Soil moisture simulation: Assessing CLM-ParFlow results with multi-resolution data in NRW domain

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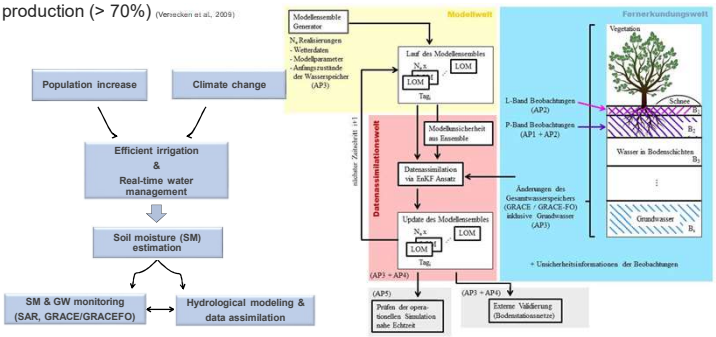
Agrosphere (IBG-3)

Motivation

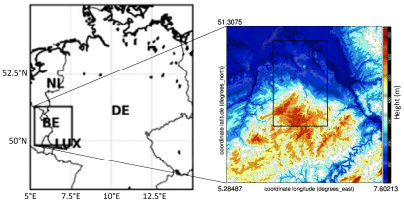
The highest percentage of the world's fresh water is consumed for irrigation and agriculture production (> 70%) (Vereecken et al., 2009)



Hydrological model

Study Site

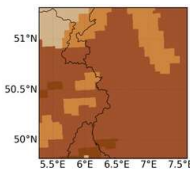
- West Germany and part of NL, BE & LUX
- Site has previously been studied, and databases have been recovered.
- Site area (150 km²): adequate for the applicability of coarse resolution Grace data while having high resolution SM data



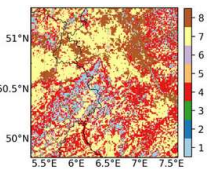
Location and topography of the study area

Model Set-up

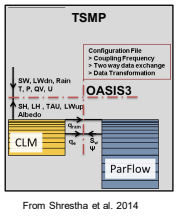
- Coupled land surface-subsurface model (CLM-ParFlow).
  - 3D subsurface & 2D overland flow module.
  - SM dynamics better captured than the CLM stand alone (Zhao et al. 2021)•
- The Terrestrial System Modeling Platform -TSMP•• 500m resolution
- Meteorological forcing: COSMO-REA6 2017-8
- Soil hydraulic properties: Rosetta Pedo-transfer functions.
- van Genuchten water retention curves
- JURECA system at Jülich Supercomputing Centre•••



Soil texture based on FAO/UNESCO Soil Map (Klimaatlas NRW)

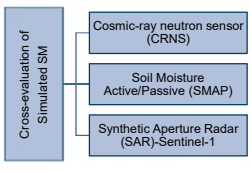


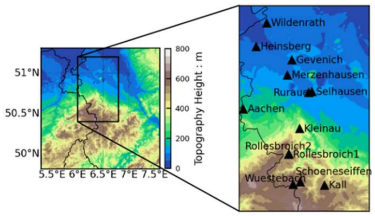
The plant functional types (PFTs) based on MODIS land cover data



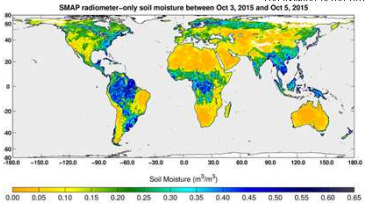
From Shrestha et al. 2014

Soil Moisture (SM) Data





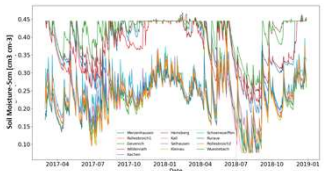
The location of the CRNS stations in the study domain



https://smap.jpl.nasa.gov/

Simulated vs Measured Soil Moisture

at CRNS stations



Simulated SM of the top 5cm of the soil at the location of the CRNS stations for the soil top 5cm, at 2017-8

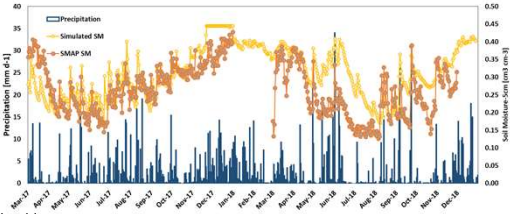
CRNS Station	Clay[%]*	Sand [%]*	Bias	RMSE	ubRMSE	r [-]
Merzenhausen	22	21	0.13	0.18	0.12	-0.48
Aachen	23	22	-0.09	0.13	0.09	-0.28
Selhausen	24	16	-0.04	0.12	0.11	-0.36
Heinsberg	19	18	0.15	0.19	0.12	-0.57
Wuestebach	23	19	-0.05	0.11	0.10	-0.43
Gevenich	20	22	0.00	0.11	0.11	-0.17
Rollesbroich1	23	22	-0.11	0.15	0.11	-0.34
Rollesbroich2	-	-	-0.12	0.17	0.11	-0.34
Ruraue	26	19	-0.05	0.12	0.11	-0.43
Wildenrath	12	65	0.21	0.23	0.09	-0.49
Kall	22	20	-0.13	0.18	0.11	-0.31
Schoeneseiffen	24	16	-0.10	0.15	0.11	-0.45
Kleinau	25	15	-0.09	0.14	0.11	-0.30
Mean	-	-	**-0.02**	**0.15**	**0.11**	**-0.38**

* (Baatz et al. 2017)

- dry biased (Negative)
- low systematic bias (ubRMSE)
- low correlation values

with SMAP L3_SM_E_P

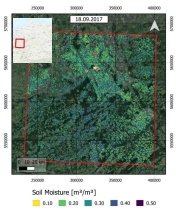
- wet biased (positive)
- low systematic bias
- low correlation values
- Least matching at high fluctuation between dry/wet.
- Resolution difference should be considered: 500m vs 9km



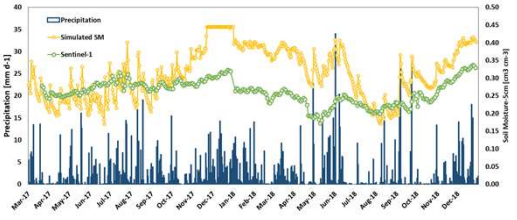
Variation in the simulated vs SMAP extracted SM of the top 5cm of the soil and the precipitation at the study area for 2017-8

Mean Monthly	bias	RMSE	ubRMSE	r
SMAP	0.04	0.01	0.05	0.48

from Sentinel-1 data

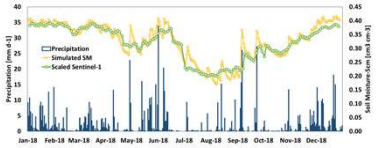


SM from Sentinel-1 for September 2017



Variation in the simulated vs Sentinel-1 extracted SM of the top 5cm of the soil and the precipitation at the study area for 2017-8

- wet biased (positive)
- low systematic bias
- SM dynamics have been well captured



Conclusions and Outlook

- The model is able to capture the SM values and dynamics to some extent.
- Relatively low systematic bias (ubRMSE)
- SM dynamics are best captured when precipitation is more steady
- Relatively low correlation values at 500m resolution

• https://doi.org/ 10.3390/rs13163068
-•• https://www.terrsysmp.org
•• https://apps.fz-juelich.de/jsc/hps/jureca

Ongoing:

- Simulation at 250m resolution and data assimilation towards improving the simulation results using high resolution satellite data.