

Onion ET Coefficients

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Estimating Crop ET (\bar{ET}_c)

+ = ET_o ET_o from weather

K_c

ET_o ?

= ET_c

$ET_c = ET_o ? K_c$

Reference Evapotranspiration

ET_o - Reference ET for a *short* crop having an approximate height of 0.12 m (similar to cool-season grass).

ASCE Committee

Evapotranspiration in Irrigation and Hydrology

California
Irrigation
Management
Information
System

<http://www.cimis.water.ca.gov/cimis/welcome.jsp>

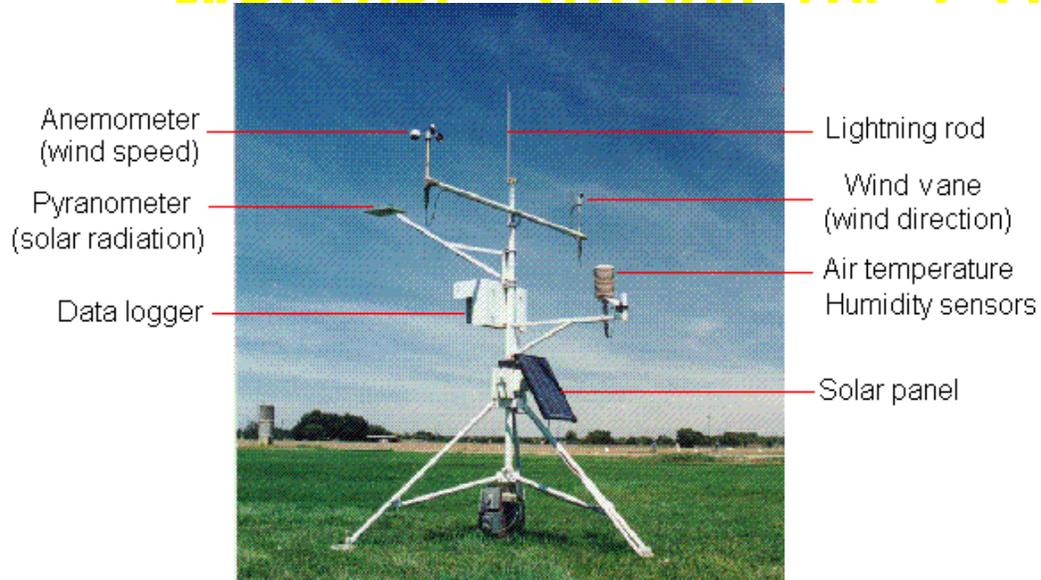
<http://ipm.ucdavis.edu/>

<http://biomet.ucdavis.edu/>

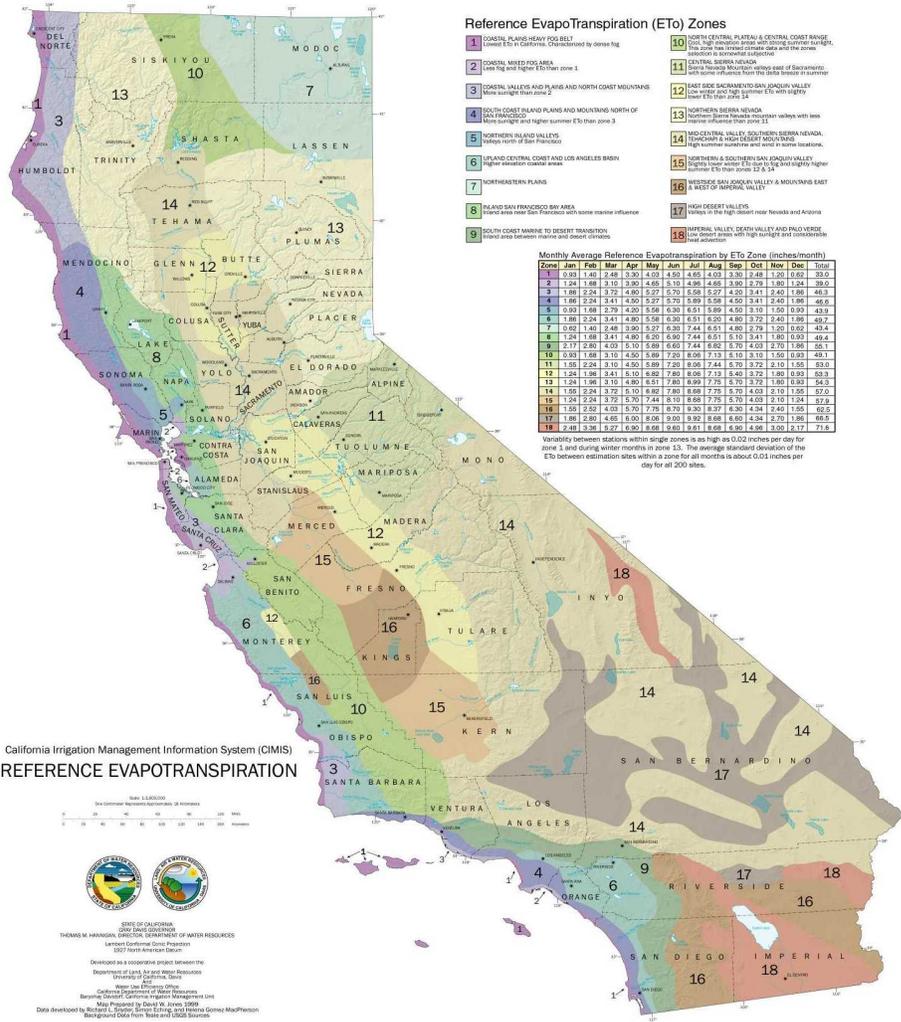
Weather Station for ET

0

Weather Station for ET_0



ET_0 = a measure of evaporative demand
 ET_0 ? ET of 0.12 m tall, cool-season grass



Reference EvapoTranspiration (Eto) Zones

- 1 COASTAL PLAINS HEAVY FOG BELT
Lowest Eto in California. Chilled by dense fog.
- 2 COASTAL MOUNT FOG AREA
Less fog and higher Eto than zone 1.
- 3 COASTAL VALLEYS AND PLAINS AND NORTH COAST MOUNTAINS
Warm nights and higher Eto than zone 2.
- 4 SOUTH COAST HIGHLAND PLAINS AND MOUNTAINS NORTH OF SAN FRANCISCO
More average and higher summer Eto than zone 3.
- 5 NORTHERN INLAND VALLEYS
Warm nights of San Francisco.
- 6 INLAND CENTRAL COAST AND LOS ANGELES BASIN
Higher elevation coastal areas.
- 7 NORTHEASTERN PLAINS
- 8 INLAND SAN FRANCISCO BAY AREA
Warm nights near San Francisco with some marine influence.
- 9 SOUTH COAST MOUNTAIN TO DESERT TRANSITION
Warm nights between marine and desert climates.
- 10 NORTH CENTRAL PLATEAU & CENTRAL COAST RANGE
High elevation areas and dense summer fog and light radiation in some areas subject to the zone.
- 11 CENTRAL SIERRA MOUNTAINS
Santa Nevada Mountain valleys east of Sacramento with some influence from the Sierra slopes in summer. Eto is low zone 14.
- 12 EAST SIDE SACRAMENTO-SAN JOAQUIN VALLEY
Low water and high Eto from the Sierra slopes in summer. Eto is low zone 14.
- 13 NORTHERN SIERRA MOUNTAINS
Northern Sierra Nevada mountain valleys with less marine influence than zone 1.
- 14 MIDCENTRAL VALLEY SOUTHERN SIERRA NEVADA
High summer sunshine and wind in some locations.
- 15 NORTHERN & SOUTHERN SAN JOAQUIN VALLEY
Higher lower water Eto than the San Joaquin higher summer Eto than zone 2, 14.
- 16 WESTSIDE SAN JOAQUIN VALLEY & MOUNTAINS EAST & WEST OF NAPAVAL VALLEY
- 17 HIGH DESERT VALLEYS
Valleys in the high desert near Nevada and Arizona.
- 18 IMPERIAL VALLEY DEPTH VALLEY AND FLO VERDE
Low desert areas with high summer Eto and high radiation.

Monthly Average Reference Evapotranspiration by Eto Zone (inches/month)

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.89	1.40	2.48	3.30	4.03	4.50	4.65	4.60	3.30	2.48	1.40	0.89	33.0
2	1.24	1.68	3.10	3.90	4.65	5.10	4.95	4.60	3.30	2.48	1.68	1.24	39.6
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	48.3
4	1.86	2.24	3.41	4.20	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	48.3
5	0.93	1.48	2.79	4.20	5.58	6.30	6.51	6.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.30	4.80	3.72	2.40	1.86	49.7
7	0.83	1.10	2.48	3.90	5.27	6.30	7.44	8.61	6.40	3.79	1.50	0.83	43.4
8	1.24	1.68	3.41	4.80	6.30	6.90	7.44	8.61	5.10	3.41	1.80	1.24	49.4
9	2.17	2.80	4.03	5.10	5.89	6.00	7.44	8.61	5.70	4.03	2.80	2.17	56.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.08	7.73	5.10	3.10	1.50	0.93	45.1
11	1.53	2.04	3.10	4.50	5.89	7.20	8.08	7.44	5.70	3.72	2.10	1.53	53.1
12	1.24	1.98	3.41	5.10	6.89	7.89	8.08	7.73	5.40	3.72	1.80	1.24	49.3
13	1.24	1.98	3.10	4.80	6.51	7.89	8.08	7.73	5.70	3.72	1.80	1.24	54.2
14	1.24	2.24	3.72	5.10	6.89	8.08	8.68	7.73	4.03	2.10	1.50	1.24	57.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.73	5.70	4.03	2.10	1.24	57.4
16	1.24	2.52	4.03	5.70	7.73	8.70	9.30	8.27	6.30	4.34	2.40	1.50	62.5
17	1.86	2.80	4.65	6.00	8.08	9.00	9.92	8.68	6.80	4.34	2.70	1.86	66.5
18	2.41	3.38	5.27	6.90	8.68	10.00	10.81	9.60	7.50	5.00	3.38	2.41	71.6

Variability between stations within single zones is as high as 0.02 inches per day for zone 1 and during winter months in zone 13. The average standard deviation of the Eto between estimation sites within a zone for all months is about 0.03 inches per day for all 200 sites.

California Irrigation Management Information System (CIMIS)
REFERENCE EVAPOTRANSPIRATION



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
THOMAS W. HANIGAN, DIRECTOR, DEPARTMENT OF WATER RESOURCES
Leland C. Conner, Chief, Program Support
Developed as a cooperative project between the
Department of Water, the United States Geological Survey,
and the University of California, Davis.
Map prepared by David M. Jones, 1998
Map published by David M. Jones, 1998
Data developed by Richard L. Squires, State of California, Department of Water Resources
Map/Report prepared from National USGS sources

Crop Coefficients

ETc - measured

ETo - estimated

Factors Affecting K_c

- Ø Albedo effect on net radiation
 - Ⓜ Reflection of solar radiation
- Ø Aerodynamic Resistance
 - Ⓜ Surface roughness
 - Ⓜ Wind speed
- Ø Surface Resistance
 - ? Stomatal Control
 - ? Surface wetness

$$ET_o + K_c = ET_c$$

Tulelake Experiment



- LE – Latent Heat Flux (Evapotranspiration)
- R_n - Net Radiation
(by net radiometer)
- G – Water & Soil Heat Flux Density
(by heat flux plates & thermistors)
- H - Sensible Heat Flux Density
(by thermocouples & surface renewal)

Net Radiometer



Heat Flux Plate

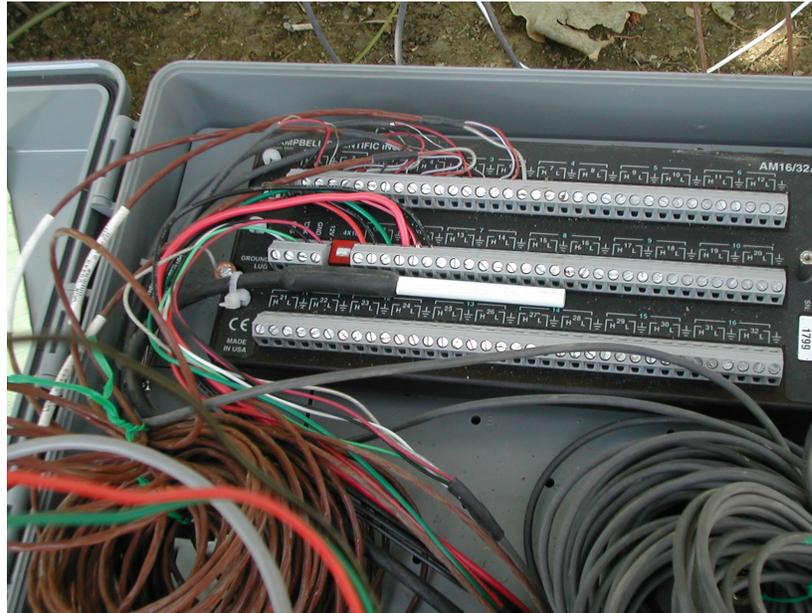


Sensible Heat Flux (H)

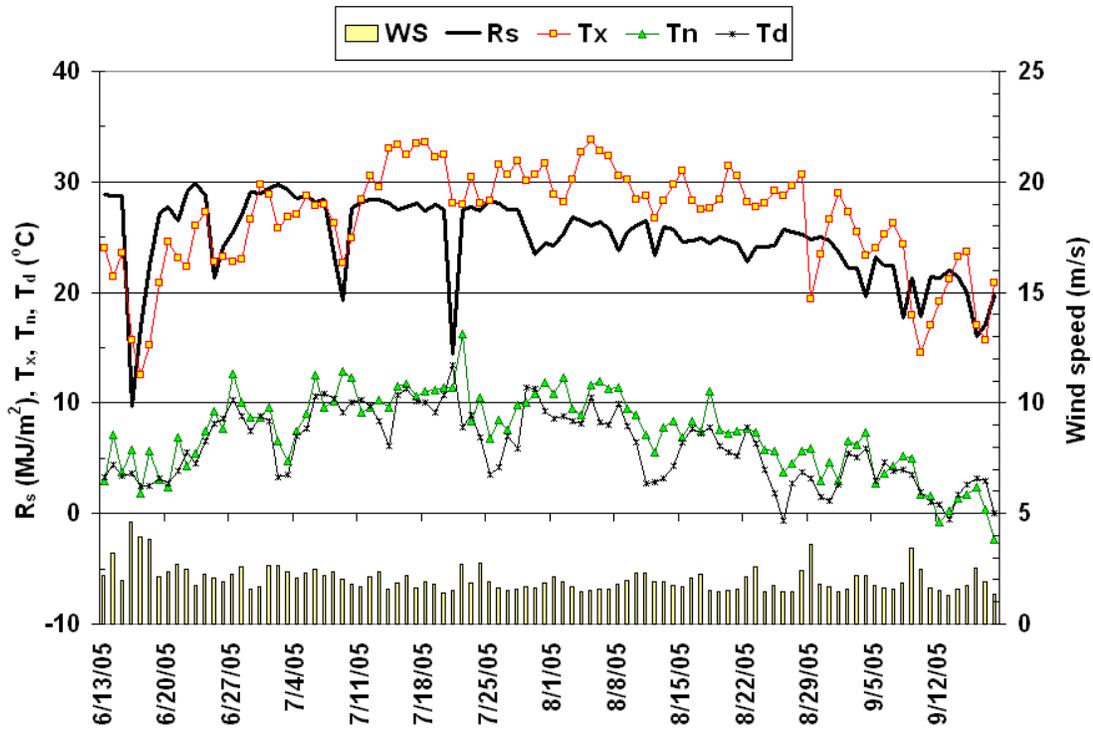


Surface Renewal

Data logger

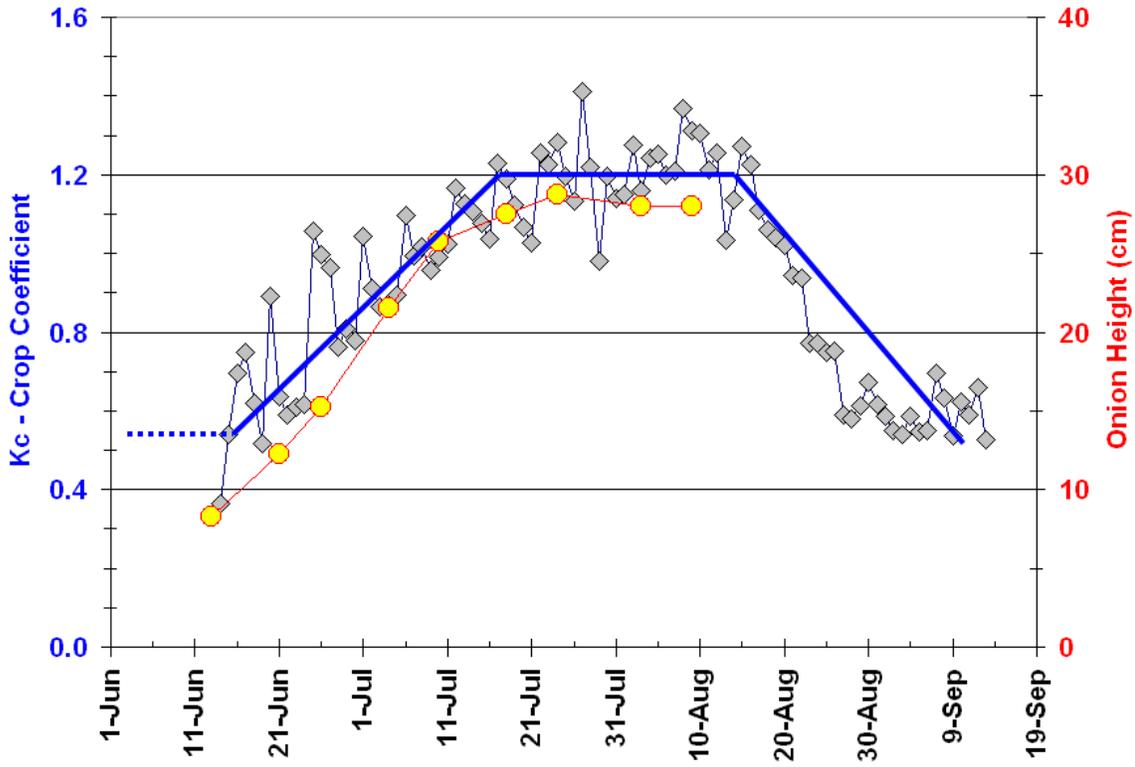


Tulelake Weather 2005



Tulelake K

c



Yield vs Water Applied

Tulelake, Planted 4/1/04
? high yield

Bulb Yield (cwt/acre)

Total Irrigation + Rainfall (inches)

Yield vs Water Applied

Tulelake, Late Planted 5/5/06
? lower yield

Bulb Yield (cwt/acre)

Total Irrigation + Rainfall (inches)

Conclusions

Maximum Yield at Full ET
C

ET
C
varies by year

Planting data affects full ET
C

ET
O
from CIMIS

Peak K
C
= 1.2 at about 1 ft height

BISe.xls <http://biomet.ucdavis.edu>
C
varies with wind speed

The End