

# Copernicus FICE 2025

## Training on In situ Ocean Colour Above-Water Radiometry towards Satellite Validation

### Reading the Water's colors

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UNIVERSITY OF TARTU



PROGRAMME OF  
THE EUROPEAN UNION



6-20 July 2025  
Venice, Italy



# PART I

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B R A Z I L

Rio  
Grande

Atlantic  
Ocean

Sediment

Ships

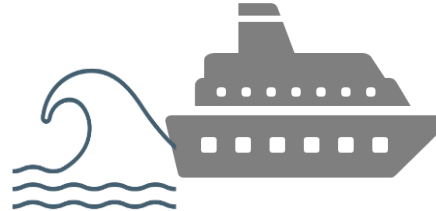


# Field measurements in San Servolo and AAOT

[copernicus.eumetsat.int](https://copernicus.eumetsat.int)



Weather conditions



Boat passage



Changing water  
Surface conditions.

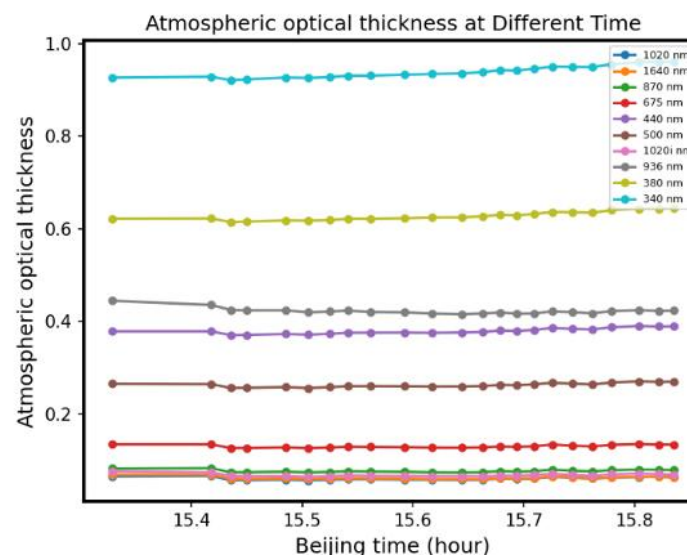
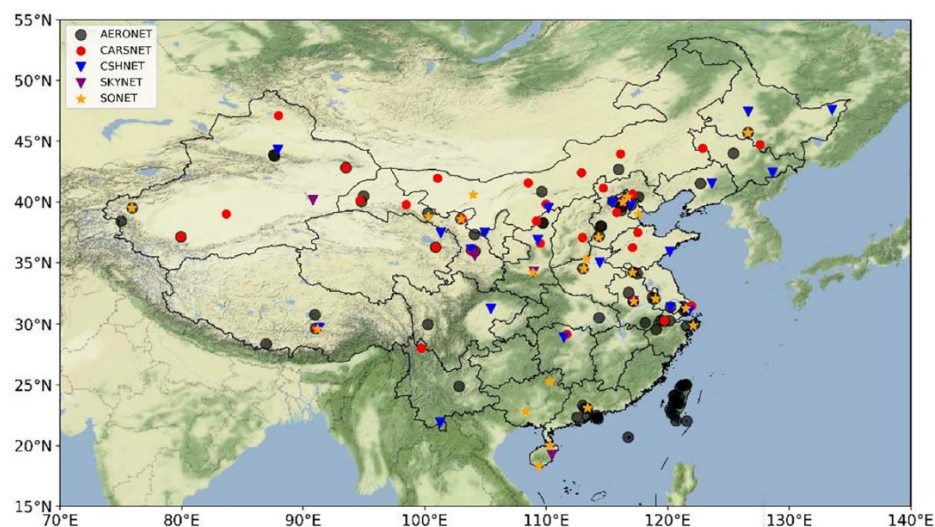






## CE318-SONET SUN PHOTOMETER INTERNSHIP

measure aerosols, looking up at the sky from the land, and it does not involve reflections from the ocean.



In this internship, a CE318 solar photometer was used to manually observe solar radiation, obtain the changes in solar radiation during the period of 15:19:42-15:50:08, and calculate the aerosol optical depth based on the given temporal and spatial conditions and calibration coefficients.



# Local field measurements

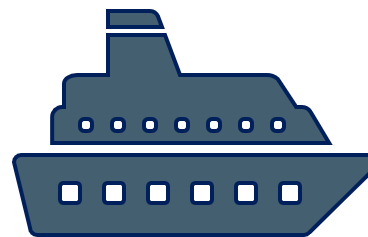
copernicus.eumetsat.int



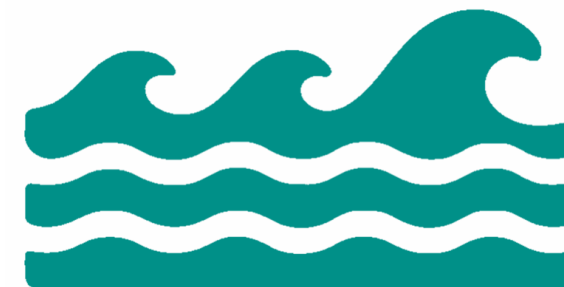
Lack IOCCG protocol application.



Adjacency and bottom effects.



Platform-induced perturbations.



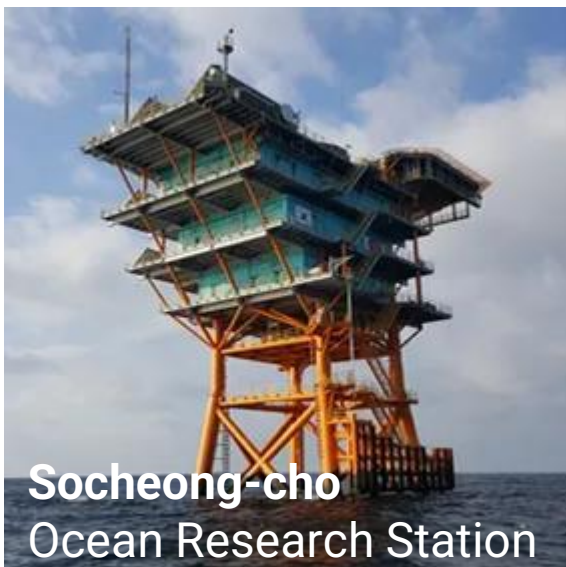
Currents, wave-dominated, complex waters.



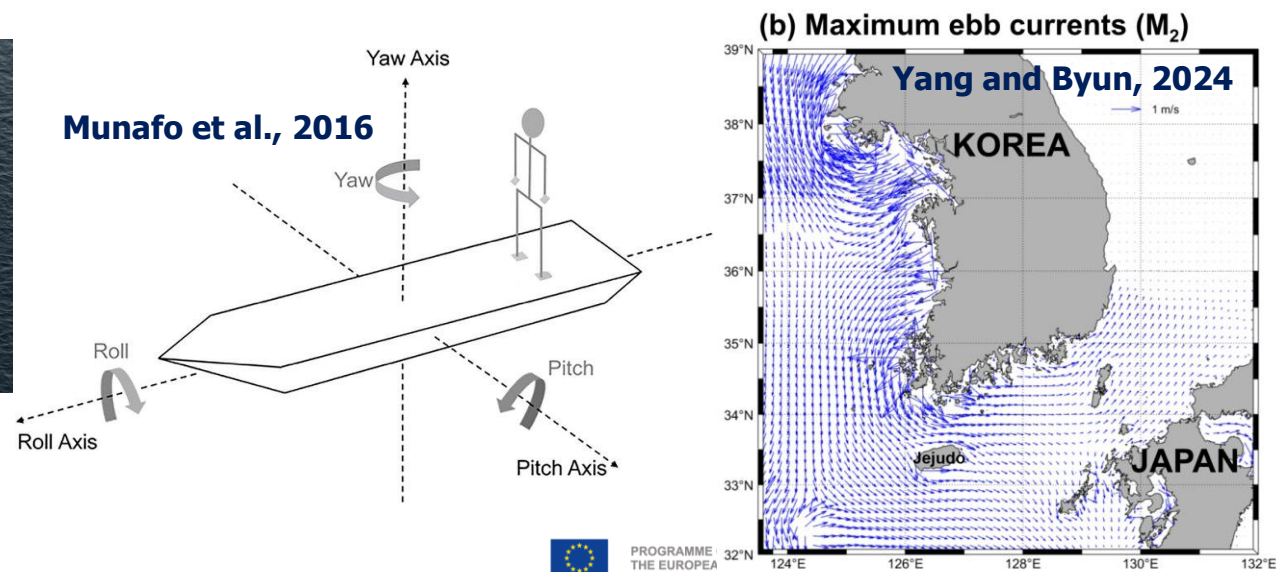


# Own experience 1

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- Ocean Research Station-Socheong-cho and Ieodo
  - ✓ Fixed platform
  - ✓ Location of instrument was fixed and **cannot change the observation angle**
  - ✓ It can make some errors due to a relative azimuth angle
- Research Vessle-Onnuri and Ieodo
  - ✓ Onnuri: 1422 ton, Ieodo: 357 ton
  - ✓ Can move heading of the vehicle
  - ✓ By the movement of ocean, such as **wave, tidal current or swell**, the observation was inhibited



# Own experience 2 and Suggestions

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ASD Fieldspec4

- TriOS and ASD Fieldspec – for hyperspectral (VIS, NIR)
- Fieldspec
  - ✓ Change viewing angle manually
  - ✓ Can use tripod for Es observation
  - ✓ **Human error** (main reason for error and uncertainty)

## • Suggestions

- ✓ The drawing for the TriOS mounting frame (like a 3D architecture)
- ✓ FRM protocols for geostationary will be needed
- ✓ Geostationary sensors have higher temporal  
re **Local Area Coverage**



GEO-KOMPSAT-2B (GK-2B) is a geostationary satellite mounted with the Geostationary Ocean Color Imager II (GOCI-II) for marine and environmental observation which always monitors the Korean Peninsula at the altitude of 36,000 km above the equator.



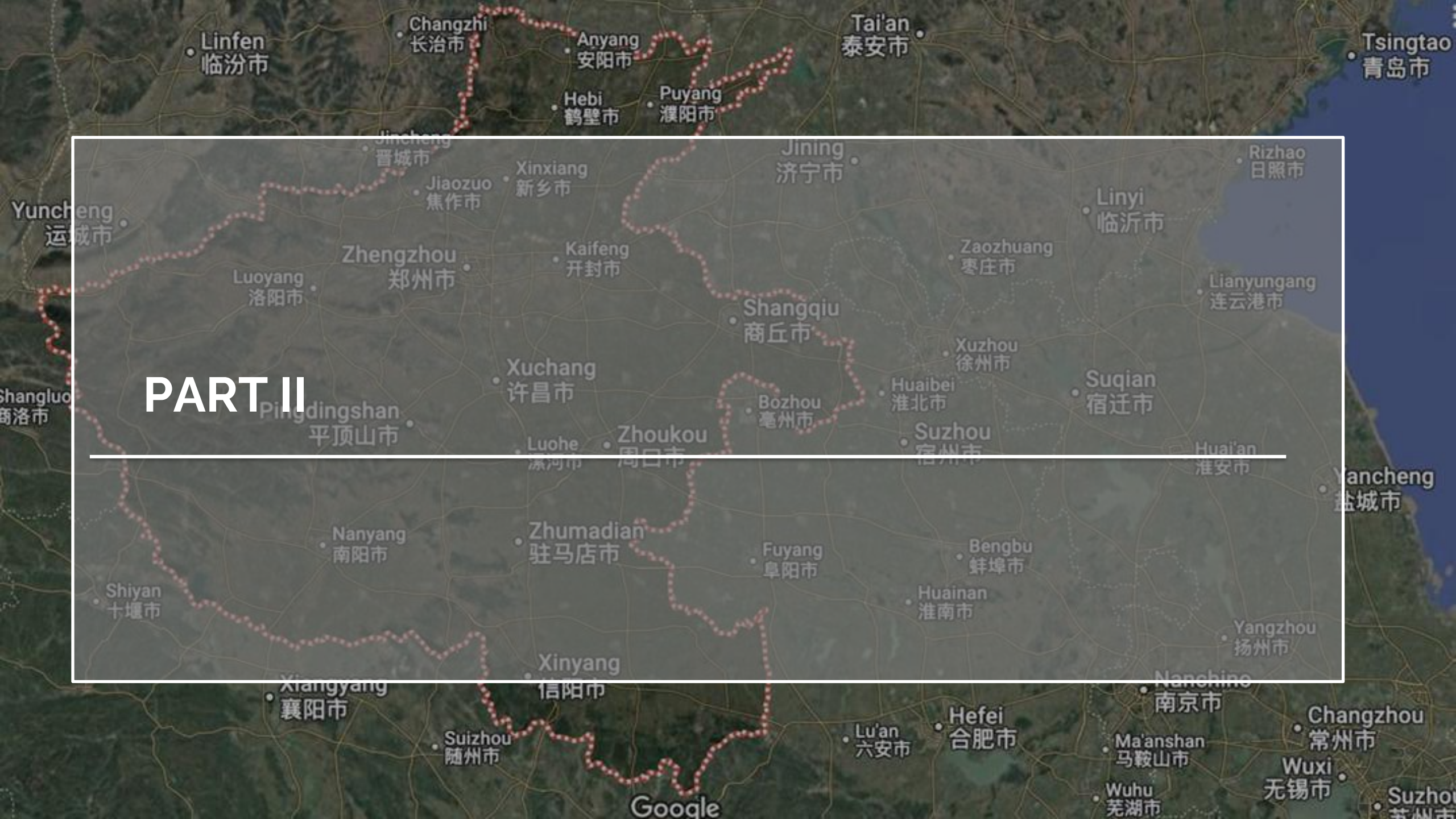
+ Temporal Resolution  
1 hour (UTC: 23:15 - 08:15)

+ Spatial Resolution  
250 m x 250 m

+ Swath  
2,500 km x 2,500 km



## PART II

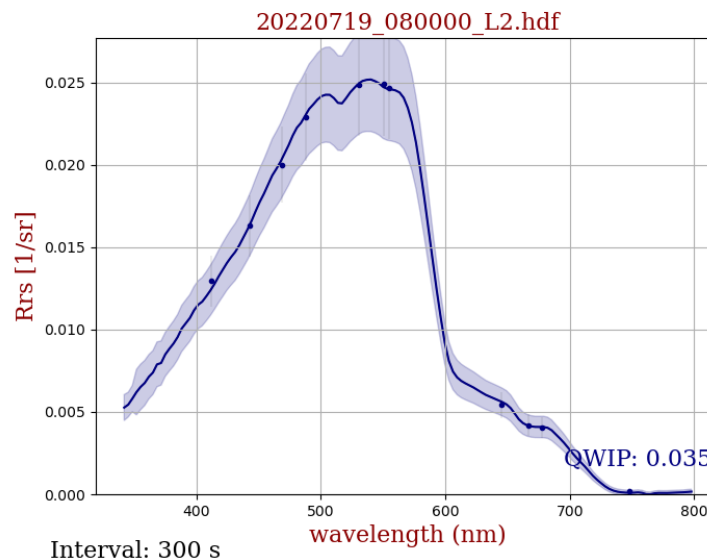
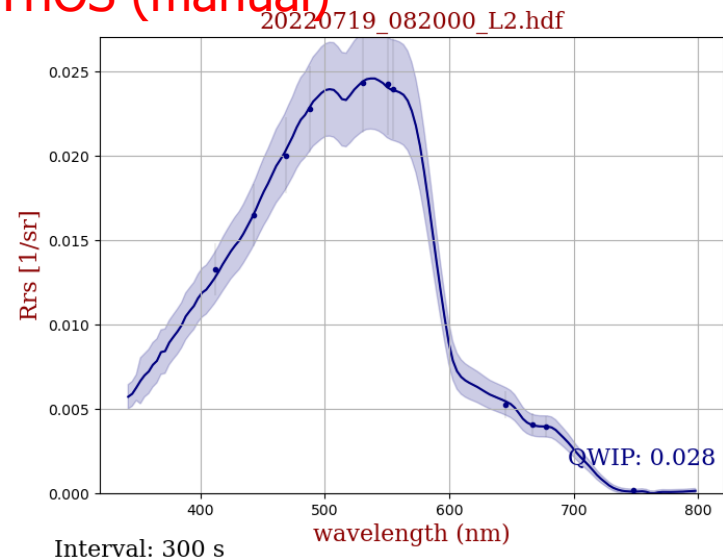




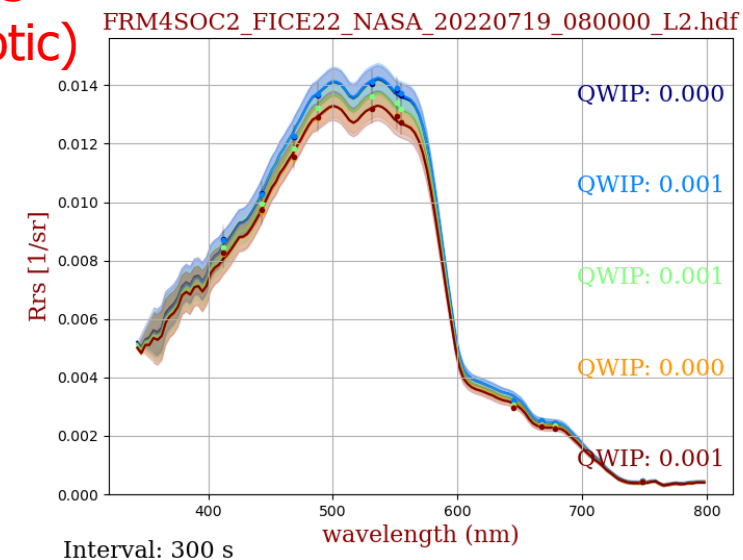


# HyperCP-First Wicket

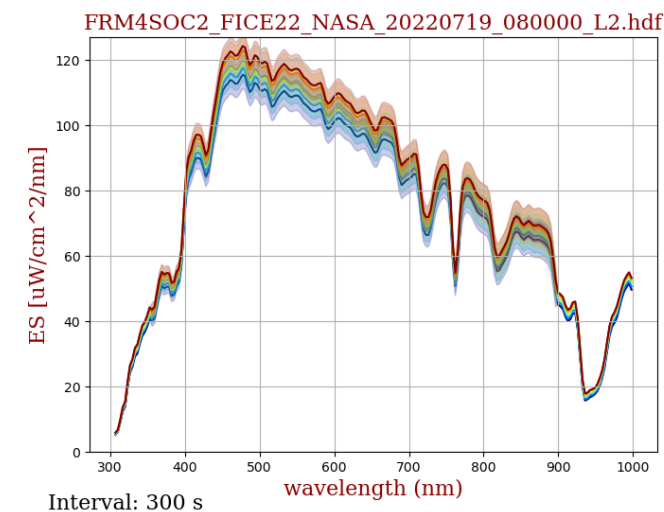
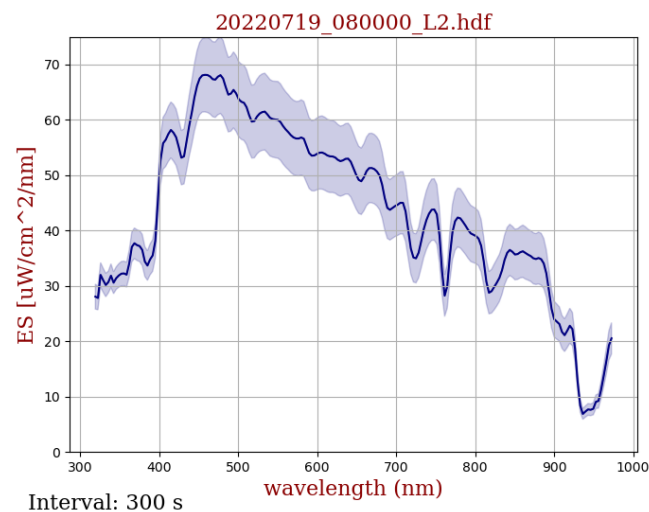
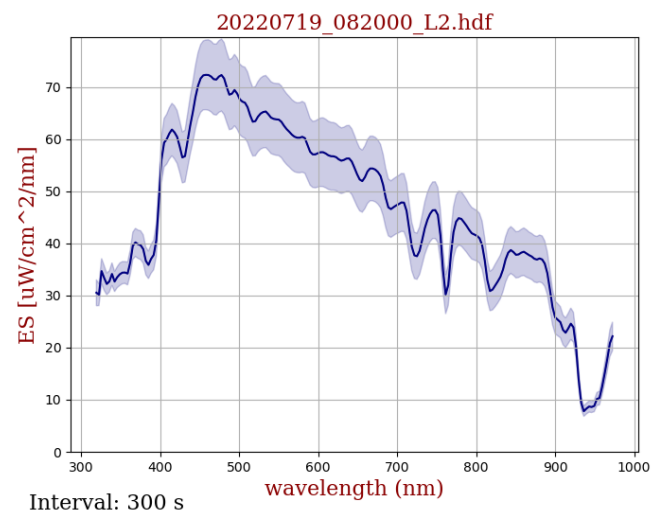
TriOS (manual)

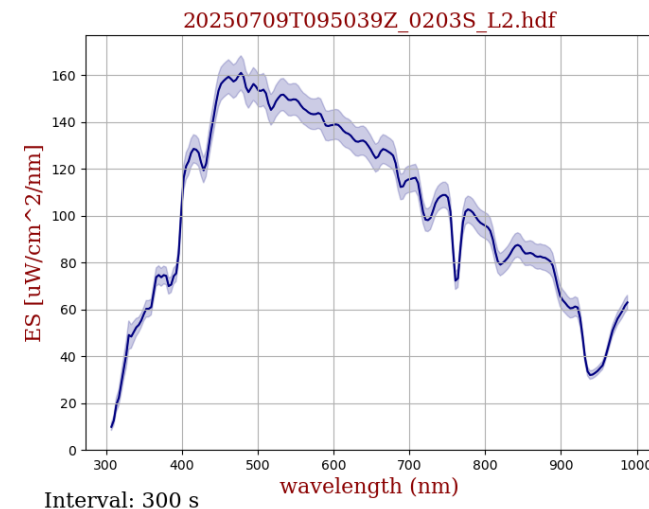
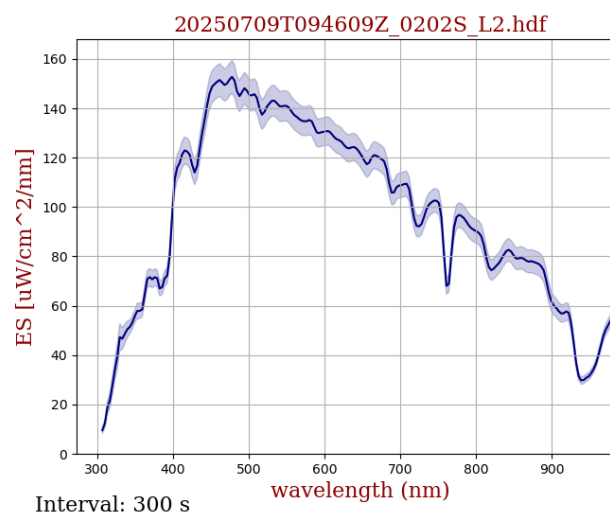
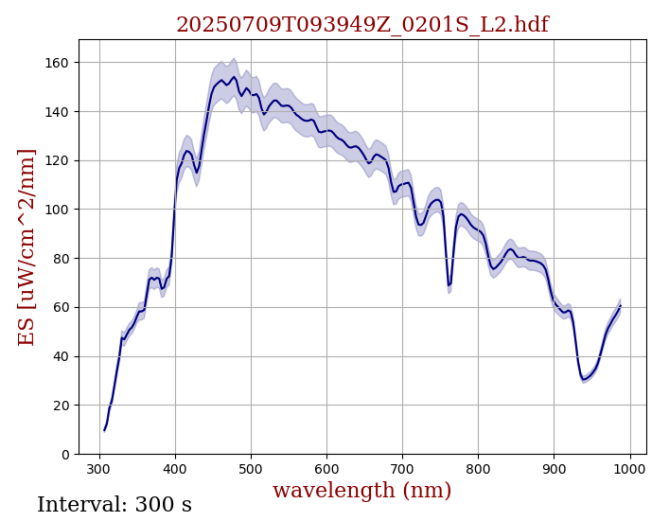
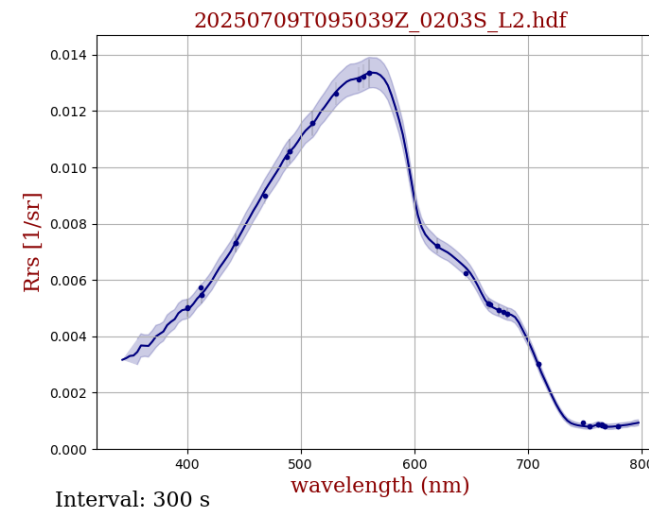
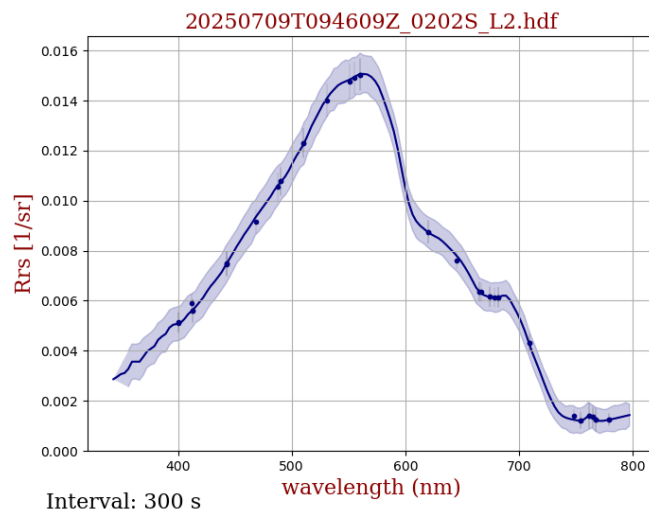
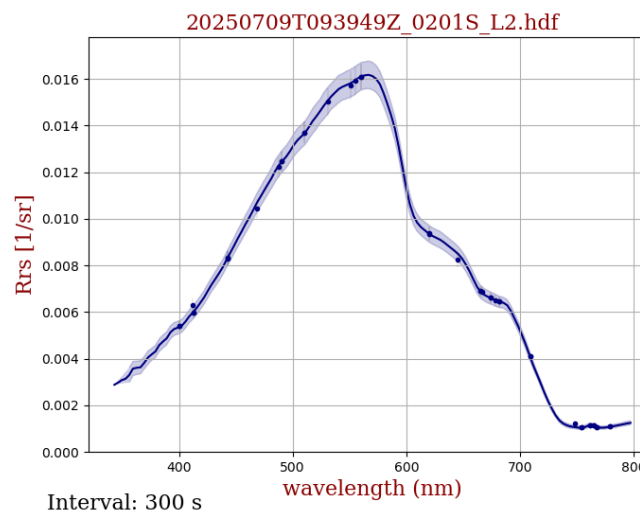


pySAS  
(robotic)



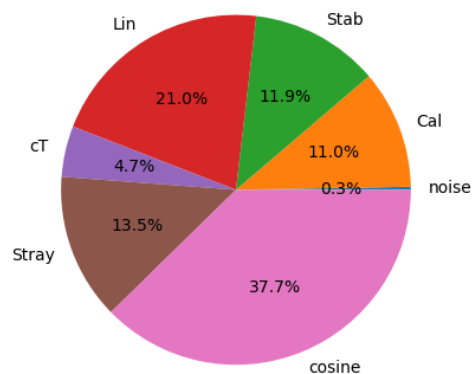
- How do  $R_{rs}$  and  $E_s$  compare between the TriOS and the SeaBird instruments?
- What is missing from TriOS plots? Why?



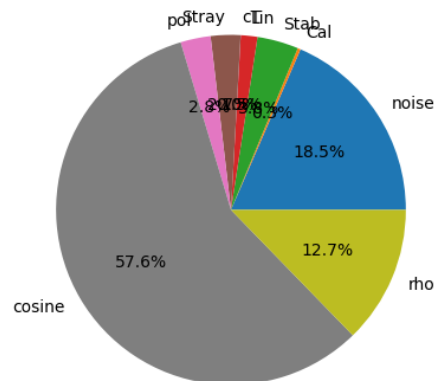




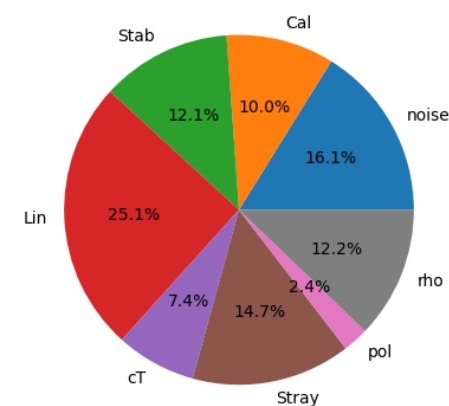
ES Class Based Uncertainty Components at 440.36nm



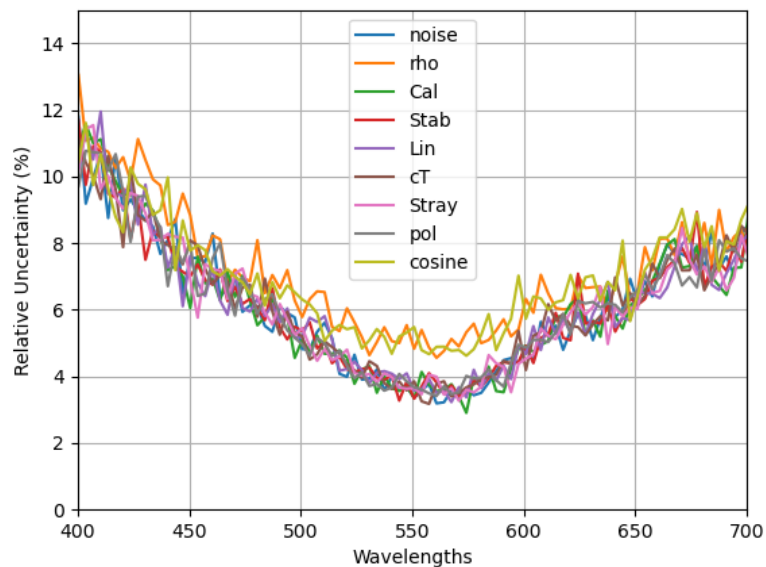
Rrs Class Based Uncertainty Components at 440.36nm



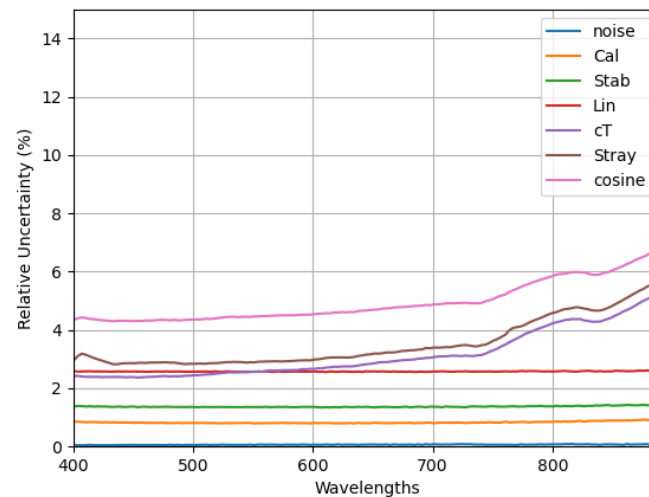
Lw Class Based Uncertainty Components at 440.36nm



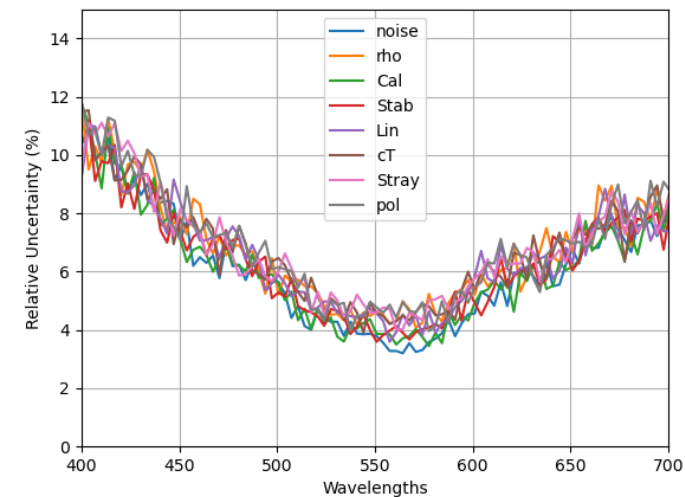
Class-Based branch Breakdown of Rrs Uncertainties



Class-Based branch Breakdown of ES Uncertainties



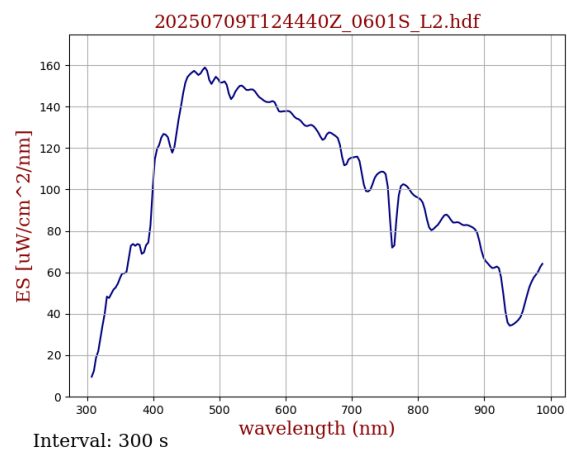
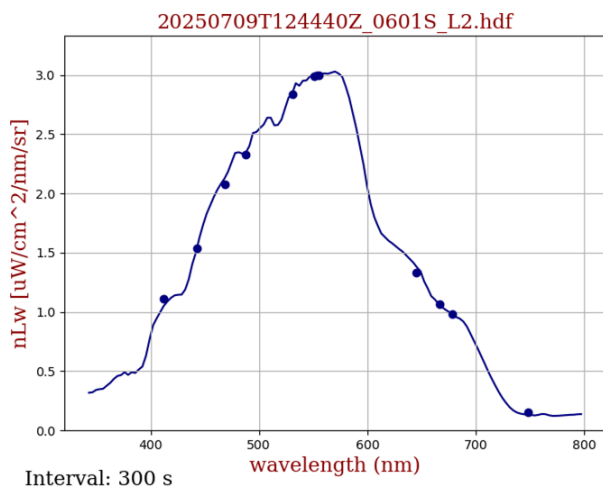
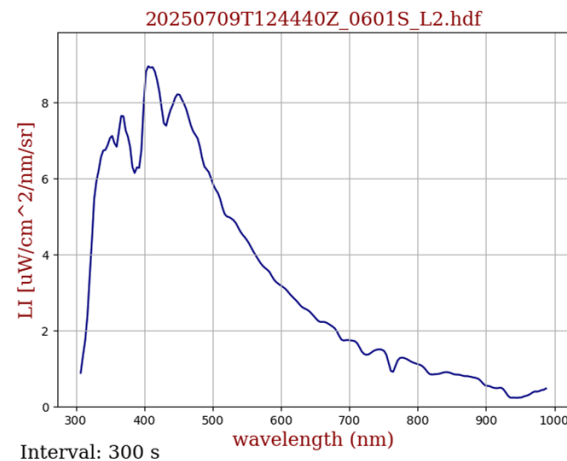
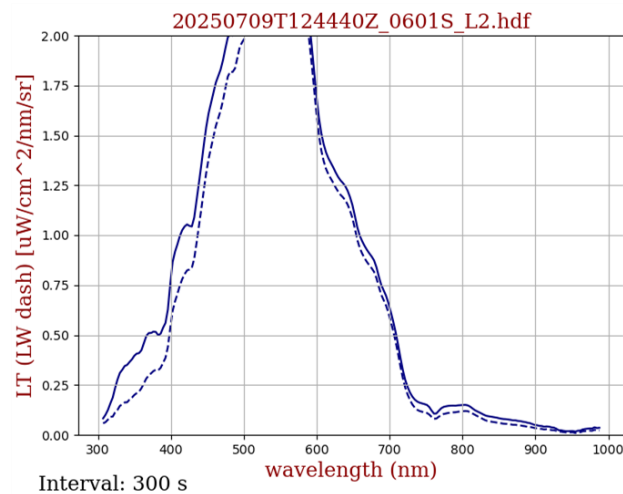
Class-Based branch Breakdown of Lw Uncertainties





# HyperCP San Servolo result

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Configuration: TriOS\_SAN\_SERVOLO.cfg

Sensor Type: TriOS

Relative Solar Azimuth Filter: ☒ Rel Angle Min: 90.0 Rel Angle Max: 135.0

Filter Sigma Es: 5.0 Filter Sigma Li: 8.0 Filter Sigma Lt: 3.0

Enable Spectral Outlier Filter: ☒ Generate Plots: ☒

Level 1A Processing: Raw binary to HDF5, Raw UTC Offset [+/-]: 0.0, Solar Zenith Angle Filter: SZA Max: 70.0, Caps-on darks only (TriOS): ☐

Level 1AQ Processing: Filter on pitch, roll, yaw, and azimuth, Pitch/Roll Filter (where present): ☐ Max Pitch/Roll Angle: 5.0, Autonomous Sun Tracker: ☐ Rotator Home Angle Offset: 0.0, Rotator Delay (Seconds): 2.0, Absolute Rotator Angle Filter: ☐ Rotator Angle Min: -40.0, Rotator Angle Max: 40.0

Level 1B Processing: Dark offsets, calibrations and corrections. Interpolate to common timestamps and wavebands. Ancillary data are required for Zhang glint correction and can fill in wind for M99 and QC. Select database download: GMAO MERRA2 ☐ ECMWF CAMS ☒ Reset credentials (GMAO or ECMWF)

Level 1BQC Processing: Data quality control filters. Eliminate where  $Lt(NIR) > Lt(UV)$ : ☒ Max. Wind Speed (m/s): 10.0, SZA Minimum (deg): 20.0, SZA Maximum (deg): 60.0

Level 2 Processing: Temporal binning, glint reduction, glint correction, residual correction, QC, satellite convolution, OC product generation, SeaBASS file output. Sensor Viewing Angle: 40°

Level 2 Ensembles: Extract Cruise Stations: ☐ Ensemble Interval (secs; 0=None): 300, Enable Percent Lt Calculation: ☒ Percent Lt (%): 10.0

Level 2 Sky/Sunglint Correction (p): Mobley (1999) p ☒ Zhang et al. (2017) p ☐ Groetsch et al. (2017) ☐ Your Glint (2023) p ☐ NIR Residual Correction: ☒ Mueller and Austin (1995) (blue water) ☐ SimSpec. Ruddick et al. (2006) (turbid) ☐ Remove Negative Spectra: ☒

BRDF Correction: Morel R.L./Q ☐ Lee IOP ☐ L2 Products: Convolve to Satellite Bands: AQUA ☒ Sen-3A ☐ V-NPP ☐ TERRA ☐ Sen-3B ☐ V-JPSS ☐ Automatic for Derived Products: Generate Spectral Plots: Rrs ☒ nLw ☒ Es ☒ Li ☒ Lt ☒ Unc. Plots (class-based only): ☐ Derived L2 Ocean Color Products: Save SeaBASS Files: ☒ Edit SeaBASS Header: TriOS\_SAN\_SERVOLO.hdr Write PDF Report: ☒

HyperCP

Save/Close Save As Cancel

- 6.9% upwelling radiance removed during the L1BQC stage.
- NIR (Near-Infrared) correction failed.
- Optically complex Waters, Chl-dominant.

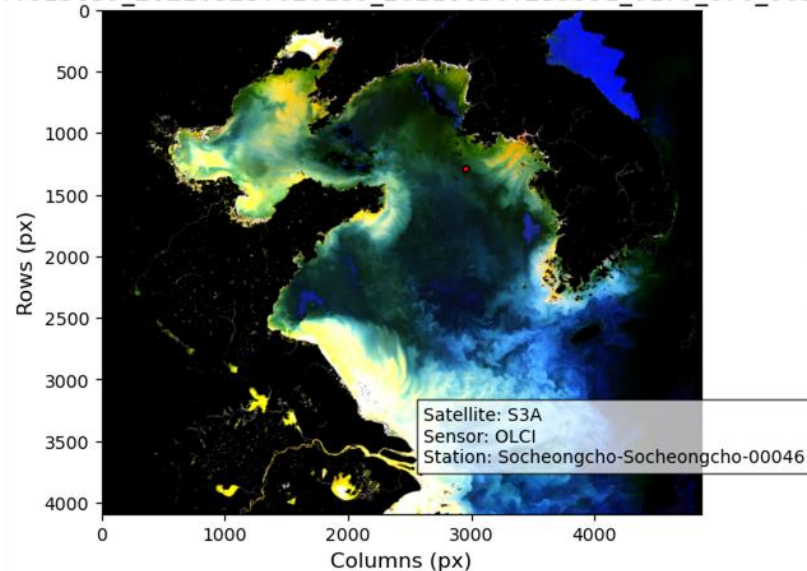




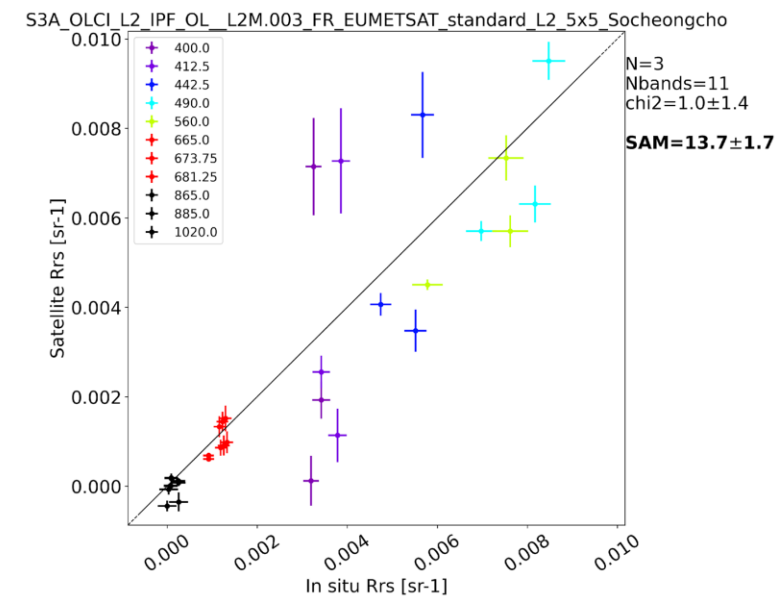
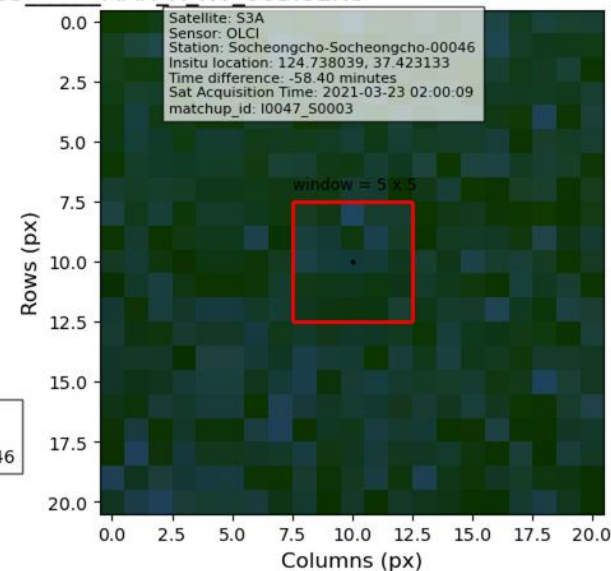
# AeronetOC Socheongcho exercise

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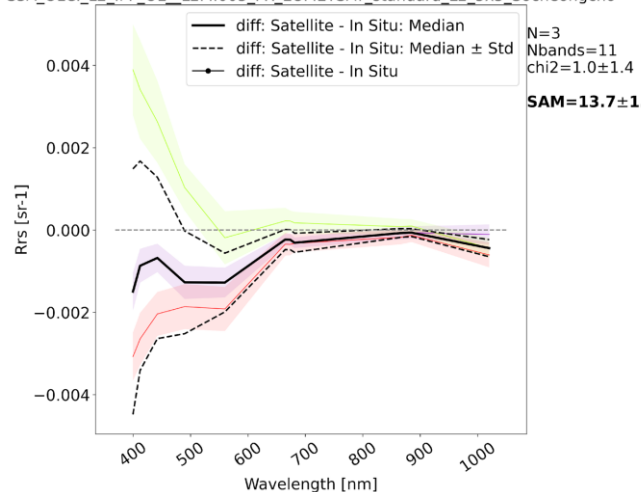
RGB Image in sensor geometry  
S3A\_OLCI\_L2\_IPF\_OL\_L2M.003\_FR\_EUMETSAT\_standard\_L2\_5x5\_Socheongcho



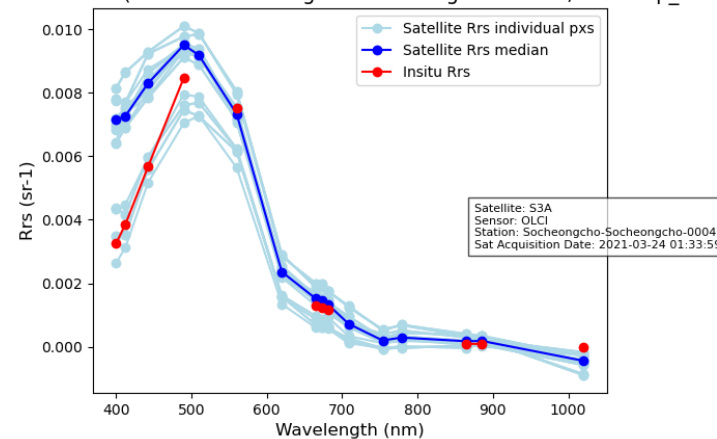
MAR\_R\_NT\_003.SEN3



S3A\_OLCI\_L2\_IPF\_OL\_L2M.003\_FR\_EUMETSAT\_standard\_L2\_5x5\_Socheongcho



Rrs for satellite and in-situ (Station: Socheongcho-Socheongcho-00049, matchup\_id: I0050\_S0004)



- 3 Matchups between Sentinel-3 and AERONETOC insitu.
- Lower in situ-satellite difference from 650 nm.

```
[global]
SetID: TEST_06
path_output: C:/Users/User/ThoMaS/Output/TEST_06
overwrite: all_except_SatData_minifiles

[workflow]
workflow: insitu, SatData, minifiles, EDB, MDB

[insitu]
insitu_input: C:/Users/User/ThoMaS/examples/06_full_matchup_workflow_MOBY_seaBASS/MOBY/MOBY_OCDB8.sh
insitu_satellite_time_tolerance_seconds: 3600
insitu_getAncillary: False
insitu_BRDF: M02

[satellite]
satellite_source: online
satellite_path-to-SatData: C:/Users/User/ThoMaS/Output/TEST_06/SatData
satellite_platforms: S3A
satellite_resolutions: FR
satellite_BRDF: M02

[minifiles]
minifiles_winSize: 5

[EDB]
EDB_protocols: L2: EUMETSAT_standard_L2
EDB_winSizes: 3, 5

[MDB]
MDB_time-interpolation: insitu2satellite_NN
MDB_stats: MonteCarlo: 100
MDB_stats_plots: True
MDB_matchup_by: matchup_plots: True
MDB_satellite_protocol: EUMETSAT_standard_L2
```

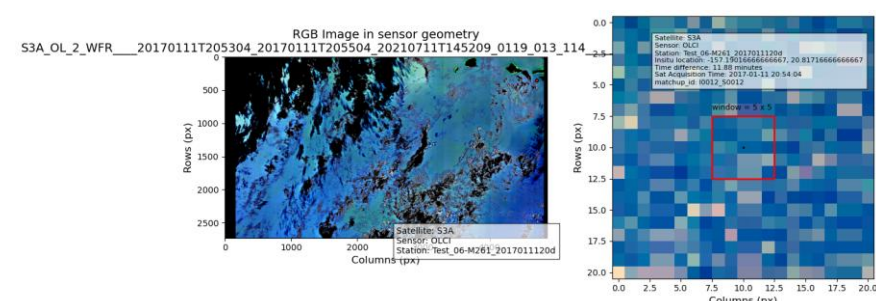
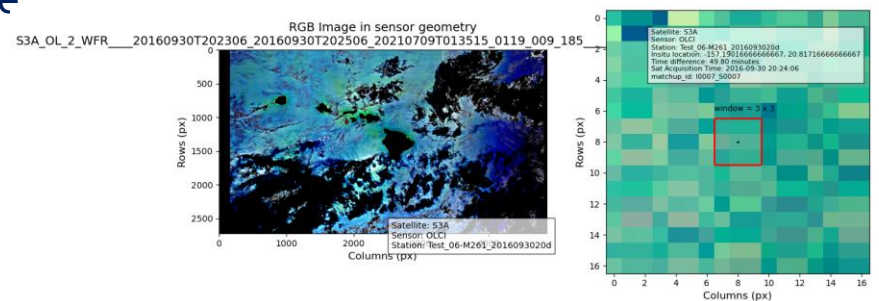
[illegible][illegible]

## 1. Configuration file

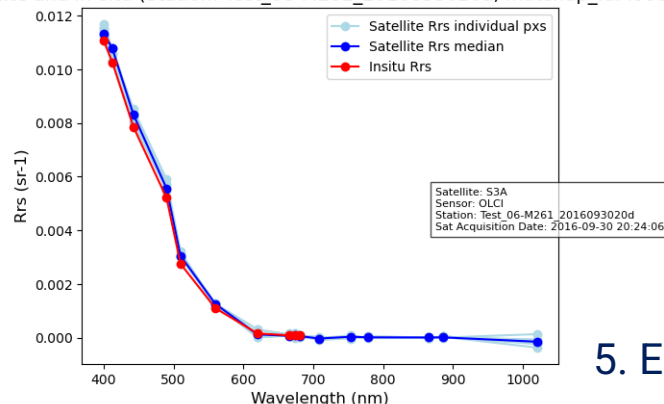
## 2. Satellite data to download

### 3. Downloaded satellite data list

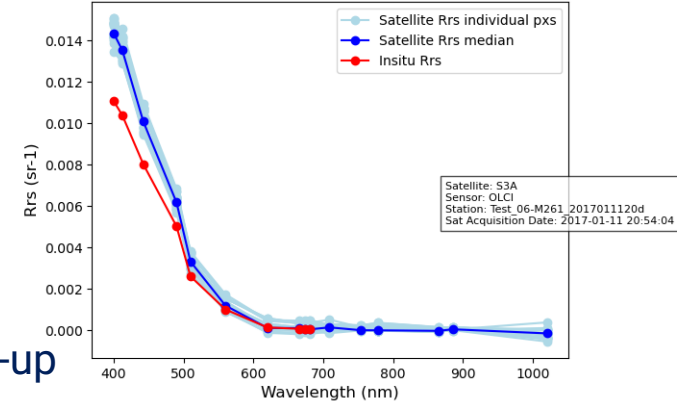
#### 4. List of match-up



Rrs for satellite and in-situ (Station: Test 06-M261 2016093020d, matchup id: I0007 S0007)



Rrs for satellite and in-situ (Station: Test 06-M261 2017011120d, matchup id: I0012 S0012)



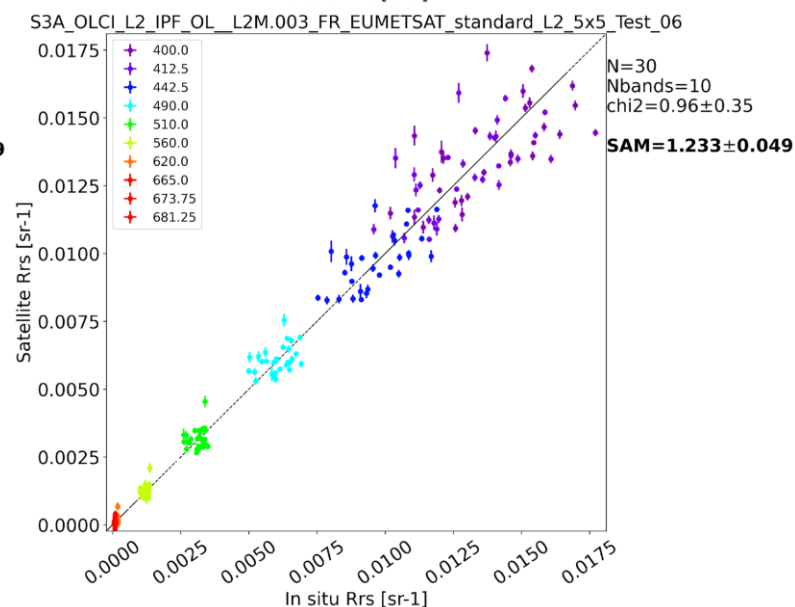
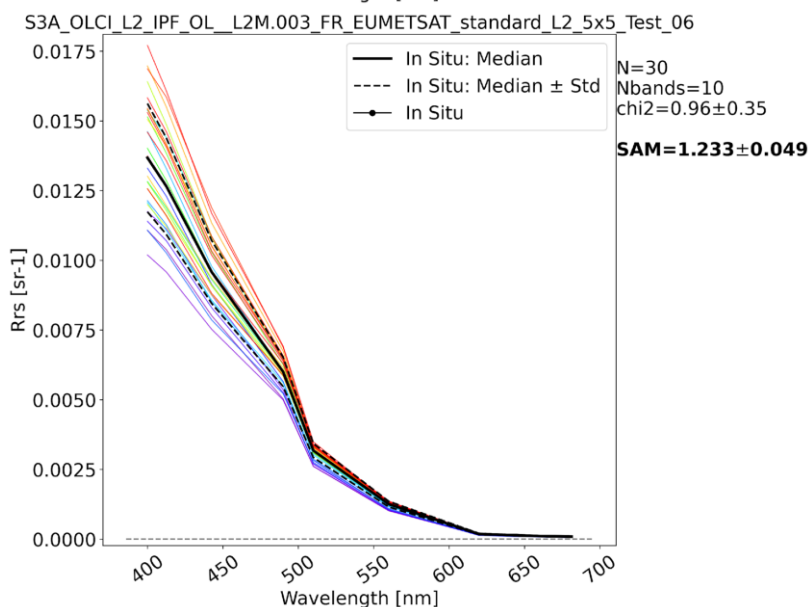
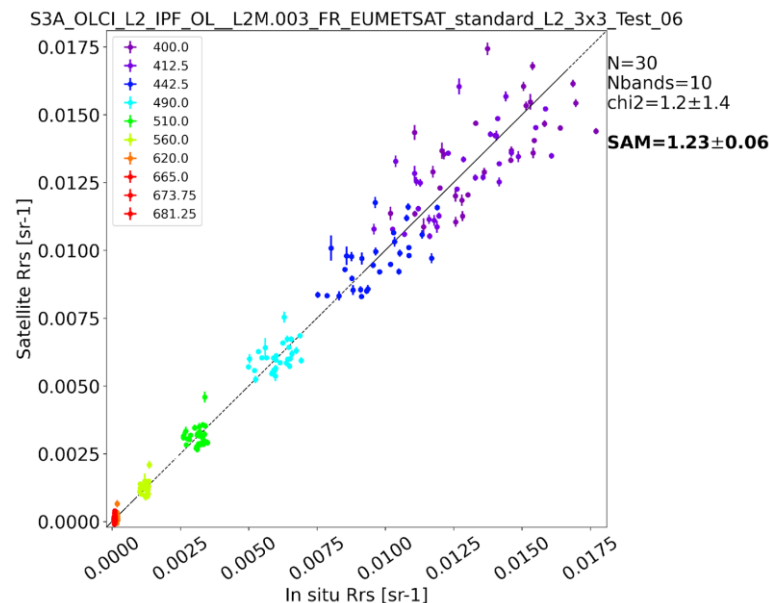
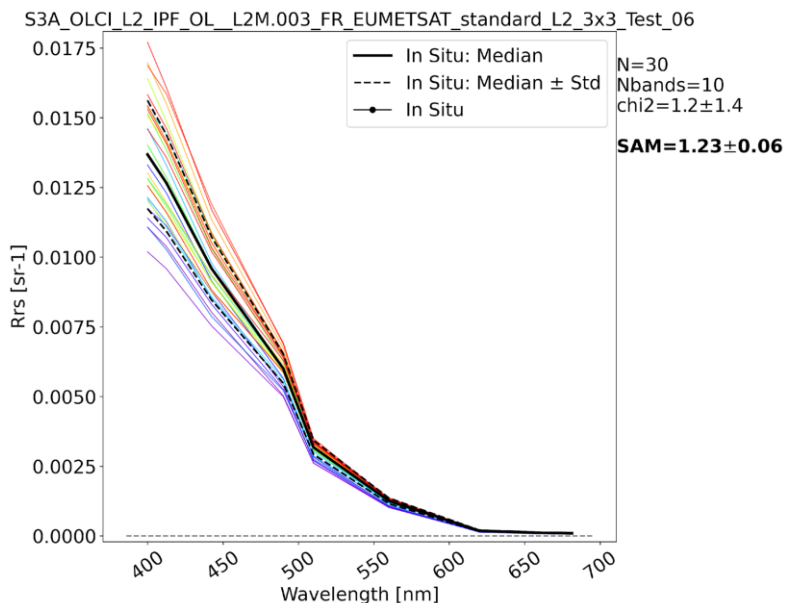
## 5. Example for match-up





# ThoMAS result for example 6

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1. There were 2 case of comparison data, one for 3x3 filter and the other for 5x5 filter.
1. There was an inverse relationship between wavelength and the magnitude of the error.
1. It looks like nearby Lānaʻi island in Hawaii.
1. I never been before, but the Rrs spectra showed ocean near this area had very clear water (case 1 water)
1. As you can see at the previous slide, match-up result showed a high similarity between satellite and in-situ data

**North Korea**

## **PART III**

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Socheong-cho station

**South Korea**

Incheon

Gyeonggi

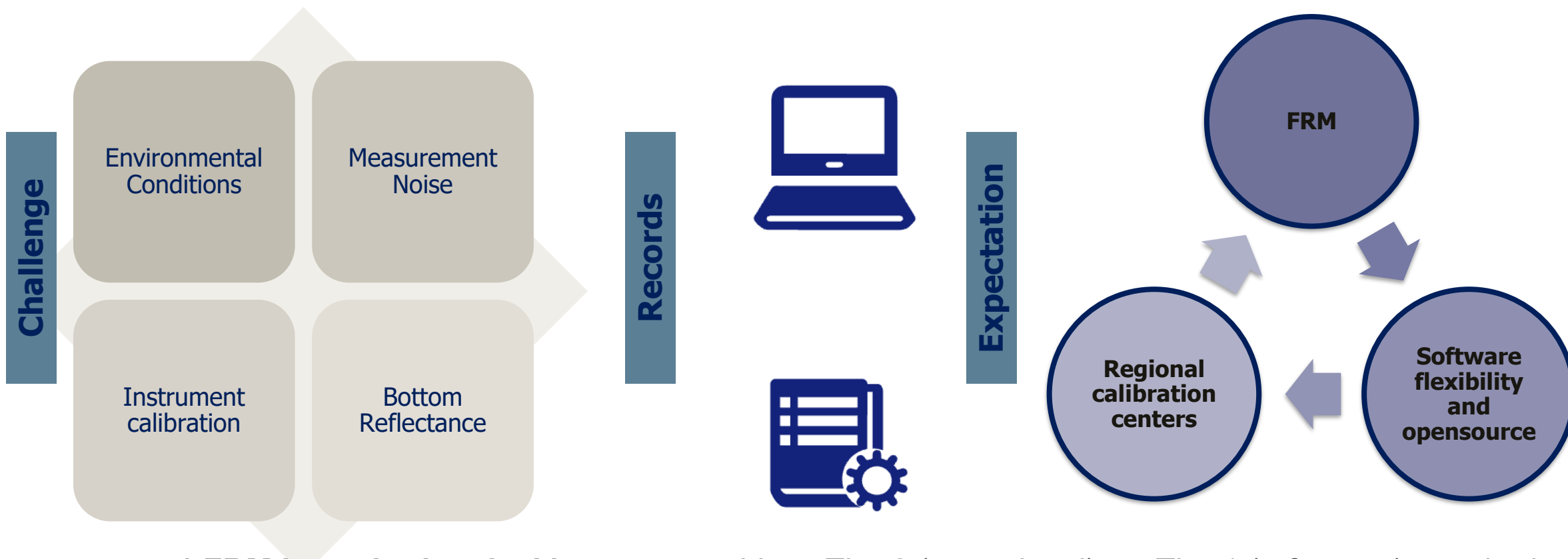
Chungnam





# Achieving “FRM quality” over future measurement

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**1.FRM is aspirational** – Most teams achieve Tier-2 (operational) vs. Tier-1 (reference) standards.

**2.Tool flexibility** is critical: Demand open-source, modular processing chains.

**3.Advocate for regional calibration centers** – Lobby ESA for "FRM4SOC-2 Regional Nodes".

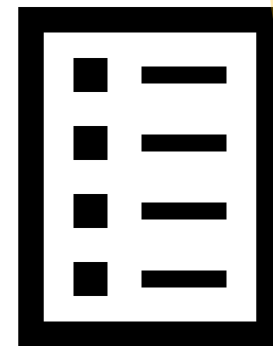


# Achieving “FRM quality” over future measurement

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Collaboration



Procedures.

FRM QA/QC framework.

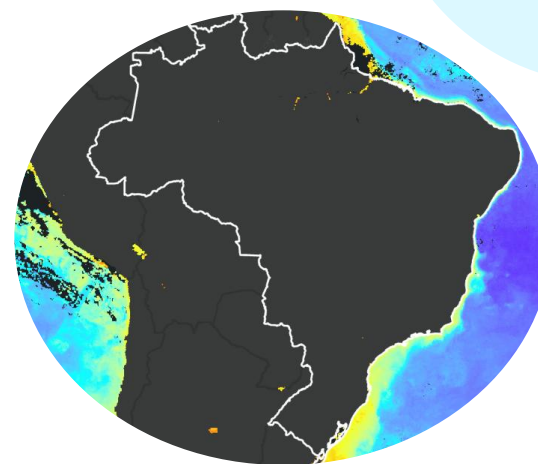
Rigorous in-situ measurements

Improve validation workflows.

**Ready to implement**



Analytical models  
for uncertainties







# Achieving “FRM quality” over future measurement

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- More smaller vessels – Jangmok-1,2(35 ton) and other commercial fishery boats
  - ✓ Easier to change heading of the boat
  - ✓ More movement by ocean and atmospheric condition – reason for error
  - ✓ Usually swell, wave, and tidal current (or sometimes wind)
  - ✓ For this reason, restrict QA/QC should be needed
- To OC community
  - ✓ Announcement for every ocean color users about FRM standard ancillary information (like SeaBASS format)

- Expectation to use HyperCP and ThoMAS
  - ✓ HyperCP is more expected to use at my institute
  - ✓ TriOS is the main radiometer for our institute.
  - ✓ Good to quantify uncertainty of TriOS data
- Suggestion for using HyperCP
  - ✓ It would be highly beneficial to have the flexibility to change the bands when matching satellite data, especially when visualizing L2 (Level 2) plots as individual points.



An aerial photograph of a coastal city, likely Venice, showing a complex network of canals and islands. A large bridge is visible in the upper left. The city is surrounded by water, and the overall scene is captured in a high-angle, wide-area shot.

# Conclusion

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**I don't know what to do!**



**During the lectures about HyperCP and ThoMaS**



**We made it !**

- It was a very good chance to learn a professional method for in-situ measurements.
- HyperCP and ThoMaS are very powerful tools to cooking data from above water radiometry instruments.
- But if anyone want to expert for it, they have to know about the instrument and field observation protocols also.
- Leveraging my experiences here, I'll strive to introduce FRM protocol, HyperCP, and ThoMaS to others, encouraging their use to collectively generate valuable field observation data. - from Jay
- The successful transfer of expertise in the FRM principles to our local institutions hinges on the practical transference of what was learned during FICE2025. - from Sergio





Grazzie!  
Gracias!  
Obrigado!  
Thank you!  
감사합니다!  
谢谢!

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