Task 3.1. Modeling individual processes

(leader: UNICA, Nicola Montaldo)

Partners: INRGREF, INAT, LISAH, UCAM, CESBIO, UNICA, IRTA, CERTE

Kick-off meeting

May 25 2021

Visio-conference

Task 3.1. Modeling individual processes

- **Water fluxes within heterogeneous rooting systems or under drip-irrigated orchards.**

  subsurface distribution of hydraulic redistribution and water flows. Innovation: hydraulic redistribution modelling. Study areas: Merguellil, Segre, Orroli. Partners: INAT, CESBIO, UNICA, IRTA.

- **Evapotranspiration.**

  surface - atmosphere exchanges within heterogeneous / multi-strata crops and above hilly crops. Innovation: modelling of exchange coefficients, including model development / parameterization / calibration. Study areas: Merguellil, Cap Bon, Tensift, Segre, Orroli. Partners: INRGREF, INAT, LISAH, UCAM, CESBIO, UNICA, IRTA.

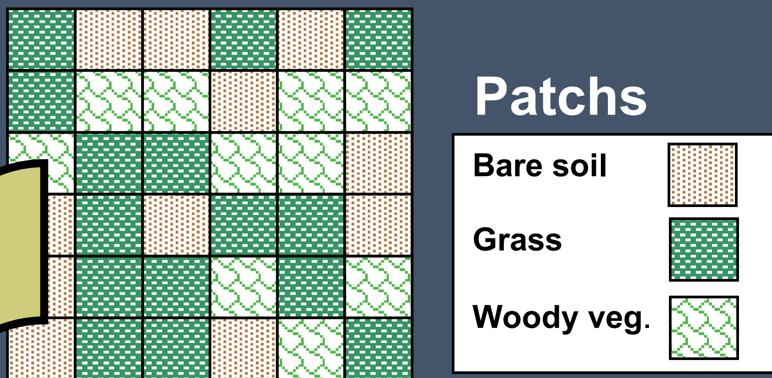
- **Dam - aquifer exchanges.**

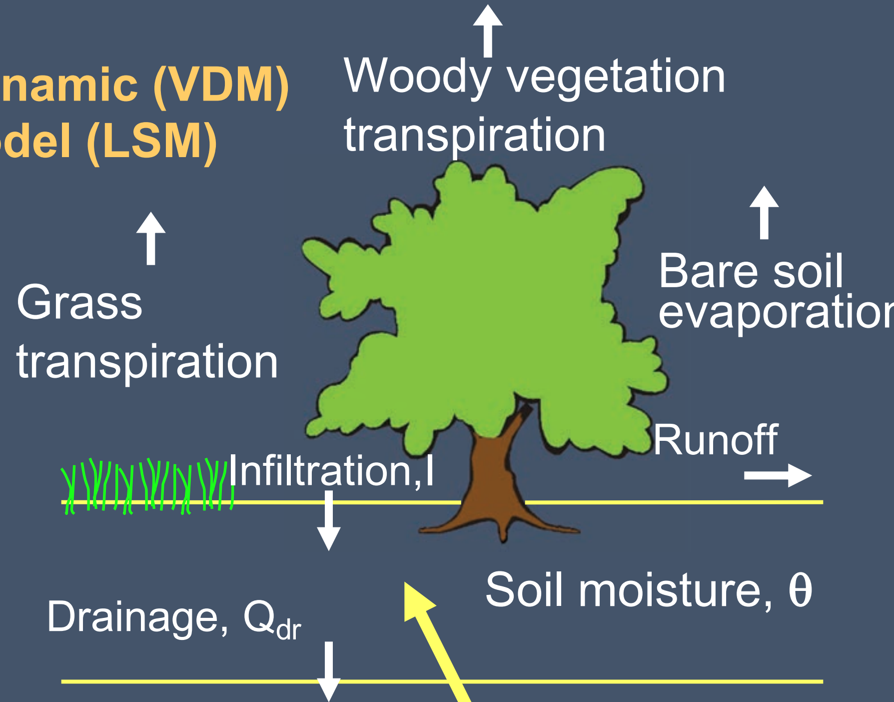
  water flows from dam leaks to underlying aquifer. Innovations: modelling of exchange coefficients, including model development / parameterization / calibration. Study areas: Cap Bon. Partners: CERTE, LISAH, UNICA.

UNICA Task 3.1. Modeling individual processes

The Vegetation Dynamic (VDM) - Land Surface model (LSM)

Patch mosaic

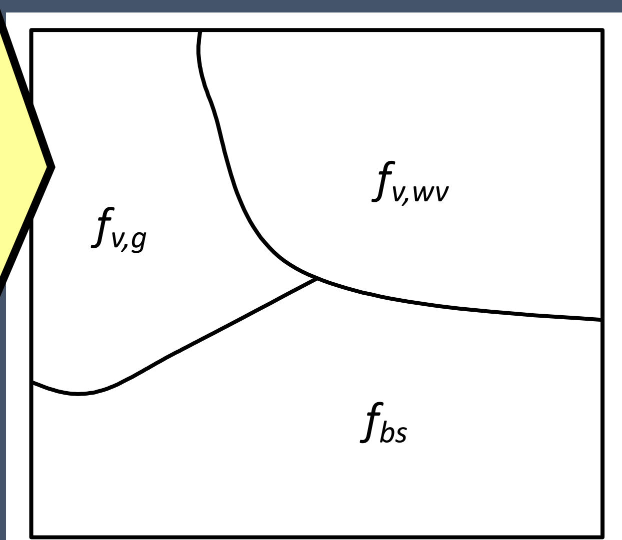




competition for root zone soil water content

Decomposition of the Landscape

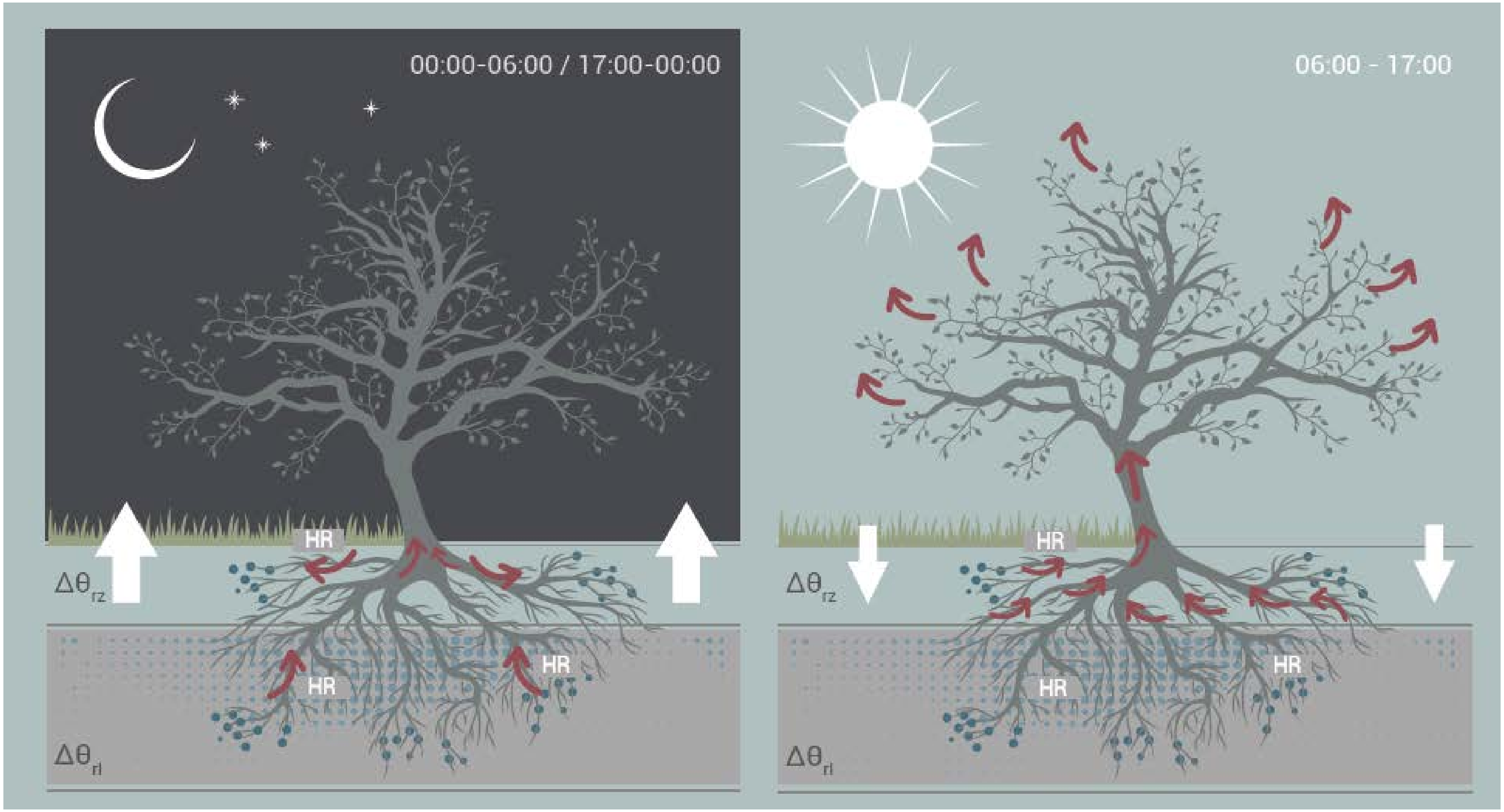
$(f_{v,g}+f_{v,wv}+f_{bs}=1)$



- Root zone budget: $$\frac{\partial\theta}{\partial t}=\frac{1}{d_{rz}}\left(I-ET-Q_{dr}\right)$$
- $$Q_{dr}=K_{sat}\cdot\left(\frac{\theta}{\theta_{sat}}\right)^{2\cdot b+3}$$

(Montaldo et al., 2005, WRR
Montaldo et al., 2008 HESS)

Task 3.1. Modeling individual processes



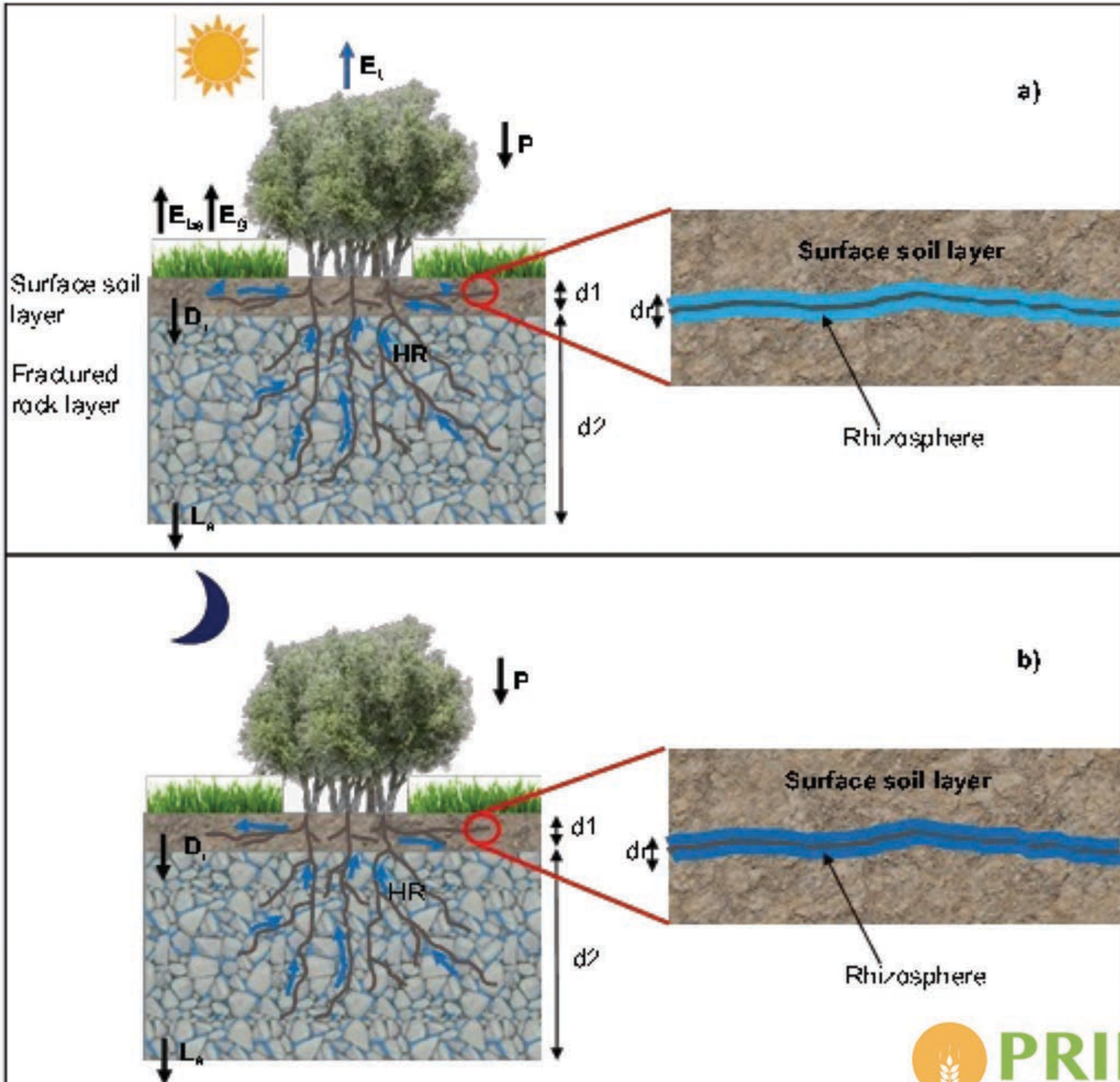
We added Hydraulic redistribution

$$HR = -C_{r,max} R_e \frac{\Delta\psi}{d_r}$$

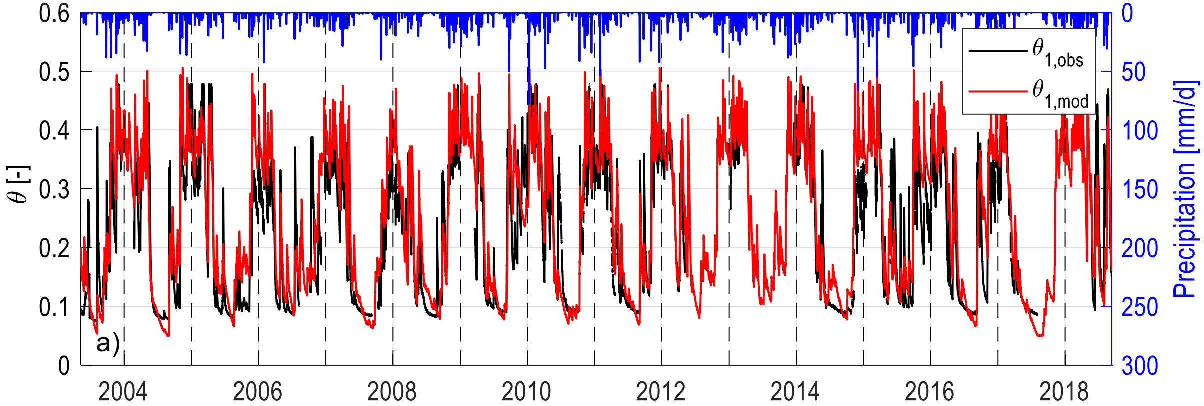
$$R_e = f^{-1}\left[\left(\psi, \psi_{50}, b_{R_e}\right)\right]$$

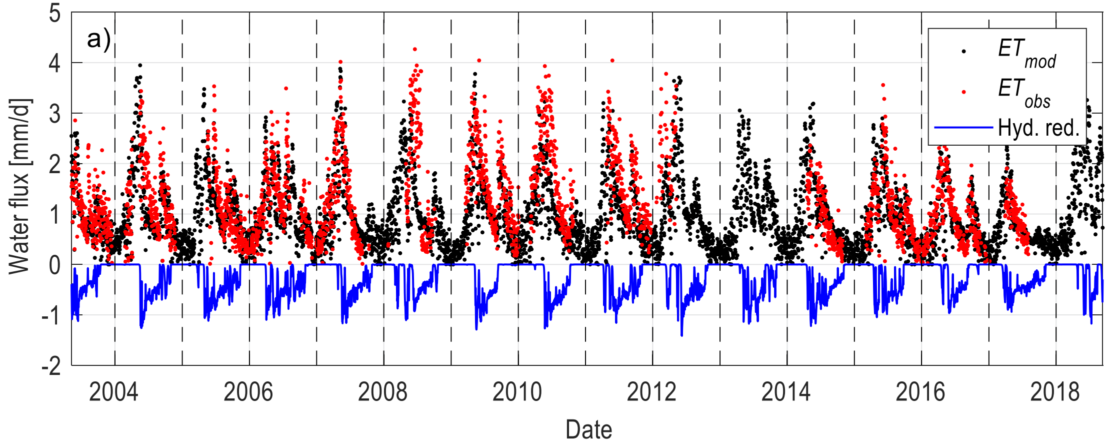
Task 3.1. Modeling individual processes

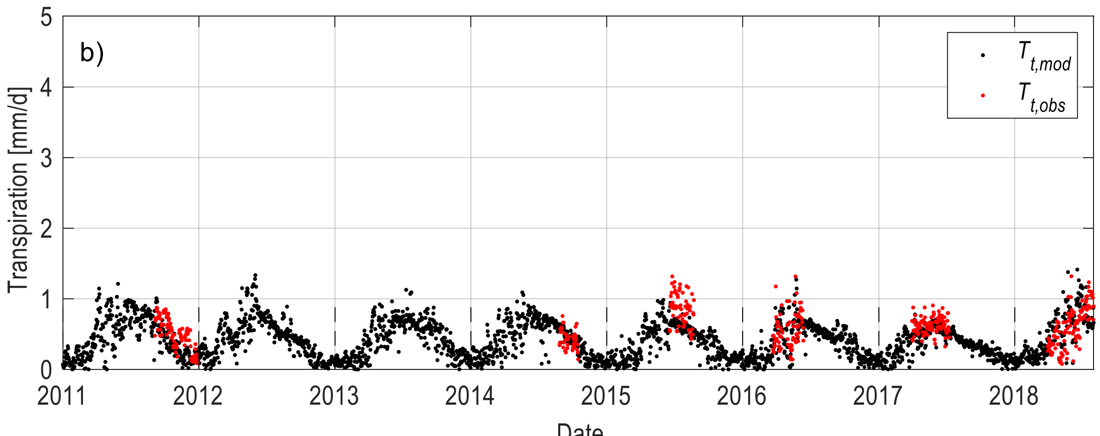
Innovation for hydraulic redistribution: simulation of the rhizosphere water balance



Task 3.1. Modeling individual processes







Task 3.1: modelling individual processes

• Water fluxes within heterogeneous rooting systems or under drip-irrigated orchards.

o Targets: subsurface distribution of hydraulic redistribution and water flows.

o Methodological innovations: hydraulic redistribution modelling with respect to root sap.

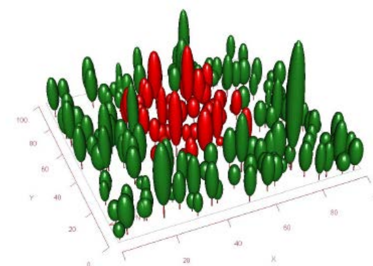
• Evapotranspiration.

o Targets: surface - atmosphere exchanges within heterogeneous / multi-strata crops and above hilly crops.

o Methodological innovations: modelling of exchange coefficients, including model development / parameterization / calibration. Comparing simulations from new parameterization against those from previous parameterizations to highlight benefits.

-> ISBA1P vs ISBA2P vs ISBA-MEB for the Agdal irrigated oliveyard (G. Aouade PhD)

-> MAESPA vs ISBA-MEB (postdoc Zied Sassi)



ISBA

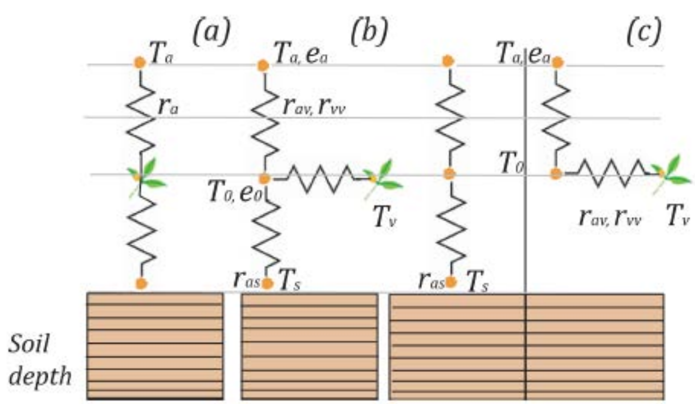
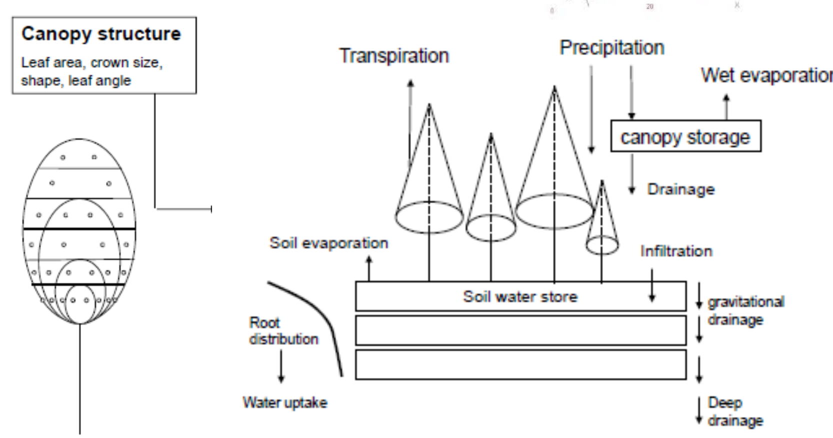
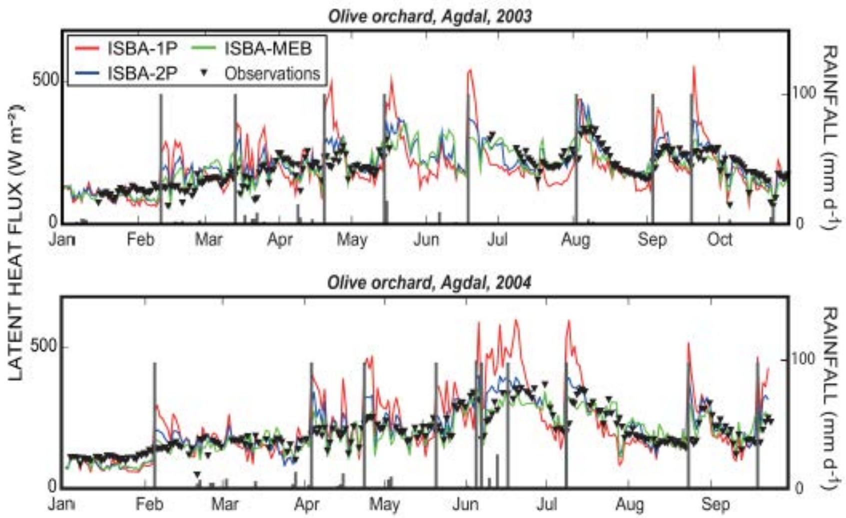


Figure 2. Schematic description of the three configurations of ISBA model: (**a**) the single-source configuration (ISBA-1P), (**b**) the layer configuration (ISBA–MEB), and (**c**) the patch configuration (ISBA-2P).

MAESPA



Task 3.1. Modeling individual processes



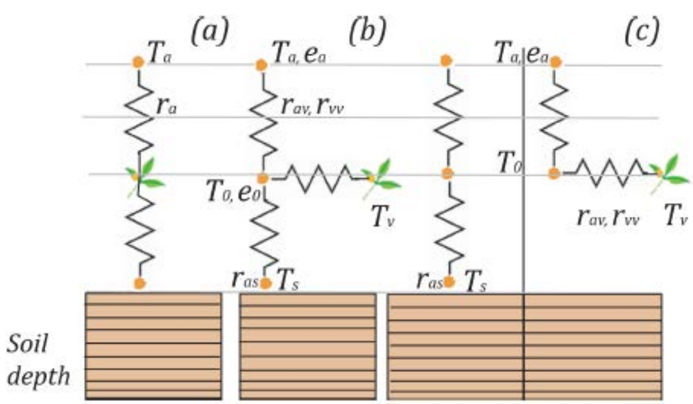
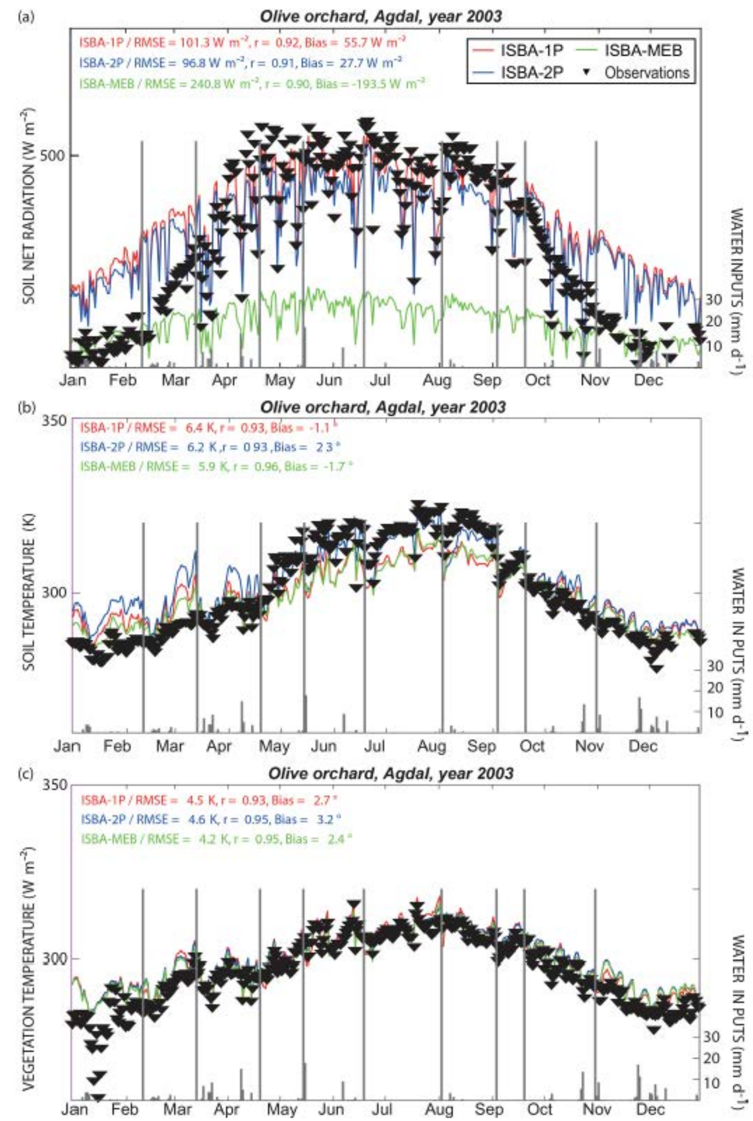


Figure 2. Schematic description of the three configurations of ISBA model: (**a**) the single-source configuration (ISBA-1P), (**b**) the layer configuration (ISBA–MEB), and (**c**) the patch configuration (ISBA-2P).

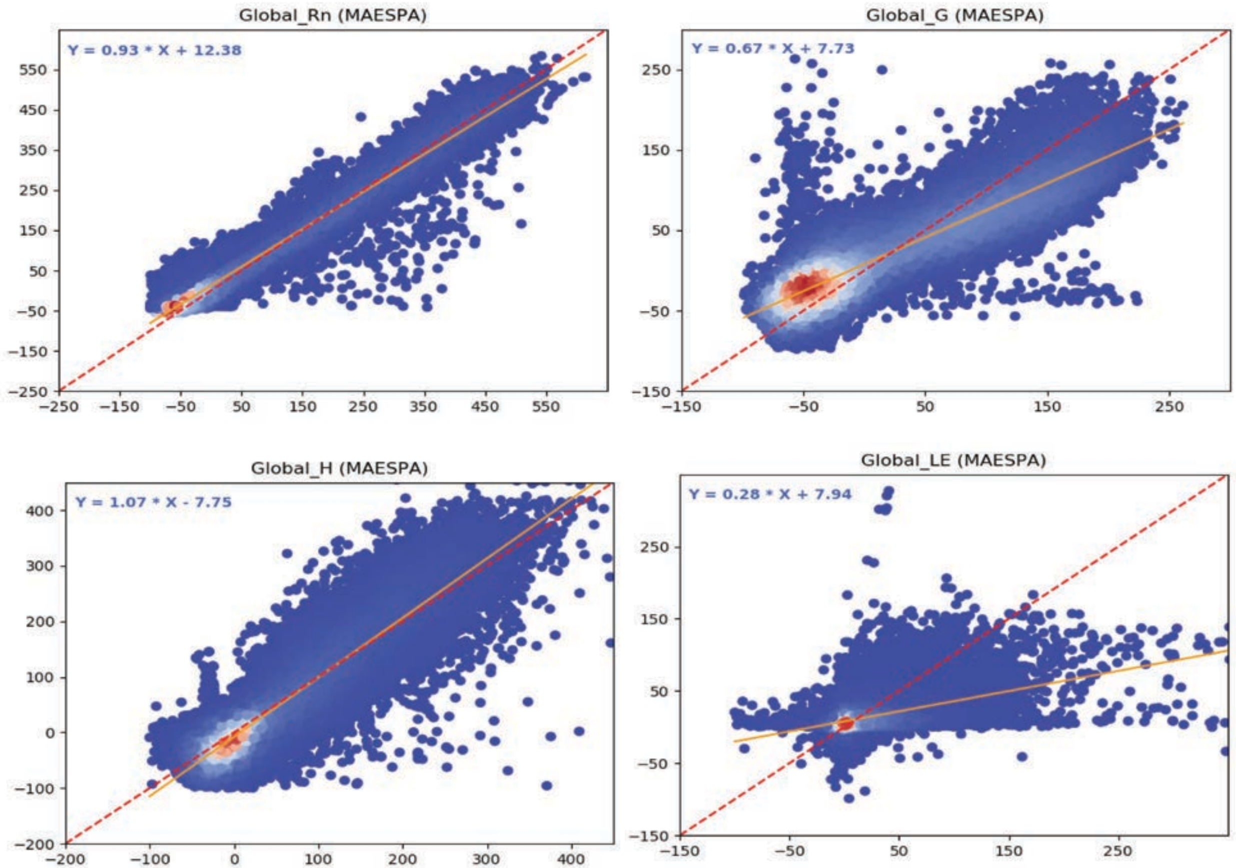


Learning from recent research on Agdal oliveyard

Task 3.1. Modeling individual processes

Nasrallah rainfed oliveyard

Energy Budget components (Jan 2013 – Dec 2014)

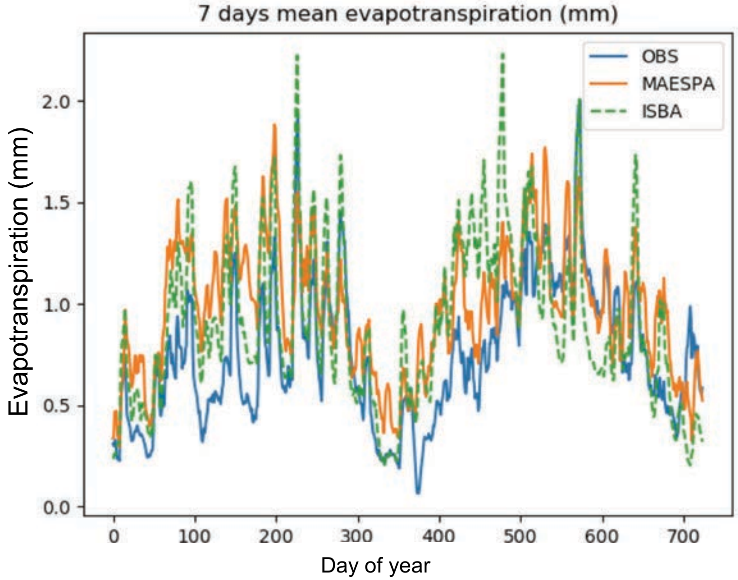


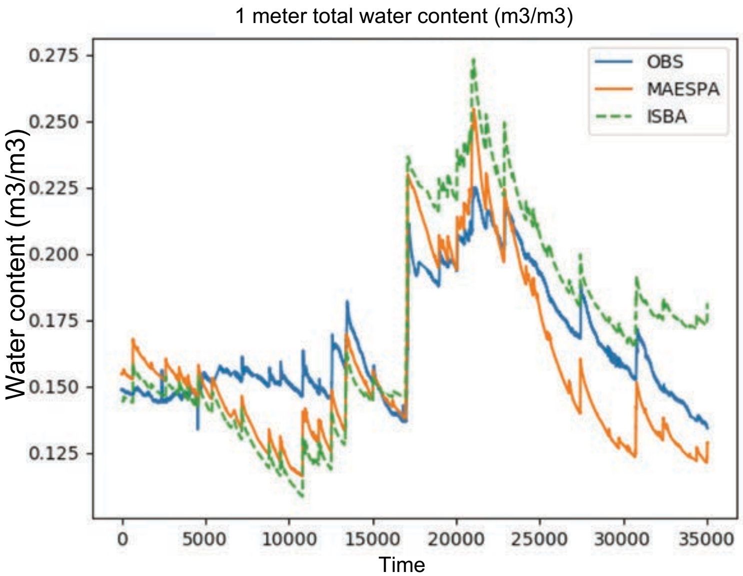
	MAESPA	ISBA-MEB
RN	32.13 (-7.42)	37.80 (-11.27)
G	38.64 (-3.64)	46.89 (-0.27)
H	40.45 (4.74)	43.96 (4.60)
LE	30.17 (6.21)	30.48 (-6.68)

Task 3.1. Modeling individual processes

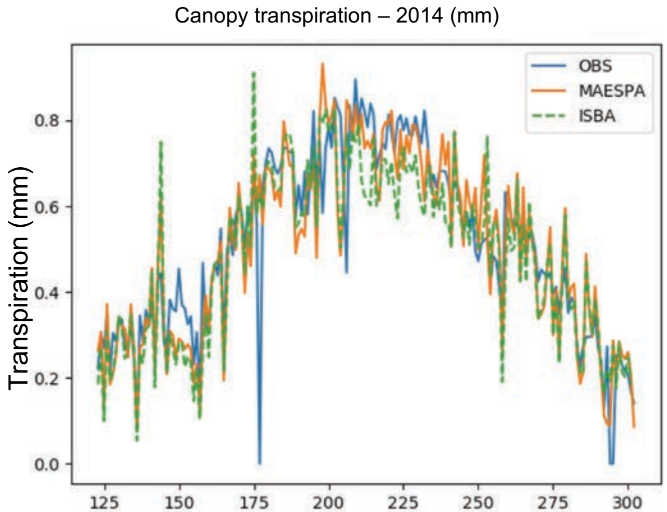
Nasrallah rainfed oliveyard

Water fluxes (Jan 2013 – Dec 2014)





- Over estimation of evapotranspiration on 2013
- Better estimation of daily evapotranspiration than ISBA-MEB on 2014
- Better estimation of daily transpiration



2013	MAESPA	ISBA-MEB
Biais	-0.29	-0.18
RMSE	0.48	0.36

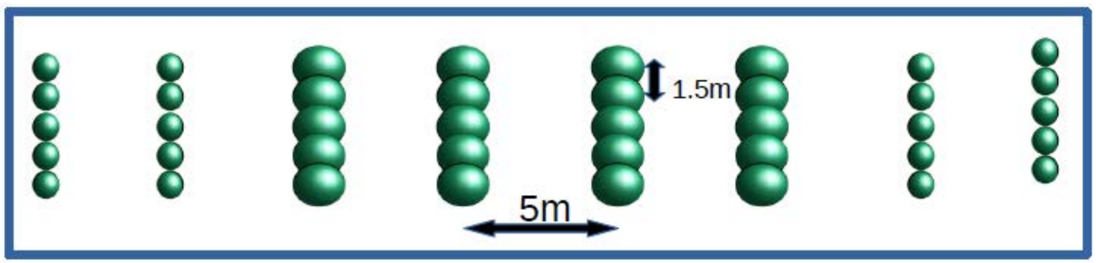
2014	MAESPA	ISBA-MEB
Biais	-0.15	-0.11
RMSE	0.38	0.48

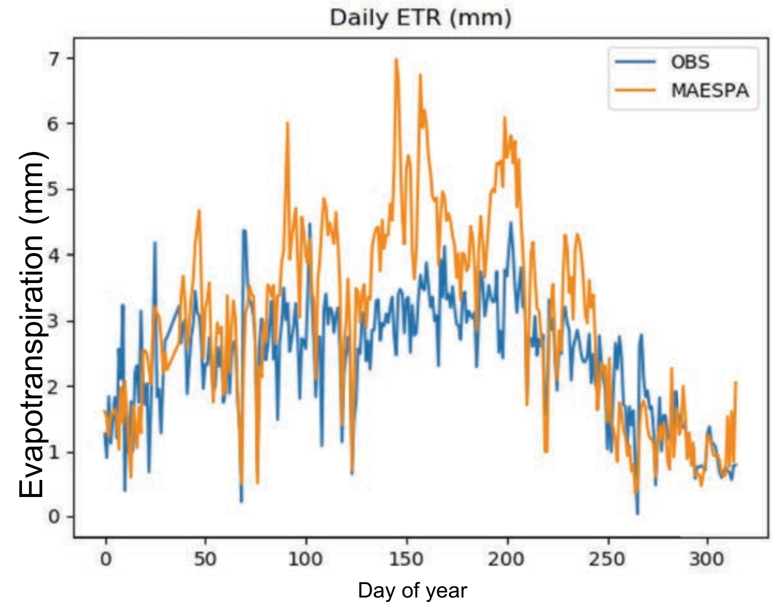
Task 3.1. Modeling individual processes

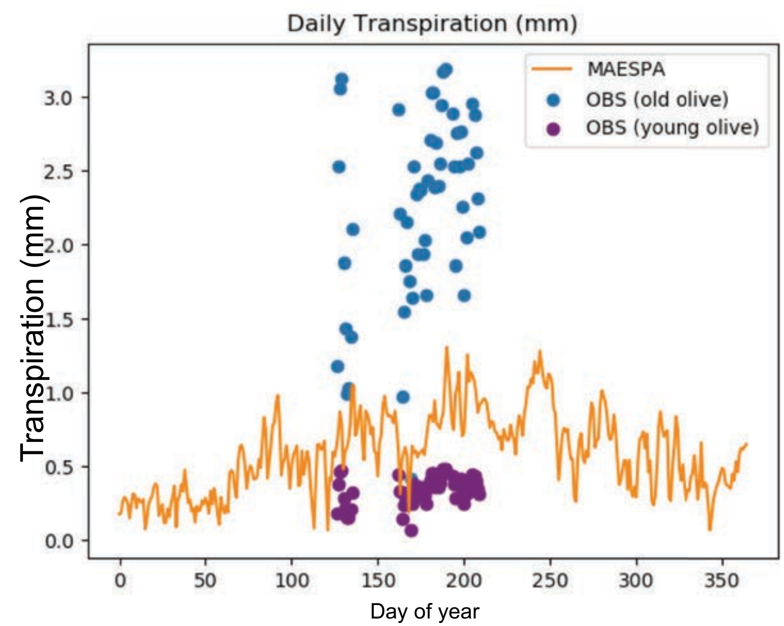
R3 drip irrigated oliveyard

(Jan 2006 – Dec 2006)

Drip irrigation







Drip irrigation process not well represented by the model leading to equal dispatch of irrigation water among the stand (over estimation of soil evaporation, under estimation of transpiration, ...)

→ Necessity of an alternative irrigation water input (deep soil water?)

Task 3.1. Modeling individual processes

Activities	Period	Study areas	Team
Evaluate the impact of an accurate modeling of the wind profile within the canopy on the TSEB model flux estimates, considering the effect of the foliage density in the wind attenuation. Two sonic anemometers will be placed at two different heights in a vineyard to validate the wind profiles estimates based on the algorithms presented in Massman (1987, 2017) and Goudriaan (1977)	2020	***Vineyard (Lleida) and apple orchard***	C Jofre J Bellvert M Pàmies A Pelechá O García-Tejera Jordi Cristóbal
Improve the accuracy of Priestley-Taylor and S-W models for estimating LE at potential conditions -> re-adjustment considering the stomatal response to VPD	2020-2021		
To evaluate the effect of the variability in soil temperature to estimate H_s			

Task 3.1. Modeling individual processes

VINEYARD

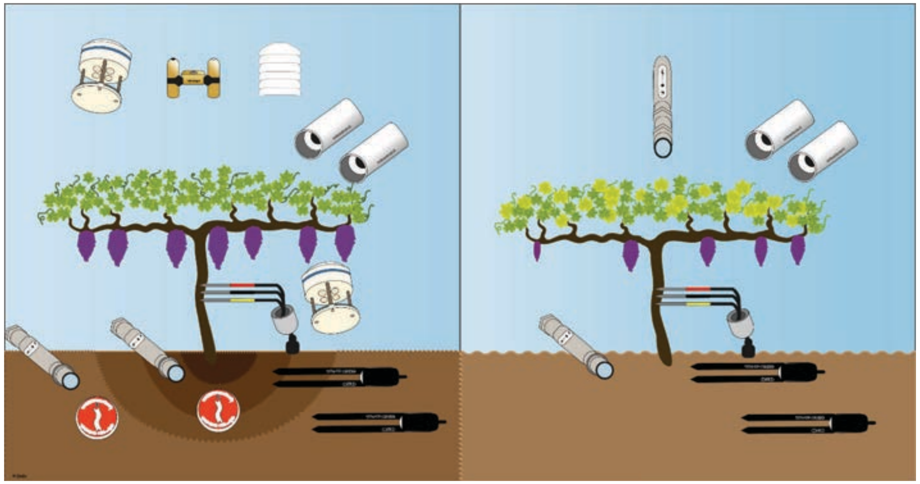
Continuous sensors

- Two sonic anemometers (Decagon DS2)
- Net radiometer (Apogee)
- Soil heat flux plates (HFP)
- 4 Infrared sensors for canopy temperature (Apogee)
- 3 Infrared sensor for soil temperature (Calex)
- 9 Sap flow sensors (Compensated heat pulse)
- Temperature and relative humidity (Decagon VP4)
- Soil moisture sensors (Decagon)

- ***+ low-cost thermal camera (CESBIO)***

Field measurements

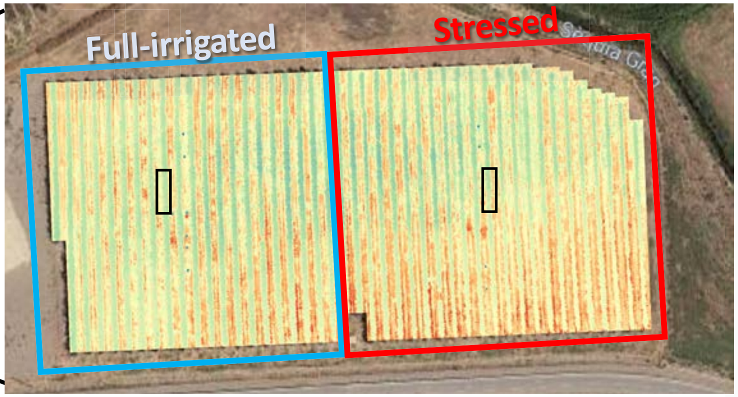
- LAI (LAI-2200) and FAPAR (LP-80)
- Stem Water potential (Scholander)

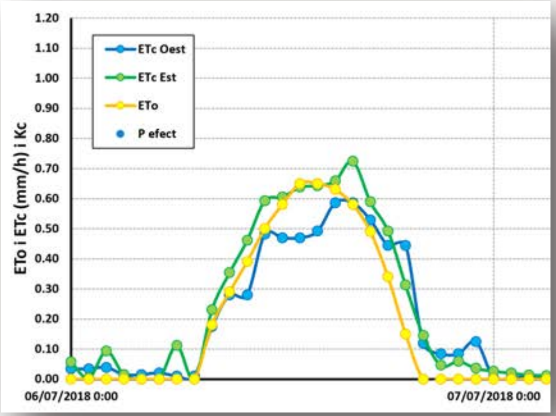


Task 3.1. Modeling individual processes

IRTA
Institut
de Recerca i Tecnologia
Agroalimentàries

APPLE ORCHARD





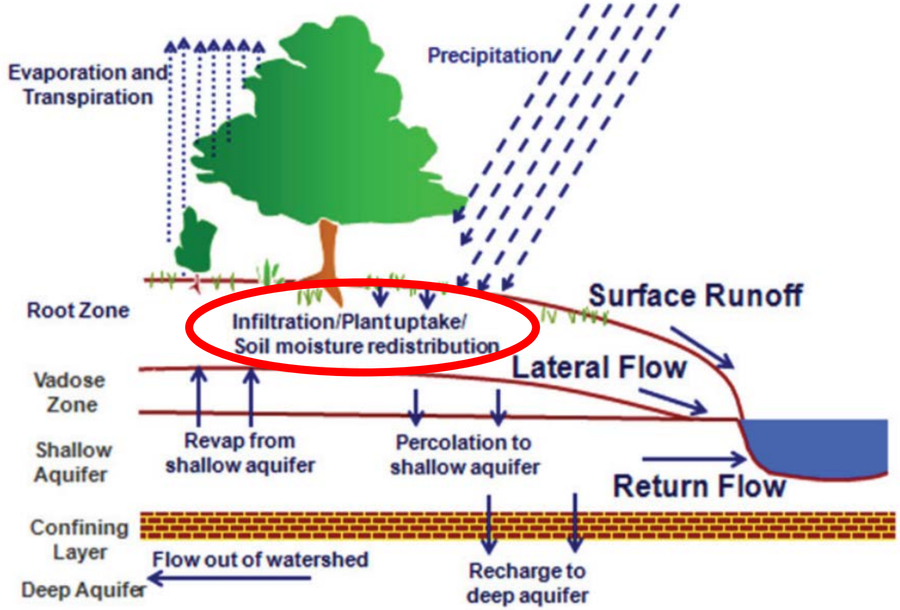
PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

Task 3.1. Modeling individual processes

INAT contribution

Evaluation of SWAT simulated soil moisture for heterogeneous orchards (rainfed and irrigation crops)

Schematic of hydrologic processes simulated in SWAT



$$SW_t = SW_o + \sum_{i=1}^{t}\left(R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}\right)$$

SW_t is the final soil water content (mm)
SW_o is the initial water content (mm)
Rday is amount of precipitation,
Qsurf is the amount of surface runoff,
ETa is the amountof evapotranspiration,
Wseep is the amount of percolation,
Qgw is the amount of return flow

➢ complementarity with task 1.1 and task 1.2 results.

Task 3.1. Modeling individual processes

INAT contribution

Comparison of soil moisture determined from different sources :

- remotely sensed (RS),
- SWAT simulated (SM)
- observed (TDR)

Task 3.1. Modeling individual processes

Hanene Chaabane, Gadha Dahmeni, Mariem Khouni, Manon Lagacherie, Olivier Grunberger ----- INAT LISAH

Objective: simulate contamination processes by pesticides fate in irrigated perimeters and rainfed catchments.

- In pluvial zones:
  - Glyphosate fate modeling (runoff and retention process) at the plot scale (To be started end of 2021 to be finished mid 2022. Eranet med CHAAMS contribution.
  - Difficulty :
    - Initial project was to use an already running SWAT hydrological model and associate it to simulation of pesticide fate. Due to the absence of existing previous model in time we switch plans to plot modeling.
- In irrigated zones:
  - Modeling of the effect of salinity on the pesticides' fate (to be started en of 2022) (at the soil profile scale (rank and interrank).
  - Difficulty :
    - We will be able to simulate this effect at the profile scale with no landscape scale numeric outputs (only qualitative results)

→*Nota : No mention of deliverables associated with modeling chemical pollutants in the project document ?*

Task 3.1. Modeling individual processes

LISAH - INRGREF

Context

- **Study site :** Kamech
- **Context : ** PhD of Dhouib Mariem
- **PhD objective** : analysis of water use efficiency within a small rainfed farmed Mediterranean catchment in Tunisia, under the constraint of climate change, and by considering the spatial distribution of crops in the landscape as an action leverage for optimizing water use by crops and agricultural production.

Simulation of runoff-infiltration partitioning under different climate and soil conditions

Simulate soil moisture, ETa and biomass for different crops and years

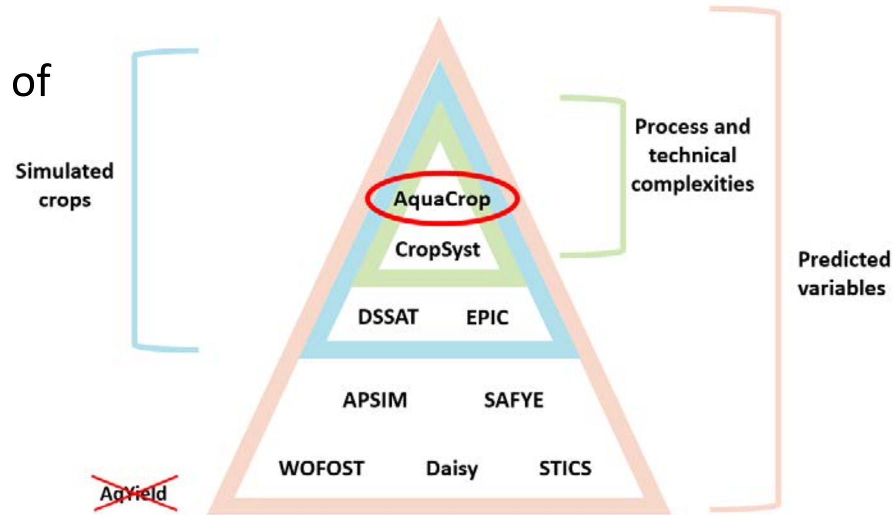
Task 3.1. Modeling individual processes

LISAH - INRGREF

Choice of crop model

Model selection criteria

- Variables to be predicted simulated by the model : soil variables, crop variables…
- Simulated crops
- Process and technical complexities : number of inputs, code availability, simulated process…



The open source version of the AquaCrop model, written in R has been selected

Task 3.1. Modeling individual processes

LISAH - INRGREF

AquaCrop simulations
Example of simulation : wheat

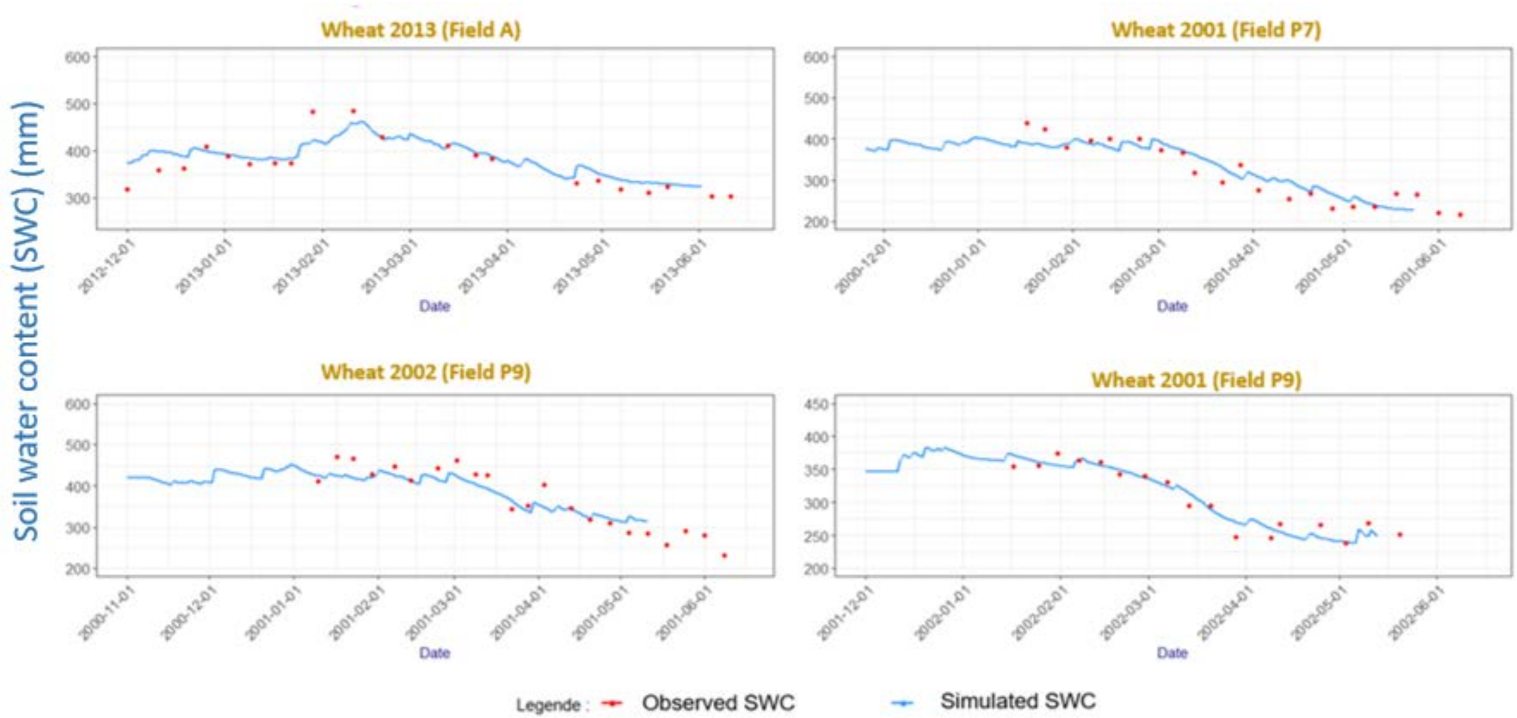
- the AquaCrop R version simulates crop growth under optimal fertilization conditions without the possibility of taking soil fertility stress into account
- Soil fertility stress impact
    - Crop parameters
        - CCx : Maximum canopy cover
        - CGC : crop growth coefficient
        - Crop decline
    - Water productivity → biomass production

Modification of the optimal crop parameters to consider Soil fertility stress

- 4 different simulations for wheat with different years and soil conditions

Task 3.1. Modeling individual processes

Soil moisture simulation



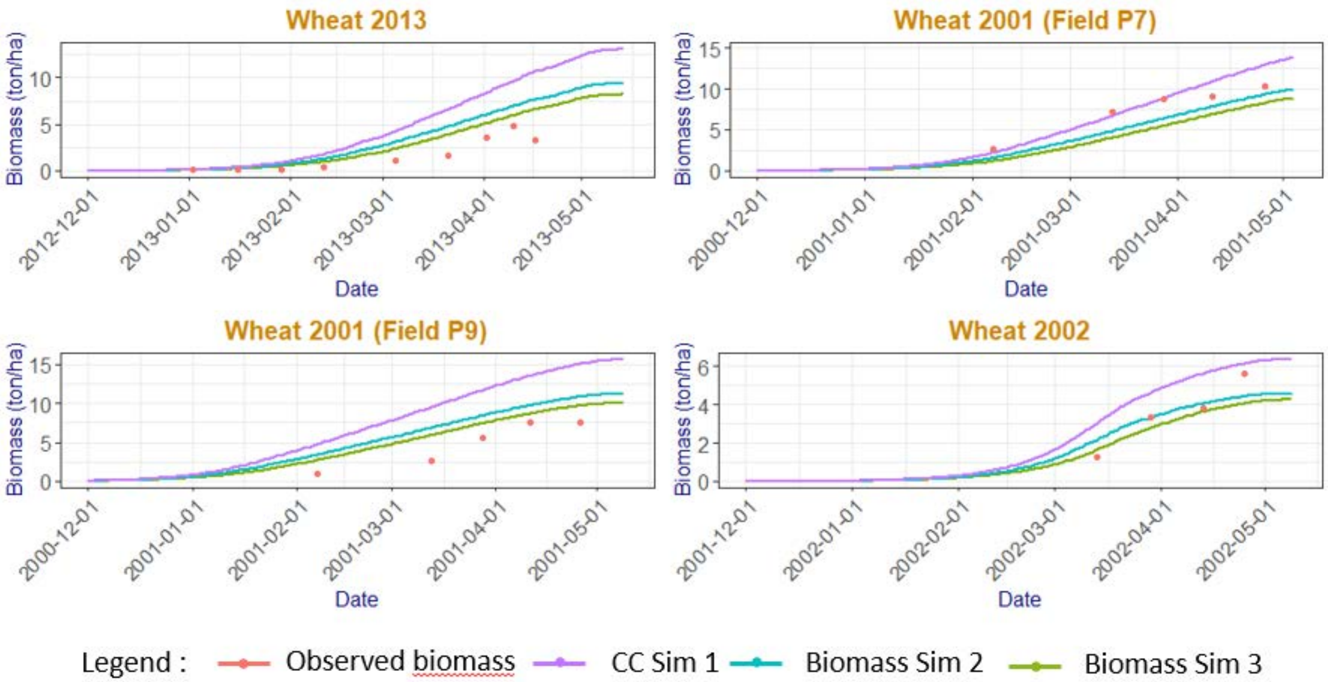
➔ Good simulation of the soil moisture for the different years and soil conditions

Task 3.1. Modeling individual processes

LISAH - INRGREF

Biomass simulation

- Sim 1 : optimal crop parameters for local conditions (Alaya et al., 2019)
- Sim 2 : modified value of water productivity
- Sim 3 : modified values of 3 crop parameters (CCx, CGC, WP)



➔ Sim 1, with optimal crop parameters, overestimates the biomass
➔ Sim 2 and sim 3 better simulate the biomass

Task 3.1: modelling individual processes.

Task 3.1.3 : Dam - aquifer exchanges.

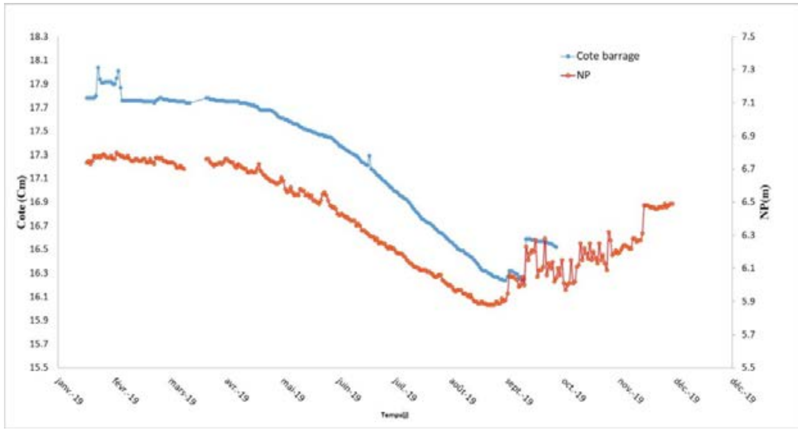
o Targets: water flows from dam leaks to underlying aquifer. o Methodological innovations: modelling of exchange coefficients, including model development/ / parameterization / calibration. o Partners: CERTE, LISAH, UNICA.

o Study areas: Cap Bon.

PhD Nejmeddine OUHICHI

Objectives :

- Modeling water flows from dam leaks to underlying aquifer.
- Modeling the relationships: surface water / groundwater and Dam / Aquifer.
- To compute from the changes in Reservoir lake supplies implied by Lebna watershed scenarios => Consequences for recharge of the coastal aquifer (cf. WP4)



Correlation (NP well 1, water in the bam)

Work performed

Conceptuel building of the model (limits, data inputs)

To be done

Modflow runs (permanent stage, calibration) (Aug. 2021)

Multiparameter confirmation (Salinity, Stable isotope) (End 2021)

Calendar & Difficulties &

Large data set integration

UCAM contribution

Assessment of GPM and TRMM Satellite Precipitation Products, and their application for Flood Simulations at Daily Scale in a sparsely gauged watershed
Case of Ghdat basin (High Atlas, Morocco)

Myriam Benkirane

Ph.D. candidate at GeoSciences Semlalia laboratory

Myriam.benkirane@edu.uca.ac.ma *

Under the supervision of : Pr. N.E. Laftouhi
Pr. S. Khabba
Pr. B. Mansouri

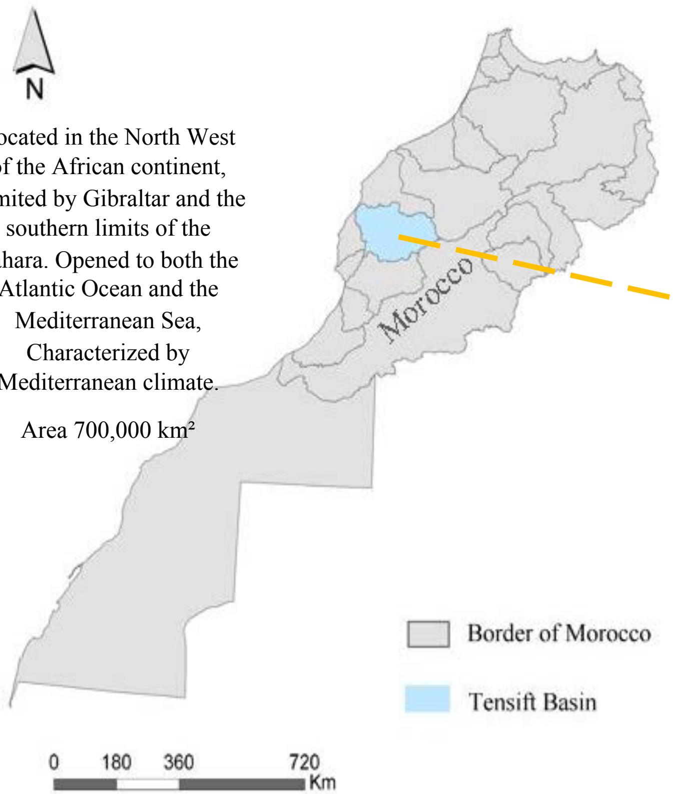
25/05/2021

UCAM contribution

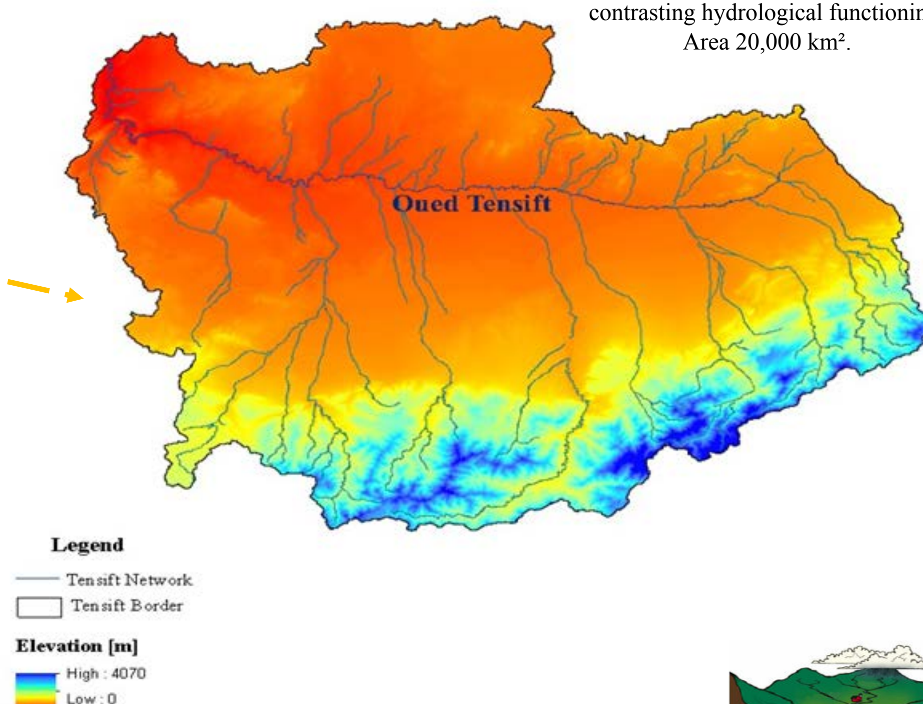
Morocco / Tensift

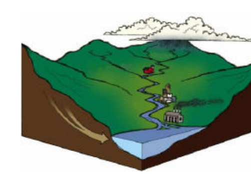
Located in the North West of the African continent, Limited by Gibraltar and the southern limits of the Sahara. Opened to both the Atlantic Ocean and the Mediterranean Sea, Characterized by Mediterranean climate.

Area 700,000 km²



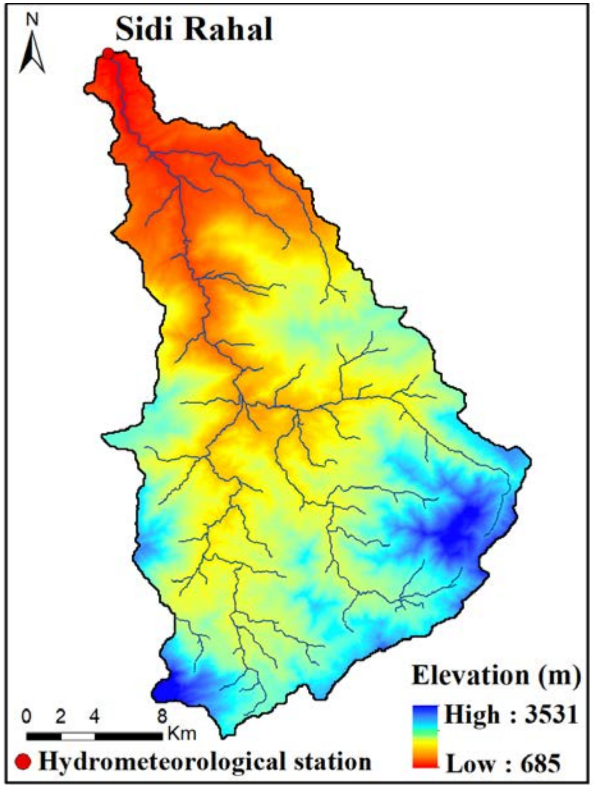
Located around Marrakech city. Mainly comprises two areas with contrasting hydrological functioning. Area 20,000 km².





UCAM contribution

Ghdat Basin



Ghdat sub-basin is located in the Moroccan High Atlas Mountains, South EST of Marrakech city.
Atlas tributary located on the left bank of Tensift river.
Characterized by an arid to semi-arid climate strongly influenced by the altitude.
Due to these slopes, the river is torrential and subject to flash floods.

Physiographic characteristics of Ghdat	
Perimeter (P) (Km)	163
Area (A) (Km²)	550
Average slope P moy%	29,30
Length of main stream (Km)	74
Compactness index Kg	1,95
"Dd" drainage density (Km-1)	1,02
Concentration time (H)	7
Torrentially coefficient Ct (Km/km^4)	1,87
Vegetation %	52,12

UCAM contribution

Introduction | Study area | **Methodology** | Results | Conclusion

Data

Gauge Precipitation Station

- Daily data are collected from Sidi Rahal station.
- Between 2010 and 2017.
- Provided by ABHT.
- Used as benchmark for evaluating SPPs.
- Monthly and yearly precipitation are accumulated from daily observations.

SPP TRMM (3B42 V7)

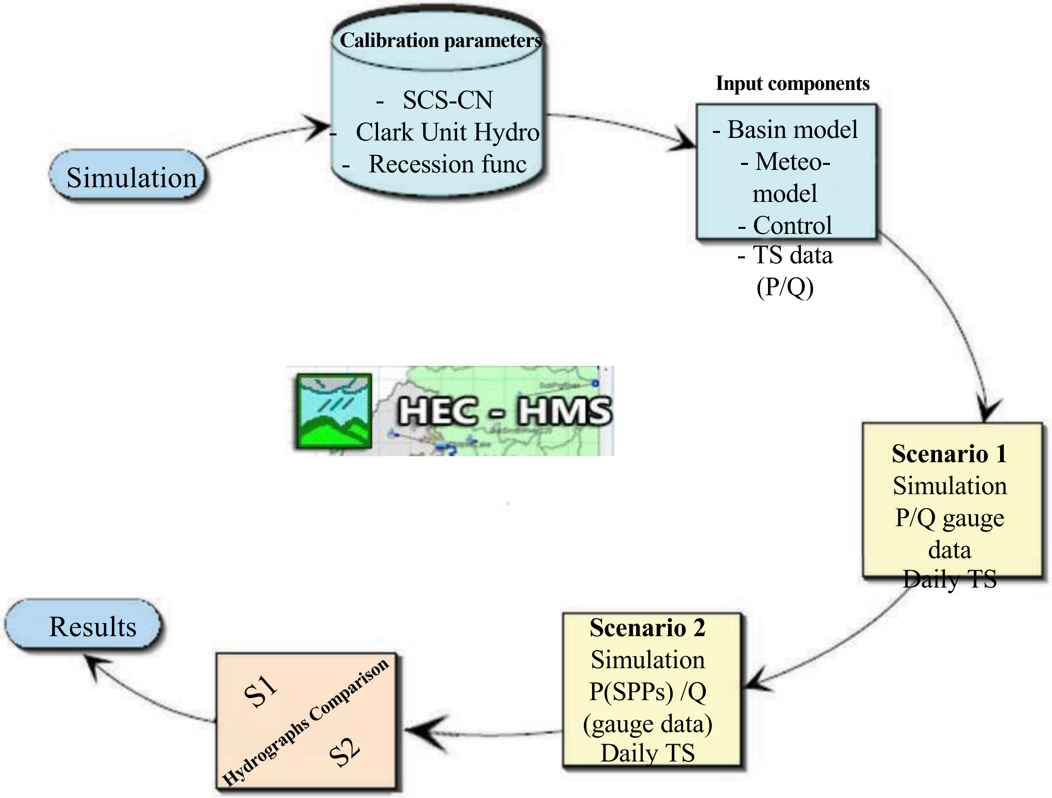
- TRMM (3B42 V7) near-real-time product combine various MW, and IR satellite based precipitation.
- Provide 3H quasi-global quantitative precipitation estimates.
- 0.25° spatial resolution
- Quasi-global coverage 50°S–50°N.

SPP GPM (IMERG V5)

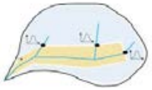
- GPM carries two major sensors: (GMI), and (DPR).
- IMERG ER, LR, FR products
- Temporal resolution of 30min
- 0.1°spatial resolution
- Spatial coverage from 60°S to 60°N.

UCAM contribution

Hydrological Method



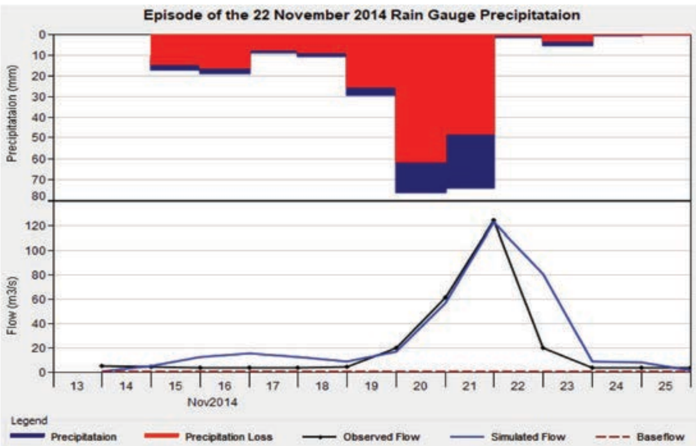
- The HEC-HMS model was used to calibrate the daily rainfall events from (1/09/2010) to (31/08/2017), over the Ghdat basin, using rainfall and flow data from gauging station, and SSPs.
- The episode we have selected to present to you is one of the most intense of the data series, the flow reached 123, 75 m3/s on November 22, 2014.



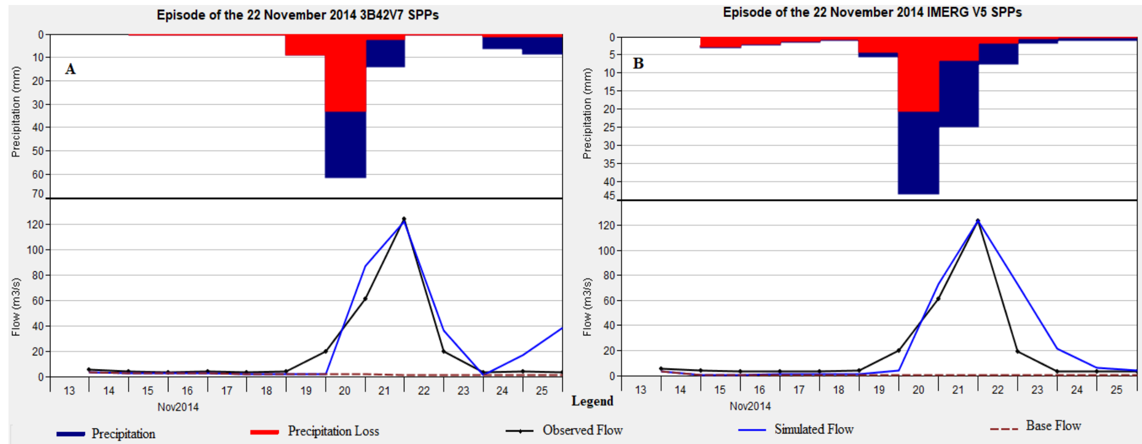
UCAM contribution

Hydrological modelling

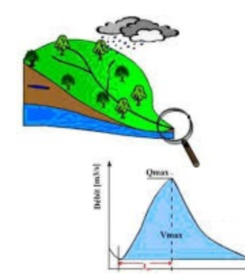
Scenario 1: runoff simulation with rain gauge calibration parameters at daily time steeps.



Scenario 2: Discharge simulation using SPPs at daily time steeps.



Scenarios	Precipitation products	Curve Number	Nash-Sutcliffe (%)	Root Mean Square Error (mm)	Bias
I	Gauge Precipitation	30	75,3	0,4	30,8
II	TRMM (3B42 V7)	87	86,4	0,5	20,5
II	GPM (IMERG V5)	78	79,1	0,4	18,2



UCAM contribution

Presented by Sara BOUGHDADI
Laboratory of Georesources, Geoenvironment and Civil Engineering.
Cadi Ayyad University.

Changing patterns of extreme hydrological events in morocco

Thesis Director : M. El Mehdi SAIDI
Thesis co- Director : Y. TRAMBLAY

II. Study area

UCAM contribution

- 17 selected stations
- Daily flows
- The longest series from 1971 to 2019

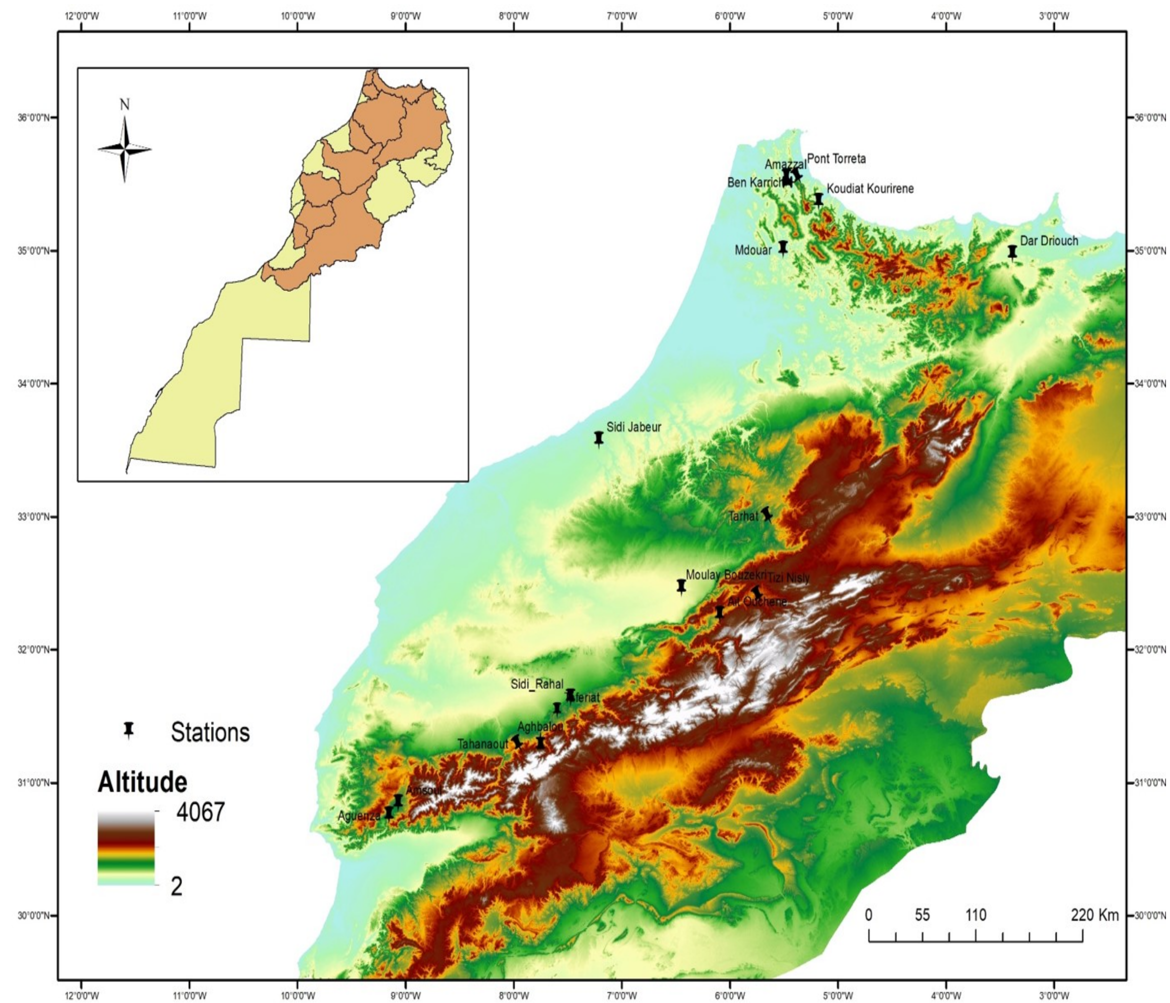


Fig1. Map of selected stations in the study area

IV.2. Variation in annual maximum flows

UCAM contribution

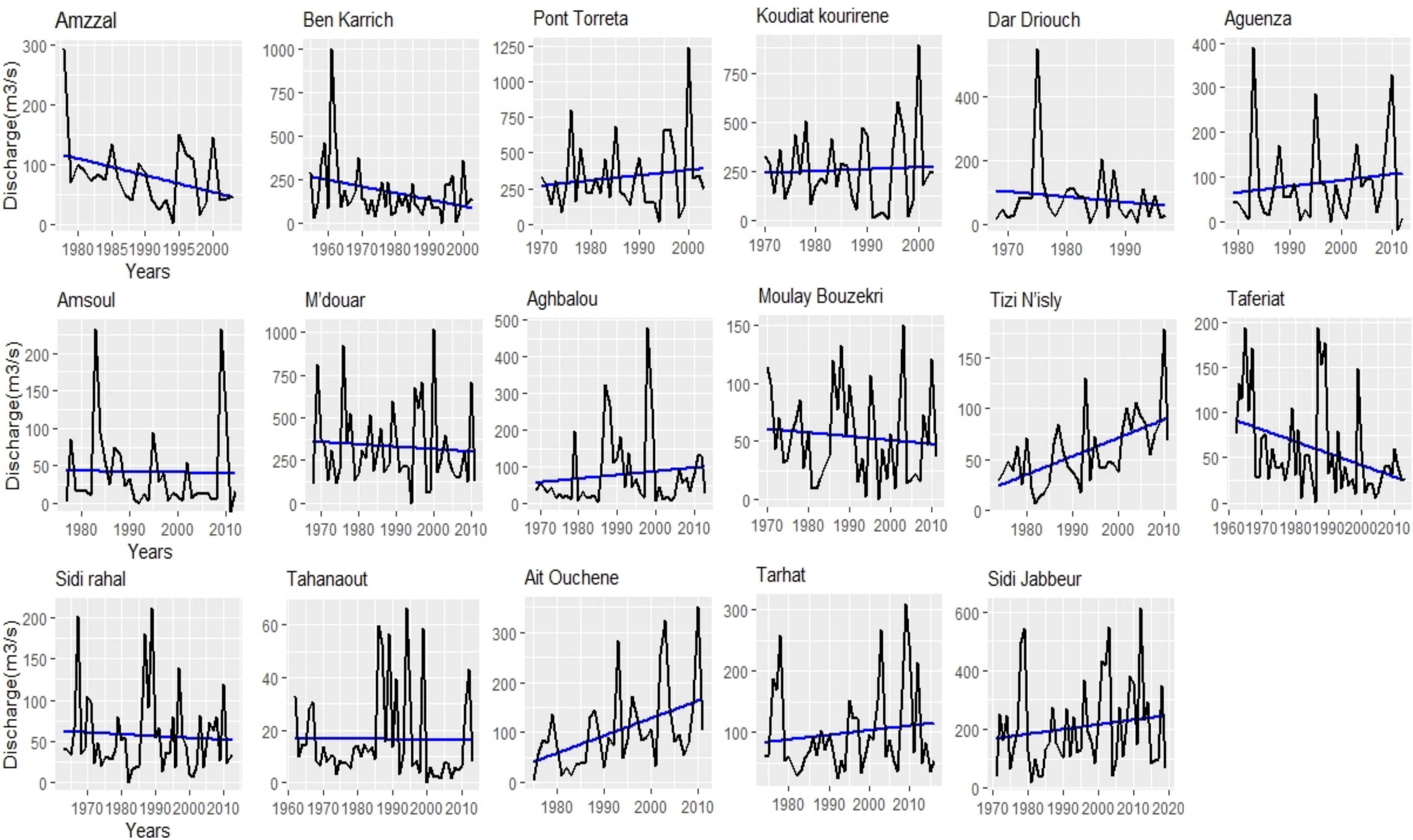


Fig3 : variation and trend of annual maximum streamflows across all studied stations

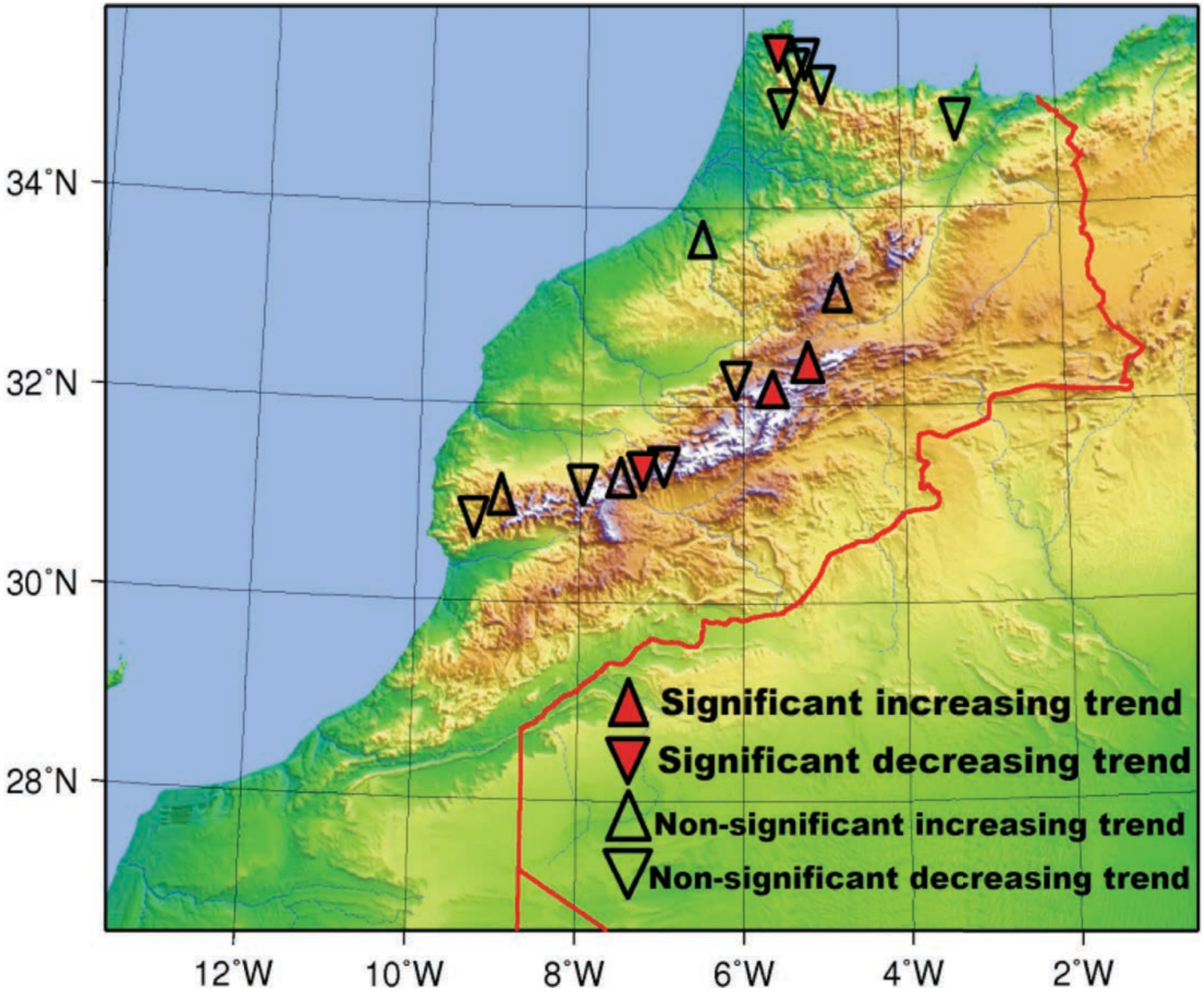


Fig4.Trends of annual maximum daily flows

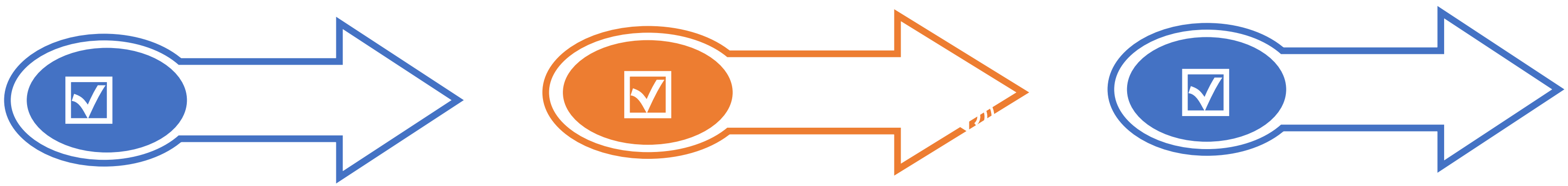
UCAM contribution

→ No clear signal on flood changes

V.Perspectives

UCAM contribution

NEXT STEPS



Add more stations

Analyse the drivers of the high-flows and low-flows variability

Relationship with atmospheric circulation indexes

Task 3.1. Modeling individual processes

Deliverables

- D3.1.1 [Task 3.1]: report on successes and progression margins for new parameterizations and calibration procedures @ Month 15, to be shared within modelling workshops in WP5 @ Month 18.
- D3.1.2 [Task 3.1]: 2 submitted publications for methodological developments of individual process modelling @ Month 27.
- D3.2.1 [Task 3.2]: report on modelling improvements via comparison exercises for integrated modelling schemes @ Month 33, to be shared within modelling workshops in WP5 @ Month 36.
- D3.2.2 [Task 3.2]: 2 submitted publications for methodological developments of integrated process modelling @ Month 36.