Assimilation of the SCATSAR-SWI with SURFEX: Resolution studies over Austria*

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*Research project EHRSOMA funded by a EUMETSAT fellowship

ZAMG Zentralanstalt für Meteorologie und Geodynamik

TU WIEN

Satellite inspired hydrology in an uncertain future
Reading, 27.11.2019

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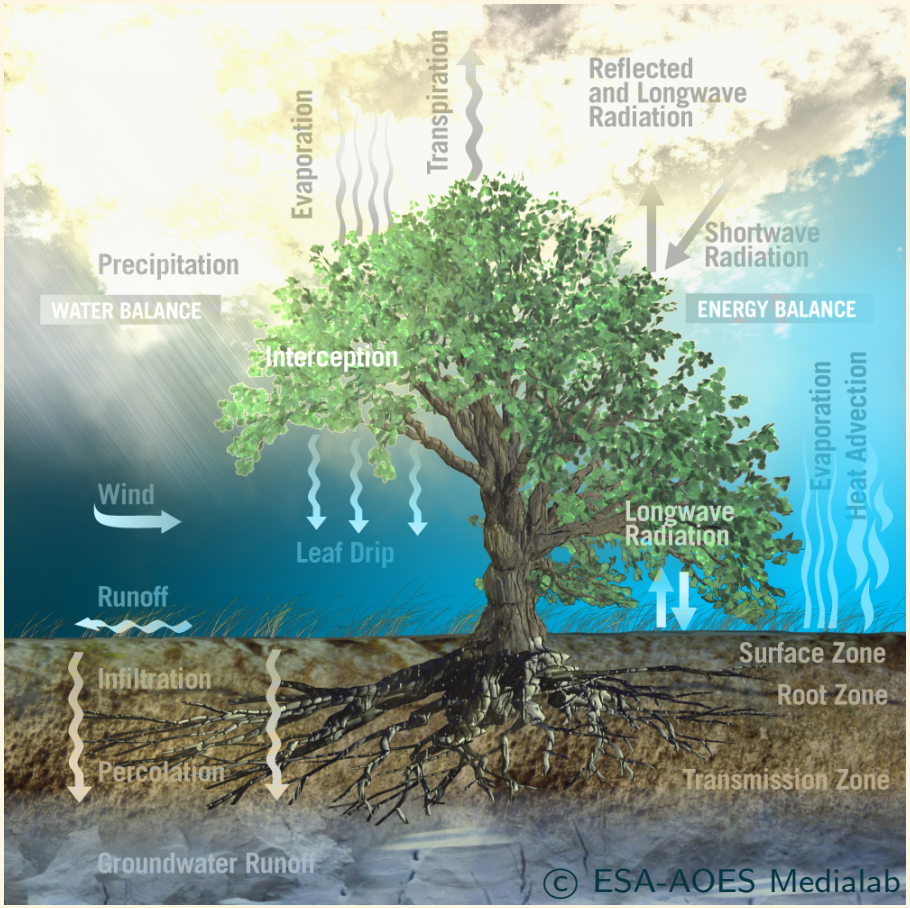
Motivation

Soil moisture assimilation can improve NWP...

... under the right circumstances



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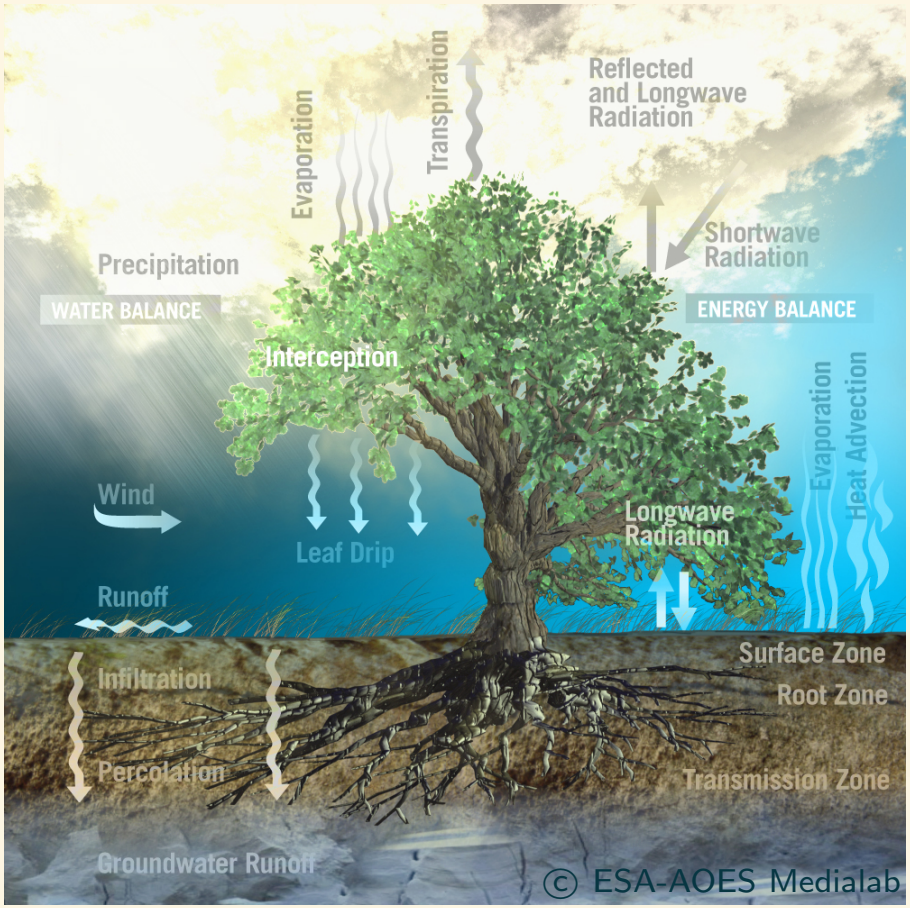
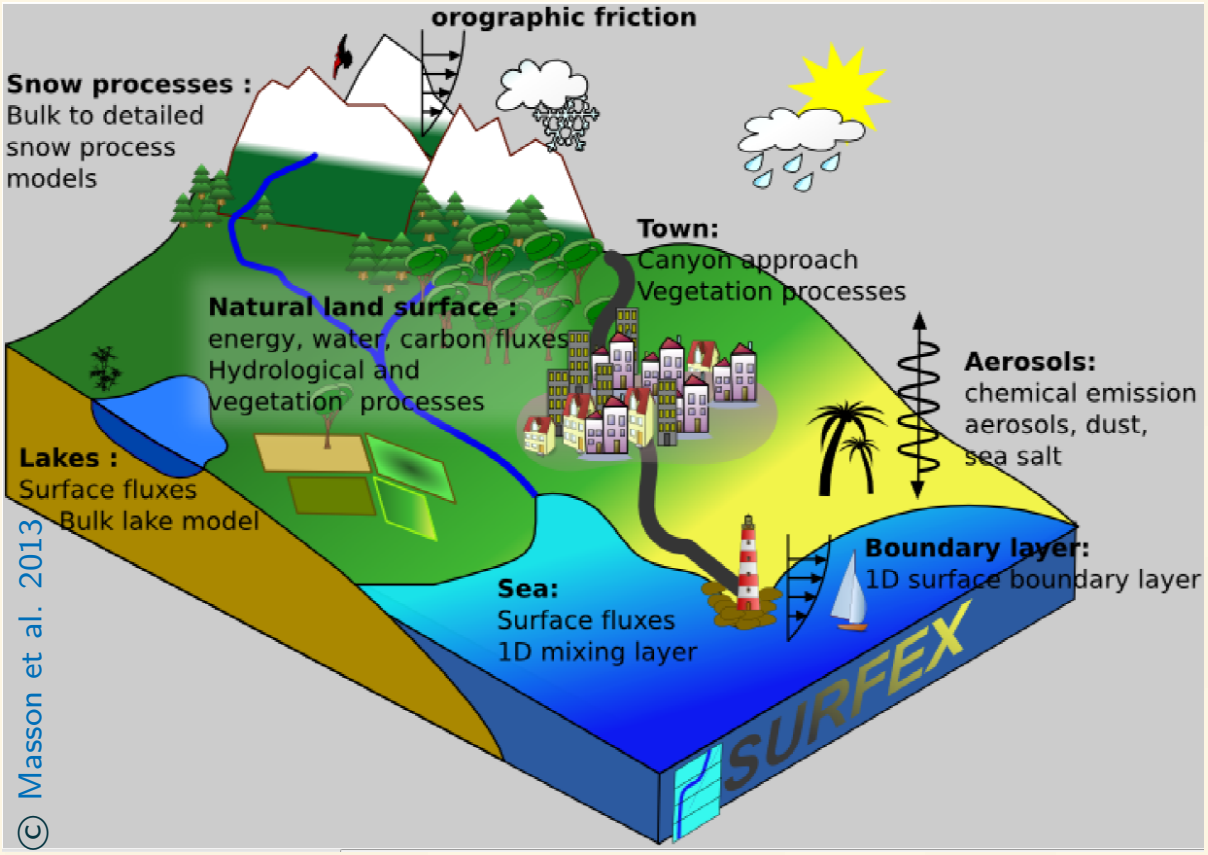


- optimise use of observations & observation error
- evaluate benefit of higher resolution

Data assimilation with SURFEX

SURFEX Offline Data Assimilation (SODA)

- simplified Extended Kalman Filter



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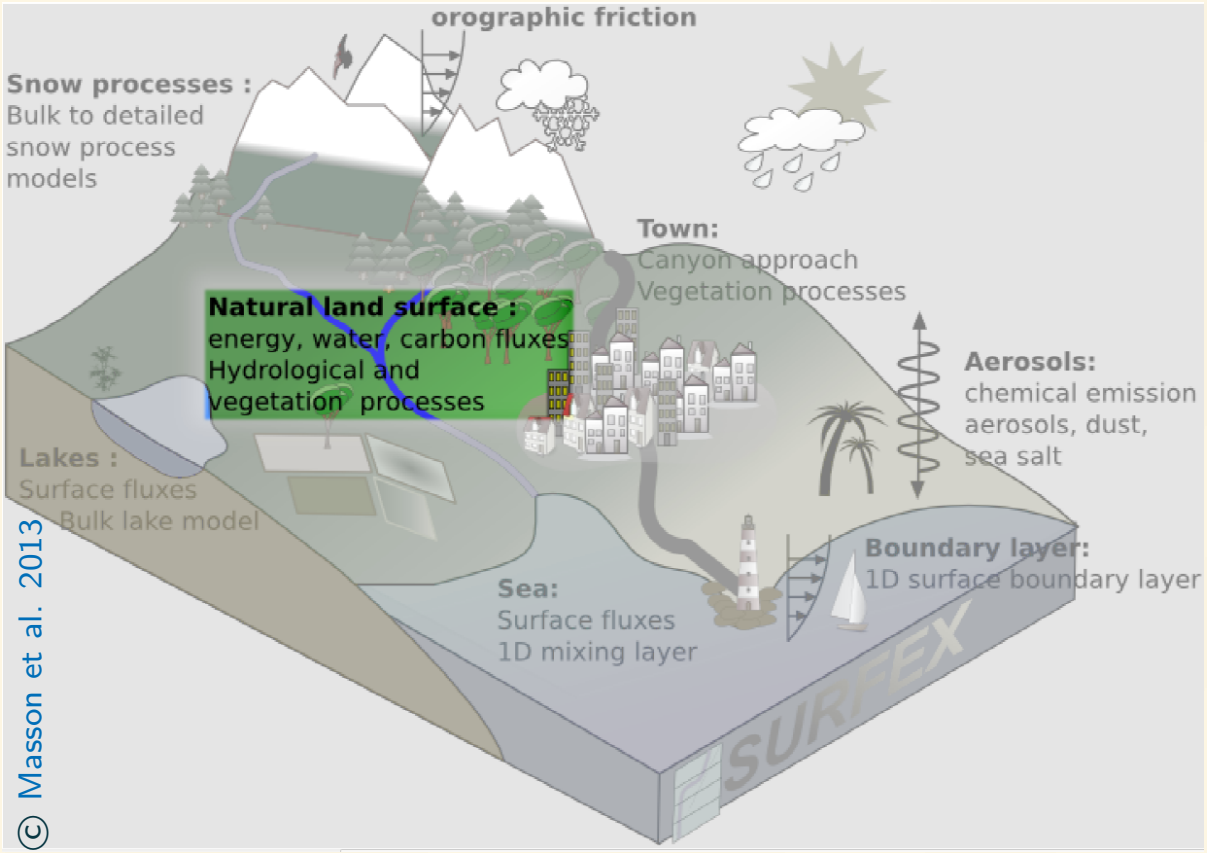

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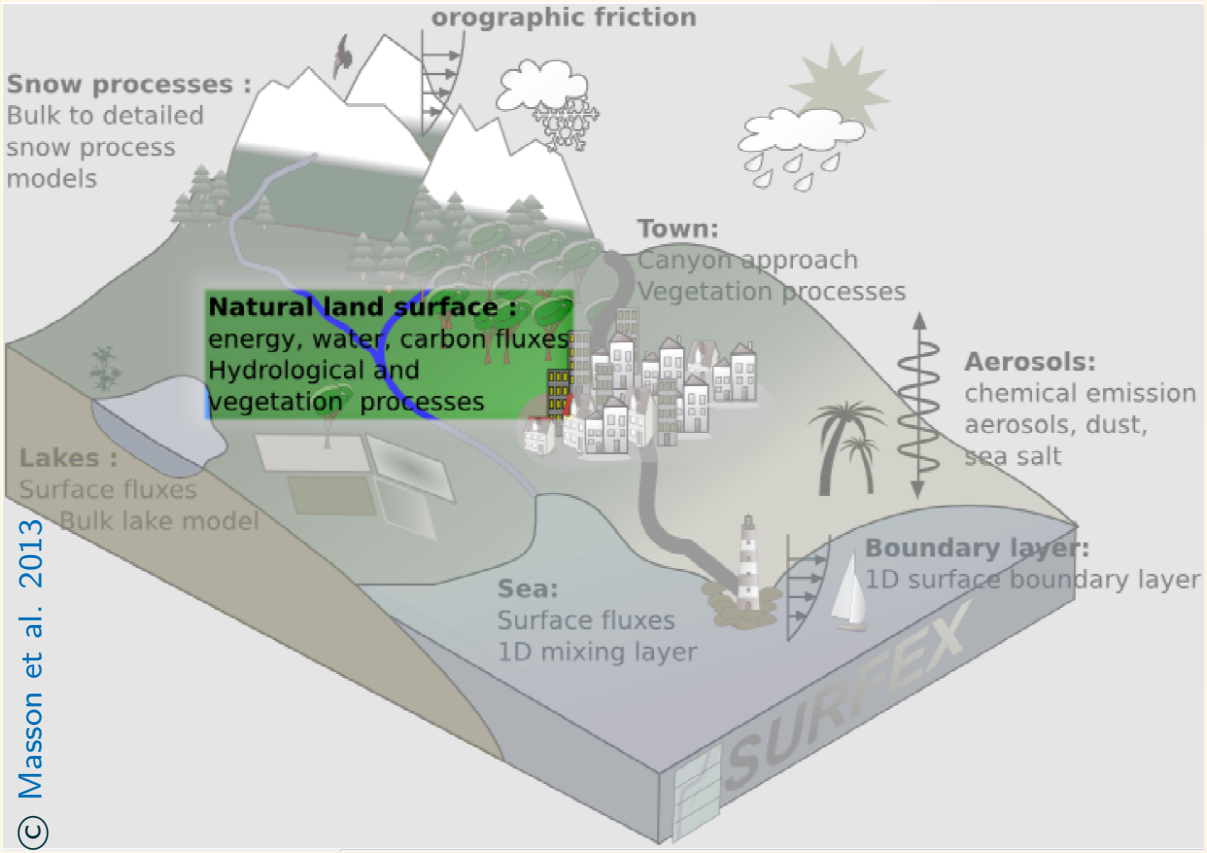
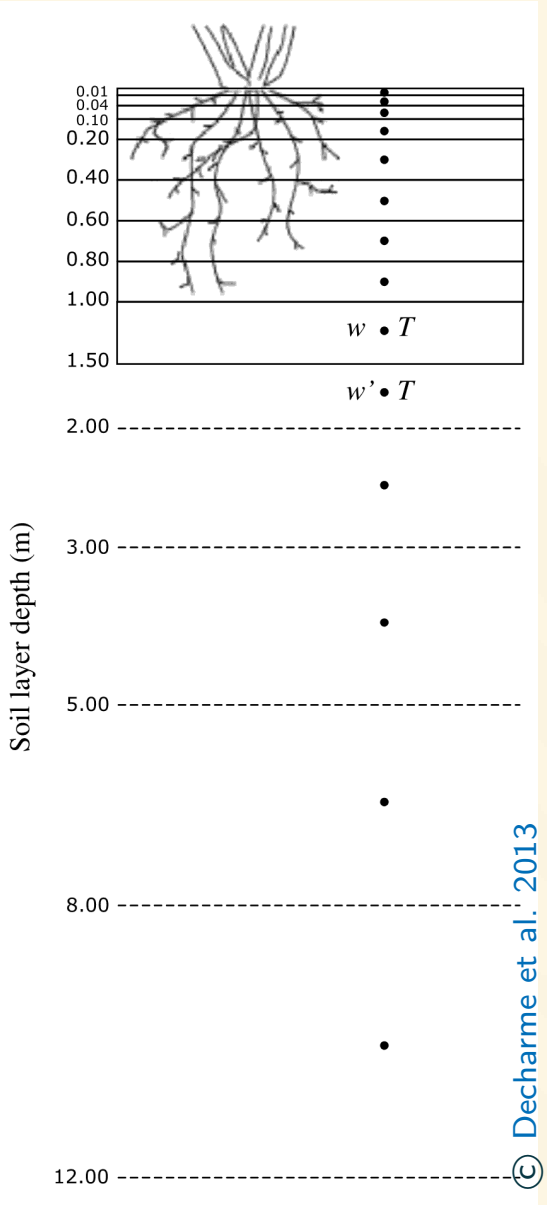
- simplified Extended Kalman Filter
- Interaction Soil Biosphere Atmosphere (ISBA): diffusion scheme, 14 soil layers





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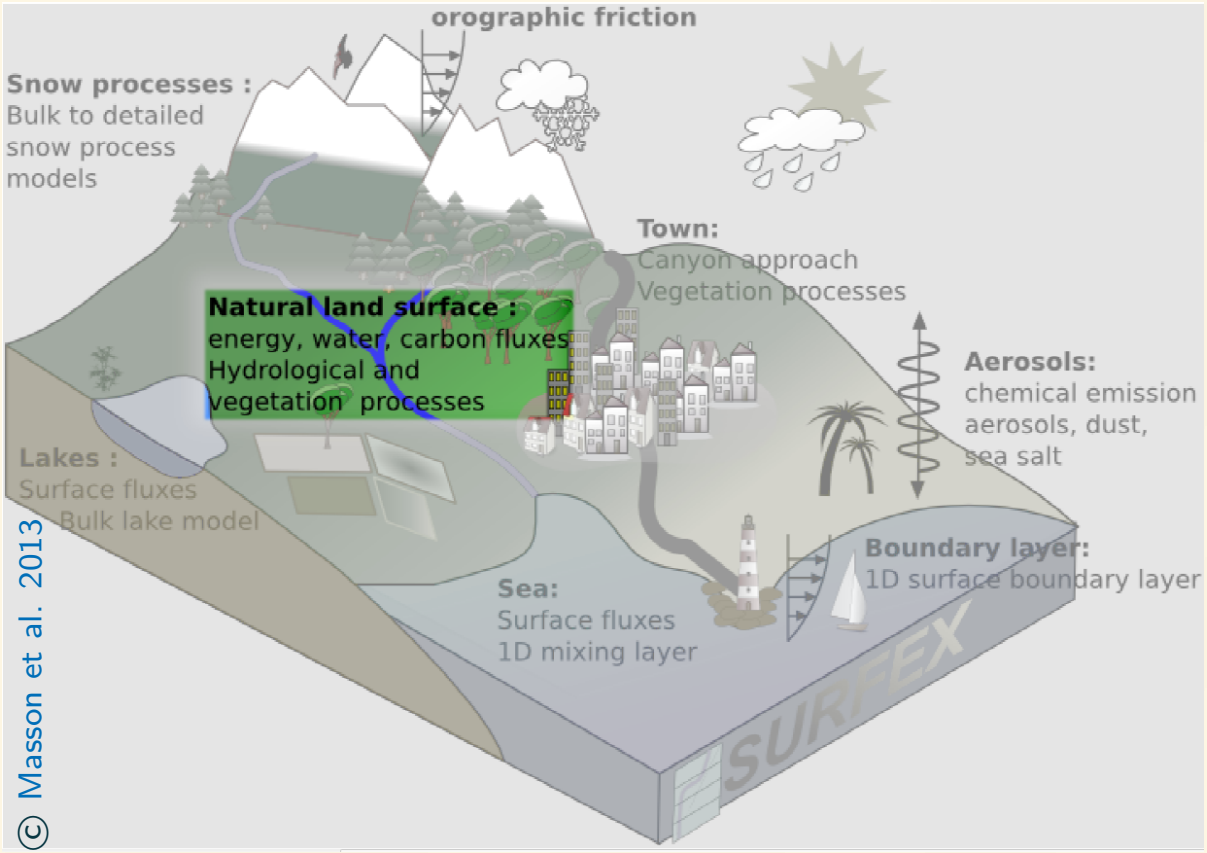
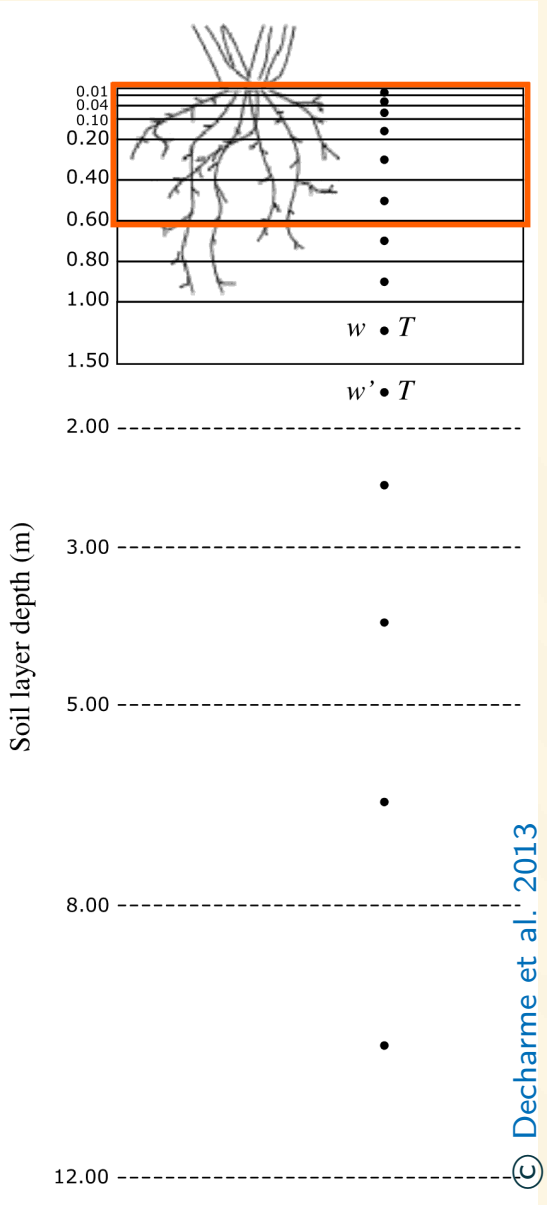
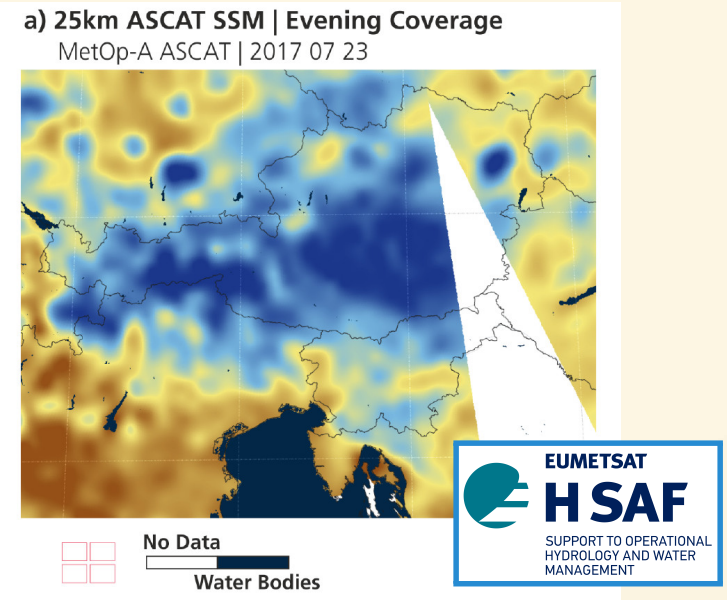
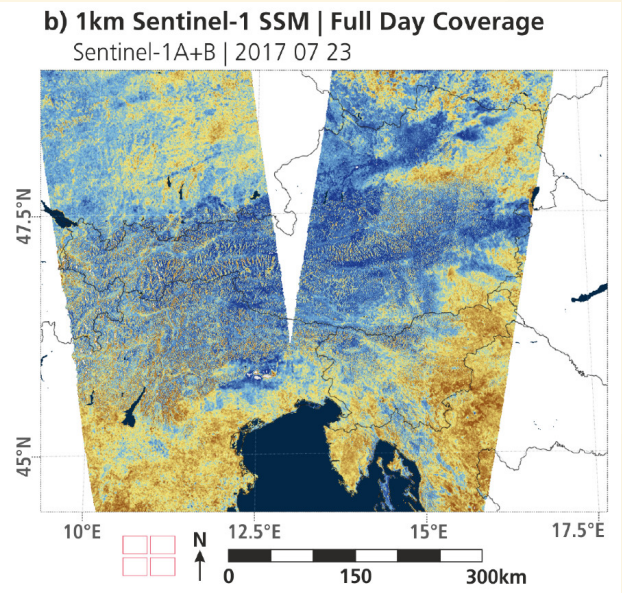
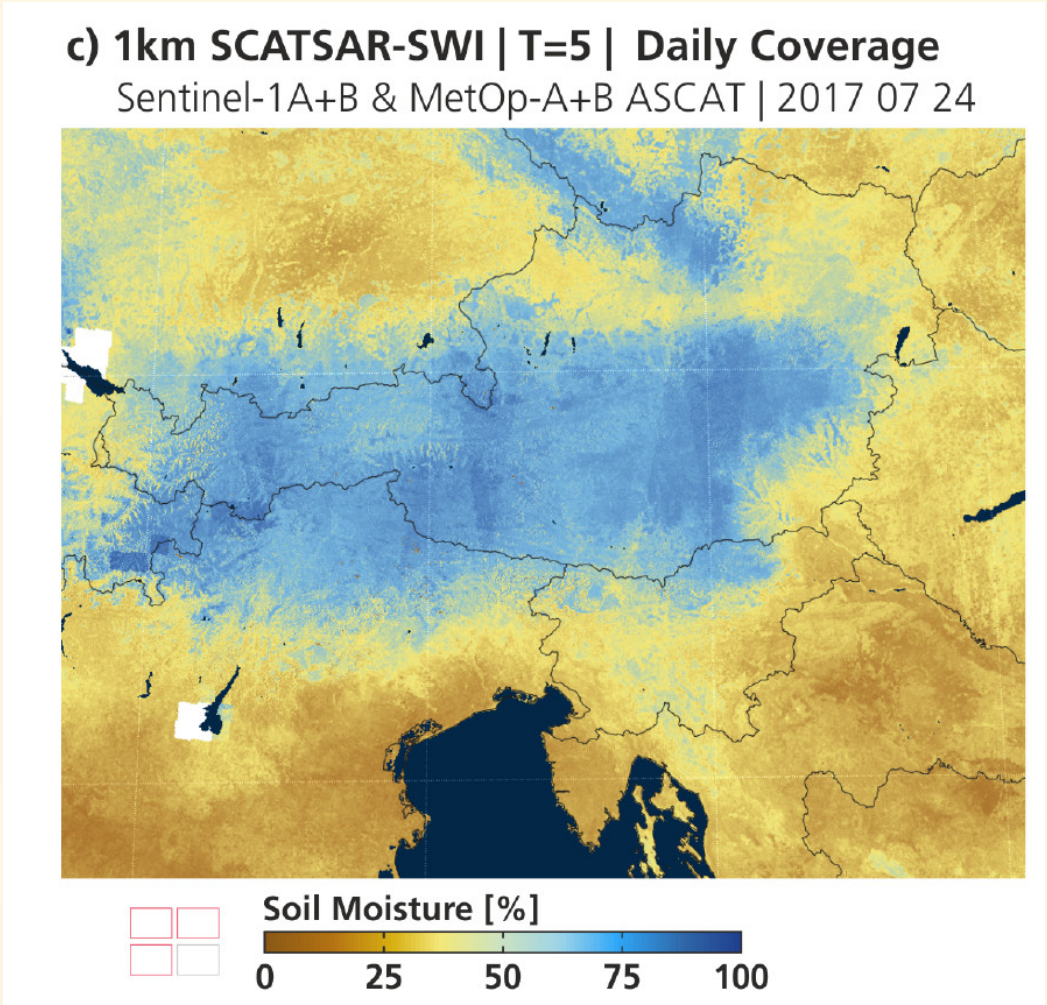




Observations: SCATSAR-SWI







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

*provided freely via the Copernicus Global Land Service

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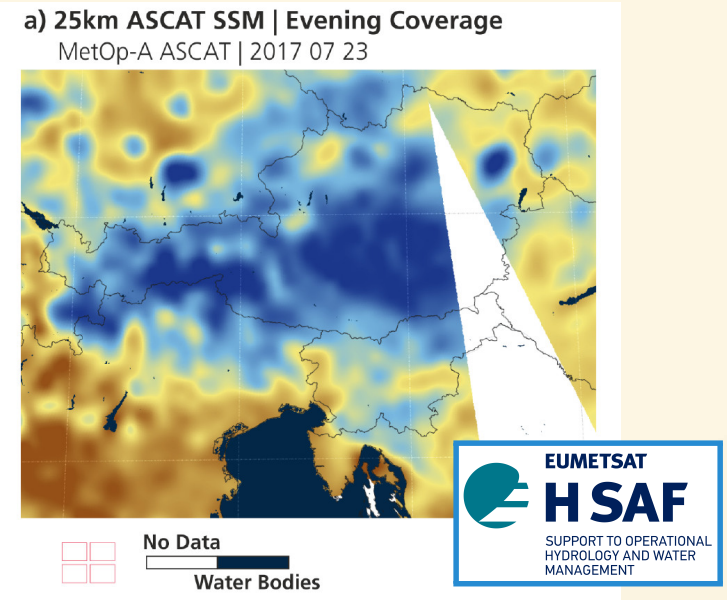

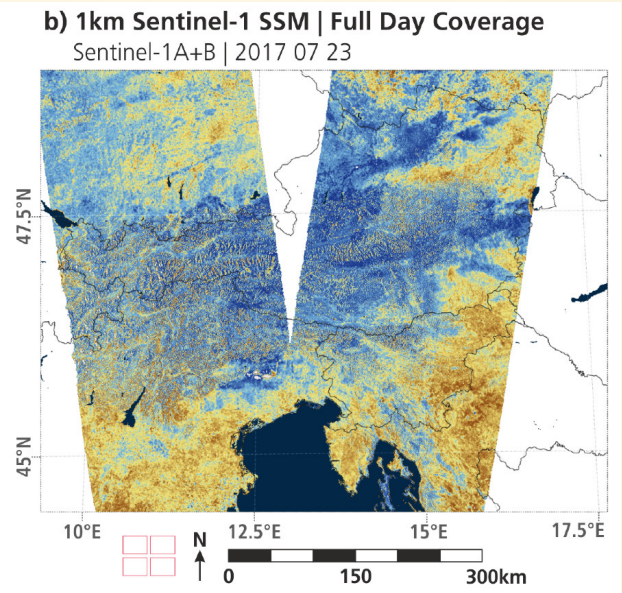

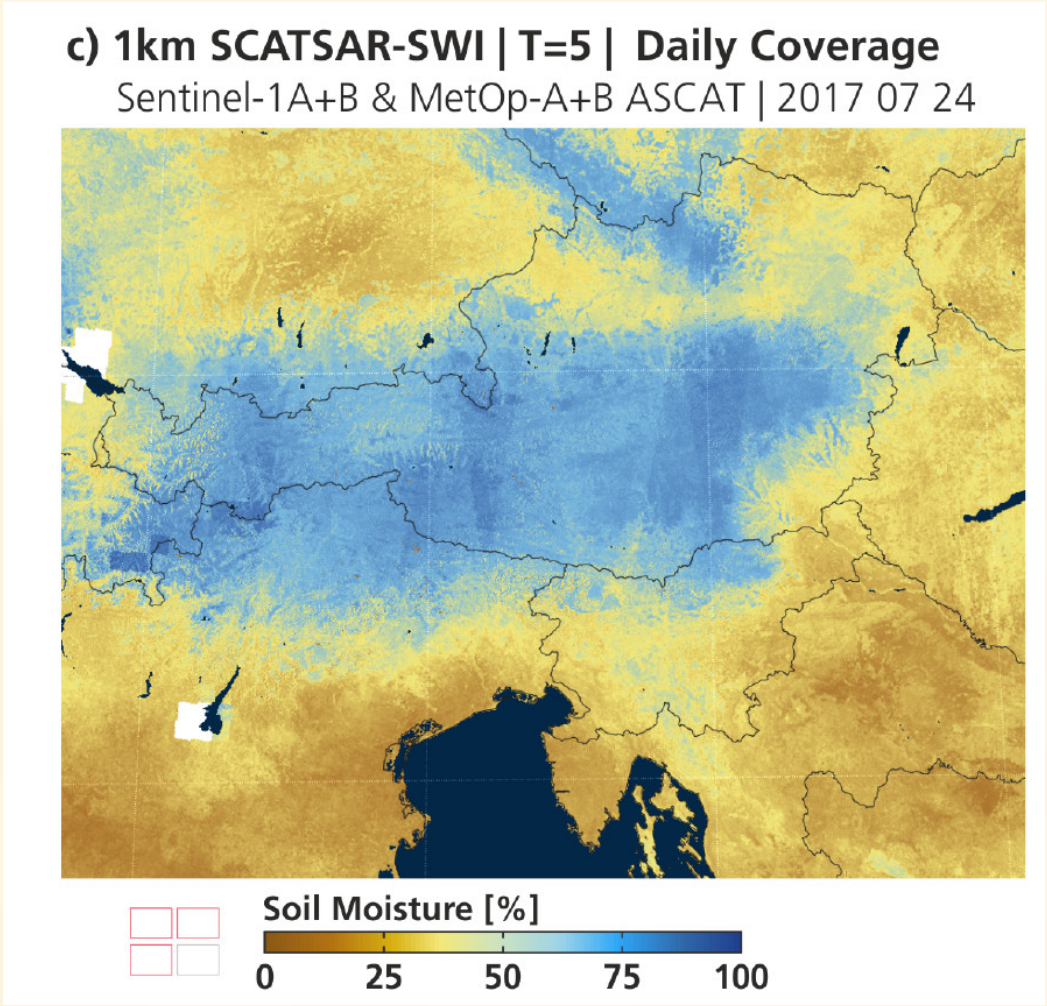

- grid sampling: ~~1.0 km*~~ 0.5 km**
- daily availability
- vertical levels: ~~8~~ → 6

*provided freely via the Copernicus Global Land Service
**internal

Observation error: Triple Collocation Analysis

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

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

- Kalman gain:

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

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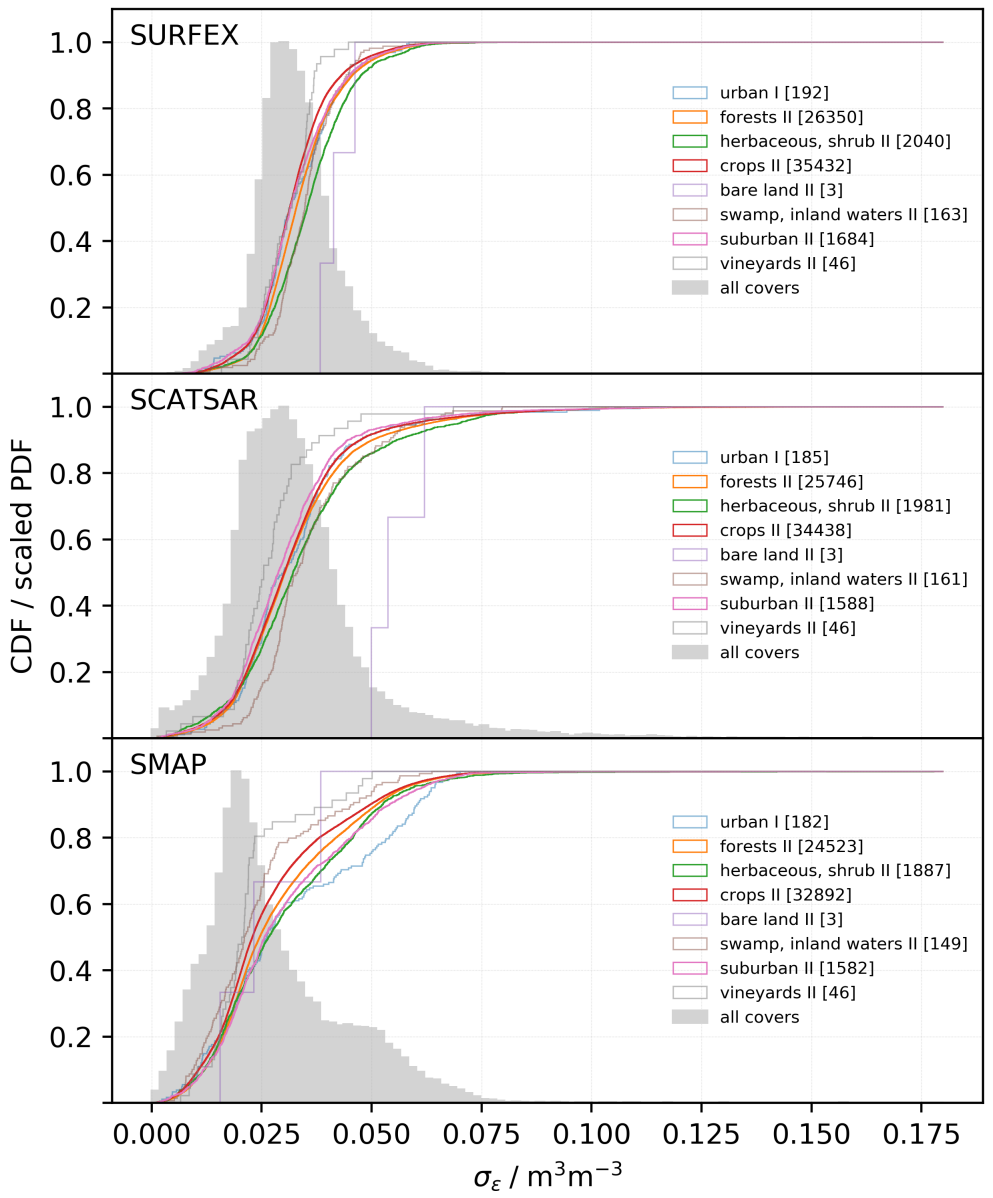

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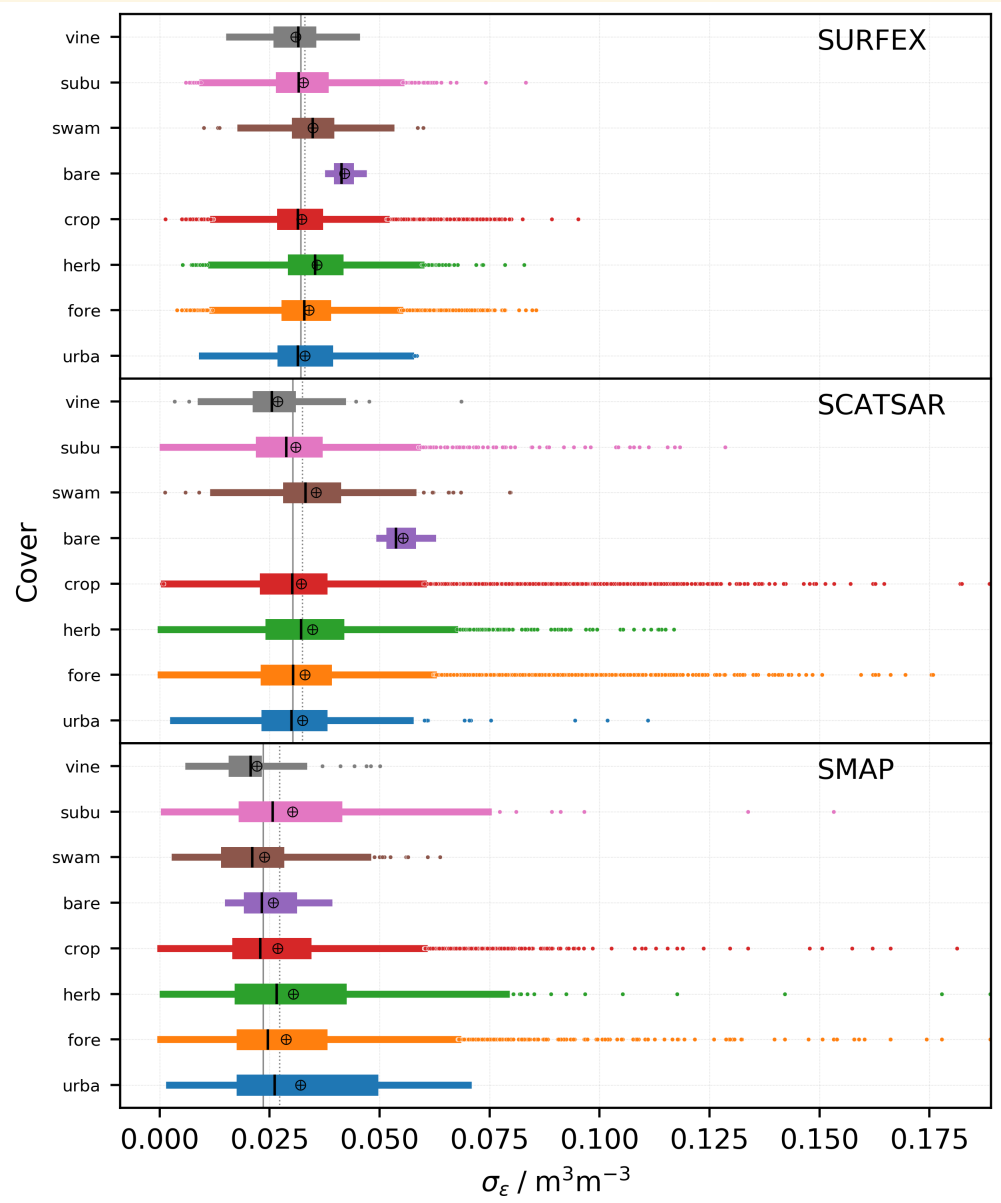
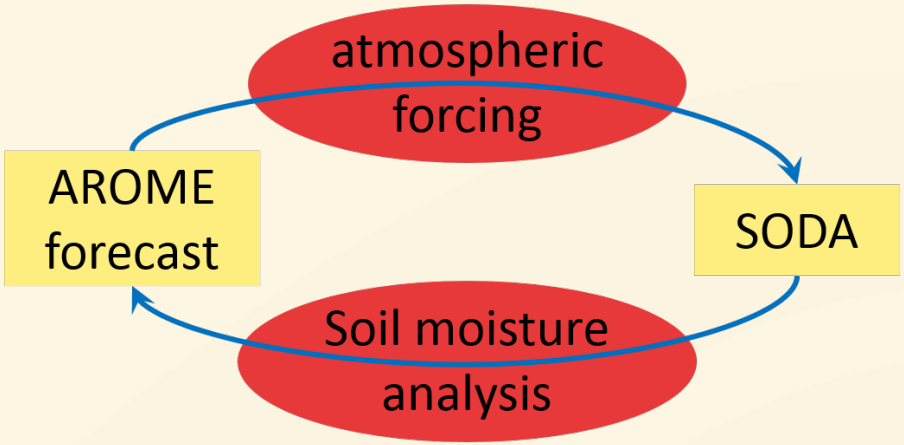
- Apparent cover dependency mostly insignificant



The data assimilation system



- June 2018 (1 month spin-up)
- Austrian domain

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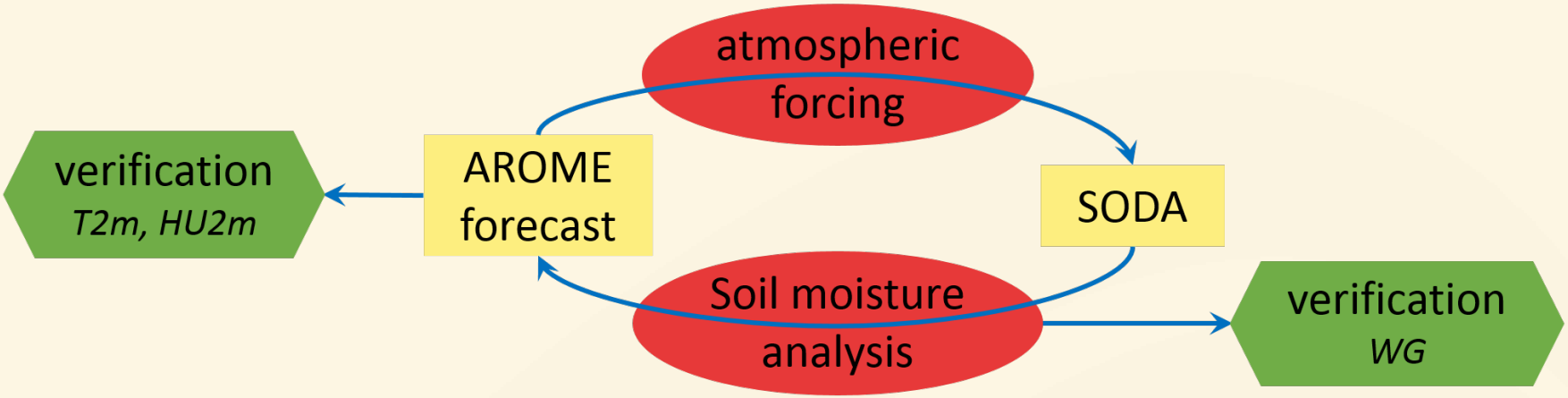
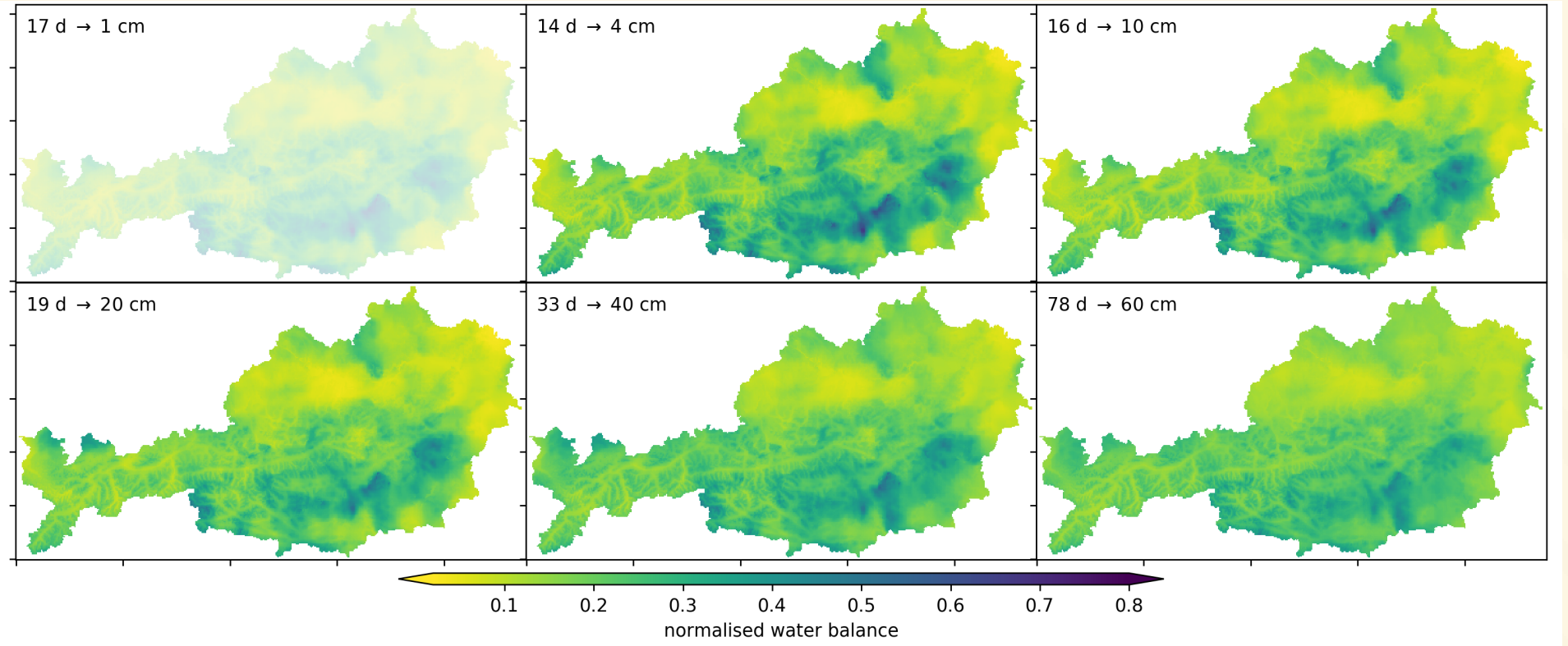


- June 2018 (1 month spin-up)
- Austrian domain
- 2.5 km vs. 1.25 km
- Global vs. local observation error

Verification of soil moisture analysis

- **water balance** $WB = RR - ET(T)$ *Haslinger et al. 2016*
- averaged over time & scaled to [0,1]



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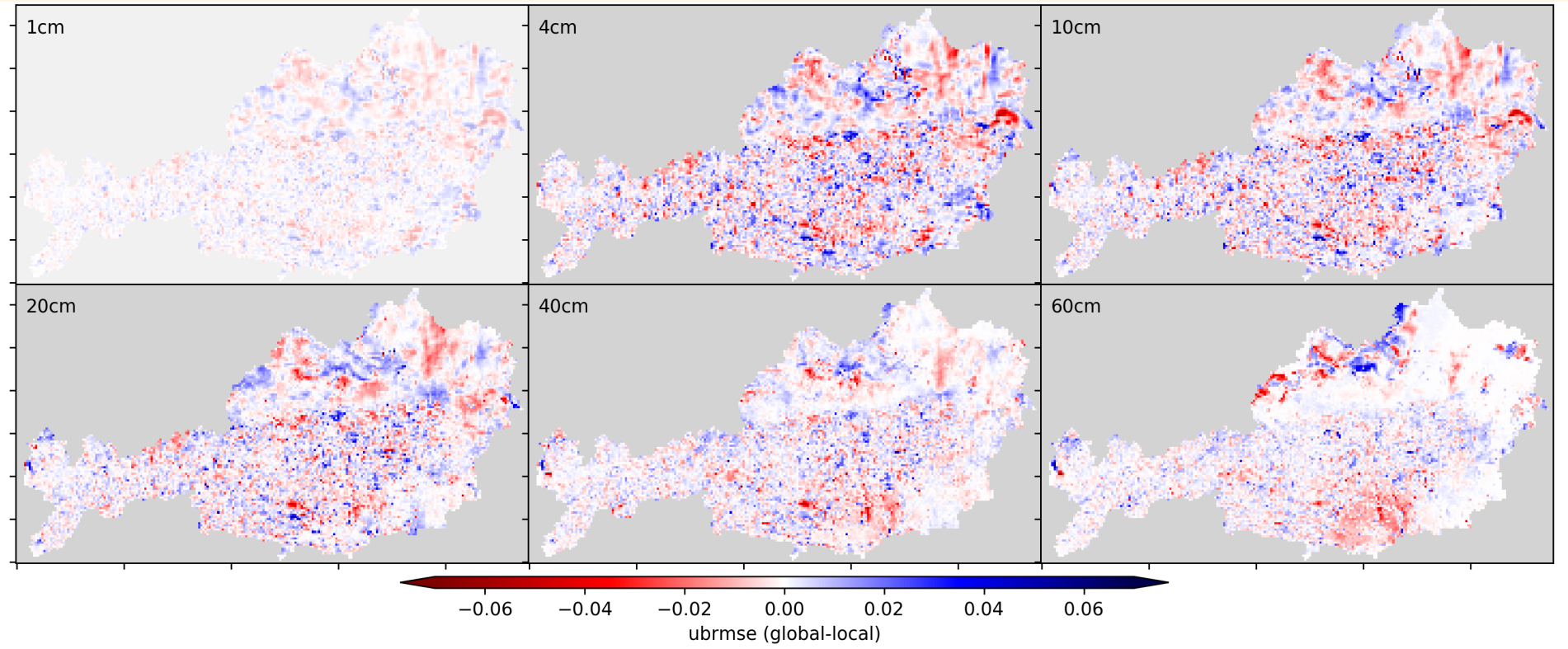

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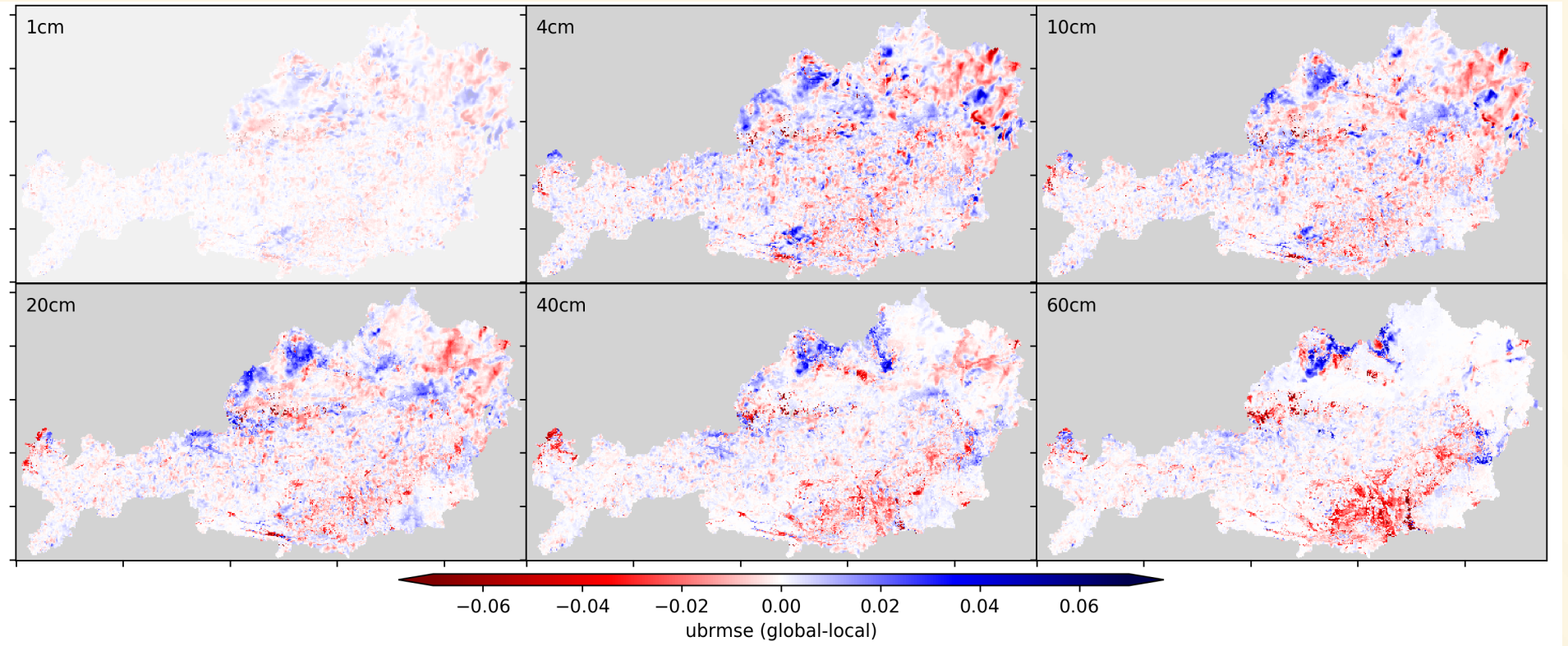

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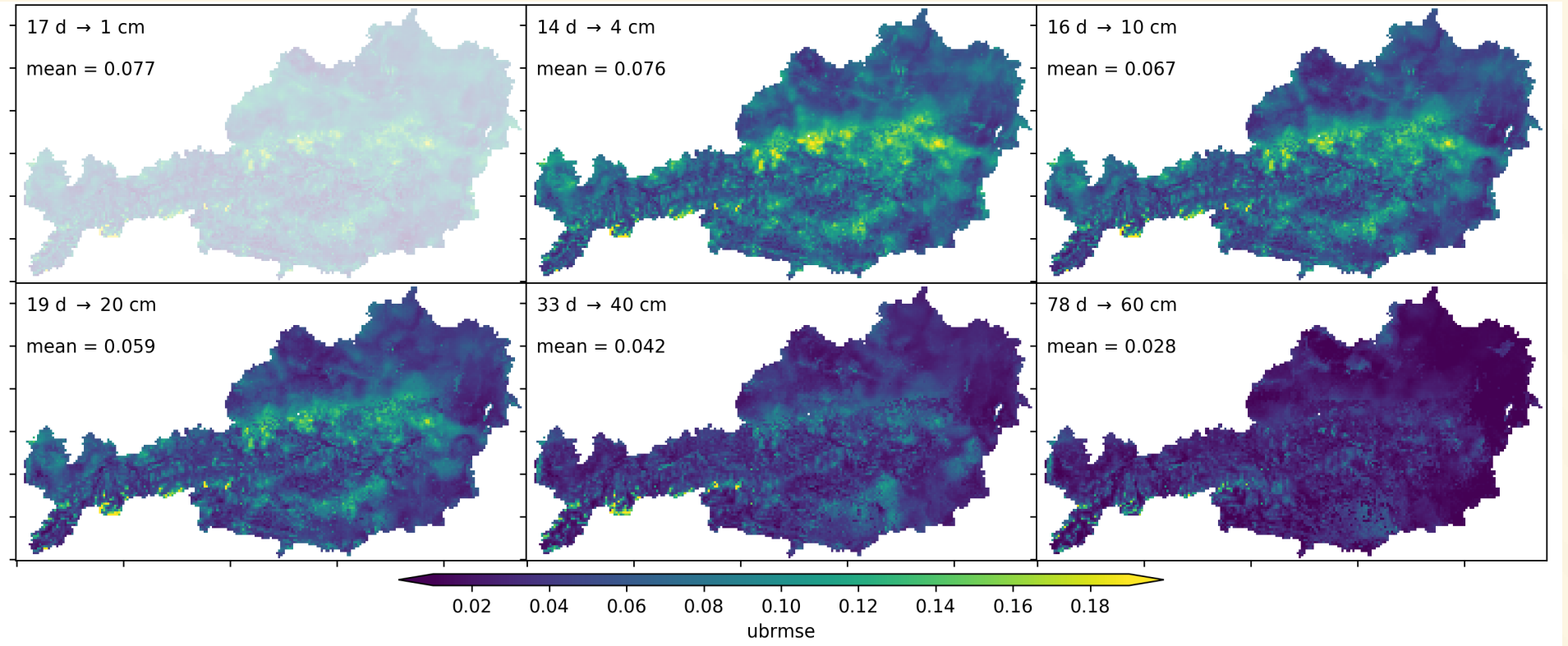

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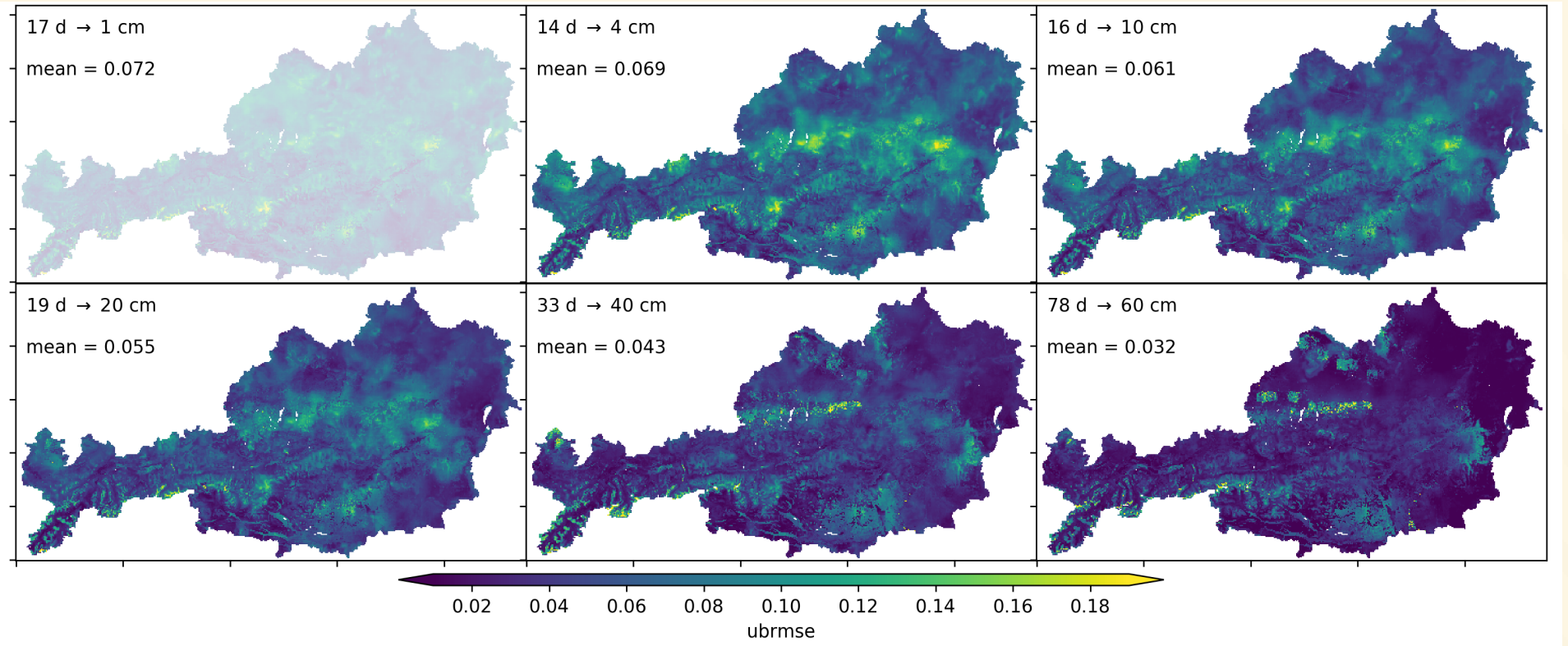
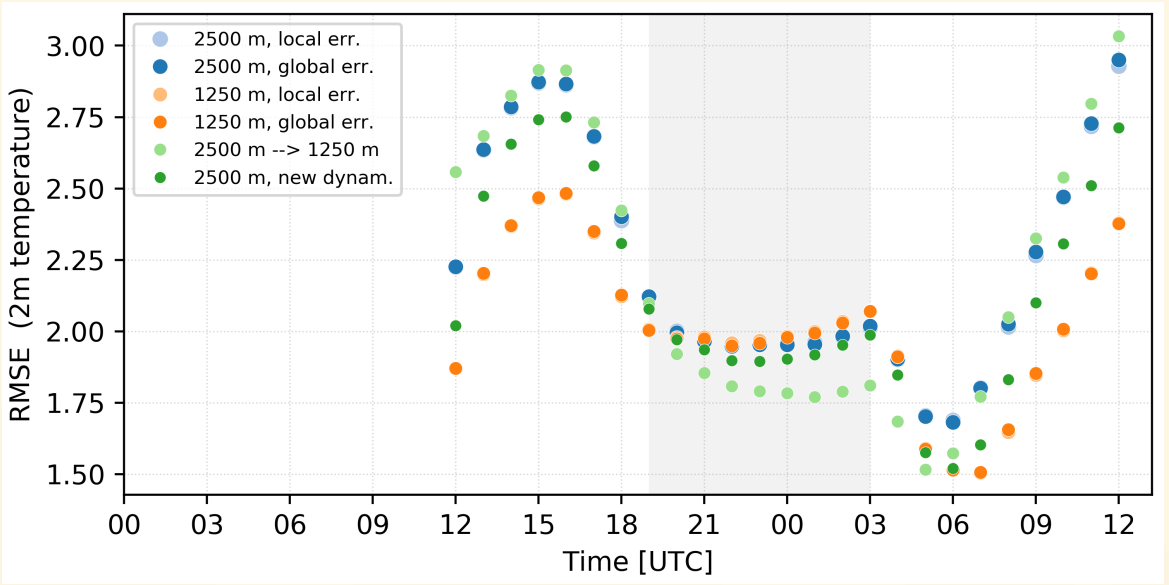
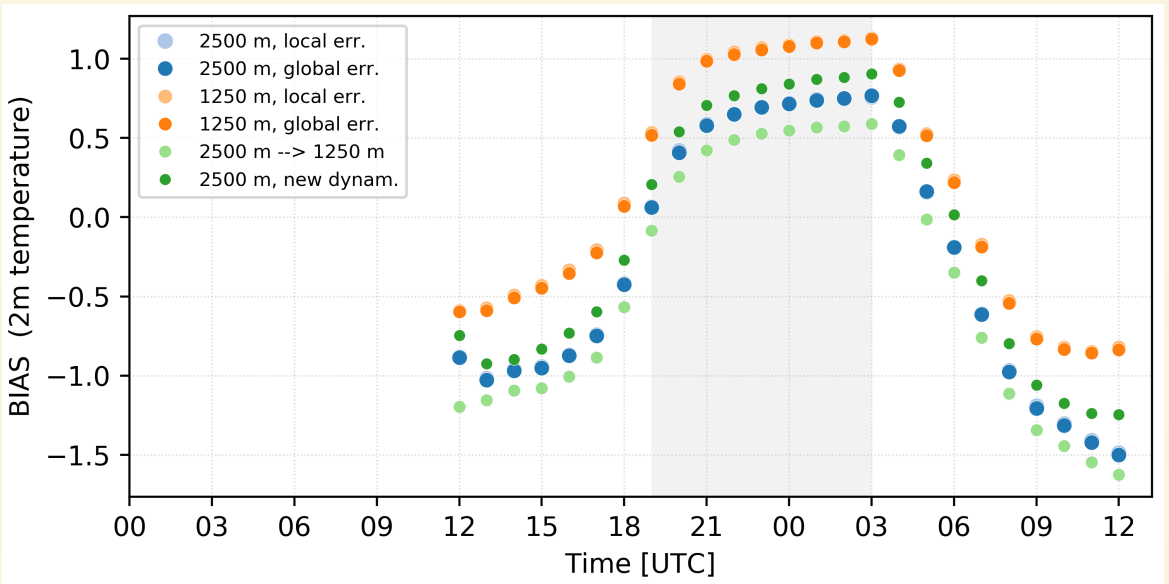


Verification against T_{2m} & HU_{2m} of Austrian TAWES stations





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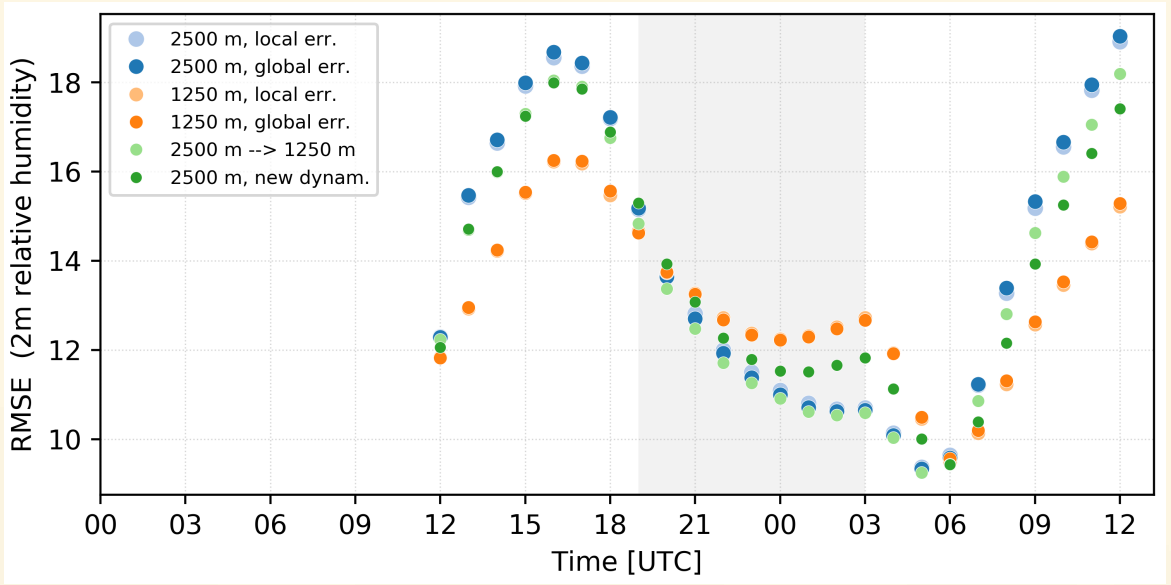

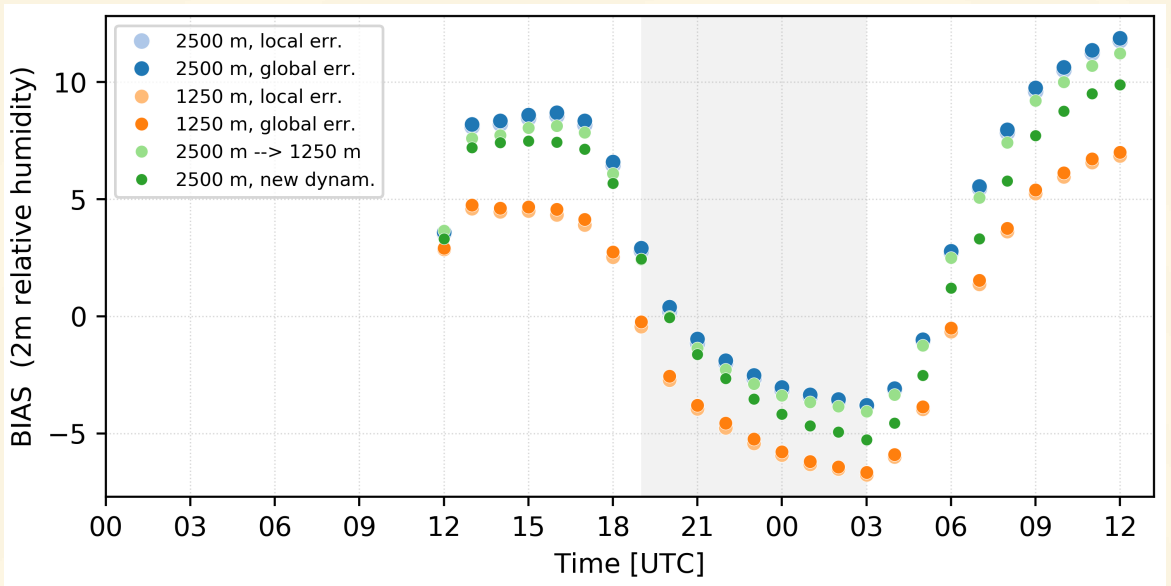

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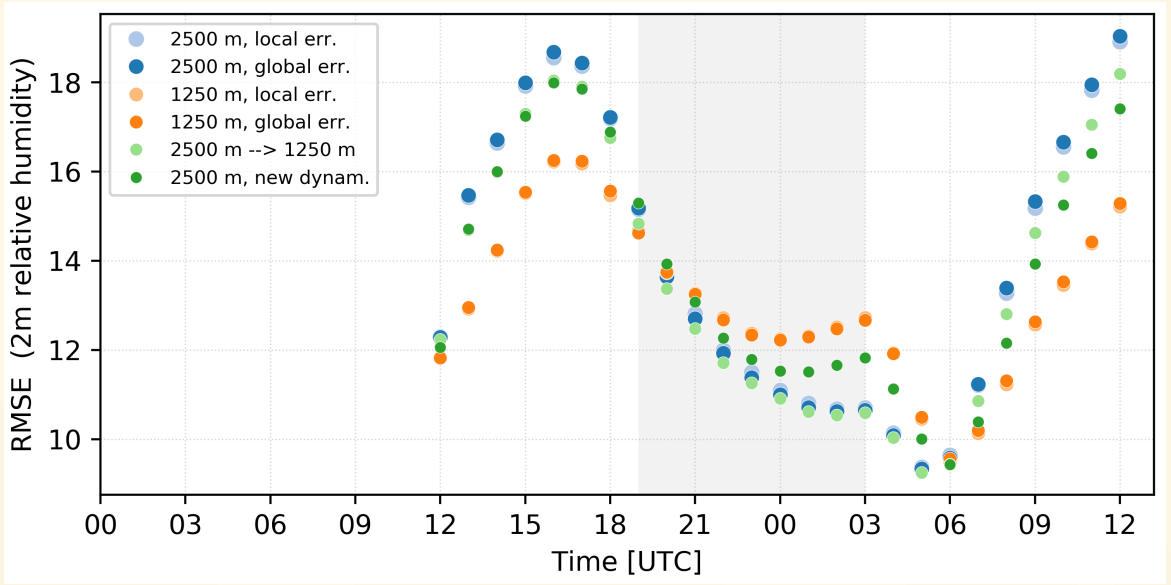
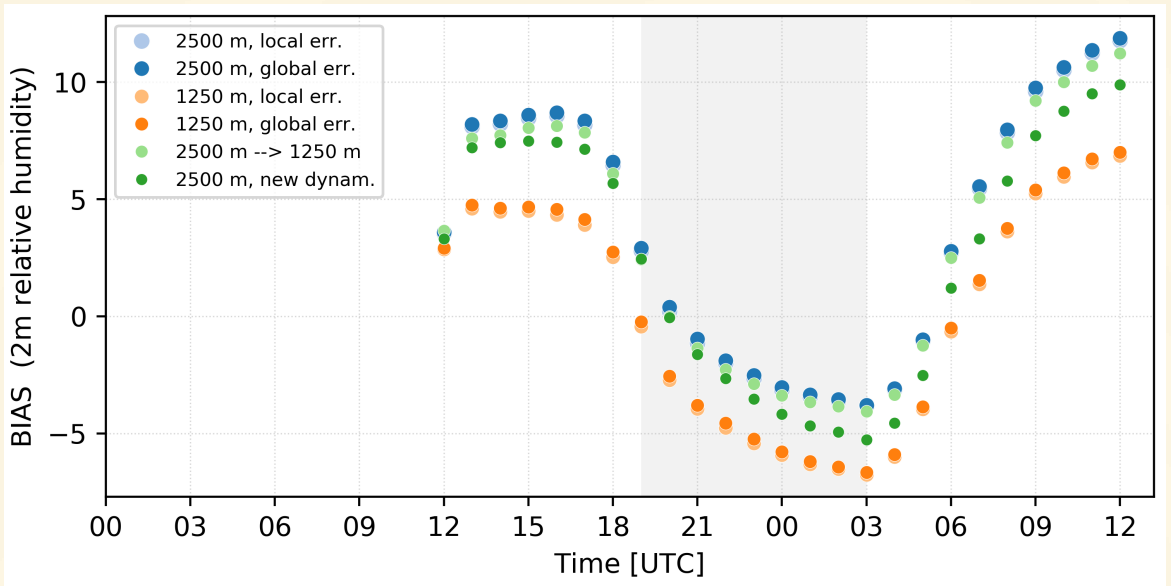
Global vs. local obs. error

- no dependency on altitude
- no dependency on land cover





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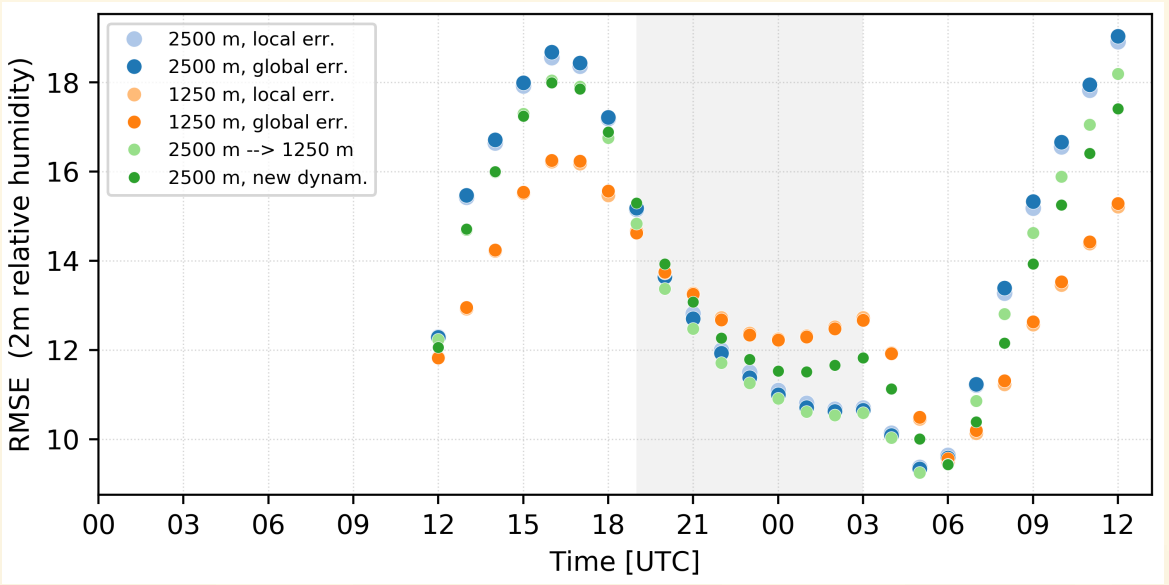
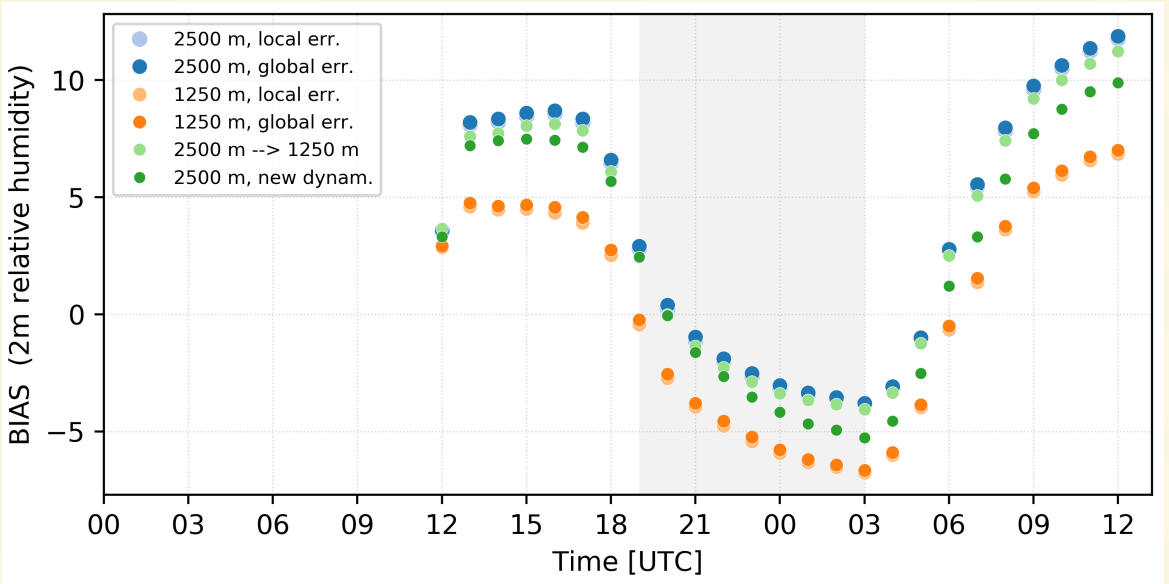
2.5 km vs. 1.25 km

- improvement for day time
- degradation for night time
- ▷ adapted model dynamics problematic when soil cool

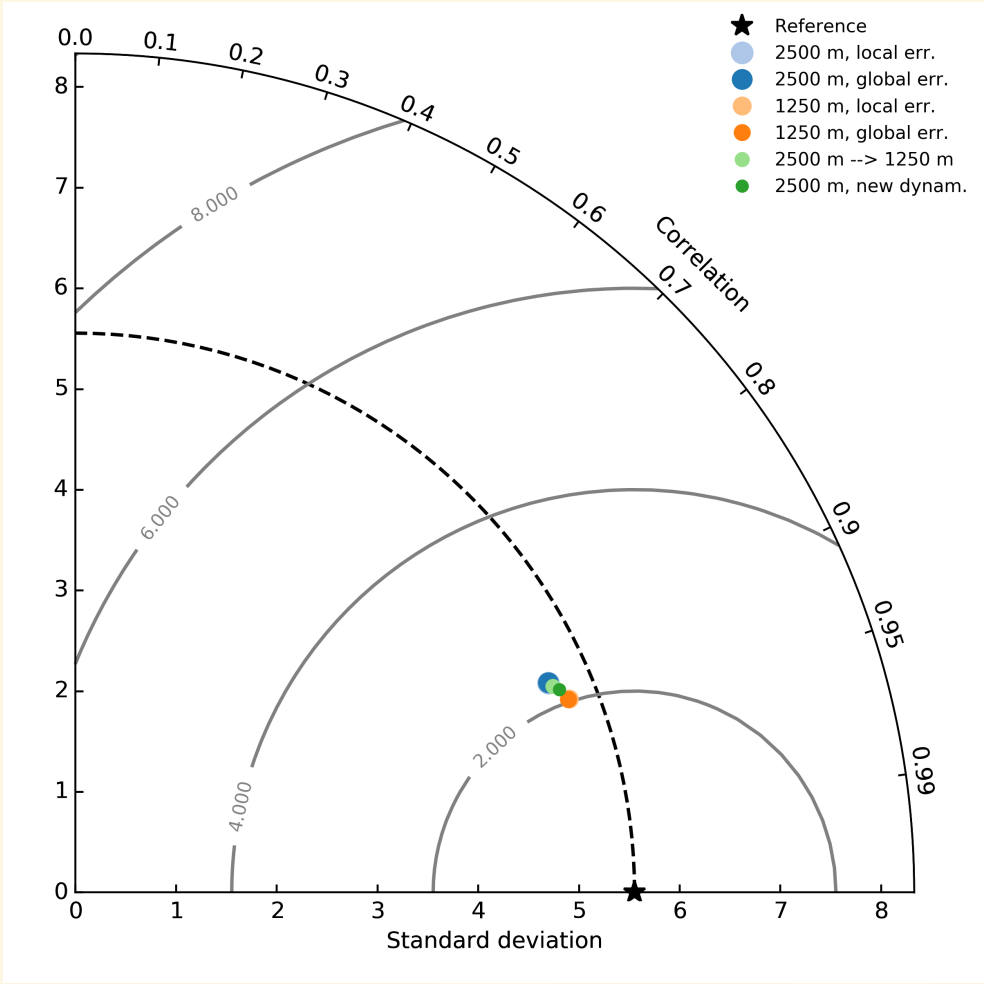




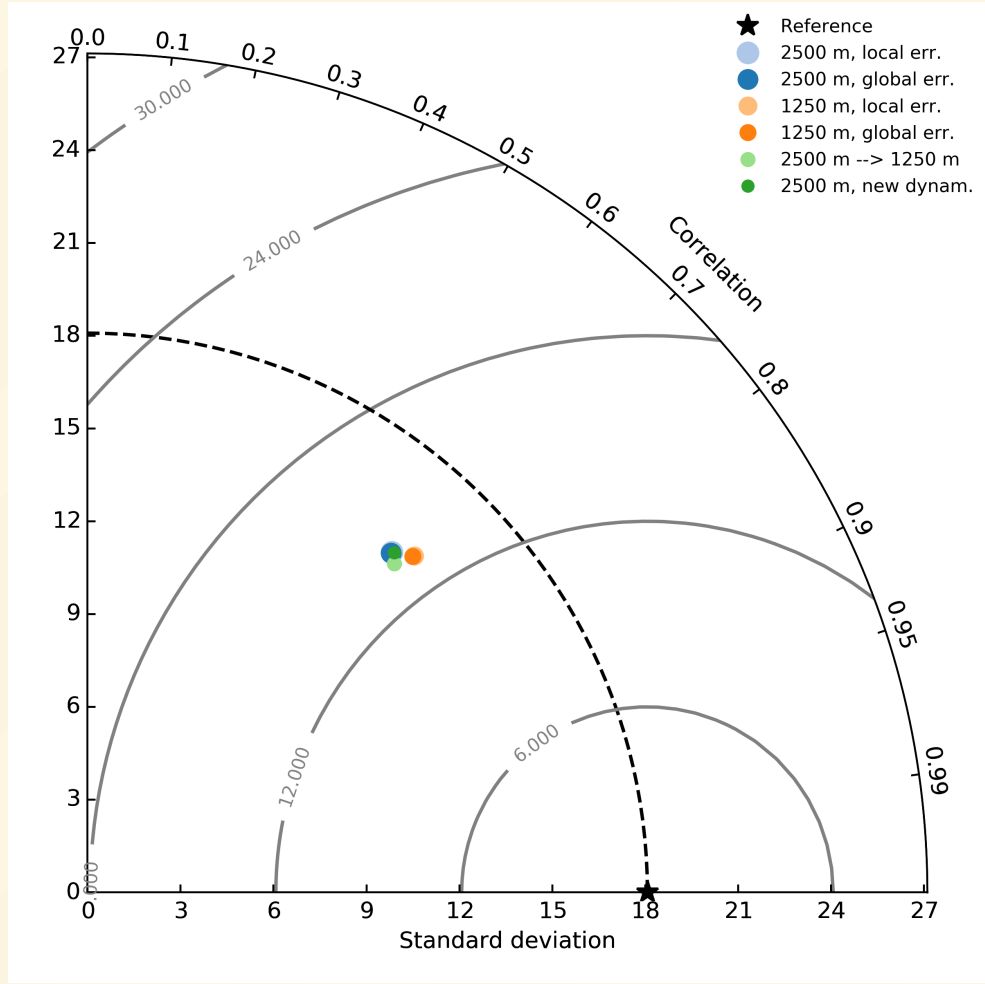
Verification against T_{2m} & HU_{2m} of Austrian TAWES stations

Taylor diagrams show clear improvement towards 1.25 km DA

T_{2m}



HU_{2m}



Summary & Outlook

- Observation error obtained with Triple Collocation Analysis
  - ▷ Water balance: visible impact, unclear pattern
  - ▷ NWP: almost no impact on T_{2m} & HU_{2m}
- Increasing grid sampling to 1.25 km
  - ▷ Water balance: small improvement
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▷ Surface DA on 500 m

▷ Run computations on European domain