

Measurement Networks!



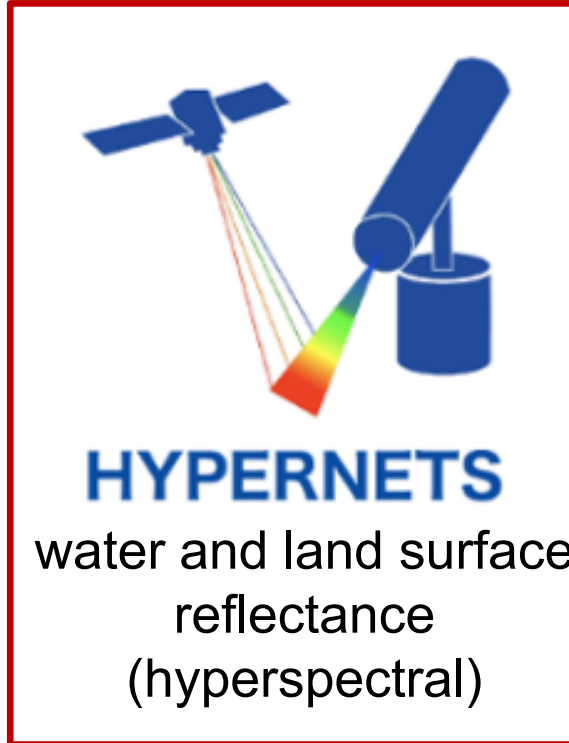
aerosol properties ... water reflectance (multispectral)



surface ... TOA reflectance (vicarious cal)



surface flux of CO_2 , CH_4 , H_2O ...



BSRN: surface radiation flux

A network of **autonomous hyperspectral radiometers**
measuring **water and land surface reflectance** for
satellite validation ... and more ...

Coordinated by Kevin Ruddick,
Royal Belgian Institute for Natural Sciences (RBINS)

HYPERNETS

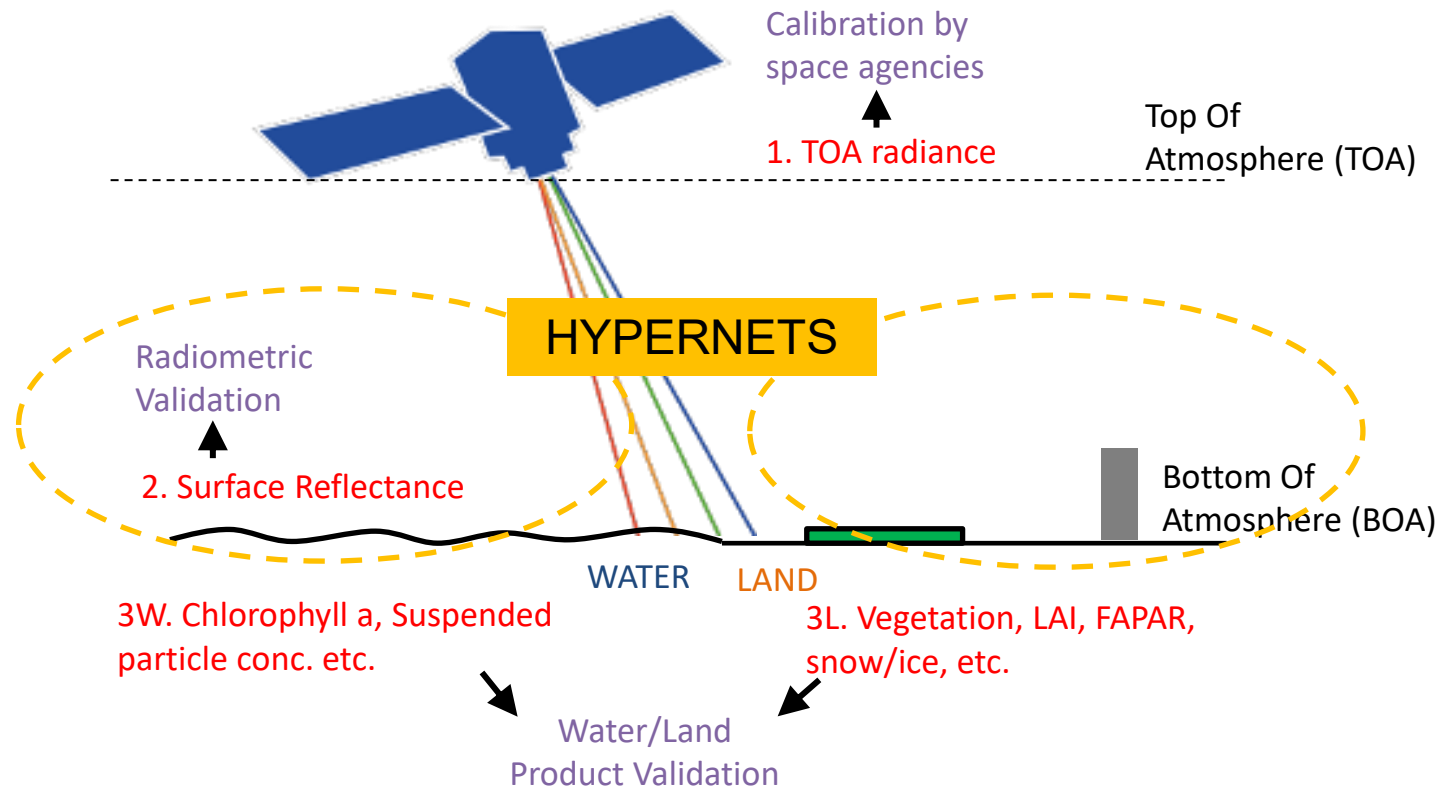


(c) HYPERNETS Consortium, 2022 (RBINS, TARTU, SU, CNR, NPL, GFZ, CONICET)

The CAL/VAL place for HYPERNETS

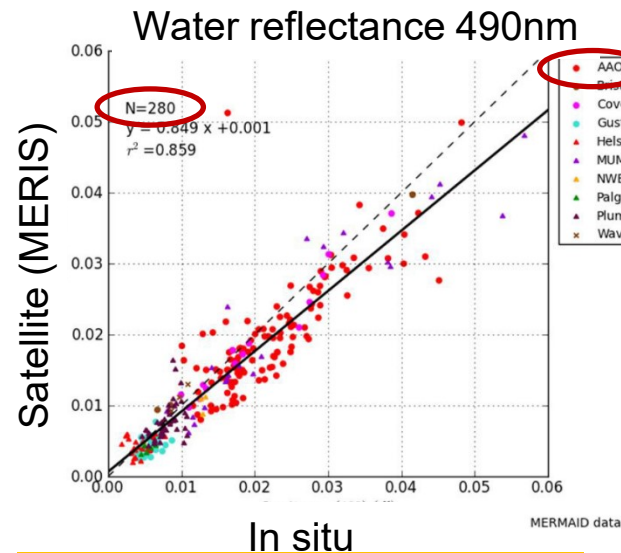
MOTIVATION =

Automated measurements for validation of water and land surface reflectance at all VIS/NIR spectral bands (380-1700 nm, @3 nm FWHM to 1020 nm)
...2300 nm? ... 2500 nm??



Why automated hyperspectral?

10 years of MERIS water reflectance validation, including a few years of AERONET-OC...



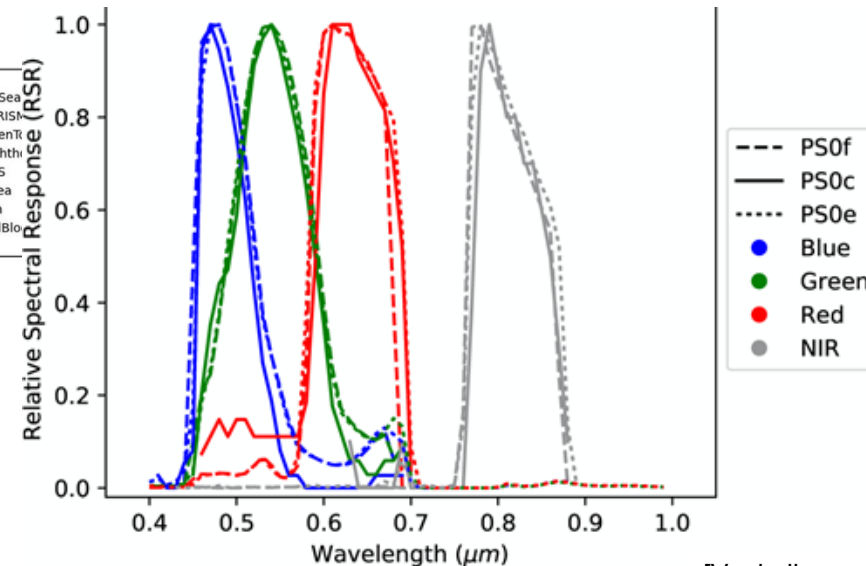
Data acquisition must be **AUTOMATED**

[MERIS 3rd reprocessing data validation report, ACRI, 2012]

Data courtesy of PIs (D. McKee, K. Ruddick, D. Siegel, S. Kratzer) and AERONET-OC PIs (G. Zibordi, G. Schuster, S. Kratzer, B. Gibson), matchup using MERMAID

Sites should be **NETWORKED**

Planetscope spectral response

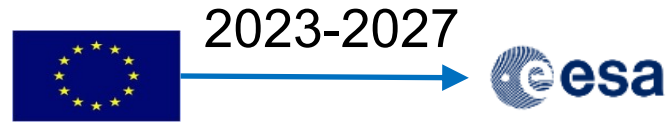


Instrument must be **HYPERSPECTRAL**

[Vanhellemont & Ruddick (2018)
<https://doi.org/10.1016/j.rse.2018.07.015>
Atmospheric correction of metre-scale optical satellite data for inland and coastal water applications]

+ new generation of hyperspectrals (EnMAP, PRISMA, EMIT ... PACE ... CHIME, SBG, GLIMR and cubesats?)

HYPERNETS in a single slide

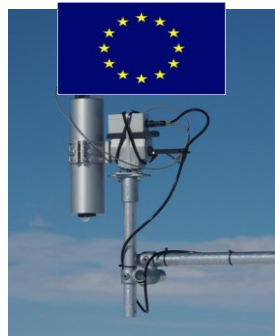


INSTRUMENTS

Automated hyperspectral measurements



PANTHYR system
[Vansteenkoven et al, 2019]
400-900nm, 10nm FWHM



HYPSTAR® system
[https://hypstar.eu/]
380-1700nm, 3-10nm FWHM

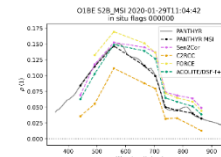
NETWORK

RBINS (BE, coordinator)
+ VLIZ (BE), CNR (IT), LOV (FR),
NPL (UK), GFZ (D), TARTU (ES),
CONICET (ARG)

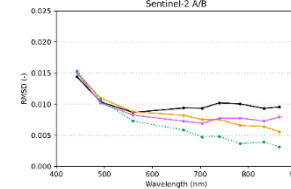


10 water and 10 land sites operating/ed
Many international requests to join in 2023 ...

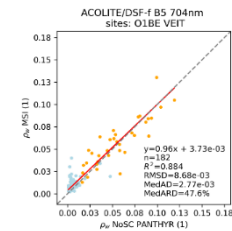
DATA PROCESSING and ANALYSIS



one band (S2/704nm), many matchups



e.g. one matchup



spectral stats, many matchups

Prototype network has provided validation data and information to:

Sentinel-2A&B, Sentinel-3A&B/OLCI, Landsat-8&9, Planetscope Doves and **Superdoves**, PRISMA, Pléiades, **ENMAP**, MODIS-A&T, VIIRS-1&2, ...

OBJECTIVE: To validate **all** VIS/NIR spectral bands (400-1700nm, @3-10nm FWHM) for **all** satellite missions measuring water or land surface reflectance

and preparing for:

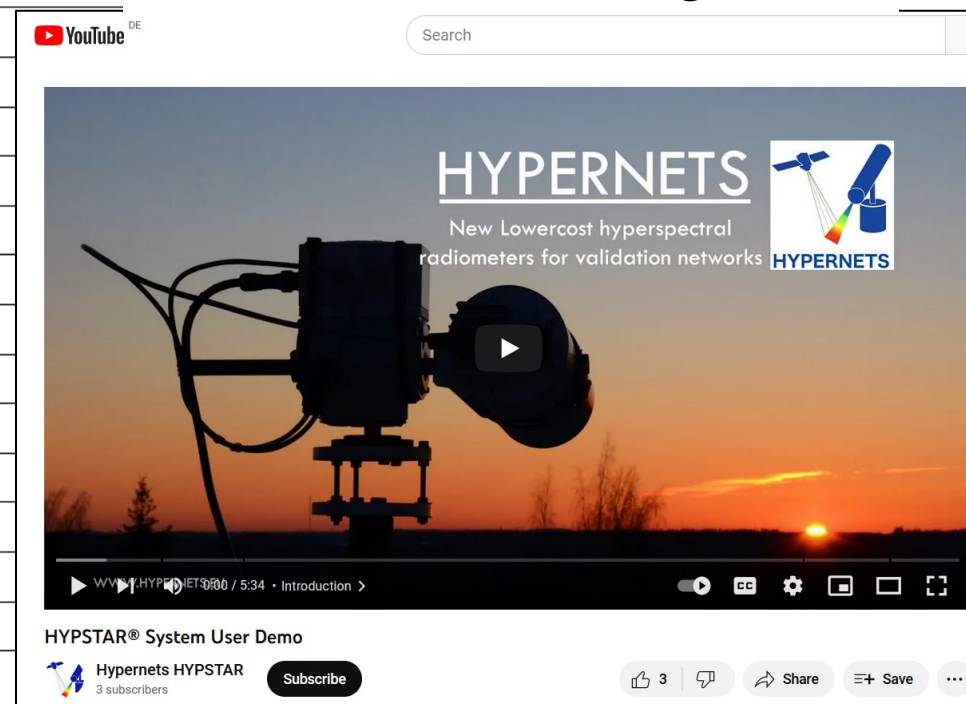
ACIX, DESIS, MTG and SEVIRI, EMIT, CHIME, LSTM, **PACE**, GLIMR, SBG, PROBAV-CC, GOCI, SABIAMAR, various **Newspace**, ... (national hyperspectral imagers from Canada, Norway, Australia, ...)

HYPSTAR® instrument spec (XR=land version)

Parameter	HYPSTAR-XR radiometer
Measured quantity	Radiance and irradiance (multiplexed)
Field of view	5° (radiance), 180° (irradiance)
Detector array	2048 px Si, 256 px InGaAs
Spectral range	380 ... 1700 nm
Spectral sampling interval	0.5 nm (VNIR), 3 nm (SWIR)
Spectral resolution	3 nm (VNIR), 10 nm (SWIR)
ADC resolution	16 bit
Integration time	1...65535 ms
Shutter	Internal
Target camera	5 Mpx, RGB
Communication interface	RS485, half duplex, 115.2 ... 8000 kbps
Housing material	Anodised marine grade aluminium
Dimensions (DxL)	Ø110.3 x 434 mm
Weight	3 kg
Power supply	8 ... 18 V DC, 2 A
Environmental protection	IP67
Operating temperature	-25 ... +45 °C
Storage temperature	-35 ... +70 °C

User demo video

<https://www.youtube.com/watch?v=dfUAPYxg5Cc>



www.hypstar.eu

SR=water version
VISNIR (380-1020nm),
2° FOV

Typically measuring every 30 mins during daytime for a year before recalibration

Water sites currently/recently running

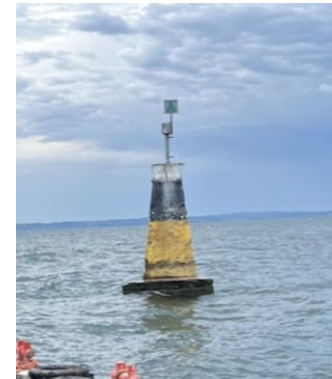
VLIZ: Oostende



RBINS: Blankaart



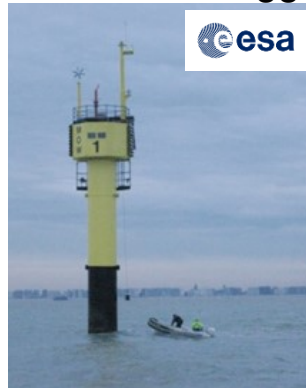
CNR: Lake Garda



CNR: Acqua Alta



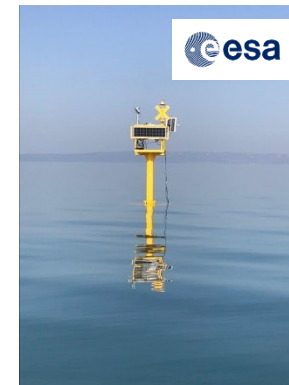
RBINS: Zeebrugge



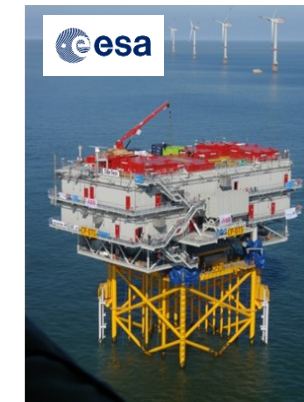
CONICET: La Plata



LOV: Etang Berre



RBINS: Thornton



LOV: Gironde



TARTU: Vortsjävän



will support 5 water sites to 2027

+
USA Chesapeake Bay co-located AERONET-OC July 2023 ...
+
UK Wraybury reservoir July 2023 ...
+ ...

Land sites currently/recently running

NPL: Wytham



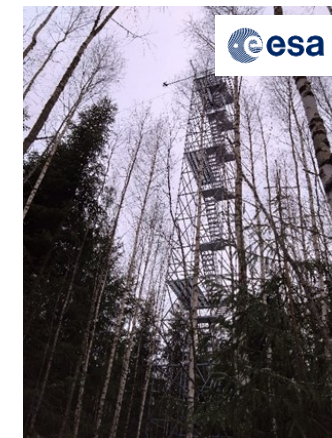
GFZ: ATB



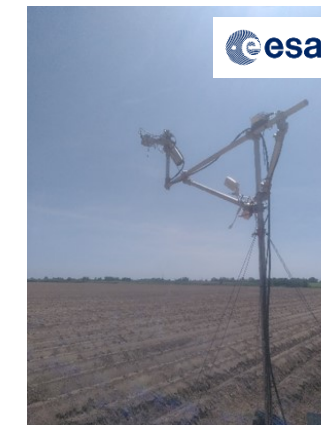
RBINS: PEAntarctica
(Dec-Jan)



TARTU: Järvselja



RBINS: Lonzee



GFZ: DEMMIN



NPL: Gobabeb



NPL/RBINS: Barrax
(Jul 2022)



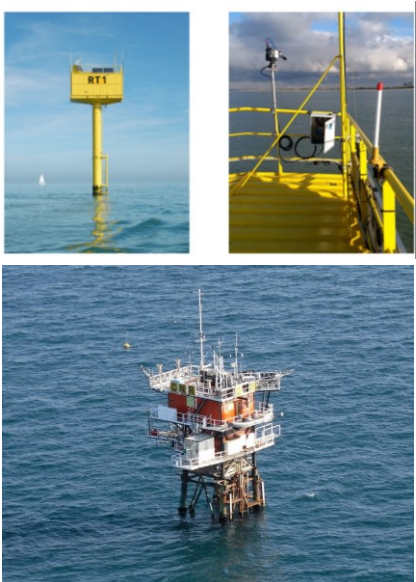
TARTU: Soontaga



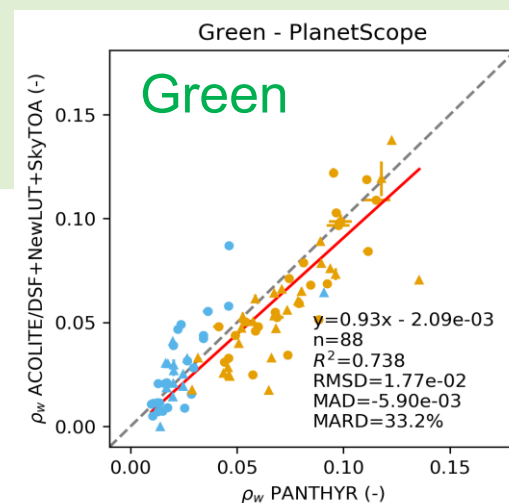
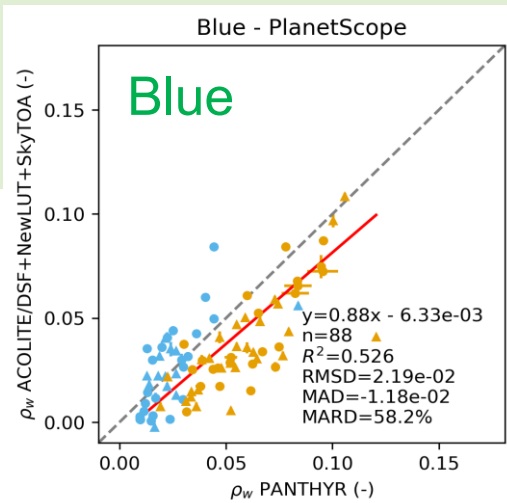
+ 
CNR: Jolanda di Savoia 2023 ...
+ ...

Validation of **Planetscope/Doves** with 2019-2020 HYPERNETS/ PANTHYR data from two sites

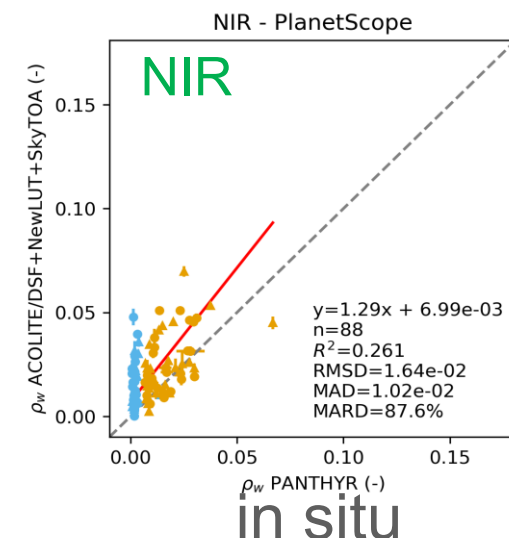
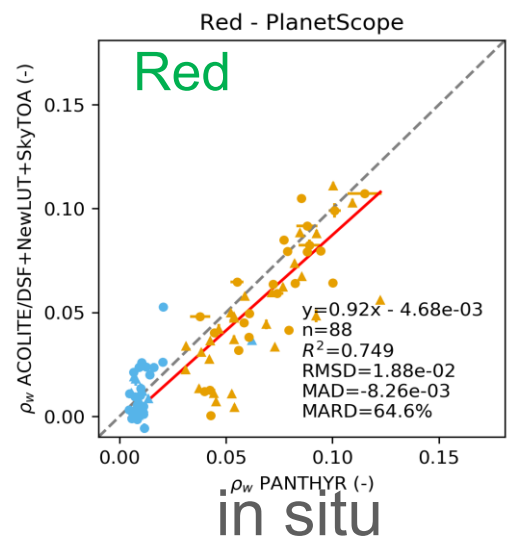
RT1 Oostende, Belgium (VLIZ: Vansteenwegen)
AAOT Venice, Italy (CNR: Brando)



satellite



satellite



Interoperability?
Red+Green usable for turbidity! (but not NIR)

88 matchups
52 different satellites

[Vanhellemont (2020) <https://doi.org/10.1364/OE.397456>


Sensitivity analysis of the dark spectrum fitting atmospheric correction for metre- and decametre-scale satellite imagery using autonomous hyperspectral radiometry]


Land properties - angular measurements of furrowed field!



[RBINS:
Lonzee]



Useful for more than just satellite validation [Goyens et al, 2022]

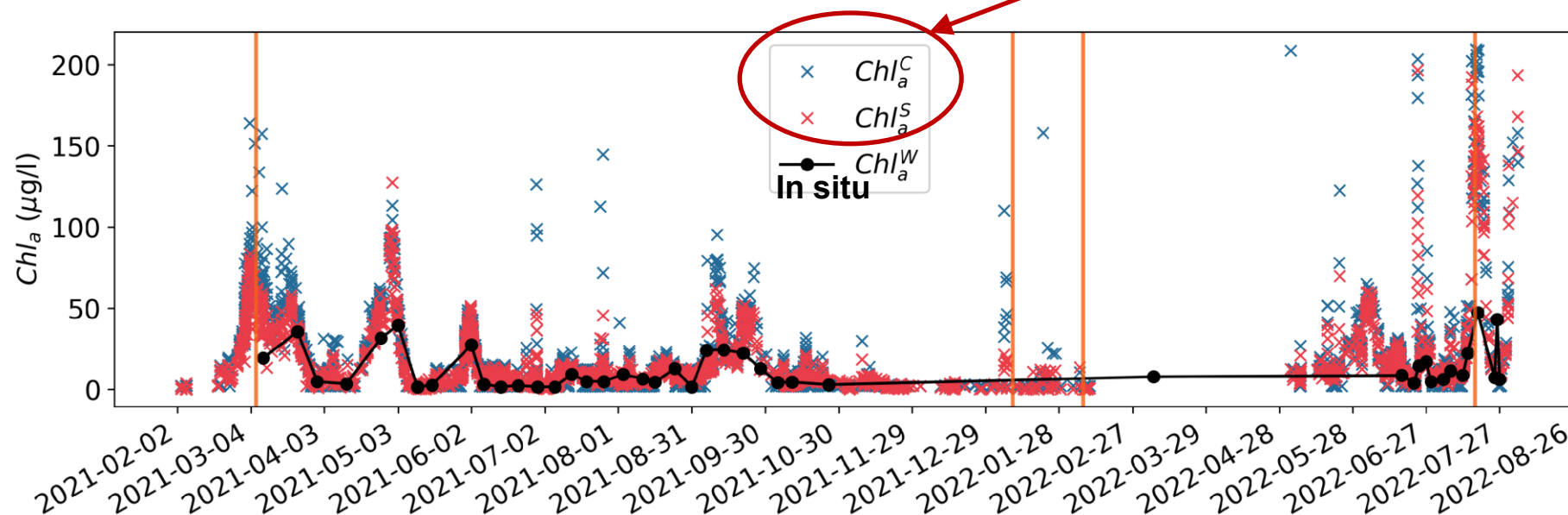

remote sensing



Article

Using Hyperspectral Remote Sensing to Monitor Water Quality in Drinking Water Reservoirs

Clémence Goyens ^{1,*} , Héloïse Lavigne ¹, Antoine Dille ¹  and Han Vervaeren ²



Data processing and distribution - status

HYPSTAR®:

Prototype data released ZENODO June 2023

Reprocessing expected by Dec 2023 (improved QC, spectral weighting, etc.)

PANTHYR:

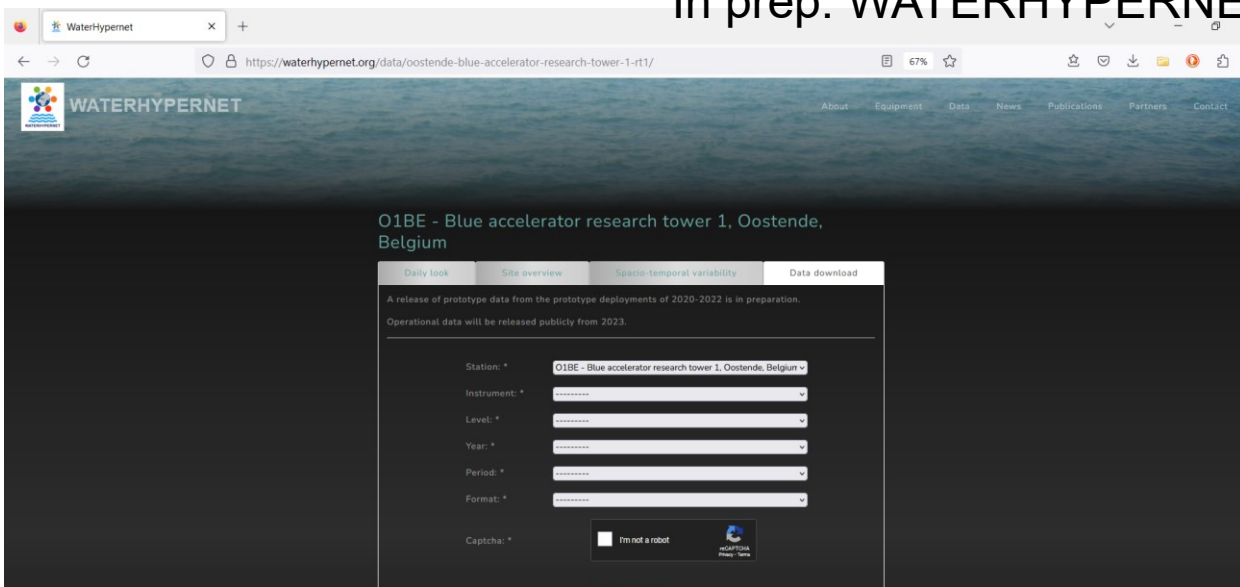
Reprocessing in progress

PANGAEA/ZENODO July 2023?

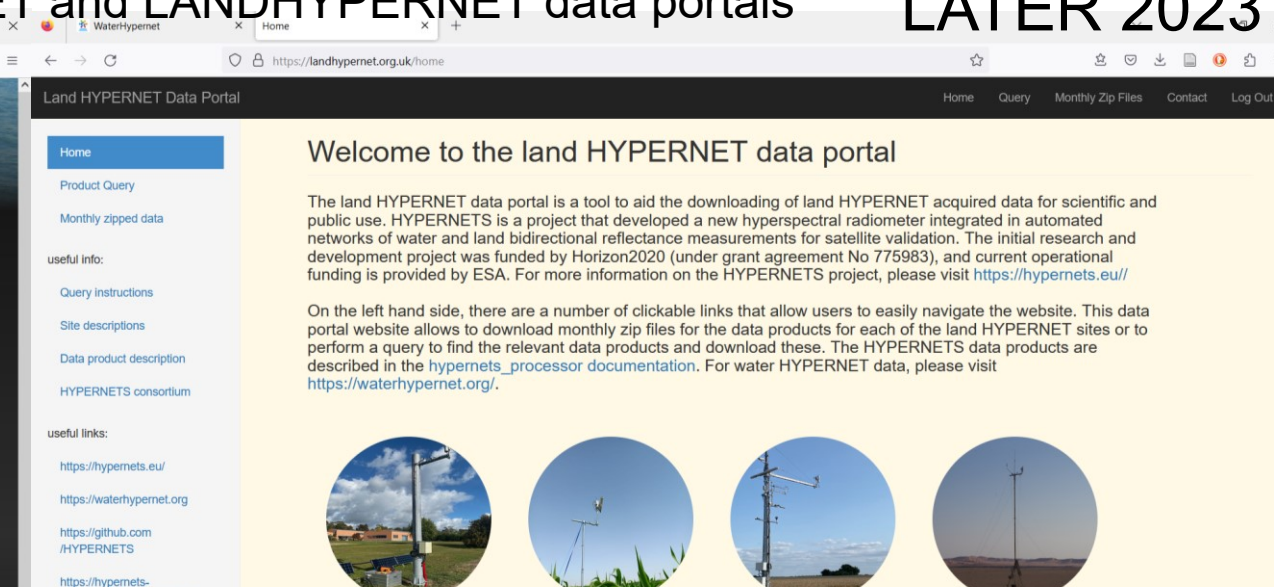
SHORT TERM

In prep: WATERHYPERNET and LANDHYPERNET data portals

LATER 2023



The screenshot shows the WaterHypernet website. The main heading is "O1BE - Blue accelerator research tower 1, Oostende, Belgium". Below this, there are tabs for "Daily look", "Site overview", "Space-temporal variability", and "Data download". A form is visible with fields for "Station", "Instrument", "Level", "Year", "Period", and "Format". A "Captcha" field is also present.



The screenshot shows the LandHypernet Data Portal. The main heading is "Welcome to the land HYPERNET data portal". Below this, there is a paragraph of text: "The land HYPERNET data portal is a tool to aid the downloading of land HYPERNET acquired data for scientific and public use. HYPERNETS is a project that developed a new hyperspectral radiometer integrated in automated networks of water and land bidirectional reflectance measurements for satellite validation. The initial research and development project was funded by Horizon2020 (under grant agreement No 775983), and current operational funding is provided by ESA. For more information on the HYPERNETS project, please visit <https://hypernets.eu/>". Below the text, there are four circular images showing different types of hyperspectral radiometers. The text "GHNA" and "abeb HYPERNETS, Namibia" is visible at the bottom right.

FOLLOW US on https://twitter.com/Hypernets_H2020 !

Surface reflectance data is **essential** for water and land product validation

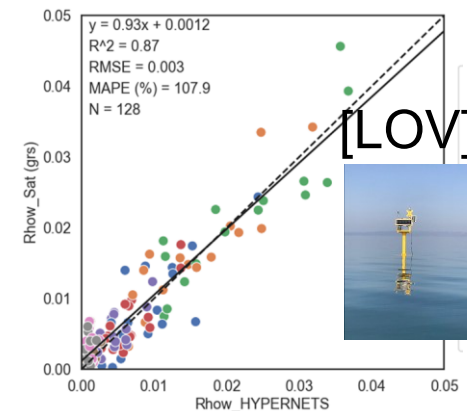
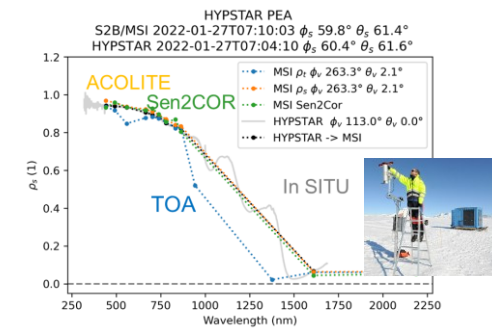
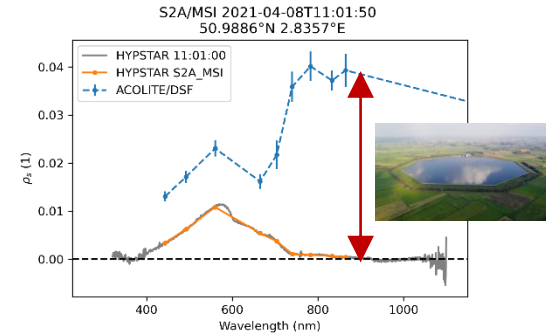
Autonomous hyperspectral network is **most cost-effective** (multi-mission context)

Zenith- and azimuth-pointing enables full HRDF for land and extra scenarios for water (as well as "parking" to protect)

Useful for other applications (not just sat val) ...

Early prototype HYPSTAR® data looks very useful ...

Diverse water and land HYPERNETS validation sites should provide good basis for validation of S2A&B, L8&9, S3A&B, EnMAP, PRISMA ... PACE ... CHIME, SBG, GLIMR ... and NewSpace and ...



Acknowledgements

- Project funding:
 - PRODEX...ESA/HYPERNET-VN&POP
 - BELSPO/HYPERMAQ+AQUALOOKS
 - EU/H2020/HYPERNETS
- Partners:
 - RBINS (K. Ruddick, M. Beck, A. Gammaru, C. Goyens, F. Ortenzio, Q. Vanhellemont) + CPOWER+AfKust+IPF+Watergroep
 - VLIZ (D. Vansteenwegen, A. Catrijsse) + POM (Oostende site)
 - CNR (V. Brando, L. Gonzales Vilas, C. Giardino)
 - TARTU (J. Kuusk, K. Flight, K. Laizans, R. Vendt)
 - NPL (A. Bialek, S. Hunt, P. De Vis, M. Sinclair)
 - LOV (D. Doxaran, A. Corrizi)
 - IAFE/CONICET (A. Dogliotti, E. Piegari, P.Perna, L. Rubinstein)
 - GFZ (D. Spengler, M. Saberioon)

Questions? Comments?

FOLLOW US on https://twitter.com/Hypernets_H2020 !