State Key Lab of Estuarine & Coastal Research
EAST CHINA NORMAL UNIVERSITY

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Beyond the Previous: Practices of Some New Monitoring Methodologies for Marine Plastics and Microplastics

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Asian Pacific Regional Consultation Meeting under UNEA AHEG
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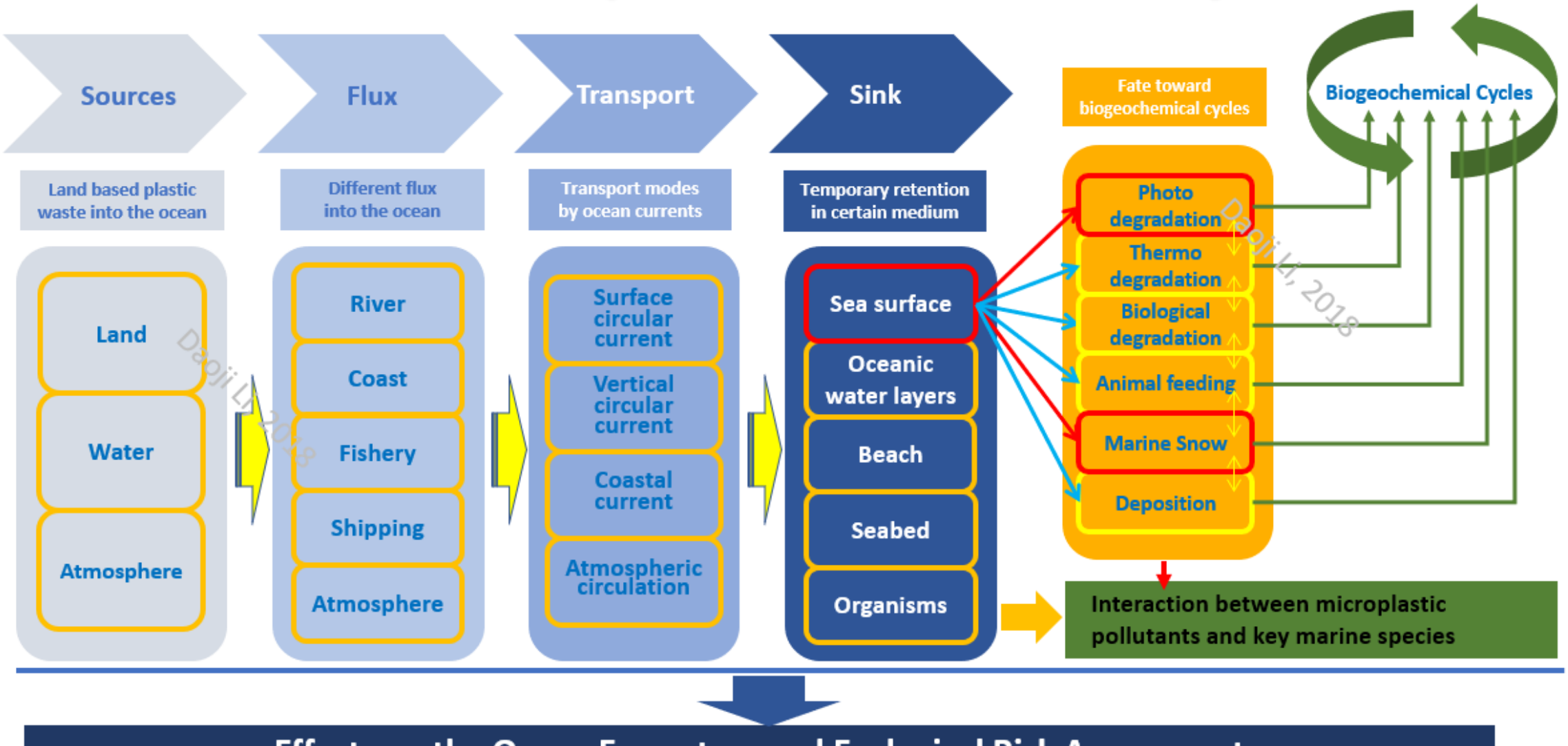
Marine Plastic and Micriplastics: Source to fate dynamics



1. Sampling Methodology of Deep Sea Microplastics

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Microplastic pollution in the surface waters of the Bohai Sea, China☆

Weiwei Zhang [a, b], Shoufeng Zhang [a], Juying Wang [a, *], Yan Wang [a], Jingli Mu [a], Ping Wang [a], Xinzhen Lin [a], Devi Ma [c]

Microplastics in the Northwestern Pacific: Abundance, distribution, and characteristics

Zhong Pan [a], Huige Guo [a], Hongzhe Chen [a], Sumin Wang [a], Xiuwu Sun [a], Qingping Zou [b], Yuanbiao Zhang [a,*], Hui Lin [a,*], Shangzhan Cai [c], Jiang Huang [c]

Lost but can't be neglected: Huge quantities of small microplastics hide in the South China Sea

Minggang Cai [a,b,c,*], Haixia He [b], Mengyang Liu [c], Siwei Li [d], Guowen Tang [c], Weimin Wang [c], Peng Huang [c], Ge Wei [e], Yan Lin [c], Bin Chen [b], Jiahui Hu [c], Zhengnan Cen [c]

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Microplastic pollution in North Yellow Sea, China: Observations on occurrence, distribution and identification

Lin Zhu [a,b], Huaiyu Bai [a], Bijuan Chen [a,b], Xuemei Sun [a,b], Keming Qu [a], Bin Xia [a,b,*]

Microplastics in sub-surface waters of the Arctic Central Basin

La Daana K. Kanhai[a,b,*], Katarina Gårdfeldt[c], Olga Lyashevska[a], Martin Hassellöv[d], Richard C. Thompson[b], Ian O'Connor[a]

Microplastics contaminate the deepest part of the world's ocean

X. Peng[1], M. Chen[1,2], S. Chen[1]*, S. Dasgupta[1],

Submerged pump

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Analysis of suspended microplastics in the Changjiang Estuary: Implications for riverine plastic load to the ocean

Shiye Zhao [a, *, 1], Tao Wang [b], Lixin Zhu [a], Pei Xu [a], Xiaohui Wang [a], Lei Gao [a], Daoji Li [a, *]

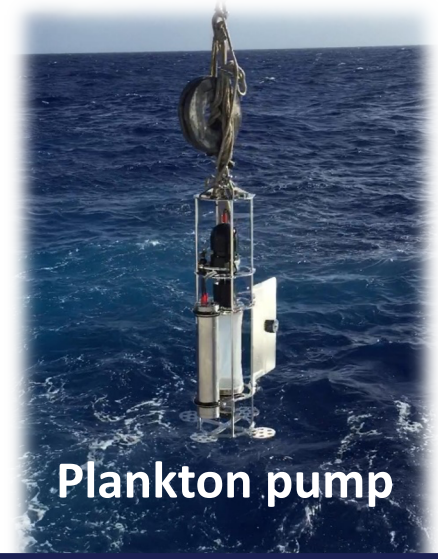
Microplastic risk assessment in surface waters: A case study in the Changjiang Estuary, China

Pei Xu, Guyu Peng, Lei Su, Yongqiang Gao, Lei Gao, Daoji Li*

Baseline

Suspended microplastics in the surface water of the Yangtze Estuary System, China: First observations on occurrence, distribution

Shiye Zhao, Lixin Zhu, Teng Wang, Daoji Li *



Contents lists available at ScienceDirect

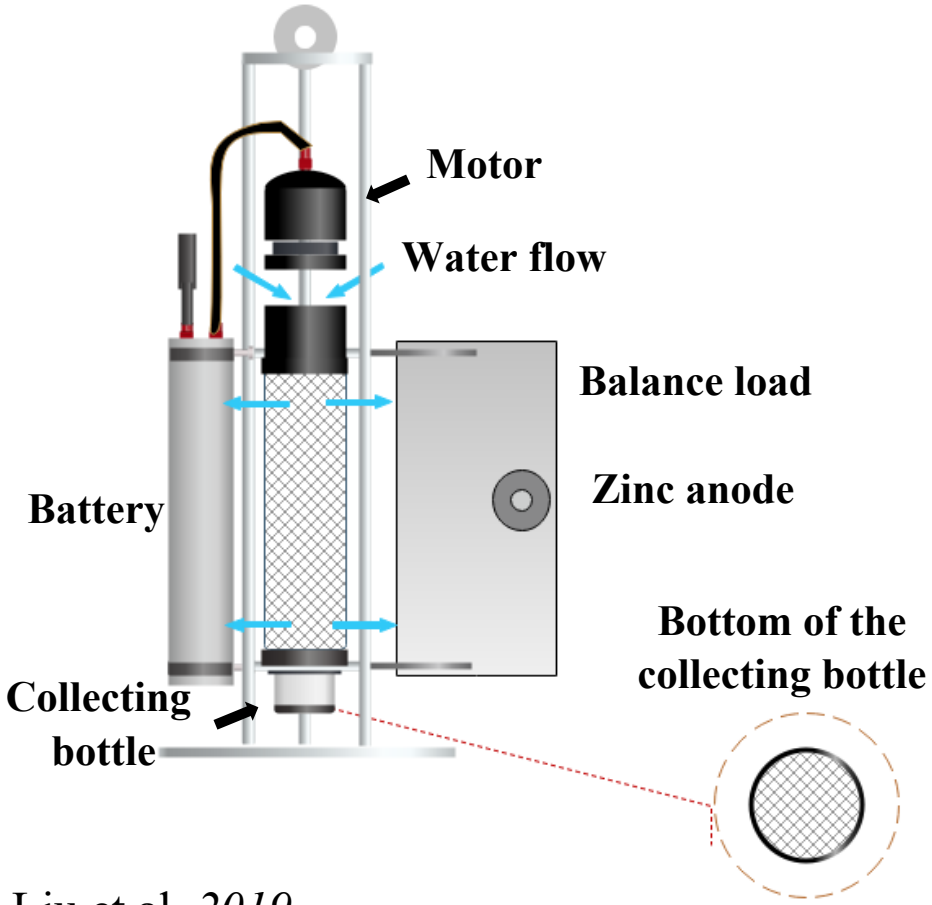
Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

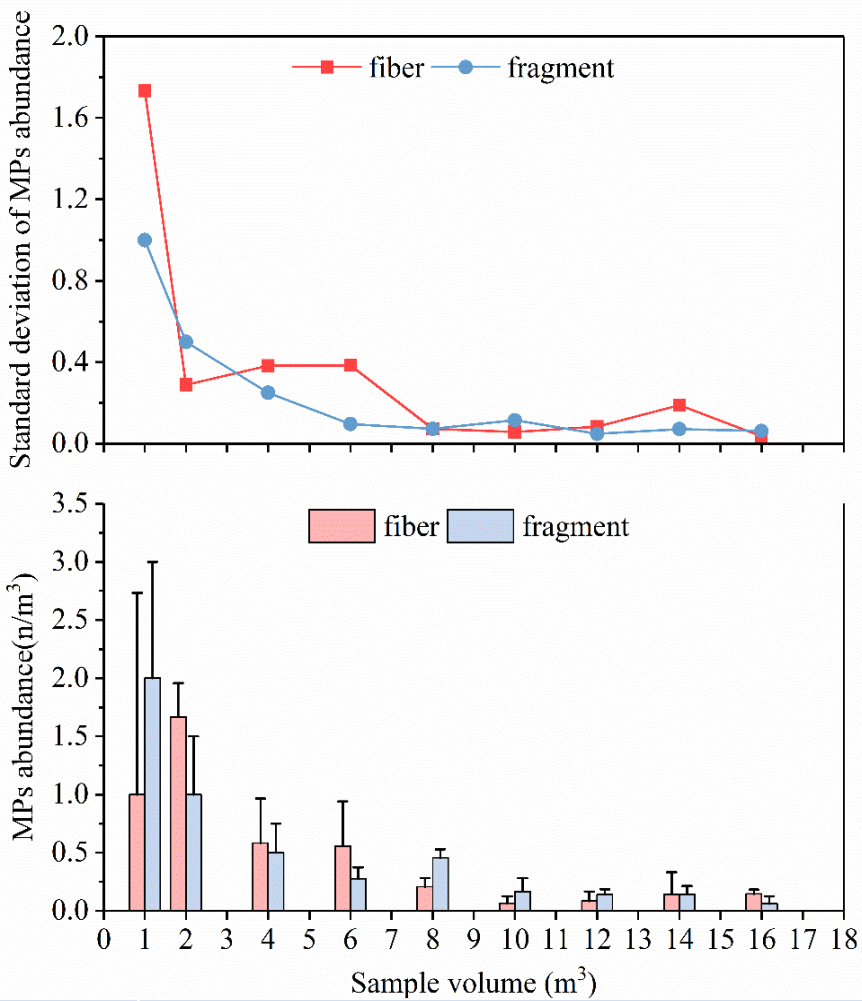
Baseline

A novel method enabling the accurate quantification of microplastics in the water column of deep ocean

Kai Liu, Feng Zhang, Zhangyu Song, Changxing Zong, Nian Wei, Daoji Li*



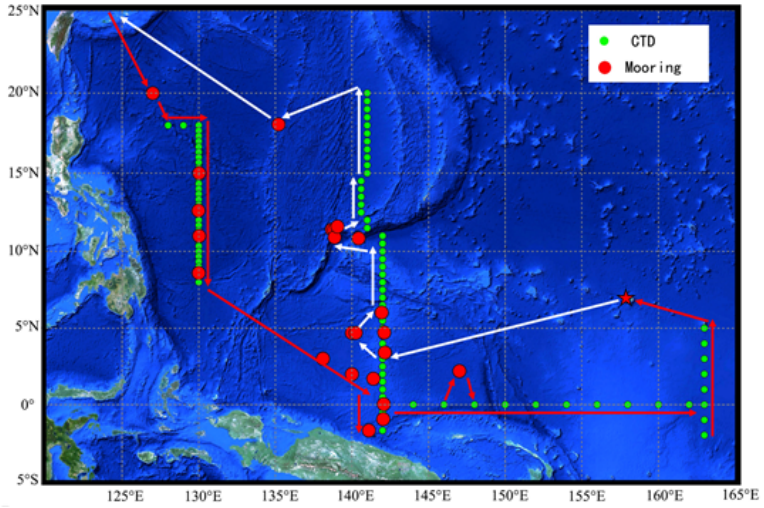
Liu et al ,*2019*



Comparison	CTD sample	Plankton pump
Advantage	Sample various layers for one deployment	Large volume sampling; easy deployment and retrieve
Disadvantage	Limited volume; difficult deployment and retrieve	….

Complete a Sampling Survey of Marine Plastic and MPS for the Fall 2019 Cruise in the Western Pacific

West Pacific Cruise Station Map in 2019



- The 1st course (red line content): set sail on October 3, 2019, and now the first course has ended on November 17th
- The 2nd course (white line content), the operation of the second segment will begin on November 19, 2019 Already called Qingdao on January 5
- 105days in total voyage

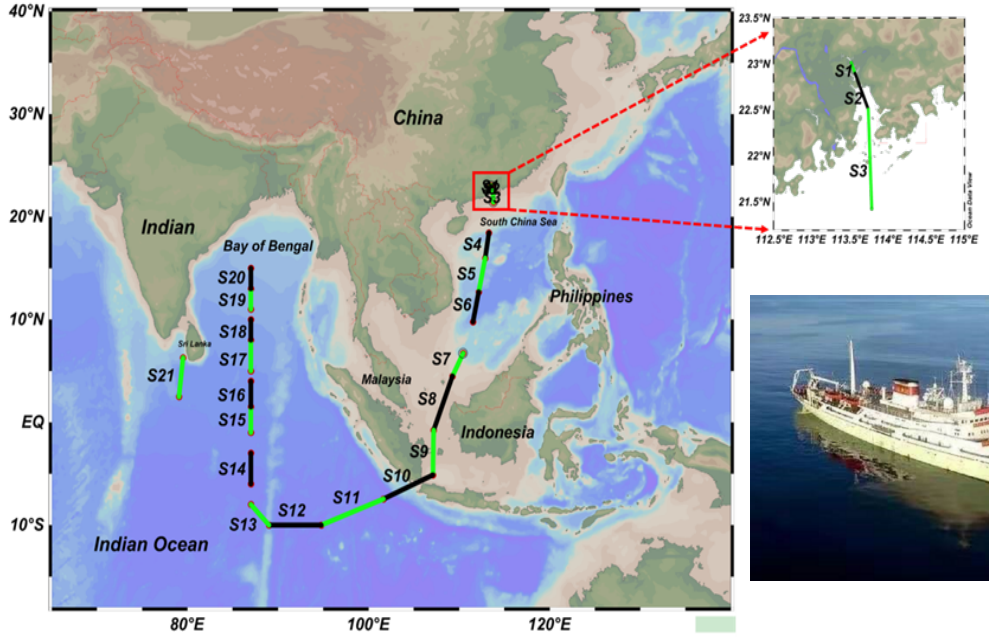
Full courses operation items

- CTD at all the depth of the water
- Manta trawl net
- sediments
- Atmospheric collector and homemade rainwater collector
- Plankton pump bulk water in situ filtration
- In-situ filtration of submersible pumps and underway water）

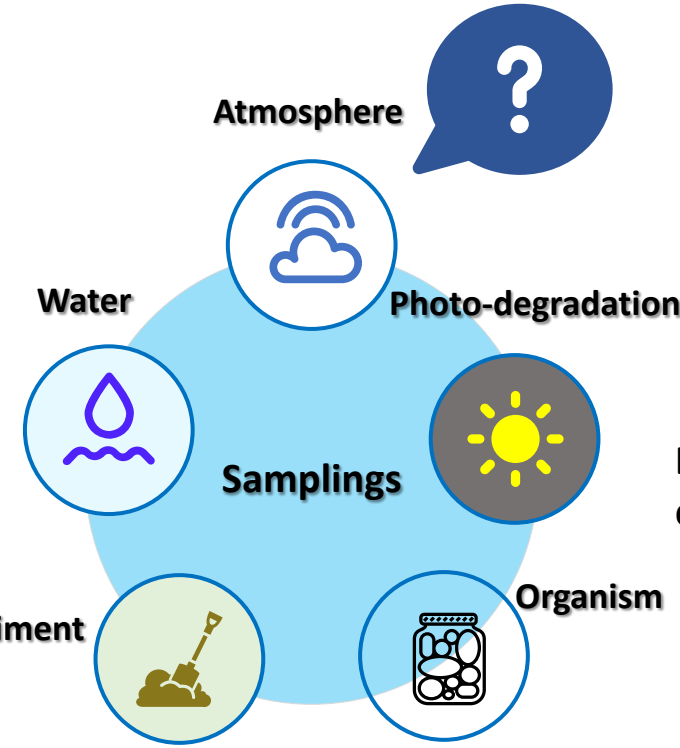
The 2019 Cruise in the South China Sea and Indian Ocean for the Source, Transportation and Fate of Microplastics

2019 NSFC Eastern Indian Ocean Shared Voyage. R/V "SHIYAN 3" set sail in Guangzhou on March 20. It lasted 2 months. After the first course, it stopped at Sri Lanka and then continued to the second course. The voyage was about 11750 nautical miles. 103 stations, got 500 samples.

Scientific question: the sources, pathways and fates of microplastics in the South China Sea and Indian Ocean



Schematic diagram of the atmospheric sampling in South China Sea and the Indian Ocean



Set sail in Guangzhou — 2019.3.20, E113° N22°

2019.3.29, E100° S10° — **Begining of first course**

End of first course — 2019.4.16, E87° N15°

2019.4.26, E80° N02° — **Beginning of second course**

End of second course — 2019.5.12, E90° N05°

2019.5.20, E113° N22° — **Arrive in Guangzhou**

2. Monitoring Method of Plastic Waste from Rivers into the Sea

River Microplastic Flux Model

Flux formula considering runoff and rainfall factors only:

$$Load_{Es}=\sum_{i=1}^{4}(Ci\times Discharge_i\times 3/10^3)$$

where $Load_{CE}$ (tons/year) is the annual plastic flux into the ocean, and i represents the four seasons (spring, summer, fall and winter).Ci is the mean monthly microplastics concentration (/m^3) for each season, and $Discharge_i$ is the mean monthly discharge (m^3/month) for each season in each river basin.$Mass_{micro}$ refers to the average weight of each microplastics.

(Zhao et al.,2019)

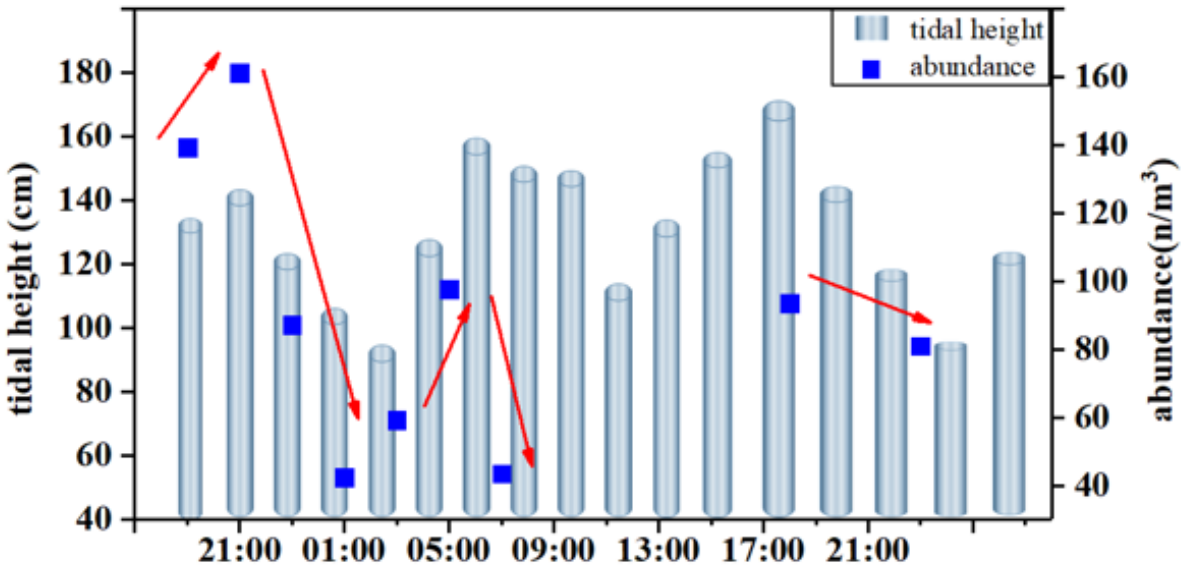
River Microplastic Residual Flux Model

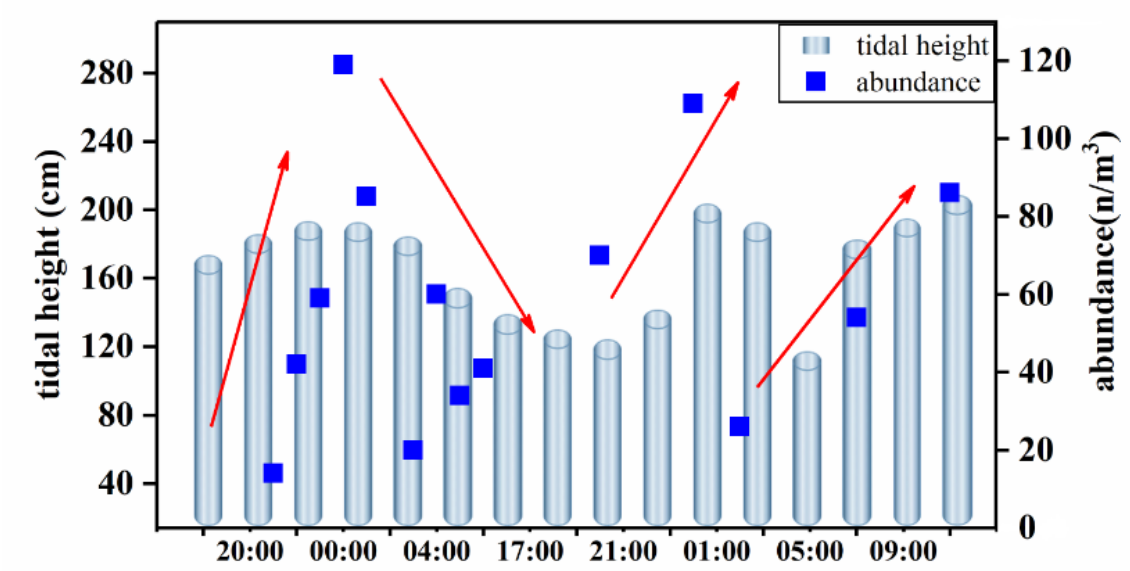
Tidal effects the estuary—
Directly influences the river flux estimation

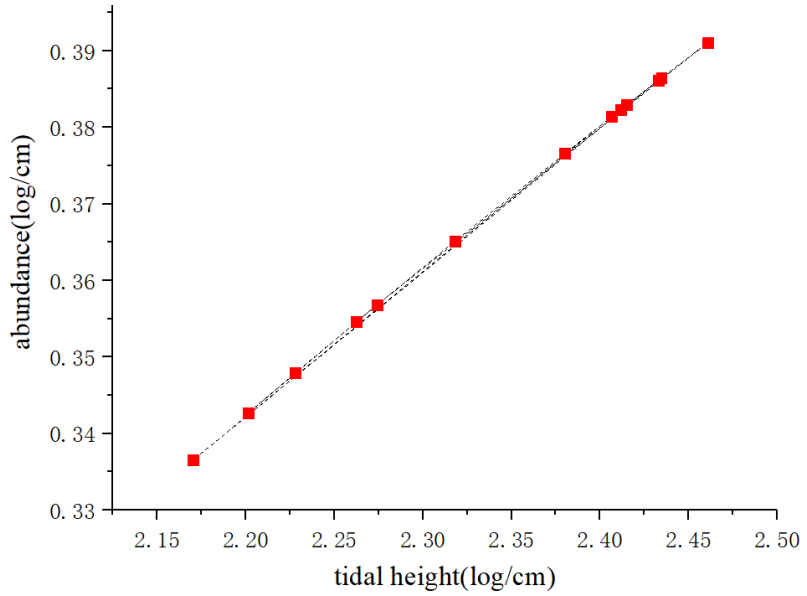
The residual flux of microplastics passing through a unit volume every day can be obtained as follows:

$$\overrightarrow{MPS}_{Res.flux} = \frac{1}{n}\sum_{i=1}^{n}(\delta \times \int MPS_i v_i \, dv_i)$$

In this formula, $\overrightarrow{MPS}_{Res.flux}(nm^{-3}s^{-1})$ represents the residual flux of microplastics, $MPS_i\ i$ (nm^{-3}) means the concentration of microplastics at that moment, v_i $(m^{-3}s^{-1})$ represents the velocity of flow at that moment ,$n(n)$ represents the number of sampling times within 26 hours .δ (g) represents the average weight of each microplastic.





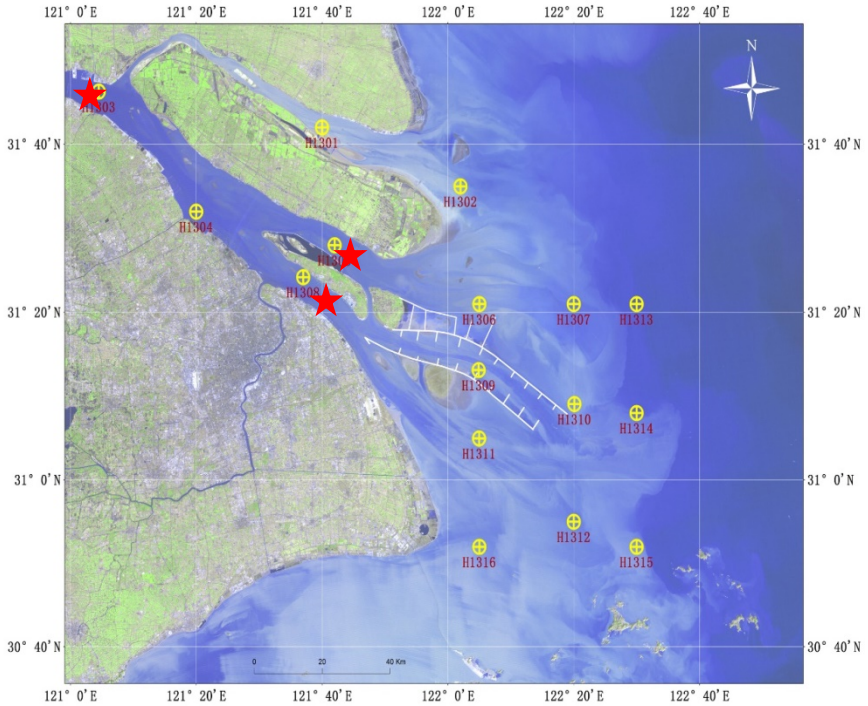


- **Sampling based a full tidal cycle**
- **There is an obvious linear relationship between the ebb and flow of the tide and the abundance of microplastics, which has been verified by Pearson Correlation Coefficient.**
- **Tidal factors will greatly influence the estimates**

Because the magnitude difference of the data is large, the data is processed by log10 for correlation analysis

Summer investigation on the flux of plastics and microplastics into the sea in the Yangtze River Estuary in 2019

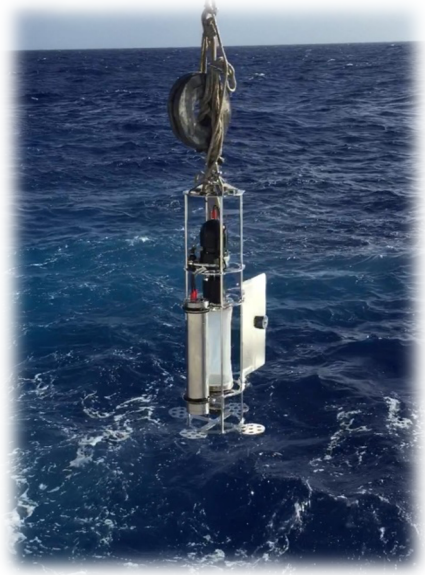
Synchronization monitor, full tidal cycle, multi-methods, full water depth, multi-hydraulic parameters



Full tidal cycle during flood season

Plastics input flux：

- **In-situ filtration device:** three stations (inner, entrance and outer water mass) at the 0‰ salinity position; three layers (surface, middle and bottom water) of every stations were collected, and 8 m3 water was in-filtrated per sample.。
- **Manta trawl:** surface trawling was conducted at every station over 30 min.
- **Macroplastics flux monitoring:** 2 m×3 m open mouth, 4 m length, 5 mm mesh size
- **Bulk samples:** Niskin bottles were used for surface, middle and bottom water
- **Other hydraulic parameters：** ADCP, surface flow meter, OBS, CTD, etc.



Monitor and estimate plastic debris input into the ocean through estuarine system

Summer Investigation on the flux of plastics into the sea in the coastal estuaries of China in 2019

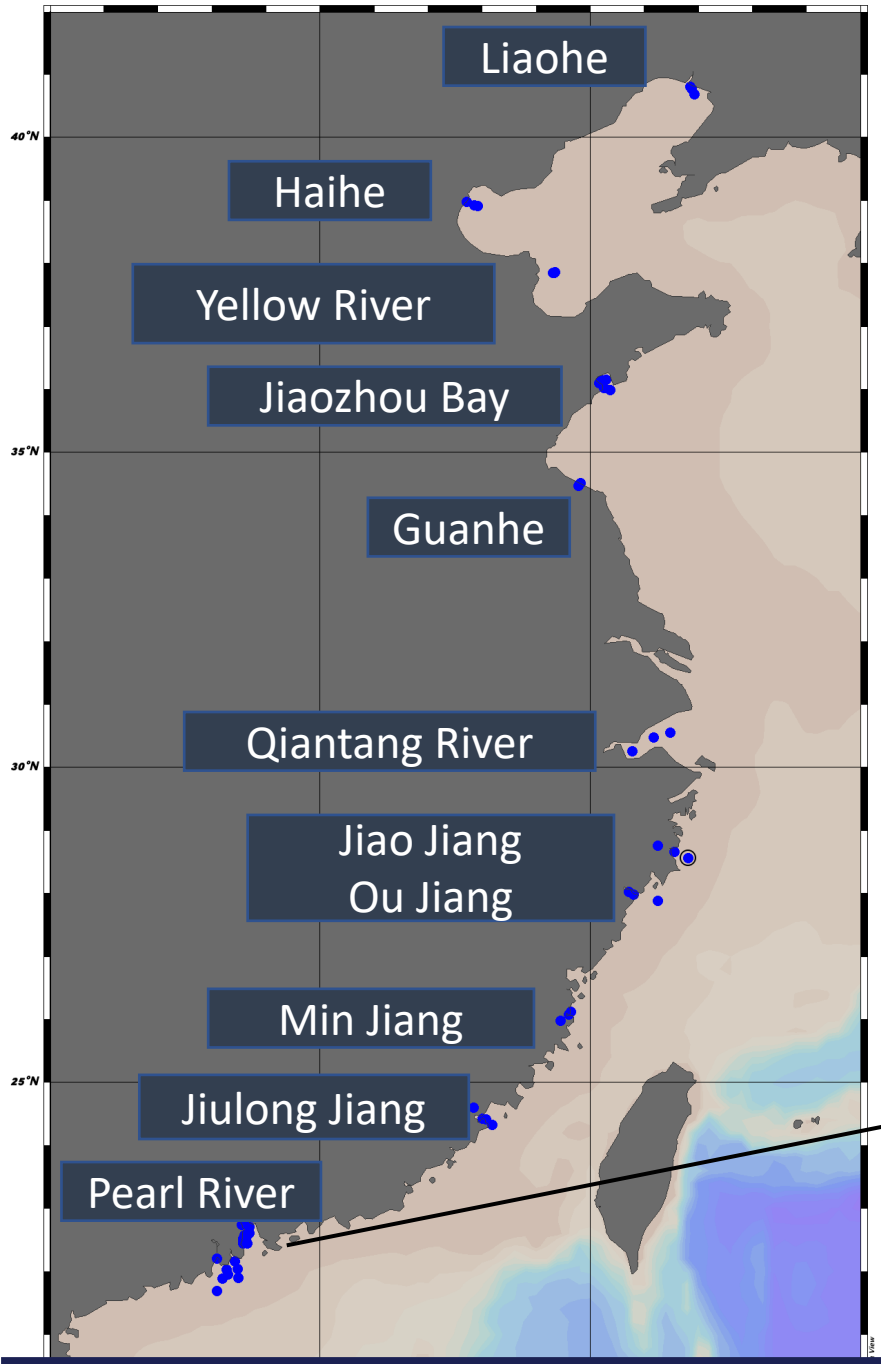
Sampling Campaign in 11 main estuarian system of China：

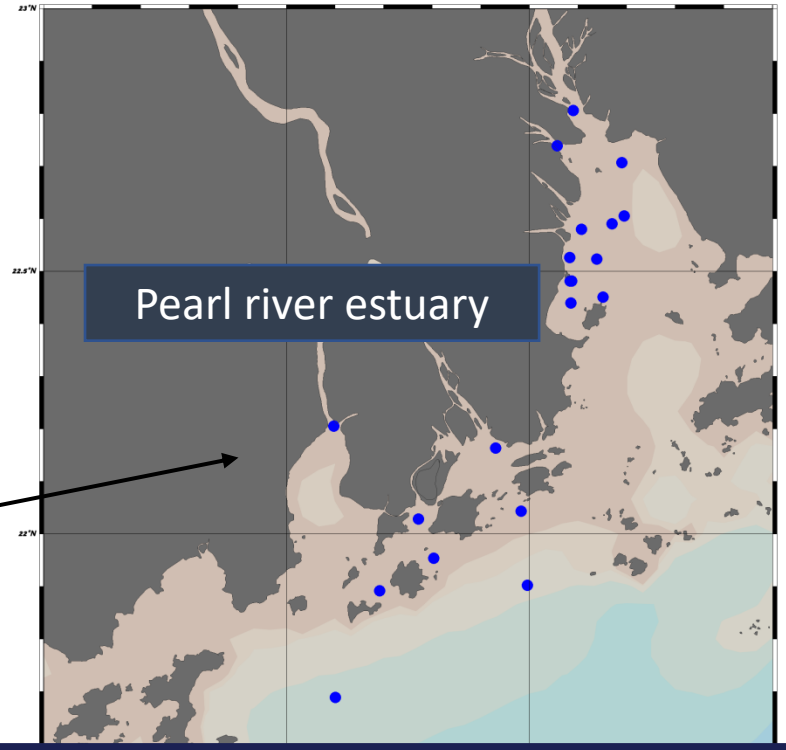
Sampling date： August 15, 2019 to September 9, 2019，

Sampling location： Pearl River Estuary，JiulongJiang，Minjiang，Jiaojiang, Oujiang，Qiantangjiang, Liaohe, Haihe, Yellow River, Jiaozhou Bay, Guanhe

Runoff flux of MPs：

1. In-situ filtration device: three stations (inner, entrance and outer water mass) at the 0‰ salinity position; three layers (surface, middle and bottom water) of every stations were collected, and 8 m^3 water was in-filtrated per sample.





2. Manta trawl: surface trawling was conducted at every station for least 30 min.

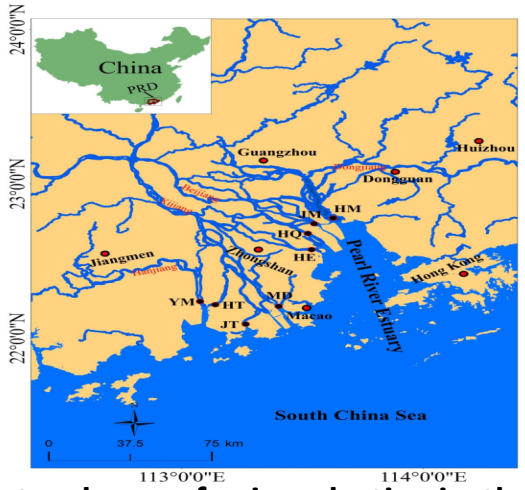
3. Bulk sampling: bulk samples were also collected

- 1. Jiaomen
- 2. Humen
- 3. Hengmen
- 4. Hongqimen
- 5. Modaomen
- 6. Jitimen
- 7. Yamen
- 8. Hutiaomen

3. Modelling River Plastic Flux of the Global Rivers

The microplastic concentration in Pearl River was in the low middle level among 22 rivers global

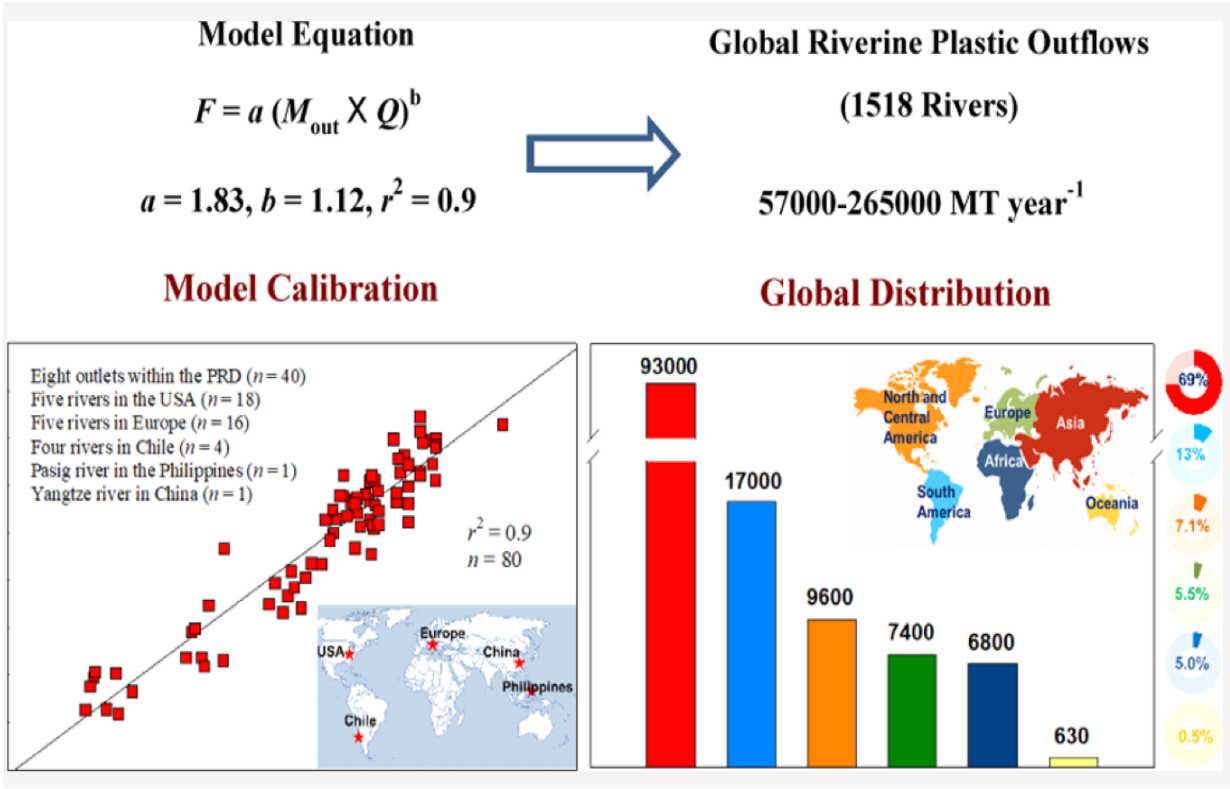
(Mai, et al.,2019,EST)



The annual transport volume of microplastics in the Pearl River is $\underline{3.9\times10^{10}}$ and weigh for <u>66</u> tons

Factors influencing the conveying volume of microplastics:

- **Human activity - Microplastic concentrations were higher in outlets adjacent to large cities such as Guangzhou, than in other entrances to forests and farmland.**
- **Tributary runoff - The runoff of three heavily polluted tributaries accounted for 25%, 20% and 14% respectively.**
- **Natural climate –The microplastic conveying volume is the highest in summer and the lowest in winter.**

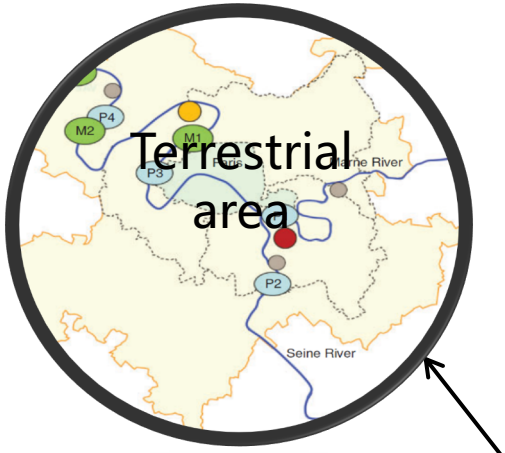


(Mai, et al.,2020,EST)

The global plastic outflows from 1518 main rivers were in the range of <u>57,000–265,000</u> (median:<u>134,000</u>) tons 2018

Based on the Human Development Index(HDI) and field data in the Pearl river, the global plastic outflows were estimated.

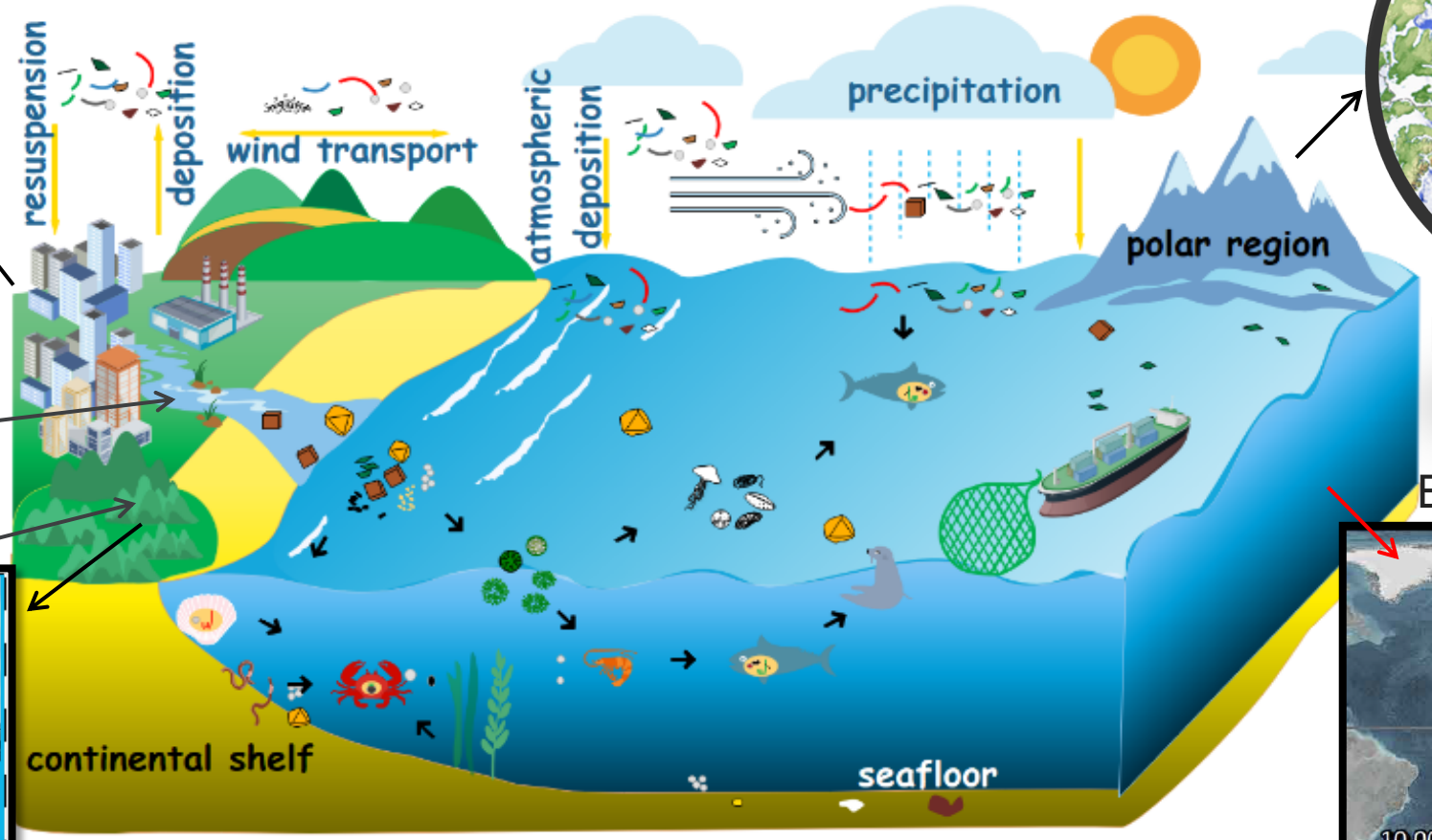
4. Collection of microplastics in the atmosphere over the sea surface for Microplastics transport to the ocean through the atmosphere



Dris et al., 2015

Riverine input

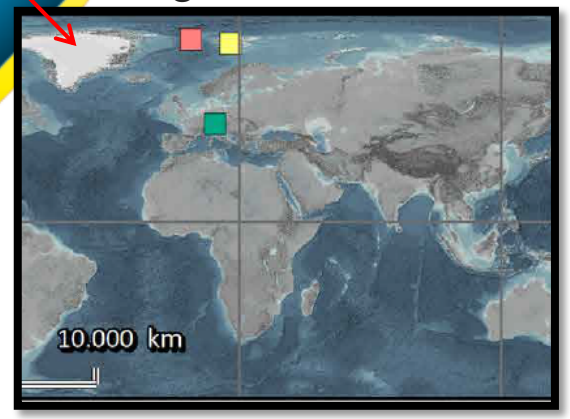
Coastal discharge

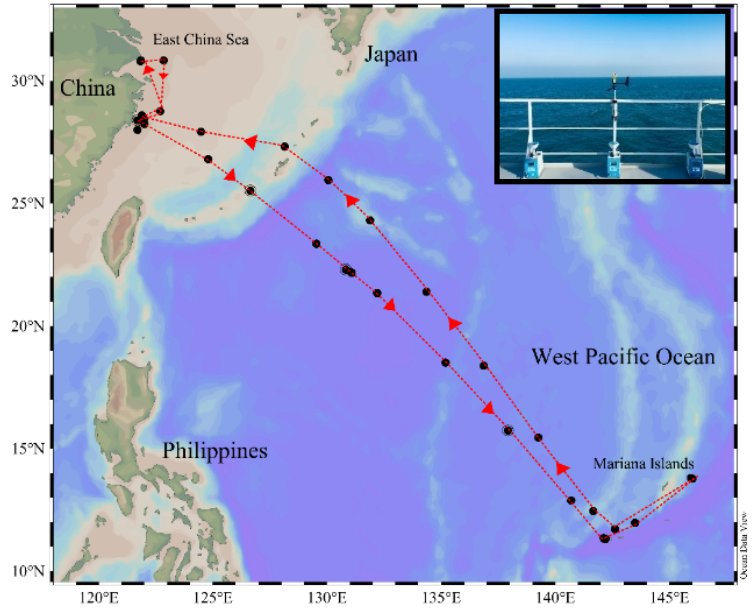


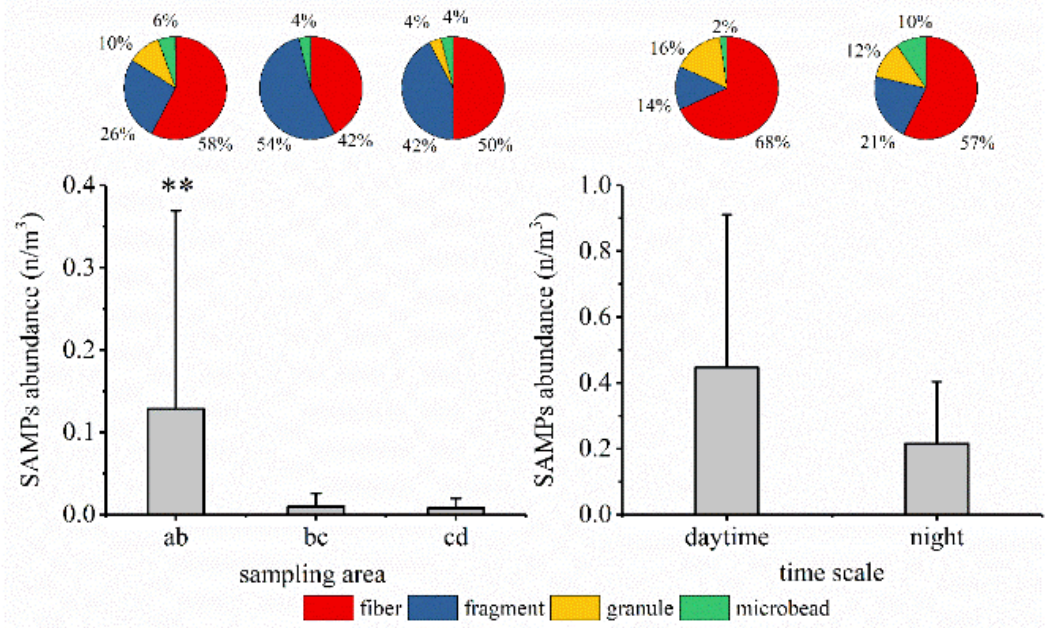
Liu et al., 2019

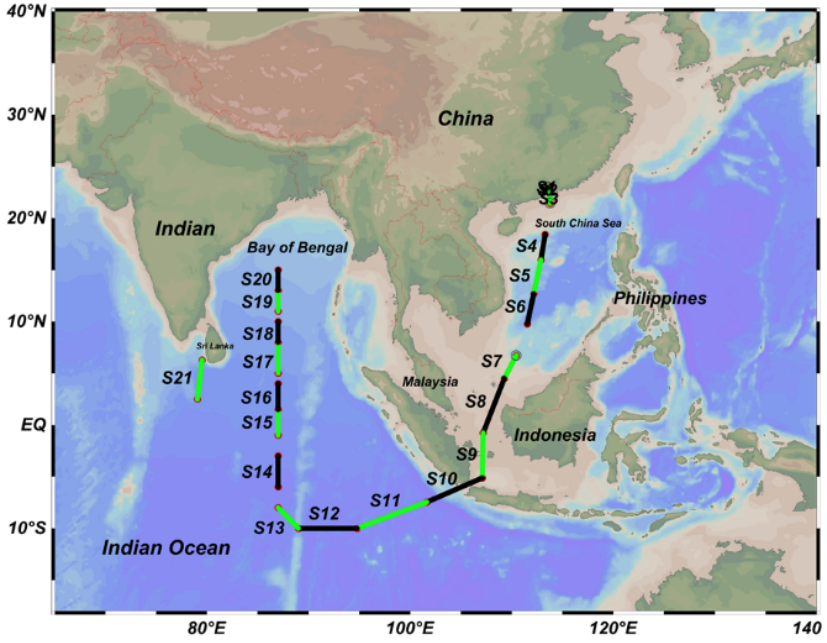
Peeken, et al., 2018

Bergmann et al., 2019




East China Sea
Japan
China
West Pacific Ocean
Philippines
Mariana Islands
30°N
25°N
20°N
15°N
10°N
120°E
125°E
130°E
135°E
140°E
145°E


6%
10%
26%
58%
4%
54%
42%
4%
4%
42%
50%
2%
16%
14%
68%
10%
12%
21%
57%
**
SAMPs abundance (n/m3)
0.4
0.3
0.2
0.1
0.0
ab
bc
cd
sampling area
1.0
0.8
0.6
0.4
0.2
0.0
daytime
night
time scale
fiber
fragment
granule
microbead


40°N
30°N
20°N
10°N
EQ
10°S
China
Indian
Bay of Bengal
South China Sea
Philippines
Malaysia
Indonesia
Sri Lanka
Indian Ocean
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
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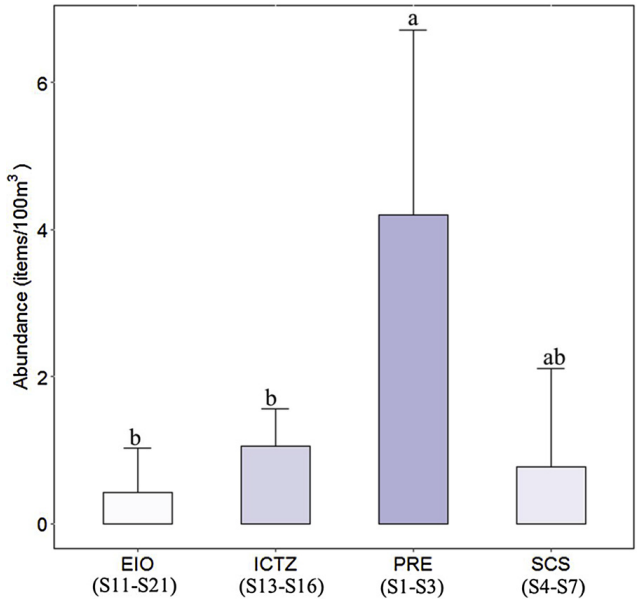
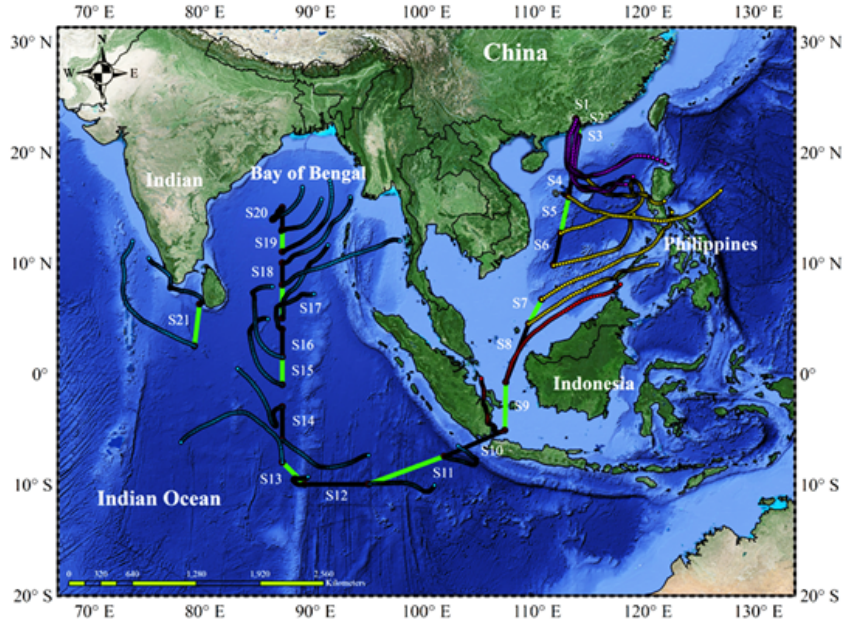
S15
S16
S17
S18
S19
S20
S21
80°E
100°E
120°E
140


Abundance (items/100m3)
6
4
2
0
a
b
b
ab
EIO
(S11-S21)
ICTZ
(S13-S16)
PRE
(S1-S3)
SCS
(S4-S7)


70° E
80° E
90° E
100° E
110° E
120° E
130° E
30° N
20° N
10° N
0°
10° S
20° S
China
Indian
Bay of Bengal
Philippines
Indonesia
Indian Ocean
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
S20
S21

THANK YOU FOR YOUR ATTENTION

谢 谢 ！