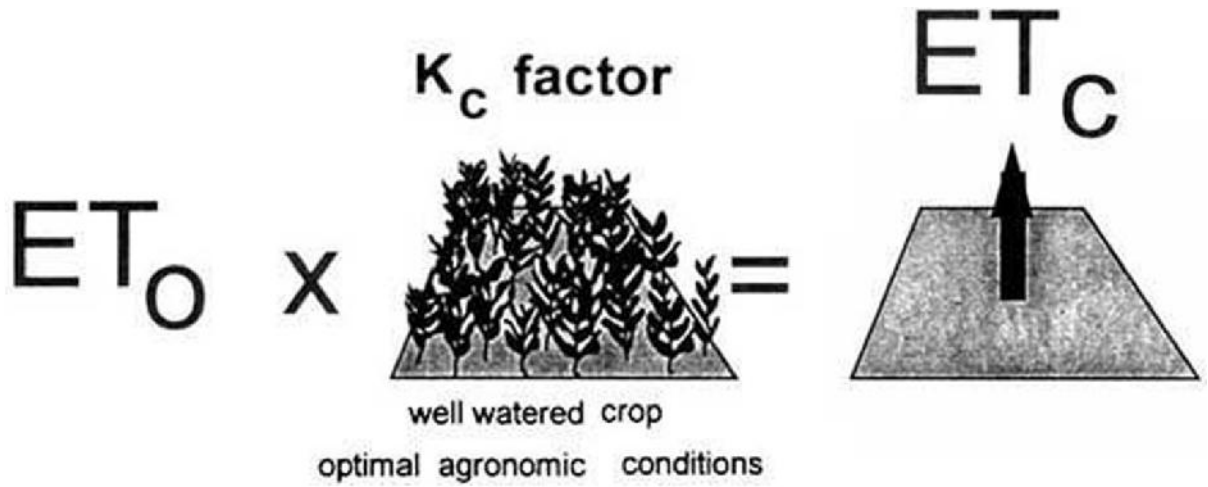
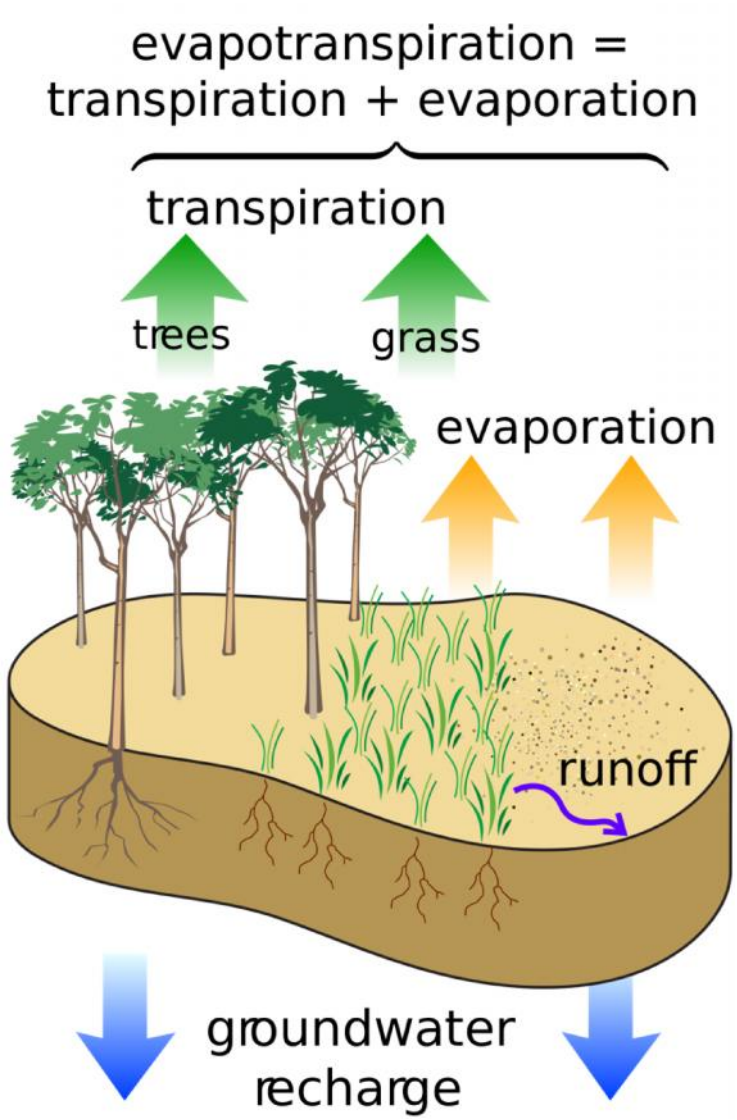
Estimating Vine Water Use:

The Quest for the Elusive K_c



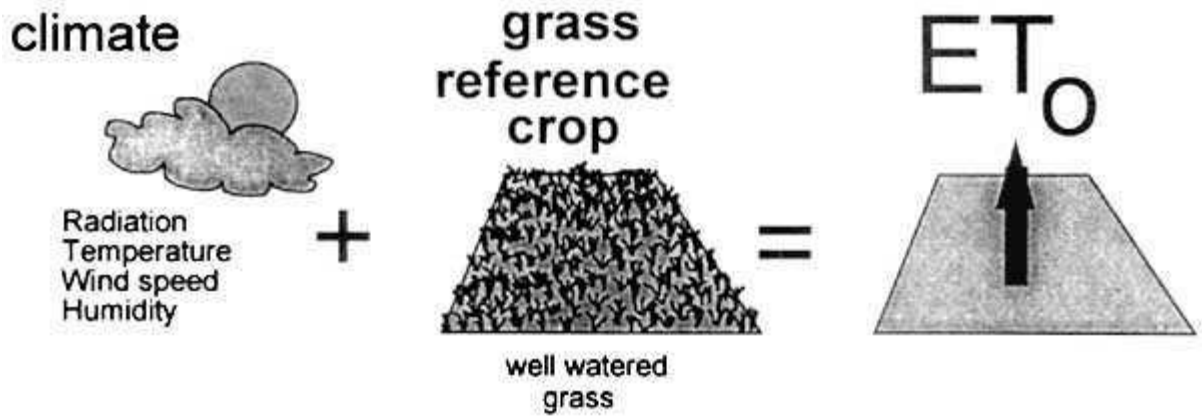
Evapotranspiration

- Irrigation decisions require knowledge of plant water loss
- Water lost = Reference for replacement
- ET= the true amount of water lost to the atmosphere



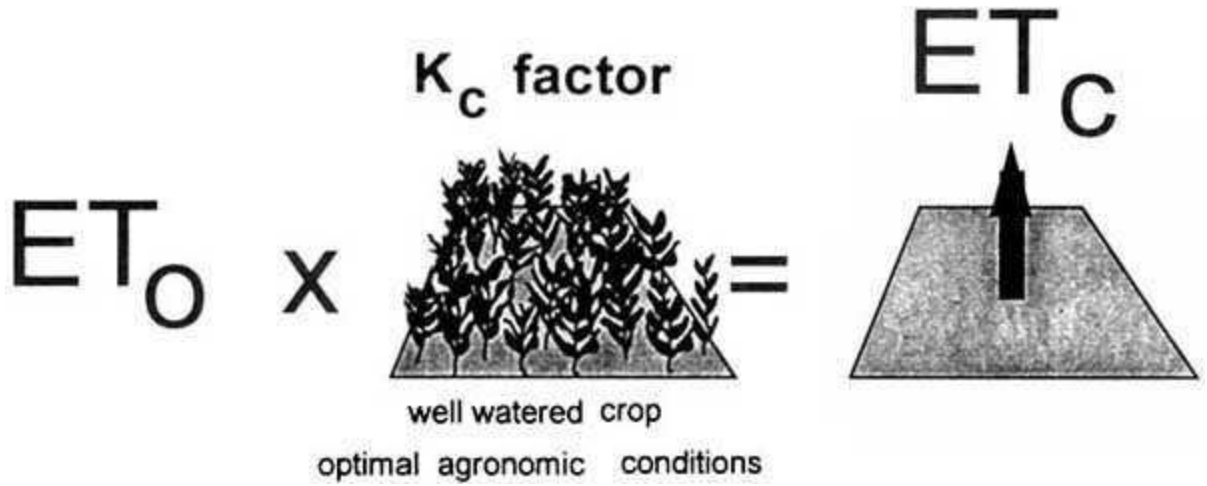
ET_o = reference ET

- An estimate of what actual ET would be for a large area
- Reference "crop" is 100% ground cover of well-watered turf
- Water use of crops in the area is calculated from that measure
- Measured in acre-inches (27154 gal.)



Crop Coefficient

- Still need to know the water use of the actual crop compared to the reference “crop”
- Requires a crop coefficient- K_c
- Crop Water Use (ET_c) = ET_o X K_c



Crop Coefficient

- Estimating ET_c is difficult
- The crop coefficient for grapes changes as the canopy changes
- More transpiration = Higher ET_c
- Therefore, accurate estimates of K_c require constant measurement.
- Williams demonstrated that it is canopy orientation (percent shaded ground) that drives K_c and not total canopy area

How to estimate K_c

Percent area shade of vineyard floor at solar noon (1:00 pm)
Where y is K_c and x is percent shaded floor area

$$y = 0.002 + 0.017\,x$$

- **29% shaded floor ; K_c = 0.500**
- **ET_o of 2” X 0.500 = ET_c of 1”**
- **1 ac.-in. = 27154 gal.**
- **729 vines per acre = 37 gal./vine**

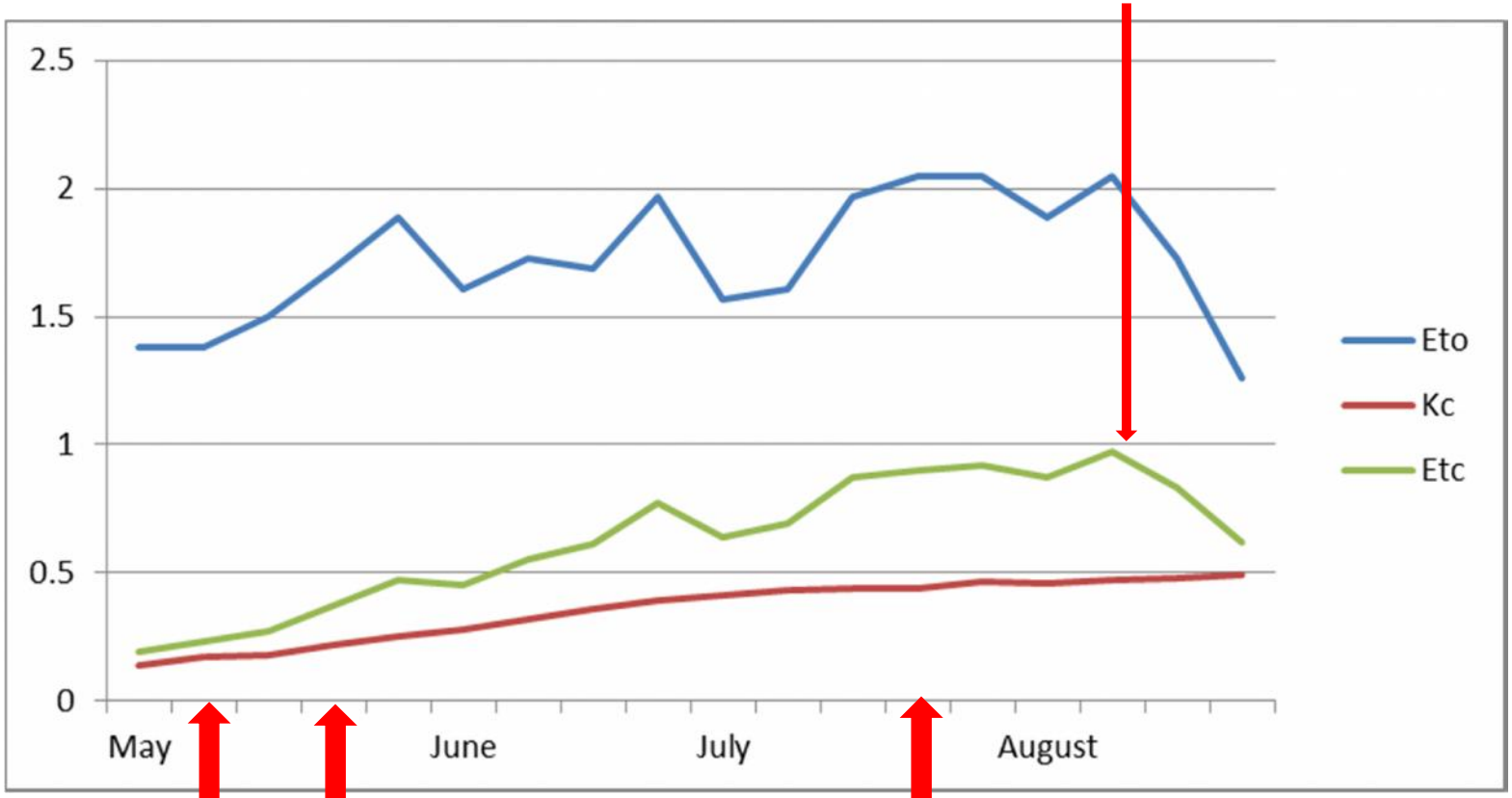
Vineyard K_c

Year 2000, Paso Robles Vineyard, PR1 weather station

10’ X 6’, 729 vines per acre

Published data from Williams 2001

Equals 36.7 gal./vine that week



Irrigation starts

Bloom

Veraison

Fruit harvested Sept. 27

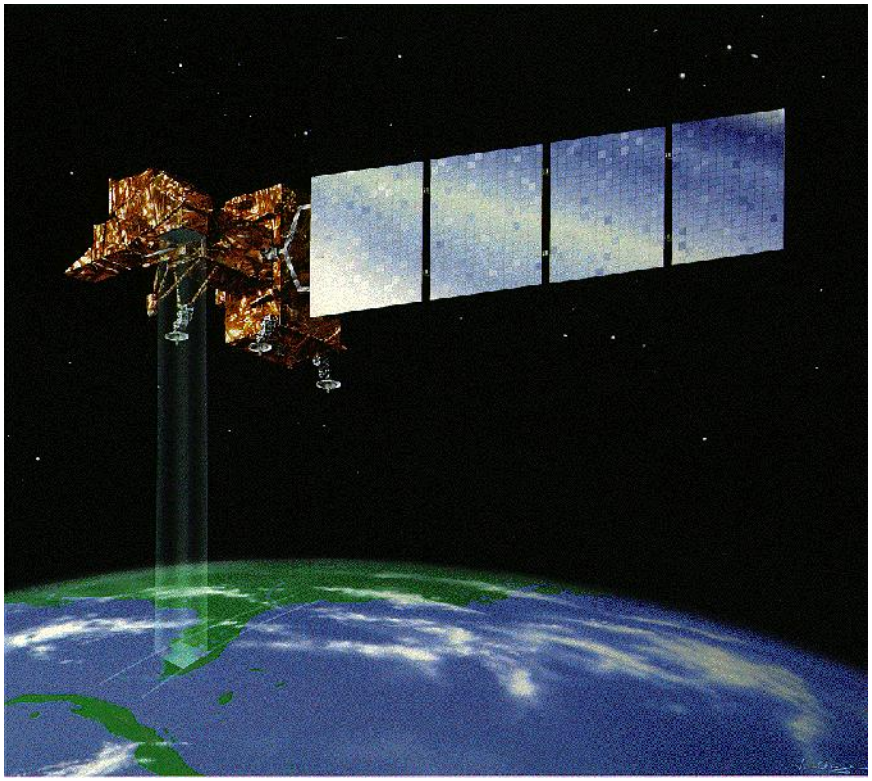
Measuring Shade with Instrumentation

Remote sensing:

- Uses NDVI
- Calculated from Infrared and Near Infrared
- Satellites
- Fixed wing fly overs
- UAV fly overs

Issues:

- Cloud cover
- Resolution
- Frequency
- Cost



The TOPS Satellite Irrigation Management System

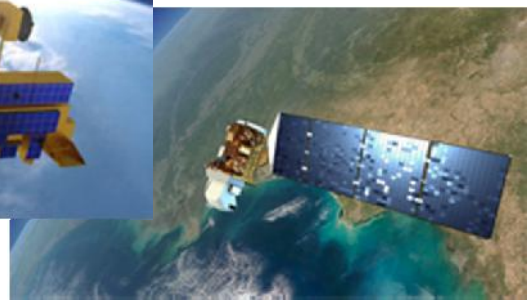
Terrestrial Observation and Prediction System

- Landsat images
  - NDVI
  - Fractional cover (Fc)
  - K_{cb}
  - ET_{cb}
- Resolution of a 1/4 acre
- Fly over every 8 days
- May go to 4 or 5 in the future
- ~ 7 days before data is available

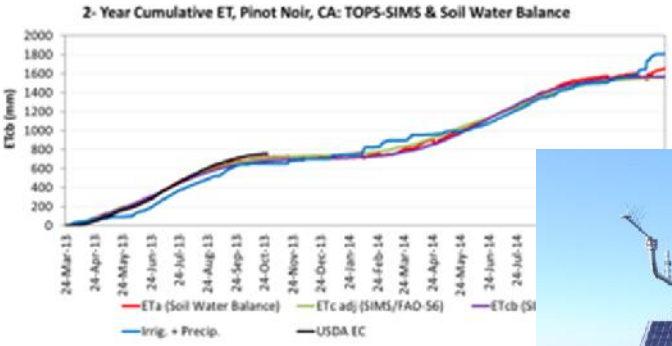
NASA Satellite Irrigation Management Support: Mapping Crop Water Requirements to Assist Growers in Optimizing Water Use

PROJECT TEAM: NASA Ames Research Center, California Dept. of Water Resources, Western Growers Association, California State University, Univ. of California Cooperative Extension, Desert Research Institute, USDA Ag. Research Service, USGS, Booth Ranches, Chiquita, Constellation Wines, Del Monte Produce, Dole, E & J. Gallo, Farming D, Fresh Express, Pereira Farms, Ryan Palm Farms

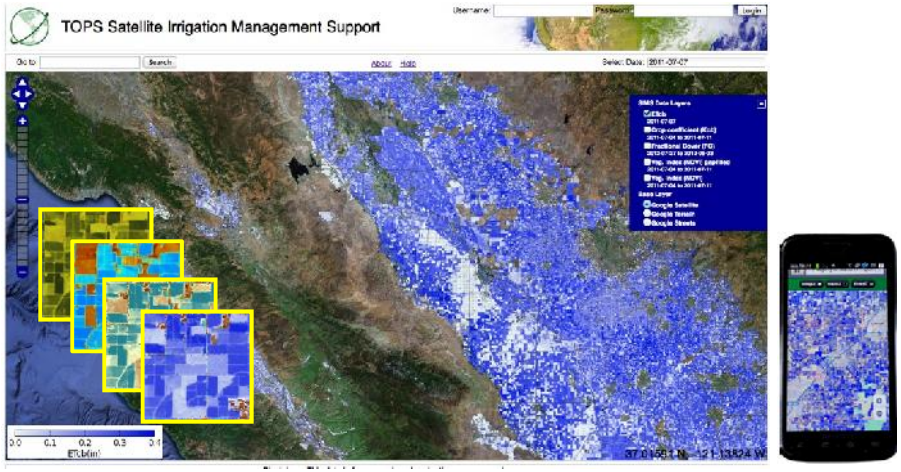
Terra Satellite



Landsat 7 & 8



3-year validation study in collaboration with E & J Gallo and USDA

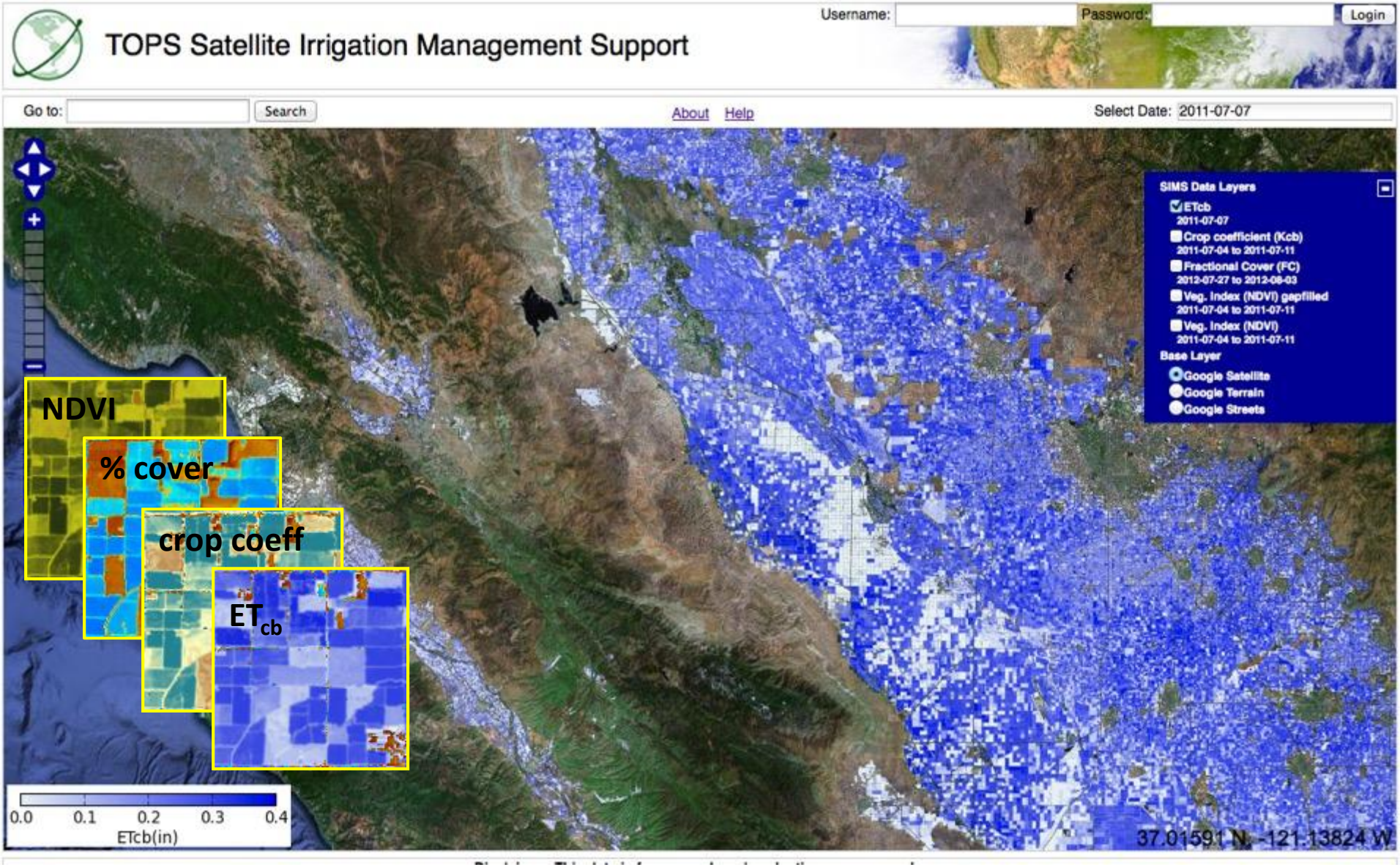


NASA SIMS web and mobile data services map crop canopy conditions and irrigation demand across 8 million acres of farm land in California

Data processing through supercomputing resources available through NASA Earth Exchange and OpenNEX, a collaboration between NASA and Amazon, Inc.

For more information, contact forrest.s.melton@nasa.gov, or visit https://c3.nasa.gov/water/projects/1/

Satellite Irrigation Management Support (SIMS) Framework



TOPS Satellite Irrigation Management Support

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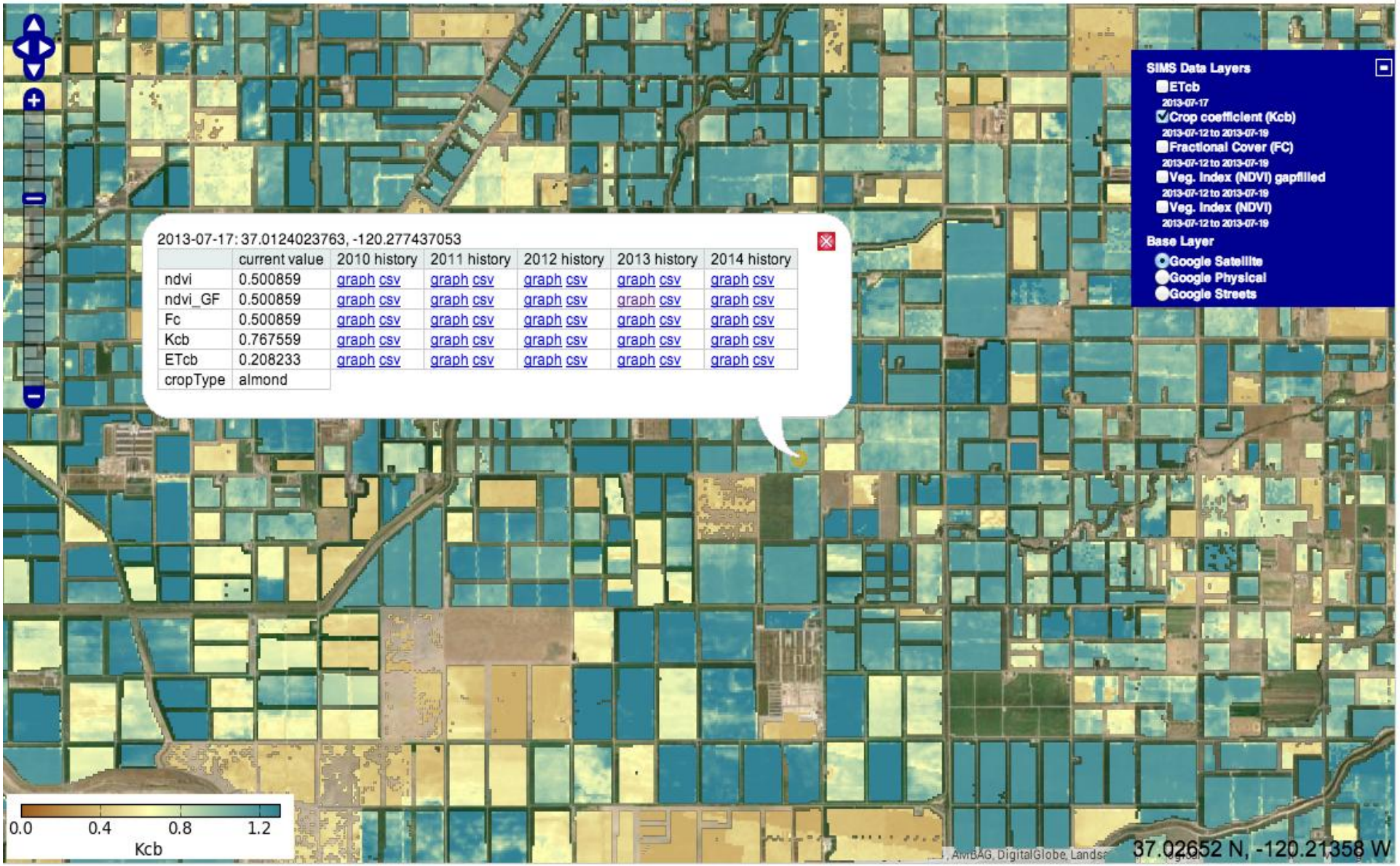
Select Date: 2013-07-17

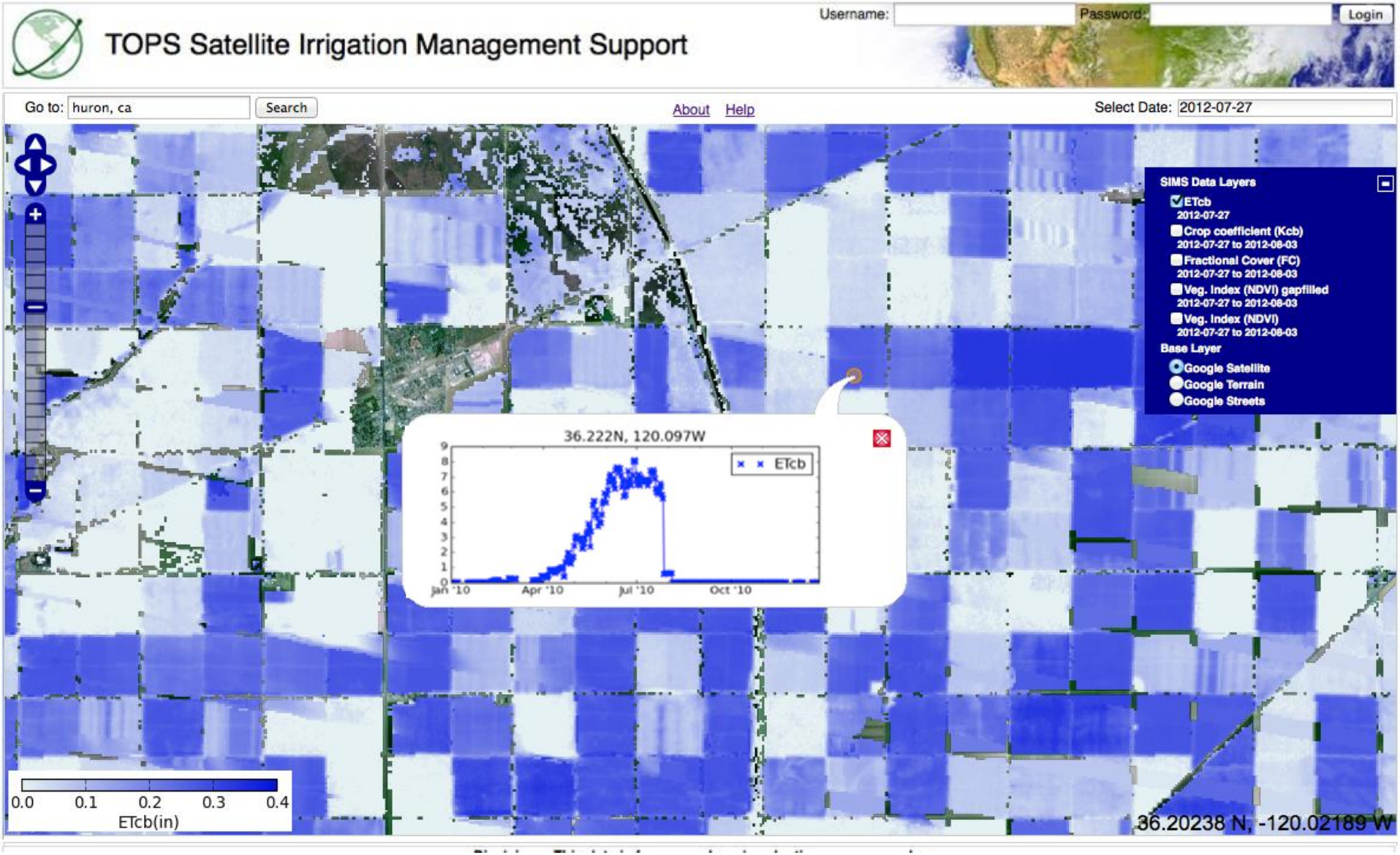


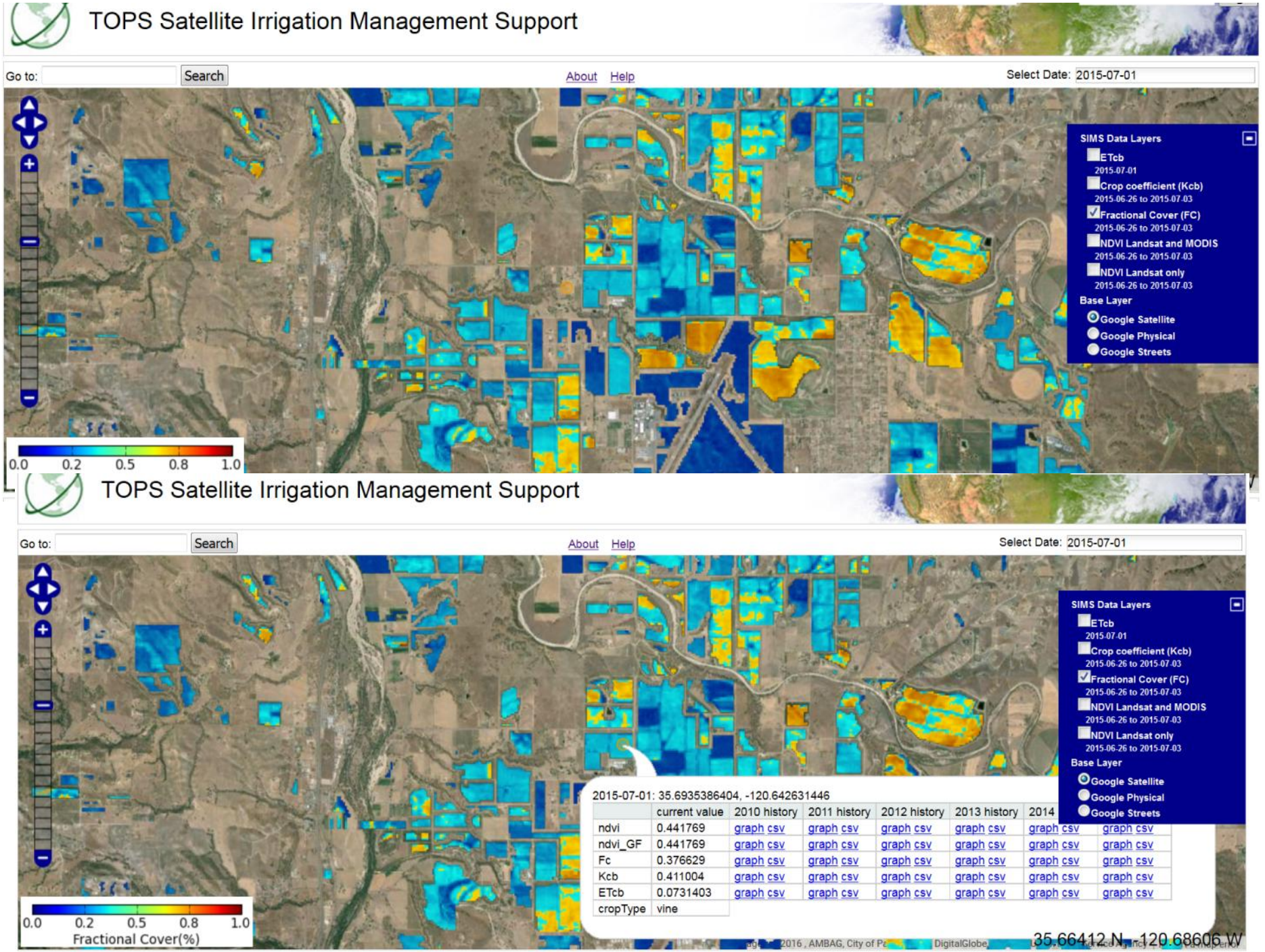
	current value	2010 history	2011 history	2012 history	2013 history	2014 history
ndvi	0.500859	graph csv	graph csv	graph csv	graph csv	graph csv
ndvi_GF	0.500859	graph csv	graph csv	graph csv	graph csv	graph csv
Fc	0.500859	graph csv	graph csv	graph csv	graph csv	graph csv
Kcb	0.767559	graph csv	graph csv	graph csv	graph csv	graph csv
ETcb	0.208233	graph csv	graph csv	graph csv	graph csv	graph csv
cropType	almond					

Disclaimer: This data is for research and evaluation purposes only.

NASA Official: Ramakrishna R.Nemani Curator: Forrest Melton Privacy Statement

Satellite Irrigation Management Support (SIMS) Framework




TOPS Satellite Irrigation Management Support
Go to:
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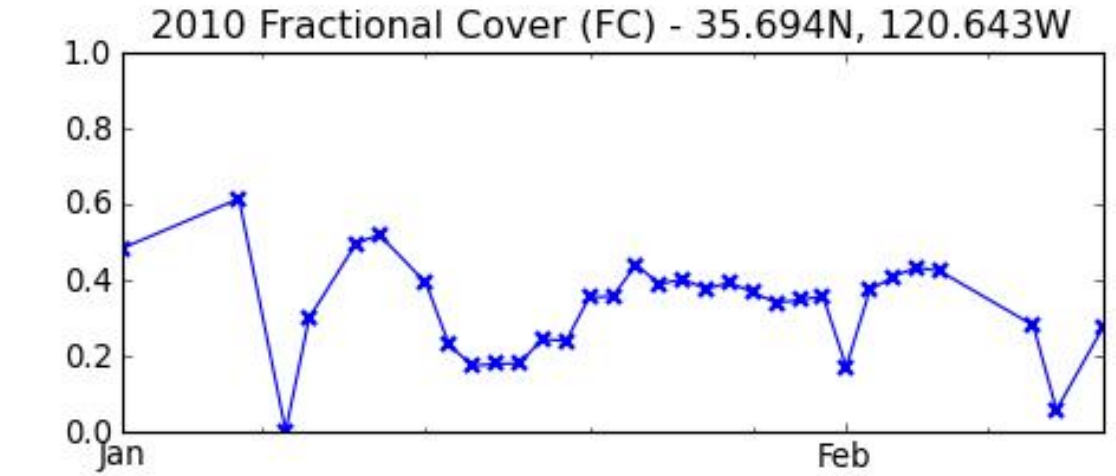
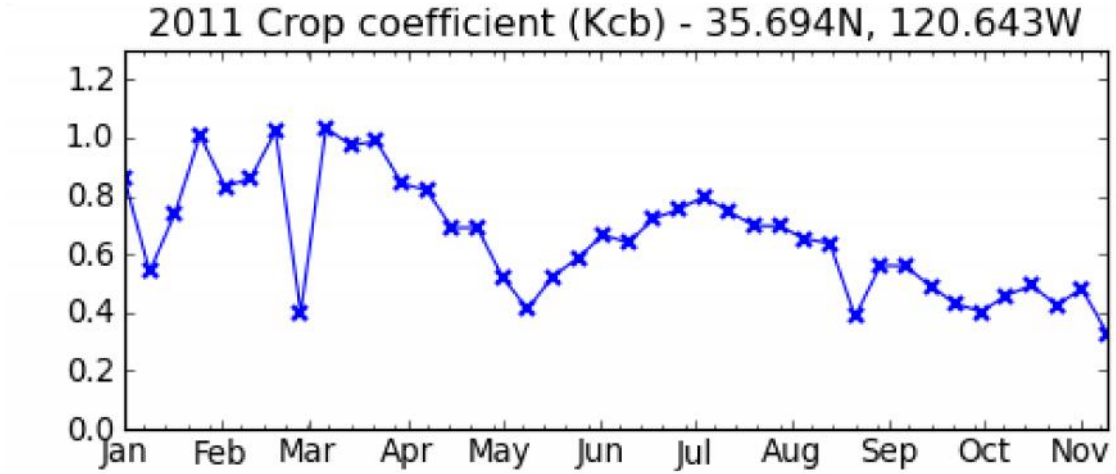
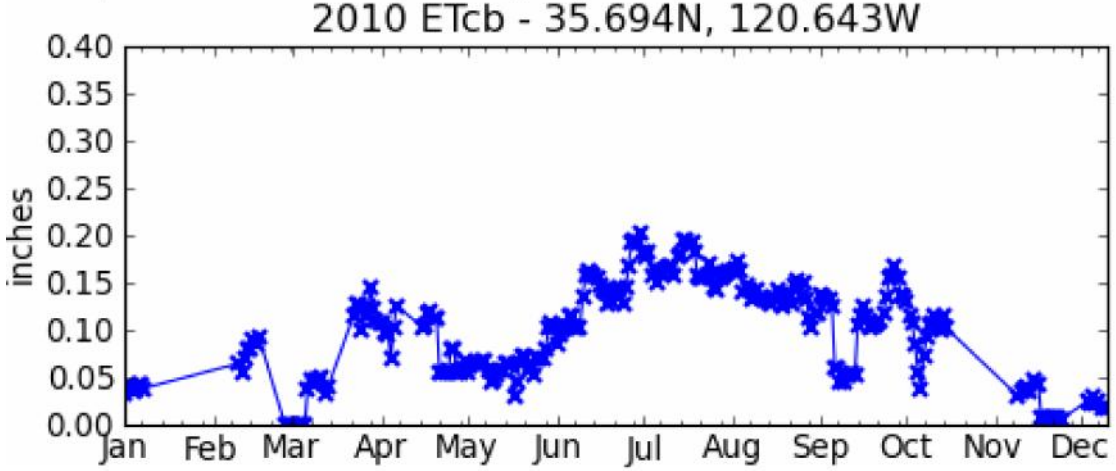
Select Date: 2015-07-01
SIMS Data Layers
ETcb
2015-07-01
Crop coefficient (Kcb)
2015-06-26 to 2015-07-03
Fractional Cover (FC)
2015-06-26 to 2015-07-03
NDVI Landsat and MODIS
2015-06-26 to 2015-07-03
NDVI Landsat only
2015-06-26 to 2015-07-03
Base Layer
Google Satellite
Google Physical
Google Streets
0.0 0.2 0.5 0.8 1.0
Fractional Cover(%)
2015-07-01: 35.6935386404, -120.642631446
current value
2010 history
2011 history
2012 history
2013 history
2014
ndvi 0.441769
ndvi_GF 0.441769
Fc 0.376629
Kcb 0.411004
ETcb 0.0731403
cropType vine
graph csv
35.66412 N, 120.68606 W


2010 Fractional Cover (FC) - 35.694N, 120.643W
1.0
0.8
0.6
0.4
0.2
0.0
Jan
Feb


2011 Crop coefficient (Kcb) - 35.694N, 120.643W
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov


2010 ETcb - 35.694N, 120.643W
inches
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fixed wing fly over

- Usually once a week
- Less cloud interference
- Cost
- Resolution of meters or centimeters

Unmanned Aerial Vehicles

- Highest resolution
- Always under cloud layer
- Cost
- Resolution of centimeters

CIMIS

California Irrigation Management Information System

- **Where is the nearest station?**
  - **Atascadero Station 163**
  - **Blackwells Corner Station 54**
  - **Kettleman Station 21**

7/12-7/18	ETo	Kc	ETc	Gal./Vine /Ac-in	Gal. lost
Atascadero	1.4	0.4	0.6	25.0	14.9
Blackwells Corner	2.1	0.4	0.9	25.0	22.4
Kettleman	2.1	0.4	0.9	25.0	22.8

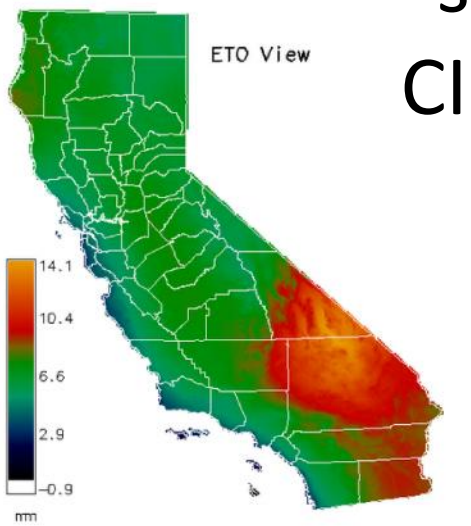
Spatial CIMIS

5915 El Camino Real, Atascadero, CA 93422(35.4897, -120.6704)

Date	ETo (in)	Sol Rad Avg (Ly/day)
7/1/2015	0.17	407
7/2/2015	0.25	713
7/3/2015	0.24	724
7/4/2015	0.23	724
7/5/2015	0.23	722
7/6/2015	0.22	711
7/7/2015	0.24	731
7/8/2015	0.23	722
Tots/Avgs	1.81	682

6169 Airport Rd, Paso Robles, CA 93446(35.6994, -120.6360)

Date	ETo (in)	Sol Rad Avg (Ly/day)
7/1/2015	0.18	378
7/2/2015	0.26	650
7/3/2015	0.26	719
7/4/2015	0.25	719
7/5/2015	0.25	714
7/6/2015	0.24	705
7/7/2015	0.25	715
7/8/2015	0.25	720
Tots/Avgs	1.94	665



Resolution = 2 km^2

Combination of geostationary satellite data and CIMIS station data

The “Paso Panel”

- Developed by UCCE Viticultural Adviser Mark Battany
- Relatively easy to build
- Relatively inexpensive
- Easy to use
- Hard data

Measuring Shade with Visual Estimation

- Sample at solar noon
- Lay “ruler” in shaded area
- Estimate the Gap Fraction
  - Amount of light within the shade area subtracted from the shaded area
- Percent shade =

  (Length of shade / Row width) X Gap Fraction X 100

Measuring Shade with Visual Estimation

8 ft. row

2 ft. shaded area

25% gaps

Means 25% shaded area, but only 75% of that is shade.

0.25 X 0.75 X 100 = 18.75% shaded area

Equals a K_c of 0.32

Estimating Vine Water Use:

The Quest for the Elusive K_c