Copernicus FICE 2025

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

Reading the Water's colors

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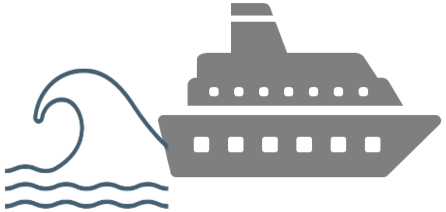
6-20 July 2025
Venice, Italy

PART I

Field measurements in San Servolo and AAOT

Weather conditions

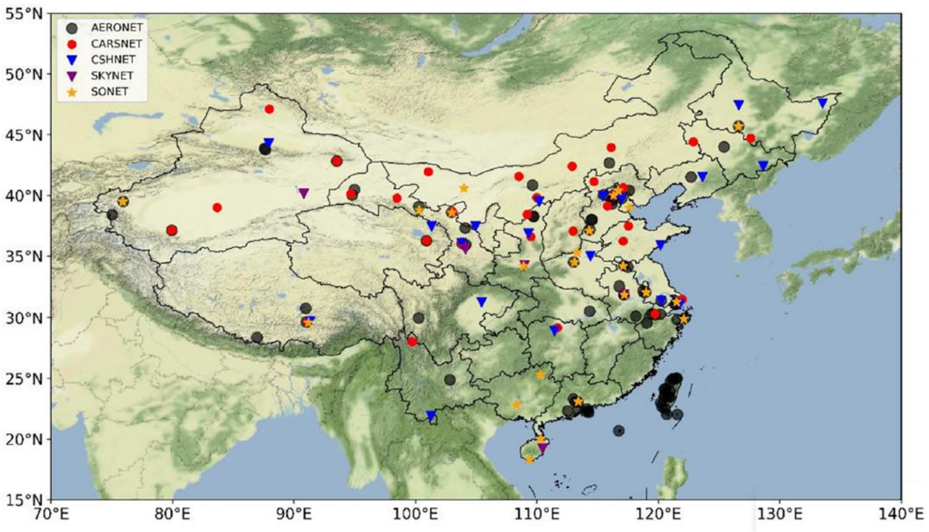


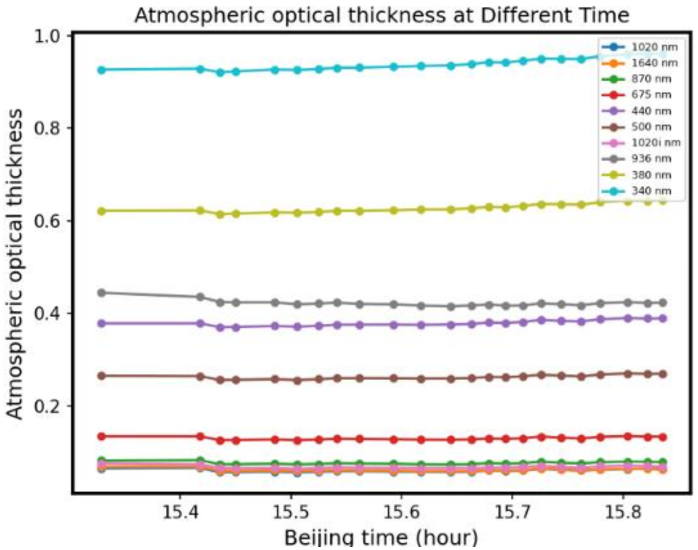
Boat passage

Changing water
Surface conditions.

CE318-SONET SUN PHOTOMETER INTERNSHIP

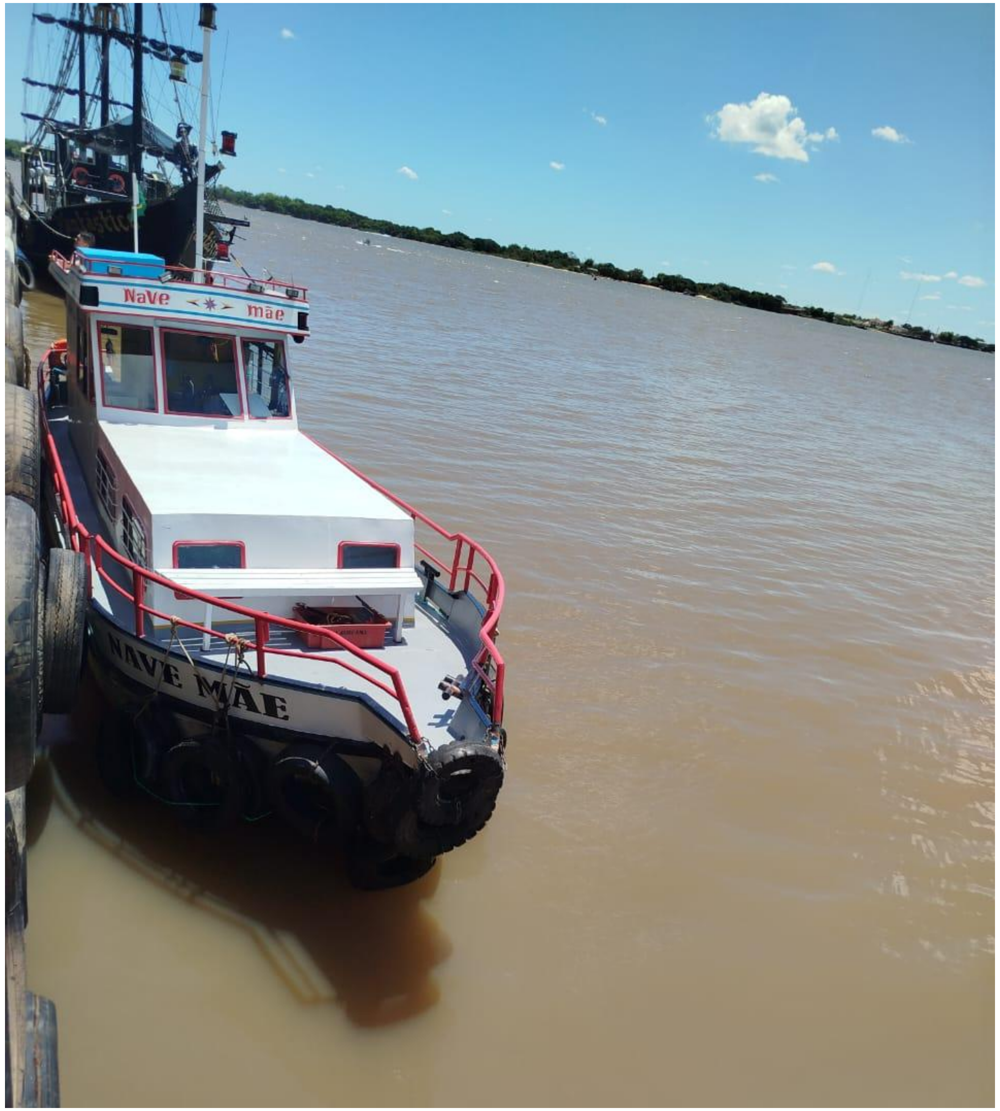
measure aerosols, looking up at the sky from the land, and it does not involve reflections from the ocean.





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.

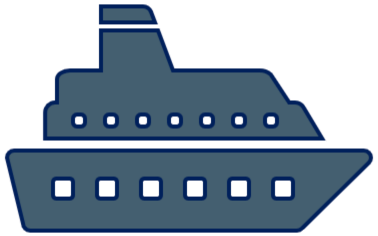
Local field measurements



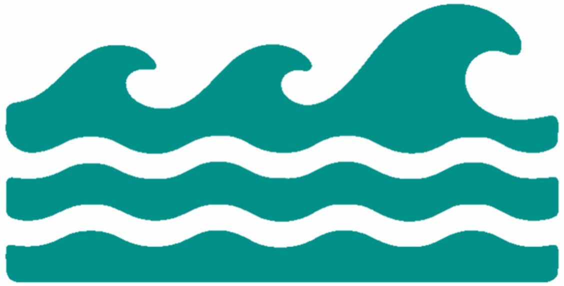
IOCCG
International
Ocean Colour
Coordinating Group

Lack IOCCG protocol application.

Adjacency and bottom effects.



Platform-induced perturbations.

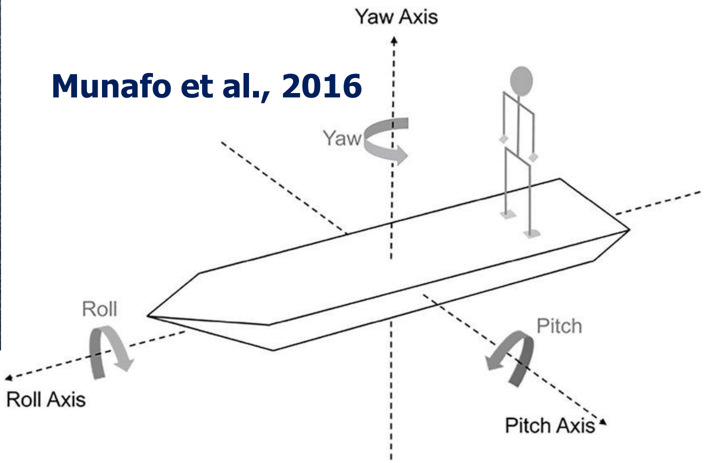


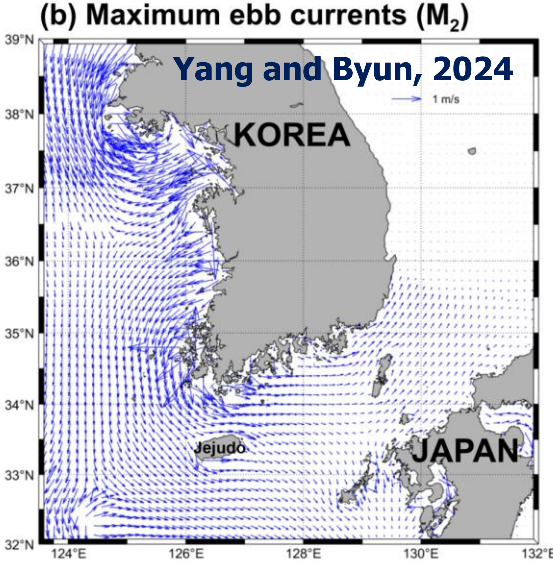
Currents, wave-dominated, complex waters.

Own experience 1

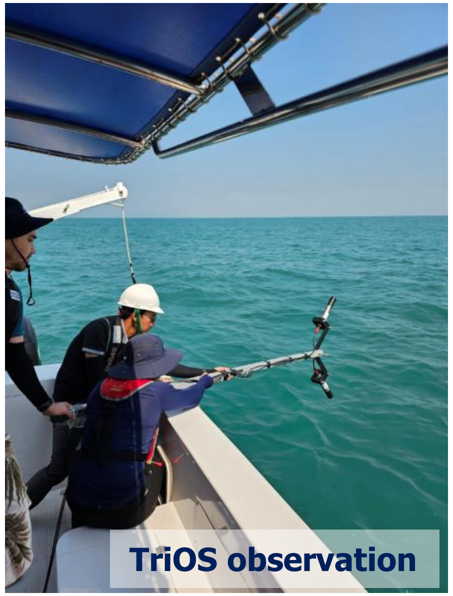
- Ocean Research Station-Socheong-cho and Ieodo
  - ✓ Fixed platform
  - ✓ Location of instrument was fixed and **cannot change the observation angle**
  - ✓ It can make some errors due to a relative azimuth angle
- Research Vessle-Onnuri and Ieodo
  - ✓ Onnuri: 1422 ton, Ieodo: 357 ton
  - ✓ Can move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

Munafo et al., 2016





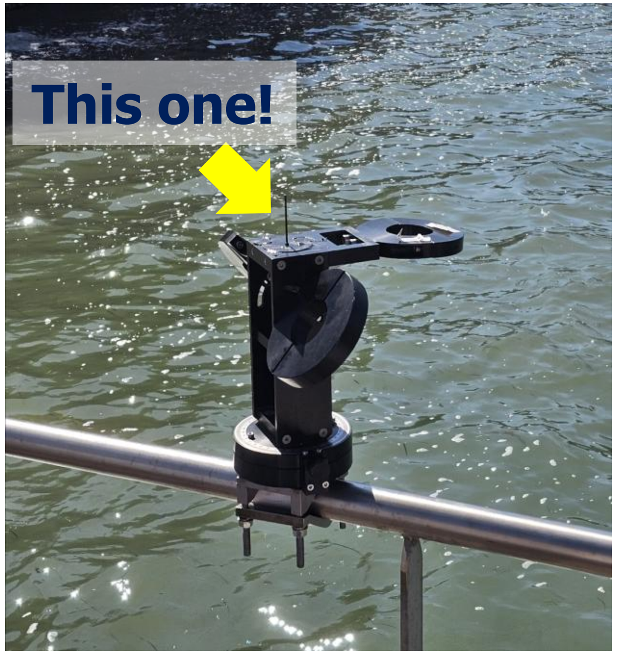
Own experience 2 and Suggestions



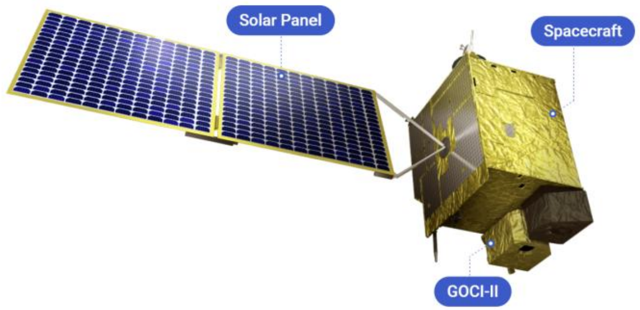
ASD Fieldspec4

- 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

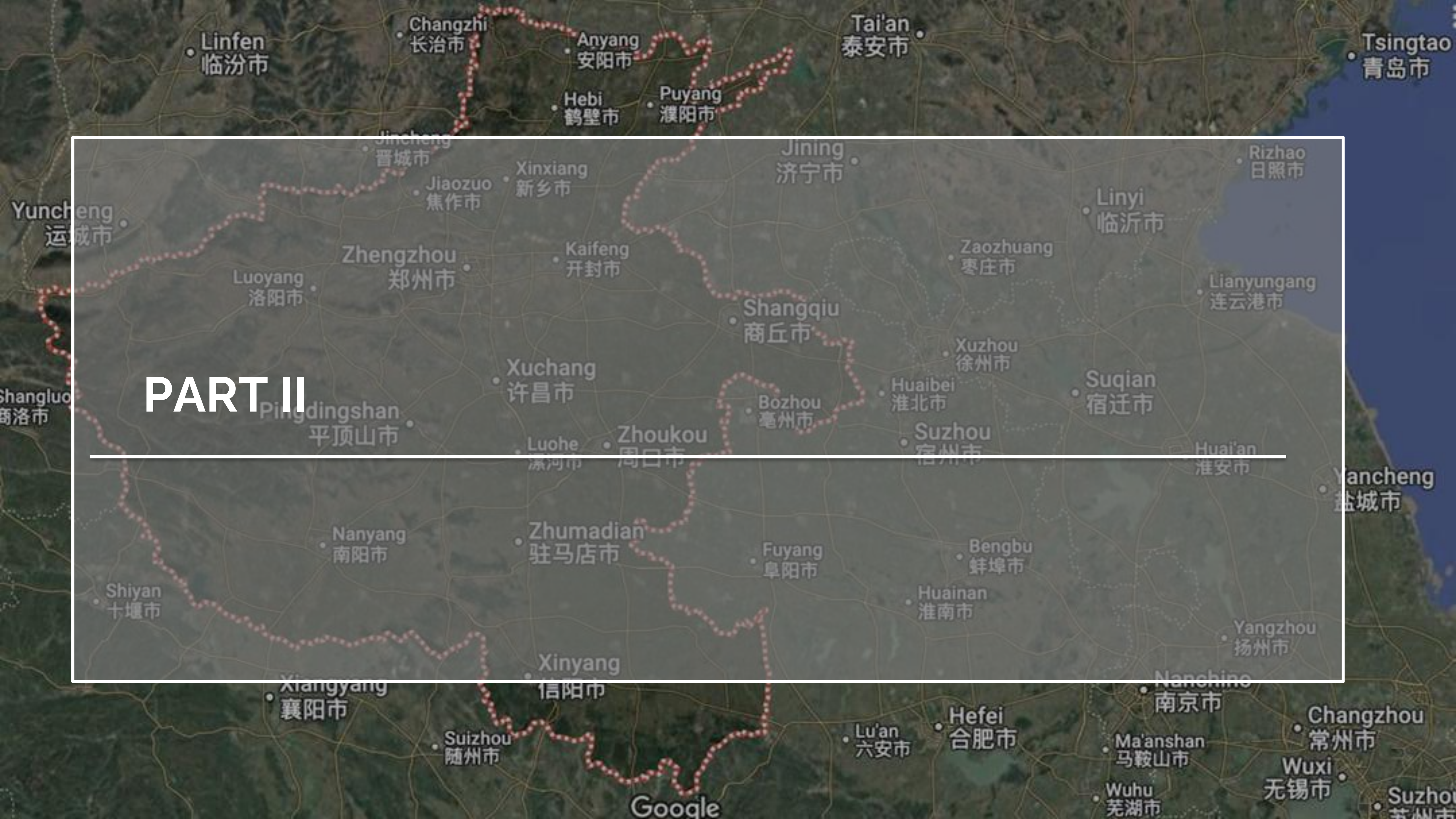


GEO-KOMPSAT-2B (GK-2B) is a geostationary satellite mounted with the Geostationary Ocean Color Imager II (GOCI-II) for marine and environmental observation which always monitors the Korean Peninsula at the altitude of 36,000 km above the equator.



Local Area Coverage

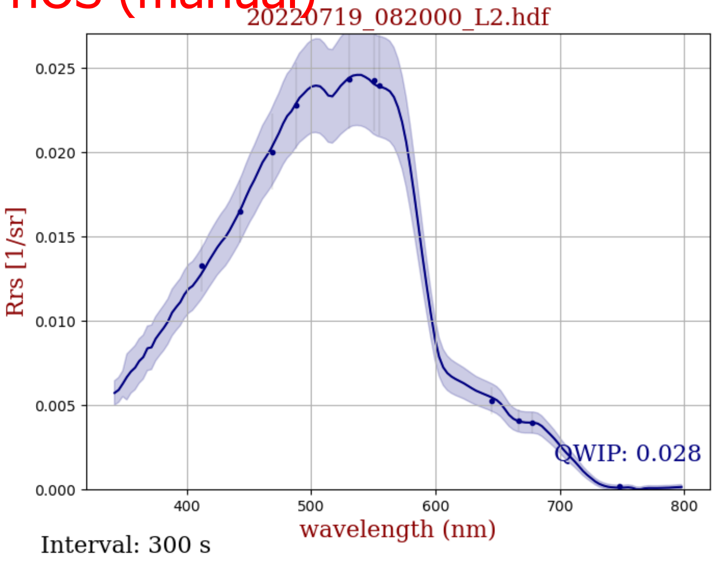
PART II

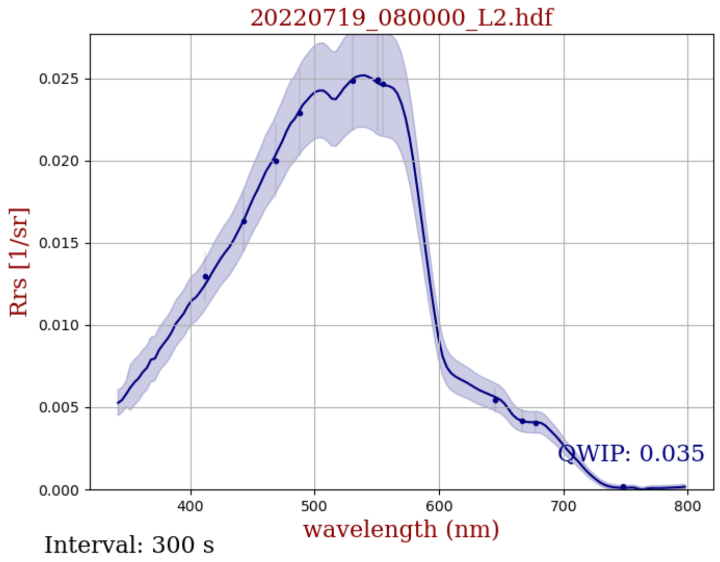

Linfen 临汾市
Changzhi 长治市
Anyang 安阳市
Hebi 鹤壁市
Puyang 濮阳市
Tai'an 泰安市
Tsingtao 青岛市
Jincheng 晋城市
Xinxiang 新乡市
Jiaozuo 焦作市
Jining 济宁市
Rizhao 日照市
Linyi 临沂市
Zhengzhou 郑州市
Kaifeng 开封市
Luoyang 洛阳市
Zaozhuang 枣庄市
Lianyungang 连云港市
Shangqiu 商丘市
Xuchang 许昌市
Xuzhou 徐州市
Huaibei 淮北市
Suqian 宿迁市
Pingdingshan 平顶山市
Bozhou 亳州市
Luohe 漯河市
Zhoukou 周口市
Suzhou 宿州市
Huai'an 淮安市
Yancheng 盐城市
Nanyang 南阳市
Zhumadian 驻马店市
Fuyang 阜阳市
Bengbu 蚌埠市
Shiyan 十堰市
Huainan 淮南市
Yangzhou 扬州市
Xinyang 信阳市
Xiangyang 襄阳市
Nanjing 南京市
Hefei 合肥市
Lu'an 六安市
Changzhou 常州市
Suizhou 随州市
Ma'anshan 马鞍山市
Wuxi 无锡市
Wuhu 芜湖市

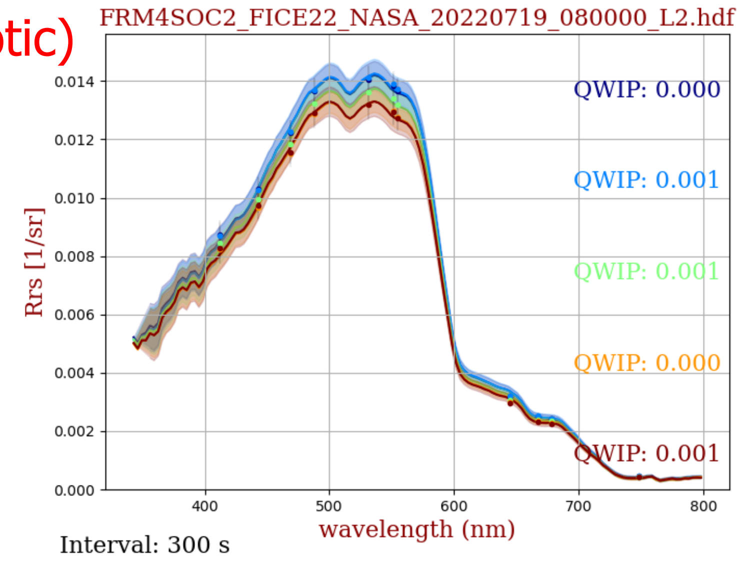
HyperCP-First Wicket

TriOS (manual)

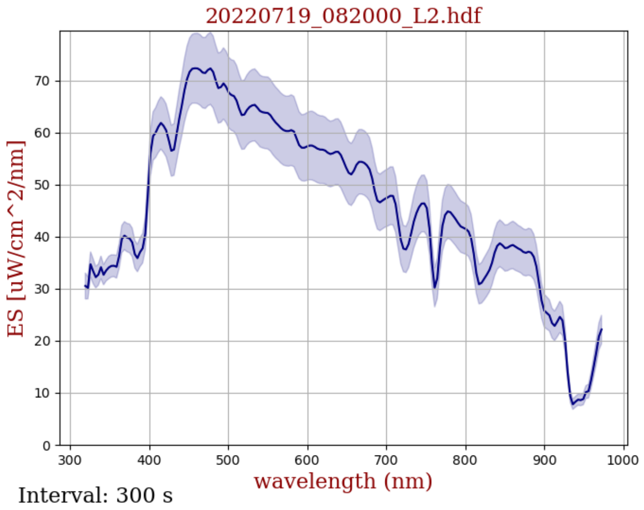
pySAS (robotic)

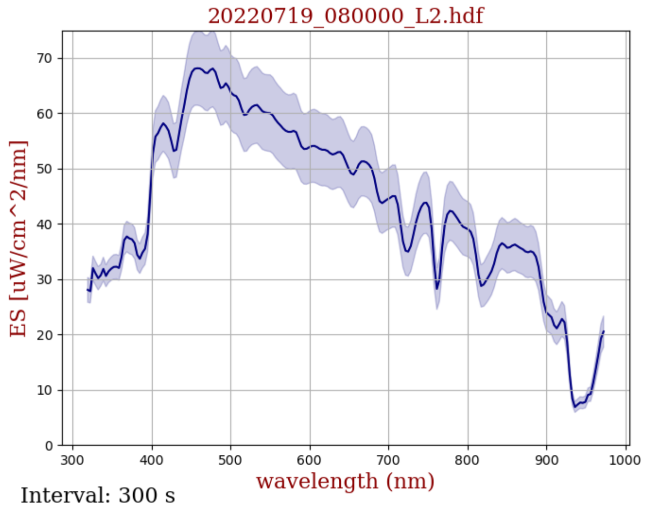


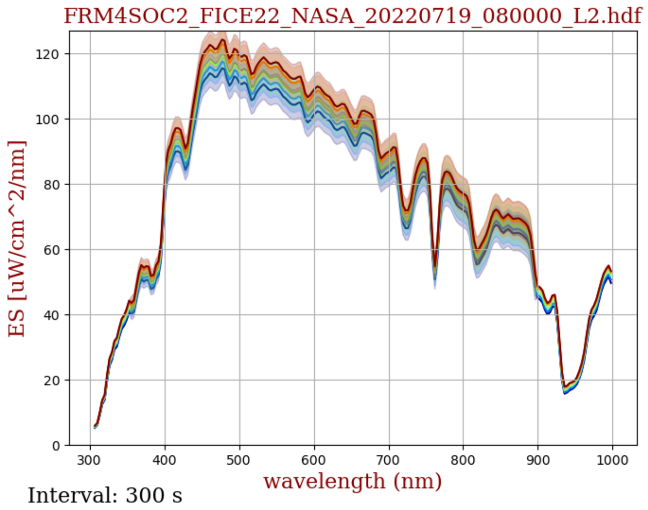




- How do R_{rs} and E_s compare between the TriOS and the SeaBird instruments?
- What is missing from TriOS plots? Why?

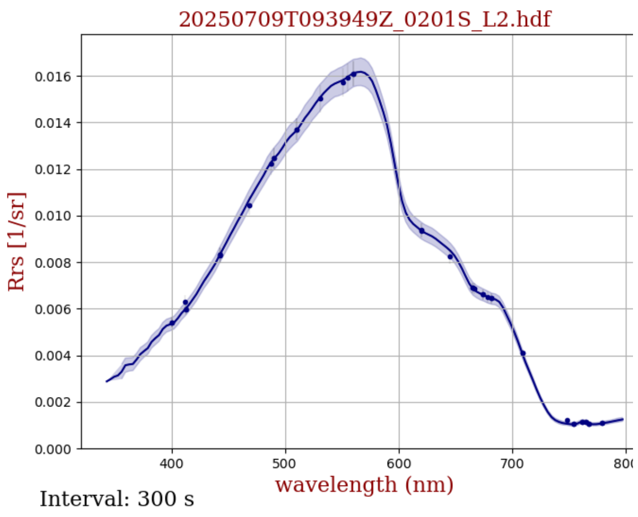


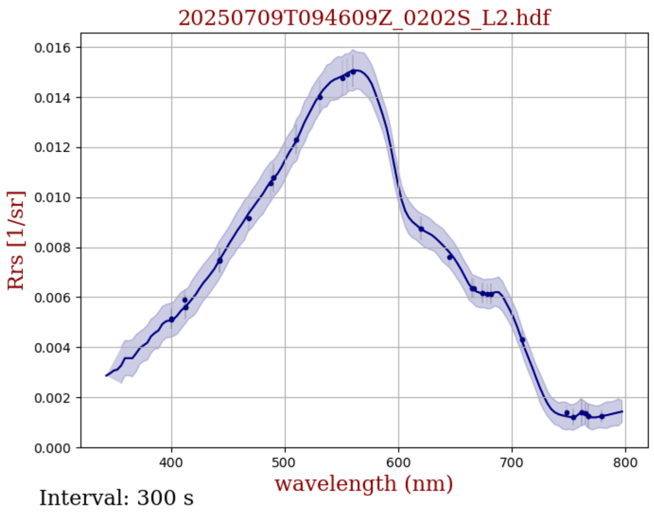


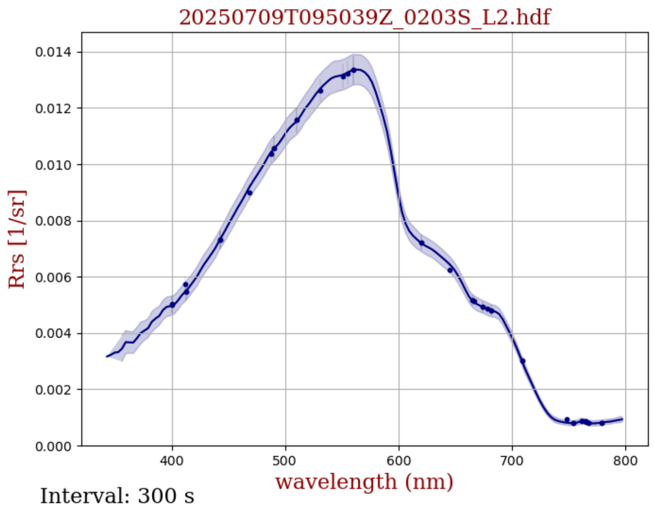


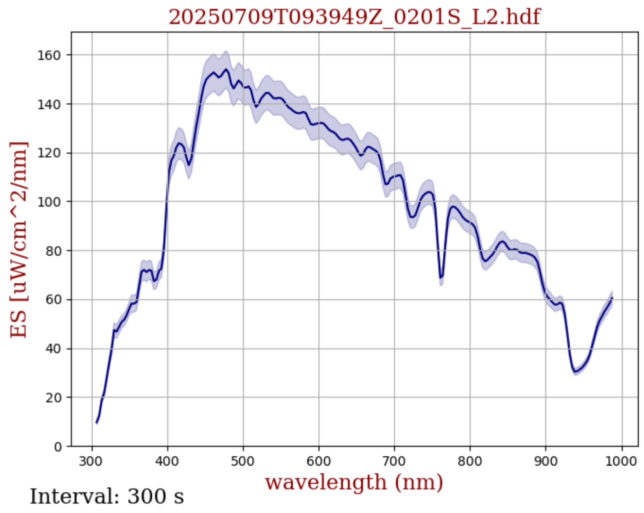
HyperCP-San Servolo data processing

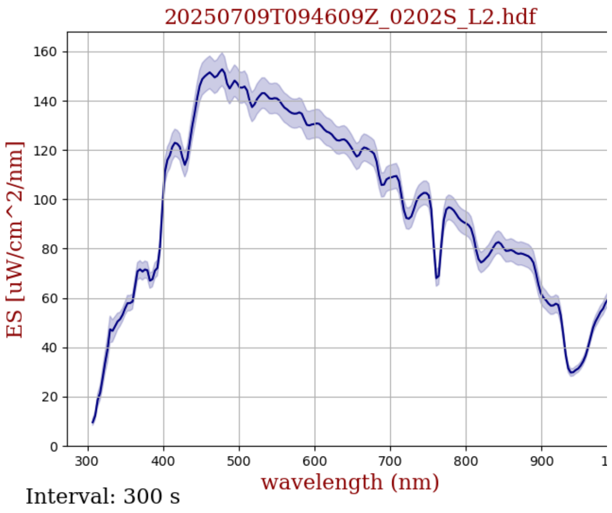
TriOS (manual)

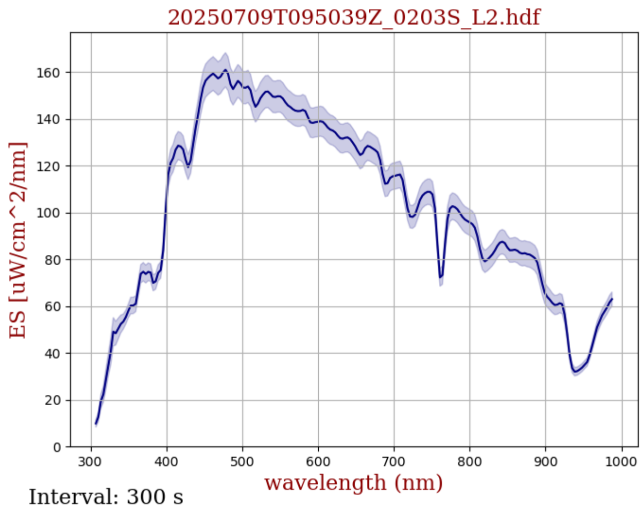






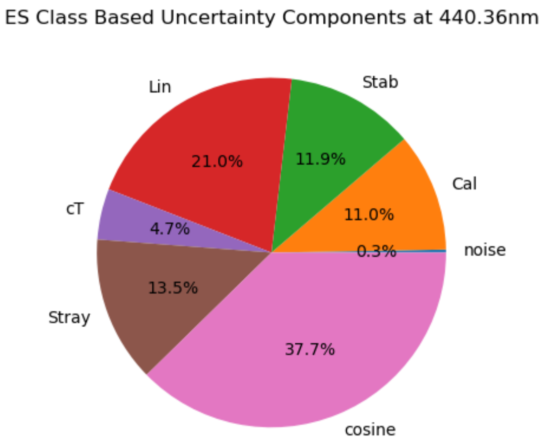


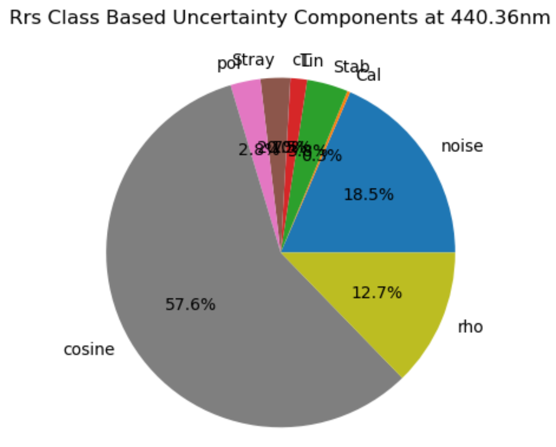


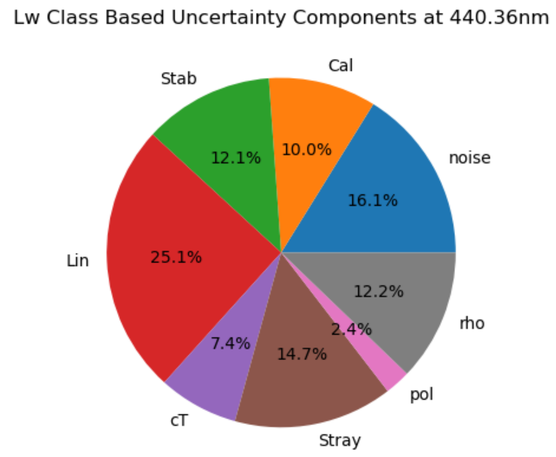


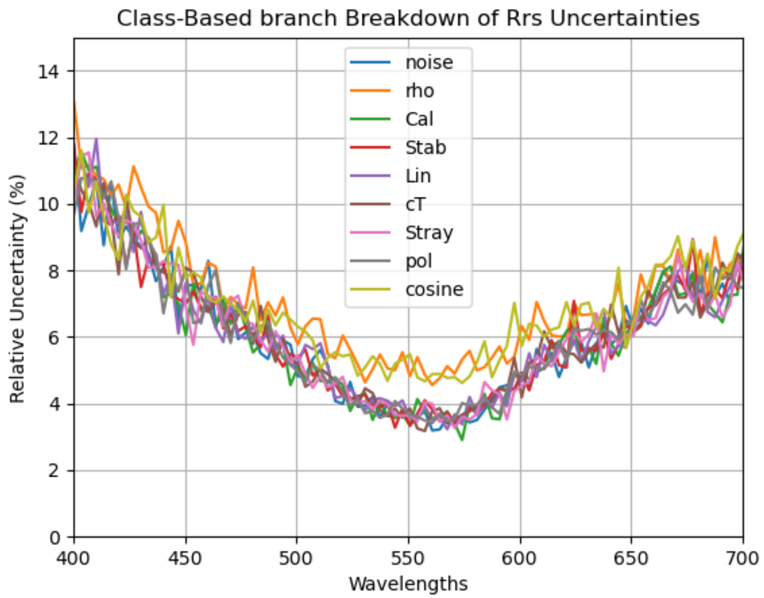
HyperCP- L2_Uncertainty_Breakdown

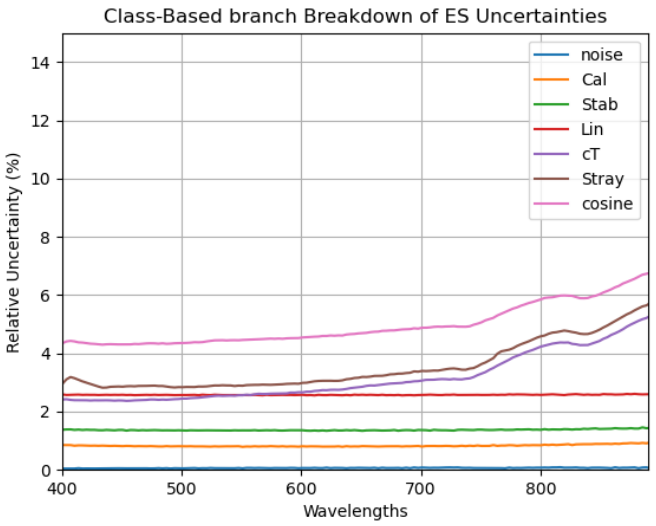
TriOS (manual)

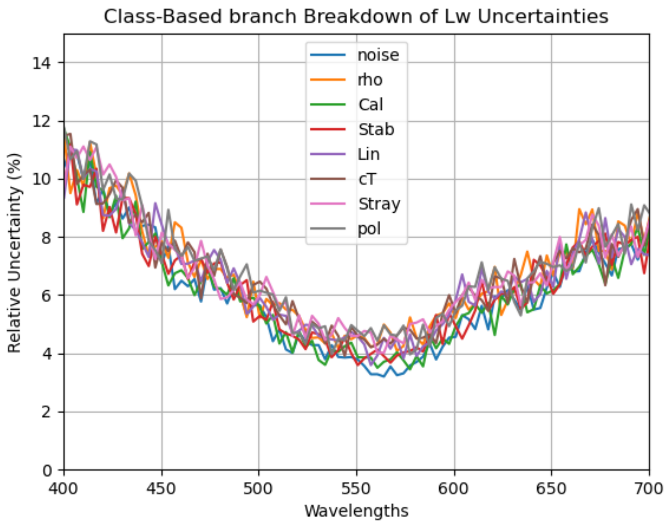




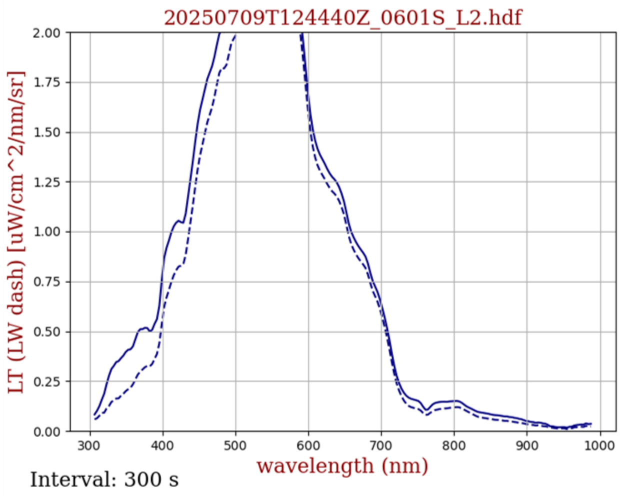


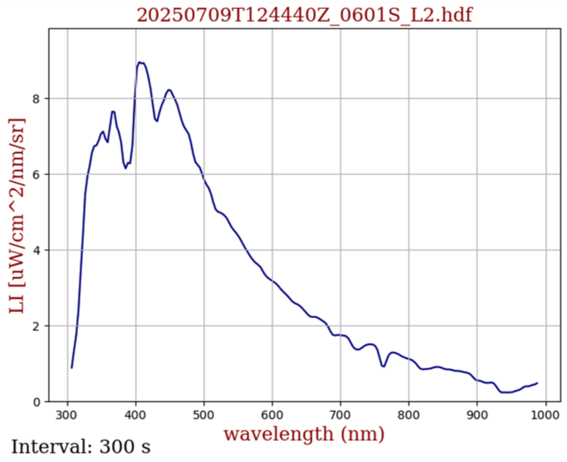


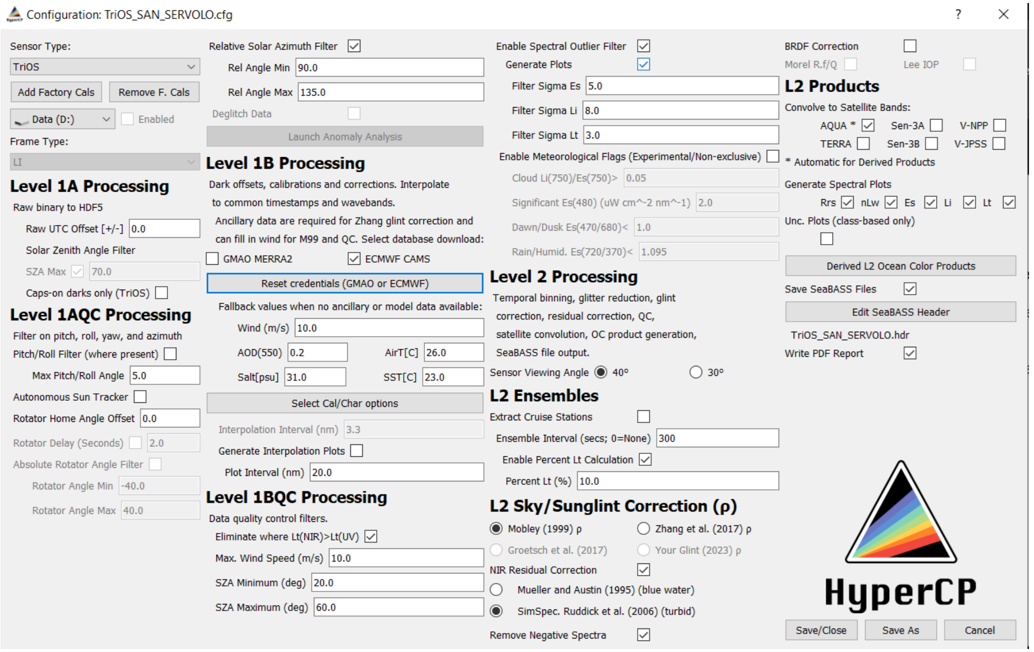


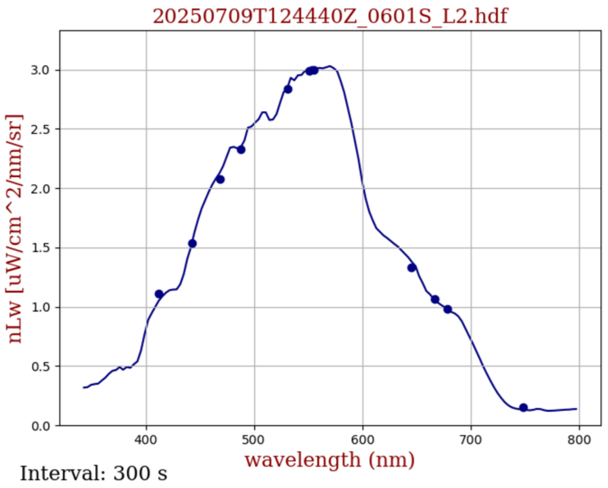


HyperCP San Servolo result









- 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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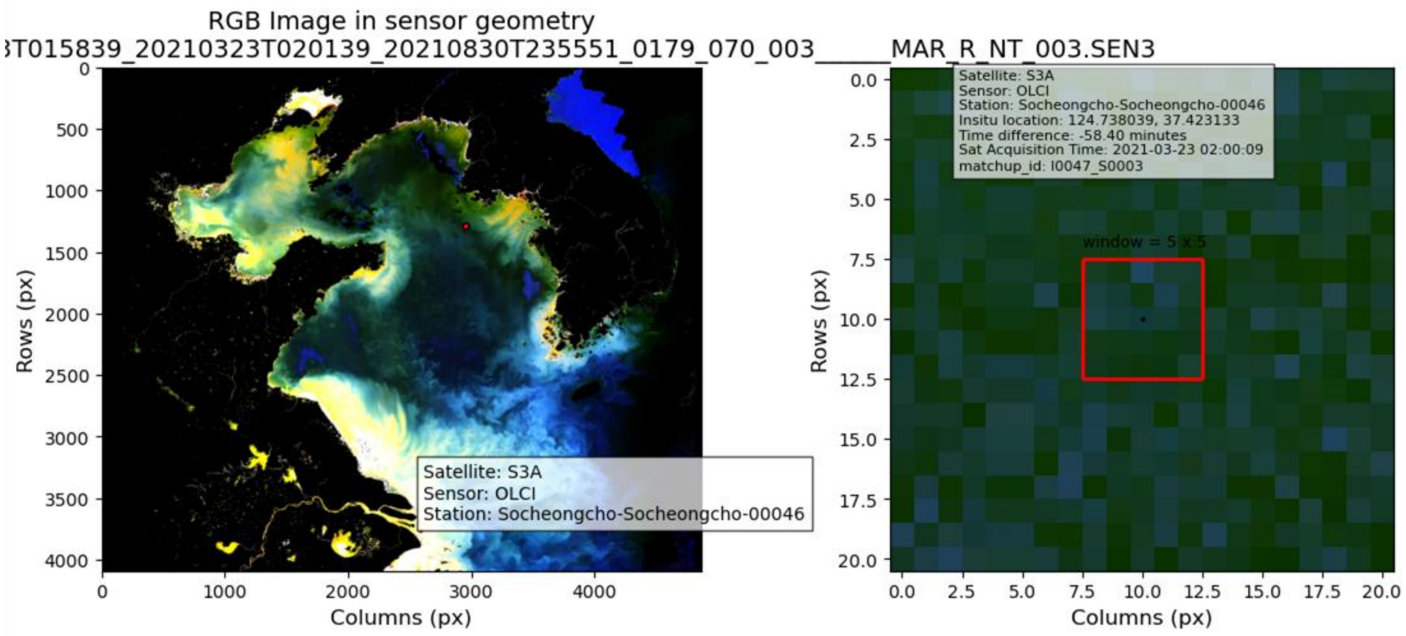

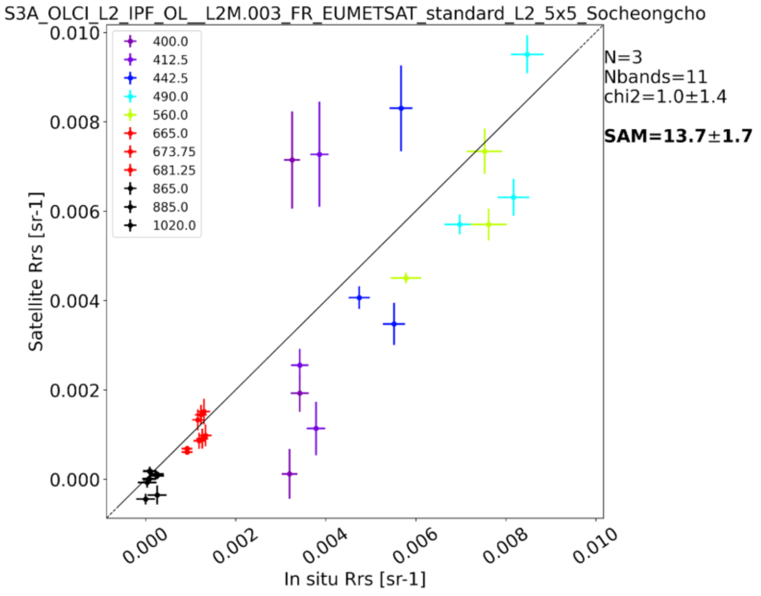

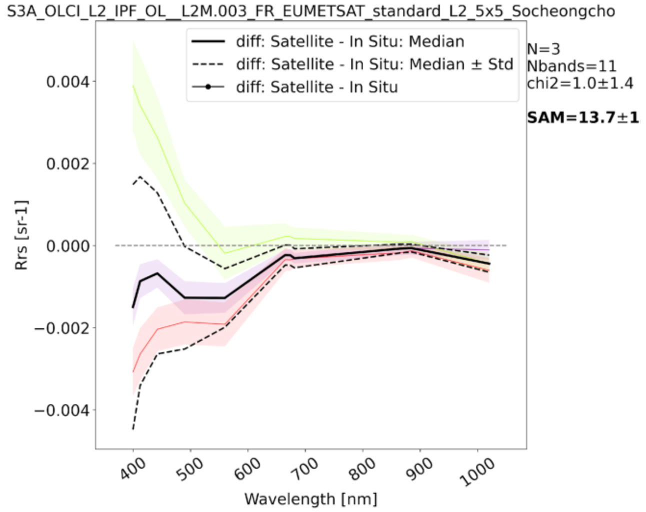

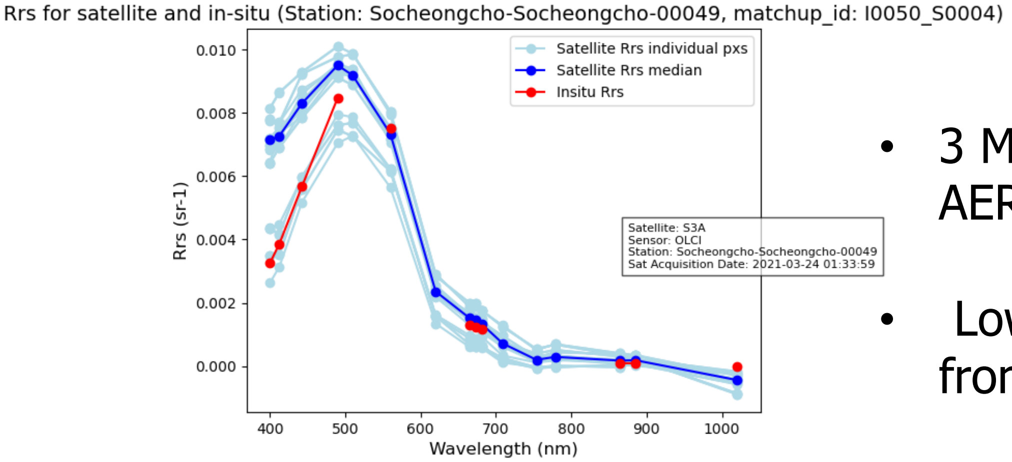

- 3 Matchups between Sentinel-3 and AERONETOC insitu.
- Lower in situ-satellite difference from 650 nm.

ThoMAS result for example 6

```
[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_OCDB.sb
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_stats_protocol: EUMETSAT_standard_L2
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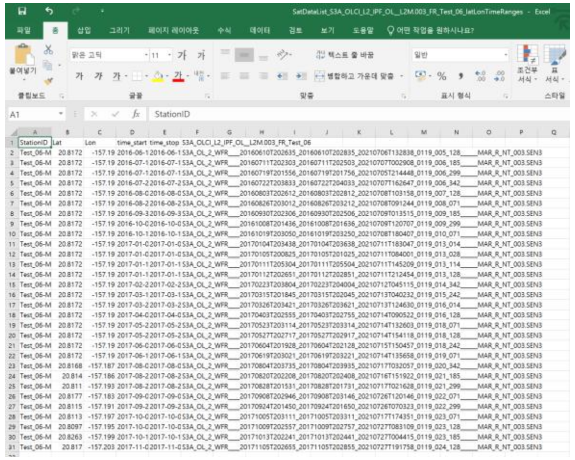
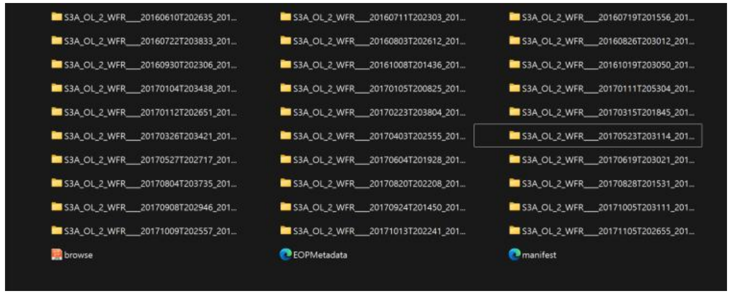
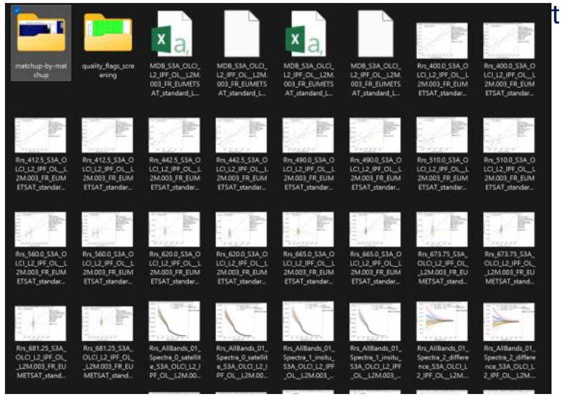
1. Configuration file



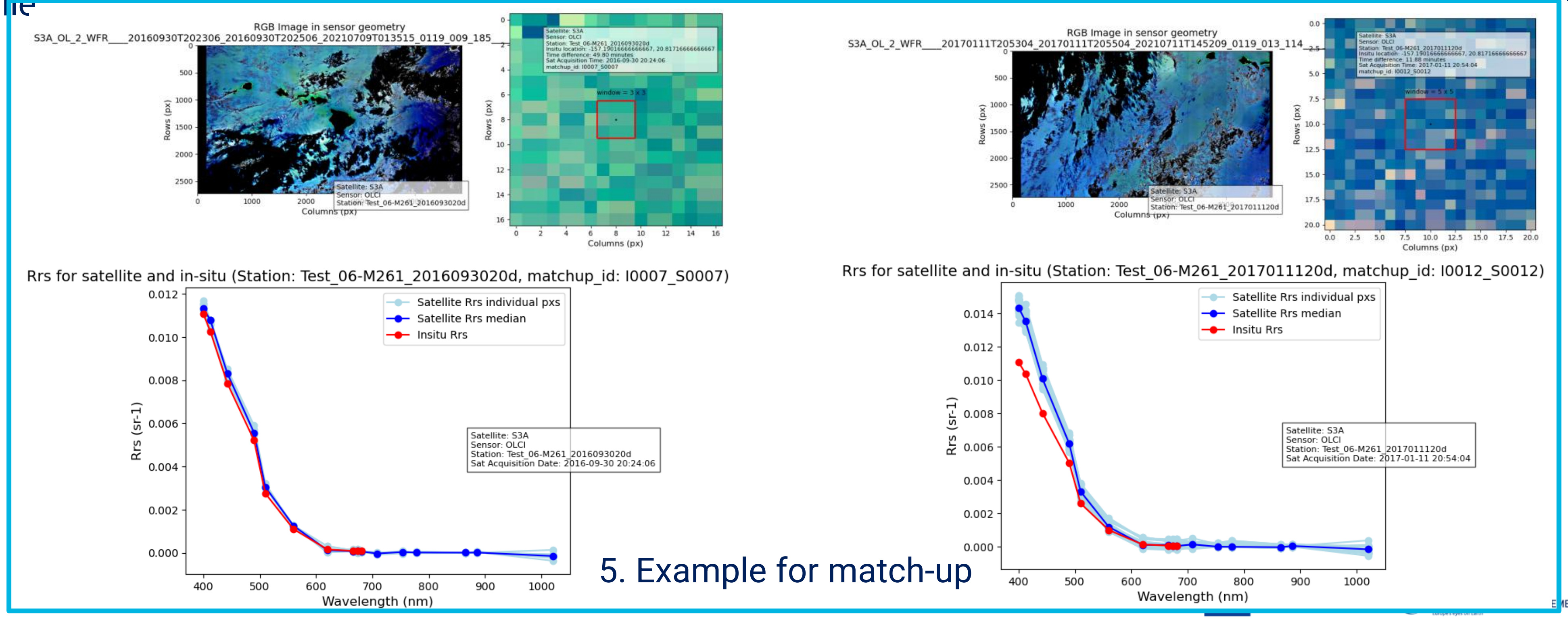
2. Satellite data to download



3. Downloaded satellite data list



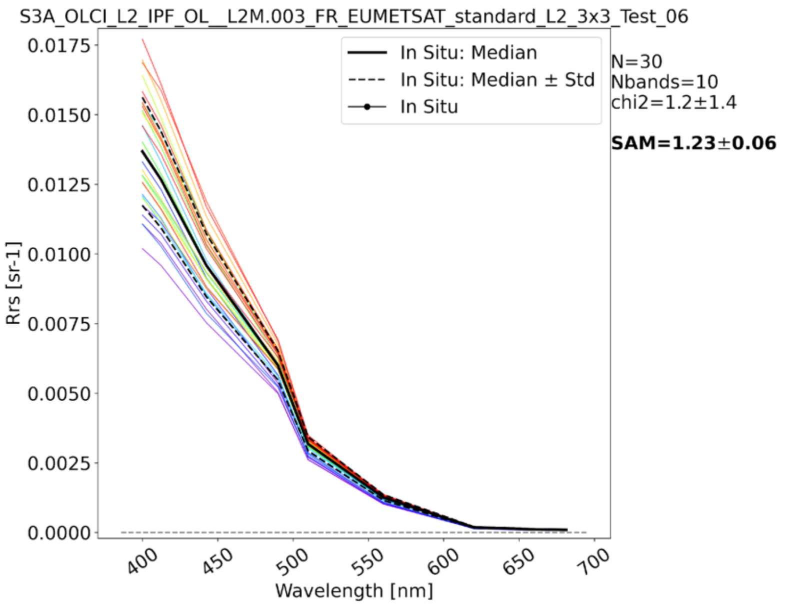
4. List of match-up

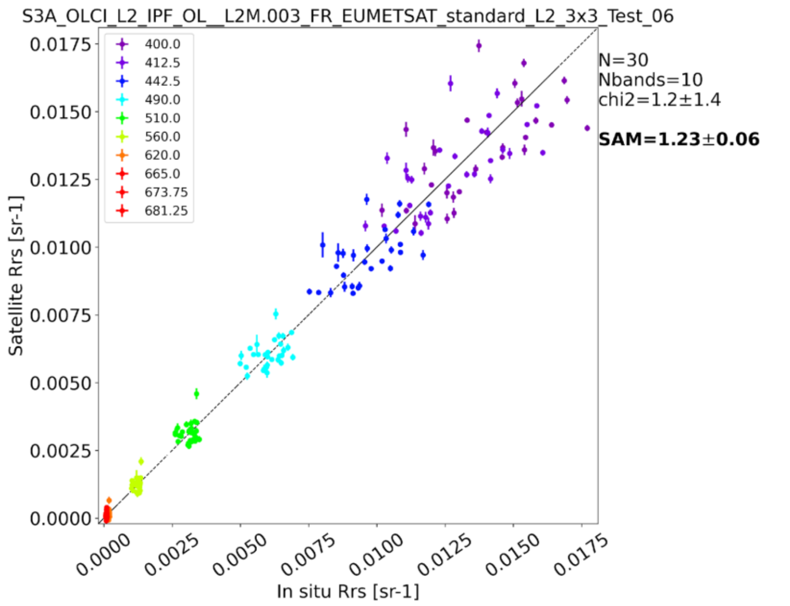


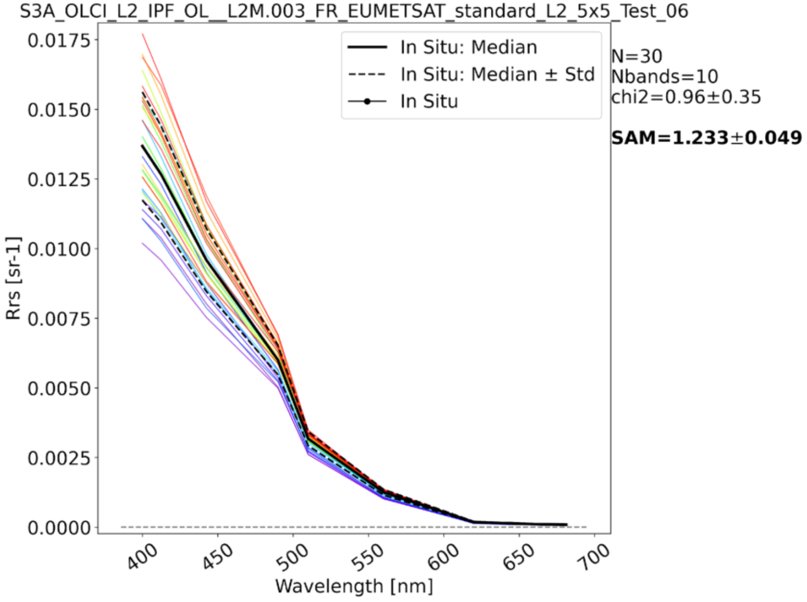
5. Example for match-up

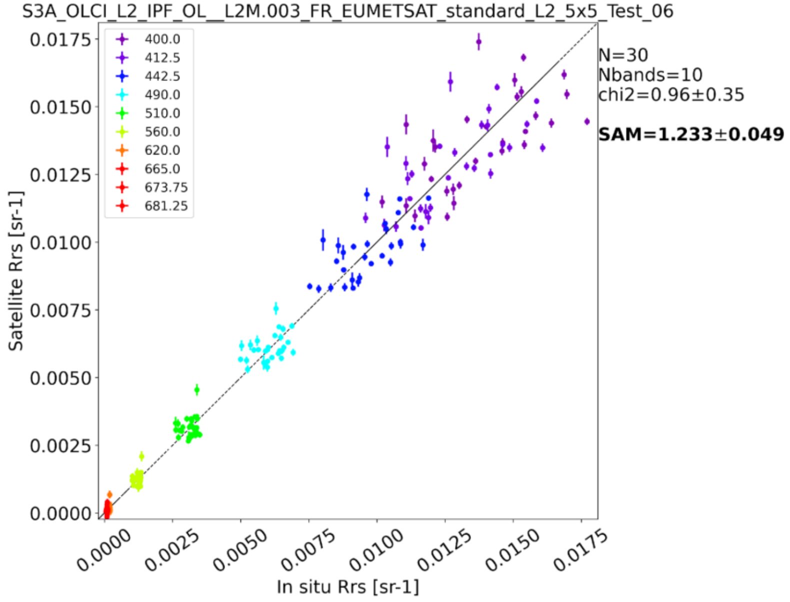
IMPLEMENTED BY EUMETSAT

ThoMAS result for example 6









1. There were 2 case of comparison data, one for 3x3 filter and the other for 5x5 filter.

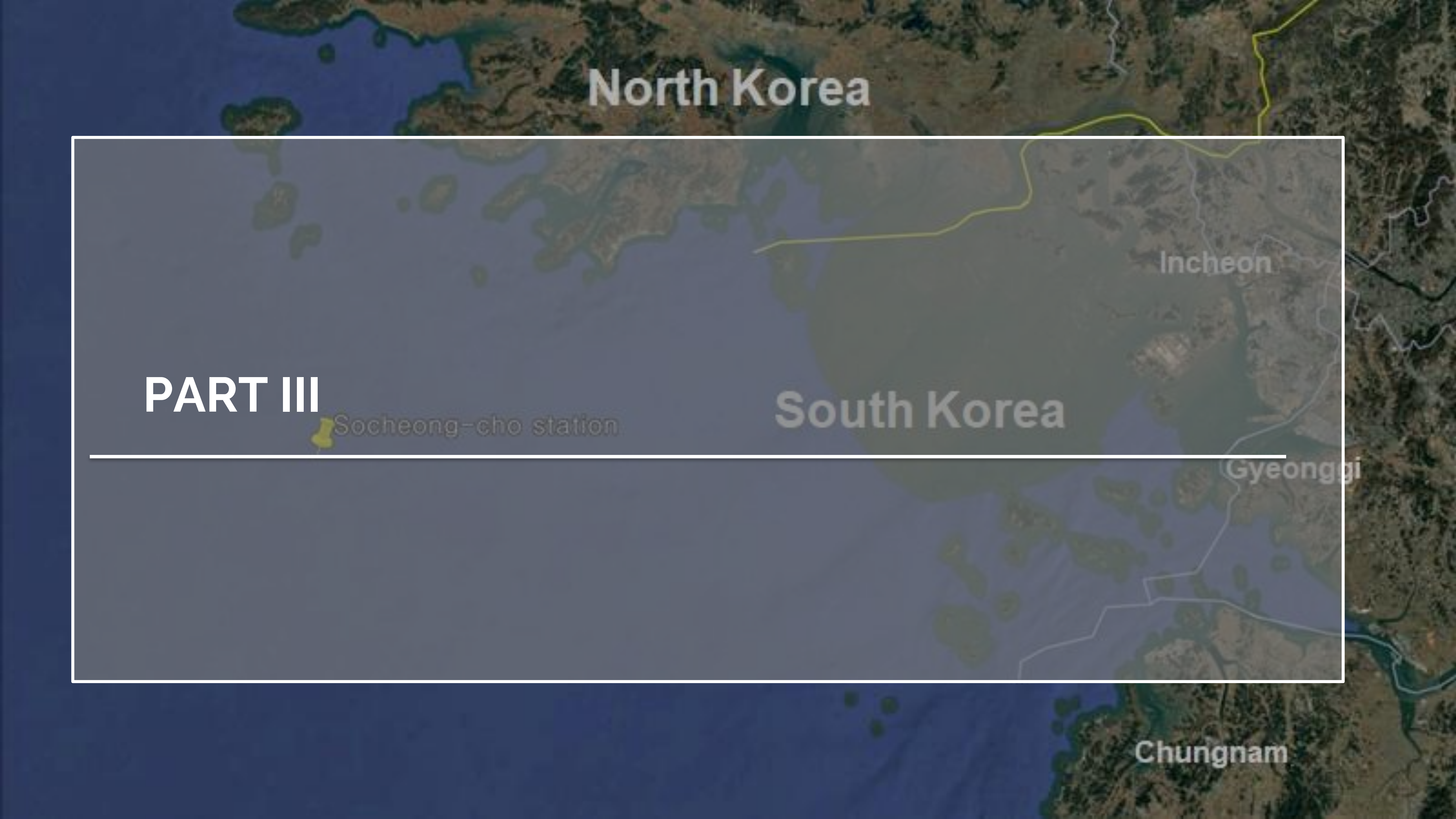
1. There was an inverse relationship between wavelength and the magnitude of the error.

1. It looks like nearby Lānaʻi island in Hawai.

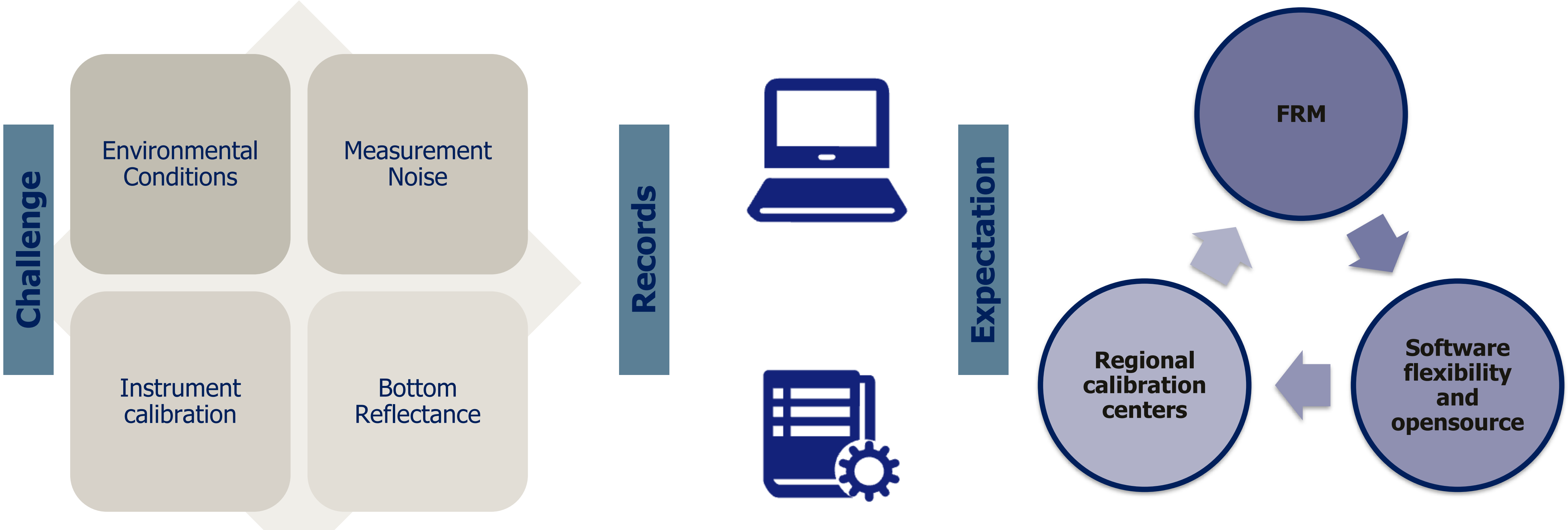
1. I never been before, but the Rrs spectra showed ocean near this area had very clear water (case 1 water)

1. As you can see at the previous slide, match-up result showed a high similarity between satellite and in-situ data

PART III


North Korea
Incheon
Socheong-cho station
South Korea
Gyeonggi
Chungnam

Achieving "FRM quality" over future measurement



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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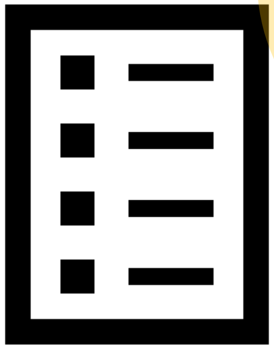
Collaboration



Procedures.

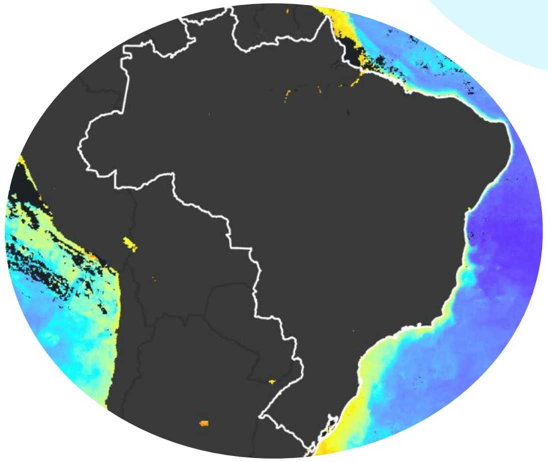
FRM QA/QC framework.

Rigorous in-situ measurements

Improve validation workflows.

Ready to implement

Analytical models for uncertainties



Achieving "FRM quality" over future measurement

- More smaller vessles – 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.

Conclusion

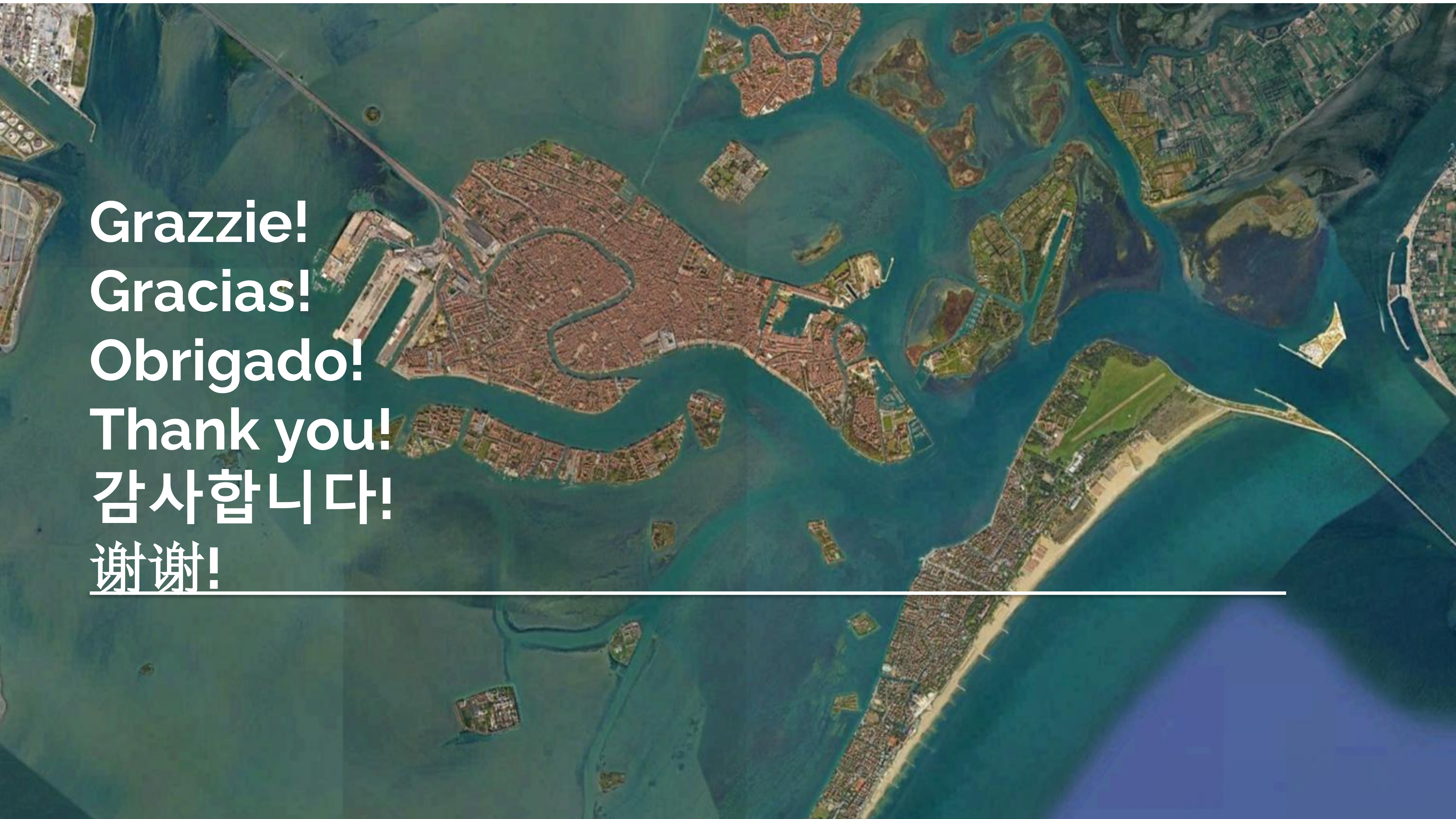
Conclusion

I don't know what to do!

During the lectures aout 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!