Study of GHGs Flux of water-air Interface and Its Concentration Chang of Lake water,TaiHu

Qitao Xiao

Outline

1 Background

2 Purpose and Significance

3 Content

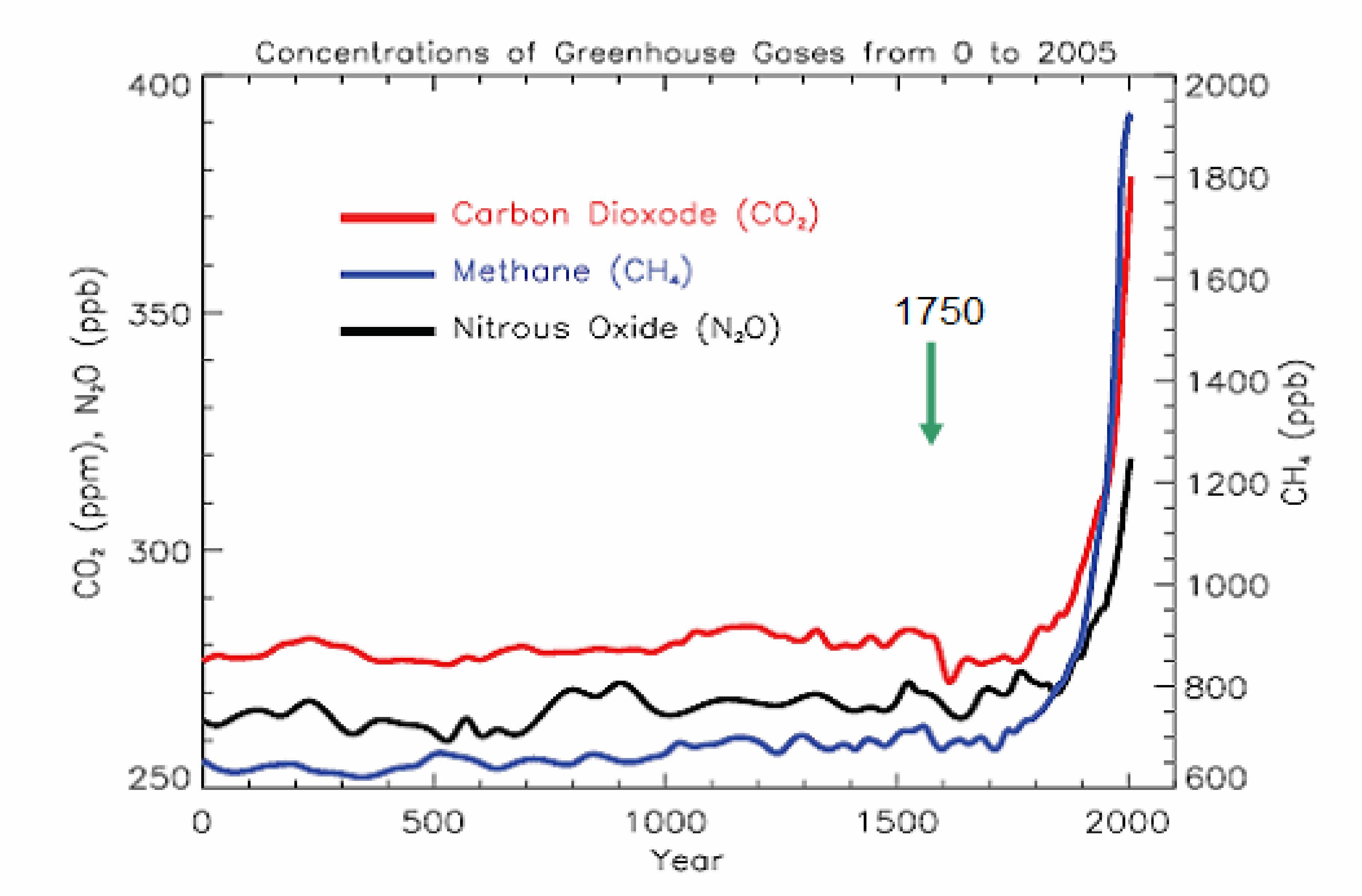
4 Methods

5 Innovation

6 Progress

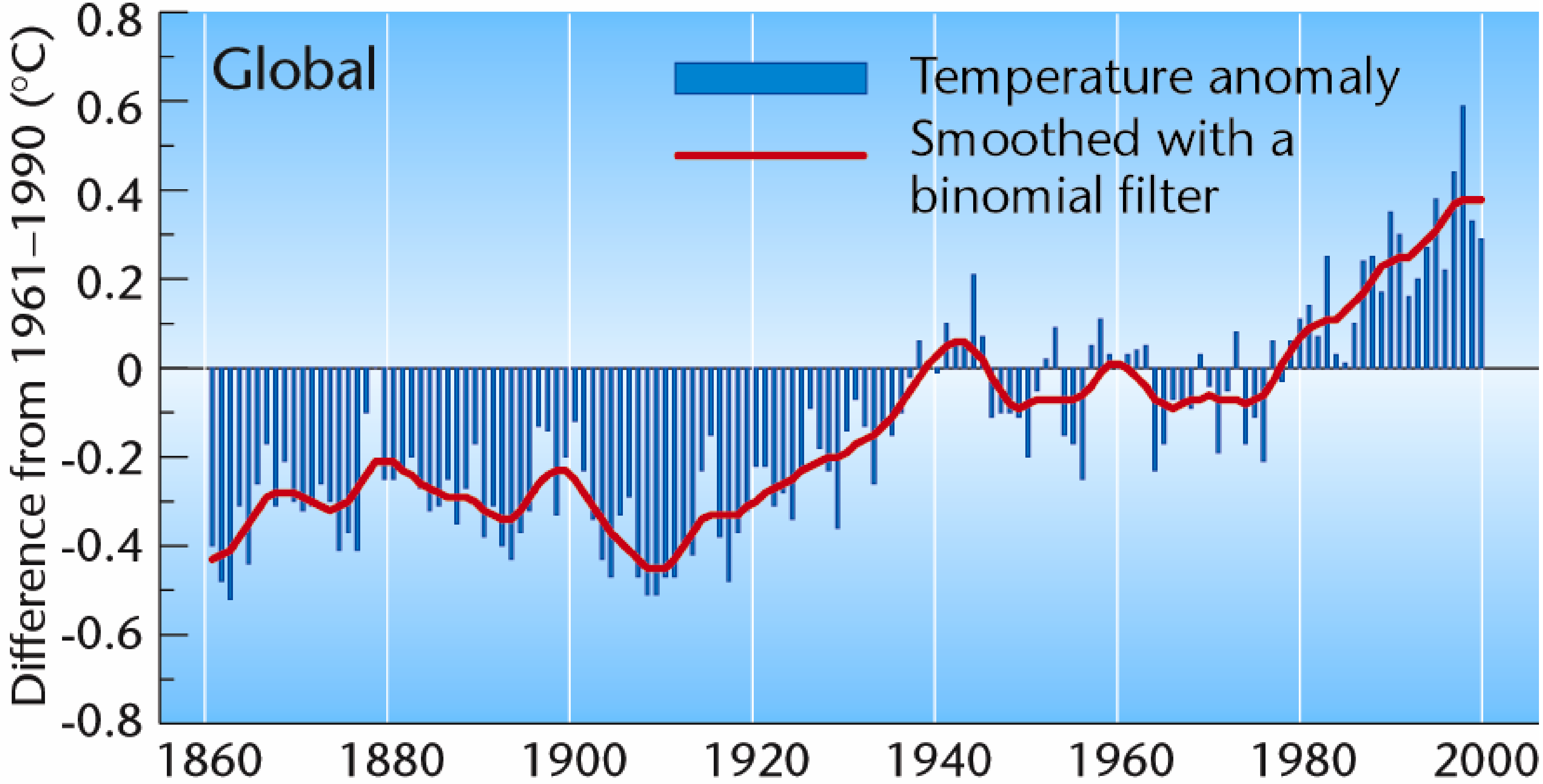
1 Background

Atmospheric concentrations of GHGs over the last 2000 years



Increase since about 1750 are attributed to human actvities in the industial area

Increased concentration of greenhouse gases affect the global temperature



IPCC ,2001

Increasing atmospheric concentrations of greenhouse gases CO_2, CH_4, and N_2O have stimulated research on their emission from terrestrial and aquatic environments (Conrad 1996,Segers 1998).

Over the last decade, several field studies conducted worldwide have shown that reservoirs constitute sources of greenhouse gases (GHG) for the atmosphere（ Nicolas Soumis et al. 2004）.

Average fluxes of CO_2 and CH_4 from the surfaces of different ecosystems.

downward arrows indicates net consumption by ecosystems (sinks)

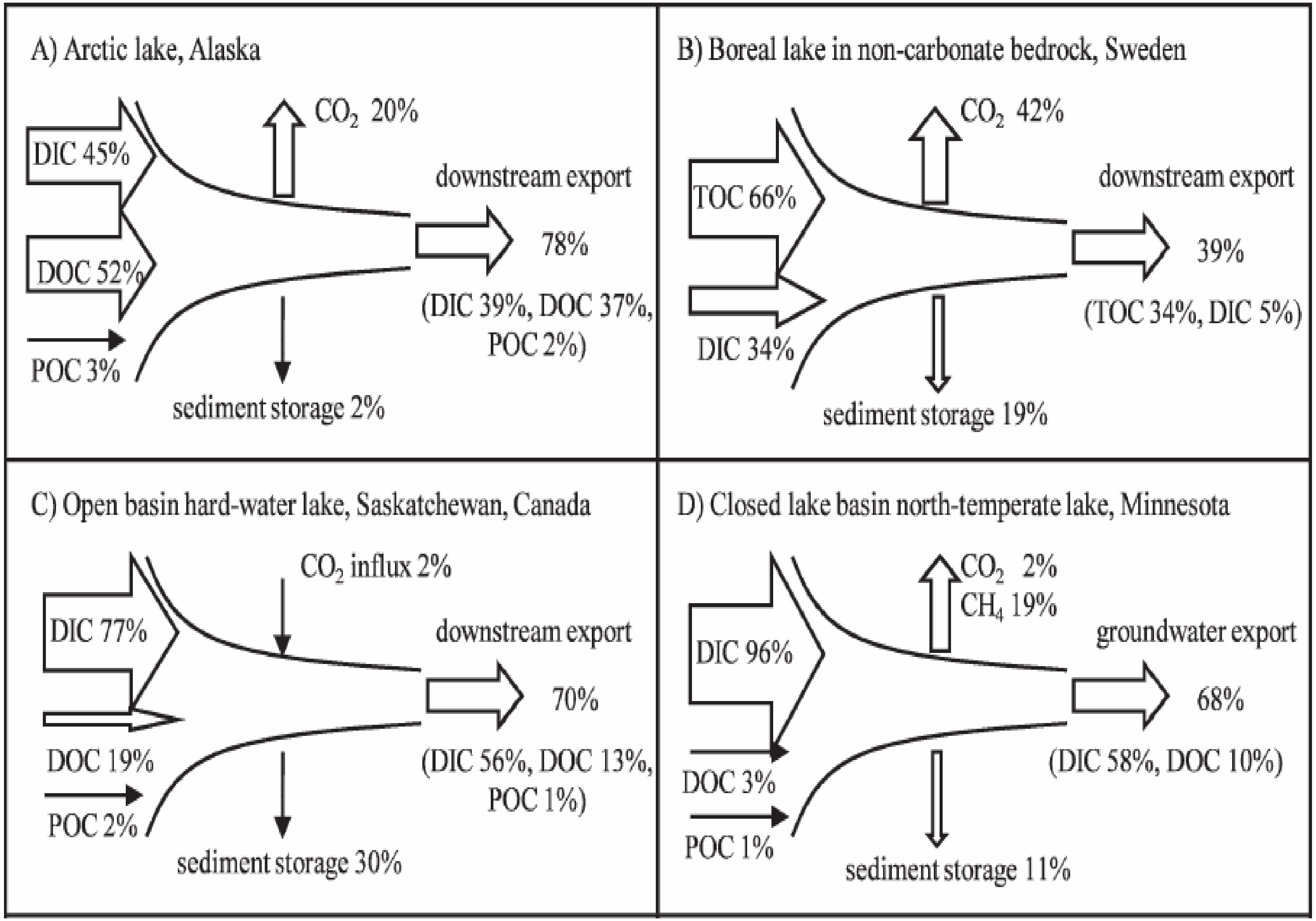
upward arrows indicate net flux to the atmosphere (sources)

Ecosystem	**Areal flux $(mg \cdot m^2 \cdot d)$[a]** CO_2	CH_4
Temperate reservoirs	*1500↑*	*20↑*
Tropical reservoirs	*3000↑*	*100↑*
Boreal/temperate forests	2100↓	1.0↓
Tropical forests	710↓	0.2↓
Northern peatlands	230↓	51↑
Lakes (worldwide)	700↑	9↑[b]

Vincent L et al.2000.Bioscience

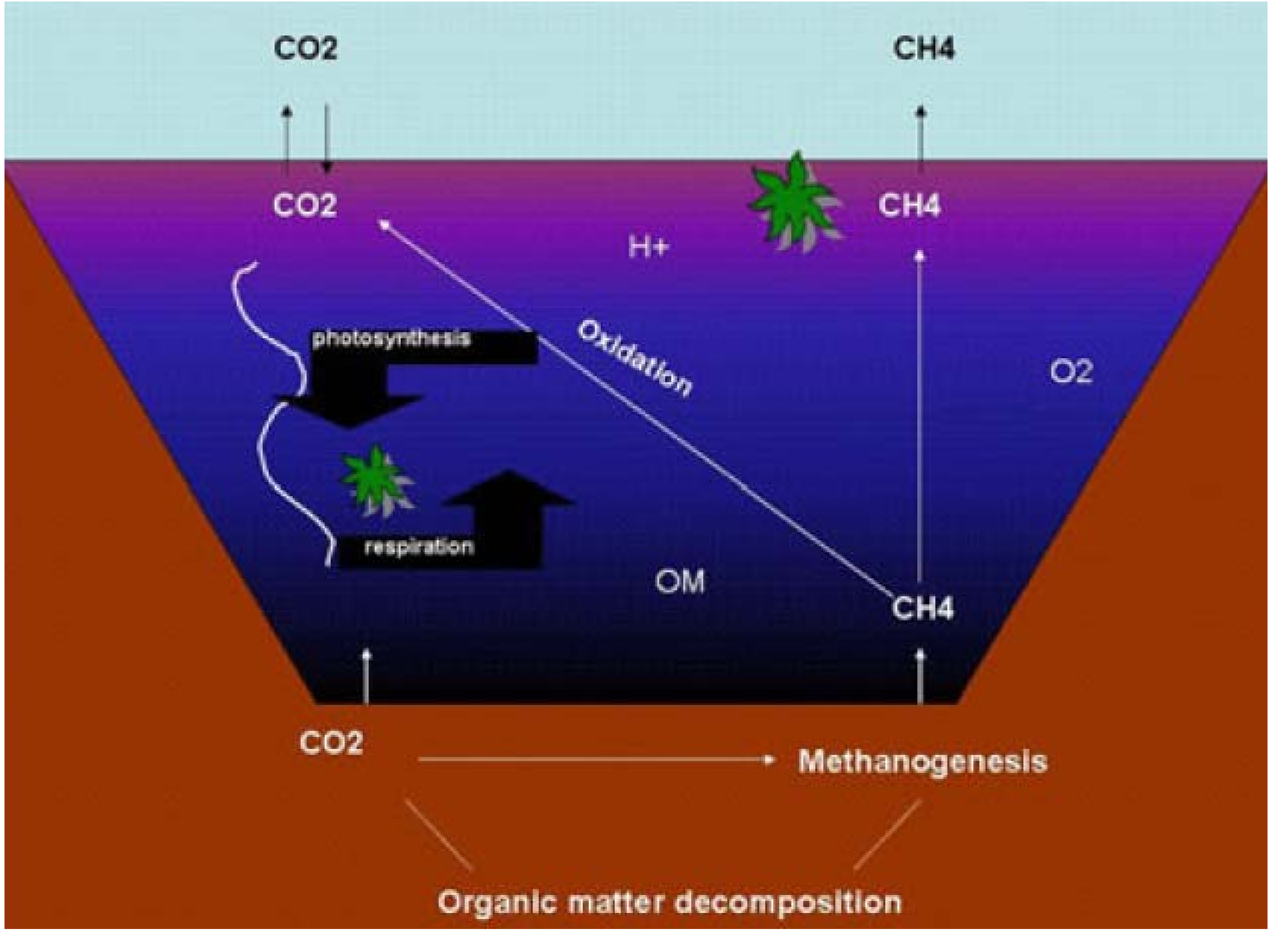
the global C cycle of lake in diverse lakes (by applying the ‘active pipe’ concep

DIC :dissolved inorganic carbon DOC :dissolved organic carbon
POC :particulate organic carbon TOC :total organic carbon



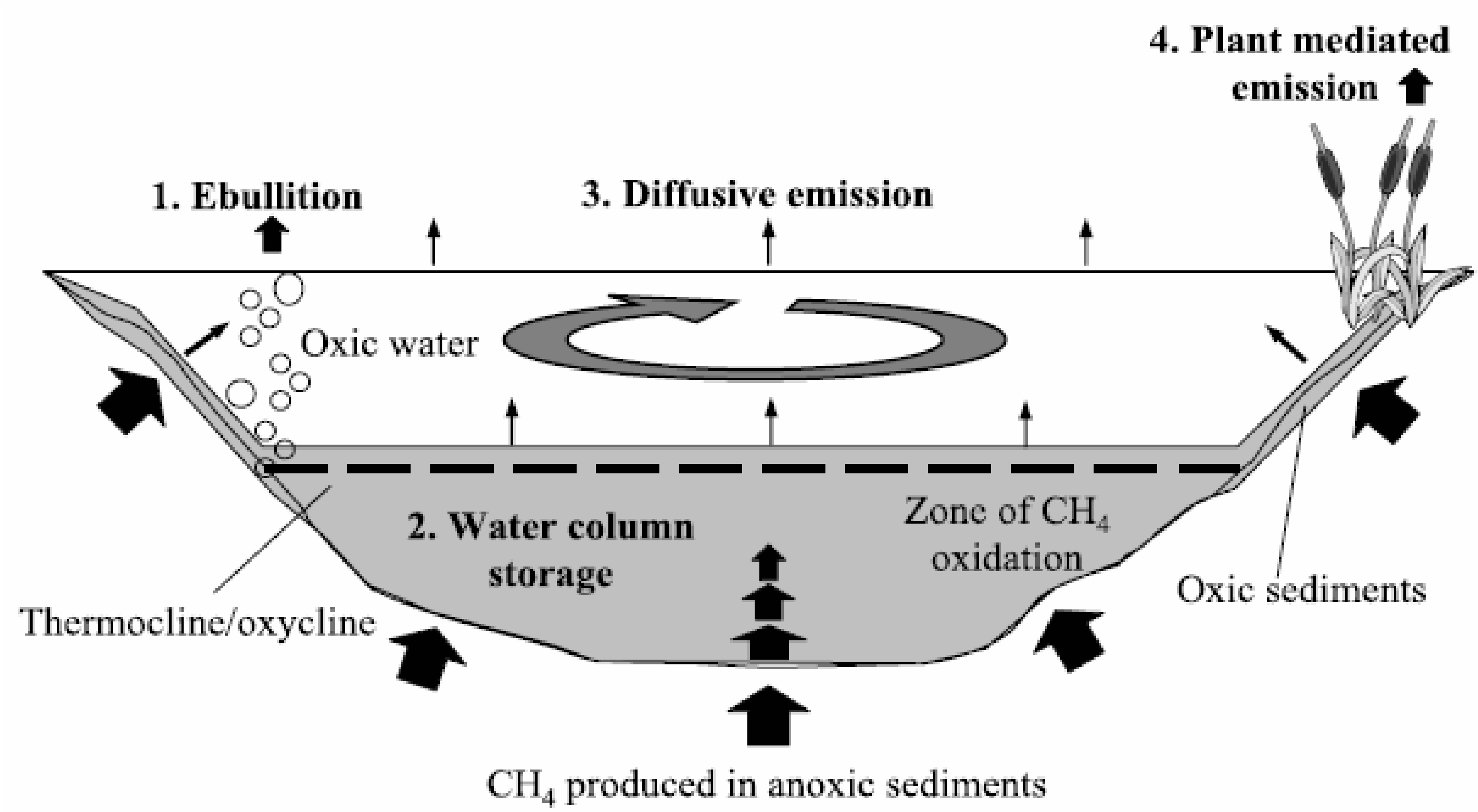
Lars J. Tranvik et al. 2009 .Limnol. Oceanogr

Simplified illustration of CO2 and CH4 dynamics in water bodies (OM organic matter）



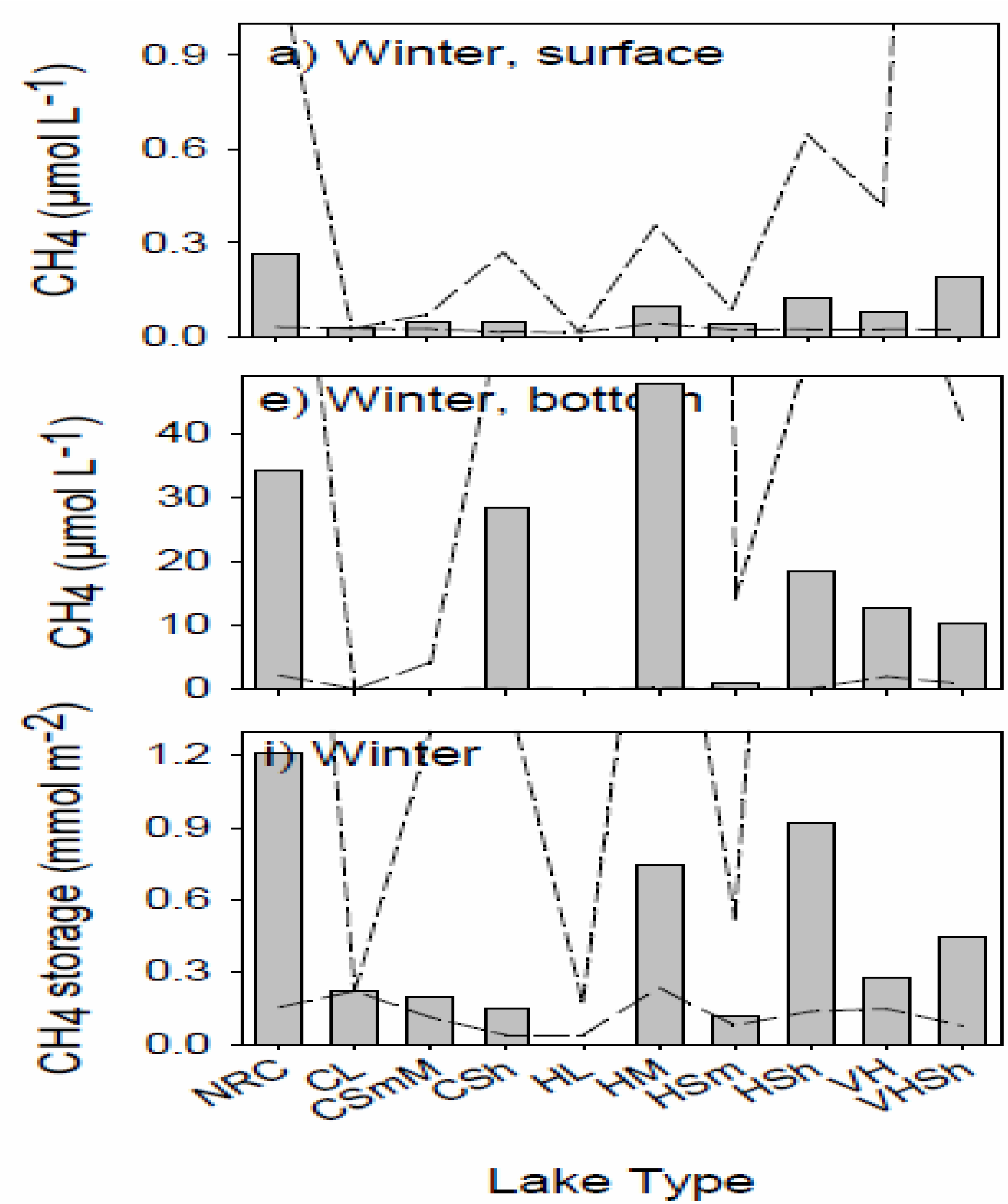
Schrier-Uijl et al. 2011. Biogeochemistry

The emission pathways of GHGs in lake(CH_4, for example)



David Bastviken et al .2004. GLOBAL BIOGEOCHEMICAL CYCLES

The dynamics of GHGs in different lake types (CH4 for example)



the type of the Lake

NRC:Nutrient rich and calcareous
CL :Clear, large
CSmM:Clear, small and middle size
SSh :Clear, shallow
HL :Humic, large
HM :Humic, middle size
HSm:Humic, small
HSH:Humic, shallow
VH:Very humic
VHSH:Very humic, shallow

S. Juutinen et al. 2009. Biogeosciences

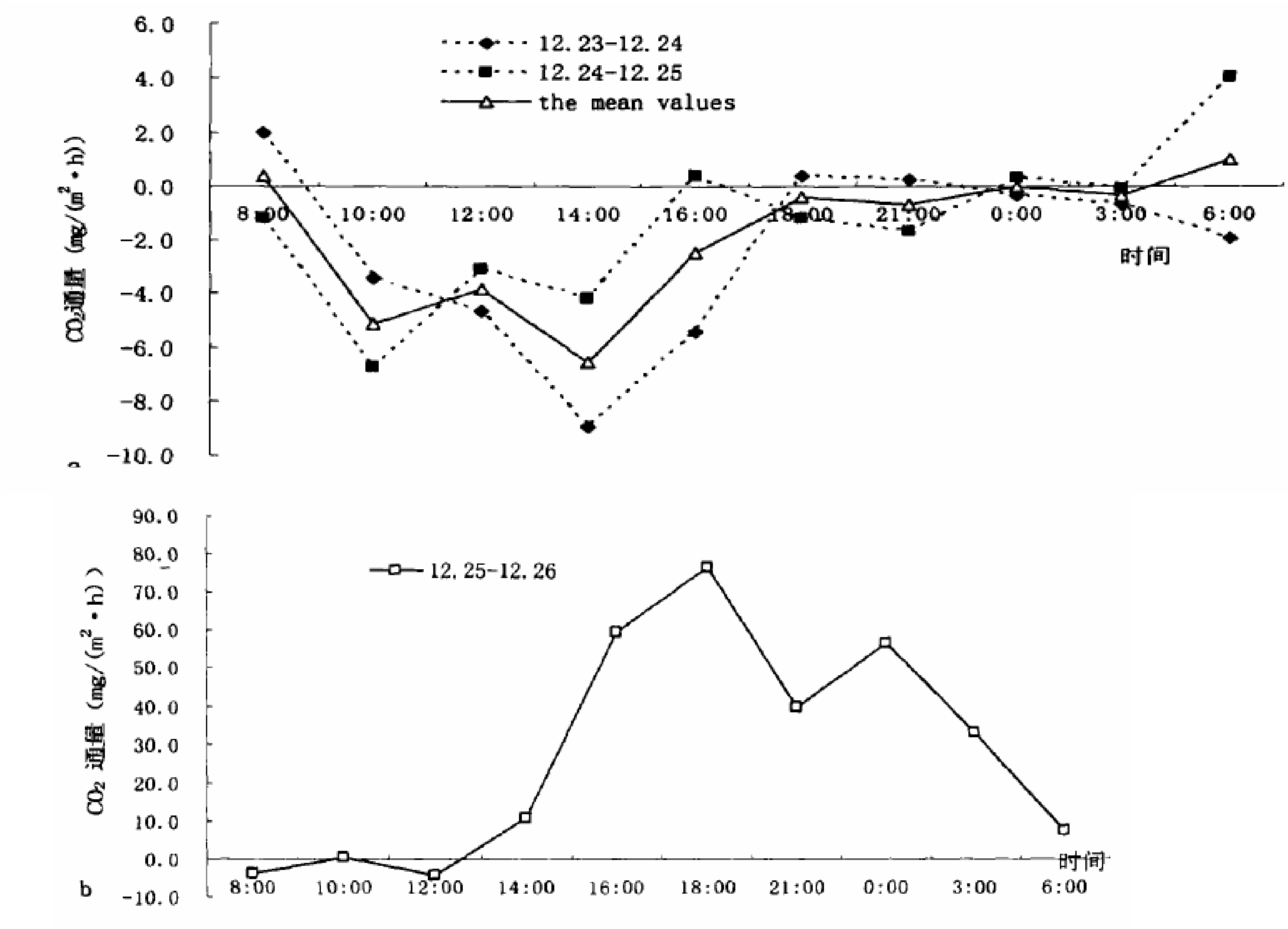
Relative research in China: Lake Taihu

The mean values of diurnal variation in Lake Taihu

CO_2 flux mg/（m^2·h）	Spring	Summer	Autumn	Winter
MLW （sunny ）	-0.81	-5.09	-5.29	-1.81
DTH （cloudy)	11.36	-2.45 （sunny ）	-	-
Lake Central （cloudy)	5.04	-	-	-

胡维平等. 生态环境. 2004

Diurnal variation of CO_2 flux on water-air interface of MLW, Taihu Lake in wintertime



李香华等. 生态学杂志. 2005

2 Purpose and Significance

1).Science assume

Based on relative information, we assumed that Lake Taihu as sources of the GHGs to the atmosphere, and it emissions CO_2、CH_4 and N_2O from the interface of water-air to atmosphere.

2).The purposes of the study

First, to determine the fluxes of CH_4、CO_2 and N_2O across the air–water interface of Lake Taihu, a shallow, eutrophic, subtropical lake

Second, to describe the temporal variations of CH_4、CO_2 and N_2O fluxes and discuss the factors affecting the change

Third, to estimate the C source/sink function of the air–water interface, with discussion on the possible dominant factors in shaping these patterns

3).The Significance of the study

Accurate, objective evaluation the contribution of the aquatic ecosystems to GHGs and provide data for the estimate of GHGs emission from fresh water bodies.

Provide support for the pollution control of lake.

3 Content

1).Study of GHGs concentration of Lake Taihu

(1)Temporal variation

Sampling at fixed time ,12:00 am every day

1).Study of GHGs concentration of Lake Taihu

(2) Diurnal variation

sampling every three hours

observed for 3 consecutive days

once a month

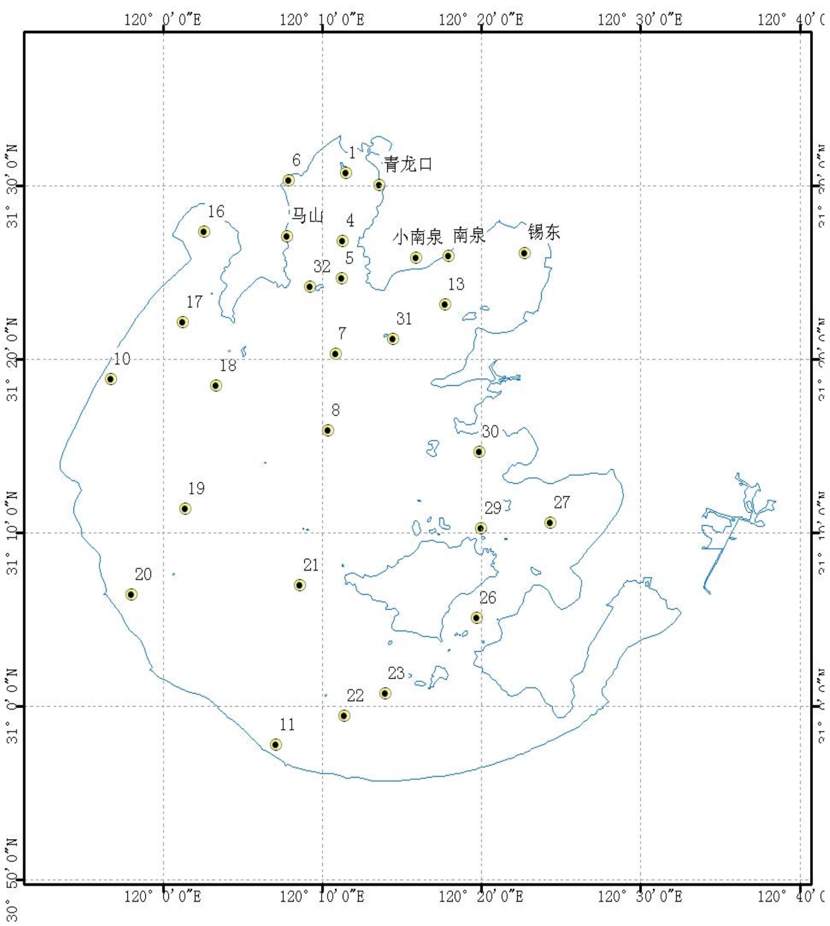
1).Study of GHGs concentration of Lake Taihu

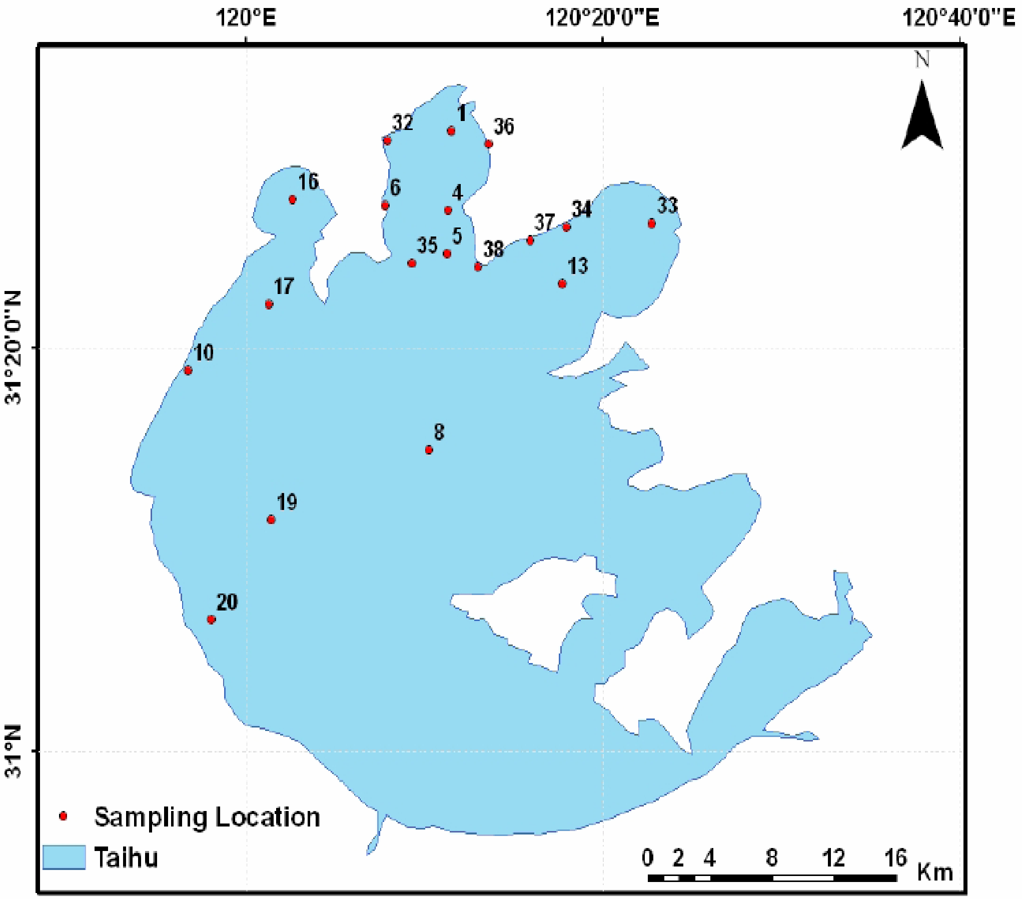
(3) Vertical profiles

Sampling at 20cm、 50cm、 100cm、 150cm of underwater，respectively

1).Study of GHGs concentration of Lake Taihu

(4) Spatial Variation





2).Study of GHGs flux of Lake Taihu

(1) Temporal variation

(2) Diurnal variation

(3) Spatial Variation

3).Analysis of mechanism

(1) Relationship between micrometeorology and [GHGx] (Fluxes)

①water temperature (include below 20cm、50cm、100cm、150cm）

②air temperature

③Solar radiation

④ wind speed

⑤wind direction

⑥precipitation

3).Analysis of mechanism

(2) Relationship between water quality and [GHGx] (Fluxes)

① pH

②dissolve oxygen

③alkalinity

④Chlorophyll

⑤Electrical conductance

⑥Turbidity

⑦The condition of algae bloom

⑧Oxidation-Reduction Potential

4 Methods

1).Gas Chromatograph method

(1)Sampling

Water samples were collected and poured into glass bottles, without air bubbles, then sealing the stopper with parafilm.

1).Gas Chromatograph method

(2) pre-treatment water samples

Headspace by N_2,100ml

Sterilization by $CuSO_4$ of 2%,5ml

1).Gas Chromatograph method

(3)Gas sampling

the conditions of Gas sampling:

Standing for some time

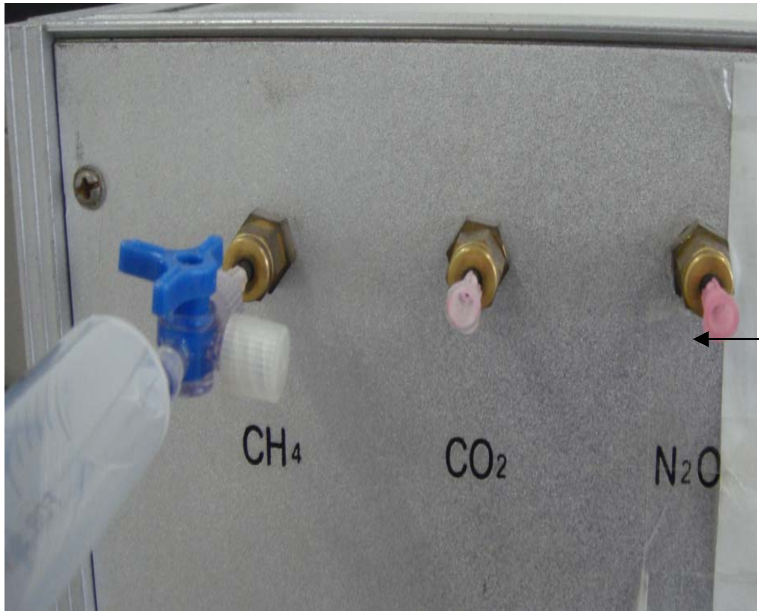
Gas-liquid two-phase equilibrium

20ml

1).Gas Chromatograph method

(4)Sampling and analysis

CA-6 gas injection device



the modified Agilent gas chromatograph

Measurement $[X]_G$ (CH4,for example)

$$\frac{CH_4\text{标准气体浓度}}{CH_4\text{标准气体峰面积}} = \frac{\text{样品气体 }CH_4\text{ 浓度}}{\text{样品气体 }CH_4\text{ 峰面积}}$$

1).Gas Chromatograph method

(4) Calculate the concentration of GHGs

$$[X]_L^0 = [X]_G \times (1/K + \beta)$$

$K = [X]_G / [X]_L$ $\beta = \mathbf{V_G / V_L}$

$[X]_G$ measured by GC

$[X]_L$ calculated by material equilibrium

V_G、 $[X]_G$

V_L、 $[X]_L$

1）.Gas Chromatograph method

(5) The study of flux

the flux was calculated using the following equations:

$$F = k\ (C_w - C_{eq}) \cdots\cdots (1)$$

where k is a piston velocity that was calculated by

$$k/k_{600} = (Sc/Sc_{600})^{(-n)} \cdots\cdots (2)$$

$U_{10} < 3.7 m/s$ $n=2/3$ $U_{10} > 3.7 m/s$ $n=0.5$

$$U_{10}/U = \ln(10/Z_0)/\ln(3.5/Z_0) \cdots\cdots (3)$$

where Z_0 is roughness $Z_0 = 0.00035m$

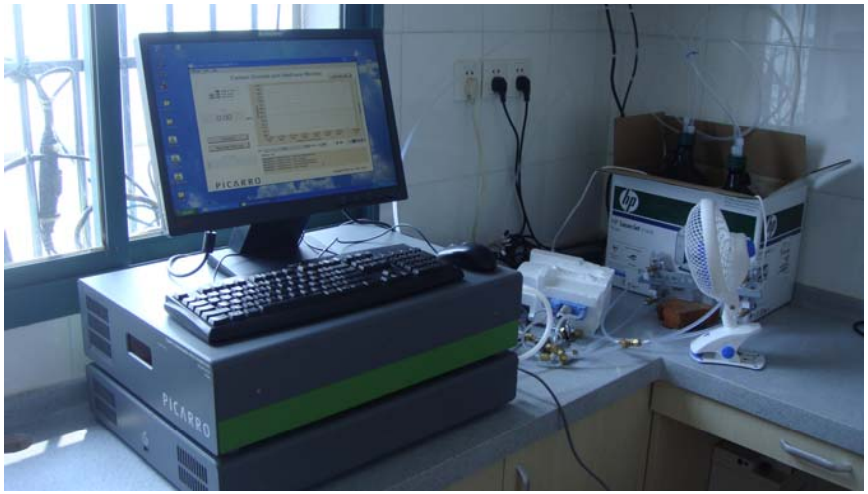
where U refers to the wind speed at the 3.5-m height

k_{600} is the corresponding value for Sc600

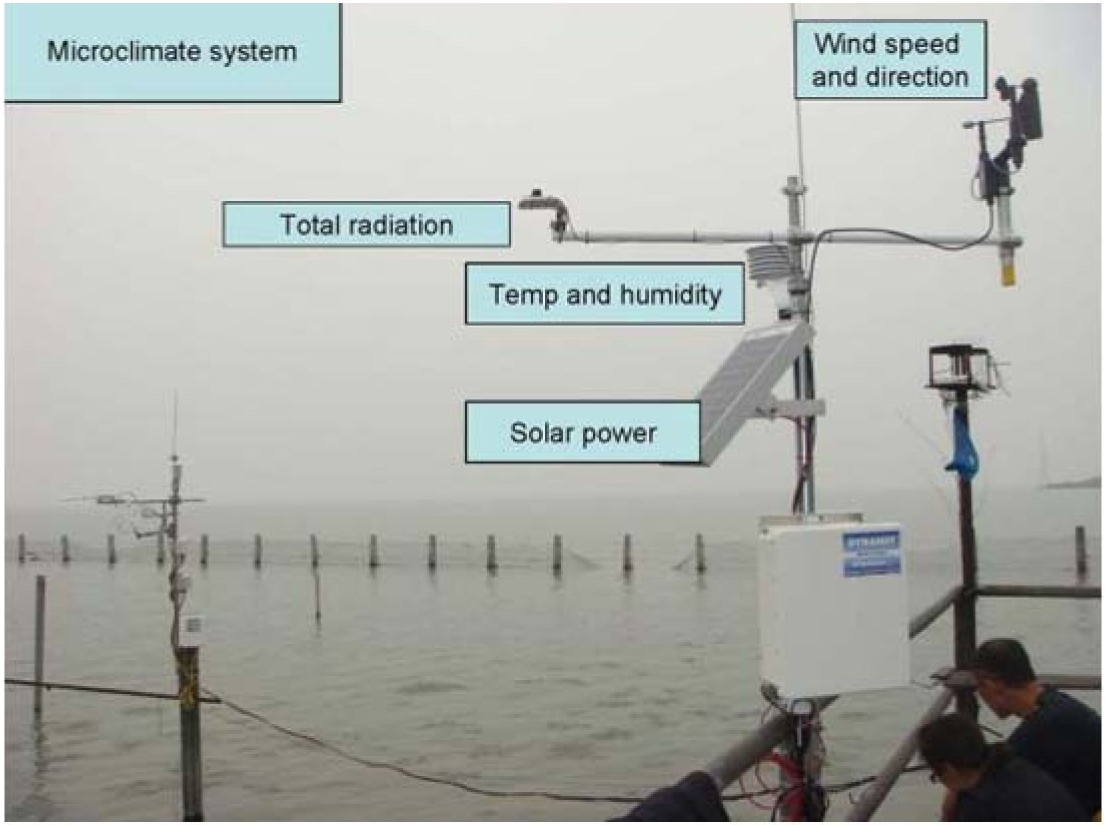
$$k_{600} = 2.07 + 0.215U_{10} \cdots\cdots (4)$$

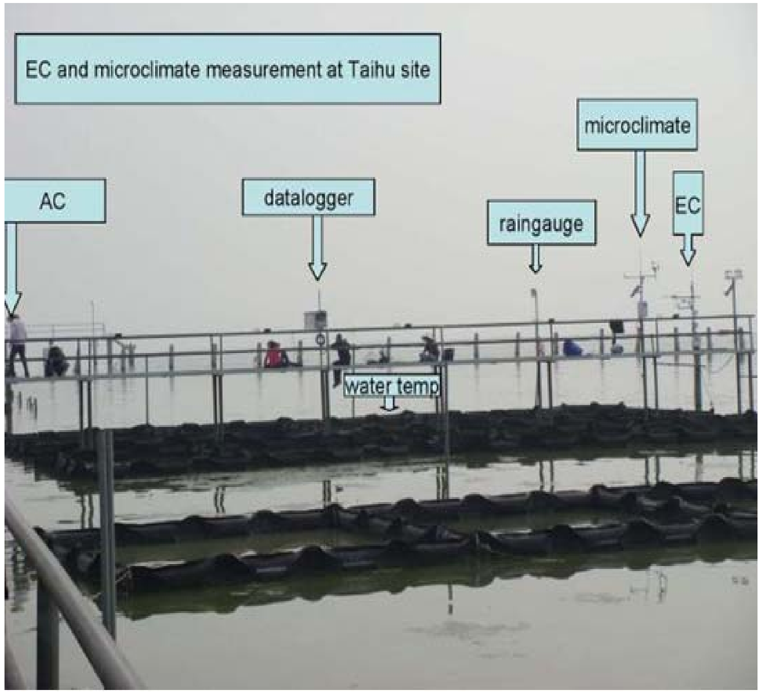
2).Picarro CO2、CH4 analyzer

Sampling port



3).Access to the data of meteorological





4).Access to the data of water quality

太湖站水华预警监测现场测定结果

			采样时间:	2010年 5 月 27 日					
水华	采样时间	水温℃	电导率Sp/Cond (ms/cm)	pH	ORP (mV)	浊度 (NTU)	Chlorphy (ug/L)	BGA (cells/mL)	DO (mg/L)
有蓝藻颗粒	6:51	22.76	0.536	7.92	442.7	19.5	5.7	2304	8.24
有蓝藻颗粒	7:17	22.9	0.524	7.47	472.7	20.2	13.1	3209	6
有蓝藻颗粒	7:24	22.86	0.627	7.66	386.3	12.5	2.4	1925	7.29
有蓝藻颗粒	7:48	23.31	0.67	7.6	516.8	45.0	21.2	4675	6.67
有蓝藻颗粒	8:20	22.52	0.493	8.06	437.8	27.1	3.9	1963	8.42
有蓝藻颗粒	8:33	22.49	0.488	8.02	444.7	42.9	4.9	2526	8.34
有蓝藻颗粒	8:56	22.4	0.507	8.05	444.1	53.6	4.6	2467	8.45
有蓝藻颗粒	9:33	23.34	0.525	8.07	418.8	11.1	1.1	1582	8.46

5 Innovation

The innovation of the study

1. GC combined with Picarro

2. Synchronous study the CO2、CH4 and N_2O

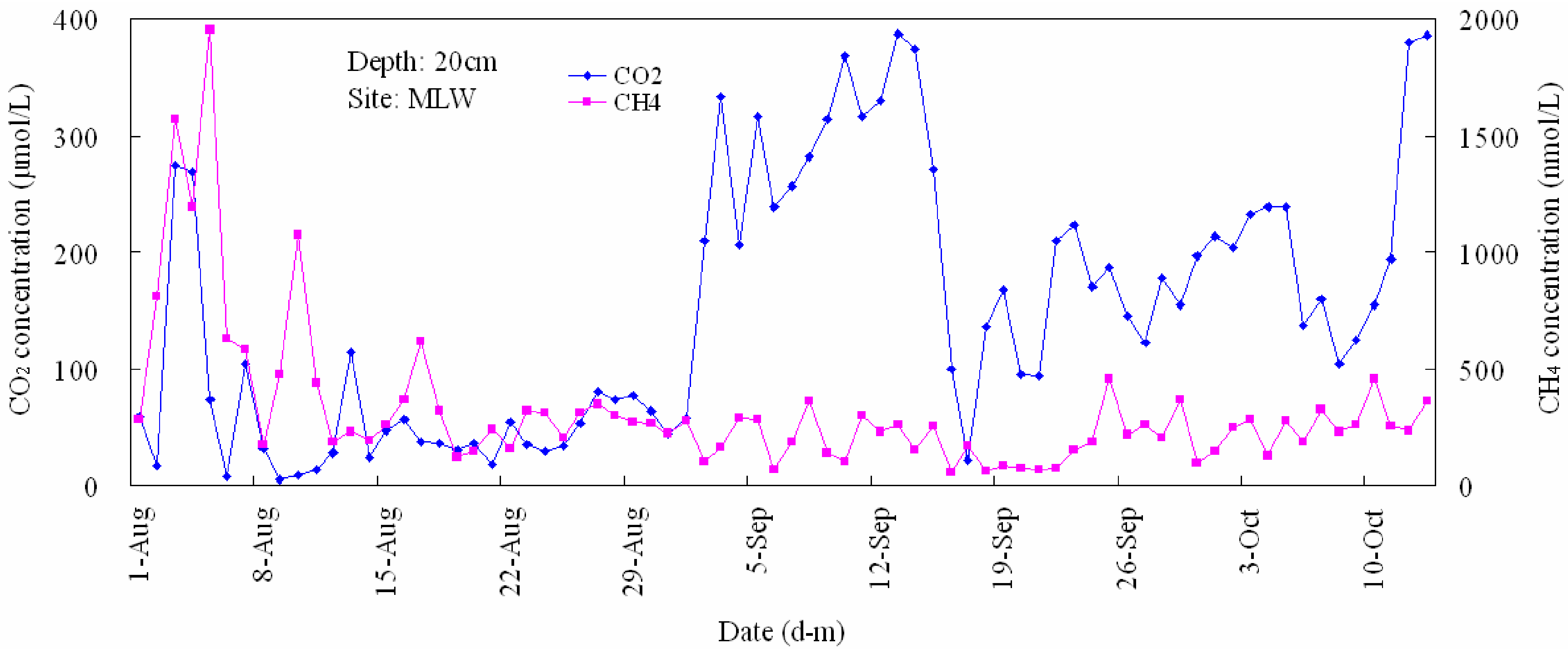
The innovation of the study

3.Research related to freshwater lakes is mostly concentrated in the small and medium lakes which productive is not high, deep lakes, ecological and hydrological characteristics of simple types, and the study of medium-sized lake which affected by human activities is more complex has not been reported in the literature .

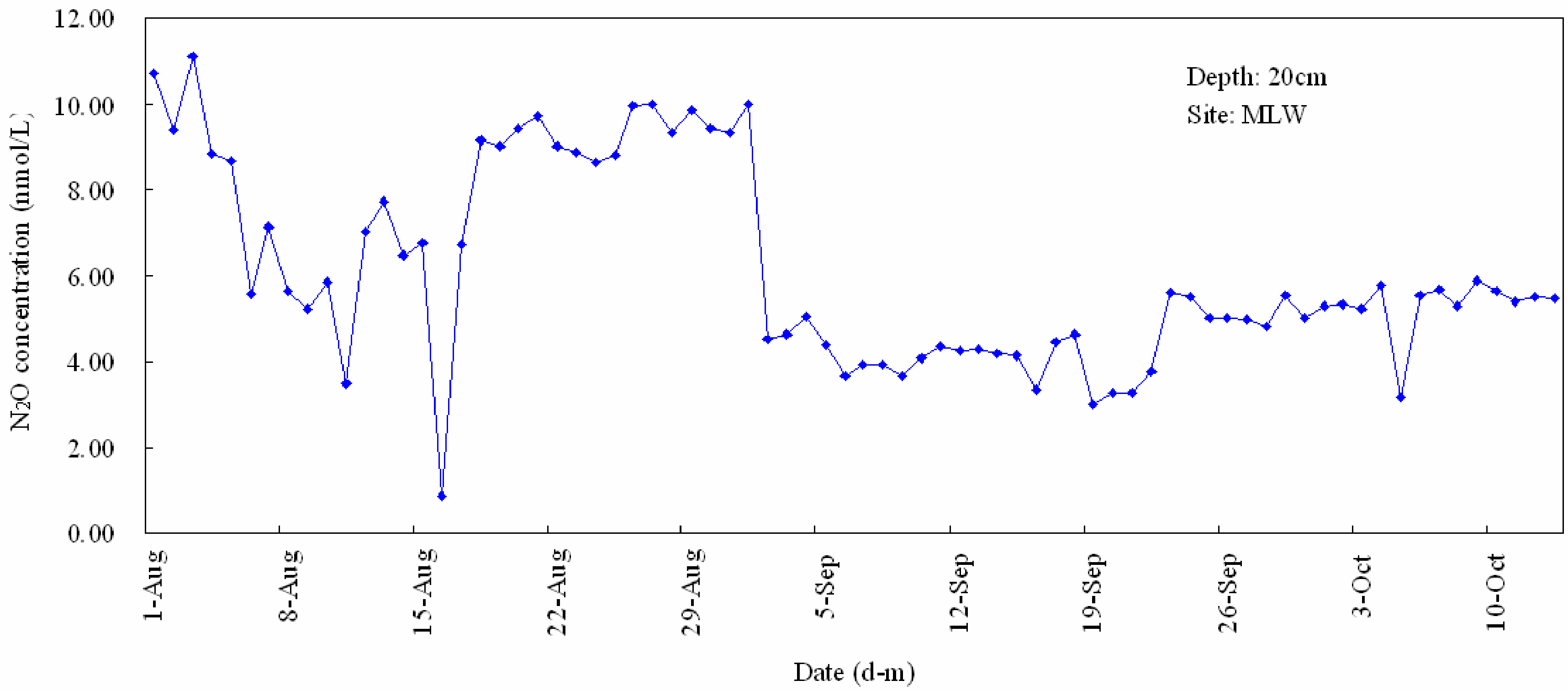
The study of Lake Taihu has a strong representation

6 Progress

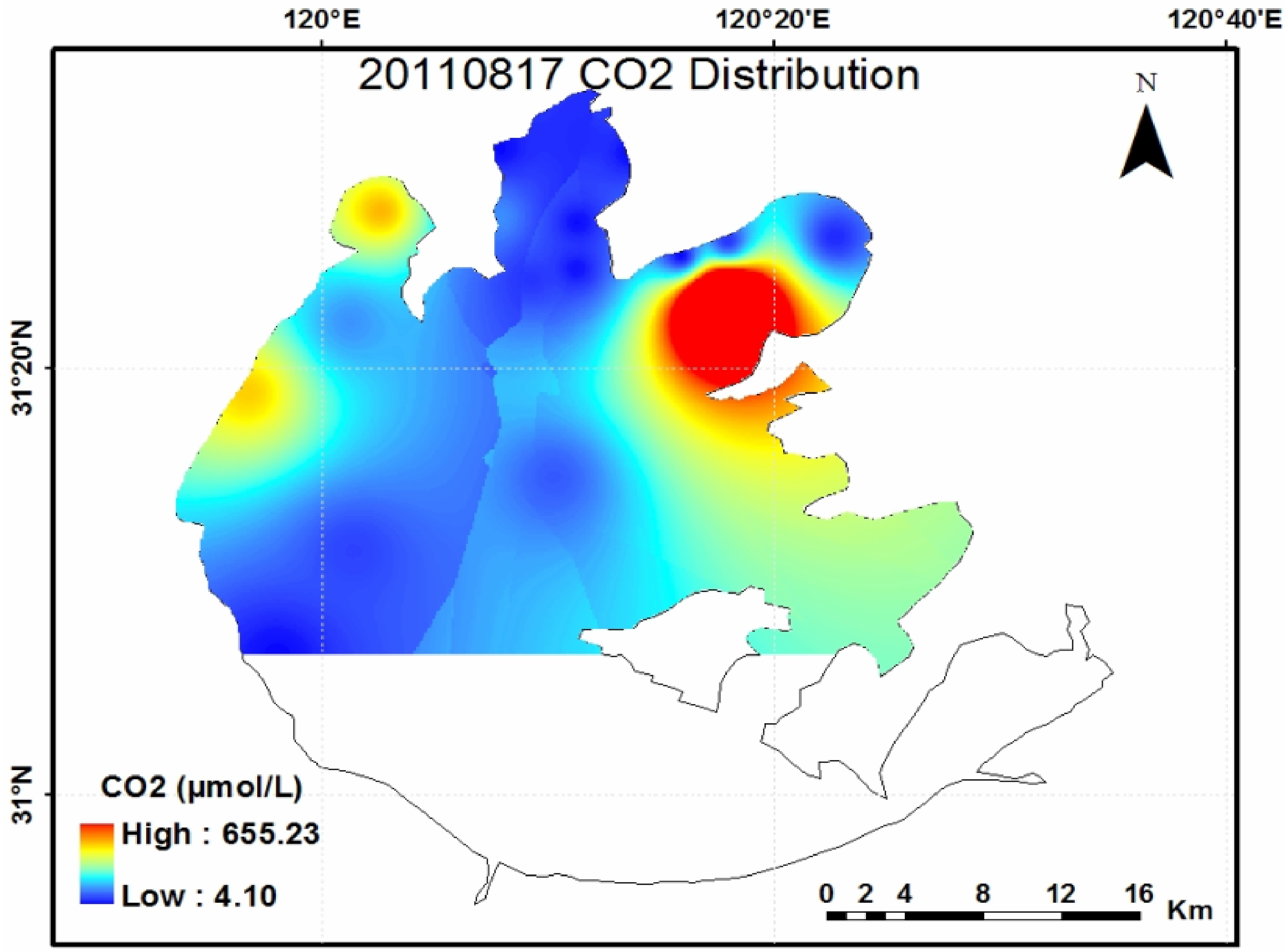
1).Temporal variation



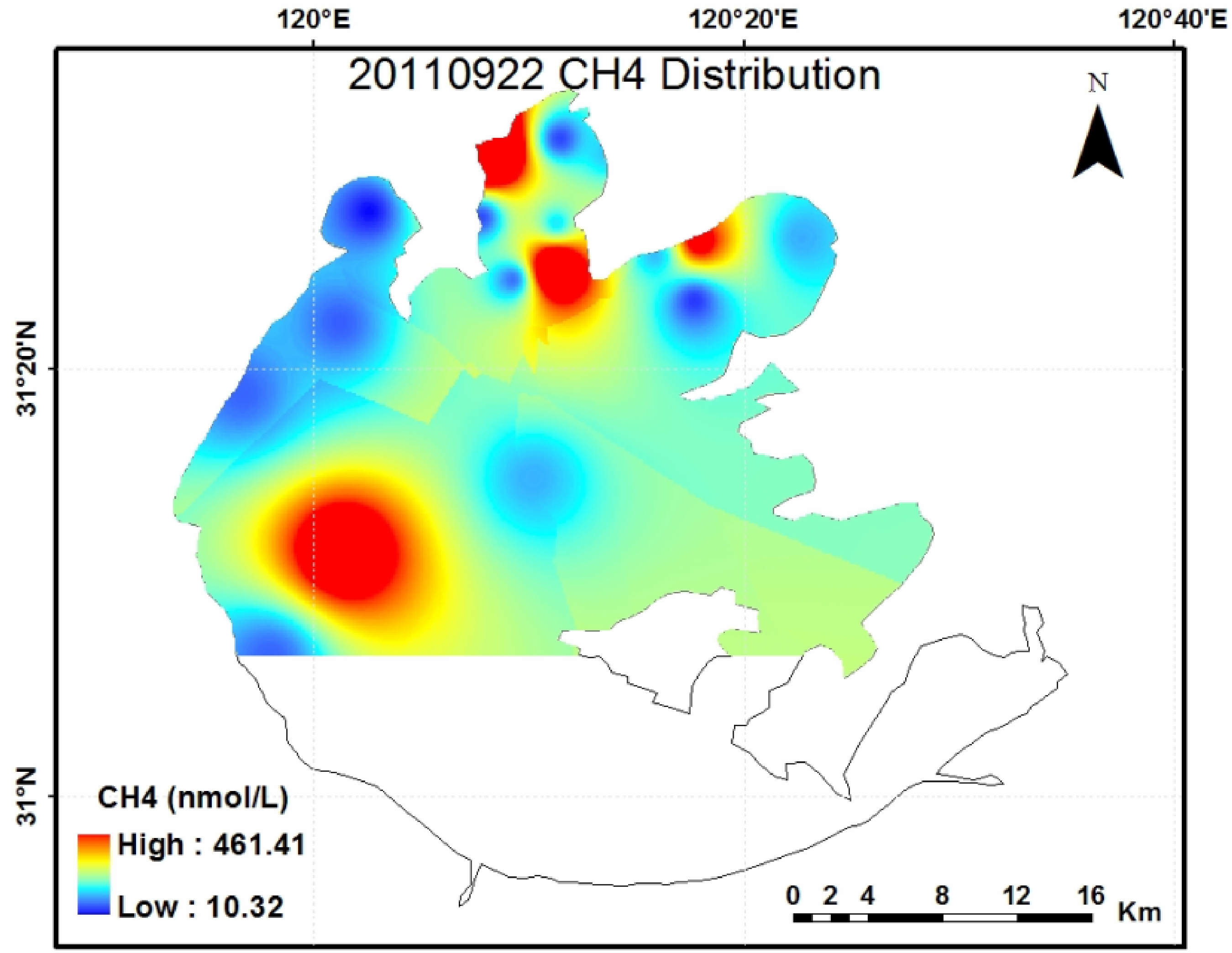
1).Temporal variation



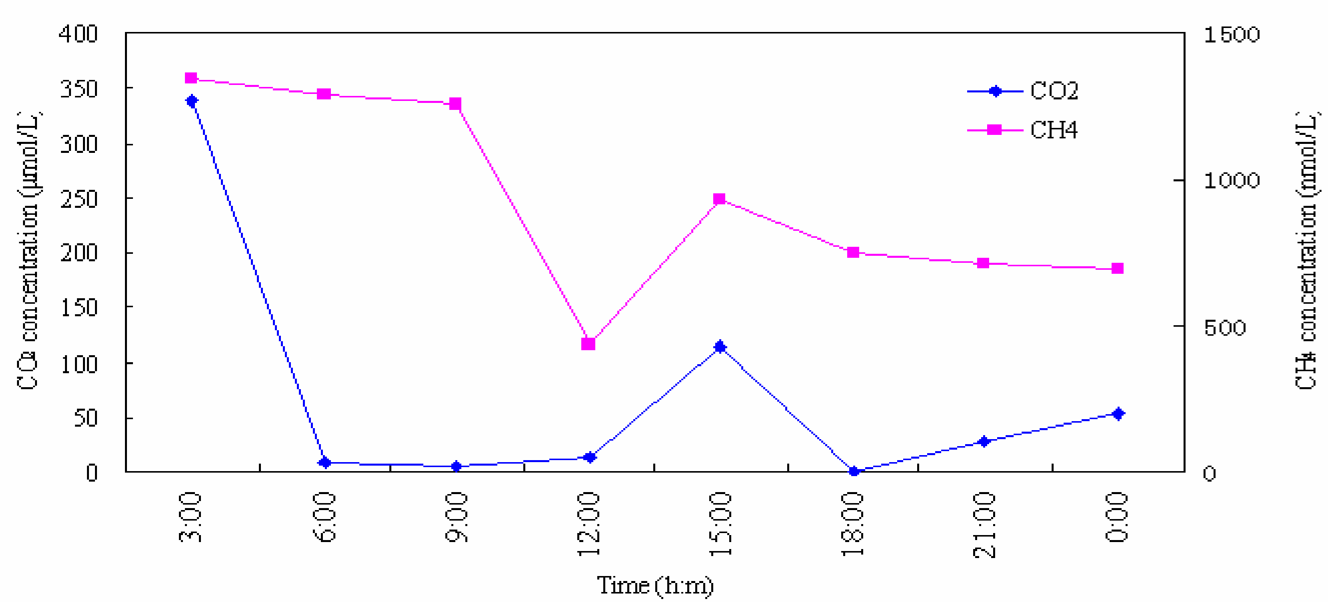
2).Spatial variation



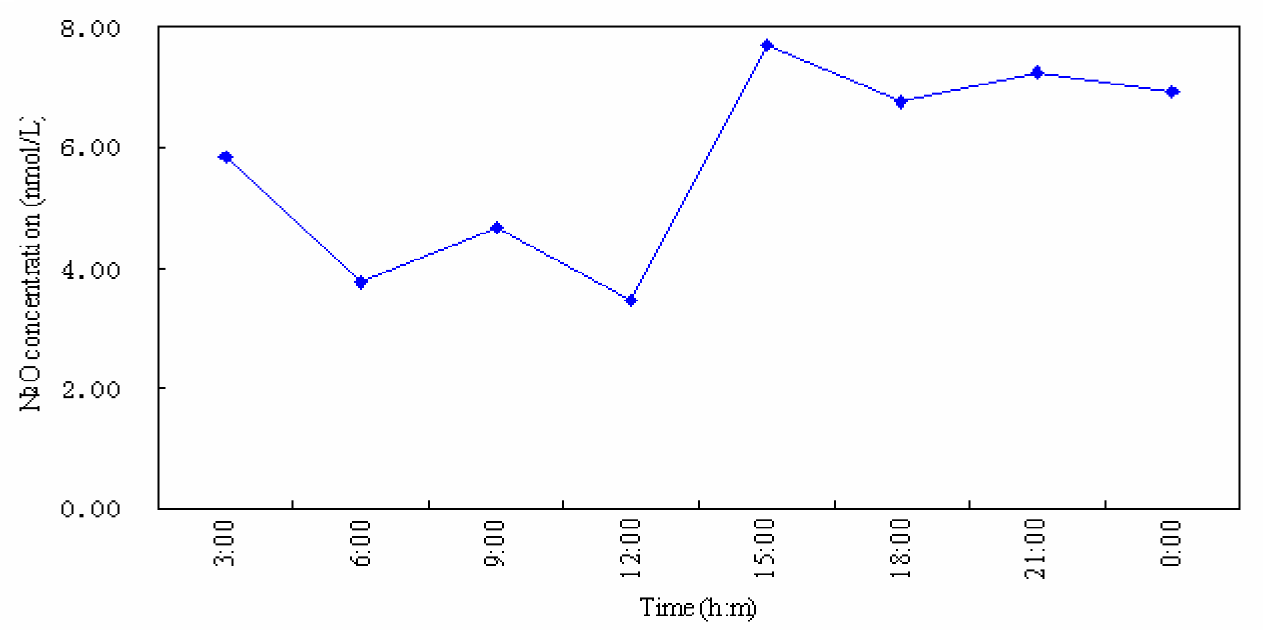
2).Spatial variation



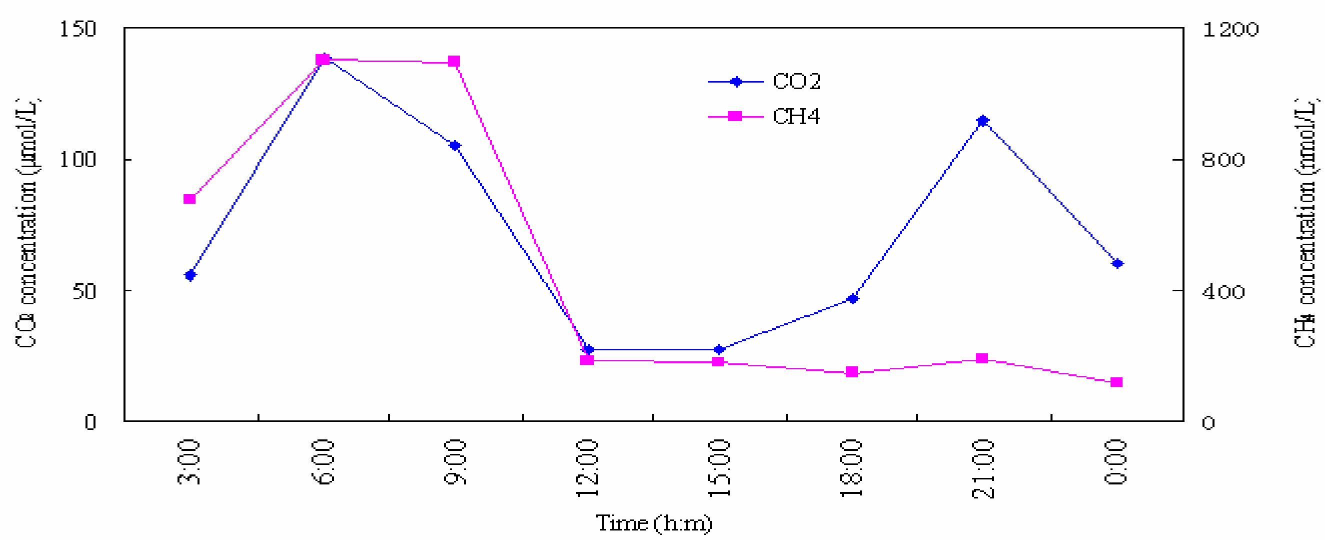
3).Diurnal variation

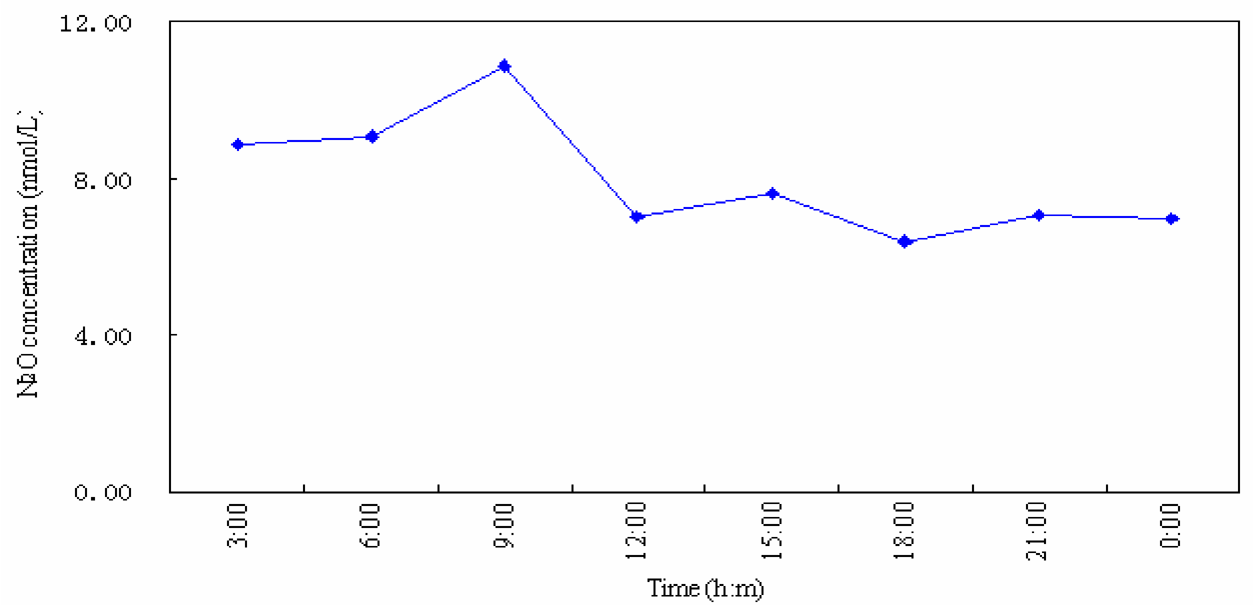


11 August, 2011
Site:MLW



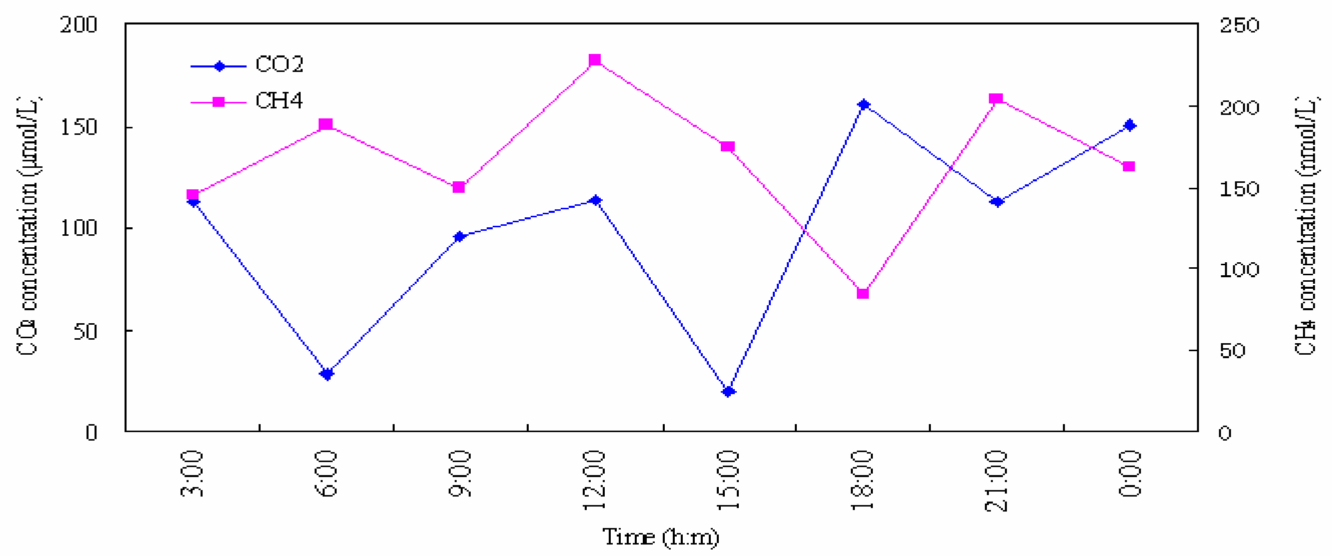
3).Diurnal variation

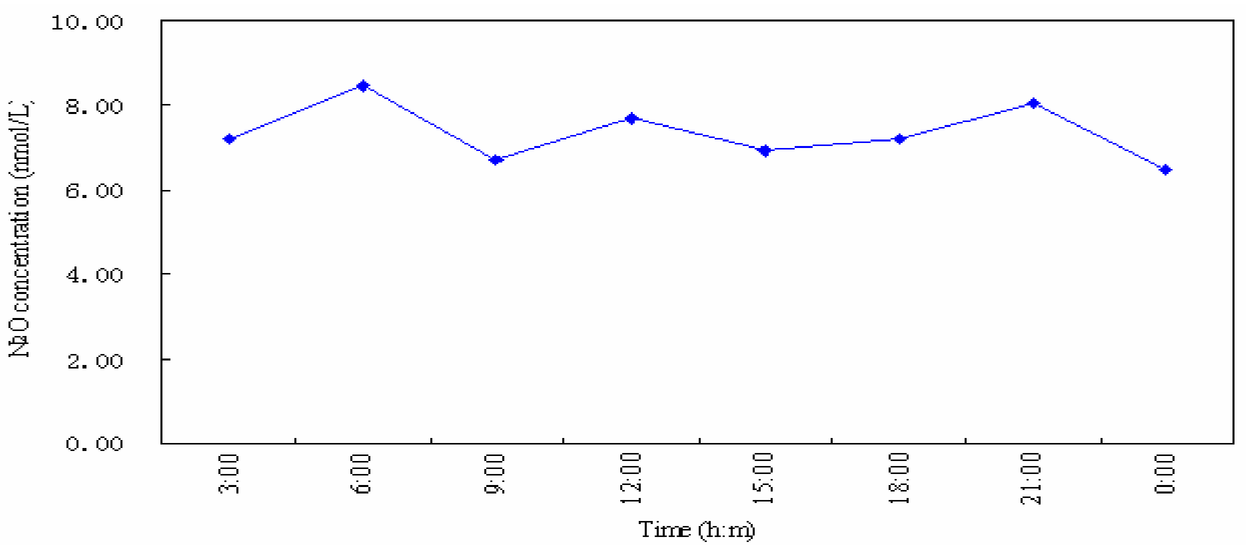




12 August, 2011
Site:MLW

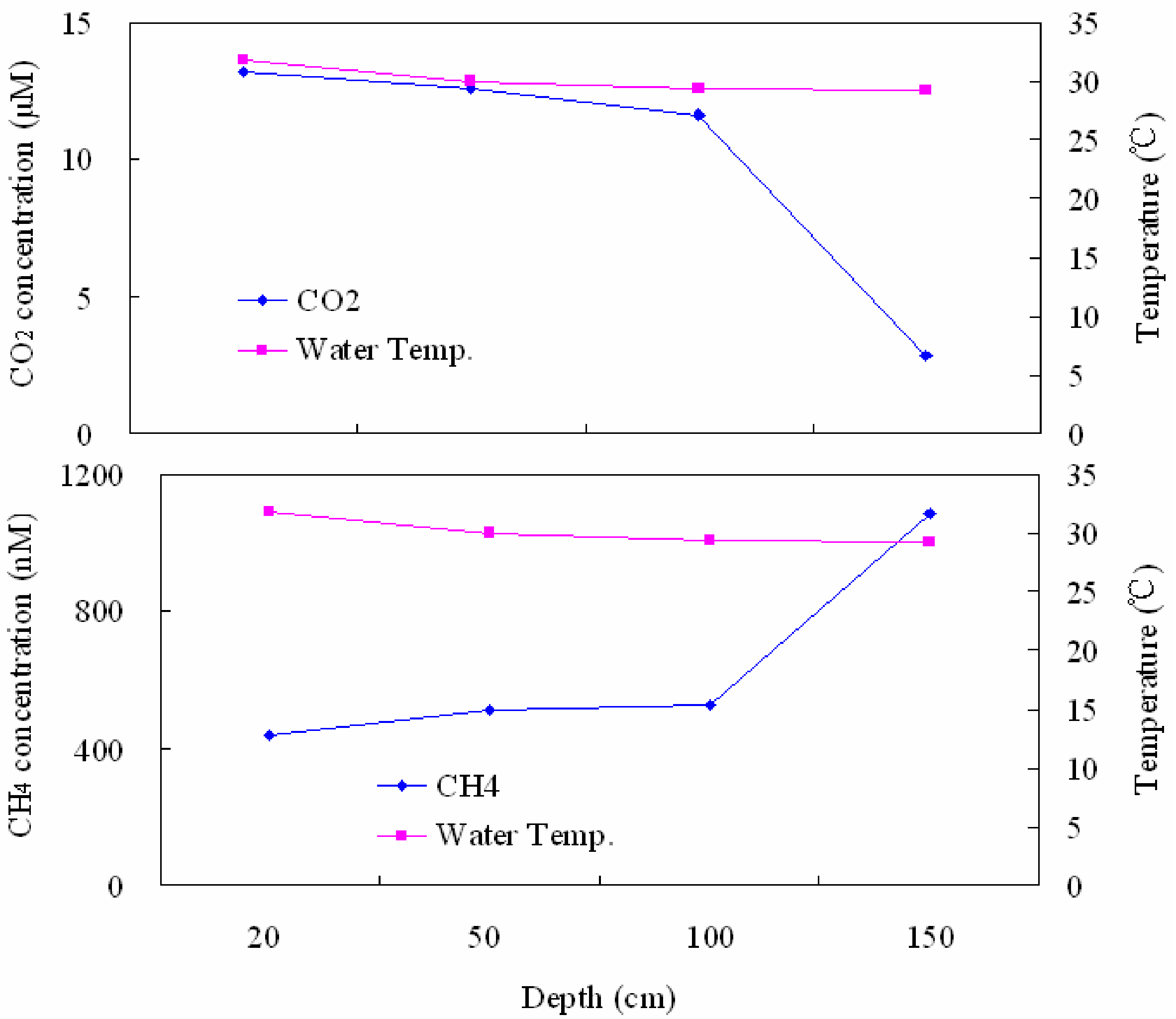
3).Diurnal variation





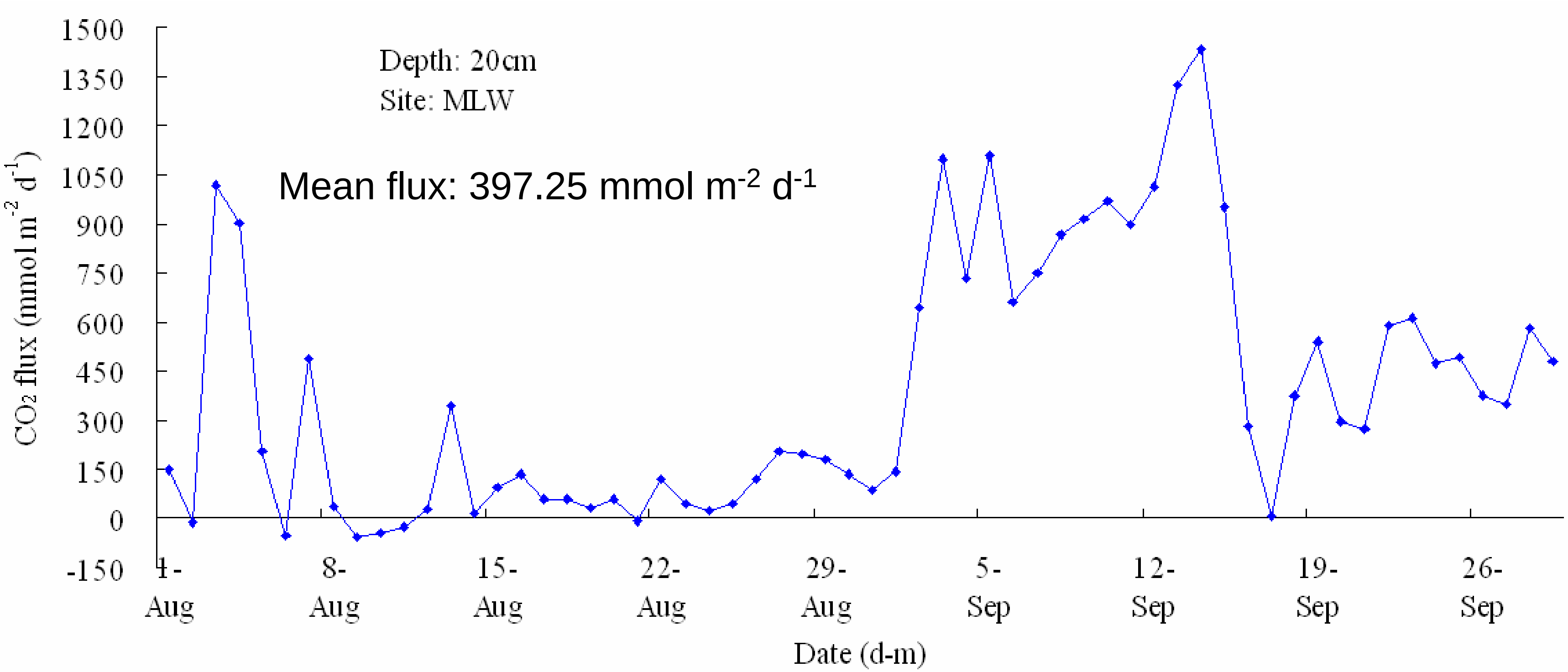
13 August, 2011
Site:MLW

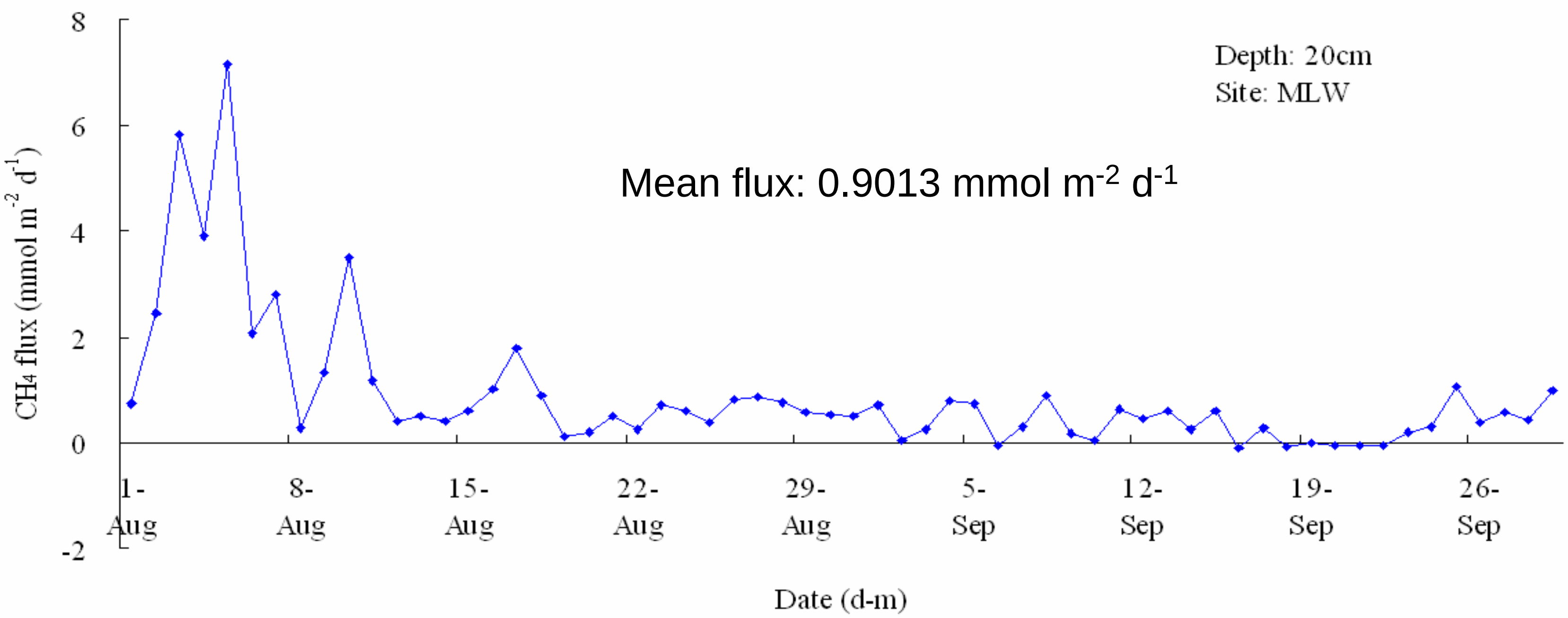
4).Vertical profiles and Micromet

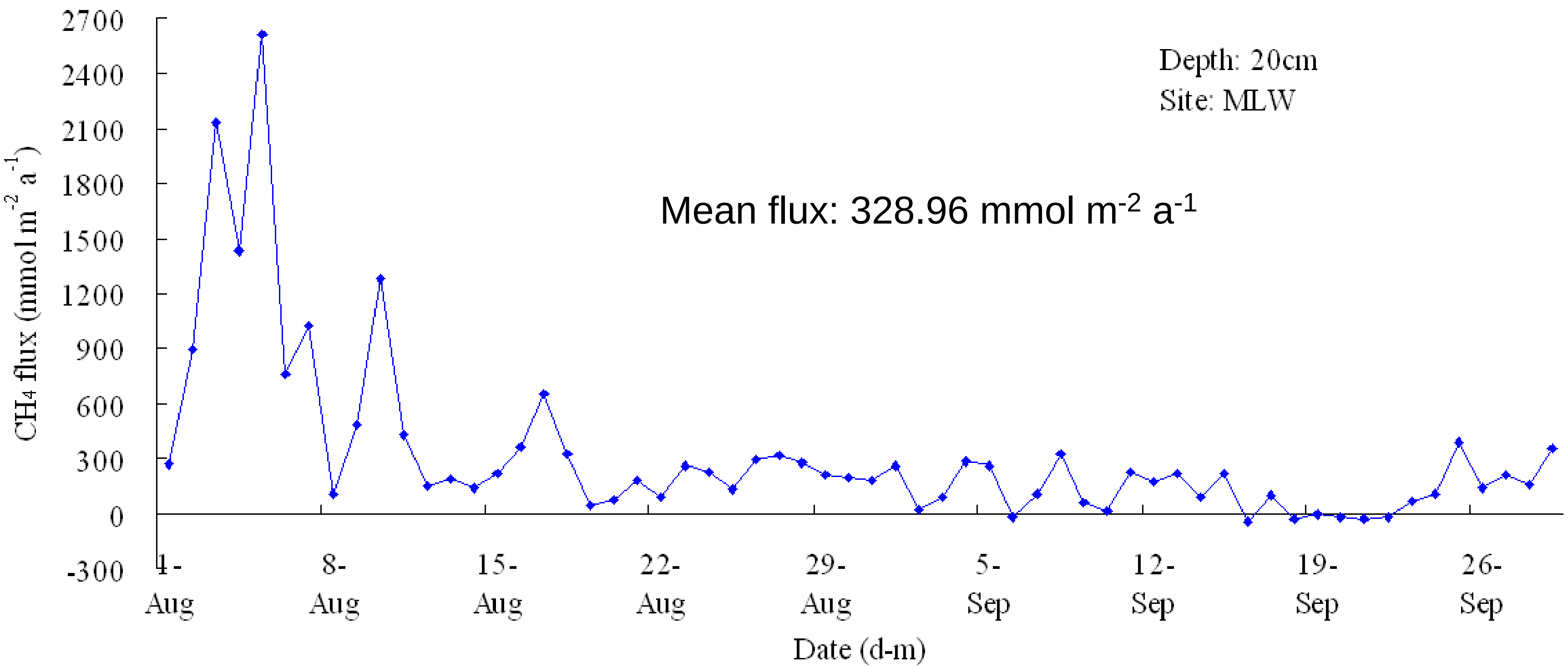


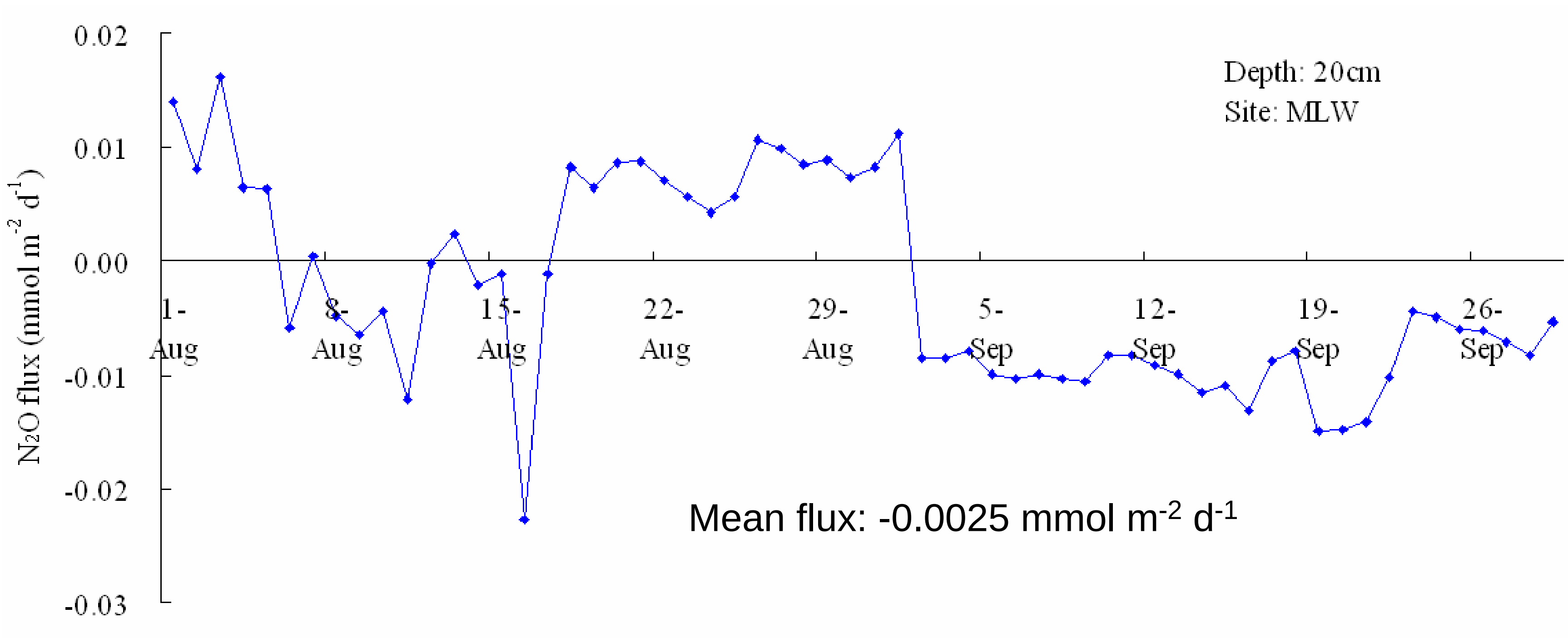
24:00
11 August, 2011
Site:MLW

5).Fluxes of GHGs

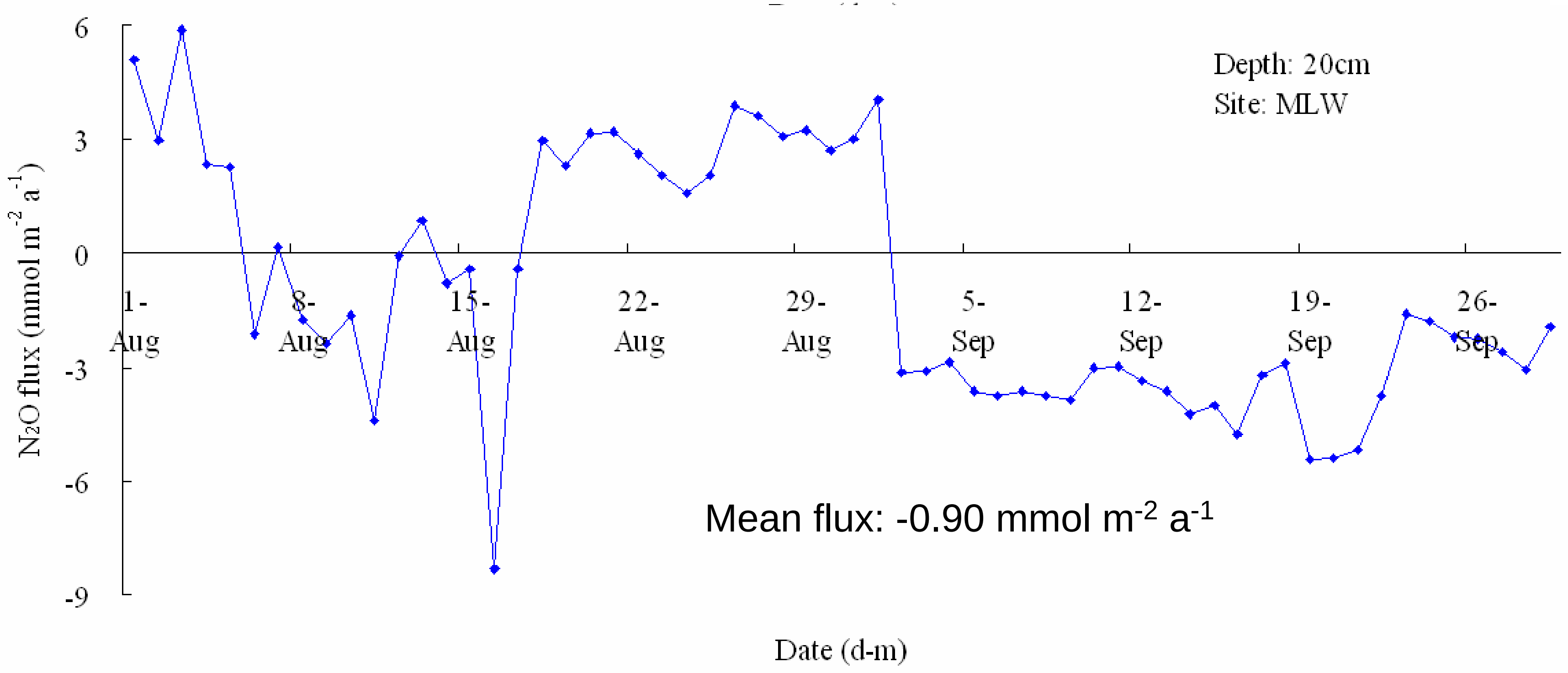



Depth: 20cm
Site: MLW
Mean flux: 0.9013 mmol m-2 d-1
CH4 flux (mmol m-2 d-1)
8
6
4
2
0
-2
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
Date (d-m)


Depth: 20cm
Site: MLW
Mean flux: 328.96 mmol m-2 a-1
CH4 flux (mmol m-2 a-1)
2700
2400
2100
1800
1500
1200
900
600
300
0
-300
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
Date (d-m)



0.02
0.01
0.00
-0.01
-0.02
-0.03
N2O flux (mmol m-2 d-1)
Depth: 20cm
Site: MLW
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
Mean flux: -0.0025 mmol m-2 d-1



6
3
0
-3
-6
-9
N2O flux (mmol m-2 a-1)
Depth: 20cm
Site: MLW
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
Mean flux: -0.90 mmol m-2 a-1
Date (d-m)


Thank you