DREXEL UNIVERSITY
Civil, Architectural, and Environmental Engineering
College of Engineering

Rainfall interception by urban shrub canopy - an experimental study in Philadelphia

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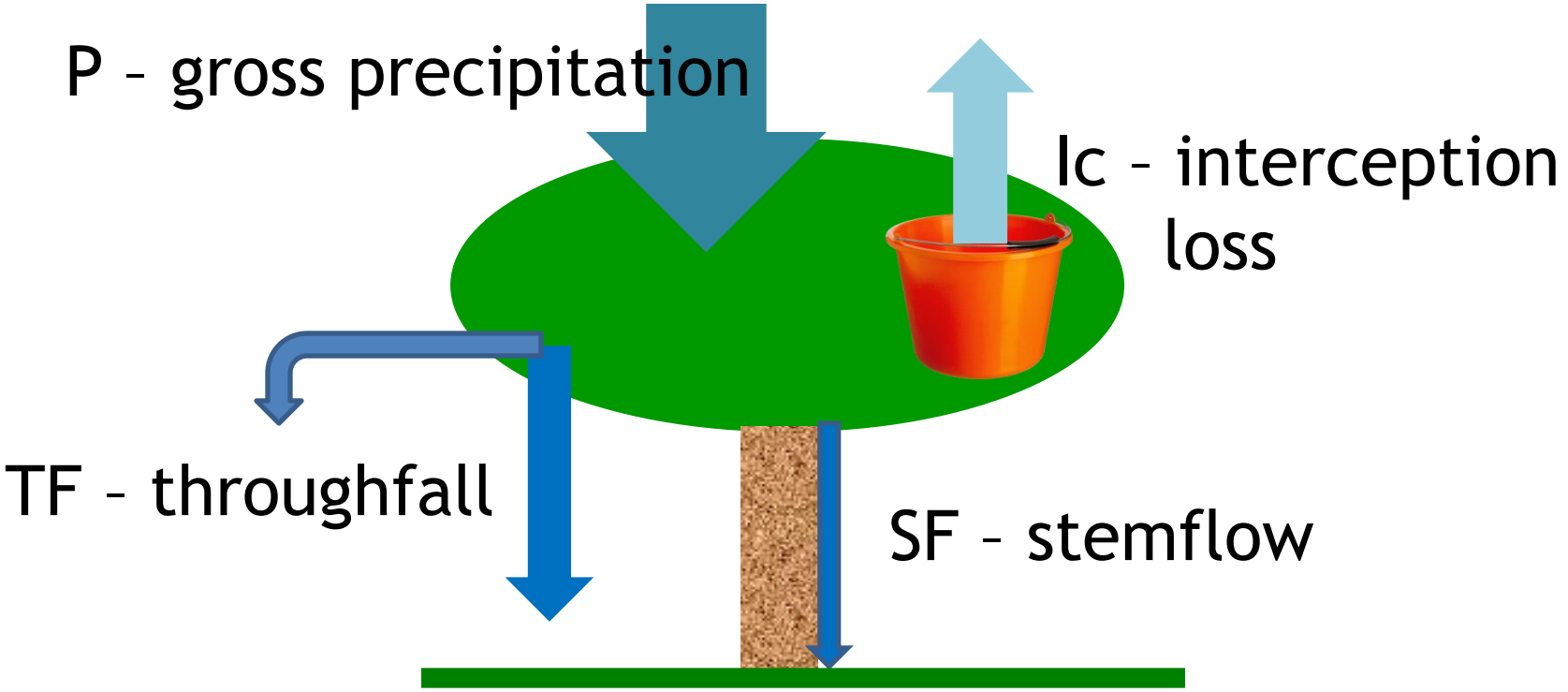
Plant Performance in Green Stormwater Infrastructure Systems

June 27, 2016

Canopy water budget



$$Pg = TF_z + TF_{xy} + SF + Ic$$

Species

Sweetspire

*Itea virginica "*Little Henry*"*

Red-twig dogwood

*Cornus sericea "*Kelseyi*"*

Species

Cherry laurel

Prunus laurocerasus “Otto”

Oakleaf hydrangea

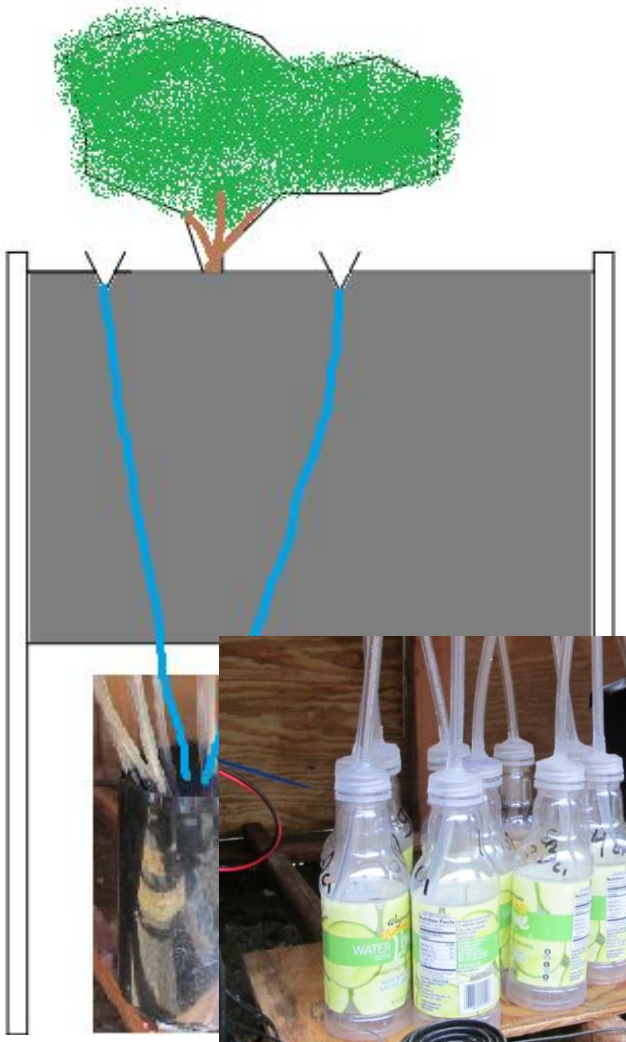
Hydrangea quercifolia “Alice”

Ultra-urban location

225 N 32nd St

Planted in 2013
Widths up to 1 m

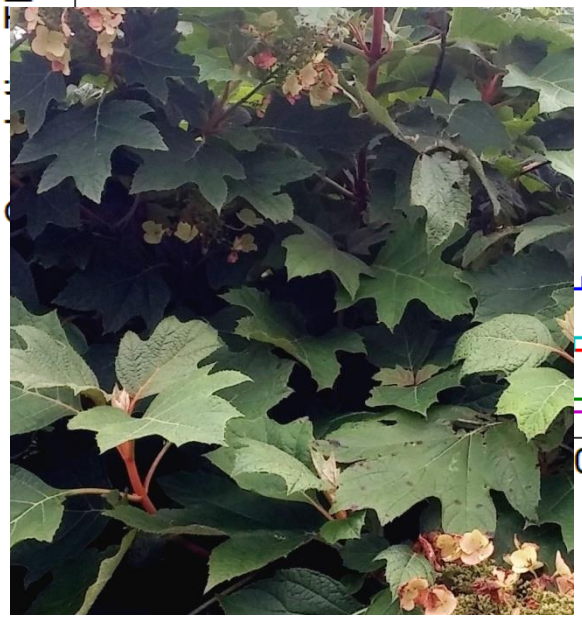
Planted in 2015
Width 60 cm



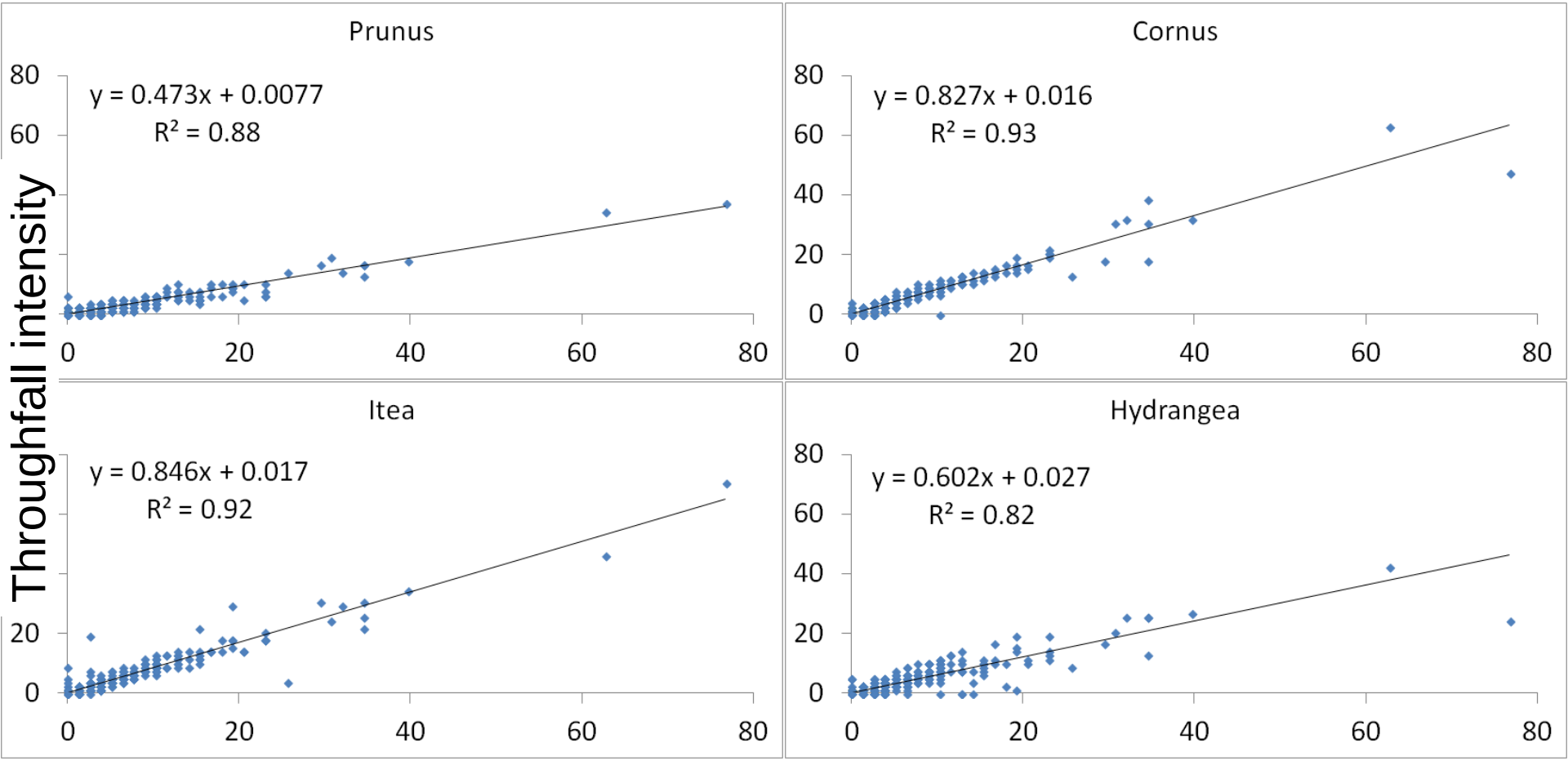

W S
1.2-1.2-6 m

Setup: gauges

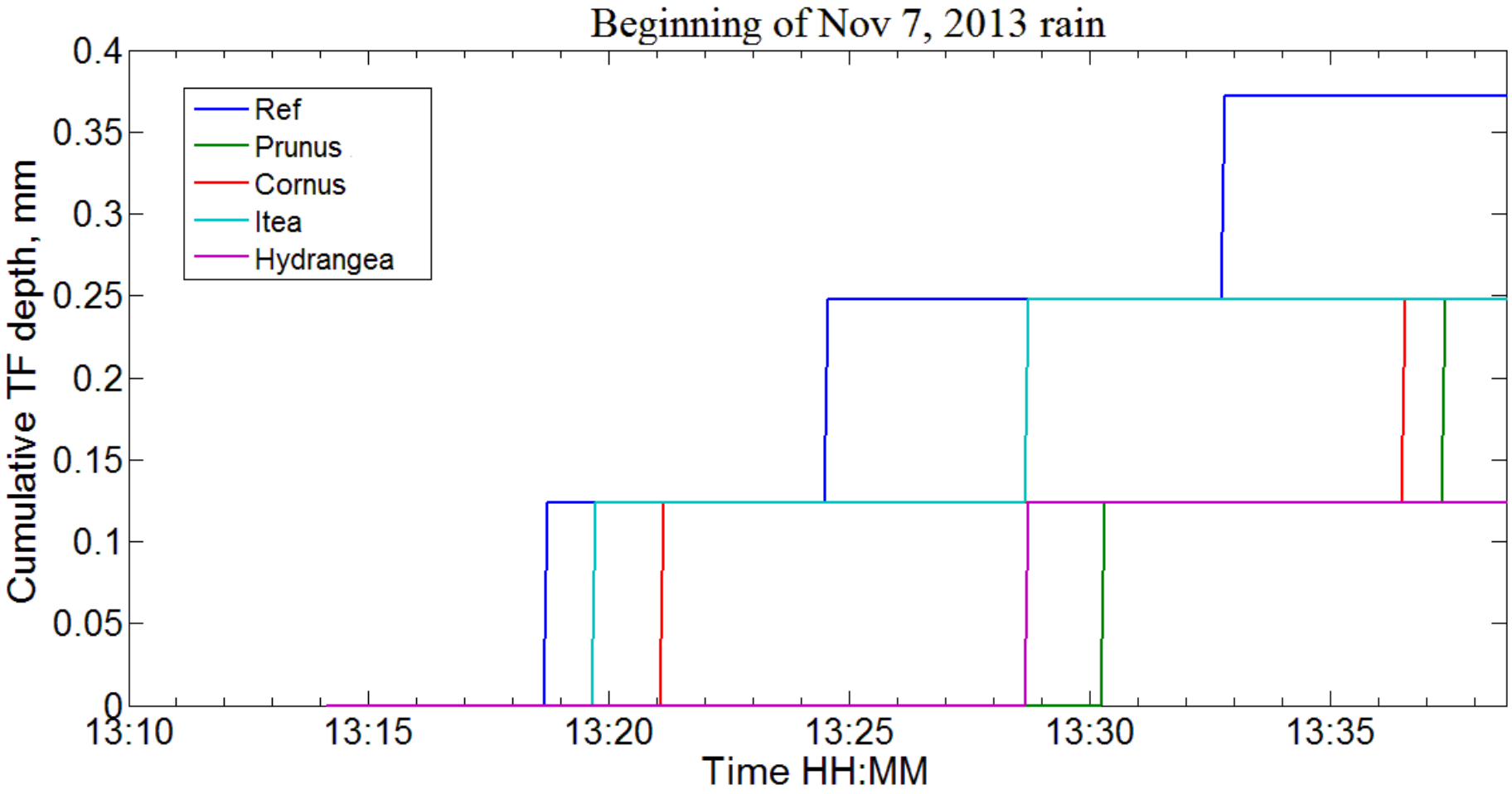
cumulatives diverge!



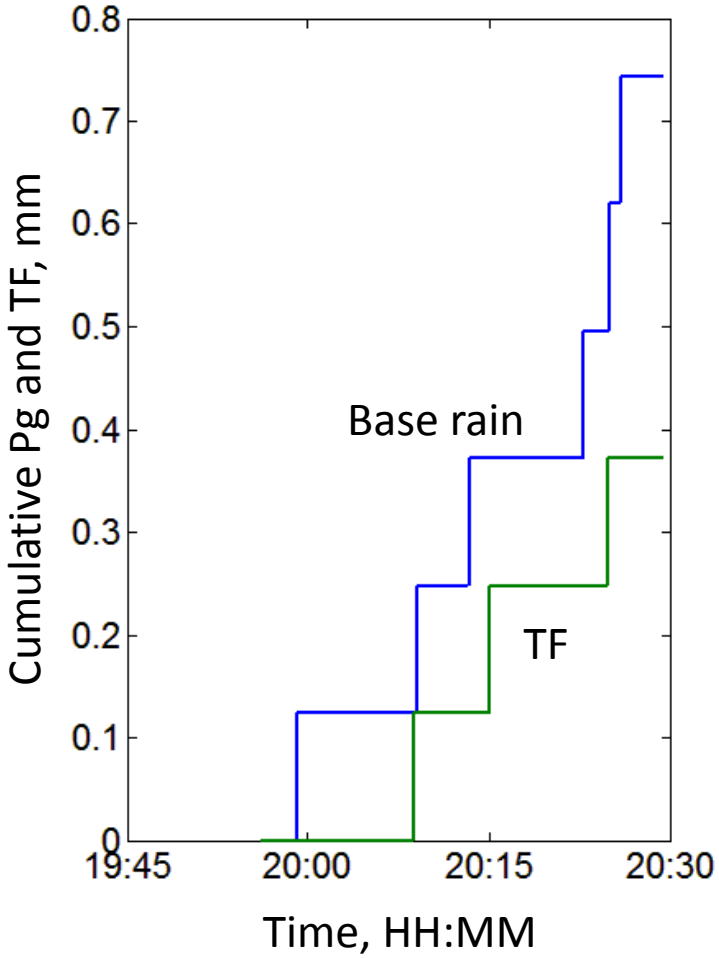
TF vs. rainfall rates, mm/hr

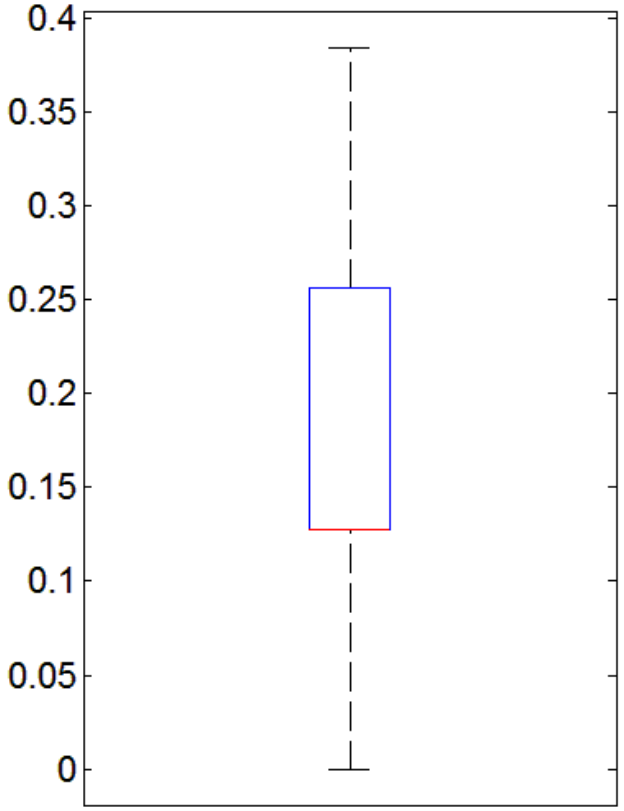


Lag of TF's onset



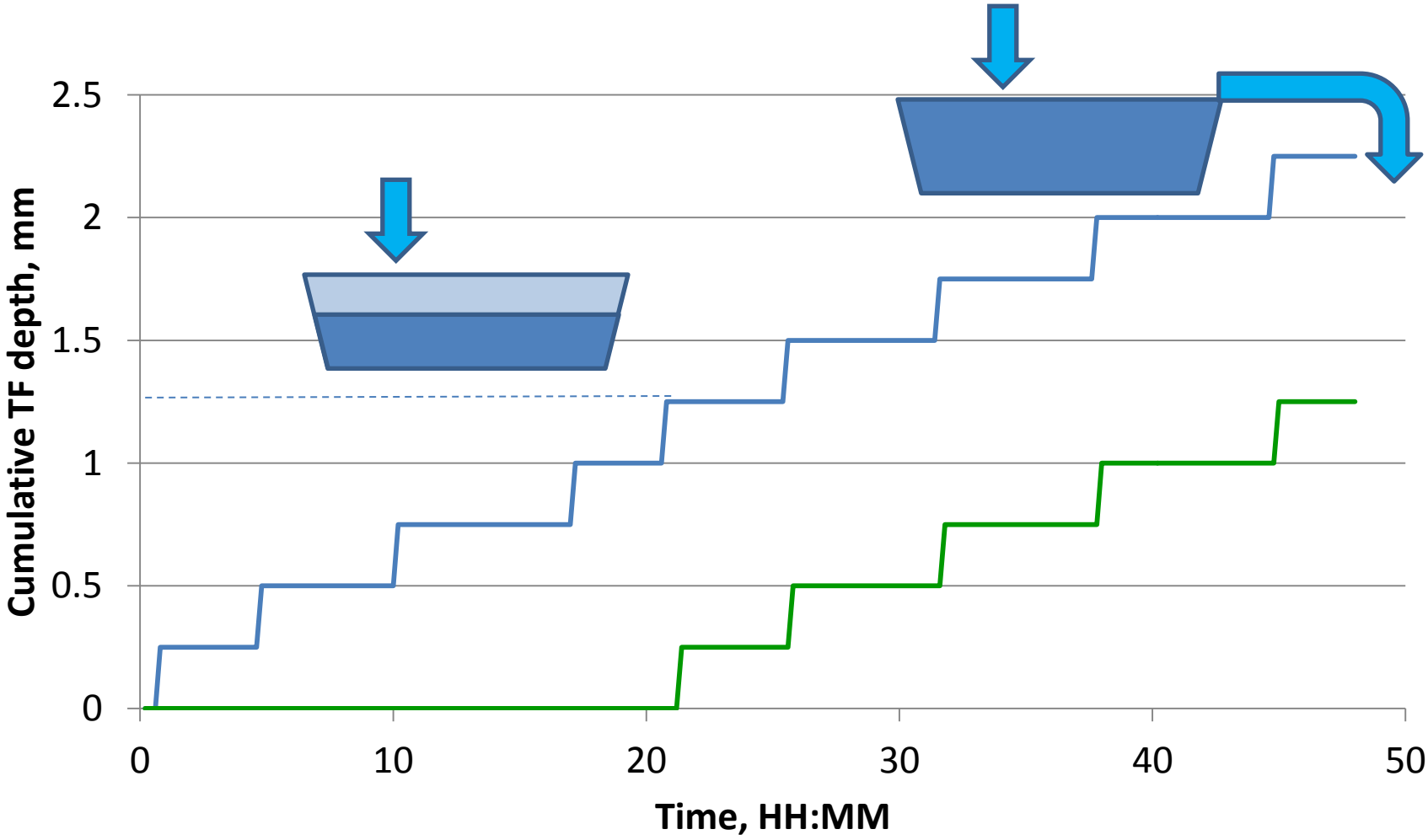
How much rain is needed to ‘saturate’ canopy?



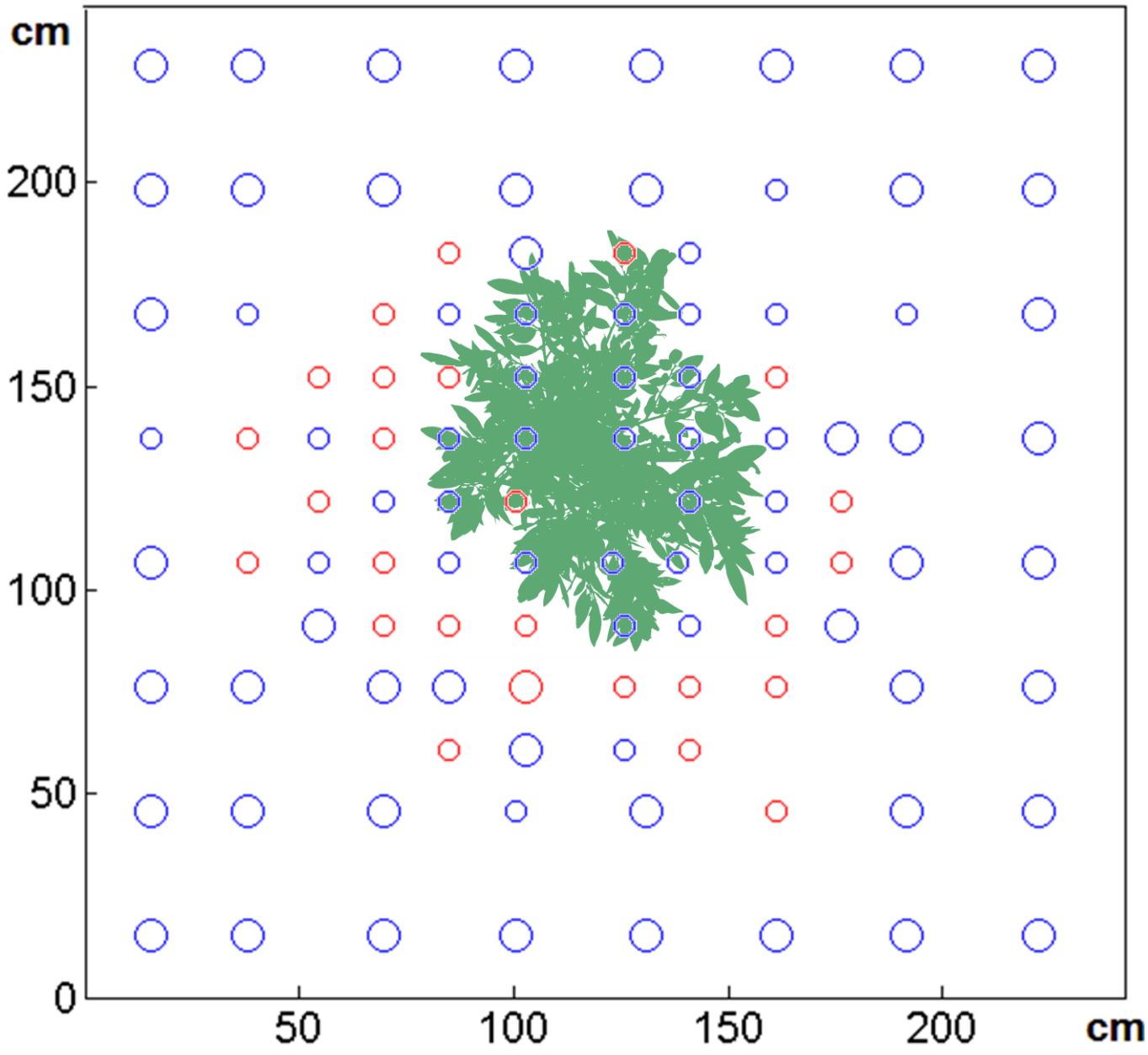


Median = 0.128 mm
n = 43

Simplified canopy storage model



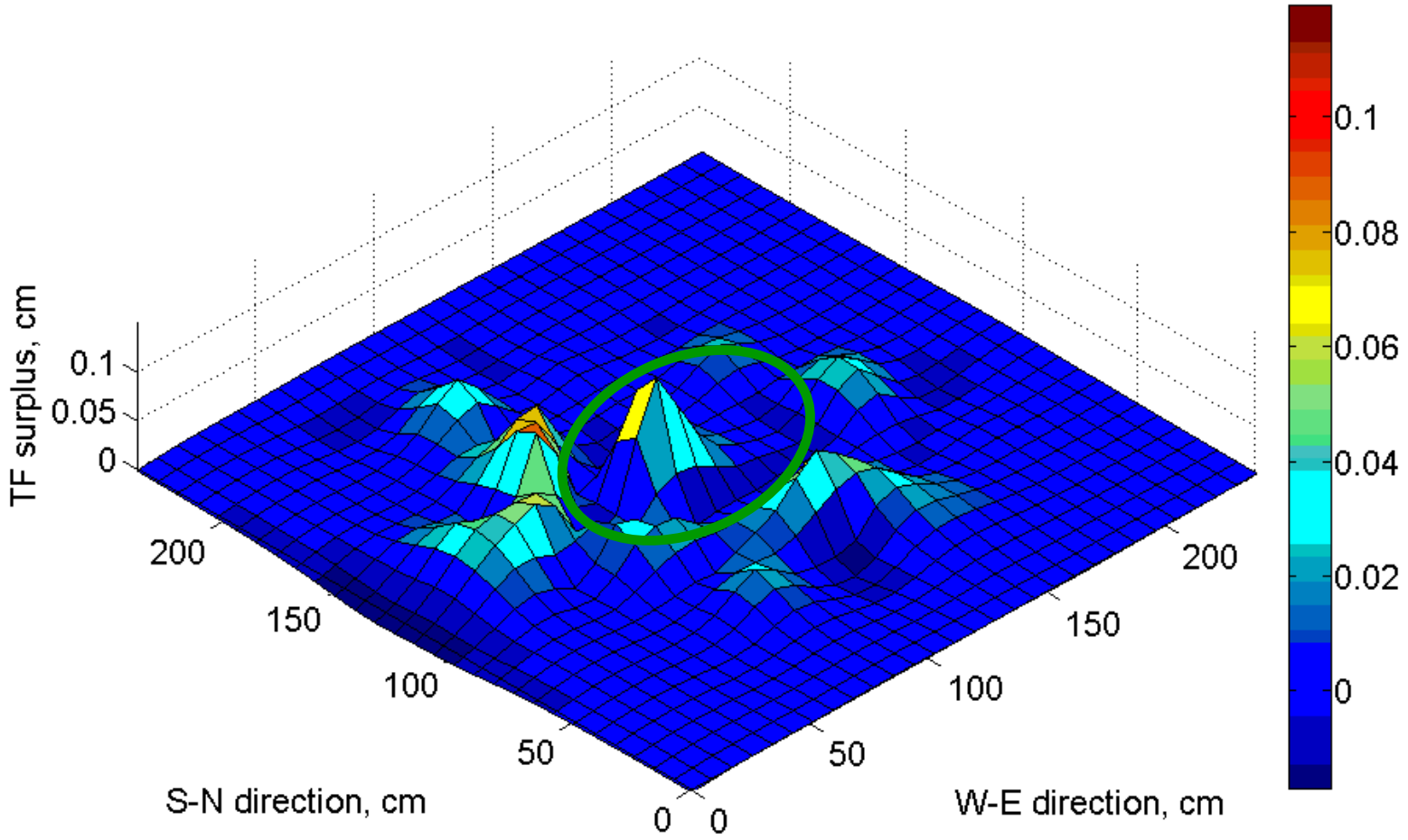
Lateral displacement of TF



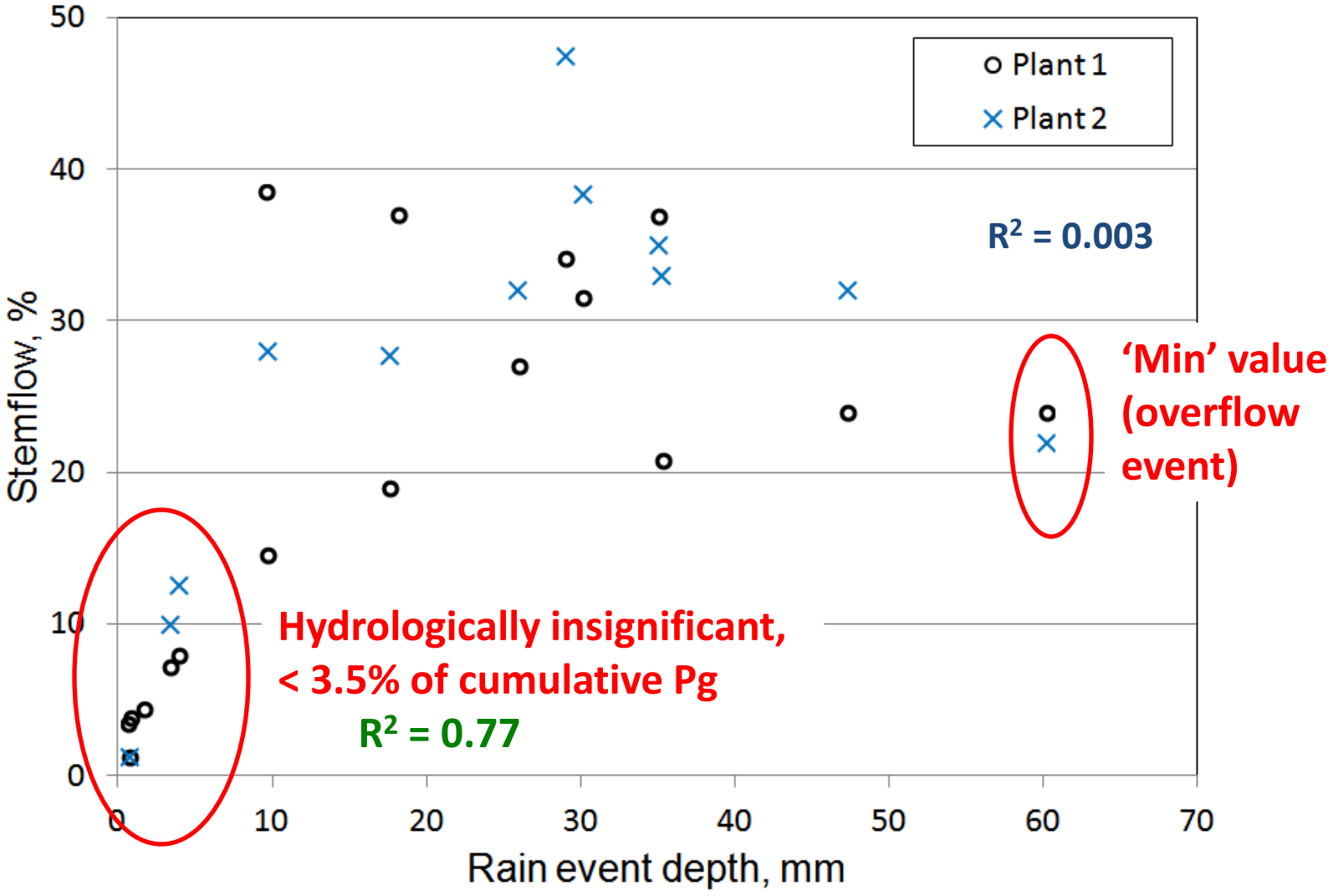
Plot size
240x240 cm

Surplus depth
TF>Pg

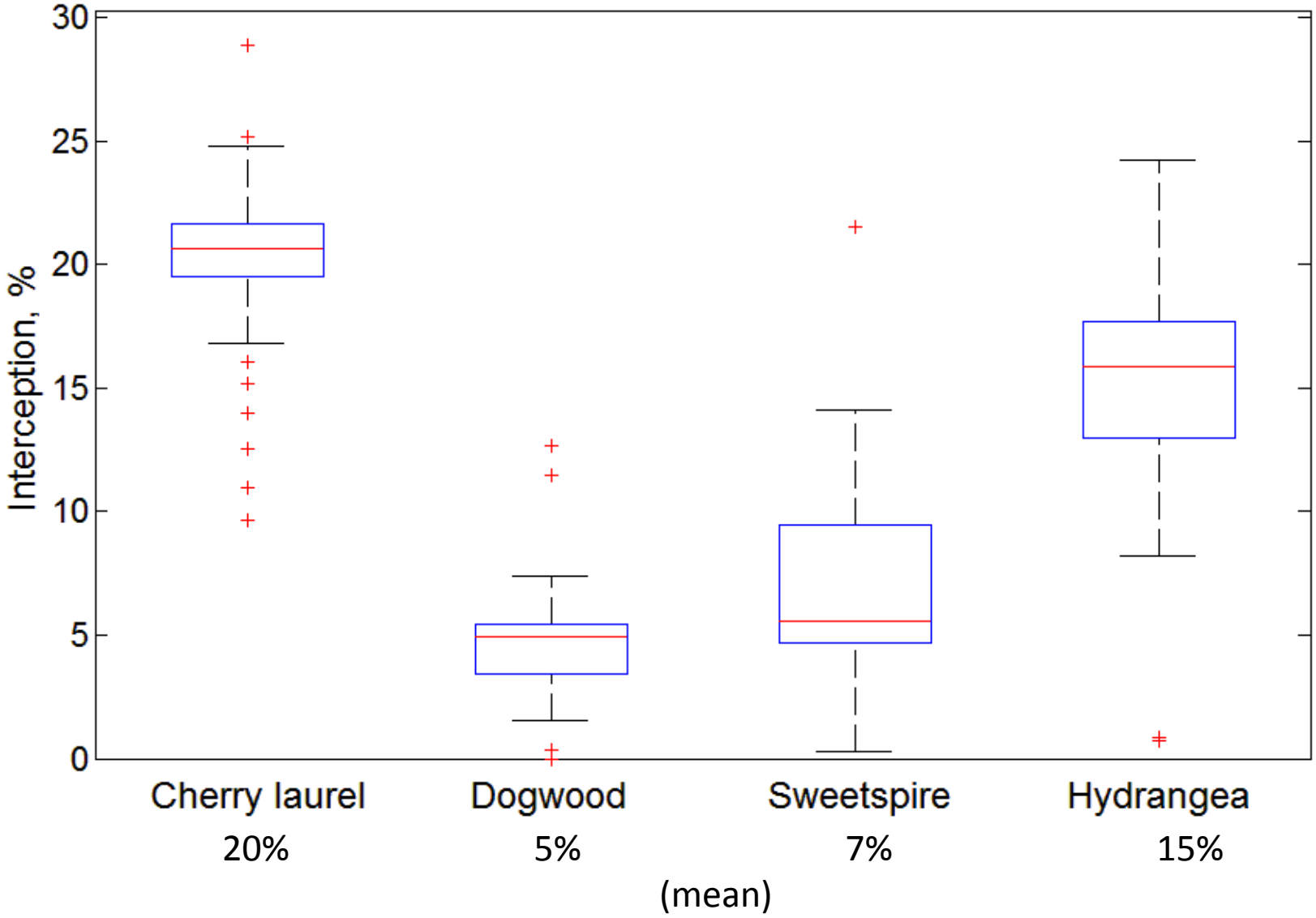
Precipitation ‘surplus’ beyond canopy projected area. Event: 28 Oct 2015 rain, 2.60 cm



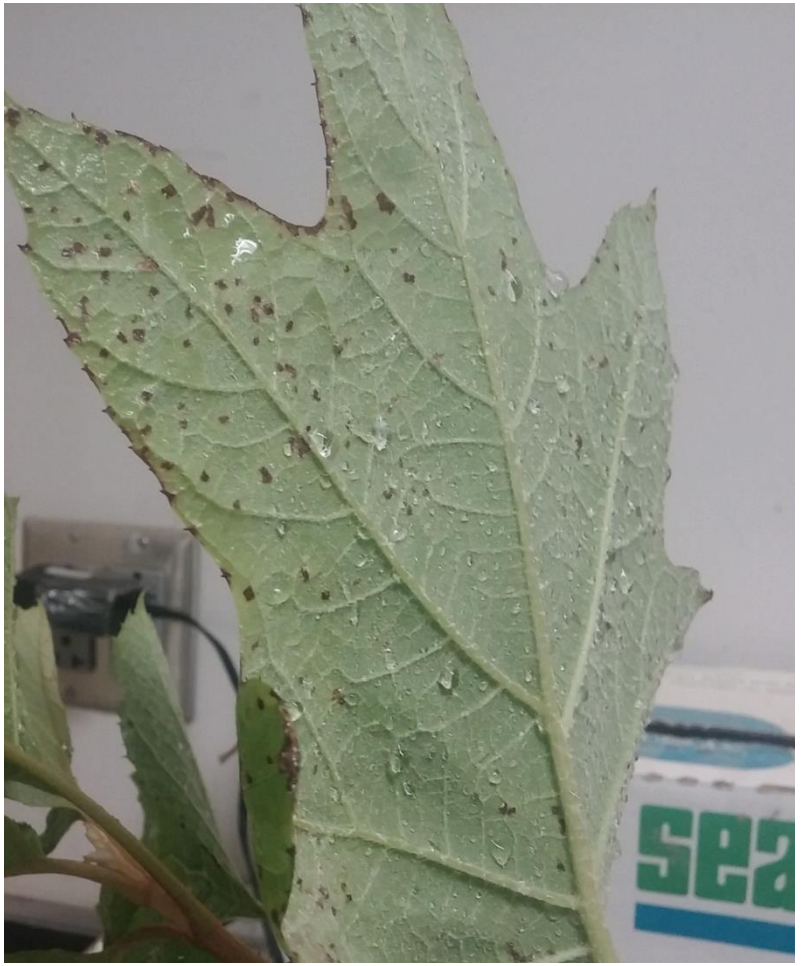
Stemflow and a depth of a rain event (*P. laurocerasus*)



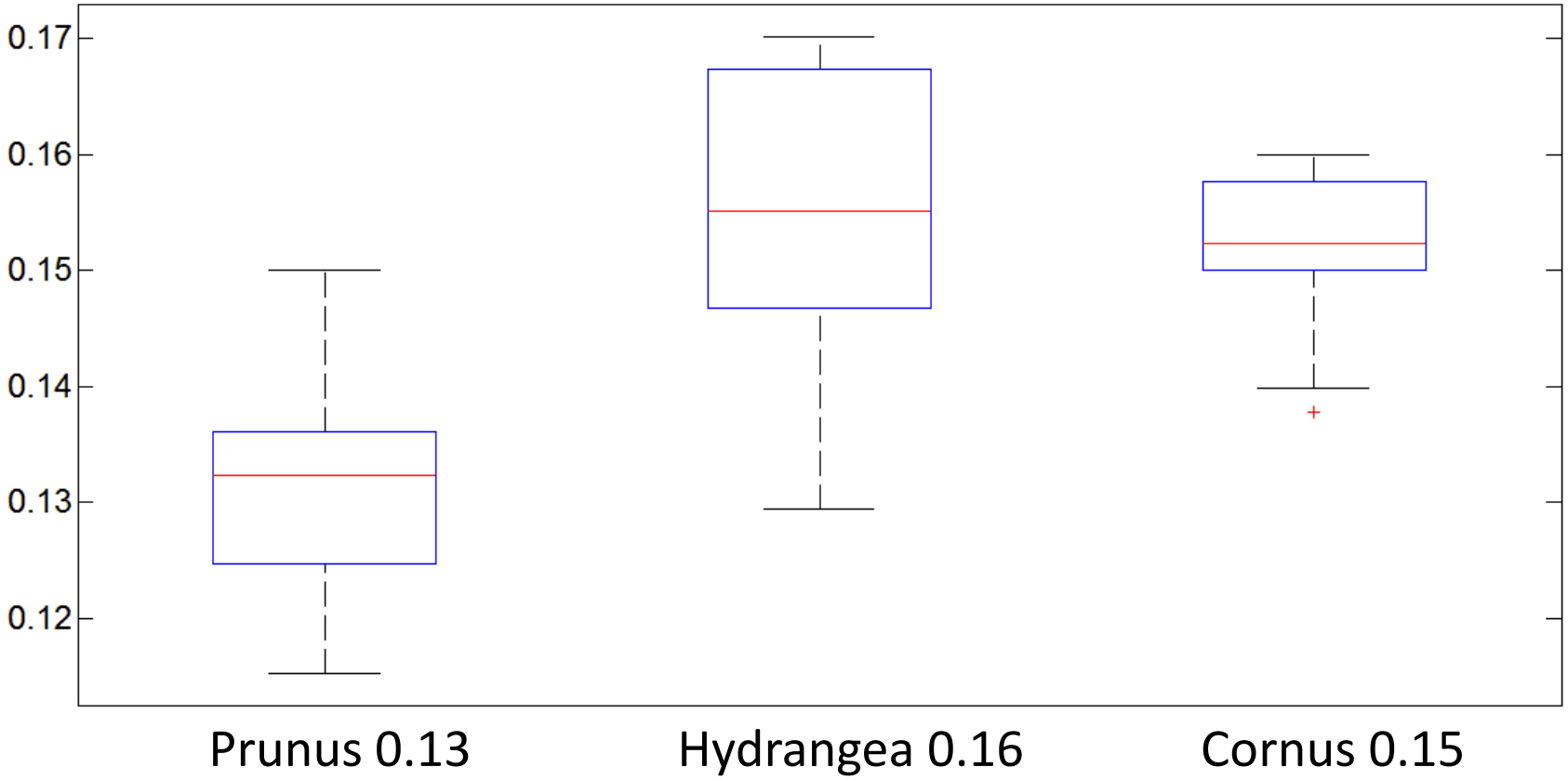
Event-based interception estimates



Canopy storage capacity



Canopy storage capacity, mm



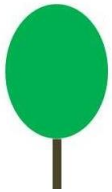
Friesen *et al* (2008) *WRR*: 0.8 mm, but were self-critical of the techniques
Xiao and McPherson(2016) *J. Environ. Qual.*: 0.86 mm, indoor experiment, 20 spp.
Most common value used is 0.2 mm, from: Dickinson, R.E. (1984) *Climate*…

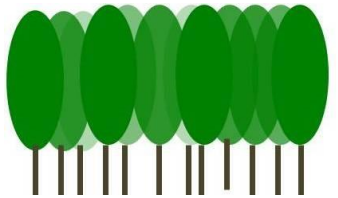
Urban and Isolated Tree Studies

Spp.	Location	Ic	SF	Experiment duration
Silver birch	SLO	40.2%	2.4%	4 mos, 85 events
Scots pine	SLO	58.3%	0.15%	4 mos, 85 events
American beech	MD	26.0%	3.0%	2 yrs, 52 events
Yellow poplar	MD	26.0%	3.0%	2 yrs, 52 events
Cork oak	CA	27.0%	15.0%	13 mos, 63 events
Callery pear	CA	15.0%	8.0%	13 mos, 63 events
Gingko	CA	25.2%	1.0%	2 yrs, 25 events
Sweet gum	CA	14.3%	4.1%	2 yrs, 25 events
Western red cedar	BC	49.1%	negl	7 mos, 7event series
Douglas fir	BC	60.9%	negl	7 mos, 7event series
Evergreen oak	ESP	21.7%	0.26%	2 yrs, 237 events

Review of **urban** *vs*. **forest** studies

Spp.	Ic, urban	Ic, forest
Silver/white birch	40.2%	20-29%
Scots/ lodgepole pine	**58.3%**	**19-31%**
American beech	26.0%	27-40%
Cork oak	27.0%	6.2%
Douglas fir	**60.9%**	**21-25%**
Evergreen oak	**21.7%**	**6.2%**

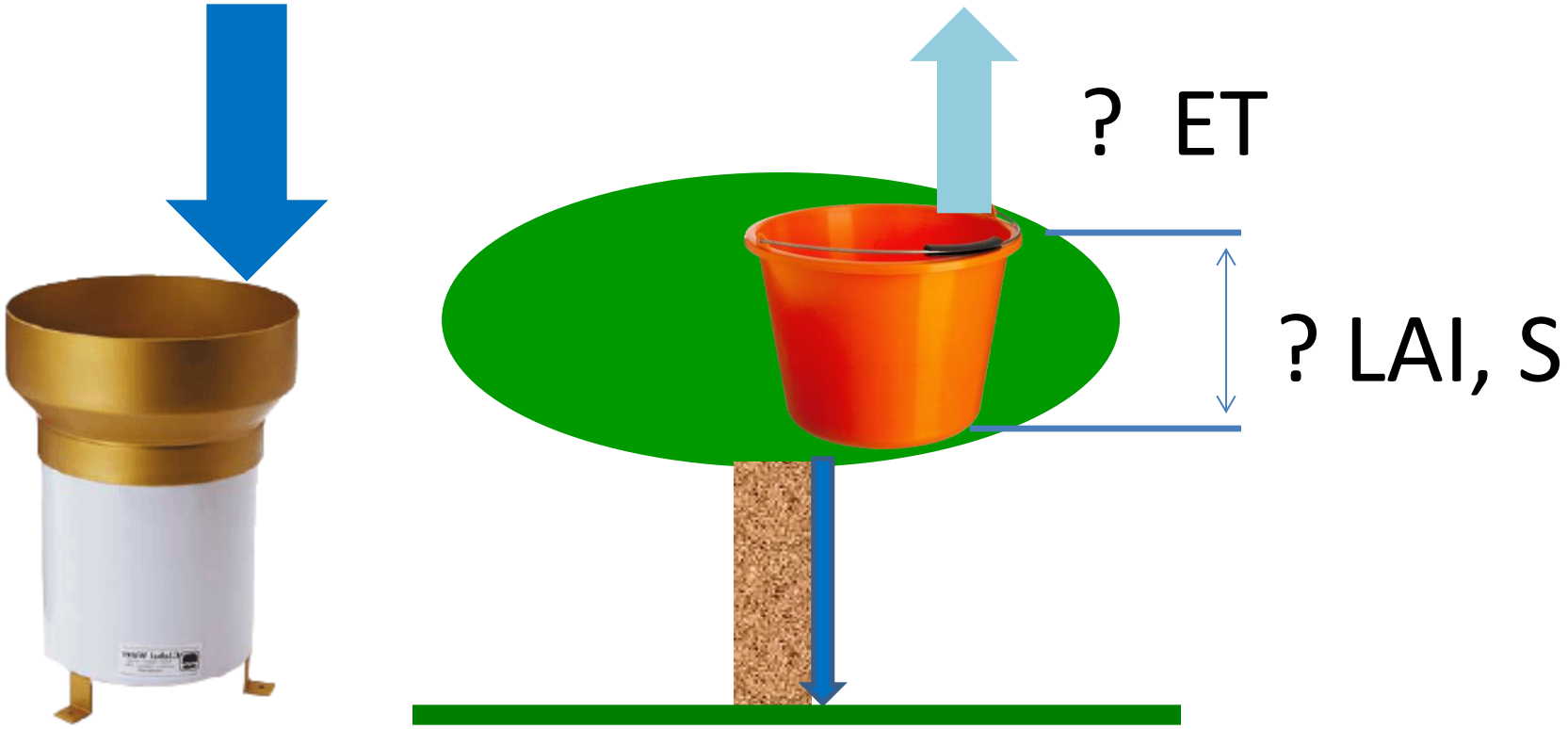




Stemflow: varies 0.5 – 8% across a large variety of species

Schooling, J. T., and D. E. Carlyle-Moses (2015), *Urban. Ecosyst.*, pp. 1-24

Discussion



Modeling *Ic*: trade-off of accuracy *vs.* availability is here to stay

Discussion

- *Ic* mass balance quantified with greater accuracy;
- *SF* appears to be a substantial flux;
- Cherry laurel, a Mediterranean shrub, shows large *SF* fraction;
- Large *SF* supports traditional closure of *Ic* balance;
- Large *SF* may create ‘hot spots’ of soil moisture within a BMP;
- Morphology defines a species’ ability of partition of rainfall;
- Design GSI research sites with redundant sensors.

Thanks!

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