Deciphering CH_4 emission pathways in a reed ecosystem employing chamber measurements and stable carbon isotope signatures

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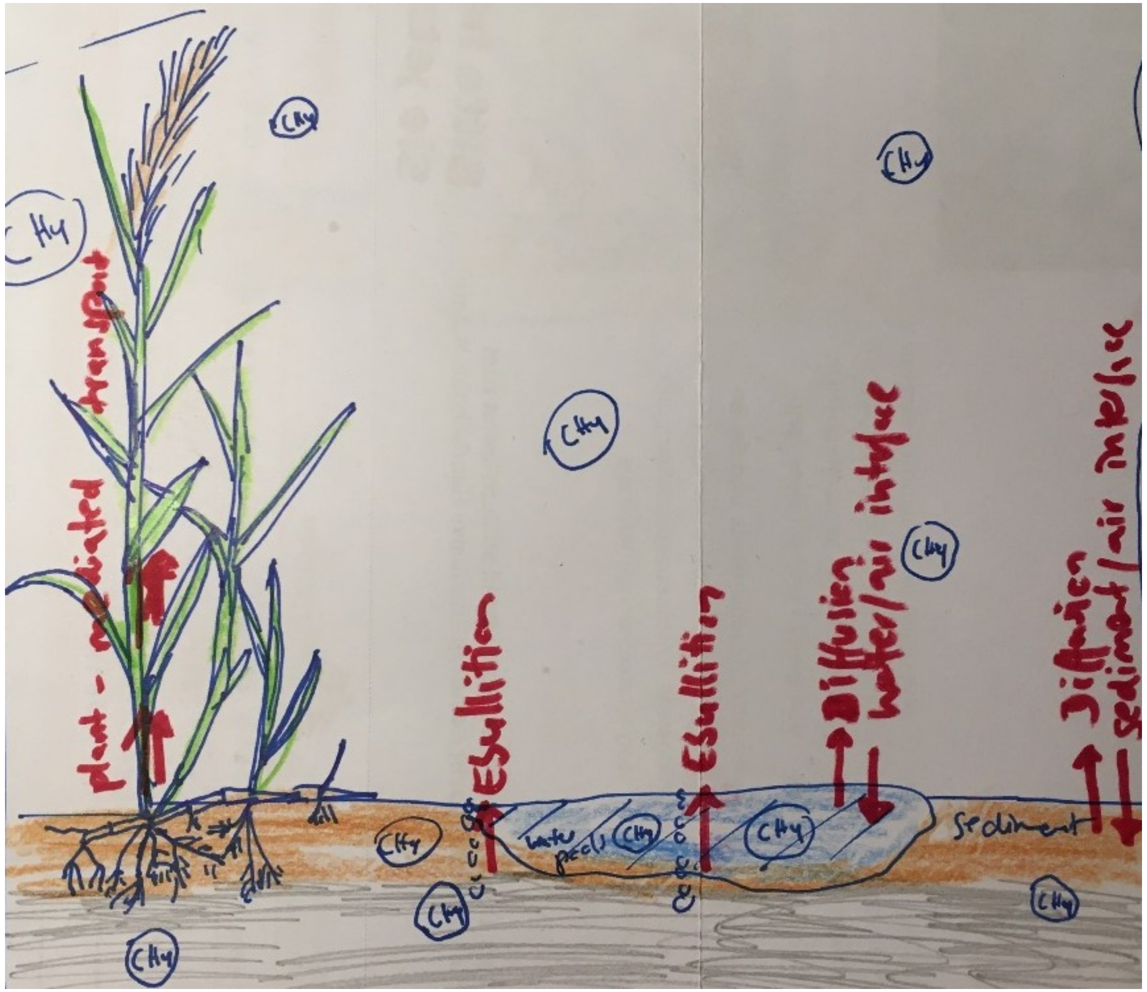
Wetland ecosystem with reed



- mosaic of reed stocks, water and sediment patches
  → temporal variability
  → effects of climate change
- release sediment-produced CH_4 emission
- various pathways of CH_4 emissions
- biogenic source of methane (Whiticar 1999): -80 to -50 ‰ of $\delta^{13}C\text{-}CH_4$
- methanogenesis (Whiticar *et al.* 1986):
  - hydrogenotrophic: -110 to -80 ‰ of $\delta^{13}C\text{-}CH_4$
  - acetoclastic: -65 to -50 ‰ of $\delta^{13}C\text{-}CH_4$

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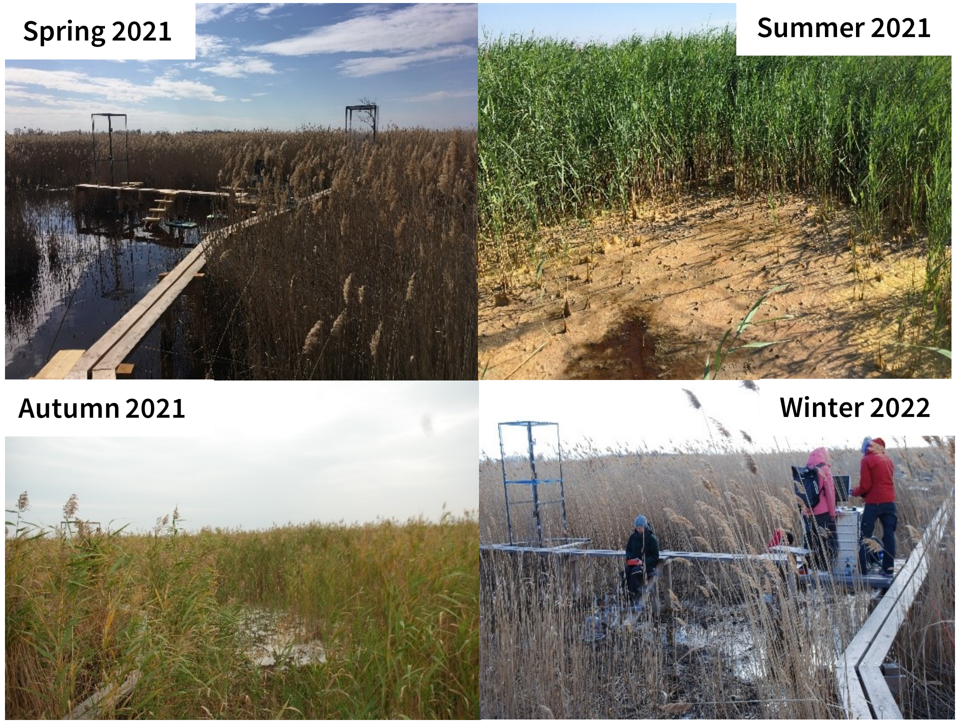
Study site: Reed belt at Lake Neusiedl

coordinates: N 47.7693°, E 16.7576°

- shallow steppe lake
- nature zone of the National Park Lake Neusiedl
- reed belt dominated by *Phragmites australis*
- special water chemistry (e.g. alkaline and saline character)

Location of the study site in Austria



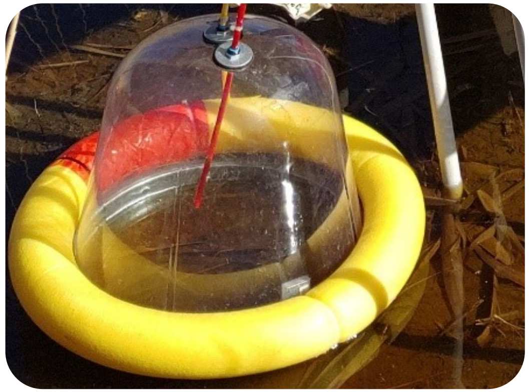
View over the study site in Spring, Summer, Autumn 2021 and Winter 2022

Satellite photo of Lake Neusiedl

Methods

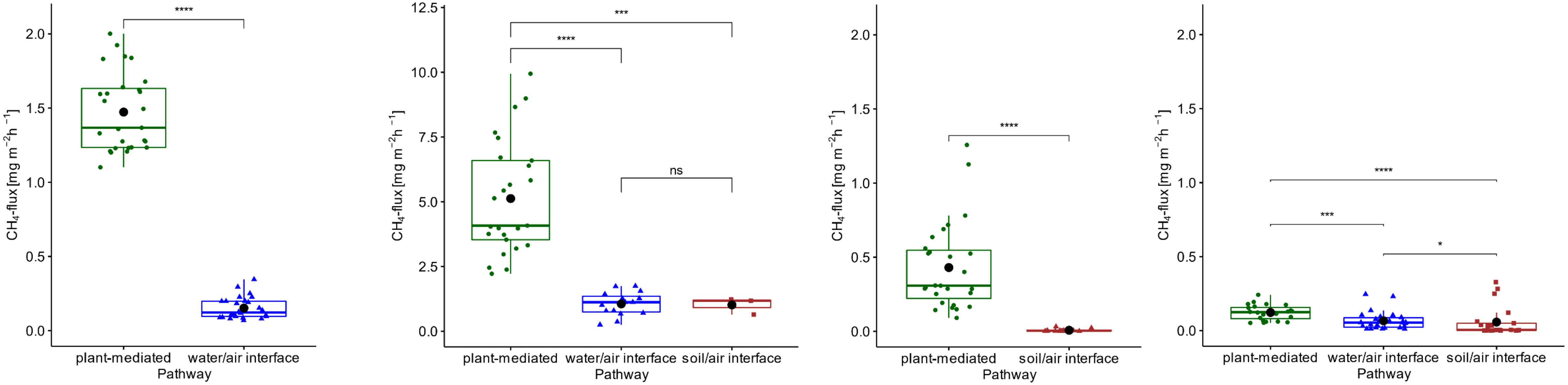
- seasonal 24 h measurement campaigns for one year (approx. every 3 months)
- chamber measurements with Picarro G2201-i

Different Pathways

Plant-mediated transport	Diffusion: water/air interface	Diffusion: soil/air interface	Ebullition of gas bubbles
			

Results: CH_4 flux of the diffusion and plant-mediated pathways

Spring 2021 | Summer 2021 | Autumn 2021 | Winter 2022



CH_4 -flux [mg m^{-2} h^{-1}]: Mean ± SD

Spring 2021 (2)

plant	1.5 ± 0.3
water/air	0.15 ± 0.07

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Summer 2021 (1)

plant	5.6 ± 3.4
water/air	1.1 ± 0.5
soil/air	1.0 ± 0.3

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Autumn 2021 (3)

plant	0.4 ± 0.3
soil/air	0.003 ± 0.009

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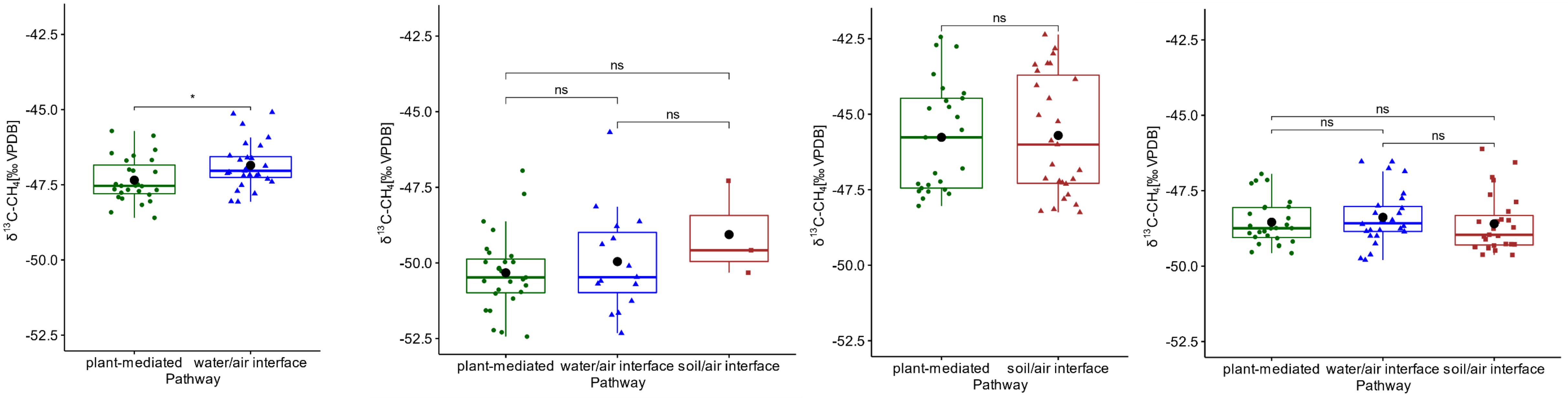
Winter 2022 (4)

plant	0.1 ± 0.05
water/air	0.07 ± 0.06
soil/air	0.05 ± 0.09

Mean T_{air} 15.9°C | Mean T_{air} 27.6°C | Mean T_{air} 15.9°C | Mean T_{air} 6.2°C

Results: $\delta^{13}C\text{-}CH_4$ of the diffusion and plant-mediated pathways

Spring 2021 | Summer 2021 | Autumn 2021 | Winter 2022



$\delta^{13}C\text{-}CH_4$ [‰]: Mean ± SD

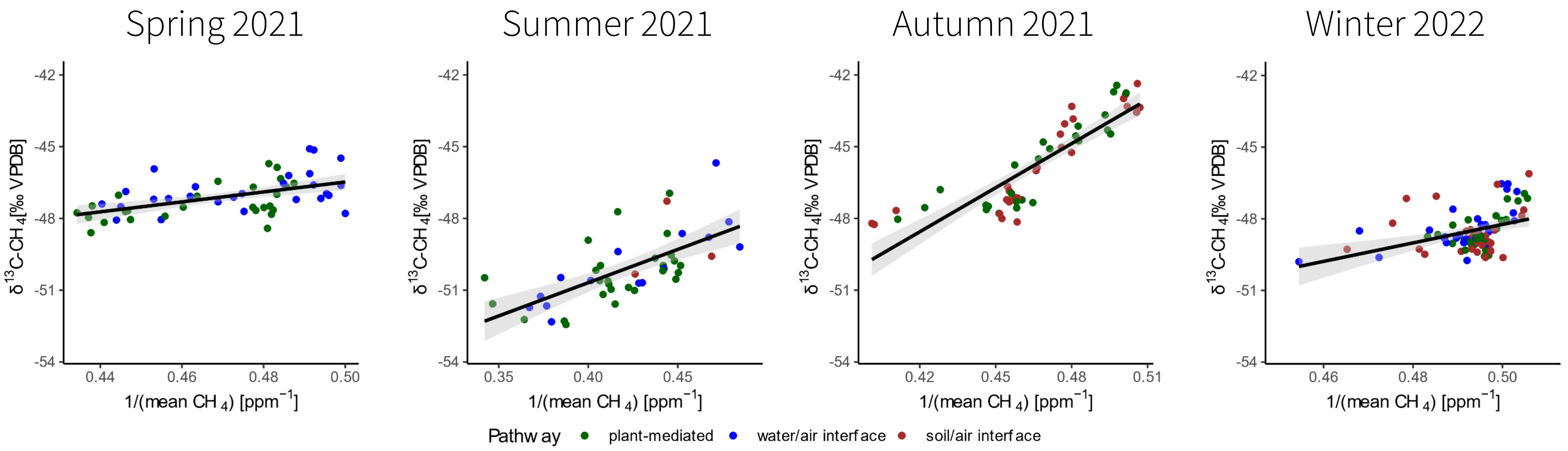
plant	-47.34 ± 0.74
water/air	-46.85 ± 0.79

plant	-50.33 ± 1.27
water/air	-49.96 ± 1.71
soil/air	-49.06 ± 1.59

plant	-45.76 ± 1.81
soil/air	-45.70 ± 1.98

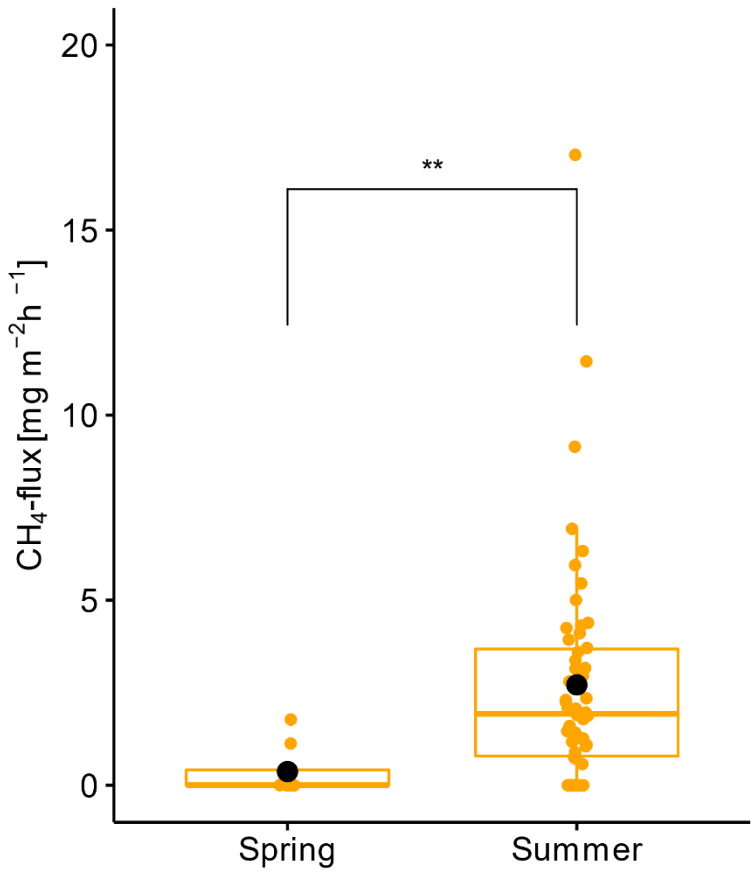
plant	-48.54 ± 0.75
water/air	-48.38 ± 0.92
soil/air	-48.60 ± 0.96

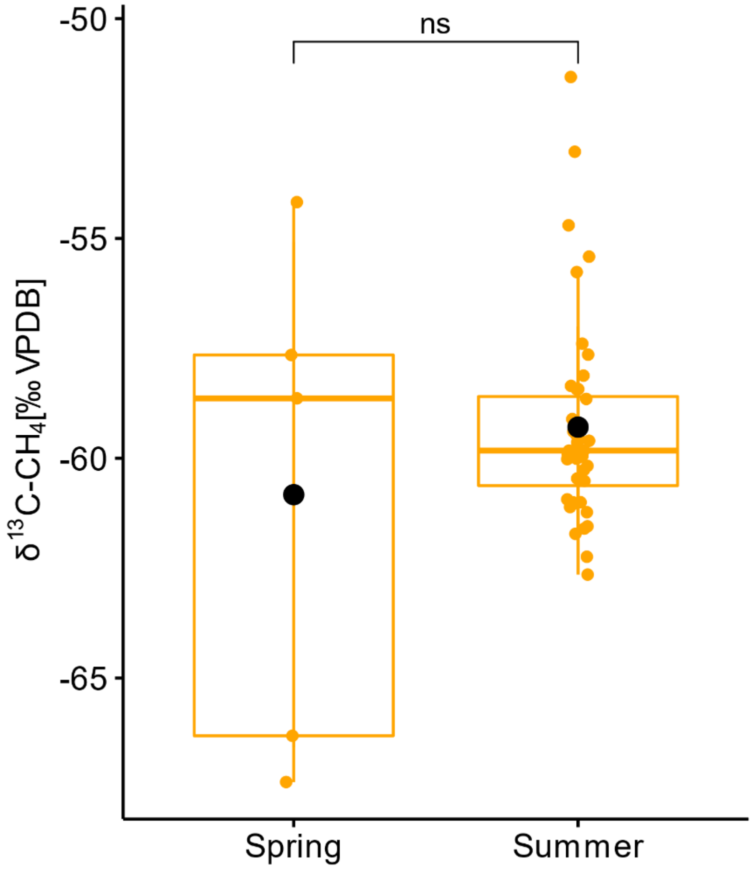
Results: Keeling plot - Source signature $\delta^{13}C\text{-}CH_4$ from plant-mediated and diffusion transport



	Spring	Summer	Autumn	Winter
Keeling plot intercept ± 95% CI [‰]	-56.88 ± 4.46	-61.81 ± 4.12	-74.37 ± 4.58	-67.60 ± 9.88
Spearman rho	0.54	0.71	0.91	0.39
Spearman p-value	<0.0001	<0.0001	<0.0001	0.0004

Results: CH_4 flux and $\delta^{13}C$ values of Ebullition pathway





	Spring	Summer
mean CH_4-flux [mg m^{-2} h^{-1}]	0.37	4.88

	Spring	Summer
mean $\delta^{13}C$-CH_4 [‰]	-60.83	-59.29

Conclusion

- highest CH_4 emissions found in summer season
- **plant-mediated transport has the highest CH_4 fluxes in each season**
- significant difference in CH_4 fluxes between plant-mediated and diffusion pathways per season
- **Keeling plot source signatures $\delta^{13}C$-CH_4 differ between the seasons and are most depleted in Autumn**
- only the measured $\delta^{13}C$-CH_4 values from the ebullition pathway differ clearly from all other pathways
- $\delta^{13}C$-CH_4 values from ebullition pathway approx. -60 ‰, show a biogenic source of methane

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I am looking forward to your feedback!

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