

APECS-ARICE Webinar

Polar marine robotics - Part 1

Moderation: Josefine Lenz (AWI, APECS & ARICE)



Speakers:

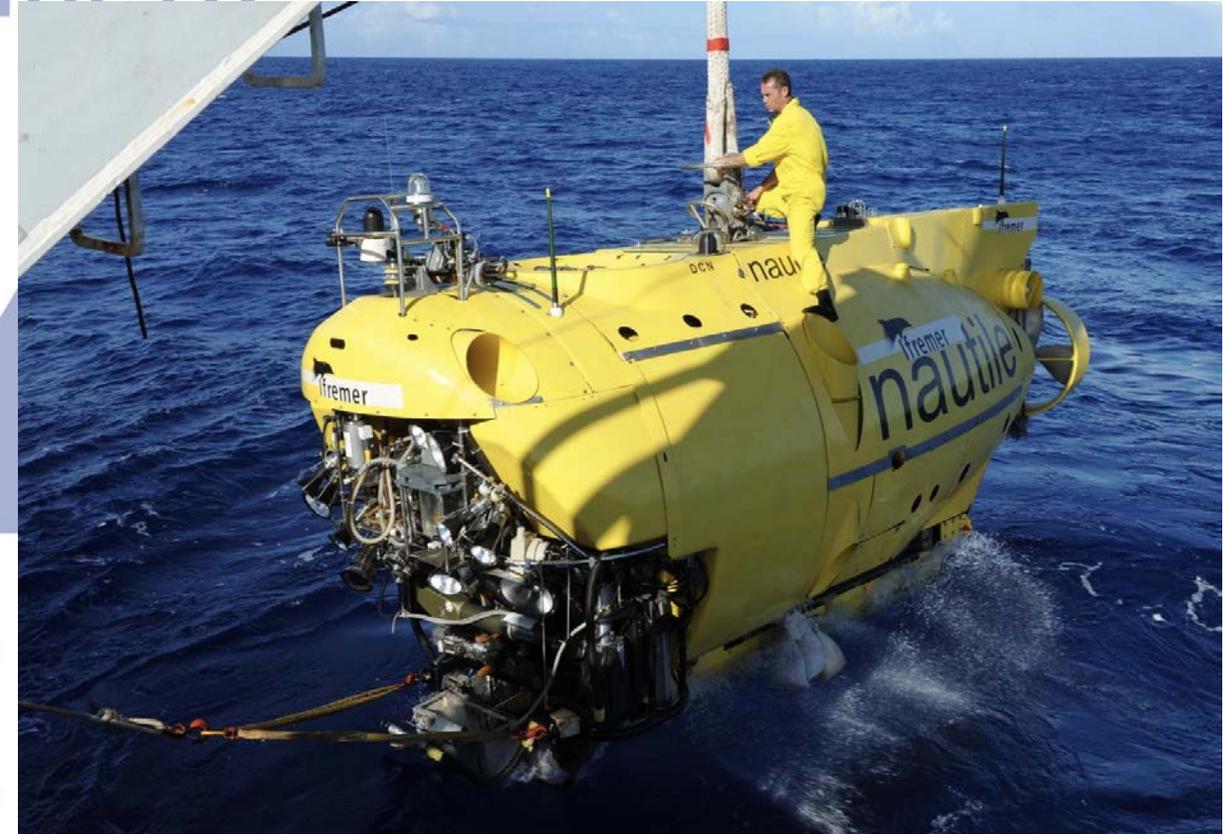
Massimo Caccia (CNR-INM)

Angelo Odetti (CNR-INM)

Raffaella Beroldo (CNR-INM)



Manned underwater exploration



ARI

Unmanned marine exploration



ROV
Remotely
Operated
Vehicle

AUV
Autonomous
Underwater
Vehicle



ASV
Autonomous
Surface
Vehicle

Glider



Robots below the Arctic ice: the origin



- Problem: topography of the packed-ice underwater profile
- Solution: using underwater vehicles equipped with acoustic sensors
- Interesting natural test site
 - Fletcher's Ice Island (T-3)
- UARS Unmanned Arctic Research Submersible
 - University of Washington's Applied Physics Laboratory
- Spring 1972
 - UARS explores the keel of Fletcher's Ice Island



Figure 2 Unmanned Arctic Research Submersible System (UARS) - University of Washington, Seattle



Launch & Recovery

- AUV deployed through a hole in the packed-ice
- **Problem: the AUV had to find the launch&recovery hole in the packed-ice after travelling a 17-mile transept!**
- **Solution**
 - an acoustic transmitter was deployed through the hole in the packed-ice
 - two directional acoustic receivers were mounted on the AUV bow
 - one omnidirectional acoustic receiver was mounted on the AUV stern
 - the AUV was recovered by using a net deployed below the hole, where the AUV nose got caught

Mid Nineties: Odyssey AUV in the Arctic

MIT Odyssey AUV

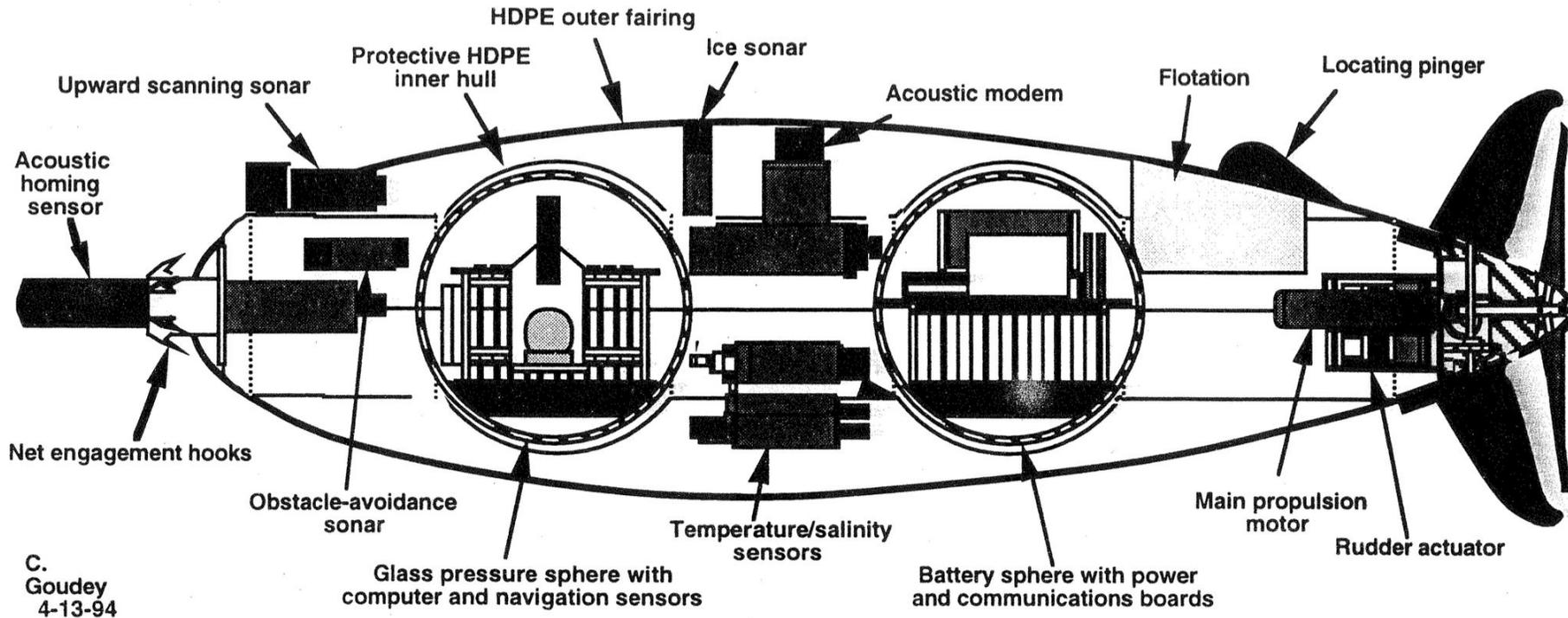


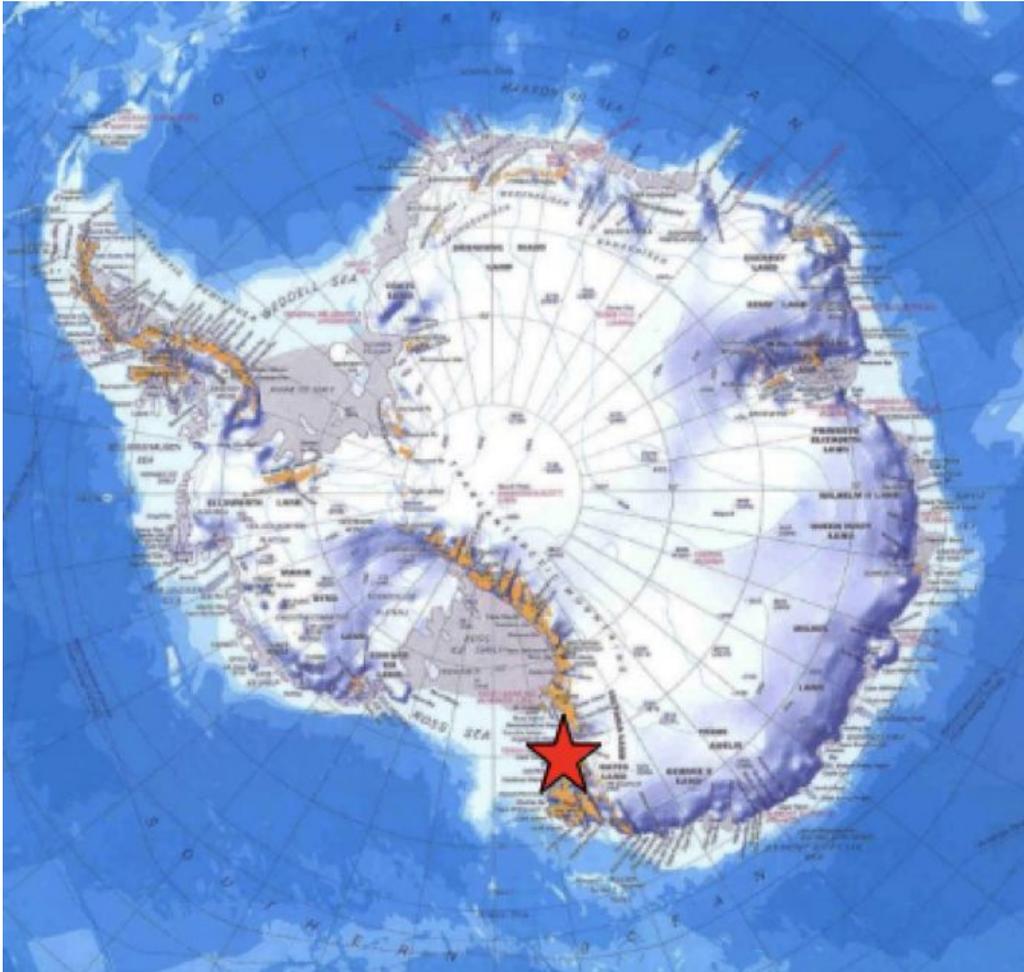
Figure 1: Arctic configuration of Odyssey II. Mission sensors are the scanning sonar at the nose, and the temperature and conductivity sensors located in the center of the vehicle.

the AUV is deployed through a hole in the packed-ice protected by a tent

Nineties: CNR ROVs in Antarctica

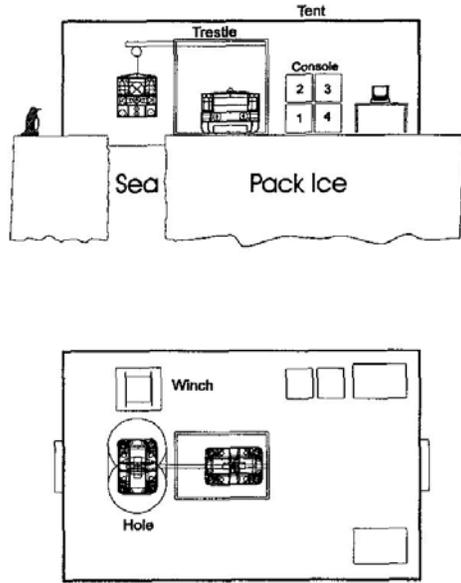


Mario Zucchelli Station, Terra Nova Bay, Ross Sea



Nineties: CNR ROVs in Antarctica

the ROV is deployed through a hole in the packed-ice protected by a tent

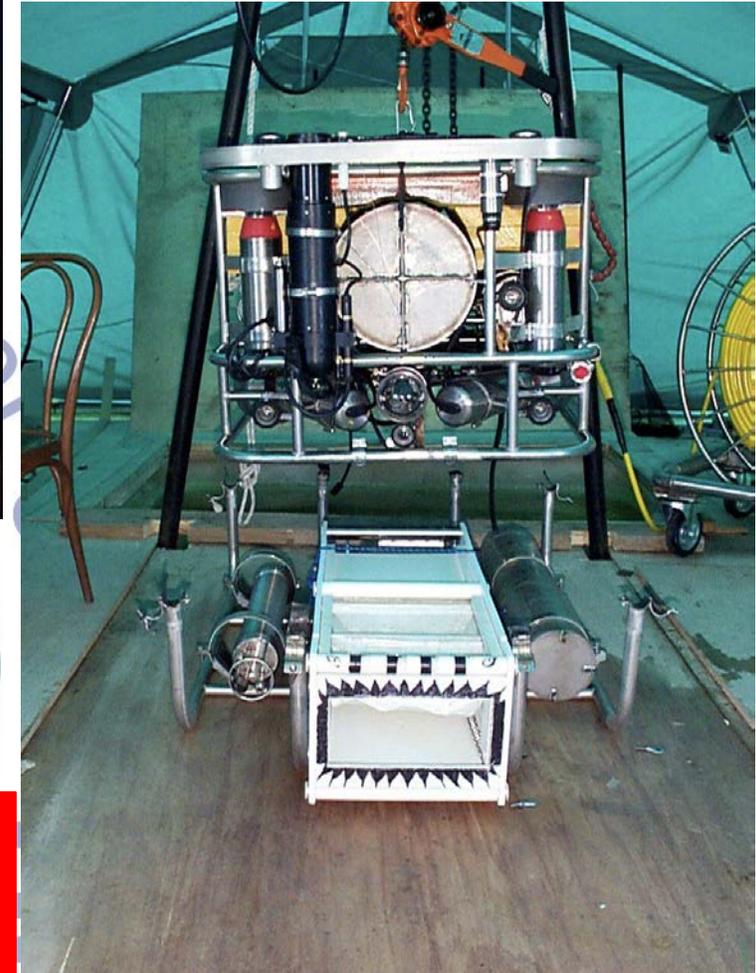


Roby2 ROV: 1993-'94



**ANTARCTIC SPECIALLY PROTECTED AREA No 161
TERRA NOVA BAY, ROSS SEA**

Malippo support vessel



Romeo ROV: 1997-'98



Nineties: CNR ROVs in Antarctica

Validation of acoustic device performances

ROV exploration of the keel of the Campbell Ice Tongue in Antarctica

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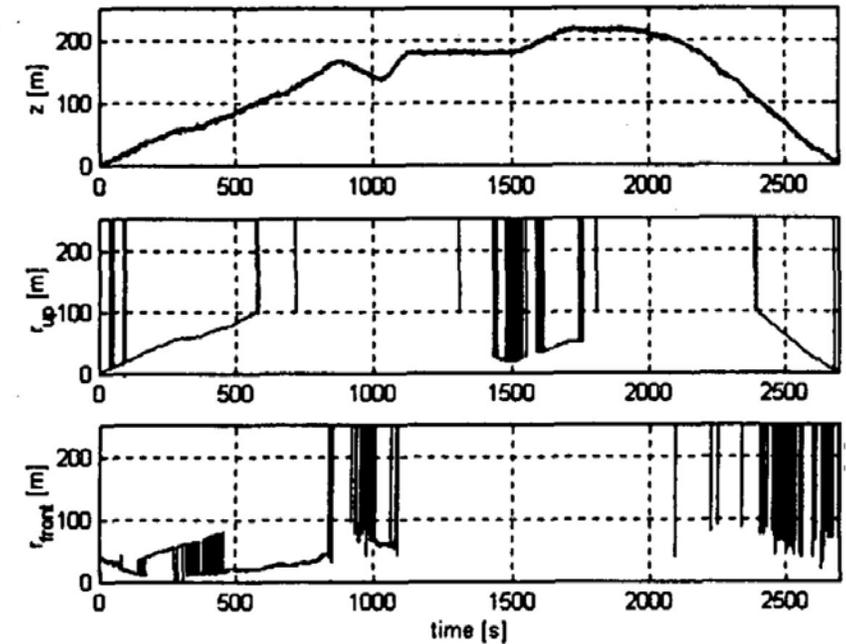
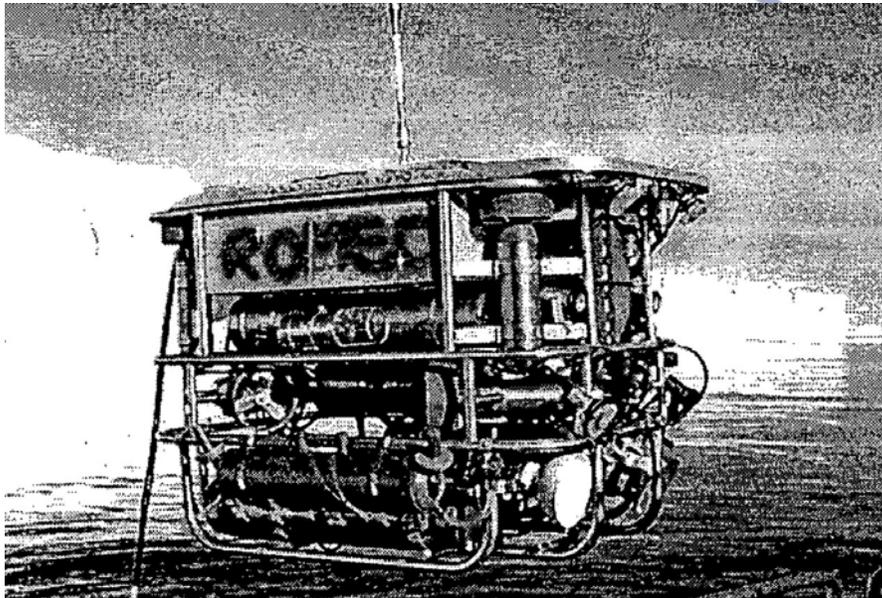


Fig. 5. Romeo depth and echo-sounder ranges

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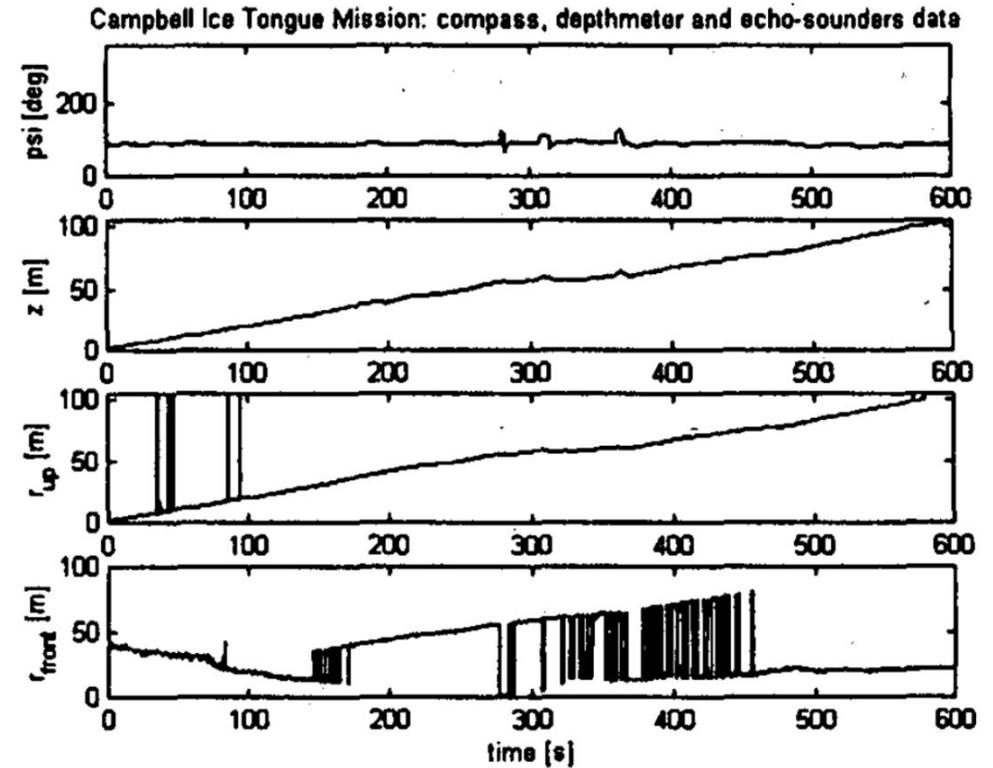


Fig. 6. Romeo heading, depth, sea surface detector and obstacle avoidance sonar range. Multi-path effects are clearly visible from time=150 s to time=450s.



Nineties: CNR ROVs in Antarctica

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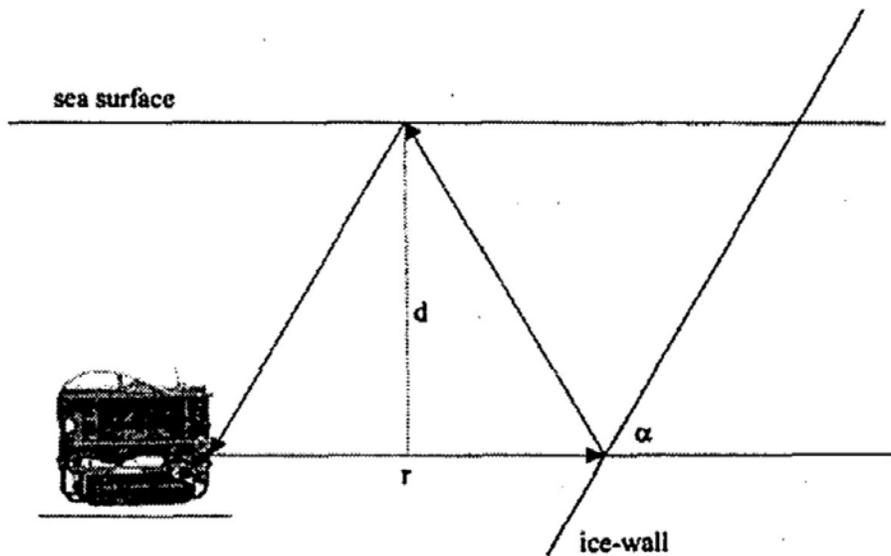


Fig. 7. Model of acoustic multi-path between the ice-wall and the sea surface.

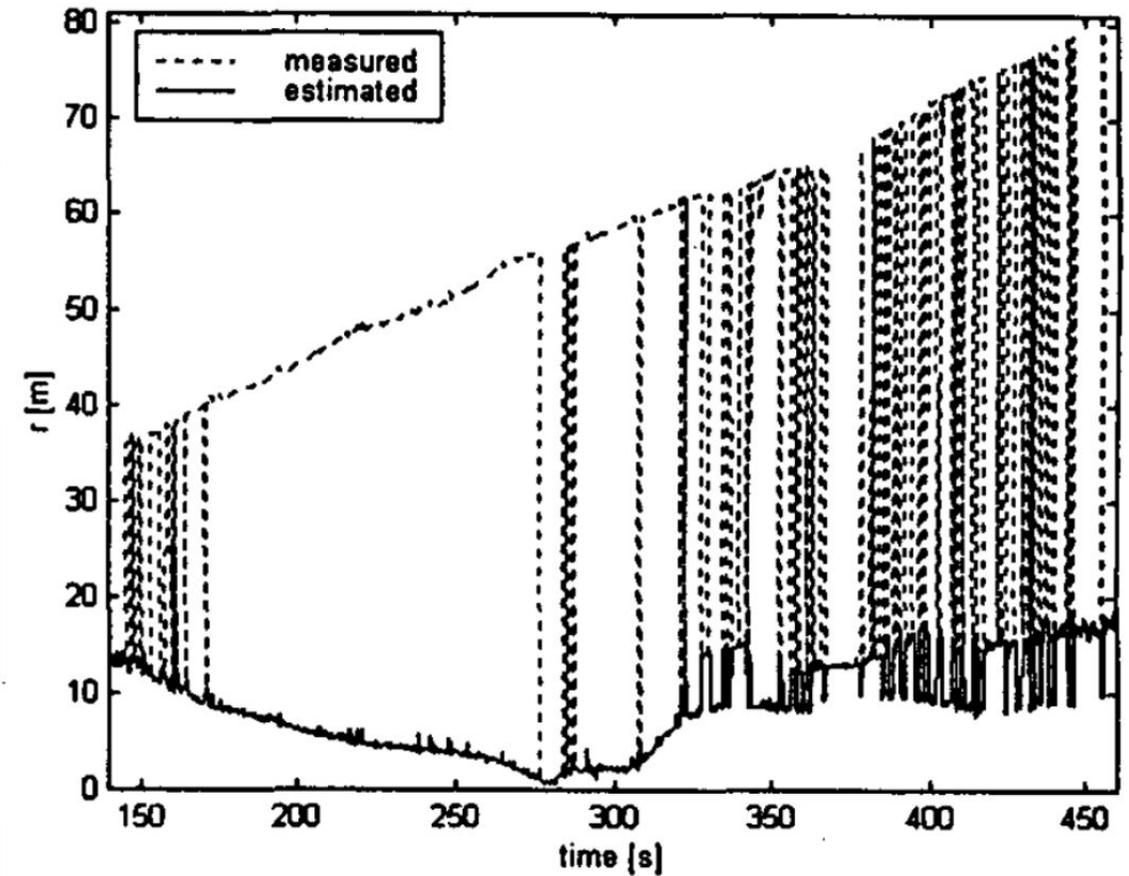
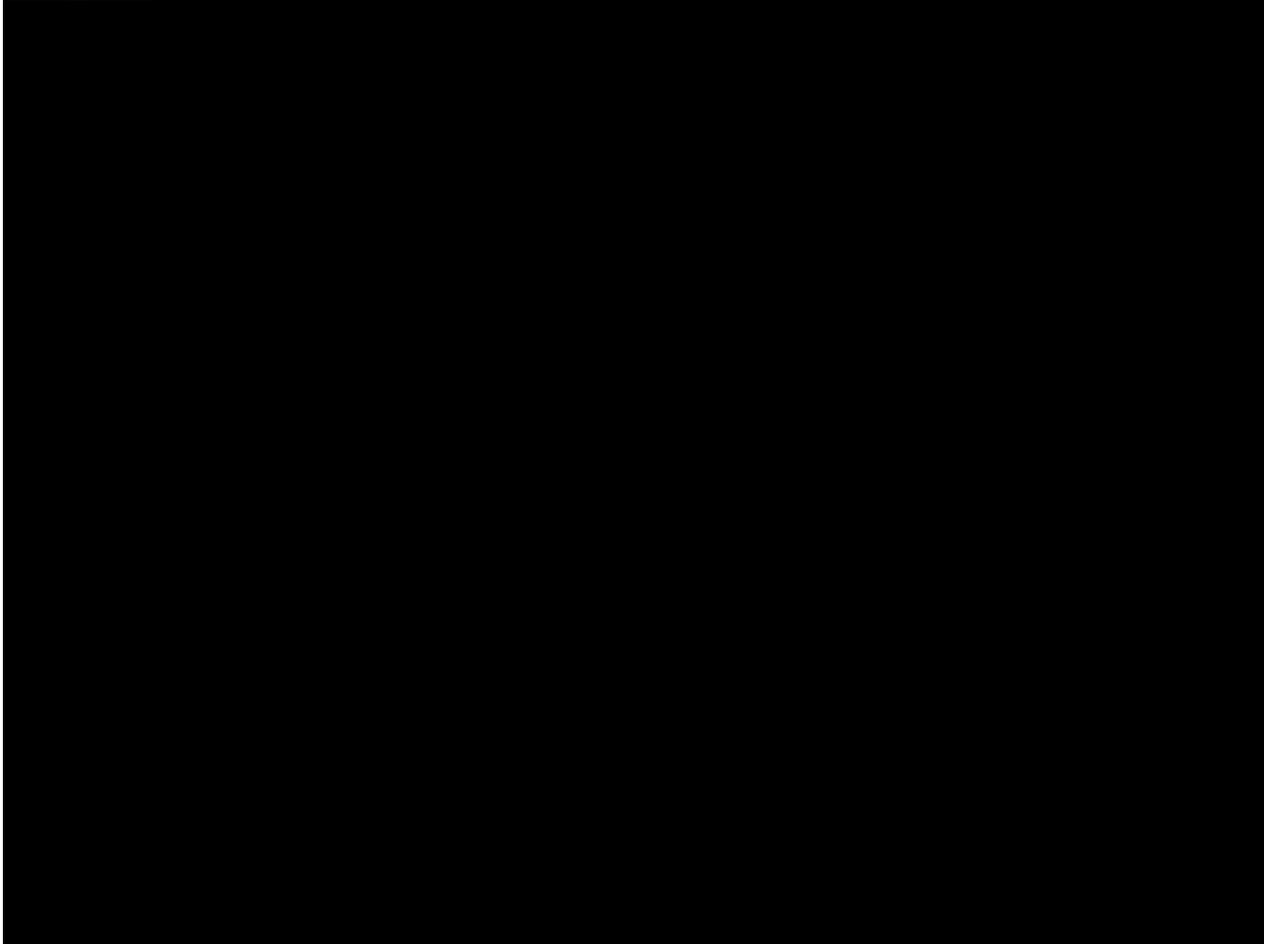


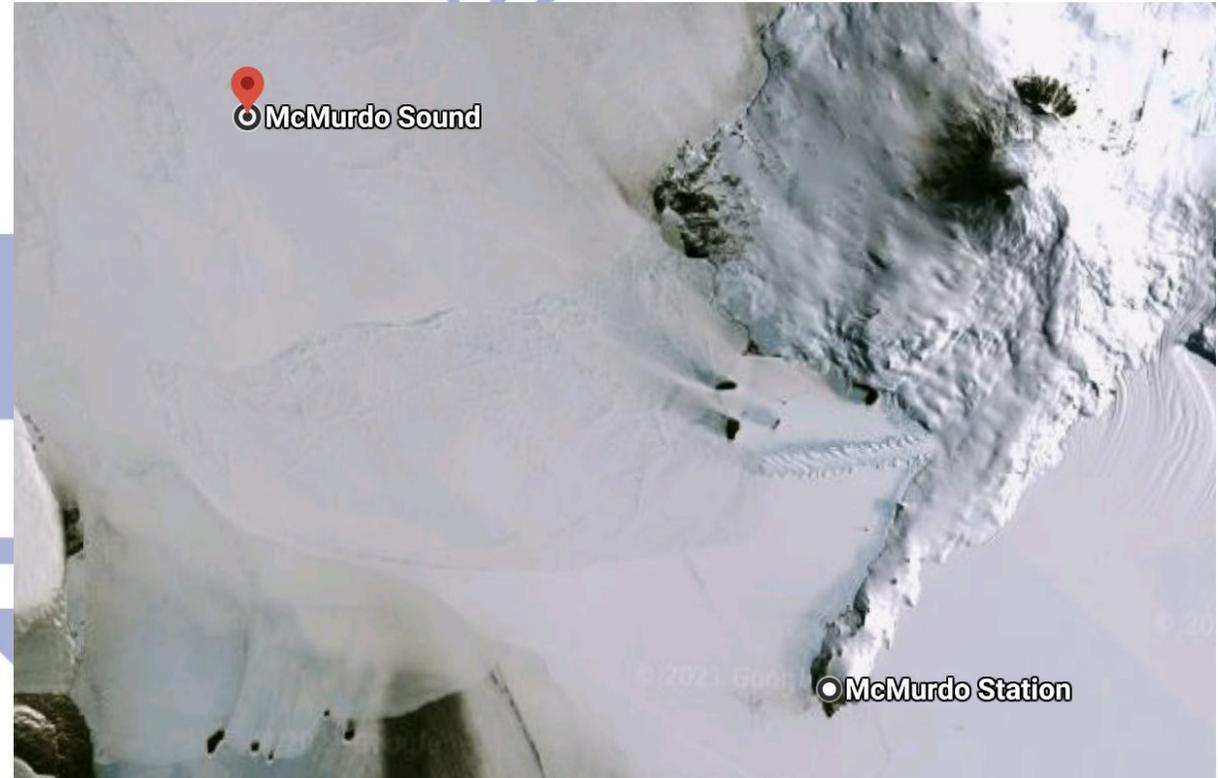
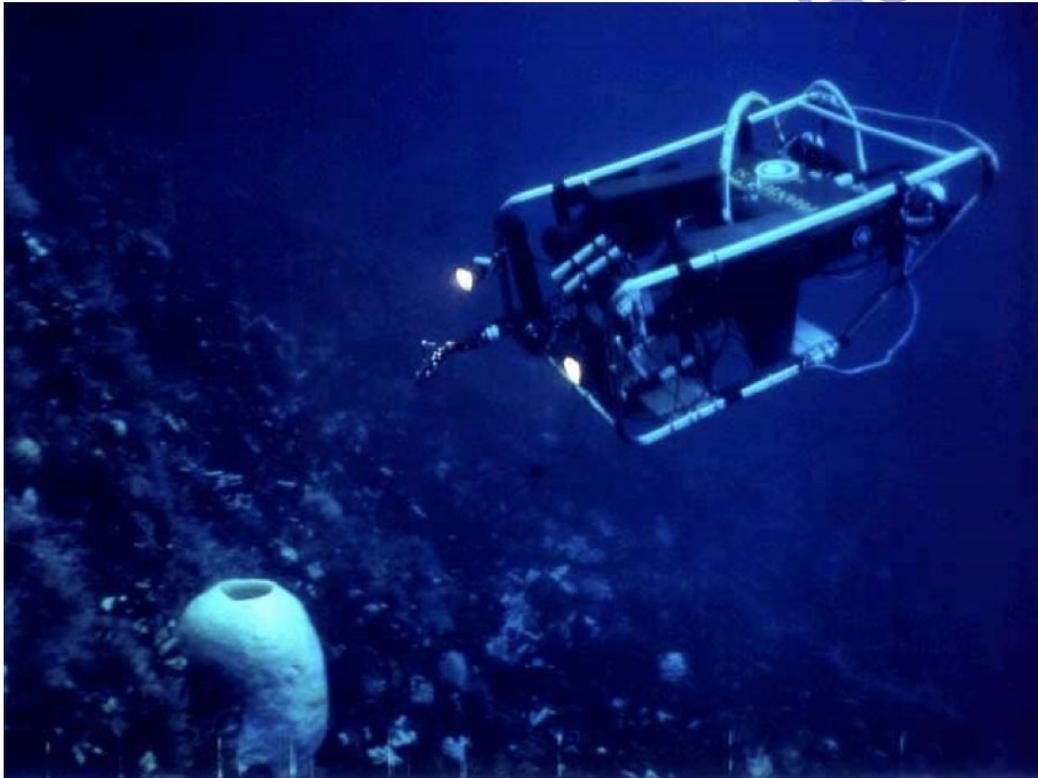
Figure 9. Measured and reconstructed obstacle avoidance sonar range.

1997-'98: Romeo ROV in Antarctica



Remote tele-operation of ROV in Antarctica

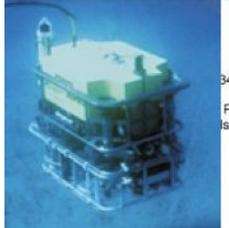
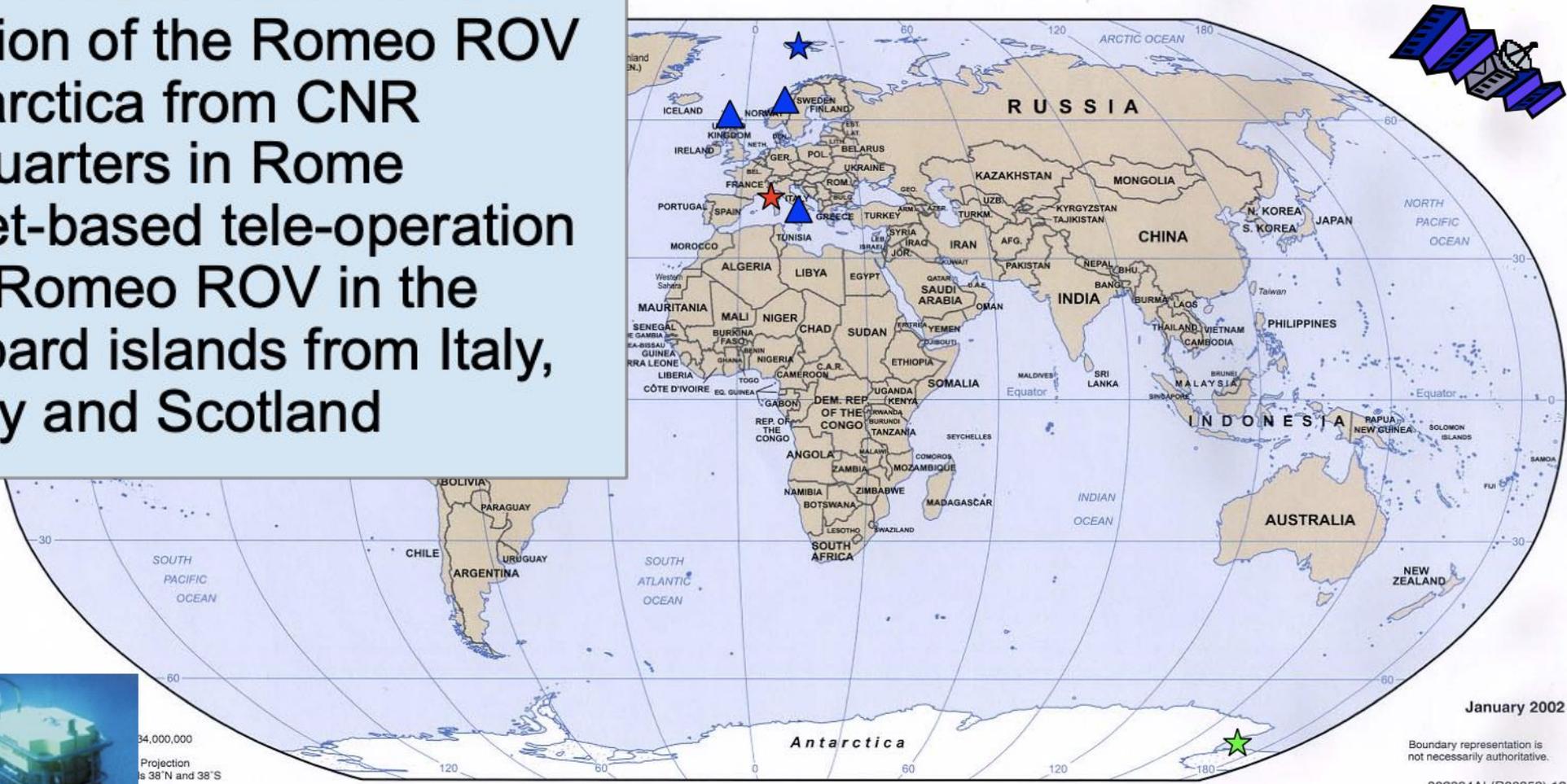
- 1993: satellite-based tele-operation of a ROV into McMurdo Sound in Antarctica from NASA AMES Research Center in USA
 - preliminary trials towards Mars missions



2002: Polar Internet-based tele-operation



- Internet-based satellite tele-operation of the Romeo ROV in Antarctica from CNR headquarters in Rome
- Internet-based tele-operation of the Romeo ROV in the Svaalbard islands from Italy, Norway and Scotland

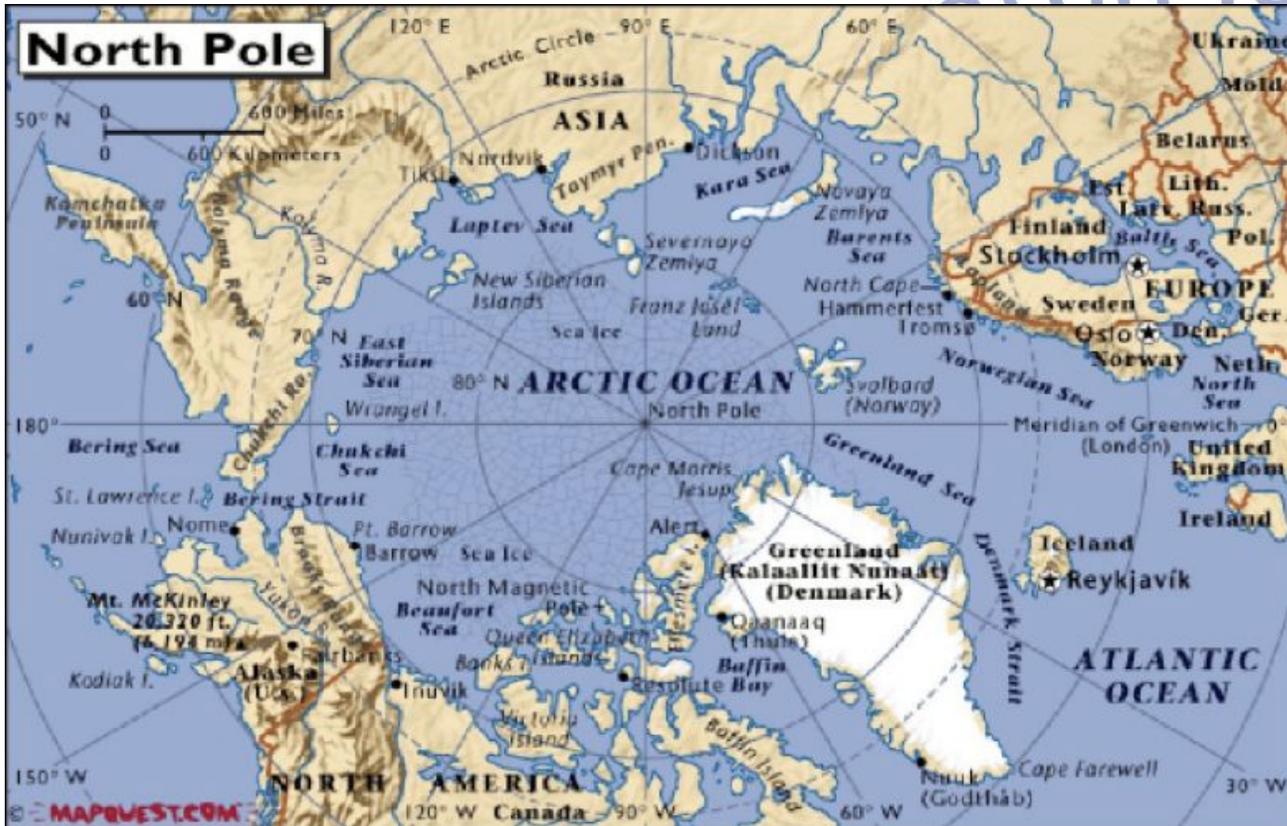


34,000,000
Projection
is 38°N and 38°S



CNR ROV in the Arctic

- Dirigibile Italia Station, Ny Alesund, Svalbard Islands



Tele-operation of Romeo ROV in Kongsfjord



ROV-supported persistent monitoring



- Goal: persistent monitoring of seafloor-water interactions below the packed-ice in Antarctica
- Solution:
Antarctic Benthic Shuttle
(PNRA ABS project -2003-'05)
 - Terra Nova Bay, Ross Sea, Antarctica
 - Romeo ROV



Under-ice persistent observation



- **Scientific goal**
Observing and understanding the Antarctic silverfish reproduction in the platelet ice
- **POLE**
(PNRA project -2015)
 - Terra Nova Bay, Ross Sea, Antarctica
 - 1 year under ice observation

Under-ice monitoring with portable robots



- **Scientific goal**
Observing and understanding the Antarctic silverfish reproduction in the platelet ice



- **RAISE**
(PNRA project -2015)
 - Terra Nova Bay, Ross Sea, Antarctica
 - Antarctic silverfish larvae and eggs sampling with an adapted VideoRay mini-ROV



Under-ice sampling



- **Scientific goal**
to collect bryozoans at 60 m depth and re-implant them in shallow water cages

- **ICECLIMALIZERS**

(PNRA project -2017)

- Terra Nova Bay, Ross Sea, Antarctica
- Proteus ROV equipped with an innovative underwater electrical arm



Antarctic air-sea interface sampling



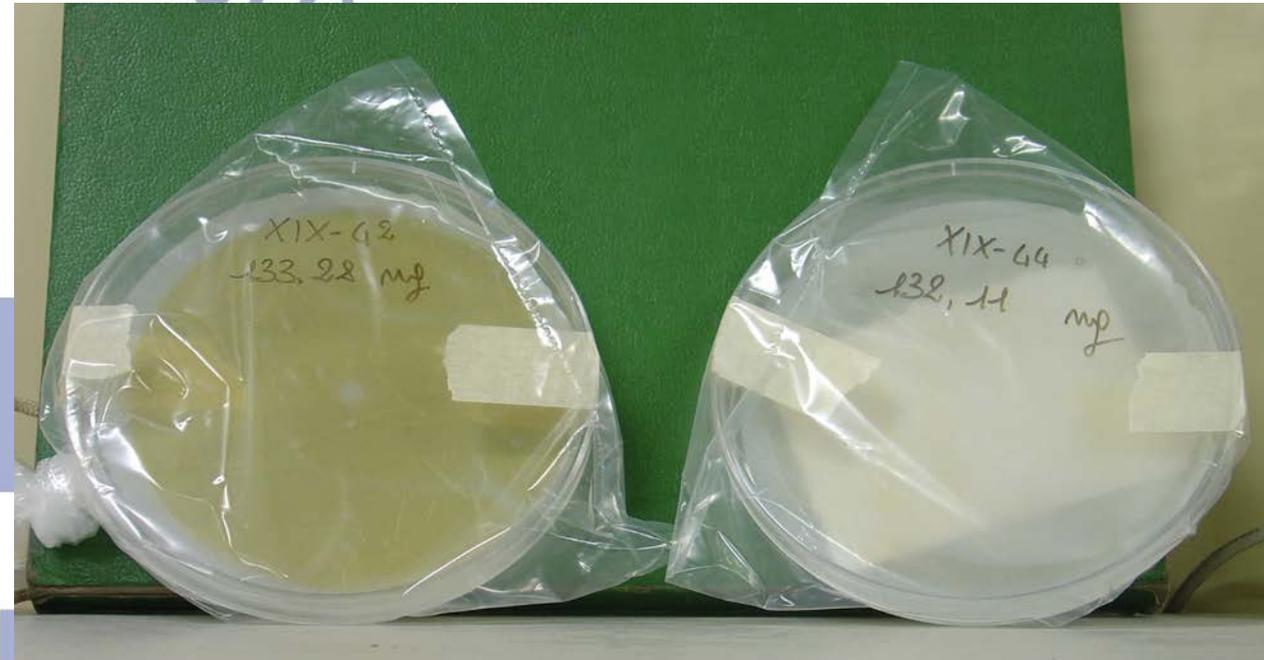
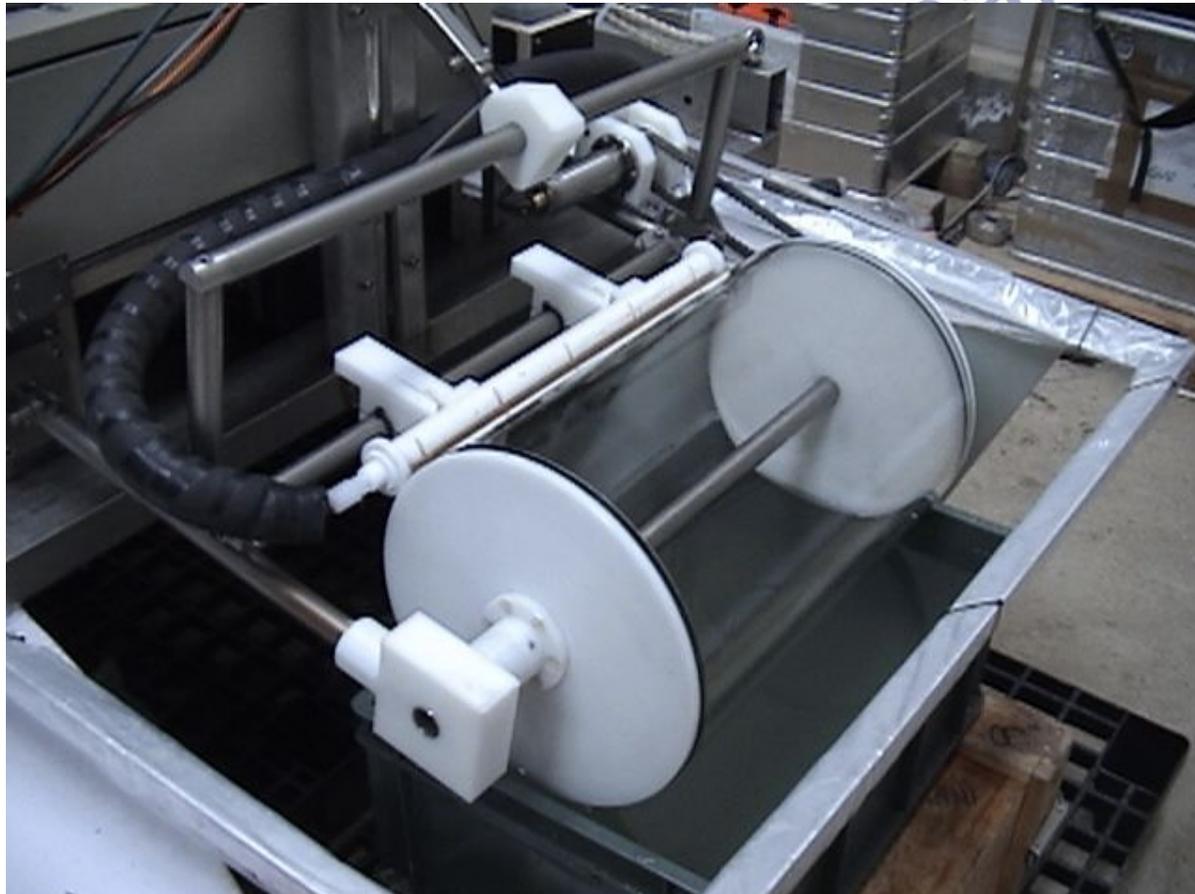
- **PNRA SESAMO project (2003-'04)**
 - integral sampling of the sea surface microlayer and immediate sub-surface water with a Harvey-like cylinder
 - Terra Nova Bay, Ross Sea, Antarctica
 - Charlie USV



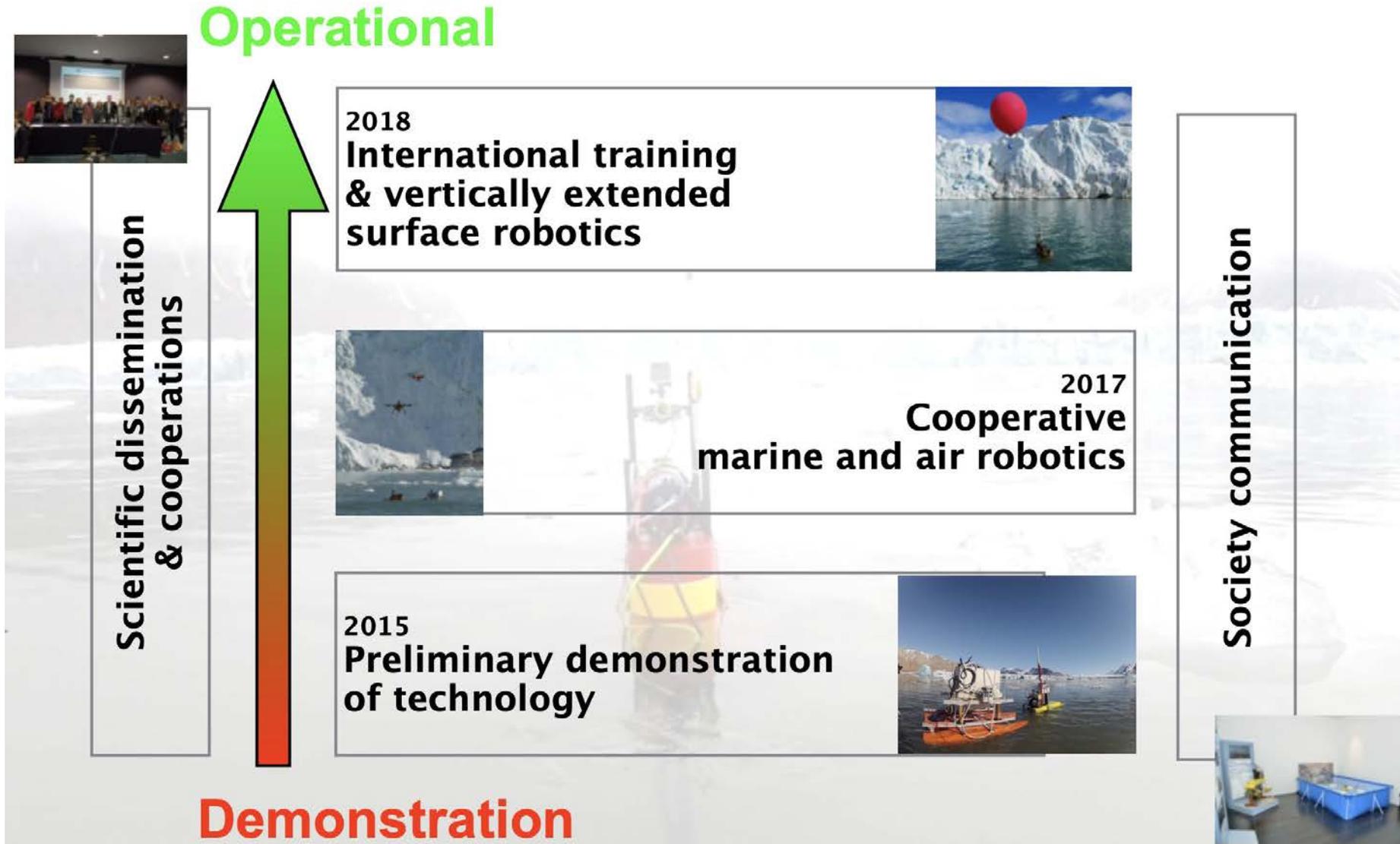
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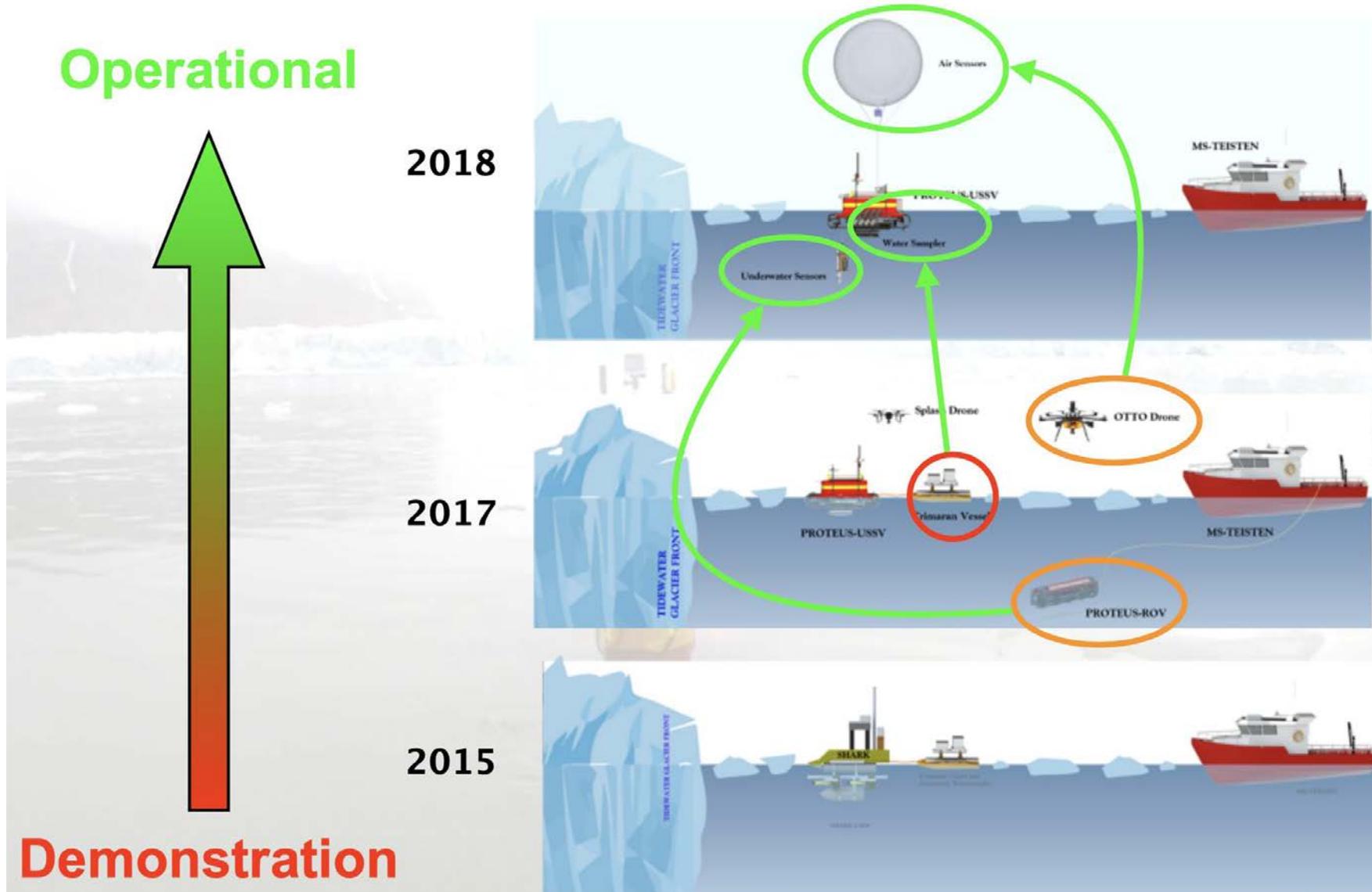
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Arctic air-ice-water interface sampling



Arctic air-ice-water interface sampling



Arctic air-ice-water interface sampling



- **CNR ARCA project (2015)**

- sampling and monitoring of the air-ice-water interface very close to the tidal glacier walls
- Kongsfjorden, Ny Alesund, Svalbard Islands



Shark USSV + towed water-sampler



Kronebreen Glacier in Kongsfjorden



Arctic air-ice-water interface sampling



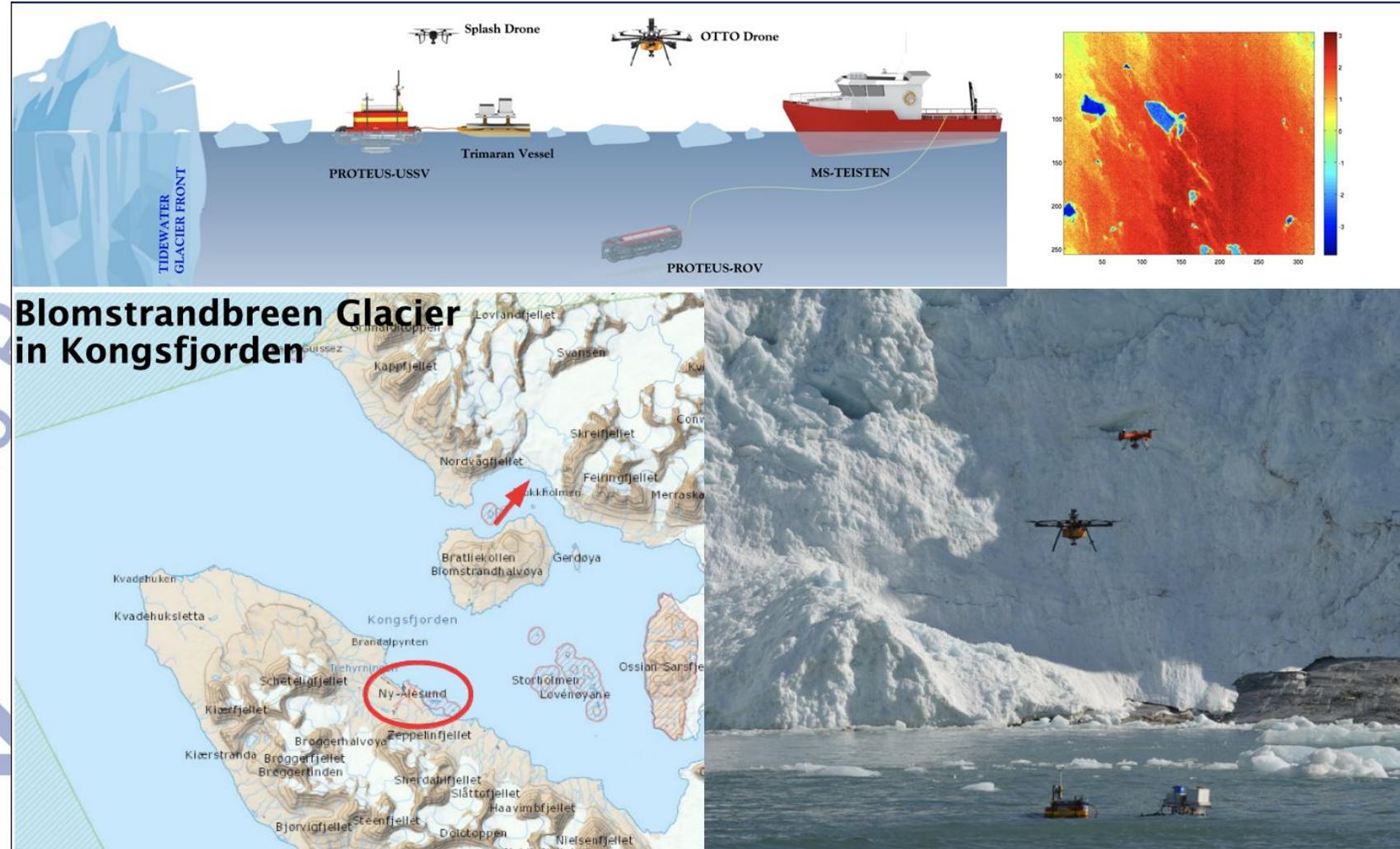
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Arctic air-ice-water interface sampling

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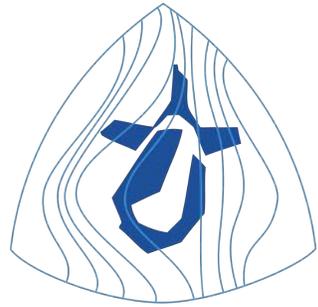


Arctic air-ice-water interface sampling

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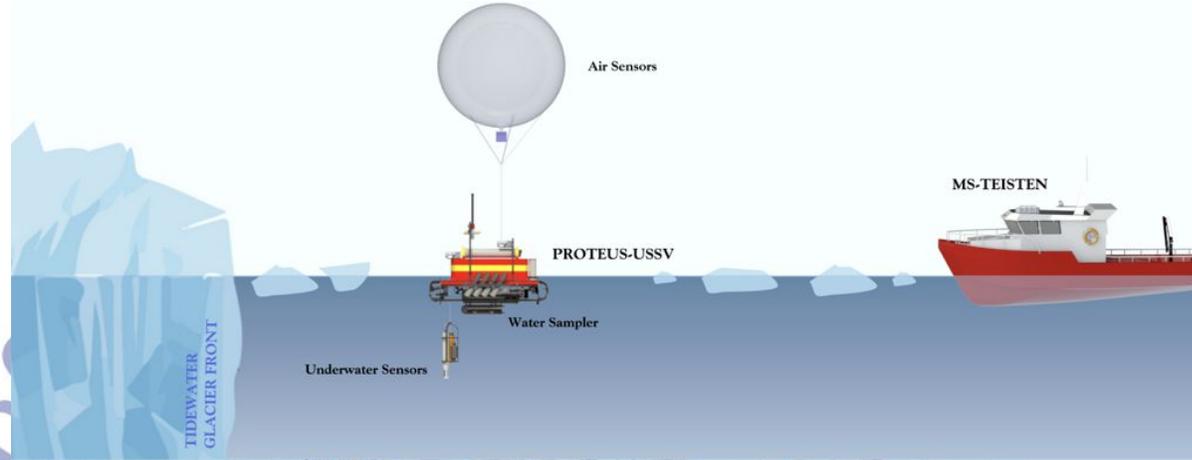


Arctic air-ice-water interface sampling

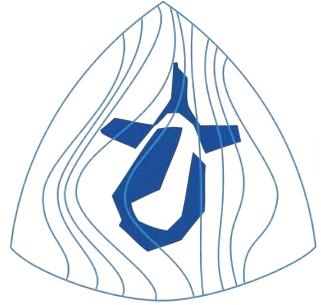


EXCELLABUST
EXCELLING LABUST IN MARINE ROBOTICS

- **H2020-TWINN-2015**
contract n. 691980
EXCELLABUST
Excelling LABUST
in marine robotics
(2018)



Arctic air-ice-water interface sampling

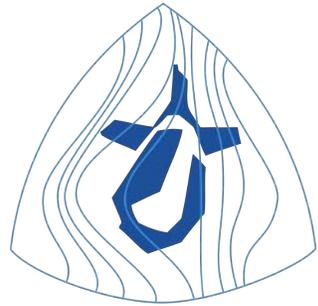


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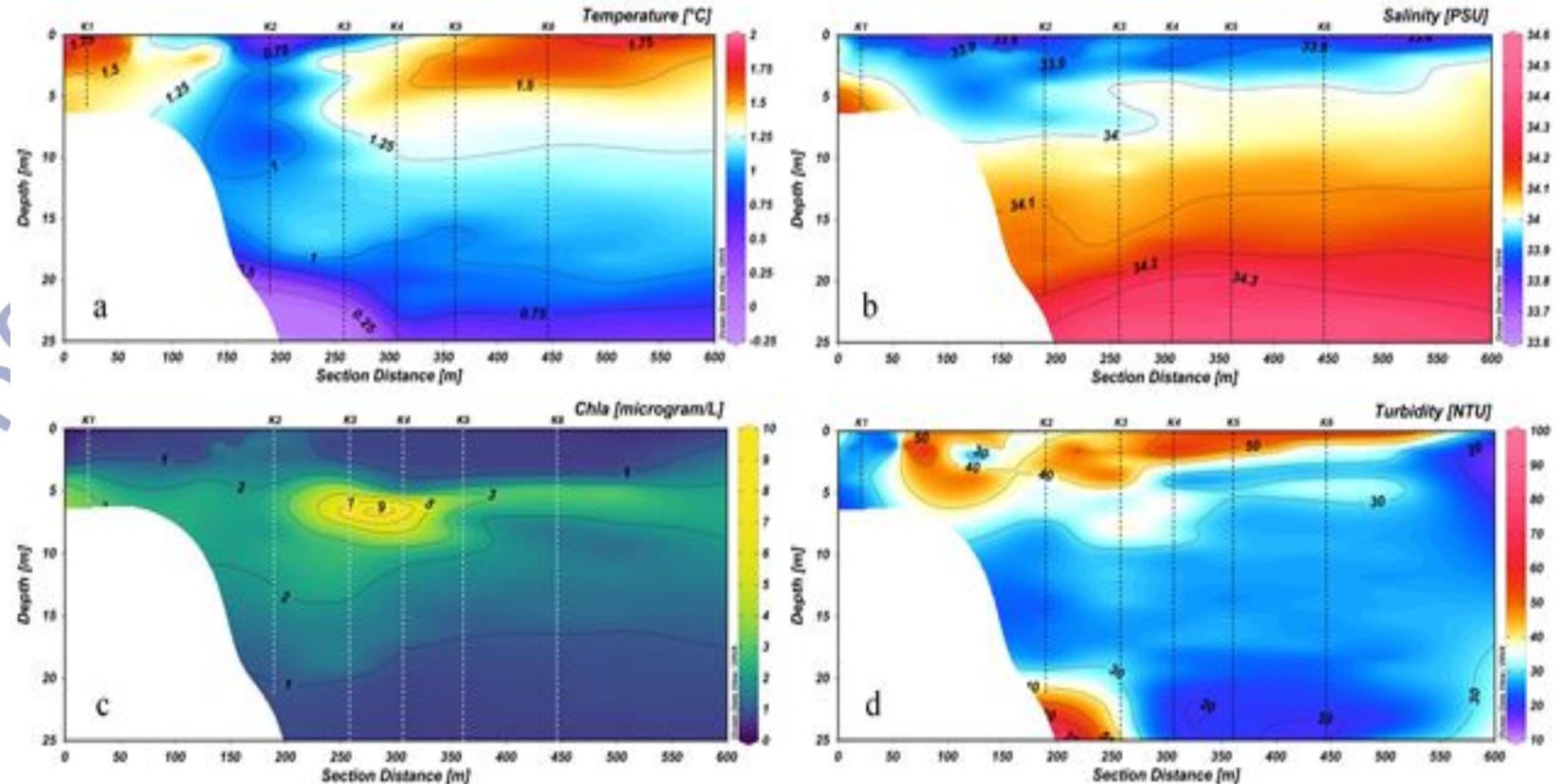


Arctic air-ice-water interface sampling



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Representation of the distribution of the variables acquired in the Kongsbreen area along the water column: a) temperature, b) salinity, c) chlorophyll a, d) turbidity; dashed lines show the position of vertical profiles.

Arctic air-ice-water interface sampling



Date	Time	Where	Water Column Sensors				Water Sensor/Sampler (Surface)		Air Sensor
			Idronaut CTD (105)	ArLoC	Fluorimeter	Turner Turbidimeter	Idronaut CTD (104)	MAWS	Airqino
25 May 2018	10:47	Bloomstrandbreen (Area 1—79.02196,12.15215)						V	
26 May 2018	13:30	Bloomstrandbreen (Area 1)	V		V	V	V	V	
28 May 2018	10:31	Bloomstrandbreen (Area 2—79.00915,12.21286)	V		V	V	V	V	V
28 May 2018	13:17	Bloomstrandbreen (Area 2)	V	V	V	V	V	V	V
29 May 2018	14:55	Bloomstrandbreen (Area 2)						V	
30 May 2018	18:12	Bloomstrandbreen (Area 2)					V	V	
30 May 2018	14:32	Kongsbreen (78.96574,12.61896)					V	V	
01 June 2018	11:05	Kongsbreen	V	V	V	V	V	V	V
30 May 2018	09:58	Kronebreen (78.88061,12.59886)					V	V	
01 June 2018	14:01	Conwaybreen (78.99109,12.53055)	V	V	V	V	V		V



APECS-ARICE Webinar

Polar marine robotics

Questions!?



An international collaboration strategy for meeting the needs of marine based research in the Arctic



APECS-ARICE Webinar

Polar marine robotics

Thank you very much!



An international collaboration strategy for meeting the needs of marine based research in the Arctic



Webinar recording will be available on arice.eu and on the APECS website