Temporal variations of methane emissions from emergent aquatic macrophytes in two boreonemoral lakes

Lina Törnqvist Supervisors: David Bastviken and Per Milberg

Linköping University
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Introduction

Methane (CH_4) is an important greenhouse gas produced in anaerobic sediment in freshwater lakes. CH_4 can be transported to the atmosphere via the roots and stems in the emergent aquatic macrophytes. Few investigations have been made on CH_4 emissions from emergent aquatic macrophytes on a temporal scale in freshwater environments.

Objective

This study aims to:

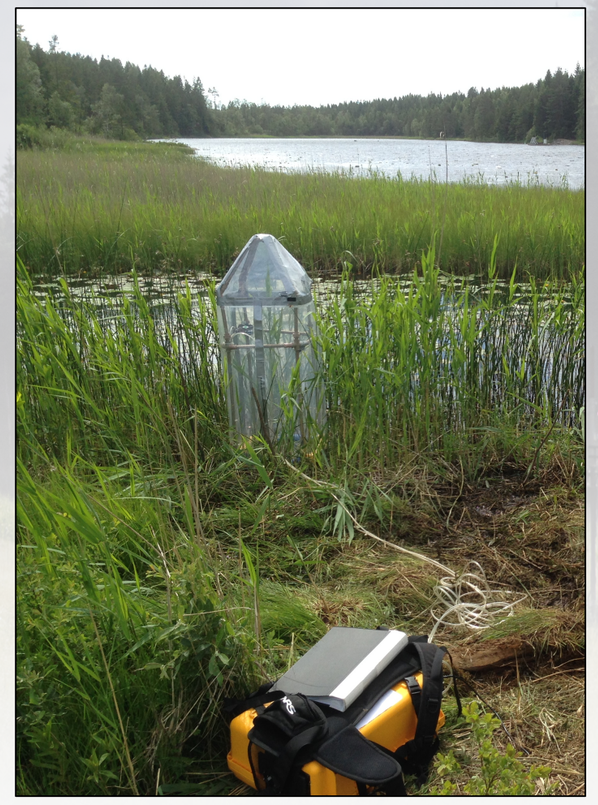
I) evaluate possible temporal variations in CH_4 emission from different emergent aquatic macrophytes.

II) test if the different variables: air temperature, light, air pressure, humidity, carbon dioxide fluxes, wind, lake type, species and biomass, can be factors controlling CH_4 emissions.

Method

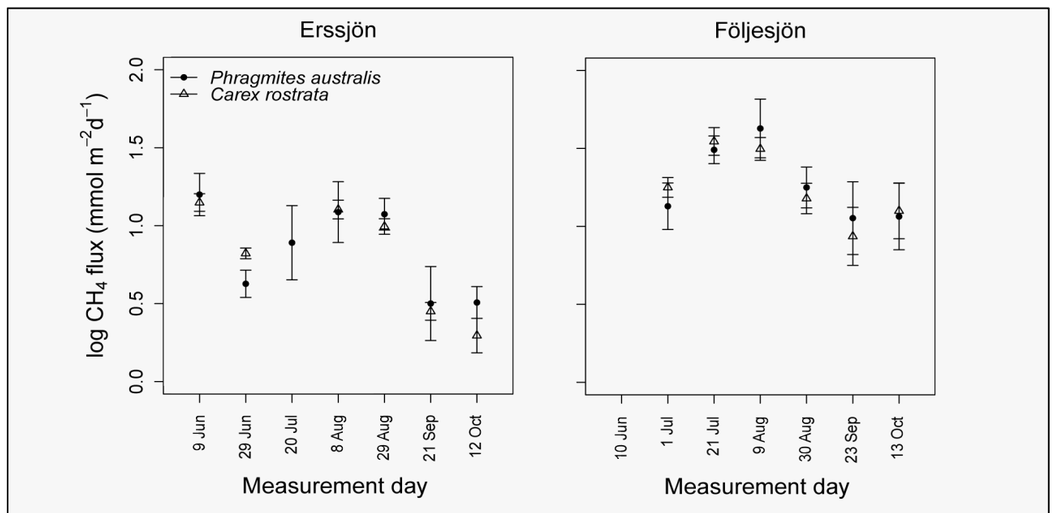
The field study was carried out in the two freshwater lakes, Lake Erssjön and Lake Följesjön.

A static chamber with air-tight plastic was used to collect CH_4 gas from stands with *Phragmites australis* and *Carex rostrata*.



Results

- There was a seasonal variation for *P. australis* and *C. rostrata*. In general there were higher CH_4 emissions from Lake Följesjön and there were no differences in emissions between the species.
- Diel variations for *P.* australis and *C. rostrata* were found in the study. However, recurrent peaks at the same time were not found.
- Lake type and air temperature were the most important variables that can explain CH_4 emissions, where CH_4 emissions increased with the air temperature.
- Light, wind and the date over the growing season affected the CH_4 emissions from the emergent aquatic macrophytes to a smaller extent, compared to lake type and air temperature.

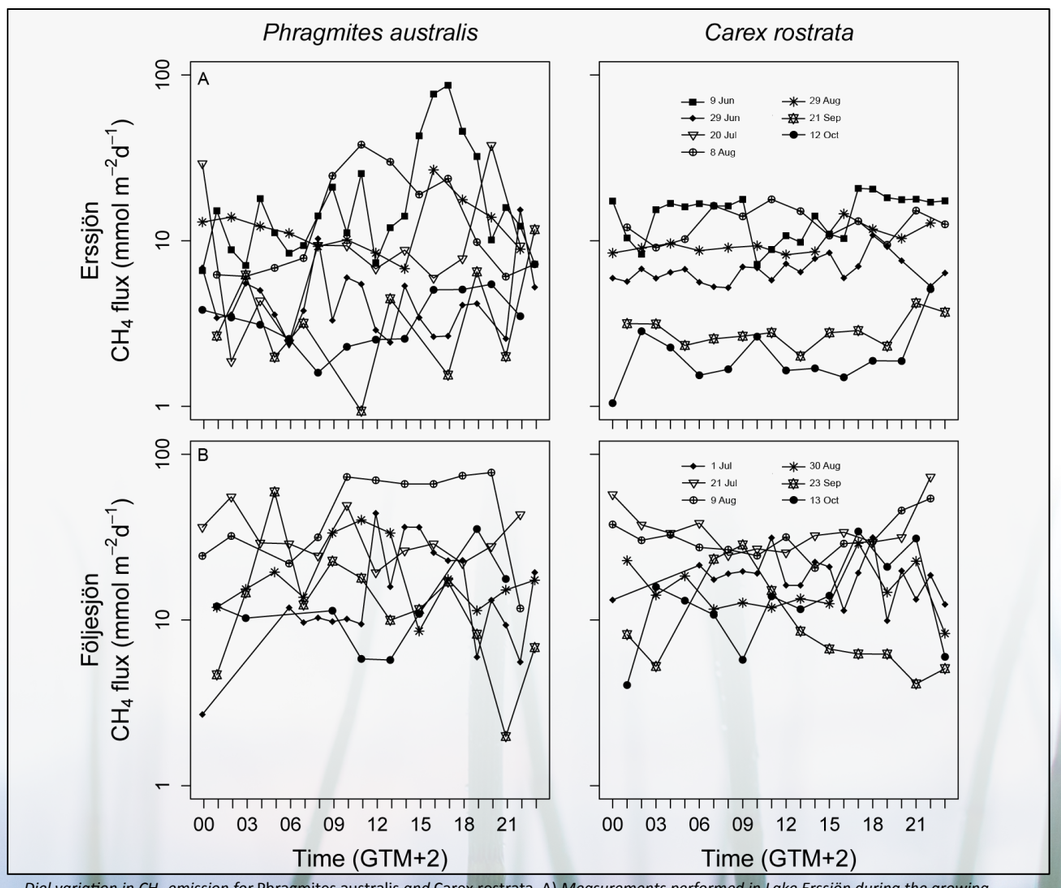


Seasonal variation in CH_4 emission (diel average with $CI_{95\%}$, n=7) from Phragmites australis *and* Carex rostrata *in Lake Erssjön and Lake Följesjön. Note that no measurement was made in Lake Följesjön the 10 June.*

Categorical and continuous variables effect on emergent aquatic macrophytes CH_4 emissions per m^2, calculated with a model averaging from a GLZ (Generalized linear model). Including model averaging parameters estimate, model average estimate, standard error (SE), z-value, 95 % confidence interval (CI) and RI* for variables.

Methane flux (mmol m^{-2} d^{-1})	Standardized values						
					CI interval		
	Estimate	MAE*	SE	z-value	Lower	Upper	RI*
Intercept	2.502e+07	2.637	0.069	37.962	**2.501**	**2.773**	
Lake Erssjön (compared with Lake Följesjön)	-9.995e-01	-0.991	0.097	10.202	**-1.181**	**-0.800**	**1.0**
Air temperature (C°)	5.826e-02	0.896	0.172	5.182	**0.557**	**1.235**	**1.0**
Light (µmol m^{-2} sec^{-1})	-2.929e-04	-0.242	0.111	2.178	**-0.459**	**-0.024**	**0.9**
Wind (m/s)	-8.890e-02	-0.218	0.095	2.291	**-0.404**	**-0.031**	**0.93**
Date 1 (Measurement day)	1.894e-05	-0.279	0.135	2.057	**-0.545**	**-0.013**	**0.9**
Date 2 (Measurement day)	-6.740e-15	-0.342	0.187	1.821	-0.710	0.026	0.9
P. australis (compared to *C. rostrata*)	1.488e-01	0.172	0.090	1.913	-0.004	0.348	0.77
Air pressure (atm)	6.357e-01	0.028	0.102	0.270	-0.172	0.227	0.27
Biomass (g DW)	-1.011e-03	-0.145	0.115	1.259	-0.370	0.081	0.50
NEE (net ecosystem exchange CO_2)	9.841e-05	0.092	0.085	1.077	-0.075	0.259	0.48
Time 1 (Time of the day)	-3.516e-02	-0.013	0.089	0.148	-0.189	0.163	0.12
Time 2 (Time of the day)	1.234e-11	0.115	0.238	0.481	-0.353	0.582	0.12

*) MAE (Model Average Estimate) and RI (Relative Importance)



Diel variation in CH_4 emission for Phragmites australis *and* Carex rostrata. A) *Measurements performed in Lake Erssjön during the growing season (June to October) and B) measurements performed in Lake Följesjön during the growing season (June to October). Time in Swedish summertime (GMT+2).*

Conclusions

There were four main conclusions from the current study:

I) There was a seasonal variation in CH_4 emissions.

II) There was no trend with unique peaks in the within day CH_4 variations for *P. australis* and *C. rostrata.*

III) The CH_4 emissions from *P. australis* and *C. rostrata* were relatively similar.

IV) Type of lake and air temperature were the most important variables controlling CH_4 emissions.

Contact information. Linköping University, IFM Biology. www.ifm.liu.se/edu/biology/master_projects/2015/lina-tornqvist-1/index.xml, linatornqvist1@gmail.com, 150528