

# The 1st Regional GEOS–Chem Asia Meeting

May 21–23, 2018

## **Mercury inputs to Chinese marginal seas - Impact of industrialization and development of China**

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<sup>3</sup>Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, China

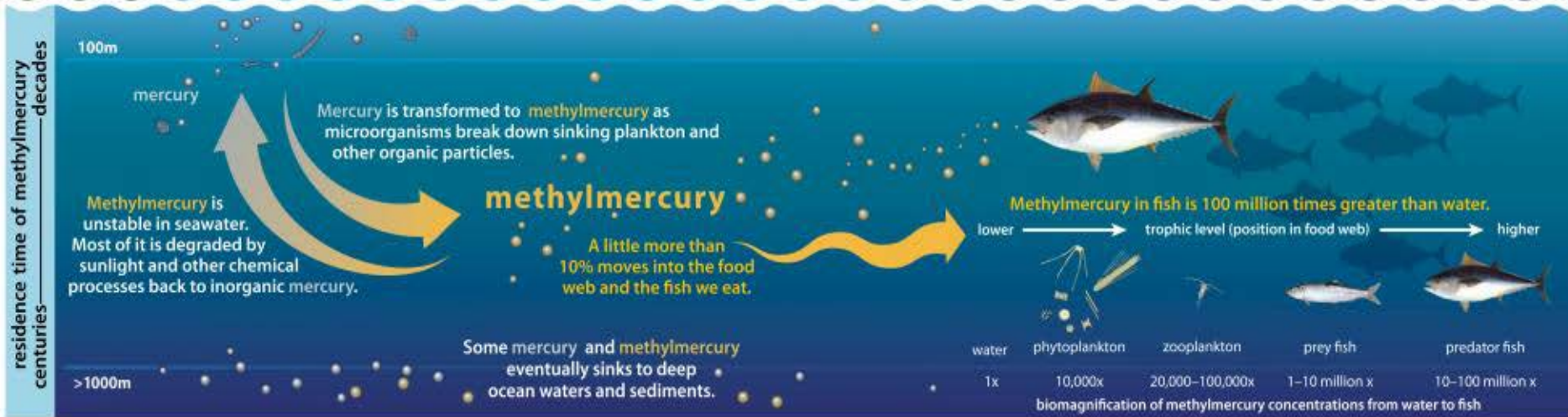
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<sup>5</sup>Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong

# 1. Introduction

**Atmosphere deposition is global important to open ocean.**

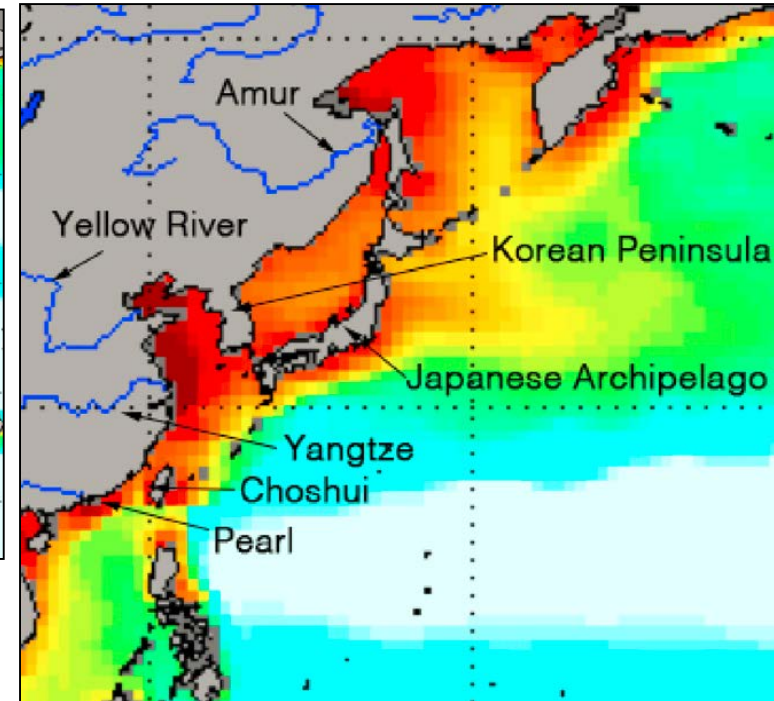
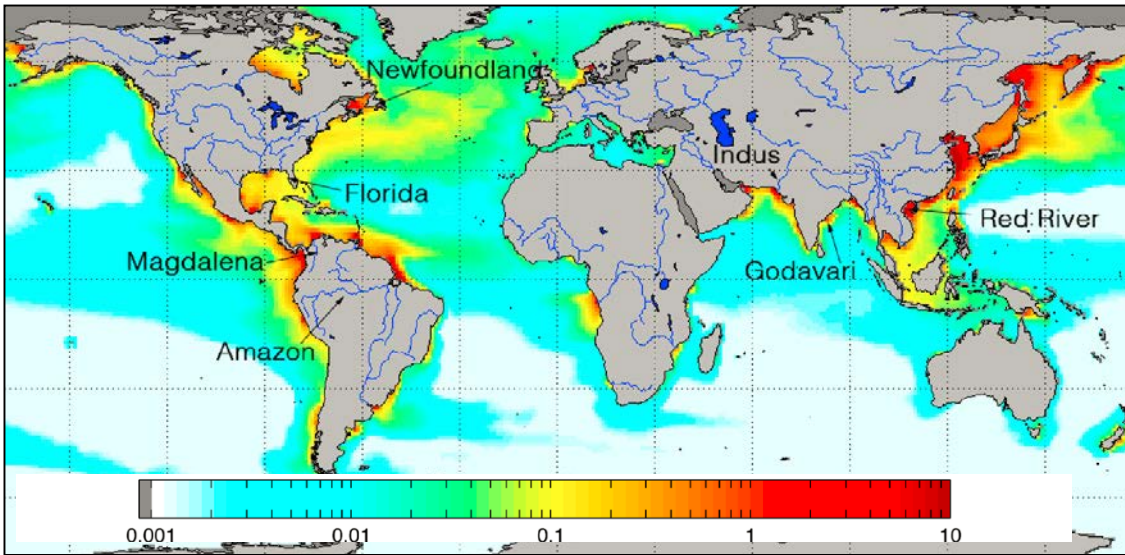
Mercury in the Open Ocean: Sources to Seafood



The graphic, "Mercury in the Open Ocean: Sources to Seafood" is reproduced from Sources to Seafood: Mercury Pollution in the Marine Environment by the Coastal and Marine Mercury Ecosystem Research Collaborative, December 2012.

# 1. Introduction

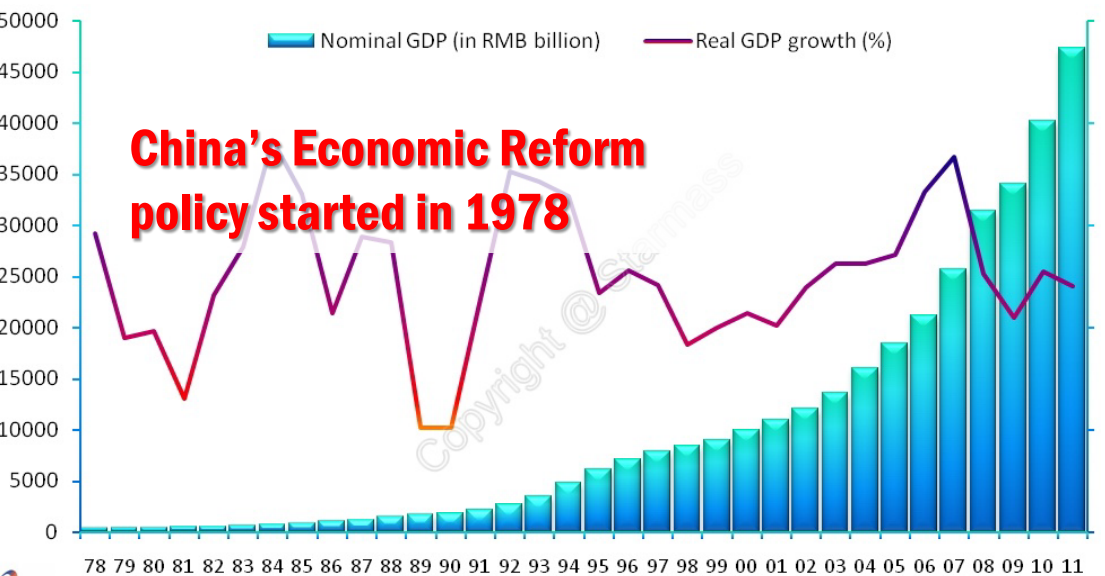
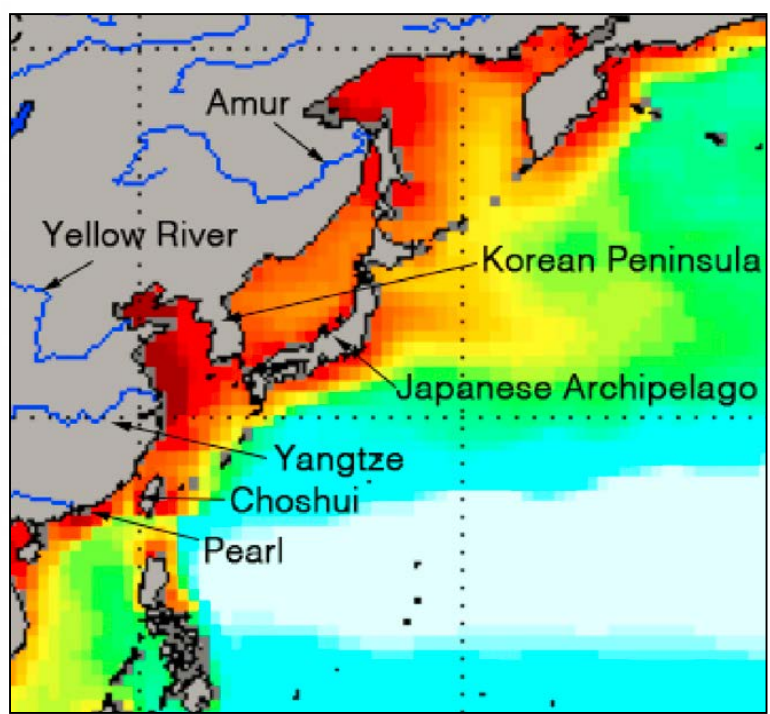
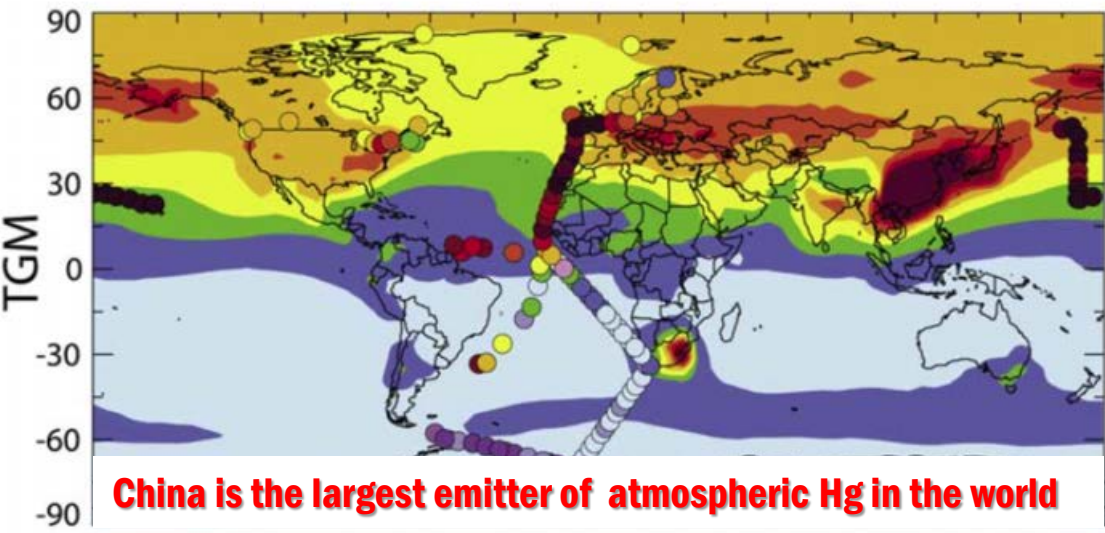
## River input is more important to coastal ocean



Contributions of riverine discharges to modeled annual total Hg concentrations  
Zhang et al. (2015 GBC)

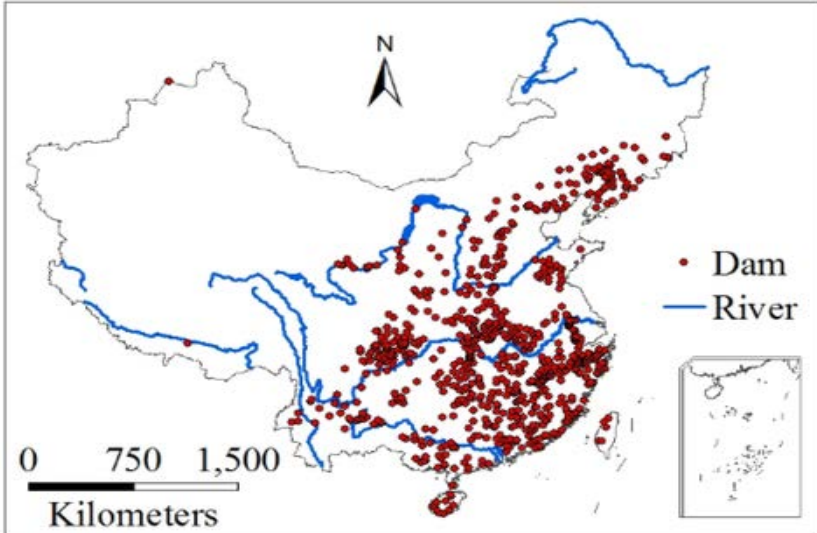
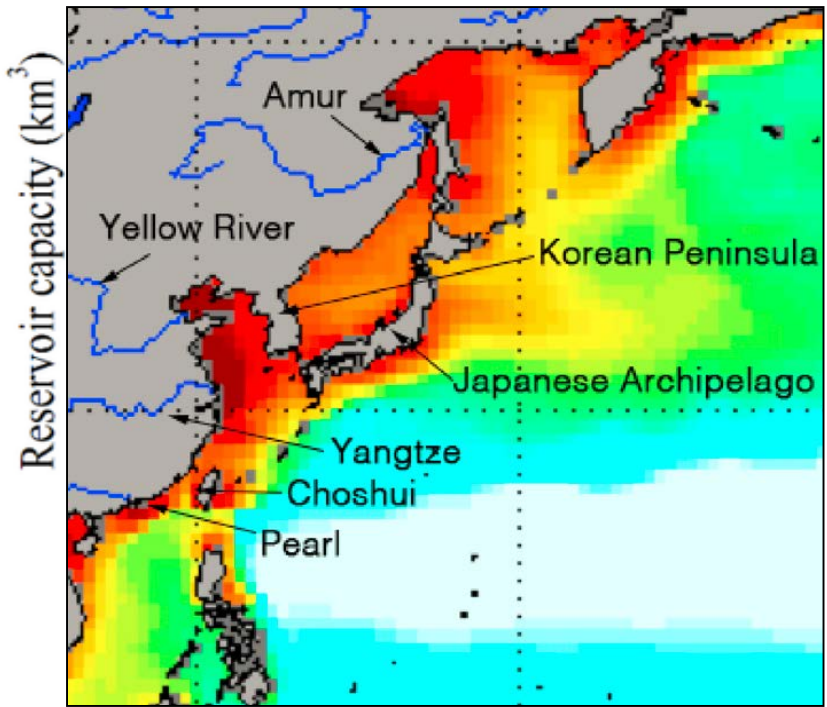
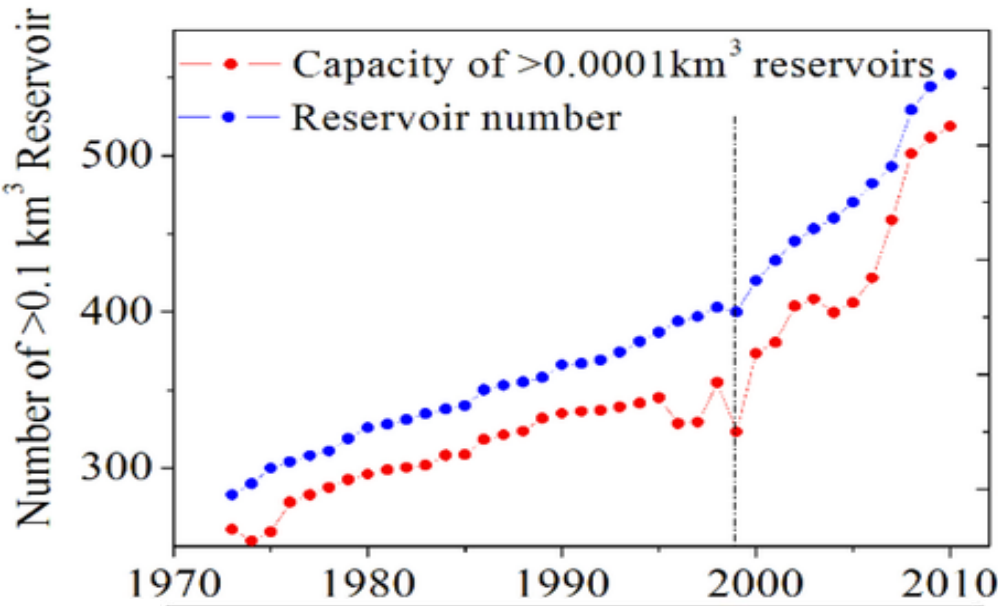
# 1. Introduction

**Hypothesis: Mercury inputs to Chinese marginal seas may have been changed**



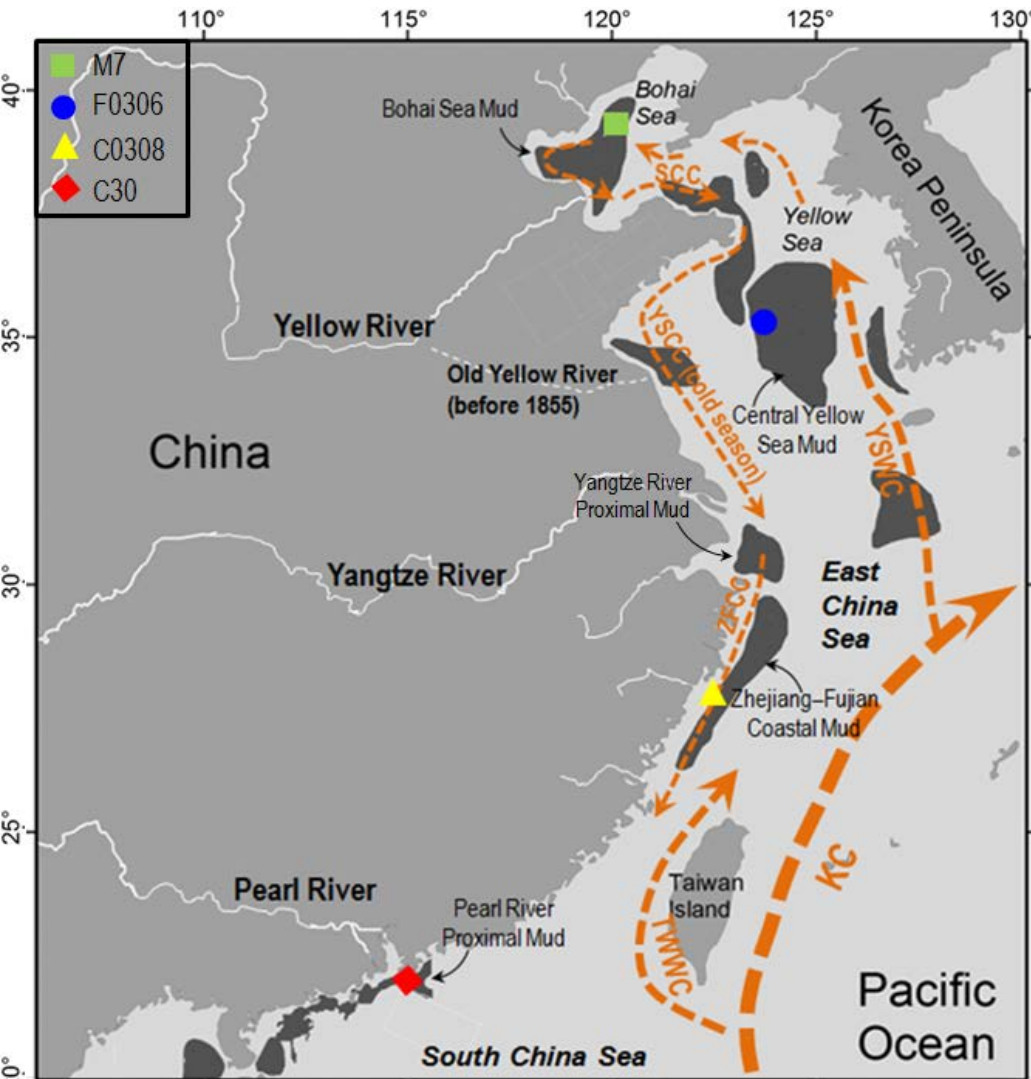
# 1. Introduction

**Hypothesis: Mercury inputs to Chinese marginal seas may have been changed**



# 2. Experimental methods

**Hypothesis: Mercury inputs to Chinese marginal seas may have been changed**

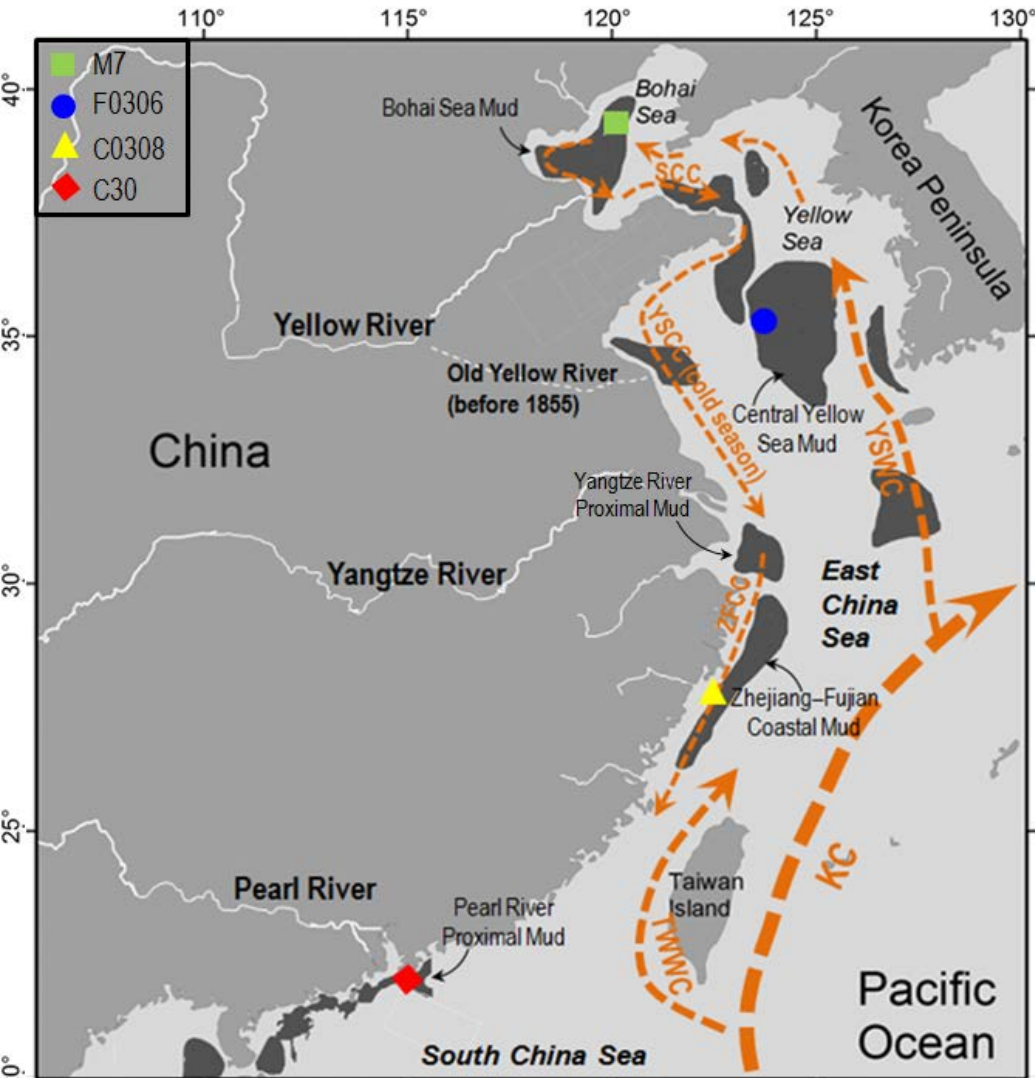


**Objective**

**Historical changes**

- 1. Dry density test &  $^{210}\text{Pb}$  Dating**  
Nanjing Institute of Geography and Limnology, CAS
- 2. Total Hg concentration**  
Shanghai Key Laboratory of Atmospheric Particle Pollution Prevention, Fudan University, China
- 3. Hg isotopic composition**  
University of Wisconsin-Madison's State Laboratory of Hygiene

# 2. Experimental methods

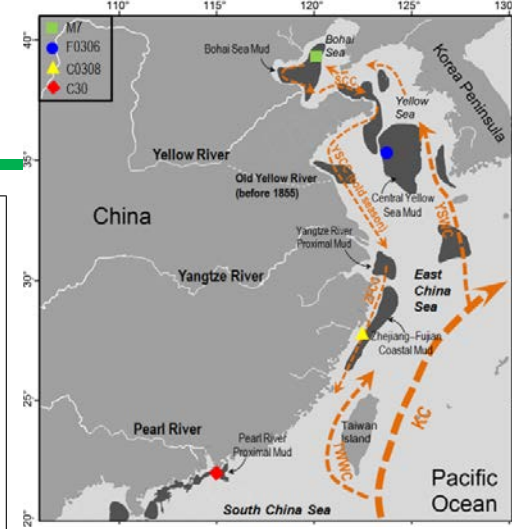
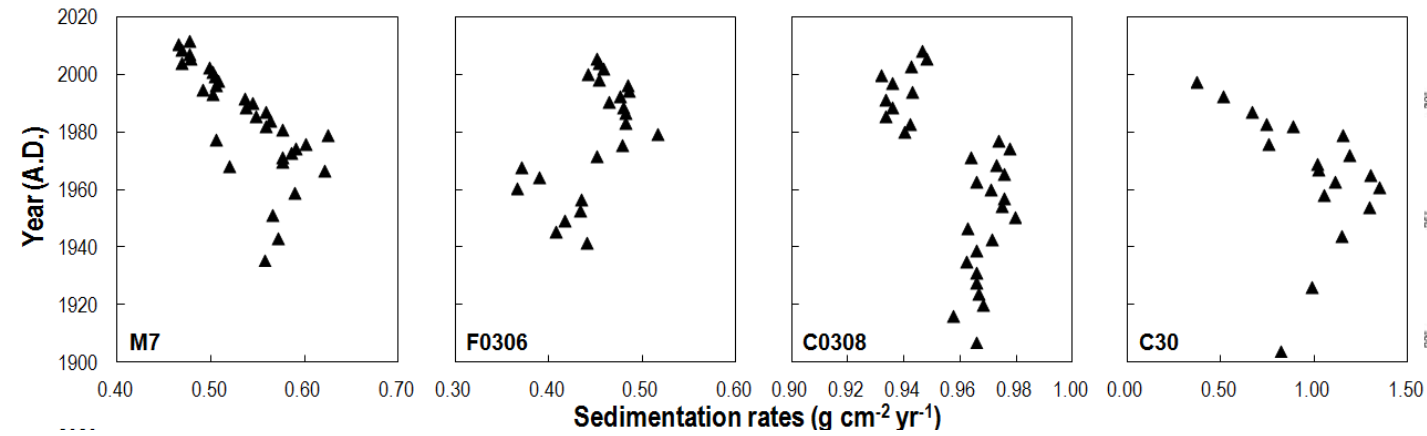


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Nanjing Institute of Geography and Limnology, CAS

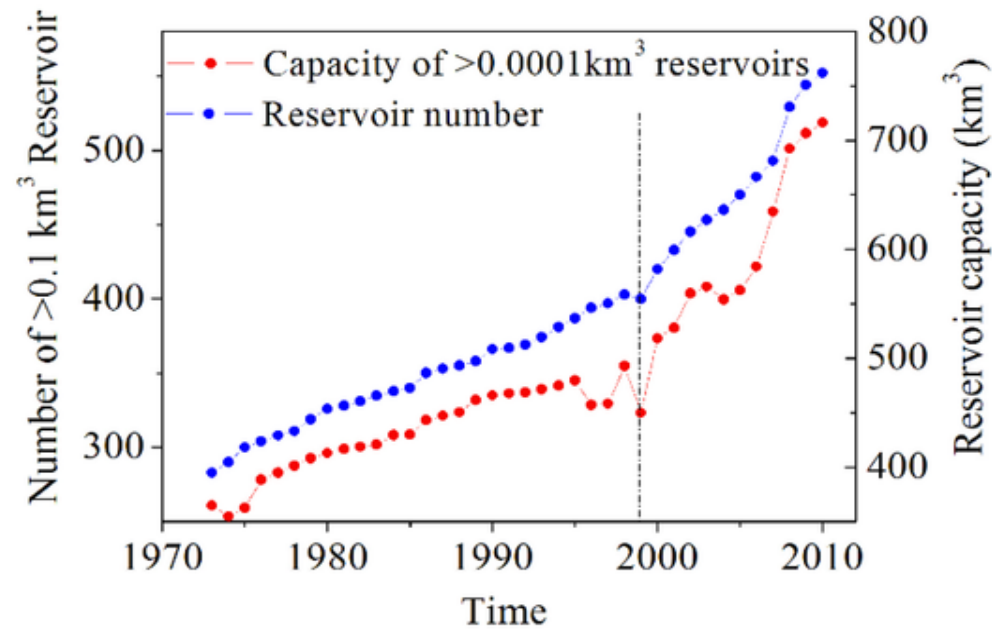
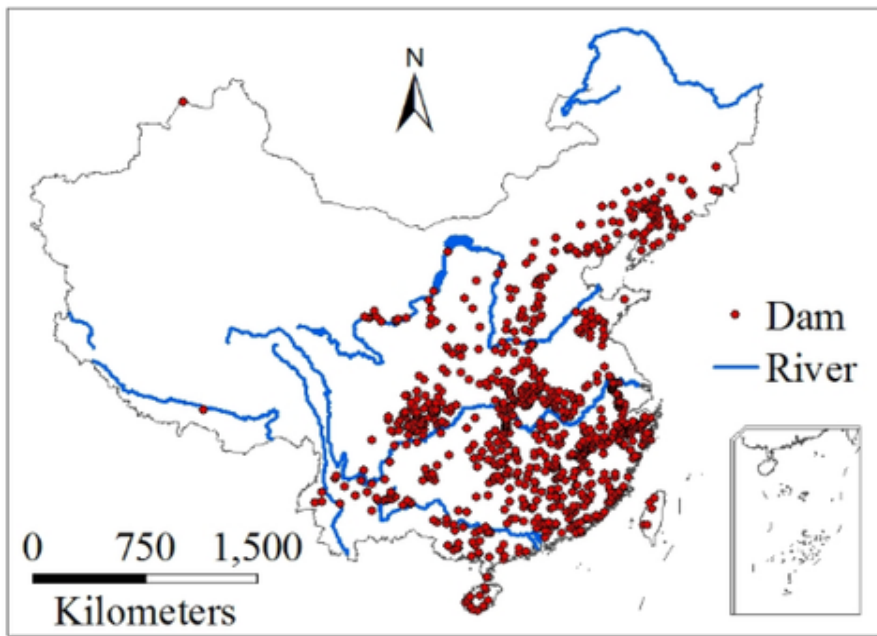
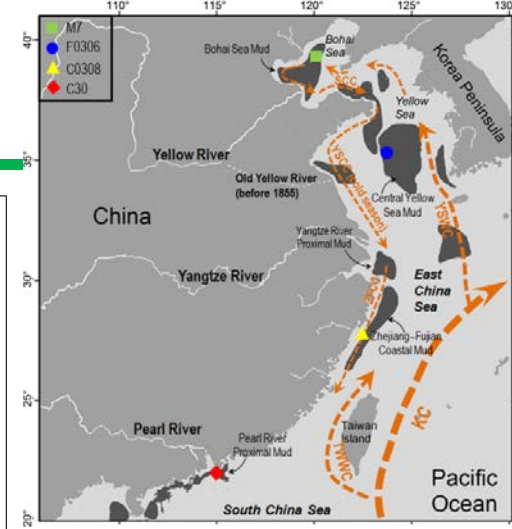
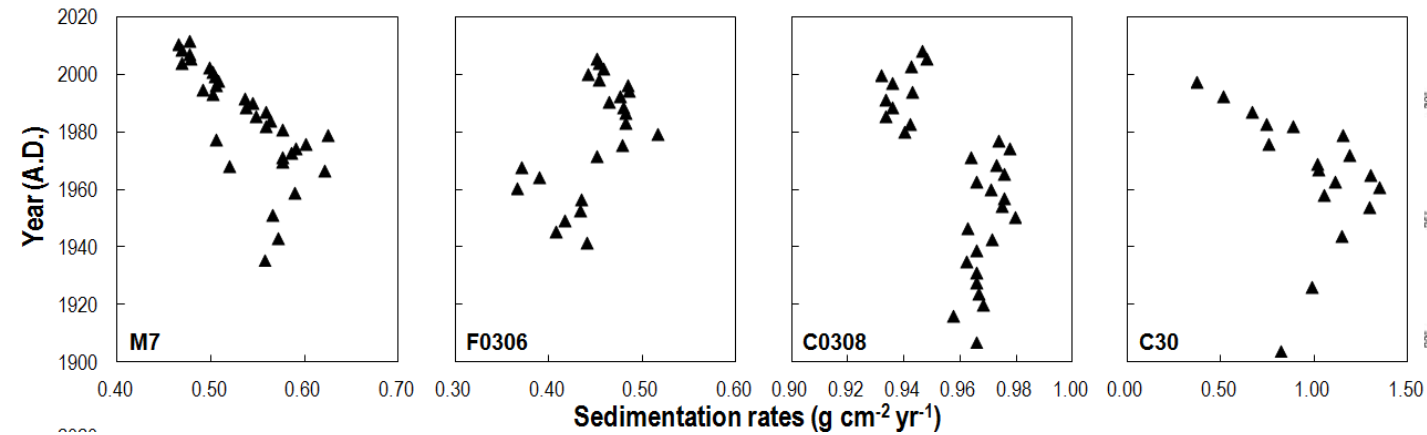
**2. Total Hg concentration**  
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**3. Hg isotopic composition**  
University of Wisconsin-Madison's State Laboratory of Hygiene

# 3. Results and Discussion

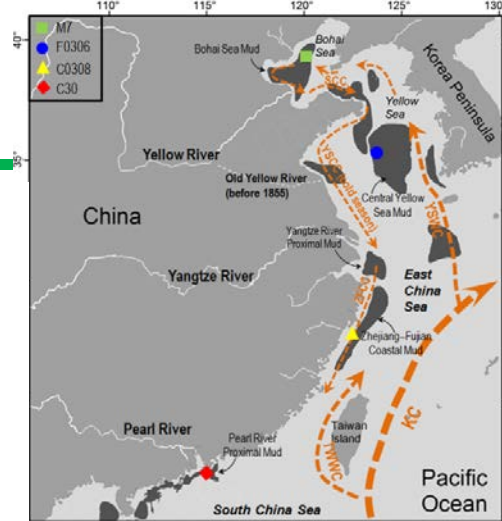
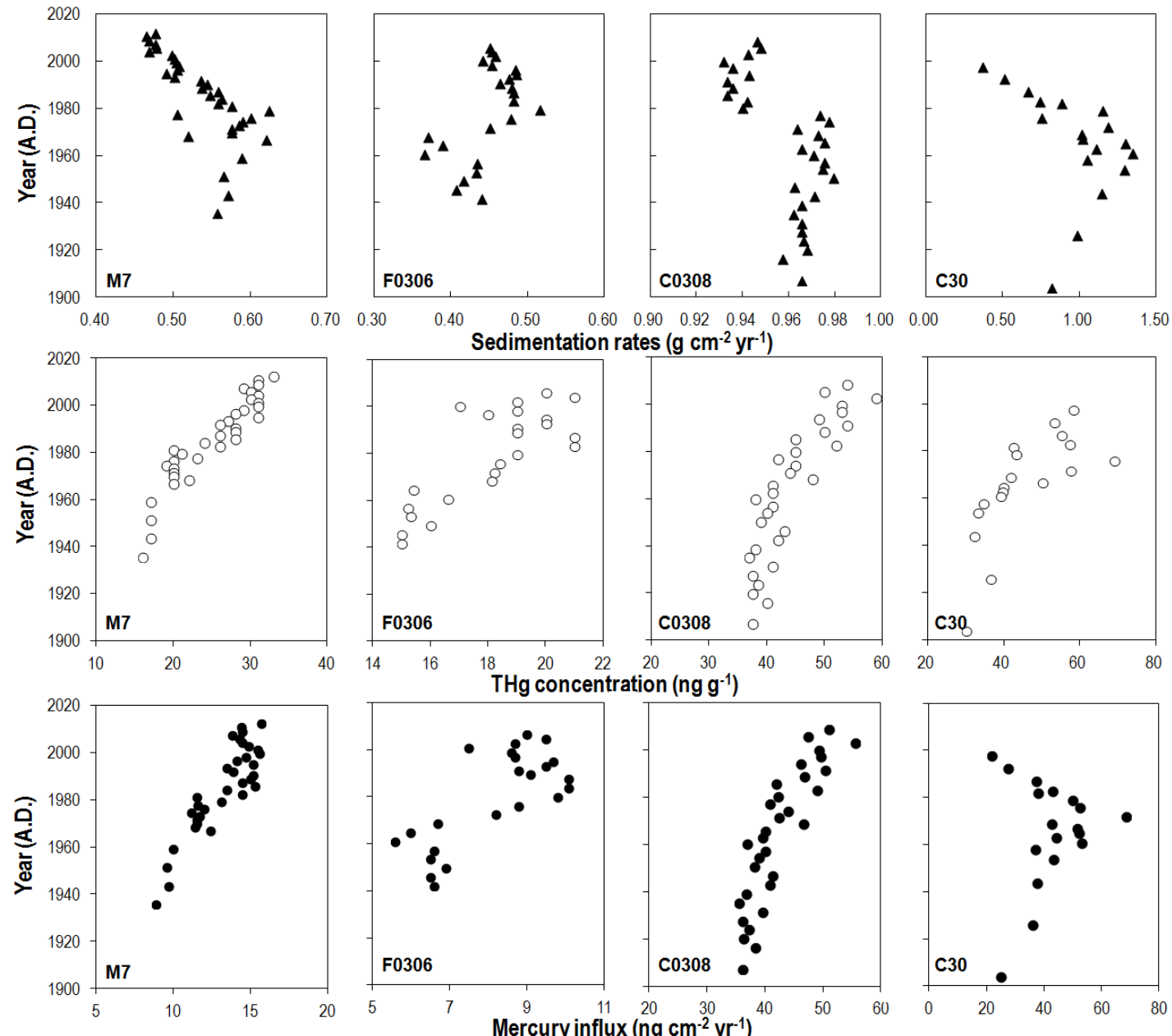


# 3. Results and Discussion



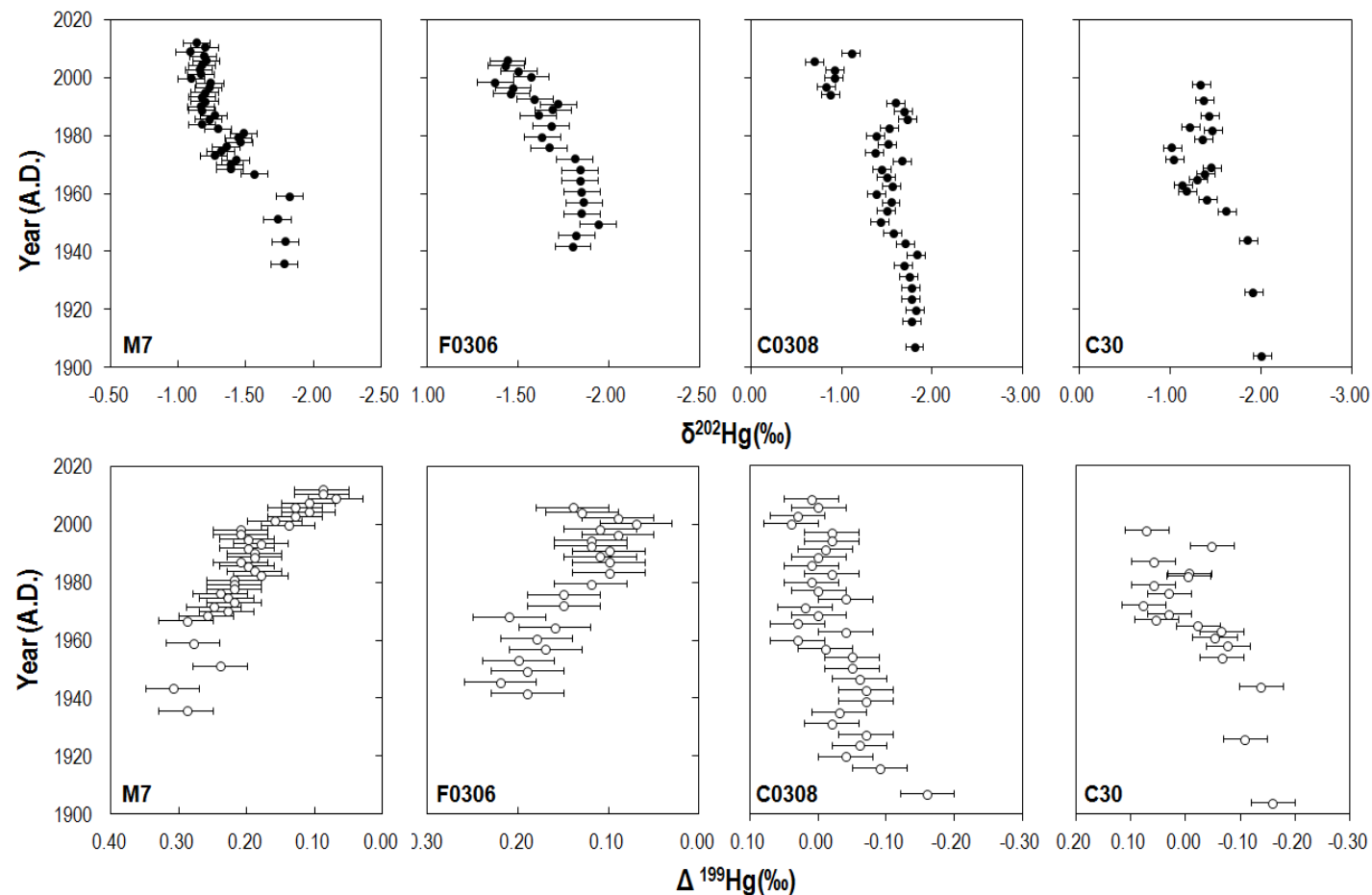
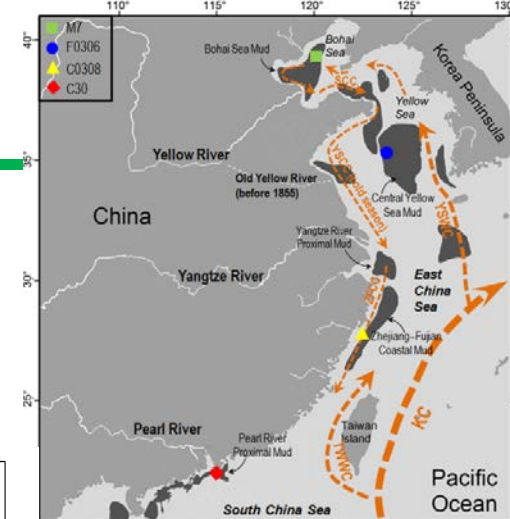
□ The sedimentation efficiency, or proportion of inflowing sediment retained by a reservoir, are averagely 30 to 40% for global reservoirs.

# 3. Results and Discussion



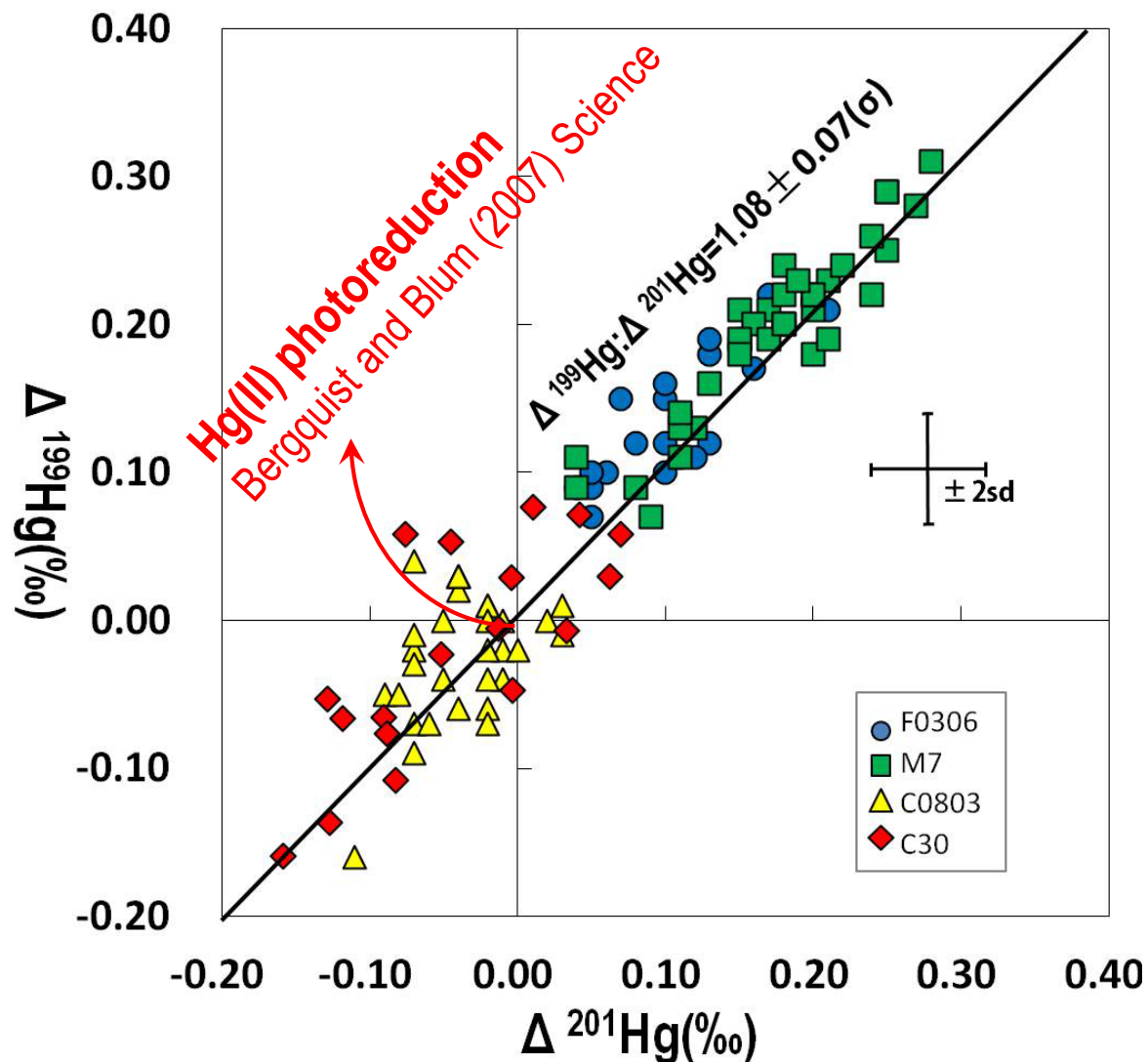
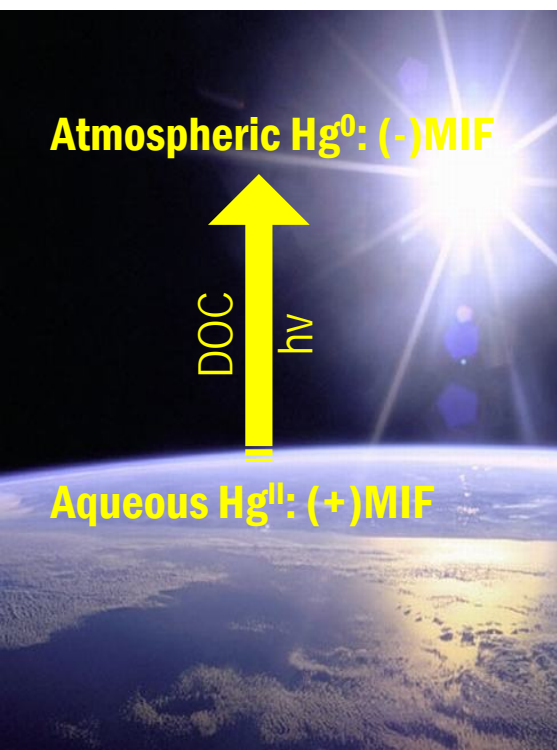
# 3. Results and Discussion

Mercury isotopes showed significant changes in the past decades



# 3. Results and Discussion

## Mercury isotope may be a source tracer



Bergquist and Blum (2007) Science

# 3. Results and Discussion

① **Industrial Hg** ( $\delta^{202}\text{Hg}$ :  $-0.5 \pm 0.4\text{‰}$ ;  $\Delta^{199}\text{Hg}$ :  $0.0 \pm 0.1\text{‰}$ ;  $\sigma$ ,  $n=292$ )

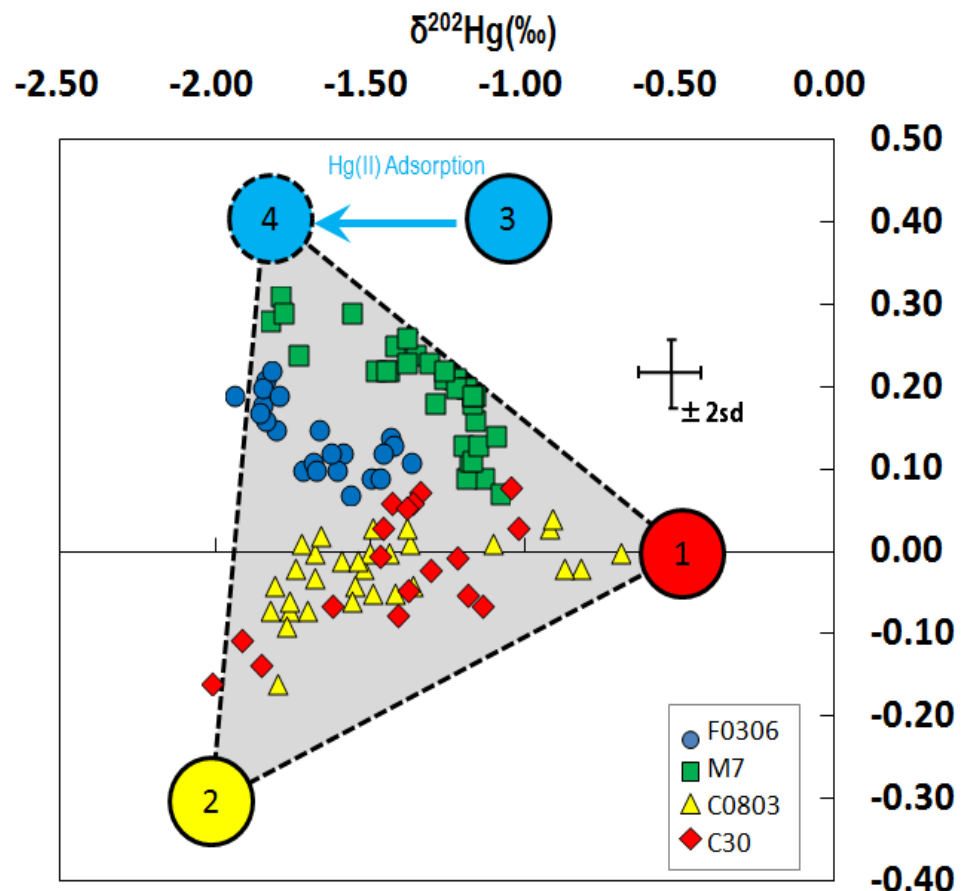
Sonke et al., 2010; Cooke et al., 2013; Donovan et al., 2013; 2015; Ma et al., 2013; Mil-Homens et al., 2013; Balogh et al., 2015; Bonsignore et al. 2015; Lepak et al., 2015; Wiederhold et al., 2014; 2015; Guedron et al., 2016; Yin et al., 2016a

② **Soil Hg** ( $\delta^{202}\text{Hg}$ :  $-1.9 \pm 0.4\text{‰}$ ;  $\Delta^{199}\text{Hg}$ :  $-0.3 \pm 0.1\text{‰}$ ;  $\sigma$ ,  $n=110$ )

Biswas et al., 2008; Demers et al., 2013; Zhang et al., 2013; Jiskra et al., 2015

③ **Precipitation-derived Hg** ( $\delta^{202}\text{Hg}$ :  $-1.2 \pm 1.1\text{‰}$ ;  $\Delta^{199}\text{Hg}$ :  $0.4 \pm 0.3\text{‰}$ ;  $\sigma$ ,  $n=104$ ).

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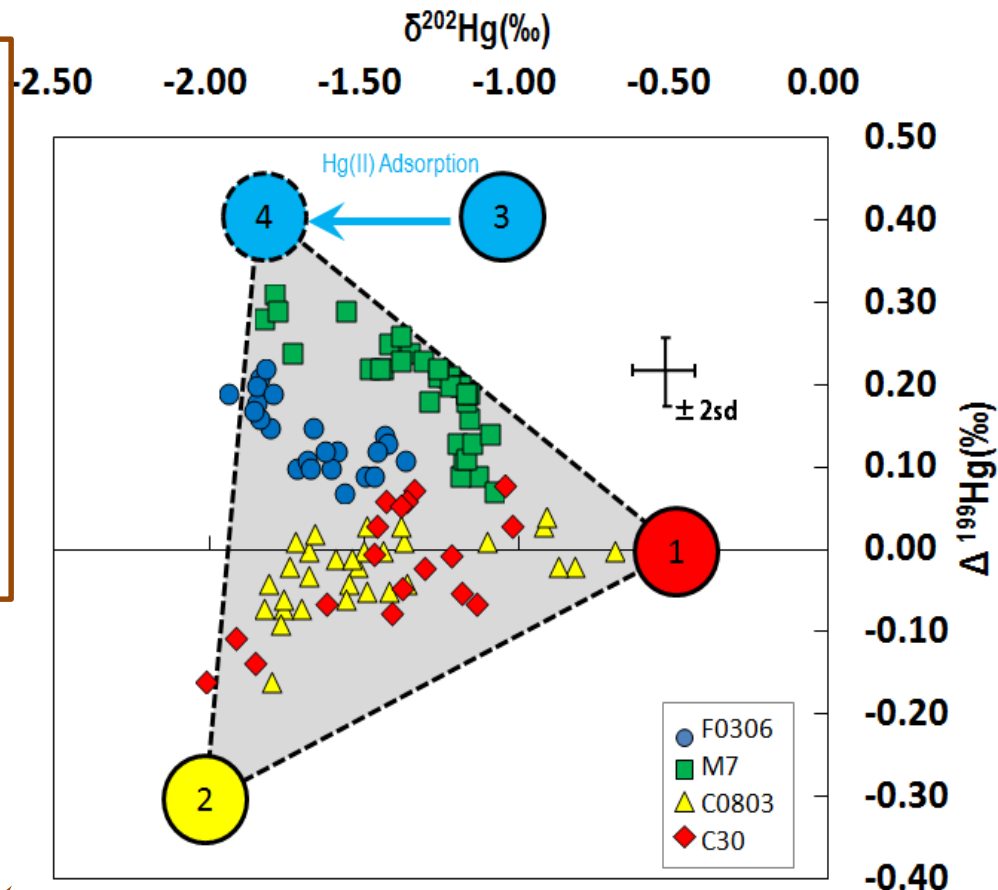
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## □ River inputs:

Mercury in major rivers is mainly particulate-bound (80-90%).  
Particulate Hg is relatively conservative.

# 3. Results and Discussion

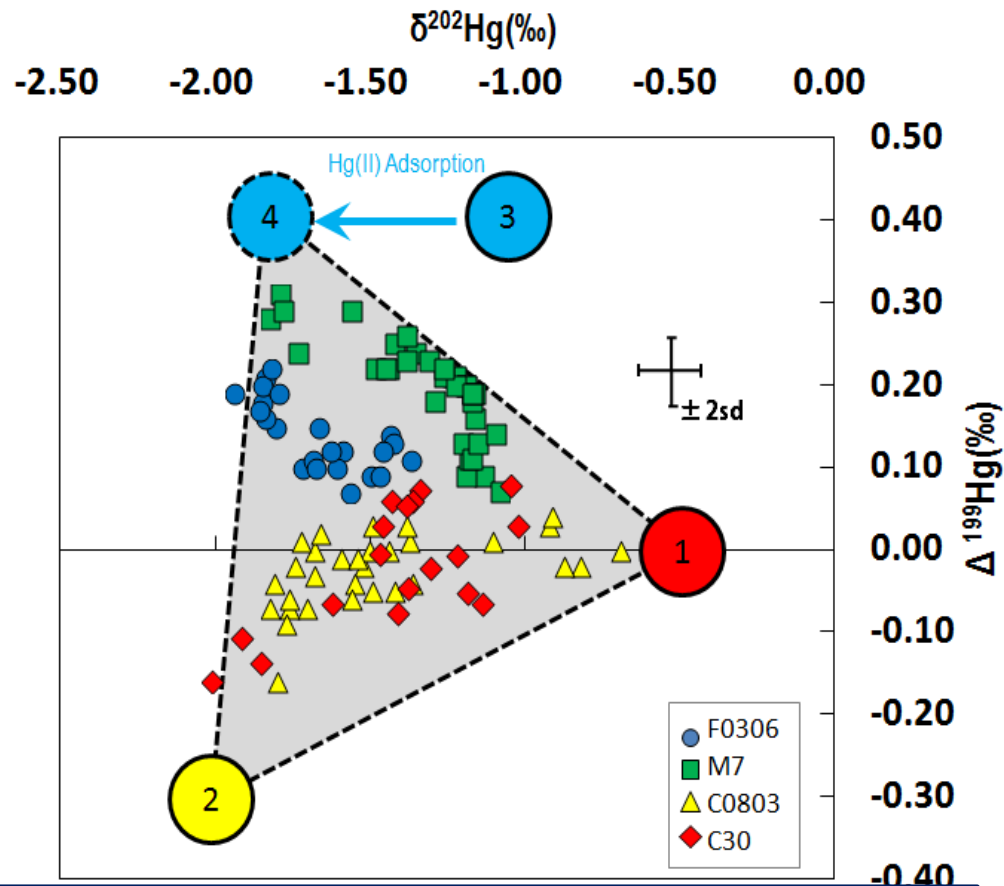
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## □ Atmospheric inputs:

Seawater contain more soluble Hg species, and precipitation Hg are more soluble and more photoreduced.

Adsorption of soluble Hg results in more negative  $\delta^{202}\text{Hg}$  in the solid phase (Wiederhold et al., 2010; Jiskra et al., 2012)

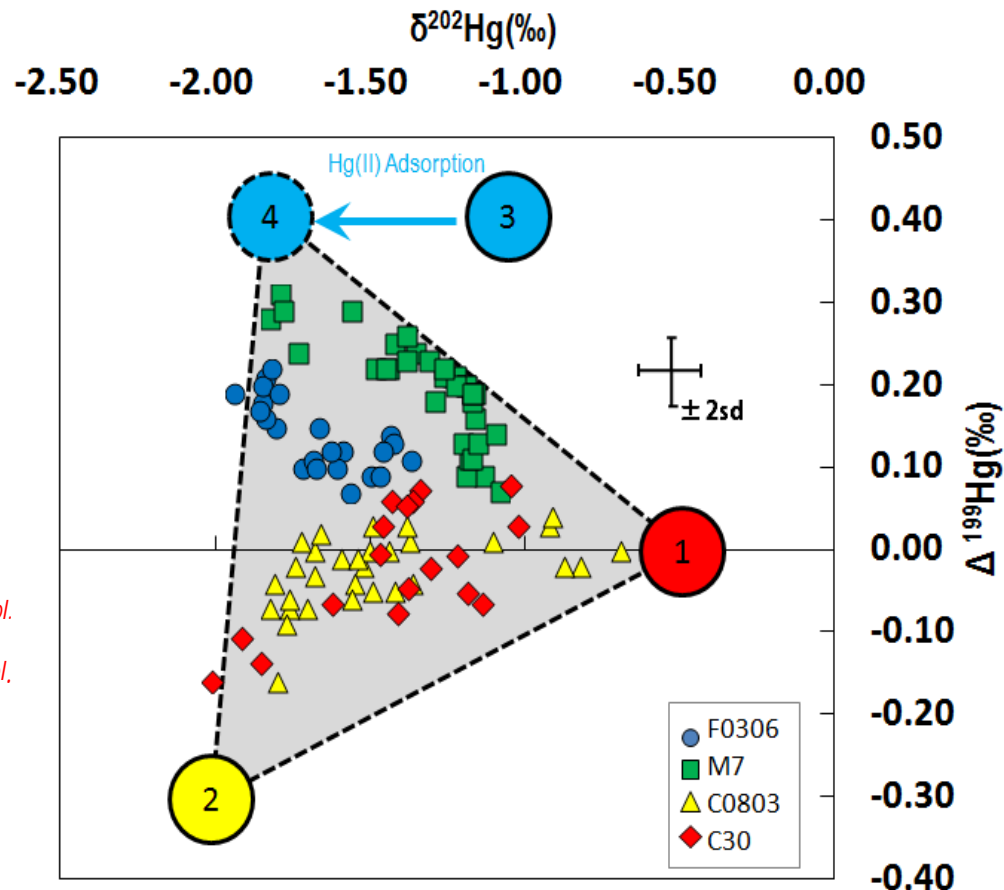
# 3. Results and Discussion

## Triple Mixing Model

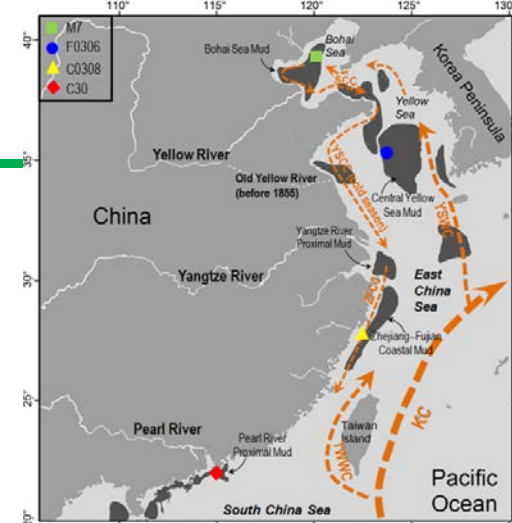
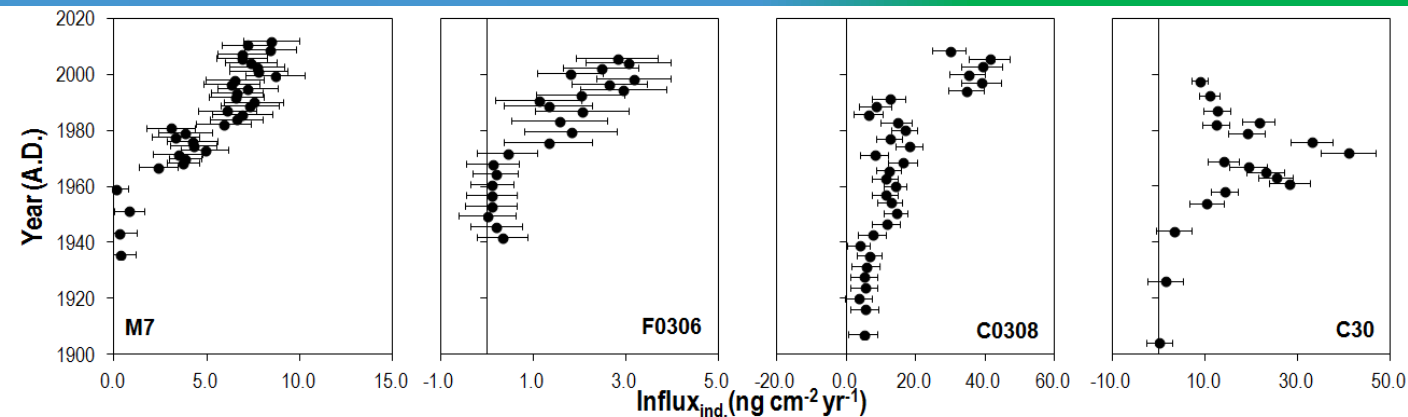
$$F_{ind.} + F_{wat.} + F_{atm.} = 1$$
$$F_{ind.} * \delta^{202}\text{Hg}_{ind.} + F_{wat.} * \delta^{202}\text{Hg}_{wat.} + F_{atm.} * \delta^{202}\text{Hg}_{atm.} = \delta^{202}\text{Hg}_{spl.}$$
$$F_{ind.} * \Delta^{199}\text{Hg}_{ind.} + F_{wat.} * \Delta^{199}\text{Hg}_{wat.} + F_{atm.} * \Delta^{199}\text{Hg}_{atm.} = \Delta^{199}\text{Hg}_{spl.}$$

## Model assumption:

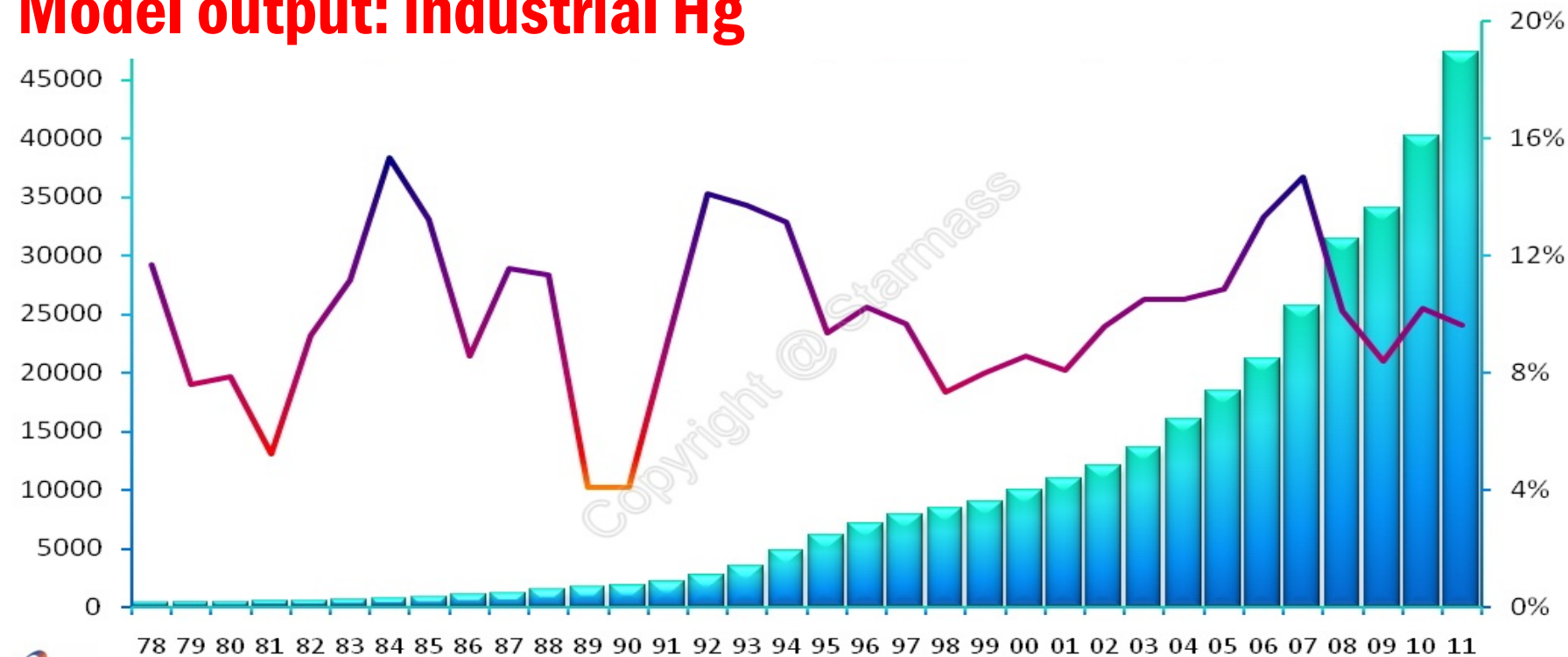
1. Industrial Hg and soil Hg were strongly bound to particles, with limited isotope fractionation.
2. Precipitation-derived Hg was adsorbed to particles prior to sedimentation, resulting a negative shift of about 0.6 ‰ for  $\delta^{202}\text{Hg}$  in the solid phase.
3. Reemission of Hg to the atmosphere is small compared to the ocean Hg pool.



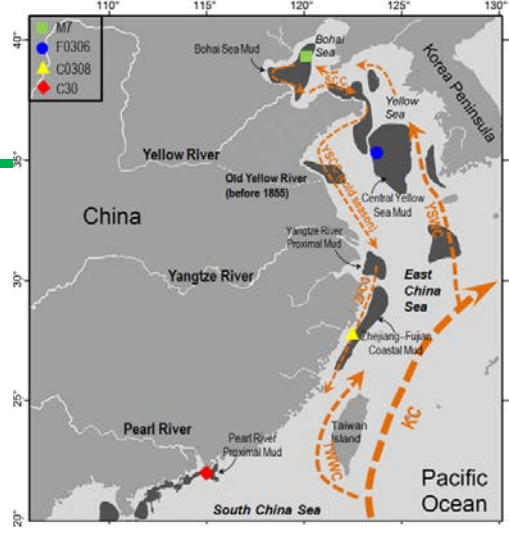
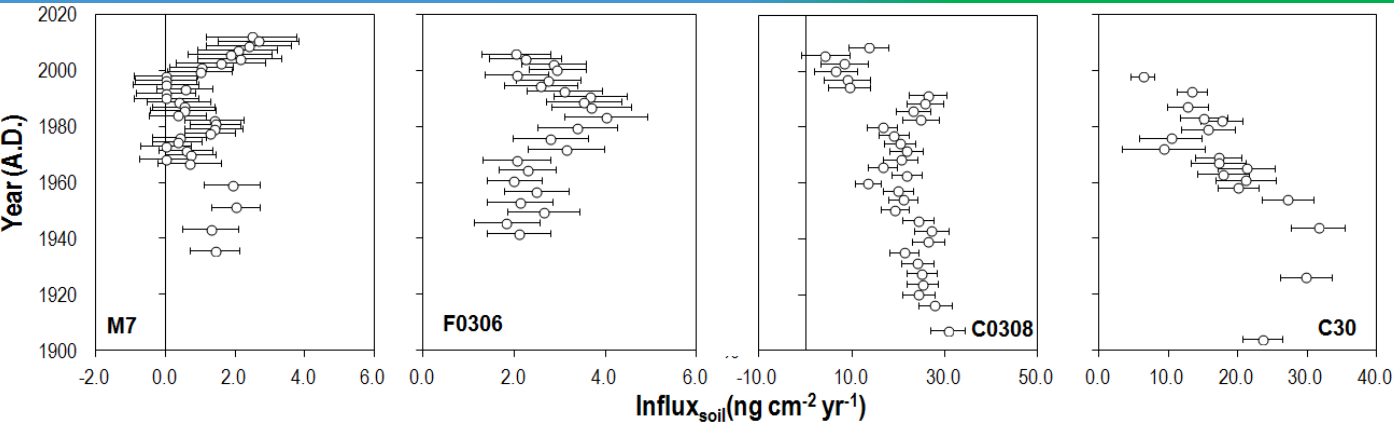
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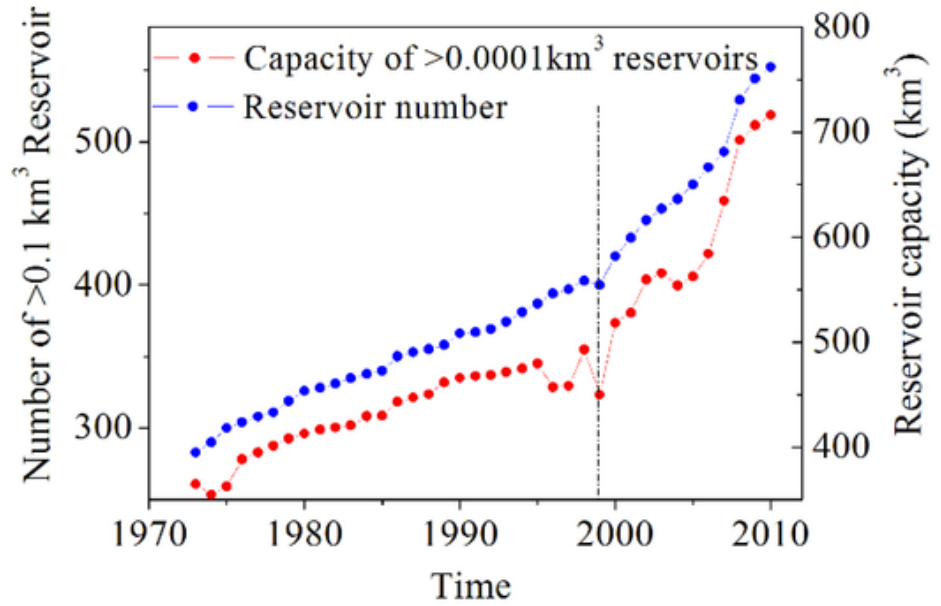
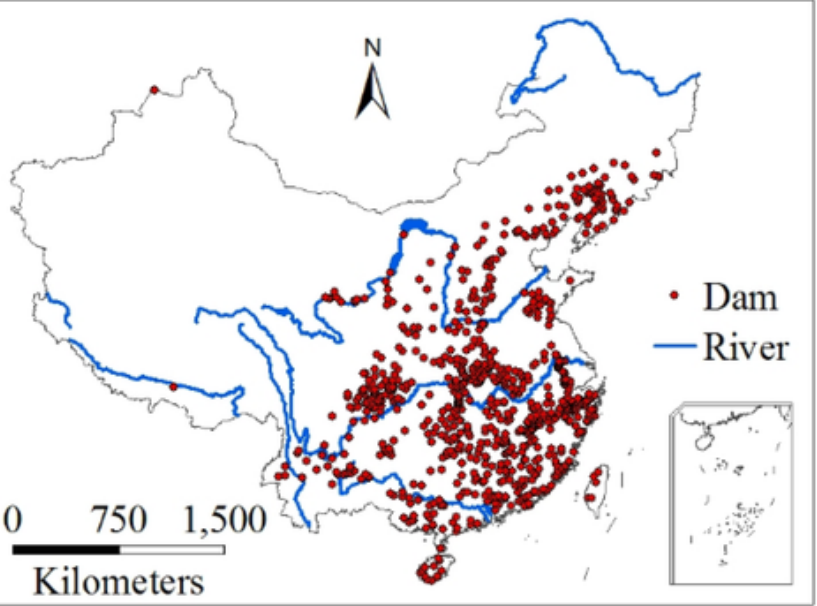
## Model output: industrial Hg



# 3. Results and Discussion

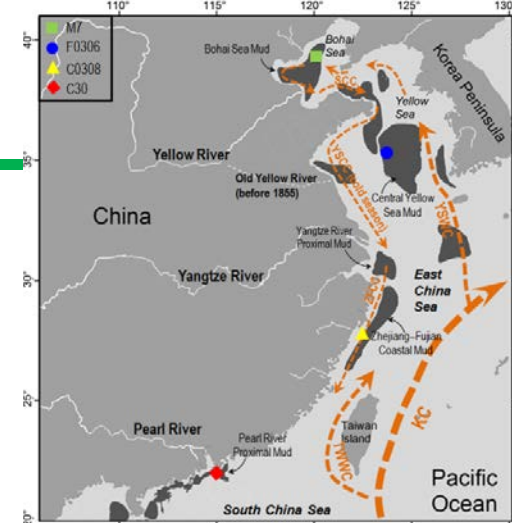
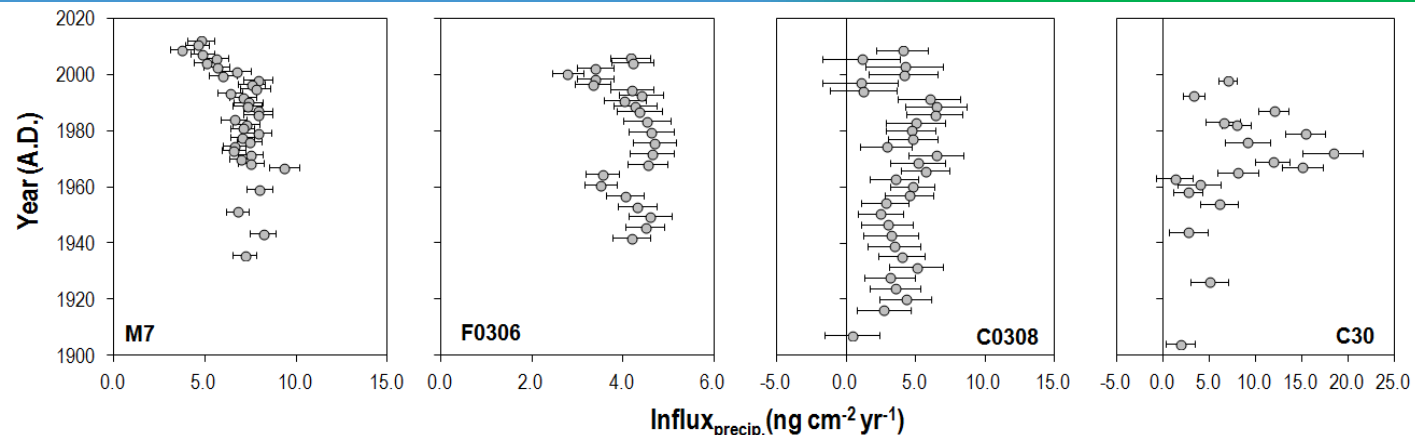


## Model output: soil Hg

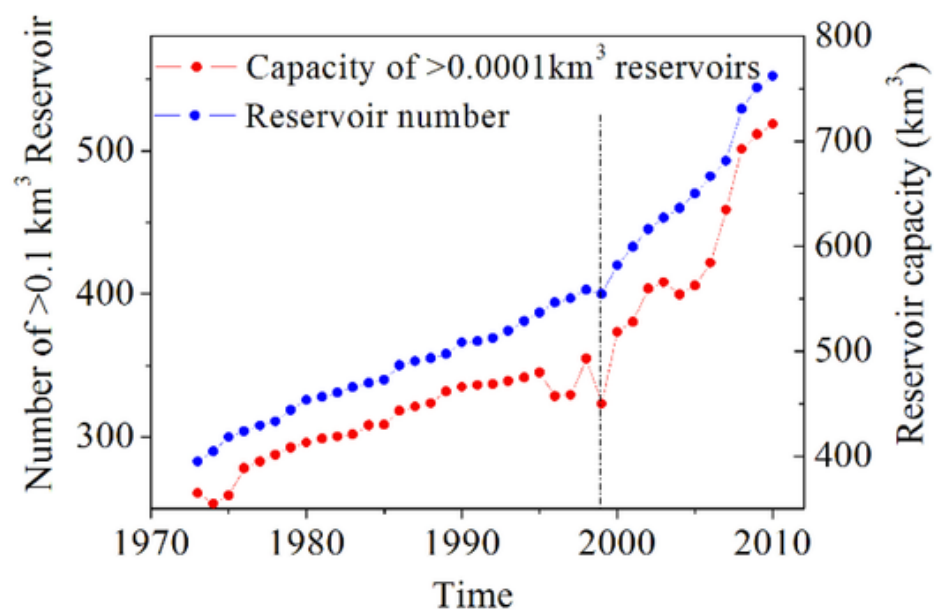
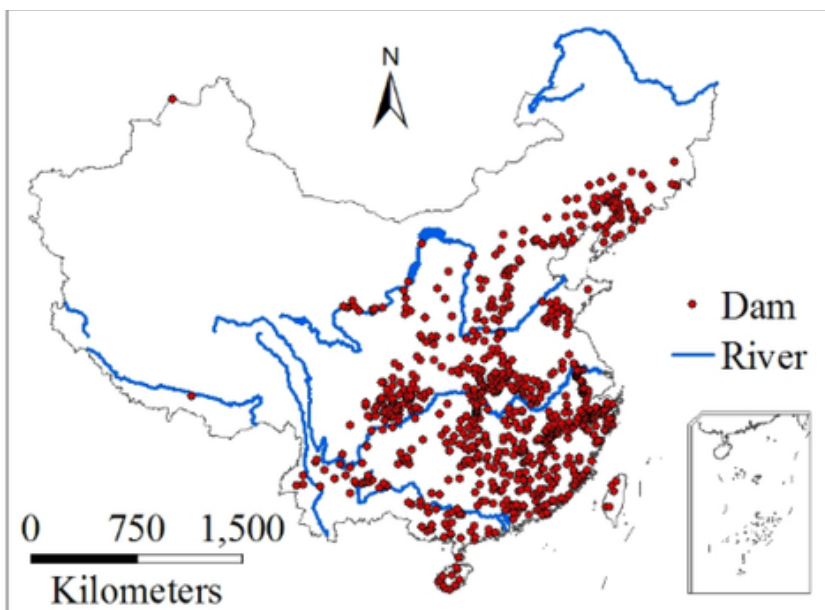


□ A recent study showed that about 40% of the total input can be retained by the reservoirs.

# 3. Results and Discussion



## Model output: precipitation Hg



Precipitation Hg seems to be controlled by river loading of soil particles.

**Thank you for your attention**