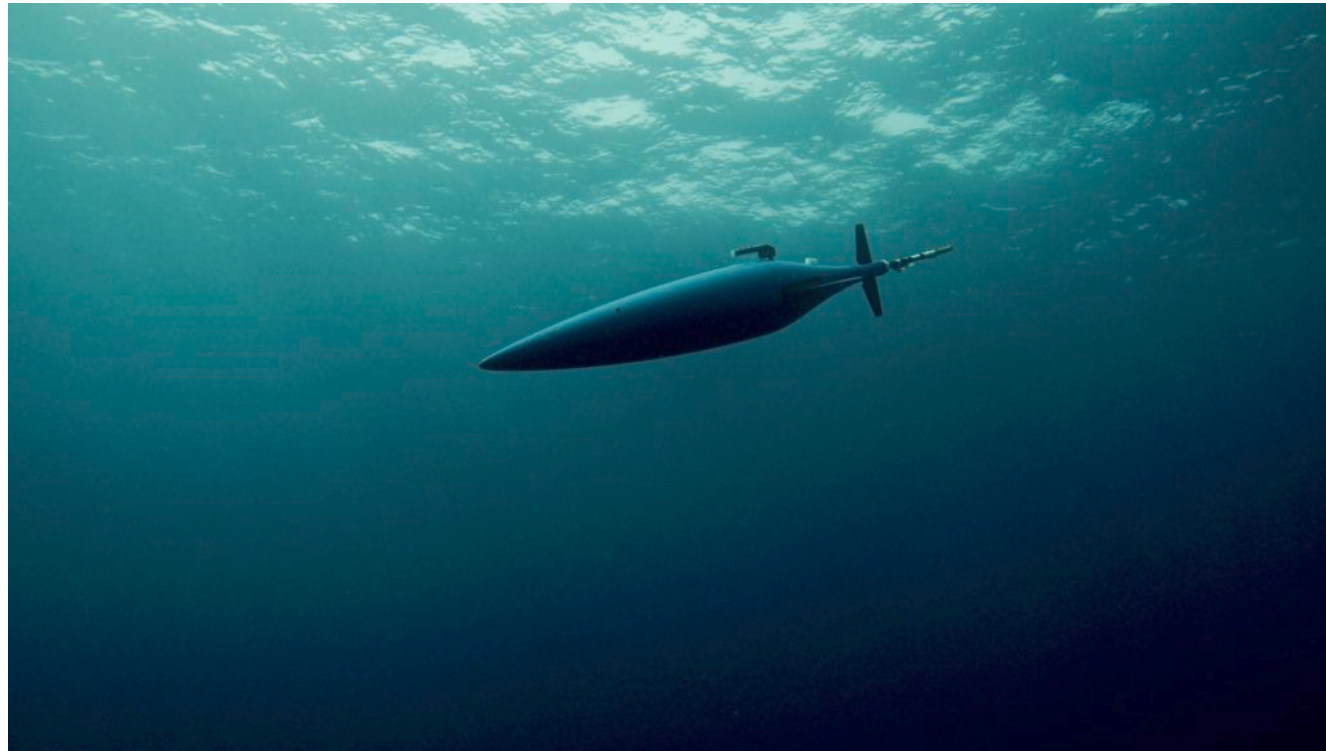




BRIDGES
BRINGING TOGETHER RESEARCH AND INDUSTRY FOR
THE DEVELOPMENT OF GLIDER ENVIRONMENTAL SERVICES


CYPRUSUBSEA
Consulting and Services C.S.C.S. Limited



Industrial Services and Applications

Daniel Hayes, CSCS
BRIDGES Keynote, University of Cyprus, 2018-02-28



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635359

36B Paragogikotitas, 2326 Lakatamia, Cyprus
57 22 750073, info@cyprus-subsea.com, www.cyprus-subsea.com

Content: Industrial Services & Applications

1. Company Profile : People and Main Activities

2. Tools at Hand

- Traditional
- Autonomous
- Numerical Modelling and Simulation

3. Sectors

- Environmental Monitoring
- Safety
- Security



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Quick Profile

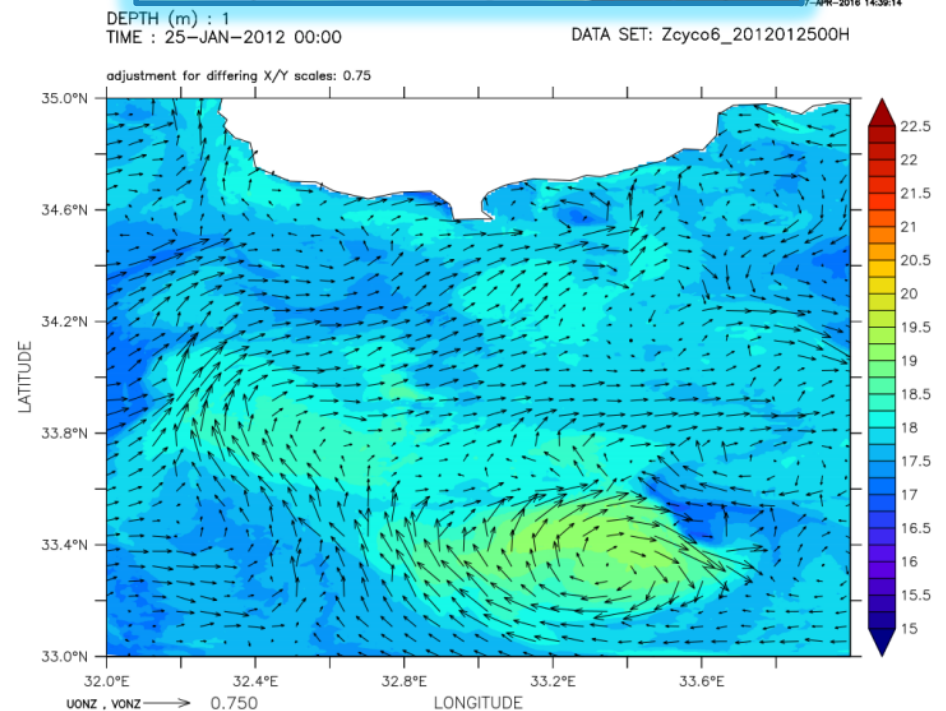
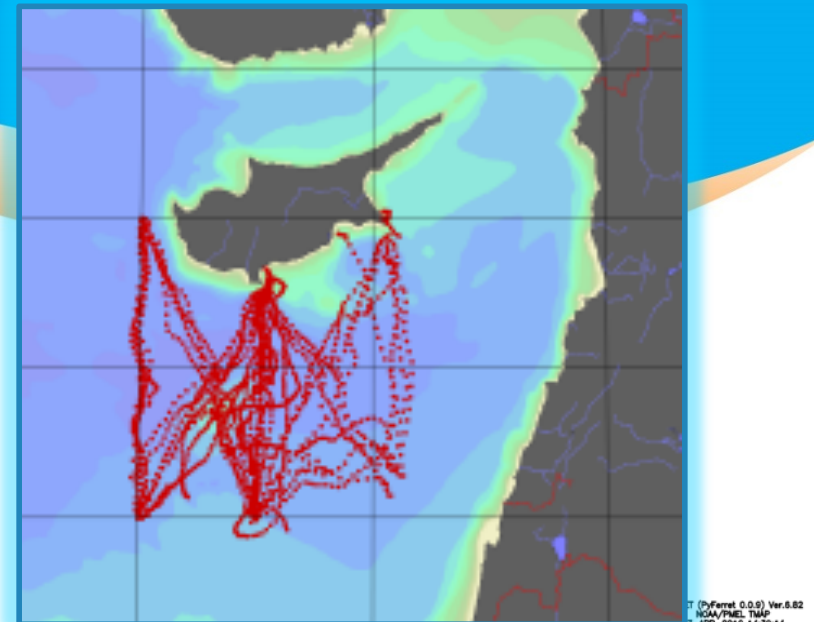
- Established in Nicosia, Cyprus, December 2012 by Daniel Hayes
- 5 employees + contractors with covering Oceanography, Ocean Biogeochemistry, Ocean Engineering, Maritime Security, and Project Management
- Service company with strong Research and Development component



CSCS provides oceanographic consultancy, services and equipment for offshore activities in the Med, European, and Global Oceans.

Summary of Expertise

- Physical Oceanography
- MetOcean systems (wave, current, sensors, platforms)
- Glider operation and analysis
- Modelling physical processes
- Merging data and models in real time
- Oil spill and trajectory modelling
- Sensor integration and interfaces
- Mission planning for autonomous systems



Summary of Activities

Services

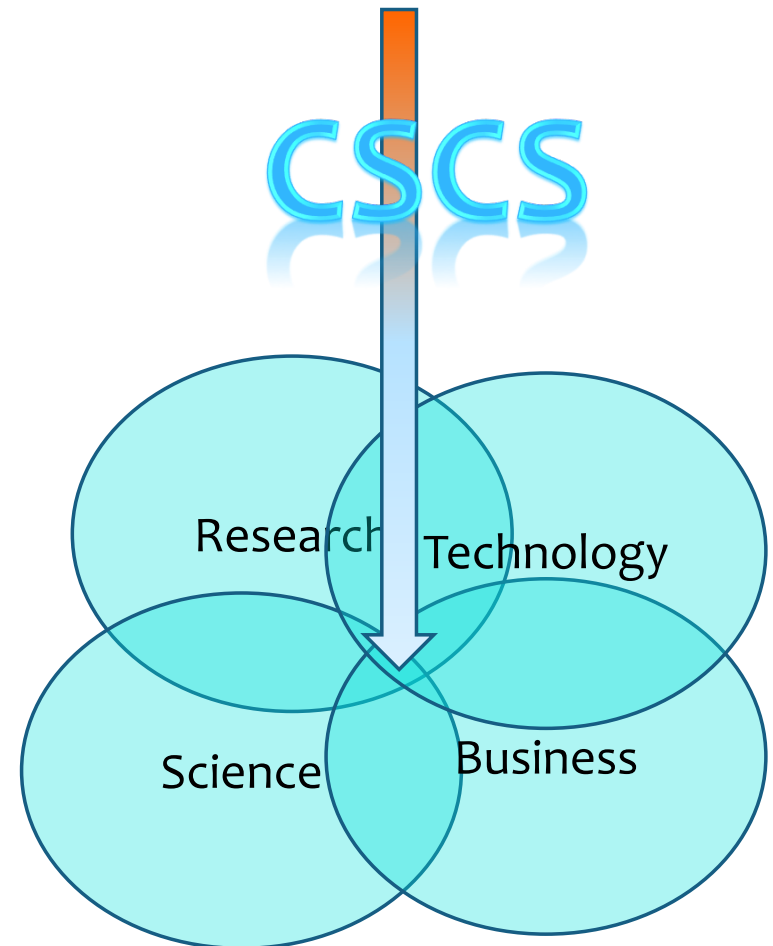
- Real time data collection: planning, execution, analysis, mix of platforms, full ocean depth
- Simulations of temperature, salinity, currents, oil spills or trajectories

Equipment

- Rental or sales
- Oceanographic sensors and platforms

R&D

- Merging data and models
- Integrating sensors and platforms
- Optimized sampling



Content: Industrial Services & Applications

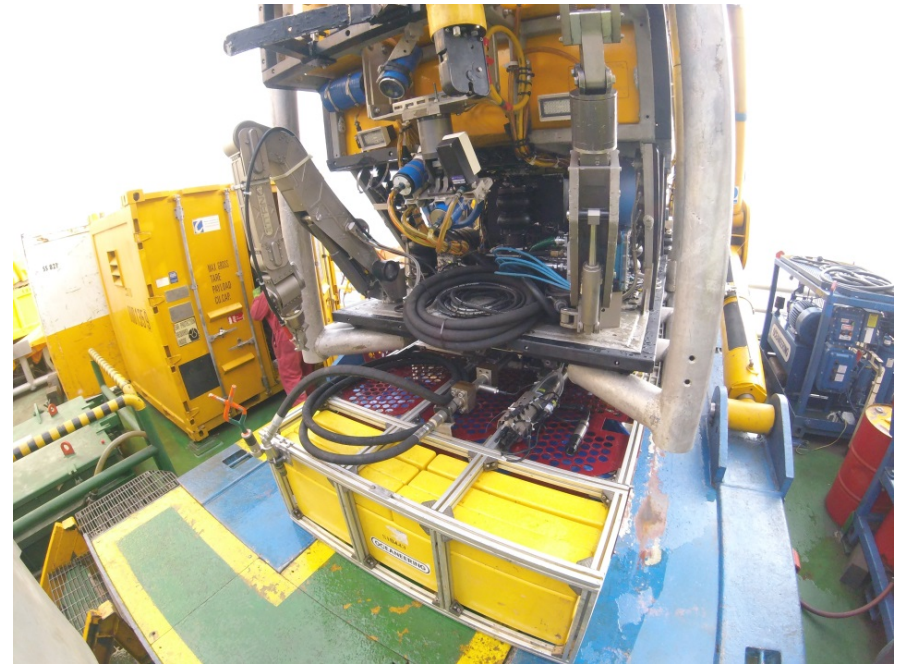
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Observing Network: (Euro)GOOS



EuroGOOS Ocean Observing Task teams

HF-Radar

Tide Gauges

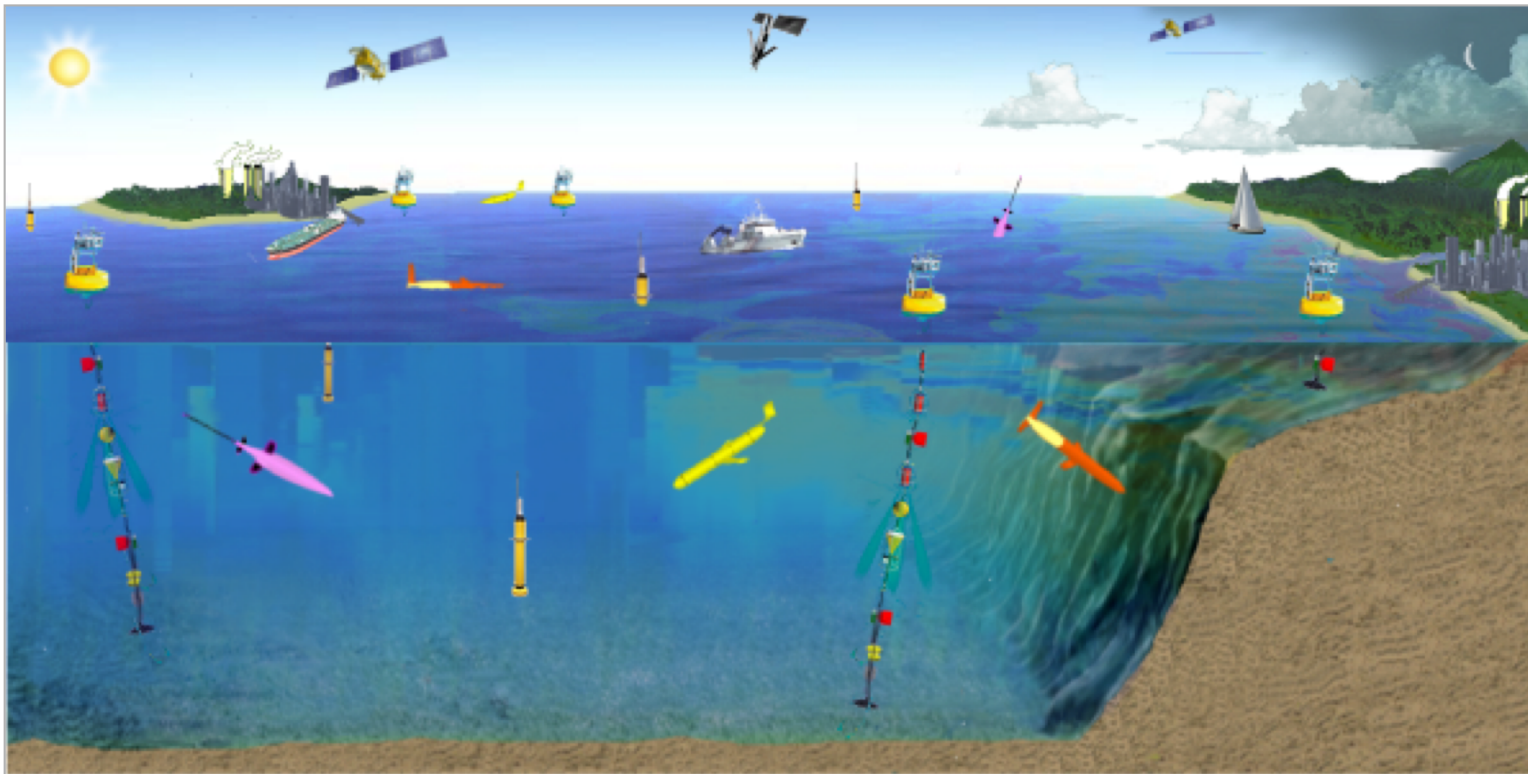
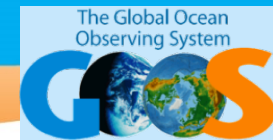
Ferrybox

Gliders

Moorings

Euro-Argo

Marine mammals



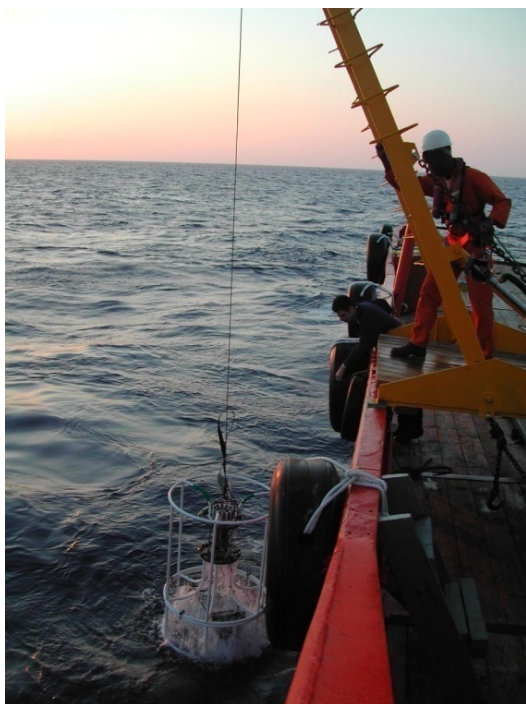
- Develop the European glider network, coordinate and assist the standardization of glider operations, data and applications
- Ensure data availability for the Copernicus Marine Environment Monitoring Service and EMODnet



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Traditional Environmental Monitoring Offshore Exploratory Drilling-before/during/after

- Water profiling and acoustic recording
- Water sampling
- Sediment sampling



Water Column Profiler

- CTD Probe: water temperature conductivity, salinity, depth

- Passive Acoustic Measurement

- pH

- redox potential (Eh)

- dissolved oxygen

- turbidity

- chlorophyll-a (fluorescence, up to 500 m)

- suspended matter

- Secchi Disk



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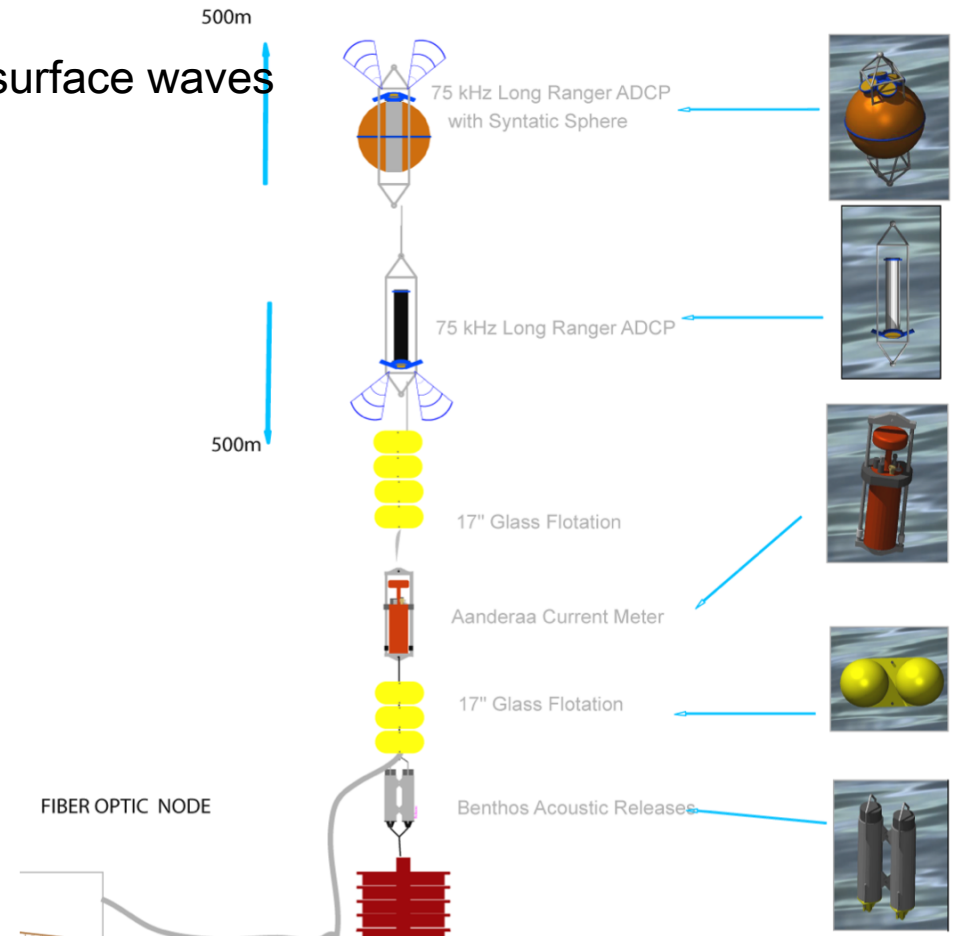
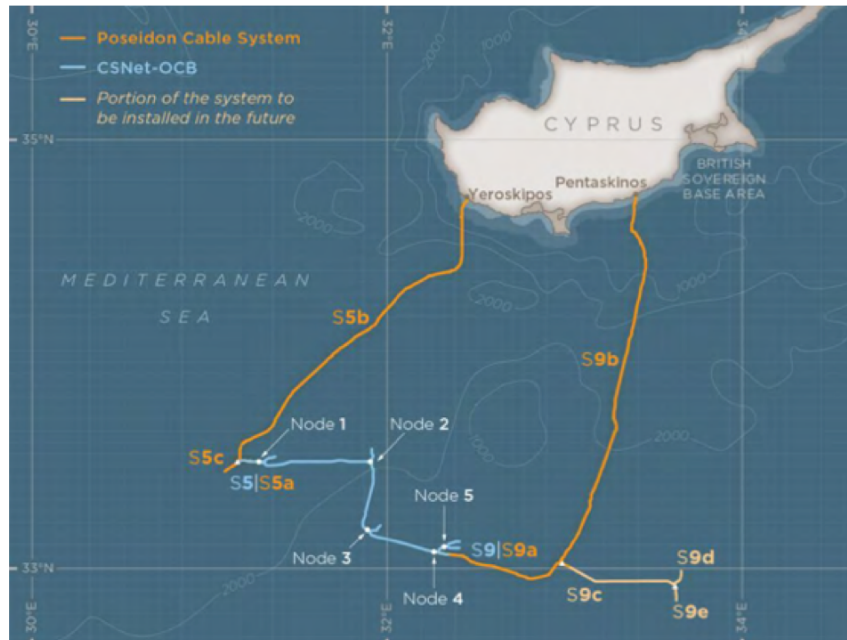
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Traditional Environmental Monitoring

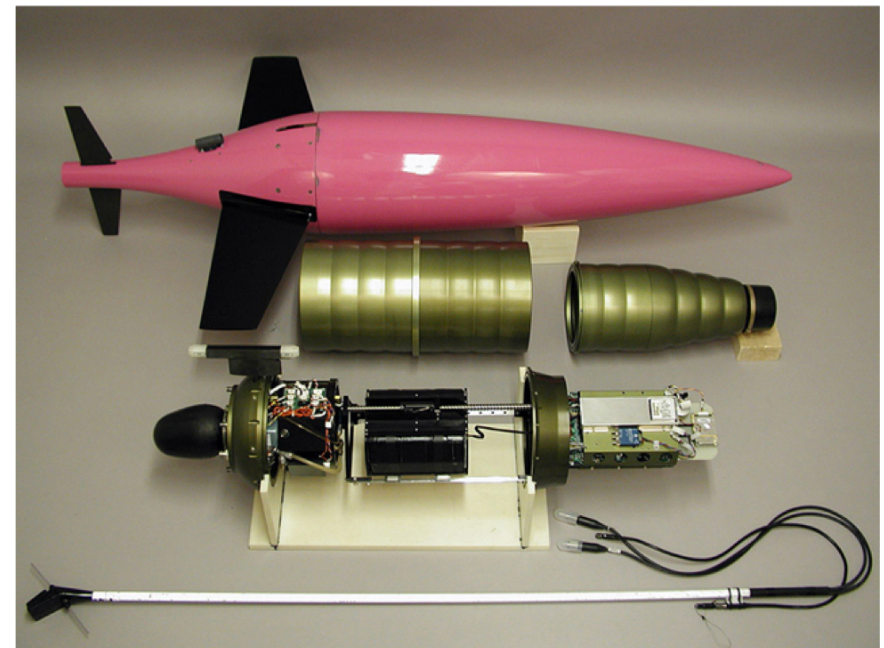
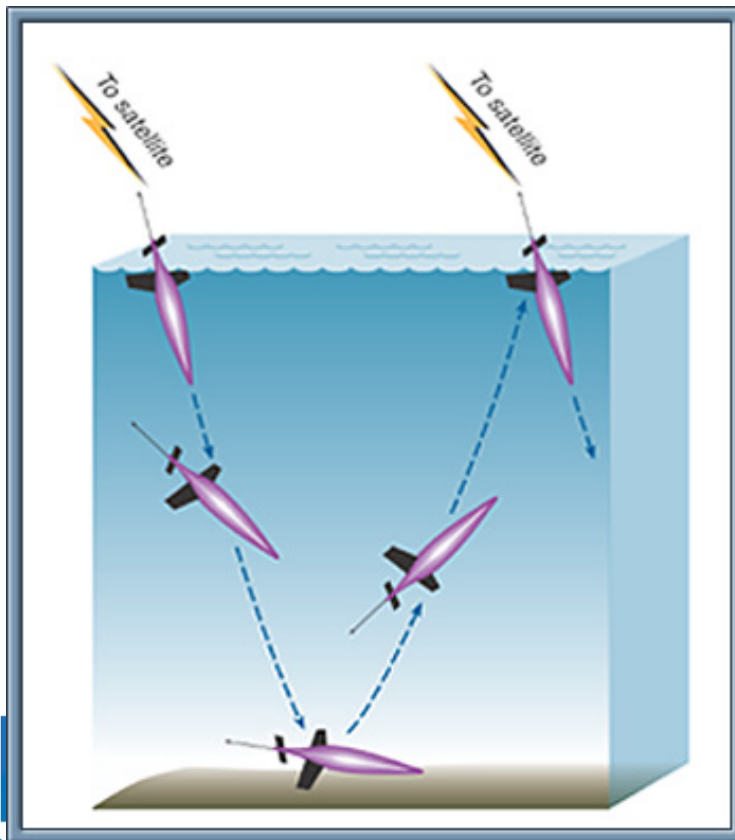
Ocean Communication Backbone (OCB): CSNet International, Inc.

- Stand-alone Vertical Sensor Array:
 - Height - 1500 m in 1565 m depth
- Sensors:
 - 3xADCP – Full depth current profiles, surface waves
 - Dissolved Carbon Dioxide
 - Optical Fluorescence
 - Temperature, Salinity
- Acoustic Modems, Release



What are gliders?

- Buoyancy-driven autonomous profilers
 - Profiling floats with wings and movable mass
 - Low power-low speed (half a knot on half a watt)
 - Sensors sample throughout, and send back w/ Iridium
 - Battery-powered, buoyancy-driven
 - 25-50 cm/s, 6-45° slope
 - CTD, oxygen, fluorescence, optical backscatter, currents
 - surface transmit/receive for data and instructions every 5h.
 - 1000 m dive capability



B

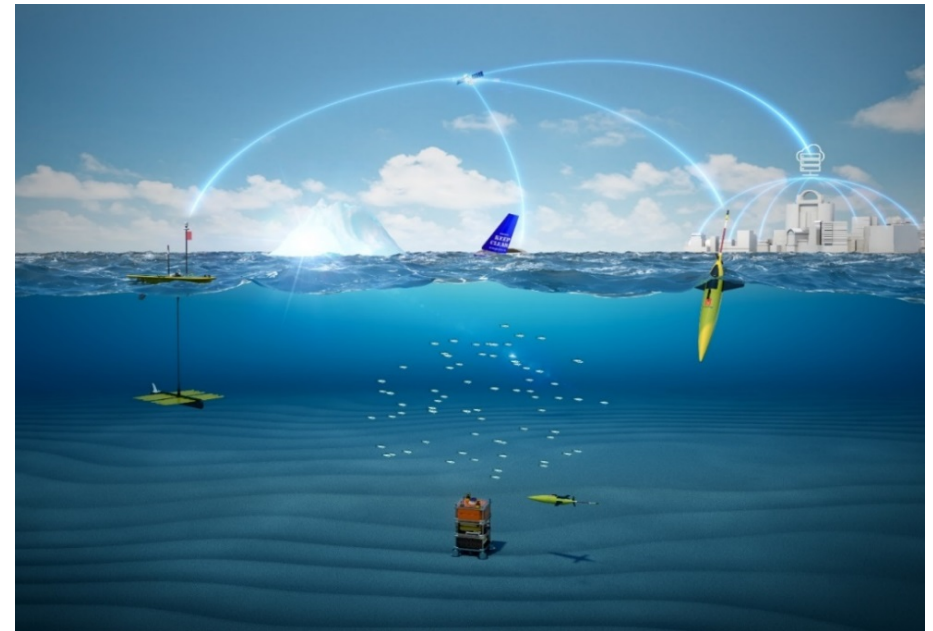
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Autonomous Advantage

Long-term and cost-effective exploration and monitoring in all ocean conditions

- Water properties, pollutants, acoustic (passive and active)
- No propeller (quiet), driven by buoyancy changes
- Host various other sensors (optical, biological, chemical)
- Persist at sea for weeks/months
- High resolution: 5 km in horizontal, 1 m in vertical up to full depth
- Compared to ships, very cheap!

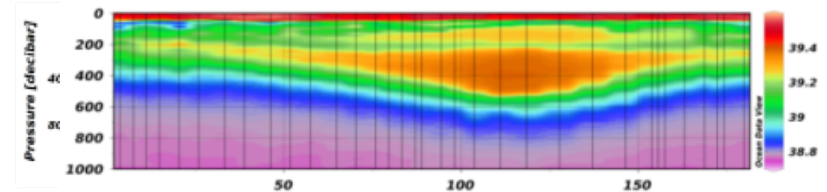
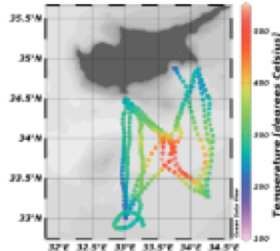
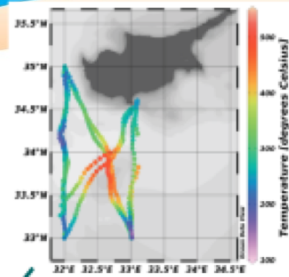


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Seagliders in Cyprus

2008

09



At its maximum:
90 km across
400 m high

Over Eratosthenes seamount

Not present
in surveyed area

1°E from
Eratosthenes seamount

11

12

2 Cyprus gliders: last 7
yrs, 1018 days, 3860
dives, 17000 km

0.5°S 1°E from
Eratosthenes
seamount
(not as extensive)

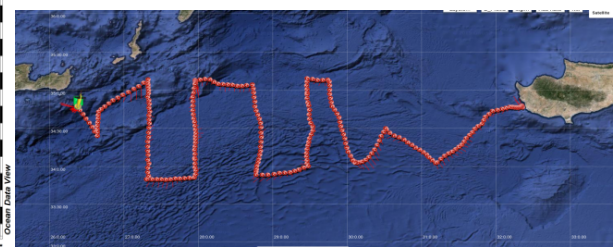
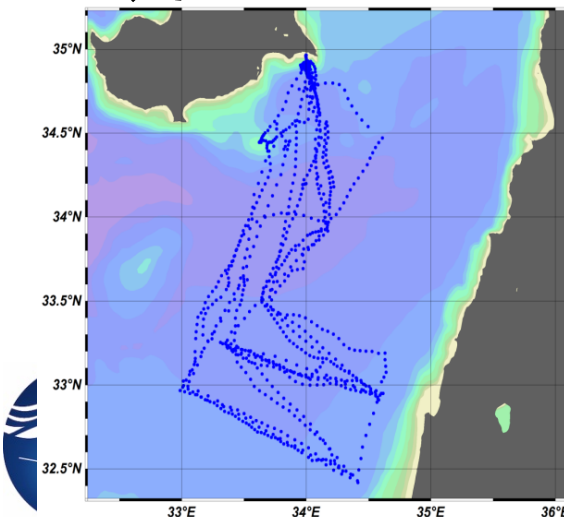
Over Eratosthenes seamount
(weaker than 2009-2010)

13

14

0.5°N 0.5°W from
Eratosthenes seamount

15

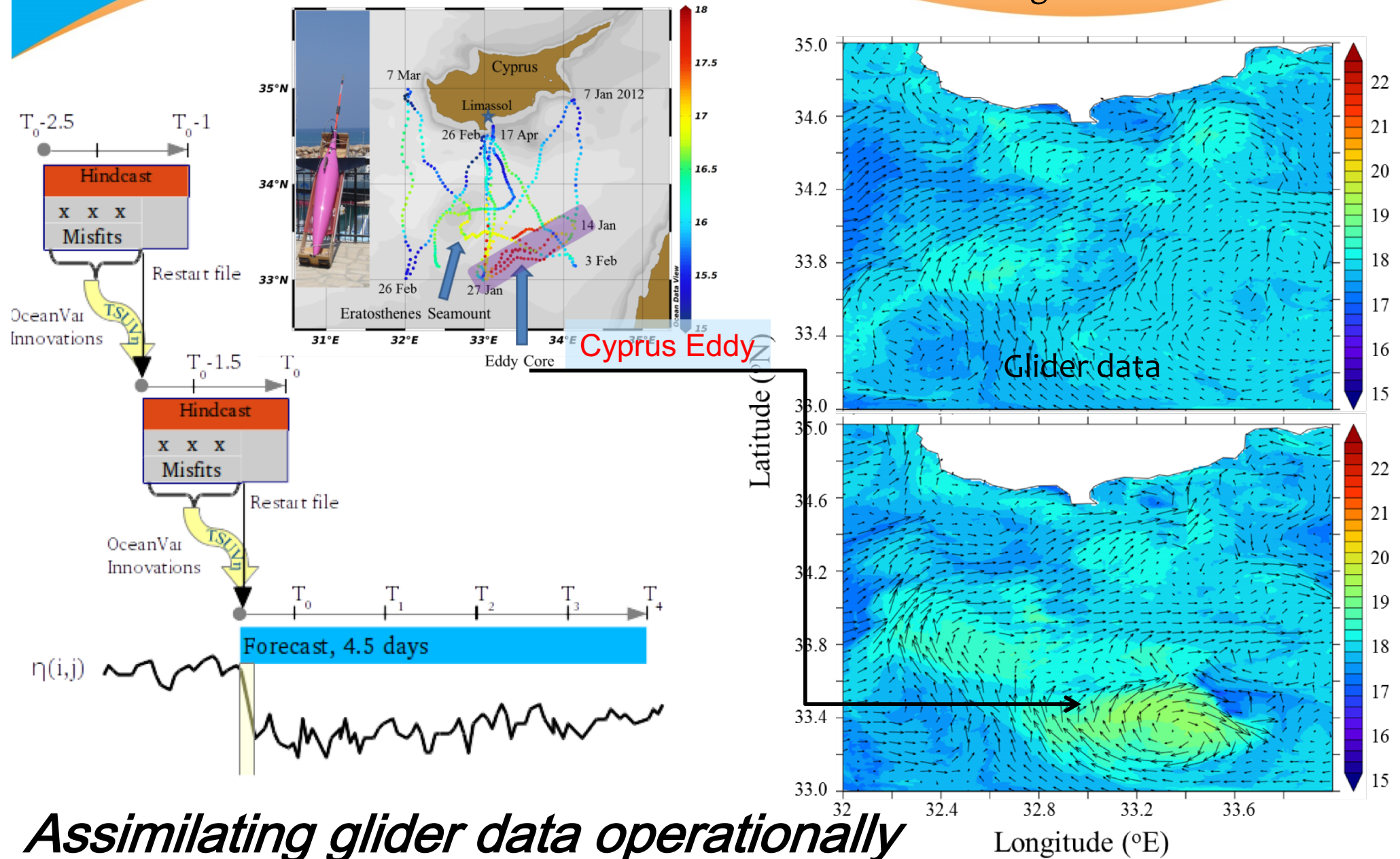


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Modelling 3D flow, T, S with the help of gliders

Clear difference in surface currents, temp when use glider data!

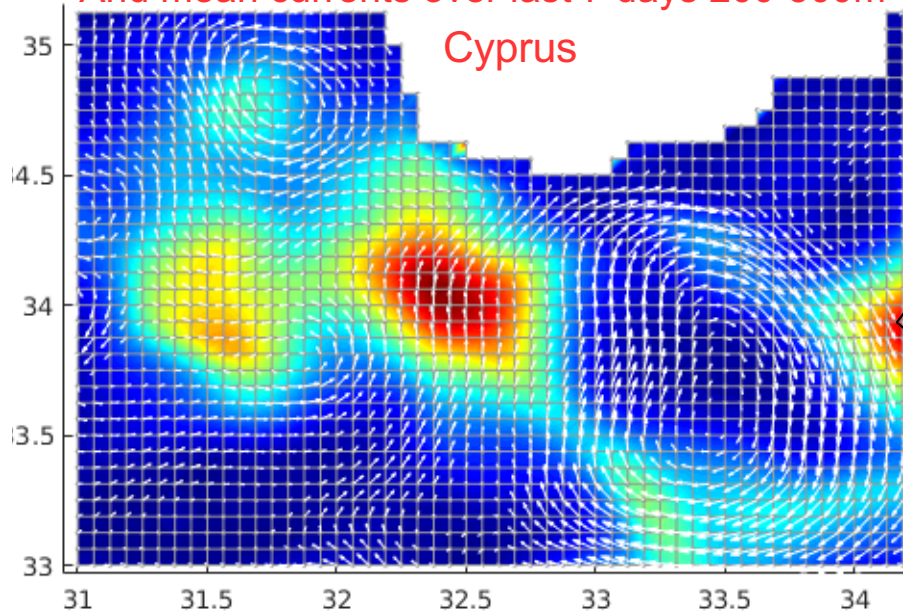
No glider data



Optimal Mission Planning Tool for fleets

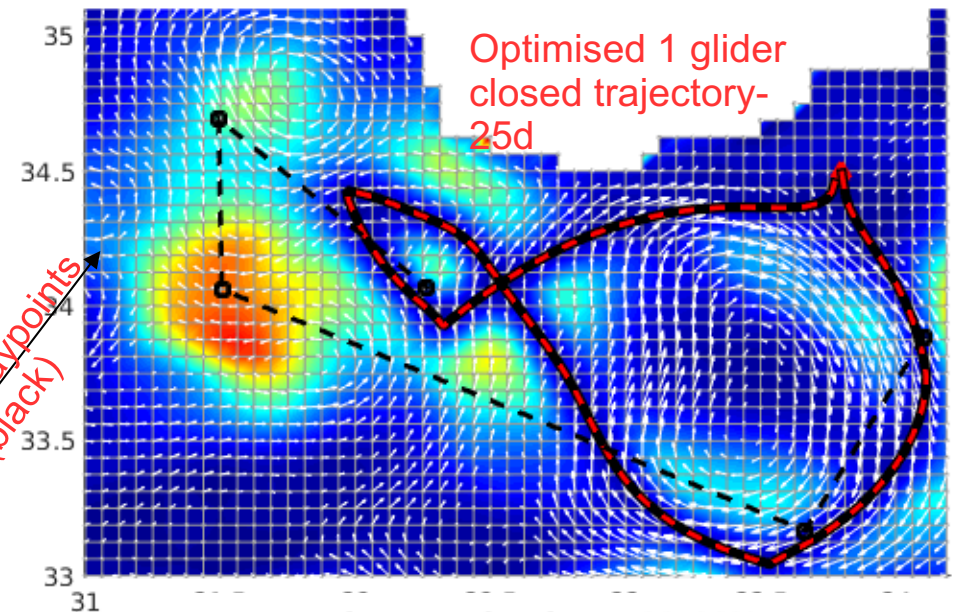
- Varying variance across time and space
- Sea currents able to drift AUVs off-course
- Limited power availability and mission time
- Problem of how to coordinate multiple AUVs

Temperature Variance over 60 days for 200-500m
And mean currents over last 7 days 200-500m



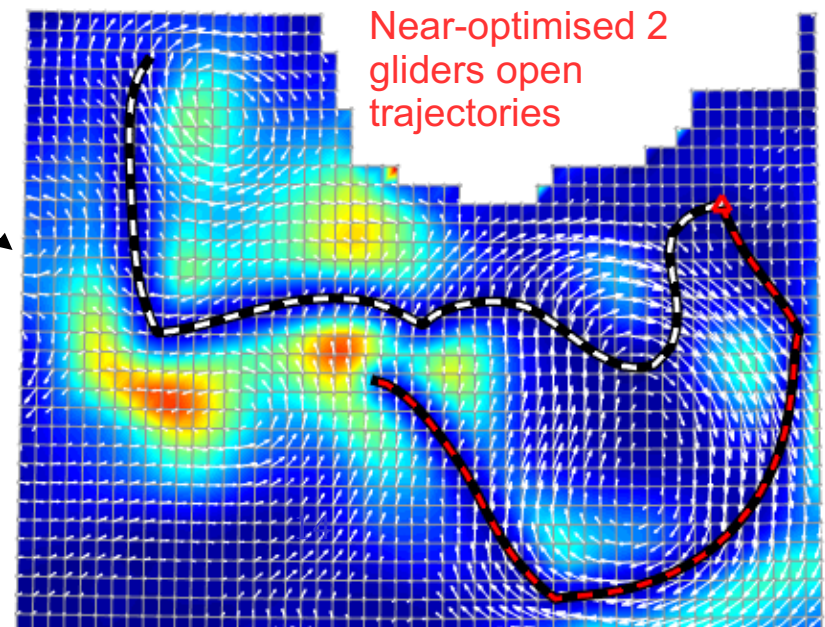
- Minimization of user-defined variance map before mission, then as needed
- Uses glider flight model and currents
- Improved coverage in regions of interest within defined mission time, results in improved forecasts if assimilation is done

Variance if assimilate data at these positions
Variance reduction = 30.71%



Optimised 1 glider
closed trajectory-
25d

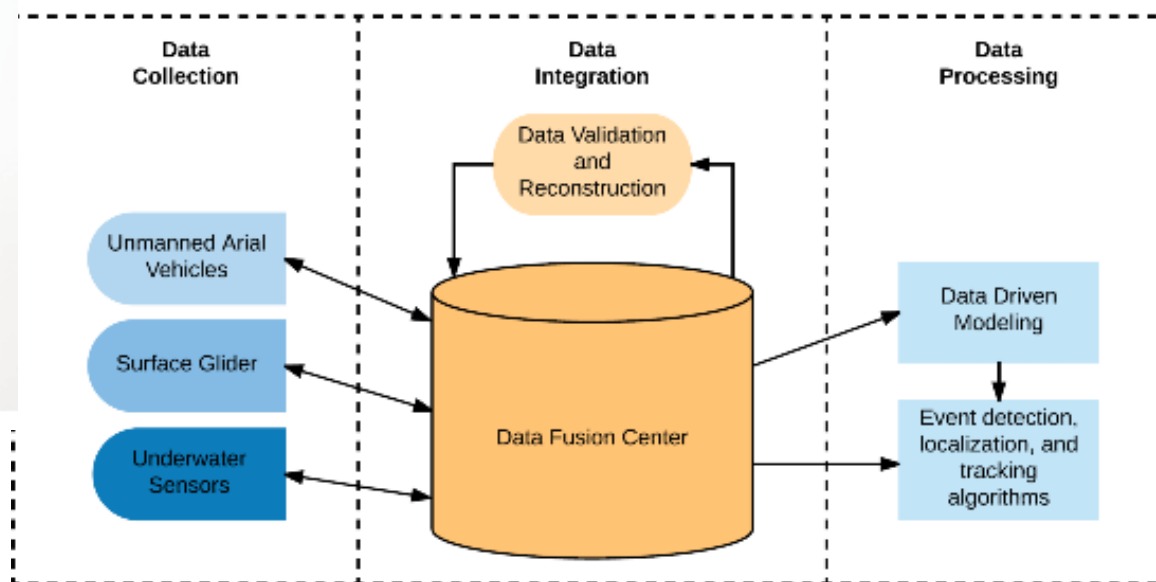
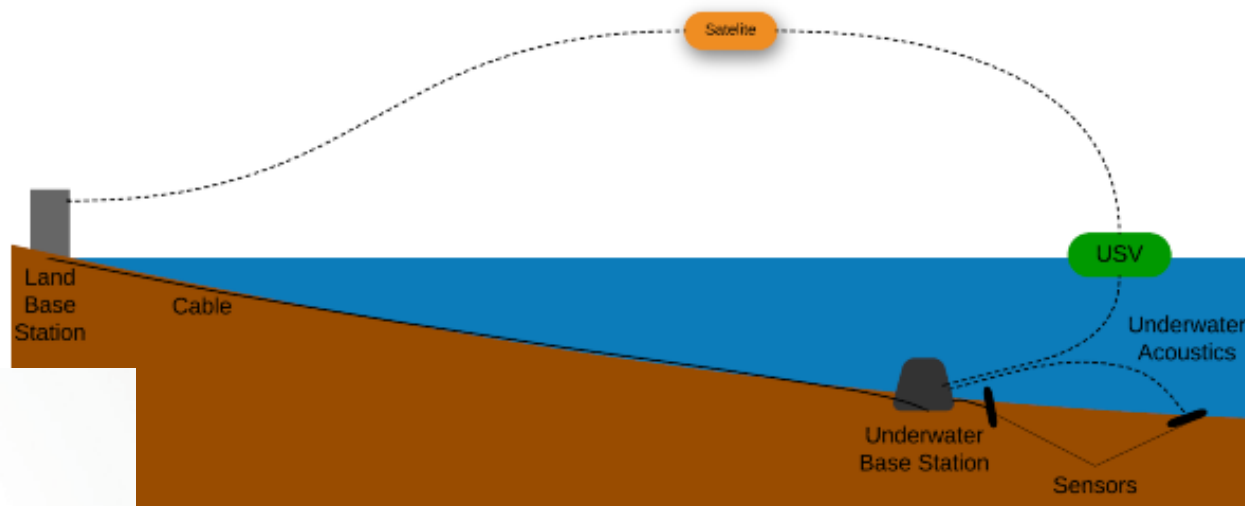
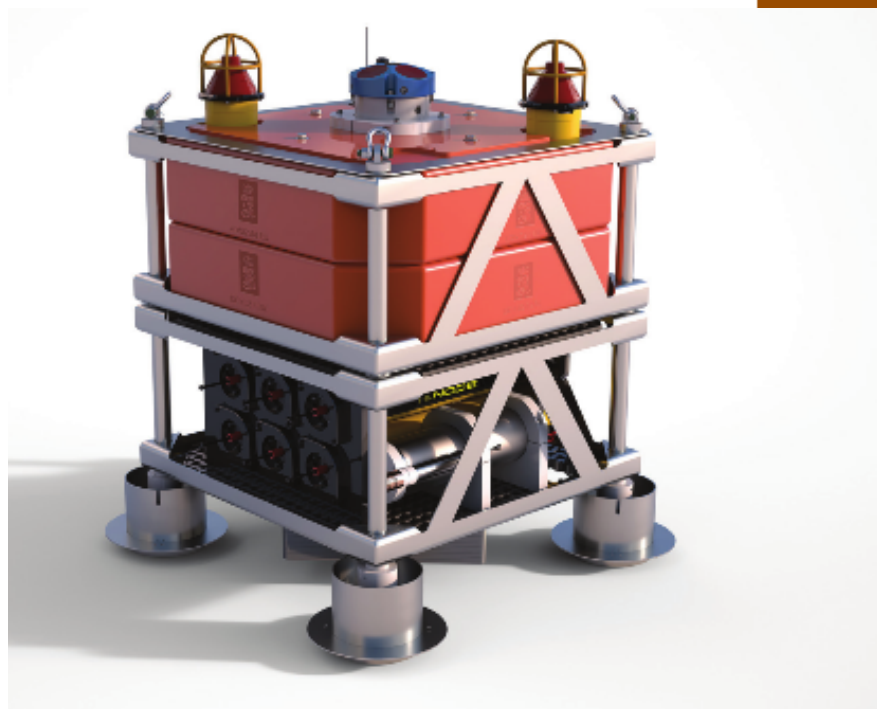
Variance reduction = 32.88%



Near-optimised 2
gliders open
trajectories

Environmental Monitoring Coastal Security and Safety

- Current Sampling
 - Acoustic comms
- Acoustic Sampling
 - Needs NRT connection



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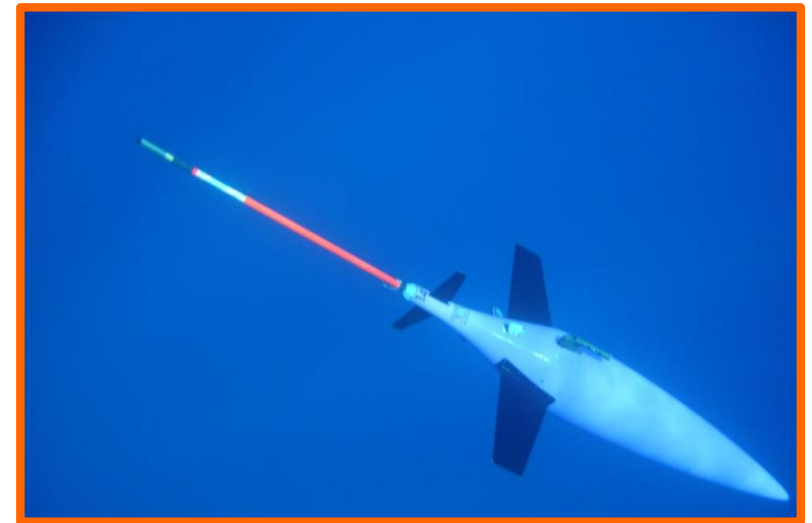


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Sectors

Long-term and cost-effective exploration and monitoring in all ocean conditions

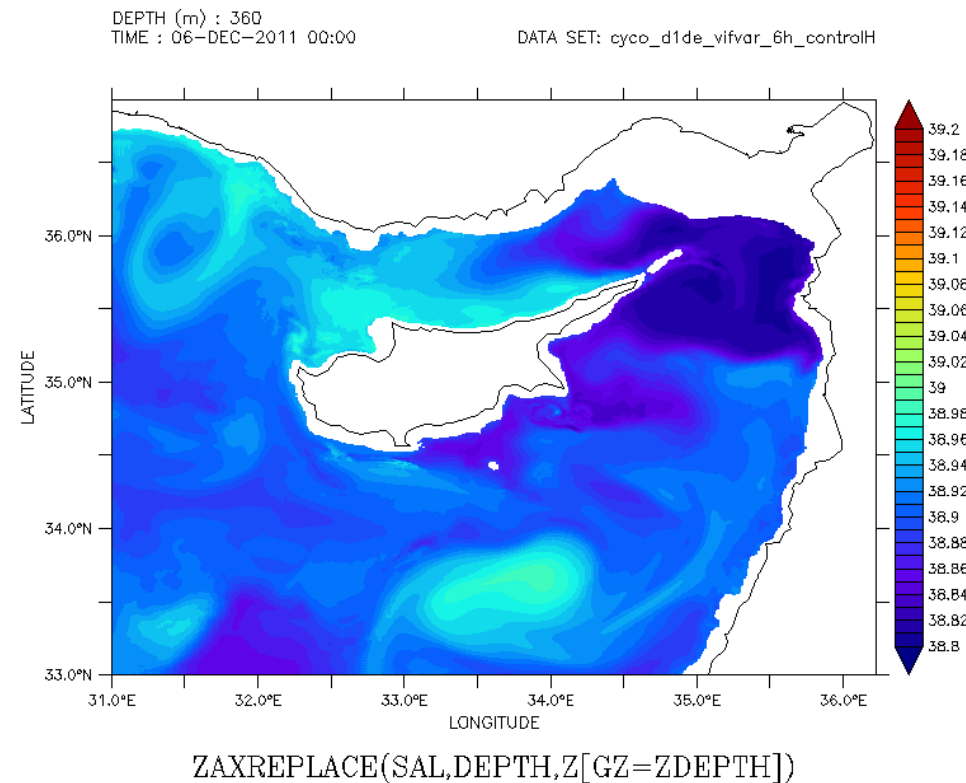
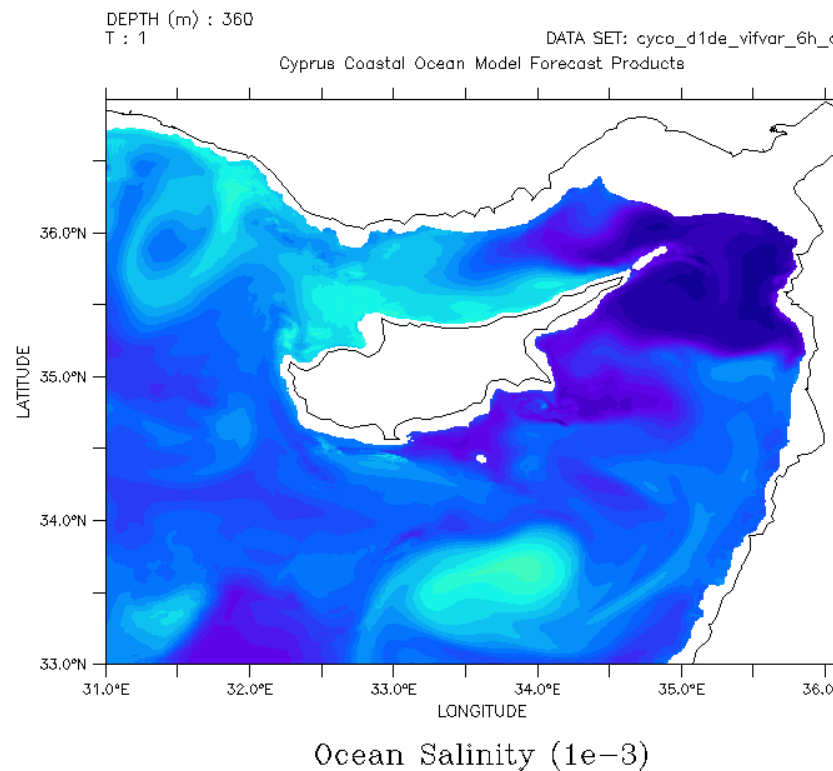
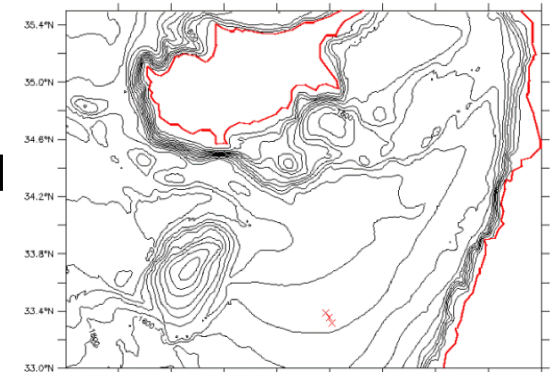
- Oil and Gas/Mining
 - EIA, EBS and operations monitoring
 - Exploration and prospecting (rare)
- Security
 - Infrastructure monitoring, threat detection,
- Safety
 - Search and Rescue, oil spill/pollution plume detection and modelling
- Blue Services for Regulatory Agencies
 - Baseline understanding, permit requirements, regulations



Situational Awareness: Assimilating glider data

Clear “addition” of salt at 360 m

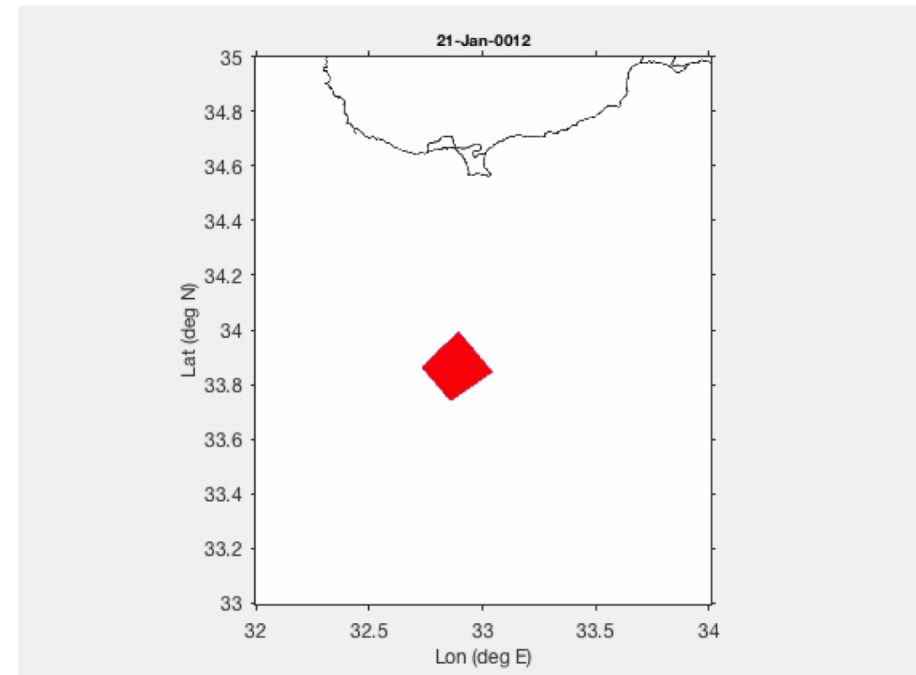
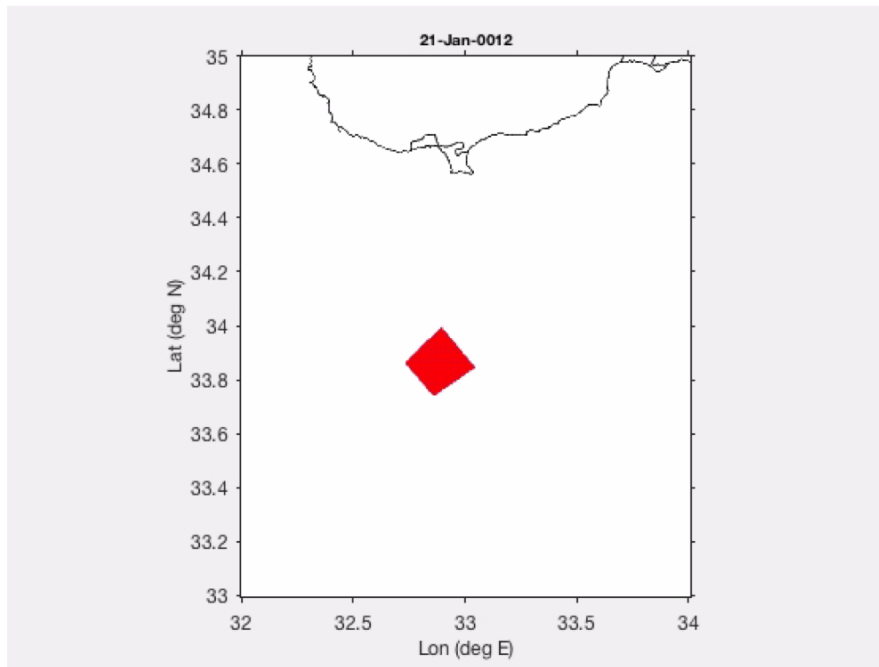
- Knowing the currents with certainty at any depth today and the next few days
- Critical for pollution modelling, search and rescue, operational safety, infrastructure safety, shipping routes,



Situational Awareness: Assimilating glider data

Different surface trajectories for glider run (right)

- Free data sets do not process glider data so their predictions at this scale are very poor



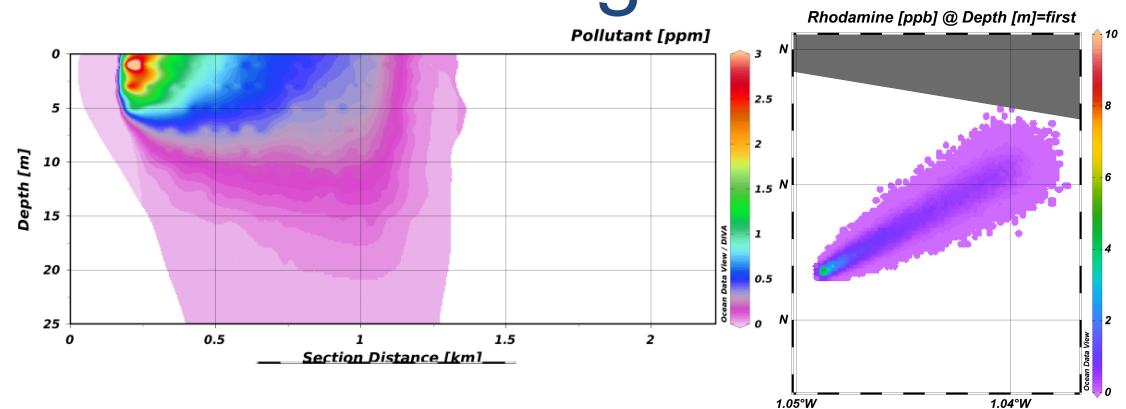
Particle trajectories courtesy Hezi Gildor

Oil Spill Detection and Trajectory Modelling

On Board of the Spanish “Clara Campoamor” in Cartagena, Spain.

- Coordinate and plan missions in a near-real time scenario using Rhodamine WT to simulate an underwater oil spill.
- Show the capabilities acquired to authorities, industry, business and government sector.

The project demonstrated the ability to locate a spill, determine its size, and predict its movement.



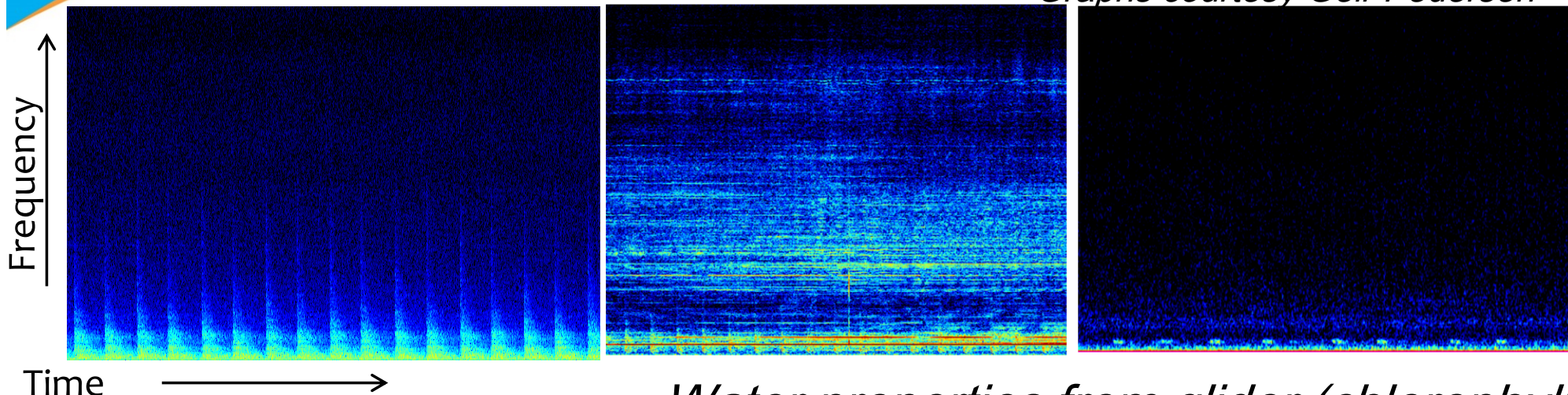
DEMONSTRATIVE EXPERIMENT



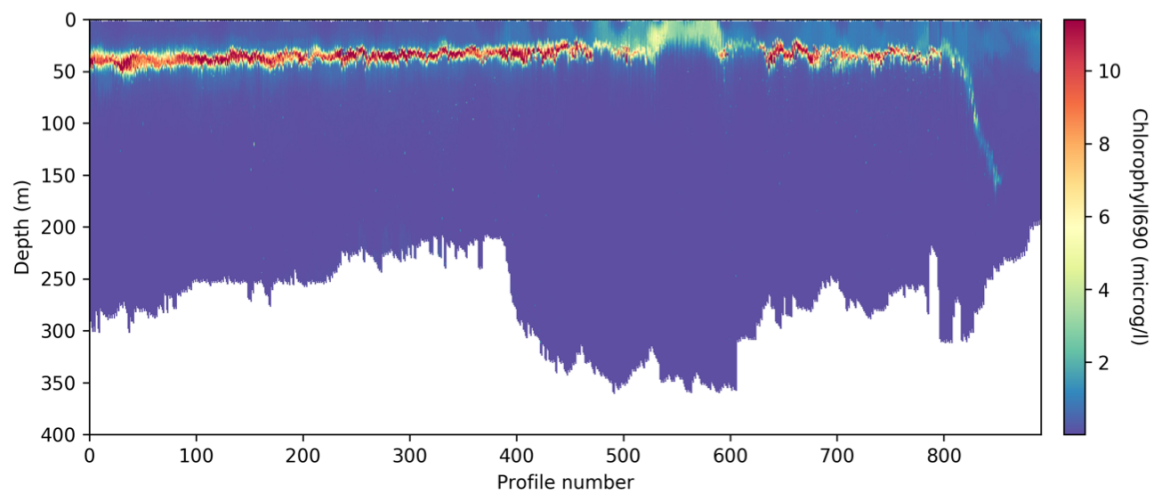
Passive Acoustic Monitoring (PAM)

Acoustic examples from glider (seismic, ship, whale)

Graphs courtesy Geir Pedersen



Water properties from glider (chlorophyll)



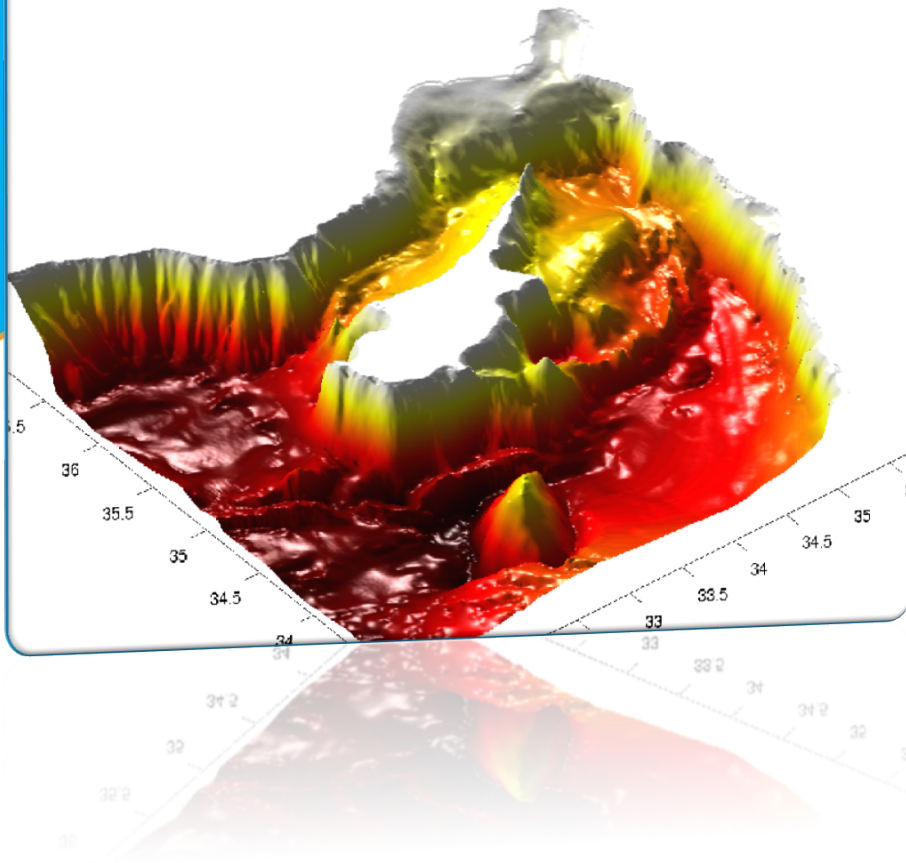
Conclusions

1. Robotics and autonomy are a reality in ocean observing.
2. Industrial and research applications are endless, but require skilled people to carry out and further develop, analyze, interpret results.
3. Environmental and monetary costs may be reduced, while capabilities increased.
4. If planned and carried out properly, different aspects the same measurements can be used by many stakeholders.

Blue growth requires blue experts!



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THANK YOU