Calculator for Water Sustainability Metrics in California Agriculture

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Adapted from: 2014 EWRI Congress

Sustainability evaluation efforts

- Standardized system for measuring/reporting performance
- Identify opportunities for increased efficiency / cost reduction
- Foster innovation & adoption of sustainable practices

State of California
The Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Statewide Integrated Water Management
Water Use and Efficiency Branch

A Proposed Methodology for Quantifying the Efficiency of Agricultural Water Use

A report to the Legislature pursuant to
Section 10608.64 of the California Water Code

Calif. Water Conservation Act of 2009

May 8, 2012

Edmund G. Brown Jr.	John Laird	Mark W. Cowin
Governor	Secretary for Natural Resources	Director
State of California	The Natural Resources Agency	Department of Water Resources

Charge: "…develop & report a proposed methodology for quantifying the efficiency of agricultural water use…"

Recommended metrics

Method for quantifying efficiency of agricultural water use[2]
Crop consumptive use fraction (CCUF) *Method evaluates the relationship between the consumptive use of a crop and the quantity of water applied.* $CCUF = ETAW/(AWb)$
Agronomic water use fraction (AWUF) *Method evaluates the relationship between the consumptive use plus the agronomic use of a crop and the quantity of water applied.* $AWUF = [ETAW+AU]/(AWb)$
Total water use fraction (TWUF) *Method expands on the CCUF by including water for crop agronomic use and to meet environmental objectives.* $TWUF = (ETAW+AU+EU)/AWb$
Water management fraction (WMF) *Method estimates the recoverable water available for reuse at another place or time in the system.* $WMF = (ETAW+ RF)/AWb$

Source: CDWR

Crop Consumptive Use Fraction (CCUF)

Method 1: Crop Consumptive Use Fraction (CCUF). *Purpose:* It quantifies the efficiency of water use for the purpose of crop evapotranspiration. It evaluates the relationship between the consumptive use of a crop and the quantity of water applied within the boundary. Method 1 is recommended for field, water supplier, and basin scales.

Equation 1
$$CCUF = [ETAW]/[AW]$$

where ETAW and AW are in units of inches per year or acre-feet per year

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- CCUF is calculated where **Evapotranspiration of Applied Water (ETAW)** is crop evapotranspiration minus the amount of precipitation evapotransipred by the crop,

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Equation 1-A
$$ETAW = ET - Pe$$

where ET and Pe are in inches per year or acre-feet per year

<u>Source</u>: CDWR

Consumptive use

"**Consumptive use** refers to water that is unavailable for reuse, e.g., evaporation, plant evapotranspiration, incorporation into plant biomass, seepage to a saline sink, or unavailability due to contamination." (CDWR)

Computational approach
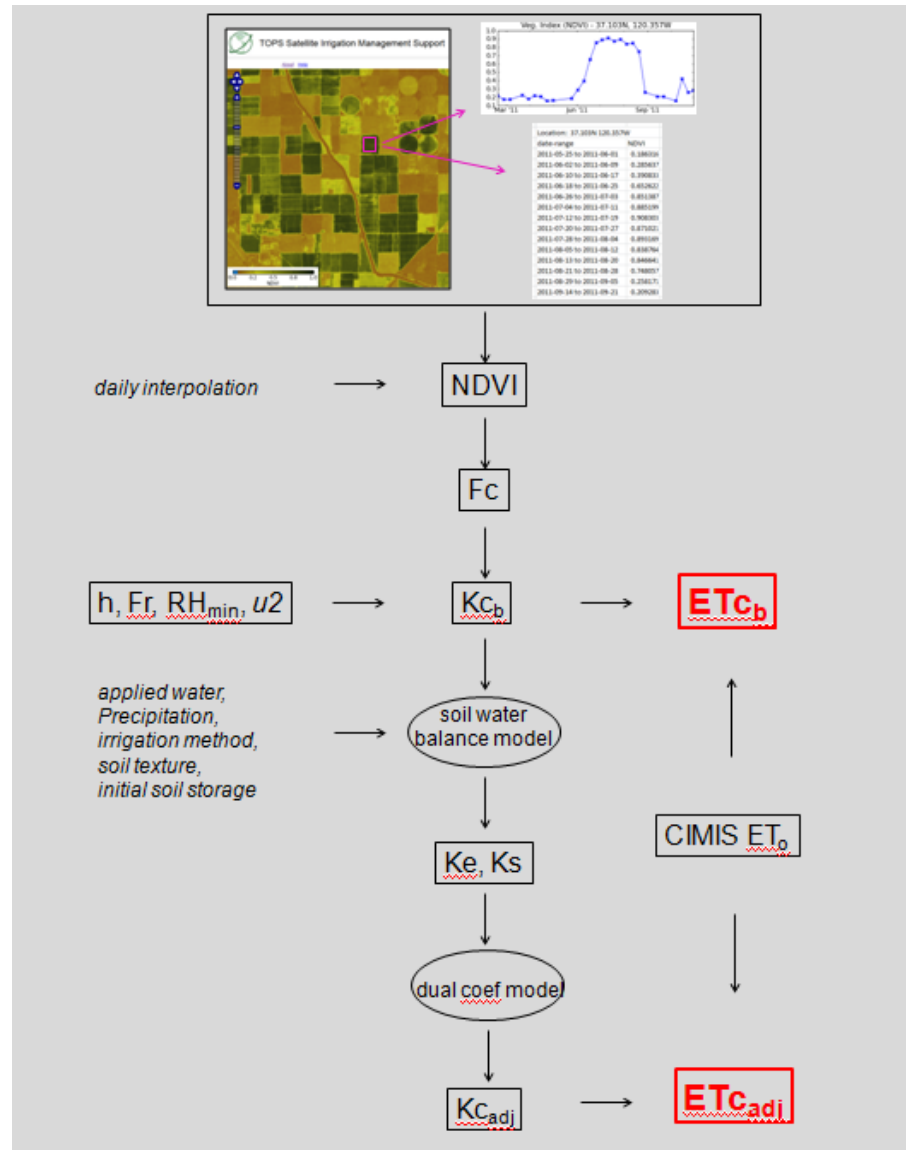
Accuracy assessment, seasonal ET
Preliminary results from 2011-2012.
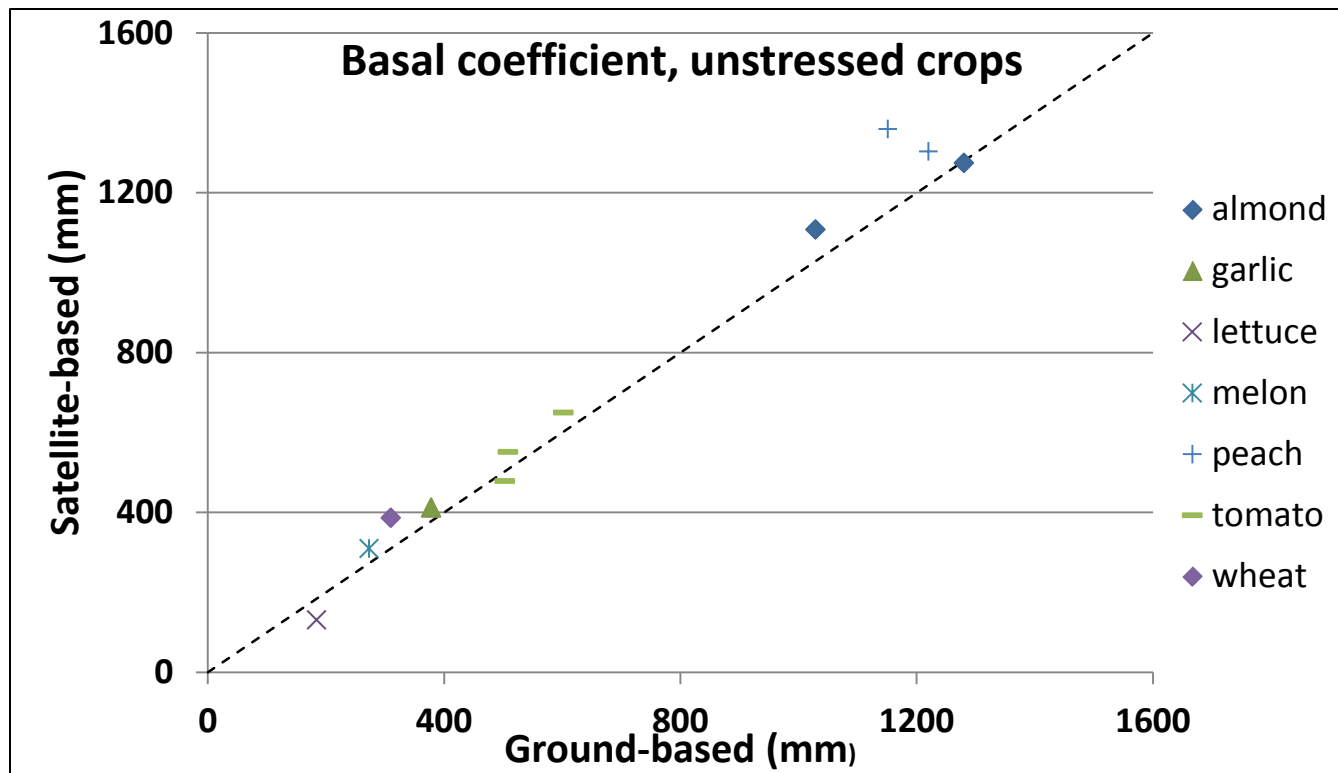
Accuracy assessment, seasonal ET

Preliminary results from 2011-2012.
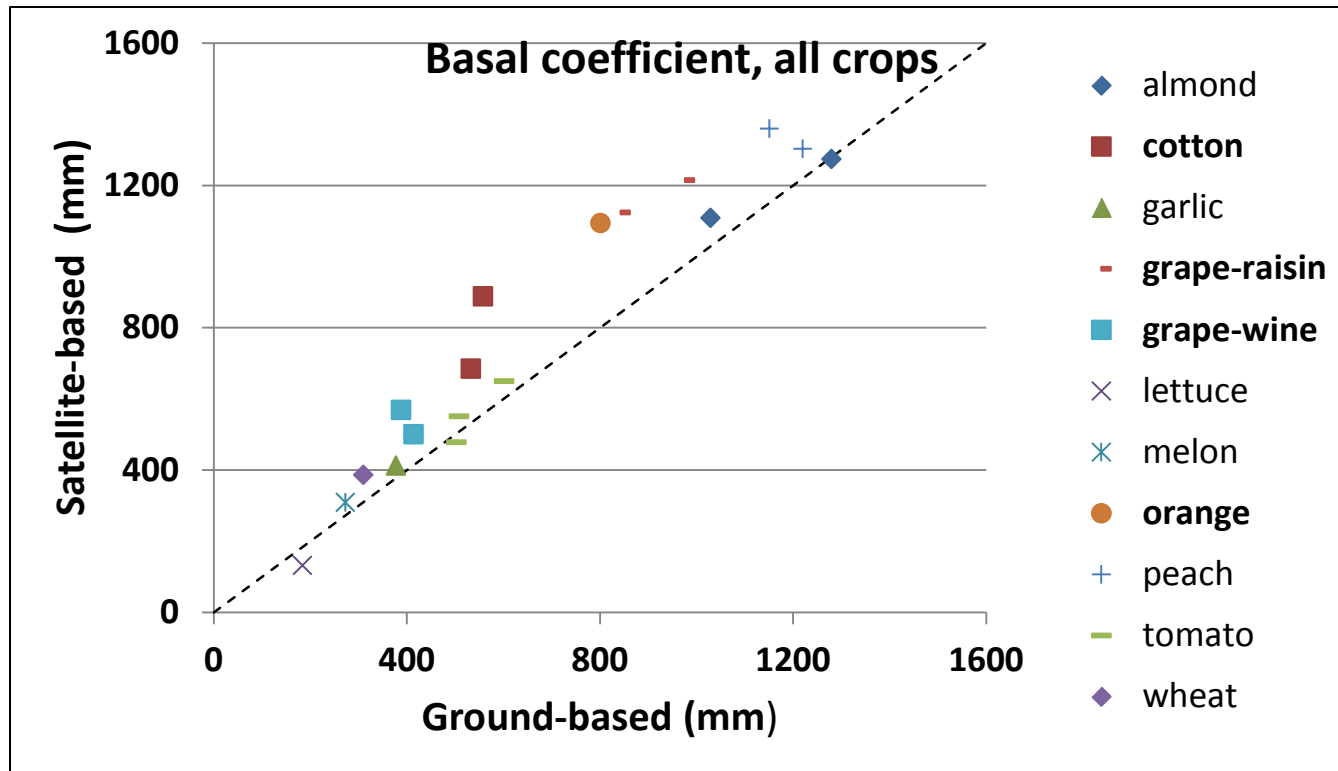
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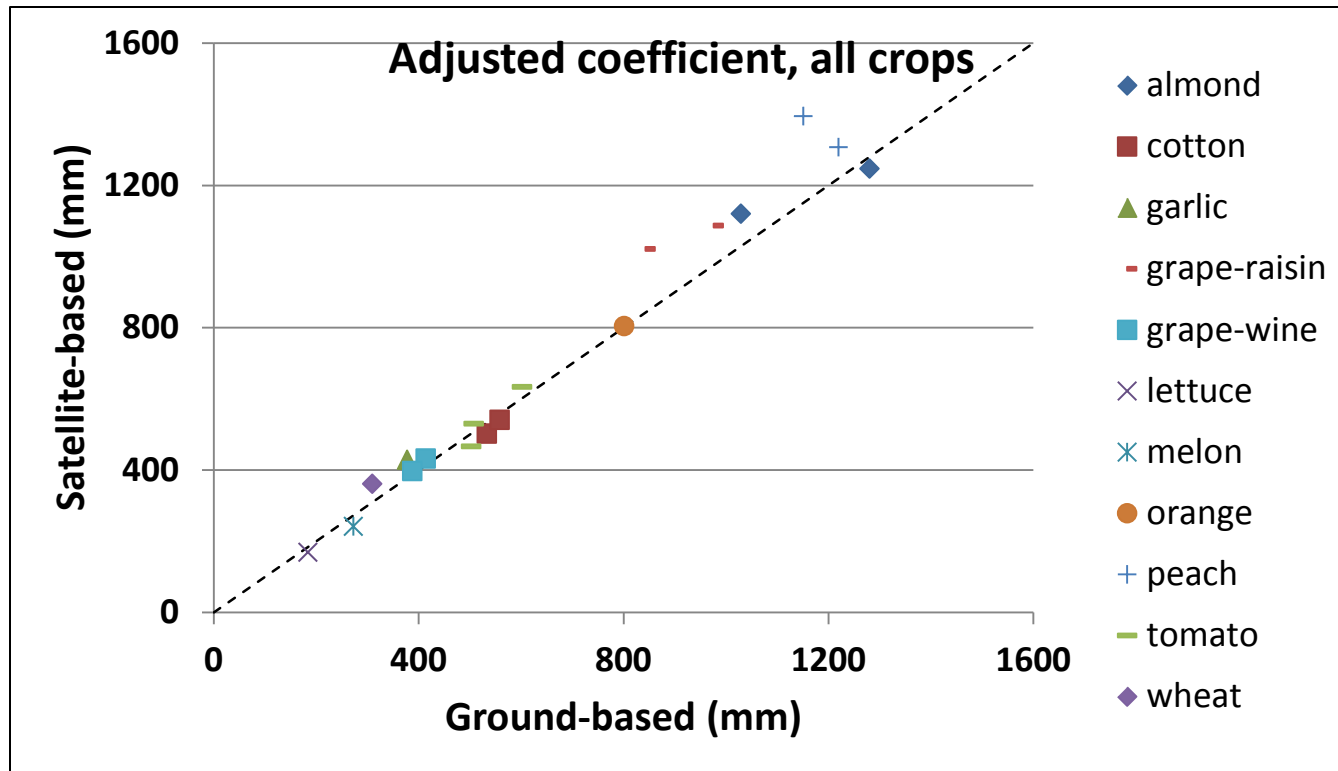
Calculator output
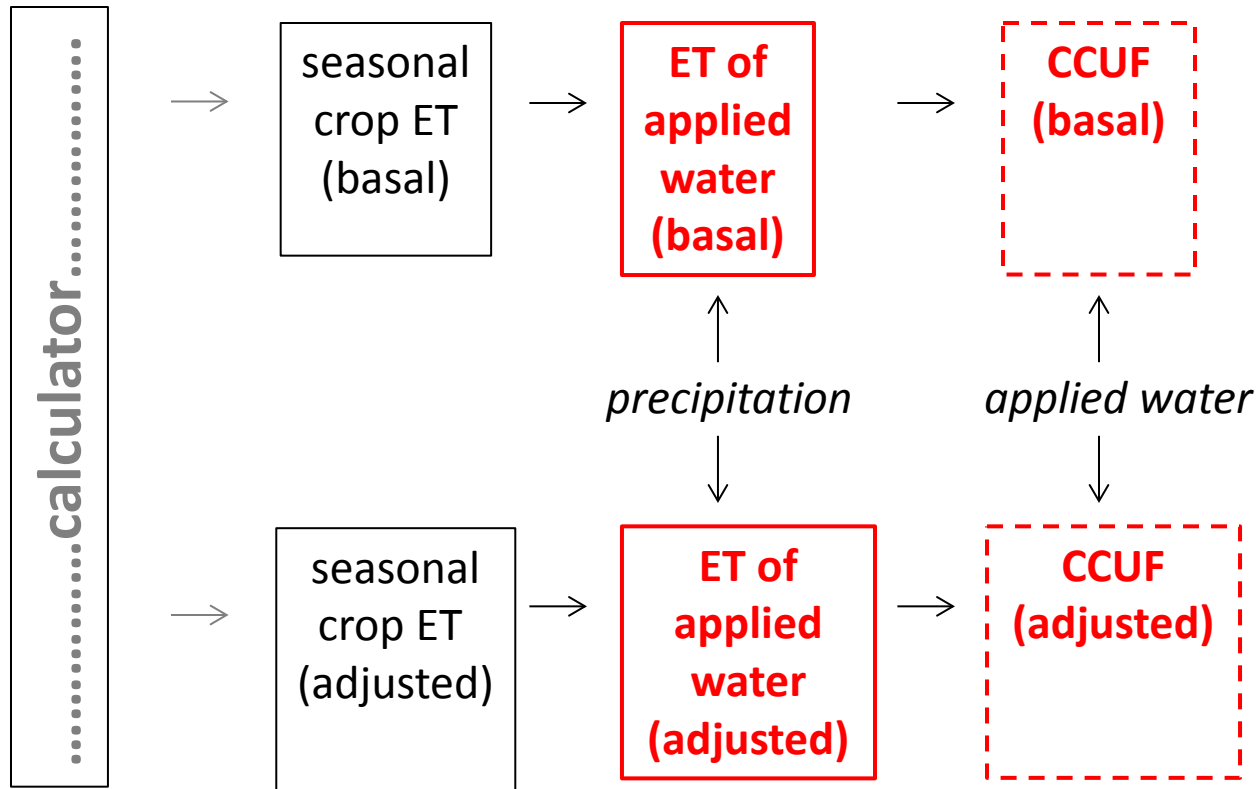
Calculator modules

- Basal ET
- Adjusted ET
- Default data 'warehouse'
- User guide

User input for basal calc's

- Crop type (almond, broccoli, cotton, garlic, grape-table/raisin, grape-wine, lettuce, orange, peach, tomato, melon, wheat)

- Region (San Joaquin Valley, Sacto Valley, North Coast, Central Coast)

- Main growing season (spring/summer, fall/winter)

- Reference ET (from CIMIS, or default to historical average)

- Total precipitation (from CIMIS, other station)

- Total applied water (grower/supplier records)

- Satellite NDVI (from SIMS)

Landsat NDVI data via SIMS web service
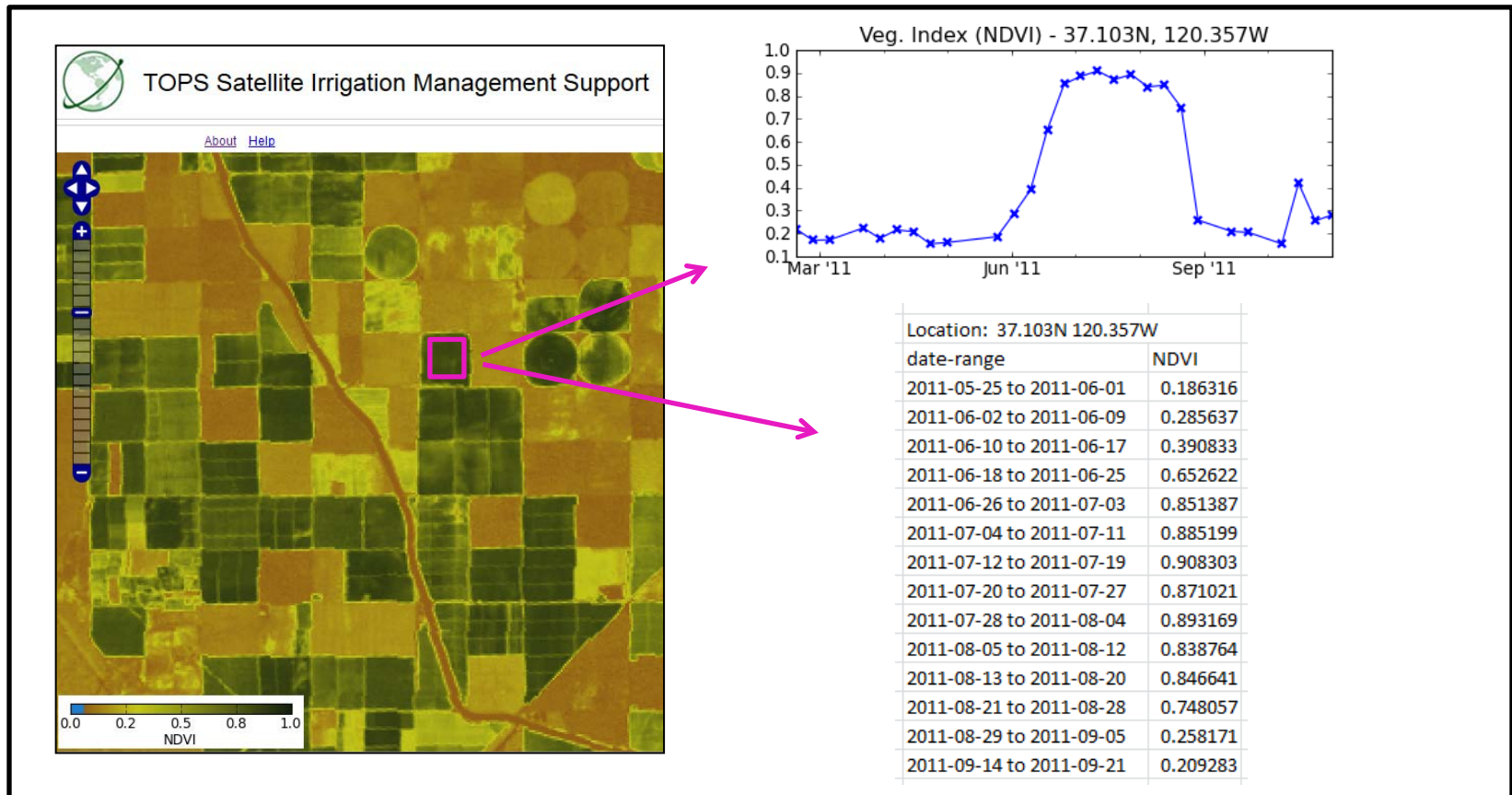
ecocast.arc.nasa.gov/dgw/sims

Landsat: 8-day revisit, ¼ acre resolution

User input for adjustments (<u>if needed</u>)

- Timing/amount of irrigation events (grower/supplier records)

- Timing/amount of precipitation events (CIMIS or other station)

- Irrigation delivery method (surface drip, subsurface drip, microjet, sprinkler, furrow, flood)

- Soil texture (from SSURGO/CaSoilWeb or grower record)

- Initial soil water storage (from soil moisture device or grower guess-timate, ie, high/medium/low)

Basal spreadsheet, user input

sims update	ndvi		crop type:	region:	mid-season period:	ETo:	view defaults	goto CIMIS	
1-Jan			broccoli	Central Coast	spring/summer	1-Jan			
9-Jan						2-Jan			
17-Jan						3-Jan			
25-Jan						4-Jan			
2-Feb						5-Jan			
10-Feb						6-Jan			
18-Feb						7-Jan			
26-Feb						8-Jan			
6-Mar						9-Jan			
14-Mar						10-Jan			
22-Mar						11-Jan			
30-Mar						12-Jan			
7-Apr						13-Jan			
15-Apr						14-Jan			
23-Apr						15-Jan			
1-May						16-Jan			
9-May						17-Jan			
17-May						18-Jan			
25-May						19-Jan			
2-Jun						20-Jan			
10-Jun						21-Jan			
18-Jun						22-Jan			
26-Jun	0.16025					23-Jan			
4-Jul	0.234751					24-Jan			
12-Jul	0.238307					25-Jan			
20-Jul	0.121565					26-Jan			
28-Jul	0.177161					27-Jan			
5-Aug	0.460034					28-Jan			
13-Aug	0.754081					29-Jan			

Basal calculations

input:

M	2
hmax	0.6
Kcb min	0.15
Fr thru mid	1
Fr end	1
late stage start	0
late stage end	999
fc rmse	0.062
mean Rhmin	47.1
mean u2	2.2

output:

ETcb cum	304

	doy	ndvi	fc	fc low	fc hi	h	Kd		Fr	Kcb full	Kcb	ETo (in)	ETcb	ETcb cum
1/1	1	0.000	0	0	0	0.062	0	0	1	1.05975	0.150	0.00	0	0
1/2	2	0.000	1											0
1/3	3	0.000	2											0
1/4	4	0.000	3											0
1/5	5	0.000	4											0
1/6	6	0.000	5											0
1/7	7	0.000	6											0
1/8	8	0.000	7											0
1/9	9	0.000	0	0	0.062				1	1.05975	0.150			0
1/10	10	0.000	1											0
1/11	11	0.000	2											0
1/12	12	0.000	3											0
1/13	13	0.000	4											0
1/14	14	0.000	5											0
1/15	15	0.000	6											0
1/16	16	0.000	7											0
1/17	17	0.000	0	0	0.062				1	1.05975	0.150			0
1/18	18	0.000	1											0
1/19	19	0.000	2											0
1/20	20	0.000	3											0
1/21	21	0.000	4											0
1/22	22	0.000	5											0
1/23	23	0.000	6											0
1/24	24	0.000	7											0
1/25	25	0.000	0	0	0	0.062	0	0	1	1.05975	0.150	0	0	0
1/26	26	0.000	1	0	0	0.062	0	0				0	0	0
1/27	27	0.000	2	0	0	0.062	0	0				0	0	0
1/28	28	0.000	3	0	0	0.062	0	0				0	0	0
1/29	29	0.000	4	0	0	0.062	0	0				0	0	0
1/30	30	0.000	5	0	0	0.062	0	0				0	0	0
1/31	31	0.000	6	0	0	0.062	0	0				0	0	0

Summary

- A spreadsheet calculator is being developed to derive Crop Consumptive Use Fraction, pursuant to Calif Water Conservation Act

- Satellite-based

- Designed to be user-friendly, flexible, and require a minimum of inputs

- Spreadsheet, runs on common desktop/laptop computers

- Anticipated delivery December 2014

Future work

- Expand to AWUF (land prep, salinity mgt, climate control), and other use fractions

- Extend to other crop types (/regions?)

- Automated linkage with external databases

- Online implementation?