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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cnes
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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

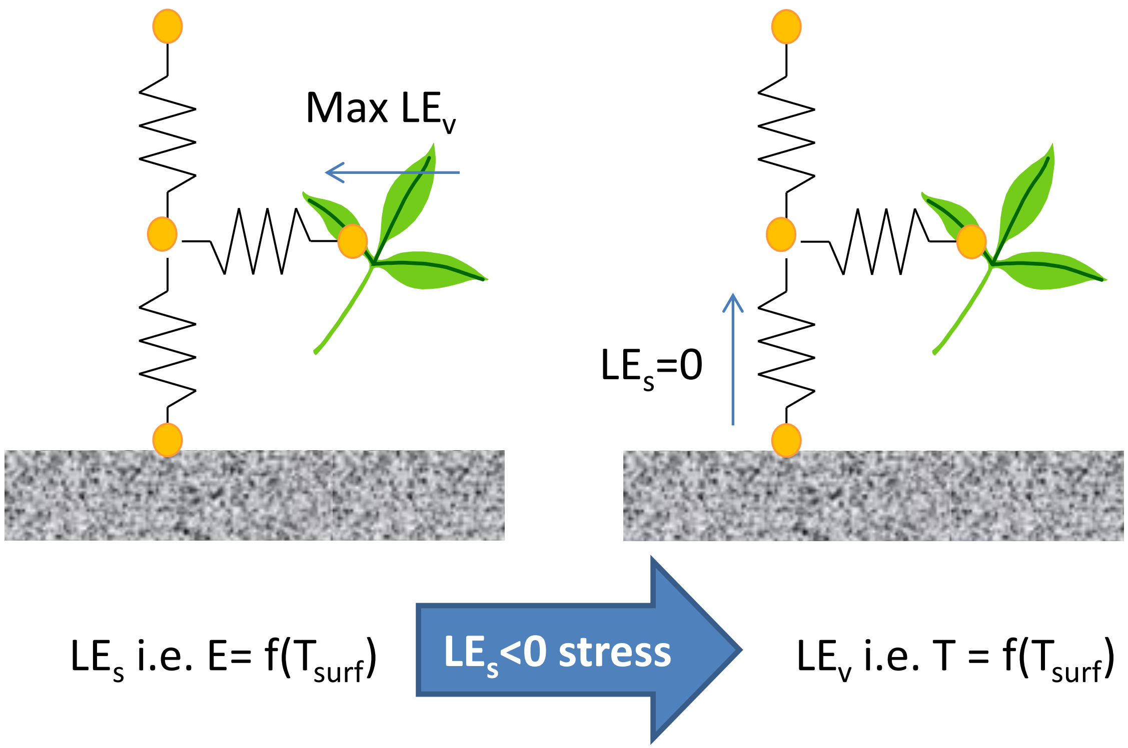
- Dual Source Energy Balance models compute both **evaporation E and transpiration T** from TIR data, as well as potential E and T

- 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 ?

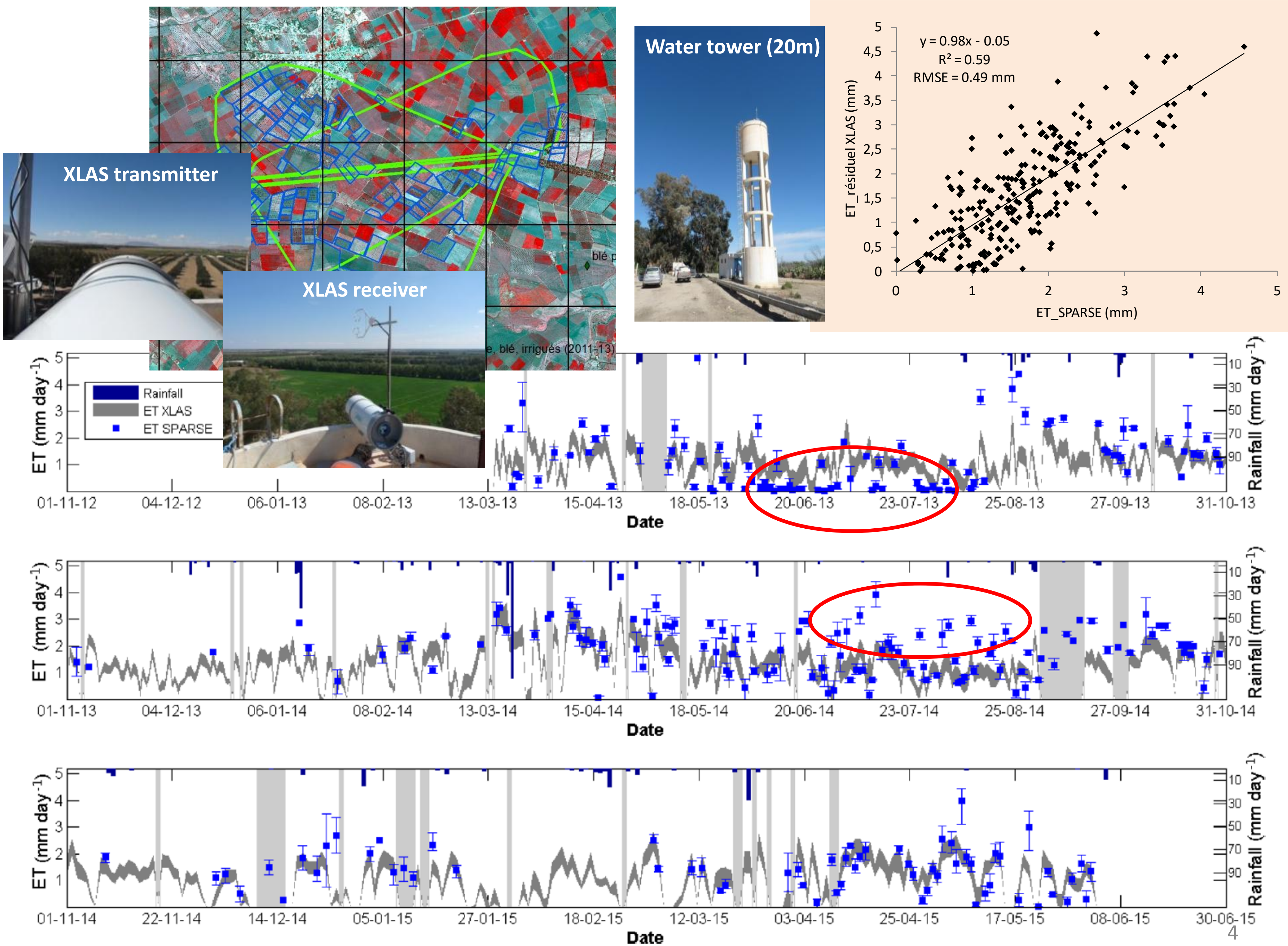
- Context = High resolution (50-100m) frequent revisit (2/3 days) TIR satellite mission TRISHNA (CNES/ISRO) as well as Copernicus LSTM

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}) ?



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



Saadi et al., HESS 2018

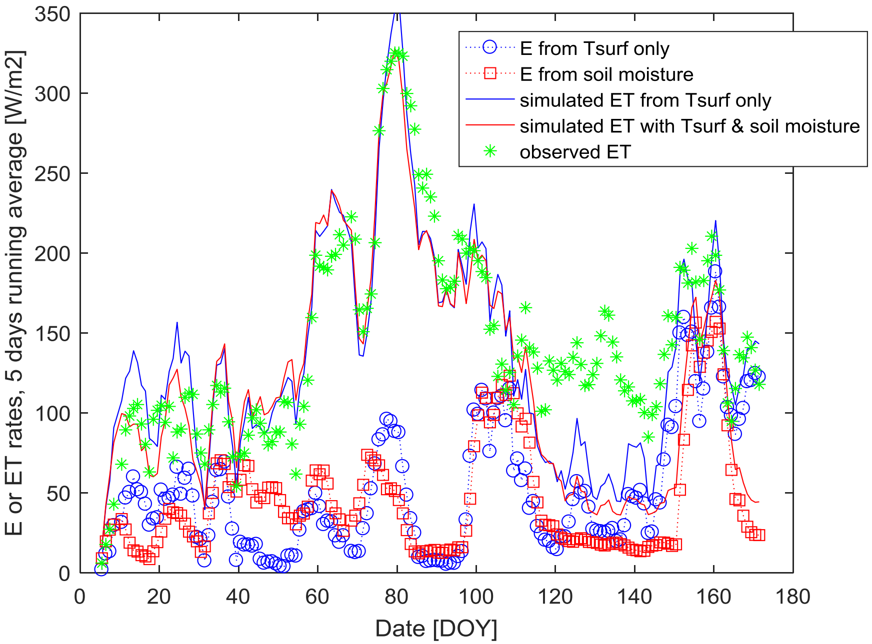
E (i.e. LE_s) forced by surface soil moisture

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

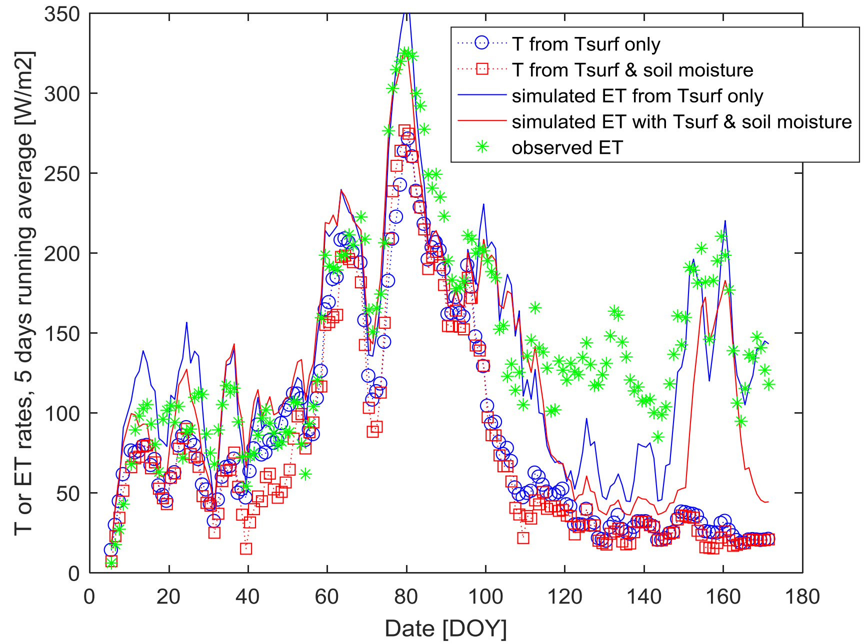
(Merlin et al., 2011)

Insitu capacitive probe for now
Maybe S1 later on ?

Rainfed wheat in Tunisia (Kairouan)

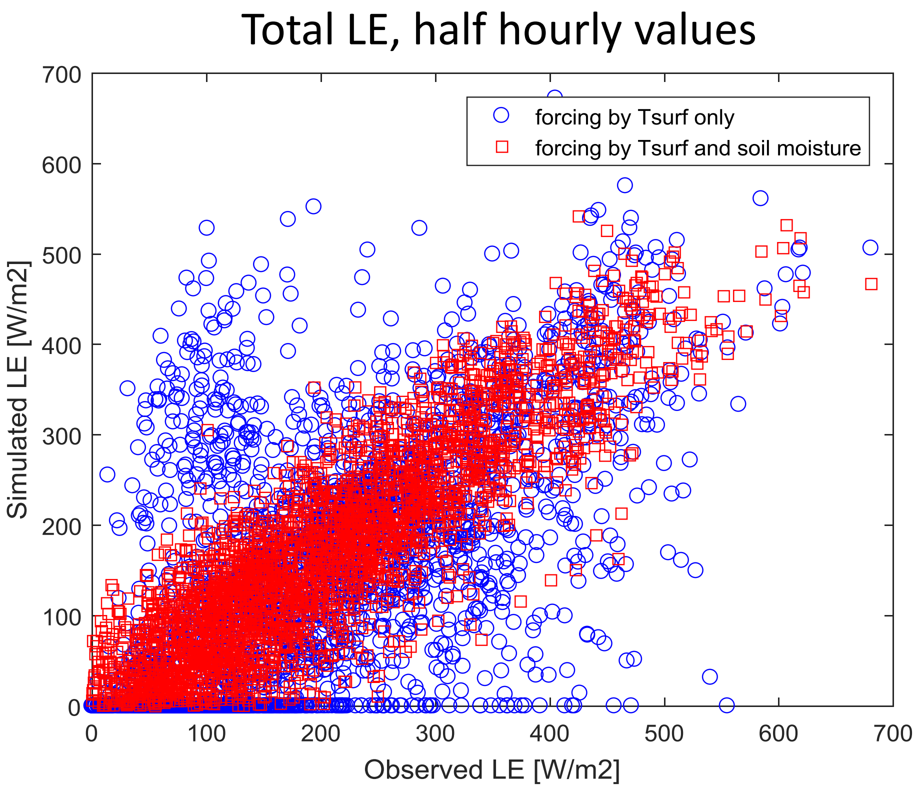


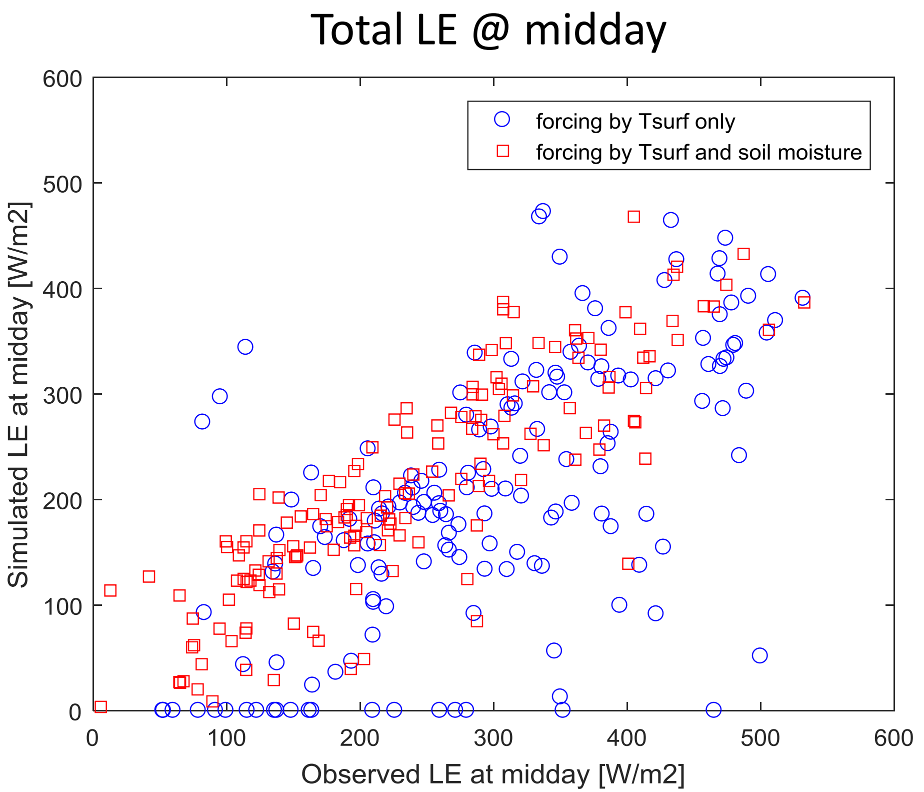
ET T_{surf} vs ET from T_{surf} and θ vs observed ET
E from T_{surf} vs **E** from T_{surf} and θ_{5cm}



ET T_{surf} vs ET from T_{surf} and θ vs observed ET
T from T_{surf} vs **T** from T_{surf} and θ_{5cm}

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

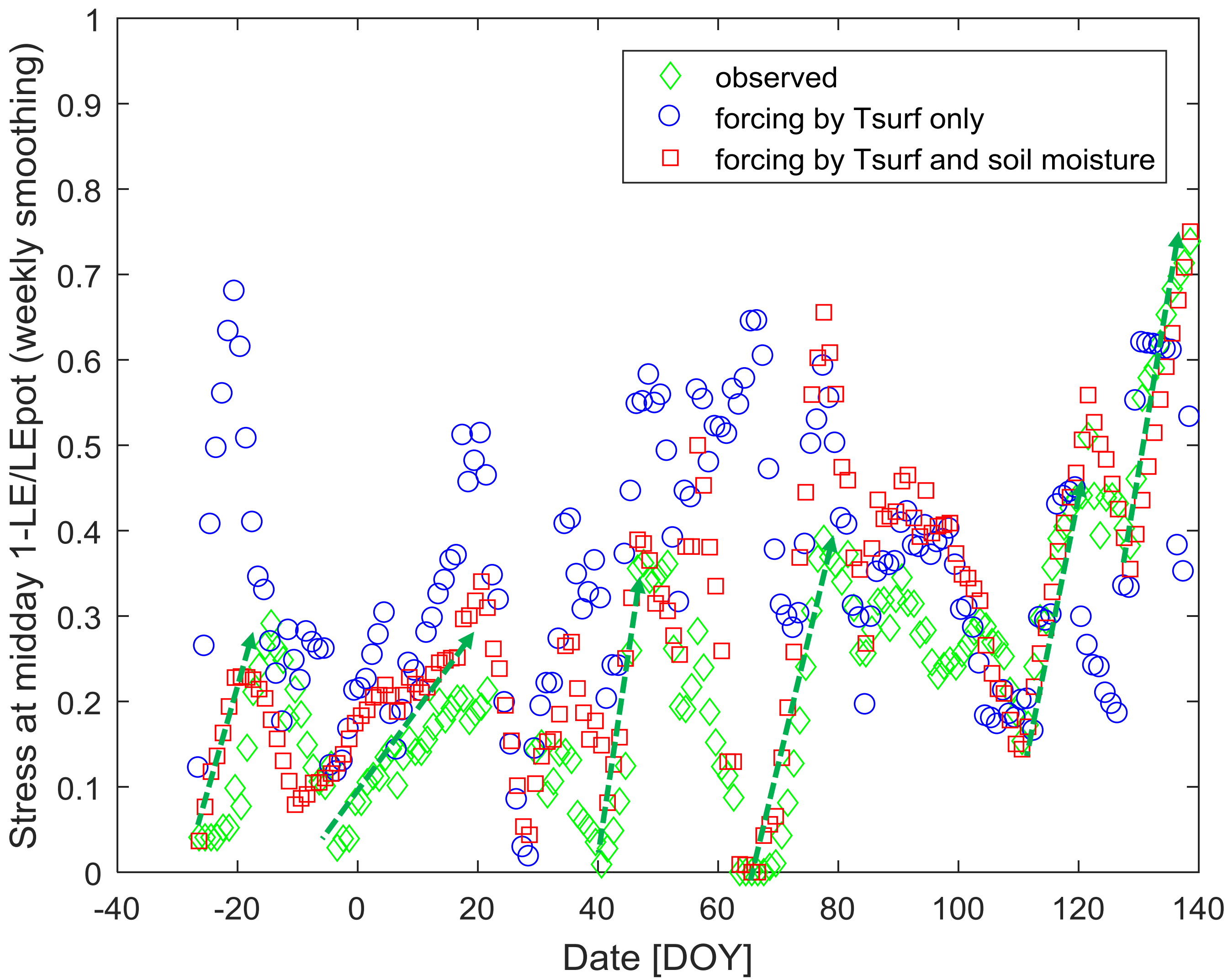




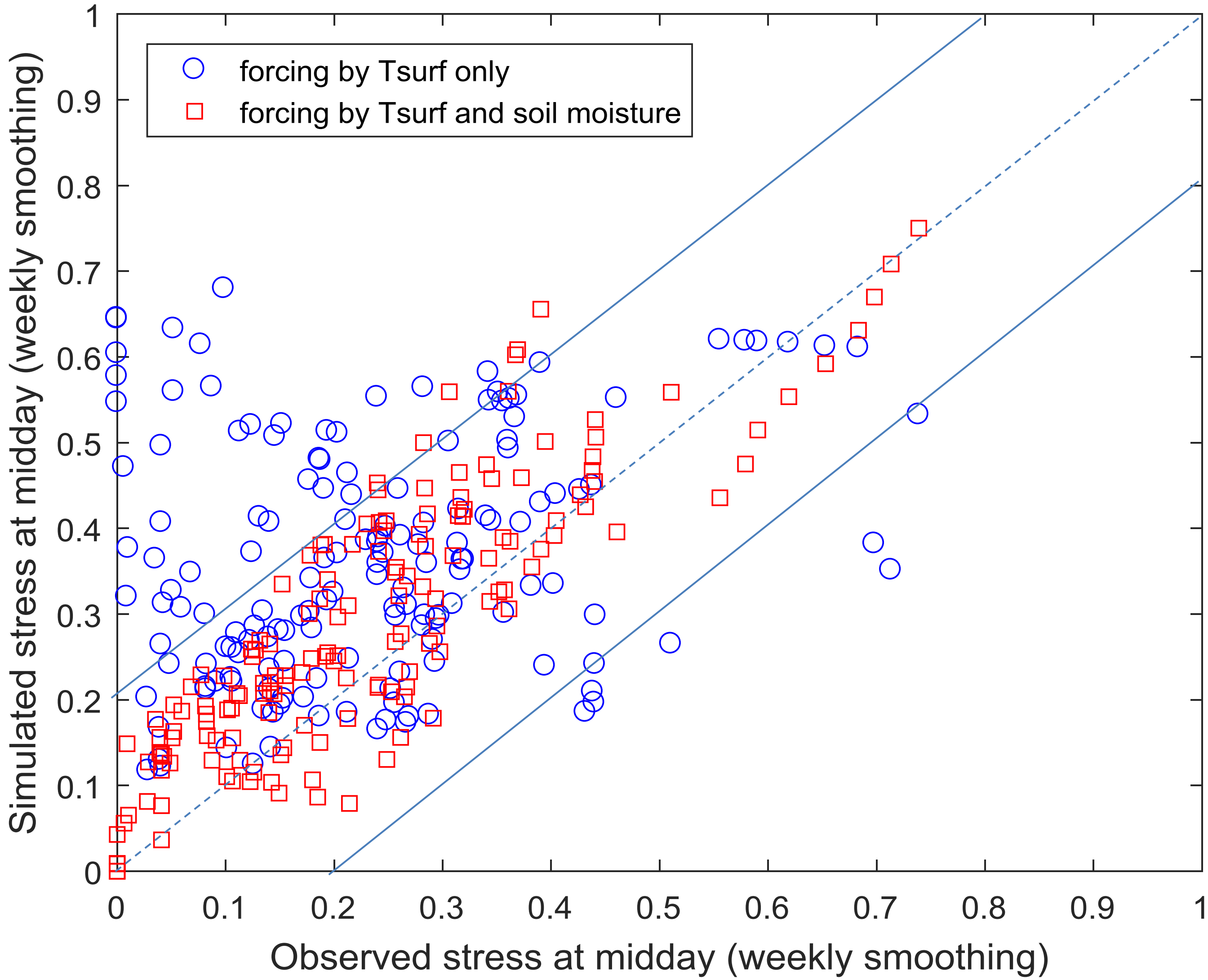
deficit irrigation wheat site in Morocco

ET from T_{surf} **only** or T_{surf} **&** θ_{surf}

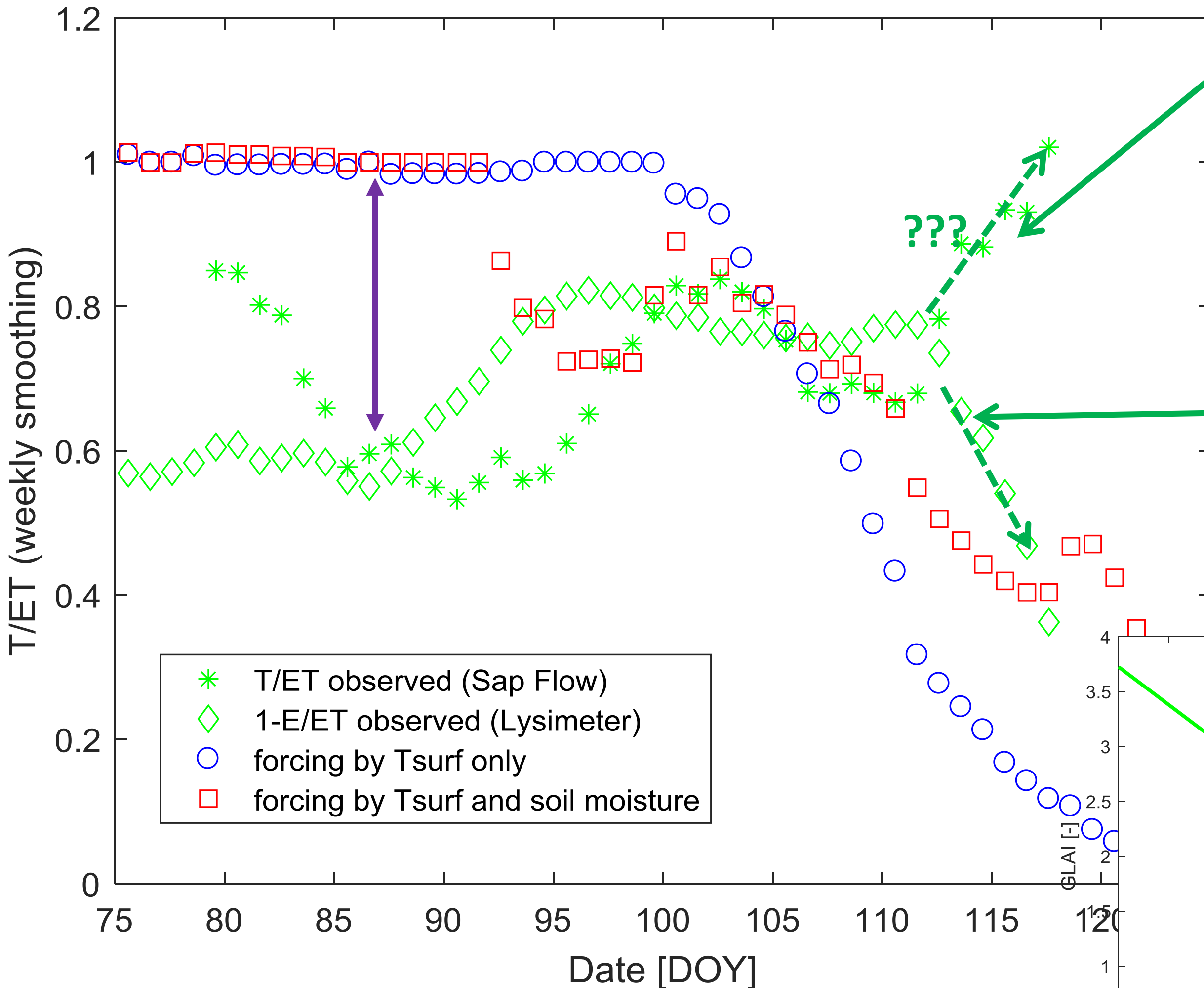
Total water stress 1-LE/LE$_{pot}$

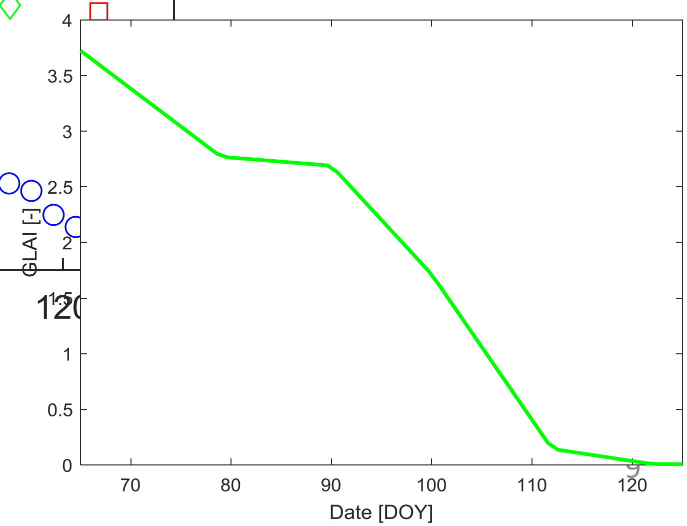


Total water stress 1-LE/LE_{pot}

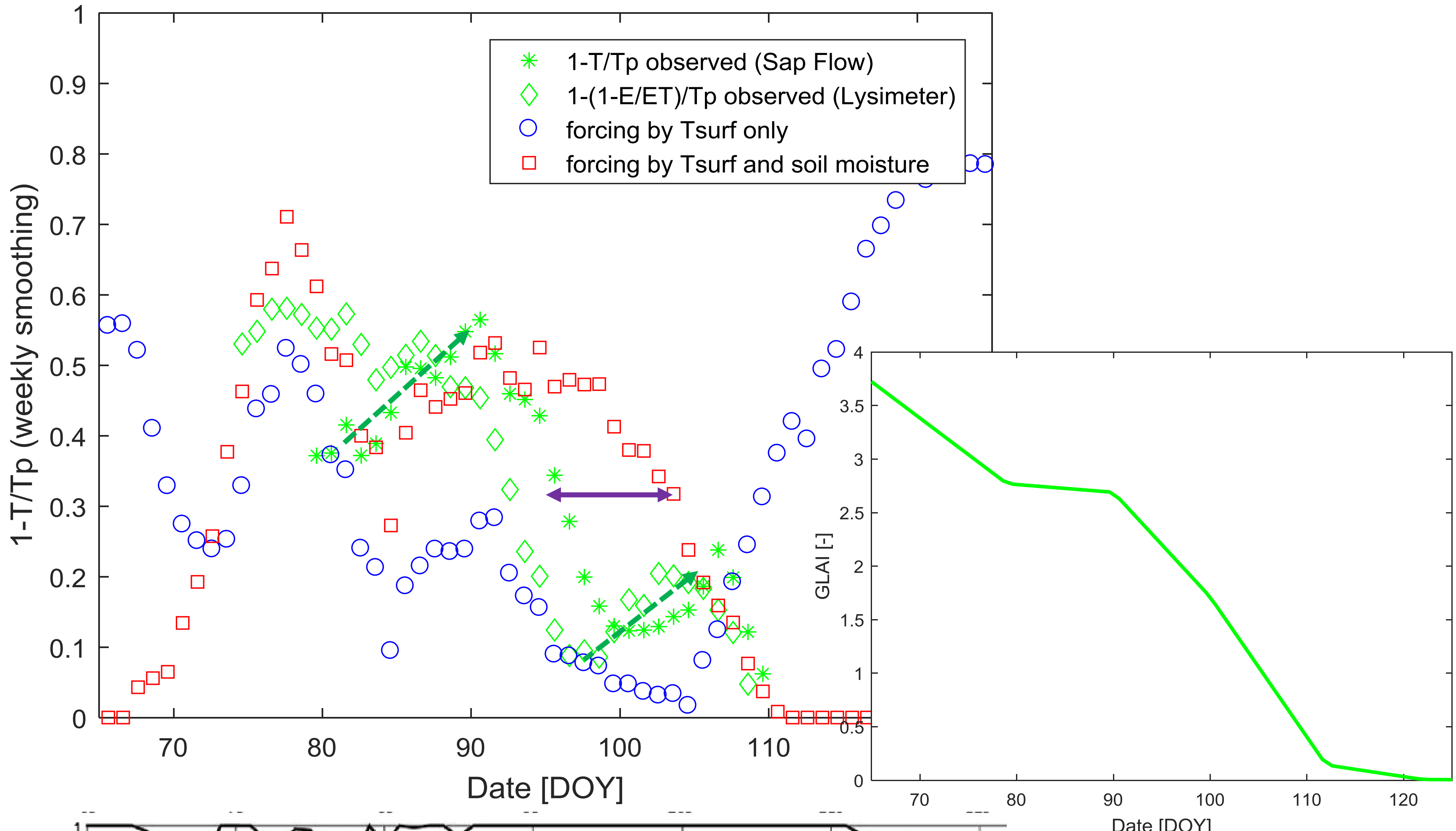


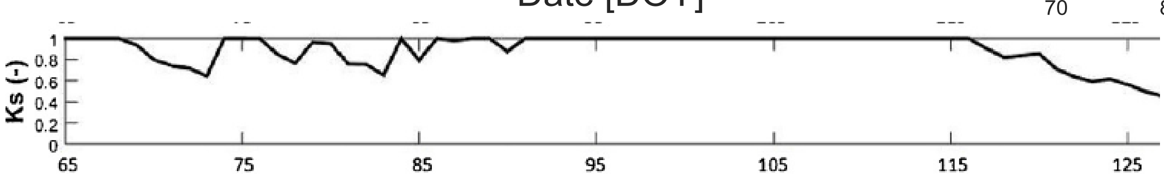
T/ET partition





Plant water stress 1-T/T_{pot}





FAO56 stress coef

T/Tp

Take home messages

- Water stress <u>of the whole surface</u> 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