# Surface Soil Moisture: toward a new combined dataset to maximize the use of satellite data

W. Moutier, N. Ghilain, N. Clerbaux, F. Gellens-Meulenberghs, A. Arboleda, M. Barrios, A. Duguay-Tetzlaff, T. Akkermans, A. Velazquez, E. Baudrez, J. Moreels and C. Aebi

*Contact:* *william.moutier@meteo.be*

## Introduction

The Surface Soil moisture (SSM) being an essential climat variable, it is fundamental to get homogeneous long term time series and catch both long and natural or human induced short-scale trends of SSM to improve predictions of the climate trajectory. The objective of this study is to take advantage of different approaches deriving the SSM by using the more appropriate dataset according the land cover. For this purpose, 3 datasets were used: the European Spatial Agency Climate Change Initiative (ESA-CCI) SSM ([1]), the ECMWF's fifth reanalysis (ERA-5; [2]) and a recent method from Ghilain et al., in prep ([3]) deriving the SSM from the land surface temperature data estimated thanks to thermal infrared sensors aboard geostationary satellites.

## Soil Moisture product : New combined approach

### REGIONAL PRODUCT SELECTION

Leaf Area Index (LAI) GLOBMAP [4]

Clusterisation *(kmeans) using the LAI / Climate informations*

Associate each cluster to a specific product according to the statistic

Define LAI criterias to select the most appropriate products according to the ground conditions (PDF of LAI parameters calculated over all the dataset for each pre-defined group)

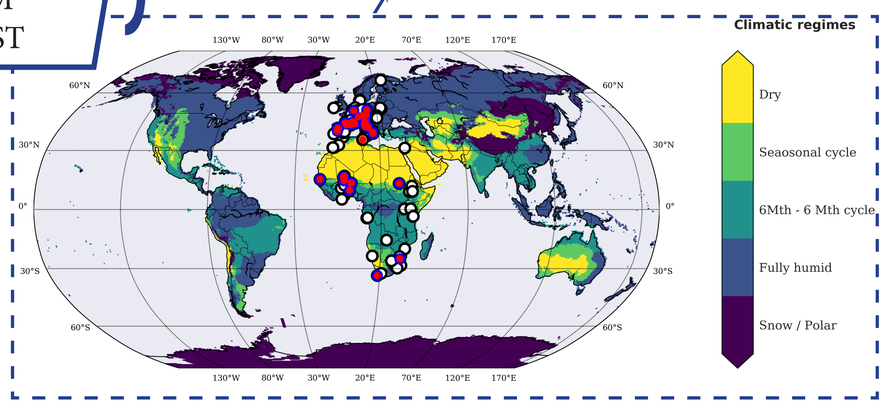
Scaled SM ERA-5

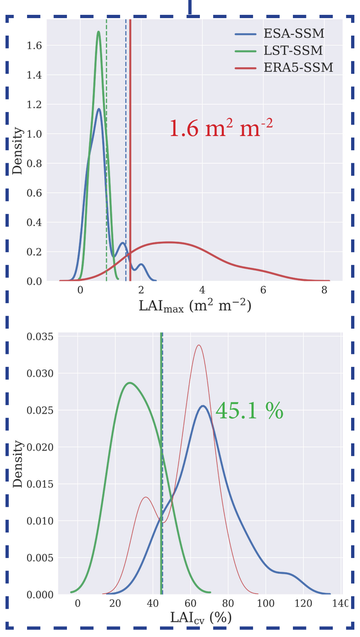
Scaled SM ESA CCI

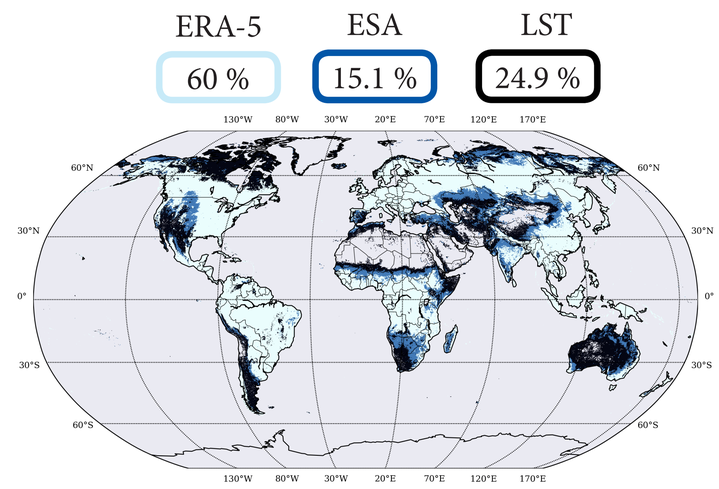
Scaled SM from the LST

Comparison with scaled In-Situ SM and identification of valid stations (R>0.6 and MAD<0.2) *52 selected*

Identify the best product according to the station




Global distribution of the selected product

| | R | MAD | Bias | N |
|---|---|---|---|---|
| ERA-5 | 0.76 ± 0.23 | 0.19 ± 0.07 | -0.05 ± 0.15 | 52 |
| ESA-SSM | 0.69 ± 0.11 | 0.21 ± 0.06 | -0.05 ± 0.12 | |
| LST | 0.5 ± 0.24 | 0.23 ± 0.08 | -0.005 ± 0.15 | |
| New one | 0.76 ± 0.1 | 0.18 ± 0.05 | 0.009 ± 0.12 | |

Average value (with its standard deviation) of the metrics calculated over the 52 selected stations.

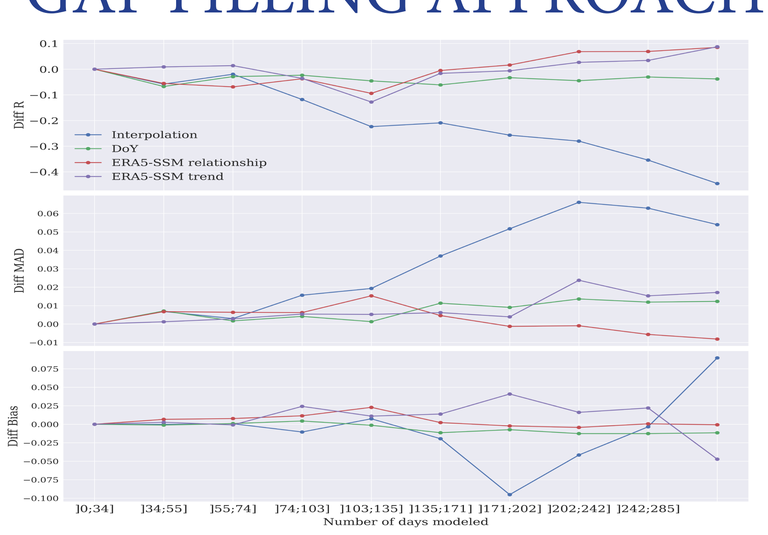
### GAP FILLING APPROACH

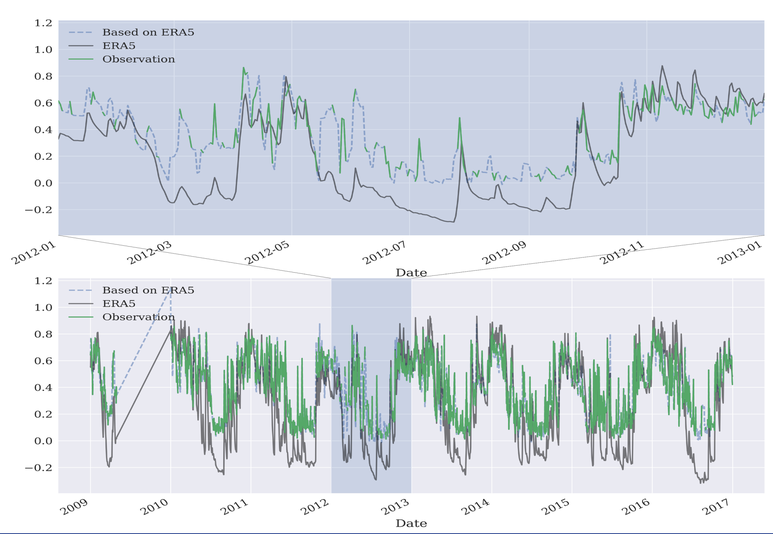
Missing values if :

1. LAI informations are not available.
2. Remote sensed estimations are not available.
3. Gaps in time series are present.

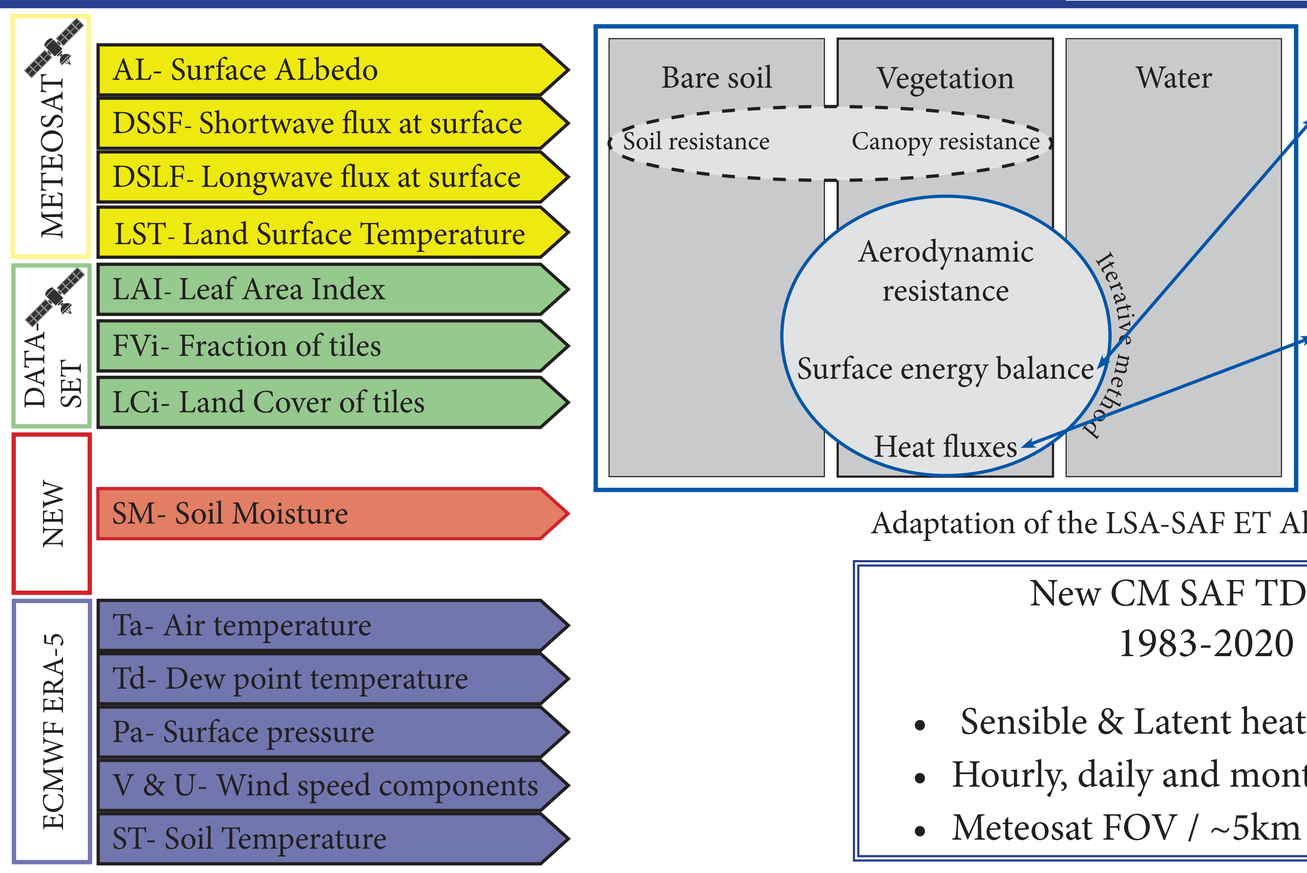
4 Methods tested :

1. Interpolation function.
2. LUT of mean values for each day of the year (based on available data).
3. Relationship linking the ERA-5 data and the other datasets.
4. Apply ERA-5 temporal trends.




## Typical example of potential application




Adaptation of the LSA-SAF ET Algorithm [5]

Surface energy balance

$$(1-\alpha)S_{\downarrow}+\epsilon(L_{\downarrow}-\sigma T_{sk,i}^4)-H_i-LE_i-G_i=0$$

Heat Fluxes

$$LE_i=\frac{L_v\rho_a}{(r_{a_i}+r_{c_i})}[q_{sat}(T_{sk,i})-q_a(T_{sk,i})]$$

$$H_i=\frac{\rho_a}{(r_{a_i})}[c_p(T_{sk,i}-T_a)-gz_a]$$

$$\Rightarrow ET=\frac{\sum_i \zeta_i LE_i}{L_v}$$

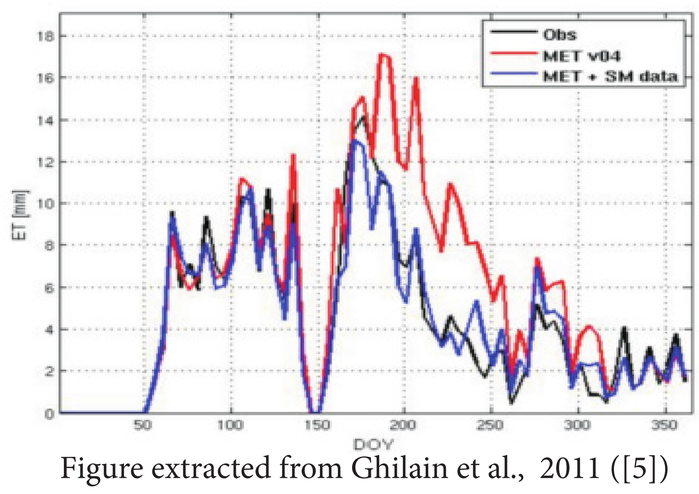



Figure extracted from Ghilain et al., 2011 ([5])

New CM SAF TDCR
1983-2020

- Sensible & Latent heat fluxes
- Hourly, daily and monthly data
- Meteosat FOV / ~5km of resolution

⟺

Why the new combined product?

1. Better estimation of a key input.
2. Maximize the use of satelite data which could prevent dependance of model output

## References

[1] Dorigo, W. et al.: (2017). ESA CCI Soil Moisture for improved Earth system understanding: State-of-the art and future directions. Remote Sensing of Environment.

[2] Hersbach, H., & Dee, D. (2016). ERA5 reanalysis is in production. ECMWF newsletter, 147(7).

[3] Ghilain, N. (in prep). Continental Scale Monitoring of Subdaily and Daily Evapotranspiration Enhanced by the Assimilation of Surface Soil Moisture Derived from Thermal Infrared Geostationary Data. In Satellite Soil Moisture Retrieval.

[4] Liu, Y., R. Liu, and J. M. Chen (2012), Retrospective retrieval of long-term consistent global leaf area index (1981–2011) from combined AVHRR and MODIS data, J. Geophys. Res., 117, G04003, doi:10.1029/2012JG002084.

[5] Ghilain, N., Arboleda, A., & Gellens-Meulenberghs, F. (2011). Evapotranspiration modelling at large scale using near-real time MSG SEVIRI derived data. Hydrology & Earth System Sciences, 15(3).

Acknowledgement: This research is funded by EUMETSAT (SAF/CM/DWD/CDOP3/CoA)-and PRODEX [4000123961] "Belgian contribution to the Satellite Application facility on Climate Monitoring (B-CMSAF)".