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Investigation on the variations in the Secchi disk depth in the Yellow Sea in 2002-2016 using MODIS aqua data
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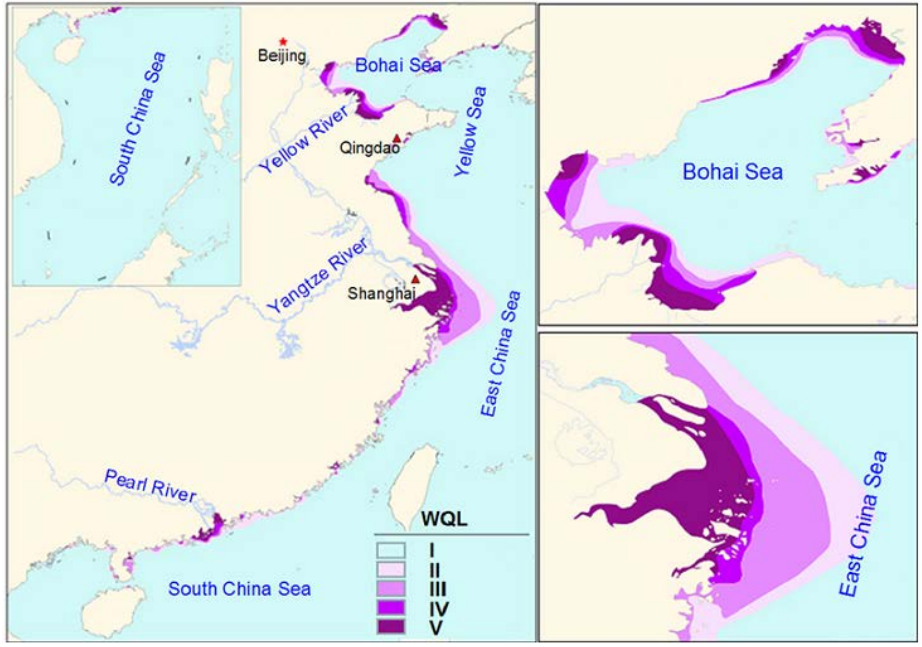
Outline

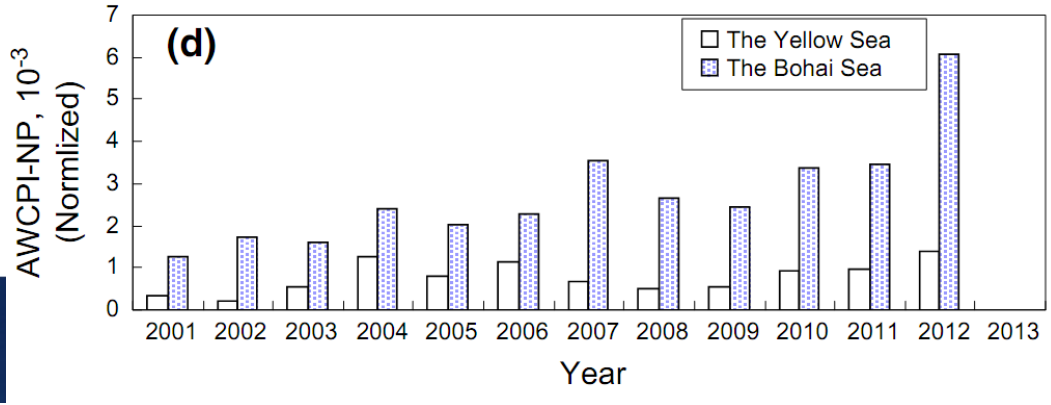
1. Background
2. Methods and data
3. Preliminary results
4. Future work

1. Background

Water clarity is an very important marine environmental factor for evaluation on the water quality and marine.

The changing China coastal seas due to human activities (nutrient pollutants discharges).

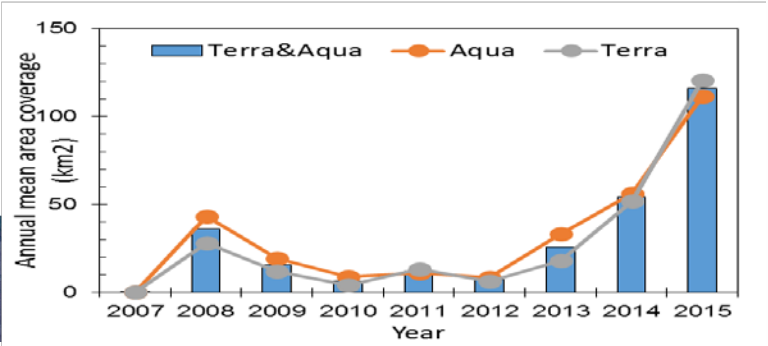


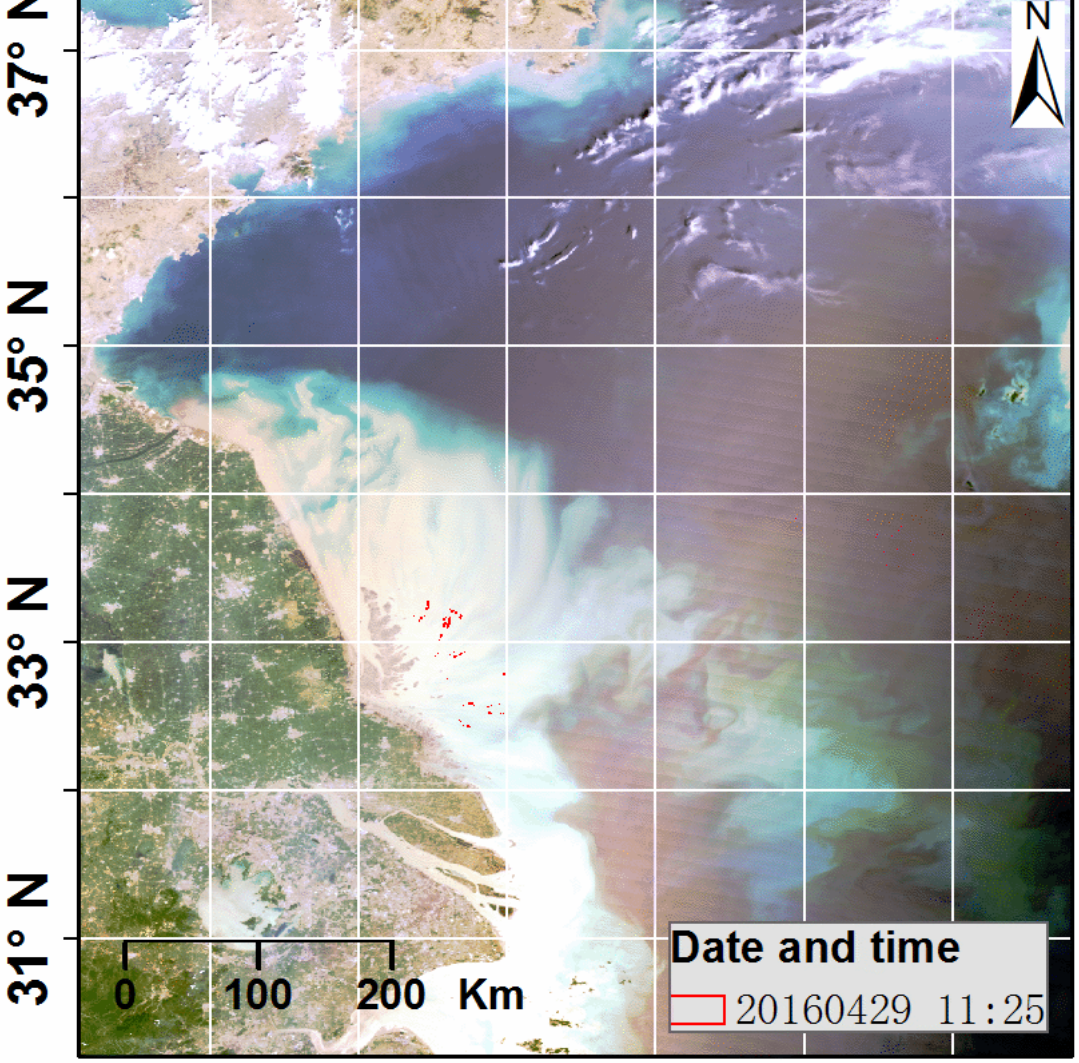


1. Background

Increasing macroalgae blooms in the Yellow Sea.

What changes in the water clarity in the Yellow Sea?

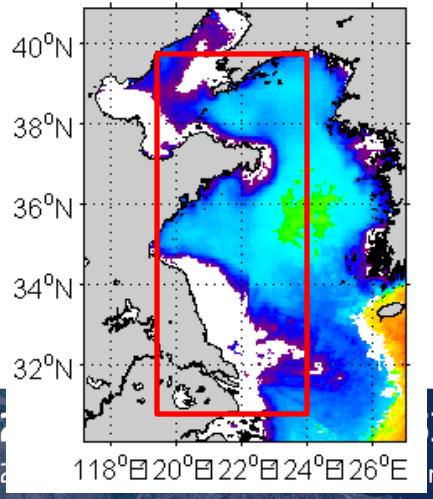




2. Data and methods

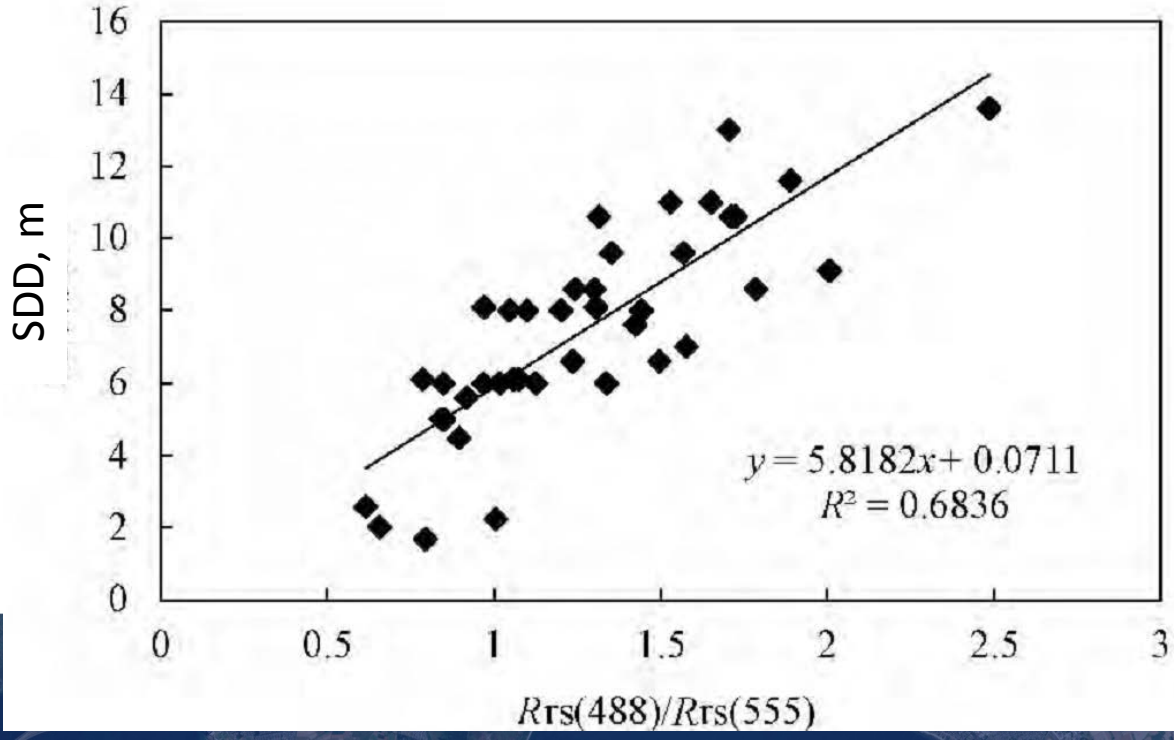
An empirical algorithm of SDD: based on

- MODIS standard product Rrs(488), Rrs(555)
- In-situ SDD in the YS-ECS



MODIS–Aqua

R^2	RMSE / m	MRE / (%)
0.6836	1.57	24.3

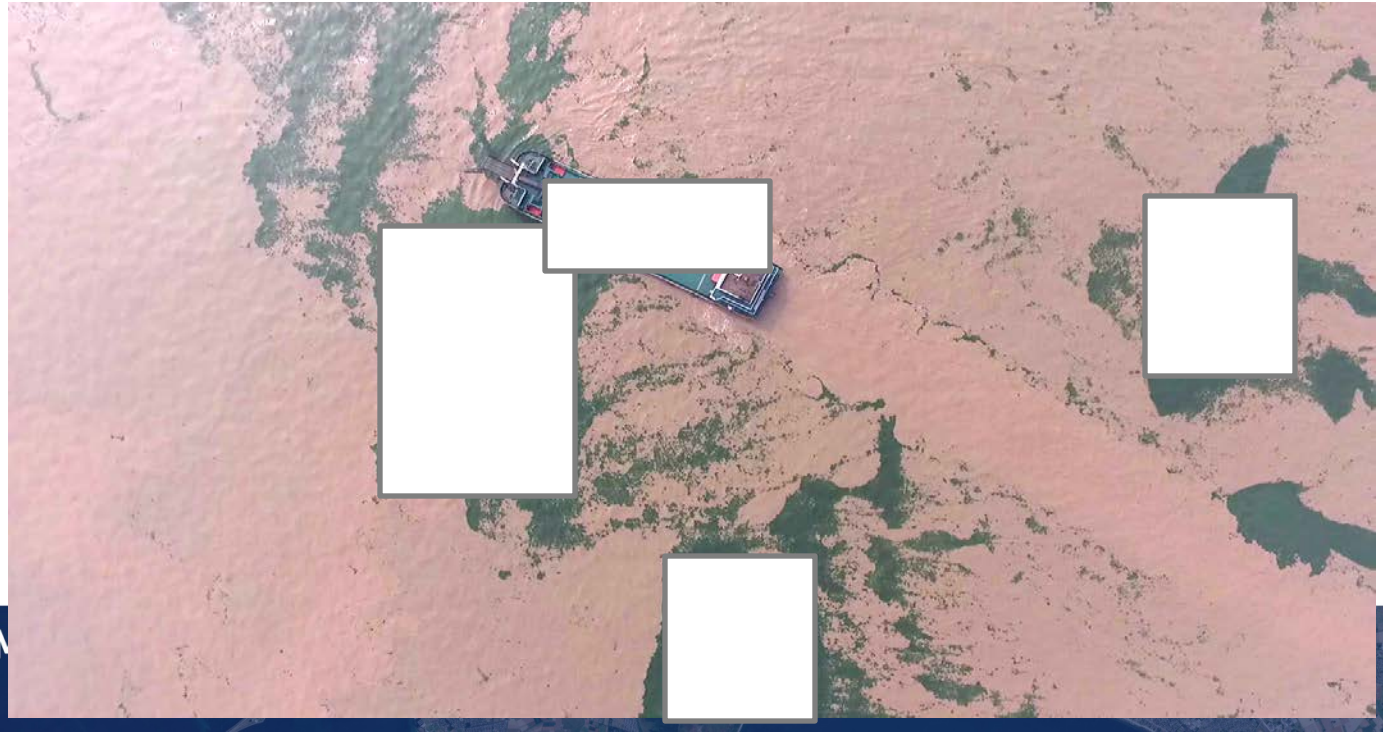


2. Data and methods

Standard Atmoshperhic correction: zero assumption for NIR band

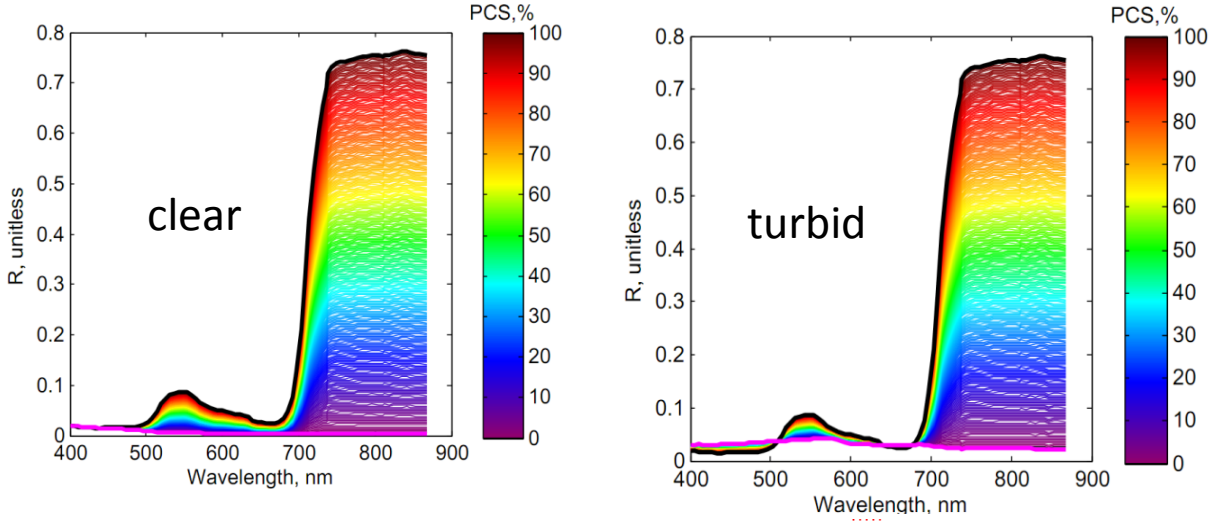
Masking as clouds, ice, or invalid data

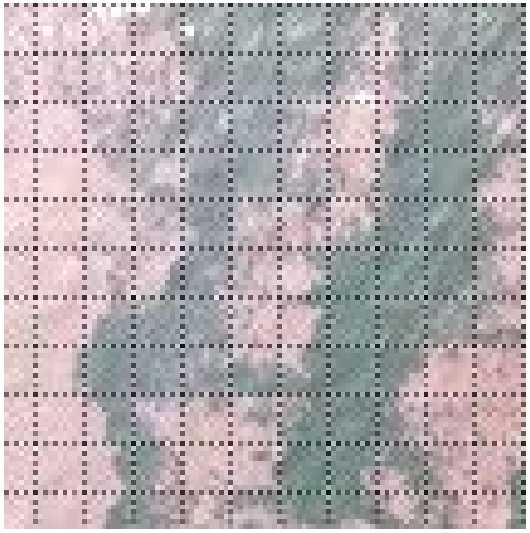
Macroalgae-containing Pixels, can bring false Values in the SDD, The Chl-a ...



2. Data and methods

Linear spectral mixing simulation:
Endmember reflectance of macroalgae and seawater





$$SDD=5.8182*Rrs490/Rrs550+0.0711, \quad (1)$$

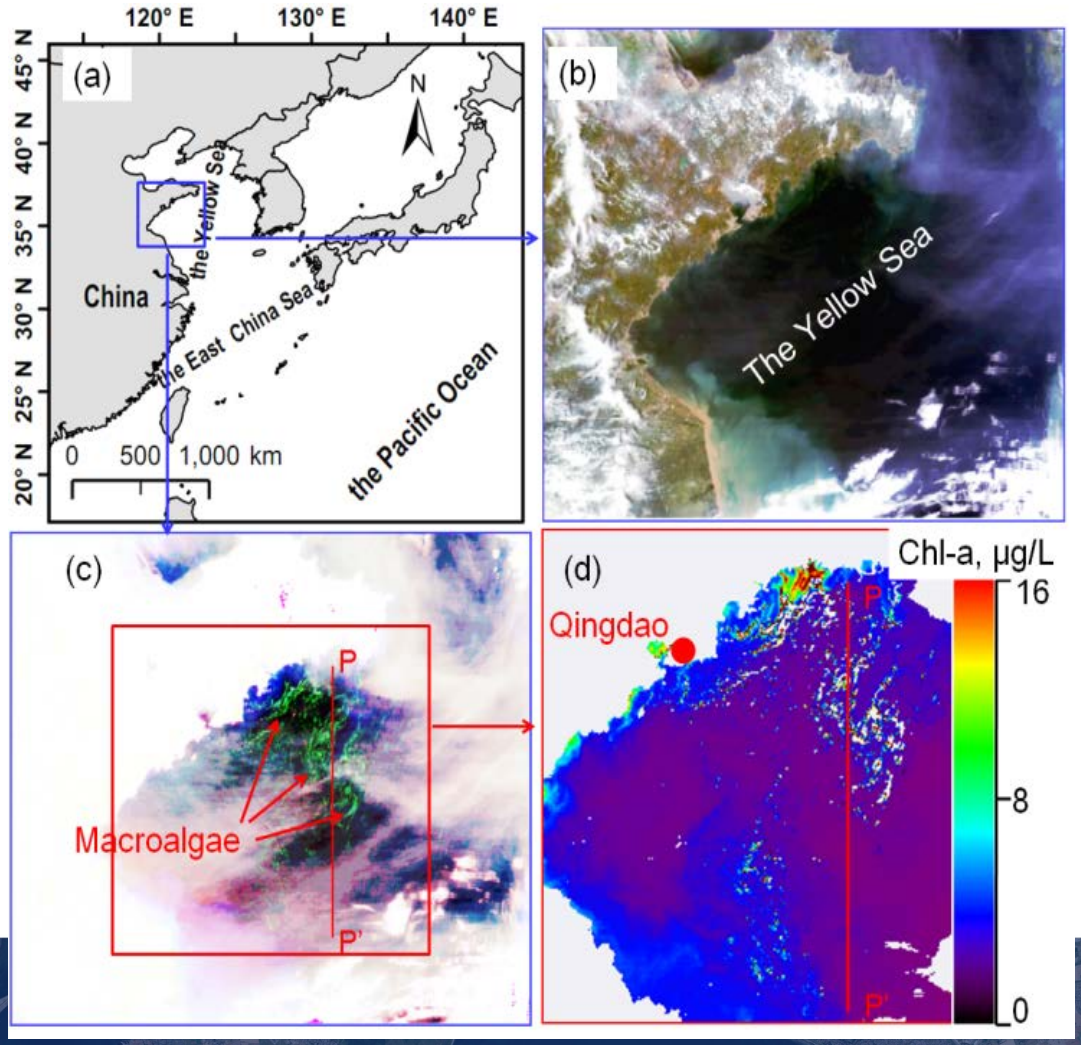
$$\log_{10}(Chl-a)=a_0+a_1X+a_2X^2+a_3X^3+a_4X^4, \quad (2)$$

where the Rrs is the remote sensing reflectance (sr^{-1}), $X=\log_{10}\left[\frac{\max(Rrs(443),Rrs(490))}{Rrs(550)}\right.$

2. Data and methods

17-July-2009,
MOIDS aqua level-1b
MOIDS level-2: Rrs, Chl-a

To check the effects of floating macroalgae on the SDD and the Chl-a products…



2. Data and methods

MODIS Level-3 Rrs : June of 2002 to December of 2016

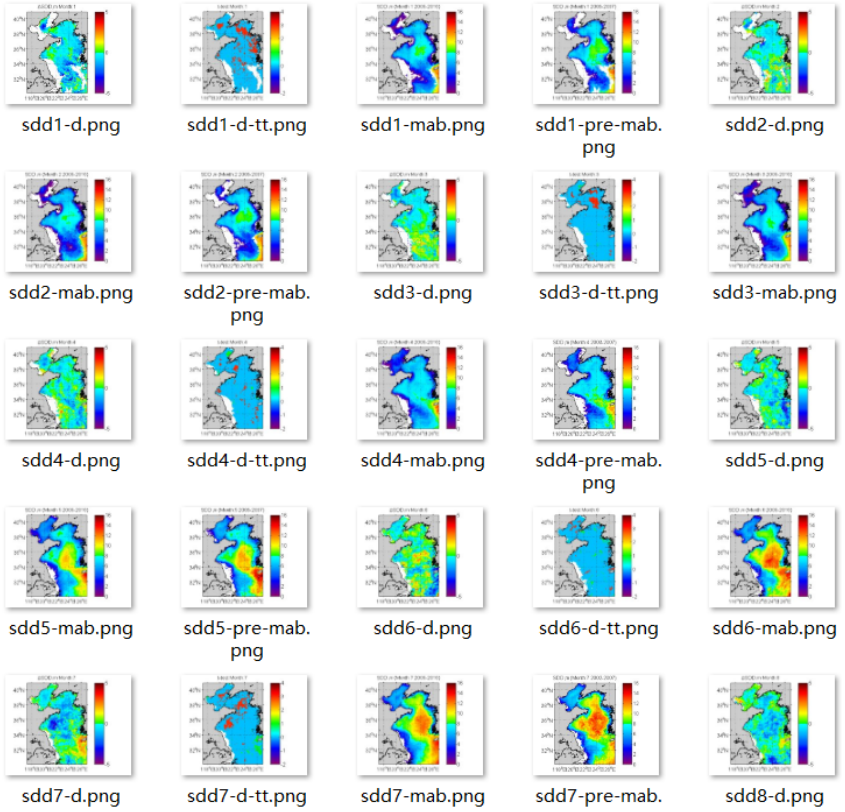
Rrs→the SSD.

(2002-2007, i.e., before the world's largest MABs, is regarded as the pre-MAB phase,

2008-2016 as the MAB phase)

The multi-year average of SDD of each month in the pre-MAB phase (SDD1) and the MAB phase (SDD2.

ΔSDD (SDD2 - SDD1), t-test significance.



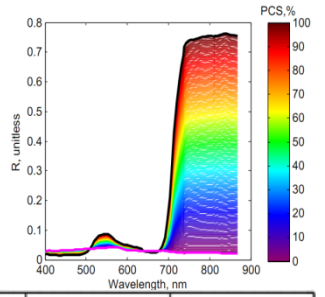
3. Results and discussions

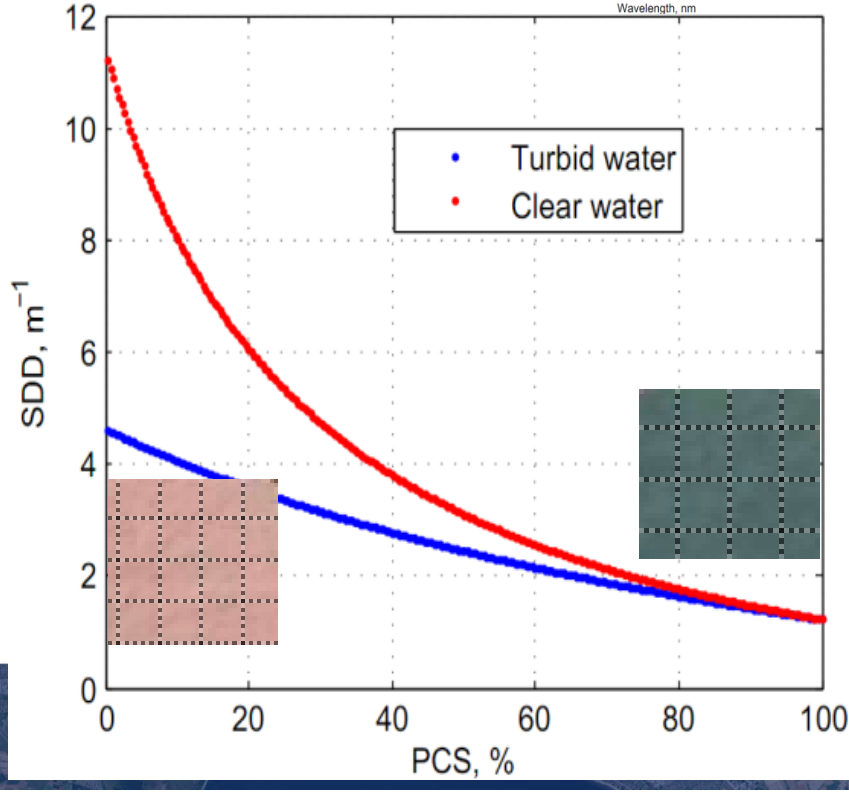
Simulation: linear reflectance spectral mixing.

The PCS: the portion of sea surface covered by macroalgae: 0 -100%.

Rrs→the SSD.

The “SDD” of the macroalgae is 1.2 m.





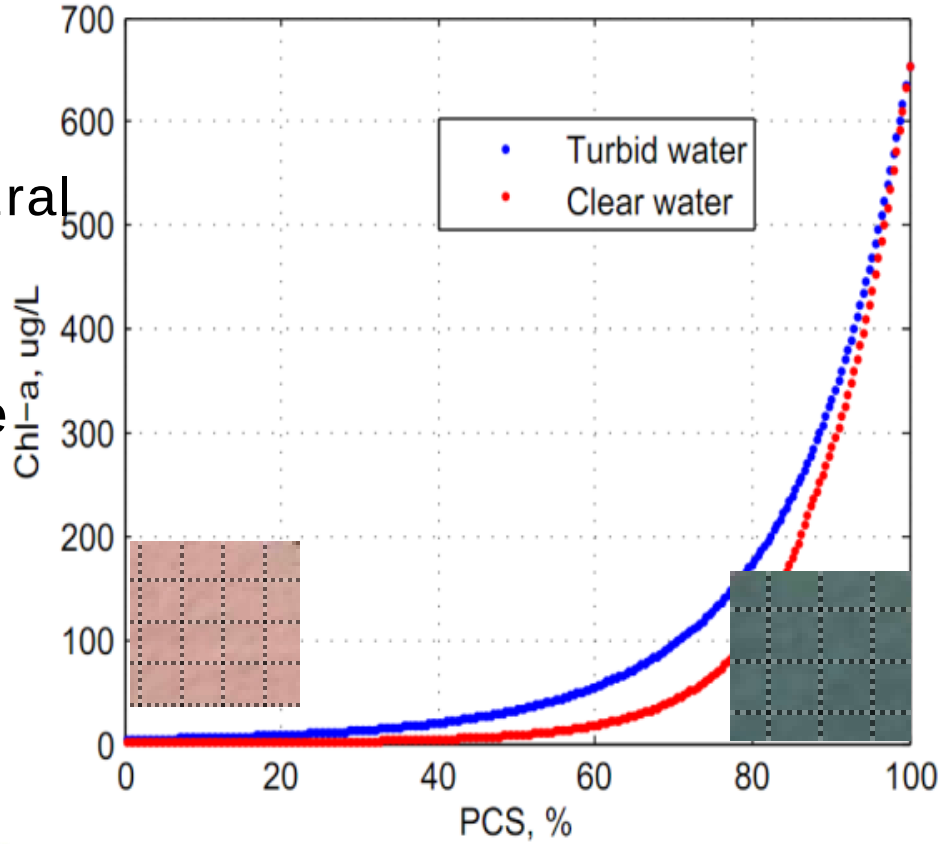
3. Results and discussions

Simulation: linear reflectance spectral mixing.

The PCS: the portion of sea surface covered by macroalgae: 0 -100%.

Rrs→the Chl-a.

The “Chl-a” of the macroalgae is 653.3 μg/L.



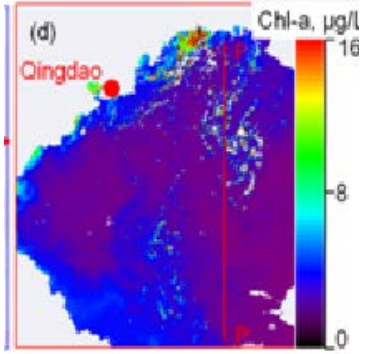
3. Results and discussions

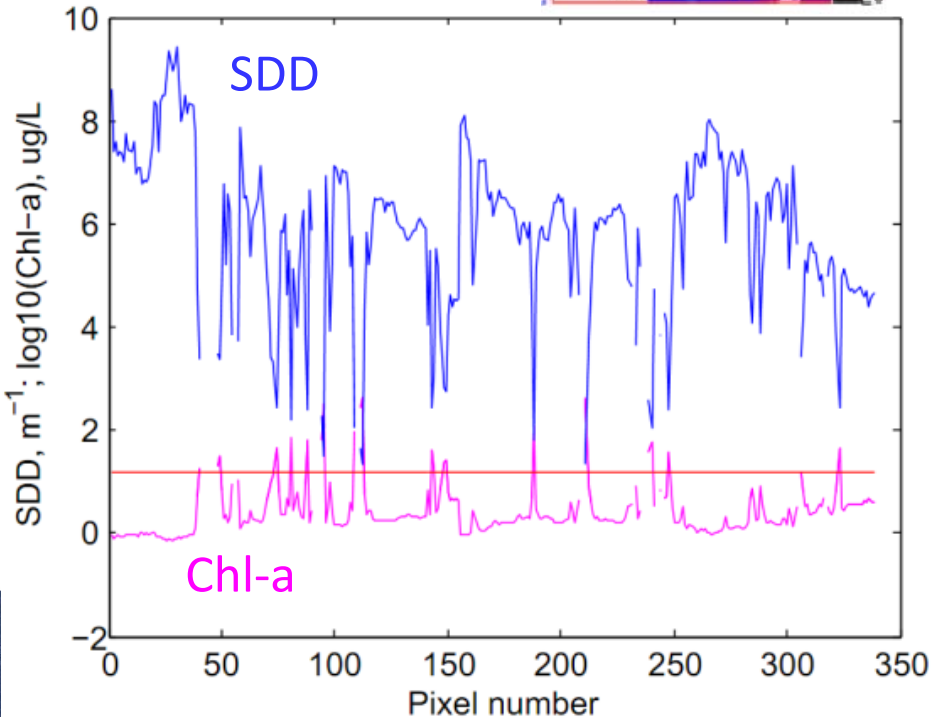
SDD, Chl-a: the profile P-P’

Downward spikes in SDD (>1.2m)

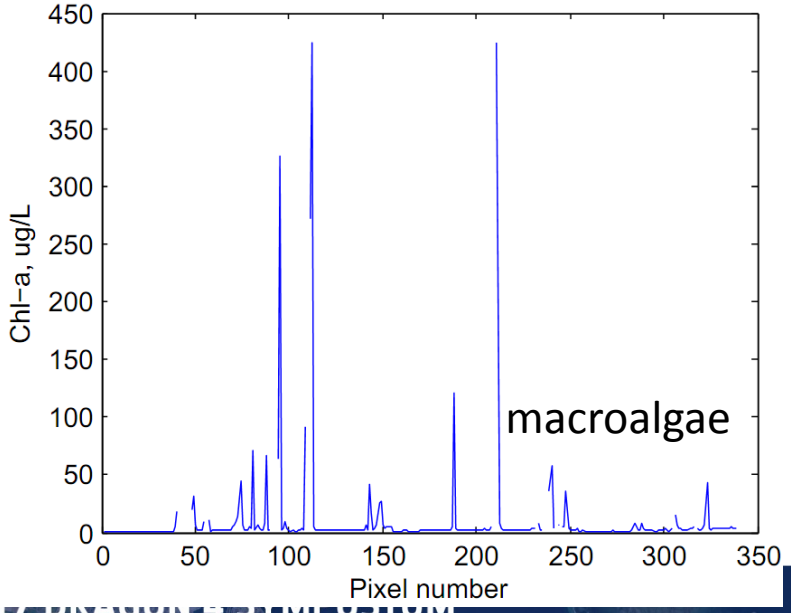
Upward spikes in Chl-a (up to 423.96 μg/L)

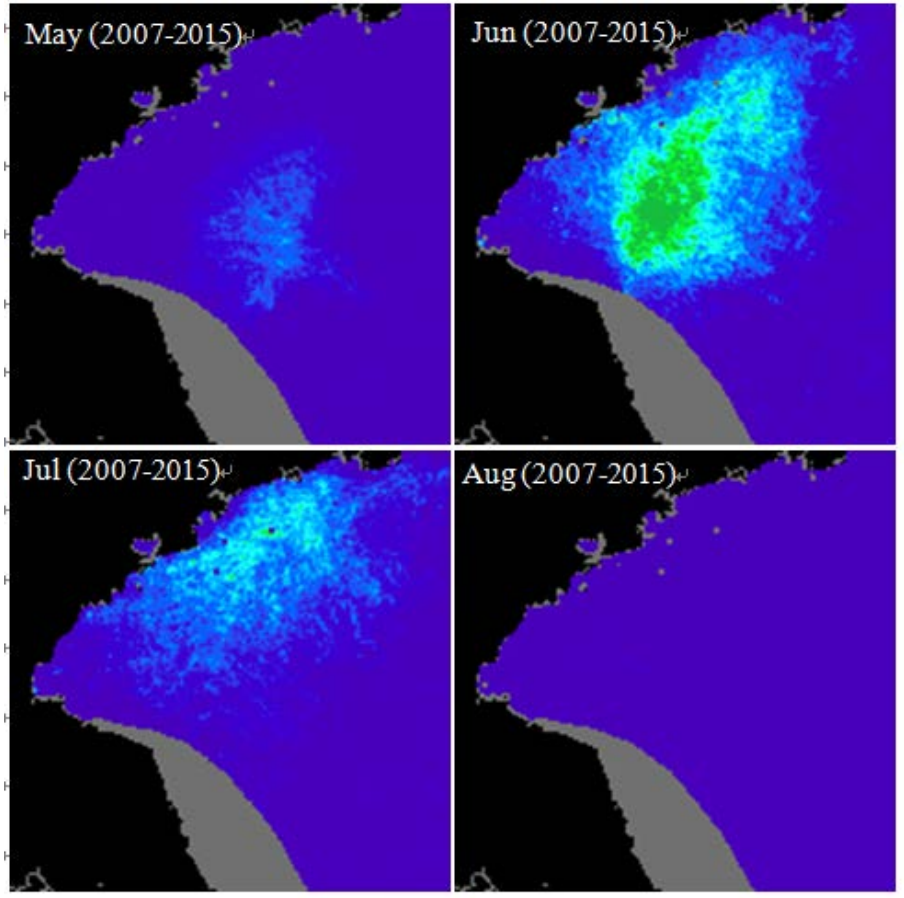
The standard Ocean Color products in MAB regions should be used with caution.





The average abundance of macroalgae in the west Yellow Sea (Qi et al., 2016).





3. Results and discussions

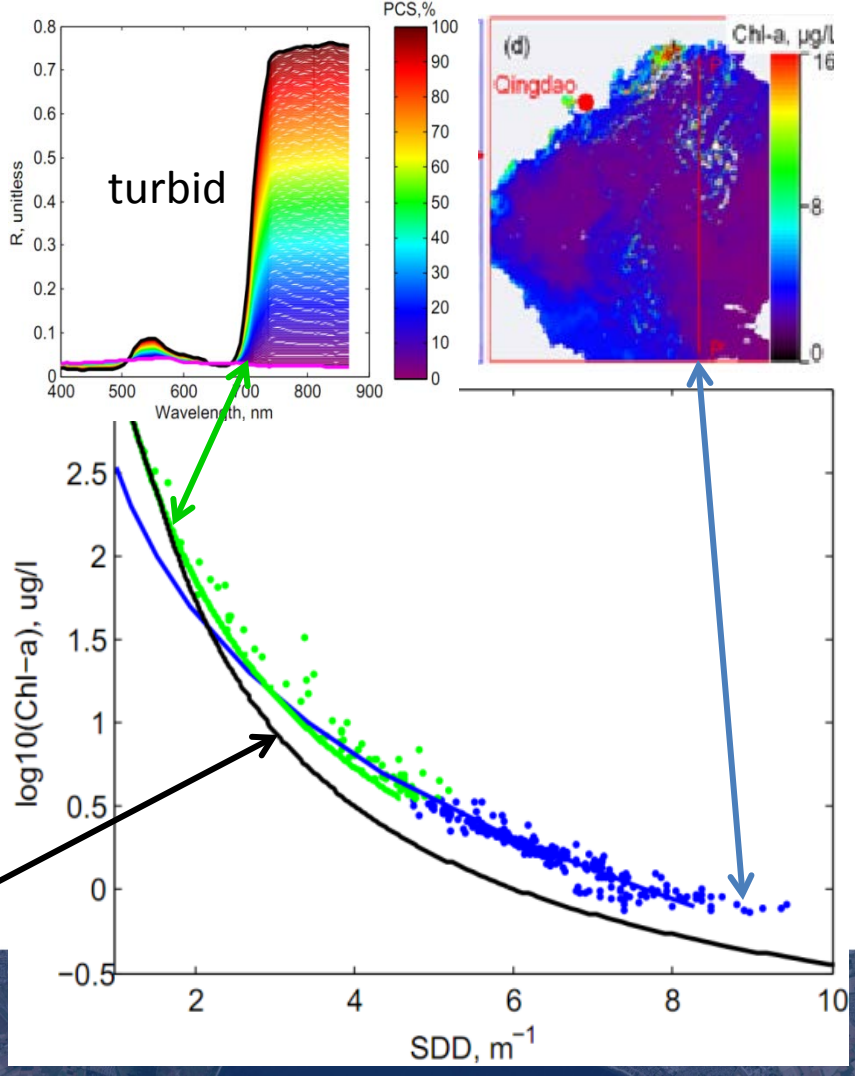
The relationship: SDD - Chl-a

The lines: simulated with linear mixng model

The scatter plots observed for the profile P-P,

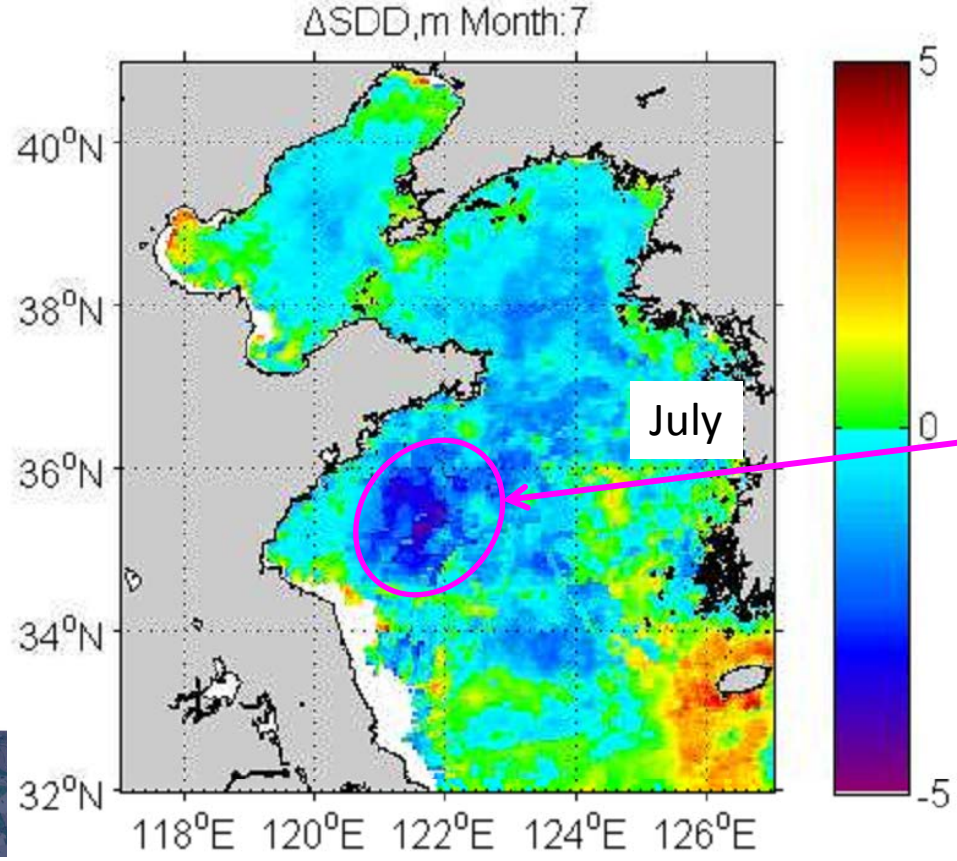
Agreement between simulation and the observation

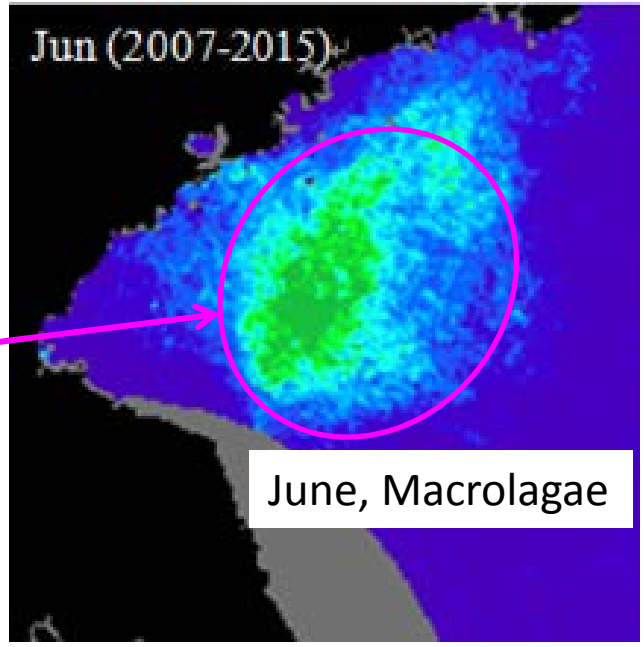
suggests the line mixing model acceptable in this work.



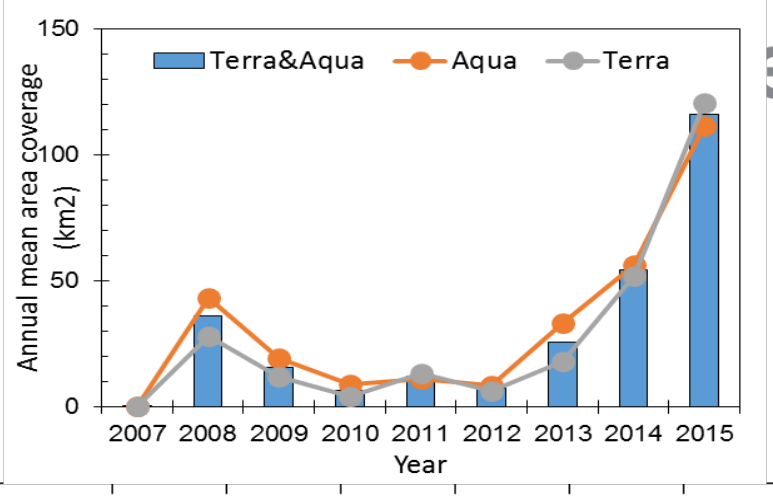
3. Results and discussions

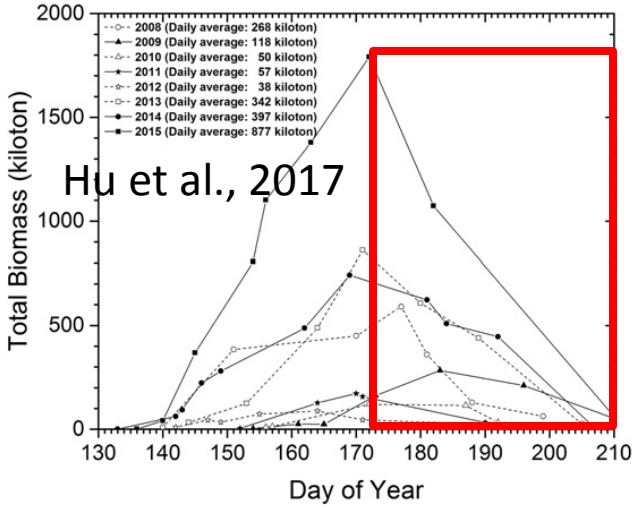
SDD observation by MODIS data

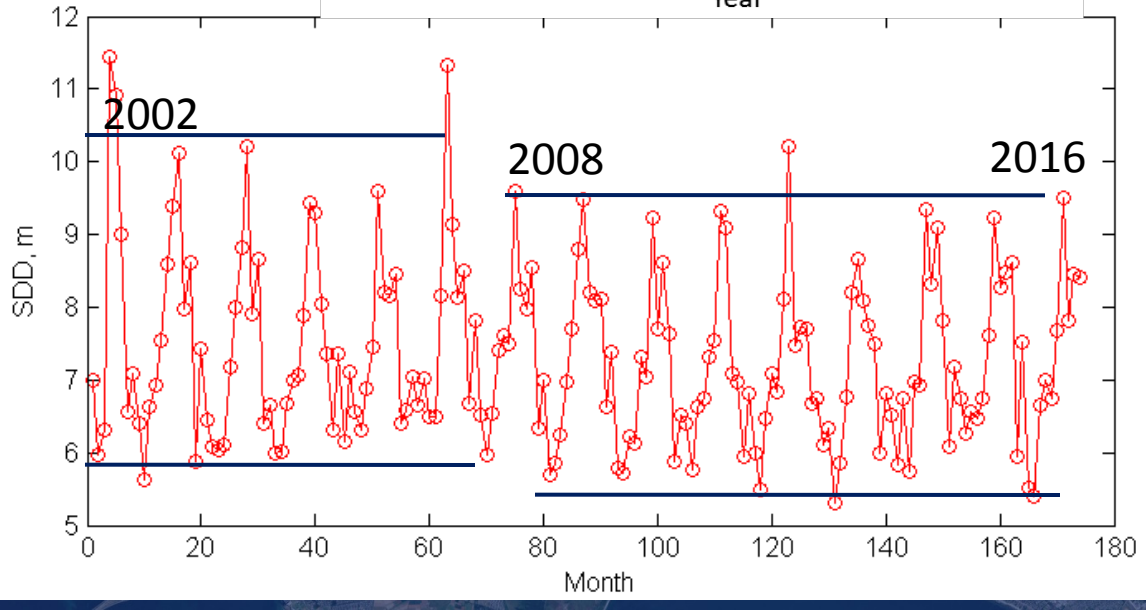




A decline in SDD <-- the increased phytoplankton <-- the enhanced nutrients due to the decomposition of macroalgae at end of June ???

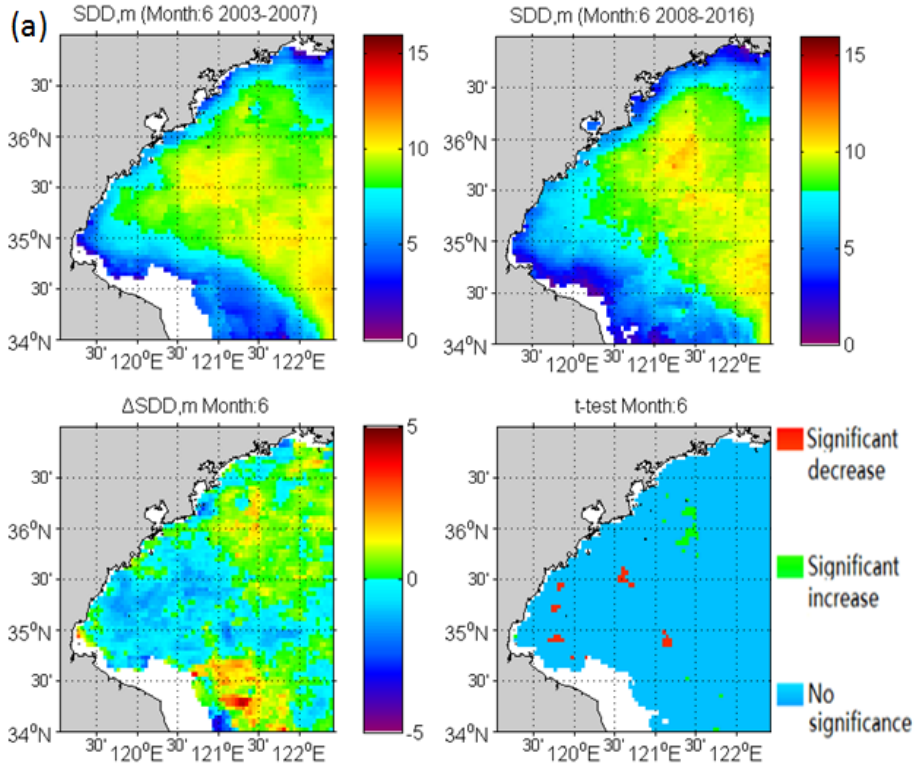






3. Results and discussions

SDD obervation by MODIS data



June:

Increase of macroalge biomass

(→ decreases in the “SDD”, pixel mixing)

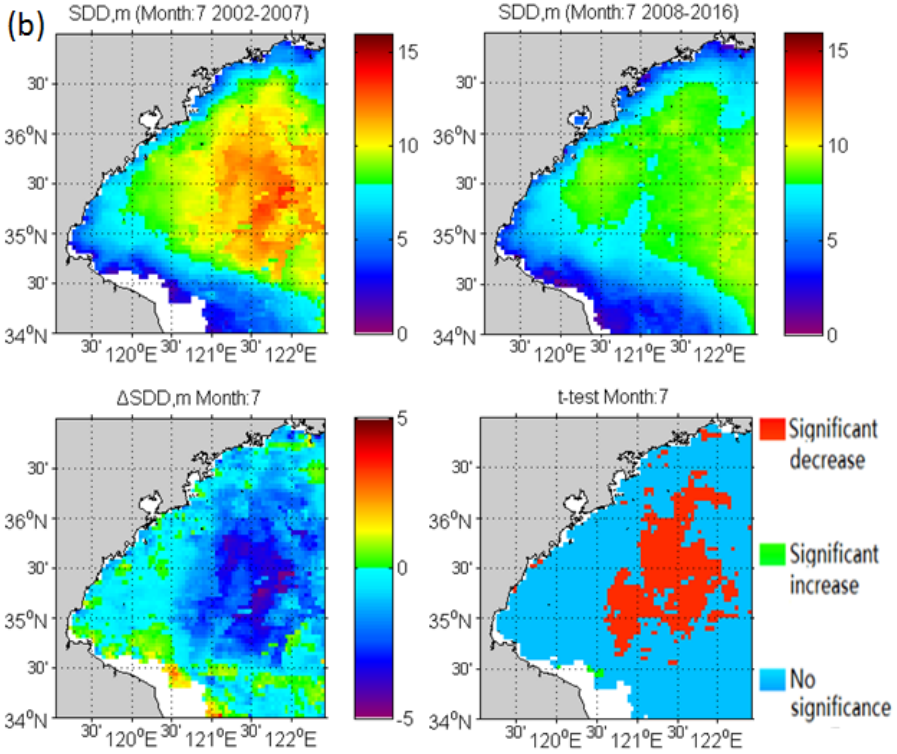
may absorb more nutrients, caused the decline in the biomass of phytoplankton

(→ increases in the SDD, Chl optical obsorptions)

No significant changes.

3. Results and discussions

SDD obervation by MODIS data



July:

Decrease of macroalge biomass

(→ decreases in the “SDD”, pixel mixing)

release more nutrients, caused the increase in the biomass of phytoplankton

(→ decreases in the SDD, Chl optical obsorptions)

Decreases in the SDD.

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4 Future work

① Long-term time series SDD: SeaWiFS-MODIS

② Study on the changes in the SDD and the Chl-a with the annual variations in the water quality in the Bohai Sea and the Yellow Sea.

③ SDD evaluation in the Bohai Sea against the river discharge of the Yellow River

④ Changes in the SDD with the human activities in the Bohai Sea: aritficial reefs

Thanks for your attention!

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