Parameterization of PET approaches for distributed hydrologic modeling

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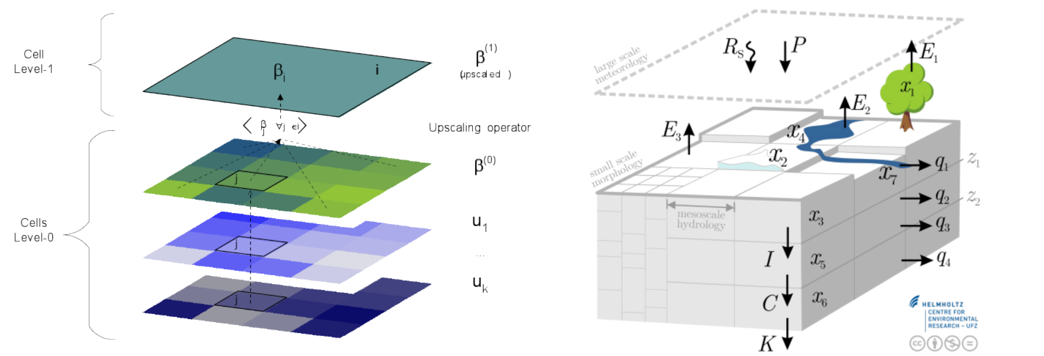
1. Motivation

Reliable soil moisture products are needed for the estimation of plant available water or agricultural droughts. For the simulation of hydrological states, e.g. soil moisture, the estimation of evapotranspiration is crucial since it has the large contribution to the water balance. In hydrological modeling the evapotranspiration (ET) is usually estimated based on potential evapotranspiration (PET). Common approaches for PET estimation and their parameterization are sufficient at the point or field scale for which they have been developed. Their robust parameterization for spatially distributed estimations on the mesoscale, e.g. 4 km, is still a challenge.

2. mesoscale Hydrologic Model (mHM)[1]



Multiscale Parameter Regionalization scheme (left) and model structure of mHM (right)

3. PET Approaches and Regionalization (regio)

Hargreaves – Samani (HS):

$$PET_{HS} = c \cdot R_a \cdot (T_{avg} + 17.8) \cdot \sqrt{T_{max} - T_{min}}$$

Priestley – Taylor(PT):

$$PET_{PT} = \alpha \cdot \frac{s \cdot R_N}{s + \gamma}$$

Penman – Monteith (PM):

$$PET_{PM} = \frac{s \cdot R_N + \frac{VPD}{r_a}}{s + \gamma \cdot \left(1 + \frac{r_s}{r_a}\right)}$$

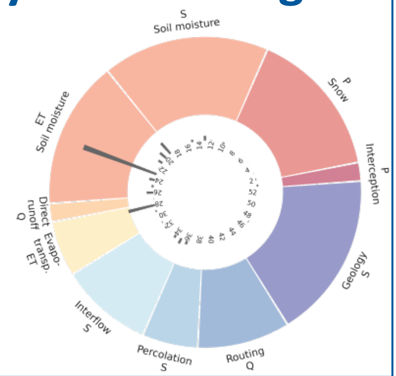
	HS	PT	PM
literature	c = 0.0023	α = 1.26	r_a = f (Land Cover)
unregio	c = [0.0016 .. 0.0030]	α = [0.75 .. 1.75]	
regio	c = f (Aspect)	α = f (LAI)	r_a = f (LAI, Land Cover)

4. Parameter Sensitivity for Discharge

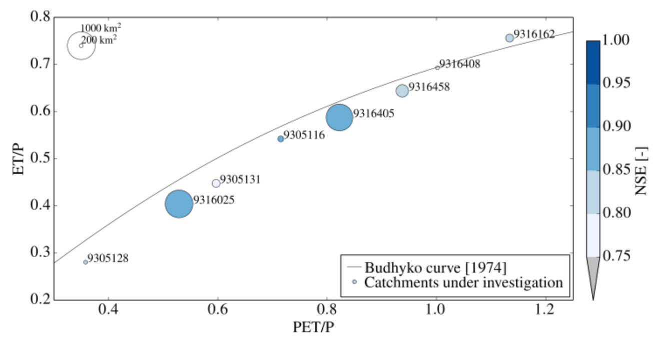
The derivative based sensitivity analysis PI Index [2] exhibited high sensitivities of parameters related to evapotranspiration.

P23 = root water uptake

P28 = PET aspect correction



5. Study Domain – 8 German basins



6. Discharge Estimation

Median and standard deviations of the Nash-Sutcliffe Efficiency (NSE) for the 8 basins and 5 parameter sets per basins (40 realizations each entry).

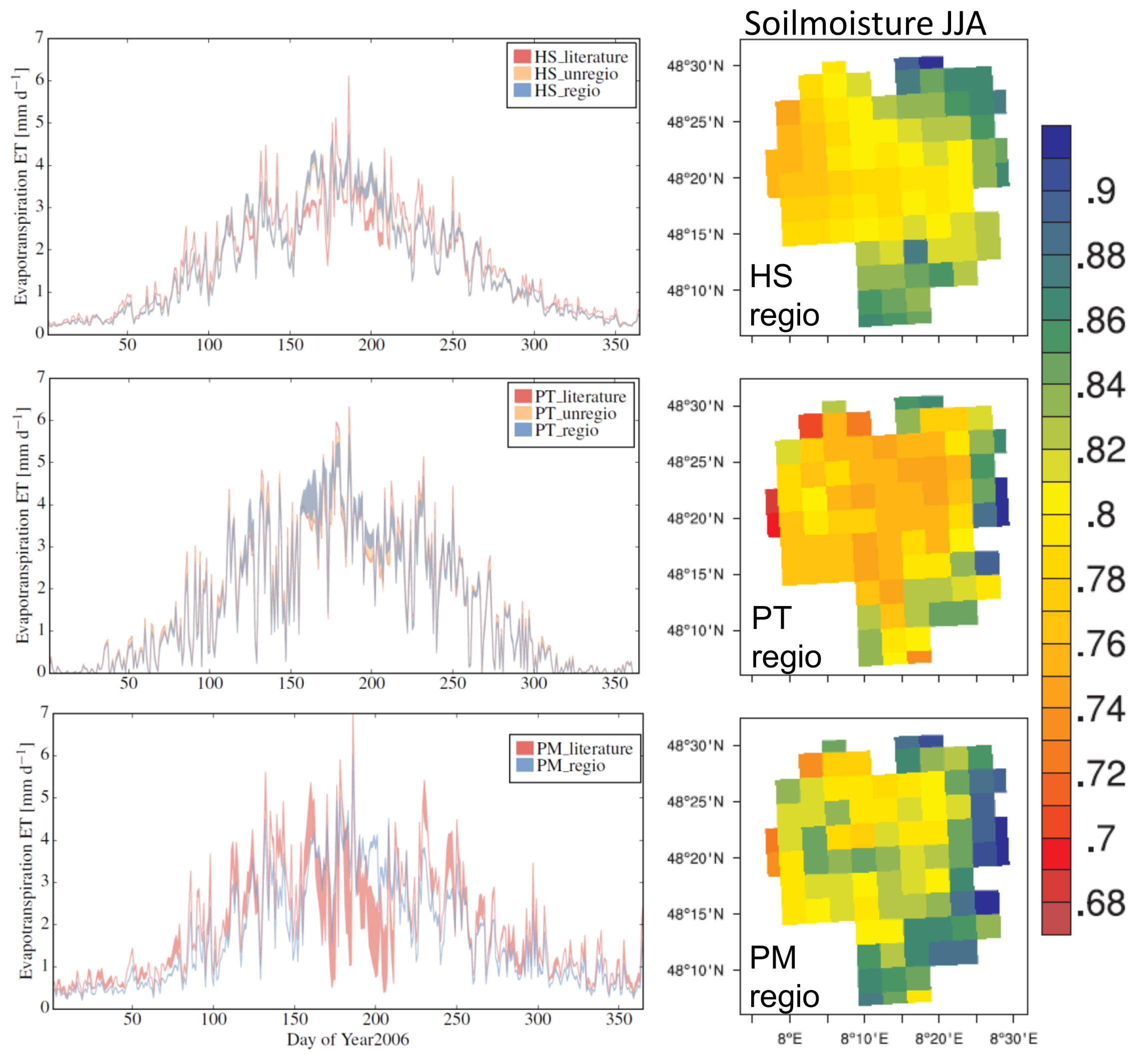
NSE(Q)	HS	PT	PM
literature	0.82 ± 0.06	0.82 ± 0.06	0.84 ± 0.04
unregio	0.82 ± 0.11	0.80 ± 0.12	
regio	0.83 ± 0.06	0.82 ± 0.09	0.83 ± 0.06

7. Parameter Transfer

Median and standard dev. of the NSE if parameters are transferred between catchments (280 realizations).

NSE(Q)	HS	PT	PM
literature	0.57 ± 0.38	0.49 ± 0.37	0.52± 1.04
unregio	0.57 ± 0.35	0.48 ± 0.41	
regio	0.61 ± 0.29	0.51 ± 0.35	0.51 ± 0.58

8. ET and Soil moisture of Catchment 9316025



9. Conclusions

- Performance of PET approaches regarding discharge is comparable
- Regionalization didn't improve transferability (wrong optimization?)

10. Outlook

- Sensitivity analysis of the different PET approaches
- Extension of the study to arid regions in Europe (e.g. Spain)

References

[1] Samaniego, L., Kumar, R., & Attinger, S. (2010). Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale. *Water Resources Research*, *46*(5)

[2] Göhler, M., Mai J., & Cuntz, M. (2013). Use of eigendecomposition in a parameter sen- sitivity analysis of the Community Land Model, J. Geophys. Res. Biogeosci.

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