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Assessment of an ESA CCI soil moisture data assimilation framework

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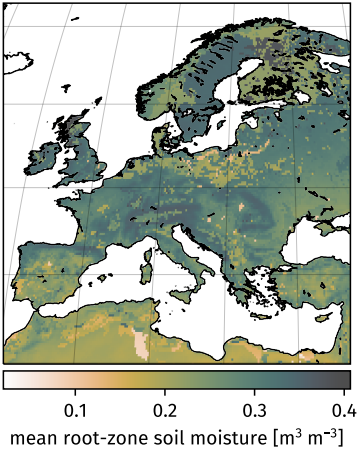
EGU General Assembly,
26 May 2022

Research question

How does assimilating ESA CCI SM improve surface and root-zone soil moisture estimates over Europe?

Set-up

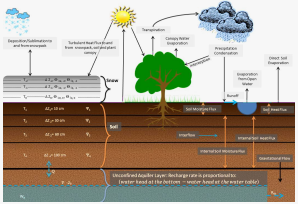
Domain	Europe
Period	2002-2020
Spatial resolution	0.25°
Temporal resolution	1 day



Approach

Land surface modeling

- Noah-MP
- 4 soil layers
- Input: ERA5 atmospheric forcing



[Niu et al., 2011]

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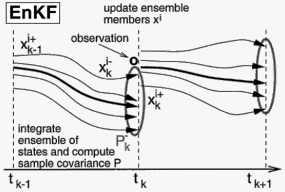
Data assimilation

- 1D ensemble Kalman filter
- Implemented in NASA-LIS [Kumar et al., 2006]



[Reichle et al., 2002]

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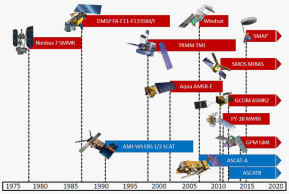
Satellite observations

- Soil moisture retrievals
- Combined ESA CCI SM product

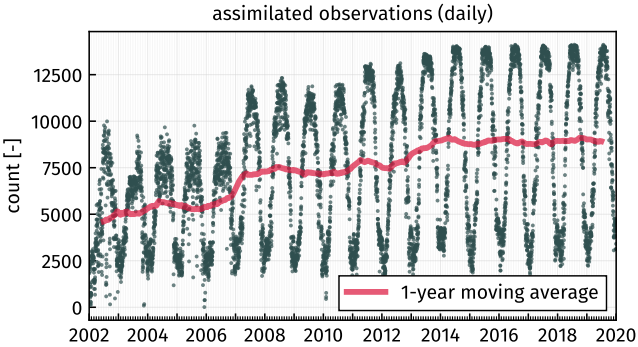


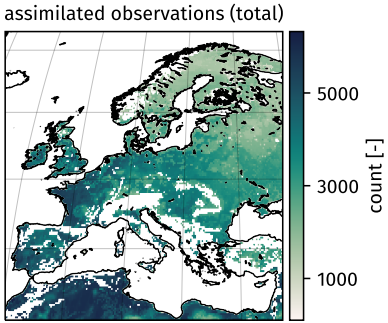
[Dorigo et al., 2017, Gruber et al., 2019]

Number of assimilated observations

No retrieval assimilation when/where ...

- topographic complexity $> 10\%$
- snow-covered/frozen soil
- heavy rainfall events
- urbanized areas
- not enough observations overall (for CDF matching)



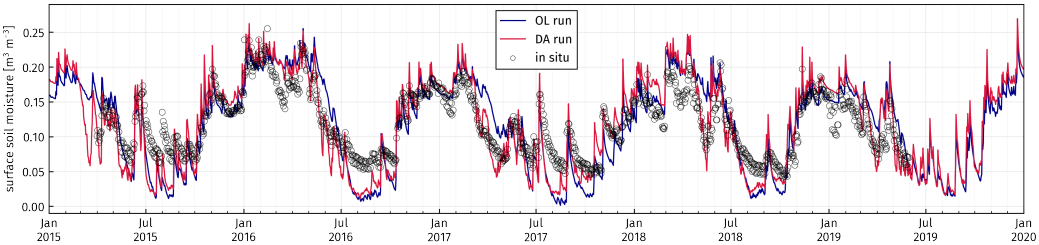


Effect of data assimilation

Time series at REMEDHUS site in Spain

→ soil moisture estimates are improved by DA

ΔubRMSD	$-0.0045\ \mathrm{m^3\ m^{-3}}$
ΔR	$+0.039$
ΔR_{anom}	$+0.021$



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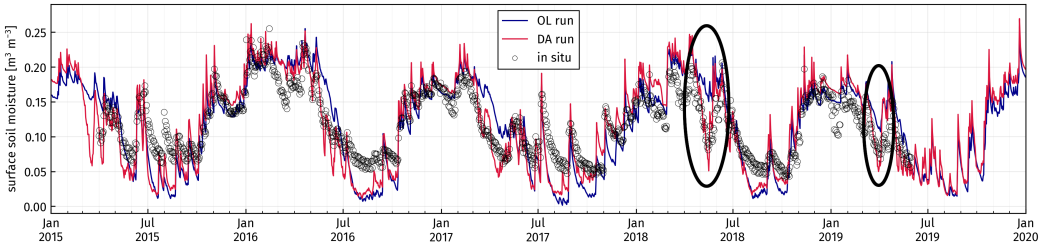
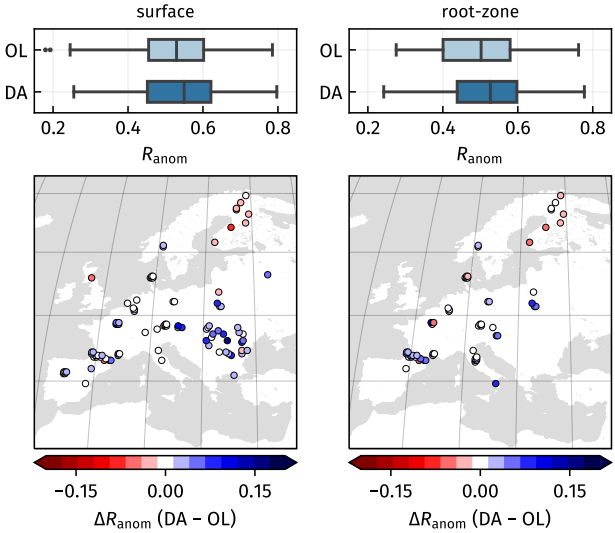
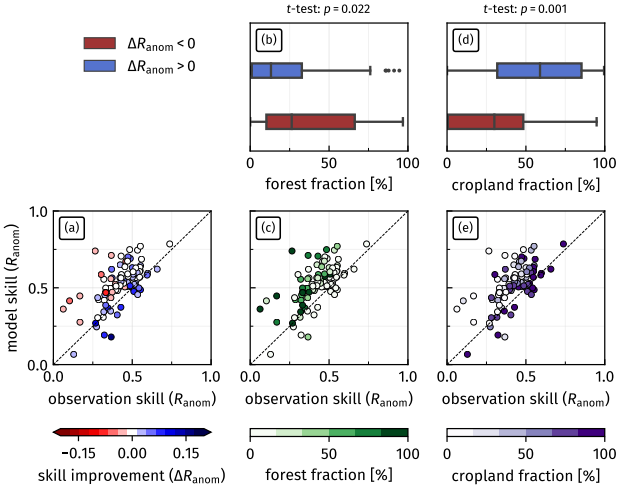


In situ validation

- In situ validation over 91 ISMN stations
- R_{anom}: Pearson correlation between simulated and in situ soil moisture anomalies
- Small improvements relative to model-only
- Regional differences

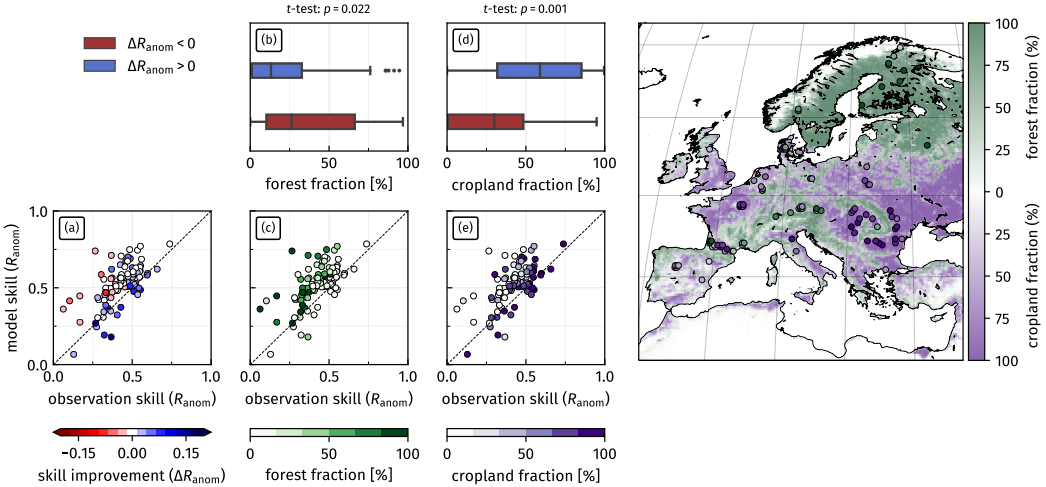


Impact of land cover



- Skill improvements by DA depend on quality of satellite retrievals
- Significant effects of land cover

Impact of land cover



Conclusions

- Modest improvements (relative to the model-only) in soil moisture estimation over Europe by assimilating ESA CCI SM
- Regional differences in skill improvements, impacted by quality of satellite retrievals
- Largest improvements over croplands, deteriorations over forests

For the impact of various DA design factors, contact:

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https://ees.kuleuven.be/en/bwb/research/land-surface-data-assimilation/

Thank you!

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