Paleoecology related to LGC

The diatom in Pearl River Estuary (N South China Sea) related to Last Glacial Cycle

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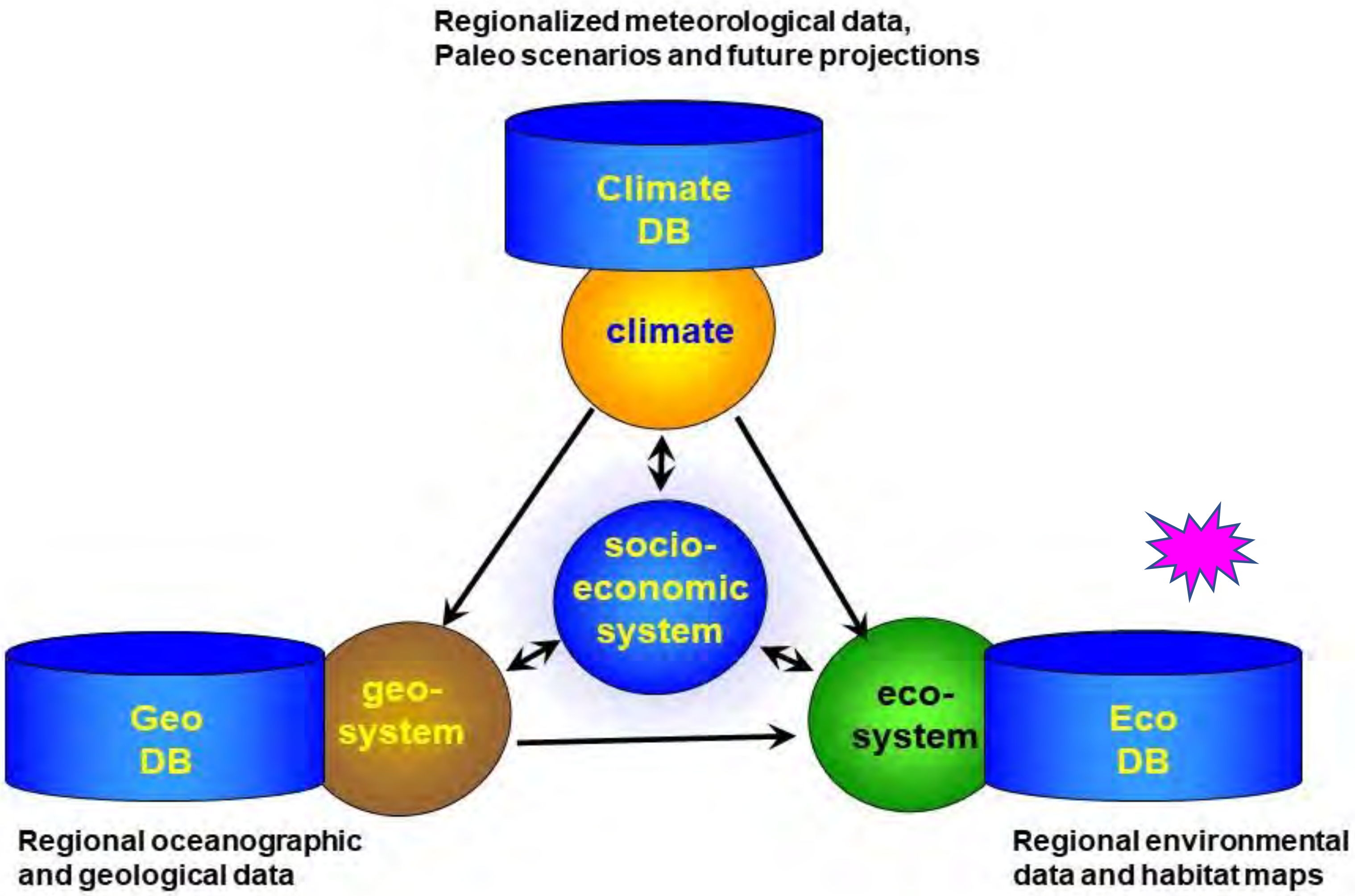
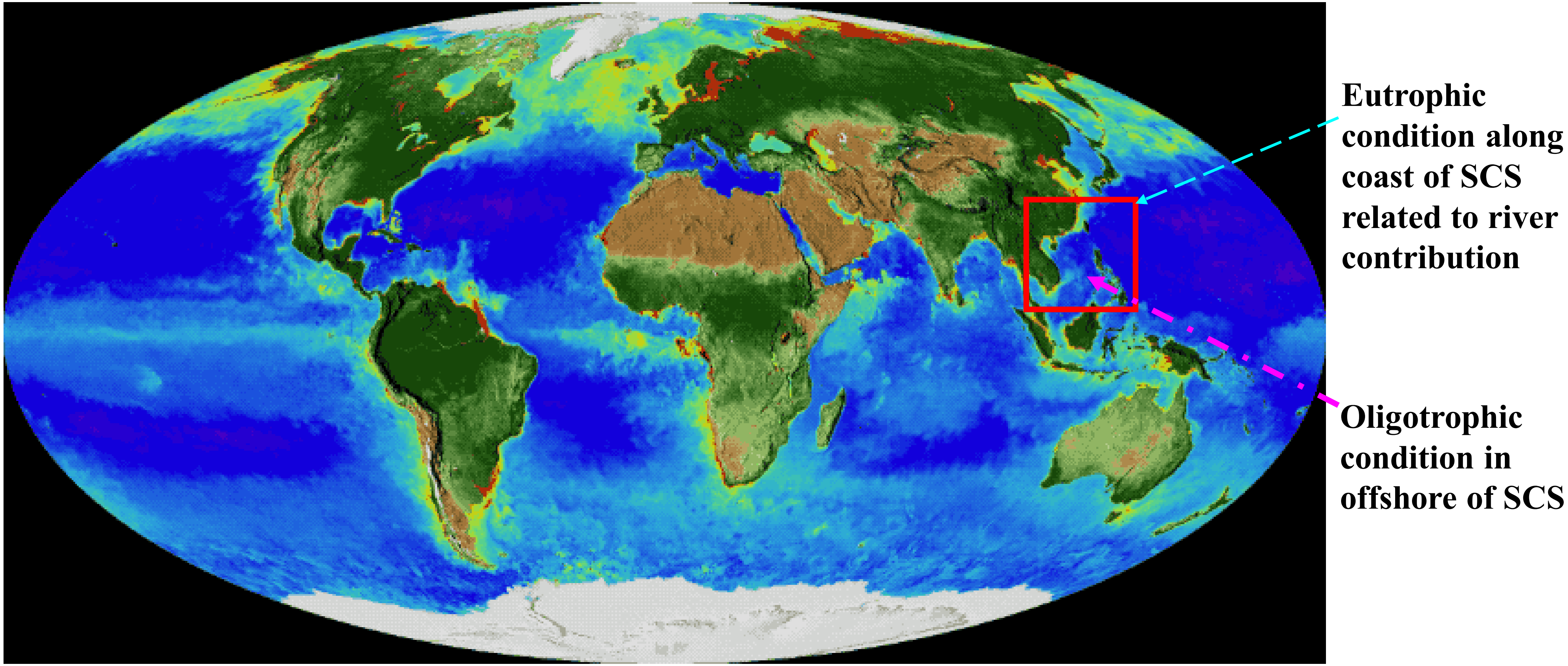
Xiamen University
16 – 17th December, 2020


Eurasia and its marginal seas
We select potential key areas for the EMS Research Initiative
South China Sea

Schematic description of the interrelation of Marginal seas' functional systems driving forces and corresponding data sources.



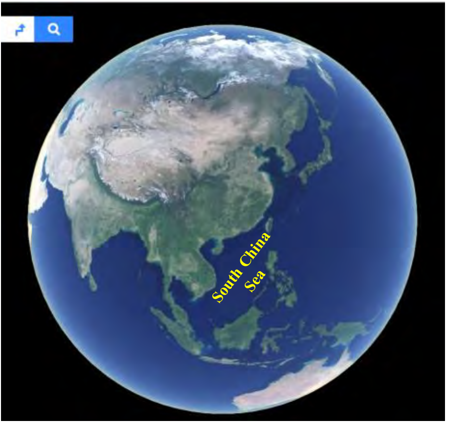
Back ground

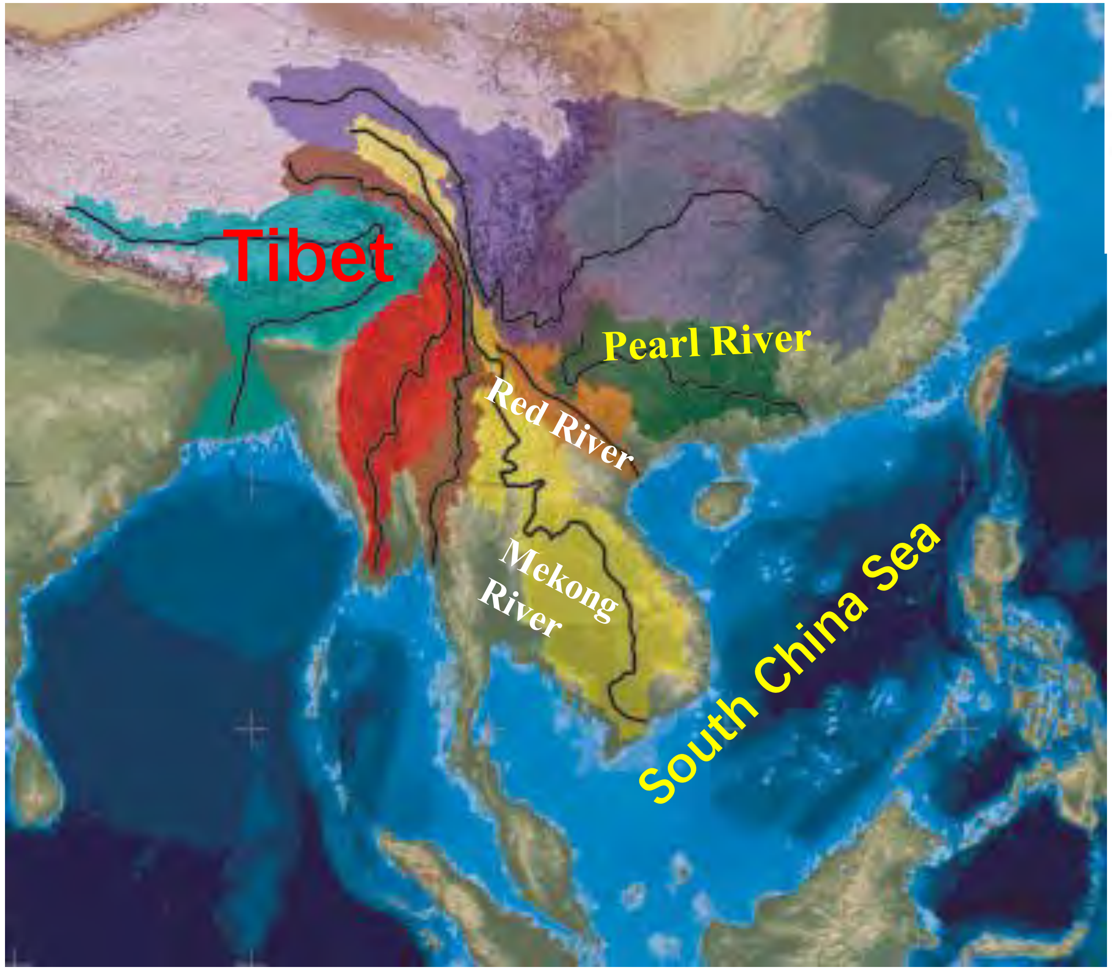


*** 1997-2017, global *plant* and *chlorophyll* change**

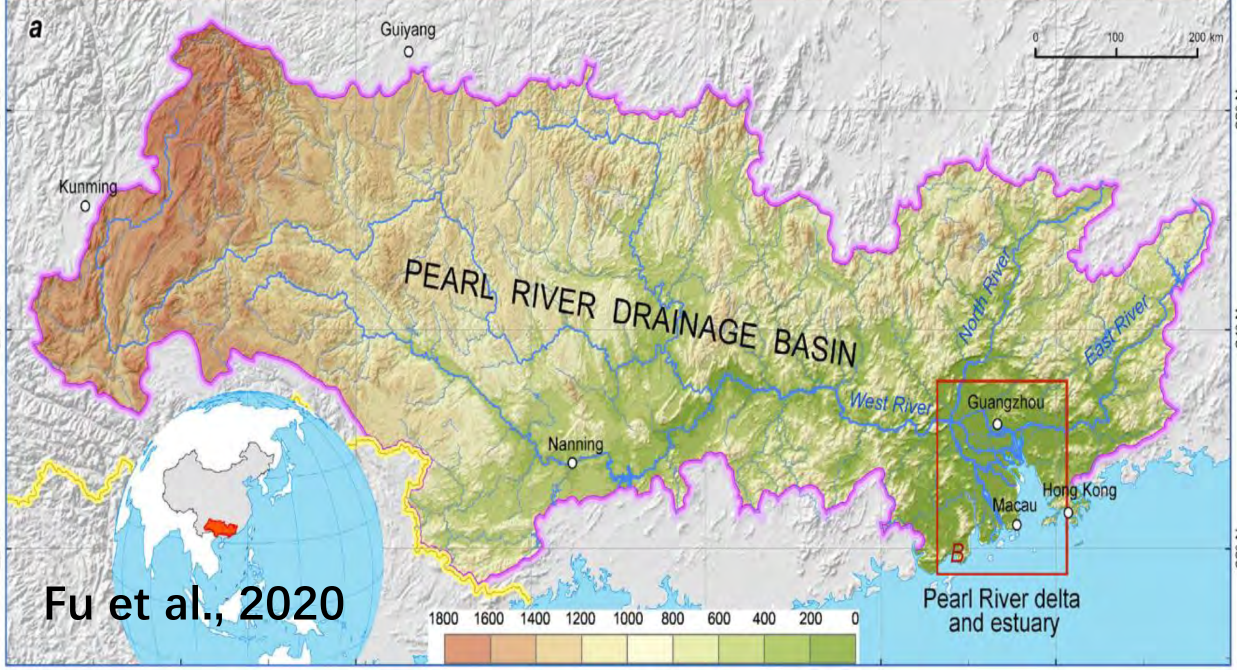
(from Sea-viewing Wide Field-of-view Sensor – SeaWiFS/NASA production)

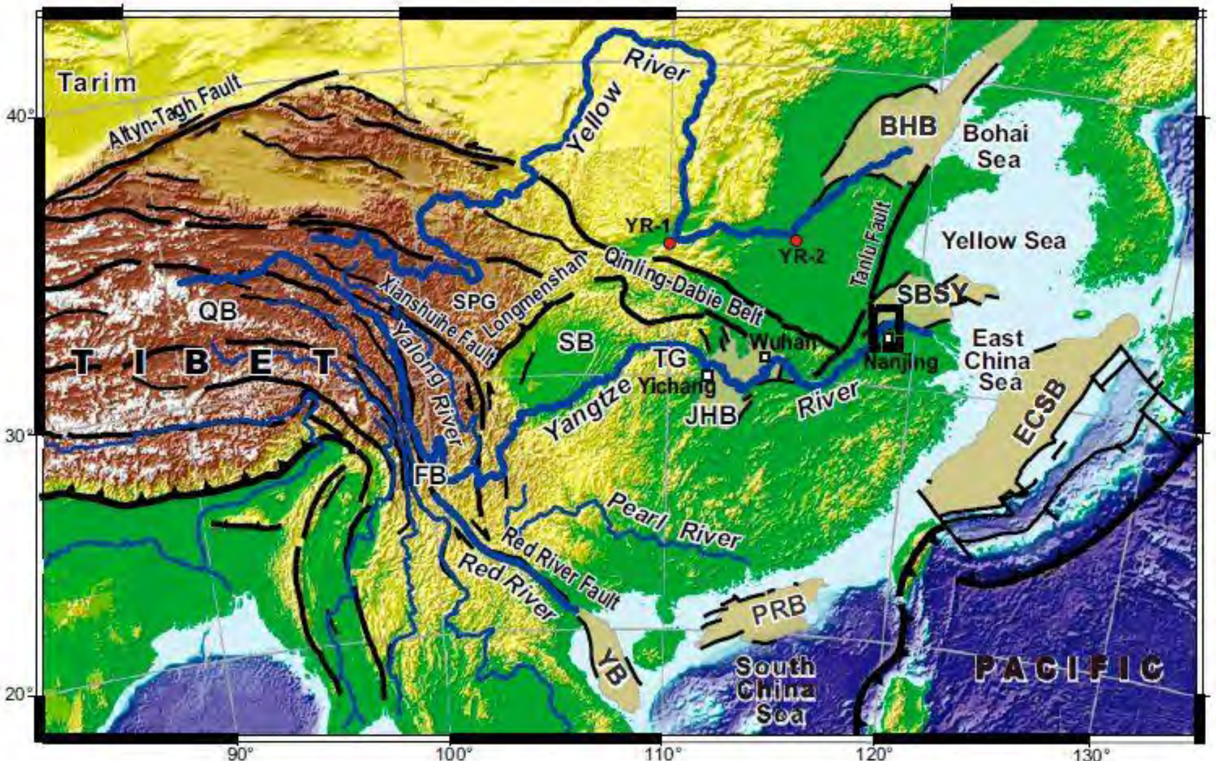
https://oceancolor.gsfc.nasa.gov/SeaWiFS/


South China
Sea


Tibet
Pearl River
Red River
Mekong
River
South China Sea

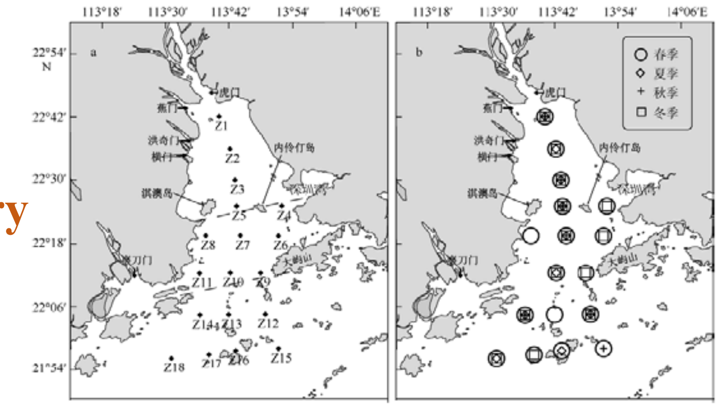
Clift, 2008


a
Guiyang
Kunming
PEARL RIVER DRAINAGE BASIN
North River
East River
West River
Guangzhou
Nanning
Macau
Hong Kong
B
Pearl River delta
and estuary
Fu et al., 2020
1800 1600 1400 1200 1000 800 600 400 200 0
26° N
24° N
22° N
0 100 200 km


Tarim
Altyn-Tagh Fault
Yellow
River
BHB
Bohai
Sea
YR-1
YR-2
Tanlu Fault
Yellow Sea
Qinling-Dabie Belt
Longmenshan
SPG
Xianshuihe Fault
QB
SBSY
T I B E T
SB
Wuhan
Nanjing
East
China
Sea
TG
Yichang
Yalong River
Yangtze
JHB
River
ECSB
FB
Pearl River
Red River Fault
Red River
PRB
YB
South
China
Sea
PACIFIC
40°
30°
20°
90°
100°
110°
120°
130°

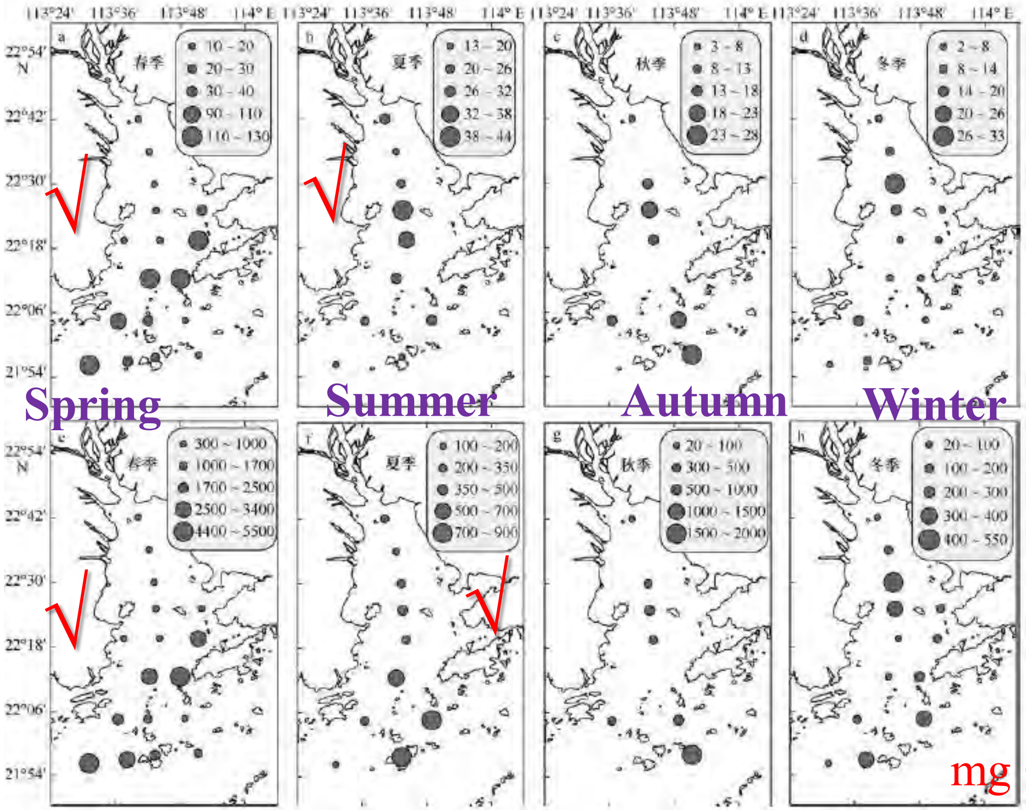
Sampling Sites in Pearl River Estuary

(Liu et al., 2017)



Seasonal variability of primary production in surface water

mg C/m³h

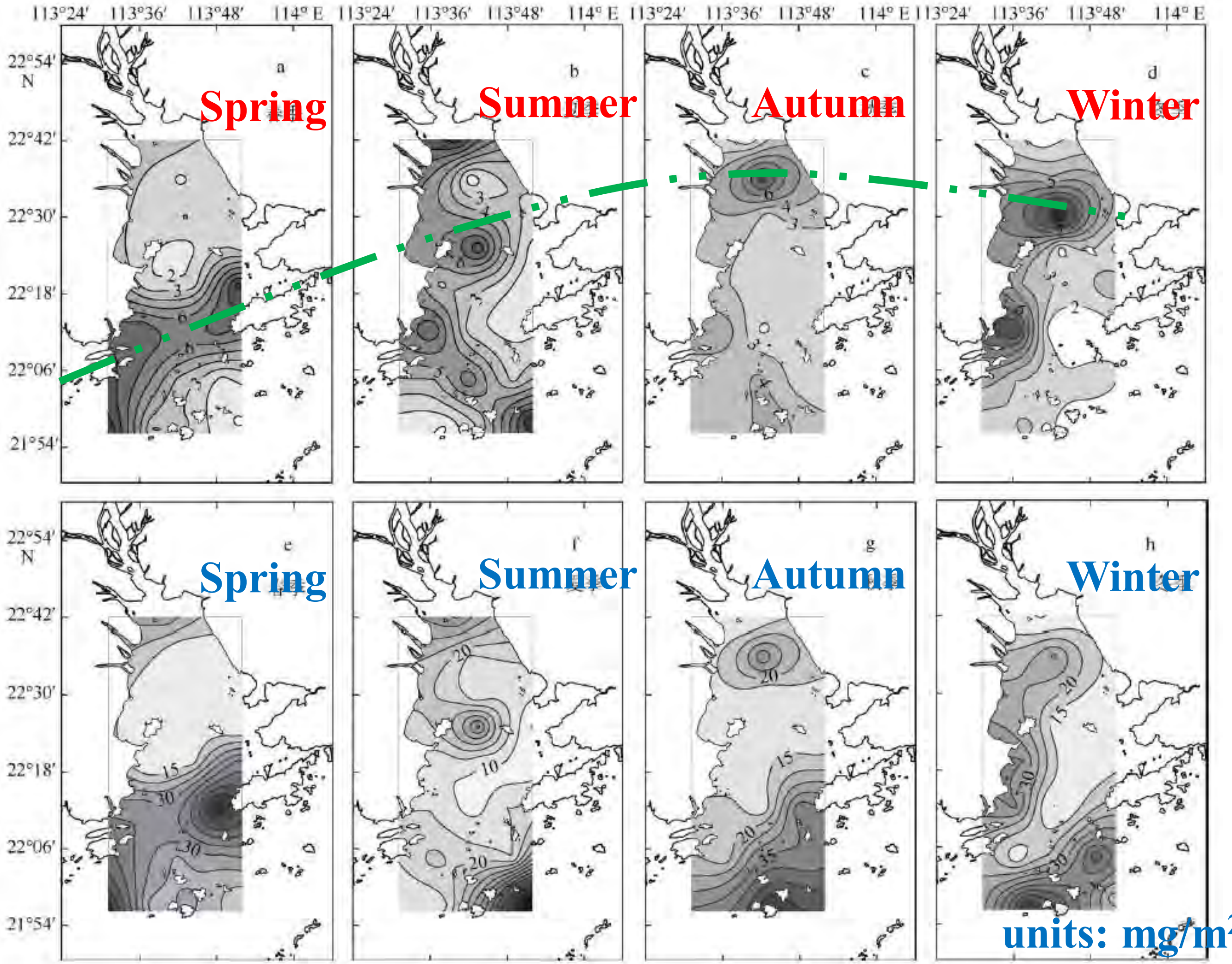


mg C/m²·d

integrated primary production (average year in water column)

Seasonal variability of Chlorophyll *a* in surface water (~ 0.5m)

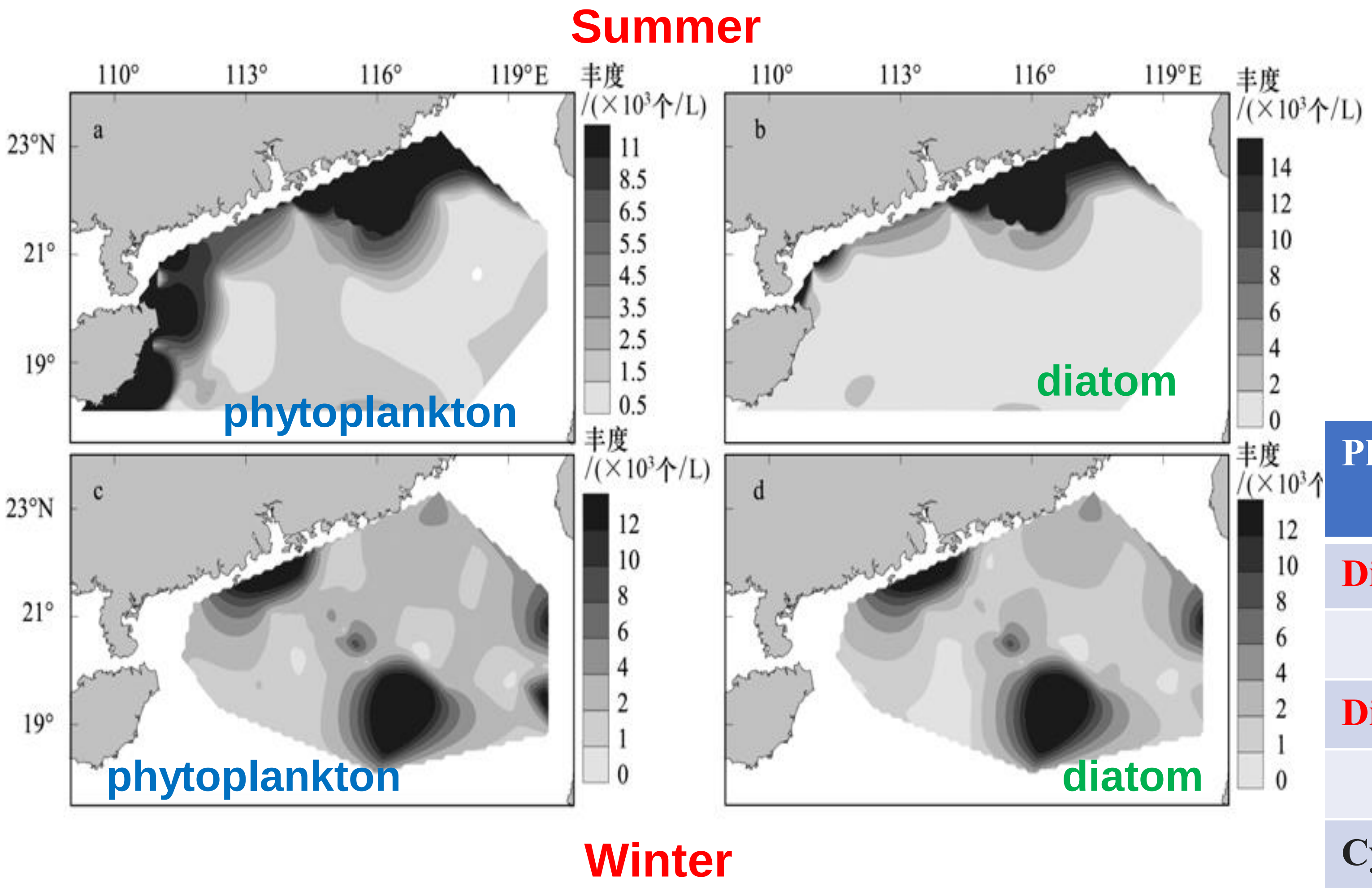
units: mg/m²



units: mg/m²

Integrated Chlorophyll *a* in Water Column

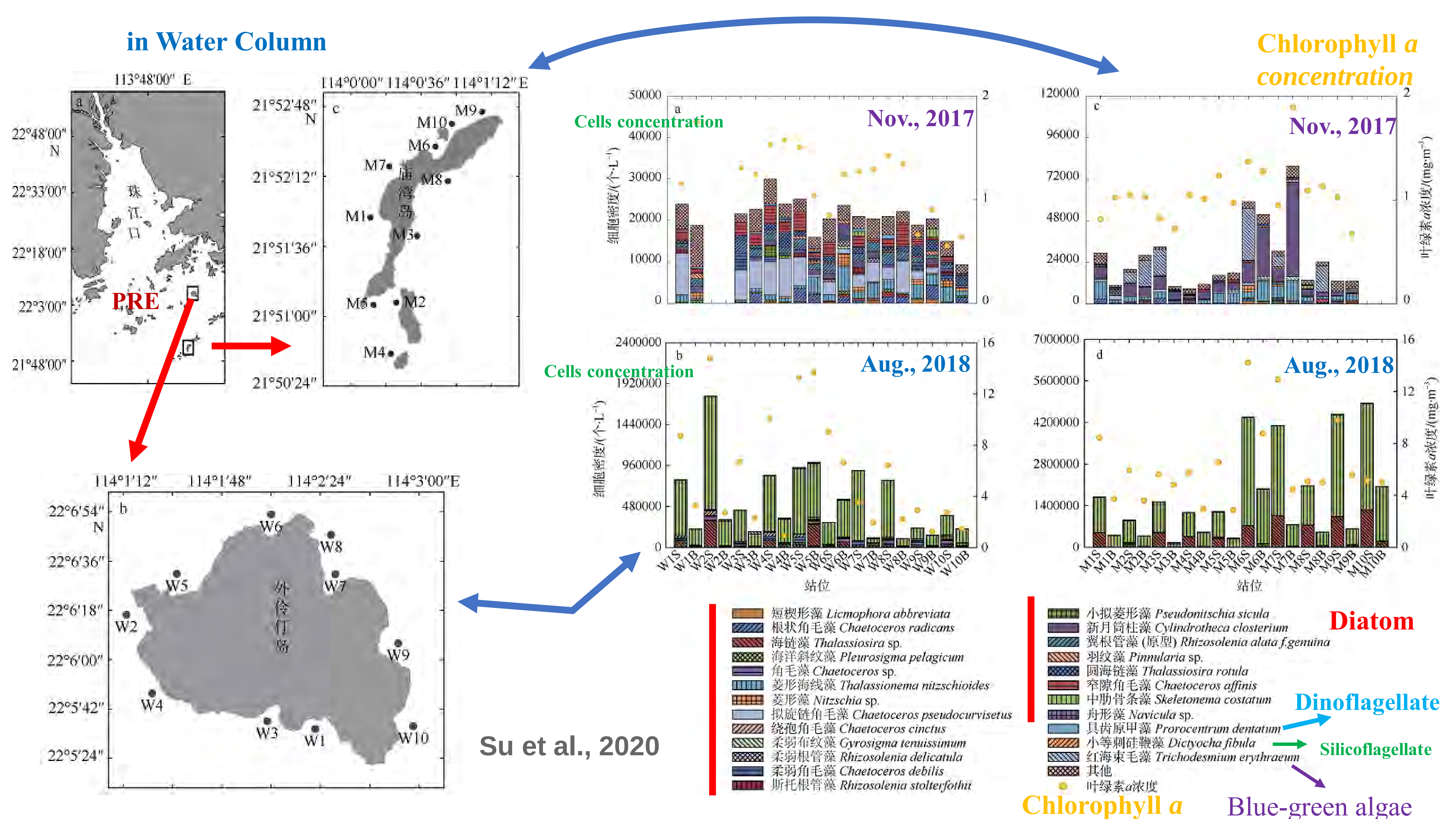
Distribution of phytoplankton abundance in 5-m seawater layer in N-SCS



Ma & Sun, 2014

The number of species & genus about phytoplankton in the survey seasons

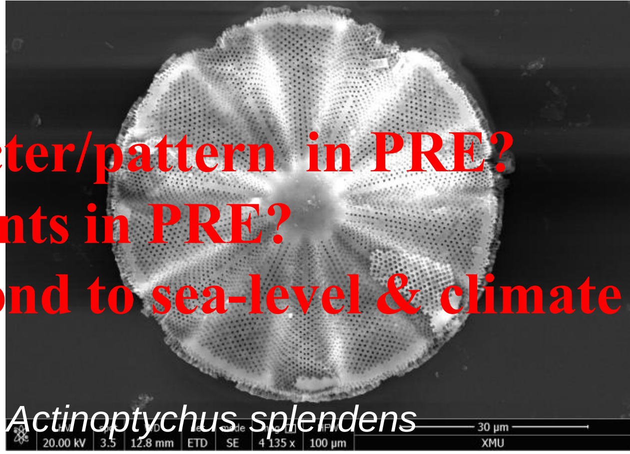
Phylum	Season	Genera	Species	Ration of richness
Diatom	Summer	50	80	53.33%
	Winter	40	100	59.52%
Dinoflagellate	Summer	18	65	43.33%
	Winter	14	63	37.5%
Cyanophyceae	Summer	2	3	2%
	Winter	2	3	1.79%
Chrysophyta	Summer	2	2	1.33%
	Winter	2	2	1.19%

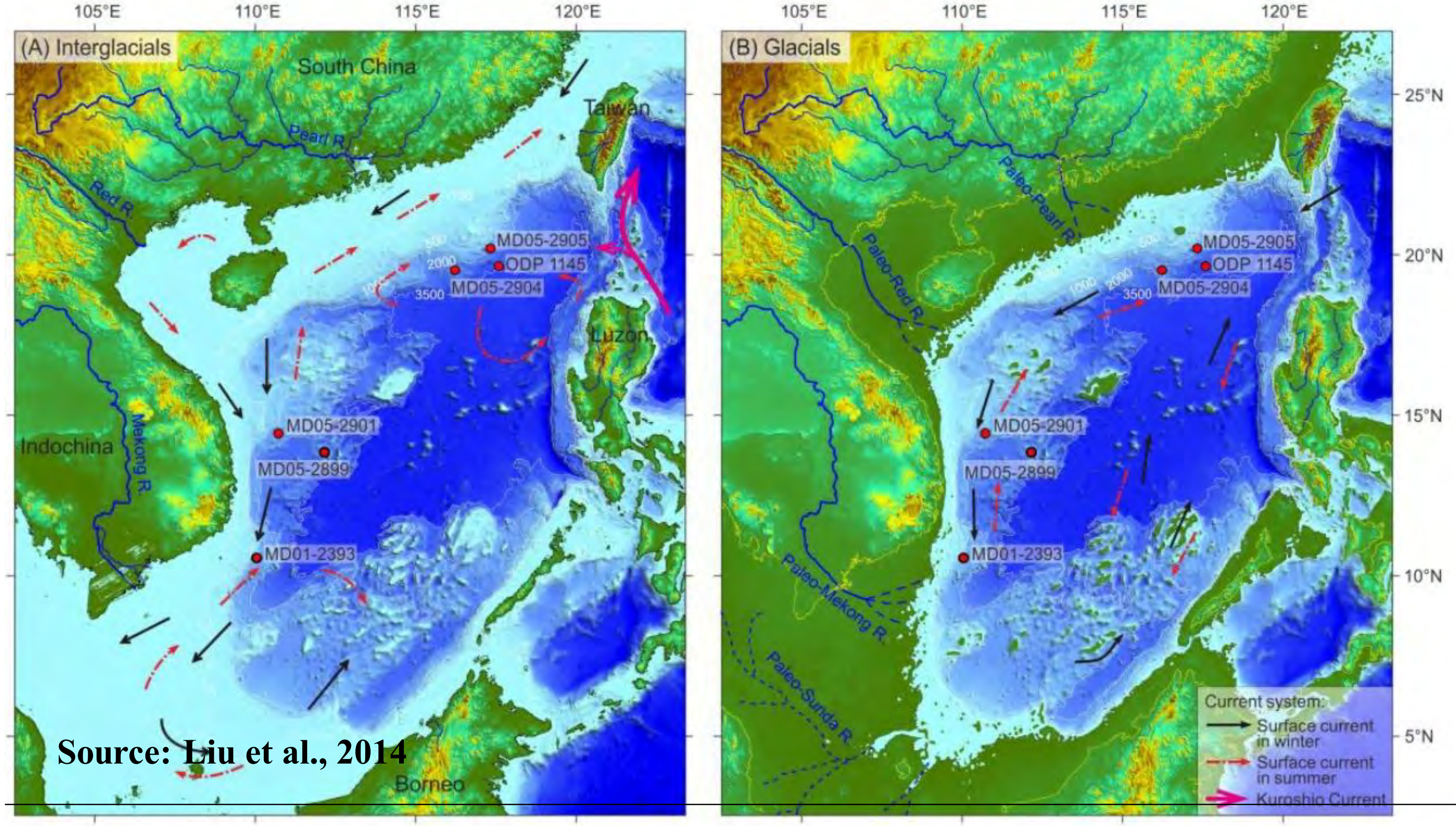


in Water Column
Chlorophyll a concentration
PRE
珠江口
庙湾岛
外伶仃岛
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
Cells concentration
Nov., 2017
Aug., 2018
细胞密度/(个·L⁻¹)
叶绿素a浓度/(mg·m⁻³)
站位
Su et al., 2020
短楔形藻 Licmophora abbreviata
根状角毛藻 Chaetoceros radicans
海链藻 Thalassiosira sp.
海洋斜纹藻 Pleurosigma pelagicum
角毛藻 Chaetoceros sp.
菱形海线藻 Thalassionema nitzschioides
菱形藻 Nitzschia sp.
拟旋链角毛藻 Chaetoceros pseudocurvisetus
绕孢角毛藻 Chaetoceros cinctus
柔弱布纹藻 Gyrosigma tenuissimum
柔弱根管藻 Rhizosolenia delicatula
柔弱角毛藻 Chaetoceros debilis
斯托根管藻 Rhizosolenia stolterfothii
小拟菱形藻 Pseudonitschia sicula
新月筒柱藻 Cylindrotheca closterium
翼根管藻 (原型) Rhizosolenia alata f.genuina
羽纹藻 Pinnularia sp.
圆海链藻 Thalassiosira rotula
窄隙角毛藻 Chaetoceros affinis
中肋骨条藻 Skeletonema costatum
舟形藻 Navicula sp.
具齿原甲藻 Prorocentrum dentatum
小等刺硅鞭藻 Dictyocha fibula
红海束毛藻 Trichodesmium erythraeum
其他
叶绿素a浓度
Diatom
Dinoflagellate
Silicoflagellate
Blue-green algae
Chlorophyll a

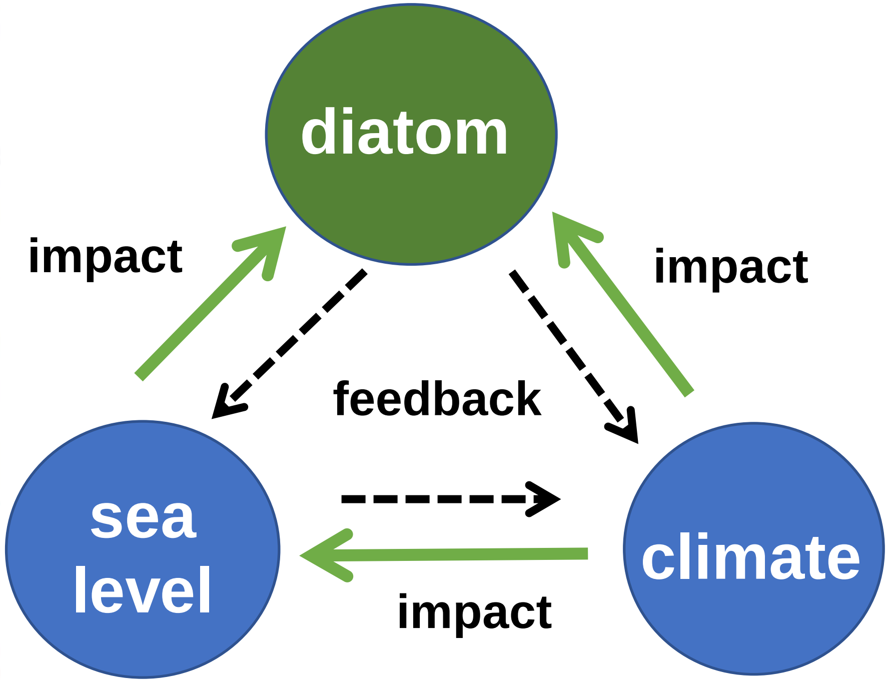
Questions:

- 1. In the geological scale, how about the fossil diatom distribution character/pattern in PRE?
- 2. How about the diatom-subfossil one distribution in the surface sediments in PRE?
- 3. What we can read from sedimentary record in PRE, particularly respond to sea-level & climate change?



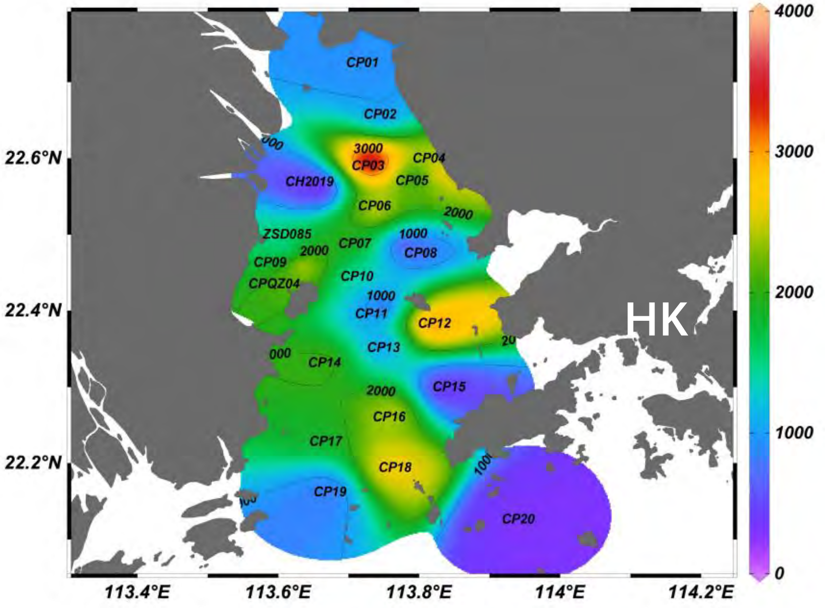


Source: Liu et al., 2014

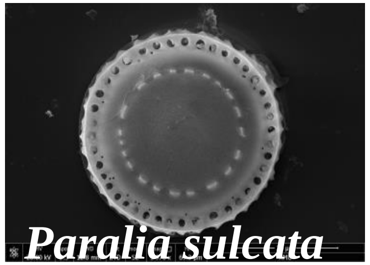


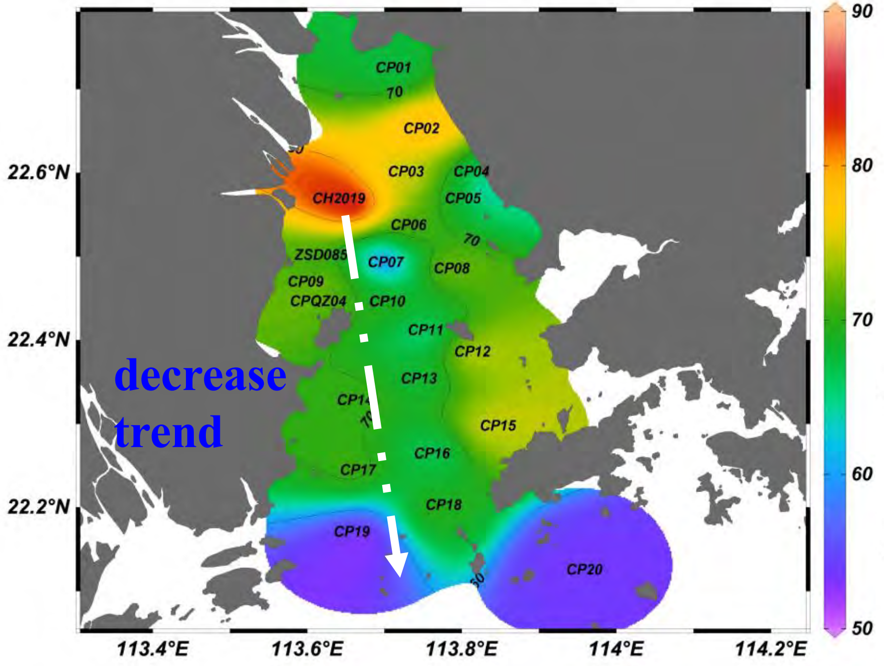
Flowing the sea level change, the geographical and currents changed in SCS between the interglacial and glacial periods, related to climate change

Distribution of diatom in surface sediment in PRE (preliminary result 2020)



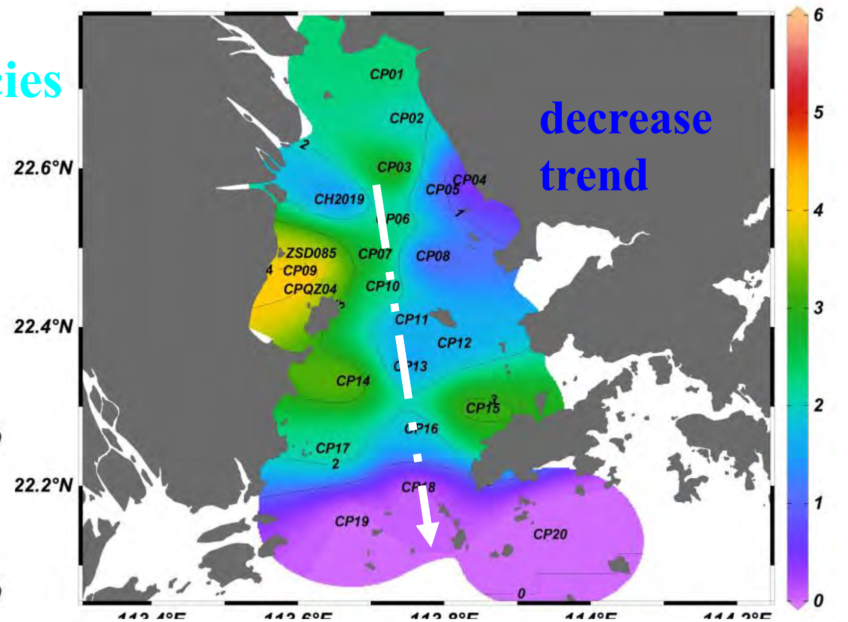
Total Abundance
(valves/g dry sediment)

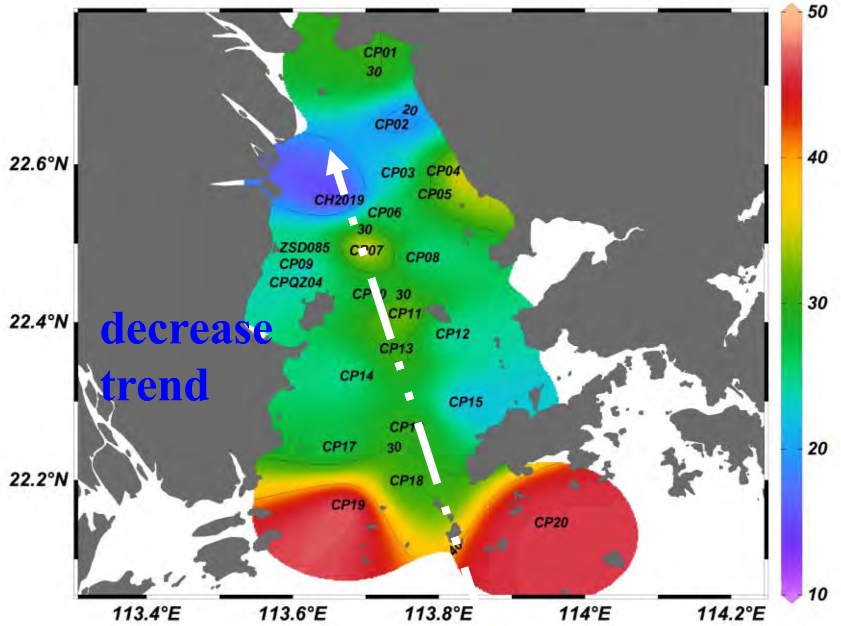




Brackish water species ratio (%)

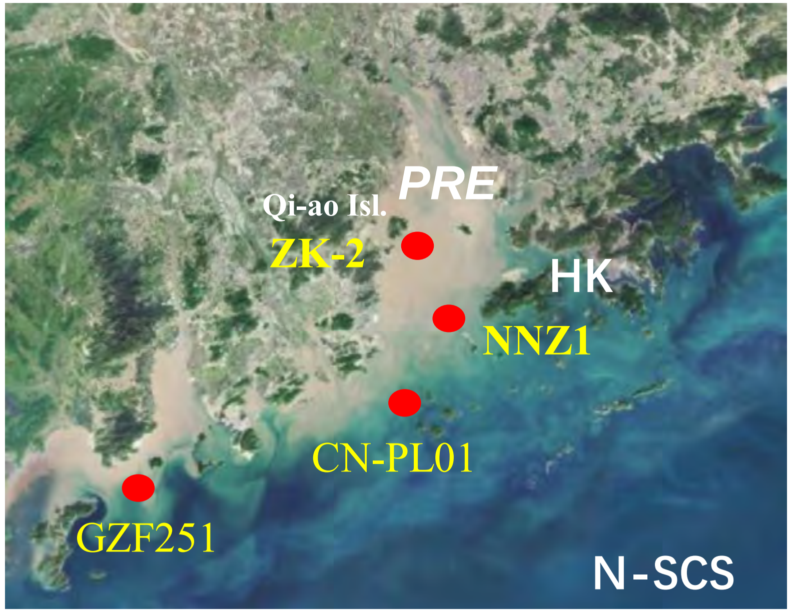
Freshwater species ratio (%)

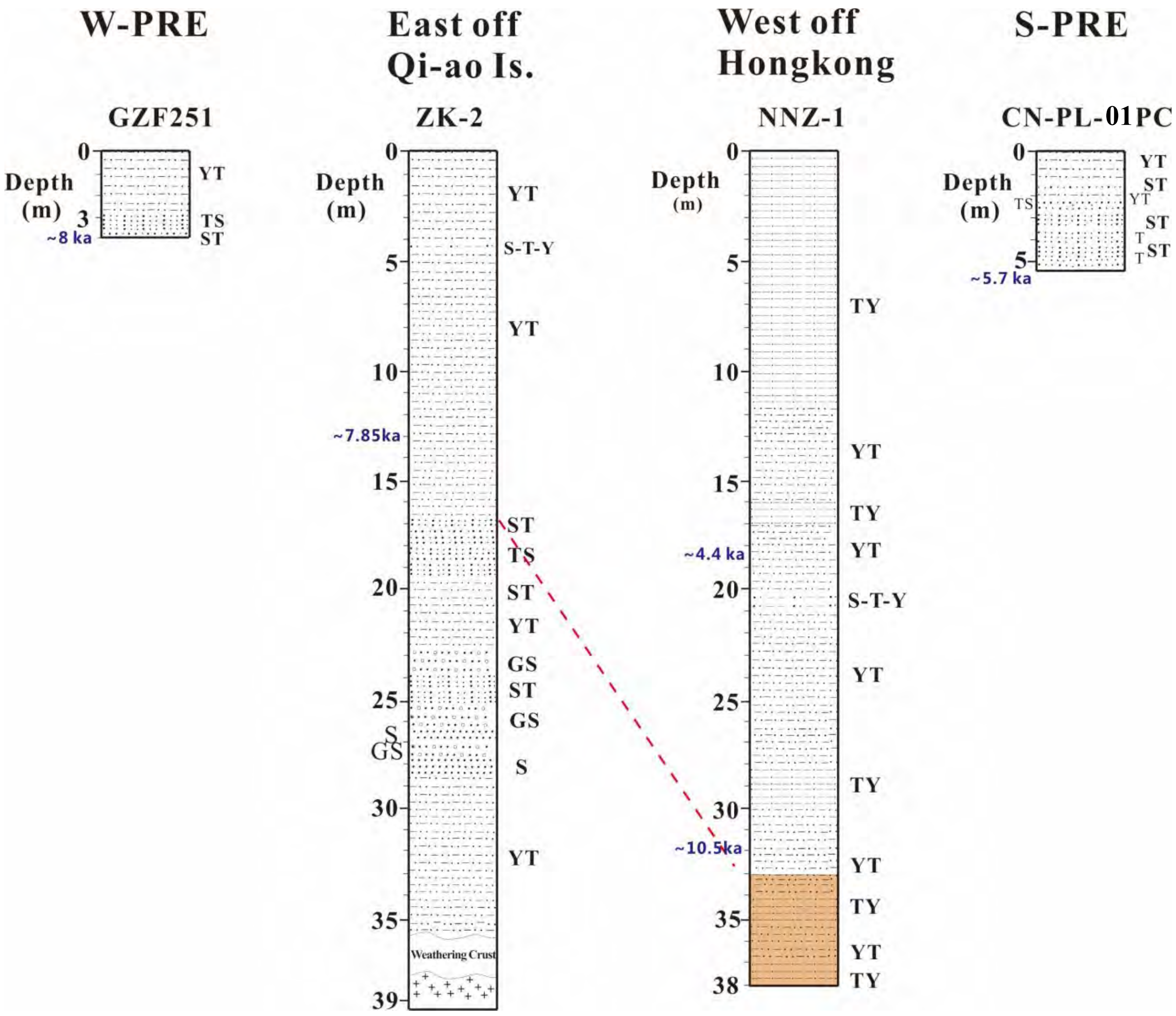




Saline/Marine species ratio (%)

Sedimentary cores with diatomology work in PRE

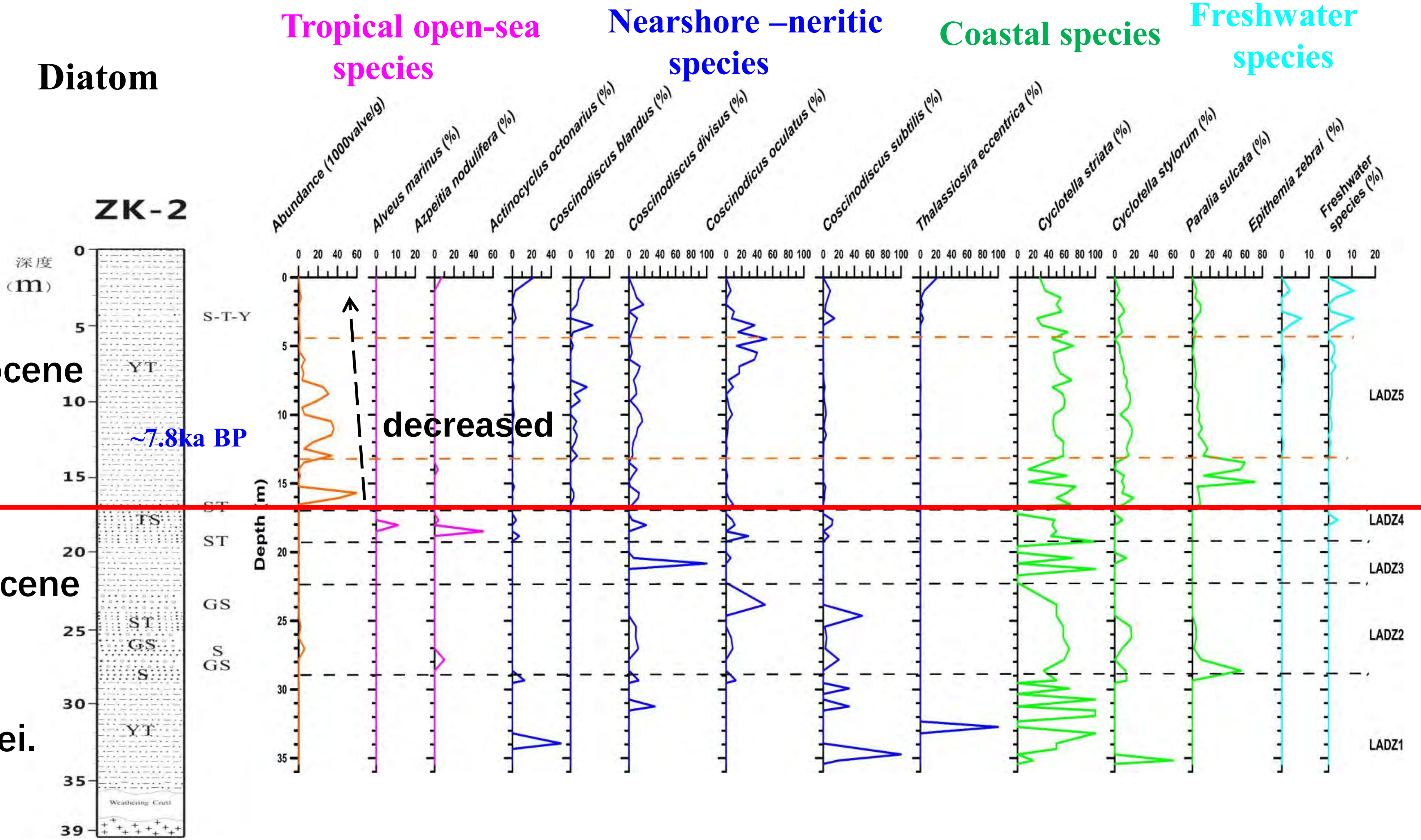




ZK-2 core, 40 m length, water depth 3 m

Holocene

Pleistocene



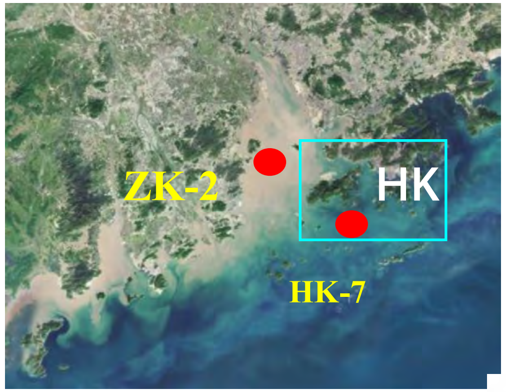
The transgressions were also occurred in Plei.

But, how many times of large amplitude sea-level change recorded in this area? The results are still not clearly, by lack of available/precise age dating work to sediment cores. E.g, MIS3 vs MIS5 debate

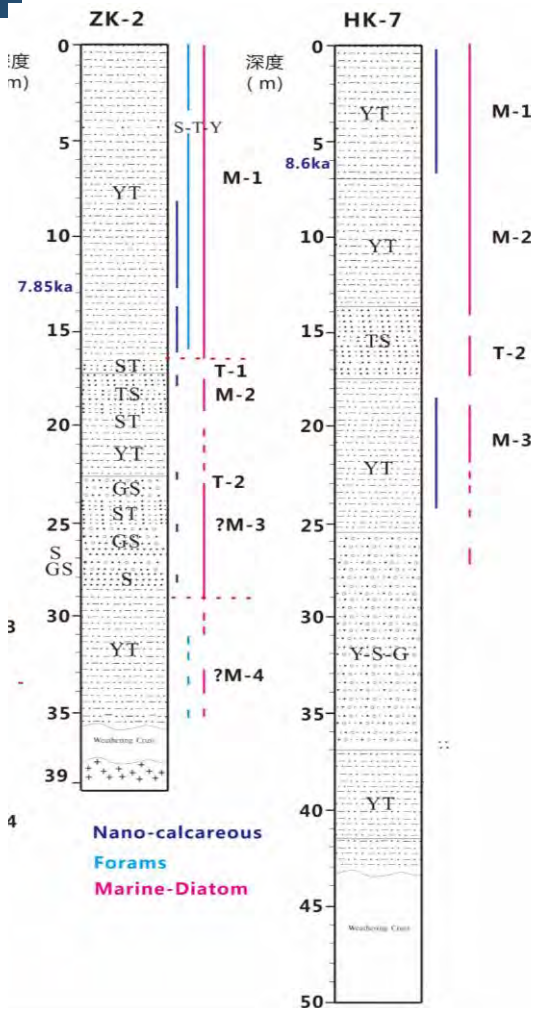
Pearl River Delta and Hongkong Sea area’ s Quaternary stratum unit correlation (cited from Zong Y. et al., 1996)

Loith-units	Sediment facies	Huang Z.G (PRD)	Yim WWS (HK)	Fyfe (HK)	Inferred age/ka B.P.	Marine Isotope Stage(MIS)
M1b	Delta silt and clay (upper marine facies)	Denglongsha, Wanqinsha, Henglan Formation	First Marine Unit	Kenkou Formation （Jiangjun-Guozhou member）	< 7	1 （Mid-Late Holocene）
M1a	River-Esutrary facies, Sandy silt			Kenkou Formation （Biliao-Donglong member)	10.5 – 7	1 （Early Holocene)
T1	Terrestrial sand, silt, and weathering clay.	Sanjiao Formation	First Terrestrial Unit	Hengluan Formation	73 – 10.5	4 - 2
M2	Shallow sea facies, silt and clay (lower marine facies)	Xinan Formation	Second Marine Unit	Shenqu Formation	125 – 73	5e – 5a
T2	Terrestrial silt, sand, gravel, pebble, rocky debris	Shipai Formation	Second TerrestrialUnit	Chilajiao Formation & Dongchong Foramtion	> 125	6
Base	Bedrock	Bedrock		Bedrock		

*In mainland research results, many researchers defined the M2 unit to MIS3 in Pearl River Delta, in term of MIS 3 vs MIS5.



Li J.Y & Yim WWS, 1999

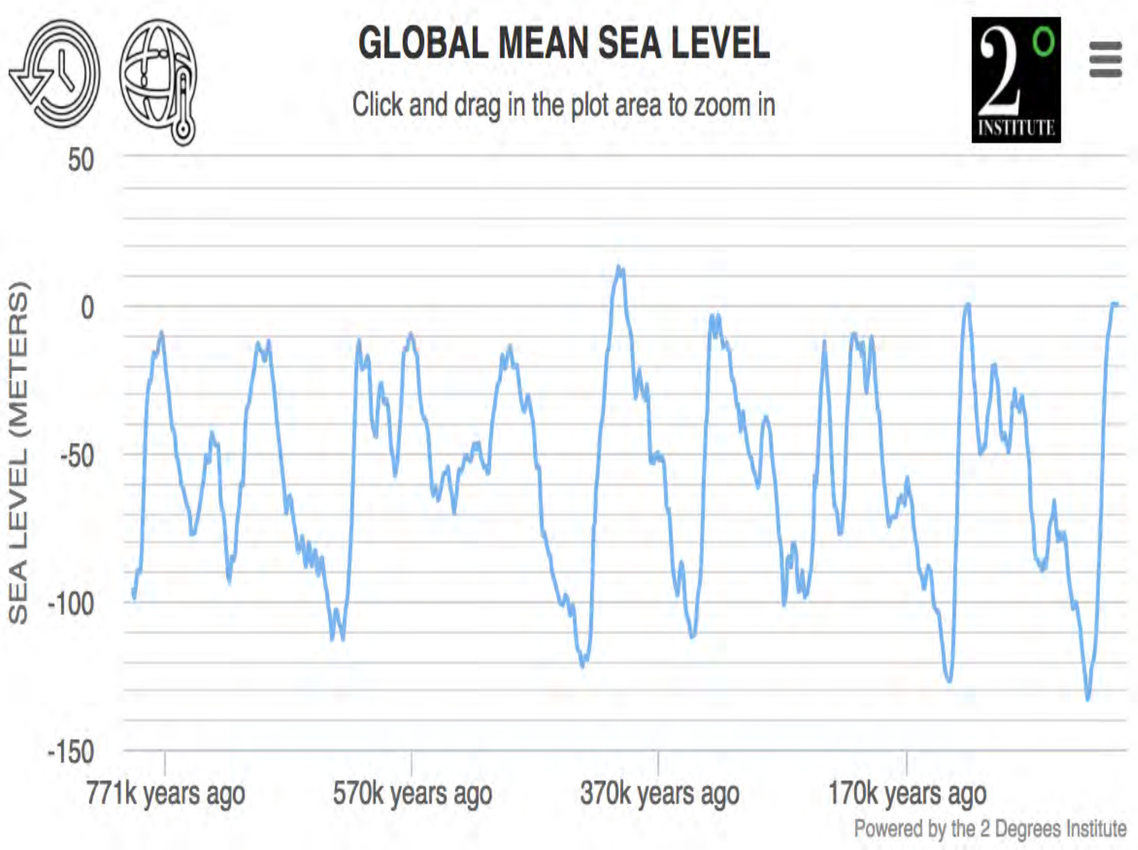


To guess there have more marine units by microfossils record

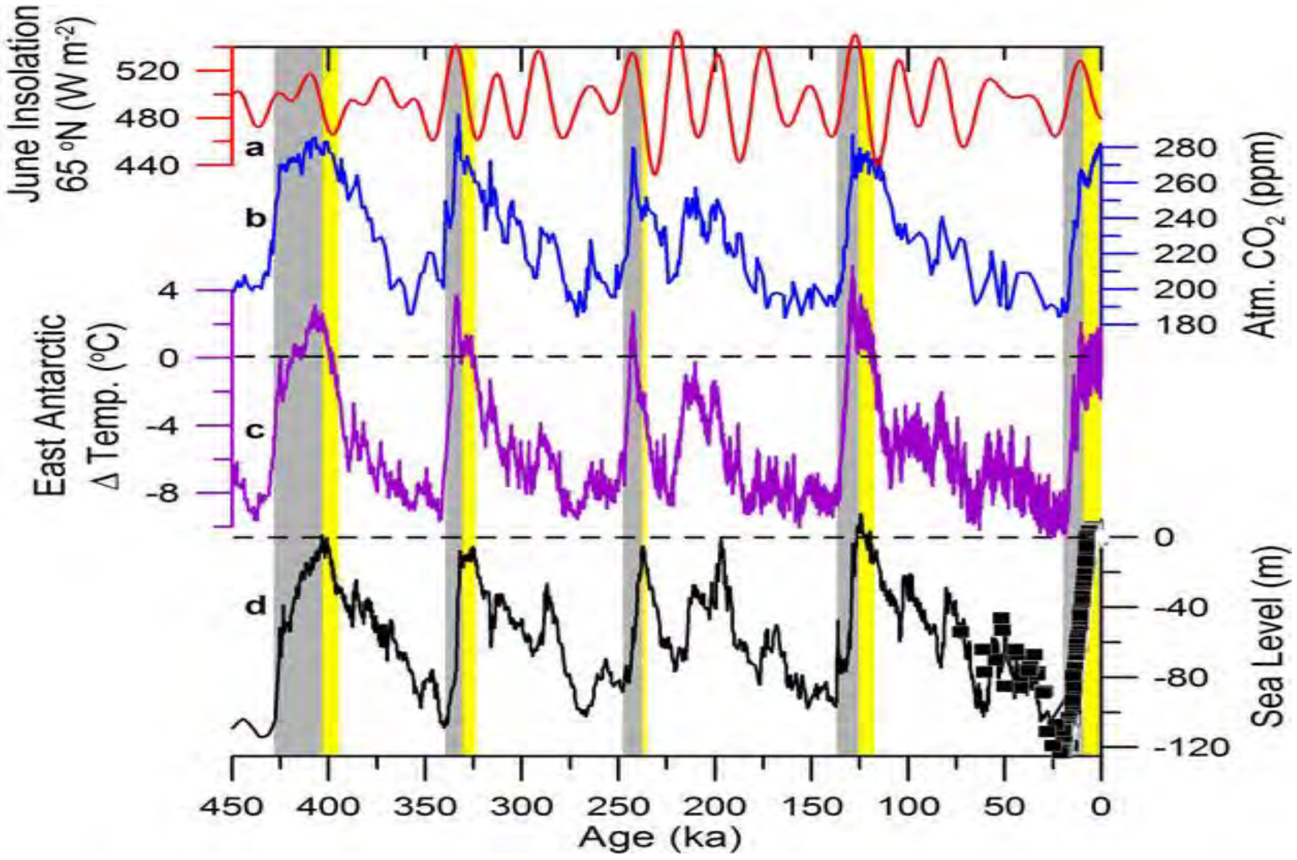
Quaternary stratum units in Hongkong Sea area (cited from Yim WWS, 1994)

Loith-units	Inferred maximum thickness /(m)	Marine Isotope Stage (MIS)	Inferred age /ka BP)
M1	17.8	1	< 8.1
T1	6	2	8.1-30
M2	15.7	5	80-140
T2	9.5	6	150-180
M3	12	7	190-240
T3	3	8	250-300
M4	14.1	9	310-340
T4	6	10	350-360
M5	3.5	11	380-430
T5	7	12	> 440

Paleo-climate and paleo-sealevel signal (literature)



Sources: 2 degrees Institute & https://www.sealevels.org/



Source: Carlson (2011)

NNZ-1 core, 38 m length, water depth 10m)

Chixin Chen preliminarily worked in 2005

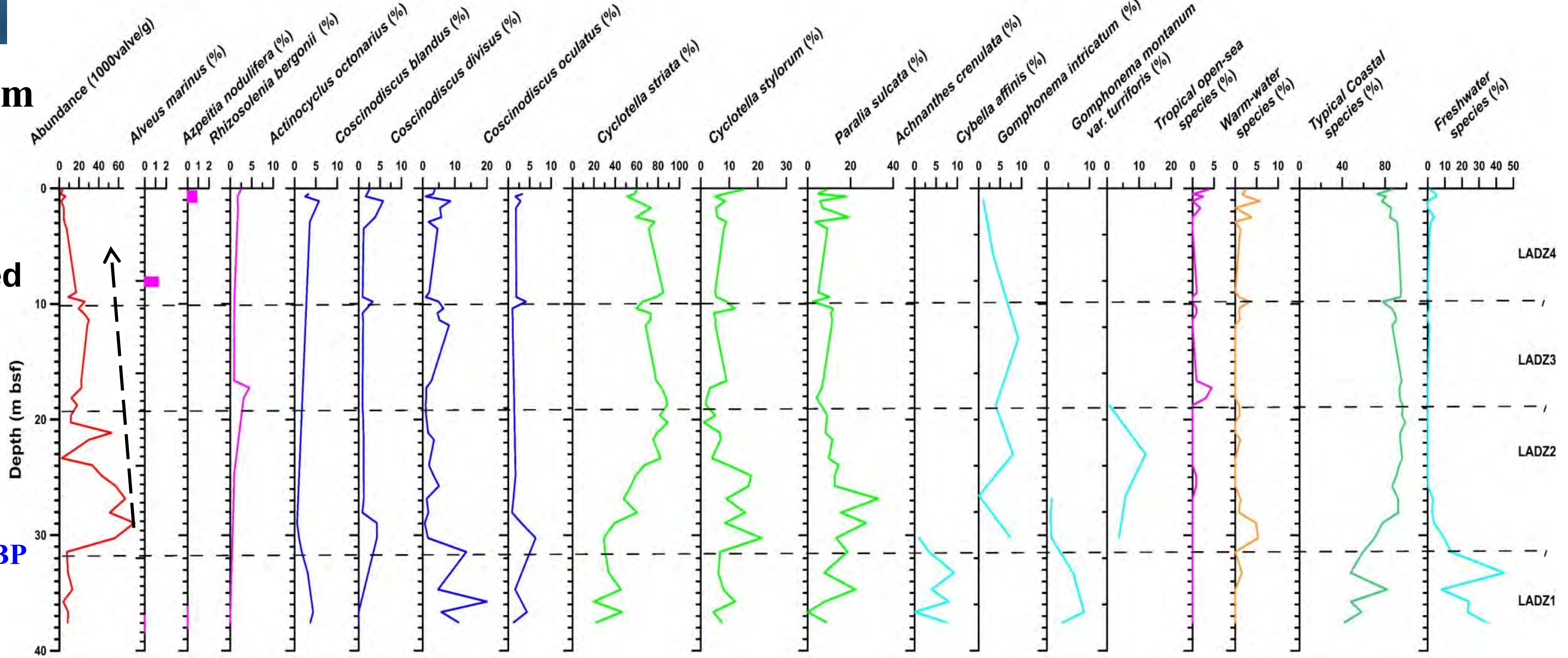
Tropical open-sea species

Nearshore –neritic species

Coastal species

Freshwater species

Diatom

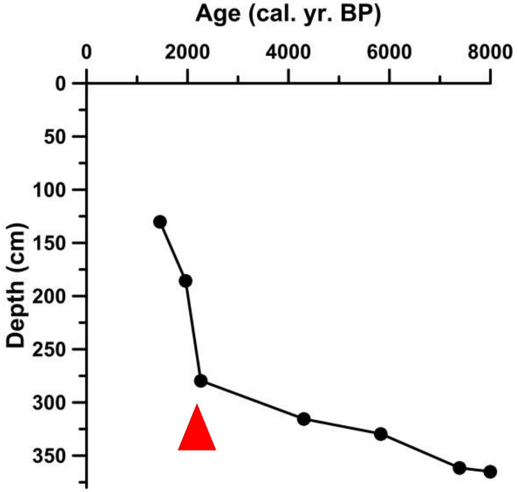


Abundance was decreased since Early Holocene, similarly to core ZK-2.

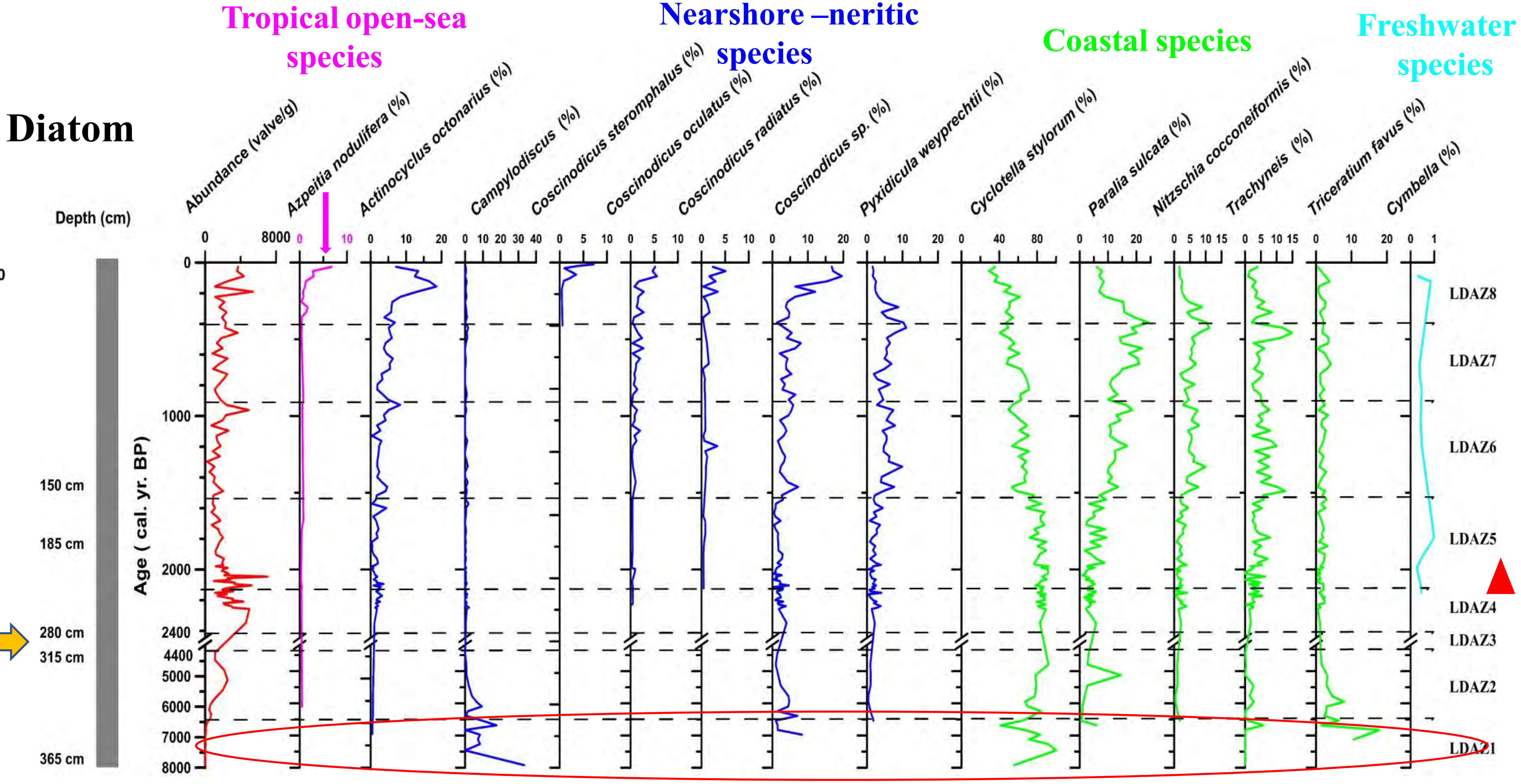
~10.5 ka BP

decreased

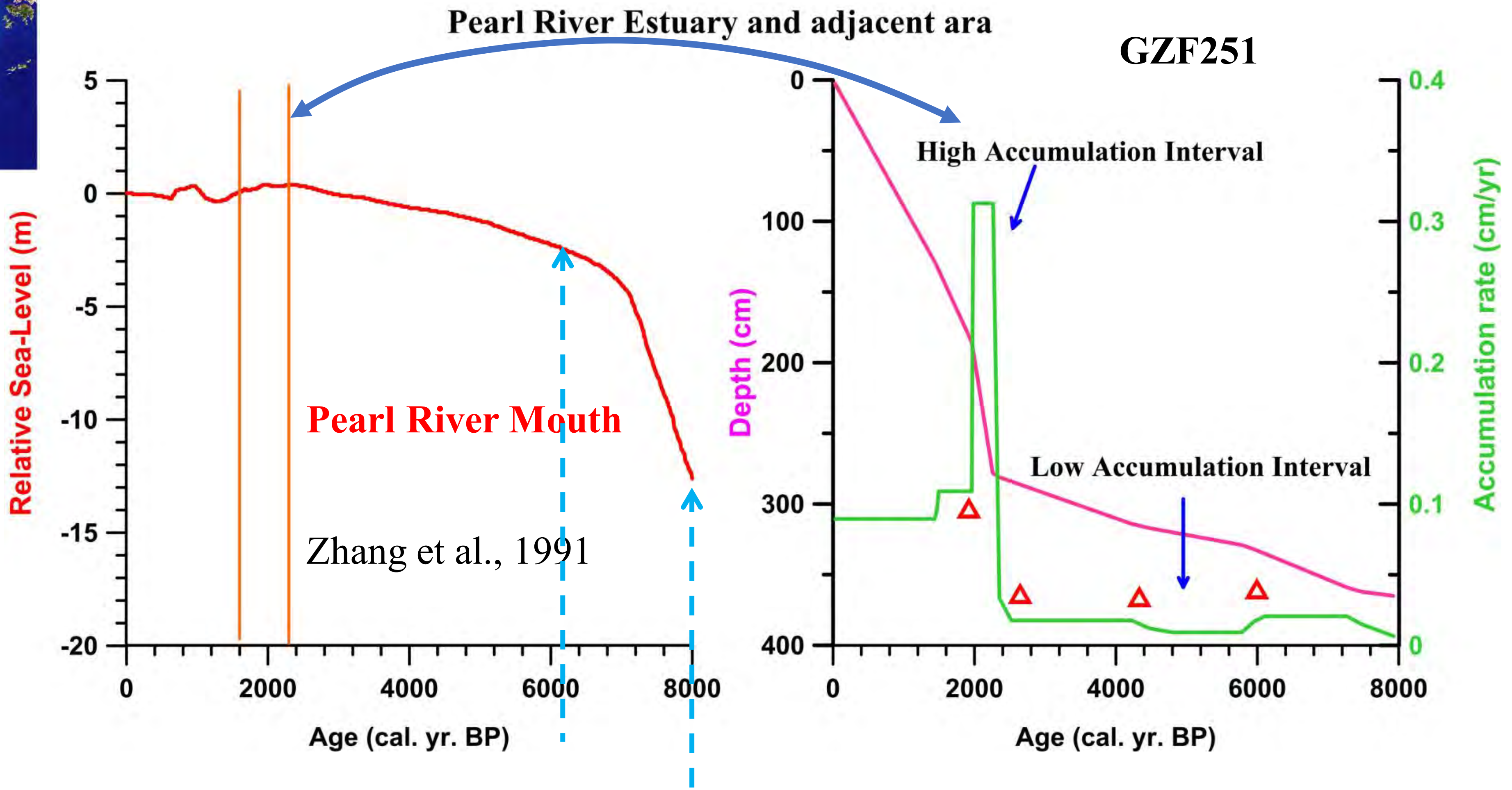
GZF251 core， 370 cm length, water depth 14.4 m (2019 result)



Condensed section

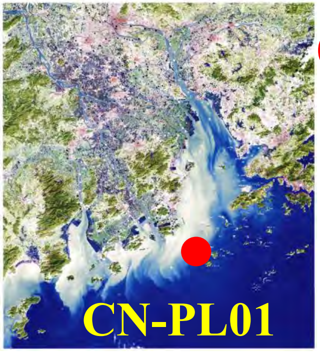


Freshwater species percentage enhanced in last ~2200 years

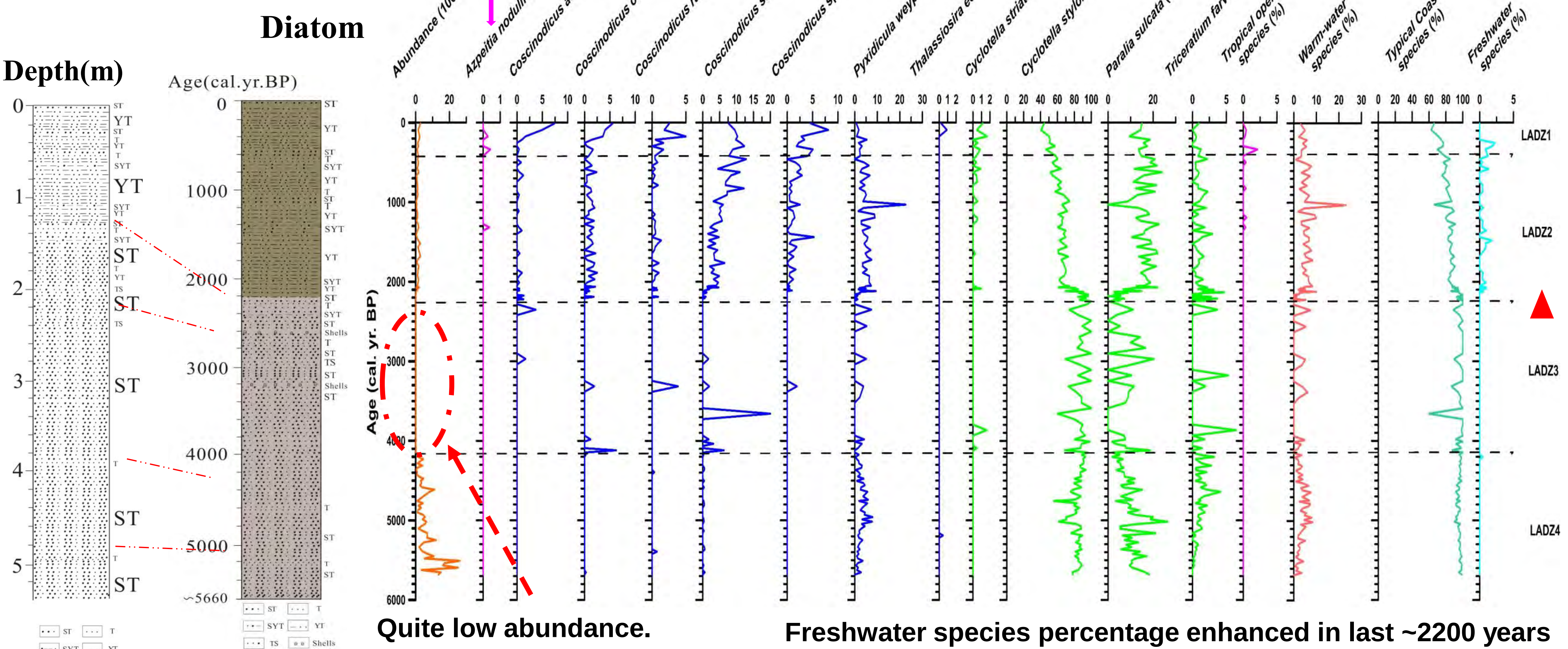


Fast sea-level rise and less diatom species number &abundances during 8-6 ky BP-Early Holocene

CN-PL01 Core, 542cm length, water depth 14.4 m (2020 result)



enhanced human impact after 2 ky BP

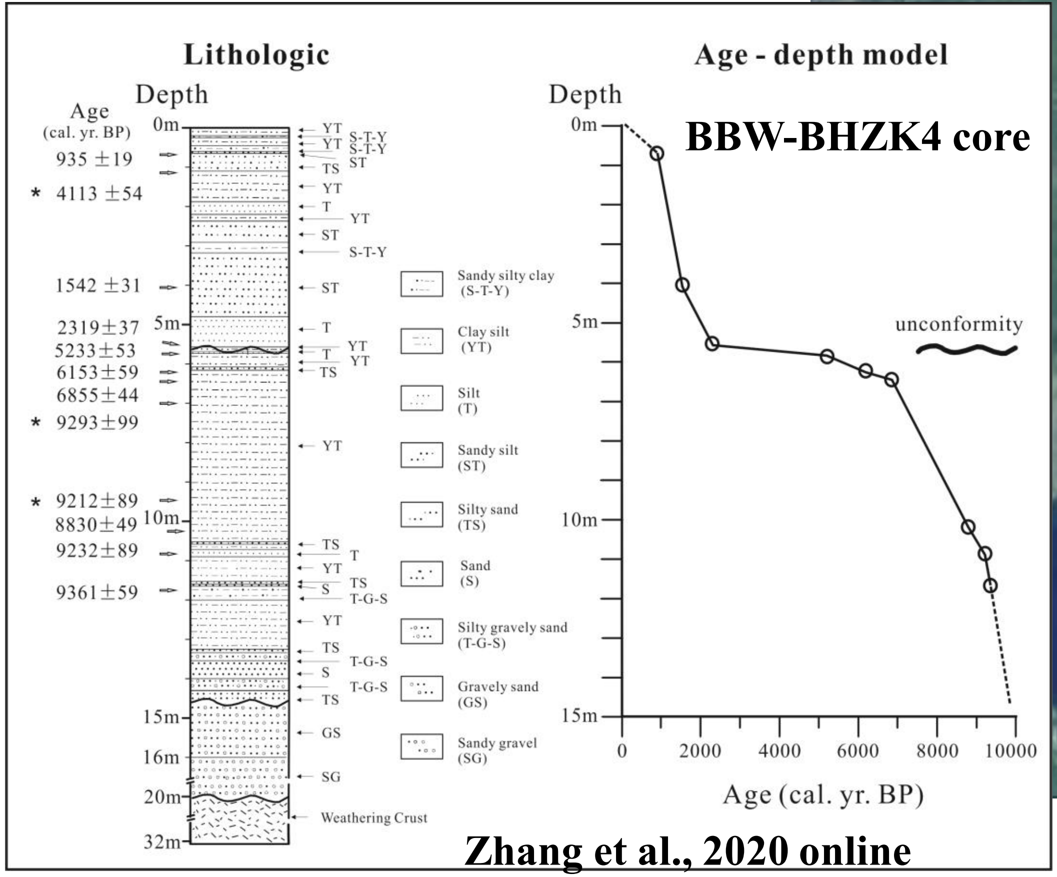


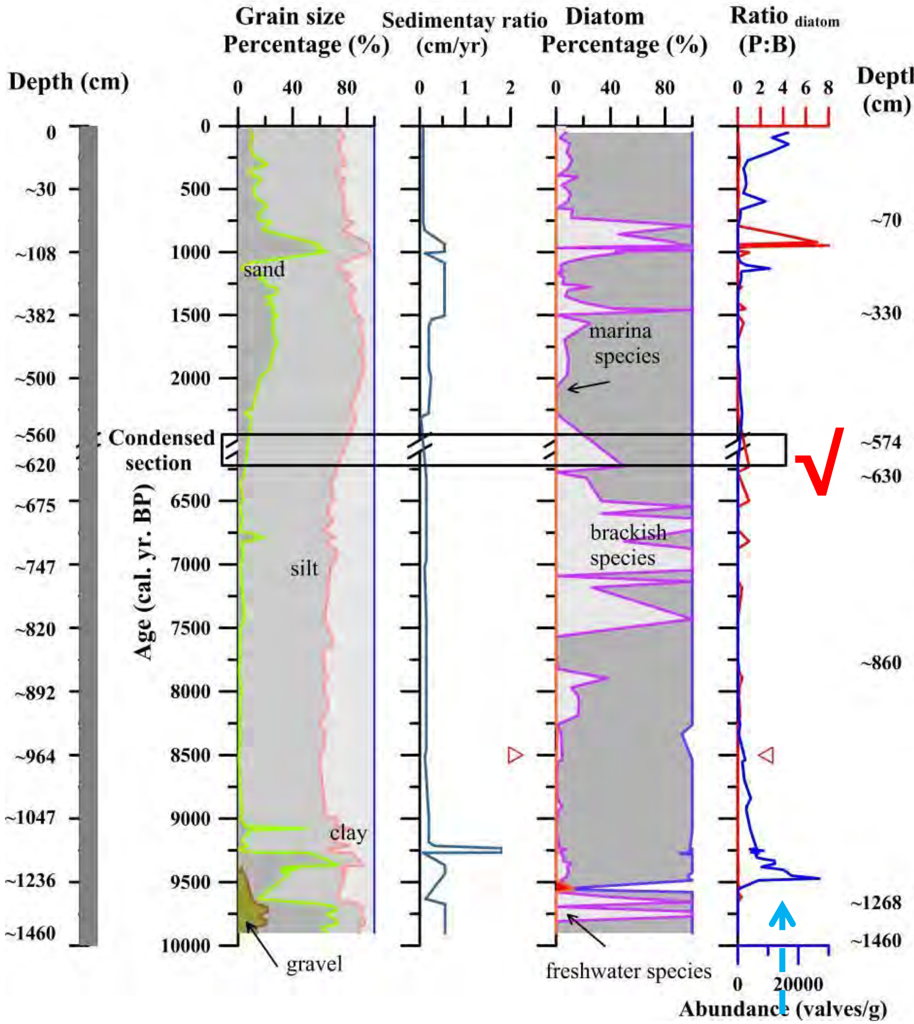
Quite low abundance.

Freshwater species percentage enhanced in last ~2200 years

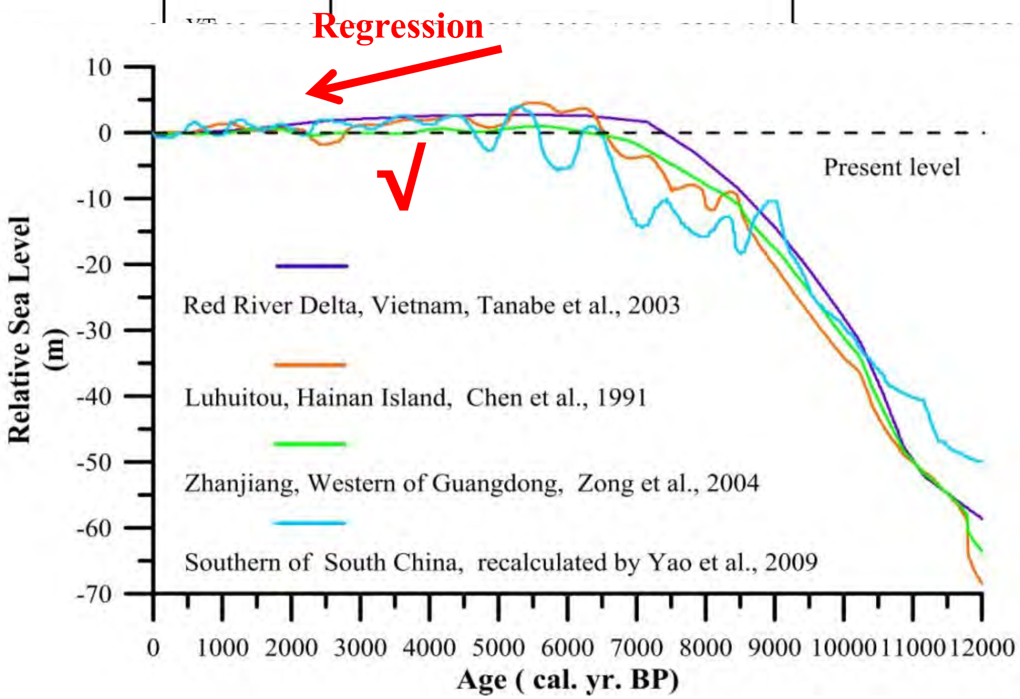
A comparable Case: a study on N-Beibu Gulf coastal area for the Holocene paleo-environment constrution

Drilling core, 10.7 m water depth





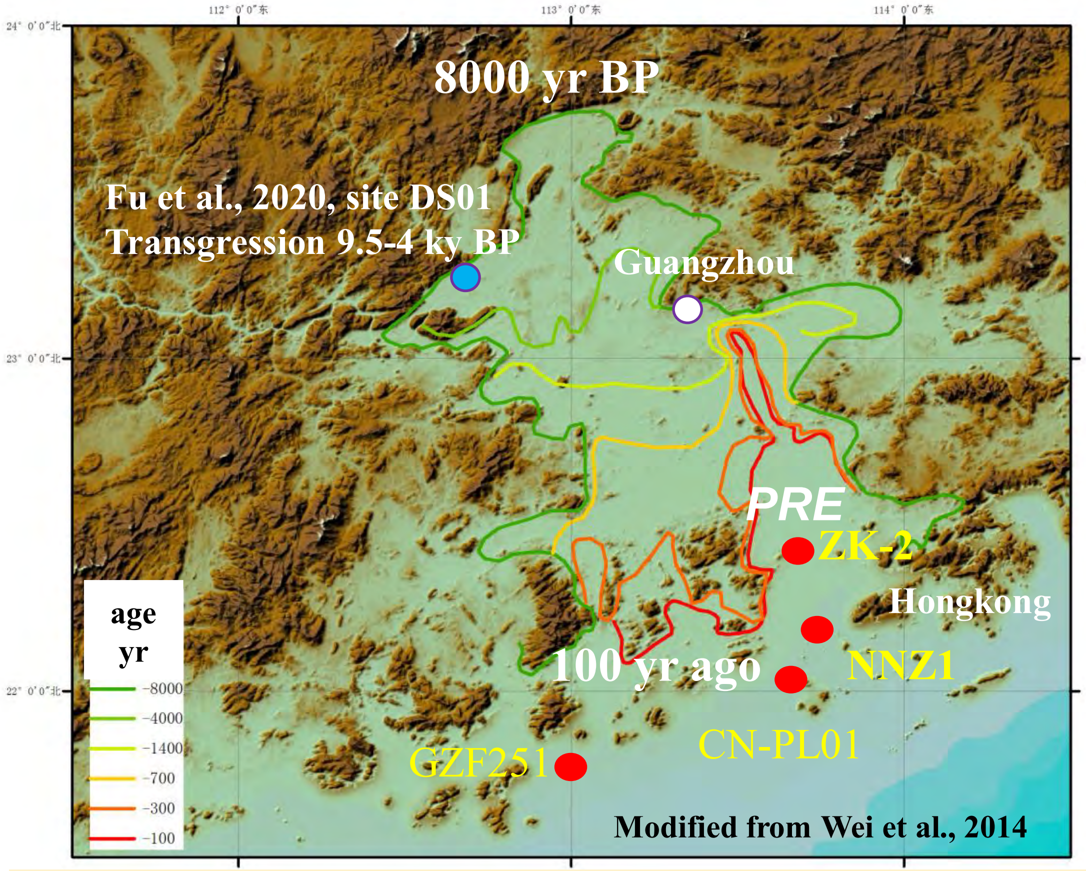
Depth (cm)	Diatom Assemblages	Sediments Types	Inffered Paleoenvironment
~70	*P. sulcata - C. stylum - C. striata*	YT, S-T-Y	relative stable sedimentary environment
~330	*P. sulcata - C. striata - C. stylum*	ST,TS,YT, S-T-Y	with strong hydrological condition
~574	*P. sulcata - C. stylum - C. striata*	T, ST,YT, S-T-Y	gradually strong terrestrial inflow
~630	*C. striata - C. stylum - P. sulcata*	YT, T	sea level drop, with marsh - littoral environment
~860	*P. sulcata - C. stylum - C. striata - A. nodulifera*	YT	higher sea level with unstable hydrological environment as a relative wide bay
~1268	*C. striata - C. s*		
~1460	*C. stylum - P. s*		



Zhang et al., 2020 online

Highest abundance before 8.5 ka

Likely, it could compare with record in PRE



Paleo-coastal line of PRE in past 8000 years

Pearl River Delta(s) should have started to prograde seawards since Early Holocene transgression.

For next step work, we could obtain more information from the sedimentary cores and diatom proxies.

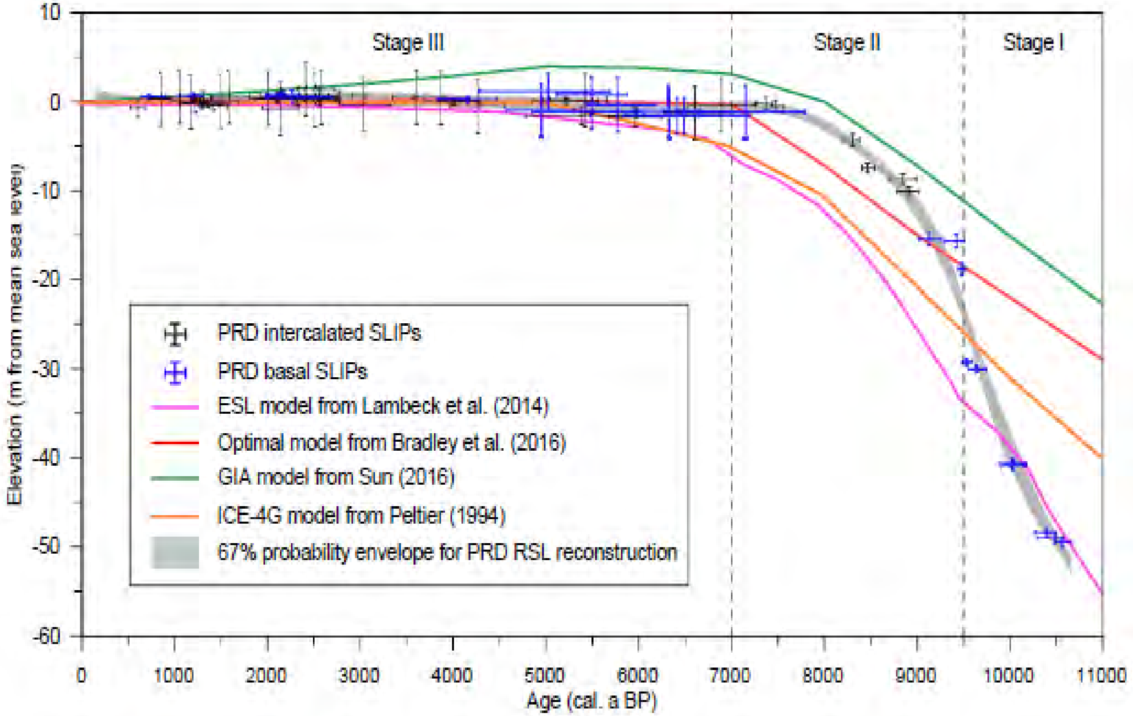


Fig. 7. The graph shows the new and the formerly published sea-level index points from the Pearl River delta compared with the ice-equivalent sea level modelled by Lambeck et al. (2014), the optimal model produced by Bradley et al. (2016), the glacial isostatic adjustment model simulated by Sun (2016), the ICE-4G ice melting history proposed by Peltier (1994) and the 67% probability envelope of the reconstructed relative sea-level history for the Pearl River delta.

Preliminary Summary

- **1. The marine/saline, brackish and freshwater diatom species were widely identified /recorded in the sedimentary cores crossing the Pleistocene and Holocene.**

- **2. In the Pleistocene, diatom record shown more times of transgression in the PRE. This can serve to understand the marine deposition units and paleo-sealevel change, after getting valuable age dating data.**

- **3. In the Holocene epoch, the diatom has recorded its absolutely abundance was decreasing from early Holocene to late Holocene, with coordinating evolution trend. It is useful to understand paleoenvironment change.**

- **4. The transgress and regression was recorded by diatom from the cores in PRE. The lower diatom abundance correlated to sea-level drop interval, ~6 – 2.4 ky BP . While, the Mid-Holocene high sea-level interval was not responded by higher salinity open sea species (as *A. nodulifera*). This may indicate by the runoff diluted sea-water salinity. [This phenomenon could be compared to Oder River area, coastal of S-Baltic, as Witkowski et al., 2017]**

- **5. In the past ~2200 years, the freshwater diatom species and percentage was enhanced, which could indicate coastal line seaward and strong human impact to the river channels.**

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IUGS

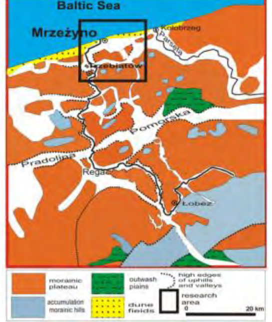
News at a Glance

1. IUGS President at the "Eurasian Marginal Seas – Past and Future" Expert Meeting

Thank you much for your attention

Merry Christmas！

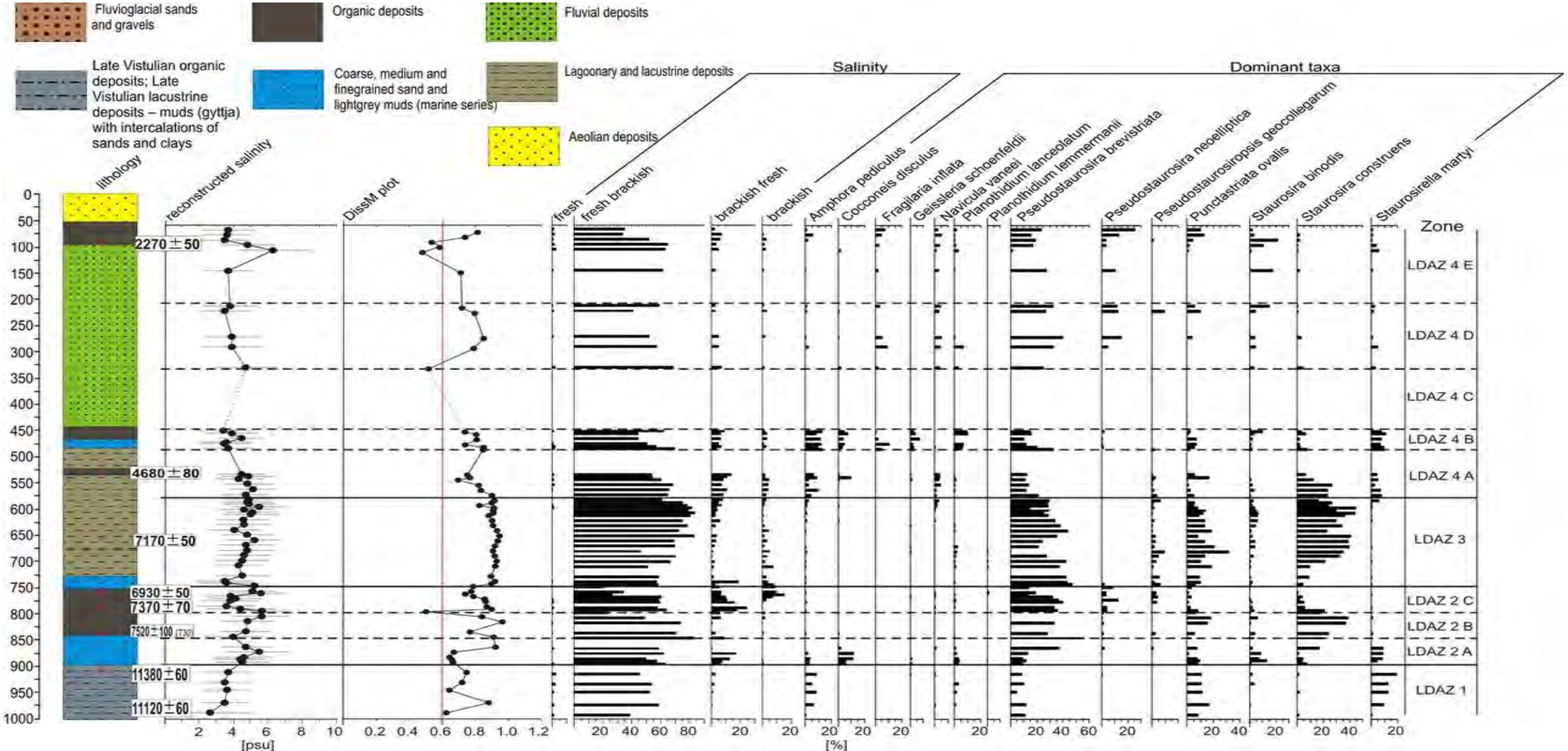
Event: 28-11-2019, Guangzhou [looking forward for future)



- S-Baltic Sea

Witkowski et al., 2017

T28



Eurasia and its marginal seas, potential key areas of the EMS Research Initiative