EGU 2026

Ecosystem-scale crassulacean acid metabolism (CAM) gas exchange of a sisal (*Agave sisalana*) plantation

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Agriculture in (semi-)arid regions

- Cultivation of crop *Agave sisalana* Perrine
- Considerable productivity despite (semi-)arid conditions

Agave sisalana

Perennial succulent plant

Crassulacaen Acid Metabolism (CAM)

- Carbon fixation during night by PEP carboxylase and stored as malic acid
- Calvin cycle during the day

→ Reduced water loss through stomates

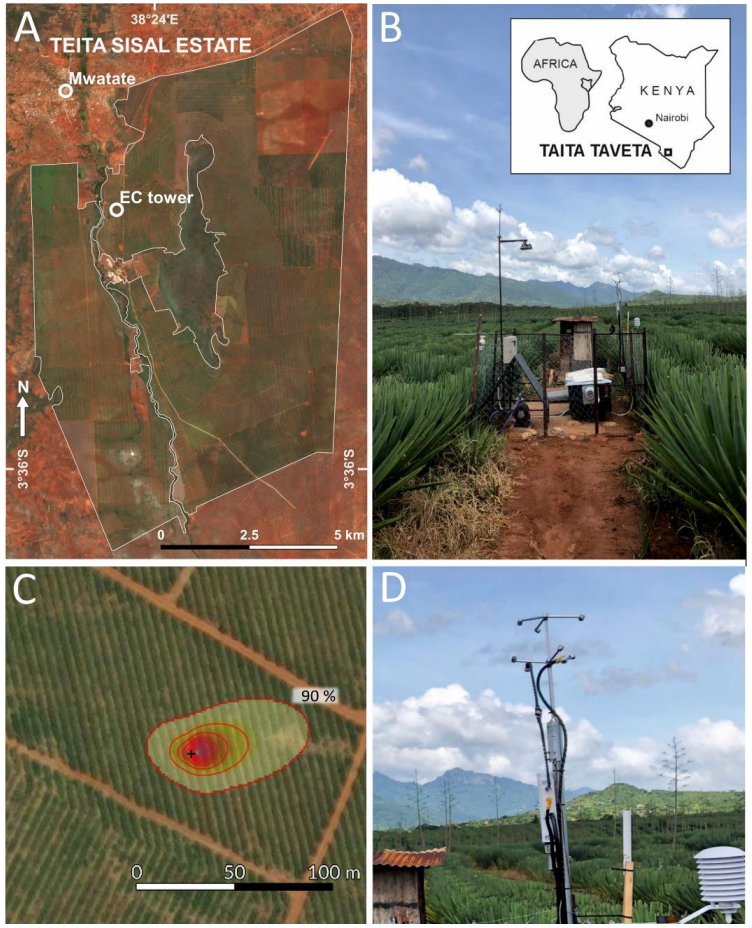
Research questions

(i) How do CO_2 and H_2O fluxes of the sisal plantation **respond to seasonal changes**?

(ii) How does its **diurnal cycle** change with seasons?

(iii) What are the **main drivers** of CO_2 dynamics?

Study site and flux monitoring



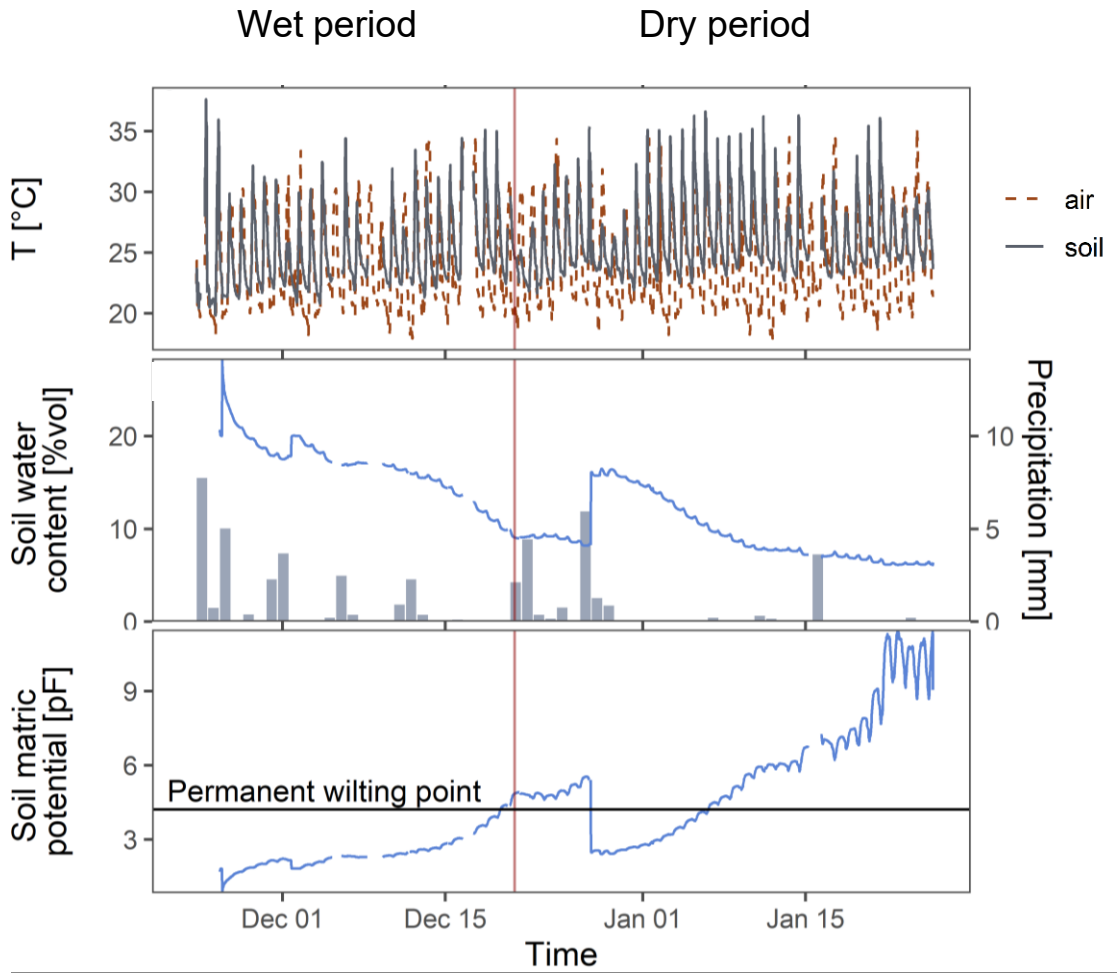
Skogberg et al. (2025), *AEE*

- Teita sisal estate in Taita-Taveta county, Kenya
- Mean annual air temperature and precipitation:

  ~24 ℃ and 600 mm (years 1981–2010) (ICPAC, 2019)

- Monitoring of carbon and water fluxes using the eddy covariance method
- Study period: 23 Nov 2019 and 31 Jan 2020

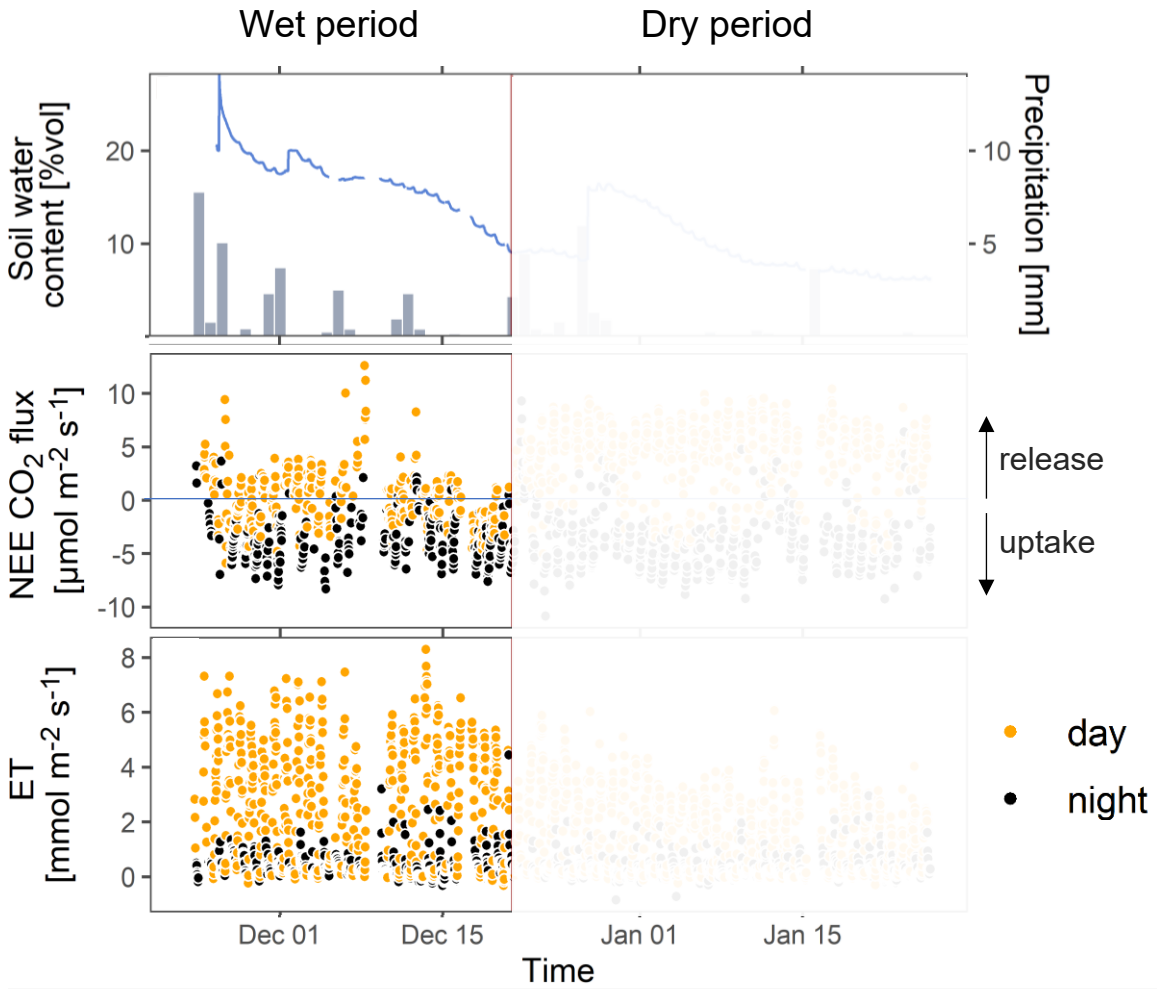
Onset of dry period



- Bimodal pattern with two rainy seasons (long: March-May, short: Nov-Dec)
- Transition to dry period during study period:
  - Significant decline in soil water
  - Temperature, PPFD and VPD: relatively stable

Skogberg et al. (2025), *AEE*

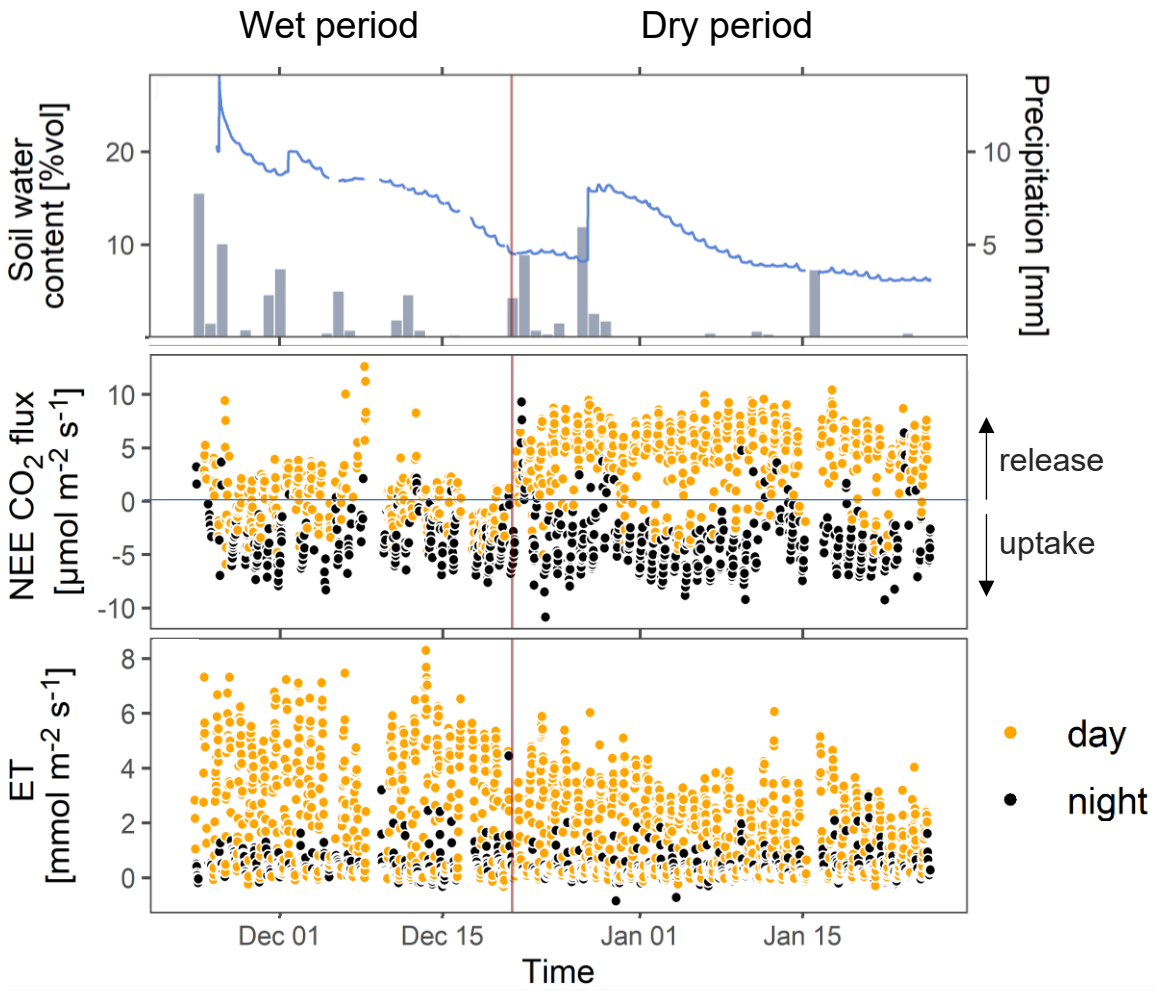
Switch in net ecosystem exchange



- Wet: carbon uptake during the day
- Soil water content declines

Skogberg et al. (2025), *AEE*

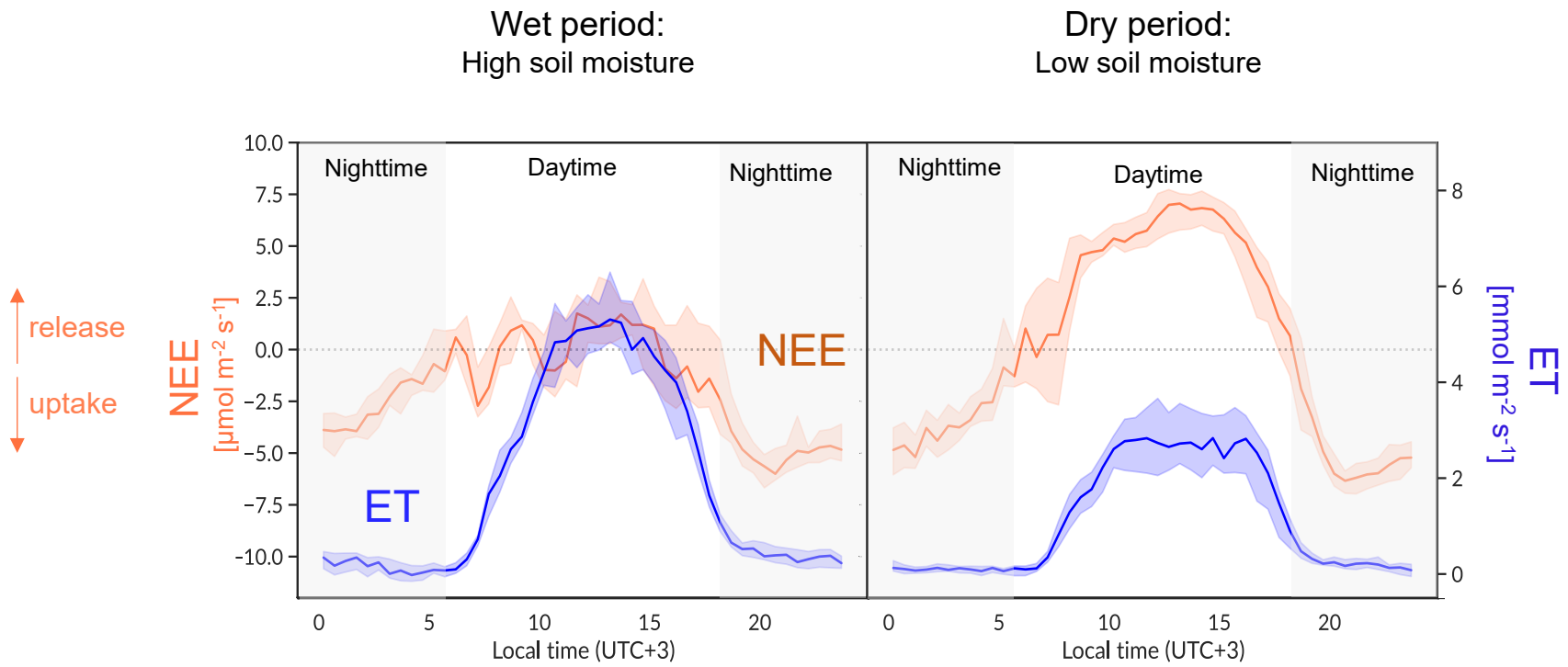
Switch in net ecosystem exchange



- Wet: carbon uptake during the day
- Soil water content declines
- Dry: no carbon uptake during the day anymore
- Decline in ET during dry period

Skogberg et al. (2025), *AEE*

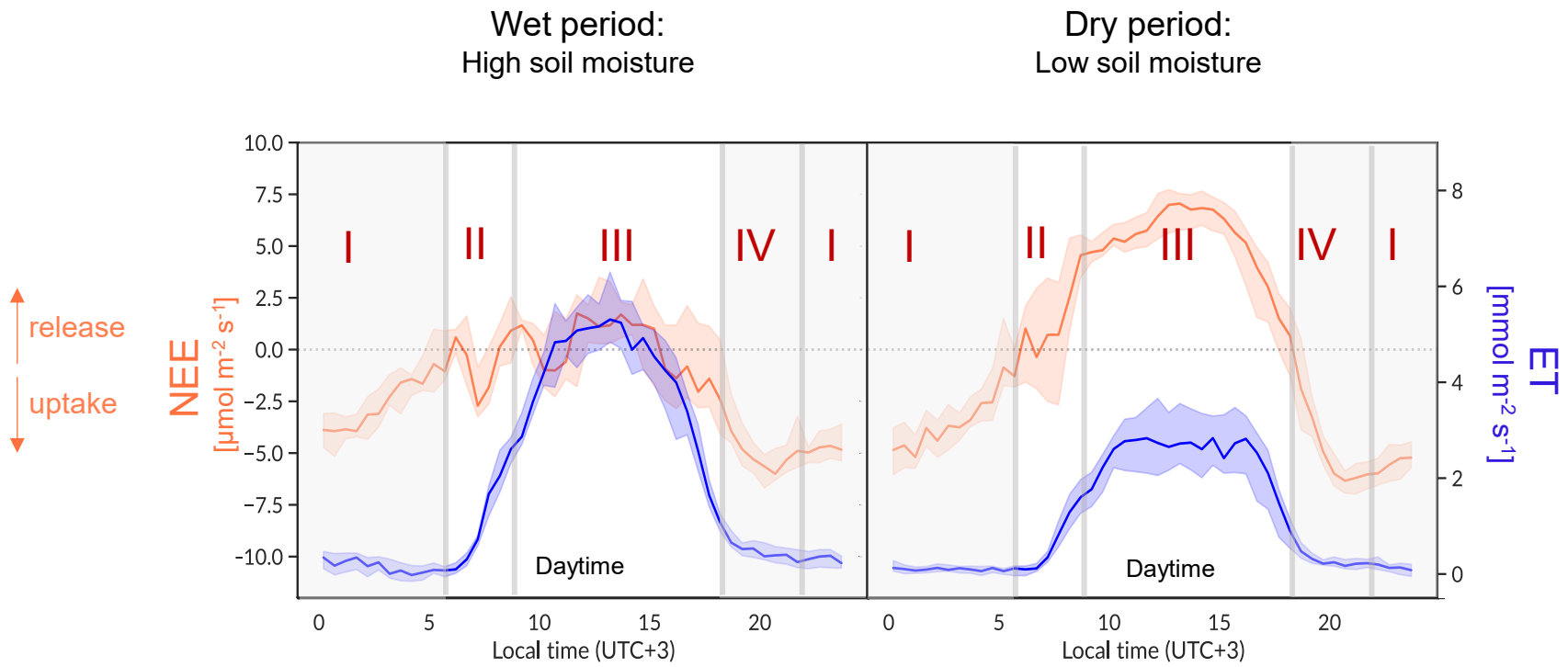
CAM: CO_2 uptake during night



- Dry: carbon release during the day
- Declined ET during dry period

Skogberg et al. (2025), *AEE*

CAM controls diurnal flux patterns



Skogberg et al. (2025), *AEE*

Photosynthetic plasticity

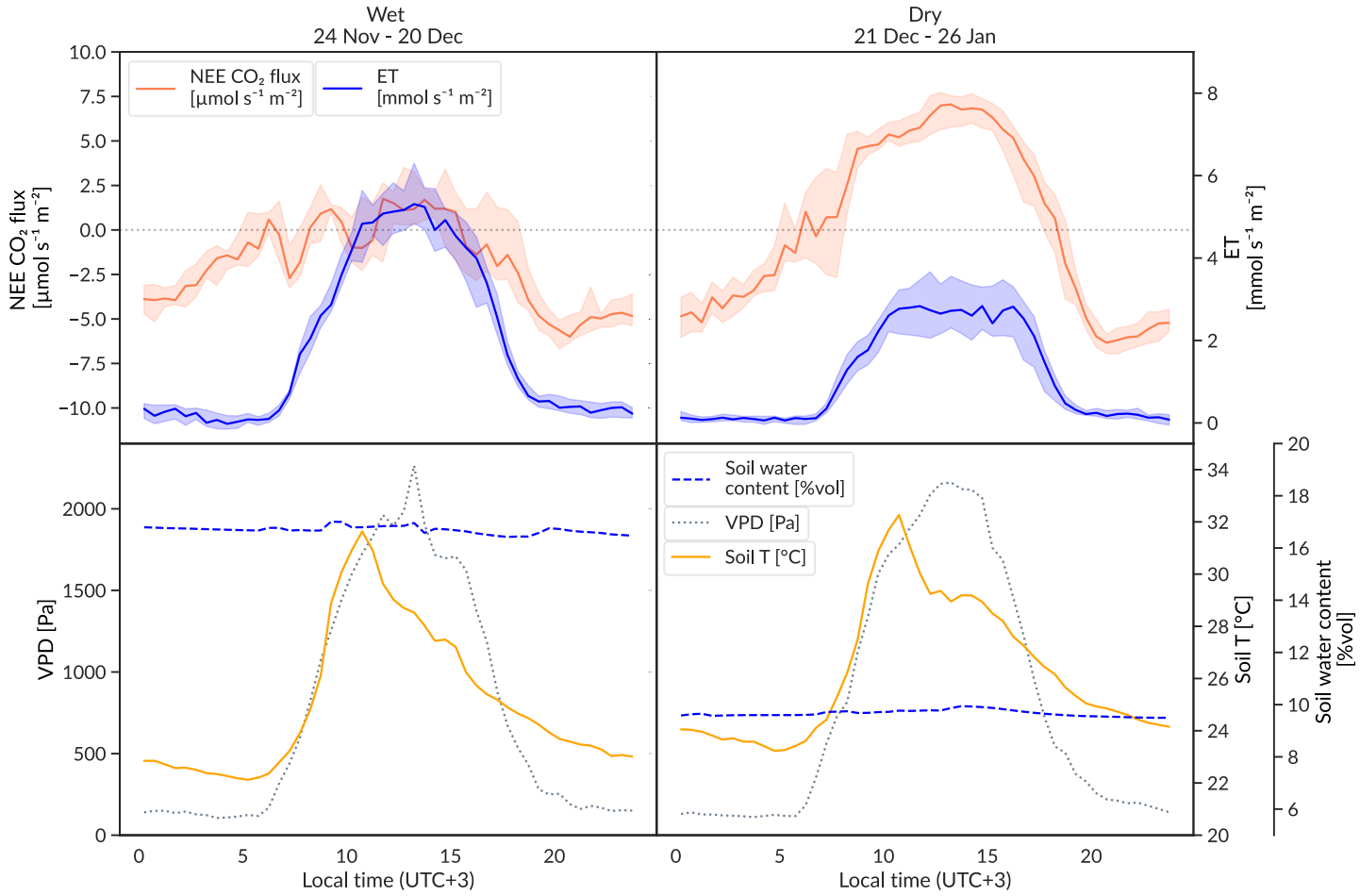
Phase I – nighttime (PEPC)

Phase II – early morning spike (PEPC and RuBisCO)

Phase III – daytime (RuBisCO)

Phase IV – transition to night (RuBisCO and PEPC)

Drivers of NEE patterns

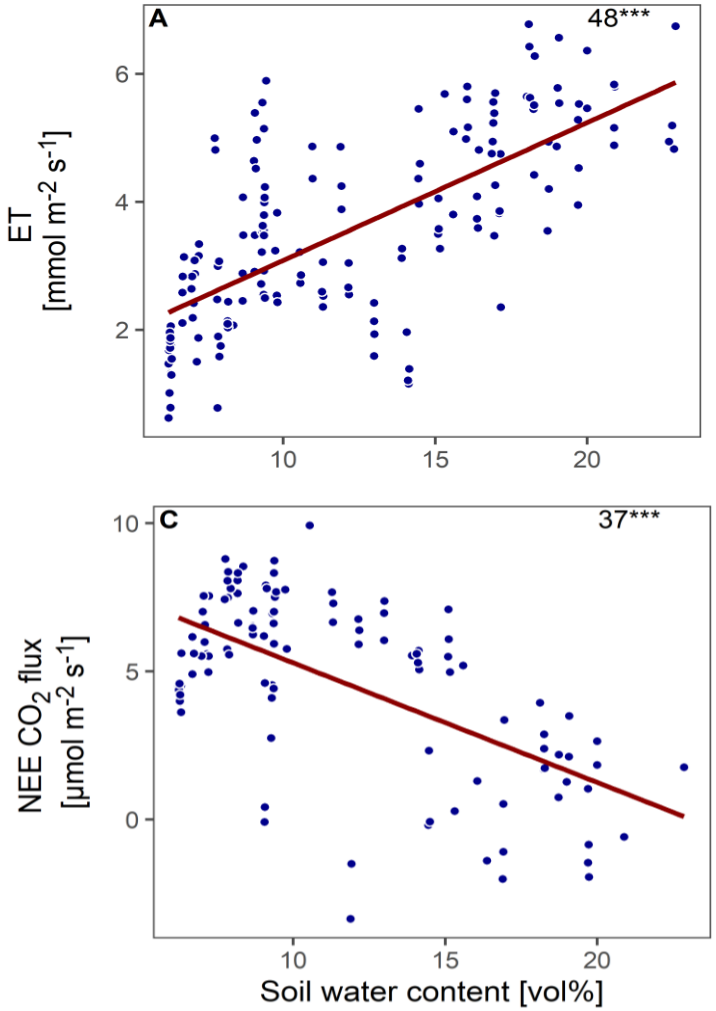


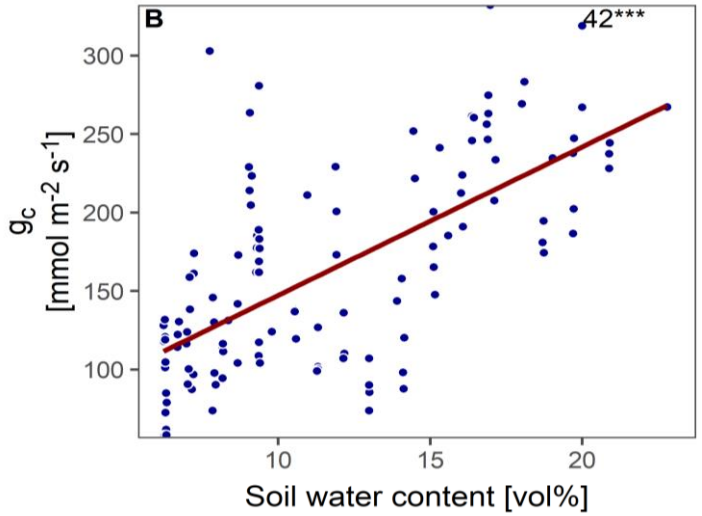
- Dry: carbon release during the day
- Declined ET during dry period

→ Soil water content as main driver

Skogberg et al. (2025), *AEE*

Soil water content effect



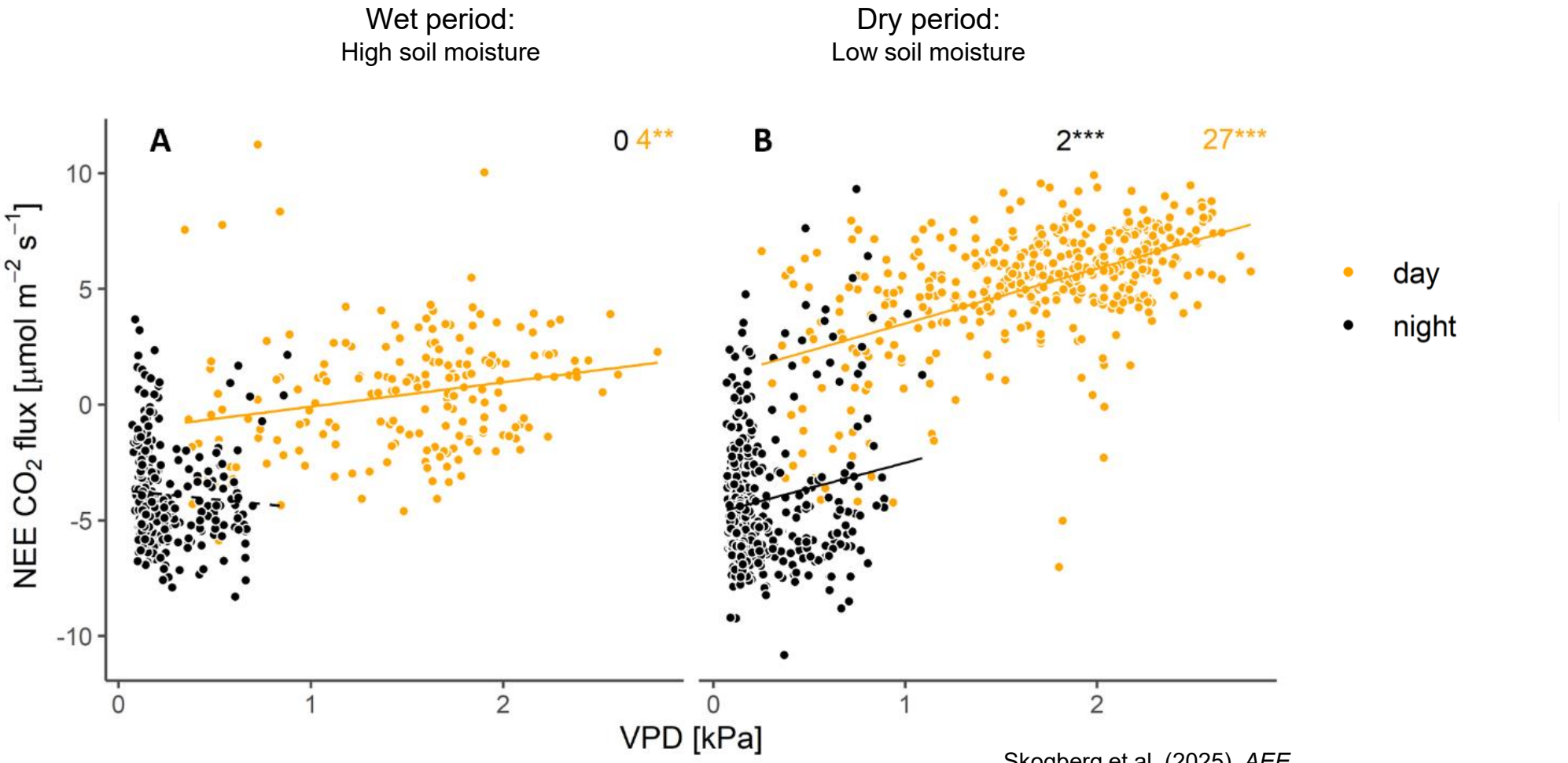


- Decline in **midday** carbon uptake and ET in response to soil water
- Smaller conductance during dry period

→ Reduced water loss

Skogberg et al. (2025), *AEE*

Increased VPD effect during dry period



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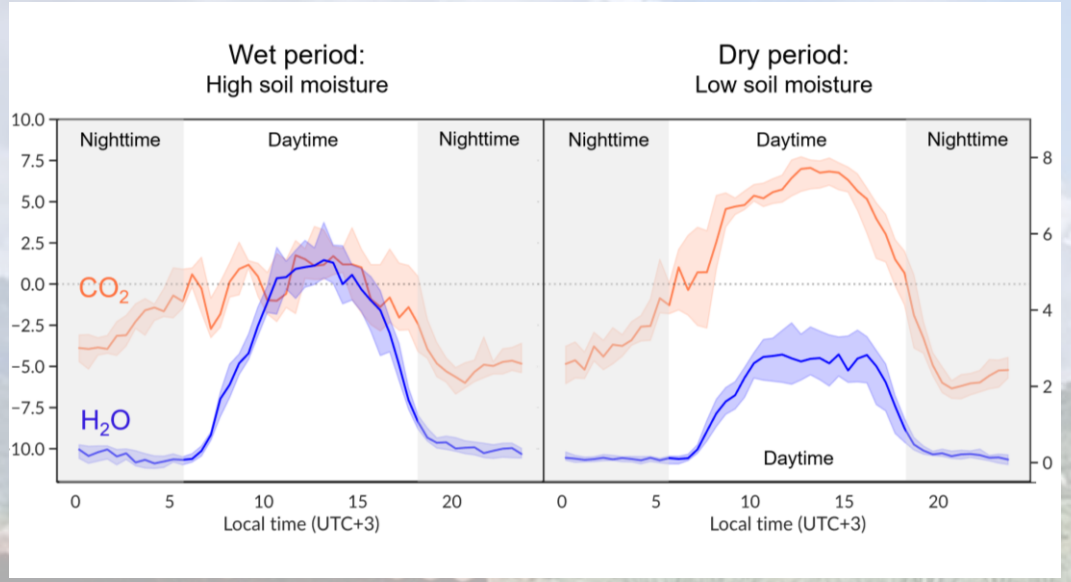
Thank you for your attention!



Sisal gas exchange

- Consistent CO_2 uptake during nightime
- High photosynthetic plasiticity in response to soil drying
  - Daytime CO_2 uptake during wet period
  - Switch to strict CAM: daytime CO_2 release during dry period

Acknowlegdments: We thank Sami Haapanala and the Taita Research Station staff, esp. Mwadime Mjomba, Muhia Gicheru and Ambrose Nyga. We also thank the International Livestock Research Institute (ILRI) staff, esp. George Wanyam.

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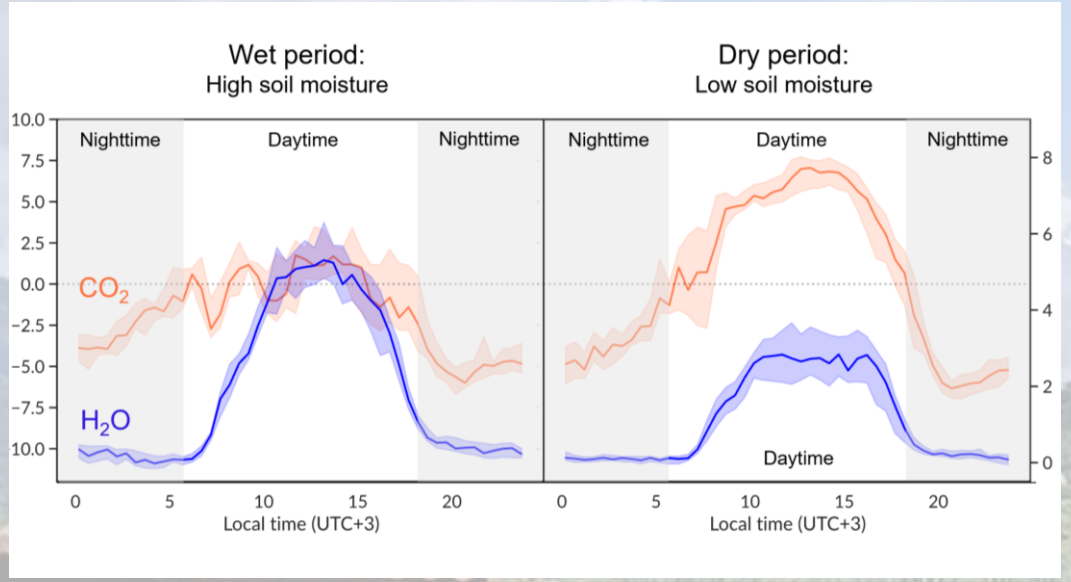

Agriculture, Ecosystems and Environment 381 (2025) 109435

Contents lists available at ScienceDirect

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Agricultural and Forest Meteorology 378 (2026) 110966

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Tracking canopy conductance and transpiration of CAM-plants *Agave sisalana* with carbonyl sulfide fluxes

Kukka-Maaria Kohonen [a,b,*], Angelika Kübert [b], Lutz Merbold [c,d], Matti Räsänen [e], Nina Buchmann [a], Ivan Mammarella [b], Petri Pellikka [f,g,h], Timo Vesala [b,e]

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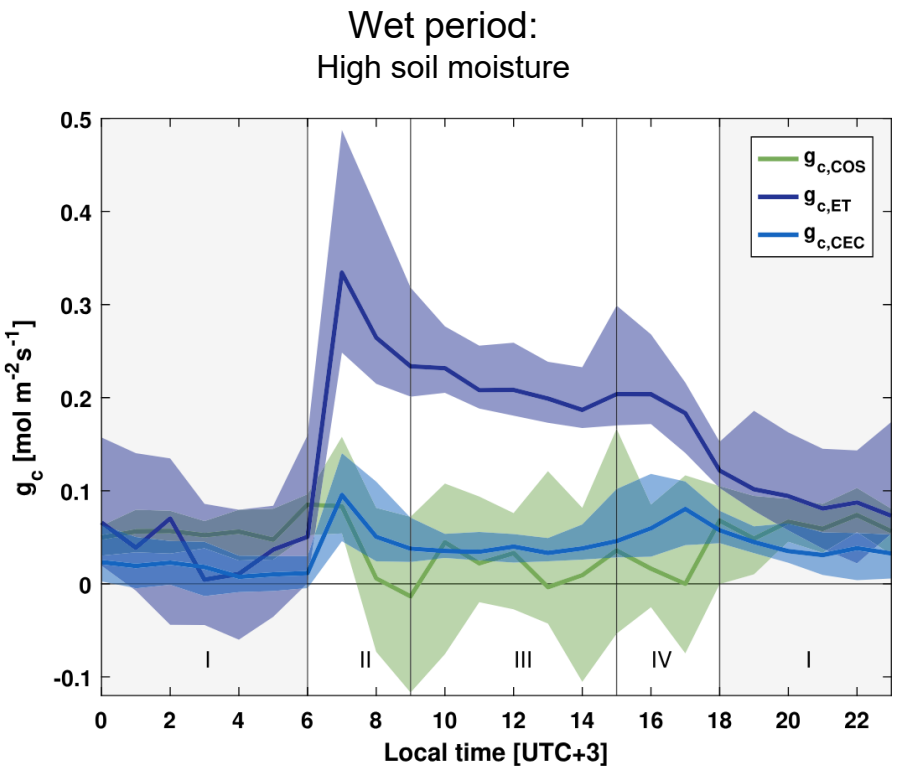
Canopy conductance comparison

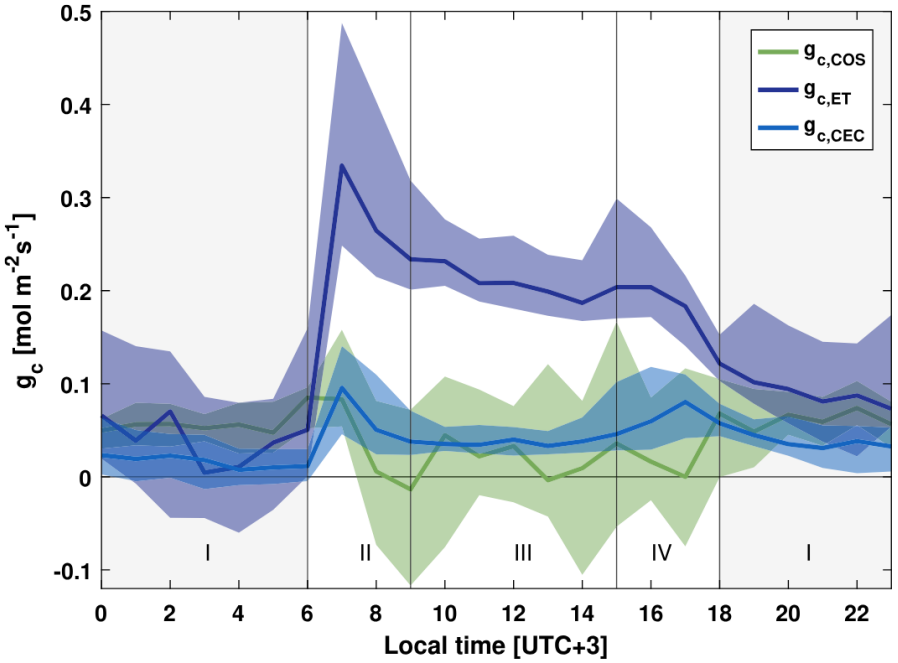


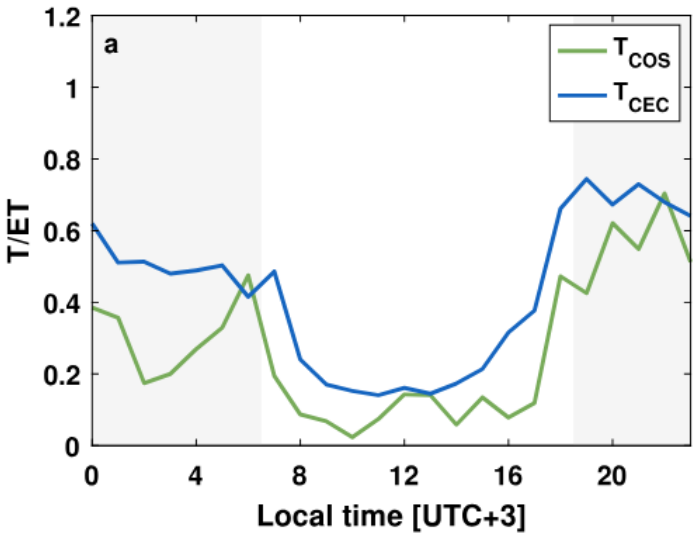
Kohonen, Kübert et al. (2025), *AFM*

Conductance derived from:

- **COS**: carbonyl sulfide (Wohlfahrt et al. 2012, *PCE*)
- **ET**: evapotranspiration (Wehr & Saleska 2021, *Biogeosciences*)
- **CEC**: conditional eddy covariance (partitioned T, Zahn et al. 2022, *AFM*)

Partitioned evapotranspiration

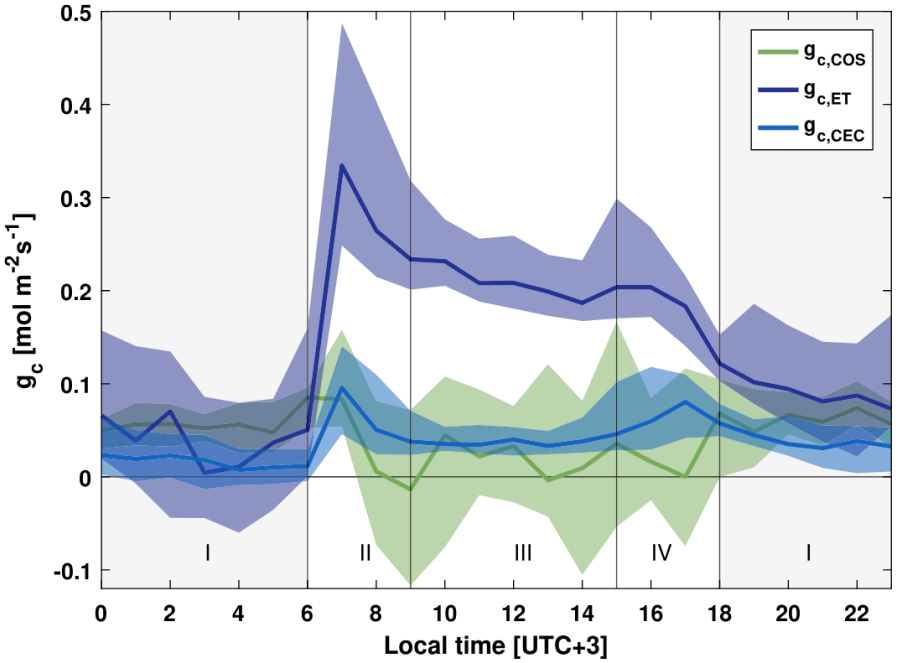




- Soil evaporation dominates daytime ET
- Transpiration dominates during nighttime

Kohonen, Kübert et al. (2025), *AFM*

Partitioned evapotranspiration



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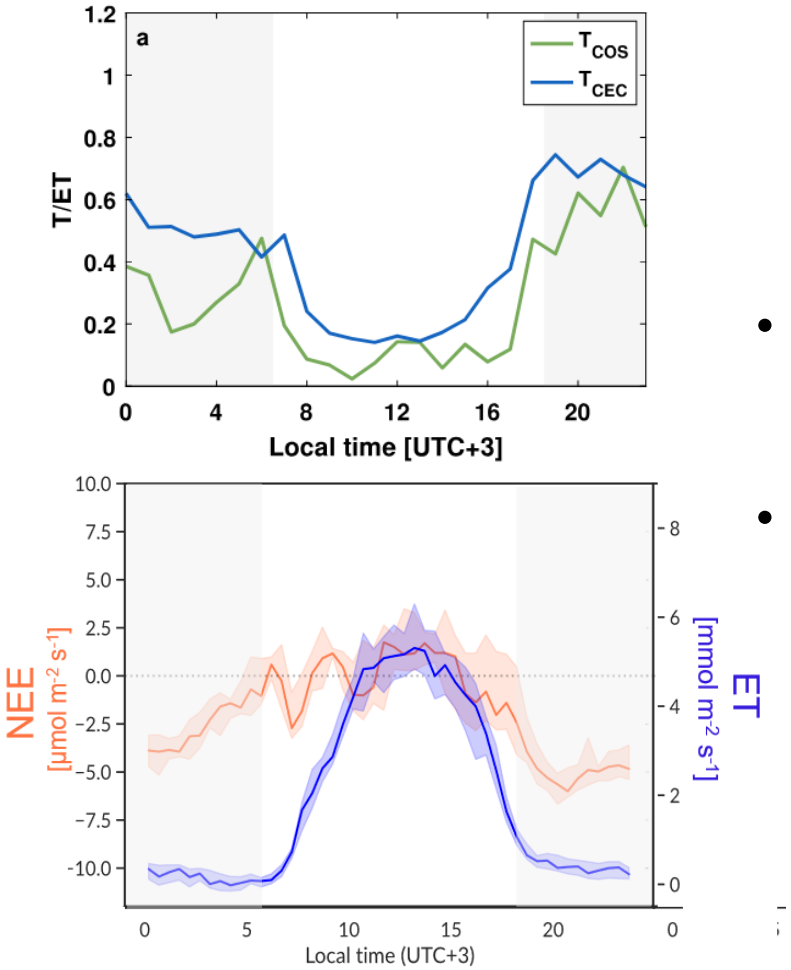

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