2022 DRAGON 5 SYMPOSIUM

MID-TERM RESULTS REPORTING

17-21 OCTOBER 2022

PROJECT ID. 59053

VALIDATION OF OLCI AND COCTS/CZI PRODUCTS AND THEIR POTENTIAL UTILIZATION IN MONITORING OF THE DYNAMIC AND QUALITY OF THE CHINESE AND EUROPEAN COASTAL WATERS

Dragon 5 Mid-term Results Project

ID. 59053

PROJECT TITLE: Validation of OLCI and COCTS/CZI products and their potential utilization in monitoring of the dynamic and quality of the Chinese and European coastal waters

PRINCIPAL INVESTIGATORS: BING HAN — NOTC (CHINA); DR. CÉDRIC JAMET — LOG (FRANCE)

CO-AUTHORS: JIANHUA ZHU, DI JIA, KAI GUO; NOTC (CHINA)
XAVIER MÉRIAUX, HUBERT LOISEL; LOG (FRANCE)
CHAOFEI MA, JIANQIANG LIU; NSOAS(CHINA)

PRESENTED BY: BING HAN, NOTC(CHINA)

国家海洋技术中心 NATIONAL OCEAN TECHNOLOGY CENTER

Objectives

(1) **Characterization of the error budgets** of officially distributed products of **OLCI** onboard Sentinel 3 satellites and **COCTS/CZI** onboard HY-1 satellites in **coastal waters around China and Europe**, e.g., Yellow Sea in China, English Channel in Europe, French Guiana in South America.

(2) Examination of the **consistency between OLCI and COCTS/CZI**, and among other ocean color sensors in these waters.

(3) Development and refinement **regional algorithms** to accurately retrieve marine environment parameters (optical and biogeochemical) in these regions of interest.

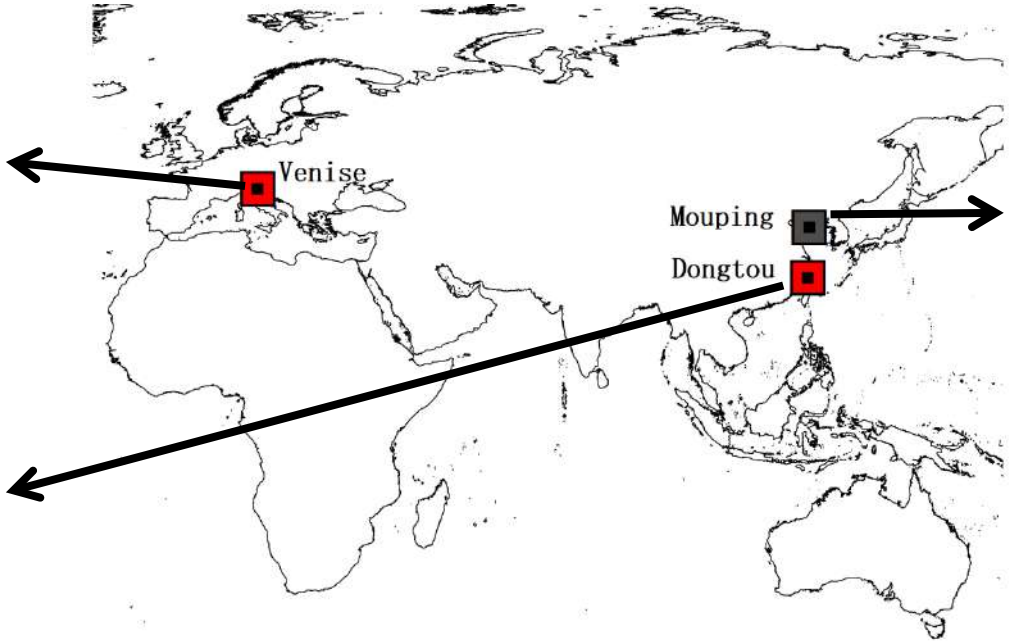
(4) **Utilization of OLCI and COCTS/CZI products** to monitor the dynamic and quality of the Chinese and European coastal waters.

Data and Methodology

(1) In-situ data: automatic measurements by SeaPRISM (CIMEL Inc., France) sun photometer operationally deployed in AERONET-OC

- Venise Adriatic Sea, Europe Operated by JRC, EU
- Dongtou East Sea, China Operated by NSOAS, MNR, China
- Mouping Yellow Sea, China Operated by NSOAS, MNR, China

Venise



Dongtou

To be included in the future

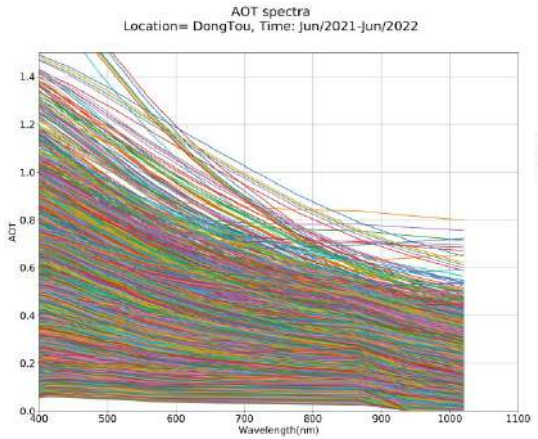
Mouping

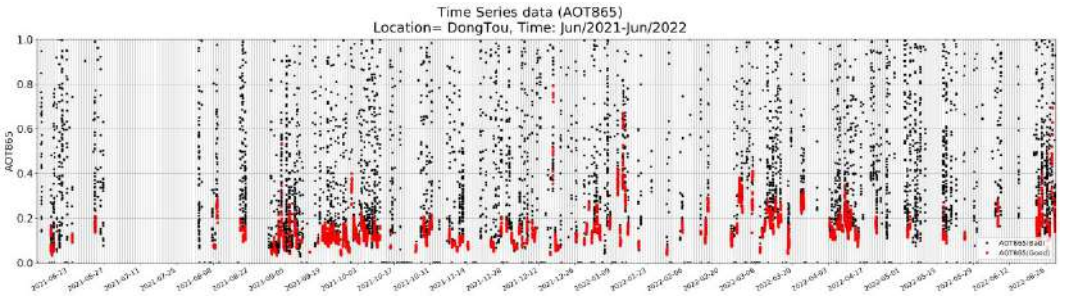
Data and Methodology

(1) In-situ data

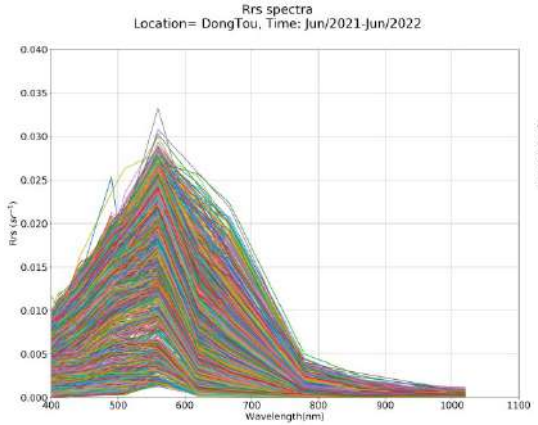
Reference: "G.Zibordi et al. A Network for Standardized Ocean Color Validation Measurements. Eos Transactions, 87: 293, 297, 2006." See also aeronet.gsfc.nasa.gov

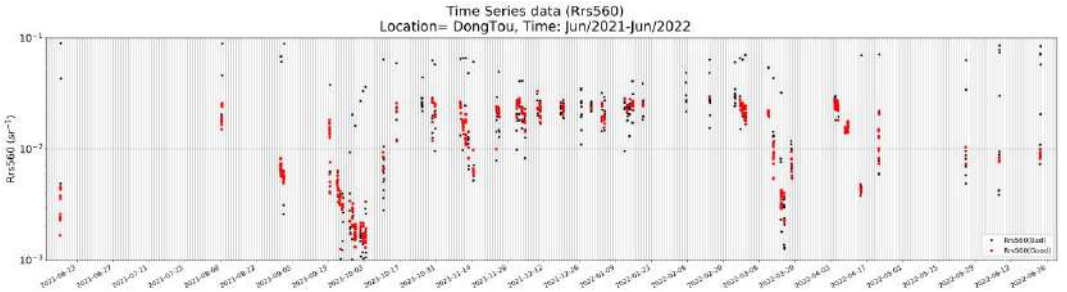
- Dongtou site locates in coastal waters around the **East China Sea**
- **~30km** away from mainland
- **~25m** deep
- SeaPRISM ~15m above surface (**offshore platform**)
- Since **March 2019**





June 2021 ~ June 2022





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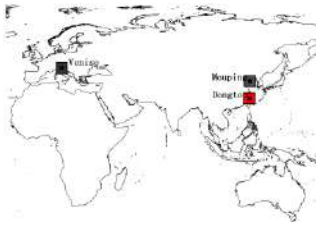
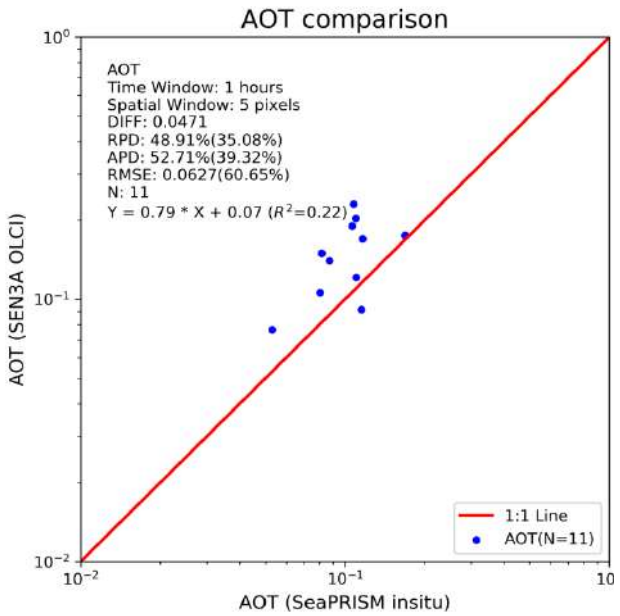
(1) Validation Activities - Ongoing

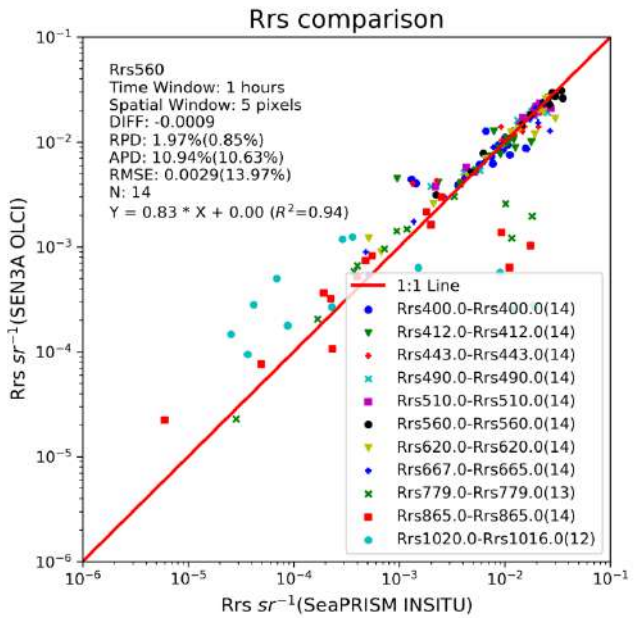
Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



OLCI/Sentinel 3A ---- L2 FR NR



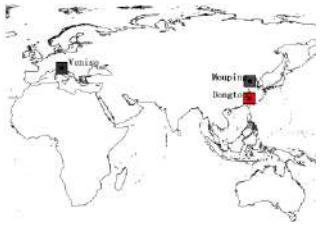


Product	RPD	APD	N
Rrs400-Rrs400	29.9%	47.8%	14
Rrs412-Rrs412	29.8%	46.1%	14
Rrs443-Rrs443	23.8%	32.8%	14
Rrs490-Rrs490	9.9%	15.5%	14
Rrs510-Rrs510	8.0%	13.7%	14
Rrs560-Rrs560	2.0%	10.9%	14
Rrs620-Rrs620	8.9%	23.4%	14
Rrs665-Rrs667	2.6%	21.4%	14
Rrs779-Rrs779	-1.1%	42.0%	13
Rrs865-Rrs865	20.2%	69.7%	14
Rrs1016-Rrs1020	180.8%	238.8%	12
AOT	48.9%	52.7%	11
Chla	-82.9%	82.9%	14

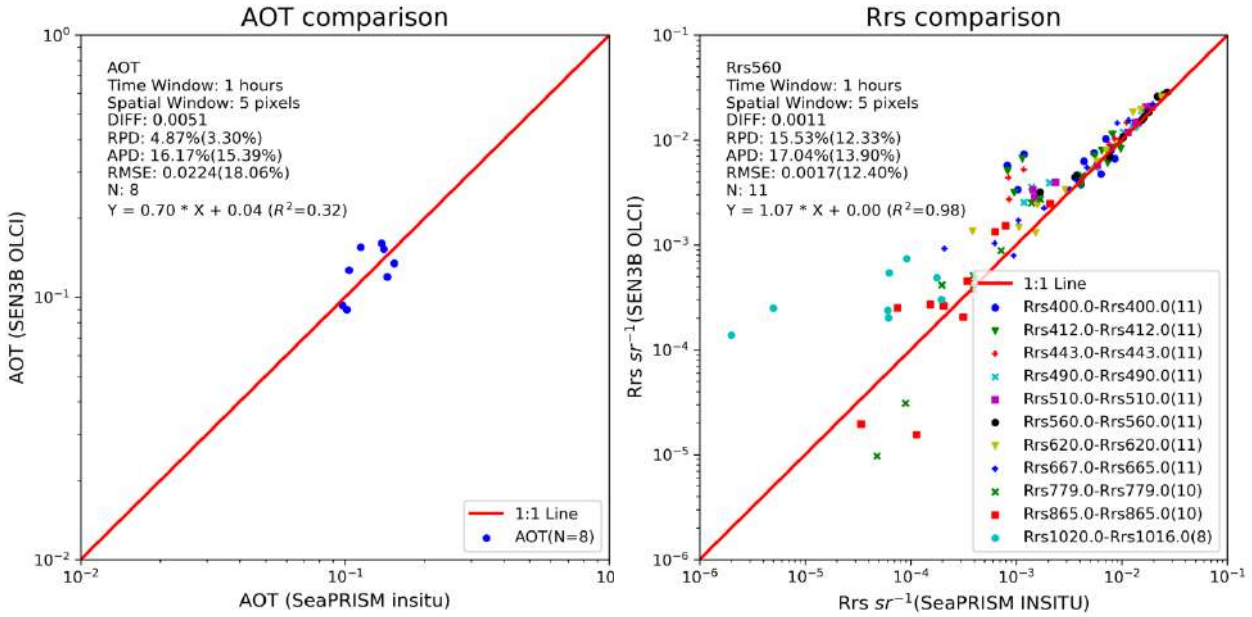
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



OLCI/Sentinel 3B ---- L2 FR NR

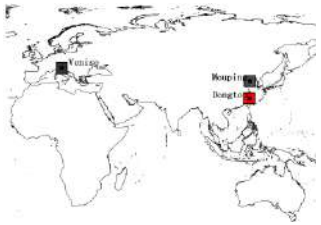


Product	RPD	APD	N
Rrs400-Rrs400	129.5%	139.6%	11
Rrs412-Rrs412	116.6%	124.4%	11
Rrs443-Rrs443	96.6%	96.9%	11
Rrs490-Rrs490	38.9%	39.3%	11
Rrs510-Rrs510	31.3%	31.7%	11
Rrs560-Rrs560	15.5%	17.0%	11
Rrs620-Rrs620	41.2%	43.7%	11
Rrs665-Rrs667	56.1%	59.1%	11
Rrs779-Rrs779	18.9%	48.7%	10
Rrs865-Rrs865	42.2%	75.0%	10
Rrs1016-Rrs1020	1741.6%	1741.6%	8
AOT	4.9%	16.2%	8
Chla	-80.1%	80.1%	11

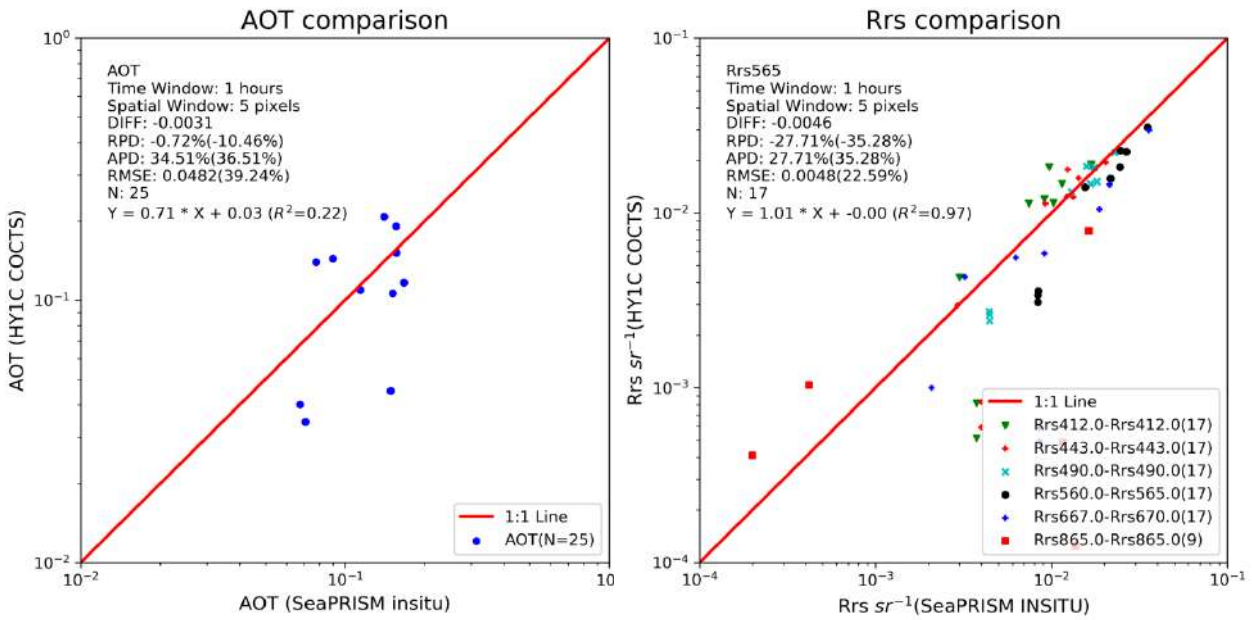
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



COCTS/Haiyang 1C ---- L2A



Product	RPD	APD	N*
Rrs412-Rrs412	20.2%	39.6%	17
Rrs443-Rrs443	-4.1%	19.9%	17
Rrs490-Rrs490	-12.5%	17.8%	17
Rrs565-Rrs560	-27.7%	27.7%	17
Rrs670-Rrs667	-36.0%	40.0%	17
Rrs865-Rrs865	-10.2%	99.3%	9
AOT	-0.7%	34.5%	25

*Match-up numbers do not match those in the figure because of duplicate COCTS scenes

(3) Summary

- EO products from both ESA (Sentinel 3A/3B) and China (Haiyang 1C/1D) are validated with automatic measurements by SeaPRISM deployed in coastal waters around the East China Sea and the Adriatic Sea in Europe
- Sentinel 3A slightly outperforms Sentinel 3B in both East China Sea and Adriatic Sea
- More scatters in COCTS products that in that of OLCI and MODIS products
- L2B products from COCTS/Haiyang 1D seems problematic in both the East China Sea and the Adriatic Sea Sea (some scenes)
- In the East China Sea, good consistency between OLCI/Sentinel 3A/3B and MODIS/TERRA except small amount of match-ups, however, AOT of OLCI tends to be higher than MODIS; Rrs412 and AOT of COCTS/Haiyang 1C tends to be lower than MODIS, however, COCTS/Haiyang 1D shows low consistency with MODIS/Terra.
- The same seems true for the case of the Adriatic Sea, both OLCI and COCTS.

Future Plans

Schedule(cont.):

☐July 2023-June 2024

(1)Develop special products for COCTS/OLCI and/or CZI/MSI in special coastal waters

(2)Description of the dynamics and quality of Chinese and European coastal waters: PhD thesis Corentin Subirdade (ESA/ULCO)

☐July 2024-December 2024

(1)Summary

Thanks for your attention

Besoins

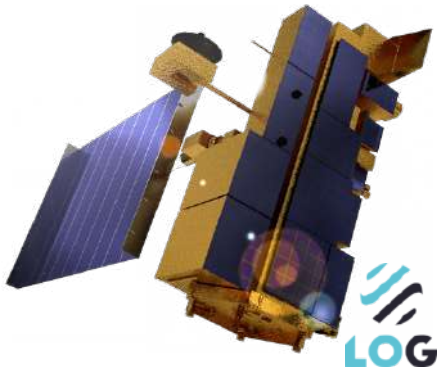
- Mise à disposition données S3 sur France et Europe
- Moyen de calcul et de stockage
- Possibilité d'implémenter des algorithmes
- **BESOINS de type ICARE**

Data and Methodology

(2) EO Data (Ocean Color)

- **Rrs**
- **AOT**
- **Chla (chlorophyll a)**

NO.	SeaPRISM @Dongtou	SeaPRISM @Venise	OLCI	COCTS	MODIS
1	400		400		
2	412	412	412	412	412
3	443	443	443	443	443
4					469
5	490	490	490	490	488
6	510		510	520	
7		532			531
8					547
9	560	551	560	565	555
10	620		620		
11					645
12	667	667	665	670	667
13			674		678
14			682		
15			709		
16			754	750	
17	779		779		
18	865	870	865	865	



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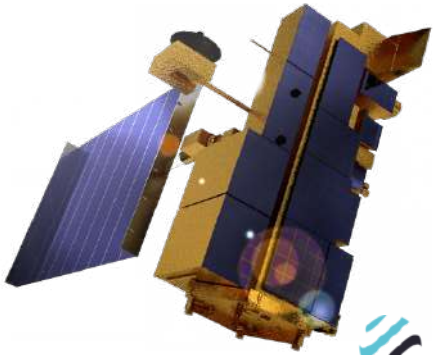
Data and Methodology

(2) EO Data (Ocean Color)

- **OLCI/Sentinel 3A/3B (Feb 16, 2016 / Apr 25 2018) ~ Local 10:00**
  - L2 Full Resolution/Near-Realtime
  - 16 spectral bands in VIS-NIR
  - 300m spatial resolution, global coverage (~1270km swath)

- **COCTS/Haiyang 1C/1D (Sep 7, 2018 / Jun 11, 2020) ~Local 10:30/13:30**
  - L2A, L2B
  - 8 spectral bands in VIS-NIR
  - 1000m spatial resolution, global coverage (~2900km swath)



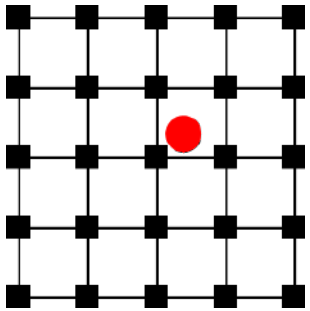
- **MODIS/TERRA (Dec 18, 1999) ~Local 10:30**
  - L2A, L2B
  - 8 spectral bands in VIS-NIR
  - 1200m spatial resolution, global coverage (~2330km swath)

Data and Methodology

(4) Validation Protocol -- Math-up and Statistics

- **In-situ data vs EO data (validation)**

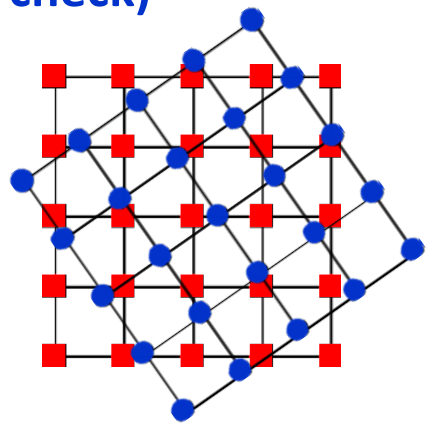
Match-up criteria



- ✓ Time window: 1 hour
- ✓ Spatial window: 5*5 pixels
- ✓ Percentage of valid pixels: >50%
- ✓ Spatial Homogeneity: CV < 0.3
- ✓ sun zenith and sensor zenith checked
- ✓ Product flags checked
- ✓ Average over defined box

- **EO data vs EO data (consistency check)**

Match-up criteria



- ✓ Time window: 1 hour
- ✓ Spatial window: 5*5 pixels
- ✓ Percentage of valid pixels: >50%
- ✓ Spatial Homogeneity: CV < 0.3
- ✓ sun zenith < 70°, sensor zenith < 60°
- ✓ Product flags not identified
- ✓ Average over defined box

$$\overline{RPD} = \frac{\sum_{i=1}^{N} \frac{y_i - x_i}{x_i}}{N} \times 100\%$$

$$\overline{APD} = \frac{\sum_{i=1}^{N} \left| \frac{y_i - x_i}{x_i} \right|}{N} \times 100\%$$

xi – reference measurement

yi – target measurement

N – number of match-ups

Mid-term Results

(1) Validation Activities – Ongoing

- Referenced with SeaPRISM measurements @ Dongtou, East China Sea
  - ✓ OLCI L2, Sentinel 3A/3B
  - ✓ COCTS L2A/L2B, Haiyang 1C/1D
  - ✓ MODIS L2, TERRA
- Based on SeaPRISM measurements @ Venise, Adriatic Sea
  - ✓ OLCI L2, Sentinel 3A/3B
  - ✓ COCTS L2A/L2B, Haiyang 1C/1D
  - ✓ MODIS L2, TERRA

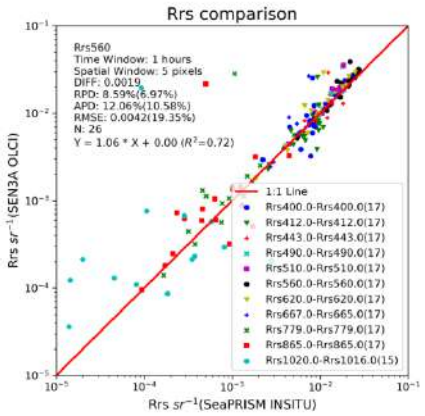
(2) Consistency Check – First Results

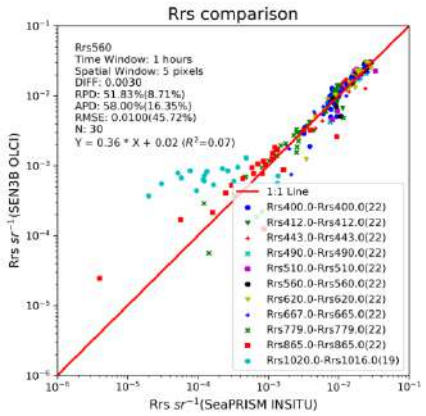
- OLCI L2 (Sentinel 3A/3B) vs MODIS L2 (Terra)
- COCTS L2A/L2B (Haiyang 1C/1D) vs MODIS L2 (Terra)

(3) Young Scientists Training

(1) Validation Activities - Ongoing

First Year (Jun/2020-Jun/2021)





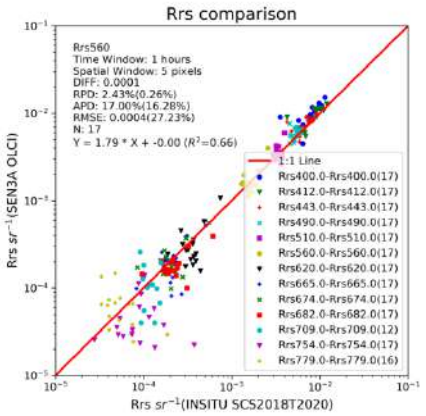
EO sensor: OLCI/Sentinel 3A/3B

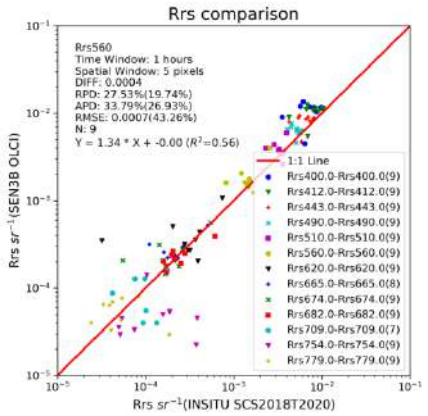
Product Type: FR NT

In-situ data: Dongtou/SeaPRISM

Time Range: Jan/2020-Jun/2021

Region: East China Sea





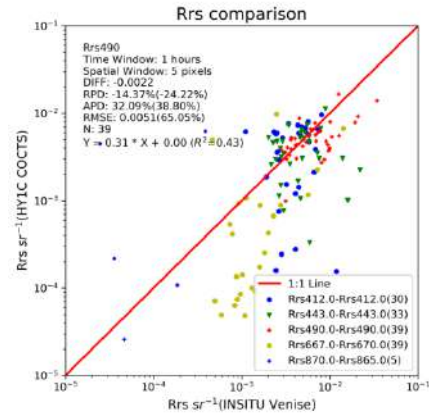
EO sensor: OLCI/Sentinel 3A/3B

Product Type: FR NT

In-situ data: HY1DIOT2020 & SCS2019

Time Range: Jul-Aug/2020

Region: East and South China Sea



EO sensor: COCTS/HY-1C

Product Type: L2A

In-situ data: Venise/SeaPRISM

Time Range: Jan/2020-Dec/2020

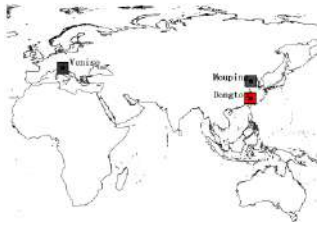
Region: Adriatic Sea

Mid-term Results

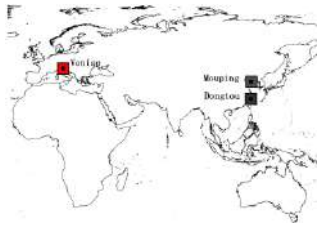
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



Venise, Adriatic Sea



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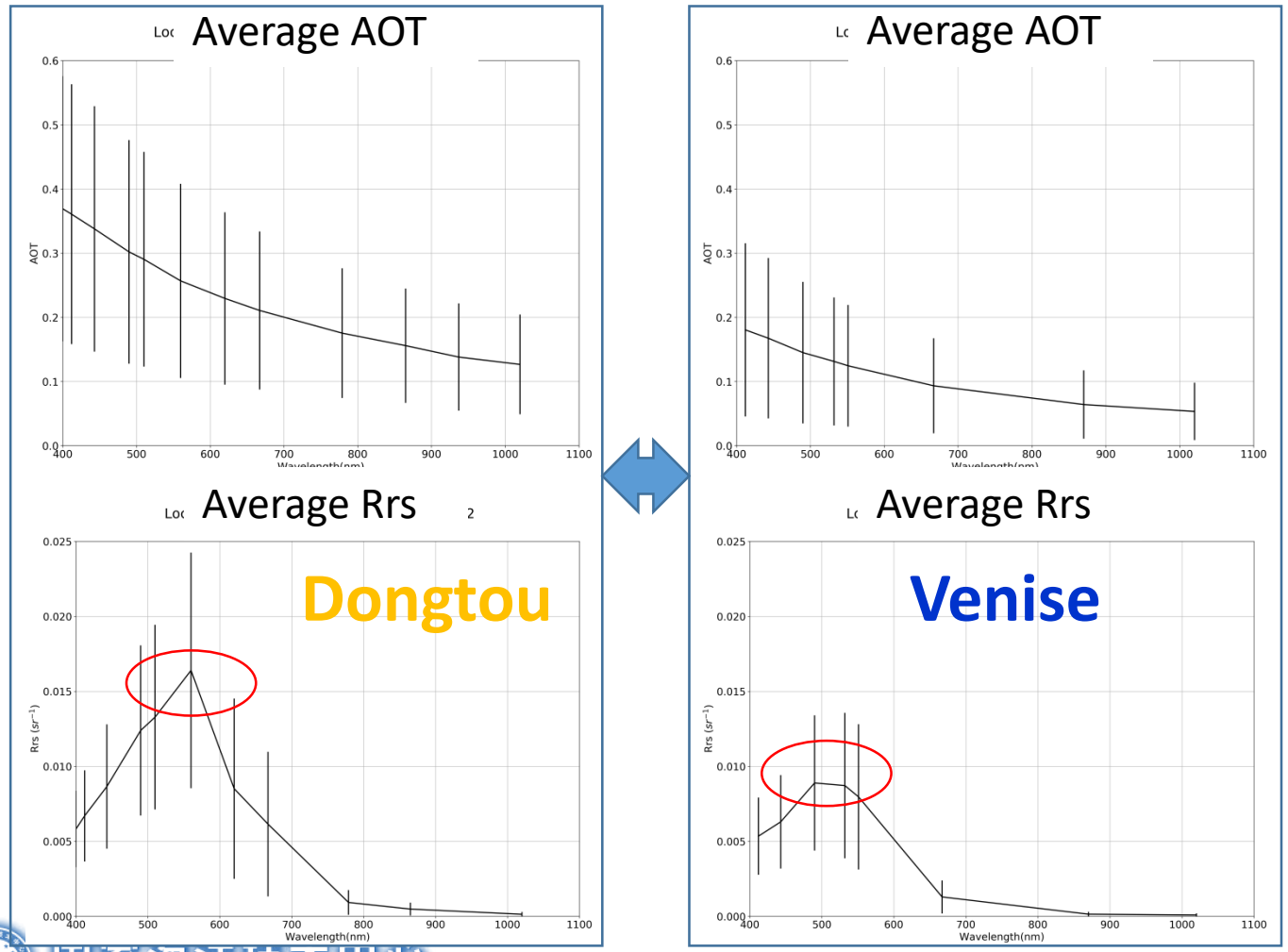
Data and Methodology

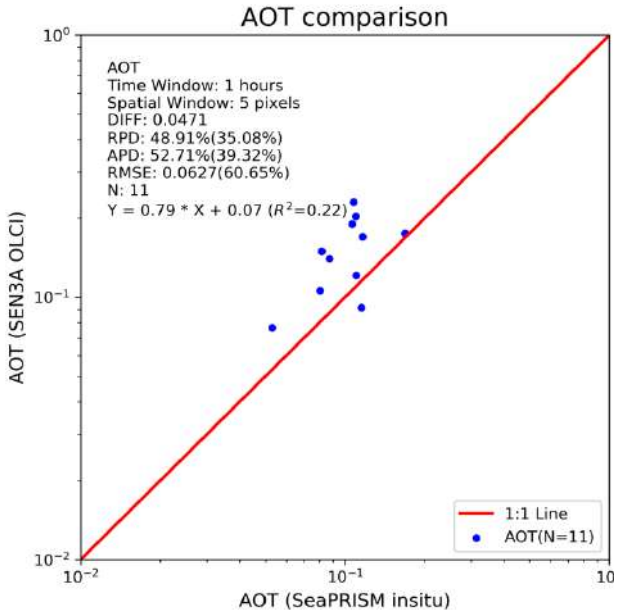
(1) In-situ data

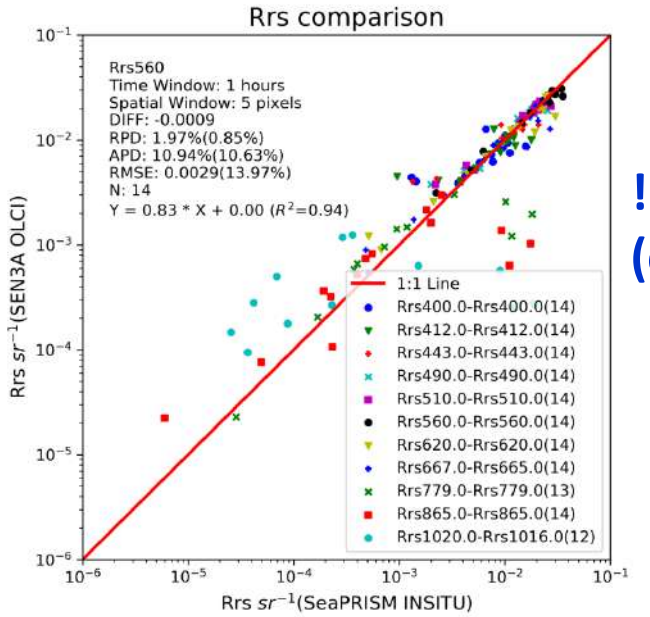


- Both typical **Case 2** spectral characteristics (see Rrs), but sometimes Case 1 for Venise
- **Aerosol load** @ Dongtou much higher (also more variance) than that @ Venise
- **Rrs peaks** around 560nm @ Dongtou, but flat shoulder between 490-532nm@Venise

(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)





!!! No in-situ data is available for Chla (chlorophyll a)

Mid-term Results

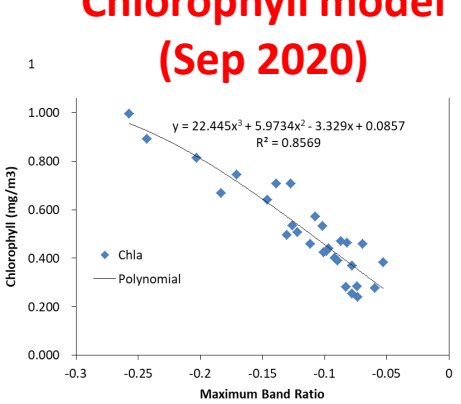
(1) Validation Activities - Ongoing

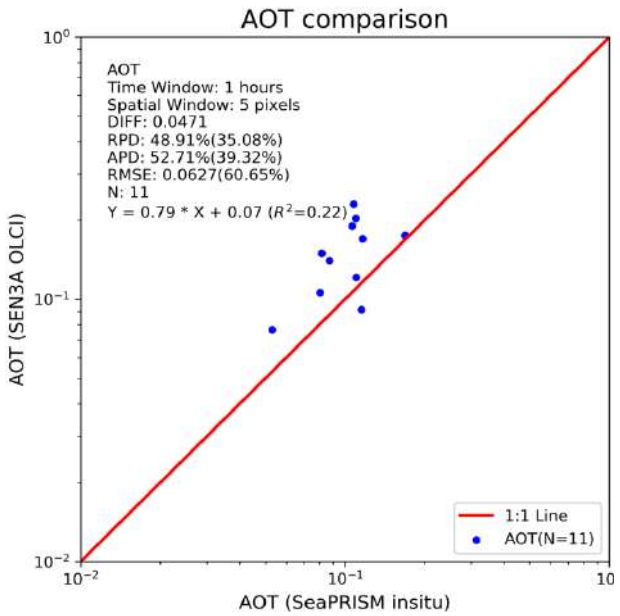
Second Year (Jun/2021 – Jun/2022)

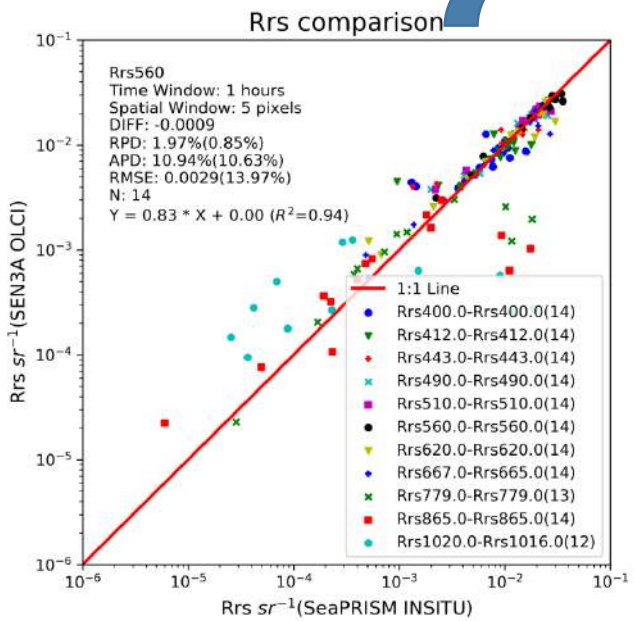
$$MBR = \max\left(\frac{R_rs412}{R_rs560}, \frac{R_rs443}{R_rs560}, \frac{R_rs490}{R_rs560}\right)$$

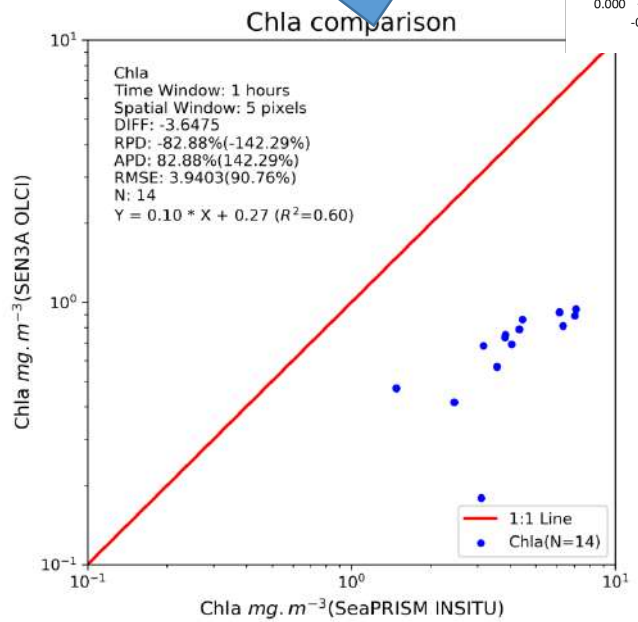
APD~13.5%

Chlorophyll model (Sep 2020)





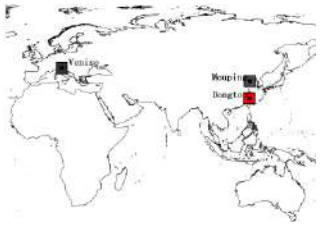




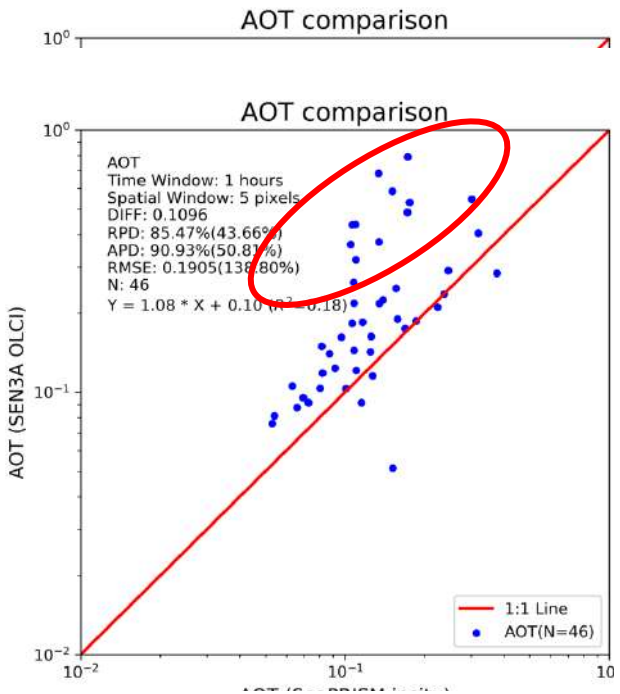
(1) Validation Activities - Ongoing

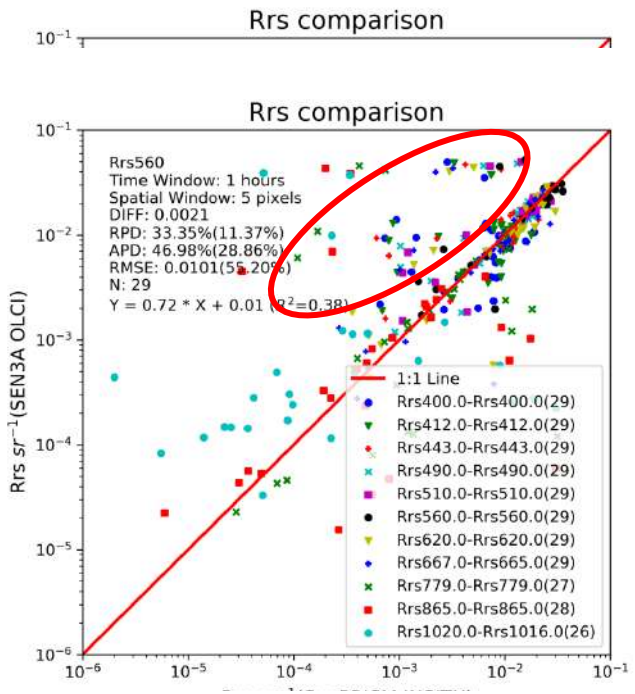
Second Year (Jun/2021 – Jun/2022)

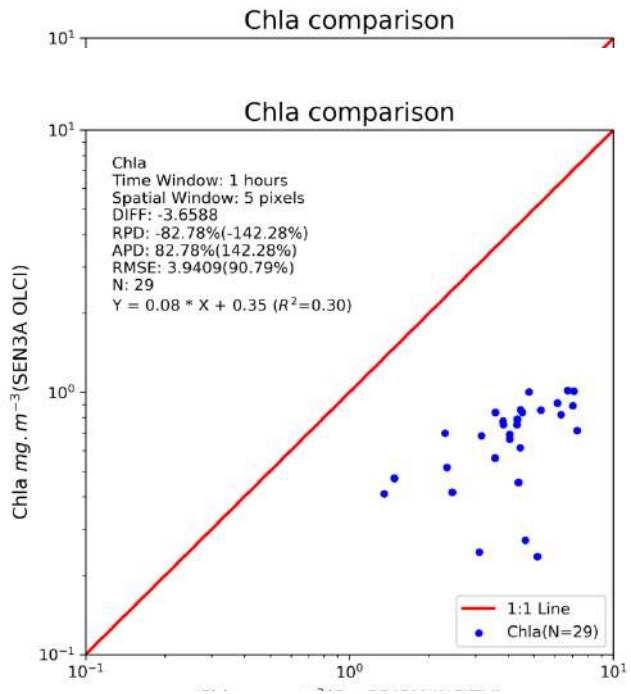
Dongtou, East China Sea



OLCI/Sentinel 3A ---- L2 FR NR







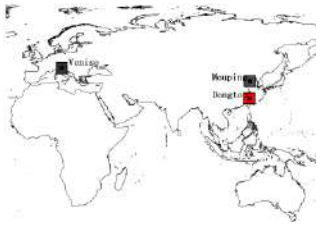
When product quality flag is not considered, number of match-ups increases greatly!

General trend remains but statistics tends to worse (due to certain cases)

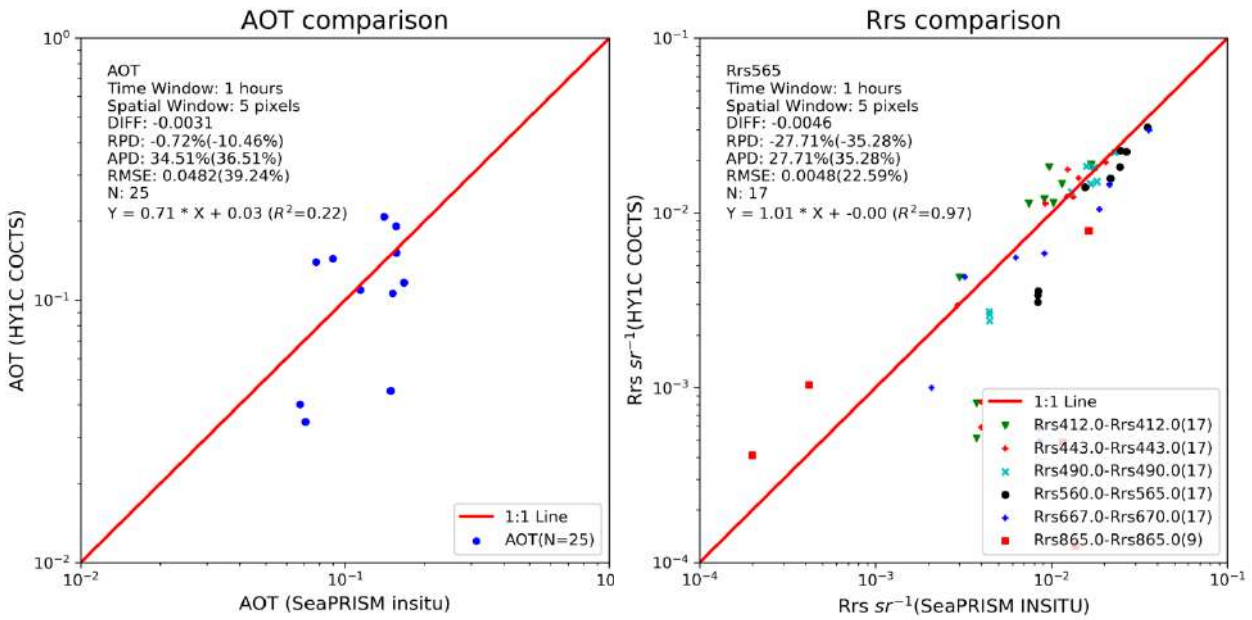
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



COCTS/Haiyang 1C ---- L2A



Product	RPD	APD	N*
Rrs412-Rrs412	20.2%	39.6%	17
Rrs443-Rrs443	-4.1%	19.9%	17
Rrs490-Rrs490	-12.5%	17.8%	17
Rrs565-Rrs560	-27.7%	27.7%	17
Rrs670-Rrs667	-36.0%	40.0%	17
Rrs865-Rrs865	-10.2%	99.3%	9
AOT	-0.7%	34.5%	25

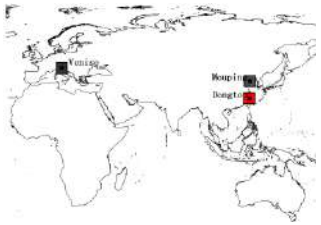
*Match-up numbers do not match those in the figure because of duplicate COCTS scenes

Mid-term Results

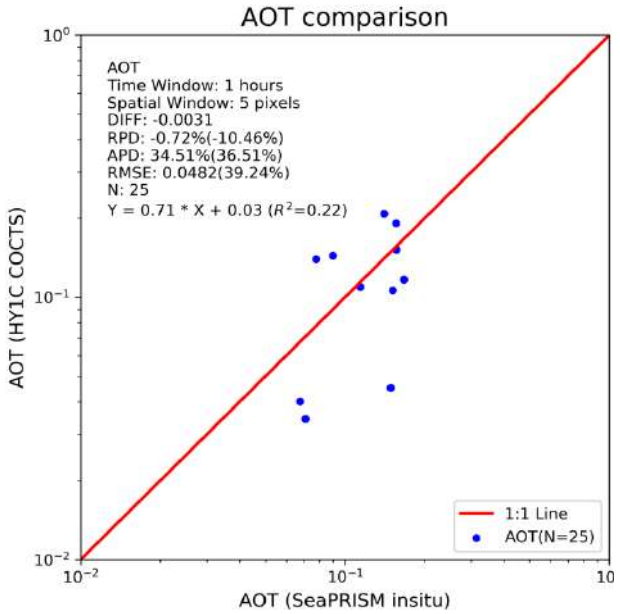
(1) Validation Activities - Ongoing

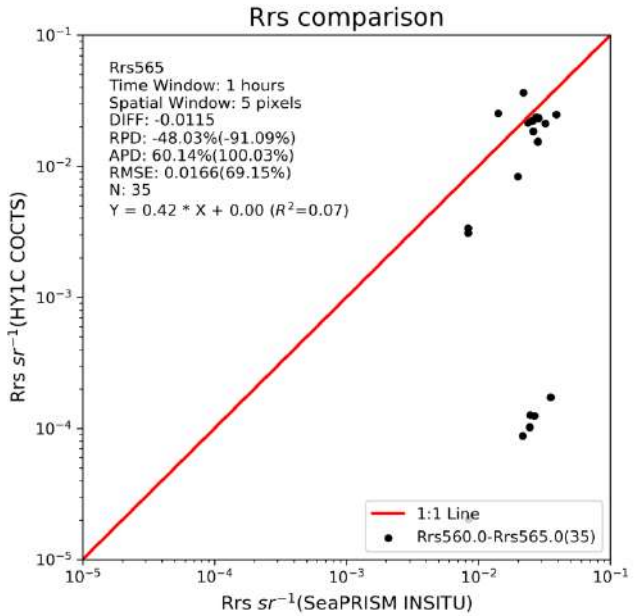
Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea

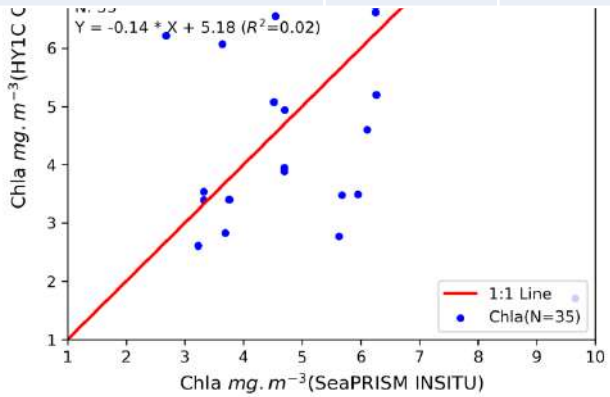


COCTS/Haiyang 1C ---- L2B





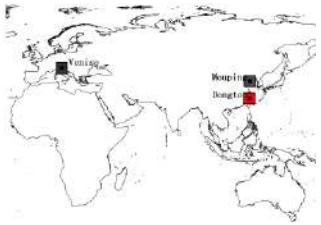
Product	RPD	APD	N*
Rrs565-Rrs560	-48.0%	60.1%	35
AOT	-4.1%	33.2%	22
Chla	-1.5%	31.4%	35
Rrs565-Rrs560	-27.7%	27.7%	17



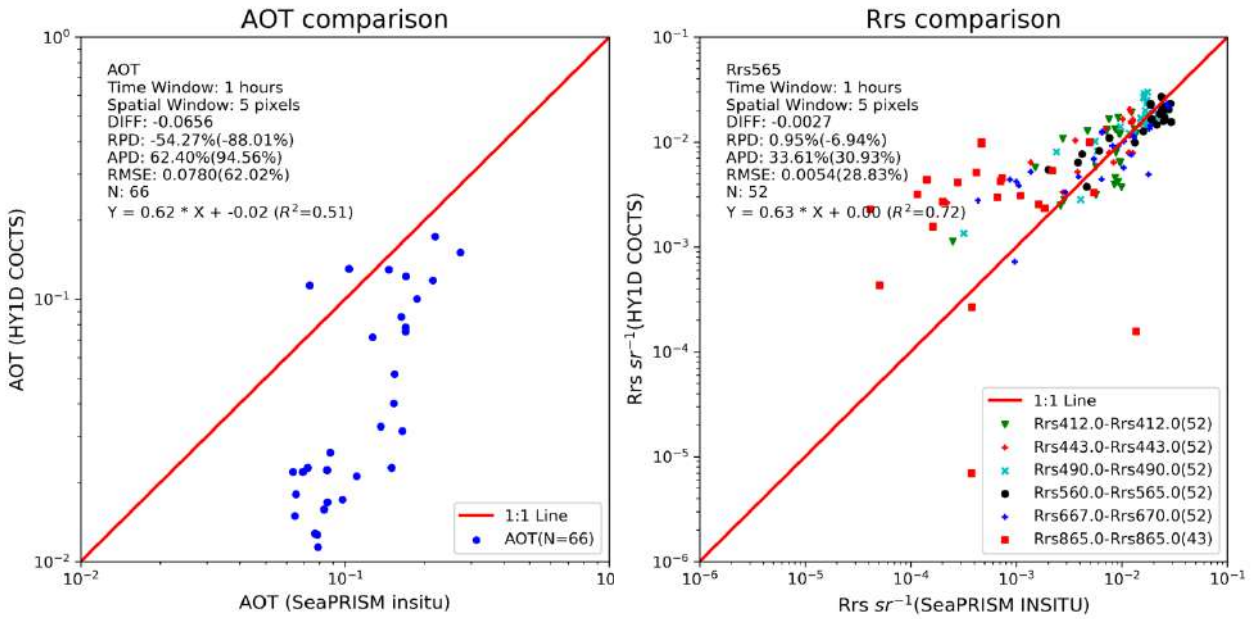
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea



COCTS/Haiyang 1D ---- L2A

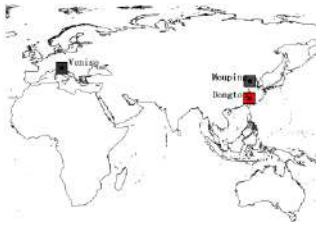


Product	RPD	APD	N*
Rrs412-Rrs412	45.1%	76.0%	52
Rrs443-Rrs443	69.3%	88.8%	52
Rrs490-Rrs490	34.2%	47.5%	52
Rrs565-Rrs560	1.0%	33.6%	52
Rrs670-Rrs667	62.3%	90.1%	52
Rrs865-Rrs865	983.7%	1003.9%	43
AOT	-54.3%	62.4%	66

(1) Validation Activities - Ongoing

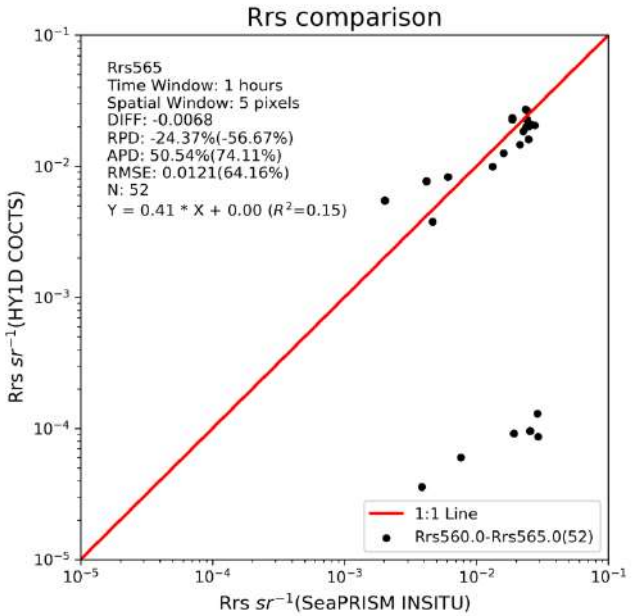
Second Year (Jun/2021 – Jun/2022)

Dongtou, East China Sea

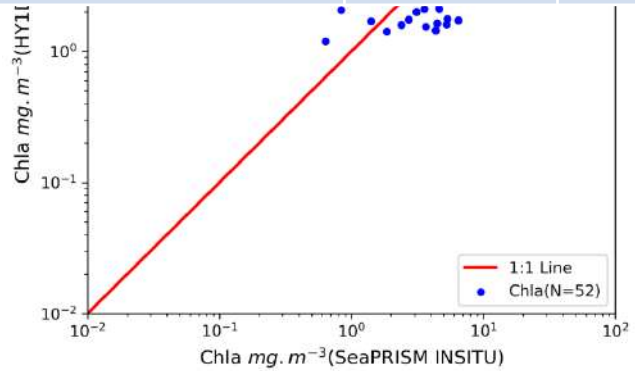


COCTS/Haiyang 1D ---- L2B

No AOT Match-up!



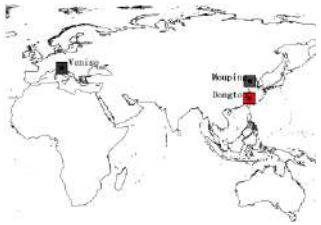
Product	RPD	APD	N*
Rrs565-Rrs560	-24.4%	50.5%	52
AOT	-	-	-
Chla	1733.3% (-19.1%)	1796.7% (46.8%)	52



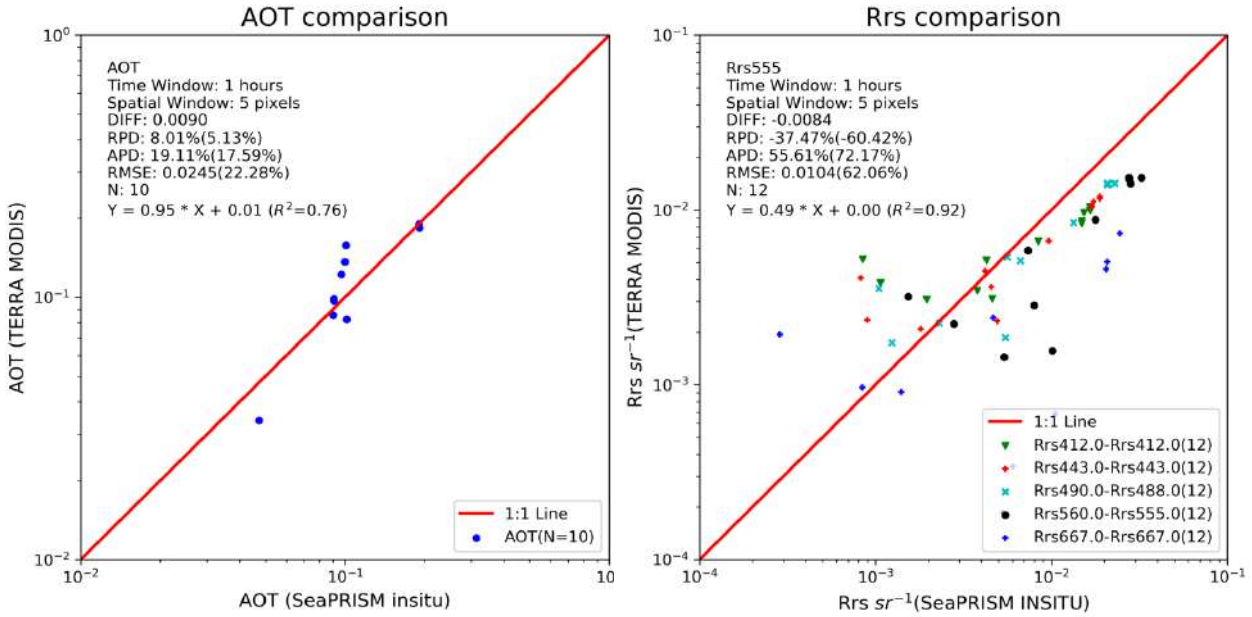
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

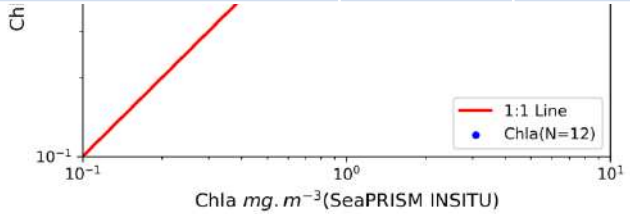
Dongtou, East China Sea



MODIS/TERRA ---- L2



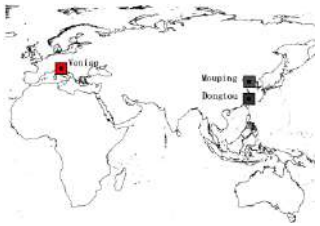
Product	RPD	APD	N
Rrs412-Rrs412	49.4%	93.1%	12
Rrs443-Rrs443	23.9%	72.5%	12
Rrs488-Rrs490	-2.0%	48.9%	12
Rrs555-Rrs560	-37.5%	55.6%	12
Rrs667-Rrs667	-12.1%	111.0%	12
AOT	8.0%	19.1%	10
Chla	-50.8%	50.8%	12



(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

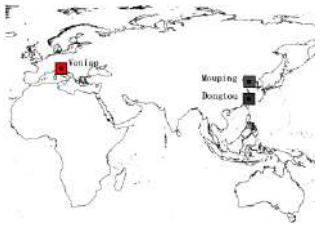
Venise, Adriatic Sea



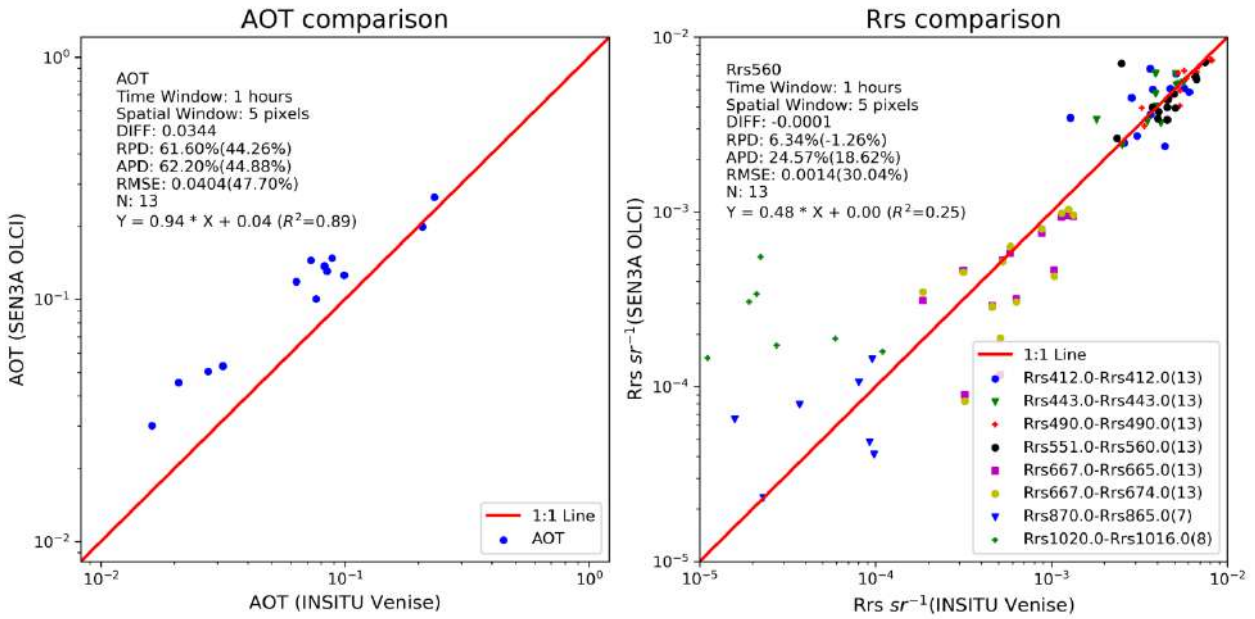
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Venise, Adriatic Sea



OLCI/Sentinel 3A ---- L2 FR NR

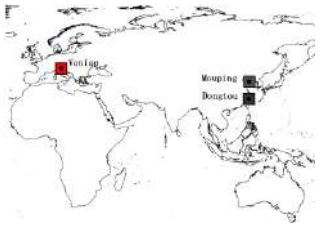


Product	RPD	APD	N
Rrs412-Rrs412	27.6%	41.9%	13
Rrs443-Rrs443	16.3%	23.0%	13
Rrs490-Rrs490	-2.1%	10.0%	13
Rrs551-Rrs560	6.3%	24.6%	13
Rrs665-Rrs667	-20.2%	37.8%	13
Rrs674-Rrs667	-16.5%	38.0%	13
Rrs865-Rrs870	57.6%	87.8%	7
Rrs1016-Rrs1020	2899.8%	2899.8%	8
AOT	61.6%	62.2%	13
Chla	823.3%	958.8%	8

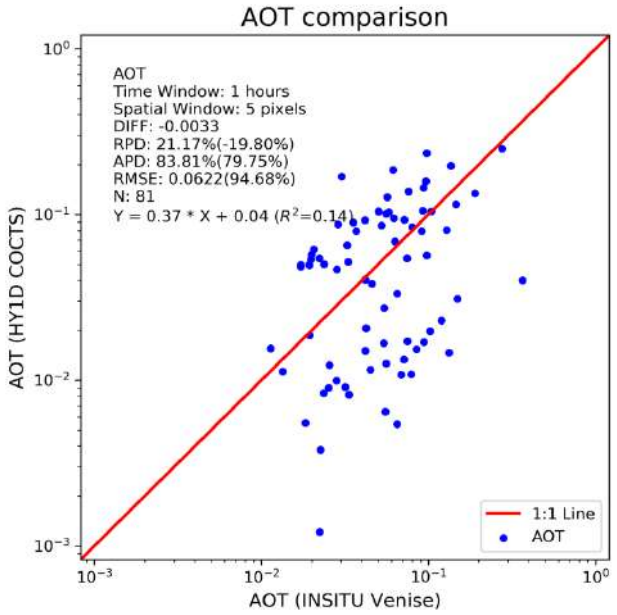
(1) Validation Activities - Ongoing

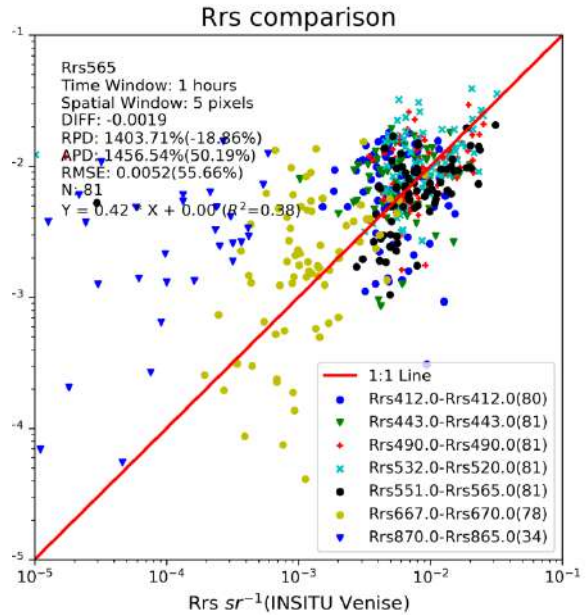
Second Year (Jun/2021 – Jun/2022)

Venise, Adriatic Sea



COCTS/Haiyang 1D ---- L2A



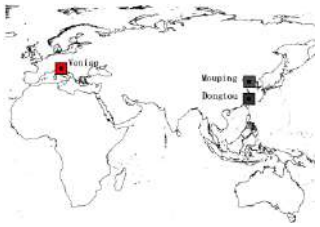


Product	RPD	APD	N
Rrs412-Rrs412	64.7%	101.1%	80
Rrs443-Rrs443	51.9%	80.2%	81
Rrs490-Rrs490	8661.5%	8692.1%	81
Rrs565-Rrs560	1403.7%	1456.5%	81
Rrs670-Rrs667	158.0%	187.6%	78
Rrs865-Rrs865	5576.8%	5576.8%	34
AOT	21.2%	83.8%	81

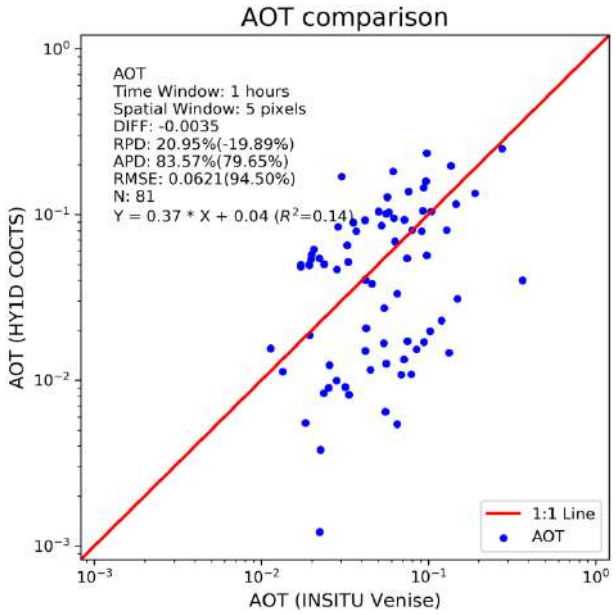
(1) Validation Activities - Ongoing

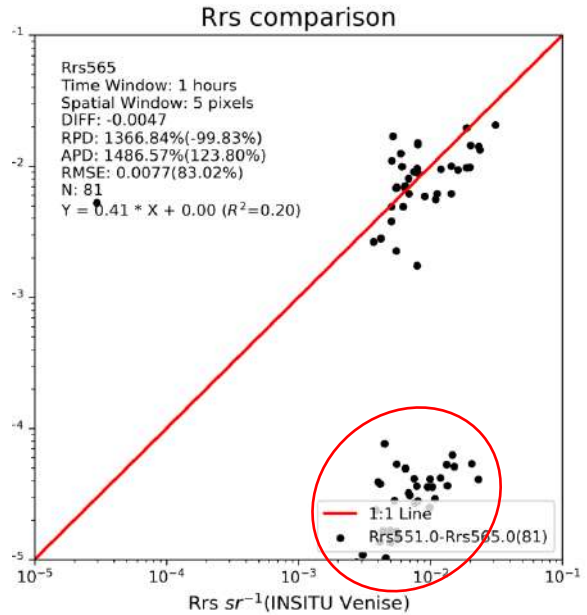
Second Year (Jun/2021 – Jun/2022)

Venise, Adriatic Sea

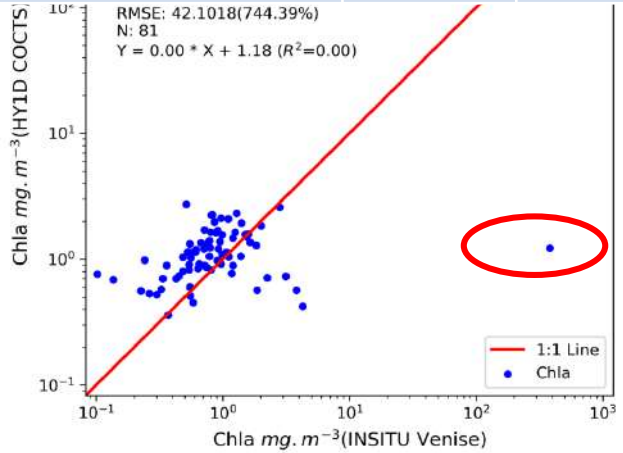


COCTS/Haiyang 1D ---- L2B



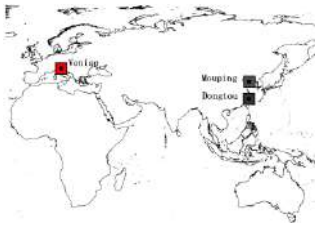


Product	RPD	APD	N
Rrs565-Rrs560	1367%	1487%	81
AOT	20.95%	83.57%	81
Chla	63%	81%	52

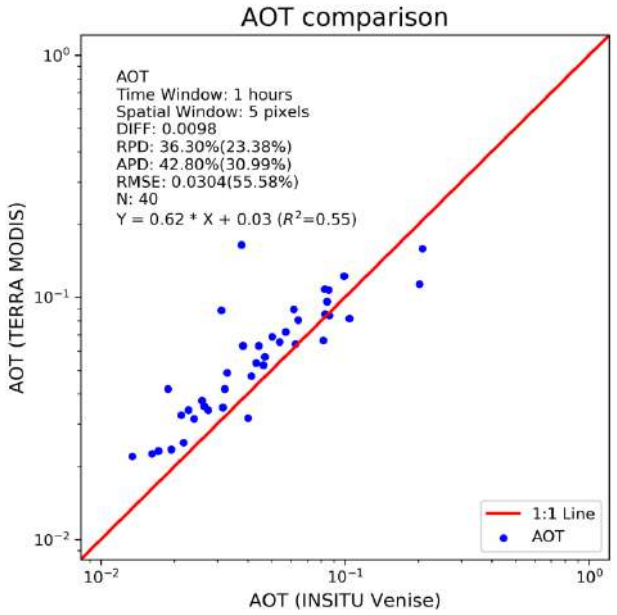


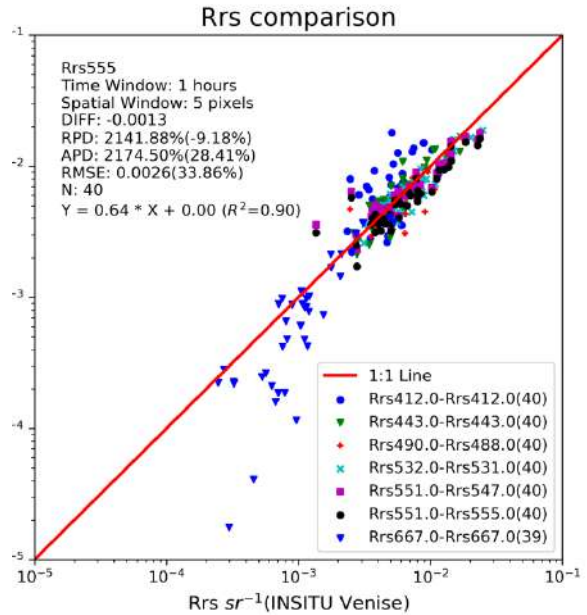
(1) Validation Activities - Ongoing

Venise, Adriatic Sea

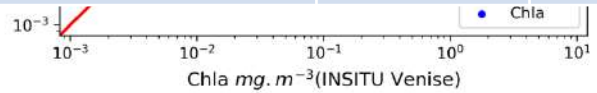


MODIS/TERRA ---- L2





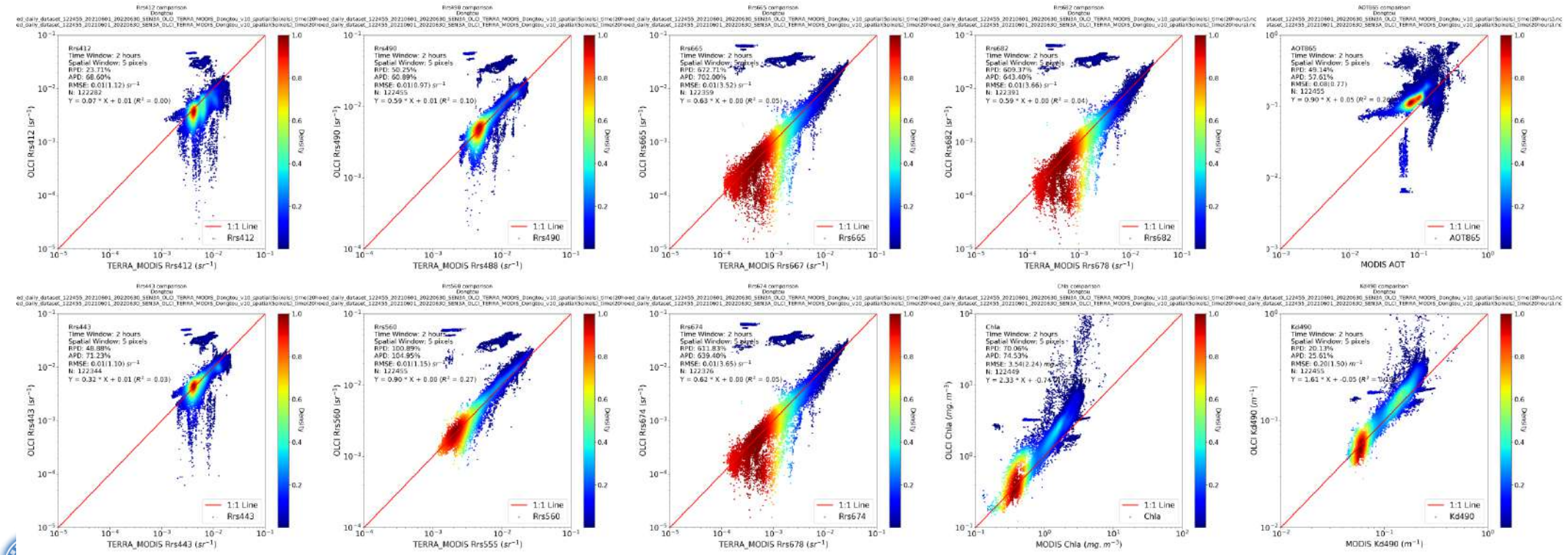
Product	RPD	APD	N
Rrs412-Rrs412	45.6%	56.3%	40
Rrs443-Rrs443	4.4%	18.9%	40
Rrs488-Rrs490	-7.9%	17.6%	40
Rrs547-Rrs551	2413.7%	2432.4%	40
Rrs667-Rrs667	-29.8%	36.2%	39
AOT	36.3%	42.8%	40
Chla	3420.0% (104.5%)	3420.4% (104.9%)	37



(2) Consistency Check – First Results

Second Year (Jun/2021 – Jun/2022)

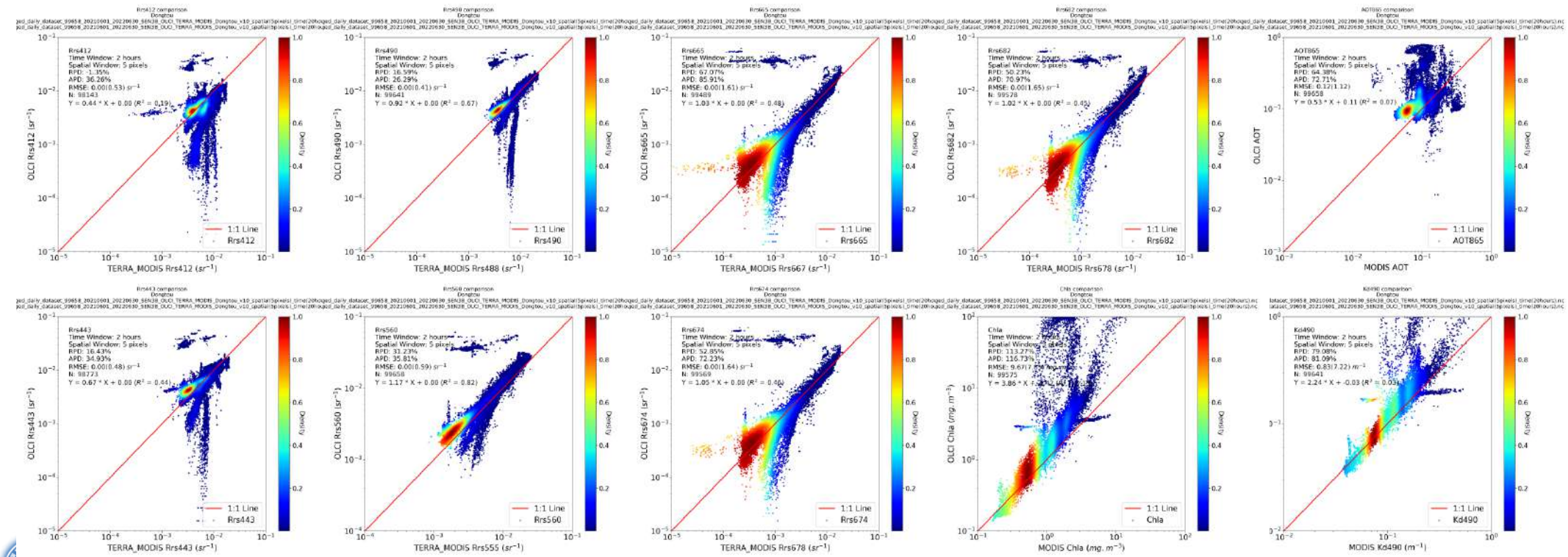
OLCI/Sentinel 3A vs MODIS/TERRA



(2) Consistency Check – First Results

Second Year (Jun/2021 – Jun/2022)

OLCI/Sentinel 3B vs MODIS/TERRA

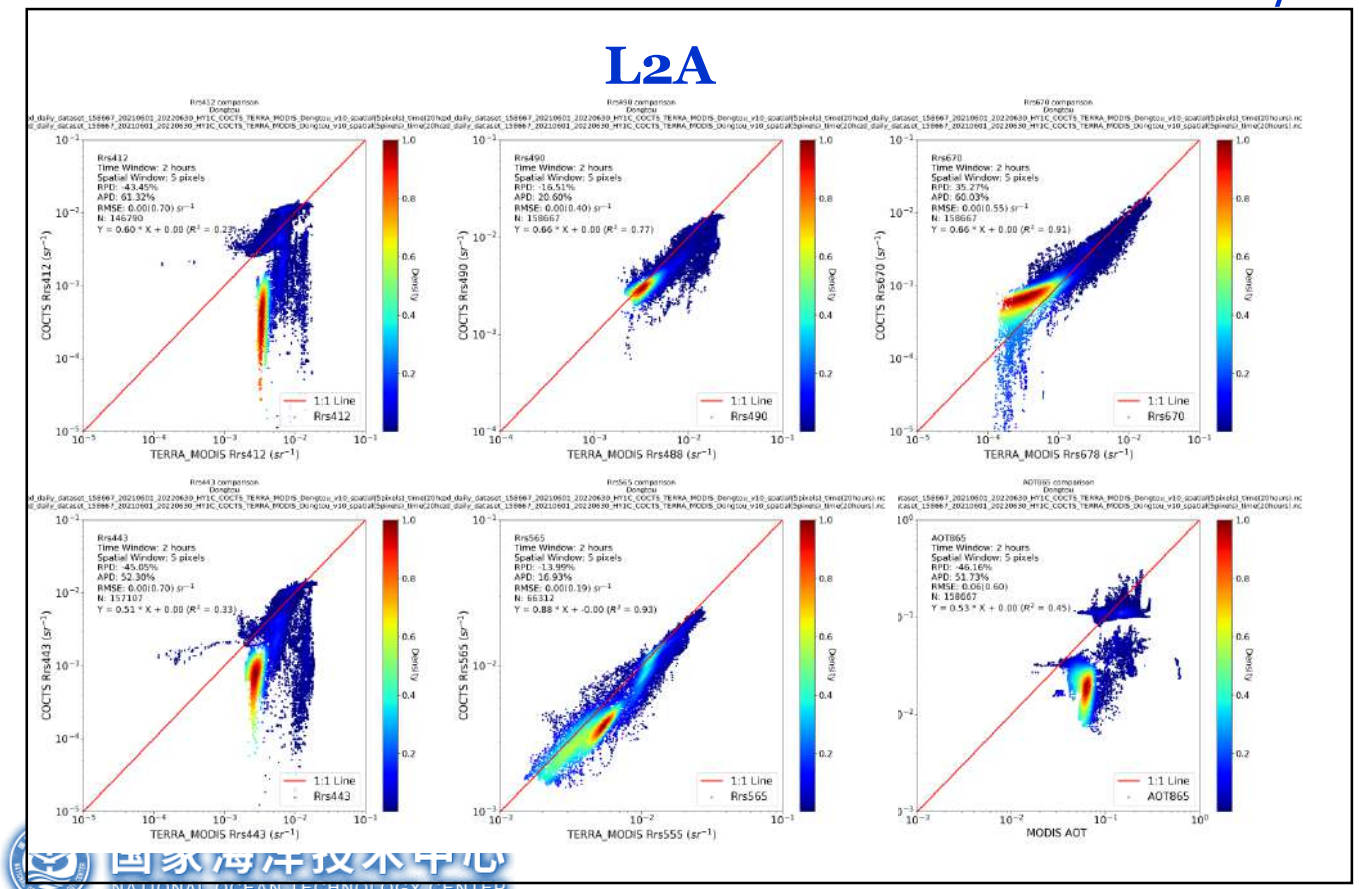


(2) Consistency Check – First Results

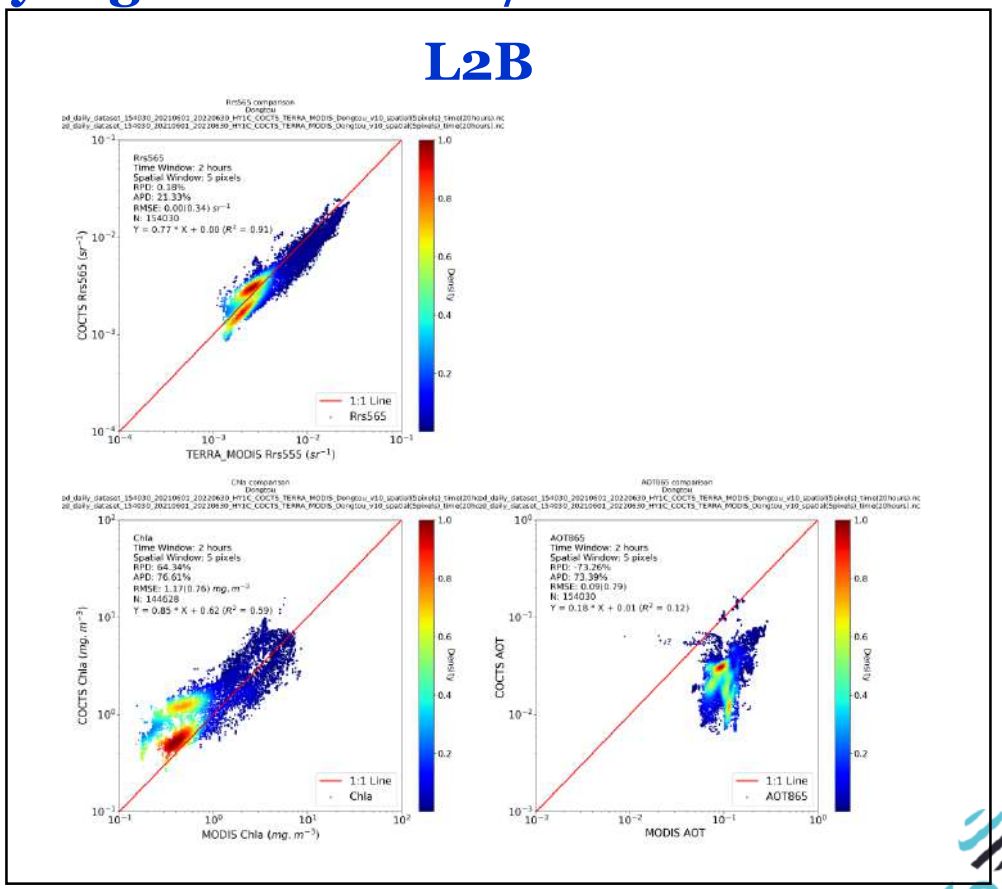
Second Year (Jun/2021 – Jun/2022)

COCTS/Haiyang 1C vs MODIS/TERRA

L2A



L2B

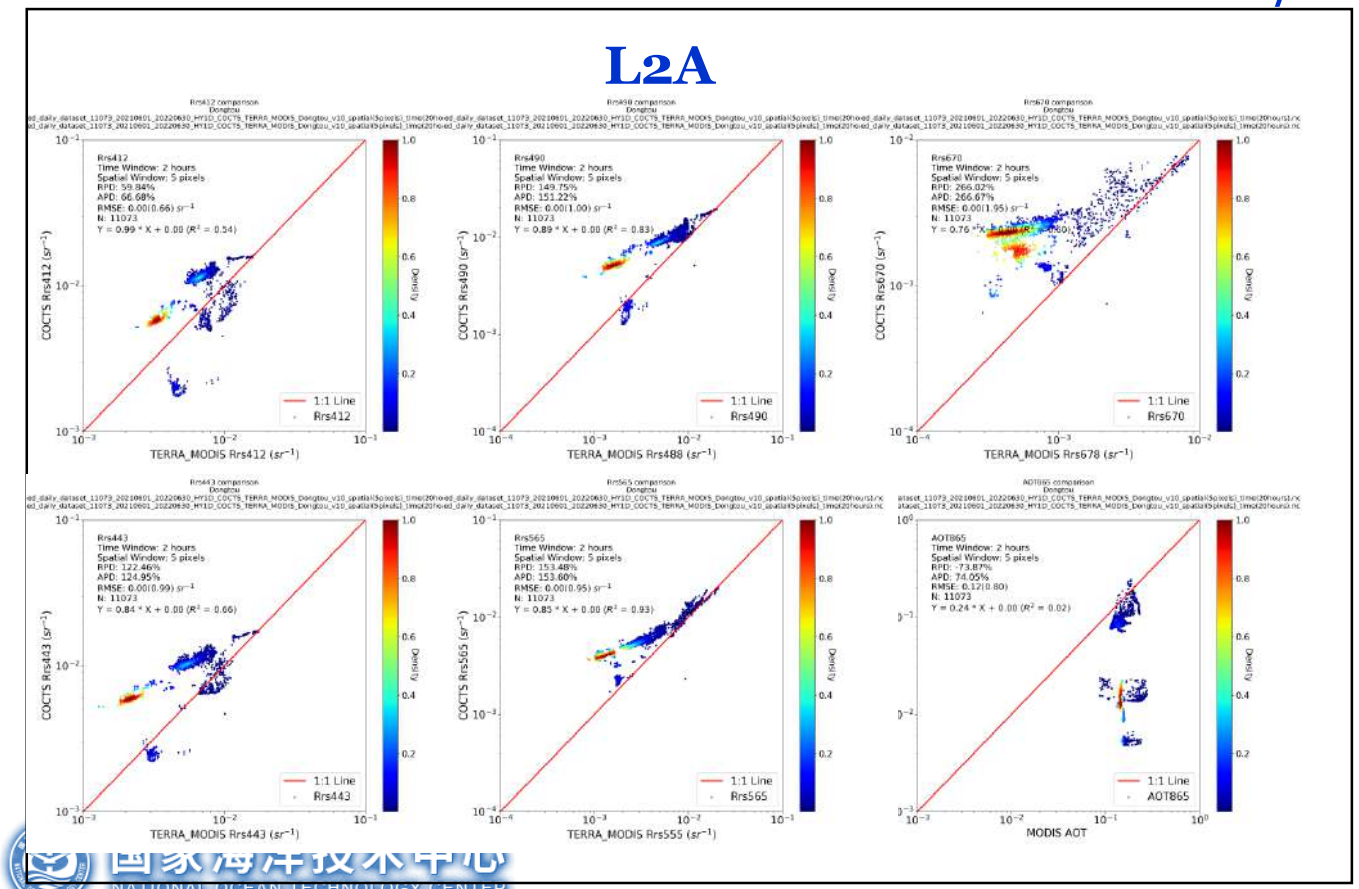


(2) Consistency Check – First Results

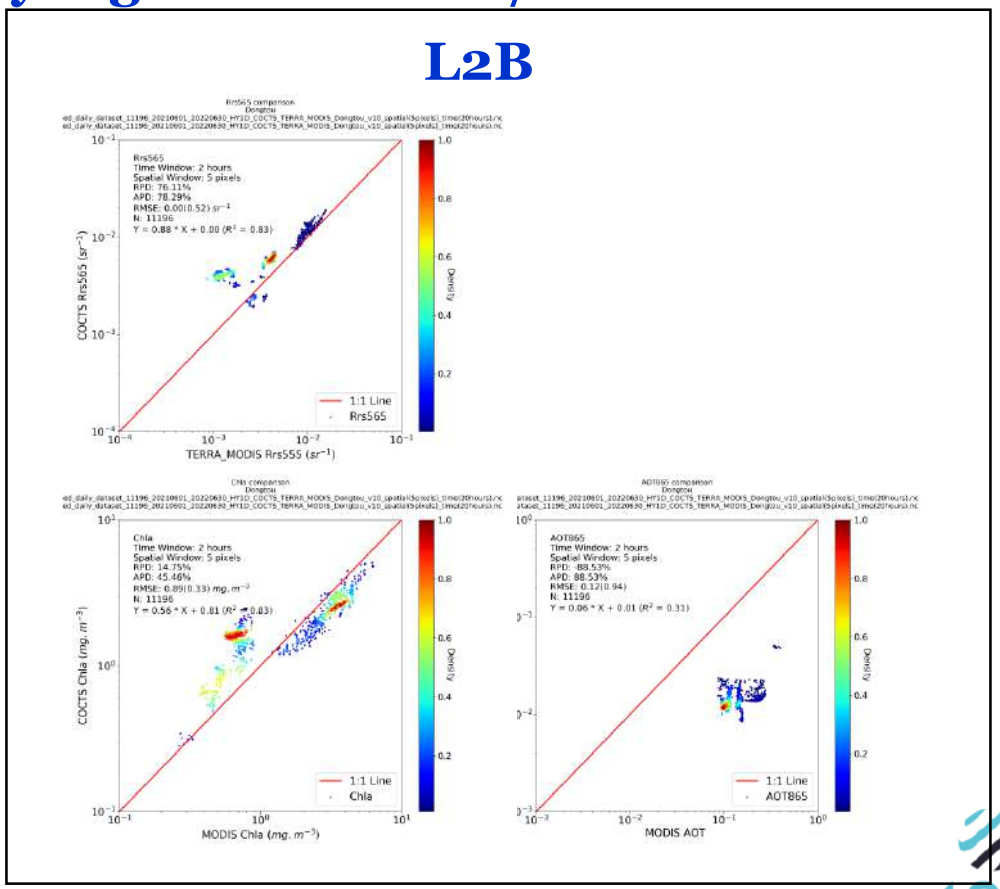
Second Year (Jun/2021 – Jun/2022)

COCTS/Haiyang 1D vs MODIS/TERRA

L2A



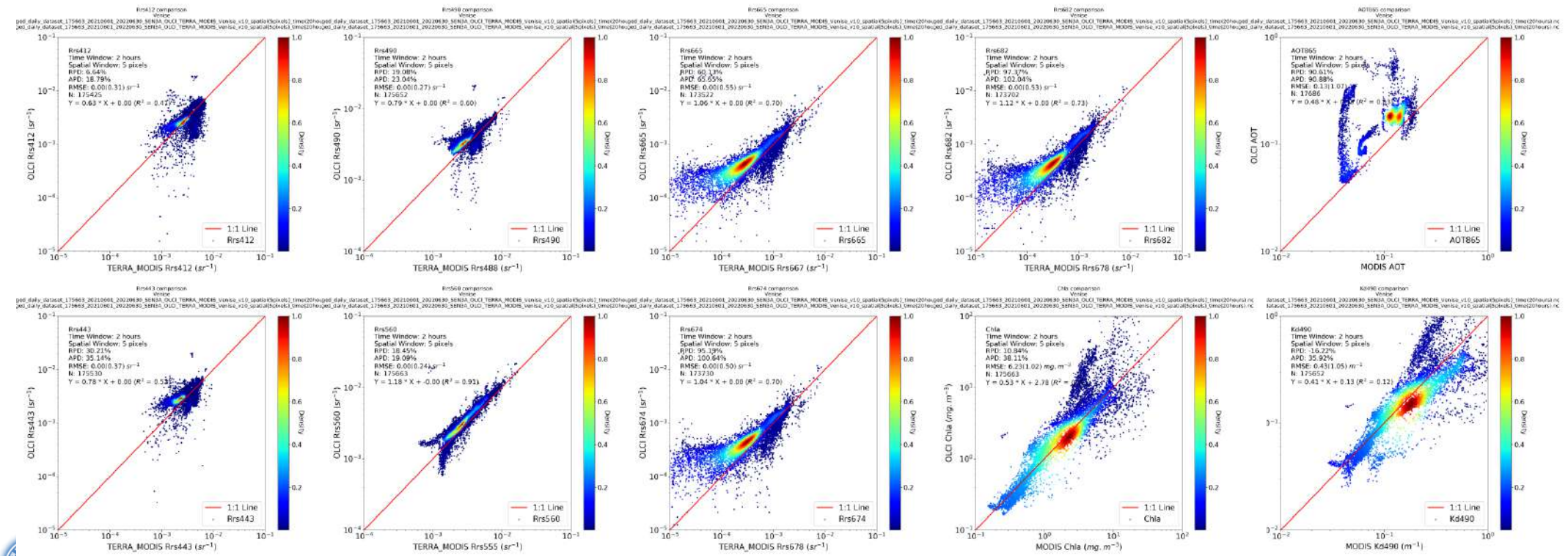
L2B



(2) Consistency Check – First Results

Second Year (Jun/2021 – Jun/2022)

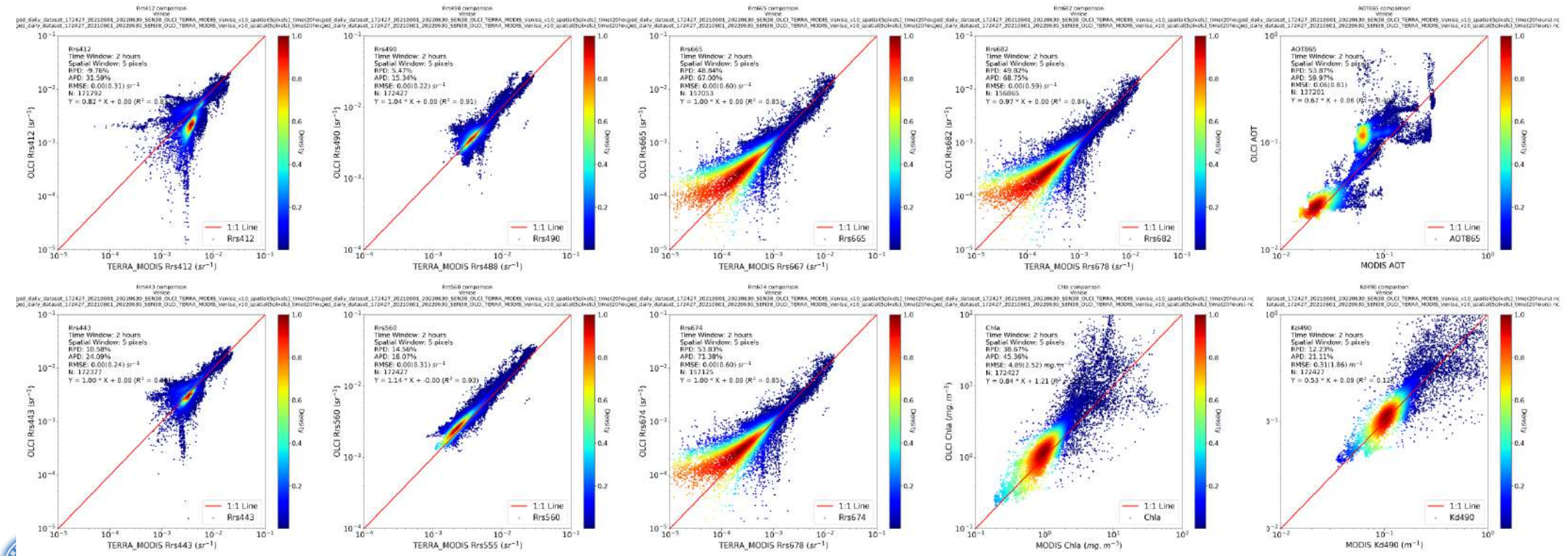
OLCI/Sentinel 3A vs MODIS/TERRA



(2) Consistency Check – First Results

Second Year (Jun/2021 – Jun/2022)

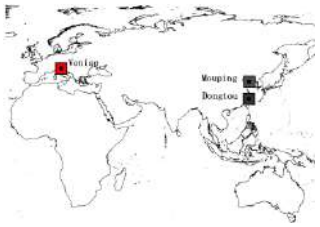
OLCI/Sentinel 3B vs MODIS/TERRA



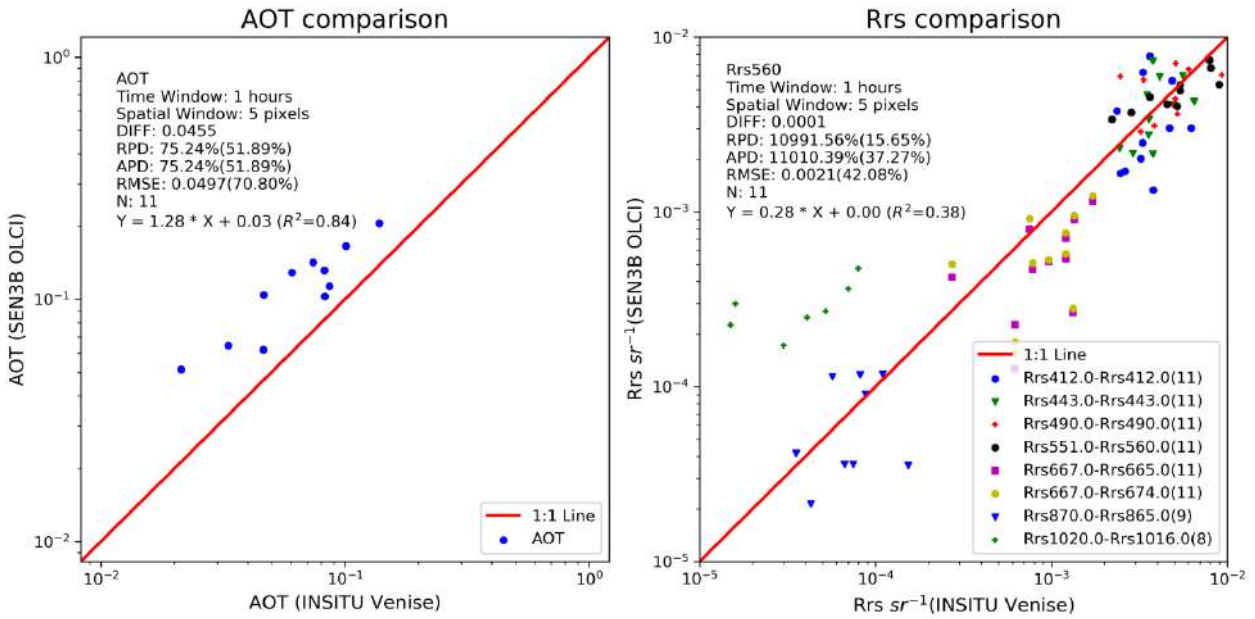
(1) Validation Activities - Ongoing

Second Year (Jun/2021 – Jun/2022)

Venise, Adriatic Sea



OLCI/Sentinel 3B ---- L2 FR NR

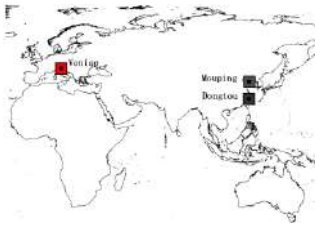


Product	RPD	APD	N
Rrs412-Rrs412	0.1%	51.2%	11
Rrs443-Rrs443	2.4%	30.1%	11
Rrs490-Rrs490	11.7%	35.7%	11
Rrs551-Rrs560	0.6%	21.3%	10
Rrs665-Rrs667	-37.3%	48.6%	11
Rrs674-Rrs667	-31.2%	50.6%	11
Rrs865-Rrs870	-5.6%	44.4%	9
Rrs1016-Rrs1020	2781.3%	2781.3%	8
AOT	75.2%	75.2%	11
Chla	-65.0%	65.0%	5

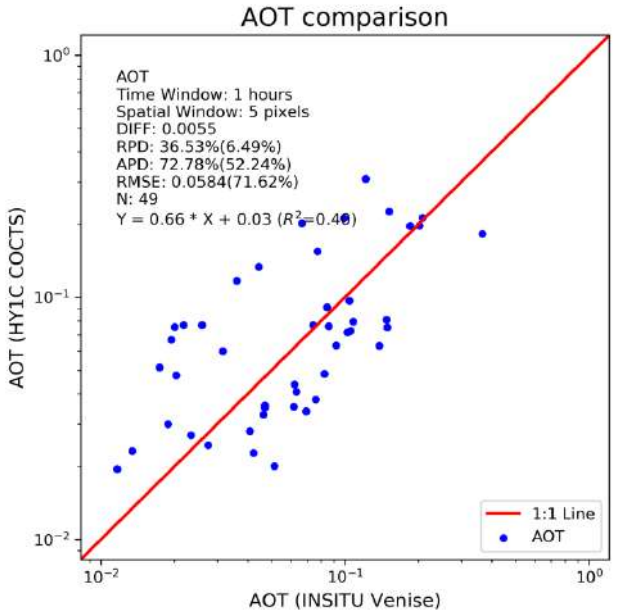
(1) Validation Activities - Ongoing

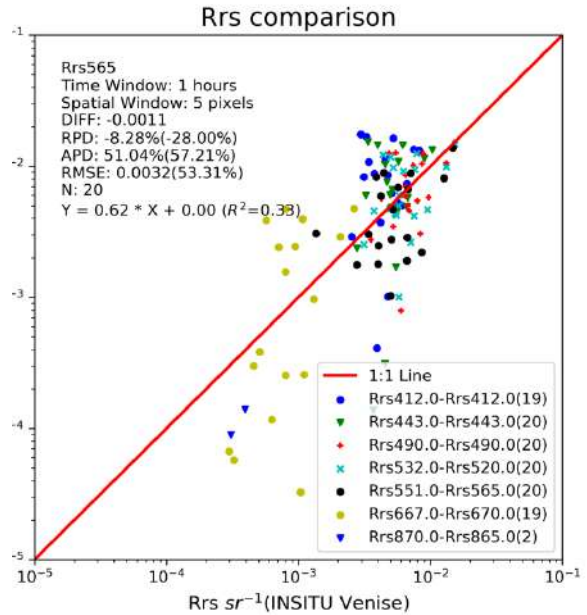
Second Year (Jun/2021 – Jun/2022)

Venise, Adriatic Sea



COCTS/Haiyang 1C ---- L2A





Product	RPD	APD	N
Rrs412-Rrs412	98.3%	119.8%	19
Rrs443-Rrs443	44.8%	78.7%	20
Rrs490-Rrs490	3.0%	42.9%	20
Rrs565-Rrs551	-8.3%	51.0%	20
Rrs670-Rrs667	62.9%	143.4%	19
Rrs865-Rrs870	-67.6%	67.6%	2
AOT	36.53%	72.78%	49

(4) Young Scientists Training

Name	Contribution	Status
Shuang CAO (postgraduate)	Backscattering modelling	Graduated
Qiaoying YUAN (postgraduate)	Validation	To graduate in 2024
Di JIA (associate researcher)	Processing and quality control of SeaPRISM	Promoted
Kai GUO (assistant researcher)	Optical measurement	-

Future Plans

Schedule:

☐July 2022-June 2023

(1)Continuously validating reflectance and other products(e.g., chlorophyll concentration) provided by OLCI and COCTS with in-situ data

(2)CZI and MSI data products needs to be considered, Mouping and other SeaPRISM data will be considered

(3)Consistency check will be extended

(4)Check difference among various atmospheric correction and bio-optical algorithms

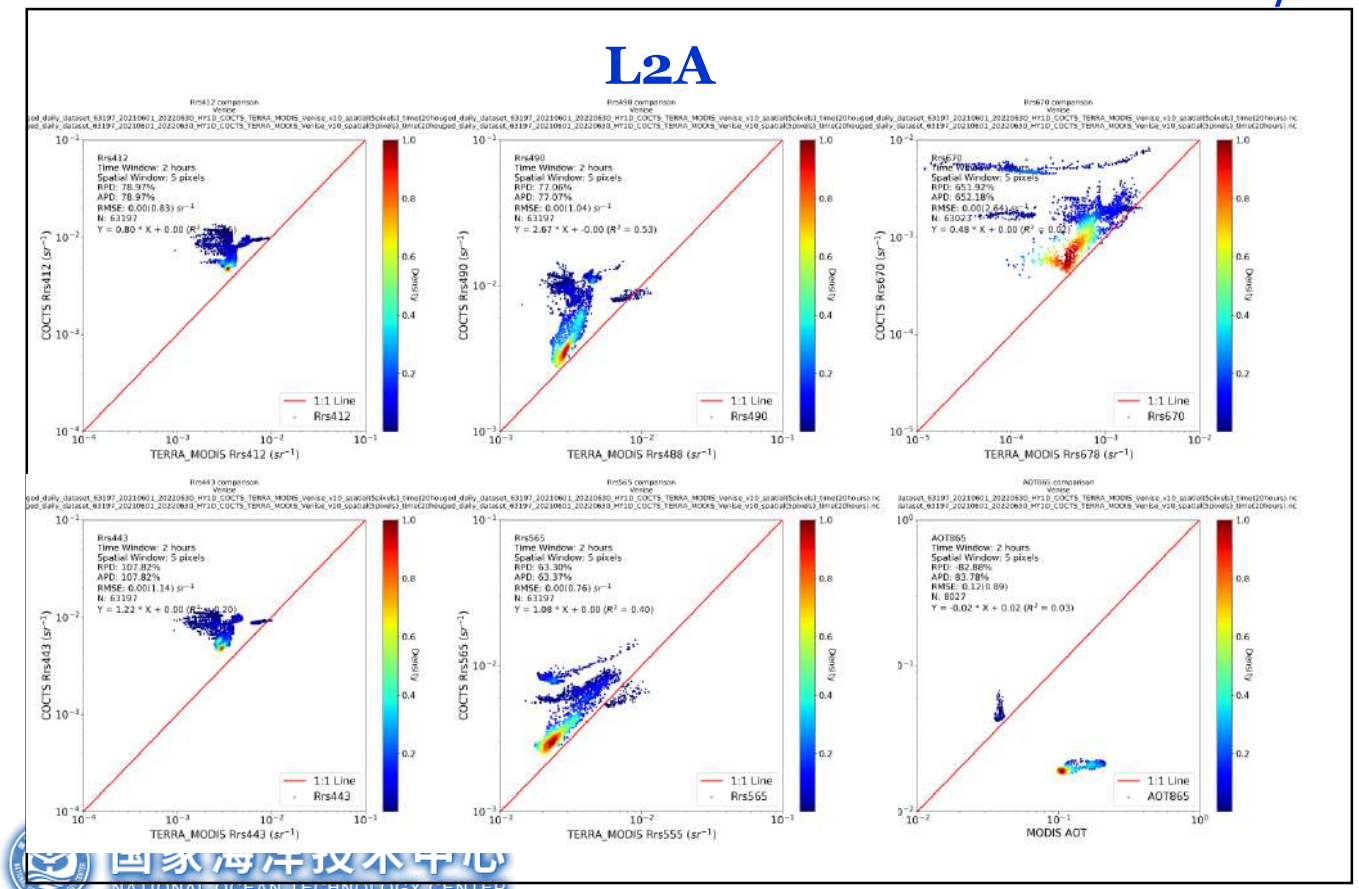
(5)Collect in-situ coincident biological and optical measurements to develop novel bio-optical algorithms, and explore more accurate EO products

(2) Consistency Check – First Results

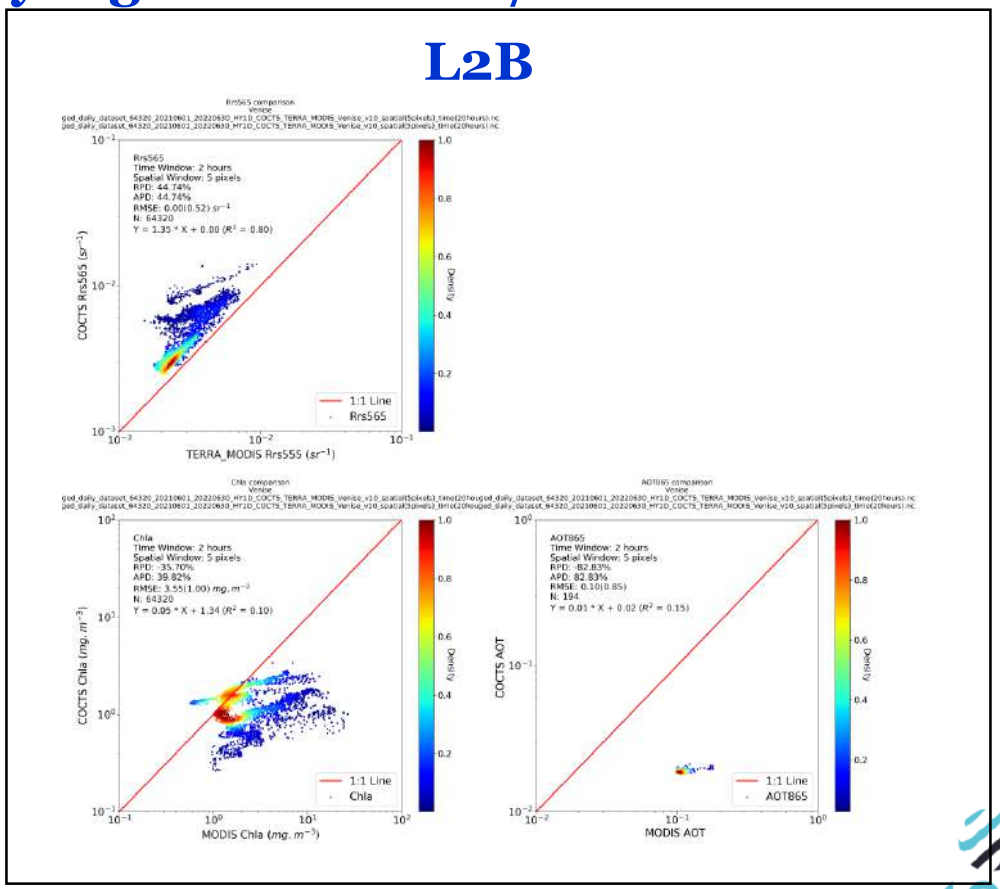
Second Year (Jun/2021 – Jun/2022)

COCTS/Haiyang 1D vs MODIS/TERRA

L2A



L2B

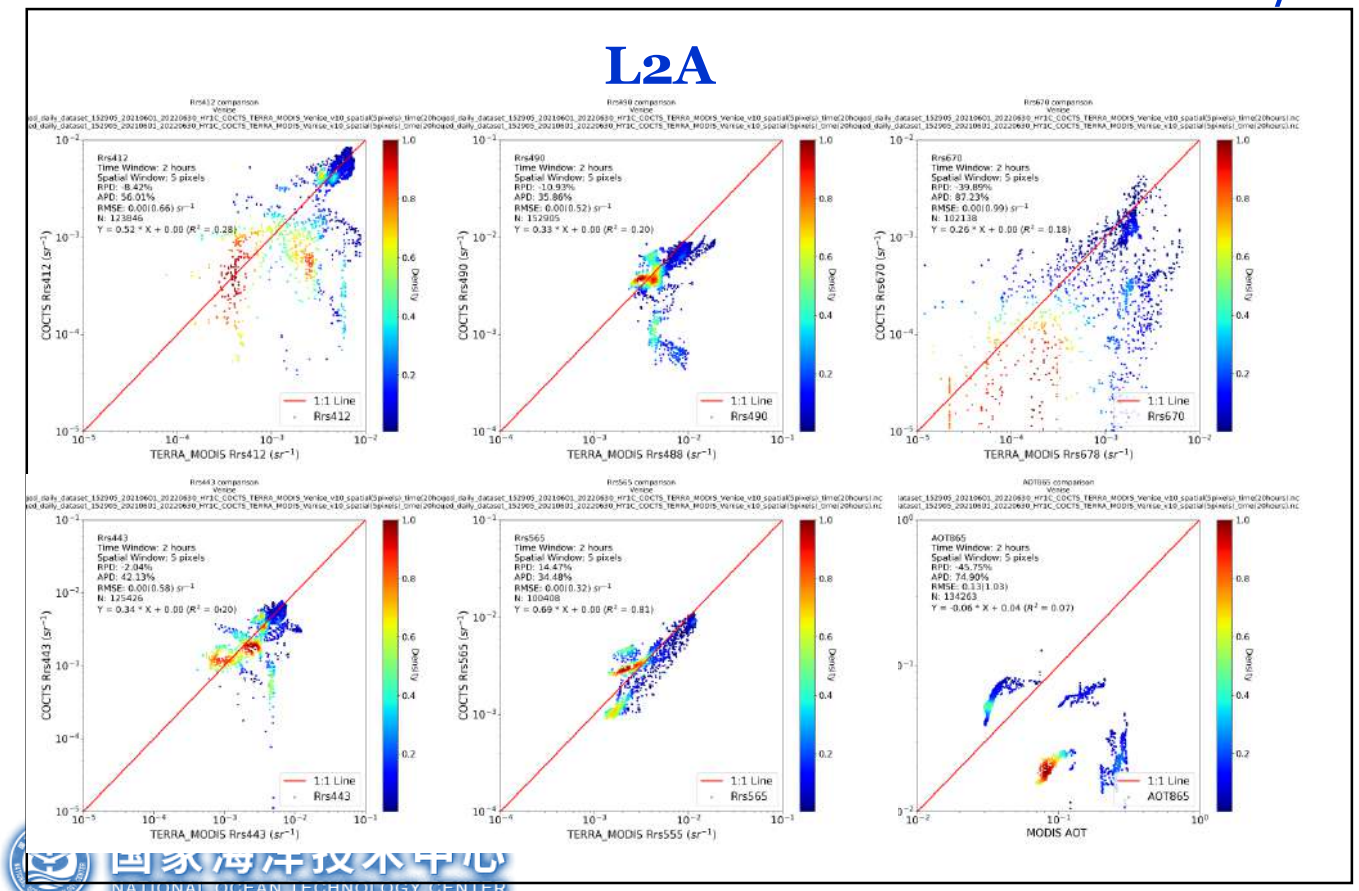


(2) Consistency Check – First Results

Second Year (Jun/2021 – Jun/2022)

COCTS/Haiyang 1C vs MODIS/TERRA

L2A



L2B