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Temporal and Spatial Variations of CH_4 Emission in Lake Taihu Measured with the Transfer Coefficient Method

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- Methods
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1. Introduction

- Lake is an important natural source of CH_4 in the atmosphere (*Walter et al., 2006; Bastviken et al., 2004, 2011; Podgrajsek et al.,2013*).
- The amount of CH_4 emission from global lakes is about 8-48TgCH_4yr^{-1}, which contributes about 6-16% of global natural source emission (*Bastviken et al., 2004; Palma-silva et al., 2013*).
- However, the amount is uncertainty because of different types of lakes and its complex environmental and biological control mechanisms.

1. Introduction

- Environmental factors, such as temperature, wind speed, and aquatic biomass control CH_4 emission from lake (*Yvon-Durocher et al., 2014; Matthes et al., 2014; Morin et al., 2014*).
- Lake Taihu located Yangzi river Delta is the biggest shallow lake in China. Lake Taihu has spatial heterogeneity because of the different types of vegetation (*Liu et al. 2007*), spatial pattern of pollution (*Zhao et al., 2011*), and wind wave situation (*Qin et al., 2007*, *Lee et al., 2014*).
- CH_4 emission in Lake Taihu may show spatial pattern.

1. Introduction

- The temporal and spatial pattern of CH_4 emission in Lake Taihu is basis for estimating accurately CH_4 emission from the whole lake.
- Currently, Algal bloom is a severe environmental problem in Lake Taihu.
- The biomass formed by algal bloom may impact the temporal and spatial pattern of CH_4 emission in Lake Taihu and the total amount.

2. Objectives

- Indentify the temporal and spatial variations of CH_4 emission in Lake Taihu.
- Obtain the total amount of CH_4 emission in Lake Taihu.
- Discuss the impact of environmental and algal bloom on CH_4 emission in Lake Taihu.

3. Methods

3.1 Sites information

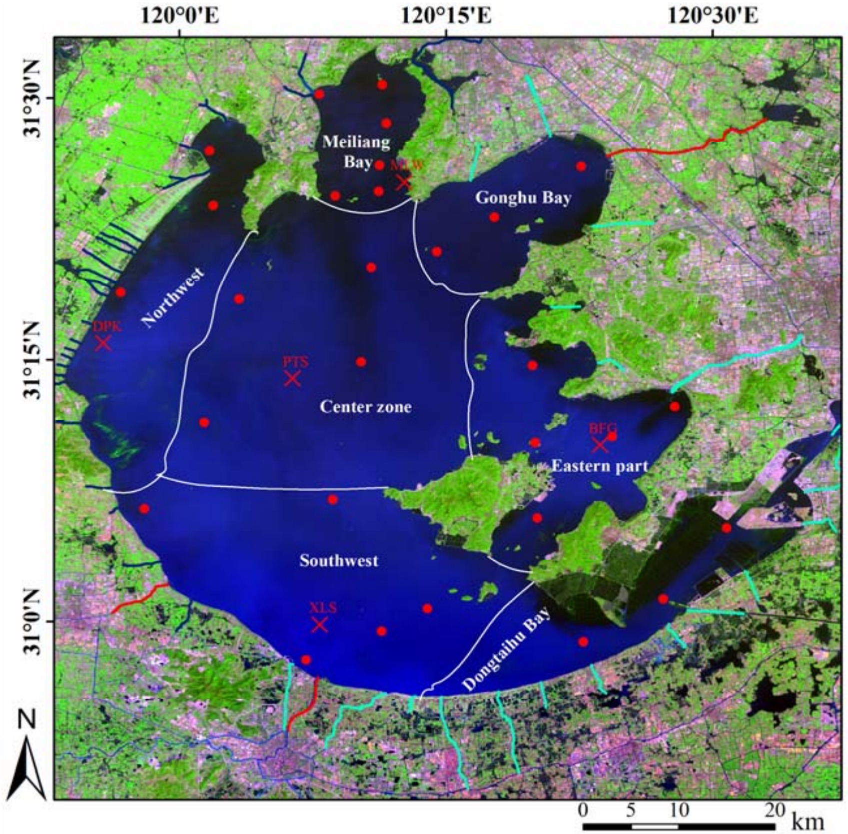

Figure 1 Locations of Flux sites (×) and sampling sites (●) (Lee et al, 2014; Yan et al, 2011)

Meiliang Bay: Semi-enclosed bay;

Gonghu Bay: Floating plants and emergent macrophytes zone;

Northwest: Hyper-eutropica zone;

Center: the center of lake;

Eastern part: Submerged macrophytes;

Southeast part: Transition zone between phytoplankton and macrophyte;

Dongtaihu Bay: Submerged macrophytes and pen fish farming zone

3.2 Measurements

- CH_4 flux is monitored at different temporal scales and spatial scales.

✓ Water sample is collected at MLW sites every day .

✓ Water samples are collected at BFG site, DPK site, XLS site, and PTS site every one or two month.

✓ Water samples are collected in whole lake every three month.

3.2 Measurements

Table 1. Sites location and start time of measurement in different Sites

Site ID	Latitude/longitude	Water depth(m)	Start time
MLW	31.42°N/120.21°E	1.8	2011.07
DPK	31.27°N/119.93°E	2.5	2012.07
BFG	31.17°N/120.40°E	1.7	2012.12
XLS	31.00°N/120.13°E	2.0	2013.01
PTS	31.23°N/120.11°E	2.8	2013.04

Water samples collected in whole lake began in 2011

3.3 Transfer Coefficient Method

- Transfer coefficient method calculates CH_4 emission flux according to the concentration difference between water surface and the atmosphere.

$$F = (C_w - C_s) \times k \quad \begin{cases} k/k_{600} = (S_{c}/S_{c600})^{-n} \\ k_{600} = 2.07 + 0.215 \times U_{10}^{1.7} \\ U_{10}/U = \ln(10/Z_0)/\ln(3.5/Z_0) \end{cases}$$

k is the gas transfer coefficient (m d^{-1}) ; C_w : CH_4 concentration (mol m^{-3}) dissolved in the surface water (at the depth of 20-cm) ; C_{eq}: the CH_4 concentration in water that is in equilibrium with the atmosphere in situ temperature; S_c is the Schmidt number of a given gas at given temperature and water density and S_{c600} is the Schmidt number 600 at temperature of 20 ℃; U_{10} is the wind speed at 10-m height; Z_0: roughness height; k_{600} is the gas transfer coefficient adjusted to Schmidt number 600; U: the wind speed measured at 3.5m height

4. Results

4.1 Temporal variation of CH_4 emission

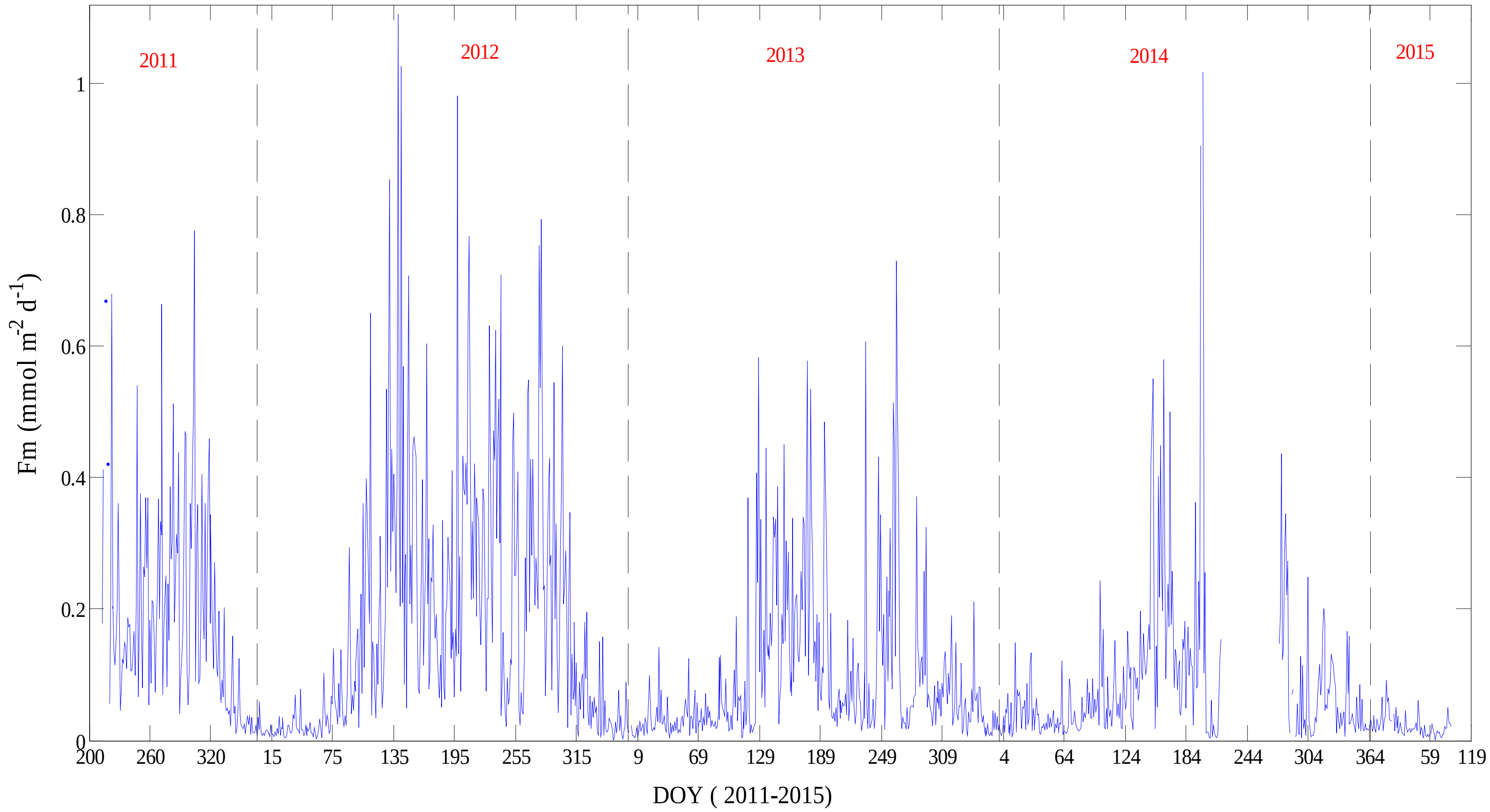

Figure 2 Temporal variation of CH_4 emission at MLW site

4.1 Temporal variation of CH_4 emission

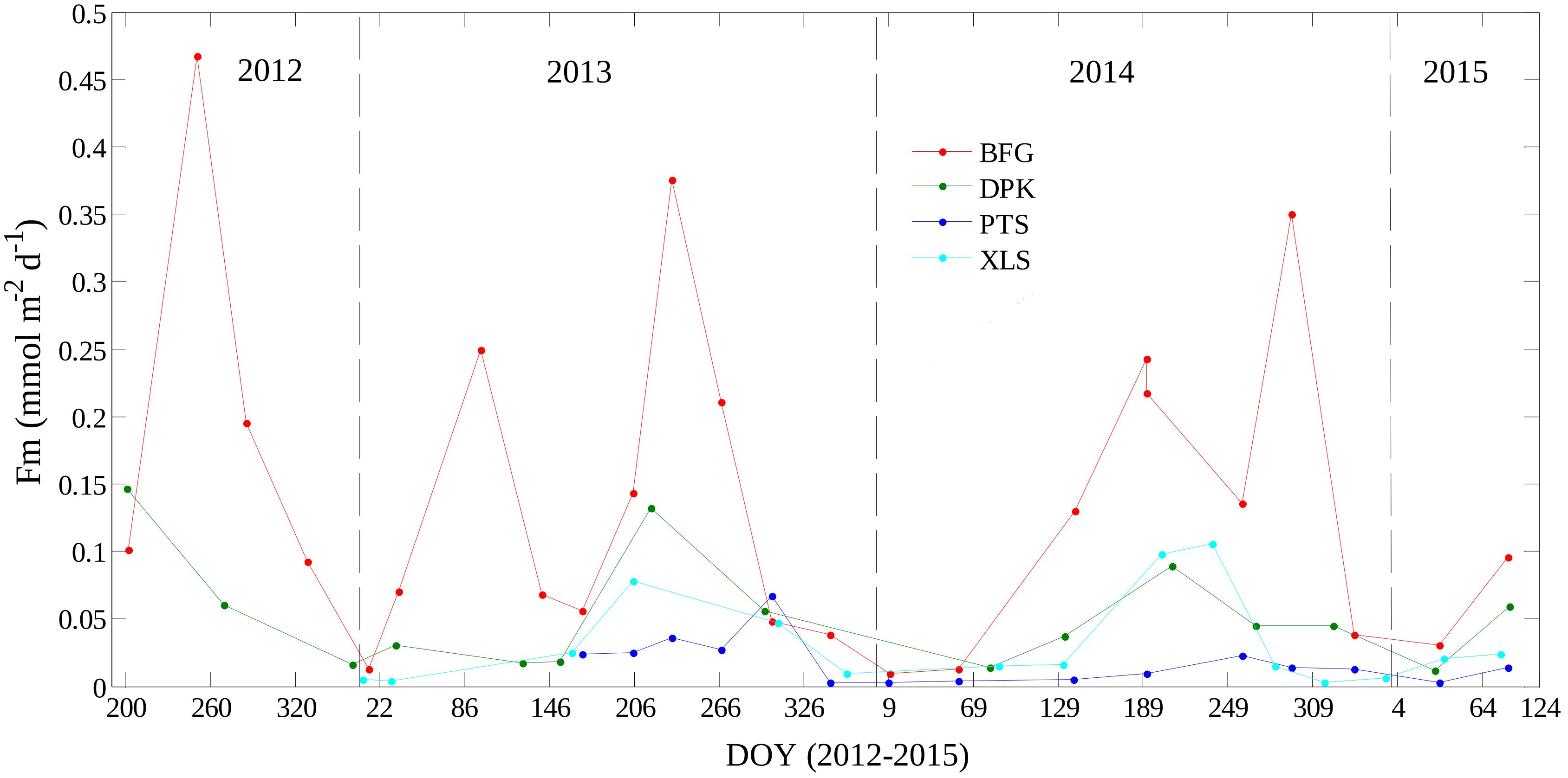

Figure 2 Temporal variation of CH4 emission at BFG site, DPK site, and PTS site, XLS site.

4.2 Spatial variation of CH_4 emission

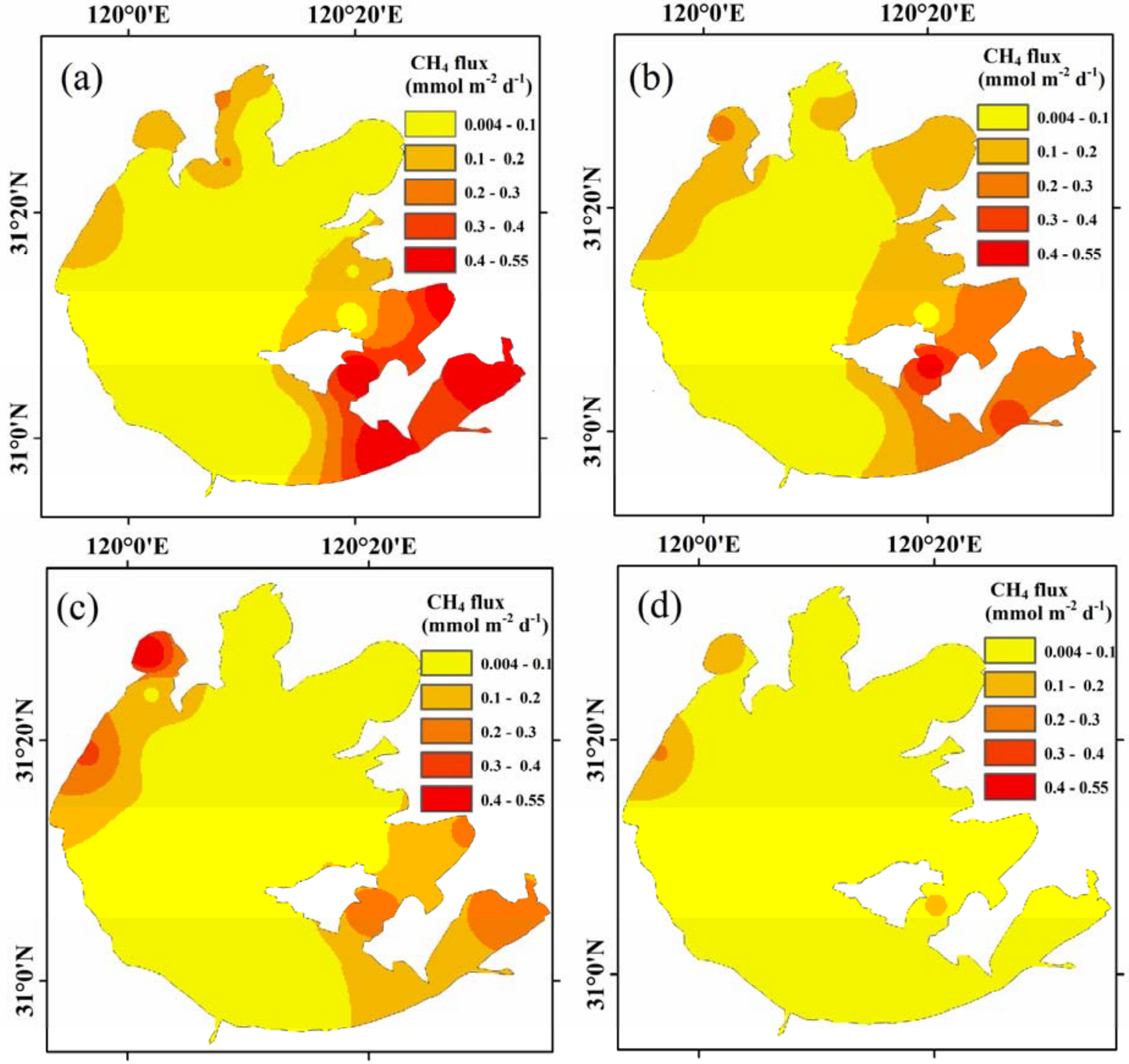

Figure 3. Spatial variation of CH_4 emission in spring (a), summer (b), autumn (c), and winter (d).

4.3 Temporal pattern of spatial variation of CH_4 emission

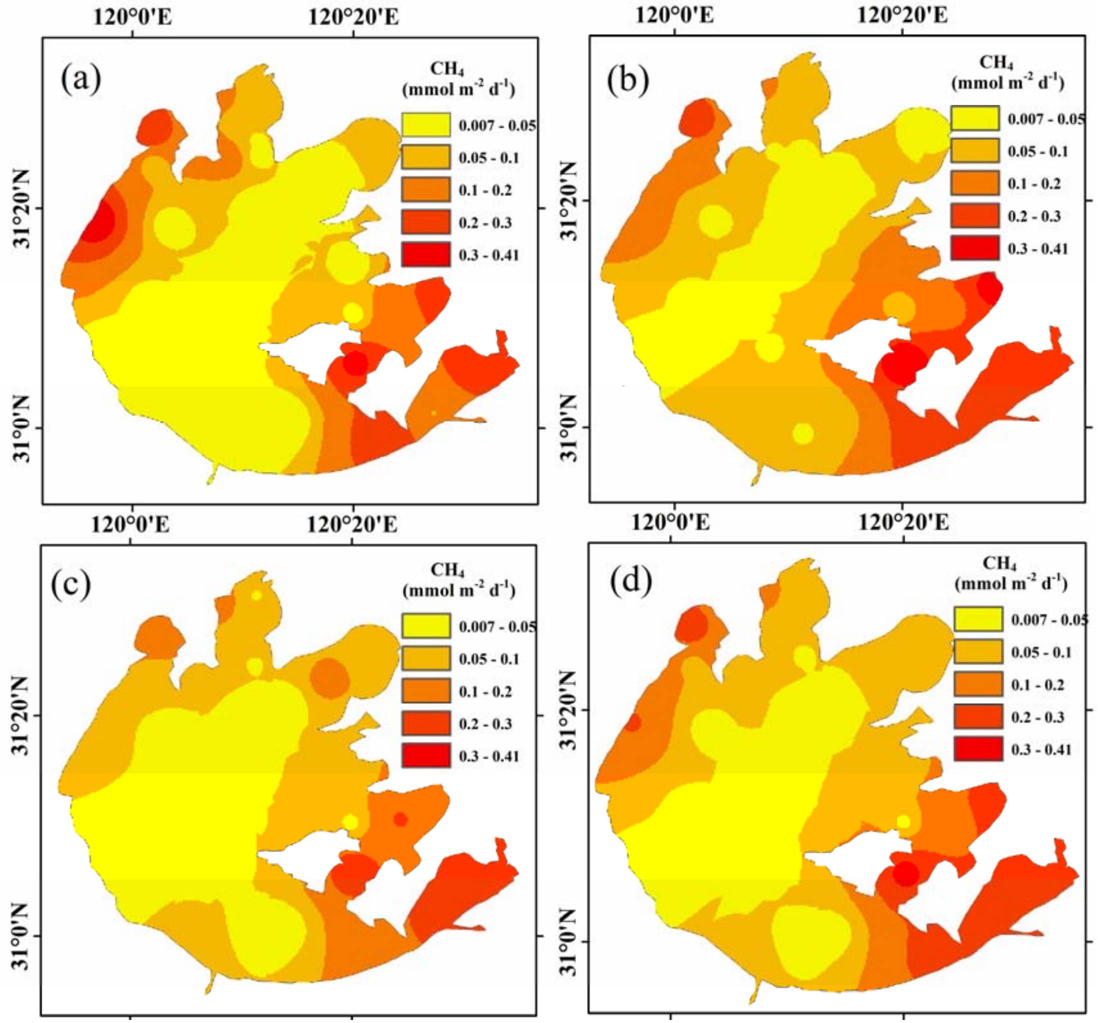

Figure 4 Temporal variations of spatial pattern of CH_4 emission flux in 2012(a), 2013(b), 2014(c), and average CH_4 emission (d) in Lake.

4.3 Temporal pattern of spatial variation of CH_4 emission

Table 2. CH_4 emission in different zone

Zones	Surface area (km^2)	Emission flux (mmol m^{-2} d^{-1})		
		2012	2013	2014
Meiliang Bay	100	0.086	0.071	0.073
Gonghu Bay	215.6	0.050	0.041	0.074
Eastern part	316.4	0.170	0.220	0.144
Dongtaihu Bay	131	0.211	0.281	0.210
Southwest	443.2	0.018	0.052	0.039
Northwest	394.1	0.249	0.190	0.116
Center	737.5	0.020	0.032	0.025
Lake Taihu	2338	0.095	0.104	0.076

Average: 0.090 mmol/m^2d

4.4 The control of temperature on CH_4 emission

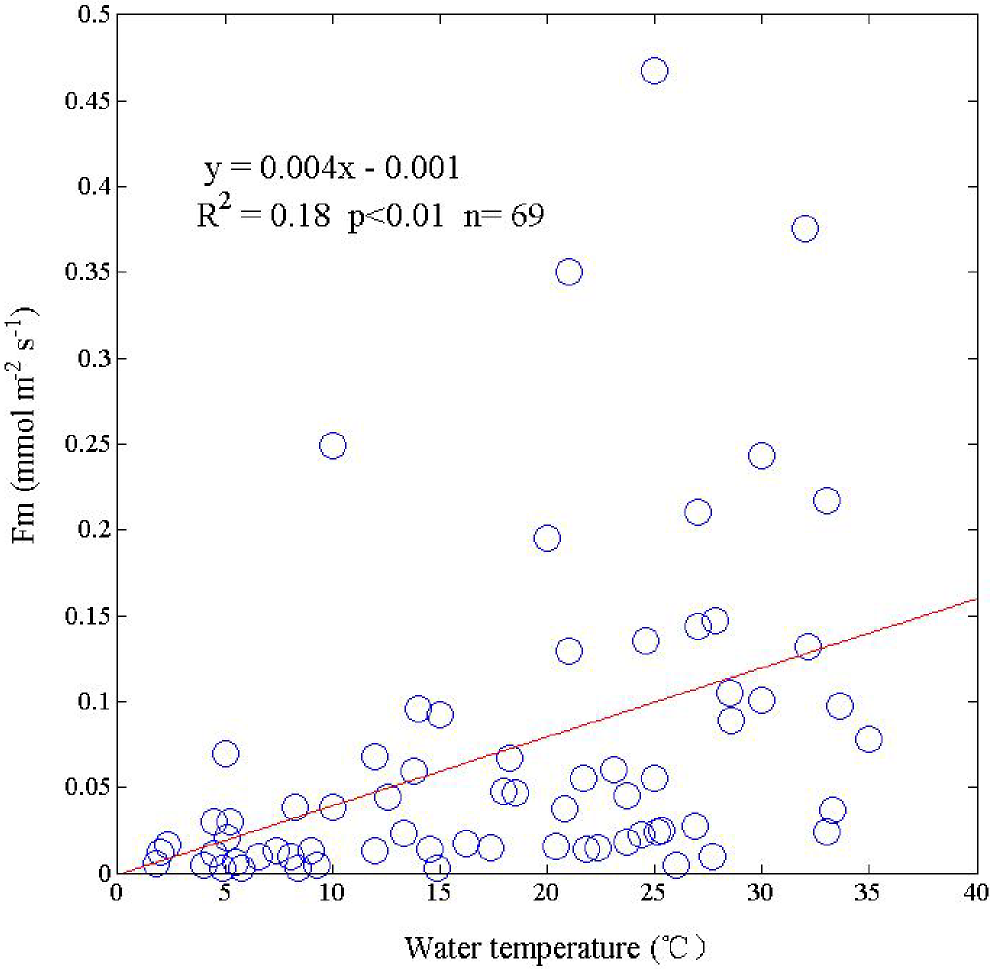

Figure 5 relationship between water temperature and CH_4 emission.

5. Conclusion

- In Lake Taihu, the CH_4 emission is higher in summer and autumn than that in winter and spring.
- The CH_4 emission is higher in eastern lake, Dongtaihu bay, and Northwest lake than the other zones.
- The spatial pattern of CH_4 shows interannual variation.
- The average value of CH_4 emission from whole lake is about 0.090 $mmol/m^2d$.
- The contribution of algal to CH_4 emission is less than the submerge macrophytes and water temperature control CH_4 emission in Lake Taihu.

Thank You!