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AquaCrop the FAO crop-model to simulate yield response to water

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Literature

© FAO, 2011. AquaCrop Reference Manual. Chapters 1-2-3.
http://www.fao.org/nr/water/aquacrop.html

http://www.fao.org/land-water/databases-and-software/aquacrop/en/

AquaCrop

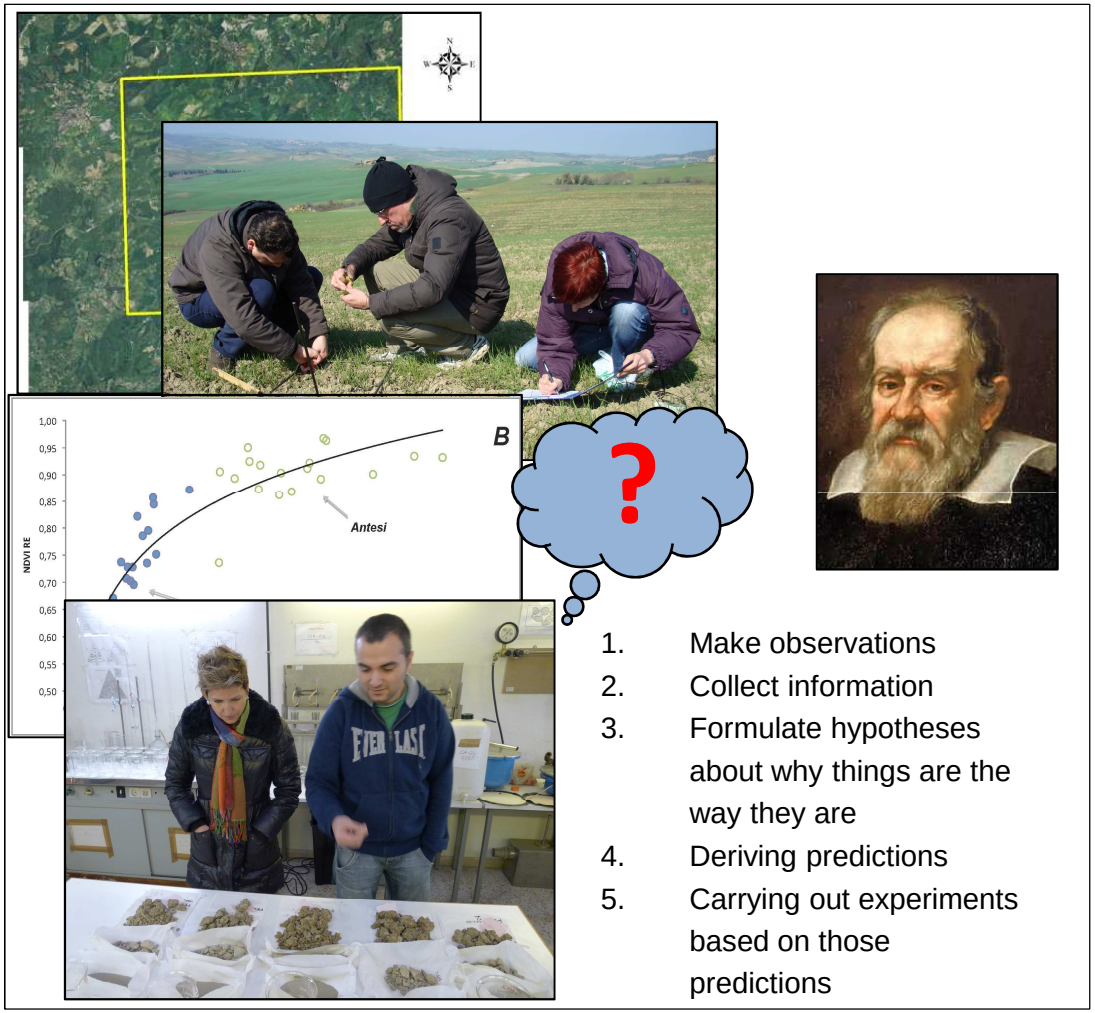
AquaCrop is a crop water productivity model developed by the Land and Water Division of FAO

It simulates **yield response to water** (relation between crop yield and water stress) of herbaceous crops, and is particularly suited to address conditions where water is a key limiting factor in crop production.

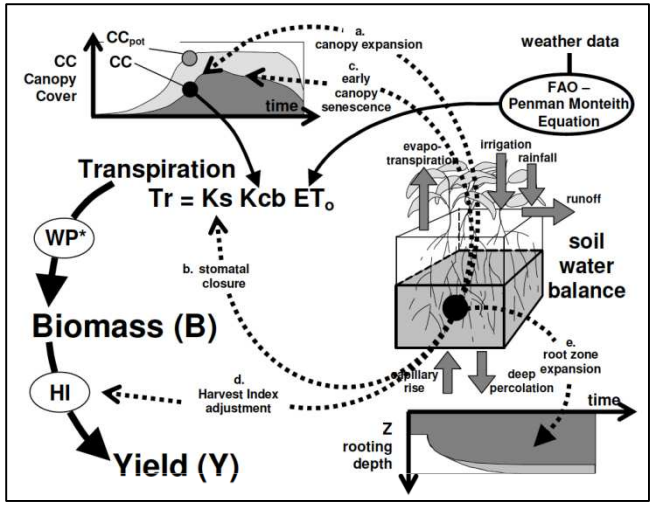
AquaCrop is essentially a crop water balance model

It attempts to balance accuracy, simplicity, and robustness:

- Relatively small number of explicit parameters and input
- Plant physiological processes
- Soil water budgeting processes



1. Make observations
2. Collect information
3. Formulate hypotheses about why things are the way they are
4. Deriving predictions
5. Carrying out experiments based on those predictions



1. Need of quick information (near real time) about what is happening in a given situation or what will change in the system as a result of perturbative events (scenario analysis)

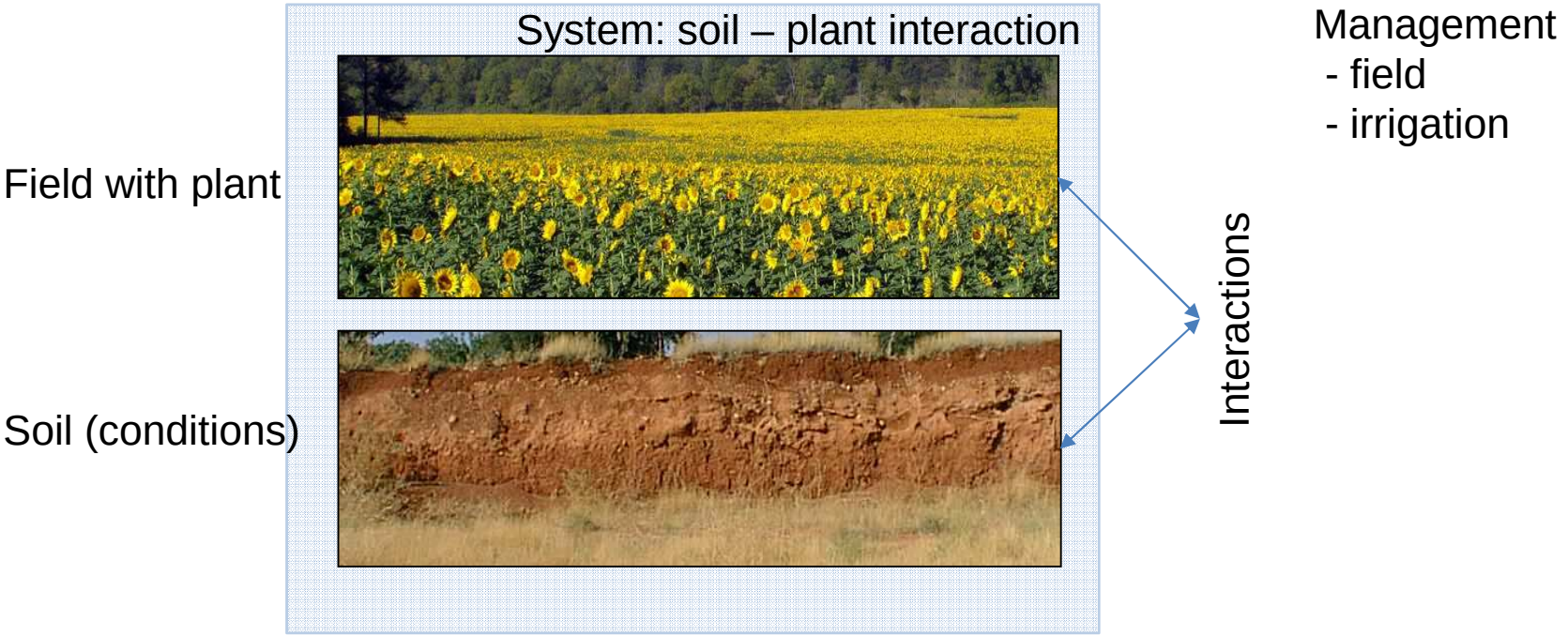
2. Limited resources for direct observations (especially on regional scale assessments)

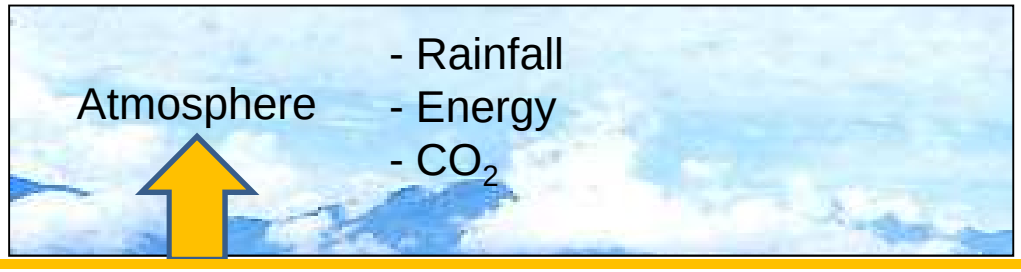
Field experiments or simulation

We are interested in the field in which the plant is cultivated

Plant production is strongly determined by soil conditions: INTERACTIONS

AquaCrop looks at the interactions between crop and the soil





System: soil – plant interaction

Field with plant

Soil (conditions)

Interactions

Management
- field
- irrigation

Water table

Capillary rise

Deep percolation

Climate

Weather data collected at field or from agro-metrological stations

- Minimum and Maximum air temperature
- ETo
- Rainfall
- CO_2 concentrations

ETo calculator

Mauna Loa Observatory (Hawaii)

Crop

Calibrated and validated crop characteristics from data bank

Adjust cultivar specific and less conservative parameters

Soil

Soil physical characteristics

- Field observations
- Default values in data bank
- Pedo transfer functions

soil texture class

Water table

Management

Field

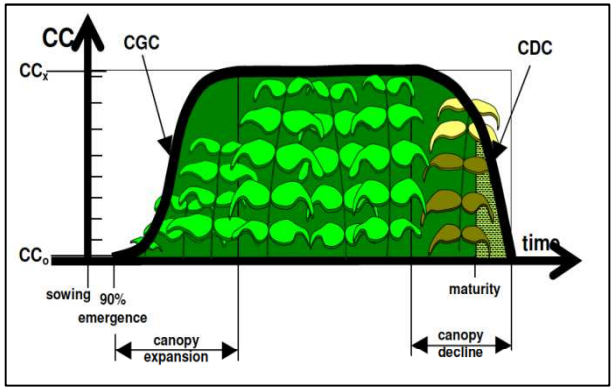
Irrigation

INPUT

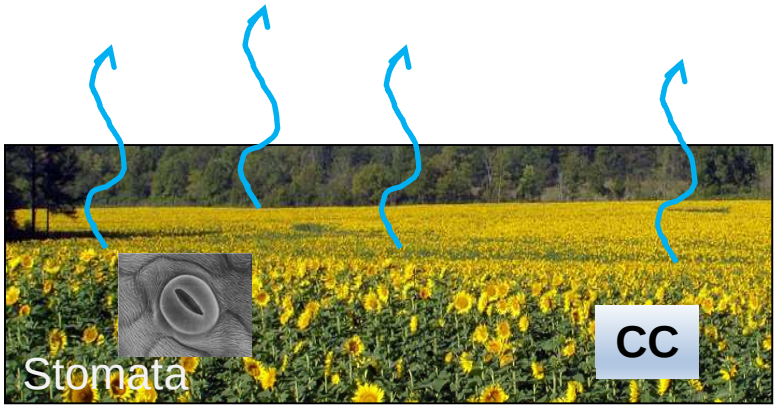
OUTPUT

Biomass
Yield
WP_{ET} → $\frac{\text{Yield (kg)}}{\text{ET } (m^3)}$

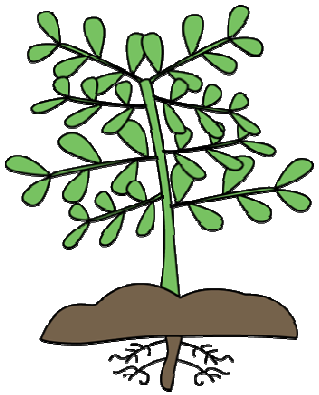
AquaCrop calculation scheme



1 - Crop development



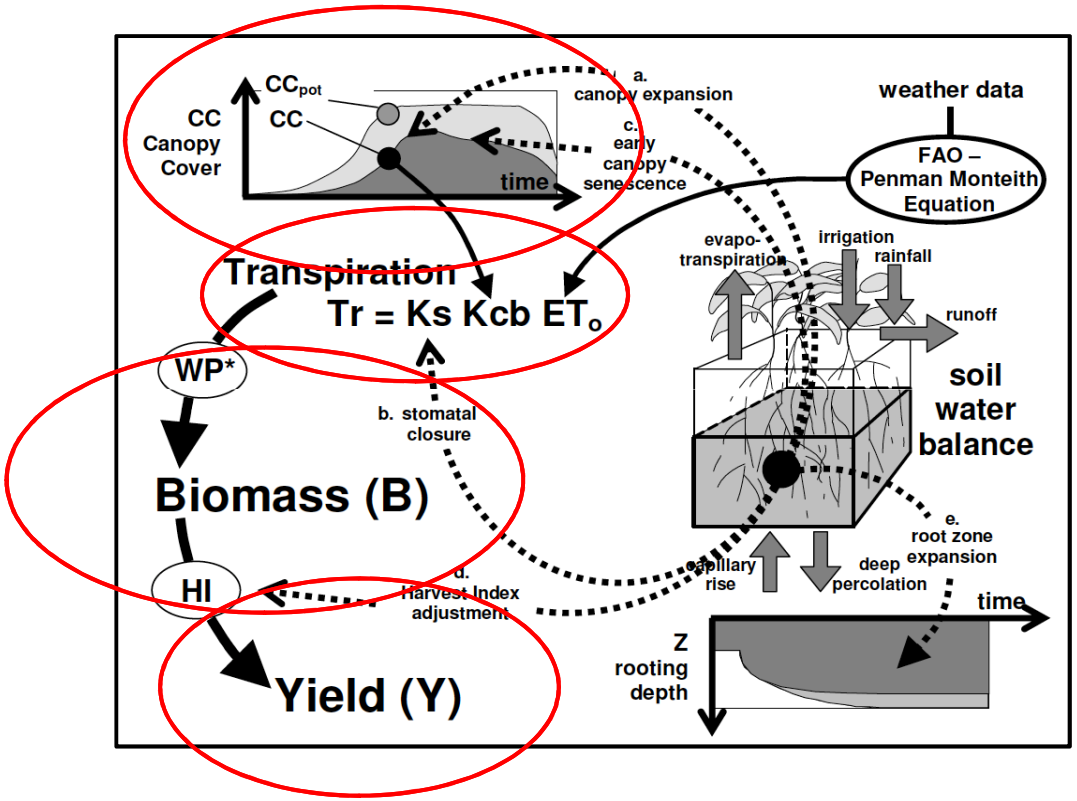
2 - Crop transpiration



3 - Biomass production

4 - Yield formation

AquaCrop calculation scheme



1 – Crop development

↓ CC

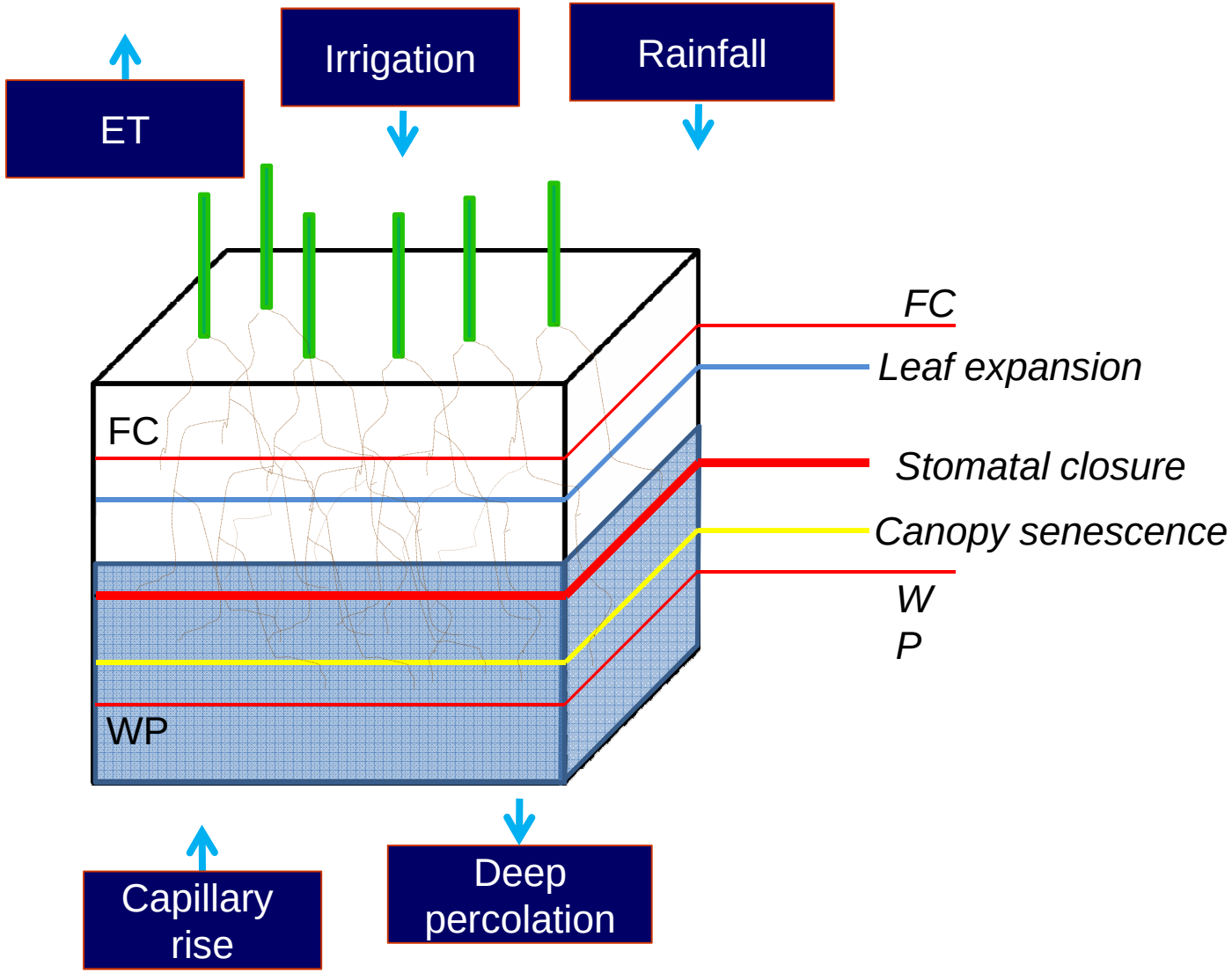
2 – Crop transpiration (Tr)

↓ WP*

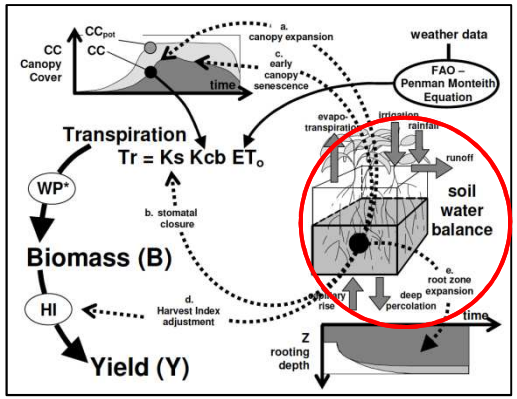
3 – Biomass production (B)

↓ HI

4 – Yield formation (Y)

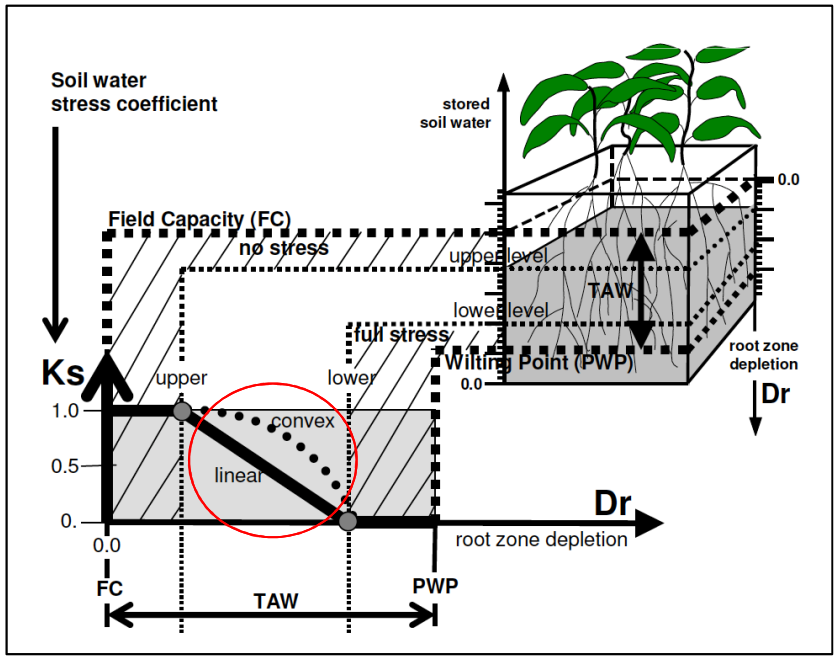

ET
Irrigation
Rainfall
FC
WP
FC
Leaf expansion
Stomatal closure
Canopy senescence
W
P
Capillary rise
Deep percolation

Soil Water Balance



Considering input and output water fluxes the amount of water retained in the root zone and the root zone depletion are calculated
The effect of water stress is described by stress coefficients Ks

Ks = 1 no stress → upper threshold of root zone depletion
Ks = 0 max stress → below threshold of root zone depletion



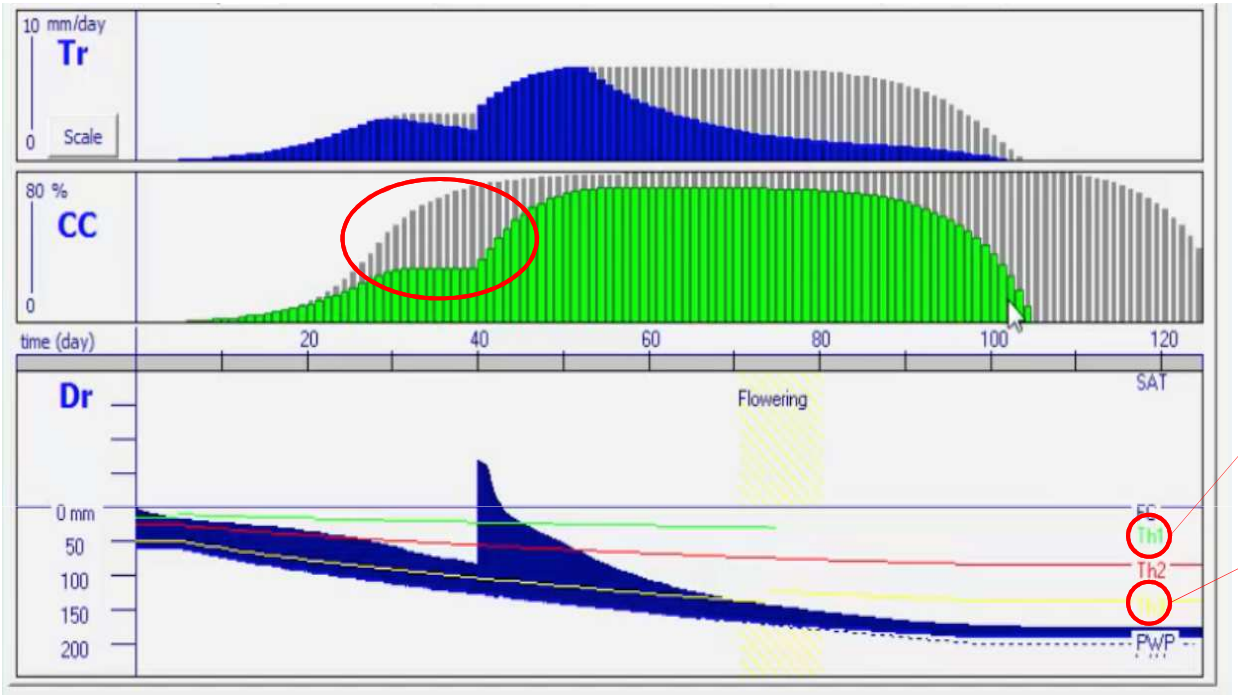
Processes affected:

- *green canopy expansion*
- *transpiration*
- *senescence*
- *harvest index*
- *root deepening*

Transpiration

Green canopy cover

Root zone depletion



Thresholds affecting:

Canopy dev.

Senescence

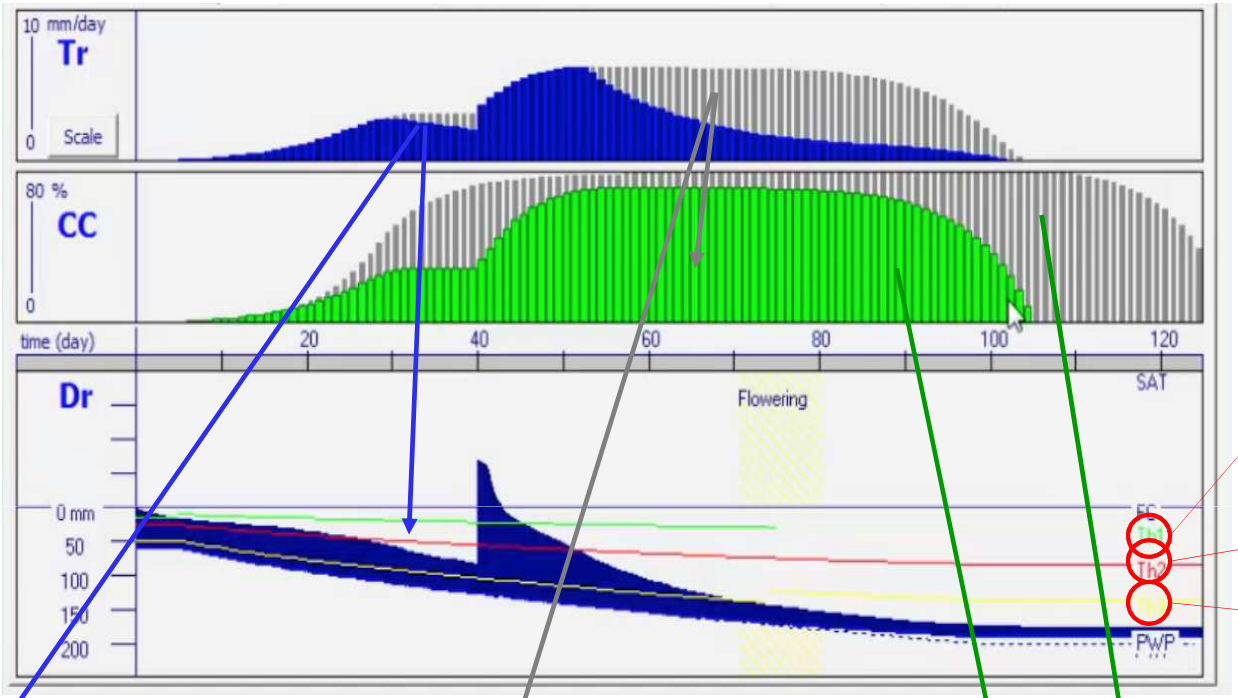
Real transpiration based on soil water content

Optimal transpiration based on actual CC

Transpiration

Green canopy cover

Root zone depletion



Thresholds affecting:

- Canopy dev.
- Stomatal closure
- Senescence

Real transpiration based on soil water content

Optimal transpiration based on actual CC

Optimal CC based non limiting conditions

Actual CC based on stress conditions

AquaCrop applications

- Crop responses to environmental changes
- WP optimization
- Yield gap analysis
- Determination of irrigation requirement
- Support to policy (comparing different scenarios)
- Impact assessment (climate change)