Study of the regional earth system (RES) for sustainable development under climate change in the Greater Bay Area (GBA)

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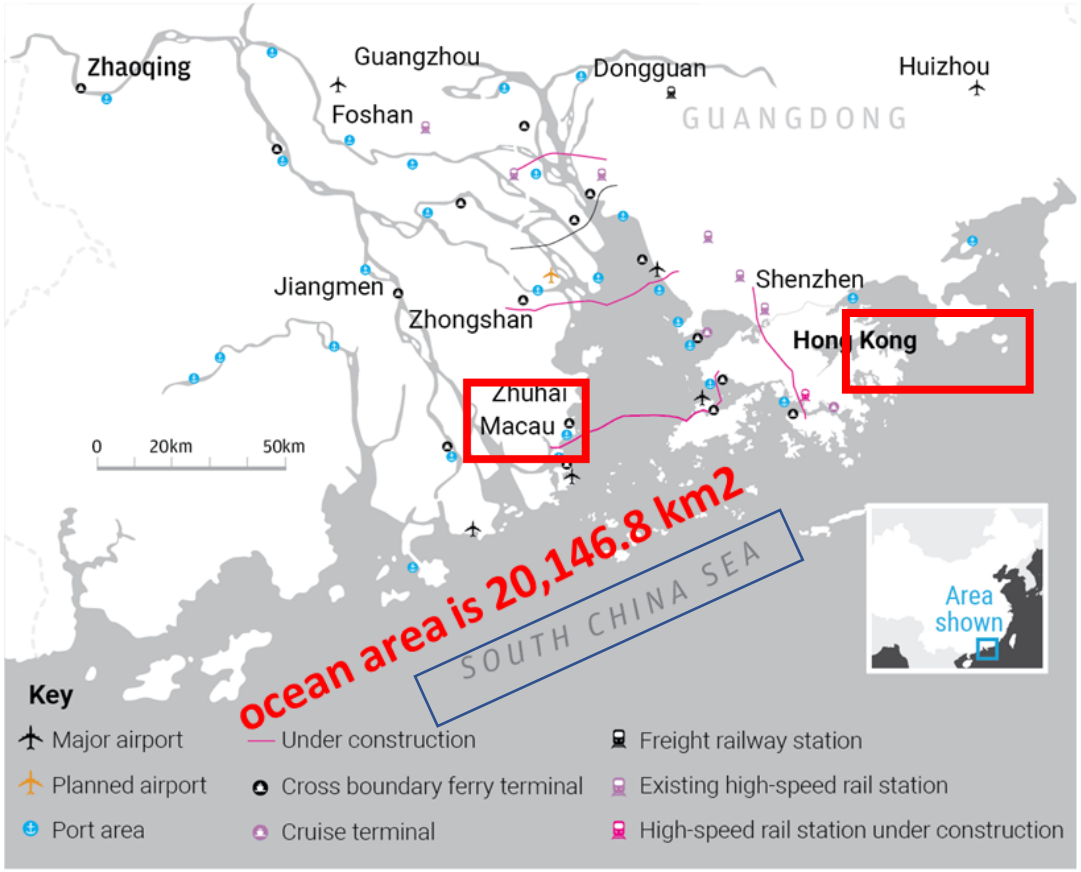
卓越學科領域計劃
Areas of Excellence Scheme

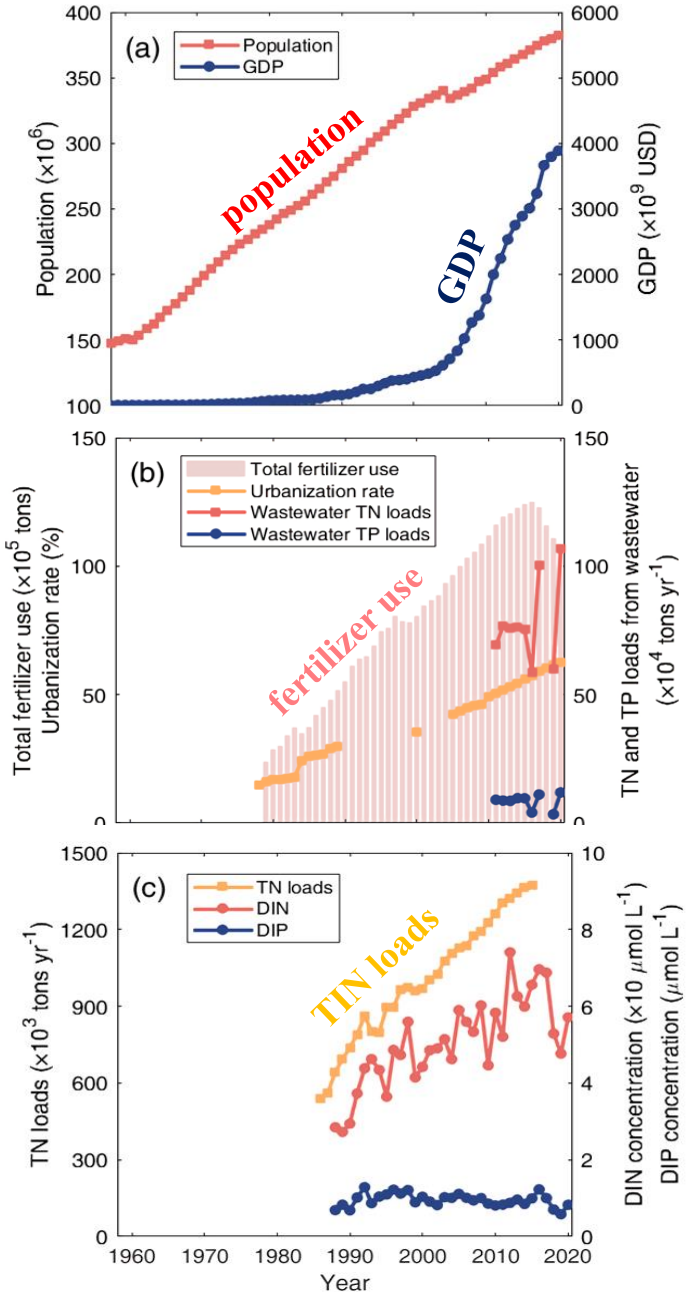
海洋科學系
DEPARTMENT OF OCEAN SCIENCE

Pearl River Delta and Greater Bay Ocean

56,000 km² Pearl River Basin ,
population of 80 million

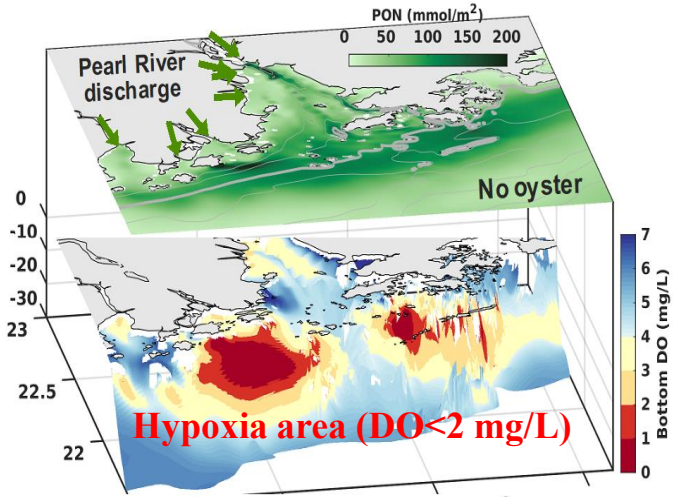


All environmental challenges GBA is facing occur inside RES and are governed by the RES dynamics



Challenges (examples)

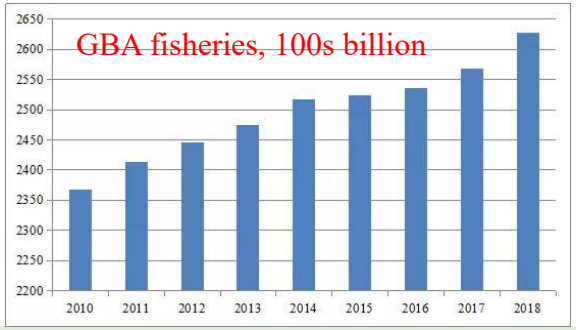
Worst GBA water quality in China coastal water



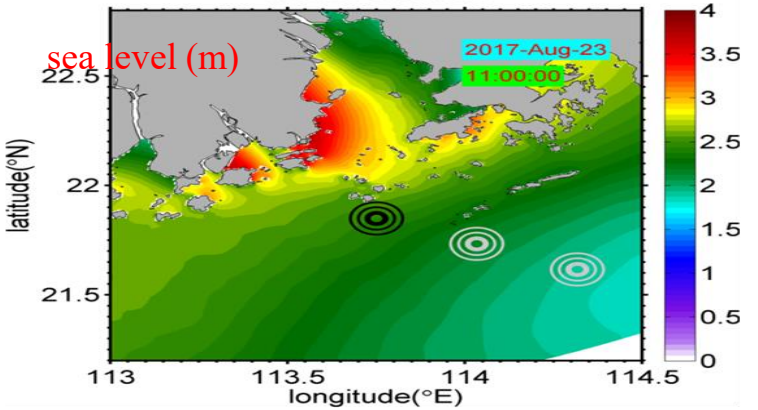
Expanding eutrophication and hypoxia area

Wetland degradation

Sustainability of fisheries



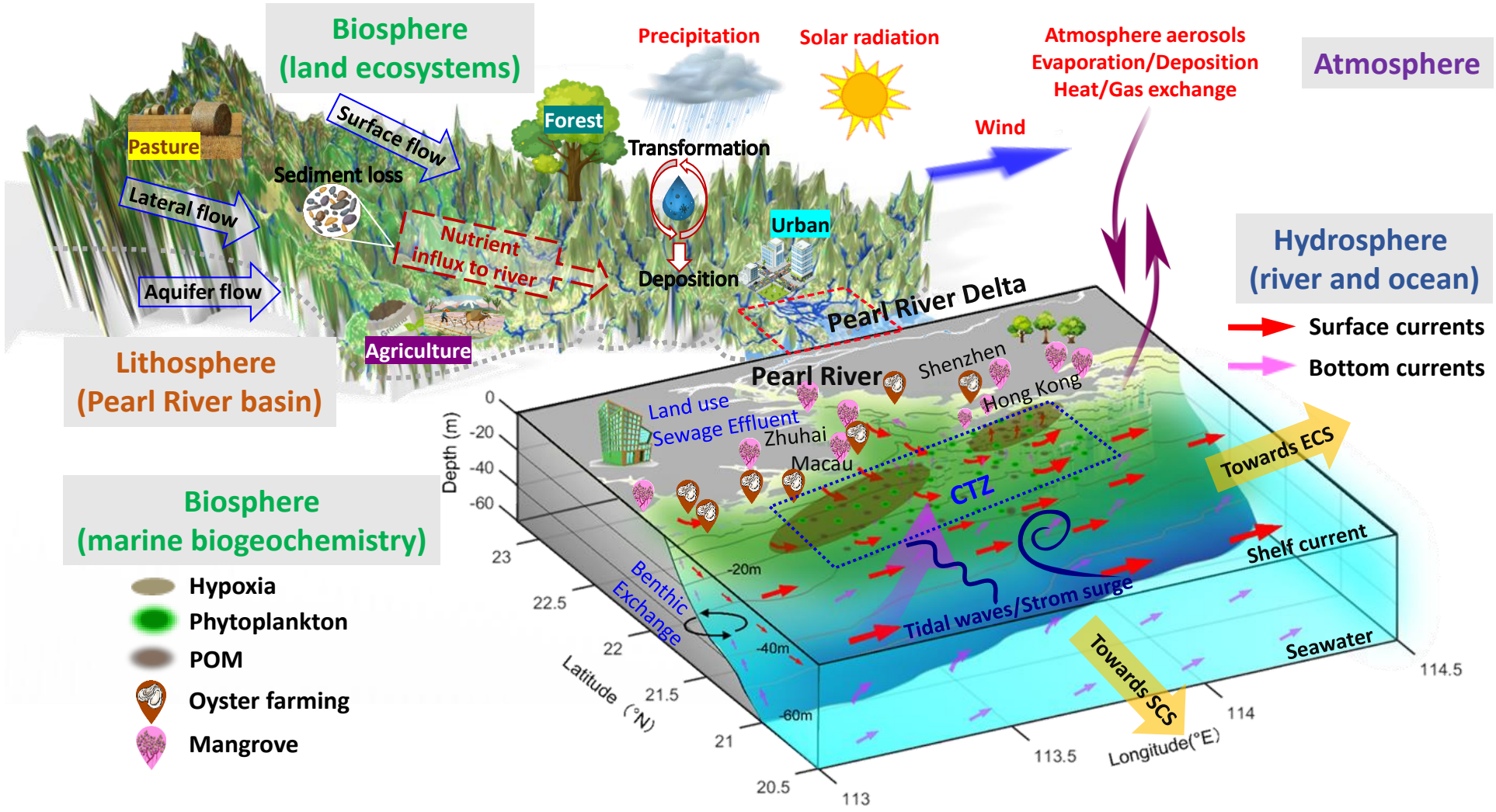
Nature hazard: typhoon induced storm surge



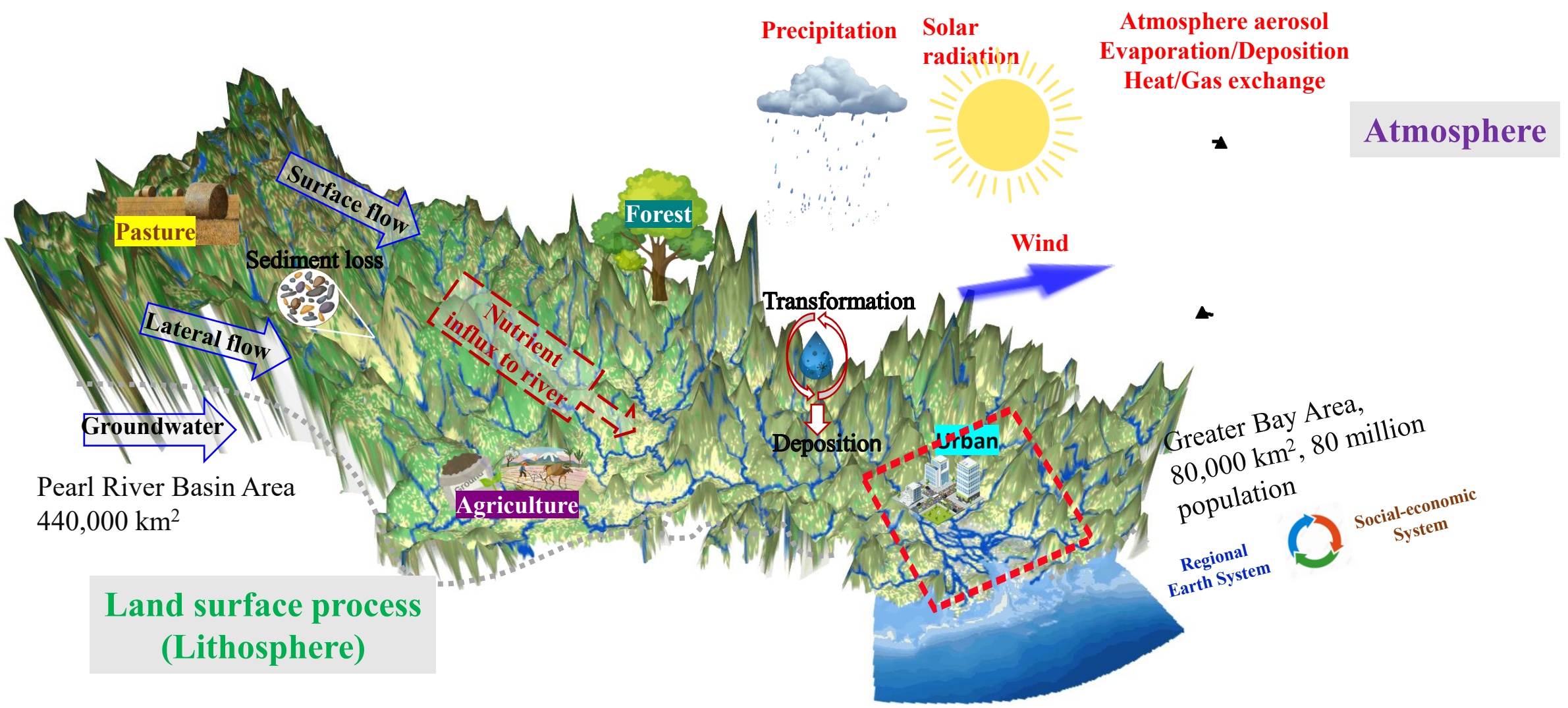
EARTH-HK
Ocean-Land-Atmosphere

Land-Ocean-Atmosphere in the Greater Bay Area

USD11 million



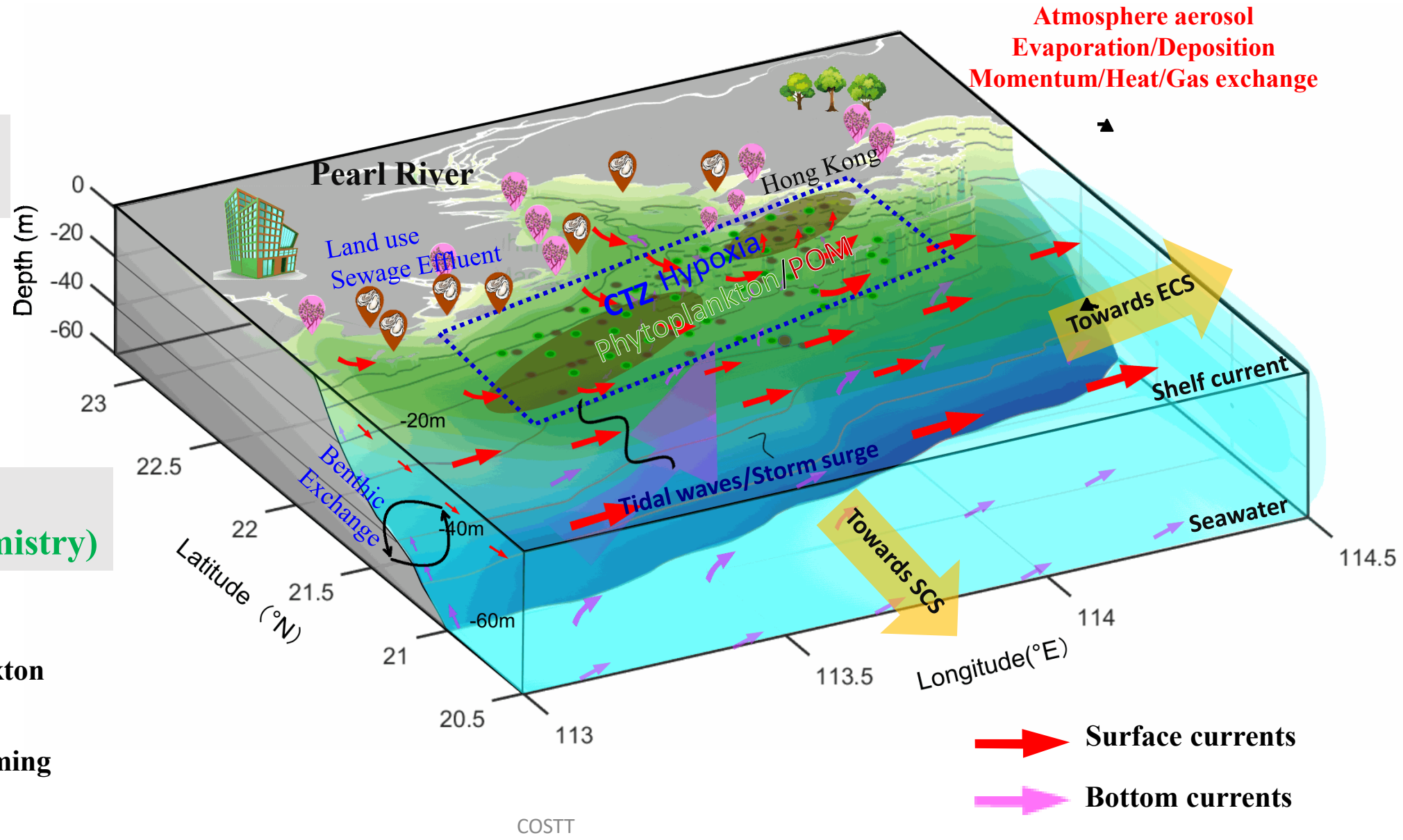
Regional Earth System consists of Pearl River basin, coastal ocean, atmosphere and human dimension



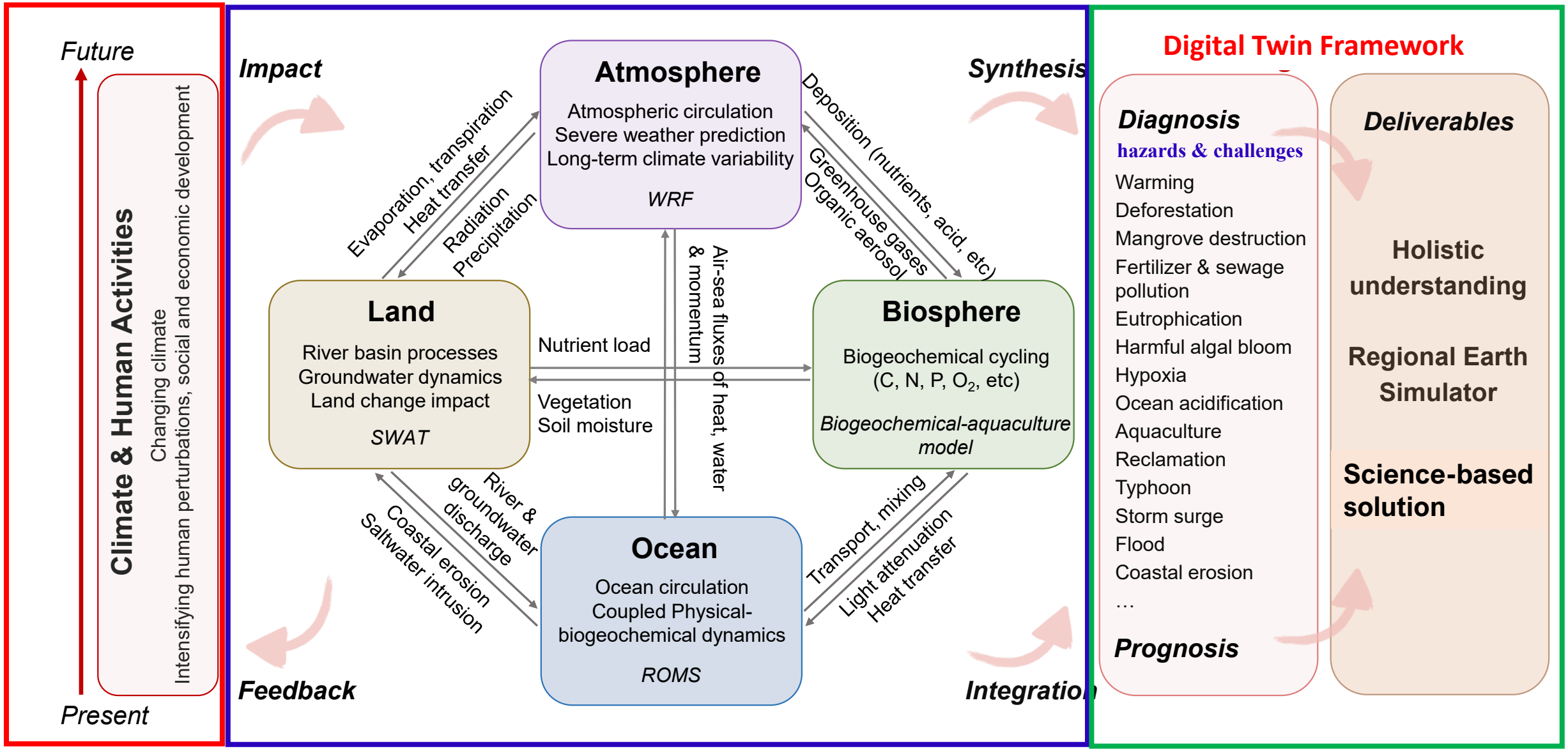
Regional Earth System consists of Pearl River basin, coastal ocean, atmosphere and human dimension

Hydrosphere (river and ocean)

Biosphere (marine biogeochemistry)

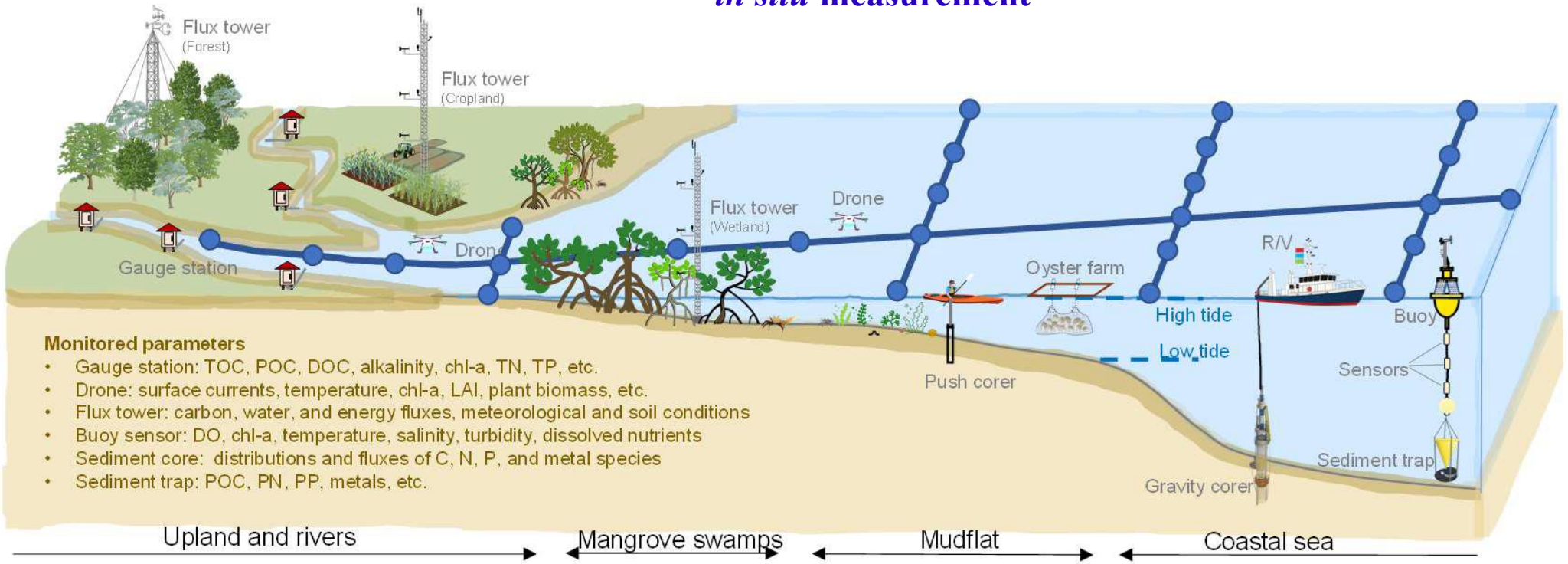


Solution to the challenges: Regional Earth System Study

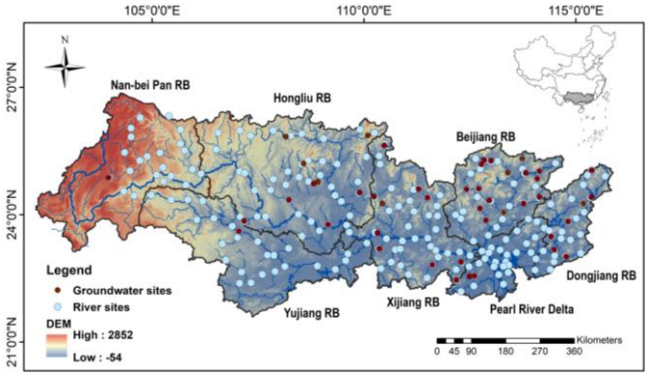


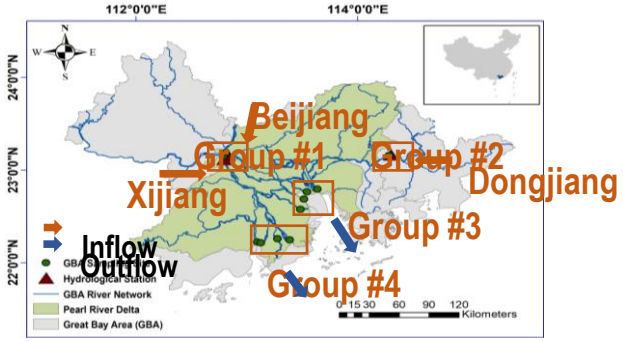
Research approach: Interdisciplinary *in situ* measurement

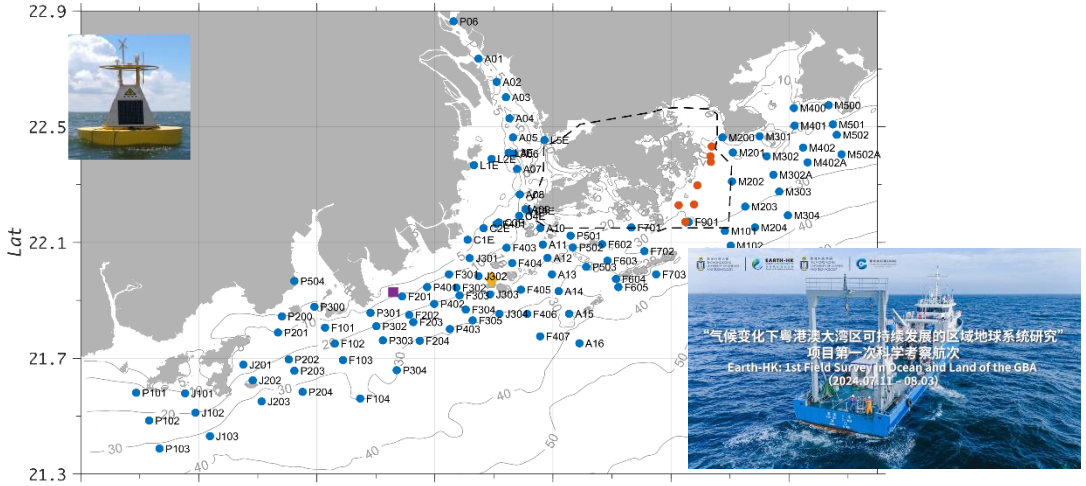
in situ measurement



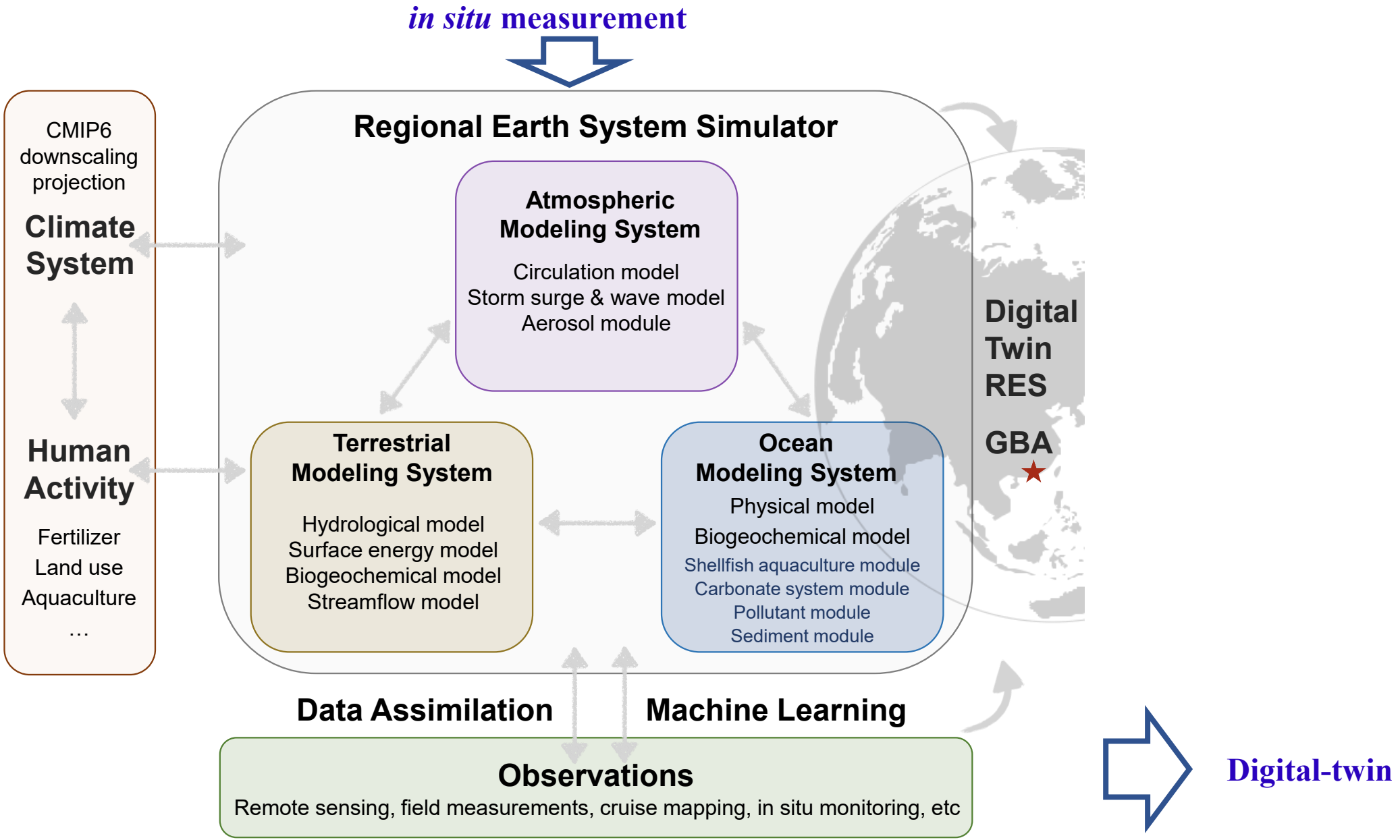
Earth System Simulator



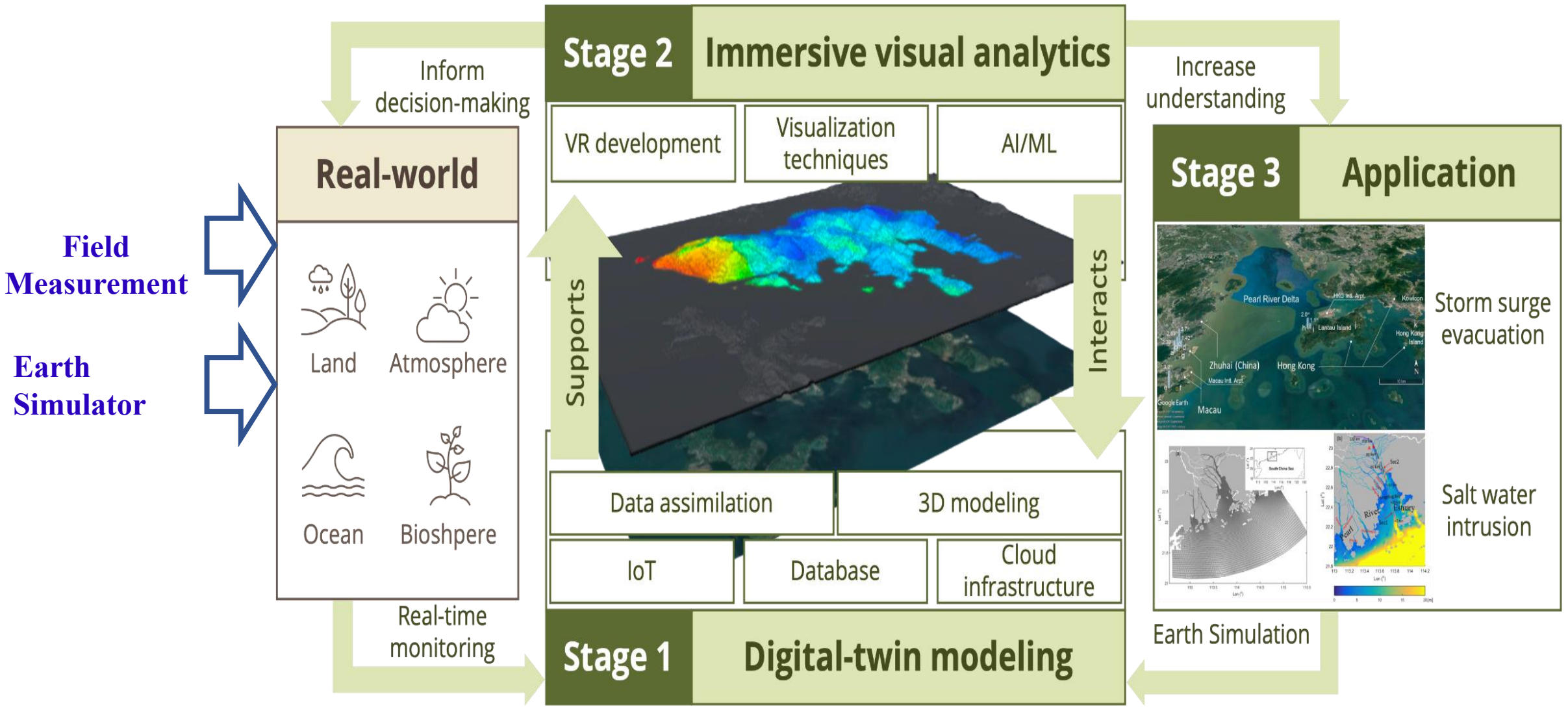


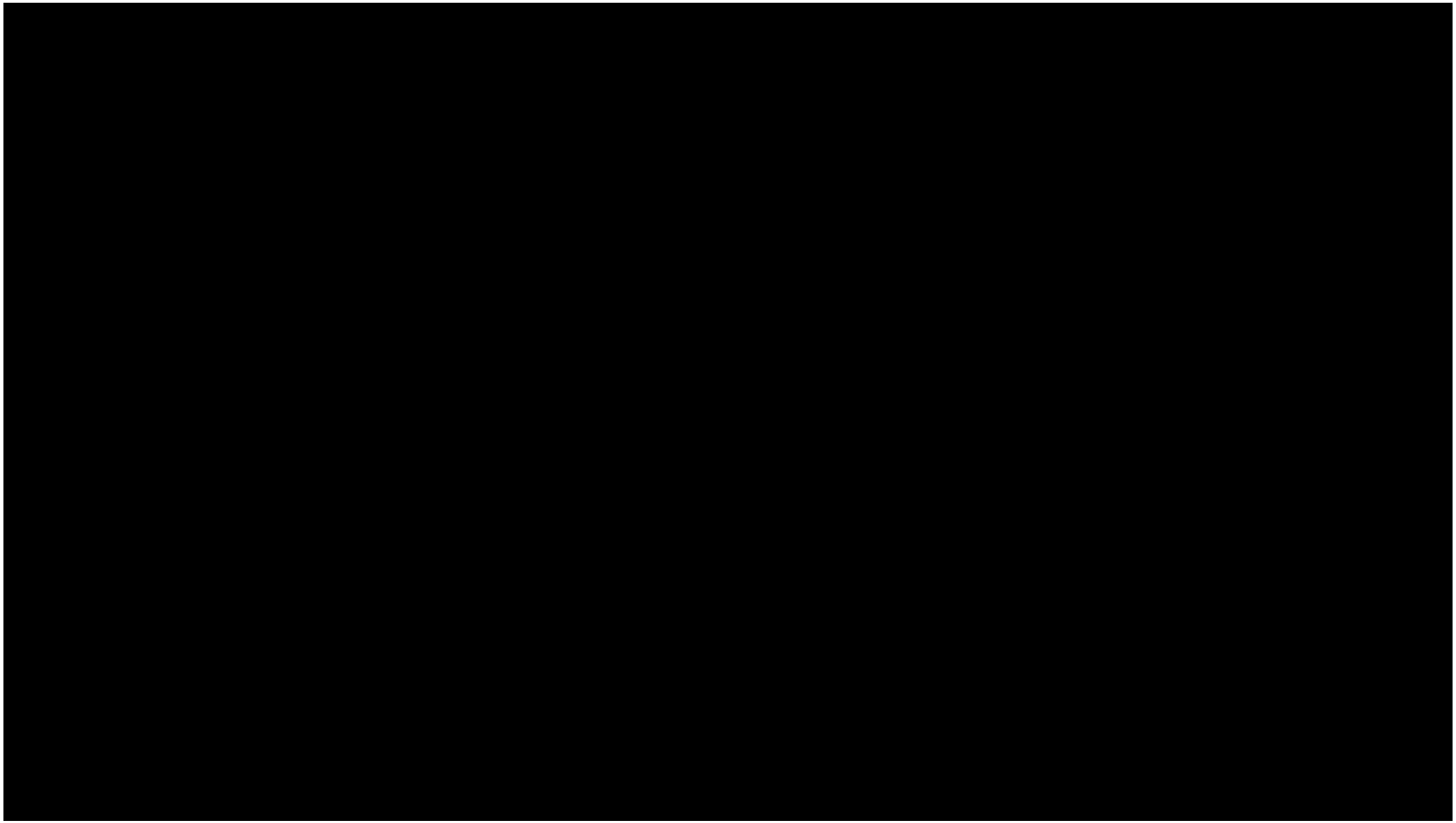


Research approach: RES simulator



Research approach: digital-twin framework

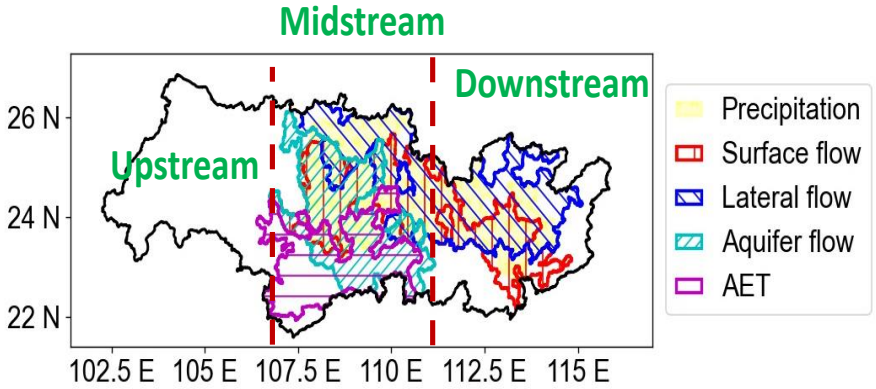


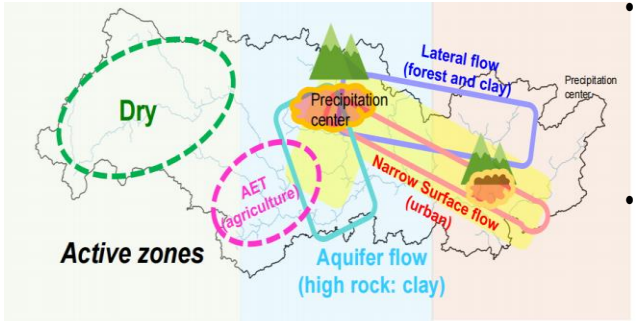


Research Highlight 1: Characteristics and trends of hydrology and nutrient flux in the Pearl River Basin

Hydrology, future trend and its controls over the PRB

Active zones of water fluxes

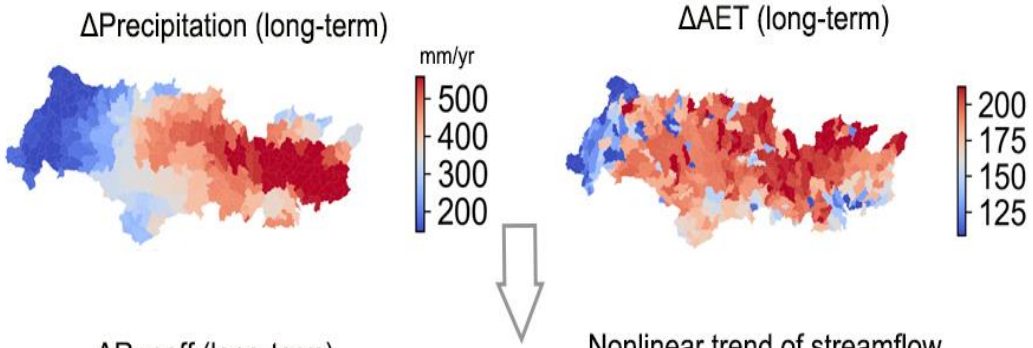


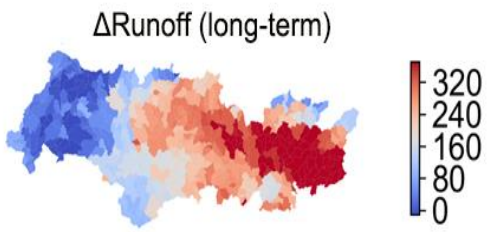


- Shaped by precipitation, which is influenced by the monsoon climate and terrain topography.
- Land use and soil texture regulate the locations of the active zones of water fluxes.

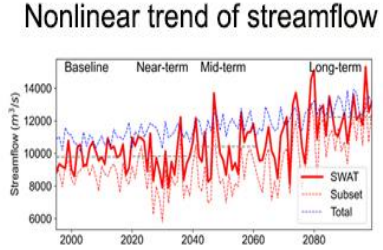
Controls of land surface processes and atmospheric impacts

Combined effects of enhanced/weakened EASM/SASM and land surface processes





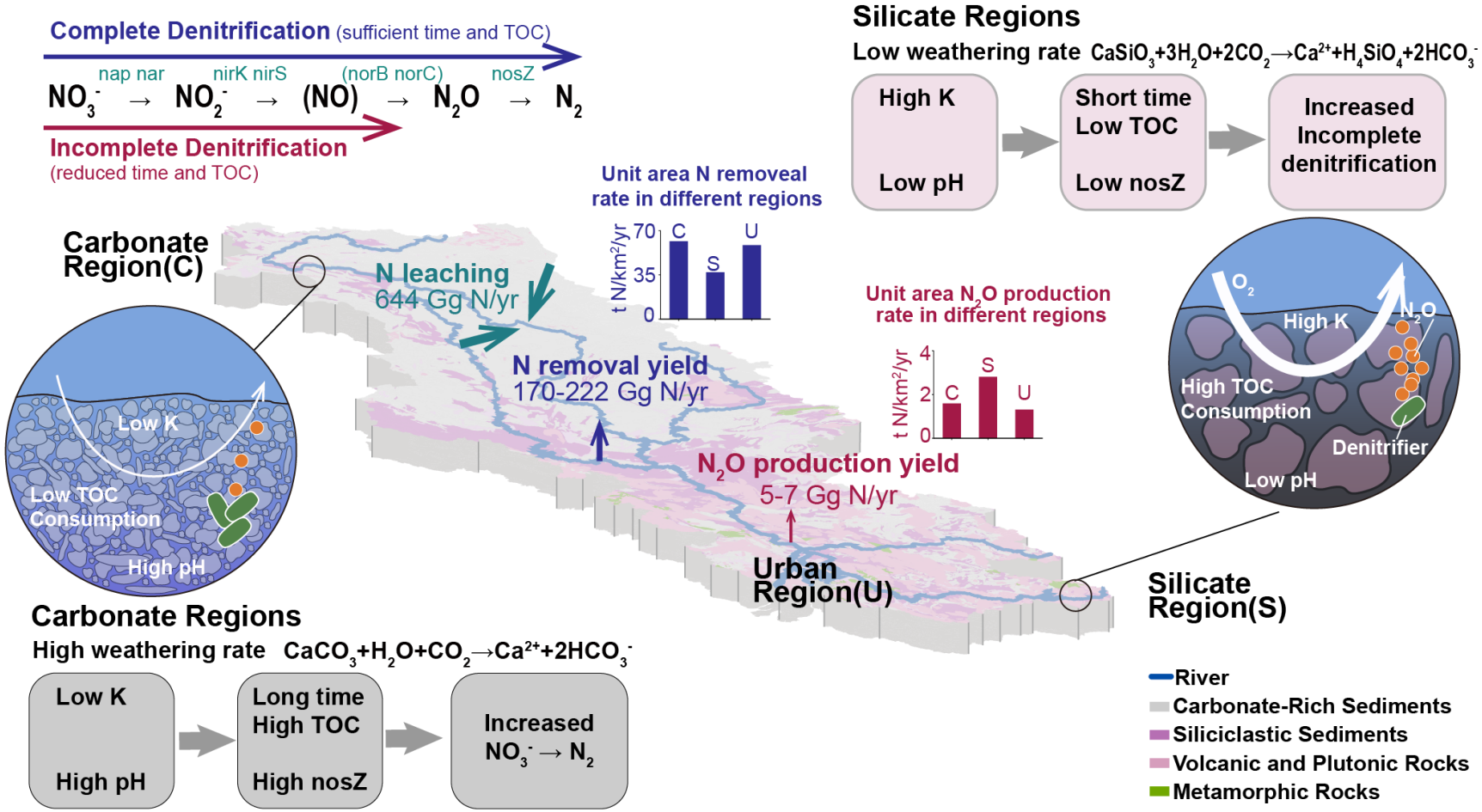
More significant increases in the eastern basin than in the west



A slight near-term reduction and a significant long-term increase

(Zhang and Gan, 2024, 2025)

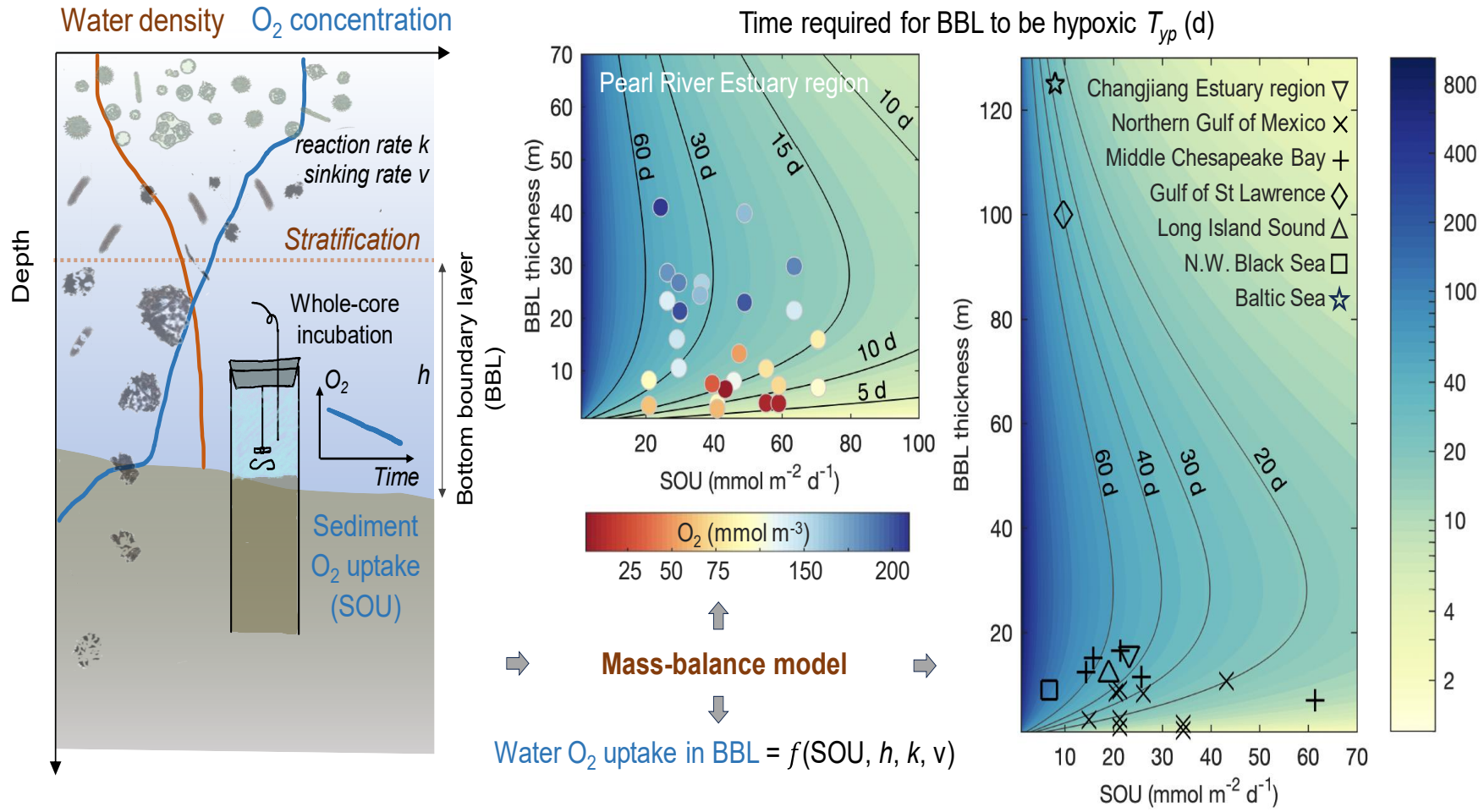
Research Highlight 2: Geological influences on N assimilation



N removal and N_2O production

NG, 2025

Research Highlight 3: Sediment oxygen uptake and hypoxia in the Pearl River Estuary and surrounding coastal region



Water research Sun et al., 2024

Research Highlight 4: Human, society and climate

nature climate change

Article

https://doi.org/10.1038/s41558-024-02193-x

Different technology packages for aluminium smelters worldwide to deliver the 1.5 °C target

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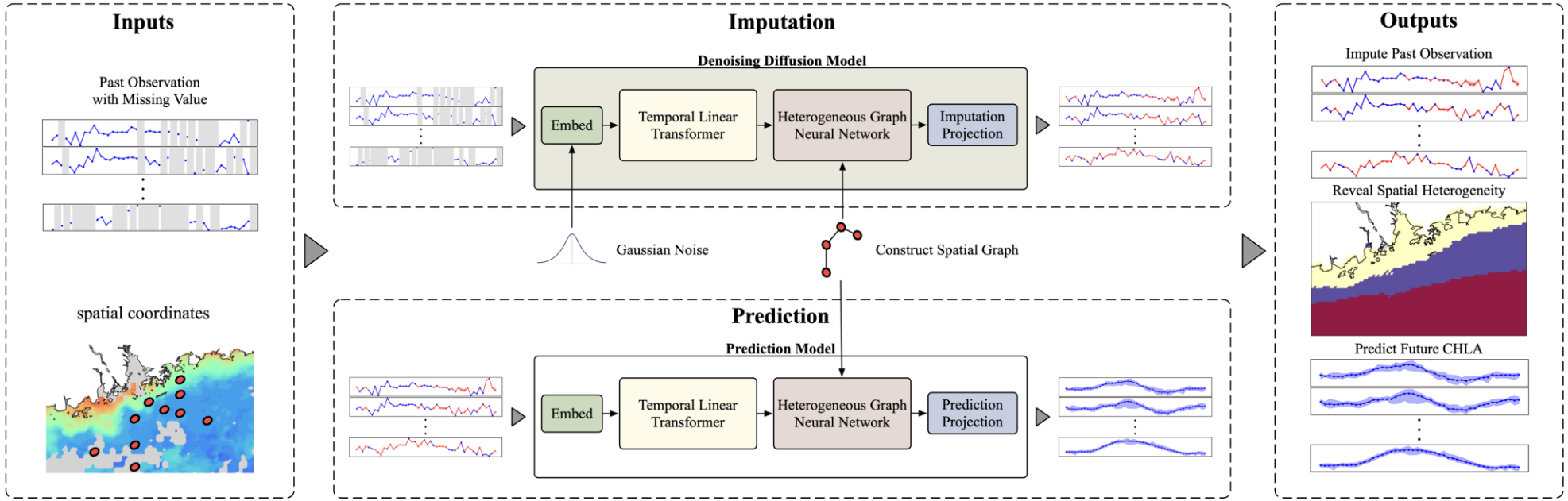
Chang Tan[1], Xiang Yu[2,3] ✉, Dan Li[4], Tianyang Lei[5], Qi Hao[1] & Dabo Guan[1,5] ✉

1. Tan, Chang, et al. "Different technology packages for aluminium smelters worldwide to deliver the 1.5° C target." ***Nature Climate Change*** (2025): 1-8.

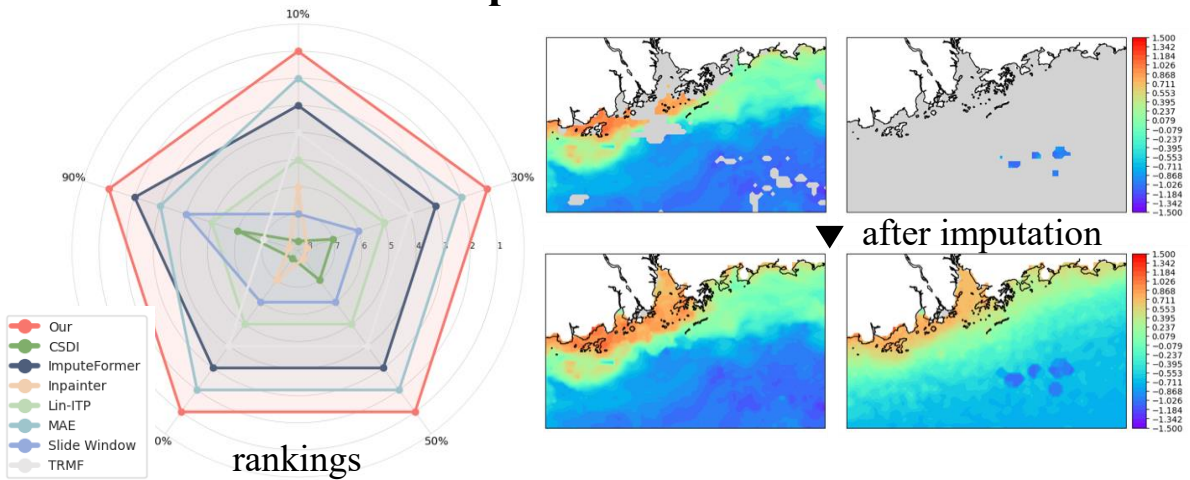
2. Lei, Tianyang et al. "A global inventory of methane emissions from abandoned oil and gas wells and possible mitigation pathways." ***National Science Review***, 2025 forthcoming

Research Highlight 4: AI-spatiotemporal imputation to predict chlorophyll-a concentration in coastal oceans

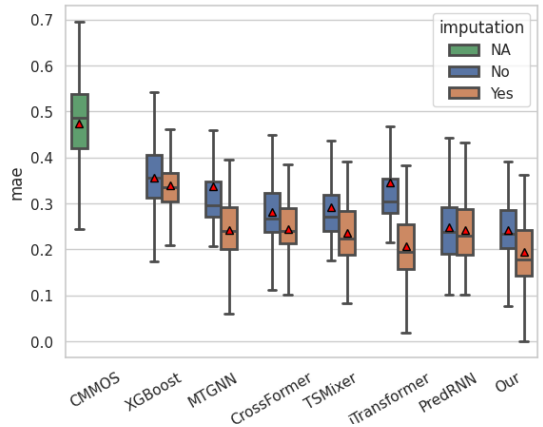


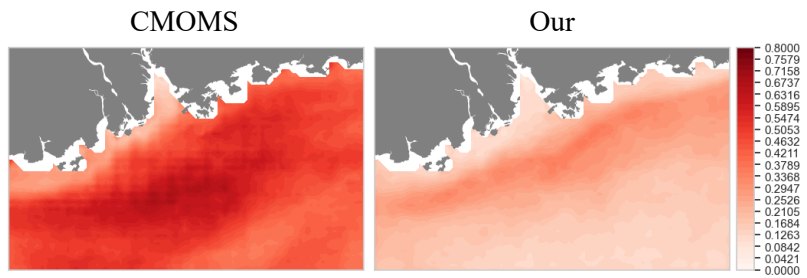
Methodology

Imputation



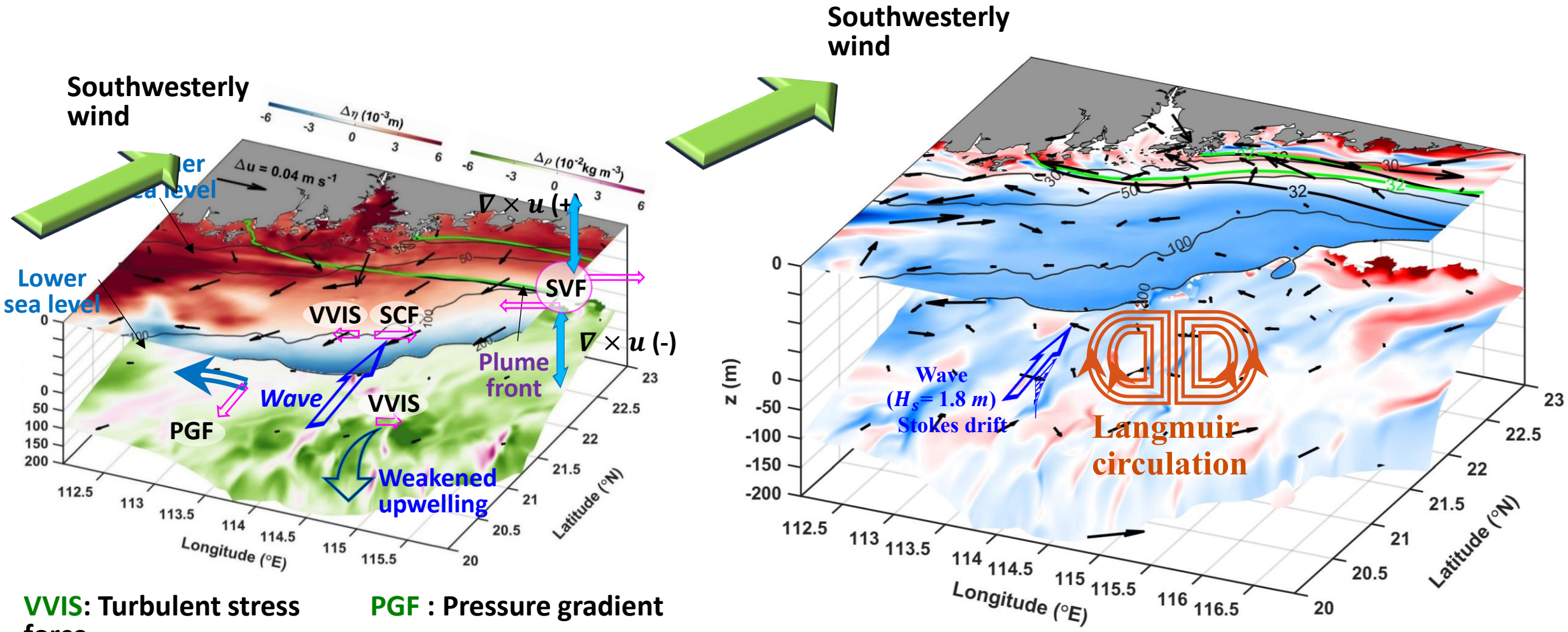
Prediction (Mean Average Error)





With NC, 2025

Research Highlight 5: Wave and Langmuir turbulence effects on upwelling



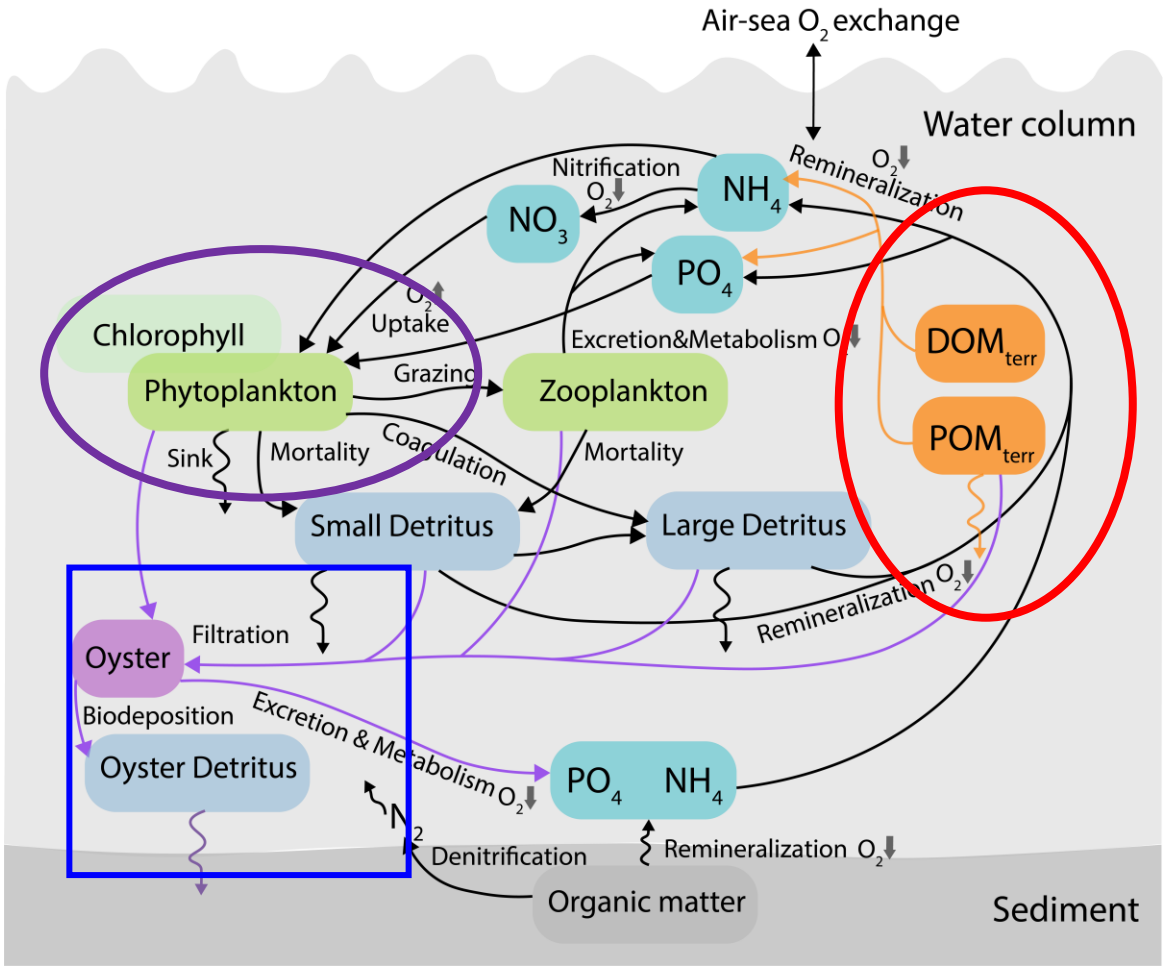
VVIS: Turbulent stress force **PGF** : Pressure gradient force

SCF : Stokes Coriolis force **SVF** : Stokes vortex force

Lin and Gan, JPO, 2025

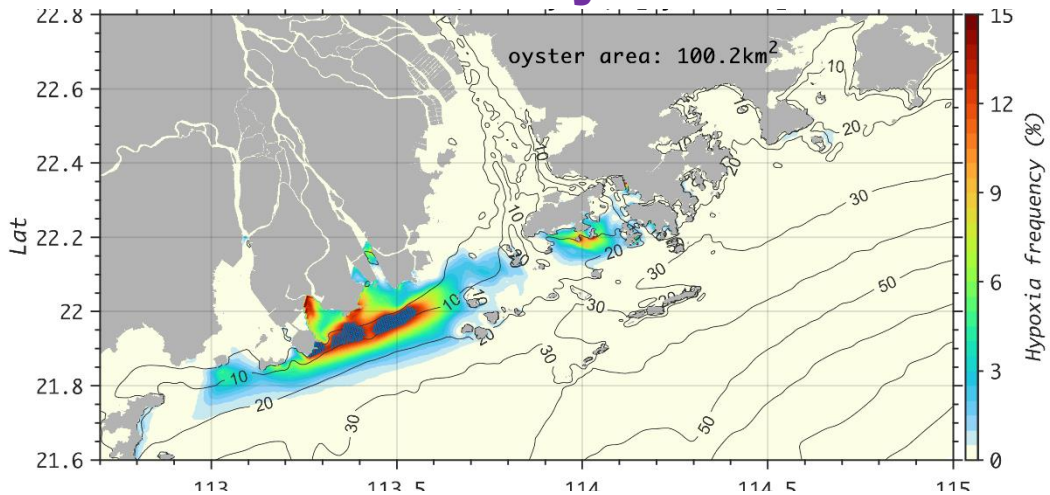
Research Highlight 6: Long-term diagnose and prognose of hypoxia

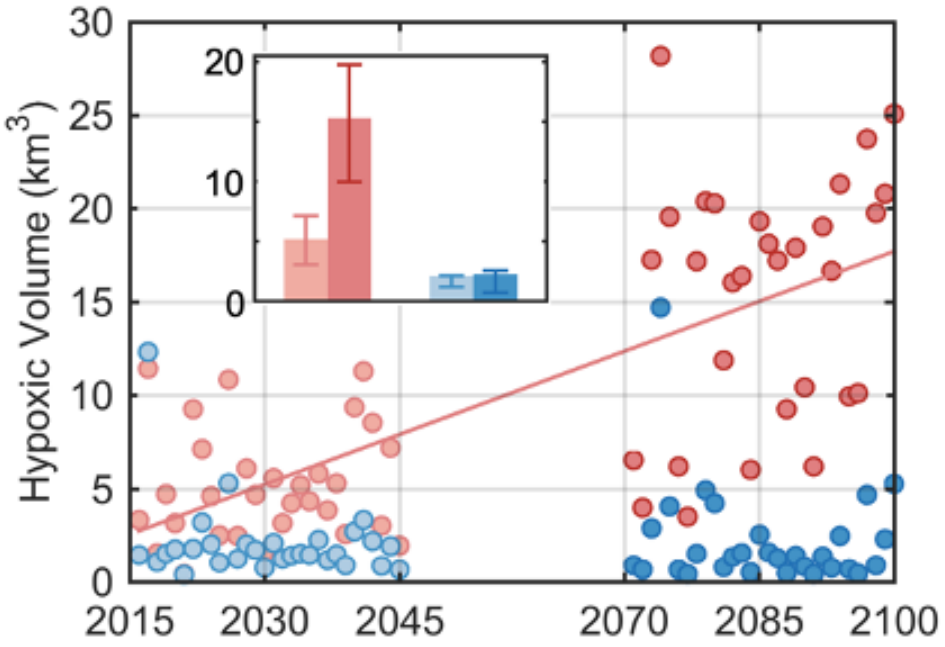
Biogeochemical cycles with terrestrial OM and aquaculture (oyster)



L & O, 2025

Last 30-year

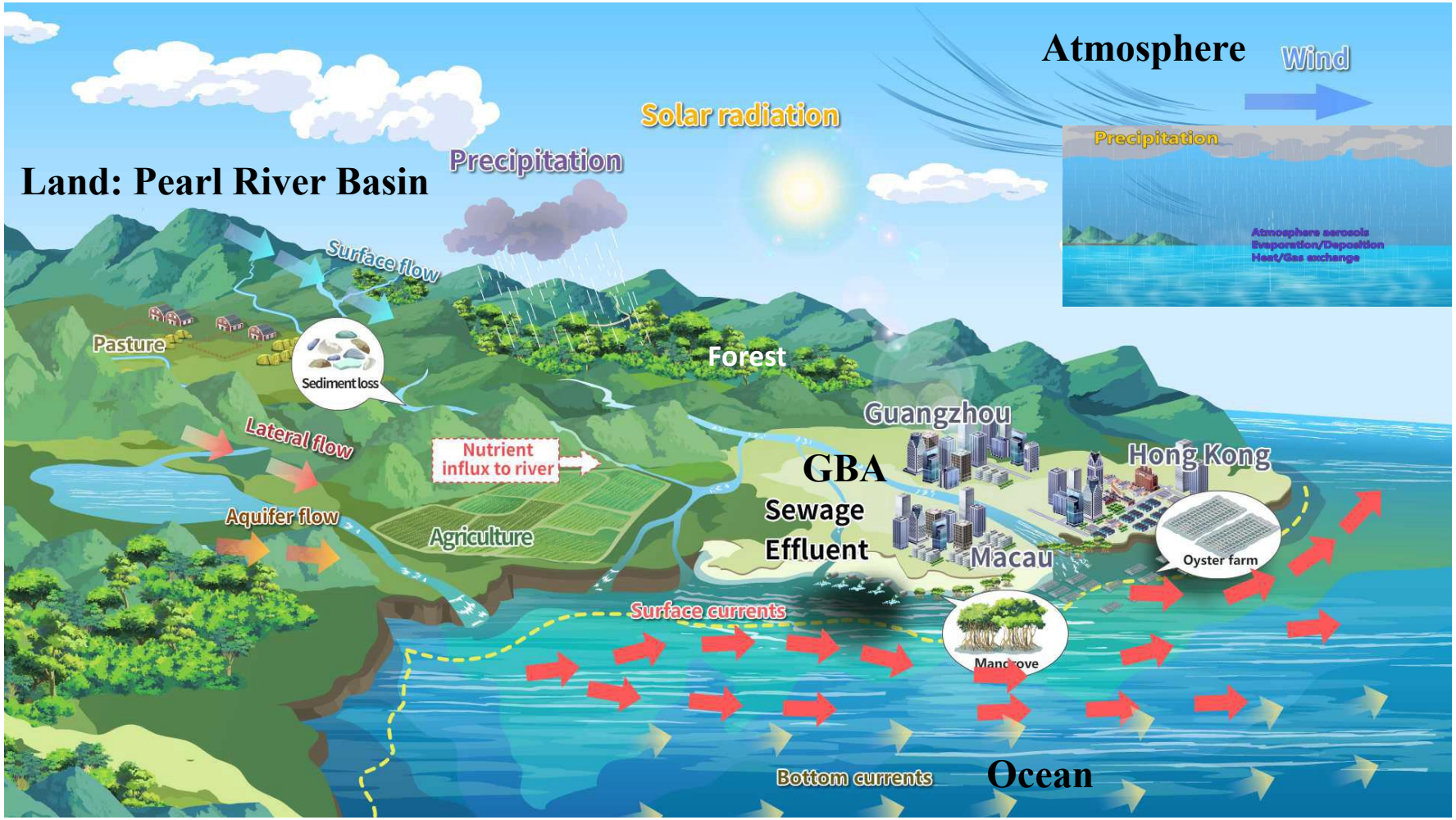




Short-term Future

Long-term Future

Innovative Earth System study for sustainable development in the GBA



Regional Earth System ⇄ **Social-economic System**