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Methane emissions from lakes in the Alpine region: insights from two years of mobile eddy covariance flux measurements

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AUTONOME PROVINZ BOZEN SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE
PROVINZIA AUTONOMA DE BULSAN SÜDTIROL

Motivation

- Recent research indicates that inland waters are an active and important component of the global carbon cycle
- So far, empirical data on lake-atmosphere exchange of CO_2 and CH_4 largely based on indirect and/or small-scale measurements
- A method to measure fluxes directly: **E**ddy **C**ovariance
  - Statistical method for computing turbulent fluxes
  - Unobtrusive; high spatial and temporal resolution

Method

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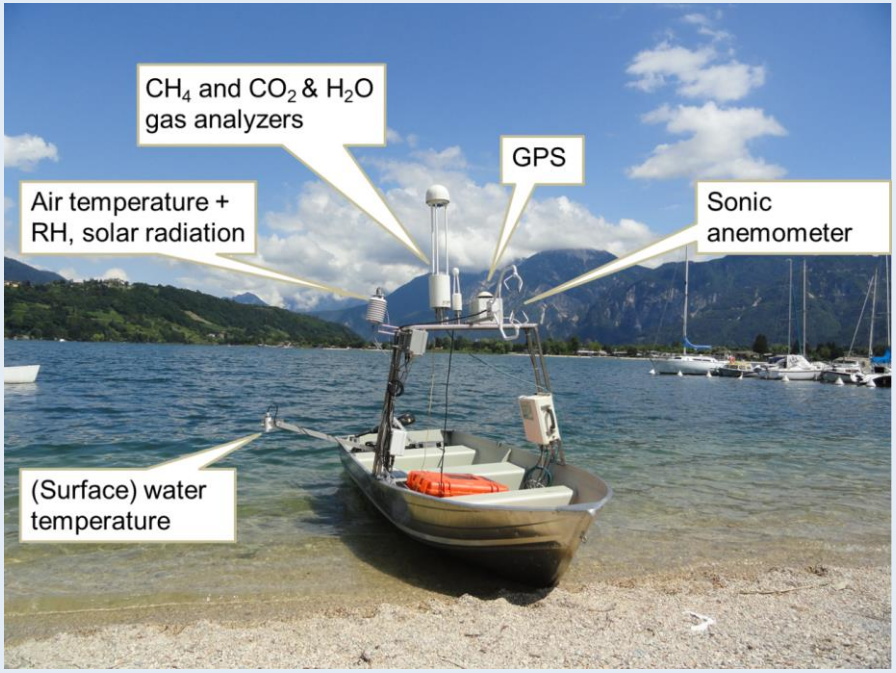
We measured CH_4 and CO_2 fluxes using the EC method at various lakes in the alpine region. For this, an aluminum boat was equipped with sensors to monitor the gas concentrations, the three wind components, and the speed and 3D orientation of the boat at high frequency (10-20 Hz).



In addition, water samples were taken at each lake and analyzed for dissolved GHGs, nutrients (N and P), chlorophyll a, and dissolved and particulate organic carbon (D/P OC).

Method

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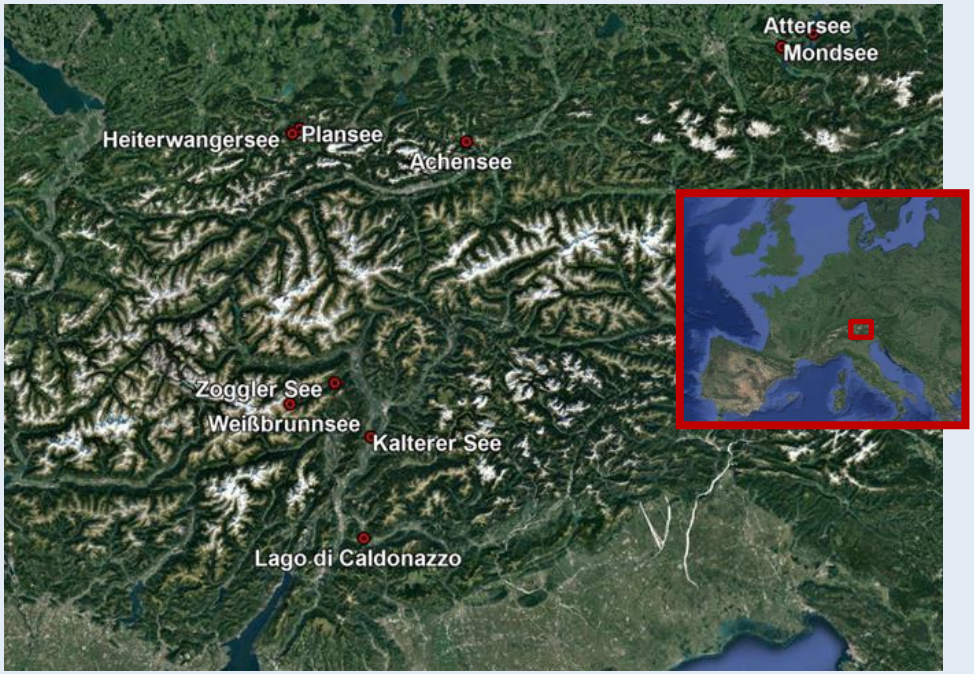
During the first year, 11 lakes in the (pre-)alpine region in Austria & Italy were visited:



→ Almost all lakes, even at high elevation, were supersaturated with CO_2 and CH_4

→ Measurements showed a trend towards higher CH_4 emissions from warm lakes at low elevation

→ Mobile eddy covariance measurements show spatial and temporal variability of lake-atmosphere GHG exchange

Method

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Based on observations of the first year, three contrasting lakes were selected for more frequent measurements during the second year.

	Kalterer See ('KAL')	Mondsee ('MON')	Zoggler See ('ZOG')
	Natural	Natural	Reservoir
Area [km^2]	1.4	13.8	1.4
Max. Depth [m]	6	70	55
Elevation [m.a.s.l.]	216	481	1141

Results

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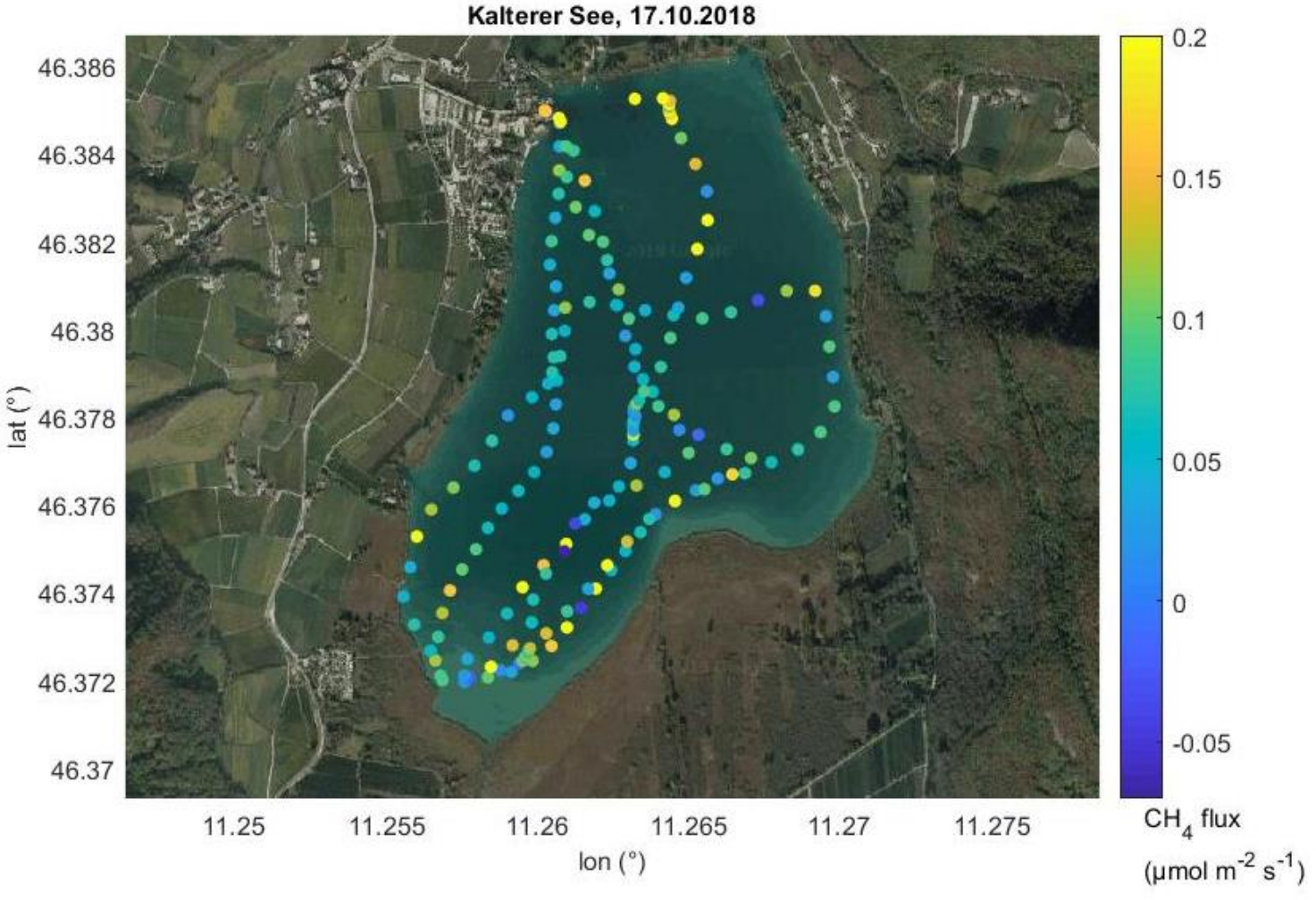
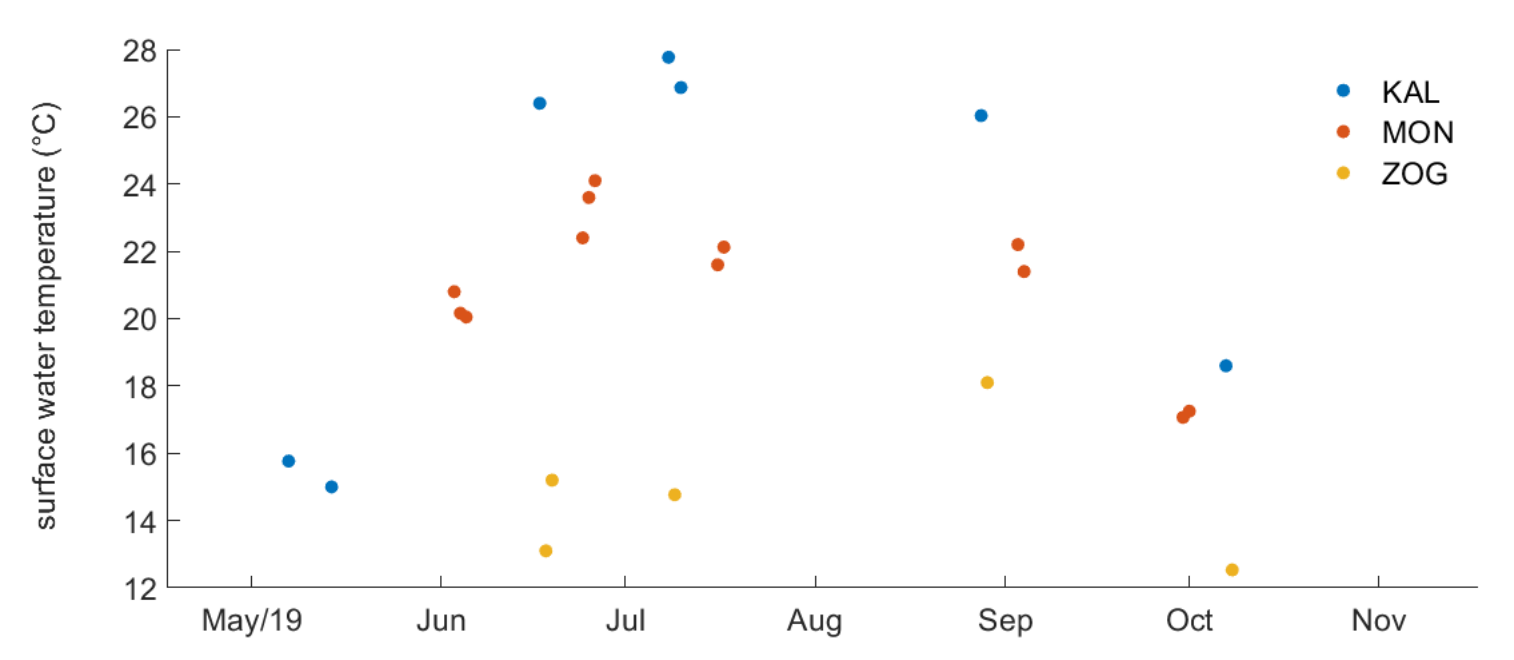


Example boat track and spatial/temporal variability of measured CH_4-fluxes at Kalterer See.

Results



Surface water temperature of the three lakes during the measurement campaigns.

Results

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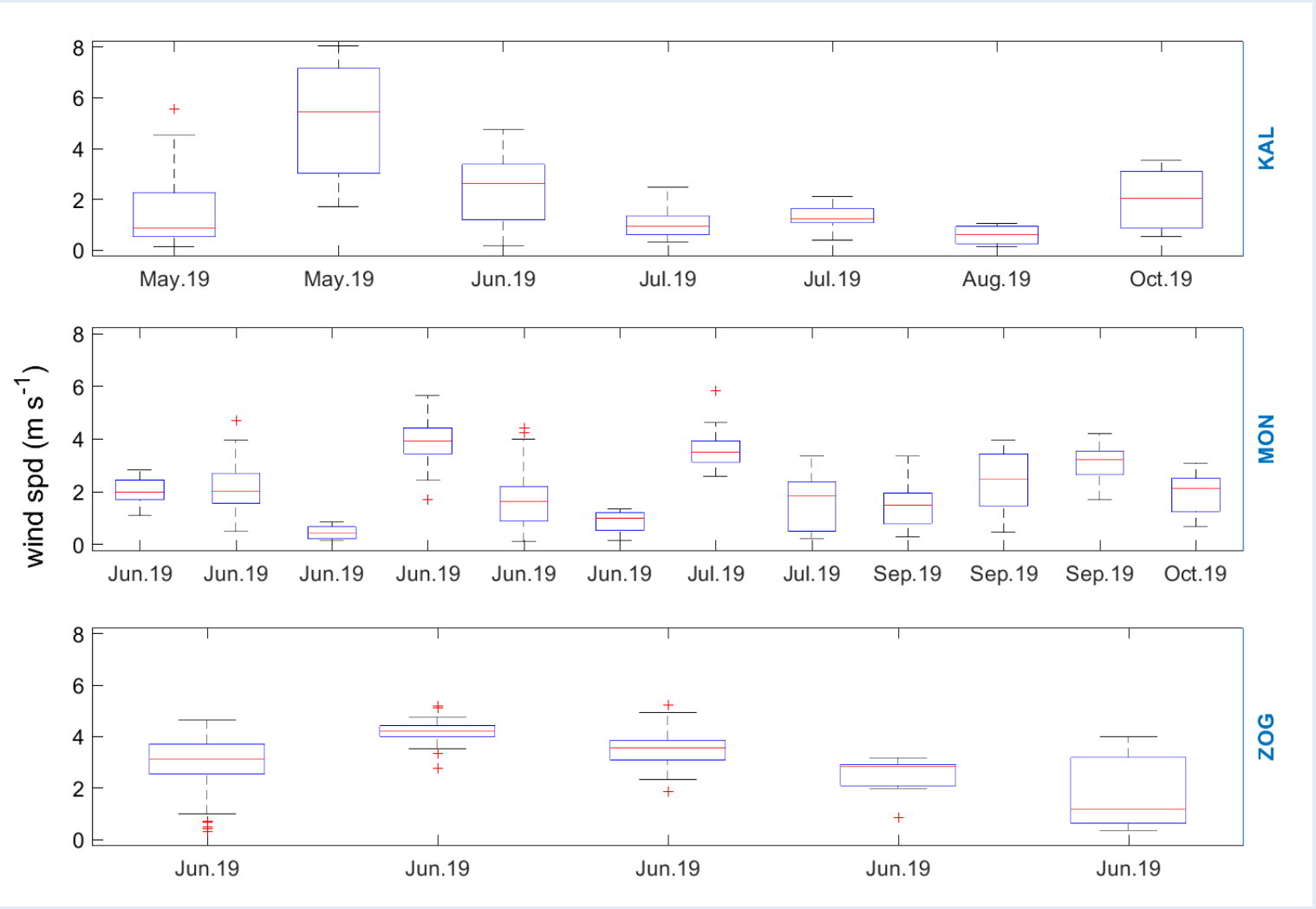
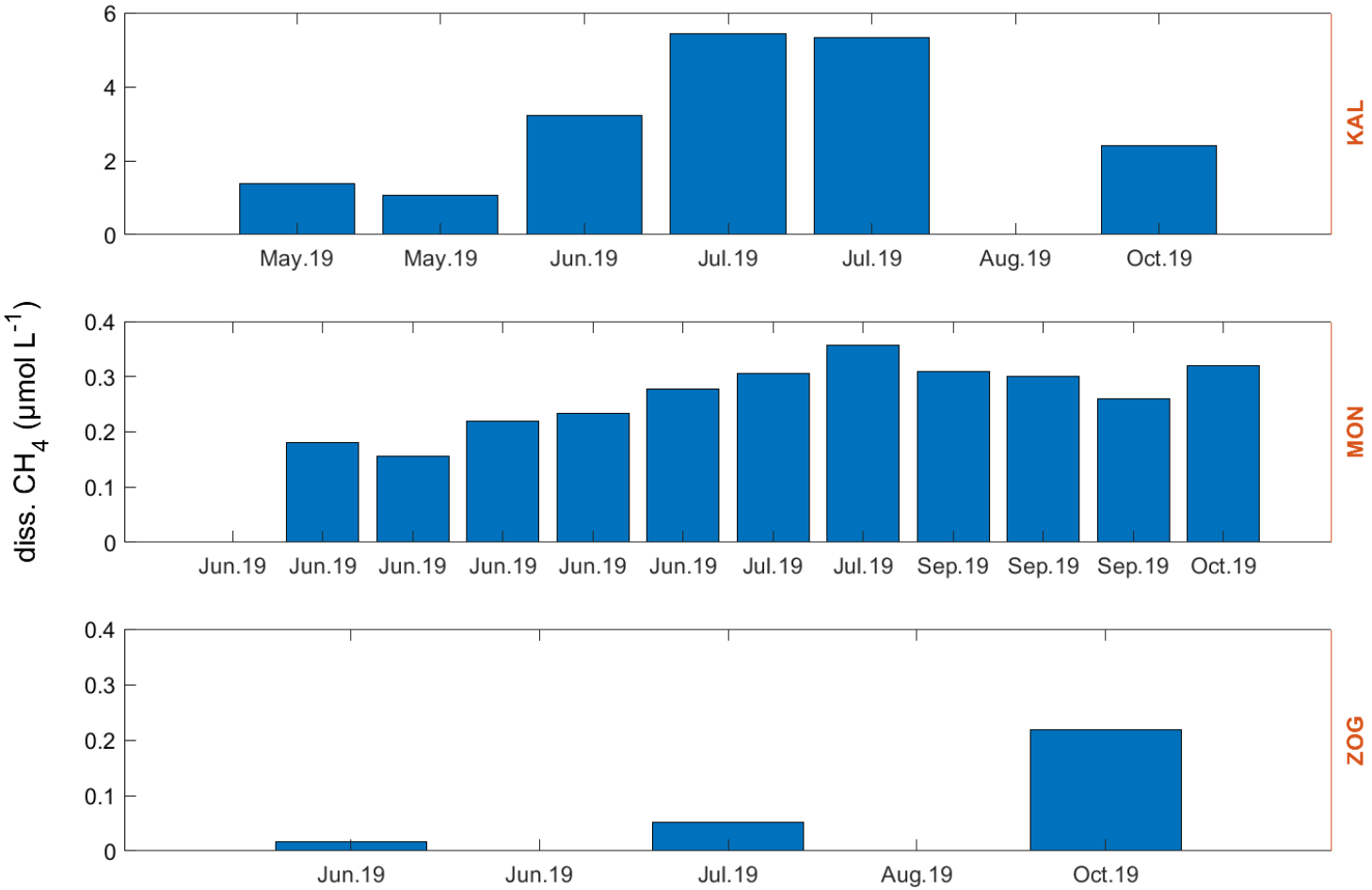


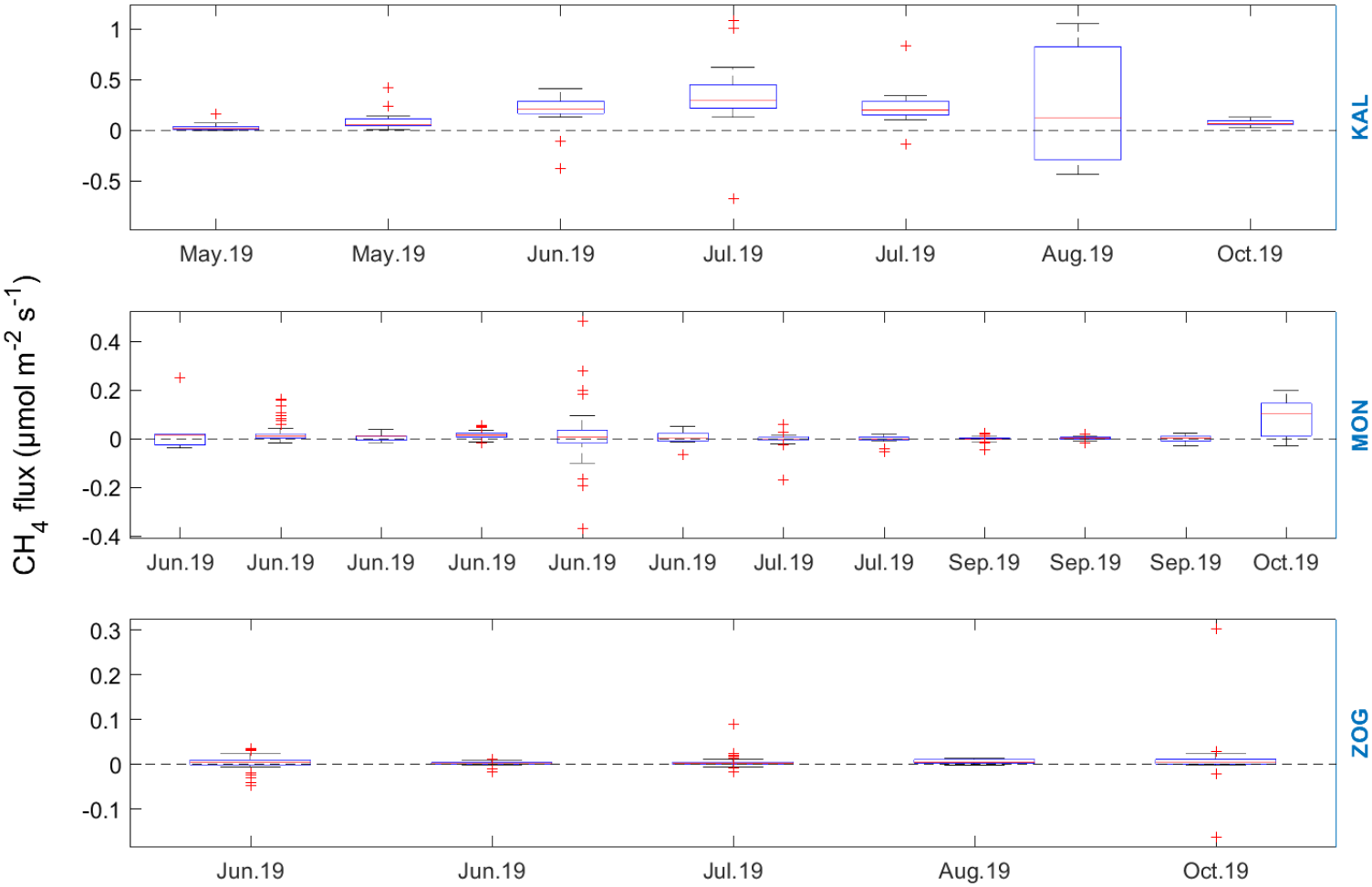
Wind speeds during the measurement campaigns.

Results



Concentrations of dissolved CH_4 in the three lakes.
Note the different y-axis scales.

Results



CH_4-fluxes measured at the three lakes.
Note the different y-axis scales.

Conclusion

- All lakes were supersaturated with CH_4 during all measurement campaigns
- Kalterer See – a small lake at low elevation – had highest CH_4 concentrations compared to the other lakes
  - CH_4 fluxes showed a seasonal trend with highest emissions in July
- Zoggler See – a reservoir at high elevation – had generally low CH_4 concentrations
  - CH_4 concentrations were highest in fall when surface water temperature was low (mixing of water column) and water level relatively low
  - CH_4 fluxes were generally low and variable but also showed an increasing trend towards fall