



Growing
ideas
through
networks

Bridging the gap between in situ measurements and proximity sensing via UAS: an experimental case for the Vegetation Monitoring Harmonious working group

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BACKGROUND

Harmonious aims to:

- **bridge the gap between field measurements by ground-based sampling, and remote sensing assessments via airborne or satellite platforms.**

WG2 aims to:

- **assess the suitability of the different approaches to monitoring vegetation variables at different spatial resolution.**

KEY QUESTIONS ARE:

- Which remote sensing based **model** is more **suitable** to **characterize** the vegetation water **stress** using UAV?
- What is the **effect of spatial resolution** on modelling accuracy? What is the optimum (**coarsest possible**) **spatial resolution** that can be used from UAV **without losing accuracy**?

Theoretical basis

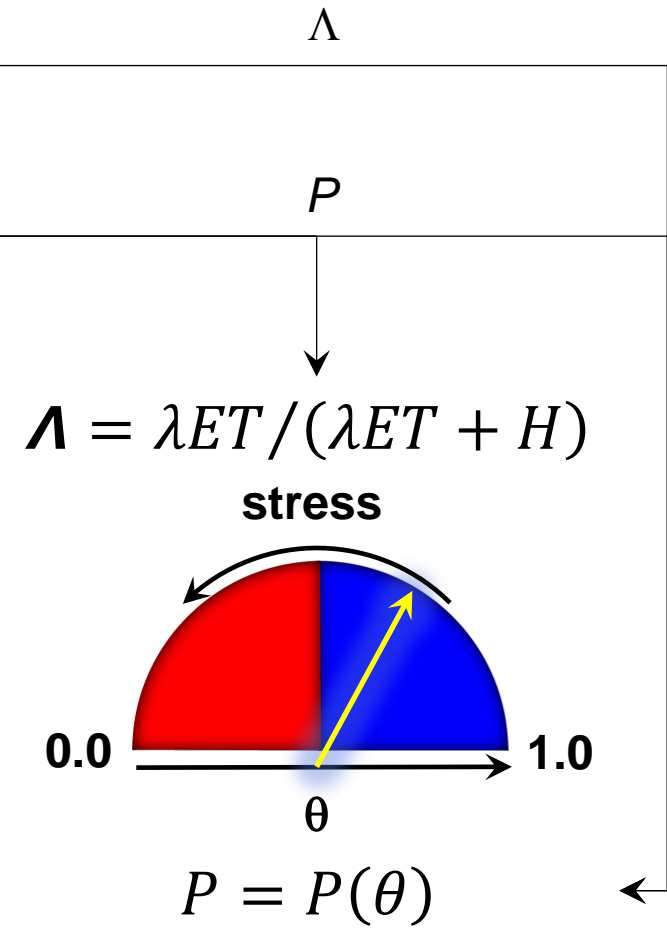
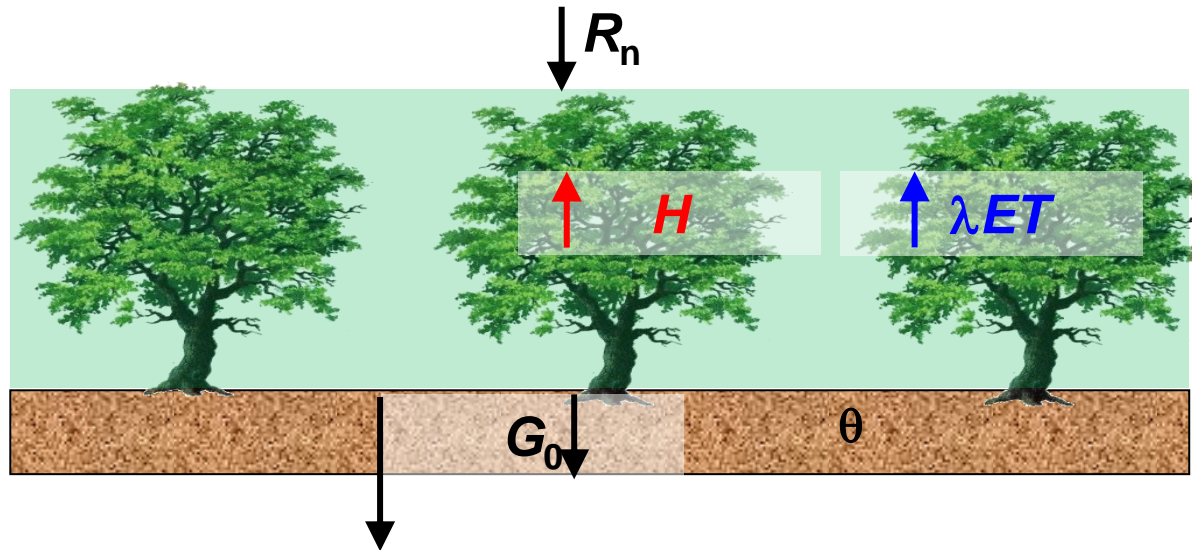
How to map vegetation water stress: Evaporative fraction, Soil moisture

Thermal diffusion eq.

$$D \frac{\delta^2 T(z,t)}{\delta z^2} = \frac{\delta T(z,t)}{\delta t}$$

Surface Energy Balance

$$G_0 = -k \left. \frac{\delta T(z,t)}{\delta z} \right|_{z=0} = R_N - \lambda ET - H$$



R_n Net radiation
 G_0 Soil heat flux

H Sensible heat flux
 λET Latent heat flux

D Thermal diffusivity
 Λ Evaporative fraction

K Thermal conductivity
 P Thermal inertia
 θ Soil moisture

Surface Energy Balance

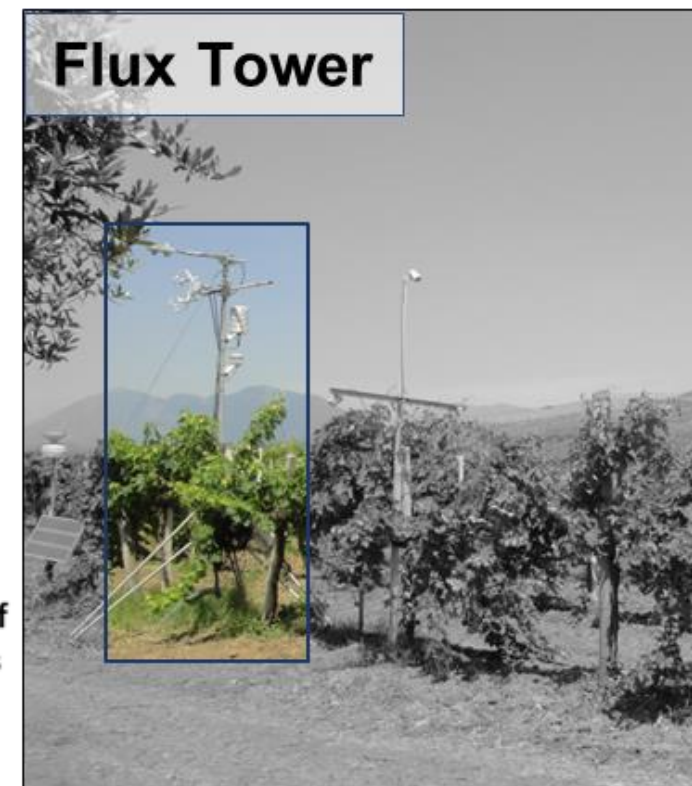
previous outcomes with high resolution airborne images



Results: comparative analysis SEB estimate vs. *flux tower in situ* measurements

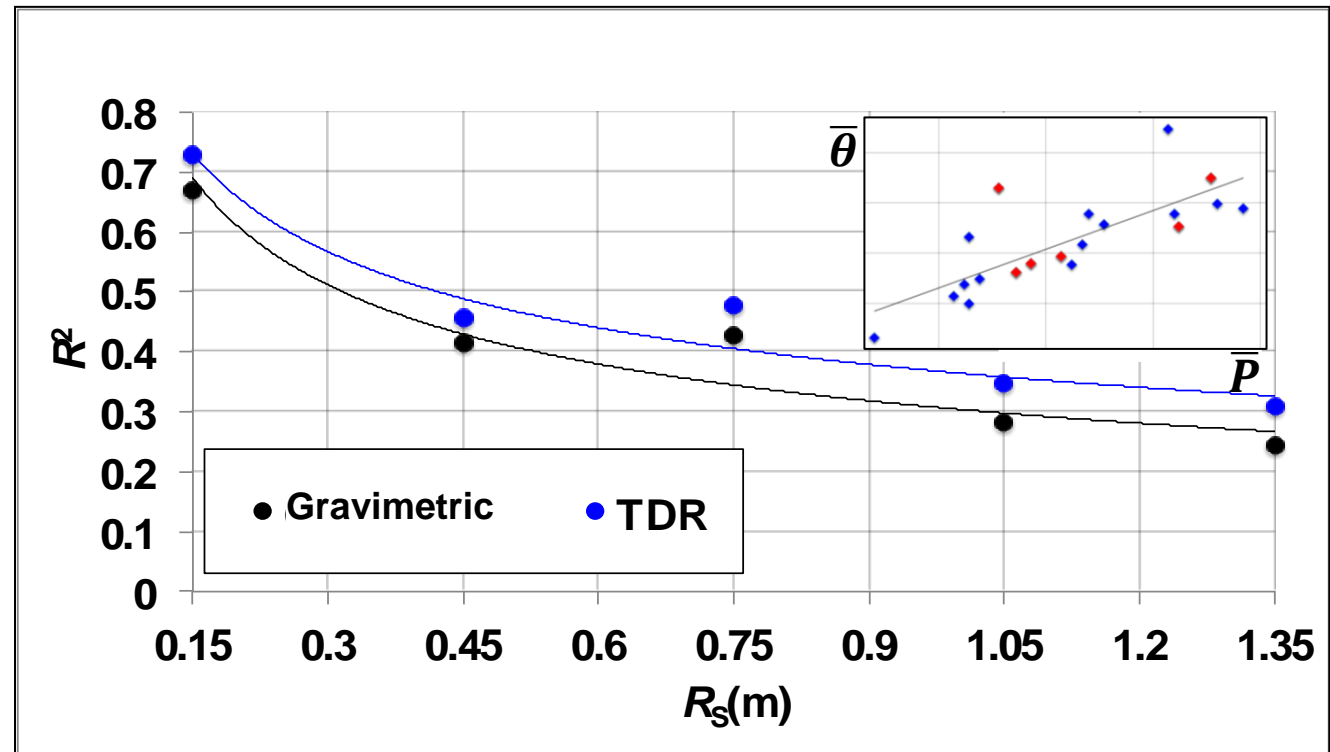
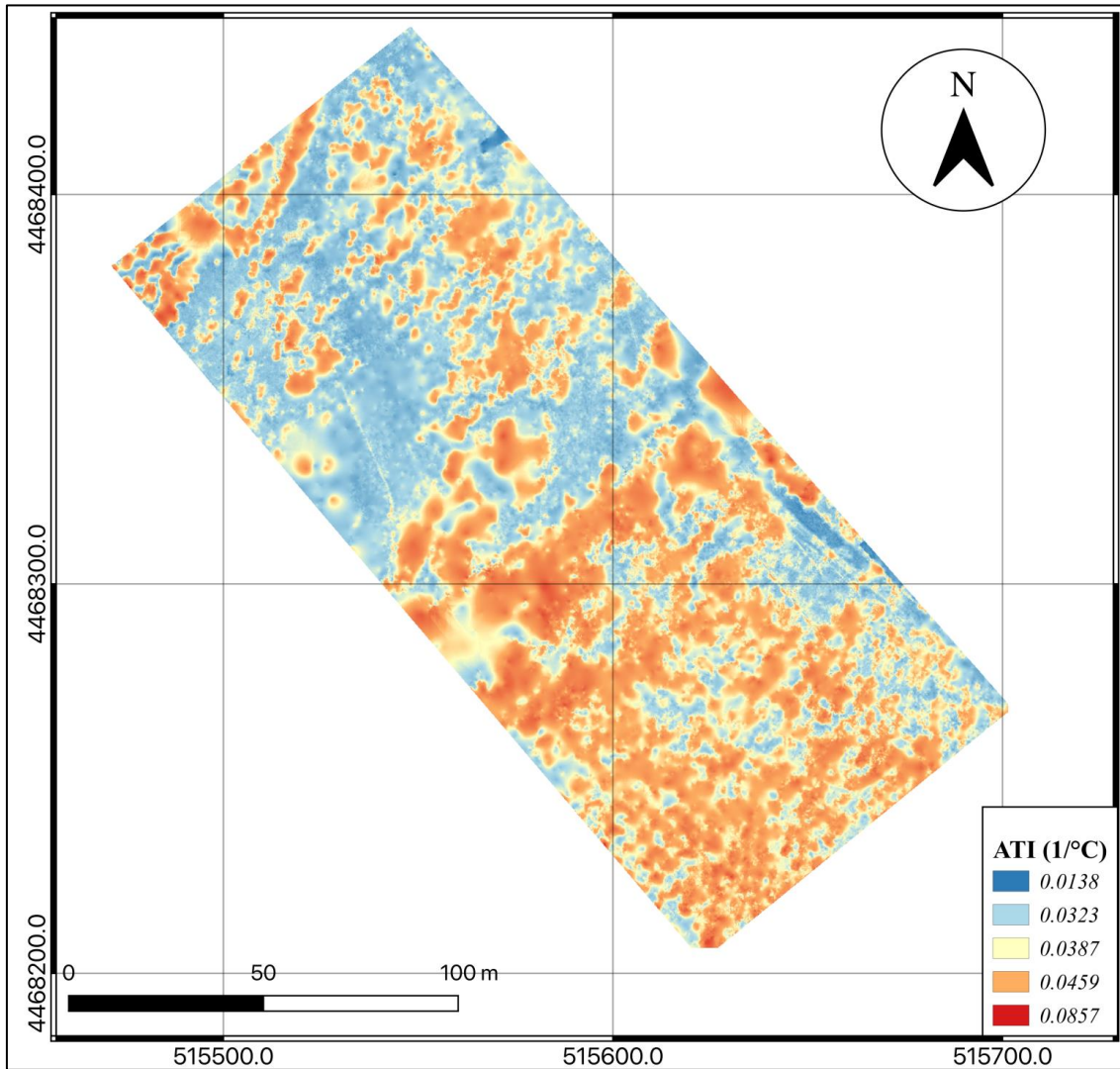


λET obtained with different model setups: June acquisition



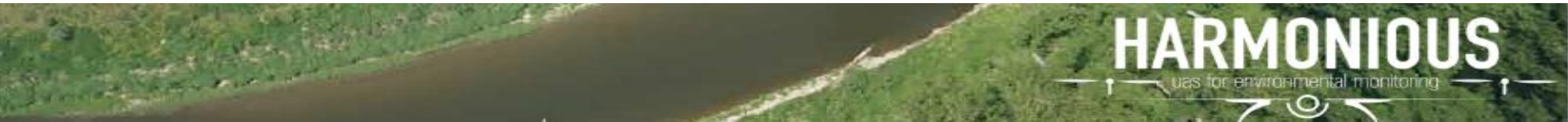
Thermal inertia outcomes with UAS images

HARMONIOUS SOIL MOISTURE WG – TEST SITE MONTEFORTE CILENTO





The WG2 case study





The *Citrus reticulata* orchard facilities in Sicily

- A fully equipped Eddy Covariance flux tower was installed in the orchard in February 2019 (Maltese/Ciraolo/Franco, Unipa);
- ❑ Eight Sentek “drill and drop” probes with remote acquisition are installed to monitor soil water content and soil temperature, divided in both fully and deficit irrigated plots, every 10 cm down to a depth of 0.60 m (deficit irrigated plot) and about 1.20 m (fully irrigated plot);
- ❑ Sap flow sensors to monitor the flux density installed in both sides of the field;
- ❑ Two psychrometers (one for each side of the field) installed for the continuous monitoring of the xylematic potential;
- ❑ A meteo station with remote acquisition of hourly solar radiation, air temperature, relative humidity, wind speed and rainfall (Provenzano/Franco/Motisi, Unipa);
- Portable Licor 6400 to measure canopy gas exchanges (Gugliuzza, CREA);
- ❑ UAS acquisitions (Manfreda/Dal Sasso UniBAS and Capodici, UniPA);
- GNSS acquisitions (Maltese/Dardanelli/Lo Brutto, UniPA);
- ❑ Spectroradiometric characterization ASD Field Spec Pro FR;
- ❑ Soil thermal properties characterization KD2Pro (Maltese/Capodici, UniPA).

NT8 THERMAL AND MULTISPECTRAL IMAGING



PHANTOM THERMAL AND MULTISPECTRAL IMAGING



NT8 cameras on board



RIKOLA: multispectral camera
H FOV: 36.5°
V FOV: 36.5°
Image res.: 1000x1000 pixels
SR at 50m a.g.l.: 3 cm
Weight: ~ 800 g

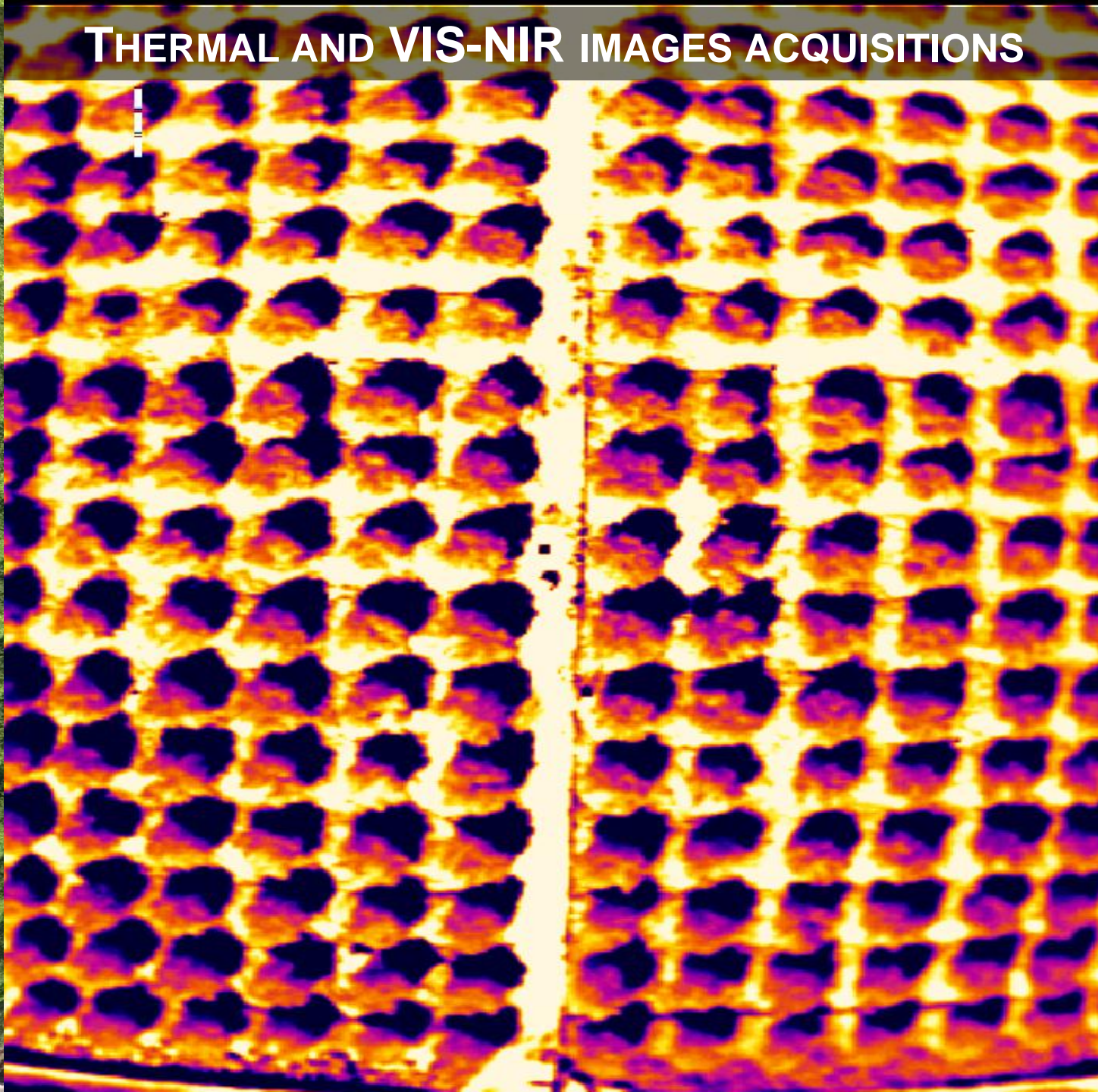
OPTRIS PI450: thermal camera
H FOV: 62°
V FOV: 49°
Image res.: 382x288 pixels
SR at 50m a.g.l.: 15 cm
Weight: 320g + 315g (netbox)



THERMAL AND VIS-NIR IMAGES ACQUISITIONS



THERMAL AND VIS-NIR IMAGES ACQUISITIONS

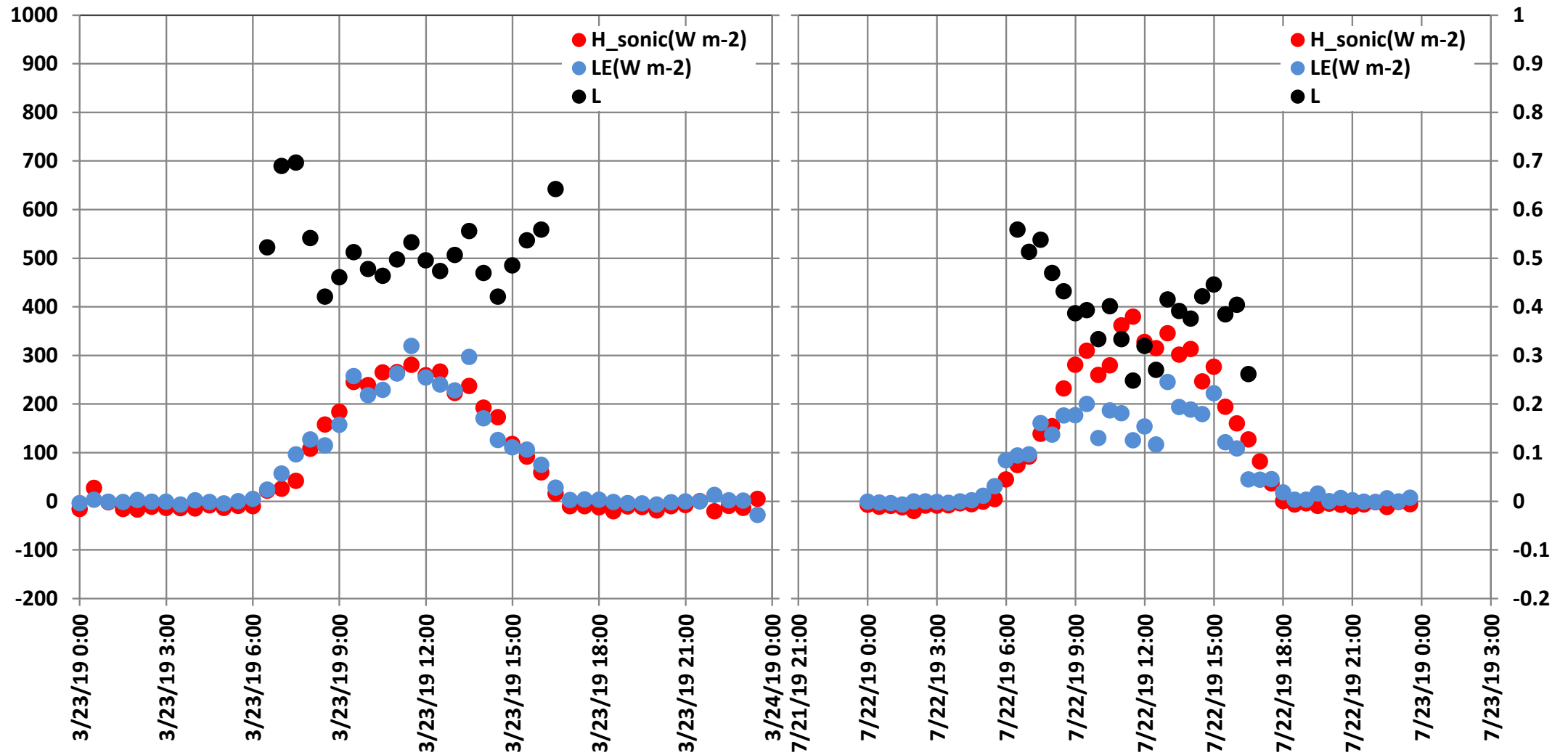


Flux tower



FIRST RESULTS:

SENSIBLE, LATENT HEAT FLUXES AND EVAPORATIVE FRACTION



CONCLUDING:

- First results seems indicating that high accuracy in monitoring vegetation water stress through SEB and Thermal Inertia can be achieved with high spatial resolution images

STILL TO BE INVESTIGATED:

- Does the different meteorological forcing play a role on the model to be employed?

WHAT WE NEED?

- One (or more) suitable dataset(s) acquired on similar experimental field(s) with different meteorological forcings;
 - Test site candidate: Denmark (Copenhagen) experimental sites managed by Monica Garcia and Jesper Sveensgard (proposed field campaign, July 2020);
 - Other datasets already acquired are welcome.

FINALLY:

- I'm glad to announce that it has been agreed the data will be made available with those members of the WG who might be interested in applying their own models for the finalities of the project
- If you are interested in contributing, please write to:
 - Antonino Maltese (WG2 Leader)
 - E-mail: antonino.maltese@unipa.it

We love how vegetation looks to us, also in false colours!
Any question?



Thanks for listening
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