Yale 耶鲁大学–南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

Lake Taihu eddy flux mesonet for atmospheric and hydrological research

Shoudong Liu[1], Wei Xiao[1], Chang Cao[1], Lichen Deng[1], Cheng Hu[1], Ning Hu[1], Hanchao Li[1], Cheng Liu[1], Jing Shen[1], Shiqiang Sun[1], Wei Wang[1], Qitao Xiao[1], Jiaping Xu[1], Dong Yang[1], Mi Zhang[1], Xuhui Lee[1,2*]

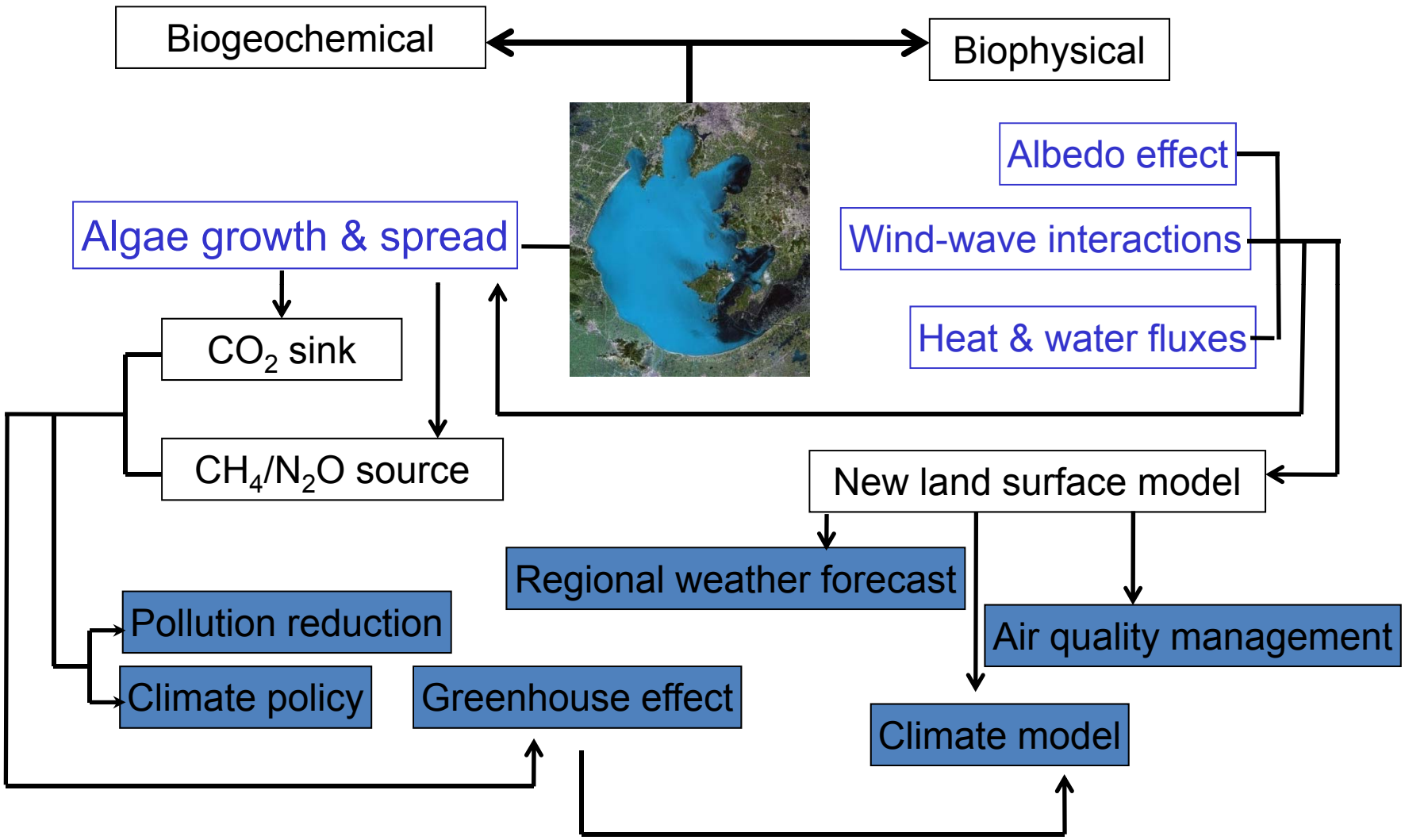
[1]Yale-NUIST Center on Atmospheric Environment, Nanjing University of Information Science & Technology, Nanjing, China
[2]School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut 06511, USA

EGU General Assembly 2013
Vienna, Austria, April 10, 2013

Background

- Lakes play a unique role in global and regional carbon and water cycles. Information on the lake-air exchanges of energy, water vapor and CO_2 are important to numerical weather models and climate change study.
- So far parameterizations of lakes in numerical weather models have been primarily based on oceanic observations and there have been only a few studies on lake-air fluxes of greenhouse gases.
- As a robust flux measurement method, eddy covariance is widely employed in studies on terrestrial ecosystems. However, long-term eddy covariance applications are still rare for lake systems.

Taihu 太湖 Eddy Flux Project

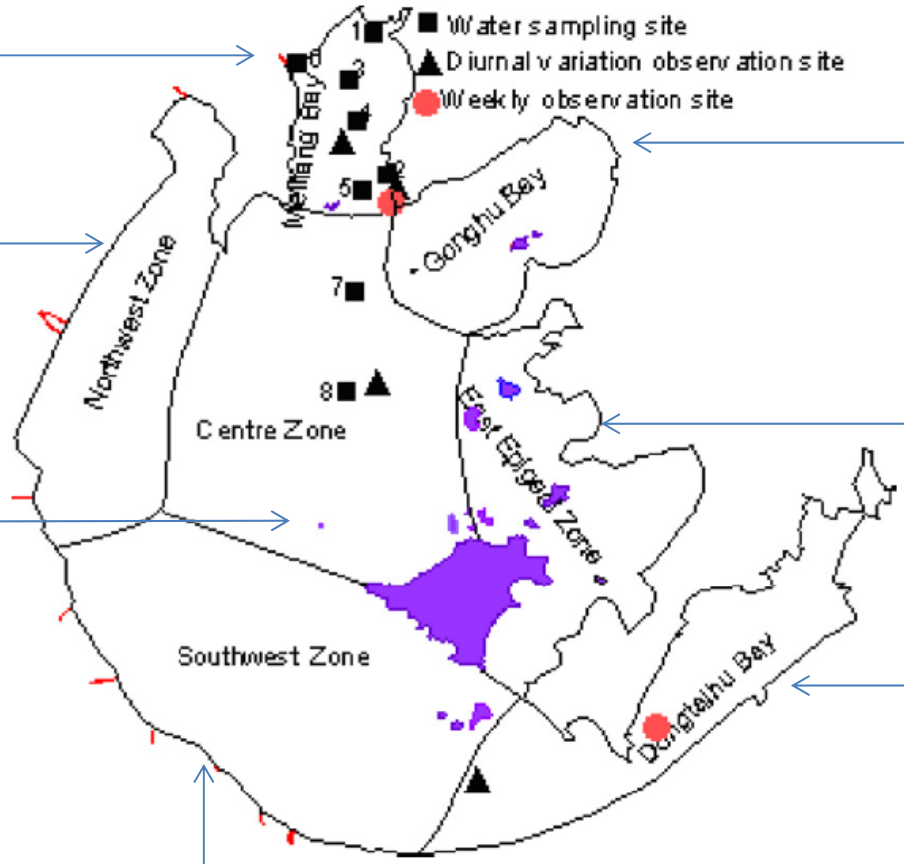


Ecological zones in Lake Taihu

Eutrophic area

Hyper-eutrophic area

Little photosynthetic activity



half of the area covered by macroplant vegetation

Submerged macrophytes

Macroplant and pen fish culture

Transition area between phytoplankton dominance and macroplant dominance

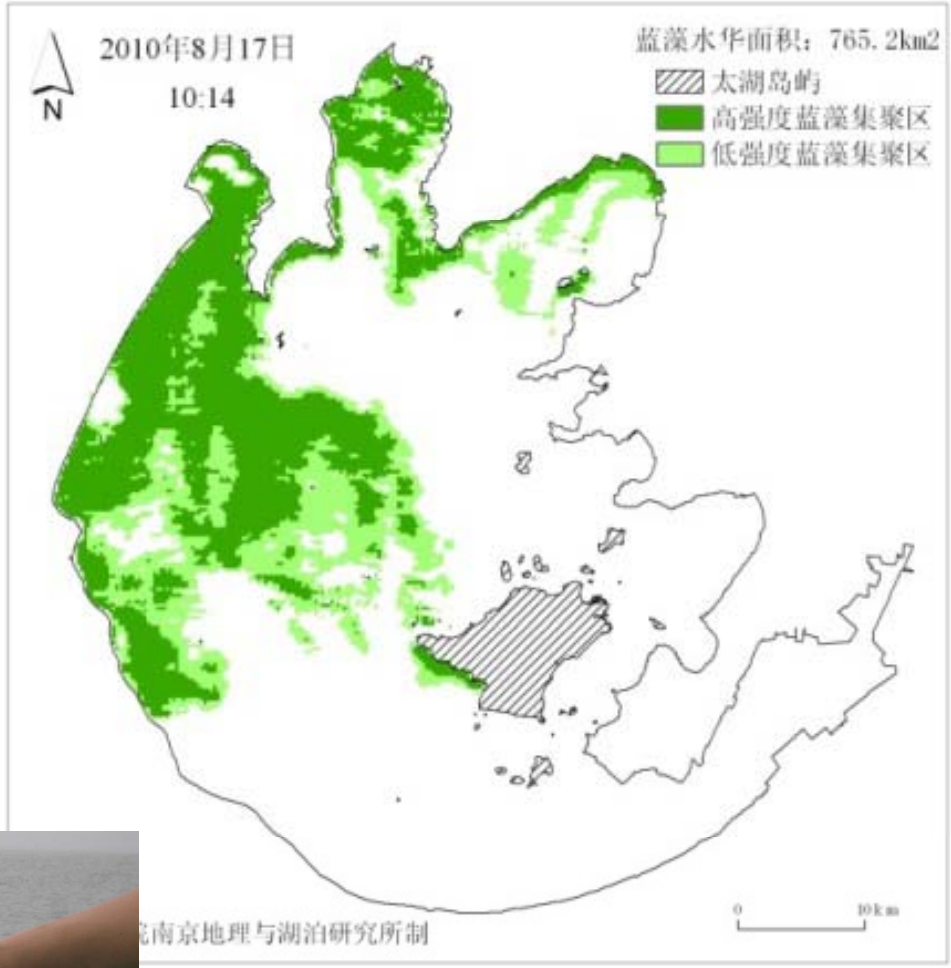
(Hu et al. 2011)

The subarea in Lake Taihu

Eutrophic area

Hyper-eutrophic area

Little photosynthetic activity



half of the area covered by macroplant vegetation

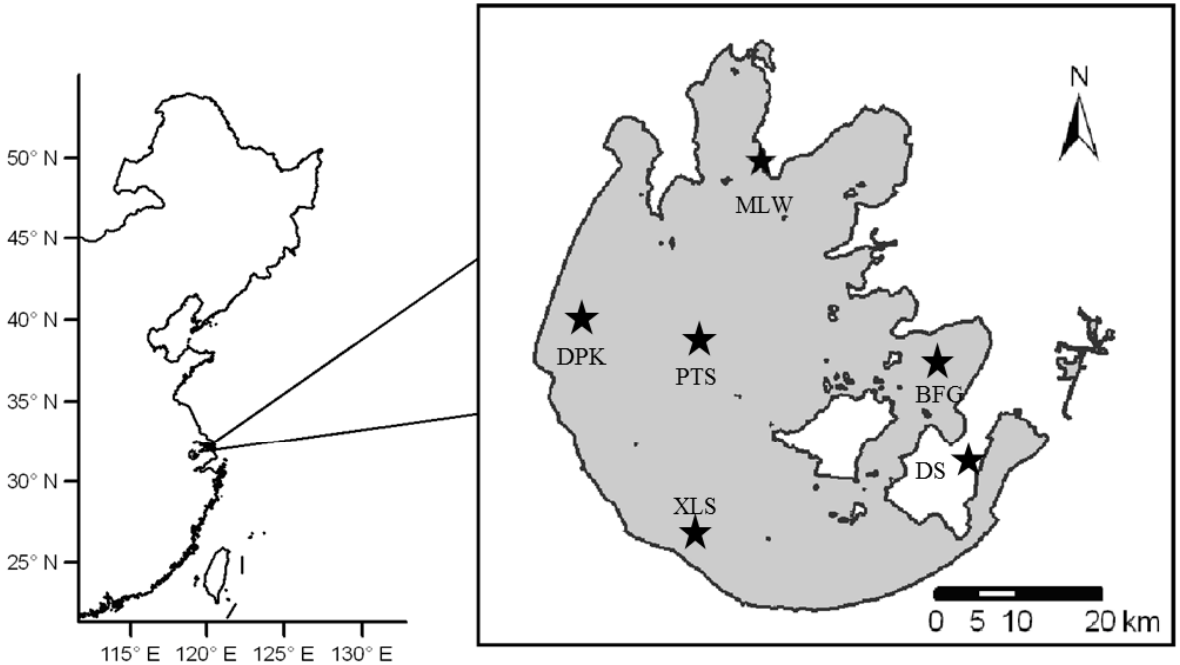
Submerged macrophytes

Macroplant and pen fish culture

n phytoplankton
plant dominance

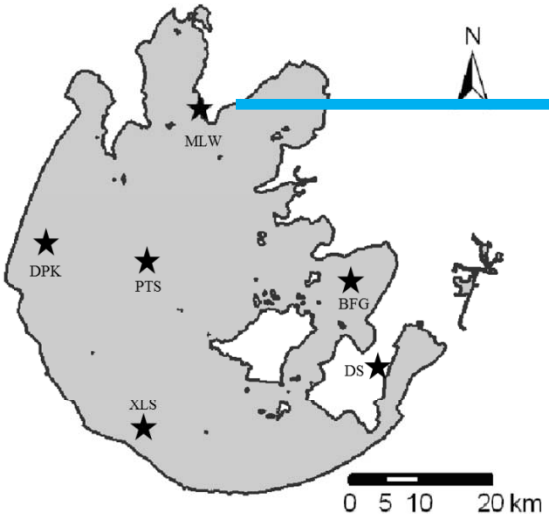
(Qin et al. 2010)

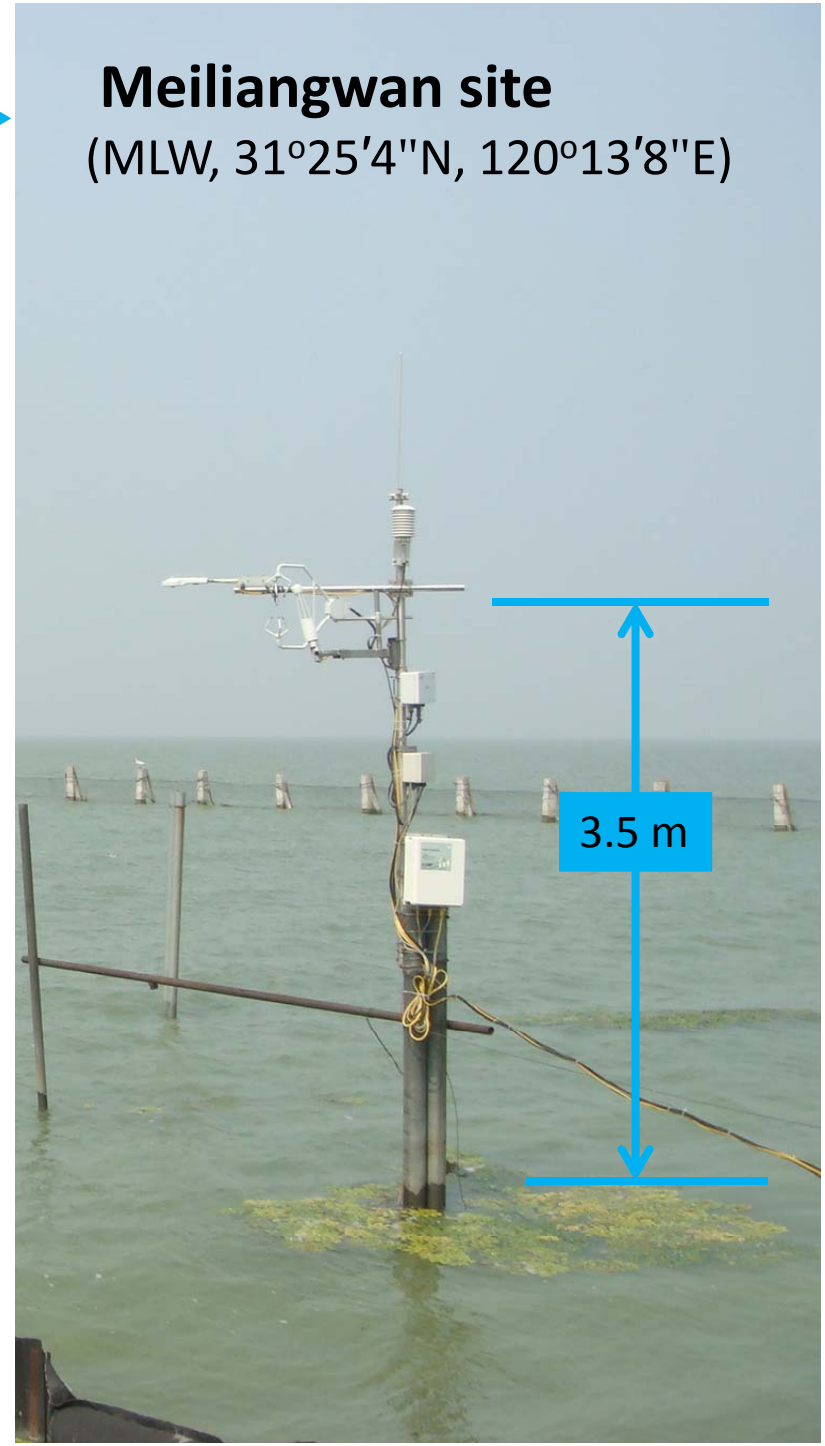
Taihu Eddy Flux Mesonet



- Lake Taihu is large (area of 2400 km^2) and shallow (depth of 2 m) and is situated in the Yangtze River Delta, East China.
- Five eddy covariance systems were installed on platforms located in the north, east, south, west and middle of the lake, representing different biological zones and wind-wave patterns. One eddy covariance system was installed on the east shore.

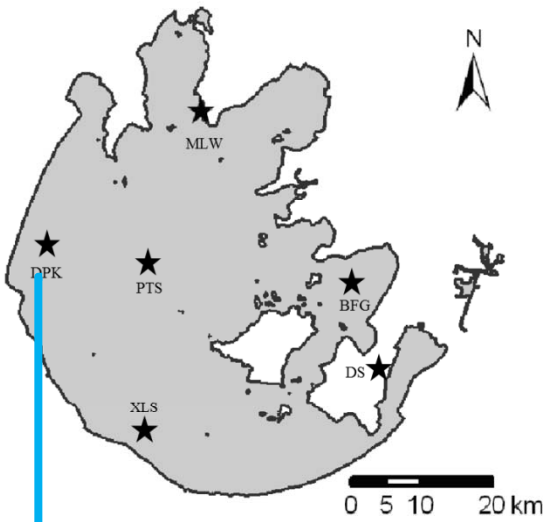
(Xiao et al. 2013)

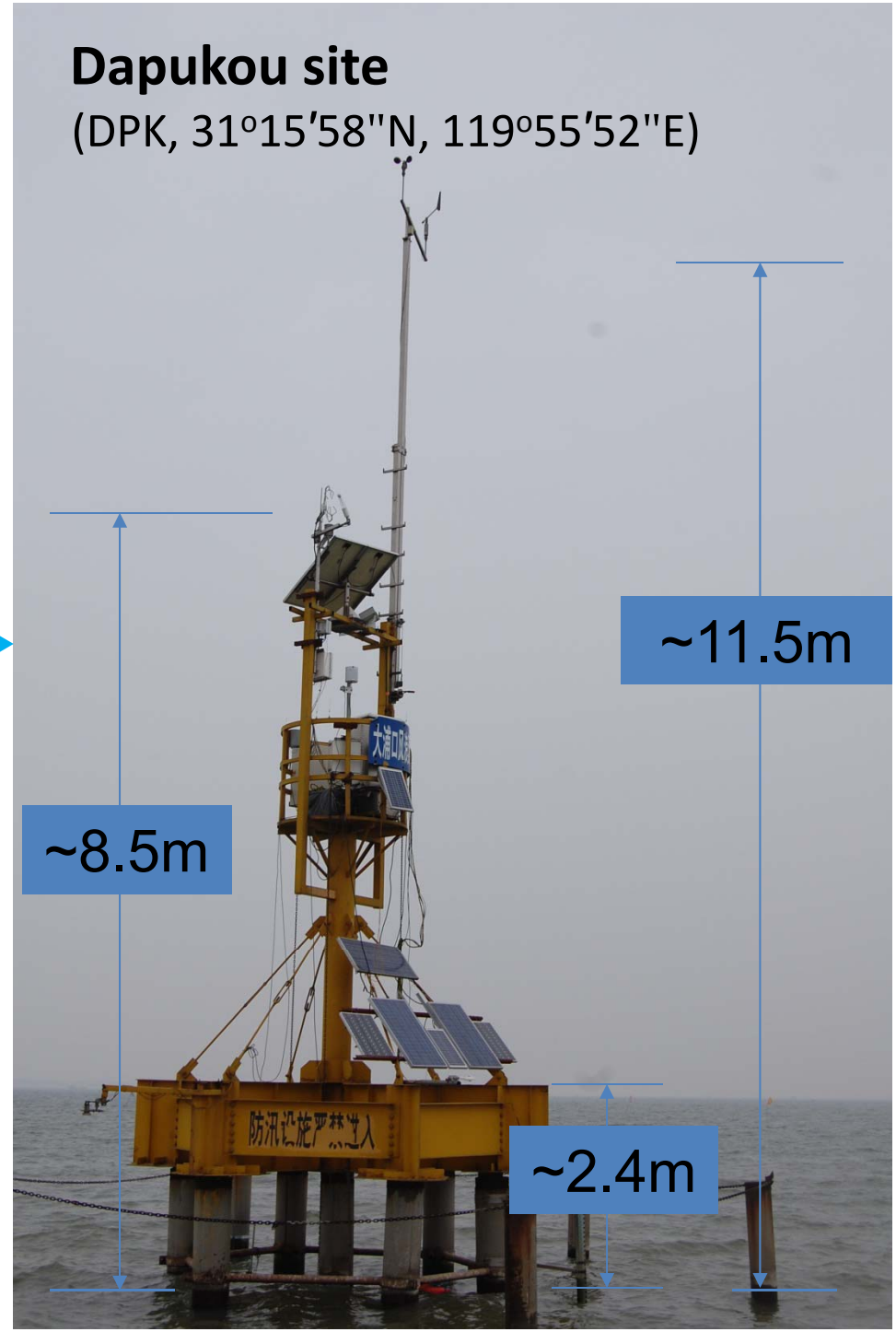




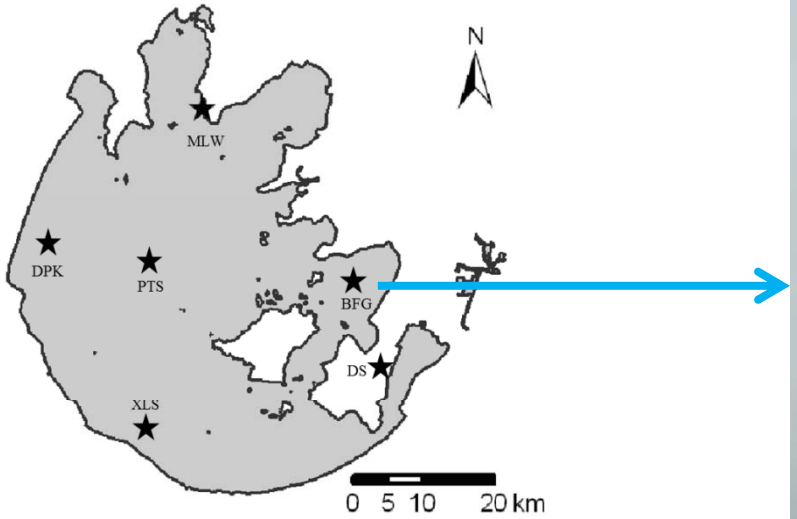
- Phytoplankton is abundant and no submerged macrophyte is present.
- Started on 14 June 2010.
- Water depth: 1.9 m.

Water temperature and meteorological measurements

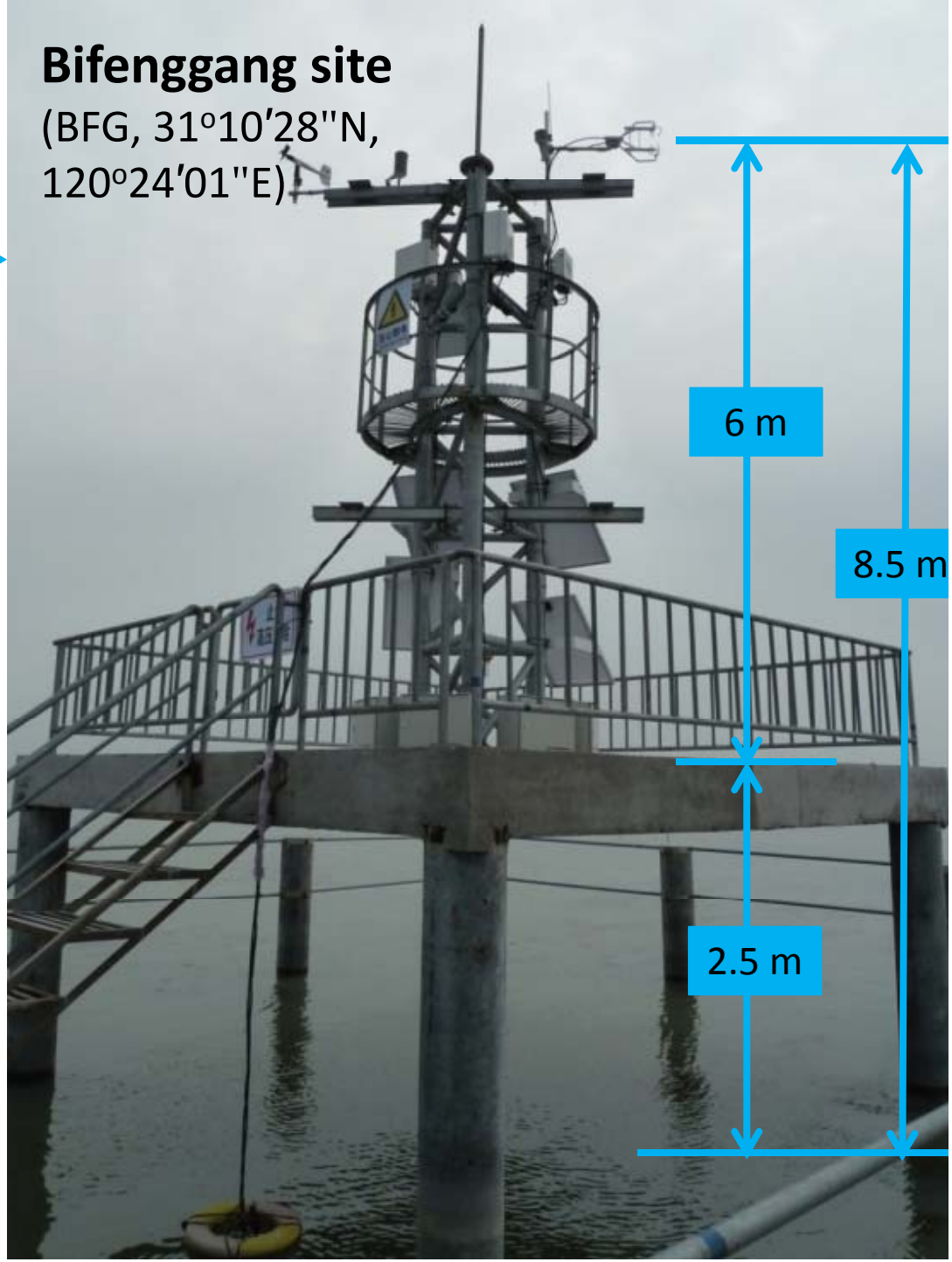


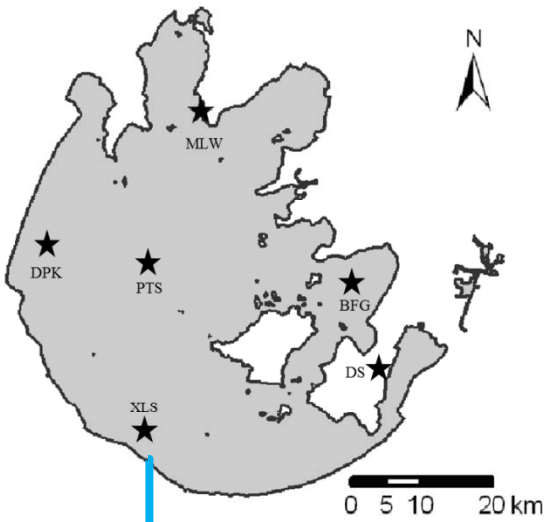


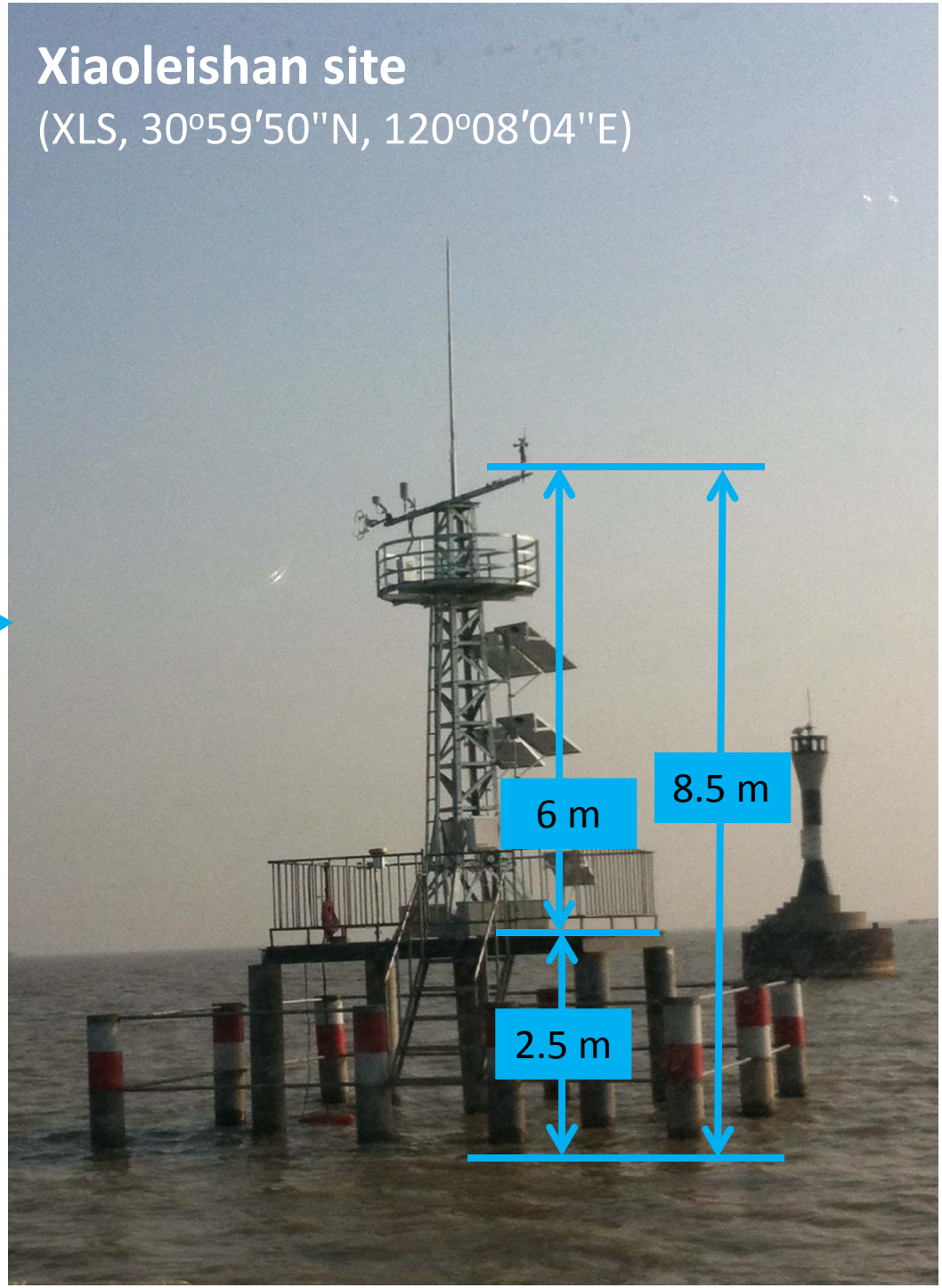
- Phytoplankton is abundant and no submerged macrophyte is present.
- The measurement started on 18 August 2011.
- Water depth: 2.6 m.
- Wind speed is ~100% greater than at the rest of the sites



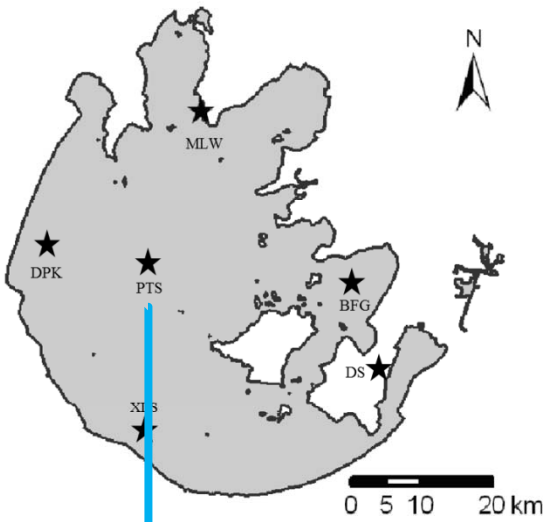
- Submerged macrophytes (mainly *Potamogeton malaianus* and *Hydrilla verticillata*) dominate the aquatic ecosystem
- Started on 15 December 2011
- Water depth: 1.8 m





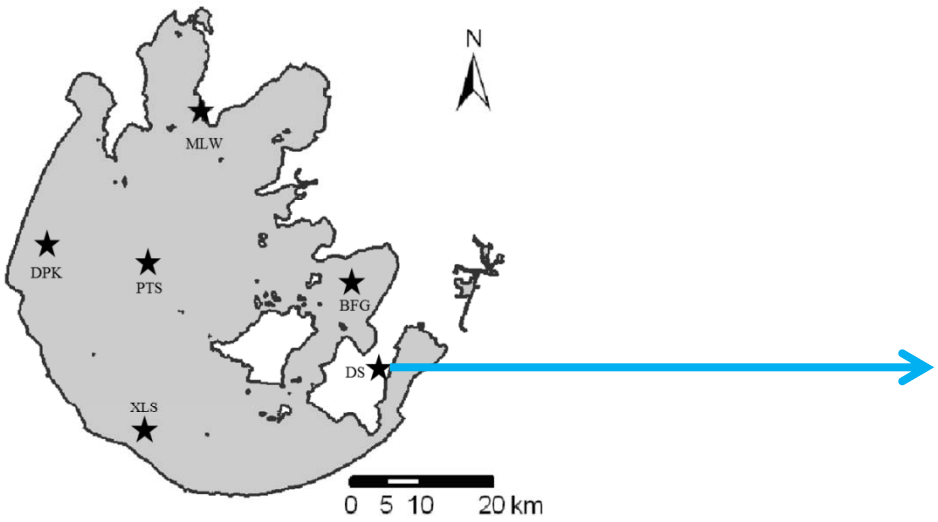


- Transition area between phytoplankton dominance and macroplant dominance
- Started on 24 November 2012
- Water depth: 1.8 m



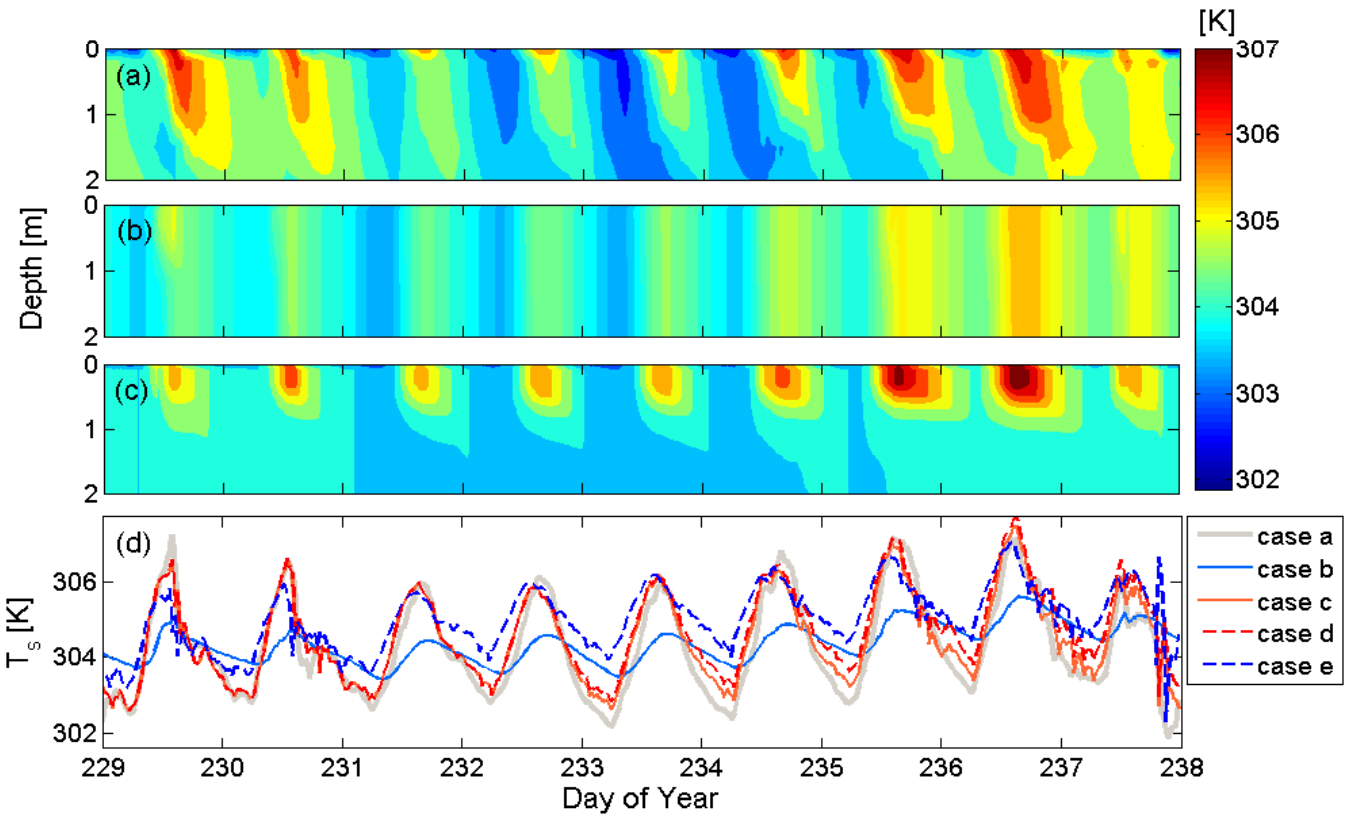
Is being built…

Will be ready in ~1 month



A companion land site is located in the Dongshan (DS) Peninsular on the southeast shore of the lake.

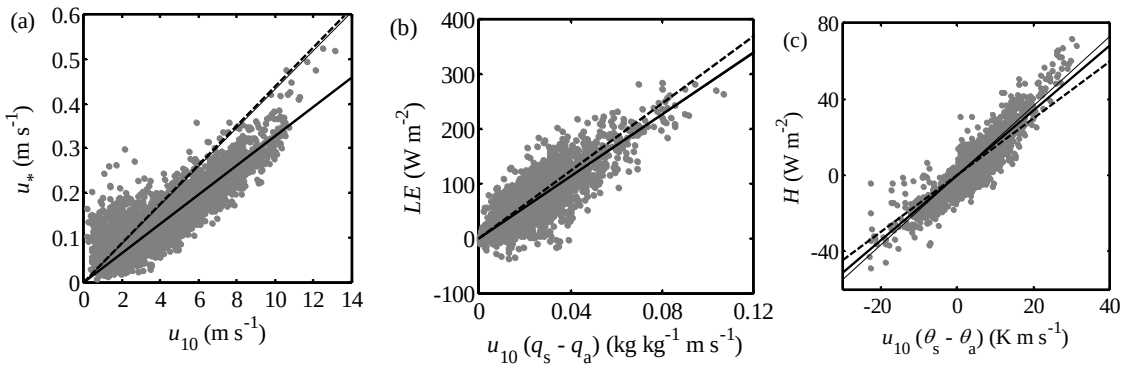
Evaluation of the CLM4 lake model at a large and shallow freshwater lake

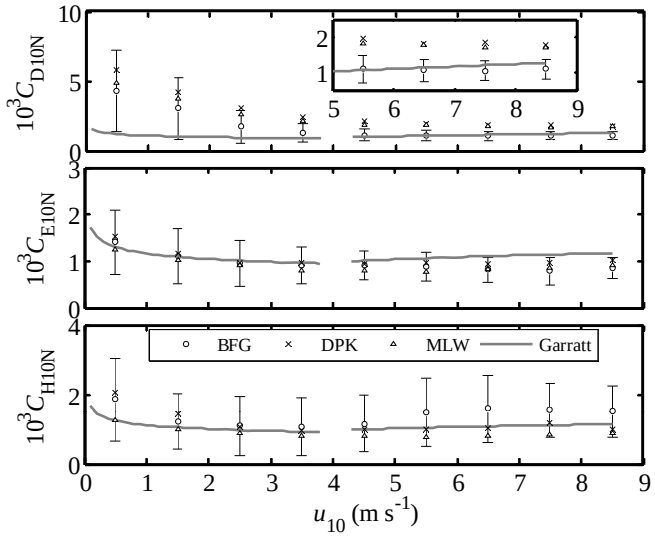


By **reducing k_e to 2%** of the value calculated with the parameterization of Henderson-Sellers (1985), CLM4-LISSS was able to reproduce the observed vertical thermal stratification and diurnal variations in T_s and to improve the T_s prediction during frontal disturbances.

(Deng et al. 2013, in press)

Transfer coefficients of momentum, heat and water vapour in the atmospheric surface layer of a large freshwater lake





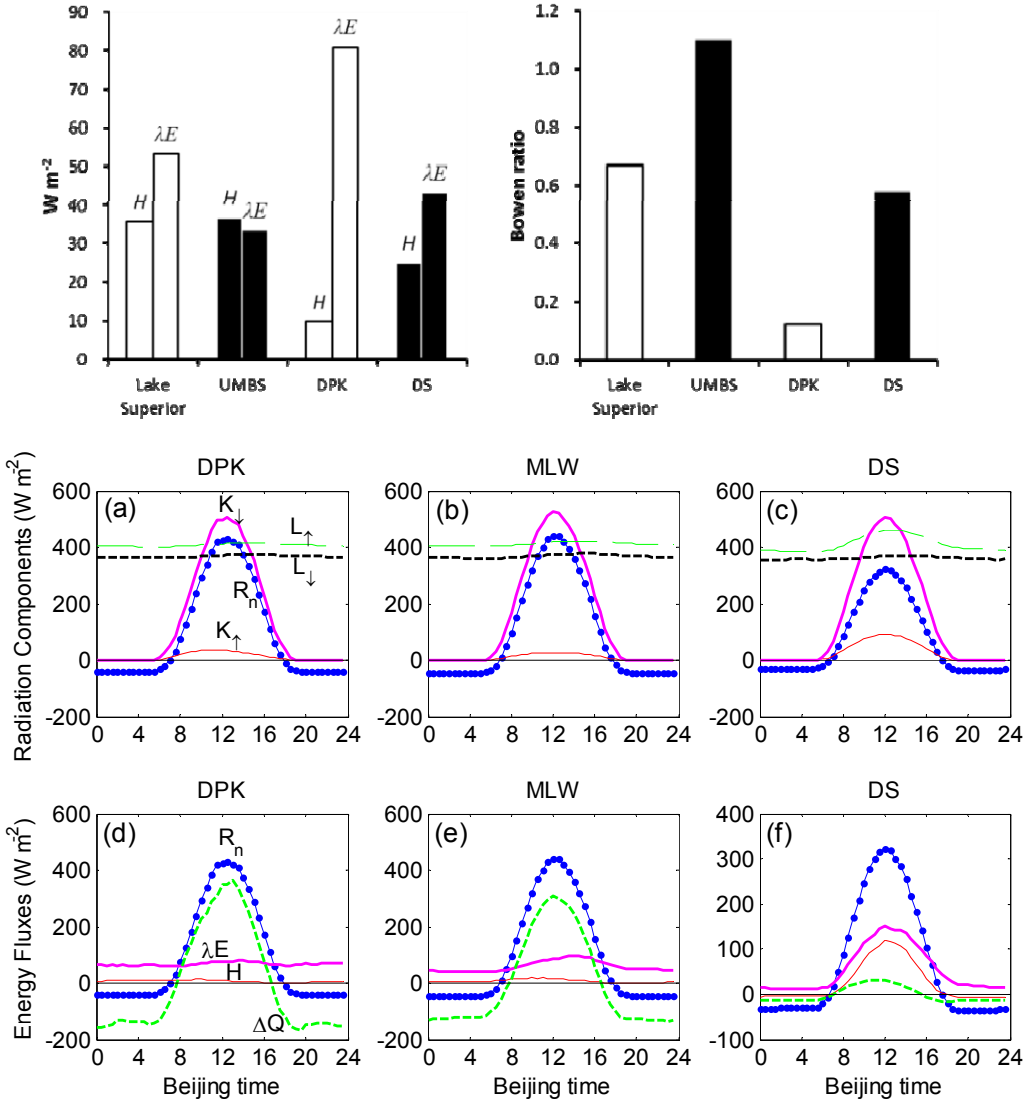
Site	10^3C_{D10}	10^3C_{E10}	10^3C_{H10}
BFG	**1.10 ± 0.02**	0.95 ± 0.01	1.38 ± 0.02
DPK	1.89 ± 0.03	1.03 ± 0.01	1.17 ± 0.02
MLW	1.80 ± 0.02	0.94 ± 0.01	1.48 ± 0.02

- The effective momentum transfer coefficient was reduced by approximately 40% in the presence of submerged macrophytes.

- At the MLW and DPK sites (free of submerged macrophytes), the observed C_{D10N} was higher than the prediction according to the Garratt (1992) model for the marine environment.
- It appears that at the same wind speed, the water surface of the lake was rougher than the ocean surface.

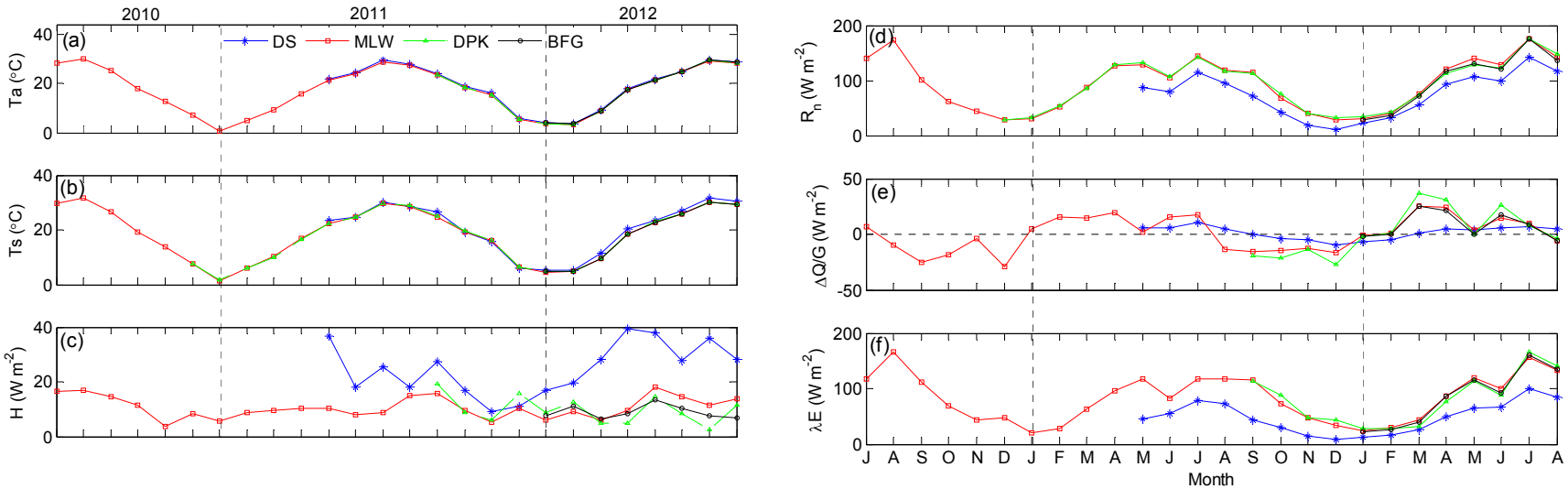
(Xiao et al. 2013, in review)

Temporal and spatial variations in radiation and energy balance across a large freshwater lake in China

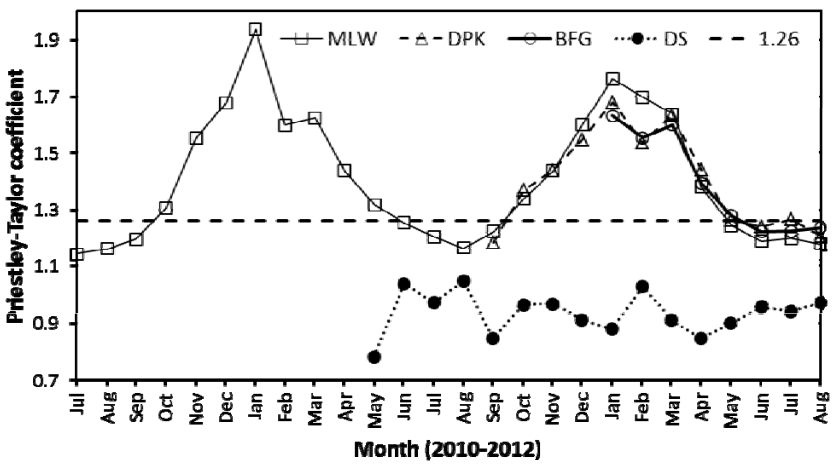


- Due to the shallowness of Lake Taihu and high temperature, its annual Bowen ratio was very small (0.12-0.13).
- The radiation and energy balances showed little spatial variations across this lake at least on the monthly and annual time scale.
- Lake Taihu can be parameterized as one grid cell in climate models.

(Wang et al. 2013, in review)



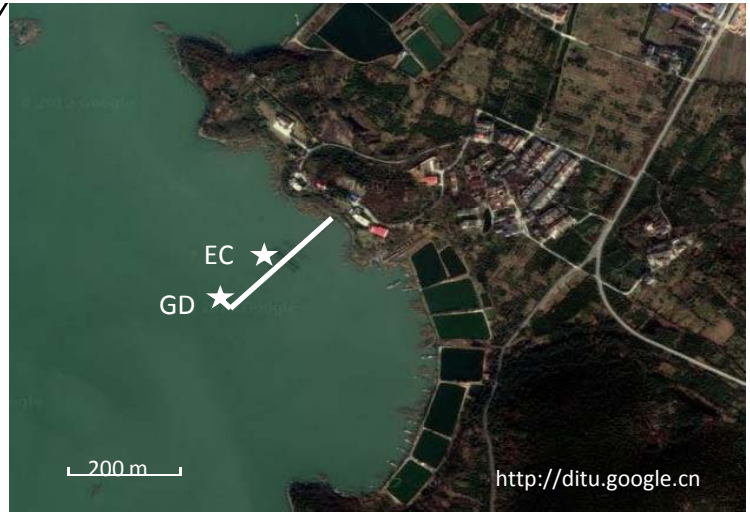
- The sensible and latent heat fluxes appeared insensitive to wind speed, water pollution status and the effect of submerged macrophytes.
- On the annual time scale, the lake latent heat flux was 37.7 W m^{-2} or 87% greater than that of the adjacent land site.



- The commonly used Priestley-Taylor coefficient of 1.26 would underestimate the annual evaporation at Lake Taihu by 10%.

(Wang et al. 2013, in review)

Flux-gradient measurement of $CH_4/CO_2/H_2O$ and isotopic H_2O at MLW site



Poster:
EGU2013-2513