# Collapse of summer biological activity in the East China Sea during 1998-2014

Young Baek Son, Taehee Lee, Dong-Lim Choi, Chan Joo Jang, Sin Jae Yoo

**Korea Institute of Ocean Science & Technology (KIOST)**

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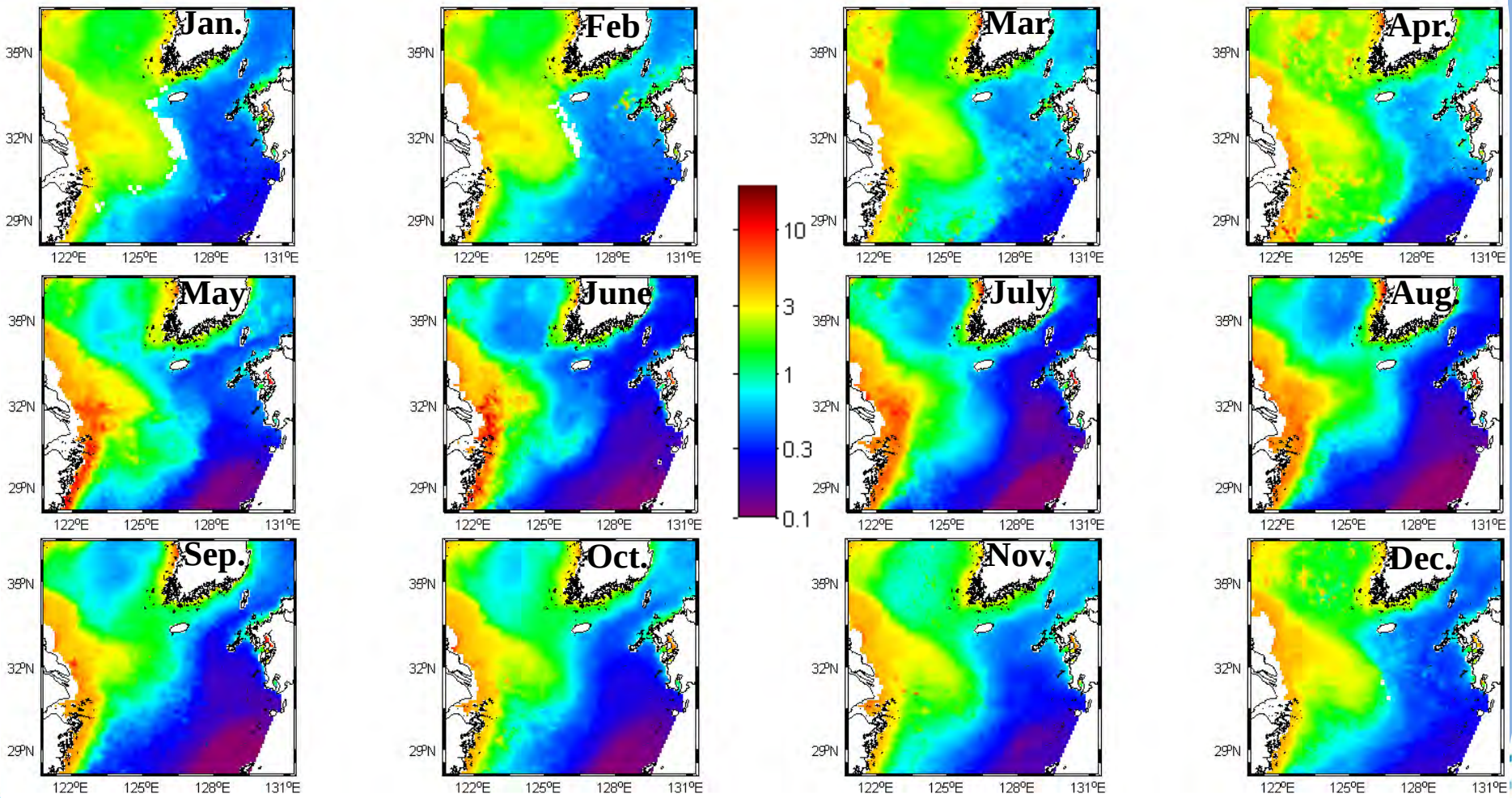
# Seasonal Patterns derived Satellite Chlor-*a* Con.

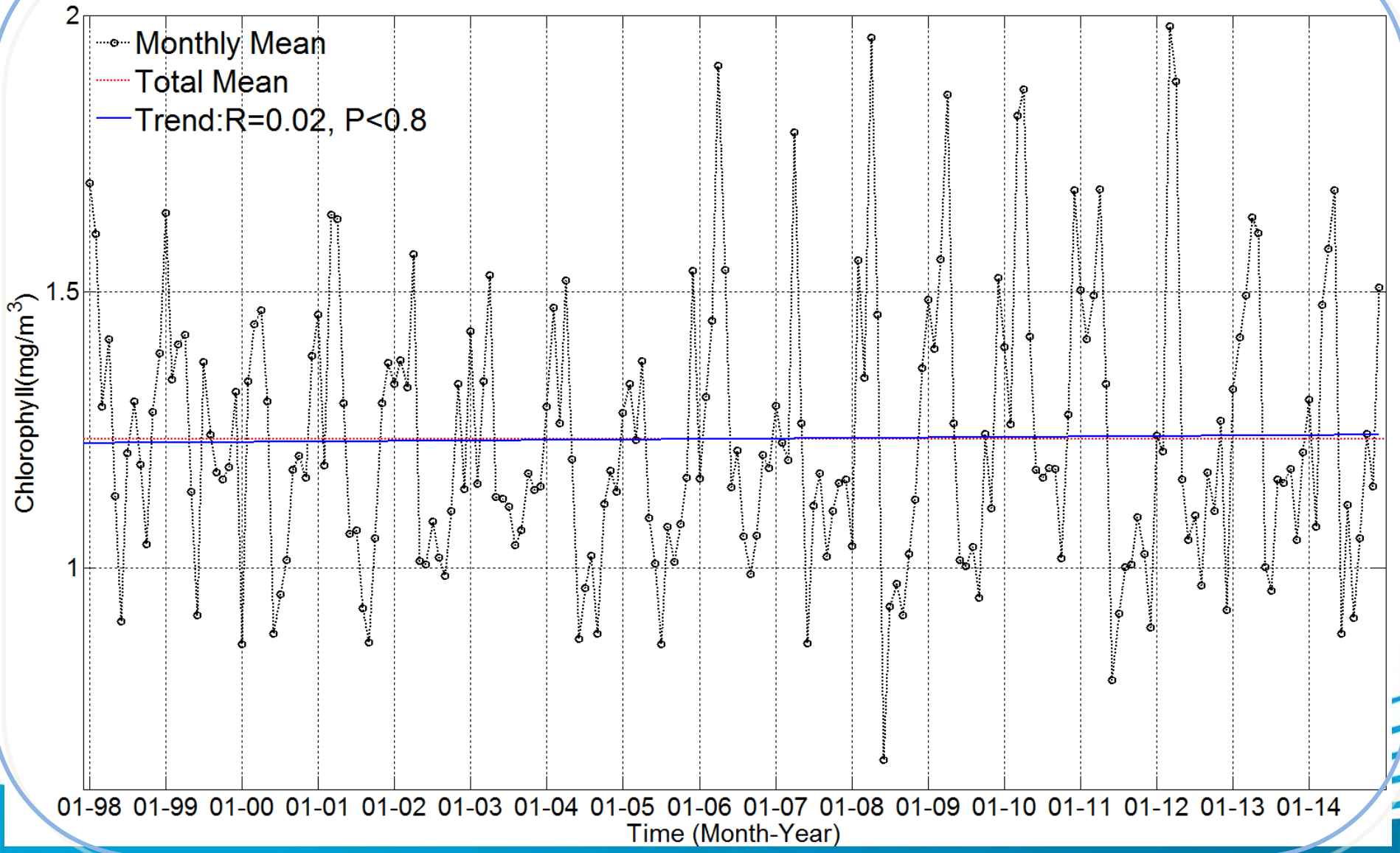
-The East China Sea is biologically productive ocean

- Recently ecosystem has been changed by human impacts and/or natural effects



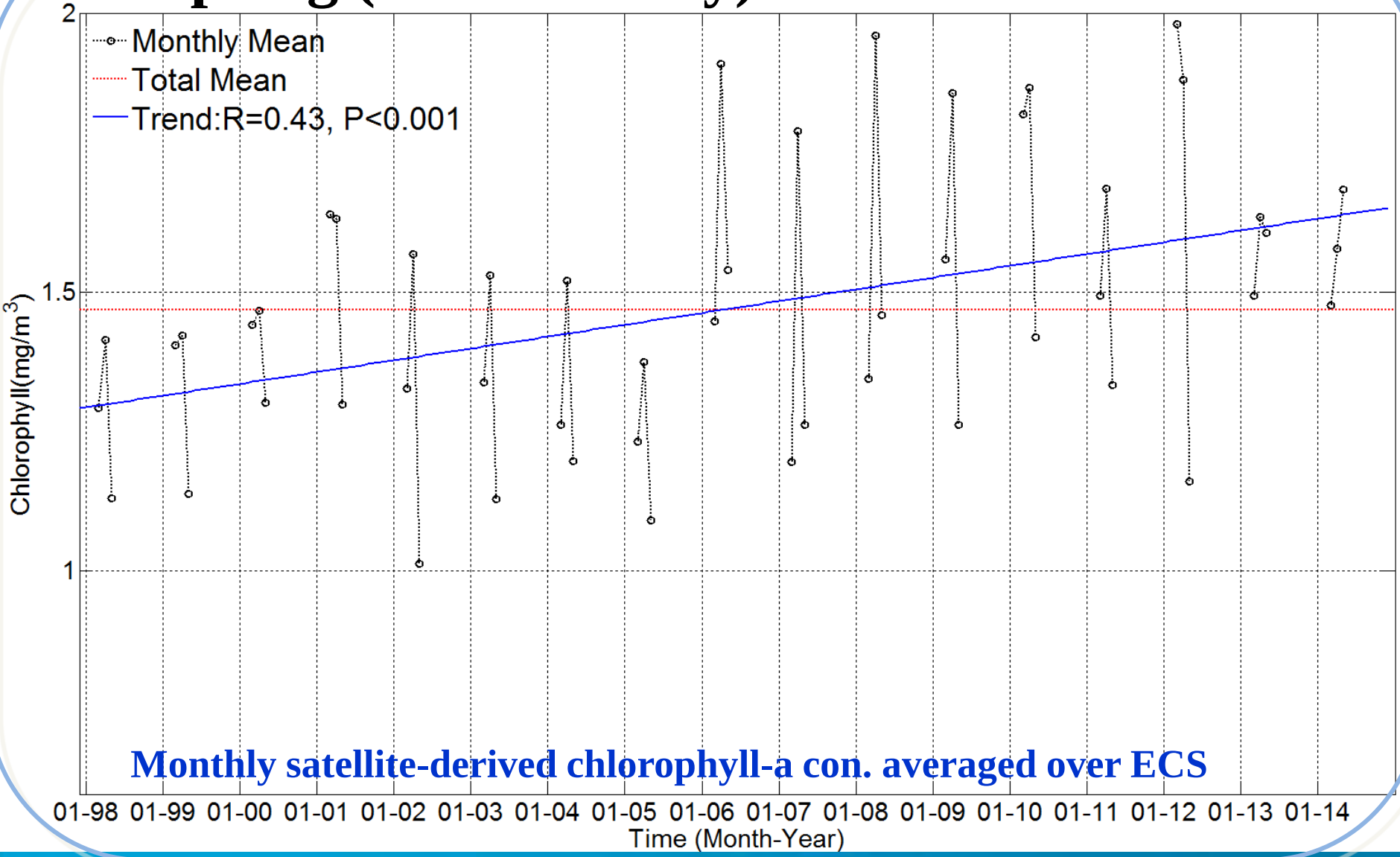
# Satellite-derived Chlor-*a* Variation

## Monthly satellite-derived chlorophyll-a con. averaged over ECS



# Satellite-derived Chlor-*a* Variation

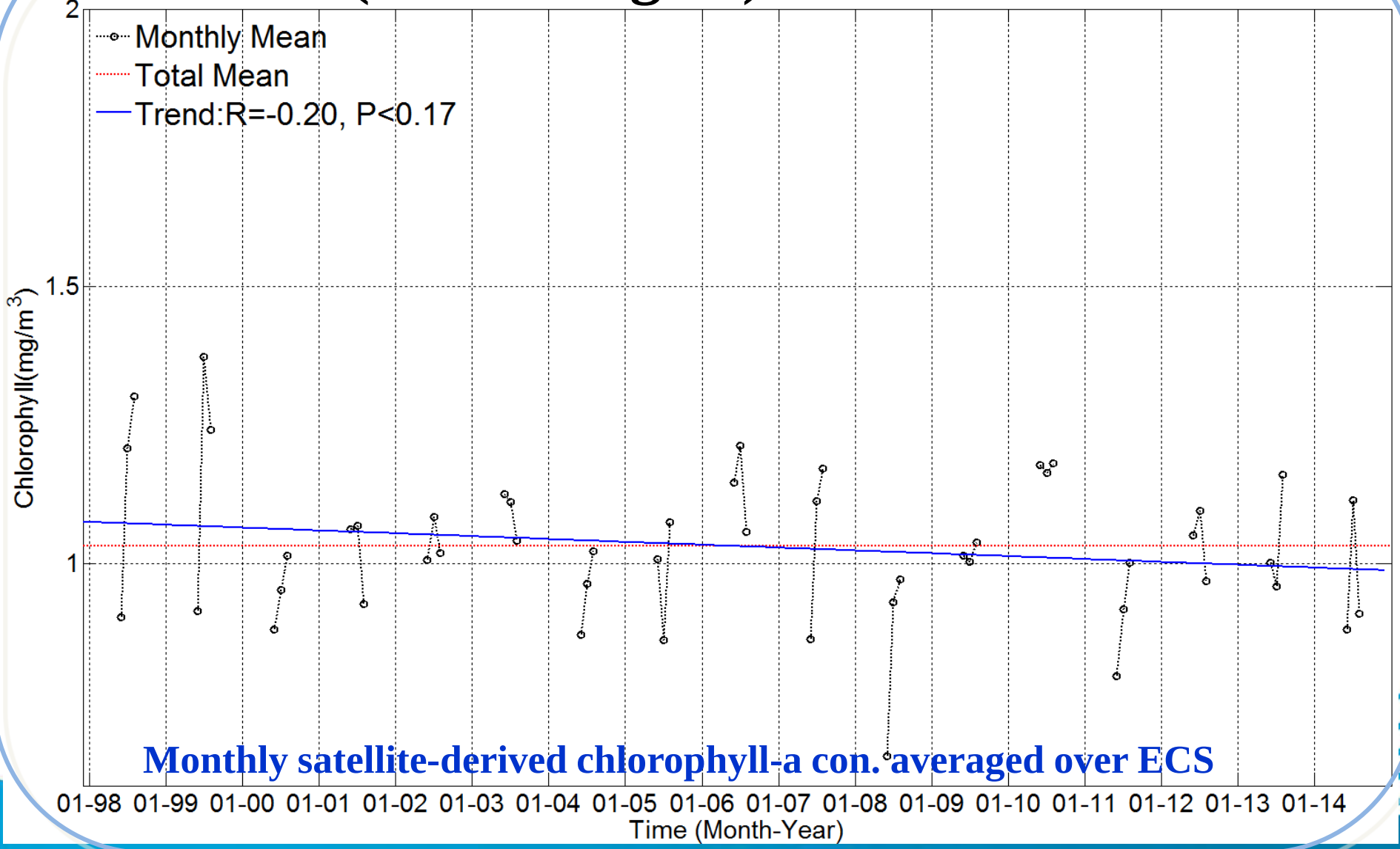
## Spring (March - May)




**Monthly satellite-derived chlorophyll-a con. averaged over ECS**

# Satellite-derived Chlor-*a* Variation

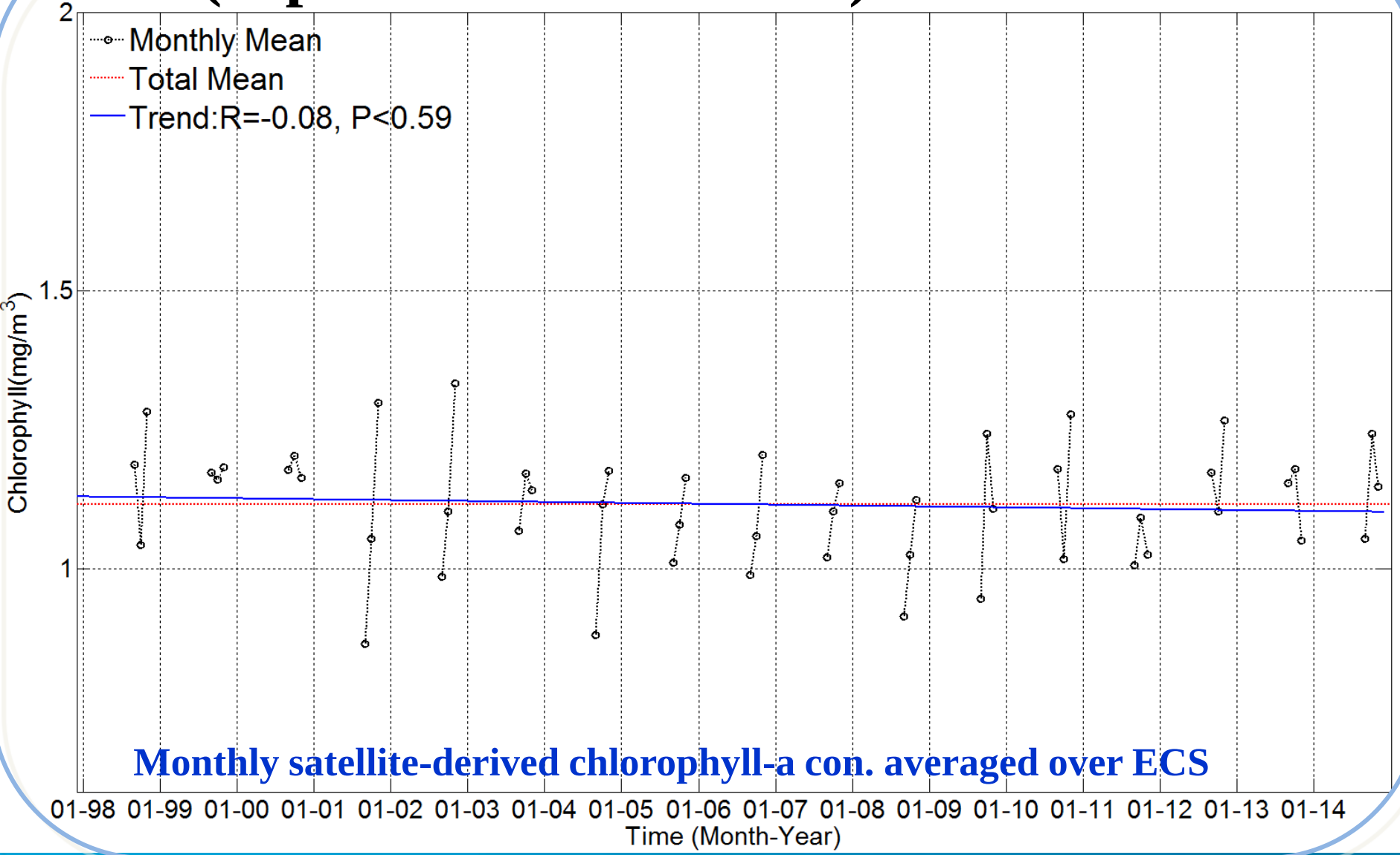
## Summer (June - August)




**Monthly satellite-derived chlorophyll-a con. averaged over ECS**

# Satellite-derived Chlor-*a* Variation

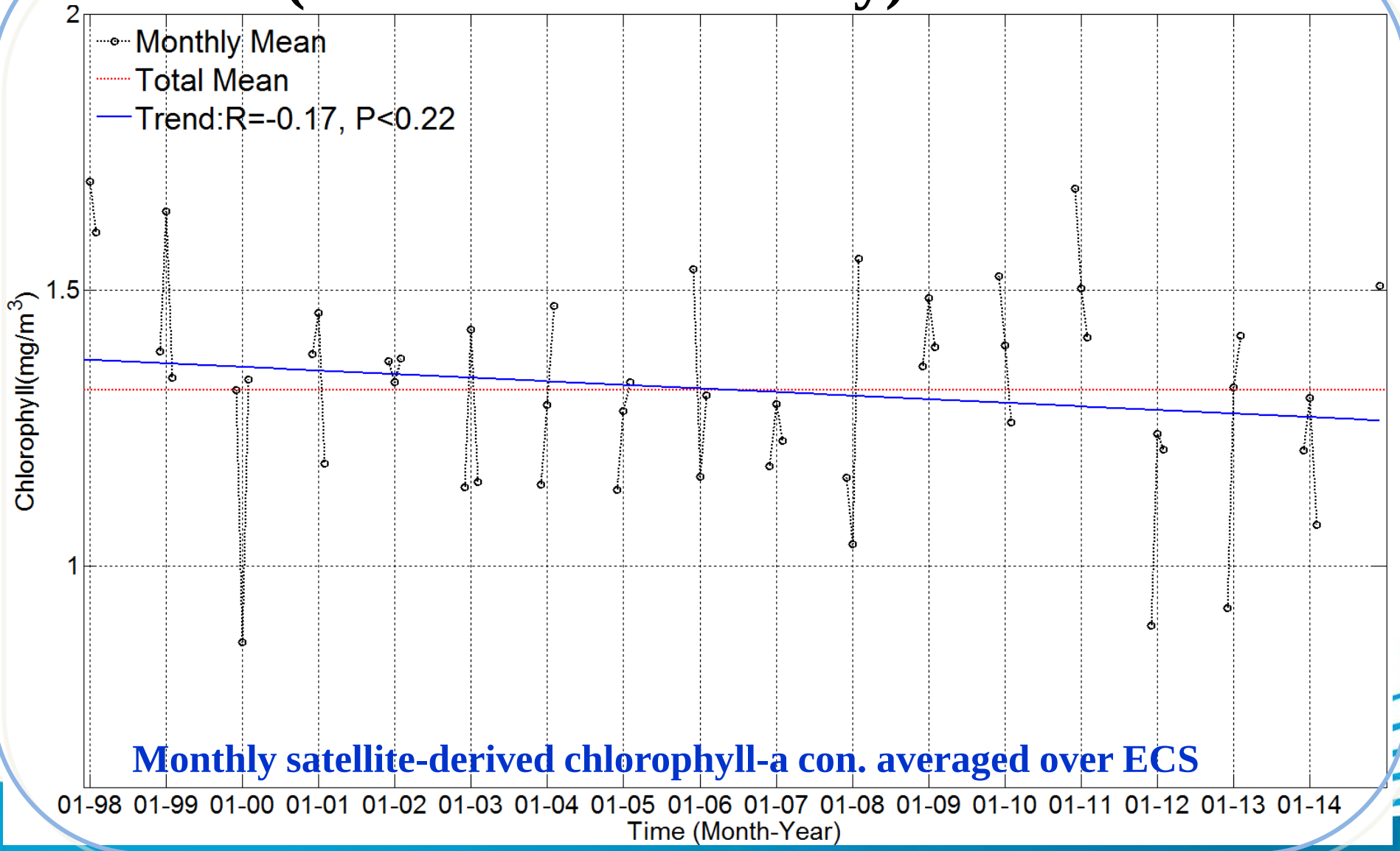
## Fall (September - November)




**Monthly satellite-derived chlorophyll-a con. averaged over ECS**

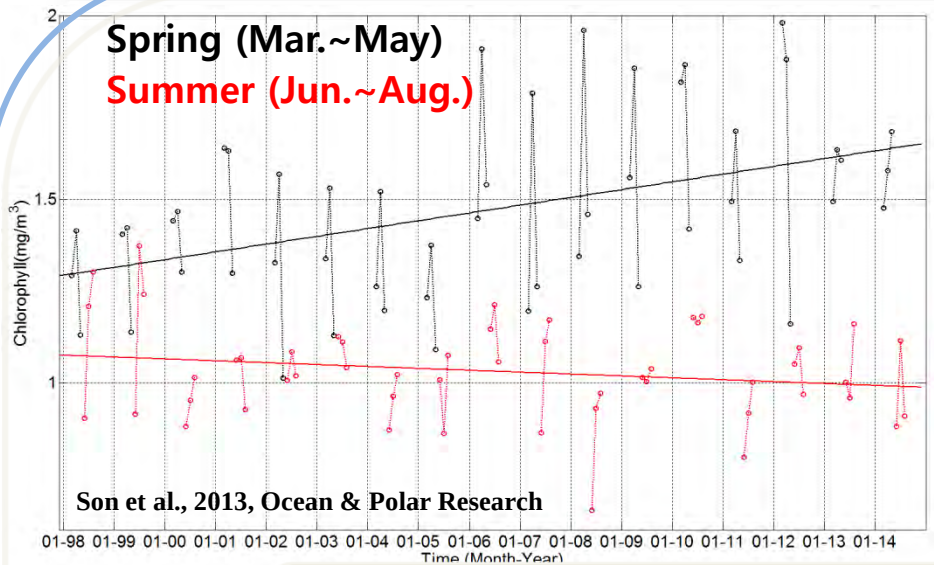
# Satellite-derived Chlor-*a* Variation

## Winter (December - February)

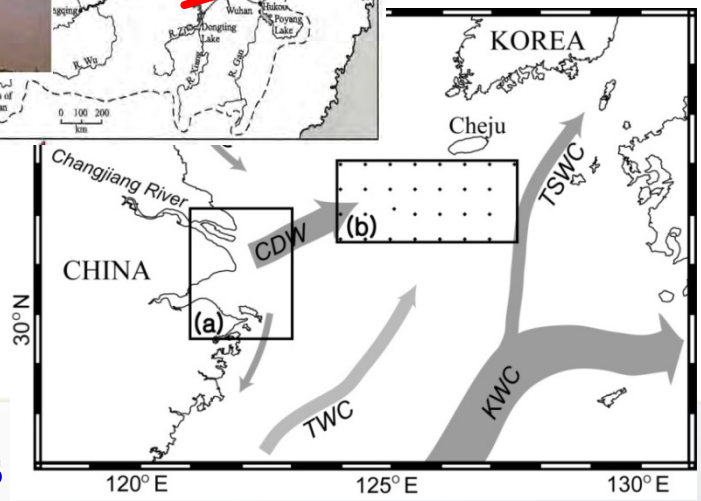



**Monthly satellite-derived chlorophyll-a con. averaged over ECS**

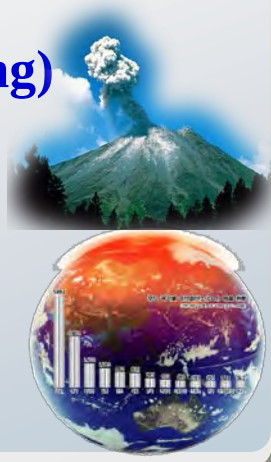
# What's happen in ECS







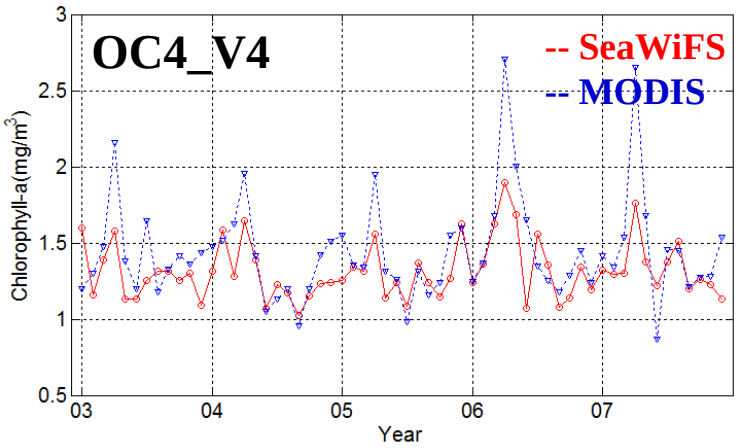

- **Highly asymmetric seasonal patterns**
  - **Reduced river discharge could be caused by the TGD**
    - **Human activity and/or natural effect (global warming)**
      - **Circulation pattern change**
      - **Limited nutrient supply into the shelf area**
      - **Ecosystem has been changed**
    - **Focused on summer seasons (98~14)**

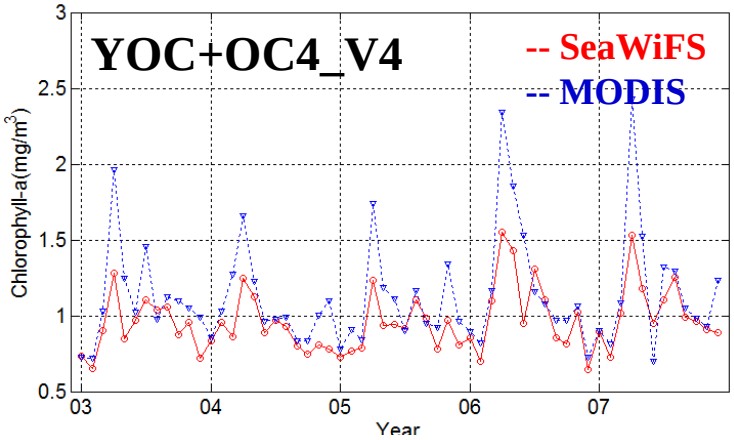



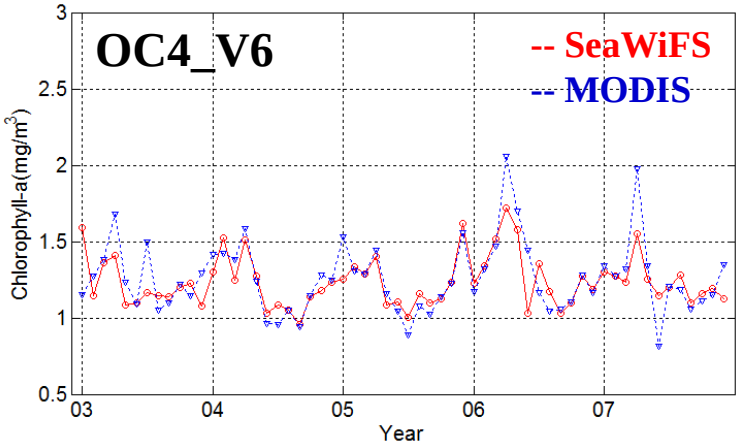
# Data and Methods

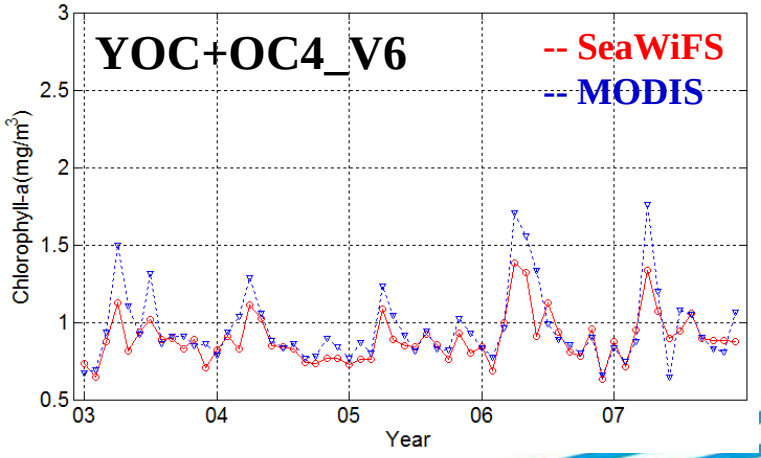
## 1. Satellite Data (Monthly)

- SeaWiFS (1998~2007), MODIS (2003~2014), Merged Periods (2003~2007)



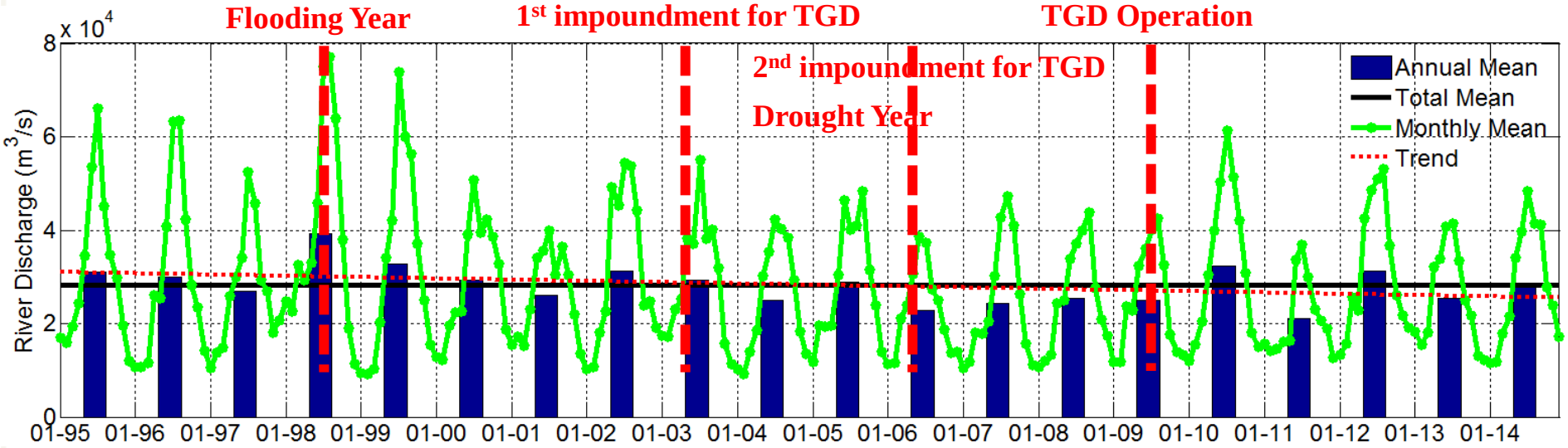



# Data and Methods

## 2. Changjiang River Discharge (Monthly)

**- Datong Station, China**

**(http://yu-zhu.vicp.net (1995~2014))**

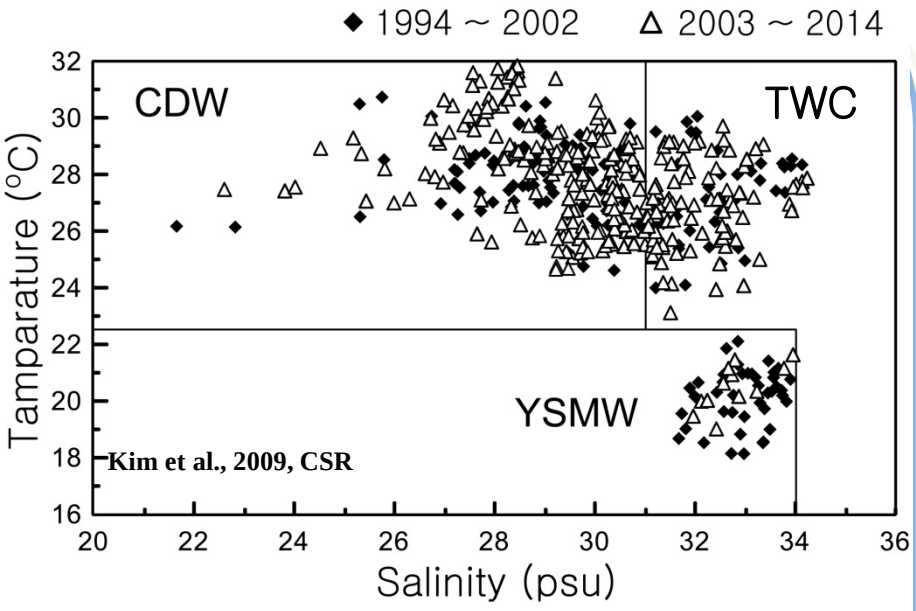



**R=-0.14,**
**P value=0.05**

# Data and Methods

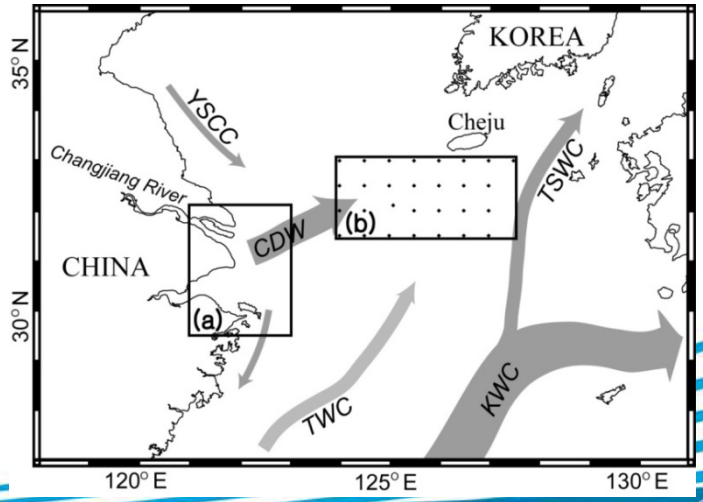
### 3. Nutrient Data (July or Aug. 1995~2014)

- NFRDI (1995~2014), Korea
- KISOT ECS Cruises Data (2007-2011)

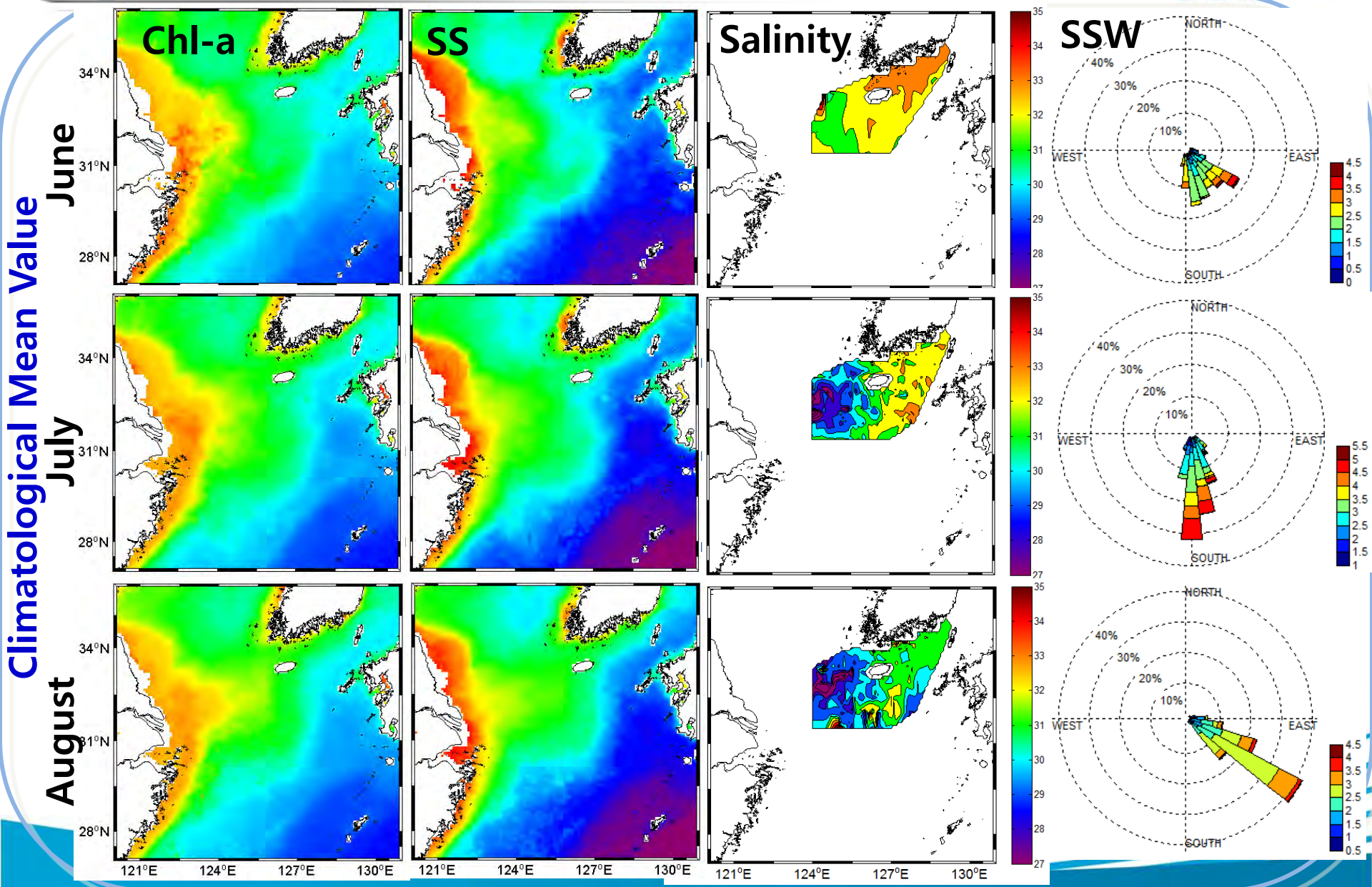



### 4. Spatial & Temporal Variation Analysis

- EOF and K mean analysis using summer (Jun.~Aug.) monthly chlor-a data (1998~2014)

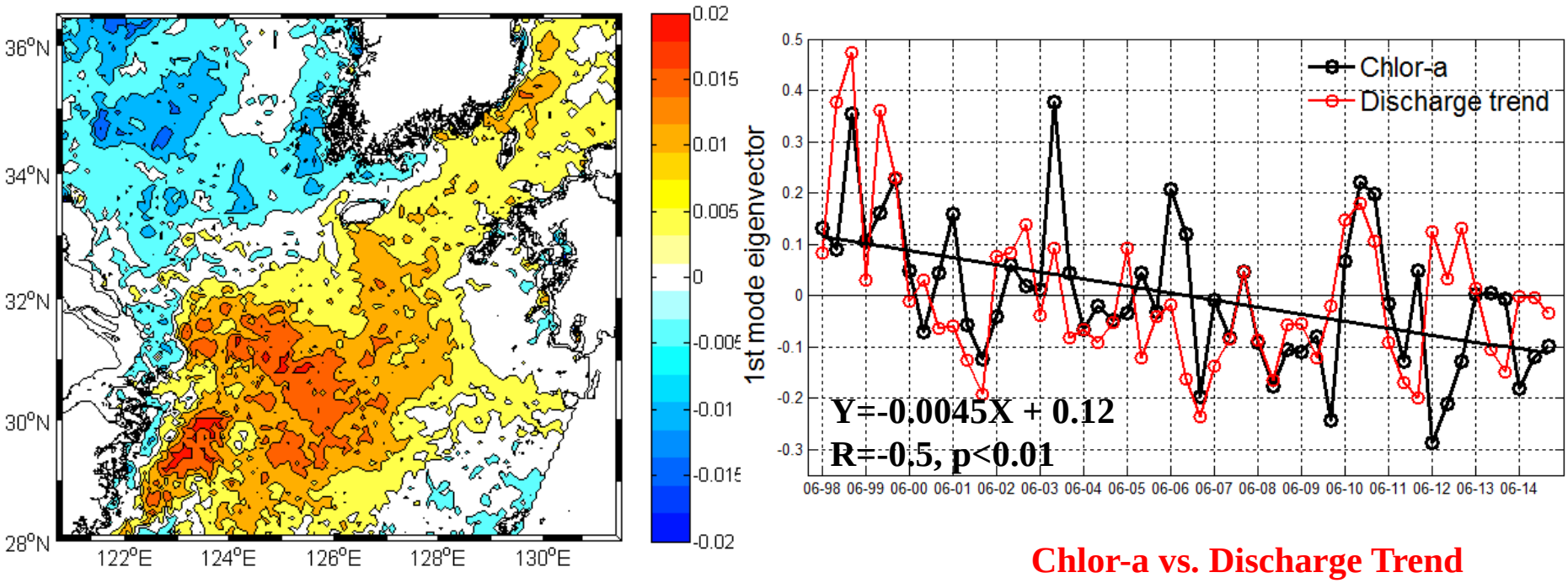


# Spatial & Temporal Variations during summer in ECS



# Spatial & Temporal Variations during summer in ECS

## EOF analysis using the summer (Jun. ~ Aug.) of 1998-2014 : 1st mode : 14 %



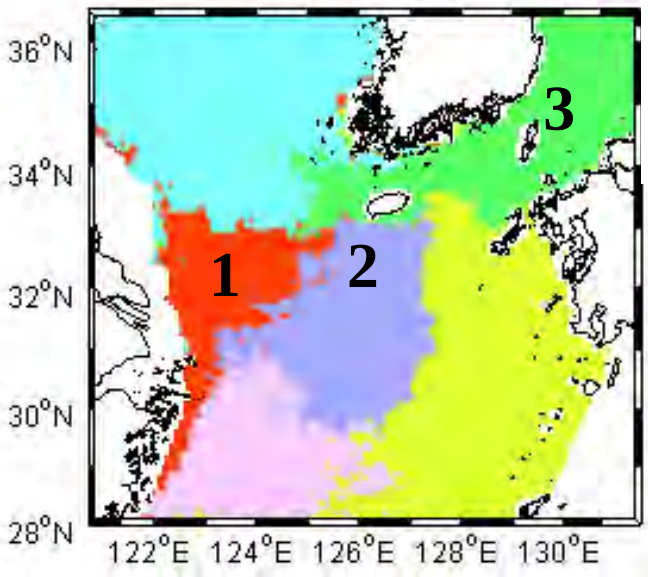

- Well correlated between Chl-a and river discharge

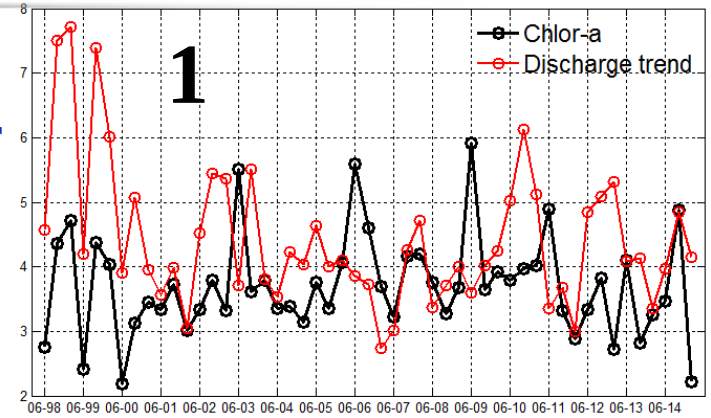
**Chlor-a vs. Discharge Trend**

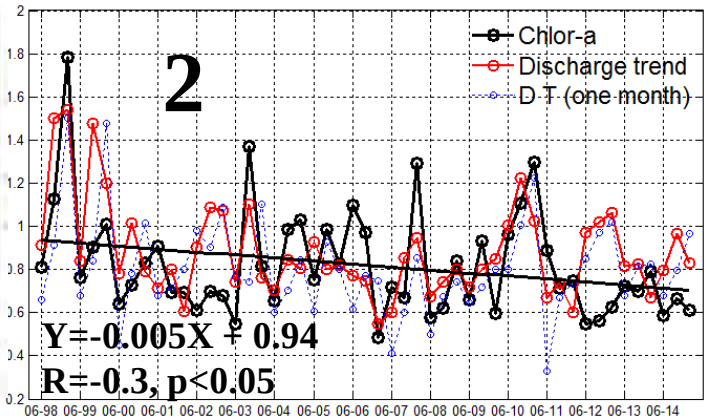
**R=0.49, p value < 0.01**

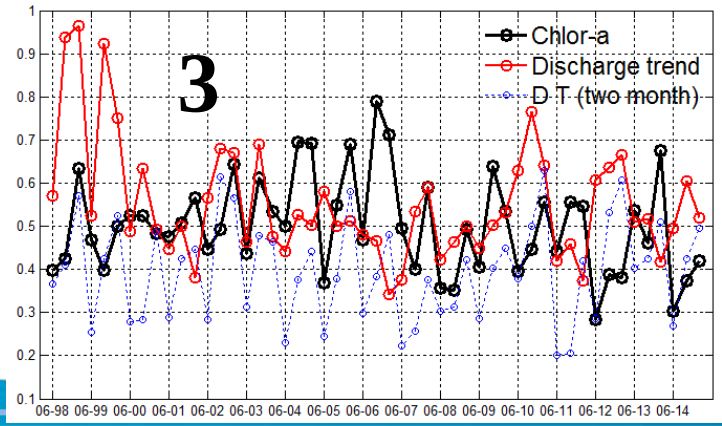
# Spatial & Temporal Variations during summer in ECS

**K mean analysis using the summer (Jun. ~ Aug.) of 1998-2014**




**Chlor-a vs. Discharge Trend**

**R=0.18, p value = 0.21**

**R=0.53, p value < 0.01**

**R=0.42, p value < 0.01**

(A lag of one month with discharge)

**R=-0.15, p value =0.30**

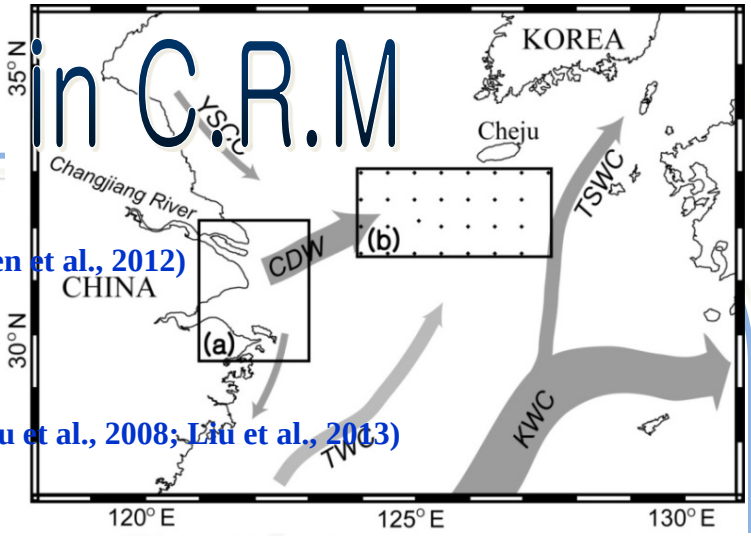
**R=0.35, p value < 0.01**

(A lag of two month with discharge)

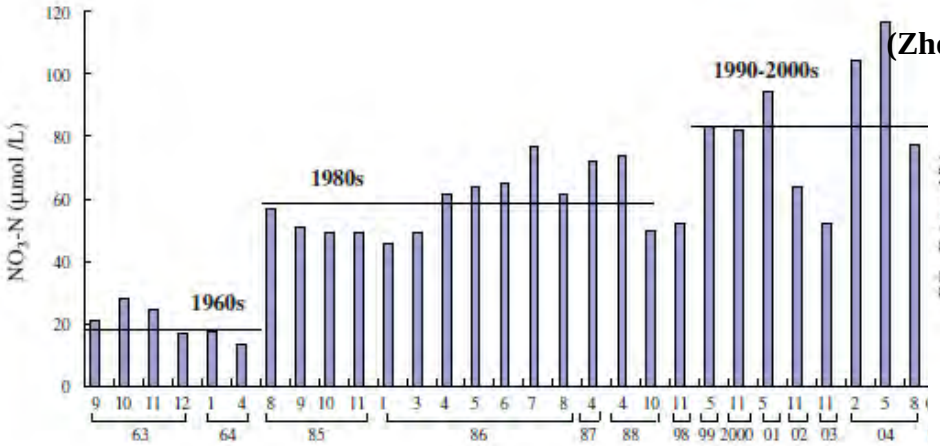
# Environmental Conditions in C.R.M

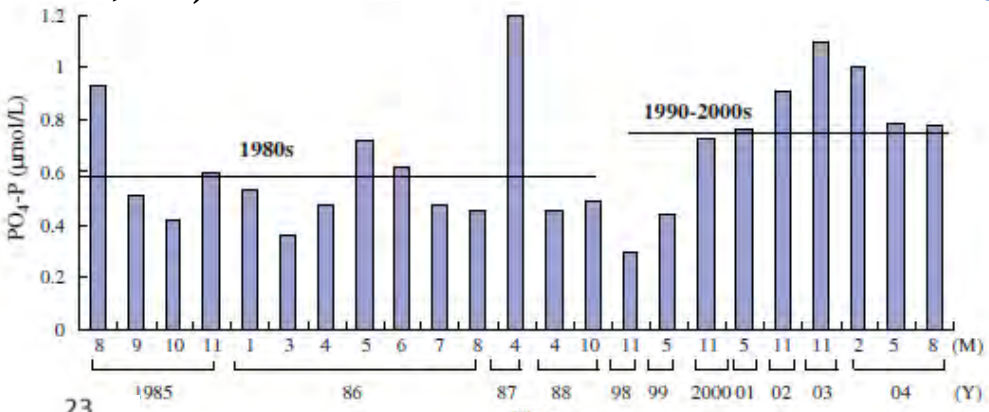
## (a) Area :

- **Increasing Nutrient Input** (Zhou et al., 2008; Chai et al., 2009; Chen et al., 2012)
- **Excess Nitrate & Reduce Phosphate (P limitation)**
- **Changing Phytoplankton Community** (Chen et al., 2003; Zhou et al., 2008; Liu et al., 2013)

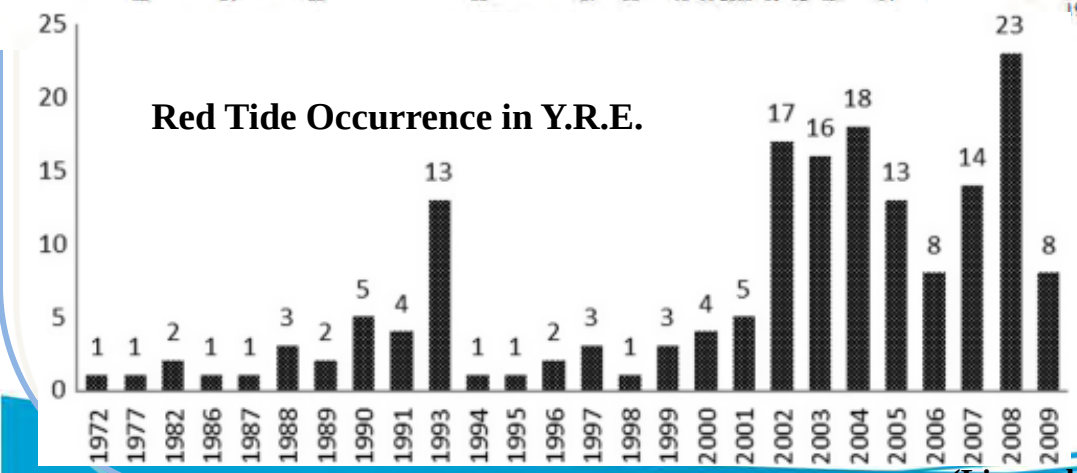


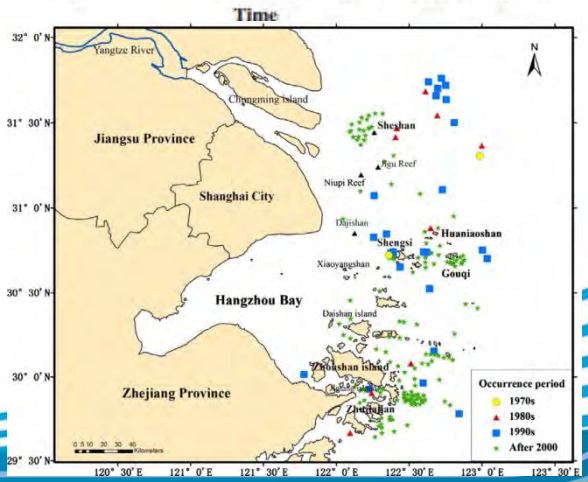

(Zhou et al., 2008)




**Red Tide Occurrence in Y.R.E.**

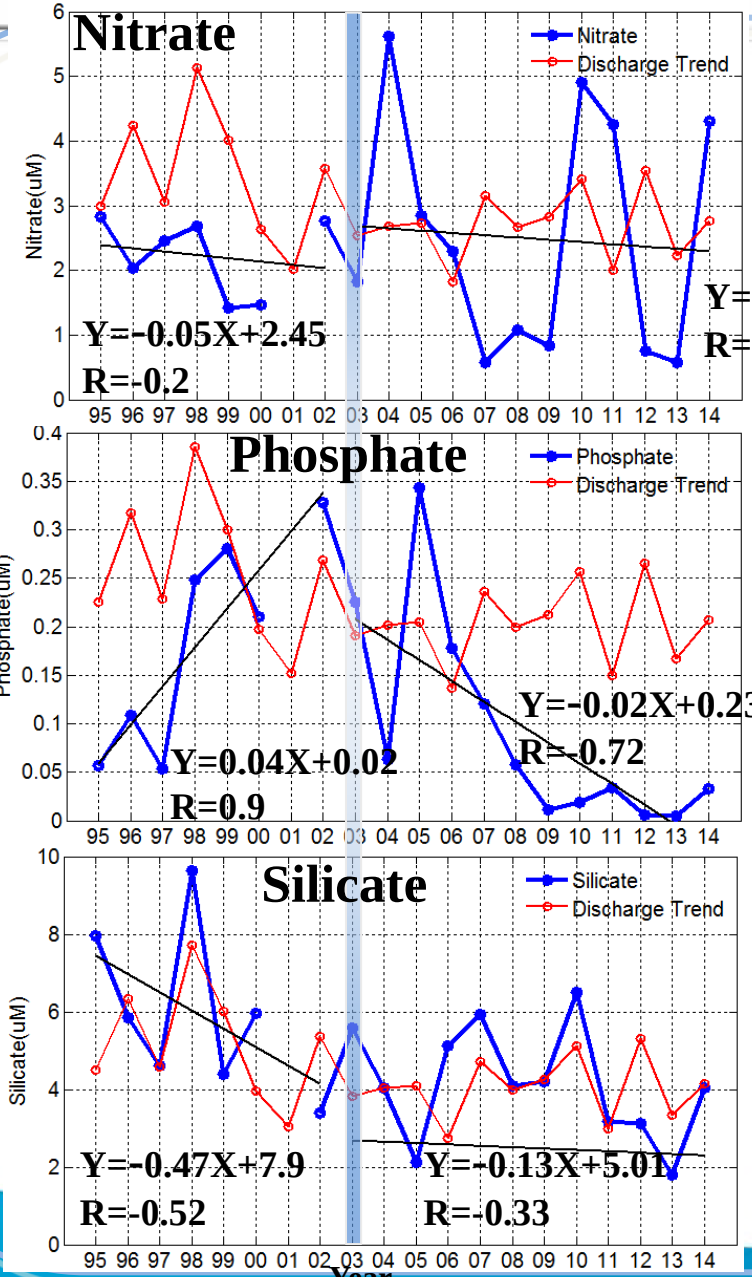



(Liu et al., 2013)

# Environmental Conditions in the Study Area

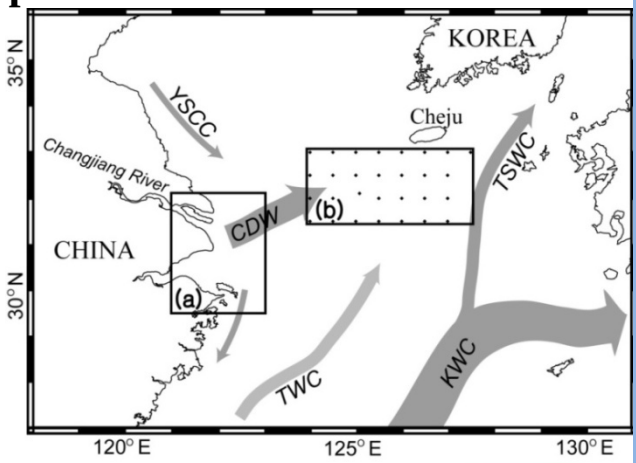
Annual Variations of Nutrients




## Nutrients vs. C.R.D. (July)

**95~14 : r=0.05, p=0.83**
**95~02: r=0.02, p=0.95**
**03~14: r=0.23, p=0.48**

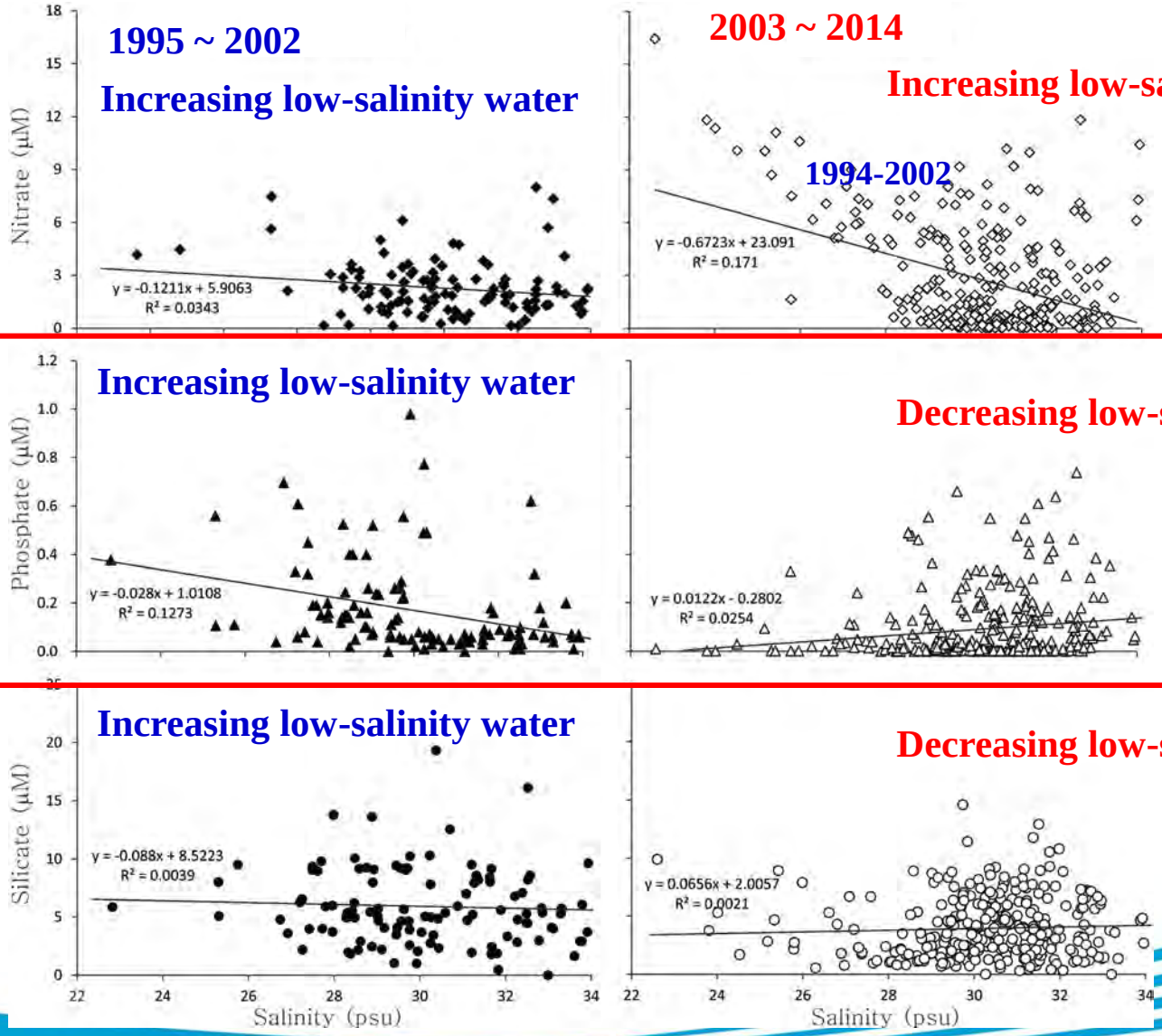
**95~14 : r=0.30, p=0.21**
**95~02: r=0.19, p=0.68**
**03~14: r=-0.11, p=0.74**




**95~14: r=0.65, p=0.002**
**95~02: r=0.53, p=0.21**
**03~14: r=0.49, p=0.1**

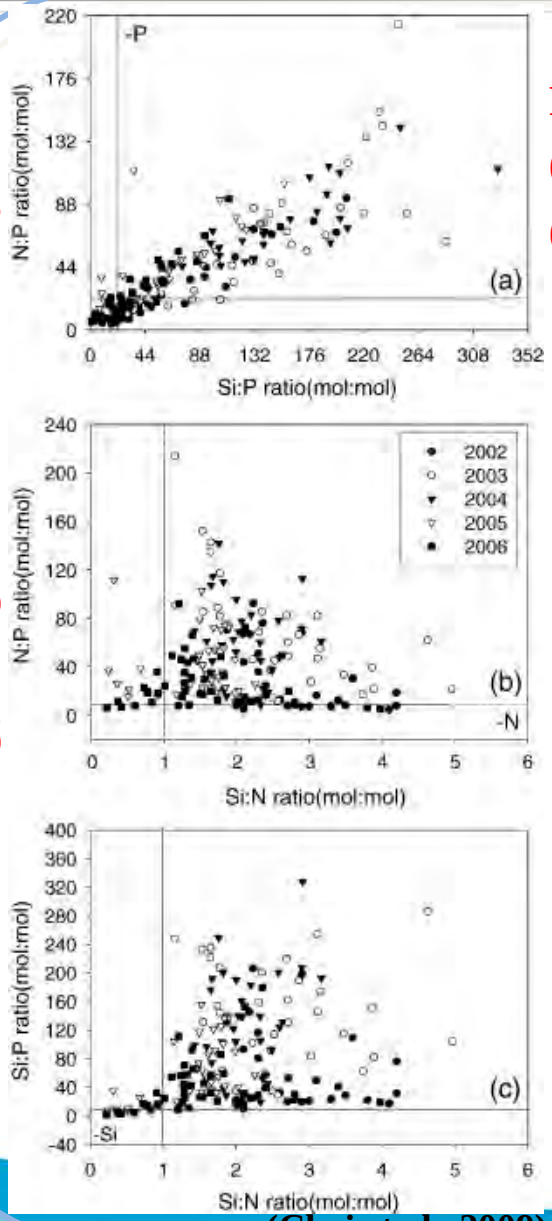
# Environmental Conditions in the Study Area

## Nutrients vs. Salinity



# Environmental Conditions in the Study Area

Changjiang River Estuary

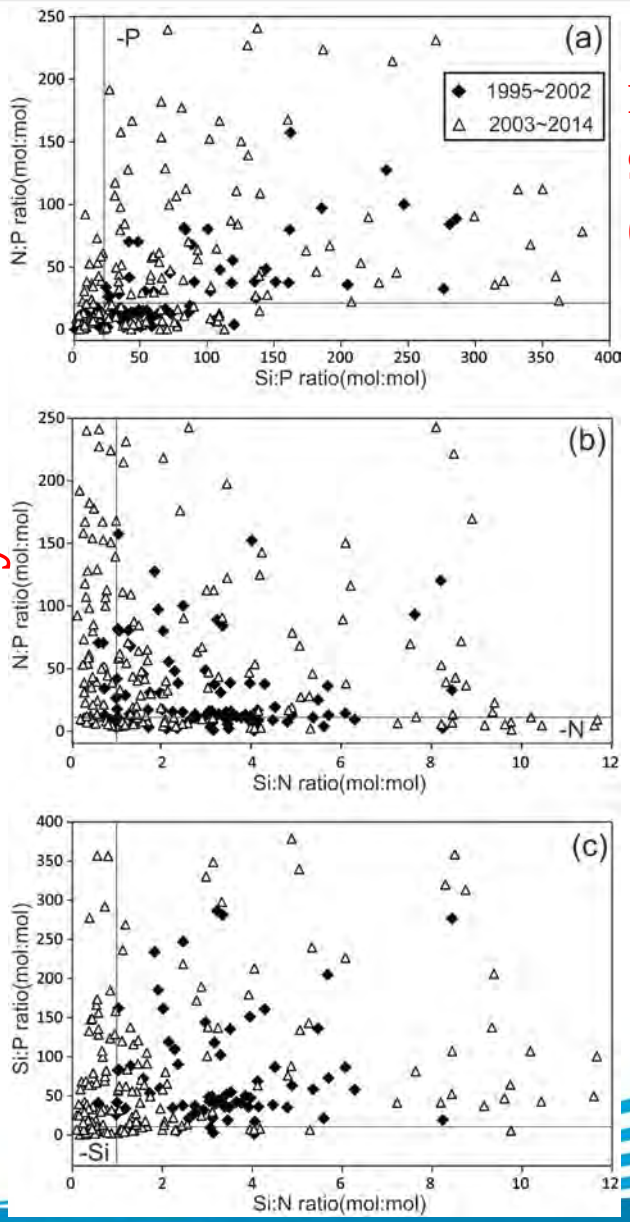



**P limitation**

**02 : 28.6%**

**03~06 : 68.1%**

Study Area




**P limitation**

**95~02 : 37.9%**

**03~14 : 63.5%**

**N limitation**

**95~02 : 28.2%**

**03~14 : 18.9%**

**Si limitation**

**95~02 : 3.9%**

**03~14 : 6.6%**

**(Chai et al., 2009)**

# Conclusions

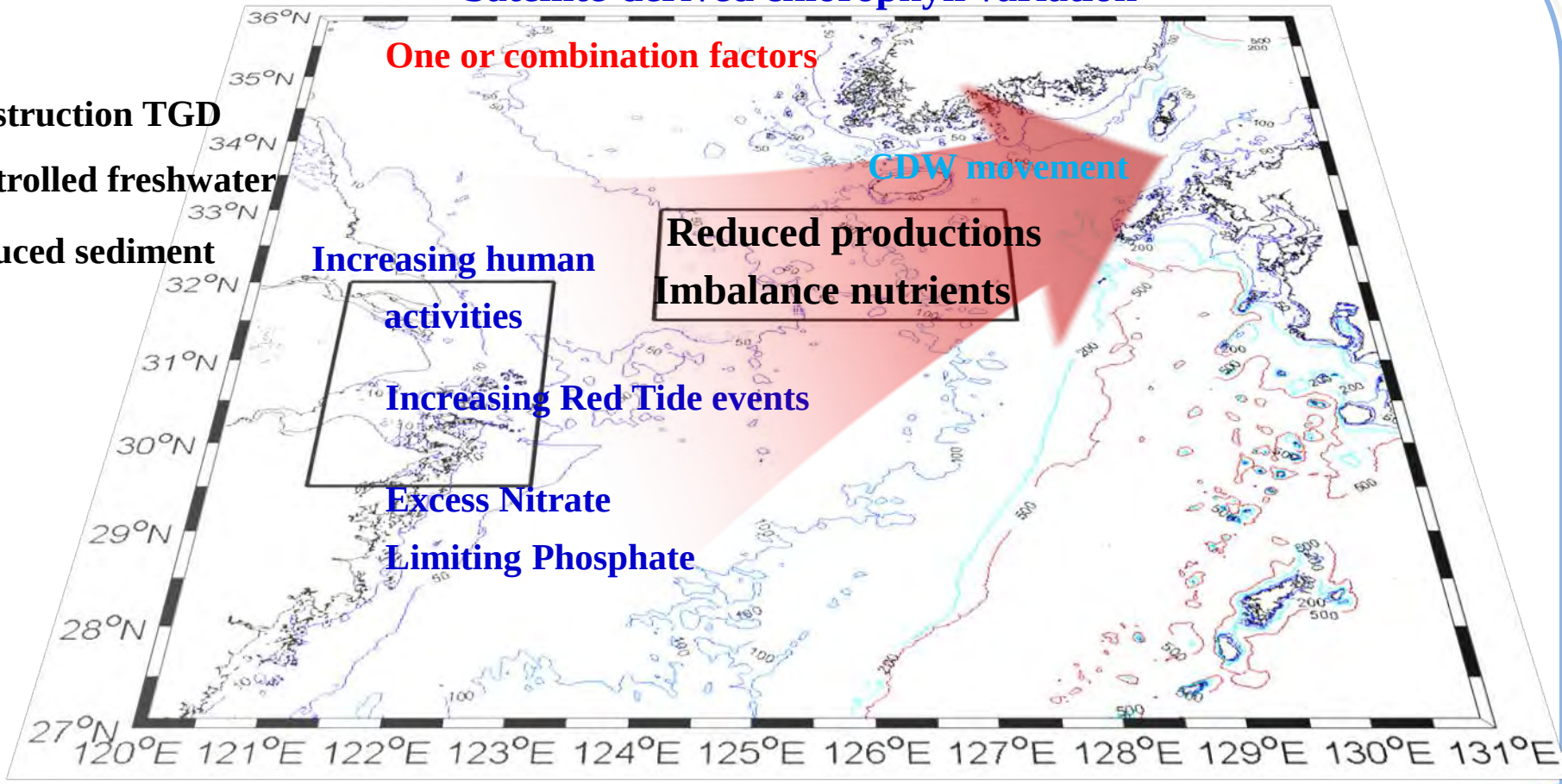
**The Summer Seasons of 1998-2014**

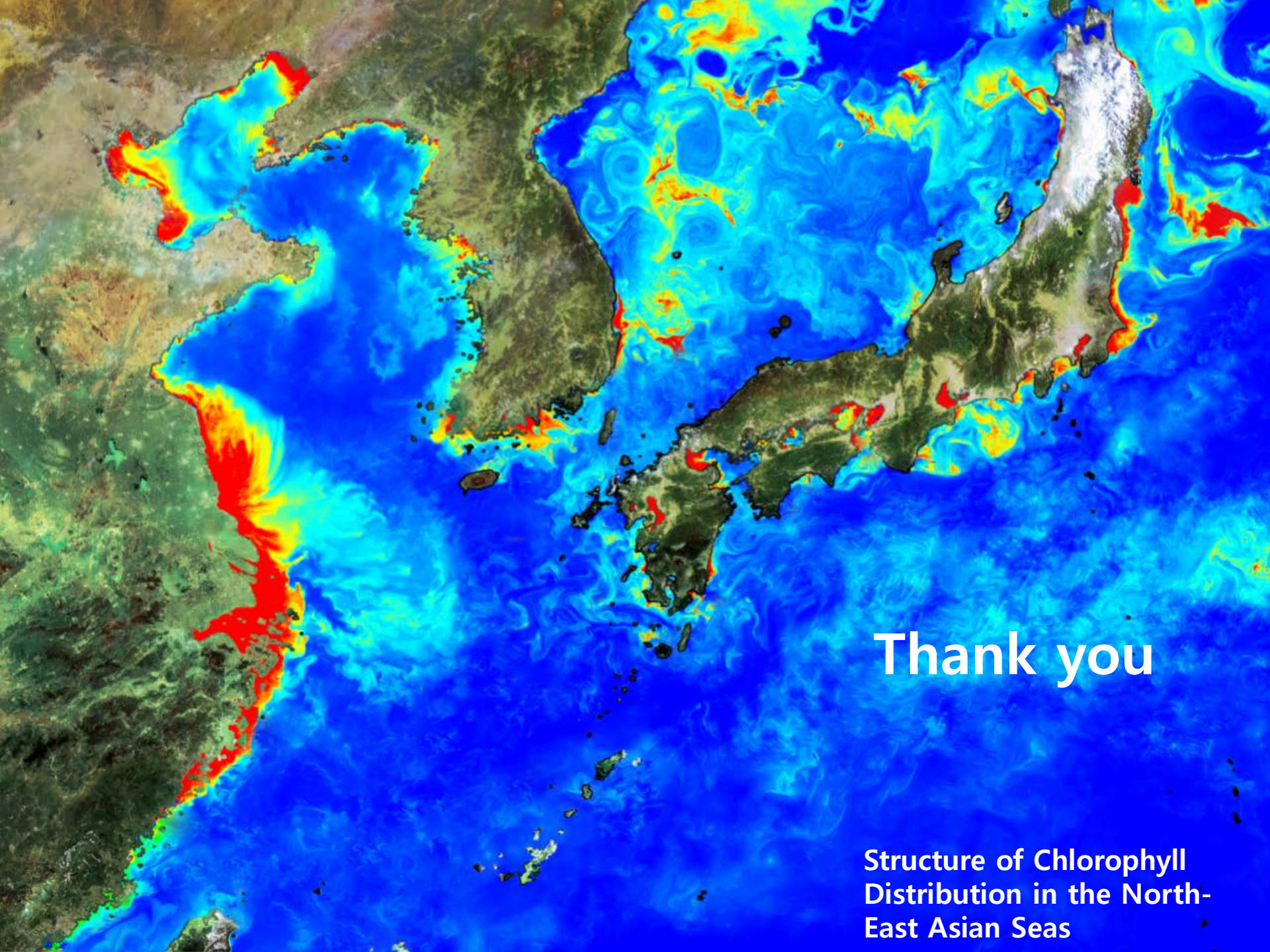
**Satellite-derived chlorophyll variation**

**Construction TGD**

**Controlled freshwater**

**Reduced sediment**




Thank you
Structure of Chlorophyll Distribution in the North-East Asian Seas