

This file contains figures and tables that will be included or updated in the revised manuscript. We apologize but their format is not yet finalized

Table 1: Spearman-rank correlation between topographic and vegetation variables and measured soil water content, temperature, and chemistry (C, N, and pH)

	Mean SWC	Mean soil temperature	C (%)	N (%)	pH
Aspect	-0.14	-0.10	-0.02	-0.07	-0.06
Profile curvature	-0.21	0.14	0.27	0.23	-0.27
Slope	-0.17	-0.24	0.25	0.22	-0.51
TPI 20m	-0.35	-0.11	0.45	0.39	-0.34
TPI 30m	-0.31	-0.08	0.64	0.55	-0.46
TPI 50m	-0.33	-0.08	0.59	0.50	-0.42
TWI saga	0.43	0.27	-0.62	-0.55	0.65
VDCN 0.5ha	-0.24	-0.16	0.61	0.52	-0.51
VDCN 2.5ha	-0.24	-0.20	0.71	0.62	-0.65
VDCN 5ha	-0.31	-0.29	0.65	0.56	-0.71
CSA	-0.37	-0.29	0.22	0.13	-0.25
CONpc	-0.17	-0.56	0.30	0.19	-0.41

Table: Selected variables for each measurement date, along with the R^2 and root mean square error (RMSE) values to evaluate the accuracy of the quantile regression forests (QRFs) model. Importance scores of the selected variables are shown in parentheses, indicating their contribution to predicting soil CH₄ fluxes. At the two dates where vegetation was selected, the model without and with vegetation (CSA) are compared (model with vegetation is in italic letters).

Date	Selected variables			R^2	RMSE
2023/04/27	TWI_saga	PrC	TPI_30	0.53	0.52
	(0.57)	(0.58)	(0.67)		
	TWI_saga	<i>CSA</i>	TPI_30		
2023/05/12	(0.64)	(0.42)	(0.50)	0.31	0.82
	TPI_30	VDCN_5			
	(0.80)	(0.66)			
2023/05/31	TWI_saga	TPI_30	VDCN_5	0.43	0.48
	(0.55)	(0.57)	(0.42)		
2023/07/06	TWI_saga	TPI_30		0.40	0.50
	(0.73)	(0.60)			
2023/07/26	TWI_saga	TPI_30		0.37	1.02
	(0.80)	(0.69)			
2023/09/04	TWI_saga	TPI_30		0.40	1.18
	(0.74)	(0.85)			
2023/10/07	TPI_30	VDCN_5		0.67	0.81
	(0.88)	(0.58)			
	TPI_30 (0.77)	VDCN_5	<i>CSA (0.27)</i>		
2023/11/07		(0.39)		0.59	0.66
	TWI_saga	TPI_30	VDCN_5		
	(0.32)	(0.84)	(0.12)	PrC (0.45)	

2023/11/30	TWI_saga (0.32)	TPI_30 (0.54)	VDCN_5 (0.21)	PrC (0.28)	0.51	0.56
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Table: Summary of the linear mixed model (LMMs) analyzing the relationship between the predicted soil CH₄ fluxes and measured soil CH₄ fluxes, where measurement periods were included as the random factor on both slope and intercept. The p-values of the fixed effect were for testing if the intercept was different from zero and the slope different from 1. The marginal (R²m) and conditional (R²c) coefficients of determination, and the root mean square error of the model are shown. Model without and with vegetation (CSA) are compared (model with vegetation is in italic letters).

Fixed effect: Predicted CH ₄ flux				Random effect: measurement dates		
Estimate ± SE		p-values		Intercept	Slope	
Intercept	0.15 ± 0.03	from 0	0.003	2023/04/27	-0.05	0.03
	[0.14 ± 0.03]		[0.003]		[-0.05]	[0.02]
Slope			2.25×10 ⁻⁹			
	1.16 ± 0.02	from 0	[1.10×10 ⁻⁸]	2023/05/12	-0.02	0.02
	[1.16 ± 0.02]					
		from 1	0.92	2023/05/31	-0.05	0.02
			[0.92]			
R ² m	0.94 [0.94]			2023/07/06	-0.06	0.02
R ² c	0.95 [0.95]			2023/07/26	0.07	0.00
				2023/09/04	0.14	-0.03
				2023/10/07	0.02	-0.04
					[0.02]	[-0.03]
				2023/11/07	-0.01	-0.04
				2023/11/30	-0.03	0.01

Figure: Comparison between predicted and measured CH₄ fluxes aggregated within topographic position classes, vegetation type, and vegetation density. The 1:1 line is drawn.

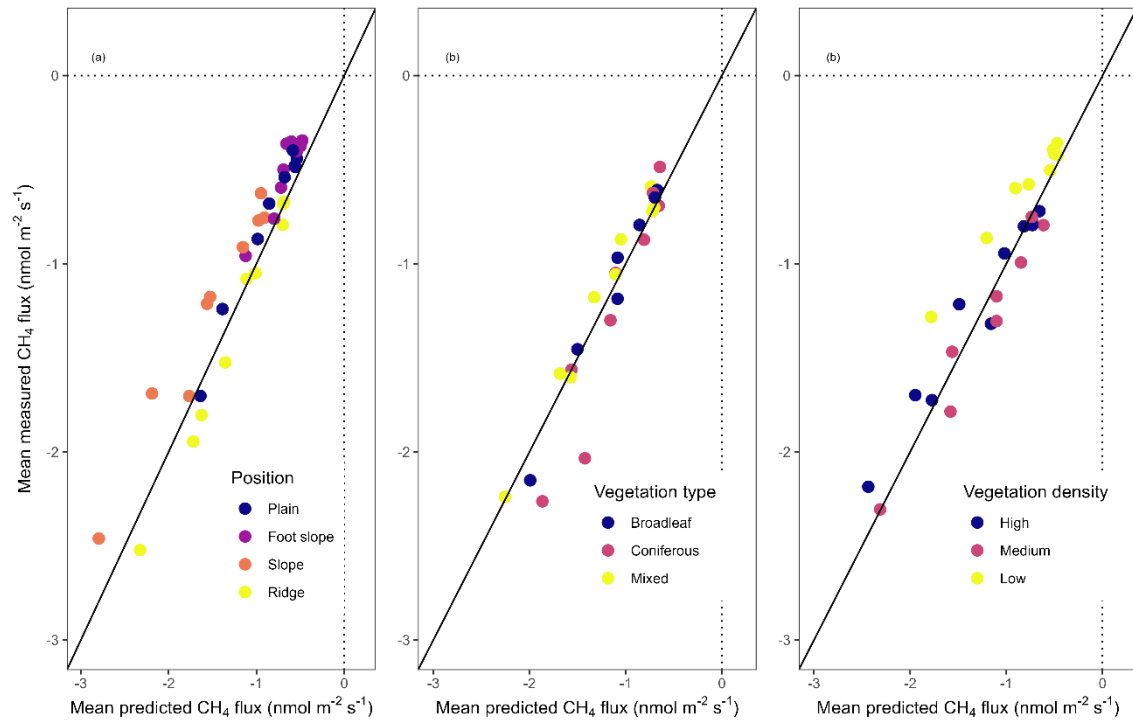


Table: summary for Position

Fixed effect: Predicted CH ₄ flux				Random effect: Positions		
Estimate ± SE		p values		Intercept Slope		
Intercept	-0.17 ± 0.04	from 0	0.006	Plain	0.01	-0.02
Slope	0.94 ± 0.05	from 0	7.8E-05	Foot slope	0.01	0.01
		from 1	0.99	Slope	-0.05	0.10
R ² m	0.93			Ridge	0.05	-0.09
R ² c	0.98					

Table: summary for Vegetation type

Fixed effect: Predicted CH ₄ flux				Random effect: Vegetation type		
Estimate $\pm$ SE		p values			Intercept	Slope
Intercept	-0.19 $\pm$ 0.07	from 0	0.08	Broadleaf	0.02	0.02
Slope	0.82 $\pm$ 0.09	from 0	0.01	Coniferous	-0.09	-0.14
		from 1	0.99	Mixed	0.08	0.12
R ² m	0.91					
R ² c	0.96					

Table: summary for Vegetation density

Fixed effect: Predicted CH ₄ flux				Random effect: Vegetation density		
Estimate $\pm$ SE		p values			Intercept	Slope
Intercept	-0.13 $\pm$ 0.05	from 0	0.08	High	-0.01	0.02
Slope	0.81 $\pm$ 0.08	from 0	1.00 $\times 10^{-2}$	Medium	0.06	-0.14
		from 1	0.99	Low	-0.05	0.11
R ² m	0.80					
R ² c	0.95					

Table 2.

Summary of the LMM analyzing the effects of topographic position, vegetation type and vegetation density on predicted soil CH₄ fluxes. Pixel ID was included as a random effect, and spatial autocorrelation among residuals eliminated. η_p^2 was calculated as the effect size of each explanatory variable

Response variable	Explanatory variables	p-value	Effect size (η_p^2) [with 95% CI]
Predicted CH ₄ fluxes	Position [df=3]	<0.001	0.43 [0.42, 0.44]
	Vegetation type [df=2]	<0.001	0.006 [0.00, 0.01]
	Vegetation density [df=2]	<0.001	0.11 [0.10, 0.12]

Figure: Comparison of measured and predicted fluxes by aggregating the temporal variation during the snow-free period (a) by topographic position classes, (b) by vegetation type classes, and (c) vegetation density classes. Grey boxplot indicates the distribution of the predicted soil CH₄ fluxes, blue triangle indicates the mean of the predicted fluxes and green square with vertical bar indicates the mean of the measured fluxes with standard error.

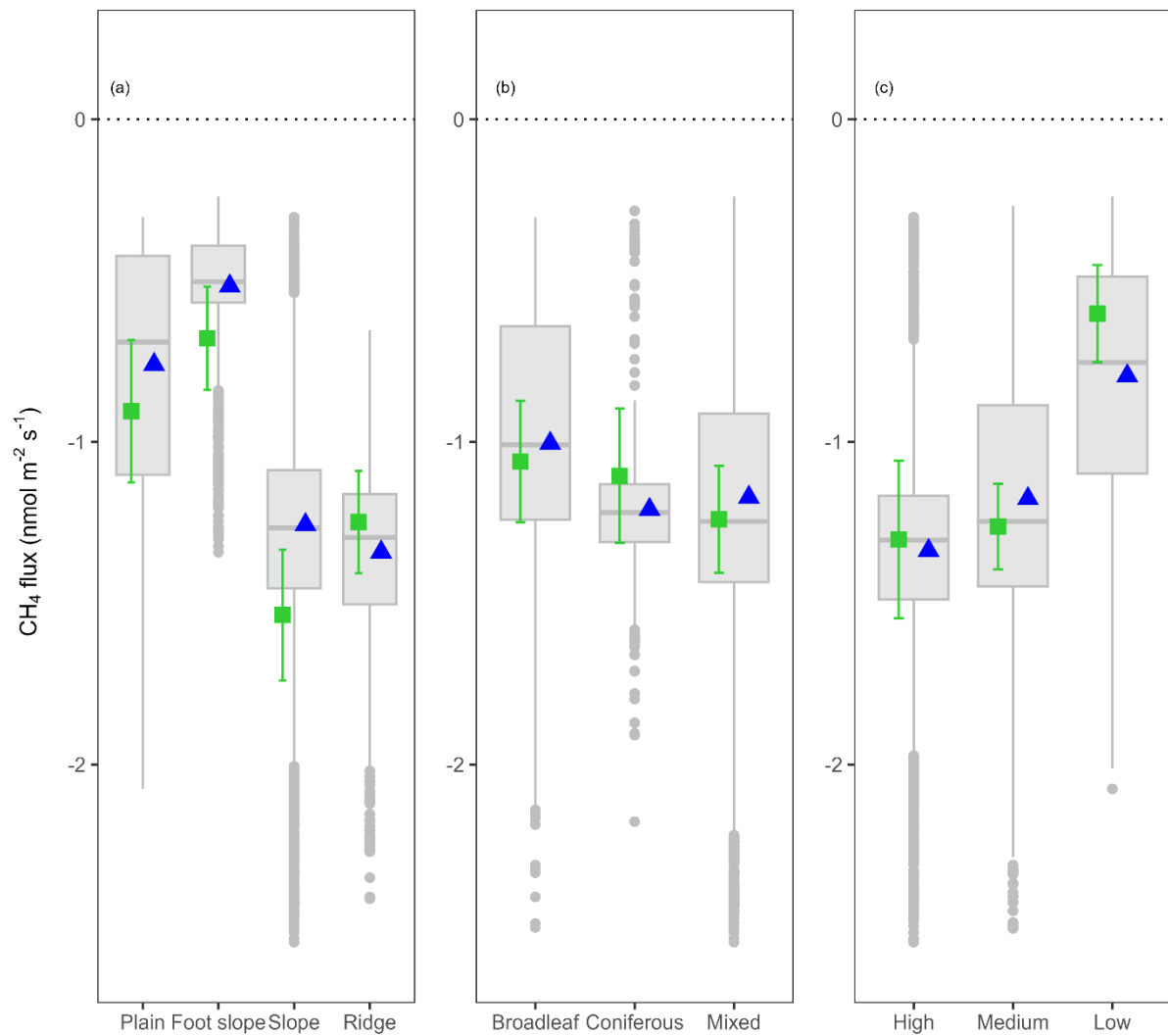


Figure: ALE plots for all variables selected at each measurement date

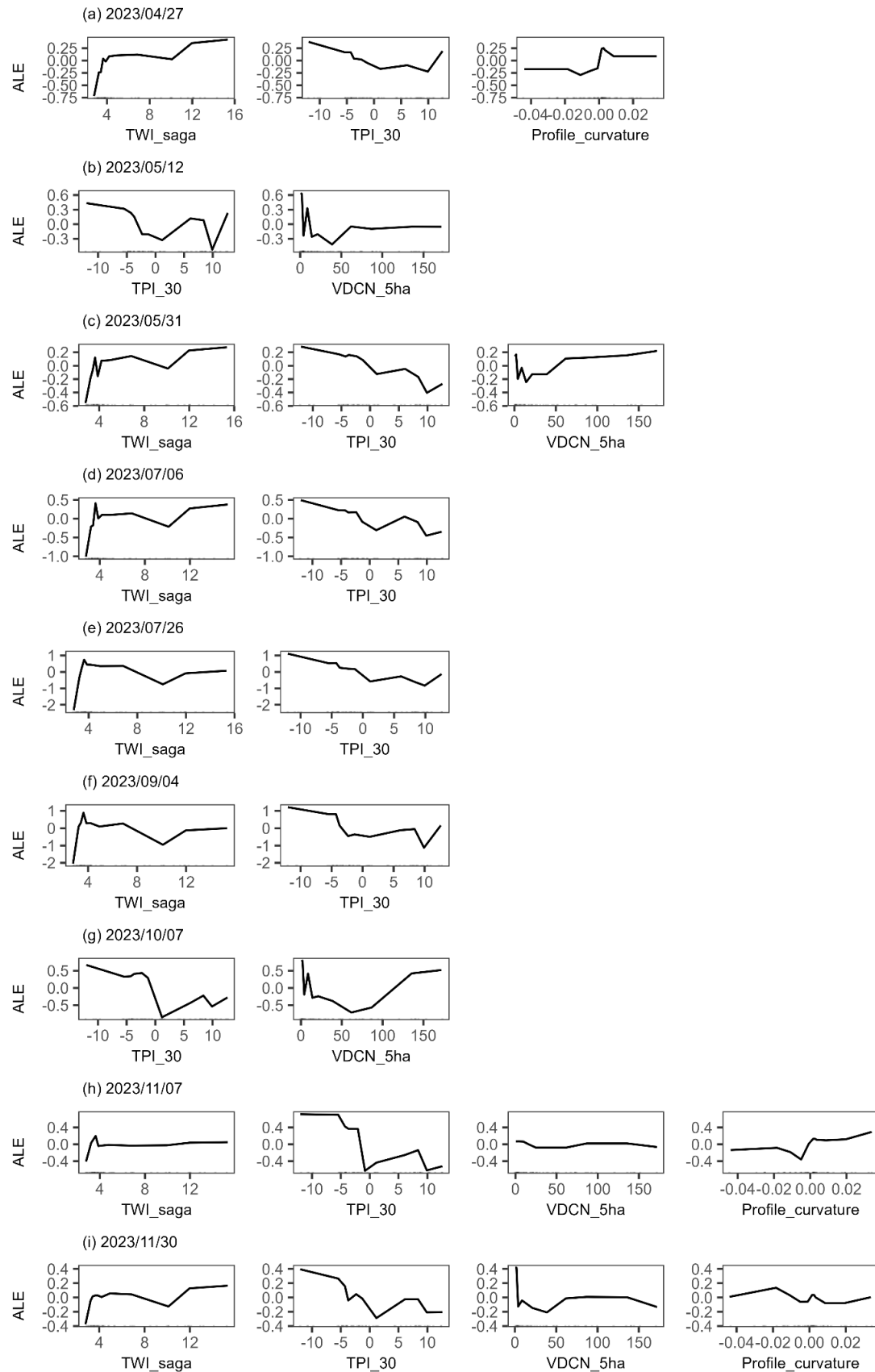


Figure: Plot comparing the distribution of topographic variables between upland and wetland pixels

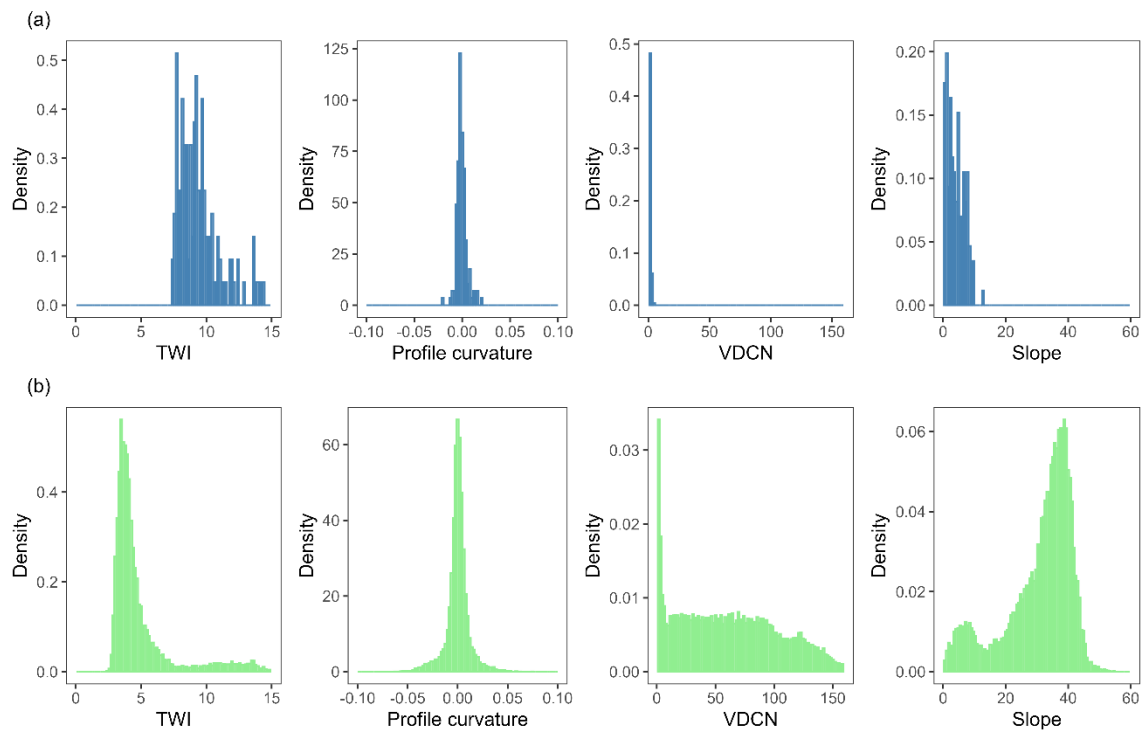


Table: Performance of model including wetland

Fixed effect: Predicted						
CH ₄ flux including						
wetland				Random effect: measurement dates		
Estimate ±						
SE		p-values				
Intercept	0.24 ± 0.08	from 0	0.01	2023/04/27	0.04	0.02
Slope	1.15 ± 0.05	from 0	2.05×10 ⁻⁸	2023/05/12	-0.14	-0.08
		from 1	0.91	2023/05/31	0.11	0.07
R ² m	0.70			2023/07/06	-0.19	-0.11
R ² c	0.70			2023/07/26	0.07	0.04
				2023/09/04	0.01	0.01
				2023/10/07	0.05	0.03
				2023/11/07	0.11	0.07
				2023/11/30	-0.06	-0.04