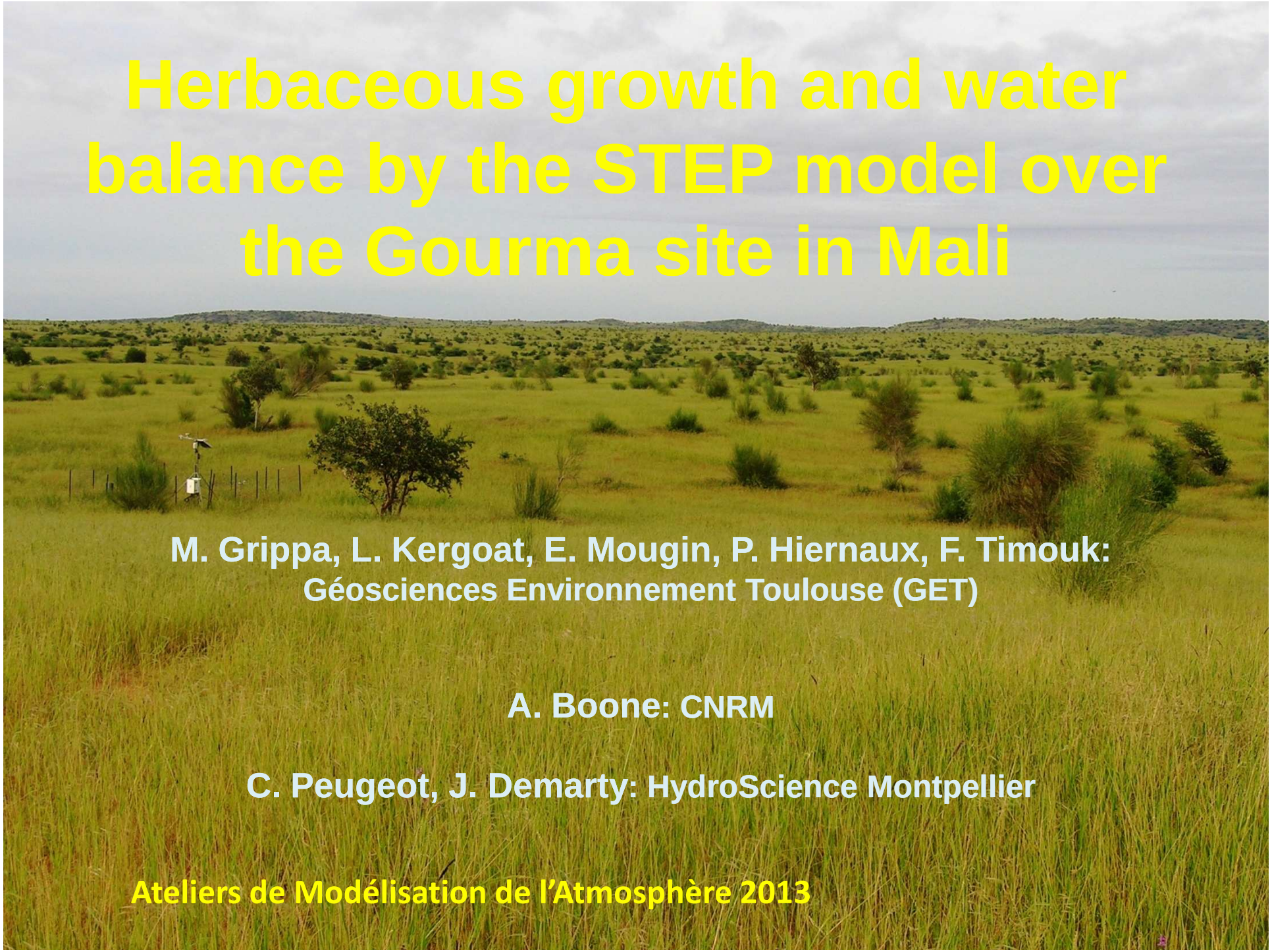
Herbaceous growth and water balance by the STEP model over the Gourma site in Mali



M. Grippa, L. Kergoat, E. Mougin, P. Hiernaux, F. Timouk:
Géosciences Environnement Toulouse (GET)

A. Boone: CNRM

C. Peugeot, J. Demarty: HydroScience Montpellier

Ateliers de Modélisation de l'Atmosphère 2013

Objectives

- **Evaluate herbaceous growth and the water balance simulated by STEP in the framework of the ALMIP2 project over the Gourma site in Mali**

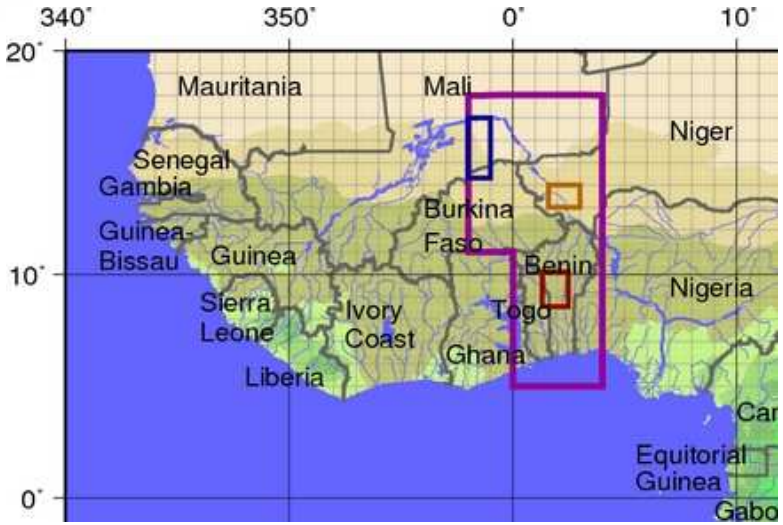
- **Investigate the impact of the meso scale forcing (soil description and the precipitation) on the STEP results**

ALMIP AMMA Land Surface Model Intercomparison Project

- **Model intercomparison and evaluation (SVAT+ hydrological and vegetation models)**
- **Comparison global and local models**

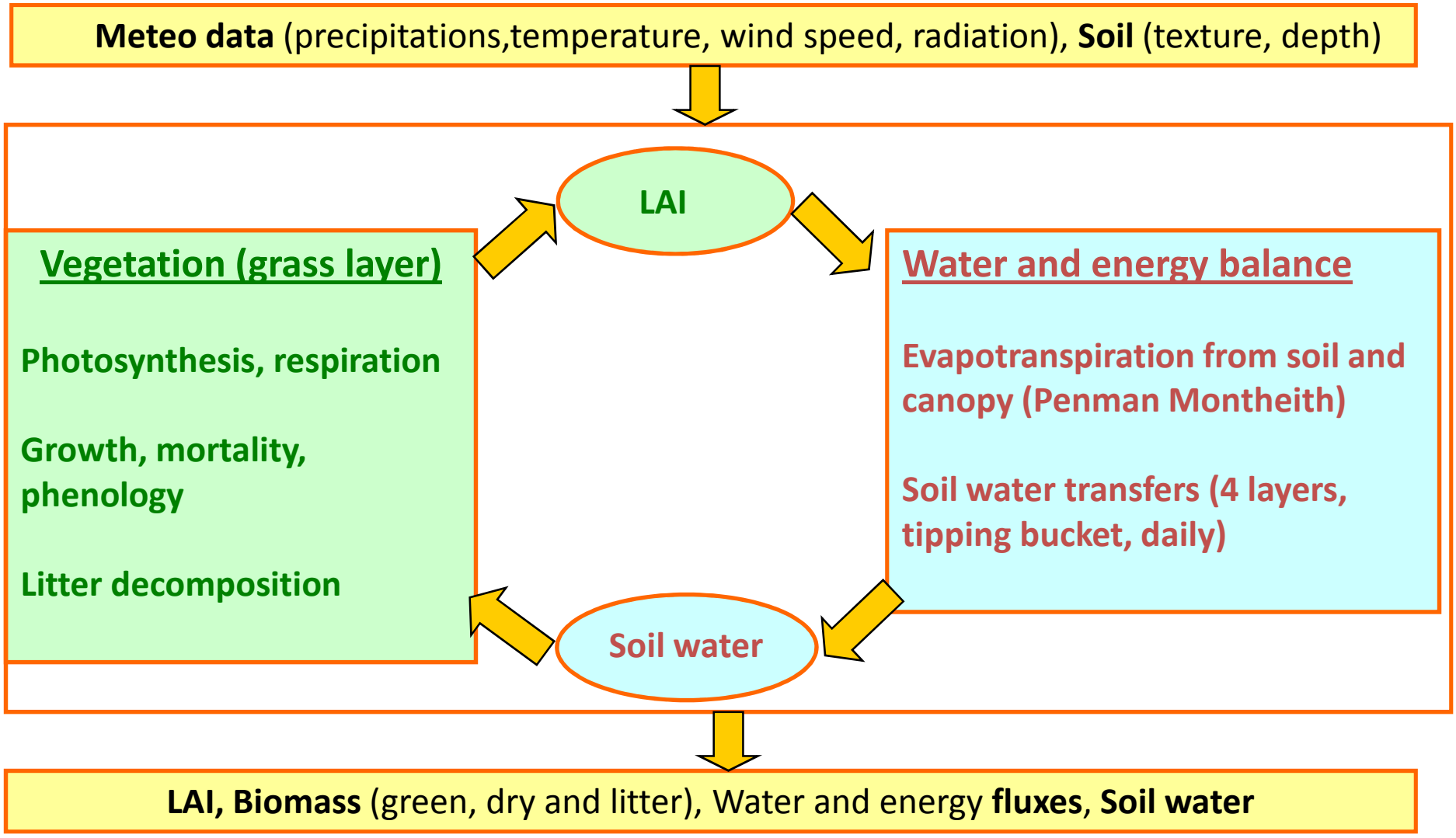
S.O. AMMA-CATCH
3 instrumented meso-sites in Mali, Niger et Benin
Specific forcing and data for evaluation

Boone et al. 2009



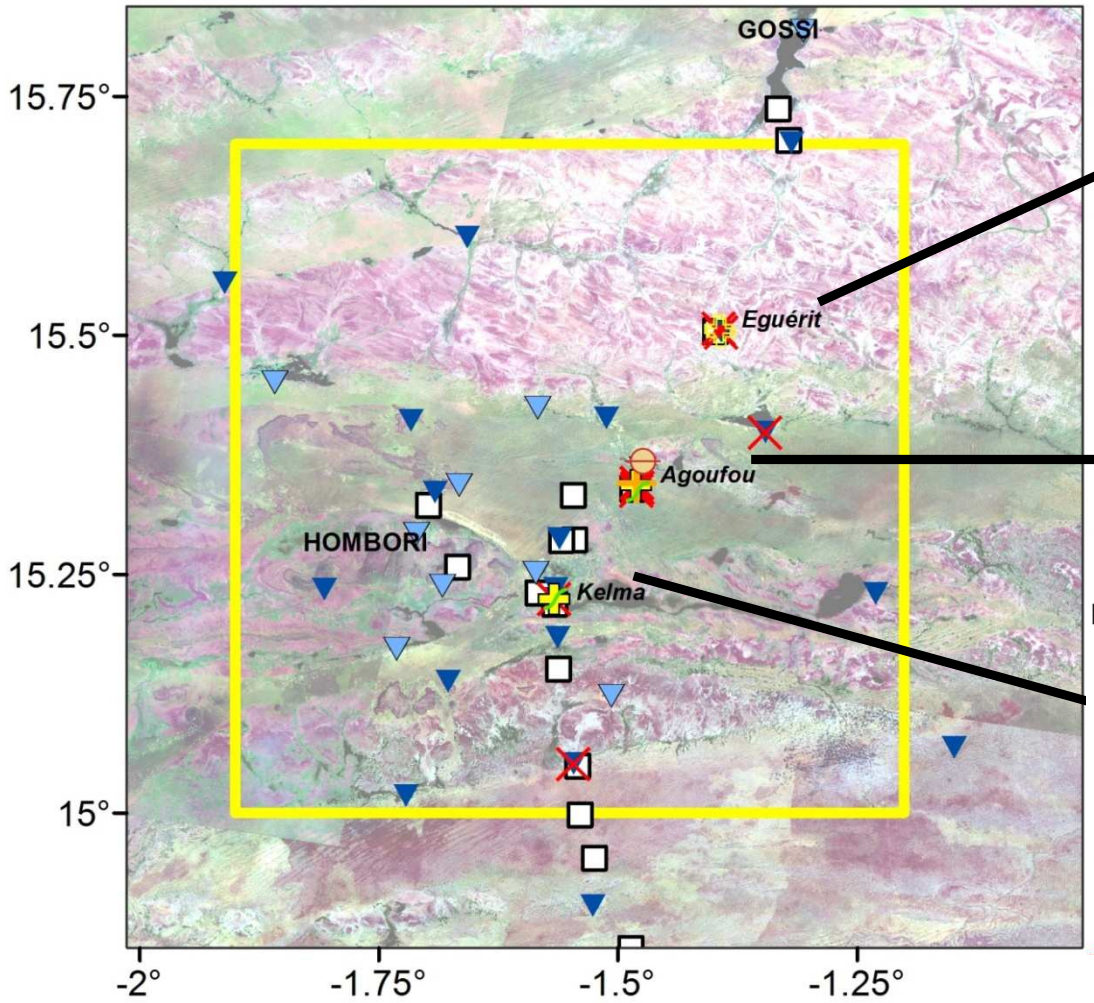
STEP model: Sahelian Transpiration Evaporation and Production model

Mougin et al. 1995



The ALMIP2 Gourma site

Meso scale site



Local sites

Dry season

Wet season

Shallows soils generating runoff →Ponds

Eguerit

Deep sandy soils endoheric

Agoufou

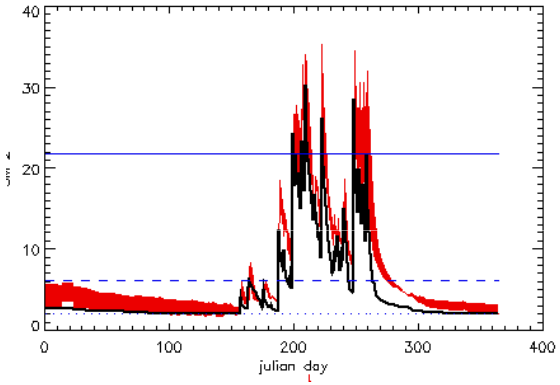
Seasonally flooded areas

Kelma

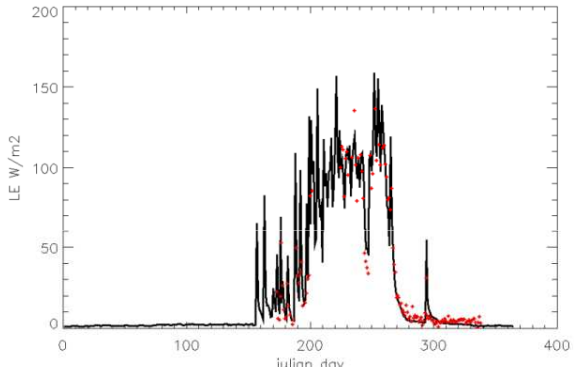
Local scale simulations

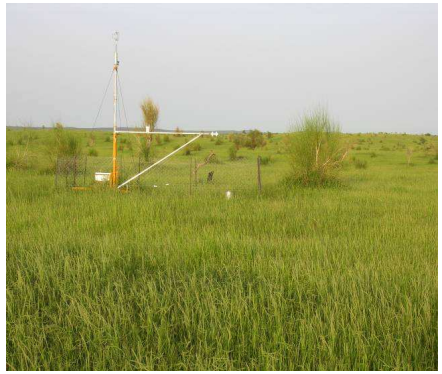
Sandy soil: Agoufou 2007

Root layer SM (mm) 2-30cm



LE flux (W/ m²)

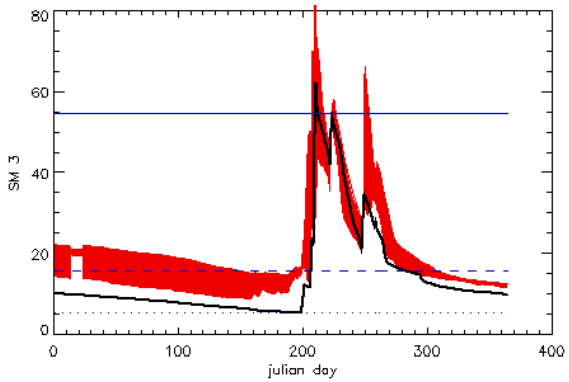




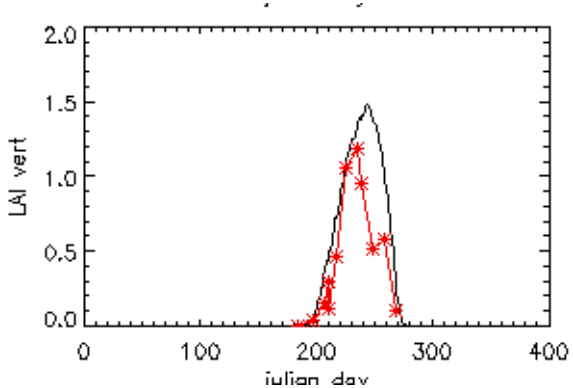
___ STEP

___ in situ measurements

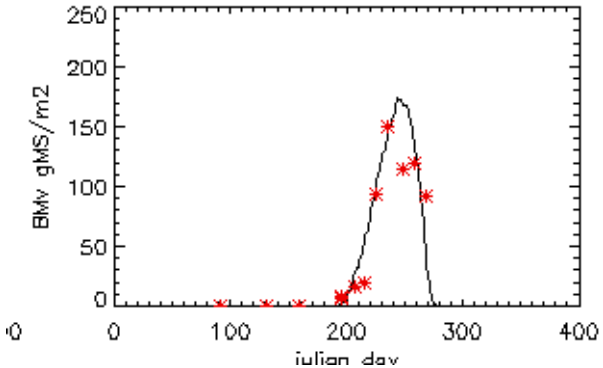
SM (mm) 30-100cm



LAI



Green biomass (g DM/m²)

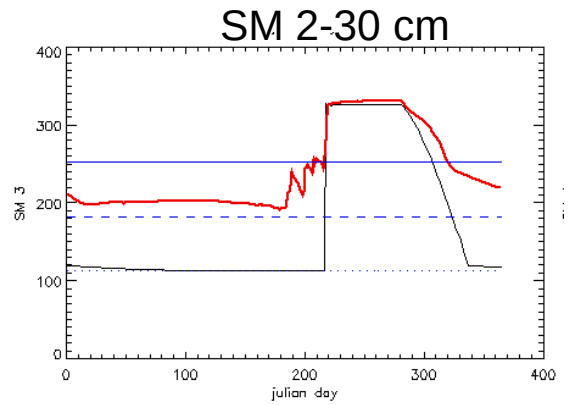


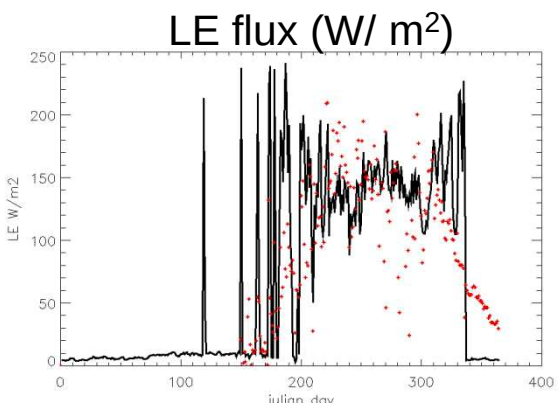
STEP water balance on other soil types than sand

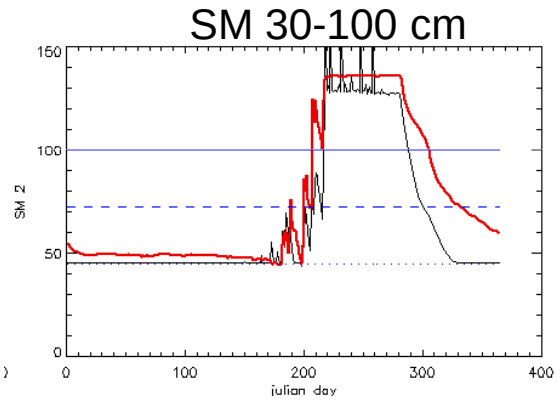
Seasonally flooded clayed soil: Kelma

- Flood period: SM in all layer forced to SM at saturation (derived from texture)

- Trees not taken into account yet!





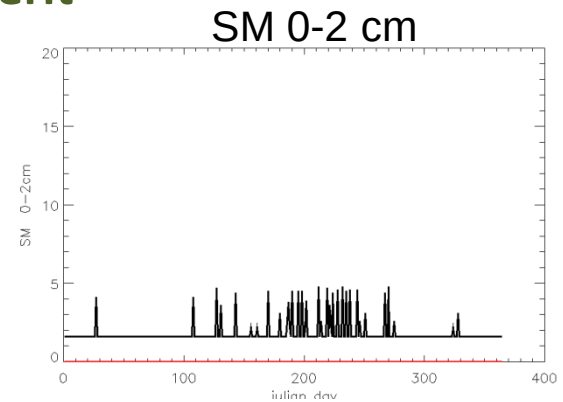


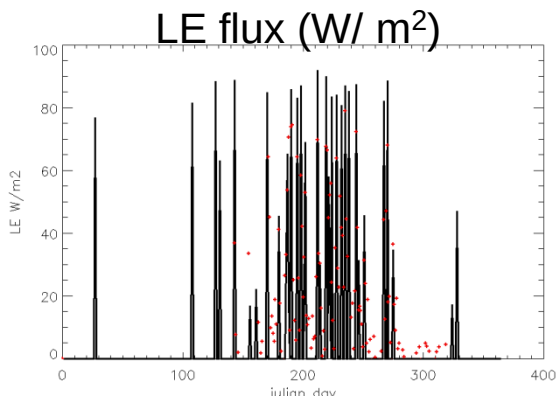
___ STEP

___ in situ measurements

Shallow soil over bedrock: Eguerit

Shallow loamy layer of 2cm over impermeable rocky layer





Meso scale simulations

Evaluate STEP at the meso scale and investigate the impact of different soil descriptions (texture and depth) and different methods for kriging precipitation

Soil type maps (texture and depth)

- ECOCLIMAP2 (version 2)

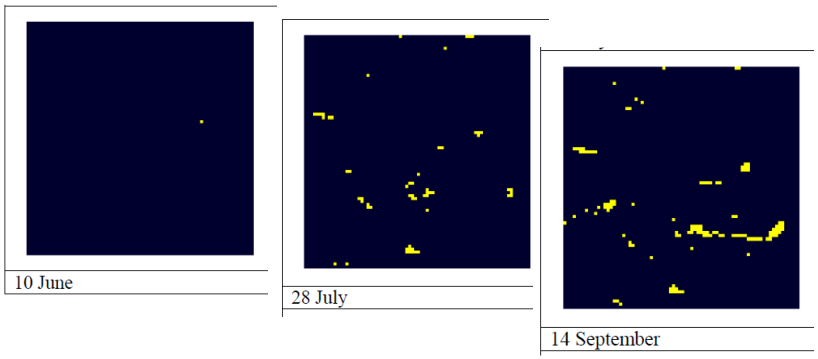
- Gourma soil texture classification derived from LANDSAT:
  - **dominant classes**
  - **subgrid** approach (including **flooded area** dynamics derived from MODIS)

Precipitation

- Thiessen 2006-2007-2008

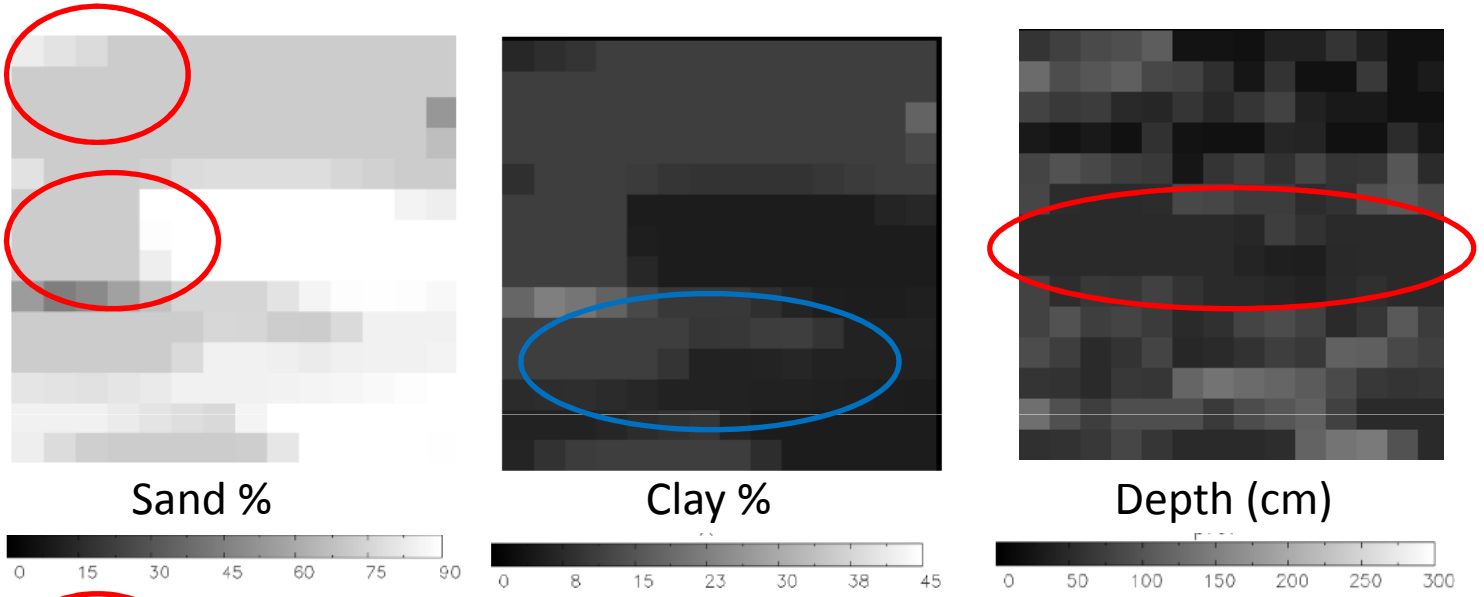
- Lagragian kriging 2008
(Vichel et al 2011)

ALMIP2 forcing
Res: 0.05°, 30 minutes



Soil databases comparison

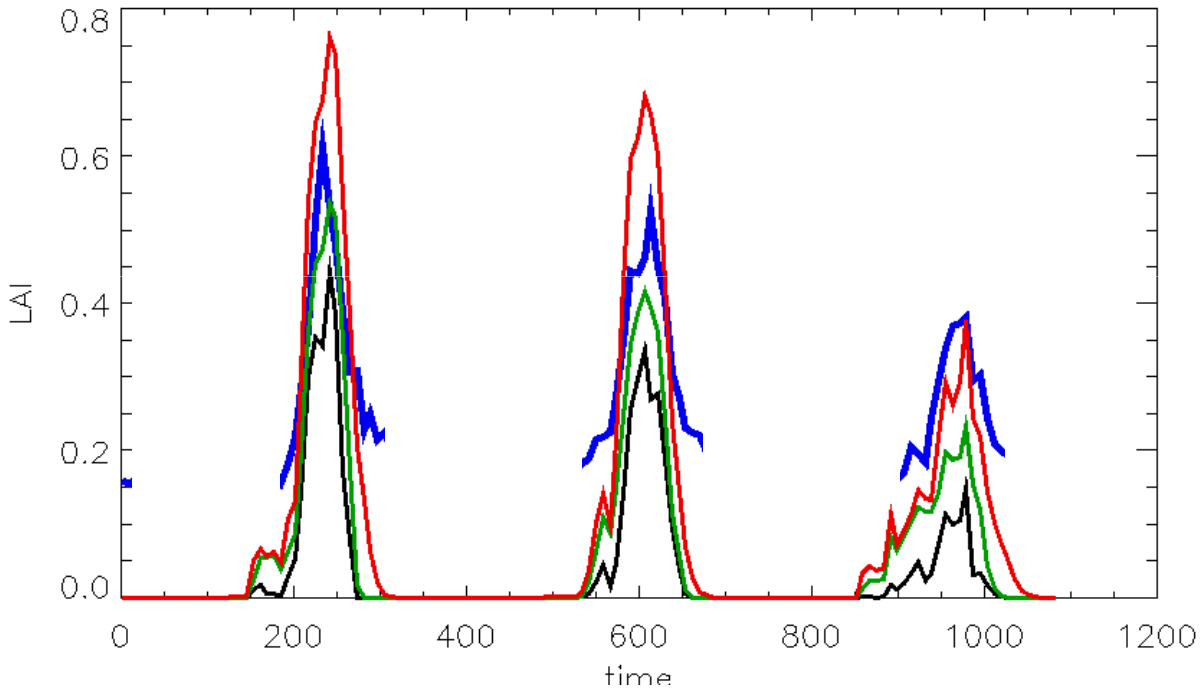
1. ECOCLIMAP2 global database



2. Gourma database, Dominant classes

Comparison of STEP LAI to MODIS data

Spatially averaged values over the meso site



MODIS wet season

STEP ECOCLIMAP

STEP Gourma dominant

STEP Gourma Subgrid

- High sensitivity to the soil type description
- General good agreement on the interannual LAI variability

LAI spatial distribution

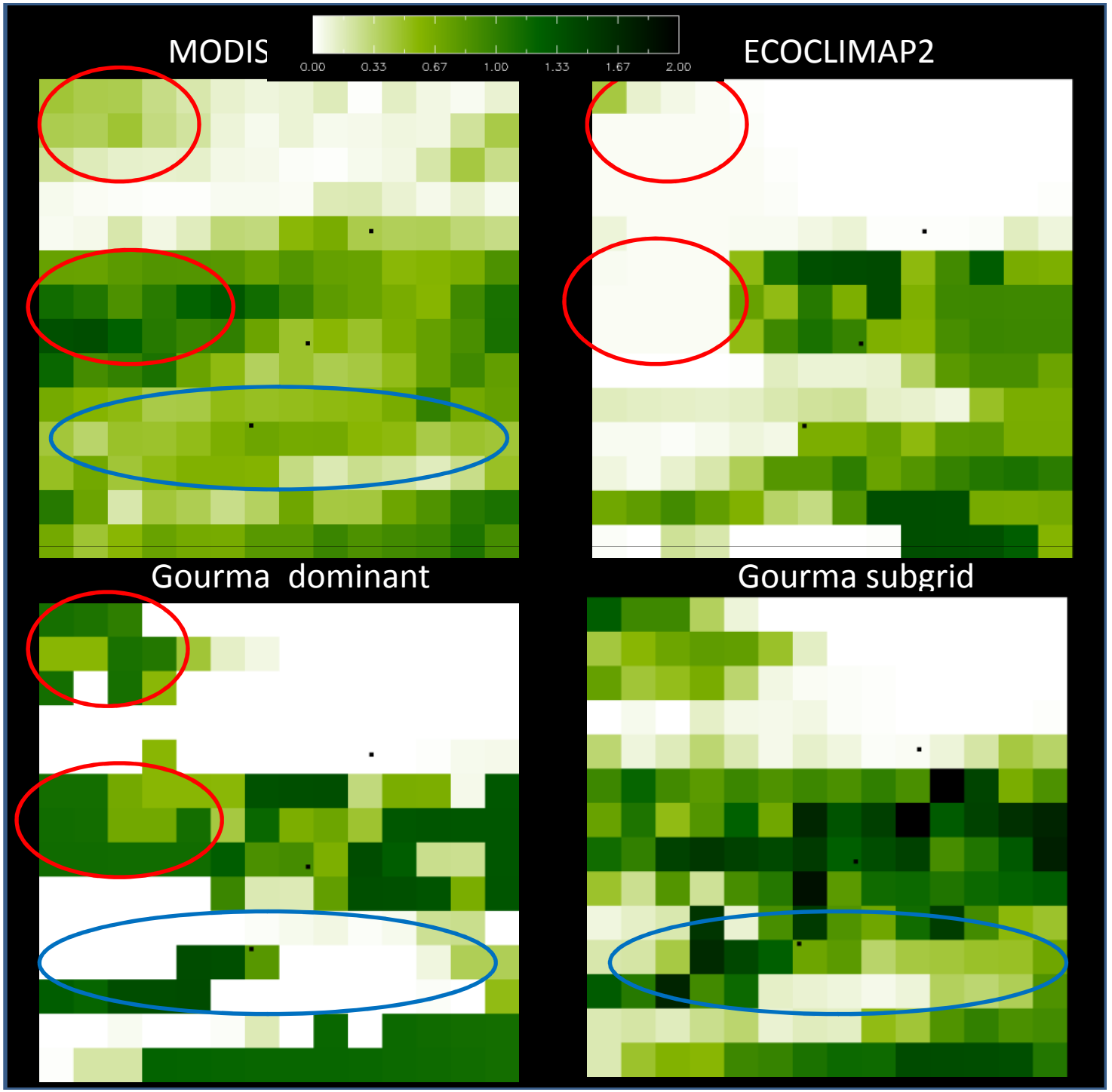
Example:
13 08 2006

R-values between MODIS and

-ECOCLIMAP=0.40

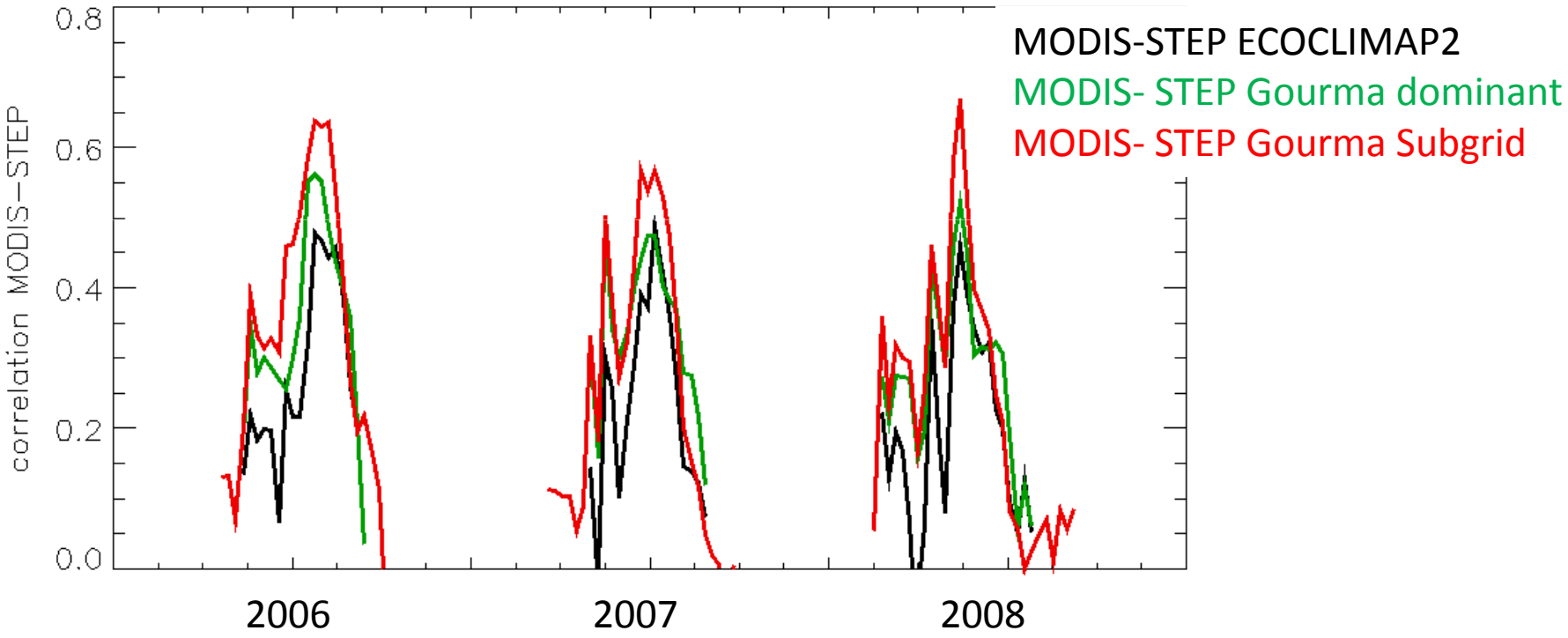
-Gourma dom=0.56

-Gourma sub=0.62



LAI STEP – MODIS: Spatial correlation

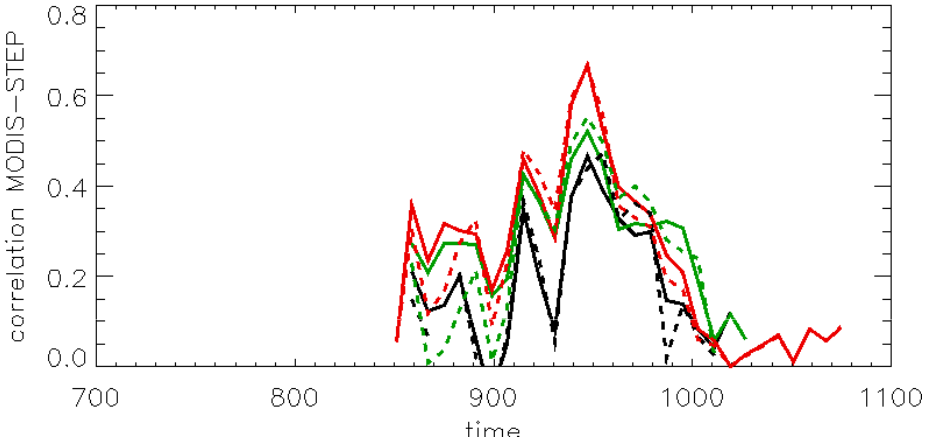
Correlation coefficients R from linear regression between MODIS and STEP LAI for each date



Correlation with MODIS higher when using the Gourma specific soil description (and subgrid parametrization)

STEP sensitivity to precipitation and soil type: LAI

Correlation coefficients R from linear regression between MODIS and STEP LAI for each date: 2008

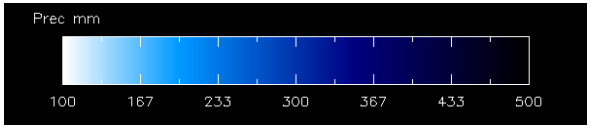


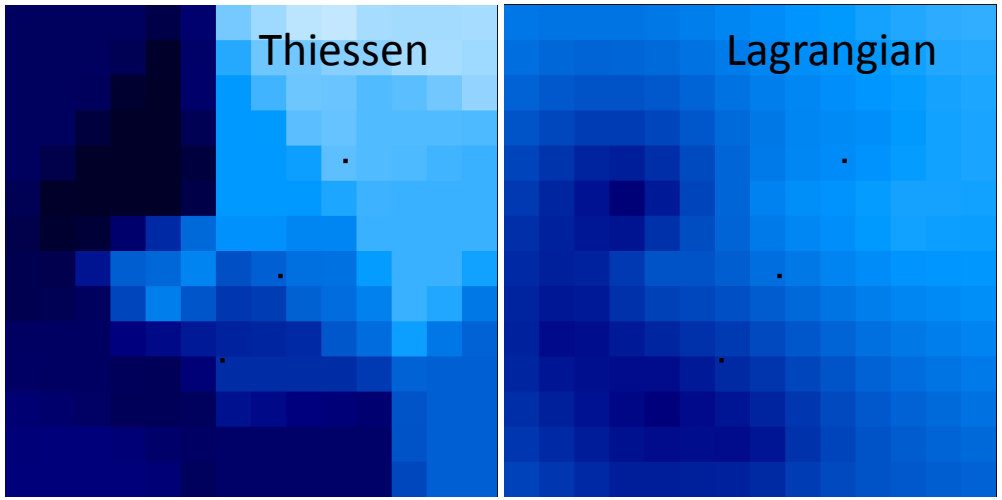
STEP ECOCLIMAP ___ Thiessen .... Lagrang

STEP Gourma dominant ___T L

STEP Gourma Subgrid ___T L

Total precip 2008

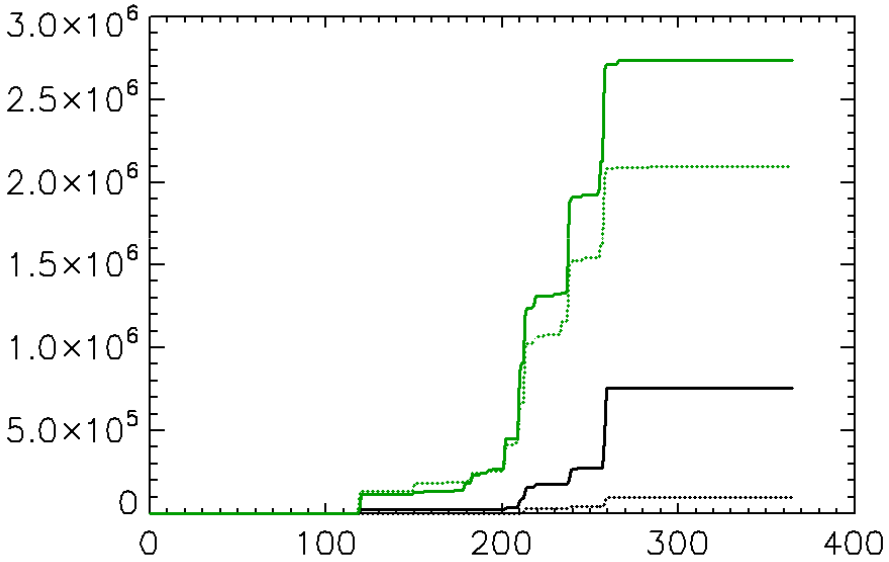


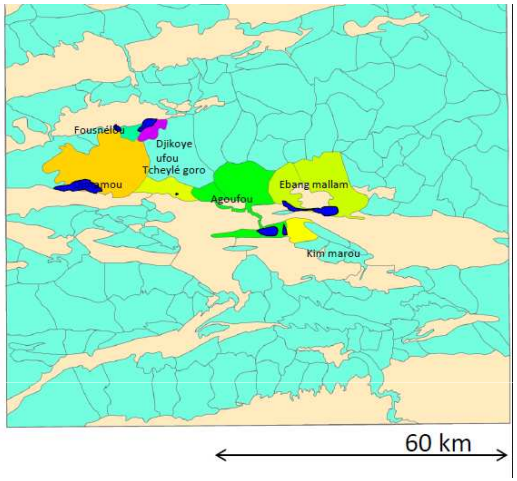


No significant differences in the correlations values when using thiessen or lagrangian precipitation kriging

STEP sensitivity to precipitation and soil type: water balance on the Agoufou watershed

Total runoff on the Agoufou watershed in 2008





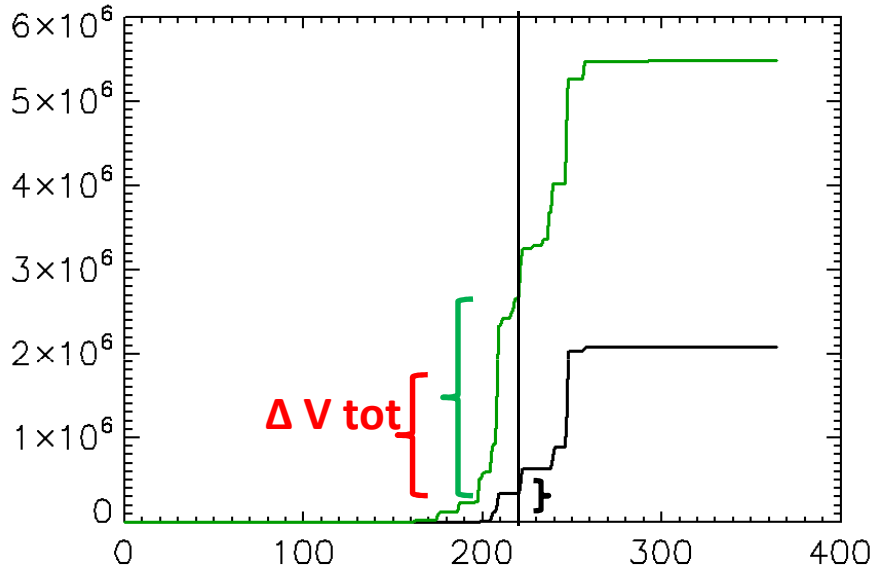
STEP ECOCLIMAP ___ Thiessen …. Lagrang

STEP Gourma dominant ___T ….. L

STEP results very sensitive to the soil description database but also to the rainfall kriging methodology

Water balance on the Agoufou watershed: very preliminary evaluation

Total runoff on the Agoufou watershed in 2007



STEP ECOCLIMAP

STEP Gourma dominant

Agoufou pond's volume

Preliminary estimation:

V-V0 = S*h - S0*h0

where h = height by limnimetric measurement,

S = pond's surface derived by classification of FORMOSAT satellite images

Runoff on the watershed > Δ Pond's volume + Δ Pond's evaporation - Δ Rainfall on pond

Between day 198 and 220

R ECOCLIMAP = 0.33 x10^6 m3
NOT ENOUGH!

R Gourma = 2.2 x10^6 m3
ENOUGH!

Δ V ponds= 1.4 x10^6 m3
Δ V tot = Δ V ponds + Δ Evap - Δ Rain= 1.2 x10^{6}m3

Conclusions

For the Gourma site in Mali

At local scale:

Good agreement between STEP and in situ measurements (soil water, LE fluxes and vegetation) acquired at three sites with different soil characteristics.

At meso scale:

- **Soil texture and depth** is the primary factor accounting for vegetation distribution and water balance at the meso scale.
- **Water re-distribution at subgrid scale** is also important.
- STEP results compare better to remote sensing estimations (LAI, ponds'volume) when these factors are well taken into accounts

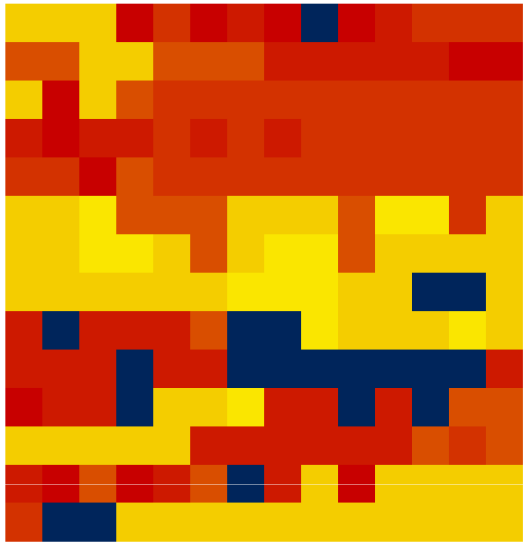
→**Future work: model intercomparison!**

Are this findings valid for other models?

Gourma soil description

12 Soil type classes derived by LANDSAT classification and field knowledge

(Hiernaux et Cheula 2007)



Dominant classes

Name	Texture grossière (%)			Texture fine (%)			Prof (cm)
	C	G	F	S	L	A	
Affleurement de cuirasse et grés	100	0	0	0	0	0	0
Sol limoneux	10	10	80	55	30	15	50
Ensablement de surface	0	0	100	85	10	5	30
Dune	0	0	100	90	6	4	> 300
Interdune	0	0	100	85	10	5	>300
Sable vif	0	0	100	95	3	2	>300
Sol Argileux	0	0	100	35	20	45	> 150
Eau de surface	0	0	100	35	25	40	>150

→ **Dominant classes**
→ **Subgrid description**

Flood progression in 2007 derived by MODIS NDPI (MIR and blue reflecetances)