

# WATERHYPERNET

## A network of hyperspectral radiometers for multi-satellite water reflectance validation

(including Sentinel-2A&B)

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### Abstract

A new network of hyperspectral radiometers is being developed for radiometric validation of satellite missions. This network follows closely the AERONET-OC federation concept [Zibordi et al, 2009] but uses the TRIOS/RAMSES hyperspectral radiometer. The instrument system consists of one radiance and one irradiance sensor on a pointing robot, controlled by a microprocessor and supplemented with GPS, inclinometer and video camera data feeds [Vansteenwegen et al – poster]. The measurement protocol is based on the above-water method of [Mobley, 1999], but includes additional scenarios for different viewing zenith and azimuth configurations. The systems will be deployed initially in Belgian coastal and inland waters, then at HYPERMAQ project partner sites in Argentina and France before full international expansion. **The network will provide water reflectance data for the radiometric validation of all visible and near infrared bands of all optical missions**, including Sentinel-3A&B, **Sentinel-2A&B**, PROBA-V, MODIS-AQUA&TERRA, VIIRS, Landsat-8, Pléiades, CHRIS-PROBA, MSG-SEVIRI ... ENMAP, PACE, MTG and ... any future optical missions, including nanosatellites.

### Why autonomous?

High number of matchups:

One cloud-free image => One matchup

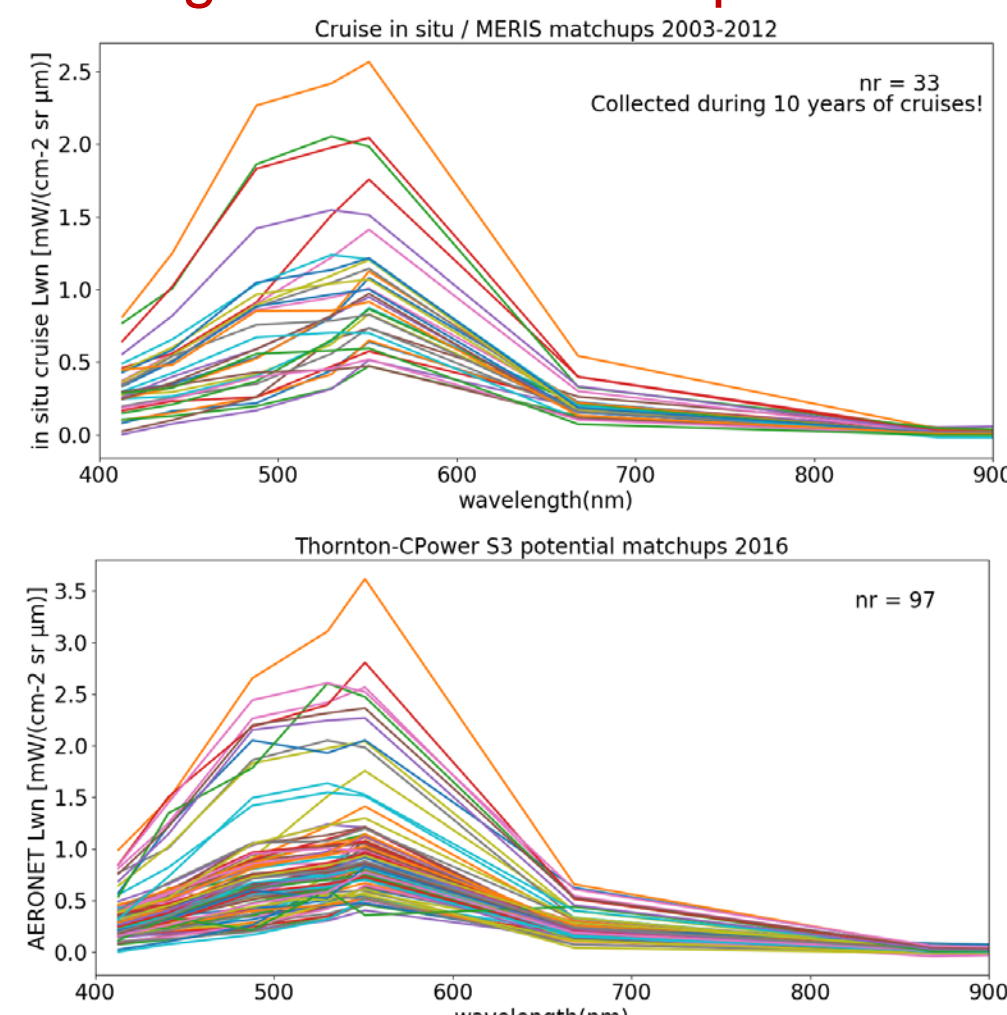


Figure 1. (top) 33 MERIS matchups acquired by RBINS/MUMM during seaborne cruises 2003-12; (bottom) 97 Potential S3/OLCI matchups acquired by RBINS from single AERONET-OC site during single year 2016

### Why Multi-Mission Validation?

Economy of scale:

Each site validates **MANY** satellite missions

Satellite/Sensor	Agency	Spatial Resolution (nadir)	Temporal Resolution (0°N)
MODIS-TERRA&AQUA	NASA	250m/1000m	Daily (2 sats)
VIIRS	NOAA	375m/750m	Daily
Sentinel-3A&B/OLCI	EU/ESA/EUM	300m	Near Daily (2 sats)
PROBA-V	ESA/BELPO	300m	Every 2 days
Landsat-8	USGS	30m	Every 8 or 16 days
Sentinel-2A&B	EU/ESA	10m/20m	Every 5 days (2 sats)
Pléiades	CNES	2m	On demand
SEVIRI-MSG	EUM	3000m	Every 5 minutes

+ future missions including ENMAP, PACE, HYPSPRI + nanosatellites? etc.

Figure 2. Characteristics of some missions that will be validated by WATERHYPERNET

### Why hyperspectral?

Complete spectral coverage:

Validates **ALL VIS/NIR bands** of **ALL** satellites

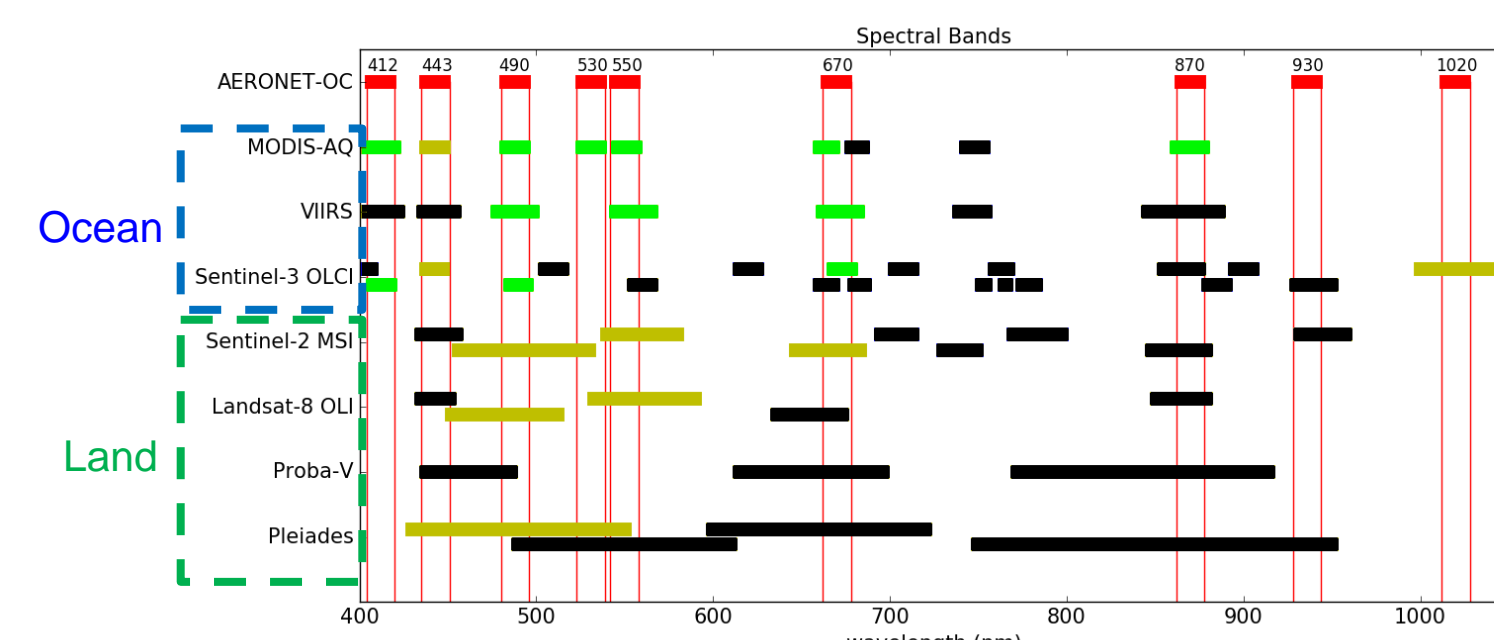


Figure 3. Overlap between spectral bands of 9-band AERONET-OC CIMEL-Seaprisim instrument (red) and some optical remote sensors with spectral bands that: a) match well (light green), b) can be matched approximately with appropriate interpolation (olive green) and c) cannot be matched. See [Van Der Zande et al, 2016] for details.

### WATERHYPERNET Objective

Objective of WATERHYPERNET is to become the **primary source** of **radiometric validation data for all optical satellite missions over water**.

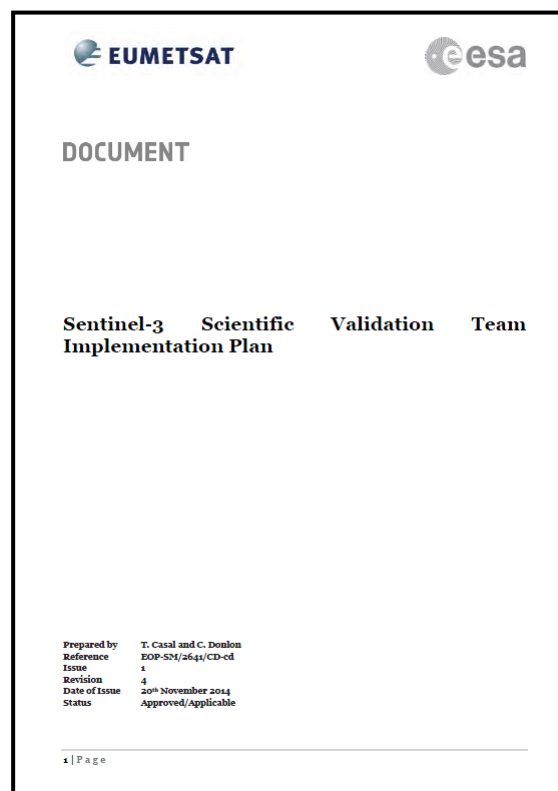
This will enable the atmospheric correction of satellite missions to be validated for all spectral bands in diverse conditions including:

- Offshore/coastal/inland
- Cases 1 and 2S/2A (including eXtremely Scattering and Absorbing)
- Bottom reflectance
- Adjacency effects
- Diverse aerosol types

### User Requirements

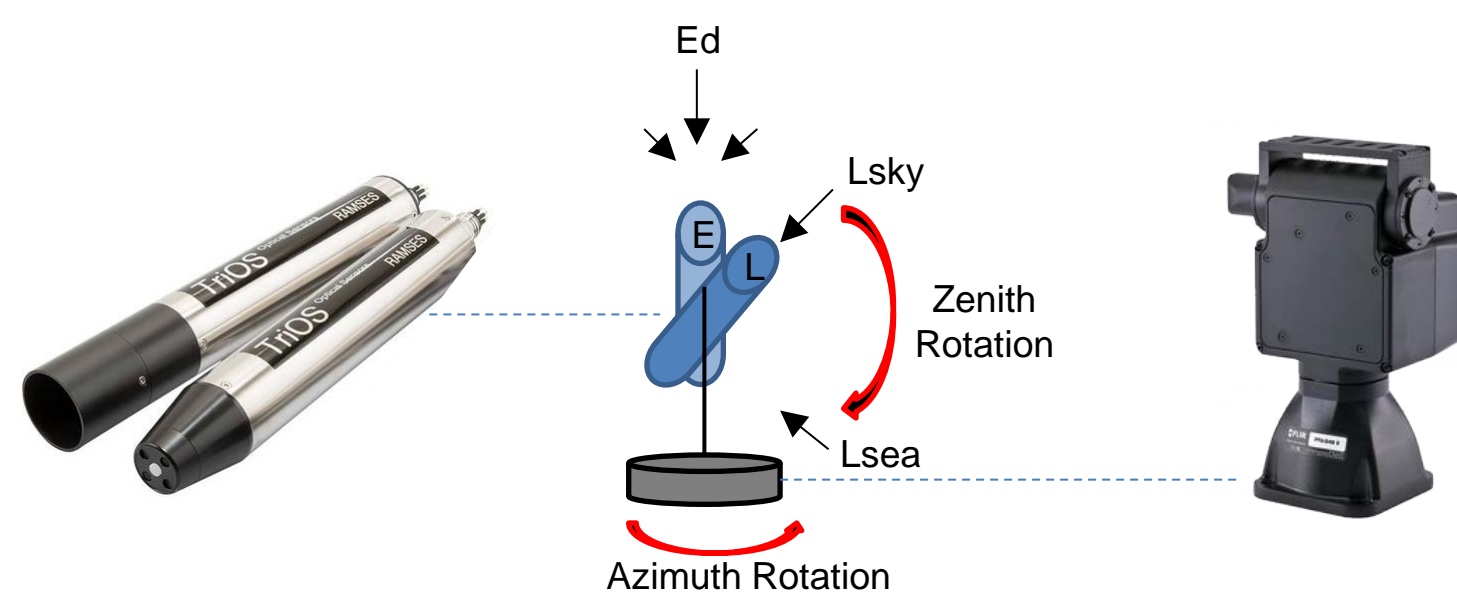
User Requirements for WATERHYPERNET are collected from space agencies and their validation teams/entities including:

- Sentinel-2AB Val. Team and MPC
- Sentinel-3AB Val. Team and MPC
- VIIRS Validation Team
- USGS (Landsat)
- NASA (MODIS...PACE)
- PROBA-V QWG and VITO
- CNES/Airbus (Pléiades)
- etc.



### Instrument System

WATERHYPERNET will use the HYPERMAQ instrument system of two TRIOS hyperspectral radiometers, an automated pointing system, controller PC and auxiliary sensors, power and data transmission.



### Measurement Protocol

WATERHYPERNET above-water measurement protocol is based on [Mobley, 1999] but with extra zenith and azimuth viewing angles. Detailed uncertainty analysis will follow FRM4SOC principles – see [www.frm4soc.org](http://www.frm4soc.org).

$$\rho_w(\theta_v, \Delta\varphi) = \frac{\pi L_{w0}(\theta_v, \Delta\varphi)}{E_d^+(0^+)}$$
$$L_{w0}(\theta_v, \Delta\varphi) = L_{w0}^+(0^+, \theta_v, \Delta\varphi) - \rho_p L_{s0}^+(0^+, -\theta_v, \Delta\varphi)$$

with  $\rho_p$  model

Protocol-related sources of uncertainty for  $L_{w0}$ :

- Estimation of  $\rho_p L_{s0}$
- Tilt and roll effects (if not fixed platform)
- Shading from superstructure/platform
- Fore-optics contamination
- High frequency fluctuations of illumination

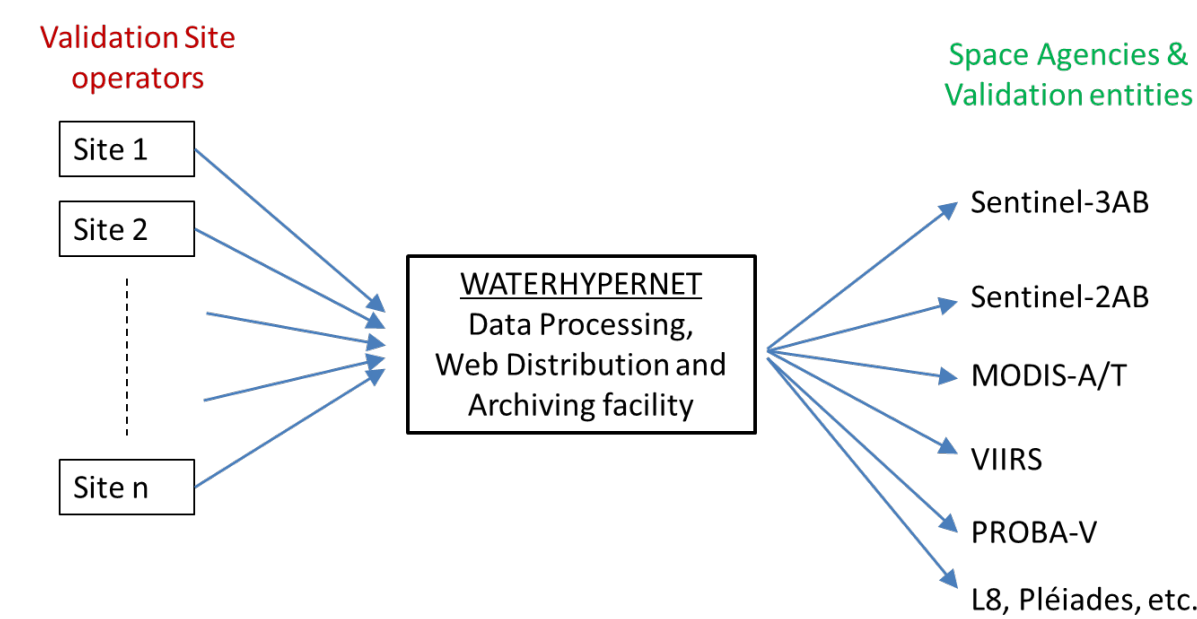
+ Instrument calibration/characterisation

+ Bidirectional effects

+ In situ vs Satellite space-time differences

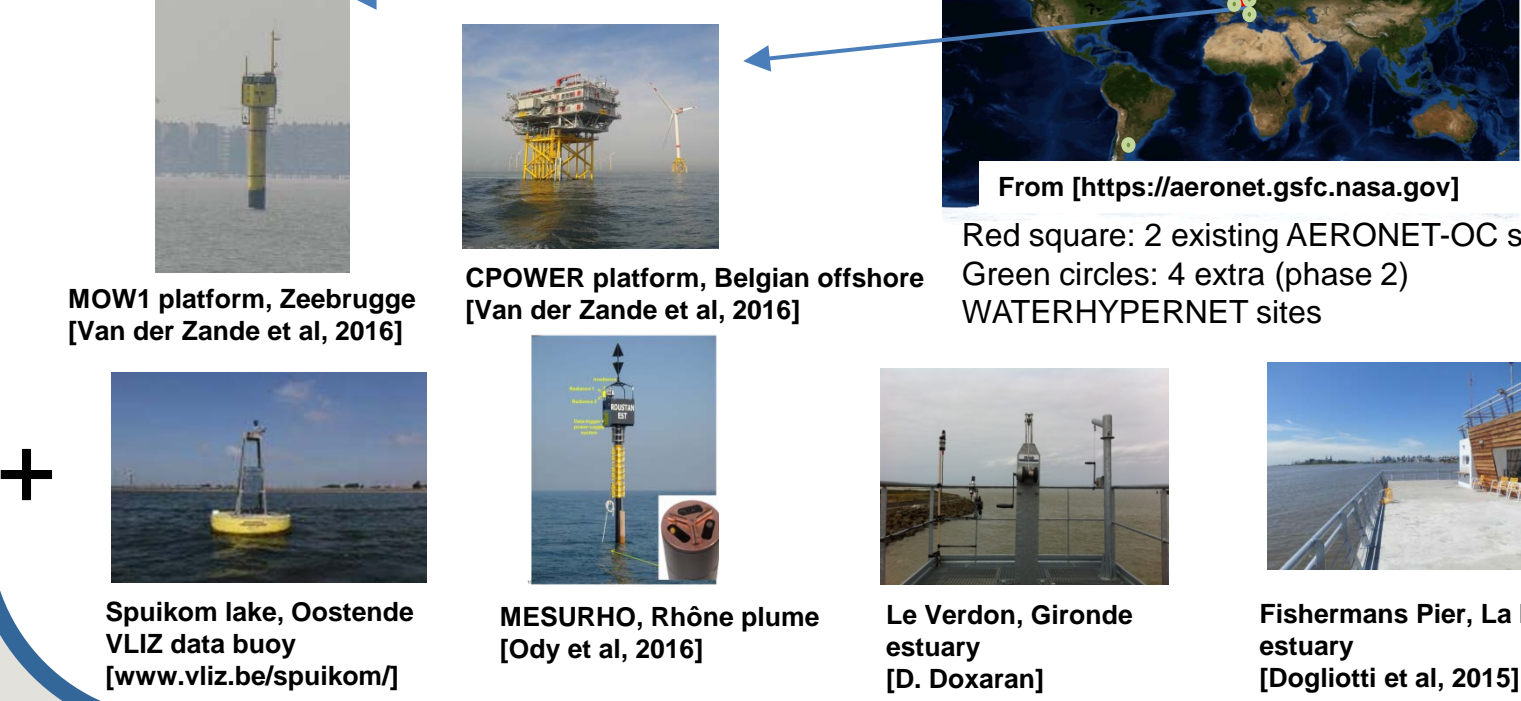
### Data Distribution

Data is transmitted daily from validation sites to Data Processing and Archiving Facility and made available via Internet for space agencies and validation entities (S2VT, S3VT, etc.)



### International Network of Sites

WATERHYPERNET will run hyperspectral instruments alongside 2 existing Belgian AERONET-OC sites + a new Belgian inland site and as addition to validation sites in French and Argentine waters + future worldwide expansion ...



### References

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The WATERHYPERNET network including measurement protocol design and data processing and distribution is being developed in the framework of the PRODEX/HYPERNET-OC project. The instrument pointing and control system is being developed in the framework of the BELSPO/STEREO-III funded HYPERMAQ project.

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