Consiglio Nazionale delle Ricerche

EGU General Assembly

Application of a highly reconfigurable surface robotic platform for freshwater plume characterization and sampling near tidewater glacier front in Arctic critical environment

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Giorgio Bruzzone, Massimo Caccia, Corrado Motta, and Angelo Odetti

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SETTING THE PROBLEM: THE LACK OF DATA IN ARCTIC CRITICAL ENVIRONMENT

Arctic critical environment

- ✓ dynamic, sensitive and fragile area
- ✓ area difficult or impossible to reach
- ✓ phenomena strongly localized in space and time
- ✓ events not repeatable and processes not completely predictable

Credits: A. Odetti
R. Ferretti
@radofoto

Lack of data is the penalizing factor in understanding **freshwater outflows** processes and their impact on the ecosystems

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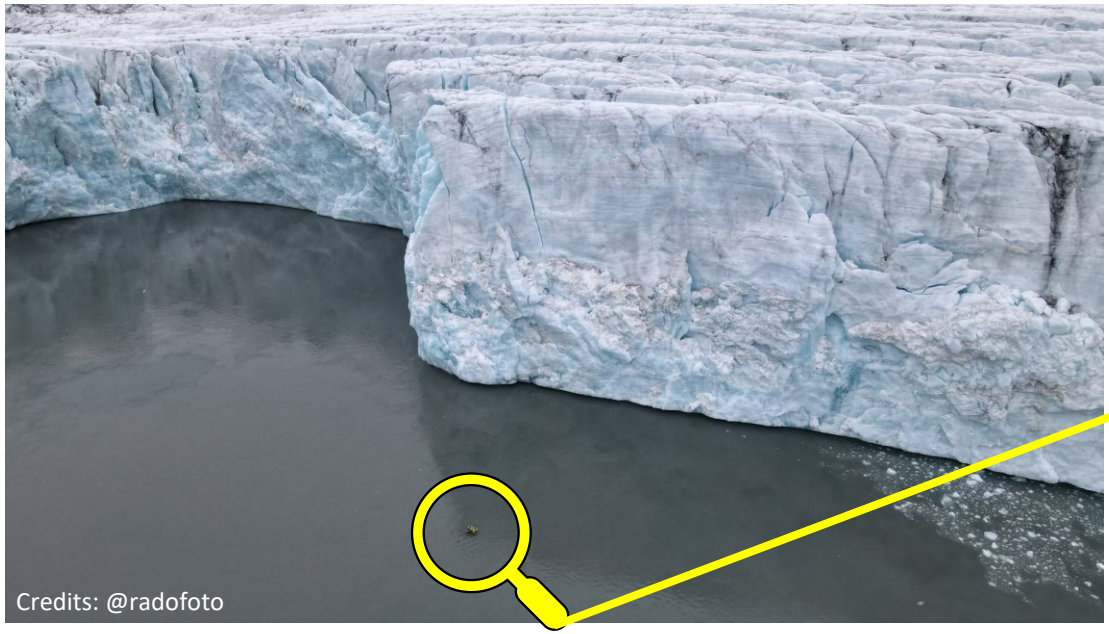
POSSIBLE SOLUTION: USE OF AUTONOMOUS ROBOTIC PLATFORMS

Use of **autonomous robotic platforms** for critical environments observation

- overcome limitations typical of traditional surveys
- possibility to operate in very dangerous areas (very close to calving glacier fronts)
- repeatability and accuracy of the data collected, georeferencing the observations
- unique spatio-temporal resolution

SWAMP – Shallow Water Autonomous Multipurpose Platform



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SWAMP IN ACTION: THE Re-load PROJECT

GOAL

Quantification of heavy metal discharge with freshwater runoff to the **Hornsund Arctic fjord** ecosystem (July and August 2022)

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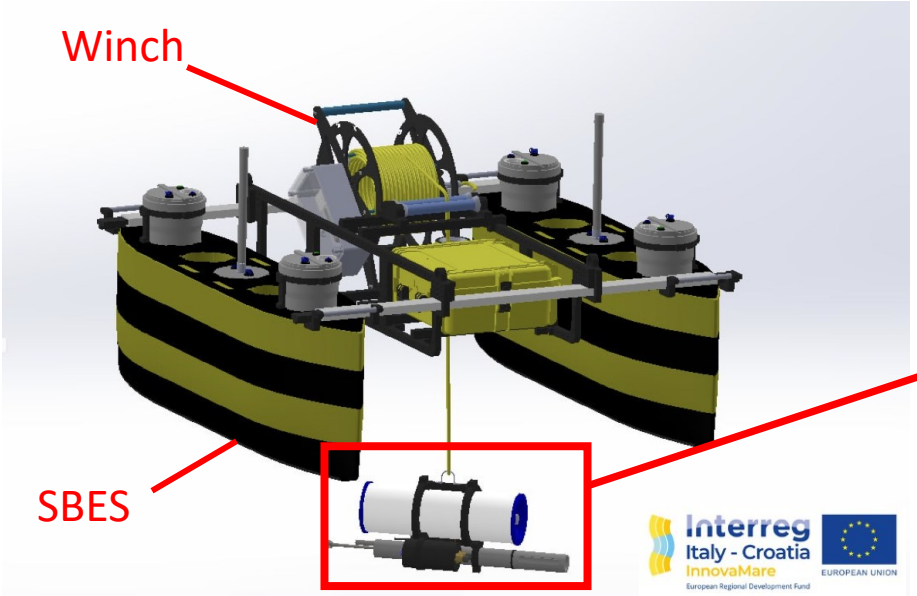
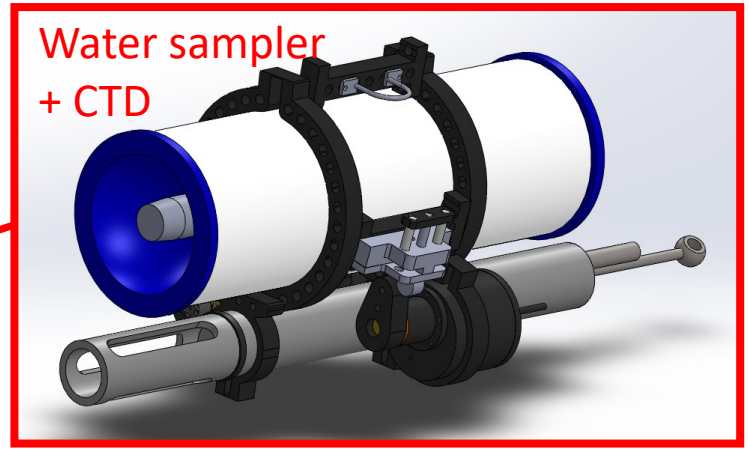
RE-LOAD





Sampling at three glacier fronts: Storbreen, Hornbreen and Hansbreen ★

- ✓ Collection of samples of the freshwater outflows
- ✓ CTD and SBES data collection for a 3D characterization of the water masses and the environment

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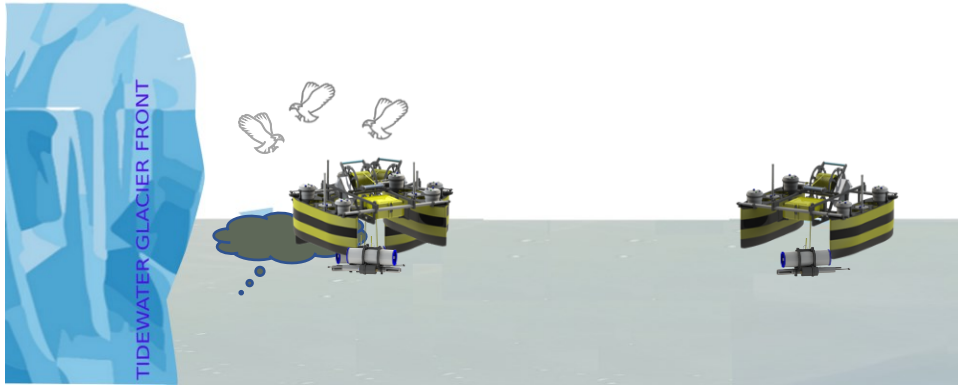
SWAMP IN ACTION: FRESHWATER PLUME SAMPLING

✓ Collection of water samples from freshwater outflow



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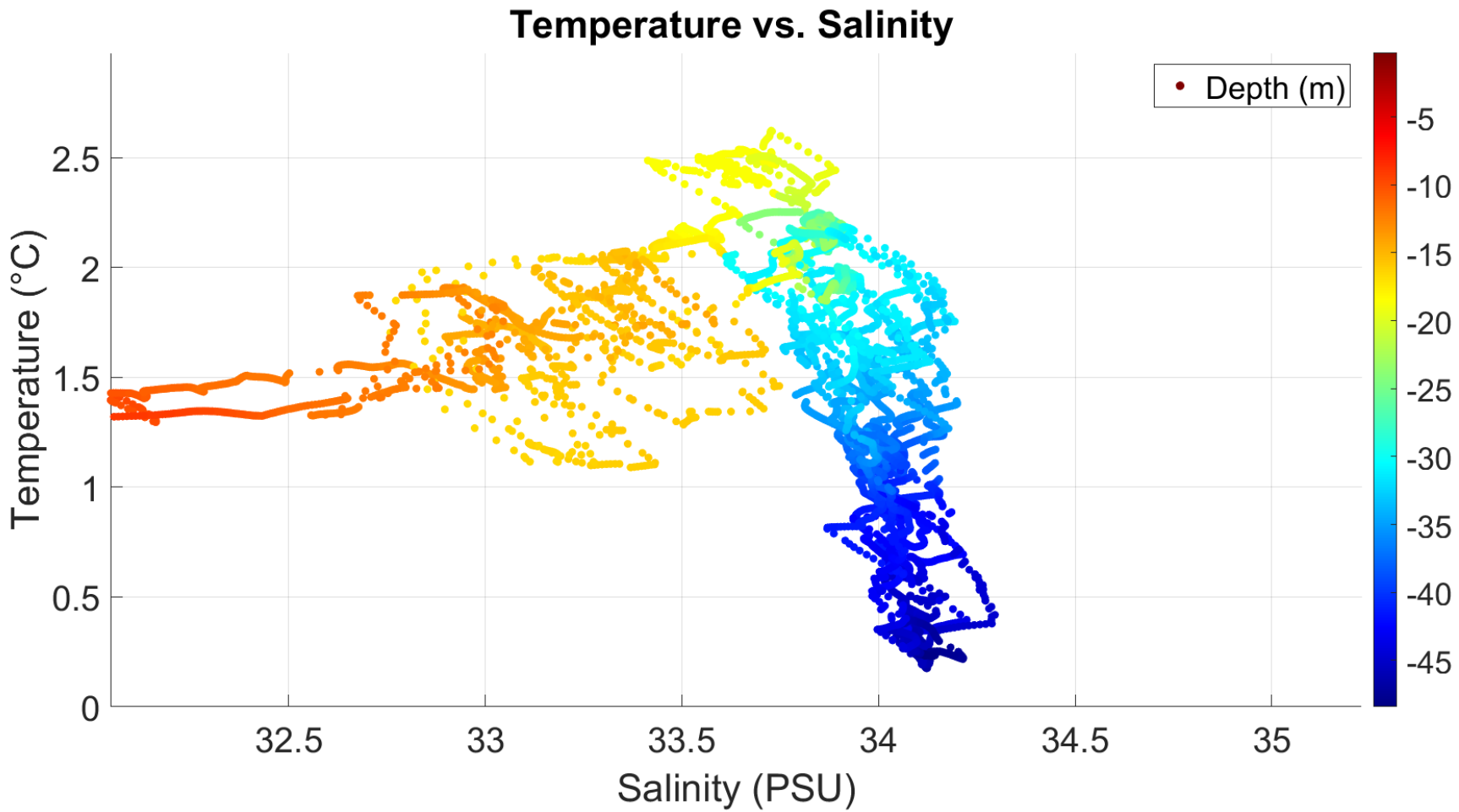
SWAMP IN ACTION: WATER MASSES CHARACTERIZATION

✓ CTD data collection along the water column for the study of water masses stratification



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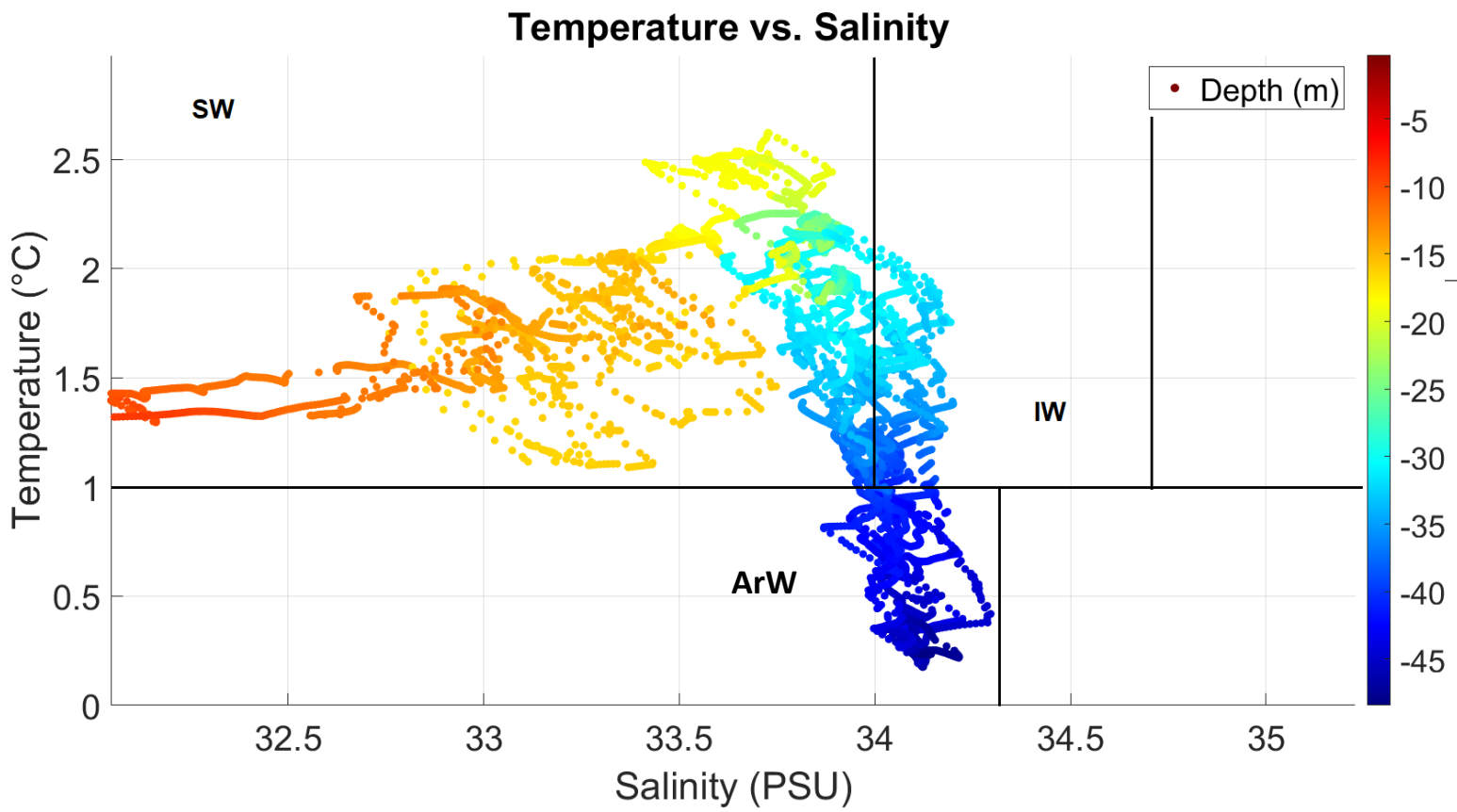
SWAMP IN ACTION: WATER MASSES CHARACTERIZATION

Graph of Salinity and Temperature along the water column



Water Mass	Abbreviation	Characteristics: Temperature (°C)	Characteristics: Salinity (PSU)
External			
Atlantic Water	AW	>3	>34.9
Arctic Water	ArW	−1.5 to 2	34–34.5
Internal			
Winter-cooled Water	WCW	<−0.5	>34.4
Local Water	LW	<1	
Surface Water	SW	>1	<34
Mixed			
Transformed Atlantic Water	TAW	>1	34.7–34.9
Intermediate Water	IW	>1	34–34.7

Water mass classification for Hornsund (adopted from Nilsen et al. 2008 and Promińska, et al. 2018)

Water Masses identification near glacier front BEFORE mixing with fjord water

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NEXT STEP: marine robotics data «FAIR by default»

Think to our research activities from a **data perspective**


SCIENTIFIC DATA

We'd like to understand how you use our websites in order to im

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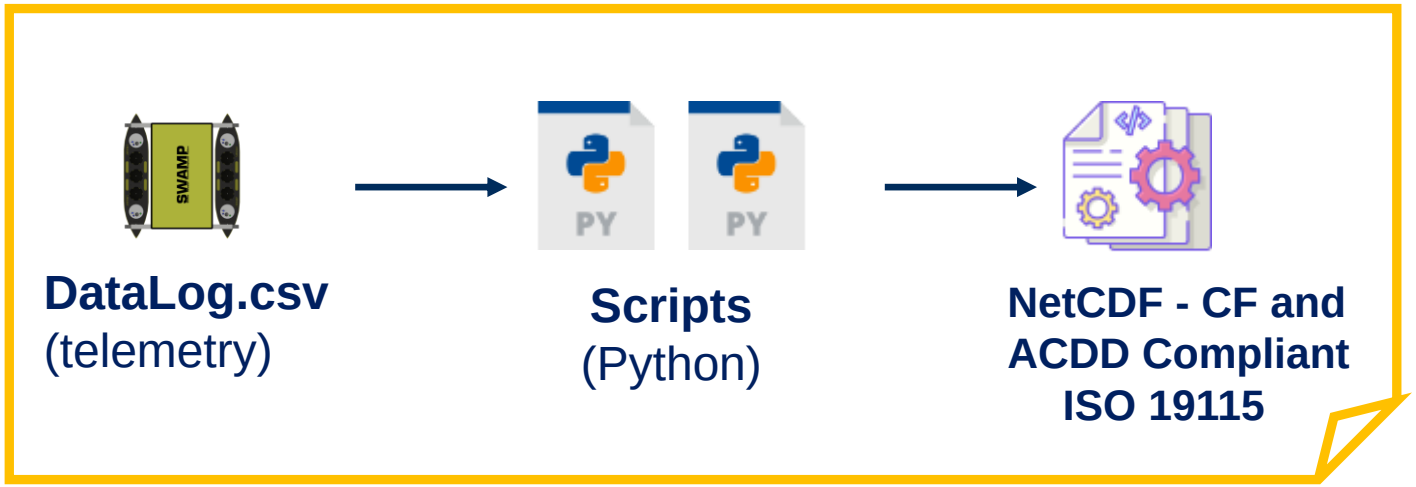
The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson, Michel Dumontier, [...] Barend Mons

FAIR guide, Nature, March 2016



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

https://github.com/CorradoMotta/FAIR-Data-in-Marine-Robotics

https://dynamics.folio3.com/blog/what-are-the-three-main-goals-of-data-lifecycle-management-dlm/

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Questions?

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Thank you for the attention!


Credits: @radofoto


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Sharing is encouraged

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Back up slides

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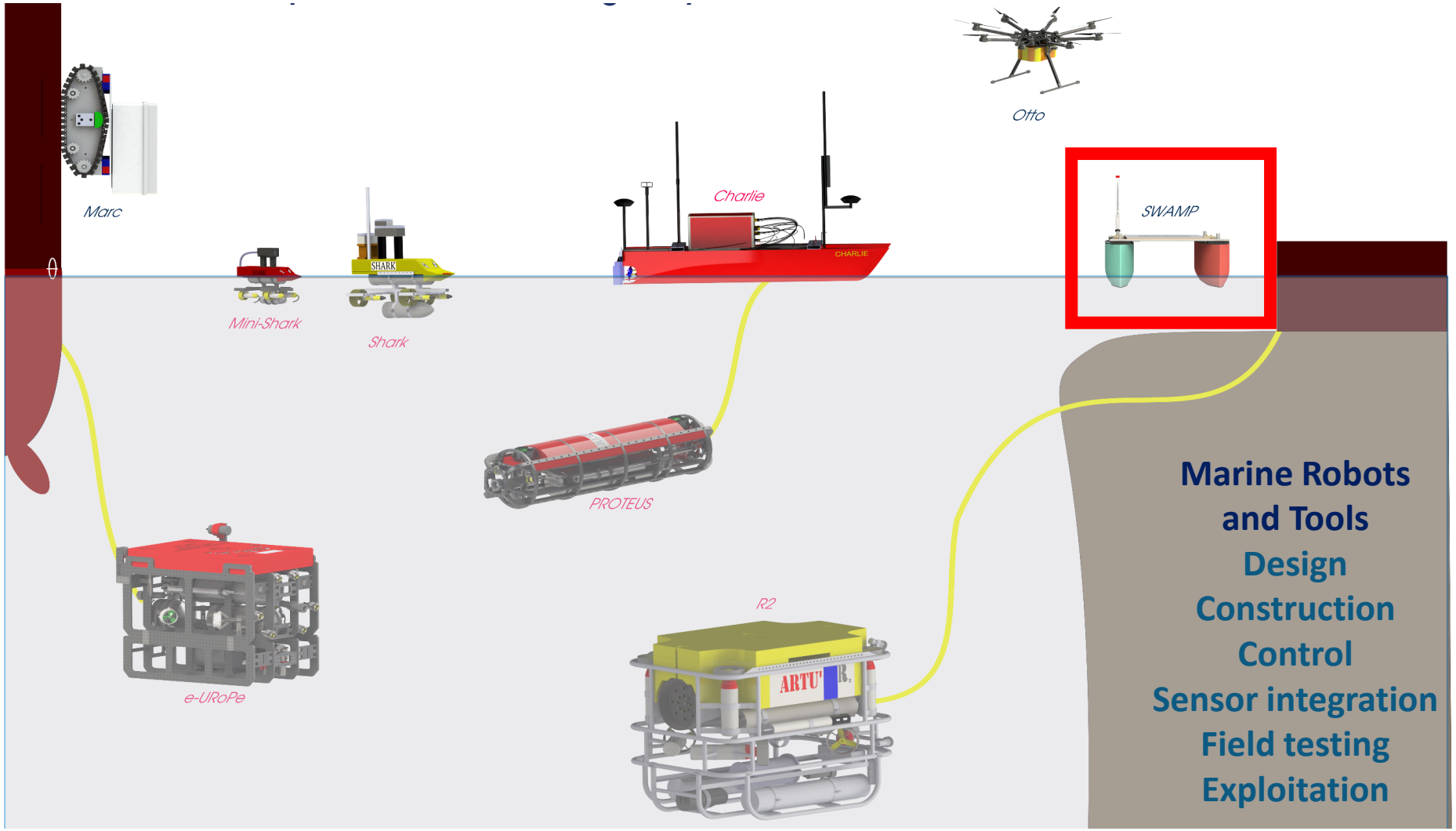
MARINE ROBOTICS @ CNR-INM GENOA: THE FLEET

INstitute of Marine engineering – National Research Council

Roma (Headquarter)
Roma – ARTOV
Genoa
Palermo



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SWAMP – Shallow Water Autonomous Multipurpose Platform

Design, development and field testing of a new Autonomous Surface Vehicle for harsh environment

- **Adaptation to critical environments:** Remoteness, Difficult access, Shallow water and High risk for operators and scientists
- **Portability:** lightweight, small dimensions
- **Reconfigurable – Modular - Multipurpose:** able to host and easily integrate different payload for different missions

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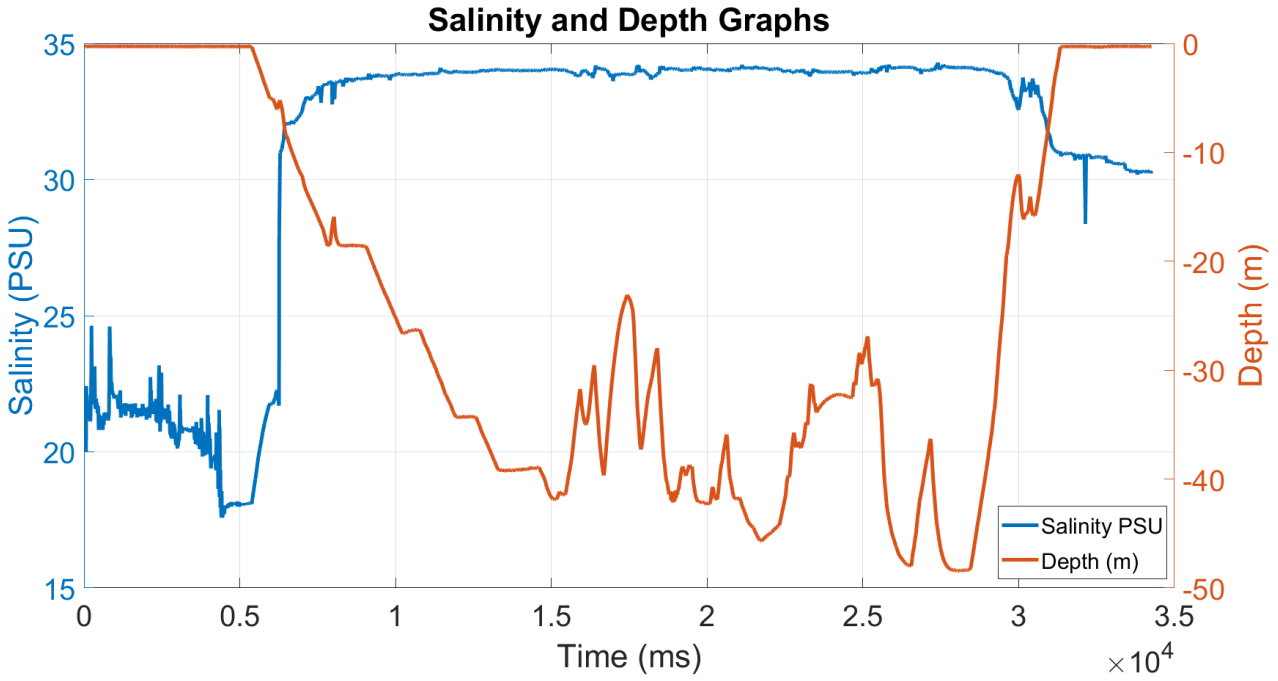
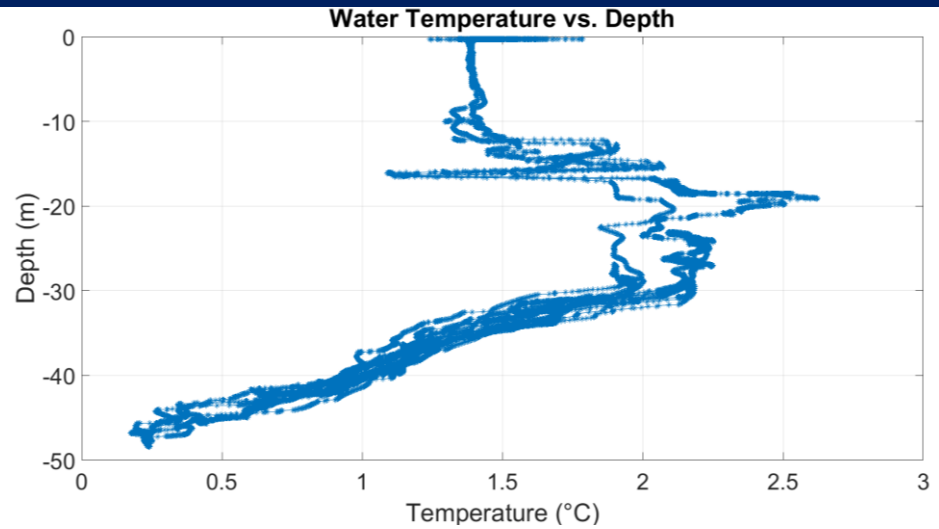
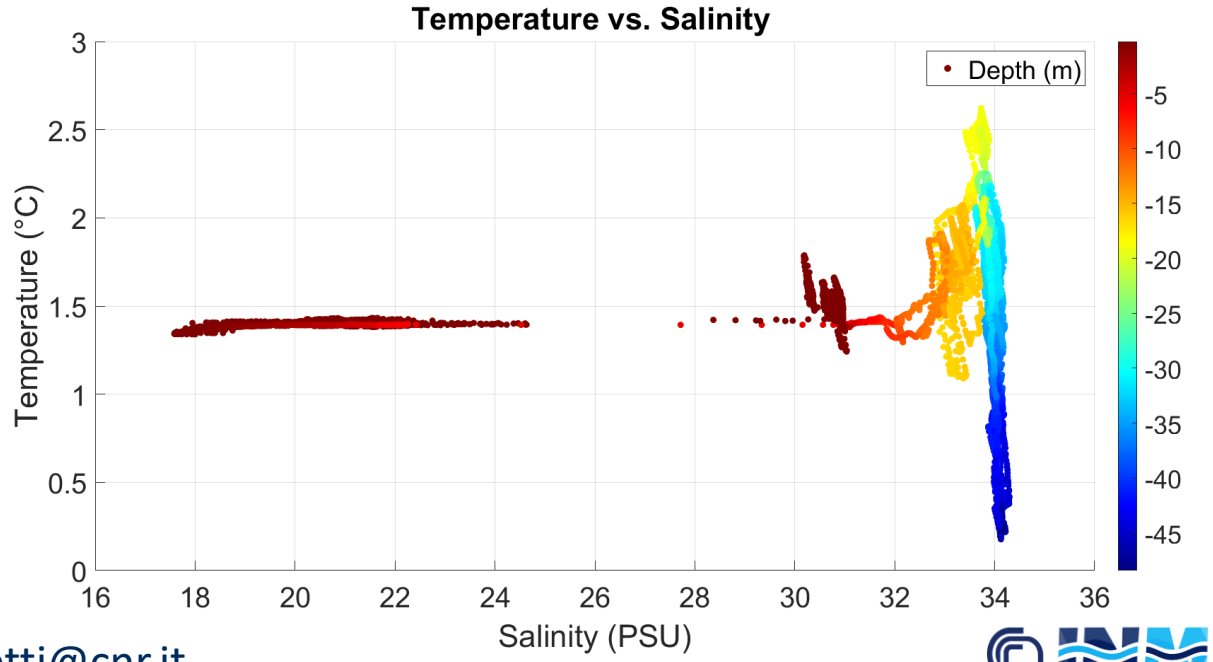
SWAMP IN ACTION: WATER MASSES CHARACTERIZATION

- ✓ CTD data collection along the water column for the study of water masses stratification







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Water mass classification for Hornsund Fjord from literature

Water Mass	Abbreviation	Characteristics	
		Temperature (°C)	Salinity (PSU)
External			
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Water mass classification for Hornsund
(adopted from Nilsen et al. 2008 and Promińska, et al. 2018)

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THE Re-load PROJECT (IO PAN)

The overall objective of this project is to assess fluxes of heavy metals discharged by freshwater (mainly meltwater from tidewater glaciers) to Hornsund fjord.

Hypothesys:
the discharge of heavy metals with glacial meltwater to marine ecosystem is the most important source of contaminants in fjord hosting tidewater glaciers

The validation of hypothesis will be implemented by measurement of **heavy metal concentrations in freshwater** and seawater, modelling of freshwater input, calculation of temporal fluxes and loads of contaminants to the fjord seawater and **assessing the risk** for marine ecosystem. The problem can be particularly relevant for semi-enclosed glacial bays with limited water exchange thus Brepollen (Hornsund) was selected for the study.

Although a proportion of heavy metals in the environment is of natural origin even up to 90% is estimated to origin from **anthropogenic activity**

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THE Re-load PROJECT (IO PAN)

The Arctic is particularly **vulnerable to contamination**. Climate changes affect transport, deposition and transfer of contaminants to and within the Arctic.

Several heavy metals (As, Cd, Cu, Pb, Zn, Hg) considered to originate from the anthropogenic activities were suggested to wider monitoring. Unfortunately, still **no regular monitoring** is performed.

Melting glaciers can be important secondary sources of contaminants to the fjord ecosystems.

WP2. Determination of heavy metal contamination in seawater and sediments at the glacier fronts

Responsible Partner: IO PAN with participation of US

Task 1 Field work planning and organization. Sampling at mid ablation season and at the end of ablation season. Sample collection will be conducted in cooperation with Dr Roberta Ferretti (from CNR-INM, Italy) using unmanned vehicles for autonomous sampling at the calving glaciers fronts. Samples transport to the IO PAN laboratory

To distinguish the **fraction of anthropogenic Pb** a method based on $^{206}Pb/^{207}Pb$ and separately on $^{208}Pb/^{206}Pb$ is used. It will be possible to distinguish natural and anthropogenic provenience of Pb.

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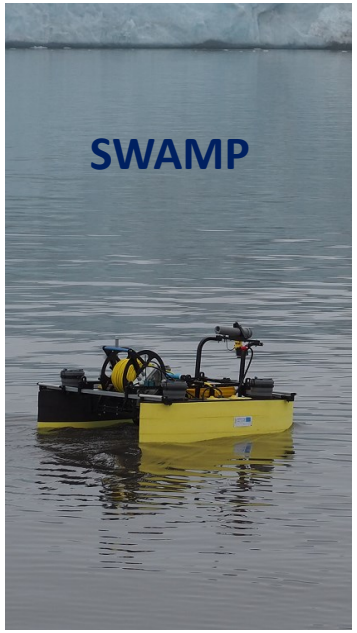
NEXT STEP: marine robotics data «FAIR by default»



HCI

SWAMP

Conf.ini (global metadata)

Log&Trace.csv (telemetry)

PY PY

Scripts (Python)

Database for global and variable metadata (JSON)

global_metadata.json

variable_metadata.json

NetCDF - CF and ACDD Compliant

ISO 19115

https://github.com/CorradoMotta/FAIR-Data-in-Marine-Robotics

SCIENTIFIC DATA

We'd like to understand how you use our websites in order to imp

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