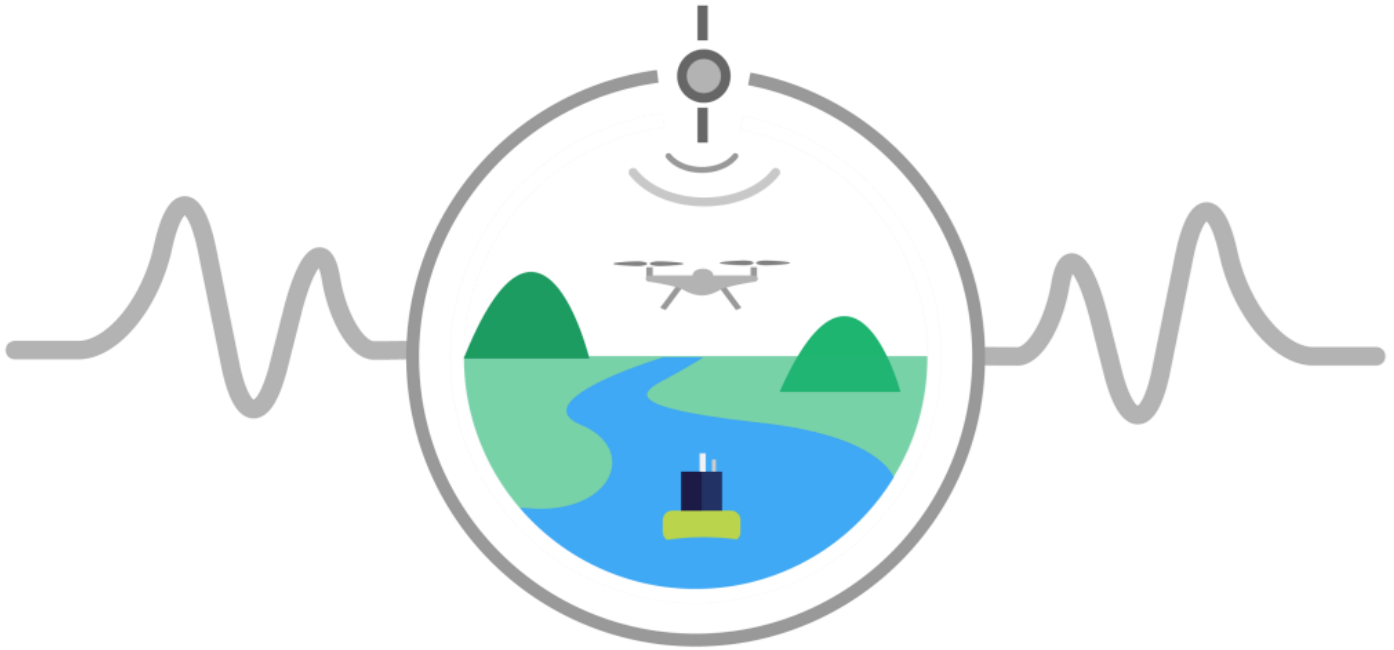

MONOCLE

Multiscale Observation Networks for Optical monitoring of Coastal waters, Lakes and Estuaries

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776480

MONOCLE

Multiscale Observation Networks for Optical monitoring of Coastal waters, Lakes and Estuaries

Alternative technologies for calibration and validation of water quality EO

Stefan Simis (PML), Jaume Piera (CSIC), Liesbeth de Keukelaere (VITO), John Wood (Peak Design), Steef Peters (Water Insight), Olivier Burggraaff (Leiden Uni), Steven Loiselle, Sasha Woods (Earthwatch)

www.monocle-h2020.eu / @monocle_h2020 / monocle@pml.ac.uk

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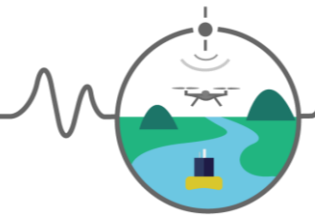
MONOCLE Rationale & Objectives



More in situ observations to support satellite cal/val, particularly in a diversity of optically complex waters and under a variable atmosphere.

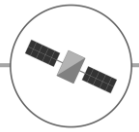
- Better understanding of uncertainties (atmospheric & water sources)
- Remote operations and data-poor regions

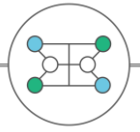
Lowered initial and operating cost

- Wider choice of reference and low-cost instruments
- Accessible options for non-expert participation (citizen science)
- Automation of measurement, data flows and quality control

Develop/improve fit-for-purpose sensors to capture:

- water and atmosphere properties through radiometry
- water column structure (optical/temperature)
- nutrients and land-use context


MONOCLE sensors and platforms

Participation

Automation

Sensors

Low-cost deployment

drones with multispectral cameras

spectropolarimeter smartphone extension

FreshWaterWatch

nutrients, land use, turbidity, colour

KdUSTICK Vertical diffuse attenuation

hyperspectral direct/diffuse pyranometer HSP-1

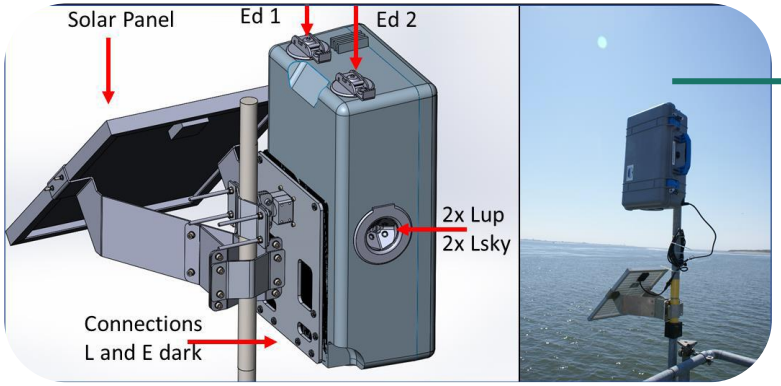
solar-tracking platform for hyperspectral radiometry on ships and buoys

hyperspectral reflectance (WISP-M)

High-end automated systems

For the latest technical specs, videos and training materials, visit
monocle-h2020.eu/Sensors_and_services

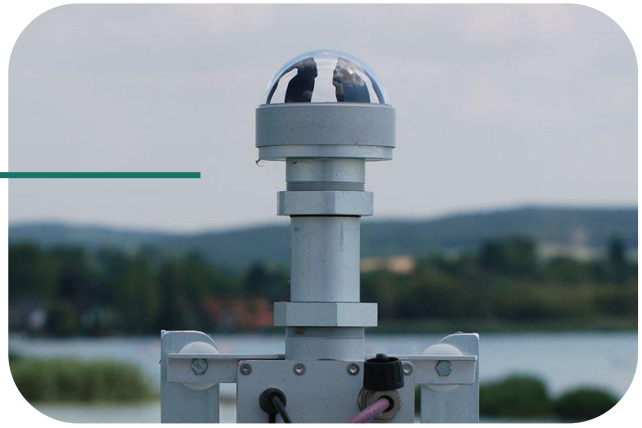
Automated radiometry systems



WISPstation by **Water Insight** provides water-leaving Reflectance from 6 channels, 2 azimuth angles, 350-1100 nm, sub-nm resolution. €25k (with tech support, data handling).

So-Rad (Solar-tracking radiometry platform) by **PML** providing water-leaving Reflectance (3 channels) integrating existing sensors, providing azimuth angle control. €2.5k to build (excl. sensors). Fully open-source.

The **Peak Design** **HSP-1** (Hyperspectral Pyranometer) provides global and diffuse downwelling irradiance, 3-nm resolution, 350-950*nm range, no motors. €11-17k target

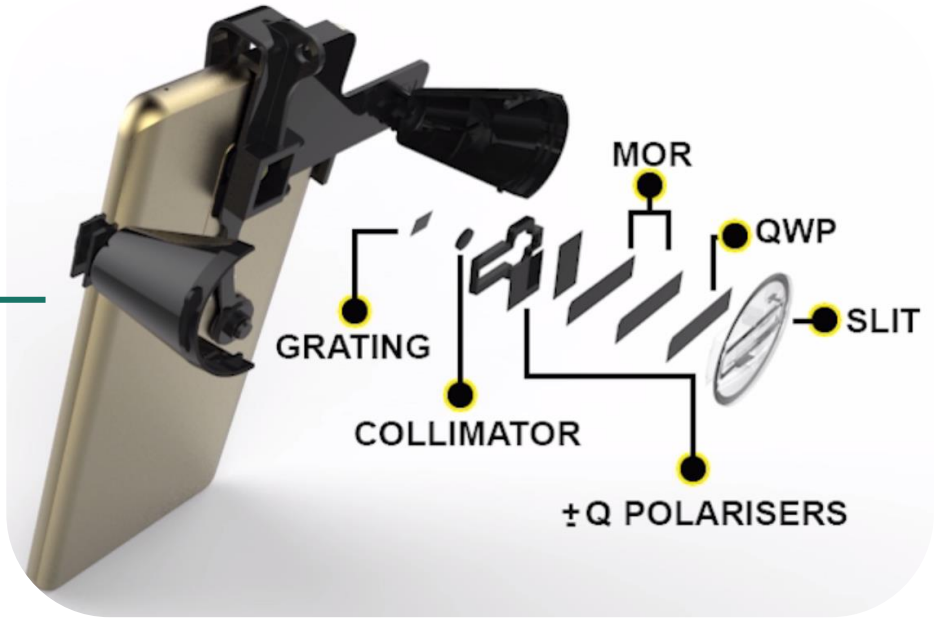


All instruments supports remote, low-power operation and monitoring, cellular data transfer and configuration and OGC-compliant metadata.

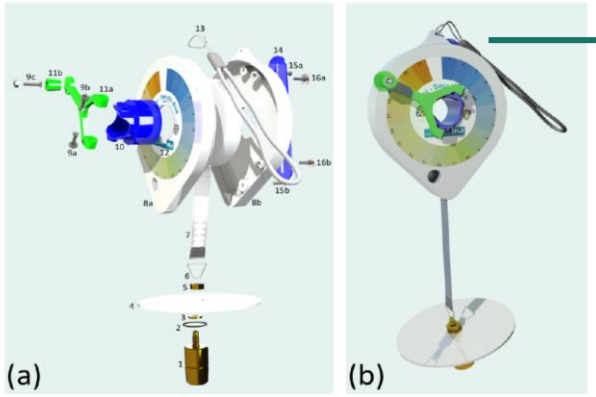
Manually operated radiometry

Drone-based solutions by **VITO** target water-leaving Reflectance from multispectral add-on payload and on-board RGB cameras, supported by flight planning and data processing service.

iSPEX 2 by **Leiden University** is a clip-on spectropolarimeter that uses the smartphone camera (app with DDQ) and camera calibrations. €15-25



Transparency, vertical attenuation



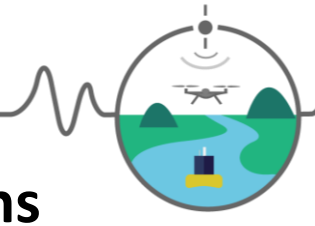
Mini Secchi-disk by **PML**, small portable disk with Forel-Ule colour index, pH paper attachment and supporting App (by DDQ). Open source, 3d printable.

Vertical attenuation using **KdUStick** by **CSIC**: chained light sensors with integrated electronics and telemetry (<€500). **KdUMod** is a more capable, modular package including RGB and temperature profiling (€2k freshwater, €6k marine)

FreshWater Watch by **Earthwatch**

Includes Turbidity tube, nutrient kit

Typical usage scenarios



Round-robin comparison of atmospheric correction solutions

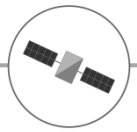
- e.g. WISPstation used extensively in ACIX-2, remote locations
- So-Rad mounted on ferries: regular coastal transects, large lakes
- HSP1 providing hyperspectral Aerosol Optical Thickness to attribute atmospheric correction uncertainties

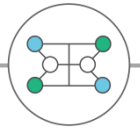
Typical deployment: strategic locations with sustained support and regular maintenance to realise fiducial reference potential.

Low-cost packages to address data gaps, microscale observations

- Turbidity, reflectance, transparency for < €500 per user (optional nutrients, coliforms, oxygen demand through citizen science kits)
- Drone-based operations starting from €1.5k
- Determine vertical water column and atmospheric conditions.

Typically embedded in citizen science projects: large potential for cross-validation, observing episodic events and grassroots environmental action.

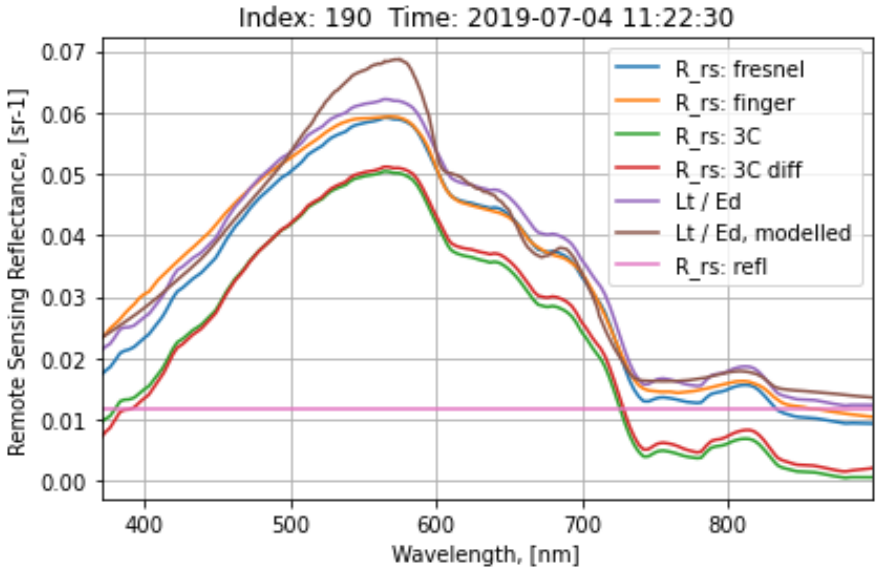




Ongoing R&D

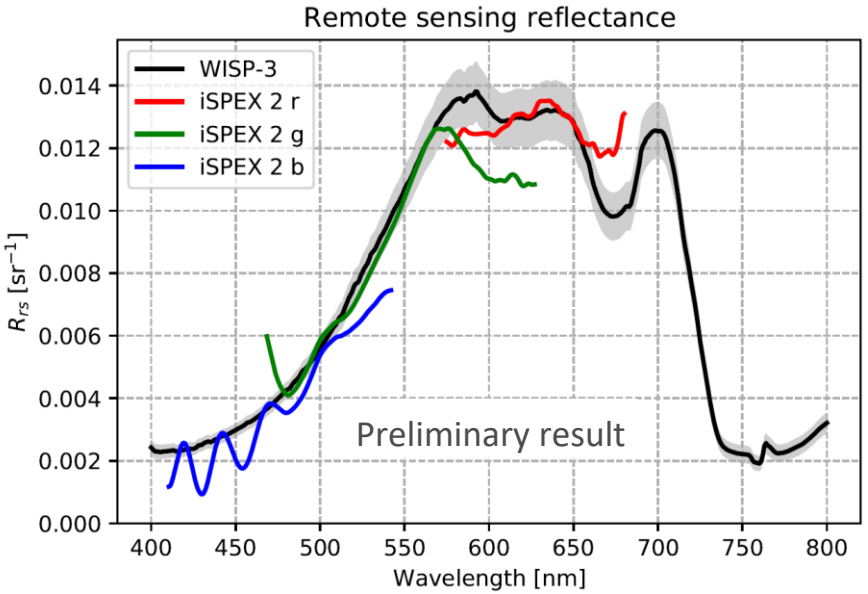
So-Rad and HSP-1 deployed together

- HSP-1: diffuse & direct downwelling irradiance (E_{dd}, E_{ds}).
- So-Rad: water (L_t) and sky (L_s) radiance. E_d not used.
- Atmospheric modelling constrains the shape and amplitude of reflectance at the water surface
  -> improved remote-sensing reflectance.
- Analysis code + paper due soon



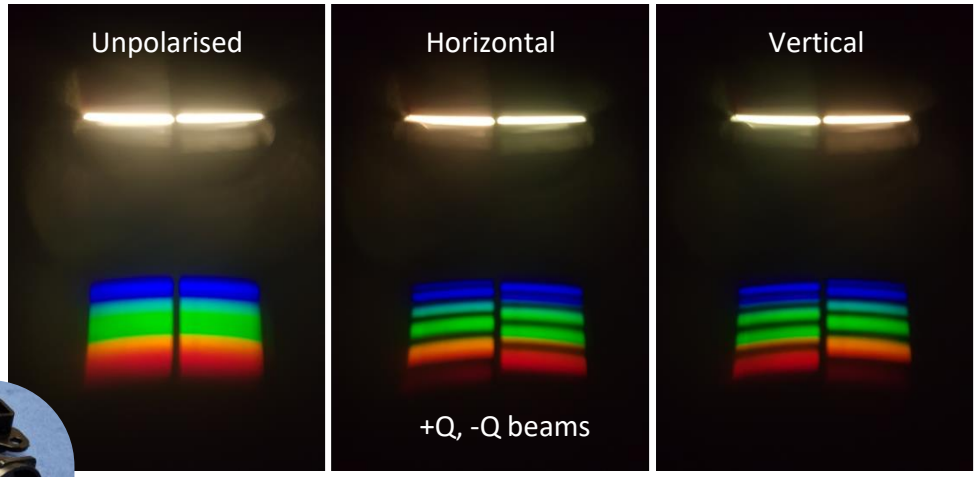
Ongoing R&D

iSPEX 2: testing mass-production units



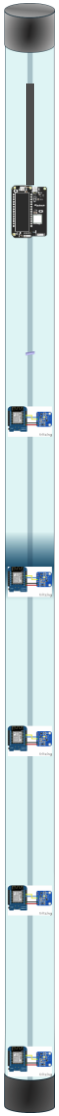
- Smartphone linear spectropolarimeter
- Universal smartphone support
- Camera calibration protocol & database
- Aerosol Optical Depth
- Remote-sensing Reflectance

3D printed iSPEX 2 prototype vs WISP-3 (black) shows good agreement (5% RMSD). Sine wave in B-band, band edge effects currently being addressed. Camera filters out > 700nm.

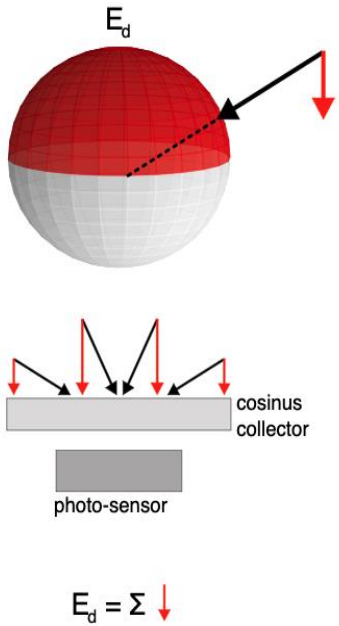


Camera images recorded with smartphone and iSPEX, polarization on/off

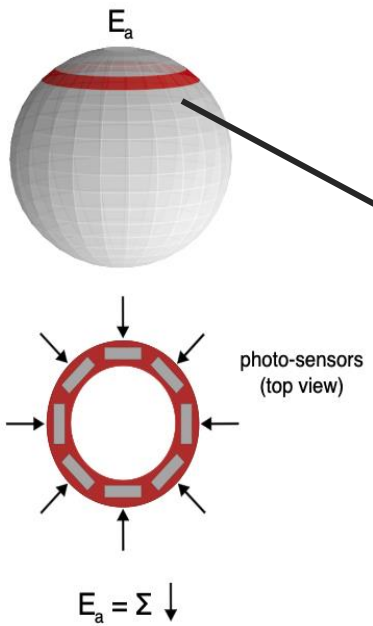
Ongoing R&D



Downward irradiance



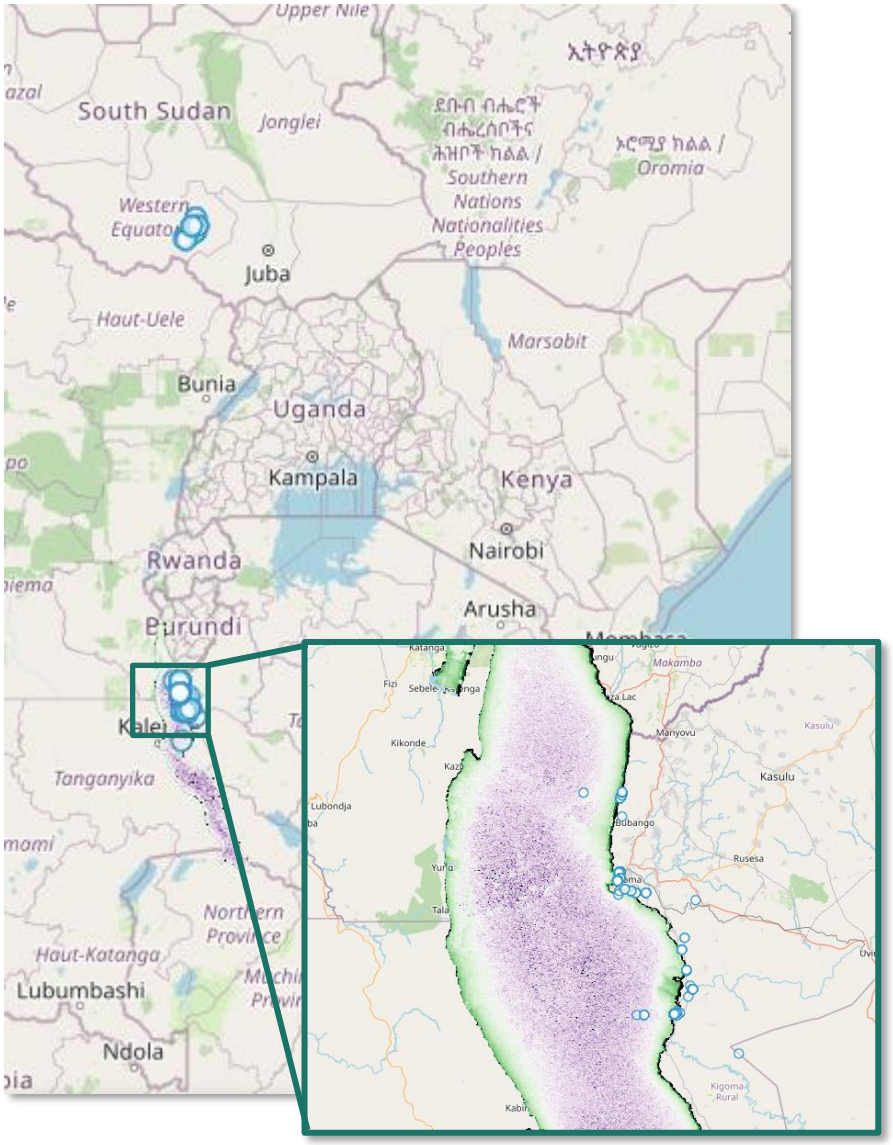
Annular irradiance



KdUStick

- Bespoke electronics board to control the integration time of the sensors
- Sensors in annular arrangement (avoiding shading)
- Open hardware design
- Do-it-yourself build possibilities

Bringing multiscale observations together



Harmonized data flows

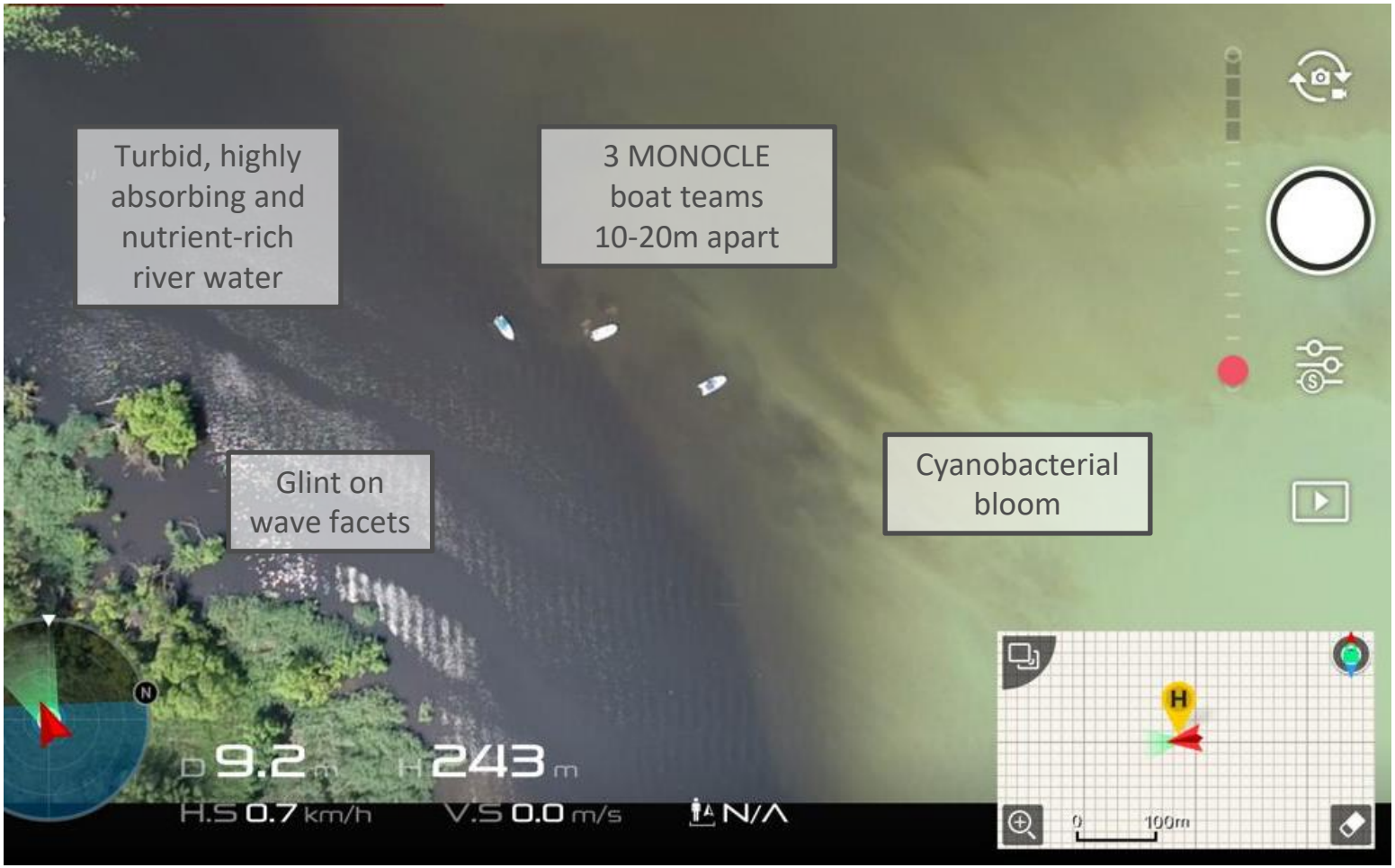
All instruments/platforms provide

- Essential metadata (See MONOCLE report D3.2)
  - Sensor/sample/operator/platform ID
  - Ownership & licensing info
  - Calibration information
- OGC-based data offering
  - [optional] Sensor-to-backend (SOS)
  - [optional] Backend-to-middleware
  - Frontend, e.g. Geoserver with WFS and WMS
- Public front-end (any GIS) can mix sources, conduct geospatial queries.

Sources currently connected

- LIMNADES (U Stirling)
- FreshWater Watch (Earthwatch)
- So-Rad systems
- MapEO drone imagery (VITO)
- …

Thank you



Lake Balaton, Hungary, 2019. The Zala river mouth by drone and 3 boats.