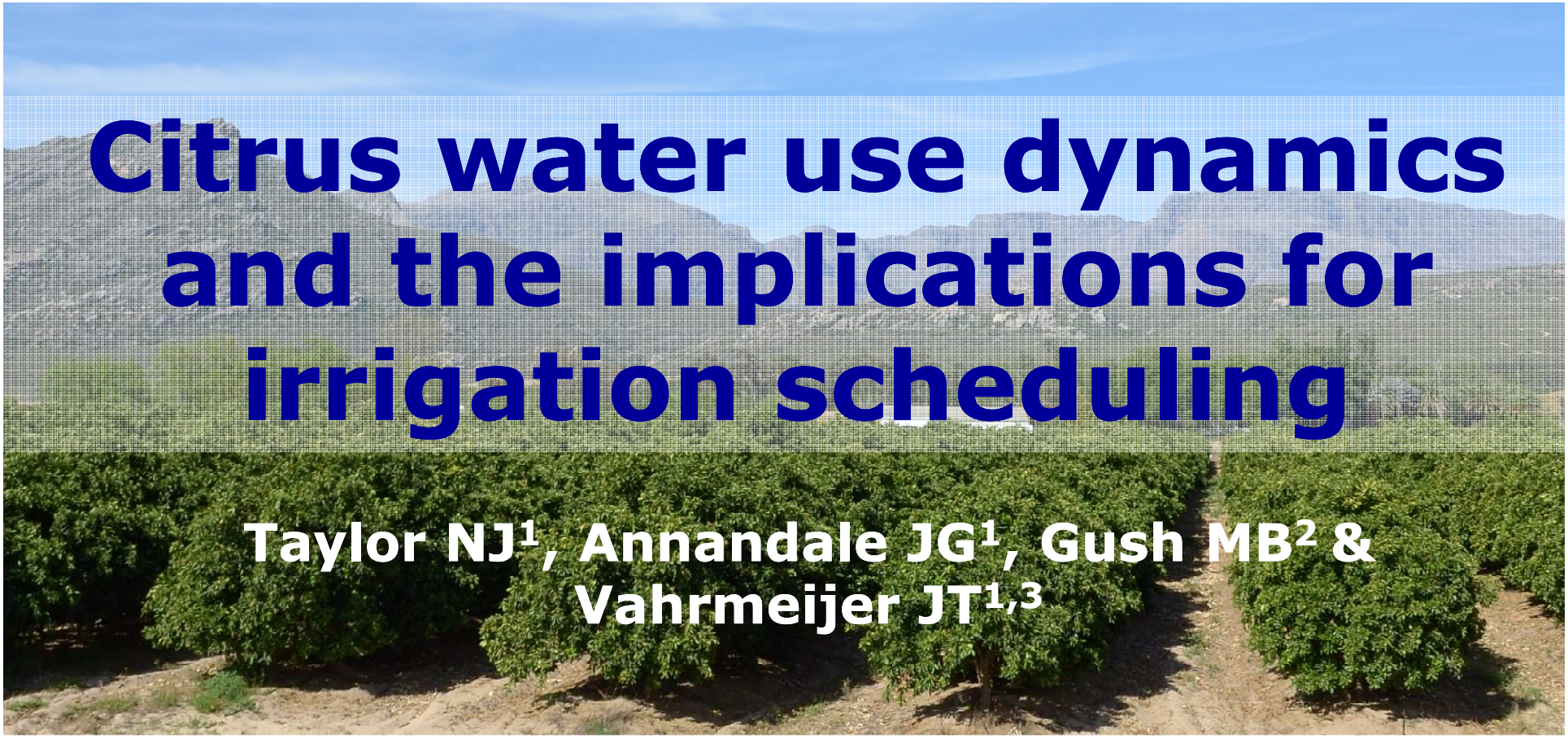
Citrus water use dynamics and the implications for irrigation scheduling



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[2]CSIR – Natural Resources and the Environment
[3]Citrus Research International

Why water use dynamics?

- Purpose of irrigation is to maintain a favourable plant water status - transpiration seen as a beneficial water loss

- Understanding the principles of plant water relations will aid in decision making regarding when **to** irrigate and when **not to** irrigate

- Modelling water use

CITRUS PRODUCING REGIONS OF SOUTHERN AFRICA

TOTAL Ha	
Eastern Cape	1
KZN	
Limpopo	1
Mpumalanga	1
North West	
Northern Cape	
Swaziland	
Western Cape	

ZIMBABWE

Limpopo (3232, 909, 2319, 312, 12308)

Letsitele

LIMPOPO PROVINCE

Hoedspruit

Nelspruit (0, 12, 32, 2, 4) (3064, 414, 2169, 593, 4067)

Senwes Tvl

Onderberg

NORTH WEST

GAUTENG

SWAZILAND (870, 113, 51, 39, 1025)

MPUMALANGA

NAMIBIA

Pongola (1828, 350, 657, 63, 987)

Vaalharts (93, 57, 310, 31, 215)

FREE STATE

KWAZULU-NATAL

Nkwalini

LESOTHO

KZN Midlands

NORTHERN CAPE

EASTERN CAPE (194, 1856, 4826, 1523, 3363)

Eastern Cape Midlands

Sundays River Valley

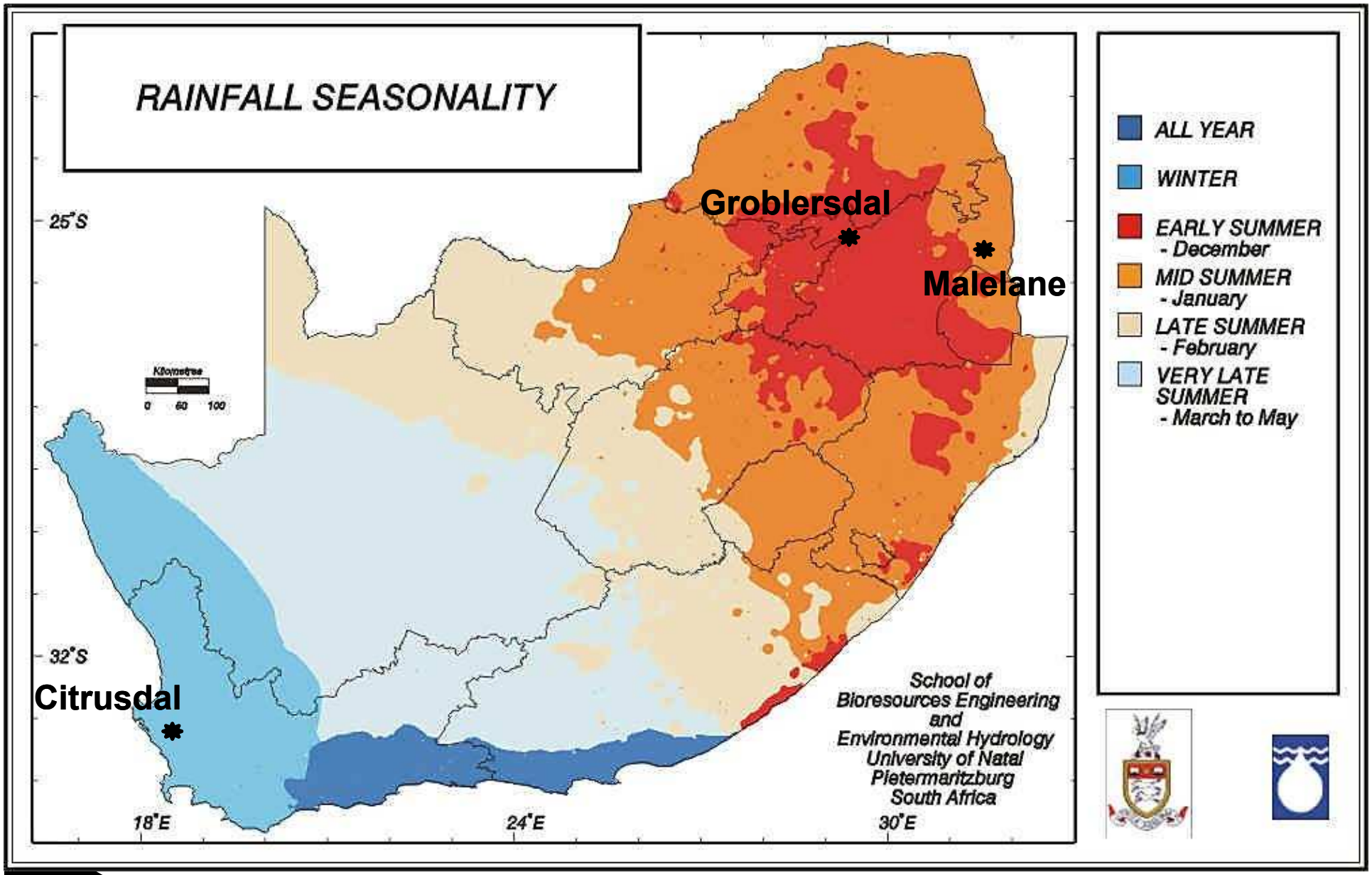
Western Cape

Patensie

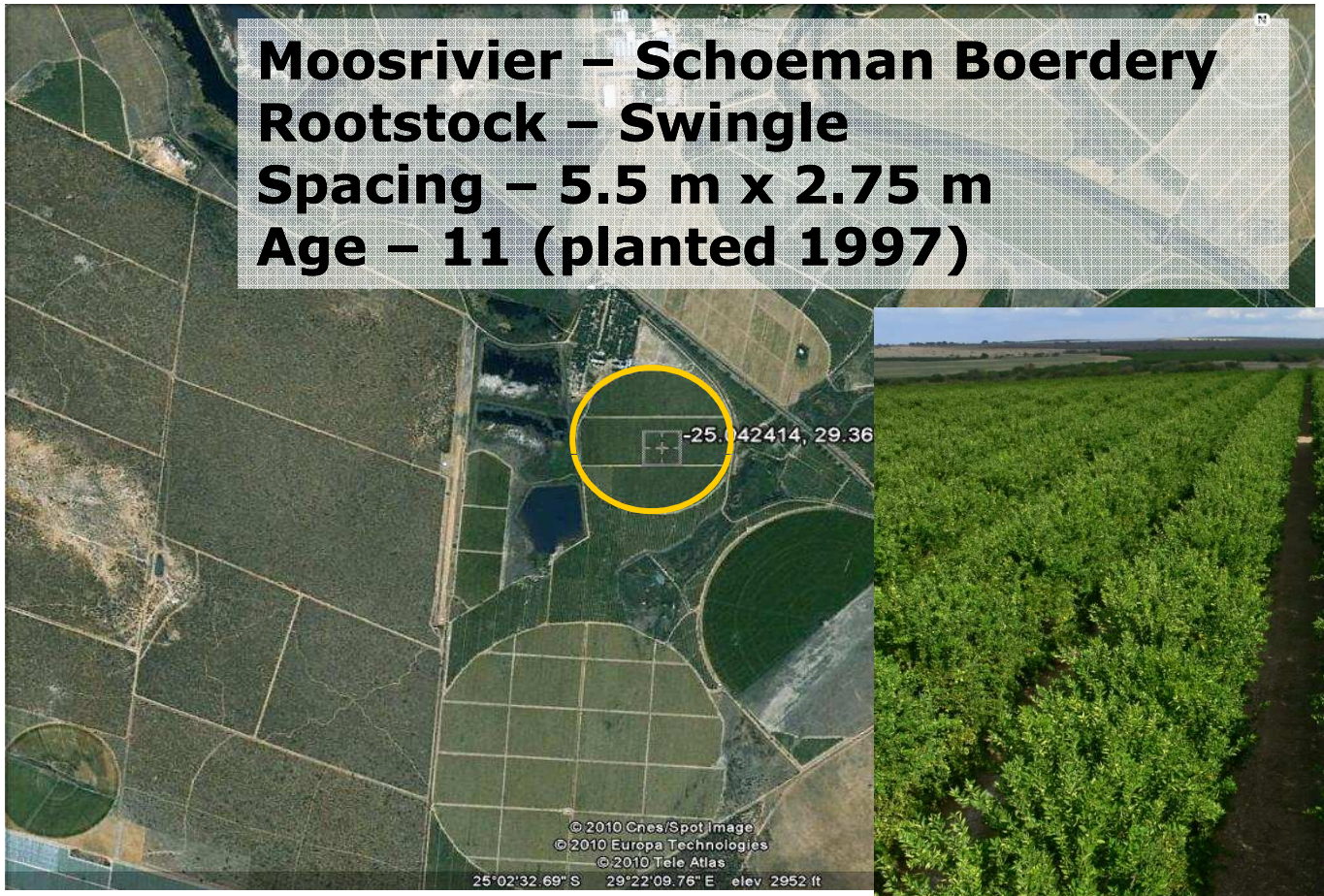
Boland (24, 715, 4134, 2470, 3487)

WESTERN CAPE

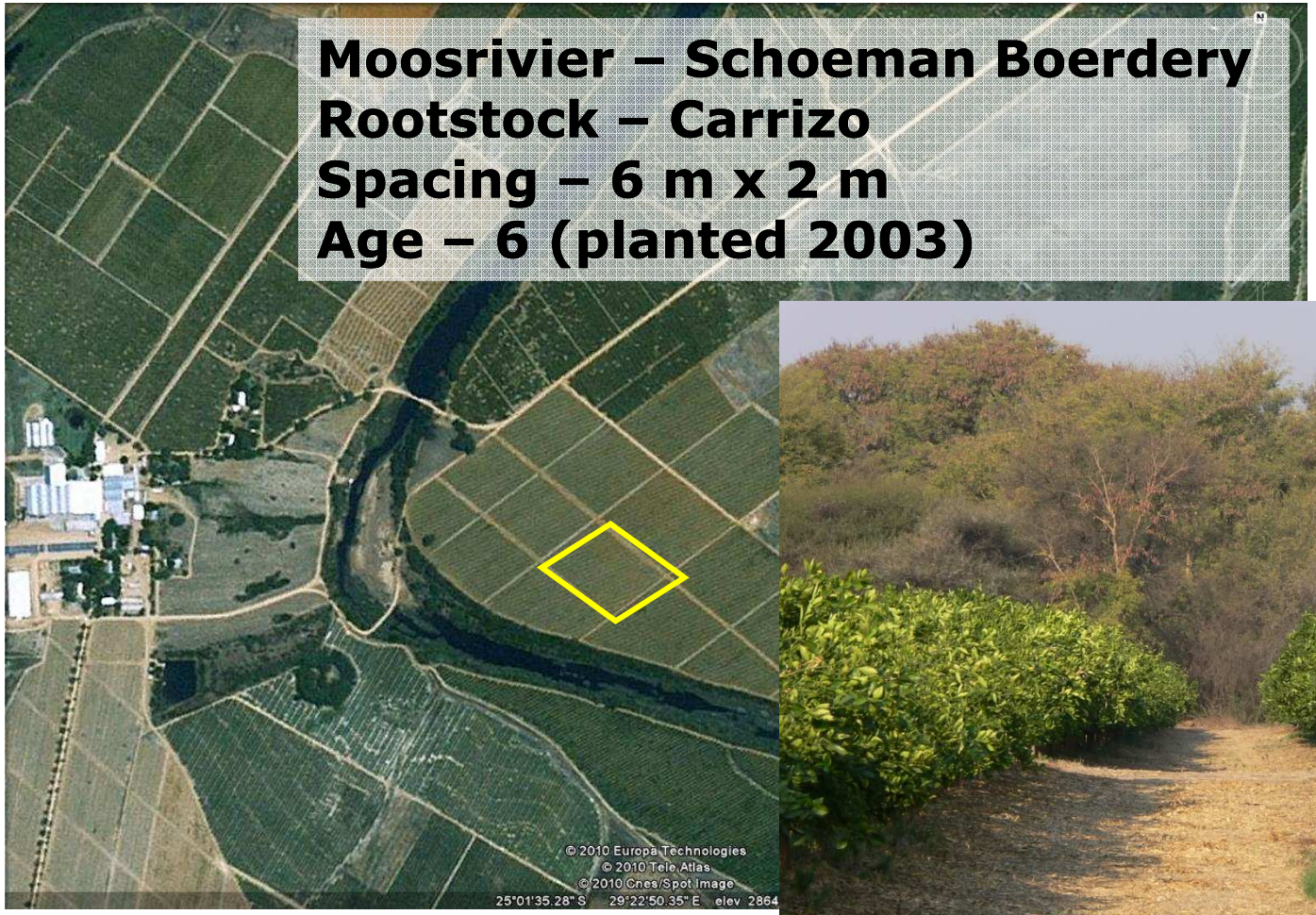
KEY to ha	T
Grapefruit	
Lemon	
Navel	1
Soft Citrus	
Valencia	2
	5

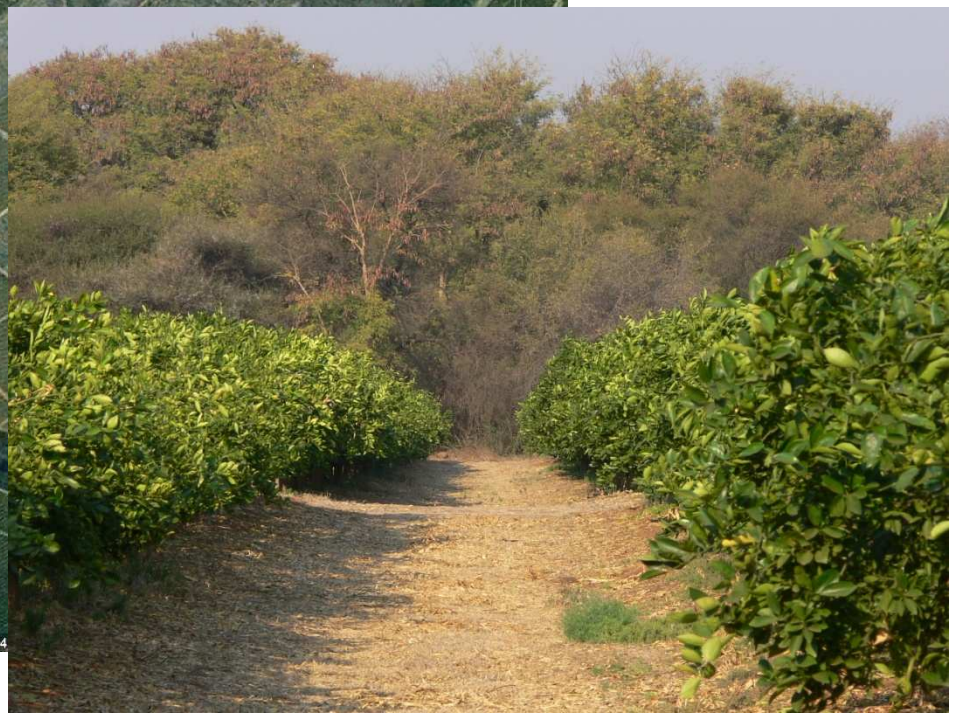

RAINFALL SEASONALITY
Groblersdal
Malelane
Citrusdal
25°S
32°S
18°E
24°E
30°E
Kilometres
0 50 100
ALL YEAR
WINTER
EARLY SUMMER
- December
MID SUMMER
- January
LATE SUMMER
- February
VERY LATE SUMMER
- March to May
School of
Bioresources Engineering
and
Environmental Hydrology
University of Natal
Pietermaritzburg
South Africa

Groblersdal - 'Delta' Valencias

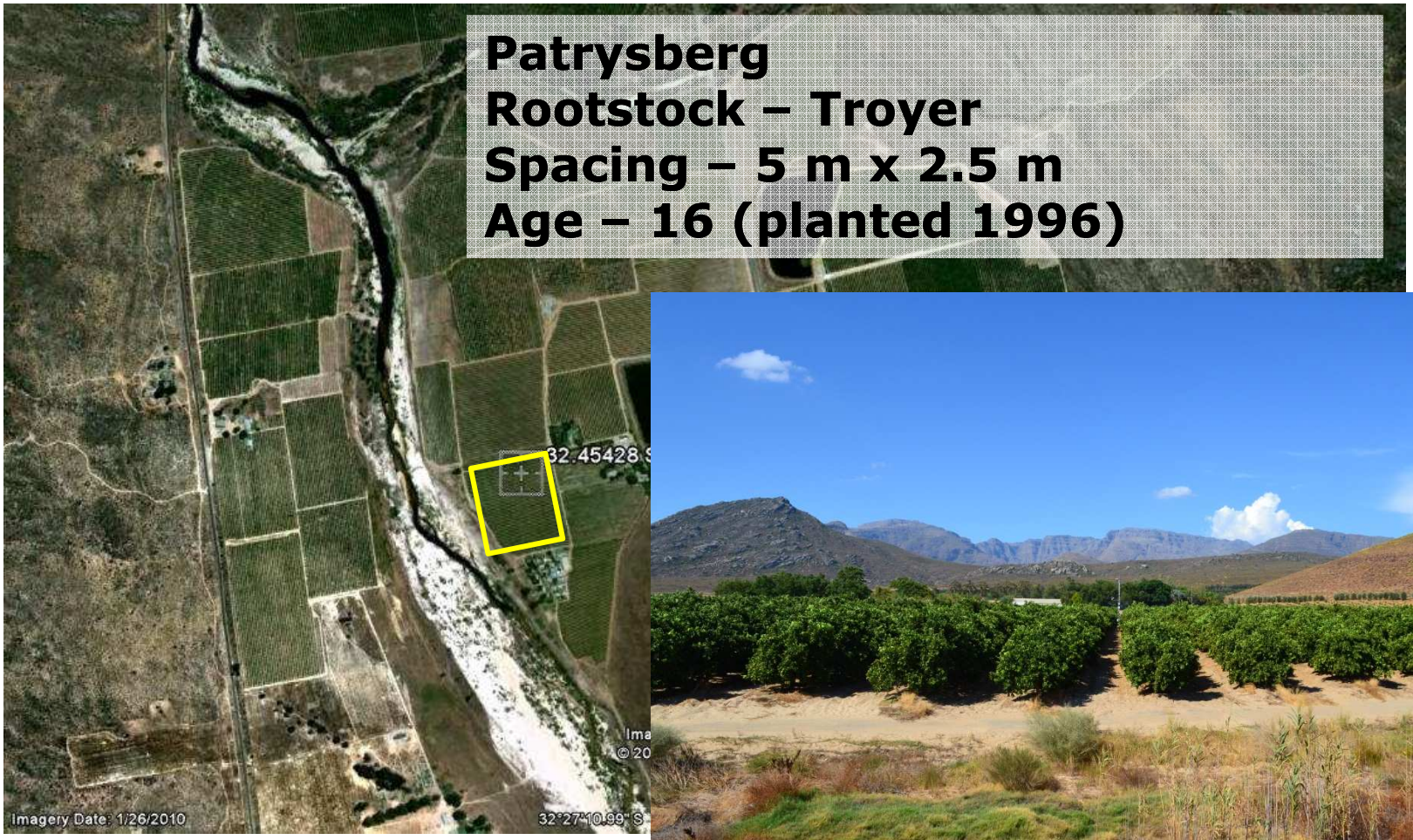


Groblersdal 'Bahianinha' Navels

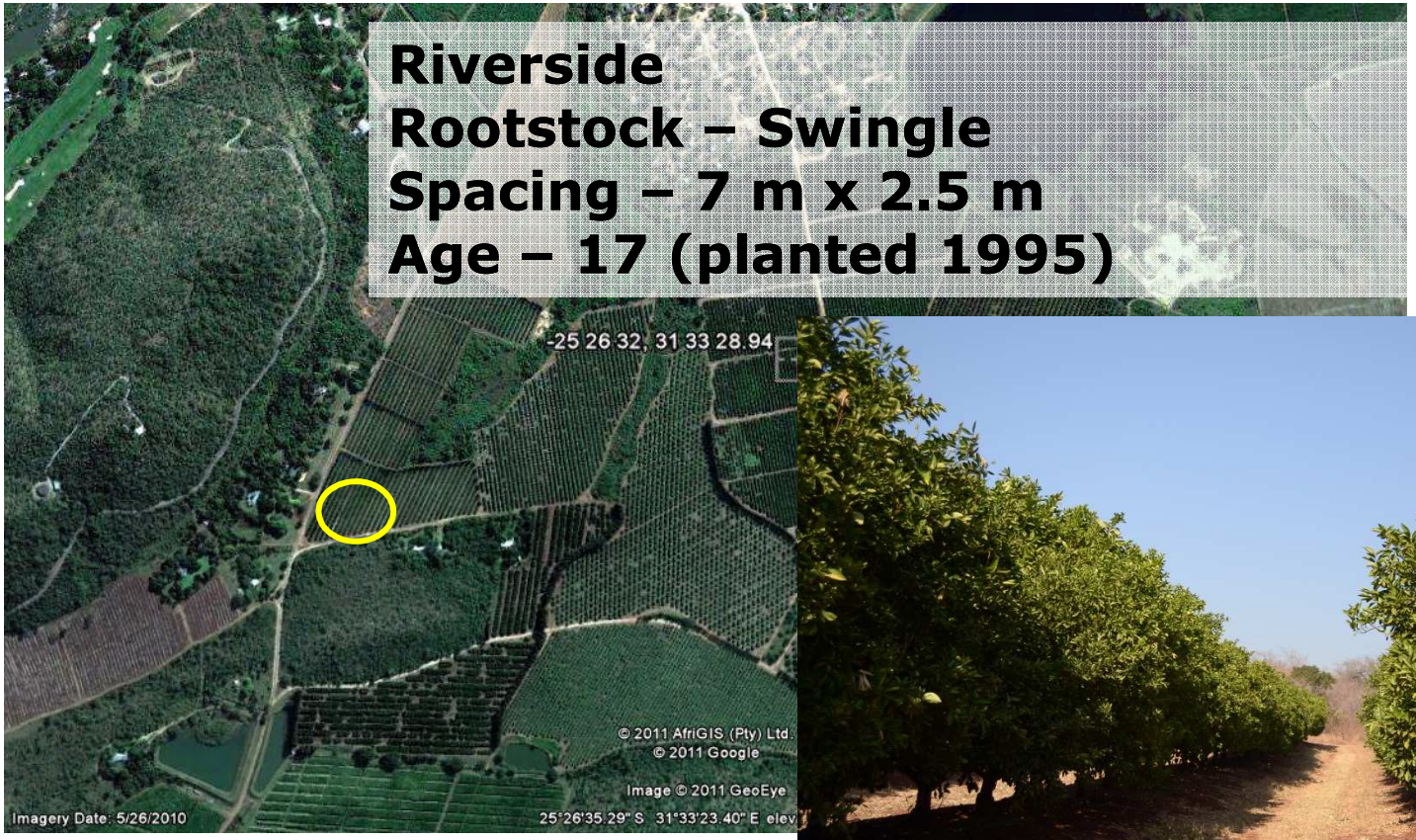




Citrusdal – 'Rustenburg' Navels

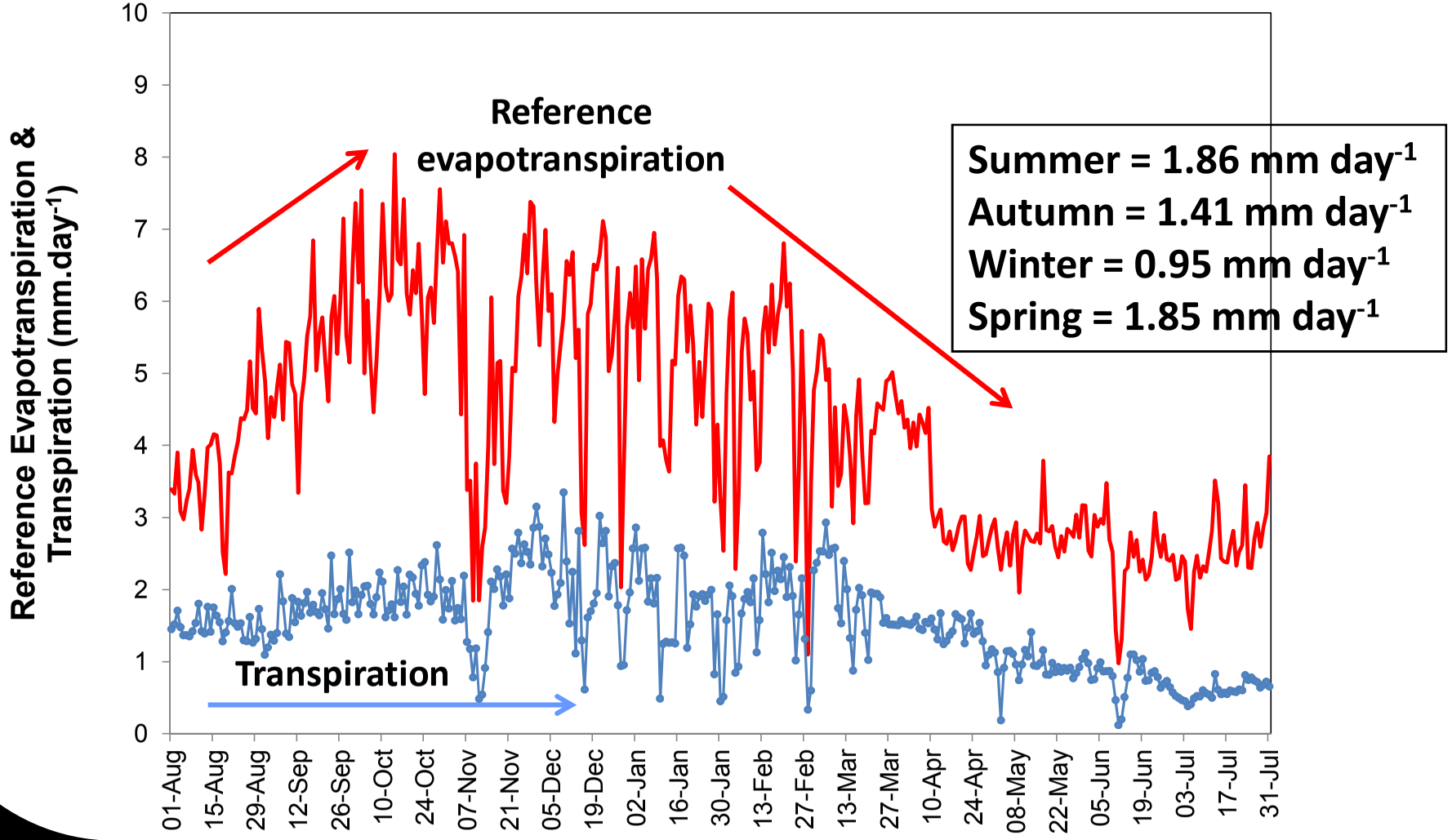


Malelane – 'Midknight' Valencias

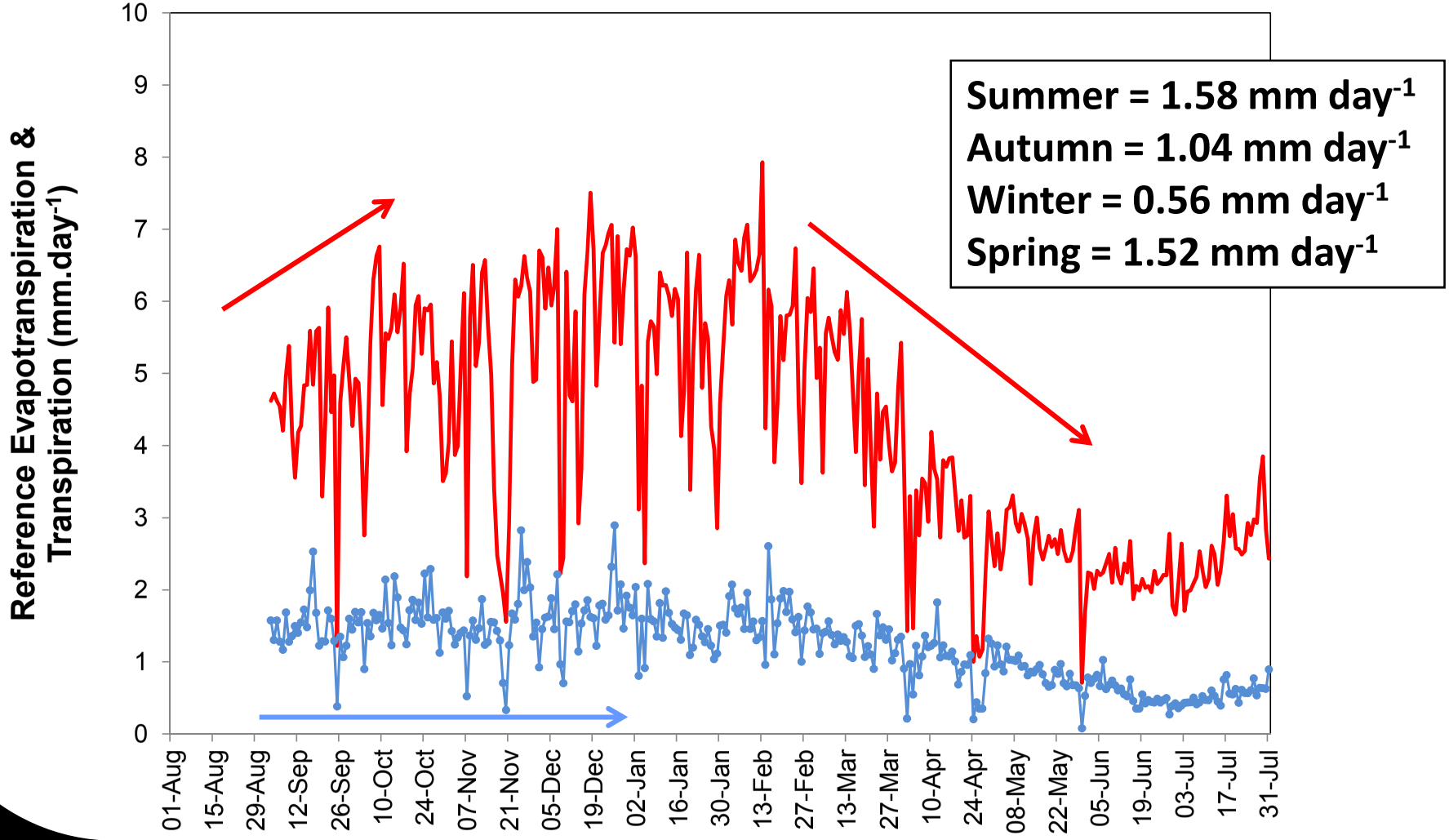


Riverside
Rootstock – Swingle
Spacing – 7 m x 2.5 m
Age – 17 (planted 1995)

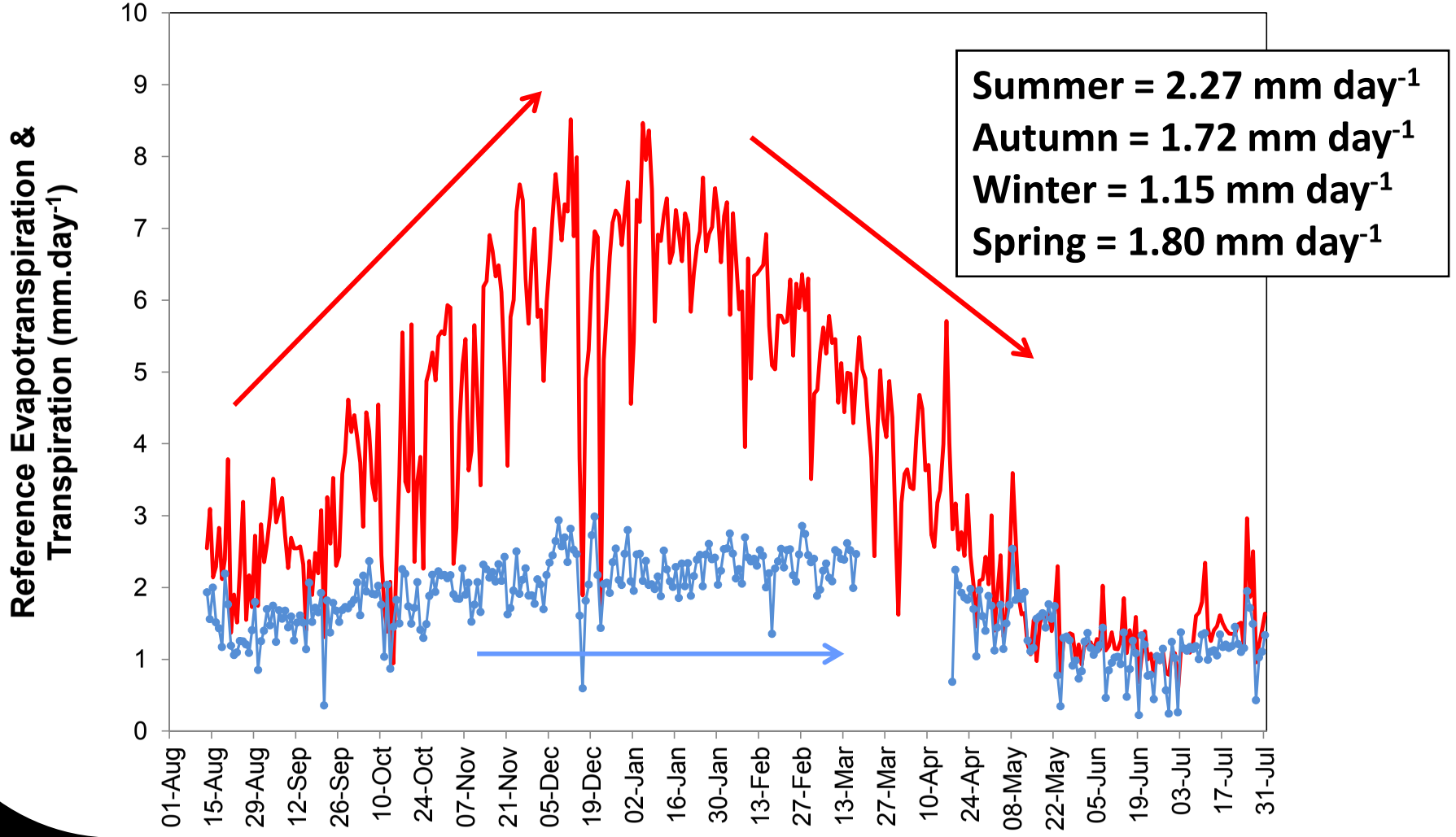
‘Delta’ Valencia - Groblersdal



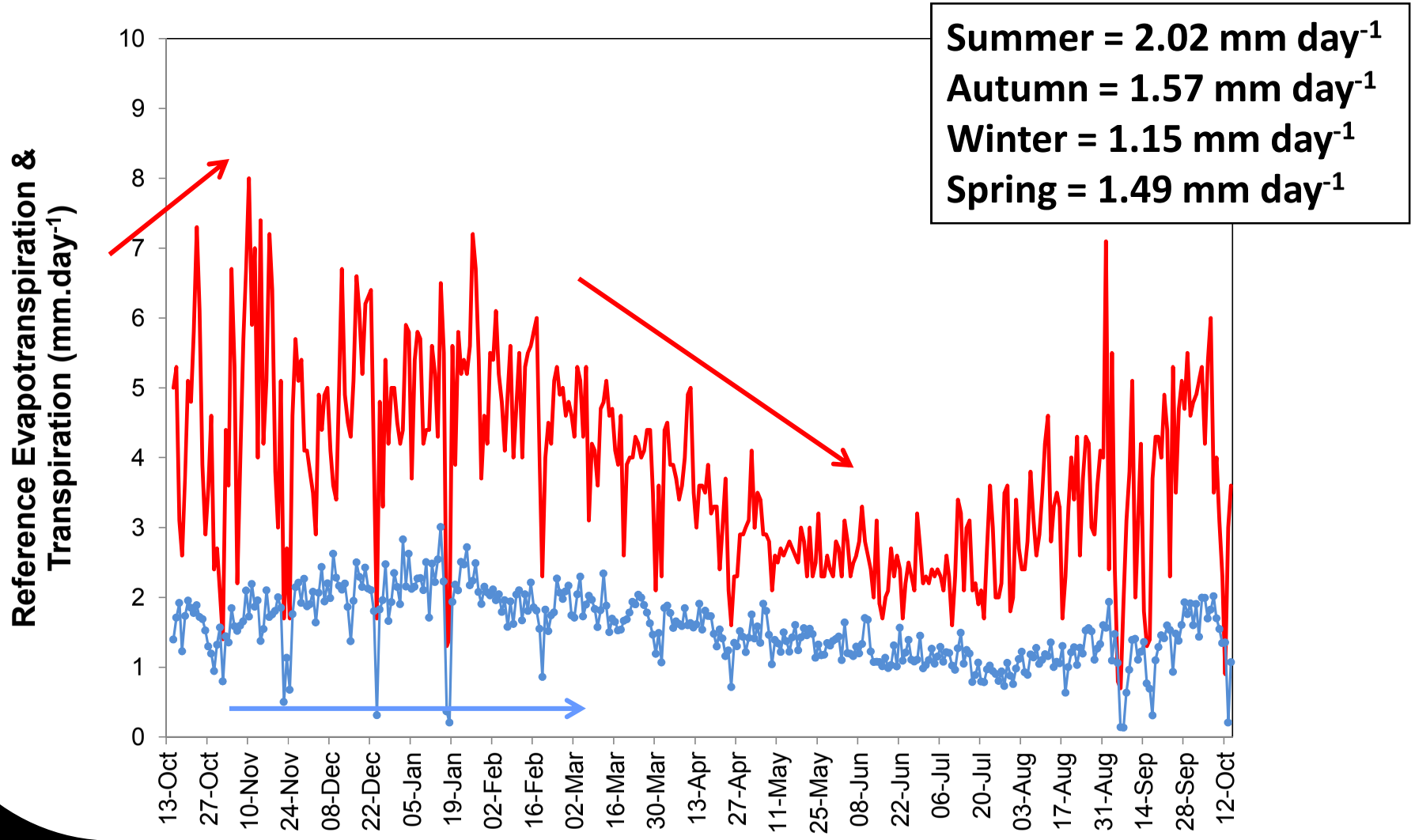
‘Bahianinha’ Navels - Groblersdal



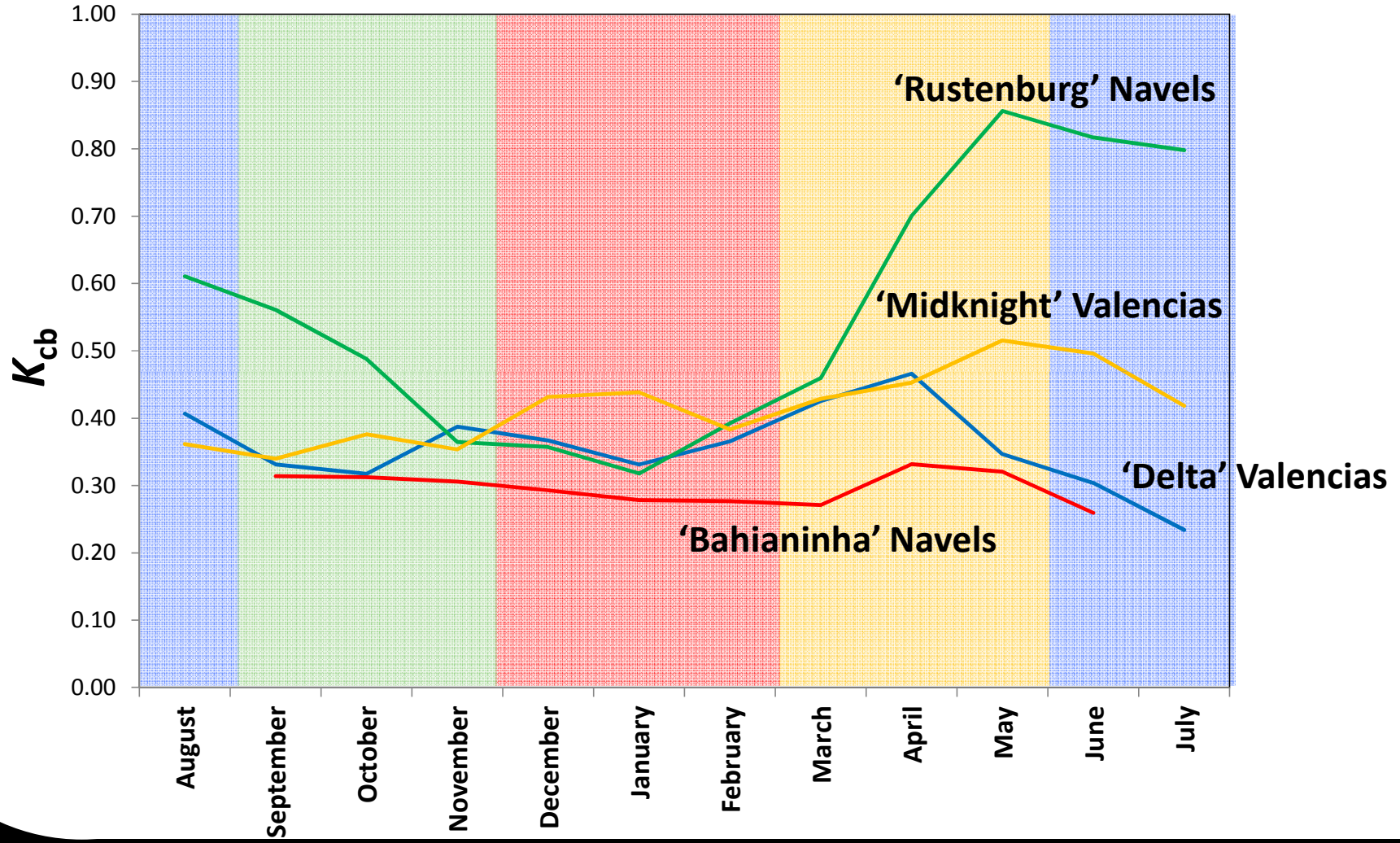
‘Rustenburg’ Navels - Citrusdal

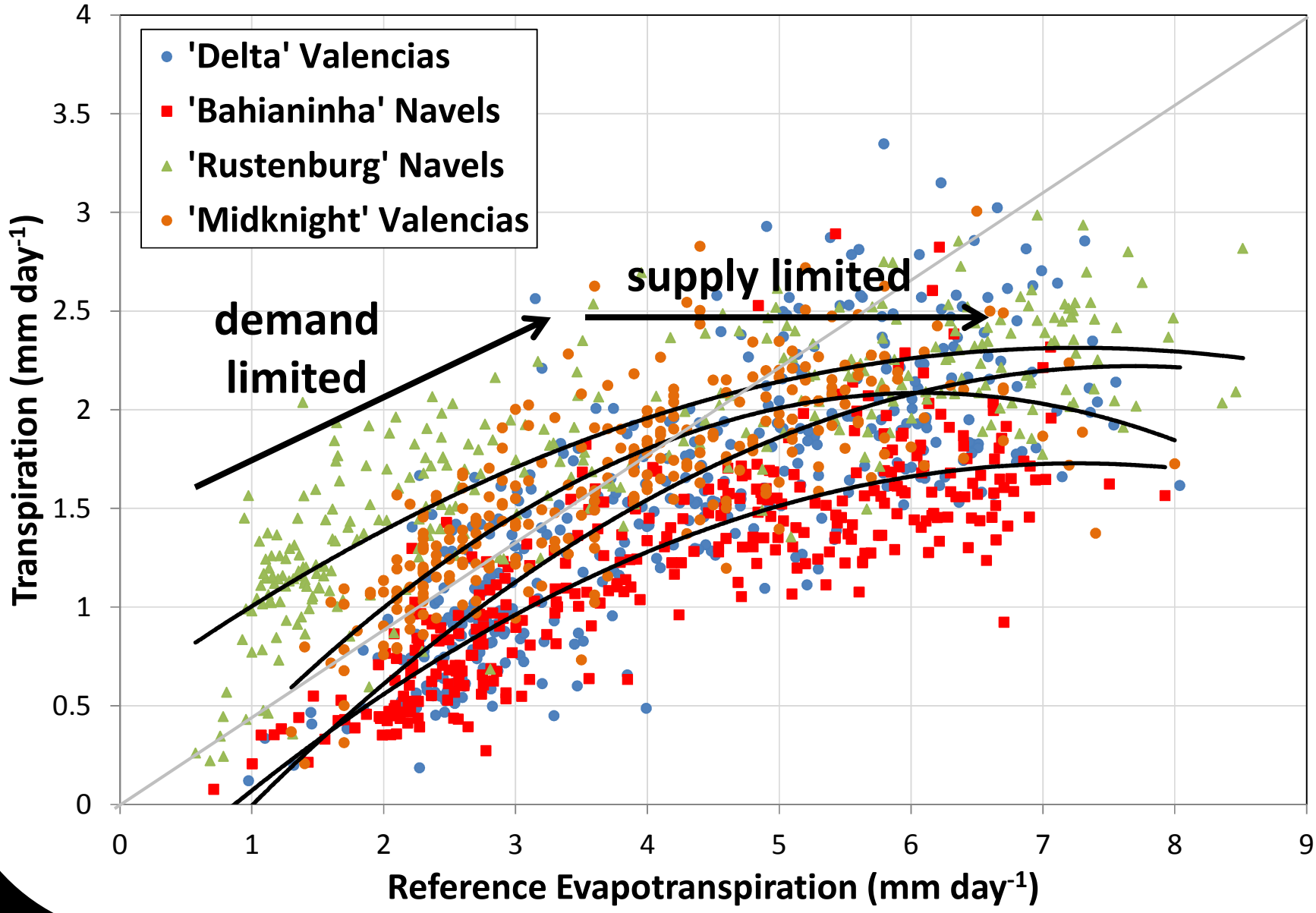


‘Midknight’ Valencias - Malelane

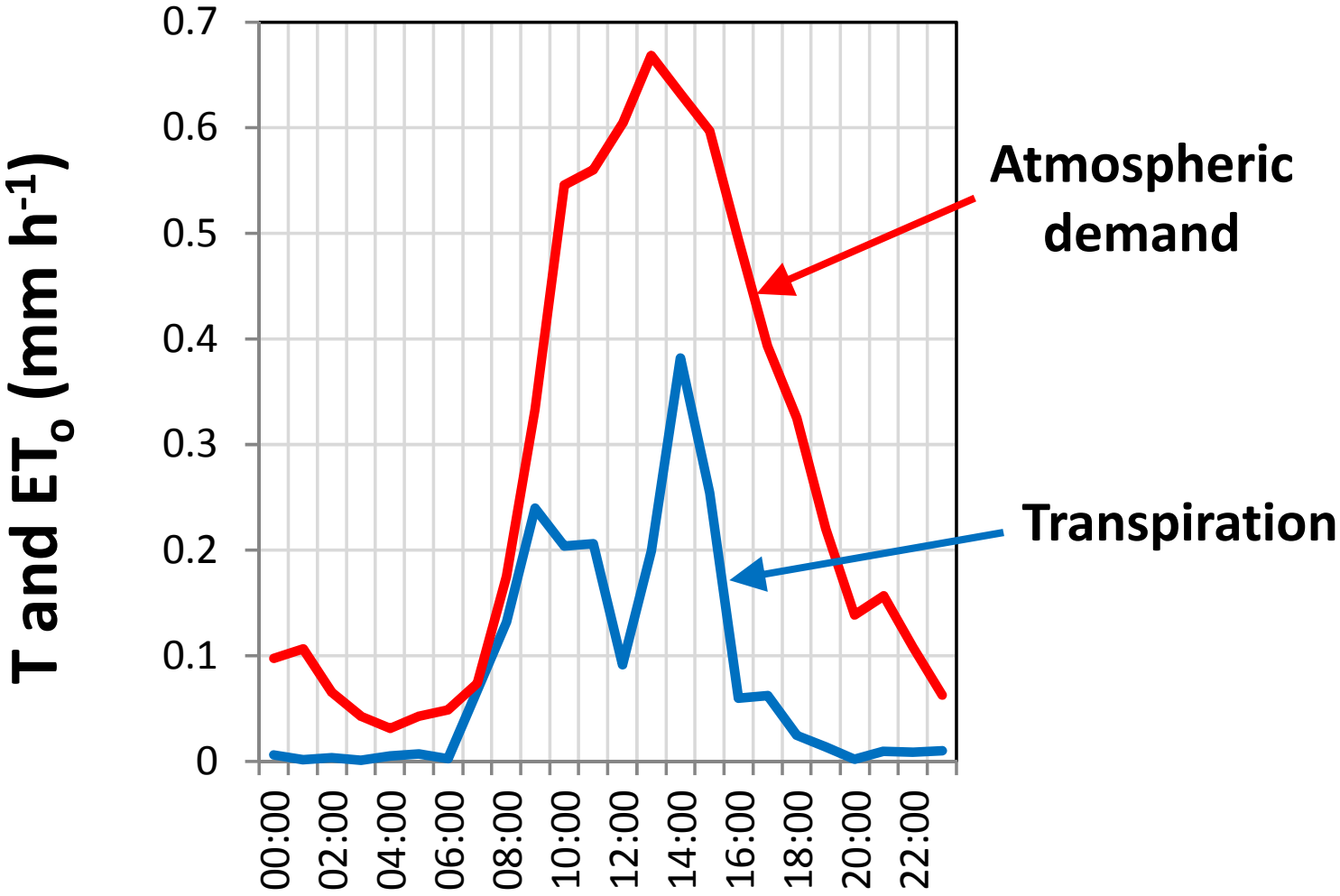


Basal crop coefficients

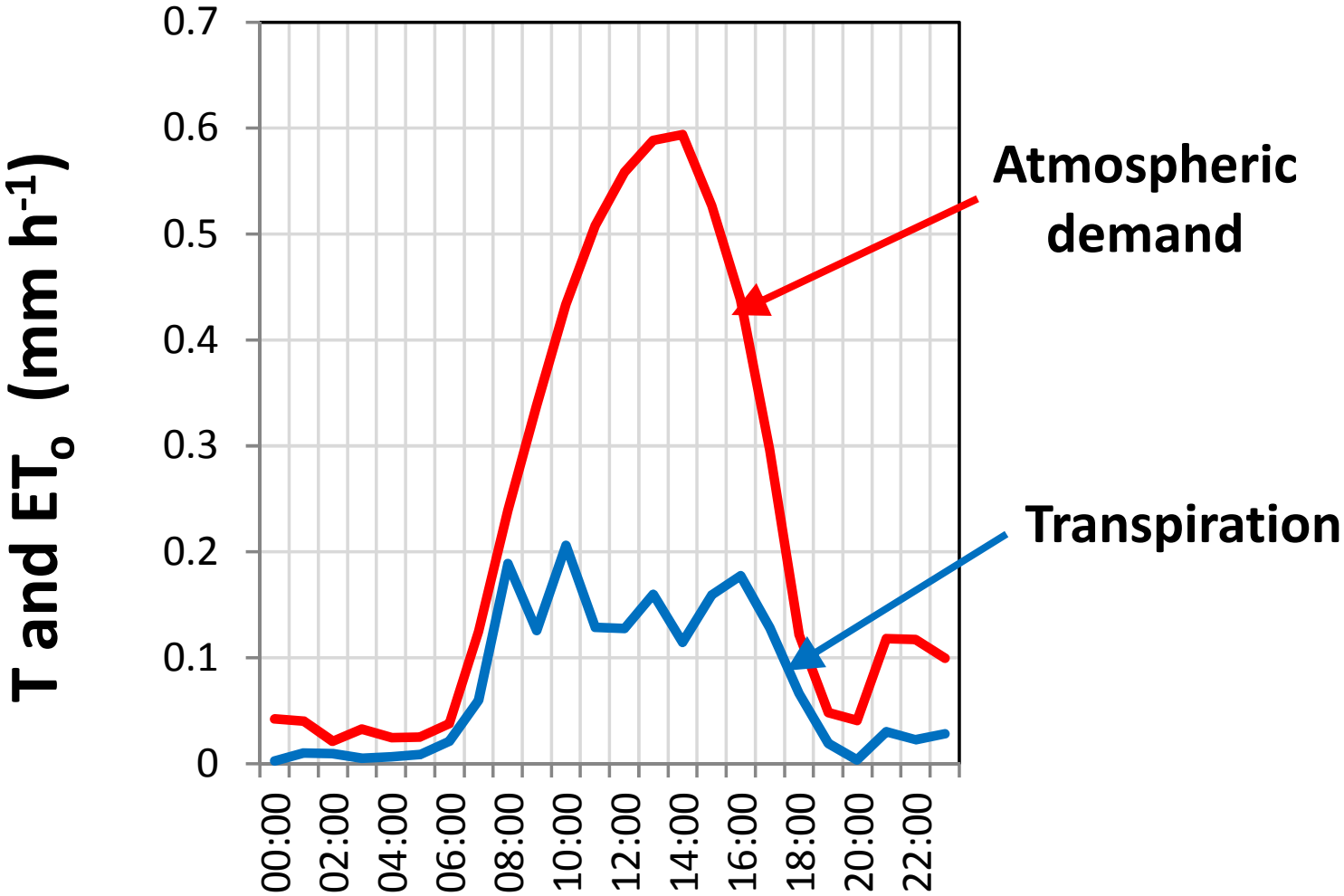



'Delta' Valencias
'Bahianinha' Navels
'Rustenburg' Navels
'Midknight' Valencias
supply limited
demand limited
Transpiration (mm day-1)
Reference Evapotranspiration (mm day-1)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
1
2
3
4
5
6
7
8
9

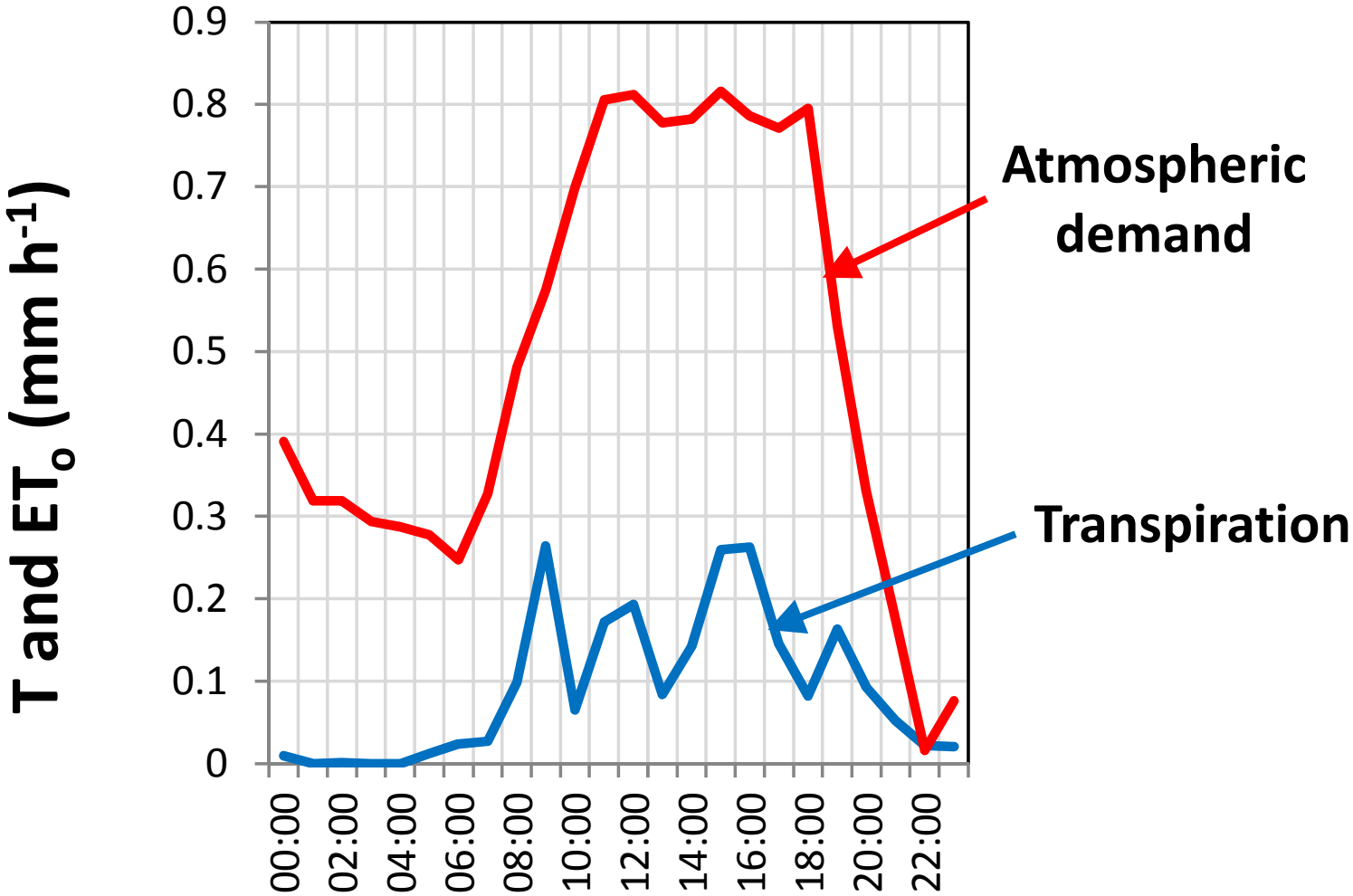
Groblersdal - Valencias

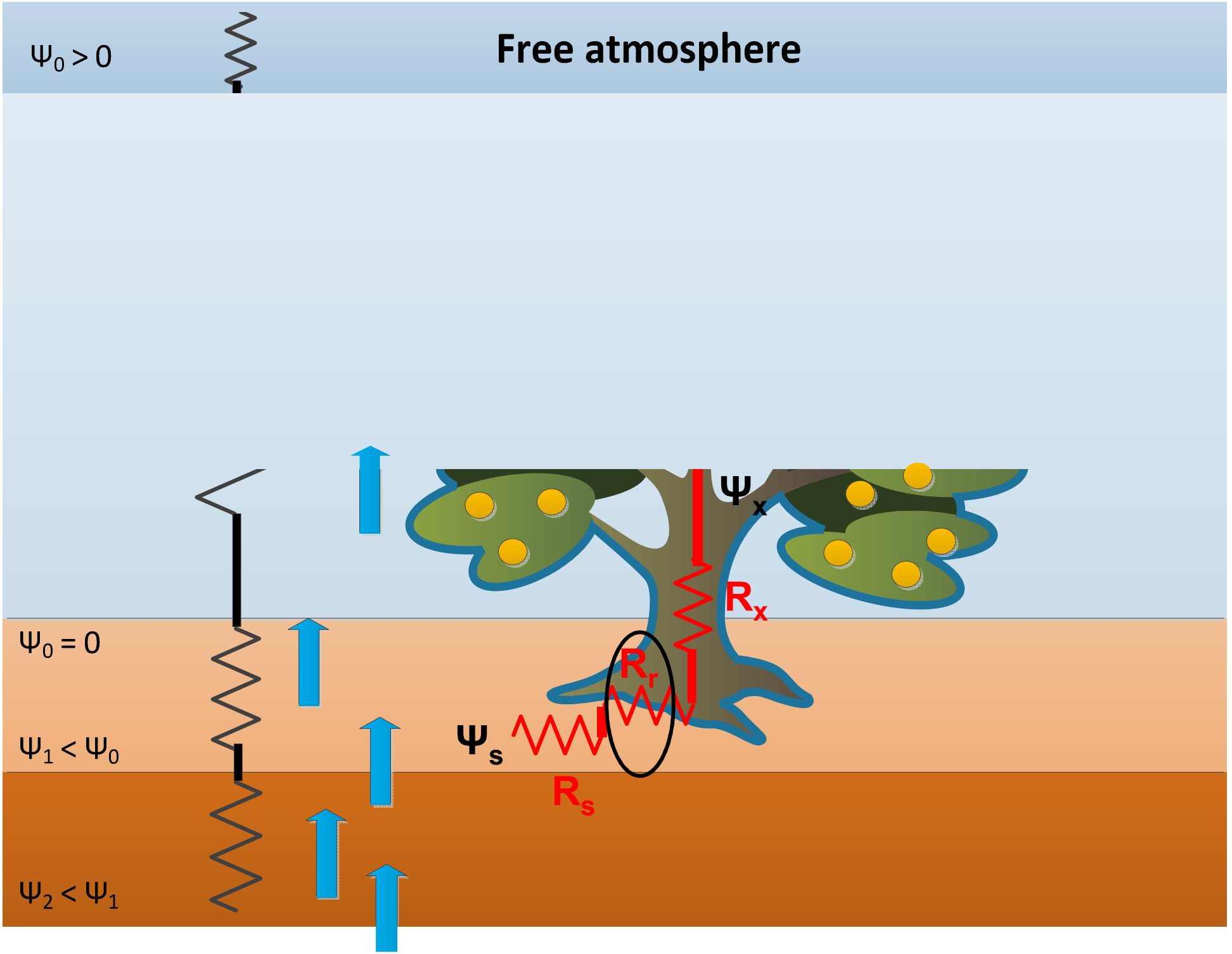


Groblersdal - Navels

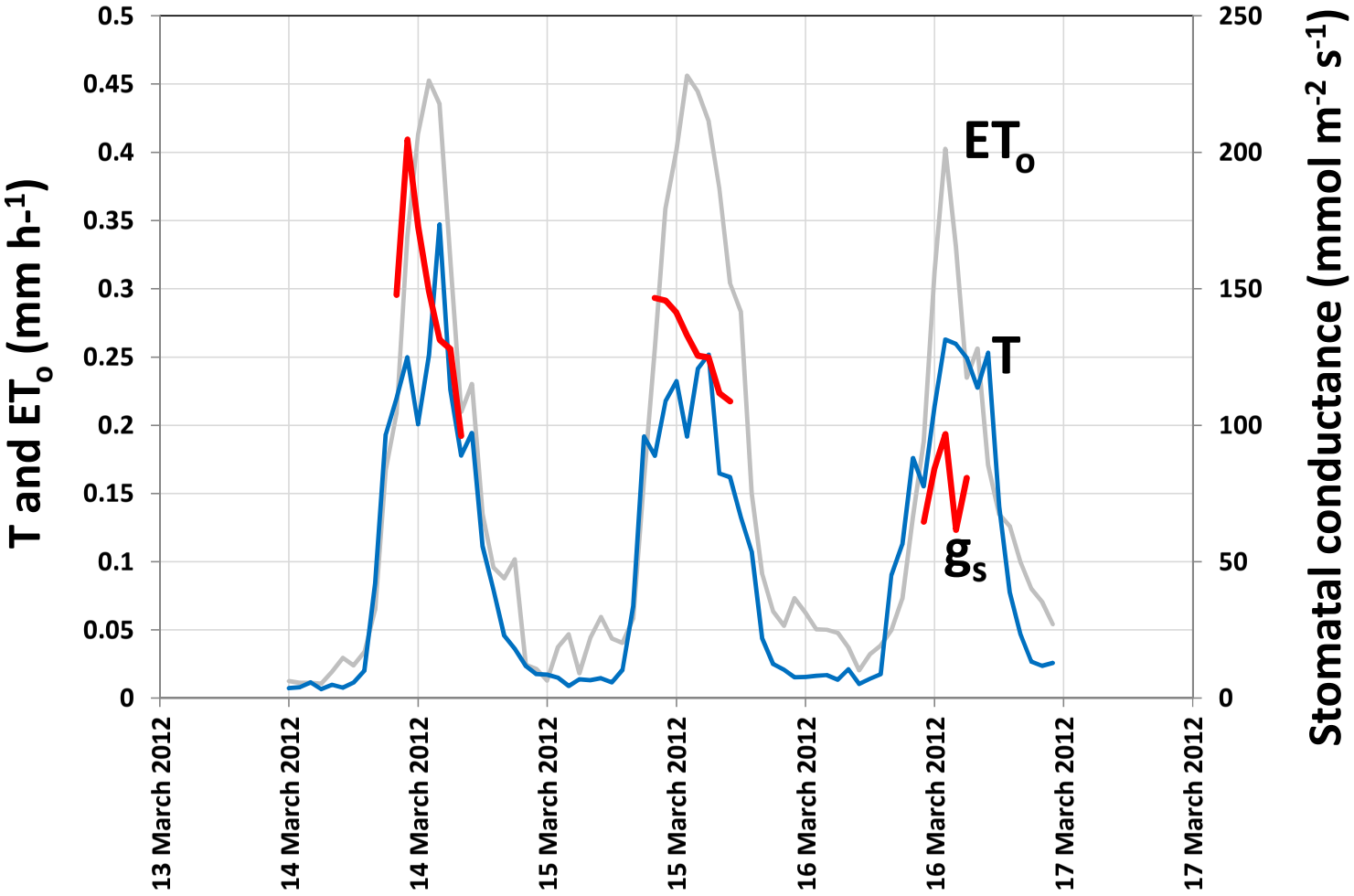


Citrusdal - Navels

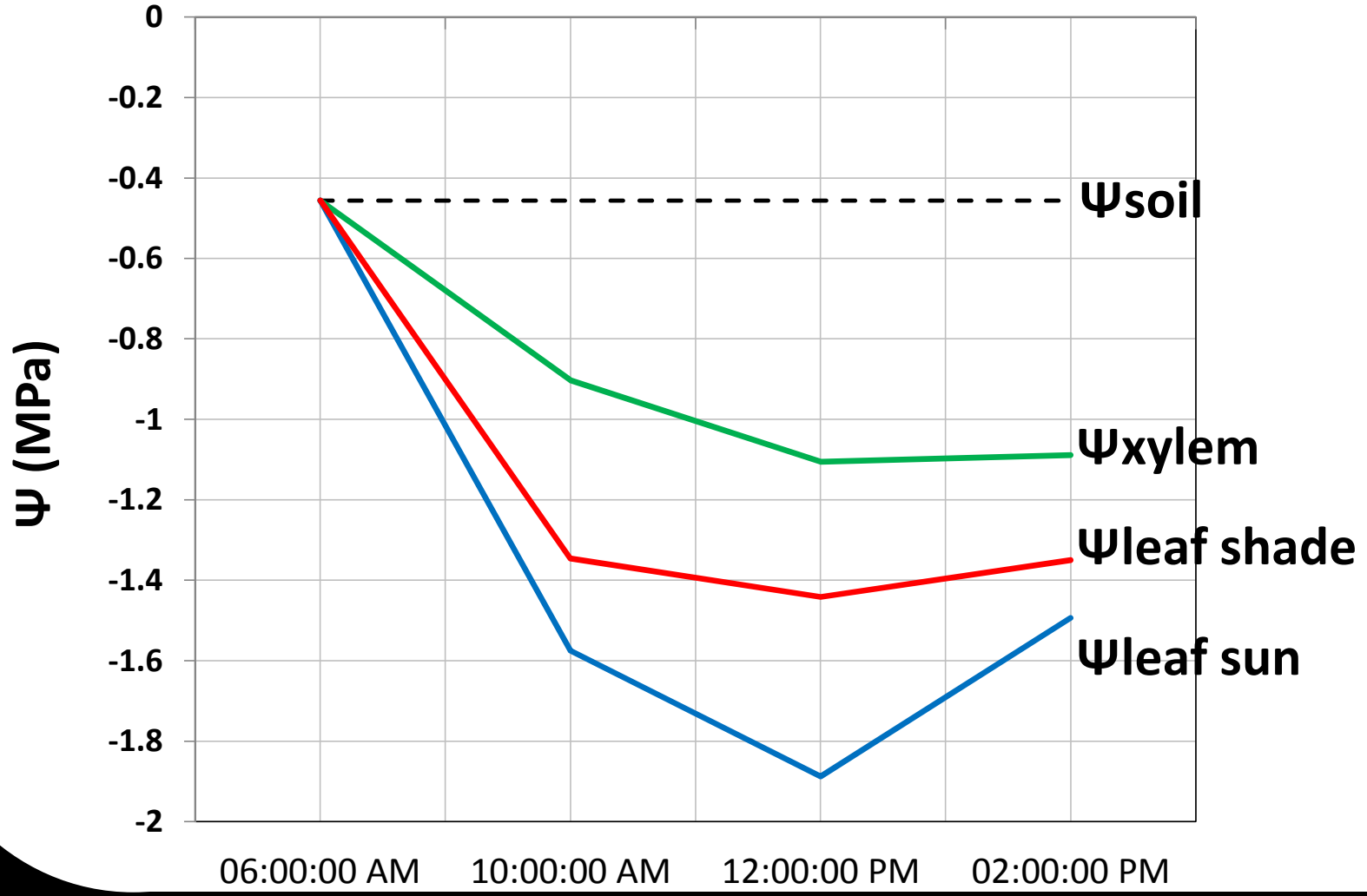



$\Psi_0 > 0$
Free atmosphere
Ψ_x
R_x
$\Psi_0 = 0$
R_r
$\Psi_1 < \Psi_0$
Ψ_s
R_s
$\Psi_2 < \Psi_1$

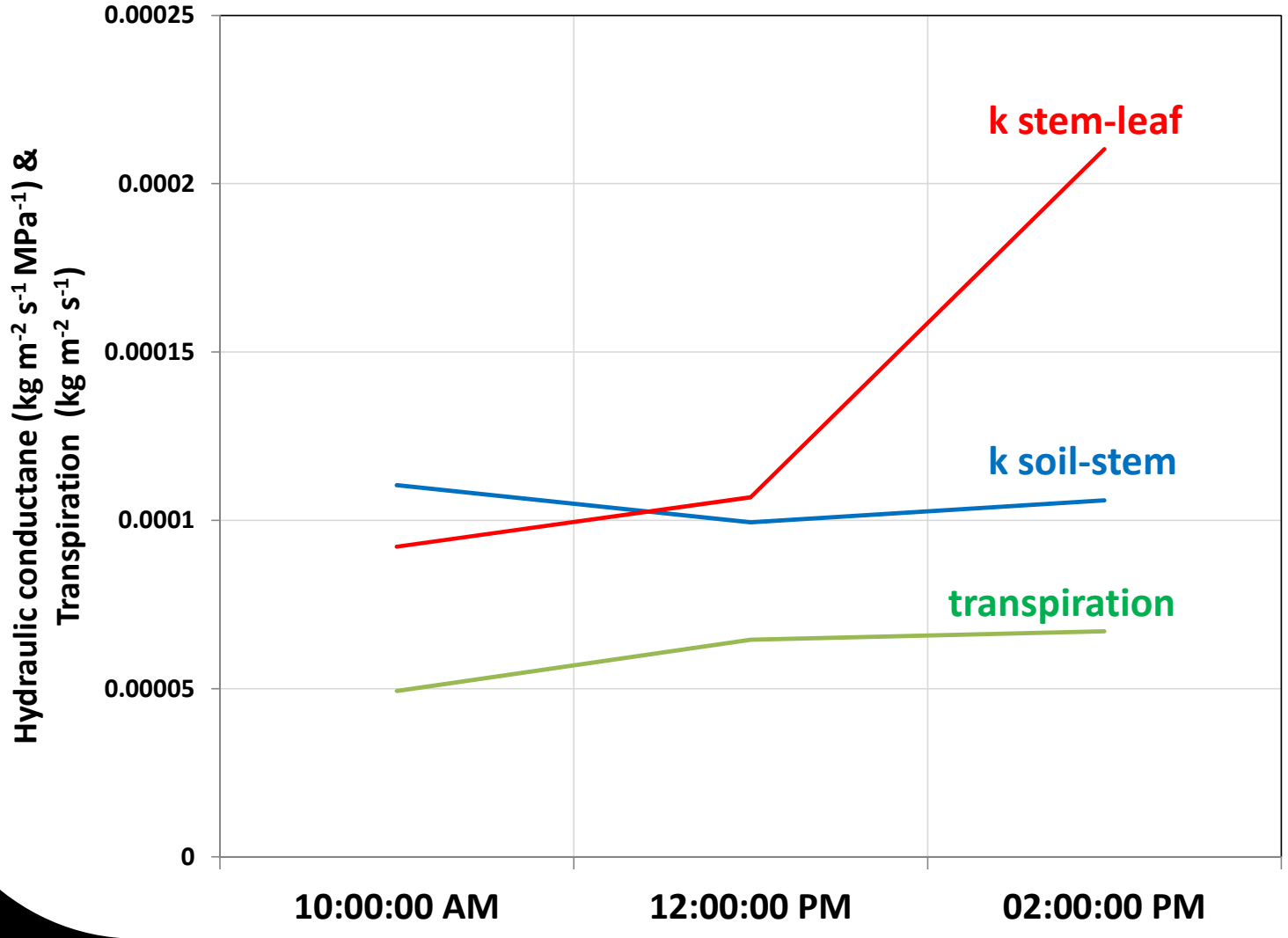
Stomatal conductance



Water potentials

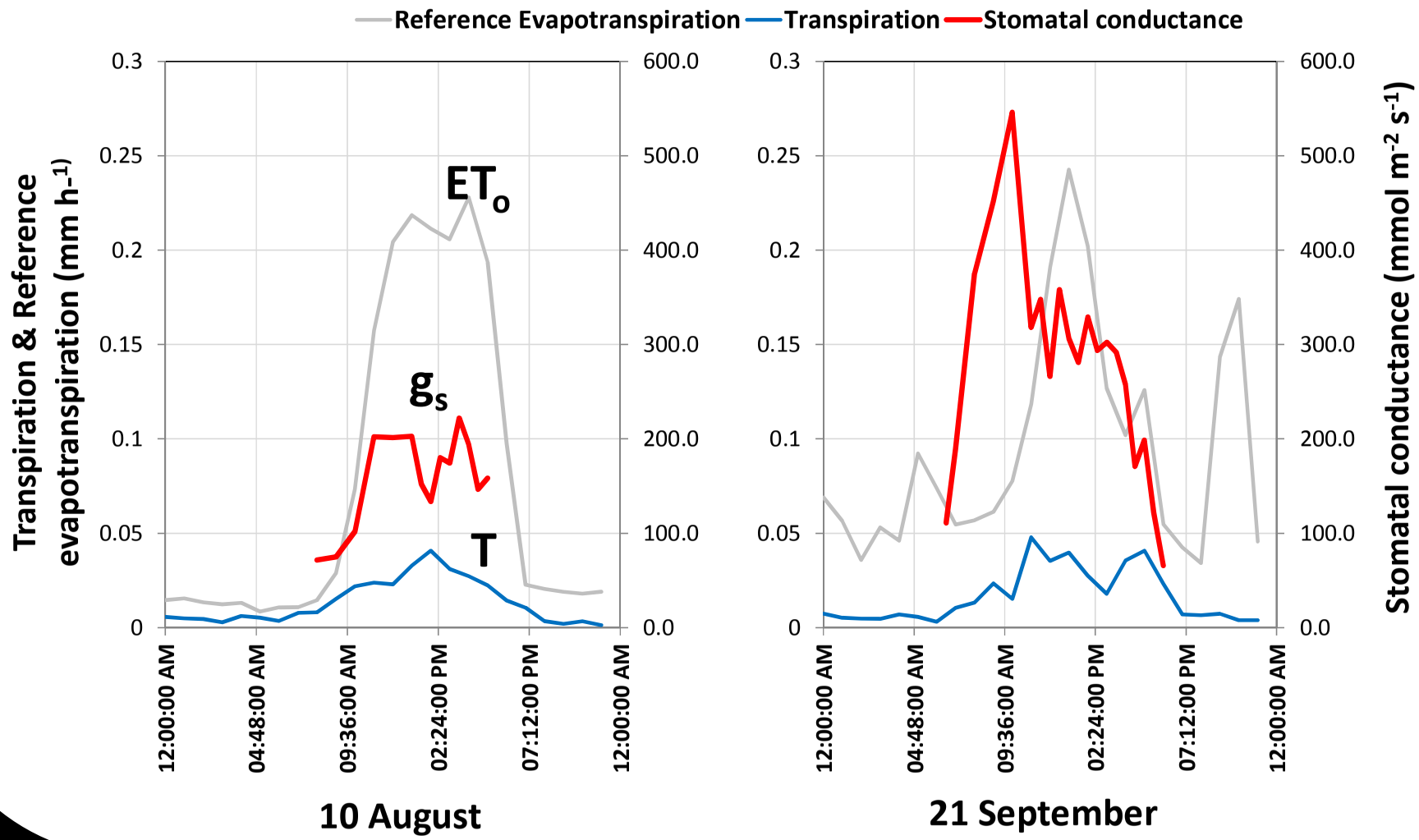


Hydraulic conductances

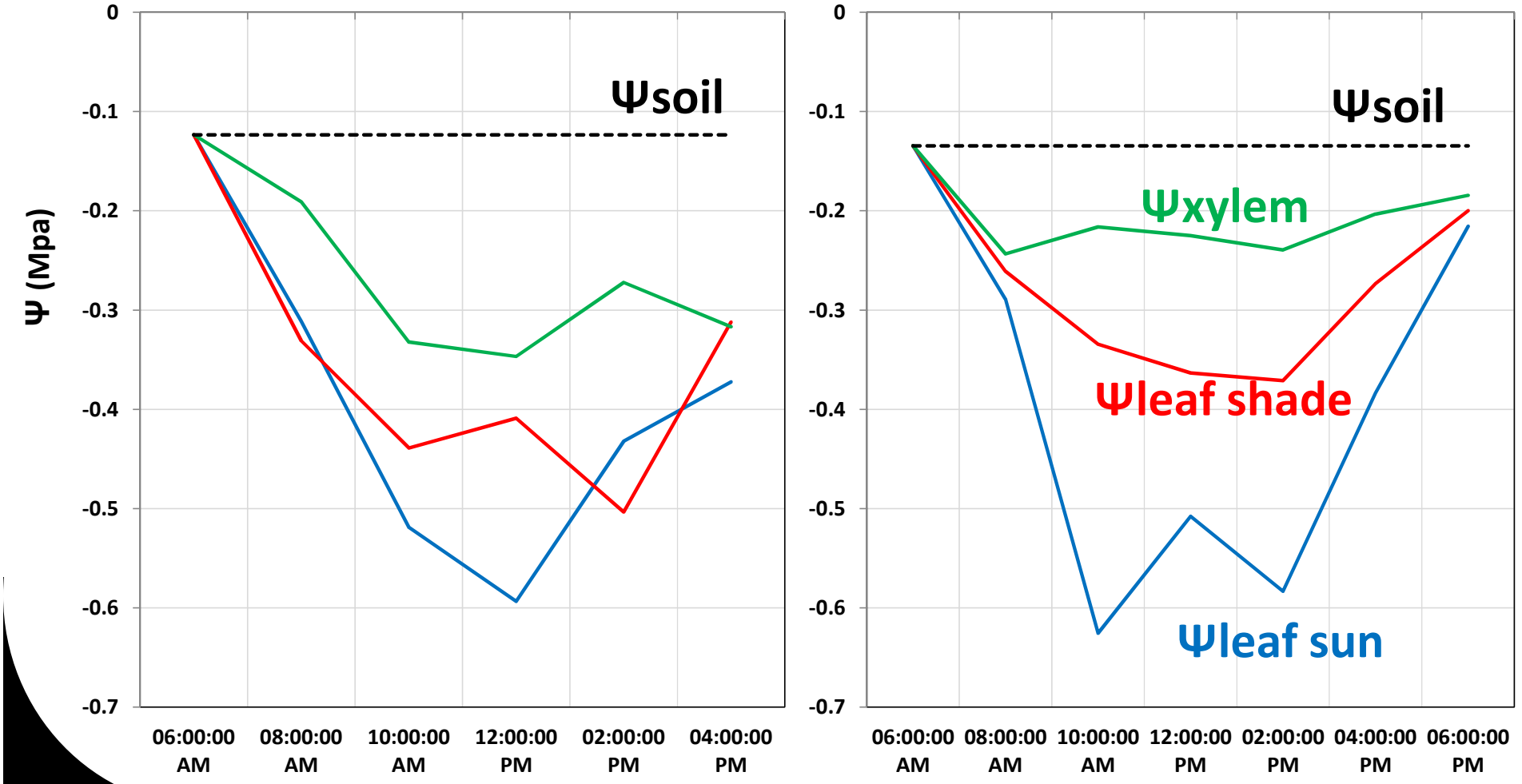


Diurnal plant water relations

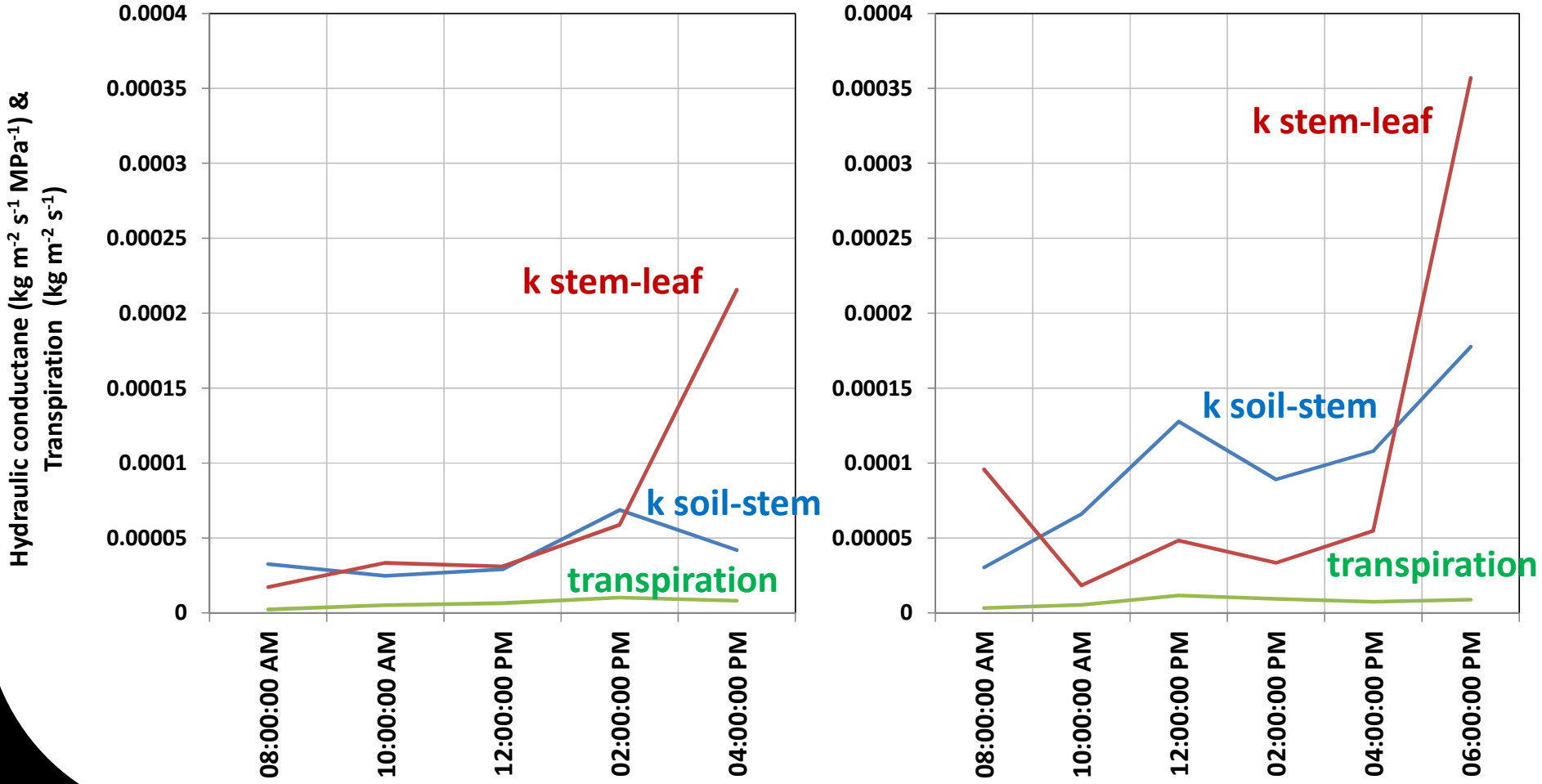
Stomatal conductance



Water potentials



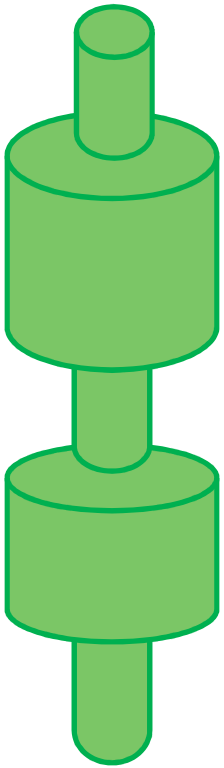
Hydraulic conductance



Implications?

- Goal of irrigation scheduling – differentiate between
  - water stress is the result of high evaporative demands
  - water stress is due to an inability of the soil to supply the required water
- What is the predominant cause of "water stress" in citrus?
- There is a maximum transpiration rate for citrus determined by hydraulic limits within the tree

Implications?



- Applying more water on hot and dry days will not increase transpiration but may have the opposite effect by:
  - Reducing soil temperature
  - Increasing root resistance (reduced oxygen in the soil)
- But where does this resistance lie and why is this important?
- Rootstock choice

Acknowledgements

- Water Research Commission
- Department of Agriculture, Forestry and Fisheries
- Walter Mahohoma, Hestia Pienaar, Gert Loubser
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