Estimating water needs of alfalfa and using ET to schedule Irrigation

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DWR-Funded Project (2014-2017) aiming at

"***Developing updated information on alfalfa water use (ET) under optimal agronomic conditions"***

NO GROWING LIMITATIONS DUE TO WATER DEFICIT, NUTRITIONAL SHORTAGES AND CROP DISEASES

Crop Evapotranspiration or ETc is the total amount of water lost to the atmosphere through evaporation from the soil and transpiration ("breathing") by the plants

ET rate depends on:

- ✓ Crop stage (the bigger the canopy the higher the ET)
- ✓ Solar Radiation (+)
- ✓ Air Temperature (+)
- ✓ Relative Humidity (-)
- ✓ Wind Speed (+)
- ✓ Soil Moisture (+)

Rationale

Irrigation scheduling by alfalfa growers aims at periodically refilling the soil profile with the amount of water lost by crop evapotranpiration (ET) since the last irrigation or rain event **(check-book method)**.

This amount of water lost by ETc can be estimated using the product of **ETo** by $\mathbf{K_c}$

$$\mathbf{ETc = ETo} \times \mathbf{K_c}$$

CIMIS and Spatial CIMIS provide daily **ETo** data: **http://wwwcimis.water.ca.gov/**

Estimating ETc requires to choose accurate values of $\mathbf{K_c}$ for the different crop growth stages

Main Objectives of the Alfalfa ET Lysimeter project are:

1. Measuring alfalfa ET by means of 3 parallel methods (Lysimeters, Eddy Covariance and Surface Renewal) under the typical weather conditions of the Sacramento Valley
2. Determining the K_c values along the crop season of alfalfa, and within the individual crop cycles
3. Providing information and tools to improve irrigation scheduling

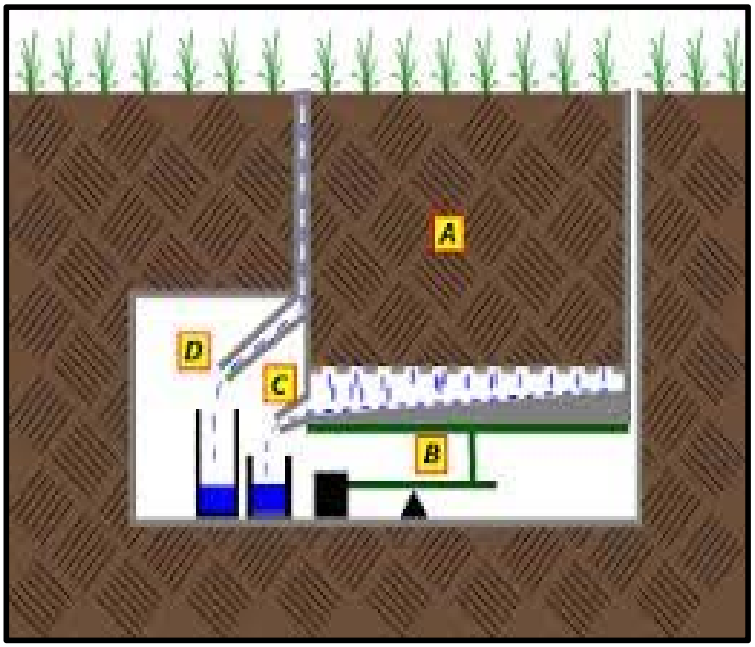
Alfalfa was established in November 2013 on a total of 6.0 acres around the two Lysimeters, each having 20 feet diameter and roughly 4 feet deep.

Alfalfa is irrigated by sprinkler irrigation (and hose) inside the lysimeters and by border-checks in the surrounding area.

Accurate estimation of alfalfa water requirements are of strategic relevance to:

- The State Water Planning and Water Allocation (California Water Plan)
- Water transfer within the State among the different hydrologic regions (Water Transfer Program)
- To promote more efficient and accurate on-farm water use

Lysimeters are **PRECISION SCALES** measuring in continuous the weight changes of a tank of soil with a crop on the surface. Weight gains in lysimeters are due to increase in soil moisture resulting from rain and irrigation, whereas weight losses are due evaporation from soil and transpiration by crop canopy.



LYSIMETERS measure the Water lost by Soil (E) & Plants (T)

Lysimeters are expensive and complicate devices to build and operate

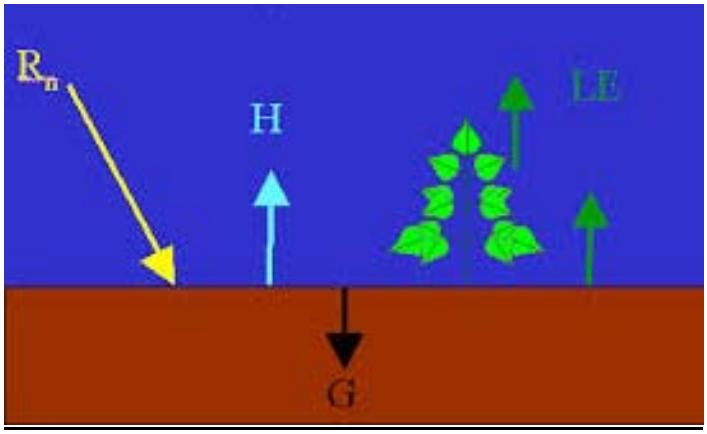
There are more portable and less expensive methods, such as Eddy Covariance, Surface Renewal and Bowen Ratio

Eddy Covariance and Surface Renewal utilize the **RESIDUAL OF ENERGY BALANCE Method to calculate actual crop ET**

$$\mathrm{Rn} = G + H + \mathrm{LE}$$

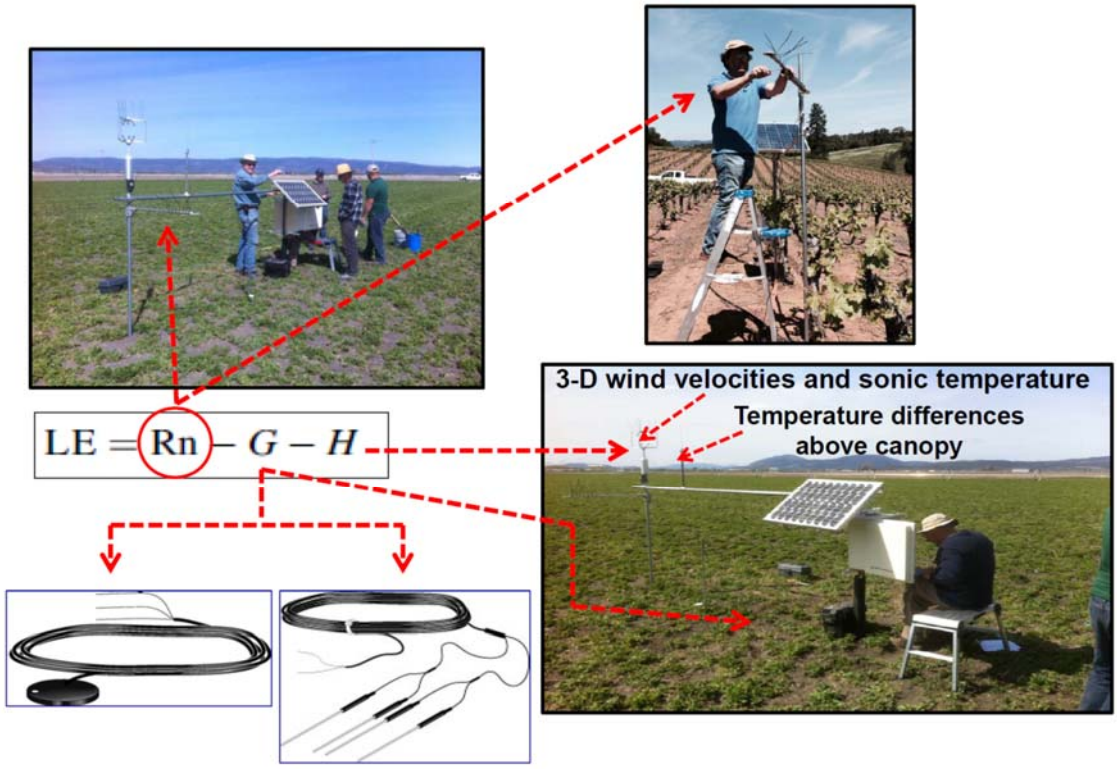
$$\mathrm{LE} = \mathrm{Rn} - G - H$$

$$\mathrm{ET} = \mathrm{LE}/L$$



ET = actual evapotranspiration
LE = latent heat flux;
R_n = net radiation;
G= soil heat flux;
H = sensible heat flux
λ = latent heat of vaporization;

FIELD EQUIPMENT FOR ET MEASUREMENTS



RESULTS FROM THE STUDY IN 2016

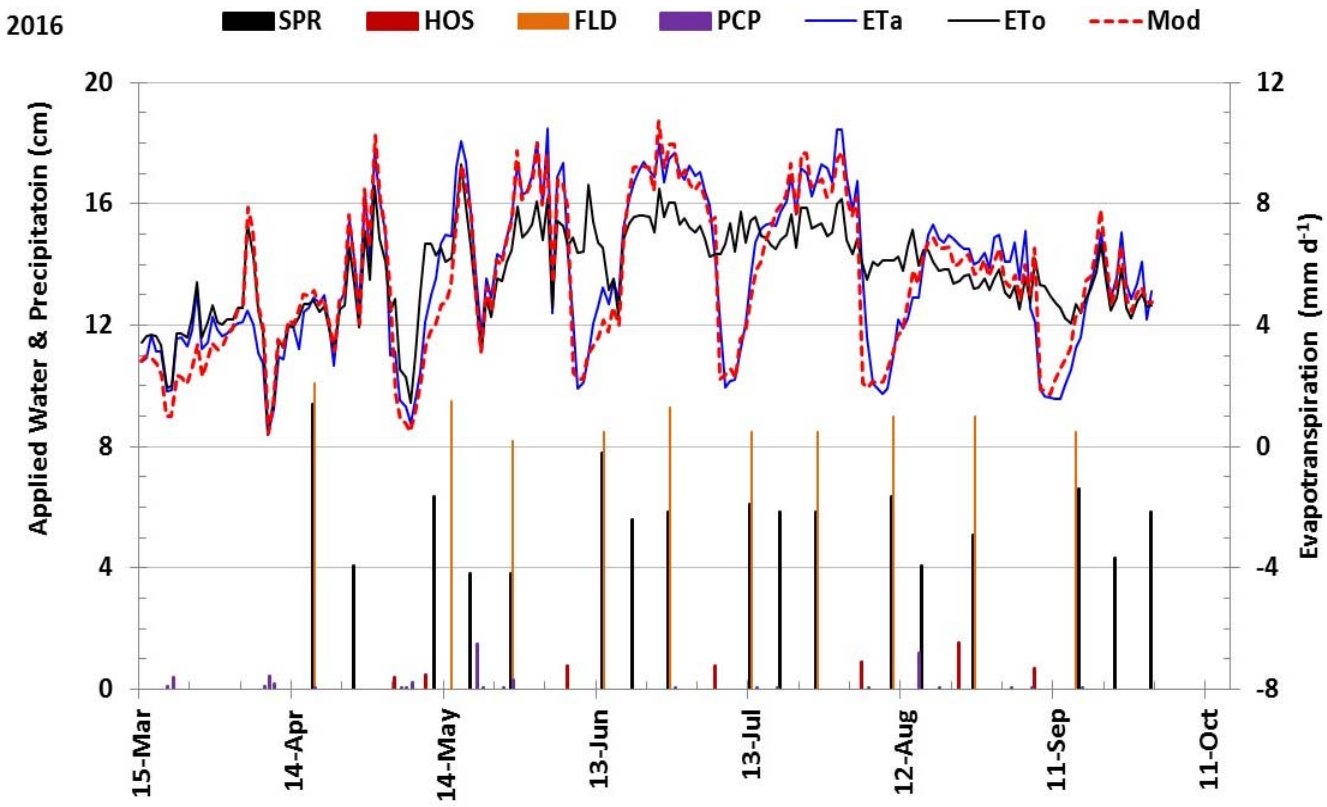


Figure 1. Actual crop ET (ETa), ETo, and crop ET calculated by the ISA Model for 2016

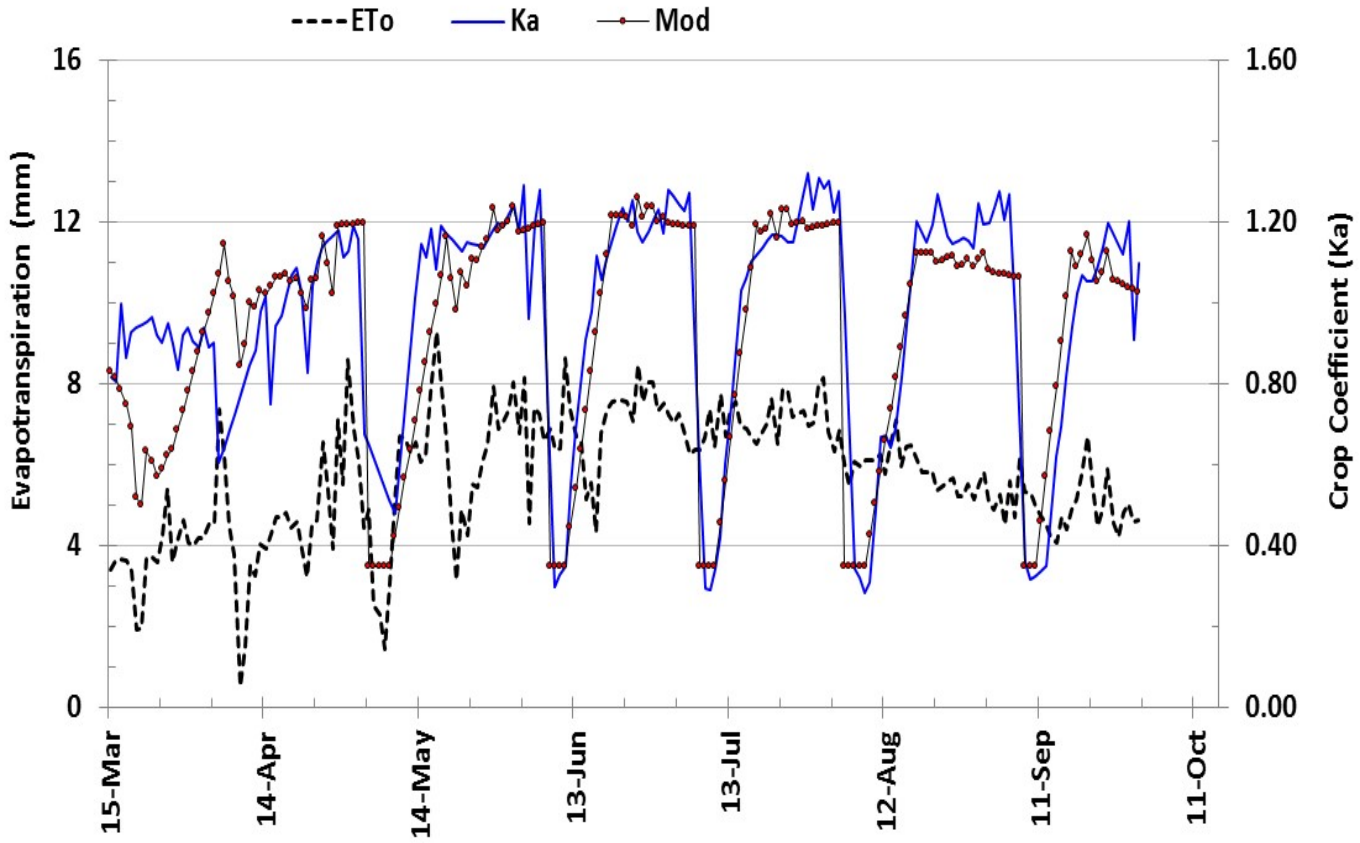


Figure 2. ETo, observed actual Kc (Ka) and Kc calculated by the ISA Model for 2016

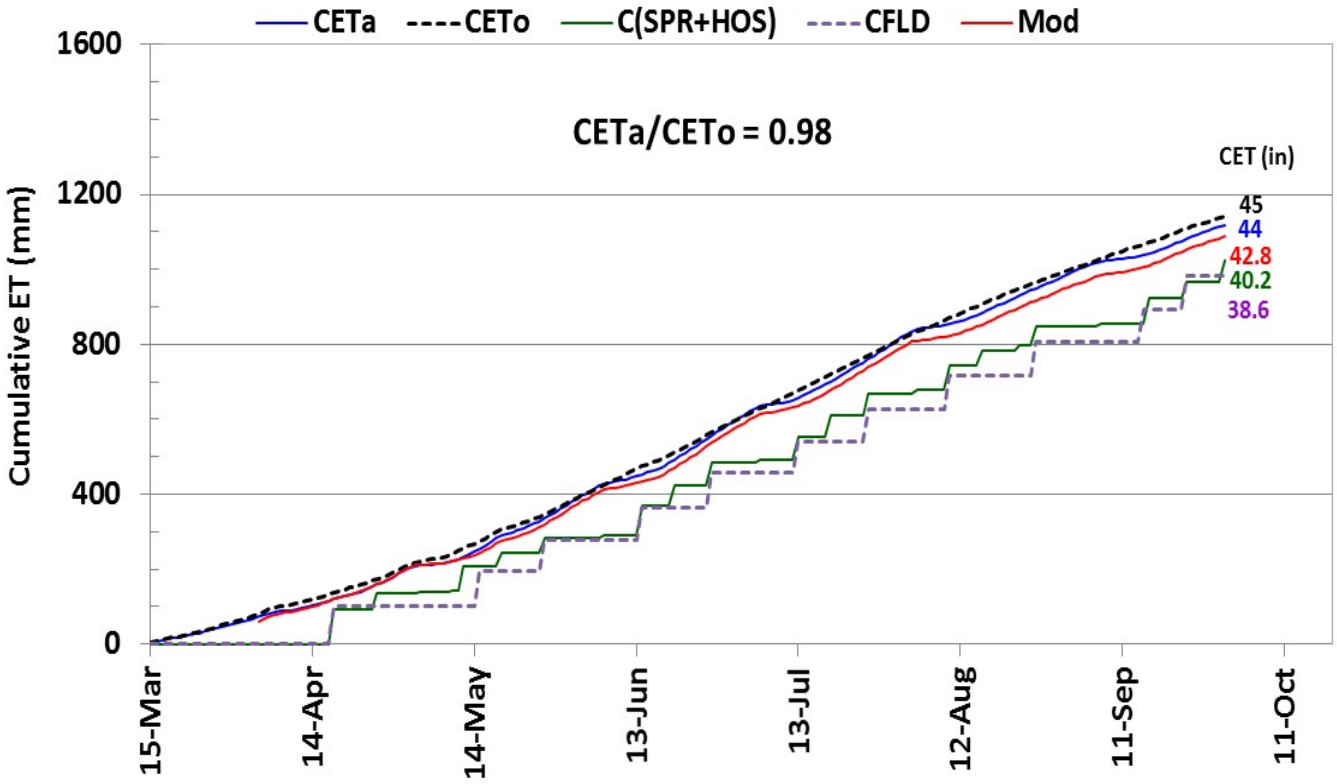


Figure 3. Cumulative ETo and ETc and seasonal Kc for 2016

General Information for scheduling irrigation

CIMIS **ET_o** and weather data: http://wwwcimis.water.ca.gov/

Seasonal Crop Coefficient:

K_c = 0.96-0.98 averaged over the season

Cycle Crop Coefficient:

$K_c \approx$ 0.35 after cutting until irrigation (5-6 days)

K_c = 1.15 to 1.2 from irrigation until the next cutting