PICES 2017 Annual Meeting

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

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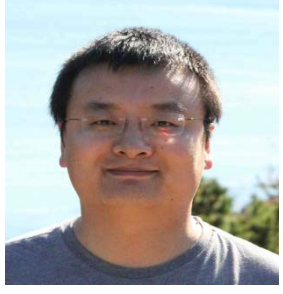
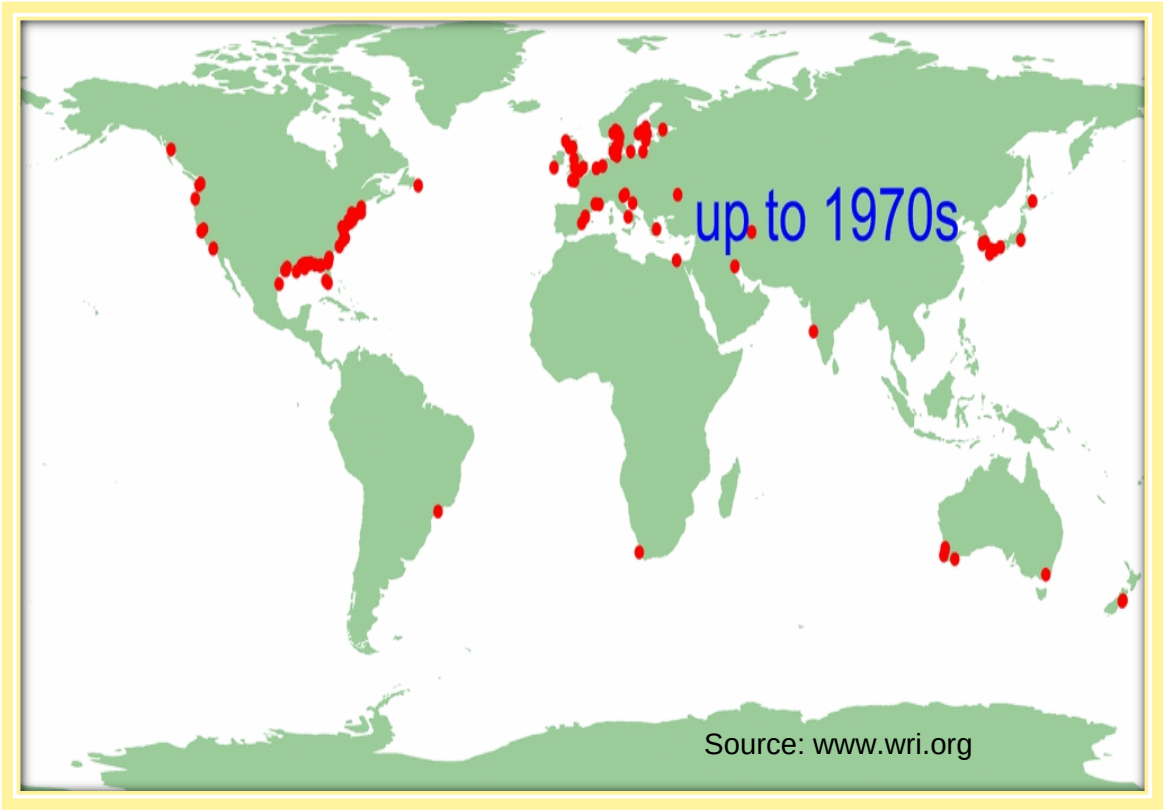


修鹏

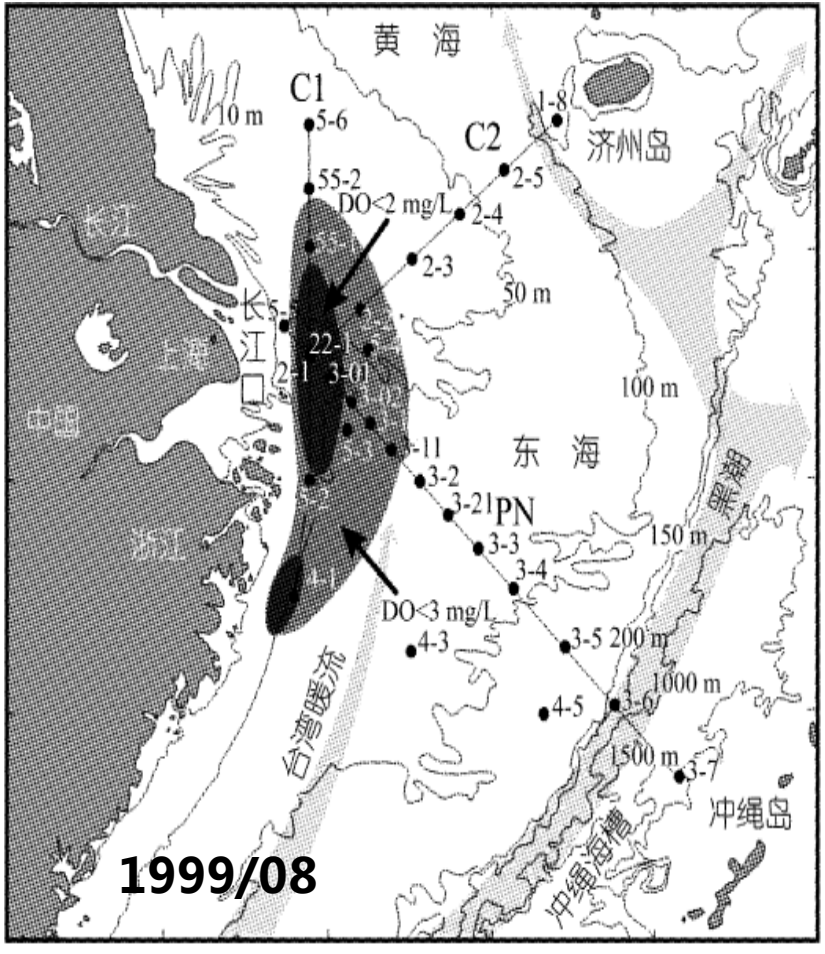
1 Background

近海动力过程与生态系统
Coastal Ocean Dynamics and Ecosystems (CODE)

Tianjin (2015/08/21) CCTV

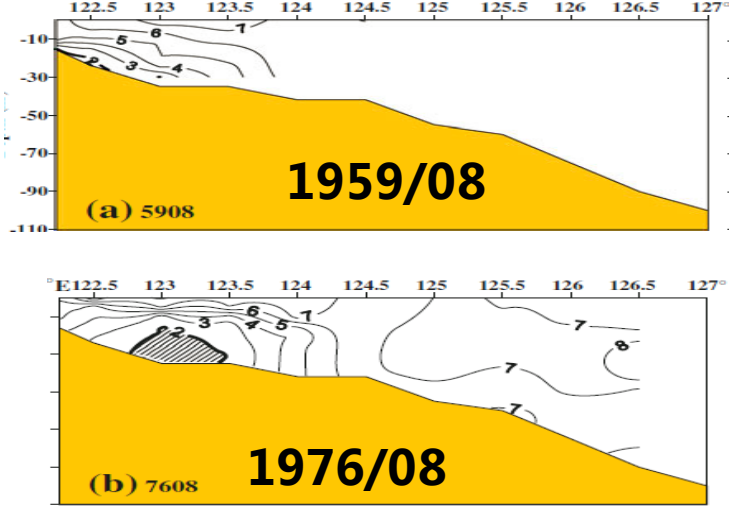


MOST 973: pilot survey



Li, Zhang, Huang et al., 2002, *Sci. China Ser. D*

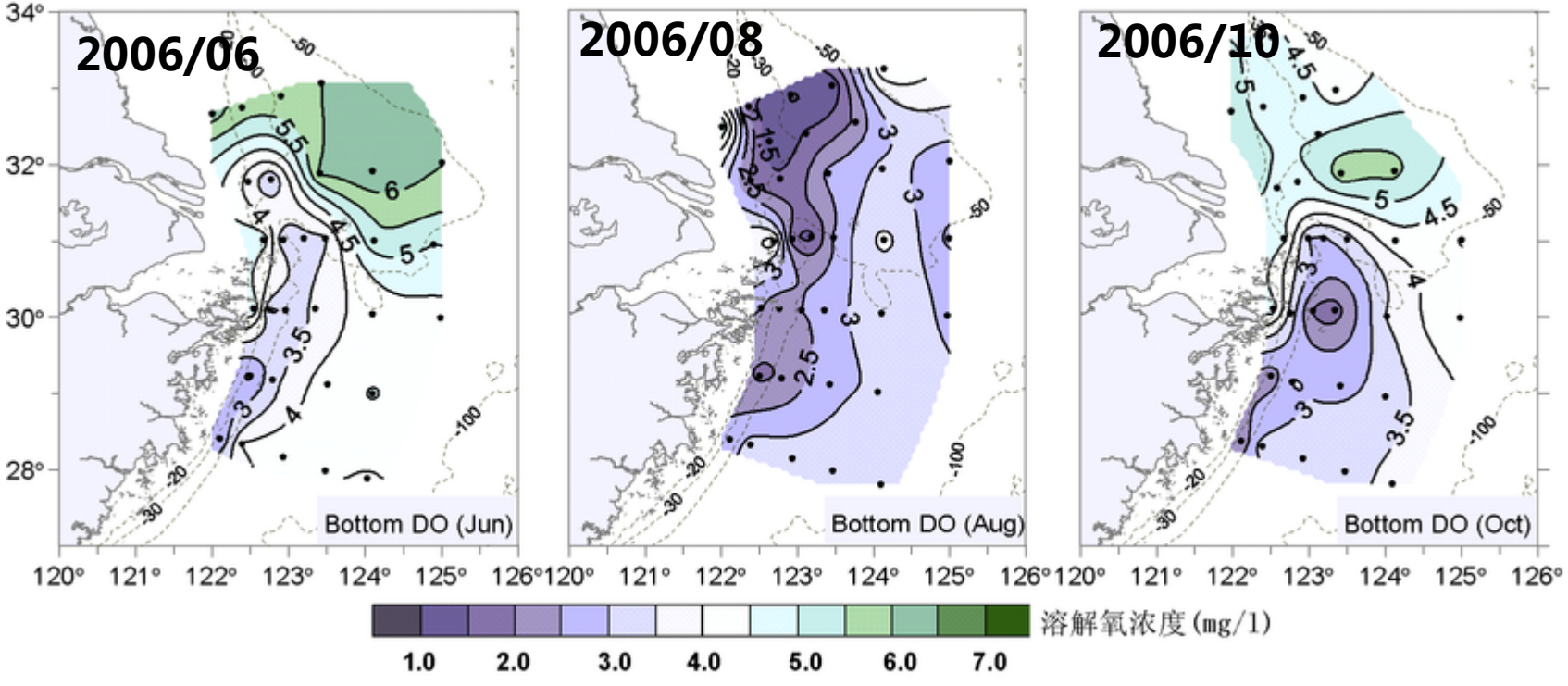
Though hypoxia was recorded in the East China Sea early in the 1950s, it has not been raised as an environmental issue worth attention, until 2002



Ning et al., 2011, *JO*

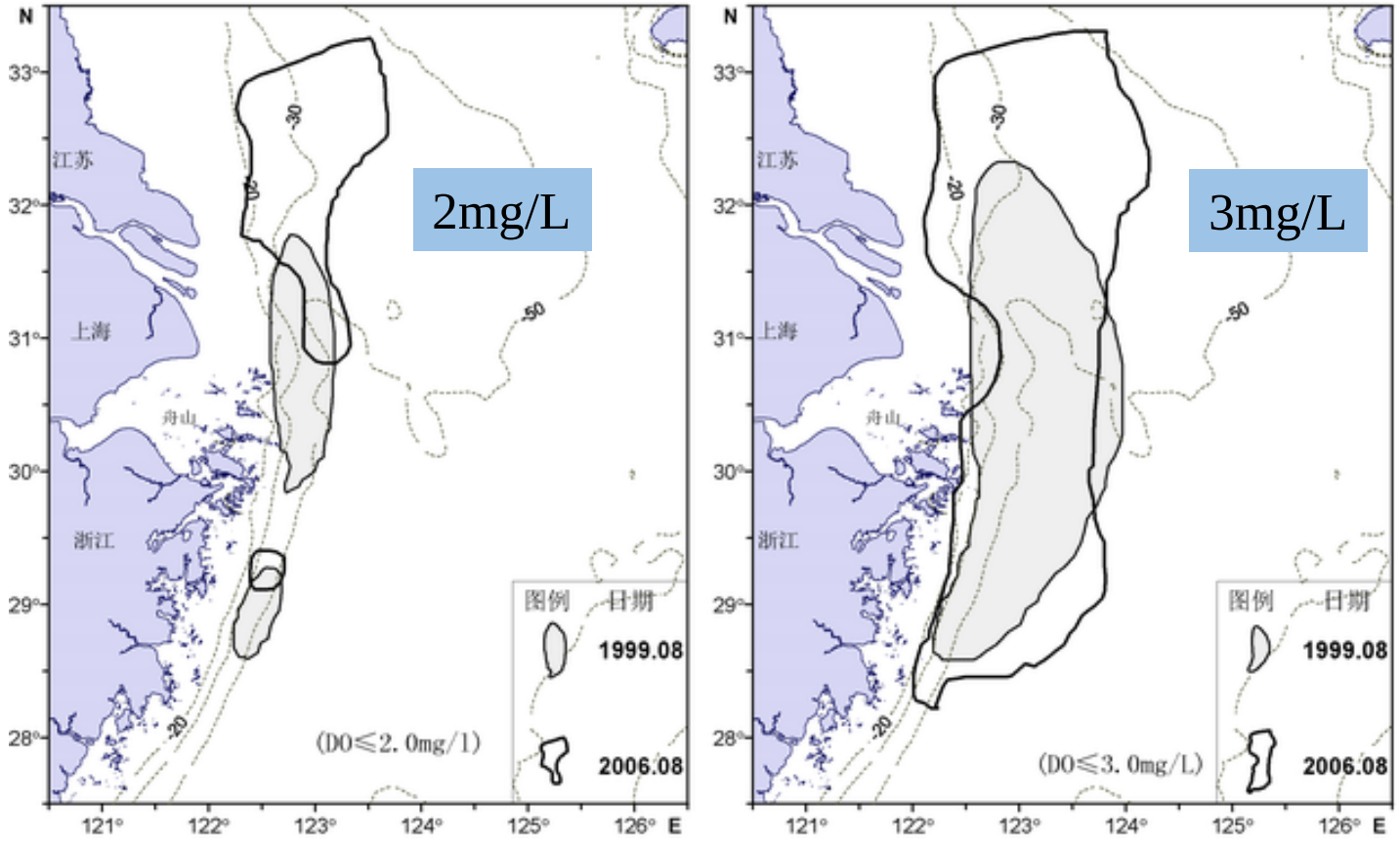
Intra-seasonal variations

MOST 973: 2nd phase

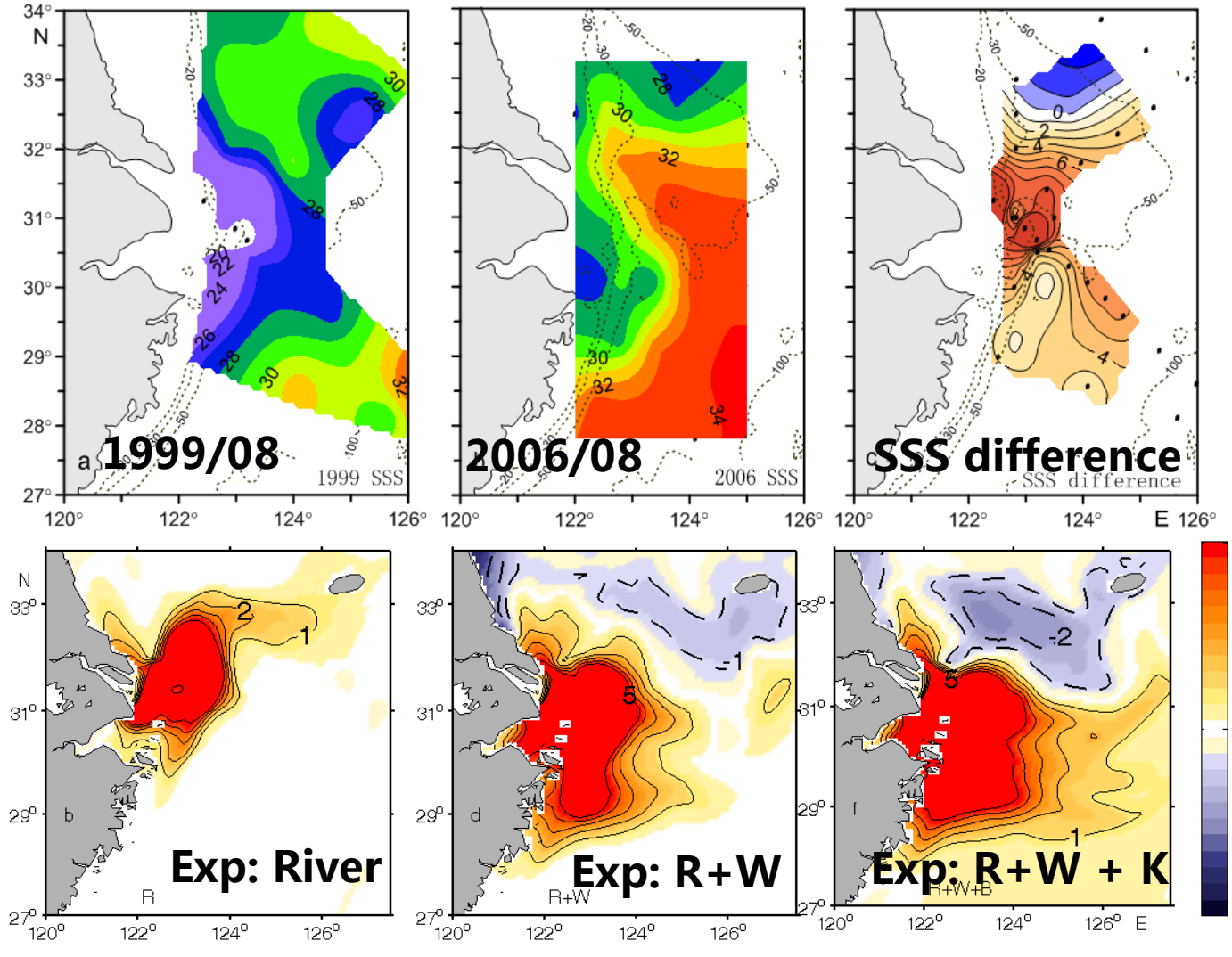


周锋等，2010, 生态学报

Year-to-year variations



Zhou et al. 2009; *Acta Oceanol. Sin.*



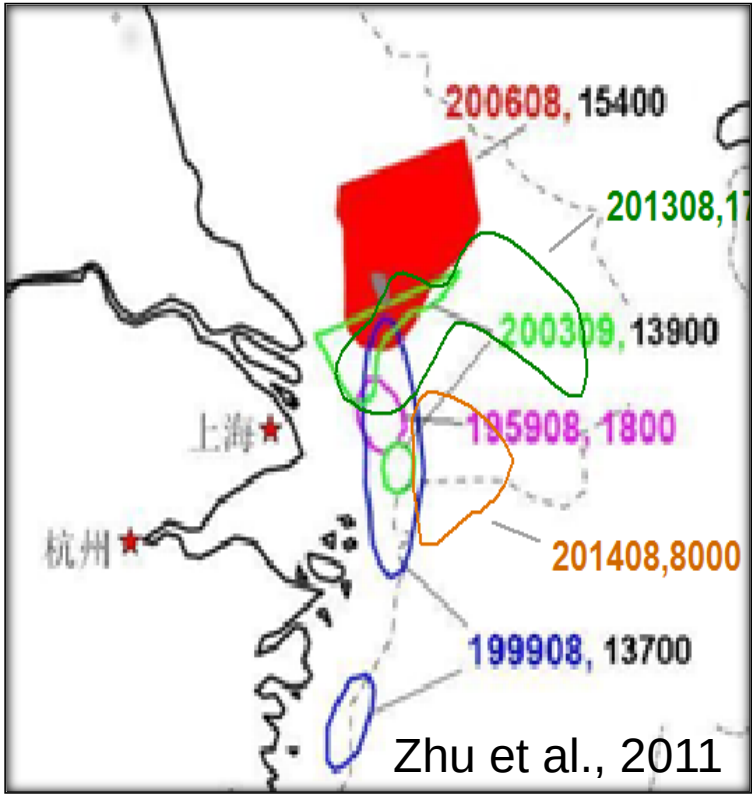
Simple idea works by using SSS as an index to predict the hypoxia location **shift** for the special cases.

Reproduced by a circulation model and sensitivity experiments.

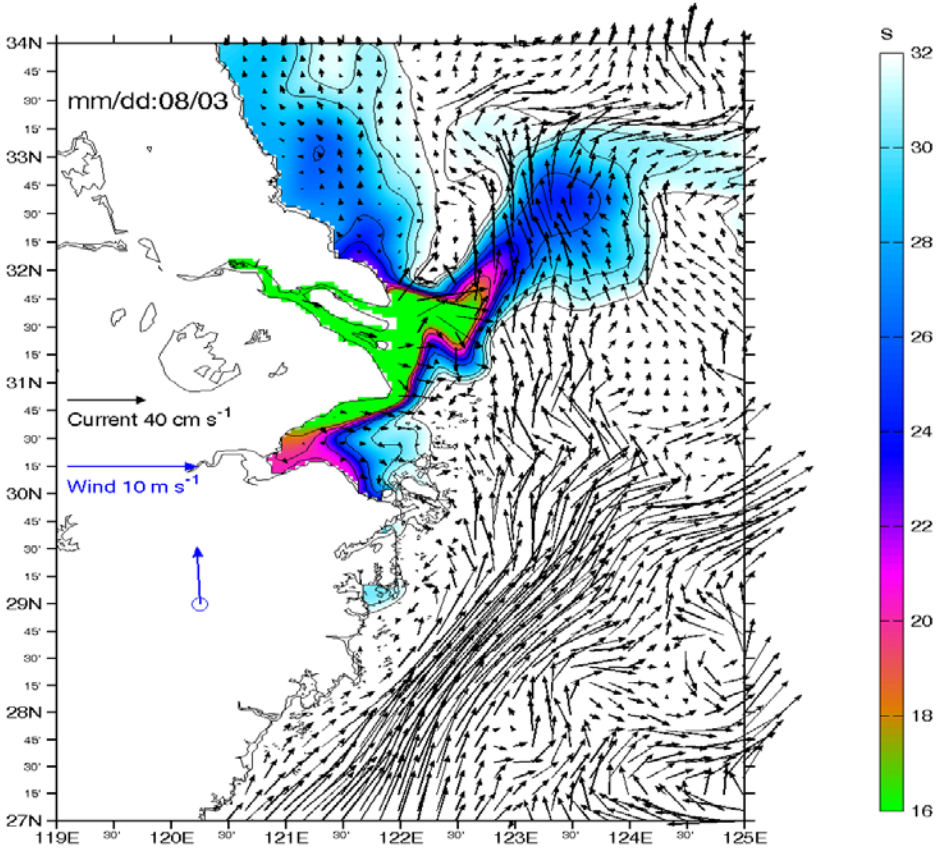
However, the exact hypoxic zone could not be predicted, yet.

Zhou et al. 2009; *Acta Oceanol. Sin.*

Interannual variations

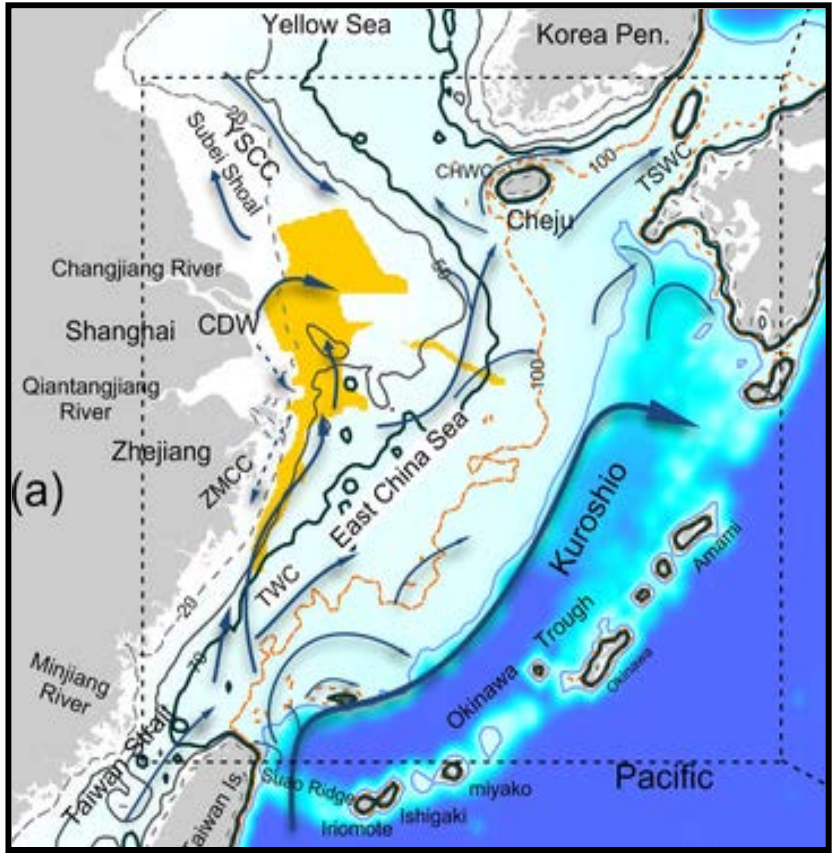


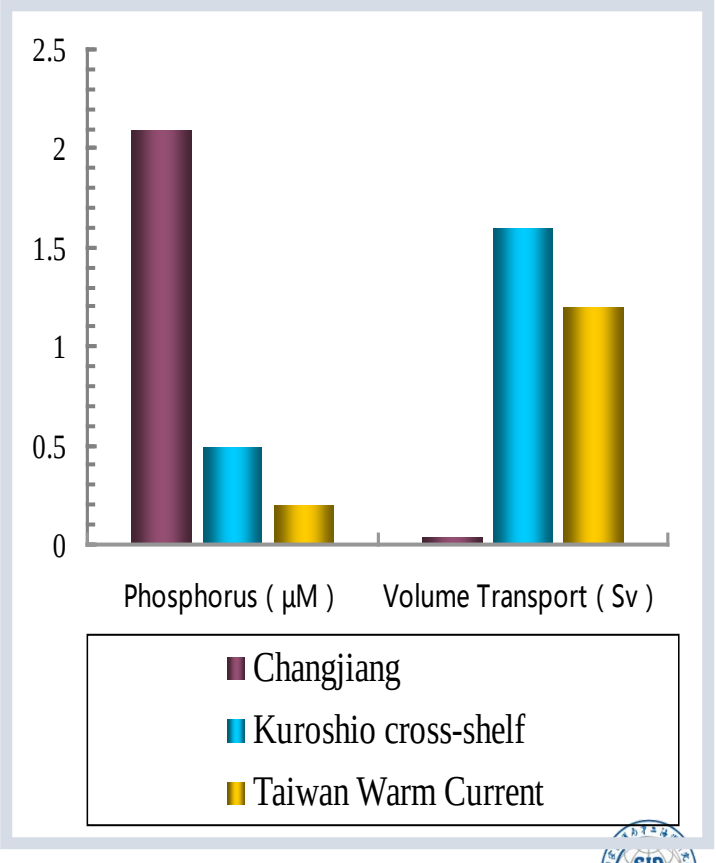
Mechanism: Phy-Bio-Chem?



2 Motivations

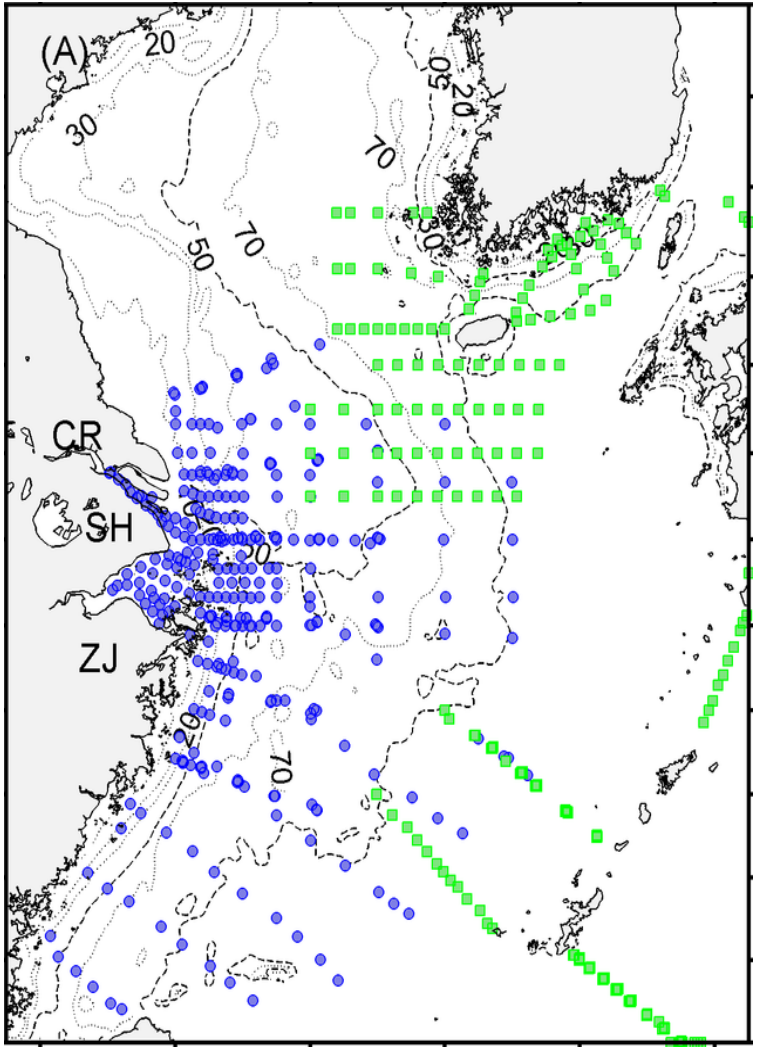
Question 1: Roles of Changjiang and Kuroshio ?
Question 2: Variability and mechanisms?



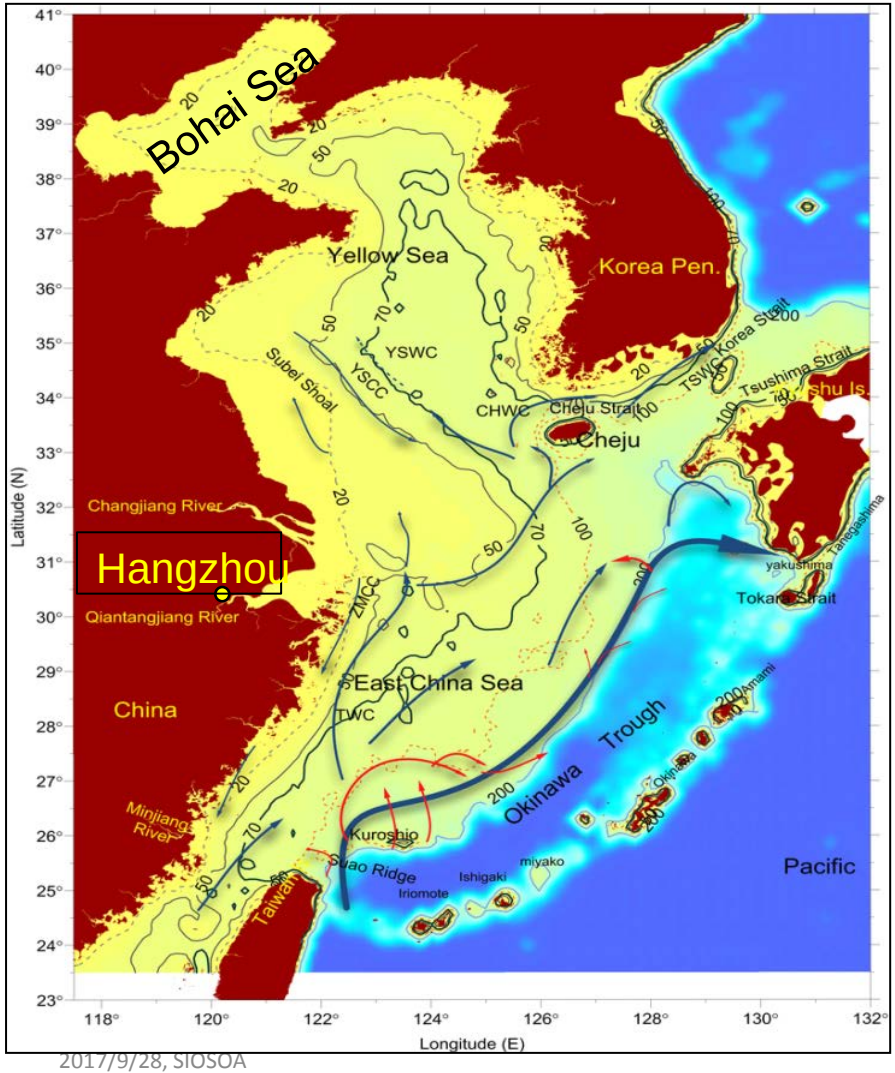


Zhou et al. (2017, *Prog. Oceanogr.*, accepted.

3 Data



- Our own 6 cruises in 2006
- World Ocean Database



Circulation model: ROMS

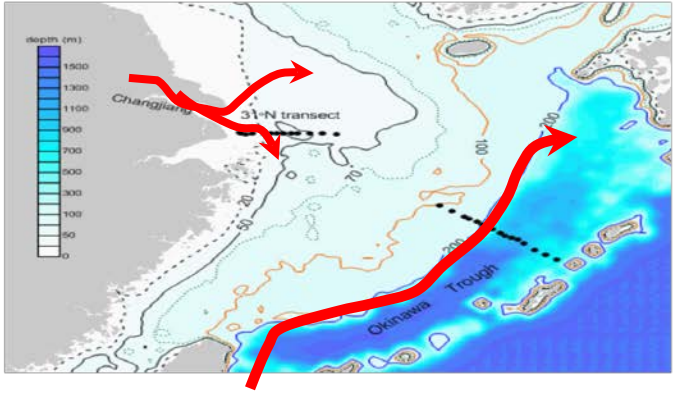
ROMS V3.7
Resolution: 1/24º (3-4 km), 30 layers
Rivers: the major 7
Tides: M2, S2, N2, K2, K1, O1 (TPXO7)
Domain: 117.5 – 131.5E; 23.5-41.0N
Max depth: 1500 m
Turbulence scheme: GEN(k-kl, MY2.5)

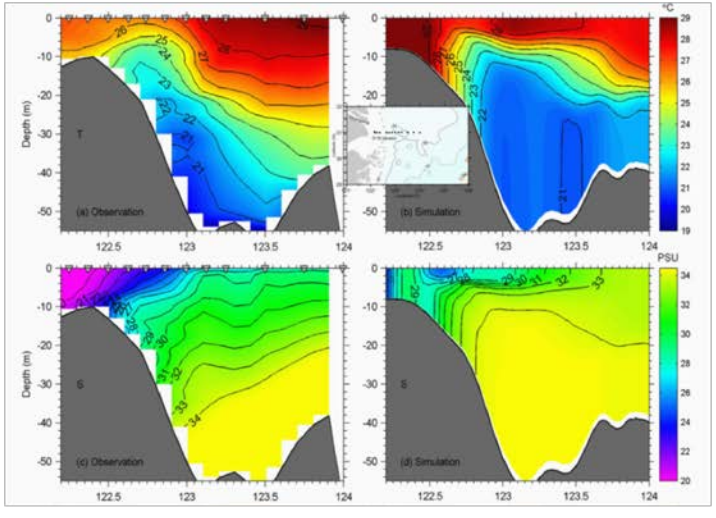
Realistic forcing: ECMWF-interim

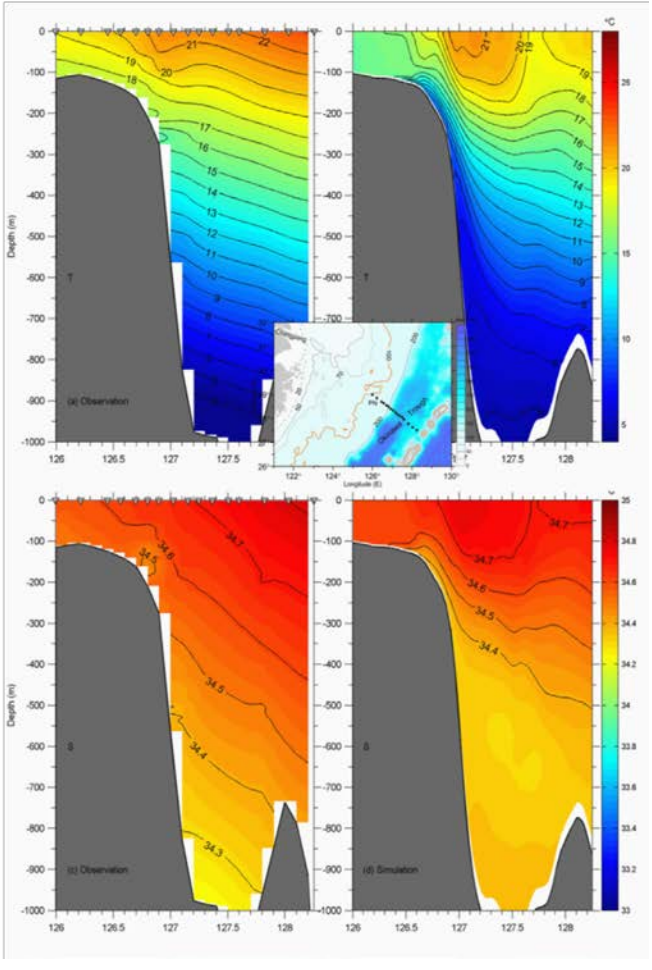
OBCs: HYCOM

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

Model-data comparison: T/S



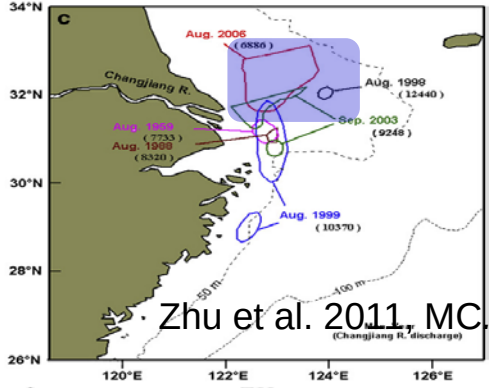




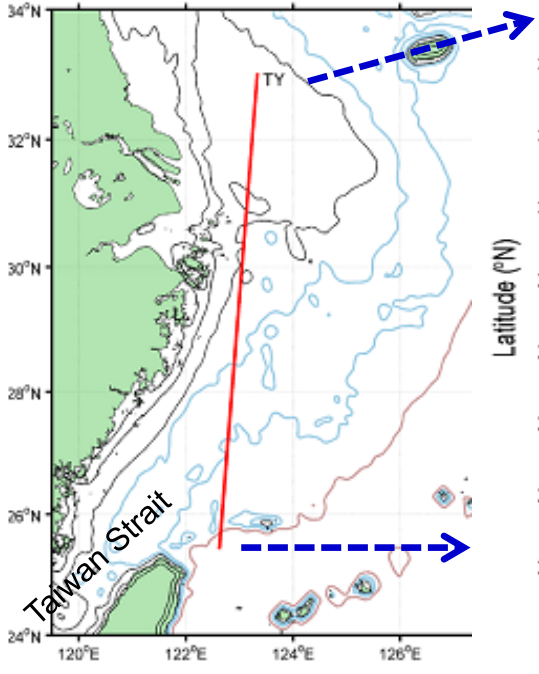
Zhou, Chai, Huang et al., 2017, PO, accepted

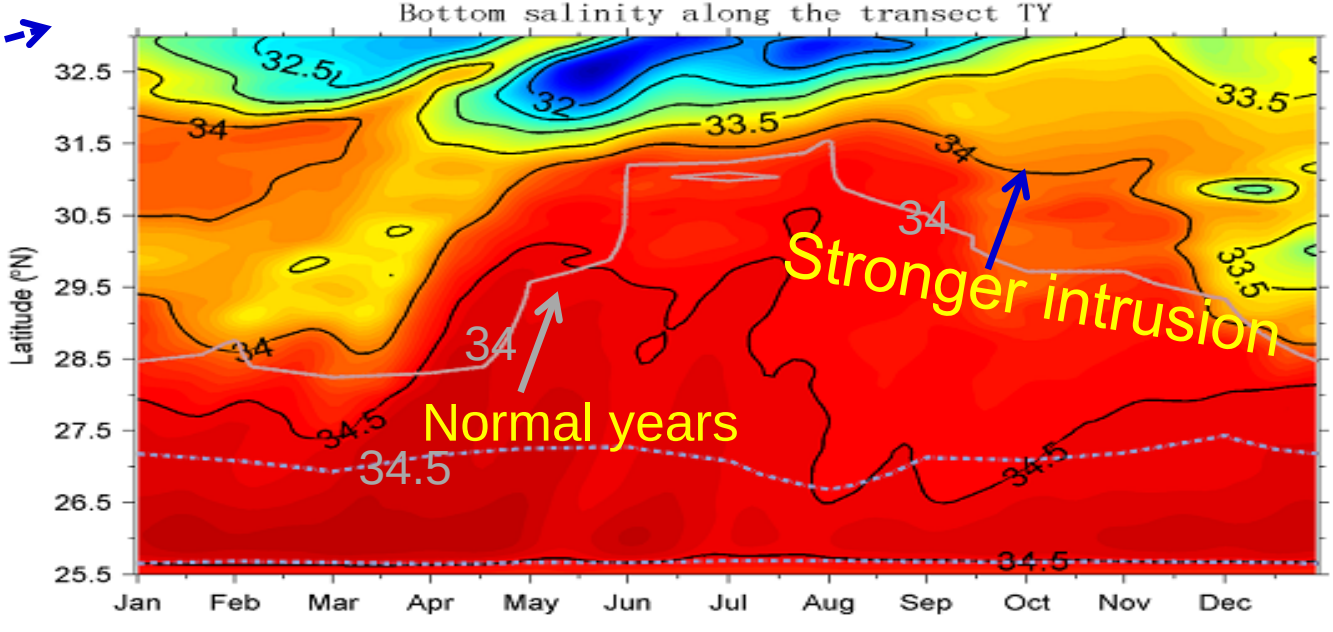
Enhanced northward transport & ecosystem implications

Cross-shelf transport + flow through the Taiwan Strait



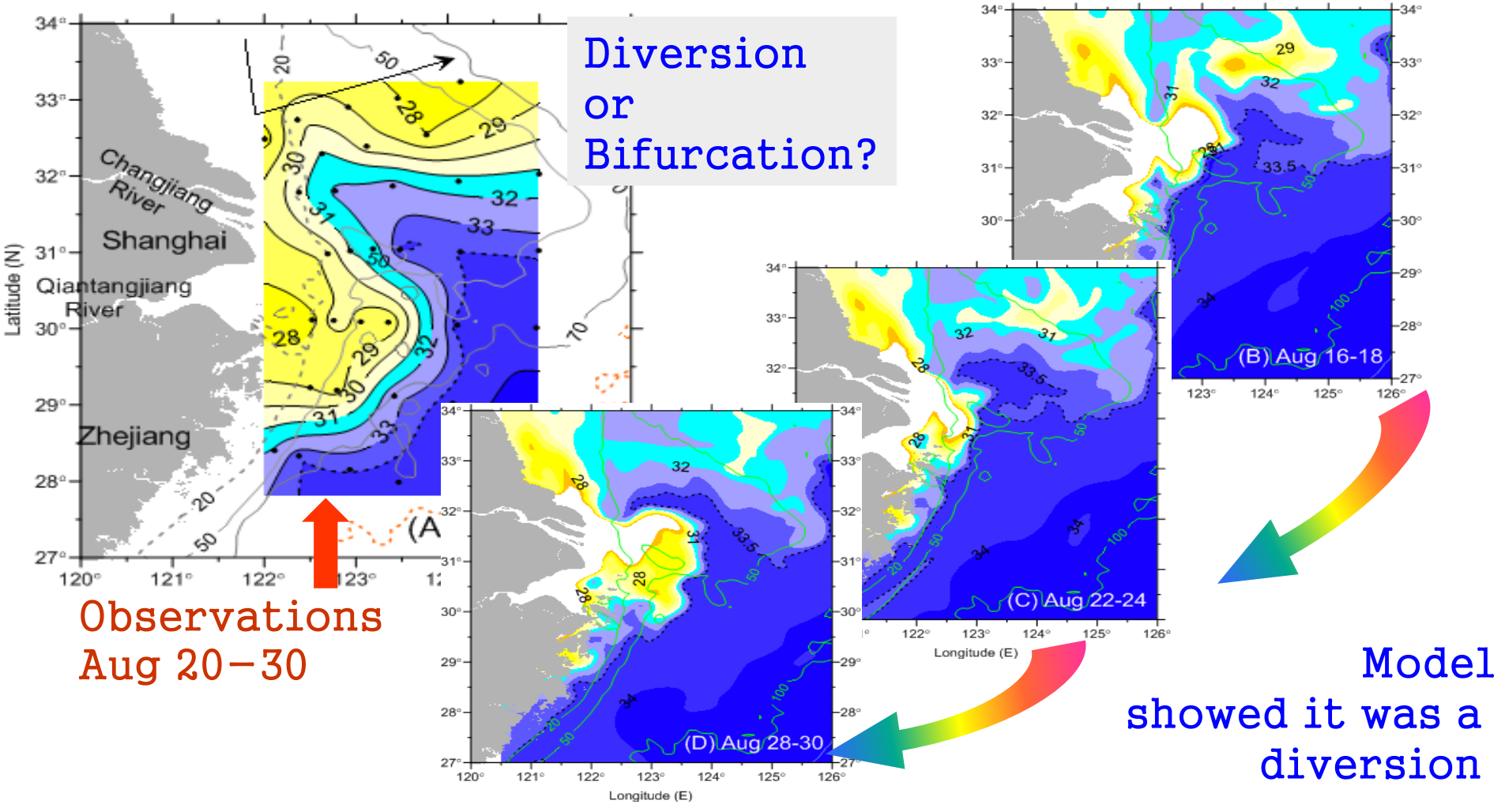
· Zhu et al. 2011, MC

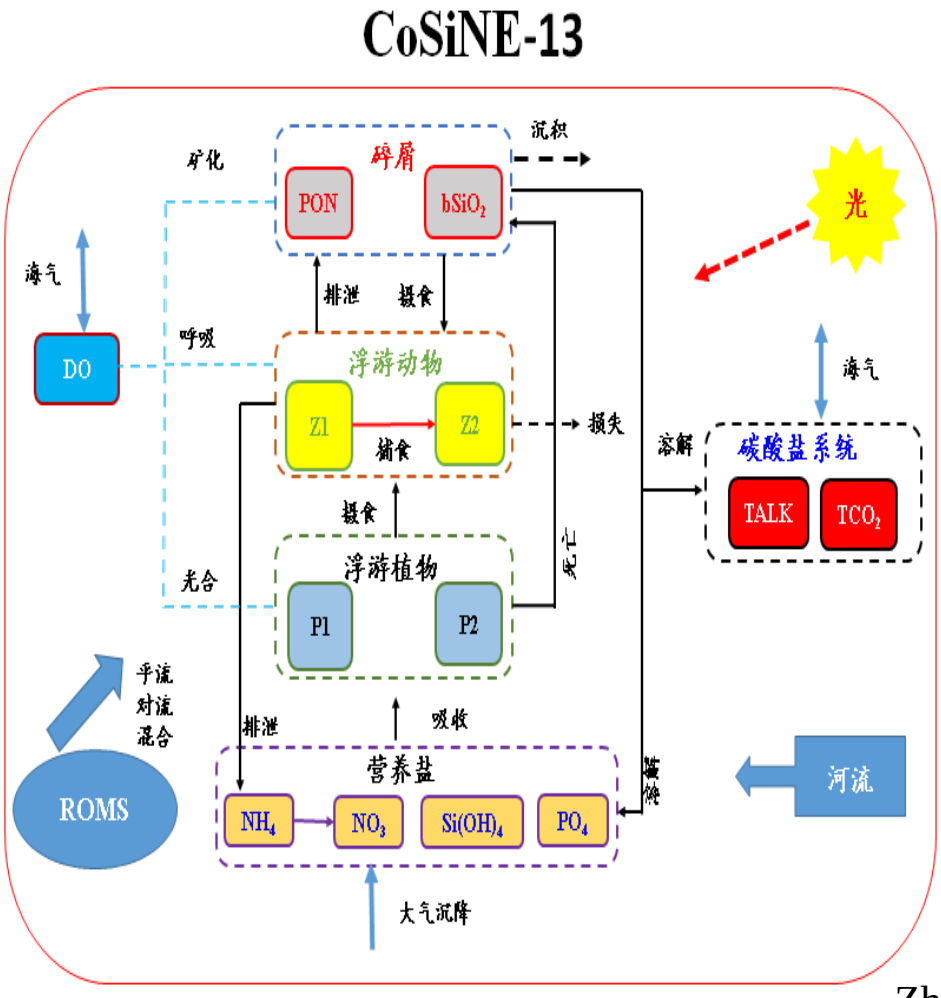




Zhou, Xue, Huang, et al., 2015, JGR-oceans

Variable Changjiang Diluted Water





Biological model: CoSiNE

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

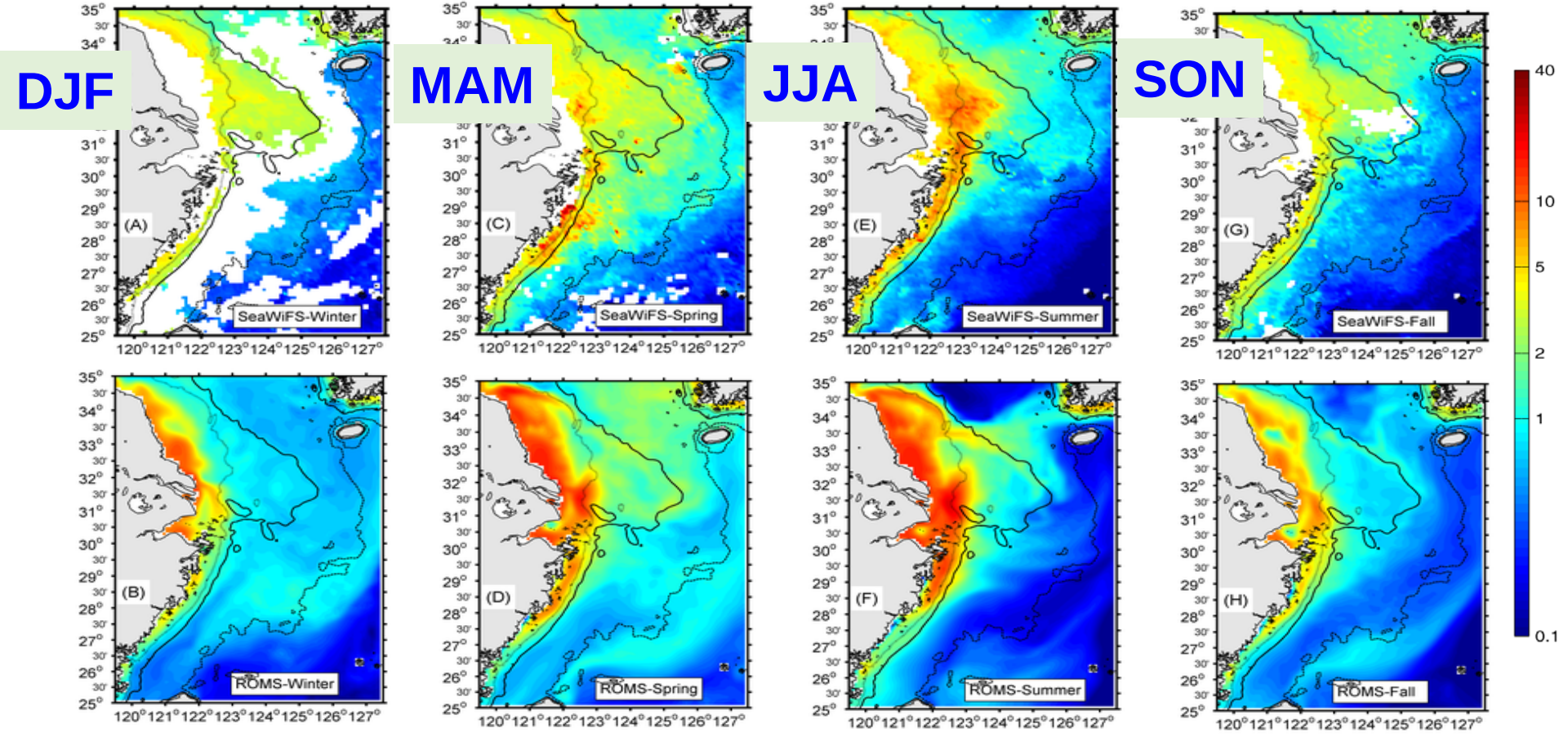
OBCs: CoSiNE-Pacific model(1/8º)
1999-2013
River nutrients: literatures
Atmosphere deposit: no

Climatological data set

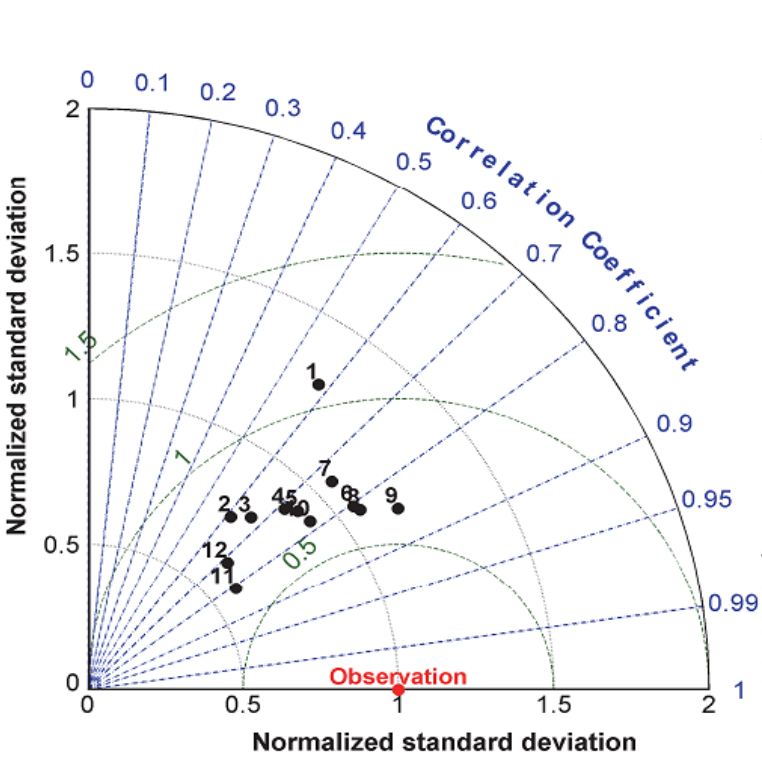
Zhou, Chai, Huang et al. 2017, PO, accepted

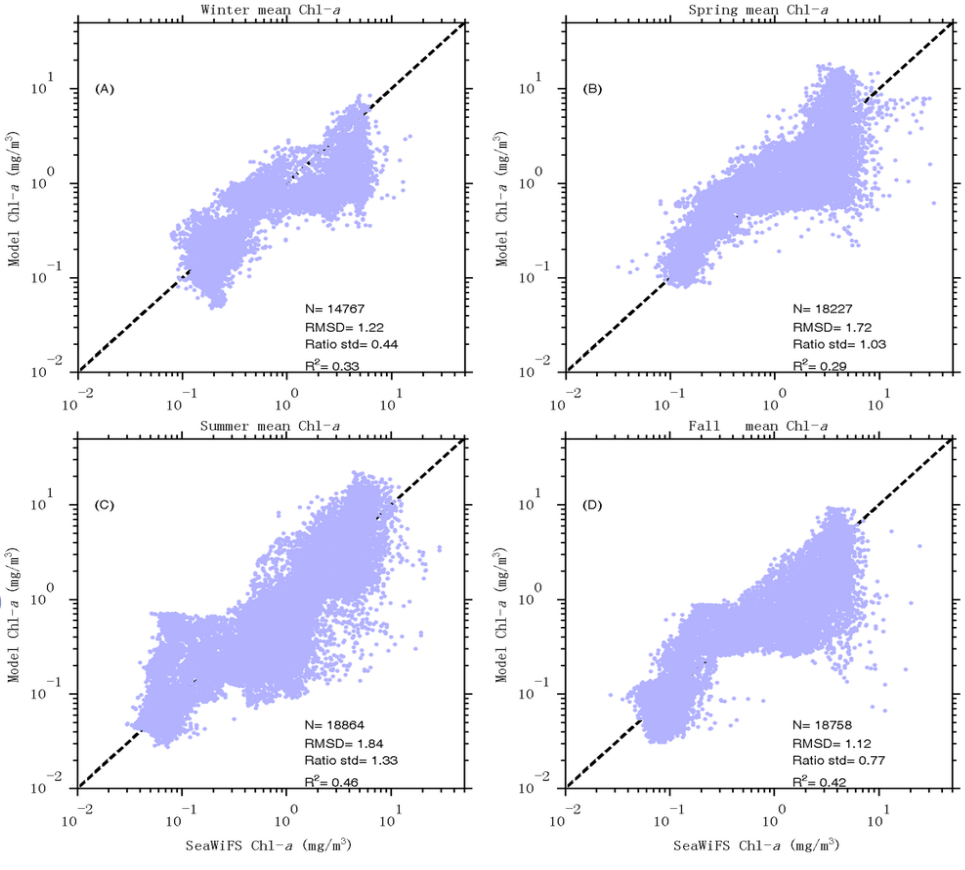
Model-data comparison: surface Chl *a*

Upper: SeaWiFS; Lower: Simulation

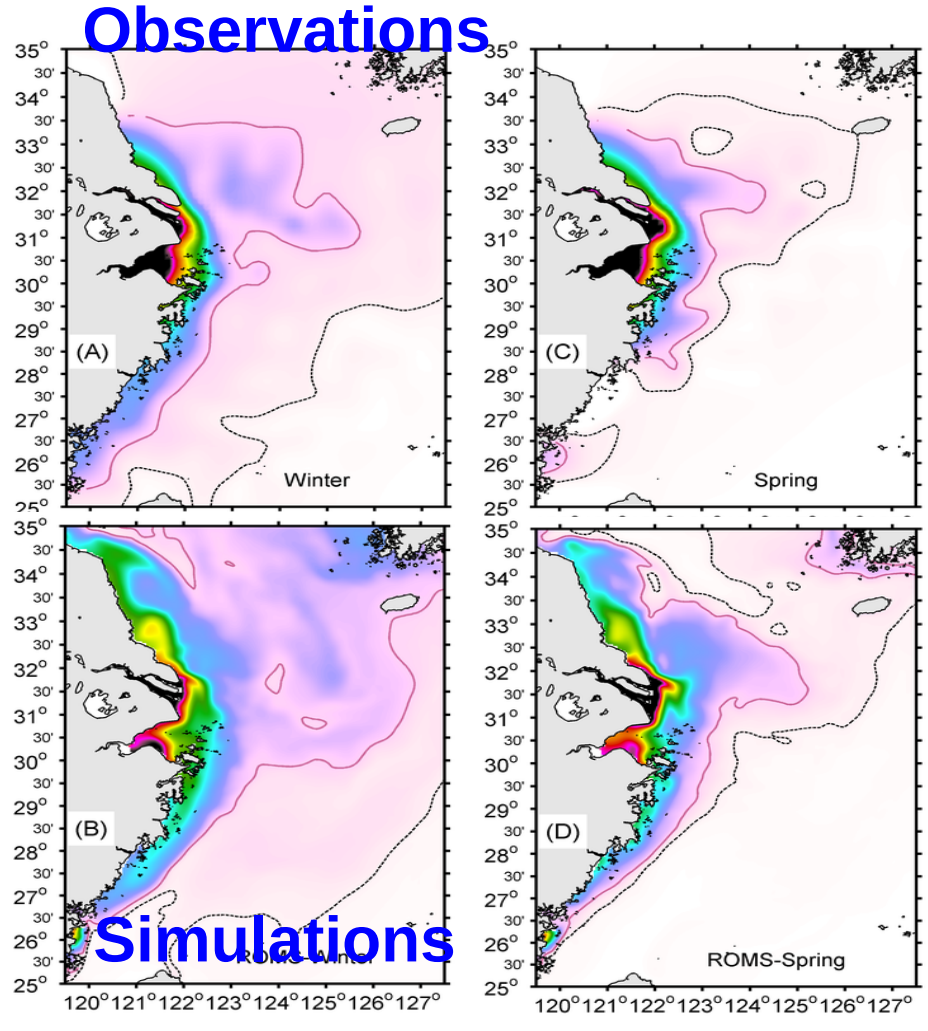


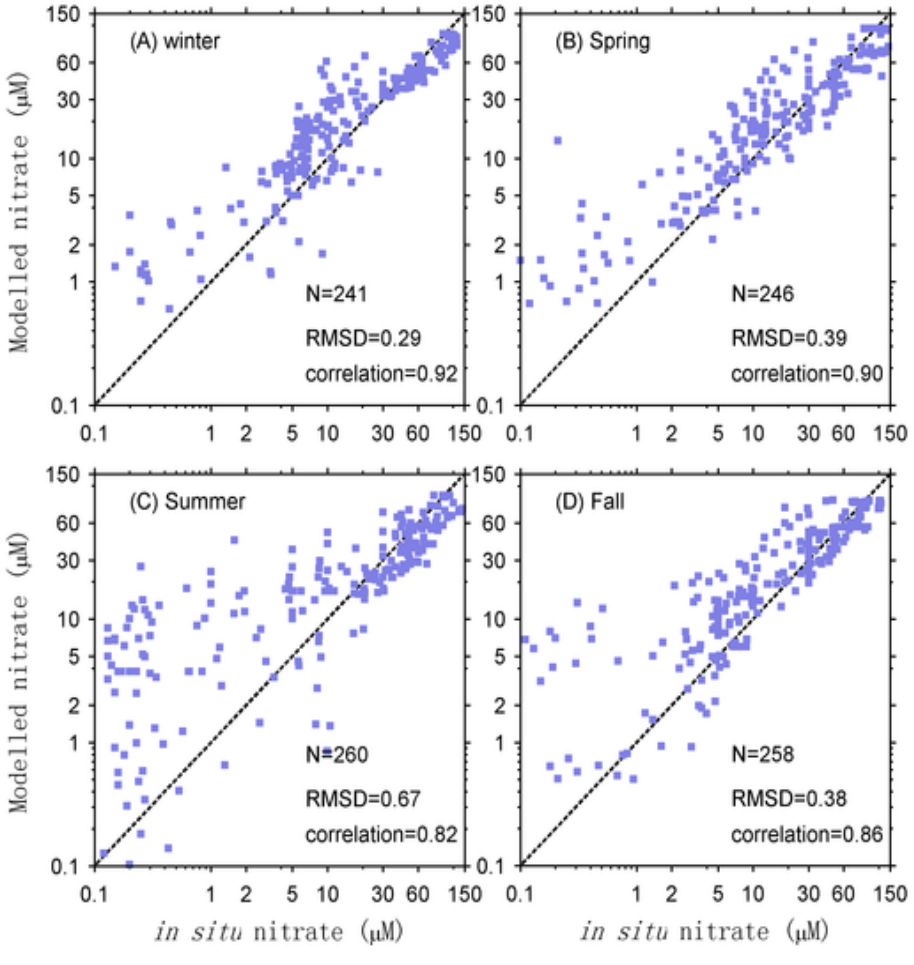
Model-data comparison: surface Chl *a*





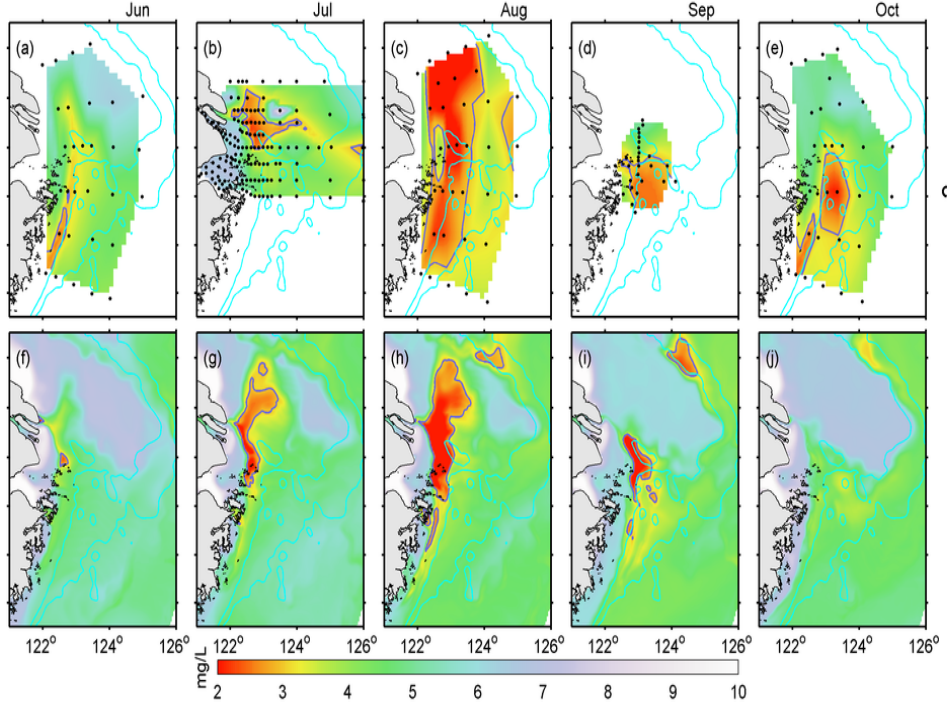
Model-data comparison: Nitrate

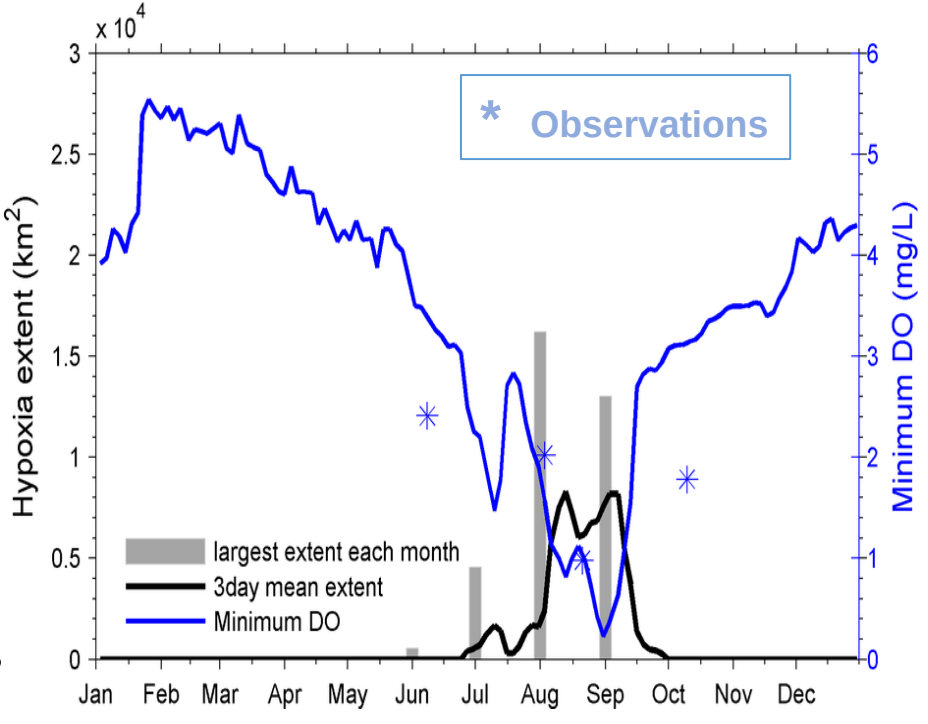




Development of hypoxia

Observations





Simulations

Zhou et al. (2017, *Prog. Oceanogr.*, accepted.

近海动力过程与生态系统
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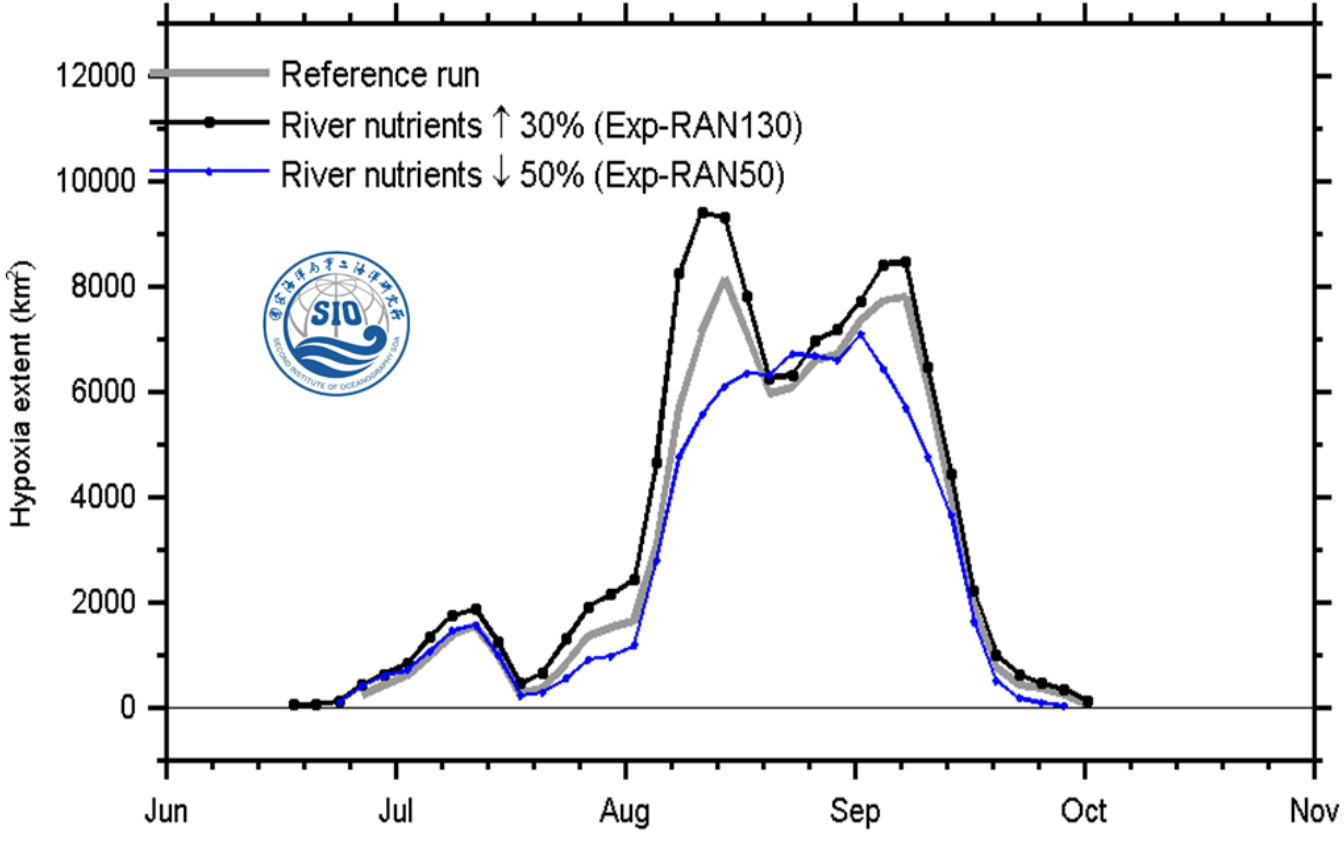
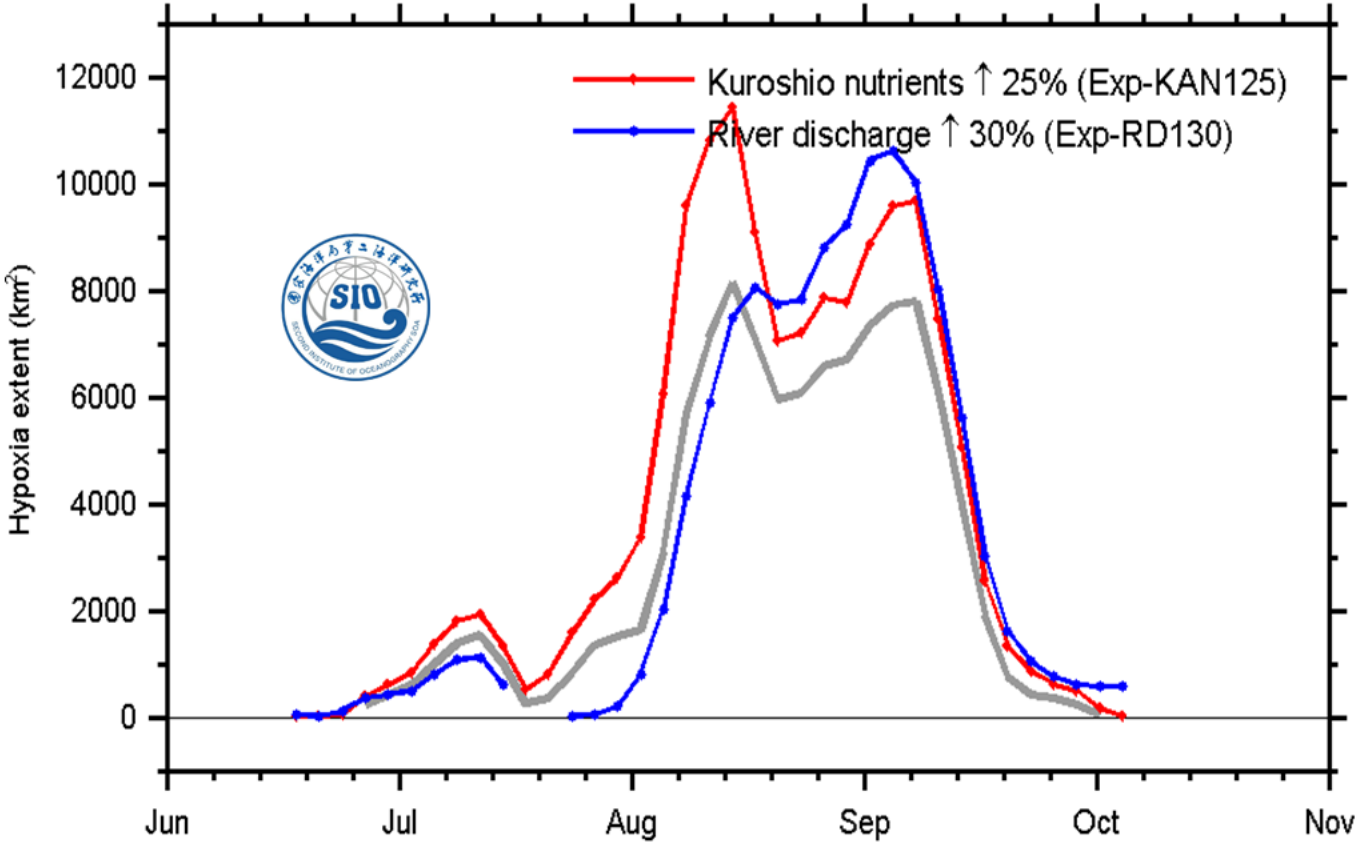
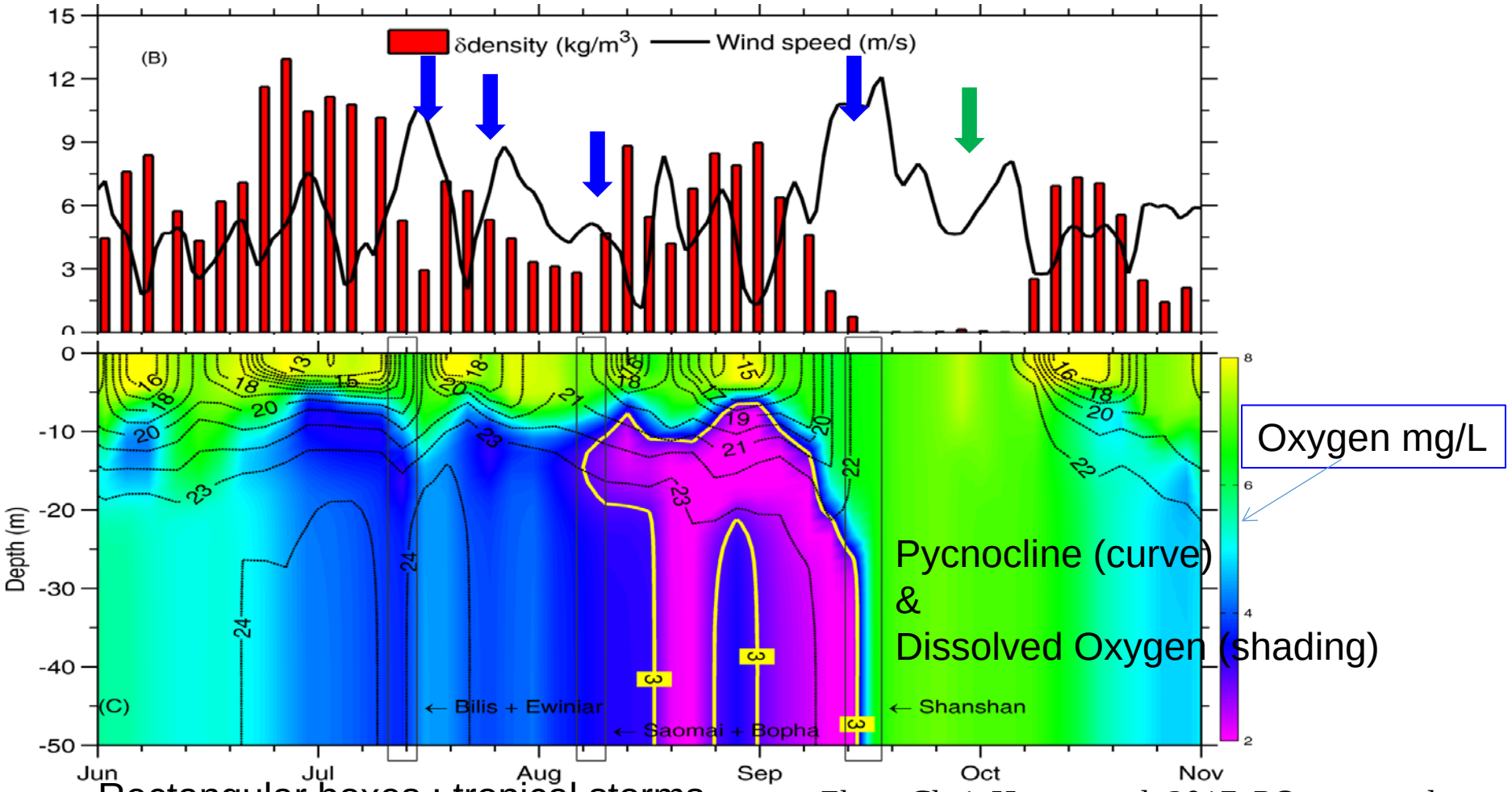
Experiments: riverine nutrients



Experiments: Changjiang vs Kuroshio

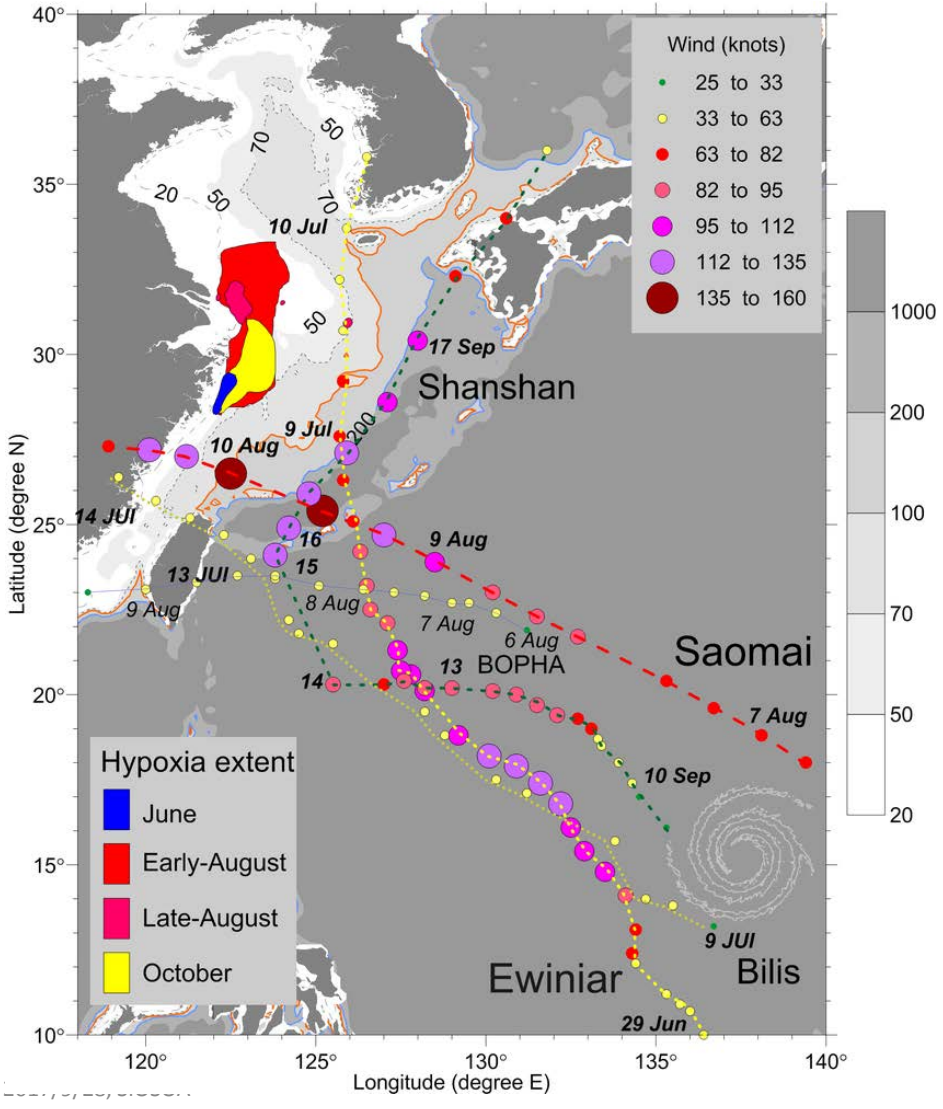


Episodic events



Rectangular boxes : tropical storms

Zhou, Chai, Huang et al. 2017, PO, accepted



Variability is probably caused by one of or some combinations from factors:

Typhoon track

Monsoon wind

Kuroshio cross-shelf

River discharge

Through flow at the Taiwan strait

Surface Temperature ?

6 Summary

- Hypoxia off the Changjiang Estuary shows large event-scale to seasonal scale variability.
  - Seasonally, the hypoxia rose in **early summer** and was most significant at the end of summer, particularly in **August** when stratification peaked, and it could be still visible in **fall**.
  - Intra-seasonal variation of the hypoxic zone or the episodic relief of the hypoxia is probably caused by enhanced **mixing** related to strength in **wind**.
- Both rivers and Kuroshio need to be considered to evaluate the hypoxia extent variations.
- Both physical and biogeochemical processes are important in inducing the hypoxia event as illustrated by the sensitivity experiments.

THANK YOU

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Ministry of Science and Technology of the People´s Republic of China

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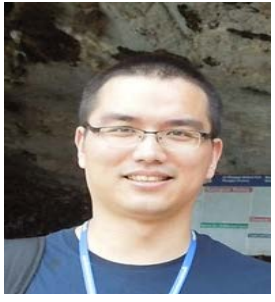
CODE: Coastal Ocean Dynamics and Environment

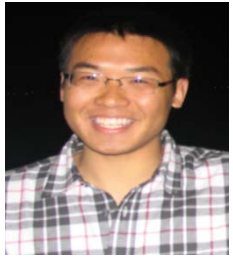
近海动力过程与生态系统
Coastal Ocean Dynamics and Ecosystems (CODE)


黄大吉


苏纪兰

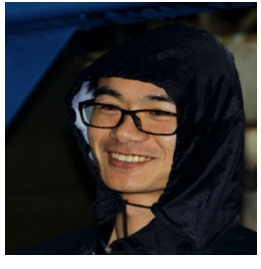

周锋


马晓


曾定勇


李佳


倪晓波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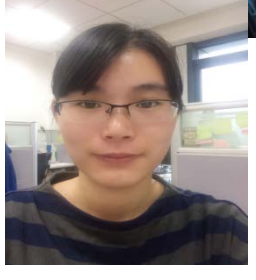
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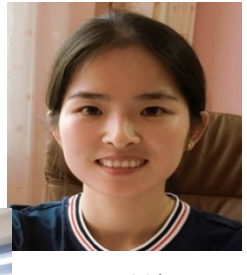
田娣


孟启承

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.
- Ni, X. B., D. J. Huang, D. Y. Zeng, T. Zhang, H. L. Li, and J. F. Chen (2016), The impact of wind mixing on the variation of bottom dissolved oxygen off the Changjiang Estuary during summer, *J. Mar. Syst.*, 154, Part A, 122–130, doi:10.1016/j.jmarsys.2014.11.010.
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- Fan, X. P., F. Zhou, X. E. Chen, D. J. Huang, and T. Pohlmann (2011), The influence of the Three-Gorges Dam on the East China Sea, *Acta Oceanol. Sin.*, 30(5), 1–11, doi:10.1007/s13131-011-0146-z.
- 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 Oceanol. Sin.*, 28(6), 1–11.
- 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