



## Synergie optique/radar pour l'estimation de l'évapotranspiration et de sa partition en vue d'un produit "stress hydrique de la plante"

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### ► To cite this version:

Gilles Boulet, Zoubair Rafi, Valérie Le Dantec, Pascal Fanise, Albert Olioso, et al.. Synergie optique/radar pour l'estimation de l'évapotranspiration et de sa partition en vue d'un produit "stress hydrique de la plante". Journées de Modélisation des Surfaces Continentales 2019, Nov 2019, Paris, France. hal-03563889

HAL Id: hal-03563889

<https://hal.inrae.fr/hal-03563889>

Submitted on 10 Feb 2022

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# Synergie optique/radar pour l'estimation de l'évapotranspiration et de sa partition en vue d'un produit "stress hydrique de la plante"

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# Context and objectives

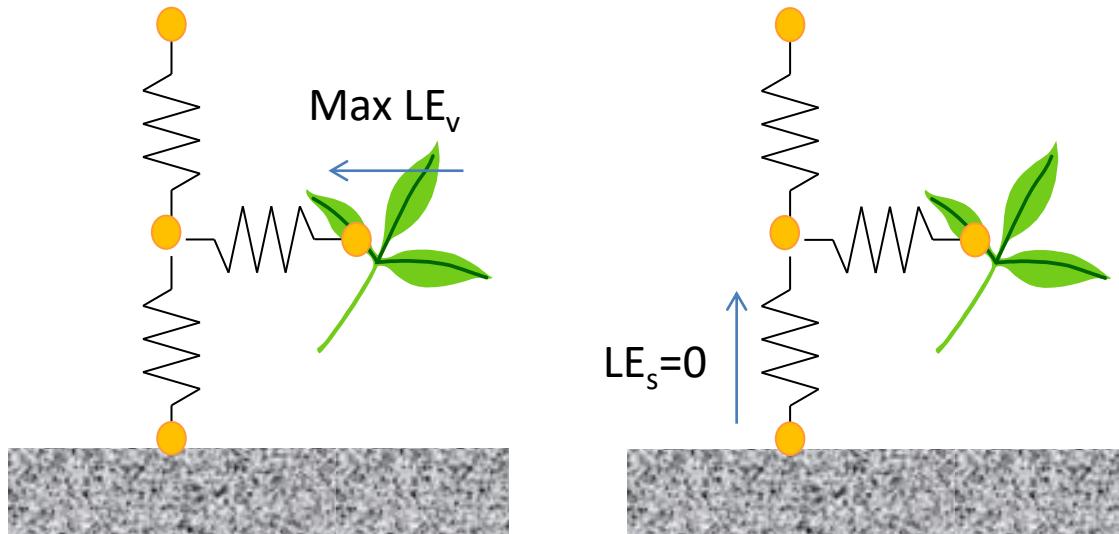
- Need to monitor **plant water use** as well as **plant water stress** for many applications :
  - Optimization of irrigation scheduling, water deficit agriculture...
  - Assess vulnerability of rainfed agrosystems to drought
- Dual Source Energy Balance models compute both **evaporation E and transpiration T** from TIR data, as well as potential E and T
- But they derive **2 unknowns** ( $E+T$ ) out of the **sole** surface temperature ( $T_{surf}$ )
  - How robust/reliable are **total and component flux** ( $T, E$ ) and **water stress** retrievals for all situations in view of operational TIR products ?
  - Can we **constraint** ET and E/T with additional information such as **surface soil moisture** (from S1 data for example) to get rid of underdeterminancies ?
- Context = High resolution (50-100m) frequent revisit (2/3 days) TIR satellite mission TRISHNA (CNES/ISRO) as well as Copernicus LSTM

# Soil Plant Atmosphere Remote Sensing

## Evapotranspiration (SPARSE) model

Same rationale as the TSEB model >

How one gets **2 unknowns** ( $E$  i.e.  $LE_s$ ,  $T$  i.e.  $LE_v$ ) from **1 data source** ( $T_{surf}$ ) ?

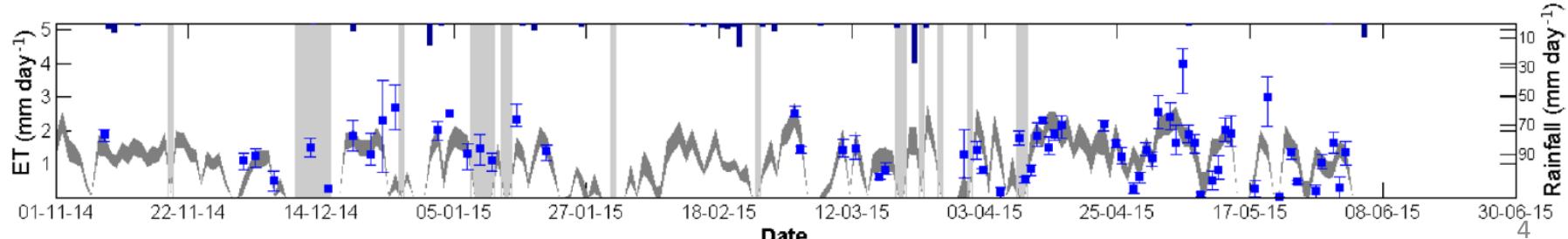
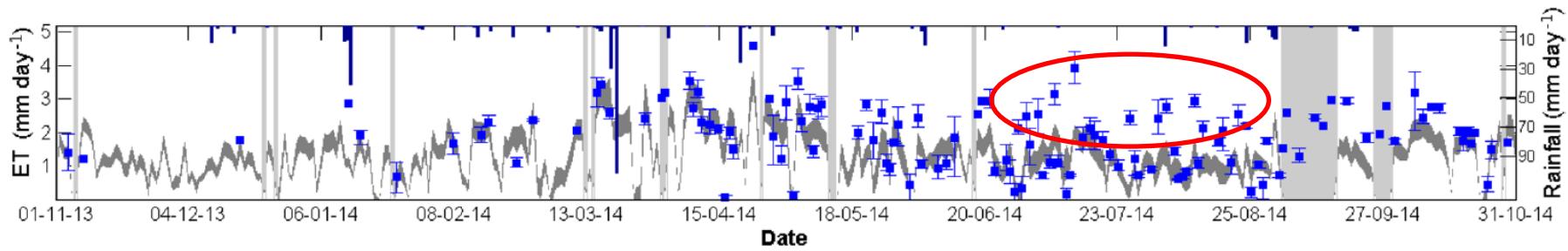
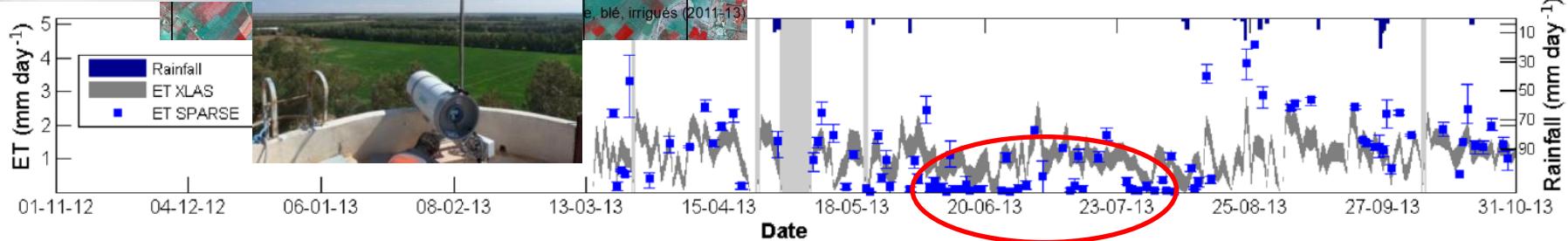
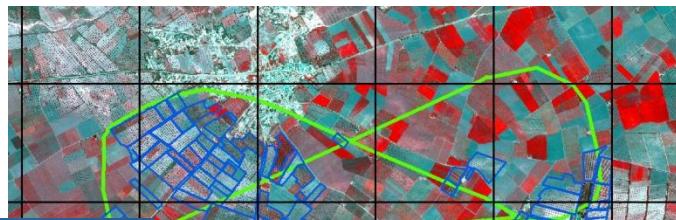


$LE_s$  i.e.  $E = f(T_{surf})$

$LE_s < 0$  stress

$LE_v$  i.e.  $T = f(T_{surf})$

**Consequence:**  
Moderately dry topsoil  
with a moderately stressed  
vegetation interpreted as a  
fully transpiring vegetation  
and a very dry soil

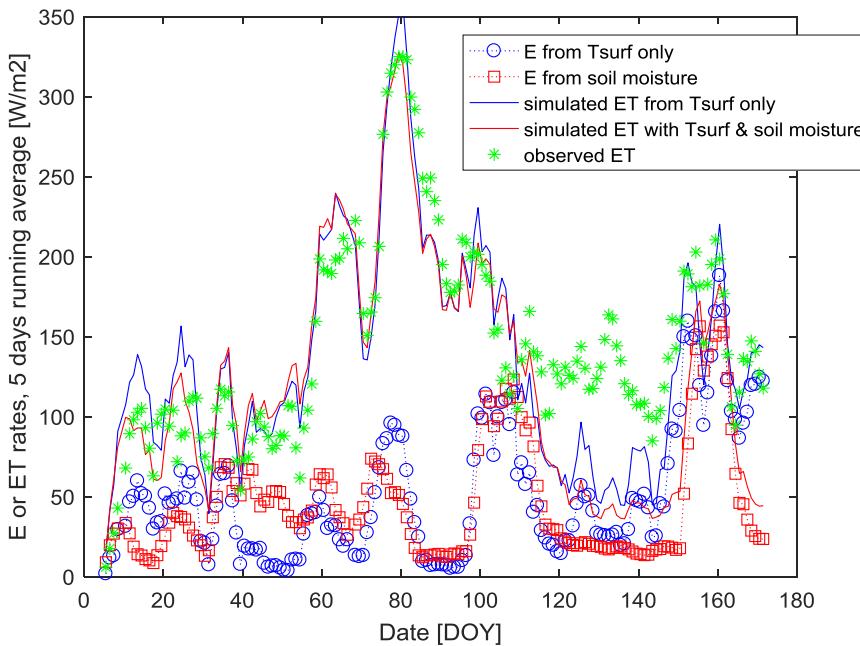


# $E$ (i.e. $LE_s$ ) forced by surface soil moisture

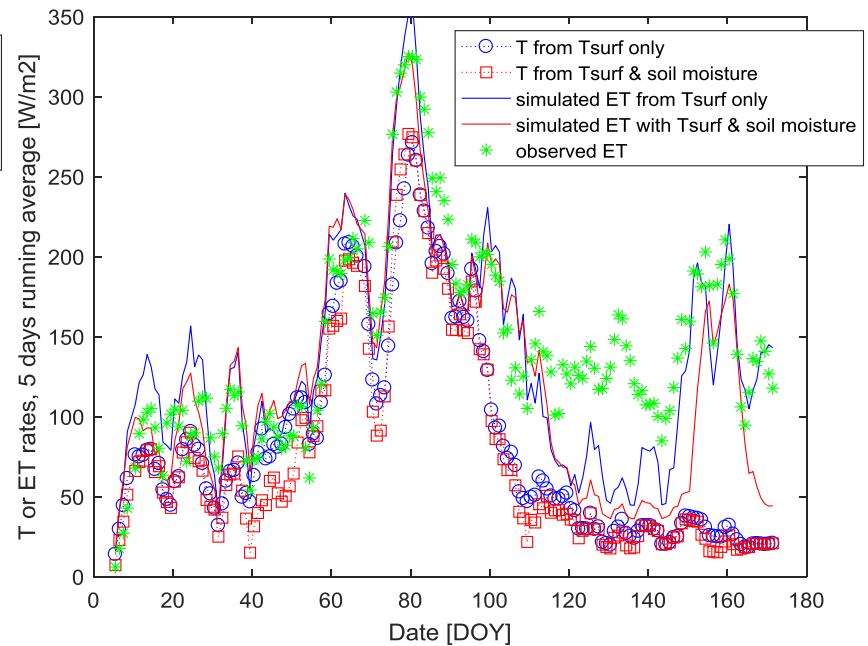
$$LE_s = \left[ 0.5 - 0.5 \cos\left(\pi \frac{\theta_{5cm}}{\theta_{sat}}\right) \right]^p LE_{spot}$$

(Merlin et al., 2011)

In situ capacitive probe for now  
Maybe S1 later on ?



Rainfed wheat in Tunisia (Kairouan)

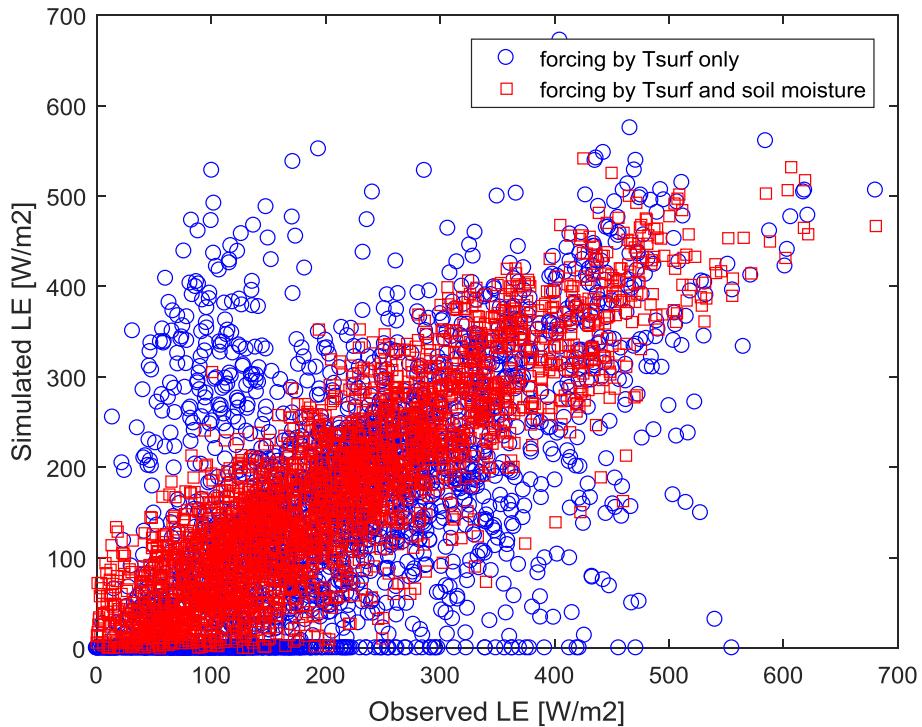


$ET_{T_{surf}}$  vs  $ET$  from  $T_{surf}$  and  $\theta$  vs observed  $ET$   
 $E$  from  $T_{surf}$  vs  $E$  from  $T_{surf}$  and  $\theta_{5cm}$

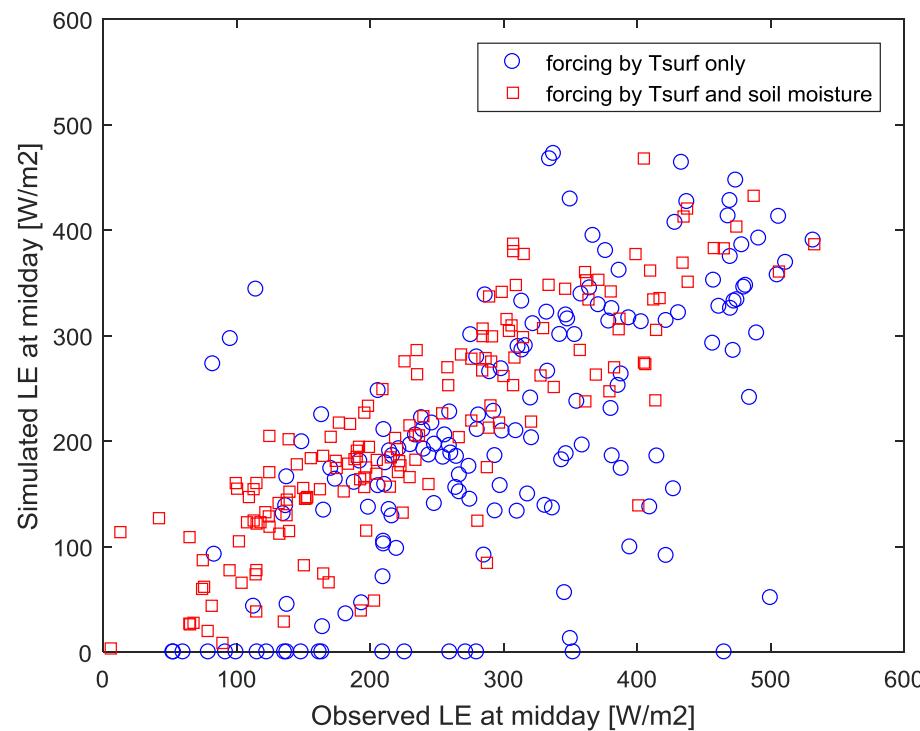
$ET_{T_{surf}}$  vs  $ET$  from  $T_{surf}$  and  $\theta$  vs observed  $ET$   
 $T$  from  $T_{surf}$  vs  $T$  from  $T_{surf}$  and  $\theta_{5cm}$

# E (i.e. $LE_s$ ) forced by surface soil moisture

Total LE, half hourly values



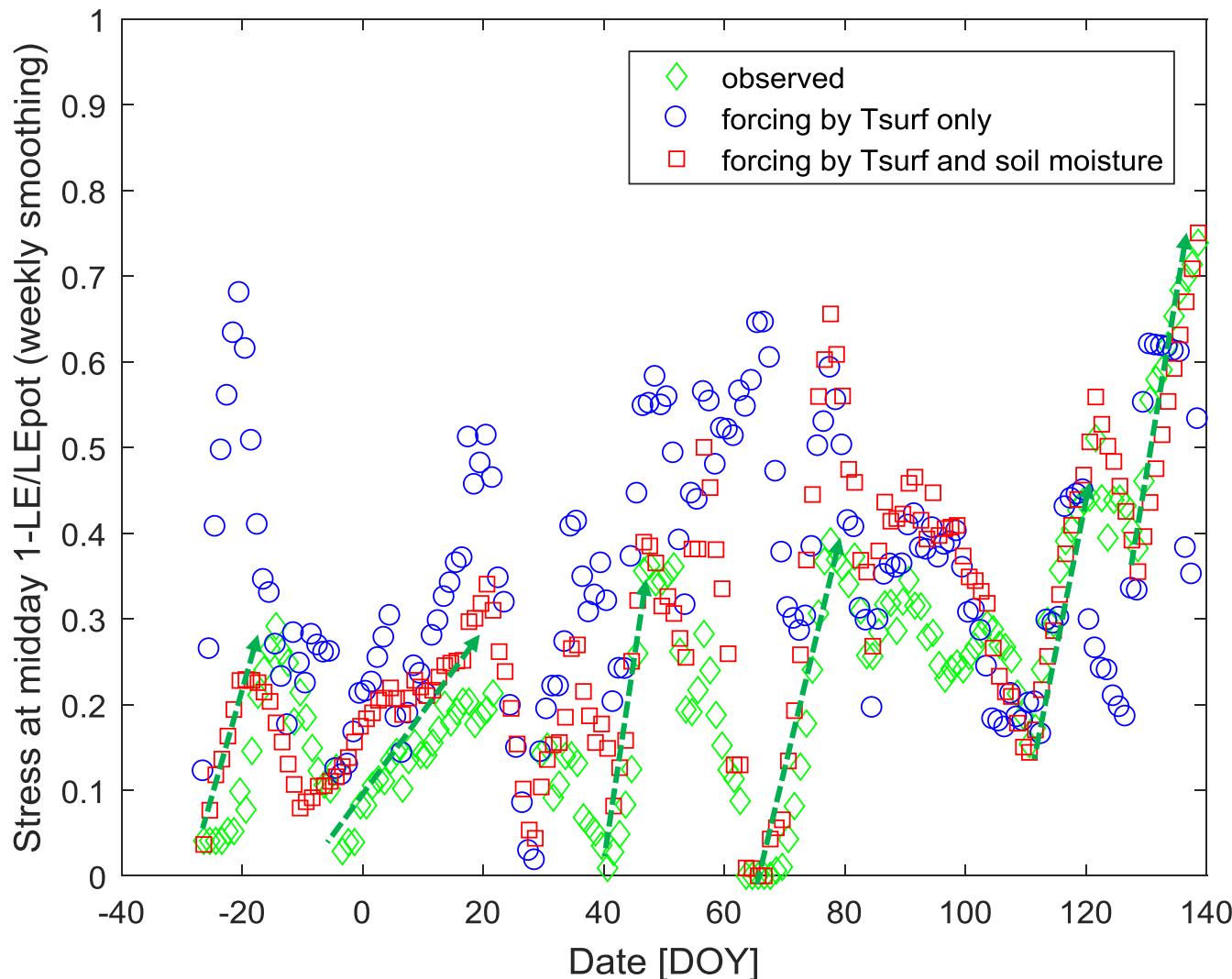
Total LE @ midday



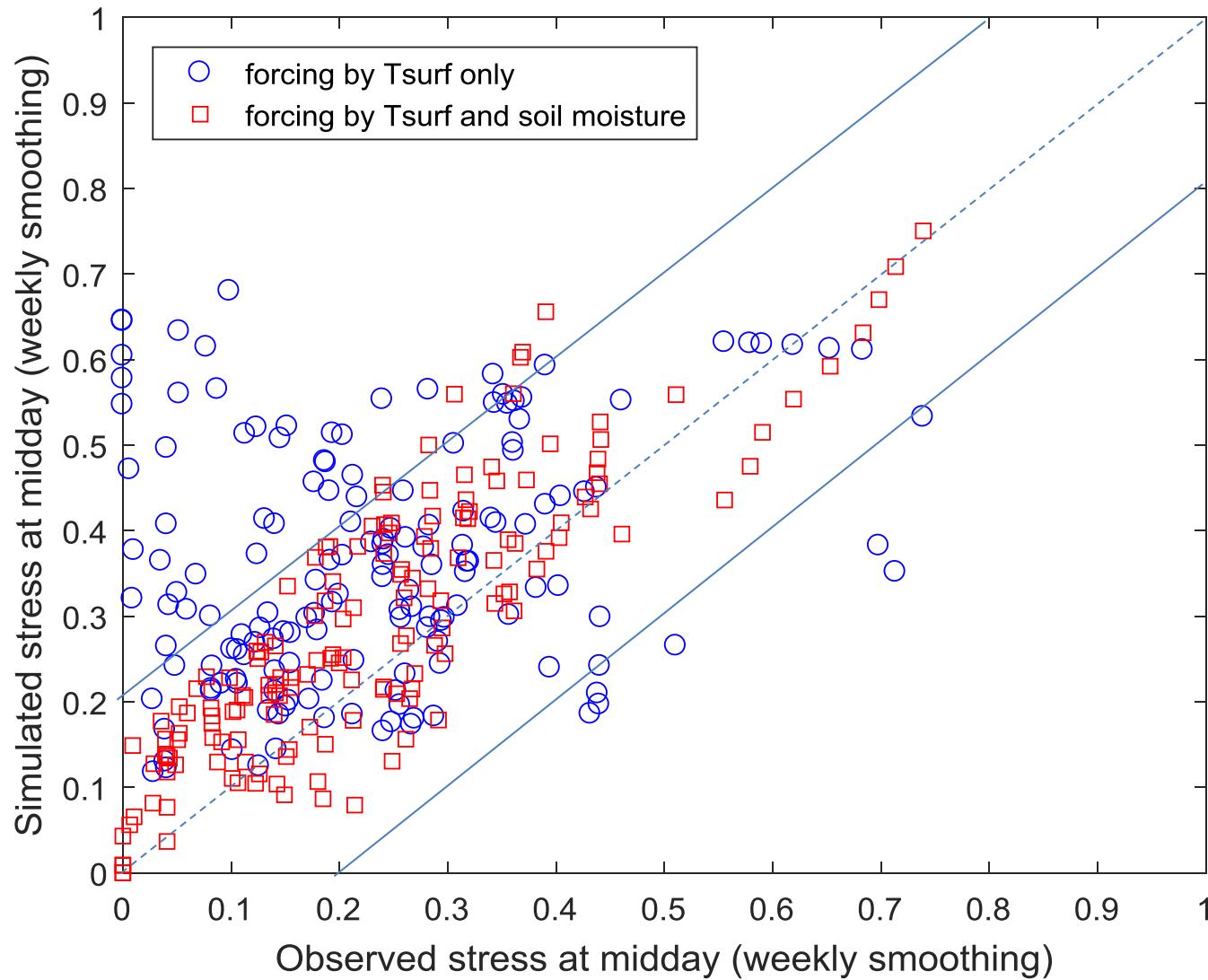
deficit irrigation wheat site in Morocco

ET from  $T_{surf}$  only or  $T_{surf}$  &  $\theta_{surf}$

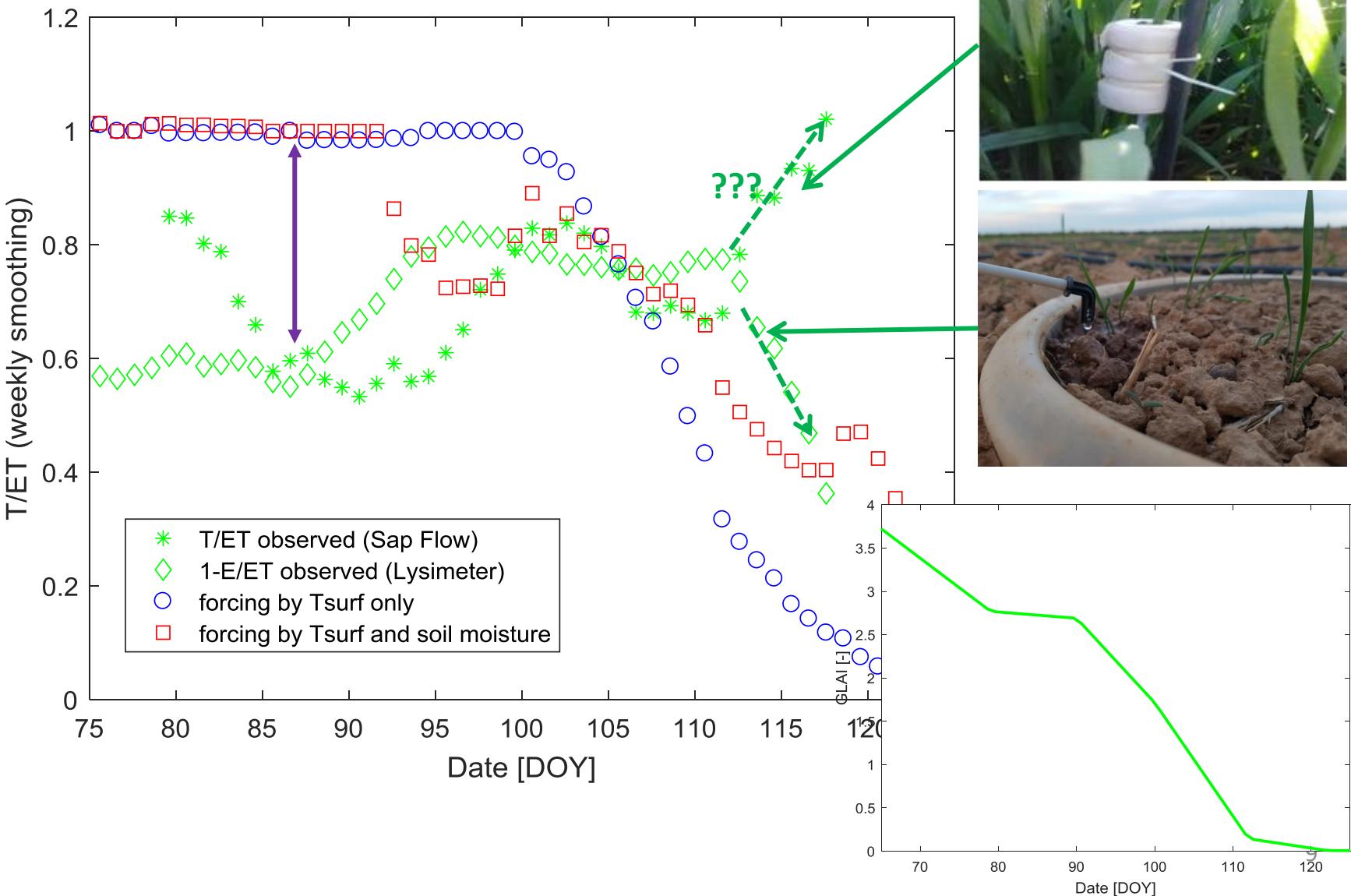
# Total water stress $1-\text{LE}/\text{LE}_{\text{pot}}$



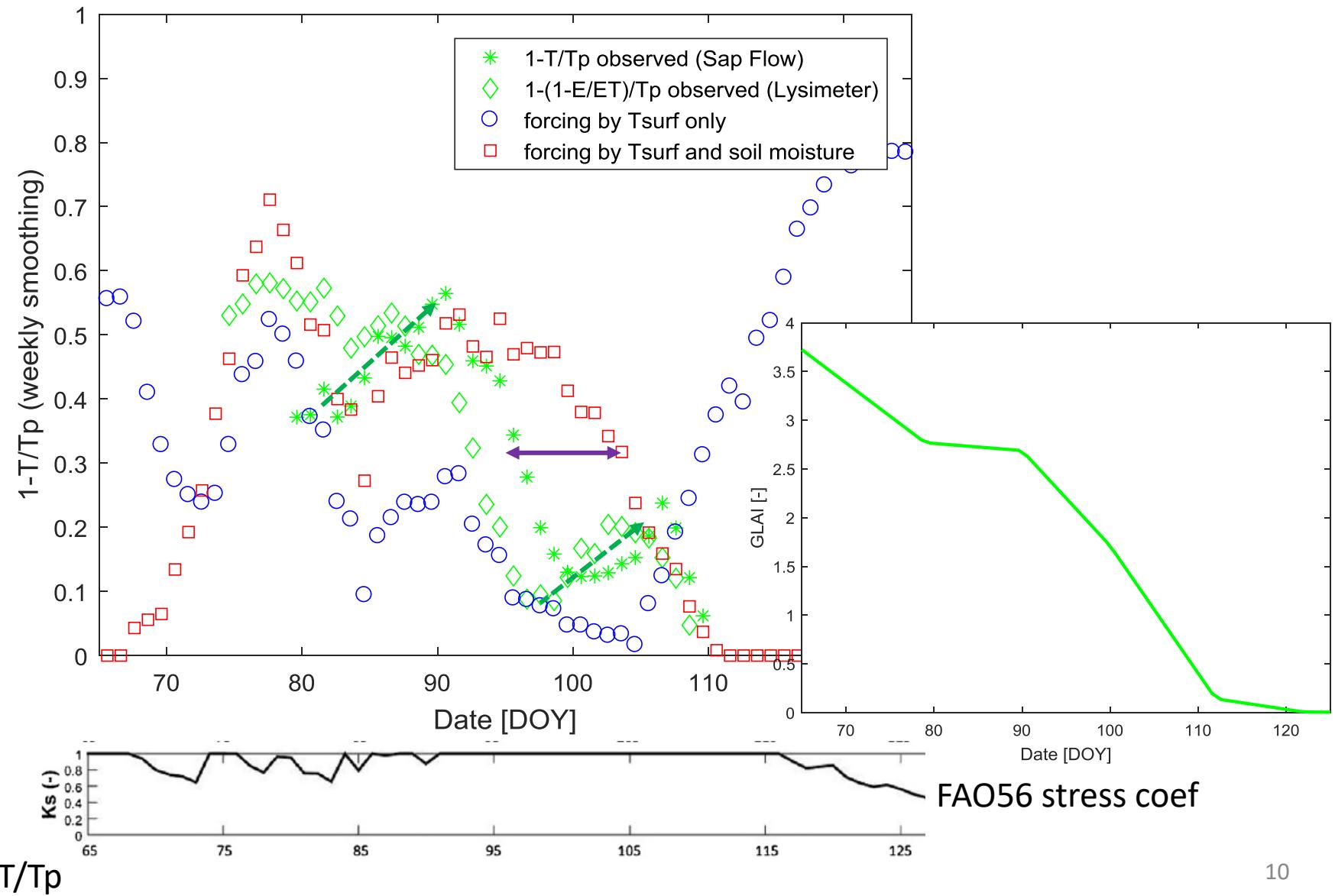
# Total water stress $1 - LE/LE_{pot}$



# T/ET partition



# Plant water stress $1-T/T_{\text{pot}}$



# Take home messages

- Water stress of the whole surface is fairly well retrieved by the uncalibrated model with a **0.2 uncertainty**, but many outliers challenge the robustness of any TIR ETR product (e.g. in a data assimilation or temporal interpolation perspective)
- Constraint by **surface soil moisture** improves total ET , T/ET as well as total and plant water stress for late mid-growth stage
- What about other indices linked to the **photosynthetic activity** (PRI, fluorescence...) or SWIR for midseason ?
- Need to find a way to evaluate **plant water stress** with additional measurements
- Extension to other sites with sapflow meas., as well as L8/S2/S1 data

