SatCO2
Ocean Carbon from Space
Joint Science Research & Satellite-based marine carbon monitoring and analysis system
中文 English

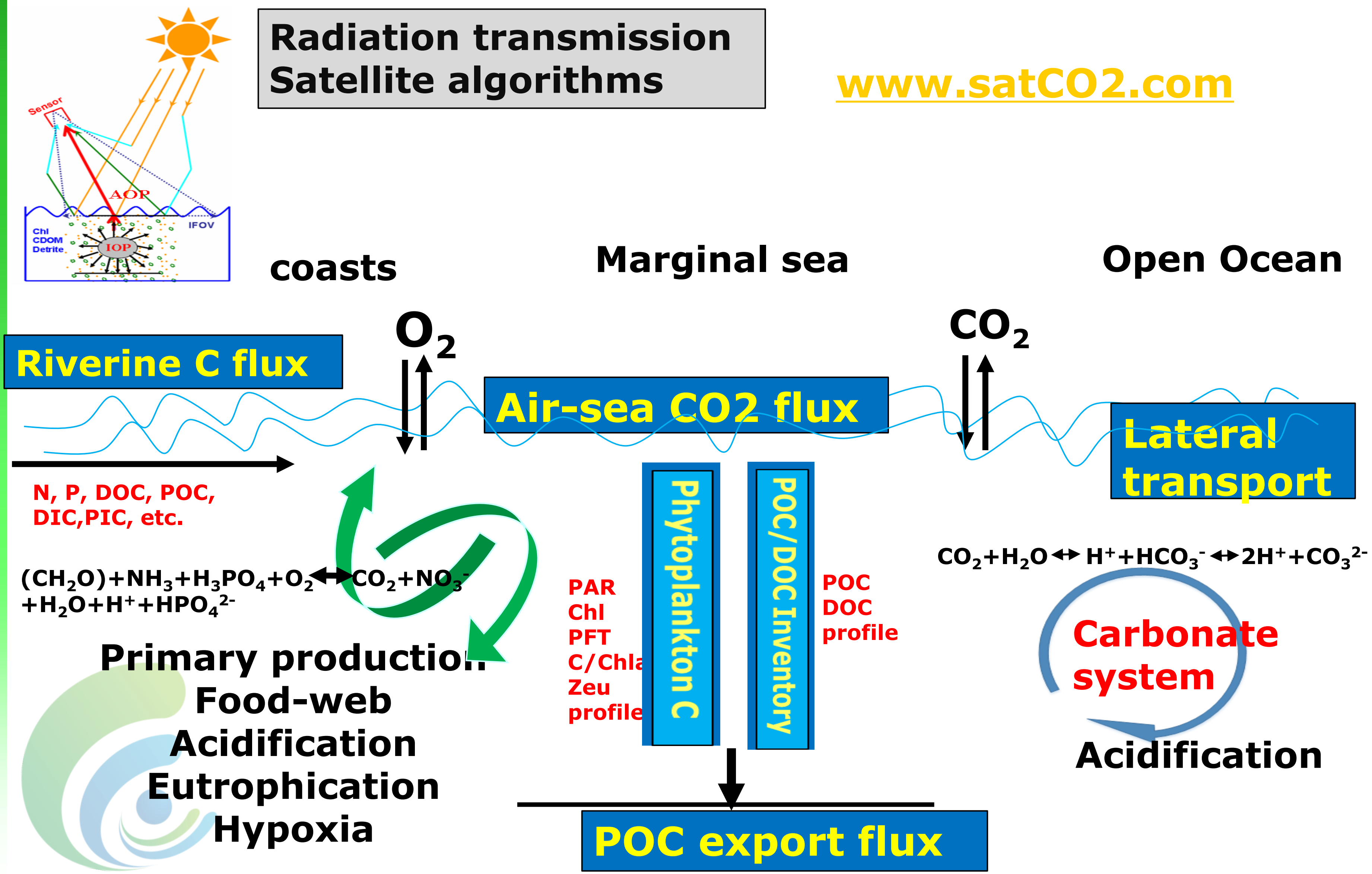
Marine carbon observation by satellite remote sensing

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

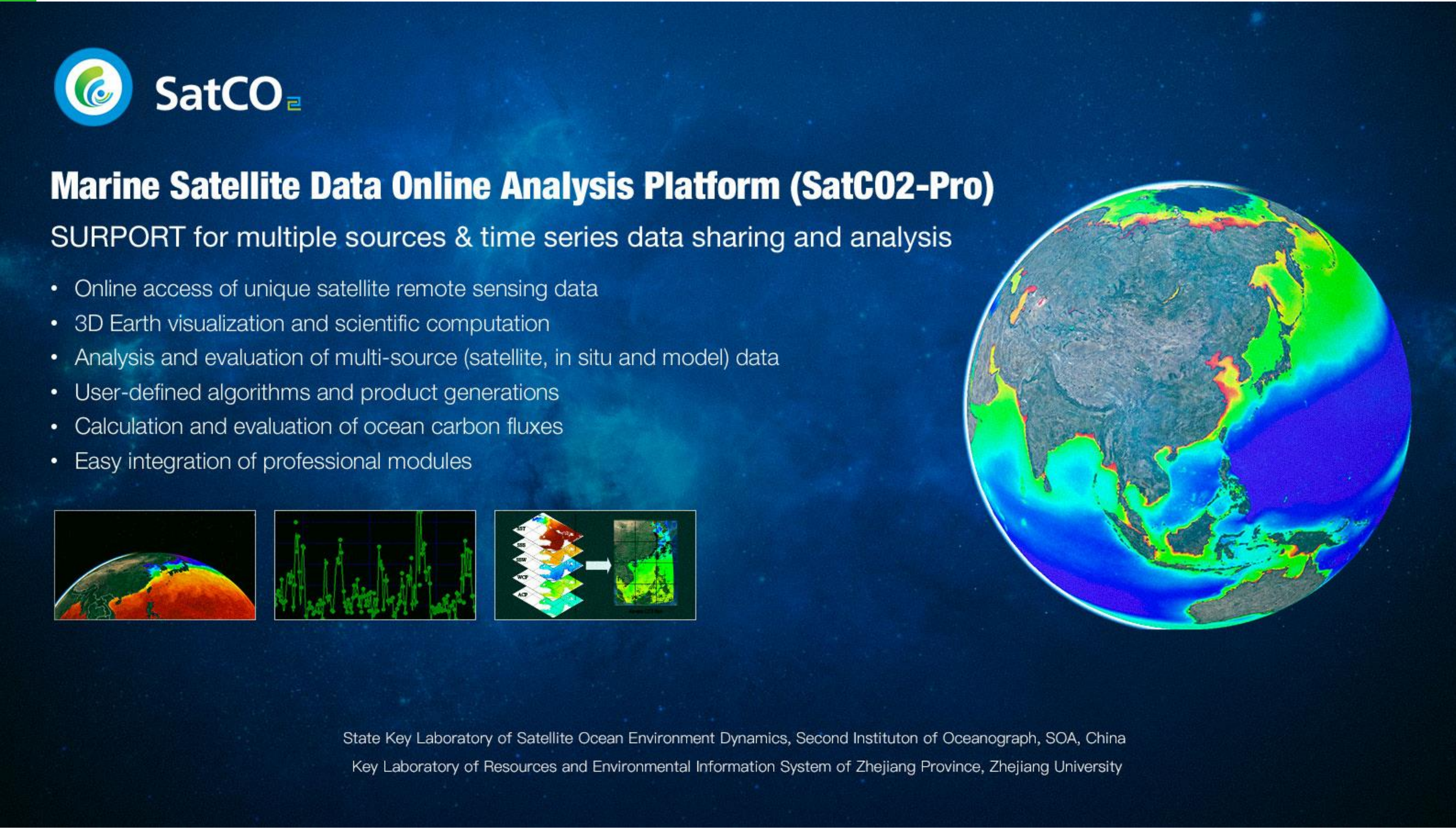
Framework of satellite-based marine carbon research



Outline

- Framework of satellite-based marine carbon research
- Example: $p\mathrm{CO_2}$ and POC export flux
- SatCO2-- Satellite-based marine carbon monitoring and analysis system

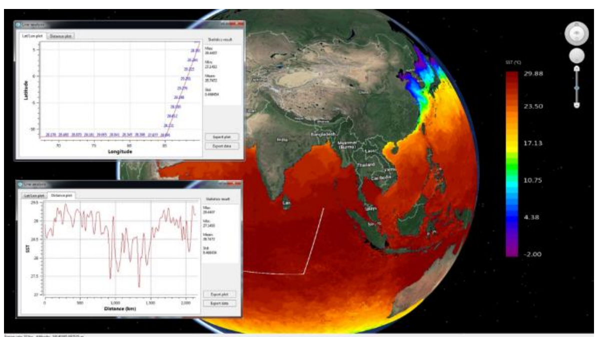
Satellite-based marine carbon monitoring and analysis system SatCO2)



- 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



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;

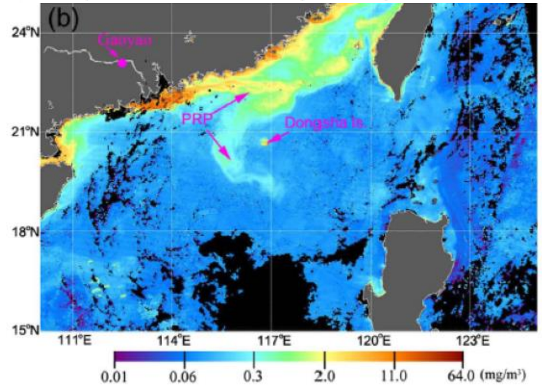
5) Calculation and evaluation of ocean carbon fluxes;

6) Easy integration of professional modules.

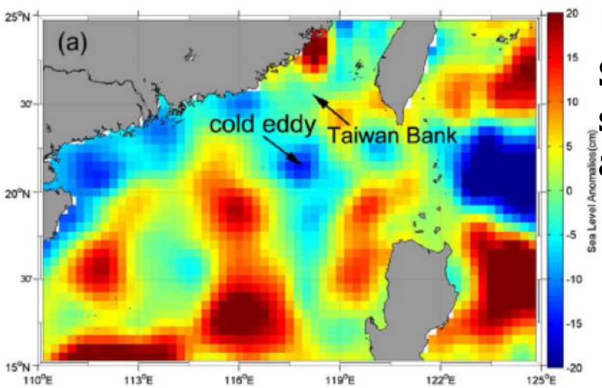
Eddy-entrained Pearl River plume into the oligotrophic basin of the South China Sea

Continental Shelf Research 124 (2016) 117–124

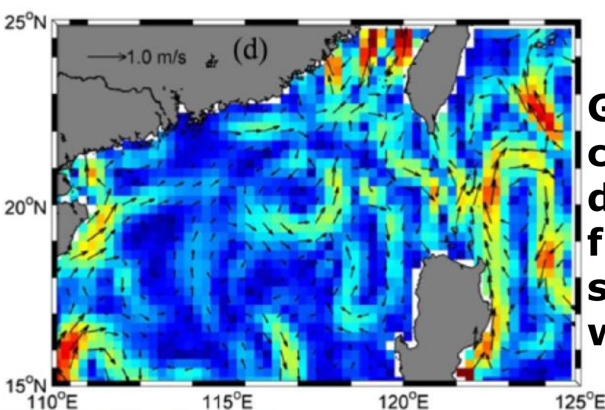
Xianqiang He [a,c,*], Dongfeng Xu [a], Yan Bai [a], Delu Pan [a], Chen-Tung Arthur Chen [b], Xiaoyan Chen [a], Fang Gong [a]



Daily satellite Chla on 17 Jun, 2015



Satellite sea level anomaly



Geostrophic current derived from satellite wind data

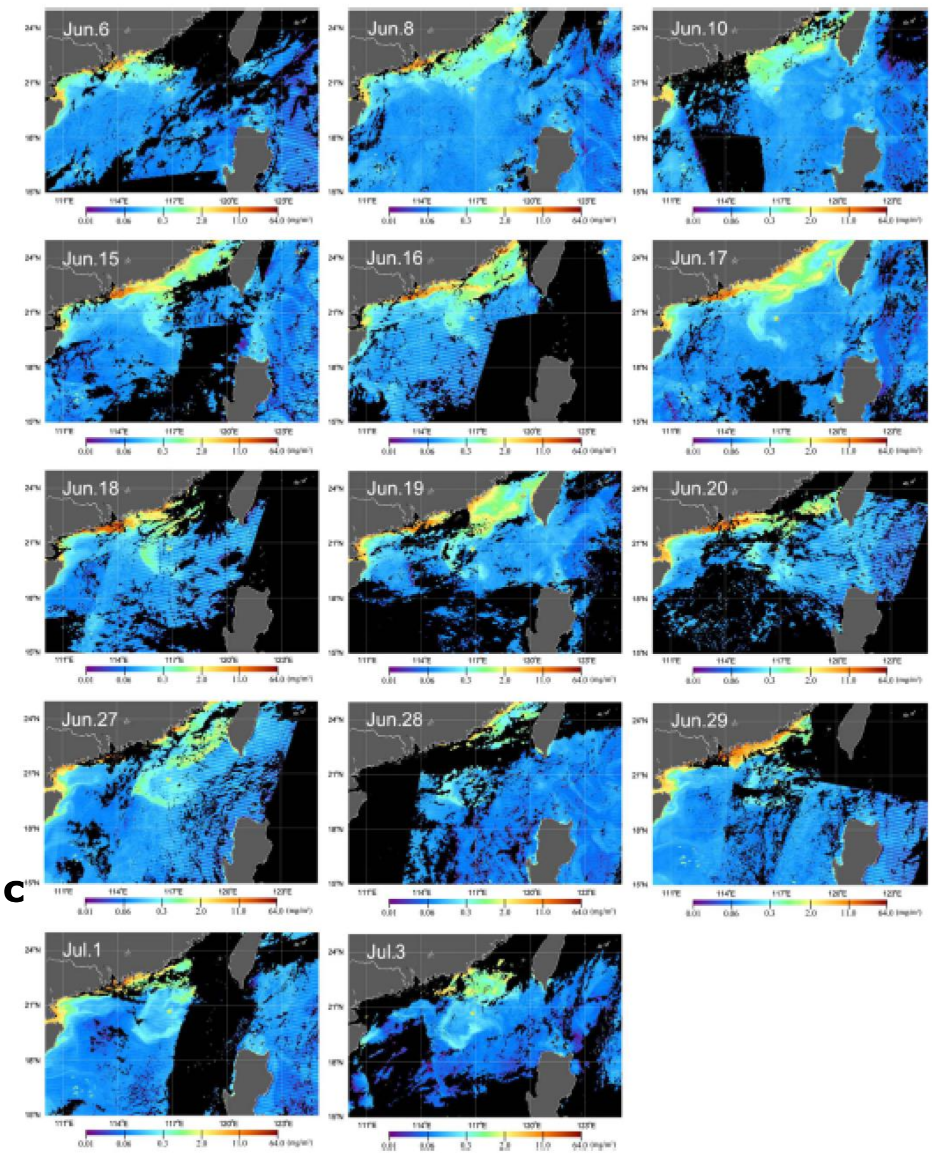
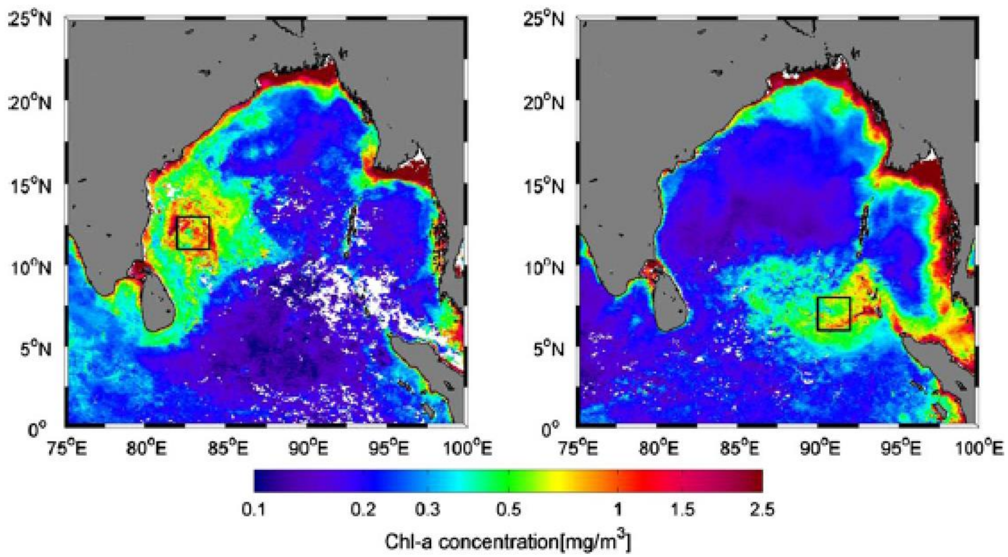


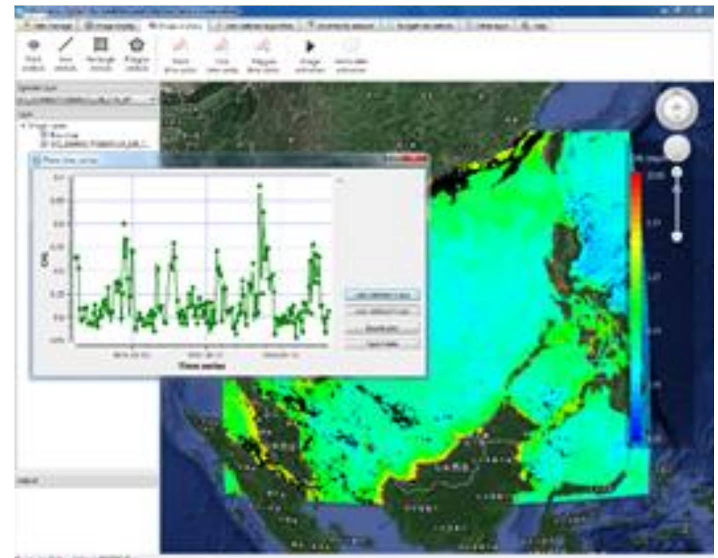
Fig. 2. Daily satellite Chla images from 6 June to 3 July 2015. Black areas are covered by clouds or contaminated by sun glint. Days with heavy cloud coverage are not shown.

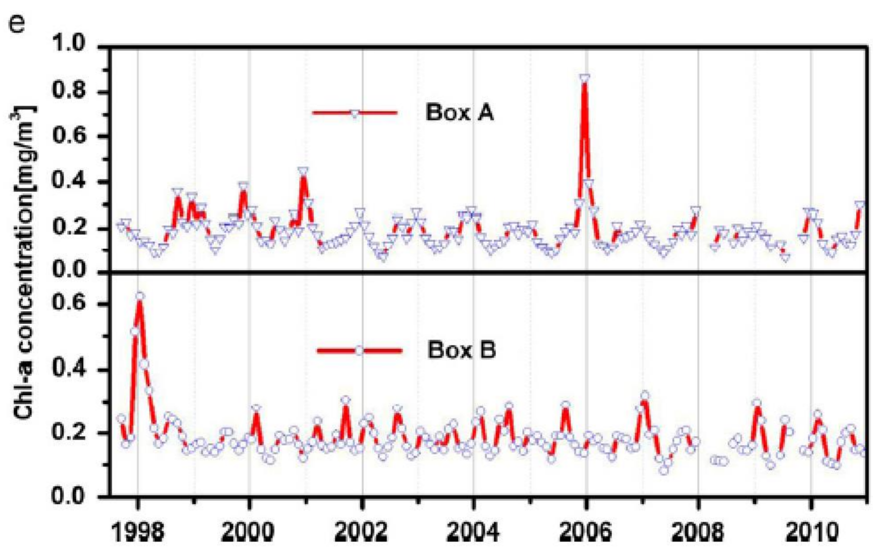
Episodic phytoplankton bloom events in the Bay of Bengal triggered by multiple forcings

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**







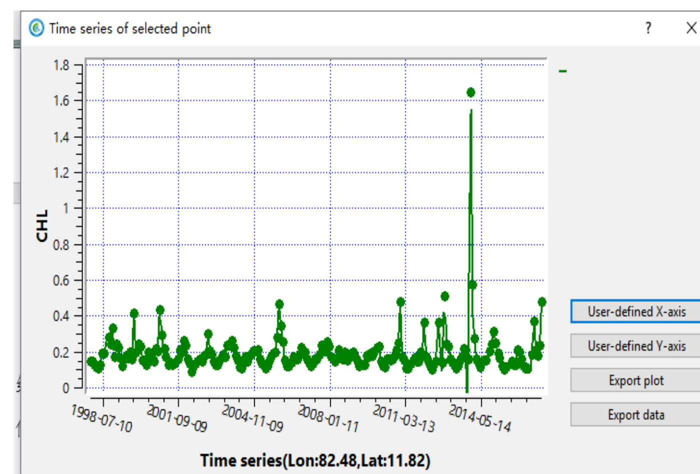
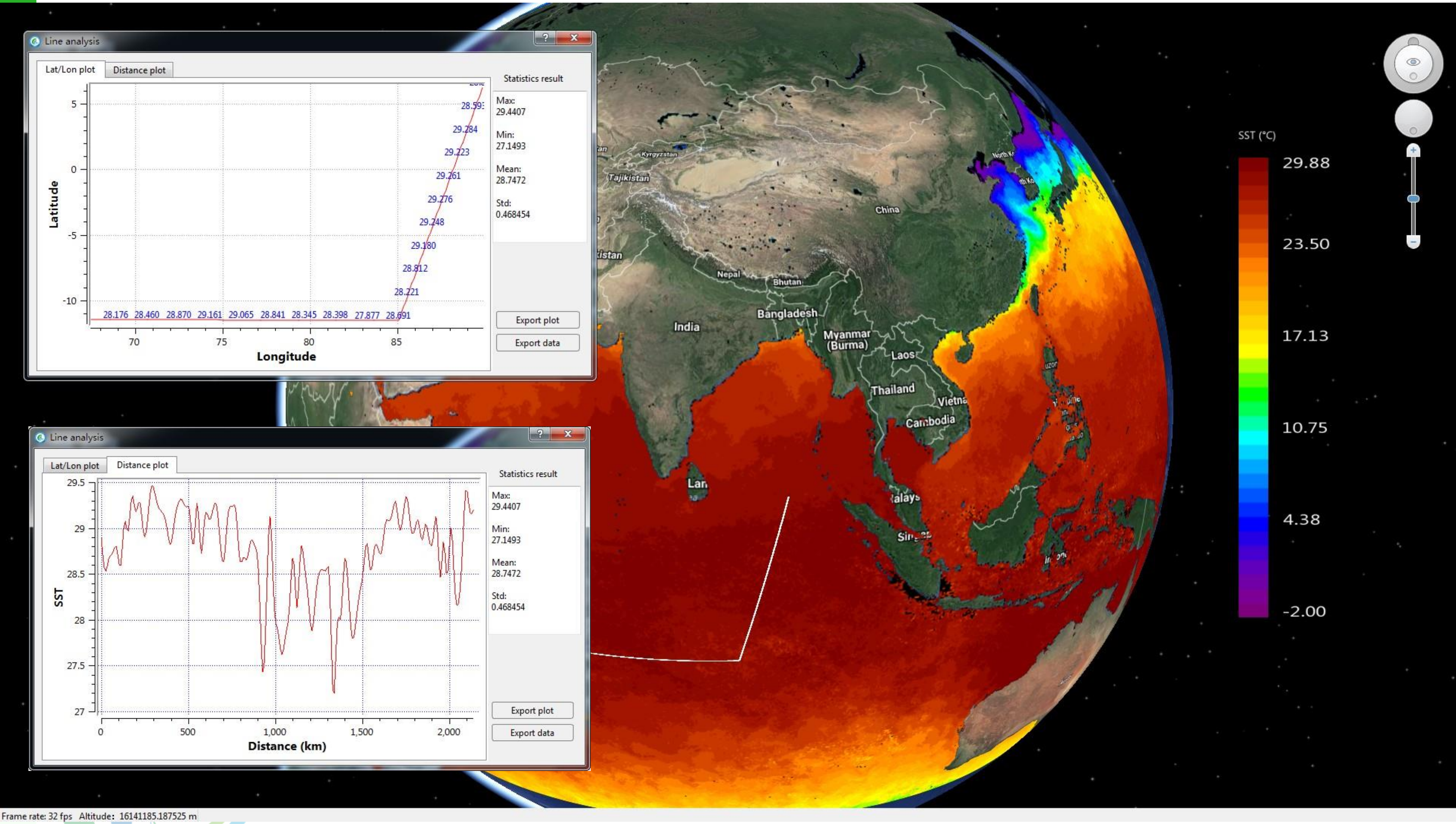
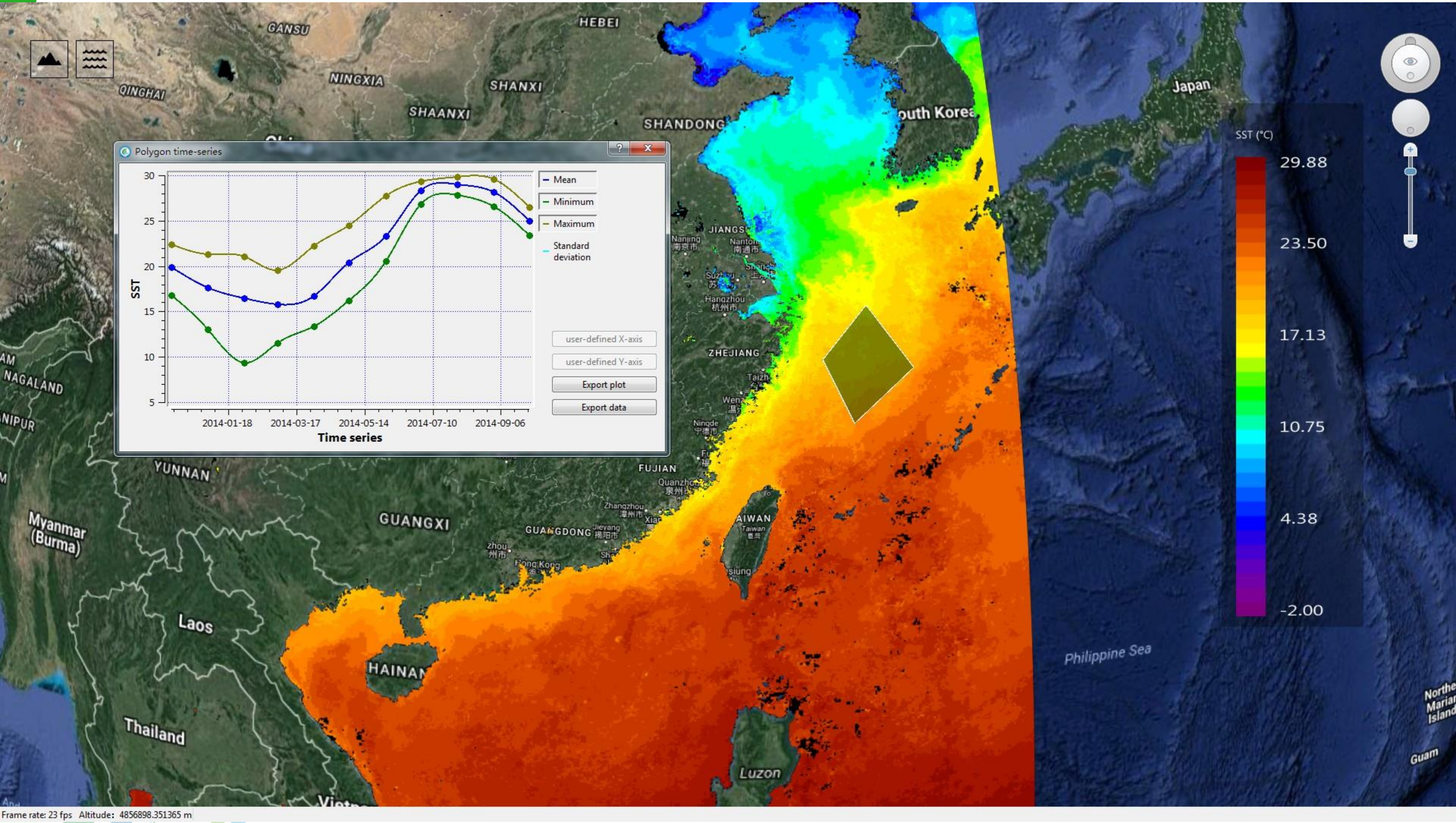


Image Analysis



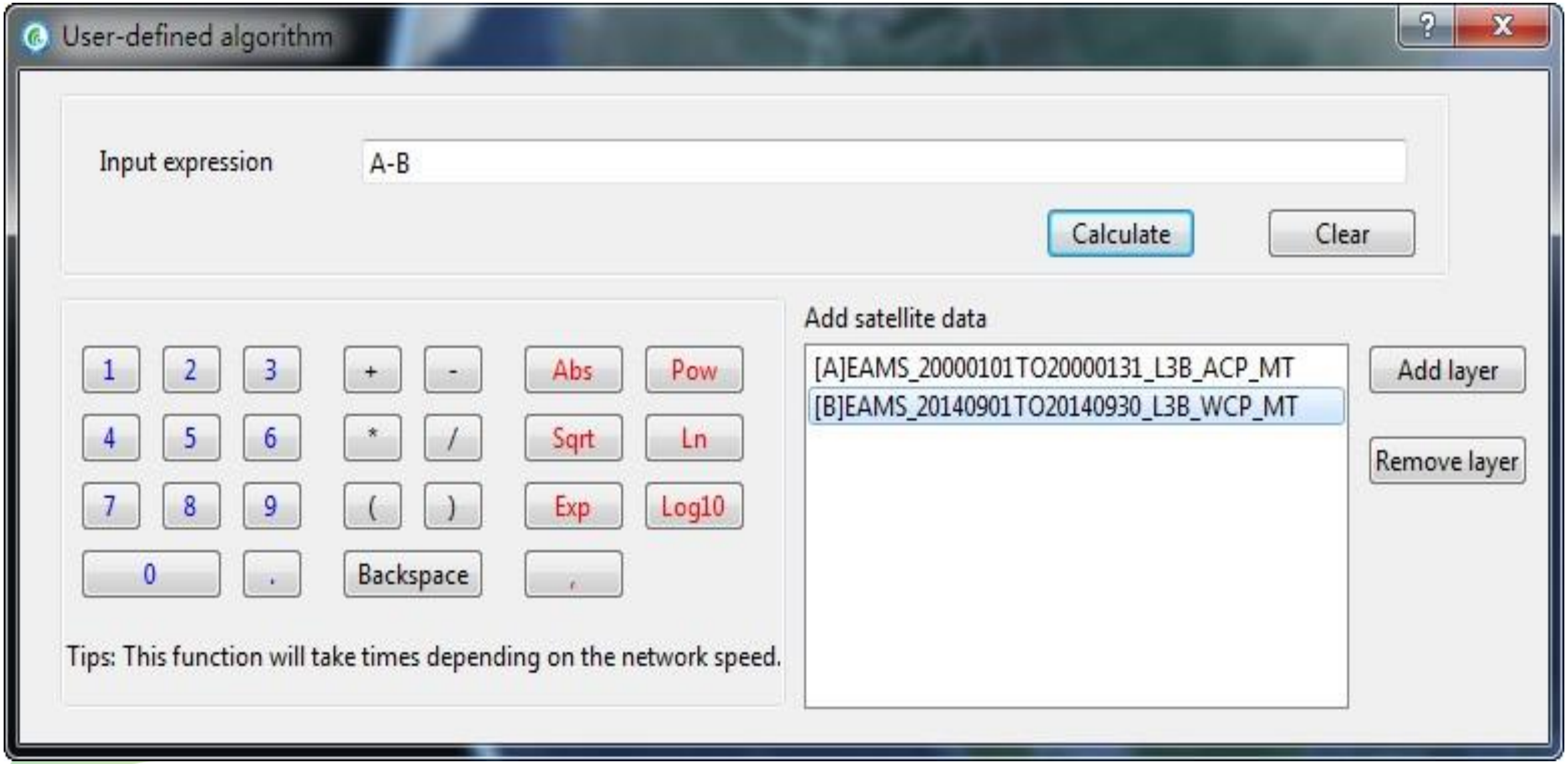
Line analysis

Time-series Analysis

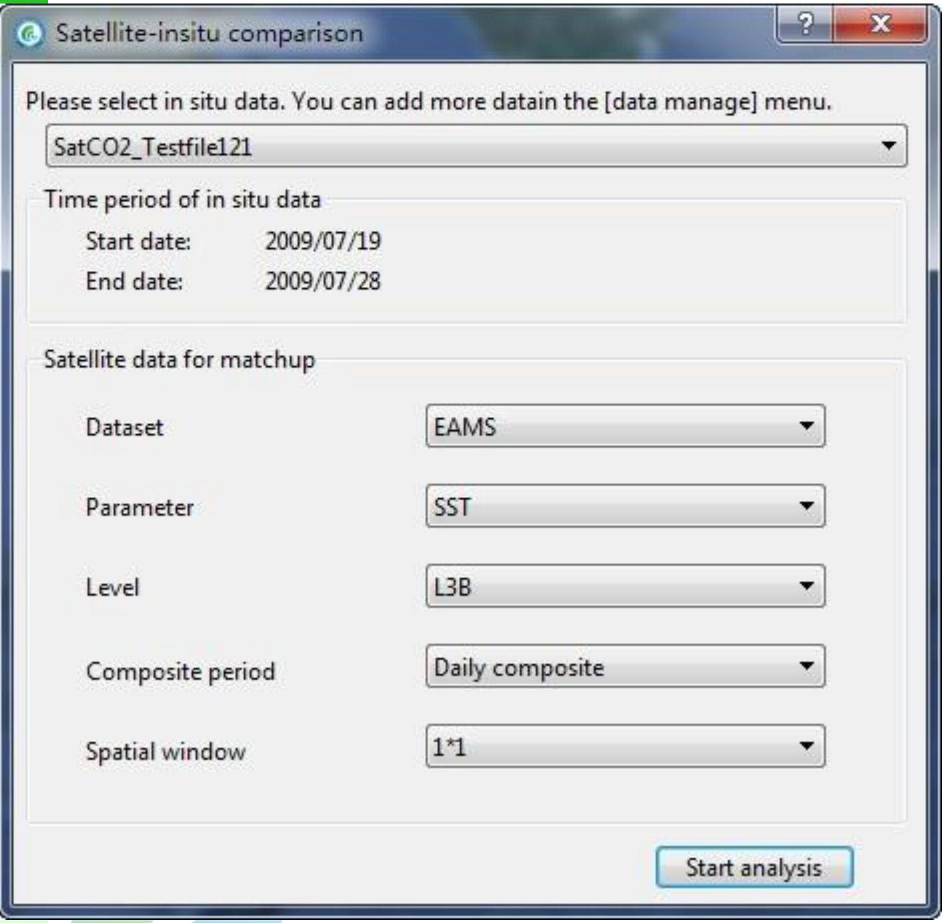


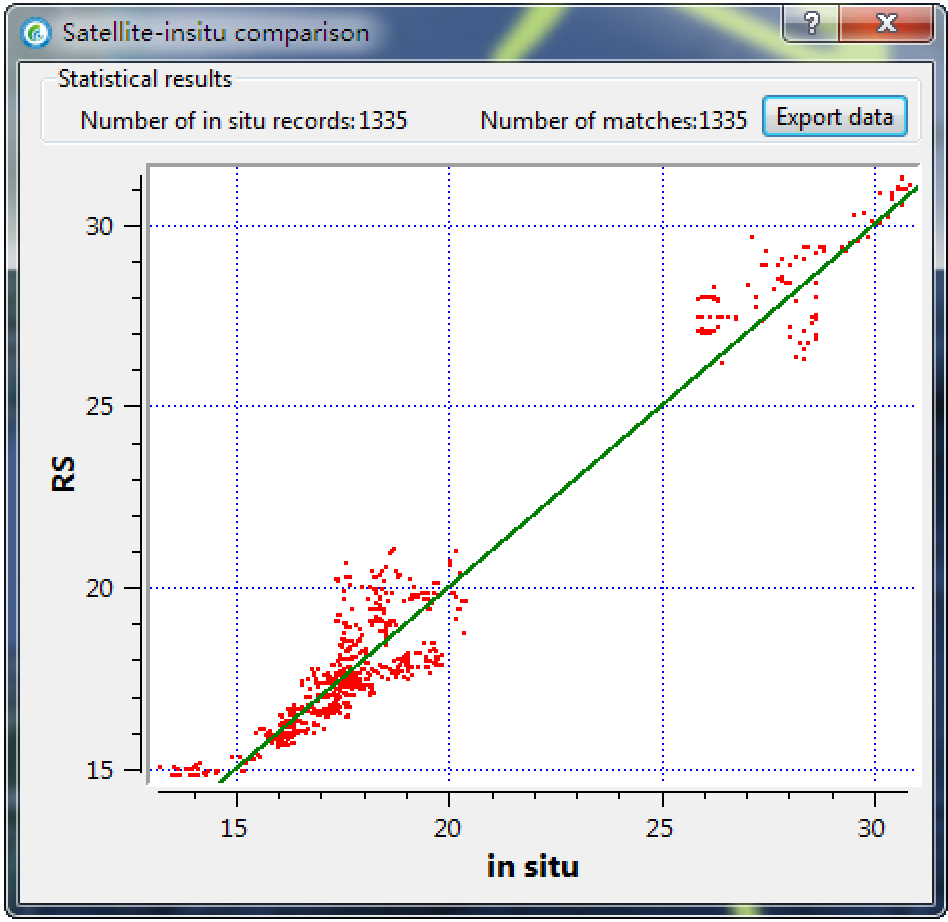
Time-series statistics (point, line and **polygon**)

User-defined Algorithm



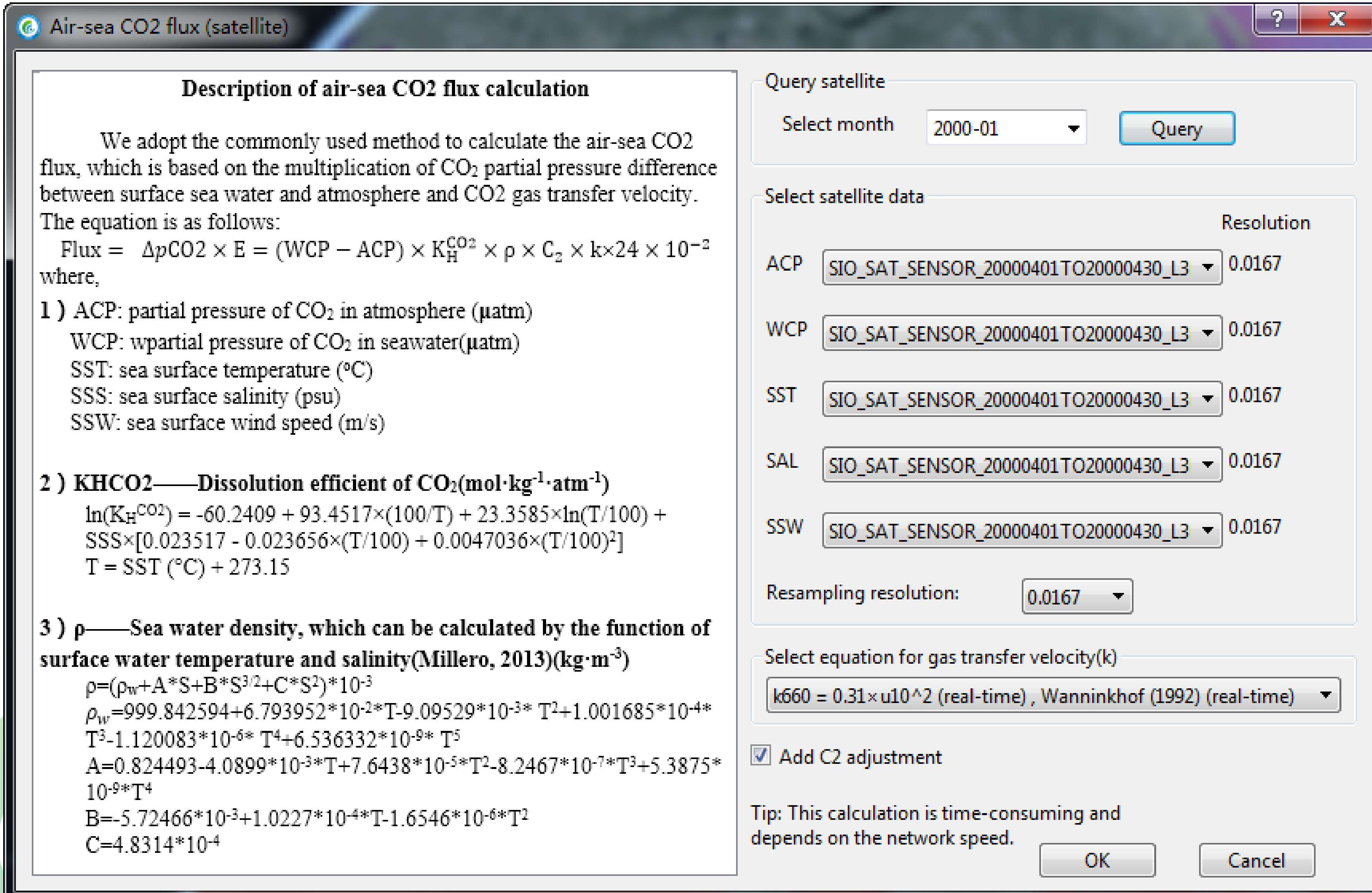
Satellite-in situ data matchup and comparison





Satellite-insitu comparison

Air-sea CO2 flux calculation



Budget Calculation

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.

Ocean Carbon from Space (SatCO2): Joint Science Workshop and Training (III) (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

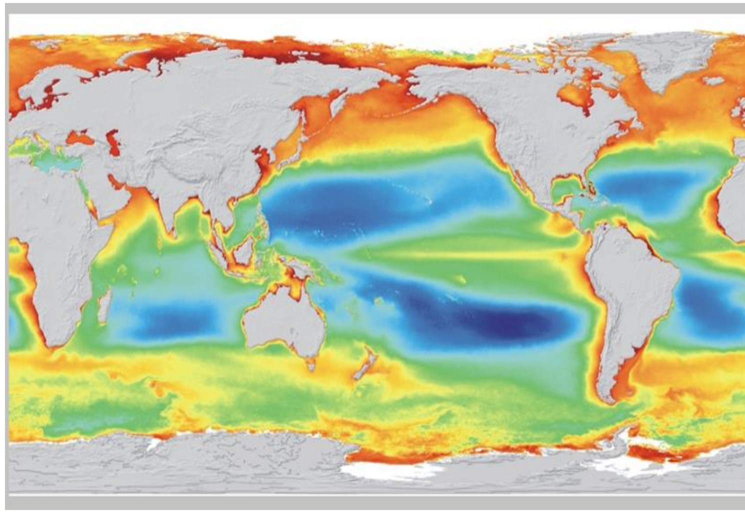
Hands-on training of SatCO2 software and database in 2016 and 2017

SatCO2

www.satCO2.com released on 11/23

Lin’an base of SIO/SOA

- **Satellite ground station and cloud based distributed databases**



临安基地建设　Lin’an Base

国际科技培训
International S & T Training Program

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 CO_2 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 CO_2 partial pressure difference between surface sea water and atmosphere and CO2 gas transfer velocity. The equation is as follows:

$$\mathrm{Flux} = \Delta pCO2 \times E = (WCP - ACP) \times K_H^{CO_2} \times \rho \times C_2 \times k \times 24 \times 10^{-2}$$

where,

1) ACP: partial pressure of CO_2 in atmosphere (μatm)

WCP: wpartial pressure of CO_2 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 CO_2($mol \cdot kg^{-1} \cdot atm^{-1}$)

$$\ln(K_H^{CO2}) = -60.2409 + 93.4517\times(100/T) + 23.3585\times\ln(T/100) + SSS\times[0.023517 - 0.023656\times(T/100) + 0.0047036\times(T/100)^2]$$

$$T = SST\ (°C) + 273.15$$

3) ρ——Sea water density, which can be calculated by the function of surface water temperature and salinity(Millero, 2013)($kg \cdot m^{-3}$)

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

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

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

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

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

5) k——Gas transfer velocity($cm \cdot h^{-1}$)

Based on the relationship between gas transfer velocity (k) and the wind speed at 10m above sea level(U_{10}), 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)

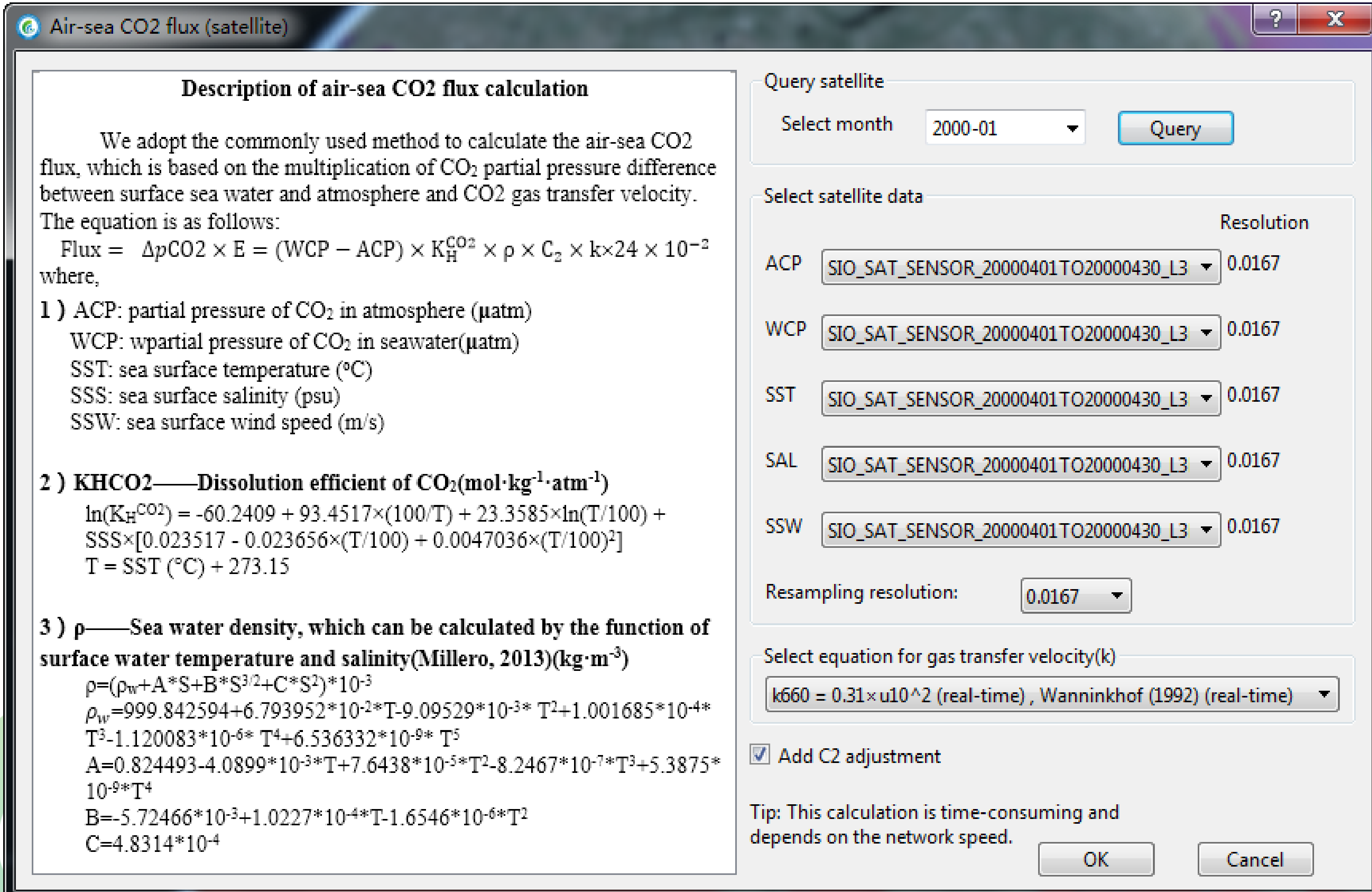
4) C2——Wind speed coefficient C2, which has been calculated and uploaded in the SOED database

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.

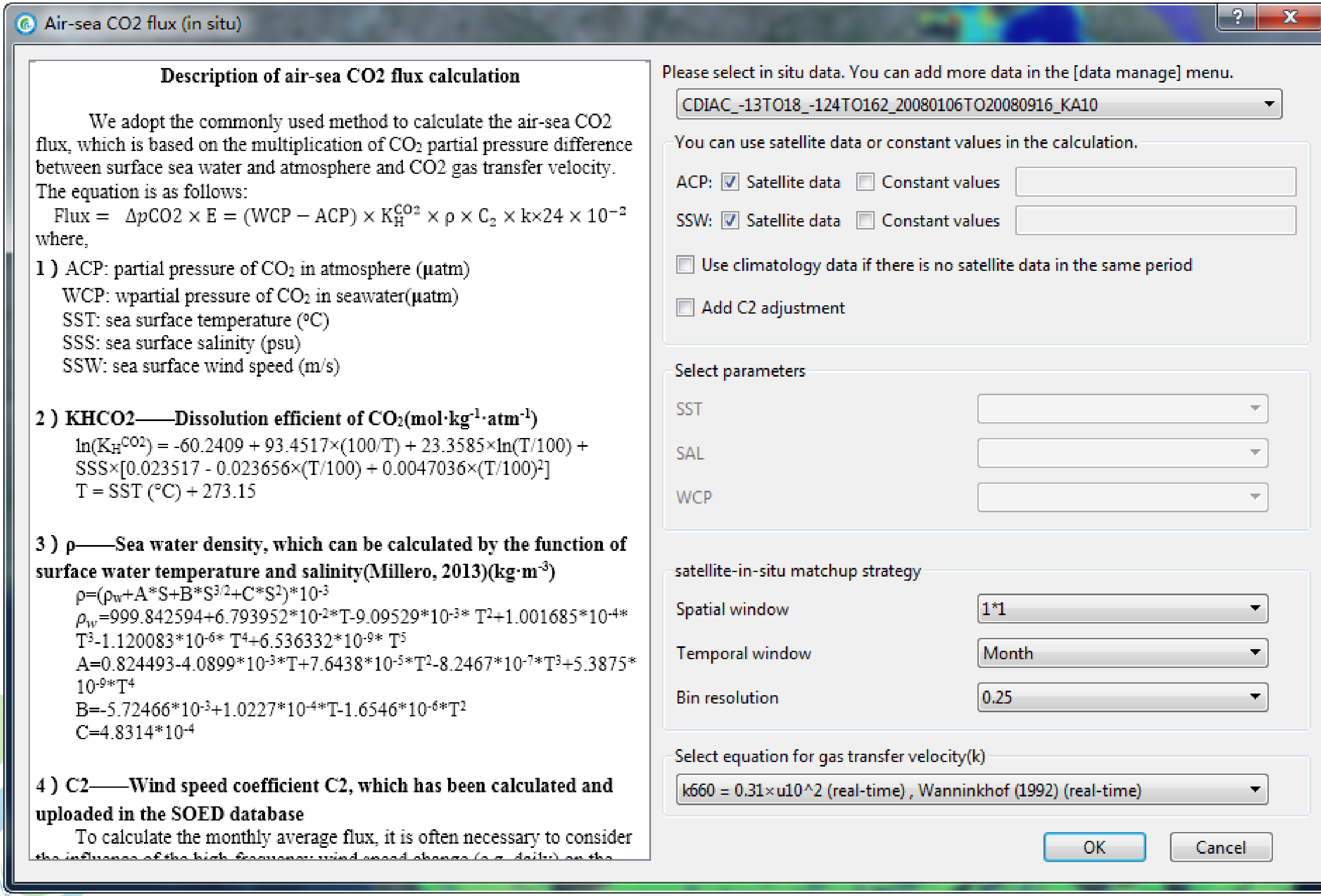
$$C_2 = \frac{(U_j^2)_{mean}}{(U_{mean})^2}$$

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 $m \cdot s^{-1}$.

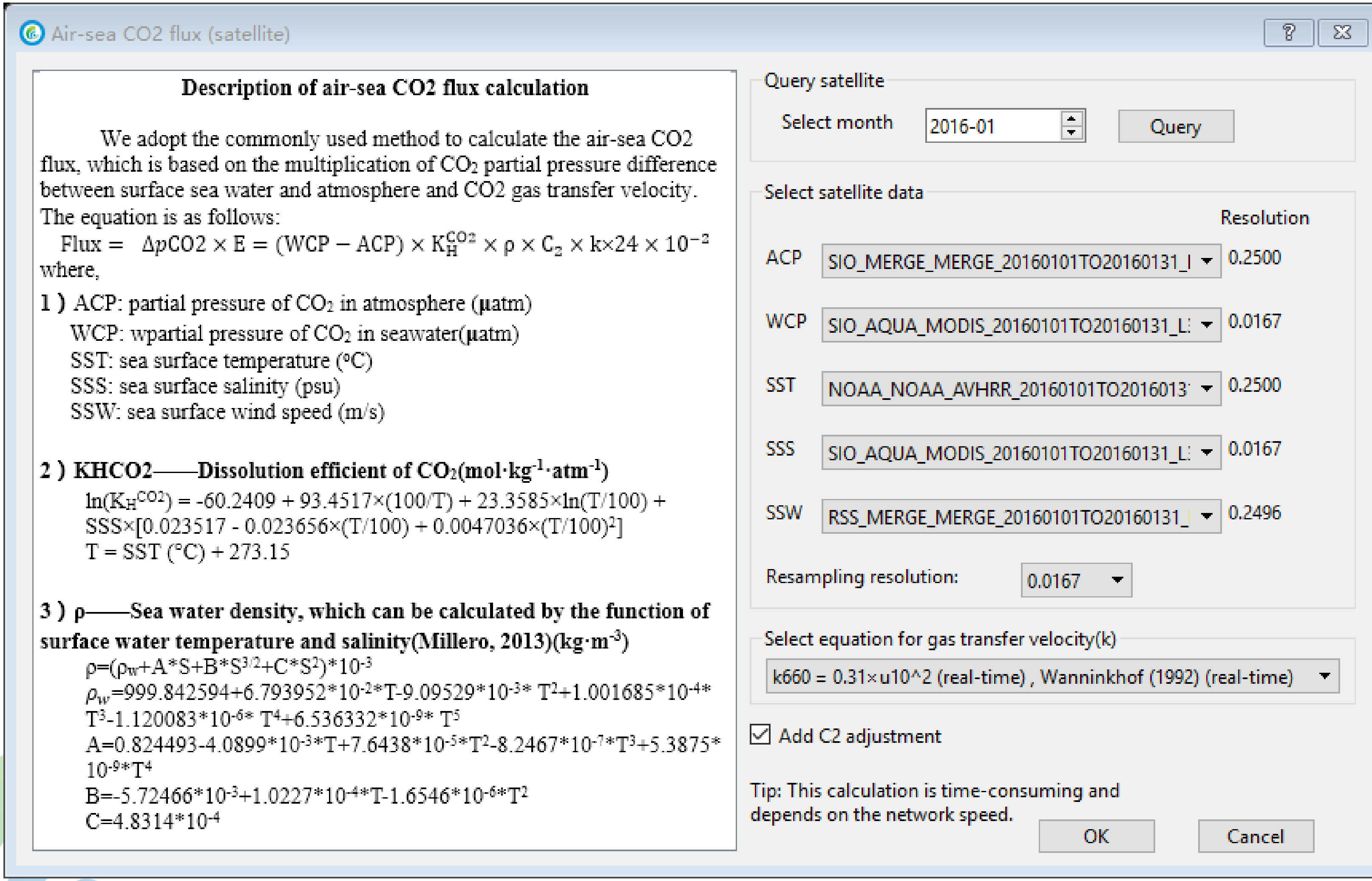
Air-sea CO2 flux calculation (Remote sensing)



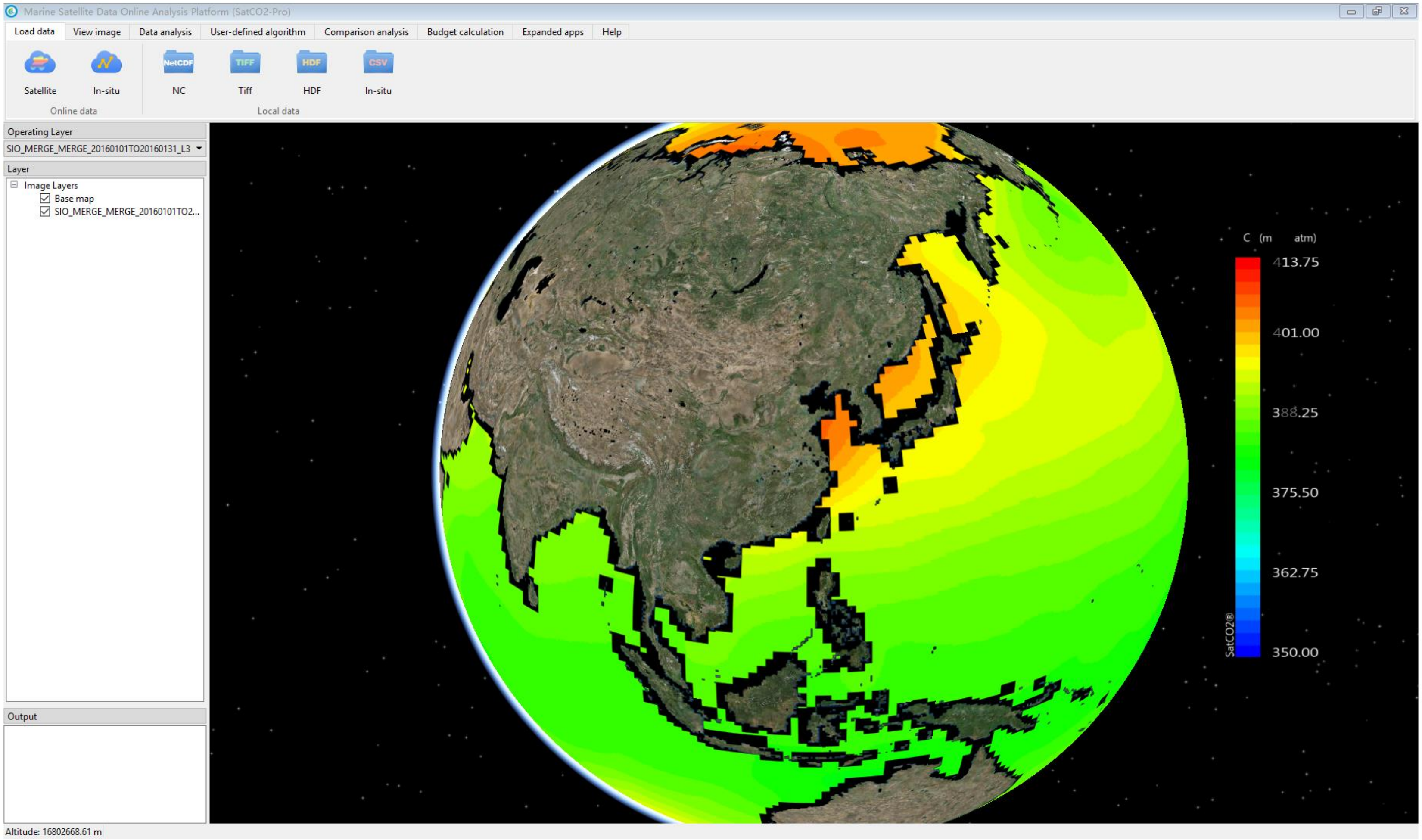
Air-sea CO2 flux calculation (In situ data)



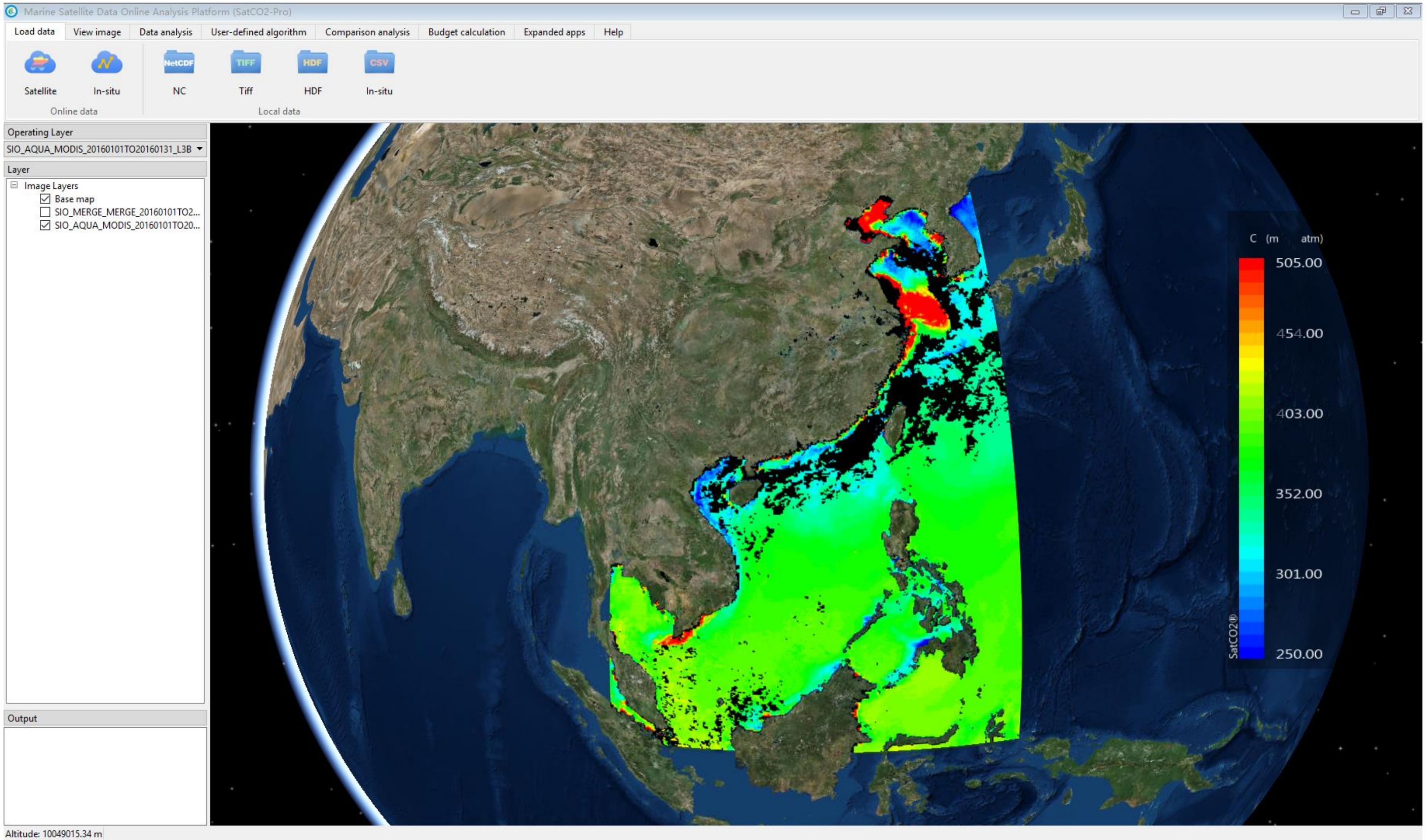
Practice case 9



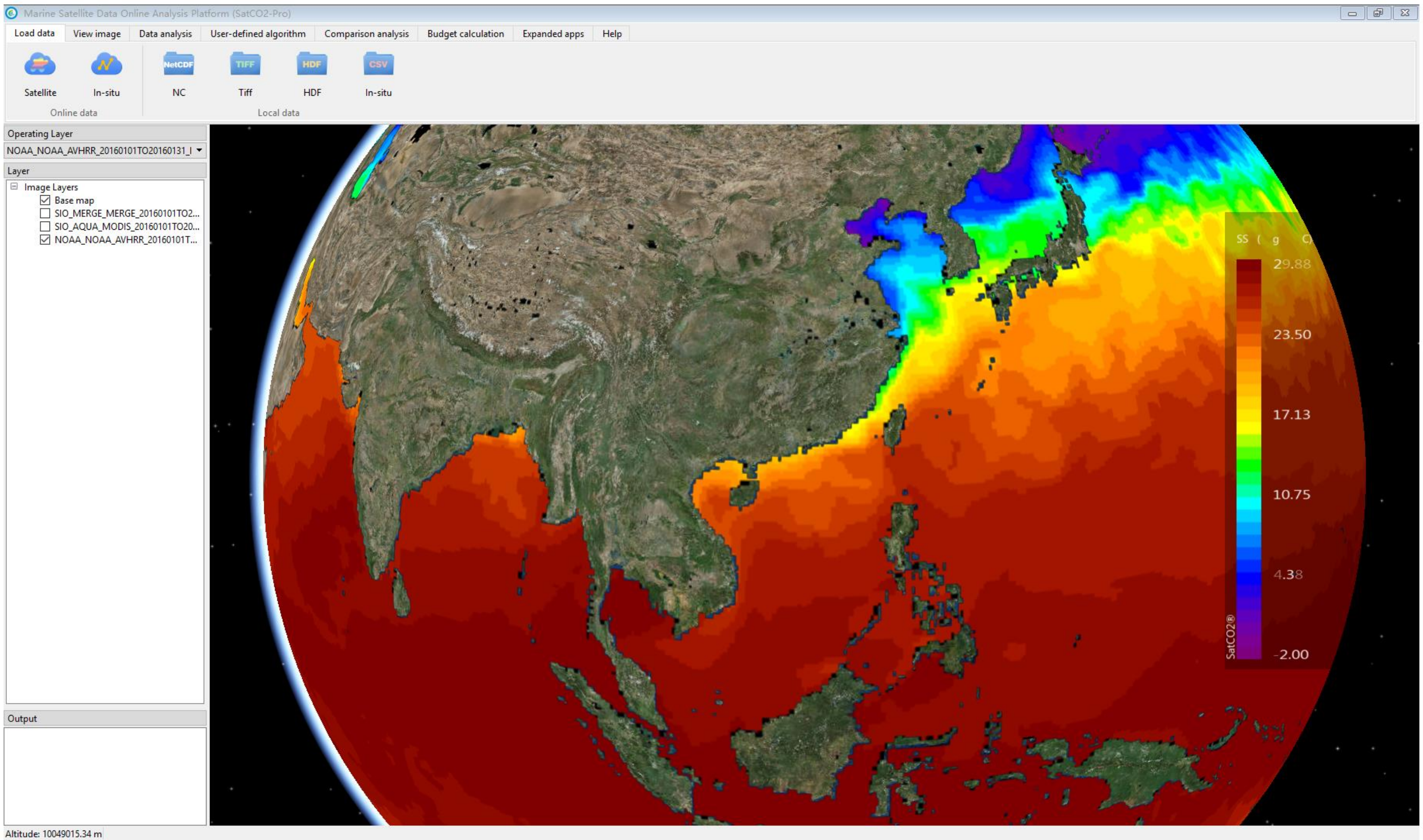
Practice case 9   ACP



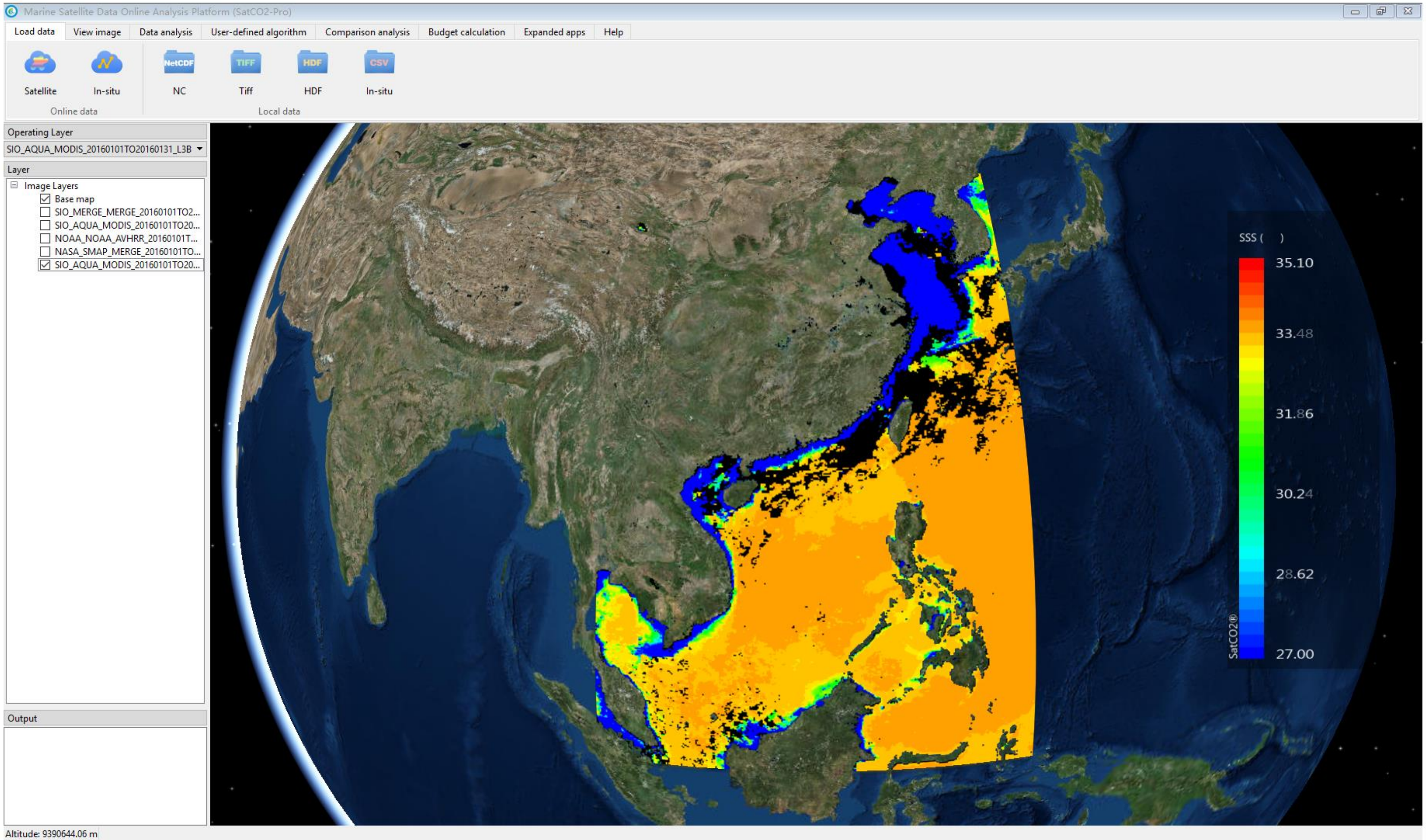
Practice case 9 WCP



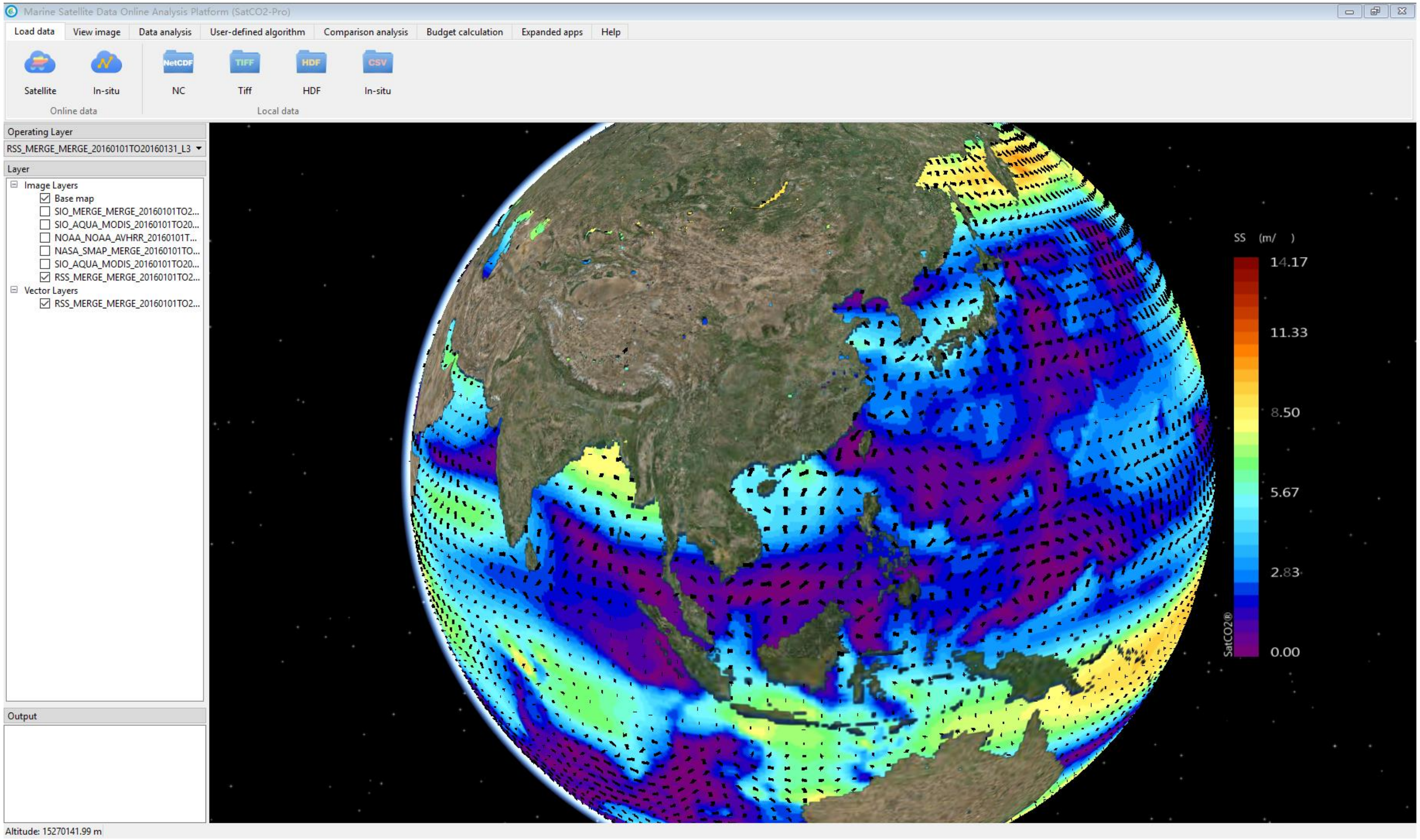
Practice case 9 SST



Practice case 9 SSS

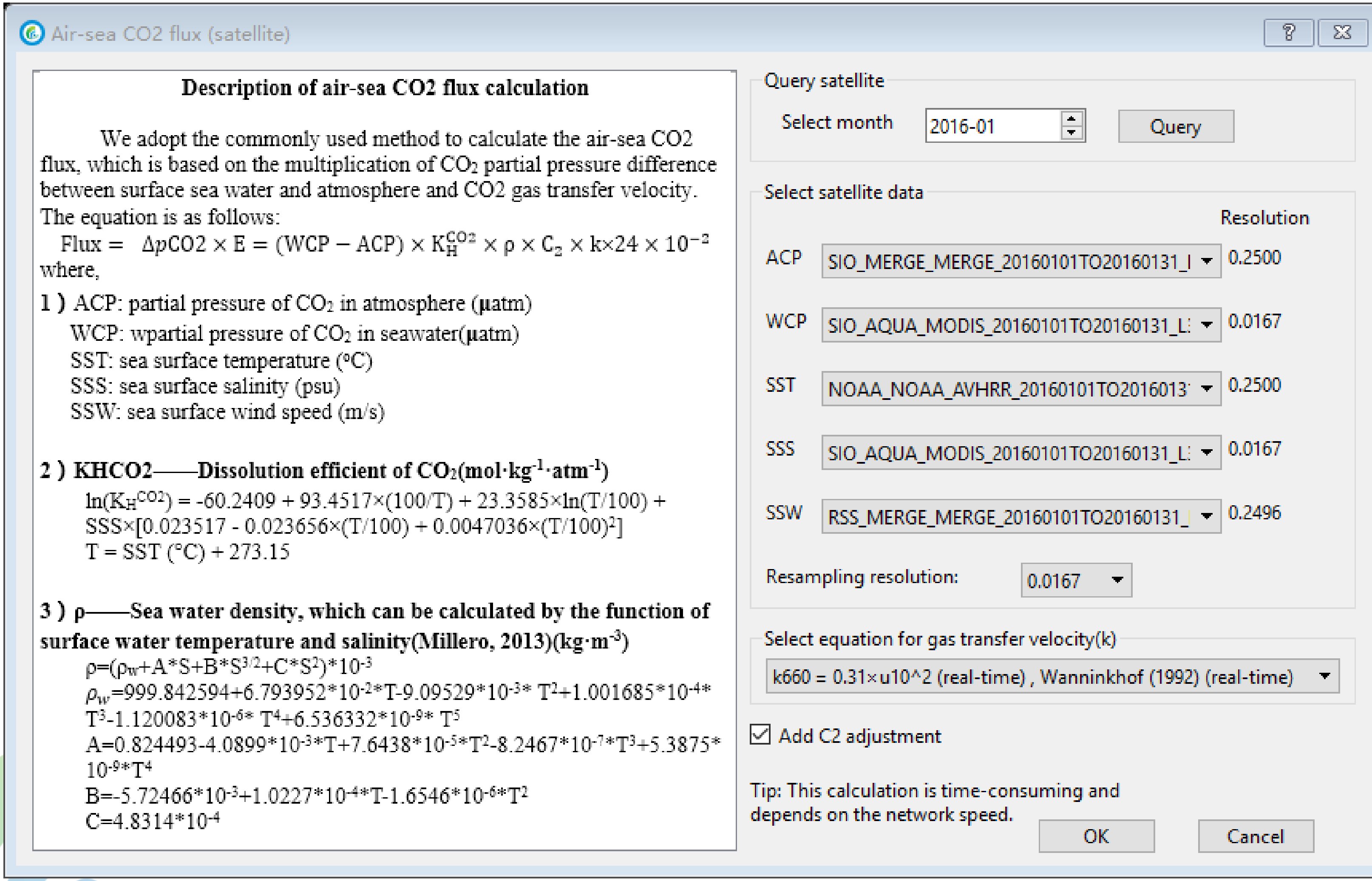


Practice case 9 SSW



Practice case 9

SatCO2



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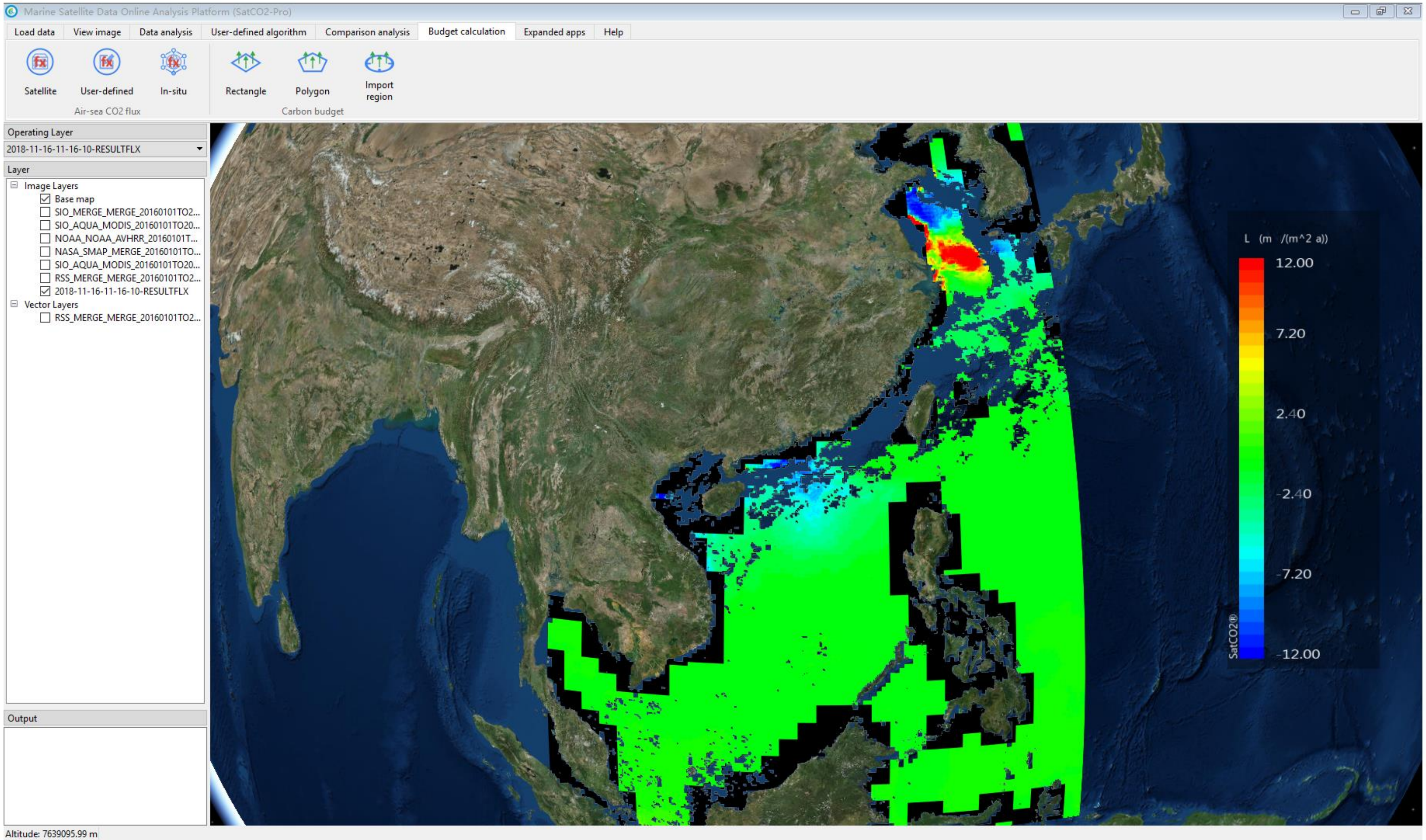
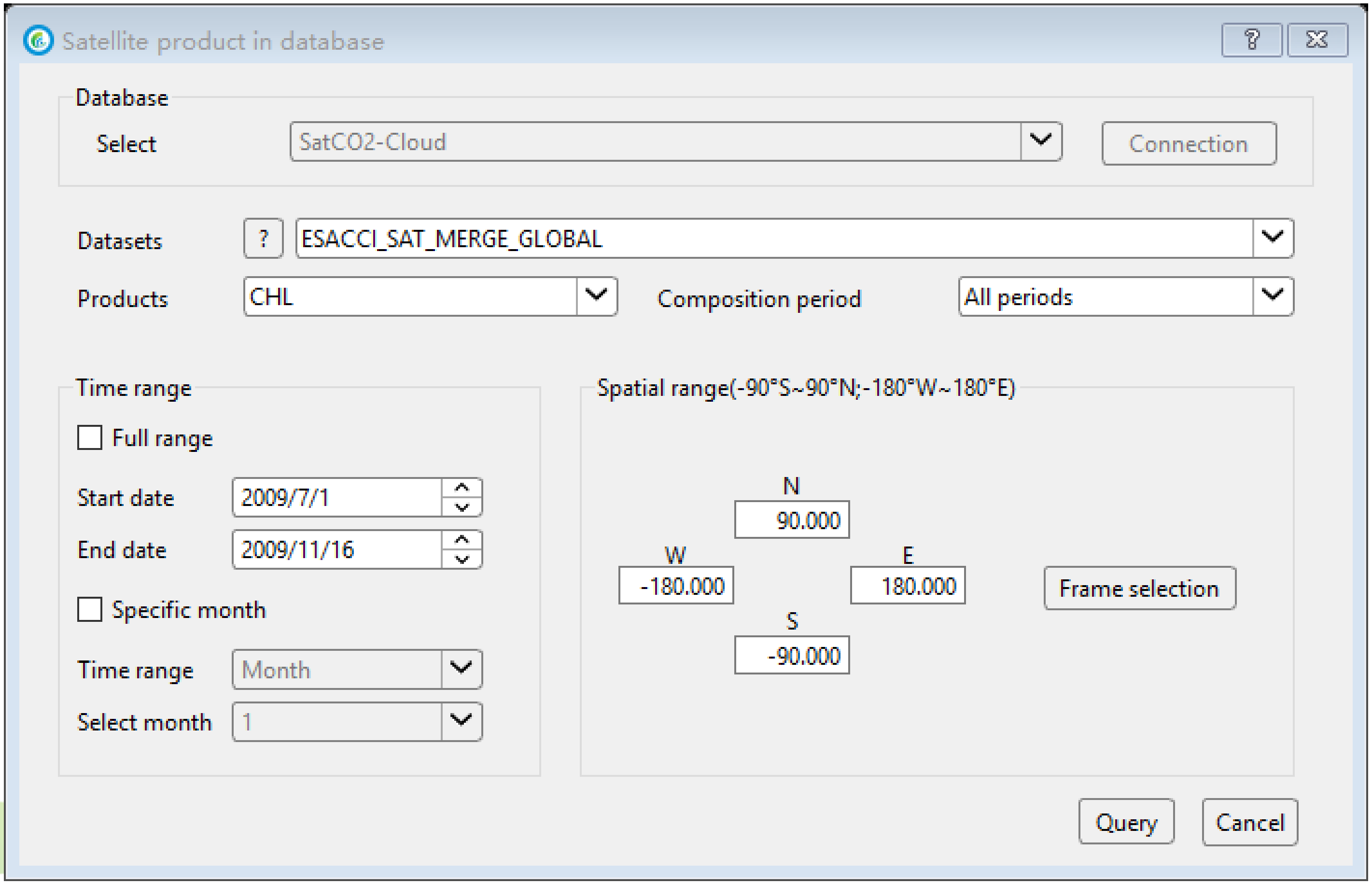


Let us begin the hands-on practice !

Practice case 1



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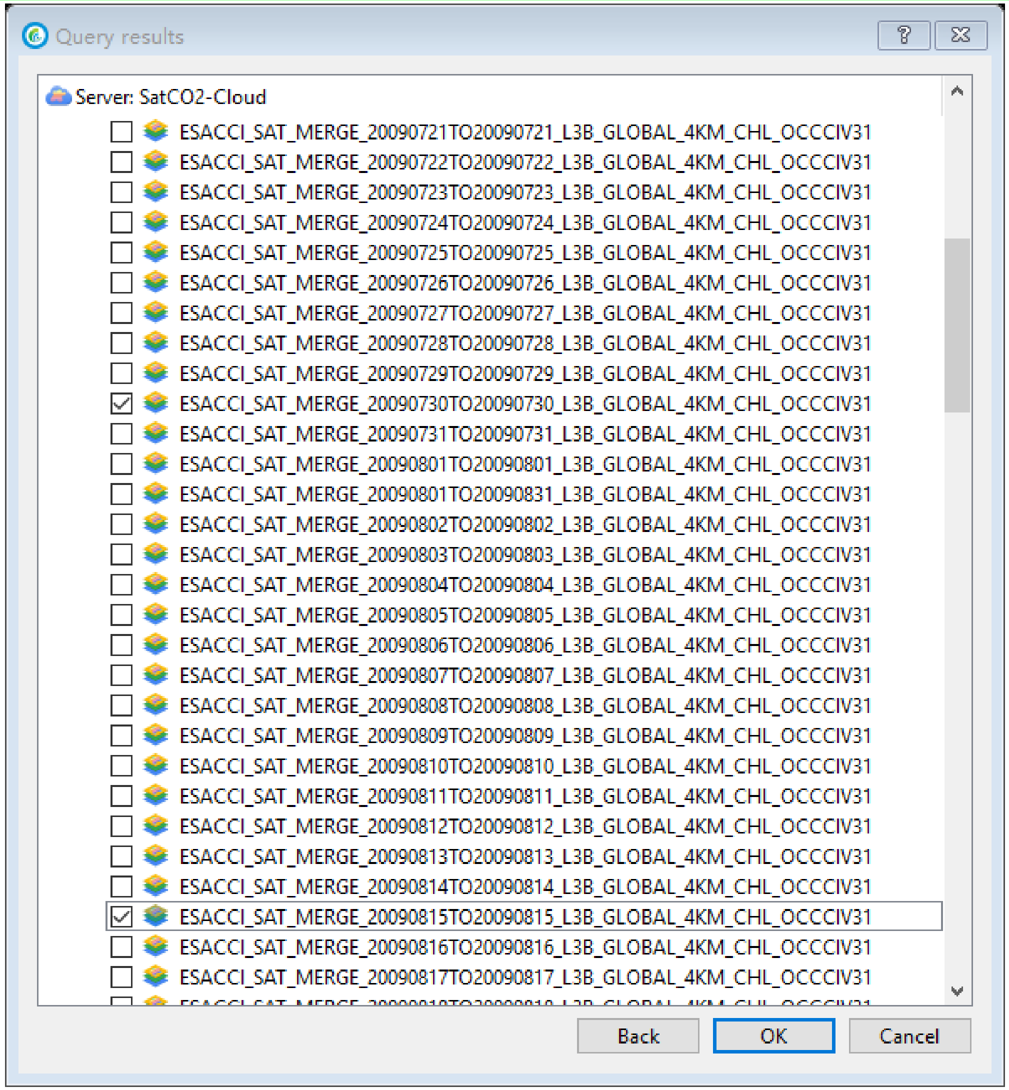

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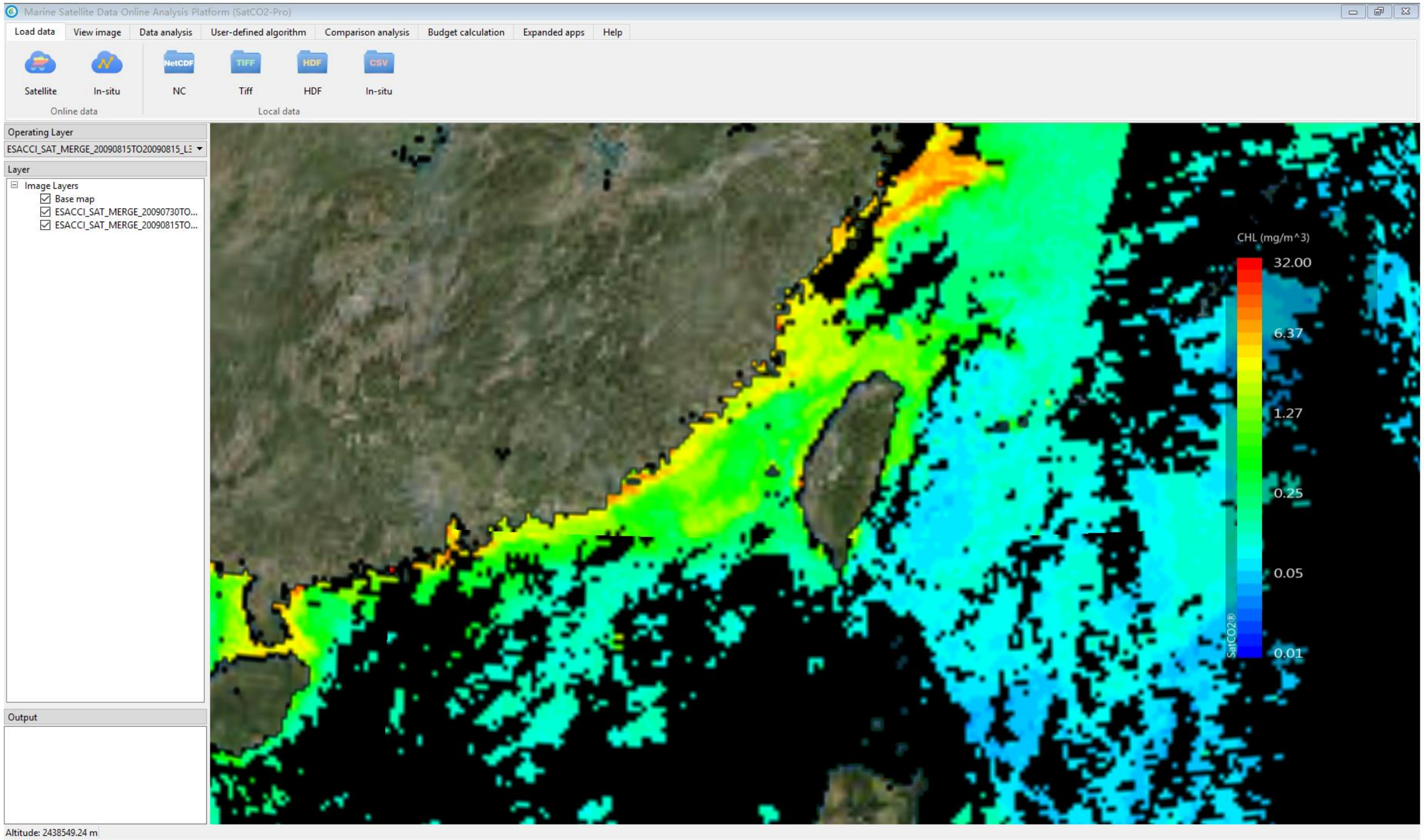

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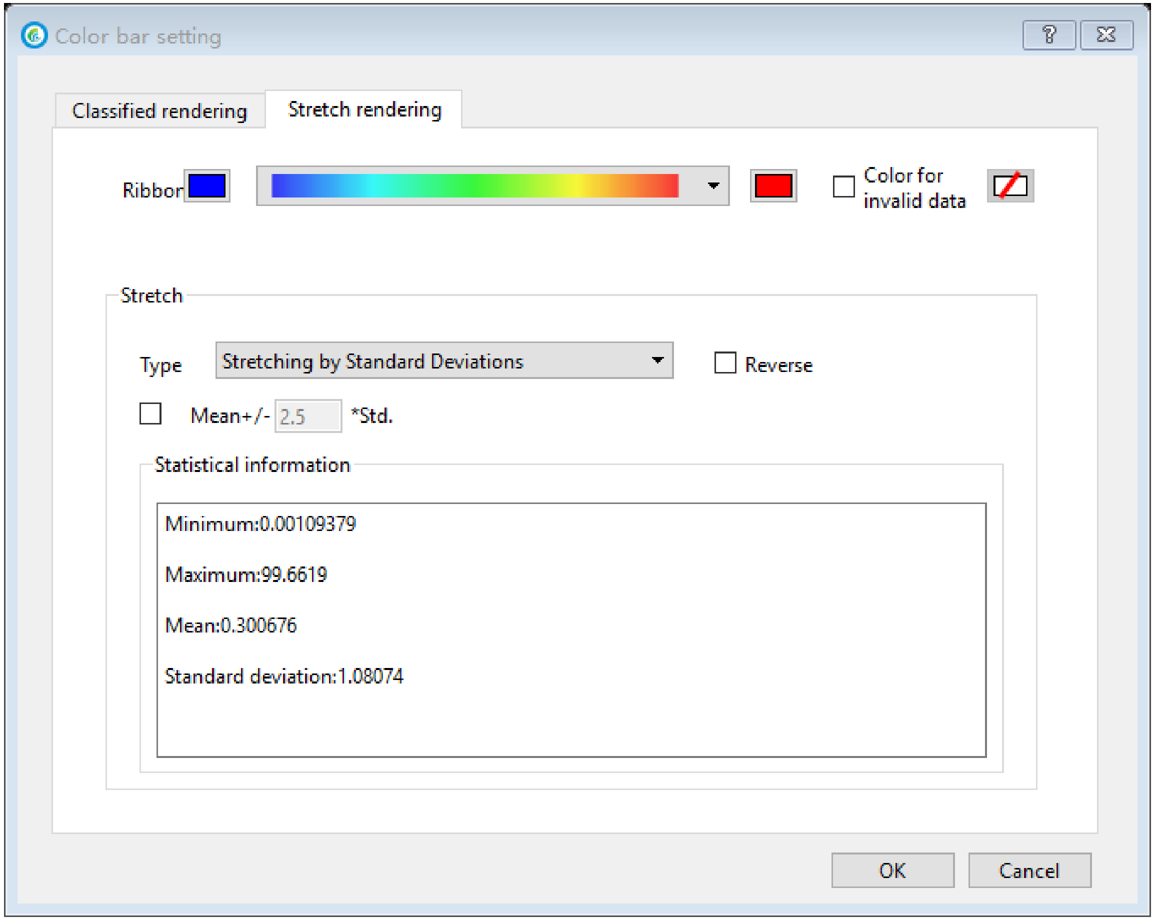

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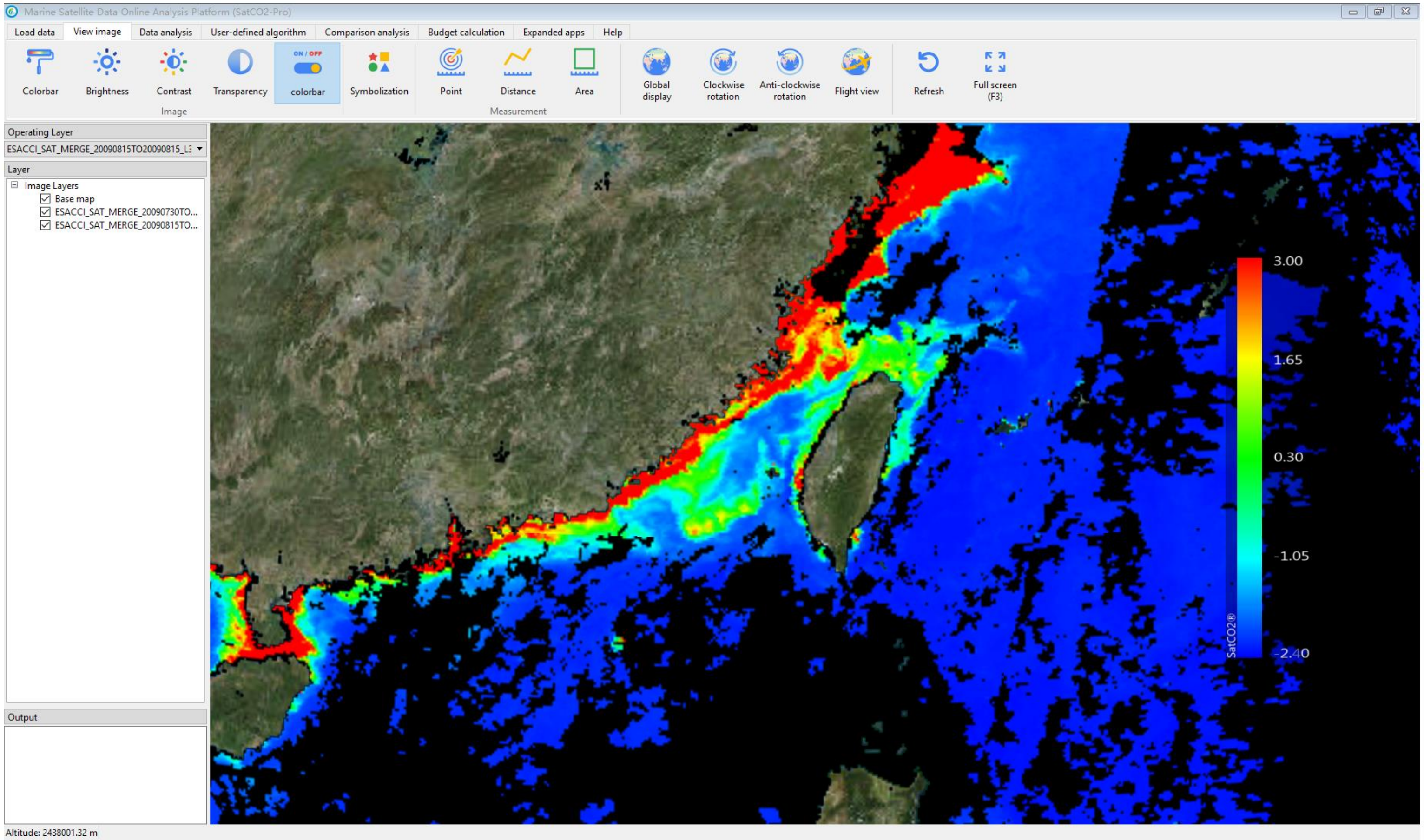

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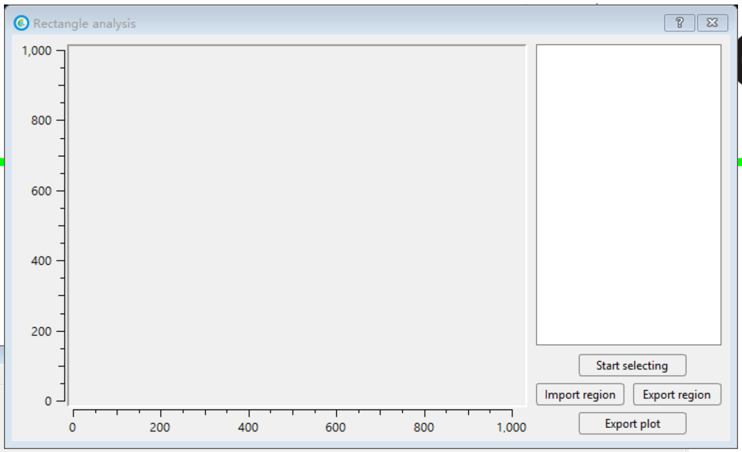

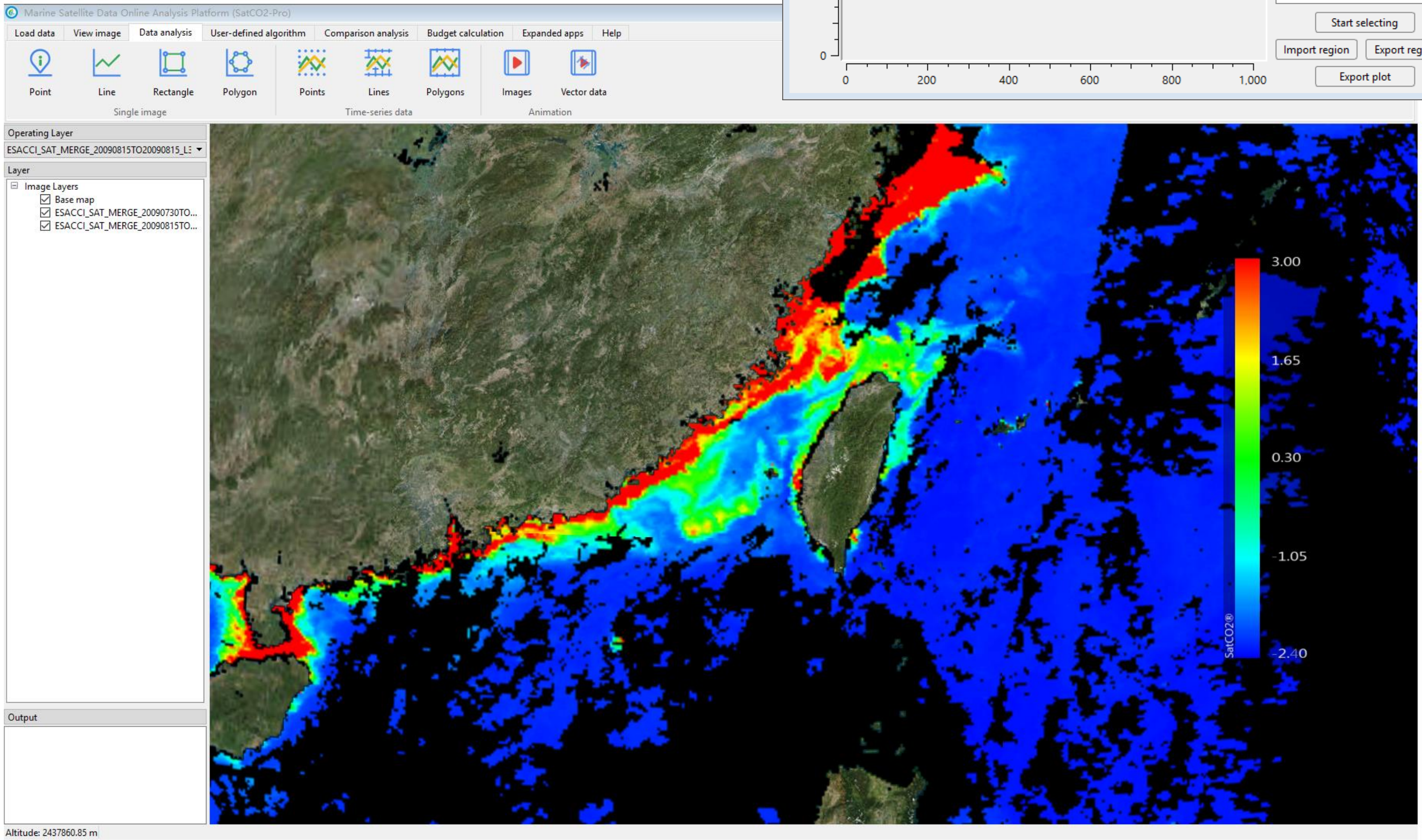

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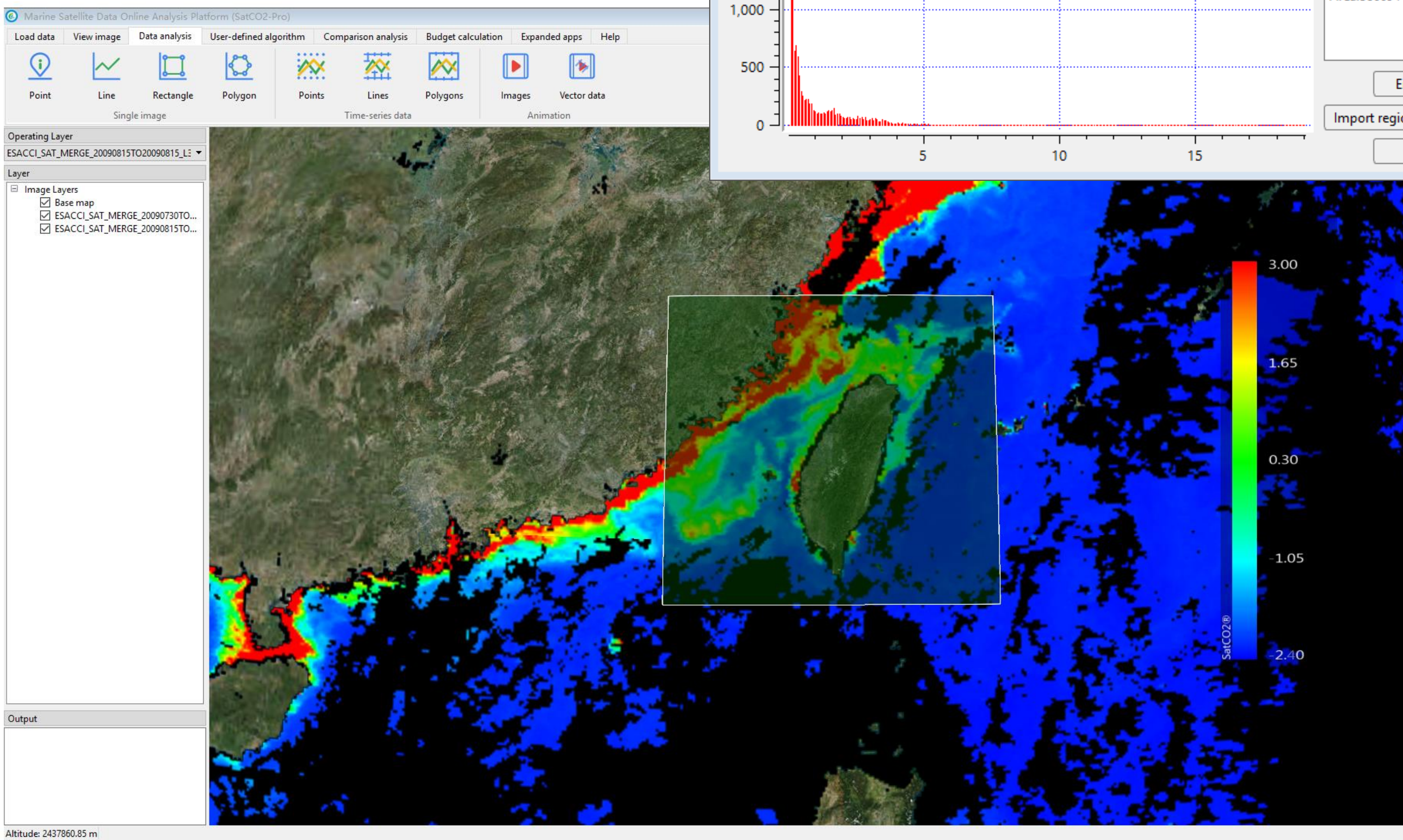
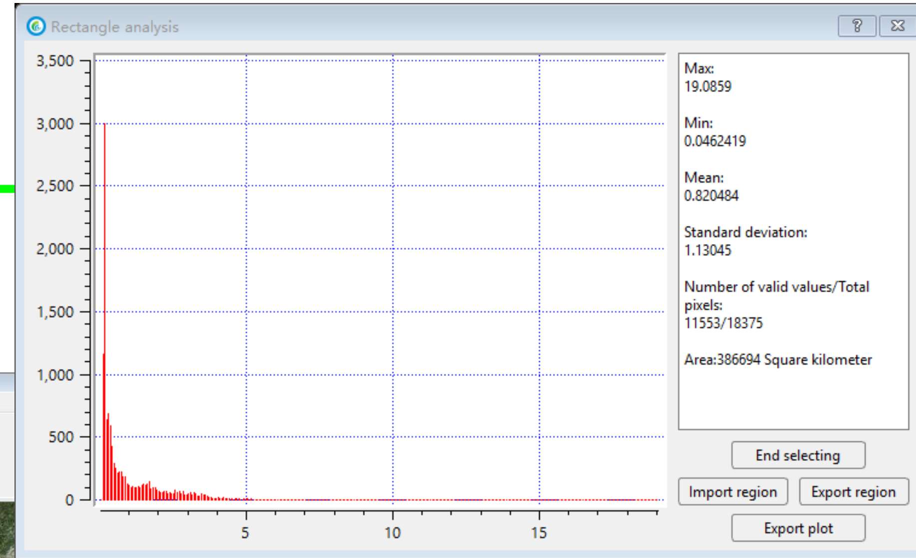
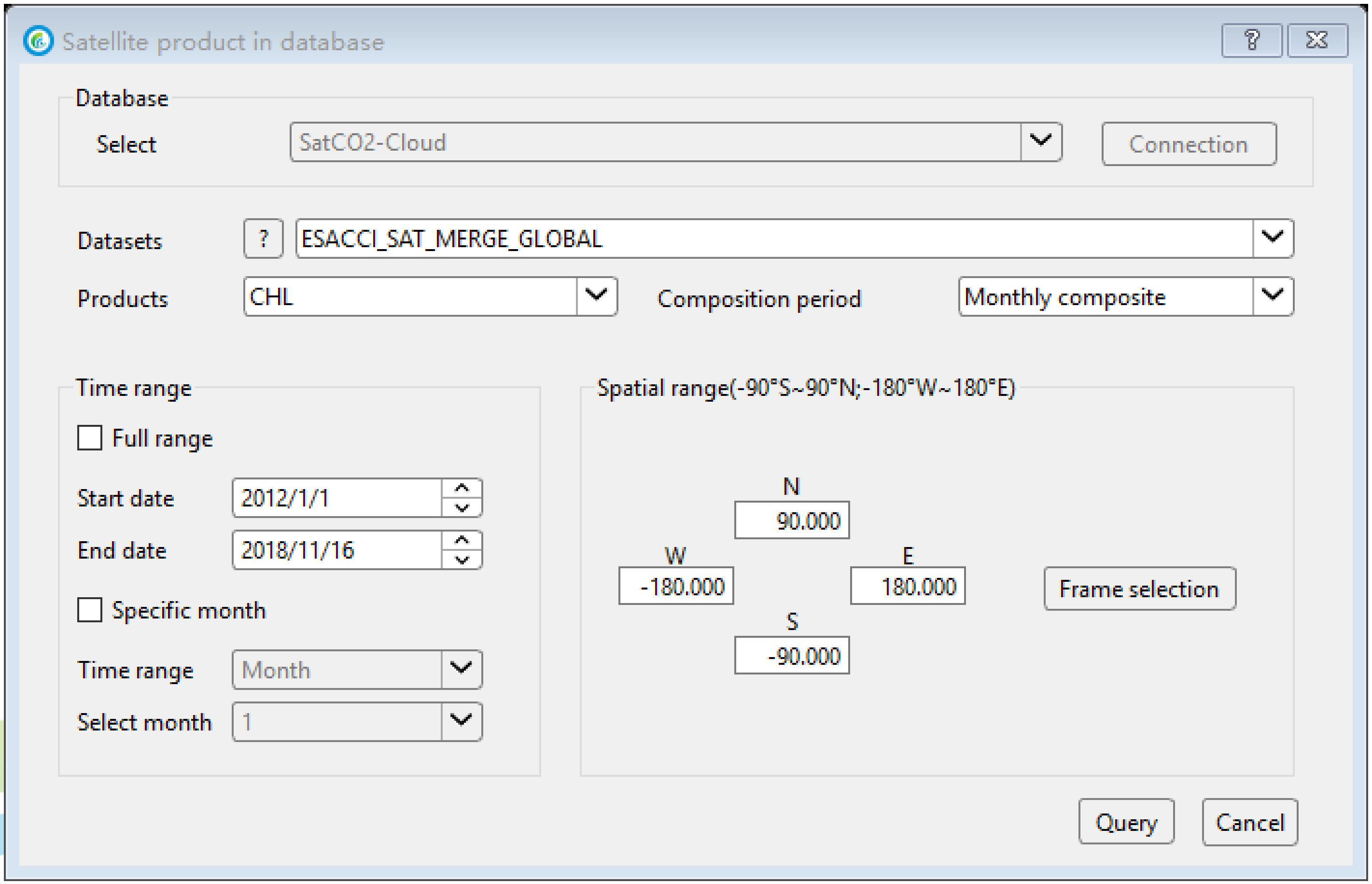




Practice case 2



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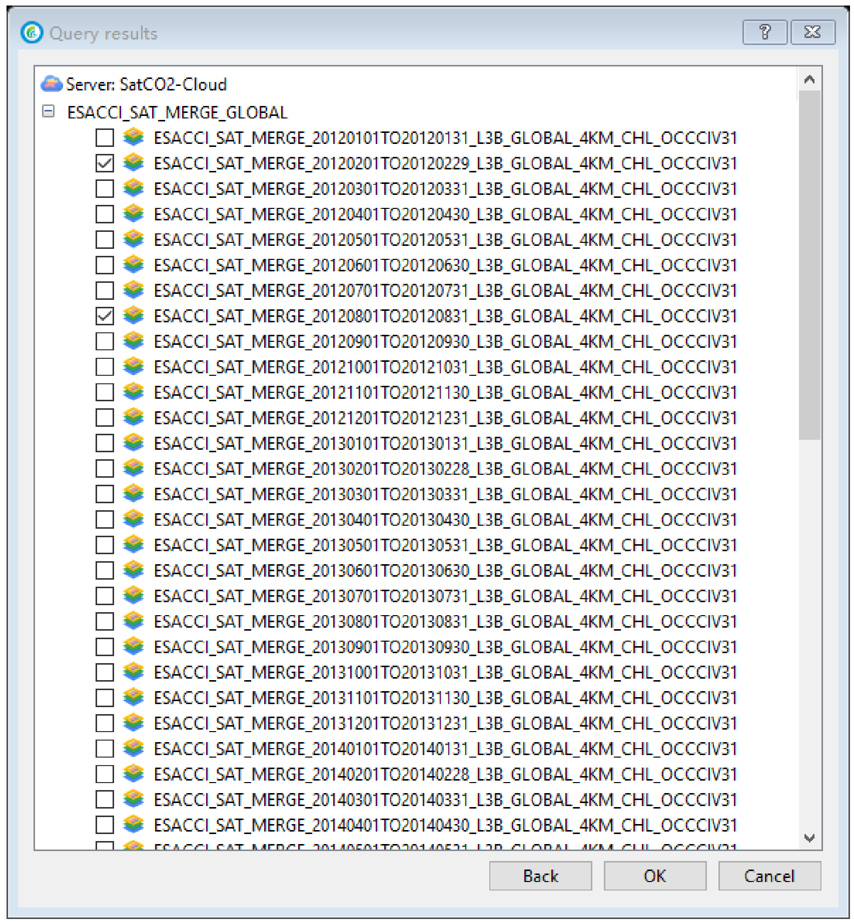

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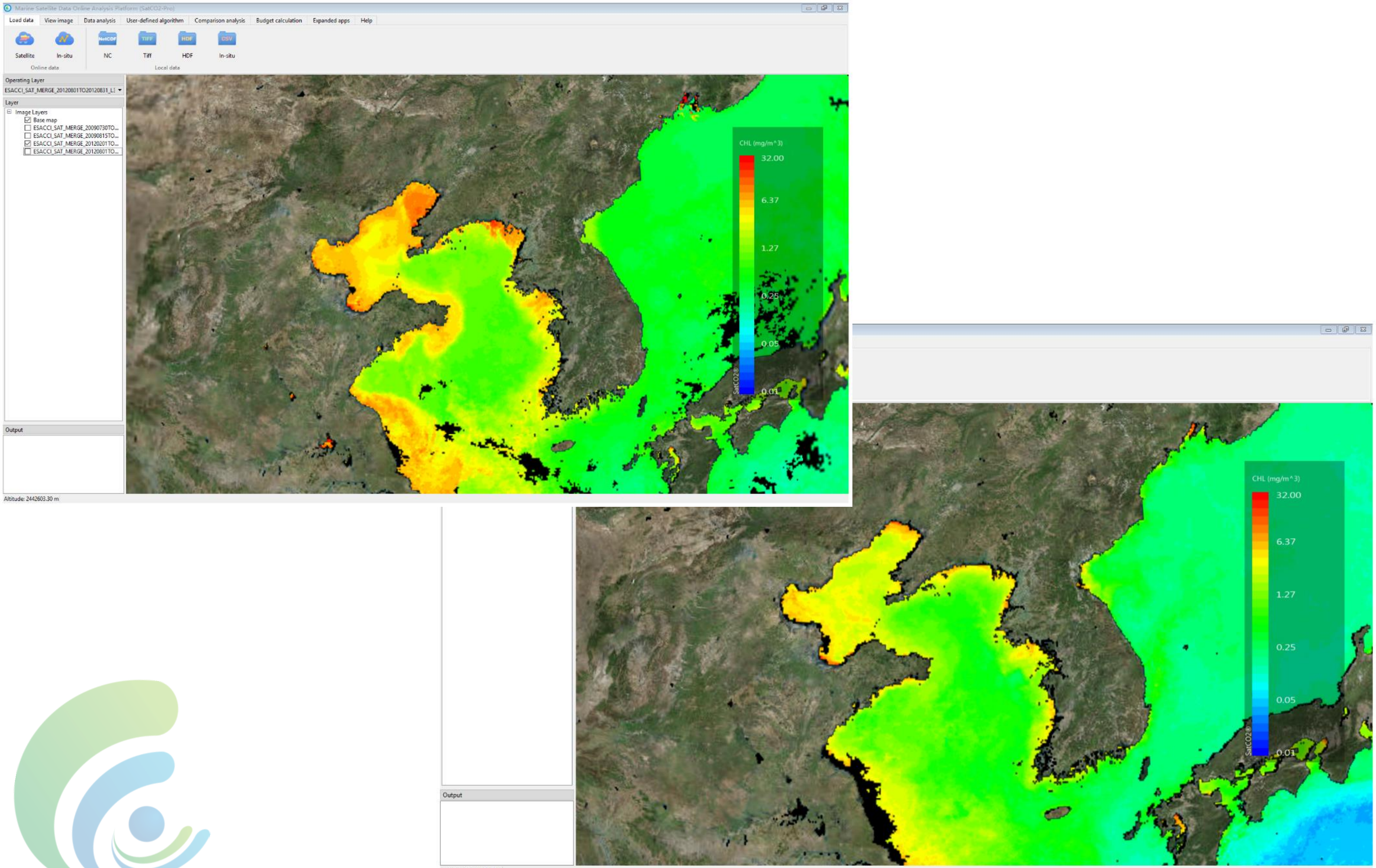

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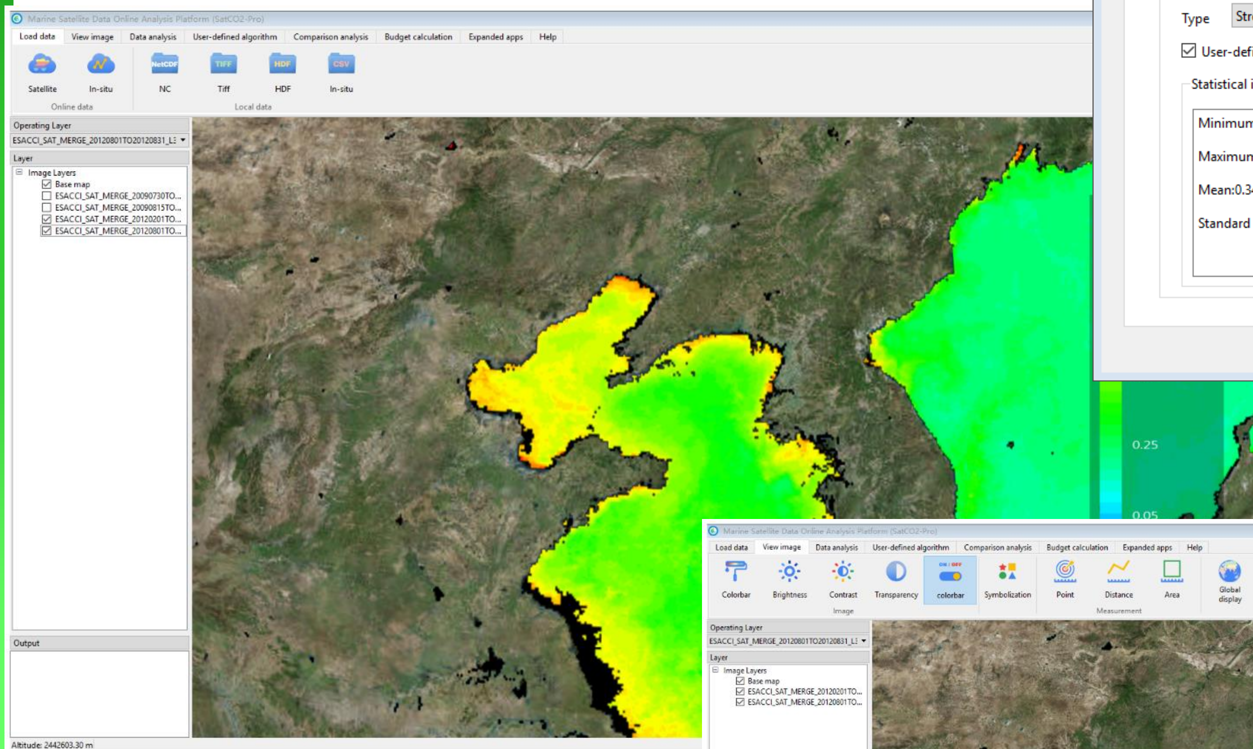

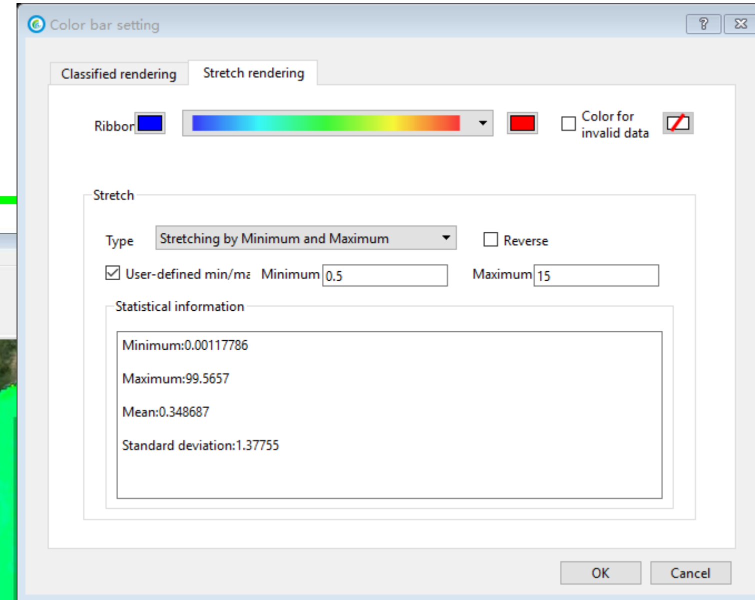

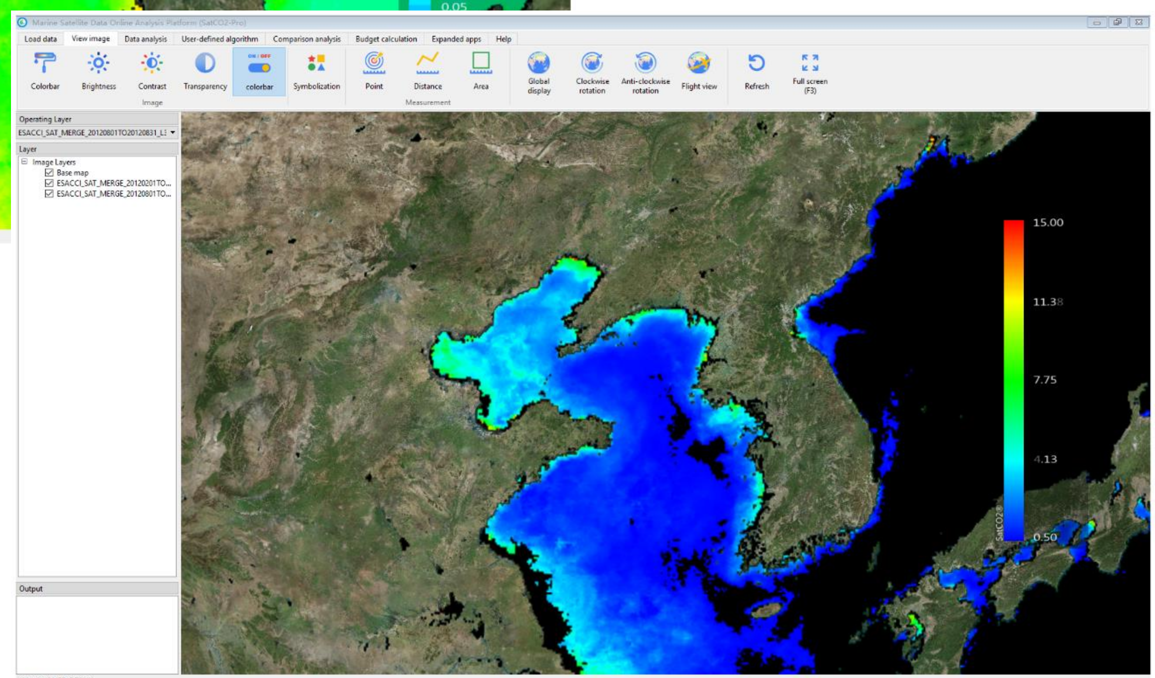

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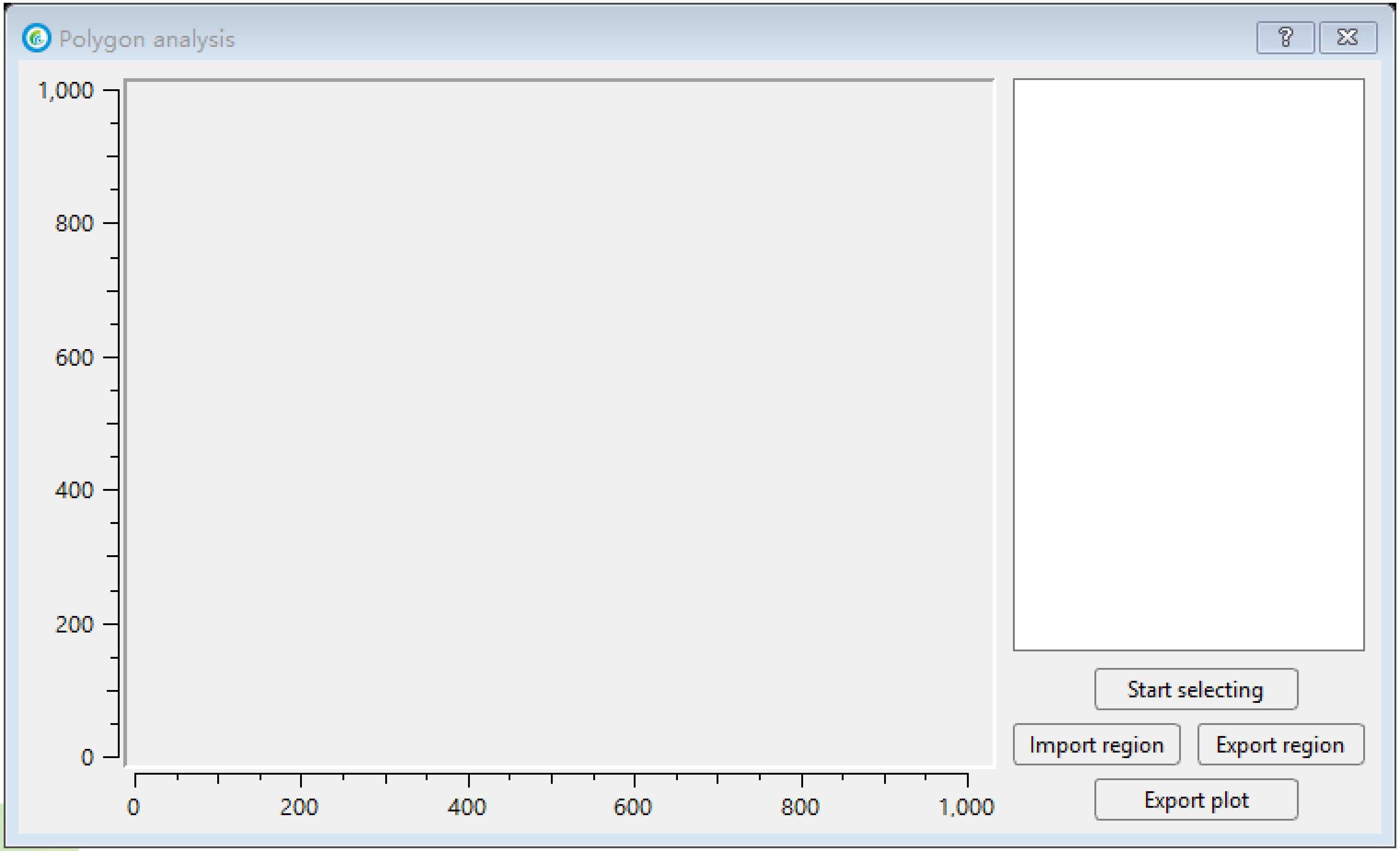

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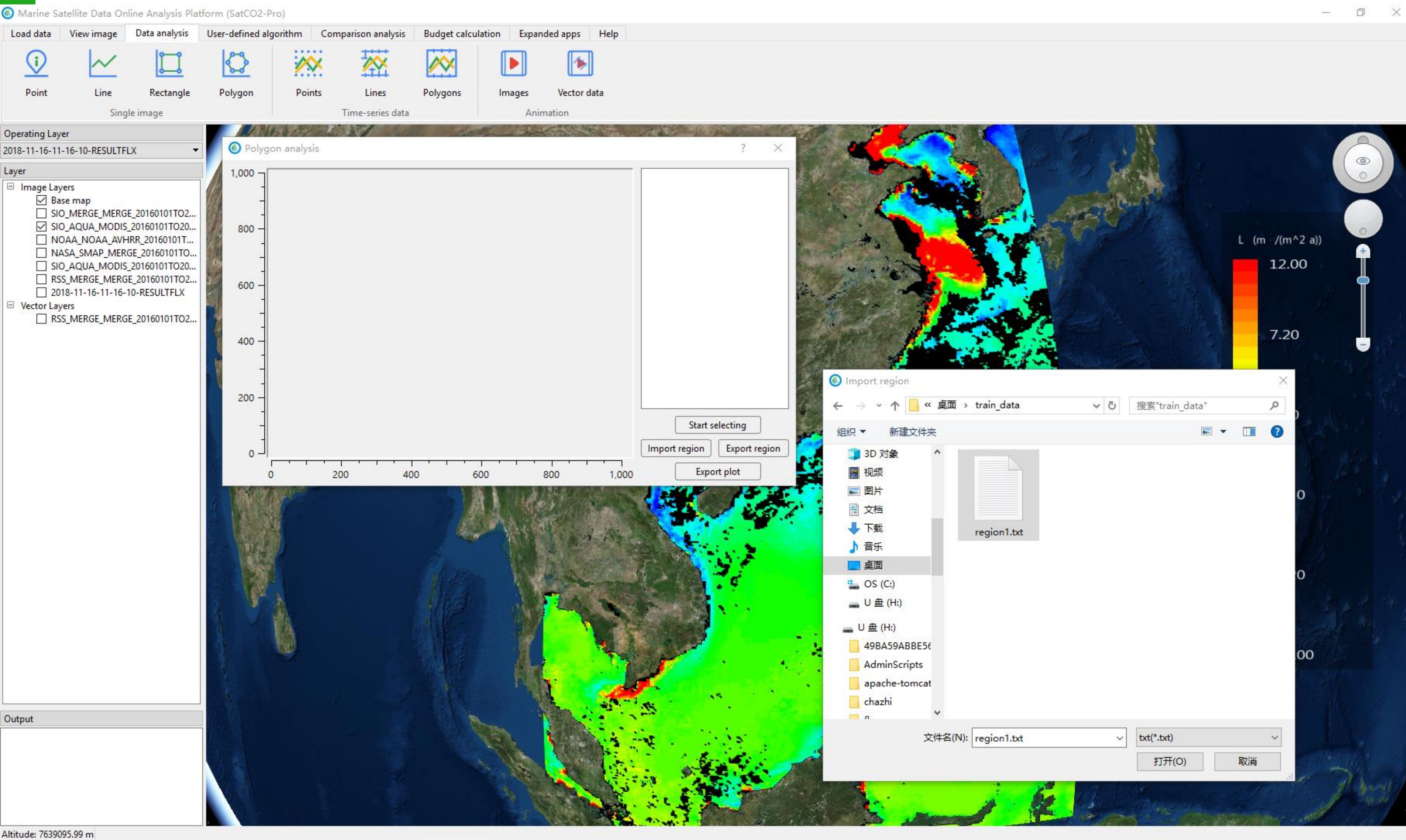

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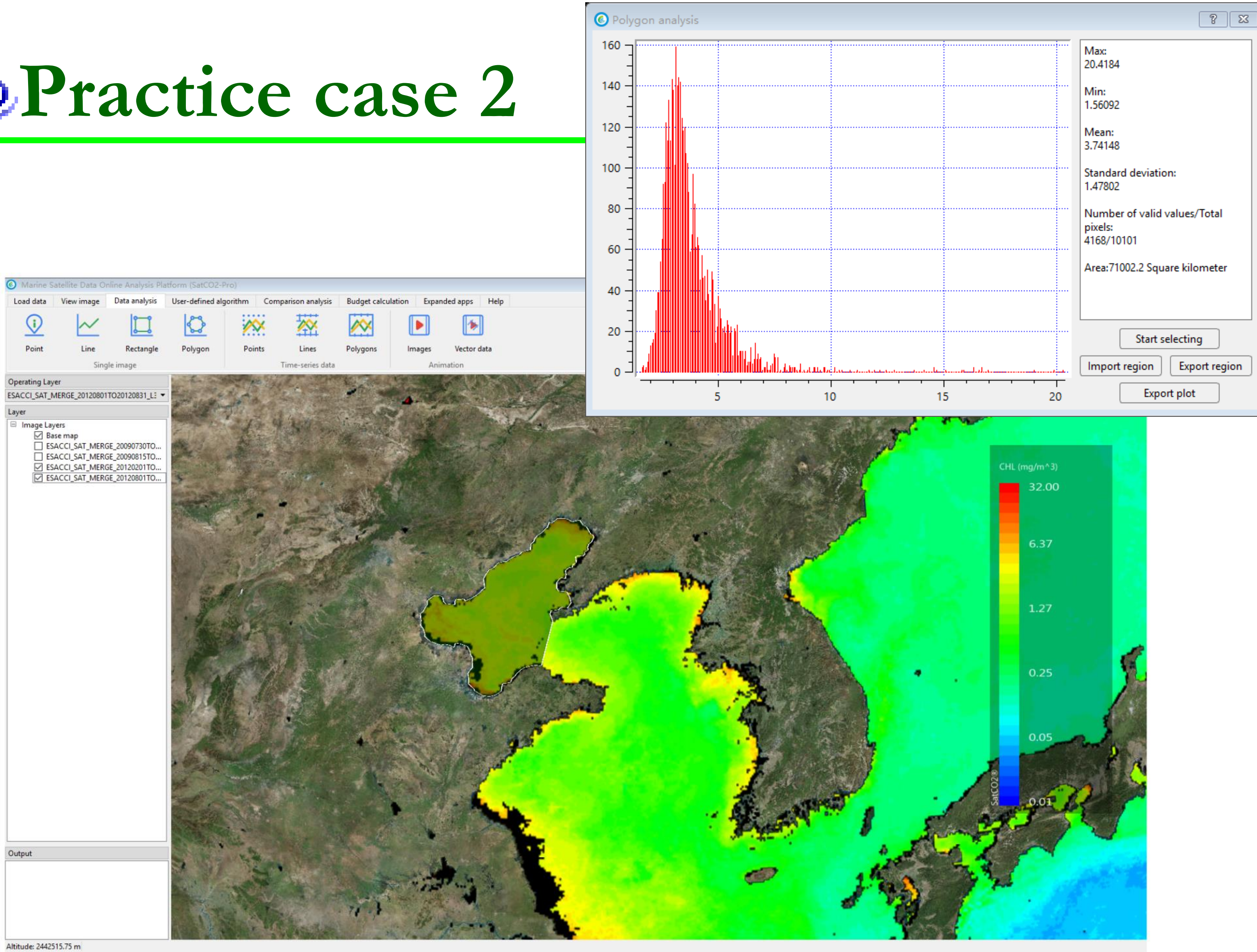
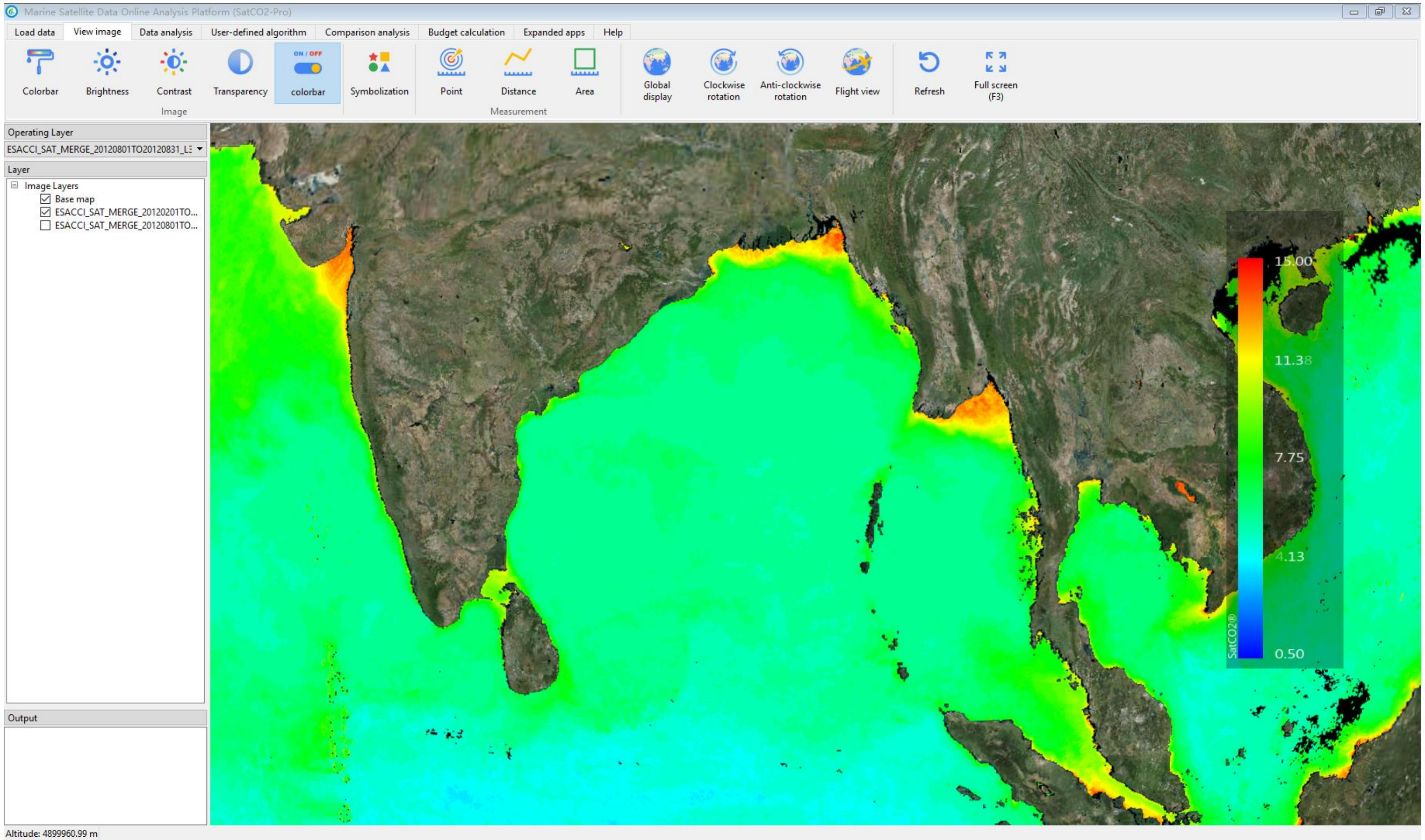


Practice case 3



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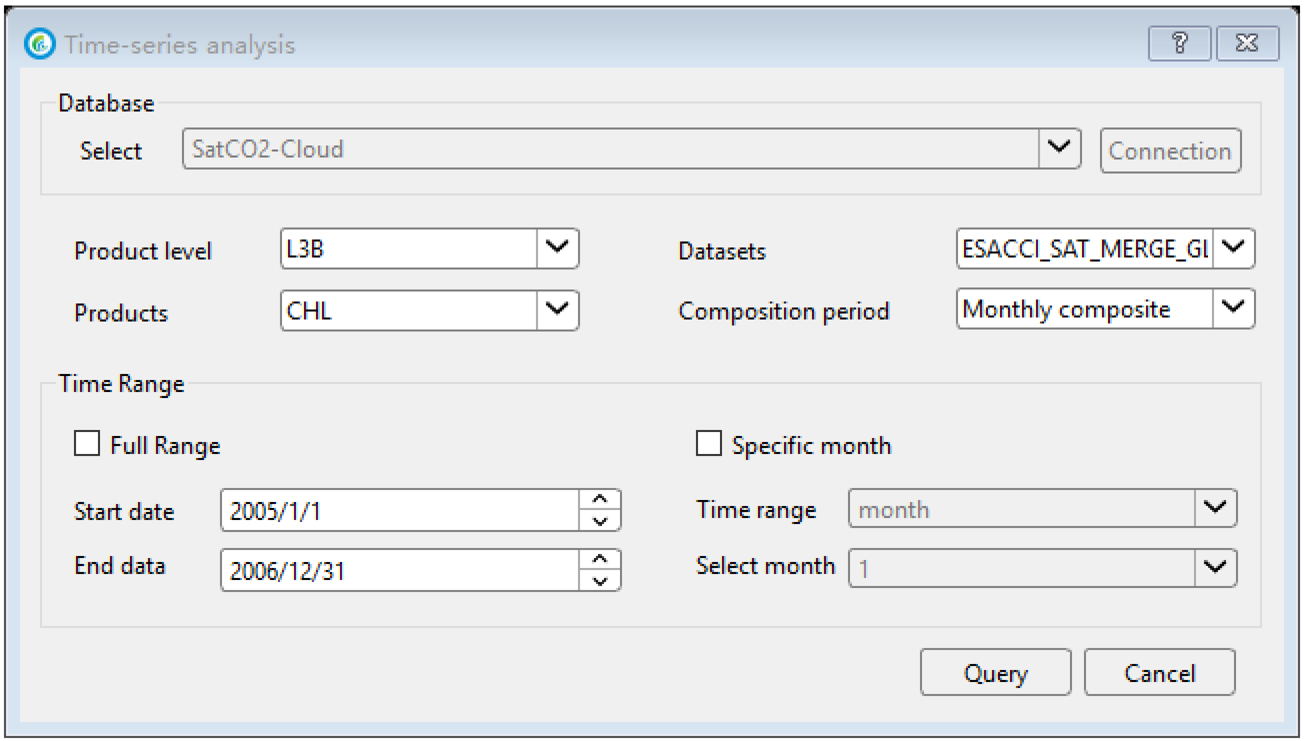

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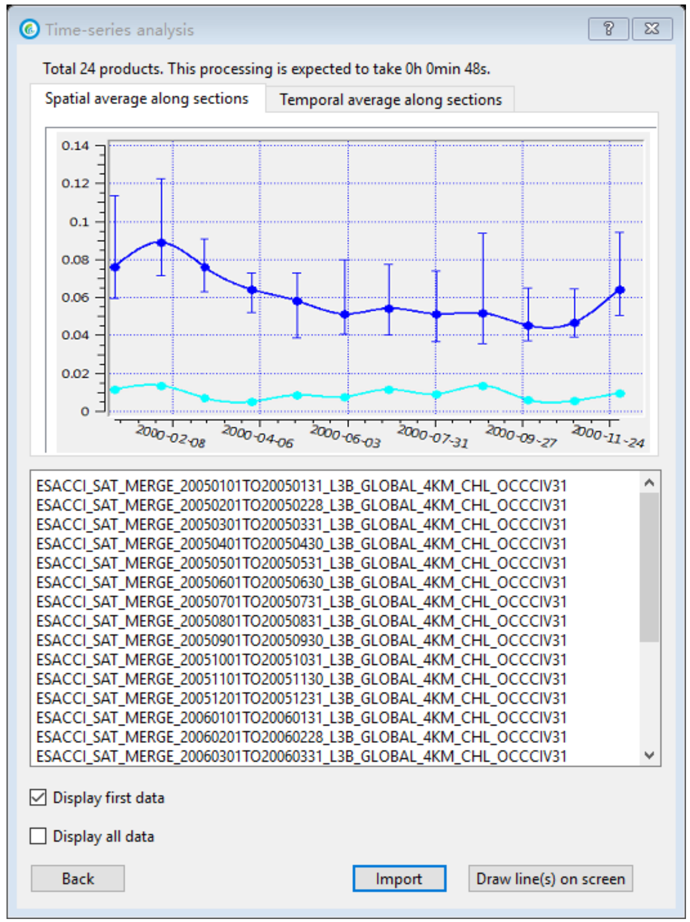

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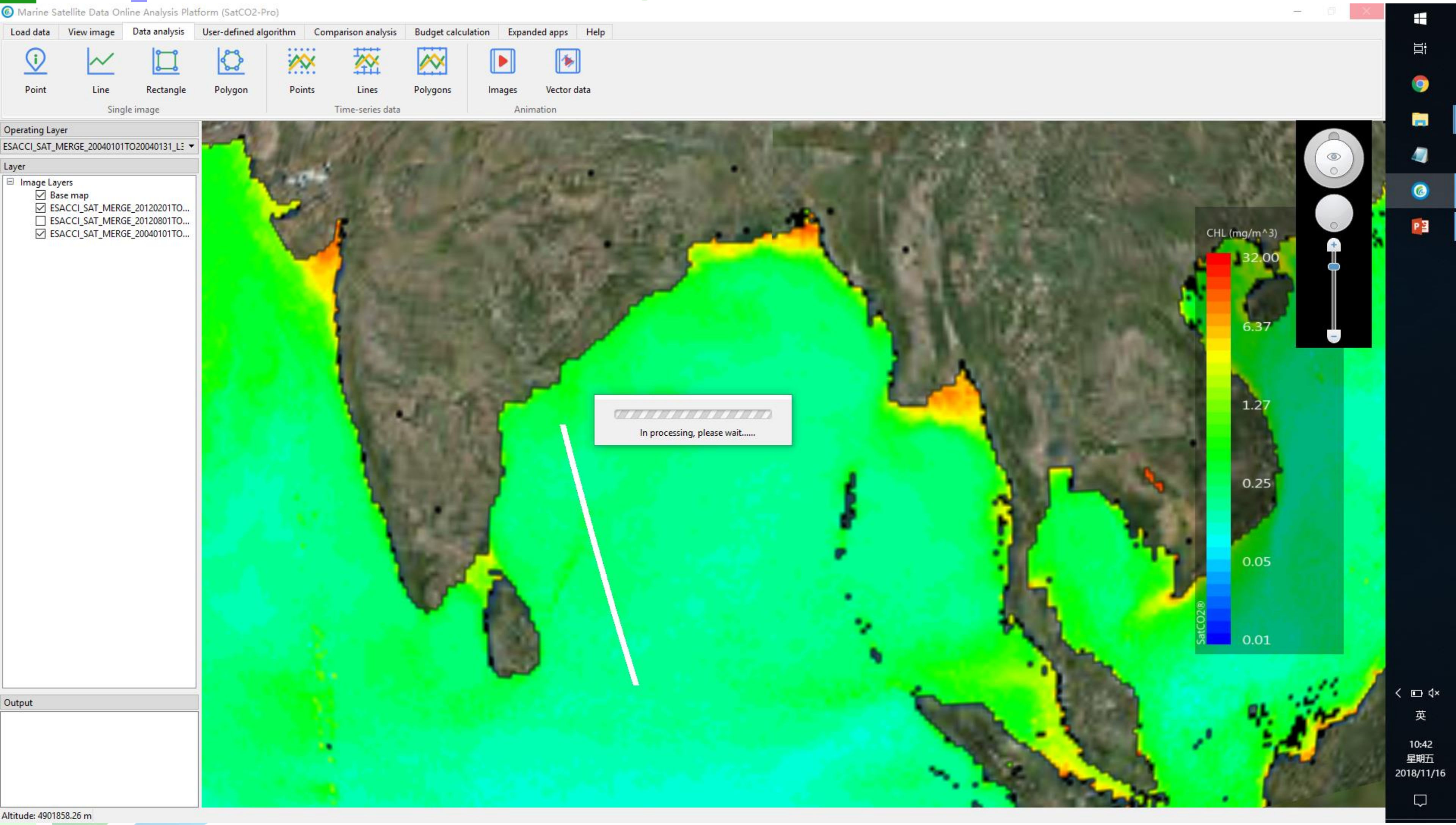

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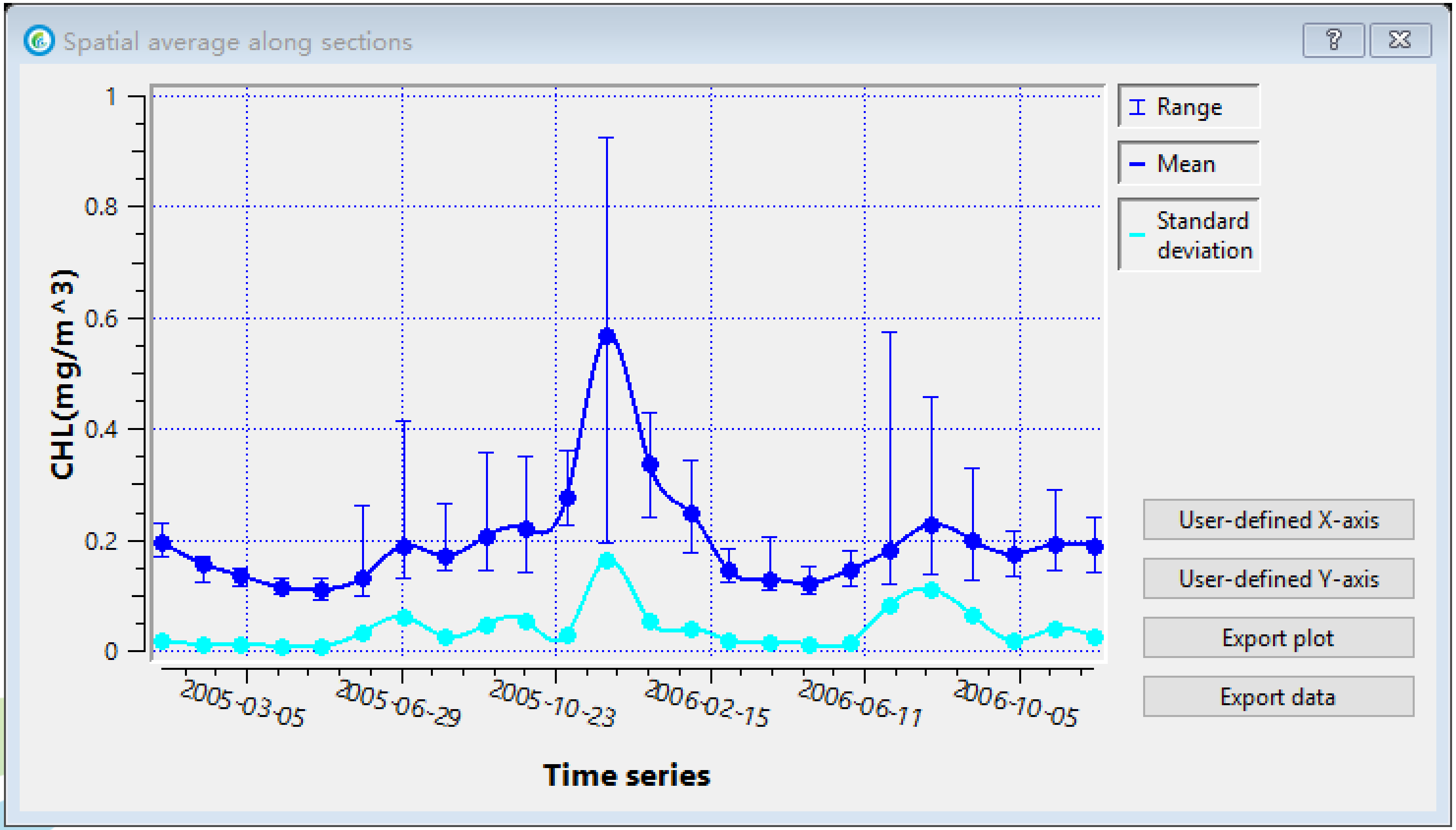
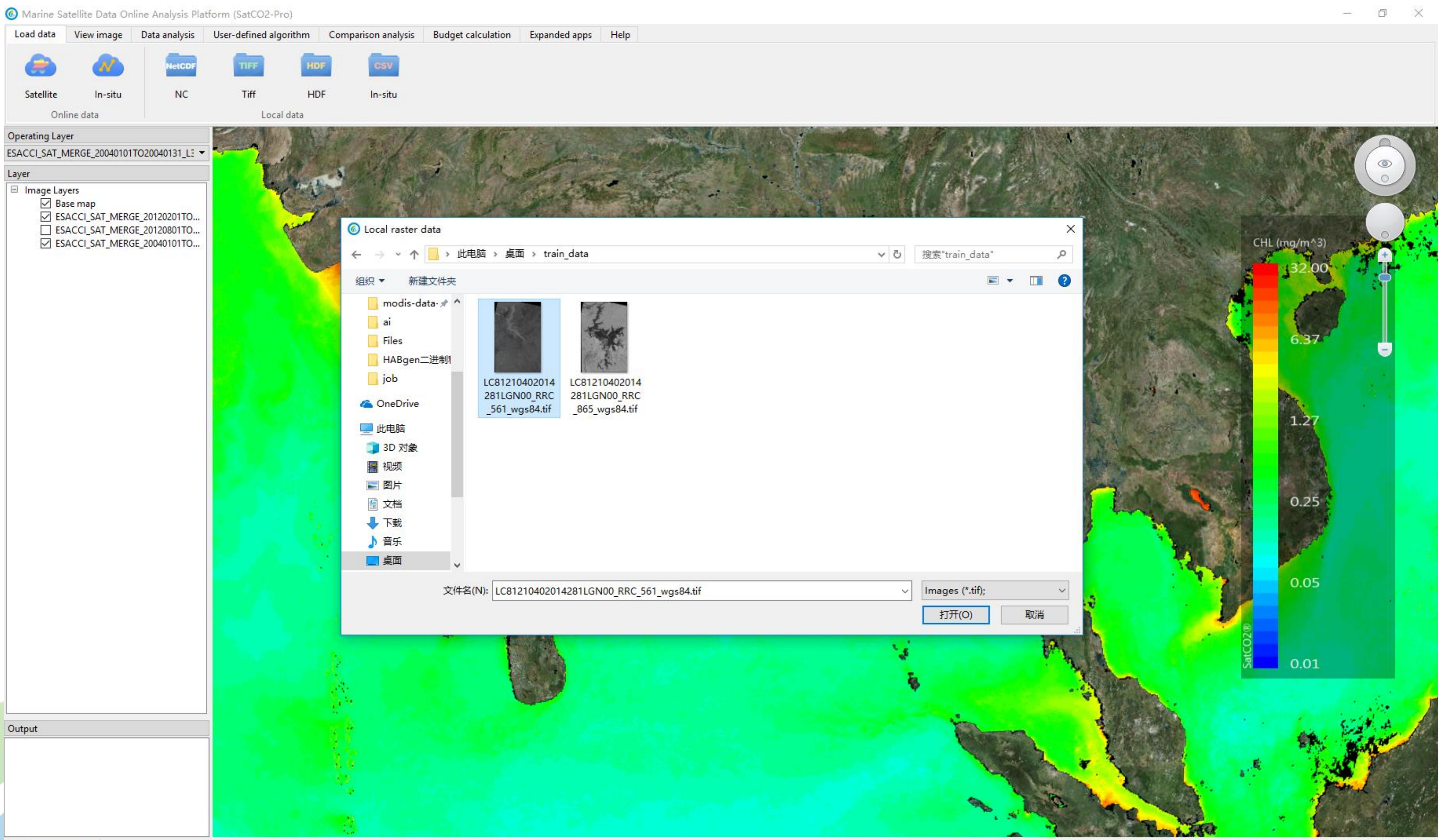
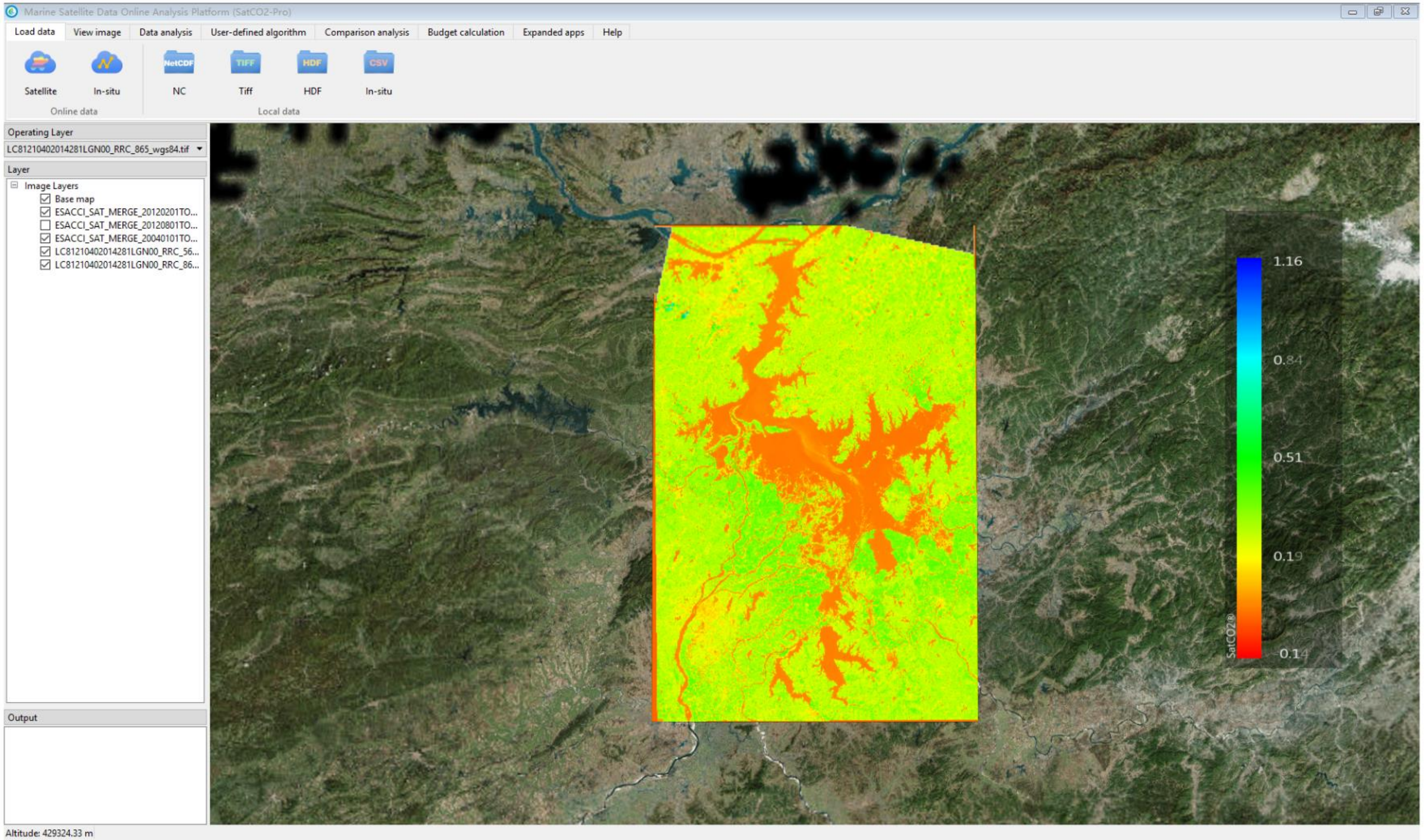


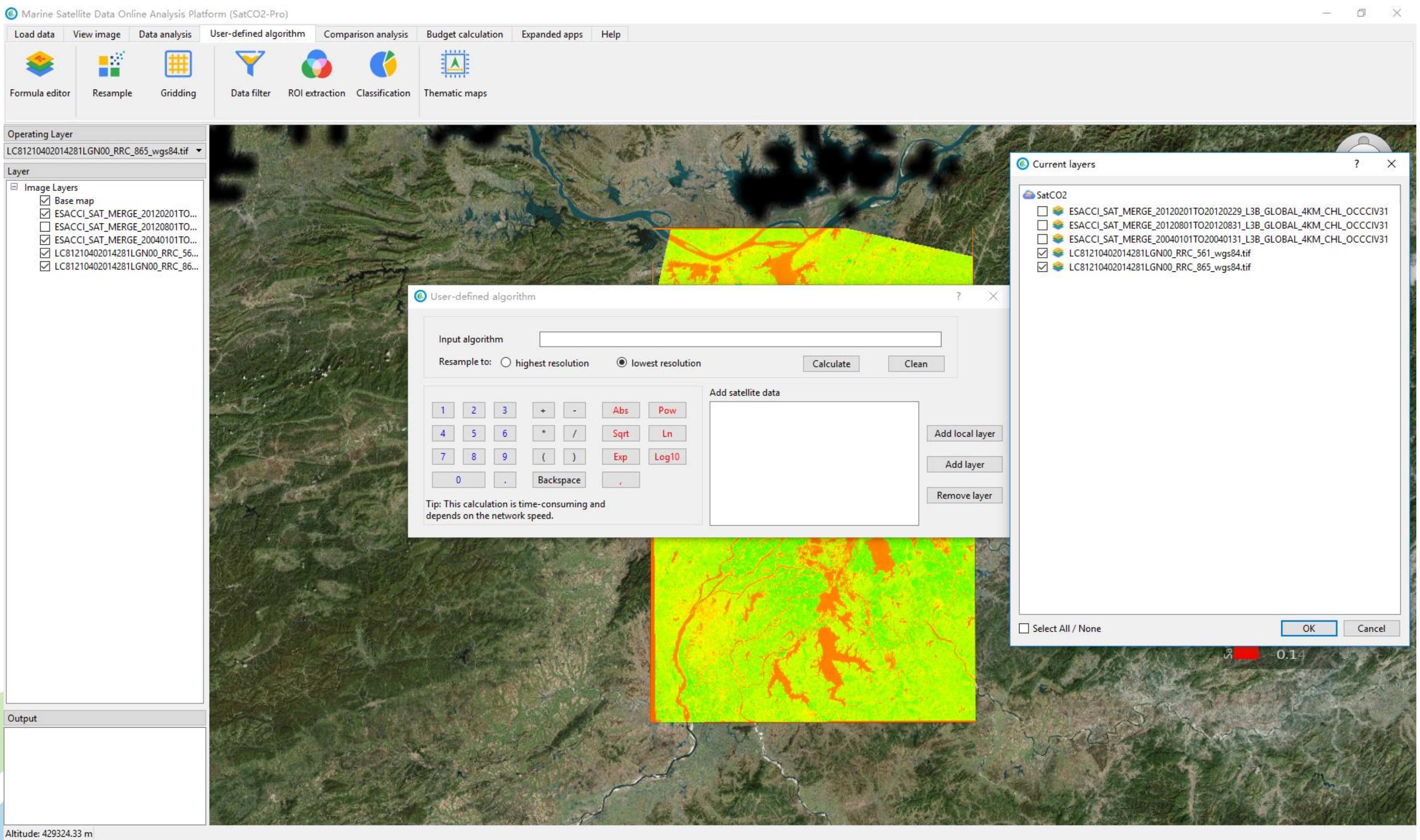
Practice case 4



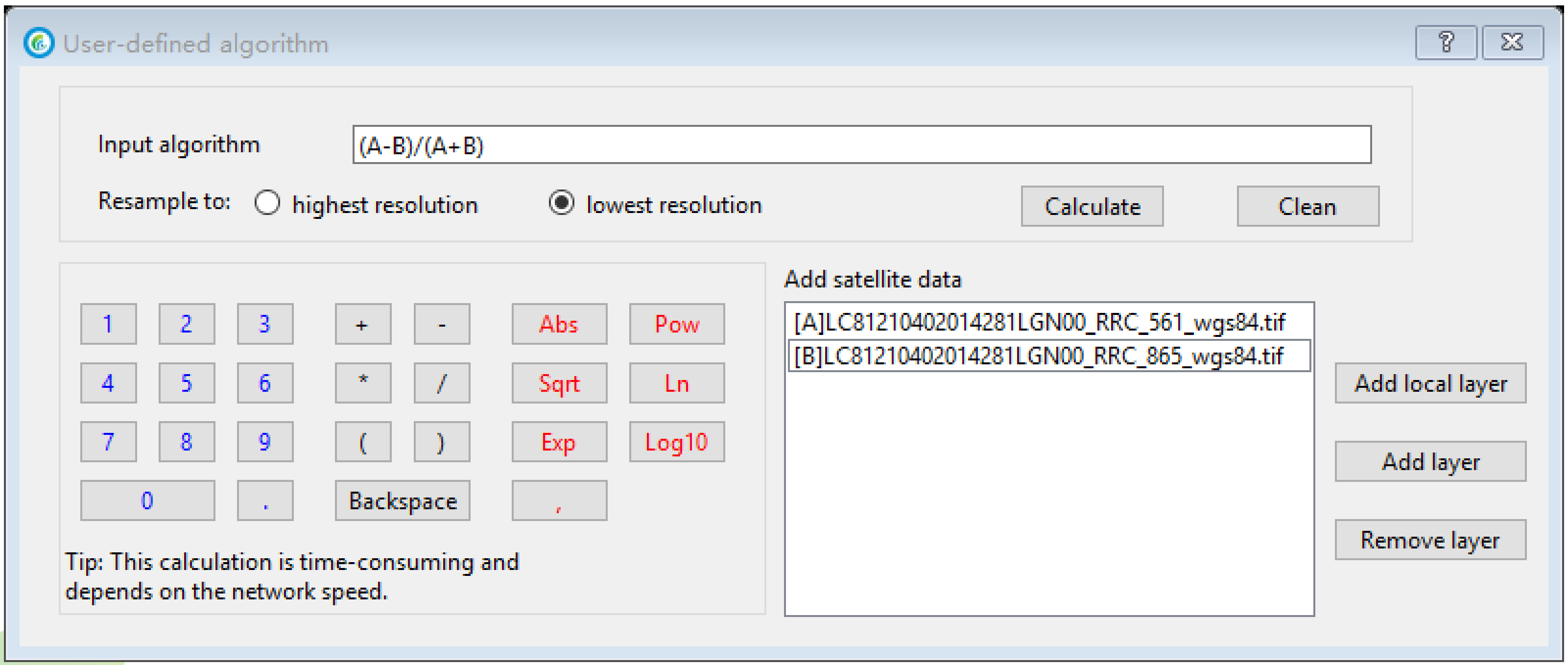
Practice case 4



Practice case 4



Practice case 4



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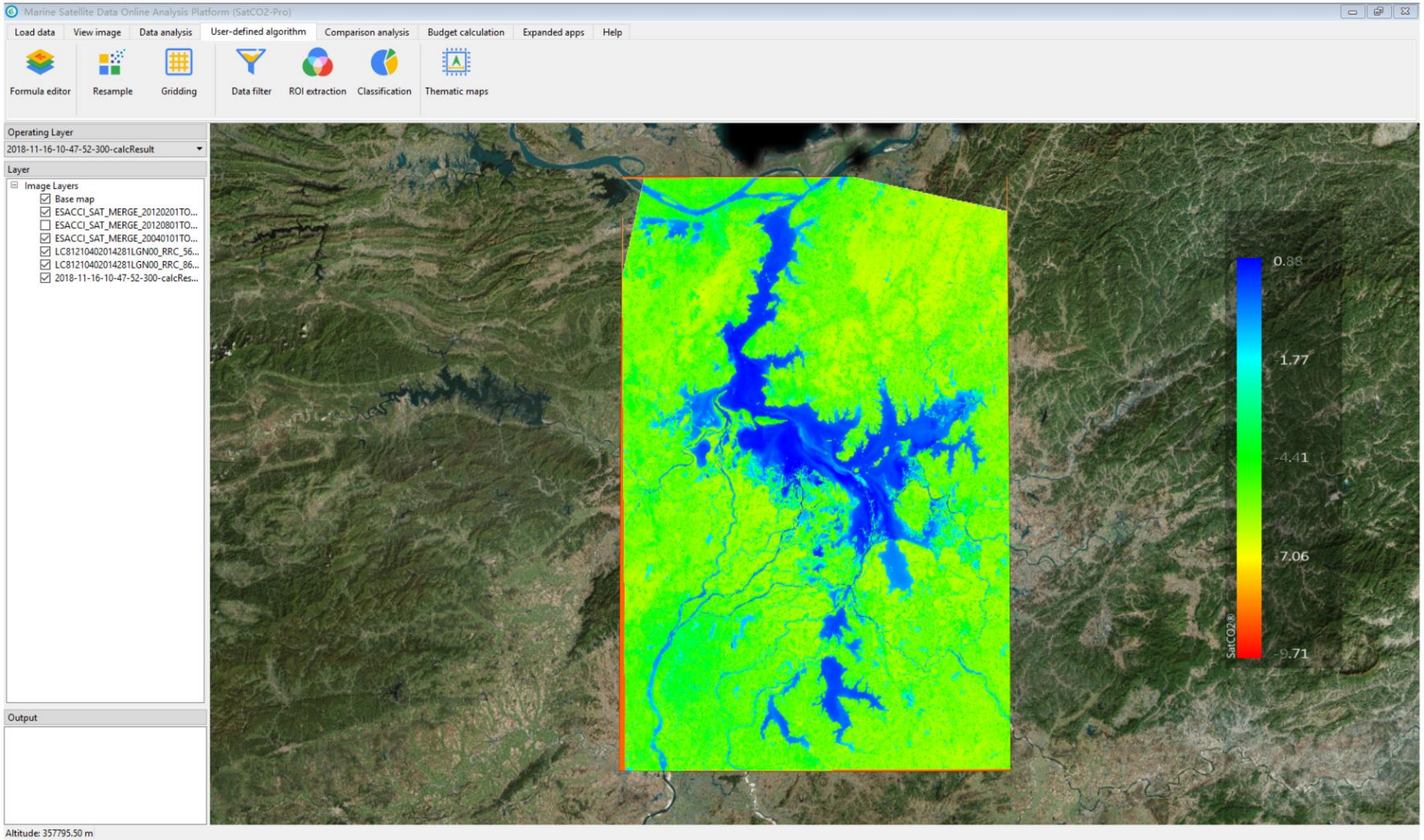

Practice case 5

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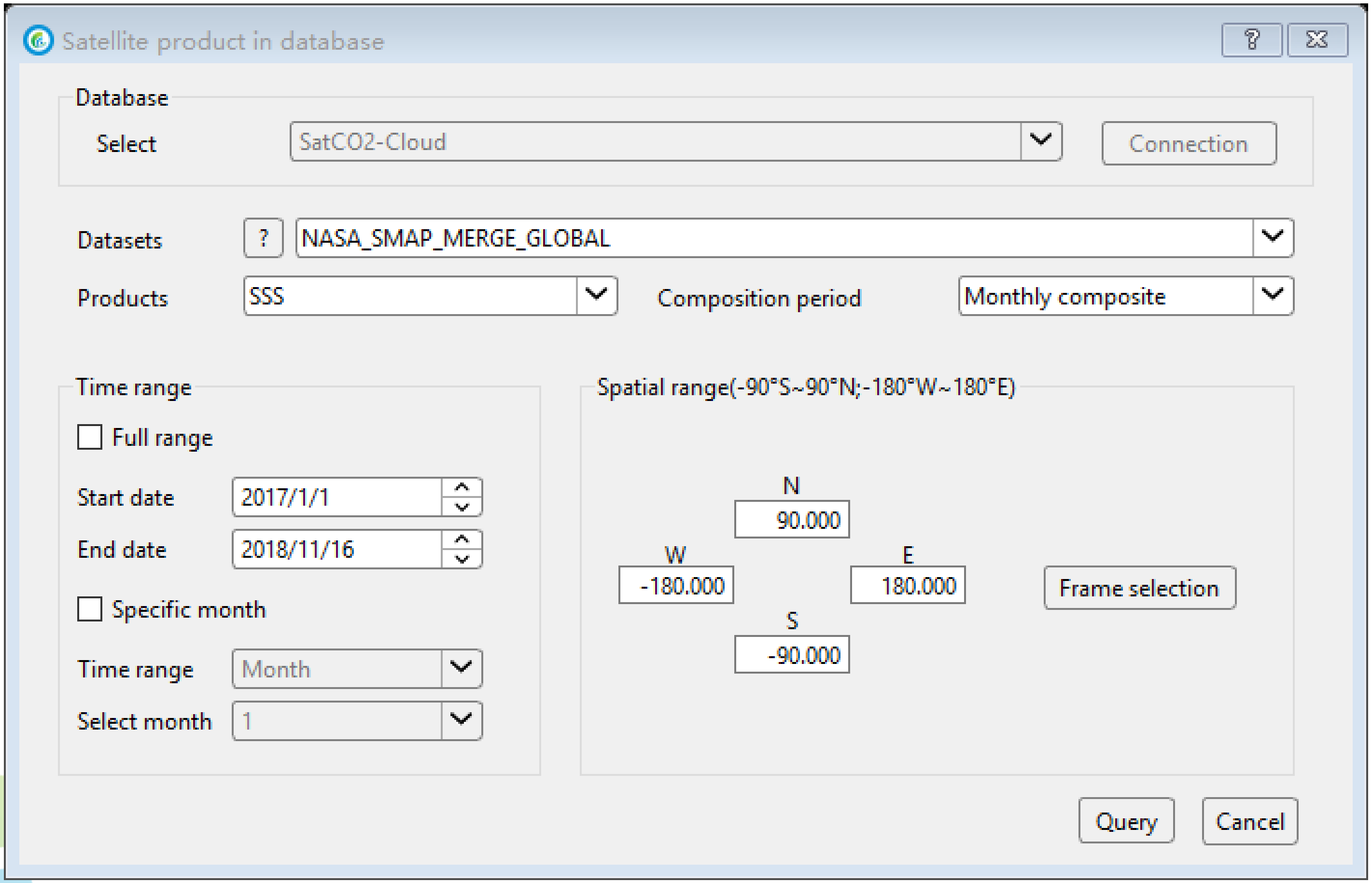
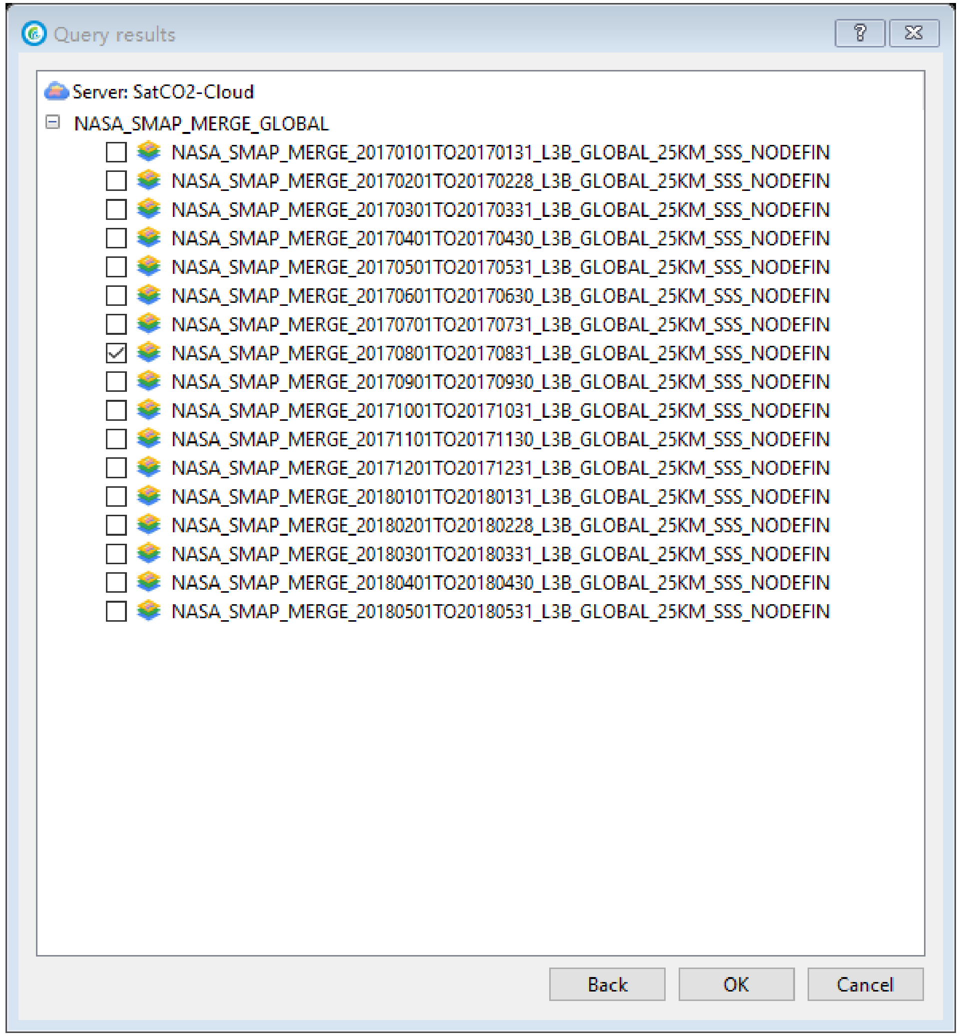


Practice case 5



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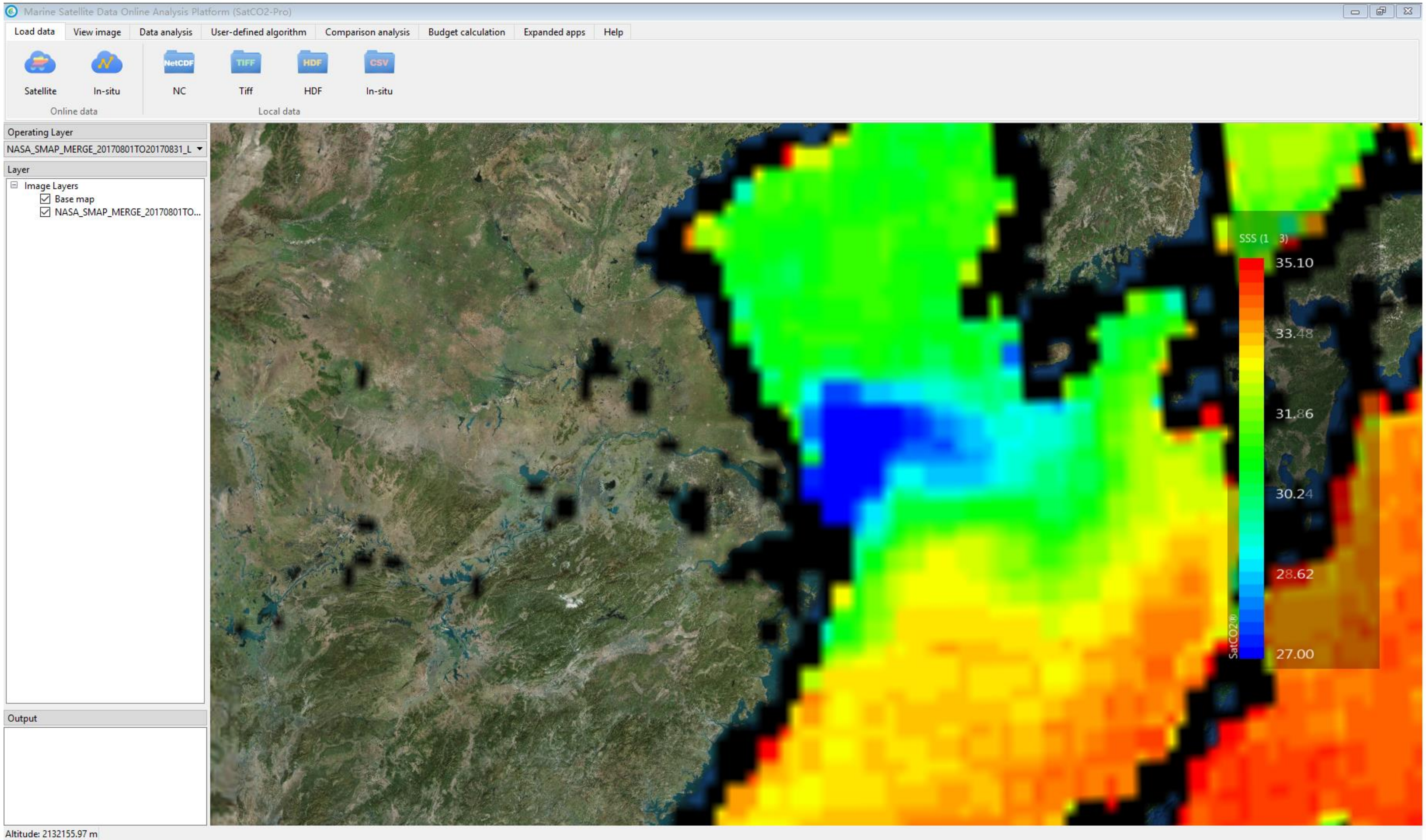
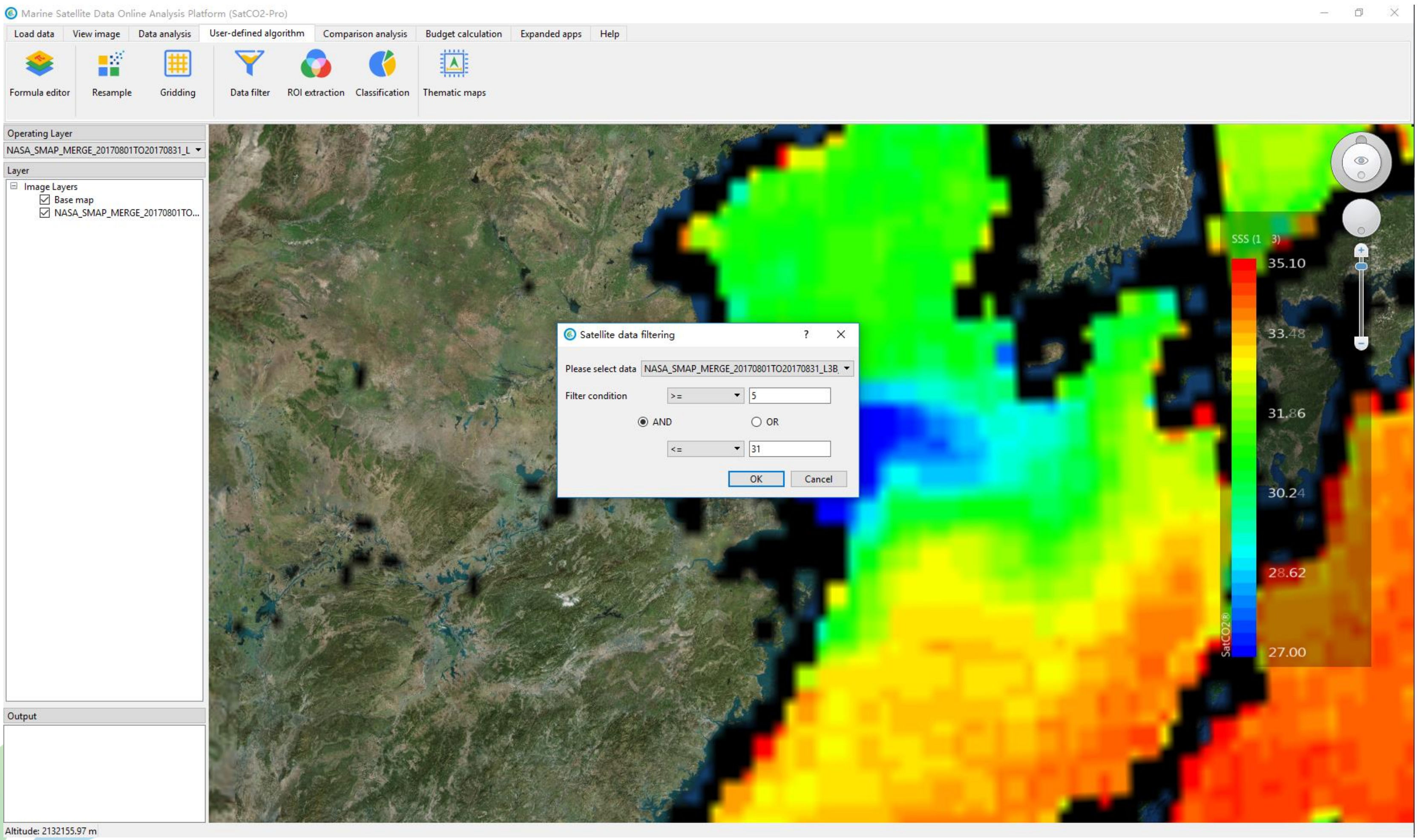
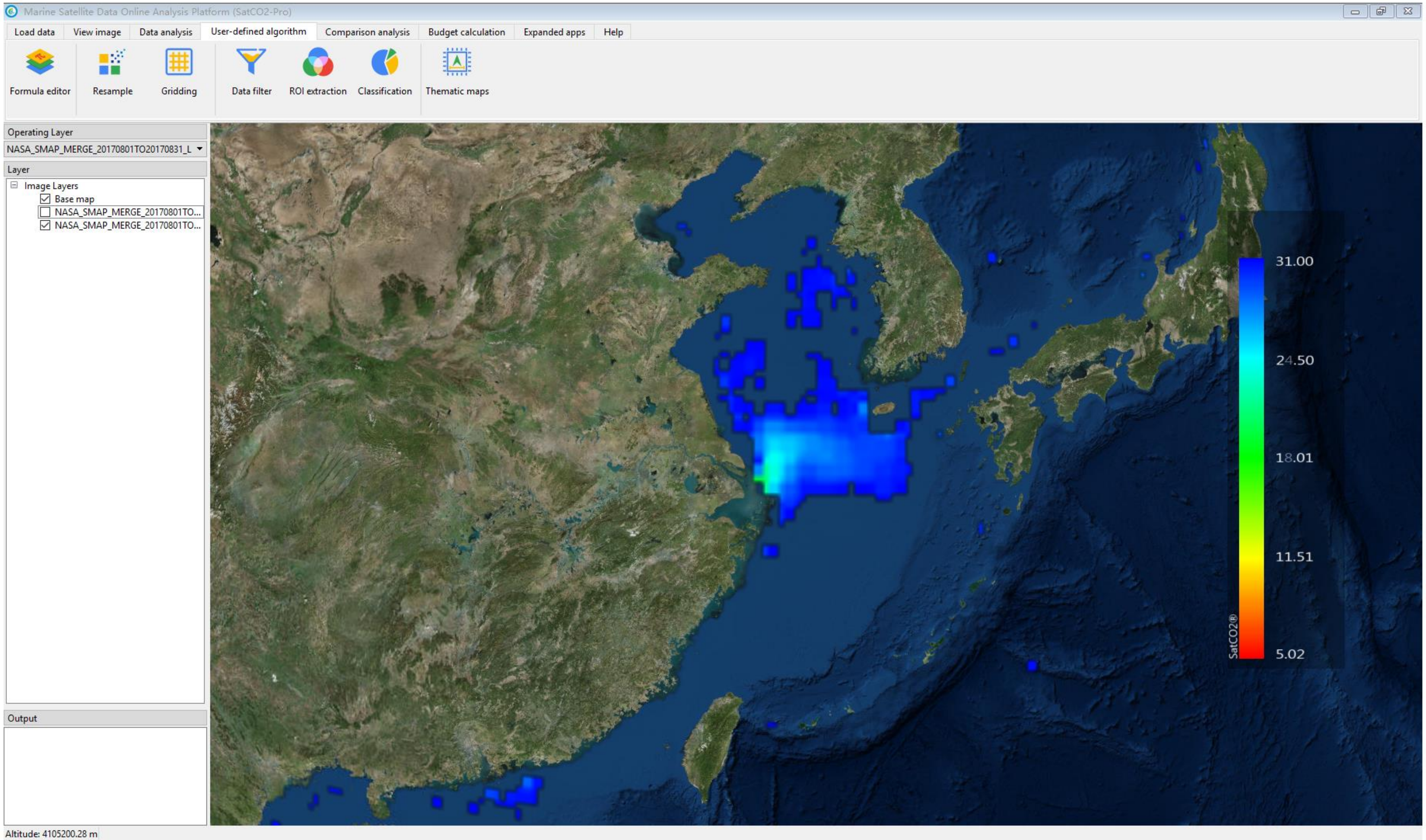


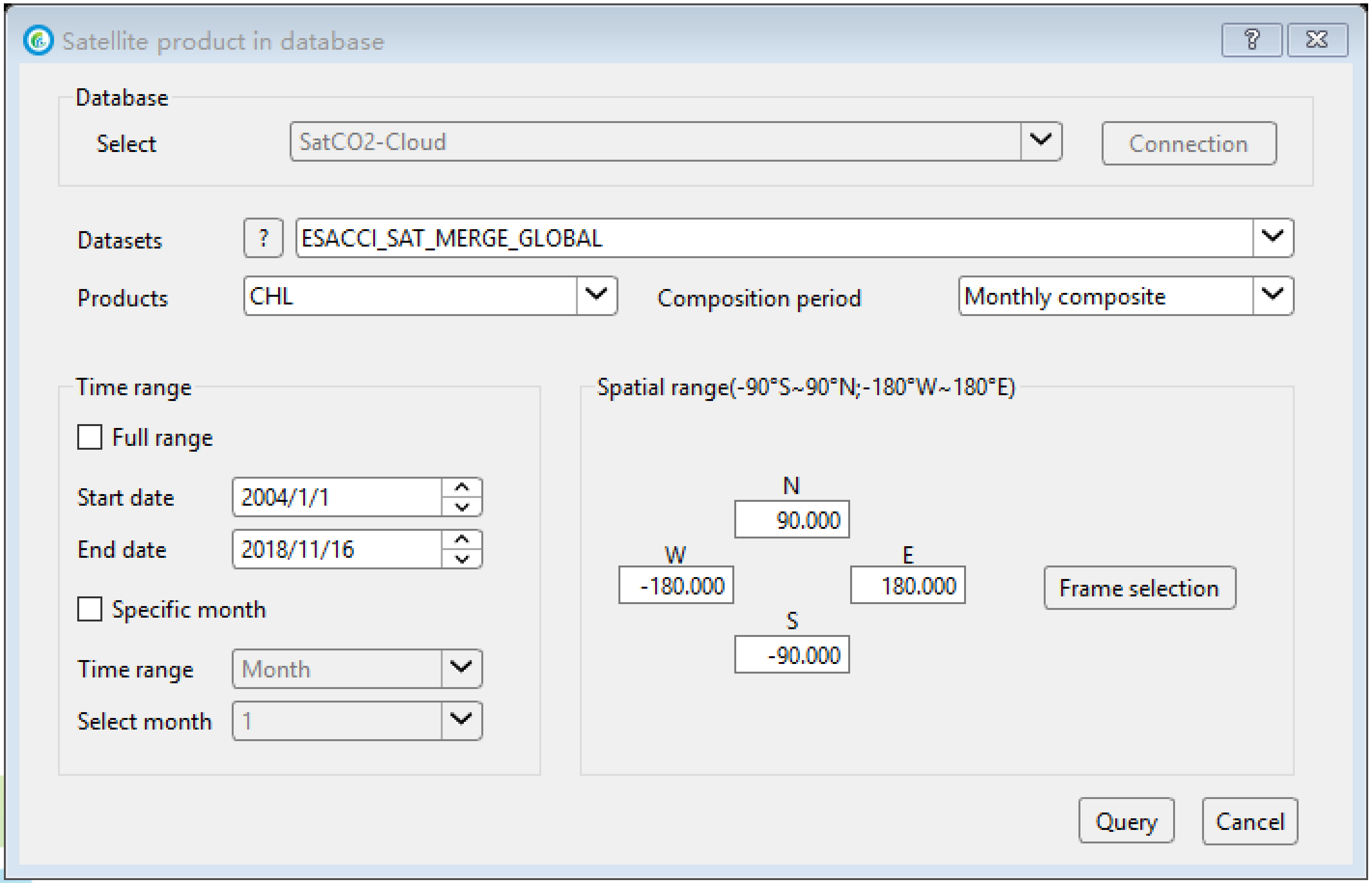
Practice case 5



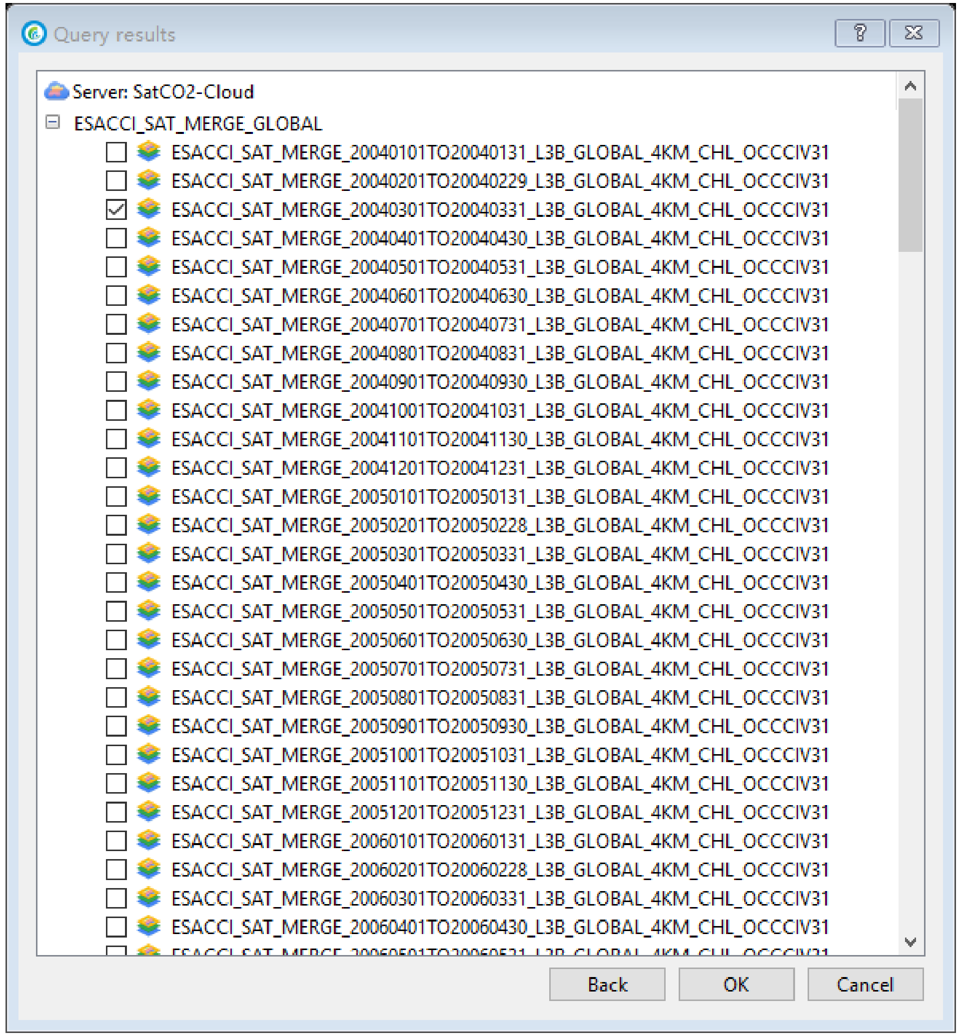
Practice case 5



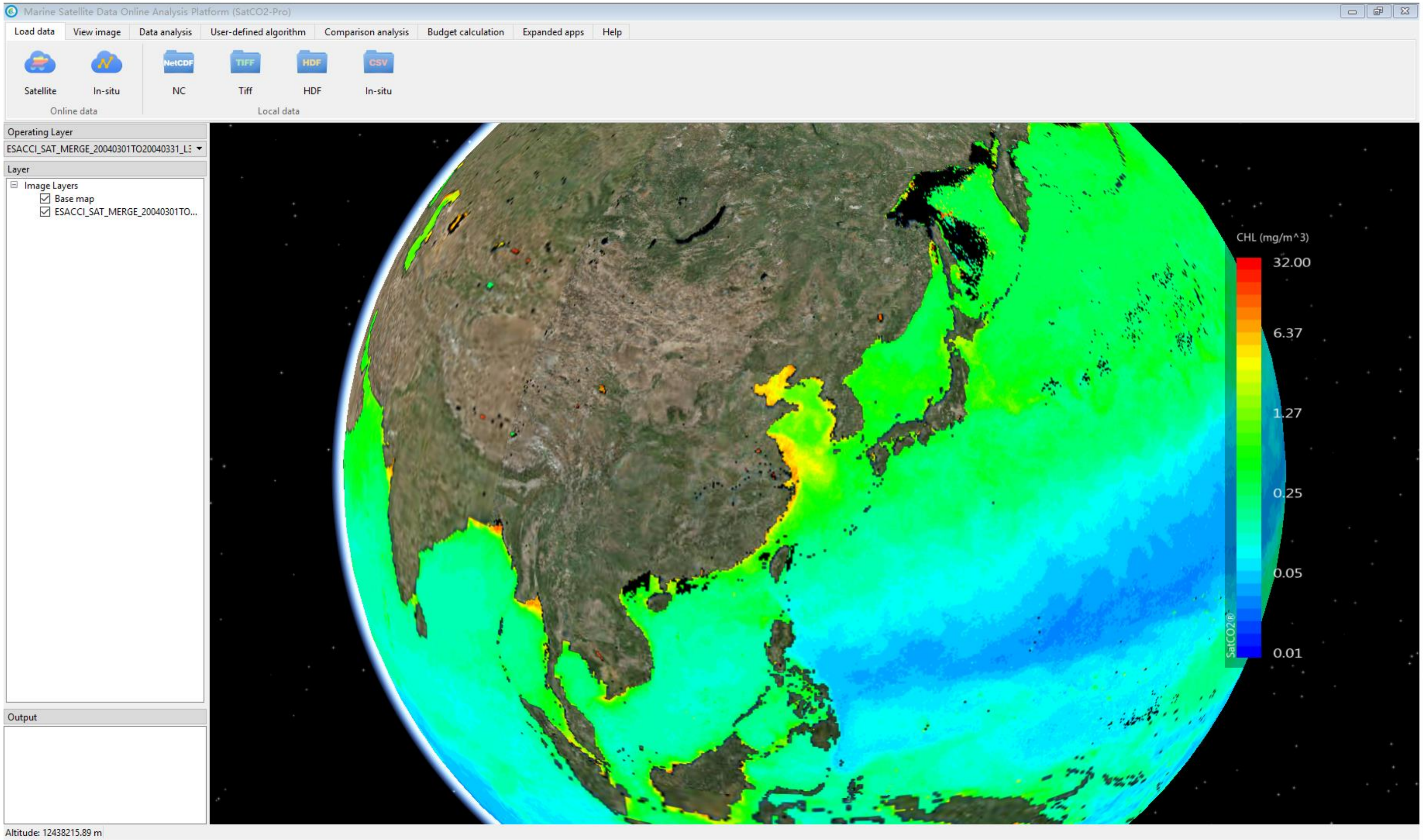
Practice case 6



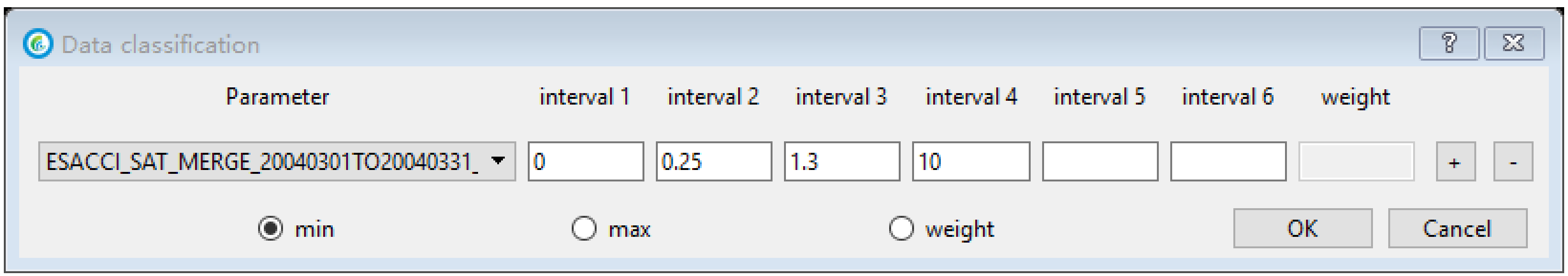
Practice case 6



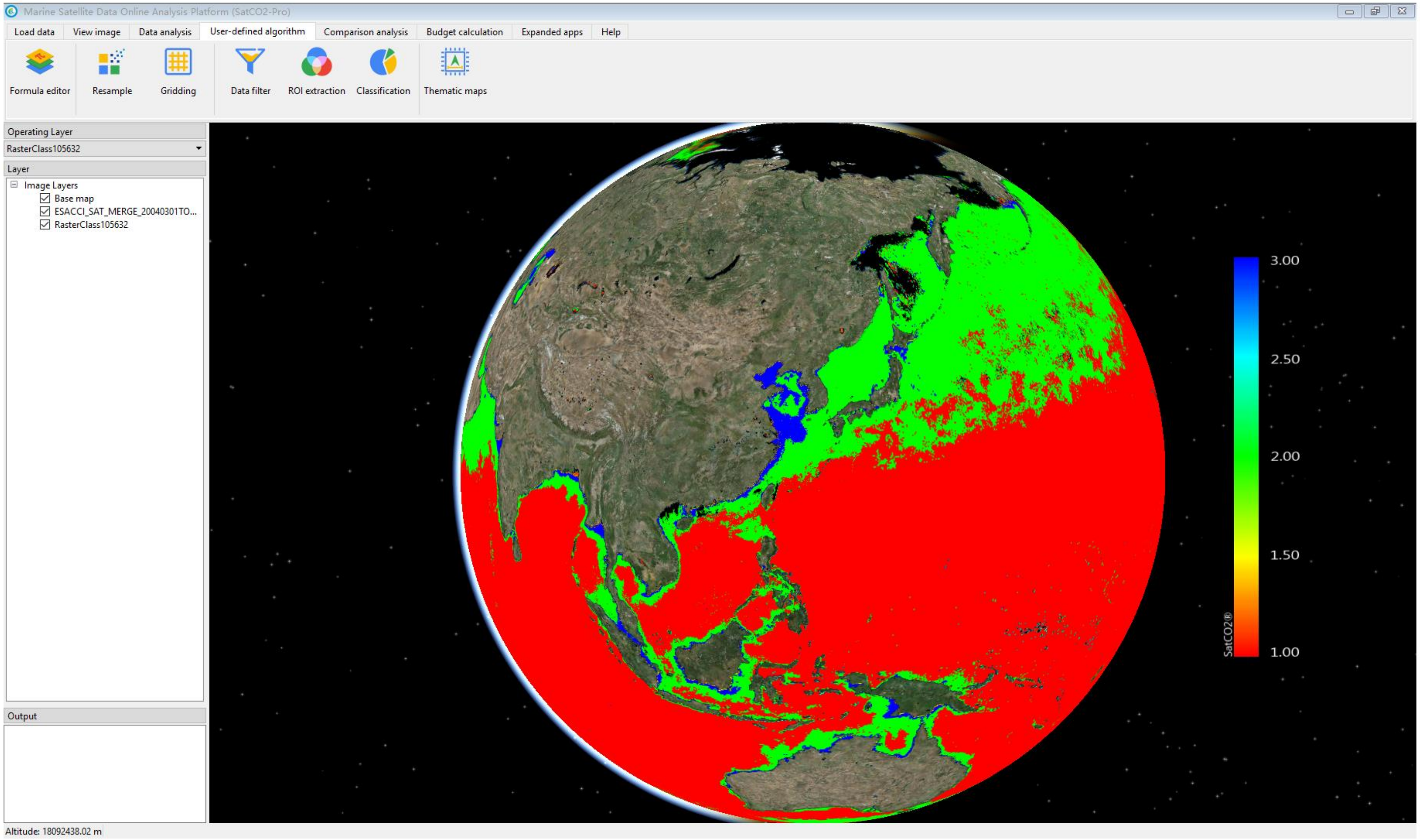
Practice case 6



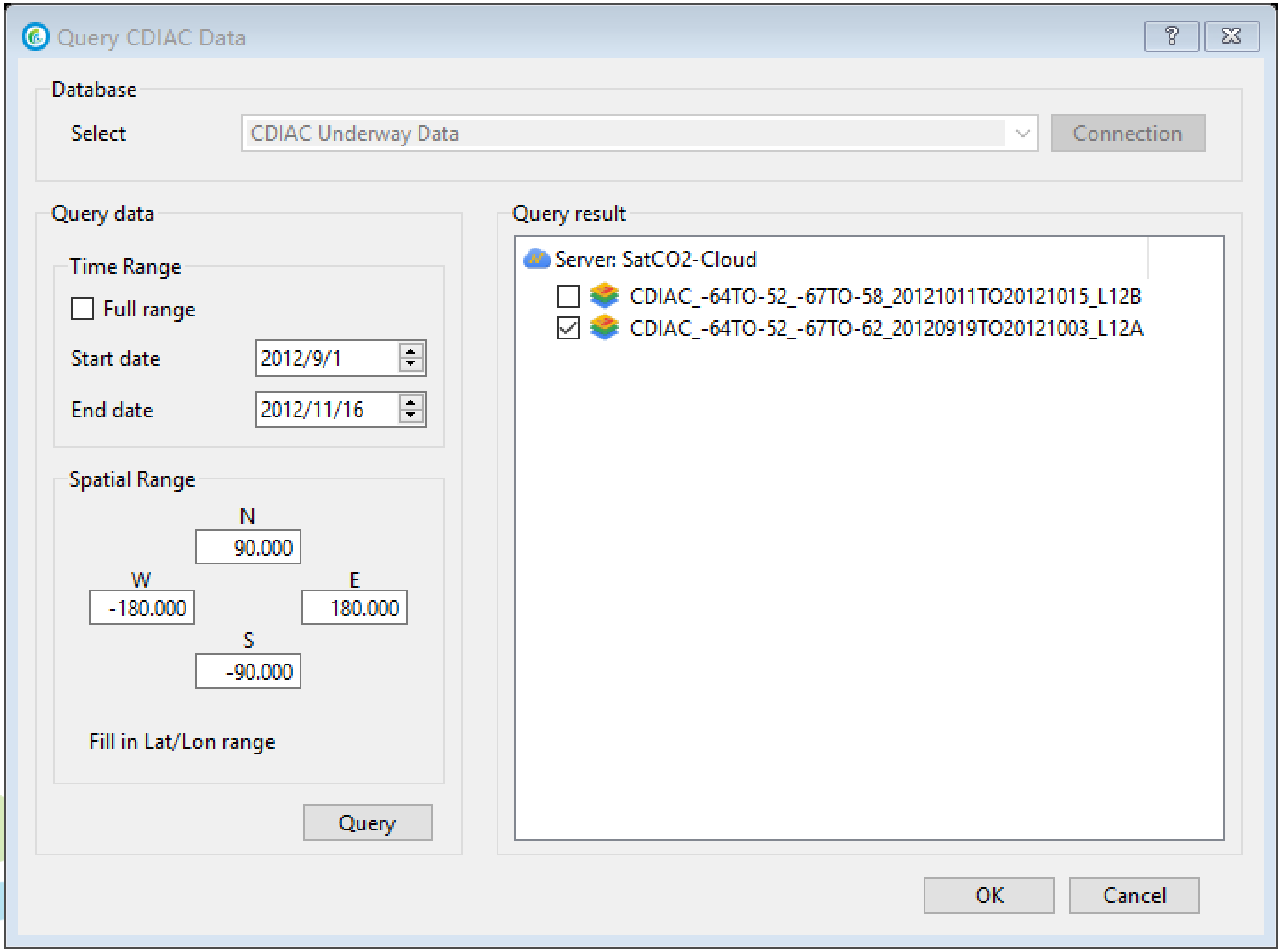
Practice case 6



Practice case 6



Practice case 7



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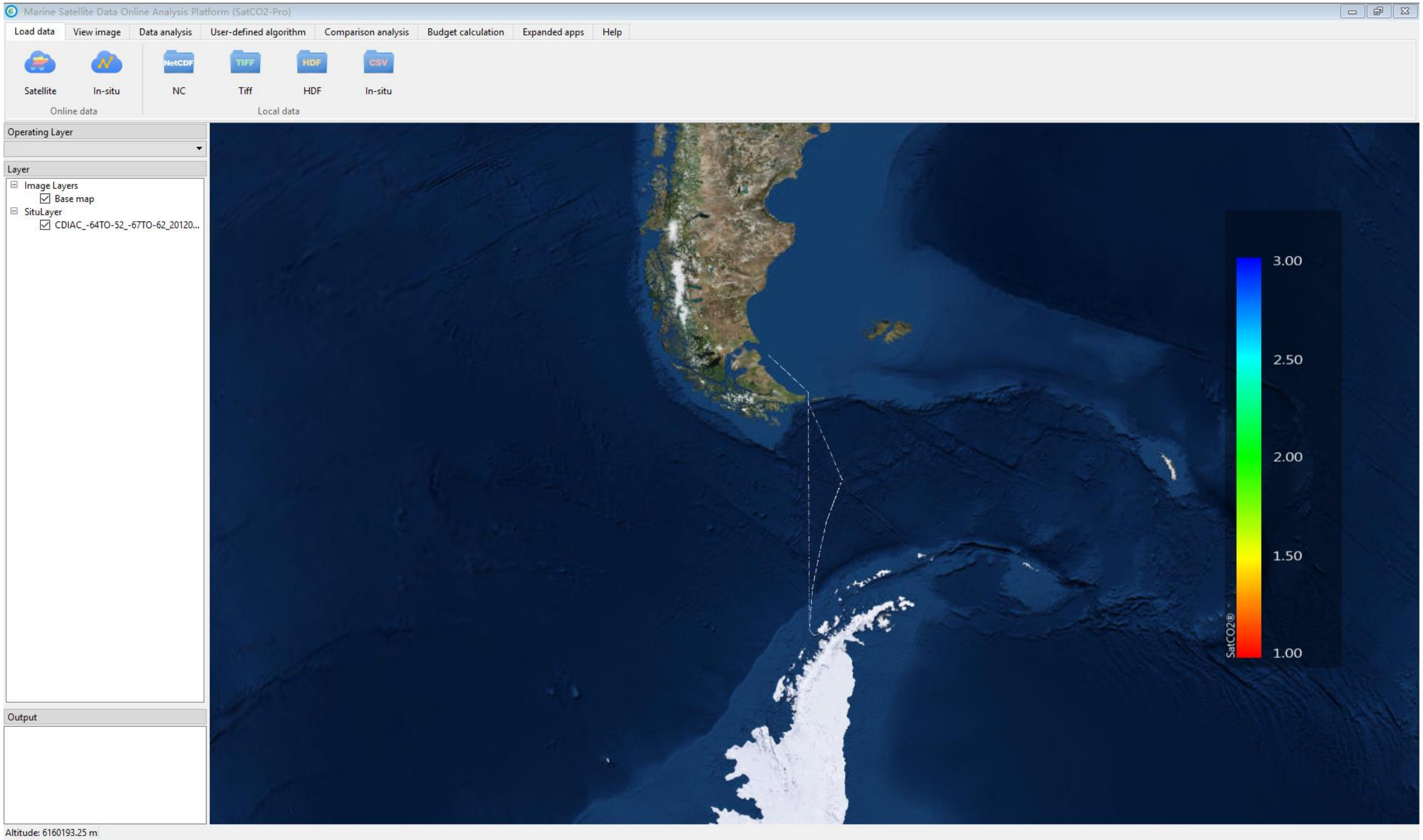
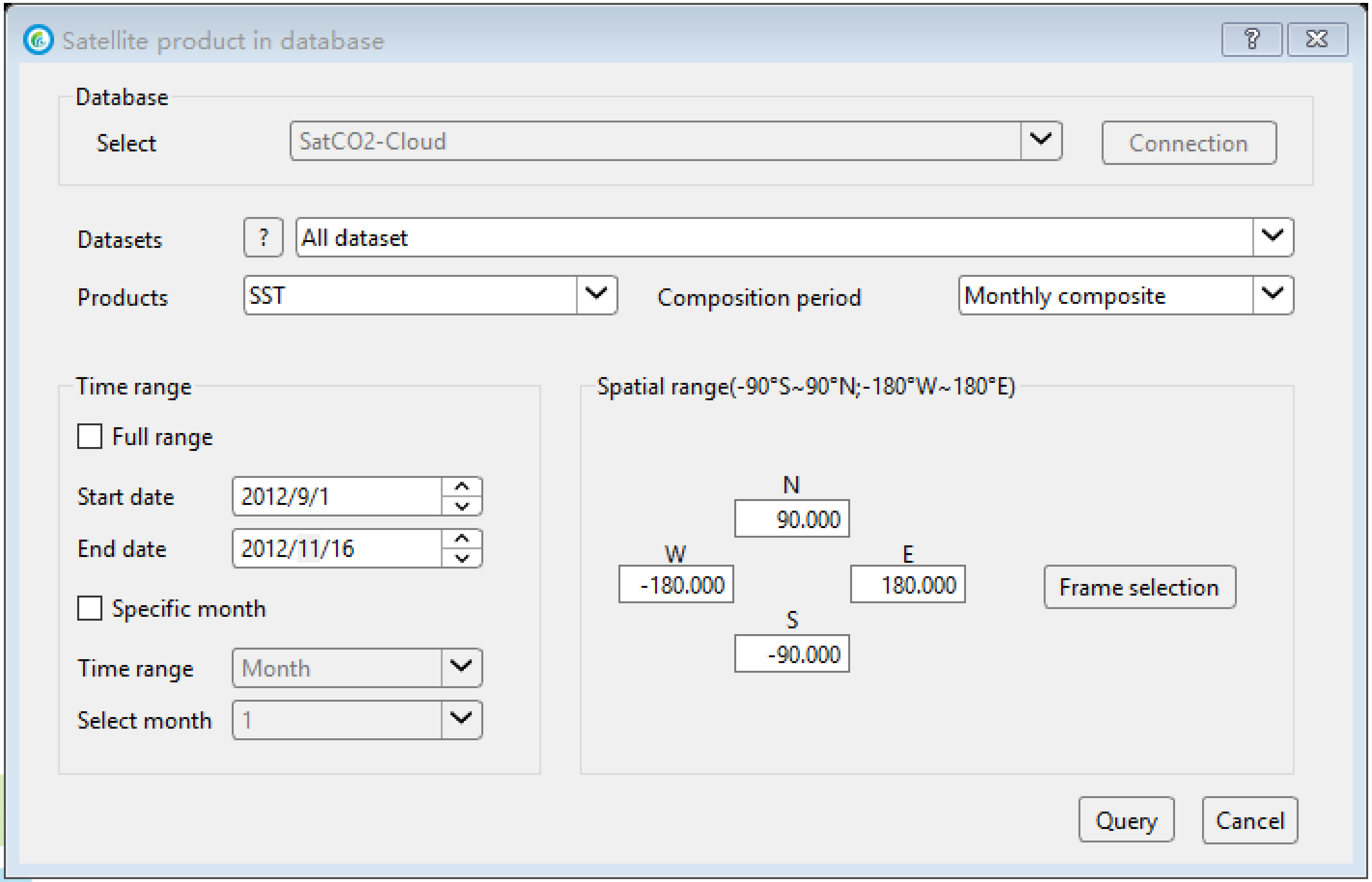
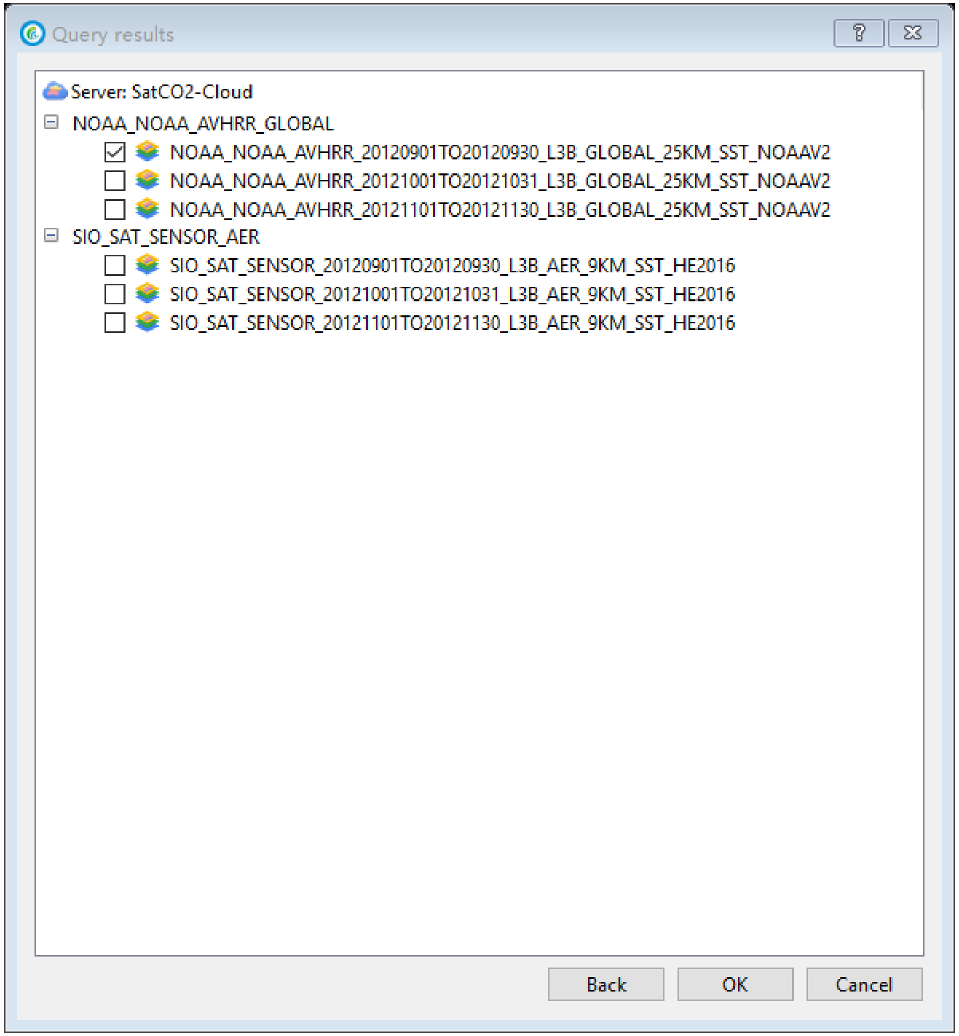


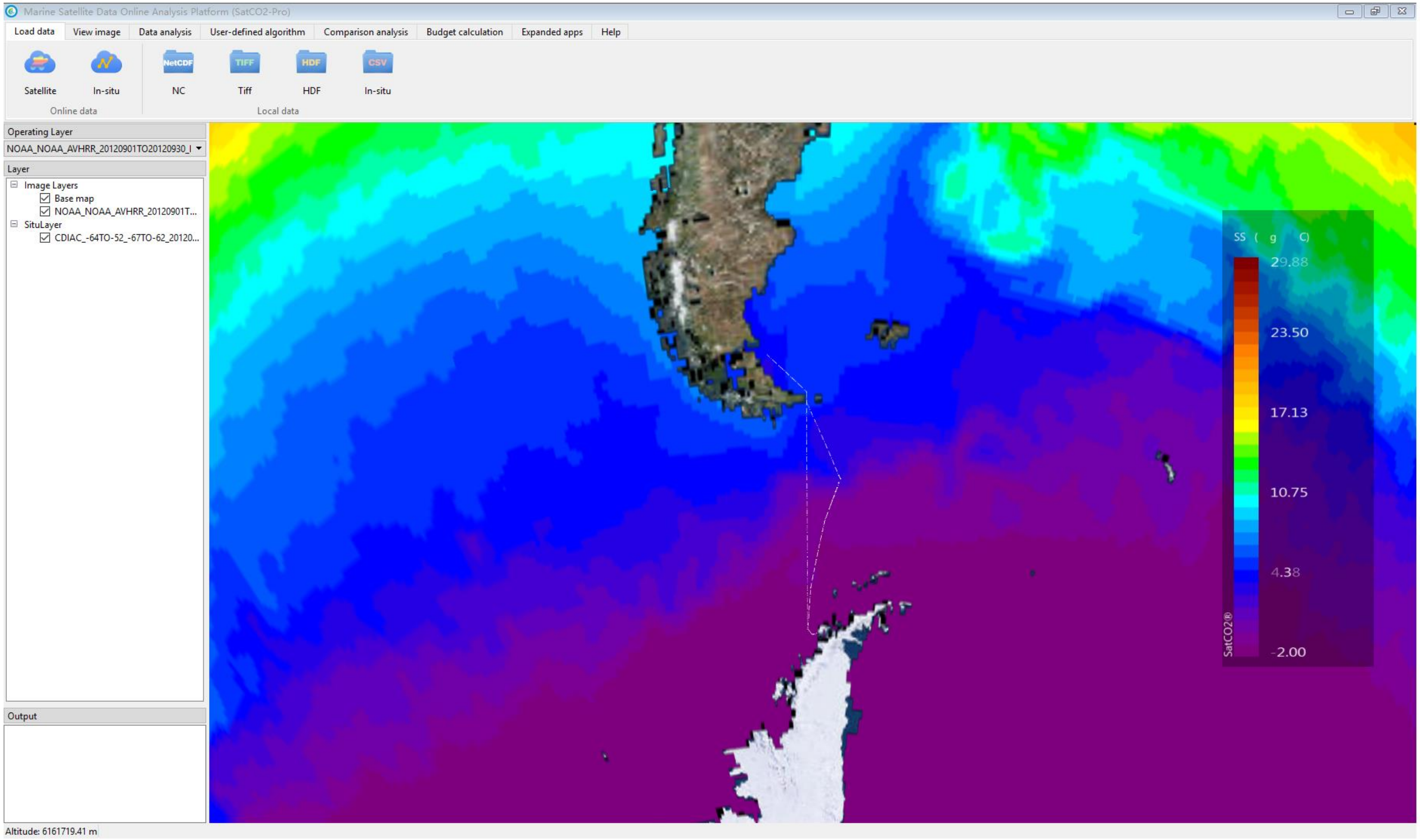
Practice case 7



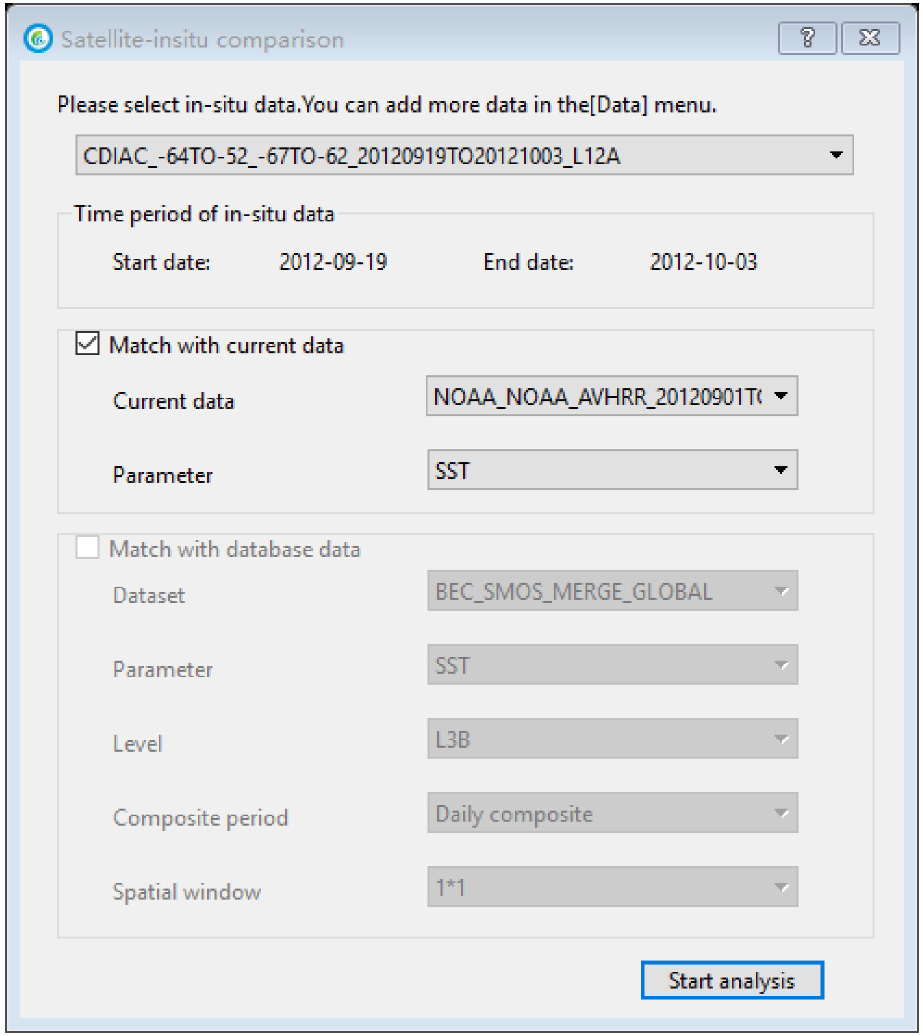
Practice case 7



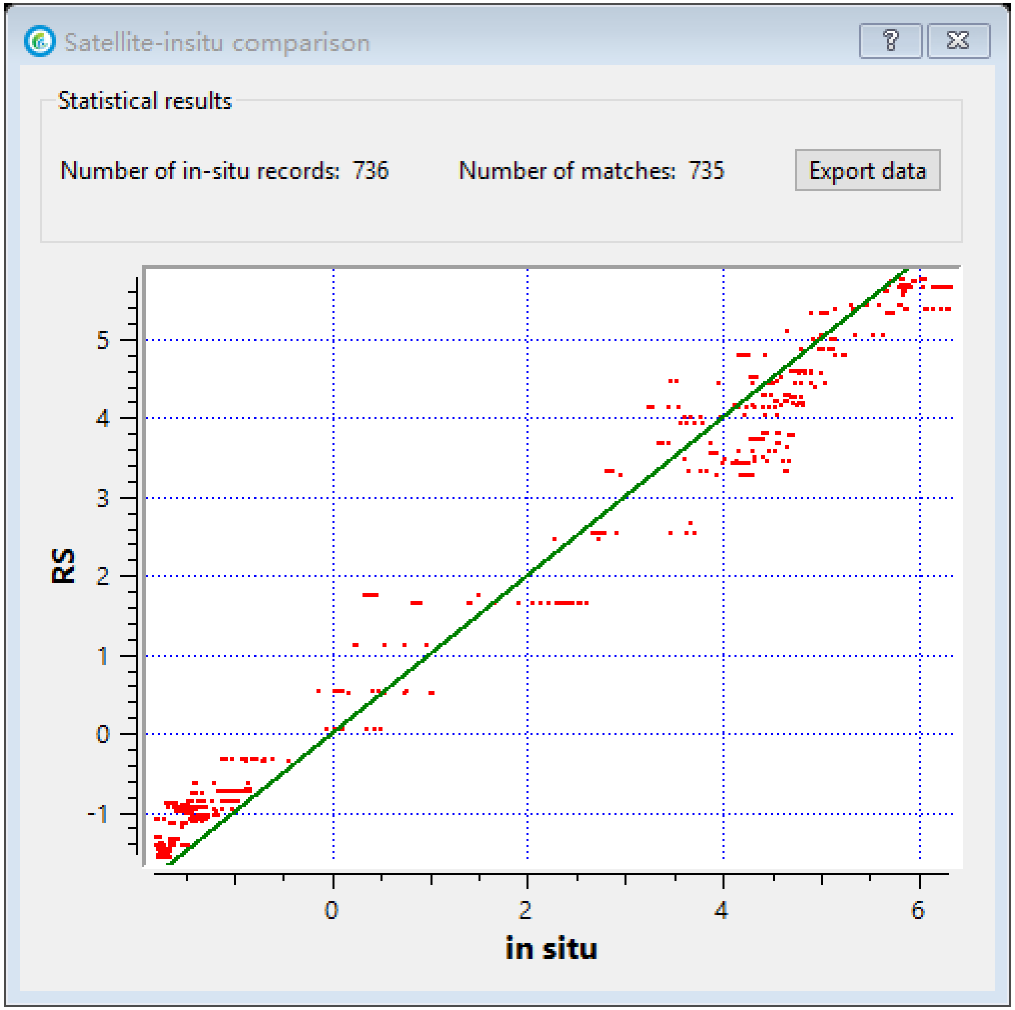
Practice case 7



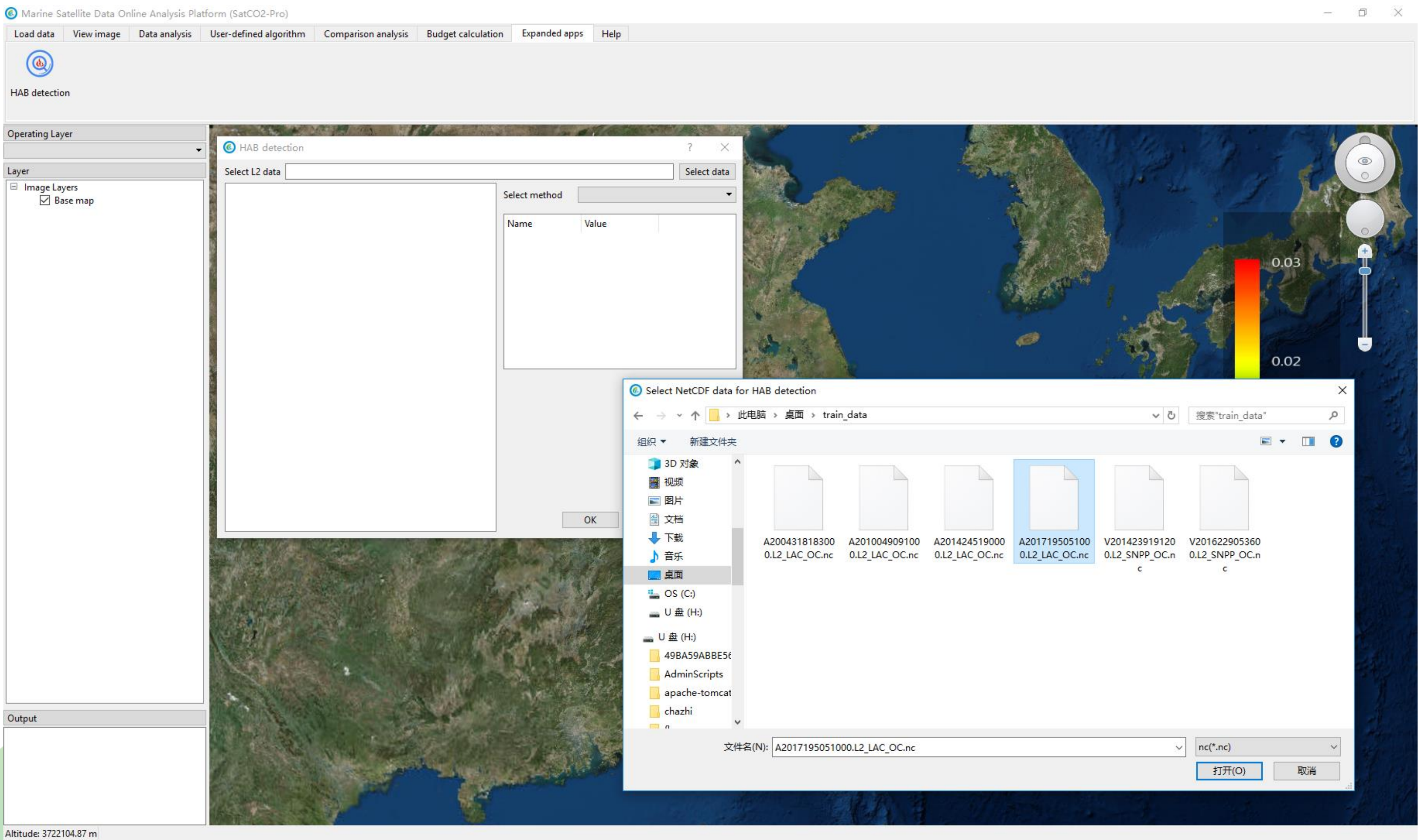
Practice case 7



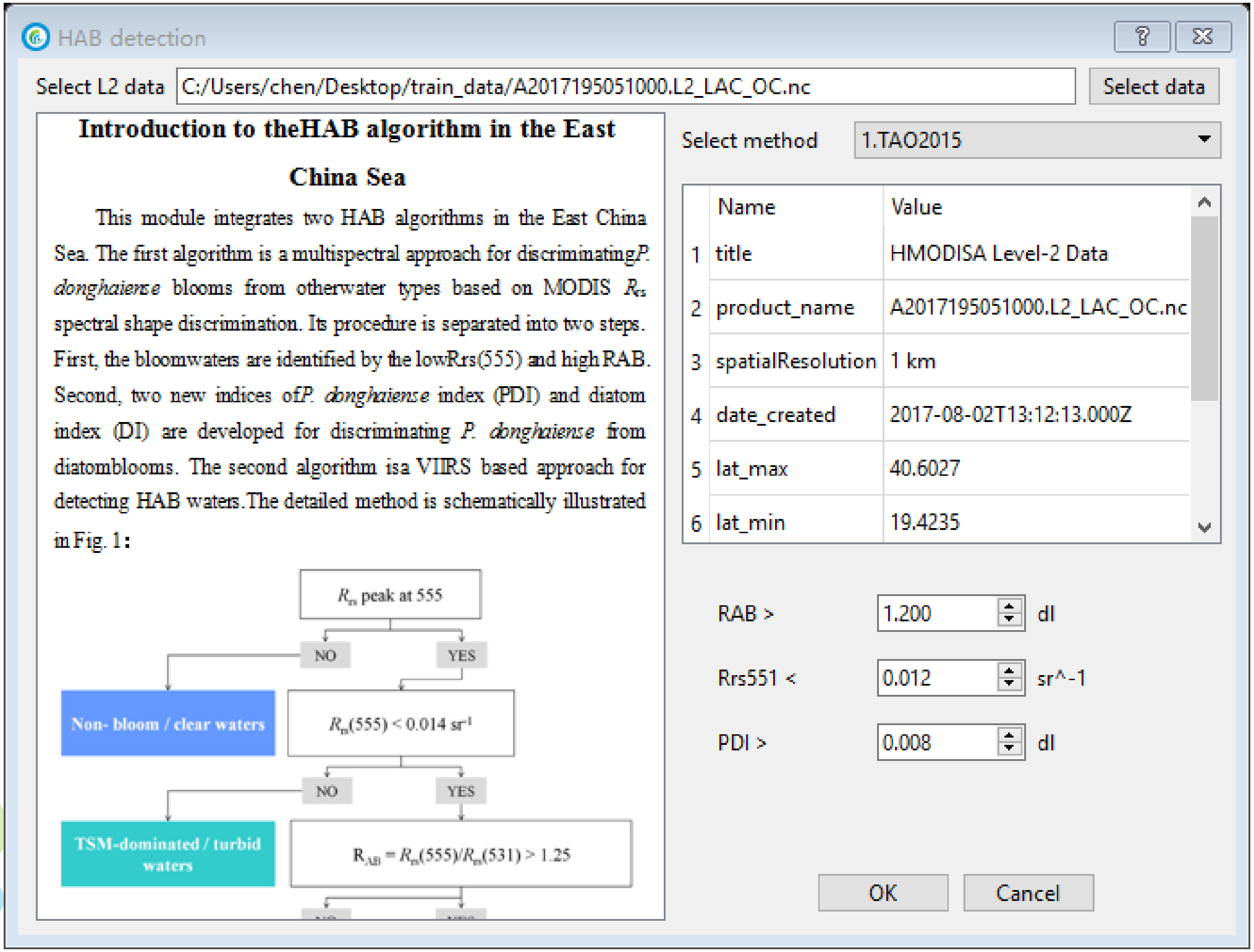
Practice case 7



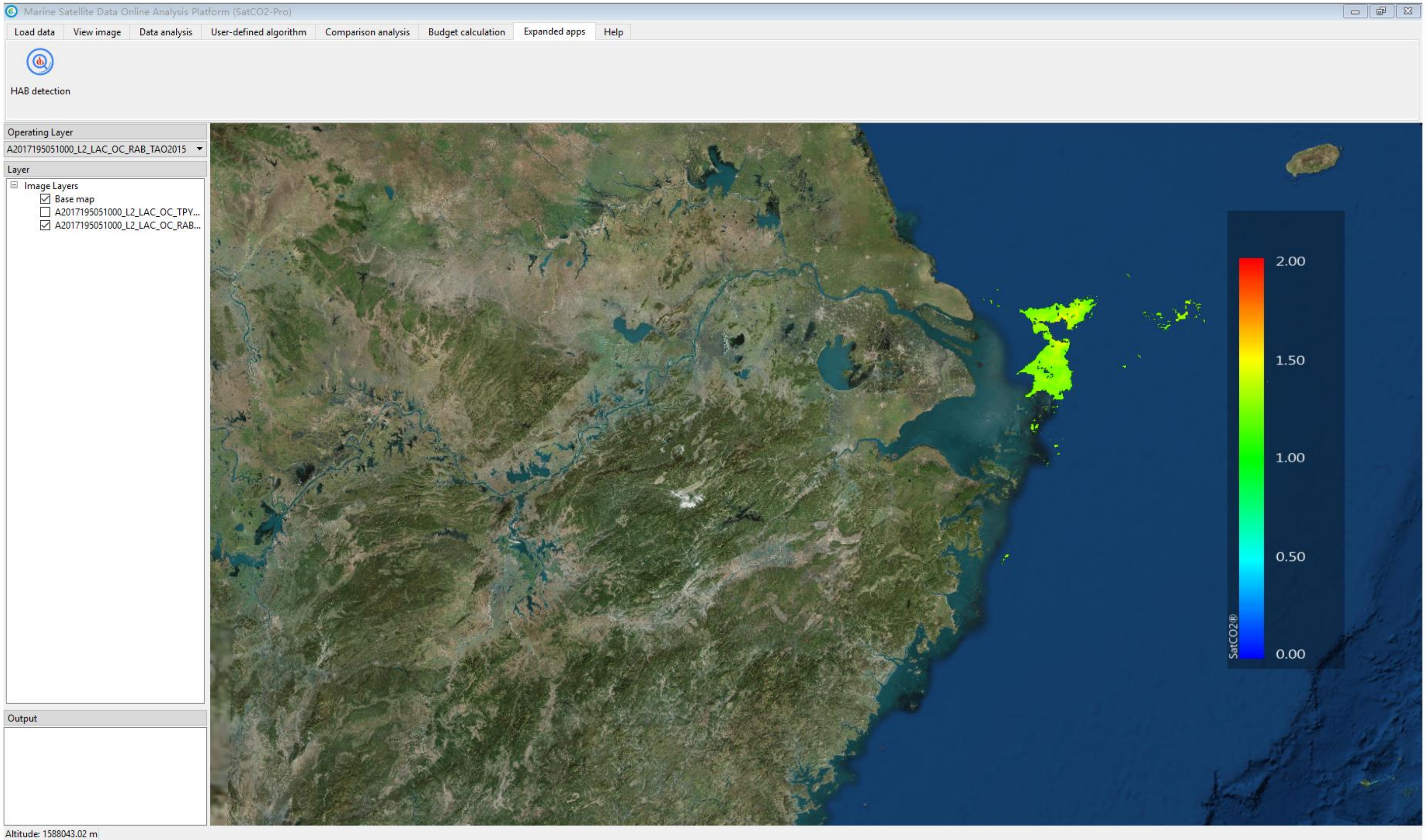
Practice case 8



Practice case 8



Practice case 8



Thank you for your attention！

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