Comparative Analysis Of Univariate Assimilation Of Four Different Remotely Sensed Soil Moisture Retrievals And A Merged Soil Moisture Product Generated By LSTM

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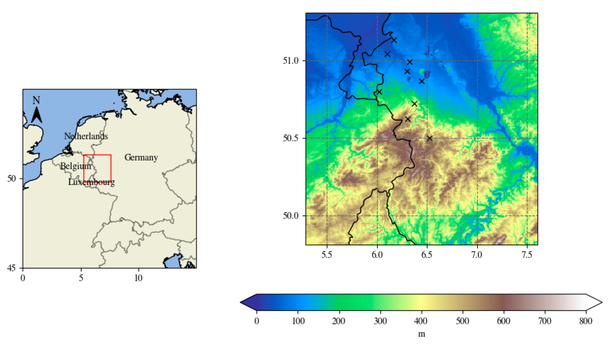
1 Background

- Knowledge of precise soil moisture (SM) plays a critical role in the effective management of water resources, agricultural production, and accurate weather prediction.
- The assimilation of remotely sensed soil moisture data into land surface models (LSMs) has shown promise in enhancing the representation of land surface conditions and the dynamics of fluxes.
- The added value obtained from assimilating microwave soil moisture observations acquired at different frequencies is still not well established.

2 Objective and Study Area

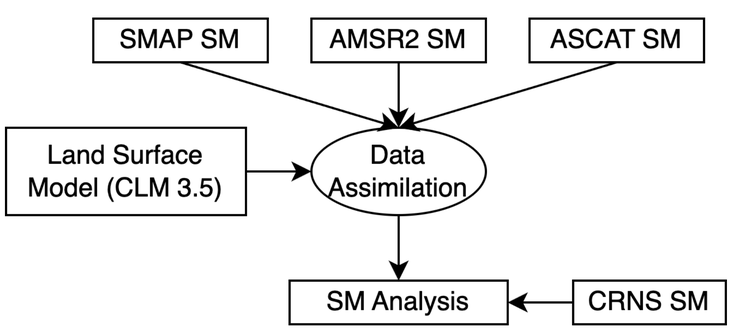
- To assess the impact of different remote sensing products on data assimilation (DA) performance.
- To examine the potential added value of joint assimilation and evaluate the effectiveness of LSTM in merging information compared to two traditional methods, linear weighting method based on Triple Collocation (TC) and simple arithmetic mean method.
- The experiment is conducted over a geographic region covering approximately 300 km × 300 km, encompassing areas of northwest Germany, the Netherlands and Luxemburg.



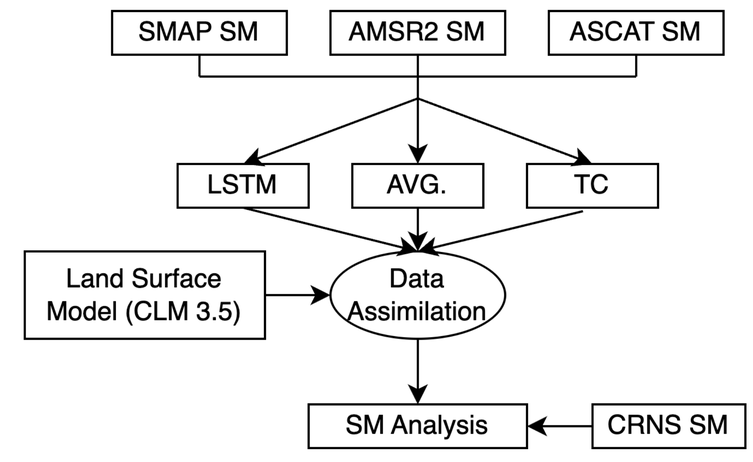
Location of the study area.

3 Method

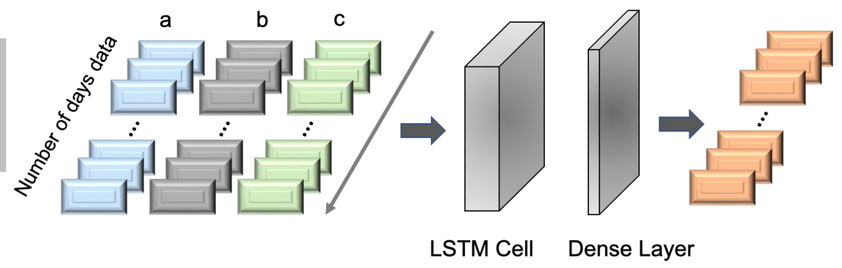
(a) Separate Retrieval Assimilation



(b) Joint Retrieval Assimilation



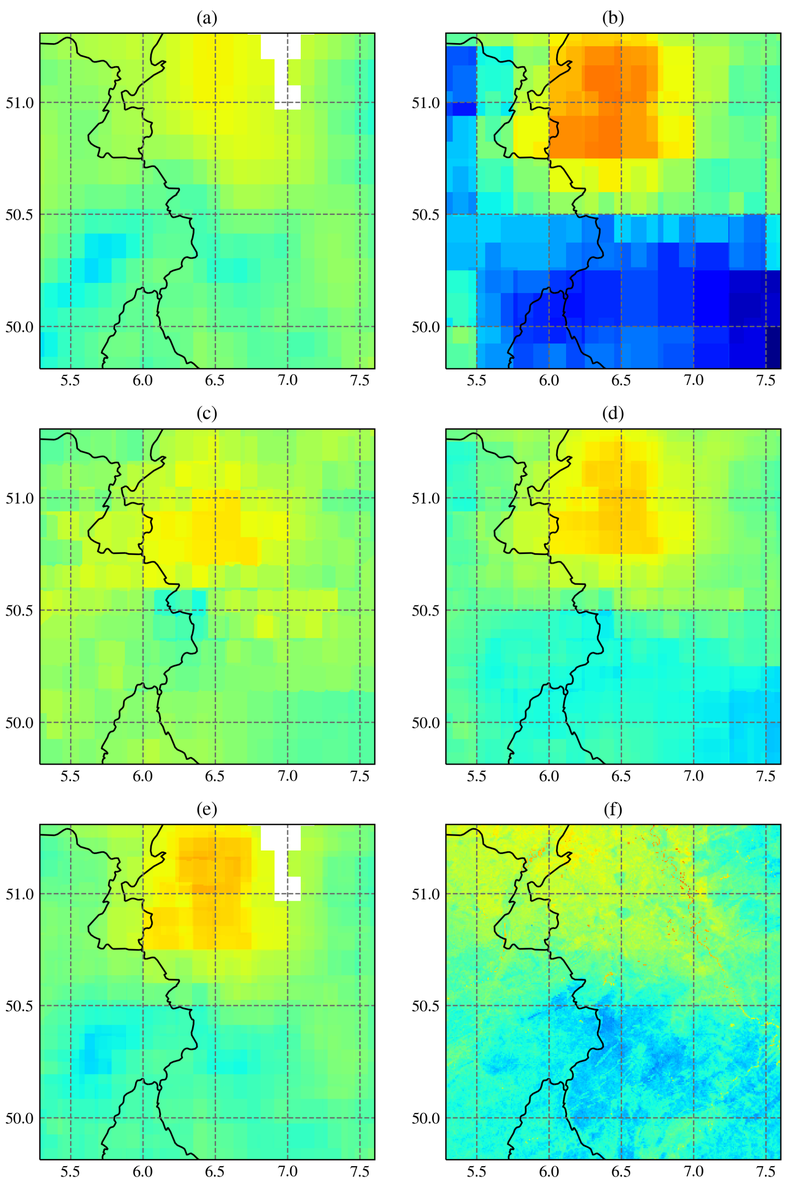
Input
a: RS SM products: SMAP, AMSR2, ASCAT
b: Dynamic: Meteorological forcings, LAI
c :Static: Sand, Clay, Silt, Bulk density, DEM



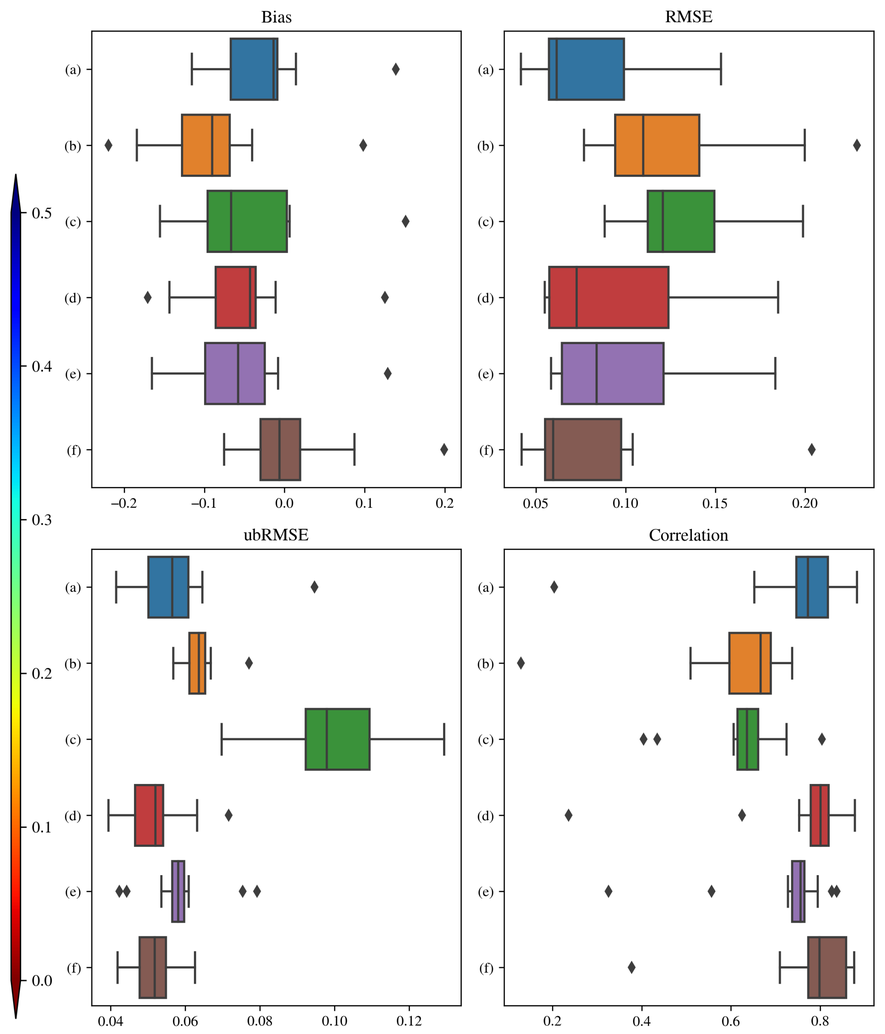
The LSTM SM merging scheme concept.

4 Results

The SM analysis of RS SM and Merged SM datasets.

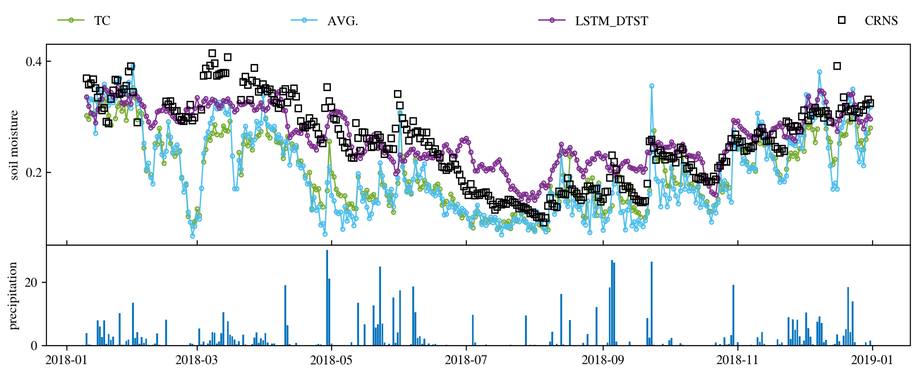


The spatial soil moisture distribution derived from original and merged datasets, averaged over the year 2018: (a) SMAP; (b) AMSR2; (c) ASCAT; (d) Arithmetic average method; (e) TC based method and (f) LSTM method.



Boxplots of statistical metrics for comparison between original and merged datasets at thirteen CRNS stations: (a) SMAP; (b) AMSR2; (c) ASCAT; (d) Arithmetic average method; (e) TC based method and (f) LSTM method.

Time series of soil moisture of in situ observations (black square) and merged dataset from TC based (green dots), arithmetic mean (cyan dots), and LSTM (purple dots) over thirteen stations for 10 January 2018 – 31 December 2018. The bottom graph represents the daily time series of precipitation forcing from COSMO-REA6.



5 Conclusions

- Different methods (simple arithmetic averaging, triple collocation, LSTM) were employed to merge different satellite soil moisture products and generate a merged soil moisture product.
- The LSTM and TC merged soil moisture products exhibit the ability to effectively integrate soil moisture information derived from diverse remote sensing products. They demonstrate comparable performance in terms of ubRMSE and R when compared to independent in-situ measurements, better than the simple arithmetic mean method.
- Notably, the LSTM approach demonstrates reduced bias and superior handling of spatial and temporal variations, owing to its intricate weighting calculations by incorporating information from both static and dynamic parameters at finer resolution.