



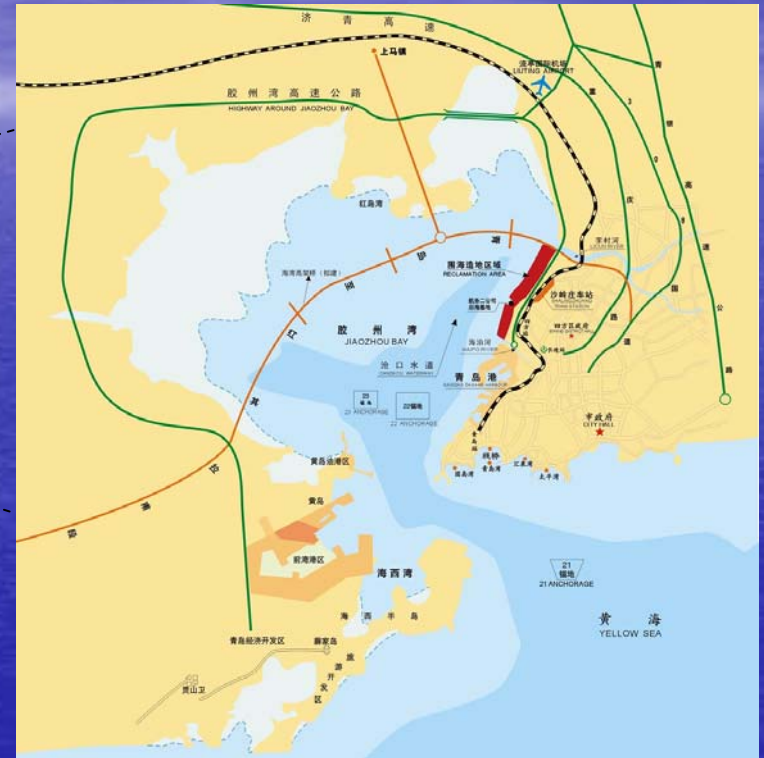
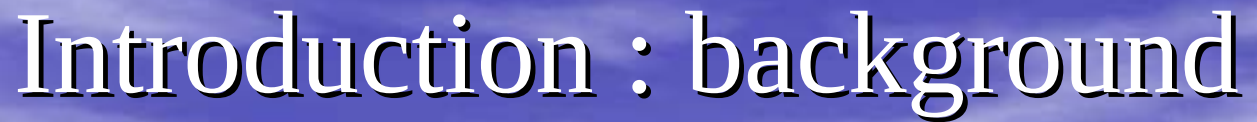
Simulation on phytoplankton system evolution of Jiaozhou Bay for recent 40 years

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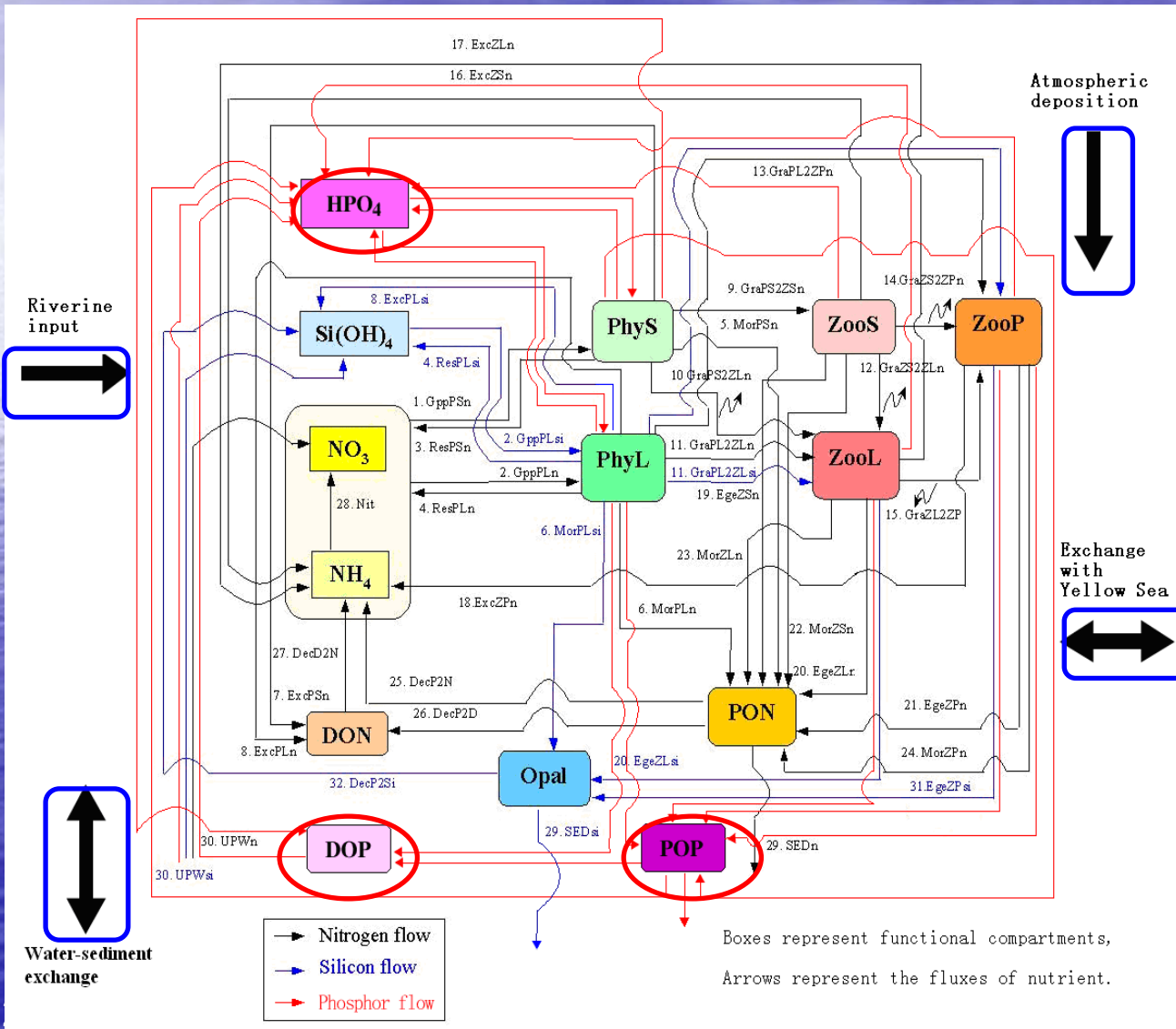
Outline

- Introduction
- Validation and results
- Numerical experiments
- Conclusion and discussion





Introduction : model structure



➤ Phosphorus cycle

➤ Riverine input and atmospheric deposition

➤ Water-sediment exchange

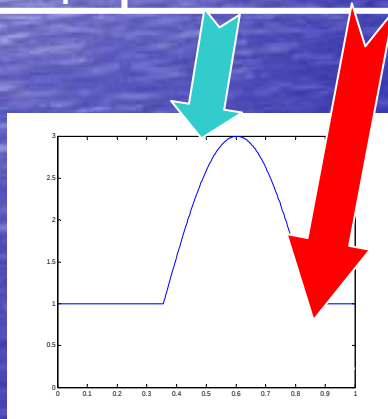
➤ Exchange with Yellow Sea



Introduction : external forces

External input of nutrient in 1990s ($\text{mol}\cdot\text{d}^{-1}$)

	Riverine input	Bottom input	Atmospheric deposition	
			Dry	Wet
DIN	4.28×10^4	7.90×10^3	1.07×10^3	6.10×10^2
DIP	2.06×10^6	9.68×10^5	1.61×10^5	9.91×10^4
$\text{Si}(\text{OH})_4$	2.03×10^5	1.06×10^6	4.30×10^2	3.73×10^3



polation

Xiulin Wang, 2006

Constant

Constant

Positively
Proportional to
precipitation



Introduction : external forces

➤ Exchange with Yellow Sea

Concentration of nutrients and planktons in Yellow Sea are assumed to be constant

$$Exchange(X) = \frac{X_{Yellow\ Sea} - X_{Jiaozhou\ Bay}}{t_{exchange}}$$

➤ Water temperature

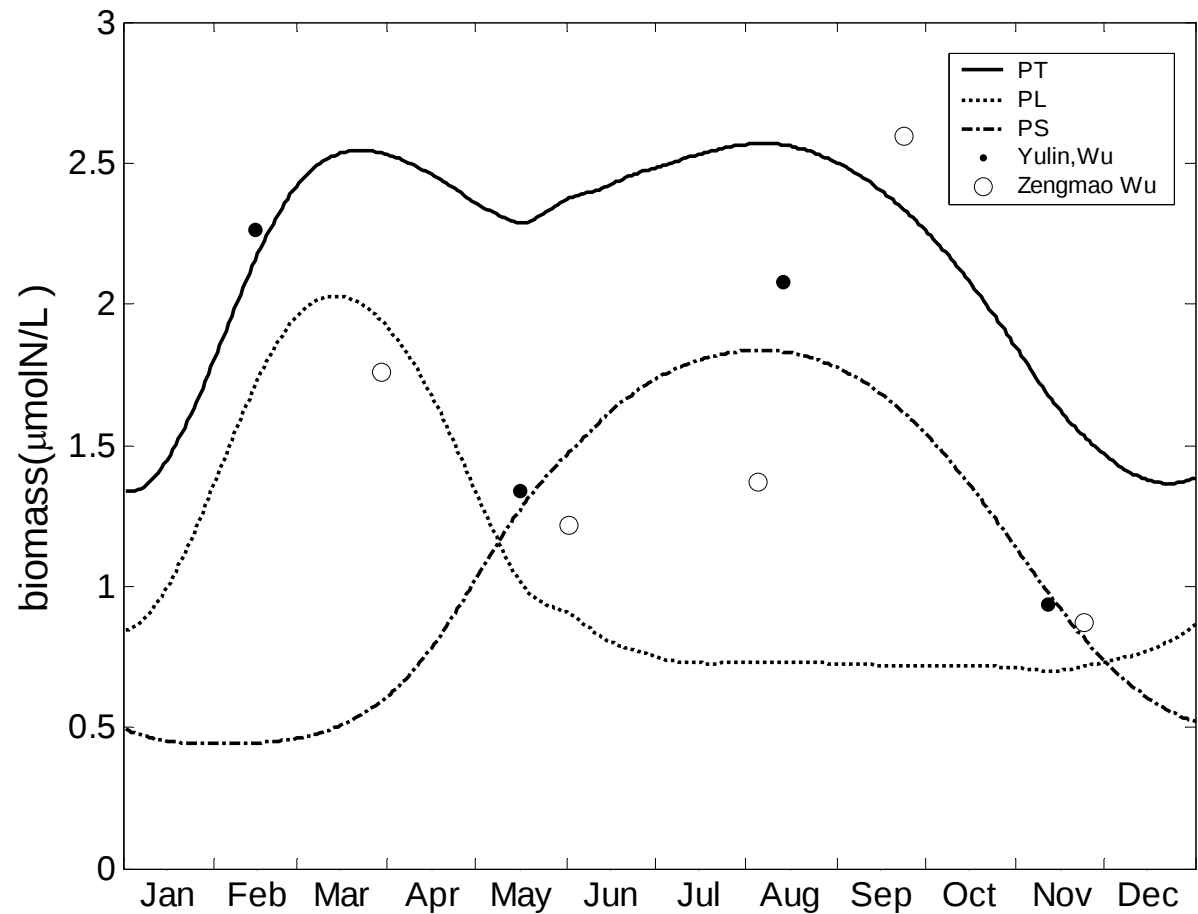
Observed data from a tidal gauge at Xiaomaidao

➤ PAR

Calculated with the cloud cover data from Tuandao weather station



Validation and results : seasonal



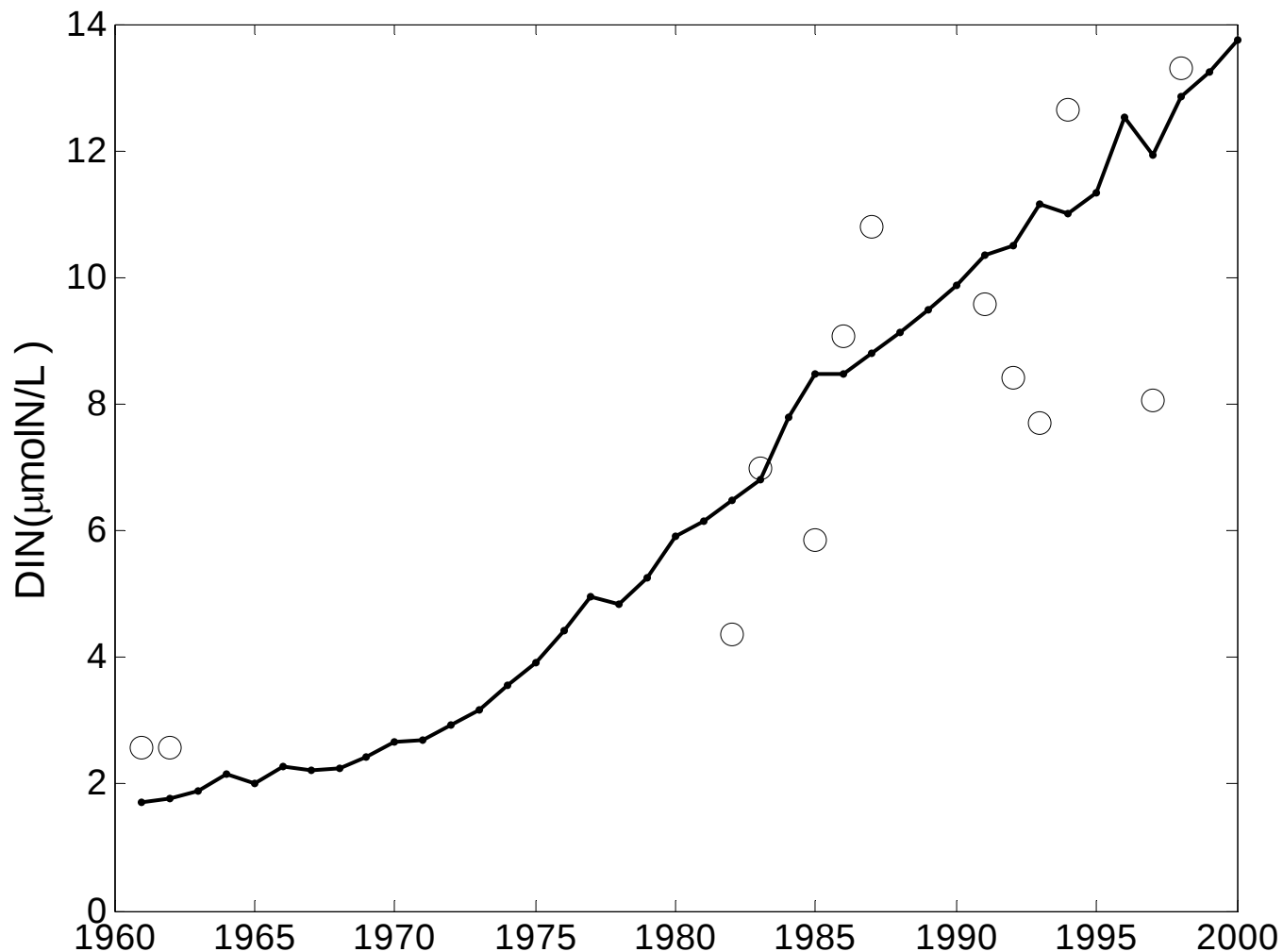


Validation and results : inter-annual

DIN

DIP

Si(OH)_4



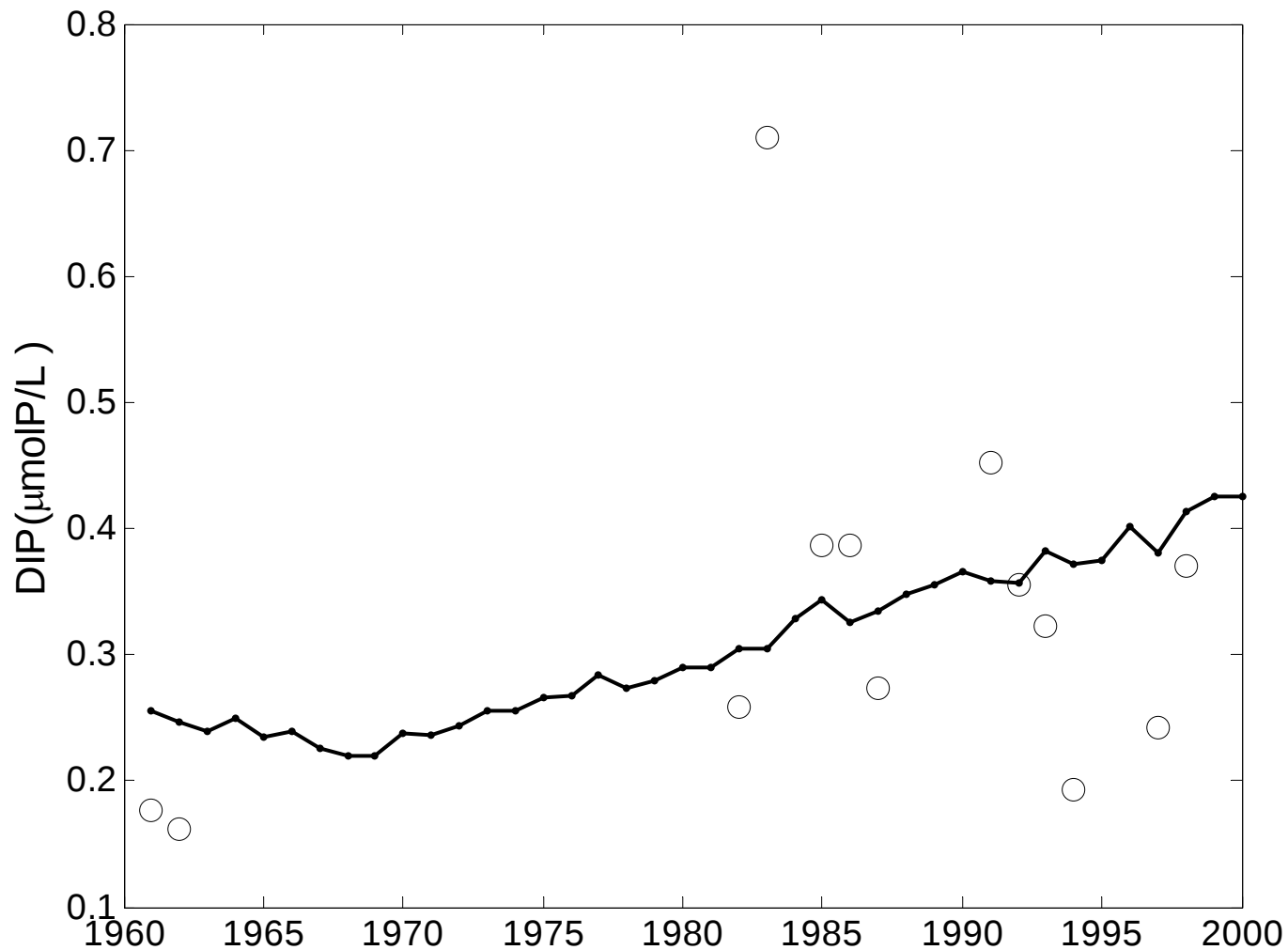


Validation and results : inter-annual

DIN

DIP

Si(OH)_4



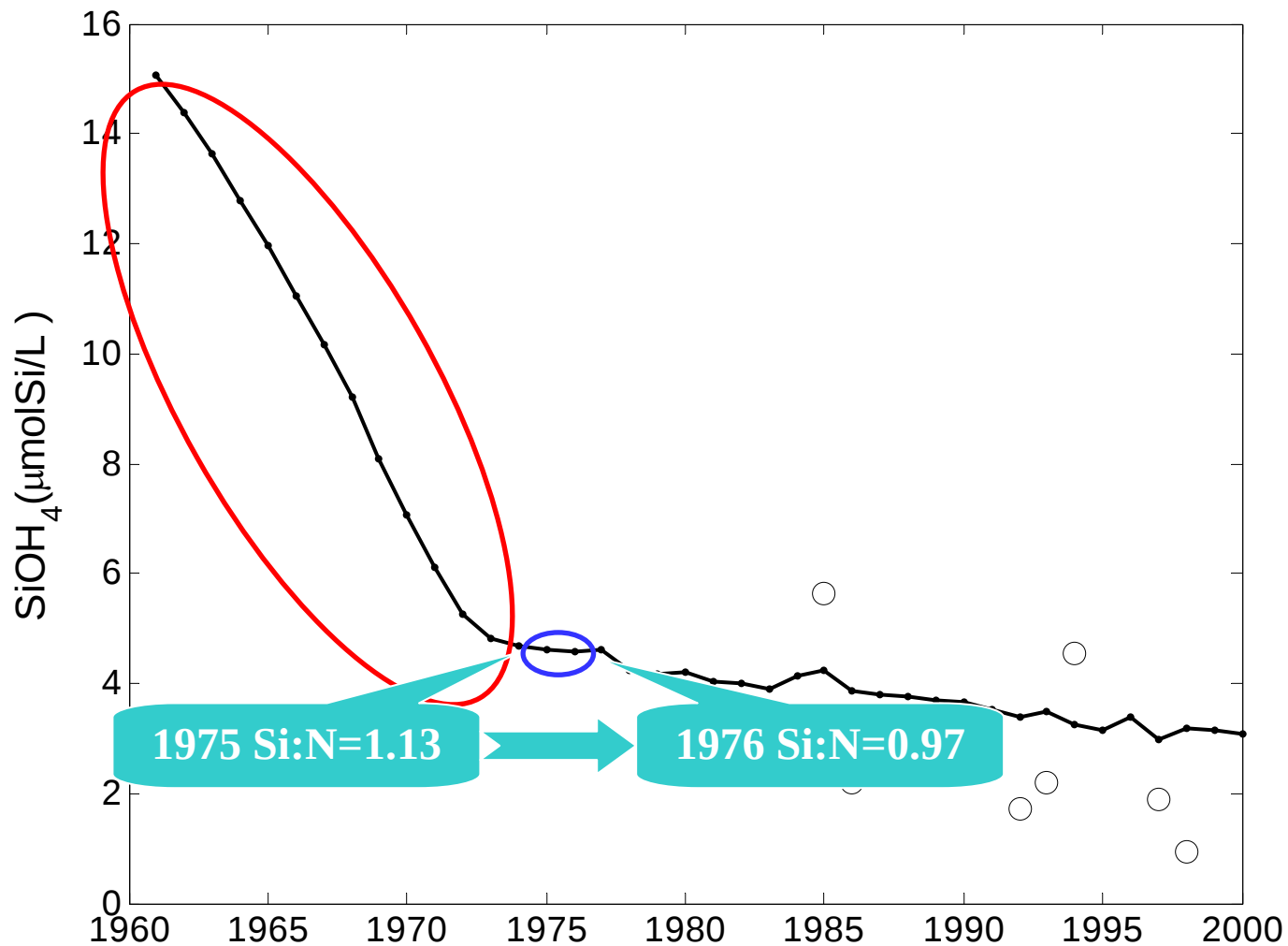


Validation and results : inter-annual

DIN

DIP

Si(OH)_4

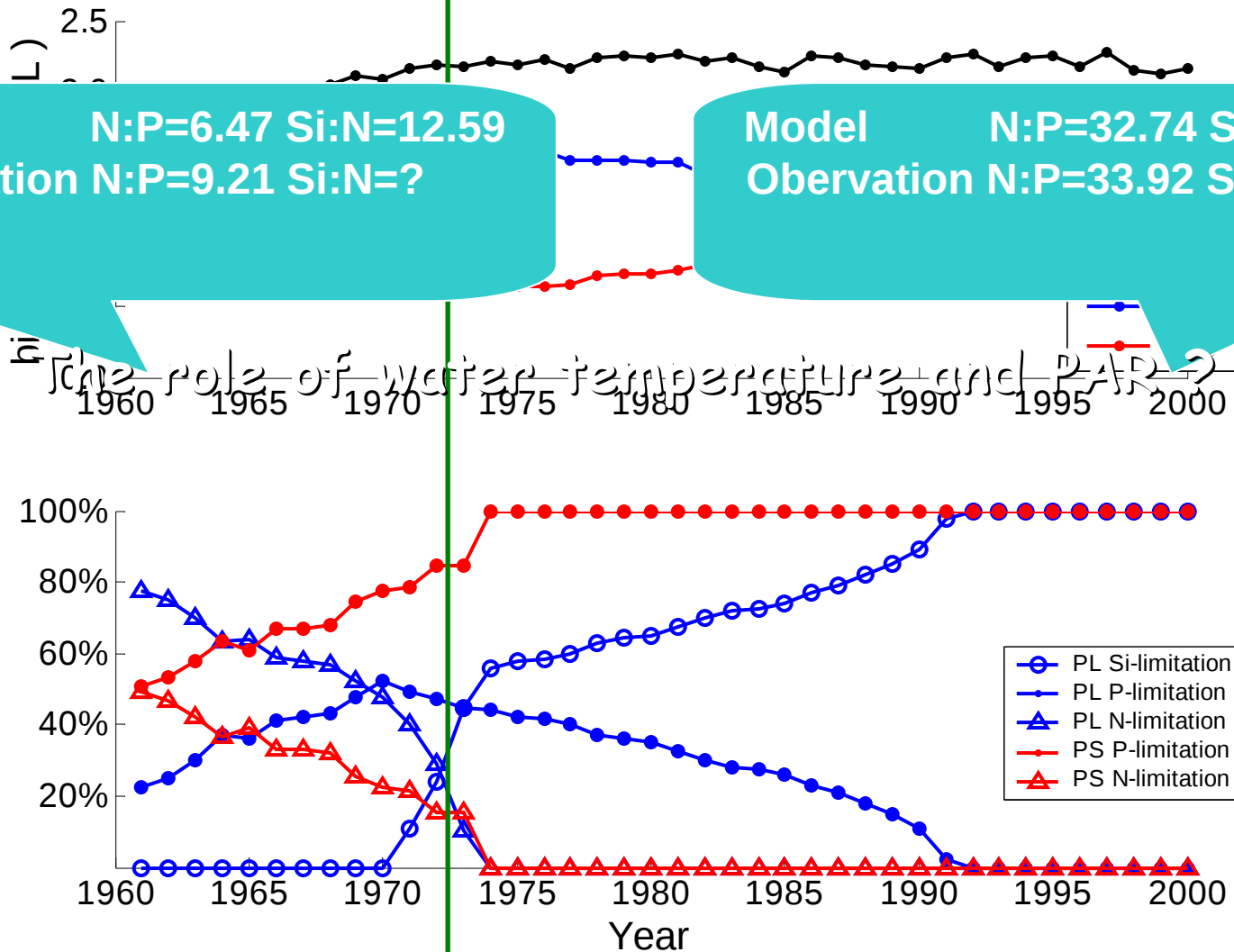




Validation and results : inter-annual

Model N:P=6.47 Si:N=12.59
Observation N:P=9.21 Si:N=?

Model N:P=32.74 Si:N=0.24
Observation N:P=33.92 Si:N=0.21



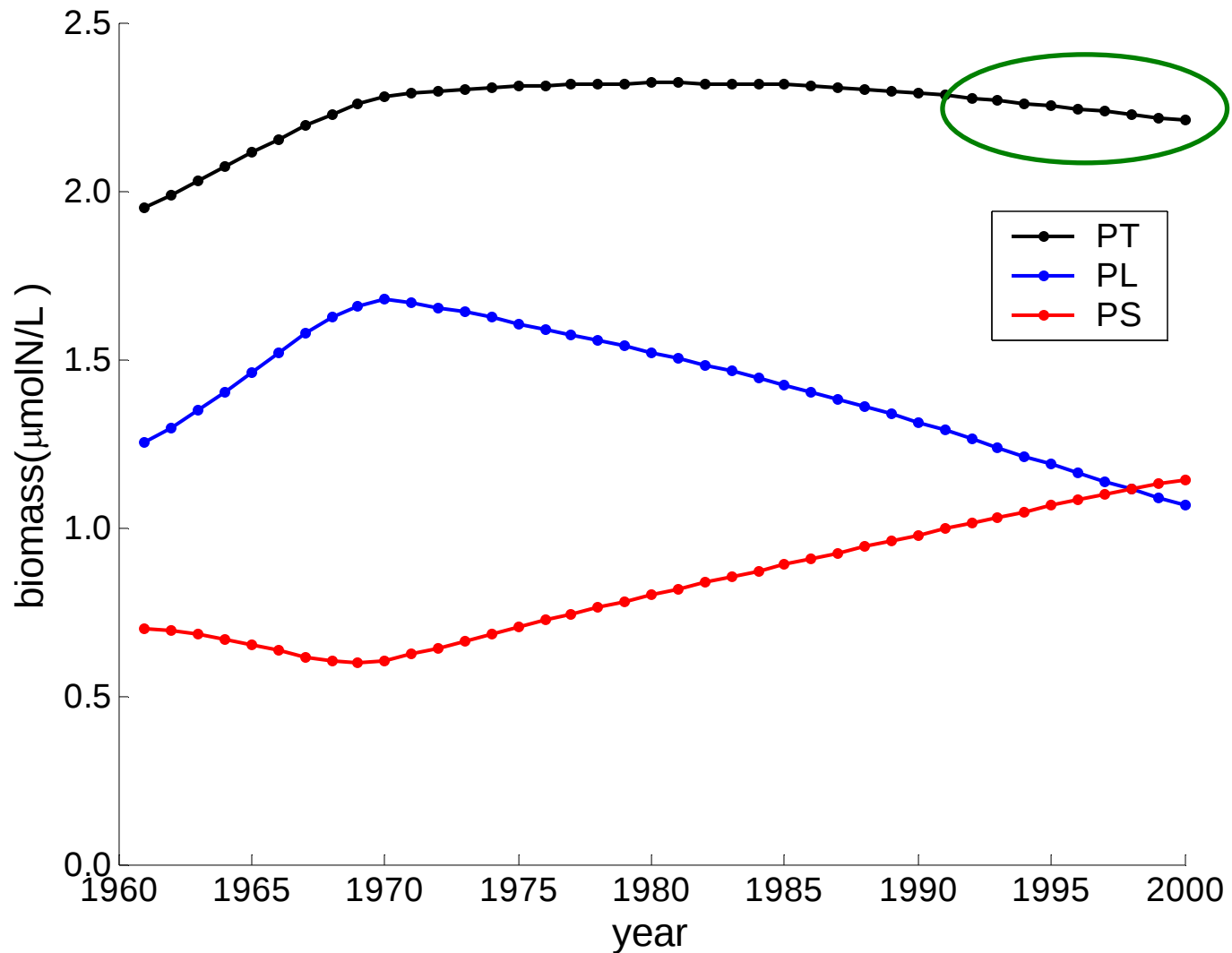


Numerical experiments

	Nutrient input	PAR	Water temperature
Experiment 1	Inter-annual change Seasonal variation of 1995	1995	1995
Experiment 2	1995	Inter-annual change Seasonal variation of 1995	1995
Experiment 3	1995	1995	Inter-annual change Seasonal variation of 1995

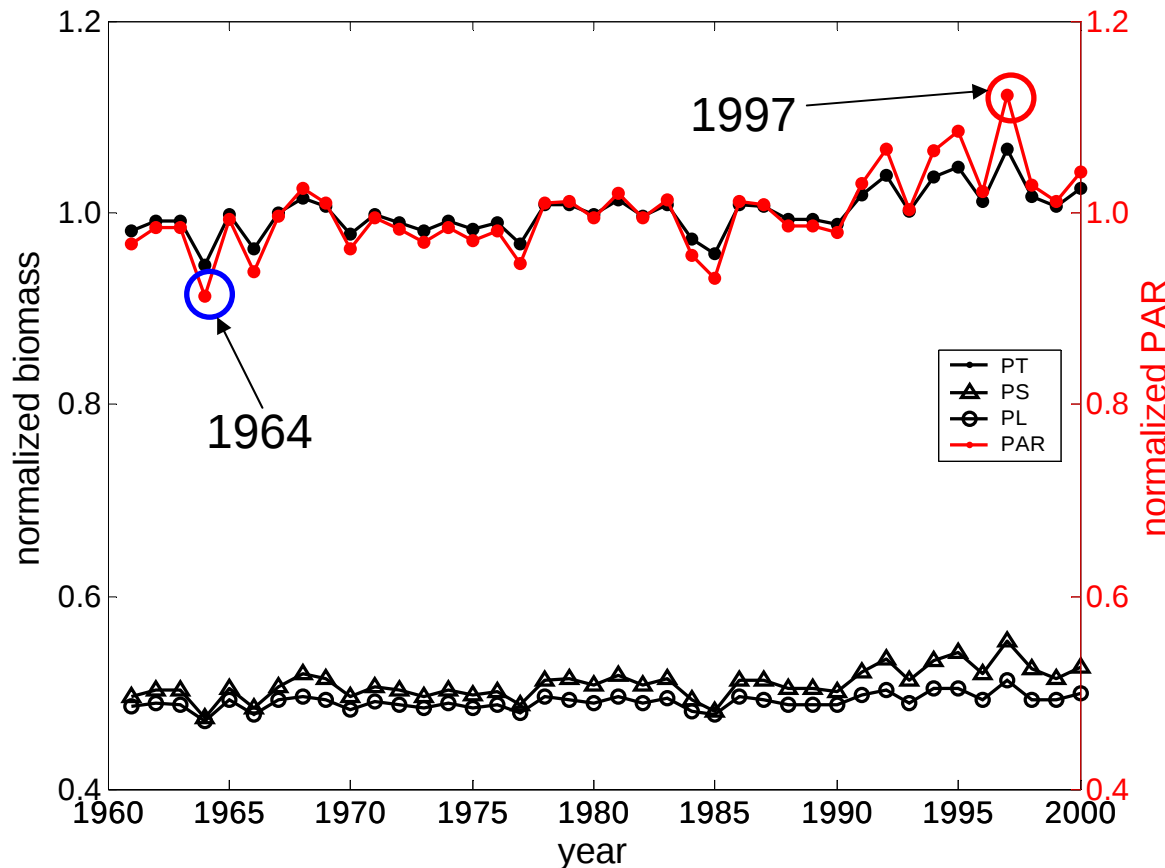


Numerical experiments : Nutrient input





Numerical experiments : PAR



$$\overline{PT} = PT / \text{mean}(PT)$$

$$\overline{PS} = PS / \text{mean}(PT)$$

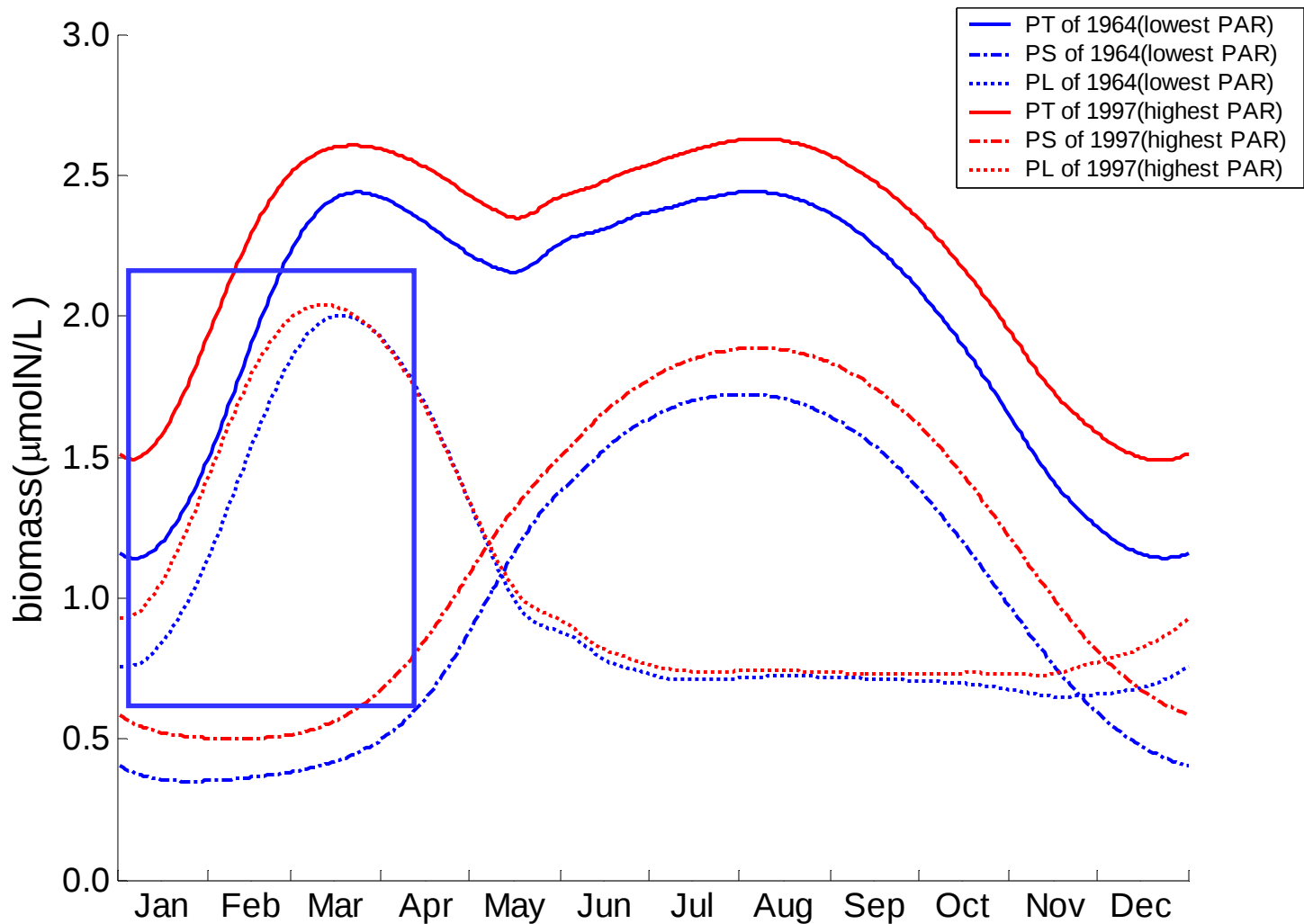
$$\overline{PL} = PL / \text{mean}(PT)$$

$$\overline{PAR} = PAR / \text{mean}(PAR)$$

**PAR is important to PT,
but has little influence
on the alternation of
dominant species**

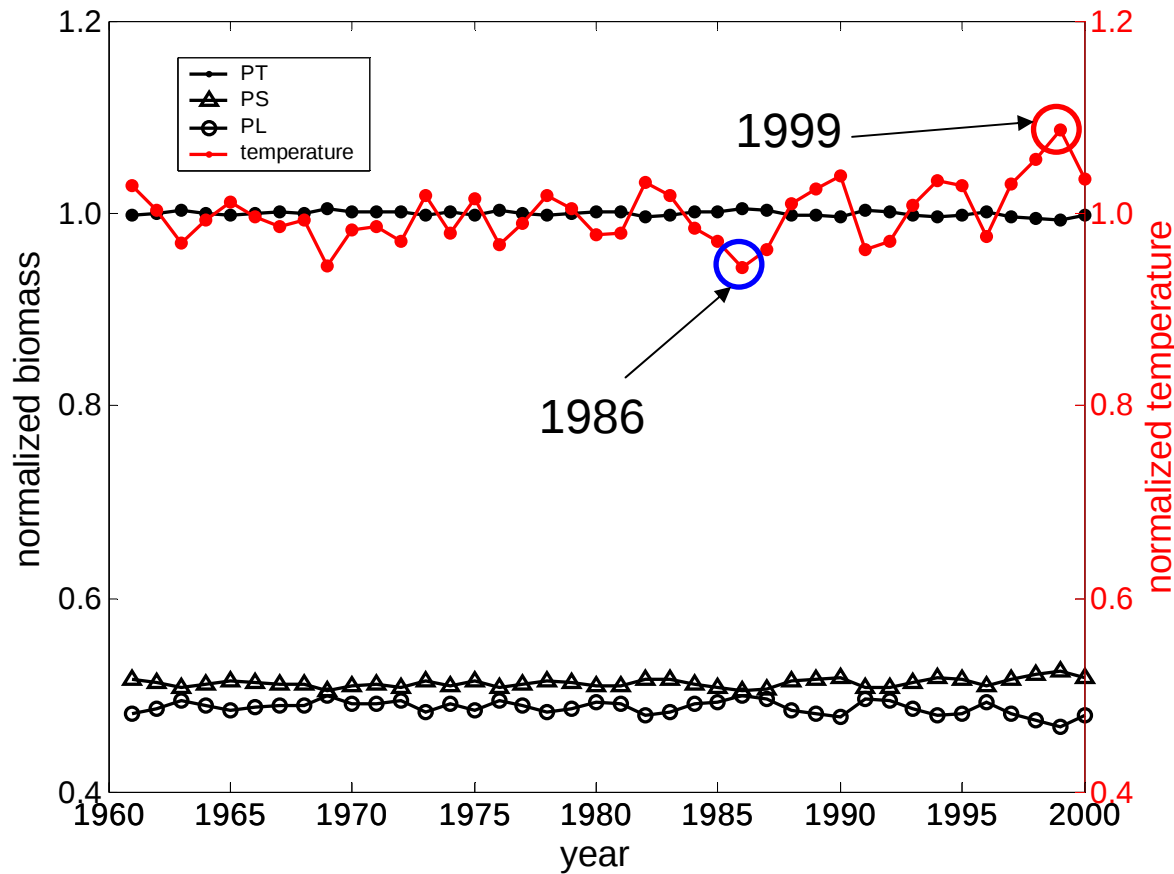


Numerical experiments : PAR





Numerical experiments : water temperature



$$\overline{PT} = PT / \text{mean}(PT)$$

$$\overline{PS} = PS / \text{mean}(PT)$$

$$\overline{PL} = PL / \text{mean}(PT)$$

$$\overline{T} = T / \text{mean}(T)$$

When it becomes warmer, there is no significant change in PT. However, for phytoplankton composition, PS increases while PL decreases



Numerical experiments : water temperature

Si(OH)₄ and Opal input from runoff, bottom and atmosphere

Higher water temperature

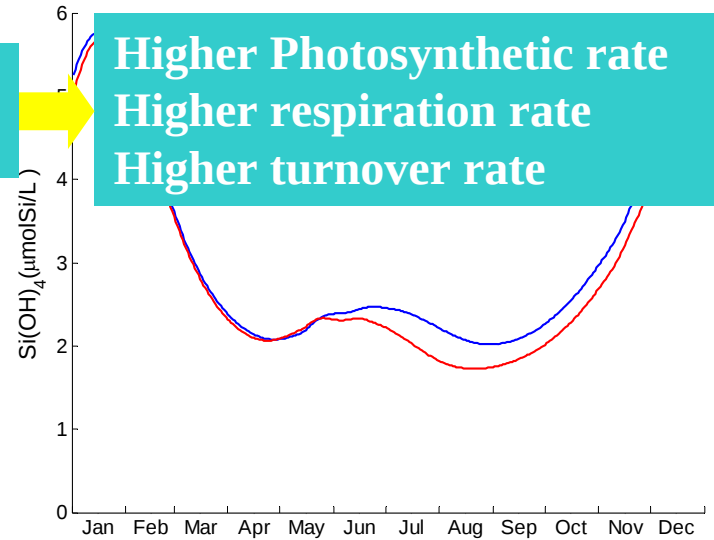
Higher Photosynthetic rate
Higher respiration rate
Higher turnover rate

Lower Si(OH)₄

Exchange with Yellow sea

Opal settling

$$\frac{d(\text{Si(OH)}_4)}{dt} = -\text{Photosynthesis (PL)} + \text{respiration (PL)} + \text{extracellular excretion(PL)} + \text{decomposition(Opal to Si(OH)}_4) + \text{bottom input(Si(OH)}_4) + \text{Yellow sea exchange(Si(OH)}_4) + \text{riverine input(Si(OH)}_4) + \text{atmospheric deposition(Si(OH)}_4)$$



biomass

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Conclusion and discussion

- In Jiaozhou Bay, nutrient structure affect the phytoplankton community. The increasing of nitrogen and phosphate and decreasing of silicate result in the alternation of the dominant phytoplankton species from large phytoplankton to small phytoplankton.
- PAR plays an important role in the inter-annual variation of total phytoplankton biomass. And also change the onset time of spring phytoplankton bloom
- Water temperature have little impact on the variation in total biomass. But it also changes the composition of phytoplankton.



Conclusion and discussion

In Jiaozhou bay, Large diatom $\rightarrow$ small diatom

NEMURO : PS~flagellate

PL~diatom

Large diatom

Small diatom



Thank you !

