Technische Universität Braunschweig

INSTITUT FÜR GEOÖKOLOGIE
Bodenkunde und Bodenphysik

Simultaneous estimation of soil hydraulic properties and surface flux using inverse modeling for a large field-lysimeter

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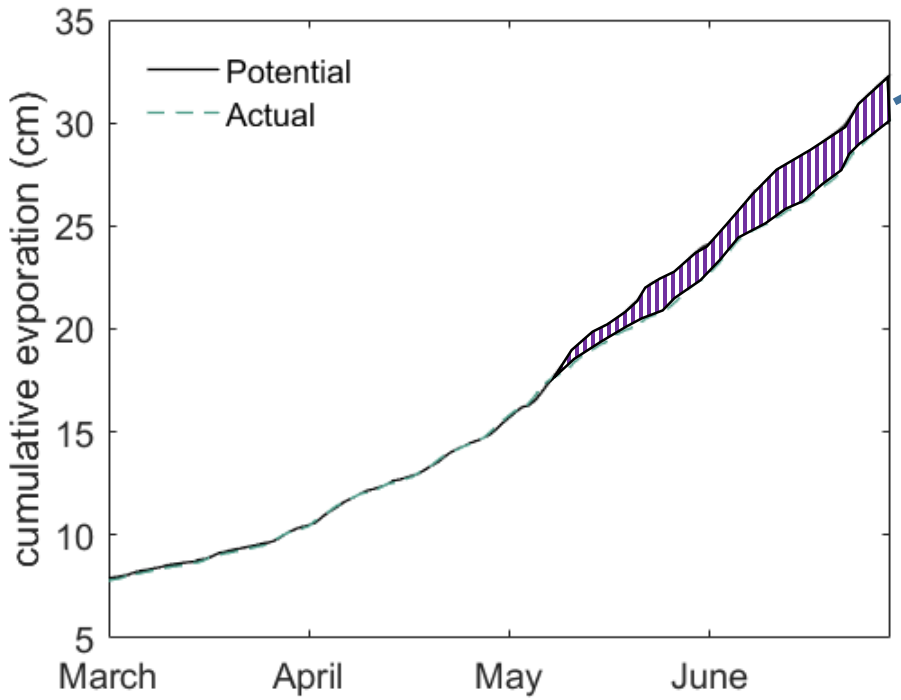
Research Question

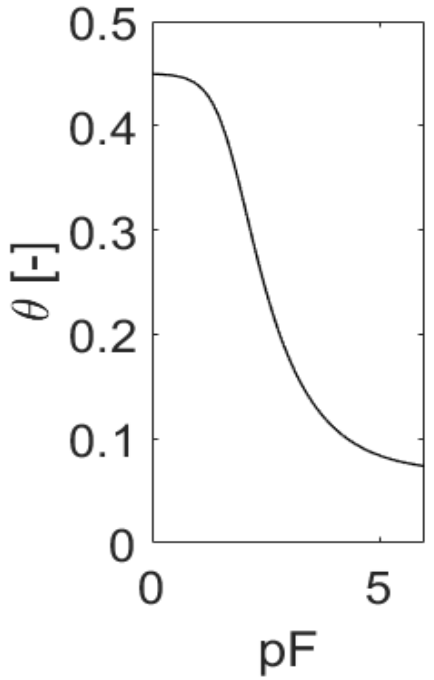
- Surface evaporation



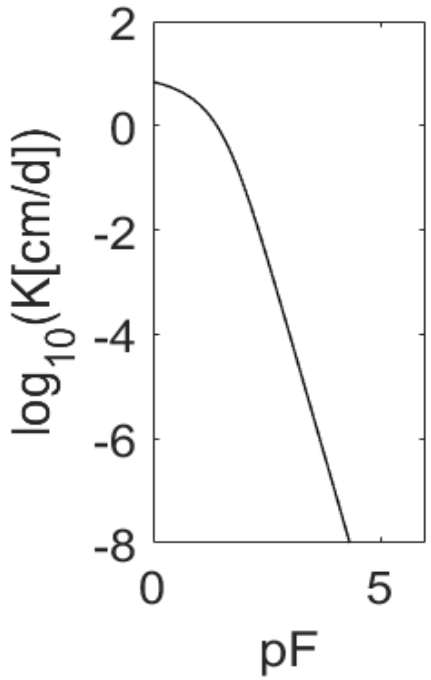
$\Delta E = E_p - E_a$

SHP

Retention function



Conductivity function



➢ Is it possible to identify SHP based on the information that comes from observations of the time series of differences between potential and actual evaporation, $\Delta E = E_p - E_a$?

Approach

(1) Proof-of-concept with synthetic data:

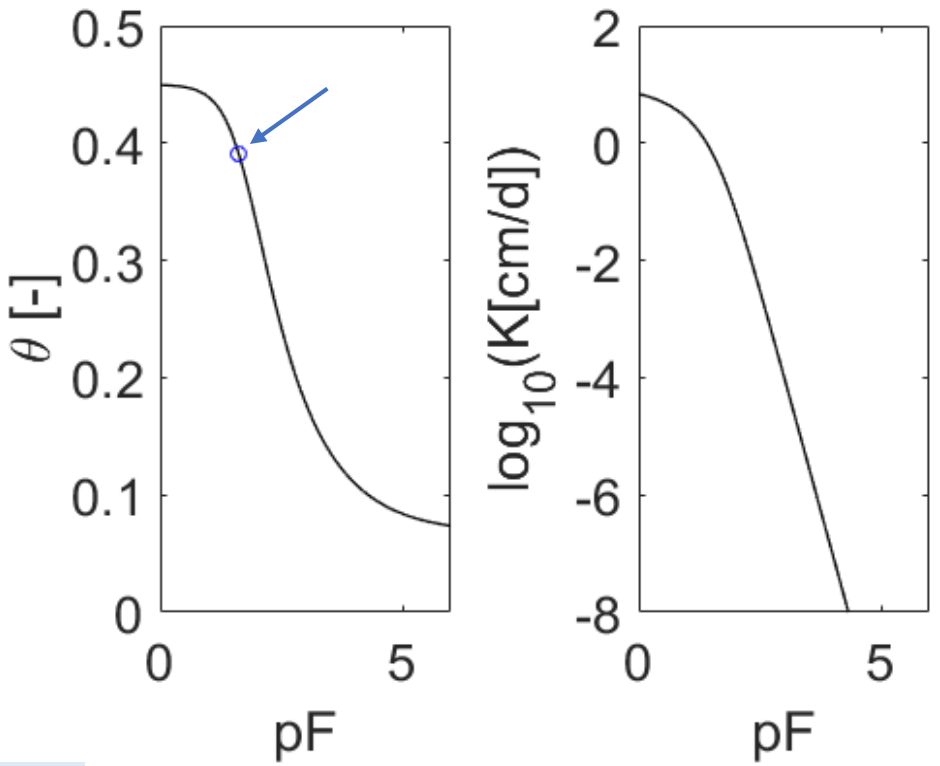
→ Numerical forward simulation (HYDRUS-1D) of water balance with prescribed E_p and given SHP.

→ Calculation of $E_a(t)$.

→ Inverse modeling to identify SHP, with use of $E_a(t)$ in the objective function*.

(2) Application to field-measured data from a large bare-soil lysimeter

Retention function | Conductivity function

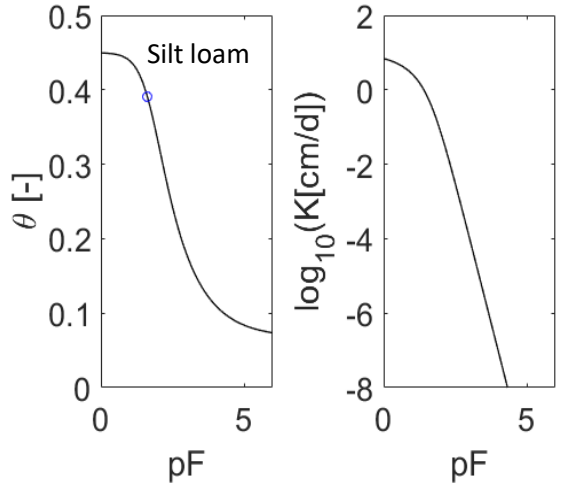


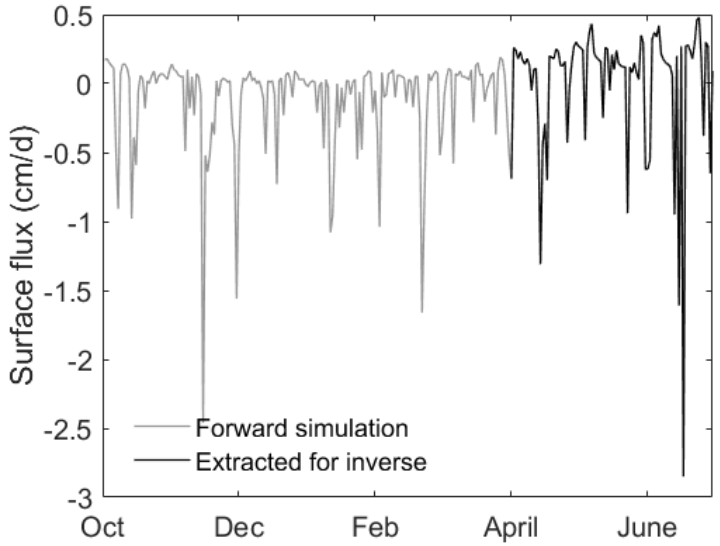
Key questions:

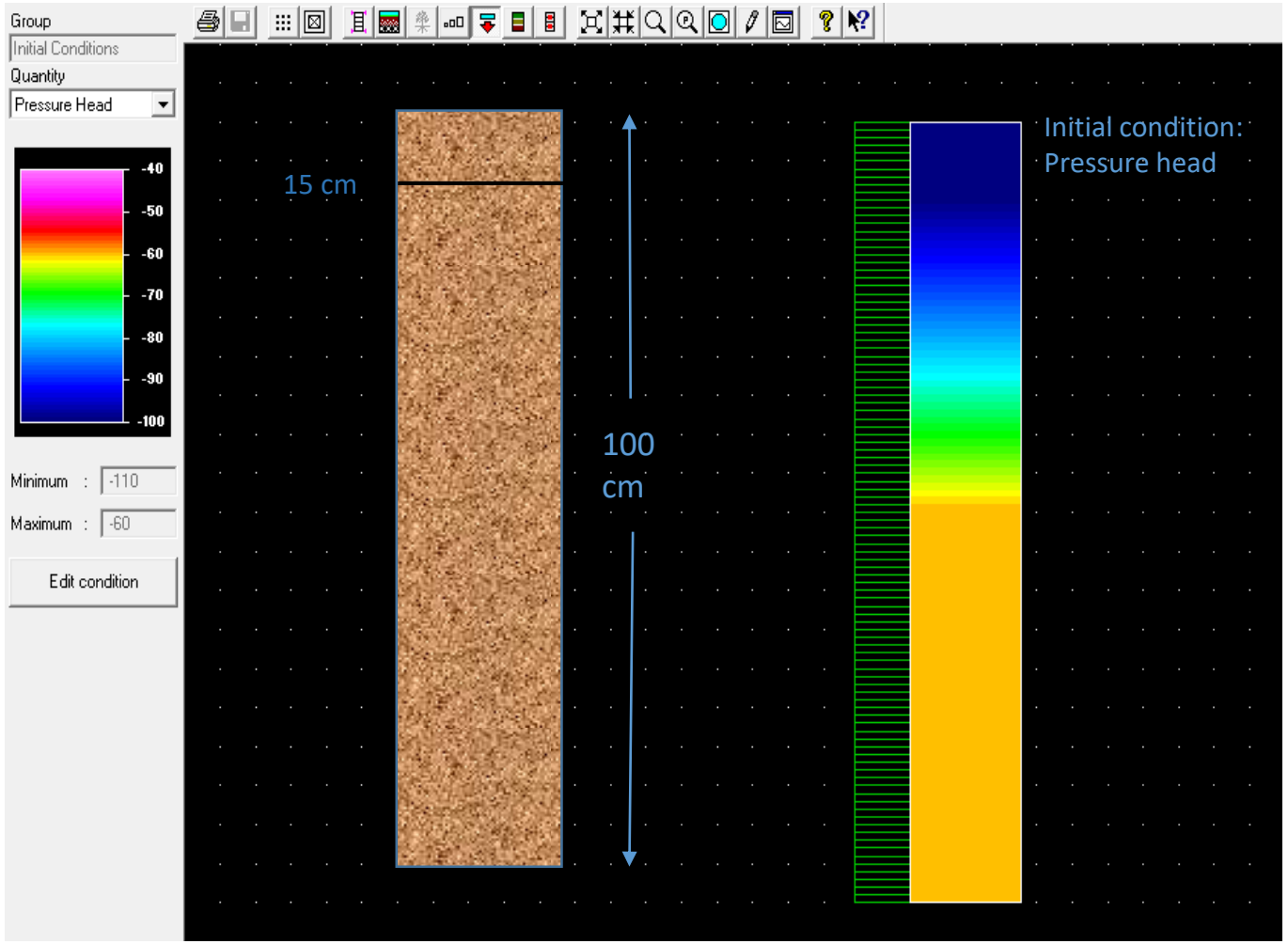
- Can we match the "observed" E_a data?
- If yes, Can we identify uniquely the underlying SHP?

*Note: Objective function must contain additionally at least one single data pair $\theta(h)$ to regularize the inverse problem.

(1) Proof-of-concept: synthetic data







(1) Proof-of-concept: Results

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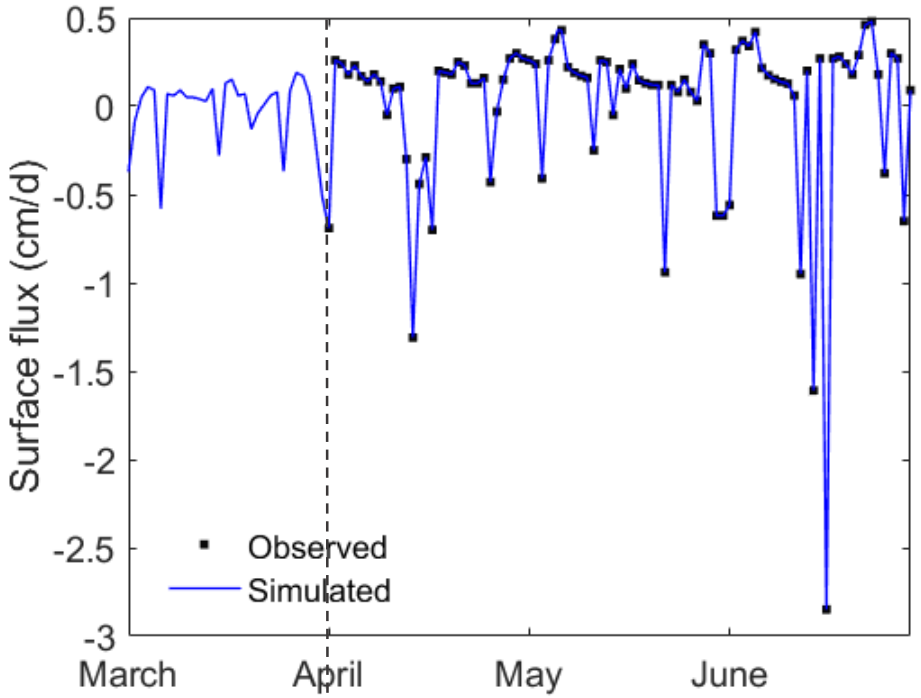
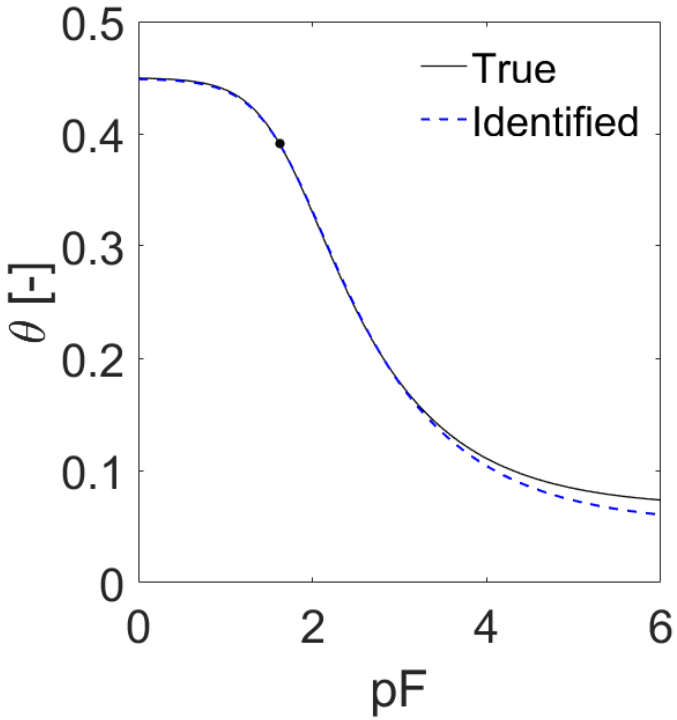
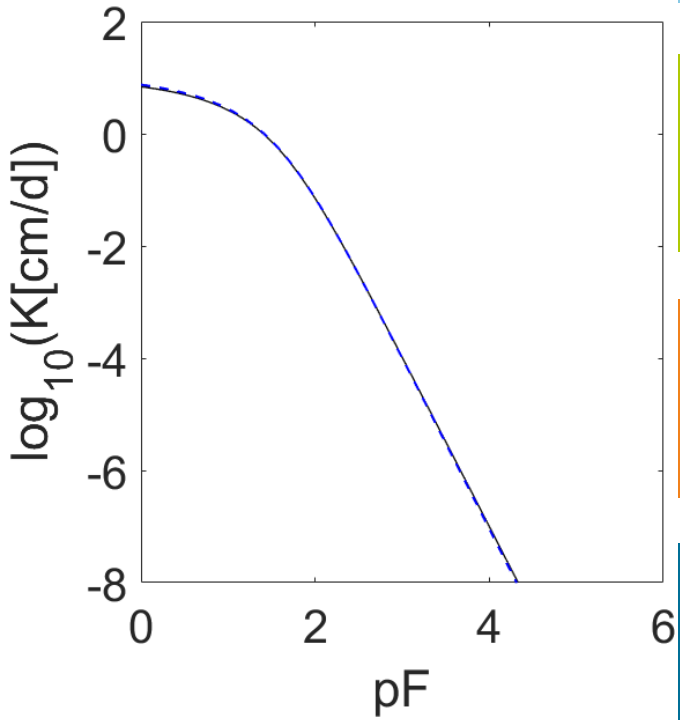
(1) Observed E_a data are well matched



Oct … April = burn-in period

(2) True SHP are well identified





(1) Proof-of-concept: Conclusion

- The investigation of synthetic data showed that it is possible to identify SHP by inverse modelling under ideal conditions* using observed ΔE.

- Burn-in period eliminated the effect of different initial conditions.

* ideal conditions are e.g.
- homogeneous soil,
- no errors in measured fluxes,
- no errors in assumed boundary conditions.

(2) Field measurements

- Large field-lysimeter (2.5 m height; 1 m^2 surface area)

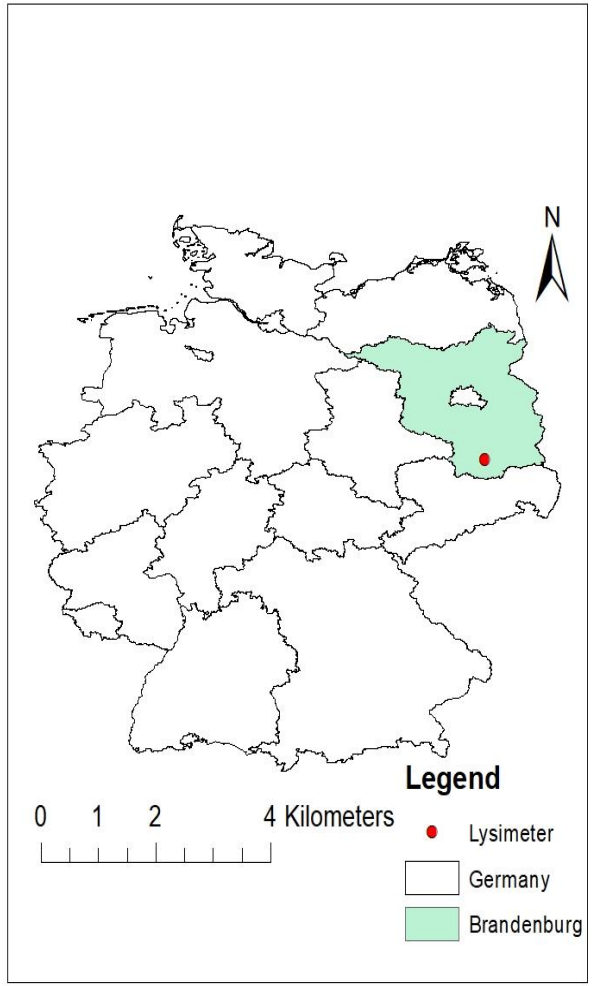
- Measurements:

  Meterological data (9 months, daily values)

  Pressure head and water content (single)

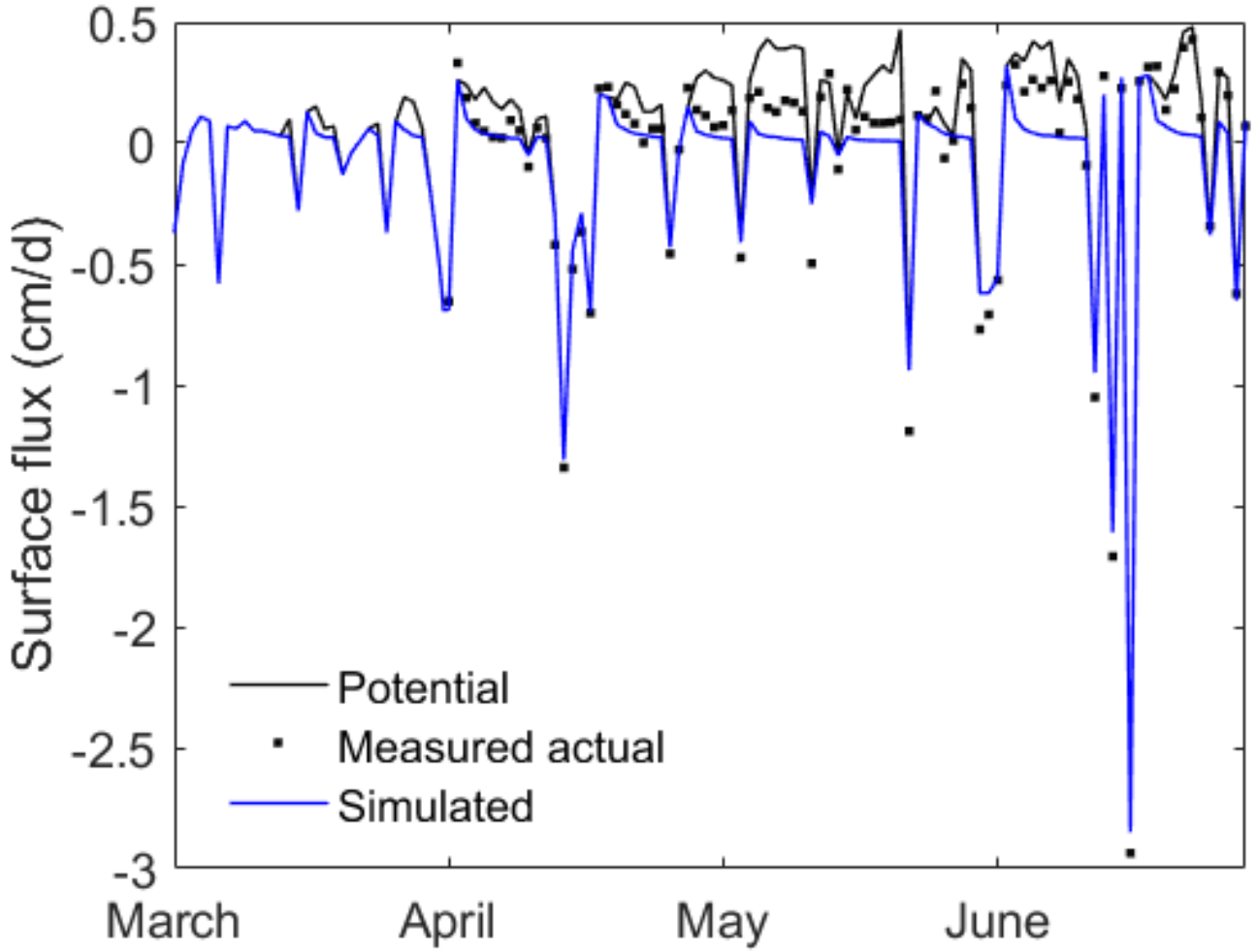
  Lysimeter and outflow mass (daily values)

Actual surface flux

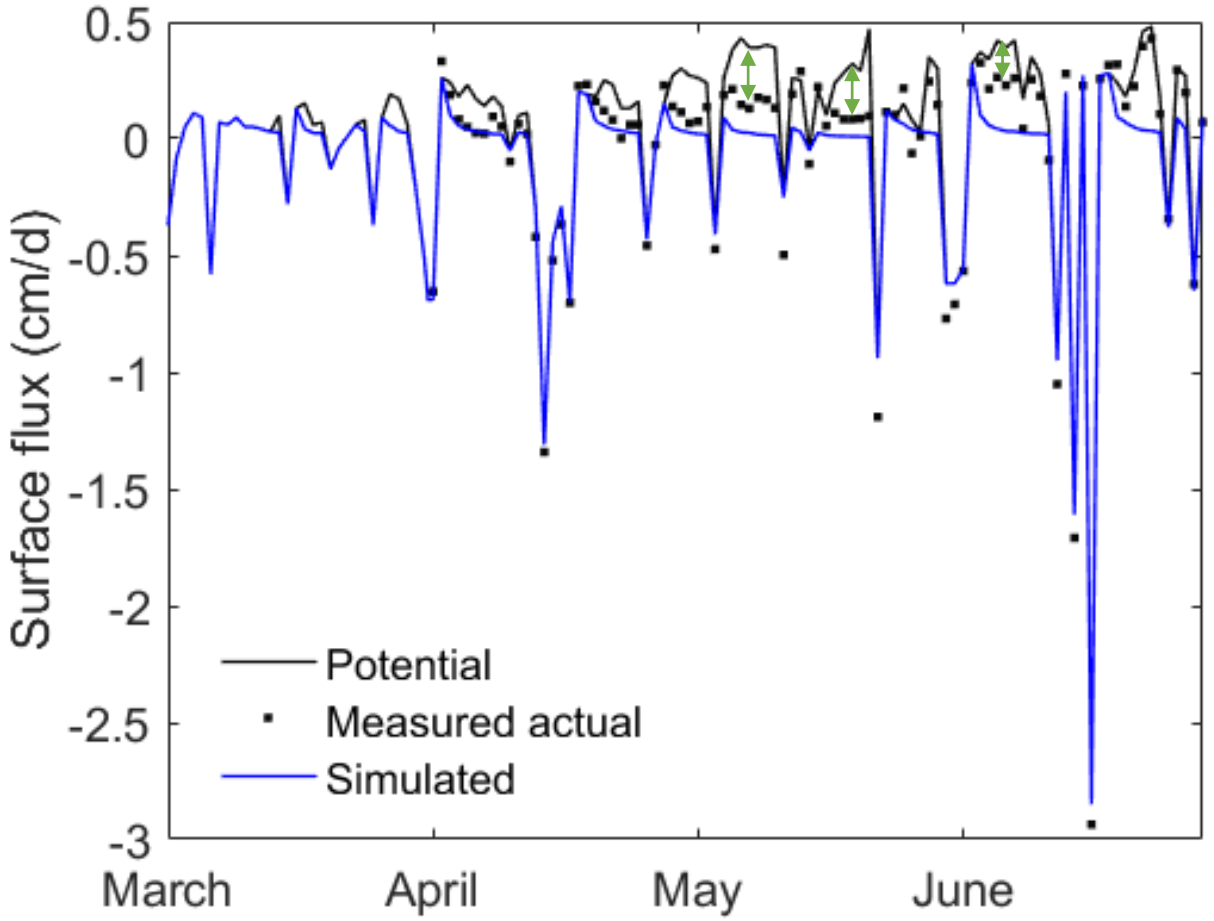


(2) Field measurements: Results

Potential, measured actual, and simulated surface flux in the simulated period

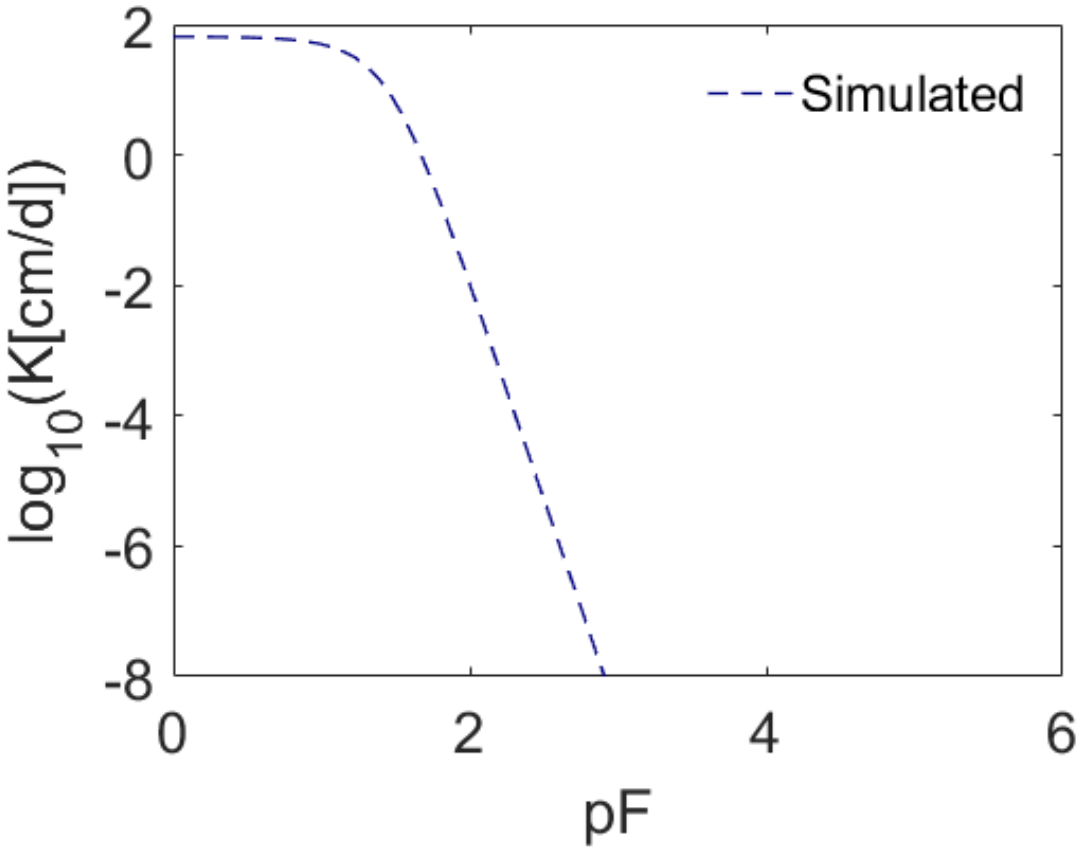


(2) Field measurements: Results



1. Measured actual fluxes from bare sand soil were close to potential surface flux only for short periods directly after rain events.
2. Simulations matched the measured E_a during these short periods.
3. In periods where soil water transport was limiting, i.e., $E_a < E_P$, the simulated flux was smaller than the measured one, i.e., simulation underestimated true evaporation.

(2) Field measurements: Conclusion



- We hypothesize that the inability of the model to match the observed E_a is caused by the underlying model of unsaturated hydraulic conductivity (VGM plus vapor flow), which **can not** represent the real conductivity in the **mid to dry moisture range**, where film and corner flow might be **significant**.

Thank you for your attention!

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