Monitoring seasonal changes in Plant Traits:

Exploring the relationship between vegetation water status and water fluxes for a tree-grass environment

TRUSTEE training

training on Remote Sensing for **Ecosystem** modelling

18.01.2018

Simposio de alumnos TIG

Universidad de Alcala (UAH)

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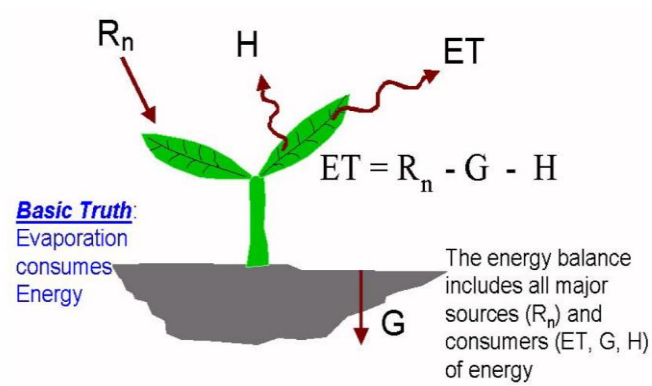
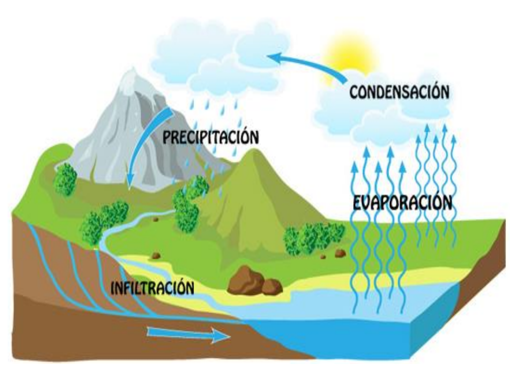
UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA | UNIVERSITY OF TWENTE. | CSIC | FONDAZIONE EDMUND MACH | MAX-PLANCK-GESELLSCHAFT | UNIVERSITY OF EXETER | vito | JÜLICH FORSCHUNGSZENTRUM | AeroVision

INTRODUCTION

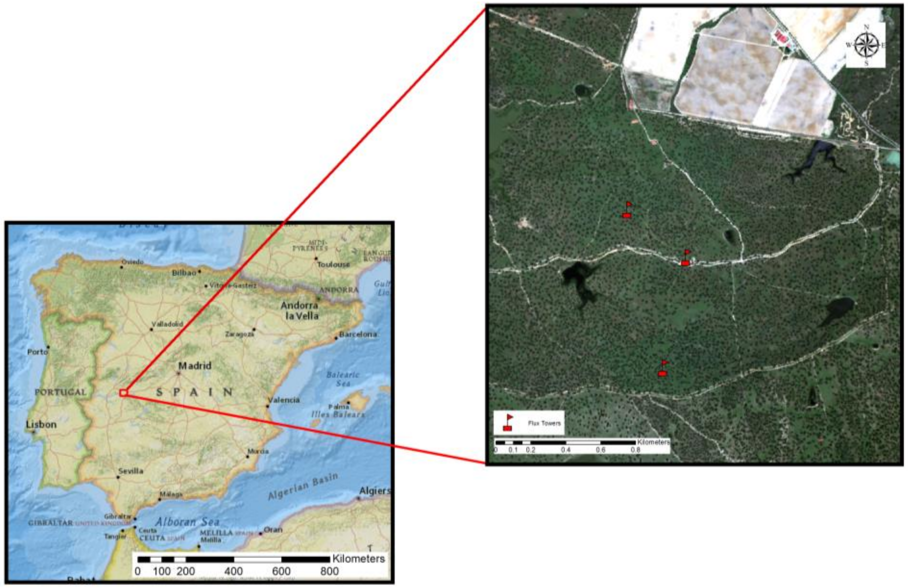
- **Vegetative systems**, both cultivated and natural, represent a significant source and flux of water
- Crucial link between **carbon, water and energy cycles** with important ecological and agricultural implications → Drought monitoring, effects of water stress
- Canopy Water Content (**CWC**, g/cm2) → Mass of water in canopy per ground area (**Water status**)
- Evapotranspiration (**ET**, mm/d) → Soil evaporation + transpiration (**Water flux**)






Evaporation + Transpiration = EvapoTranspiration (ETo)

STUDY SITE – Majadas de Tietar, Extremadura



- Mediteranan Tree-Grass (*dehesa*) ecosystem
- Continental Mediterranean climate
  - Mean annual Temp: 16.7 C
  - Mean annual P: 650mm
- 20% tree cover (mainly Holm oak - *Quercus ilex*)
- Long history of environmental monitoring
  - FLUXNET tower (2003-)
  - Many ground sampling campaigns
- Time period: 2010-2017
  - 10 flight campaigns
    - 8 INTA (AHS-CASI) , 1 drone, and1 Quantalab manned aircraft

OBJECTIVES

Overall goal: Estimating, monitoring and comparing seasonal changes in CWC and ET using multi-source and multi-scale spectral information in Majadas between 2010-2017

Phase 1: ET Modeling

- Modeling ET using two source energy balance (TSEB) scheme and compare against a one source energy balance scheme (SEBAL)
- Thermal Sharpening of airborne images (AHS to CASI) to be used as a reference for sharpening sentinel-3 to sentinel-2 scale
- Separation/un-mixing of canopy, grass and soil components for adapted modeling scheme (Three source model)
    - Fine resolution airborne data as a reference for separating components at medium spatial scale

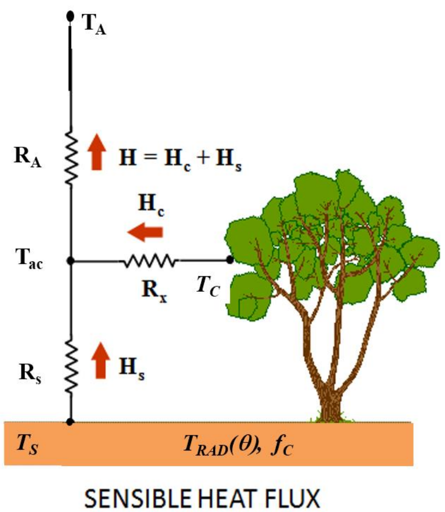
Phase 2: CWC Modeling

- Radiative transfer models and spectral indices

Phase 3: Investigate relationship between ET and CWC for the estimation of water fluxes

METHODOLOGY – TSEB Scheme

Developed by Normal et al. (1995)



Norman and Kustas, et al. (1995)

System, soil, canopy budgets

$R_n = H + \lambda E + G$

$R_{n,s} = H_S + \lambda E_S + G$

$R_{n,c} = H_C + \lambda E_C$

Two-source approximation

$T_{RAD}(\theta)^4 \sim f_C(\theta)\, T_C^4 + [1-f_C(\theta)]\, T_S^4$

Temperature constraint

$H_C, H_S, R_{n,c}, R_{n,s}, G$

PT, PM or LUE R_C model

λE_C

Residual

$\lambda E_S = R_n - H - G - \lambda E_C$

Iterative solution

- Two layer model that computes **turbulent fluxes** as function of:
  - Directional surface temperature with VZA
  - LAI, Fc
  - Canopy architecture (height and leaf size)
  - Irradiance, Ta, Wind Speed and humidity
- Calculates ET (**latent heat**) as a residual of energy balance

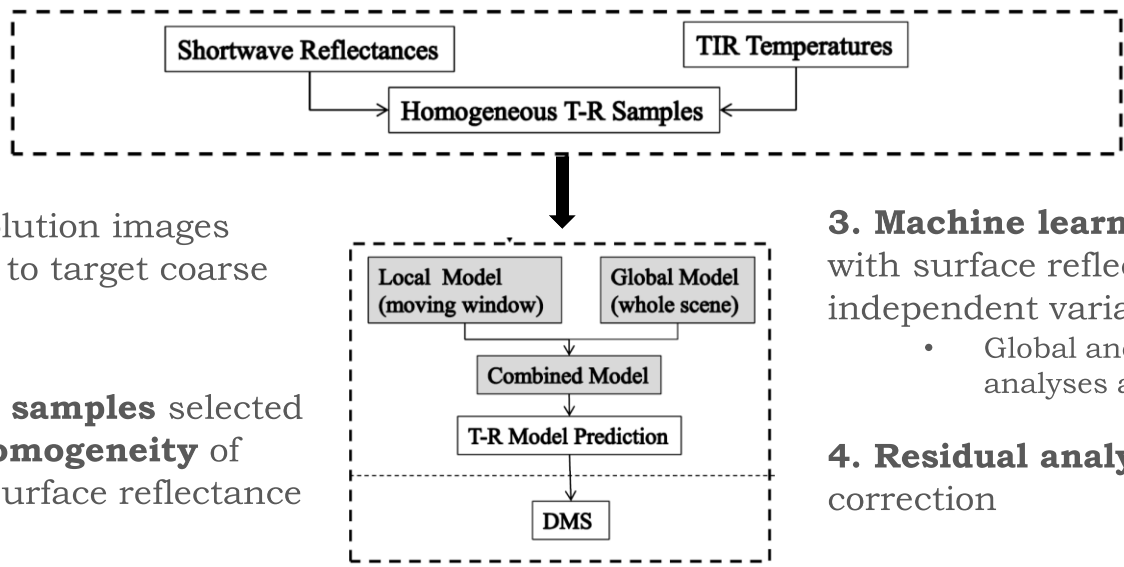
  $$\lambda ET = R_n - H - G$$
- Decouples energy fluxes for **plant canopy** and **soil** components
  - Accommodates for sensor viewing angle

METHODOLOGY – Thermal Sharpening

Data Mining Sharpener (DMS): Machine learning algorithm for disaggregation of low-resolution images using high-resolution images
(Based on Gao et al. (2012))

1. Fine resolution images **aggregated** to target coarse resolution

2. Training samples selected based on **homogeneity** of ‘sub-pixel’ surface reflectance



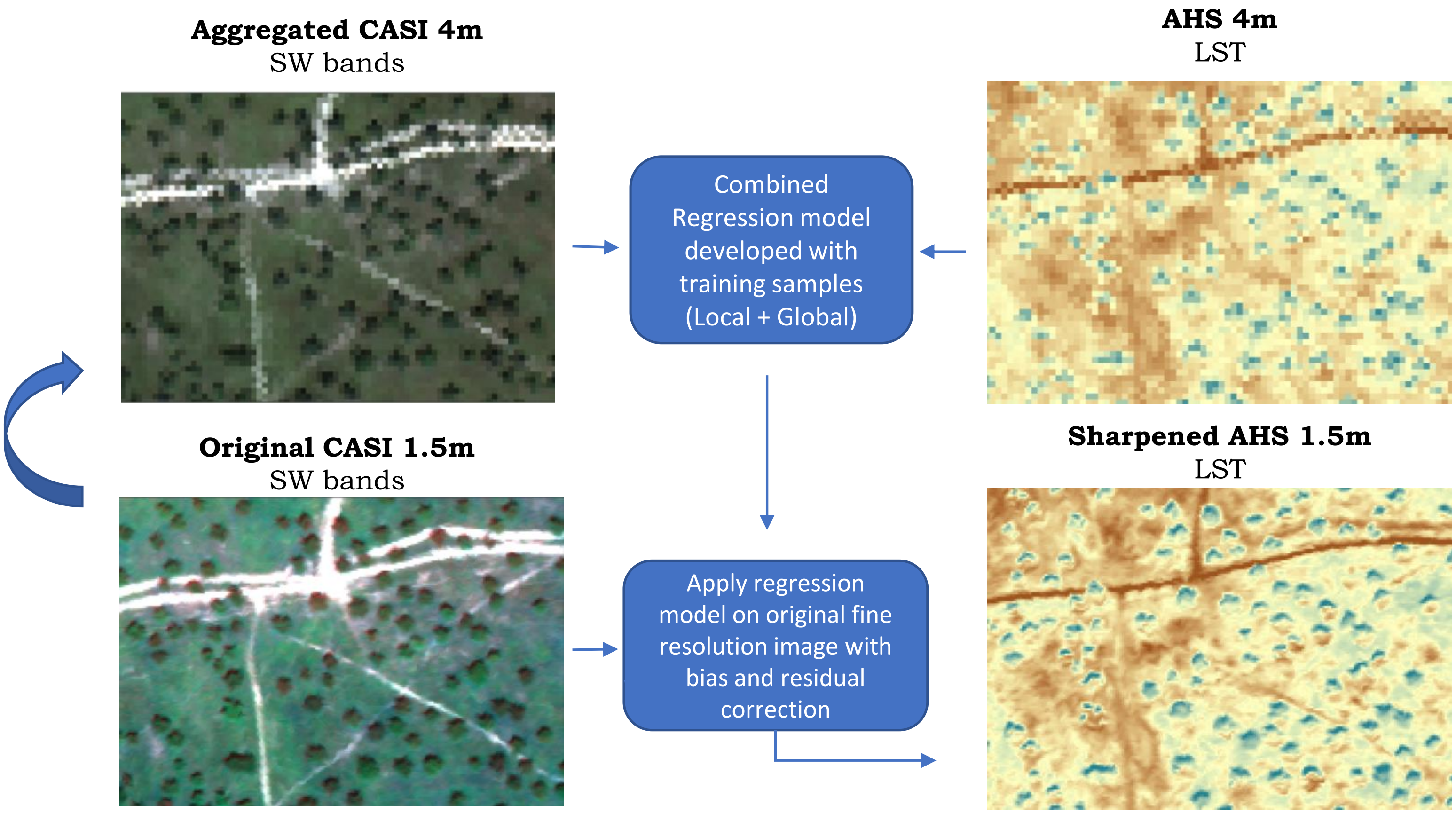
(From on Gao et al. (2012))

3. Machine learning algorithm with surface reflectance as independent variables

- Global and local regression analyses are combined

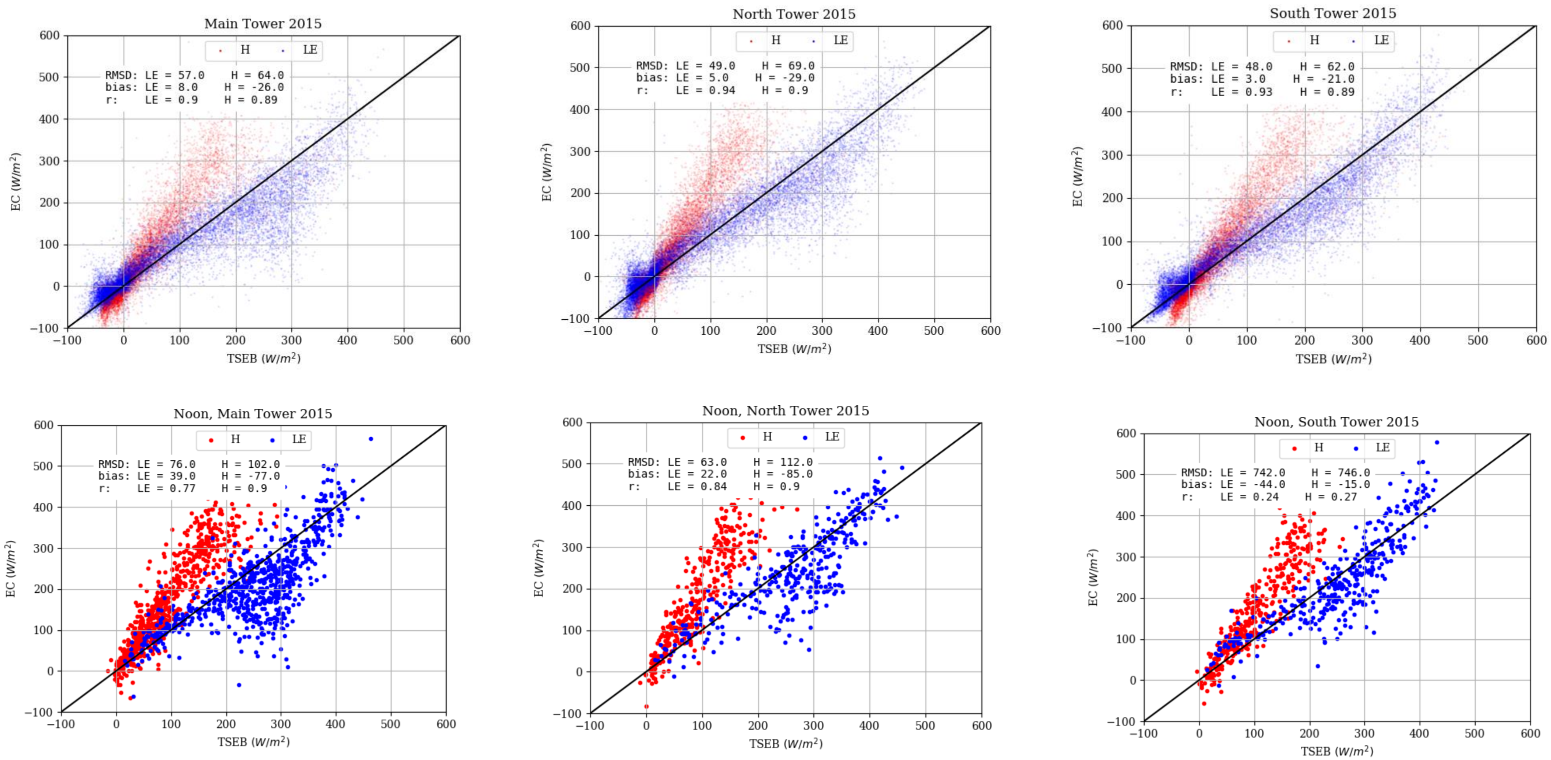
4. Residual analysis and bias correction

METHODOLOGY – Thermal Sharpening



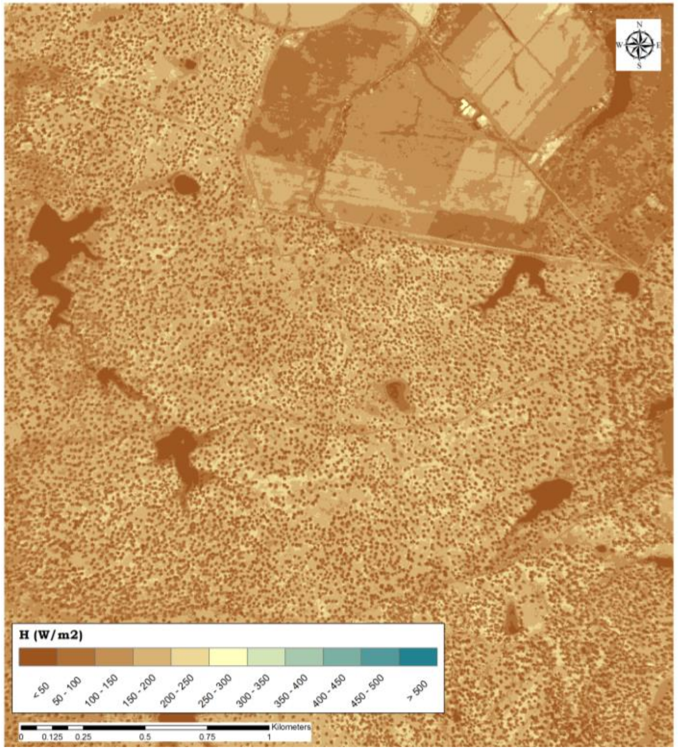
PRELIMINARY RESULTS

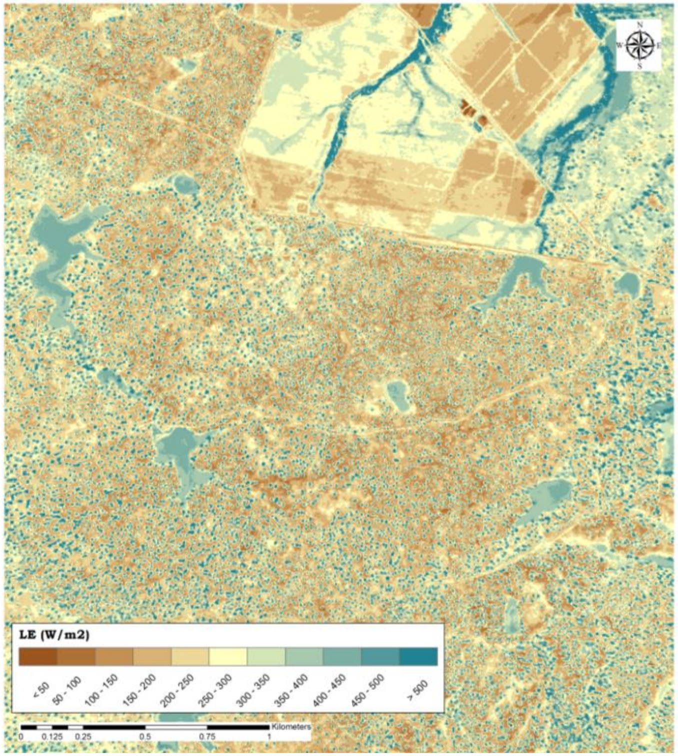
Test run using flux tower time series data (Main, North and South tower)



PRELIMINARY RESULTS

Running with AHS images





NEXT STEPS

Point scale time series from flux towers

- ❖ Sensitivity analysis/calibration of input biophysical parameters (i.e LAI, Canopy height, wind attenuation profiles)

High resolution AHS-CASI Data

- ❖ Downscaling AHS LST images to CASI resolution and compare with non-sharpened results
- ❖ Running TSEB for Grass (Two-Source) and Oak (One-Source) seperately
  - Validate with flux tower data (Rn, LE, H and G)
  - Obtain high resolution flux maps to be used as a reference

Medium resolution sentinel-2 (3) and Landsat

- ❖ Investigate methods to separate mixed pixels to obtain both Oak and grass/soil temperatures at sentinel-2 pixel level (based on AHS-CASI maps)
- ❖ Thermal Sharpening from sentinel-3 to sentinel-2

GRACIAS!

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