Observatorio Binacional LagoTiticaca

Living Lakes 16va

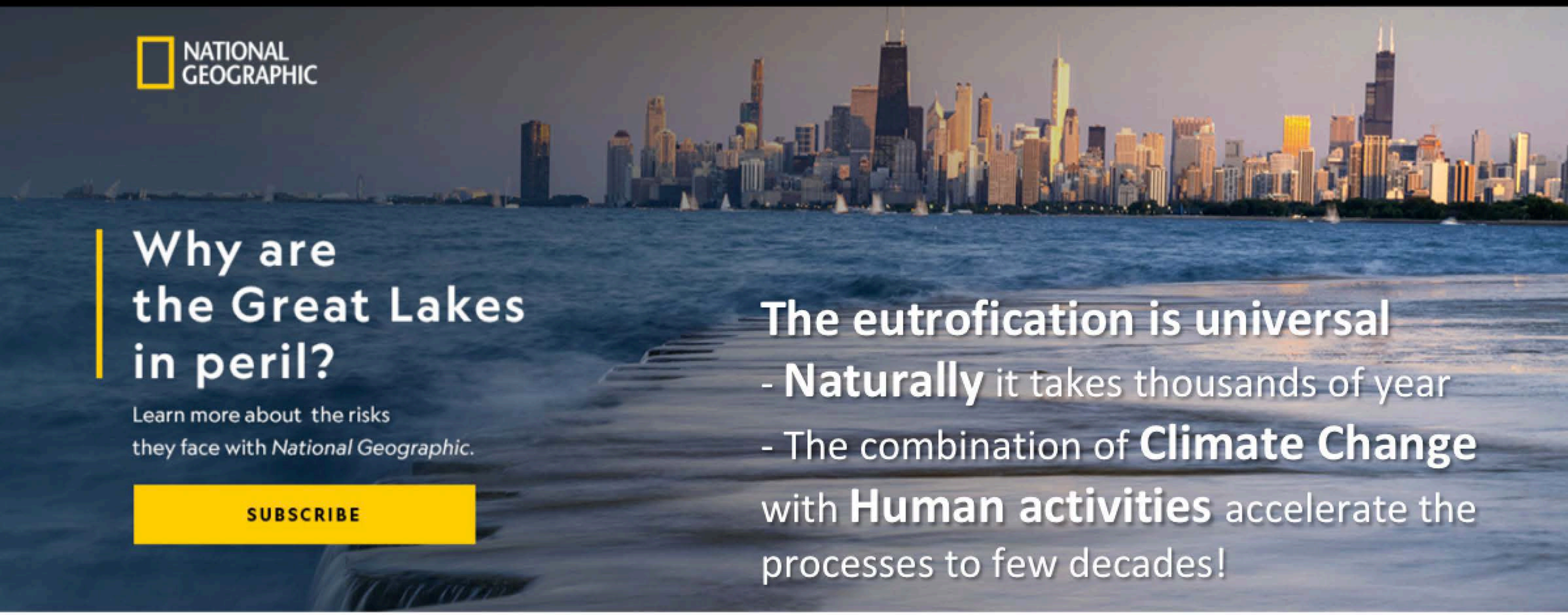
Innovative technologies for lakes monitoring, research, protection, and restoration

Automatic, high-frequency, real time, remote transmission, open source software, Open and Big data

Buoys, Gliders, Drones, ROVs, Floating laboratory, Remote sensing….

Xavier Lazzaro
IRD-Bolivia
xavier.lazzaro@ird.fr

Organization of some binational authorities



We're concerned about the Great Lakes

Most people seldom think about Lakes Michigan, Huron, Superior, Erie, and Ontario. But they should care about them because, the Great Lakes are "arguably the continent's most precious resource." Learn more about the Great Lakes and appreciate the beauty of the landscape with our subscriber exclusive content.

What examples of transboundary lake observatories do we have?

<u>NORTH AMERICA:</u> 5 Laurentian Great Lakes (*USA - Canada*) Great Lakes National Program Office (GLNPO) of the US Environmental Protection Agency (US EPA).
In 1972, **Great Lakes Water Quality Agreement** between USA and Canada. 39 years of monitoring since 1983

<u>EUROPE:</u> Lake Maggiore (*Italy-Slovenia*). Since the creation in 1938 of the Italian Institute of Hydrobiology.
Lake Constance (*Germany-Switzerland-Liechtenstein-Italy-Austria*). Monitoring since 1950.
Lake Geneva (*France - Switzerland*). In 1963, creation of CIPEL-International Commission for the Protection of Lake Geneva. Since 1971, research and monitoring programs

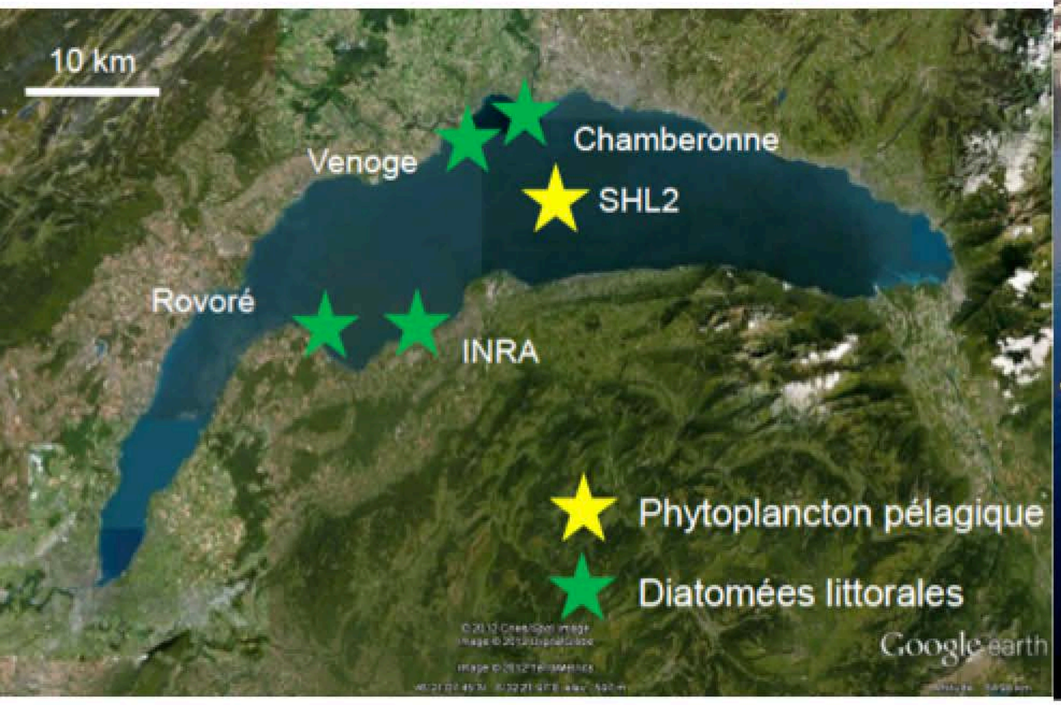
<u>AFRICA:</u> Lakes Malawi, Tanganyika, Kivu, Edward, Victoria and Turkana (2-3 countries/lake, among ***Mozambique, Zambia, Tanzania, Rwanda, Burundi, Zaire, Uganda, Kenya and Ethiopia***).
Lake Chad (*Nigeria, Niger, Cameron, Chad*)

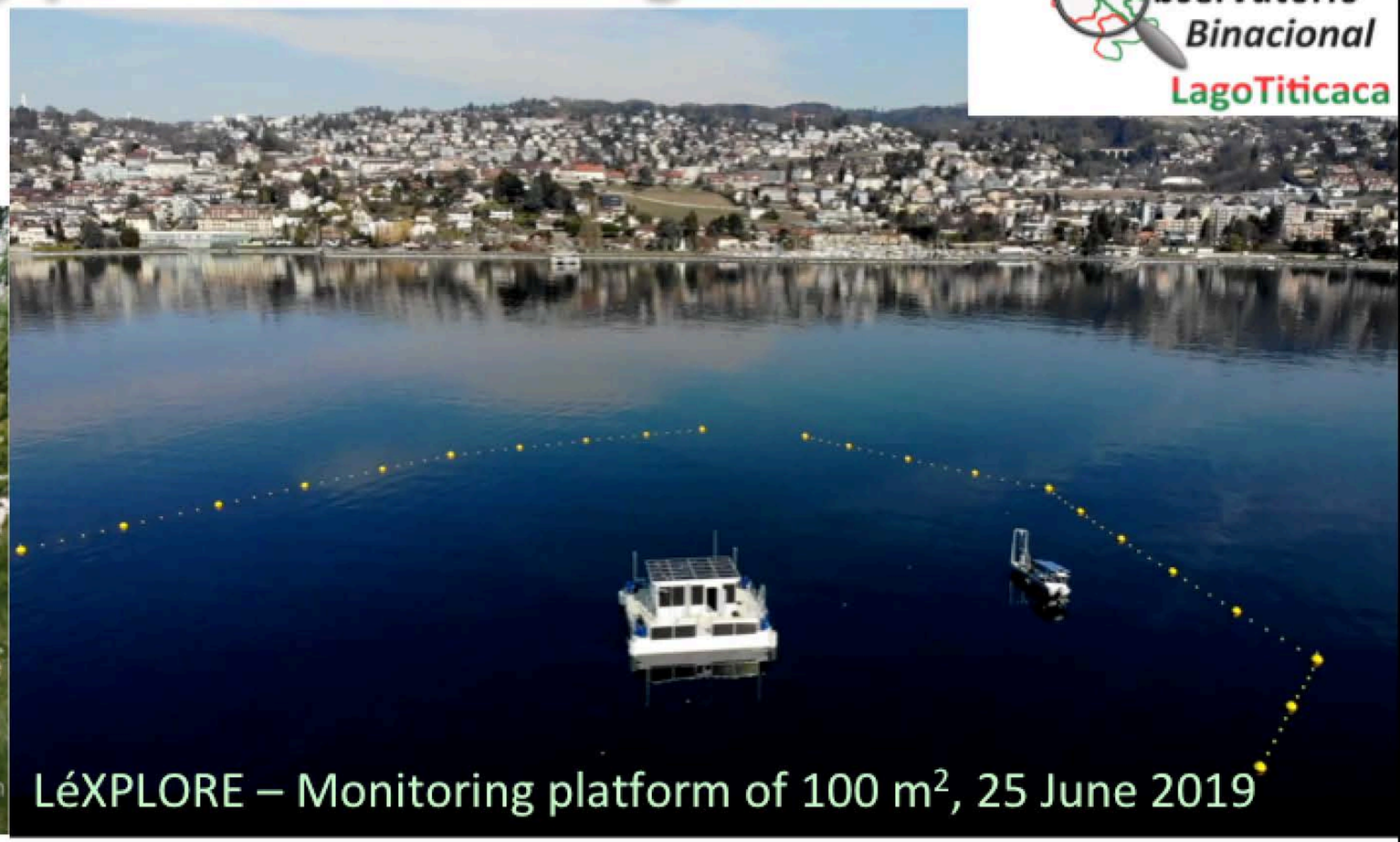
RELOC / RELOB: Red Latino-Americana de Organismos de Cuenca
RIOC (Jean François Donzier): Red Internacional de Organismos de Cuenca
RALCEA: Latin American network of knowledge centres in the water sector
RIOCC: Red Iberoamericana de Oficinas de Cambio Climático
EUWI: European Union Water Initiative

☑ Monitoring platforms of Large lakes

Observatorio Binacional LagoTiticaca

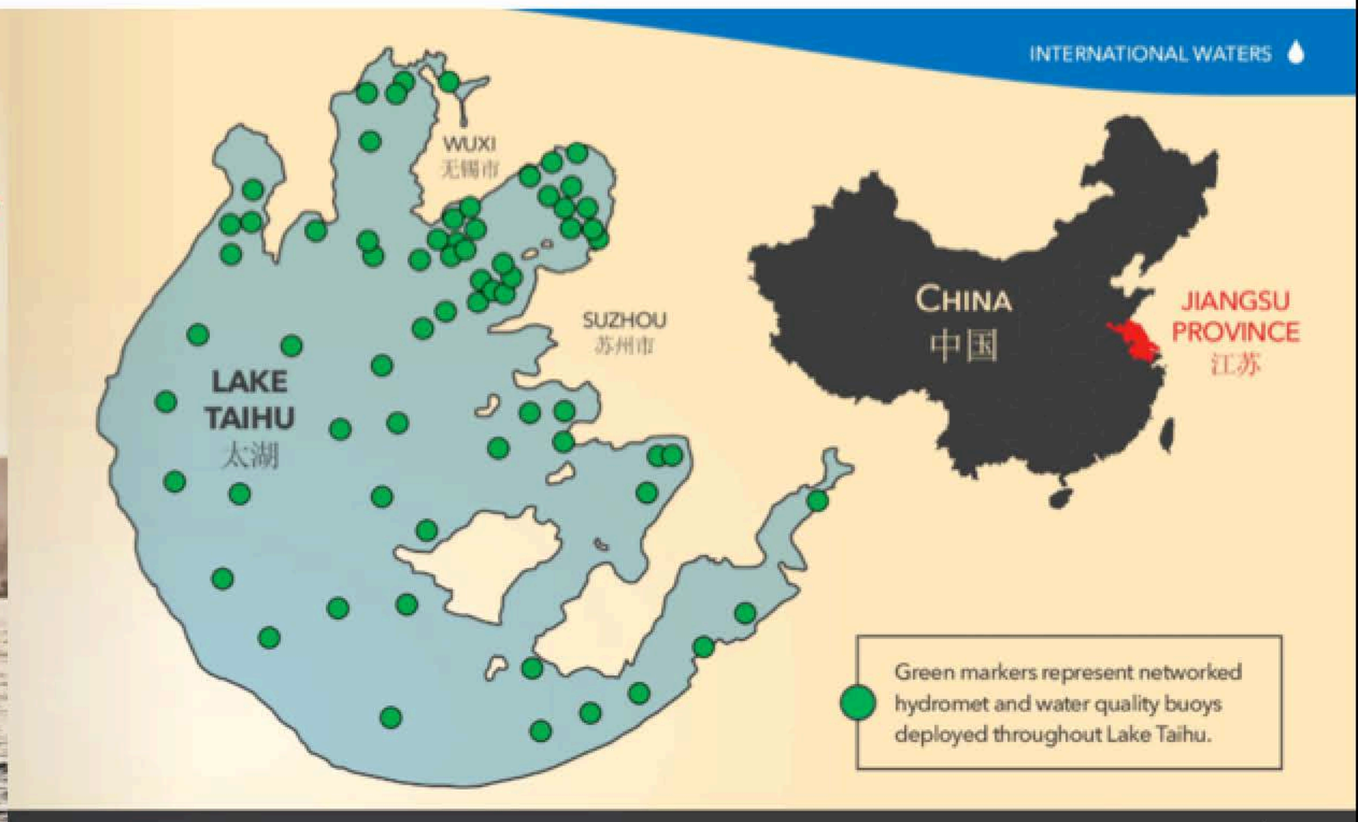
Lake Geneva, CIPEL (France-Swiss)
580 km² (1/10 Titicaca)





Lake Taihu (2nd largest lake in China)
2.250 km²
(1/4 Titicaca)

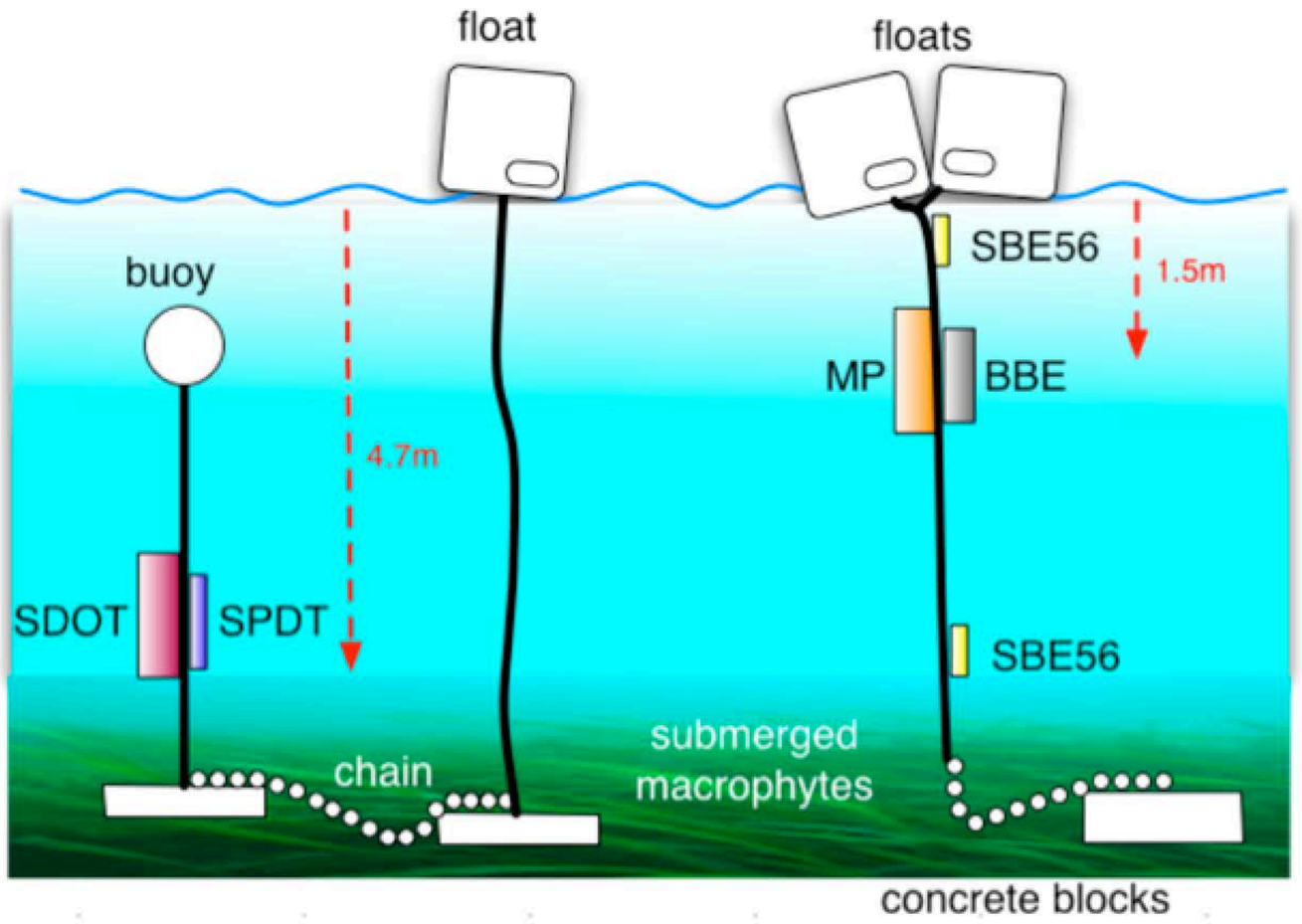
Lake Titicaca
8.372 km²



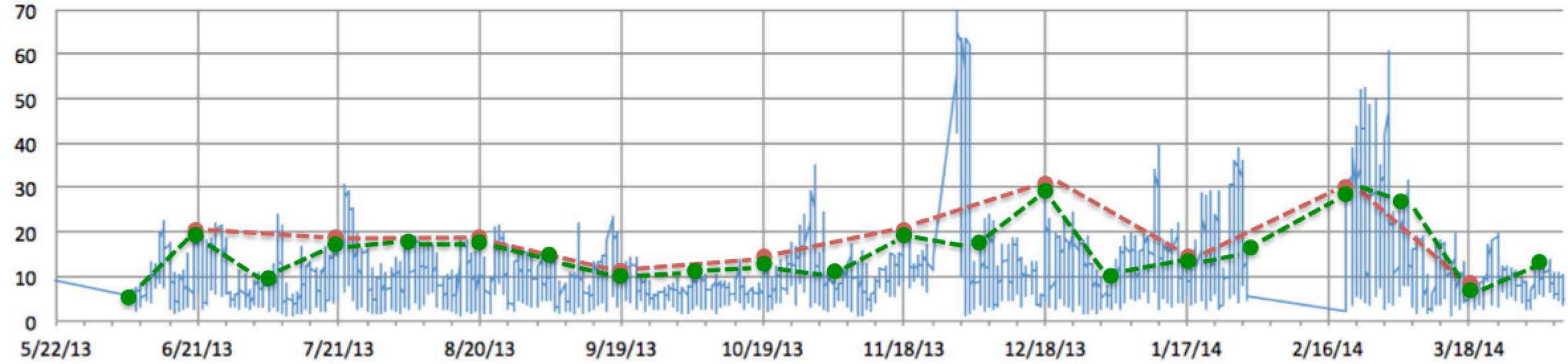
Why an Hydro-meteorological Buoy with high-frequency acquisition?

Observatorio Binacional LagoTiticaca

Lazzaro, Point, Groleau et al. 2014.
Proyecto Titicaca Sensors, Huatajata -
Frecuencia de medición 45 min



Clorofila-*a* total (fluorescencia, eq µg Cl-*a*/L)



High frequency: every 45 min during 2 years (Dec. 2012 - Dec. 2014)

30 days 15 days

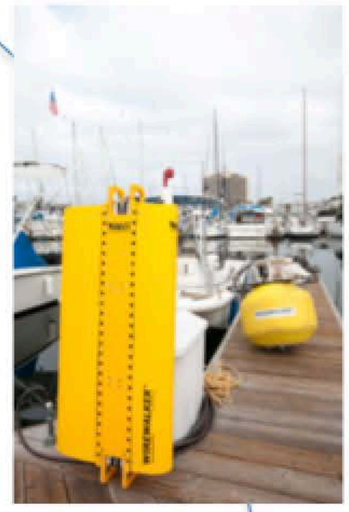
Hydro-meteo Buoy for Lake Titicaca: selection and sensor parameters

OTT HydroMet (Germany)

Water Quality Buoy

Del Mar Oceanographic (USA)

with Wirewalker™



Selection technical/cost/performance among the leading brands in the market!

Polimater LLC/BaseFlow /Xylem Analytics (USA)

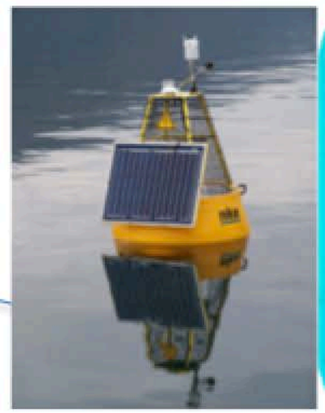
HydroMet Profiler Pontoon/Raft

EIVA Marine Survey Solutions (Denmark)

Tough Buoy Panchax wave buoy

NKE Instrumentation (France)

Profiling buoy type PROLIPHYC



The first Sentinel Buoy in Lake Titicaca

VAISALA ultrasonic weather station

WXT531

LOW-COST, MAINTENANCE FREE
RAINFALL MEASUREMENT

WXT532

LOW-COST, MAINTENANCE FREE
ULTRASONIC WIND SPEED AND DIRECTION MEASUREMENT

WXT533

COMBINED MEASUREMENTS OF PRECIPITATION AND WIND
MAINTENANCE-FREE OPERATION

WXT534

MEASUREMENTS OF ATMOSPHERIC CONDITIONS

WXT535

MULTI-PARAMETER WEATHER TRANSMITTER WITH FOUR KEY MEASUREMENTS

WXT536

COMPLETE MULTI-PARAMETER WEATHER HUB
WITH THE ABILITY TO INTEGRATE ADDITIONAL SENSORS

Multiparameter submersible probe YSI EXO2

YSI 599502-02

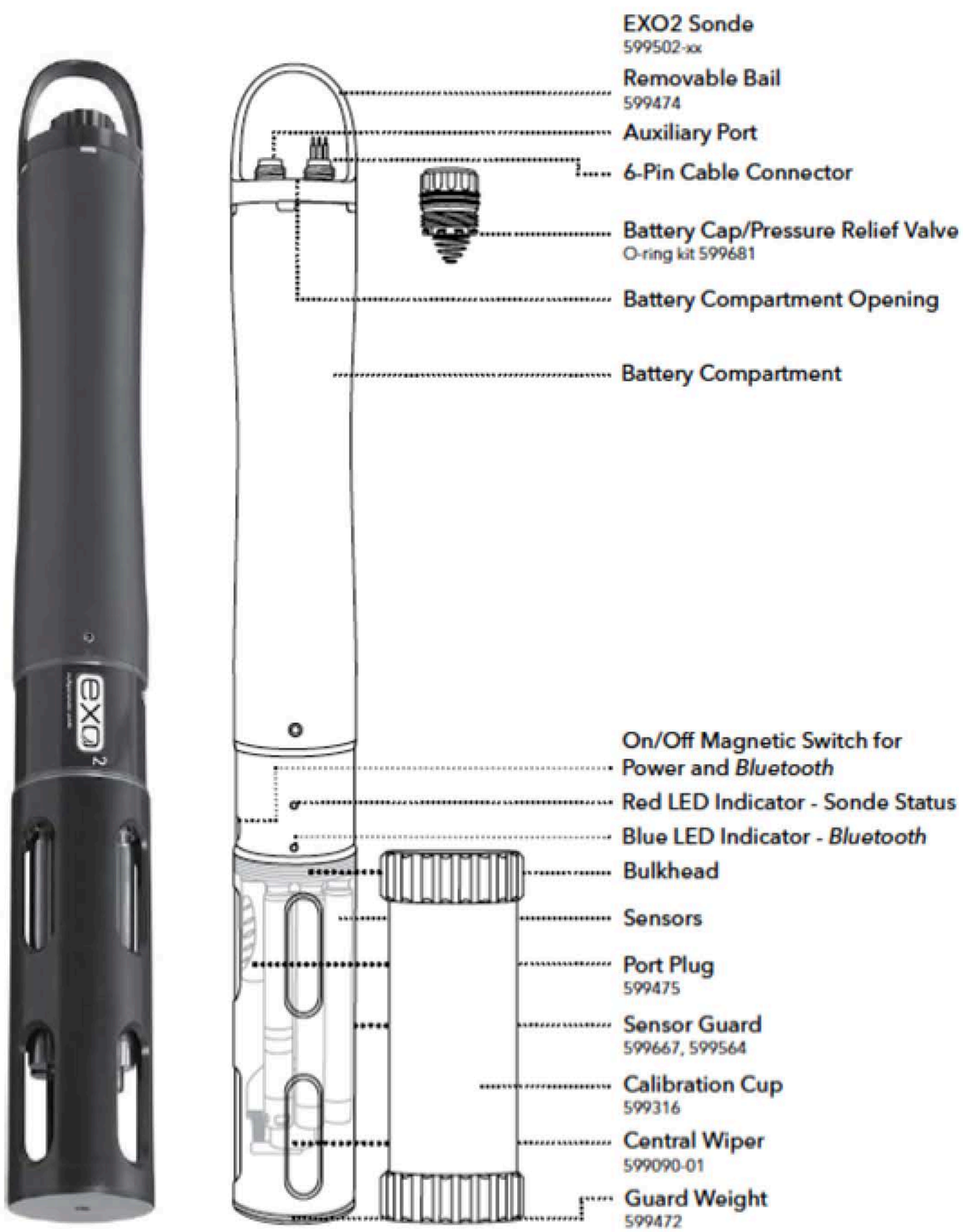
EXO2 probe, 100 meters depth, **6 sensor ports, 1 wiper port**

Depth range: 0-100 metros.

- AUX port for future expansion.
- Contains: Probe, 4 "D" batteries, calibration vessel, tool kit, 4-port plugs, USB drive loaded with user manual and KOR software.

Probe communications: Bluetooth; Cable: RS-485; Adapters: RS-232, Bus Mode, USB, SDI-12

- External power supply: 9-16 VDC; internal: (4) D-batteries
- Operating temperature: -5 to +50°C; Storage temperature: -20 to +80°C; Battery life: 90 days
- Dimensions: Diameter: 7.62 cm; length: 71.1 cm; weight with batteries: 3.60 kg



YSI EXO2 Multiparameter probe sensors

YSI 599870
EXO Conductivity / Temperature sensor

Specifically designed to combat sensor fouling in long-term monitoring applications
New high precision flow and temperature channel design
Incorporates wetted connector and welded titanium housing
Specifications: Range: 0 to 200 mS/cm | Accuracy: 0 to 100: ± 0.5% of reading or 0.001 mS/cm, e.g.; 100 to 200: ± 1% of reading | Response: T63 <2 sec | Resolution: 0.0001 to 0.01 mS / cm (range dependent)

YSI 599706
EXO pH/ORP sensor

unprotected, Ti
- Compatible with any EXO probe
- Patented user-replaceable sensor head
- Incorporates wet mating connector and welded titanium housing
Specifications:
Range: -999 to 999 mV | Accuracy: ± 20 mV in standard ORP solution | Response: T63 <5 sec6 | Resolution: 0.1 mV

YSI 599102-01
EXO Total Algae Sensor: Chlorophyll-*a* and Phycocyanin

- Optimized for freshwater use - Phycocyanin
- chlorophyll and cyanobacteria sensors in one sensor
- Incorporates wet mating connector and welded titanium sealed design
Specifications:
Range: 0 to 100 µg / L; 0 to 100 RFU; | Accuracy: Linearity: R2> 0.999 for serial dilution of Rhodamine WT solution from 0 to 100 µg / ml of BGA-PC equivalents | Response: T63 <2 sec | Resolution: 0.01 µg / L; 0.01 RFU

YSI 599104-01
EXO fDOM sensor

- AKA CDOM or UV Fluorimeter
- Incorporates a wet mating connector and welded titanium sealed design.
Specifications:
Range: 0 to 300 ppb Quinine Sulfate Equivalents (QSU) | Accuracy: Linearity: R2> 0.999 for serial dilution of 300 ppb QS solution.
Limit of detection: 0.07 ppb QSU | Response: T63 <2 sec | Resolution: 0.01 ppb QSU

YSI EXO2 Multiparameter probe sensors

YSI 599100-01
EXO DO Optical sensor, Ti
- Compatible with any EXO probe
- User replaceable sensor cap (installed)
- Incorporates wetted connector and welded titanium housing.

Specifications:
Range: 0 to 50 mg / L | Accuracy: 0 to 20 mg / L: ± 0.1 mg / L or 1% of reading, eg; 20 to 50 mg / L: ± 5% of reading | Response: T63 <5 sec | Resolution: 0.01 mg / L

YSI 599101-01
EXO Turbidity sensor, Ti
- Compatible with any EXO sonde
- Wide range sensor reads 0 to 4000 FNU
- Incorporates wetted connector and welded titanium housing.

Specifications:
Range: 0 to 4000 FNU | Accuracy: 0 to 999 FNU: 0.3 FNU or ± 2% of reading, eg; 1000 to 4000 FNU: ± 5% of reading | Response: T63 <2 sec | Resolution: 0 to 999 FNU = 0.01 UNF;
1000 to 4000 FNU = 0.1 FNU

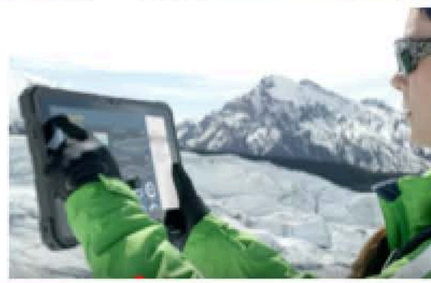
YSI 599090-01
EXO2 Center port wiper, Ti
- Installs in the center port wiper on the EXO2 sonde only.
- Includes two cleaner brushes and installation tool
- Used in unattended monitoring deployments to reduce 'biofouling''

YSI 608040 / 608090
EXO NitraLED UV Nitrate sensor
- Depth rating: 250 m
- Measurement range: 0-10 mg/L
- Minimum Detection Limit: 0.01 mg/L
- Operating Temperature: 5-35ºC
- Resolution: 0.01 mg/L
- Unit of Measure: NO3-N (Nitrate-N) in mg/L

Laptop DELL Latitude 5420 Rugged

Buoy programming

Intel® Core ™ i3-7130U Processor
(Dual Core, 3M cache, 2.7GHz, 15W)
Operating System Windows 10 Pro 64bit
English, French Spanish
Intel HD 620 integrated graphics processor
Memory 16GB, 2x8GB, 2400MHz DDR4 without ECC
Hard disk drive M.2 256GB NVMe PCIe PCIe Class 40 solid state SSD
14" FHD WVA (1920x1080) non-glare, non-touch LCD screen



Ports and locations
1. Removable primary SATA storage compartment | 2. SD card slot | 3. SIM card slot | 4. USB 3.0 slot | 5. Native serial port | 9. RJ-45 Gigabit Ethernet network connector | 10. HDMI | 11. Noble Anti-Theft Location | 12. Entrada de CC | 13. USB 3.0 Type-C ™ | 14. USB 3.0 | 15. USB 3.0 | 16. conector de audio universal

Almost a ton of equipment!

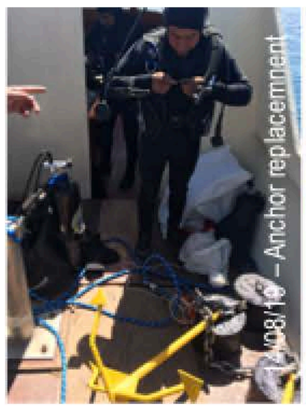
Polimater LLC/BaseFlow/Xylem Analytics
Box 1: 712 kilos, 4.2x2.1x1.2 m
Box 2: 253 kilos, 1.6x0.8x1.7 m

Vessel / Voyage : Sprit of Lisbon 916
ETD : April 25 – Port Everglades, FL
ETA : May 14 – La Paz

Unexpected

Hardware, Software, Files

observatorio Binacional LagoTiticaca



Two dataloggers
Campbell CR1000:
Weather | Water Quality

Software
Campbell LoggerNet

WEATHER

<MET_Met_IntervalData>	<MET_Met_24HrData>
On average every 5 min	*Daily average*

WATER QUALITY

<PROFILER_SondeHourly>	<PROFILER_PFL_Step>
Average at 1m depth every 30 min	*Every 2 hrs vertical profile At 1 m depth interval*

High-frequency data from the HydroMet Buoy

Real-time remote download – Software LoggerNet>ViewPro from CAMPBELL SCIENTIFIC

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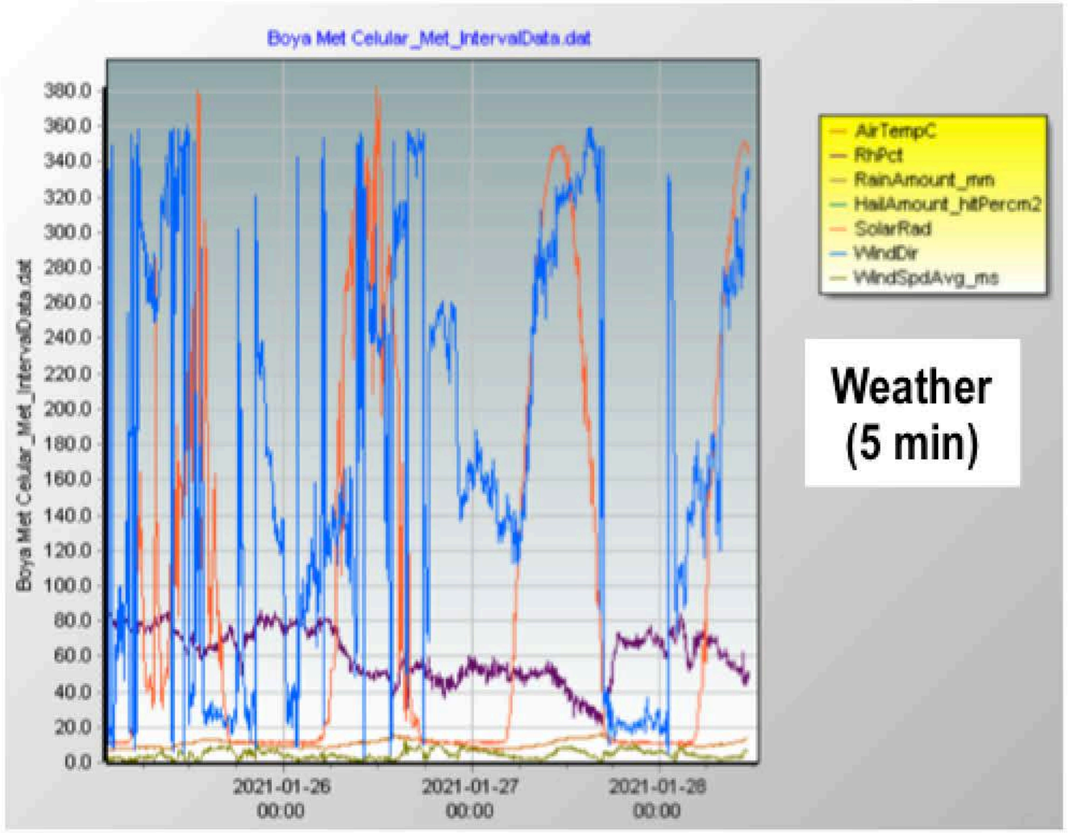
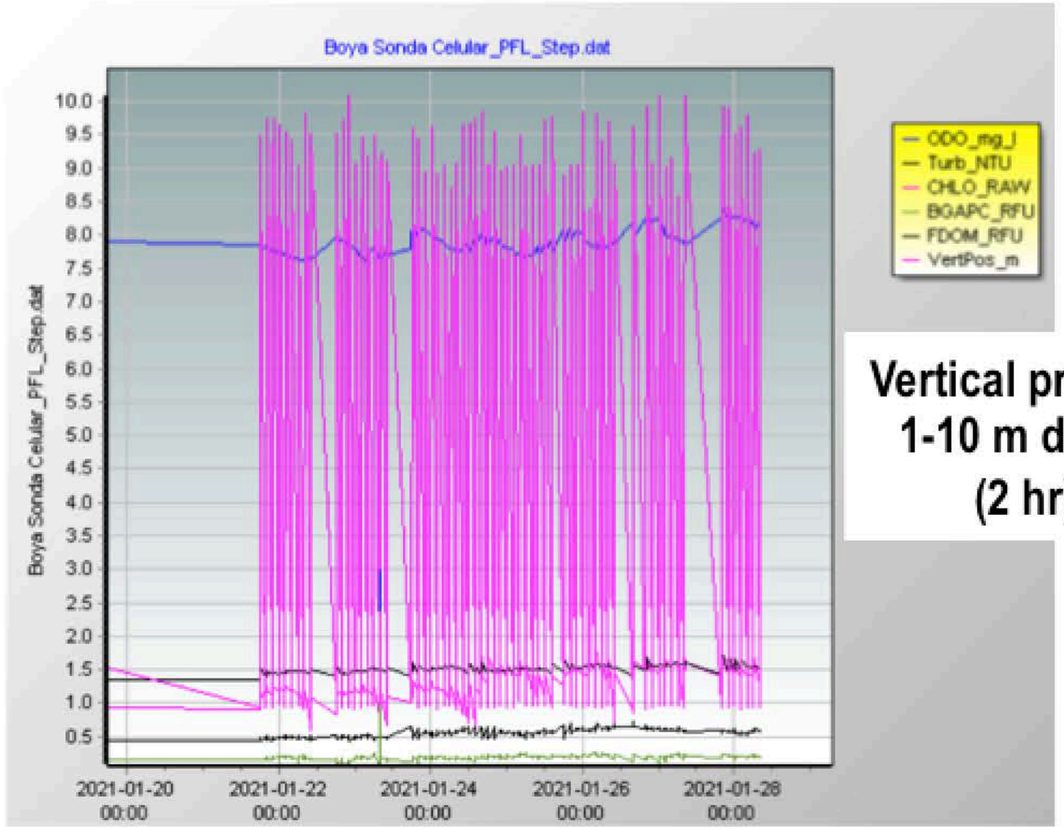
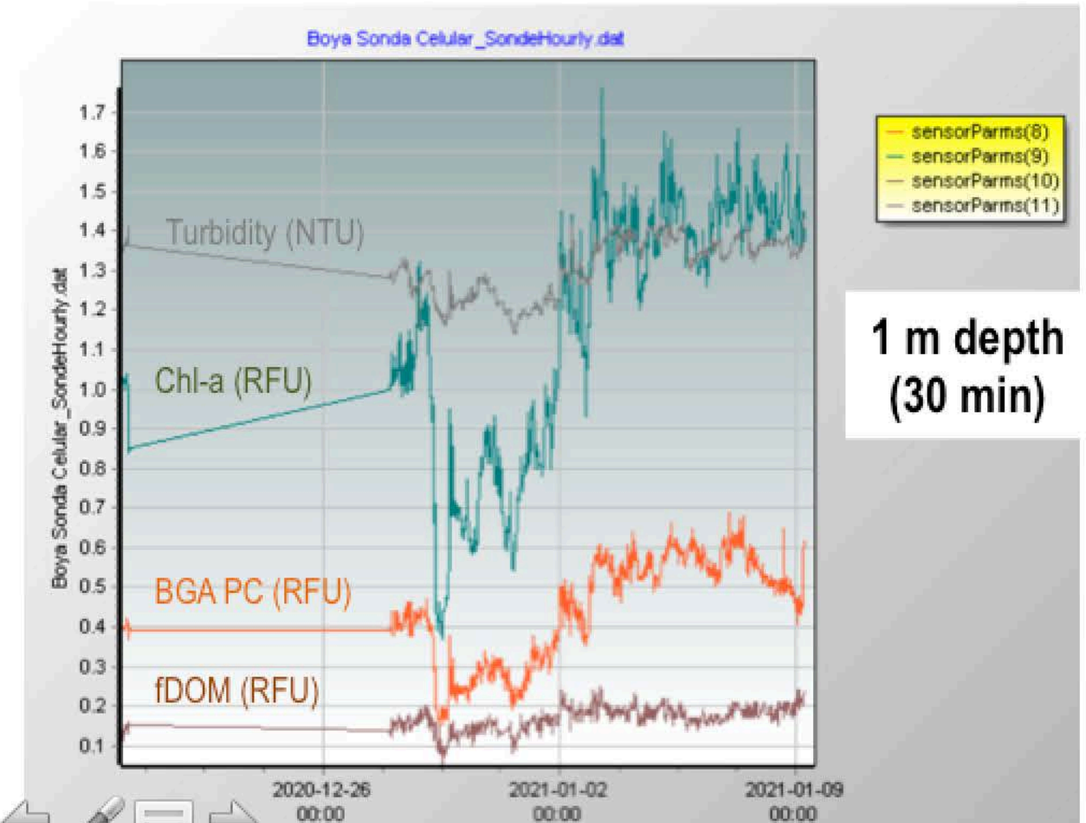


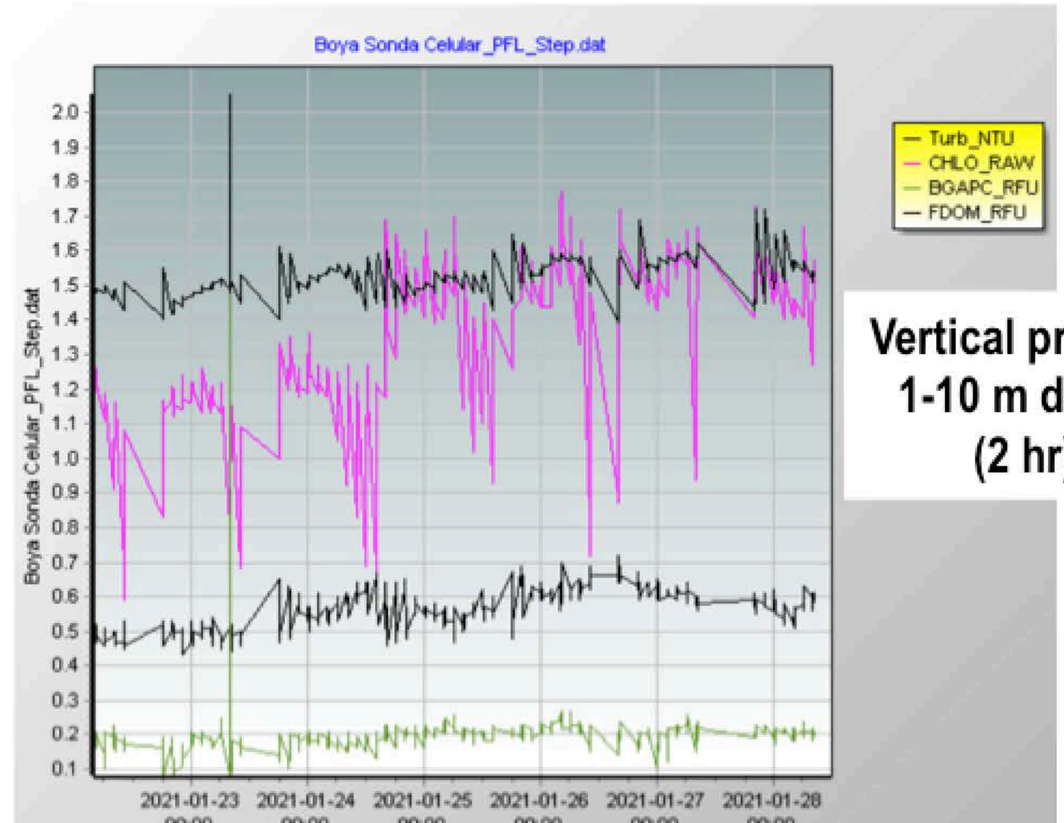
Weather (5 min)



Vertical profiles 1-10 m depth (2 hr)

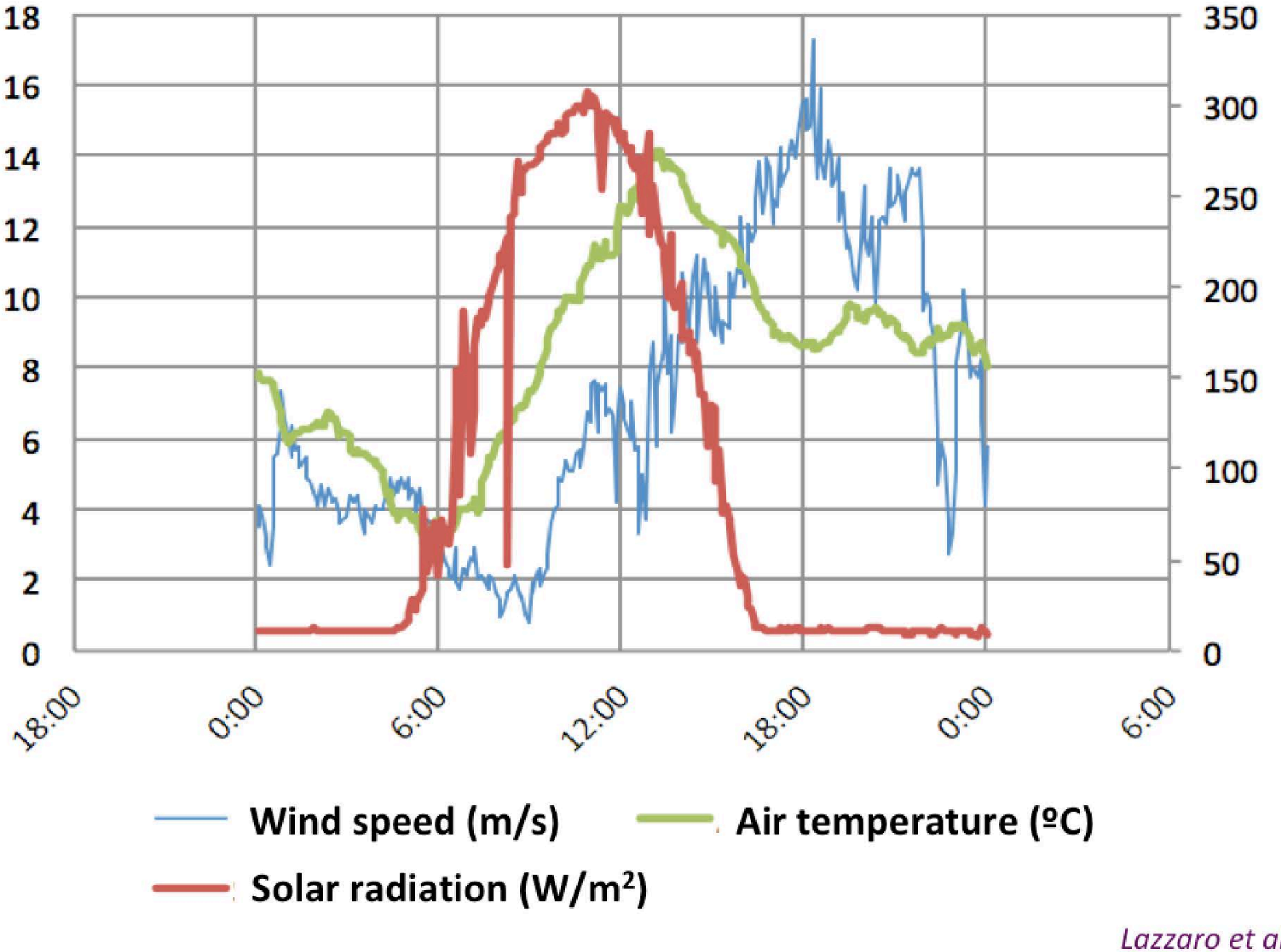


1 m depth (30 min)



Vertical profiles 1-10 m depth (2 hr)

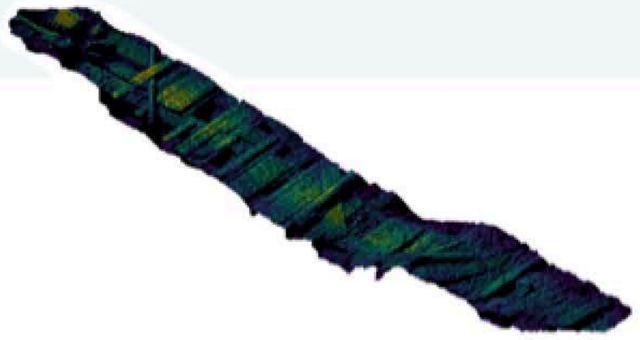
HydroMet Buoy – Weather conditions – 26/08/20



Lazzaro et al. (in prep.)

North American Great Lakes Observatory System (GLOS)

The Great Lakes Observing System (GLOS) is a nonprofit that provides end-to-end data services that support science, policy, management, and industry in the U.S. and Canada.



Smart Great Lakes

Today's connected region has a chance to improve our understanding, use, conservation, and management of the Great Lakes.

READ MORE

Lakebed 2030

Lakebed 2030 brings together new and existing high-density bathymetric data to create a map of the lakefloor that's easy to use and open to everyone.

READ MORE

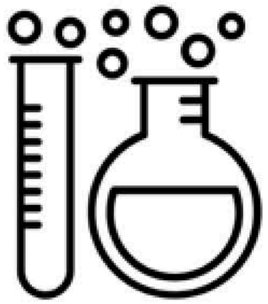
Seagull

Made for the Great Lakes, GLOS developed the Seagull platform to get lake information into the hands of more people than ever before.

READ MORE

Smart Great Lakes

https://glos.org/priorities/smart-great-lakes/

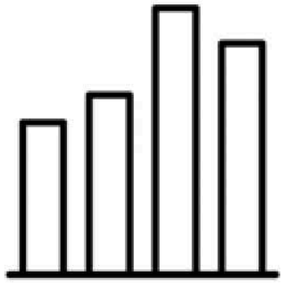


SCIENCE, INNOVATION, AND TECHNOLOGY

Goal 1: Develop novel and interdisciplinary research

Goal 2: Support science, innovation, and technology that improve our ability to identify, assess and respond to stressors and change

Goal 3: Build resilient, adaptable observing systems in support of a swimmable, drinkable, fishable, and equitable future

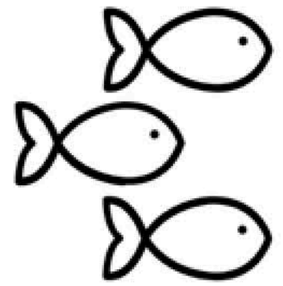


DATA AND INFORMATION

Goal 4: Improve discoverability of Great Lakes data by increasing findability and accessibility

Goal 5: Foster data compatibility by developing a framework supporting interoperability and reusability

Goal 6: Empower data providers to share and access new data by facilitating reuse and access



POLICY AND MANAGEMENT

Goal 7: Ensure Smart Great Lakes provides opportunities and resources for the Indigenous Tribes, First Nations, and Métis within the Great Lakes basin through respectful engagement

Goal 8: Strengthen Great Lakes-related policies

Goal 9: Invest in Smart Great Lakes

Goal 10: Accelerate SGLi communication, outreach, education, and engagement

great lakes observing system

https://glos.org/about-glos/

Type and hit enter...

ABOUT GLOS | NEWS & EVENTS | PRIORITIES | OBSERVING | DATA | CONTACT | APPS

SEAGULL

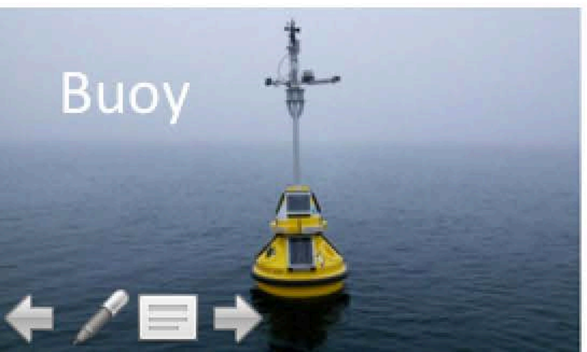
Connecting people to the lakes: A powerful, cloud-based platform, Seagull reimagines how data becomes information and insights in observers' hands.

TRY SEAGULL >

Seagull

GLOS is part of a network of dozens of (mostly academic) organizations from USA and Canada that maintain the observing network, serve data, advance technology, and more.

The Ohio State University | Illinois | US Army Corps of Engineers



https://glos.org/learn-more-about-the-habon-project/

The HAB (harmful algal blooms) Observing Network project

Researchers work on an AUTOHOLO device, which uses holographic technology to image and detect harmful algal blooms. Photo by Aditya Nayak, Florida Atlantic University.

Since 2020, GLOS and a number of regional partners have been part of a pilot project team that is testing and deploying technologies that can help better **understand harmful algal blooms**.
Some technologies that the group is working on include a **holographic imaging system** called **AUTOHOLO** and a "lab in a can" environmental sample processor that can autonomously track toxin levels.
This Great Lakes pilot is funded through the **National HAB Observing Network (NHABON)** and has expanded in scope and the number of organizations involved since its inception. The collaboration includes:

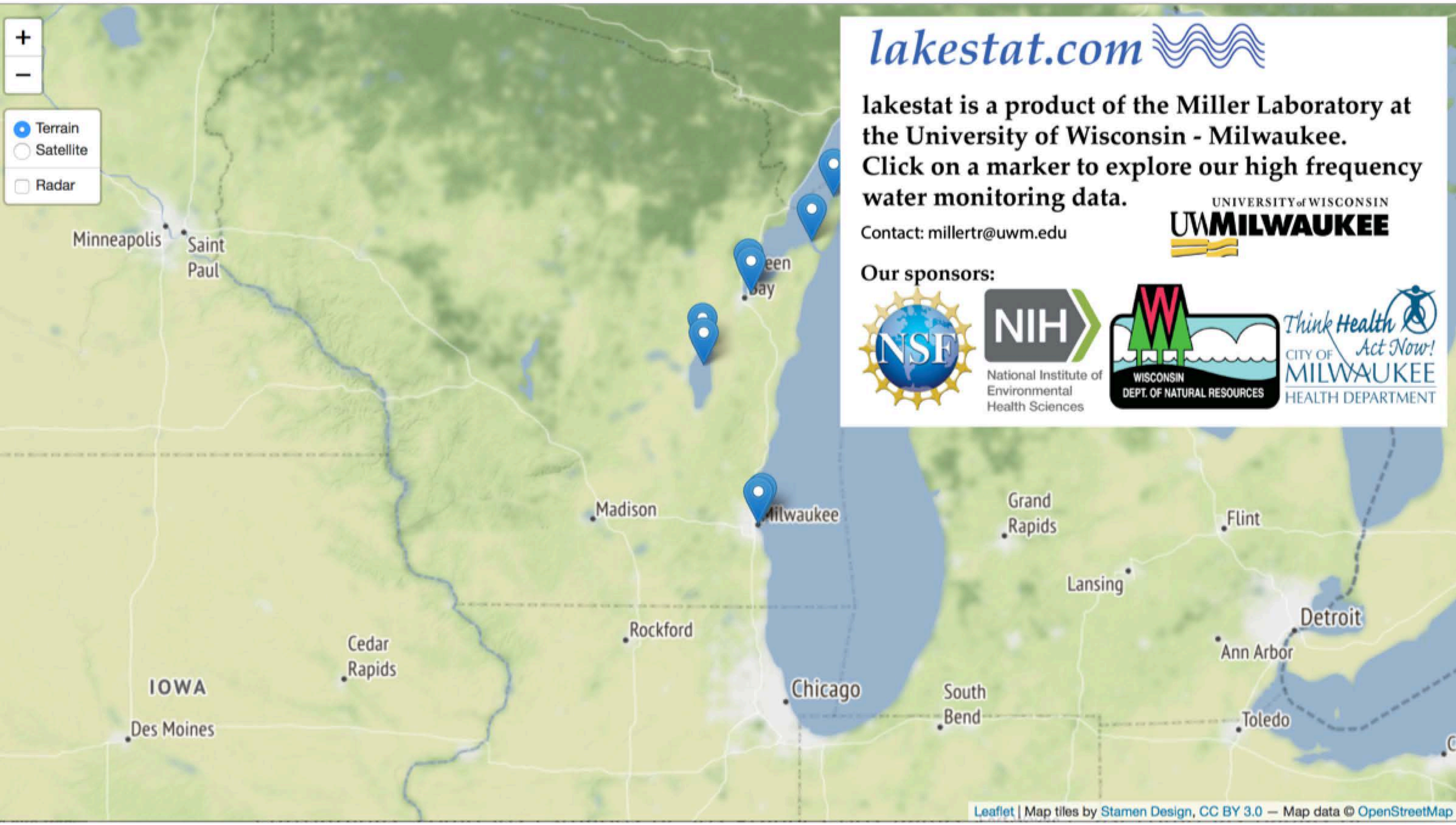
NOAA GLERL | NOAA National Centers for Coastal Ocean Science (NCCOS) | Michigan Tech Research Institute | Monterey Bay Aquarium Research Institute | Florida Atlantic University | University of Minnesota-Duluth | University of Wisconsin-Milwaukee | University of Wisconsin-Green Bay | NewWater | Cellcom | Aexonis

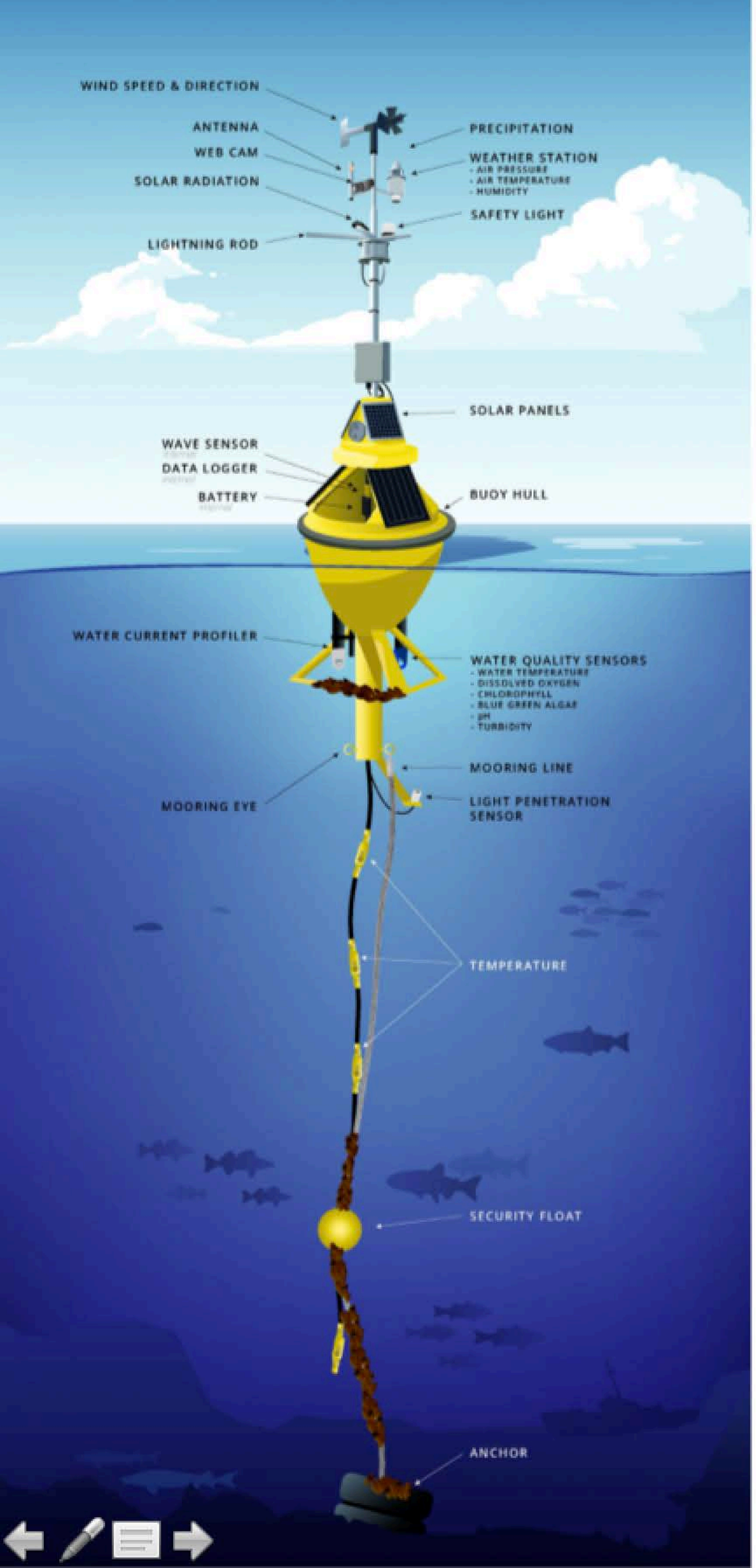
https://glos.org/low-cost-open-source-panther-buoys-are-now-on-seagull/

Low-cost, open-source Panther buoys are now on Seagull

Todd Miller, a researcher at **University of Wisconsin - Milwaukee's Zilber School of Public Health** has been leading his lab to build a new type of low-cost buoy for the Great Lakes. They're called Panther buoys. These platforms are built using **open-source technologies** with documentation and code published online for anyone to use and reproduce. And last year, GLOS funded several via Smart Great Lakes mini-grants. This was a new sort of connection for Seagull, but recently, GLOS staff was able to help build a direct connection so data flows securely to Seagull. These buoys also send data to other services, including UWM's own Lakestat page.

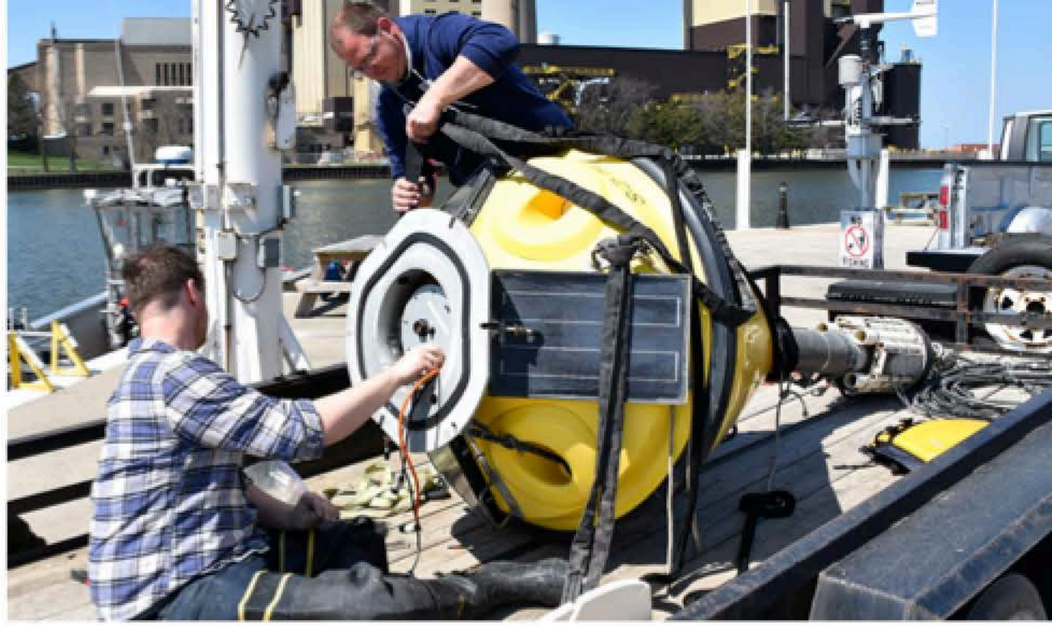
https://web.uwm.edu/lakestat/



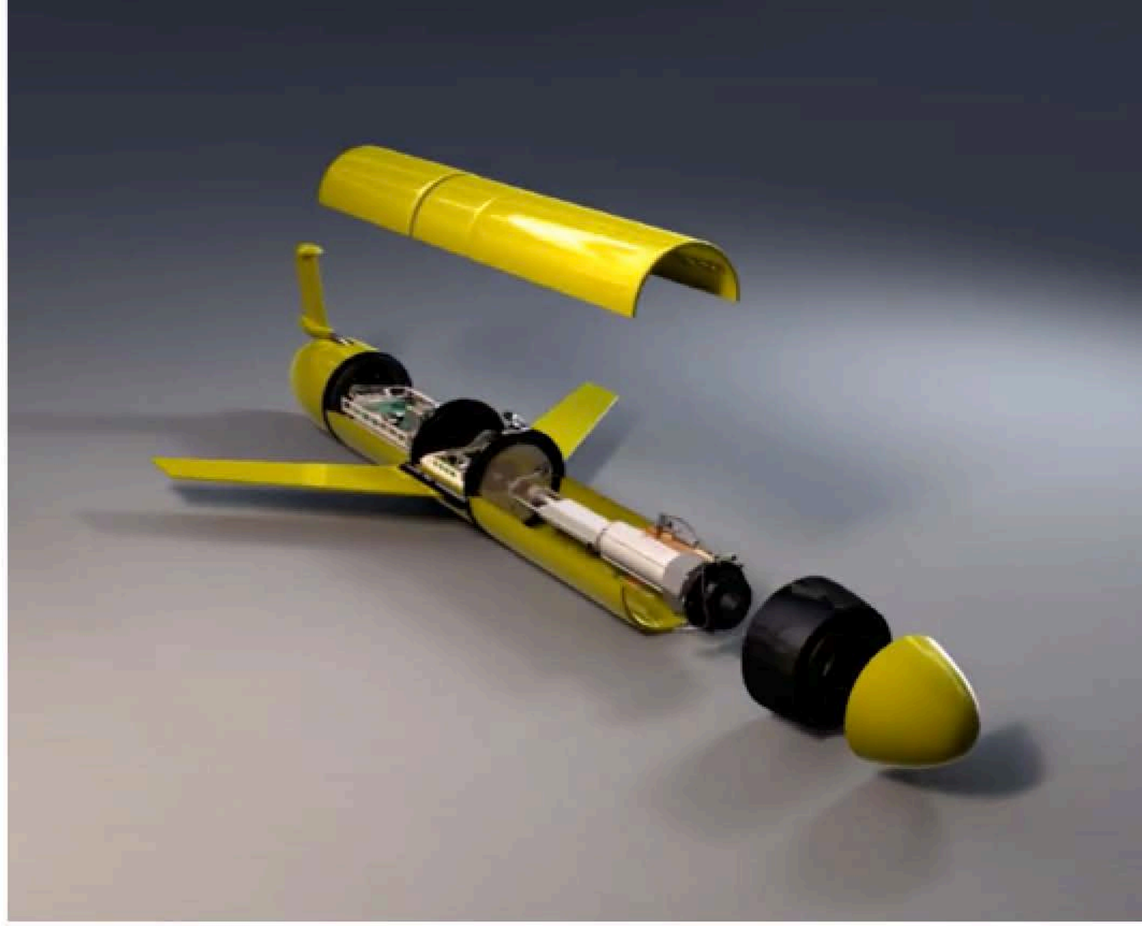


https://glos.org/observing/buoys/

Buoys



https://glos.org/observing/uncrewed-systems/

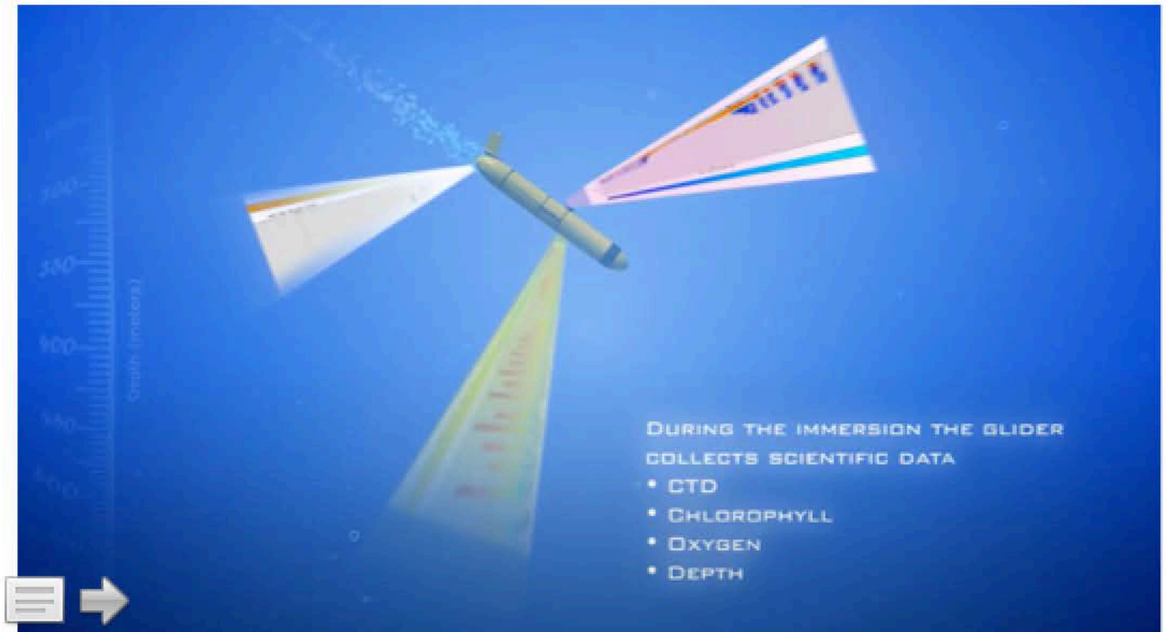


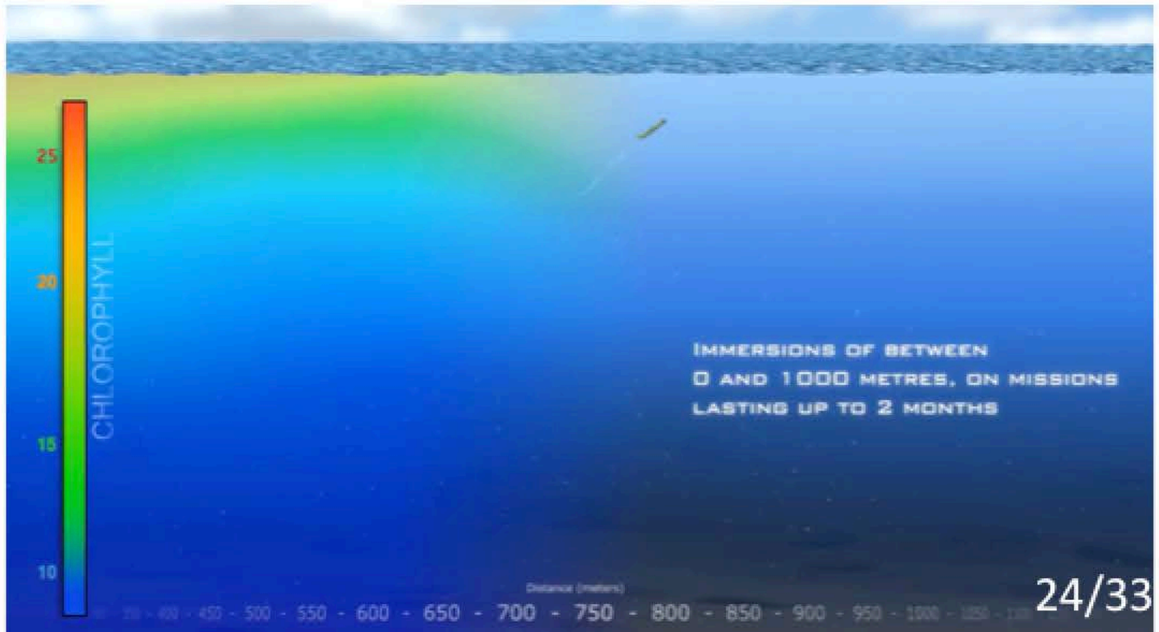
Gliders

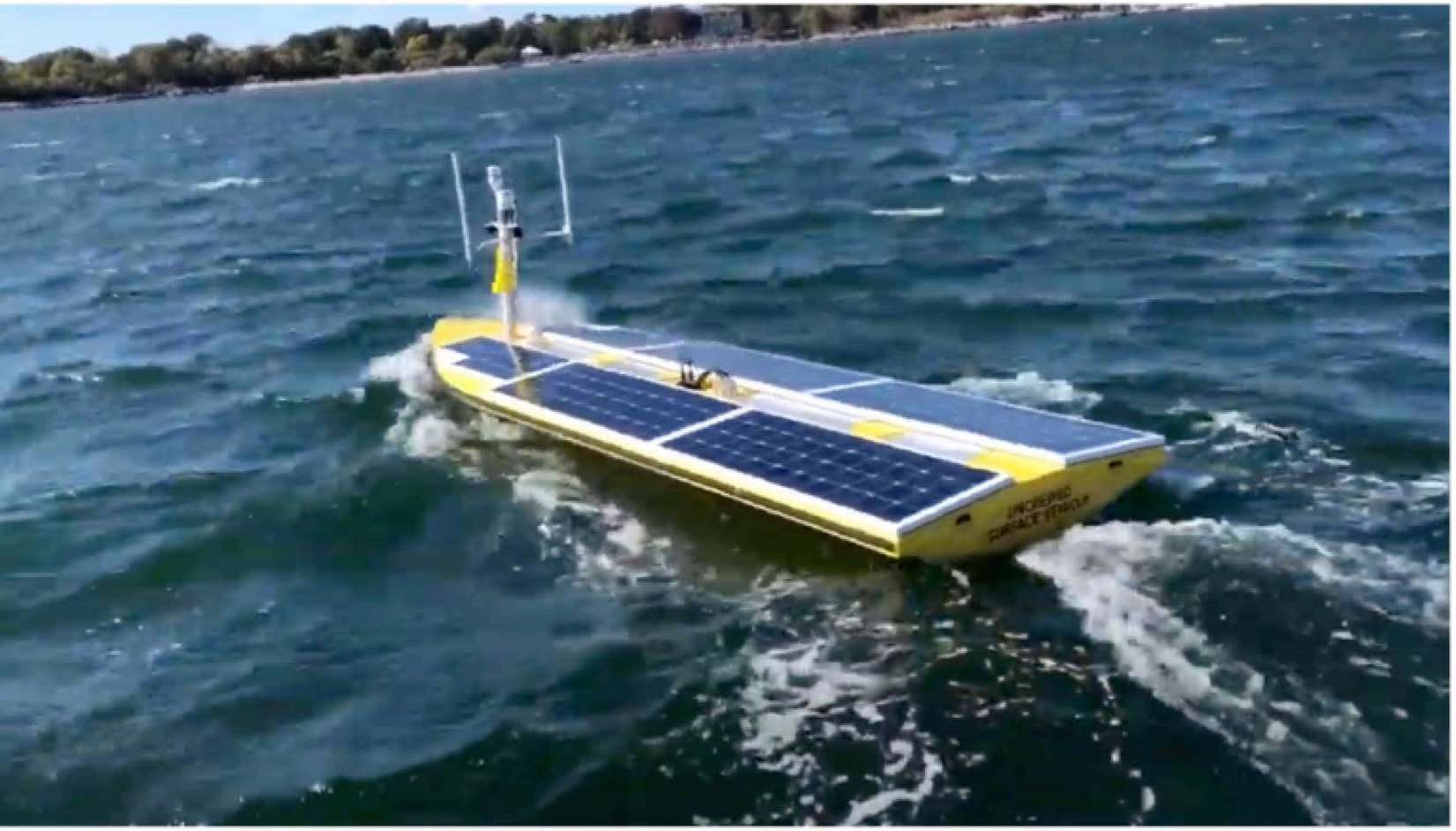
Model: **Teledyne Slocum G2 and G3**

Onboard: **Seabird CTD**, Wetlabs ECO Triplet (**chlorophyll-*a*, backscatter, and CDOM**), **PAR**, **fast-response dissolved oxygen sensor**, rechargeable lithium-ion battery

Max depth: 200 m and 50 m, respectively







ROV

The SeaTrac SP-48 ROV collects data from the water surface and meteorological data from the air.

Drone

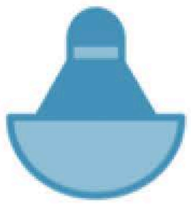
A DJI Phantom drone collects photographs that help to map the changing Lake Michigan shoreline.

https://glos.org/data/connect-your-data/

Join the community of dozens of other observers already sharing their observing data (real-time, historical, and predictive) with the region via GLOS

We will work with you to connect your device or data stream:
🌊Physical data about the wind, waves, underwater environment, and more
[?] Biogeochemical data like chlorophyll, oxygen, and toxins
🐟Biological and ecosystem data about fish, algae, and beyond

Data sources include:



BUOYS AND MOORINGS

SHORE-BASED SYSTEMS

UNCREWED SYSTEMS

VESSELS OF OPPORTUNITY

HIGH-FREQUENCY RADAR

SATELLITES

SCIENTIFIC MODELS

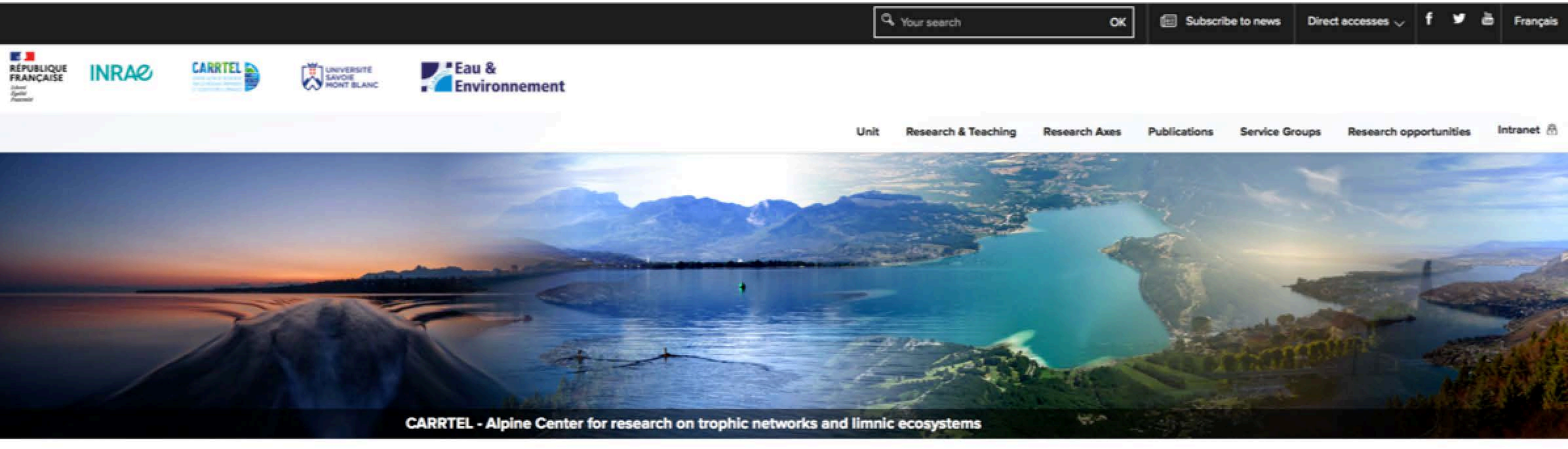
Measuring stations

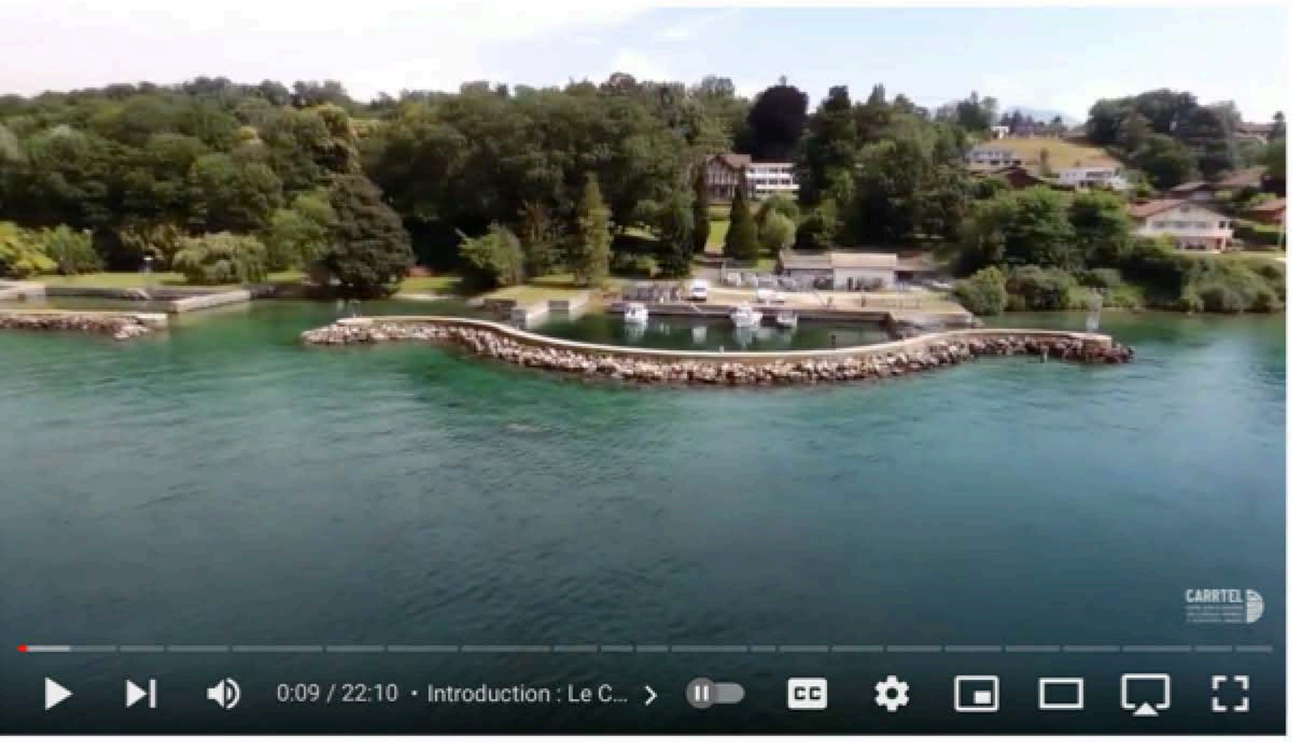
Lake Geneva is monitored by two measuring stations: **station SHL2** located at the deepest point of the lake (309 m) is monitored by **CARRTEL of INRAE in Thonon-les-Bains** and **station GE3** located in the small lake where the depth is 70 m is monitored by the **Water Ecology Service of Geneva** The previous **data recorded at station SHL2** can be **downloaded from the OLA website**.

CIPEL - International Commission for the Protection of the Waters of Lake Geneva, binational between France and Switzerland

https://www6.lyon-grenoble.inrae.fr/carrtel

CARRTEL – Alpine Center for Research on Trophic Network and Limnic Ecosystems





OLA, l'Observatoire des LAcs

https://www.youtube.com/watch?v=HNl9-I-Wqcg

Le suivi des grands lacs alpins (UMR CARRTEL) .

https://www.youtube.com/watch?v=q7m2LFDgRns

https://www6.lyon-grenoble.inrae.fr/carrtel/Long-term-Observatory-and-experimentation-on-LAkes/About

OLA - Observatory and experimentation on LAkes

Login

Home

Welcome on IS OLA (Observatory on LAkes)

The database of the Observatory include various types of data from monitored lakes, including biological, physical and chemical parameters (phytoplankton, zooplankton, fish, water chemical analyses, physical characteristics, etc..). The data are, on the one hand, data obtained from direct in situ measurements, as those collected from probe sensors (vertical depth profiles for pH, T°, turbidity, transparency, fluorescence, etc..), and, on the other hand, data obtained from laboratory and microscopy analyses (plankton composition, nutrients concentrations in water, ?). The OLA SI provides long-term data on 4 deep peri-alpine lakes (Lake Geneva, Lake Annecy, Lake Bourget and Lake Aiguebelette), and more recent dataset (from 2015) for several high altitude alpine lakes (sentinel lakes).

For optimal use of this information system, we advise you to use Chrome or Firefox browsers.

IS OLA news

List of observatory sites and variables

How to access data ?

See what data are currently available in the database.

The information system contains data that are freely available and accessible data after validation of a specific request from the responsible scientist. In all cases, you must login before you can query the database and retrieve data for your needs.

Log in **Create my login id**

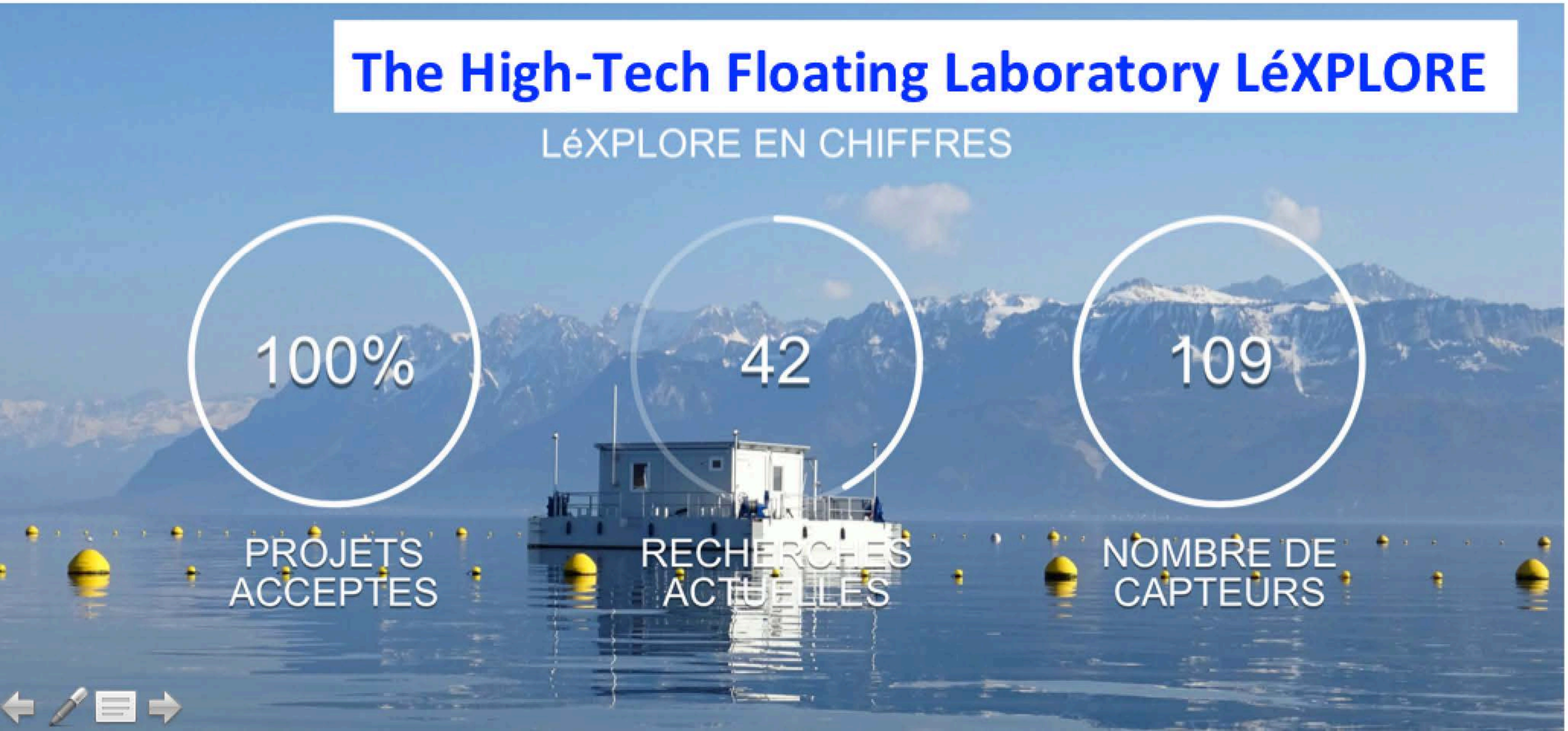
How to use the data ?

Access to and use of data from OLA-IS are governed by terms of use that you will have to acc

For more informations about OLA:

Please consult the OLA's website.


https://lexplore.info/fr/r
Le laboratoire flottant
LéXPLORE
Depuis 2019, la plateforme LéXPLORE est installée sur le Léman, et permet aux chercheurs de réaliser des projets collaboratifs et innovants.
Découvrez notre plateforme


The High-Tech Floating Laboratory LéXPLORE
LéXPLORE EN CHIFFRES
100%
PROJETS ACCEPTES
42
RECHERCHES ACTUELLES
109
NOMBRE DE CAPTEURS

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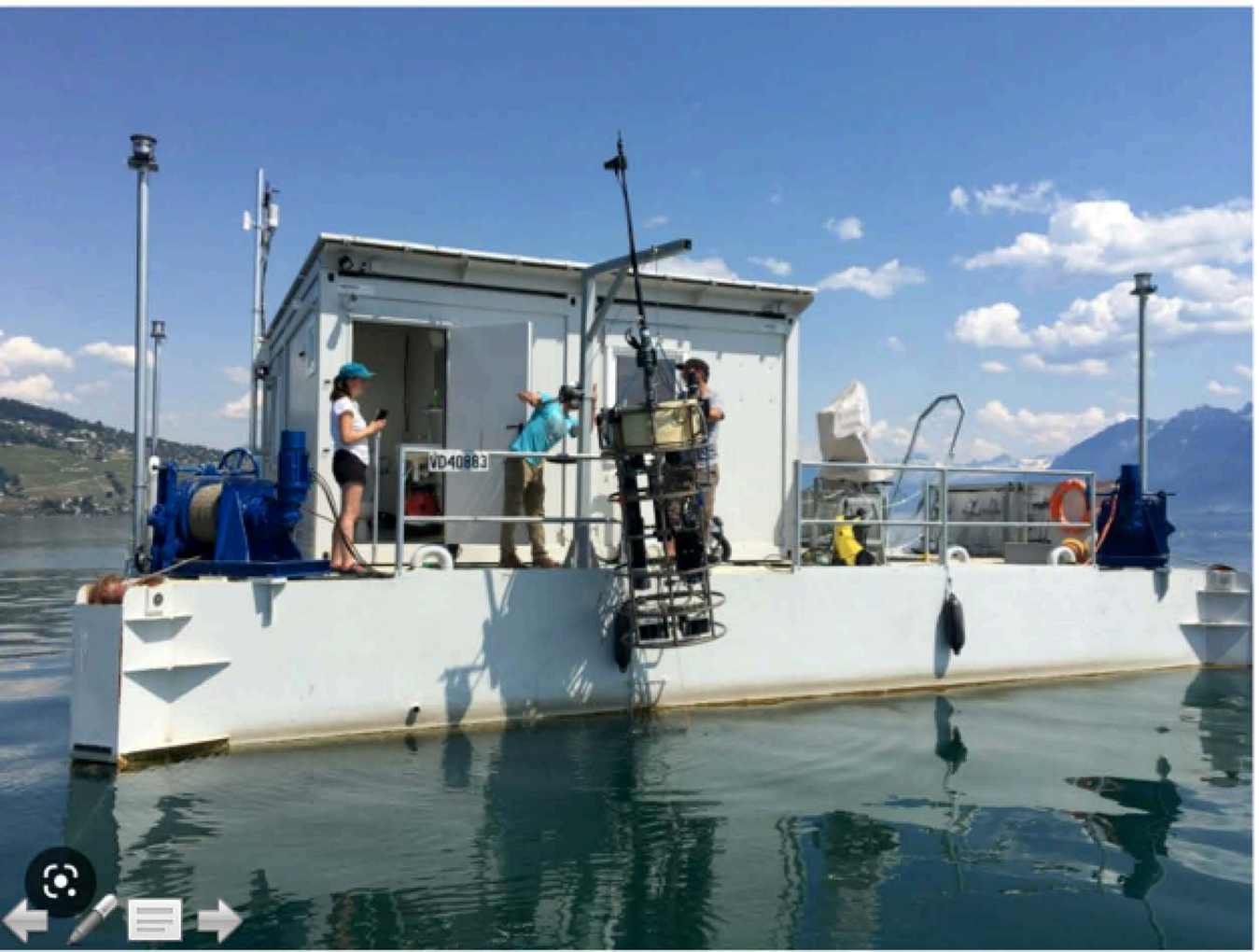
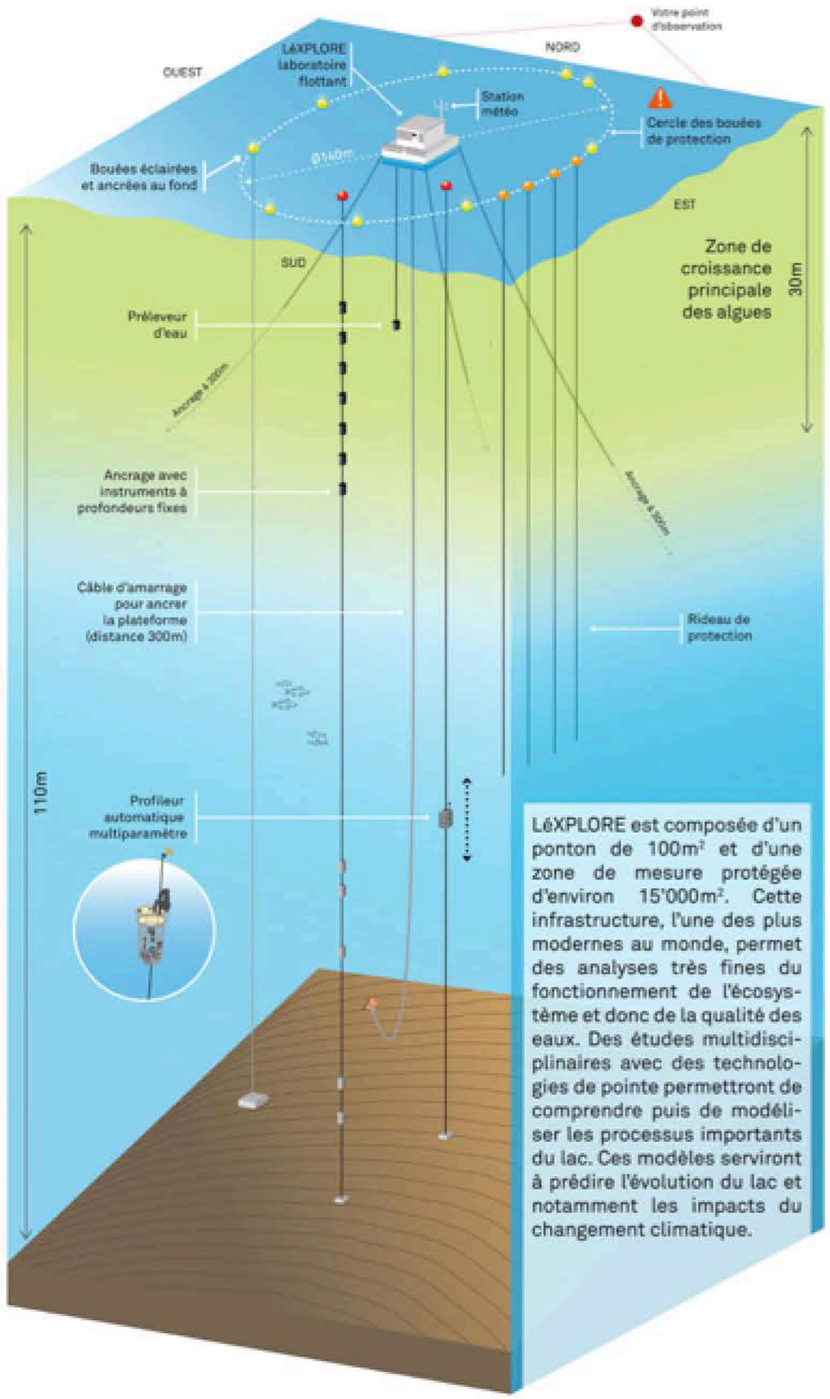


LéXPLORE

Outil de pointe pour comprendre
les changements environnementaux
dans le Léman

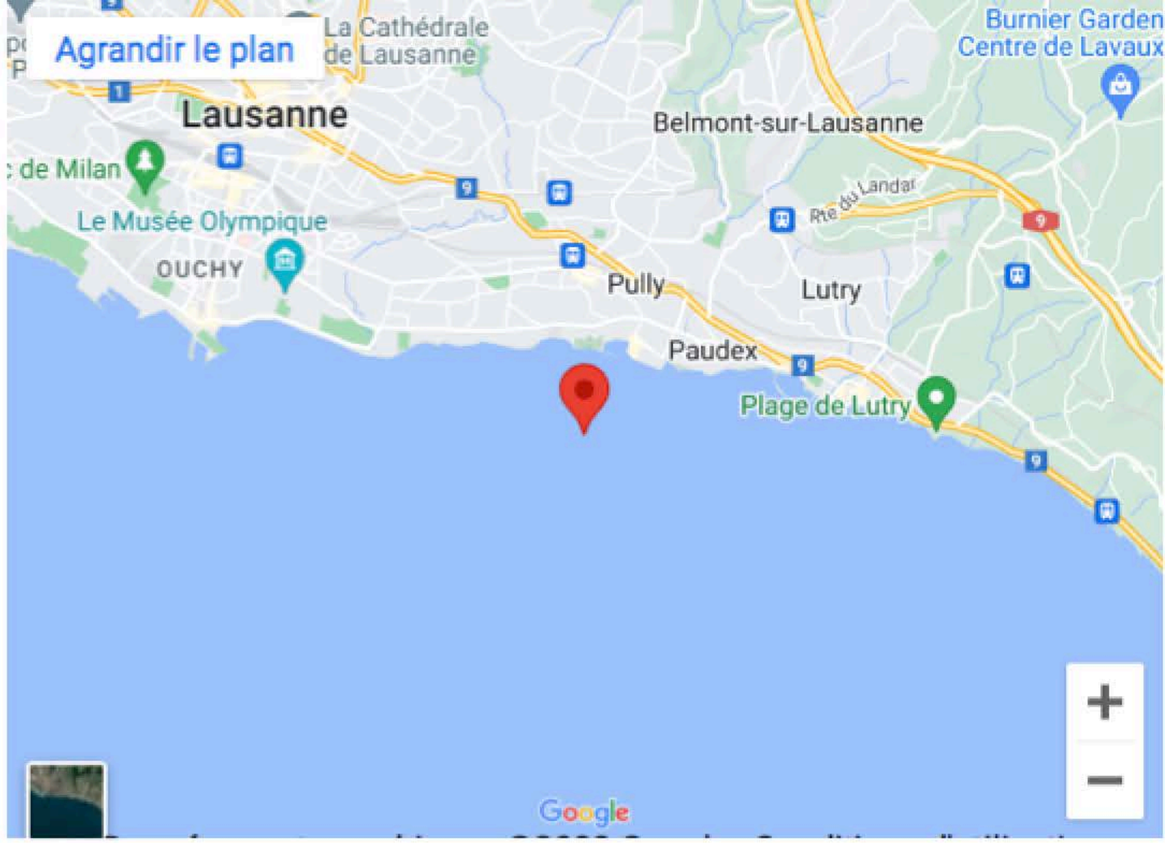
Connaître tout le lac grâce aux images satellites



LéXPLORE est composée d'un ponton de 100m² et d'une zone de mesure protégée d'environ 15'000m². Cette infrastructure, l'une des plus modernes au monde, permet des analyses très fines du fonctionnement de l'écosystème et donc de la qualité des eaux. Des études multidisciplinaires avec des technologies de pointe permettront de comprendre puis de modéliser les processus importants du lac. Ces modèles serviront à prédire l'évolution du lac et notamment les impacts du changement climatique.

Attention: Le cercle des bouées est interdit à la navigation. Des instruments y sont déployés et certains peuvent émerger subitement, il en va donc de votre sécurité. Tout accès à la plateforme est également interdit.

www.lexplore.ch



The High-Tech Floating Laboratory LéXPLORE

Gracias !

Observatorio permanente del Lago Titicaca – OLT:

https://olt.geovisorumsa.com (español)

https://olt.geovisorumsa.com/english/index-en.html (english)

https://girh-tdps.com/proyecto-piloto-05/ (GIH/TDPS)

Xavier Lazzaro
IRD-Bolivia / UMSA
+591 7202 6879
xavier.lazzaro@ird.fr