Activity of methane-oxidizing bacteria along the River Elbe downstream to its estuary

Anna Matoušů[1,2], Karel Šimek[2] & Ingeborg Bussmann[3]

[1]University of South Bohemia, Faculty of Science, České Budějovice, Czech Republic (anna.matousu@gmail.com)
[2]Biology Centre of the AS CR, v.v.i., Institute of Hydrobiology, České Budějovice, Czech Republic (ksimek@hbu.cas.cz)
[3]Alfred-Wegener-Institut for Polar and Marine Research, Marine Station Helgoland, Germany (ingeborg.bussmann@awi.de)

INTRODUCTION

Although rivers and estuarine systems do not belong to the major methane sources, their contribution to the global methane and carbon cycle is an essential information. To estimate the fate of methane originated in water (in the sediments) of a large European river over a longer period, we intend to quantify to amount of dissolved methane and the metabolic activity (i.e. the rate of microbial methane oxidation) of aerobic methanotrophic bacteria in the River Elbe, from its source in the Giant Mountains (Czech Republic) towards to its estuary in the North Sea. An essential information for the evaluation of the methane oxidation is the determination and investigation of factors influencing the process rate.

RESULTS

(a) CH_4 CONCENTRATION IN THE WATER COLUMN:

- **Upper Elbe**: there is an increasing trend from partly natural river sites (51. km from source) downstream to the polluted canalized sites (105. - 129. km), then the CH_4 concentration remains more or less constant, with the exception of the weir at Střekov (326. km) with very high CH_4 concentration (see figure 3)
- **Middle Elbe**: the CH_4 concentrations are comparable with the values measured at the Czech-German border
- **Lower Elbe**: a strong increase of measured CH_4 concentration occures at the harbour of Hamburg (990. km downstream), however the CH_4 concentration decreases rapidly with the increasing salinity (see figure 1)

(b) CH_4-OXIDATION RATE:

- **Upper Elbe**: surprisingly the highest CH_4-oxidation rate was measured at the second sampling station (51. km), little bit smaller, but still an important microbial activity was measured at the weir Střekov (326. km), (see figure 4)
- **Middle Elbe**: the oxidation rates are comparable with the values measured at the Czech-German border
- **Lower Elbe**: at the harbour of Hamburg was measured a very high methanotrophic activity, which decreased rapidly with the increasing salinity (see figure 2)

(c) FACTORS INFLUENCING THE CH_4-OXIDATION RATE:

- there are no significant differences in observed values (CH_4 concentration, CH_4-oxidation rate) at different depths of water column ("surface" vs. "bottom"), (see tabel 1)
- there were observed significant effects of the CH_4 concentration, content of SiO_4, NO_2 and NH_4 on the CH_4-oxidation rate

Correlation with R_{ox}	W. depth	CH_4	SPM	O_2	Temp.	SiO_4	PO_4	NO_2	NO_3	NH_4
P-value	0,548	**< 0.0001*** **	0,170	0,759	0,214	**0,039***	0,635	**0,011***	0,133	**0,014***
R^2	0,004	0,248	0,021	0,001	0,018	0,084	0,005	0,126	0,046	0,118

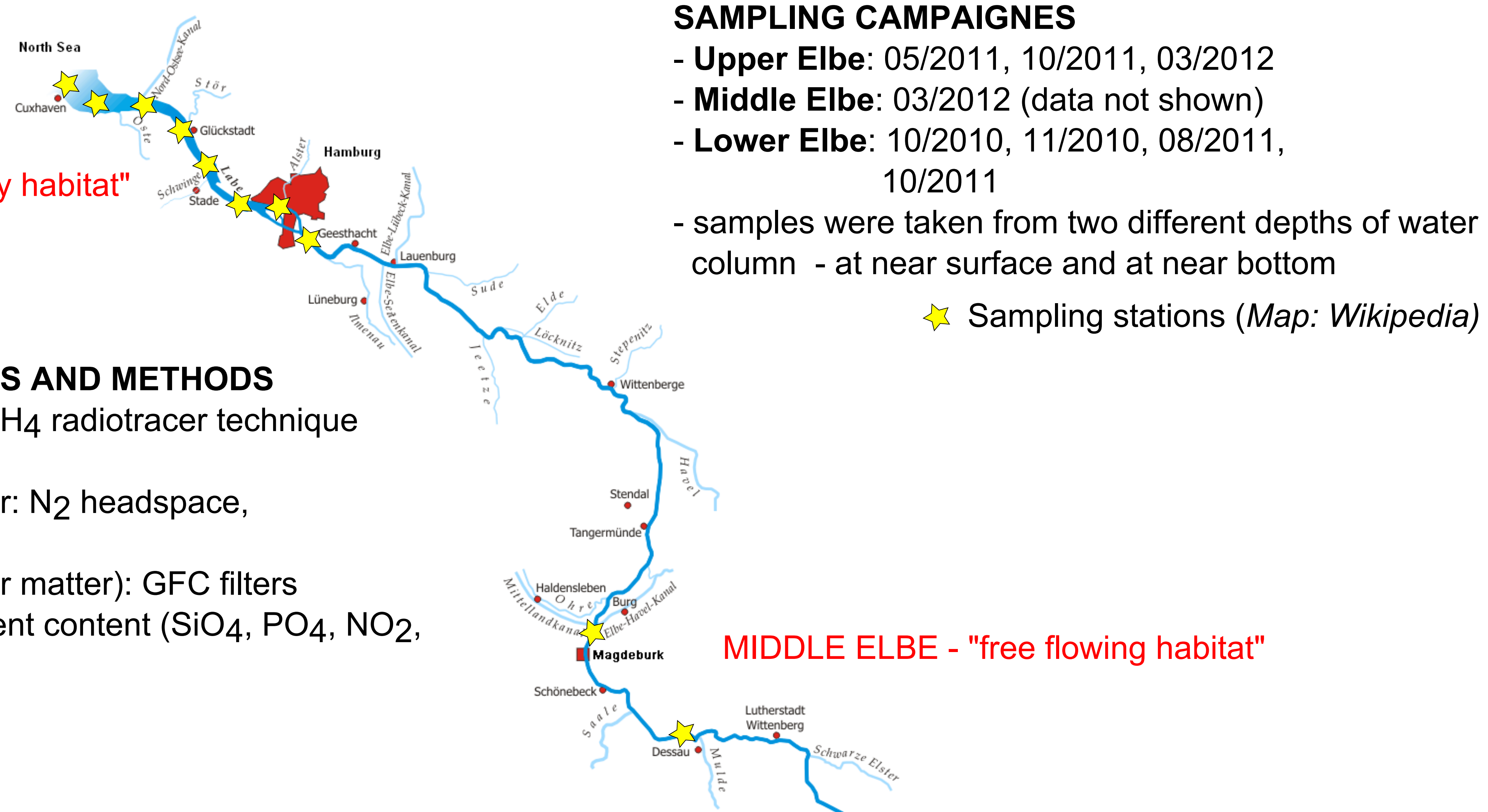
Tab. 1: *Correlation (95% confidence interval) between microbial CH_4-oxidation rate (R_{ox}) and other measured parameters (*significant correlation on p=0,05 level; *** significant correlation on p<0,0001 level)*

OUTLINES

- comparing the methanotrophic population structure at different sites along the River Elbe (using molecular methods)
- additional field and laboratory experiments to elucidate the influence of varying environmental factors on the methane oxidation rates
- estimate the carbon transfer originated in methane via methanotrophs to higher trophic levels (different grazers); experiments build on previous data (Šimek *et al.* 2007)

REFERENCES

Šimek *et al.*, 2007: Environmental Microbiology 9(3), 789-800
Valentine *et al.*, 2001: Geochimica et Cosmochimica Acta 65(16), 2633-2640.



LOWER ELBE - "estuary habitat"

MIDDLE ELBE - "free flowing habitat"

UPPER ELBE - "retaining habitat"

SAMPLING CAMPAIGNES

- **Upper Elbe**: 05/2011, 10/2011, 03/2012
- **Middle Elbe**: 03/2012 (data not shown)
- **Lower Elbe**: 10/2010, 11/2010, 08/2011, 10/2011
- samples were taken from two different depths of water column - at near surface and at near bottom

☆ Sampling stations (*Map: Wikipedia*)

MEASURED PARAMETERS AND METHODS

- CH_4 oxidation rate: [3H]-CH_4 radiotracer technique (Valentine *et al.*, 2001)
- CH_4 concentration in water: N_2 headspace, gas chromatography
- SPM (suspended particular matter): GFC filters
- Chemical analysis of nutrient content (SiO_4, PO_4, NO_2, NO_3, NH_4)

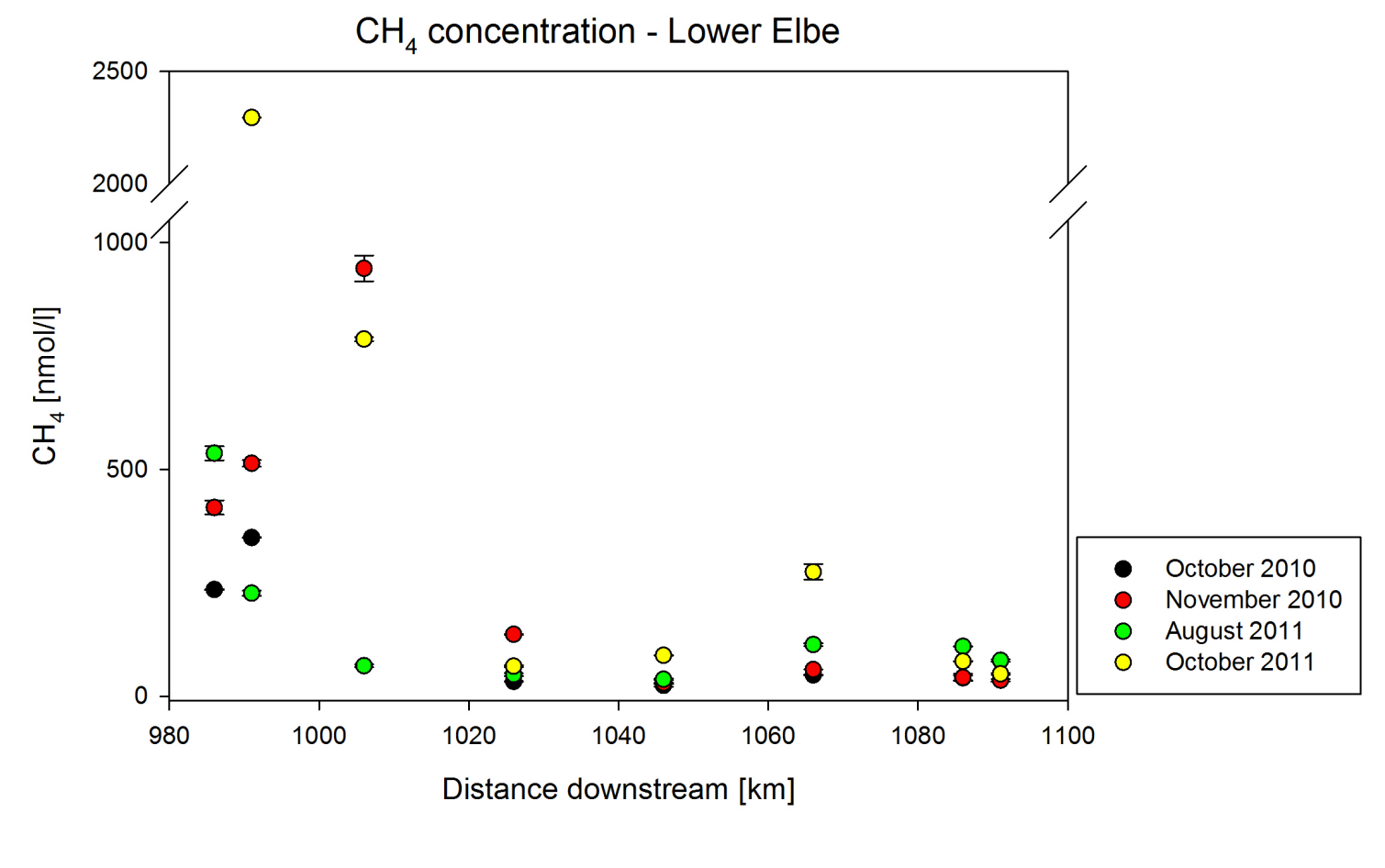


Fig. 1: *Mean values of measured CH_4 concentration in the water column (at near bottom) of the Lower Elbe over 4 sampling campaignes; error bars - standart deviation.*

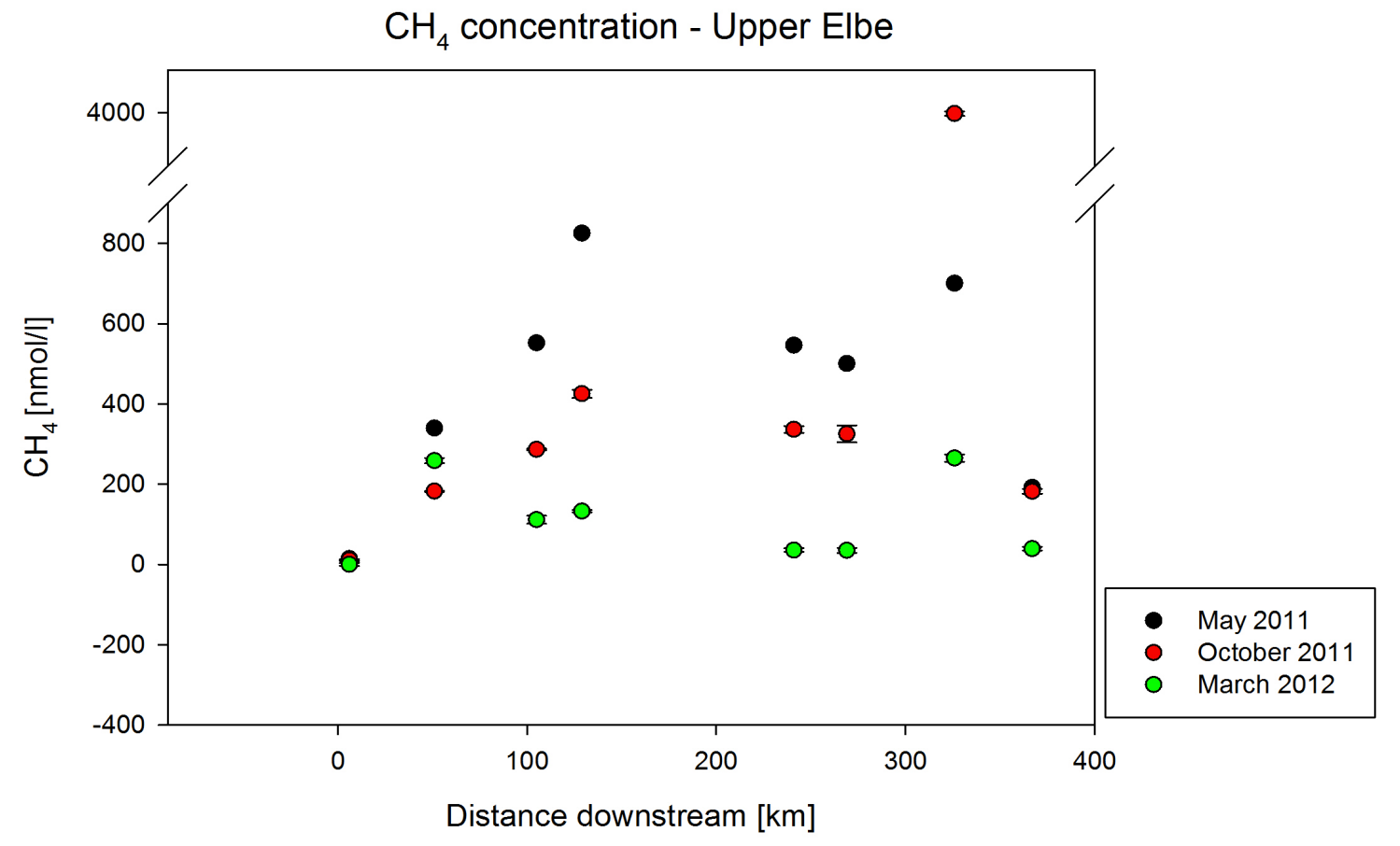


Fig. 3: *Mean values of measured CH_4 concentration in the water column (at near bottom) of the Upper Elbe over 3 sampling campaignes; error bars - standart deviation.*

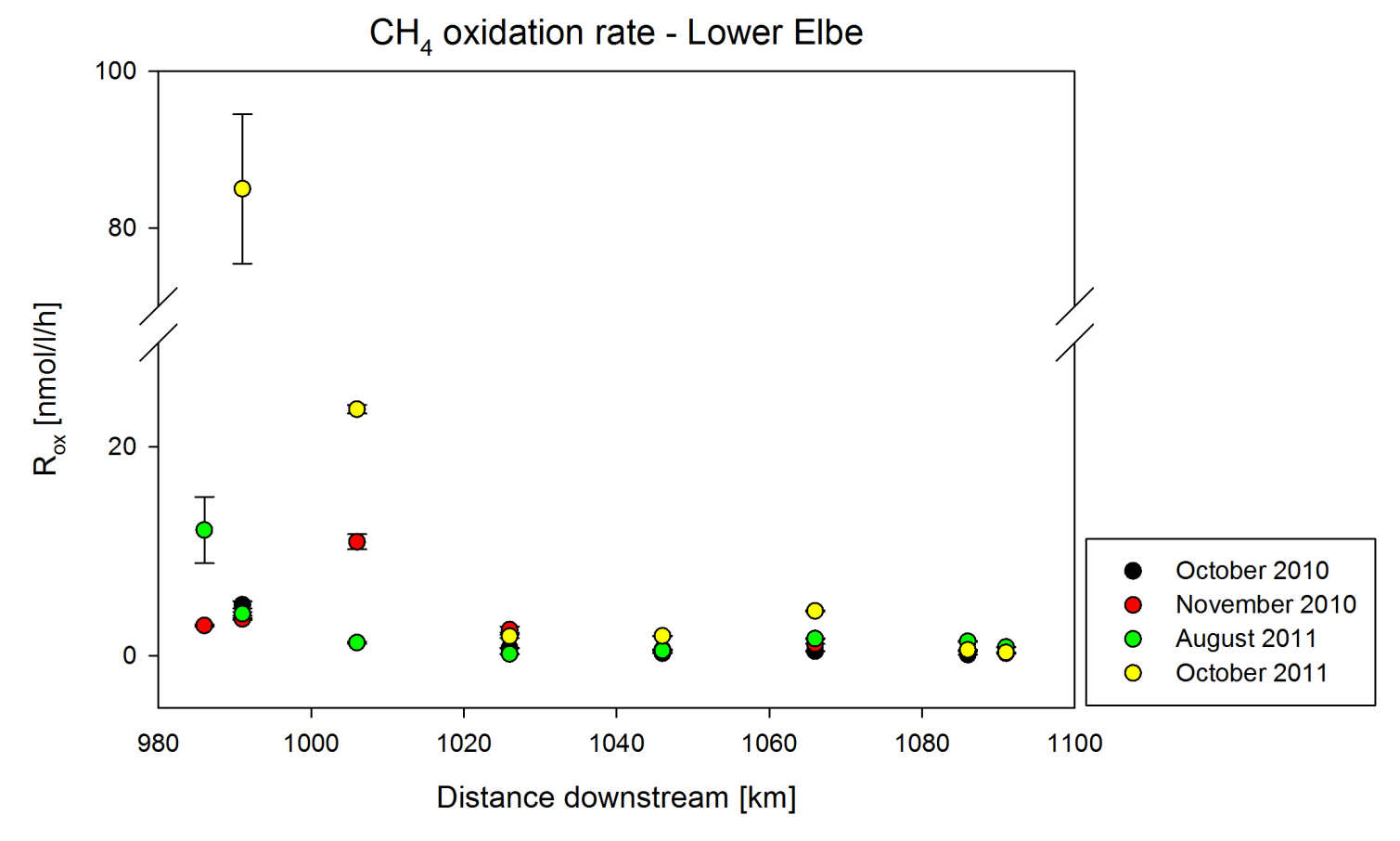


Fig. 2: *Mean values of measured CH_4-oxidation rate in the water column (at near bottom) of the Lower Elbe over 4 sampling campaignes; error bars - standart deviation.*

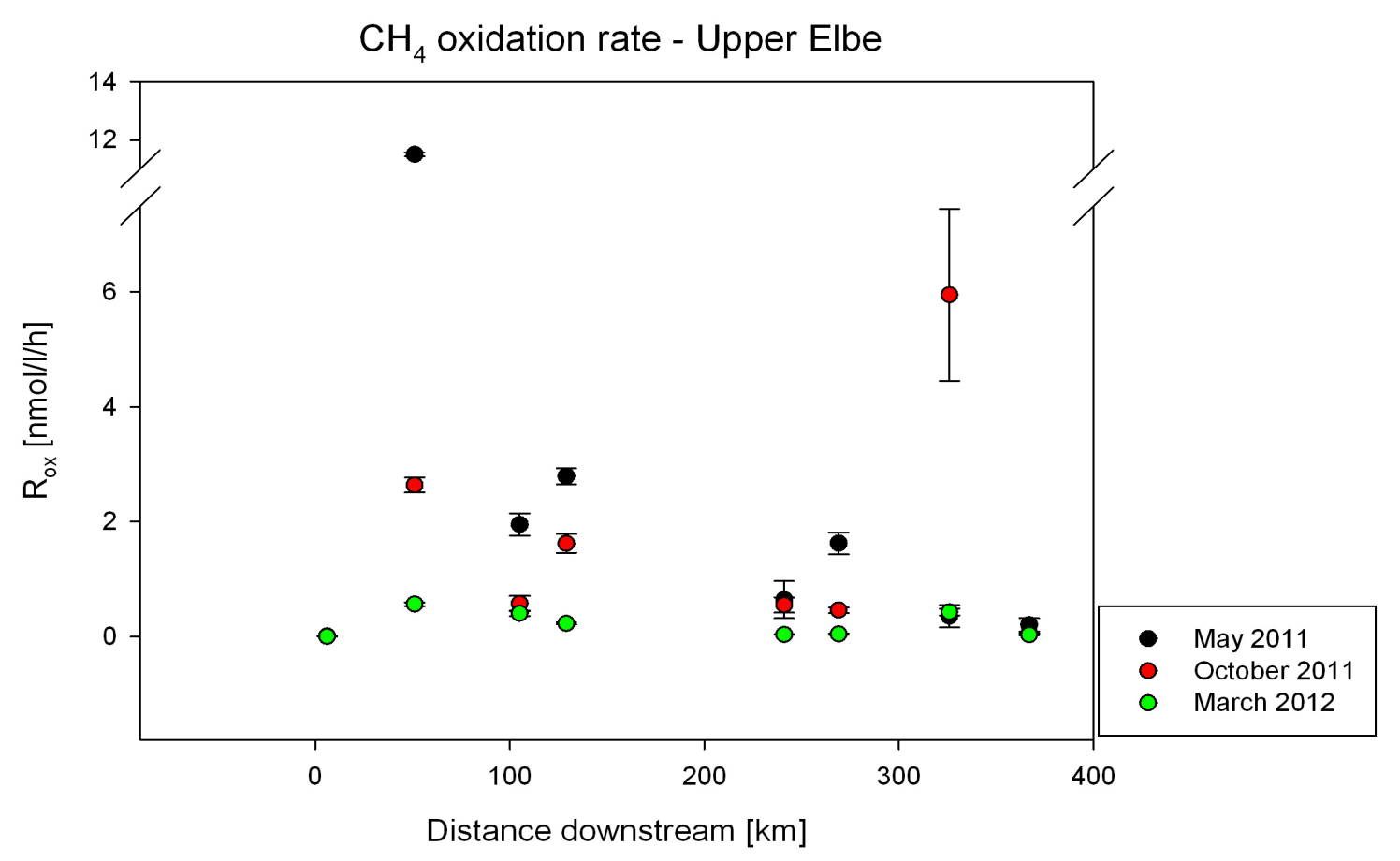


Fig. 4: *Mean values of measured CH_4-oxidation rate in the water column (at near bottom) of the Upper Elbe over 3 sampling campaignes; error bars - standart deviation.*

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