Methanotropic bacteria in forest soils

Verena Lang [1,2] | Valentin Gartiser [1] | Nora Anderson [1] | Peter Hartmann [1] | Alexander Schengel [1] | Martin Maier [1,2]

[1] *Forest Research Institute Baden-Württemberg (FVA), Germany*
[2] *Department of Crop Sciences, Chair of Soil Physics, University of Göttingen, Germany*
Verena.Lang@forst.bwl.de

Forest Research Institute Baden-Württemberg

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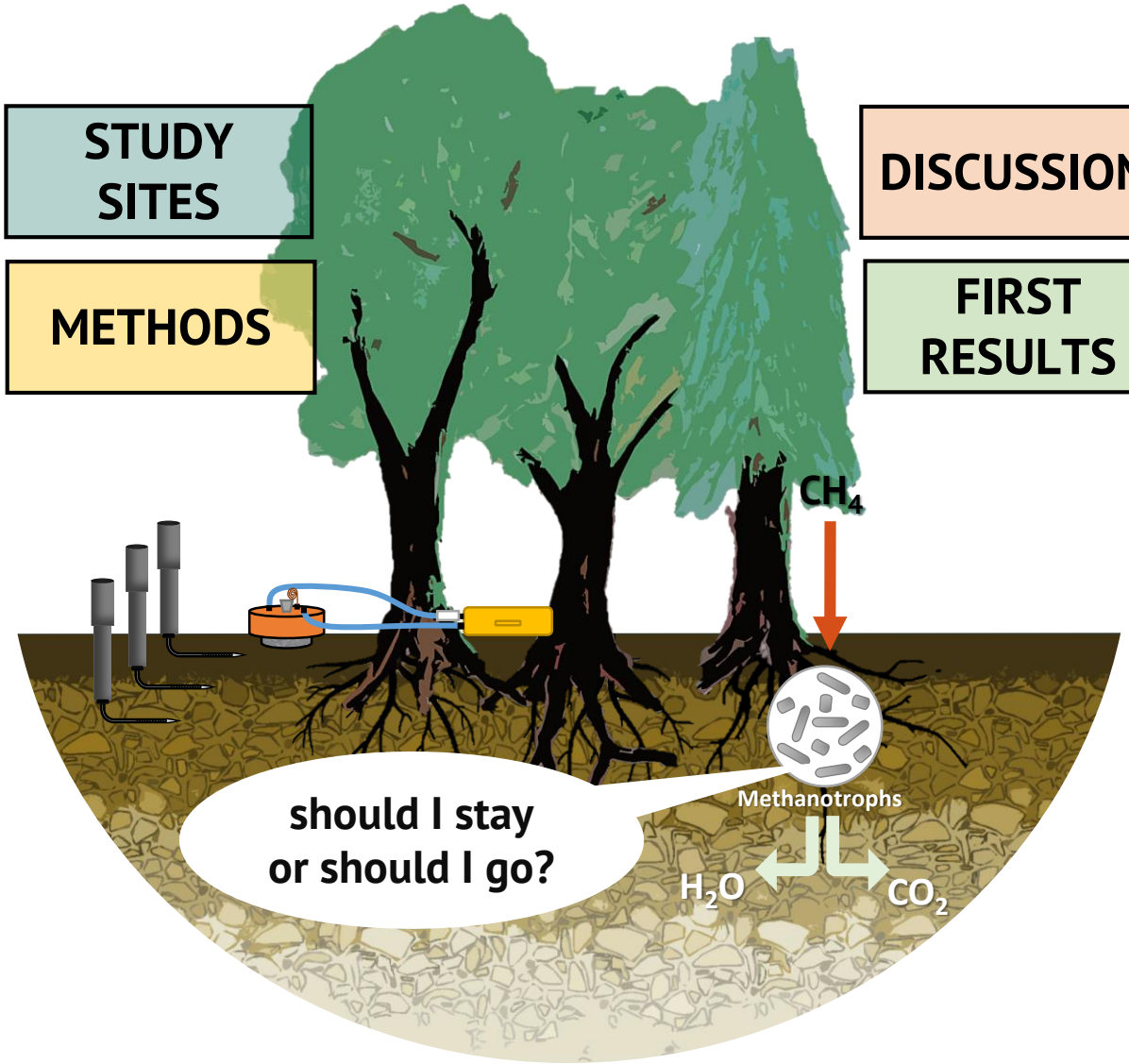
brings you back to the start page



Study objectives

(1) Quantification of the CH_4 sink
(2) Trend analysis: long-term decrease?
(3) Identification of drivers
(4) Closing the data gap on long-term measurements

Gefördert durch:

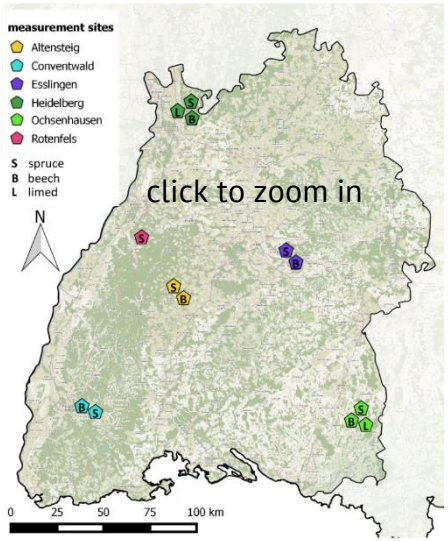
Bundesministerium für Ernährung und Landwirtschaft

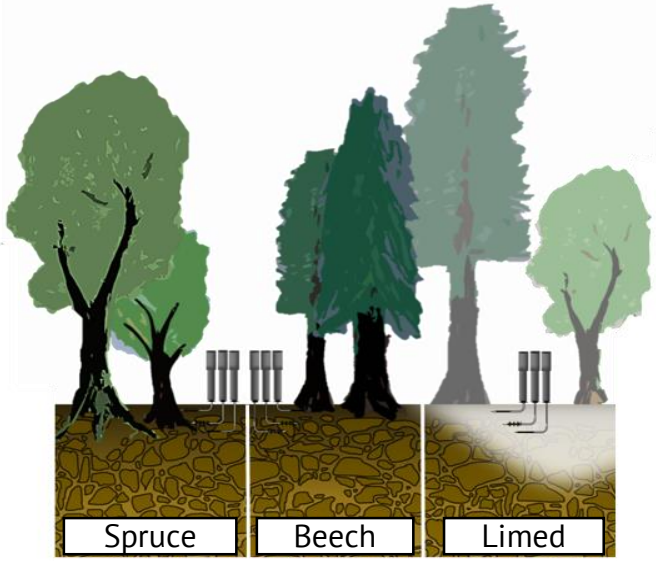
aufgrund eines Beschlusses des Deutschen Bundestages

Waldklimafonds

FKZ: 2218WK58X4

Study Sites





including 13 longterm-monitoring – sites

>20 study **sites** in Germany

up to **25 years** of methane fluxes

Study areas provide:

- tree species comparison (beech / spruce)
- gradients of forest management
- differences in N-deposition and liming
- events (drought/ storms...)

main plots of the FVA (project studies are not included)

Plot	Temp. Ø [°C]	Prec. Ø [mm]	Altitde [m]	tree /treatment	years of data	Soiltype (FAO)	Humustype	Humus-height (cm)	Skel (%)	NDepo (kgN/ha*a)
Altensteig	8.5	817	512	Spruce	**24**	Haplic Cambisol	Mull (MUO)	8	5	13.6
				Beech	**12**	Stagnic Cambisol	Mull (MUO)	7	1	12.2
Conventwald	8.3	1385	816	Spruce	**22**	Haplic Cambisol	Moder (MOT)	10	80	22.3
				Beech	**12**	Skeletic Cambisol	Moder (MOT)	10	50	14.4
Esslingen	9.6	862	345	Spruce	**24**	Vertic Stagnosol	Moder (MOT)	9	0	22.3
				Beech	**12**	Haplic Stagnosol	Mull (MUF)	6	2	14.9
Heidelberg	7.4	1113	505	Spruce	**24**	Haplic Cambisol	Moder (MOT)	7	10	28.9
				Spruce/limed	**24**	Haplic Cambisol	Moder (MOT)	7	10	30.5
				Beech	**12**	Haplic Stagnosol	Mull (MUF)	3	1	16.1
Ochsenhausen	8.6	1111	682	Spruce	**24**	Abruptic Luvisol	Moder (MOR)	9	2	28.4
				Spruce/limed	**24**	Abruptic Luvisol	Moder (MOR)	9	8	28.4
				Beech	**12**	Epidystic Luvisol	Moder (MOR)	6	2	19.2
Rotenfels	9	1258	600	Spruce	**24**	Hyperalbic Podzol	Rawhumus (ROR)	15	25	22.4

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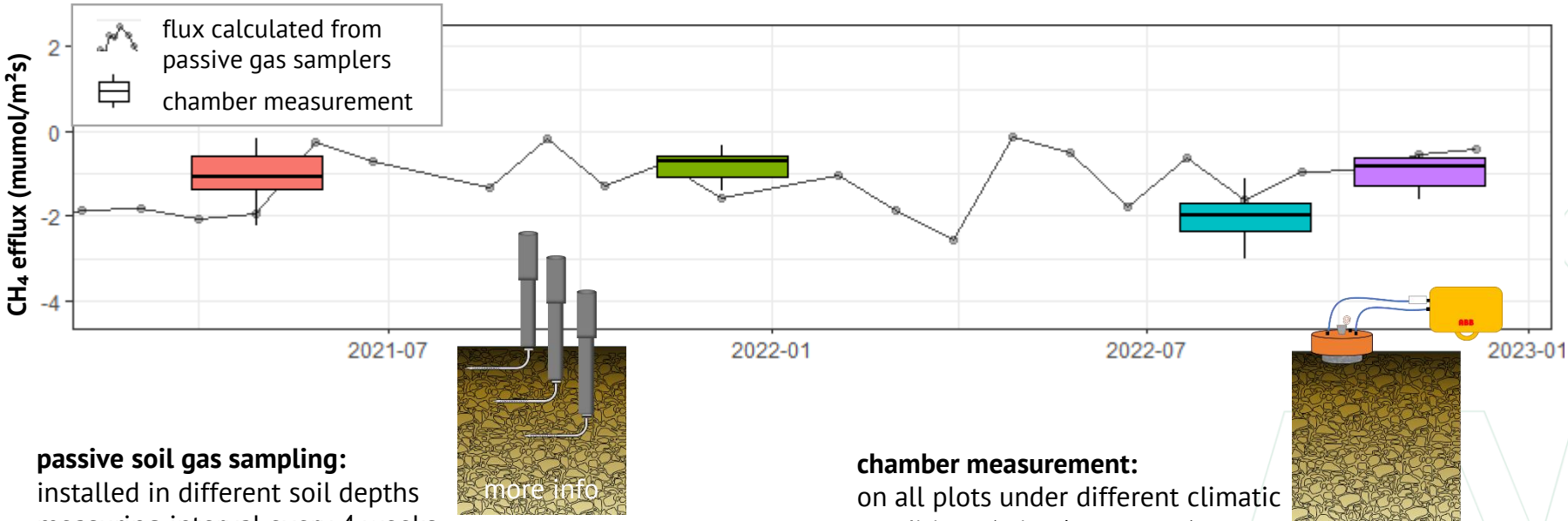

passive soil gas sampling:
installed in different soil depths
measuring interval every 4 weeks
→ enables long-term measurement series

chamber measurement:
on all plots under different climatic conditions (min. 4x per year)
→ enables quantification of methane fluxes

Objective:
To minimize the differences in the absolute amount of gas fluxes.
Consequence:
Parameter fixing (Humus height, TPS, diffusion model parameters)
Focus:
CO_2 with seasonal expectation value

How do we do?
soil gas transport model "ConFluxPro"
- inverse method for flux calculation from concentration gradients
- optimization approach for validation with chamber measurements

„ConFluxPro“ is published as R-Package on github by Valentin Gartiser
https://github.com/valentingar/ConFluxPro

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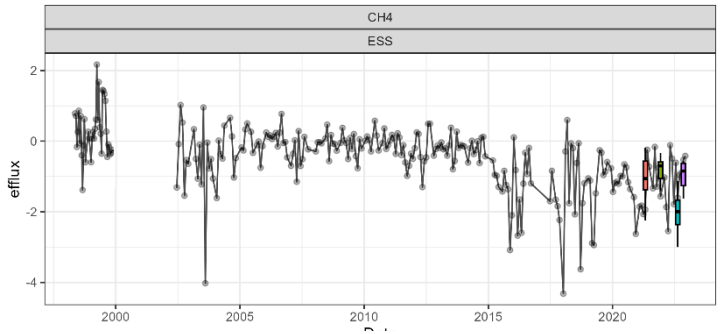
First Results

validation results &
analysis of predictors

some good fits



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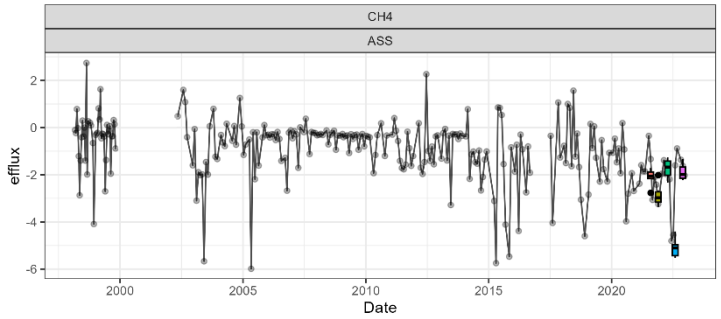
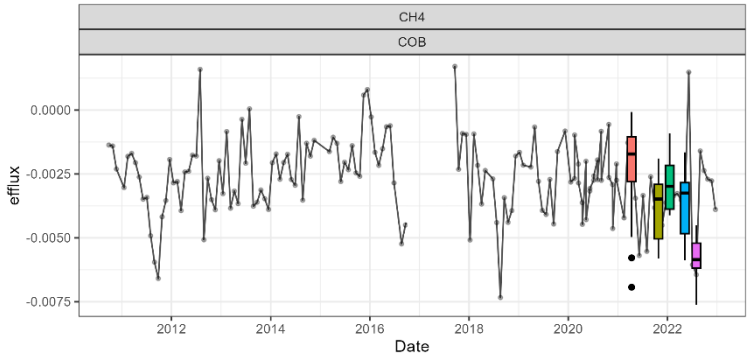
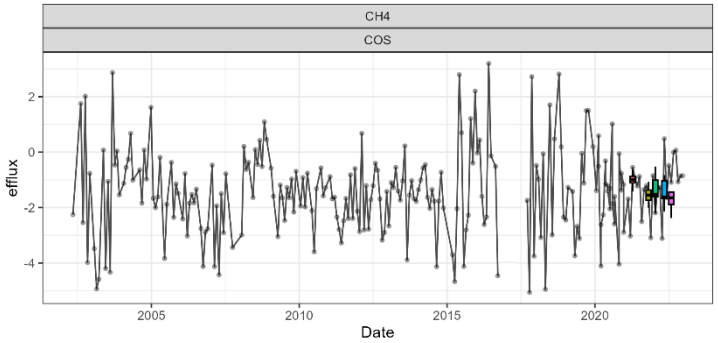
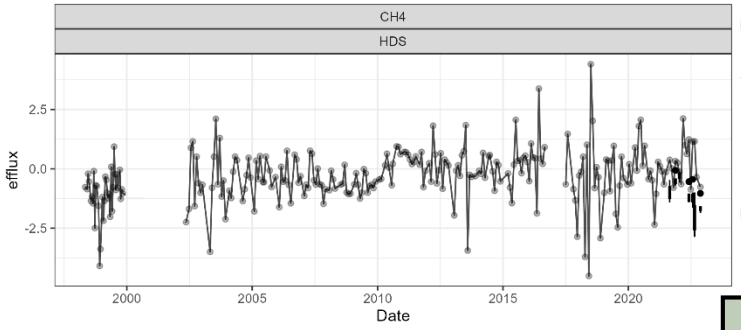




still some work to do





click to
zoom in

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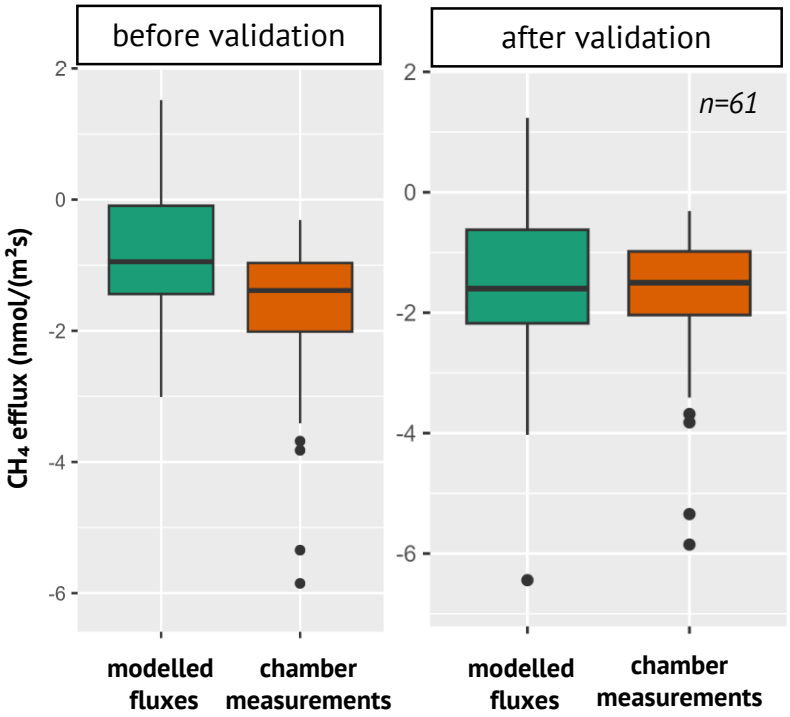
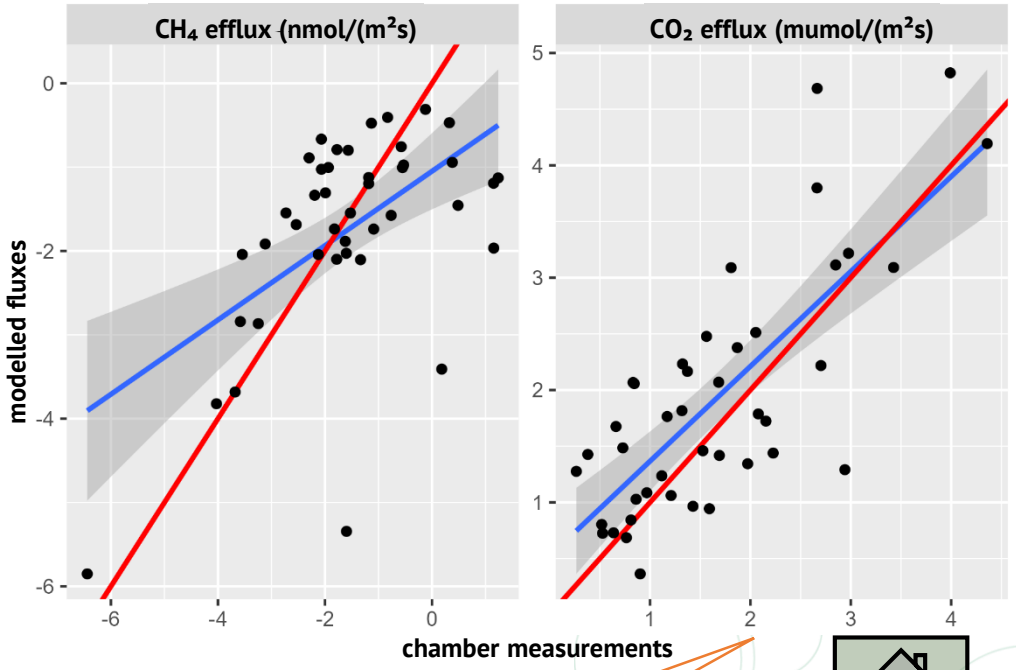
look at some time series

analysis of predictors case study on site Esslingen

effect of validating the gas sampler fluxes with chamber measurements





Optimization of CO_2 profiles is easier, which is why they were also taken into account.

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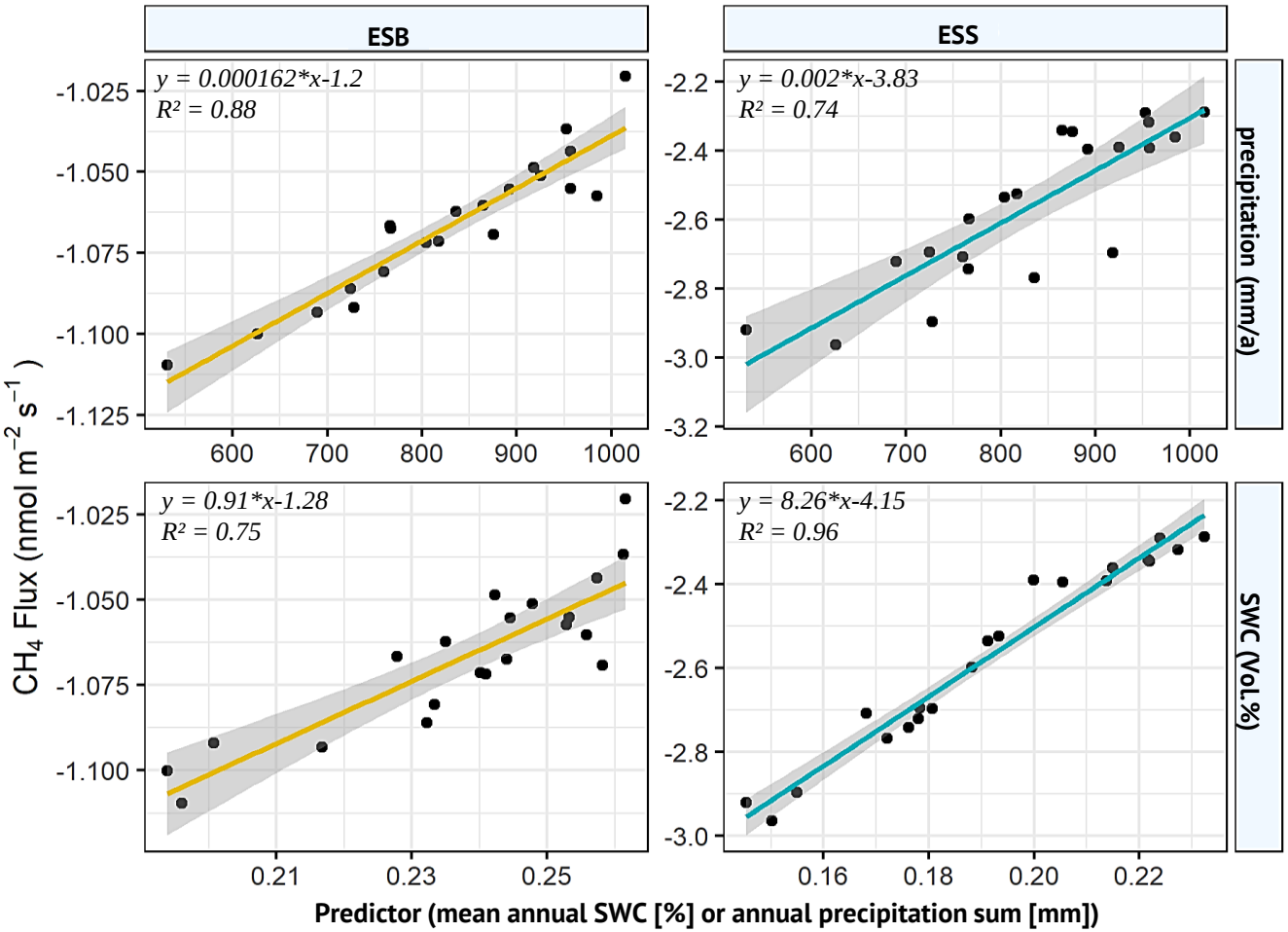
annual values for CH_4 consumption, soil water content (SWC) and annual precepitation sum

example of 2 plots in Esslingen with beech and spruce stand (ESB and ESS)



interannual variation:
higher SWC / precipitation leads to highly significant reduced CH_4 consumption, but... (next slide)

case study Esslingen was done by Nora Anderson

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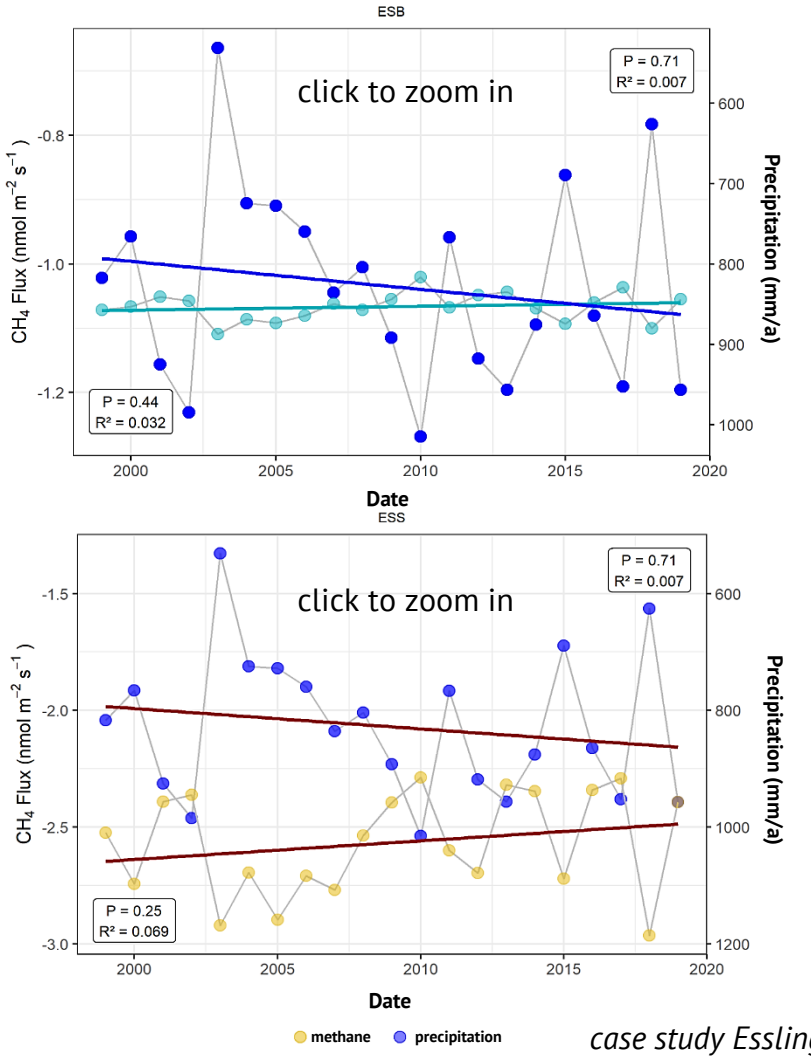
temporal analysis of annual values for CH_4 consumption and annual precepitation sum

example of 2 plots in Esslingen with beech and spruce stand (ESB and ESS)



long-term trend?

There is no significant trend in methane oxidation caused by precepitation.

Scatter over time and uncertainty in the mean flux / predictor estimation make statements about a temporal trend impossible.

case study Esslingen was done by Nora Anderson

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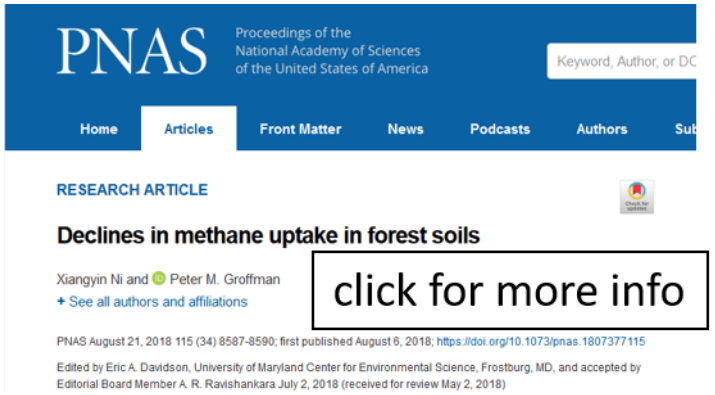
Comparison to other research

Ni & Groffman (2018)

- *Investigation of 4 US sites*
- *Time series: 15-20 years*
- *+ metastudy*



Testing the hypothesis

Forecast:
long-term decrease in CH_4 oxidation
Reason: Precipitation?

Current status of our results:

no clear negative trends in longterm CH_4-uptake, due to no significant trend precipitation

What‘s next?

- individual model development for gap filling on every plot
- Aggregation of annual values
- Investigation of long-term and short-term influencing factors
- In addition to long-term data, evaluation of project-specific sites

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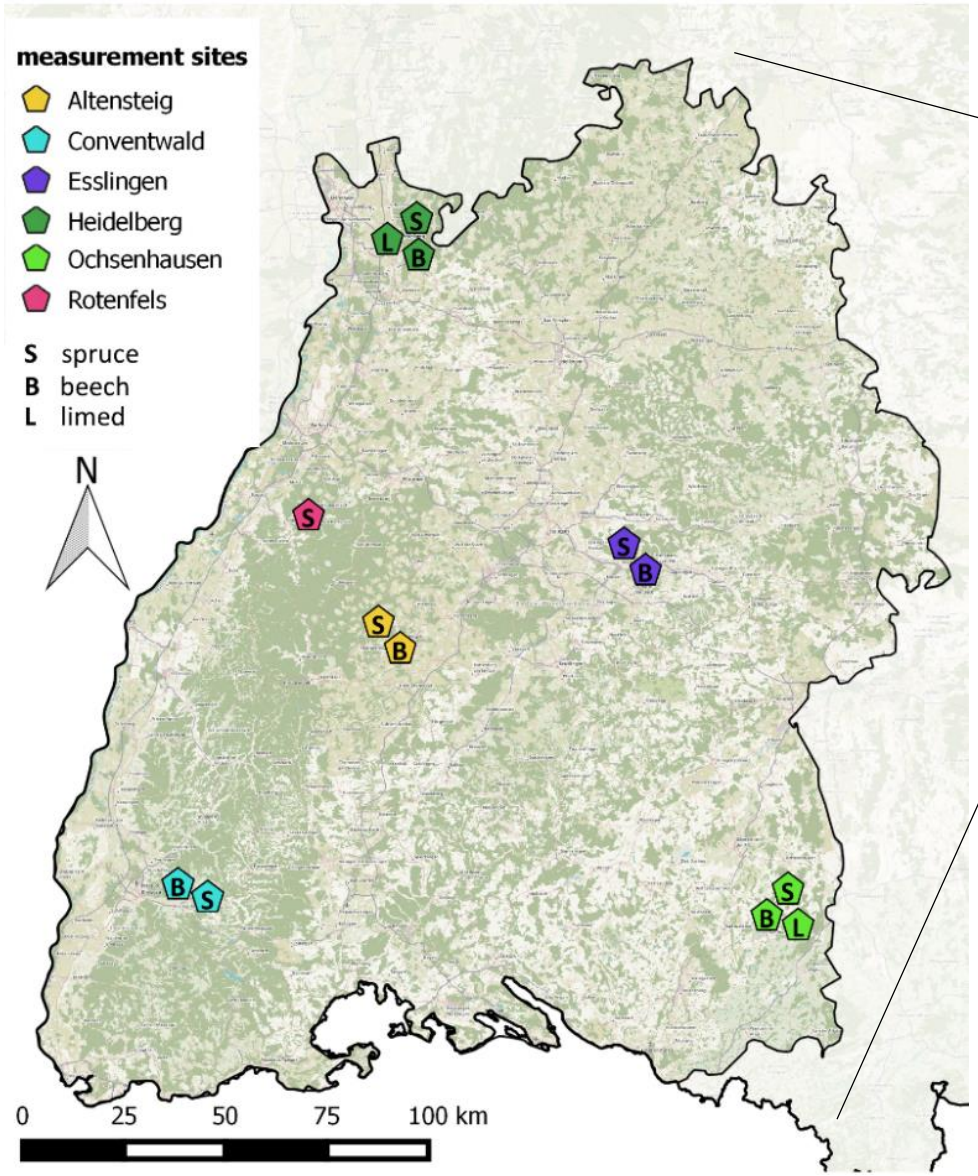
Study Sites



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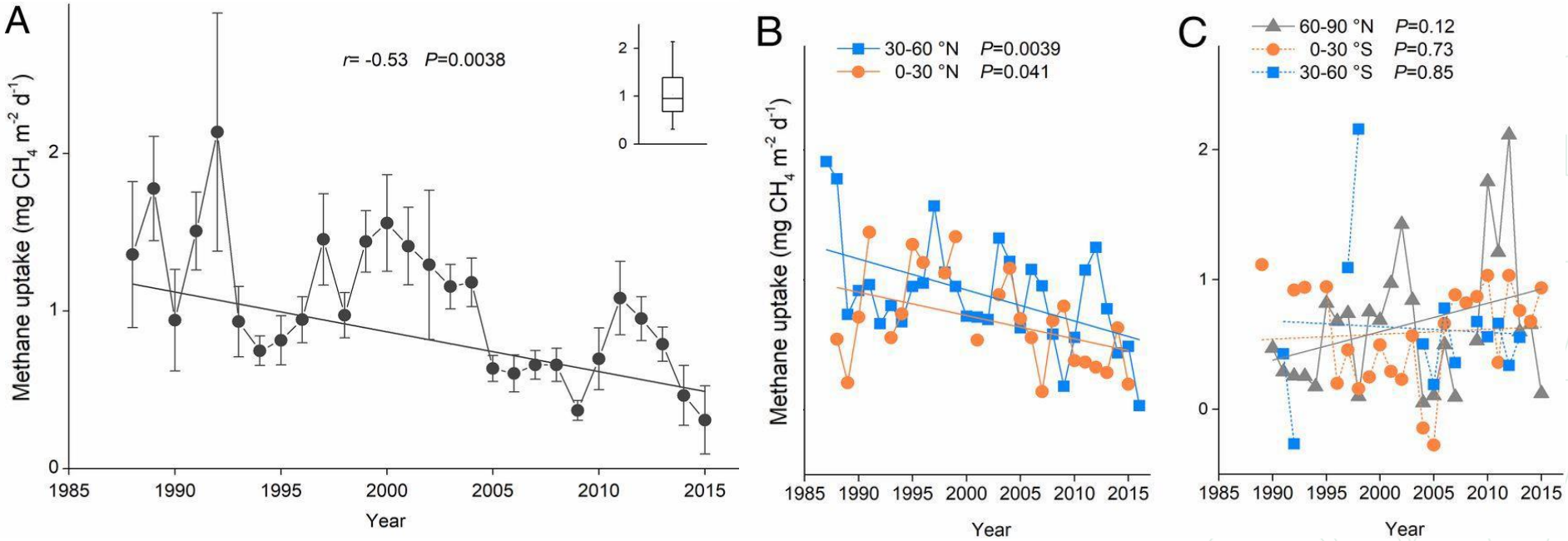
Discussion

Ni & Groffman (2018): Declines in methane uptake in forest soils



Methane uptake in forest soils retrieved from published studies. (A) Global annual CH_4-uptake in forest soils from 1988 to 2015. The *Inset* represents average CH_4-uptake for the full period from 1988 to 2015. The boxes show median and 5th and 95th percentiles. Error bars denote SEs. (B) Annual CH_4-uptake in forest soils from 0 to 30 °N and 30–60 °N latitude. (C) Annual CH_4-uptake in forest soils from 60 to 90 °N, 0–30 °S and 30–60 °S latitude. All trends with time are statistically significant in A and B ($P<0.05$) but are not significant in C. The data in A were actually measured annual CH_4-uptake and those in B and C include both actually measured and estimated annual CH_4-uptake.

can not be observed on our sites, yet!

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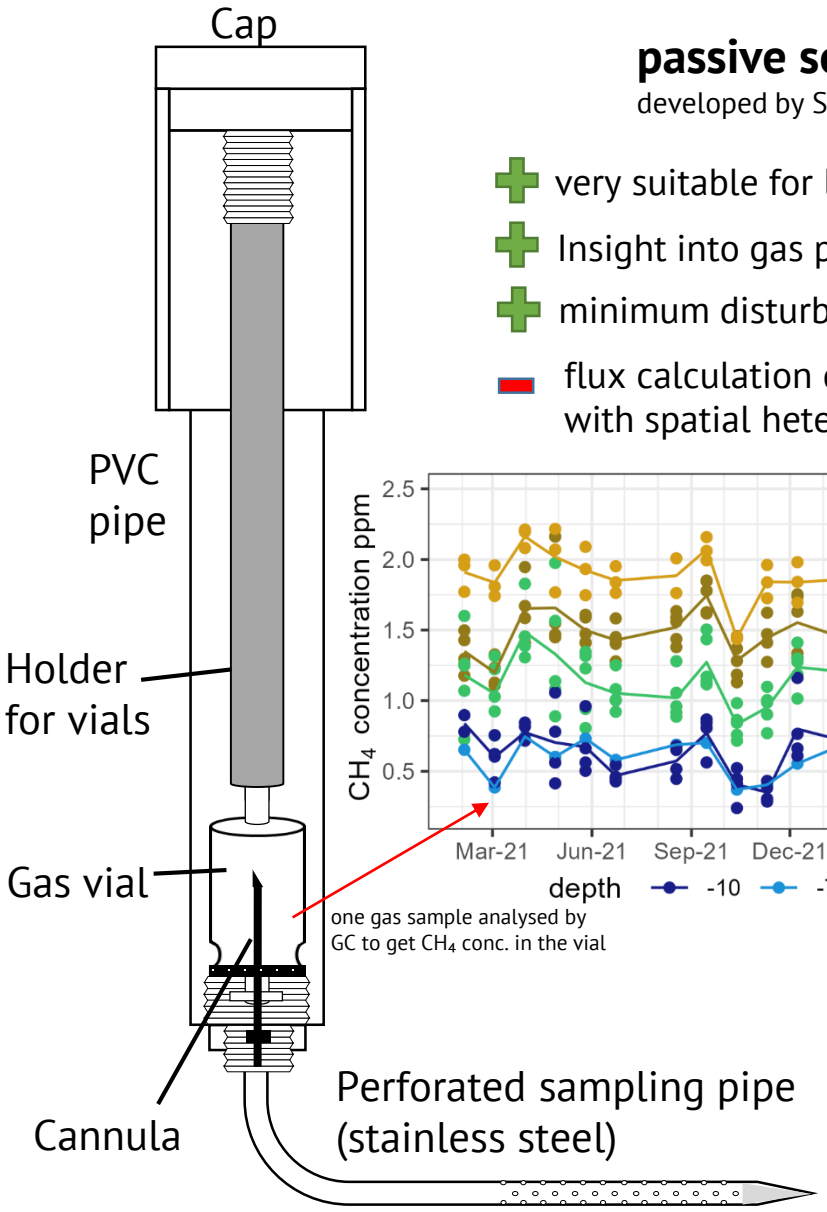
Methods



passive soil gas sampler

developed by Schack-Kirchner et al. 1992

- very suitable for long-term monitoring
- Insight into gas processes of different soil layers
- minimum disturbance of soil and site
- flux calculation dependent on soil physic parameters with spatial heterogenity

one gas sample analysed by GC to get CH_4 conc. in the vial

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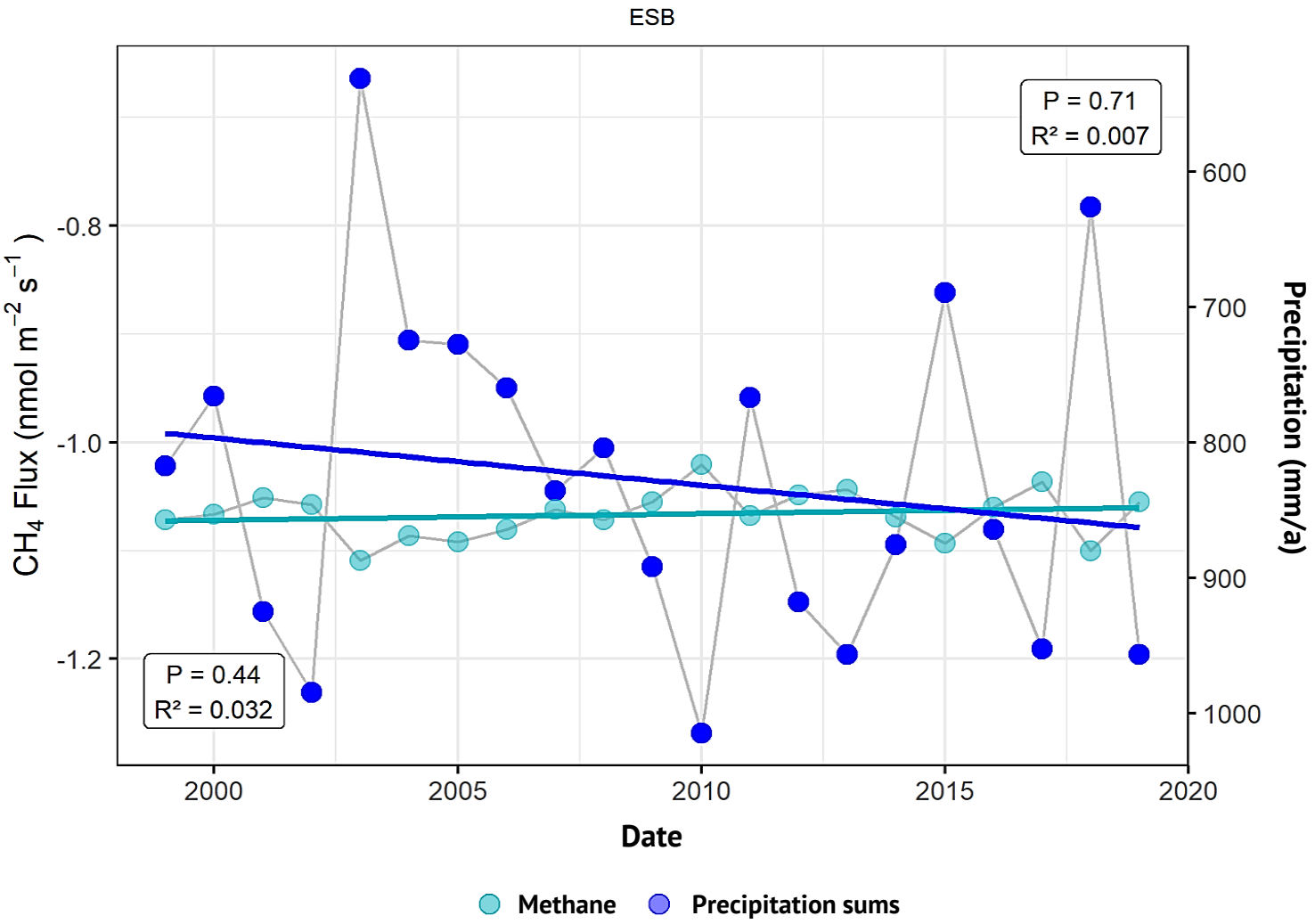
First Results



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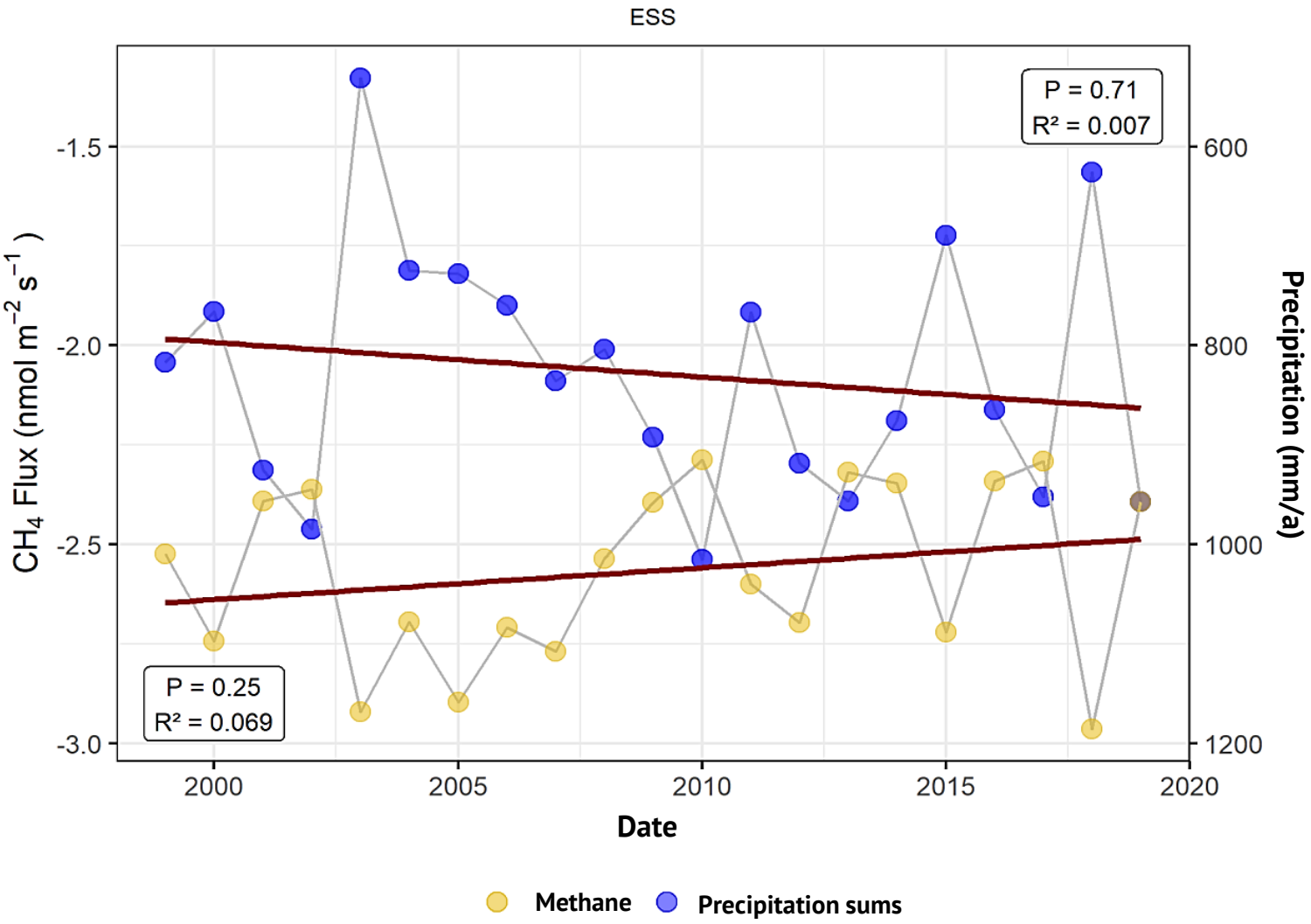

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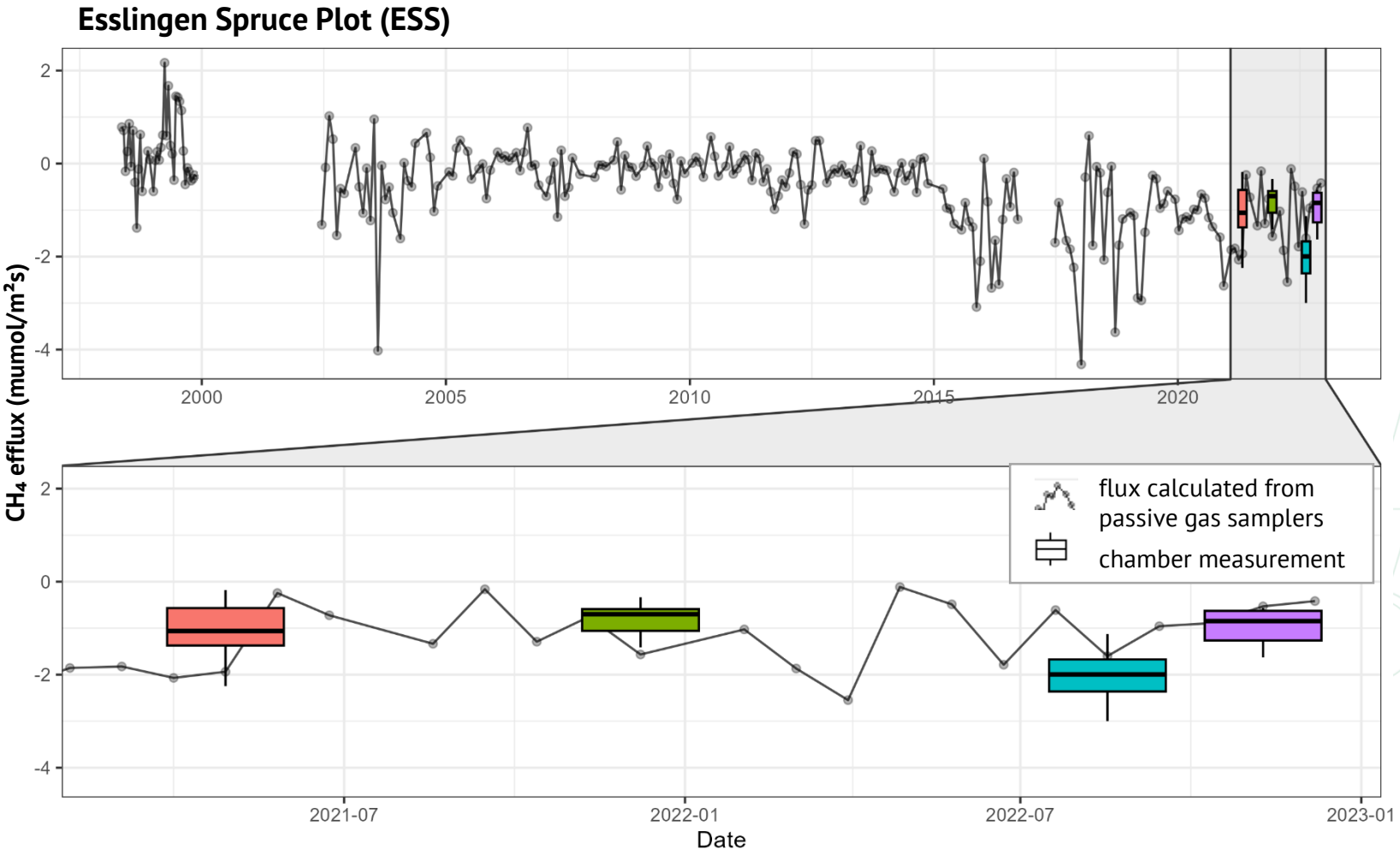

– good correlation between modelled fluxes and chamber measurements

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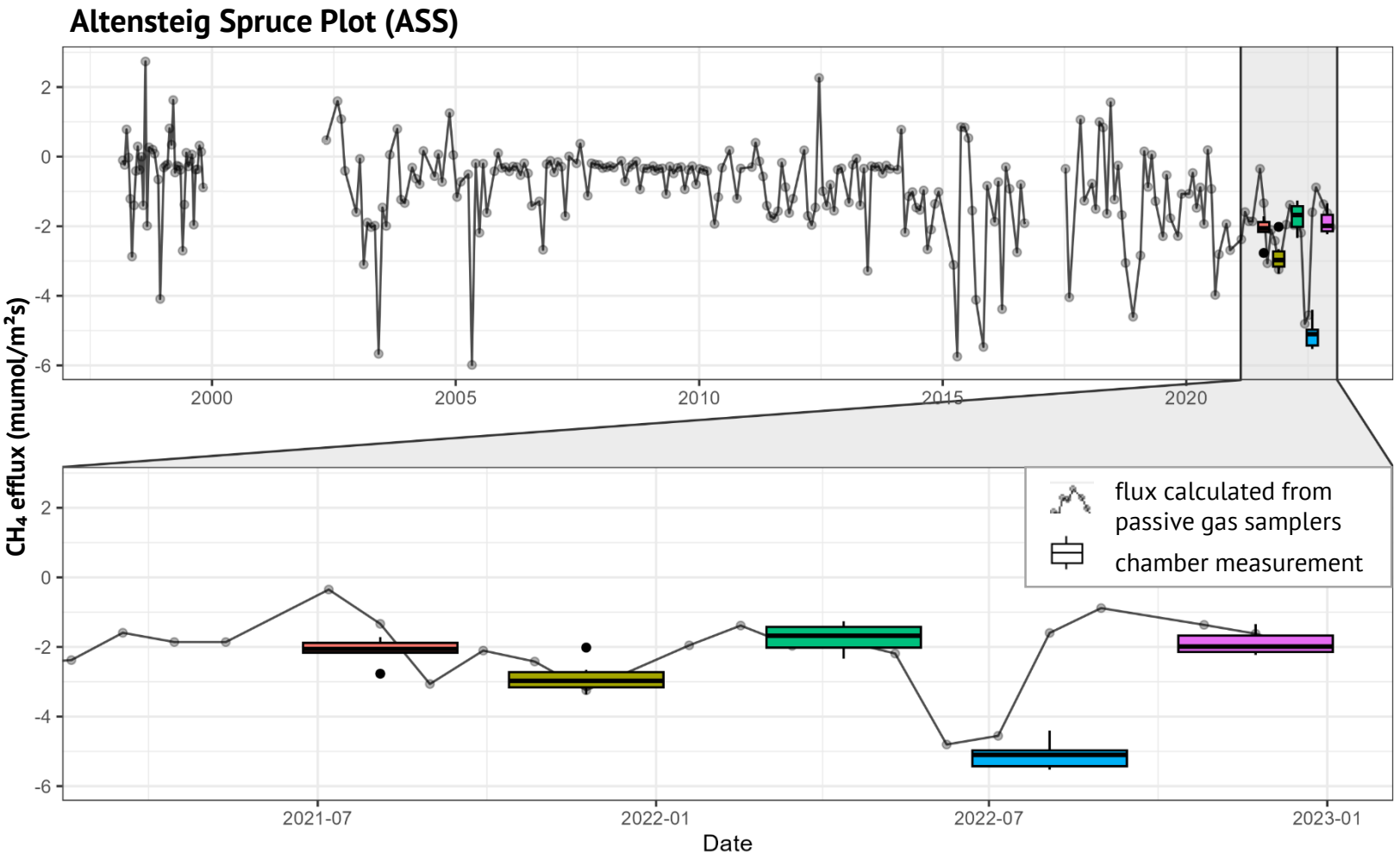

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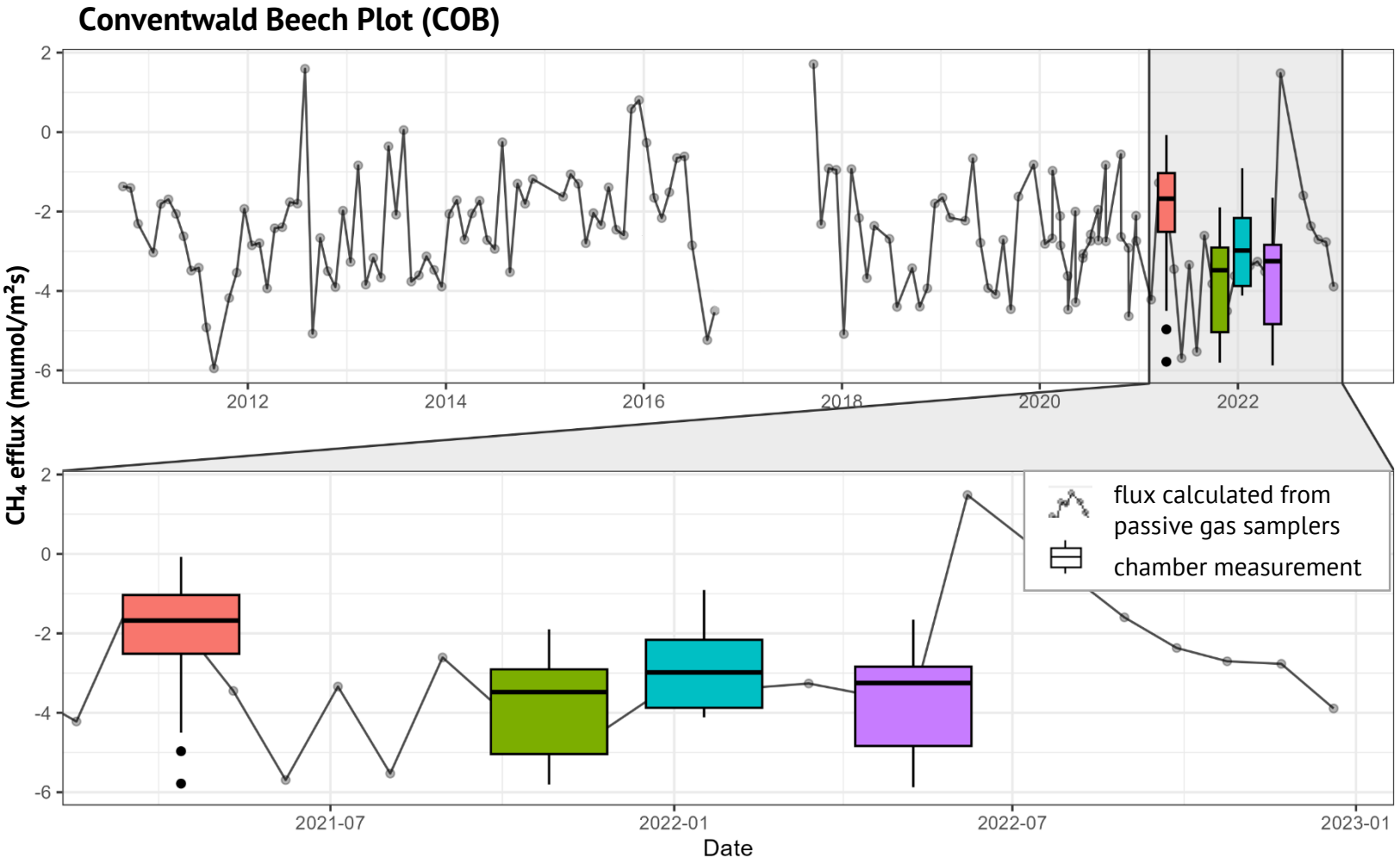

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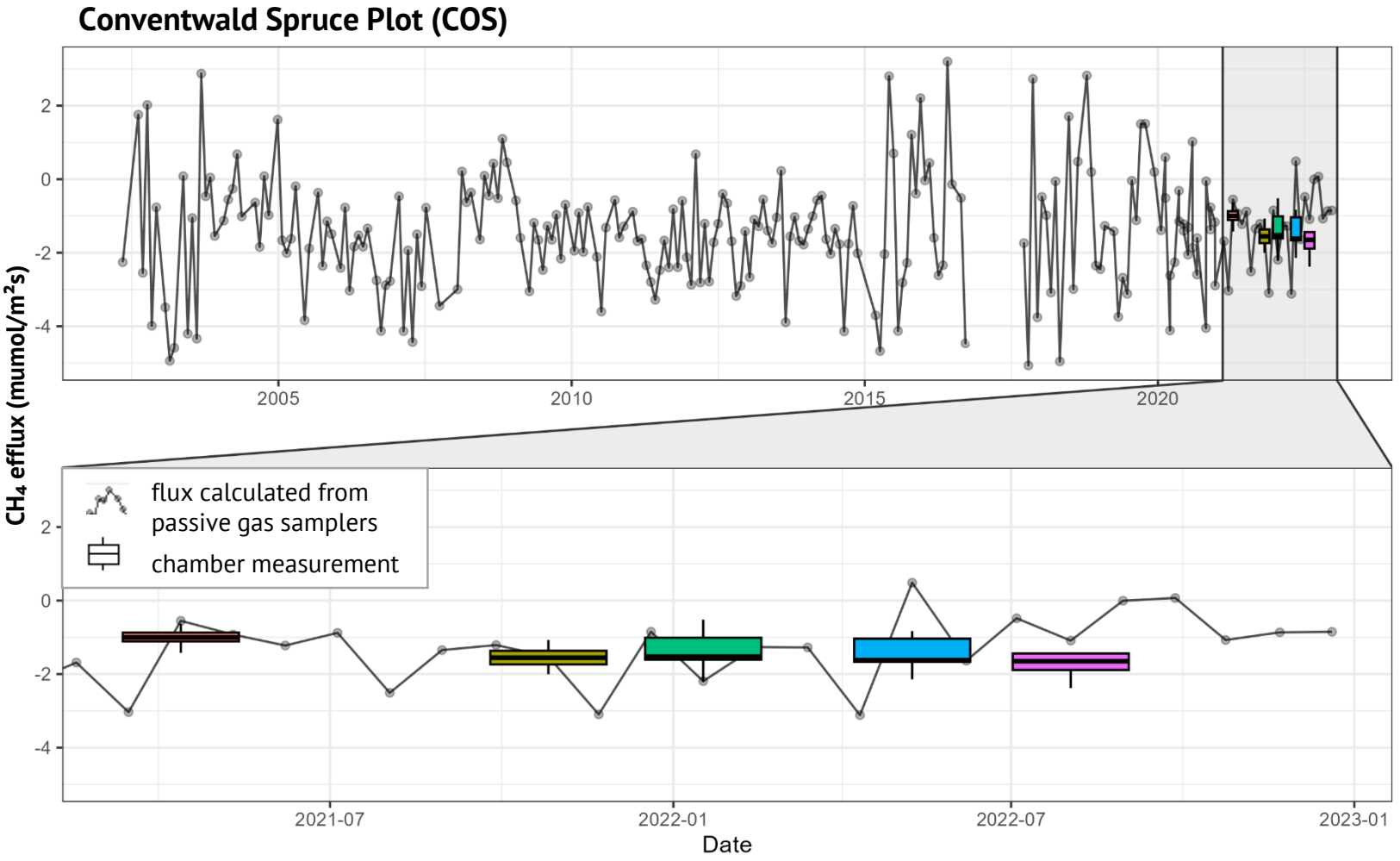

- Chamber measurements show less variation between measurement days.
- High skeleton content makes further adjustments in the diffusion model necessary

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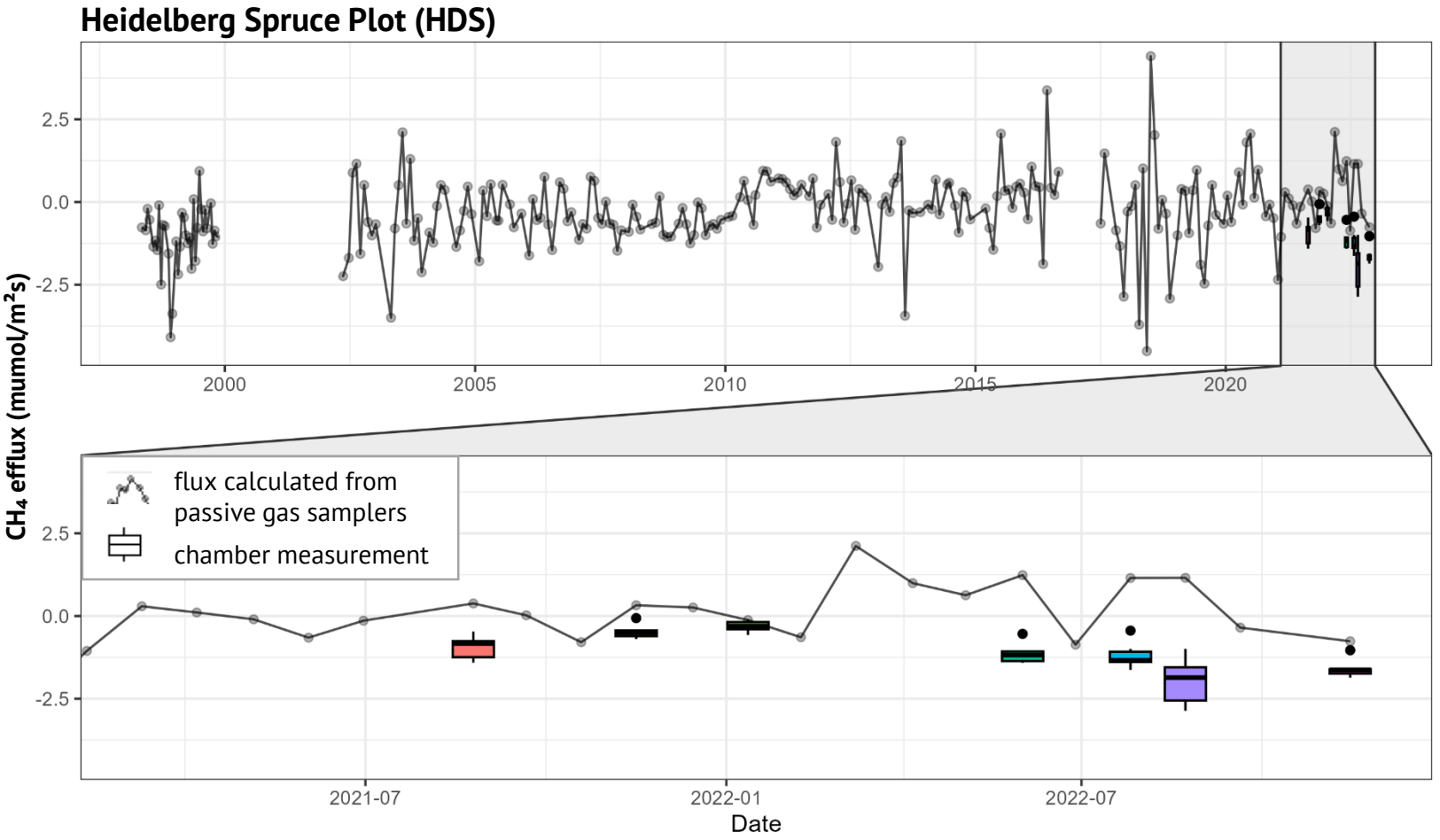

– underestimation of the methane consumption in modelled fluxes

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