Temporal variations of transpiration and latent heat fluxes from isolated linden crowns and lawns in a park at Strasbourg, France

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[3] UMR EEF (INRA-UL), Nancy (France)

Urban Heat Island and Vegetation

Climate
Global Climate Change

Urban Structure

Urban Heat Balance

Urban Heat Island Effect

Human Health

Rizwan et al., 2008

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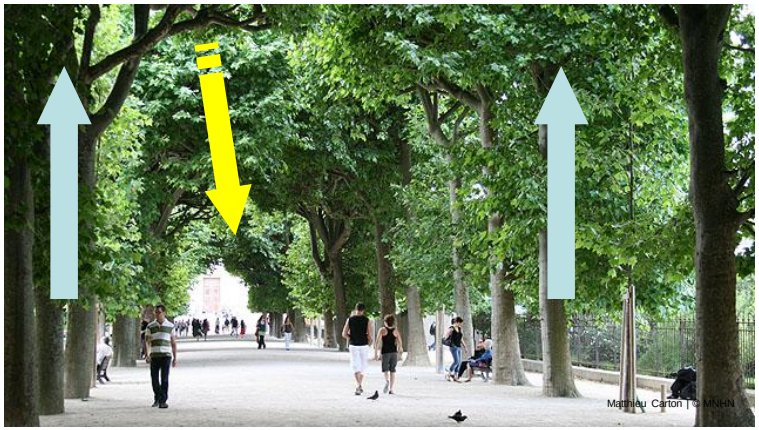

Ong et al., 2003; Bowler et al., 2010; Santamouris, 2013;

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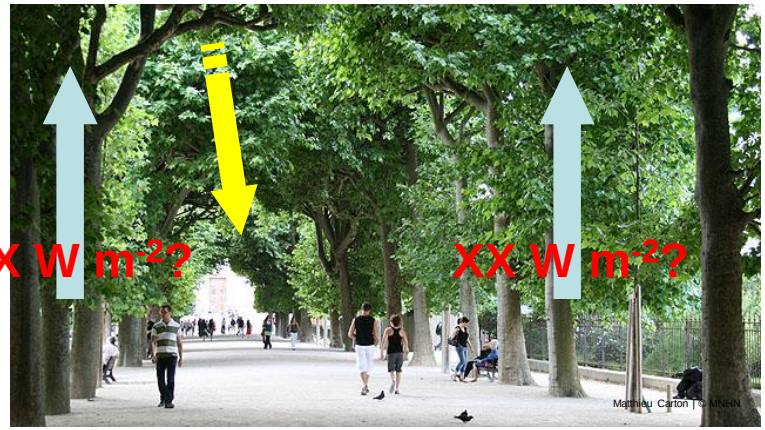

Human Health

OBJECTIVES

1. To quantify the latent heat flux emitted by a lawn surface (E_L) and isolated linden trees (E_T) in the city centre of Strasbourg (France)

2. To characterize the seasonal evolution of these fluxes with respect to atmospheric variables

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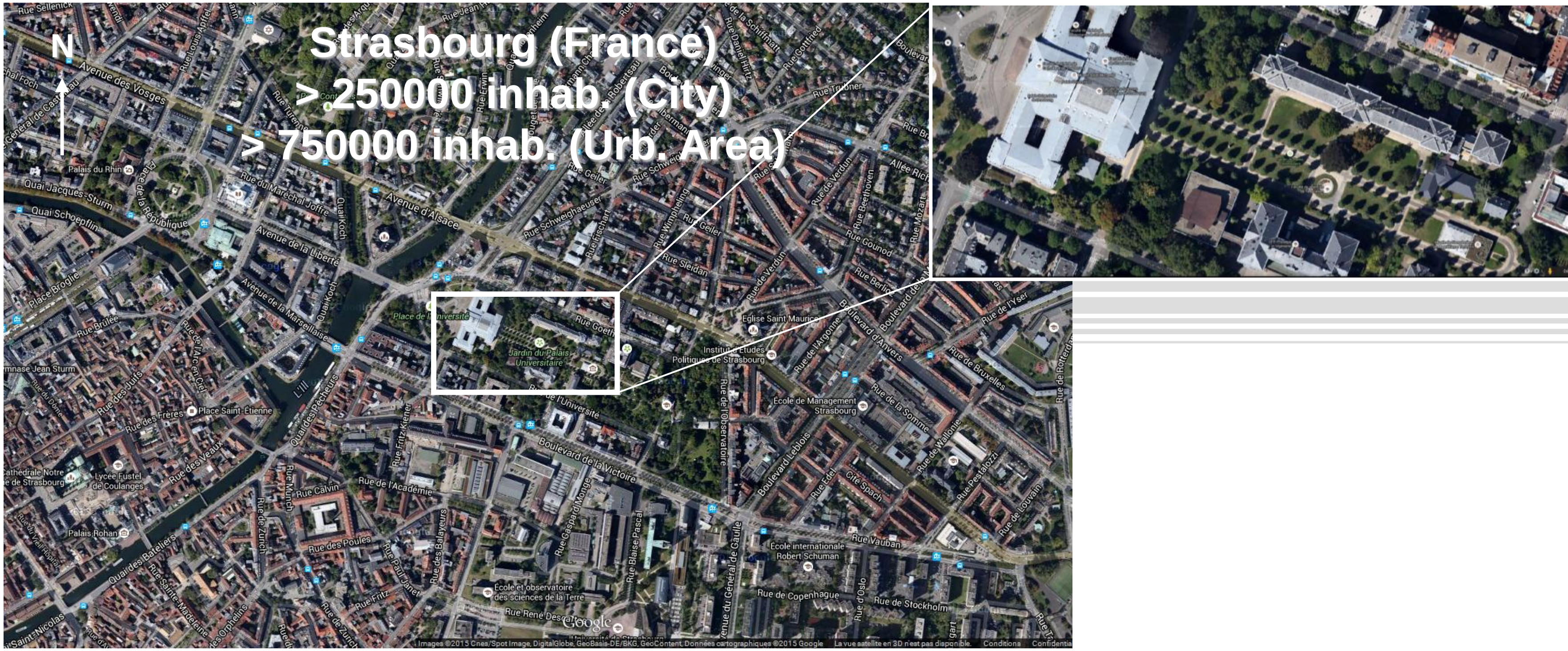
- **Q1: Order of magnitude of E_L and E_T?**
- **Q2: Environmental variables influencing E_T?**
- **Q3: Drought Stress in Urban Environment?**

Experimental Site



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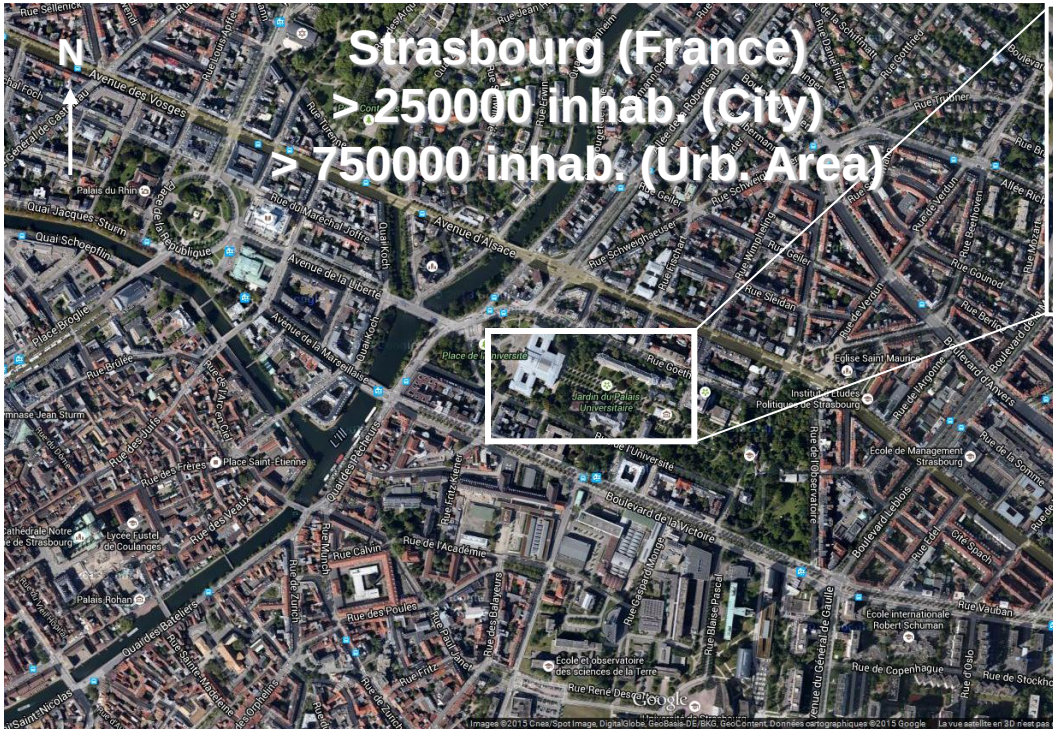
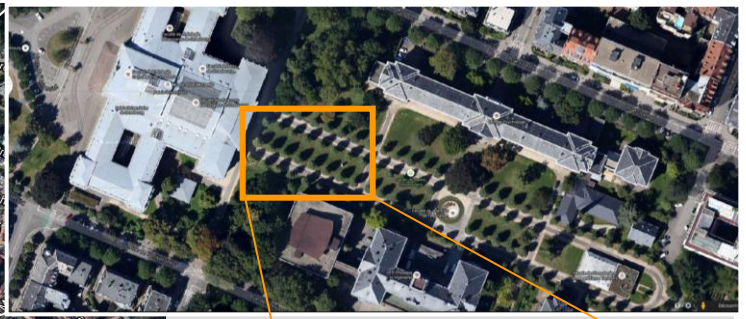


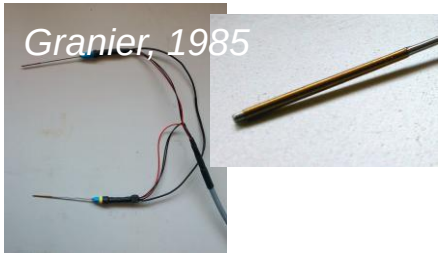


Field Measurements

E_L = Lawn transpiration (Closed Transpiration Chamber)

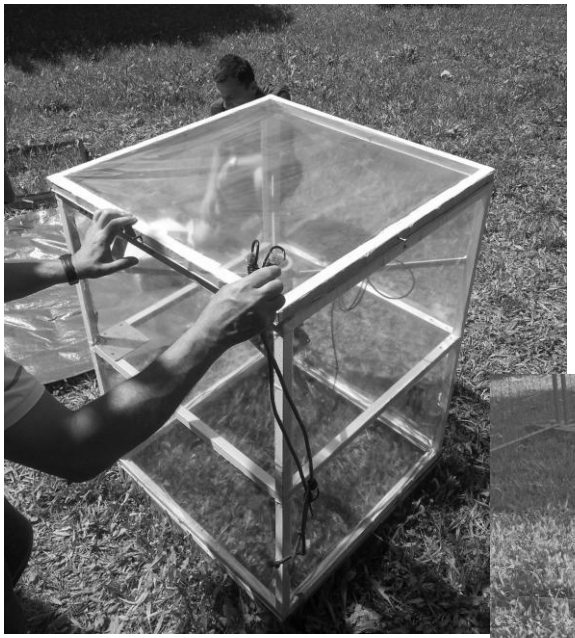
- 2-min measurements every 20 min

Field Measurements



✓ E_T = Tree transpiration (Thermal Dissipation Probes)

- Half-hourly timestep for all trees



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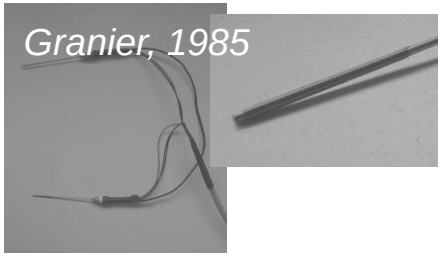
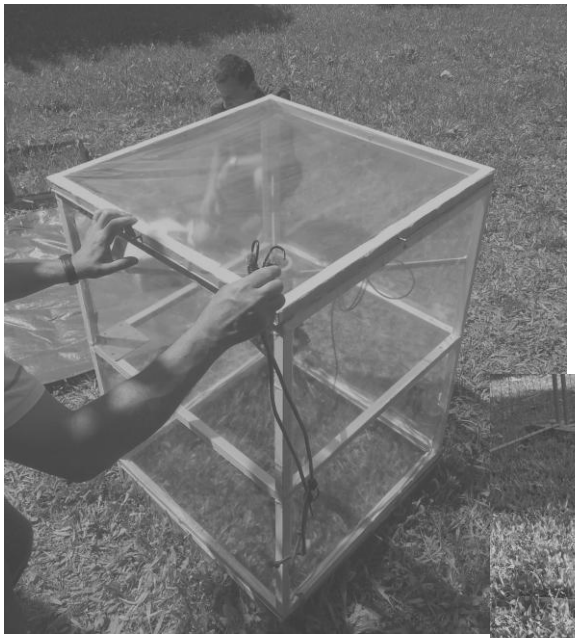
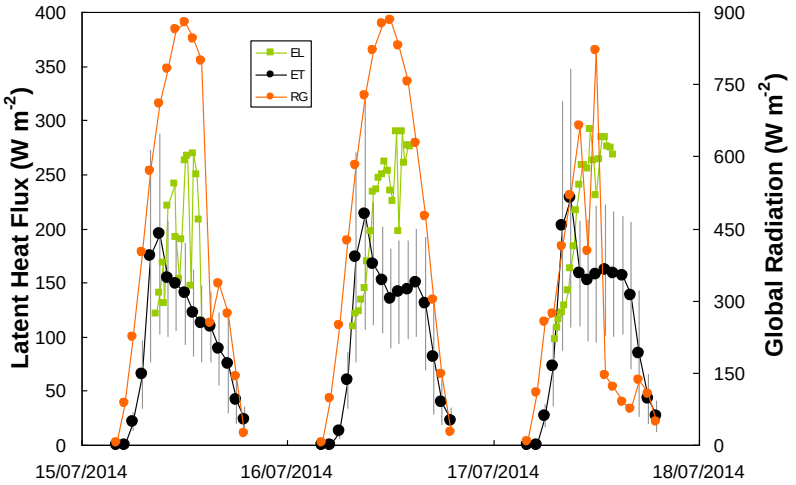


- ✓ E_T: Corrected for the sapwood width *Gebauer et al., 2008*
- ✓ Ground surface area - based values
- ✓ Meteorological data:
  - ➢ PET computation (**Penman** formula)
  - ➢ Canopy conductance (Penman-Monteith formula)

$$E_T = \frac{\Delta.(R_n - G) + \rho.Cp.VPD.g_a}{\lambda.[\Delta + \gamma.(1 + g_a/\mathbf{g_c})]}$$



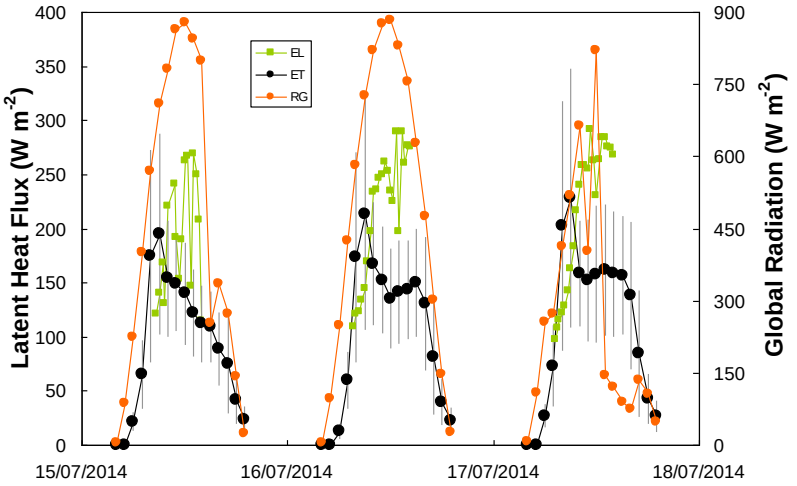
Q1: Order of Magnitude?



- E_L and E_T: **Similar order of magnitude**
- **Maximum λE: ~35% (E_L) and 20-40% (E_T) of maximum R_G**

Qiu et al., 2013

Q2: Influencing Environmental Variables : E_L



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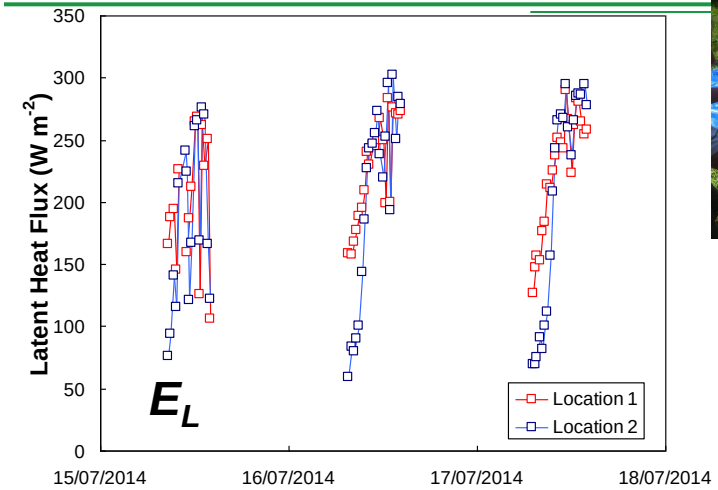

- Daily Spatio-Temporal Variability of E_L

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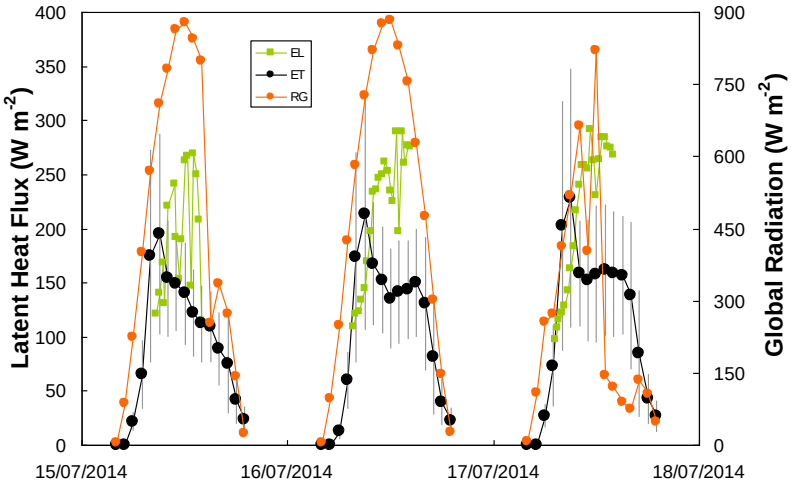

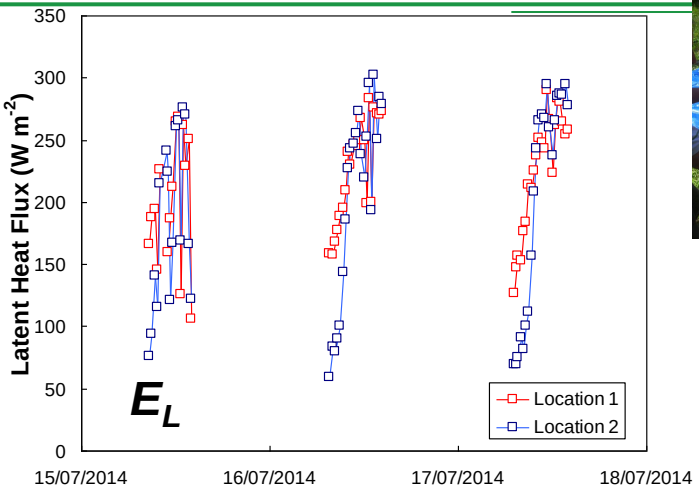

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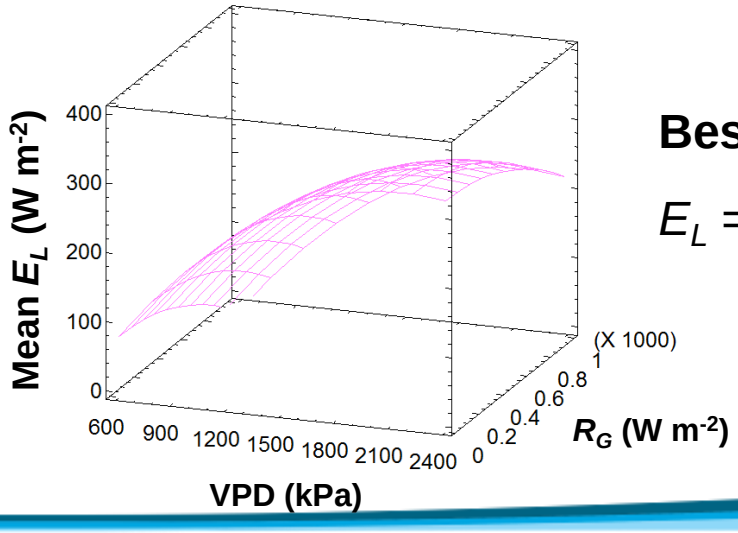
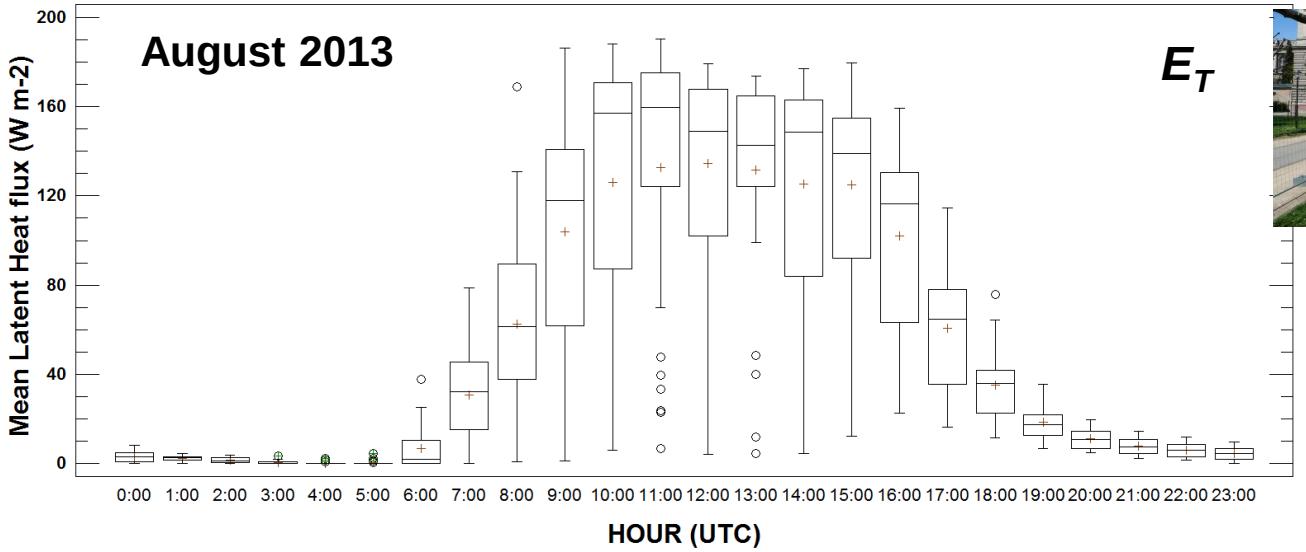


Best Model

$$E_L = -0.0001\ VPD^2 + 0.44\ VPD - 0.0001\ R_G^2 + 83$$

$$R^2 = 0.83;\ AIC = 7.78$$

Q2: Influencing Environmental Variables : E_T



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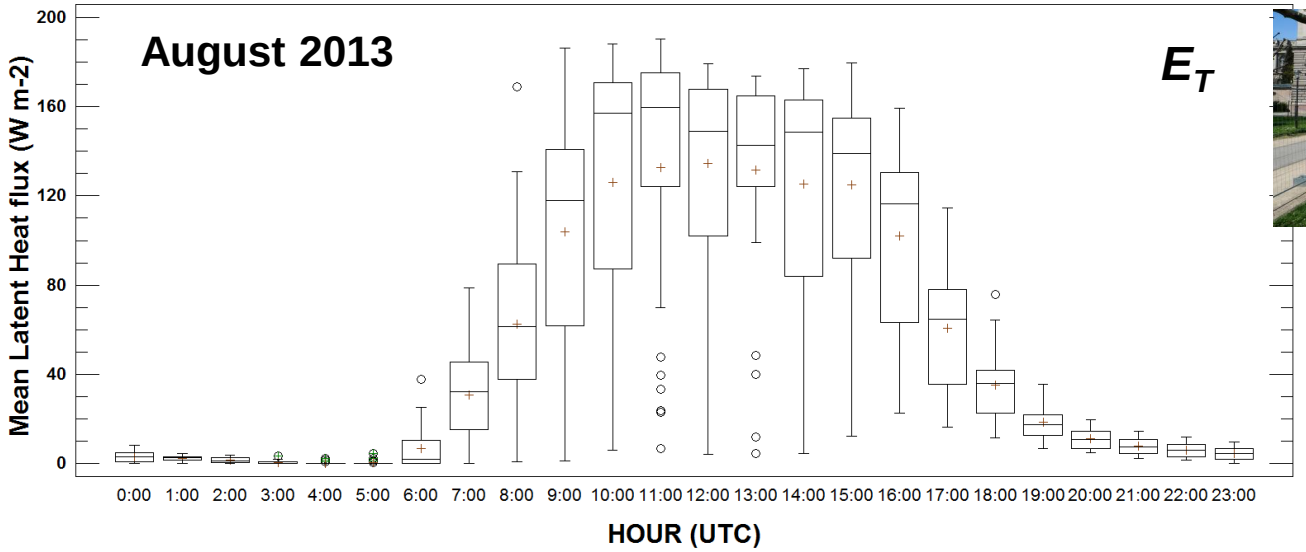
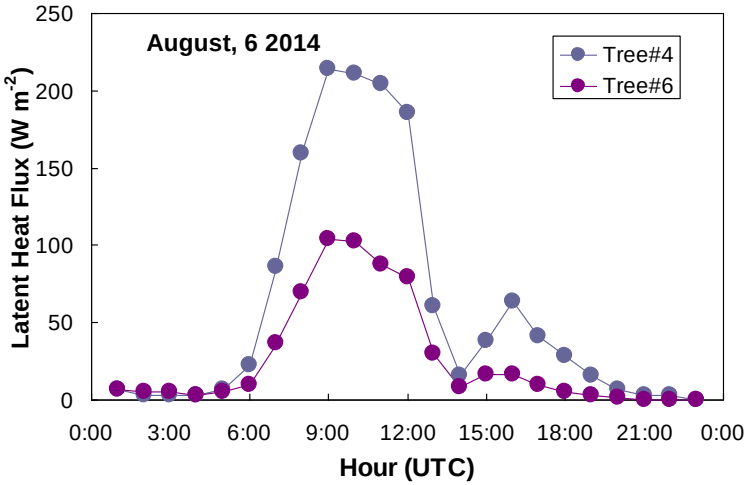
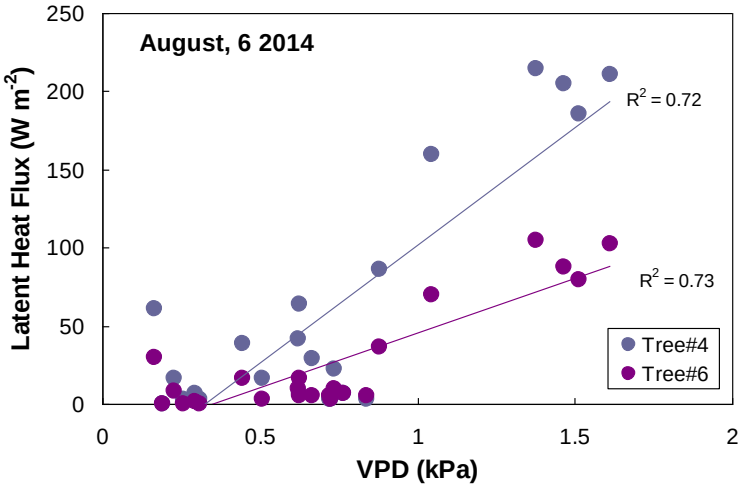


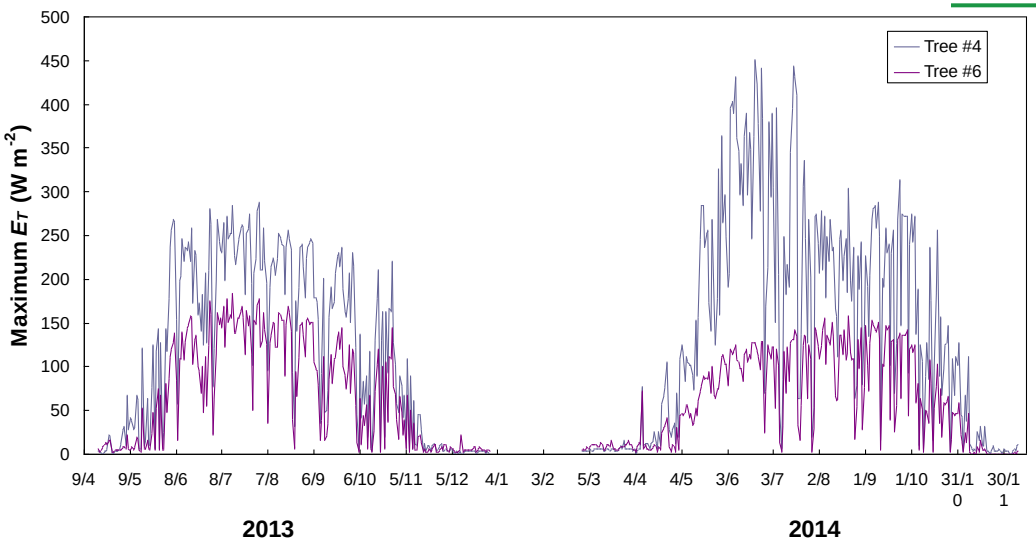




➢ Inter-Individual Variability of E_T

➢ Strong influence of VPD…

Q2: Influencing Environmental Variables : E_T



✓ Strong influence of **tree's phenology**

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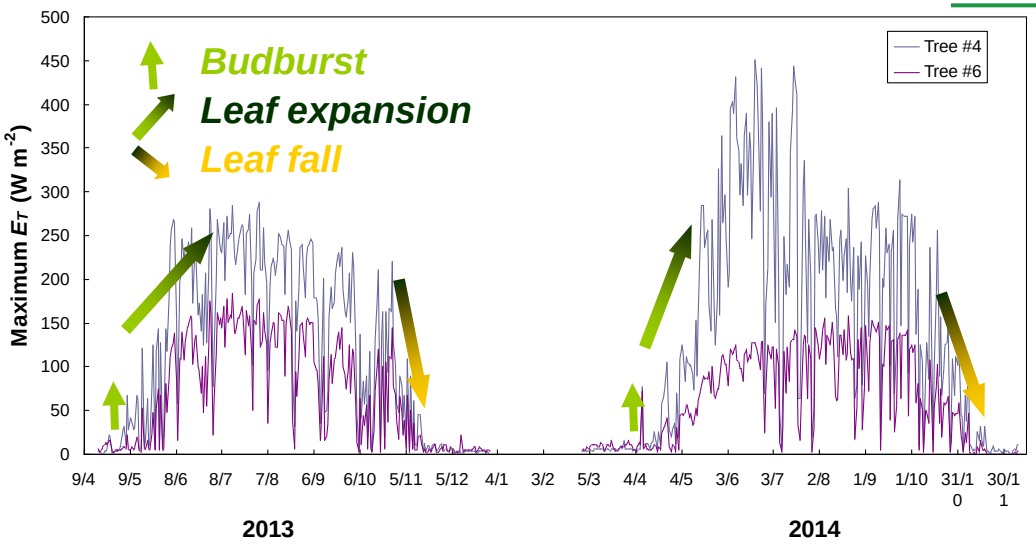

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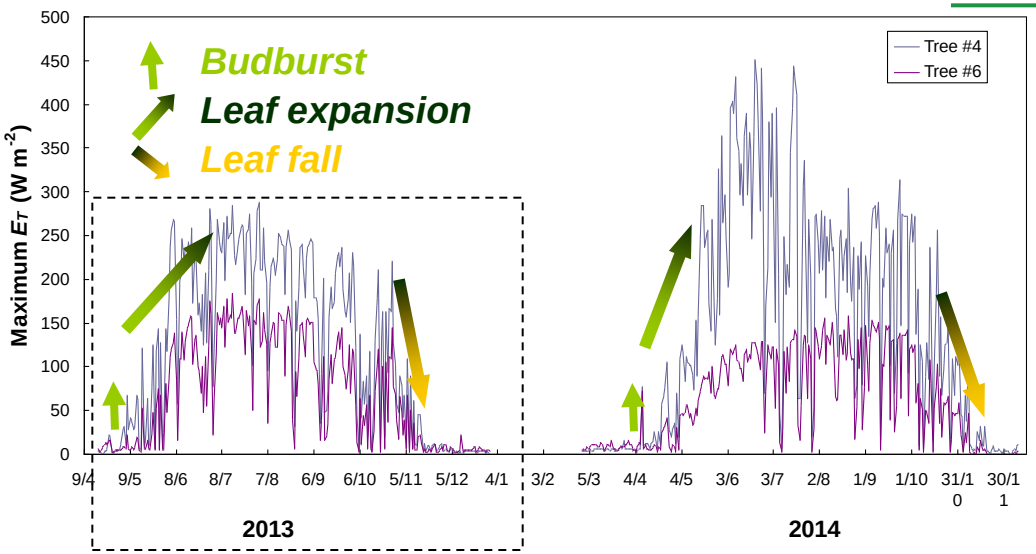
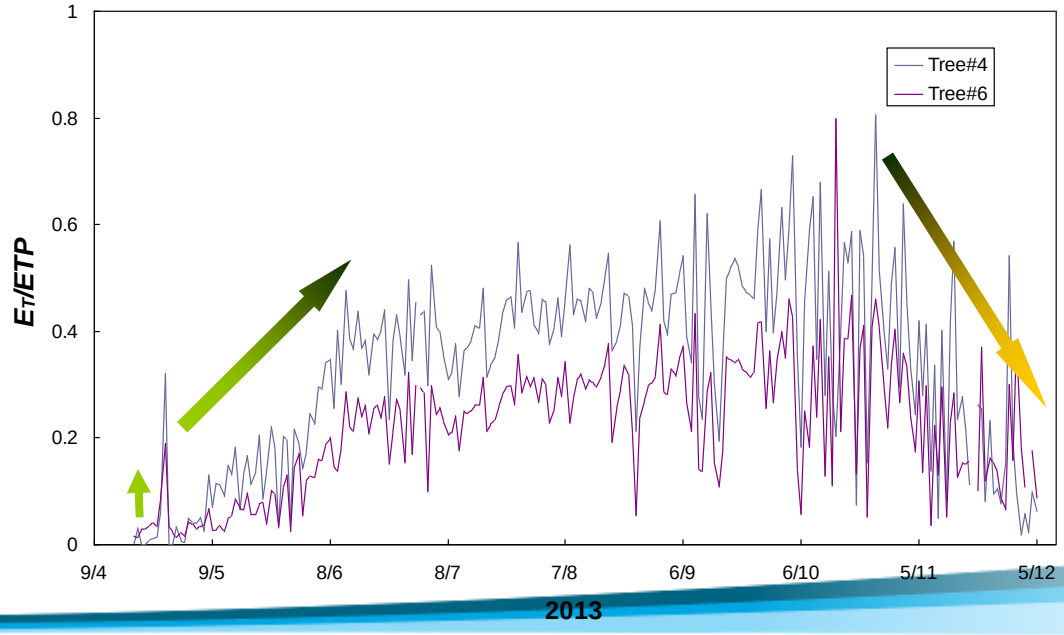


- ✓ Strong influence of **tree's phenology**
- ✓ Penman Equation:

$$PET = \frac{\Delta.R_n + \rho.Cp.VPD.g_a}{\lambda.[\Delta + \gamma]}$$



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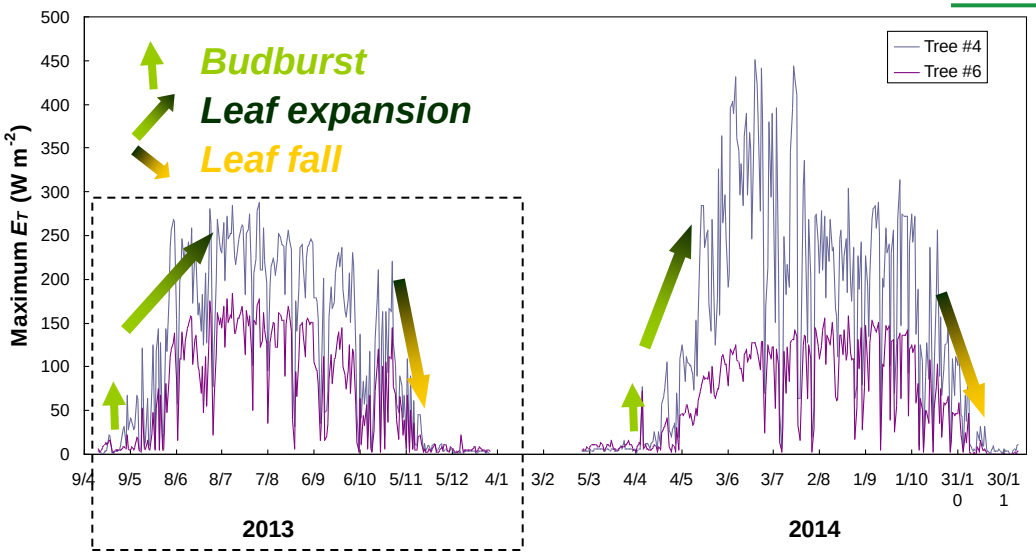

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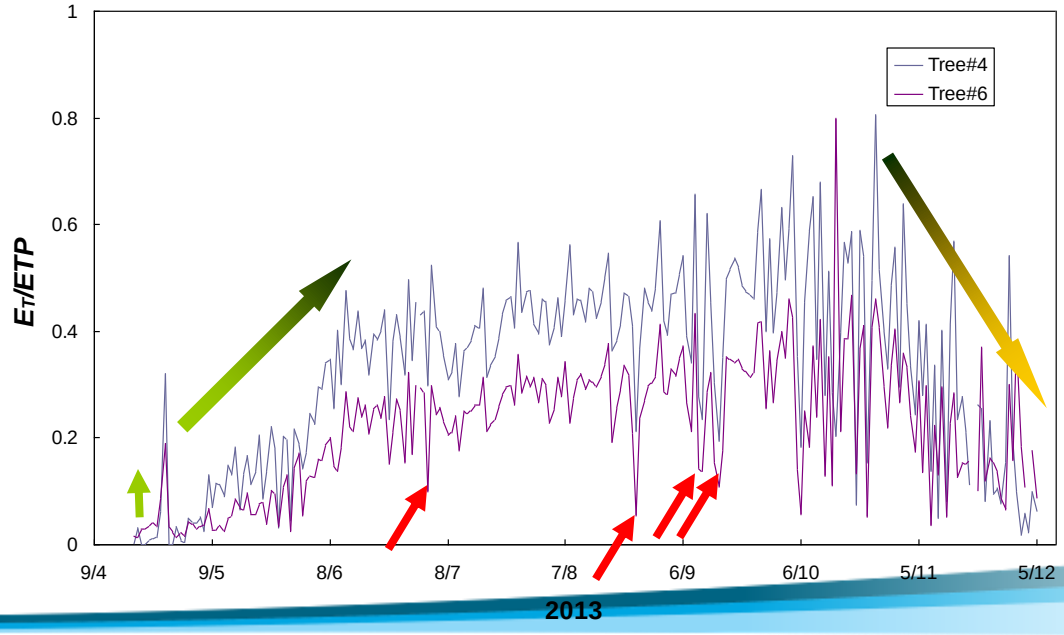
$$PET = \frac{\Delta.R_n + \rho.Cp.VPD.g_a}{\lambda.[\Delta + \gamma]}$$

- ➢ E_T/PET ratio: no major stress



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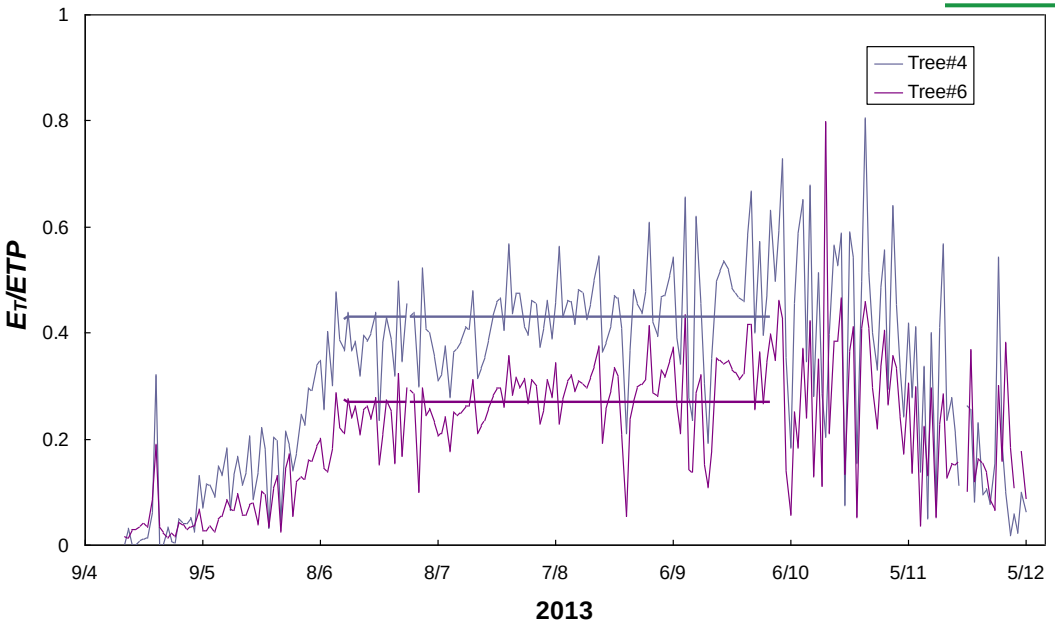

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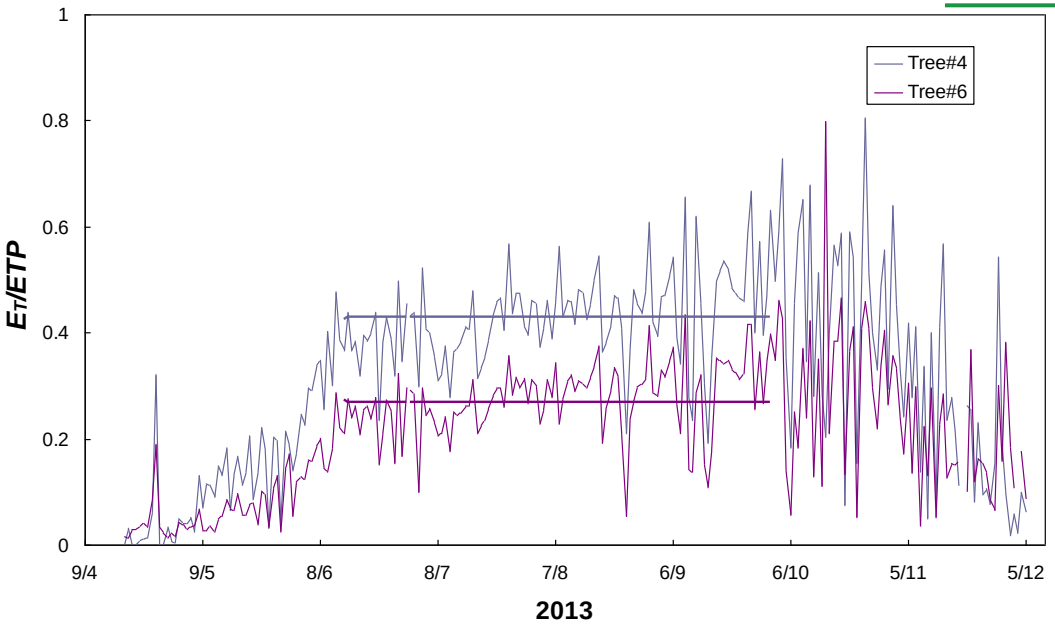

✓ Canopy condutance (Penman-Monteith Equation):

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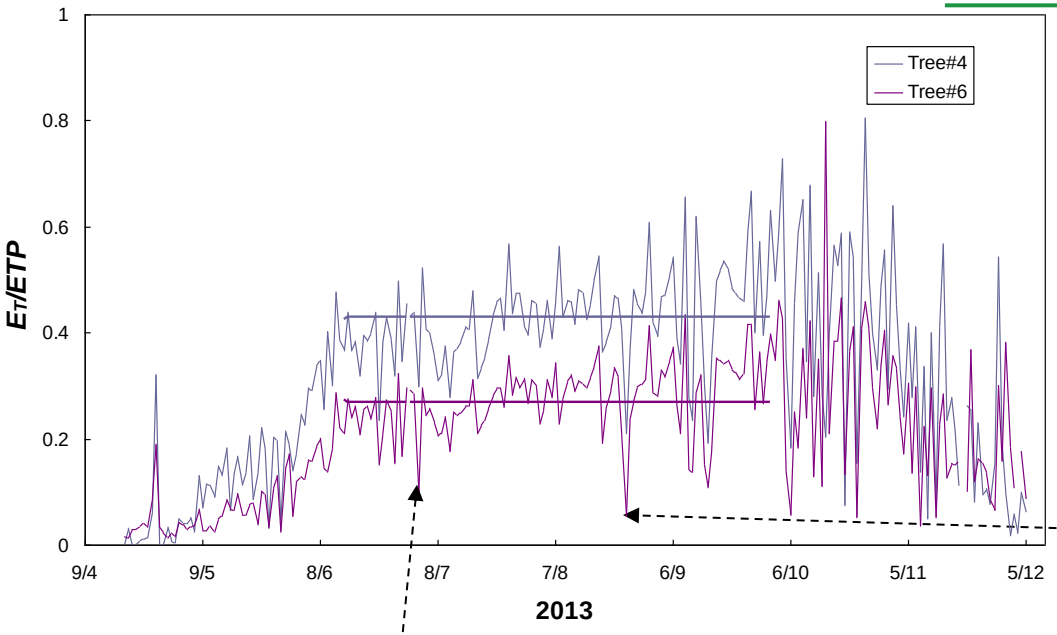

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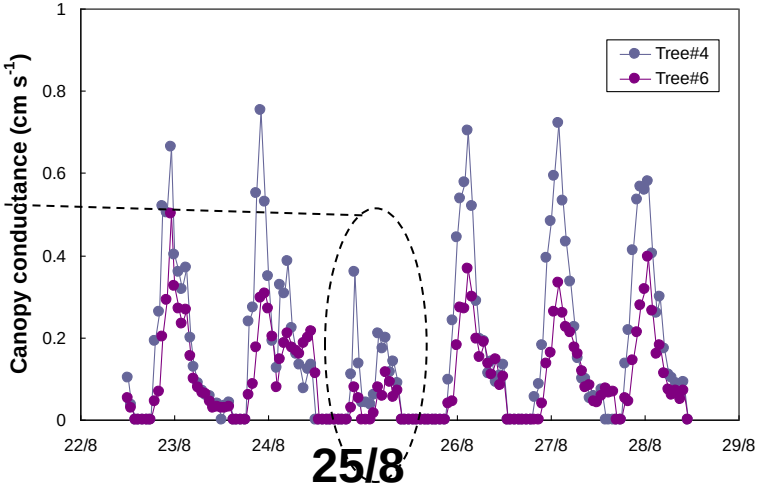

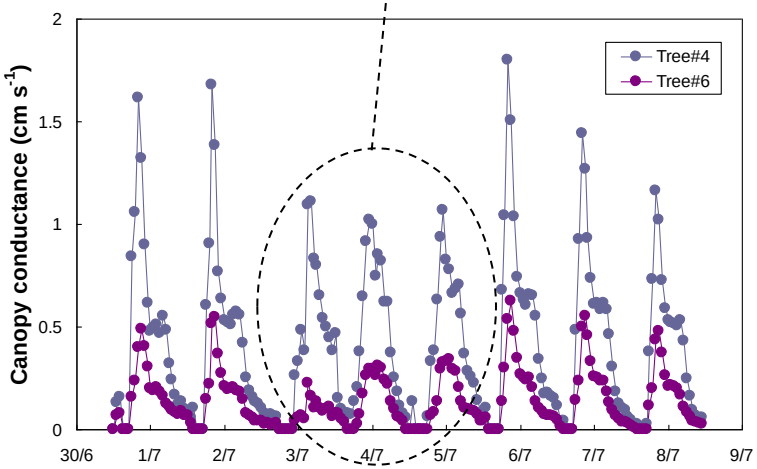

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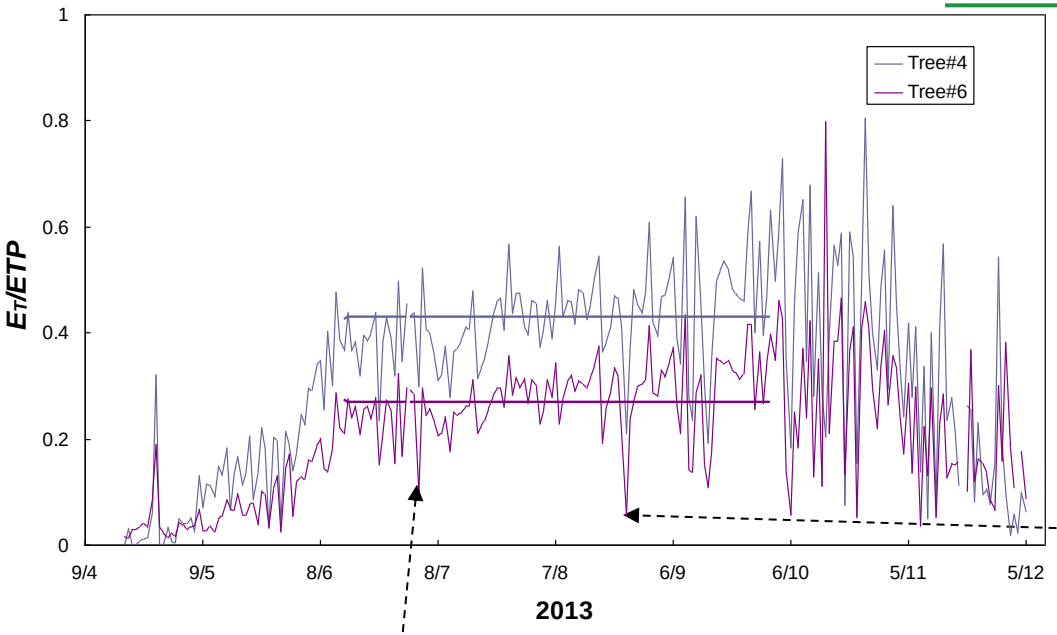

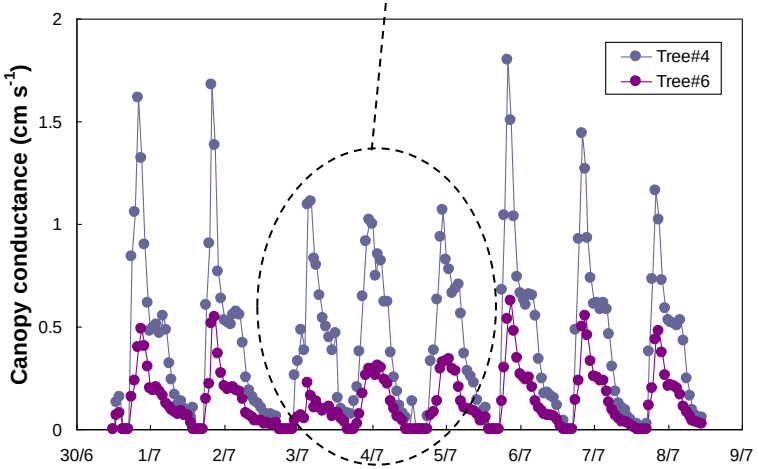

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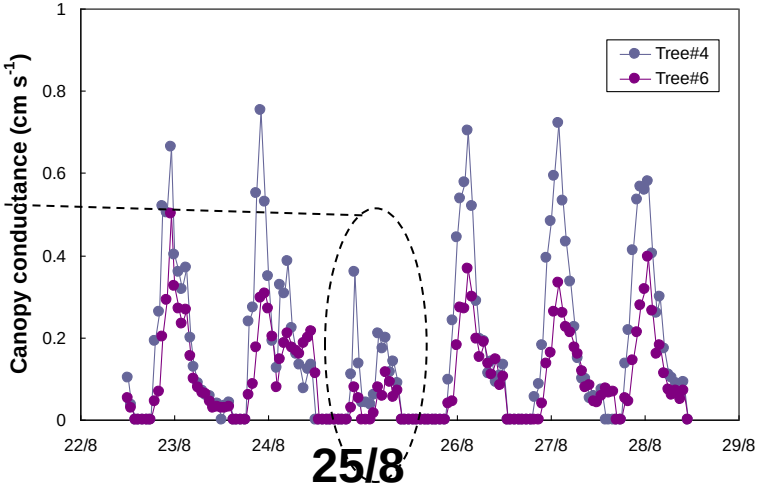

- **Stomatal limitation** of E_T at the crown-level
- Signs of drought stress in urban conditions?

Q3: Drought Stress?

✓ Drought stress: looking at the tree's hydric status…

➔ Stem/Branch Diameter Variations

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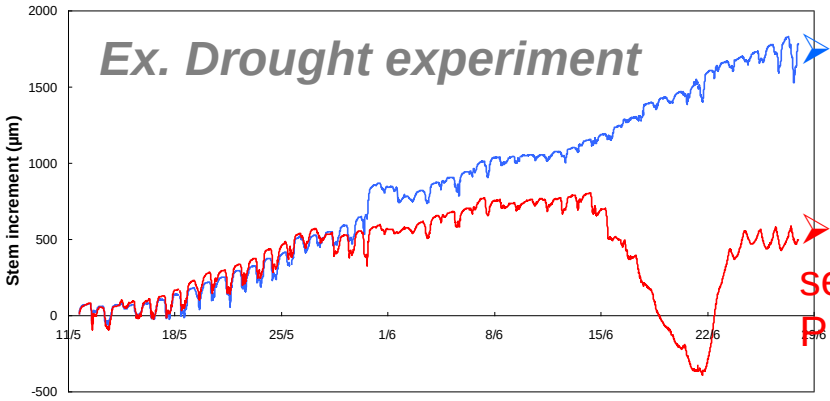

Well watered tree

Stem skrinkage due to server water shortage and high PET conditions

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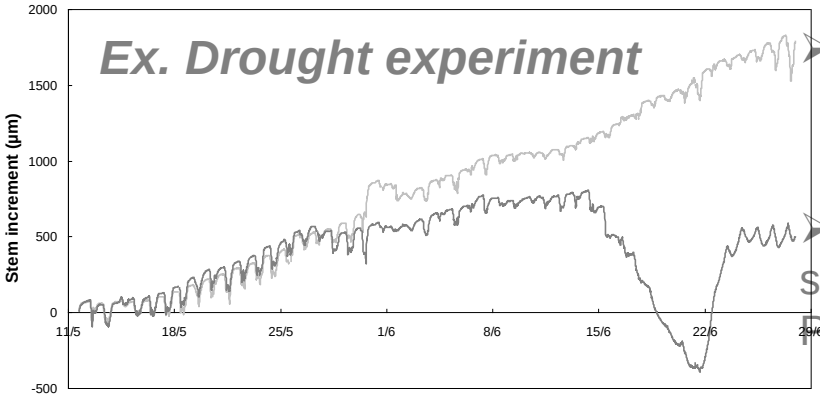

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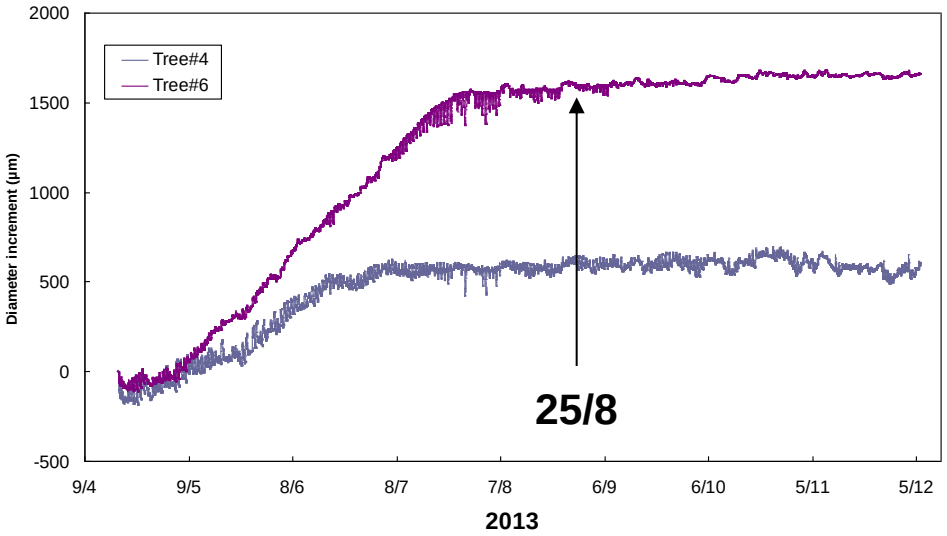

➢ **No significant stem shinkrage**

➢ Avoidance of drought stress during the growing period

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CONCLUDING REMARKS

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  ➔ Necessity to have precise measurements and/or model outputs of variables of biological interest (*e.g.* wind speed)

- **Phenology**: strong influence on fluxes, itself under climate forcing

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✓ Q3: Drought Stress in Urban Environment?

- No drought stress (**strong stomatal control**, water table?)
- Other sites with more constraining water conditions?

CONCLUDING REMARKS

✓ Toward a more complete scheme of energy balance

- ✓ Atmospheric radiative and energy balance: Pyranometers, pyrgeometer, pyrheliometer, sonic anemometer
- ✓ Water balance: soil and plant parameters
- ✓ 3D Geometry of both urban infrastucture and vegetation **(tree)** for accurate radiative and energy balance simulation (LASER/F model *Kastendeuch et Najjar 2009* and RATP model *Sinoquet et al., 2001*)

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Poster 22: NOMTM

- **Najjar *et al.*,** A three years long fieldwork experiment to monitor the role of vegetation on the urban climate of the city of Strasbourg, France
- **Landes *et al.*,** 3D tree architecture modeling from laser scanning for urban microclimate study

Thank you for your attention!

http://www6.clermont.inra.fr/piaf/

http://icube-web.unistra.fr/imbcu_fr/index.php/Accueil