Temporal and spatial variable of GHGs in Lake Taihu

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Video conference of YNCenter
2012-11-9

◆Outline

- **1 Concentration**
- **2 Flux**
- **3 Challenge & Question**

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1 Concentration

1. Temporal variable

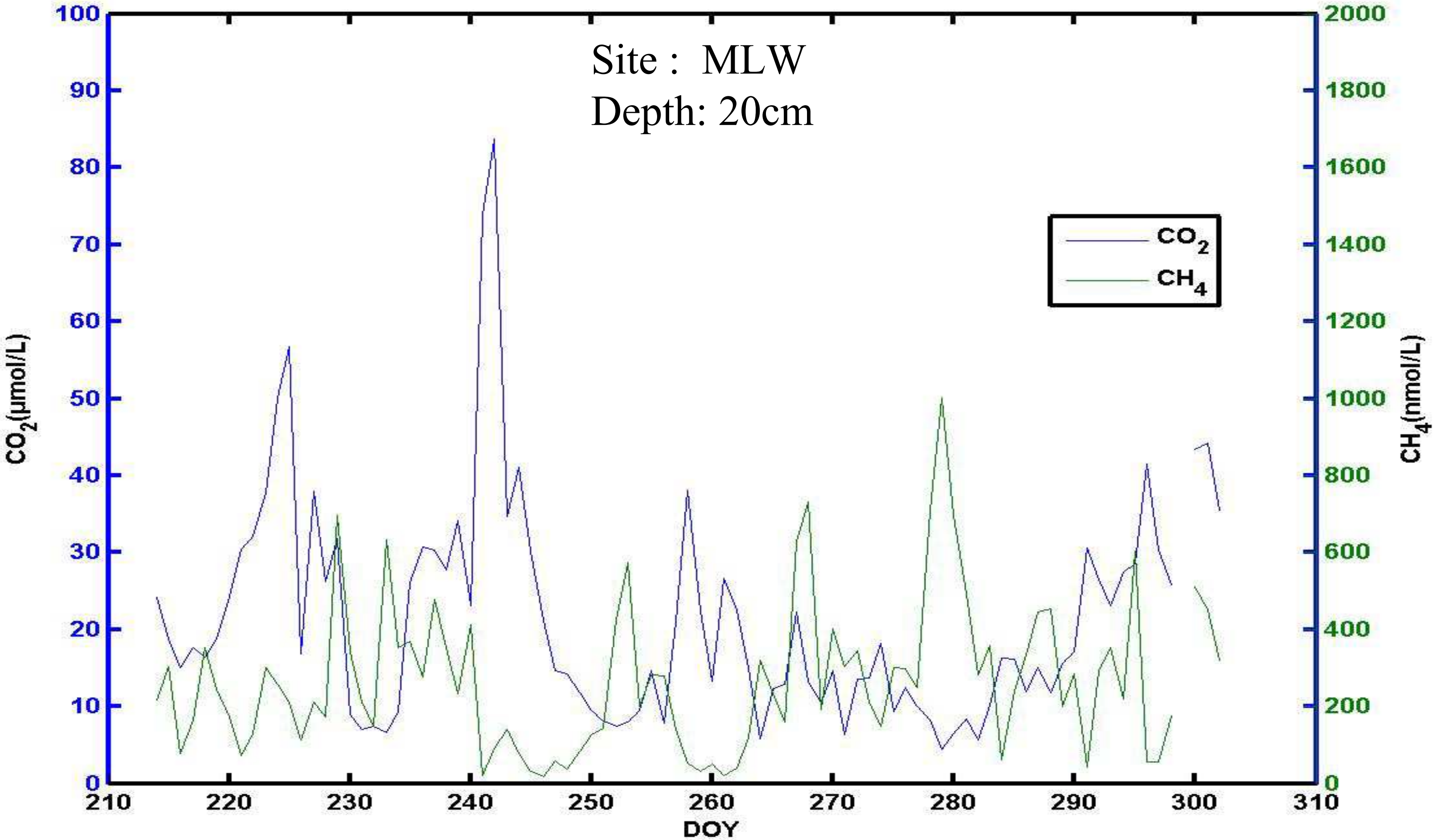


Fig 1: The temporal variable of CO_2 and CH_4 from August 1 ,2012 (doy 214) to October 28, 2012(doy 302).
Missing data : October 25,2012(doy 299)

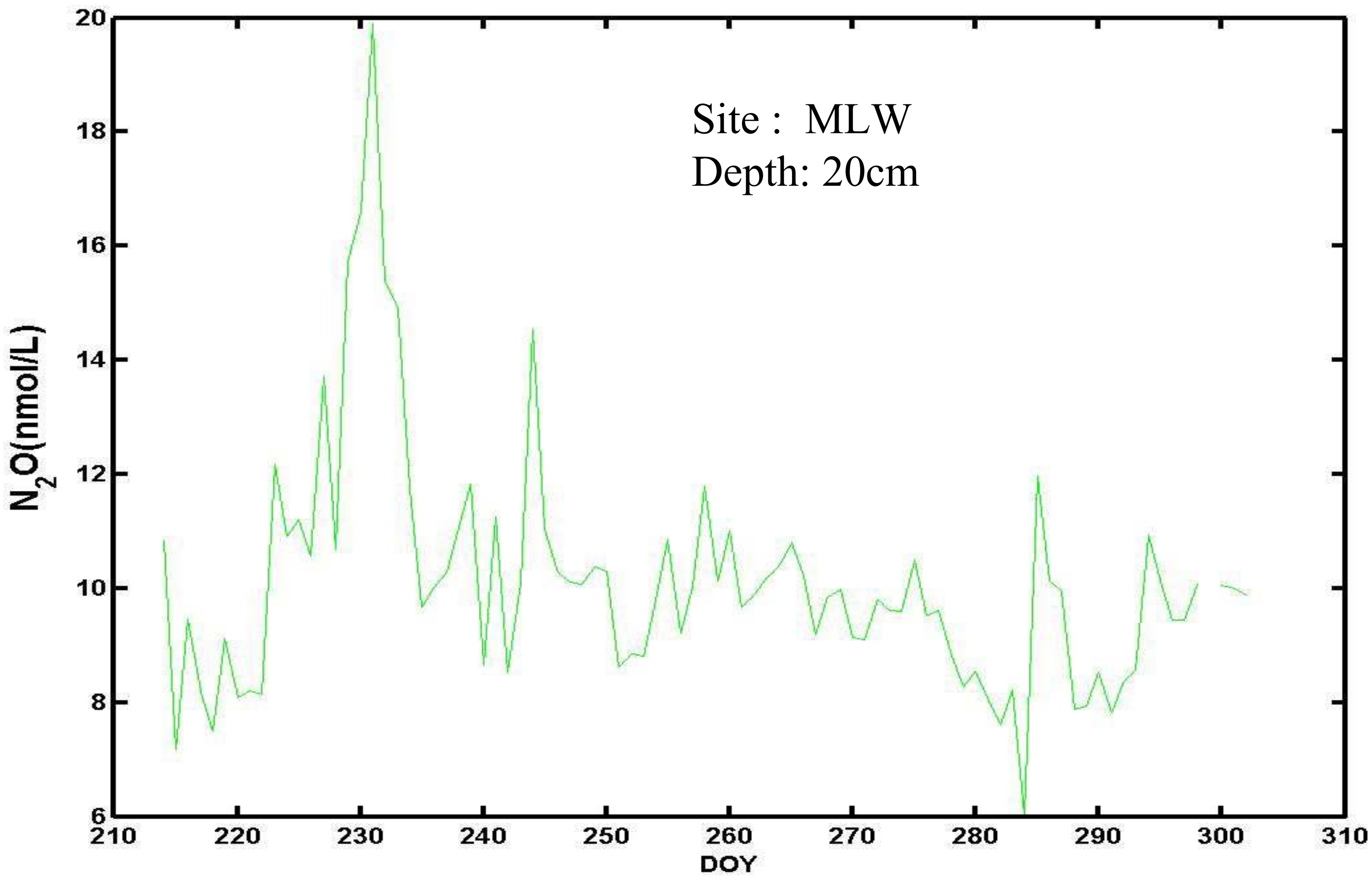
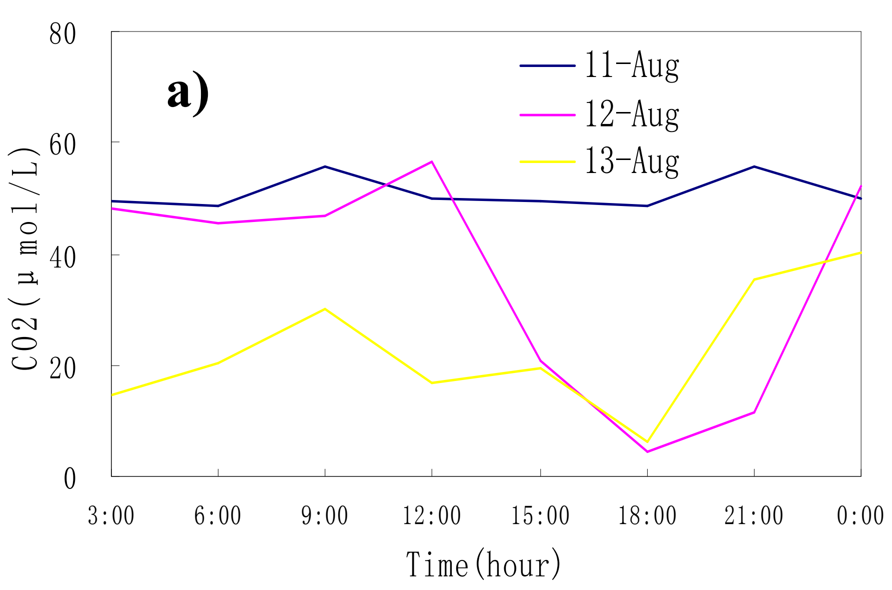
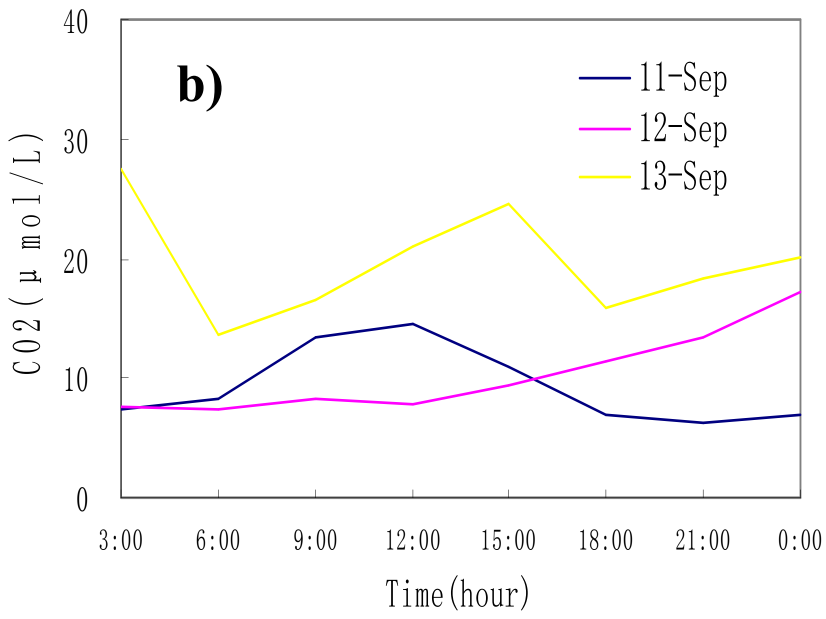


Fig 2: The temporal variable of N_2O from August 1 ,2012 (doy 214) to October 28, 2012(doy 302).
Missing data : October 25,2012(doy 299)

◆2. Diurnal variable





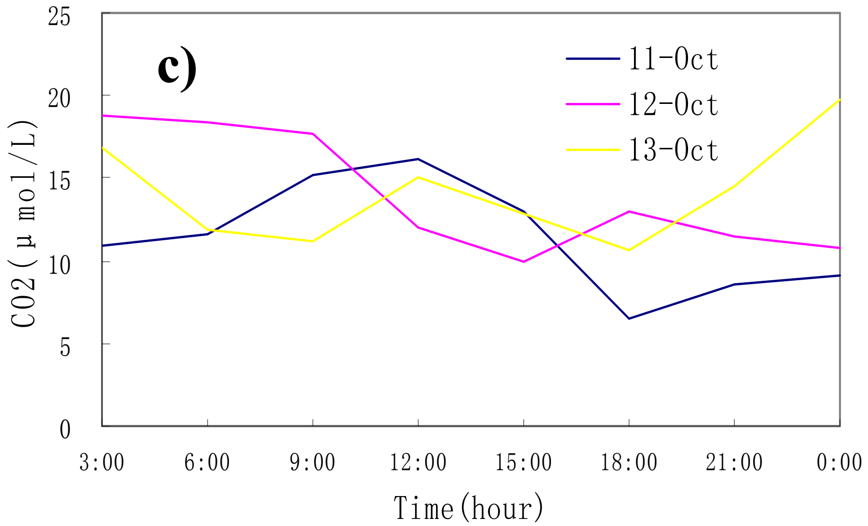


Fig 3: The diurnal variable of CO_2

The interval of sample is three hours, and it last three days.

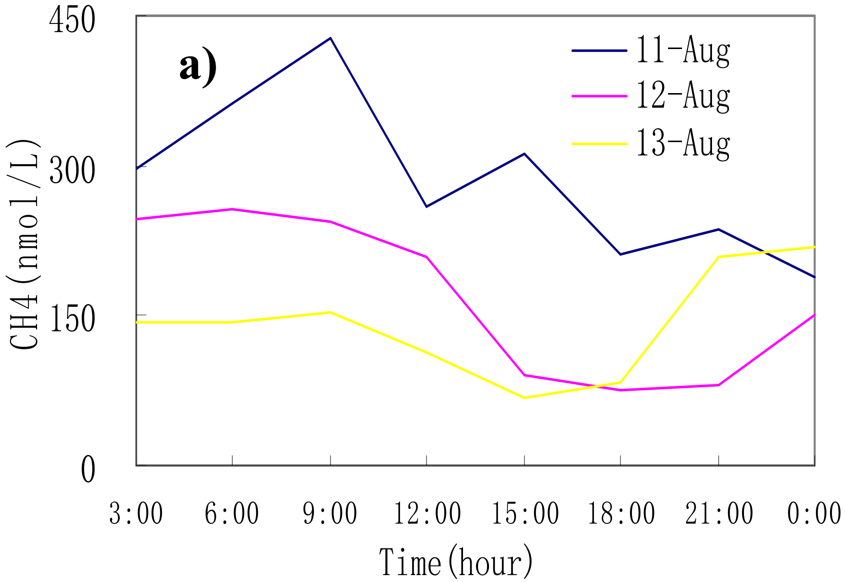
Site :MLW

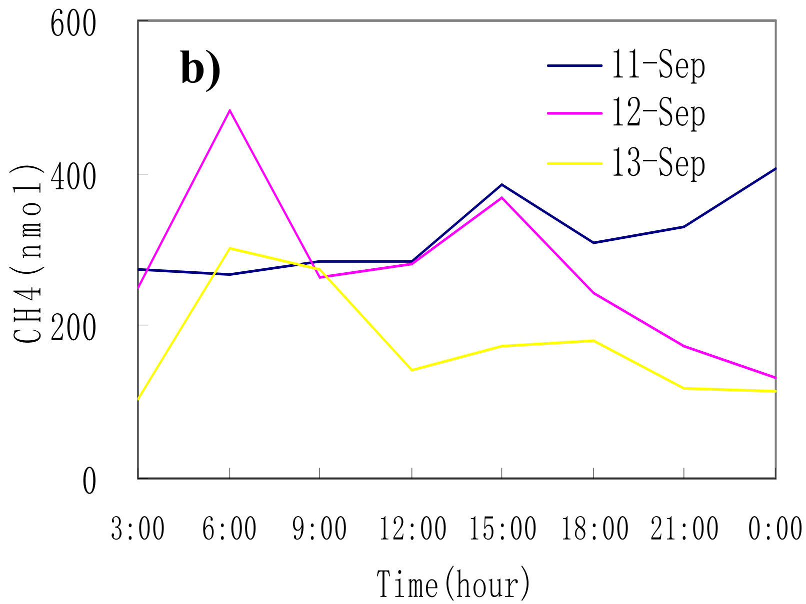
Depth: 20cm from the surface of lake

Time: a) August

b) September

c) October





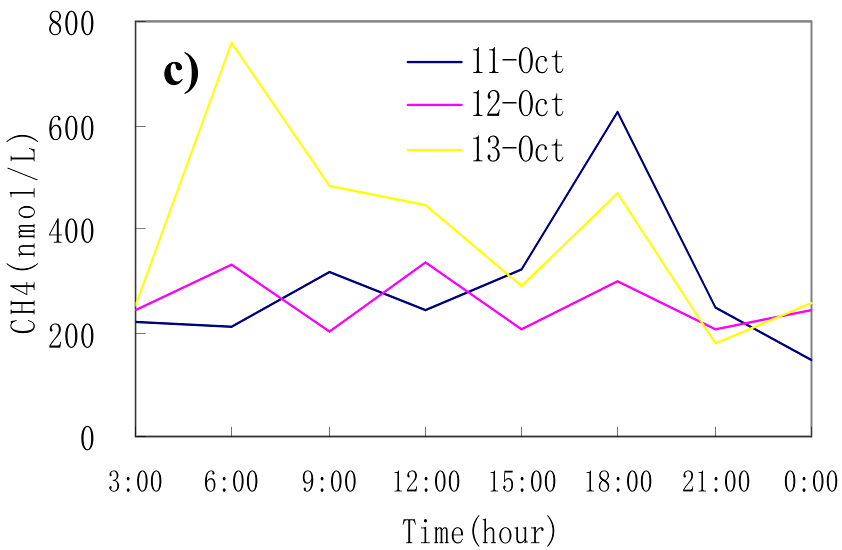


Fig 4: The diurnal variable of CH_4

The interval of sample is three hours, and it last three days.

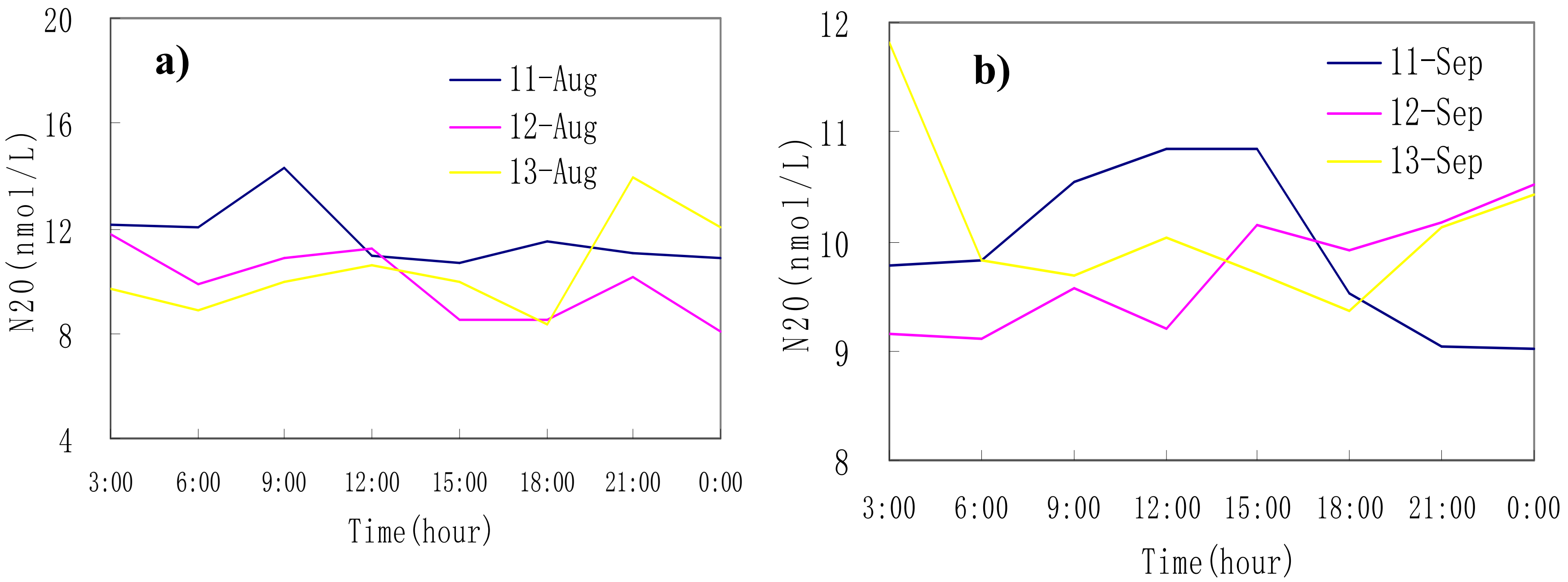
Site :MLW

Depth: 20cm from the surface of lake

Time: a) August

b) September

c) October



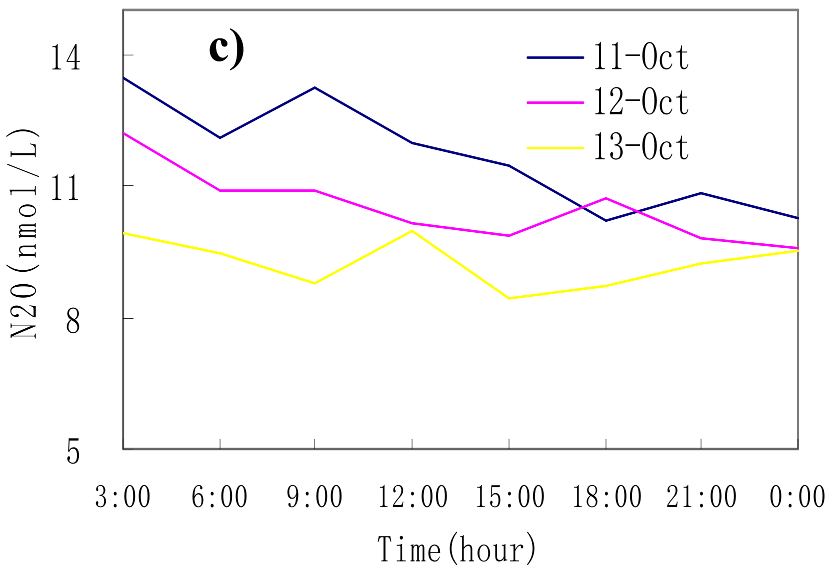


Fig 5: The diurnal variable of N_2O

The interval of sample is three hours, and it last three days.

Site :MLW

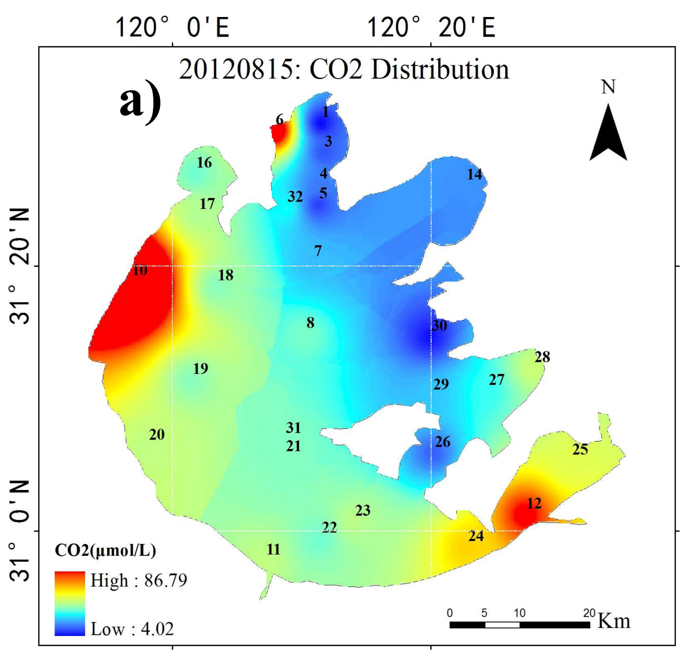
Depth: 20cm from the surface of lake

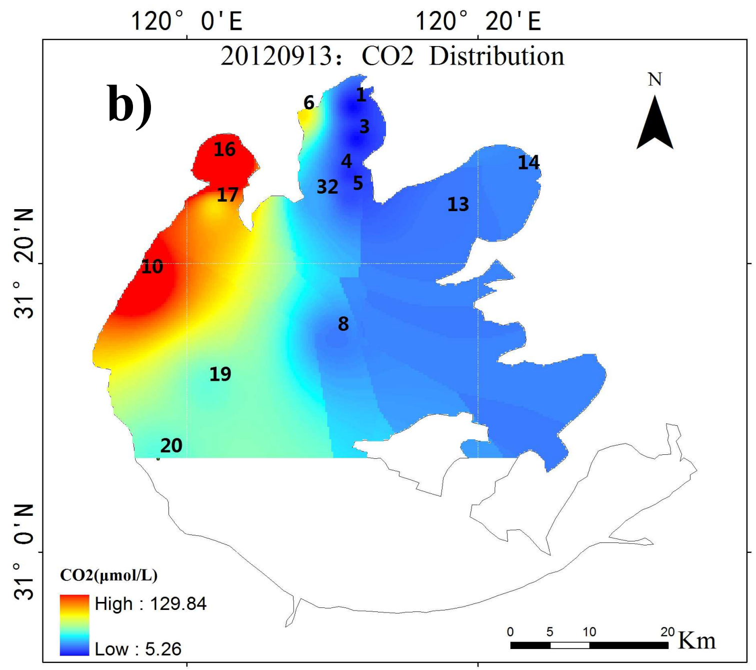
Time: a) August

b) September

c) October

◆ 3 . Spatial variable





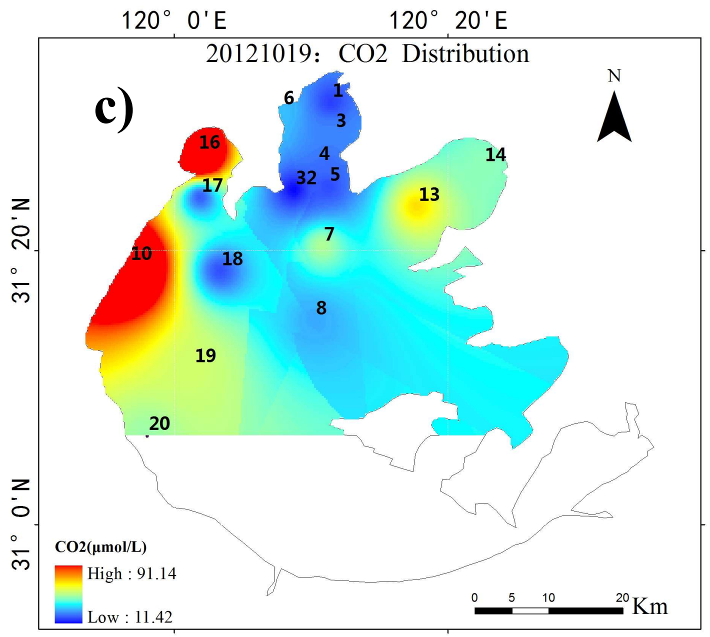
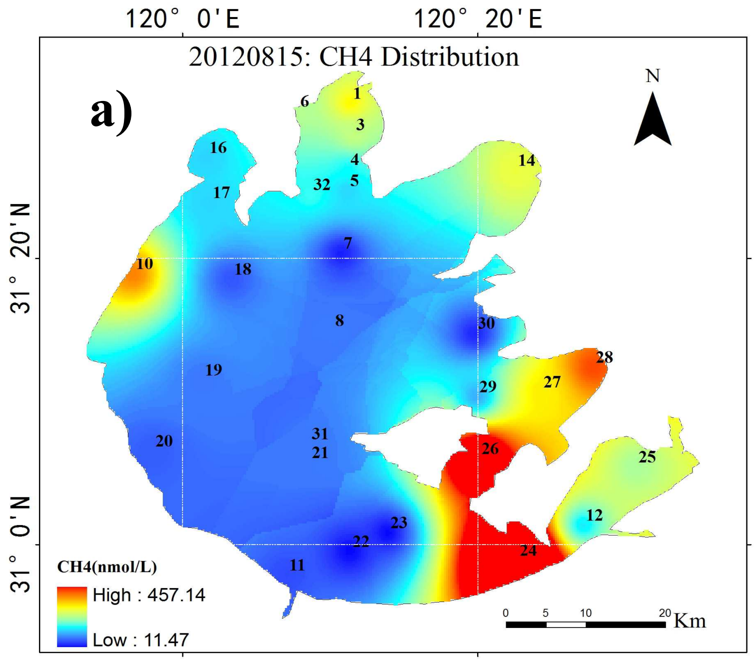


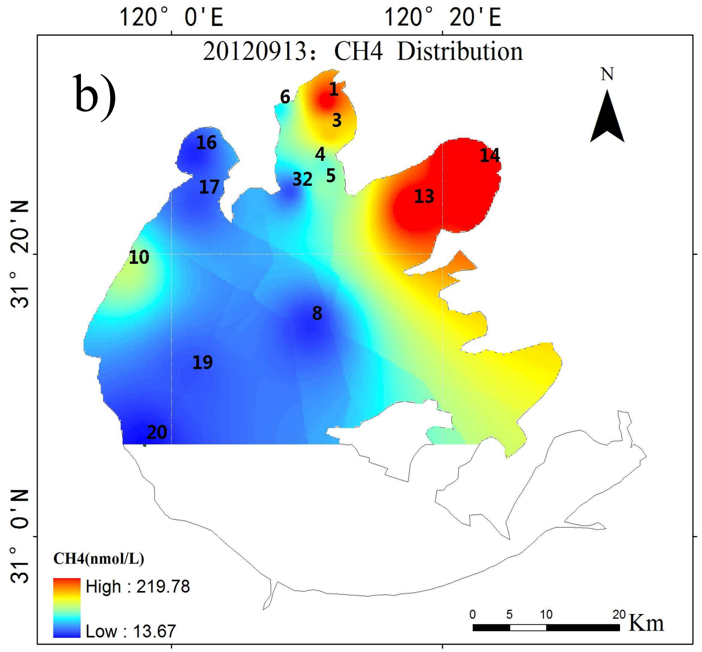
Fig 6: The spatial variable of CO_2

a) sample time : August 15 and 16,2012
   the number of sample sites are 32

b) sample time: September 13,2012
   the number of sample sites are 14

c) sample time :October 19,2012
   the number of sample site are 16





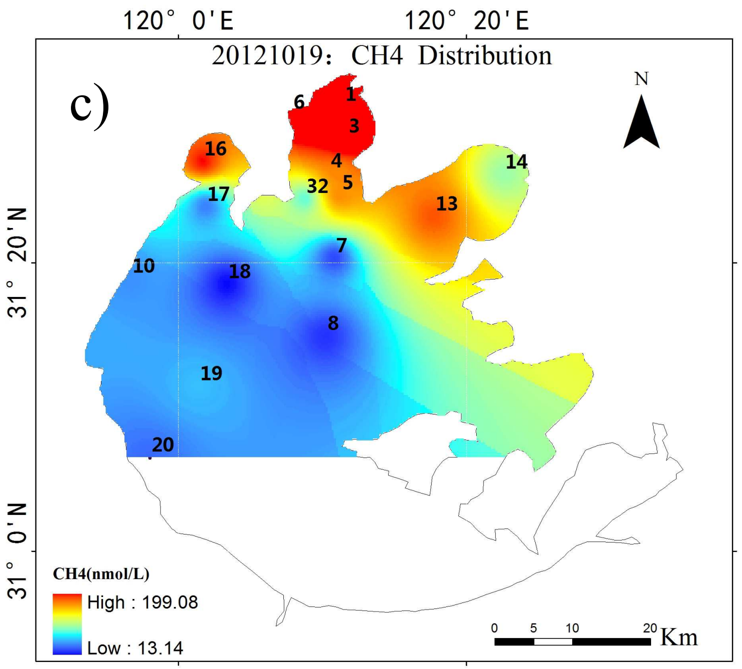
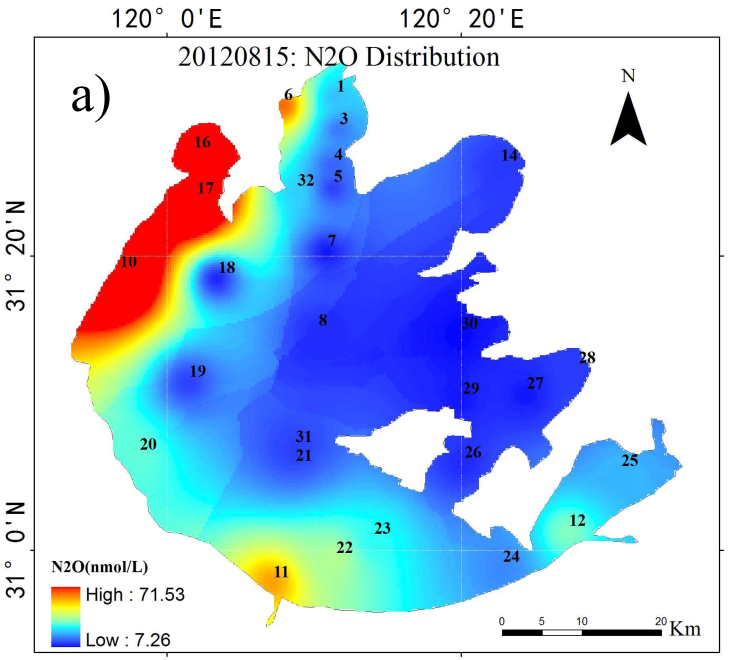


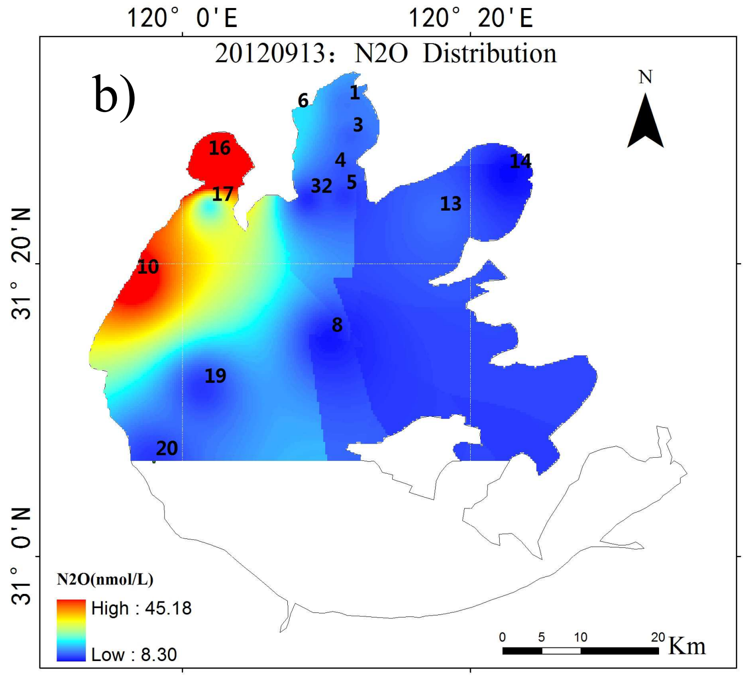
Fig 7: The spatial variable of CH_4

a) sample time : August 15 and 16,2012
   the number of sample sites are 32

b) sample time: September 13,2012
   the number of sample sites are 14

c) sample time :October 19,2012
   the number of sample site are 16





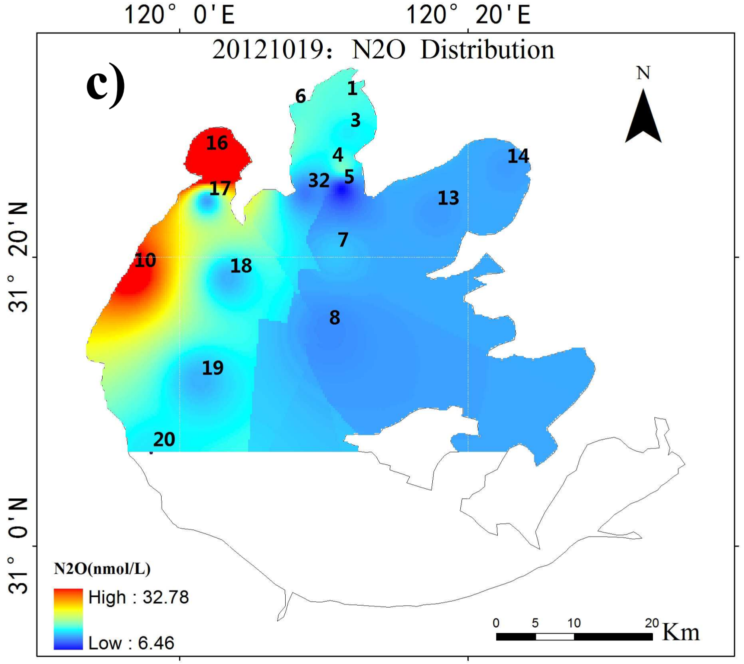


Fig 8: The spatial variable of N_2O

a) sample time : August 15 and 16,2012
   the number of sample sites are 32

b) sample time: September 13,2012
   the number of sample sites are 14

c) sample time :October 19,2012
   the number of sample site are 16

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◆ 4 .The relationship between GHGs concentration and micrometeorological

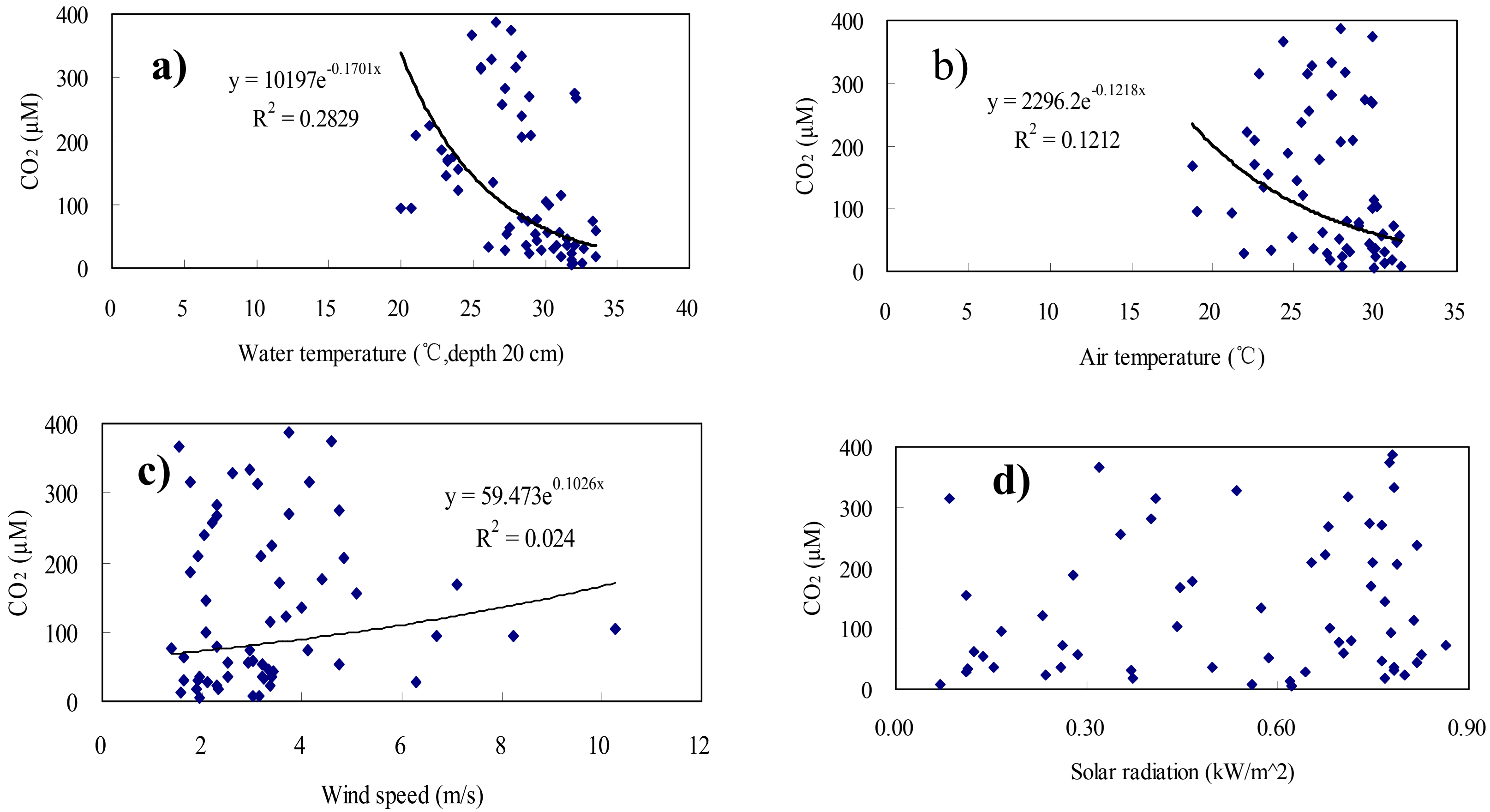

Fig 9: The correlation between CO_2 concentration and :

a) water temperature b) air temperature

c) wind speed d) solar radiation

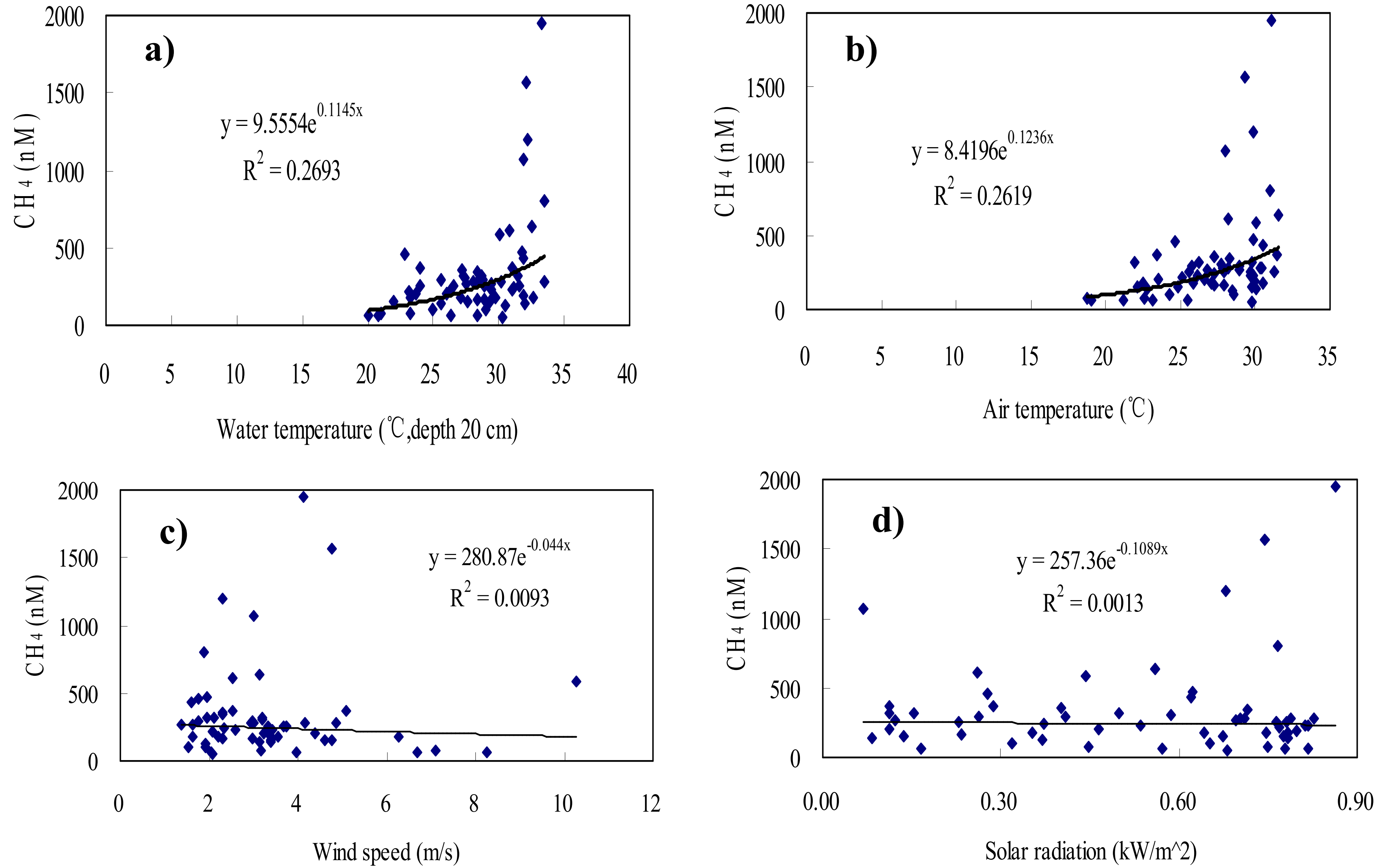

Fig 10: The correlation between CH_4 concentration and :

a) water temperature b) air temperature

c) wind speed d) solar radiation

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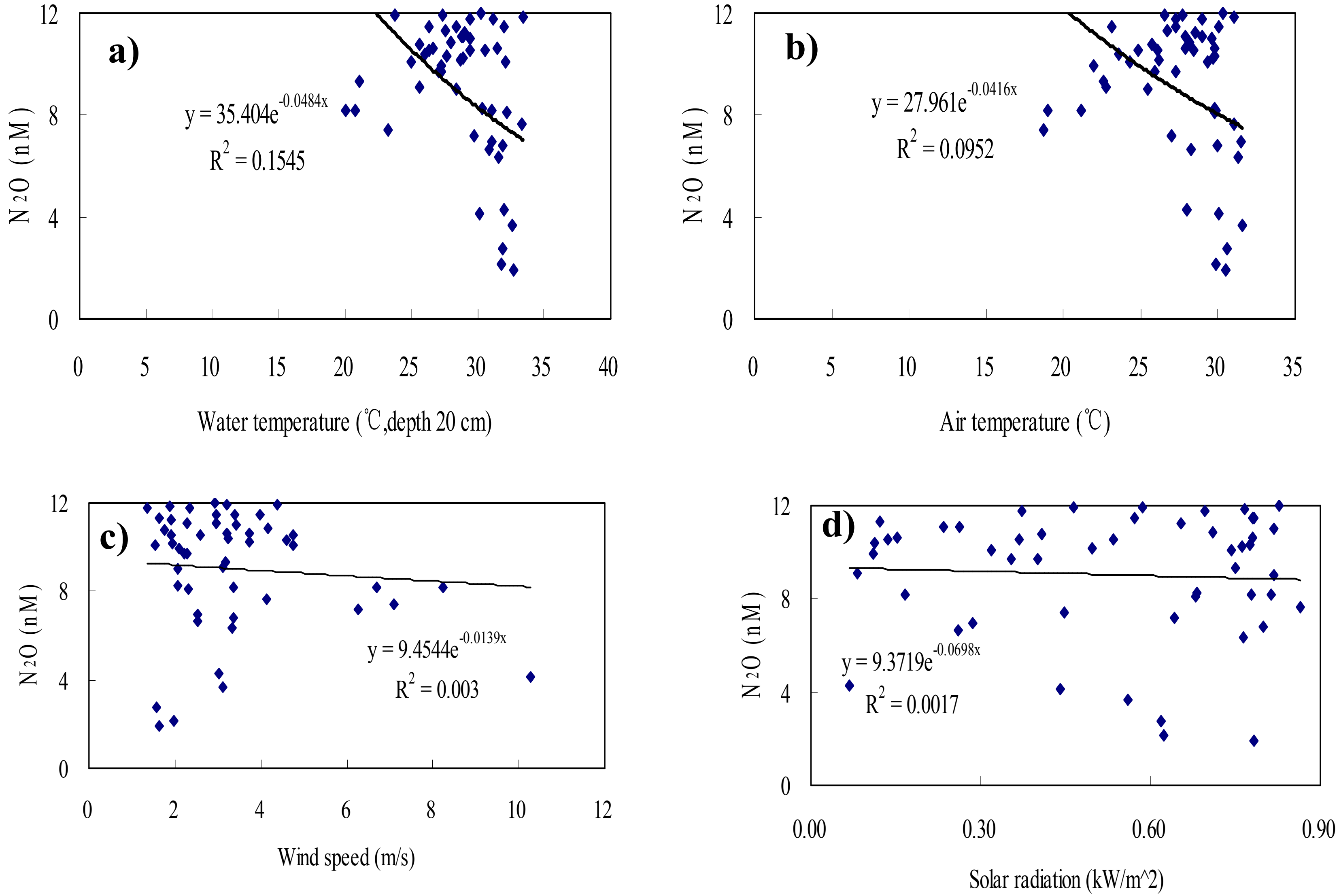

Fig 11: The correlation between N_2O concentration and :

a) water temperature b) air temperature

c) wind speed d) solar radiation

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◆5.The relationship between GHGs concentration and water quality

The correlation coefficients between CO_2 concentration and most lake chemical、physical and morphometrical variables were statistically significant, the best predictor For lake CO_2 concentration was O_2 saturation percentage, followed by NH_4-N and water temperature. *(Pirkko Kortelainen et al, Global Change Biology, 2006)*

The data of water quality is measured by YSI when spatial sampling, and the main parameters measured by YSI contain : water temperature、conductivity、pH、 oxidation-reduction potential (ORP)、 turbidity、Chlorophyll、 blue green algae（BGA)、 dissolved oxygen（DO).

The scene of measure water quality

Table 1: The Correlation between CO_2 concentration of spatial water sample and water quality ($p<0.05$)

	August (n =15)	September (n =14)	October (n =16)	whole data (n =45)
Water temperature	NS	NS	NS	NS
Conductivity	$R^2 = 0.1259$	NS	$R^2 = 0.6631$	NS
pH	$R^2 = 0.2471$	R2 =0.5674	$R^2 = 0.0234$	$R^2 = 0.2376$
ORP	NS	NS	NS	NS
Turbidity	$R^2 = 0.1411$	$R^2 = 0.1538$	NS	NS
chlorophyll	NS	$R^2 = 0.1991$	$R^2 = 0.2789$	NS
BGA	$R^2 = 0.1089$	NS	NS	NS
DO	$R^2 = 0.3043$	$R^2 = 0.939$	$R^2 = 0.7668$	$R^2 = 0.2648$

NS : no significant
BGA: blue green algae
ORP: oxidation-reduction potential
DO :dissolved oxygen
whole data: data of August, September, October

Table 2: The Correlation between CH_4 concentration of spatial water sample and water quality ($p<0.05$)

	August (n =15)	September (n =14)	October (n =16)	whole data (n =45)
Water temperature	NS	NS	$R^2 = 0.1394$	NS
Conductivity	NS	NS	$R^2 = 0.1808$	NS
pH	NS	NS	NS	NS
ORP	$R^2 = 0.193$	NS	$R^2 = 0.1576$	NS
Turbidity	$R^2 = 0.4823$	$R^2 = 0.2504$	NS	NS
chlorophyll	$R^2 = 0.2587$	NS	NS	NS
BGA	NS	NS	NS	NS
DO	NS	NS	NS	NS

NS : no significant

BGA: blue green algae

ORP: oxidation-reduction potential

DO :dissolved oxygen

whole data: data of August, September, October

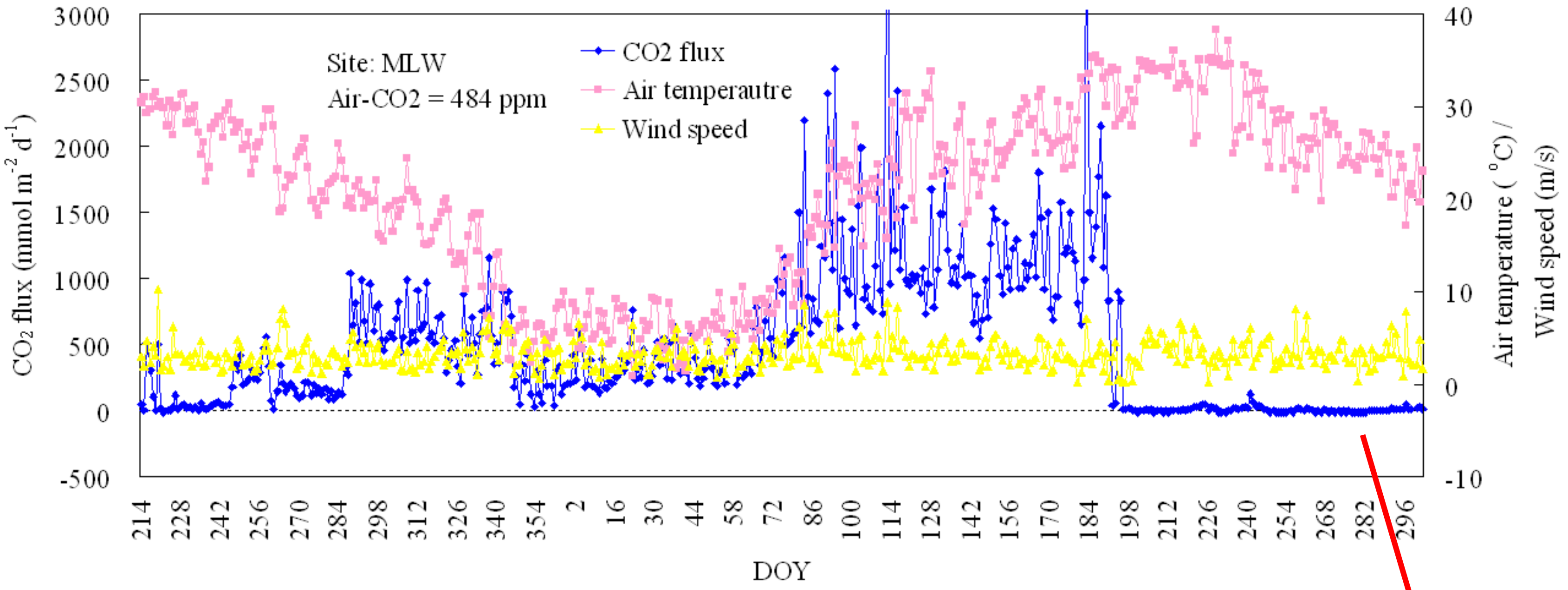
Table 3: The Correlation between N_2O concentration of spatial water sample and water quality ($p<0.05$)

	August (n =15)	September (n =14)	October (n =16)	whole data (n =45)
Water temperature	$R^2 = 0.1922$	NS	$R^2 = 0.1902$	NS
Conductivity	$R^2 = 0.7448$	$R^2 = 0.1124$	$R^2 = 0.3178$	$R^2 = 0.1856$
pH	NS	$R^2 =0.3019$	NS	$R^2 = 0.2376$
ORP	$R^2 = 0.1837$	NS	NS	NS
Turbidity	NS	$R^2 = 0.2947$	NS	NS
chlorophyll	$R^2 = 0.4055$	$R^2 = 0.3326$	$R^2 = 0.1935$	$R^2 = 0.2882$
BGA	$R^2 = 0.2255$	NS	NS	NS
DO	$R^2 = 0.1287$	$R^2 = 0.8013$	$R^2 = 3227$	$R^2 = 0.2938$

NS : no significant
ORP: oxidation-reduction potential
whole data: data of August, September, October
BGA: blue green algae
DO :dissolved oxygen

2 Flux

1.MLW CO_2 Flux



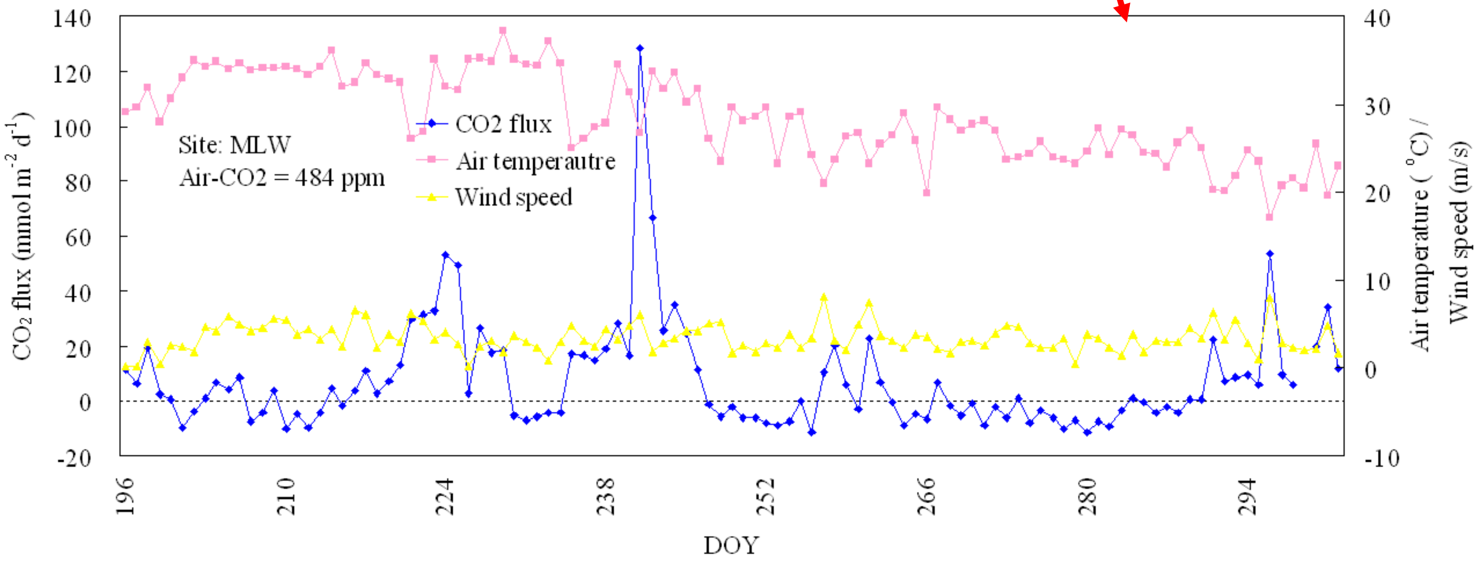


Fig 12: The flux of CO_2 . Shaking the bottle for 2 minutes from doy 65 2012. $CuSO_4$ wasn't added in water sample and water sample was Immediately analyzed after shaking 5 minutes from doy 196 2012

◆2.MLW CH_4 Flux

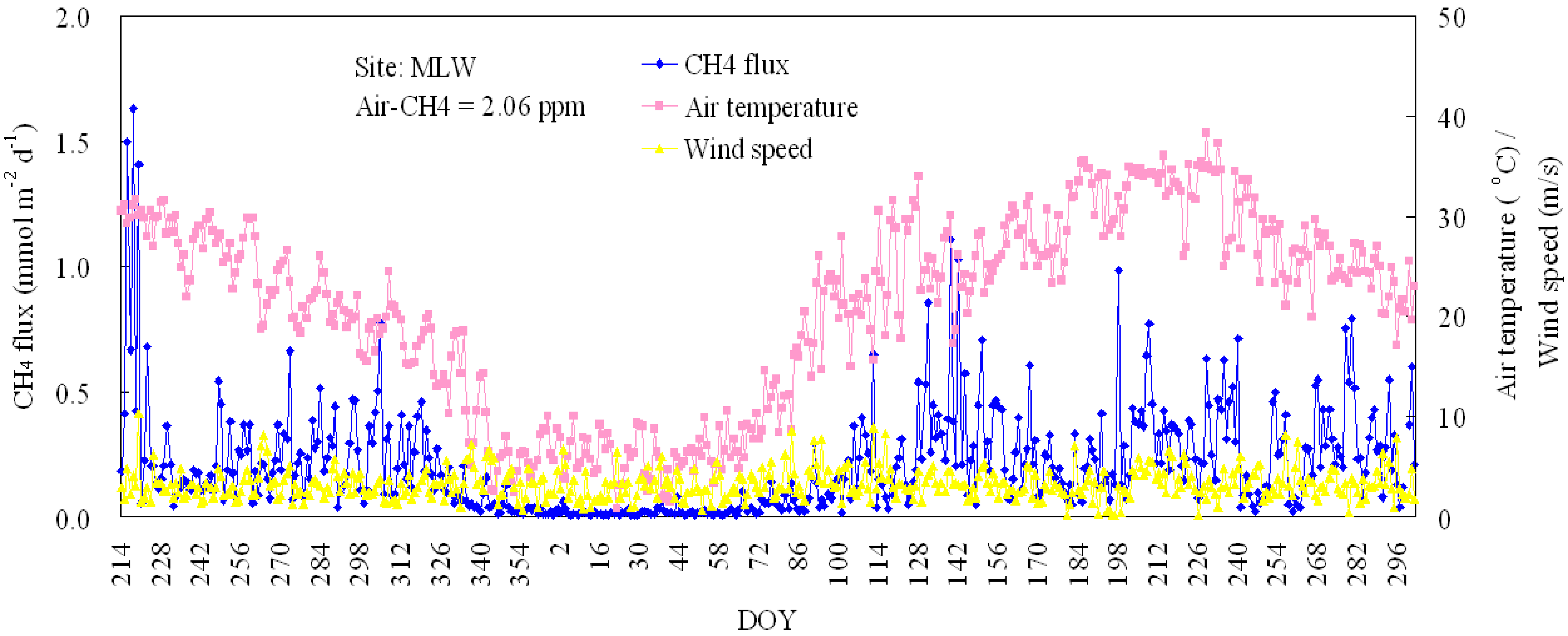


Fig 13: The flux of CH_4 . Shaking the bottle for 2 minutes from doy 65 2012. $CuSO_4$ wasn't added in water sample and water sample was immediately analyzed after shaking 5 minutes from doy 196 2012

◆3.MLW N_2O Flux

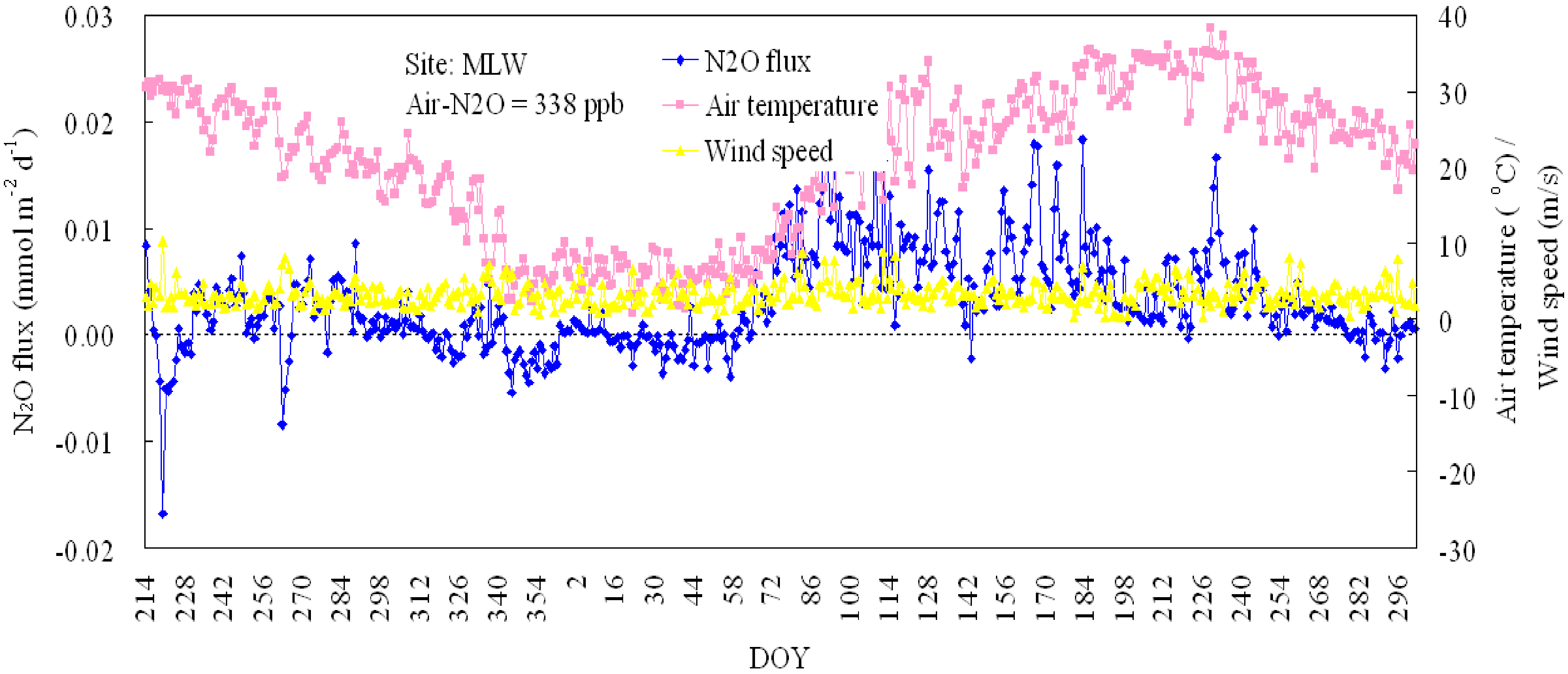


Fig 14: The flux of N_2O . Shaking the bottle for 2 minutes from doy 65 2012. $CuSO_4$ wasn't added in water sample and water sample was immediately analyzed after shaking 5 minutes from doy 196 2012.

◆4. Compare the CO_2 and CH_4 flux measured by three different methods.

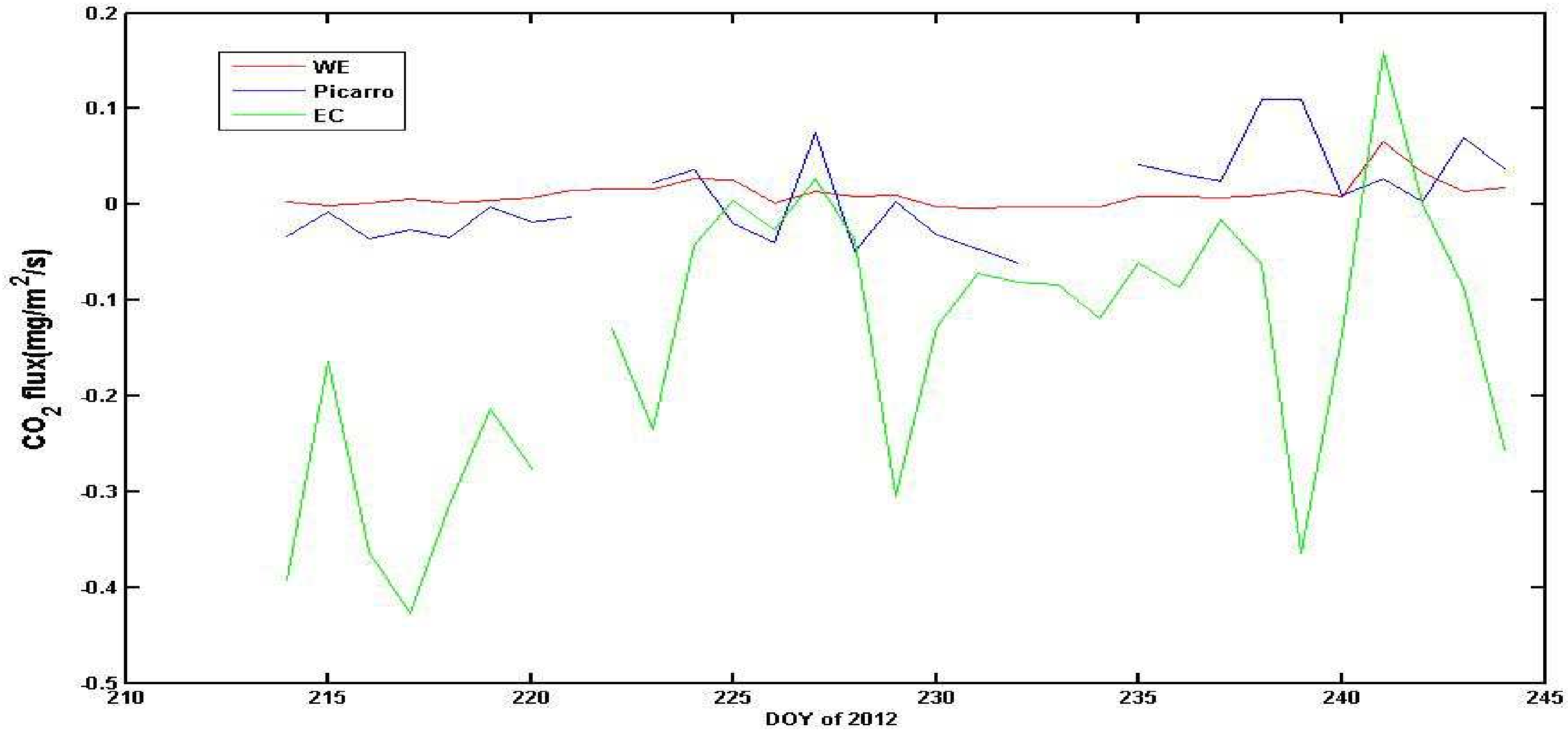


Fig 15: CO_2 flux of August,2012 measured by gradient diffusion method (Picarro), eddy covariance system (EC) and water equilibrium method (WE).

Median values of EC, Picarro, WE were -0.1428, 0.0066, 0.0106 $mgm^{-2}s^{-1}$

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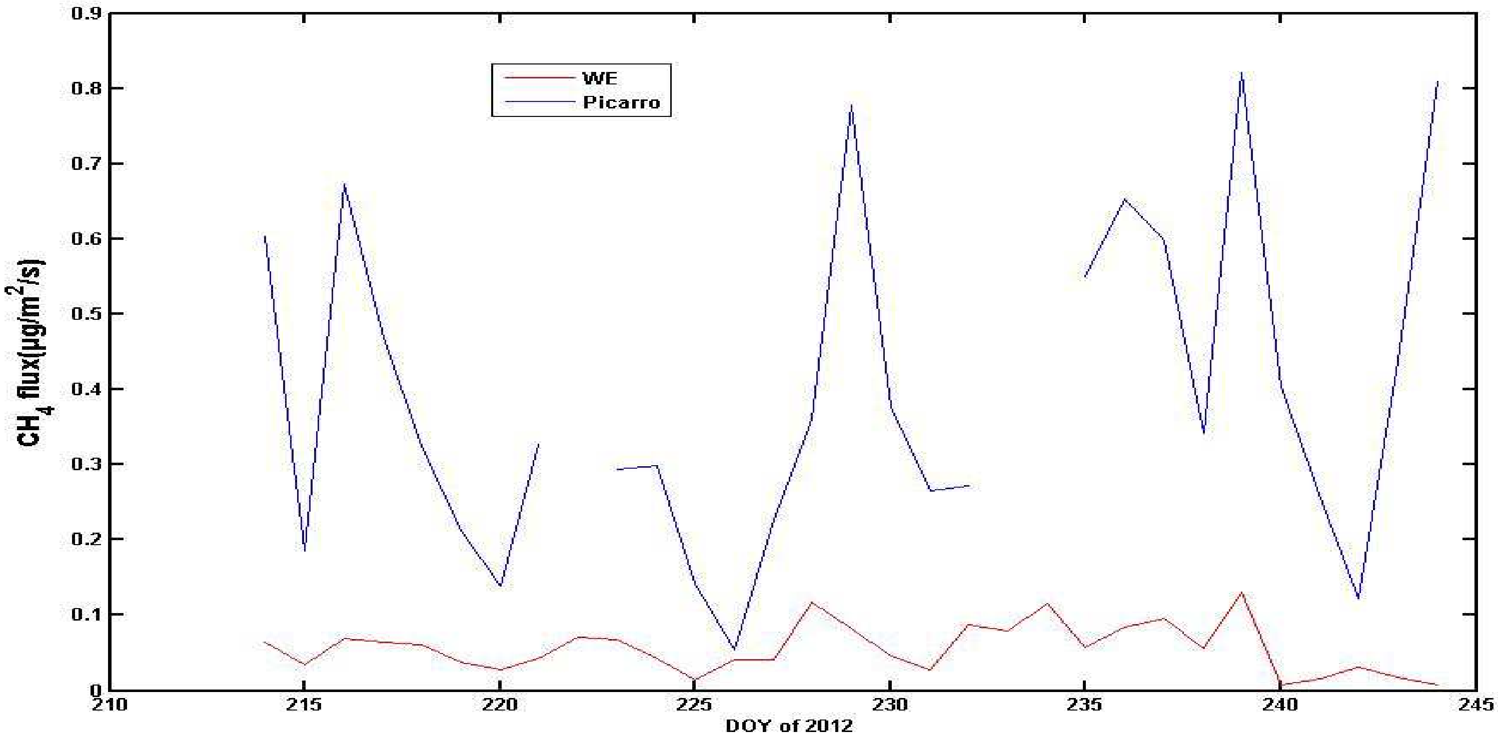

Fig 16: CH_4 flux of August,2012 measured by gradient diffusion method (Picarro), eddy covariance system (EC) and water equilibrium method (WE).

Median values of Picarro, WE were 0.3927, 0.06 $\mu\ gm^{-2}s^{-1}$

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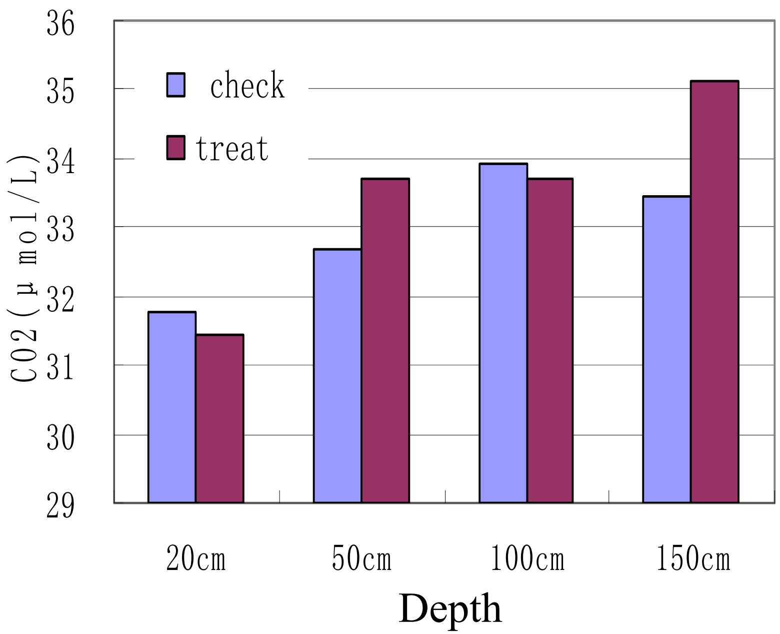
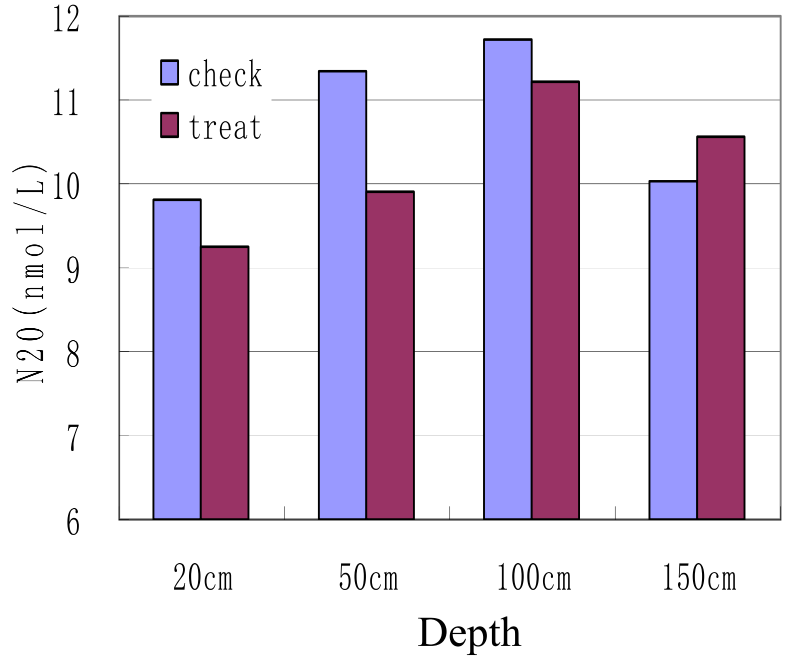
3 Challenge & Question

◆1.The impact of analysis time on GHGs concentration





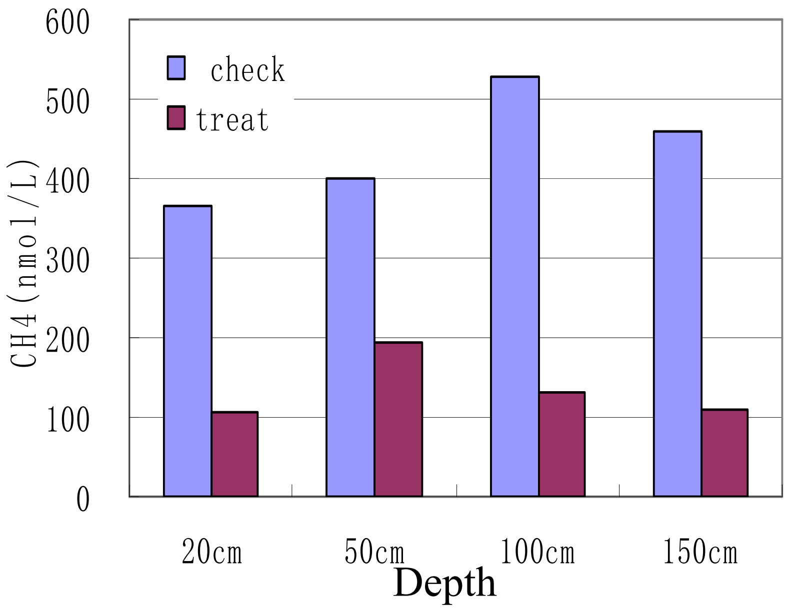


Fig 17: The impact of analysis time at different water depth.

check : water sample was analyzed as soon as possible .

treat : 20cm analyzed after 7days
50cm analyzed after 10 days
100cm analyzed after 14days
150cm analyzed after 18days

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◆2.Cacluate CO_2 concentration by using data of alkalinity

- Oak Ridge National Laboratory pointed out that they can use two of the four measureable parameters of the CO_2 system (total alkalinity, total inorganic CO_2, pH, and partial of CO_2) to calculate the other two parameters through a program.

- The relationships between CO_2 concentration and lake chemistry were examined using Pearson's concentration coefficients ,and stepwise multiple linear regression models predicting CO_2 concentration were carried out.

  eg. $\ln CO_2(\mu M) = 6.24 - 0.0266 O_2(\%) + 0.130 \ln conductivity(mSm^{-1})$

(Pirkko Kortelainen et al. Sediment respiration and lake trophic are important predictors of large CO_2 evasion from small boreal lakes. Global Change Biology. 2006)

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- **A Slide Rule for Carbonate Equilibria and Alkalinity in water supplies .**

$$CO_2 = 9.70 \times 10^{10} (H^+) \times F(\text{Alk, pH})$$

$$\frac{\left[\dfrac{Alk}{50{,}000} + (H^+) - \dfrac{10^{-14}}{(H^+)}\right]}{1 + \dfrac{11.22 \times 10^{-11}}{(H^+)}} = F(Alk, \text{pH})$$

CO_2 : ppm
(H^+) :hydrogen-ion concentration, mol/L
Alk： total alkalinity , ppm $CaCO_3$

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Thank You