

European High-Resolution Soil Moisture Analysis

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Bernhard Bauer-Marschallinger²,
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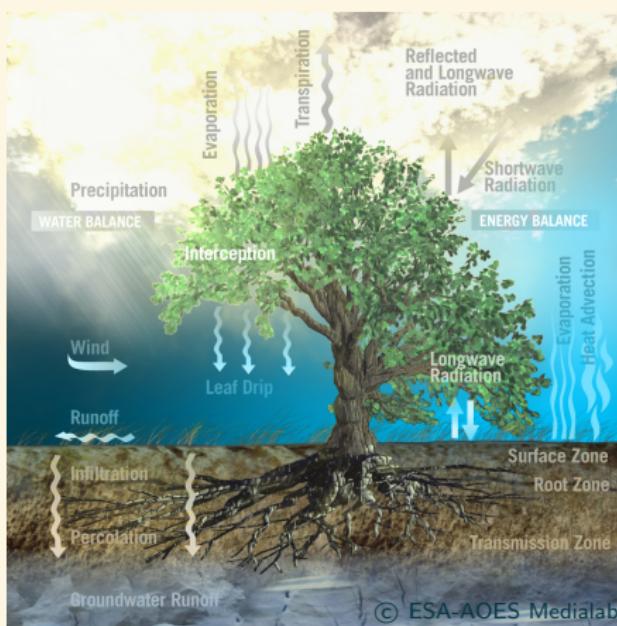
¹Zentralanstalt für Meteorologie und Geodynamik; Vienna, Austria

²Department of Geodesy and Geoinformation, TU Wien; Vienna, Austria

³Department of Earth and Environmental Sciences, KU Leuven; Belgium

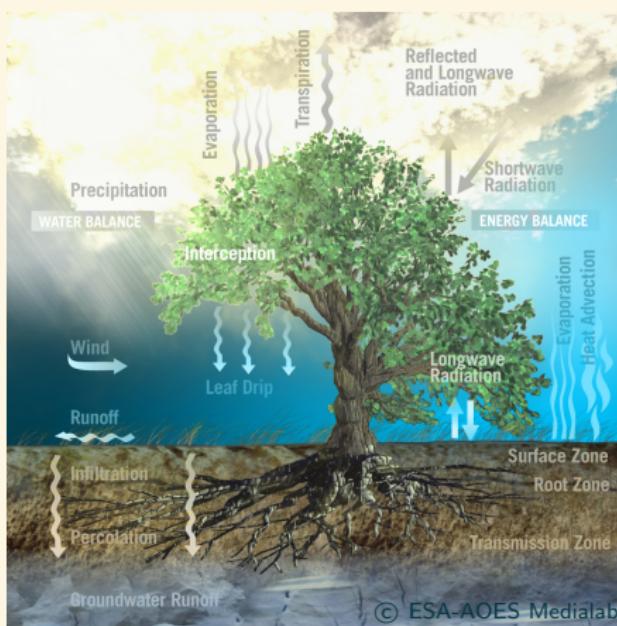
Overview

- High-resolution soil moisture observations + surface model
⇒ European soil moisture product



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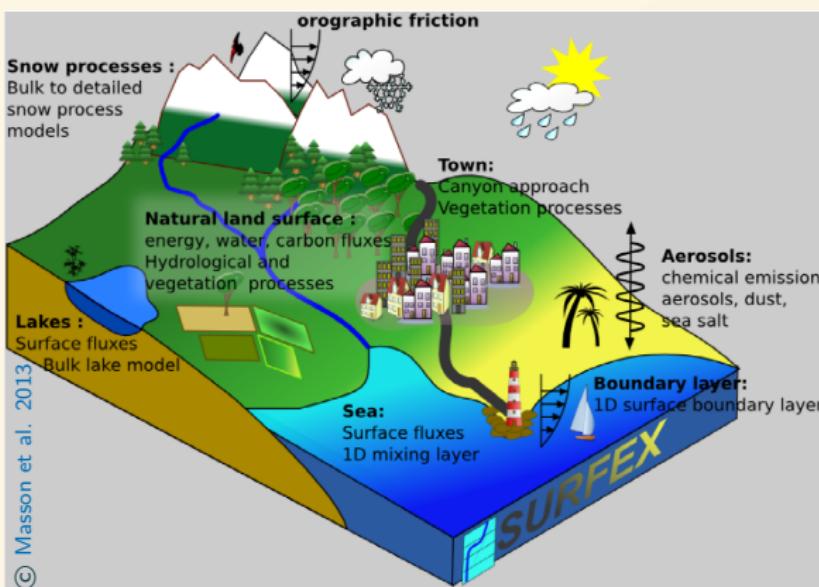


- ▷ Observations & observation error
- ▷ Benefit of higher grid sampling
- ▷ Direct & indirect soil moisture verification

Data assimilation with SURFEX

SURFEX Offline Data Assimilation (SODA)

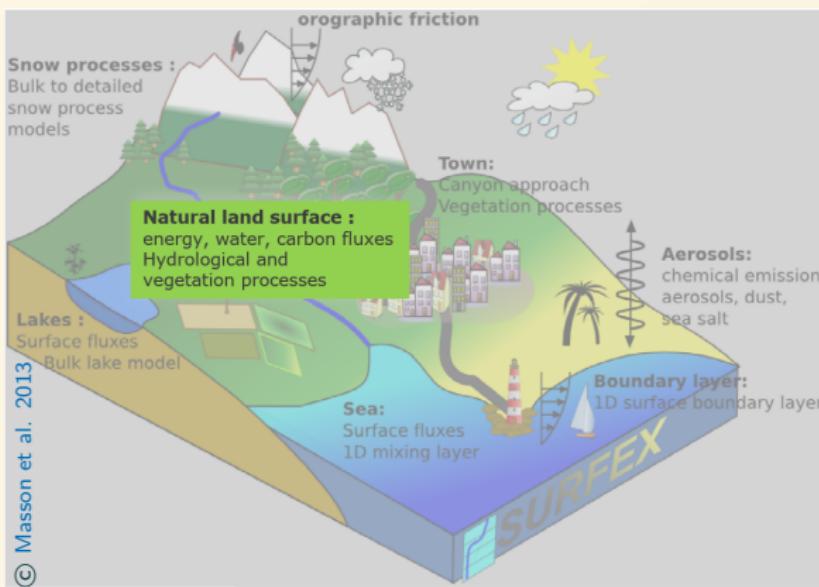
- ▷ simplified Extended Kalman Filter



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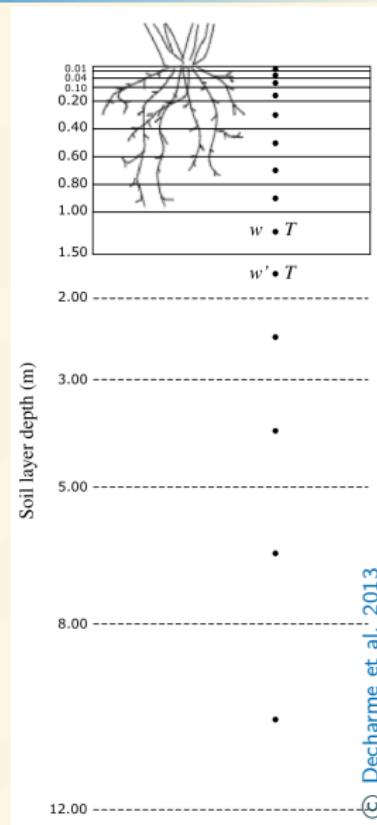
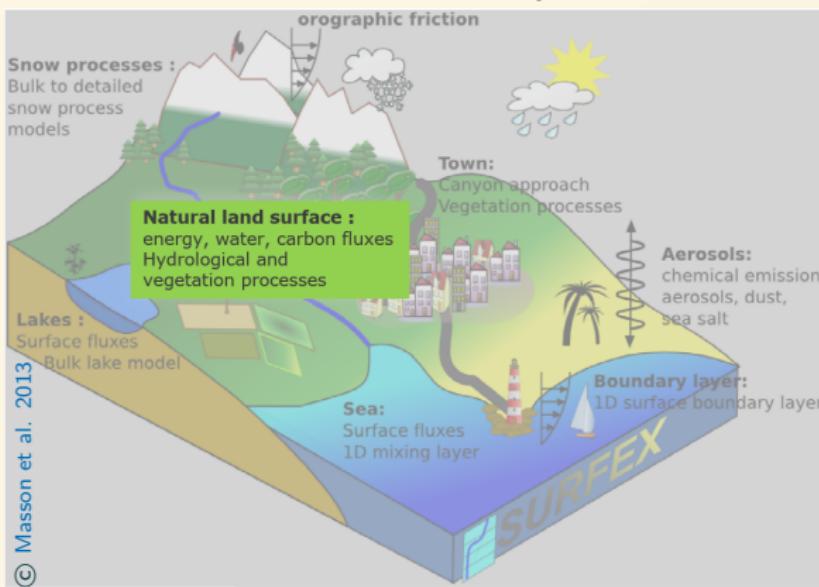
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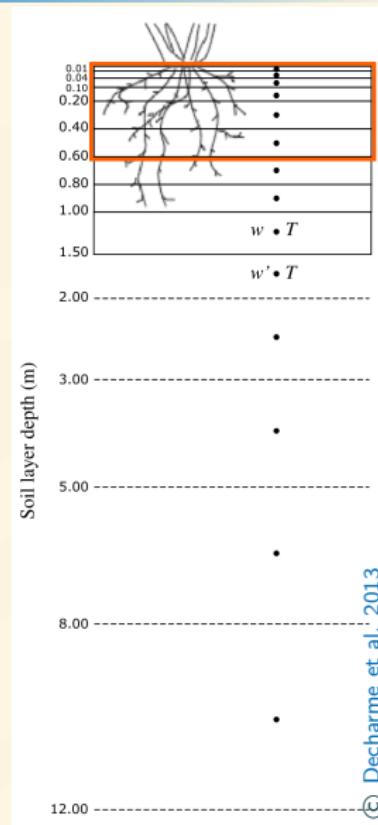
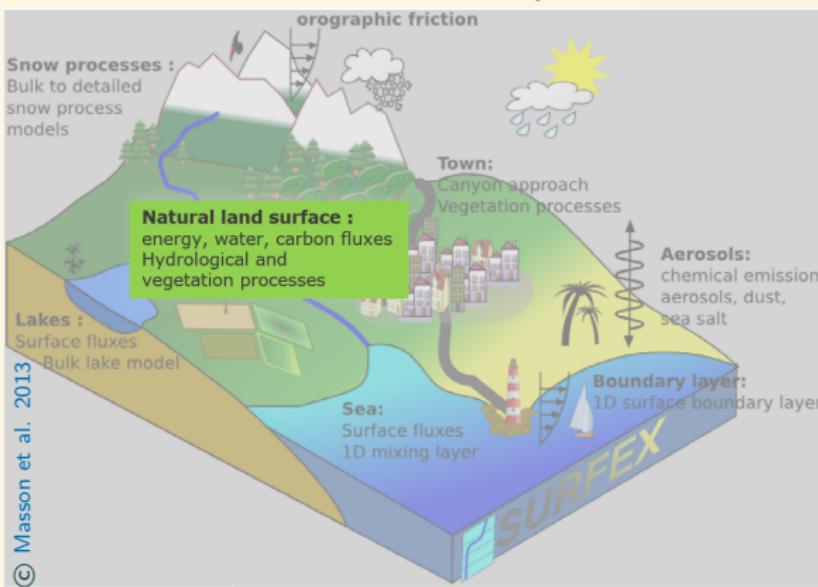
- ▷ simplified Extended Kalman Filter
- ▷ Interaction Soil Biosphere Atmosphere (ISBA): diffusion scheme, 14 soil layers



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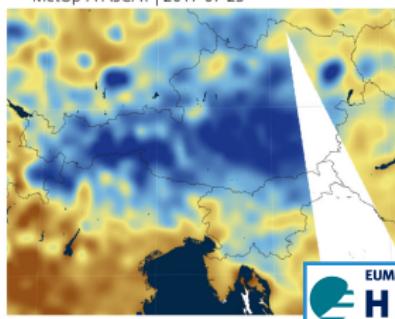
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Observations: SCATSAR-SWI

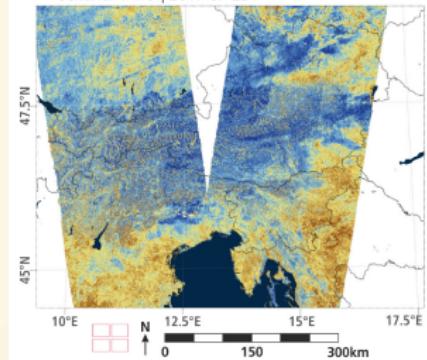
a) 25km ASCAT SSM | Evening Coverage

MetOp-A ASCAT | 2017 07 23



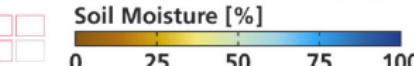
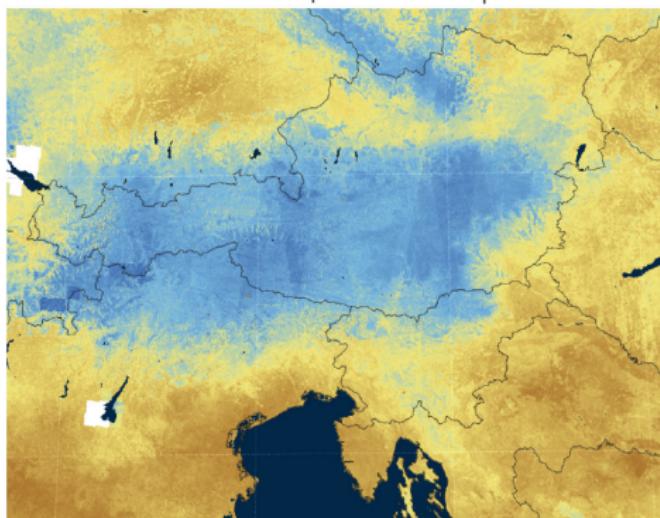
b) 1km Sentinel-1 SSM | Full Day Coverage

Sentinel-1A+B | 2017 07 23



c) 1km SCATSAR-SWI | T=5 | Daily Coverage

Sentinel-1A+B & MetOp-A+B ASCAT | 2017 07 24



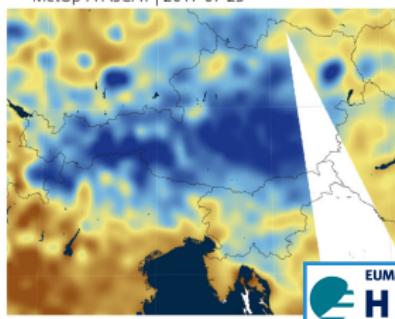
- grid sampling: 1.0 km*
- daily availability
- vertical levels: 8

* provided freely via the Copernicus Global Land Service

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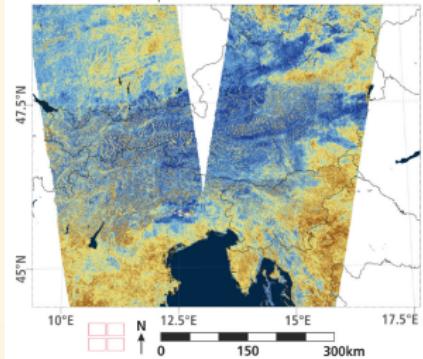
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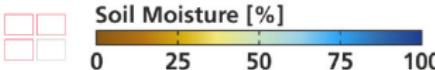
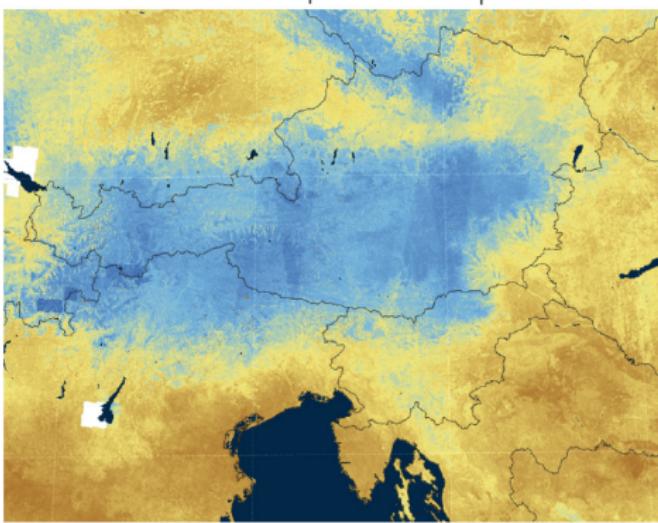
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- grid sampling: $1.0 \text{ km}^* 0.5 \text{ km}^{**}$
- daily availability
- vertical levels: $8 \rightarrow 6$

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** internal

Observation error: Triple Collocation Analysis

- Estimation of error variances σ_ϵ^2 of soil moisture signal Θ_{true}

$$\Theta_{\text{obs}} = \alpha + \beta\Theta_{\text{true}} + \epsilon$$
$$\Rightarrow \sigma_\epsilon^2$$

⇒ Kalman gain:

$$\mathbf{K} = \mathbf{B}\mathbf{H}^T(\mathbf{H}\mathbf{B}\mathbf{H}^T + \mathbf{R})^{-1}$$

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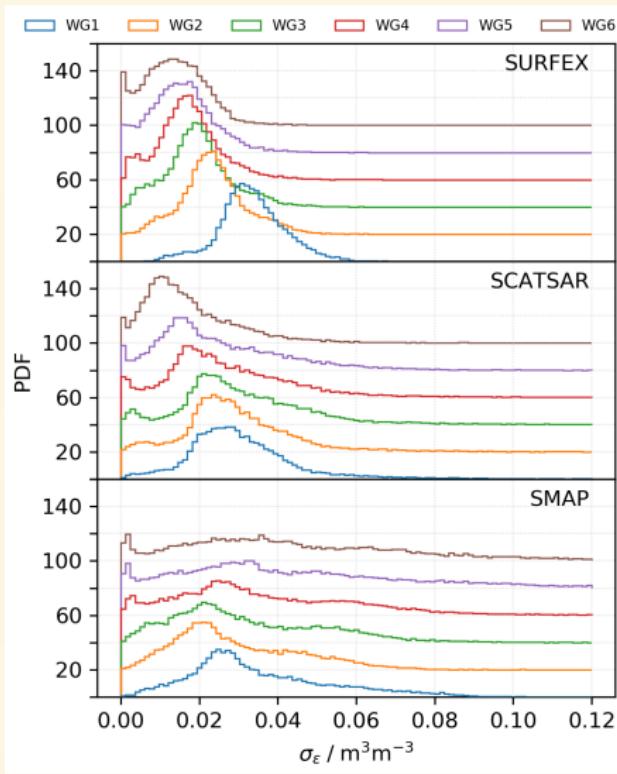
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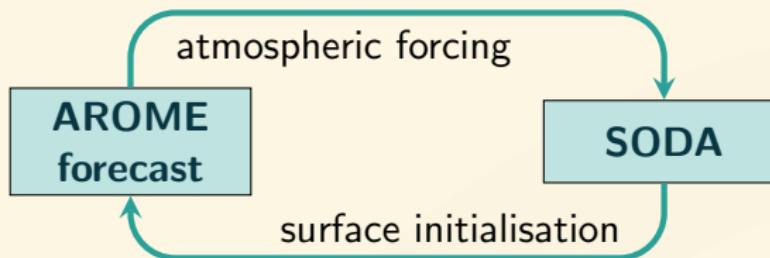
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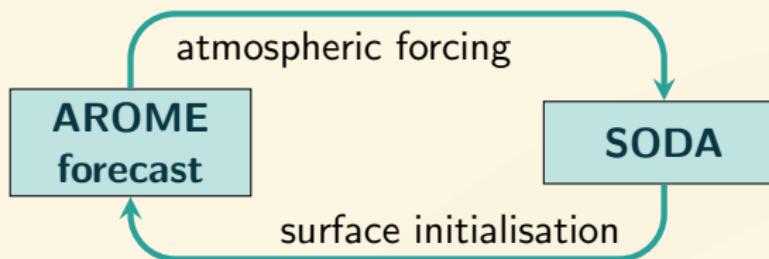
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The data assimilation system

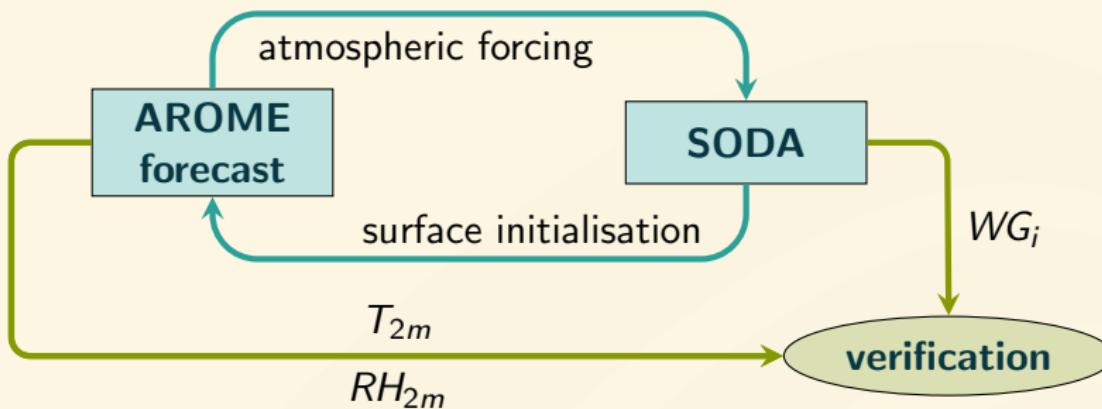


The data assimilation system



- Austrian domain
- April to September / June 2018

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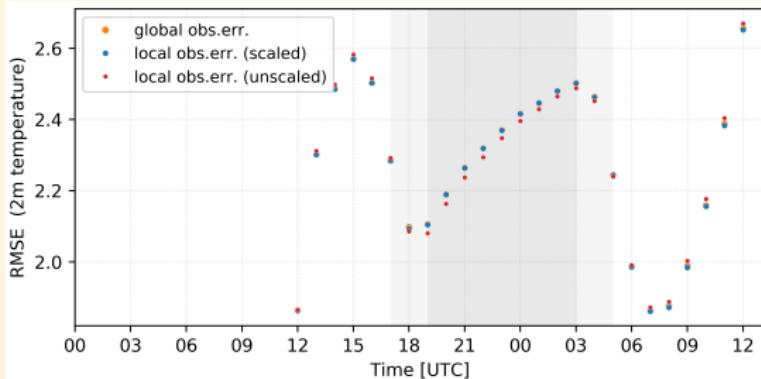


- Austrian domain
- April to September / June 2018
 - Global vs. local observation error
 - 2.5 km vs. 1.25 km

Global vs. local obs. error

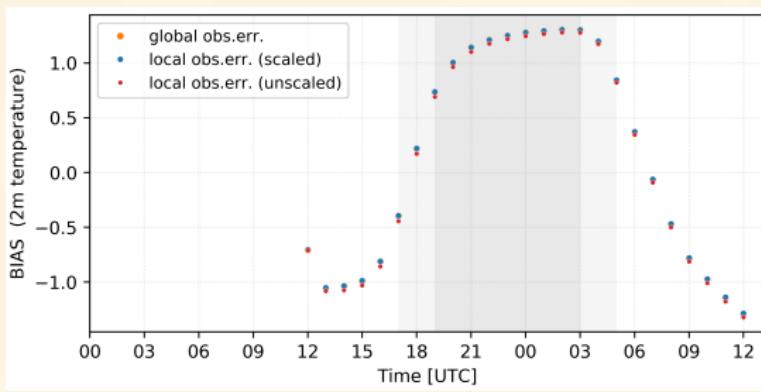
scaled:

- ▷ In average same magnitude as global σ_ϵ
- ▷ To test for dependence on spatial error distribution



unscaled:

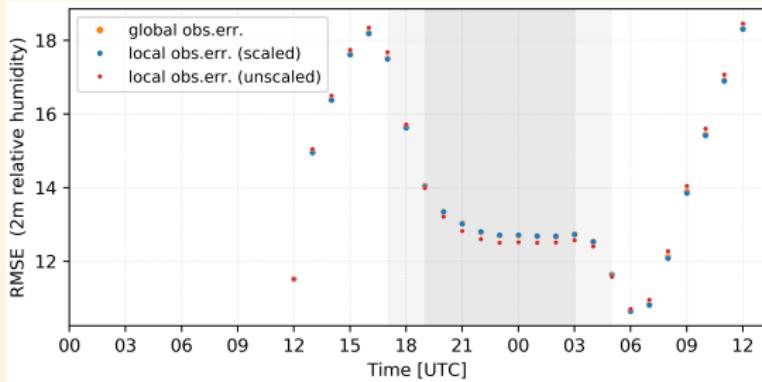
- ▷ ≈ 3 time smaller than global σ_ϵ
- ▷ Forecast more humid & colder



Global vs. local obs. error

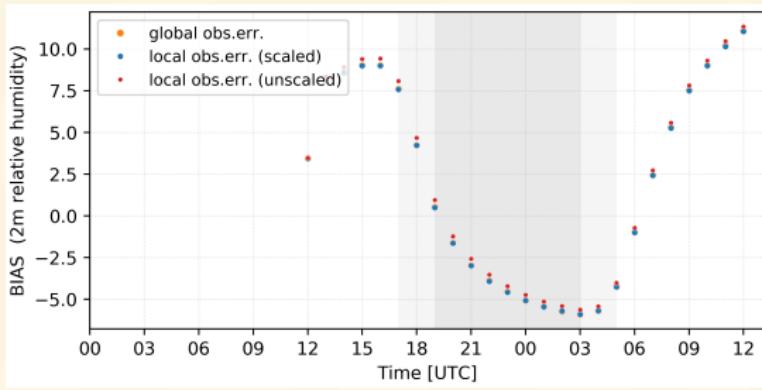
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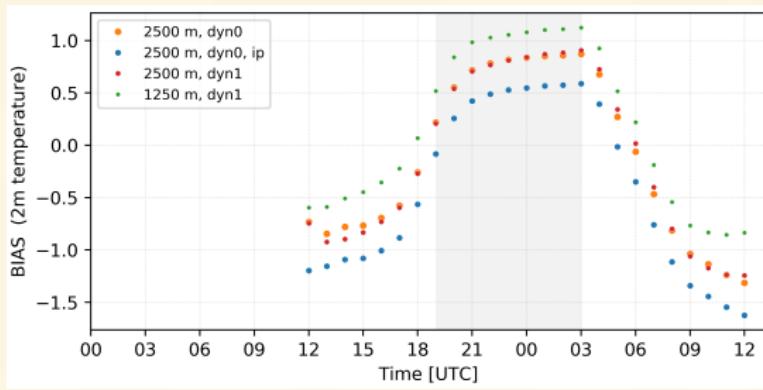
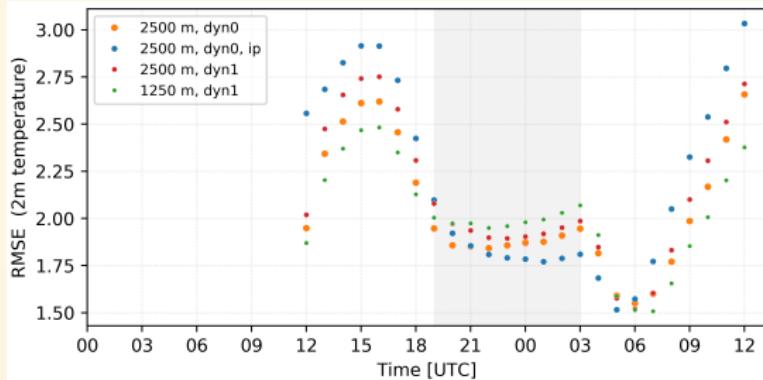
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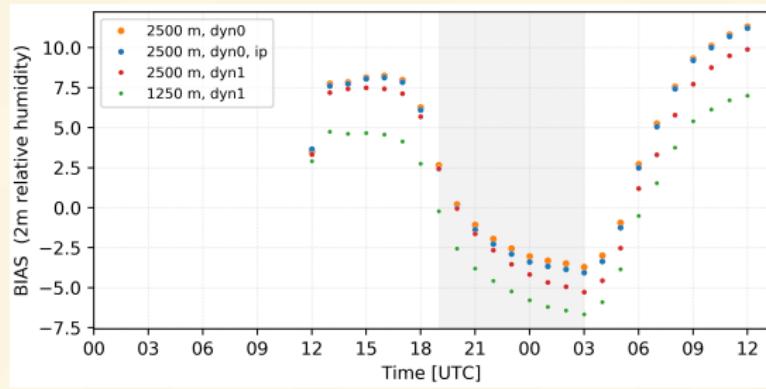
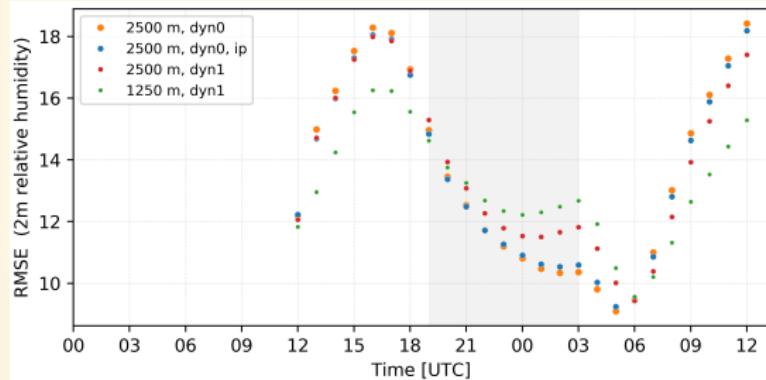
2.5 km vs. 1.25 km

- DA impact larger than mere interpolation
- Night time degradation due to model dynamics



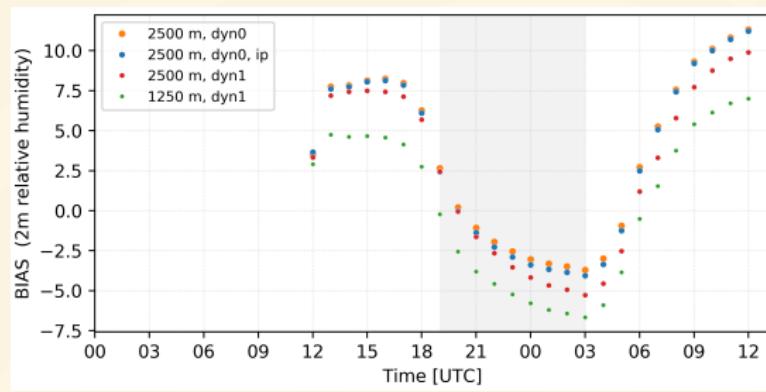
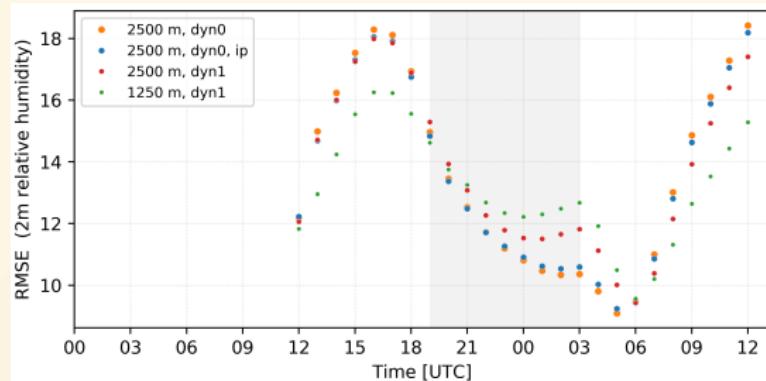
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2.5 km vs. 1.25 km

- DA impact larger than mere interpolation
- Night time degradation due to model dynamics
- Forecast dryer & warmer
- Improvement for day time
- In average: improvement for RH_{2m} (neutral for T_{2m})



Water balance

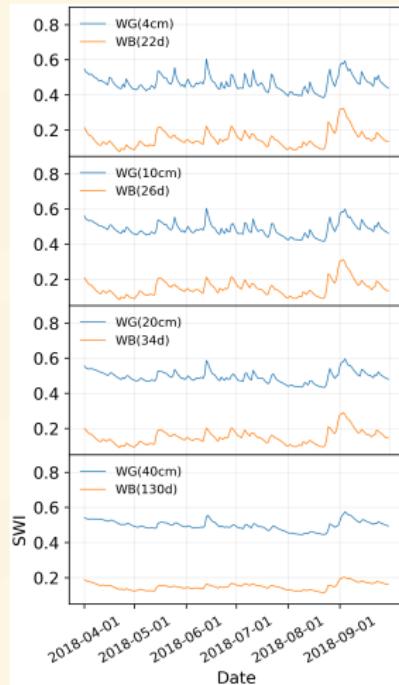
match

- $WB \approx RR - ET(T)$
- Temporal averaging: exponential

Water balance

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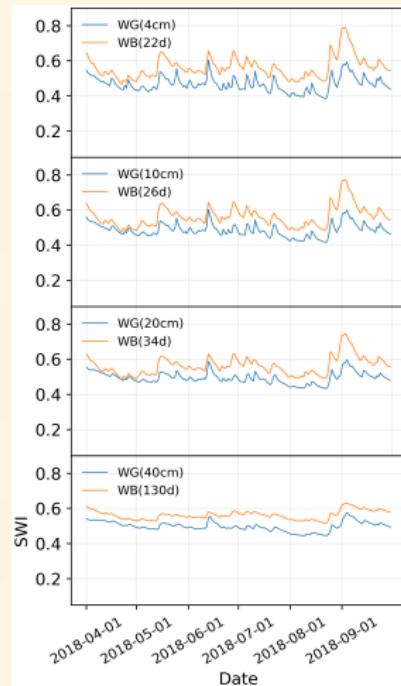
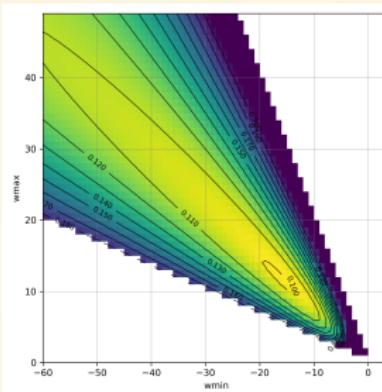
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- Compute $SWI \approx \frac{wb - wb_{min}}{wb_{max} - wb_{min}}$
- Test minimum/maximum values



Water balance

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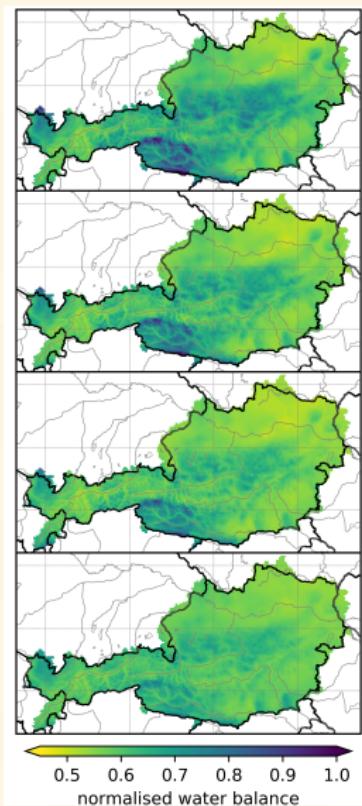
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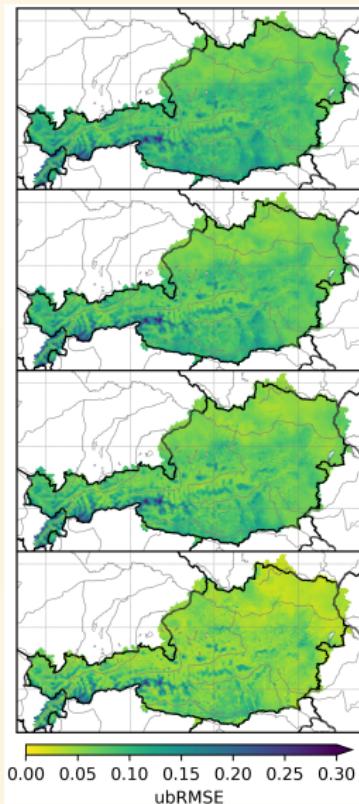
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verify

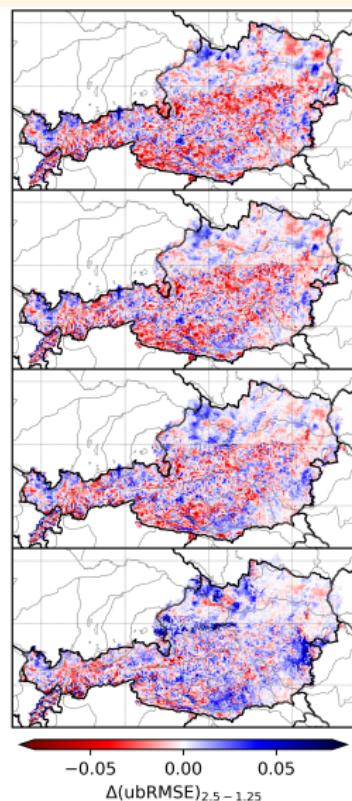
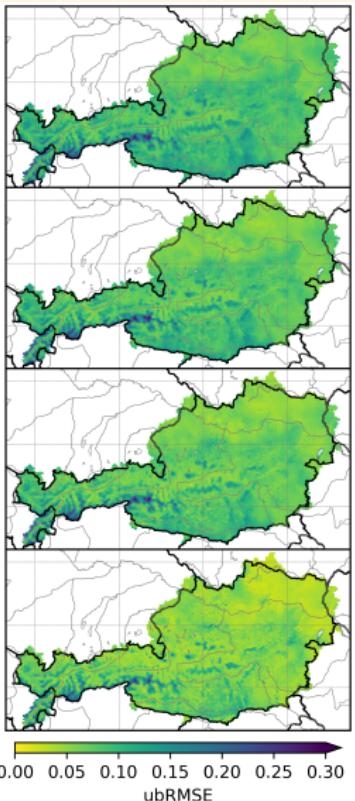
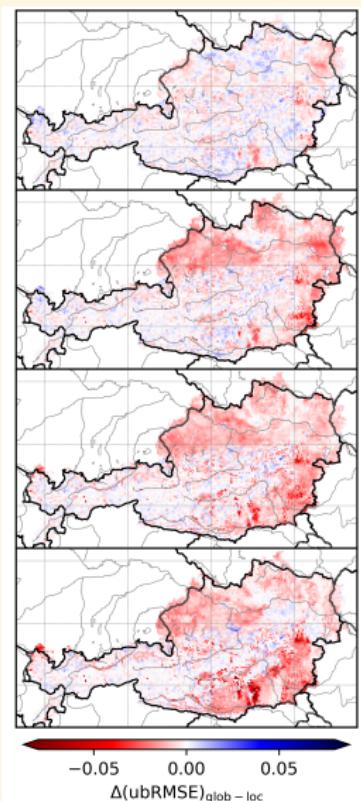
- Use findings for comparison with soil moisture analysis



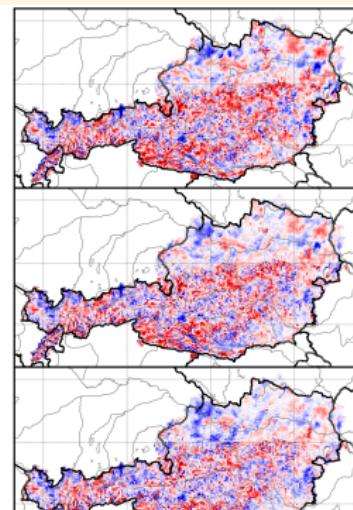
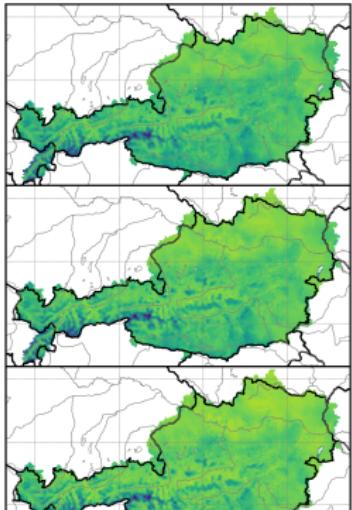
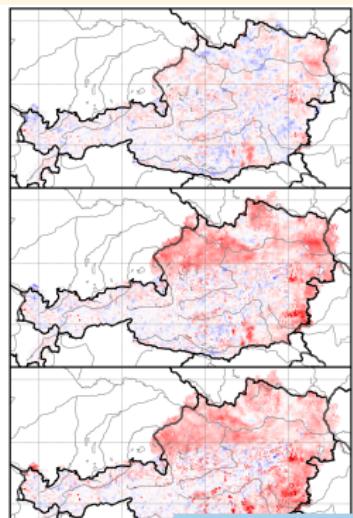
Verification of soil moisture analysis against water balance



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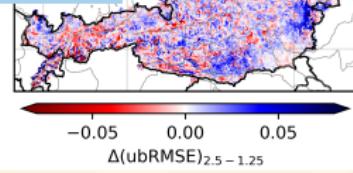
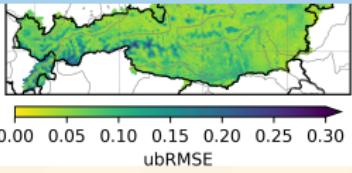
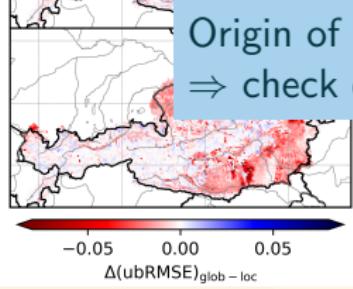


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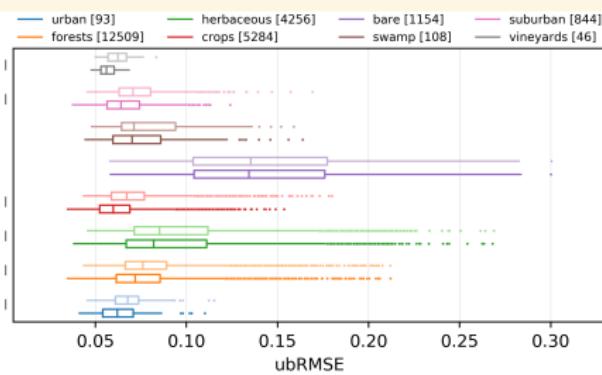
Origin of pattern?

→ check dependencies on physiographic variables



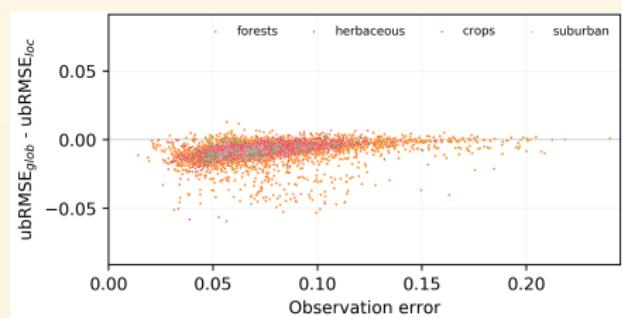
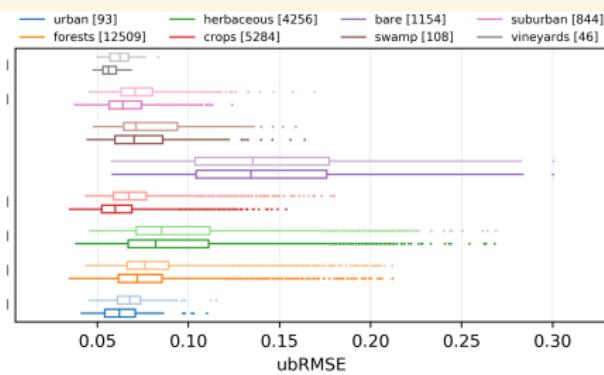
Global vs. local observation error

- local error degrades ubRMSE especially for small error values



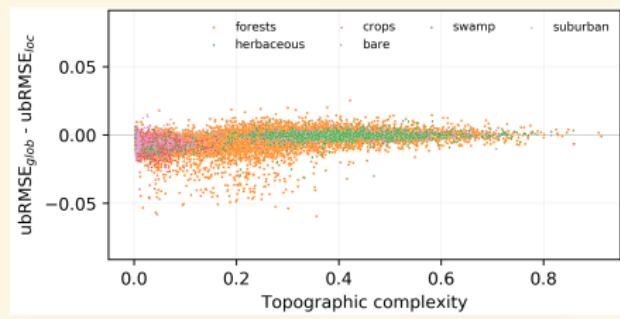
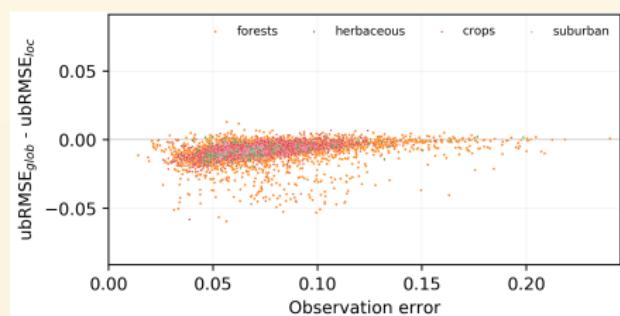
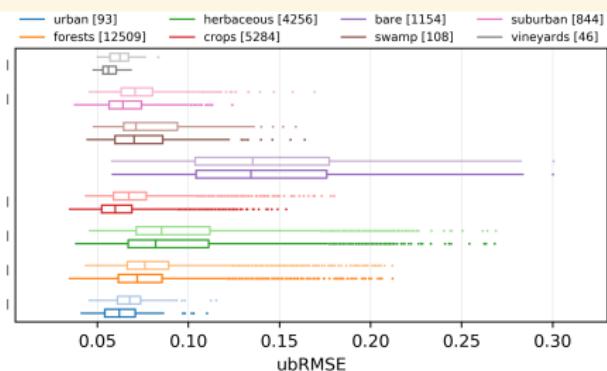
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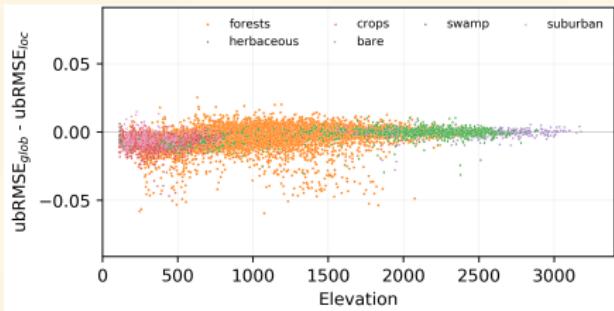
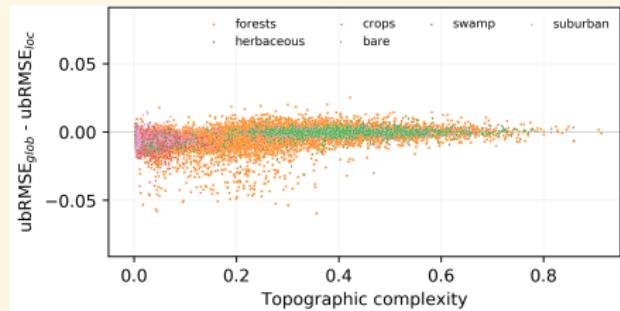
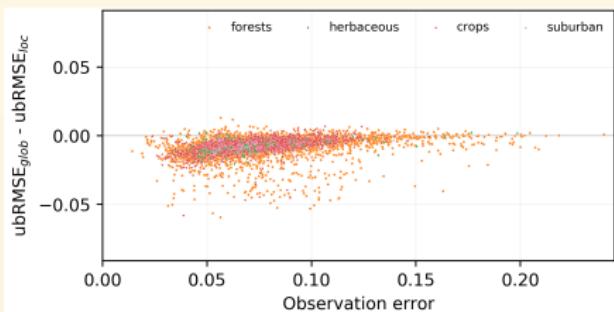
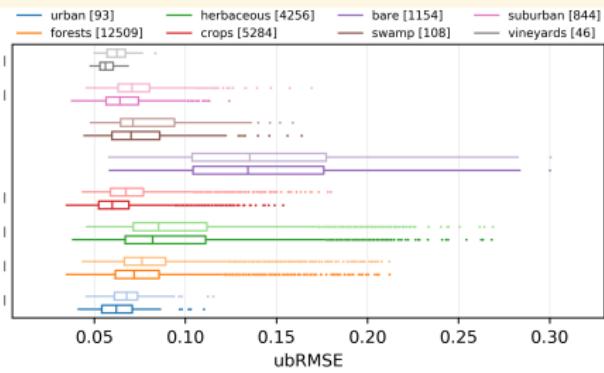
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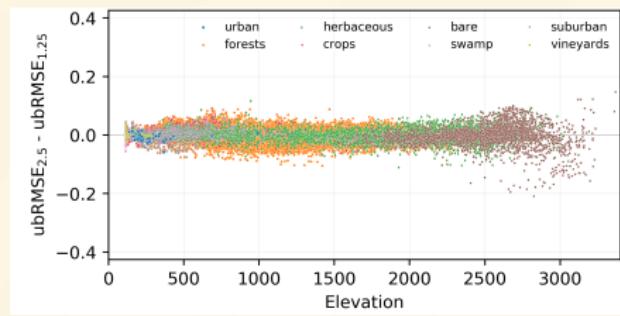
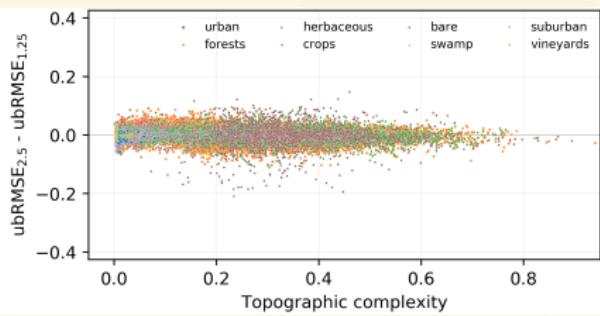
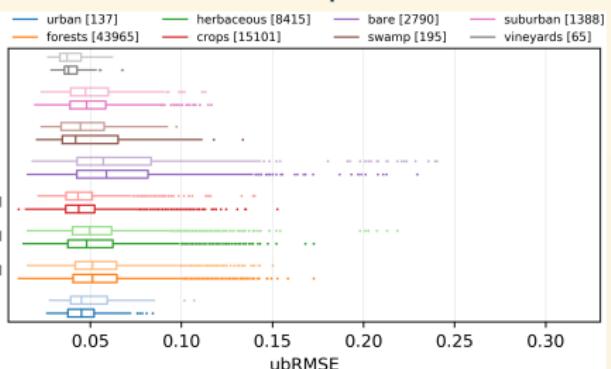
Global vs. local observation error

- local error degrades ubRMSE especially for small error values
- slight degradation for low elevations



2.5 km vs. 1.25 km

- 1.25 km confines ubRMSE distribution for some covers
- no other dependencies found



Summary & Outlook

- Local observation error obtained with Triple Collocation Analysis
 - ▷ 2 m values: slight degradation
 - ▷ Water balance: degradation especially for small errors
- Increased grid sampling to 1.25 km
 - ▷ 2 m values: day time performance improved, especially RH_{2m}
 - ▷ Water balance: slightly land-cover dependent

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 - ▷ 2 m values: slight degradation
 - ▷ Water balance: degradation especially for small errors
- Increased grid sampling to 1.25 km
 - ▷ 2 m values: day time performance improved, especially RH_{2m}
 - ▷ Water balance: slightly land-cover dependent
 - ▶ Further increase of grid sampling
 - ▶ Test computations on European domain
 - ▶ Publication in preparation