Water Insight

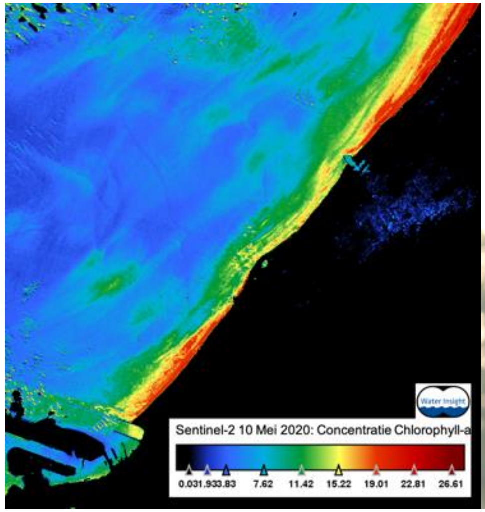
FRM4SOC-2 Cal/Char of OCR

Water Insight

Since 2005 active in optical water quality monitoring

Our main mission is:

- To provide water quality information products and services based on our award-winning optical in-situ sensors and satellite data processing methods





Optical Instruments

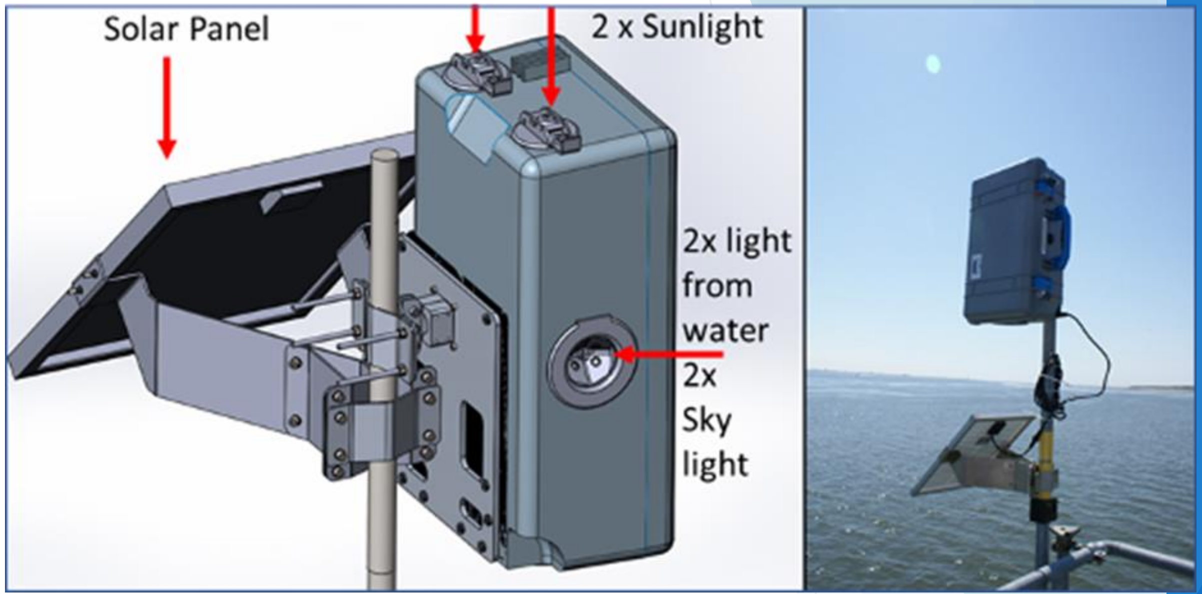
We produce the following instruments:

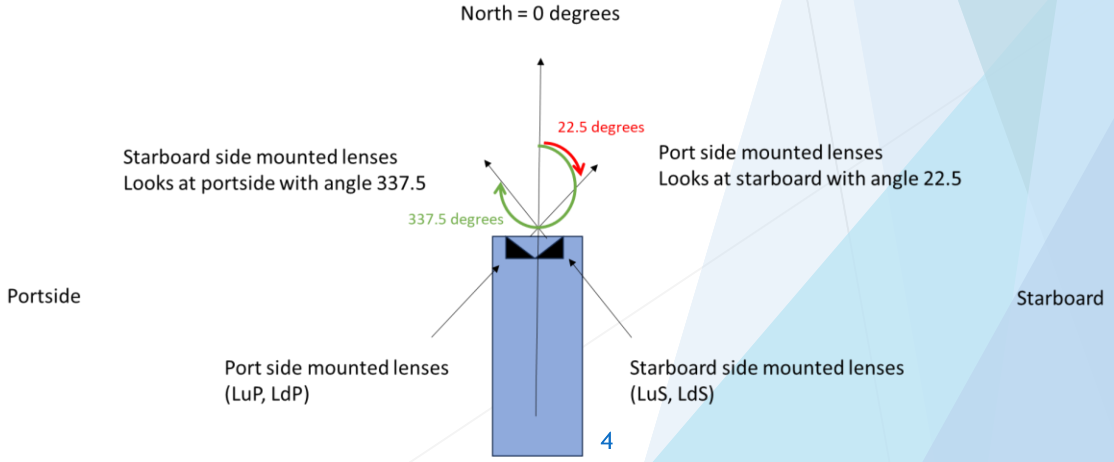
The handheld spectrometer system (WISP Orca)

The fixed position spectrometer system (WISPstation)

Main characteristics of the WISPstation

- 2 Ed sensors
- Lup and Ld at -22.5 degrees Azimuth
- Lup and Ld at + 22.5 degrees Azimuth
- All foreoptics connect to the same spectrometer
- Autonomous L0 collected and sent to backend
- Takes 10 measurements per channel
- The backend calibrates and processes the data
- An API to fetch results
- QC results at L1B, L2R and L2W





Azimuth angles of WISPstation lenses (Top view)

Main characteristics of the WISP ORCA

- Ed, Lup and Ld sensor
- Handheld so you control the azimuth
- Precision motion sensor to record roll, pitch and yaw
- Precision GPS to track location
- All foreoptics connect to the same spectrometer
- Autonomous L0 collected and sent to backend
- Takes 5 measurements per channel
- The backend calibrates and processes the data
- An API to fetch results
- QC results at L1B, L2R and L2W
- iPhone to control measurement angles, send data to backend and view results

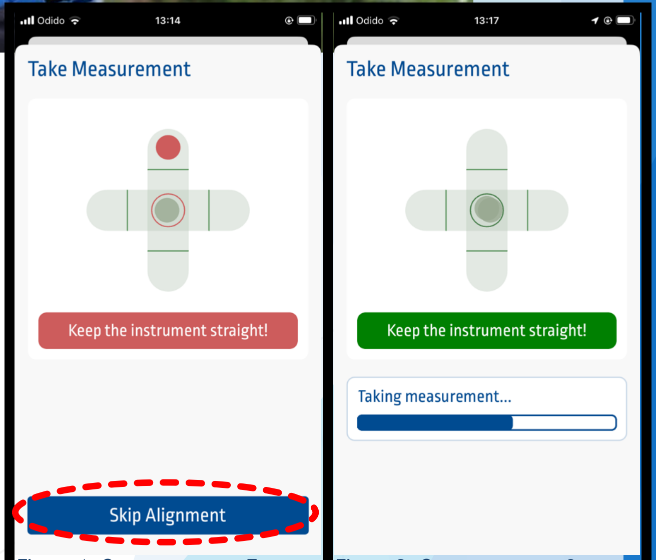


Figure 1: Orca app screen 7

Figure 2: Orca app screen 8

Internal spectrometer characteristics of WISPstation and ORCA

- The ORCA and WISPstation have an AVANTES AvaSpec-Mini2048CL inside which is a CMOS detector that is capable of measuring between 200 and 1100 nm.
- Every ORCA is vicariously calibrated against our own gold-standard system which is calibrated using a NIST traceable labsphere HELIOS system certified between 350 and 2400 nm.
- In the process of vicarious calibration, we use an Ocean Optics lamp providing light between 360 and 2400 nm. So, in principle the ORCA is calibrated between 360 and 1100 nm.
- Spectral sampling interval = 0.43nm / pixel, or 4.6 nm FWHM
- Stray light <0.2%; Temperature range 0-55C

Corrections / calibrations applied to all WISP instruments

- Dynamic dark current correction (corrects for temperature variations)
- Wavelength calibration (maps each pixel to a wavelength) (certified)
- Non-linearity correction (corrects for non-linear behaviour of pixels) (certified)
- Radiometric calibration (relative to commercially NIST traceable calibrated Gold standard instrument)
- Sky reflection correction: fixed $\rho = 0.028$ (Mobley, 1999)

$$Rrs = \frac{Lup - \rho . Ld}{Ed}$$

Integrating sphere calibration of our gold standards

Wavelength Calibration Certificate

AVANTES
MEMBER OF THE NYNOMIC GROUP

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Calibration Coefficients

Intercept	1,446645851E+2
First coefficient	6,133882608E-1
Second Coefficient	-1,062224676E-5
Third Coefficient	-2,205660036E-9
Standard Deviation	0,04615
Correlation Coefficient	0,99999998

Pixel #	**Present λ (nm)**	**Standard λ (nm)**	**|Δλ| (nm)**
113,10	213,90	213,86	0,04
137,60	228,86	228,80	0,06
178,20	253,62	253,65	-0,03
249,00	296,71	296,73	-0,02
266,90	307,58	307,59	-0,01
310,50	334,03	334,15	-0,12
532,30	467,83	467,81	0,02
552,60	480,01	479,99	0,02
554,40	481,09	481,05	0,04
600,30	508,58	508,58	0,00
663,10	546,09	546,08	0,01
907,30	690,80	690,75	0,05
917,10	696,57	696,54	0,03
934,40	706,74	706,72	0,02
948,00	714,73	714,70	0,03
969,30	727,23	727,29	-0,06
988,30	738,37	738,40	-0,03
1031,30	763,53	763,51	0,02
1046,50	772,41	772,42	-0,01

Avantes Nonlinearity Correction Report, page 1/2

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Model                : AvaSpec-Mini2048CL-WIS5
Description          : Compact Fiber Optic Spectrometer, 75mm AvaBench,
                       integrated electronics, 2048 pixel CMOS detector,
                       USB2 interface
Grating              : MN300-0.30 - 300 lines/mm from 200 nm to 1100 nm
Options Installed    : Slit-100, FCPC
Serial Number        : 7514320SP

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Scanning Parameters used:

Low Integration Time          :     0,04 msec
High Integration Time         :     4,00 msec
Integration Time Step         :    0,040 msec
Saturation Value              :   16000
Averaging #                   :   50
Pixel # Values                :    668   723   779   834   889
                                   944  1055  1110  1221  1276

Regression Results:

Points Used                   :   627
Lower Counts Limit            :   400
Upper Counts Limit            :   16000
Intercept                     :   1,00012220729043E+000
Coefficient #1                :  -4,72279121339436E-006
Coefficient #2                :   2,60516213740946E-009
Coefficient #3                :  -6,53514568088350E-013
Coefficient #4                :   8,37835053384273E-017
Coefficient #5                :  -6,07020640585199E-021
Coefficient #6                :   2,32896705975328E-025
Coefficient #7                :  -3,69439188843830E-030
Standard Deviation            :   0,0015
Regression Coefficient        :   0,85888640
Linearity BEFORE Correction   :   98,80 %
Linearity AFTER Correction    :   99,85 %
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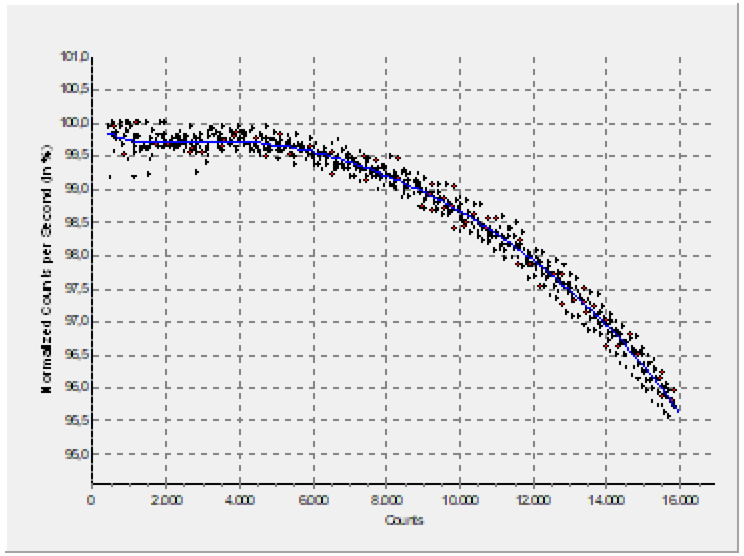
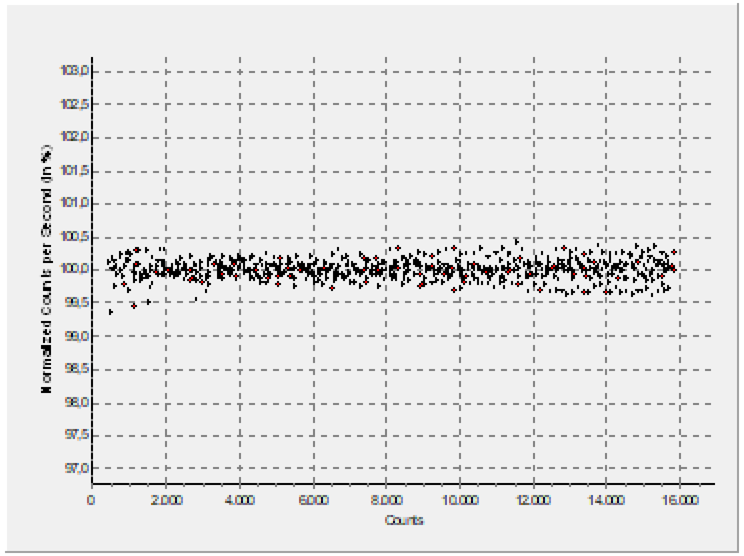
Avantes Nonlinearity Correction Report, page 2/2

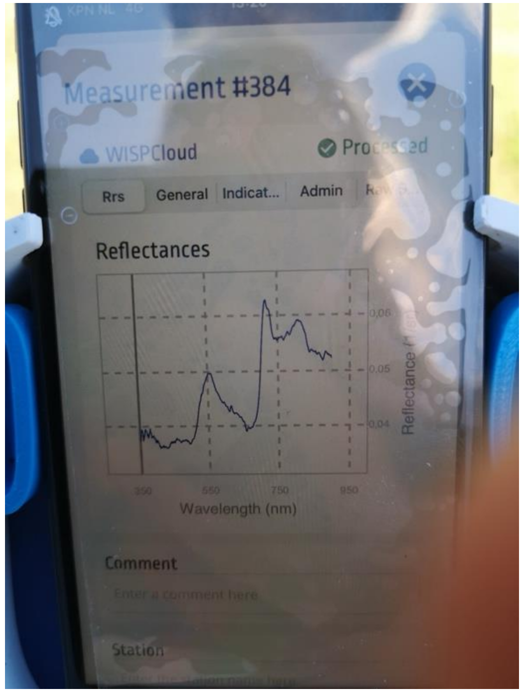
Normalized Counts per Second versus Counts, before linearization

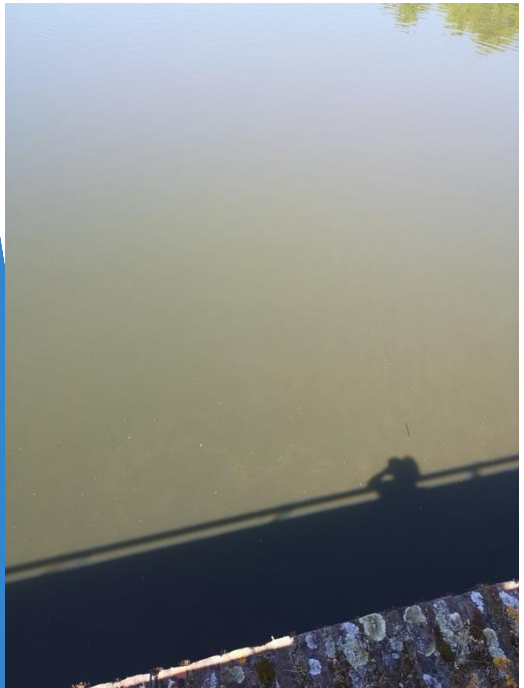


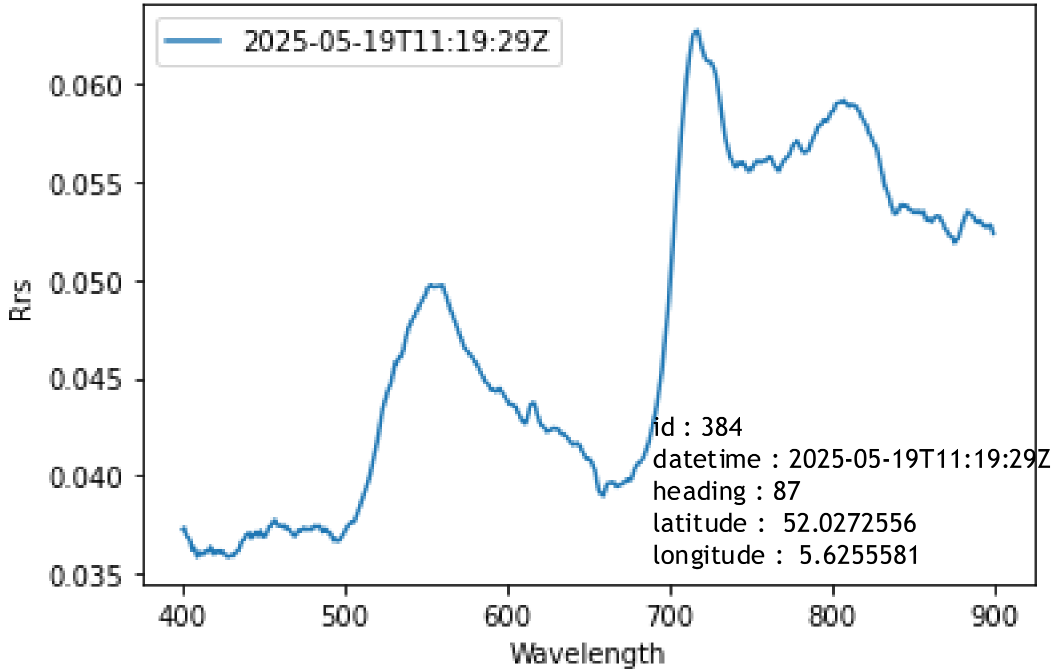
CPS versus Counts, after linearization

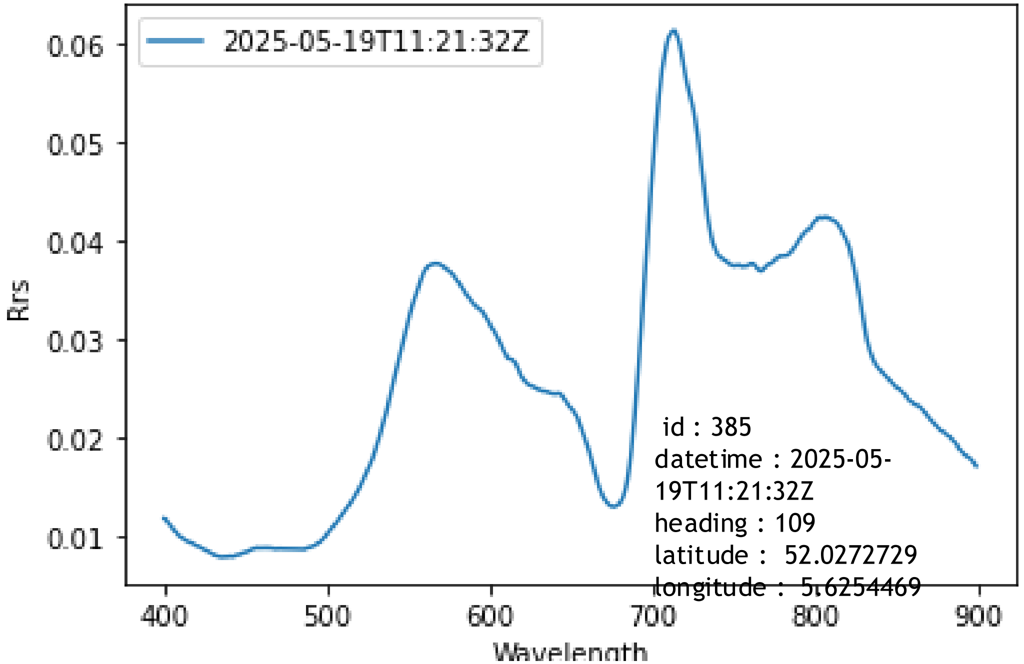


Some ORCA test results






2025-05-19T11:19:29Z
Rrs
Wavelength
id : 384
datetime : 2025-05-19T11:19:29Z
heading : 87
latitude : 52.0272556
longitude : 5.6255581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Rrs
Wavelength
id : 385
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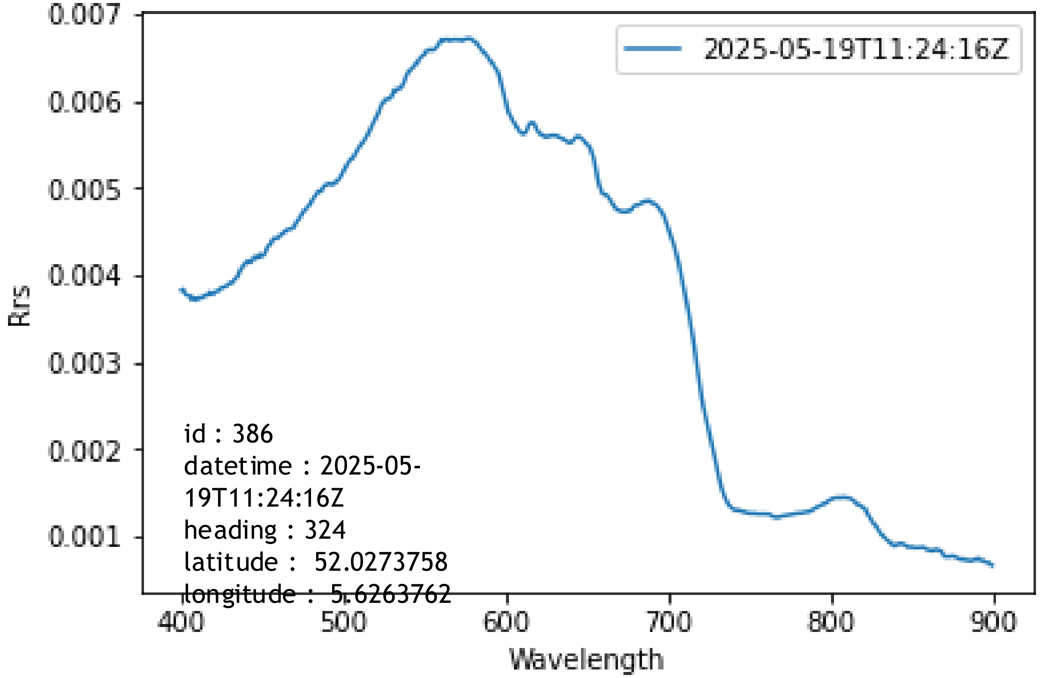
heading : 109
latitude : 52.0272729
longitude : 5.6254469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Rrs
Wavelength
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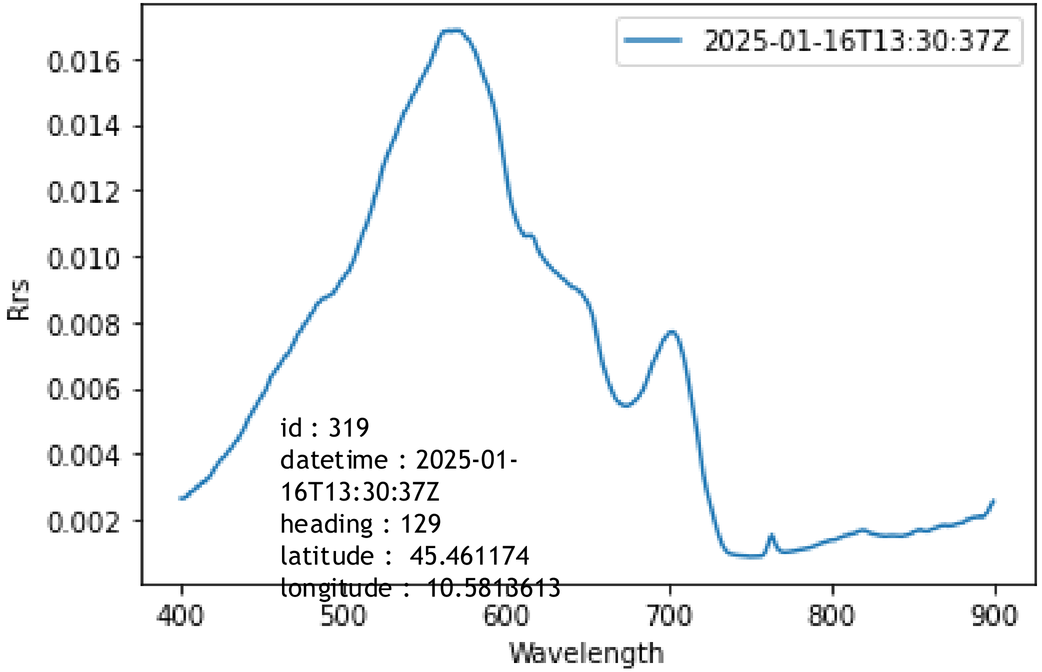
longitude : 5.6263762


2025-01-16T13:30:37Z
Rrs
Wavelength
id : 319
datetime : 2025-01-16T13:30:37Z
heading : 129
latitude : 45.461174
longitude : 10.5813613

Prior cal/val experience

- ASIX-II data collection and paper
- WI contributed to MERMAID and LIMNADES databases for cal/val
- WI data was in the GLORIA data collection
- WI collaborated in many H2020 projects with a focus on instrument developments together with the scientific community, Rrs comparisons and product validation (e.g. CHL-a): GLaSS, EOMORES, TAPAS, MONOCLE, etc.
- WISP-3 was analysed and published in several FRM4SOC publication
- We are open to participate in cal/val activities, specifically with the WISPstation and the WISP ORCA
- Some publications: for more see: https://www.waterinsight.nl/info/media-downloads

Annelies Hommersom, Susanne Kratzer, Marnix Laanen, Ilmar Ansko, Martin Ligi, Mariano Bresciani, Claudia Giardino, Jose M. Beltran-Abaunza, Gerald Moore, Marcel R. Wernand, Steef W. Peters, "Intercomparison in the field between the new WISP-3 and other radiometers (TriOS Ramses, ASD FieldSpec, and TACCS)," J. Appl. Rem. Sens. 6(1) 063615 (12 December 2012) https://doi.org/10.1117/1.JRS.6.063615

Warren, M. A., Simis, S. G., Martinez-Vicente, V., Poser, K., Bresciani, M., Alikas, K., ... & Ansper, A. (2019). Assessment of atmospheric correction algorithms for the Sentinel-2A MultiSpectral Imager over coastal and inland waters. *Remote sensing of environment*, *225*, 267-289.

FRM4SOC-2 considerations

- Our radiometric scale is NIST traceable
- Use of a gold standard instrument for vicarious calibration is beneficial because:
  - We believe that a well kept and protected instrument remains stable for a long term
  - It allows us to calibrate the whole optical pathway
- Stability could possibly be verified using FRM4SOC-2 activities
- Interesting to know: angular variations of lenses and cosine correctors
- **Support from communities:**
  - intercomparison of Rrs
  - Protocols for data and meta-data formats for FRM requirements

FRM4SOC-2 considerations

- **IOCCG's addendum to Protocol no 3:**
  - Our instruments do and provide multiple takes per channel: how to come to uncertainties?
  - Uncertainties associated to absolute calibration coefficients: we could do multiple calibrations and provide an uncertainty based on that: not sure if that is useful. It would add to the costs for the instrument
- **Let's not forget**
  - Angular variability during a measurement is a big source of uncertainty (The ORCA records and provides that data)
  - Time differences between Ld, Lu and Ed measurements is also a big source of uncertainty (our instruments are fast and record starting and ending times of scans)
- With the ORCA:
  - you are always on time
  - the boat does not need to be turned in the right direction
  - You see directly if the measurement is ok