USSR) with degrees in Engineer-Oceanologist. Soon after, we married and settled in Sevastopol, Crimea, Ukraine, where we began our scientific careers: Igor at the Marine Hydrophysical Institute, and Iryna at the Institute of Biology of the Southern Seas. There, we measured and scaled the physics and biogeochemistry of the ocean — and discovered our shared fascination with its endless horizons for study and exploration. At the turn of the century, we decided to change course completely and move to Canada. We were fortunate to join RBR Ltd., a company that designs and builds oceanographic instruments where we took part in developing, calibrating, and testing advanced high-accuracy oceanographic measuring systems. Sailing is our passion, so we bought 25-foot sailing boat and became members of the Nepean Sailing Club. Starting from zero knowledge about sailing, we have been sailing for 20 years and won 6 trophies in the club races.

Our other passion is traveling and trekking, which lead us to the peaks of Kilimanjaro and Cotopaxi. We visited many countries, especially in Latin America, sailed the Caribbean Sea on chartered sailboats, and always took RBR measuring instruments with us. After two decades we came to another turning point. Life, we realized, is finite — and our dreams should not wait. So, we traded the comfort of home for the freedom of the open sea, embarking on a voyage aboard SV Oceanolog.The question was how to leave behind a beloved profession, stay useful, and remain free.The answer came naturally: **Sail for Science!**

SV Oceano*log* (ex.Spallpeen)

Built: 1966 by the Cheoy Lee Shipyard, Hong Kong
Design: Gulf40 by William Garden
Rig: Long-keeled Bermuda sloop
Length: 40 feet
Breadth: 11.2 feet
Draft: 6 feet 3 Inches
Weight: 9.66 net ton
Engine: Perkins 4.108 diesel
Elecronics: Raymarine Axiom+9, Wind instrument i60, Radar Quantum, AIS
Power: Solar 700W, 1kW DC/AC
Communication: VHF Ray70, Starlink
Accommodation: Sleeps 6

RBR*concerto*^{3}CTD

Specifications:

Conductivity

Range	0-85mS/cm
Initial accuracy	±0.003mS/cm
Resolution	0.0001mS/cm
Typical stability	0.010mS/cm/year

Temperature

Range	-5°C to 35°C
Initial accuracy	±0.002°C
Resolution	0.00005°C
Typical stability	0.002°C/year

Pressure

Range	0-2000 dbar
Initial accuracy	±1 dbar
Resolution	0.02dbar

Axillary sensors:

Dissolved Oxygen (RBRcodaODO)

Range: 0-500uM/L (0-120%)

Accuracy: ±8uM/L or ±5%

Backscatter (RBRtridente)

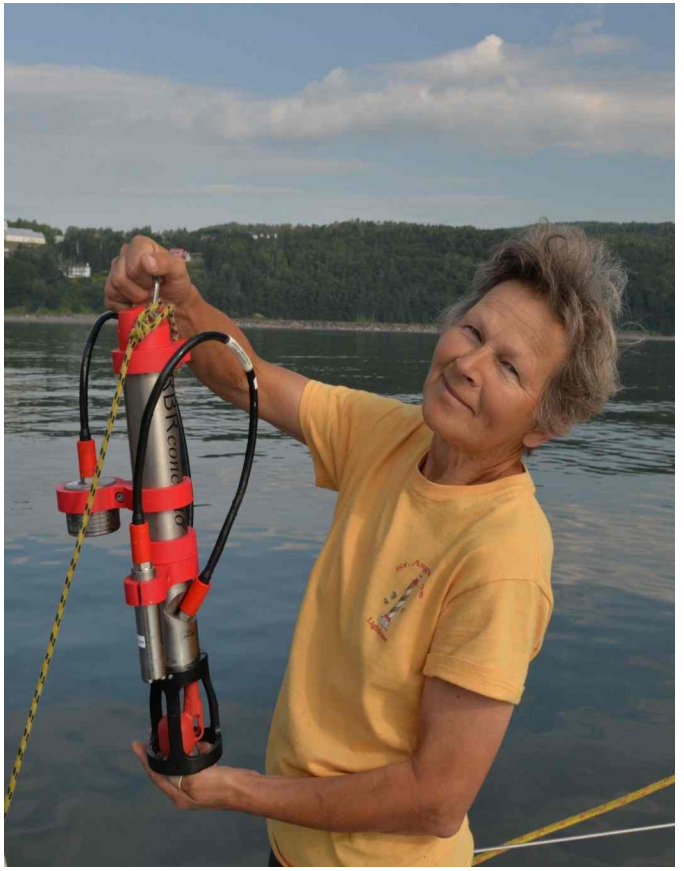
Range 0-0.05 $m^{-1}sr^{-1}$, Accuracy ±5%

Chlorophyll *a* (RBRtridente)

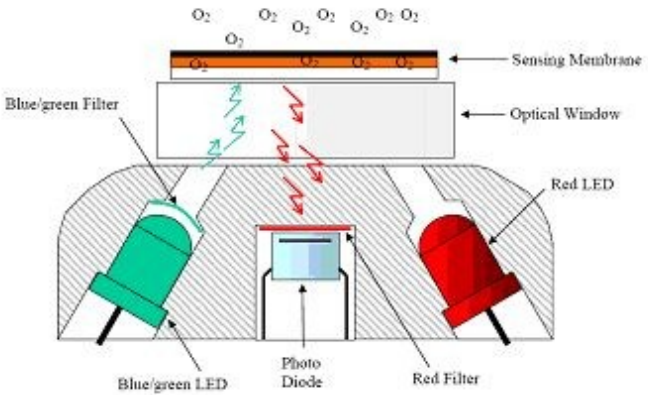
Range 0-50ug/L, Accuracy ±5%

fDOM (RBRtridente)

Range 0-500ppb, Accuracy ±5%

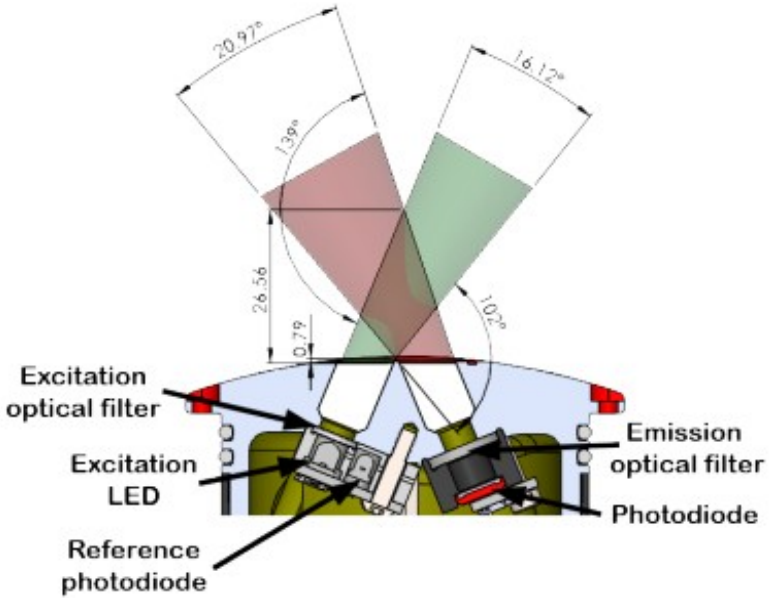


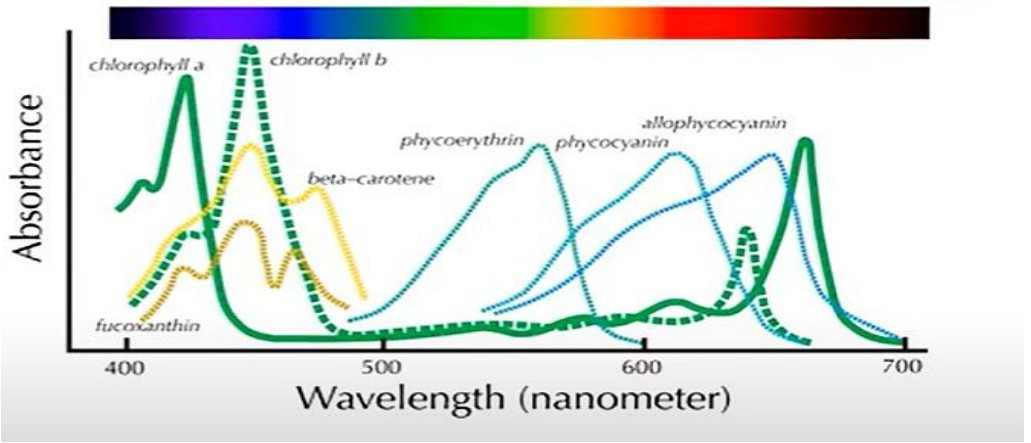
Oxygen Optode RBR*coda*^{3}T.ODO



Oxygen optodes work by using luminescence quenching: an LED excites a luminophore (special chemical dye) in a sensing foil, causing it to fluoresce, but dissolved oxygen molecules collide with the excited dye, stealing energy and reducing the light's intensity or lifetime (quenching). By measuring how much the light is quenched (often by detecting the phase shift or decay time), the sensor calculates the oxygen concentration, providing a non-consumptive, optical measurement.

Combined fluorescence-backscattering sensor RBR*tridente*





EXCITATION/EMISSION PAIRS USED BY THE RBR*tridente* DEPENDING ON THE TARGETTED VARIABLE.

Variable	Excitation Wavelength (nm)	Emission Wavelength (nm)
Chlorophyll-a	470	700
Chlorophyll-a	435	700
Phycoerythrin	525	600
Phycocyanin	590	654
fDOM	365	450
Rhodamine WT	550	600
Fluorescein	460	550

Our Path from Ottawa to Panama
July 2023 – July 2025

- More than 7 thousand miles sailed
- 22 countries visited
- 260 CTD casts and moorings performed
- 88MB of data for 7 EOVs collected and submitted to the ocean data repositories
- 1 ARGO float deployed
- Hurricane Beryl monitored

Visiting Ocean Research Centers

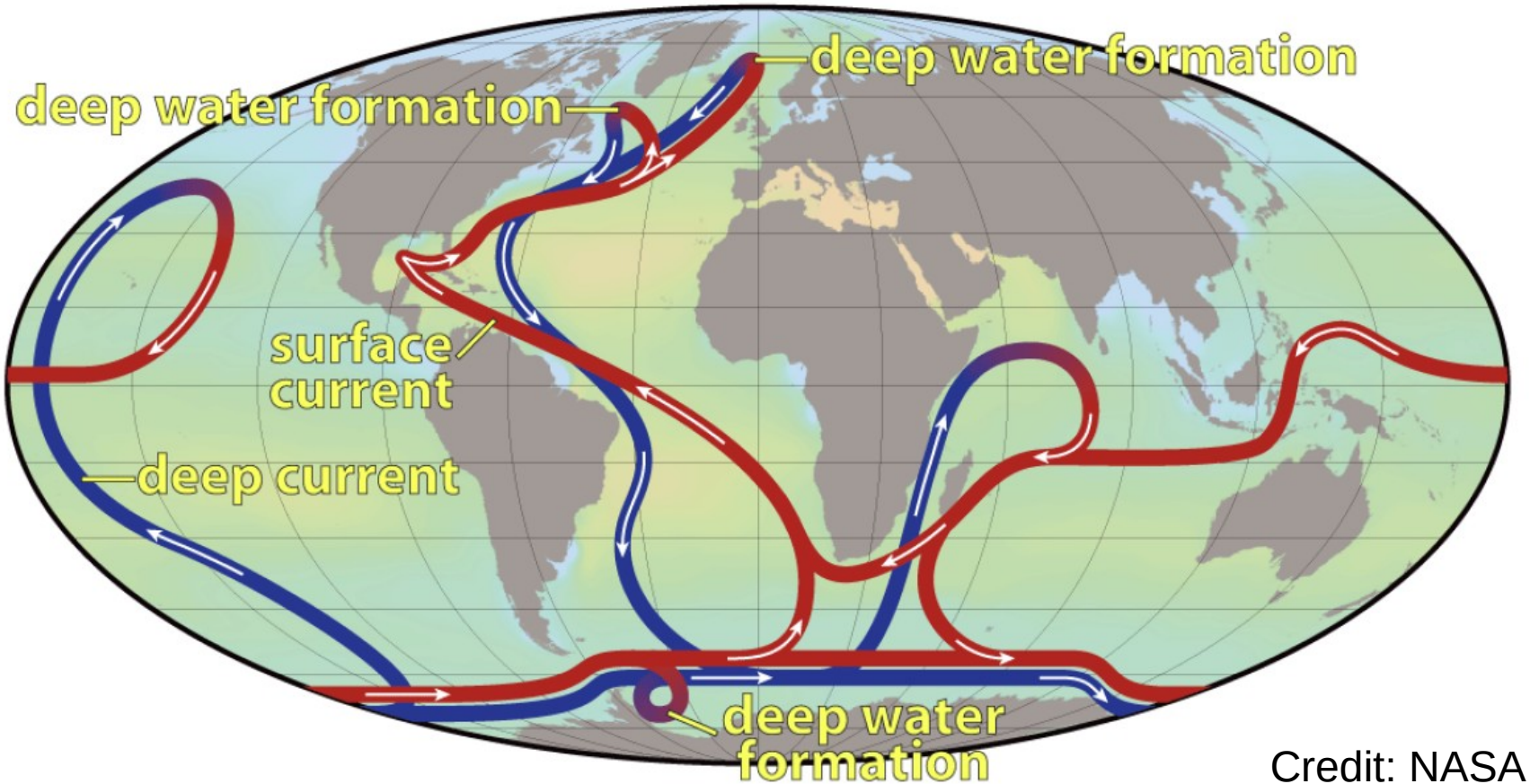
Why are CTD data important?

Collecting CTD data in oceanography is important for:

- **Understanding ocean circulation**
- **Studying climate change**
- **Monitoring marine ecosystems**
- **Improving weather forecasts**

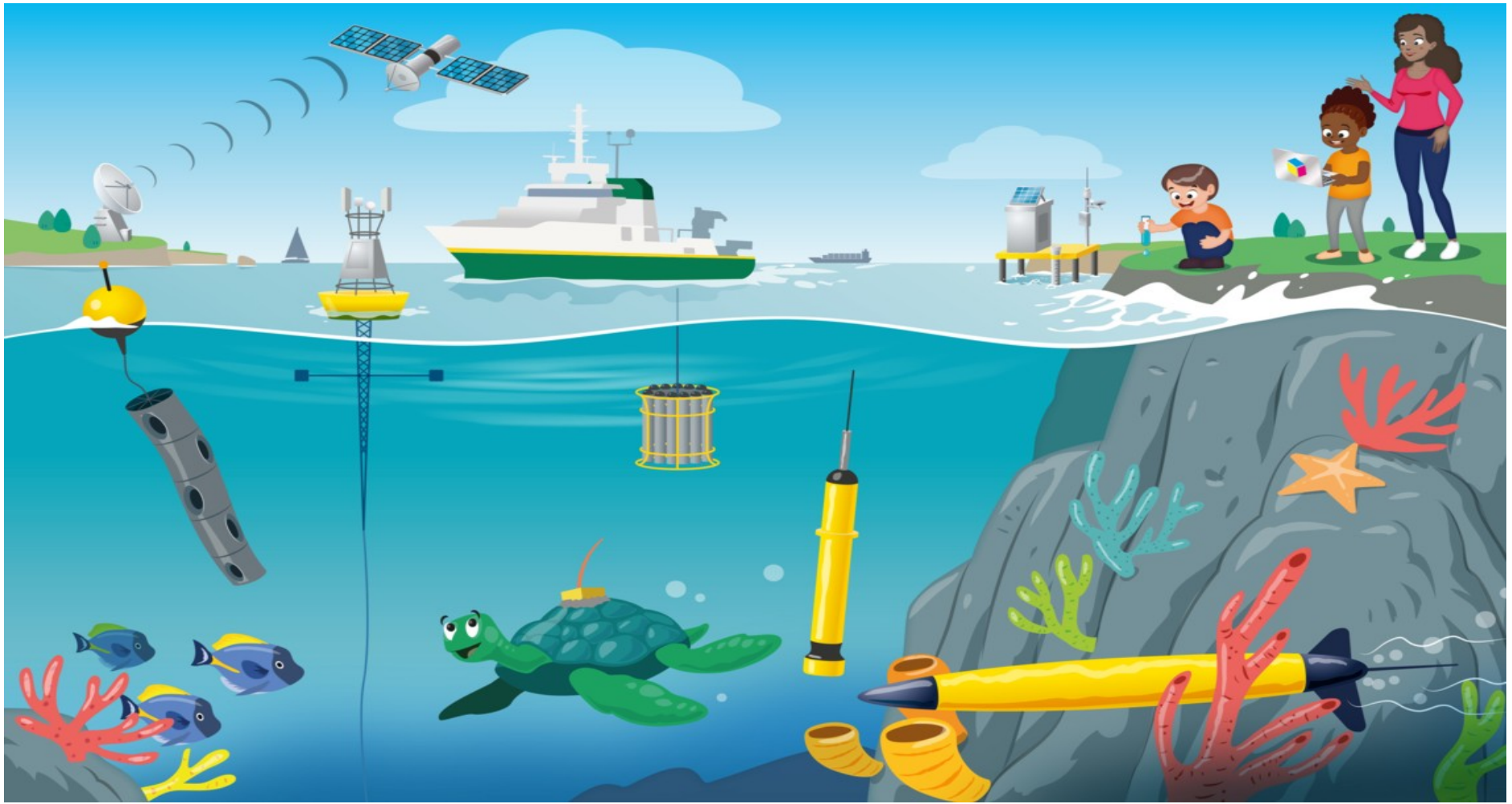
In summary, temperature, salinity and density data is essential for understanding the complex processes that govern the world's oceans and for predicting how they will change in the future.

The Ocean Thermohaline Circulation (The Global Conveyor Belt)



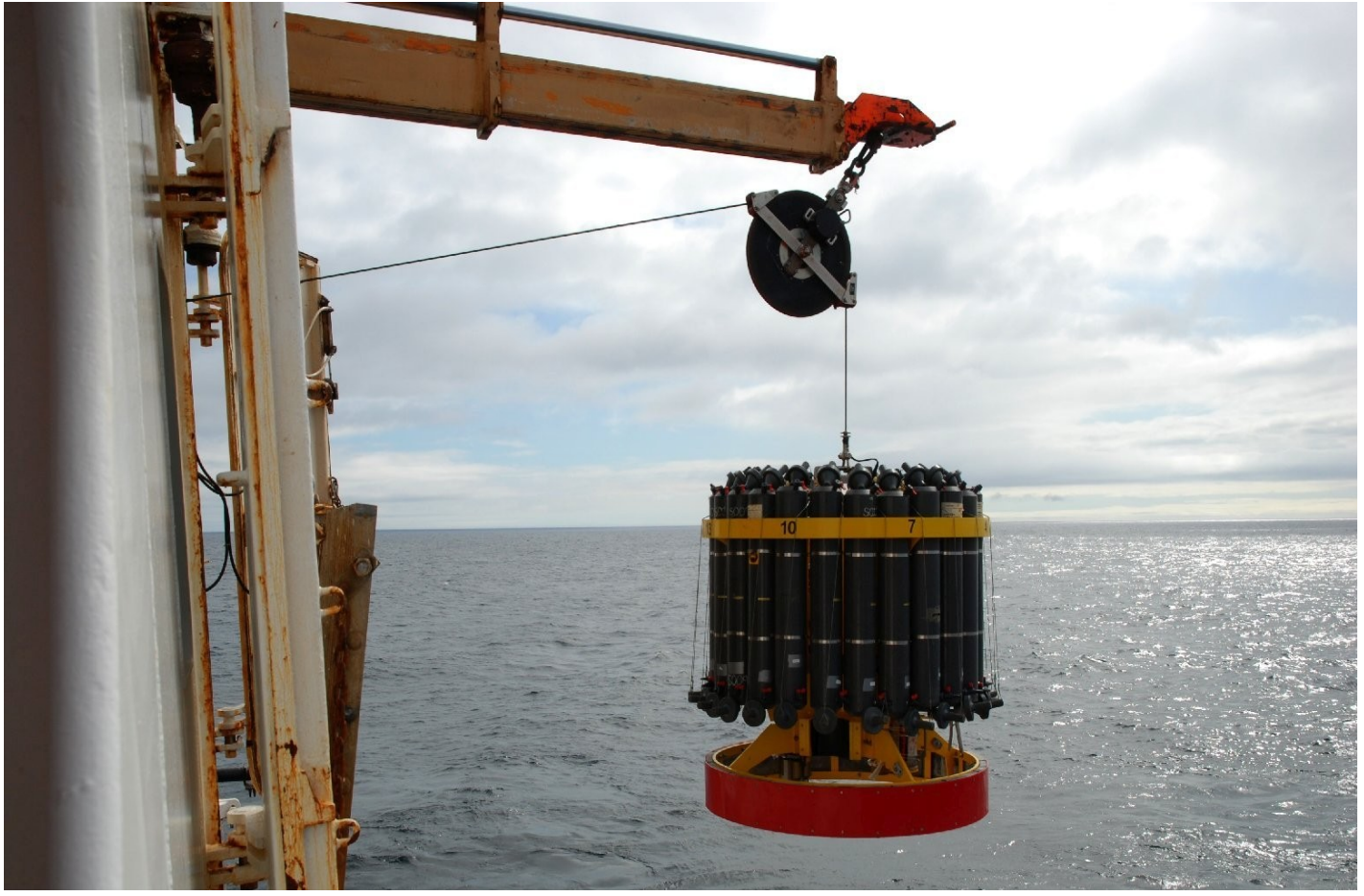
Credit: NASA

Ocean Observing

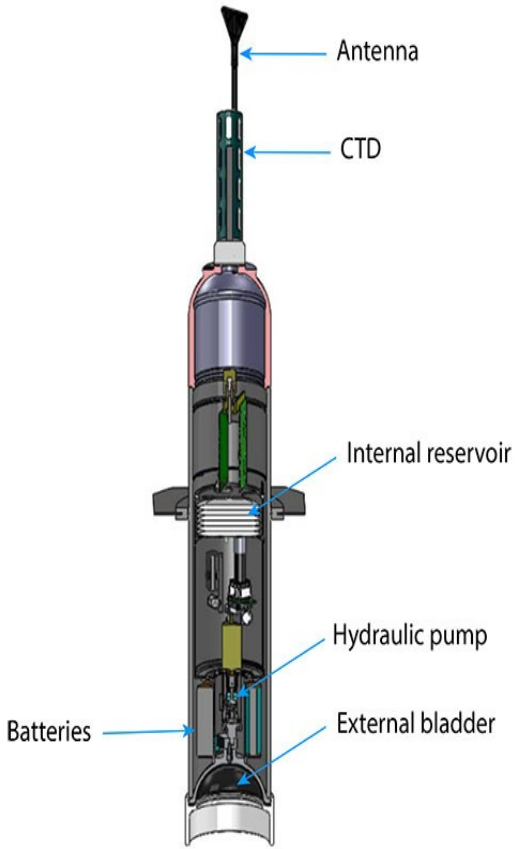


Credit: Ocean Observing Initiative

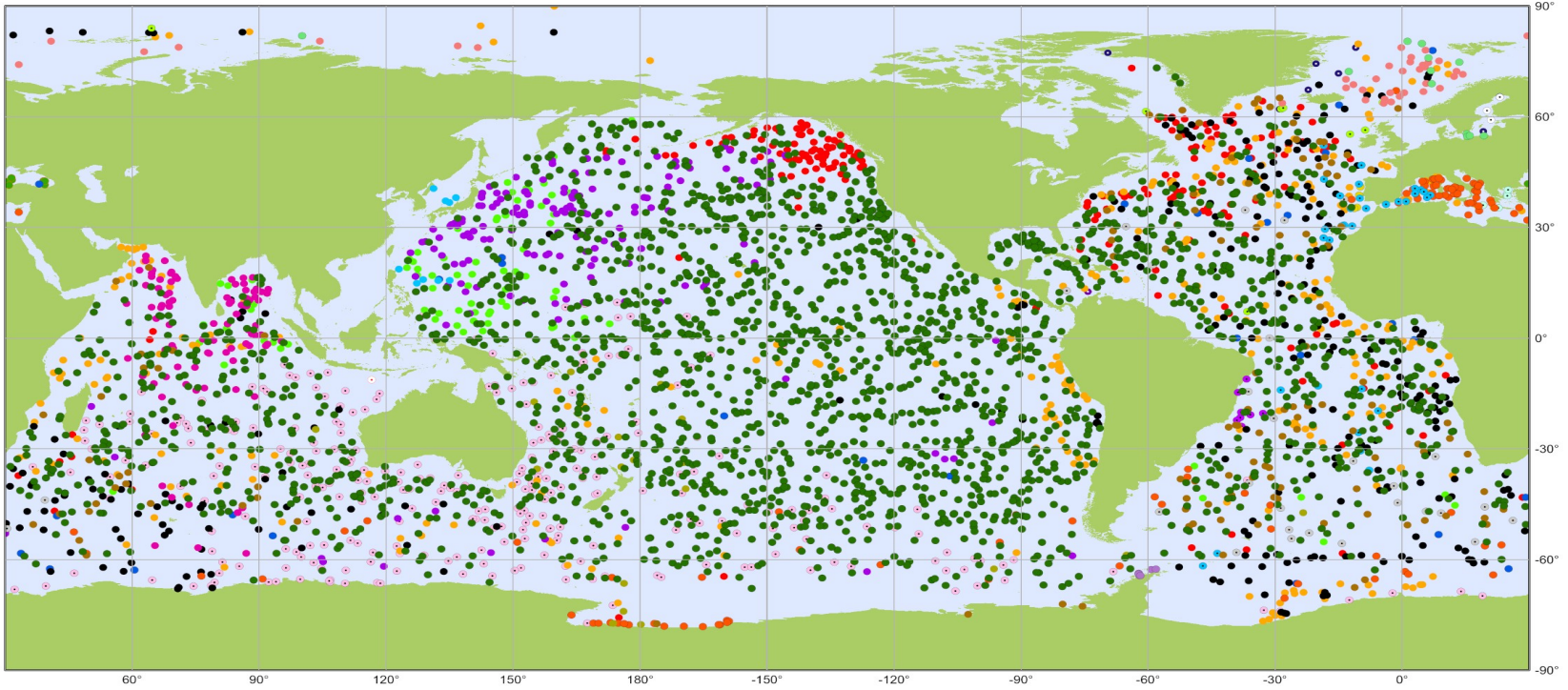
CTD measuring system onboard CCGS Hudson



Argo floats – “Sea-work-horses” for collection of oceanographic data



The global network of ARGO floats



Argo

National contributions- 4162 operational floats

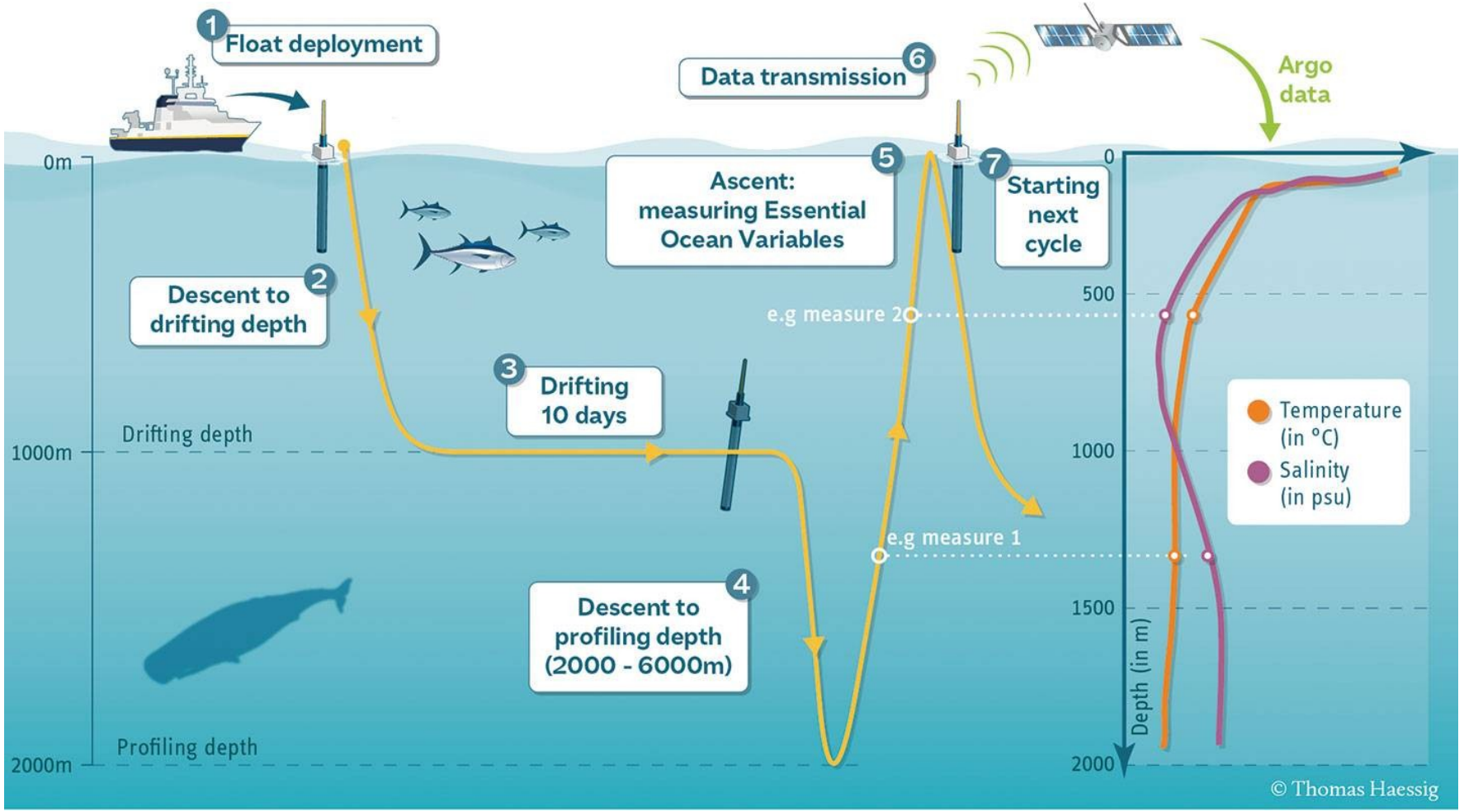
Latest location of operational floats (data distributed within the last 30 days)

December 2025

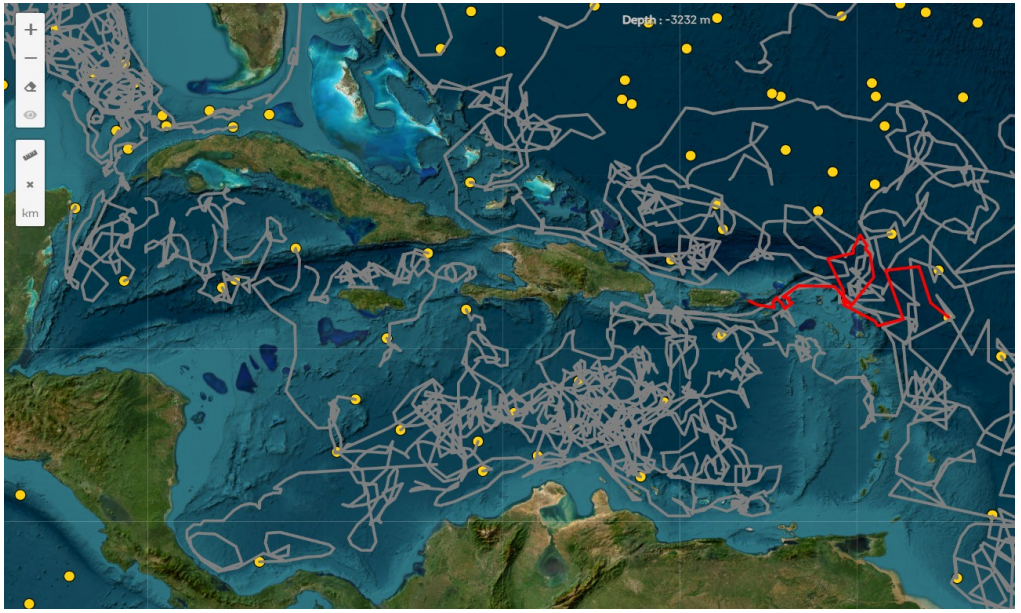
AUSTRALIA (301)	COLOMBIA (1)	GERMANY (293)	ITALY (103)	POLAND (12)	UKRAINE (6)
BRAZIL (8)	DENMARK (7)	GREECE (6)	JAPAN (157)	PORTUGAL (4)	USA (2283)
BULGARIA (8)	EUROPE (31)	INDIA (92)	NETHERLANDS (30)	KOREA, REPUBLIC OF (9)	
CANADA (199)	FINLAND (3)	INDONESIA (1)	NEW ZEALAND (18)	SPAIN (33)	
CHINA (82)	FRANCE (302)	IRELAND (8)	NORWAY (39)	UK (126)	

Generated by ocean-ops.org, 2026-01-02
Projection: Plate Carree (-150.0000)

ARGO Float Mission



SV Oceanolog and ARGO Floats Tracks Through the Caribbean

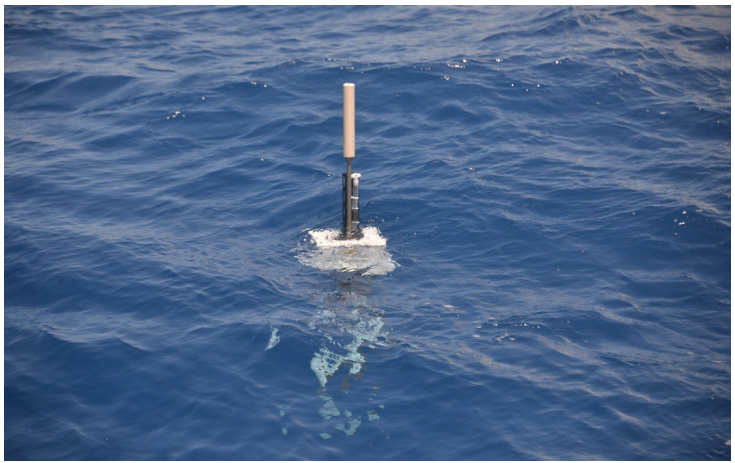


Plot of all tracks of ARGO floats around Caribbean Islands well show areas with gaps in ocean data, caused by limitation of parking (drifting) depth in 1000m, set for the floats. In red is the track of ours deployed float

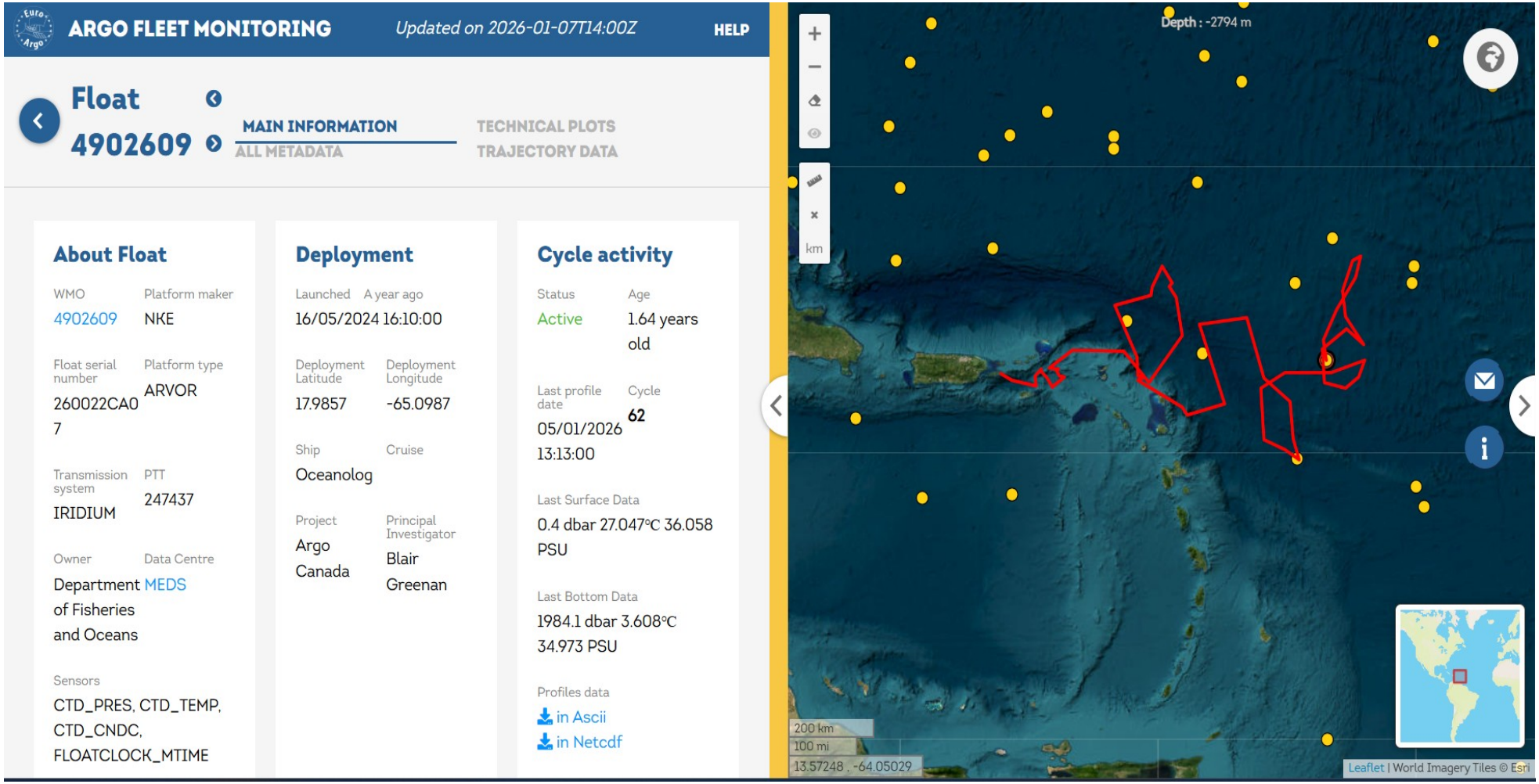
A plot of SV Oceanolog track through the Caribbean with marked points of underway CTD casts to fill in gaps with ocean data.

Vendee Globe Race Argo program - NKE floats equipped with RBR argo³CTD

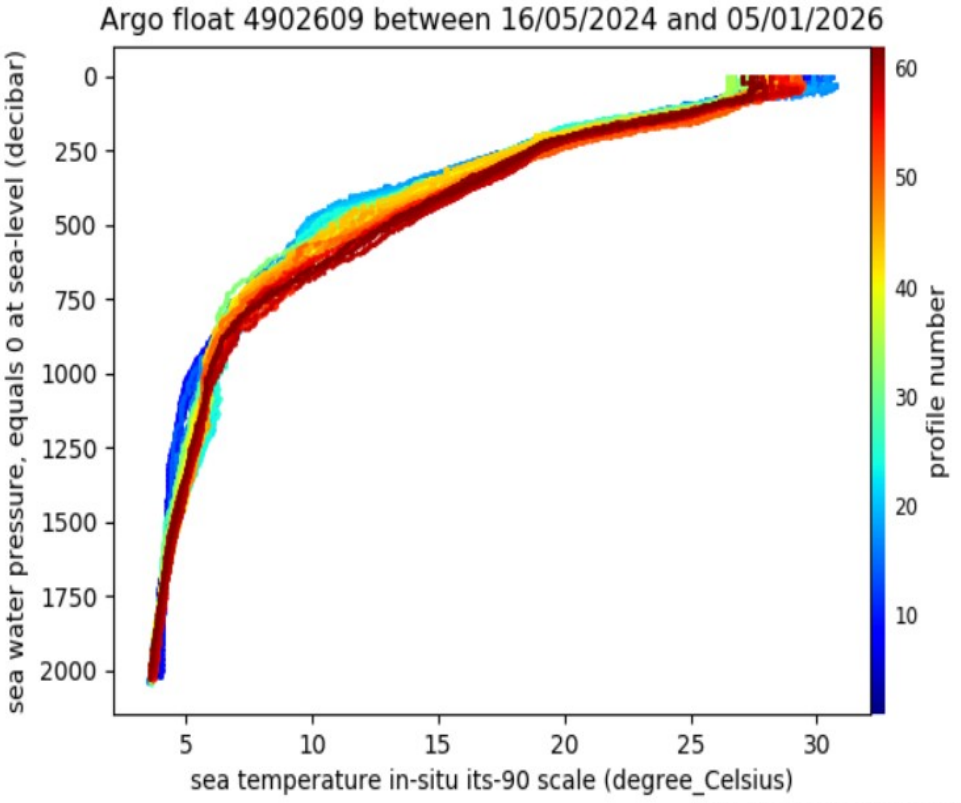
Deployment of ARGO float May,16th 2024

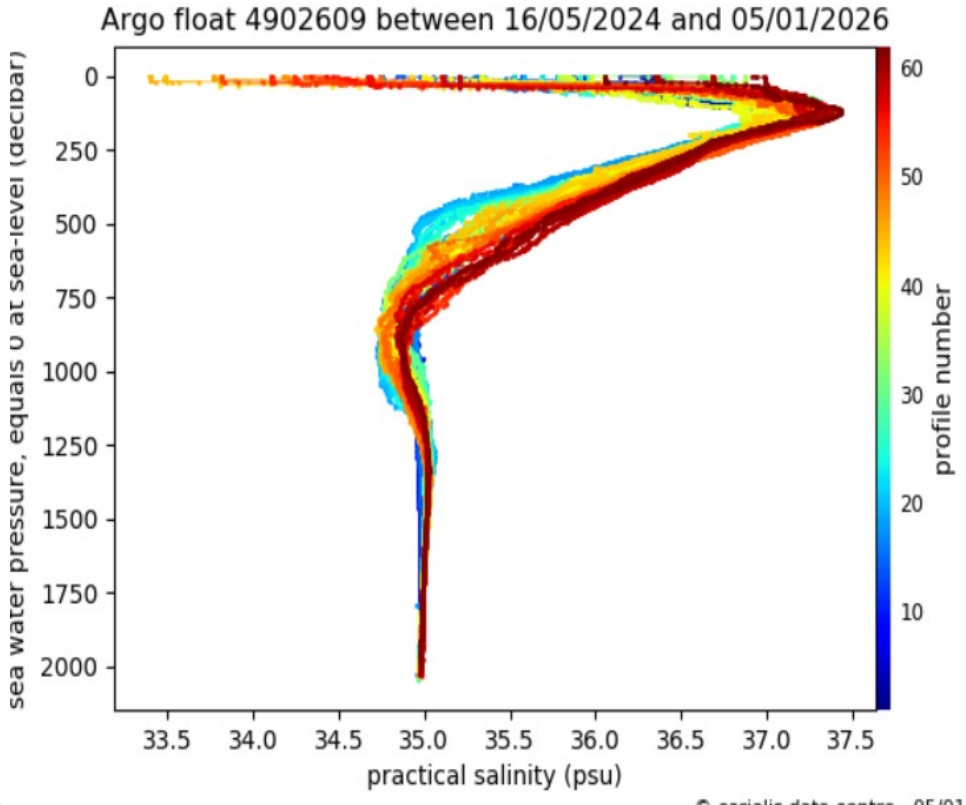


https://fleetmonitoring.euro-argo.eu/float/4902609



Temperature and Salinity Data from ARGO Float #4902609



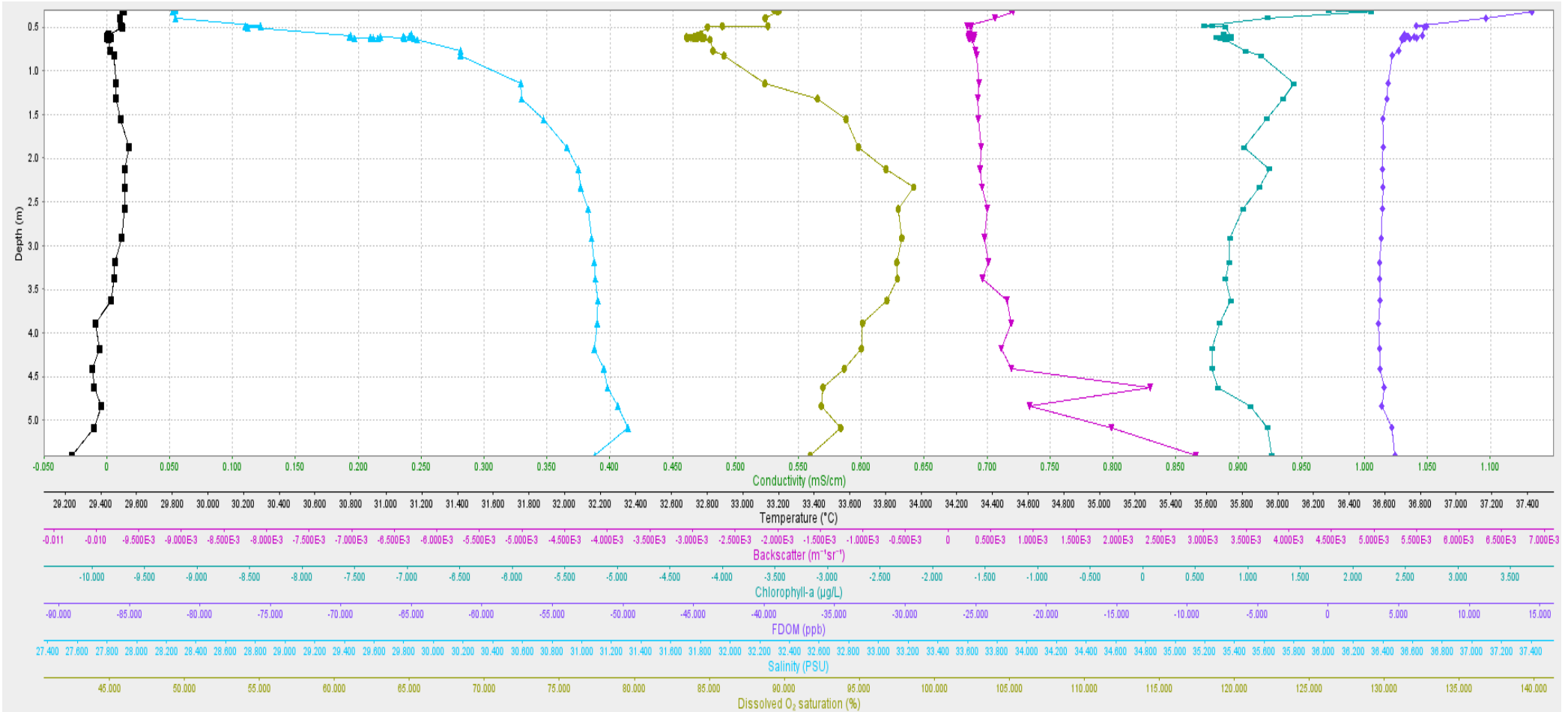


CTD casts on moorings

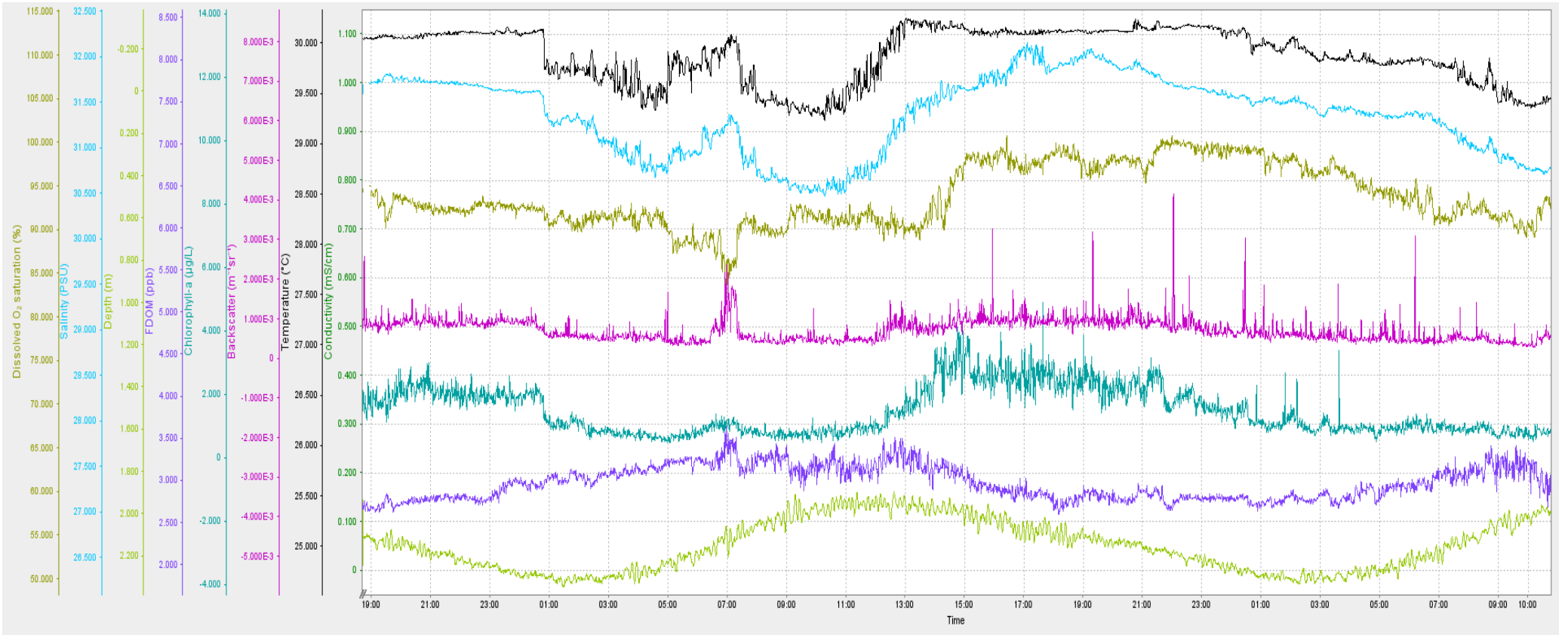
CTD cast in the Shelter Bay Marina (Panama)

02 August 2025 Ruskin software plot of the CTD cast data

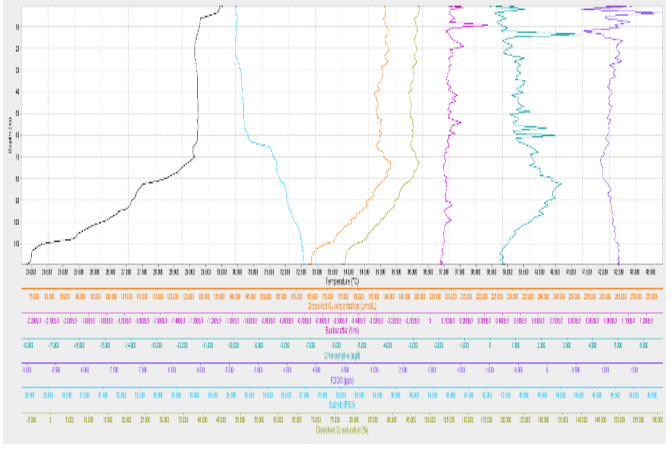
Panama, Colon, Shelter Bay Marina



16-17May25 Plot of the CTD mooring data Panama, Colon, Shelter Bay Marina



Underway “heaving to” CTD casts



Caribbean Through-Flow

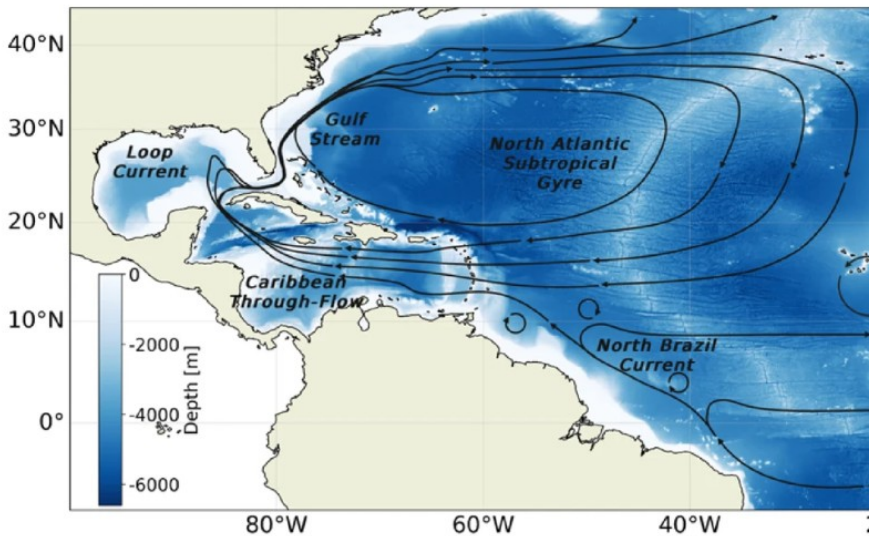
ELSEVIER

Deep Sea Research Part I: Oceanographic Research Papers

Volume 225, November 2025, 104581

Westward modification of Caribbean through-flow water mass structure

Joseph C. Gradone [a], W. Douglas Wilson [b], Scott M. Glenn [a], Travis N. Miles [a]

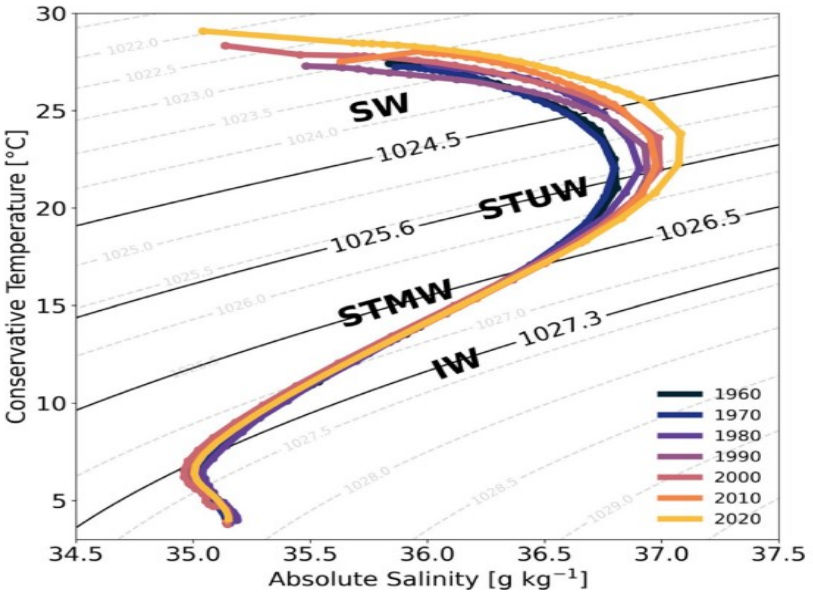


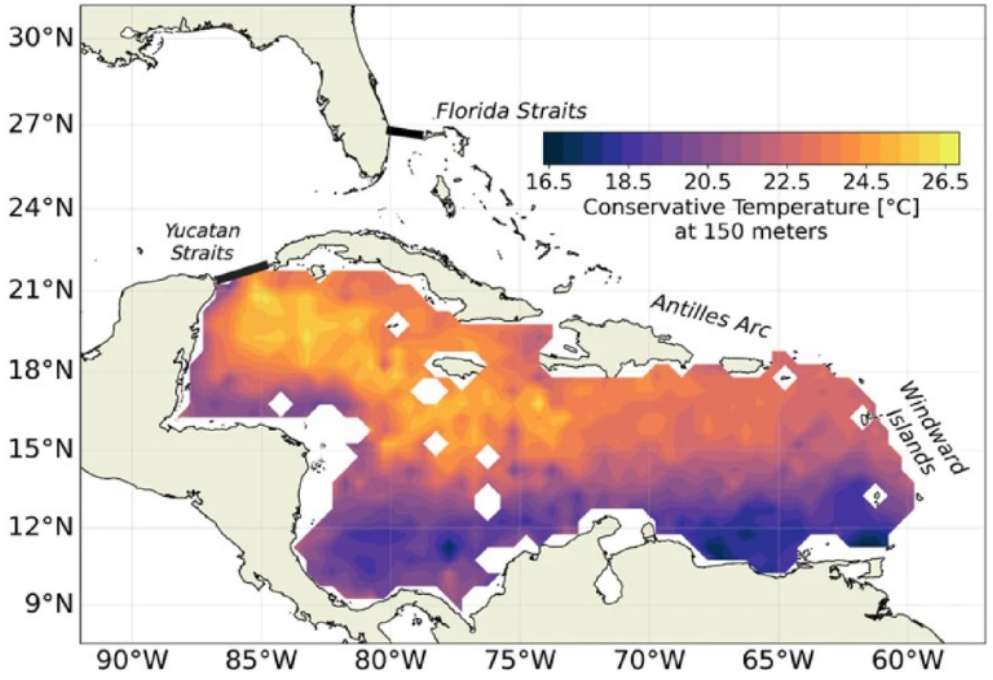
Article | Open access | Published: 02 July 2025

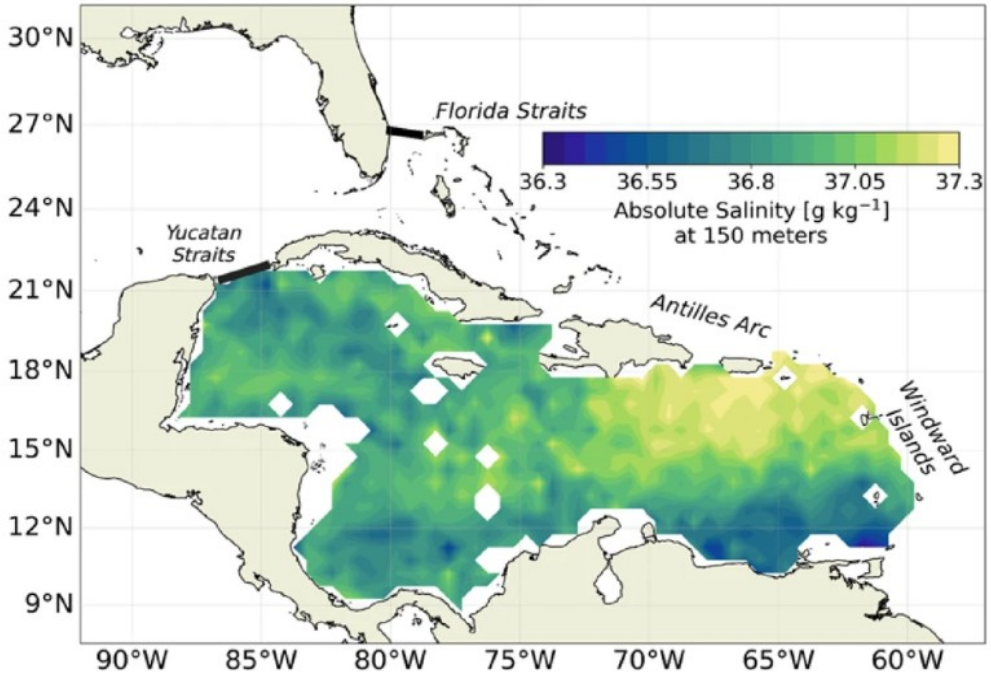
Warming and salinity changes of the upper ocean Caribbean through-flow since 1960

Joseph C. Gradone, T. N. Miles, J. B. Palter, S. M. Glenn & W. D. Wilson

Scientific Reports **15**, Article number: 23157 (2025) | Cite this article





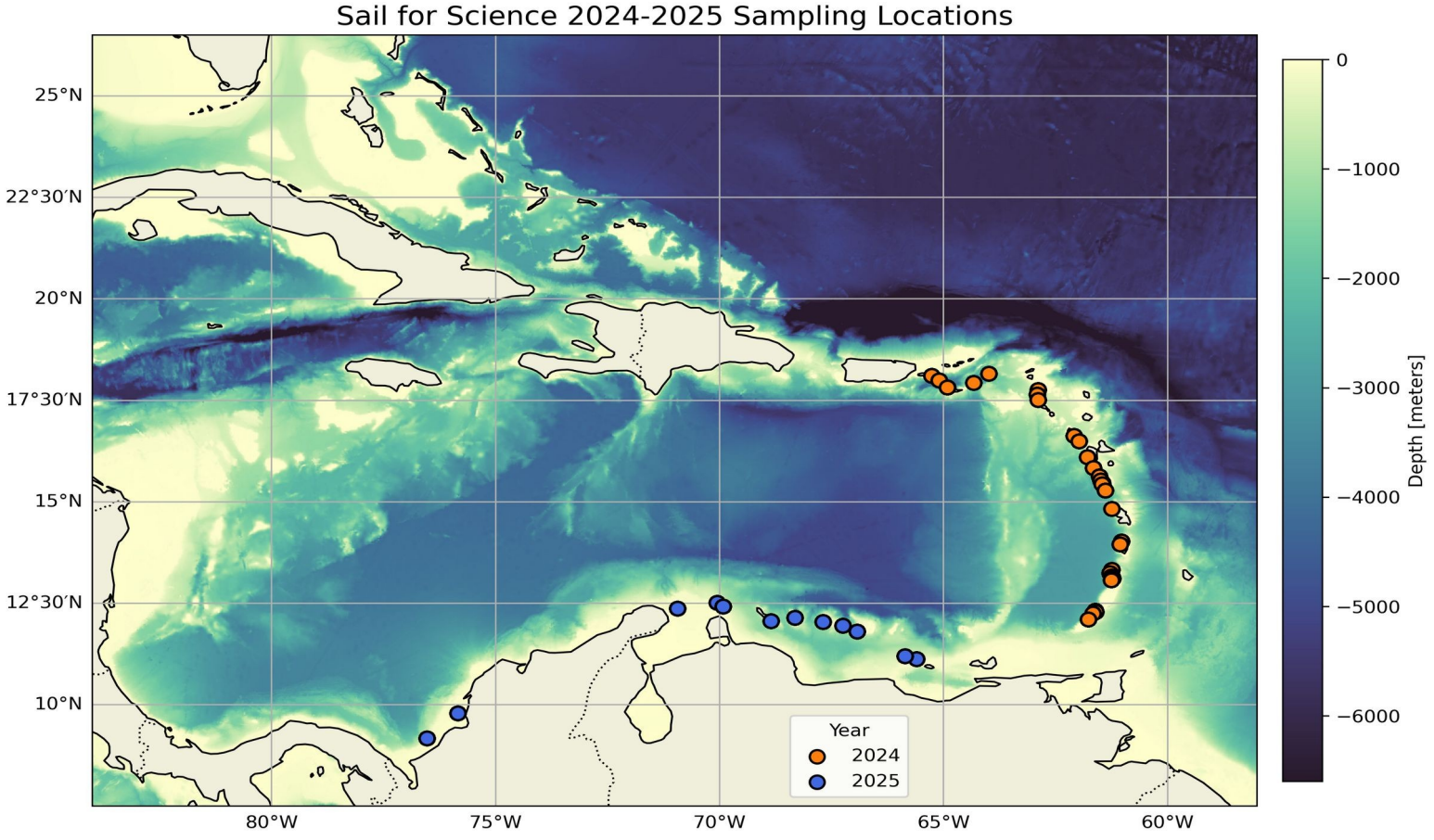


"*These findings highlight the CTF as a bottleneck for climatically important water masses and emphasize the need for sustained subsurface observations here.*"

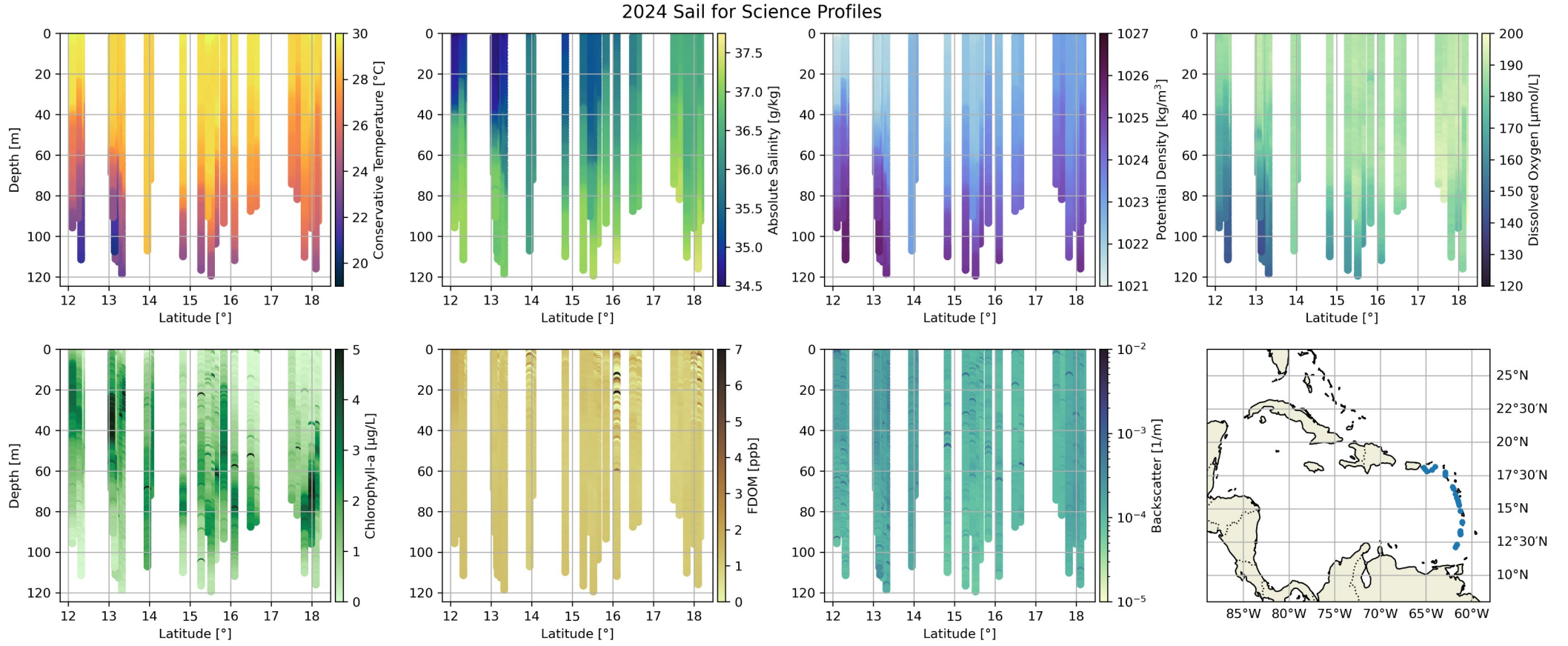
Joe Gradone, RUCOOL

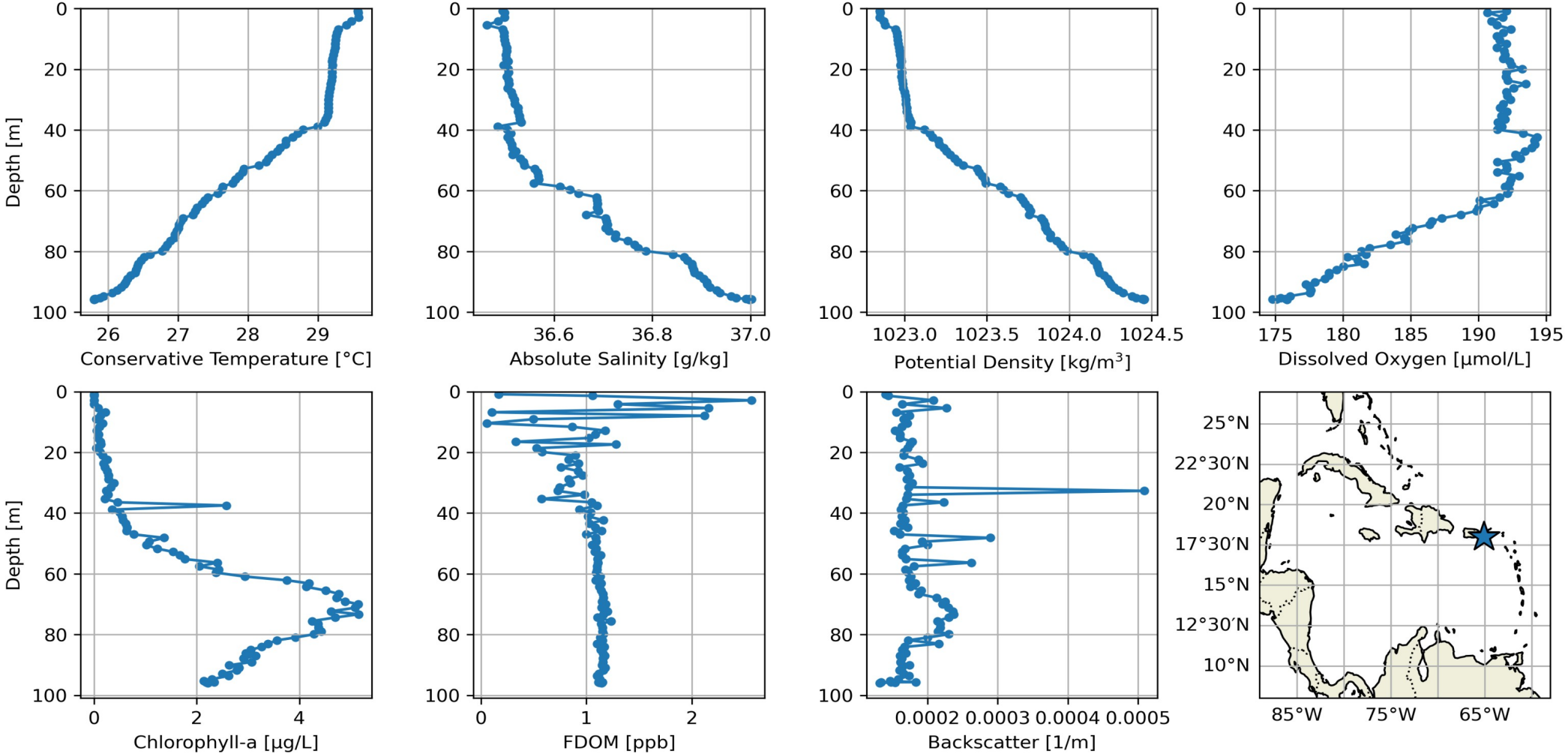
“Enjoying looking at this data!”

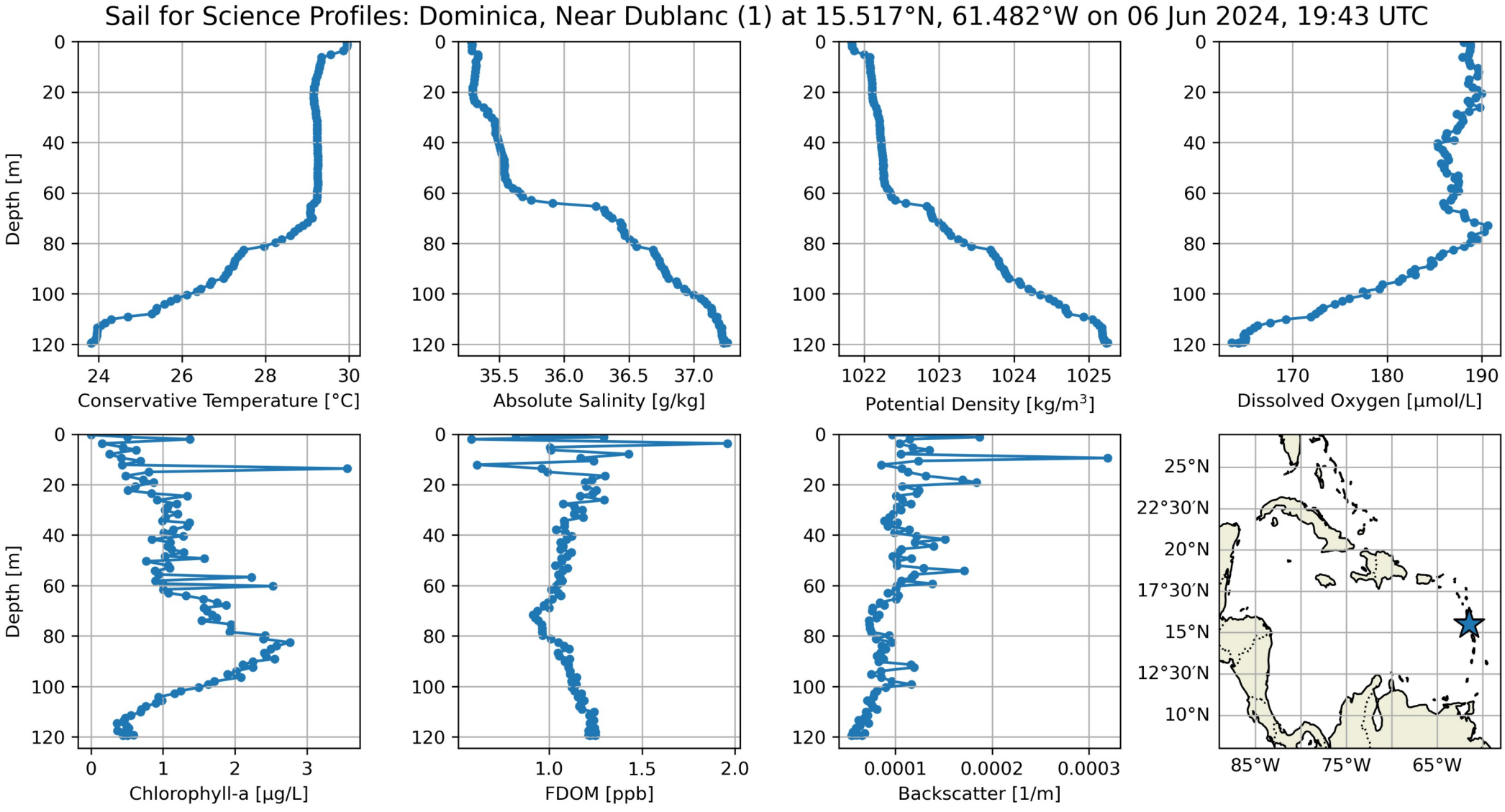
Joe Gradone, Ph.D., Assistant Research Professor
Center for Ocean Observing Leadership, Rutgers University

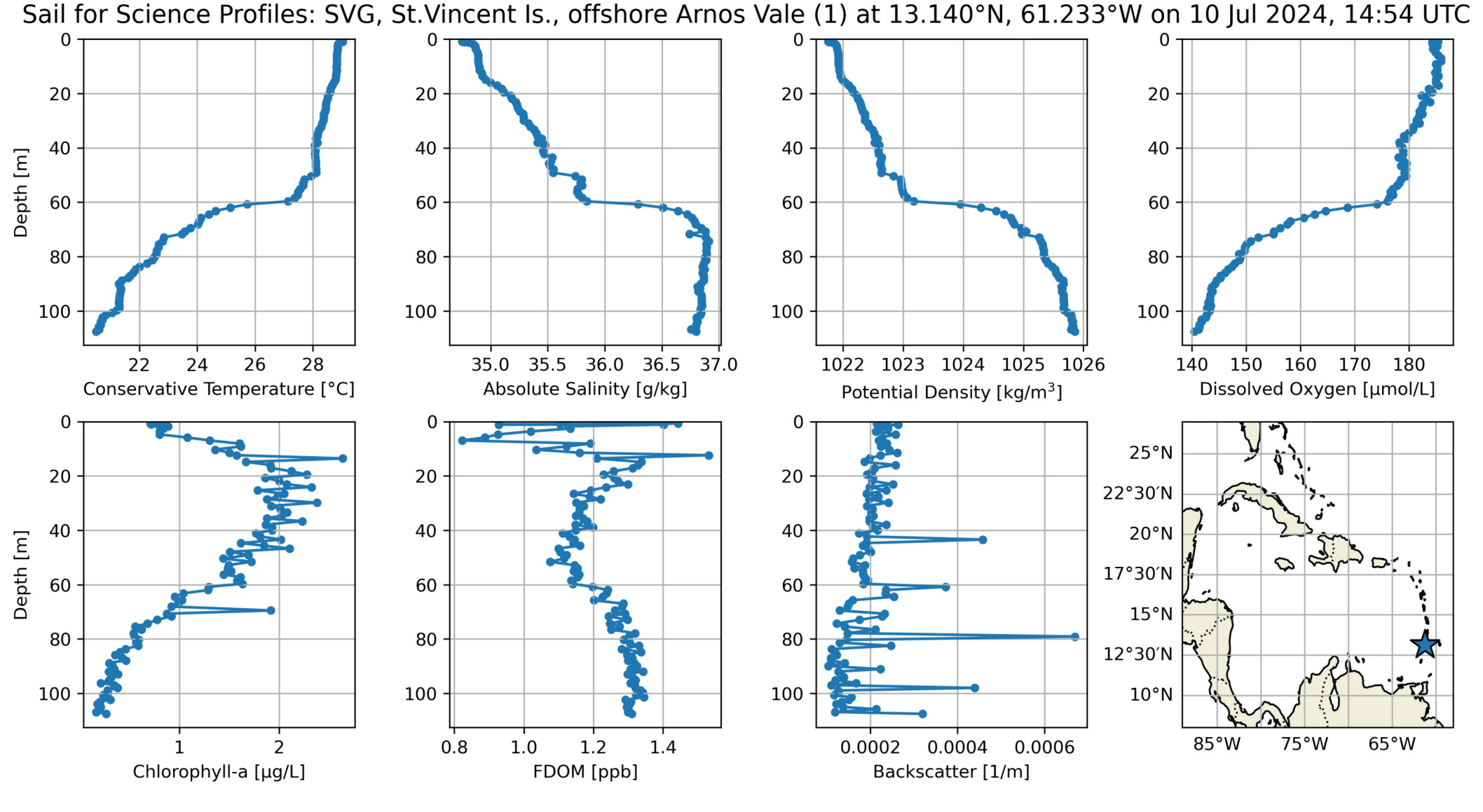


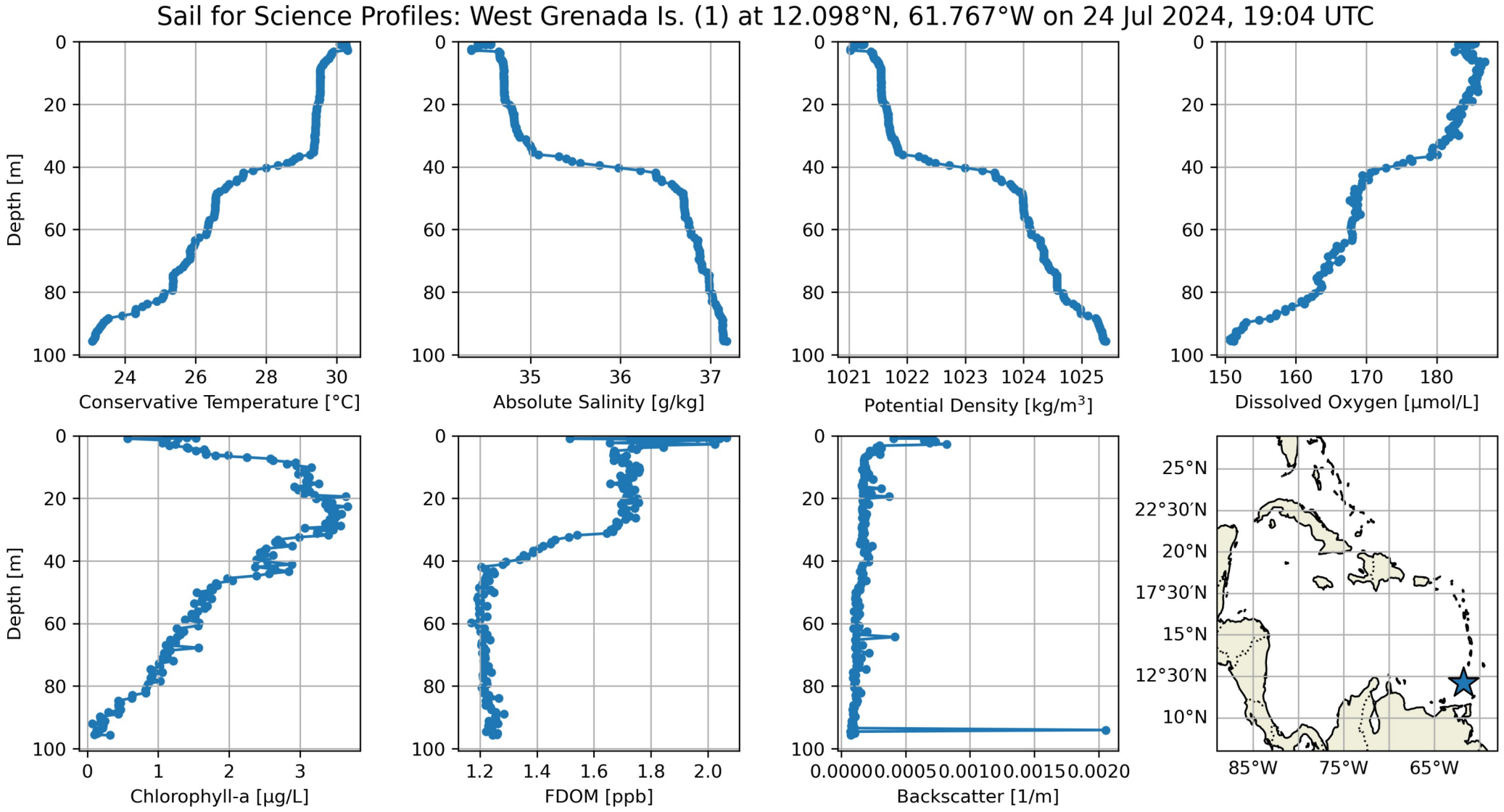
Caribbean Sea meridional CTD profiles
Sail for Science-2024



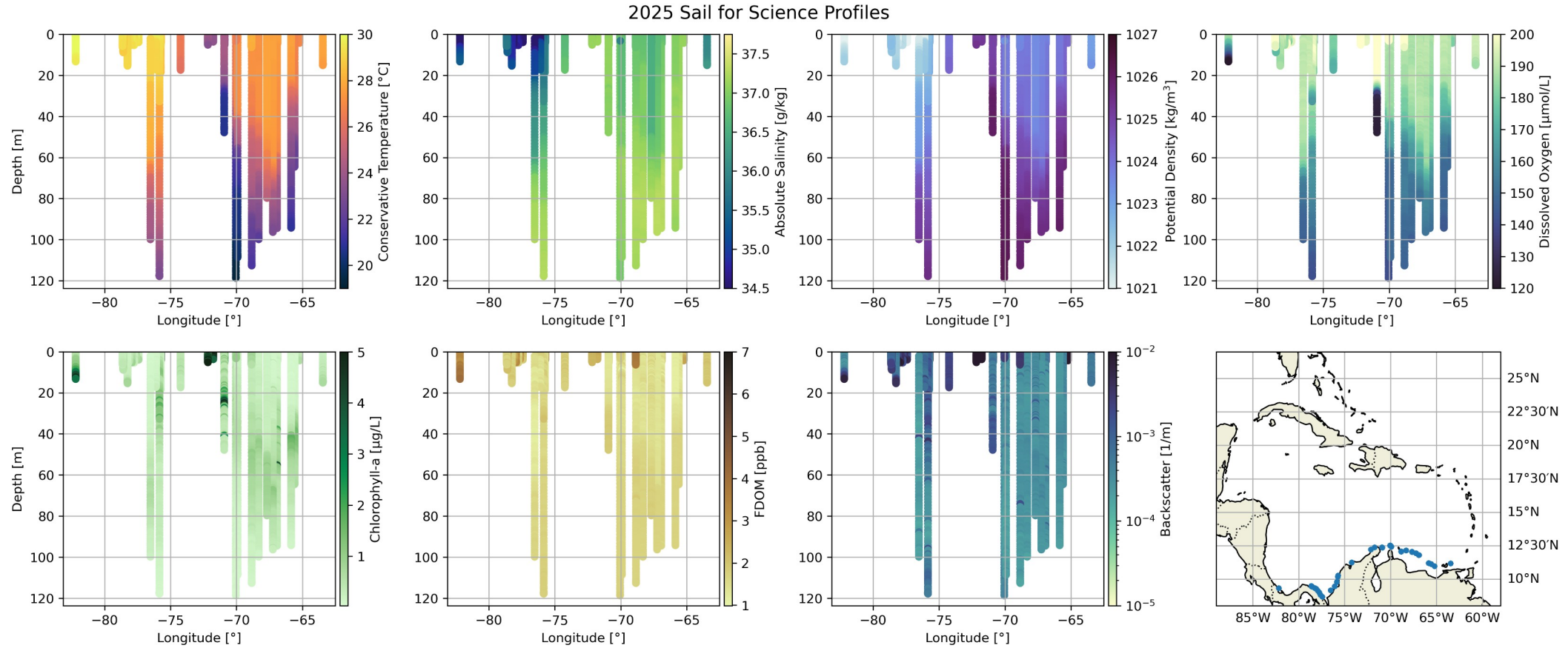

Sail for Science Profiles: Argo float deployment (1) at 17.985°N, 65.098°W on 16 May 2024, 17:22 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

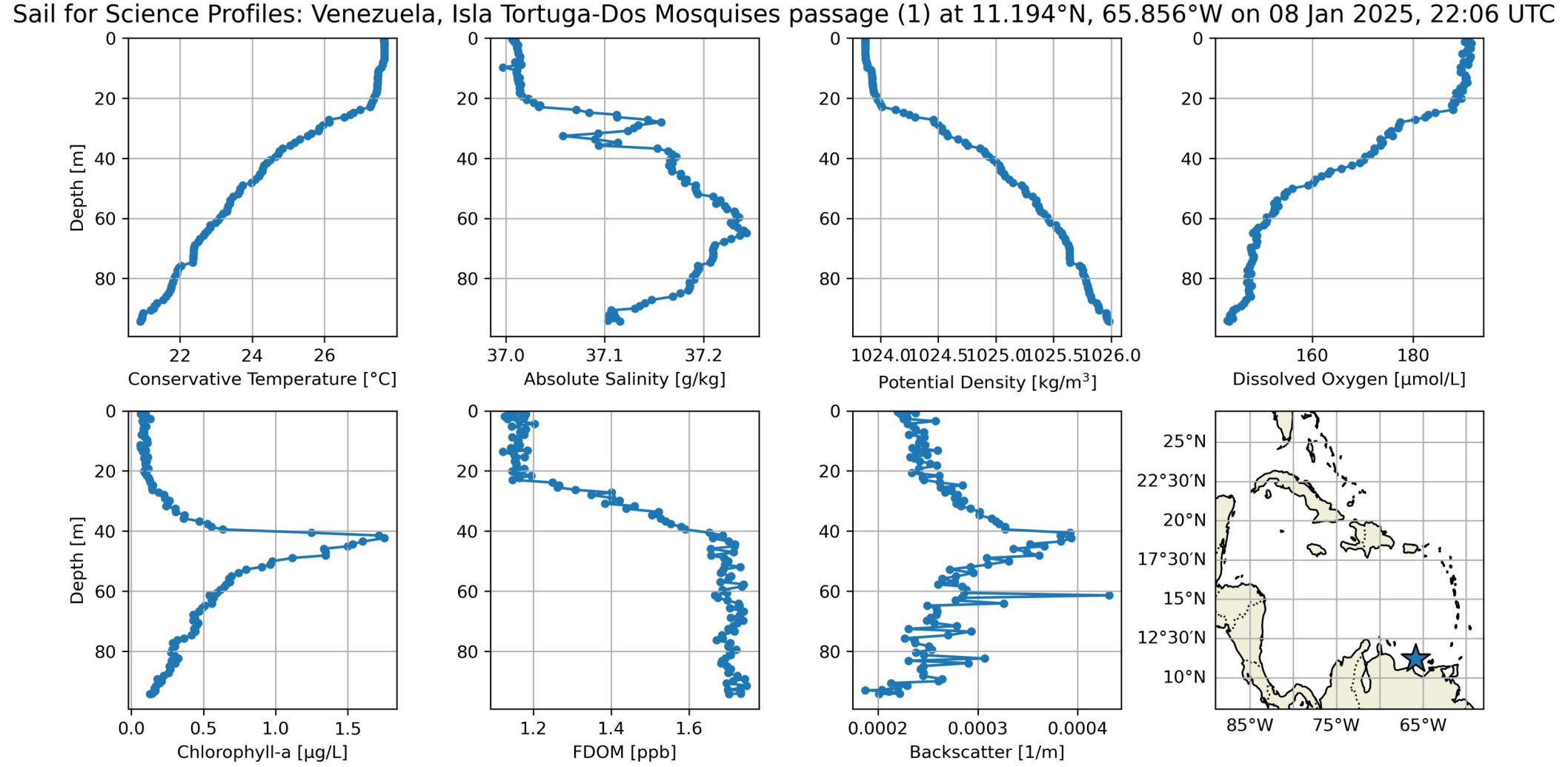

Sail for Science Profiles: Dominica, Near Dublanc (1) at 15.517°N, 61.482°W on 06 Jun 2024, 19:43 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

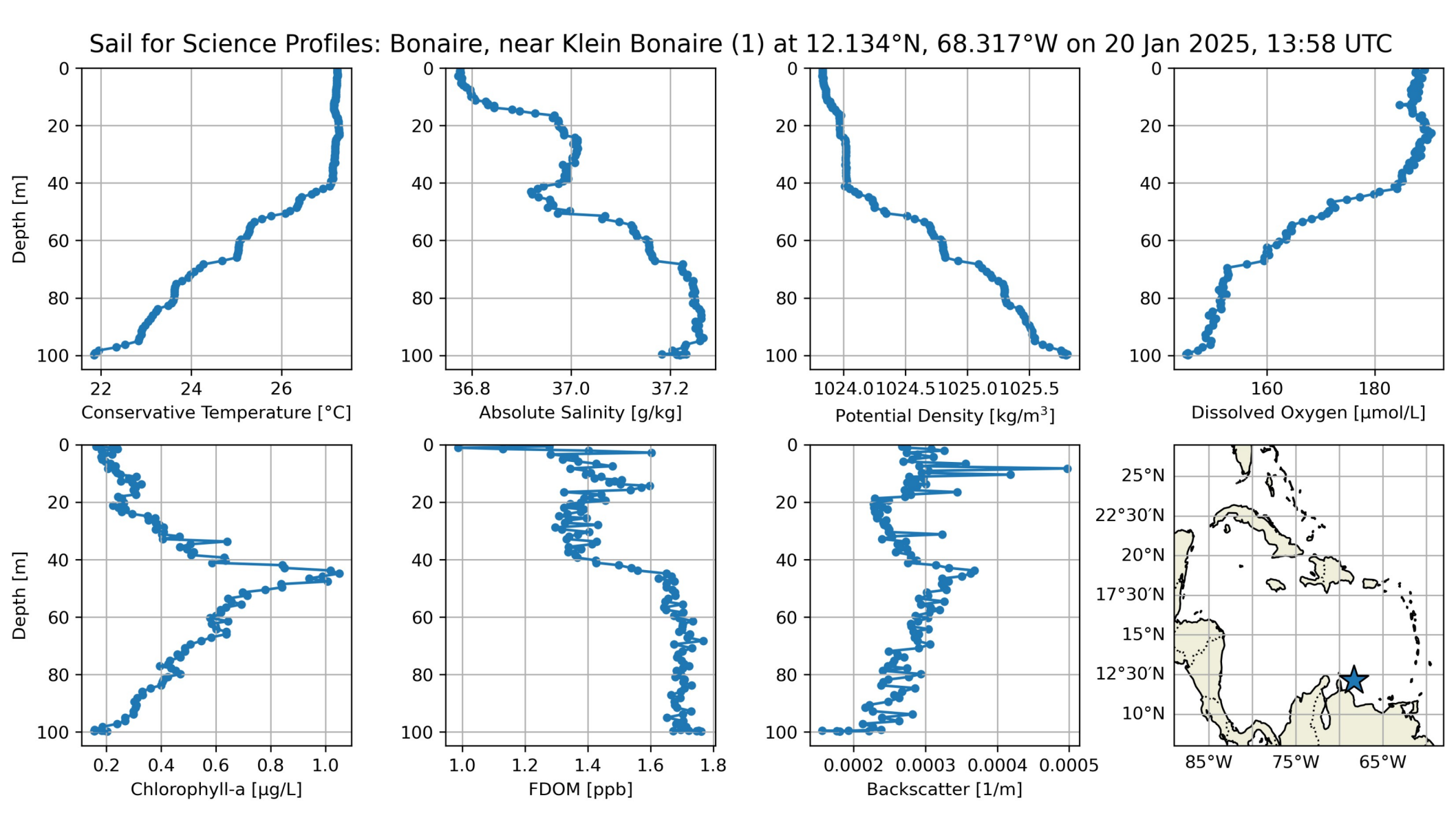

Sail for Science Profiles: SVG, St.Vincent Is., offshore Arnos Vale (1) at 13.140°N, 61.233°W on 10 Jul 2024, 14:54 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

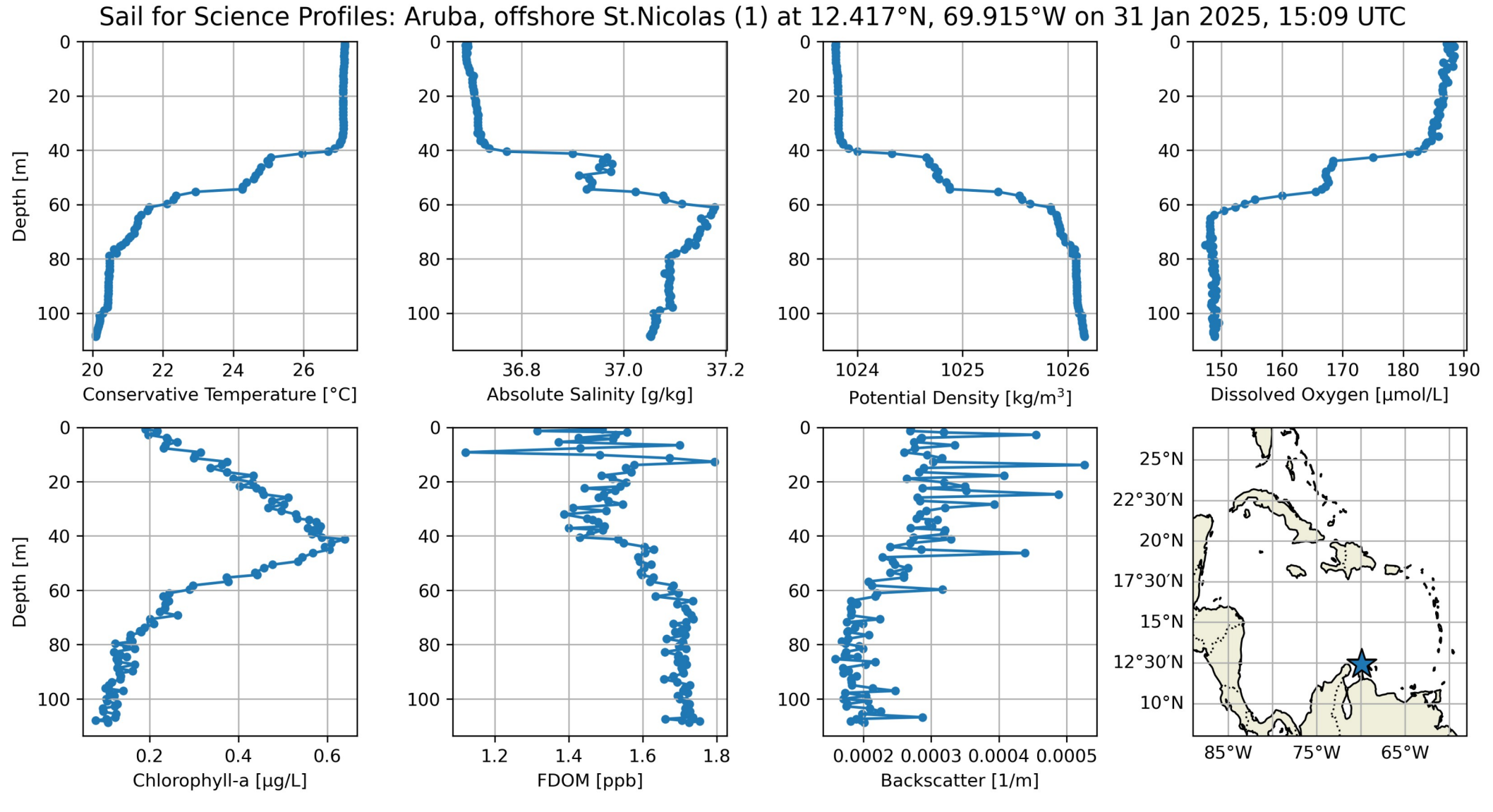

Sail for Science Profiles: West Grenada Is. (1) at 12.098°N, 61.767°W on 24 Jul 2024, 19:04 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m³]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

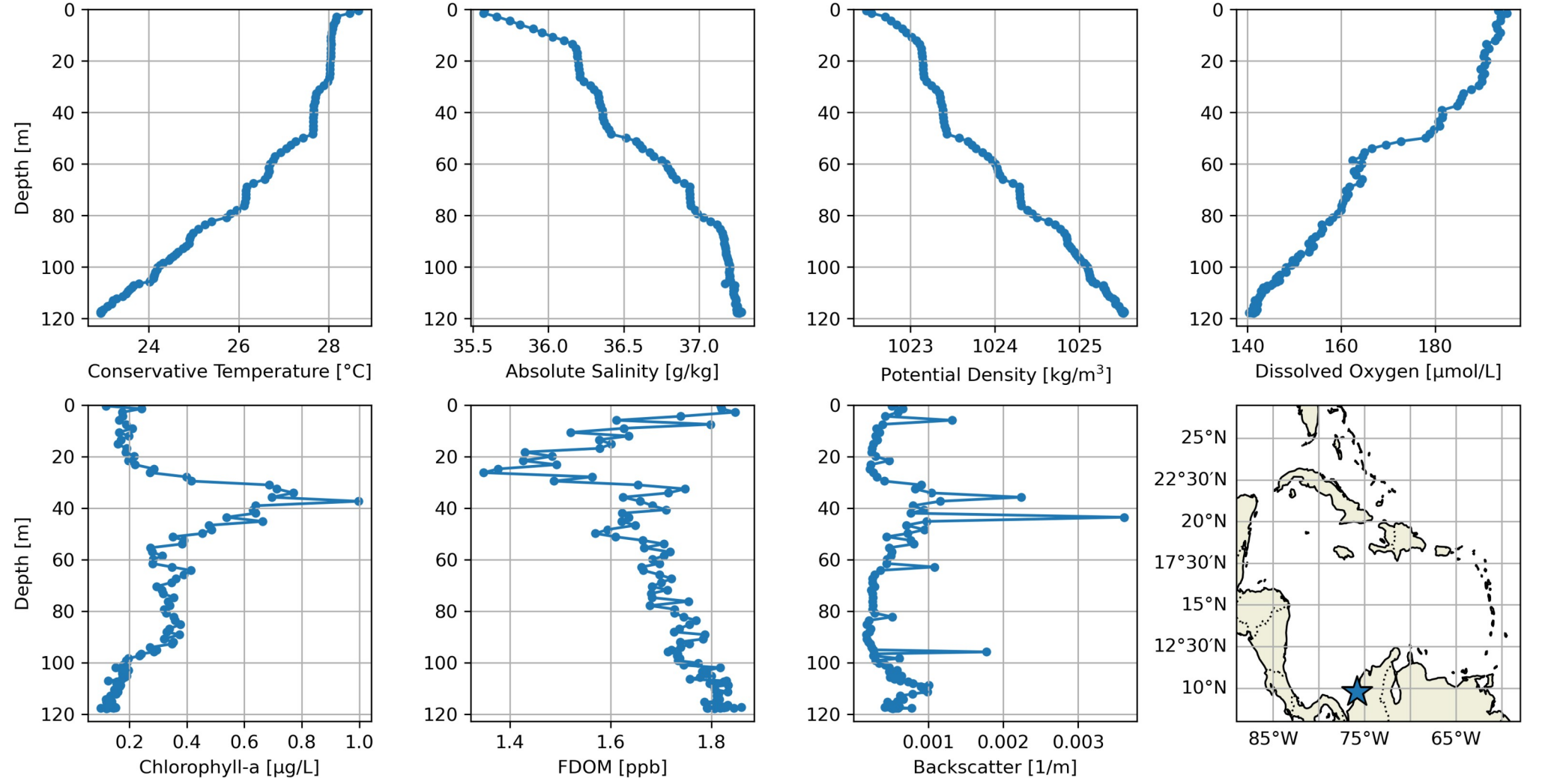
Caribbean Sea zonal CTD profiles
Sail for Science-2025



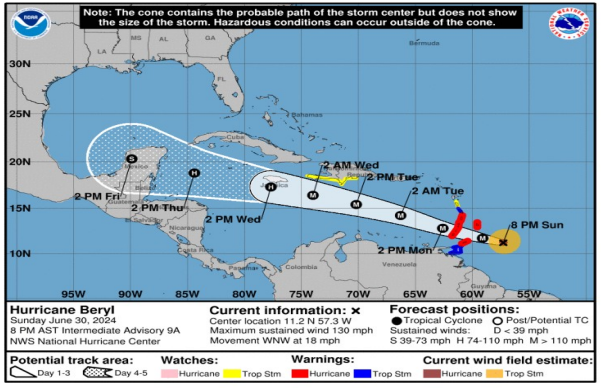

Sail for Science Profiles: Venezuela, Isla Tortuga-Dos Mosquises passage (1) at 11.194°N, 65.856°W on 08 Jan 2025, 22:06 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

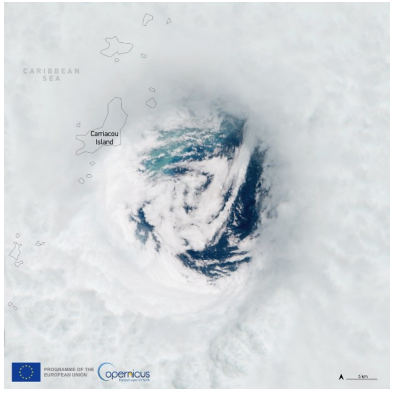

Sail for Science Profiles: Bonaire, near Klein Bonaire (1) at 12.134°N, 68.317°W on 20 Jan 2025, 13:58 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

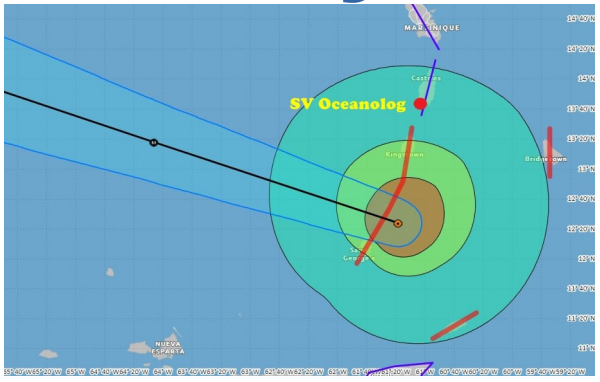

Sail for Science Profiles: Aruba, offshore St.Nicolas (1) at 12.417°N, 69.915°W on 31 Jan 2025, 15:09 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

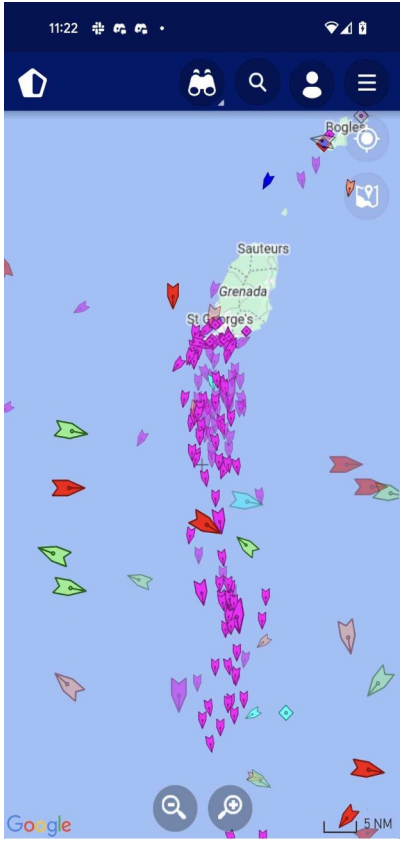

Sail for Science Profiles: Colombia, Cartagena-Isla Rosario passage (1) at 9.784°N, 75.839°W on 08 Mar 2025, 18:58 UTC
Depth [m]
Conservative Temperature [°C]
Absolute Salinity [g/kg]
Potential Density [kg/m^3]
Dissolved Oxygen [µmol/L]
Chlorophyll-a [µg/L]
FDOM [ppb]
Backscatter [1/m]
25°N
22°30′N
20°N
17°30′N
15°N
12°30′N
10°N
85°W
75°W
65°W

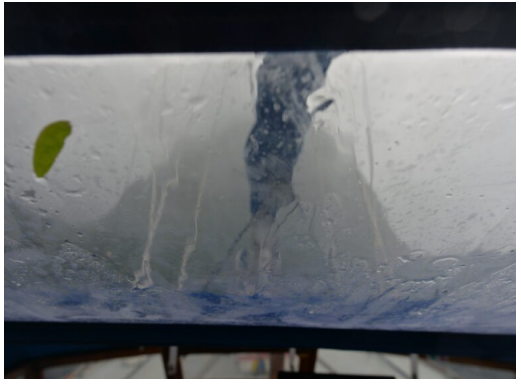
Surviving and monitoring Hurricane Beryl



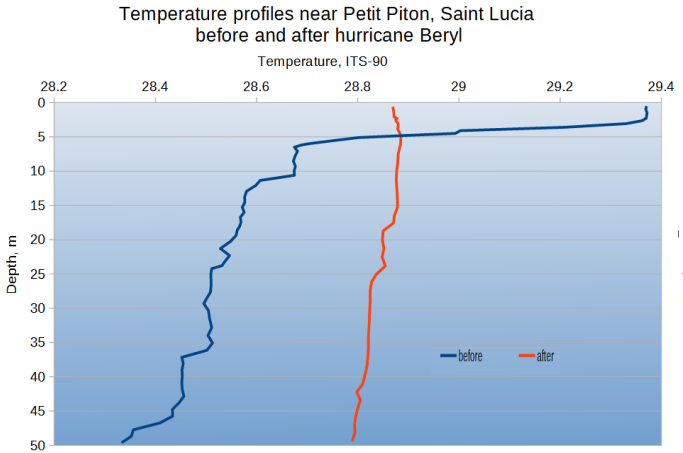


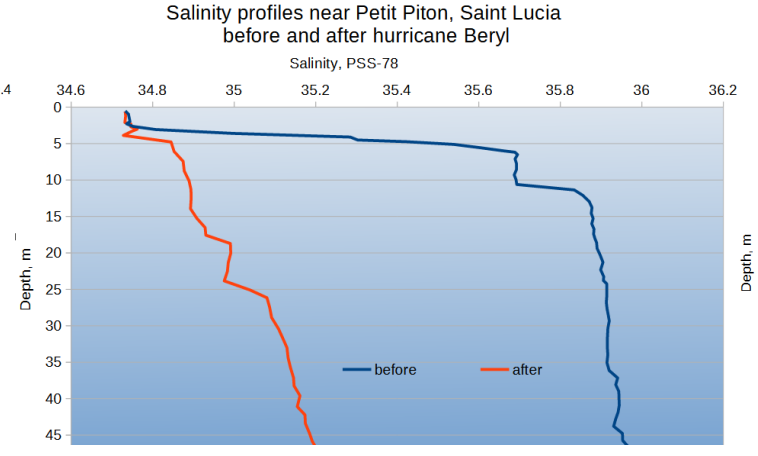


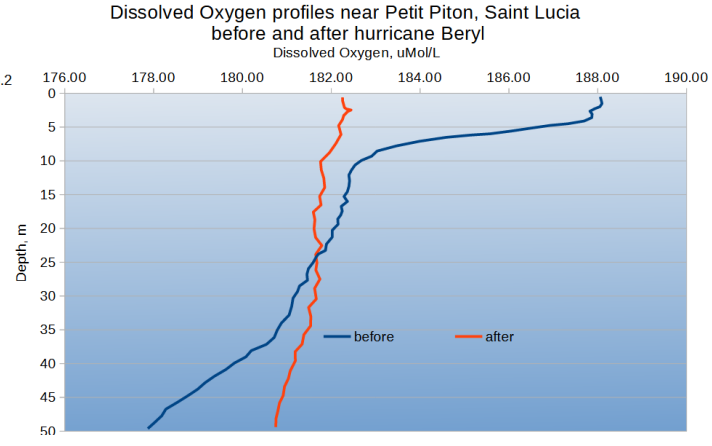


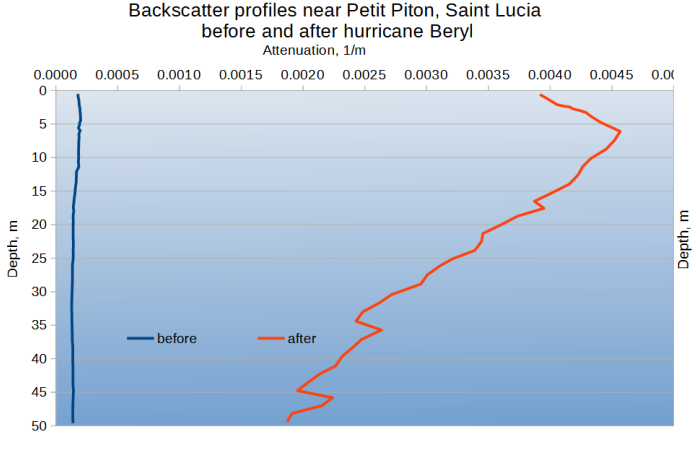


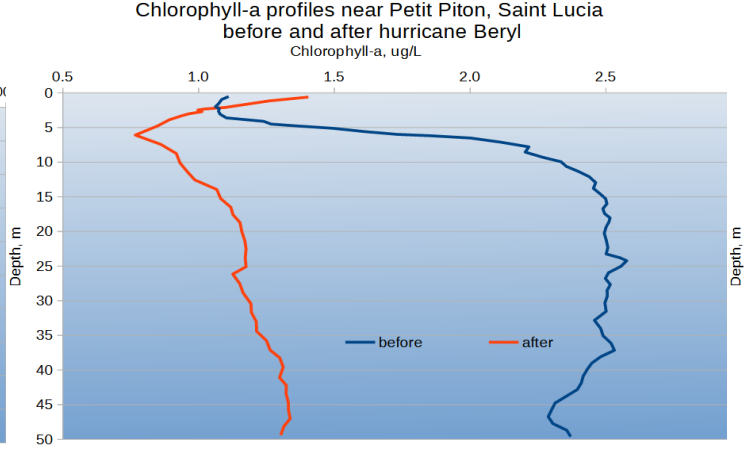
CTD cast near Petit Piton, Saint Lucia before and after passing Hurricane Beryl

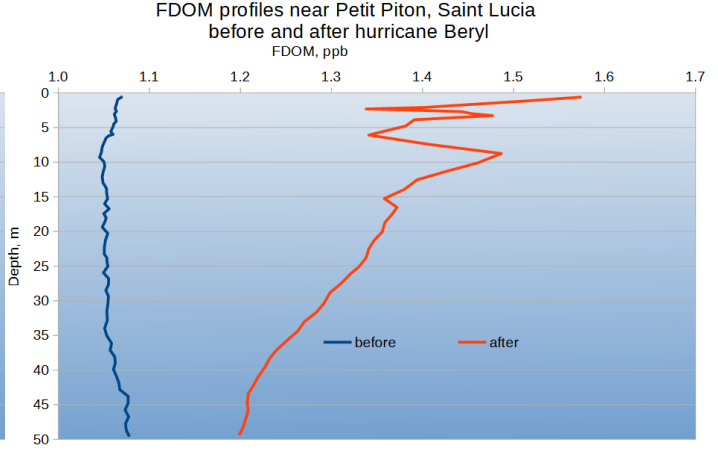










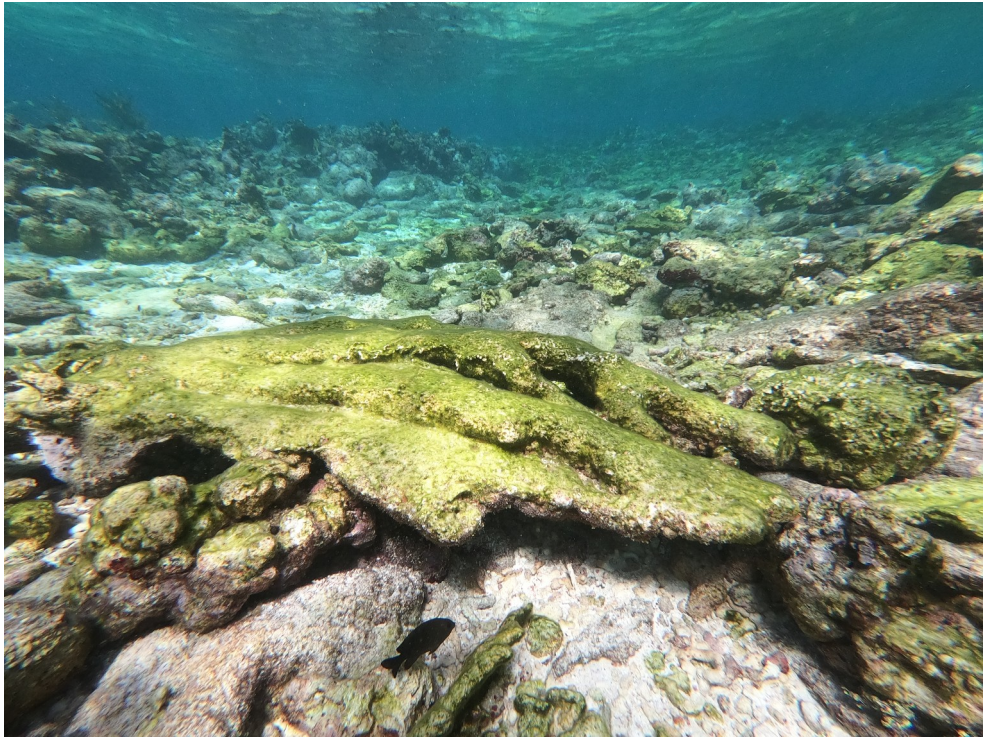


Aftermath of Hurricane Beryl on sailing community Carriacou Island, Grenada

The Tipping Point for Warm-water Corals

"The central estimate of the thermal tipping point for warm-water coral reefs of 1.2°C global warming above pre-industrial is already exceeded and without stringent climate mitigation their upper thermal threshold of 1.5°C may be reached within the next 10 years, compromising reef functioning and provision of ecosystem services to millions of people."

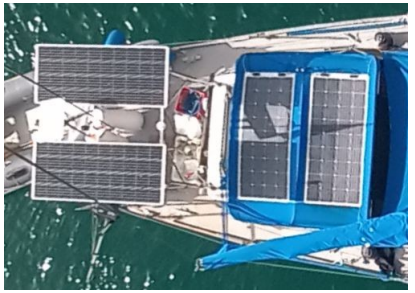
The Global Tipping Points Report 2025

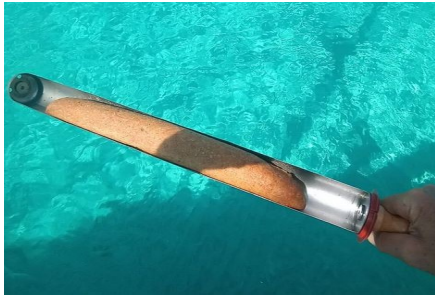


Dead coral reef in Tobago Cay (St.Vincent and Grenadines), 10 years ago we saw it alive...

Sustainable Living Aboard

- 700W solar panels
- Cooking mostly on Inductive stove
- Using Go-Sun Solar stove for cooking, making bread, cookies
- Fishing, salting catch
- Harvesting mushrooms, berries, tropical fruits and coconuts



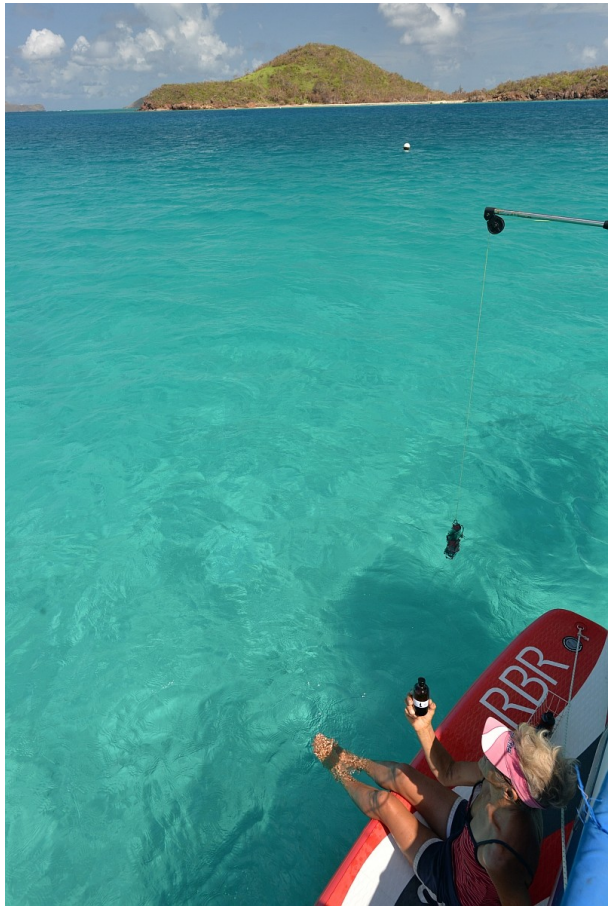


Verification of salinity data accuracy

Micro-Salinometer MS-310 was developed at RBR in 2004 specially for use on small crafts, without the need for a temperature-controlled room and 120V power. It uses the ratiometric principle of conductivity ratio measurements, where the conductivity of salinity sample is directly compared to the reference standard seawater.

Igor Shkvorets and Frank Johnson "Ocean Performance of the New MS-310" *Sea Technology, 10, 2006*

Taking Reference Salinity Samples

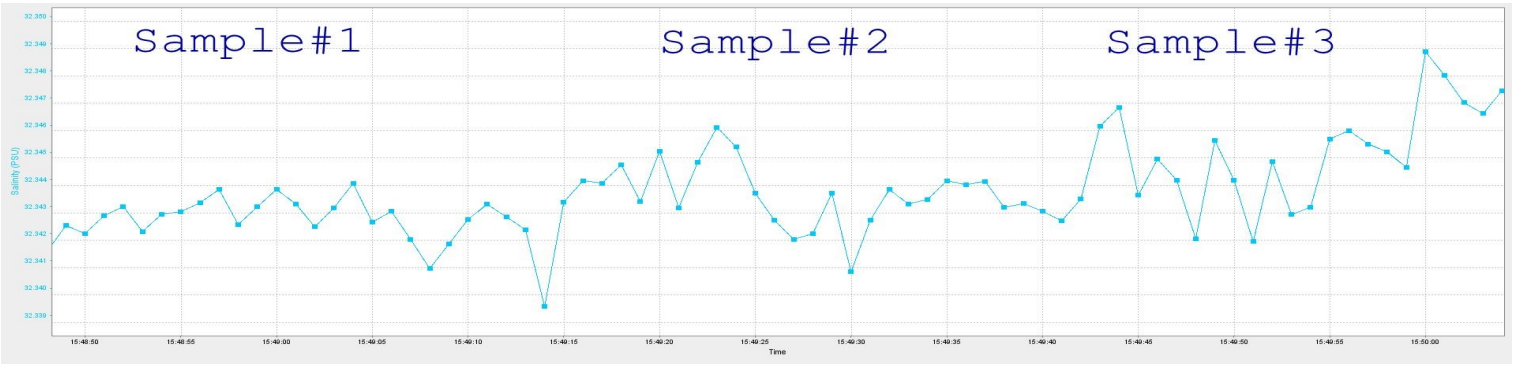


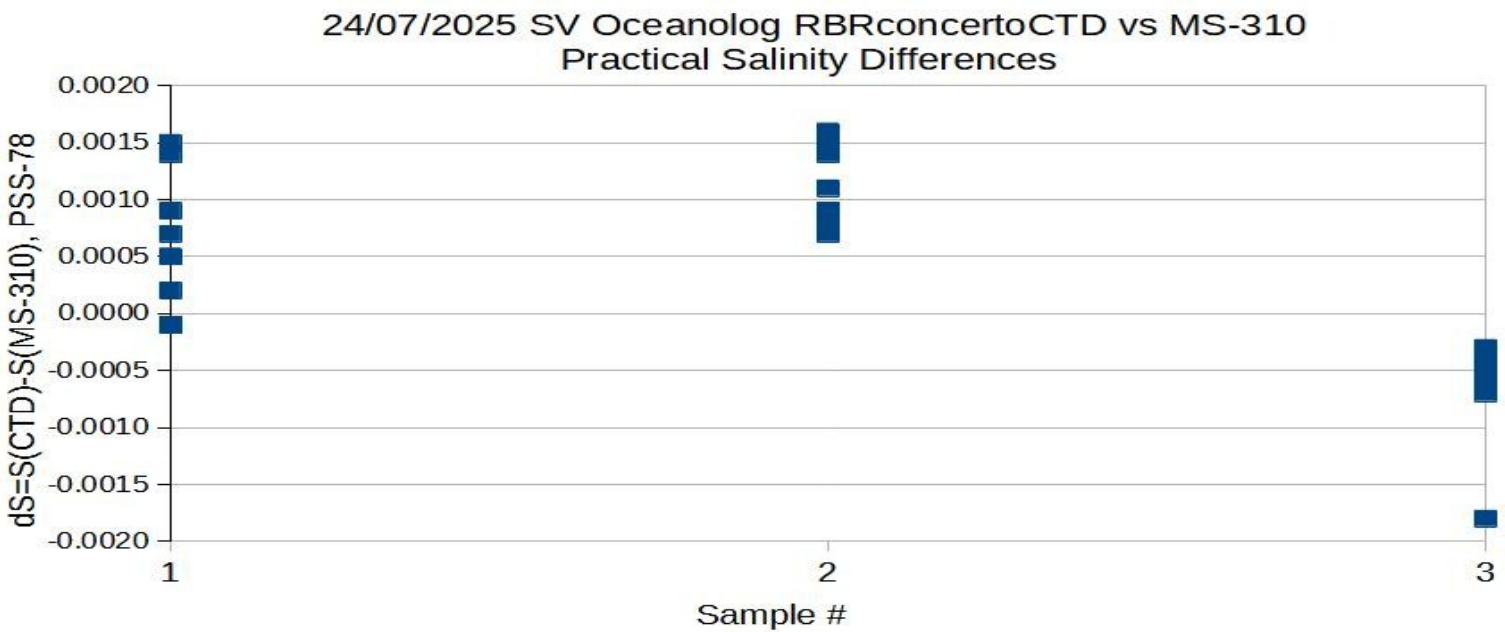
Onboard Salinometry with RBR Micro-Salinometer MS-310 and IAPSO Standard Seawater

GIL President R.Timmons presented us with a box of SSW and a bottle of his own Port.

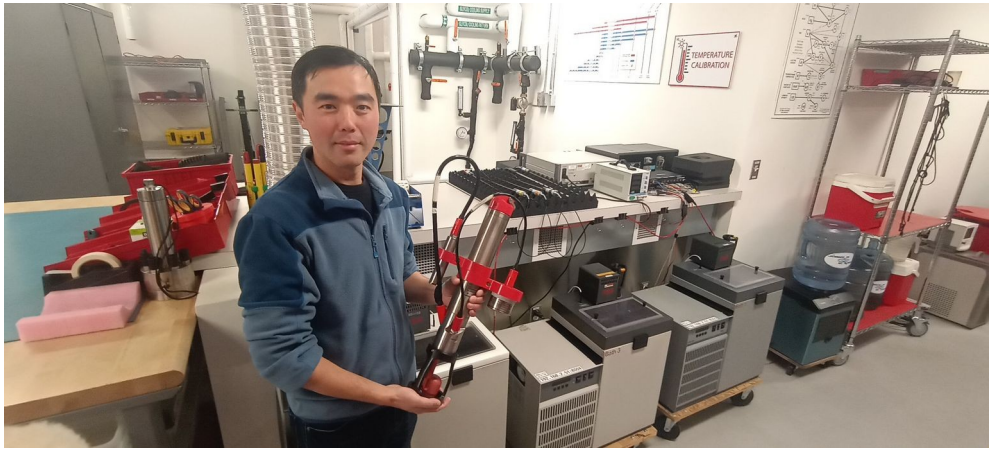
Operating Micro-Salinometer in Oceanographic lab onboard SV Oceanolog. T=32degC, no an air conditioner needs!

Results of verification of salinity accuracy





Calibration of our CTD in RBR



Quality Control of *in situ* Temperature and Salinity Data

QC tests:

Group 1 *Required*	Test 1)	Gap Test
	Test 2)	Syntax Test
	Test 3)	Location Test
	Test 4)	Gross Range Test
	Test 5)	Climatological Test
Group 2 *Strongly Recommended*	Test 6)	Spike Test
	Test 7)	Rate of Change Test
	Test 8)	Flat Line Test
Group 3 *Suggested*	Test 9)	Multi-Variate Test
	Test 10)	Attenuated Signal Test
	Test 11)	Neighbor Test
	Test 12)	TS Curve/Space Test
	Test 13)	Density Inversion Test

IOOS Integrated Ocean Observing System

QARTOD Quality Assurance/Quality Control of Real-Time Oceanographic Data

Manual for

Real-Time Quality Control of In-situ Temperature and Salinity Data

A Guide to Quality Control and Quality Assurance for In-situ Temperature and Salinity Observations

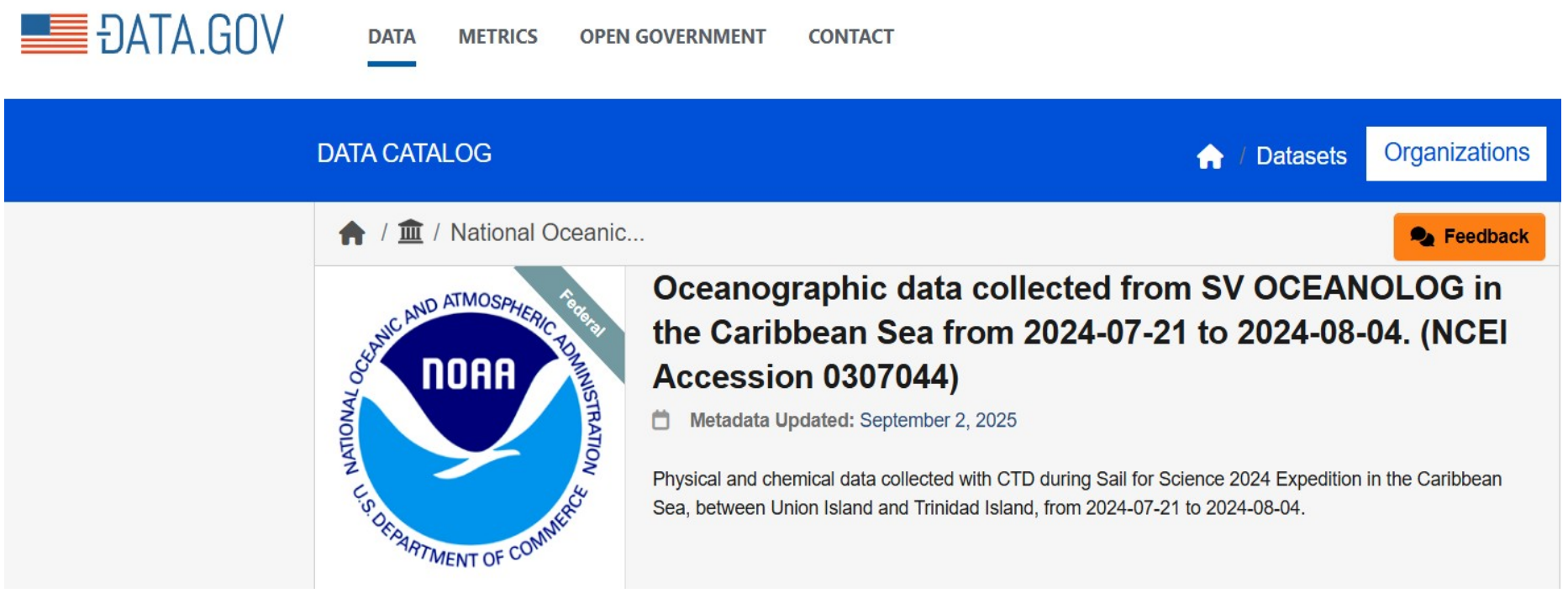
Version 2.0
January 2016

Quality Flagging

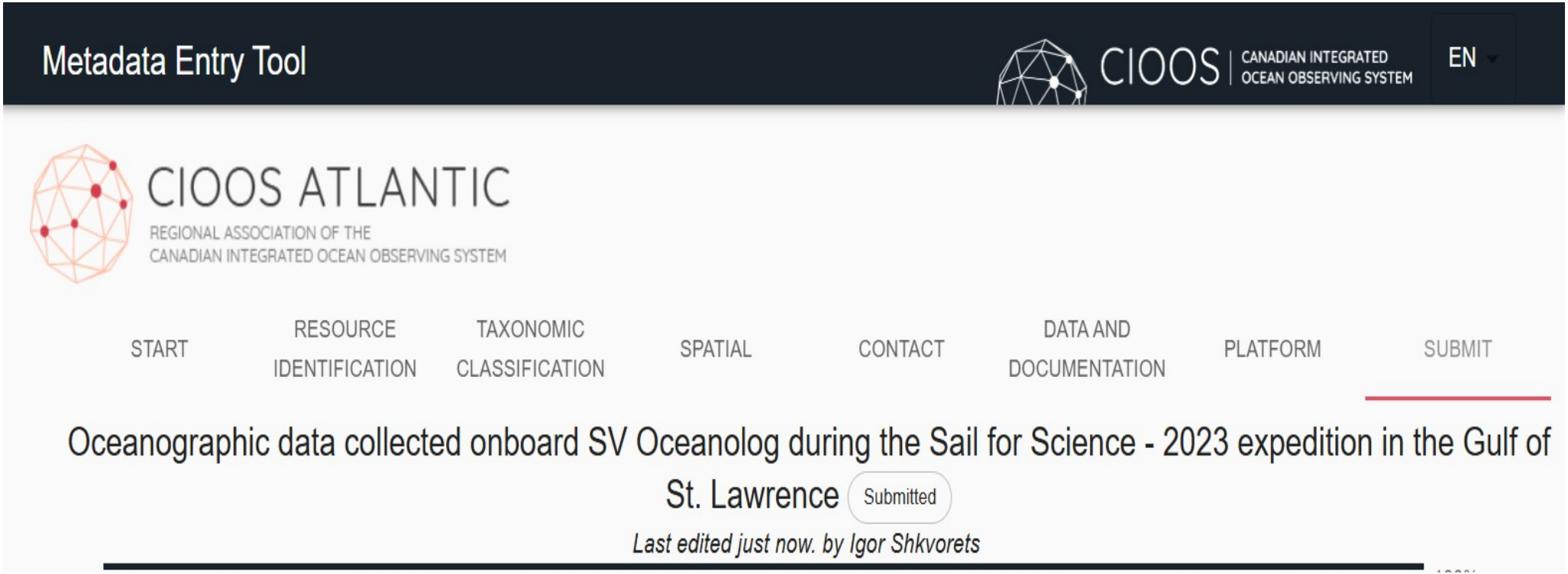
Flag	Description
Pass=1	Data have passed critical real-time quality control tests and are deemed adequate for use as preliminary data.
Not evaluated=2	Data have not been QC-tested, or the information on quality is not available.
Suspect or Of High Interest=3	Data are considered to be either suspect or of high interest to data providers and users. They are flagged suspect to draw further attention to them by operators.
Fail=4	Data are considered to have failed one or more critical real-time QC checks. If they are disseminated at all, it should be readily apparent that they are not of acceptable quality.
Missing data=9	Data are missing; used as a placeholder.

Credit: Global Indigenous Data Alliance

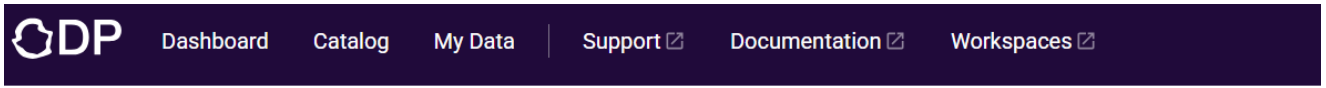
Submission of Data to the World Ocean Database (NCEI)



Submission of Data to the Canadian Integrated Ocean Observing System (CIOOS Atlantic)



Submission of Data to the Ocean Data Platform (HubOcean)



Oceanographic data from the Sail for Science-2024 Expedition

Dataset

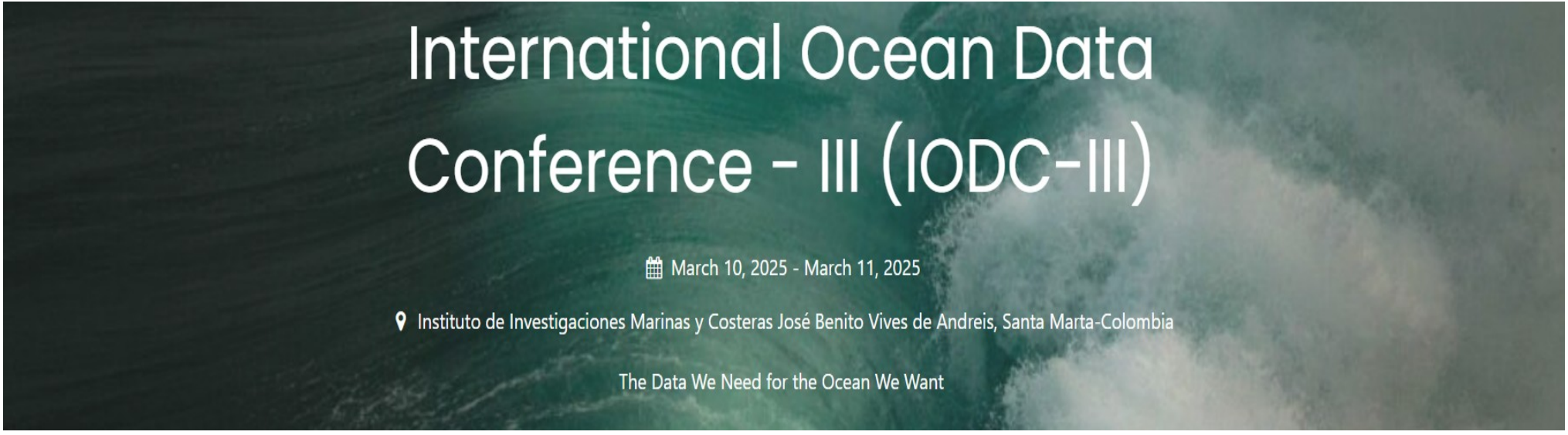
Description: Oceanographic data collected onboard SV OCEANOLOG during the Sail for Science-2024 Expedition in the Caribbean Sea using RBRconcerto3CTD in profiling mode from 3m to 110m depth and sampling interval 1s for variables: Temperature, Conductivity, Pressure, Practical Salinity, Dissolved Oxygen, Chlorophyll a, Transmittance, fDOM, Speed of Sound, Density
Tags: temperature, practical salinity, dissolved oxygen, chlorophyll a, transmittance, fDOM, speed of sound, density

Oceanographic data from the Sail for Science-2025 Expedition

Dataset

Description: Oceanographic data collected onboard SV OCEANOLOG during the Sail for Science-2025 Expedition in the Caribbean Sea using RBRconcerto3CTD in profiling mode from 3m to 100m depth and sampling interval 1s for variables: Temperature, Conductivity, Pressure, Practical Salinity, Dissolved Oxygen, Chlorophyll a, Transmittance, fDOM, Speed of Sound, Density Anomaly
Tags: temperature, practical salinity, dissolved oxygen, chlorophyll a, transmittance, fDOM, speed of sound, density

Poster presentation on the IODC-III

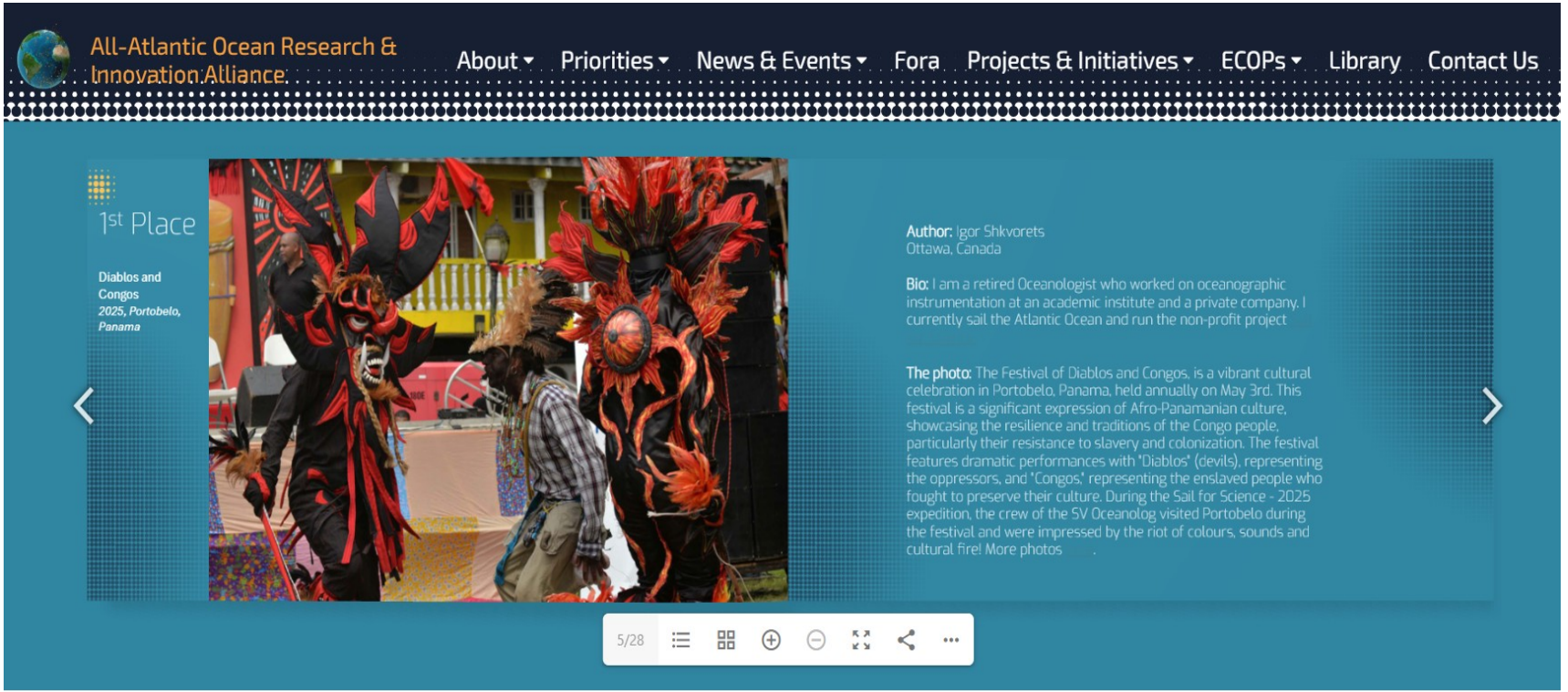


Sail for Science – how sailors can help science to fill gaps in oceanographic data

Igor Shkvorets, Iryna Troshyna, Sail for Science

"Sail for Science" is a pioneering initiative that bridges the gap between oceanographers and the global sailing community, enabling citizen scientists to contribute valuable oceanographic CTD data. Using advanced yet accessible instruments like the RBRconcertoCTD, we collect high-resolution and high-accuracy data of seawater properties, including temperature, salinity,

1st place on All-Atlantic Ocean Research and Innovation Alliance photo competition



Introduction CTD to Sailors

Marine Citizen Science programs:

1. Secchi Disk Study: www.secchidisk.org
2. Marine Debris Tracker: www.debristracker.org
3. The Globe Program: www.globe.gov
4. eOceans: www.eoceans.org
5. Sailors for the Sea: www.sailorsforthesea.org
6. Citizens of the Sea: www.citizensofthesea.org
7. Sailing4Science: www.sailing4science.org
8. The International SeaKeepers Society:www.seakeepers.org
9. Oceano-vox initiative: www.oceano-vox.com
10. Seabed-2030 program: www.seabed2030.org

Big Thanks to our Sponsors:

Thank you!
Any questions?