The Global Ocean Observing System

Uncrewed Surface Vehicles for GOOS: A New Frontier for Observing and Monitoring at the Air-Sea Interface

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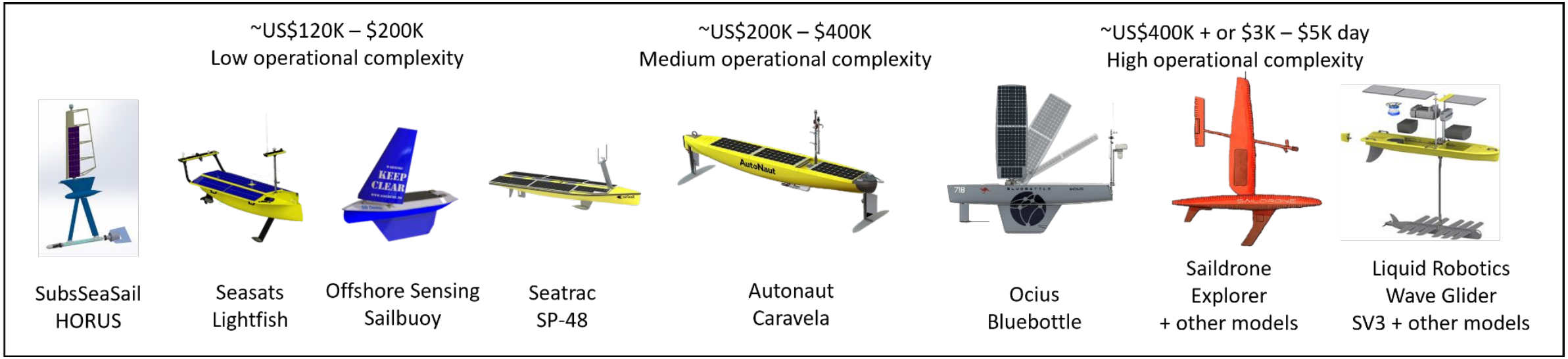
ONC, Victoria, British Columbia, Canada

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Ruth Patterson*, Johan Edholm**, Joana Beja, Meghan Cronin, Sebastiaan Swart, Adrienne Sutton, Dongxiao Zhang, Virginie Ramasco, Lionel Camus, Lev Looney**, Leandro Ponsoni, Wieter Boon, Elizabeth McGeorge*, Laurent Grare, Iwao Ueki, Marcel du Plessis*, Greg Foltz, Jim Thomson, Luc Lenain, Jaime Palter, Chidong Zhang, Sarah Nicholson*, Clive McMahon, Verena Hormann, James Burris, Makio Honda, Carey Kuhn, Calvin Mordy, Charles Addey**, Akira Nagano, Elizabeth Siddle*, Paban Bhuyan**, Mike Flanigan, Cheyenne Steinbarger*, Andreas Marouchos, Nick Rozenauers, Satoshi Mitarai, Alex Parker, Naoko Kosaka, David Peddie, Noriko Tada, Lars Hole, Sarah Nickford*

Network Overview

- Observing Air-Sea Interaction Strategy – OASIS
- **Mission: To develop a practical and integrated approach to observing air-sea interactions through capacity development and leveraging multidisciplinary activities**
- Endorsed UN Ocean Decade Project, under the OASIS UN Ocean Decade Programme



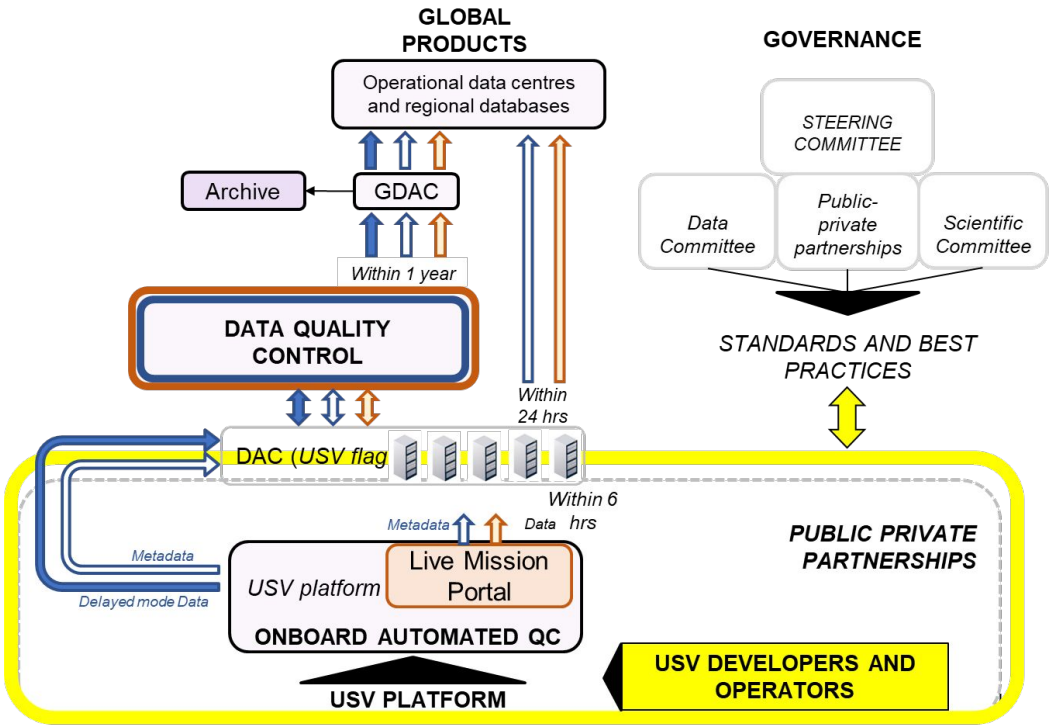
Patterson et al (in prep)

Why USVs?

- The power of this network lies in:
  - Manoeuvrability/dynamic sampling at surface
  - Sample many co-located variables simultaneously
  - Low-cost (relatively, $, emissions)
  - Real-time data (because remotely operated)
  - Deployment/operational permissions are unique
  - Data intercomparisons need to be made on each platform

- Air-sea flux data needs to be available in real-time (GTS)
- Concerns that complexity related to the USVs will dilute existing networks

Discipline	No. Studies	Maximum Number of Variables on One Platform
Air-sea interaction	14	16
Surface observations	10	10
Acoustics (sound)	8	12
Acoustics (biomass)	6	11
Seafloor Geodesy	6	2
Typhoon, Hurricane, Cyclone	5	15
Ocean Currents	3	8
Sea Ice	3	14
Waves	3	4



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Progress/Achievements

Draft manuscript for USVs for GOOS

- Collated metadata
- Built community
- Quantified EOV/ECV
- Facilitated industry contribution
- Multidisciplinary
- Data needs!

Face to face OASIS workshop at OSM Feb 2024

- Discussed network purpose and goals
- Discussed network identity (separate or part of another network?)
- Discussed data requirements (research, QC, metadata requirements)
- Facilitated industry contribution

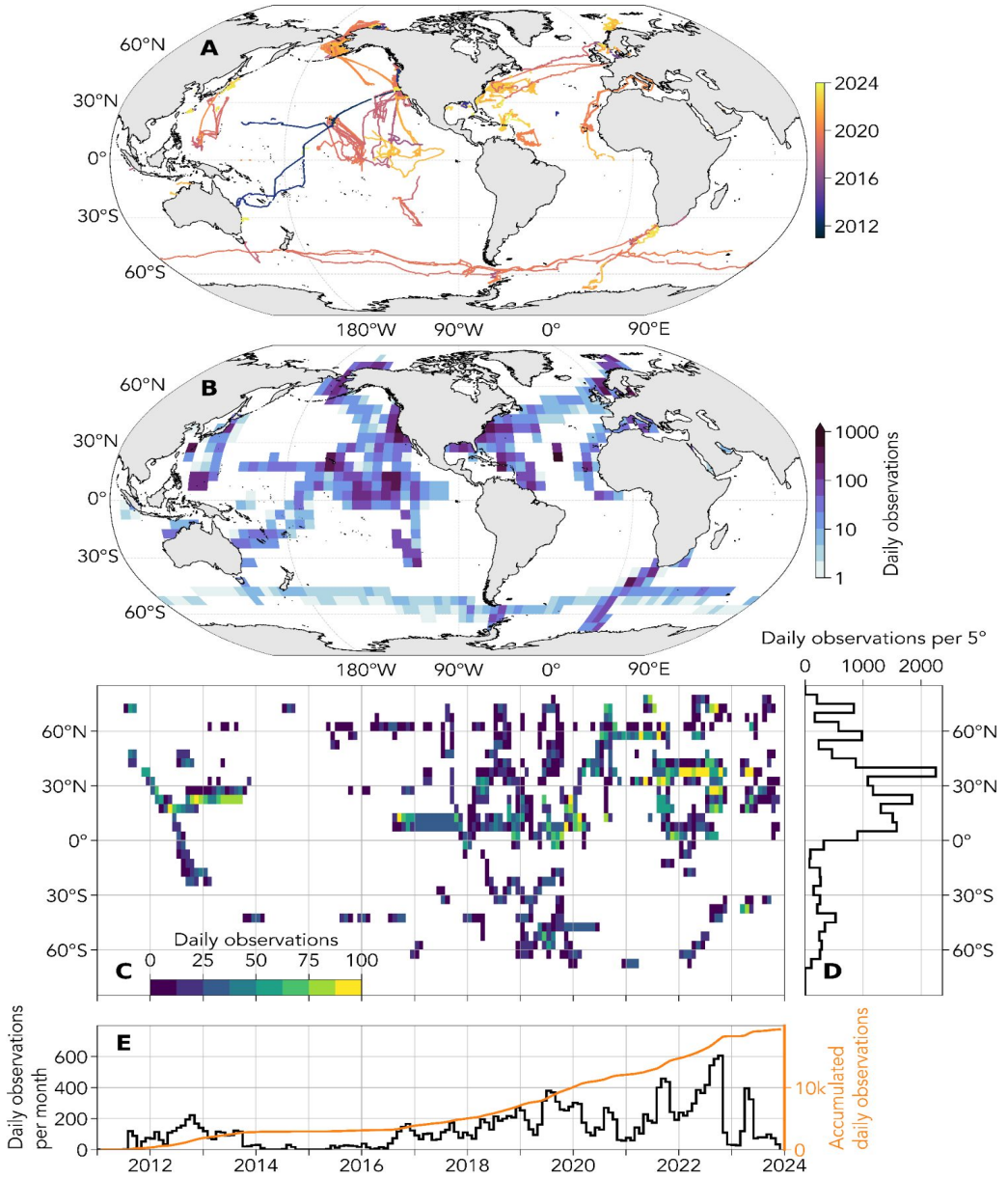
Recent hybrid OASIS workshop had more than 54 in person participants, with Early Career Ocean Professionals from Africa, South America, Asia, Australia, Europe, and North America

Network Attribute Update

- Global in scale
- Observes one or more Essential Ocean Variables or Essential Climate Variables
- Environmental stewardship awareness
- Undertakes capacity development and technology transfer
- Ensures metadata quality and delivery
- Develops and follows standards and best practices
- Delivers data that are free, open and available in a timely manner
- Community of practice
- Observations are sustained
- Maintains network mission and targets

TEPEX

An OASIS priority: Funding needed for paid internships and visiting scholars



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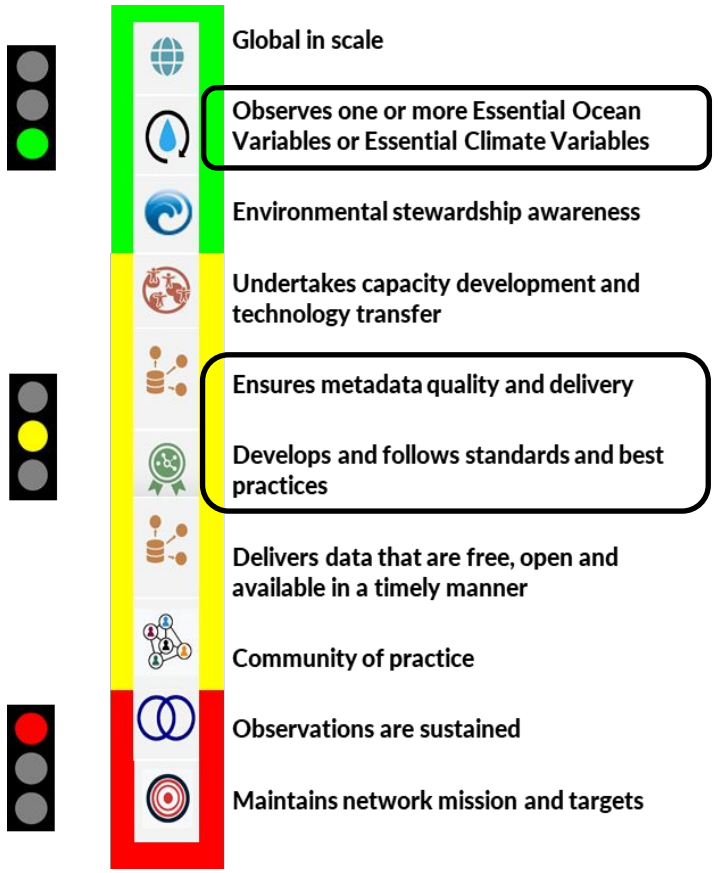
Network Attribute Update



"A standardised data and metadata format would have made things a lot easier"

Johan Edholm
(created global map)

"We didn't realise the importance of metadata"

USV manufacturer

		Essential Ocean and Climate Variables	Air sea interaction	Air-sea interaction (tropical cyclone)	Mesoscale, sub-mesoscale processes	Sea ice	Waves	Surface ocean	Passive acoustics	Biomass /ecology	Geodesy	Other
ESSENTIAL OCEAN VARIABLES	Physics	Sea state	✓	✓	✓		✓	✓	✓	✓		
		Ocean surface stress					✓					
		Sea ice				✓						
		Sea surface height									✓	
		Sea surface temperature	✓	✓	✓	✓	✓	✓	✓	✓		
		Subsurface temperature	✓	✓	✓	✓	✓	✓	✓	✓		
		Surface currents	✓		✓			✓				
		Subsurface currents	✓	✓	✓		✓	✓				
		Sea surface salinity	✓	✓	✓	✓	✓	✓	✓	✓		
		Ocean surface heat flux	✓	✓								
		Ocean bottom pressure									✓	
	Biochemistry	Oxygen	✓	✓	✓	✓	✓	✓	✓	✓		
		Nutrients										
		Inorganic carbon										
		Transient tracers										
		Particulate matter								✓		
		Nitrous oxide										
		Stable carbon isotopes										
		Dissolved inorganic carbon										
	Biology and Ecosystems	Phytoplankton biomass and diversity								✓		
		Zooplankton biomass and diversity								✓		
		Fish abundance and distribution	✓						✓	✓		
		Seabird abundance and distribution										✓
		Marine mammal abundance and Distribution	✓						✓			
		Hard coral cover and composition										
		Seagrass cover and composition										
		Macroalgal canopy cover and composition										
		Mangrove cover and composition										
	Cross-disciplinary	Ocean colour	✓	✓	✓	✓	✓	✓	✓	✓		
		Marine Debris (emerging)										
		Ocean Sound						✓				
ESSENTIAL CLIMATE VARIABLES	Surface Atmosphere	Precipitation	✓									
		Pressure	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Radiation budget	✓	✓	✓	✓			✓			
		Temperature (temporal resolution and height above surface if known)	✓	✓	✓	✓	✓	✓	✓	✓		
		Water Vapour	✓	✓	✓	✓	✓	✓	✓	✓		
		Wind speed and direction	✓	✓	✓	✓	✓	✓	✓	✓		
	Atmospheric composition	Aerosols										
		Carbon dioxide, methane and other greenhouse gases	✓	✓		✓	✓	✓		✓		
		Ozone										
		Precursors for aerosols and ozone										
OTHER	Other payloads	Cameras		✓	✓	✓						
		Photosynthetically Active Radiation		✓	✓	✓				✓		
		Magnemometer	✓									
		pH		✓		✓						
		Multibeam echosounder	✓									
		eDNA								✓		

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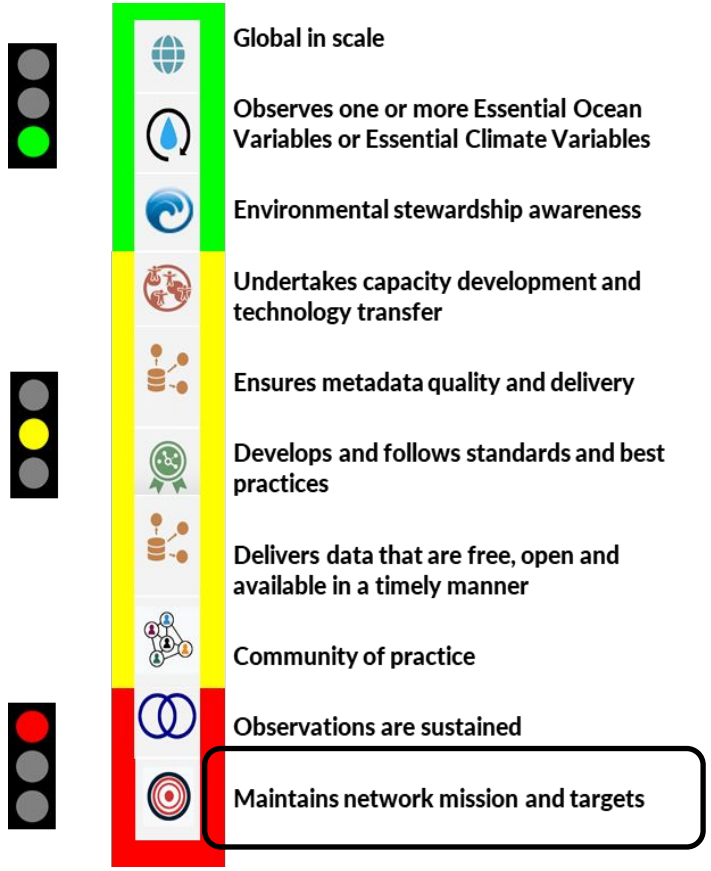
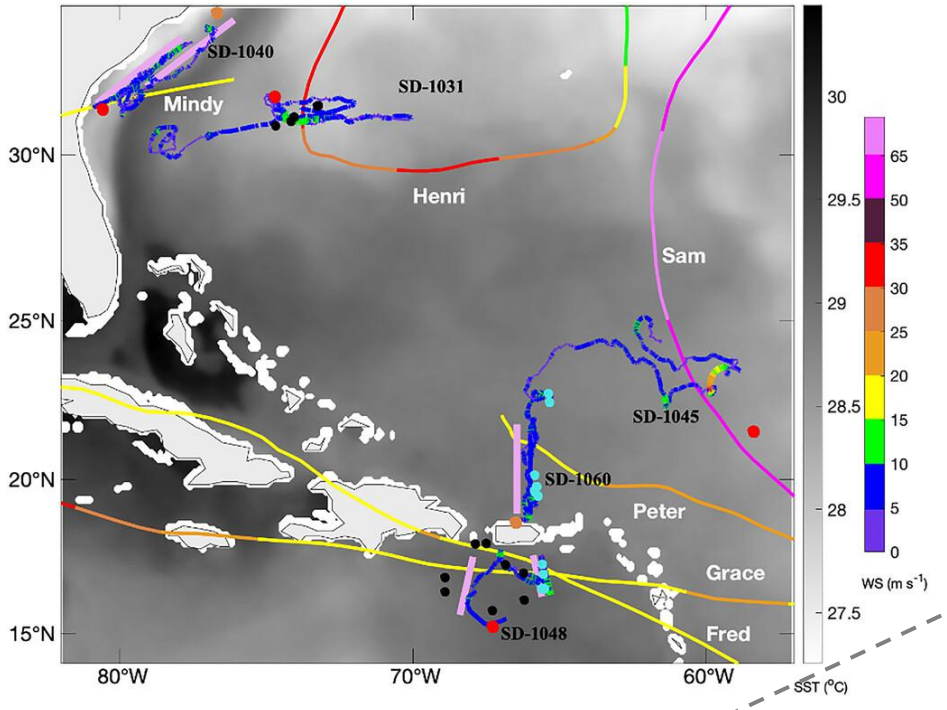
Network Attribute Update



USVs for GOOS missions: to fill gaps in existing networks

- **Monitor extreme events at the surface**
- **Multiple (>8) co-located instrument-based data streams (air-sea fluxes, ecology, fisheries)**
- **Dynamic and persistent fine-scale surface observations**
- **Geographic and disciplinary gaps**

Connected and Complementary



Zhang et al, 2023, Hurricane observations by uncrewed systems, American Meteorological Society

VOS?

USVs for GOOS

Real-time / intercomparisons

Dynamic sampling

"GO-USV"

SOCONET

OceanSITES

OceanGliders

TPOS transect (seasonal?)

Gases (CO2)

Momentum

Surface heat

Extreme weather

Interior ocean exchange

GLOSS?

Argo?

AniBOS?

Bio-Eco

Fish Abundance and distribution

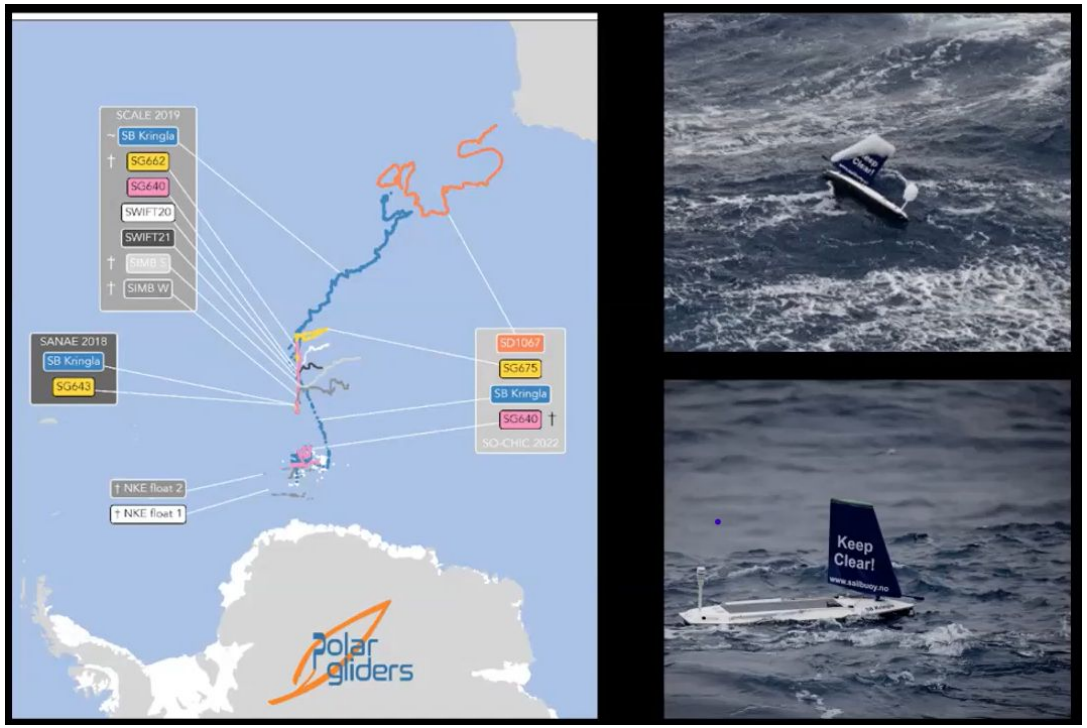
Passive acoustics

eDNA

(seabirds)

Challenges and asks

- Progress is slow without funding
- Support from regional networks would be useful
- USV data roadmap (guidance)



Seb Swart et al

Next steps for 2024-25

- Funding application to define governance structure
- Website development for USV metadata
- USV data roadmap
  - Standards and community recommended practices
  - USV data template

The Global Ocean Observing System

OASIS

Thank you

airseabos.org

unesco
Intergovernmental
Oceanographic
Commission

WORLD
METEOROLOGICAL
ORGANIZATION

UN
environment
programme

International
Science Council