

Modeling root water uptake depth driven by climate and soil texture using a bucket model approach

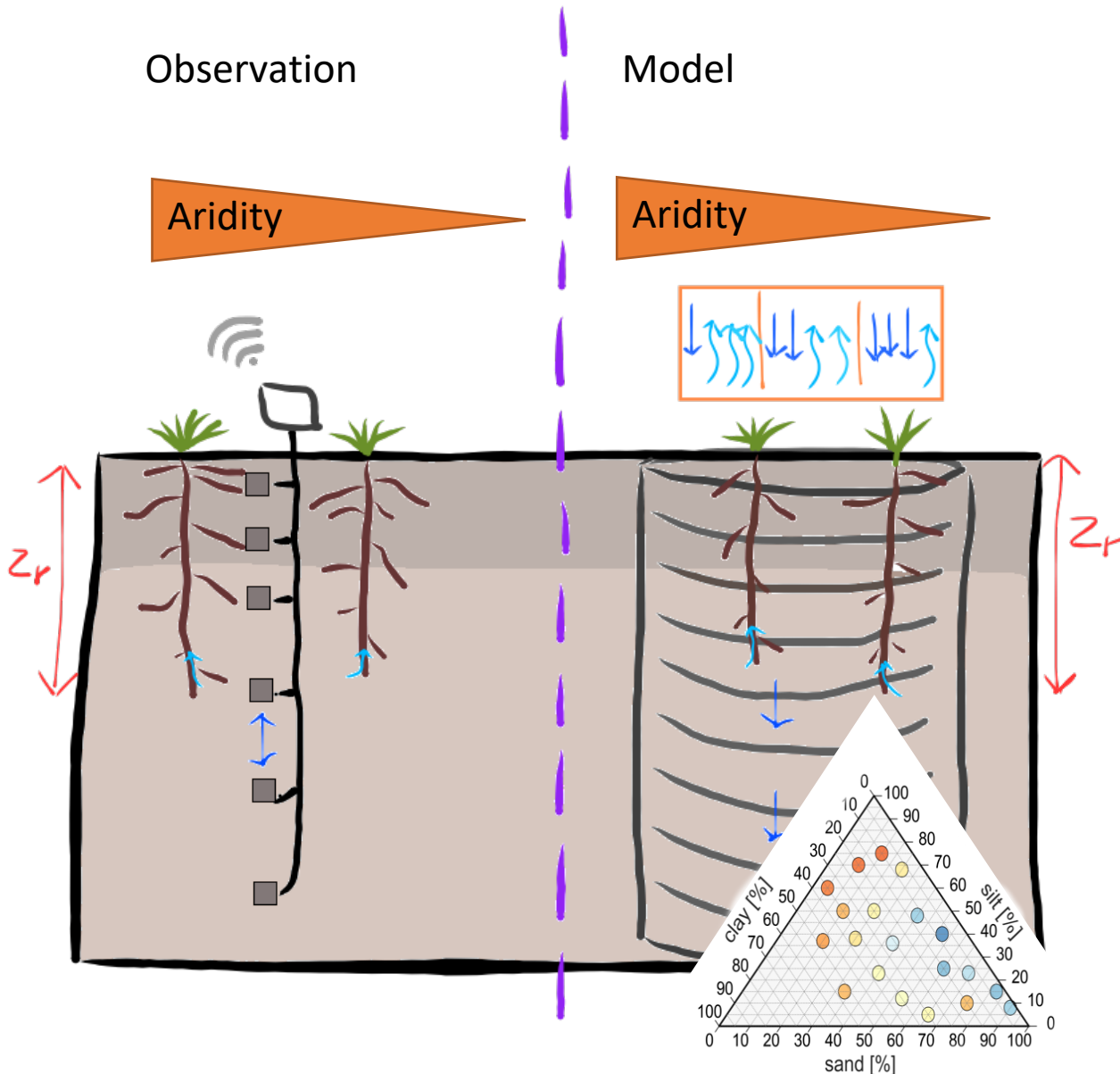
Ruth Adamczewski^{1,2}, Sven Westermann², Anke Hildebrandt²

¹Chair of Soil Physics, University of Bayreuth, Germany

²Terrestrial Ecohydrology, Friedrich-Schiller-University, Jena, Germany

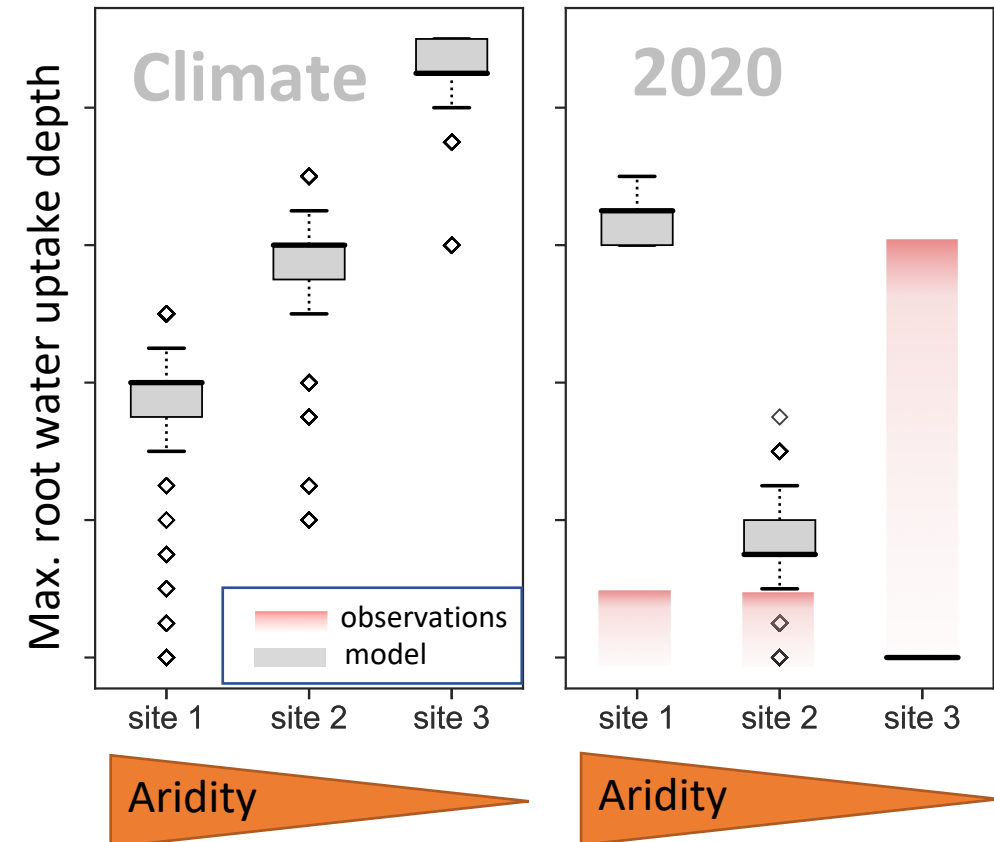
Modeling root water uptake depth driven by climate and soil texture using a bucket model approach

Ruth Adamczewski et al.
Panel EGU21-16434



Model predicts shallower root water uptake compared to observations.

Soil water redistribution and climate adapted transpiration are probable causes.

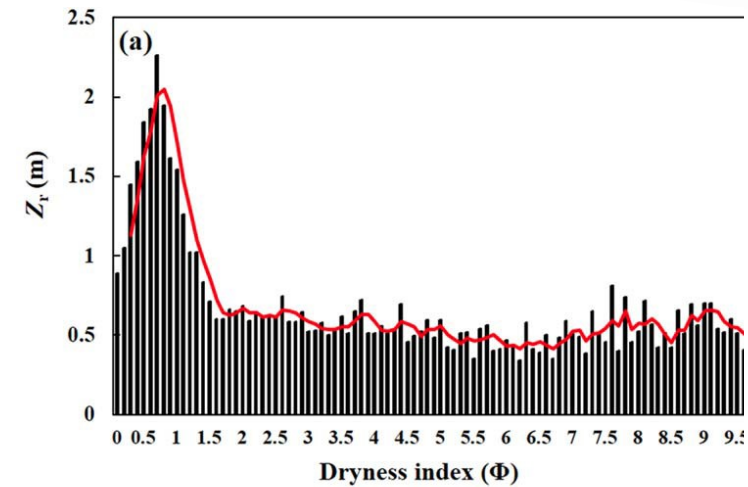
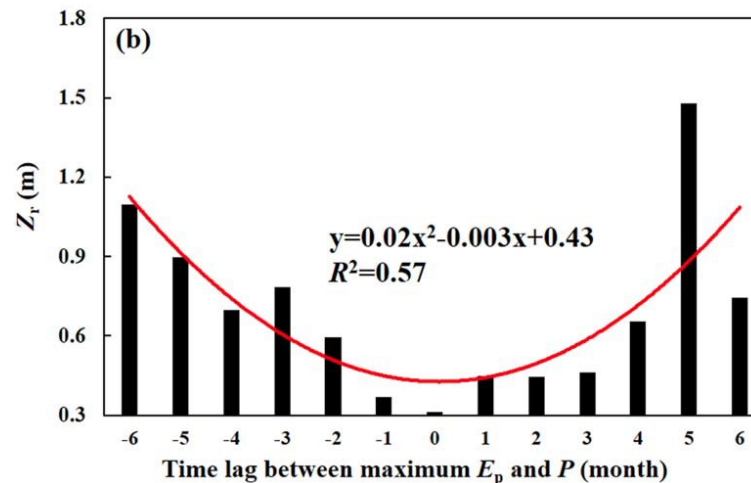
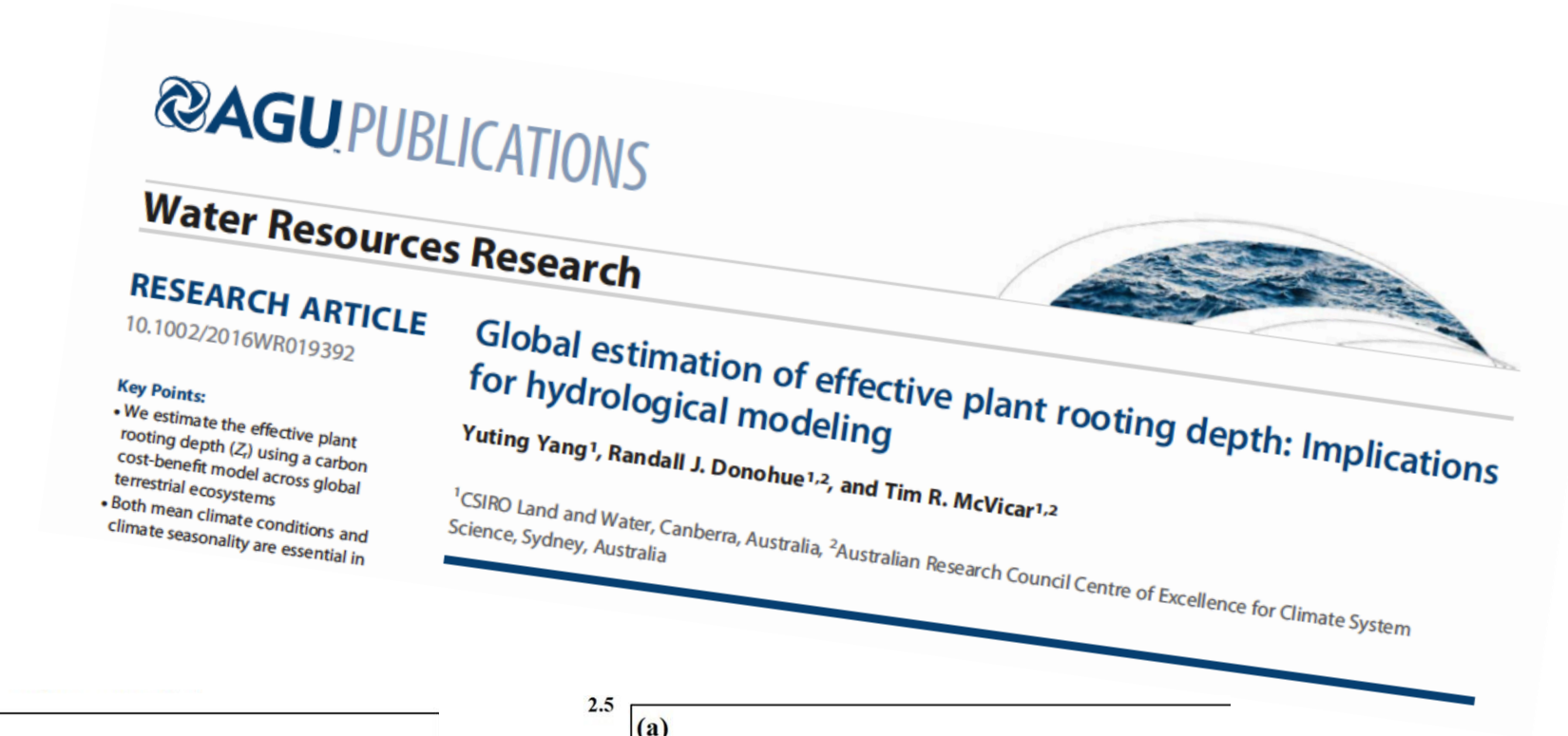


Motivation

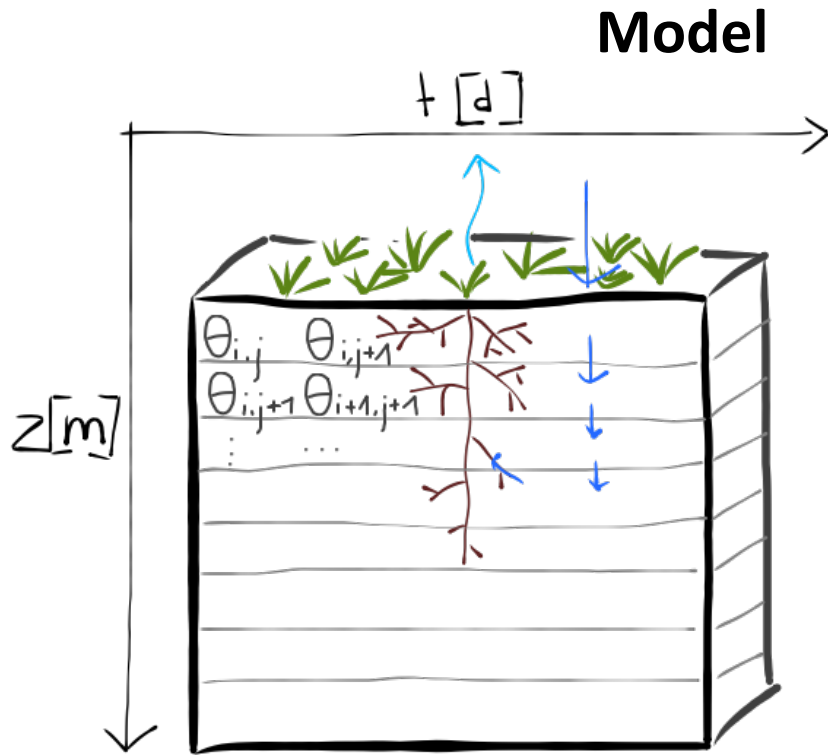
Models indicate that roots water uptake depth should shift deeper in drier environments to access more soil storage.

Also soil properties affect plant available water.

How important are soil properties?



Methods



A simple bucket model was implemented, to simulate soil moisture dynamics, with only three input parameters: climate, soil texture and SOC

Root water uptake start in top soil and moves deeper until either PET is satisfied or soil depth was reached

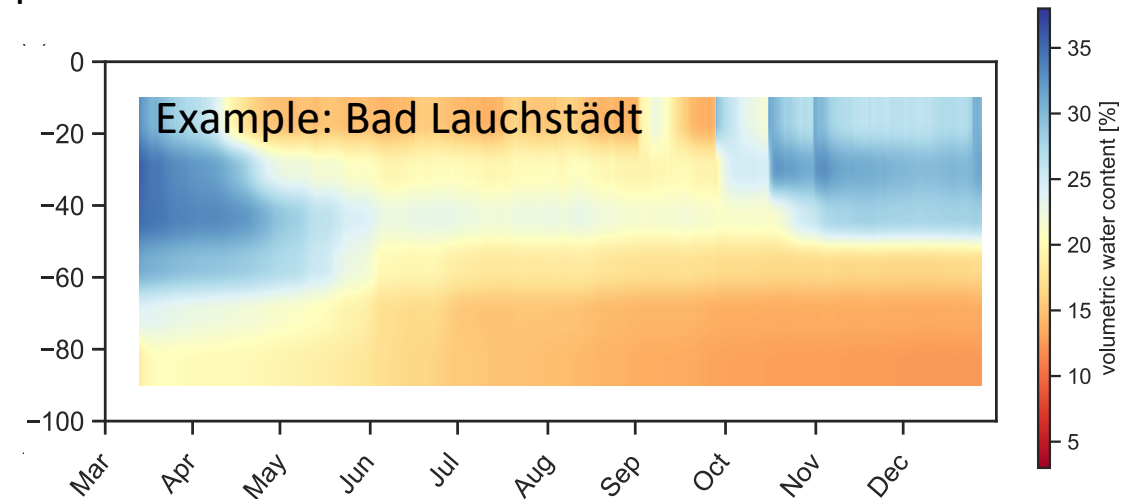
The sensitivity of root water uptake depth to the parameters were tested

Field observations in managed grasslands

Soil moisture sensors were installed, to observe soil water content dynamics along a climate gradient in Europe in three sites of the Nutrient Network (www.nutnet.org).



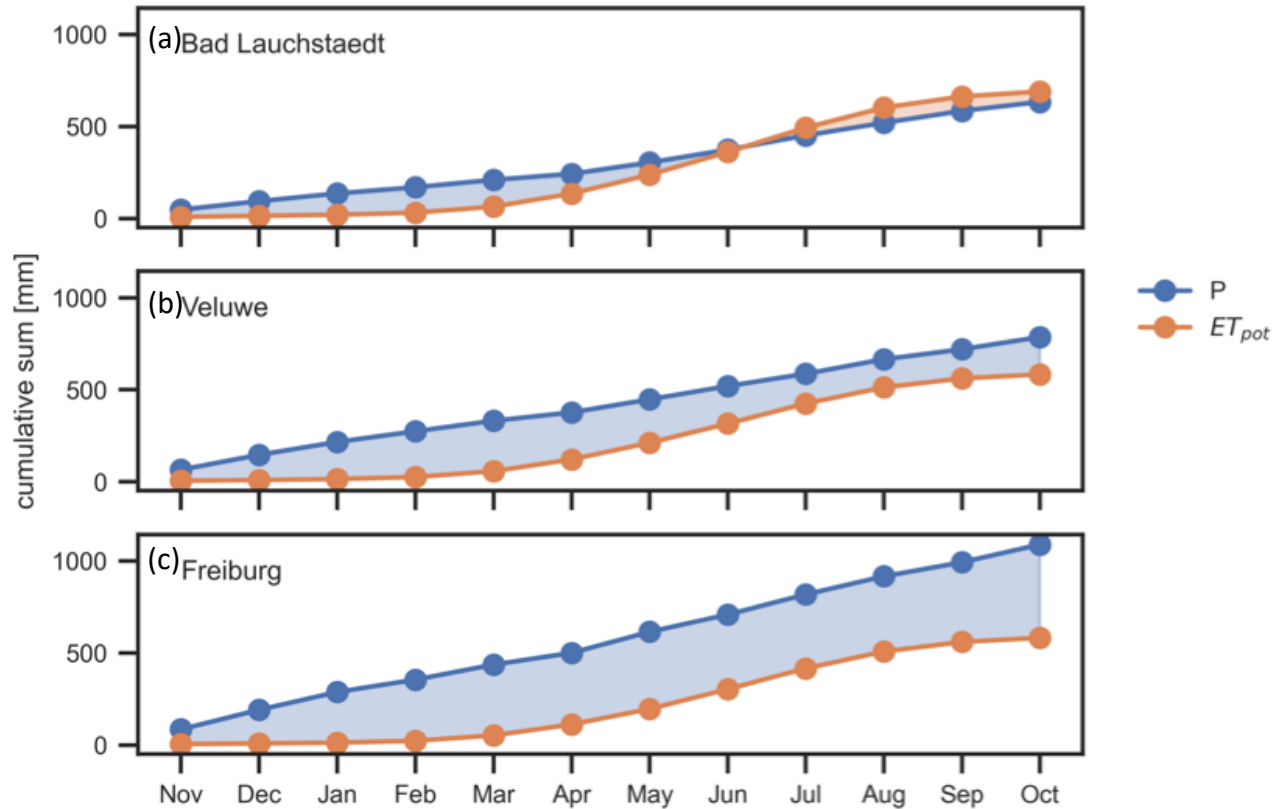
Site specific soil hydraulic properties were determined.



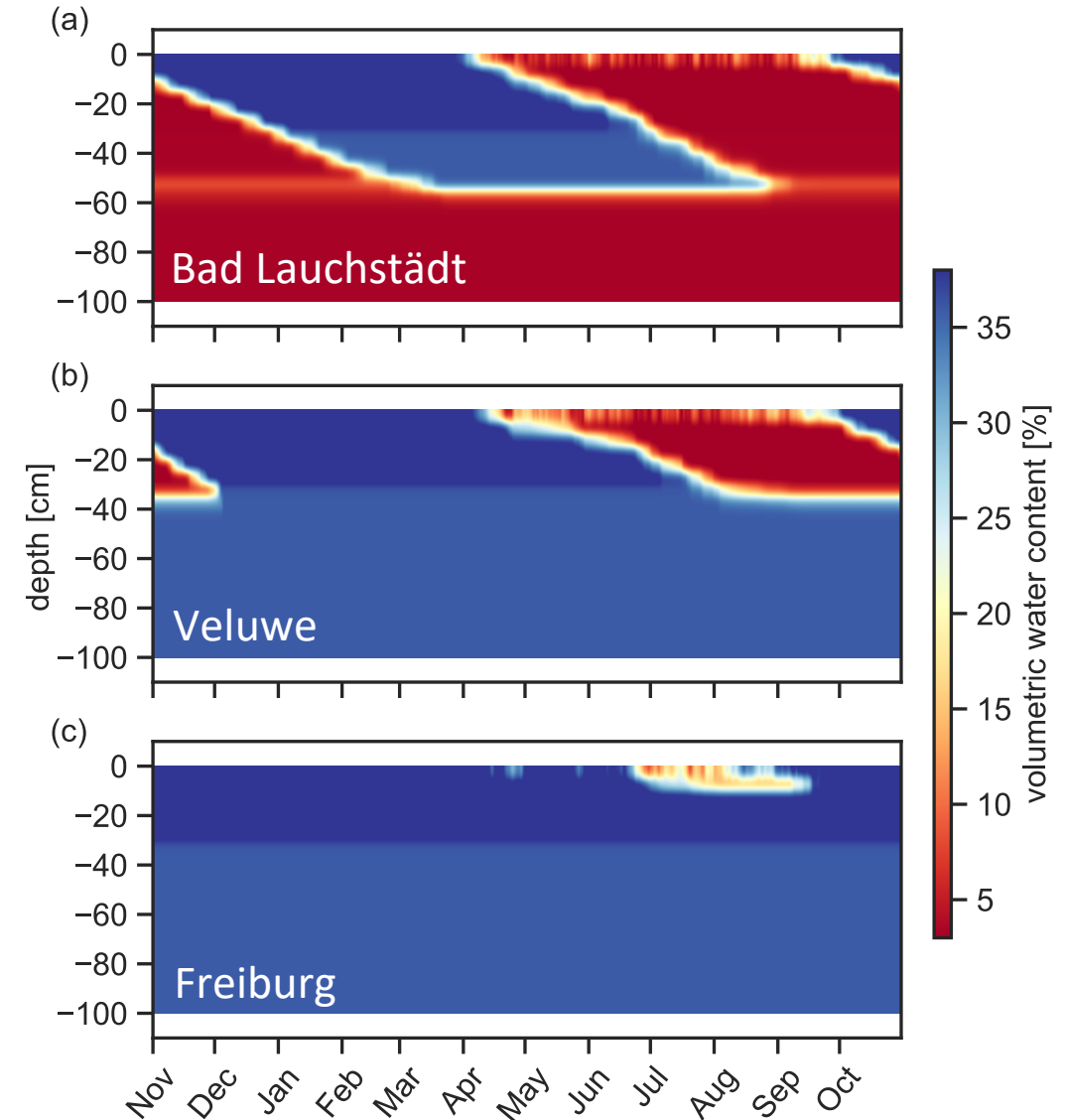
Root water uptake was calculated from soil water contents Guderle & Hildebrandt 2015, Jackisch et al. 2020

Climate

The climate at the selected sites ranges from energy limited to water limited

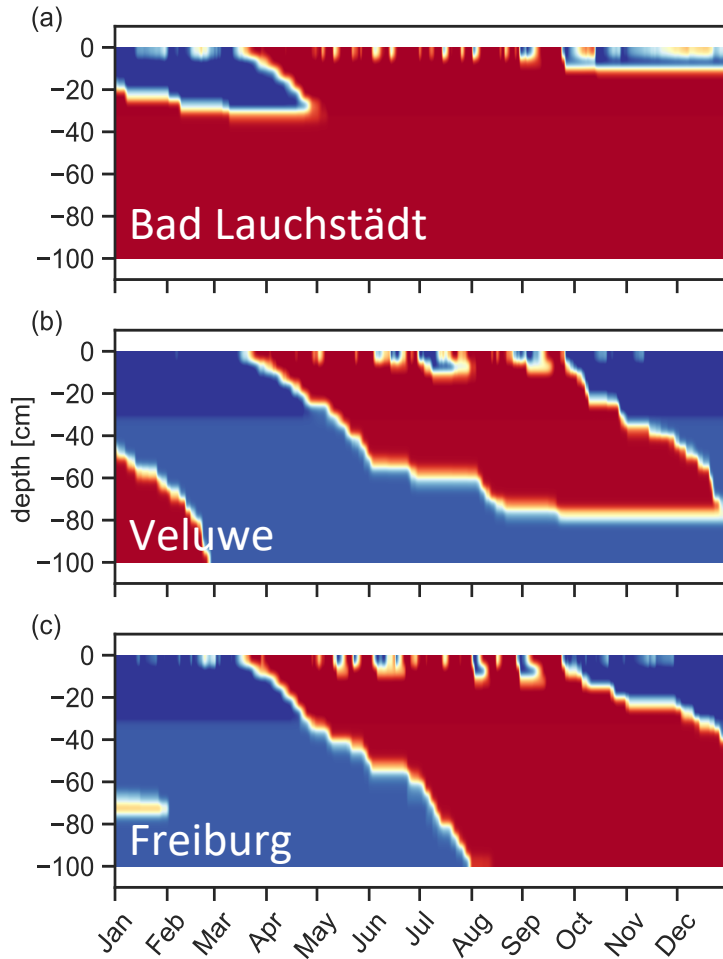


Modeled soil water content (average climate)

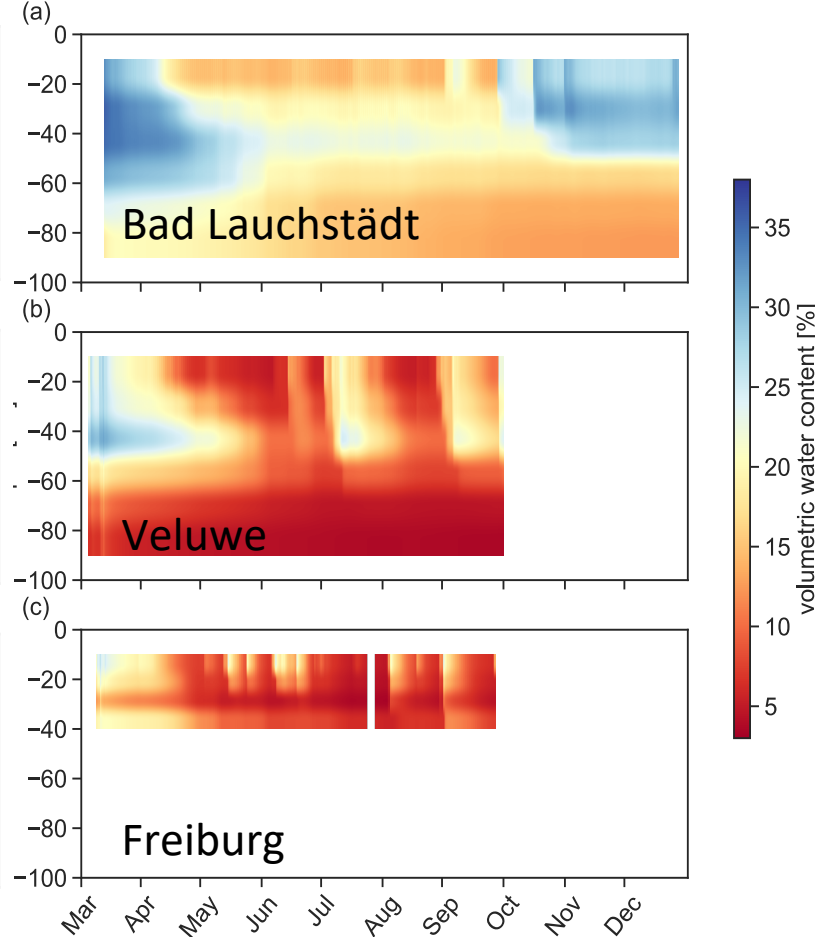


Results Model vs. Observations in 2020

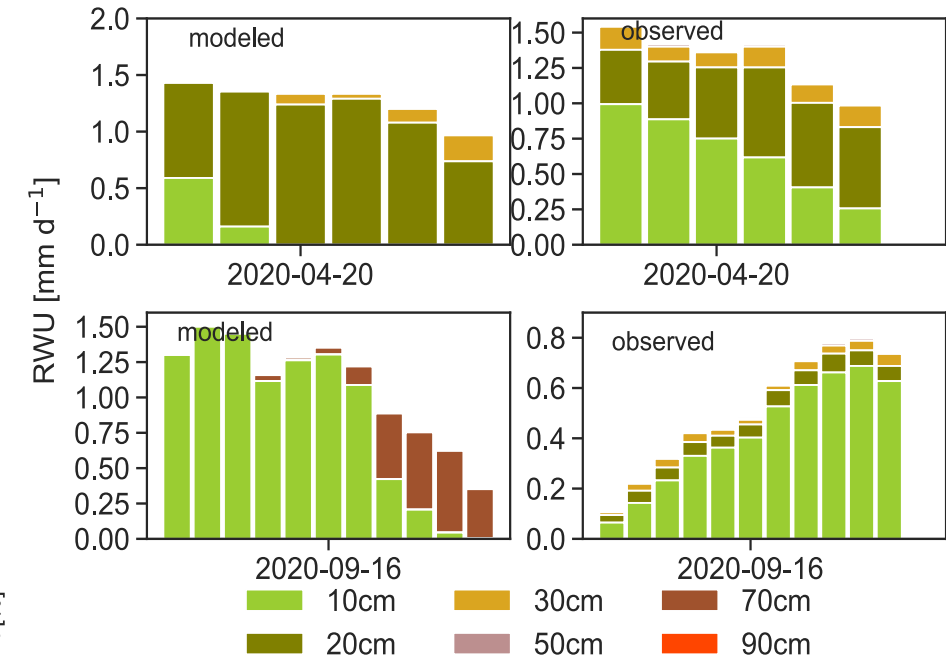
Modeled soil water



Observed soil water



Example Veluwe (b):



- Shift of root water uptake to deeper layers both in model and observation
- Maximum RWU depth at all sites at the lower observation limit (90 cm in a and b, 40cm in c) in the dry year 2020.

Conclusion

In the model:

- Climate is the major driver for uptake depth, the drier the year, the deeper the modeled root uptake. If dryness is too extreme, uptake shifts back to shallower layers
- Coarser texture lead to slightly shallower RWU depth
- Decreasing soil organic carbon causes slight increase in uptake depth
- In the dry year 2020, uptake patterns shift

Observations suggest:

- Even deeper RWU uptake than predicted by model
- Long-term adapted transpiration (below potential ET) at drier sites, therefore overall moister soil profiles and moistening to greater depth also at drier sites
- Drier subsoils at wetter sites due to extremely low soil water retention and coarse textures.

