

Oyster farming overrides bottom-up control of phytoplankton phenology in a coastal embayment

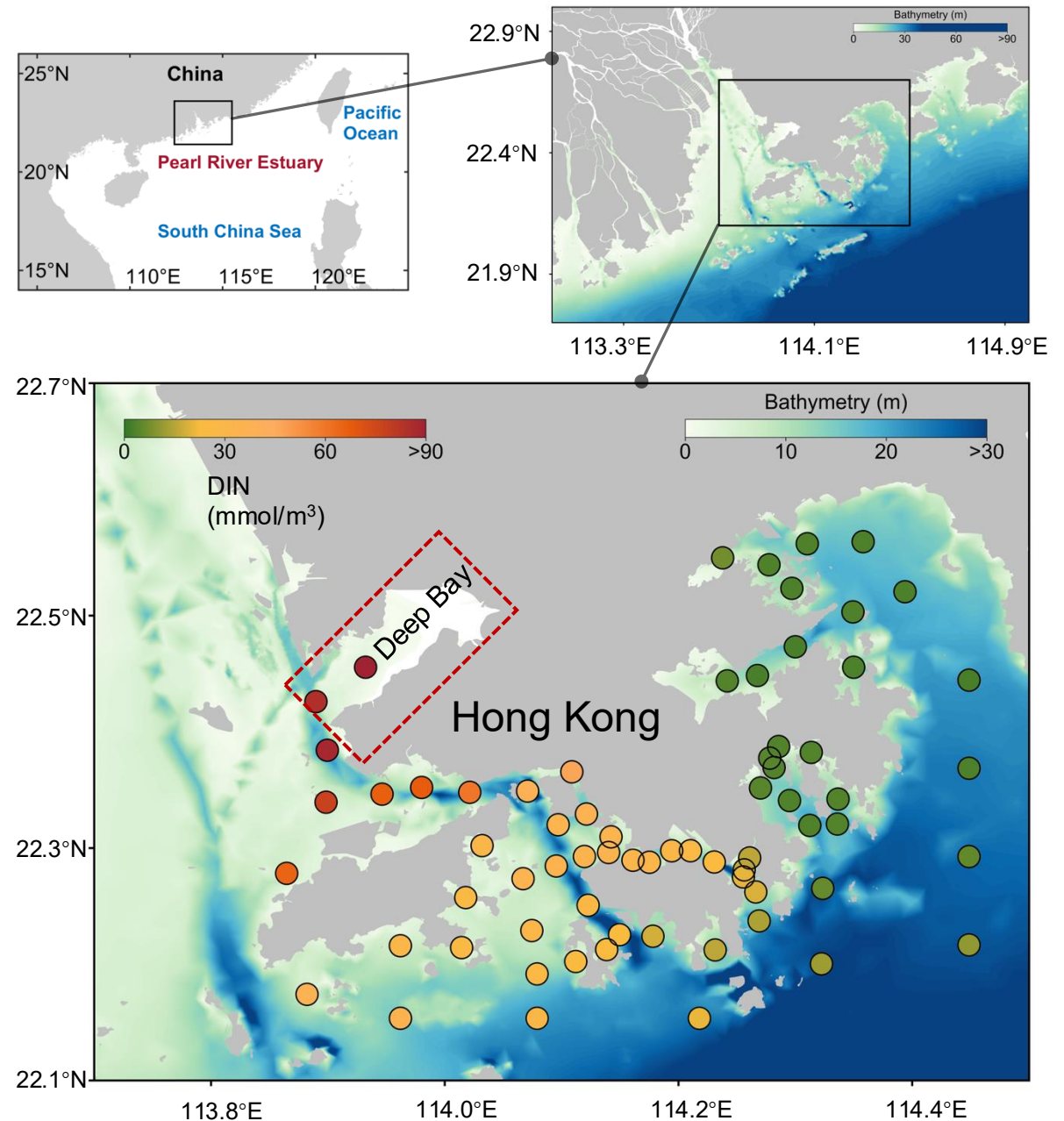
Liuqian Yu

MEAP-TT meeting | 2026.09

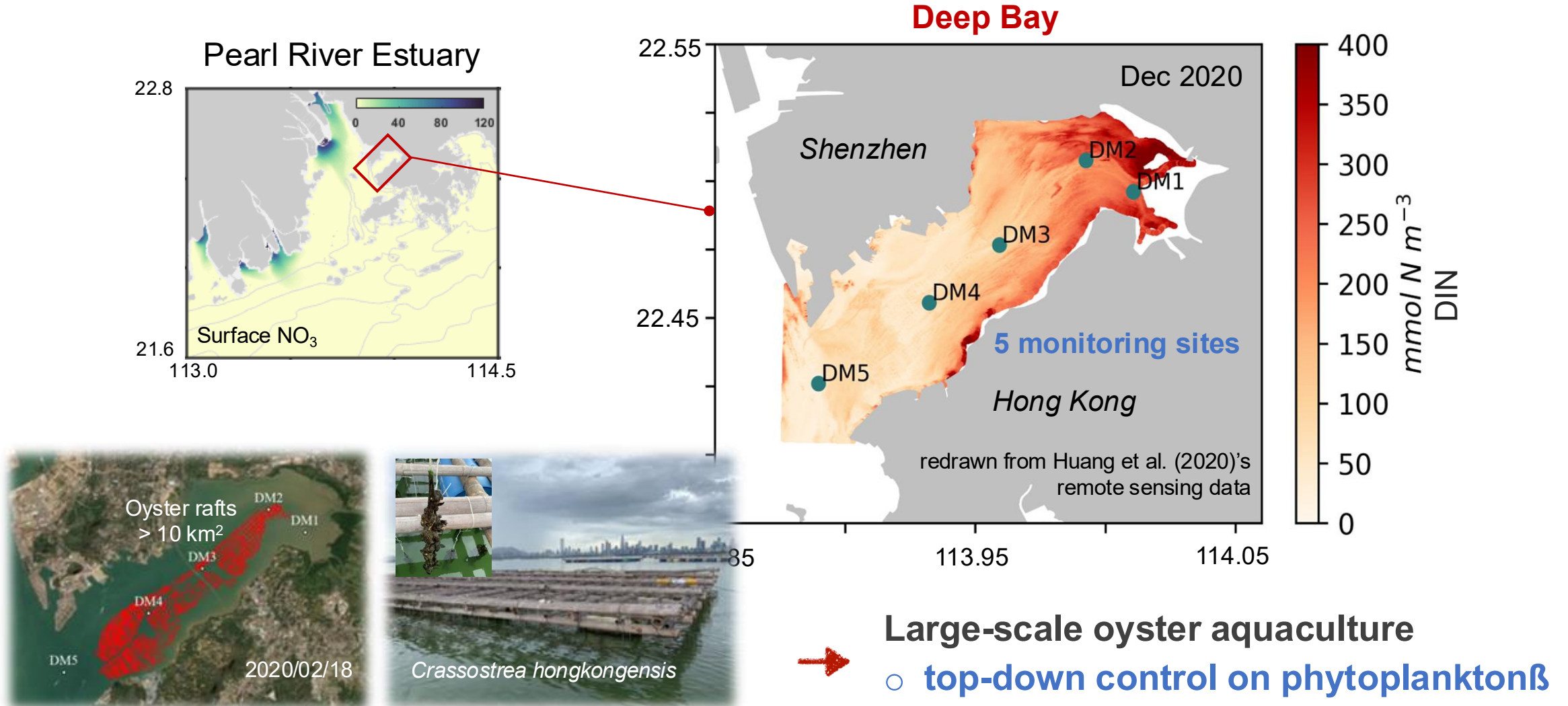


Long-term water quality monitoring in Hong Kong

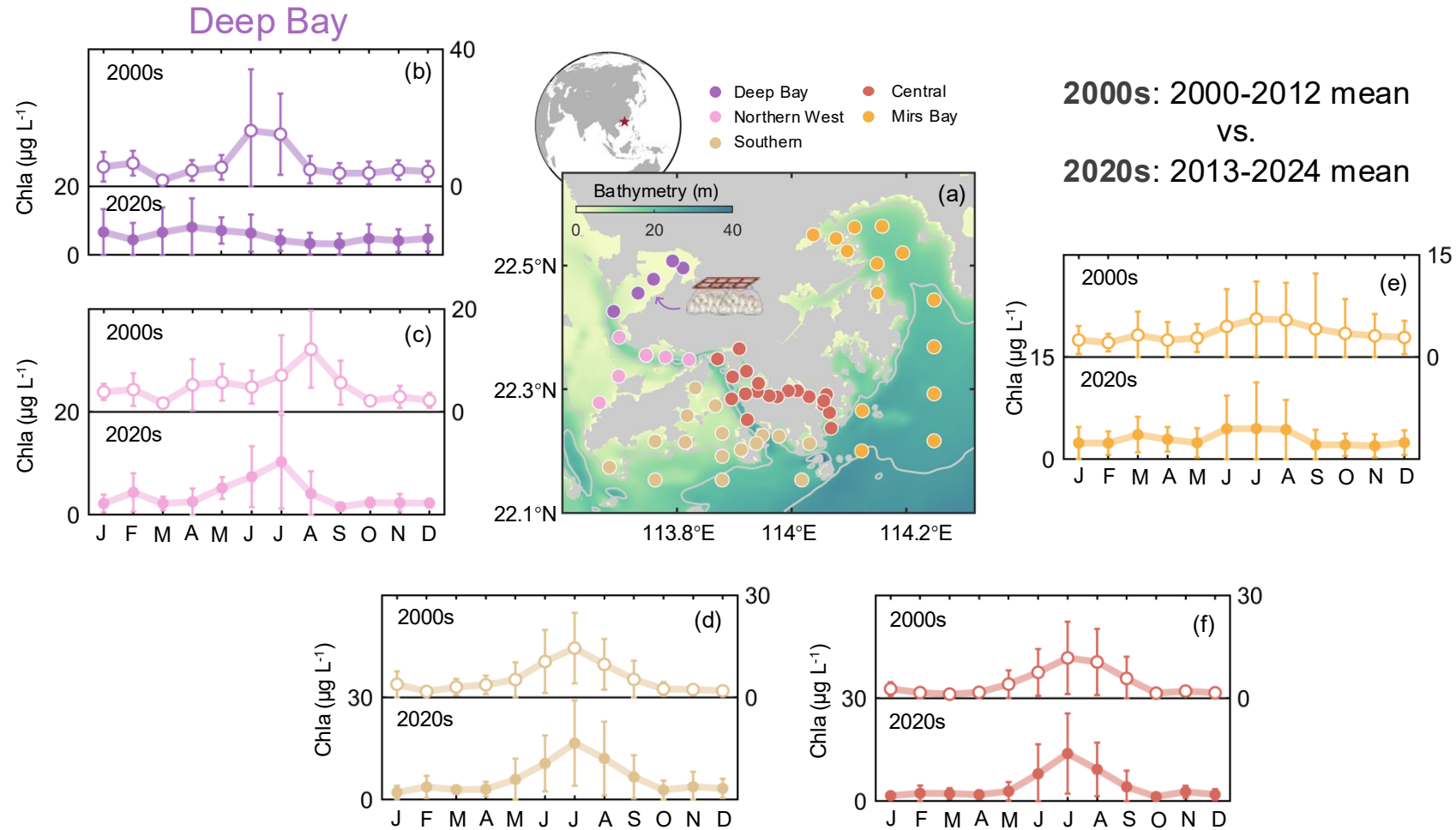
- ✓ Downstream of Pearl River Estuary
 - discharge & nutrient inputs peak in summer
 - phytoplankton blooms & bottom hypoxia
- ✓ **76 monitoring stations** (69 shown on map)
- ✓ Bimonthly sampling since 1990s
- ✓ A wide range of parameters (~40)
 - Temperature, salinity
 - Turbidity, suspended solids
 - NO_3^- , NO_2^- , NH_4^+ , PO_4^{3-} , SiO_3^{2-}
 - Chl-a, O_2
 - Metals, organics, coliform bacteria, ...



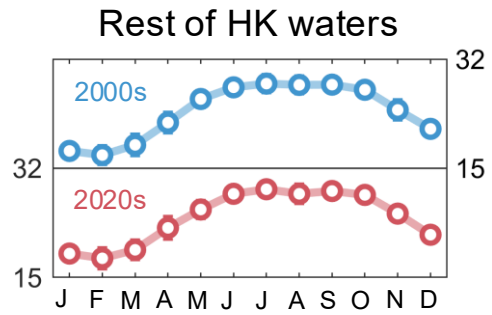
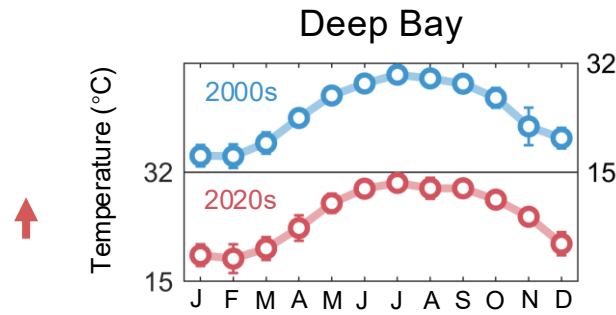
A bay of two tales



The anomaly: a phytoplankton phenology shift in Deep Bay

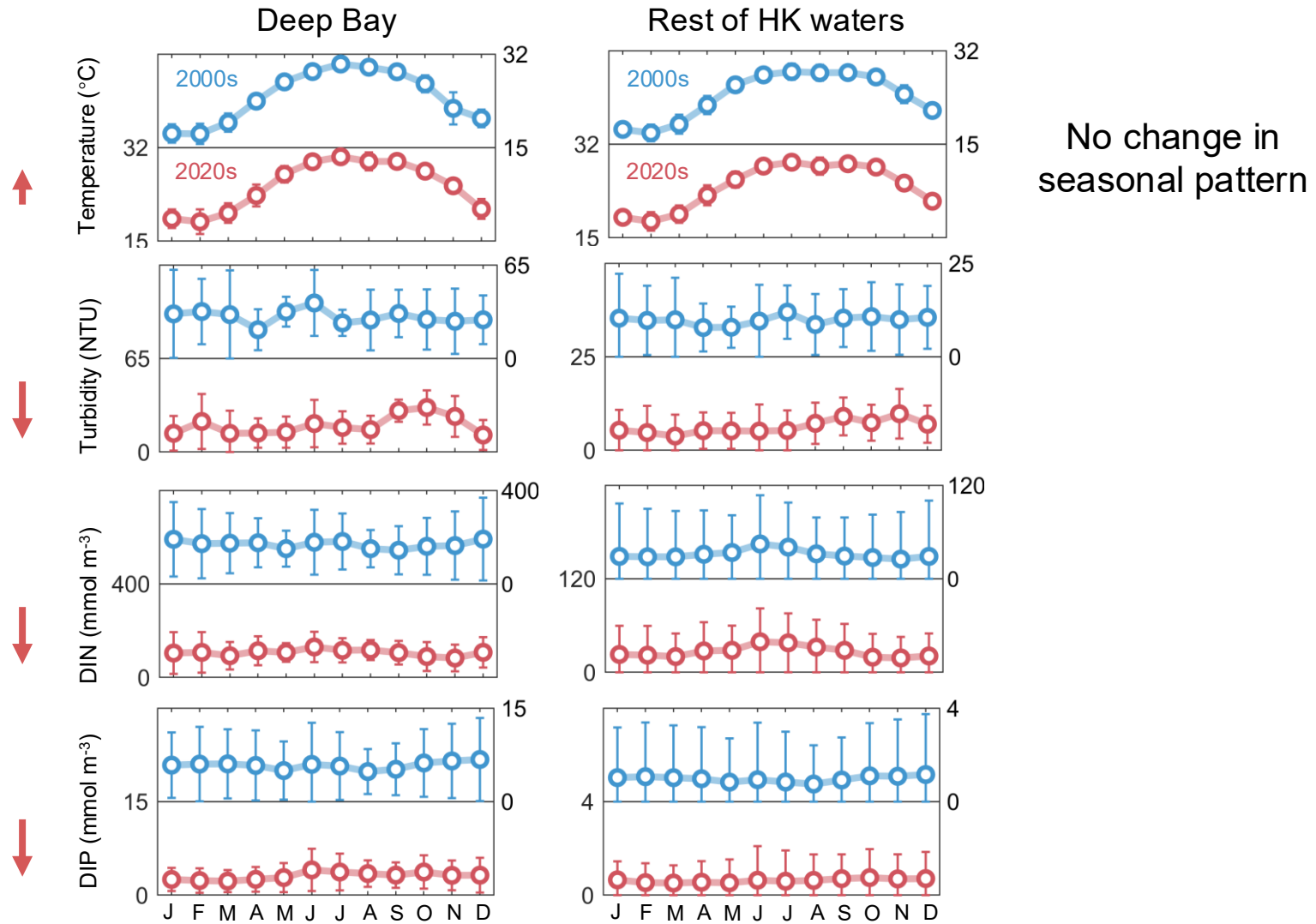


Did bottom-up drivers change?



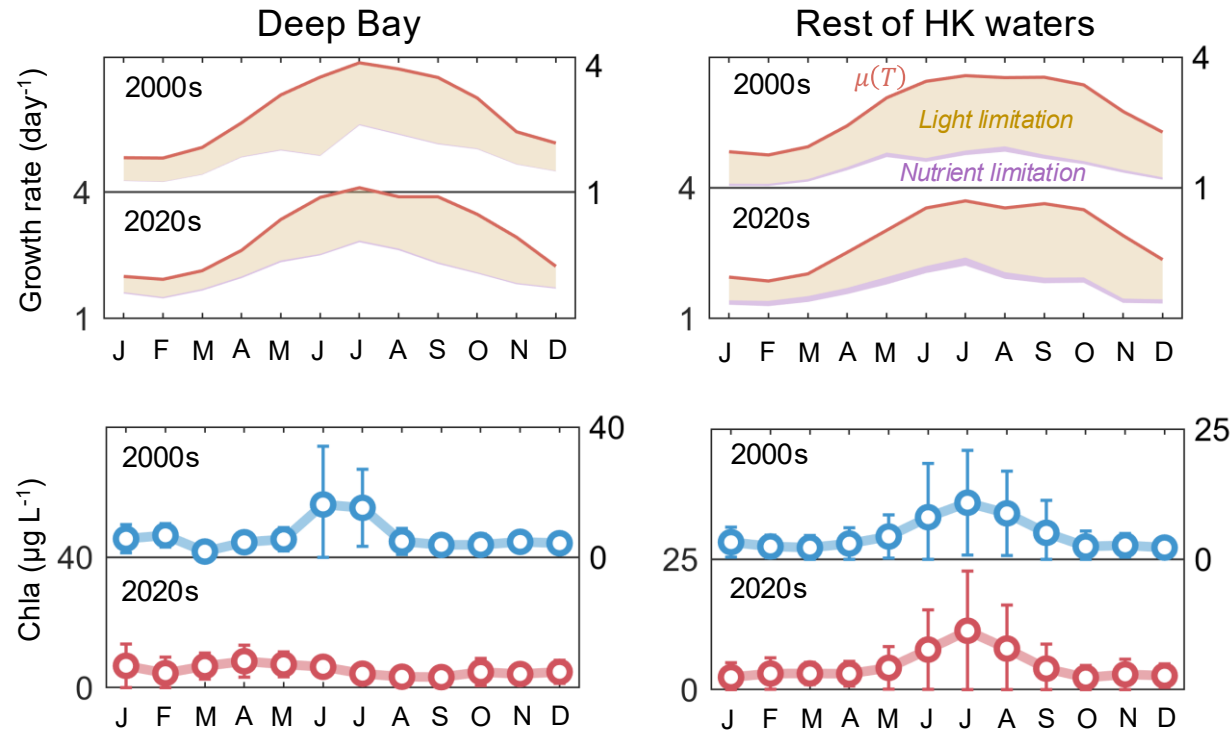
No change in
seasonal pattern

Did bottom-up drivers change?



Bottom-up regulated growth: still peaks in summer

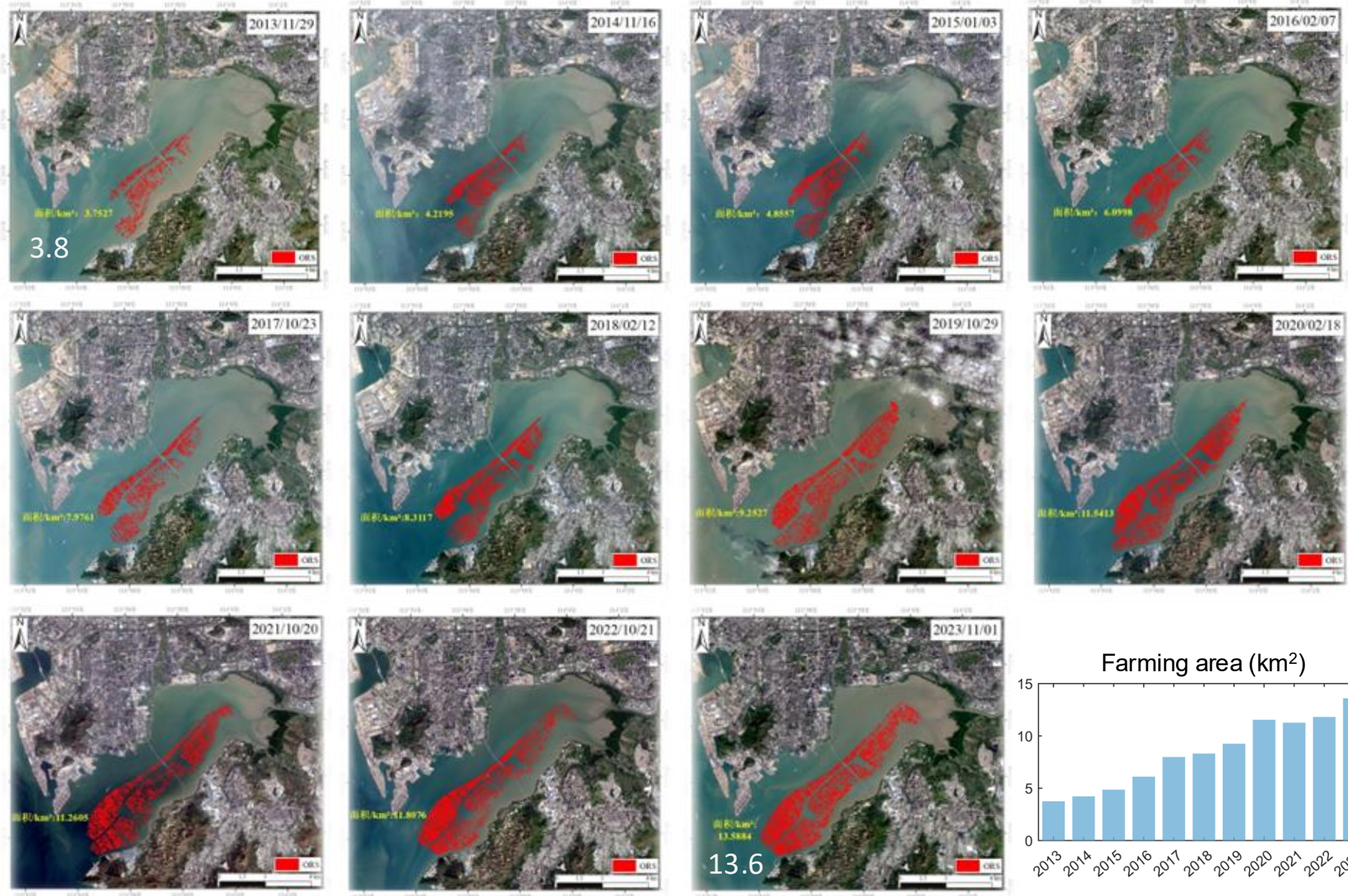
$$\text{Growth rate} = \mu(T) \times f(\text{light}) \times f(\text{nutrient})$$



→ Phenology change in Deep Bay **cannot** be explained by bottom-up factors

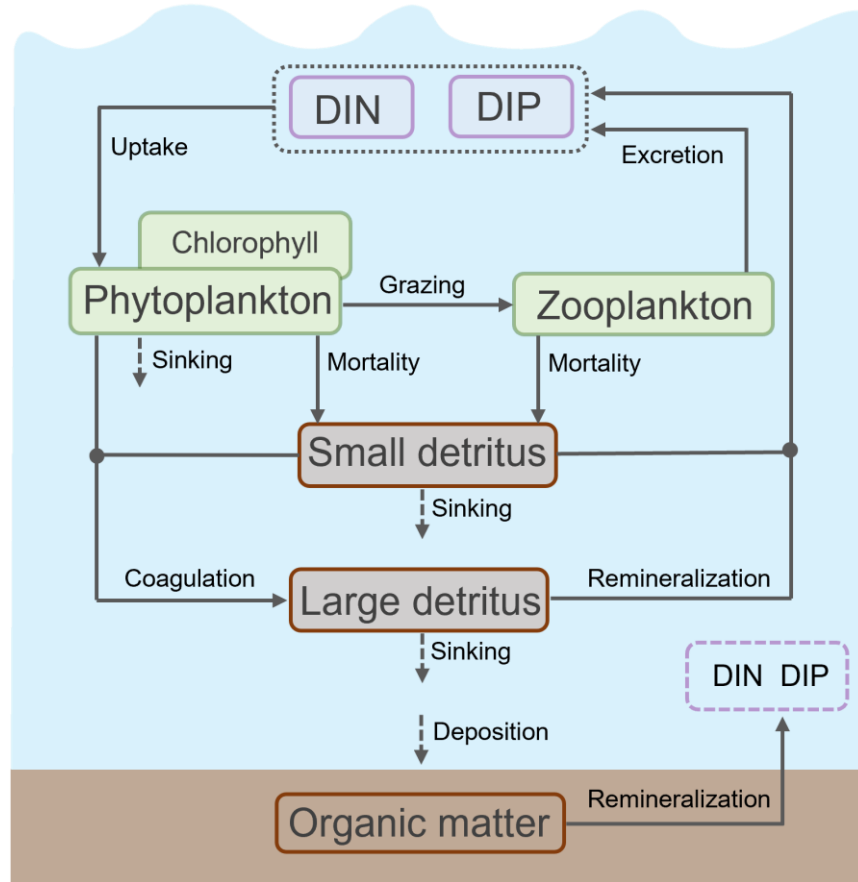
The suspect: oyster farming expansion

2013
|
2023

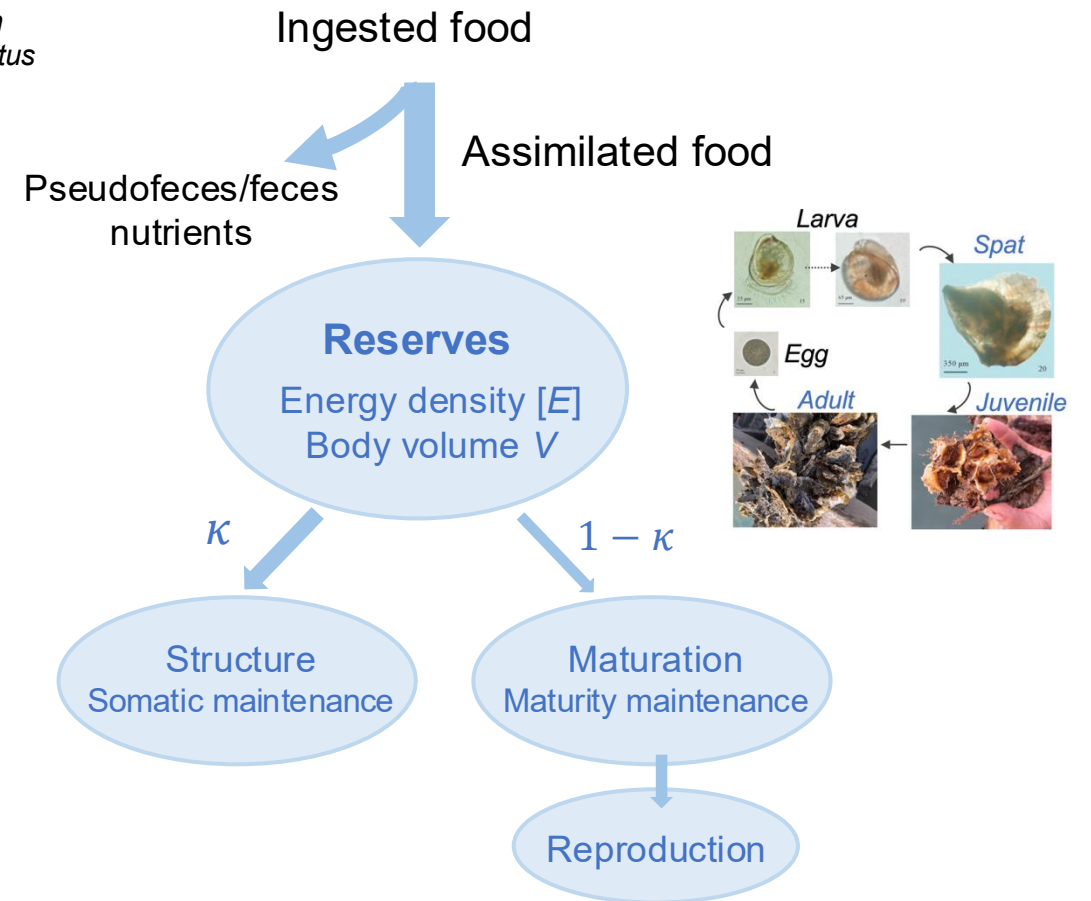


Testing the hypothesis: coupled **BGC**-**DEB** model

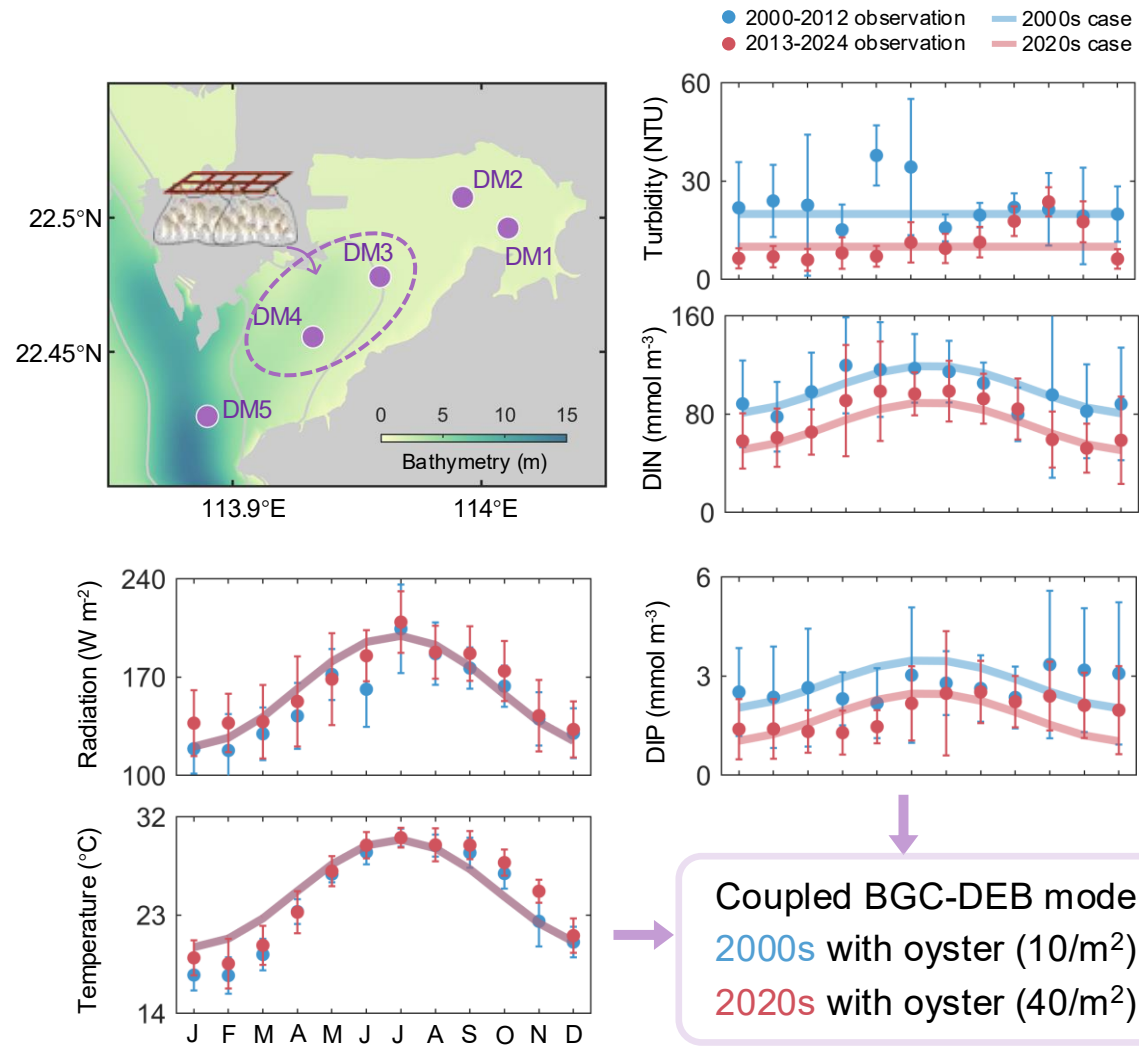
Biogeochemical (BGC) model



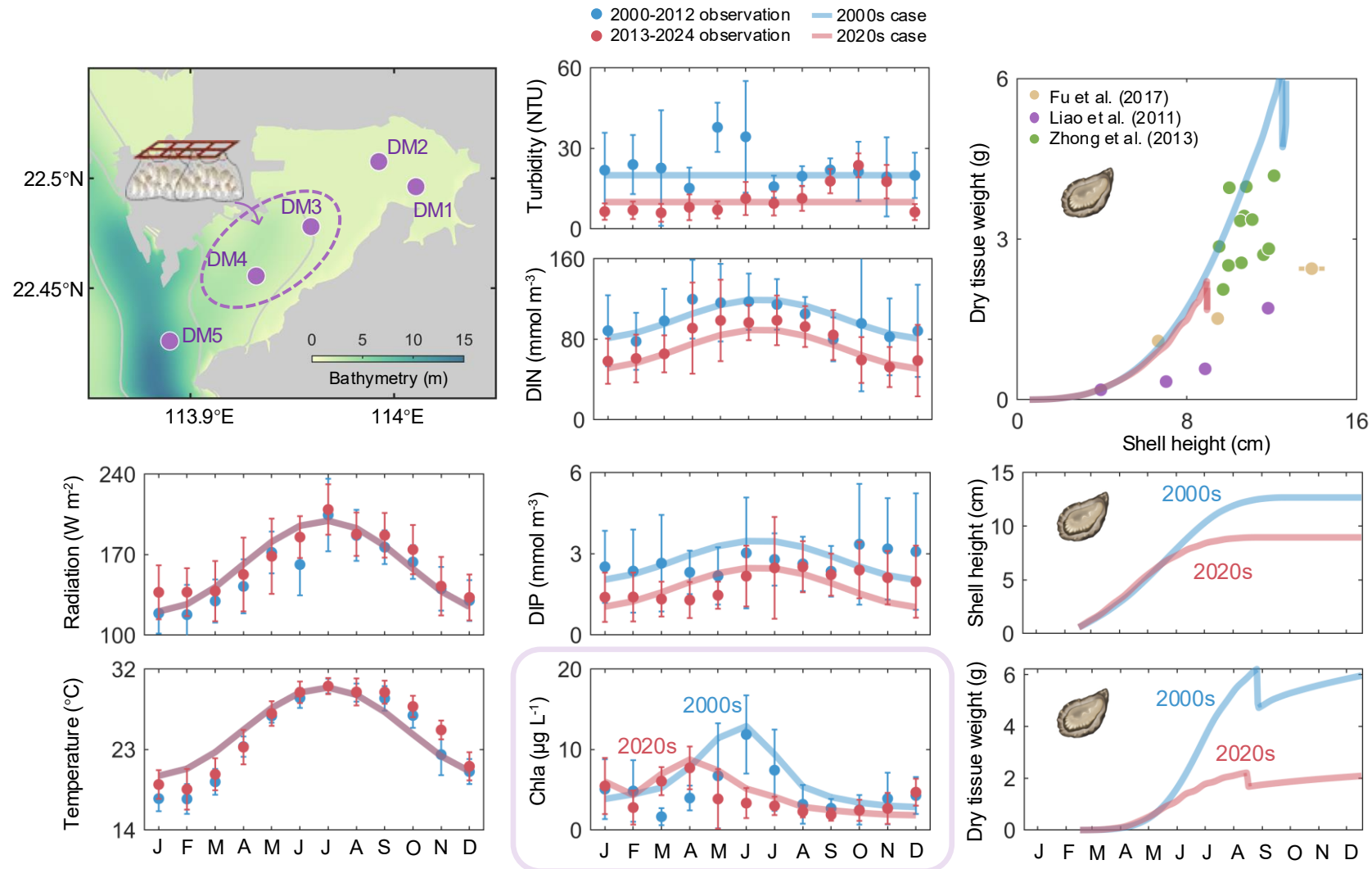
Oyster **Dynamic Energy Budget** (DEB) model



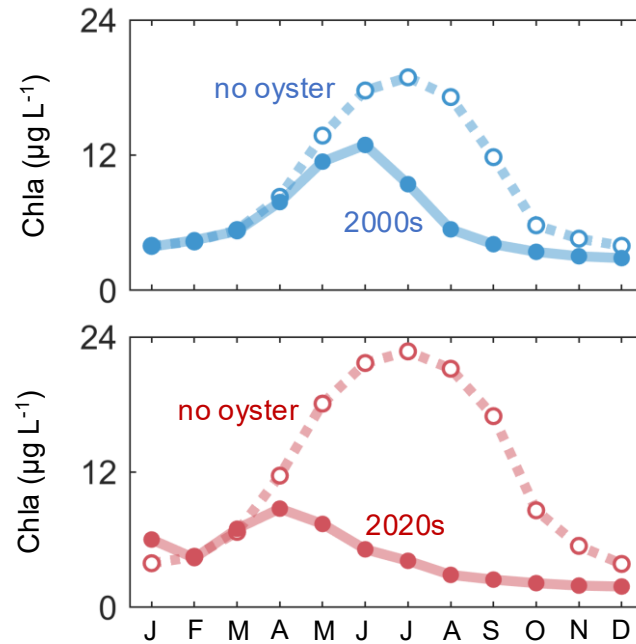
Model validation: reproducing Chla and oyster growth



Model validation: reproducing Chla and oyster growth



Isolating the driver: oyster farming impact

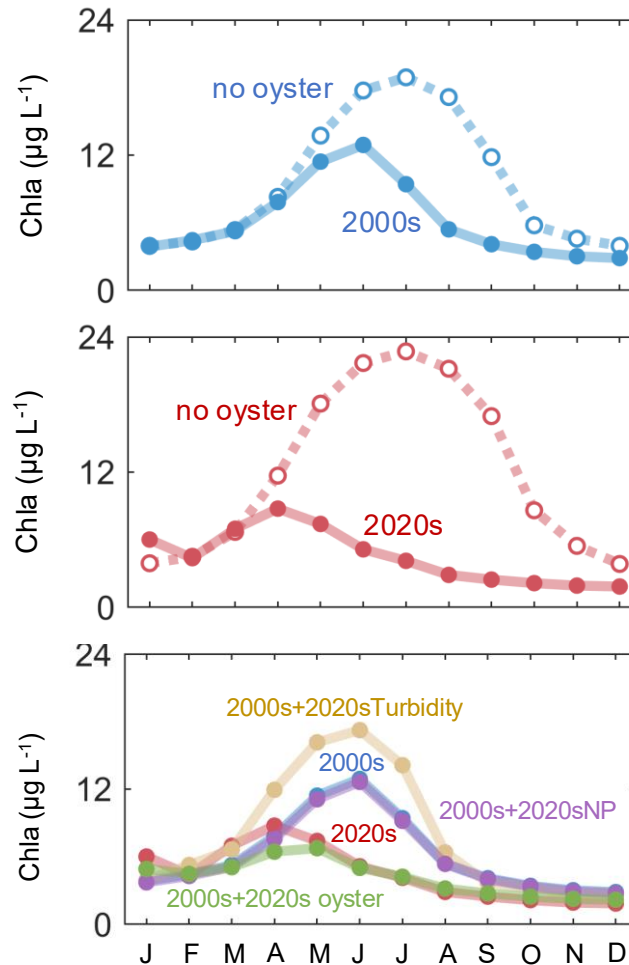


No oyster farming → Summer peak persists (even larger in 2020s)

Isolating the driver: **oyster** vs. **light** vs. **nutrient** impact

Future directions

- ✓ Include C cycle & carbonate chemistry
- ✓ Quantify how oyster farming affects carbonate chemistry
- ✓ Assess how environmental change (declining pH) affects oyster growth



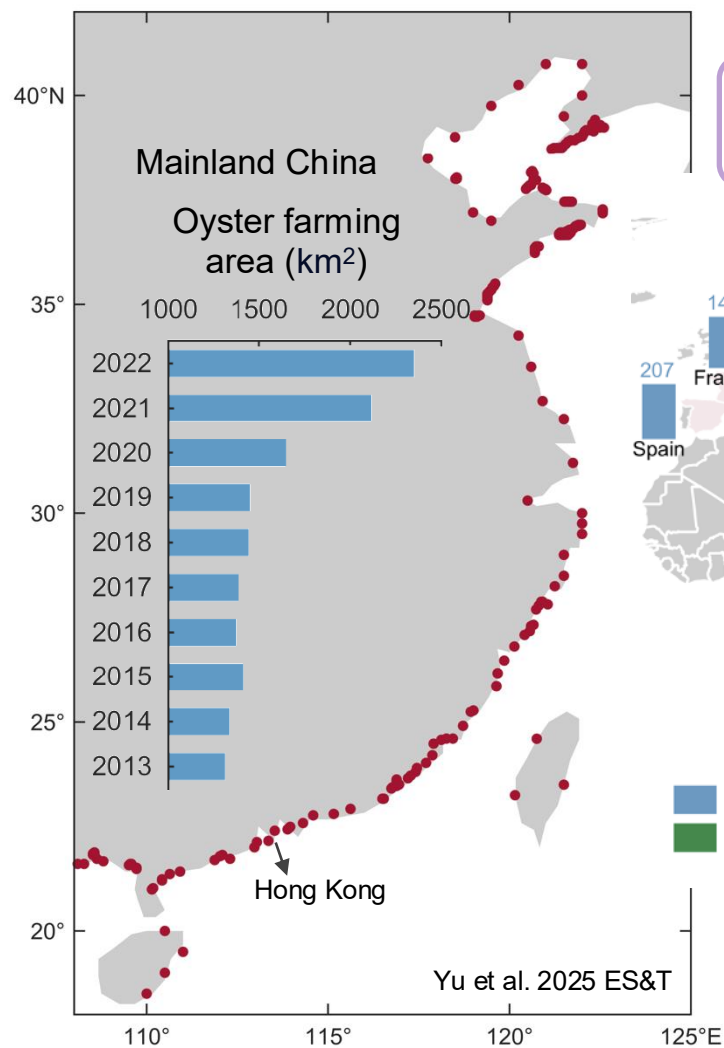
- ✓ The historic summer peak has crashed due to intensified oyster filter-feeding
- ✓ Oyster farming overrides bottom-up control of phytoplankton phenology in Deep Bay

2000s baseline with one forcing replaced by 2020s value

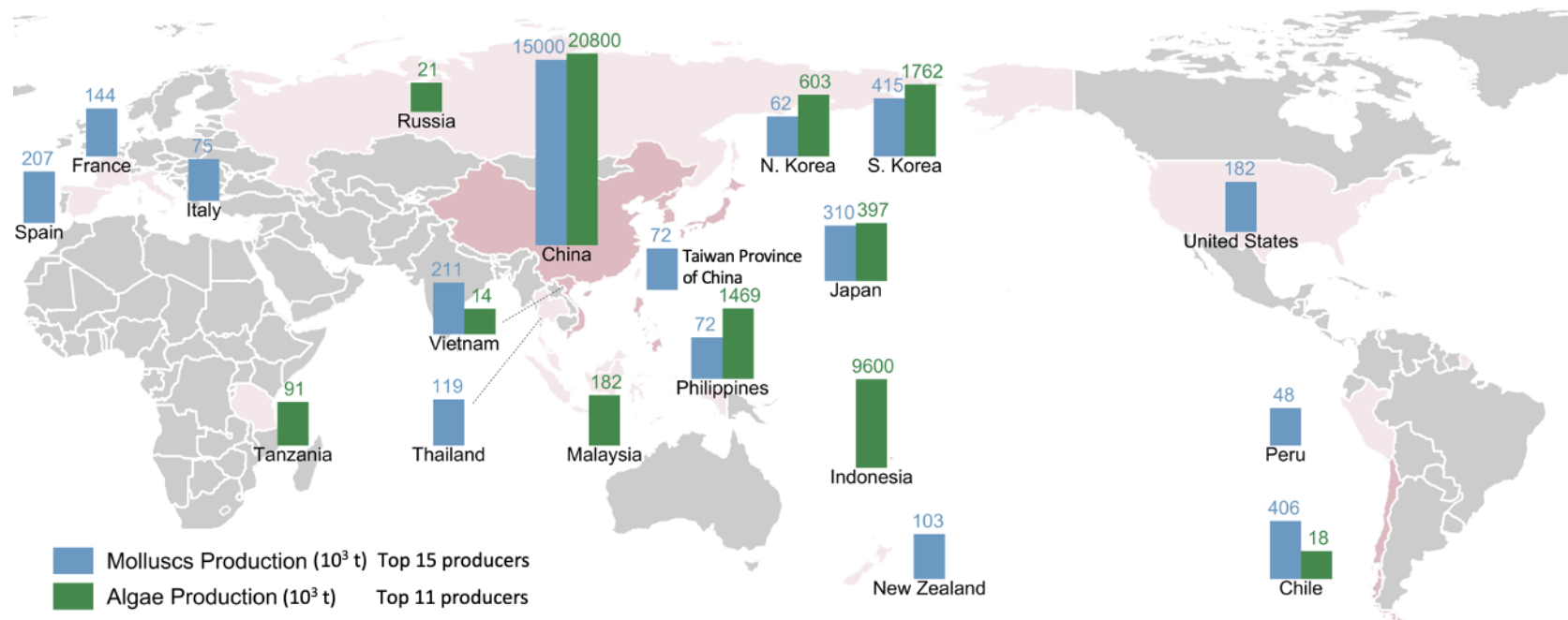
- ✓ 2000s+2020sTurbidity → improved light
- ✓ 2000s+2020sNP → lower DIN & DIP
- ✓ 2000s+2020s oyster → more oysters

Water Supplies Department

- control algal blooms in Hong Kong's drinking water reservoirs?



Increasing global seafood demand + Immense potential for expansion



→ Mitigate eutrophication via non-fed aquaculture

Thank you!