Measuring Alfalfa Evapotranspiration (ET) in the field

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DWR-Funded Project (2014-2016)

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

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

Evapotranspiration or ET is the total amount of water lost through evaporation from the soil and transpiration ("breathing") of the plants

ET depends on:

- ✓ Crop stage
- ✓ Solar Radiation
- ✓ Air Temperature
- ✓ Relative Humidity
- ✓ Wind Speed
- ✓ Soil Moisture

- 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 inside the lysimeters and by border-checks in the surrounding area

<u>Main Objectives are</u>:

1. Measure Alfalfa ET by means of 3 parallel methods (Lysimeters, Eddy Covariance and Surface Renewal) under the typical weather conditions of the Sacramento Valley
2. Determine the K_c along the crop season of Alfalfa, and within the crop cycles
3. Provide information to improve irrigation scheduling

Why this project is important?

- Alfalfa is commonly grown on a large acreage (about 0.8 - 1.0 million acres) in California, mostly to feed the Dairy, a 8 Billion $/year industry, and international export & trade

- Alfalfa is probably the 2nd largest single agricultural water user in California. According to estimations (2010), Alfalfa uses approximately 5 Million Acre-feet of water, around 16% of the total state-wide agricultural water use of California

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

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

Rationale

Irrigation decisions by alfalfa growers are based on periodically refilling the soil profile with what is lost by evapotranpiration (ET)

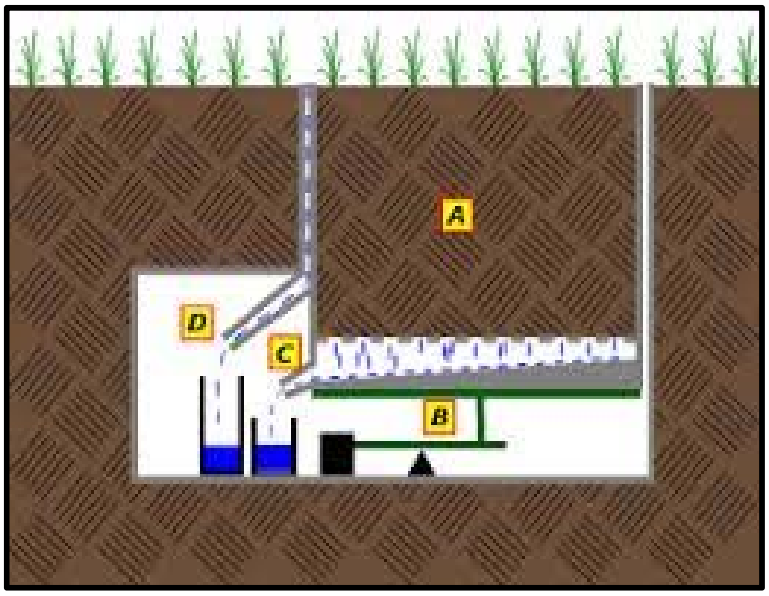
$$\mathbf{ET = ETo \times K_c}$$

Daily **ETo** data can be obtained from CIMIS: **http://wwwcimis.water.ca.gov/**

The uncertainties are still in the $\mathbf{K_c}$ component of the equation

- Lysimeters are among the most accurate ways to measure crop ET. 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 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

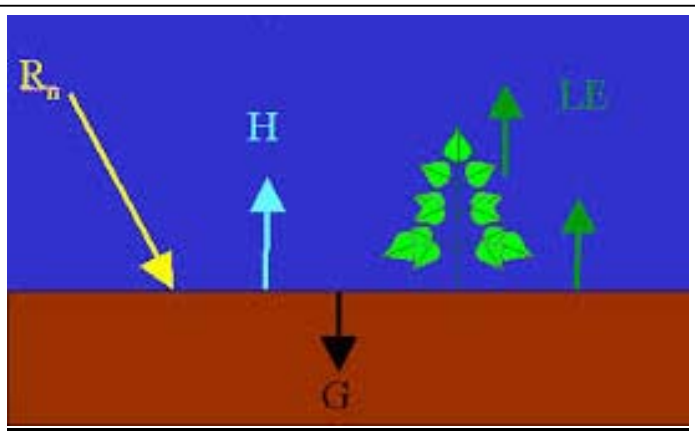
There are more portable and less expensive methods, such as Eddy Covariance, Surface Renewal and Bowen Ratio

<u>Eddy Covariance</u> and <u>Surface Renewal</u> utilize the **RESIDUAL OF ENERGY BALANCE Method**

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

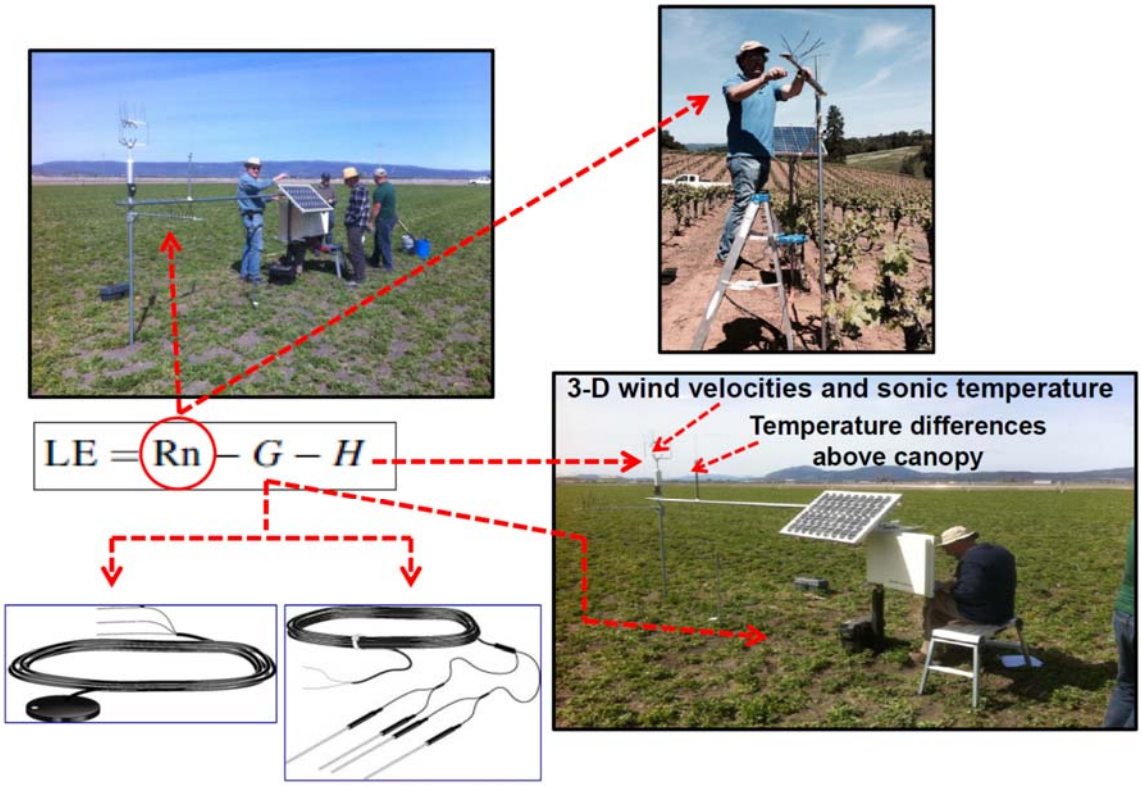
$$\mathrm{LE} = \mathrm{Rn} - G - H$$

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



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 2015

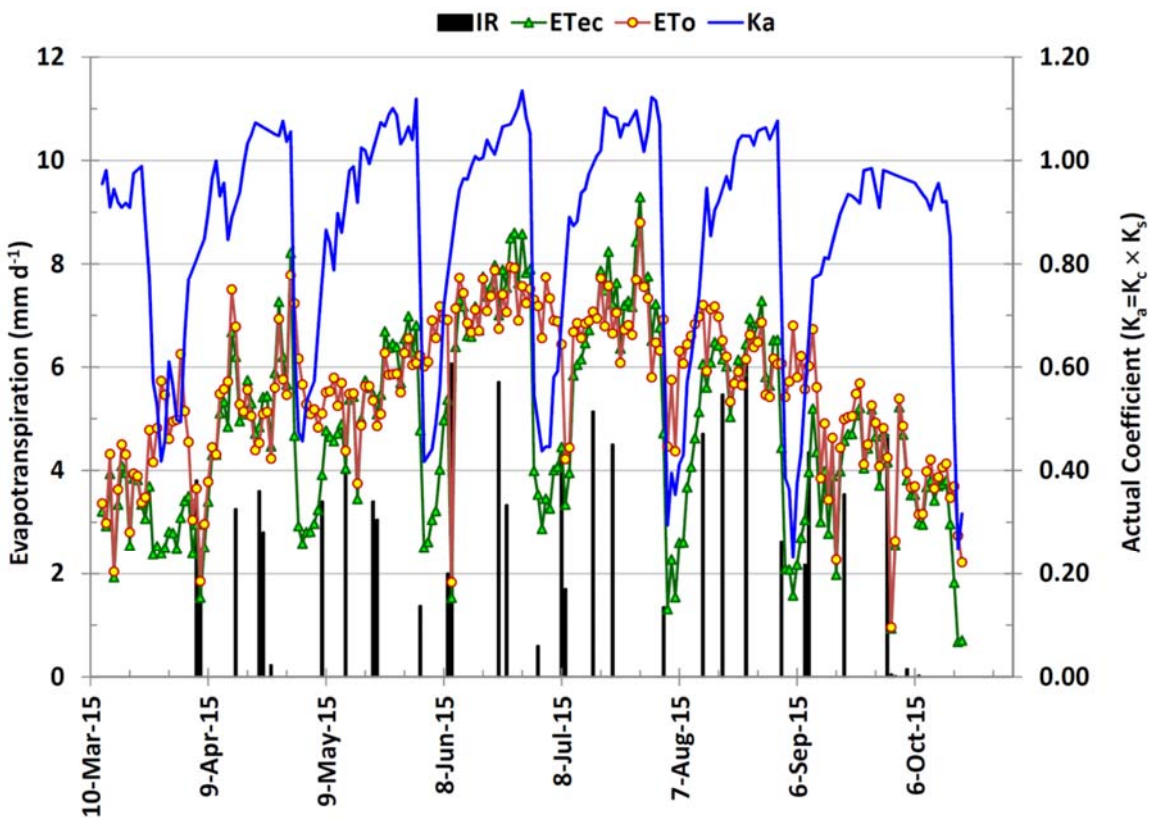


Figure 1. ETo, ETc and Kc for Alfalfa lysimeter study 2015

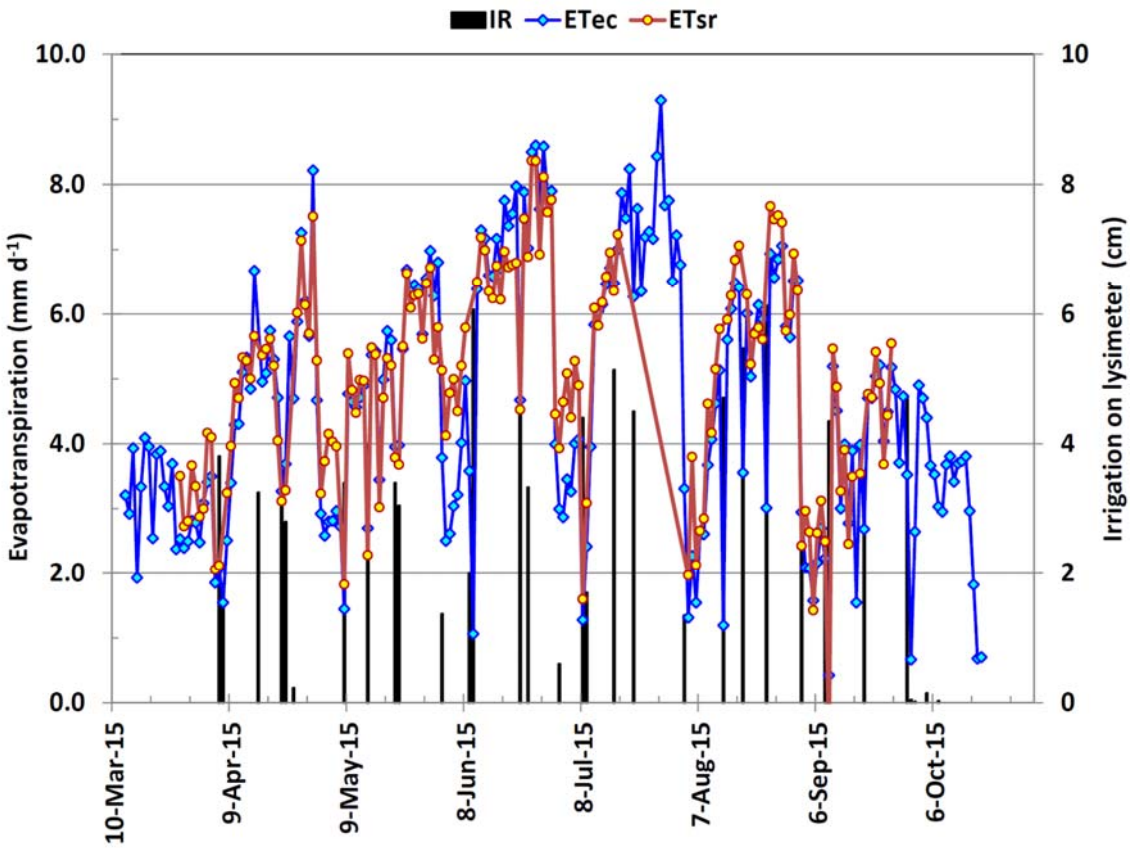


Figure 2. ET from eddy covariance (sonic) and from surface renewal (thermocouple) in 2015

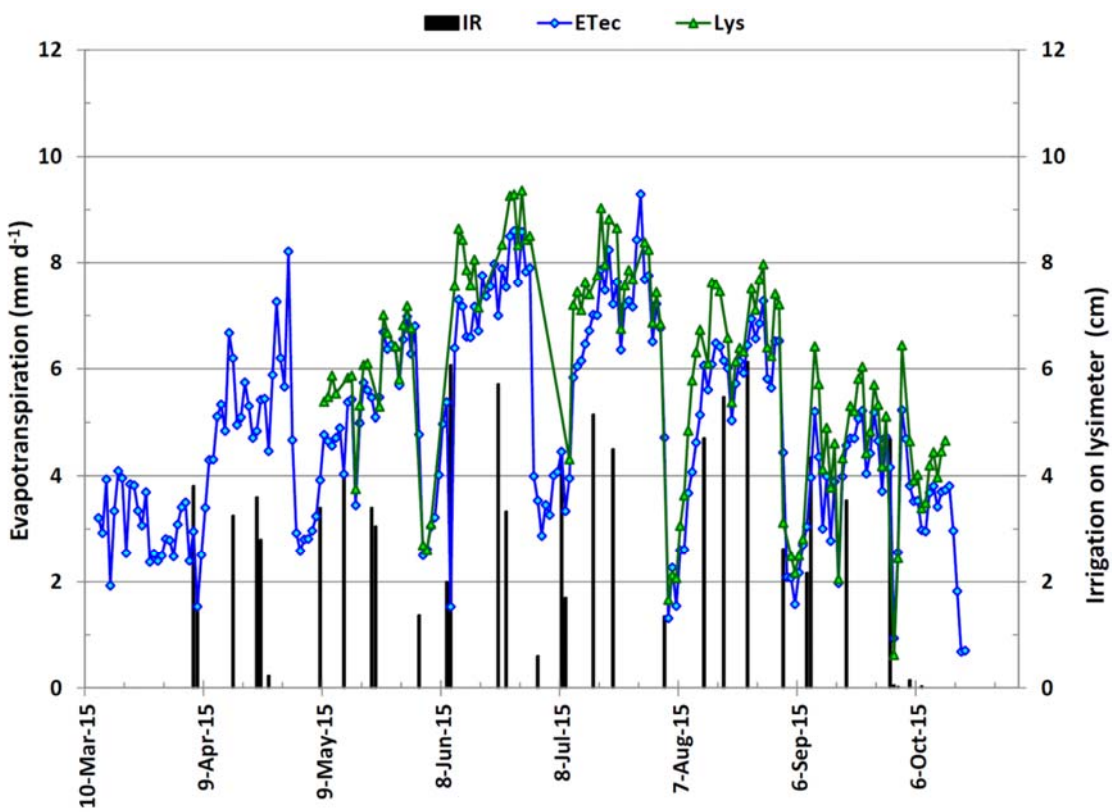


Figure 3. Comparison of ETc from eddy covariance with weighing lysimeter.

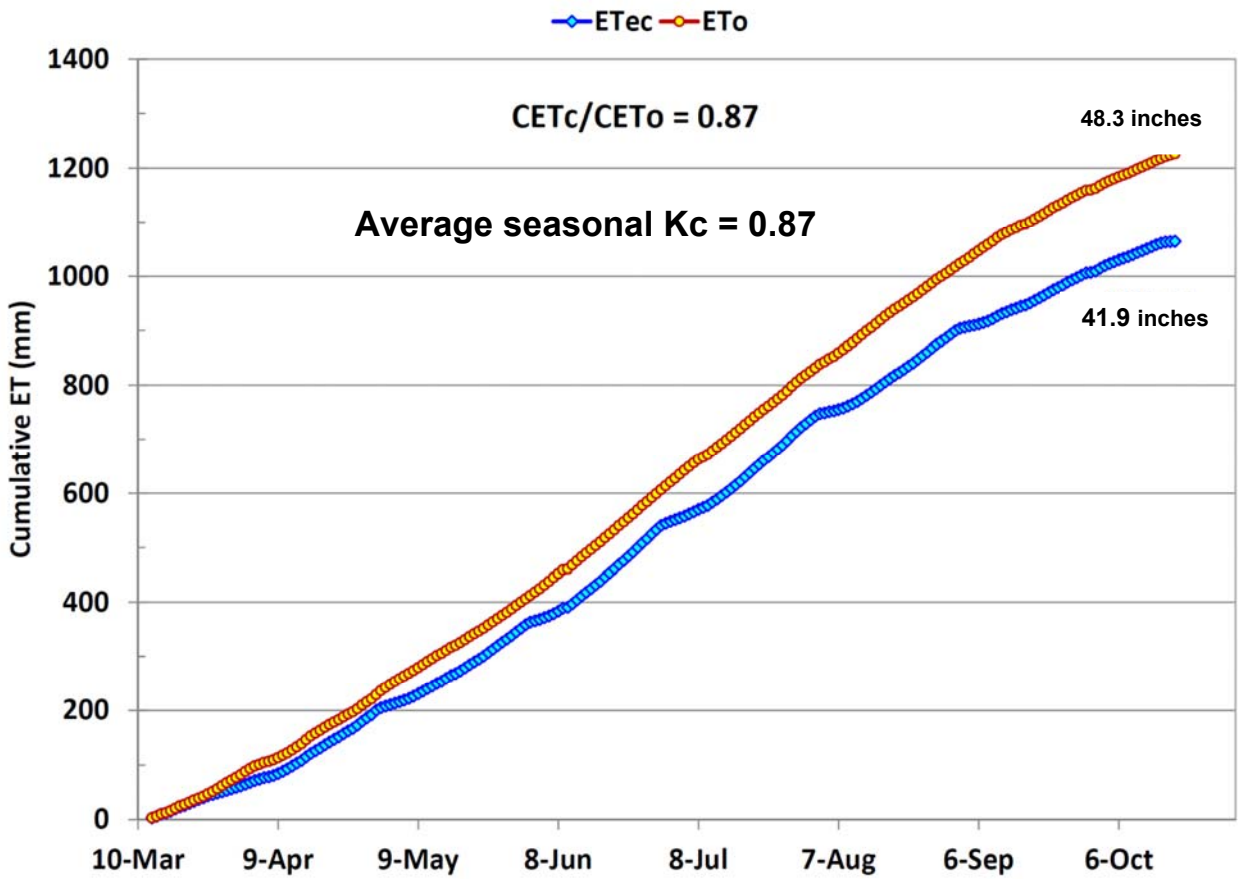


Figure 4. Cumulative ETo and ETc from the Alfalfa study 2015 (March 12th – Oct. 30th)

General Information

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

Seasonal Crop Coefficient:

K_c = 0.90 averaged over the season

Cycle Crop Coefficient:

$K_c \approx 0.45$ after cutting until irrigation

K_c = 1.05 to 1.10 from 2-3 days after irrigation until the next cutting