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Microclimate regulation potential of different tree species:

Transmissivity measurements in Szeged, Hungary

Urban trees – urban forestry

Cultural Ecosystem Services

Aesthetic

Community building

Educational services

Recreational

Regulating Ecosystem Services

Stormwater runoff reduction

Air filter – improving air quality

Noise reduction

Climate regulation (micro- and local scale)

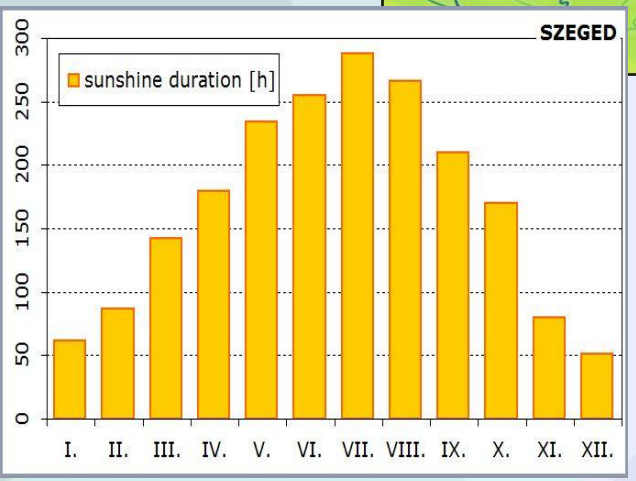
Study area: Szeged

3rd largest city of Hungary
(population: ca. 162,000 + 25,000 students)

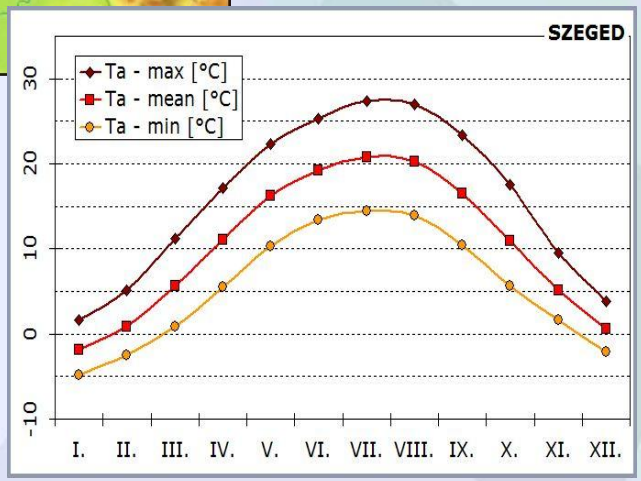
Southeastern part of Hungary
(46.255°N 20.145°E)

The 'city of the sun'

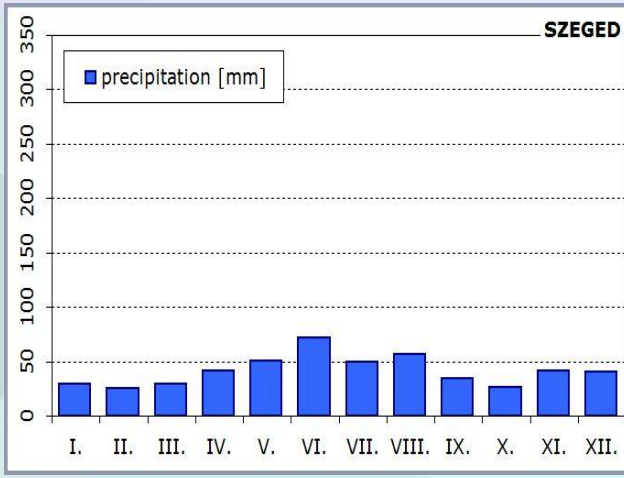
Hungarian Meteorological Service (OMSZ) – CLINO 1961-1990



2023 h
yearly sum of sunny hours

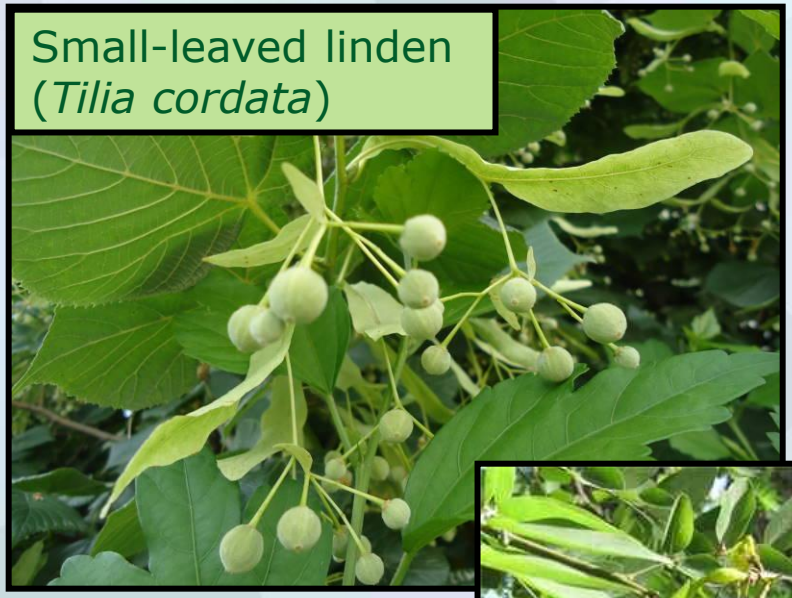


10.5 ºC
mean annual temperature



495 mm
yearly sum of precipitation

Studied tree species


Small-leaved linden
(*Tilia cordata*)


Common hackberry
(*Celtic occidentalis*)


Pagoda tree
(*Sophora japonica*)


Horse-chestnut
(*Aesculus hippocastanum*)

healthy

adult

single trees

without the disturbing effect

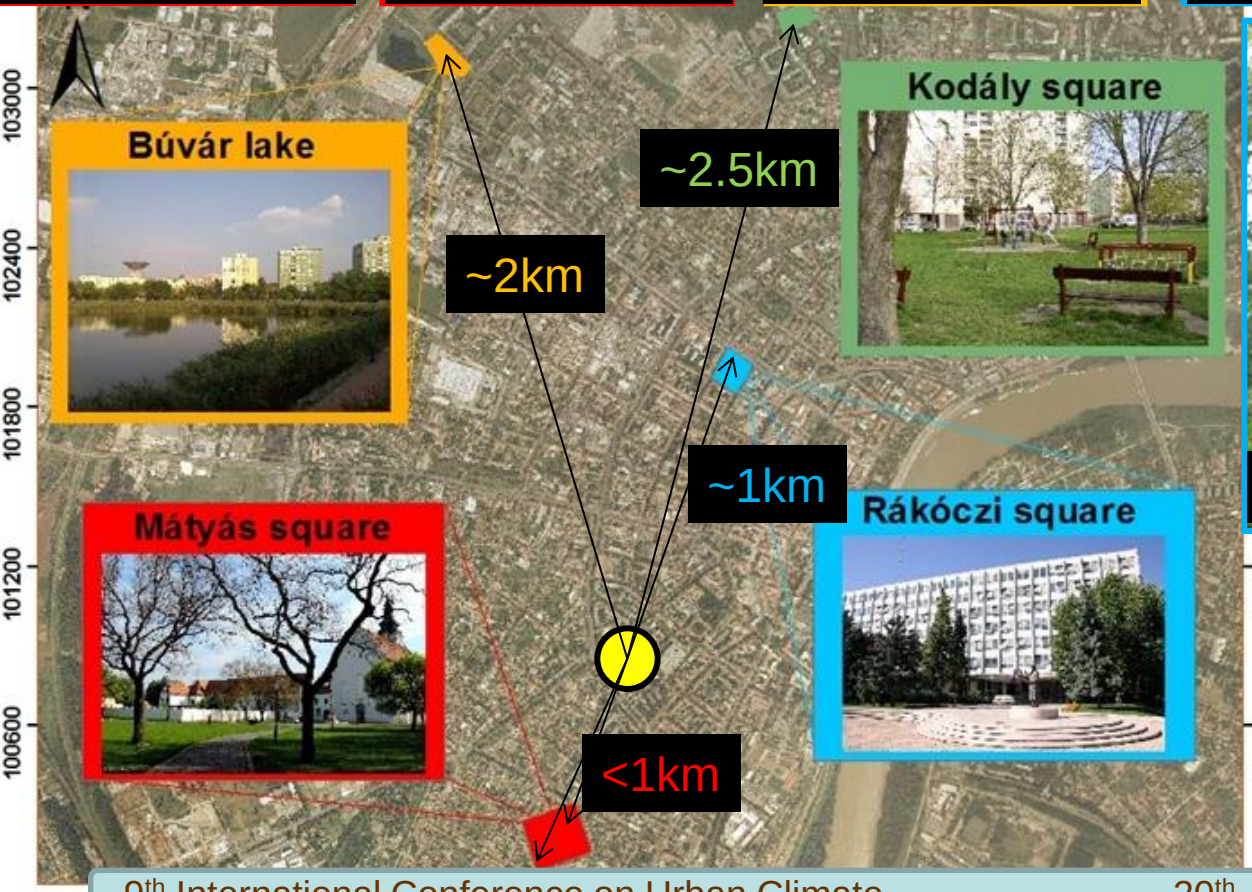
linden

pagoda tree

hackberry

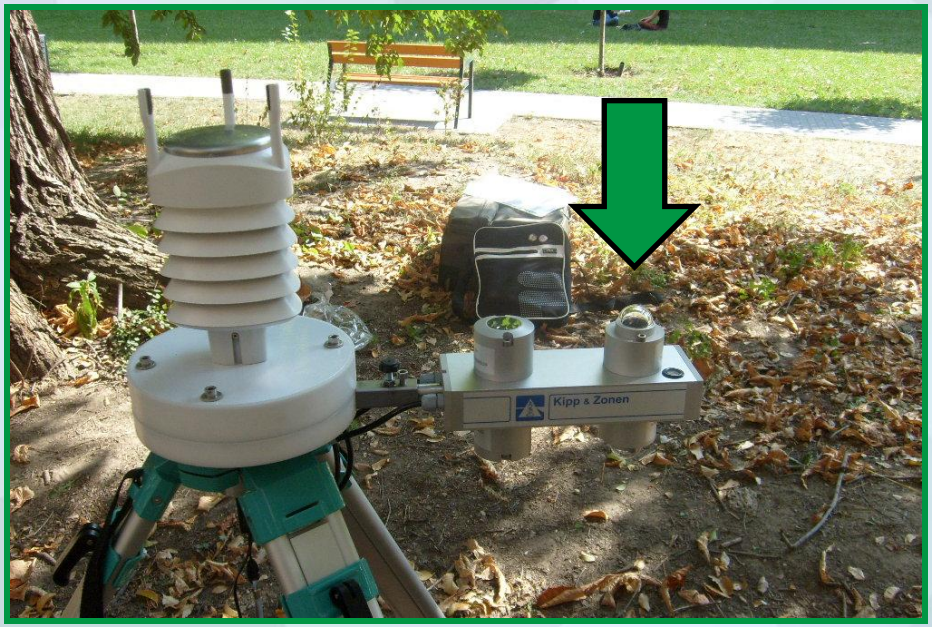
chestnut - I

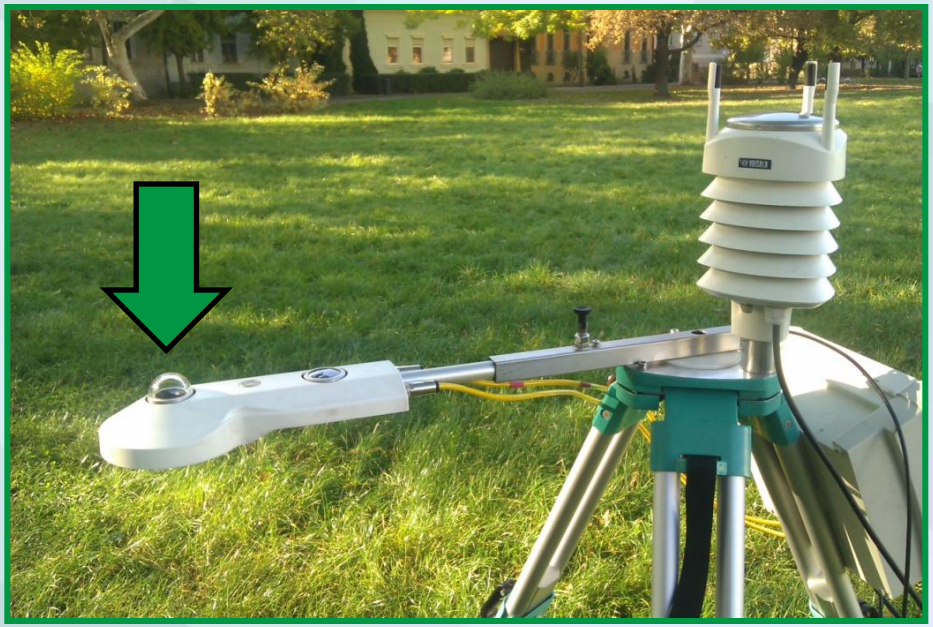
chestnut - II



leafminer attack

Radiation measurements





Vaisala WXT-520

- air temperature – Ta [°C]
- relative humidity – RH [%]
- wind velocity – v [m/s]
- air pressure
- precipitation

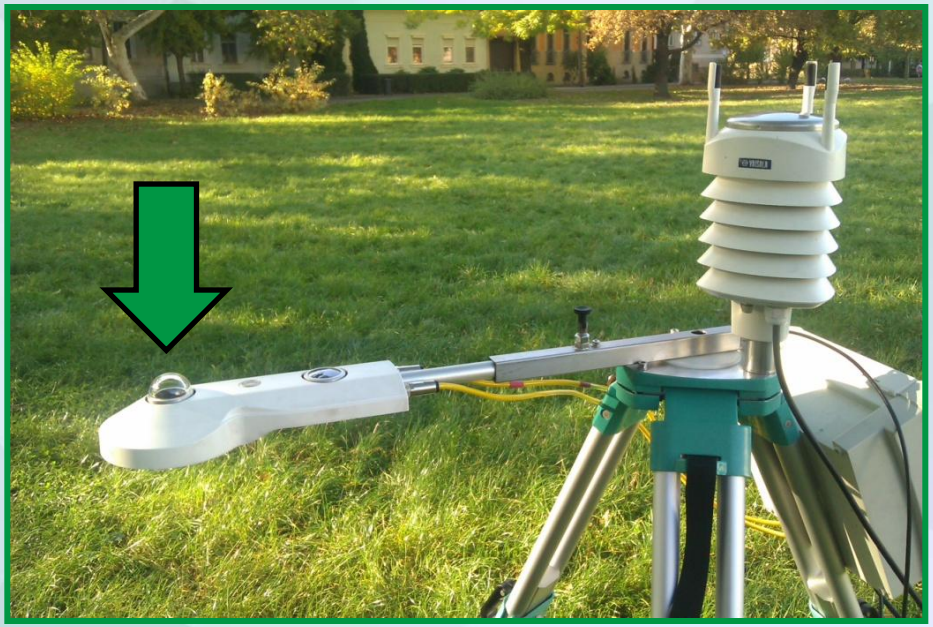
Kipp & Zonen CNR-1, CNR-4

- short- and longwave radiation
  - K↓ [W/m²] = **Gtrans**
  - K↑ [W/m²]
  - L↓ [W/m²]
  - L↑ [W/m²]

Gtrans [W/m²]
transmitted global radiation
UNDER THE TREES

face to South
2 m away from the tree trunk
North-side of the tree
1.1 m a.g.l.
1-min averages

Radiation measurements



Gact [W/m²]
actual value of global radiation
ON THE ROOF of the Univ. of Szeged
official inner city weather station

Gtrans [W/m²]
transmitted global radiation
UNDER THE TREES

pyranometer faces to South
SVF=1

18 m a.g.l.
10-min averages

Transmissivity:
Gtrans / Gact

from 10-min averages

face to South
2 m away from the tree trunk
North-side of the tree
1.1 m a.g.l.
1-min averages

Measurement days

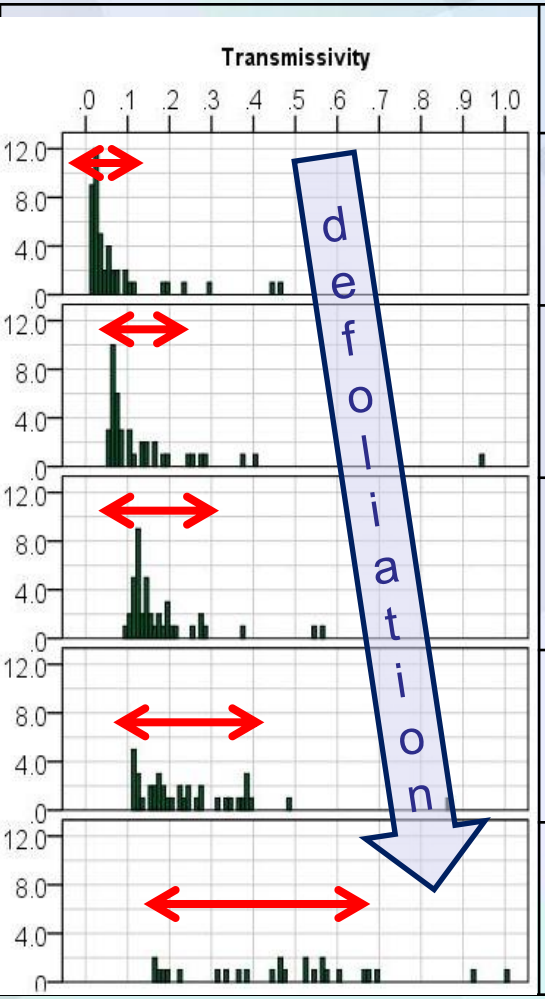
Date	Small-leaved linden	Pagoda tree	Common hackberry	Horse-chestnut	sky conditions
27-Jun-2014		10:10 – 17:20			cloudy
1-Jul-2014	10:10 – 17:30				overcast
2-Jul-2014			9:50 – 18:10		cloudy
4-Jul-2014				10:10 – 17:40	clear
24-Jul-2014			9:40 – 18:10	10:10 – 16:50	cloudy
25-Jul-2014	9:40 – 17:50	10:00 – 17:40			cloudy
28-Aug-2014	10:00 – 16:50	10:20 – 16:30			cloudy
9-Sep-2014			9:50 – 17:20	10:10 – 17:00	mostly clear
18-Sep-2014	10:00 – 16:30	10:20 – 16:10			mostly clear
29-Sep-2014	10:00 – 16:30	10:20 – 16:10			clear
30-Sep-2014			9:40 – 16:40	10:00 – 16:20	clear
28-Oct-2014			10:10 – 15:00	10:40 – 14:50	clear
4-Nov-2014	10:00 – 14:50	10:20 – 14:30			clear

inter-species comparison

seasonal change of the foliage

Seasonal change of the foliage

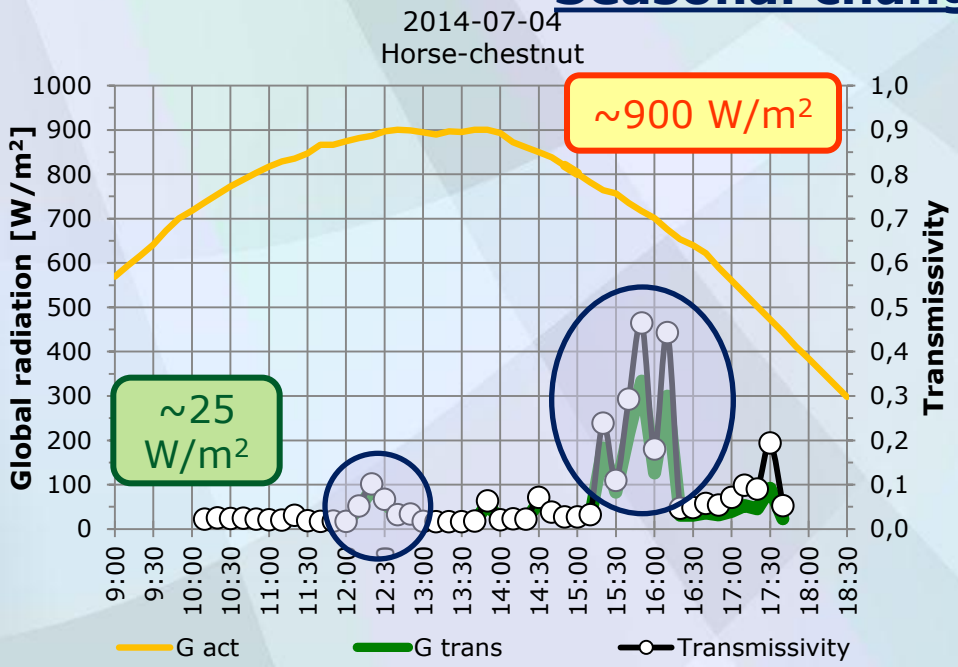
Horse chestnut

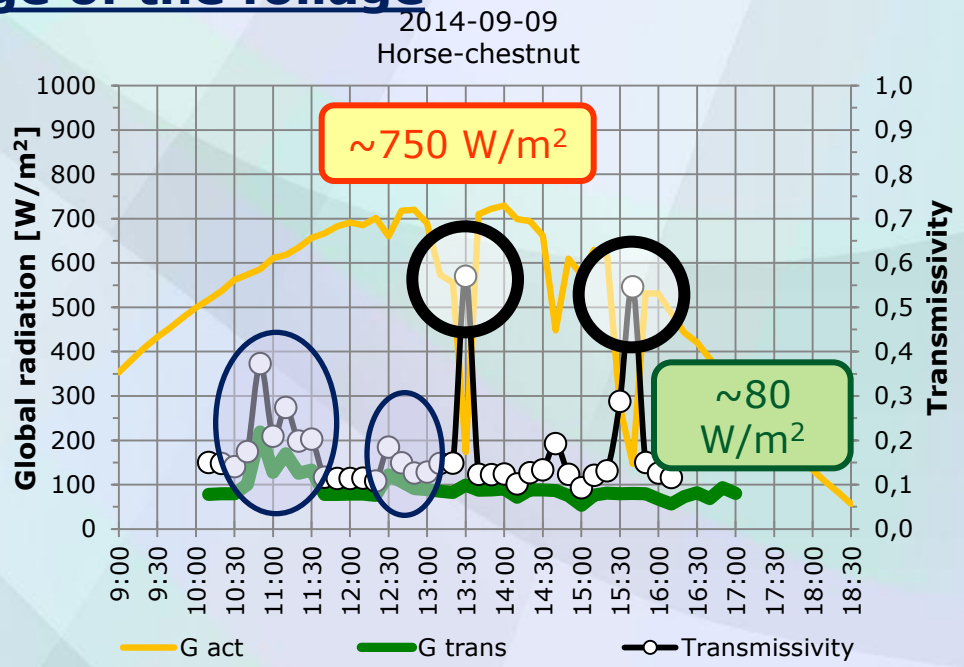


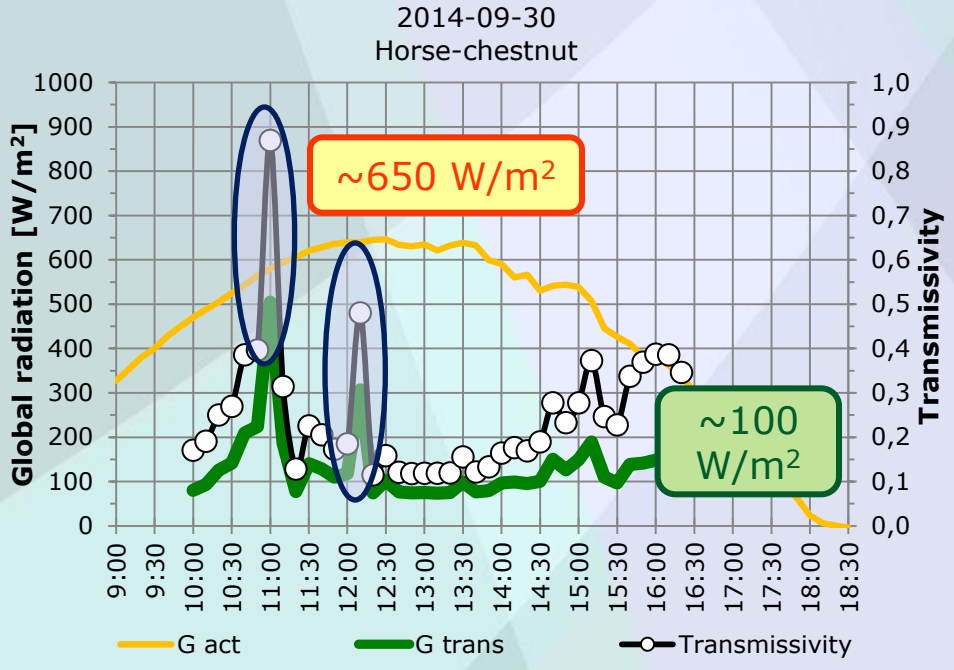
Date	N	SD	Mean	Median	Mode	Min.	Max.
4-Jul-2014	46	0.10	0.07	**0.03**	0.02	0.02	0.47
24-Jul-2014	41	0.15	0.15	**0.08**	0.06	0.05	0.94
9-Sep-2014	42	0.10	0.18	**0.15**	0.13	0.09	0.57
30-Sep-2014	39	0.14	0.25	**0.21**	0.11	0.12	0.87
28-Oct-2014	26	0.22	0.47	**0.47**	0.46	0.17	1.00

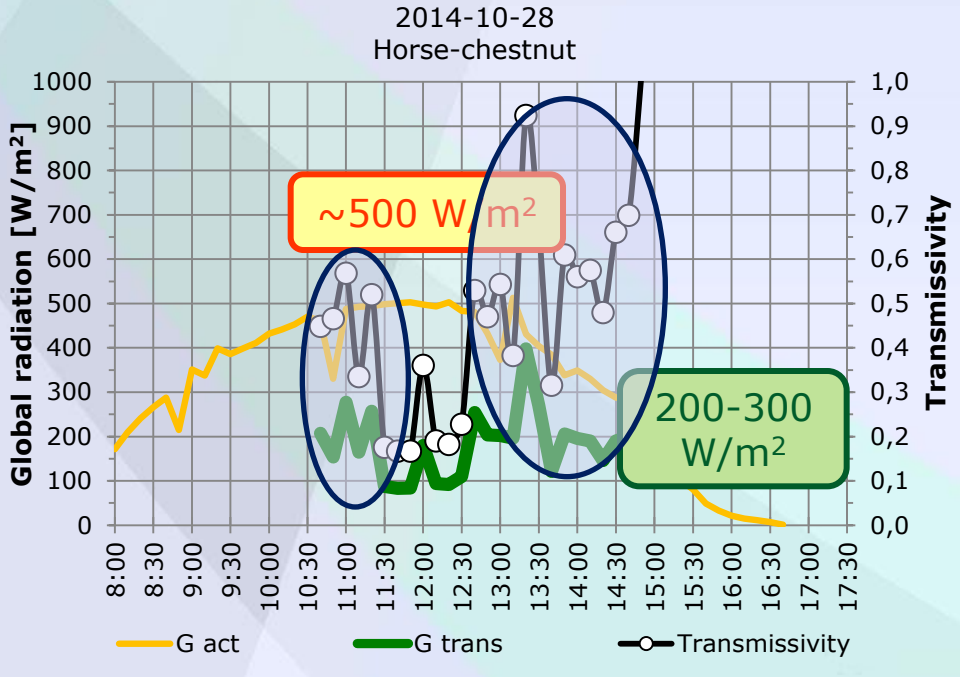
Note: arithmetical mean is very sensitive to the extreme values
→ better to characterize the distribution's central tendency with the **MEDIAN**.

Seasonal change of the foliage



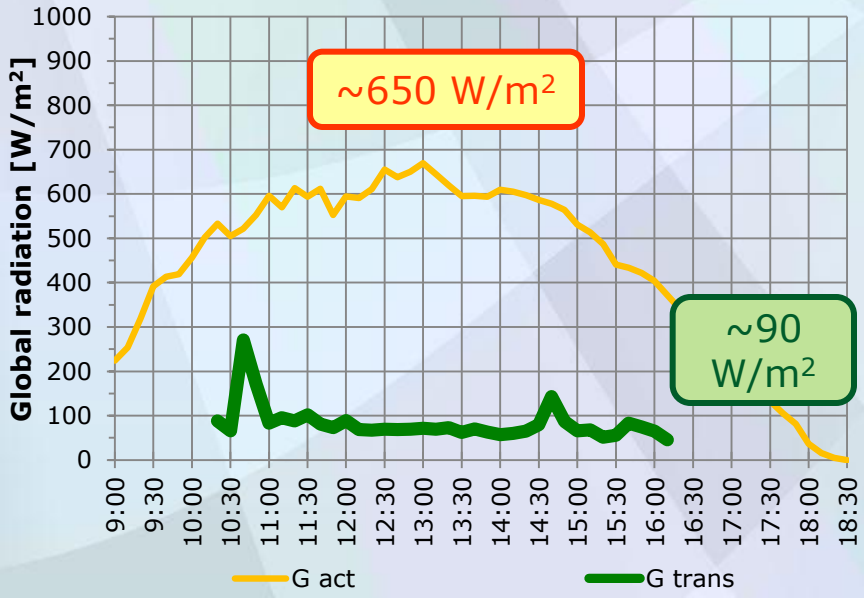




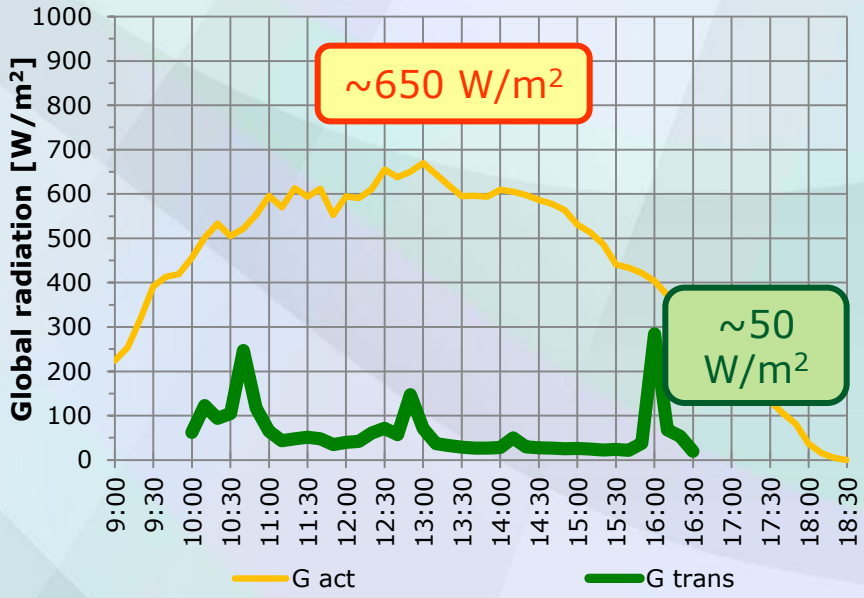


Inter-species comparison

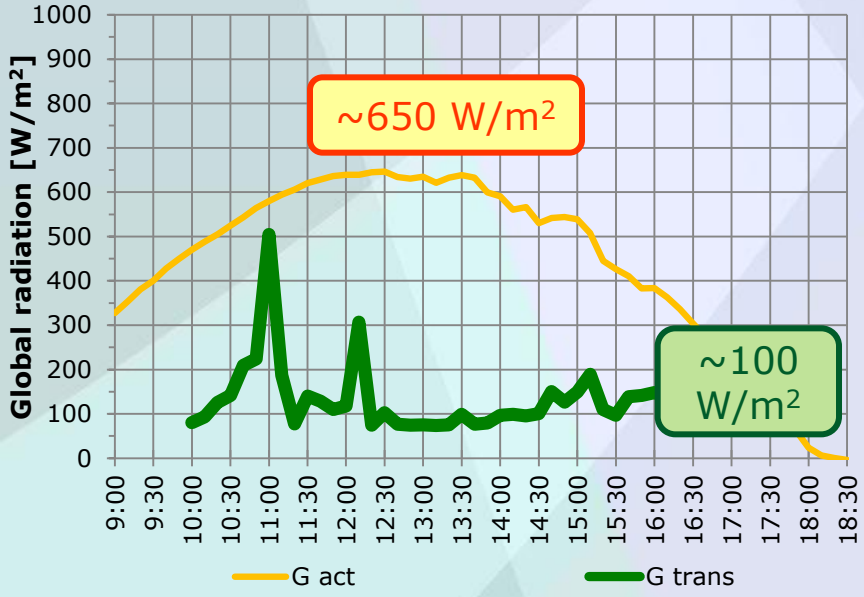
2014-09-29
Pagoda tree



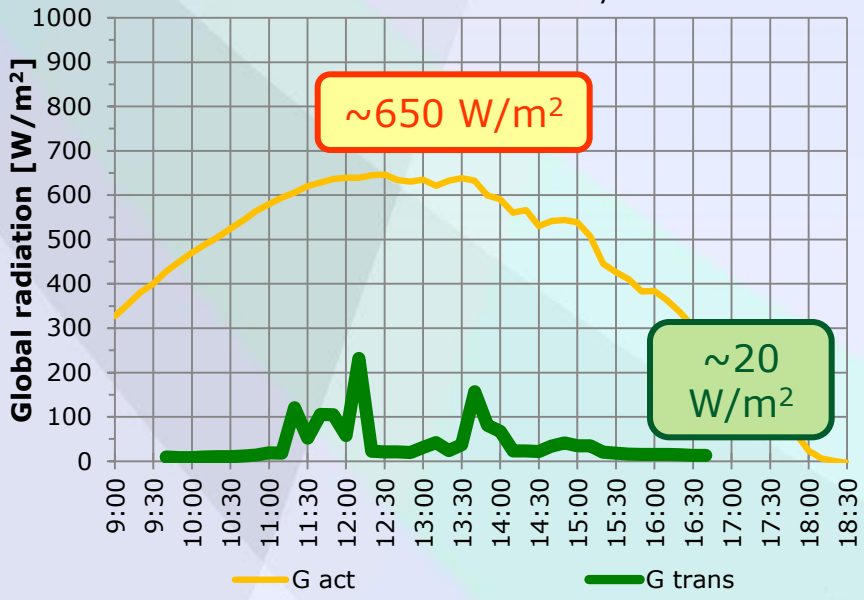
2014-09-29
Small-leaved linden



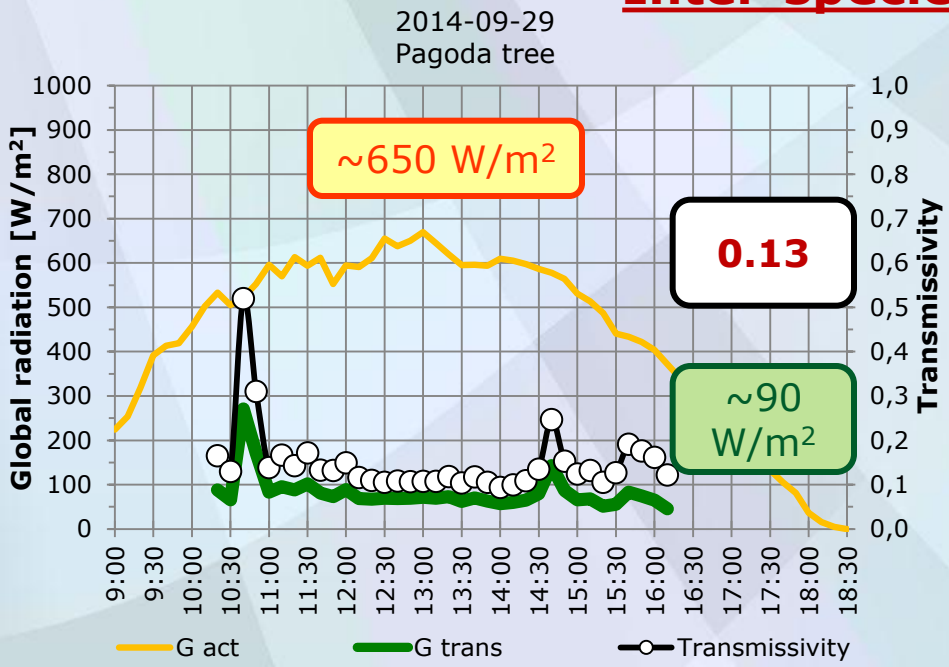
2014-09-30
Horse-chestnut

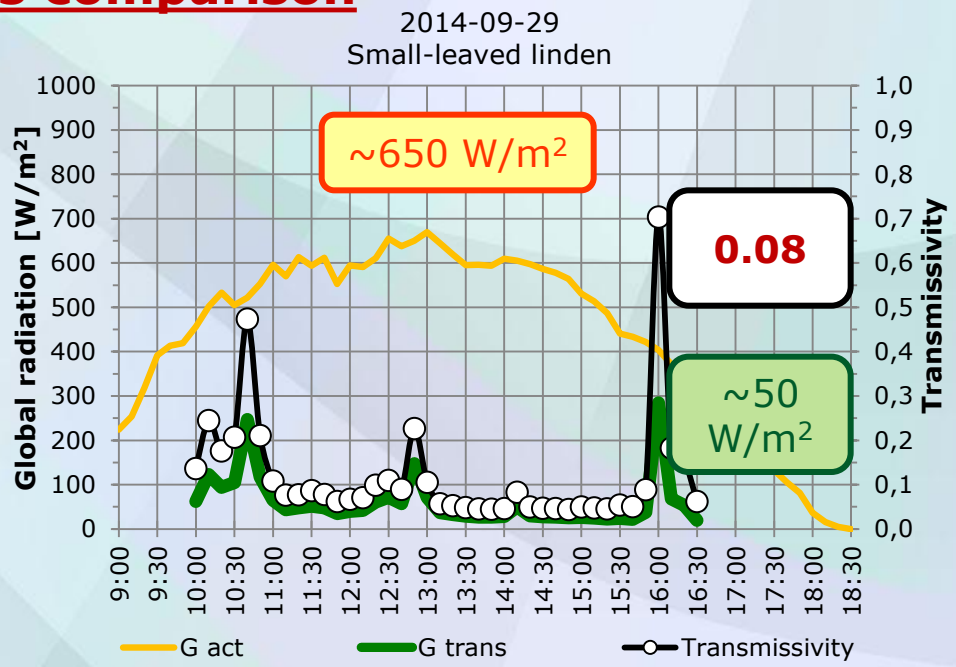


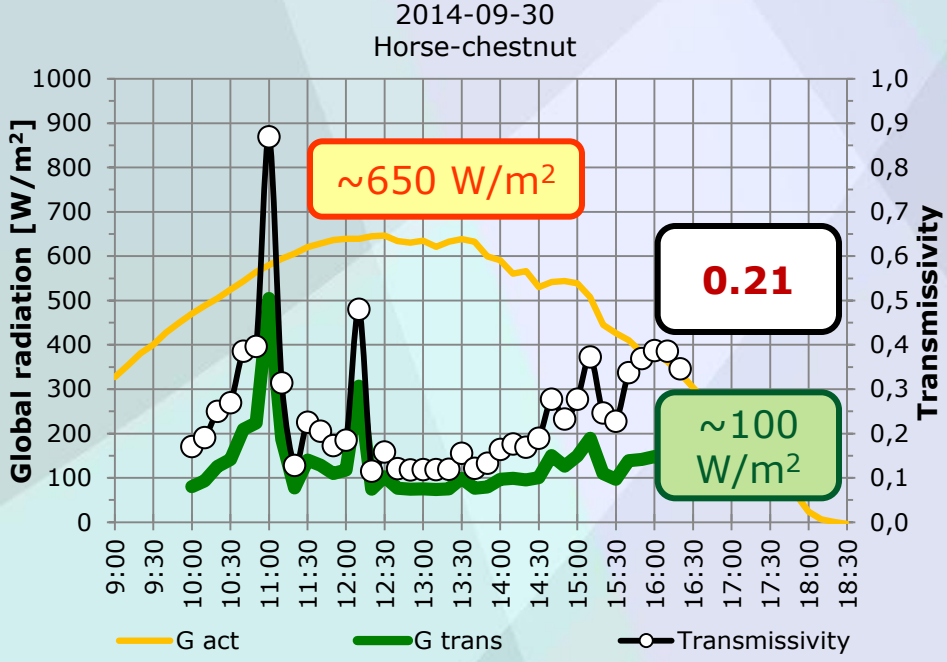
2014-09-30
Common hackberry

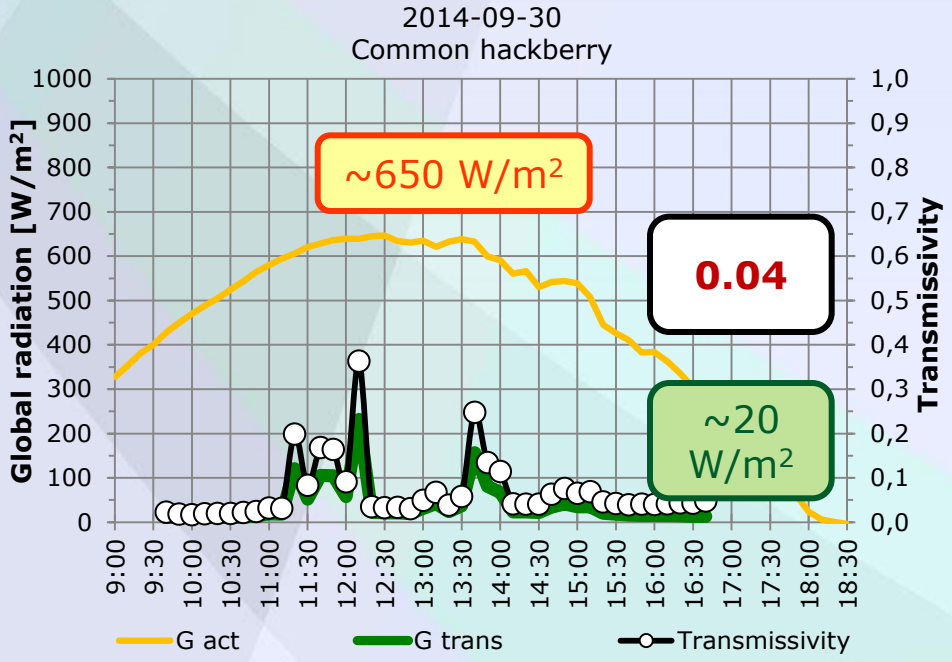


Inter-species comparison



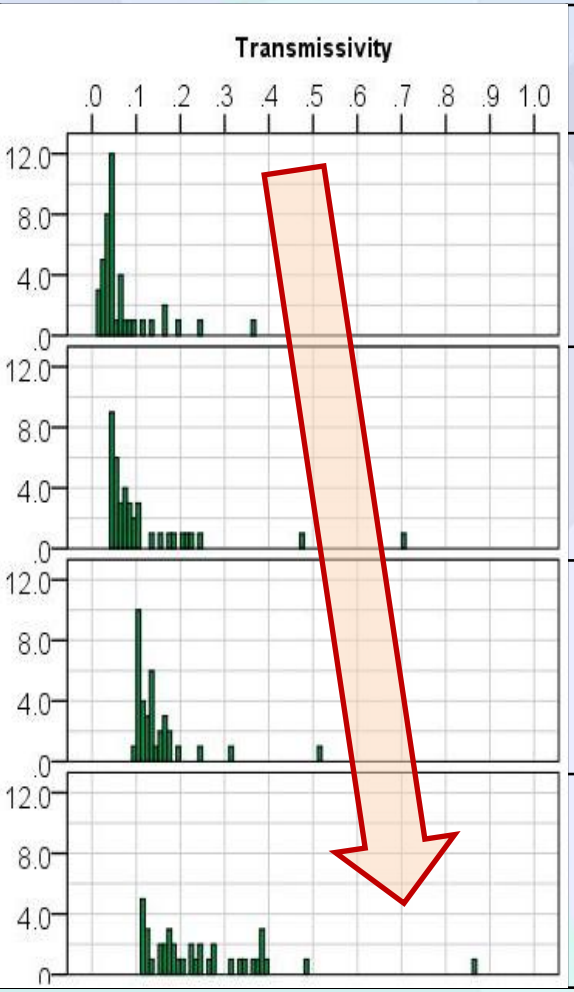






Inter-species comparison

Consecutive clear days (29 & 30-Sep-2014)



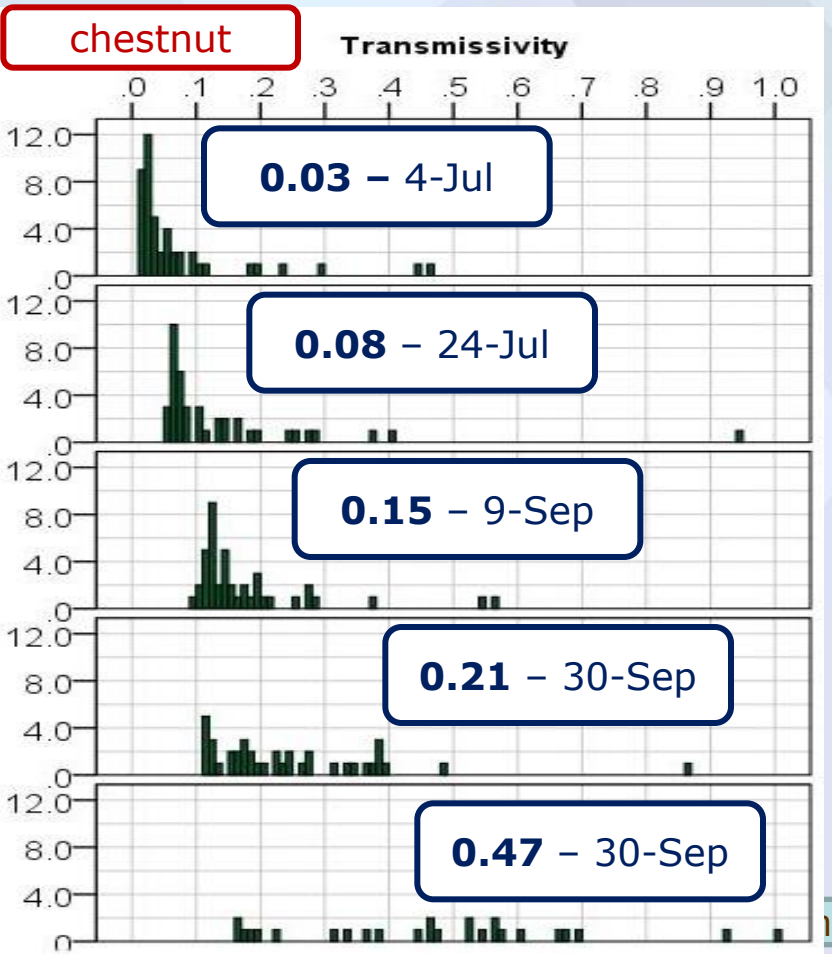
Species	N	SD	Mean	Median	Mode	Min.	Max.
Common hackberry	43	0.07	0.07	**0.04**	0.04	0.02	0.36
Small-leaved Linden	40	0.13	0.12	**0.08**	0.04	0.04	0.70
Pagoda Tree	36	0.08	0.15	**0.13**	0.10	0.09	0.52
Horse-chestnut	39	0.14	0.25	**0.21**	0.11	0.12	0.87

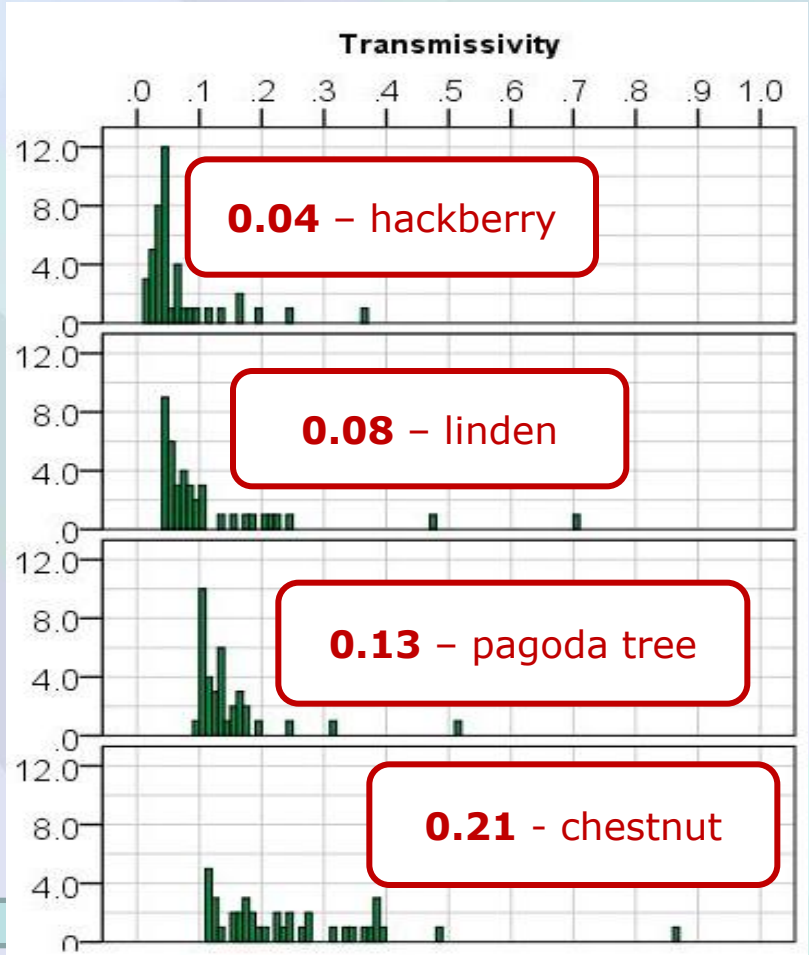
Conclusions & Outlook

higher **annual changes** in the case of the same tree

↕

inter-species differences on the same time of the year





Conclusions & Outlook

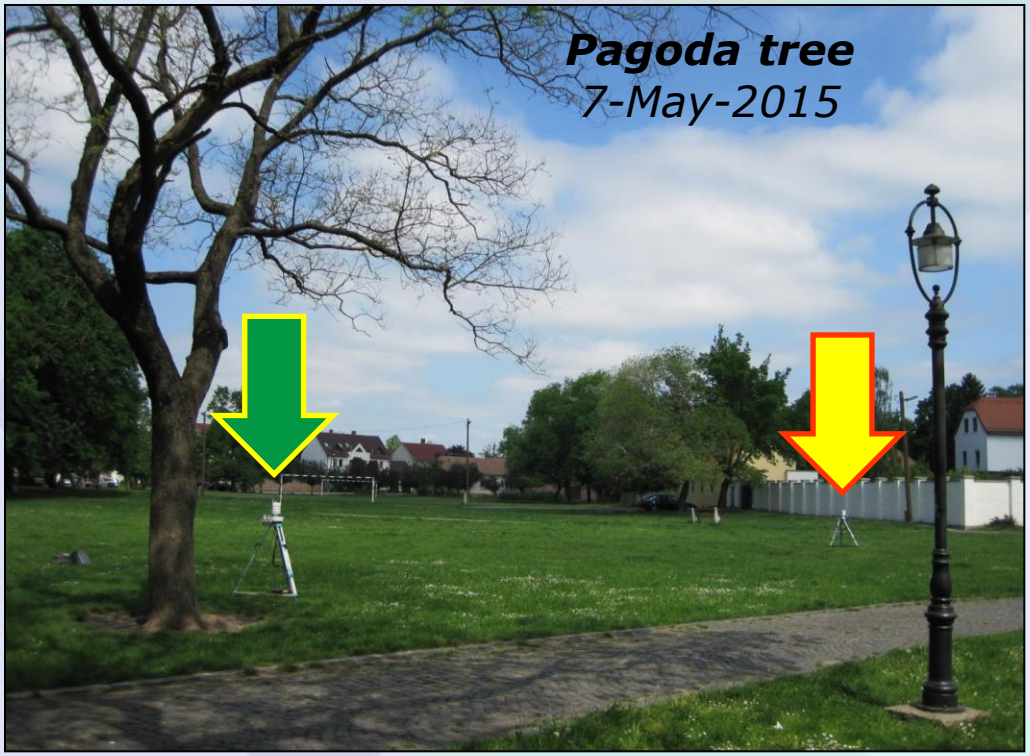
→ Motivation for a longer & deeper investigation series

better observed the **foliation–defoliation process** (spring – summer - autumn)

→ Motivation for a new research design

to avoid the problem of 'apparent transmissivity increase'

both stations on the same study area
- under the tree (Gtrans)
- in the sun – high SVF! (Gact)



additional benefits:
- finer temporal resolution (1 min)
- radiation budget & microclimate analyzes
  - short-wave radiation
  - long-wave radiation
  - temperature
  - humidity
- to investigate the effect of health conditions healthy & attacked horse-chestnut are also included

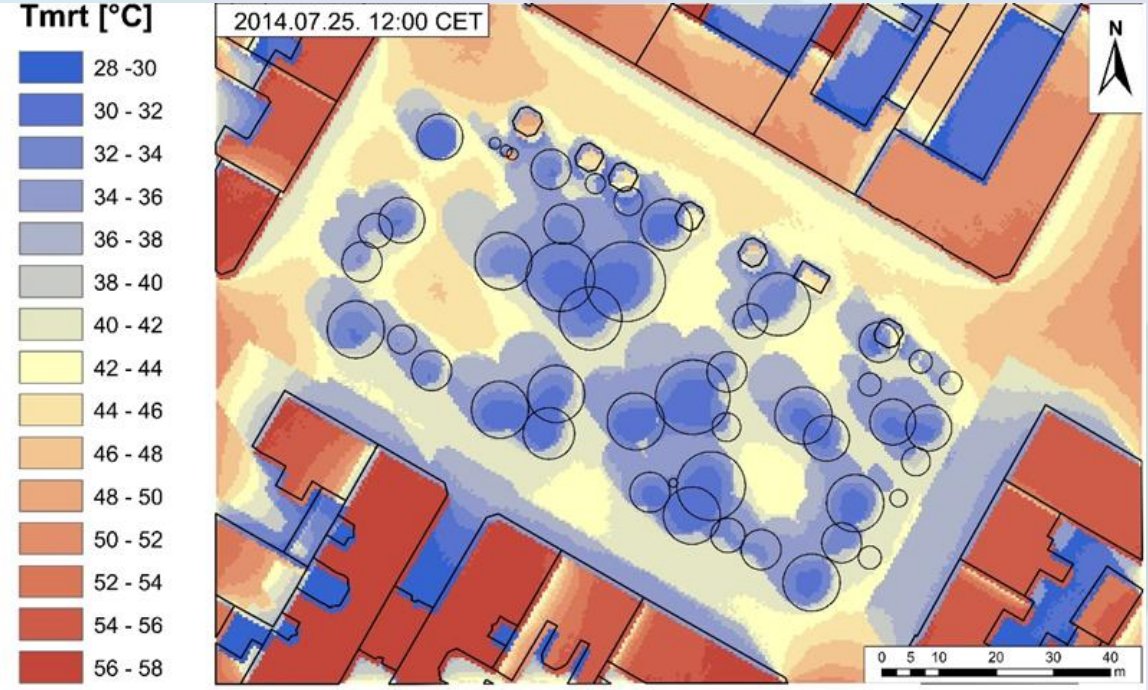
Conclusions & Outlook

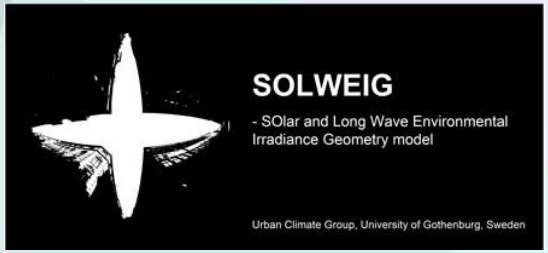
→ Application of the measured transmissivity

inputs for radiation and bioclimate modeling

support more reliable simulations

investigate the effect of tree species selection





Lindberg et al., 2008

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THANK YOU FOR YOUR ATTENTION!

Ágnes Takács

Márton Kiss

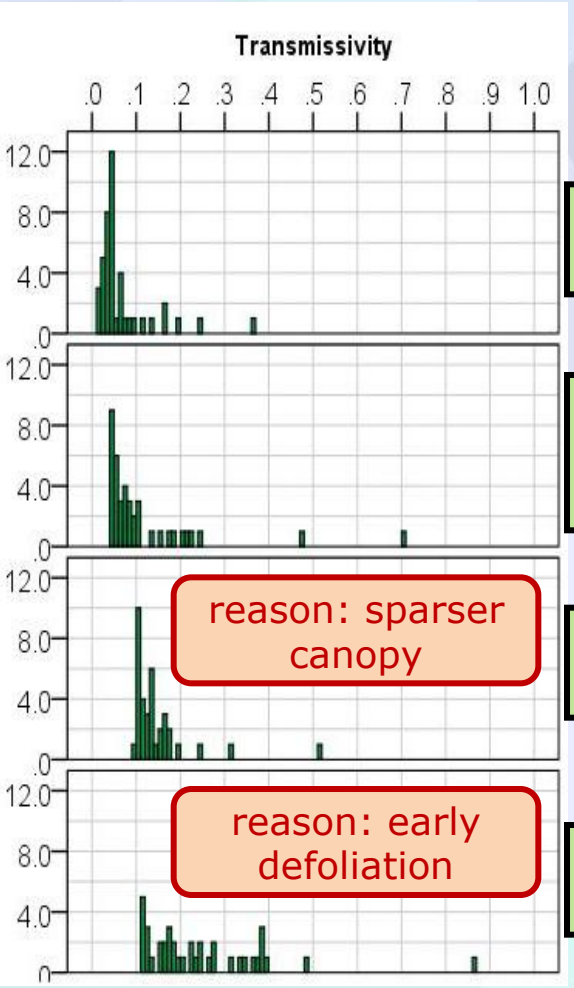
Ágnes Gulyás

Noémi Kántor

Inter-species comparison

Transmissivity

Autumn defoliation



reason: sparser canopy

reason: early defoliation

Common hackberry	II.	
Small-leaved linden	II.	
Pagoda Tree	III.	
Horse-chestnut	I.