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Variability and mechanisms of seasonal hypoxia off the Changjiang Estuary, China

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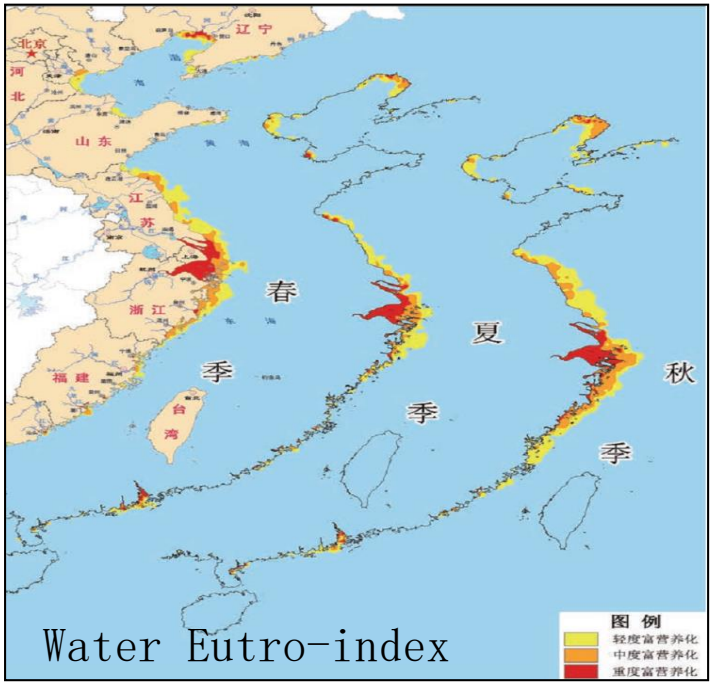
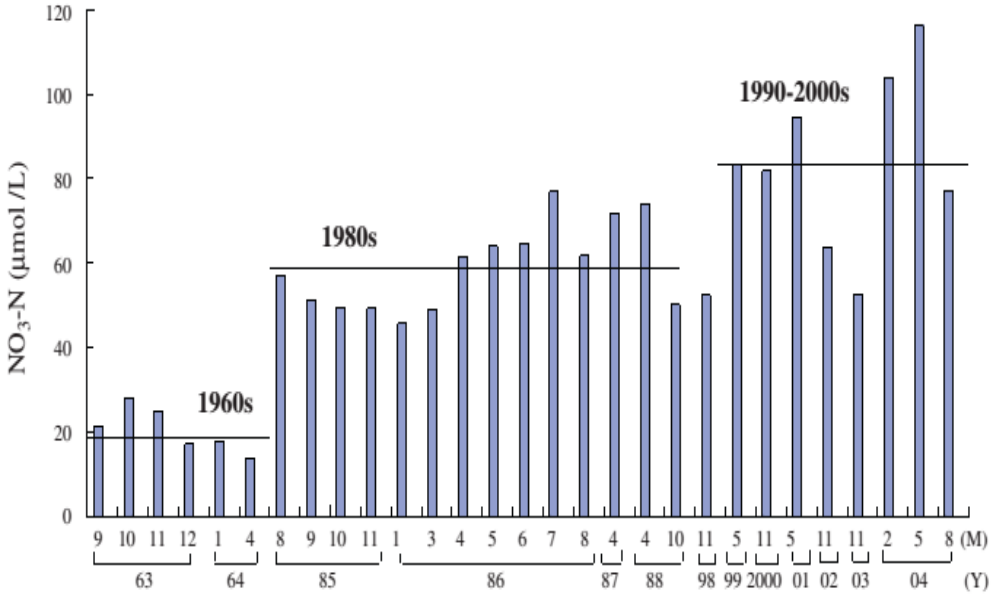
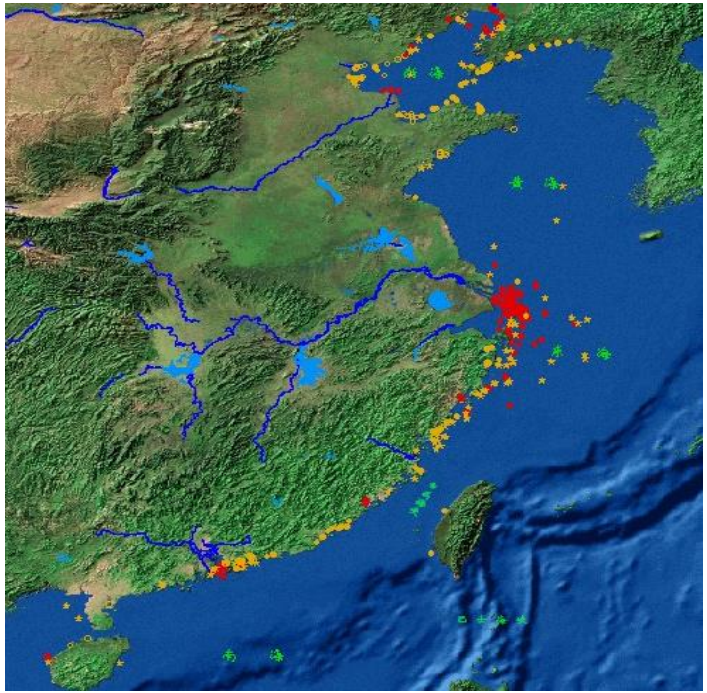
Eutrophication off the Changjiang Estuary





Zhou *et al*. 2008, *JMS*

Eutrophication and Harmful algal blooms



Harmful Algae blooms
SIOSOA, Satellite data

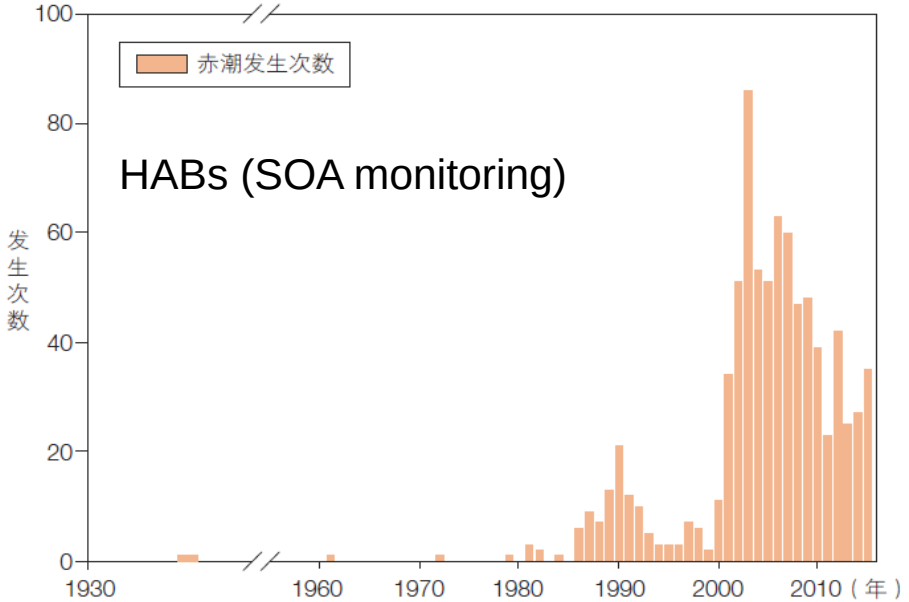
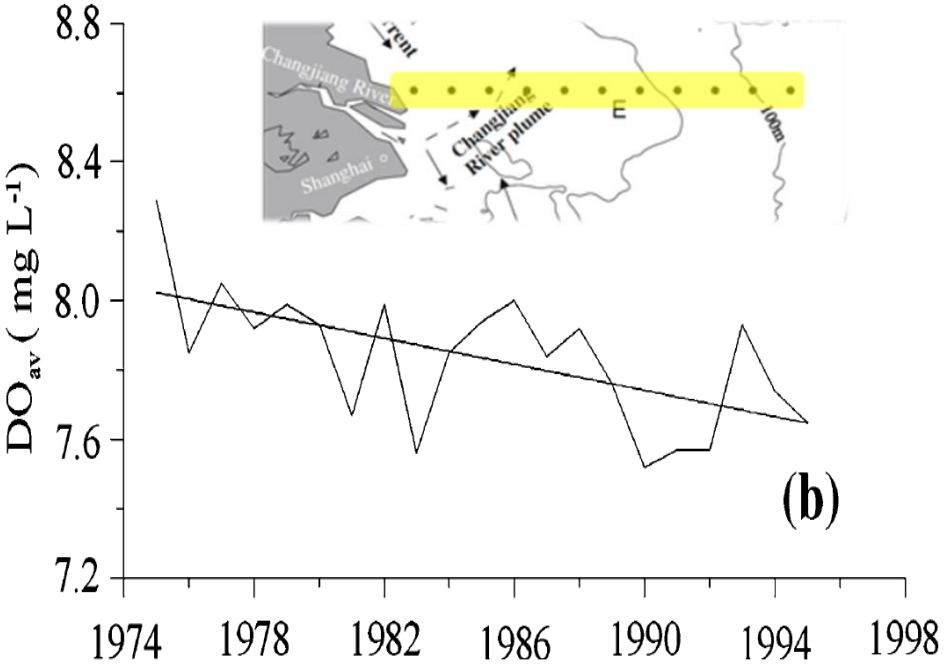


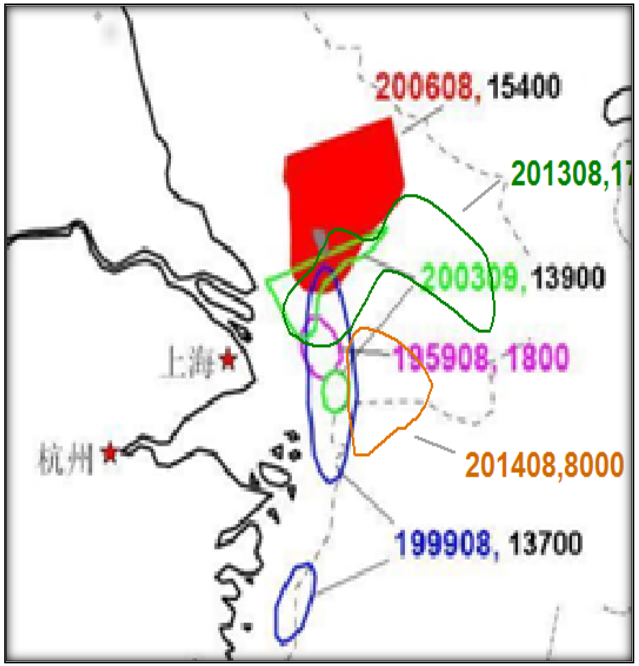
图 1　东海海域赤潮发生次数

于仁成和刘东艳, 2016, 中国科学院院刊

Deoxygnation and large inter-annual variability of hypoxia



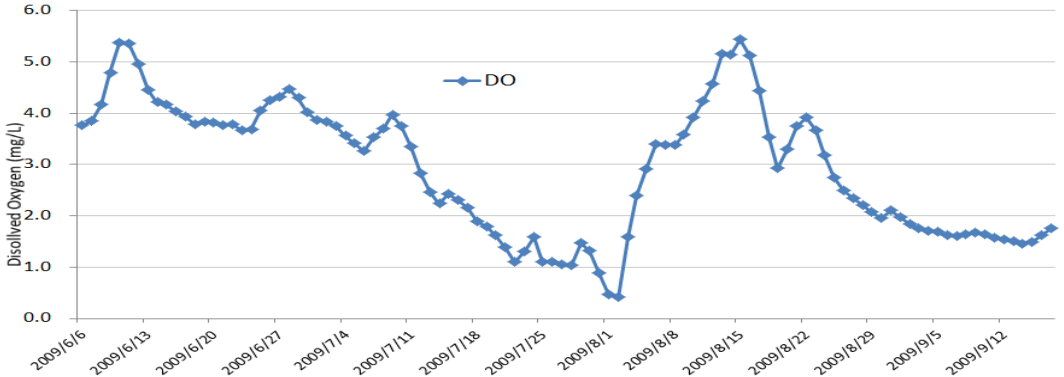
Ning et al., 2011, JO



Zhu et al., 2011, Marine. Chemistry

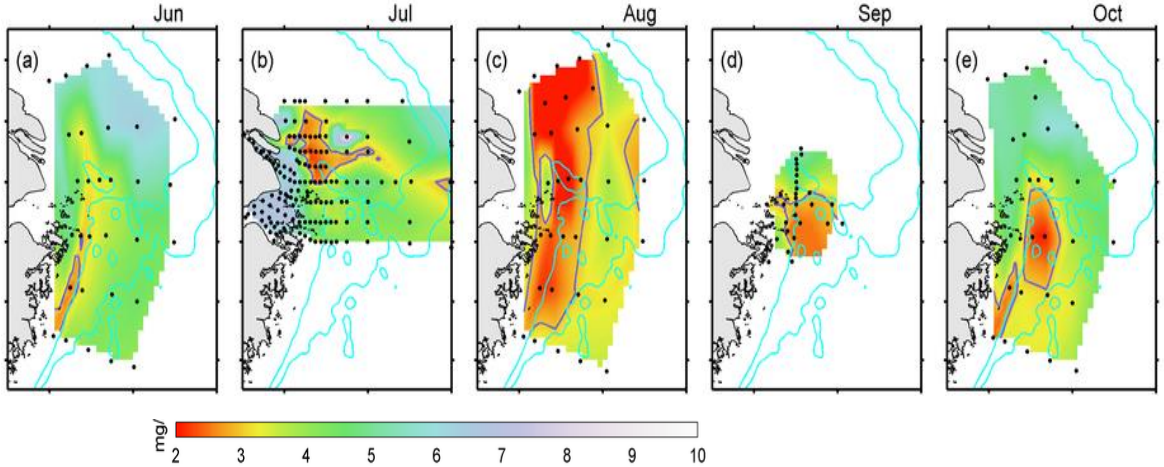
Event-scale and seasonal variability of hypoxia

2009



Ni, et al. (2016), *J Marine Syst*

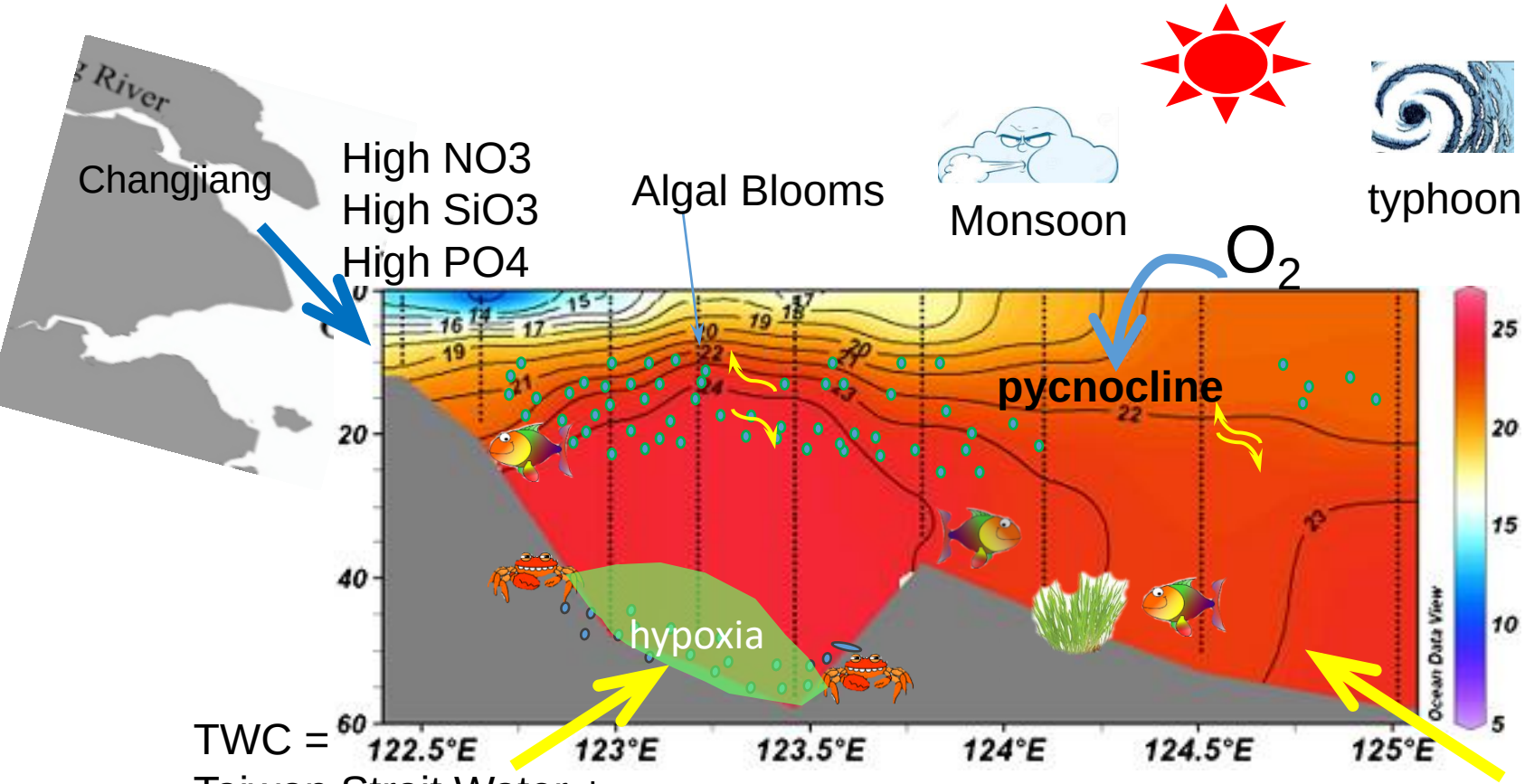
2006



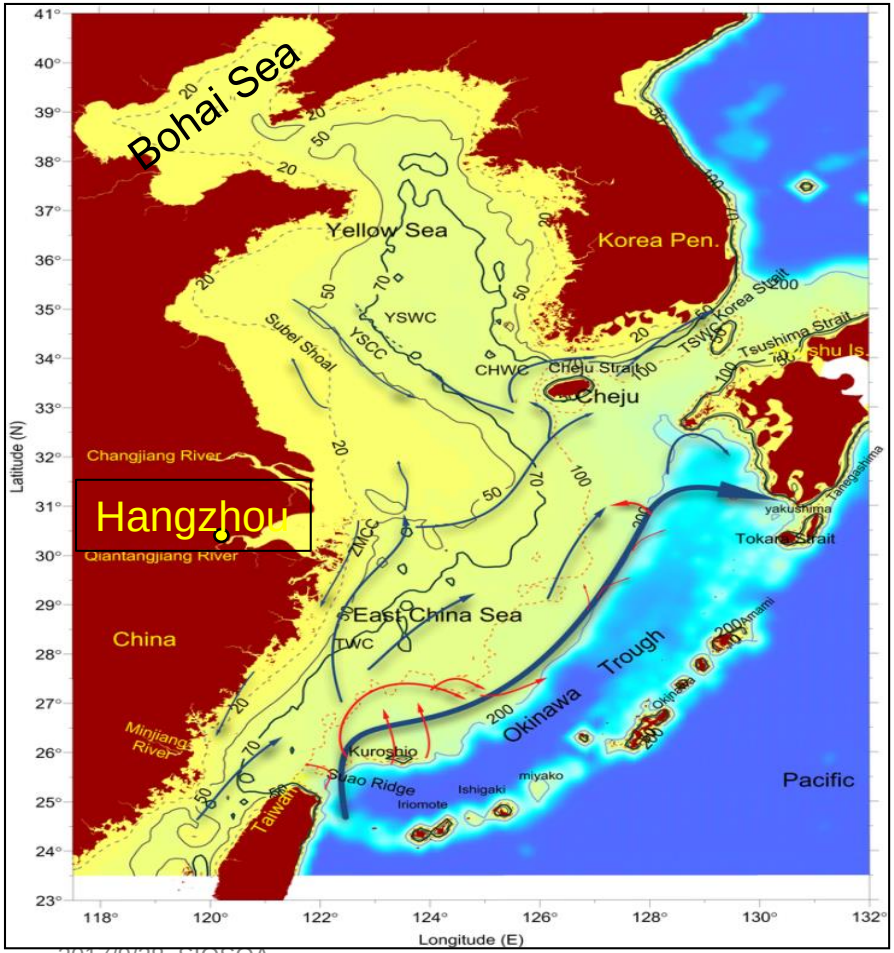
Zhou et al., 2018, *Prog. Oceanogr.*

Hypothesis

Schematic of Eutrophication-HABs-Hypoxia



Method



Circulation model: ROMS

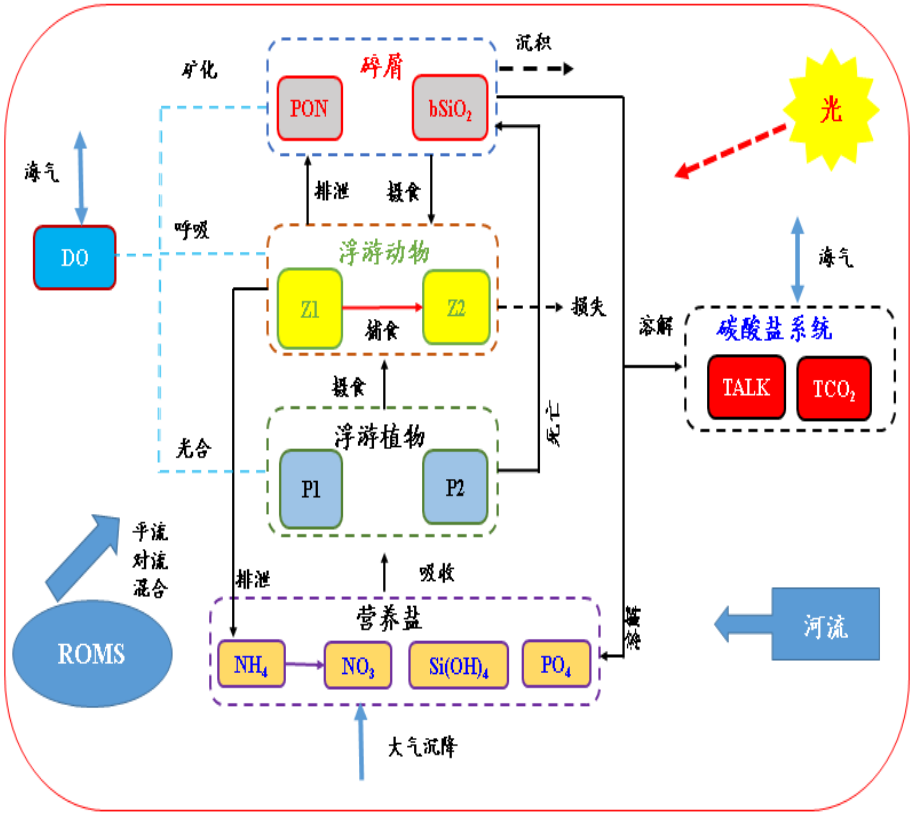
ROMS V3.7
Resolution: 1/24º (3-4 km), 30 layers
Rivers: the major 7
Tides: M2, S2, N2, K2, K1, O1 (TPXO7)
Domain: 117.5 – 131.5E; 23.5-41.0N
Max depth: 1500 m
Turbulence scheme: GEN(k-kl)

Realistic forcing: ECMWF-interim

OBCs: HYCOM

Zhou, Xue, Huang et al. 2015; JGR
Zhou, Huang, Xue et al., 2017, CSR

Biological model: CoSiNE



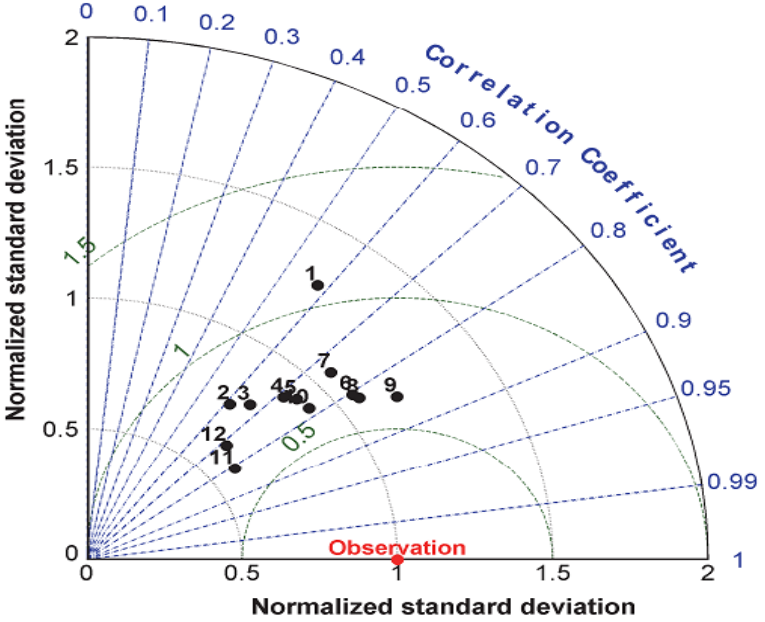
CoSiNE-13
Nutrients: NO3, **PO4**, NH4, SiO4
Phytoplankton: s1(**diatoms**), s2 (**non-diatoms**)
Zooplankton: z1, z2
Detritus: sdet1, sdet2
Plus: **oxygen**, CO_2, TA

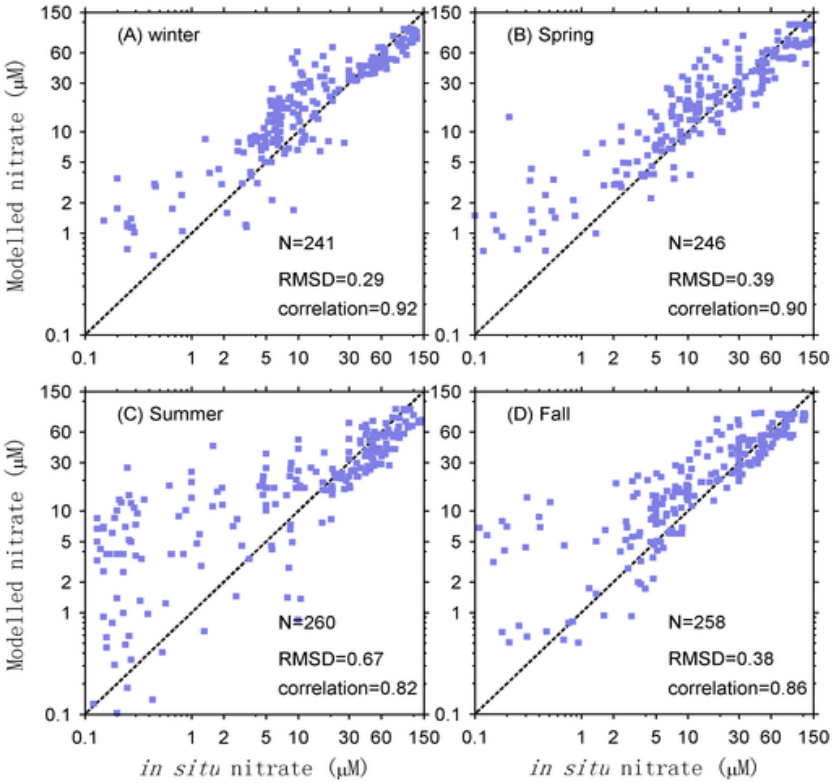
OBCs: CoSiNE-Pacific model， 1999-2013
River nutrients: monthly, from literatures
Atmosphere deposit: no

See details of the model setup and validation in
Zhou, Chai, Huang et al. 2017, *Prog. Oceanogr.*

Model validation: Chl a & Nitrate

Monthly-mean Chl a

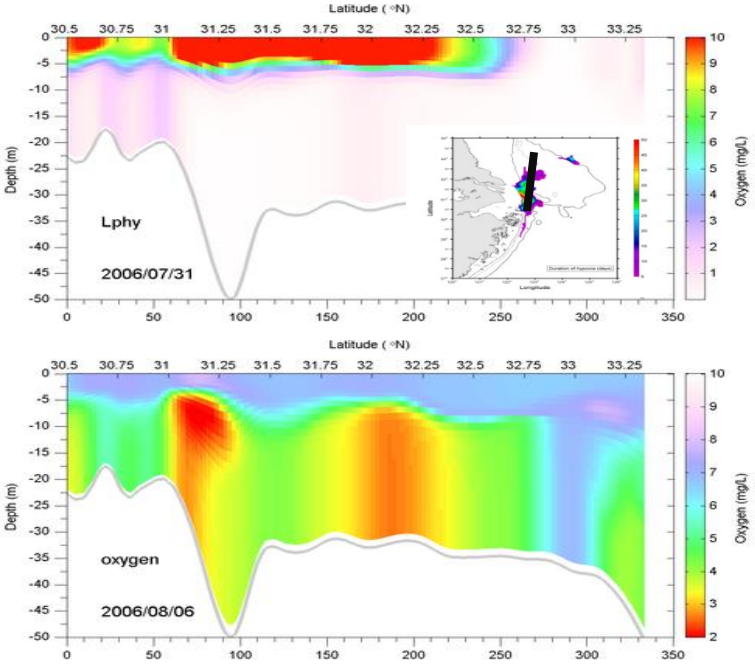




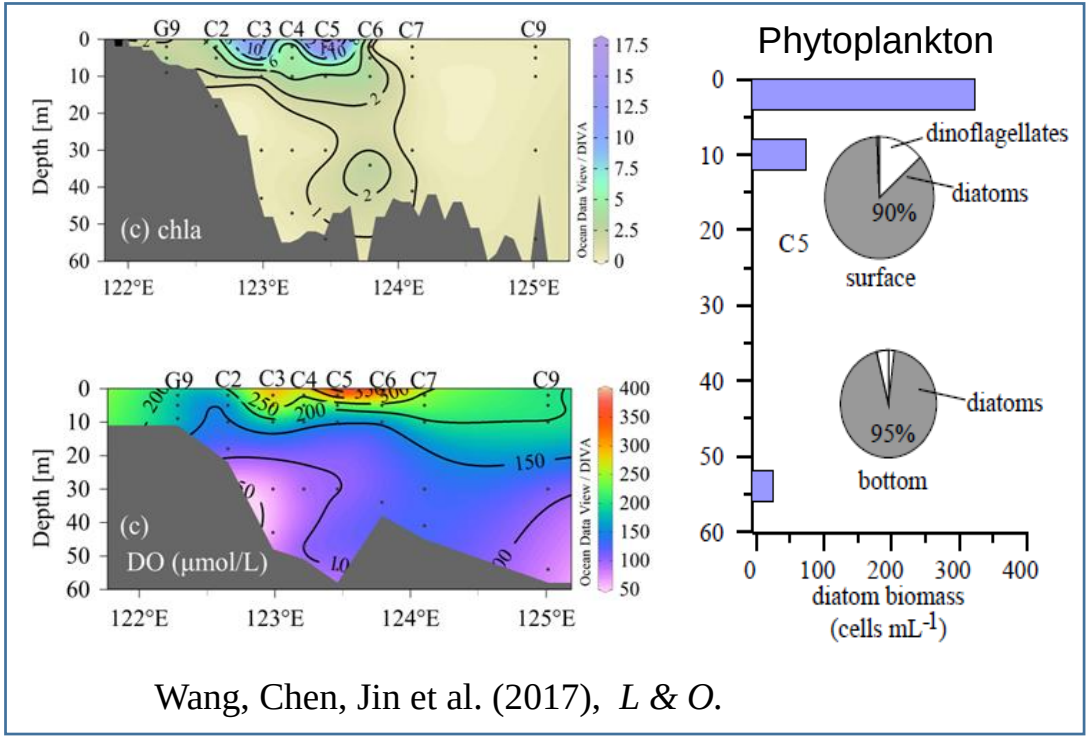
Zhou, Chai, Huang et al. 2017, *Prog. Oceanogr.*

Model validation: Diatoms and DO

About O(1) week delay between the diatoms bloom and significant oxygen depletion



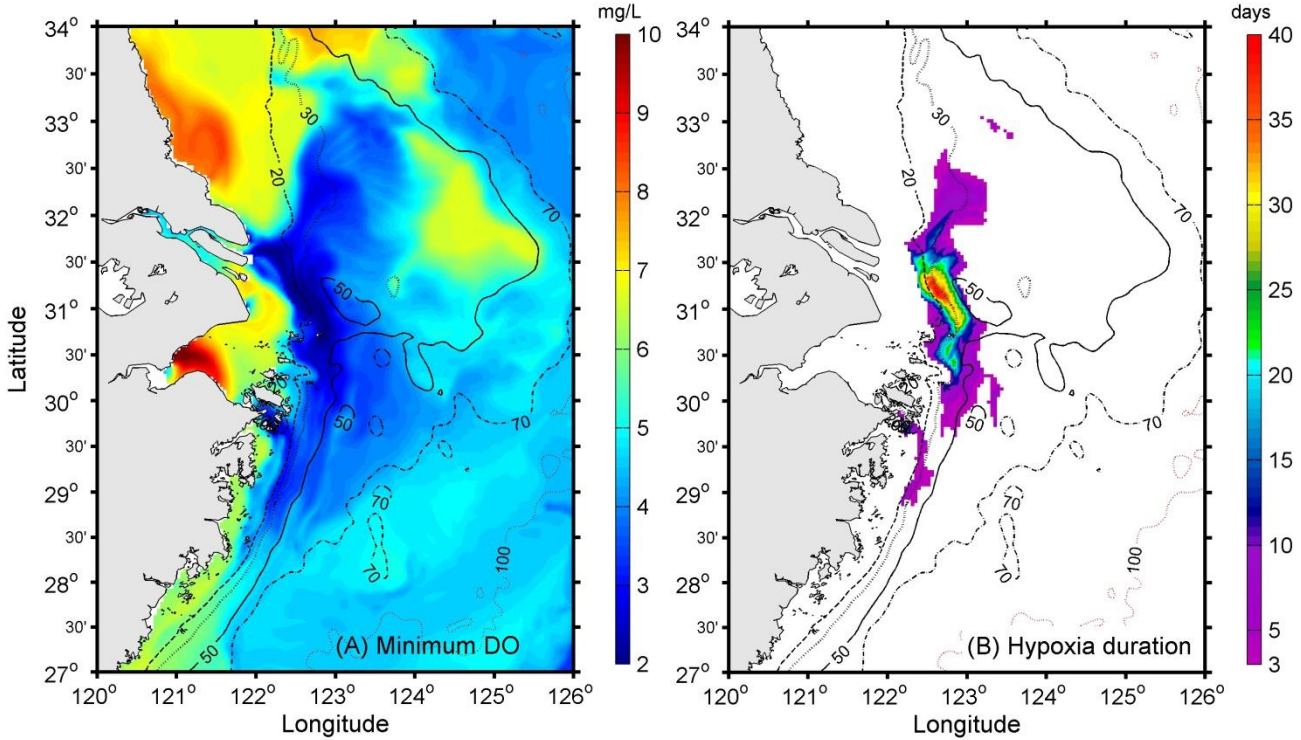
Observations



Wang, Chen, Jin et al. (2017), *L & O.*

Results

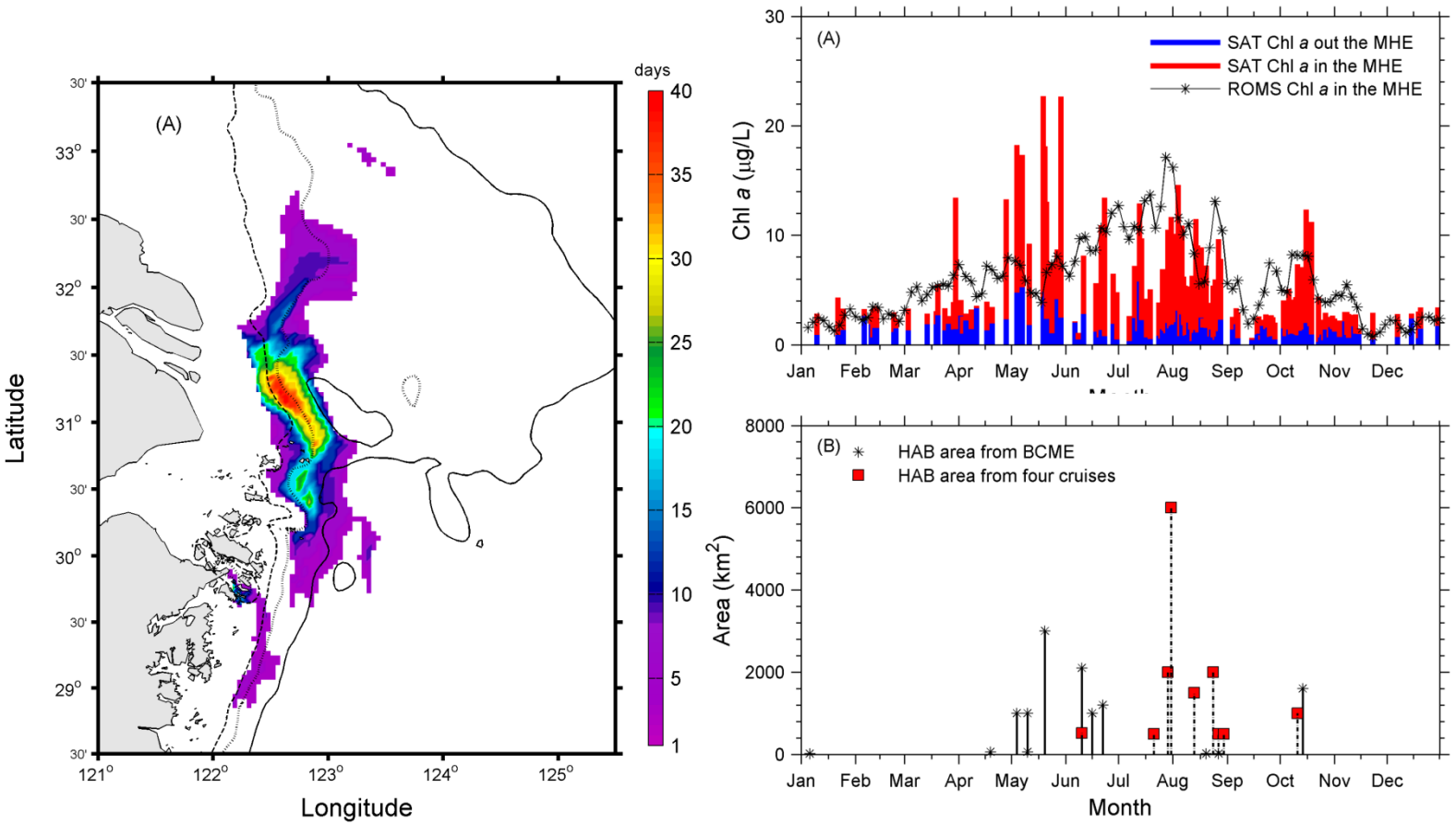
Simulated minimum DO distribution & hypoxia duration



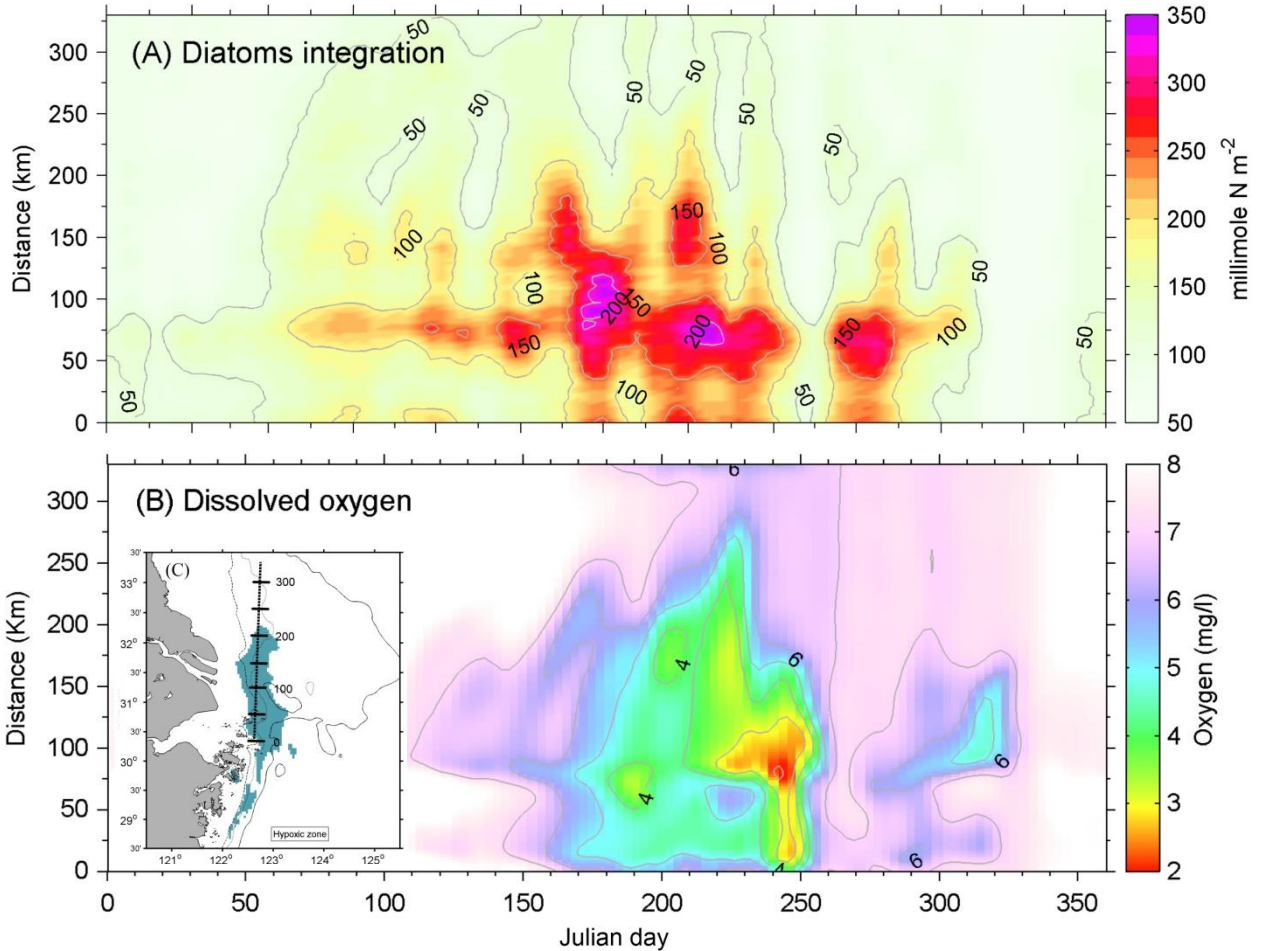
Simulated minimum DO (bottom)

Simulated hypoxia durations (days)

Phytoplankton blooms in/out the hypoxic zone



Diatom blooms

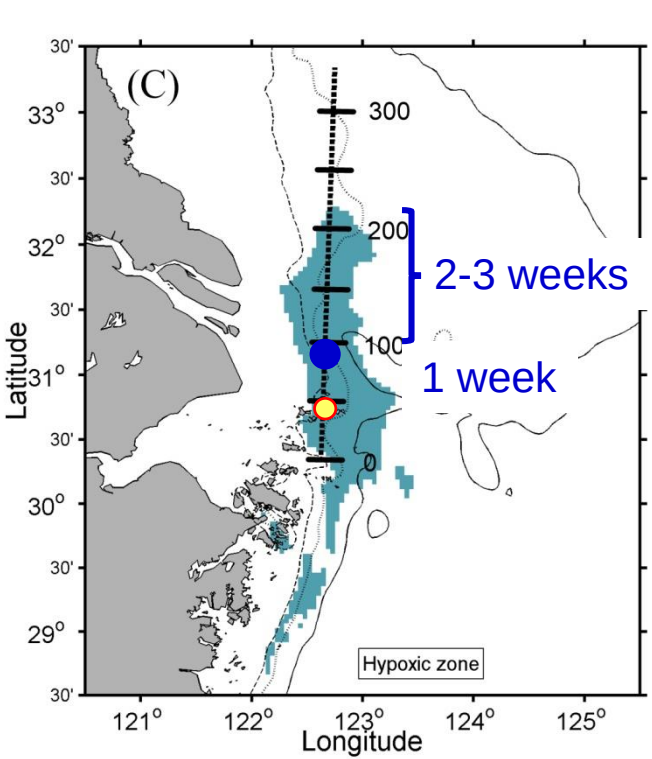


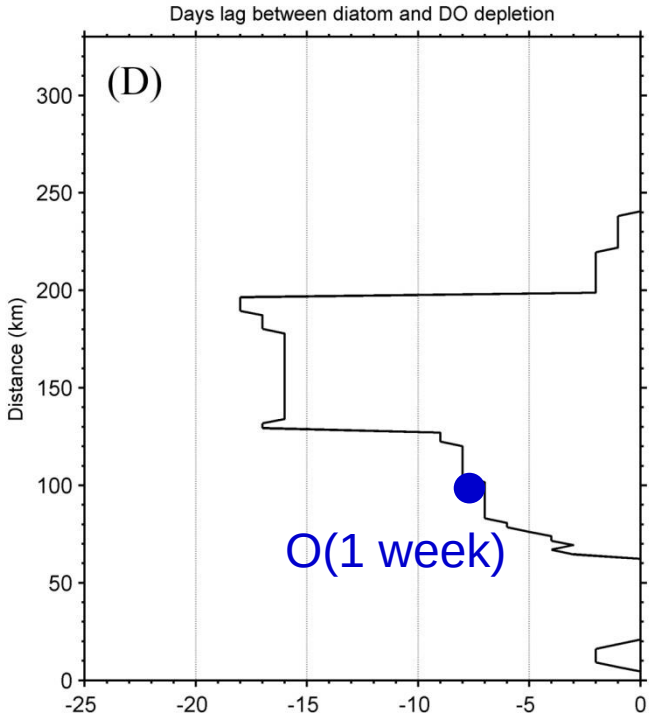
水层积分的硅藻

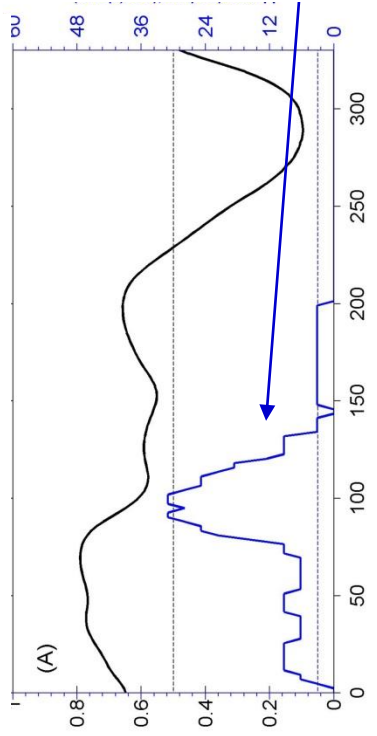
底层溶解氧

Duration (days)

缺氧持续时间(days)

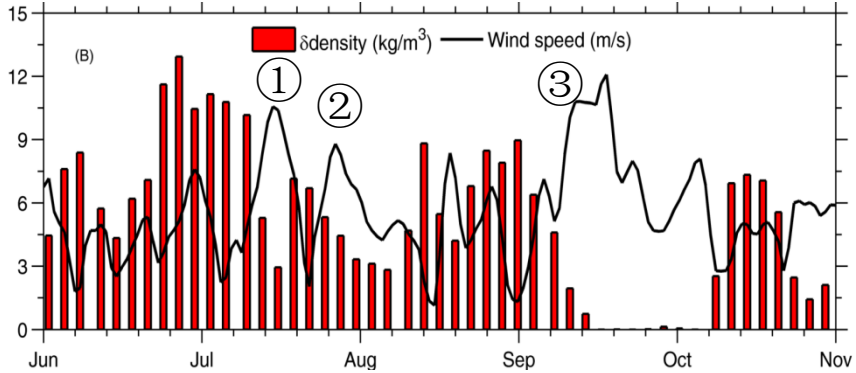




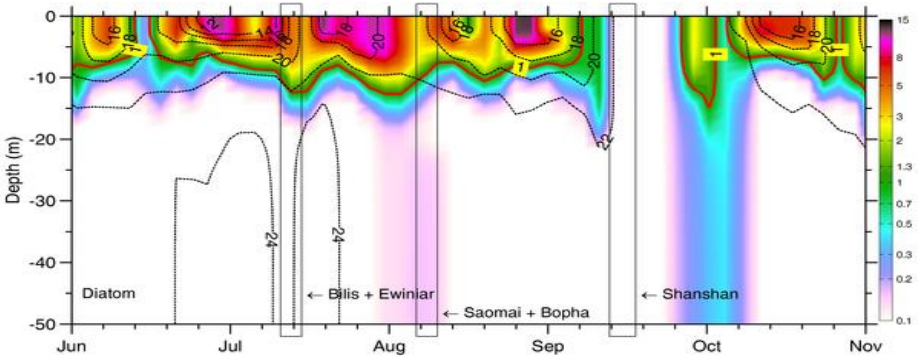


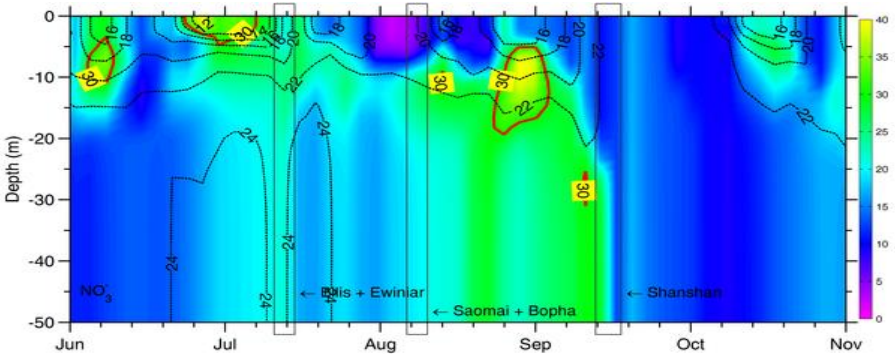
Tropical storms (UNISYS)　　① ② ③ strong wind events (Blend Sea winds)

Wind (curve) & stratification (bar)

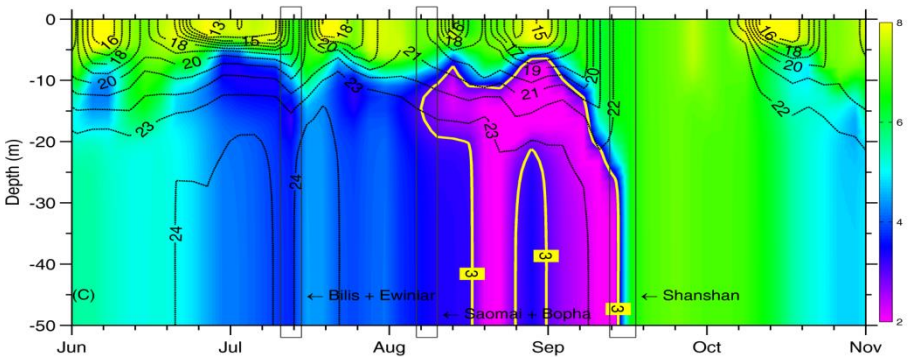


Diatom (shading)





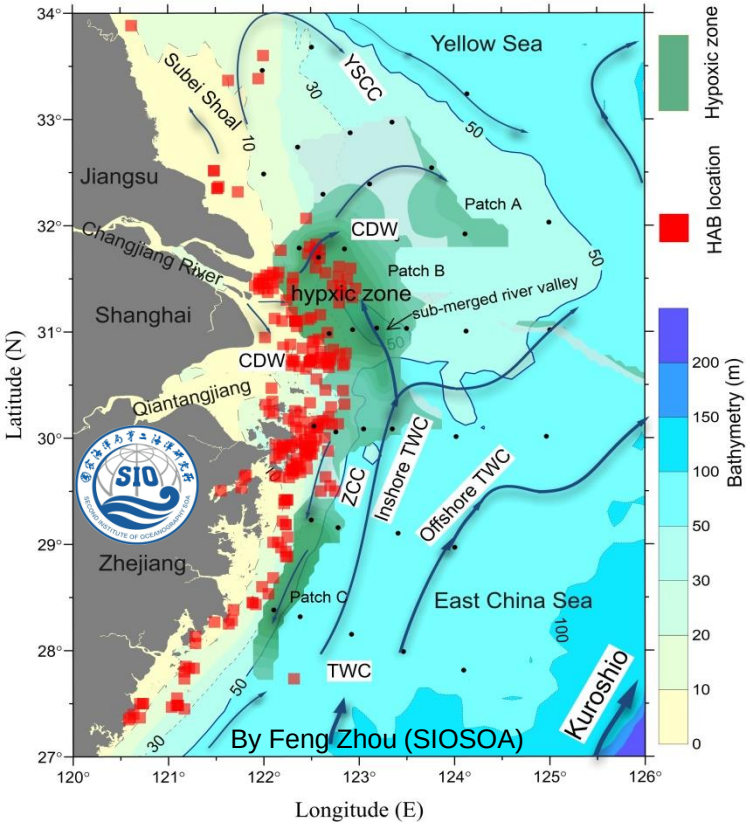
Nitrate (shading)

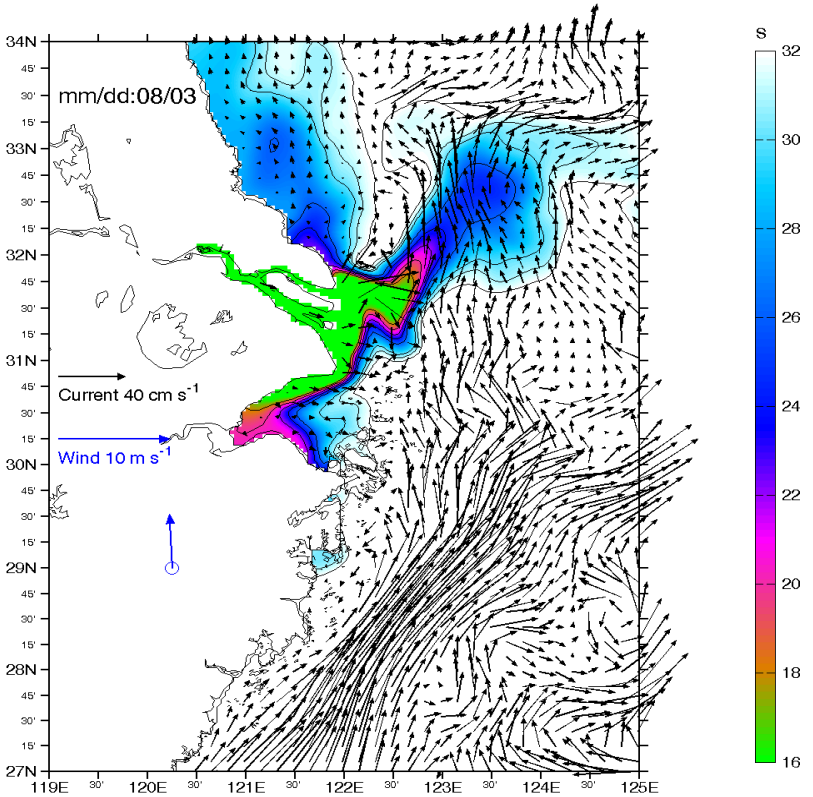


DO (shading) & pycnocline (contour)

Discussion

Highly varied plume & role of advection





After Zhou et al. (2015), JGR-oceans

Summary

- High-concentration of riverine nutrients (anthropogenic eutrophication), causing frequent and severe HABs, is the essential BGC factor of hypoxia off the CJE
  - Hypoxia occurred ca 1-2 weeks later than diatom blooms
  - Hypoxic zone occurred around the area of diatom blooms
  - Two roles of the Kuroshio: advection of low DO + nutrient flux

- Both algal blooms and hypoxia show large temporal variability, which partly are due to highly varied Changjiang Diluted Water

- The mismatch between location of diatom blooms and hypoxic zone is mostly due to the advection before organic matter sinks to the sea bed.

- The relationship between non-diatom blooms and hypoxia need to be addressed further.

4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop

14-18 April 2019
Hangzhou, China

Session 3: Modeling and forecasting ocean and coastal acidification, and ecosystem responses

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http://www.goa-on.org/workshops/hangzhou2019/workshop.php

THANK YOU !

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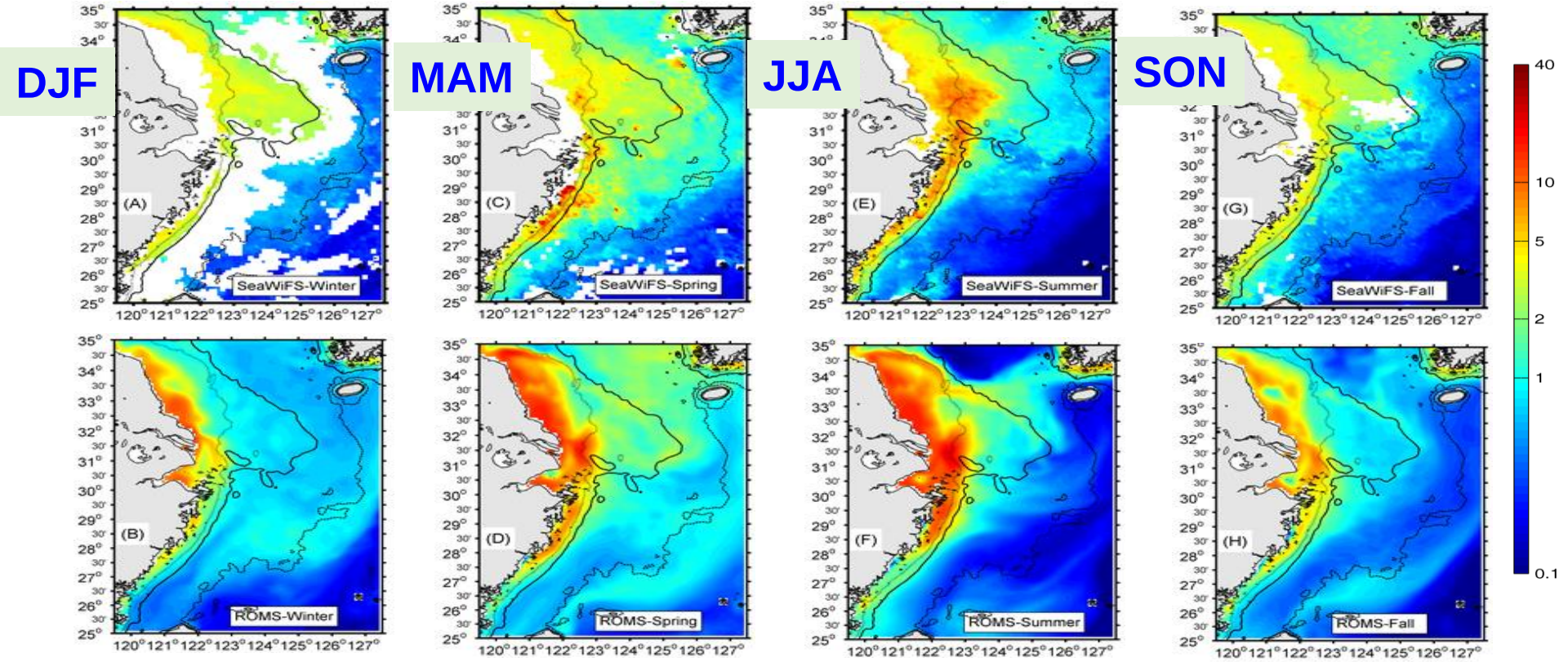
Chl a

Upper: SeaWiFS; Lower: Simulation



Zhou, Chai, Huang et al. 2017, *Prog. Oceanogr.*

Related publications

- Zhou, F. et al. (2017), Investigation of hypoxia off the Changjiang Estuary using a coupled model of ROMS-CoSiNE, *Prog. Oceanogr.*, accepted.
- Zhou, F., D. Huang, H. Xue, J. Xuan, T. Yan, X. Ni, D. Zeng, and J. Li (2017), Circulations associated with cold pools in the Bohai Sea on the Chinese continental shelf, *Cont. Shelf Res.*, 137, 23–58, doi:10.1016/j.csr.2017.02.005.
- Zhou F, Xue H J, Huang D J, Xuan J L, Ni X B, Xiu P and Hao Q, 2015. Cross-shelf exchange in the shelf of the East China Sea. Journal of Geophysical Research: Oceans. 120 (3), 1545−1572, doi:10.1002/2014JC010567.
- 周锋, 黄大吉, 倪晓波, 宣基亮, 张经和竺可欣 (2010), 影响长江口毗邻海域低氧区多种时间尺度变化的水文因素, 生态学报, 30 (17), 4728–4740.
- Zhou, F., J. L. Xuan, X. B. Ni, and D. J. Huang (2009), A preliminary study on variations of the Changjiang Diluted Water between August 1999 and 2006, *Acta Oceanologica Sinica*, 28(6), 1–11, doi:10.3969/j.issn.0253-505X.2009.06.001.