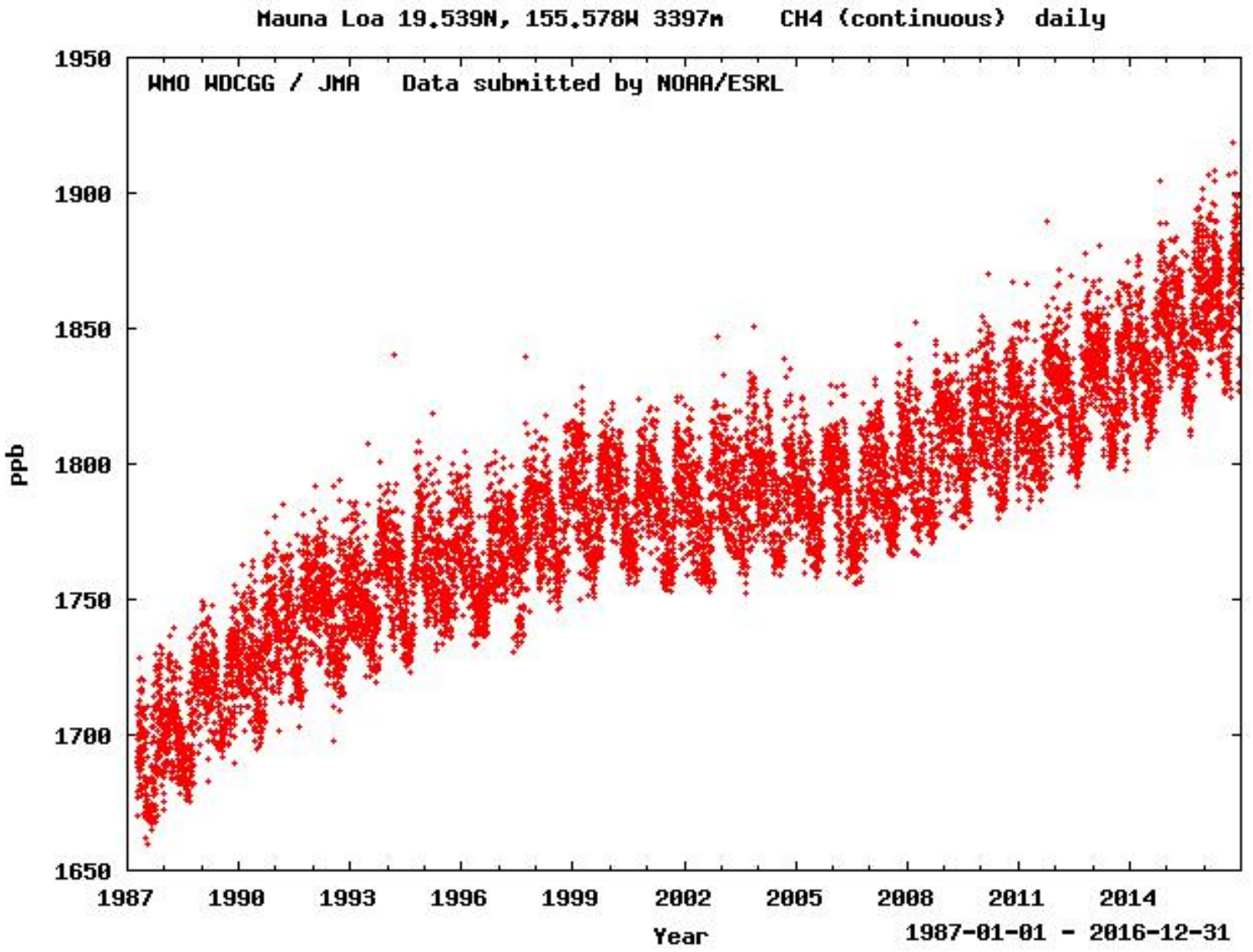
Anthropogenic CH_4 Emissions in the Yangtze River Delta Based on a Top-down Method

Reporter: HUANG Wenjing

2018.06.22

Background


Mauna Loa 19.539N, 155.578W 3397m CH4 (continuous) daily
WMO WDCGG / JMA Data submitted by NOAA/ESRL
ppb
1950
1900
1850
1800
1750
1700
1650
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
Year
1987-01-01 - 2016-12-31

Rice paddies

Fossil fuel use

Wetland

Livestock

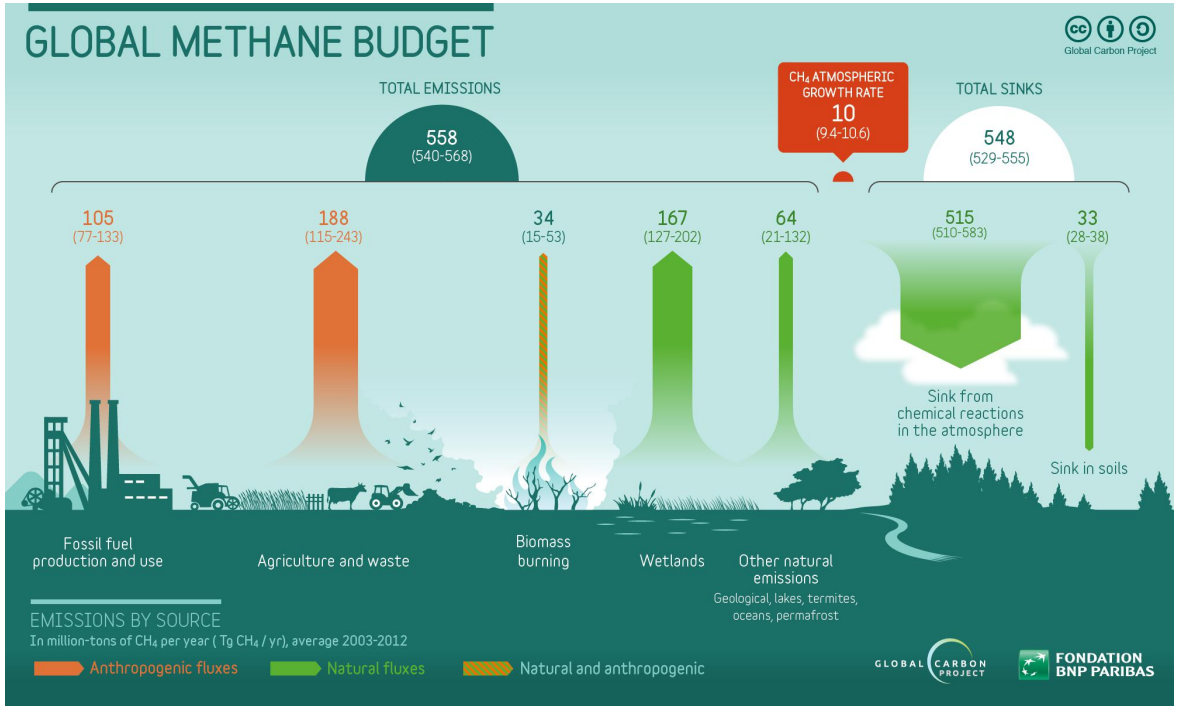
Straw & firewood burning

Fire

Landfill

Coal mining

Wastewater treatment



China emission/world total

(EDGAR v4.2, 2012)

22%

Anthropogenic CH_4 emissions:

50 - 65 %

Uncertainty:

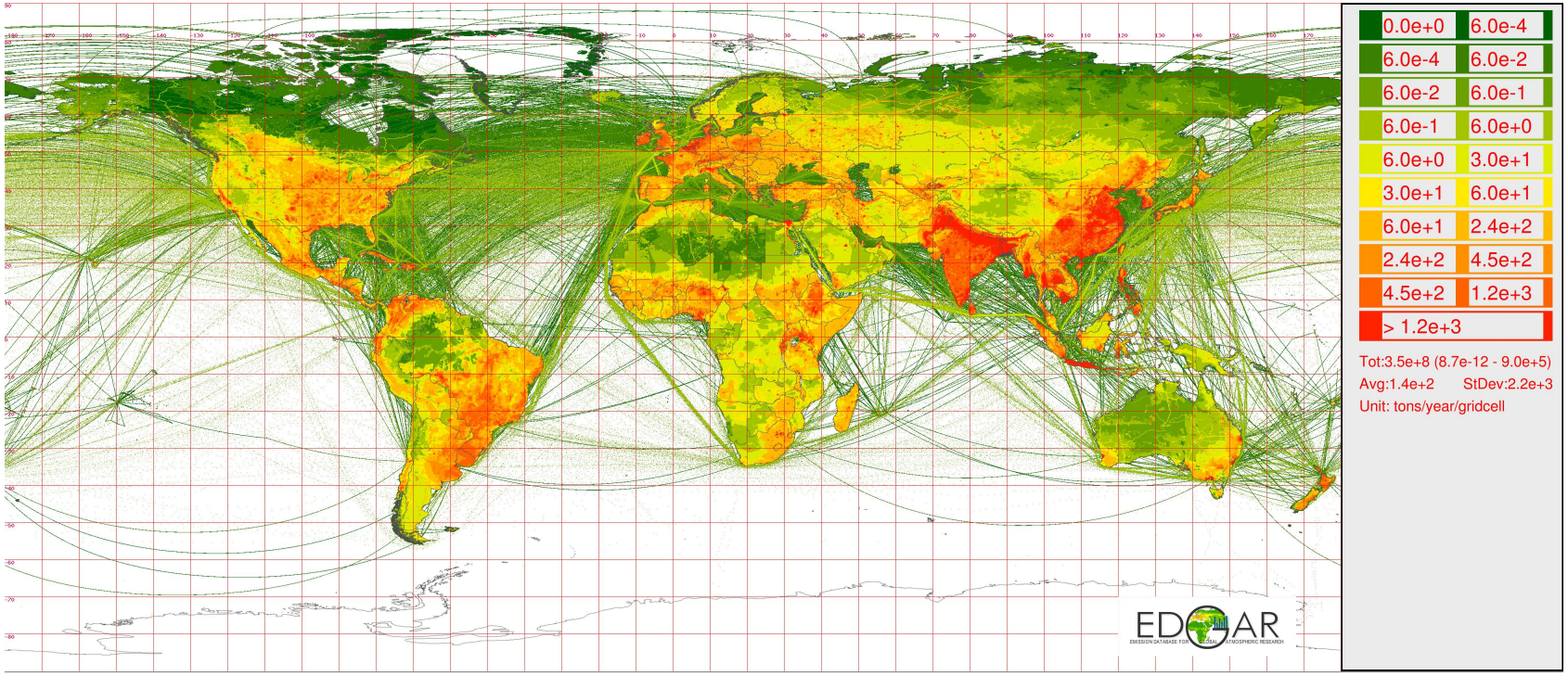
30% (global)

>100% (regional)

Global CH_4 budget (2003–2012):

total emissions − total sinks= 10 ($\pm$0.6) Tg CH_4/yr

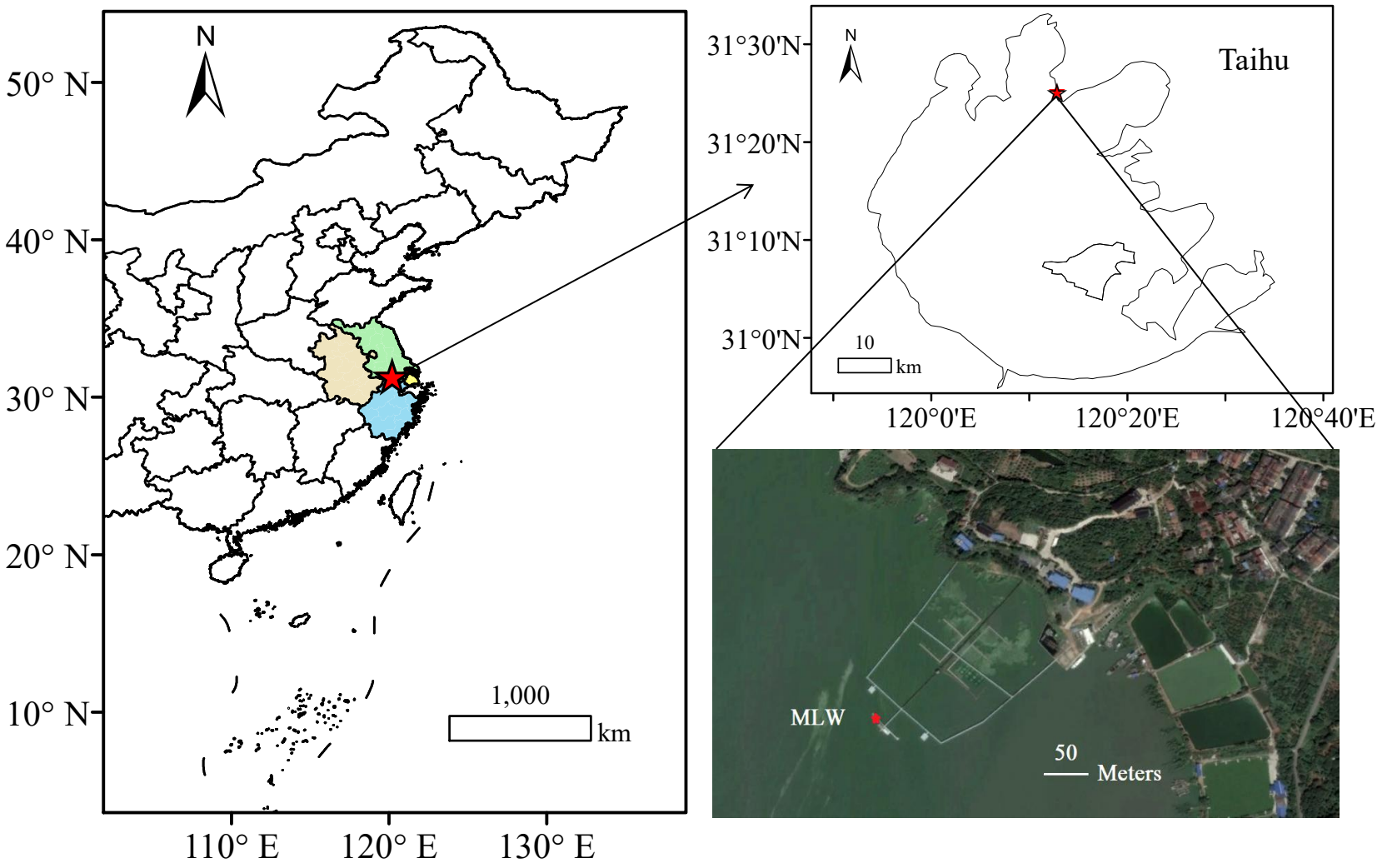
2012 CH_4 emissions (0.1º × 0.1º)



unit: ton/year/gridcell

Wetlands ☒

Site

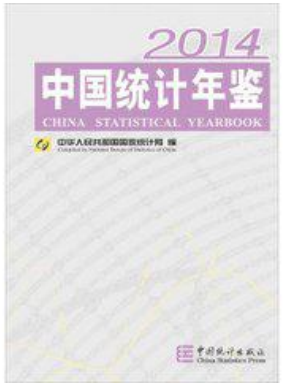

N
50° N
40° N
30° N
20° N
10° N
110° E
120° E
130° E
1,000
km
31°30'N
31°20'N
31°10'N
31°0'N
120°0'E
120°20'E
120°40'E
Taihu
10
km
MLW
50
Meters

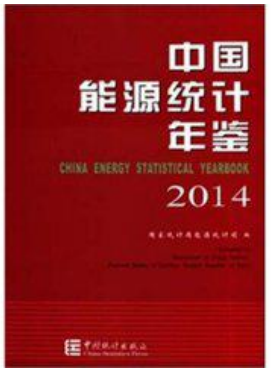
Method

IPCC method

CO_2

Activity data	Emission factors	Emissions





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中国垃圾填埋场2012 年甲烷排放特征研究
蔡博峰 - 环境工程, 2016 - cqvip.com
垃圾填埋场是全球重要的CH_4 排放源. 基于中国1955 个
数据库, 核算了中国2012 年垃圾填埋场CH_4 排放水平,
容量的计算模型. 2012 年中国垃圾填埋场的CH_4 排放量
西藏排放量最低. 华东地区的垃圾填埋场CH_4 排放在7 个
达到33.00%, 西北地区排放占比最低, 为8.76%; 大型填埋
45.88%. 中国垃圾填埋场CH_4 排放在空间分布上具有较

…

=

…

[±10 %

(min, max)]

Monte Carlo →

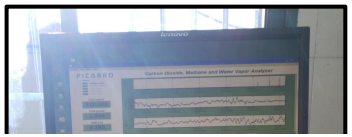
[(min, max)]

Method

Atmospheric method

Winter ☑

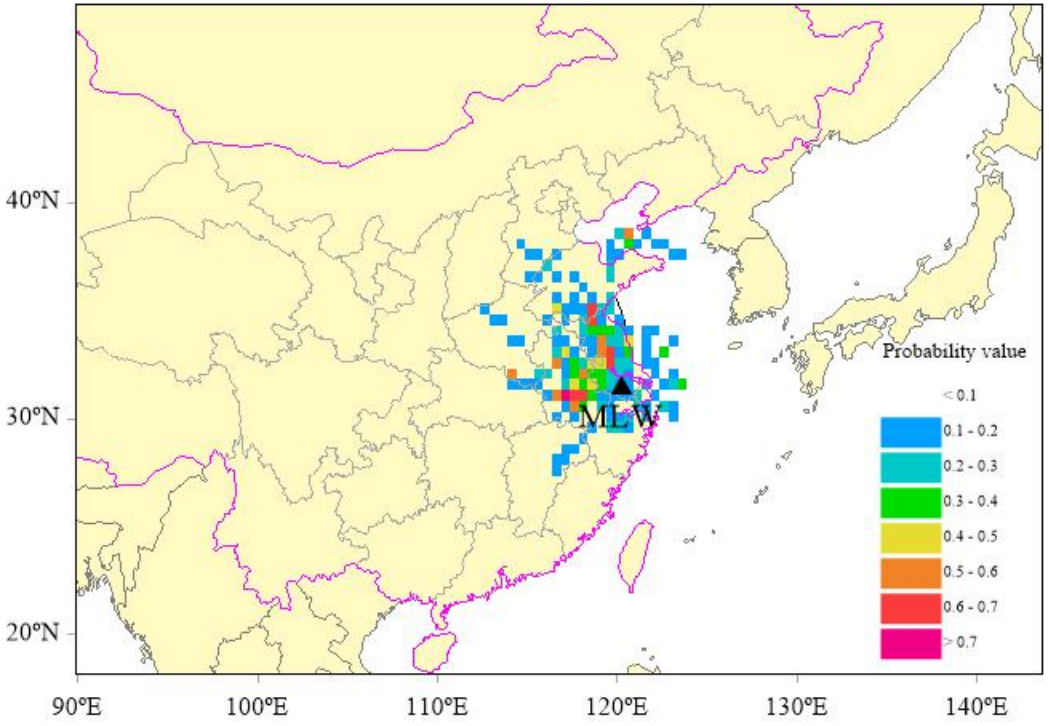
Daytime (10:00 -17:00) ☑



$$F_{CH_4}|_{t-d} = F_{CO_2}|_{b-u} \times \frac{CH_4}{CO_2}|_{slope} \times \frac{M_{CH_4}}{M_{CO_2}}$$

CH_4/CO_2

Source area?



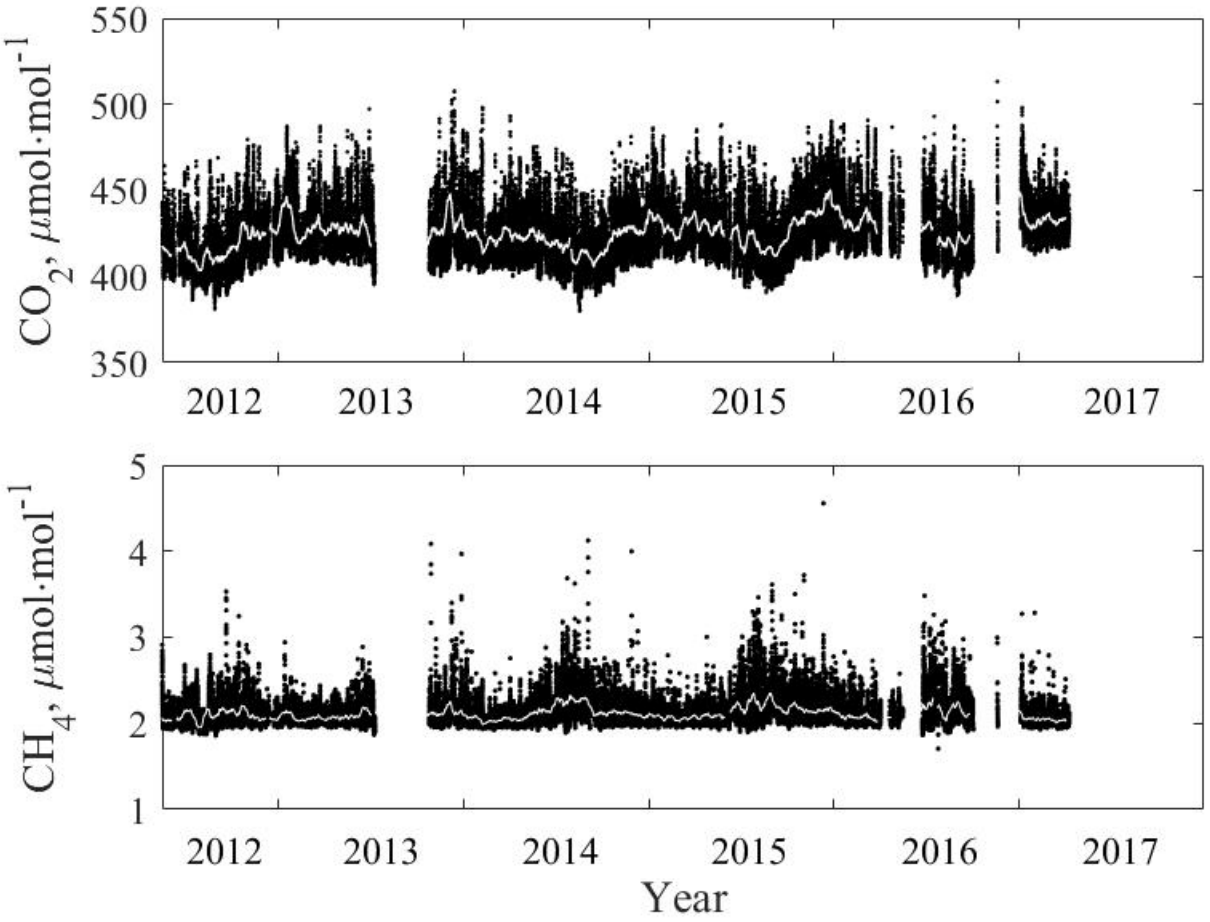
81% Inland area

↓

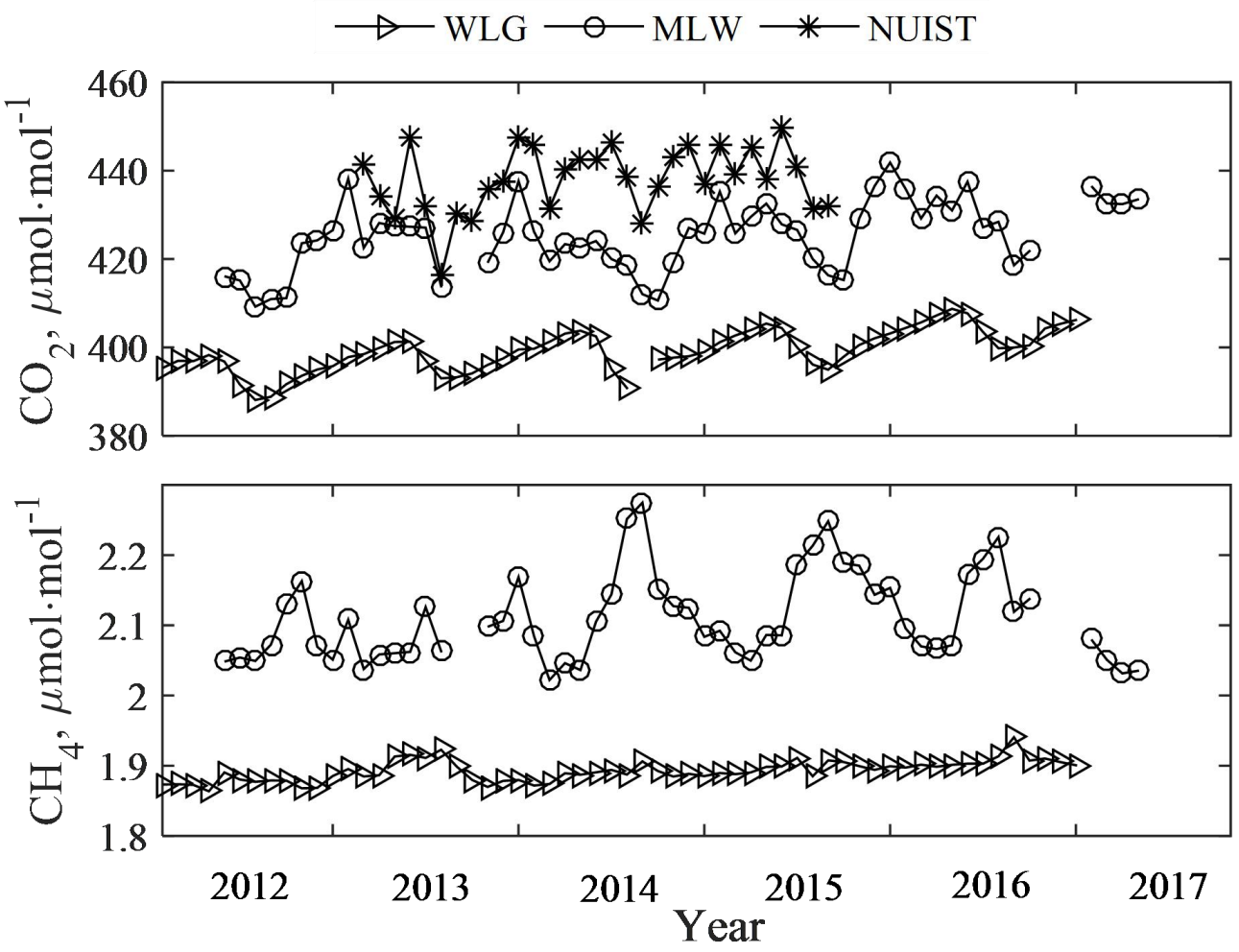
76% YRD

Results

Half-hourly

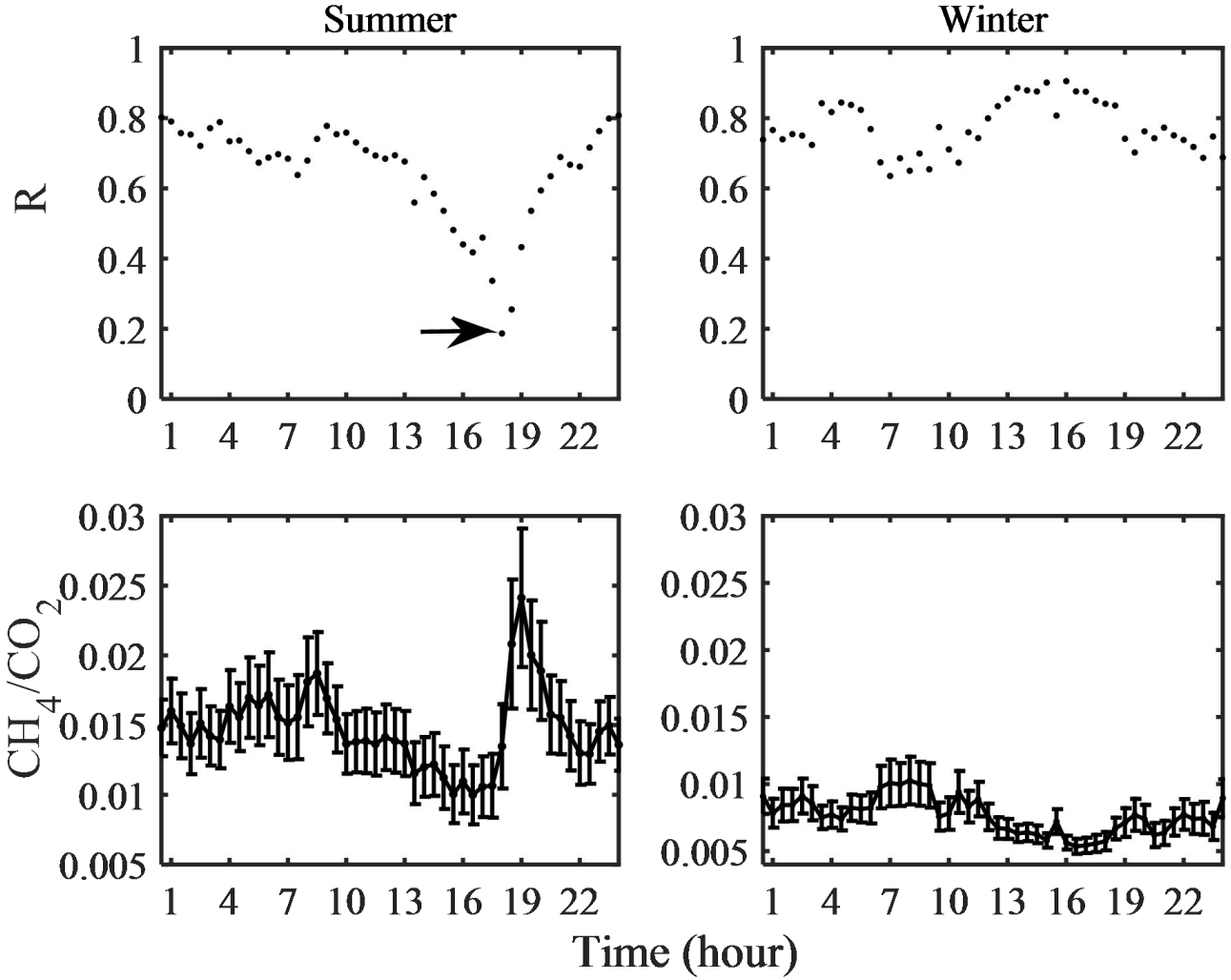


The white points are 14-day moving averages.


WLG
MLW
NUIST
460
440
420
400
380
CO_2, μmol·mol^{-1}
2.2
2.1
2
1.9
1.8
CH_4, μmol·mol^{-1}
2012
2013
2014
2015
2016
2017
Year

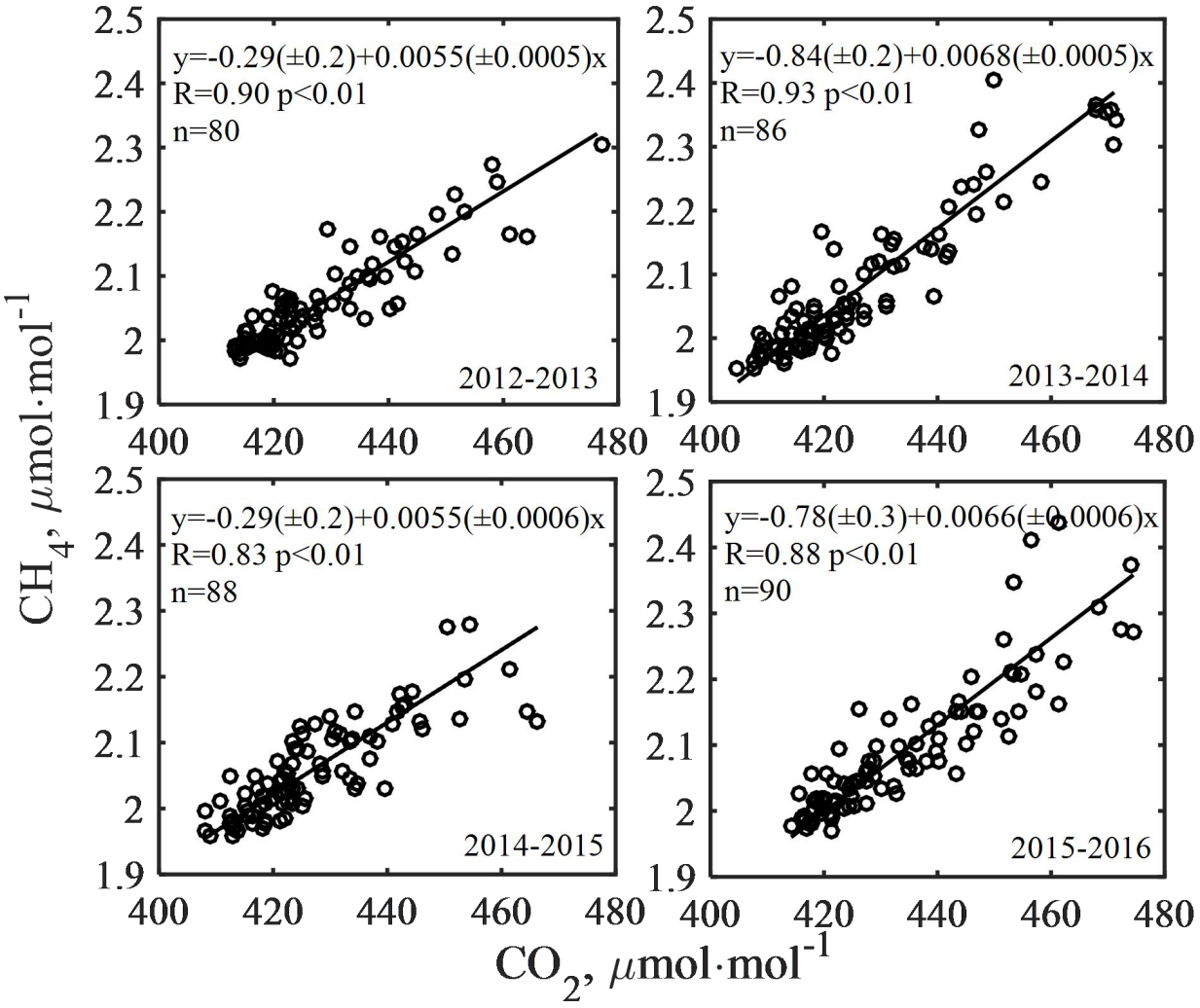
9 %

53 %



(The arrow indicates the linear correlation at the P value of 0.05.)

Summer in 2014 and winter in 2014 - 2015.



Scatter plots of winter (December – February) daytime CH_4 and CO_2 concentrations at MLW from 2012 to 2016.

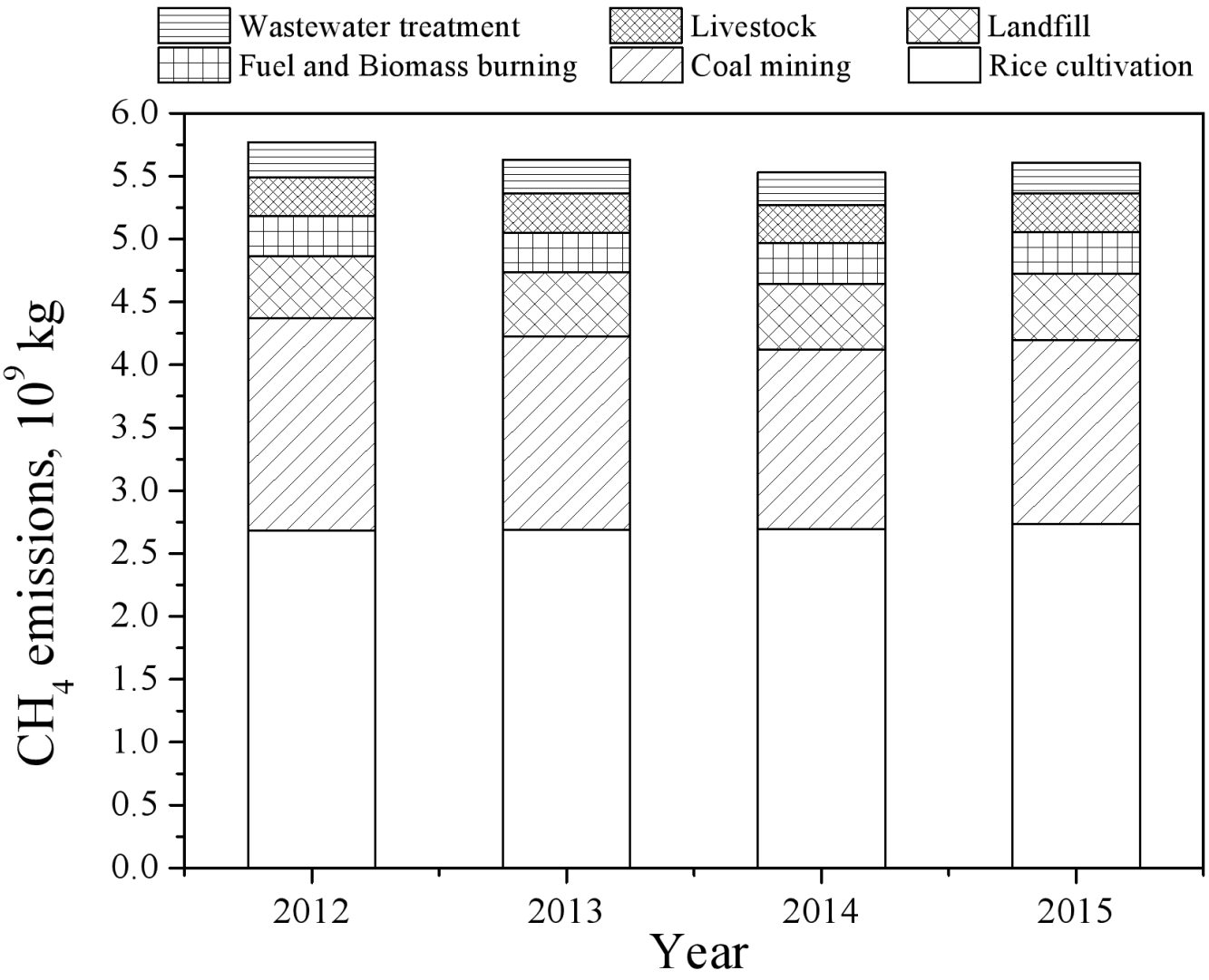
Table 1. Anthropogenic CO_2 emissions in the Yangtze River Delta in 2012.

Sector	Emission ($\times 10^{11}$ kg)	Percent of total (%)
Industrial energy consumption*	13.03 ($\pm$ 11 %)	67.9
Industrial processes	4.40 ($\pm$ 10 %)	23.0
Transportation	1.35 ($\pm$ 18 %)	7.0
Household	0.40 ($\pm$ 8 %)	2.1
Total	19.18 ($\pm$ 10 %)	100

*CO_2 emissions in manufacturing, commerce, and construction are also included in this sector.

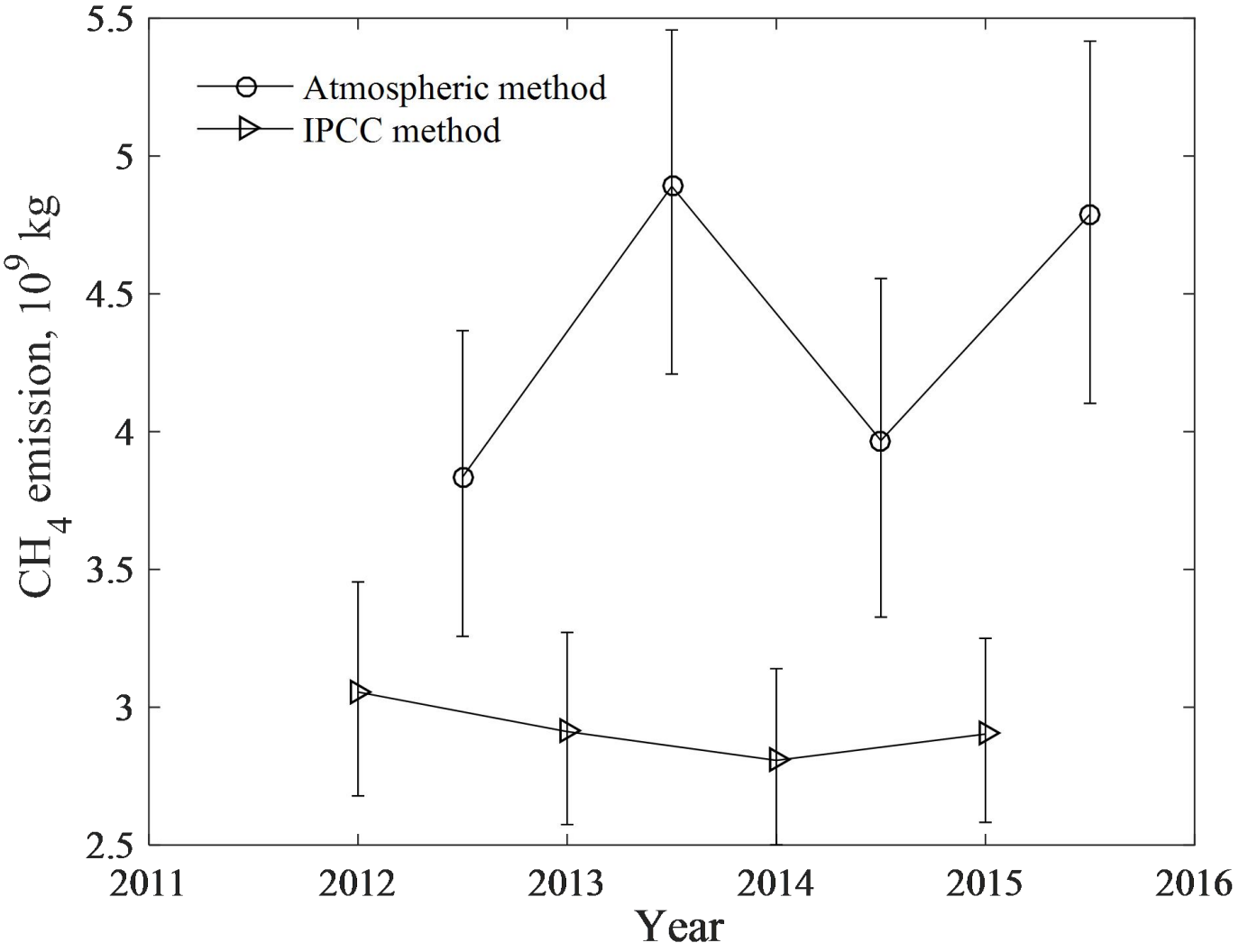
Table 2. Anthropogenic CH_4 emissions in the Yangtze River Delta in 2012, based on the IPCC inventory method.

Sector	Emission ($\times 10^9$ kg)	Percent of total (%)
Rice cultivation	2.68 (± 12 %)	46.3
Landfill	0.50 (± 35 %)	8.7
Wastewater treatment	0.28 (± 40 %)	4.8
Livestock	0.31 (± 14 %)	5.4
Fuel and Biomass burning	0.32 (± 17 %)	5.6
Coal mining	1.69 (± 30 %)	29.2
Total	5.78 (± 21 %)	100


Wastewater treatment
Livestock
Landfill
Fuel and Biomass burning
Coal mining
Rice cultivation
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
CH4 emissions, 10^9 kg
2012
2013
2014
2015
Year

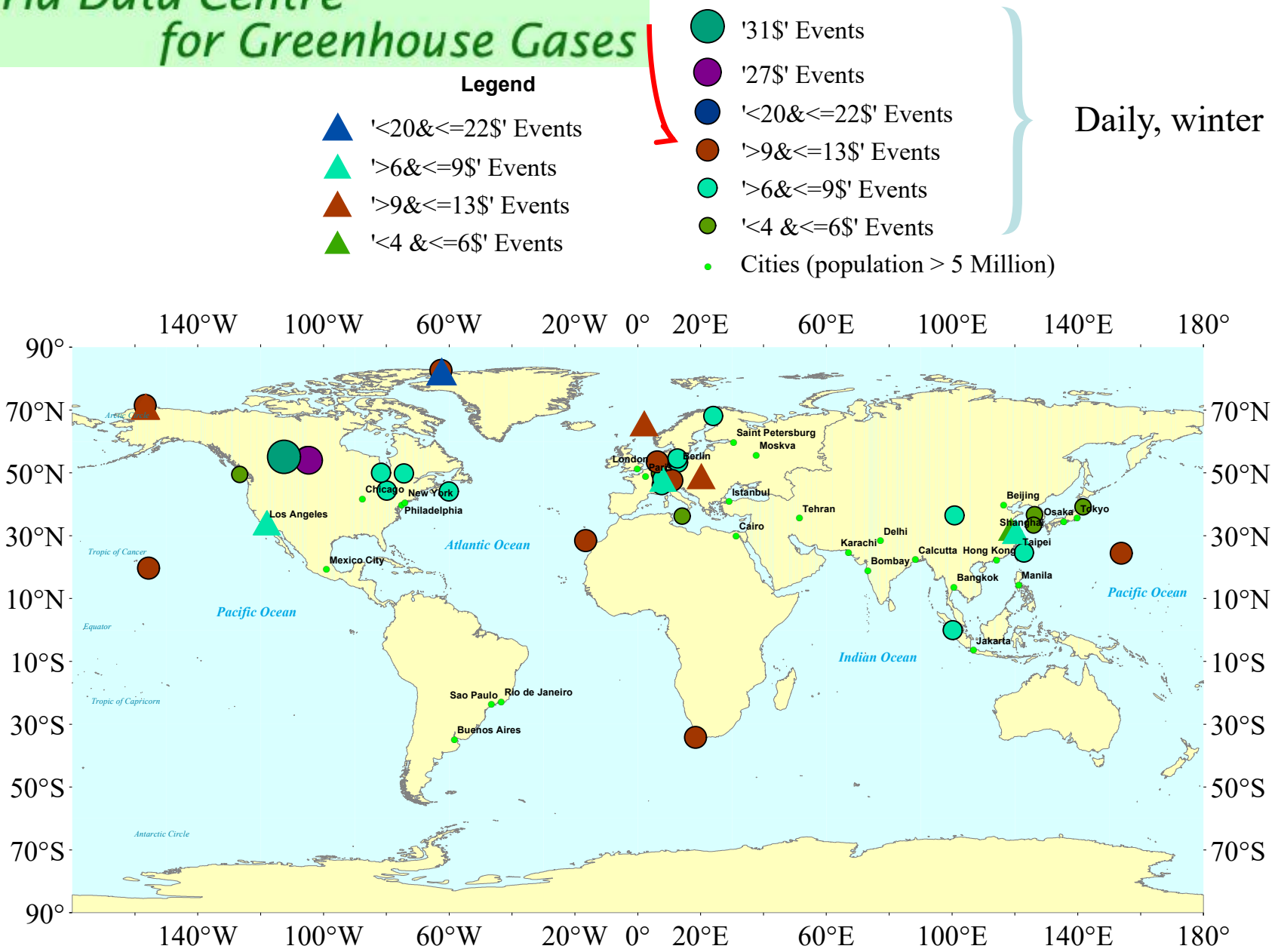
The annual average anthropogenic emission of CH_4:

$(4.37 \pm 0.61) \times 10^9$ kg y^{-1}



top-down/bottom-up=1.2 - 1.7 times

World Data Centre for Greenhouse Gases

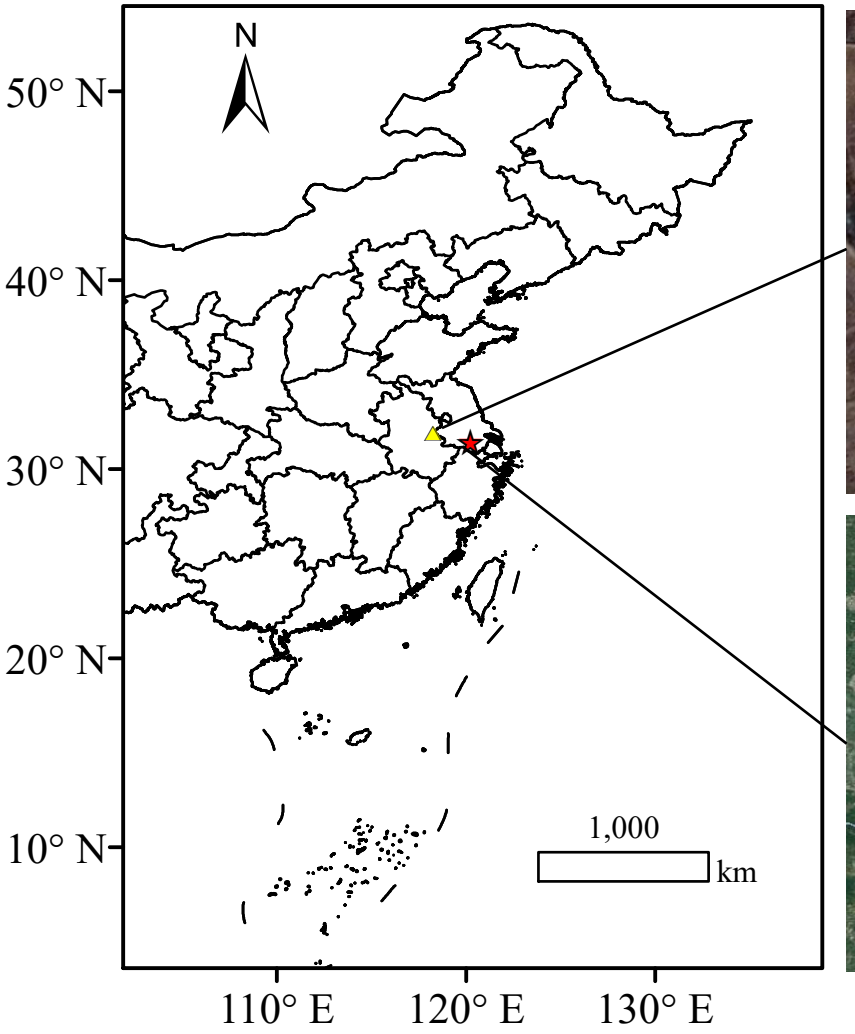


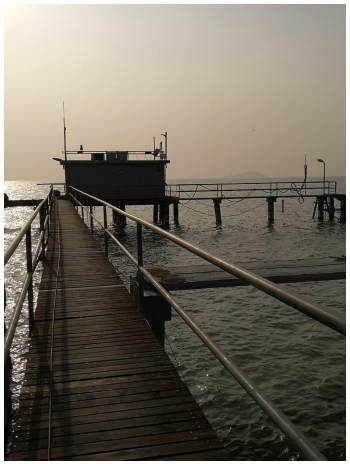
N=13 + 31 = 44

Conclusions

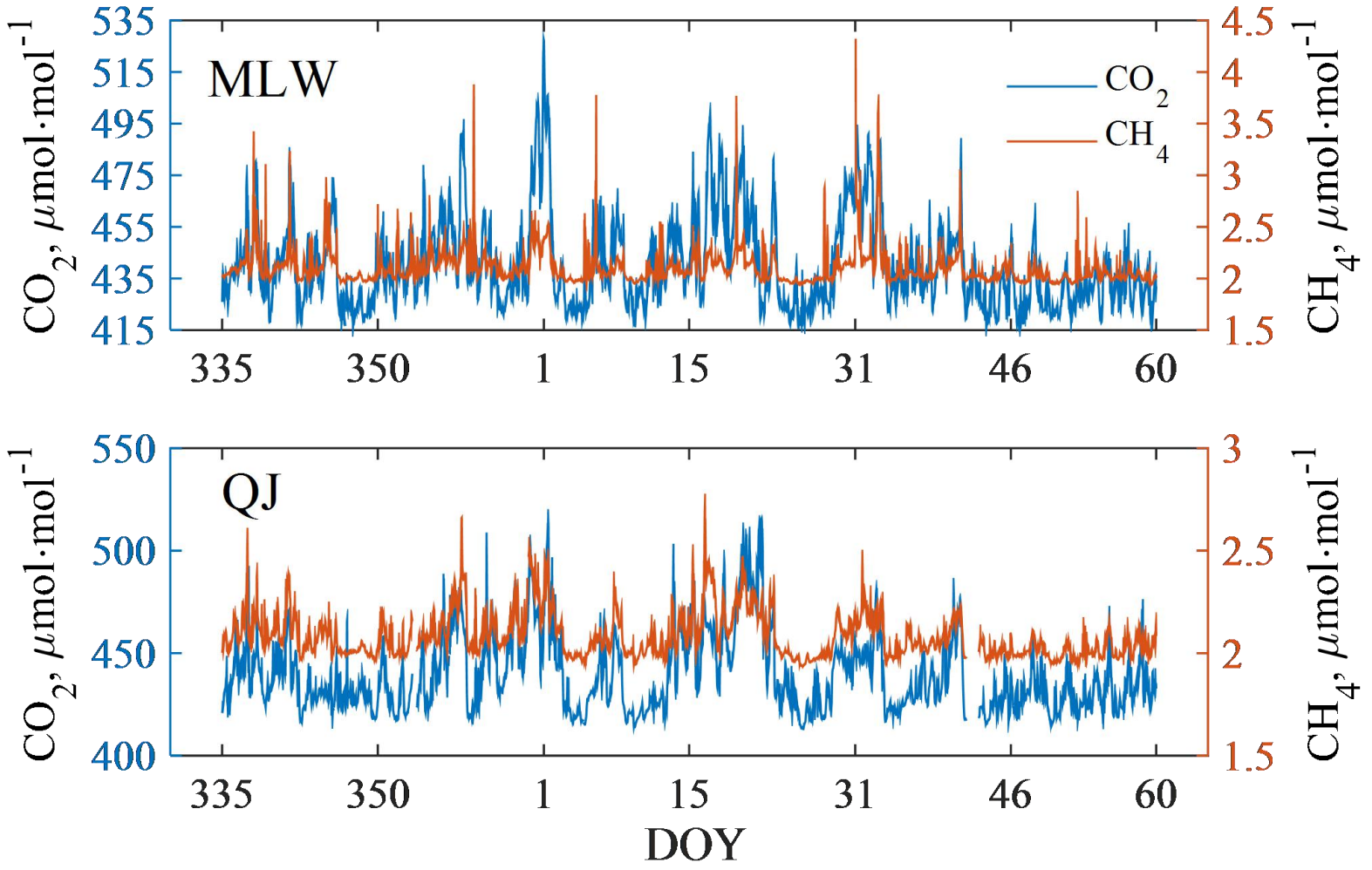
- Results indicate that the emissions ratio fluctuates between 0.0055 ± 0.0006 and (winter of 2012 - 2013 and 2014 - 2015) and 0.0068 ± 0.0005 (winter of 2013 - 2014). These ratios are similar to those observed in Los Angeles and Pasadena, USA.
- According to the top-down method, the annual average anthropogenic emission of CH_4 in the YRD from 2012 to 2015 is $(4.37 \pm 0.61) \times 10^9$ kg y^{-1} (excluding rice cultivation), which is 1.2 to 1.7 times the result from the IPCC inventory.
- We suggest that possible sources of the discrepancy include low biases in the IPCC calculation of emission from landfills, ruminants and the transport sector.

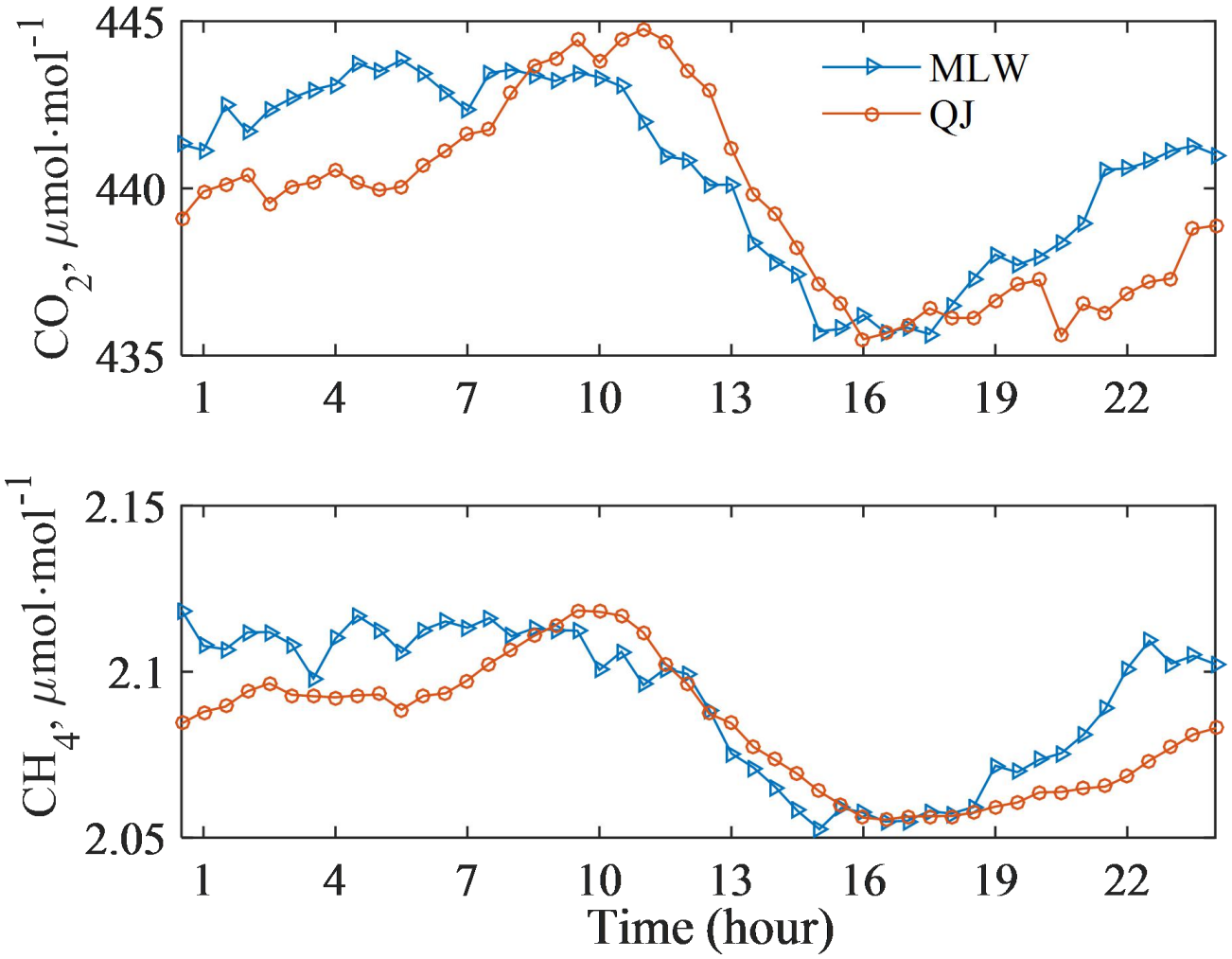
Next work



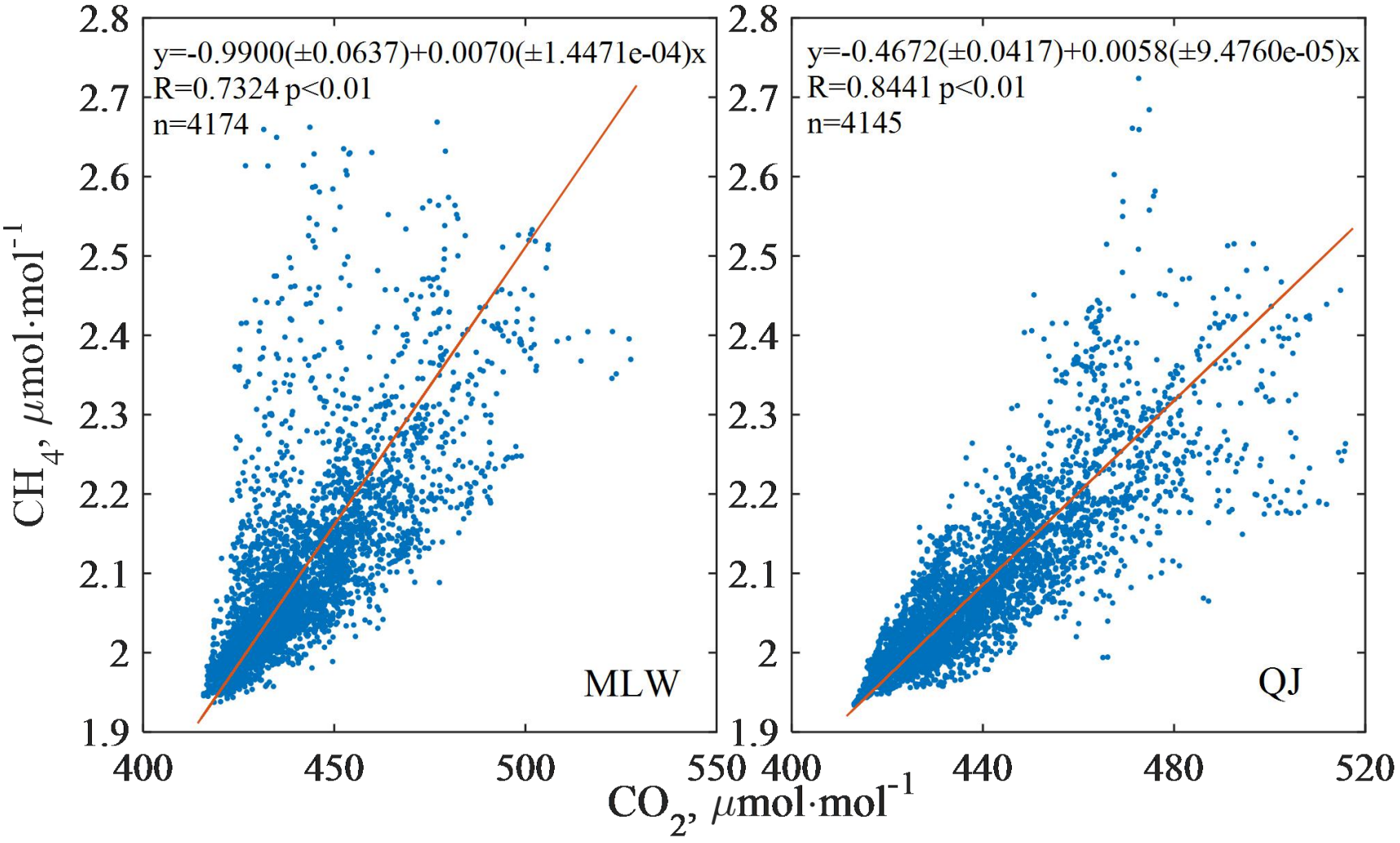


2017.12 – 2018.2

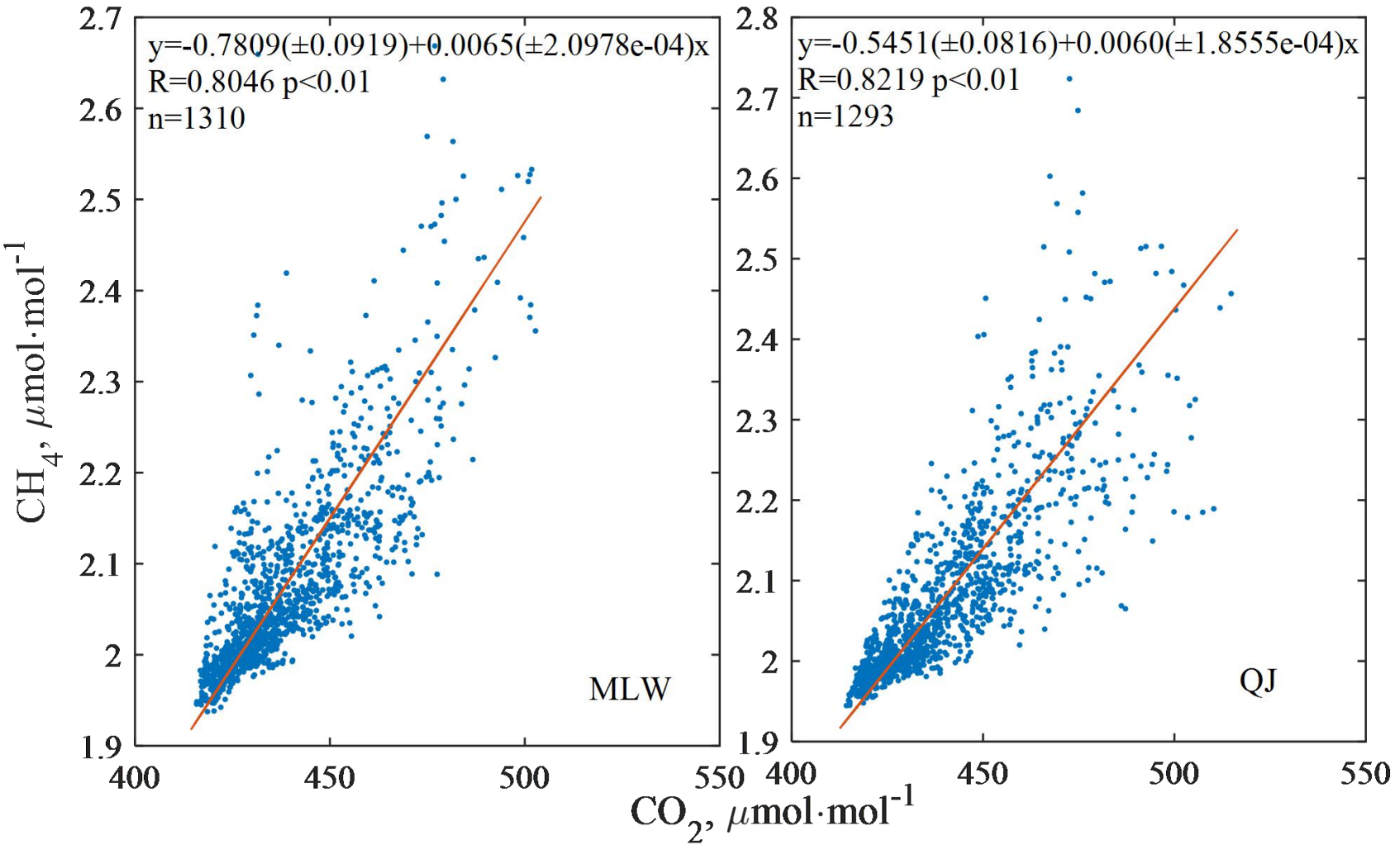



445
440
435
CO_2, μmol·mol^{-1}
MLW
QJ
1
4
7
10
13
16
19
22
2.15
2.1
2.05
CH_4, μmol·mol^{-1}
Time (hour)

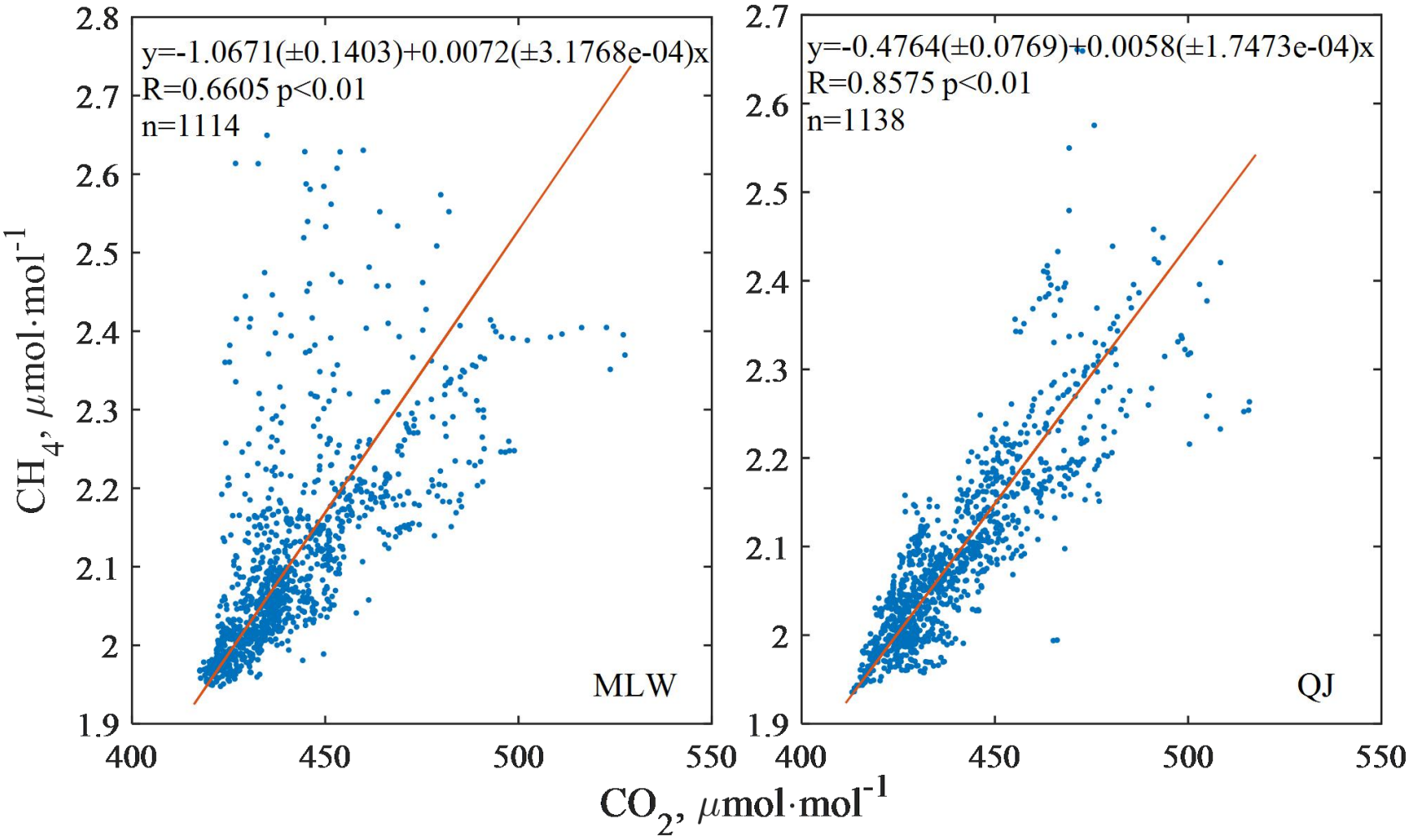
Half-hourly


y=-0.9900(±0.0637)+0.0070(±1.4471e-04)x
R=0.7324 p<0.01
n=4174
MLW
y=-0.4672(±0.0417)+0.0058(±9.4760e-05)x
R=0.8441 p<0.01
n=4145
QJ
CH4, μmol·mol-1
CO2, μmol·mol-1
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
400
450
500
550
440
480
520

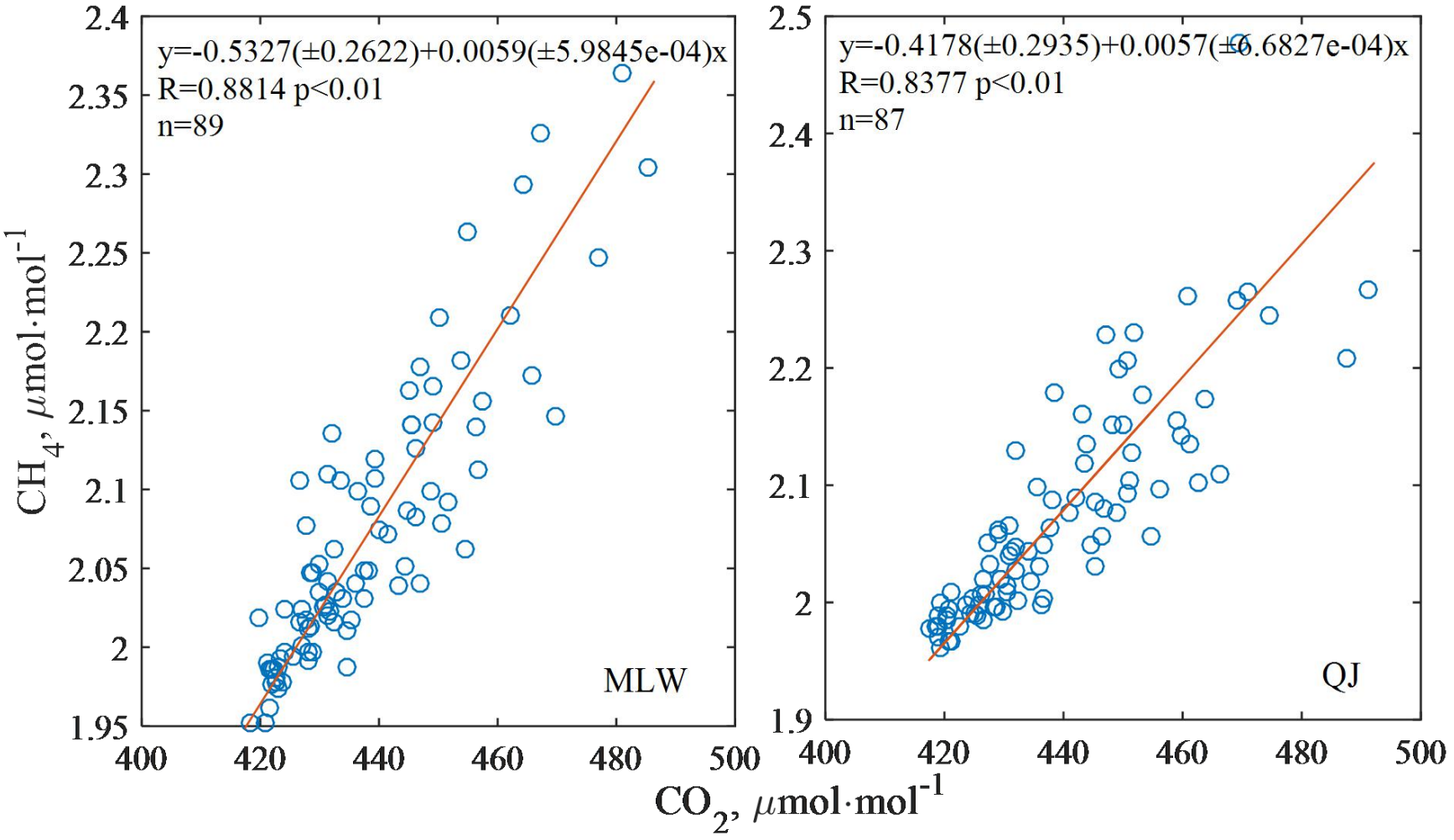
Half-hourly (daytime)

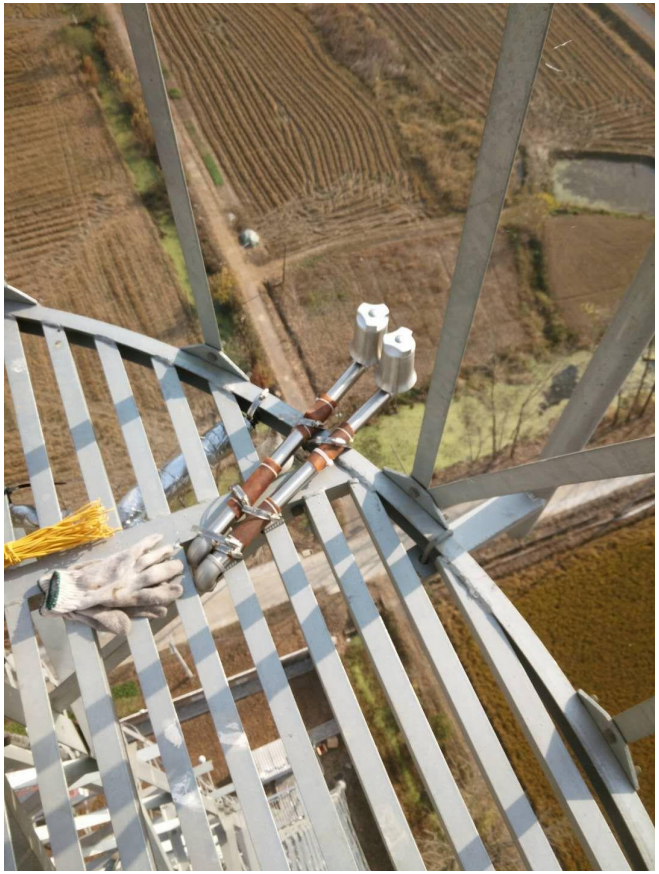


Half-hourly (nighttime)



Daily (daytime)





Thank you!