



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

Gilles Boulet, Zoubair Rafi , Valérie Le Dantec, Pascal Fanise,  
Albert Oliosio, Salah Er-Raki et Olivier Merlin

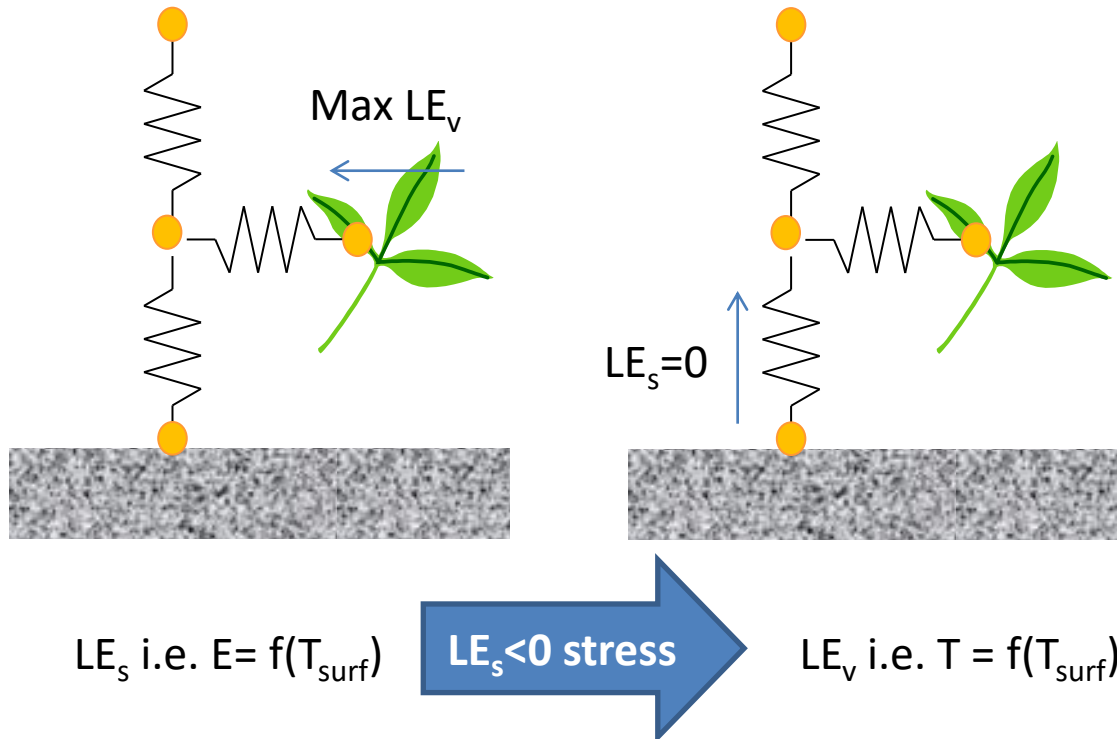
# Context and objectives

- 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 ( $T_{\text{surf}}$ )
  - 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

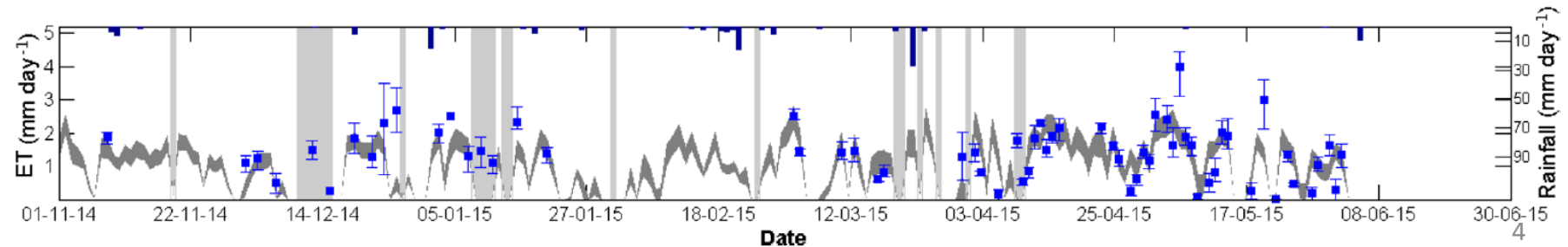
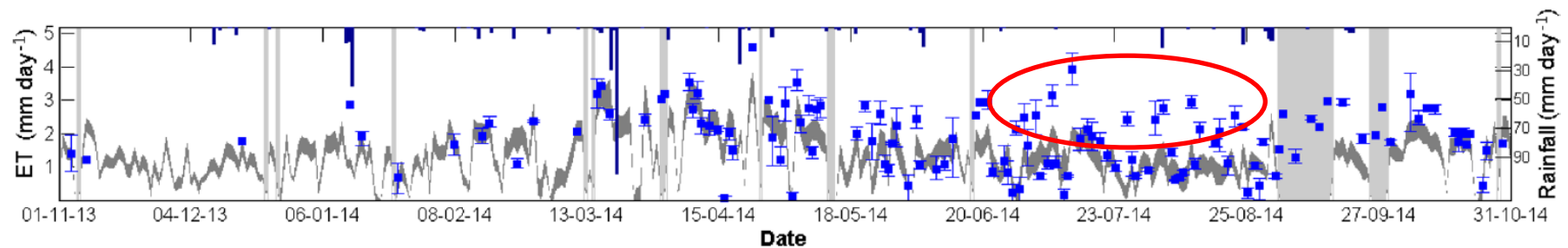
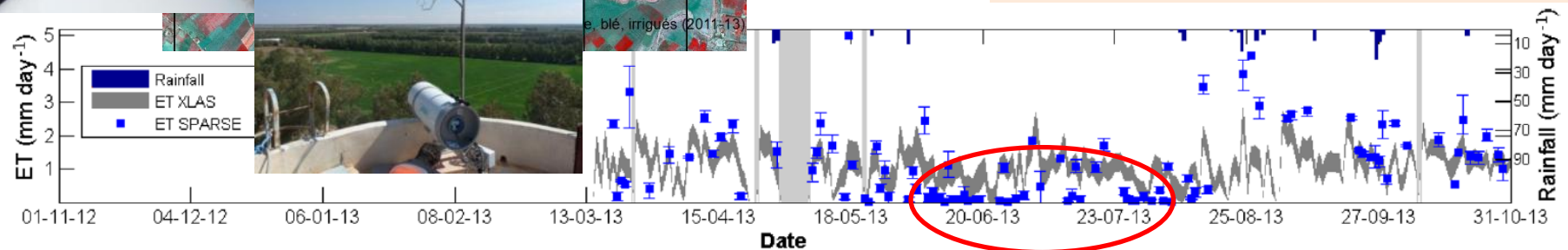
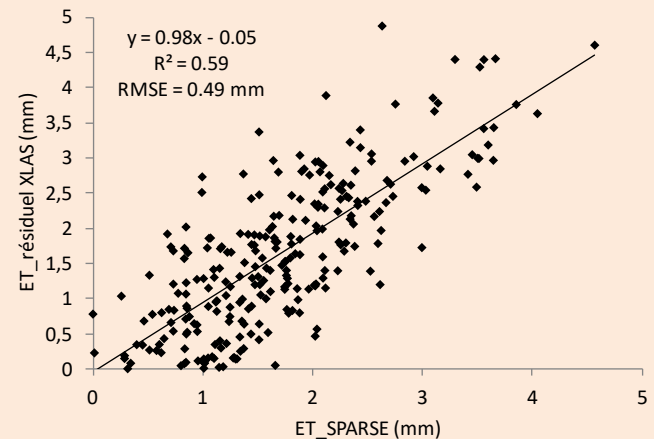
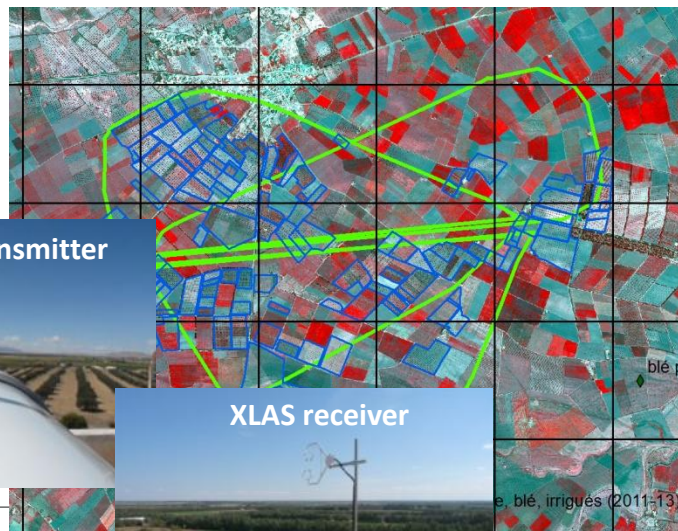
Same rationale as the TSEB model >

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



## Consequence:

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

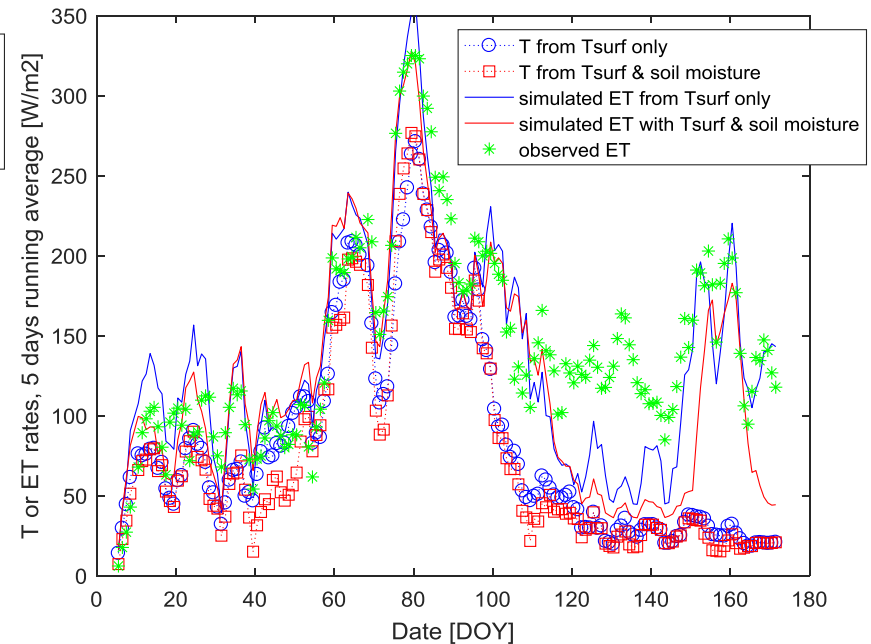
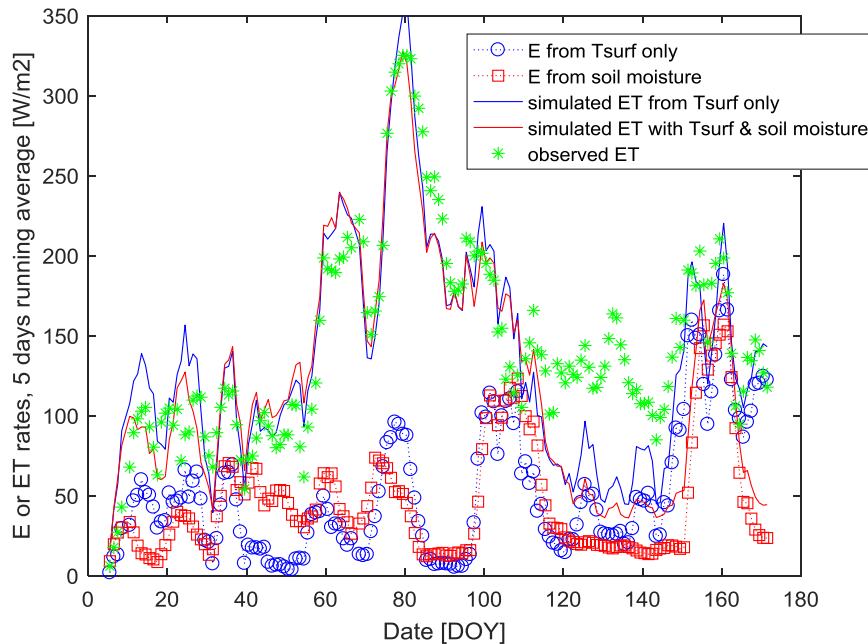


# E (i.e. $LE_s$ ) forced by surface soil moisture

$$LE_s = \left[ 0.5 - 0.5 \cos \left( \pi \frac{\theta_{5cm}}{\theta_{sat}} \right) \right]^p LE_{spot} \quad (\text{Merlin et al., 2011})$$

Insitu 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

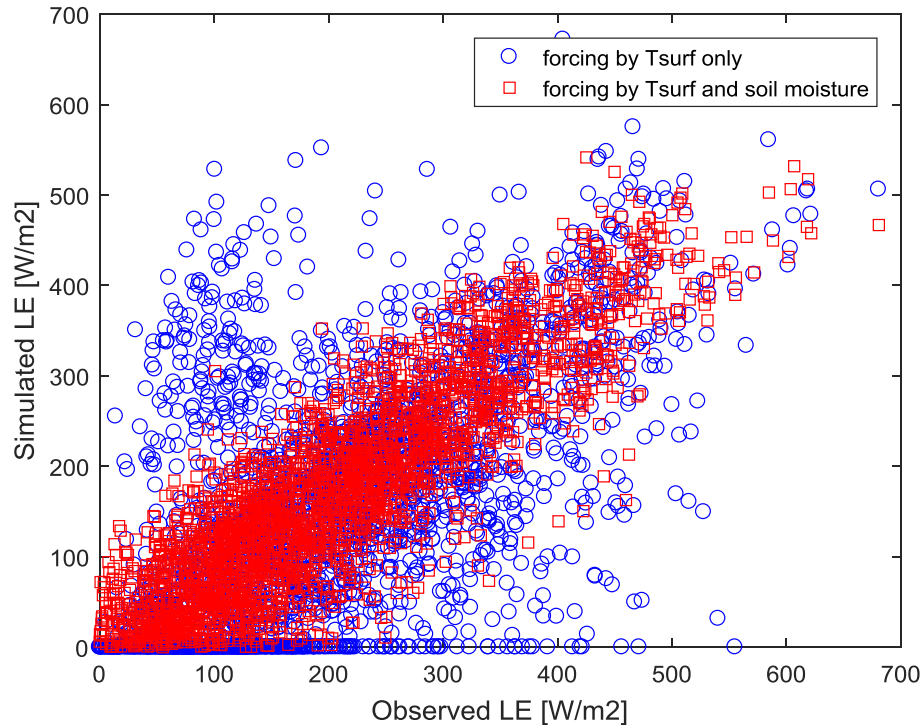
**E** from  $T_{surf}$  vs **E** from  $T_{surf}$  and  $\theta_{5cm}$

ET  $T_{surf}$  vs ET from  $T_{surf}$  and  $\theta$  vs observed ET

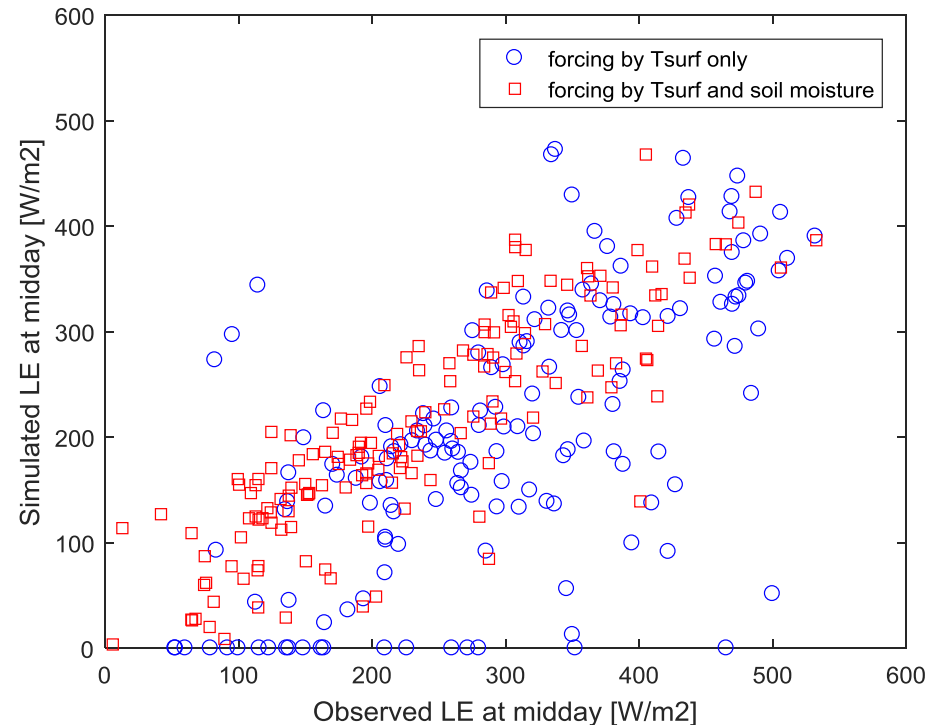
**T** from  $T_{surf}$  vs **T** from  $T_{surf}$  and  $\theta_{5cm}$

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

Total LE, half hourly values



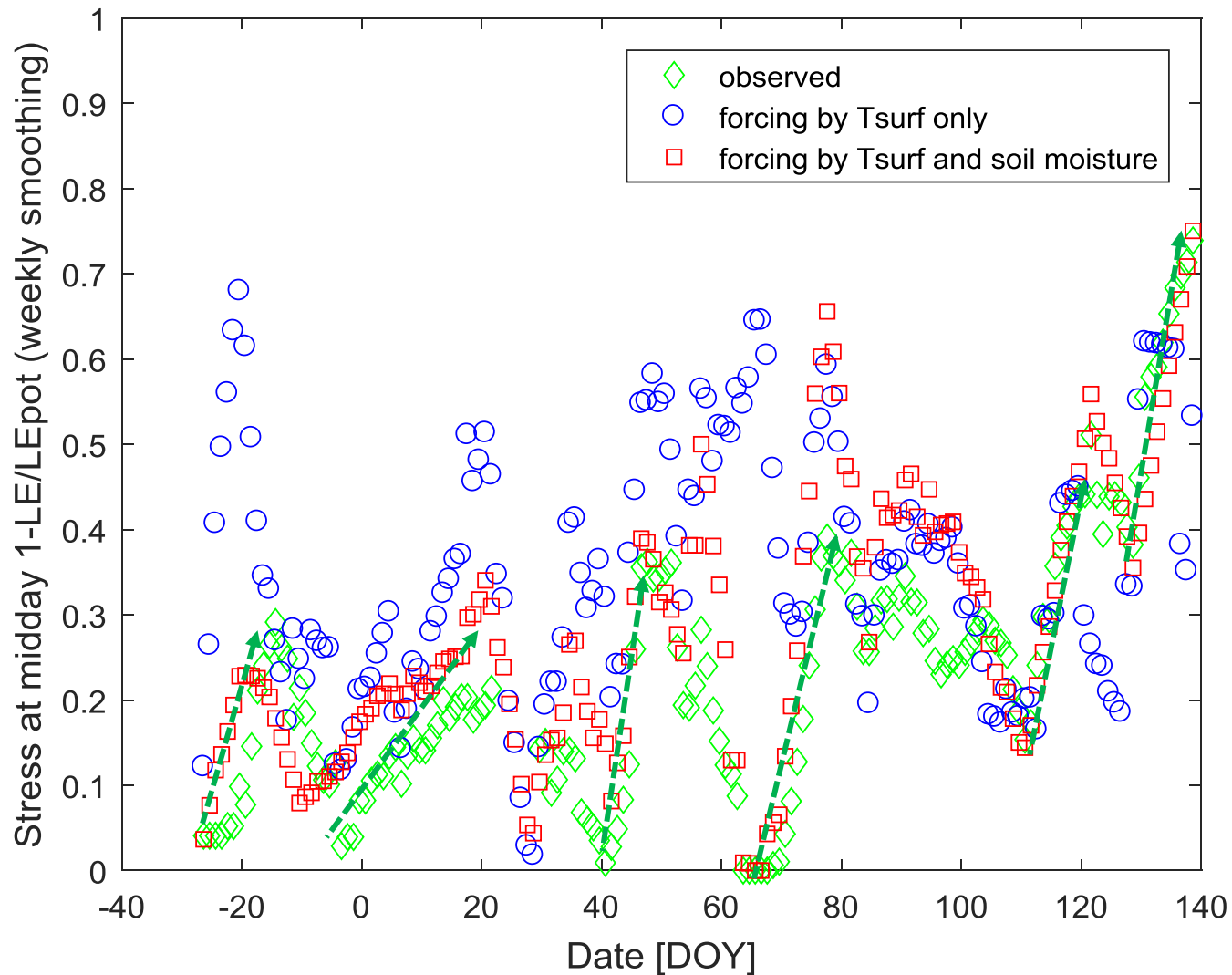
Total LE @ midday



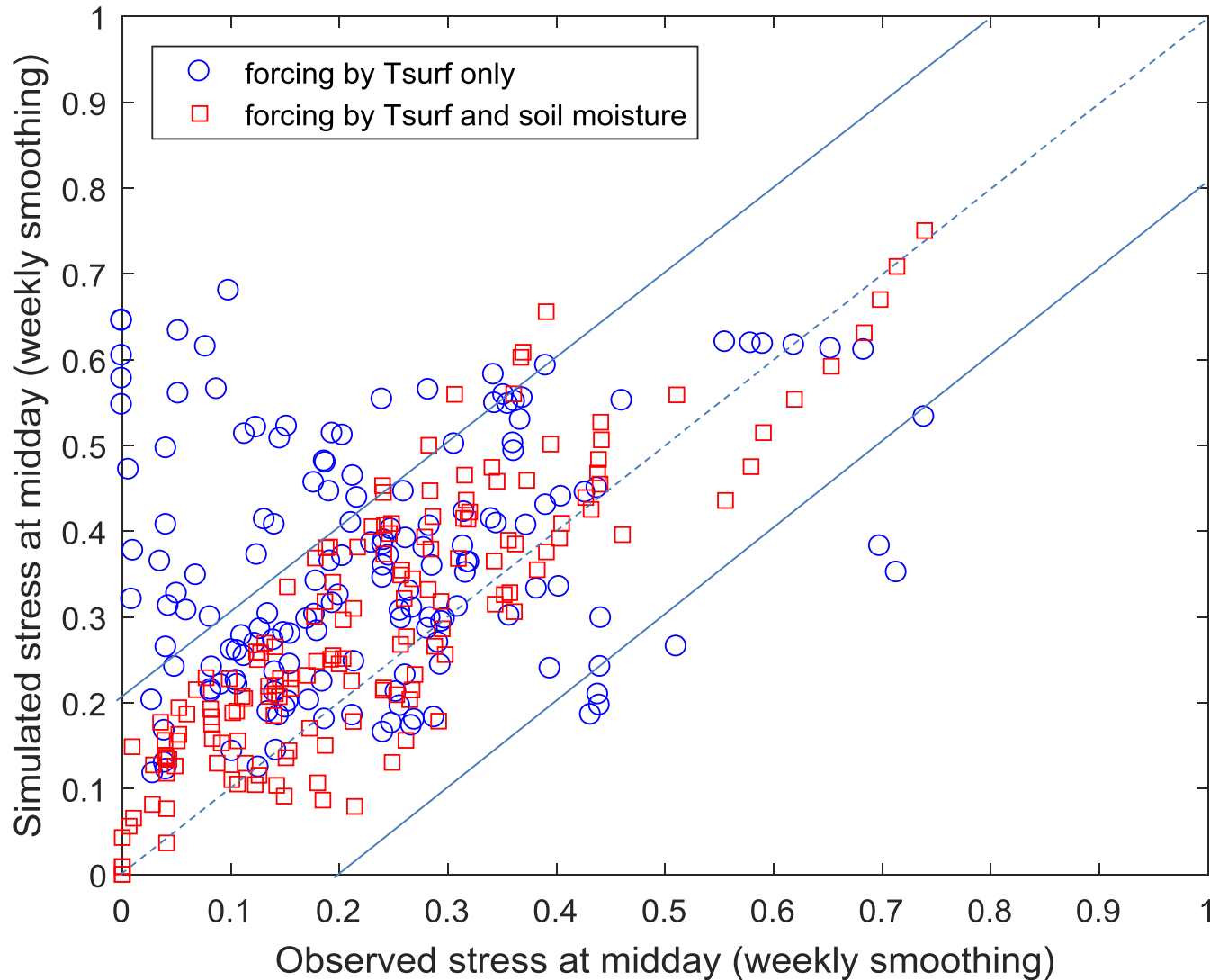
deficit irrigation wheat site in Morocco

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

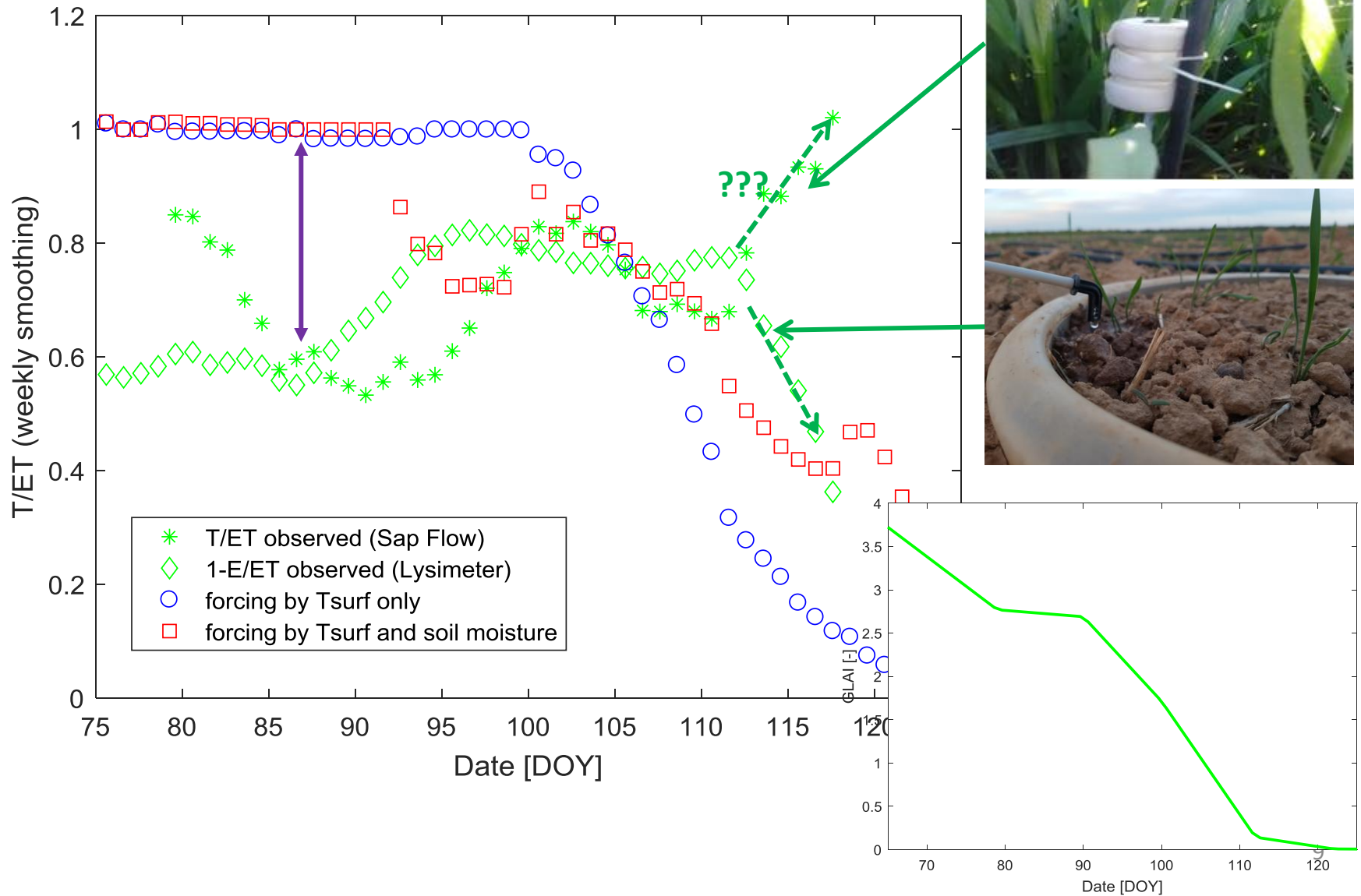
# Total water stress $1-LE/LE_{pot}$



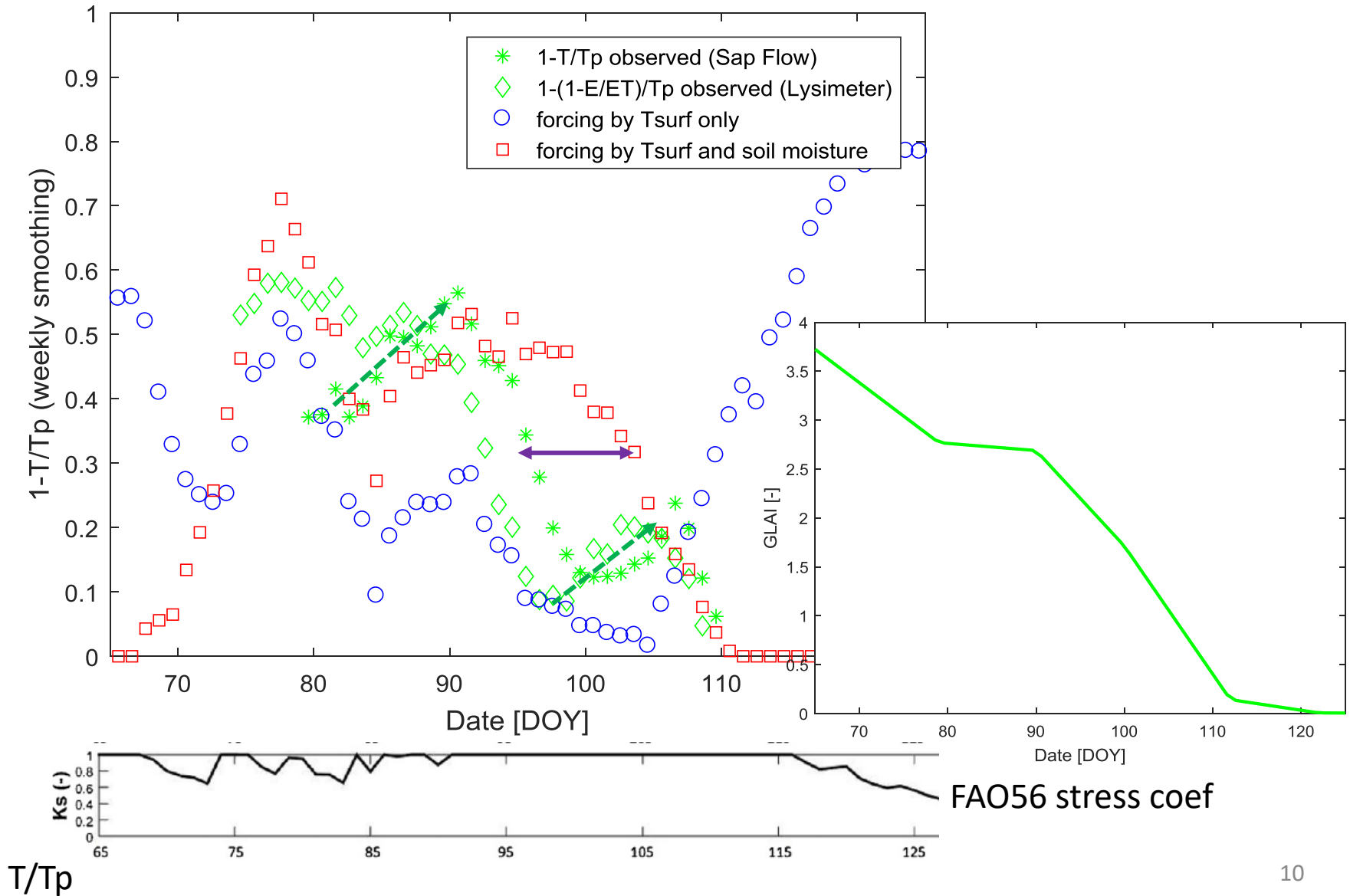
# Total water stress $1-LE/LE_{pot}$



# T/ET partition



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



# 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

