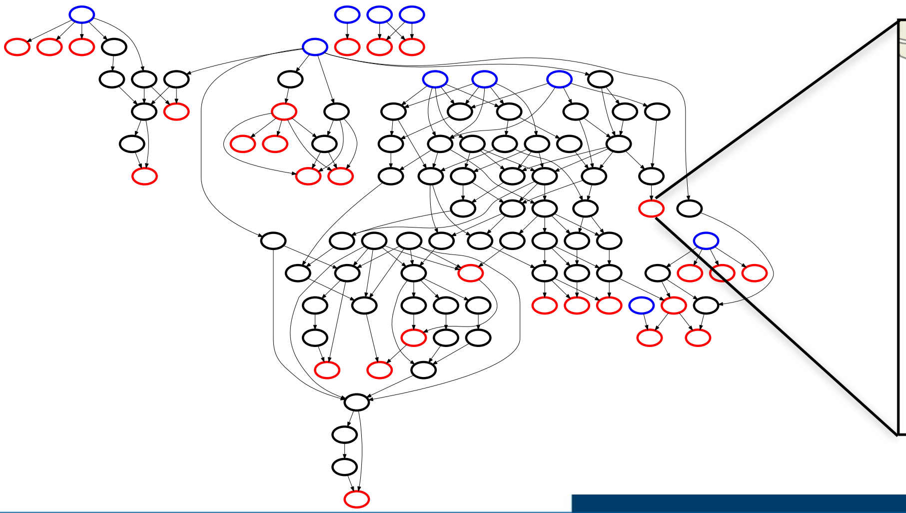
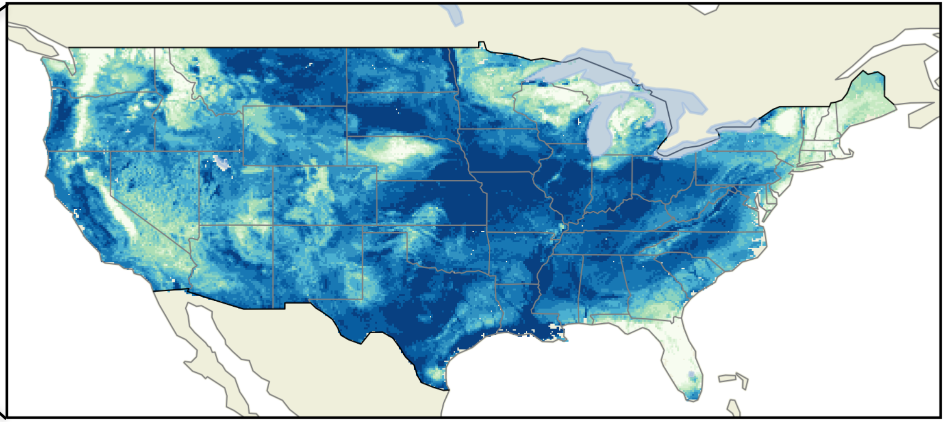
Development of a stand-alone Multiscale Parameter Regionalization (MPR) tool for the estimation of effective model parameters for any distributed model

Photography encouraged





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EGU2019-7478 - April 12th 2019

Universität Potsdam

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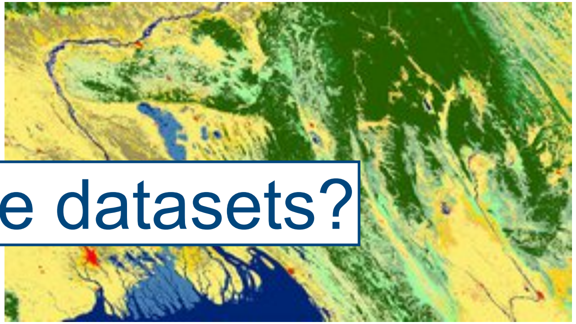
Estimating parameters for a distributed model

Van Looy, 2017 (Rev. o. Geo.)

$$O_{it} = f\left(I_{it}, \beta_{it}\right)$$
$$\#\beta_i = \#i$$

$f(\cdot)$: process representation
I: process input
β: process parameters
O: process output
i: cell index
t: time index

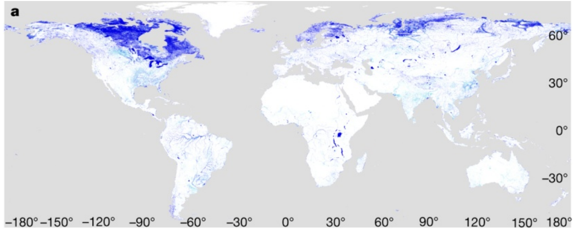
High-resolution data

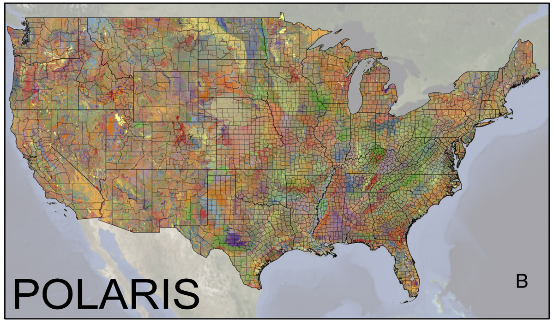


How to profit from these datasets?

ASTER (NASA, 2001)
elevation at 30m

MODIS (Friedl, 2019)
land cover, LAI, VI,… at 500m





JRC GSW (Pekel, 2016 Nat)
lake alimetry at 30m

POLARIS (Chaney, 2016 Geoderma)
soil at 30m

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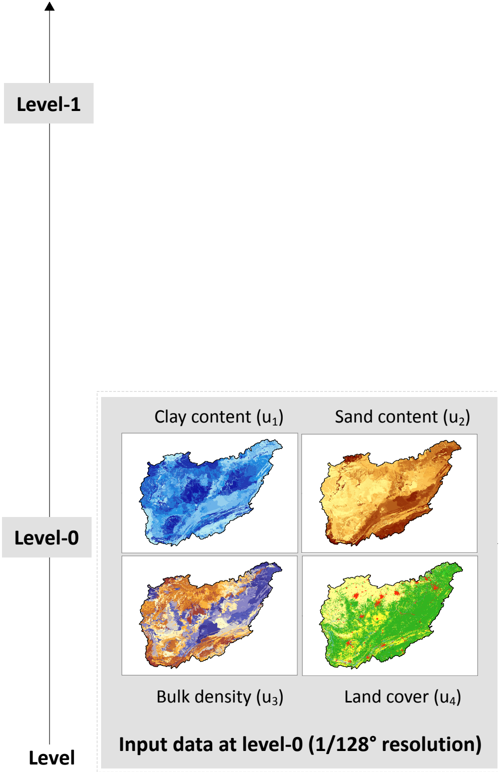
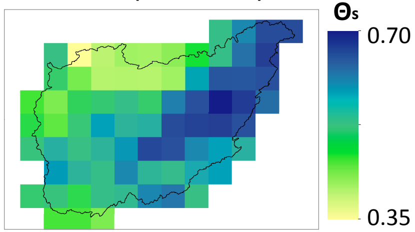
Multiscale Parameter Regionalization (MPR)



Porosity (Θ_s^1)
at level-1 (1° resolution)



steps:

1. transfer function
2. upscaling

Samaniego, 2010 (WRR), Kumar, 2013 (WRR)

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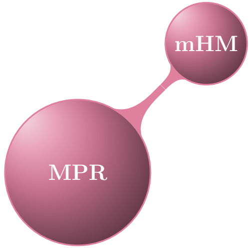
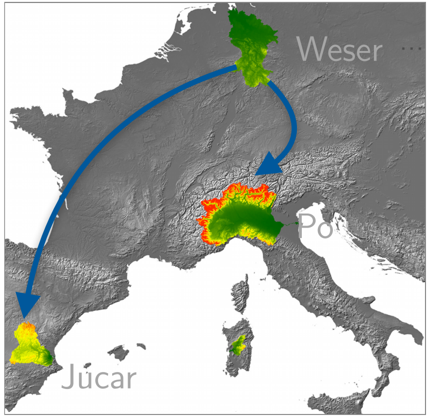
MPR key advantages

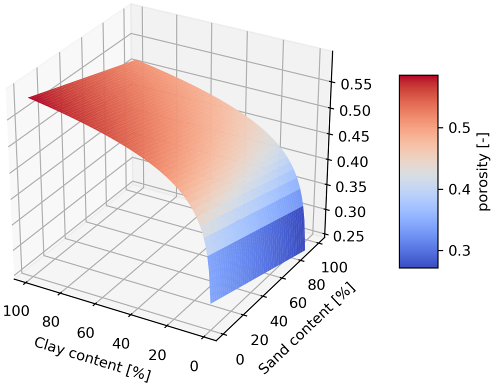


Samaniego, 2010 (WRR)



adapted from Samaniego

- Regularisation of parameter space at input data resolution
- Transferability across scales and location



$$O_{it} = f\left(I_{it}, \beta_i\right)$$

$$\#\beta_i = \#i$$

$$\beta_i = f_u\left(f_t\left(P_{kj}, \gamma\right)\right)$$

$$\#\gamma = 3$$

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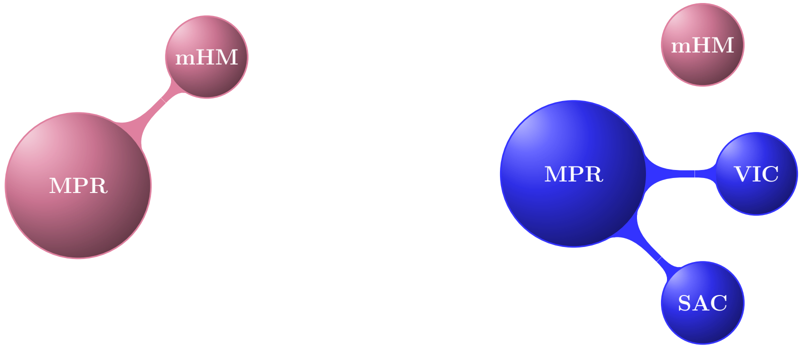
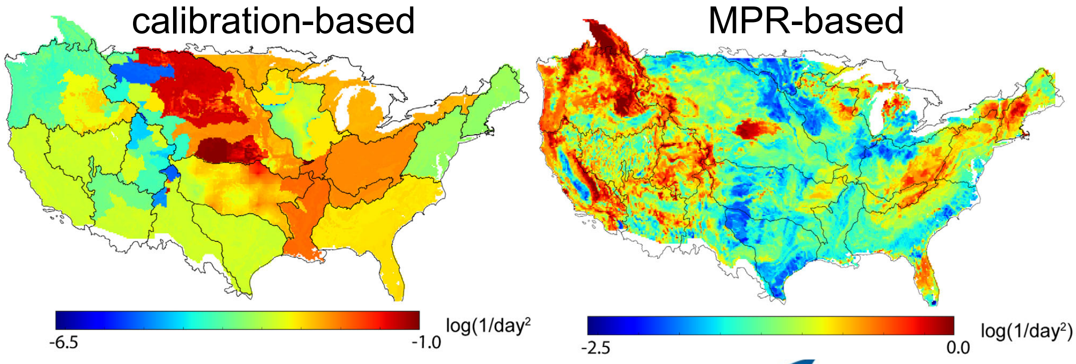
MPR key advantages



Mizukami, 2017 (WRR)



- Regularisation of parameter space at input data resolution
- Transferability across scales and location
- Seamless parameter fields

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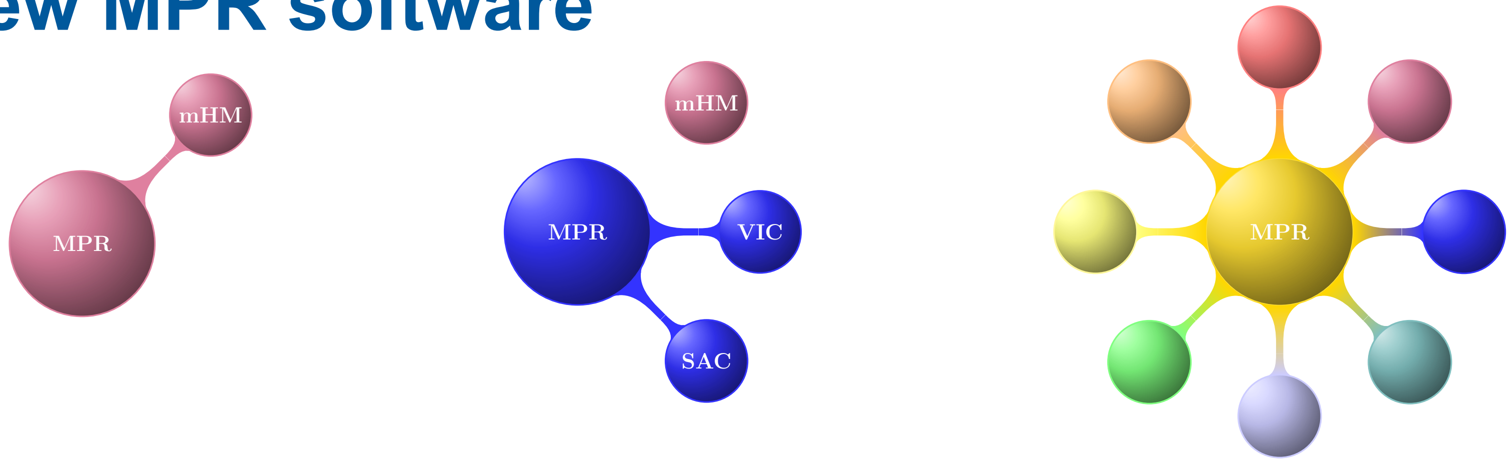
new MPR software



Schweppe, 2019 (in preparation)

What is the effect of using different transfer functions on model behaviour?

How can MPR be implemented?

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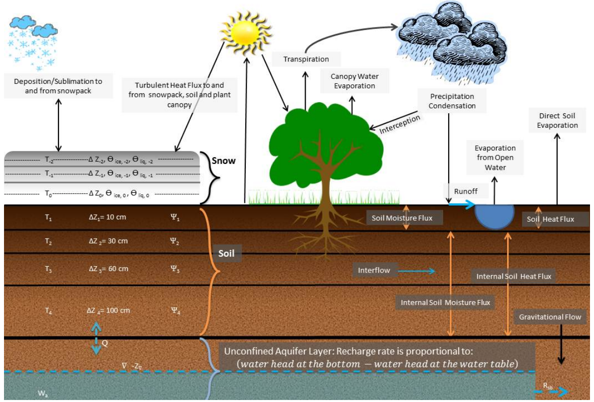
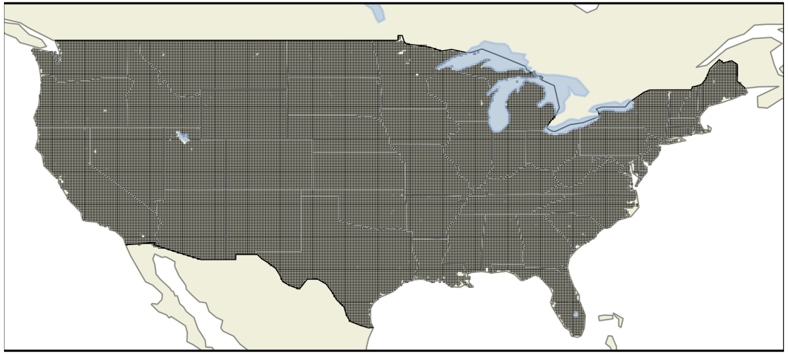
Land-Surface Model Noah-MP

- Part of WRF HYDRO framework
- Used in operational NOAA National Water Model
- Richards' (1931) equation & Campbell (1974) parameterization



University of Texas at Austin



- NLDAS2 forcing
- Hourly time step, 1/8° resolution

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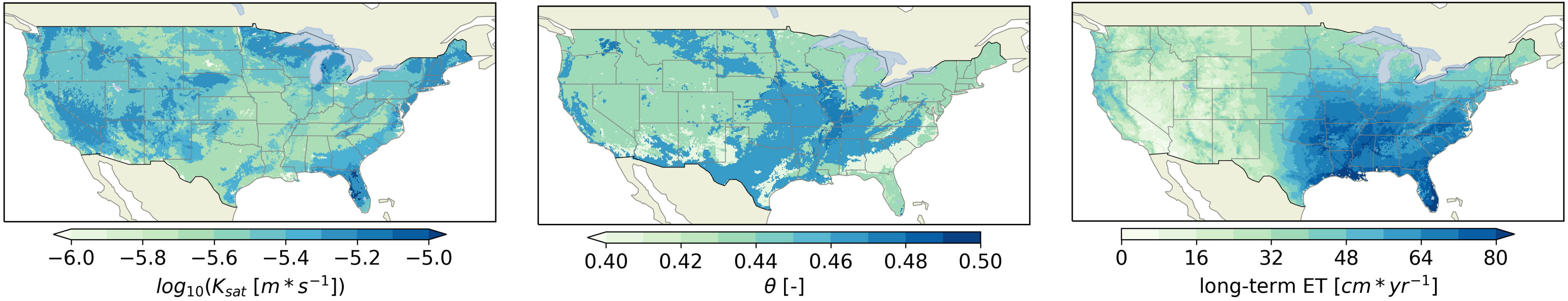
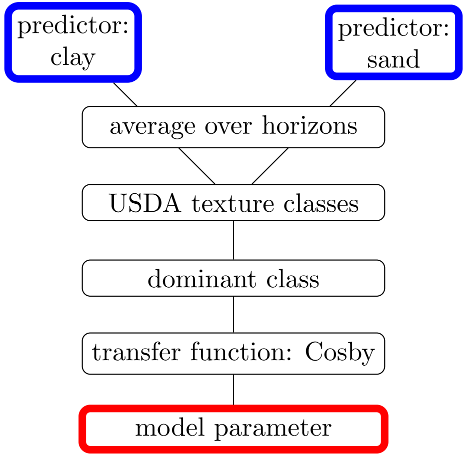
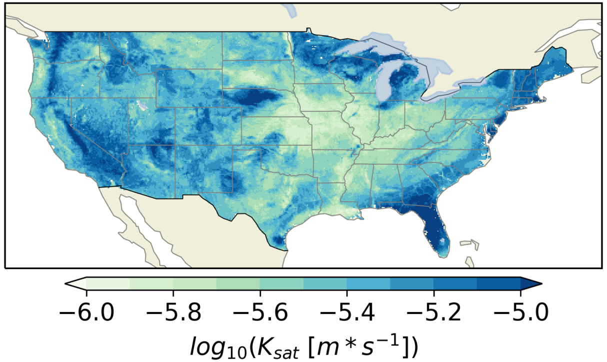
Application with Noah-MP

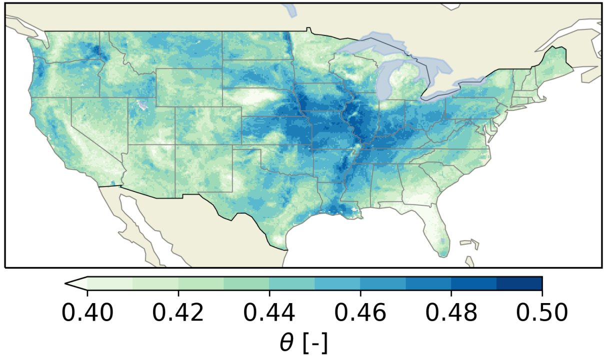


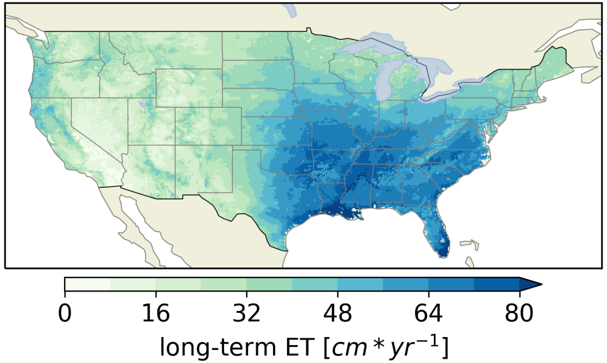


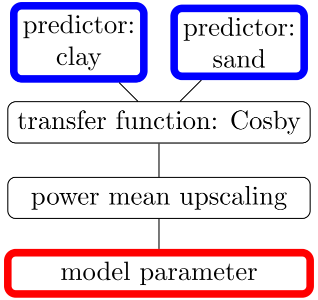
Hengl, 2017 (PLoS One) Cosby, 1984 (WRR)

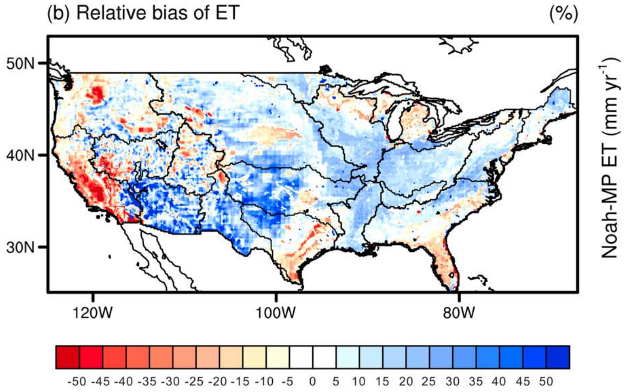
Application with Noah-MP



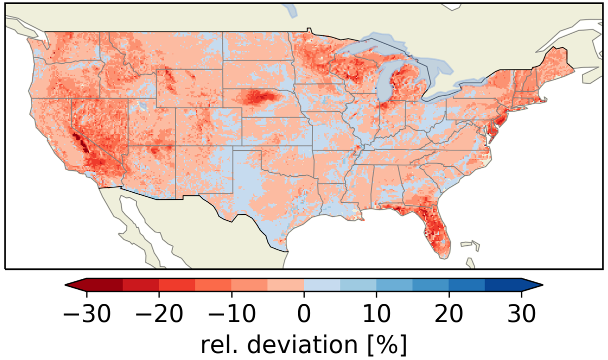








Ma, 2017 (JGRA)



Hengl, 2017 (PLoS One) Cosby, 1984 (WRR)

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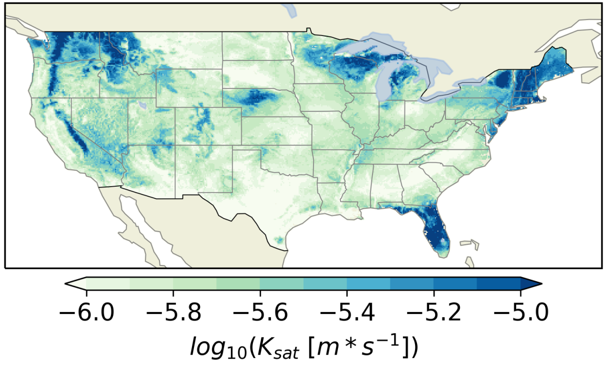
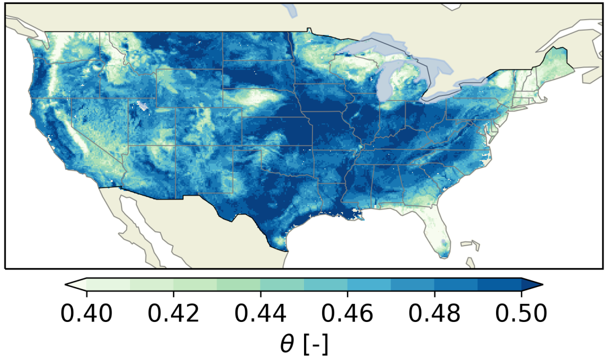
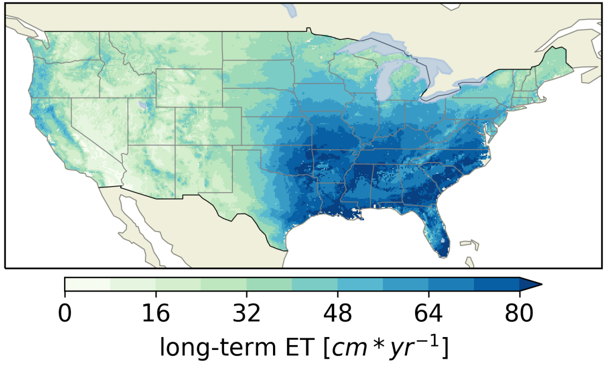
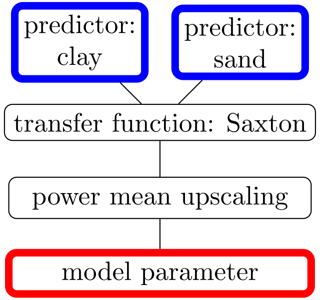
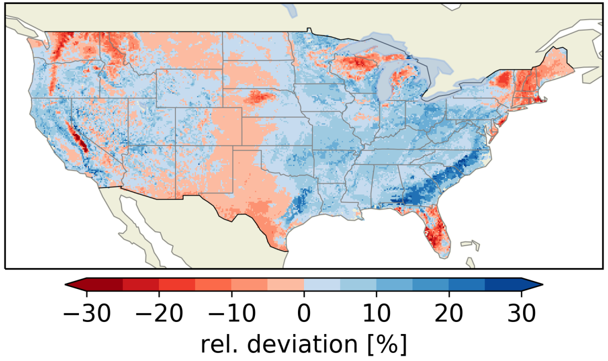
Application with Noah-MP











Hengl, 2017 (PLoS One) Saxton, 1986 (SSSAJ)

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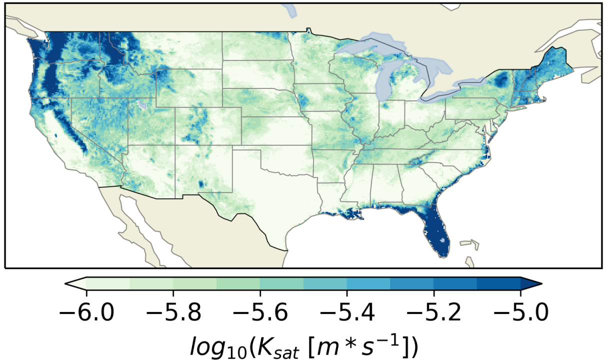
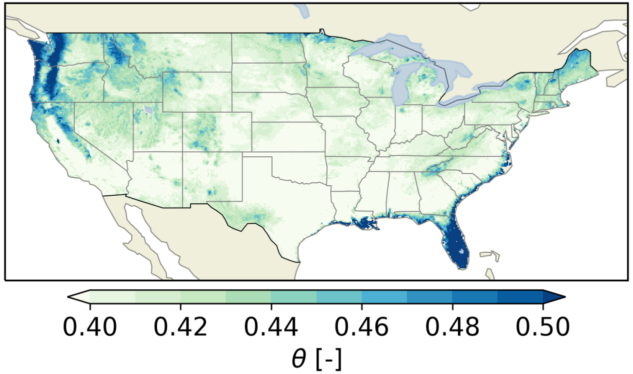
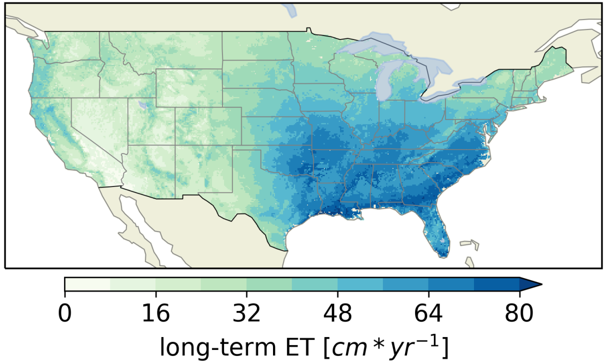
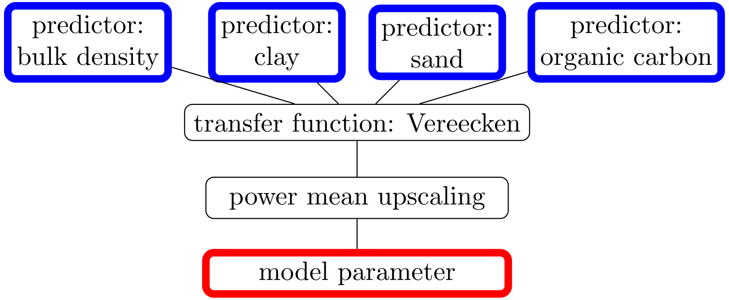
Application with Noah-MP

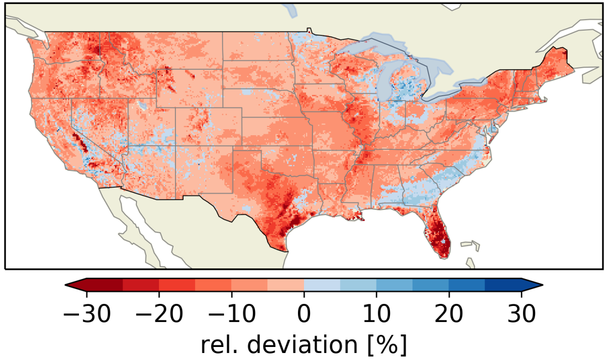








Variable	2000–50 sand	50–2 silt	Carbon content, %	Bulk density, g cm^{-3}
Maximum value	97.80	80.70	6.60	1.230
Minimum value	5.60	0.00	0.01	1.040



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Hengl, 2017 (PLoS One) Vereecken, 1989 & 1990 (SS)

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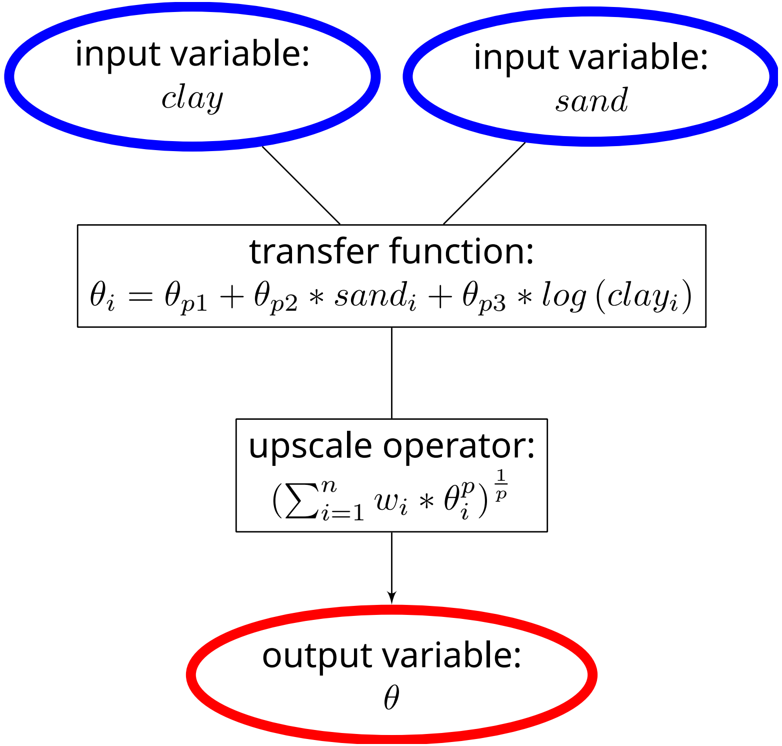
MPR configuration is simple



what you want…

```
&mainconfig
out_filename = "MyParams.nc"
dim_name_alias(:,1) = “x_in", "x_out"
dim_name_alias(:,2) = “y_in", "y_out"
dim_name_alias(:,3) = “z_in", "z_out"
/

&Data_Arrays
names(1) = "clay"
from_file(1) = "PathTo/MyNetcdfFile.nc"
names(2) = "sand"
from_file(2) = "PathTo/MyNetcdfFile.nc"
names(3) = "theta"
transfer_funcs(3) = "theta_p1 + theta_p2 * sand + theta_p3 *
log(clay)”
from_data_arrays(1:2,3) = "sand", "clay"
target_dim_names(1:3,3) = "z_out", "y_out", "x_out"
upscale_ops(1:3,4) = "1.0", "1.0", "1.0"
/

&Dimensions
dim_names(1:3) = "x_out", "y_out", "z_out"
dim_reference(1:3) = "center", "center", "end"
dim_step(1:2) = 0.125, 0.125
dim_bound(3) = 0.0
dim_vector(:,3) = 0.1, 0.4, 1.0, 2.0
/

&Parameters
parameter_names(1:3) = "theta_p1", "theta_p2", "theta_p3"
parameter_values(1:3) = 0.505, -0.00142, -0.00037
/
```

what you type…

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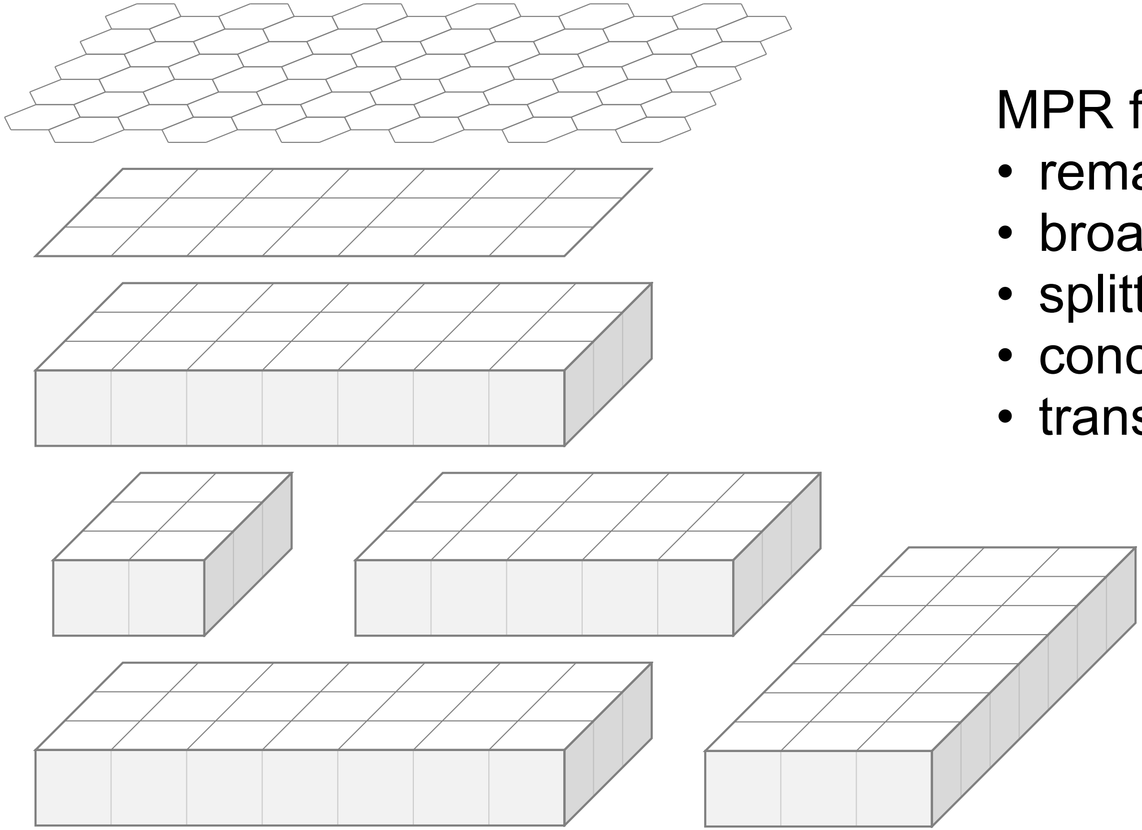
MPR configuration is flexible



MPR features dimension:

- remapping of irregular shapes
- broadcasting
- splitting
- concatenation
- transposing

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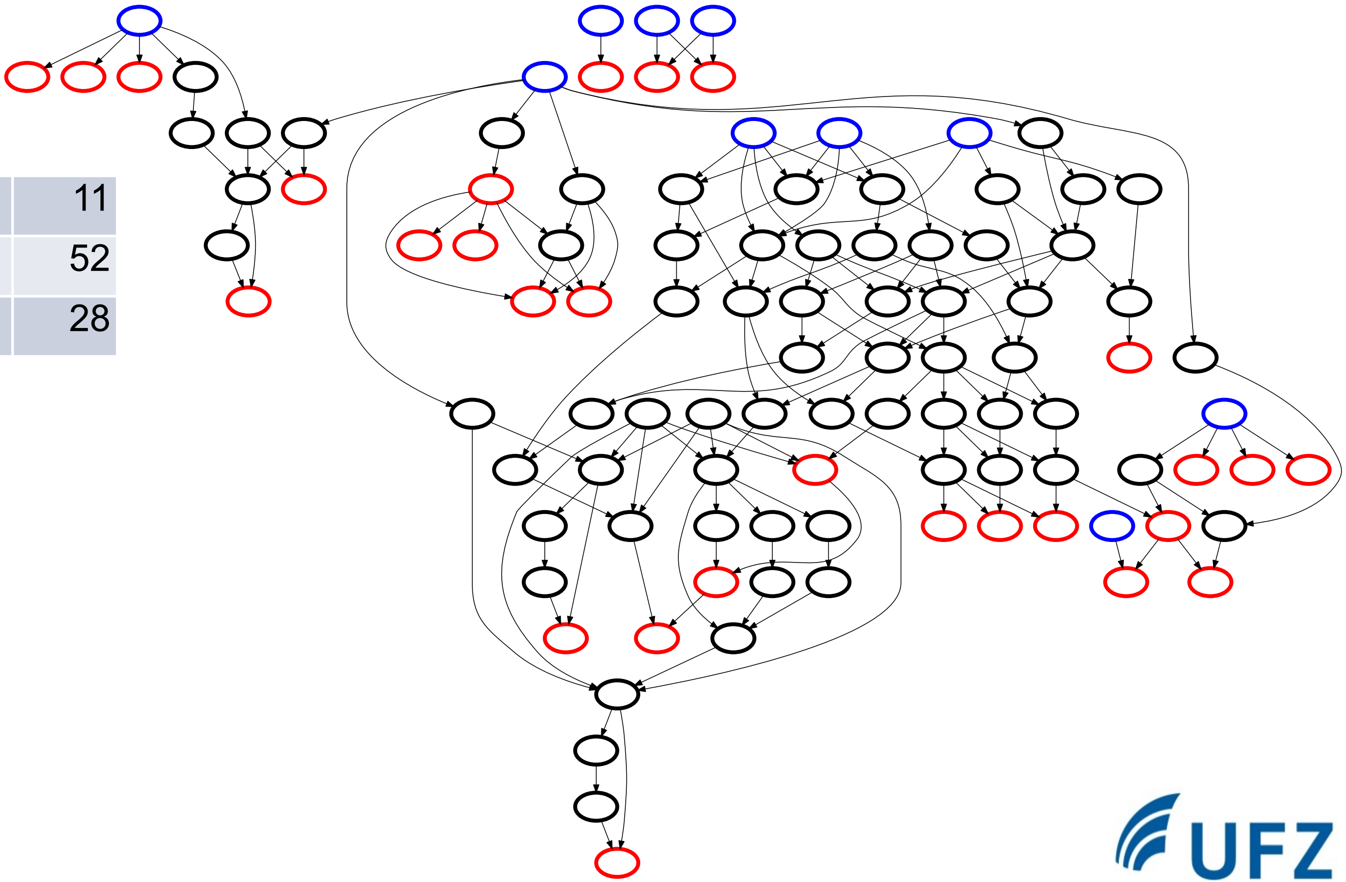
MPR configuration is modular

predictor variables	11
global parameters	52
model parameters	28



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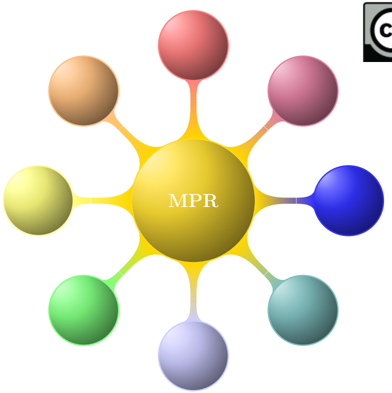
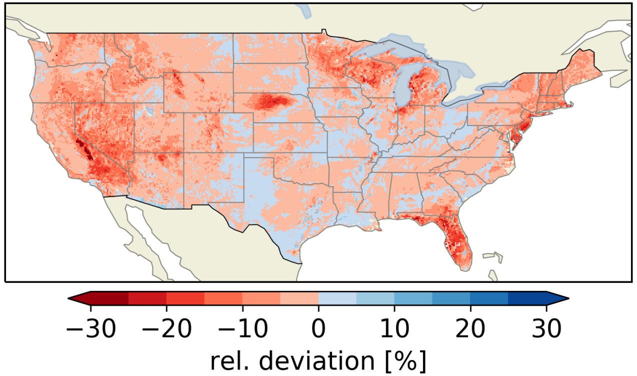
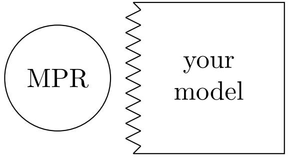
Summary

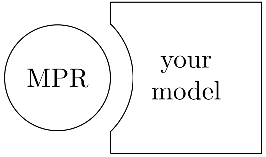
- MPR uses transfer functions and upscaling operators to estimate model parameters from high-resolution data
- Simple, flexible, modular setup, can be coupled to any model
- MPR reveals uncertainty in transfer functions and aggregation methods
- Code development on git.ufz.de/CHS/MPR





1st MPR workshop





Thank you!

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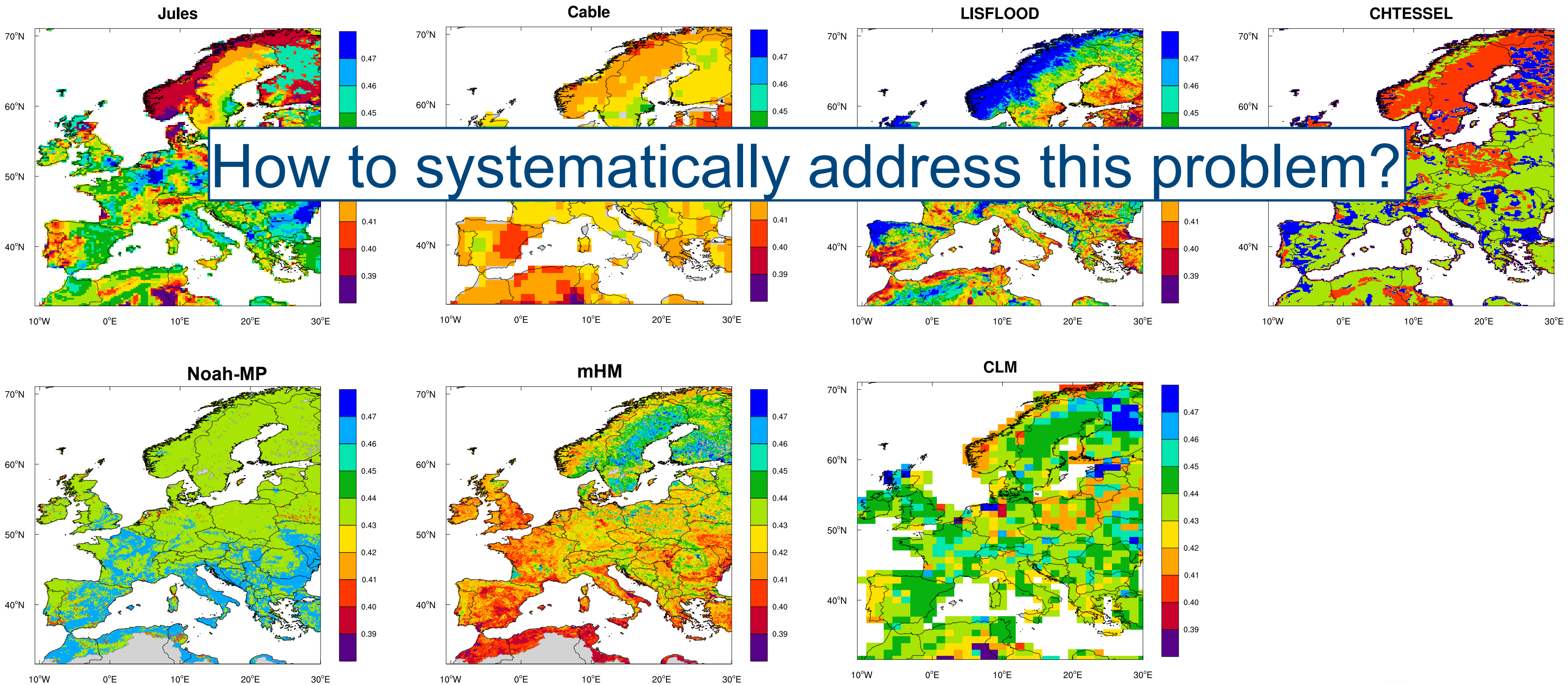
Appendix

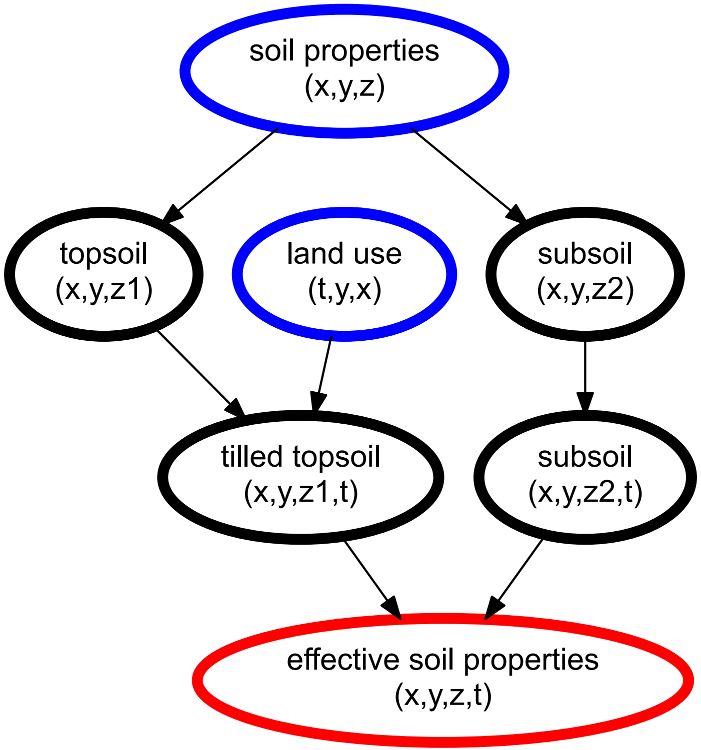
Porosity in different models



How to systematically address this problem?

Samaniego, 2017 (HESS)

MPR configuration is flexible



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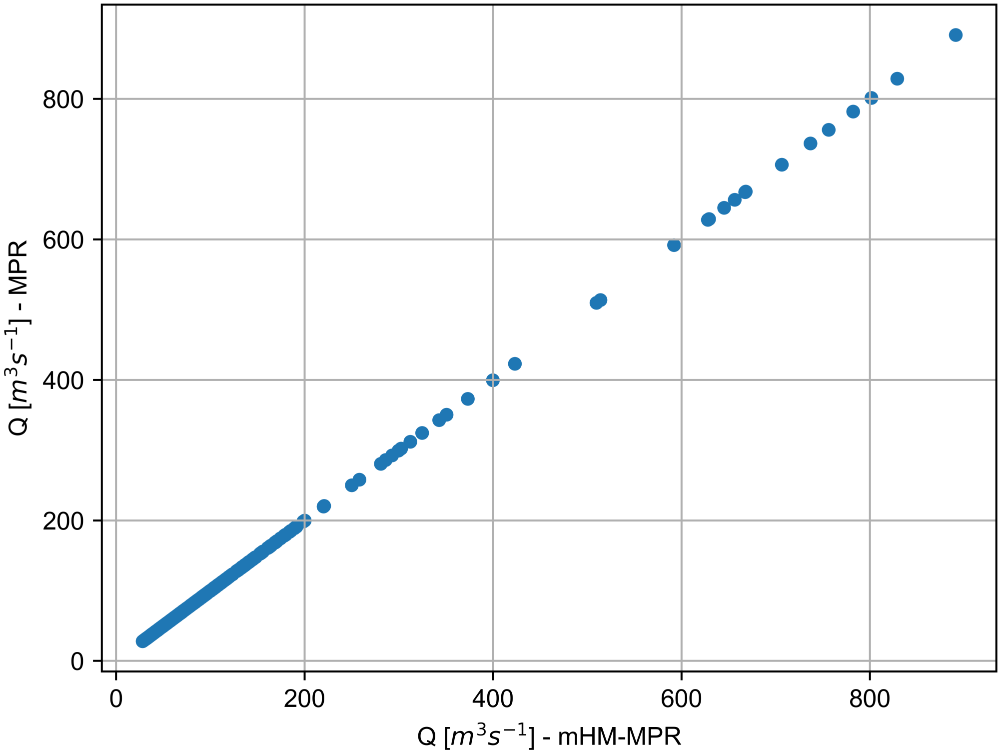
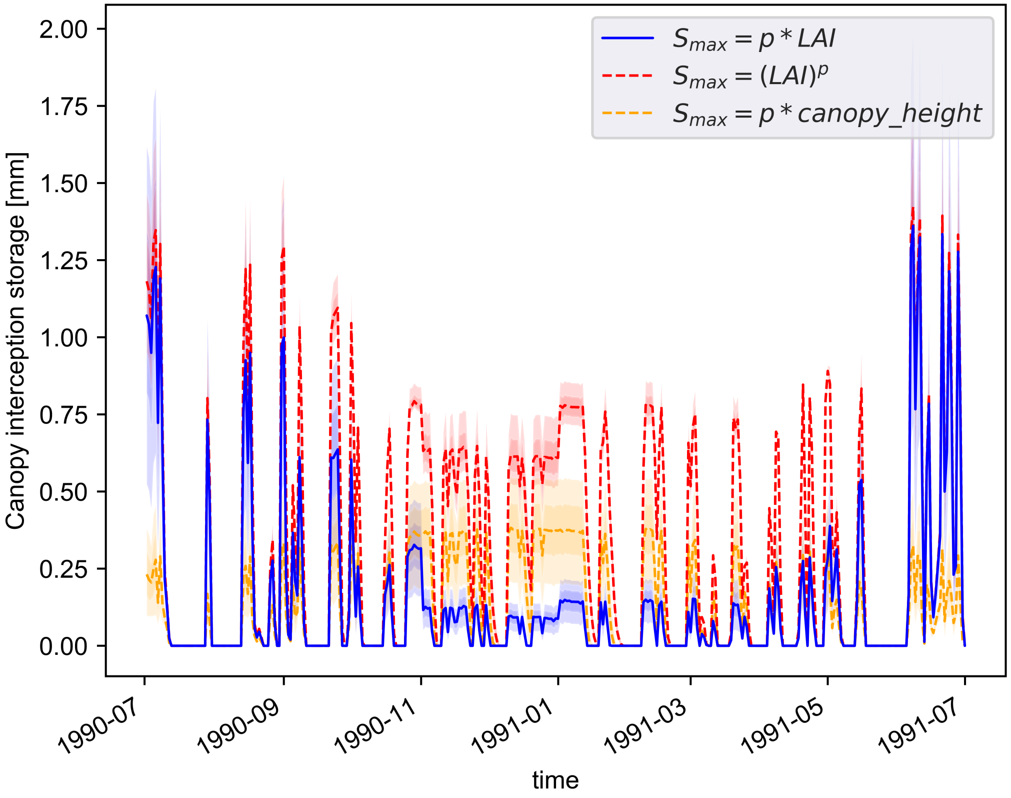
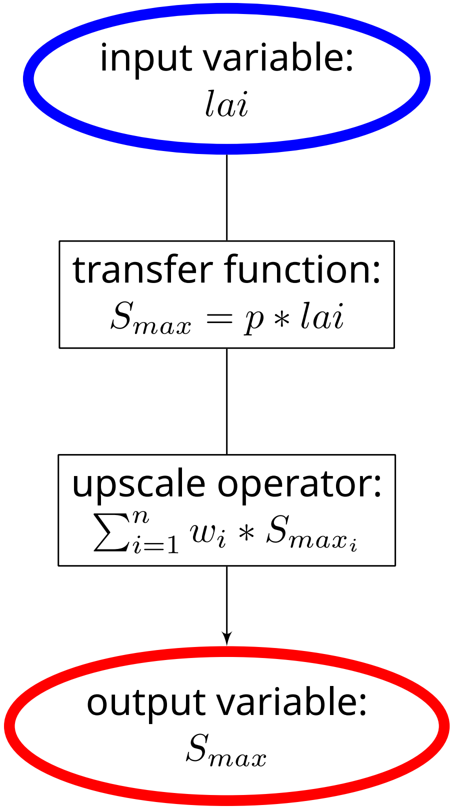
MPR verification

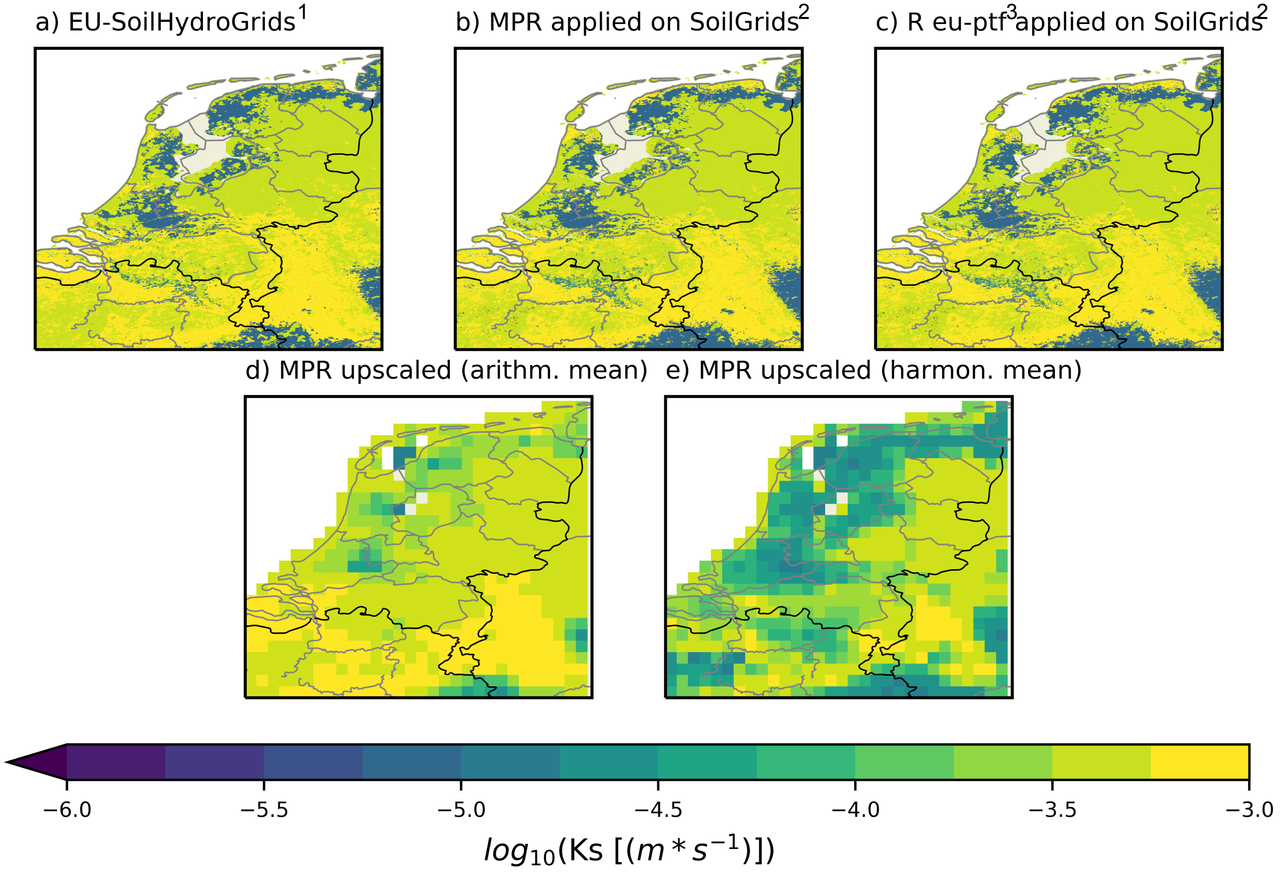


MPR coupling to mHM





How MPR validation with EU-SoilHydroGrids



[1] Tóth et al., 2017 (HP) [2] Hengl et al., 2017 (PLOS) [3] Weynants & Tóth, 2014

Questions

- Regionalization approach classes are defined as (Beck, 2016 (WRR)):
    - (i), catchment-by-catchment calibration followed by regression;
    - (ii), simultaneous calibration and regression;
    - (iii), geographic proximity;
    - (iv), physiographic and/or climatic similarity;
    - (v), regional calibration; and
    - (vi), Q signatures.

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