ON THE CALIBRATION OF AN EVAPORATION-BASED METHOD OF SMOS SOIL MOISTURE

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Water resources scarcity

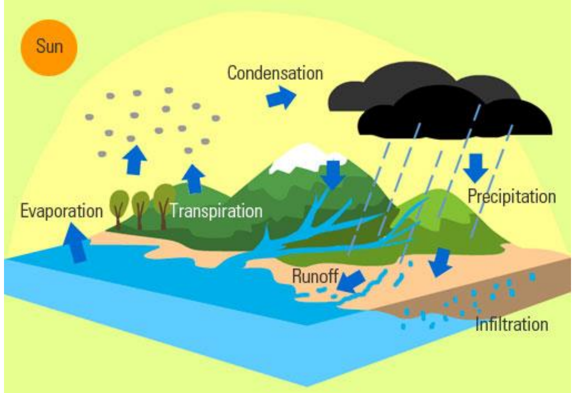
Agricultural constraint

- High percentage of water used for irrigation in Mediterranean countries
- Rainfall predictions uncertain
- Droughts
- Mismatch irrigation – actual needs

Water use efficiency

Monitoring resources

Modeling hydrological fluxes



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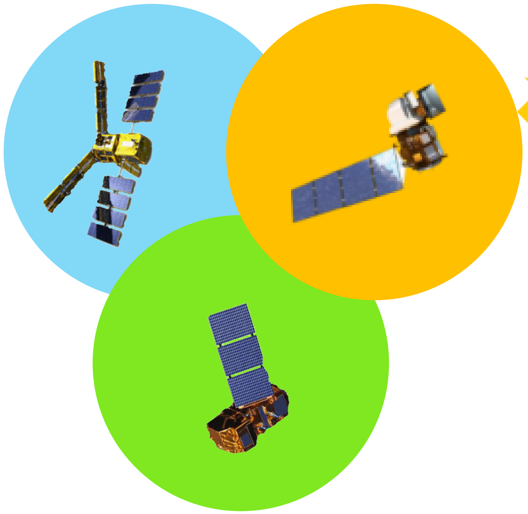
Soil moisture - SM (soil evaporation)

L-band (and C-band) Microwave



Land Surface Temperature - LST (Evapotranspiration)

Thermal Infrared

Vegetation index - F_c (Evaporation/Transpiration partition)

Visible and Near Infrared

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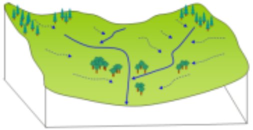
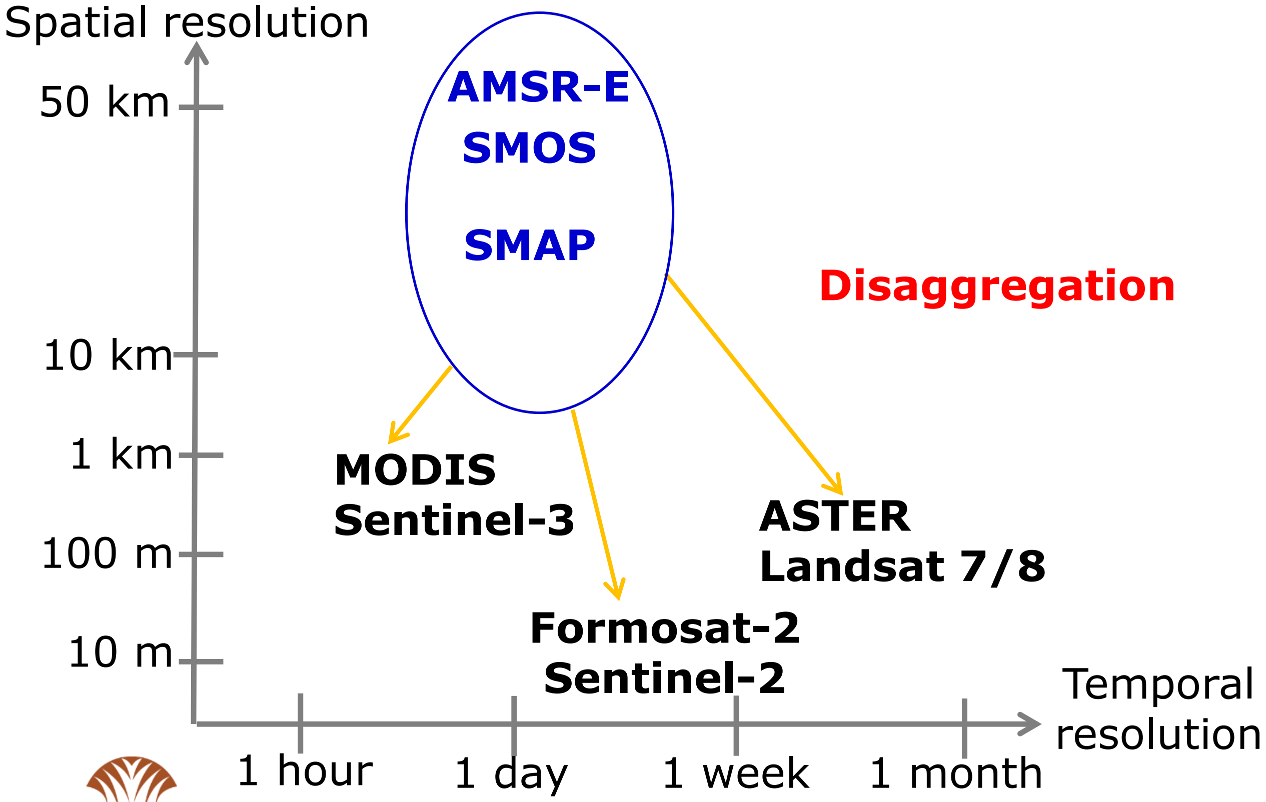
Meteorological & climatological

Watershed



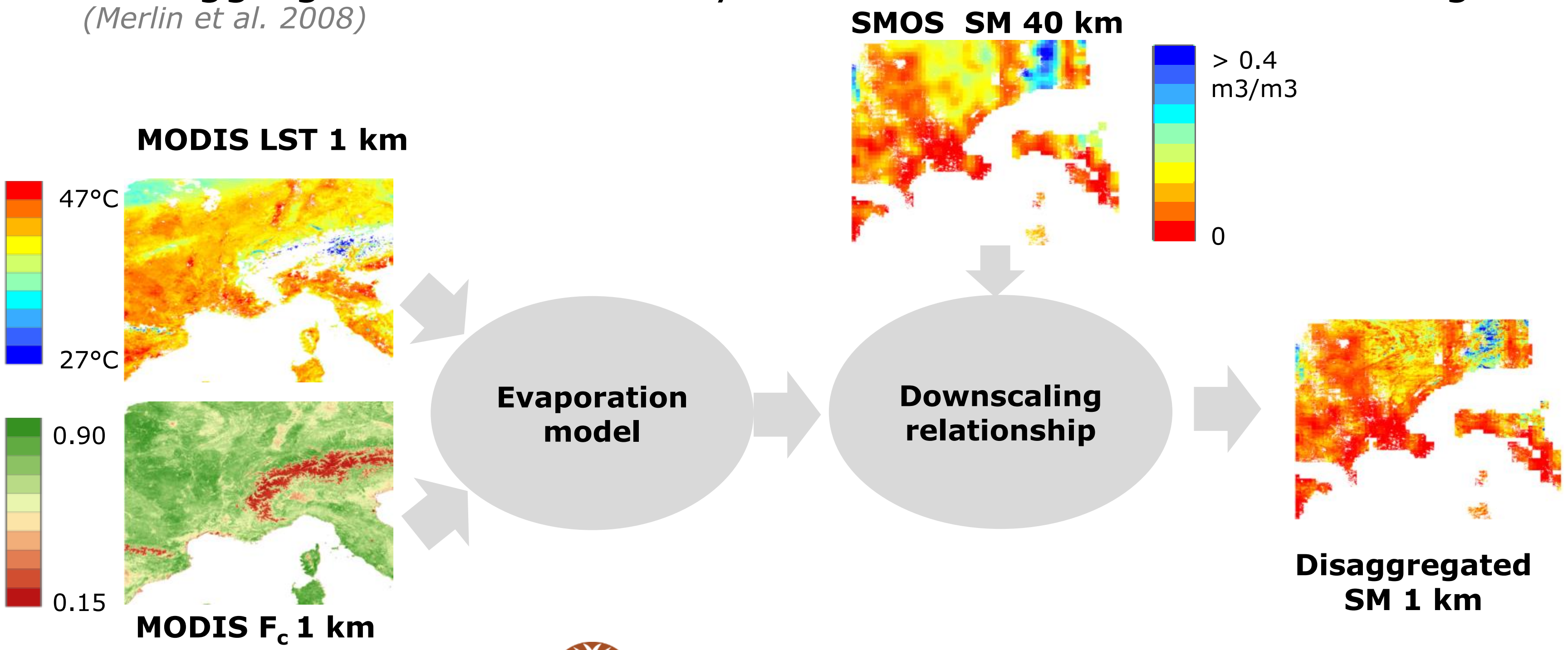
Agricultural

In situ Validation



DISaggregation based on **P**hysical **A**nd **T**heoretical scale **CH**ange

(Merlin et al. 2008)



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DISPATCH

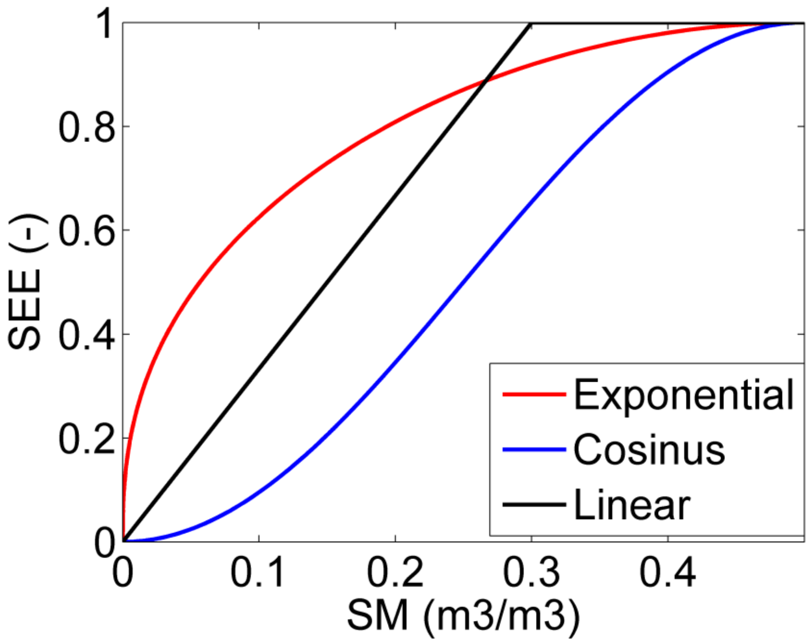
1.Disaggregation equation: $$SM_{HR} = SM_{LR} + \left(\frac{\partial SM_{\mathrm{mod}}}{\partial SEE}\right)_{SEE=SEE_{LR}} * \left(SEE_{HR} - SEE_{LR}\right)$$

2.Semi-physical SEE(SM) model

3.Soil Evaporative Efficiency: $SEE(LST) = LE_s / LE_{p,s} = (T_{s,dry} - T_s) / (T_{s,dry} - T_{s,wet})$

- $\mathbf{T_{s,dry}}$ – soil temperature in fully dry conditions
- $\mathbf{T_{s,wet}}$ – soil temperature in fully wet conditions

SEE(SM)



Linear
(Budyko 1956, Manabe 1969)

Cosinus
(Lee&Pielke 1992, Noilhan&Planton 1989)

Exponential
(Komatsu 2003)

$$SEE = 1\text{-}\exp(SM/SM_c)$$

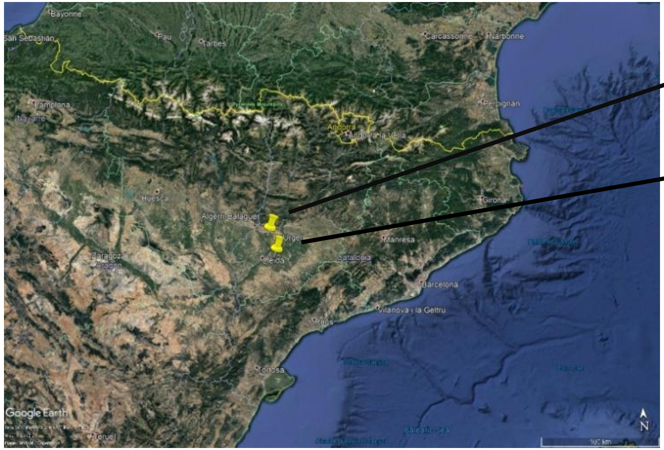
SEE(SM)

Linear
(Budyko 1956, Manabe 1969)

Exponential
(Komatsu 2003)

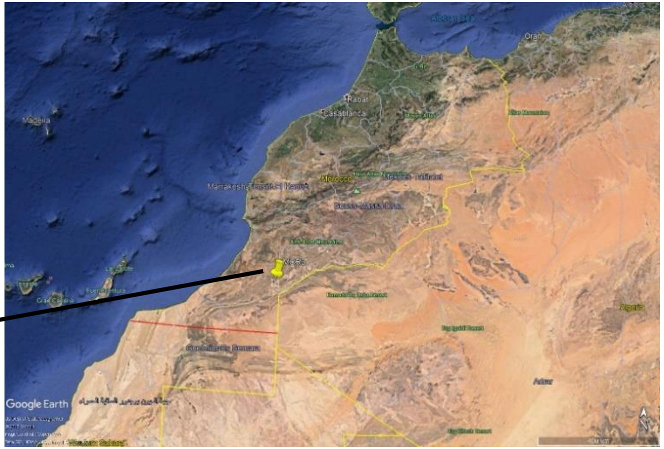
Calibrated on a daily and multi-date basis and introduced in DISPATCH

Study sites



Algerri Balaguer (Catalonia, Spain)

Urgell (Catalonia, Spain)



MOR3 (Morocco)

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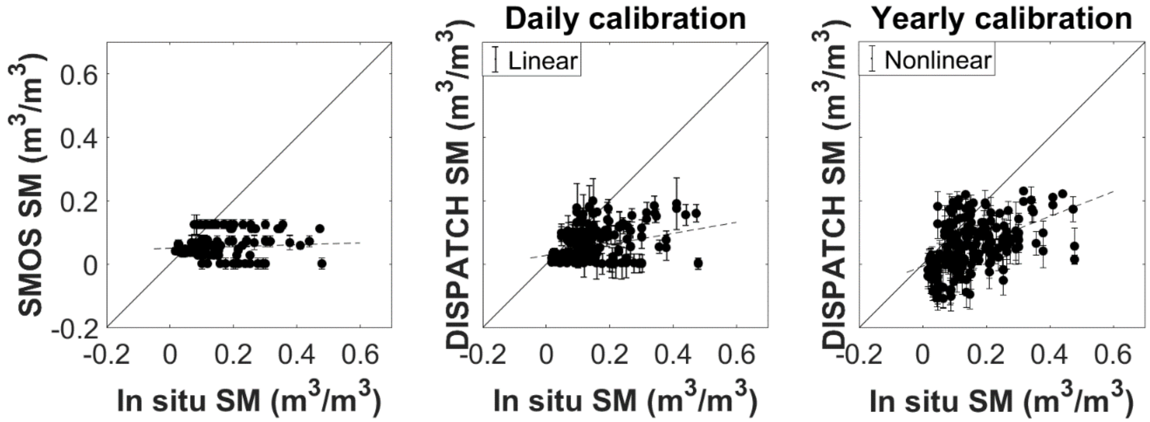
Results

- Statistical results: correlation coefficient (R), slope of linear regression (S), bias and unbiased root mean square difference (uRMSD) presented per site, for all models and all calibrations
- Scatterplots presented per site, for the best model within each calibration

Urgell 2011-2012

	R	Slope	Bias	uRMSD
SMOS	0.084	0.028	**-0.088**	0.097
DISPATCH linear, daily calibration	0.34	0.17	-0.089	0.090
DISPATCH linear, multi-date calibration	0.084	0.028	**-0.088**	0.097
DISPATCH nonlinear, daily calibration	0.36	0.21	**-0.088**	0.089
DISPATCH nonlinear, multi-date calibration	**0.50**	**0.39**	-0.092	**0.077**

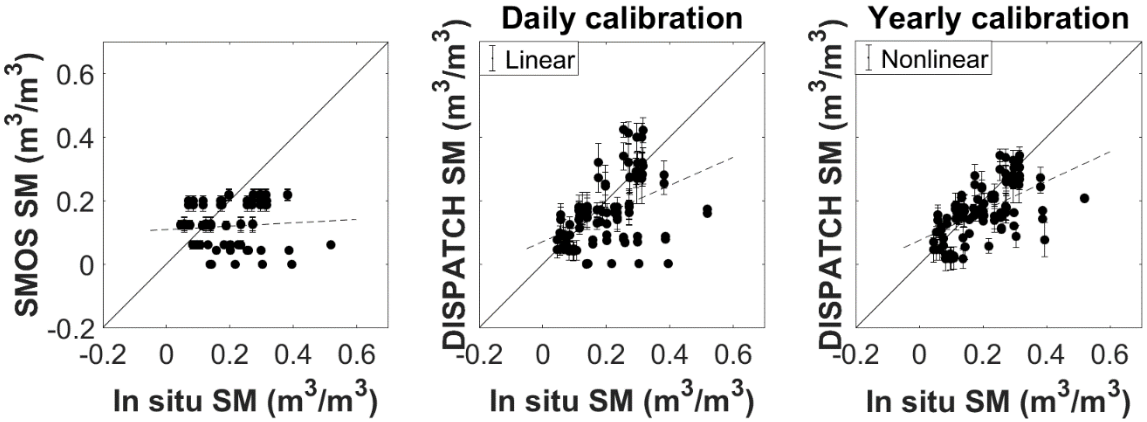
Urgell 2011-2012



Urgell 2015

	R	Slope	Bias	uRMSD
SMOS	0.081	0.053	-0.079	0.096
DISPATCH linear, daily calibration	0.44	0.44	-0.04	0.092
DISPATCH linear, multi-date calibration	0.081	0.053	-0.079	0.096
DISPATCH nonlinear, daily calibration	0.081	0.053	-0.079	0.096
DISPATCH nonlinear, multi-date calibration	**0.57**	**0.47**	**-0.031**	**0.073**

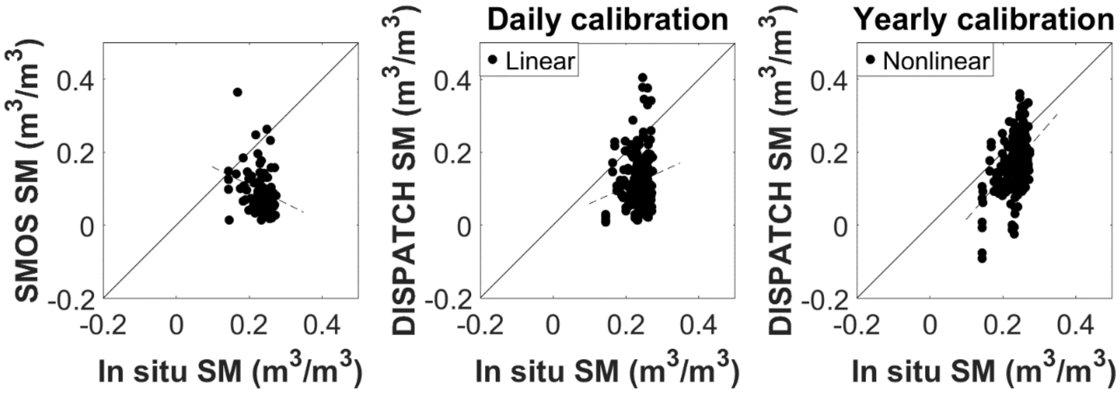
Urgell 2015


Daily calibration
Yearly calibration
Linear
Nonlinear
SMOS SM (m3/m3)
DISPATCH SM (m3/m3)
DISPATCH SM (m3/m3)
0.6
0.4
0.2
0
-0.2
-0.2
0
0.2
0.4
0.6
In situ SM (m3/m3)
In situ SM (m3/m3)
In situ SM (m3/m3)

Algerri Balaguer

	R	Slope	Bias	uRMSD
SMOS	-0.20	-0.49	-0.14	0.066
DISPATCH linear, daily calibration	0.18	0.44	-0.11	0.061
DISPATCH linear, multi-date calibration	-0.081	-0.14	-0.15	0.056
DISPATCH nonlinear, daily calibration	-0.081	-0.14	-0.15	0.056
DISPATCH nonlinear, multi-date calibration	**0.47**	**1.16**	**-0.063**	**0.054**

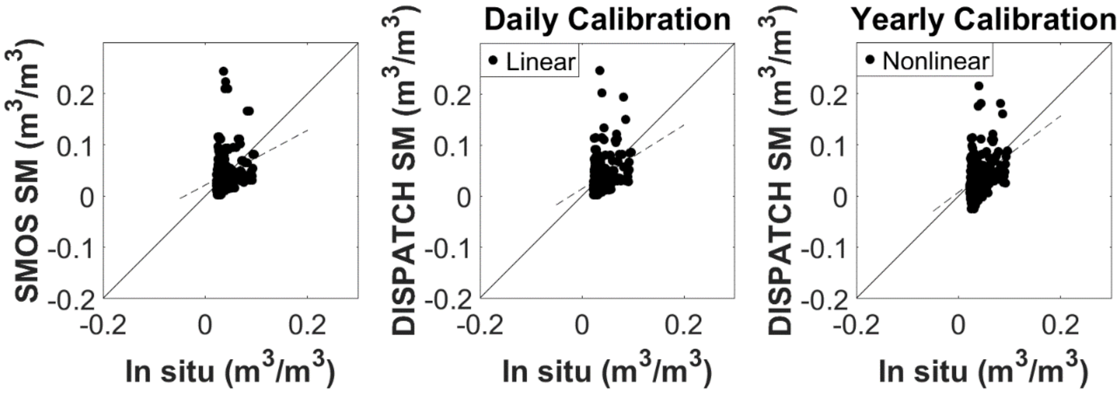
Algerri Balaguer



Morocco

	R	Slope	Bias	uRMSD
SMOS	0.25	0.54	0.0041	0.032
DISPATCH linear, daily calibration	0.32	0.62	**-8e-5**	**0.031**
DISPATCH linear, multi-date calibration	0.25	0.54	0.0041	0.0032
DISPATCH nonlinear, daily calibration	0.31	0.65	-0.0013	**0.031**
DISPATCH nonlinear, multi-date calibration	**0.33**	**0.75**	-0.0021	0.033

Morocco



Daily Calibration
Yearly Calibration
Linear
Nonlinear
SMOS SM (m^3/m^3)
DISPATCH SM (m^3/m^3)
DISPATCH SM (m^3/m^3)
In situ (m^3/m^3)
In situ (m^3/m^3)
In situ (m^3/m^3)
0.2
0.1
0
-0.1
-0.2

Conclusions and perspectives

- This work has lead to the writing of an article: ***Temporal calibration of an evaporation-based spatial disaggregation method of SMOS soil moisture data (Stefan et al. 2020, under revision for Remote Sensing)***
- Two SEE(SM) models (linear and nonlinear), with a daily and a multi-date calibration, have been implemented in DISPATCH and tested over 3 areas
- The nonlinear SEE(SM) model with a multi-date calibration performs better over all sites
- The nonlinear SEE(SM) model with a multi-date calibration could be implemented in the CATDS L4 (current version uses linear model with daily calibration) and into existing evapotranspiration models (based on a combination of thermal and microwave data)