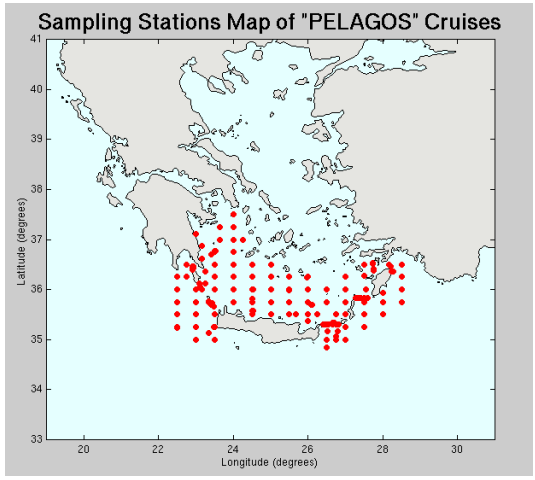
Ocean Gliders in marine research

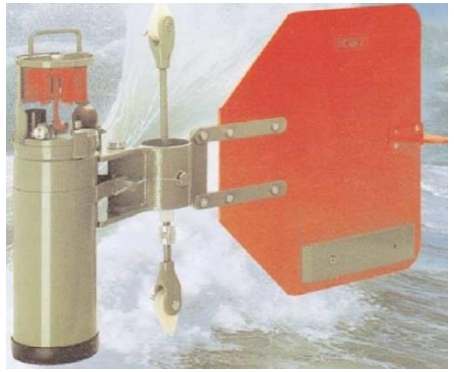
Leonidas Perivoliotis
Institute of Oceanography
HELLENIC CENTRE FOR MARINE RESEARCH
HCMR

29 April 2022

Traditional way of collecting oceanographic data

R/V + Cruise plan





Current meter

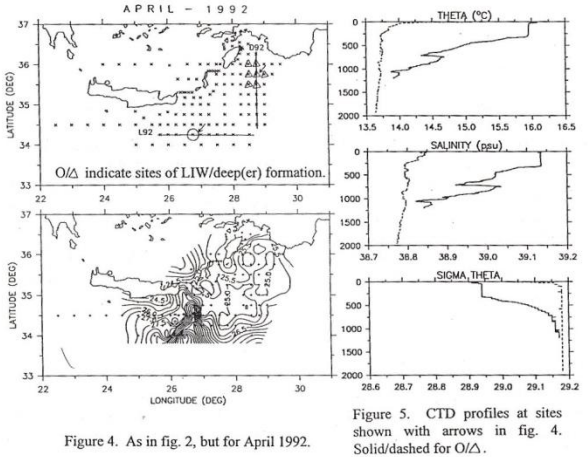


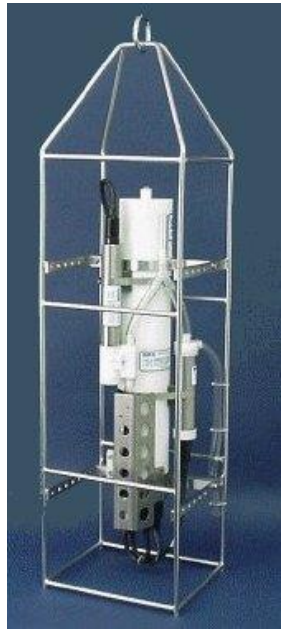
Figure 4. As in fig. 2, but for April 1992.

Figure 5. CTD profiles at sites shown with arrows in fig. 4. Solid/dashed for O/Δ.

Data analysis

Water samples: Niskin bottles

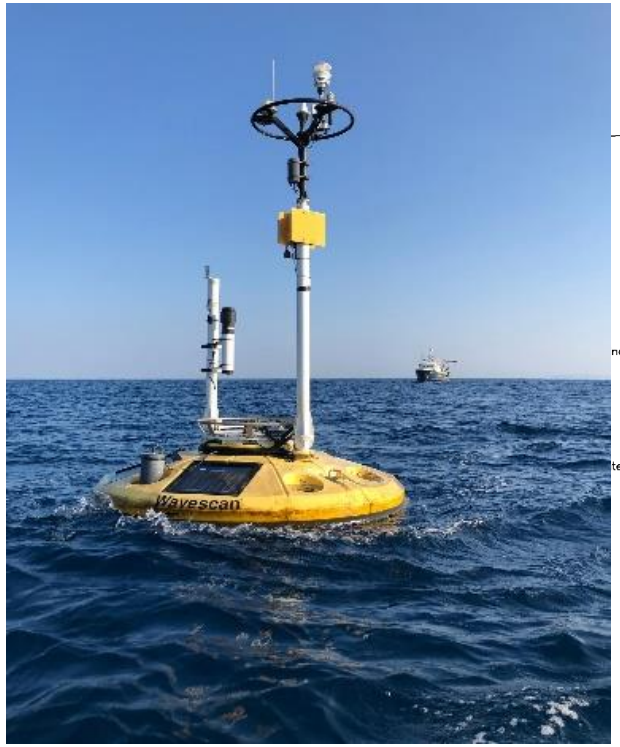
Plankton Net and Trawl



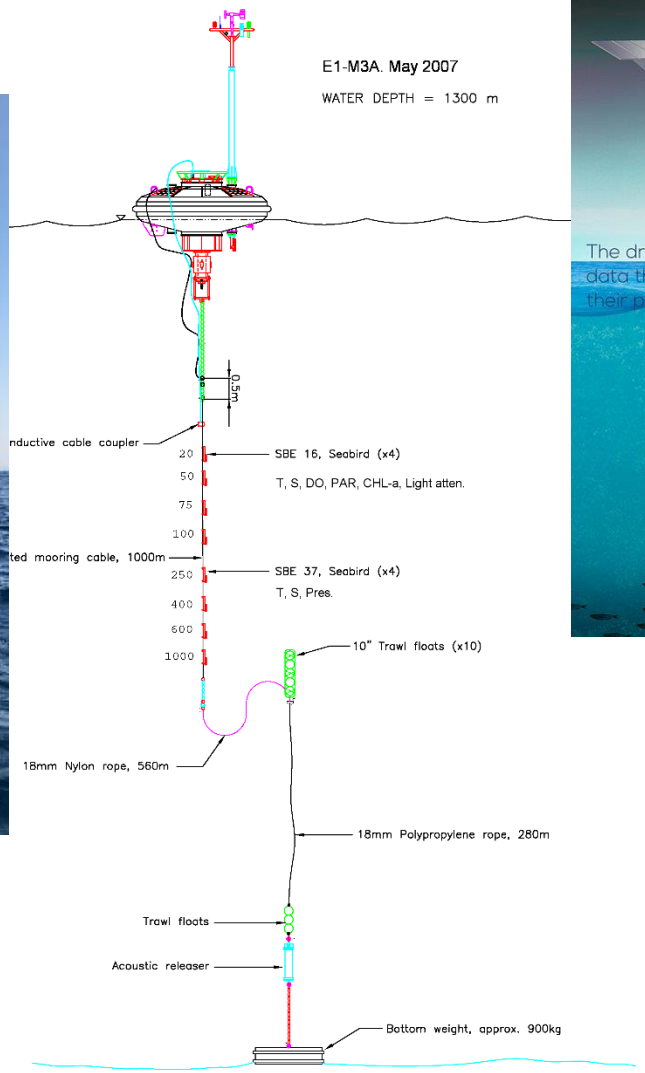
CTD (Conductivity, Temperature, Depth)

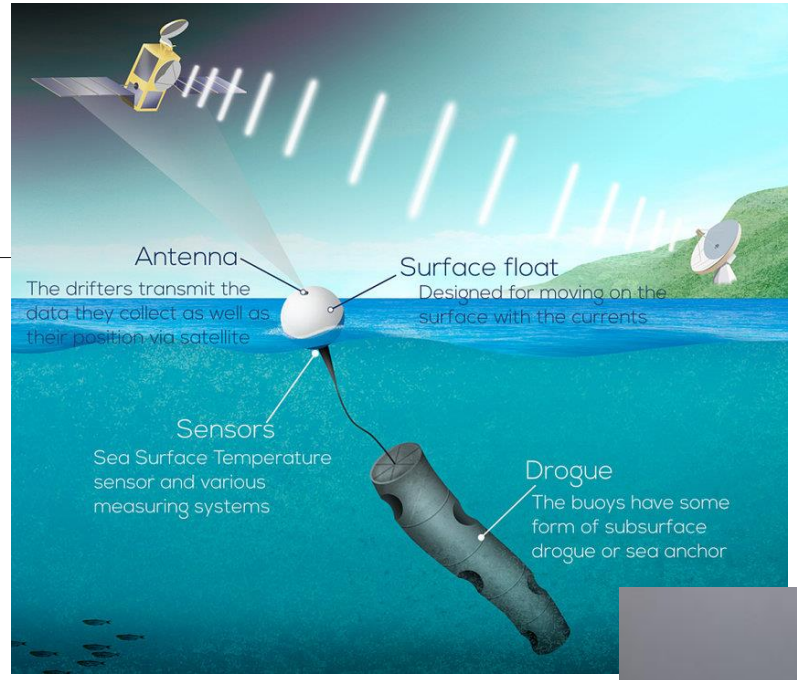
Geostrophic maps

The era of autonomous oceanographic platforms



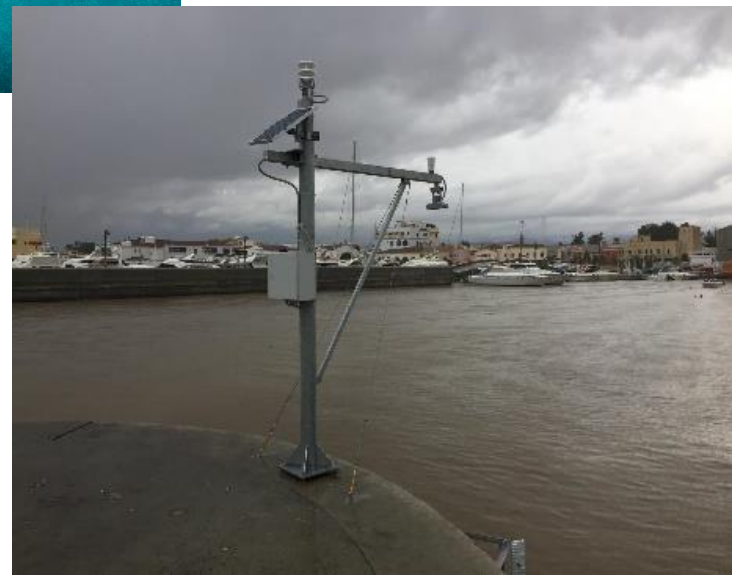
Fixed stations (Buoys)



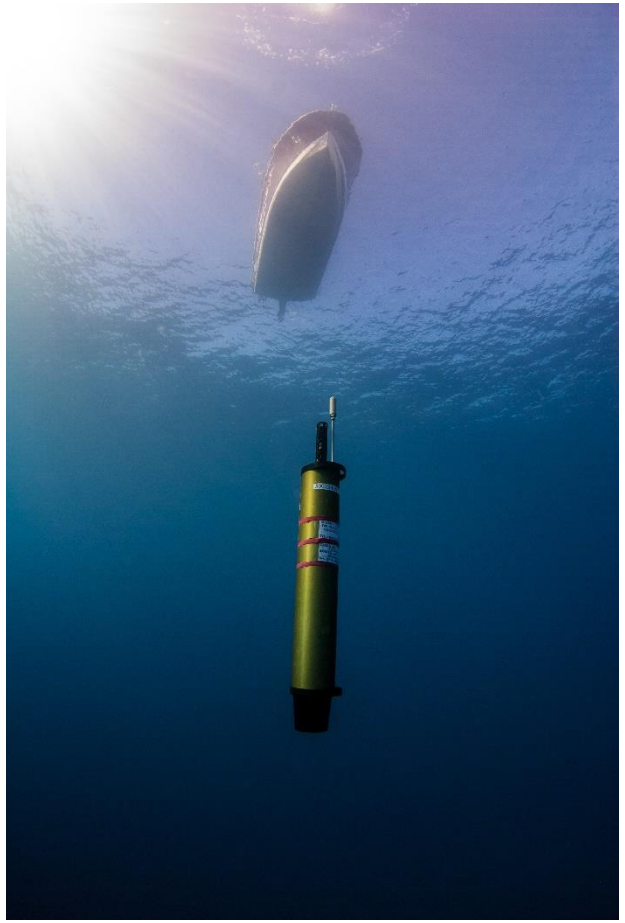


Drifters

New generation tide gauges

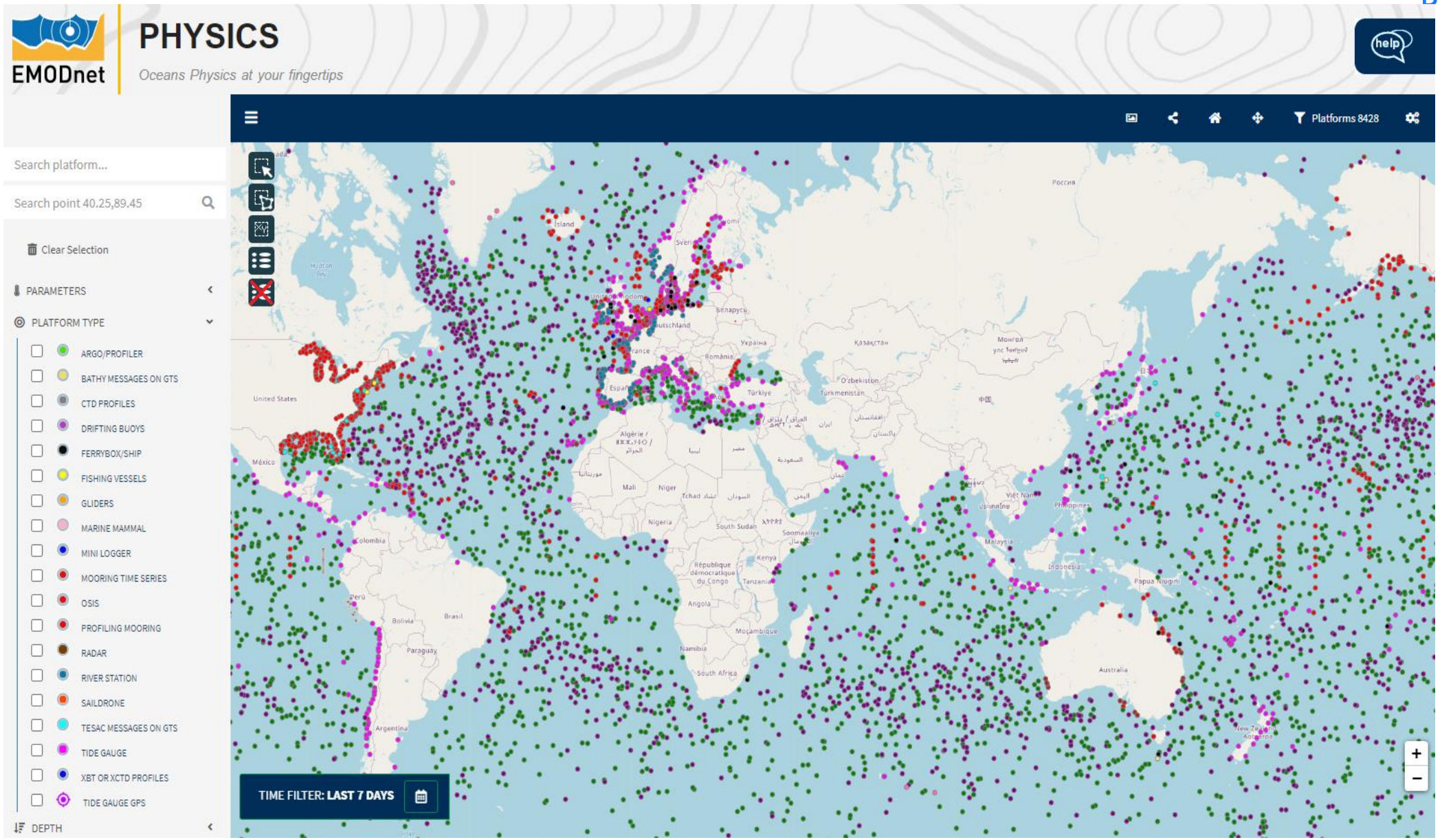


The era of autonomous oceanographic platforms



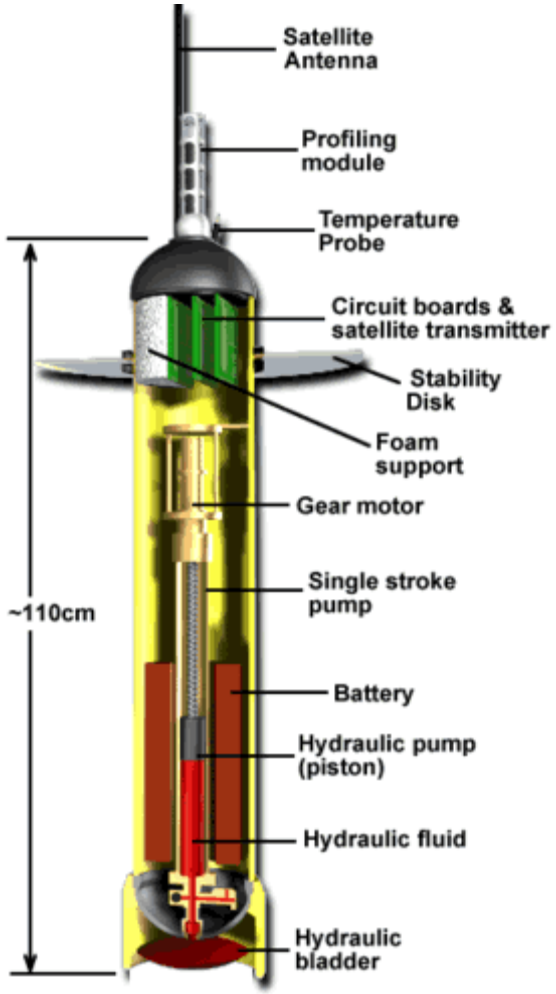
- Vertical profilers:
  - Argo floats
  - Underwater gliders (Seaglider, Slocum, SeaExplorer)

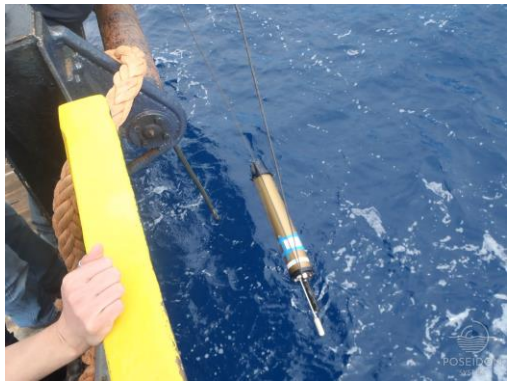
Today's Global Ocean Observing System



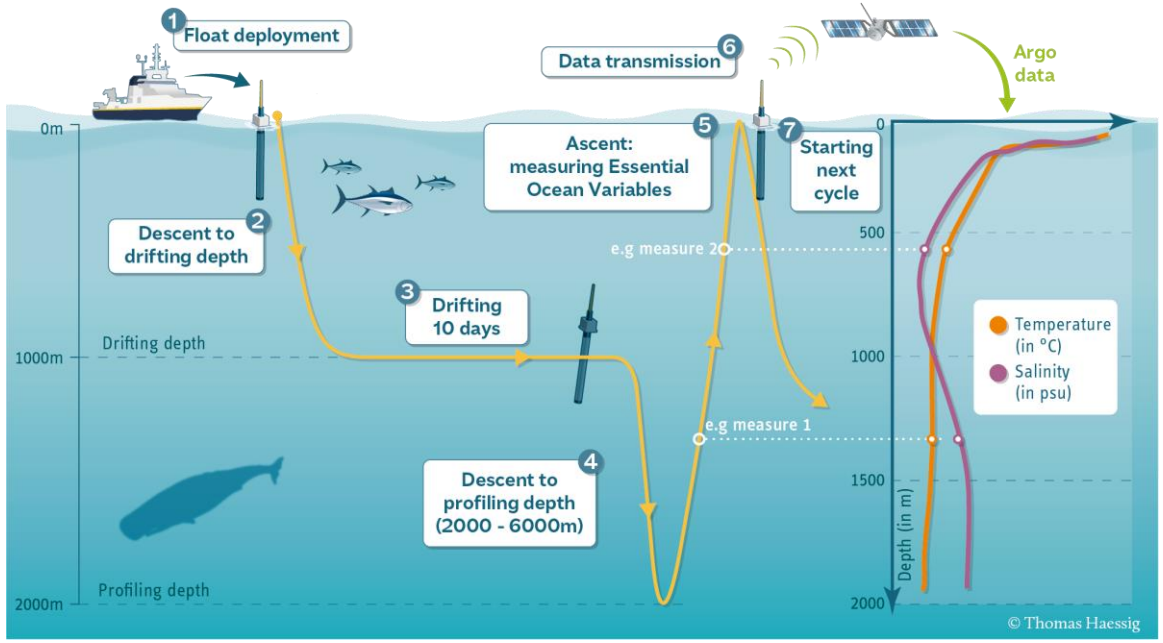
Argo floats

- The mature autonomous profiling float for oceanographic research





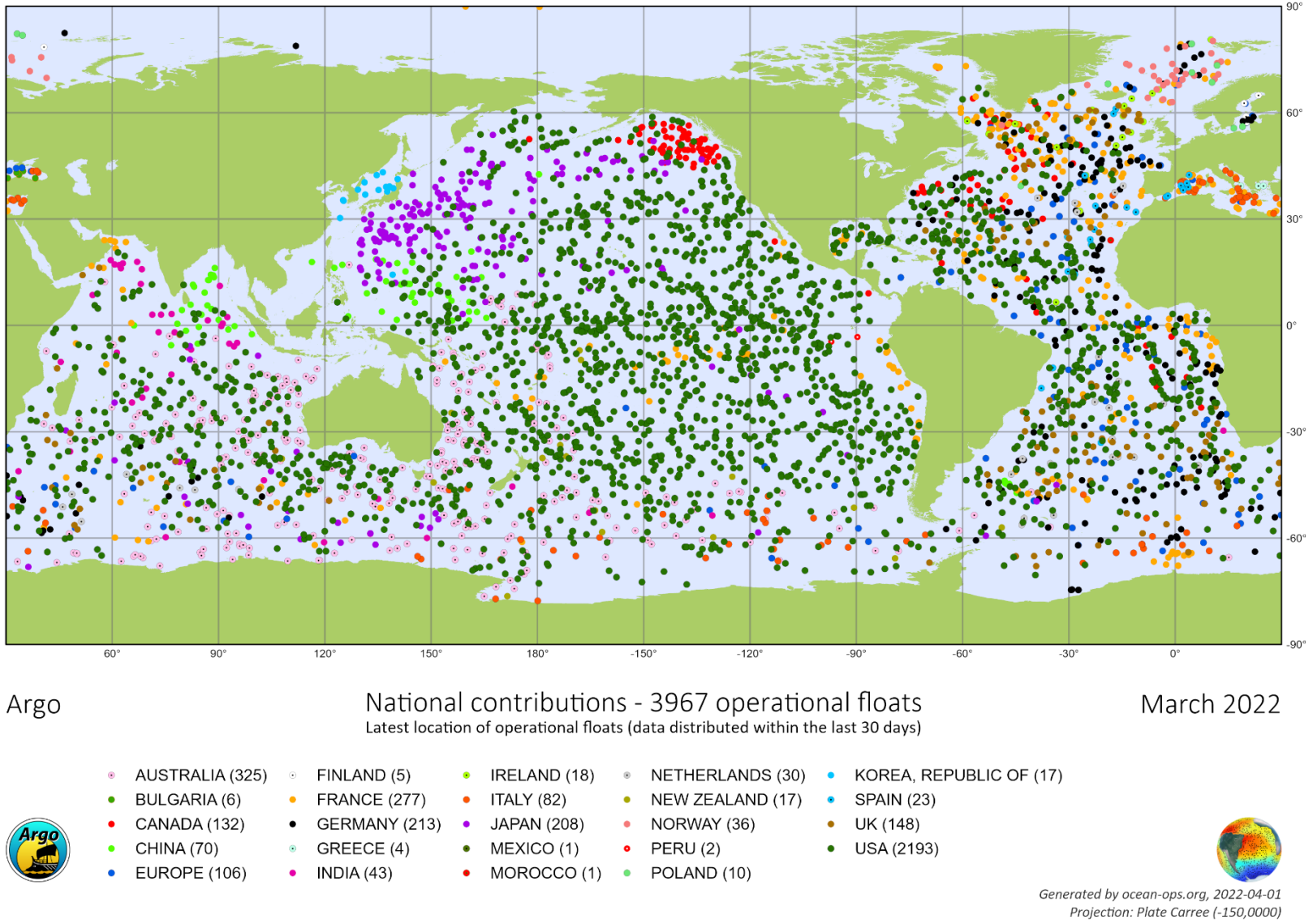
The first Argo floats were deployed in 2001.



Argo Network

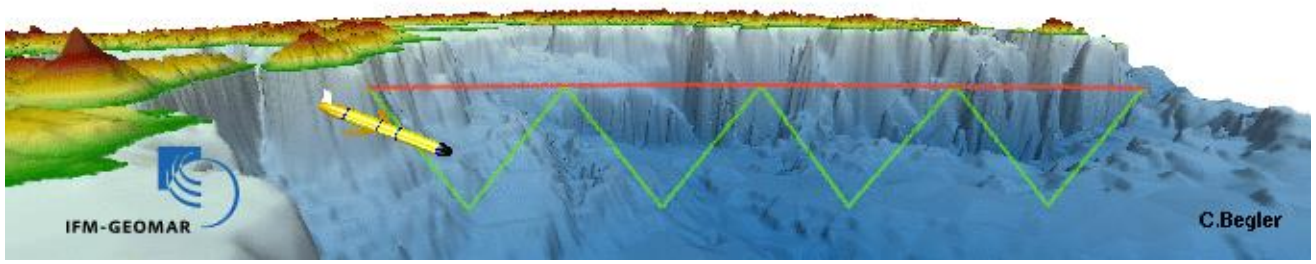
- During the last two decades the Argo network has become an integral and necessary component towards ocean monitoring which is crucial for climate dynamics and climate change

- Today, the global Argo network consists of approximately 4000 floats and has become the first ever global, in-situ ocean observing network in the history of oceanography



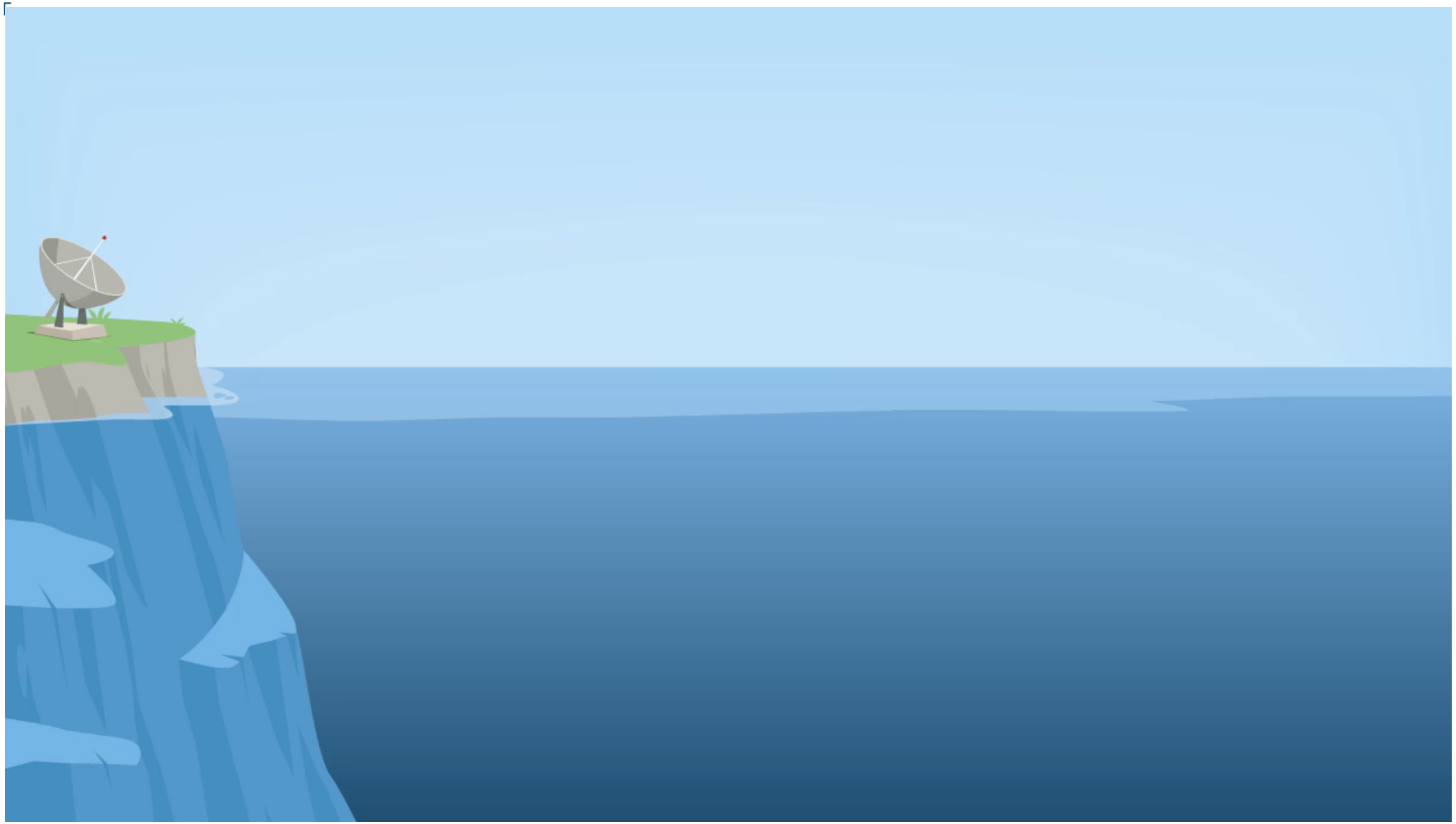
Underwater Gliders

- They travel changing their buoyancy and attitude in order to dive up and down successively, while they sample the seawater to collect oceanographic data.
- Typically profile in a saw tooth pattern from the surface to 1000 m depth, travelling 3 – 6 km in the horizontal plane at a speed of about 1 km/h in every dive cycle.
- They are operating extensively for sustained observations both in coastal and open seas, collecting information of physical parameters like temperature, salinity, dissolved oxygen, chlorophyll, etc. along predefined transects.



- One descending + One ascending profile every 5-8 hours
- 6-10 profiles/day
- 180-300 profiles/month
- High frequency recording of data
- Measuring the Ocean variability

Glider’s principle



Glider's technology

Energy

Alkaline (3 weeks)/Primary lithium (5 months max)/Rechargeable (60 days) ~ 30% of total weight

Low consumption electronics (Persistor computer)

Propulsion

Oil bladder

Wings

30 cm/s horz. and 15 cm/s vert.

Navigation

Compass (pitch, roll, heading)

GPS

Current correction

Rudder or moving batteries

Communications

Iridium

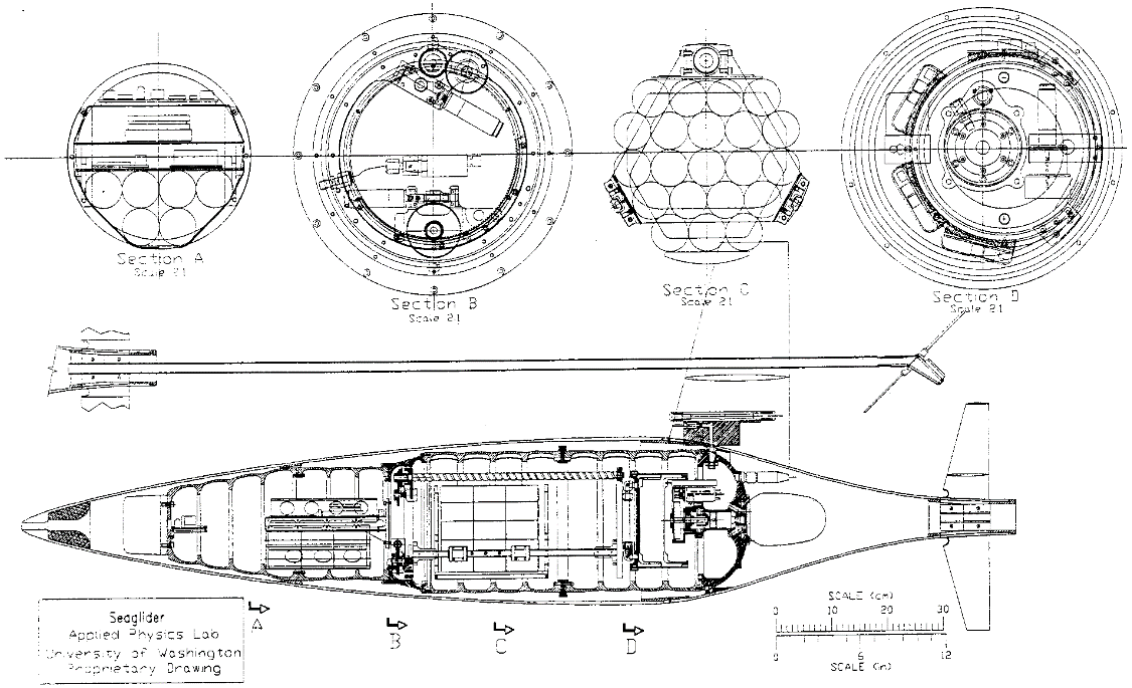
Freewave or Serial cable

ARGOS

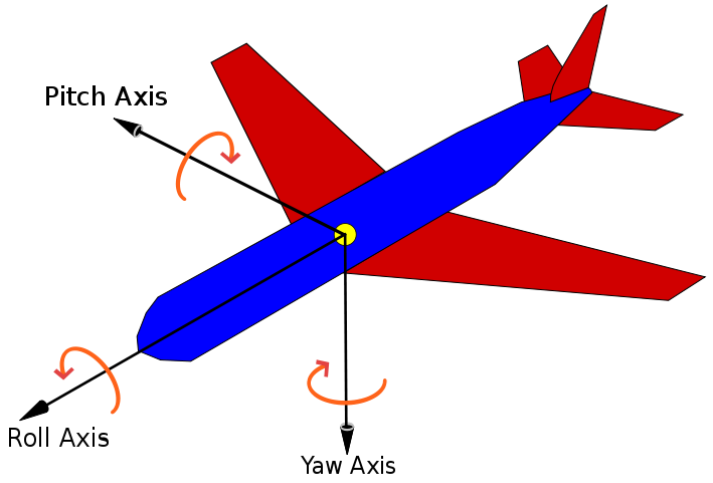
Sensors

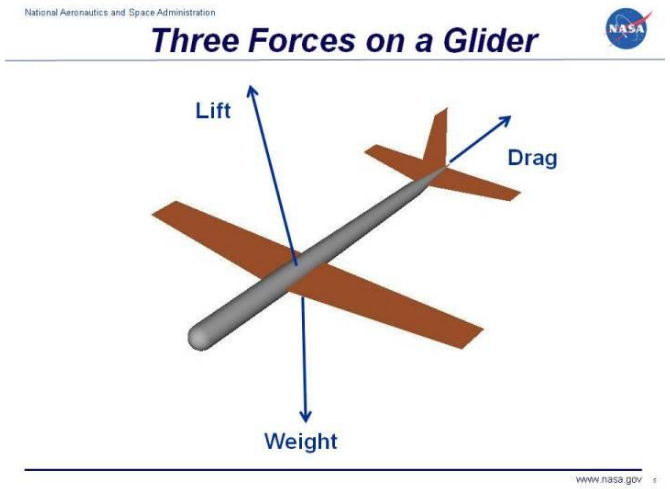
Conductivity(Salinity), Temperature, Depth, Fluorometer, Oxygen, ADCP,…

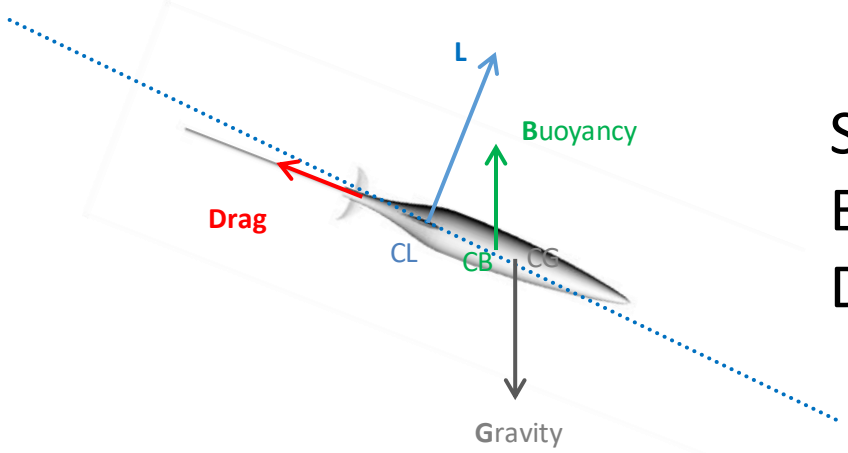
Custom (Animal tracking, radioactivity,..)



Flight dynamics



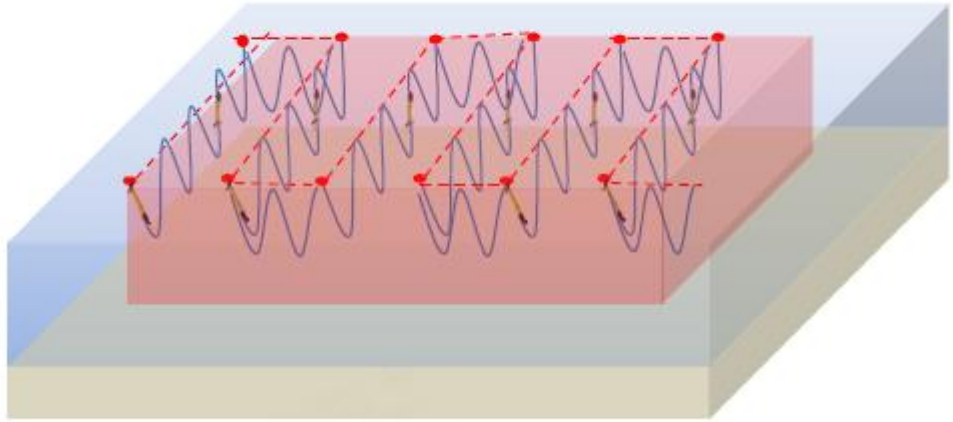




Static Forces: Gravity, Buoyancy force
Dynamic Forces: Lift, Drag

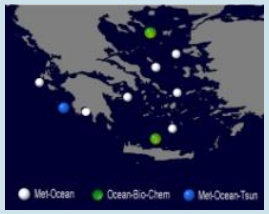
Data collection with Ocean Gliders

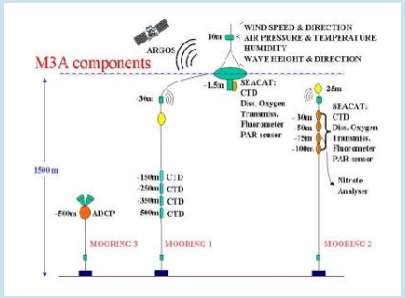
- Cost effective:
  - Large scale (spatial & temporal)
  - Long autonomy
  - Sustained & real-time observation
  - No supervising vessel required
- Wide variety of sensors:
  - monitor temperature, salinity, currents, biochemical ocean conditions as well as marine mammals (sound), advancing the sustained monitoring from the coastal environment to the open seas
- Used for applications in the oil and gas industry being able to detect hydrocarbons and methane
- In defense and security using passive acoustic sensors.



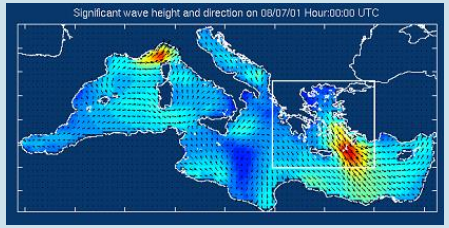
The POSEIDON System – https://poseidon.hcmr.gr

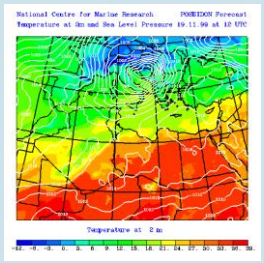
Observations

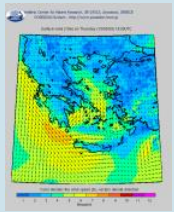


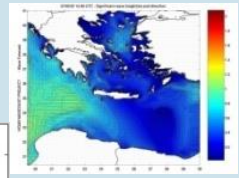


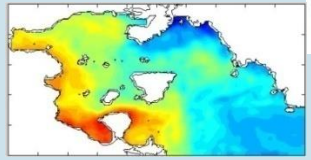
Processing & Modeling



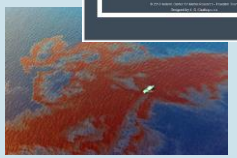


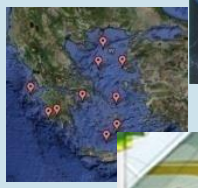






Information and Decision Support Systems

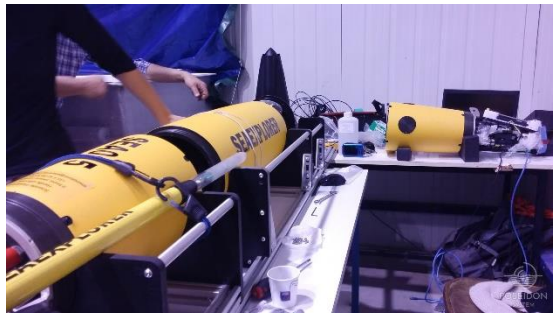


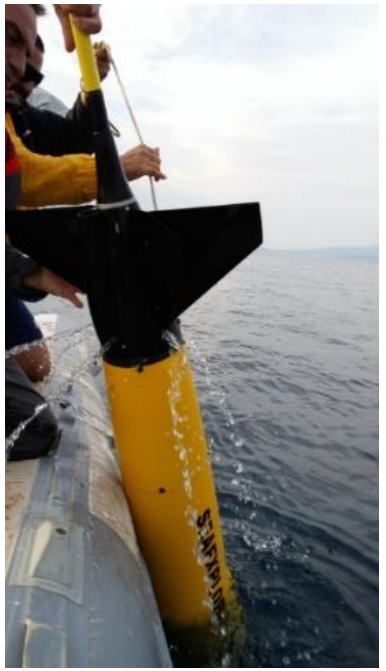


End Users

The POSEIDON Gliders

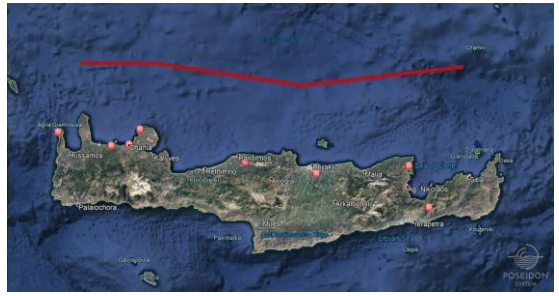
- Poseidon System has integrated 3 SeaExplorer gliders in its observing network for the Greek Seas
- Payload of CTD (conductivity, temperature, depth), a dissolved oxygen sensor (GPCTD + DO sensor of the SEABIRD ELECTRONICS company), WET Labs ECO Puck Triplet – FLBBCD
- The pre-deployment preparation is made in the glider lab, HCMR premises in Anavyssos
- The deployment as well as the recovery of the gliders is usually conducted from a small boat as the whole procedure is carried out by hand

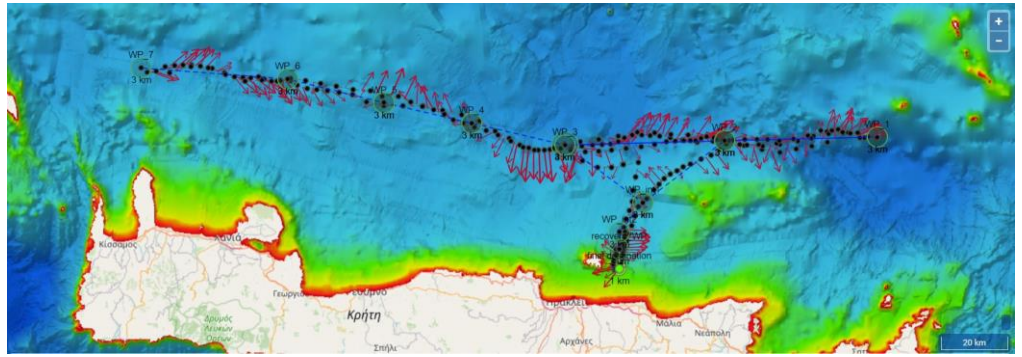




The Cretan Sea missions

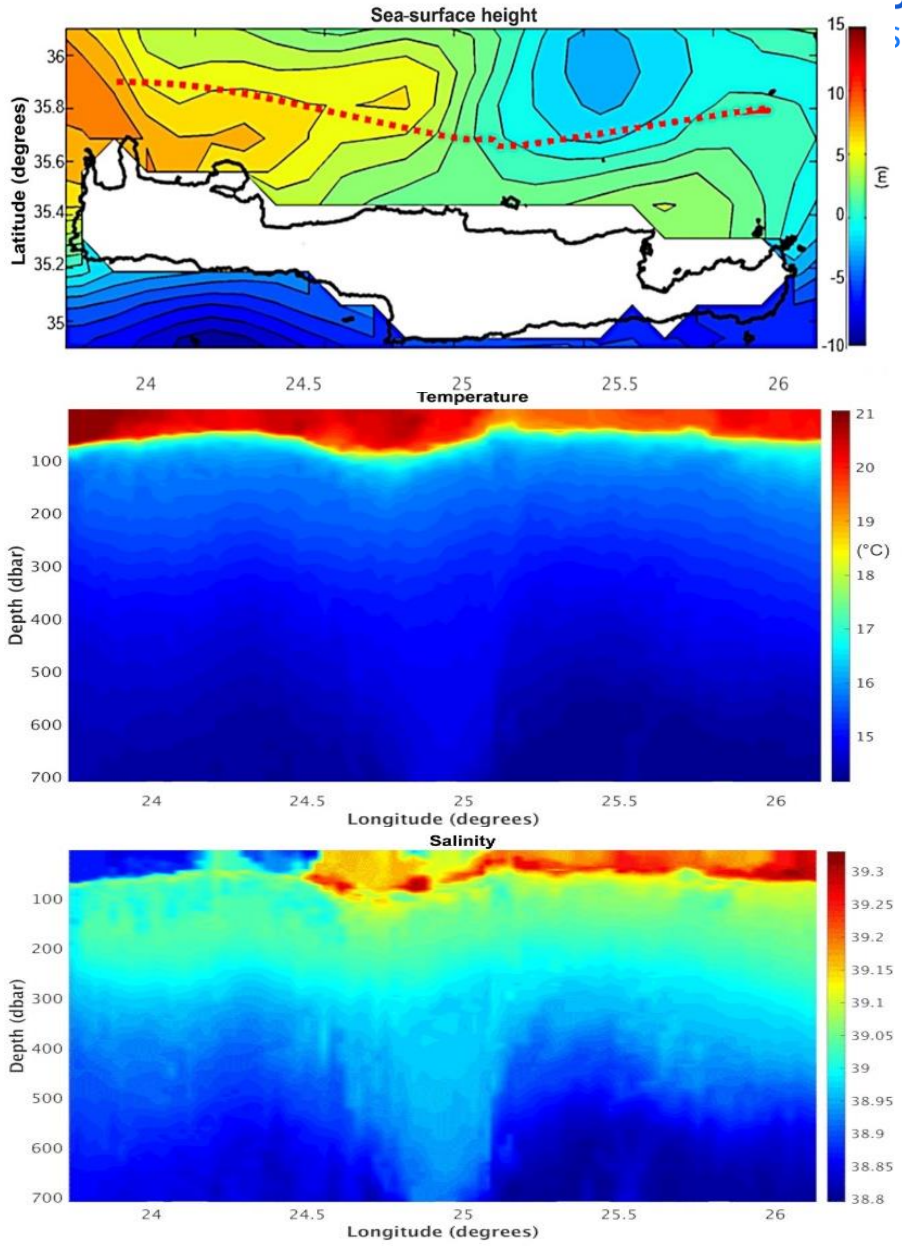
- During its mission the glider performs profile measurements following a trajectory parallel to the island of Crete, which has a length of approximately 220 km
- The missions have a duration of 30 to 45 days, while the glider is able to repeat this trajectory 2 to 3 times during each mission





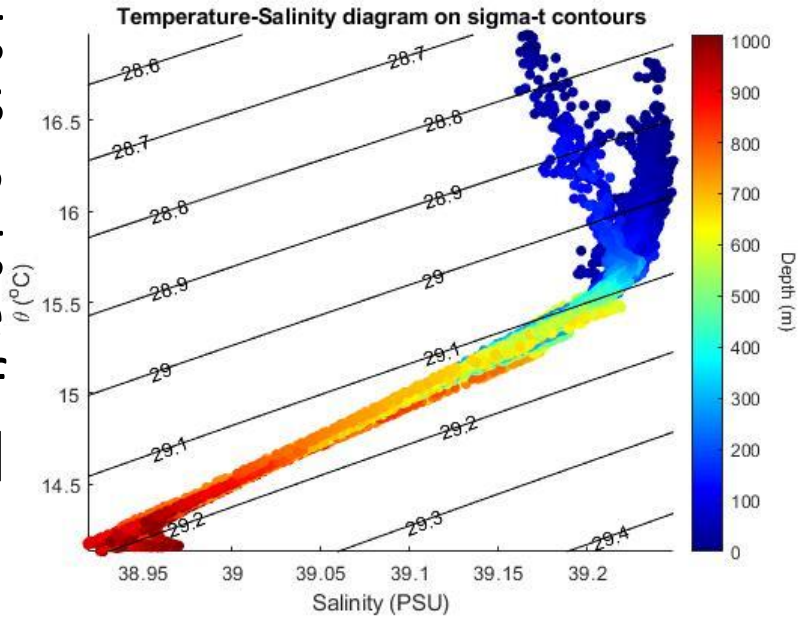
The Cretan Sea missions

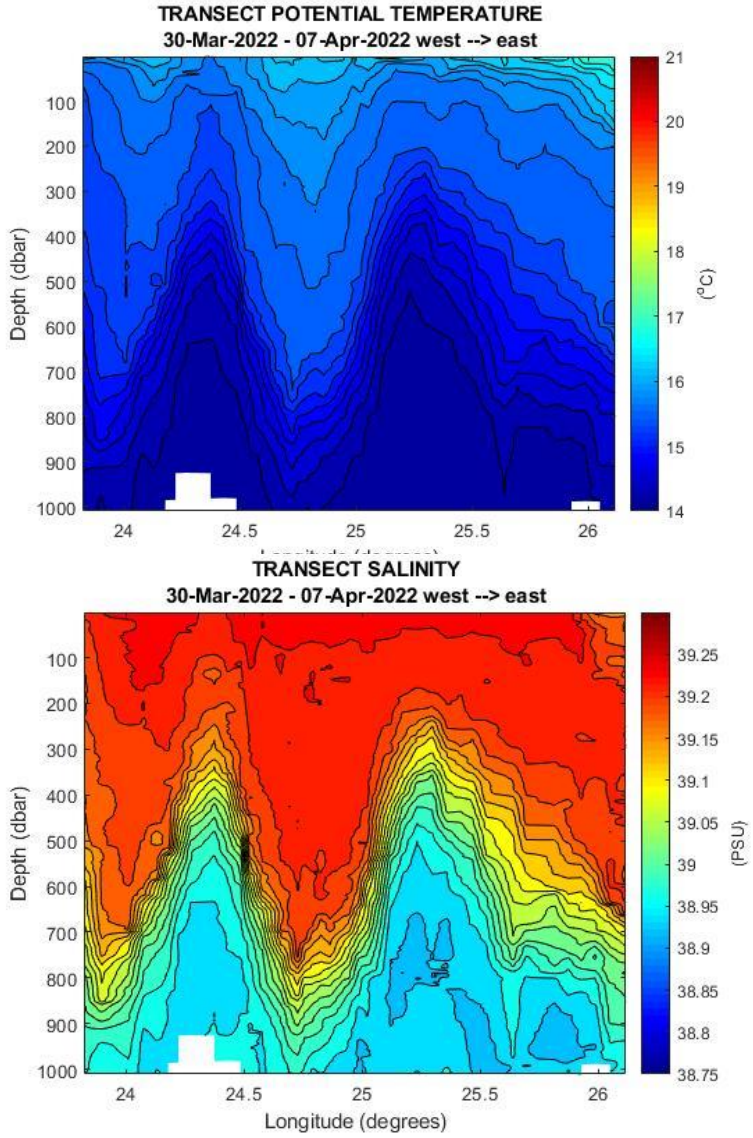
- Oceanographic data gathered by the glider along its transect in the Cretan Sea during November 2017: the vertical distribution of temperature up to 700 m; the vertical distribution of salinity up to 700 m
- They are reasonably consistent with the sea-surface height distribution



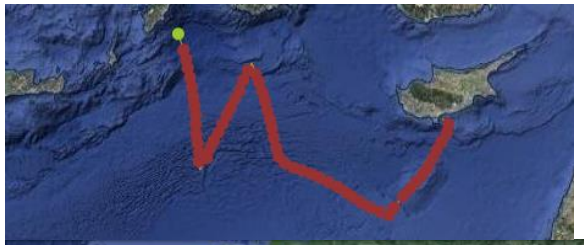
The Cretan Sea missions

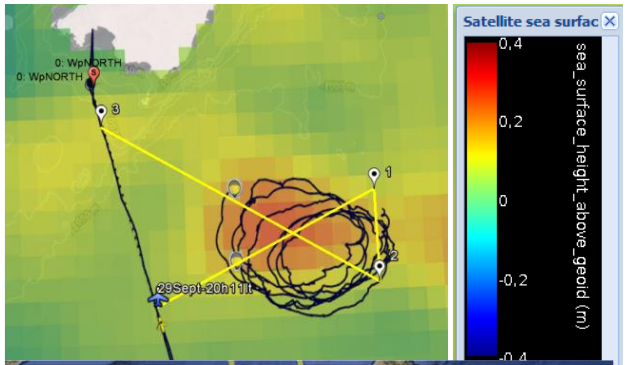
- Since 2017, 12 glider missions have been conducted to support the Cretan endurance line: 4 missions during winter, 5 missions during spring, and 3 missions during summer, with the optimal objective of three seasonal missions per year.

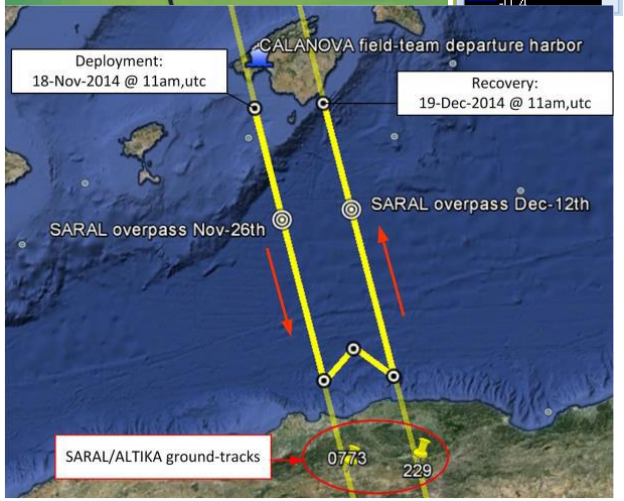


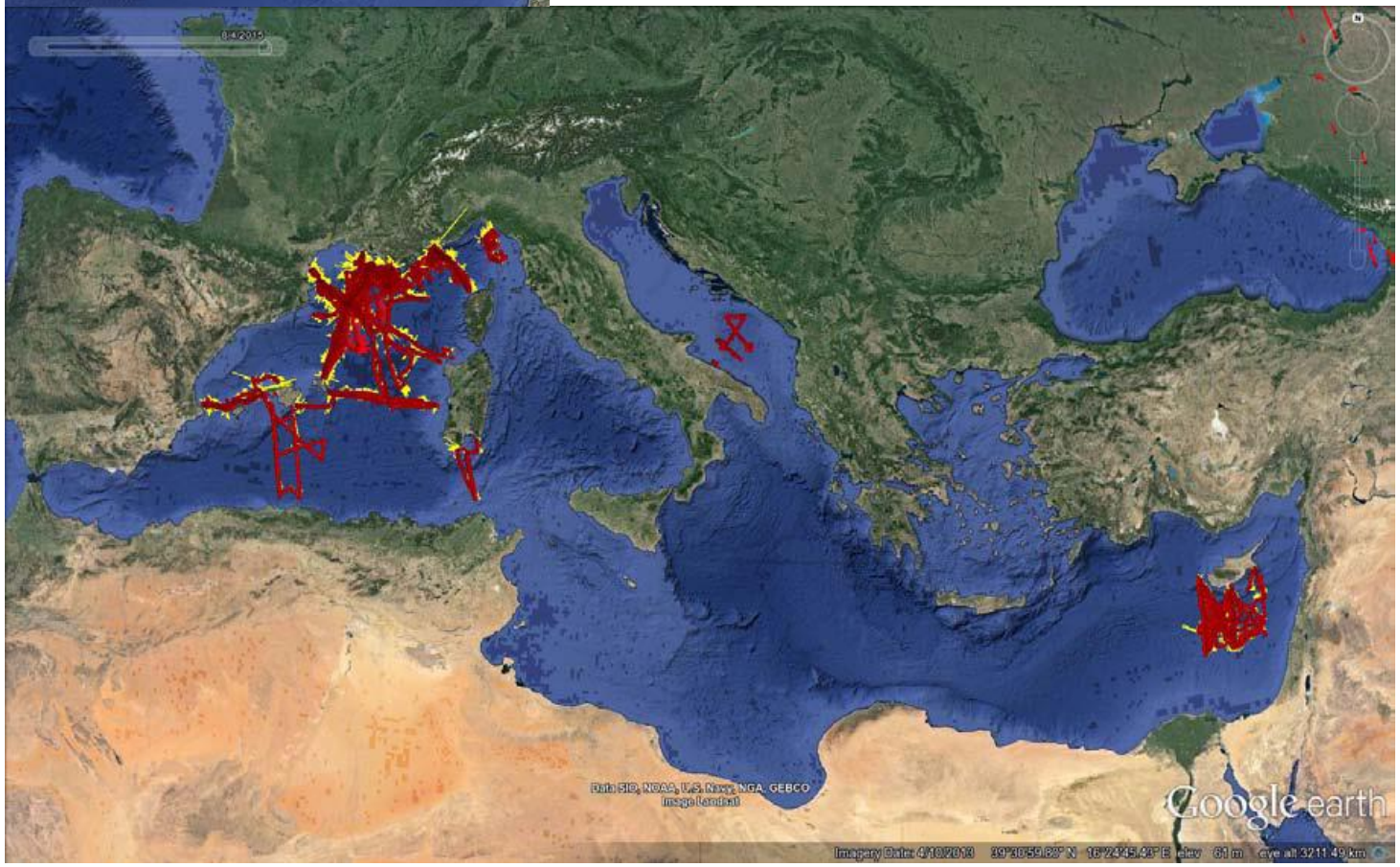


Repeated glider sections in the Mediterranean Sea





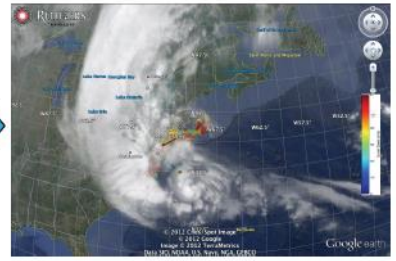




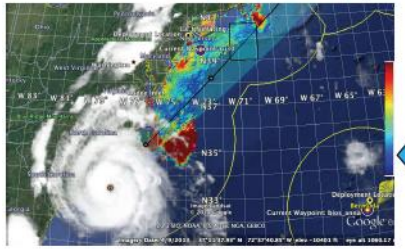
Glider experiments in the Mediterranean Sea between January 2012 and June 2015.

Monitoring the hurricanes using gliders

Hurricane Irene August 28, 2011
NOAA/NHC Damage: >$16 Billion.
Track Accurate; Intensity Over-predicted.



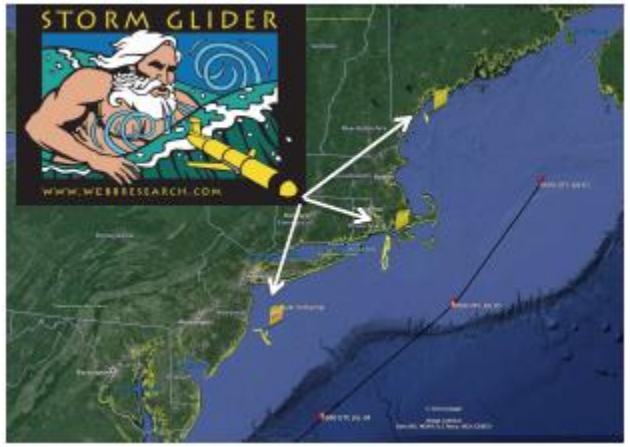
Hurricane Sandy October 29, 2012
NOAA/NHC Damage: >$68 Billion
Track Accurate; Impact Under-predicted.

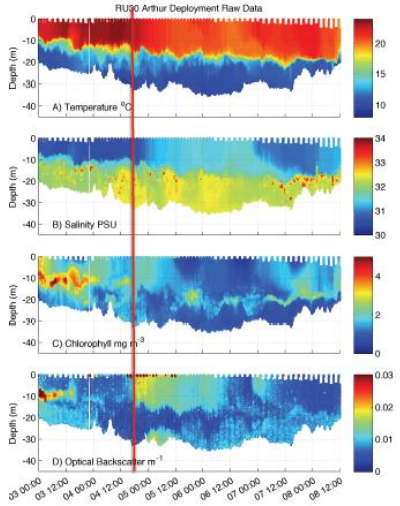


Hurricane Arthur July 4th, 2014
Track Accurate; Intensity well-handled

- **Make hurricane modeling more accurate**: deploy a fleet of gliders that can get right up under the eye of a storm to gather real-time data on what's happening in the ocean below, like how temperatures are changing at different depths. Researchers are analyzing data gathered by these gliders during Irene and Sandy to try to figure out what makes the difference between a relatively weak hurricane and a superstorm.
- use these data to validate some of the models

RAPID RESPONSE STORM GLIDER





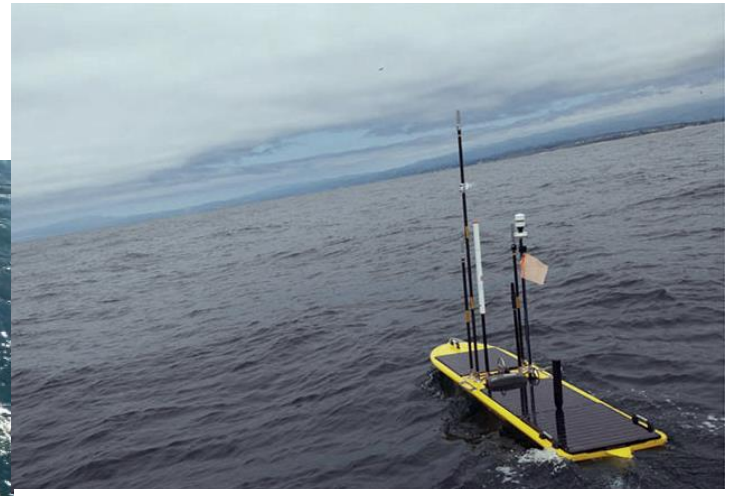
Hurricane Arthur
4 Storm Glider
Deployments

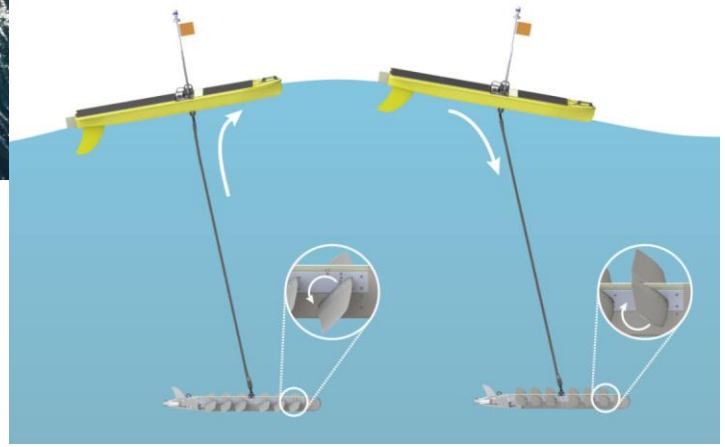
Autonomous systems in ocean monitoring

Unmanned surface vehicles

Saildrone

Sailbuoy





Wave glider

Thank you for your attention