



SatCO

Ocean Carbon from Space

Joint Science Research & Satellite-based
marine carbon monitoring and analysis system

中文 English



Marine carbon observation by satellite remote sensing

Practice

**Yan Bai,
Xianqiang He, Xiaoyan Chen, Teng Li, Shujie
Yu, Chen-Tung Arthur Chen, Wei-Jun Cai, etc.**



**State Key Laboratory of
Satellite Ocean Environment Dynamics (SOED)
Second Institute of oceanography(SIO), China**



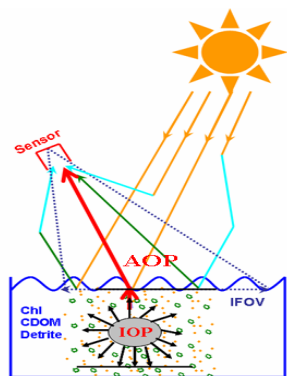
Framework of satellite-based marine carbon research



SatCO2

Radiation transmission
Satellite algorithms

www.satCO2.com



coasts

Marginal sea

Open Ocean

Riverine C flux

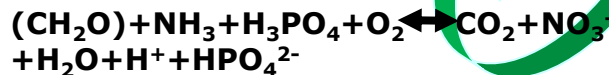


Air-sea CO₂ flux



Lateral transport

N, P, DOC, POC,
DIC, PIC, etc.



Primary production
Food-web
Acidification
Eutrophication
Hypoxia

PAR
Chl
PFT
C/Chla
Zeu
profile

Phytoplankton C

POC/DOC Inventory

POC
DOC
profile



Carbonate system

Acidification

POC export flux

- **Framework of satellite-based marine carbon research**
- **Example: $p\text{CO}_2$ and POC export flux**
- **SatCO₂-- Satellite-based marine carbon monitoring and analysis system**





SatCO₂

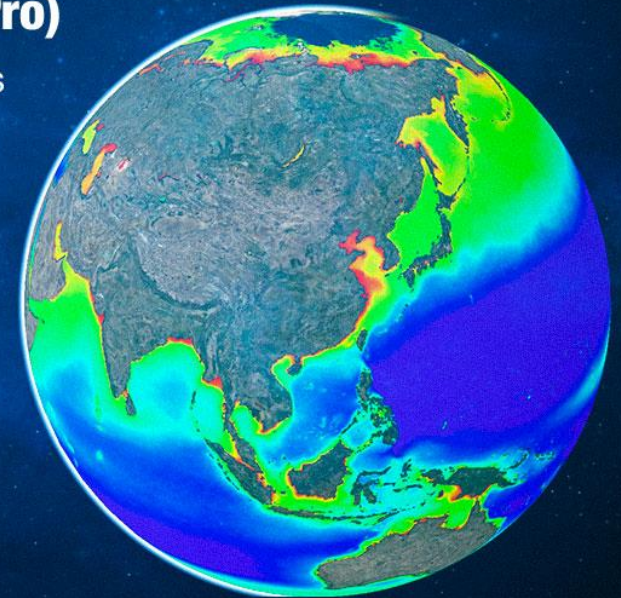
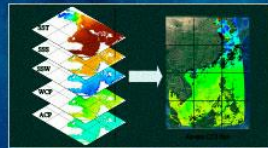
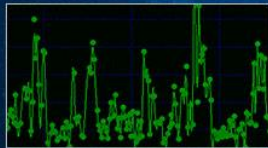
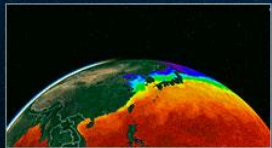
Satellite-based marine carbon monitoring and analysis system (SatCO₂)



Marine Satellite Data Online Analysis Platform (SatCO₂-Pro)

SUPPORT for multiple sources & time series data sharing and analysis

- Online access of unique satellite remote sensing data
- 3D Earth visualization and scientific computation
- Analysis and evaluation of multi-source (satellite, in situ and model) data
- User-defined algorithms and product generations
- Calculation and evaluation of ocean carbon fluxes
- Easy integration of professional modules





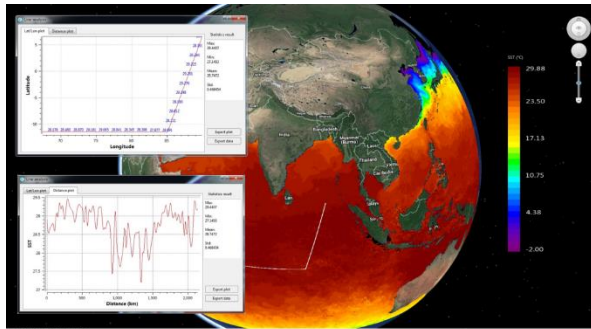
- SatCO₂-Pro is **a free distribution for the public**, to achieve multi-source data online processing and analysis of three-dimensional earth visualization, for multi-disciplinary researchers, especial non-remote sensing people.
- Developed by the State Key Laboratory of Satellite Ocean Environment Dynamics (SOE/SIO/SOA) and the Zhejiang Provincial Key Laboratory of Geographic Information Systems at Zhejiang University.
- The software is **supported by the database in the Online Data Sharing Center of SOED**, which shares the latest datasets of long-term time series of remote sensing data.

Marine Satellite Data Online Analysis Platform (SatCO₂-Pro)

**SURPORT for multiple sources & time series data sharing
and analysis**



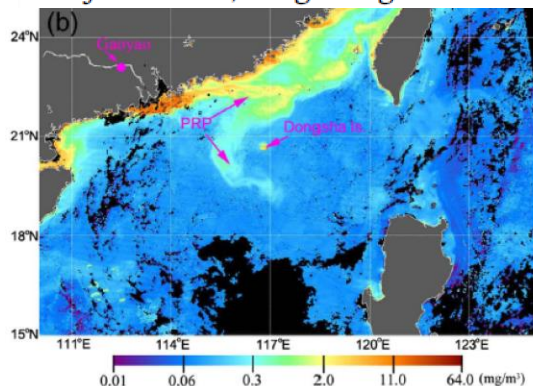
SatCO₂



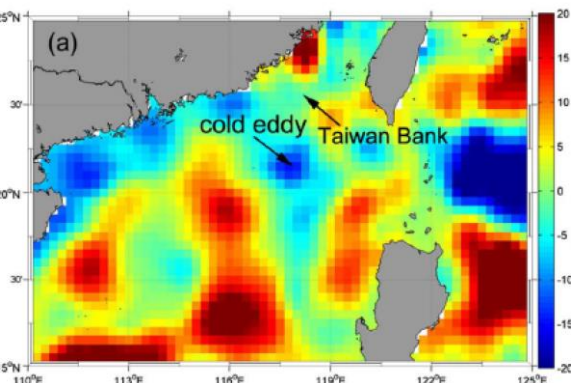
- 1) Online access of unique satellite remote sensing data;
- 2) 3D Earth visualization and scientific computation;
- 3) Analysis and evaluation of multi-source (satellite, in situ and model) data;
- 4) User-defined algorithms and product generations;
- 5) Calculation and evaluation of ocean carbon fluxes;
- 6) Easy integration of professional modules.

Eddy-entrained Pearl River plume into the oligotrophic basin of the South China Sea

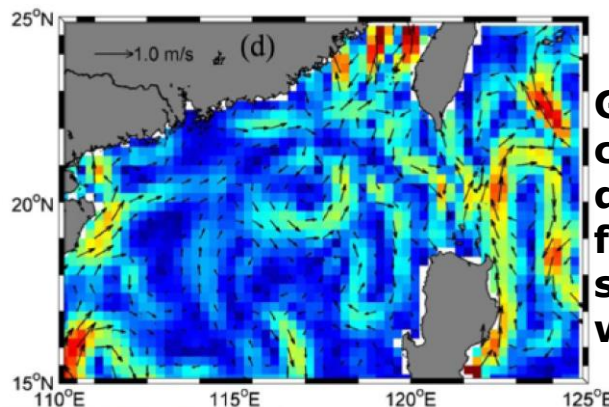
Xianqiang He^{a,c,*}, Dongfeng Xu^a, Yan Bai^a, Delu Pan^a, Chen-Tung Arthur Chen^b,
 Xiaoyan Chen^a, Fang Gong^a



Daily satellite Chla on 17 Jun, 2015



Satellite sea level anomaly



Geostrophic current derived from satellite wind data

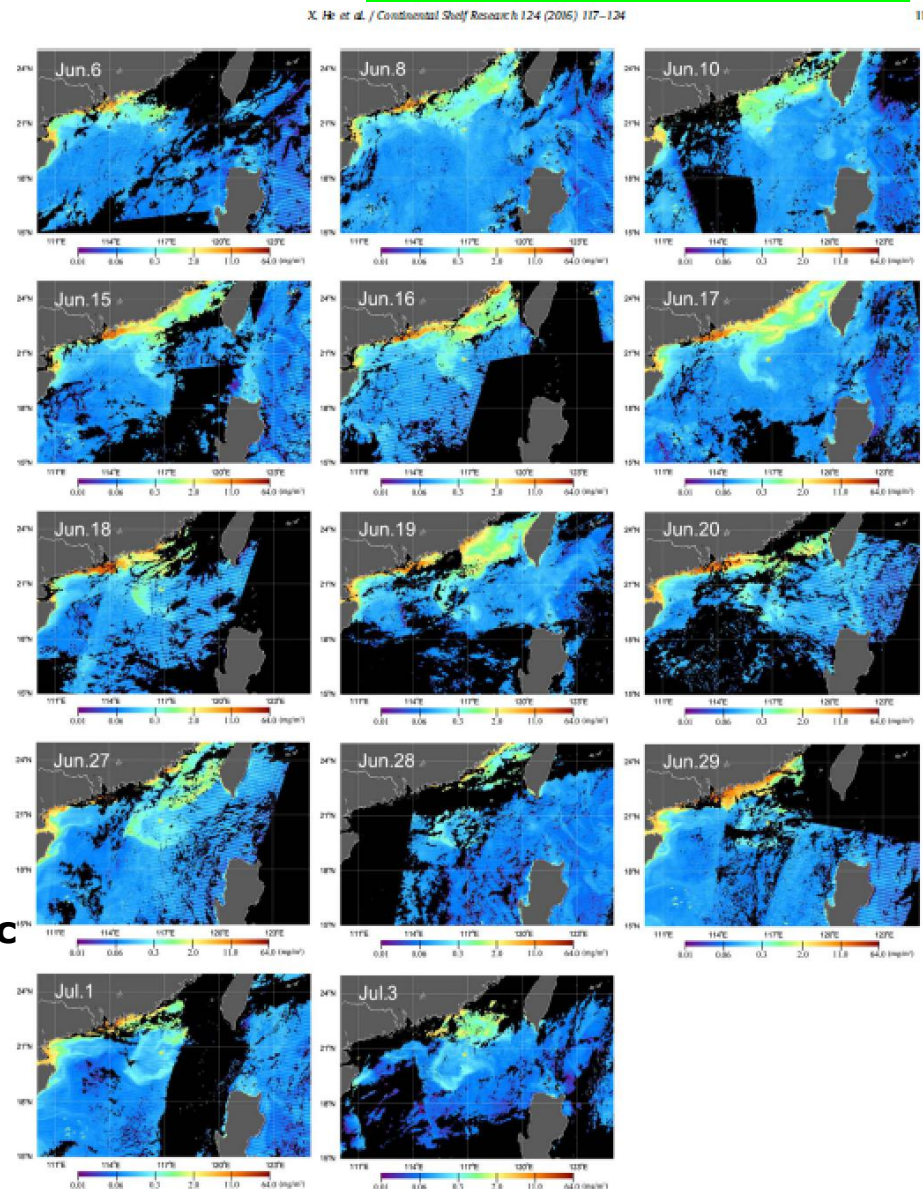


Fig. 2. Daily satellite Chla images from 6 June to 3 July 2015. Black areas are covered by clouds or contaminated by sun glint. Days with heavy cloud coverage are not shown.

Episodic phytoplankton bloom events in the Bay of Bengal triggered by multiple forcings

Xiaoyan Chen^{a,b}, Delu Pan^{a,b,*}, Yan Bai^b, Xianqiang He^{a,b}, Chen-Tung Arthur Chen^c, Zengzhou Hao^b

Deep-Sea Research I 2013

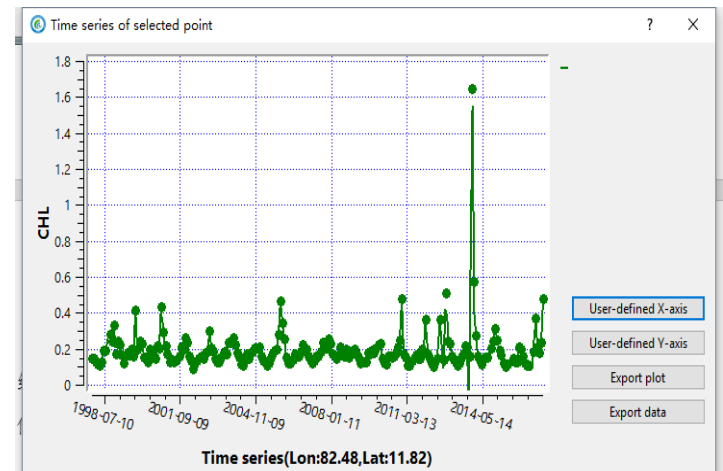
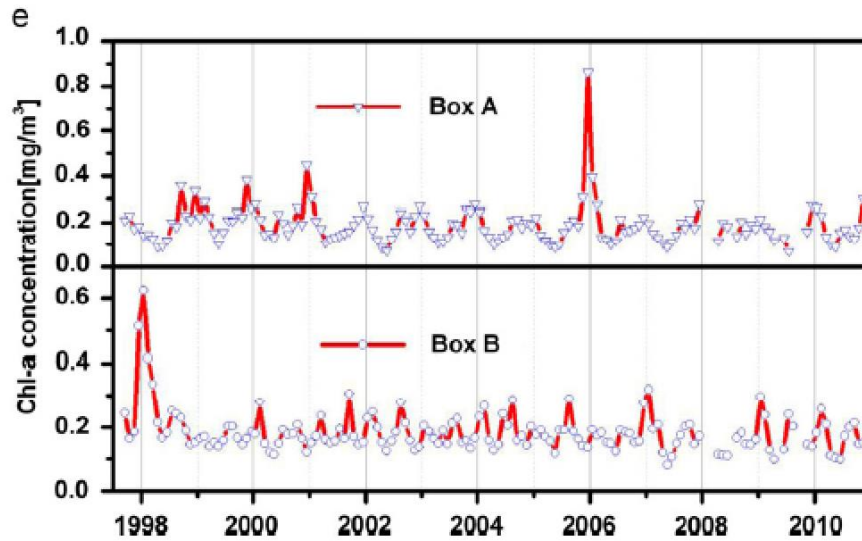
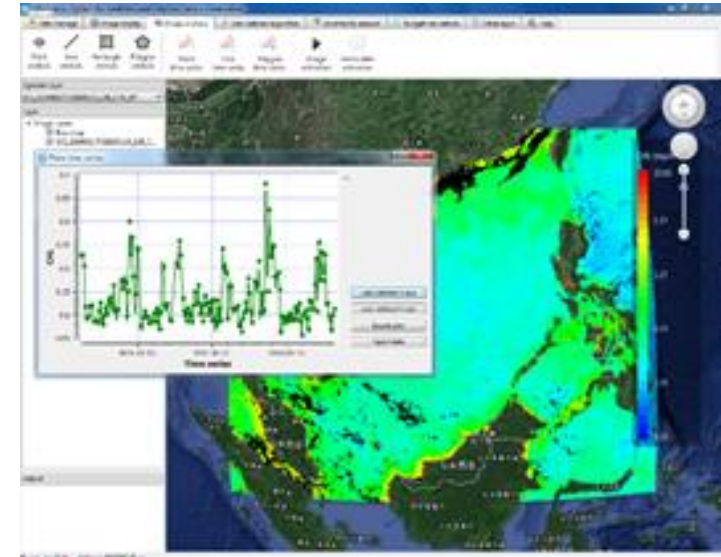
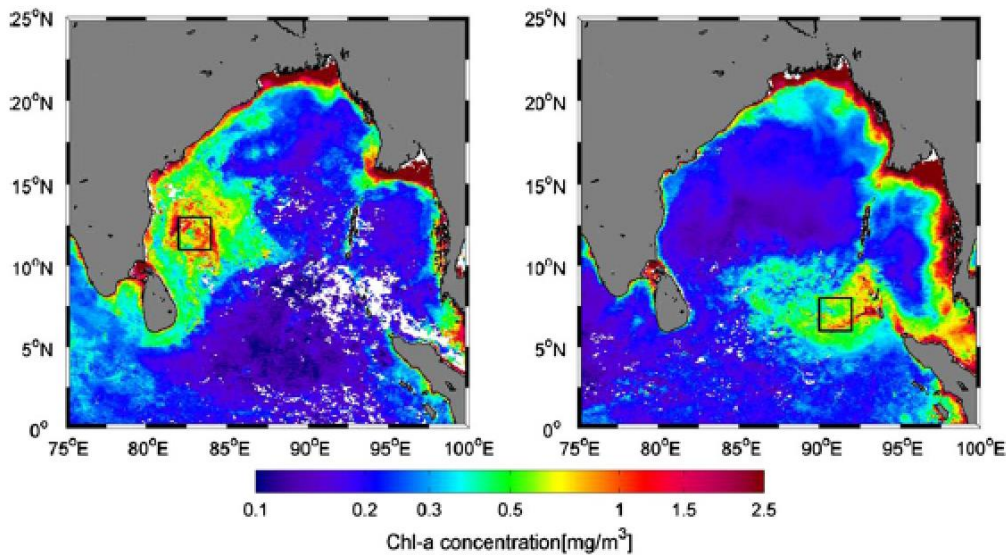
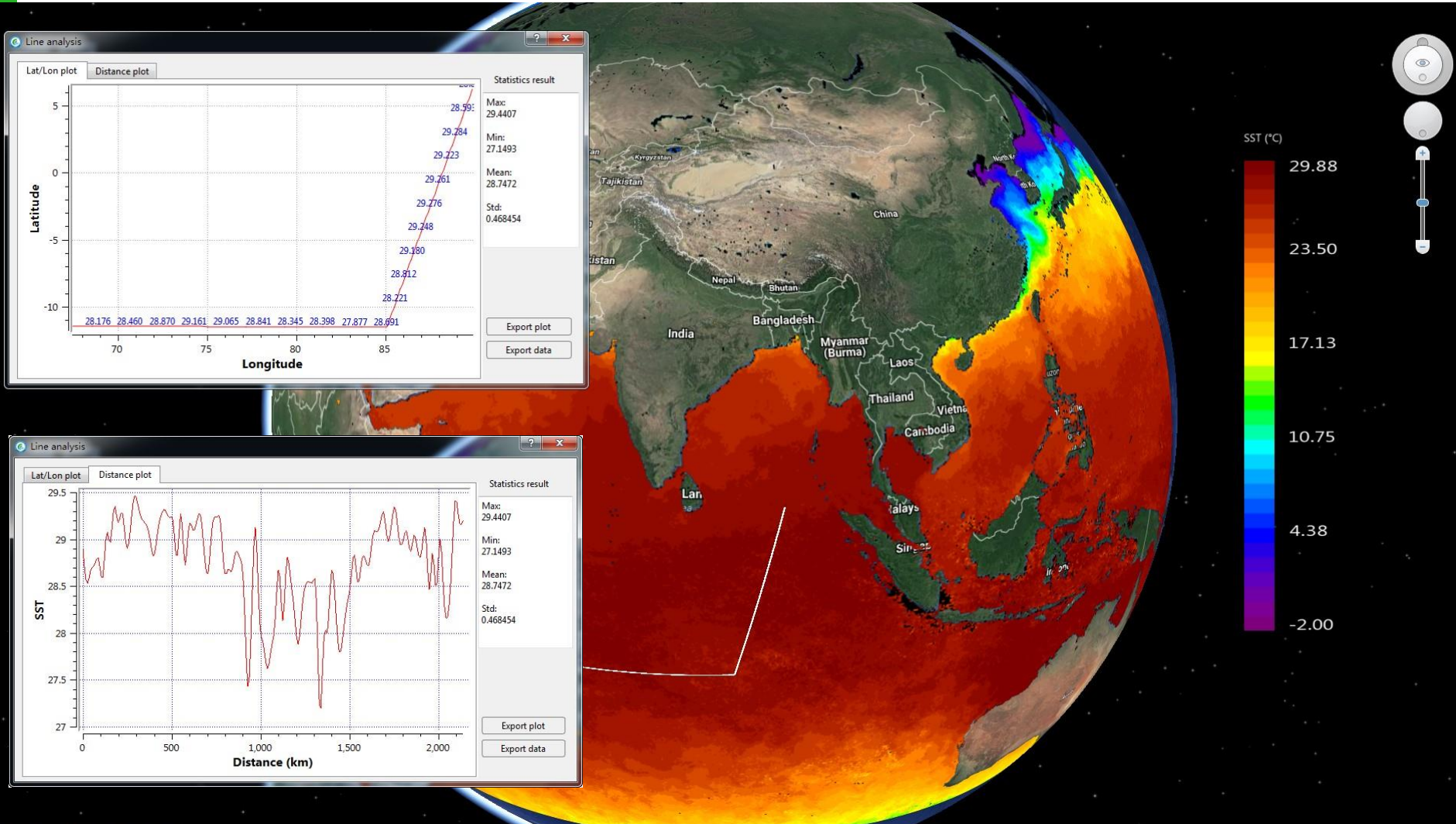


Image Analysis



SatCO₂



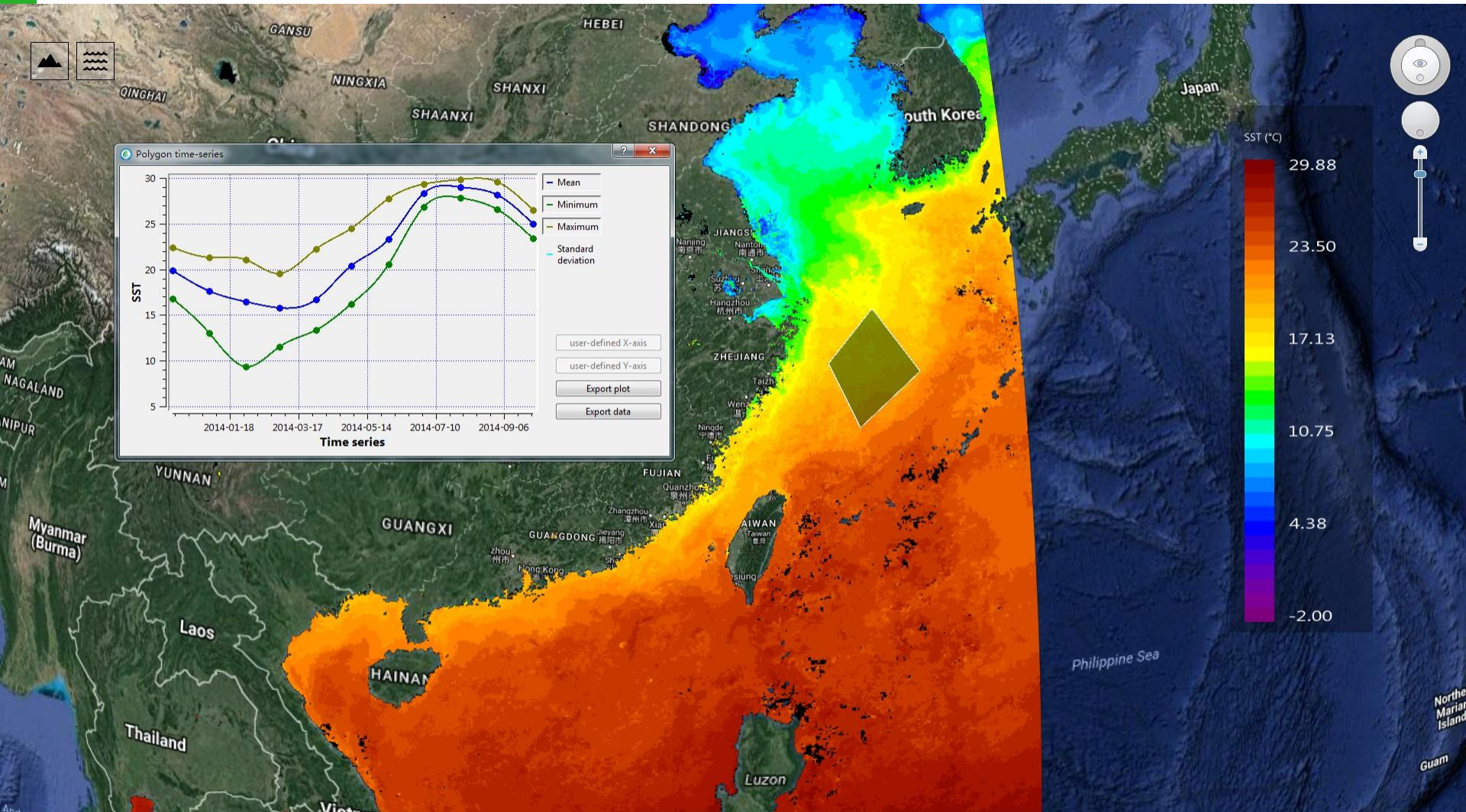
Frame rate: 32 fps Altitude: 16141185.187525 m

Line analysis

Time-series Analysis



SatCO₂



Time-series statistics (point, line and **polygon**)

User-defined Algorithm



SatCO₂

User-defined algorithm

Input expression: A-B

Calculate Clear

1 2 3 + - Abs Pow
4 5 6 * / Sqrt Ln
7 8 9 () Exp Log10
0 . Backspace .

Add satellite data

[A]EAMS_20000101TO20000131_L3B_ACP_MT
[B]EAMS_20140901TO20140930_L3B_WCP_MT

Add layer
Remove layer

Tips: This function will take times depending on the network speed.



Satellite-in situ data matchup and comparison



SatCO₂

Satellite-insitu comparison

Please select in situ data. You can add more data in the [data manage] menu.

SatCO₂_Testfile121

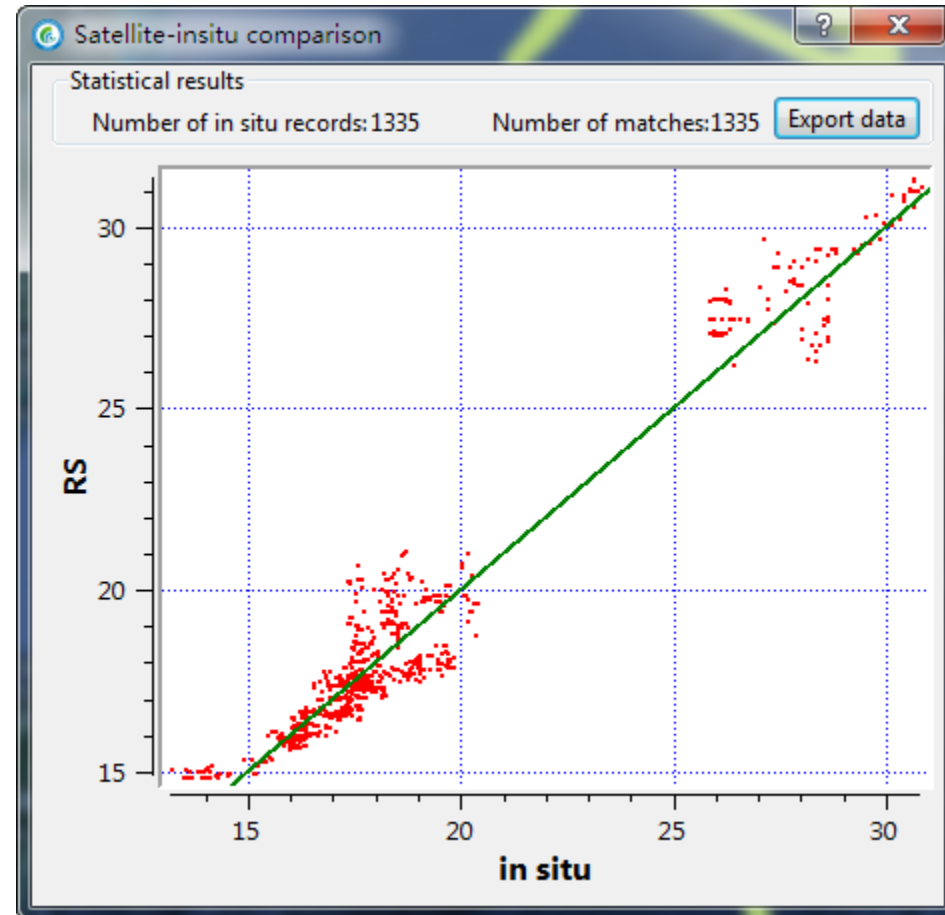
Time period of in situ data

Start date: 2009/07/19
End date: 2009/07/28

Satellite data for matchup

Dataset: EAMS
Parameter: SST
Level: L3B
Composite period: Daily composite
Spatial window: 1*1

Start analysis



Satellite-insitu comparison



Air-sea CO₂ flux calculation



SatCO₂

Air-sea CO₂ flux (satellite)

Description of air-sea CO₂ flux calculation

We adopt the commonly used method to calculate the air-sea CO₂ flux, which is based on the multiplication of CO₂ partial pressure difference between surface sea water and atmosphere and CO₂ gas transfer velocity. The equation is as follows:

$$\text{Flux} = \Delta p_{\text{CO}_2} \times E = (\text{WCP} - \text{ACP}) \times K_{\text{H}}^{\text{CO}_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

- 1) ACP: partial pressure of CO₂ in atmosphere (μatm)
WCP: wpartial pressure of CO₂ in seawater(μatm)
SST: sea surface temperature (°C)
SSS: sea surface salinity (psu)
SSW: sea surface wind speed (m/s)
- 2) KHCO₂—Dissolution efficient of CO₂(mol·kg⁻¹·atm⁻¹)
 $\ln(K_{\text{H}}^{\text{CO}_2}) = -60.2409 + 93.4517 \times (100/T) + 23.3585 \times \ln(T/100) +$
 $\text{SSS} \times [0.023517 - 0.023656 \times (T/100) + 0.0047036 \times (T/100)^2]$
T = SST (°C) + 273.15
- 3) ρ—Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)(kg·m⁻³)
 $\rho = (\rho_w + A * S + B * S^2 + C * S^3) * 10^{-3}$
 $\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$
A=0.824493-4.0899*10⁻³*T+7.6438*10⁻⁵*T²-8.2467*10⁻⁷*T³+5.3875*10⁻⁹*T⁴
B=-5.72466*10⁻³+1.0227*10⁻⁴*T-1.6546*10⁻⁶*T²
C=4.8314*10⁻⁴

Query satellite

Select month: 2000-01

Select satellite data

	Resolution
ACP: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
WCP: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SST: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SAL: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SSW: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167

Resampling resolution: 0.0167

Select equation for gas transfer velocity(k)

k660 = 0.31 × u10² (real-time) , Wanninkhof (1992) (real-time)

Add C2 adjustment

Tip: This calculation is time-consuming and depends on the network speed.

Budget Calculation



SatCO₂



Select pre-defined regions or import region

Through the [Import region] button, user can multiple-select pre-defined regions or import region file with shapefile (*.shp) format. Click the [Calculate] button to conduct budget calculation for each region.



SatCO₂

Ocean Carbon from Space (SatCO₂): Joint Science Workshop and Training (II) (Hangzhou, China, November 23-25, 2018)

The SatCO₂ series workshop was jointly initiated by researchers from remote sensing and biogeochemistry to address the concerns about the **ocean carbon cycle and ocean acidification**.

SOED has successfully hosted two SatCO₂ workshops previously, in December 12-16, 2016 and December 1-5, 2017, and received positive feedback from attendants and users.

**SatCO₂-I
December 12-16, 2016**



**SatCO₂-II
December 1-15, 2017**



Hands-on training of SatCO2 software and database in 2016 and 2017



SatCO₂

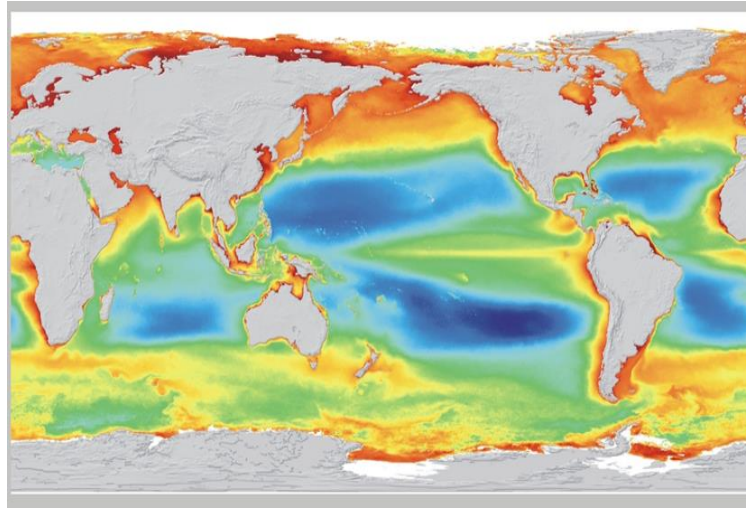
www.satCO2.com released on 11/23

Lin'an base of SIO/SOA



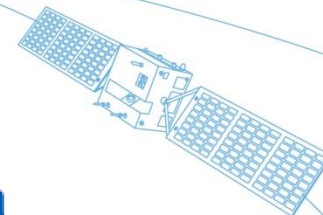
SatCO

- Satellite ground station and cloud based distributed databases





INTERNATIONAL TRAINING WORKSHOP ON
MARINE SATELLITE REMOTE SENSING
AND ARGO MONITORING TECHNOLOGIES



International Training Workshop on Marine Satellite Remote Sensing and Argo Monitoring Technologies (Sat-Argo)

Hangzhou, China

November 12-26, 2018



自然资源部第二海洋研究所
SECOND INSTITUTE OF OCEANOGRAPHY, MNR



【自然资源部第二海洋研究所】
卫星海洋环境动力学国家重点实验室
[SECOND INSTITUTE OF OCEANOGRAPHY, MNR]
STATE KEY LABORATORY OF SATELLITE OCEAN ENVIRONMENT DYNAMICS



全球海洋酸化观测网第四届国际研讨会

The 4th GOA-ON International Workshop

Apr. 14-17, 2019 | Hangzhou, China

<http://www.goa-on2019.com/en/sevents.html>

There will be two special events taking place on 14 April 2019 afternoon, which are:

Special Event 2: Ocean Carbon from Space (SatCO₂): Joint Science Training Workshop

This is an inter-disciplinary platform to facilitate and promote interaction and cooperation among scientists who aim to integrate satellite remote sensing data and biogeochemical studies for a better understanding of the ocean carbon system.

**Let us begin
the hands-on practice!**



Air-sea CO₂ flux

Description of air-sea CO₂ flux calculation

We adopt the commonly used method to calculate the air-sea CO₂ flux, which is based on the multiplication of CO₂ partial pressure difference between surface sea water and atmosphere and CO₂ gas transfer velocity.

The equation is as follows:

$$\text{Flux} = \Delta p_{\text{CO}_2} \times E = (WCP - ACP) \times K_{\text{H}}^{\text{CO}_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

1) ACP: partial pressure of CO₂ in atmosphere (μatm)

WCP: wpartial pressure of CO₂ in seawater(μatm)

SST: sea surface temperature (°C)

SSS: sea surface salinity (psu)

SSW: sea surface wind speed (m/s)

2) K_HCO₂—Dissolution efficient of CO₂(mol·kg⁻¹·atm⁻¹)

$$\ln(K_{H}^{CO_2}) = -60.2409 + 93.4517 \times (100/T) + 23.3585 \times \ln(T/100) + SSS \times [0.023517 - 0.023656 \times (T/100) + 0.0047036 \times (T/100)^2]$$

$$T = SST (^{\circ}C) + 273.15$$

3) ρ—Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)(kg·m⁻³)

$$\rho = (\rho_w + A * S + B * S^{3/2} + C * S^2) * 10^{-3}$$

$$\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$$

$$A = 0.824493 - 4.0899 * 10^{-3} * T + 7.6438 * 10^{-5} * T^2 - 8.2467 * 10^{-7} * T^3 + 5.3875 * 10^{-9} * T^4$$

$$B = -5.72466 * 10^{-3} + 1.0227 * 10^{-4} * T - 1.6546 * 10^{-6} * T^2$$

$$C = 4.8314 * 10^{-4}$$

5) k—Gas transfer velocity(cm·h⁻¹)

Based on the relationship between gas transfer velocity (k) and the wind speed at 10m above sea level(U₁₀), the commonly used equations for calculating k are shown in the table below.

No.	Equation	References
1	$k_{660} = 0.31 \times u_{10}^2$ (Instantaneous wind speed) $k_{660} = 0.39 \times u_{10}^2$ (Long-term average wind speed)	Wanninkhof (1992)(Instantaneous) Wanninkhof (1992)(Long-term)
2	$k_{660} = 0.27 \times u_{10}^2$	Sweeney et al. (2007)
3	$k_{600} = 0.266 \times u_{10}^2$	Ho et al. (2006)
4	$k_{660} = 0.24 \times u_{10}^2$	Wanninkhof et al. (2009)
5	$k_{600} = 0.17 \times u_{10}$ ($u_{10} < 3.6$ m/s)	Liss and Merlivat (1986)
6	$k_{660} = 0.0283 \times u_{10}^3$	Wanninkhof and McGillis (1999)
7	$k_{600} = 2.85 \times u_{10} - 9.65$ ($3.6 < u_{10} < 13$ m/s)	Liss and Merlivat (1986)
8	$k_{600} = 5.9 \times u_{10} - 49.3$ ($u_{10} > 13$ m/s)	Liss and Merlivat (1986)

4) C2—Wind speed coefficient C2, which has been calculated and uploaded in the SOED database

To calculate the monthly average flux, it is often necessary to consider the influence of the high-frequency wind speed change (e.g. daily) on the monthly average wind speed, using a coefficient of C2 (Wanninkhof, 2002). The C2 coefficient is not needed when calculate daily flux.

$$C_2 = \frac{(U_j^2)_{\text{mean}}}{(U_{\text{mean}})^2}$$

U_j is high-frequency satellite-derived wind speed (e.g. daily), and U_{mean} is satellite-derived monthly average wind speed, both with unit of $\text{m} \cdot \text{s}^{-1}$.



Air-sea CO₂ flux calculation (Remote sensing)



SatCO₂

Air-sea CO₂ flux (satellite)

Description of air-sea CO₂ flux calculation

We adopt the commonly used method to calculate the air-sea CO₂ flux, which is based on the multiplication of CO₂ partial pressure difference between surface sea water and atmosphere and CO₂ gas transfer velocity. The equation is as follows:

$$\text{Flux} = \Delta p_{\text{CO}_2} \times E = (\text{WCP} - \text{ACP}) \times K_{\text{H}}^{\text{CO}_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

- 1) ACP: partial pressure of CO₂ in atmosphere (μatm)
WCP: wpartial pressure of CO₂ in seawater(μatm)
SST: sea surface temperature (°C)
SSS: sea surface salinity (psu)
SSW: sea surface wind speed (m/s)
- 2) KHCO₂—Dissolution efficient of CO₂(mol·kg⁻¹·atm⁻¹)
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 $\text{SSS} \times [0.023517 - 0.023656 \times (T/100) + 0.0047036 \times (T/100)^2]$
T = SST (°C) + 273.15
- 3) ρ—Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)(kg·m⁻³)
 $\rho = (\rho_w + A * S + B * S^2 + C * S^3) * 10^{-3}$
 $\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$
A=0.824493-4.0899*10⁻³*T+7.6438*10⁻⁵*T²-8.2467*10⁻⁷*T³+5.3875*10⁻⁹*T⁴
B=-5.72466*10⁻³+1.0227*10⁻⁴*T-1.6546*10⁻⁶*T²
C=4.8314*10⁻⁴

Query satellite

Select month: 2000-01

Select satellite data

	Resolution
ACP: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
WCP: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SST: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SAL: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167
SSW: SIO_SAT_SENSOR_20000401TO20000430_L3	0.0167

Resampling resolution: 0.0167

Select equation for gas transfer velocity(k)

k660 = 0.31 × u10² (real-time) , Wanninkhof (1992) (real-time)

Add C2 adjustment

Tip: This calculation is time-consuming and depends on the network speed.

Air-sea CO₂ flux calculation (In situ data)



SatCO₂

Description of air-sea CO₂ flux calculation

We adopt the commonly used method to calculate the air-sea CO₂ flux, which is based on the multiplication of CO₂ partial pressure difference between surface sea water and atmosphere and CO₂ gas transfer velocity. The equation is as follows:

$$\text{Flux} = \Delta p\text{CO}_2 \times E = (\text{WCP} - \text{ACP}) \times K_{\text{H}}^{\text{CO}_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

- 1) ACP: partial pressure of CO₂ in atmosphere (μatm)
WCP: wpartial pressure of CO₂ in seawater(μatm)
SST: sea surface temperature (°C)
SSS: sea surface salinity (psu)
SSW: sea surface wind speed (m/s)
- 2) KHCO₂—Dissolution efficient of CO₂(mol·kg⁻¹·atm⁻¹)
 $\ln(K_{\text{H}}^{\text{CO}_2}) = -60.2409 + 93.4517 \times (100/T) + 23.3585 \times \ln(T/100) +$
 $\text{SSS} \times [0.023517 - 0.023656 \times (T/100) + 0.0047036 \times (T/100)^2]$
T = SST (°C) + 273.15
- 3) ρ—Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)(kg·m⁻³)
 $\rho = (\rho_w + A * S + B * S^2 + C * S^3) * 10^{-3}$
 $\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$
A=0.824493-4.0899*10⁻³*T+7.6438*10⁻⁵*T²-8.2467*10⁻⁷*T³+5.3875*10⁻⁹*T⁴
B=-5.72466*10⁻³+1.0227*10⁻⁴*T-1.6546*10⁻⁶*T²
C=4.8314*10⁻⁴
- 4) C₂—Wind speed coefficient C₂, which has been calculated and uploaded in the SOED database
To calculate the monthly average flux, it is often necessary to consider the influence of the high frequency wind speed change (e.g. daily) on the

Please select in situ data. You can add more data in the [data manage] menu.

CDIAC_-13TO18_-124TO162_20080106TO20080916_KA10

You can use satellite data or constant values in the calculation.

ACP: Satellite data Constant values

SSW: Satellite data Constant values

Use climatology data if there is no satellite data in the same period

Add C₂ adjustment

Select parameters

SST

SAL

WCP

satellite-in-situ matchup strategy

Spatial window: 1*1

Temporal window: Month

Bin resolution: 0.25

Select equation for gas transfer velocity(k)

k660 = 0.31×u10² (real-time) , Wanninkhof (1992) (real-time)

OK Cancel

Practice case 9



Air-sea CO₂ flux (satellite)

Description of air-sea CO₂ flux calculation

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where,

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T = SST (°C) + 273.15
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 $\rho = (\rho_w + A * S + B * S^2 + C * S^3) * 10^{-3}$
 $\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$
A=0.824493-4.0899*10⁻³*T+7.6438*10⁻⁵*T²-8.2467*10⁻⁷*T³+5.3875*10⁻⁹*T⁴
B=-5.72466*10⁻³+1.0227*10⁻⁴*T-1.6546*10⁻⁶*T²
C=4.8314*10⁻⁴

Query satellite

Select month: 2016-01

Select satellite data

	Resolution
ACP: SIO_MERGE_MERGE_20160101TO20160131_I	0.2500
WCP: SIO_AQUA_MODIS_20160101TO20160131_LI	0.0167
SST: NOAA_NOAA_AVHRR_20160101TO20160131	0.2500
SSS: SIO_AQUA_MODIS_20160101TO20160131_LI	0.0167
SSW: RSS_MERGE_MERGE_20160101TO20160131_I	0.2496

Resampling resolution: 0.0167

Select equation for gas transfer velocity(k):
k660 = 0.31 × u¹⁰ (real-time), Wanninkhof (1992) (real-time)

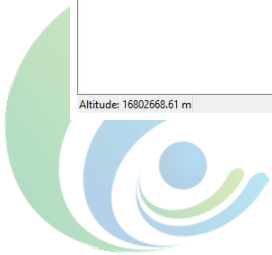
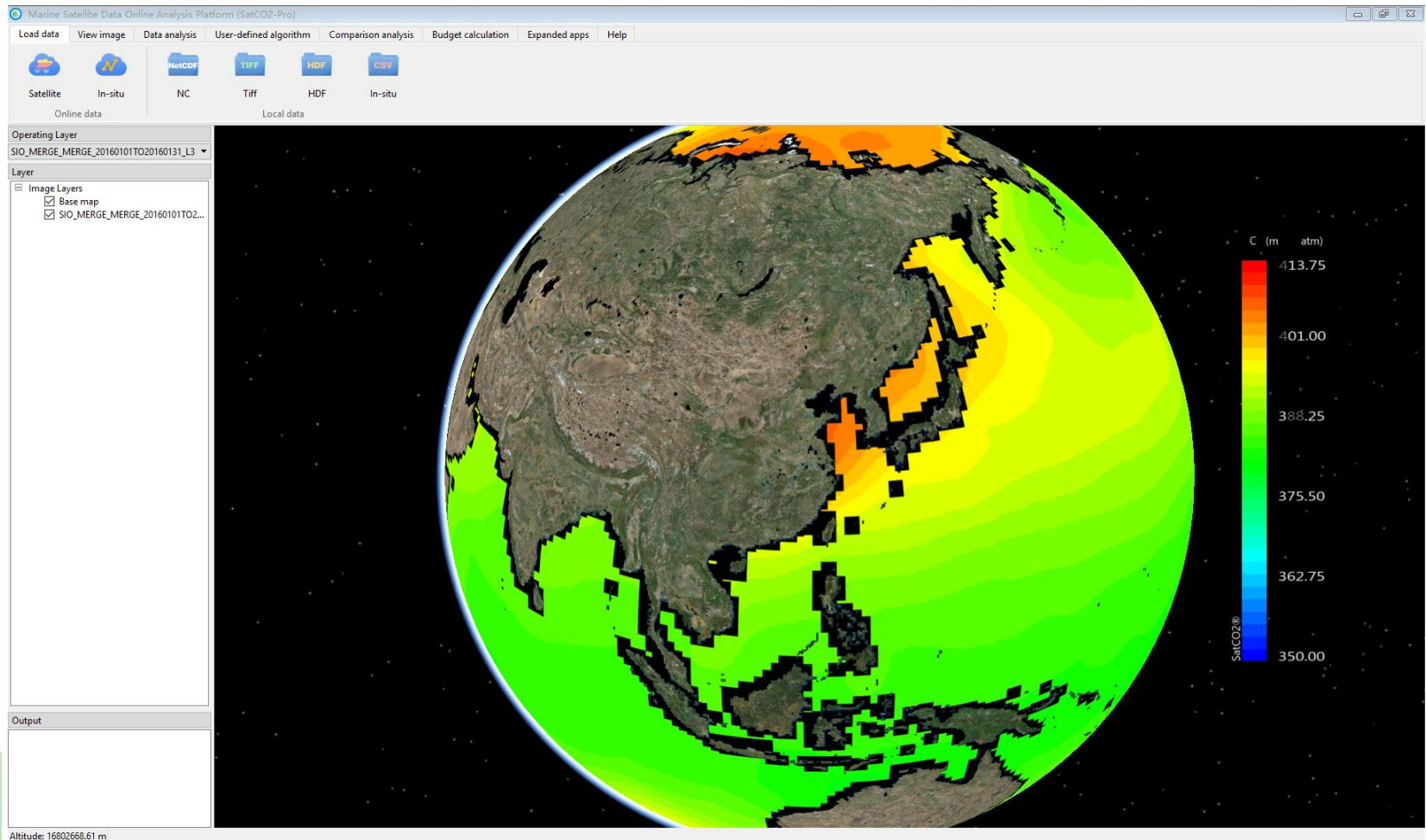
Add C₂ adjustment

Tip: This calculation is time-consuming and depends on the network speed.

Practice case 9 ACP



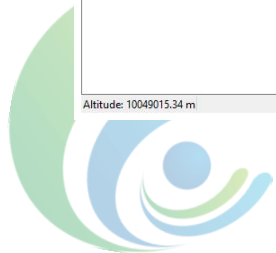
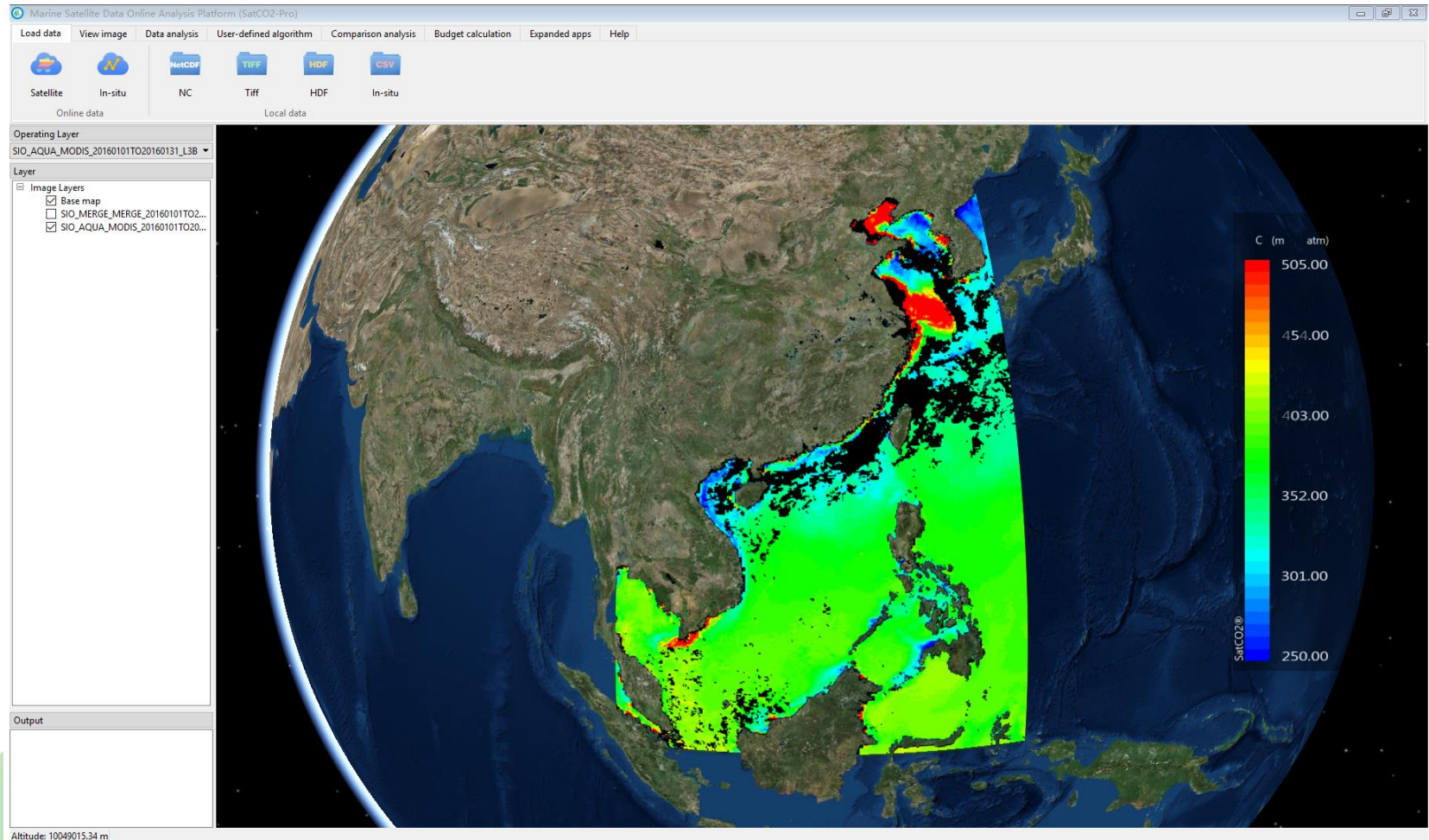
SatCO2



Practice case 9 WCP



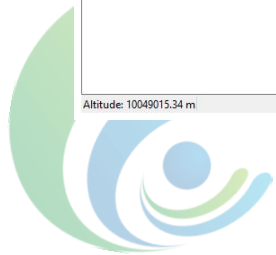
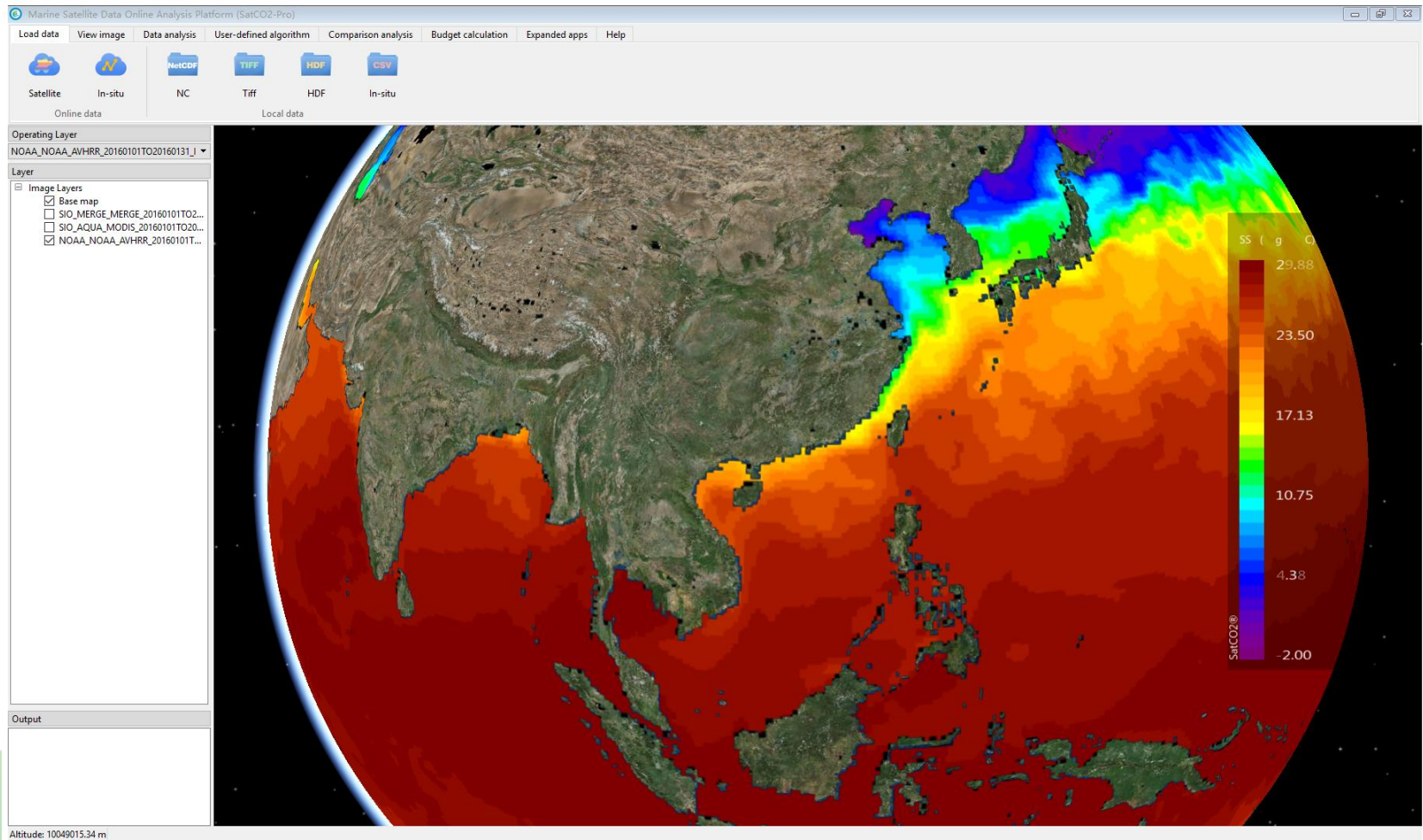
SatCO2



Practice case 9 SST



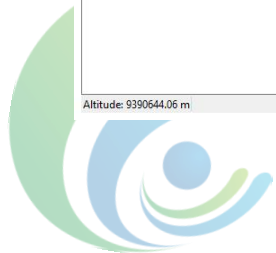
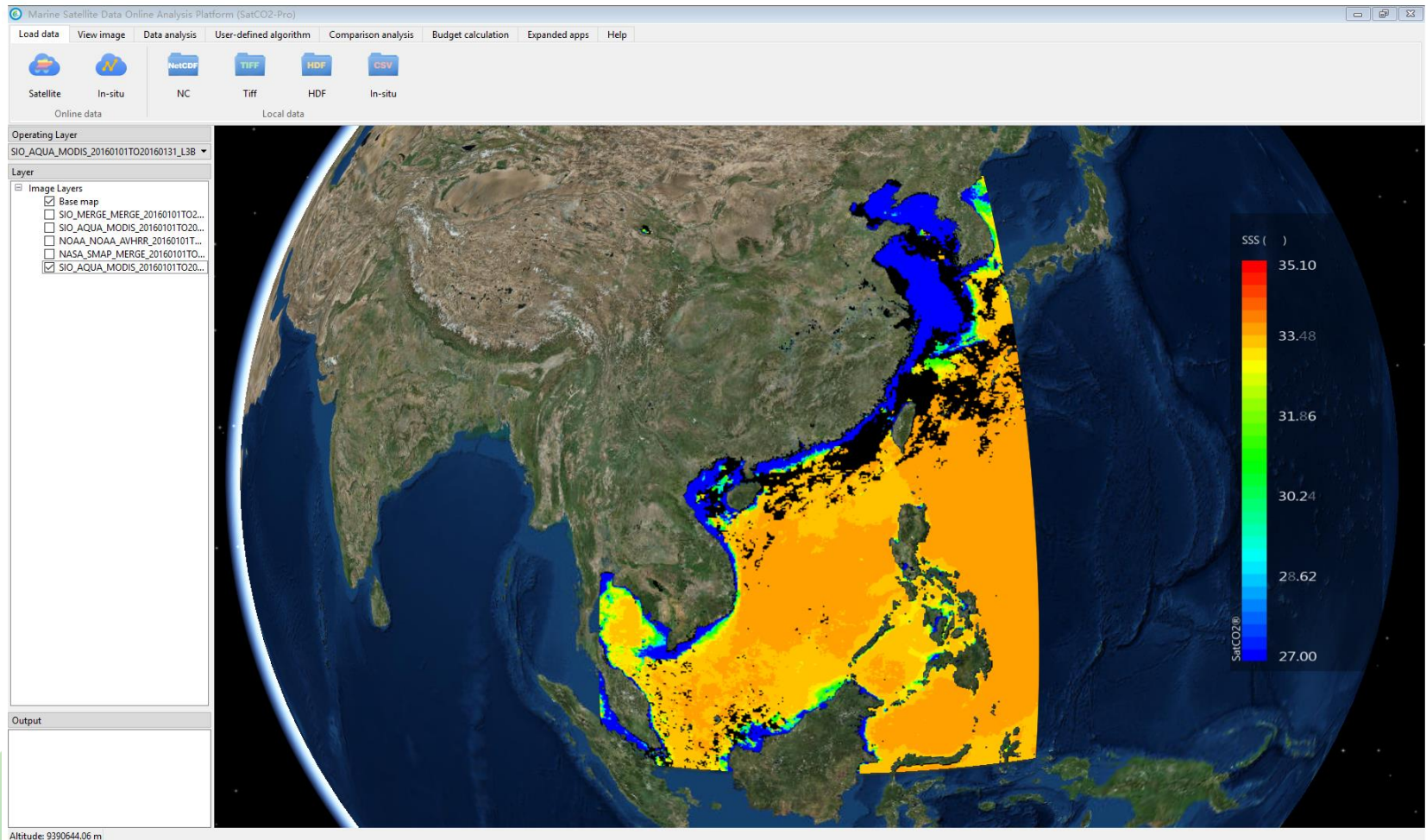
SatCO₂



Practice case 9 SSS



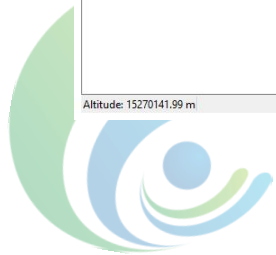
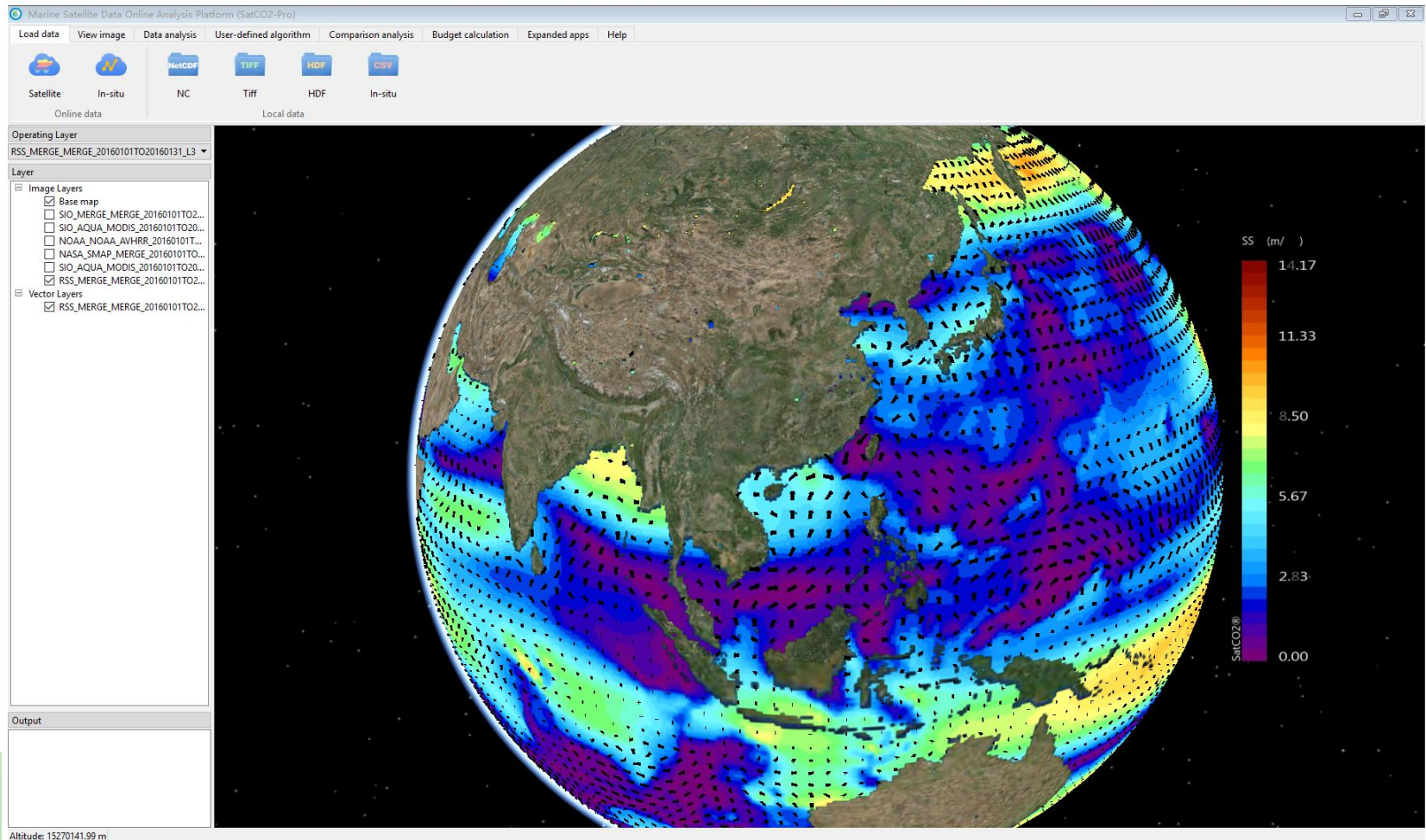
SatCO2



Practice case 9 SSW



SatCO2



Practice case 9



Air-sea CO₂ flux (satellite)

Description of air-sea CO₂ flux calculation

We adopt the commonly used method to calculate the air-sea CO₂ flux, which is based on the multiplication of CO₂ partial pressure difference between surface sea water and atmosphere and CO₂ gas transfer velocity. The equation is as follows:

$$\text{Flux} = \Delta p\text{CO}_2 \times E = (\text{WCP} - \text{ACP}) \times K_{\text{H}}^{\text{CO}_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

- 1) ACP: partial pressure of CO₂ in atmosphere (μatm)
WCP: wpartial pressure of CO₂ in seawater(μatm)
SST: sea surface temperature (°C)
SSS: sea surface salinity (psu)
SSW: sea surface wind speed (m/s)
- 2) KHCO₂—Dissolution efficient of CO₂(mol·kg⁻¹·atm⁻¹)
 $\ln(K_{\text{H}}^{\text{CO}_2}) = -60.2409 + 93.4517 \times (100/T) + 23.3585 \times \ln(T/100) + \text{SSS} \times [0.023517 - 0.023656 \times (T/100) + 0.0047036 \times (T/100)^2]$
T = SST (°C) + 273.15
- 3) ρ—Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)(kg·m⁻³)
 $\rho = (\rho_w + A * S + B * S^2 + C * S^3) * 10^{-3}$
 $\rho_w = 999.842594 + 6.793952 * 10^{-2} * T - 9.09529 * 10^{-3} * T^2 + 1.001685 * 10^{-4} * T^3 - 1.120083 * 10^{-6} * T^4 + 6.536332 * 10^{-9} * T^5$
A=0.824493-4.0899*10⁻³*T+7.6438*10⁻⁵*T²-8.2467*10⁻⁷*T³+5.3875*10⁻⁹*T⁴
B=-5.72466*10⁻³+1.0227*10⁻⁴*T-1.6546*10⁻⁶*T²
C=4.8314*10⁻⁴

Query satellite

Select month: 2016-01

Select satellite data

	Resolution
ACP: SIO_MERGE_MERGE_20160101TO20160131_I	0.2500
WCP: SIO_AQUA_MODIS_20160101TO20160131_LI	0.0167
SST: NOAA_NOAA_AVHRR_20160101TO20160131	0.2500
SSS: SIO_AQUA_MODIS_20160101TO20160131_LI	0.0167
SSW: RSS_MERGE_MERGE_20160101TO20160131_I	0.2496

Resampling resolution: 0.0167

Select equation for gas transfer velocity(k)

k660 = 0.31 × u¹⁰ (real-time) , Wanninkhof (1992) (real-time)

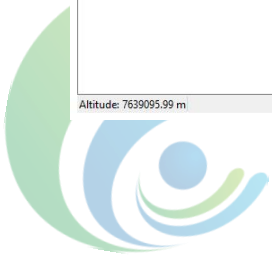
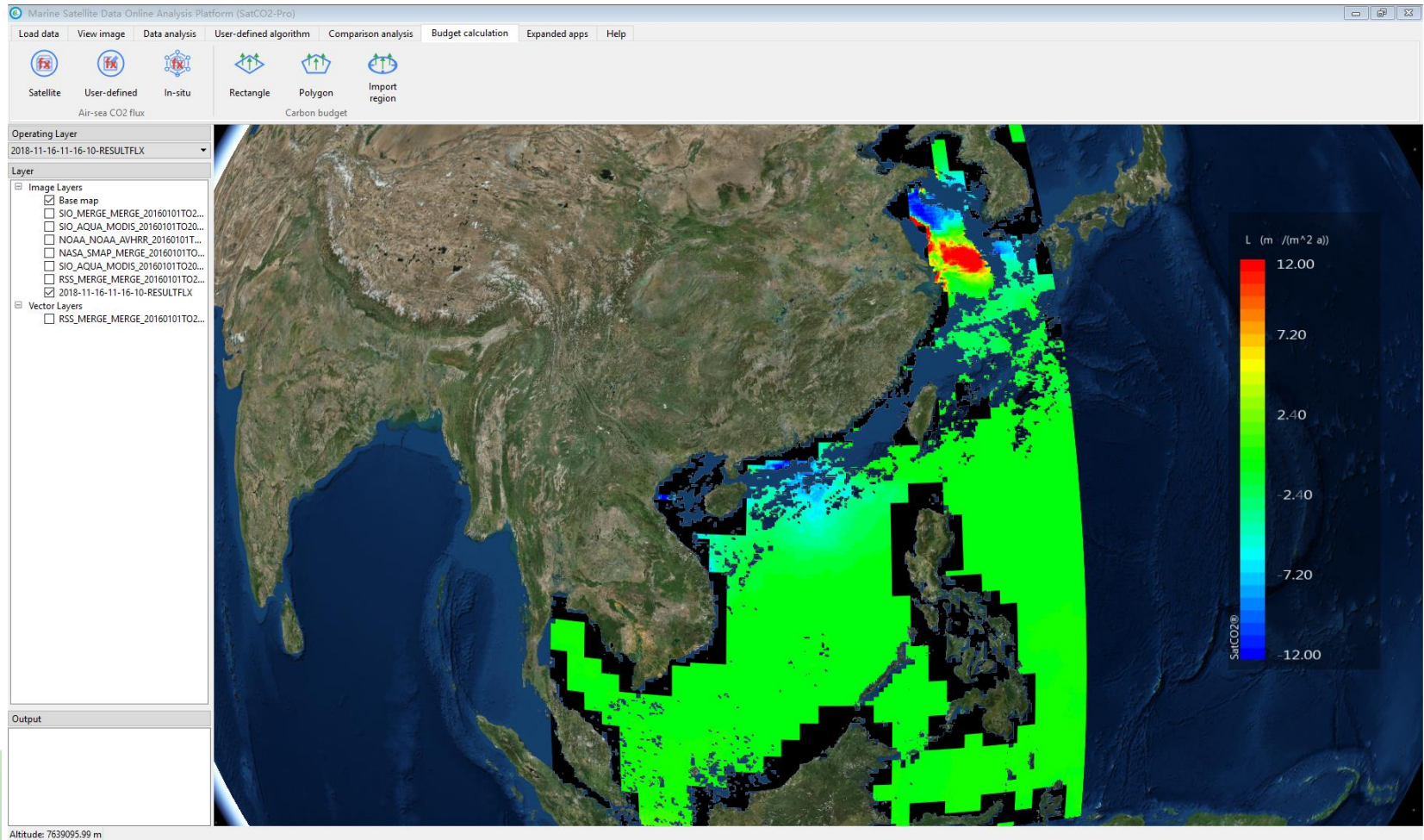
Add C₂ adjustment

Tip: This calculation is time-consuming and depends on the network speed.

Practice case 9



SatCO2





**Let us begin
the hands-on practice!**



Practice case 1

Satellite product in database

Database
Select

Datasets

Products Composition period

Time range
 Full range
Start date
End date
 Specific month
Time range
Select month

Spatial range(-90°S~90°N;-180°W~180°E)
N 90.000
W -180.000 E 180.000
S -90.000



Practice case 1

Query results

Server: SatCO2-Cloud

- ESACCI_SAT_MERGE_20090721TO20090721_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090722TO20090722_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090723TO20090723_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090724TO20090724_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090725TO20090725_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090726TO20090726_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090727TO20090727_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090728TO20090728_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090729TO20090729_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090730TO20090730_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090731TO20090731_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090801TO20090801_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090801TO20090831_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090802TO20090802_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090803TO20090803_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090804TO20090804_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090805TO20090805_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090806TO20090806_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090807TO20090807_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090808TO20090808_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090809TO20090809_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090810TO20090810_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090811TO20090811_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090812TO20090812_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090813TO20090813_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090814TO20090814_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090815TO20090815_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090816TO20090816_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090817TO20090817_L3B_GLOBAL_4KM_CHL_OCCCIV31
- ESACCI_SAT_MERGE_20090818TO20090818_L3B_GLOBAL_4KM_CHL_OCCCIV31

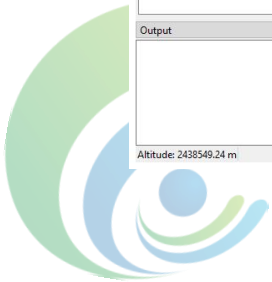
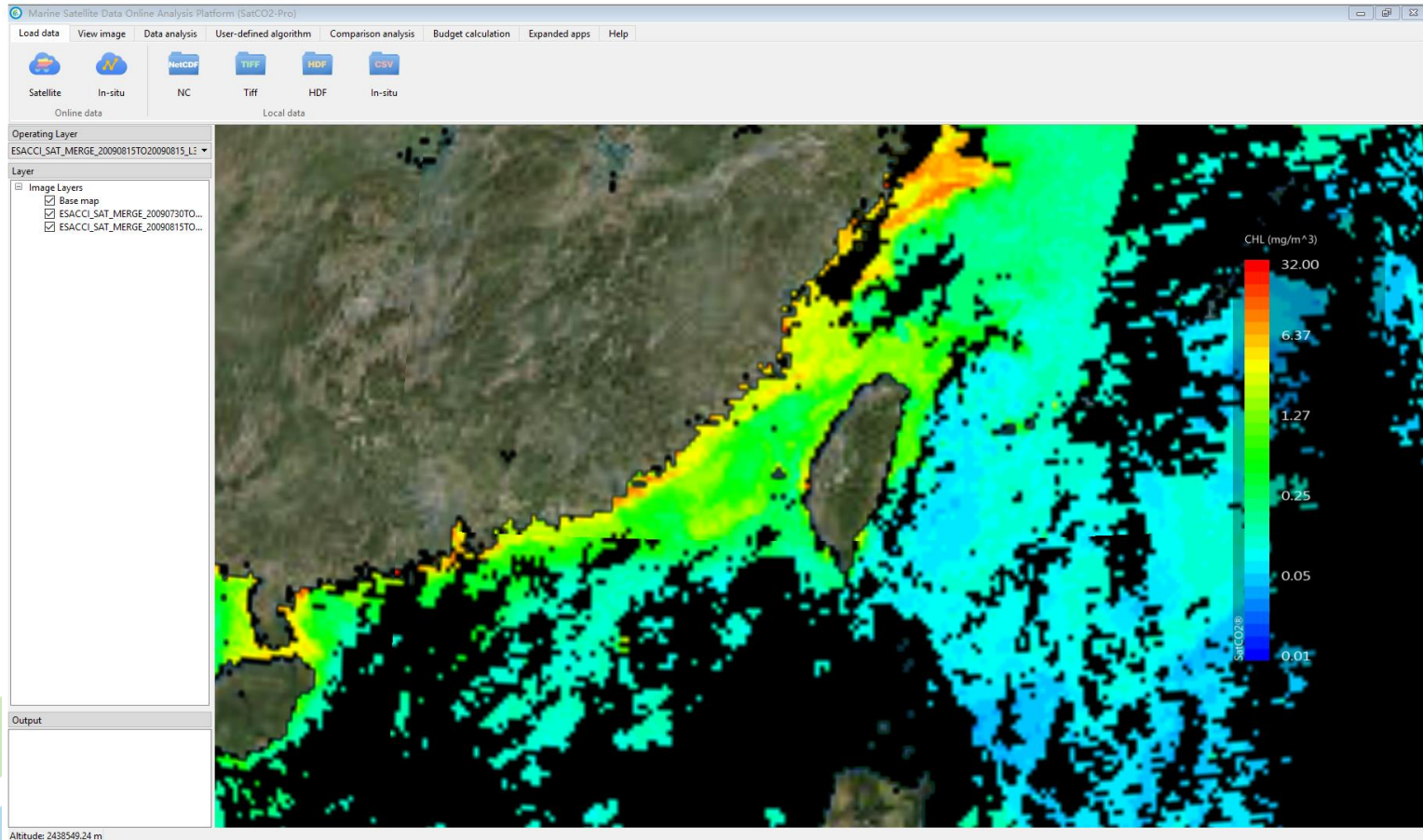
Back OK Cancel



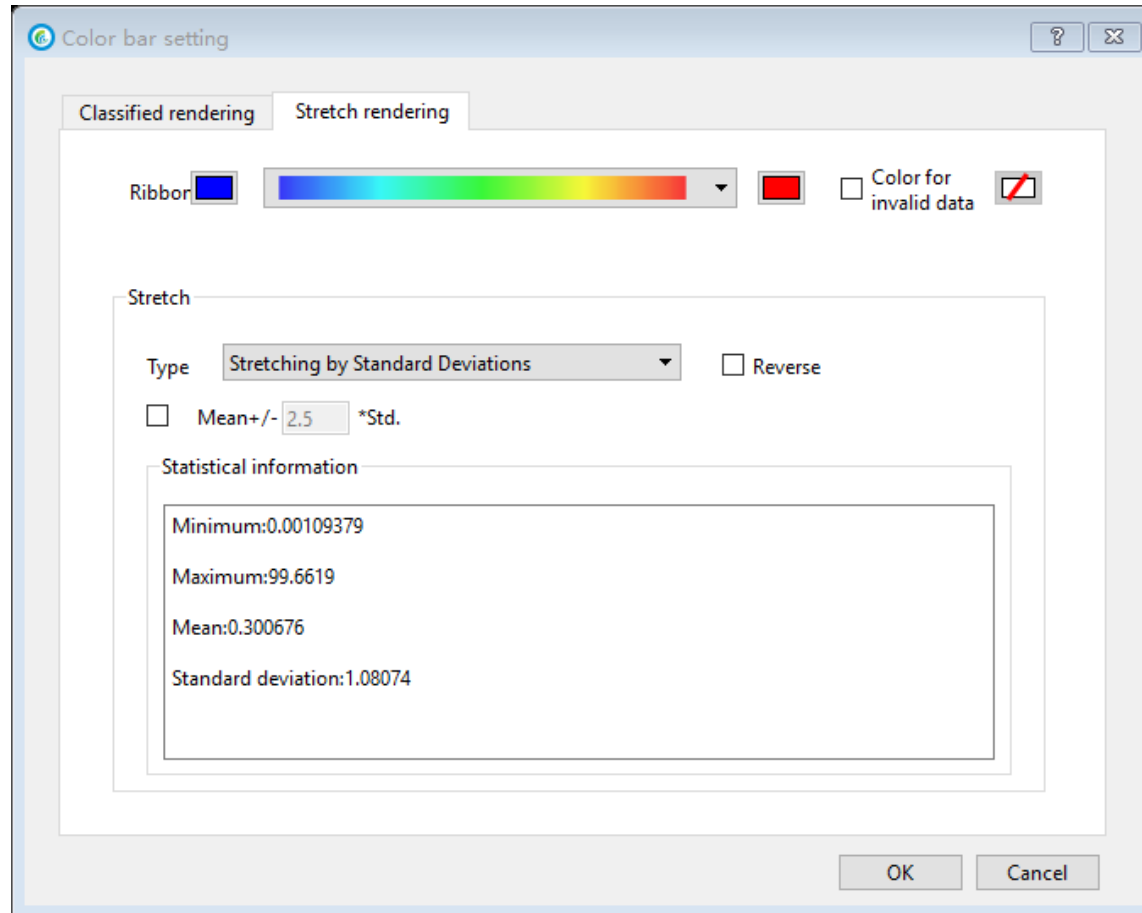
Practice case 1



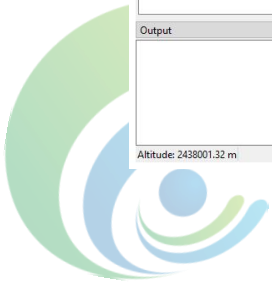
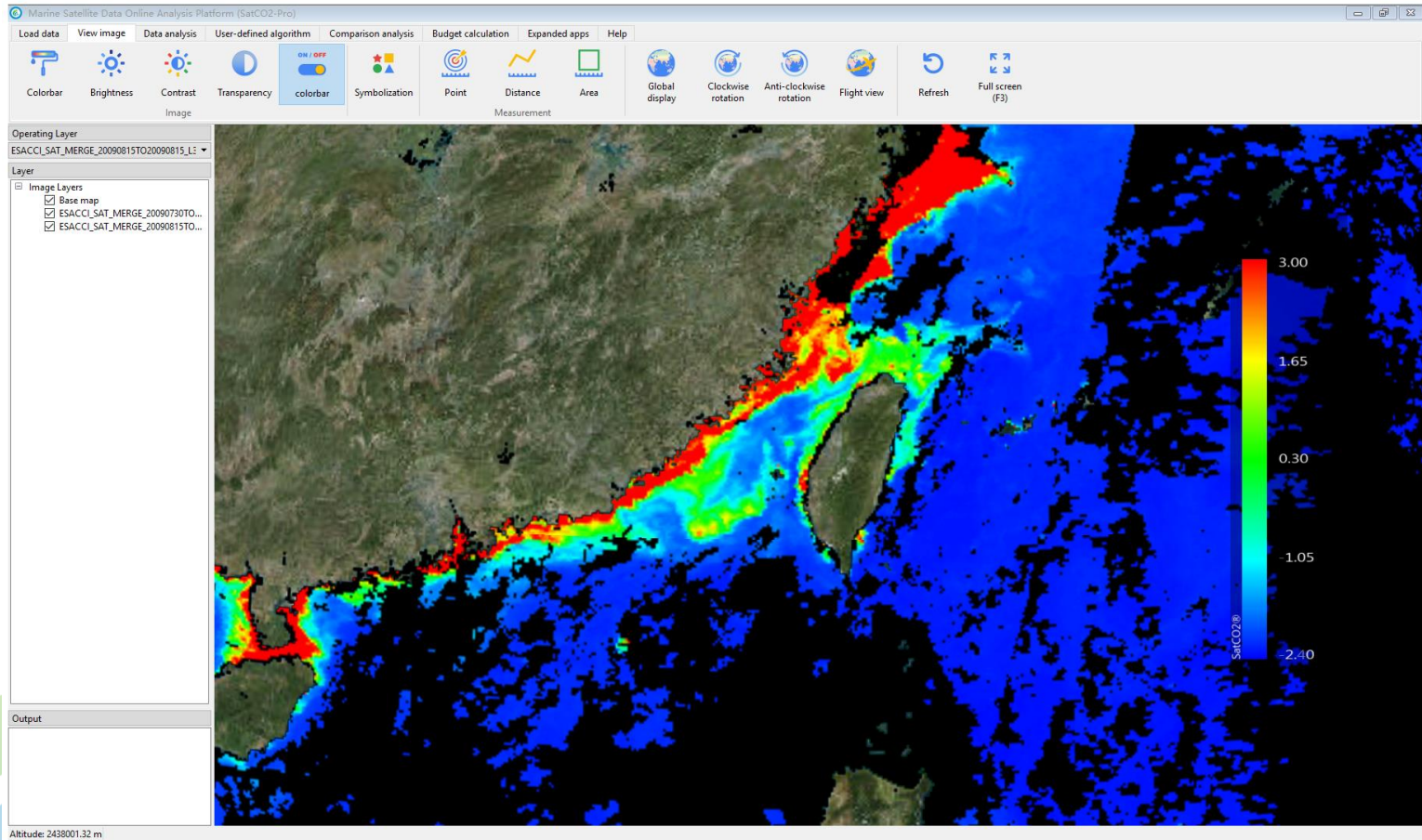
SatCO2



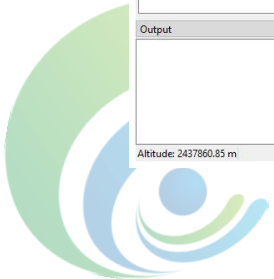
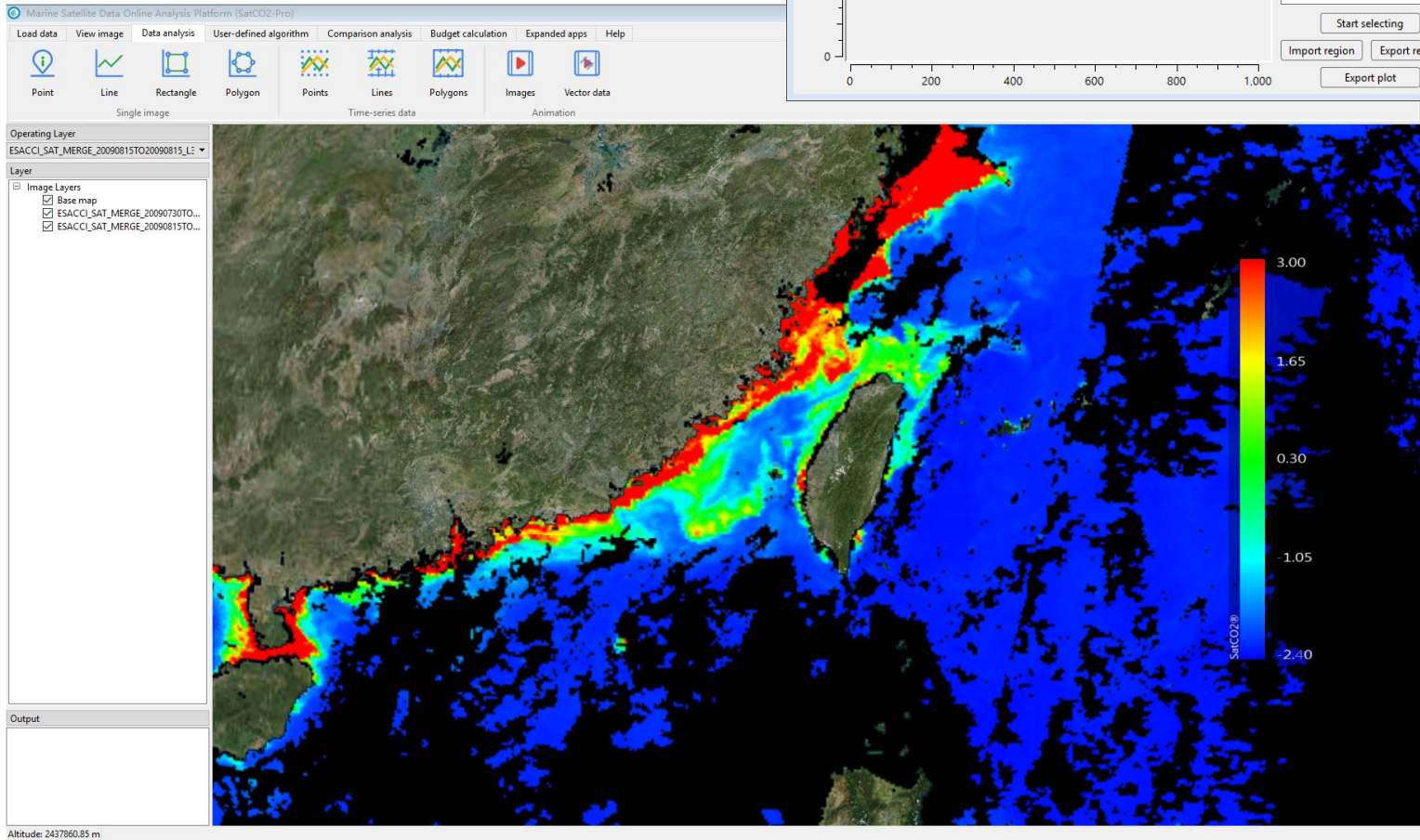
Practice case 1



Practice case 1



Practice case 1



Practice case 1

Marine Satellite Data Online Analysis Platform (SatCO2-Pro)

Load data | View image | Data analysis | User-defined algorithm | Comparison analysis | Budget calculation | Expanded apps | Help

Point | Line | Rectangle | Polygon | Points | Lines | Polygons | Images | Vector data

Single image | Time-series data | Animation

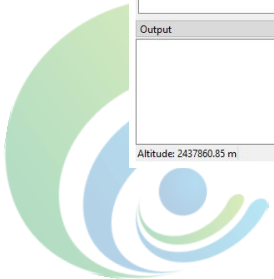
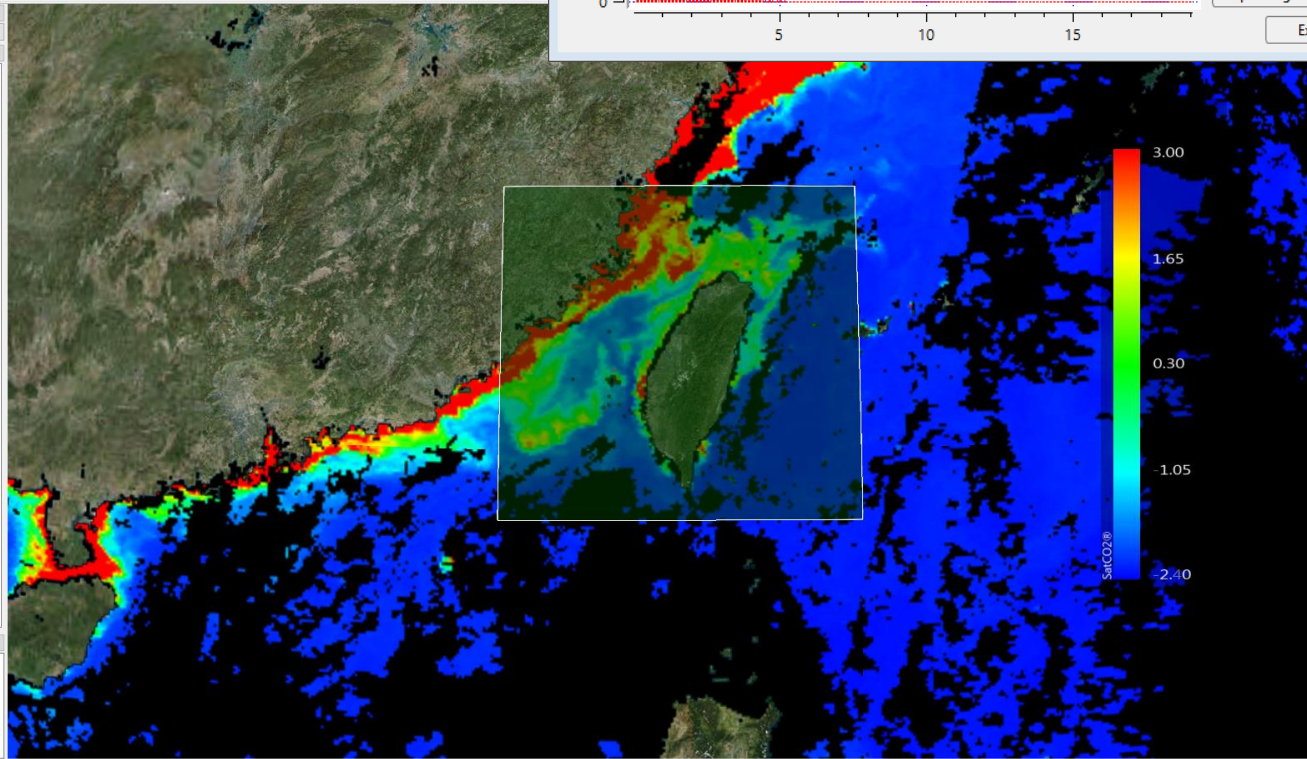
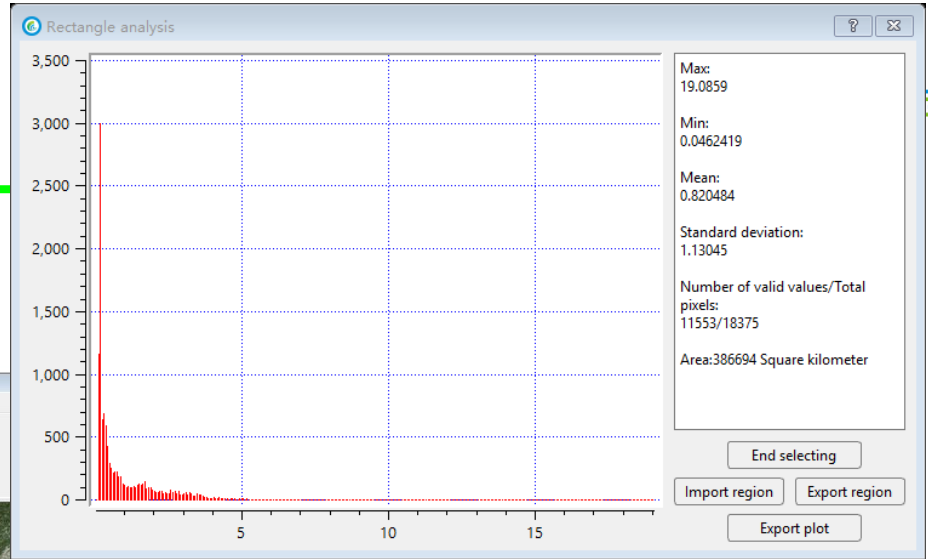
Operating Layer
ESACCI_SAT_MERGE_20090815TO20090815_L1

Layer

- Image Layers
 - Base map
 - ESACCI_SAT_MERGE_20090730TO...
 - ESACCI_SAT_MERGE_20090815TO...

Output

Altitude: 2437860.85 m





Practice case 2

Satellite product in database

Database
Select SatCO2-Cloud Connection

Datasets ? ESACCI_SAT_MERGE_GLOBAL

Products CHL Composition period Monthly composite

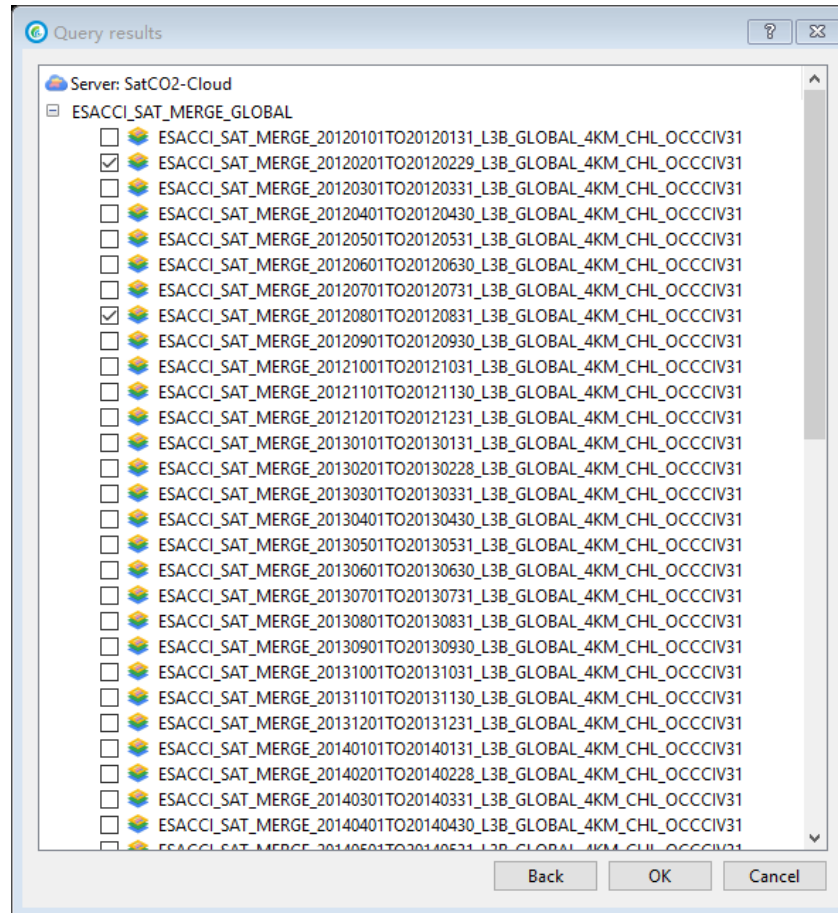
Time range
 Full range
Start date 2012/1/1
End date 2018/11/16
 Specific month
Time range Month
Select month 1

Spatial range(-90°S~90°N;-180°W~180°E)
N 90.000
W -180.000 E 180.000
S -90.000
Frame selection

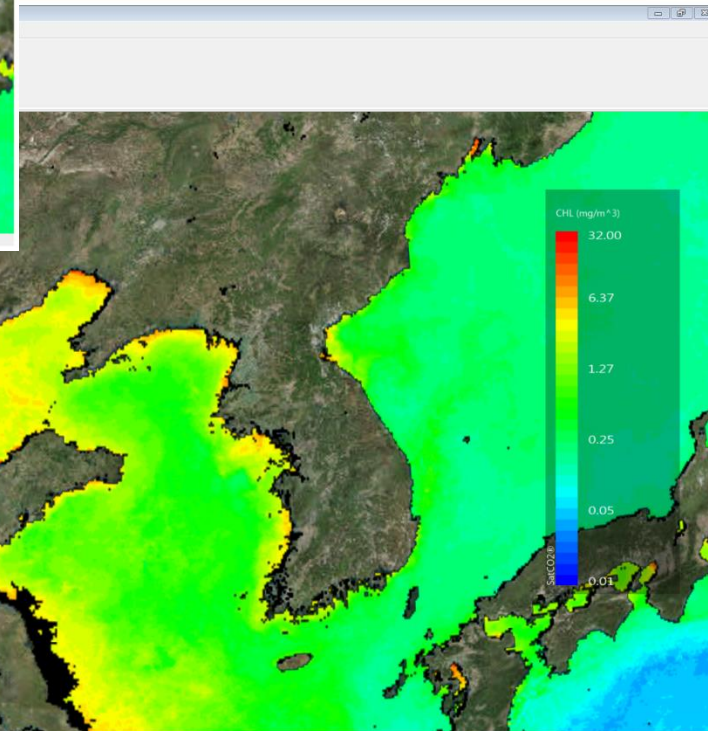
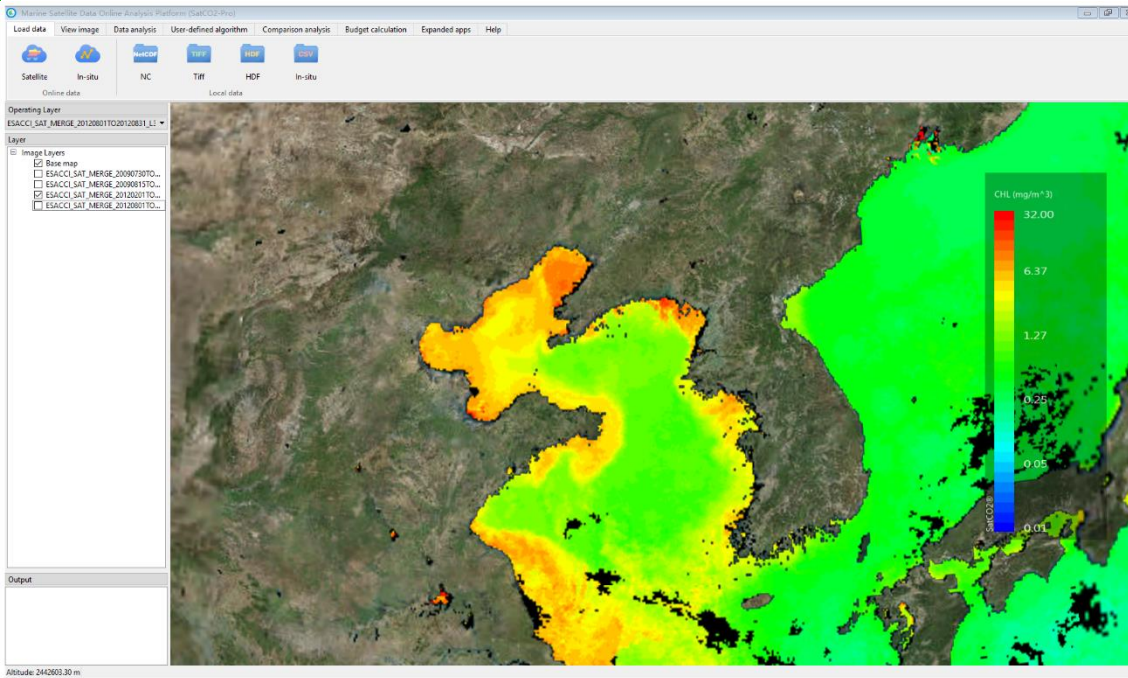
Query Cancel



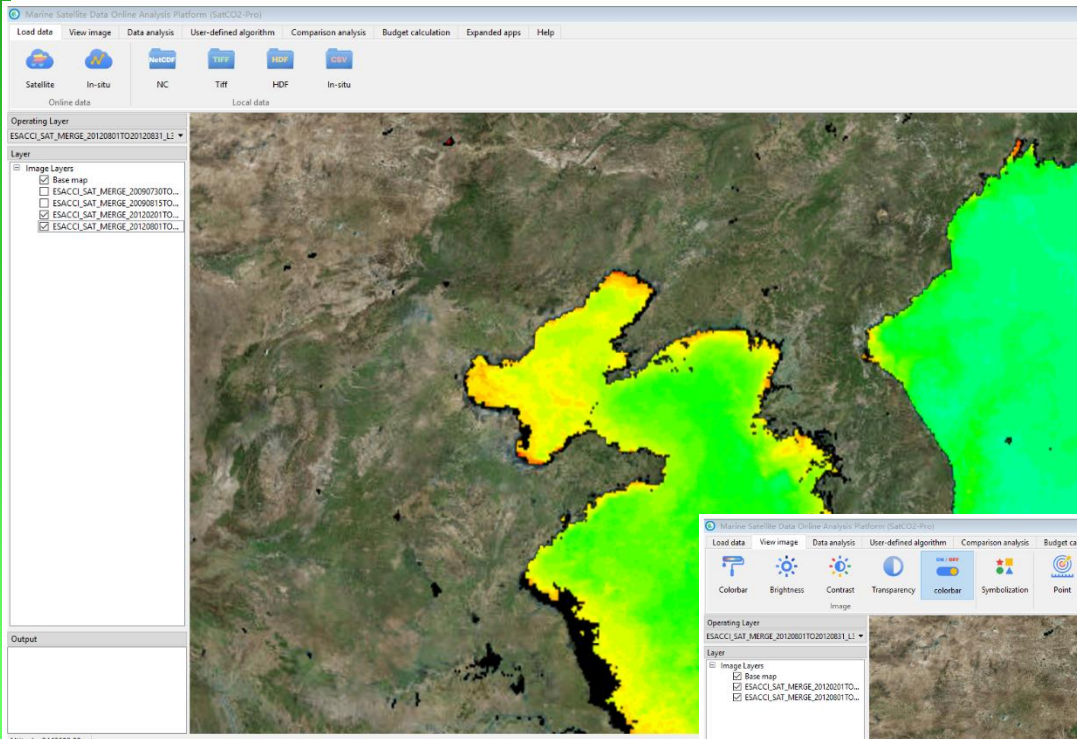
Practice case 2



Practice case 2



Practice case 2



Color bar setting

Classified rendering | **Stretch rendering**

Ribbon: Color for invalid data

Stretch

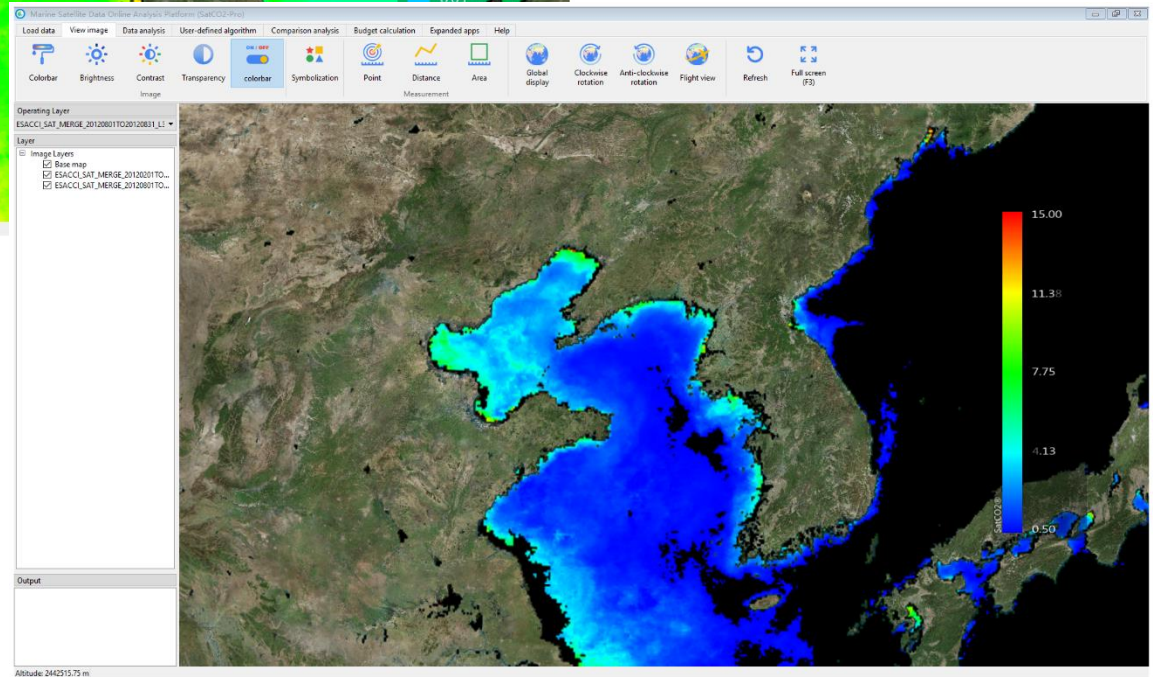
Type: **Stretching by Minimum and Maximum** Reverse

User-defined min/mx Minimum: 0,5 Maximum: 15

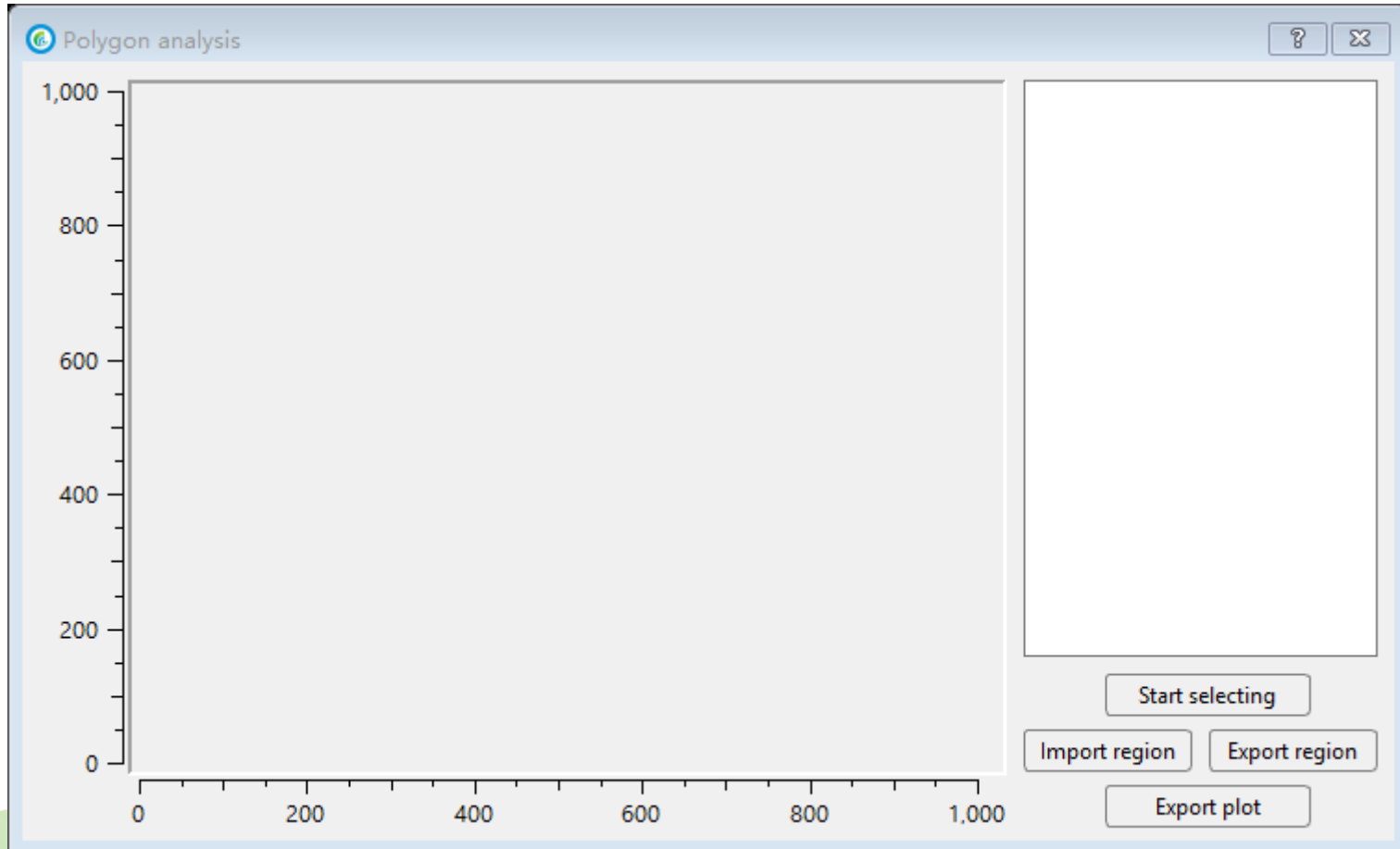
Statistical information

Minimum: 0.00117786
Maximum: 99.5657
Mean: 0.348687
Standard deviation: 1.37755

OK Cancel

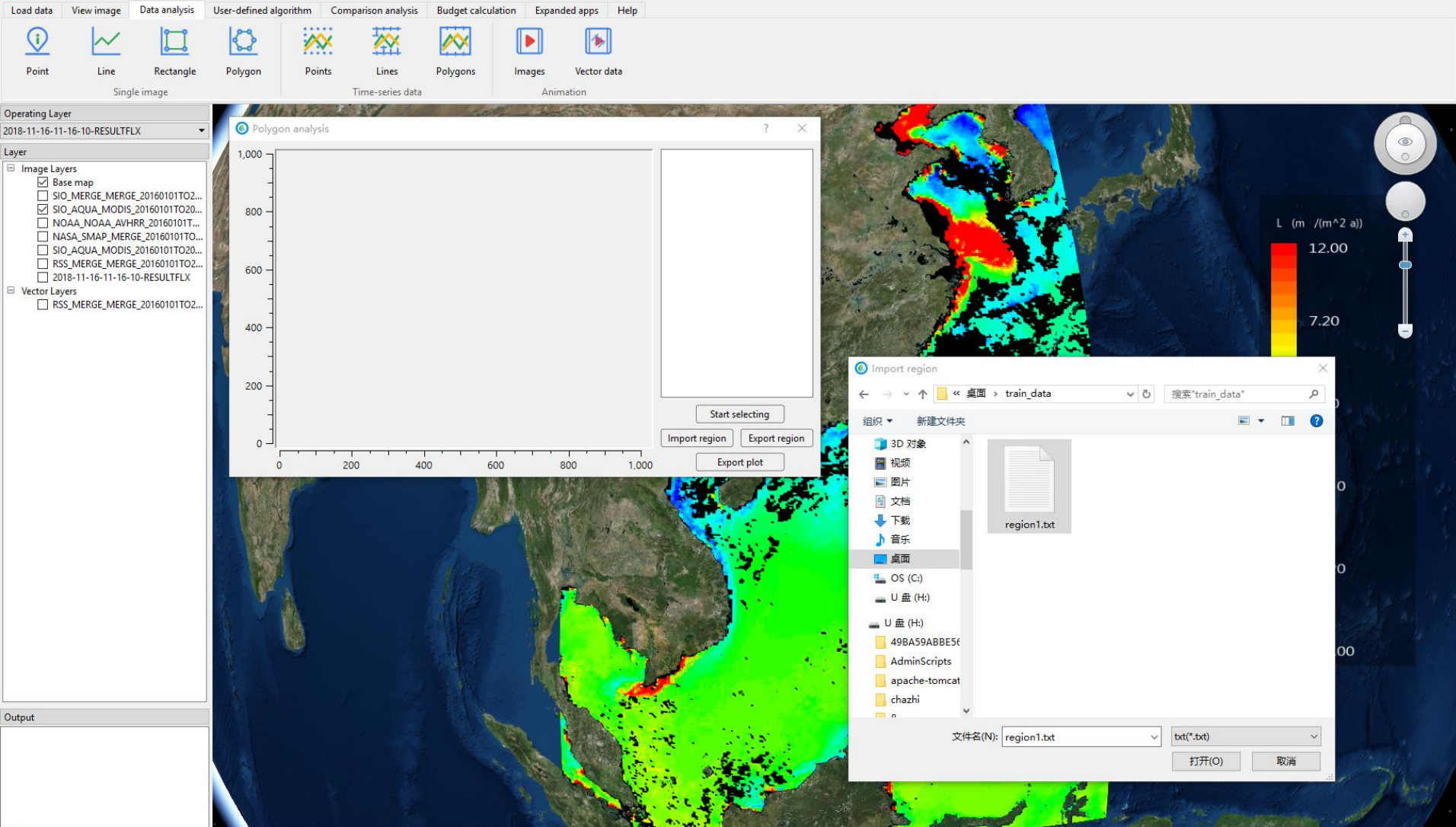


Practice case 2



Practice case 2

Marine Satellite Data Online Analysis Platform (SatCO2-Pro)



The interface includes a top navigation bar with the following tabs: Load data, View image, Data analysis, User-defined algorithm, Comparison analysis, Budget calculation, Expanded apps, and Help. Below the navigation bar are icons for various data types: Point, Line, Rectangle, Polygon, Points, Lines, Polygons, Images, and Vector data. The main map area shows a satellite-based data overlay on a geographical map of the Indian Ocean region. A color scale on the right indicates values in $\text{m}^2/\text{m}^2 \text{ a}$, ranging from 7.20 to 12.00. A 'Polygon analysis' window is open, showing a 1000x1000 coordinate grid with axes labeled from 0 to 1000. It contains buttons for 'Start selecting', 'Import region', 'Export region', and 'Export plot'. An 'Import region' dialog box is also open, showing a file named 'region1.txt' selected on the desktop. The dialog box includes a search bar, a file list, and buttons for '打开(O)' (Open) and '取消' (Cancel).

Practice case 2

Marine Satellite Data Online Analysis Platform (SatCO2-Pro)

Load data | View image | Data analysis | User-defined algorithm | Comparison analysis | Budget calculation | Expanded apps | Help

Point | Line | Rectangle | Polygon | Points | Lines | Polygons | Images | Vector data

Single image | Time-series data | Animation

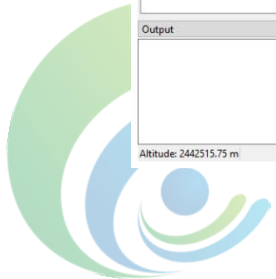
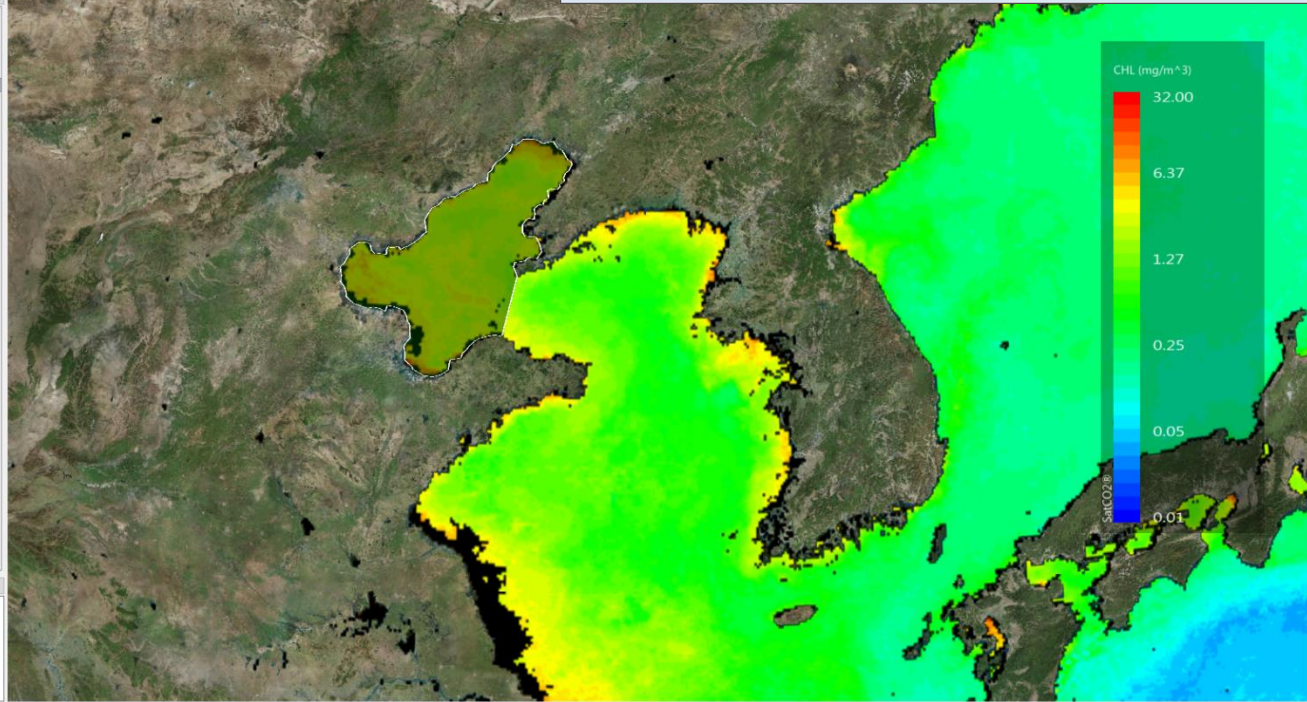
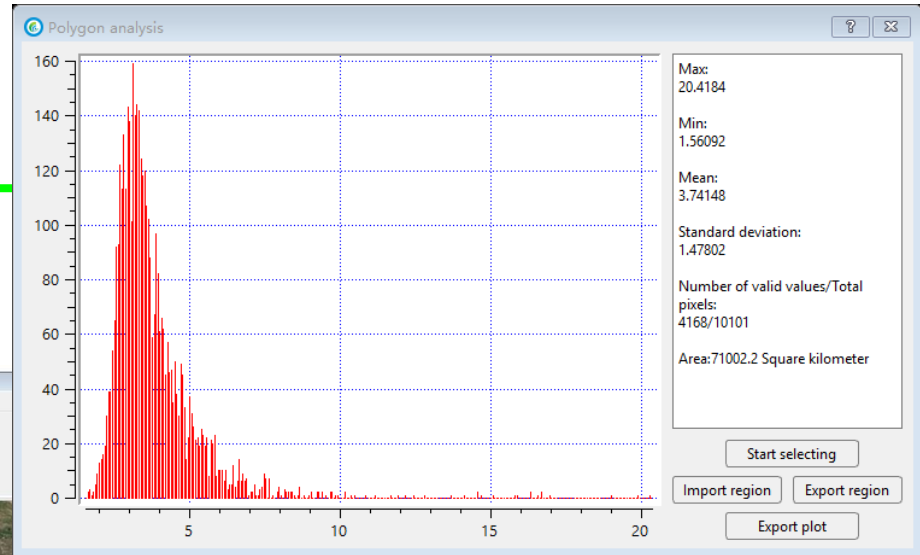
Operating Layer
ESACCI_SAT_MERGE_20120801TO20120831_L1

Layer

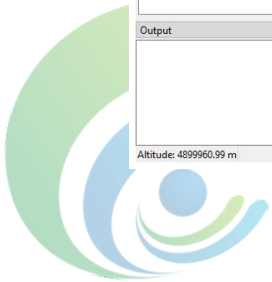
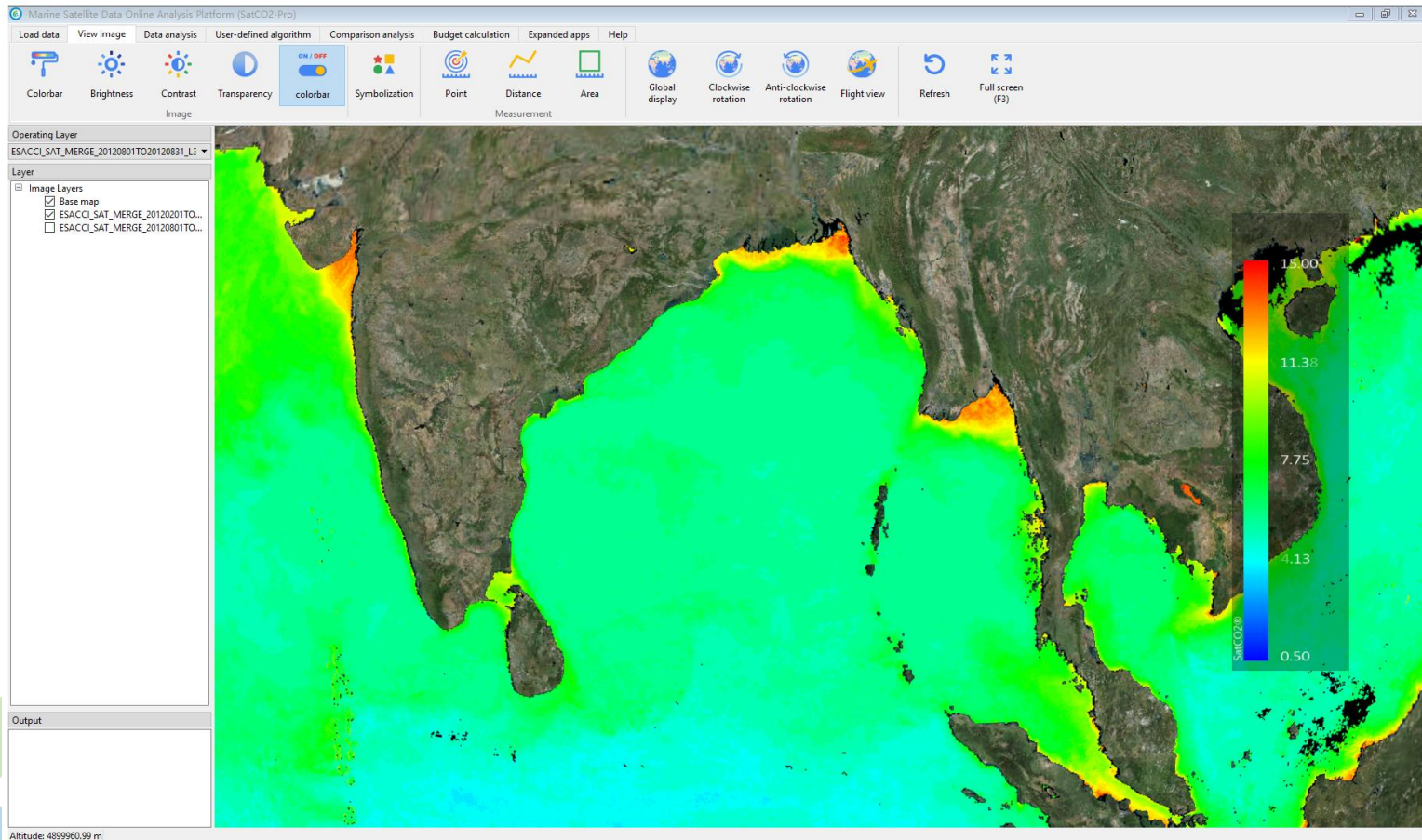
- Image Layers
 - Base map
 - ESACCI_SAT_MERGE_20090730TO...
 - ESACCI_SAT_MERGE_20090815TO...
 - ESACCI_SAT_MERGE_20120201TO...
 - ESACCI_SAT_MERGE_20120801TO...

Output

Altitude: 2442515.75 m



Practice case 3





Practice case 3

Time-series analysis

Database
Select SatCO2-Cloud Connection

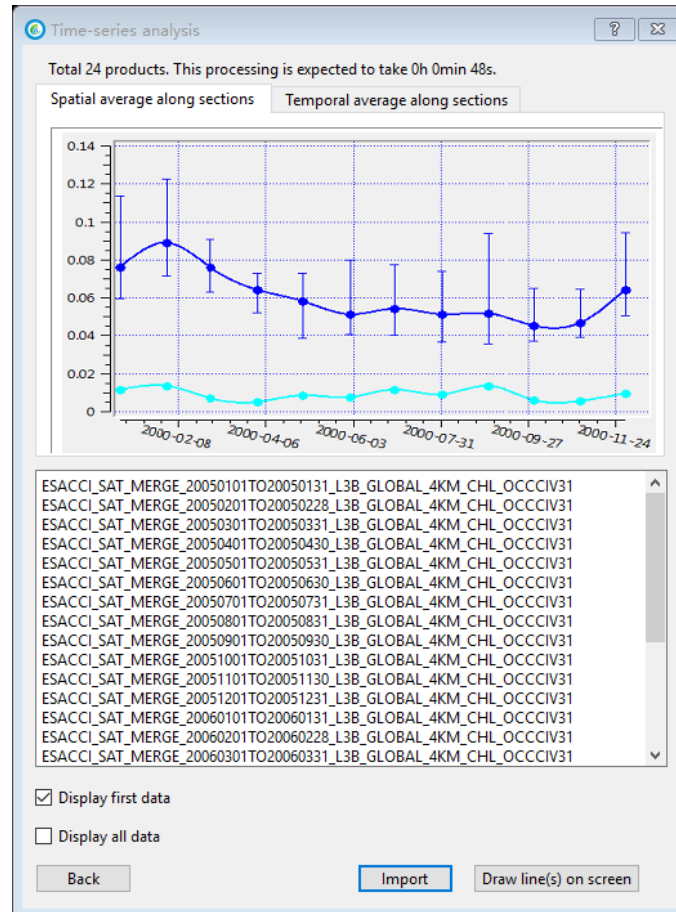
Product level L3B Datasets ESACCI_SAT_MERGE_GI
Products CHL Composition period Monthly composite

Time Range
 Full Range Specific month
Start date 2005/1/1 Time range month
End data 2006/12/31 Select month 1

Query Cancel



Practice case 3





Practice case 3

Marine Satellite Data Online Analysis Platform (SatCO₂-Pro)

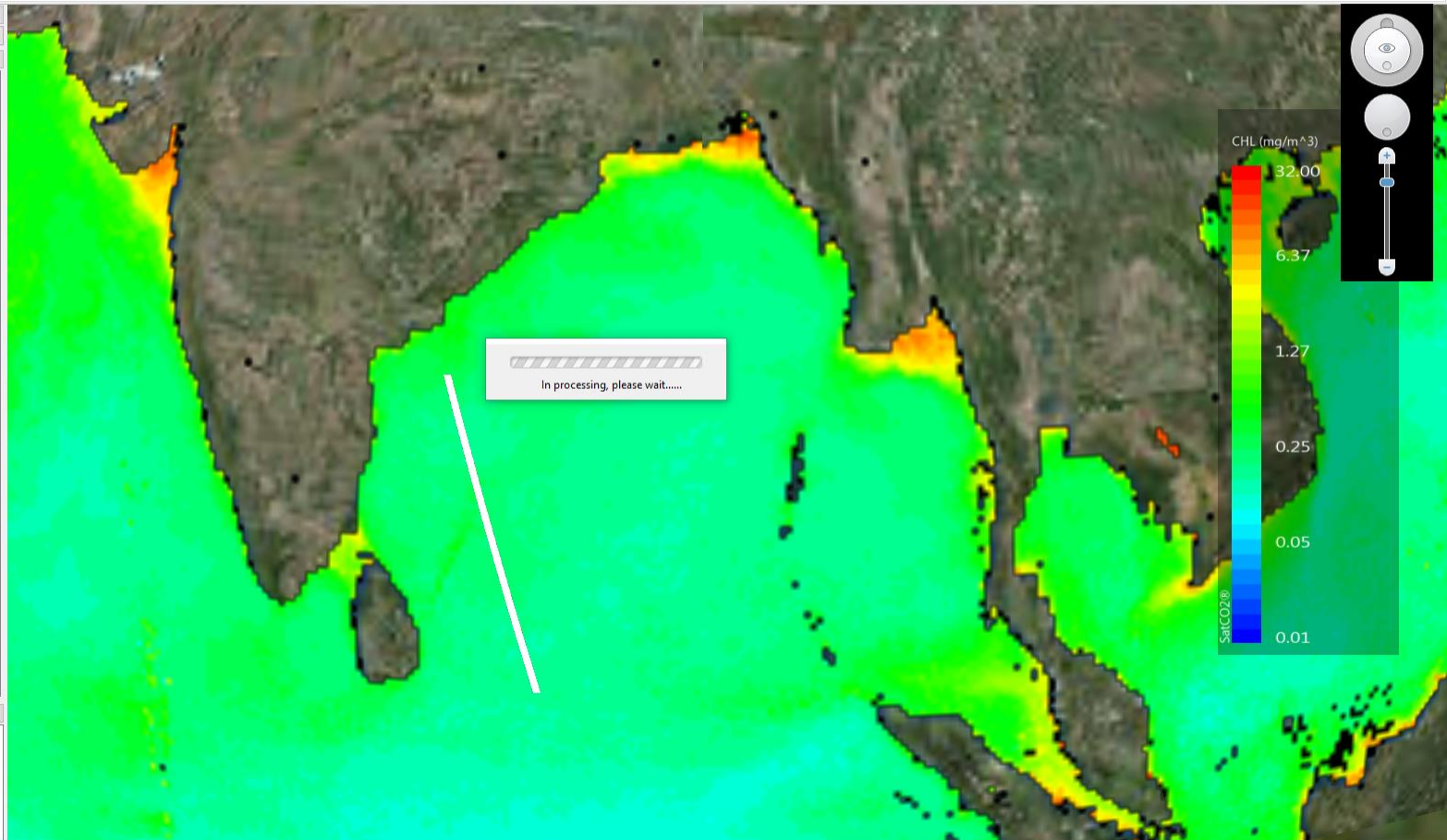
Load data | View image | Data analysis | User-defined algorithm | Comparison analysis | Budget calculation | Expanded apps | Help

Point | Line | Rectangle | Polygon | Points | Lines | Polygons | Images | Vector data

Single image | Time-series data | Animation

Operating Layer
ESACCI_SAT_MERGE_20040101TO20040131_L1

- Layer
- Image Layers
 - Base map
 - ESACCI_SAT_MERGE_20120201TO...
 - ESACCI_SAT_MERGE_20120801TO...
 - ESACCI_SAT_MERGE_20040101TO...



Output

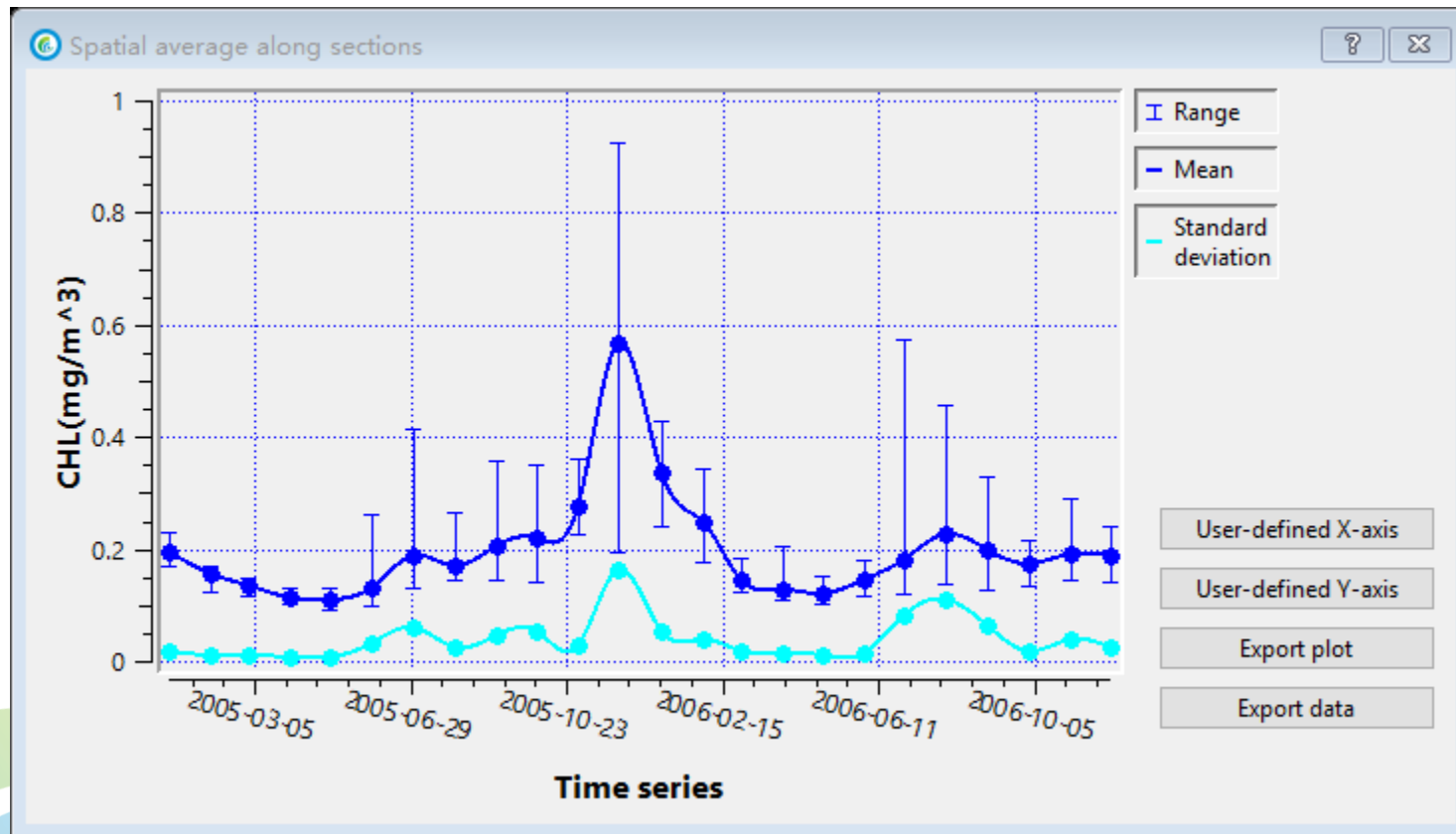
Altitude: 4901858.26 m



Windows taskbar icons: Start, File Explorer, Google Chrome, Microsoft Edge, PowerPoint, etc.

System tray: < q×, 英, 10:42, 星期五, 2018/11/16, □

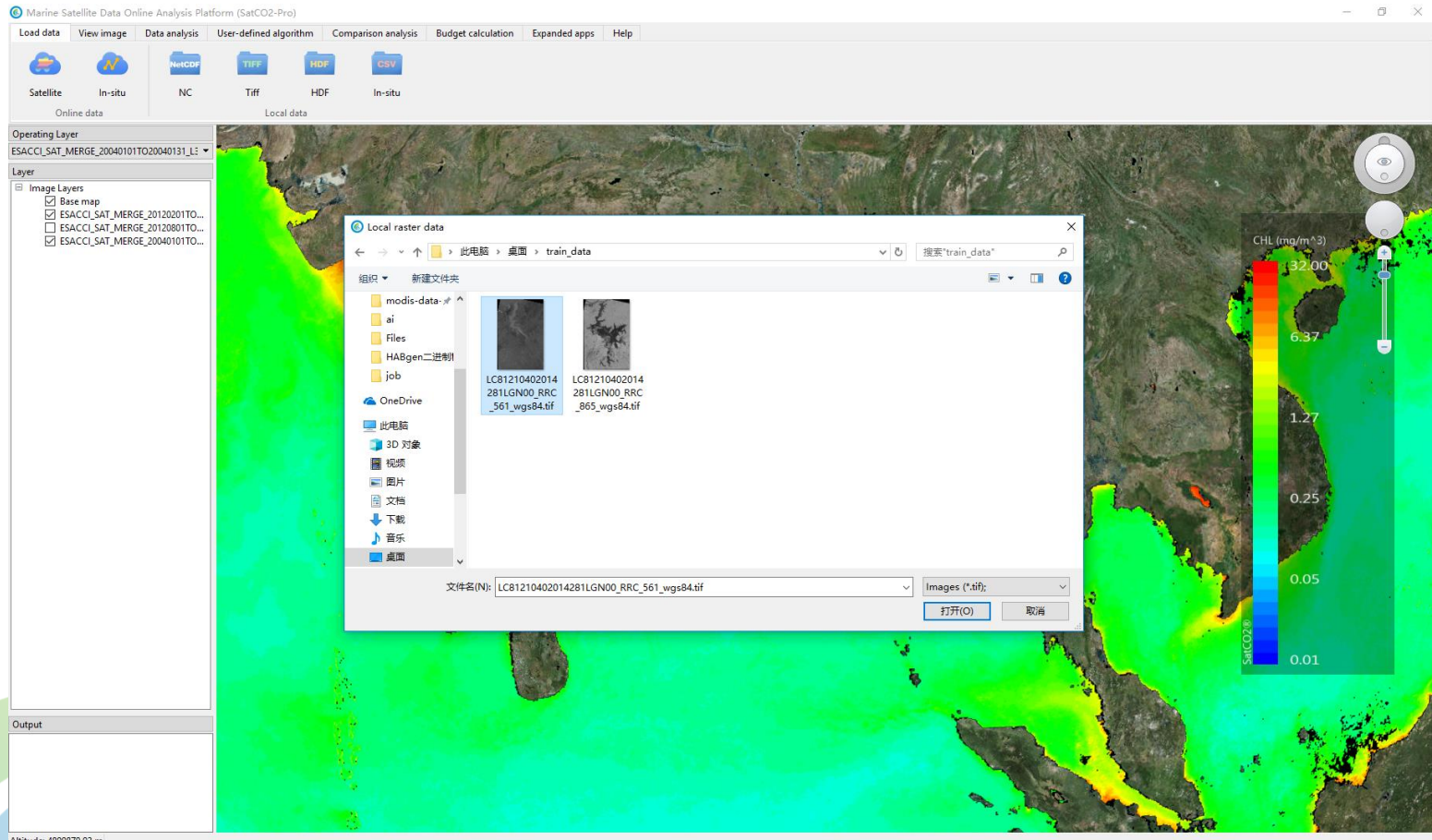
Practice case 3



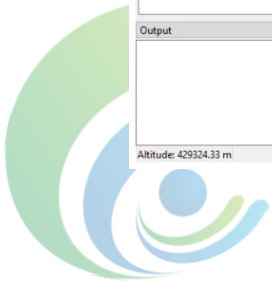
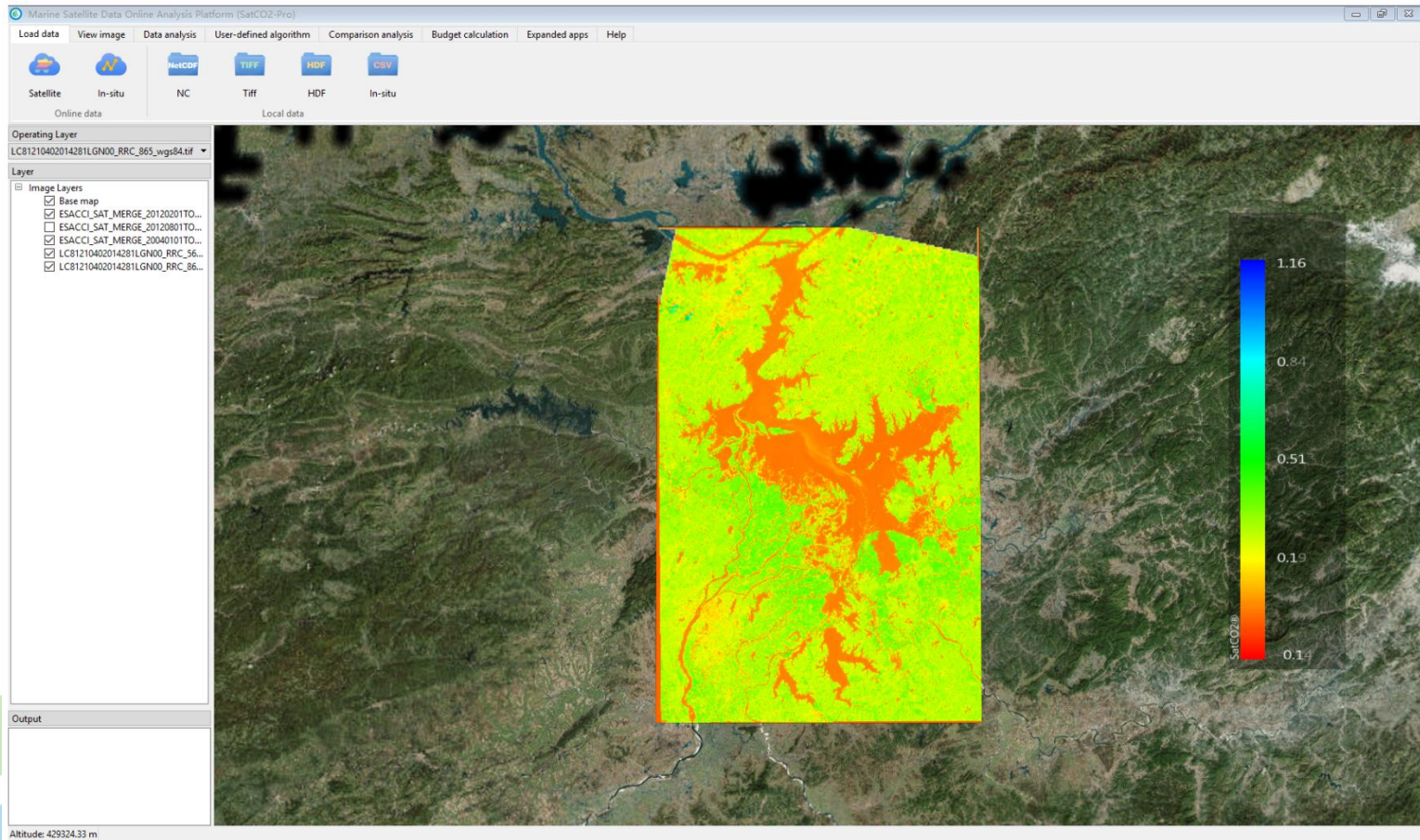
Practice case 4



SatCO2



Practice case 4



Practice case 4



SatCO₂

Marine Satellite Data Online Analysis Platform (SatCO₂-Pro)

Operating Layer: LC81210402014281LGN00_RRC_865_wgs84.tif

Layer: Image Layers

- Base map
- ESACCL_SAT_MERGE_20120201TO...
- ESACCL_SAT_MERGE_20120801TO...
- ESACCL_SAT_MERGE_20040101TO...
- LC81210402014281LGN00_RRC_56...
- LC81210402014281LGN00_RRC_86...

User-defined algorithm

Input algorithm:

Resample to: highest resolution lowest resolution

Buttons: Calculate, Clean

Calculator interface:

1	2	3	+	-	Abs	Pow
4	5	6	*	/	Sqrt	Ln
7	8	9	()	Exp	Log10
0	.	Backspace	.			

Add satellite data:

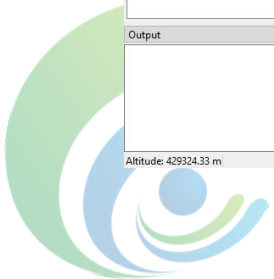
Buttons: Add local layer, Add layer, Remove layer

Tip: This calculation is time-consuming and depends on the network speed.

Current layers

- SatCO₂
- ESACCL_SAT_MERGE_20120201TO20120229_L3B_GLOBAL_4KM_CHL_OCCCV31
- ESACCL_SAT_MERGE_20120801TO20120831_L3B_GLOBAL_4KM_CHL_OCCCV31
- ESACCL_SAT_MERGE_20040101TO20040131_L3B_GLOBAL_4KM_CHL_OCCCV31
- LC81210402014281LGN00_RRC_561_wgs84.tif
- LC81210402014281LGN00_RRC_865_wgs84.tif

Altitude: 429324.33 m



Practice case 4

User-defined algorithm

Input algorithm:

Resample to: highest resolution lowest resolution

1	2	3	+	-	Abs	Pow
4	5	6	*	/	Sqrt	Ln
7	8	9	()	Exp	Log10
0	.	Backspace	.			

Tip: This calculation is time-consuming and depends on the network speed.

Add satellite data

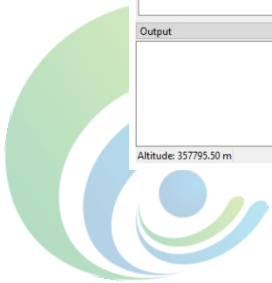
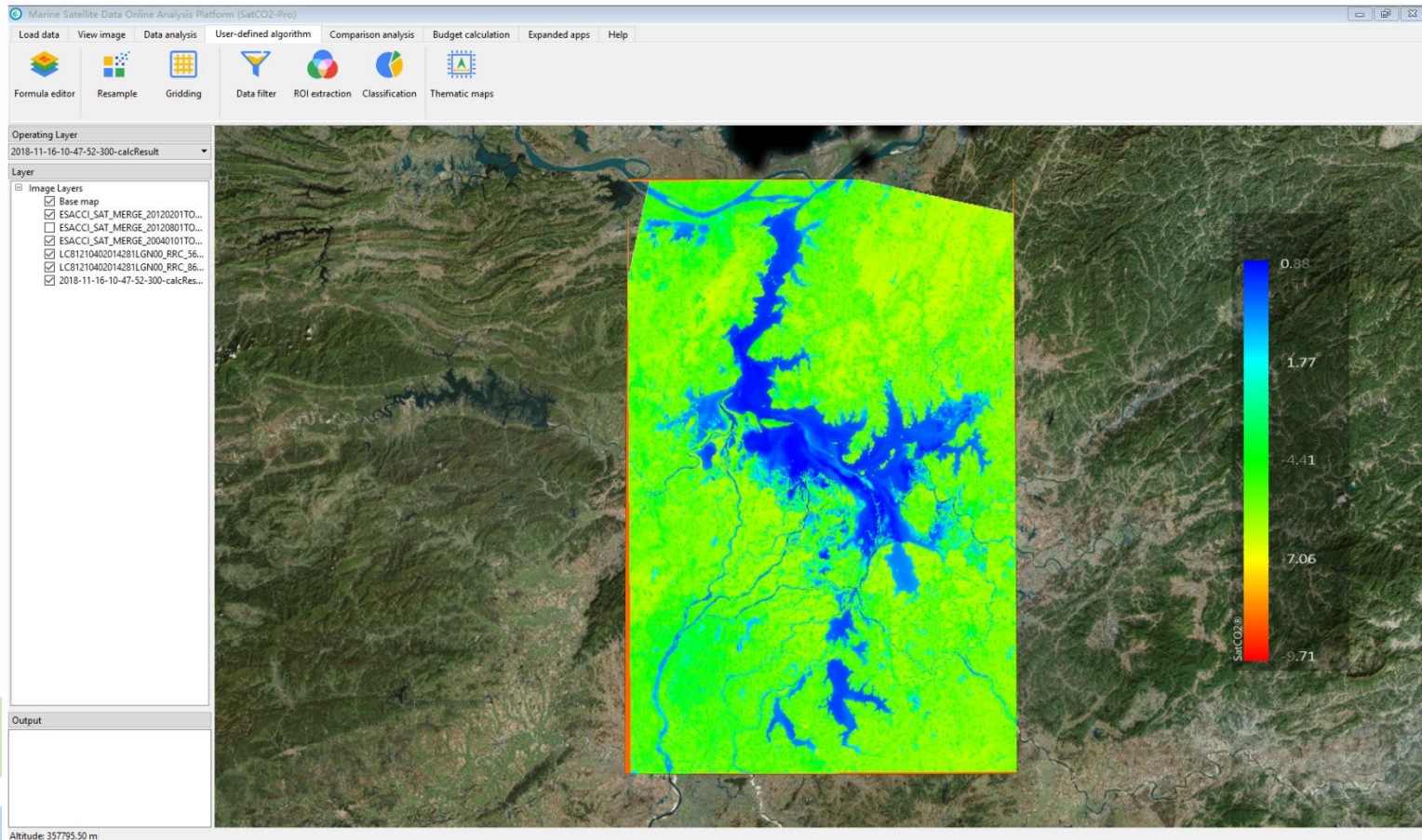
[A]LC81210402014281LGN00_RRC_561_wgs84.tif
[B]LC81210402014281LGN00_RRC_865_wgs84.tif



Practice case 4



SatCO₂



Practice case 5



Satellite product in database

Database
Select

Datasets

Products Composition period

Time range
 Full range
Start date
End date
 Specific month
Time range
Select month

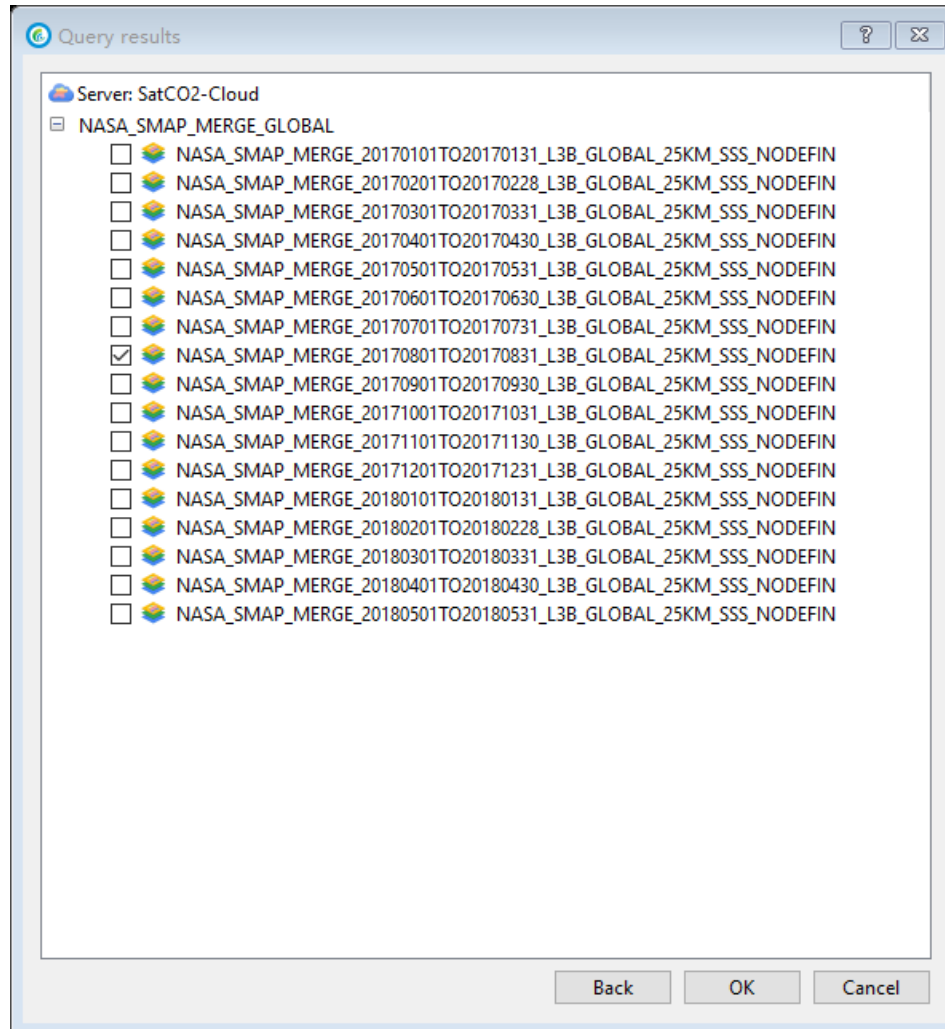
Spatial range(-90°S~90°N;-180°W~180°E)
N 90.000
W -180.000 E 180.000
S -90.000



Practice case 5



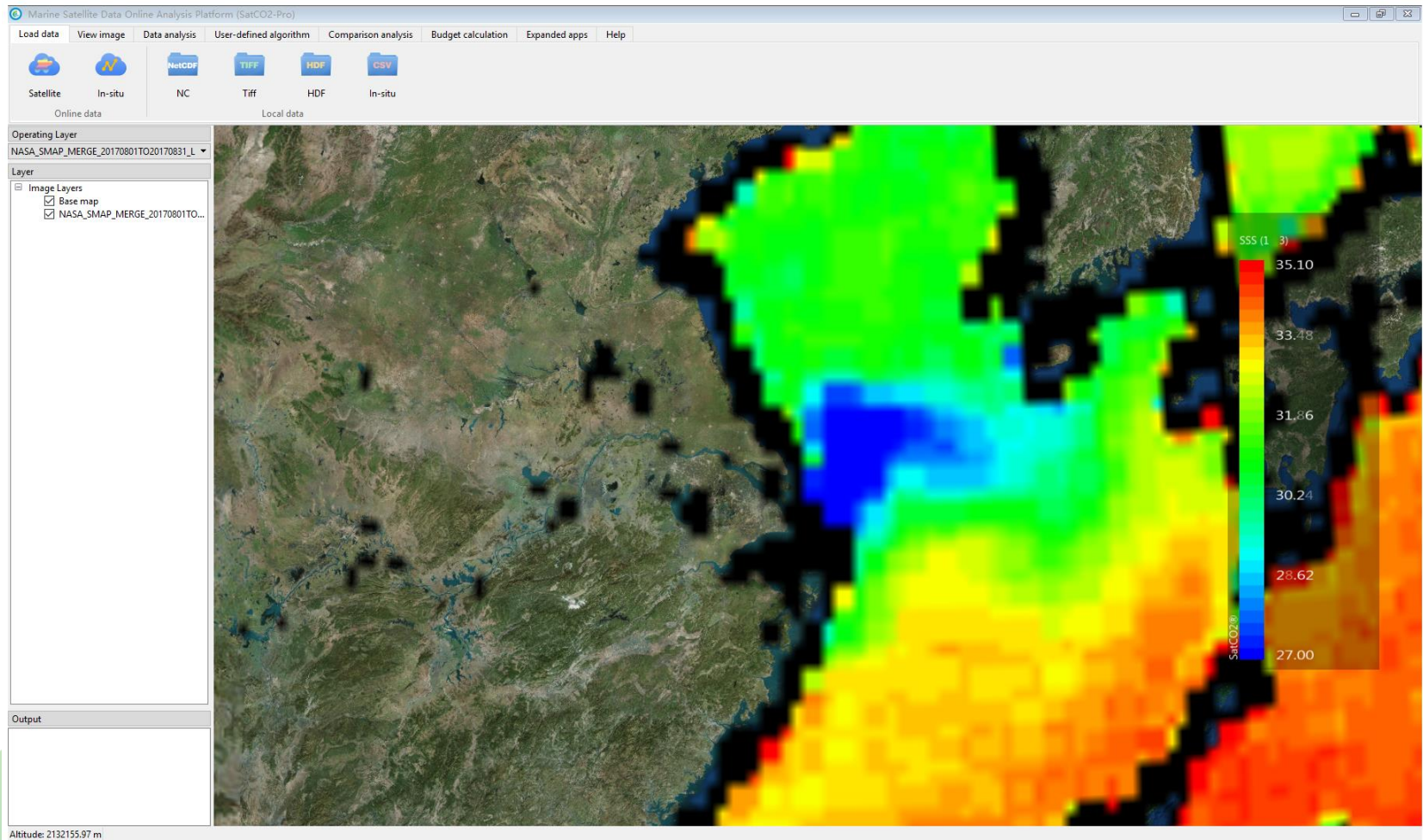
SatCO₂



Practice case 5



SatCO2



Practice case 5



SatCO2

Marine Satellite Data Online Analysis Platform (SatCO2-Pro)

Load data | View image | Data analysis | User-defined algorithm | Comparison analysis | Budget calculation | Expanded apps | Help

Formula editor | Resample | Gridding | Data filter | ROI extraction | Classification | Thematic maps

Operating Layer
NASA_SMAP_MERGE_20170801TO20170831_L_...

Layer
Image Layers
 Base map
 NASA_SMAP_MERGE_20170801TO...

Output

Altitude: 2132155.97 m

Satellite data filtering

Please select data: NASA_SMAP_MERGE_20170801TO20170831_L3B

Filter condition: \geq 5

AND OR

\leq 31

OK Cancel

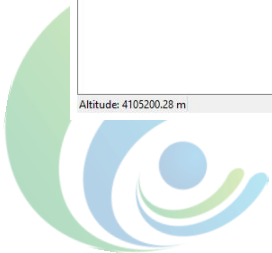
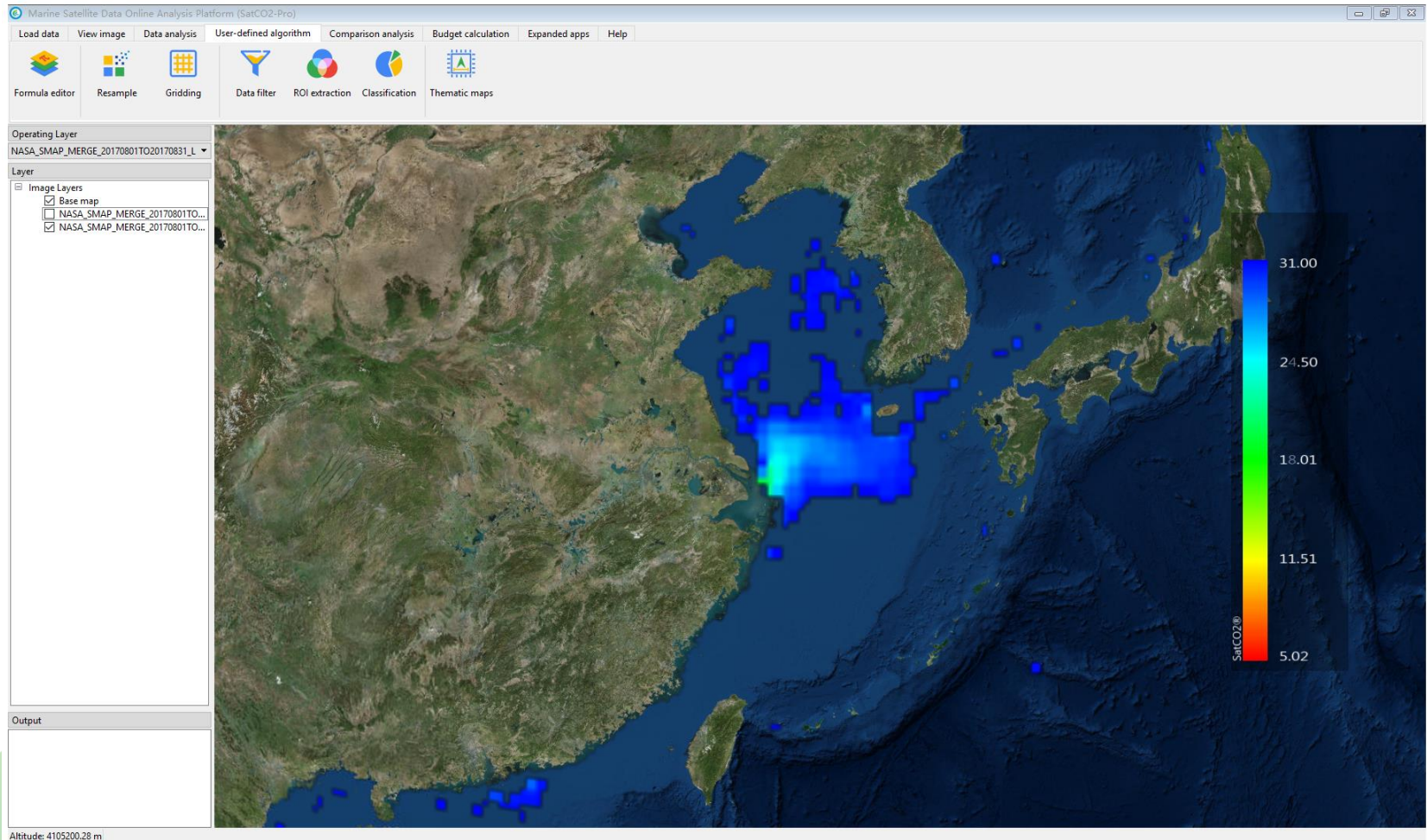
SSS (1 3)
35.10
33.48
31.86
30.24
28.62
27.00



Practice case 5



SatCO2



Practice case 6



Satellite product in database

Database
Select SatCO2-Cloud Connection

Datasets ? ESACCI_SAT_MERGE_GLOBAL

Products CHL Composition period Monthly composite

Time range
 Full range
Start date 2004/1/1
End date 2018/11/16
 Specific month
Time range Month
Select month 1

Spatial range(-90°S~90°N;-180°W~180°E)
N 90.000
W -180.000 E 180.000
S -90.000
Frame selection

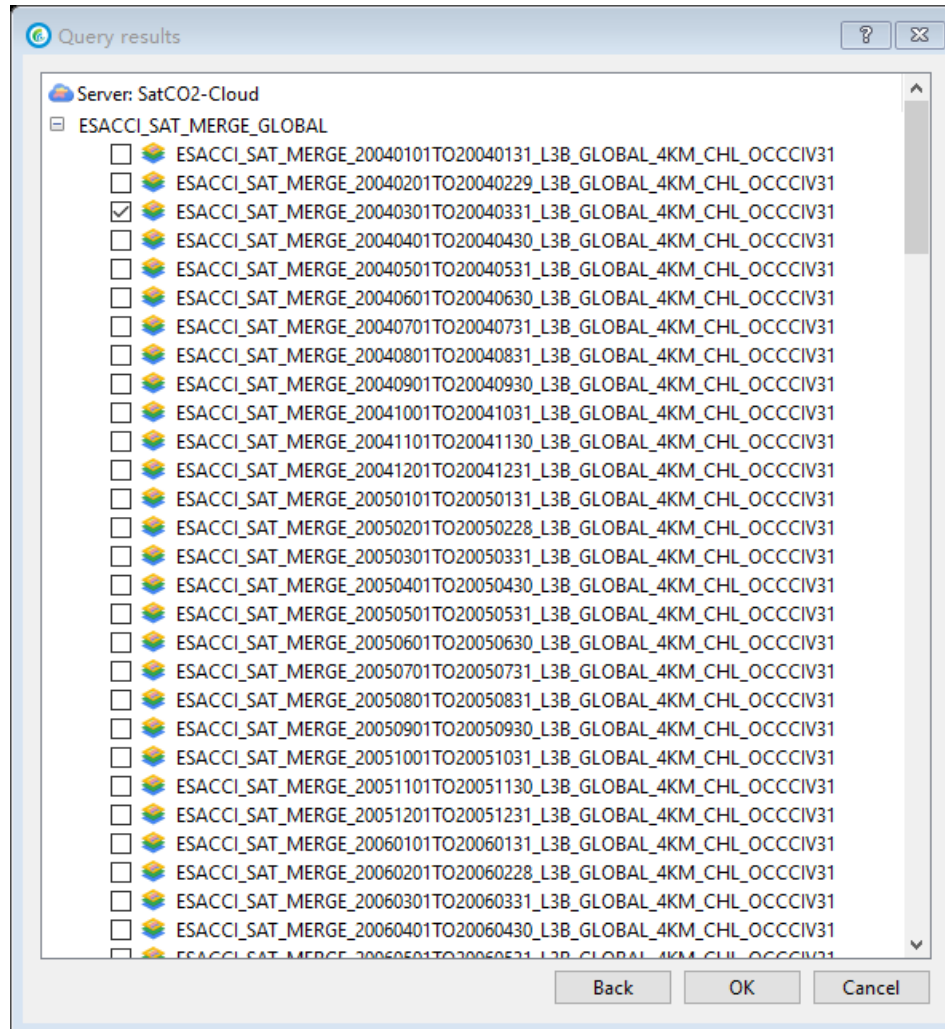
Query Cancel



Practice case 6



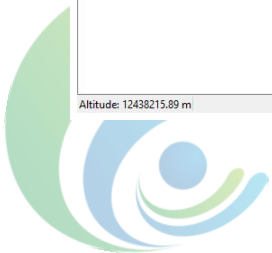
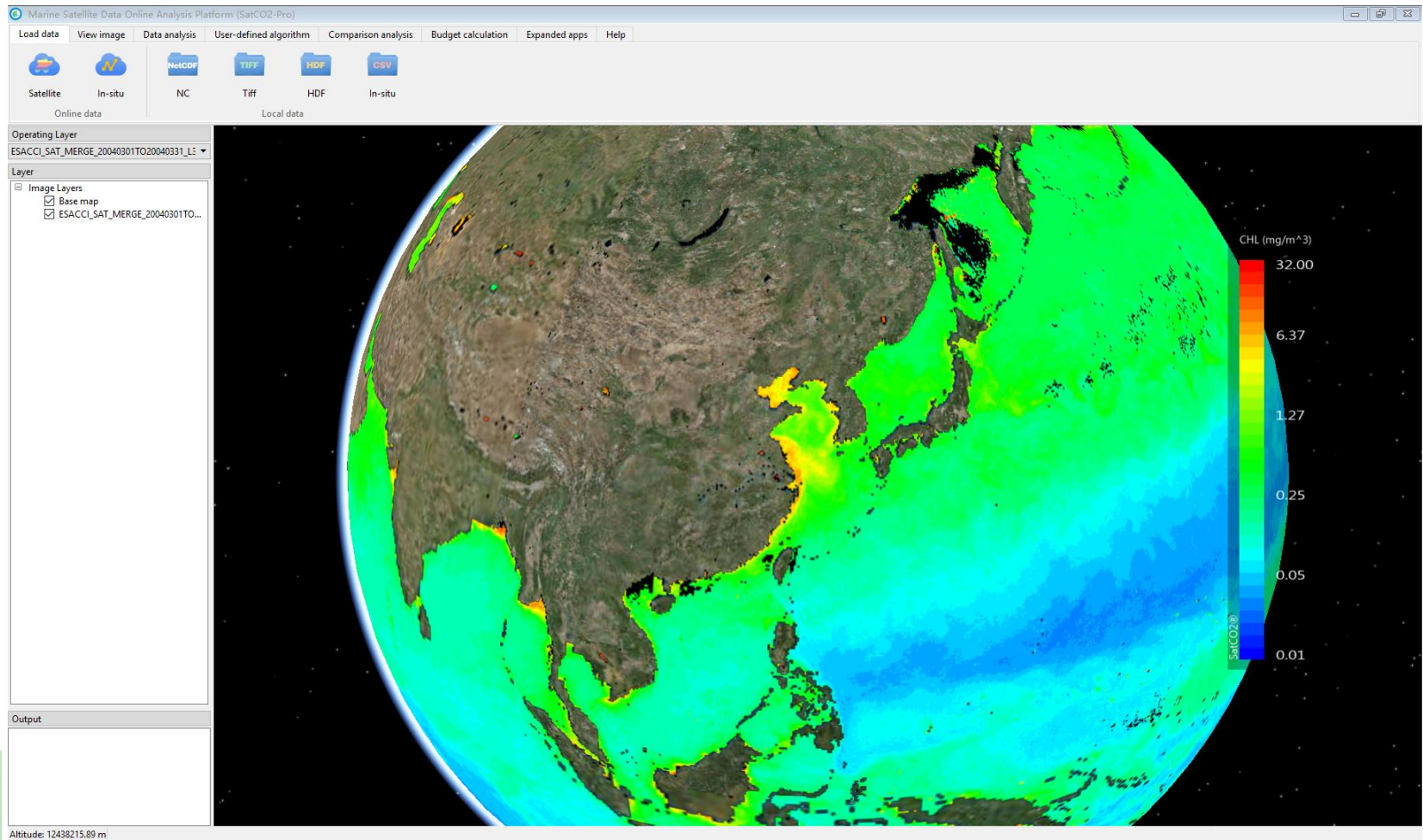
SatCO



Practice case 6



SatCO2



Practice case 6



SatCO

Data classification

Parameter	interval 1	interval 2	interval 3	interval 4	interval 5	interval 6	weight
ESACCI_SAT_MERGE_20040301TO20040331_	0	0.25	1.3	10			

min max weight

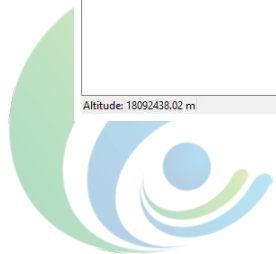
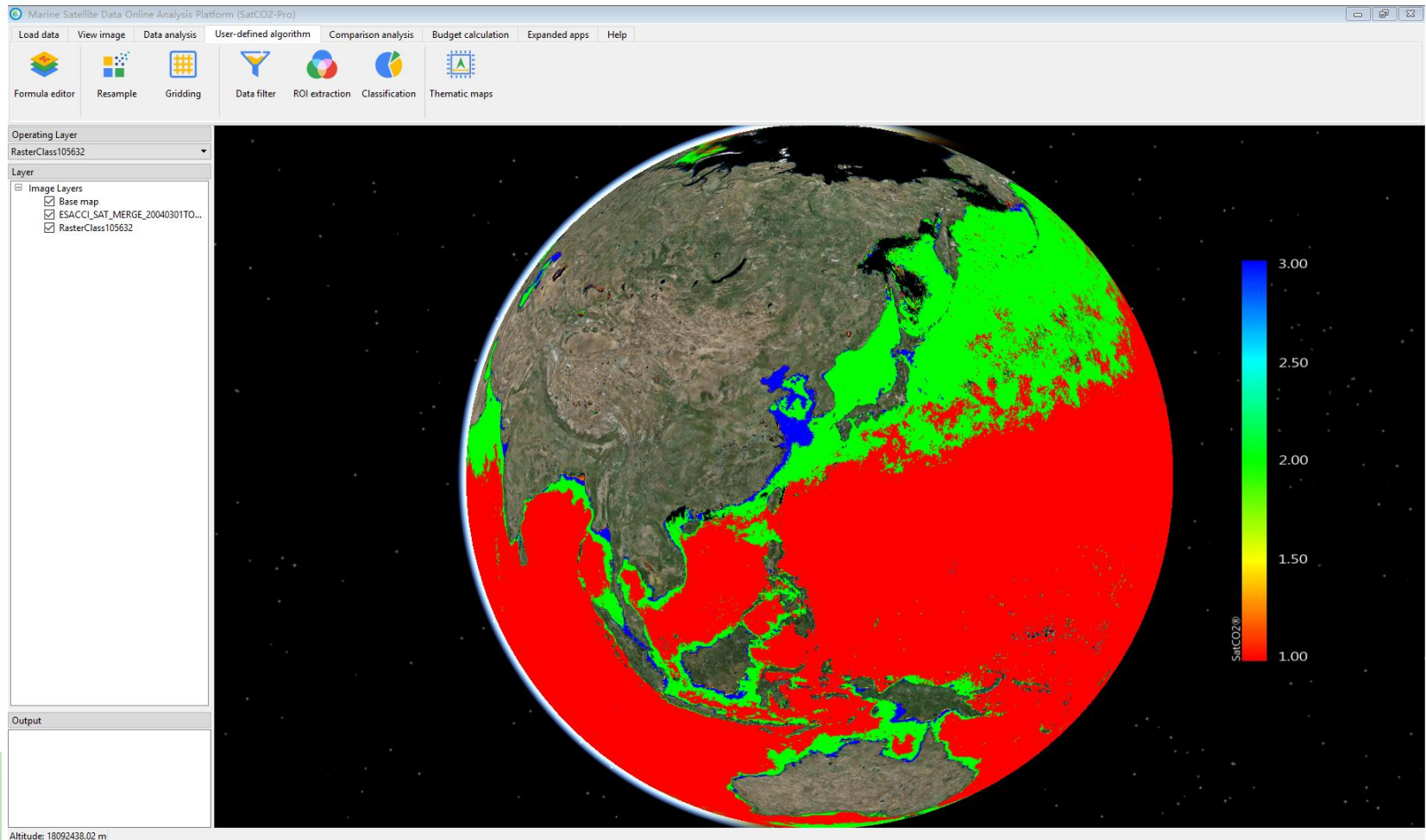
OK Cancel



Practice case 6



SatCO2



Practice case 7



SatCO₂

Query CDIAC Data

Database
Select:



Query data

Time Range
 Full range
Start date:
End date:

Spatial Range
N:
W: E:
S:
Fill in Lat/Lon range

Query result

Server: SatCO2-Cloud

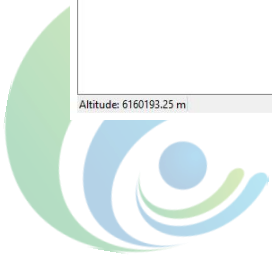
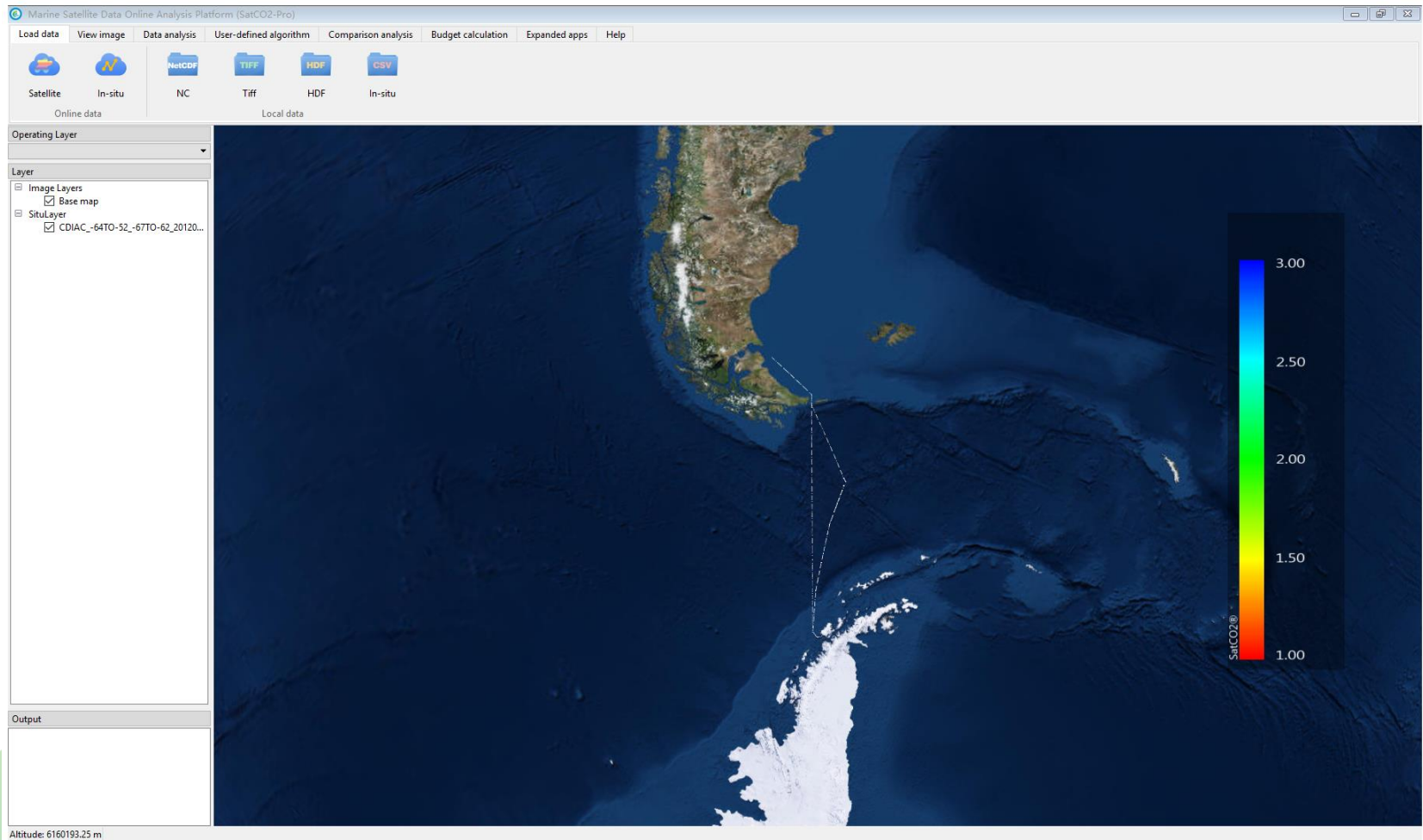
-  CDIAC_-64TO-52_-67TO-58_20121011TO20121015_L12B
-  CDIAC_-64TO-52_-67TO-62_20120919TO20121003_L12A



Practice case 7



SatCO2



Practice case 7



Satellite product in database

Database
Select SatCO2-Cloud ▼ Connection

Datasets ? All dataset ▼

Products SST ▼ Composition period Monthly composite ▼

Time range
 Full range
Start date 2012/9/1 ▲▼
End date 2012/11/16 ▲▼
 Specific month
Time range Month ▼
Select month 1 ▼

Spatial range(-90°S~90°N;-180°W~180°E)

N
90.000
W -180.000 E 180.000
S -90.000

Frame selection

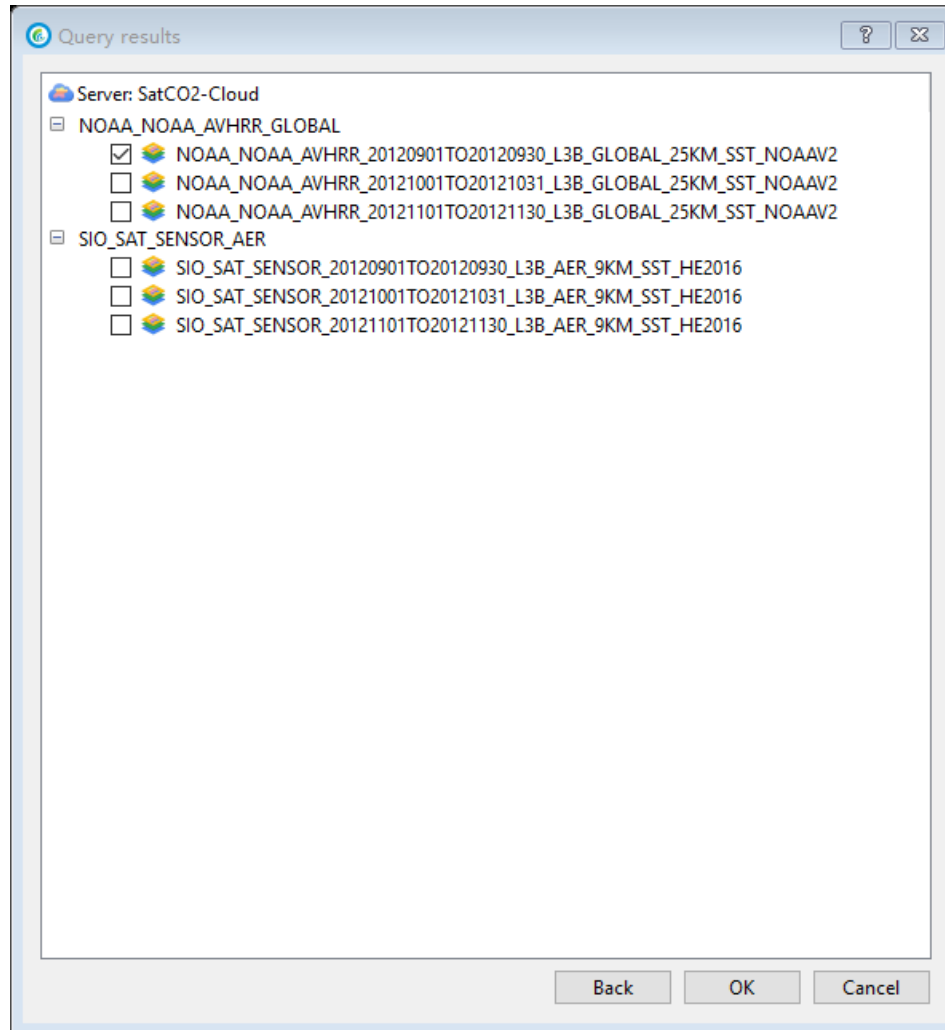
Query Cancel



Practice case 7



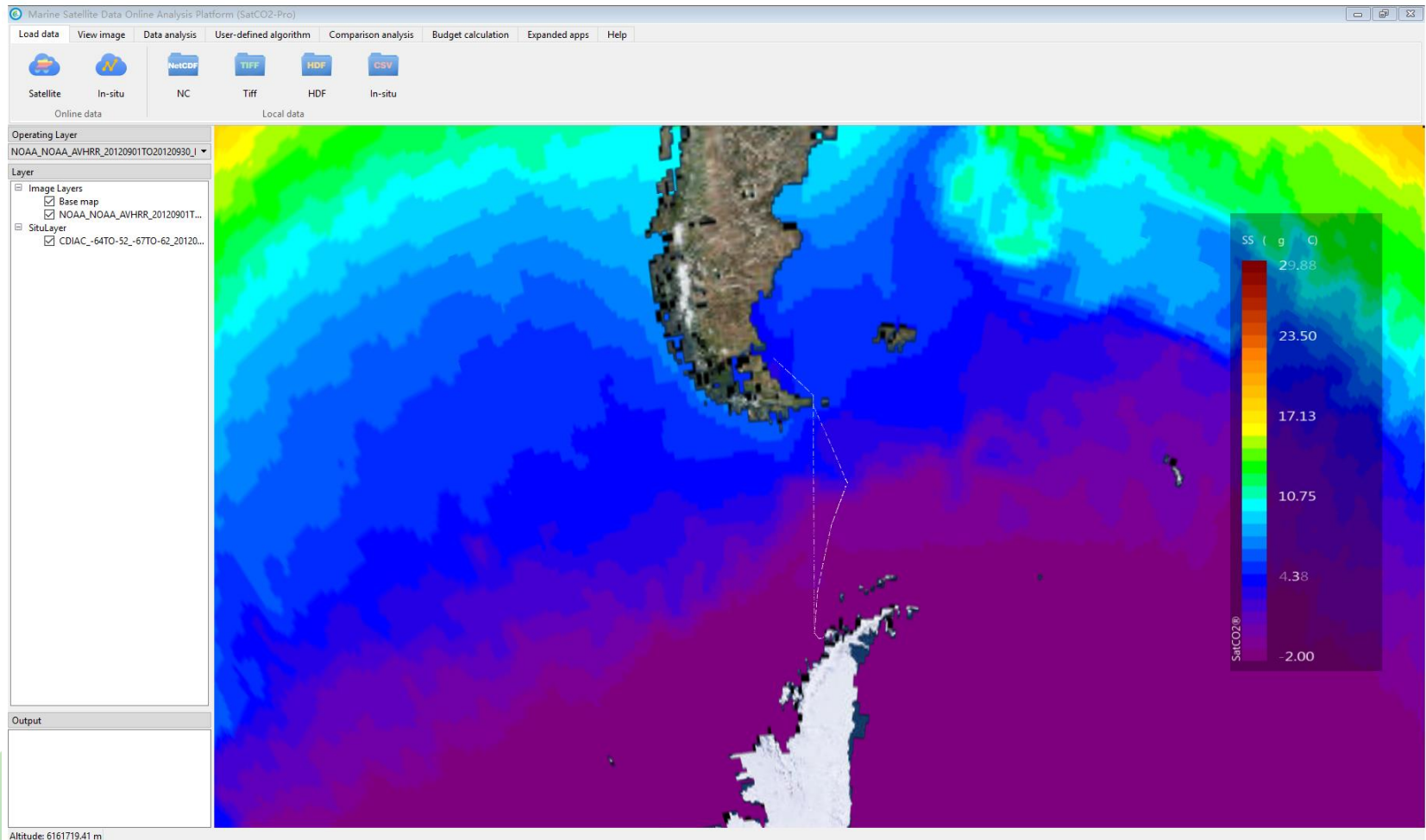
SatCO₂



Practice case 7



SatCO2



Practice case 7



Satellite-insitu comparison

Please select in-situ data. You can add more data in the [Data] menu.

CDIAC_-64TO-52_-67TO-62_20120919TO20121003_L12A

Time period of in-situ data

Start date: 2012-09-19 End date: 2012-10-03

Match with current data

Current data: NOAA_NOAA_AVHRR_20120901T

Parameter: SST

Match with database data

Dataset: BEC_SMOS_MERGE_GLOBAL

Parameter: SST

Level: L3B

Composite period: Daily composite

Spatial window: 1*1

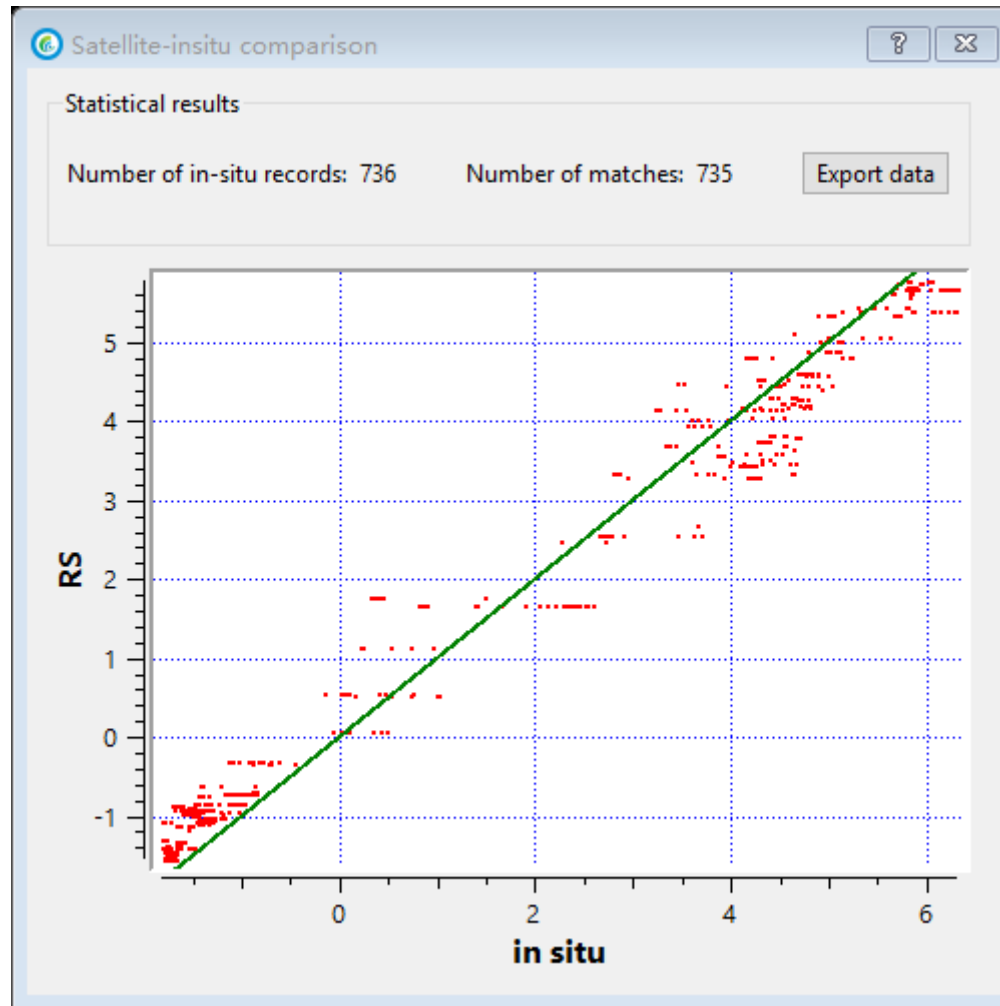
Start analysis



Practice case 7



SatCO₂



Practice case 8



SatCO₂

Marine Satellite Data Online Analysis Platform (SatCO2-Pro)

Operating Layer

Layer

- Image Layers
 - Base map

HAB detection

Select L2 data

Select method

Name	Value
------	-------

Select NetCDF data for HAB detection

此电脑 > 桌面 > train_data

搜索"train_data"

组织 新建文件夹

- 3D 对象
- 视频
- 图片
- 文档
- 下载
- 音乐
- 桌面
- OS (C:)
- U 盘 (H:)
- U 盘 (H:)
- 49BA59ABBE5c
- AdminScripts
- apache-tomcat
- chazhi
- n

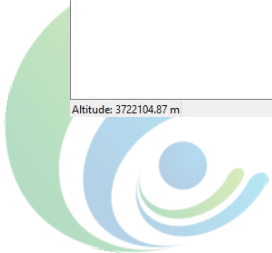
A200431818300	A201004909100	A201424519000	A201719505100	V201423919120	V201622905360
0.L2_LAC_OC.nc	0.L2_LAC_OC.nc	0.L2_LAC_OC.nc	0.L2_LAC_OC.nc	0.L2_SNPP_OC.nc	0.L2_SNPP_OC.nc

文件名(N): A2017195051000.L2_LAC_OC.nc

nc(*.nc)

打开(O) 取消

Altitude: 3722104.87 m



Practice case 8



HAB detection

Select L2 data

Introduction to the HAB algorithm in the East China Sea

This module integrates two HAB algorithms in the East China Sea. The first algorithm is a multispectral approach for discriminating *P. donghaiense* blooms from other water types based on MODIS R_{rs} spectral shape discrimination. Its procedure is separated into two steps. First, the bloomwaters are identified by the low $R_{rs}(555)$ and high RAB. Second, two new indices of *P. donghaiense* index (PDI) and diatom index (DI) are developed for discriminating *P. donghaiense* from diatom blooms. The second algorithm is a VIIRS based approach for detecting HAB waters. The detailed method is schematically illustrated in Fig. 1:

```
graph TD; A["Rrs peak at 555"] -- NO --> B["Non-bloom / clear waters"]; A -- YES --> C["Rrs(555) < 0.014 sr^-1"]; C -- NO --> D["TSM-dominated / turbid waters"]; C -- YES --> E["RAB = Rrs(555)/Rrs(531) > 1.25"];
```

Select method

Name	Value
1 title	HMODISA Level-2 Data
2 product_name	A2017195051000.L2_LAC_OC.nc
3 spatialResolution	1 km
4 date_created	2017-08-02T13:12:13.000Z
5 lat_max	40.6027
6 lat_min	19.4235

RAB > dl

$R_{rs551} <$ sr^{-1}

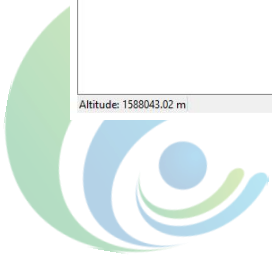
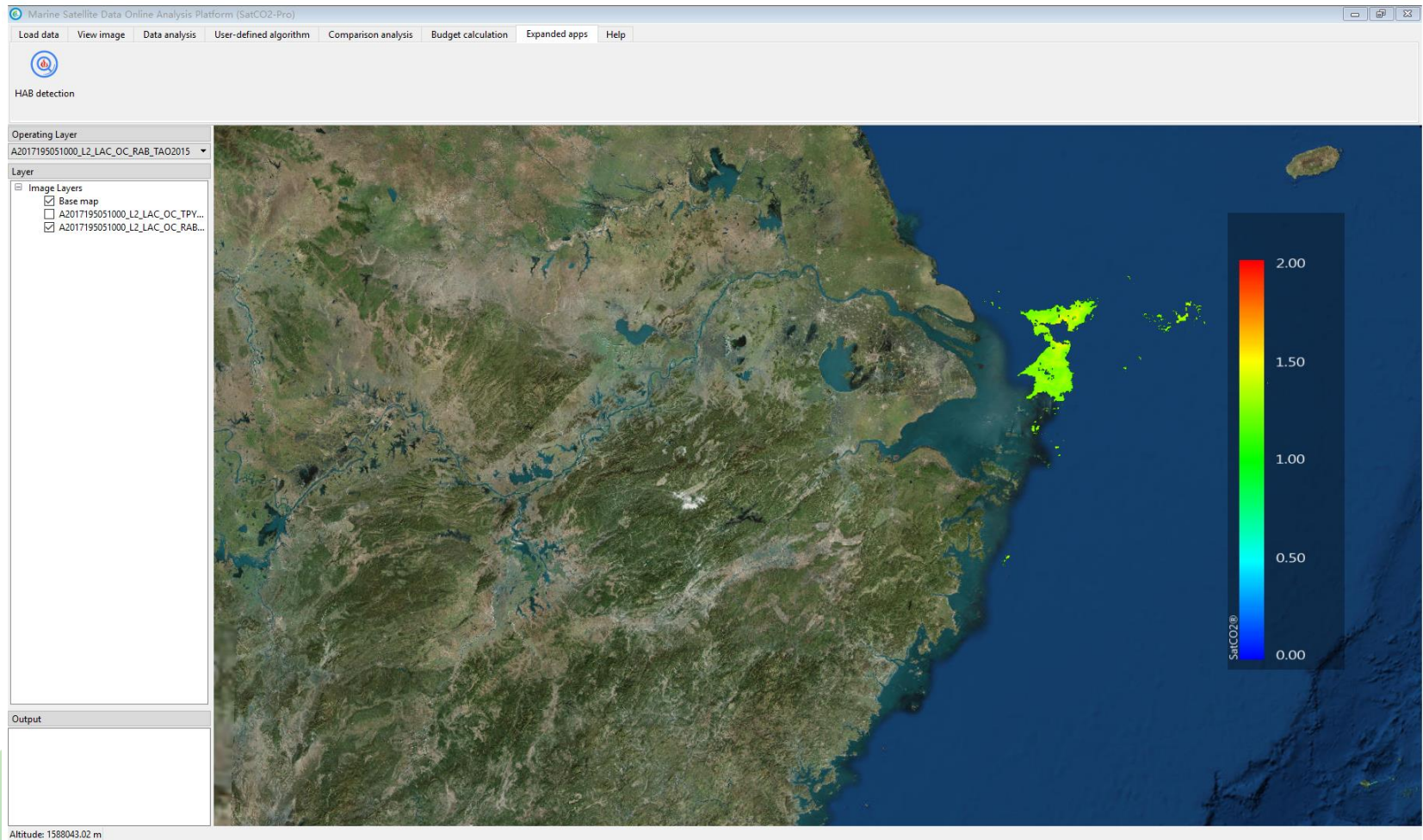
PDI > dl



Practice case 8



SatCO2





**Thank you
for your
attention!**

