Validation of ocean colour satellite products
in coastal lagoons and estuaries
using autonomous hyperspectral sensors
(the HYPERNETS network)

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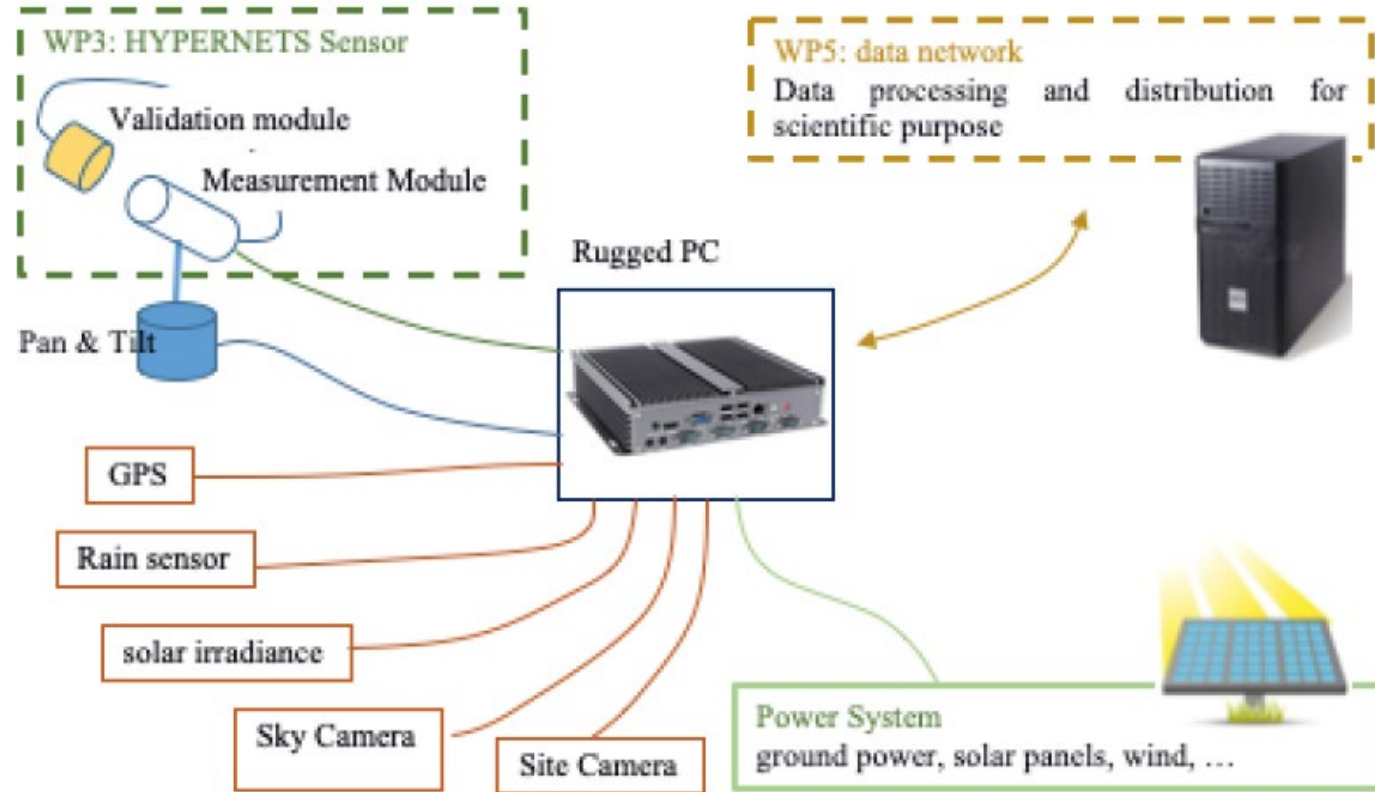*Laboratoire Océanographie Villefranche, CNRS/SU*
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Outline

1. The HYPERNETS sensors / system

2. French sites in operation

3. Matchups with satellite data / Protocols

4. Matchups with satellite data / Results

5. Conclusions / Next steps

1. The HYPERNETS sensors / system

New hyperspectral radiometers:
VIS-NIR (water) and
VIS-NIR-SWIR (land)
Radiance (L_u, L_s),
irradiance (E_d), images
(320-1100 nm, 0.5 nm)

WP3: HYPERNETS Sensor
Validation module
Measurement Module
Pan & Tilt
GPS
Rain sensor
solar irradiance
Sky Camera
Site Camera
Rugged PC
WP5: data network
Data processing and distribution for scientific purpose
Power System
ground power, solar panels, wind, ...

New system for autonomous field operation: power, point, execute measurement sequences, record and transfer data to servers for quality control and processing, remote control depending on conditions

2. French sites in operation

- **Berre coastal lagoon:** since <u>24th February 2021</u>, every 30 mn (v1), to help monitoring impacts of turbid freshwaterd ischarge and (harmful) algal blooms on water quality

- **Gironde estuary:** since <u>8th November 2021</u>, every 15 mn (v2), to help monitoring the dynamics of the maximum turbidity zone and its discharge to the coastal ocean
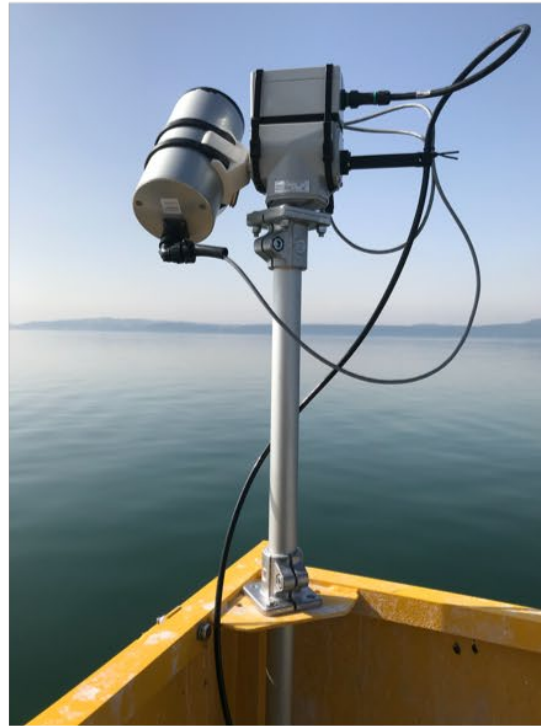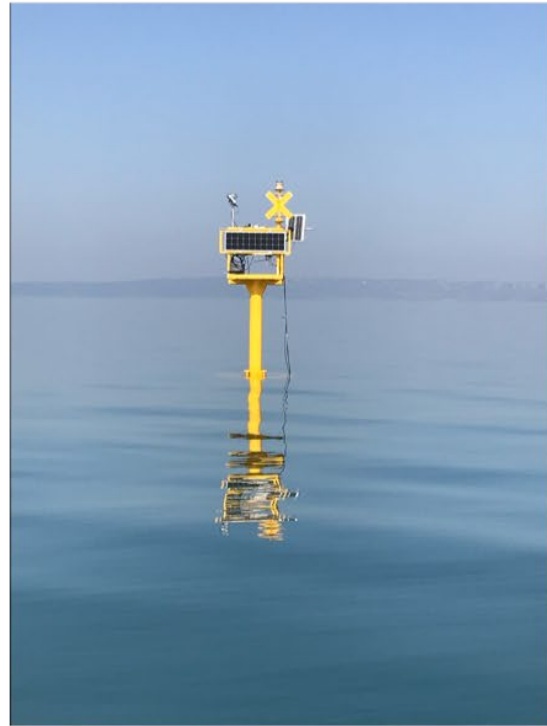

S2A/MSI 2022-05-03 11:08:37
ρ_s RGB
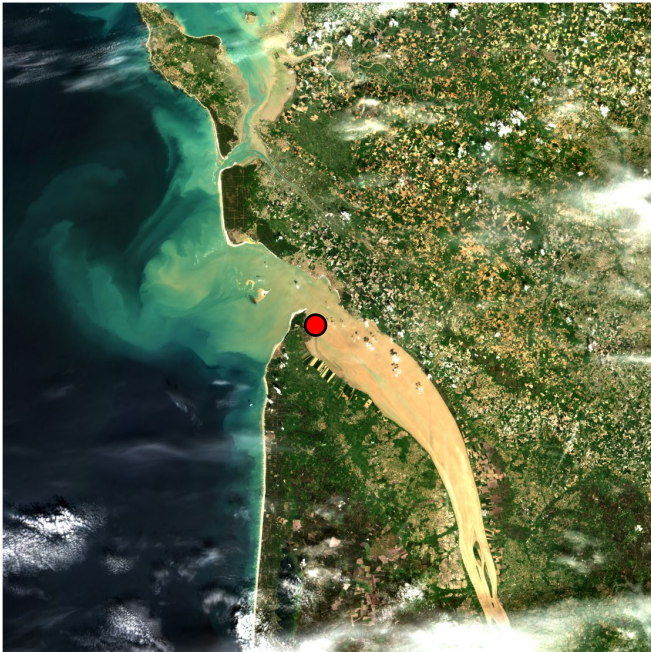
S2A/MSI 2018-10-25 10:41:15
ρ_s RGB
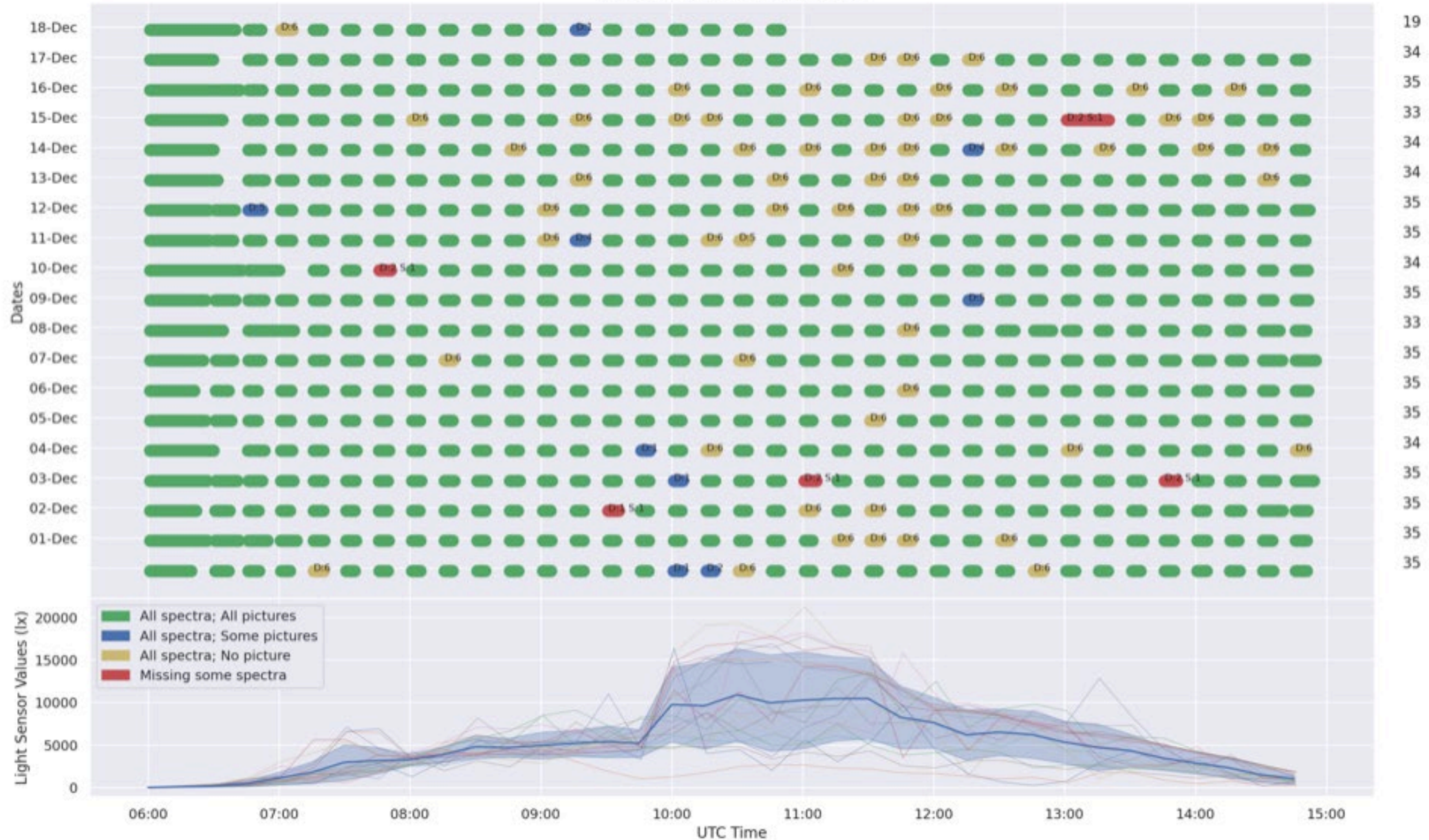
2. French sites in operation

New platform:

- <u>Above-water</u>: meteo station, HYPSTAR-VIS, rain and light sensors, 2 webcams (N & S), solar panels
- <u>In-water</u>: b_b, fluo_chla, T, S, O_2 ,
- Monthly maintenance and water sampling

2. French sites in operation

MAFR: Duration of sequences over the last month
(Update: Fri Dec 31 12:01:52 2021)

3. Matchups with satellite data / Protocols

Satellite data	L8/9-OLI	S2-MSI	S3-OLCI	MODIS
AC algorithms	C2RCC C2X Acolite iCOR	Sen2Cor C2RCC GRS Polymer Acolite, CMEMS-HR iCOR	BAC C2RCC Polymer Acolite CMEMS	MUMM NIR-SWIR

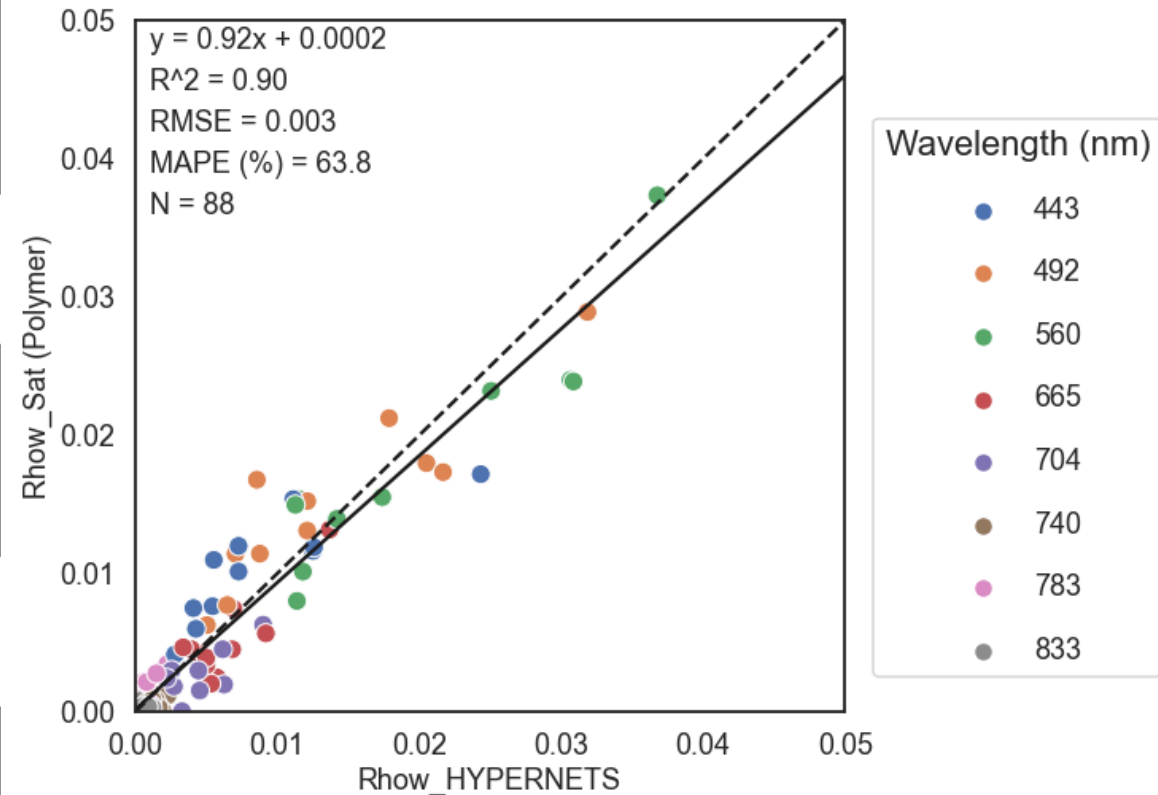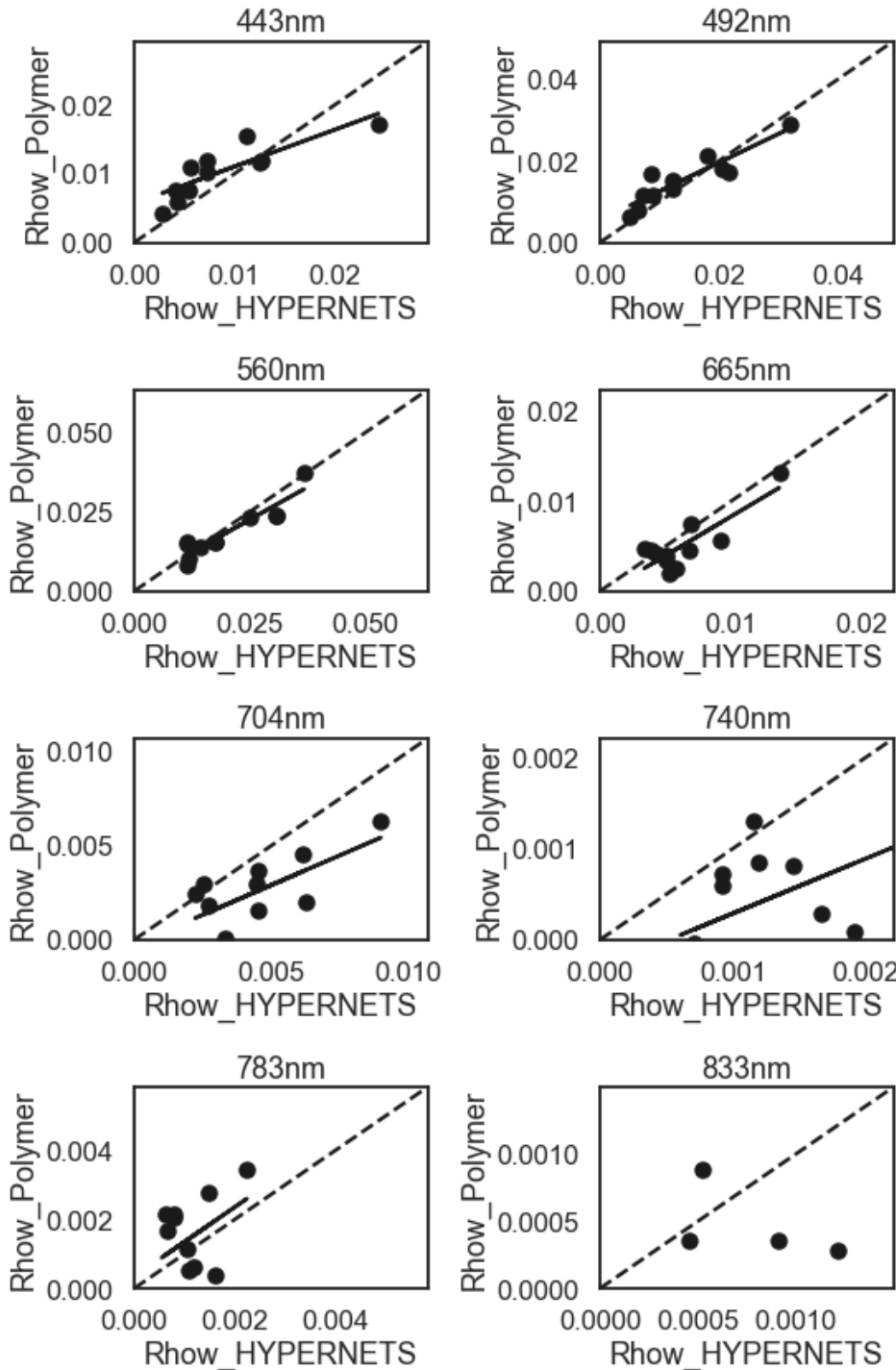# Quality controls on field and satellite data

HYPERNETS data
- Data availability
- Rhow > 0
- Glint effects
- Light conditions
- Temporal variations of Rhow_555 (<20%)

Satellite data
- 1*1, 3**, 5*5 pixels
- Cloud cover
- Spatial heterogeneity <20%
- Rhow sat > 0
- Flags (glint, dupl. pixels)
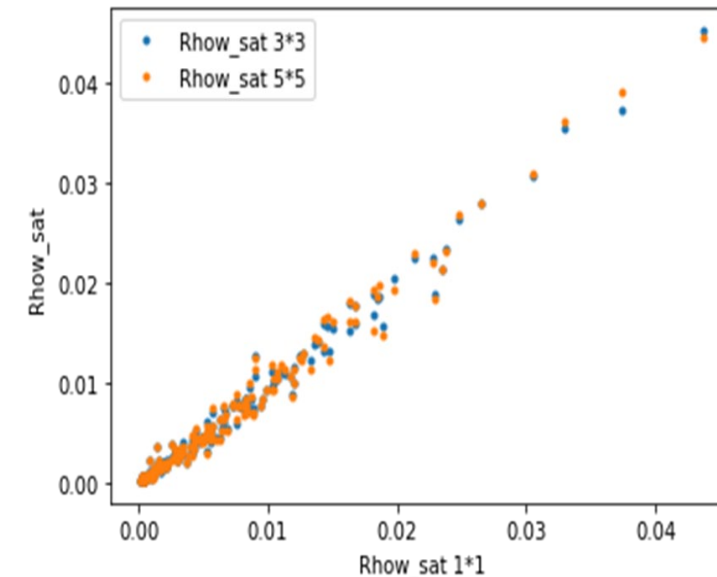
4. Matchups with satellite data / Results

Berre S2-MSI POLYMER

Glint!!

y = 0.92x + 0.0002
R^2 = 0.90
RMSE = 0.003
MAPE (%) = 63.8
N = 88

W (nm)	N	slope	intercept	R2	MAPE (%)	RMSE
443	11	0.54	0.006	0.72	45.2	0.0037
492	11	0.70	0.006	0.83	29.6	0.0037
560	11	0.82	0.002	0.86	16.9	0.0036
665	11	0.87	-0.000	0.70	28.3	0.0020
704	11	0.63	-0.000	0.47	45.7	0.0023
740	11	0.60	-0.000	0.25	77.4	0.0009
783	11	1.01	0.000	0.17	>100	0.0011
833	11	-0.09	-0.000	0.00	>100	0.0014

4. Matchups with satellite data / Results

Berre S2-MSI GRS

Glint!!

y = 0.93x + 0.0012
R^2 = 0.87
RMSE = 0.003
MAPE (%) = 107.9
N = 128
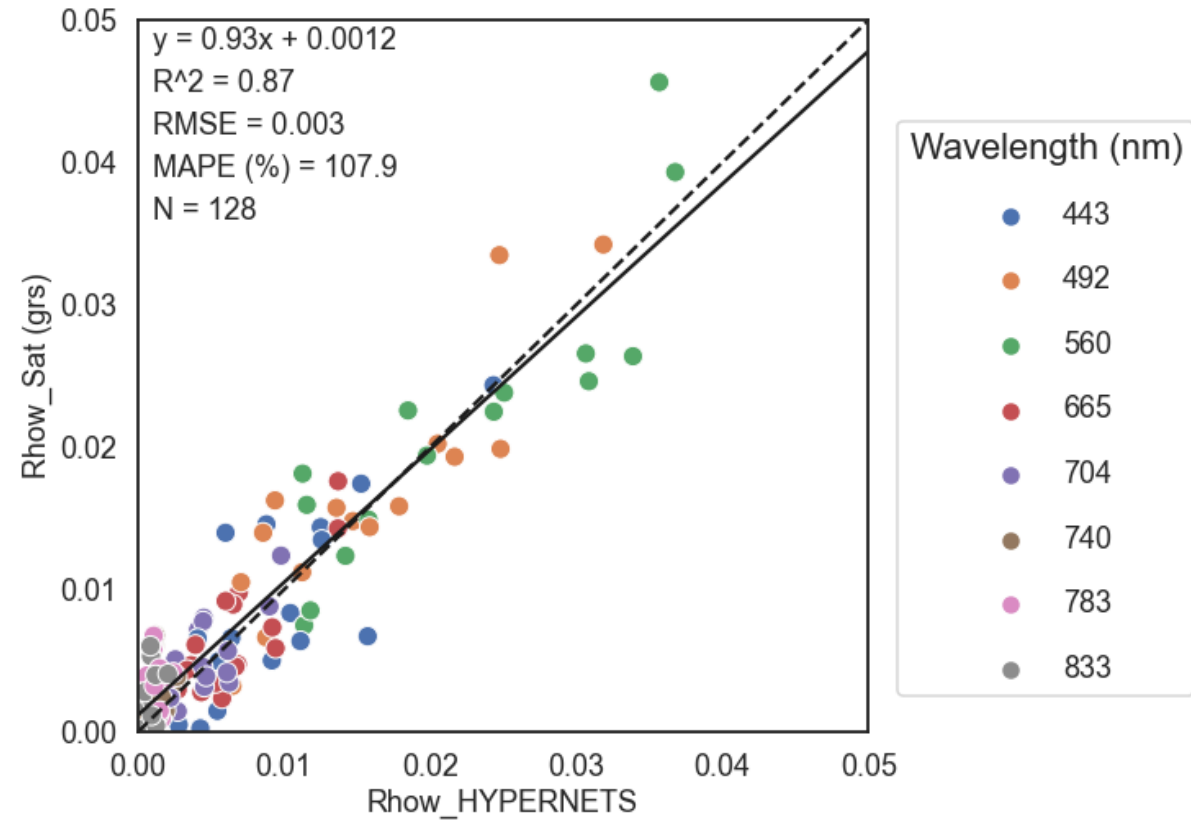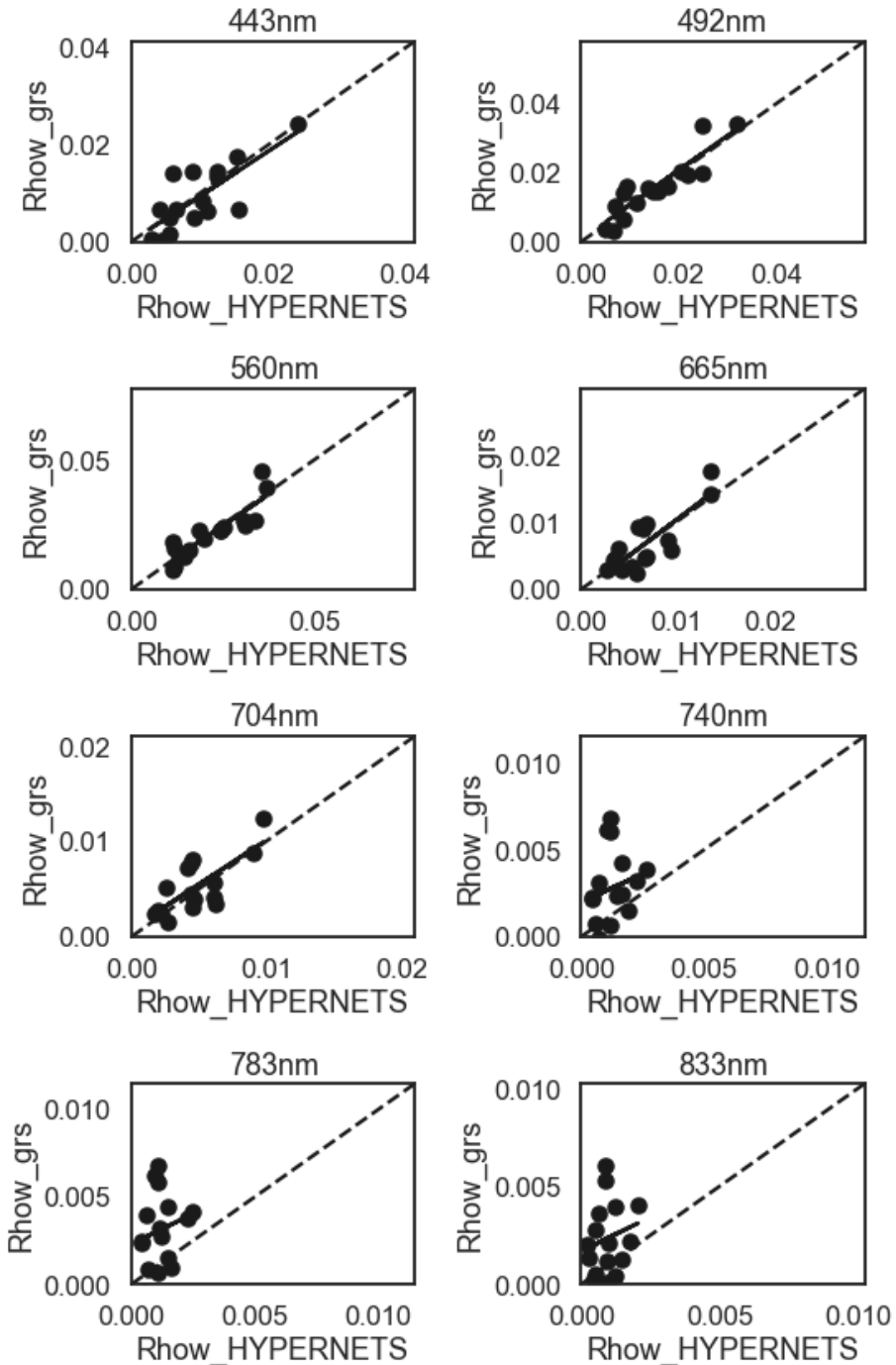
| W (nm)	N	slope	intercept	R2	MAPE (%)	RMSE
443	16	0.93	0.000	0.60	45	0.0041
492	16	1.00	0.001	0.81	24	0.0037
560	16	0.96	0.001	0.78	19	0.0046
665	16	1.07	-0.0001	0.68	33	0.0023
704	16	0.93	0.001	0.55	38	0.0019
740	16	0.65	0.002	0.04	>100	0.0025
783	16	0.69	0.002	0.04	>100	0.0027
833	16	0.70	0.002	0.04	>100	0.0022

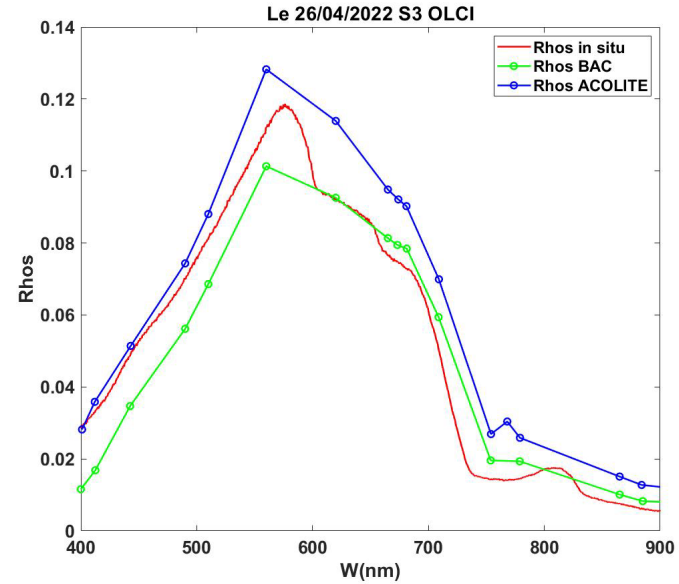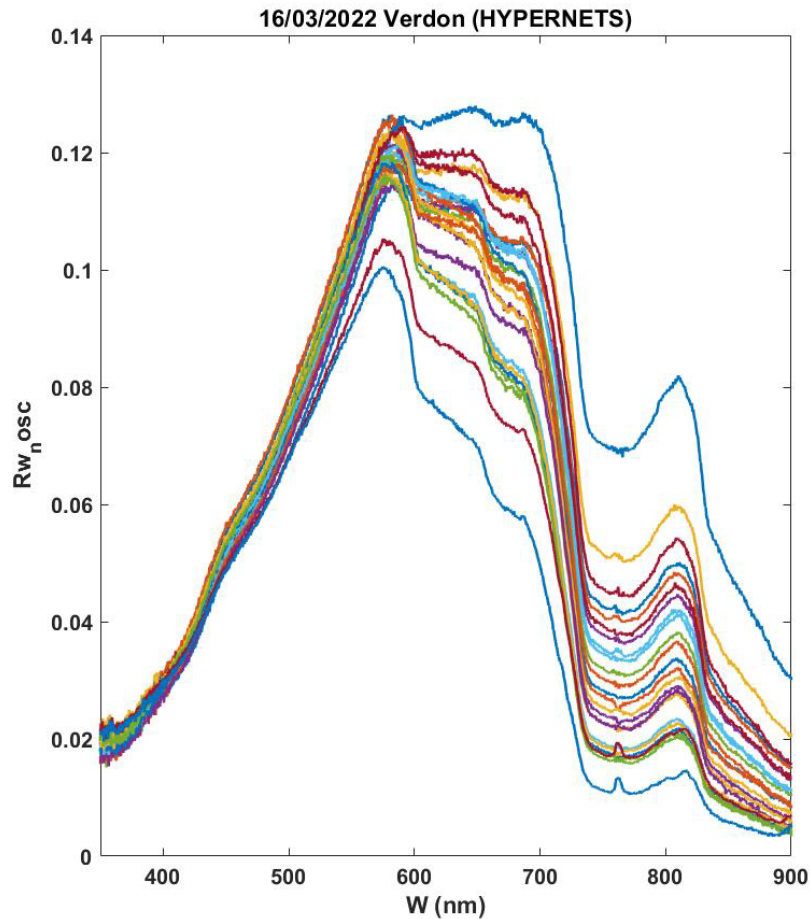# 4. Matchups with satellite data / Results

Berre S3-OLCI POLYMER

Glint!!
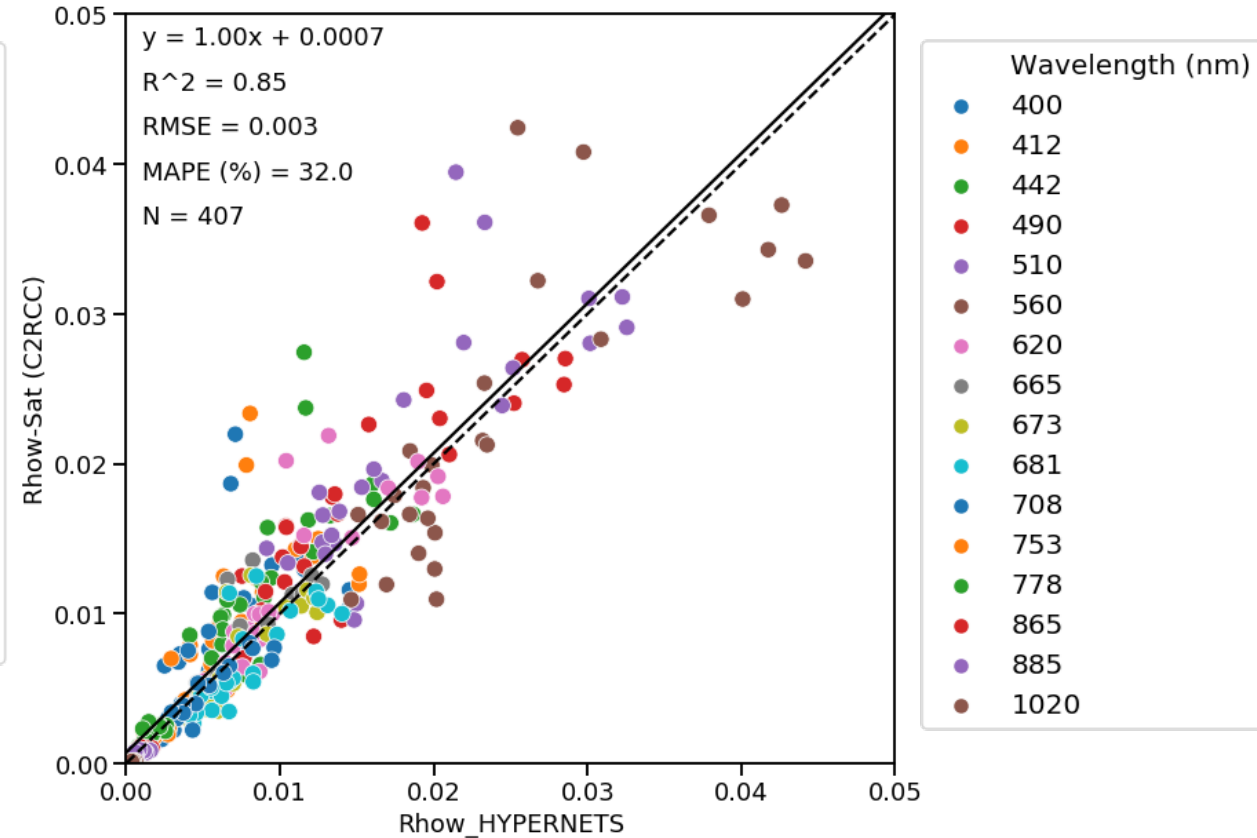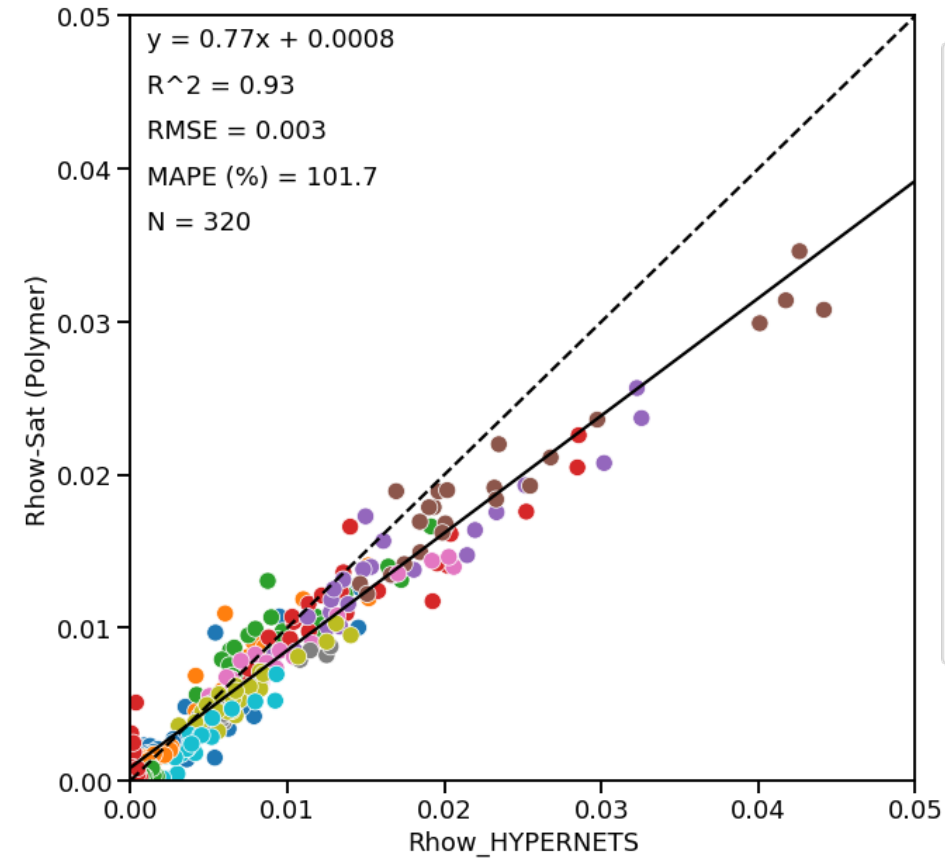
➔ Less scatter but underestimation for POLYMER compared to C2RCC (slope of 1)

Data recorded at the mouth of a macrotidal estuary: the Gironde

16/03/2022 Verdon (HYPERNETS)
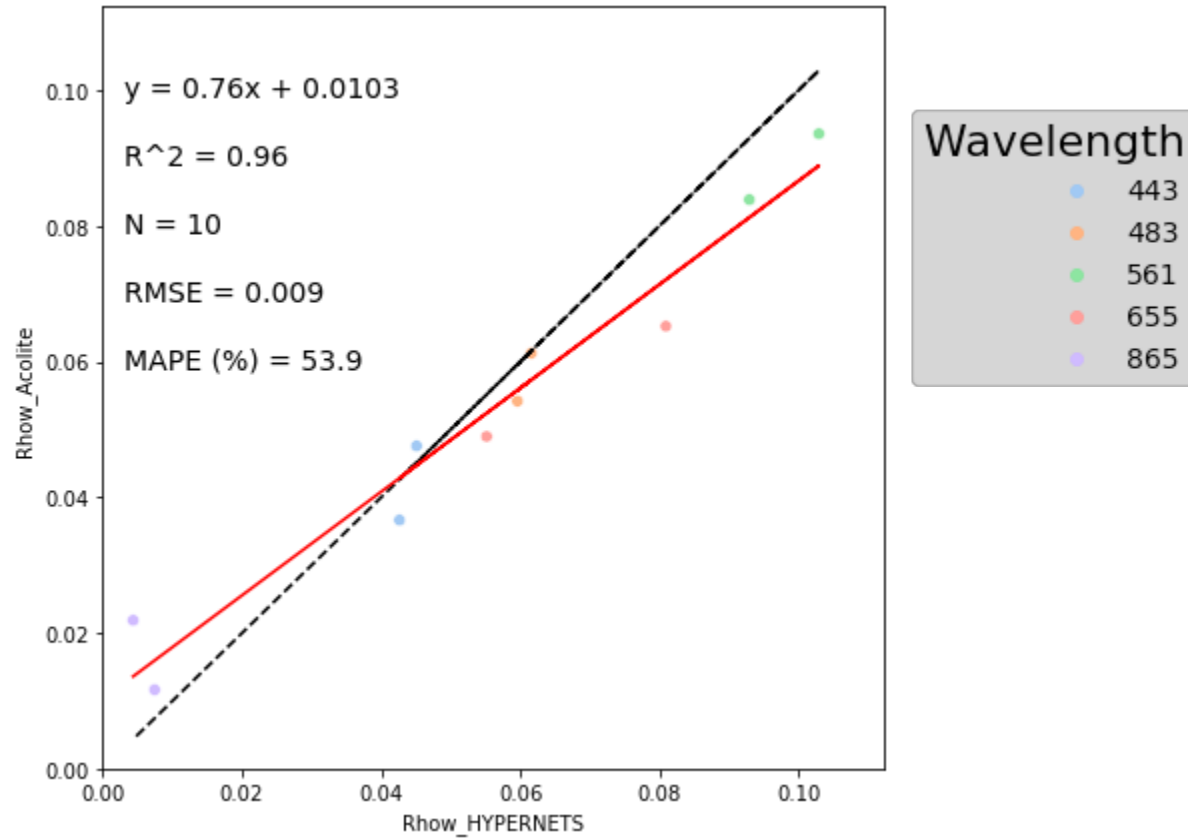

Le 26/04/2022 S3 OLCI

Le 08/05/2022 s3 OLCI
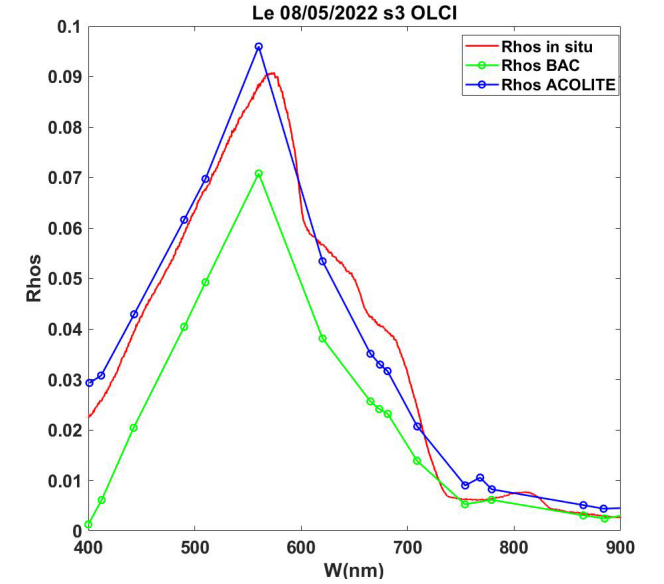
Up to 35 water reflectance spectra a day, varying along the daily tidal cycle with turbidity and providing matchups to test the validity of AC corrections applied to any satellite data
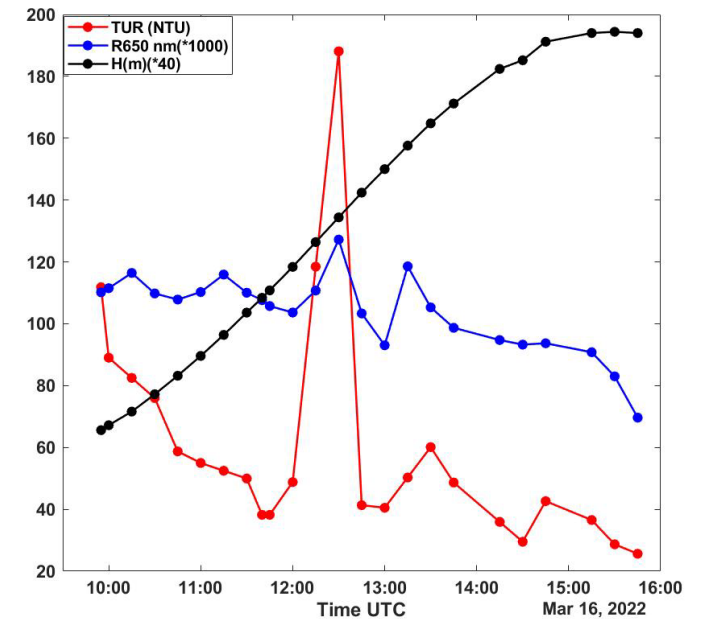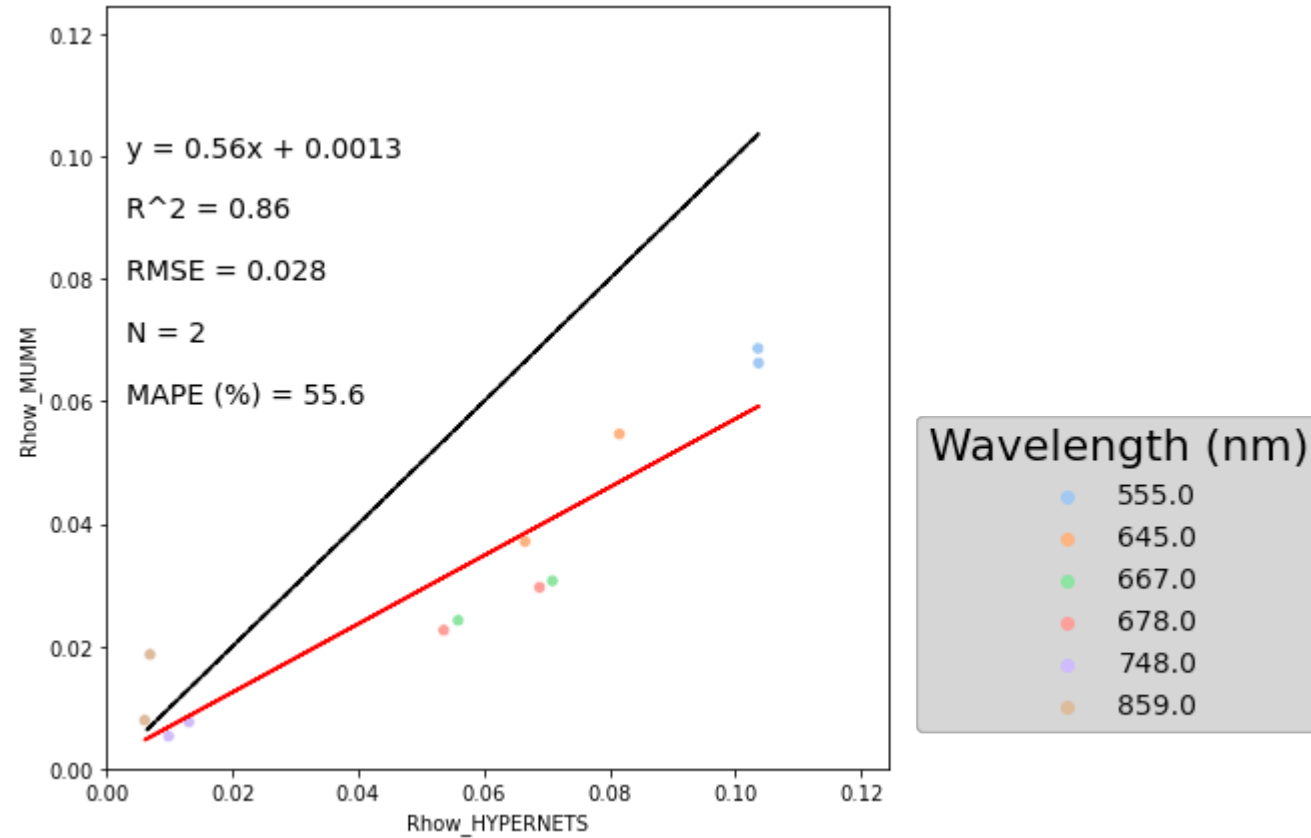
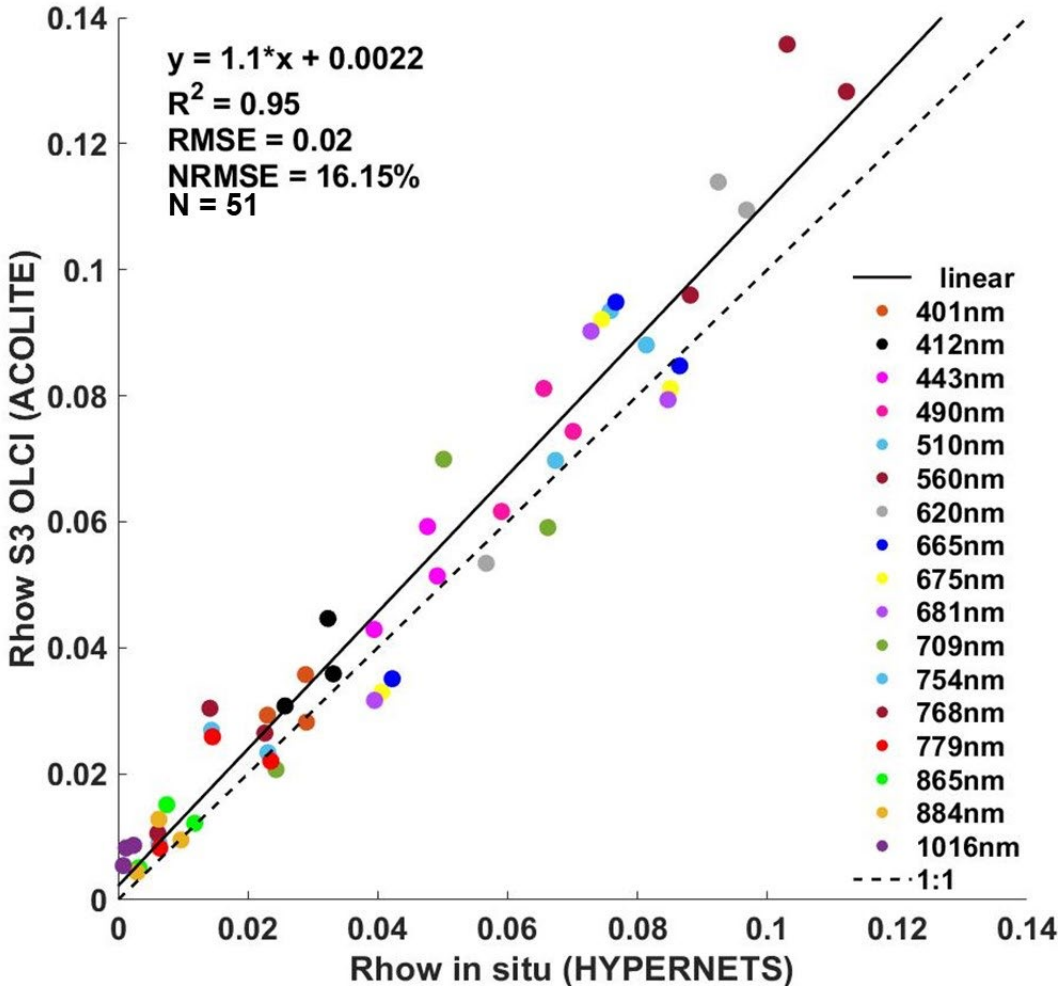## Gironde Estuary

L8/9-OLI ACOLITE

AQUA-MODIS MUMM

➔ ACOLITE provides satisfactory results for OLI and MSI (TBC) while MUMM and NIR-SWIR AC respectively understimates/masks the turbid estuarine waters
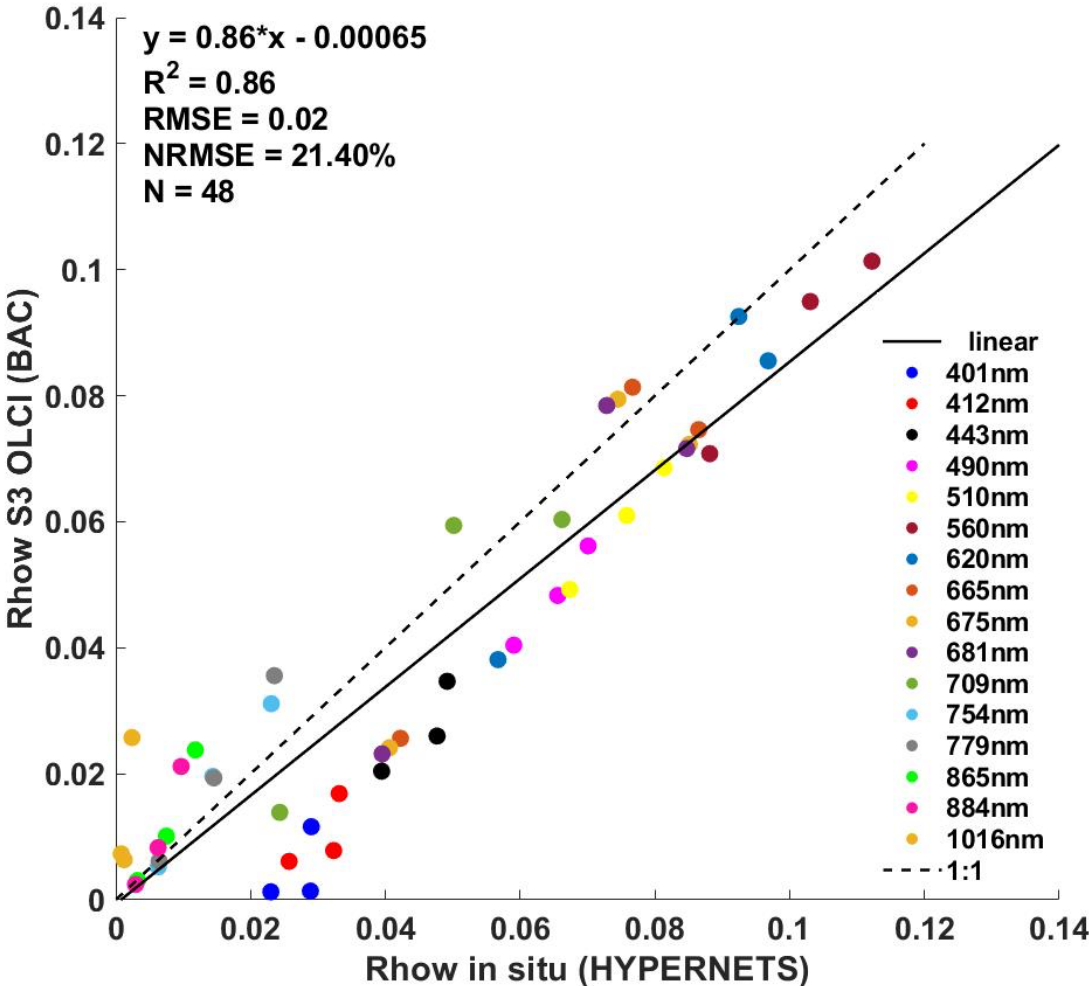
Gironde Estuary S3-OLCI

ACOLITE

$y = 1.1*x + 0.0022$
$R^2 = 0.95$
RMSE = 0.02
NRMSE = 16.15%
N = 51

BAC

$y = 0.86*x - 0.00065$
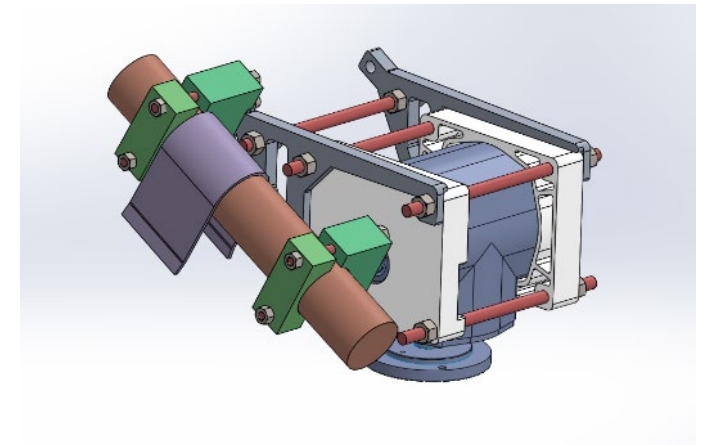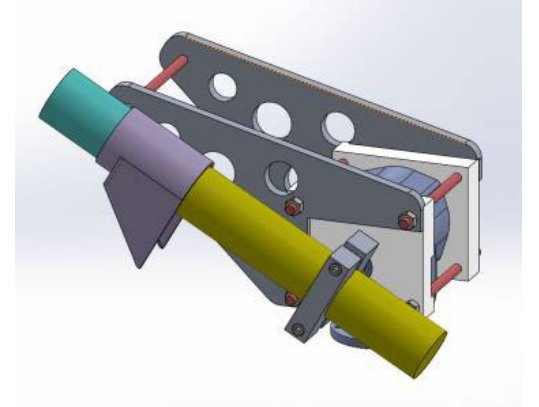$R^2 = 0.86$
RMSE = 0.02
NRMSE = 21.40%
N = 48

Conclusions / Next steps

➢ From prototype to v1 then v2, the HYPERNETS system becomes operationnal for autonomous hyperspectral radiometric measurements on field water/land sites

➢ Need automatic quality control and new matchup protocols adapted to each site

➢ A lot of data and matchups with satellite data

➢ Next version will include an on-site calibration module

Thank you!