

Surface Renewal Evapotranspiration Measurements



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Research Team



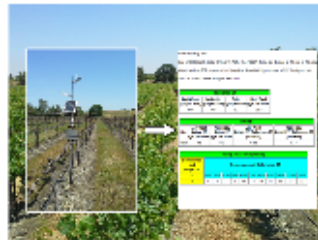
Rick Snyder
UC Davis

Kate Theisen
UC Davis

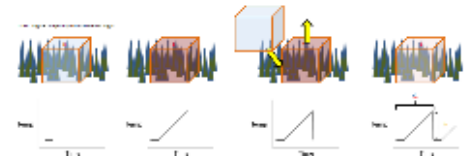
Andrew McElroy
USDA-ARS & UC Davis

Tom Reardon
Formerly UC Davis
Tale Technologies

Utility



Background



Research Team



Rick Snyder
UC Davis



Kyaw Tha Paw U
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Andrew McElrone
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Tom Shapland
Formerly UC Davis
Tule Technologies

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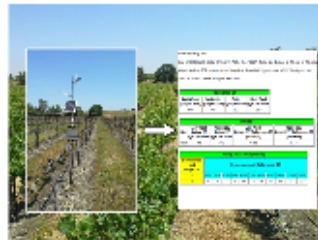
McCoy
UC Davis

Bob Theisen
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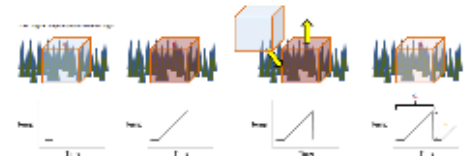
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Good morning, Tom,

See email contents below for today's Water Use Report. Terms are defined at the end of the email.

Attachments: A PDF version of this Water Use Report with figures, and a CSV file of your data.

You can interact online with your data [here](#).

Reference ET			
Last Week (gal per vine)	Yesterday (gal per vine)	Today (gal per vine)	Next Week (gal per vine)
30.4	4.9	5.2	35.5

Actual ET				
Site	Last Week Actual ET (gal per vine)	Yesterday Actual ET (gal per vine)	Last Week Actual ET / Reference ET (unitless)	Yesterday Actual ET / Reference ET (unitless)
Paso	9.8	0.9	0.32	0.18

Pump Run-Time (hours)											
Days since last irrigation	Percentage of Reference ET										
	20%	30%	40%	50%	60%	70%	80%	90%	100%	110%	120%
--											
5	4	6	7	9	11	13	15	17	19	21	22

Advantages of Actual Vineyard Evapotranspiration Measurements

Scale

Simplicity

Remote Monitor of Vine Water Status



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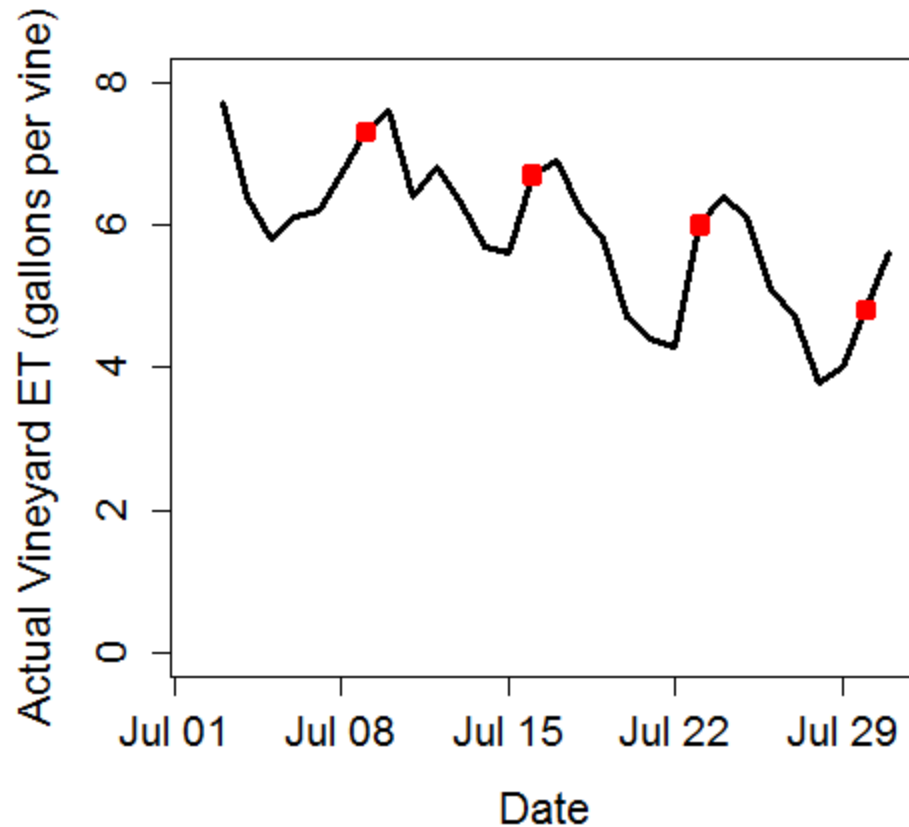
Data Product

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Site	Last Week Actual ET (gal per vine)	Yesterday Actual ET (gal per vine)	Last Week Actual ET / Reference ET (unitless)	Yesterday Actual ET / Reference ET (unitless)
CS43	9.8	0.9	0.32	0.18

Pump Run-Time (hours)											
Days since last irrigation	Percentage of Reference ET										
	20%	30%	40%	50%	60%	70%	80%	90%	100%	110%	120%
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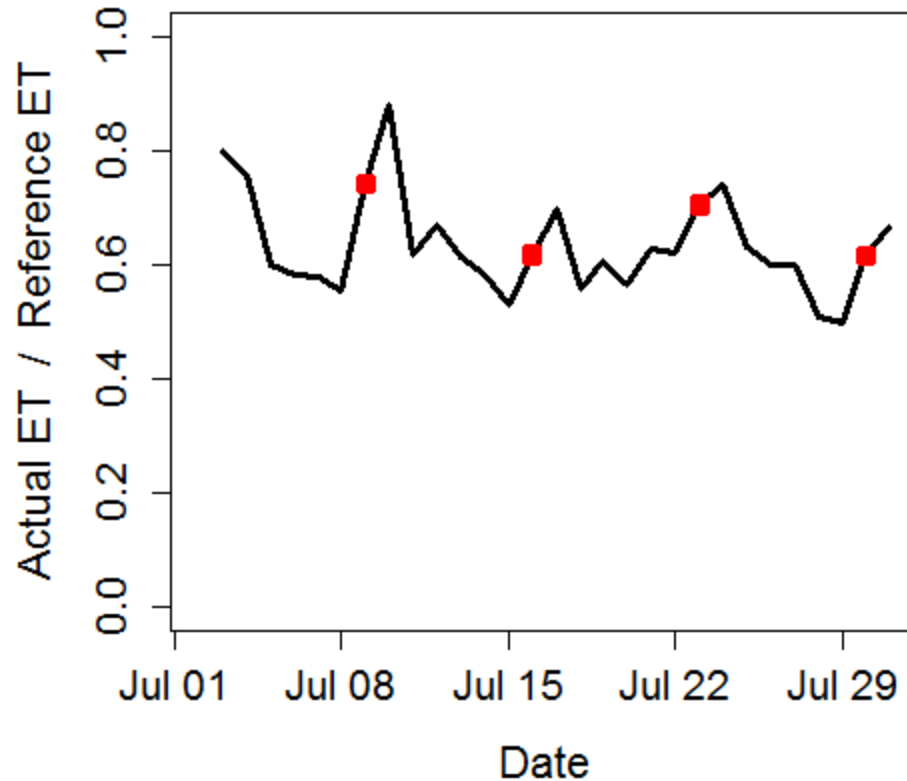
Data Product



Weather, Canopy Size, Water:
All affect Actual ET.

Red square are irrigation events

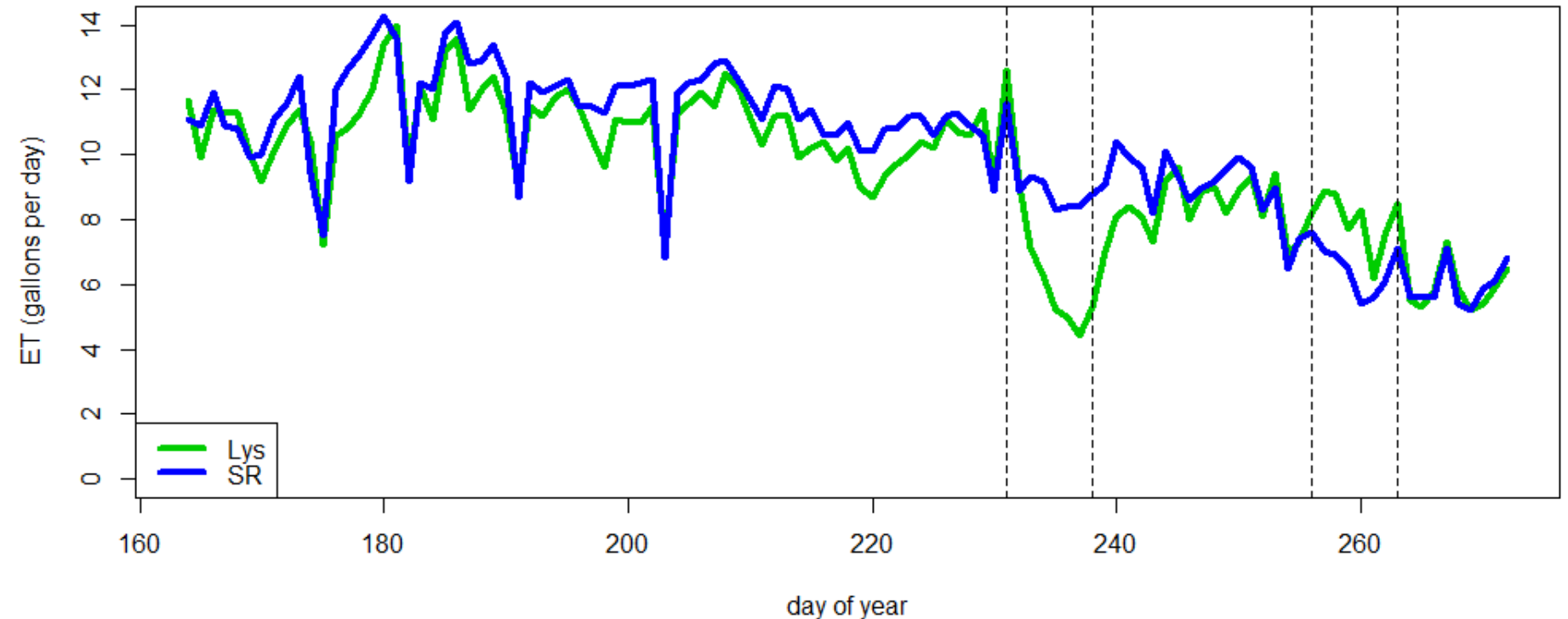
Data Product



Divide Actual ET by Reference ET to minimize weather effect
and focus on water availability

How We Know Surface Renewal Works

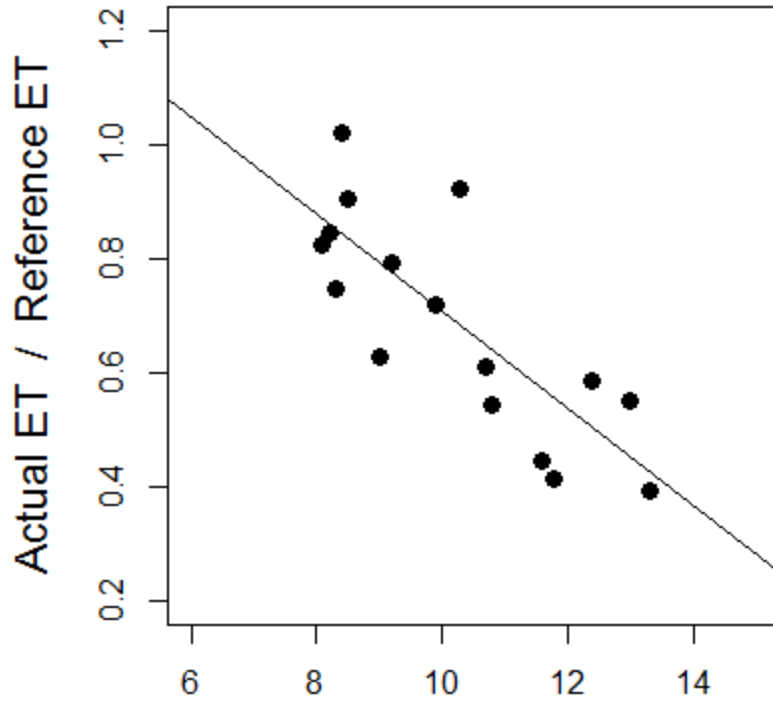
Kearney Ag Center



Irrigation treatments occur between dash vertical lines

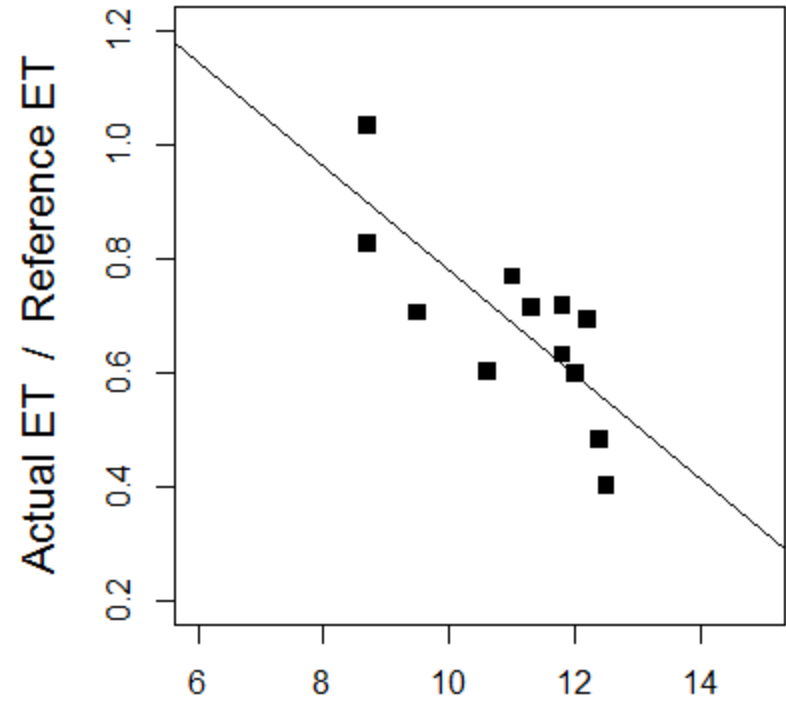
Data Product

Lysimeter



Midday Leaf Water Potential (|bars|)

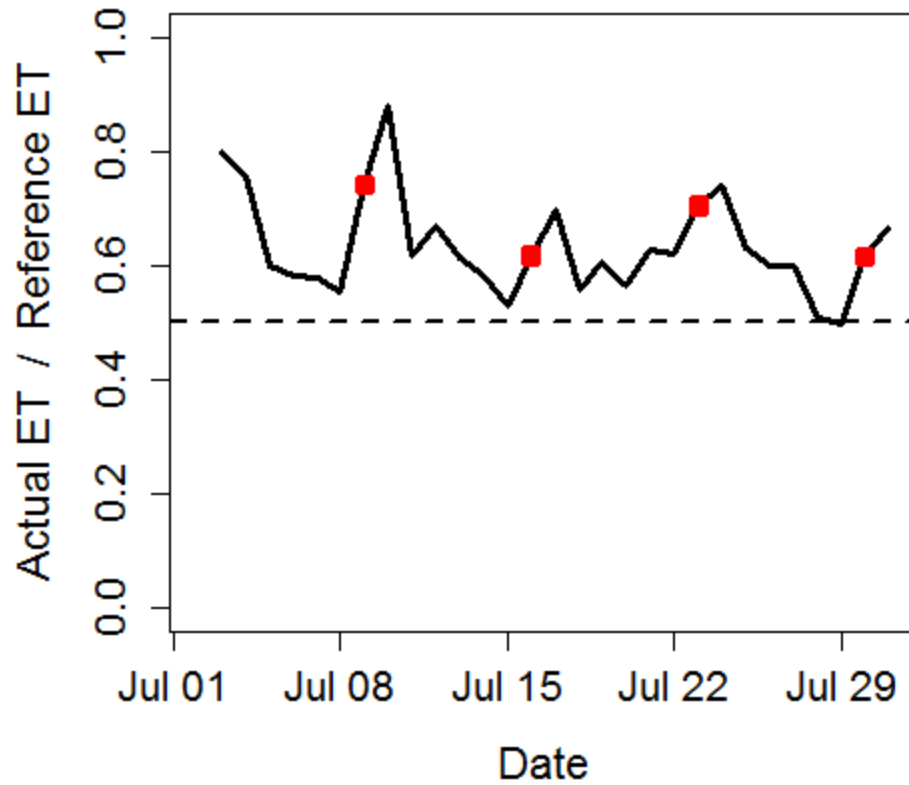
Surface Renewal



Midday Leaf Water Potential (|bars|)

Date

Data Product



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Research Team



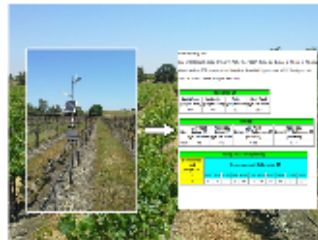
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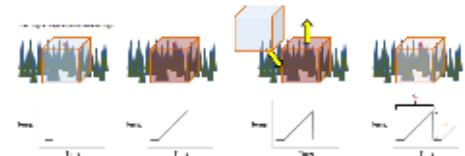
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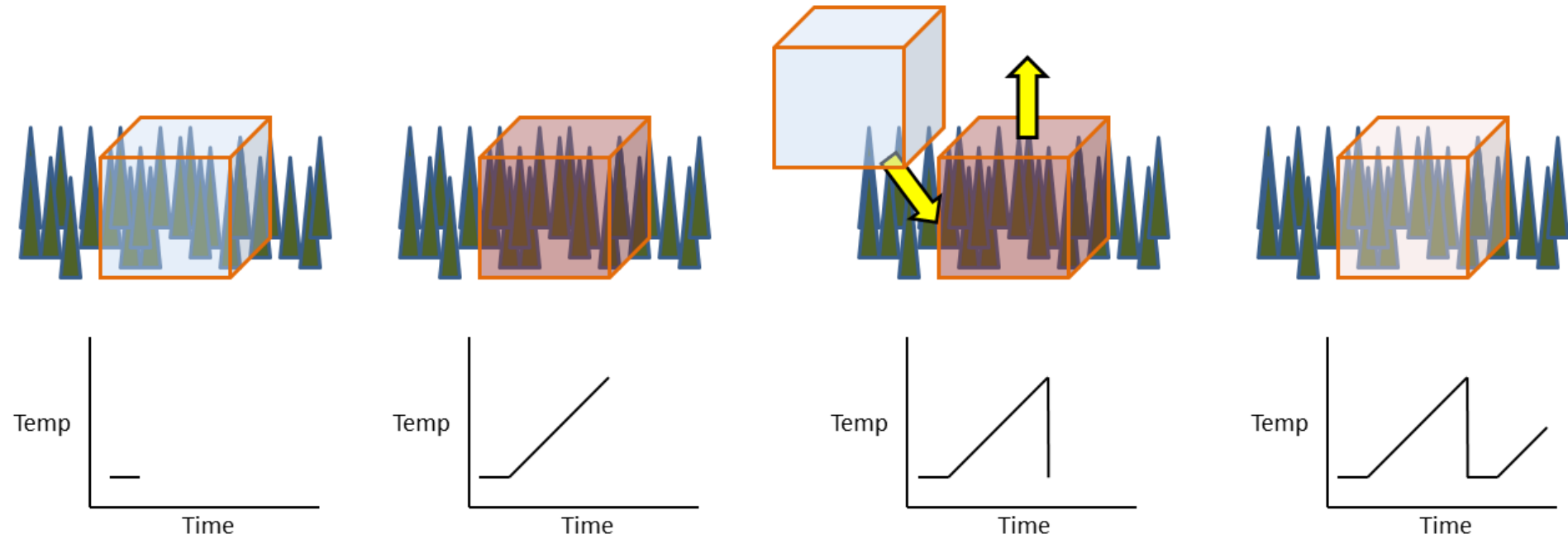
Utility



Background



Background



Energy Balance



Energy Balance

$$LE = R_n - G - H$$

Ease/Cost of
Measurement:

Easy/Cheap



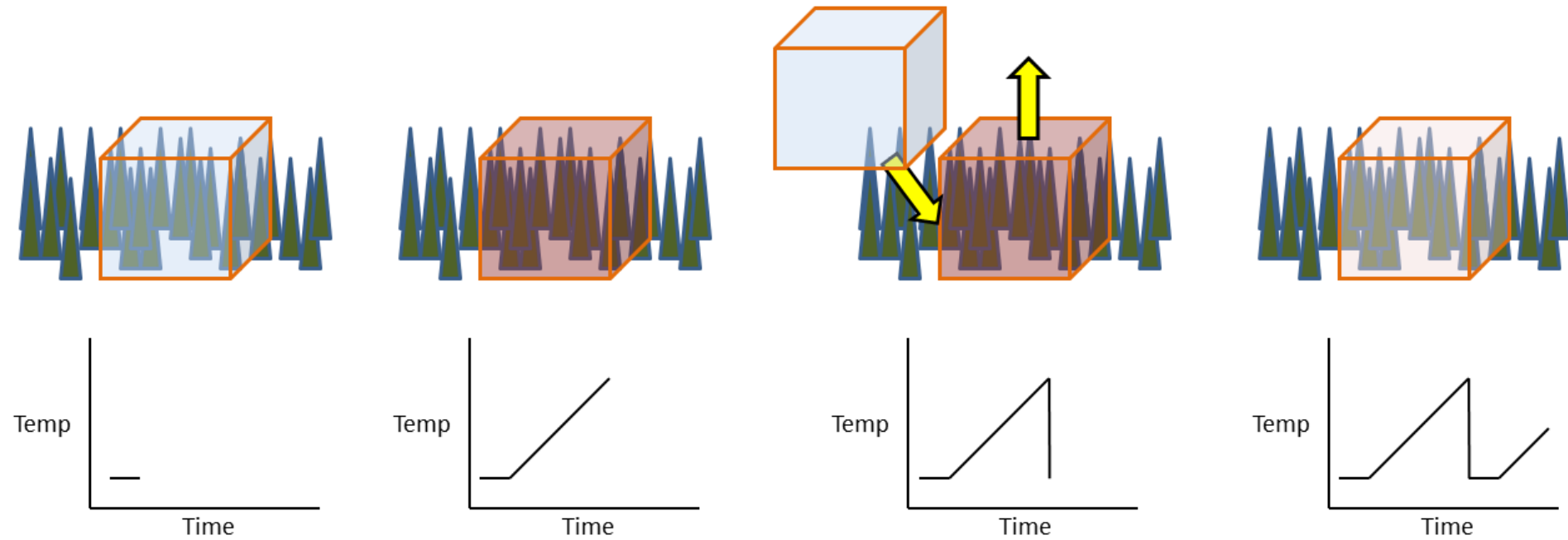
Easy/Cheap



Diff/Expensive

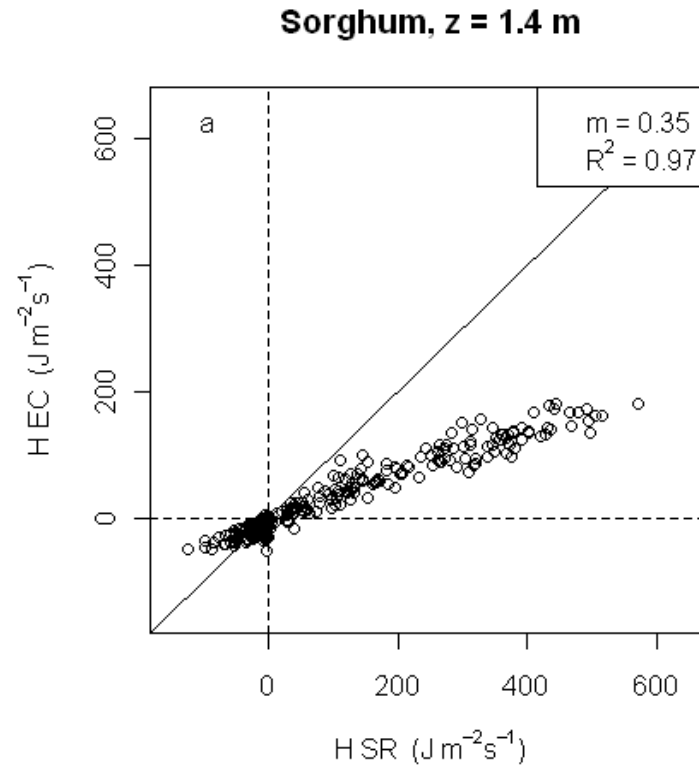


How Surface Renewal Works



Paw U et al. 1995
20 years of research over various crops.

How Surface Renewal Works



$$H = \alpha z \rho C_p \frac{a}{(d + s)}$$

Alpha calibration problem

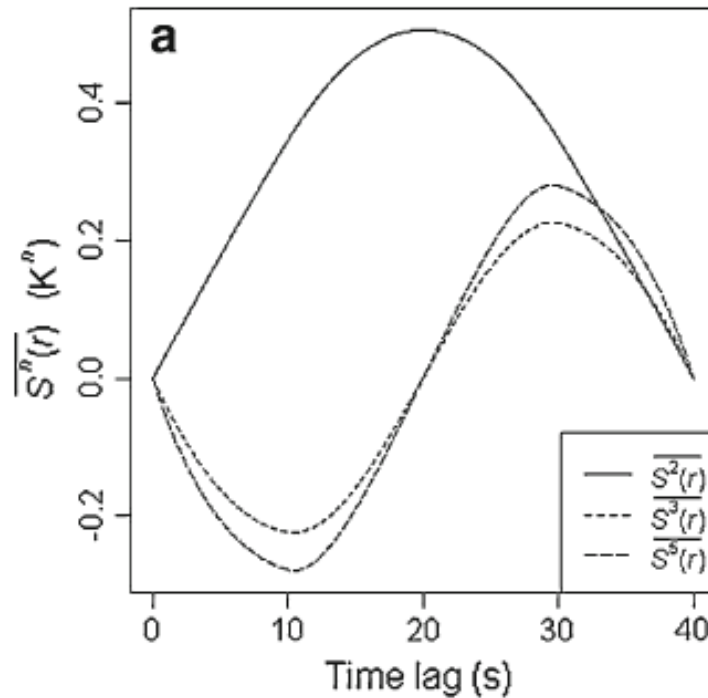
Breakthrough

$$\overline{S^n(r)_c} = \frac{1}{(d+s)_2} \left\{ \int_0^{s_2} [\Delta T(t)]^n dt + \int_{s_2}^{(d+s)_2} [\Delta T(t)]^n dt \right\}$$

$$a_j \cong \left[\frac{(d+s)_j}{r} R_j \sin \frac{2\pi r}{(d+s)_j} \right]^{\frac{1}{3}}$$

$$\frac{(d+s)_1}{\left[\frac{(d+s)_1}{(d+s)_2} + 1 \right]} = -\frac{a^3 r}{S^3(r)_c}$$

$$\overline{S^n(r)_I} = \frac{1}{L} \int \overline{S^n(r)} (K^n)$$



$$\left. \frac{[T_o(t-r)]^n}{dr} dt \right\}$$

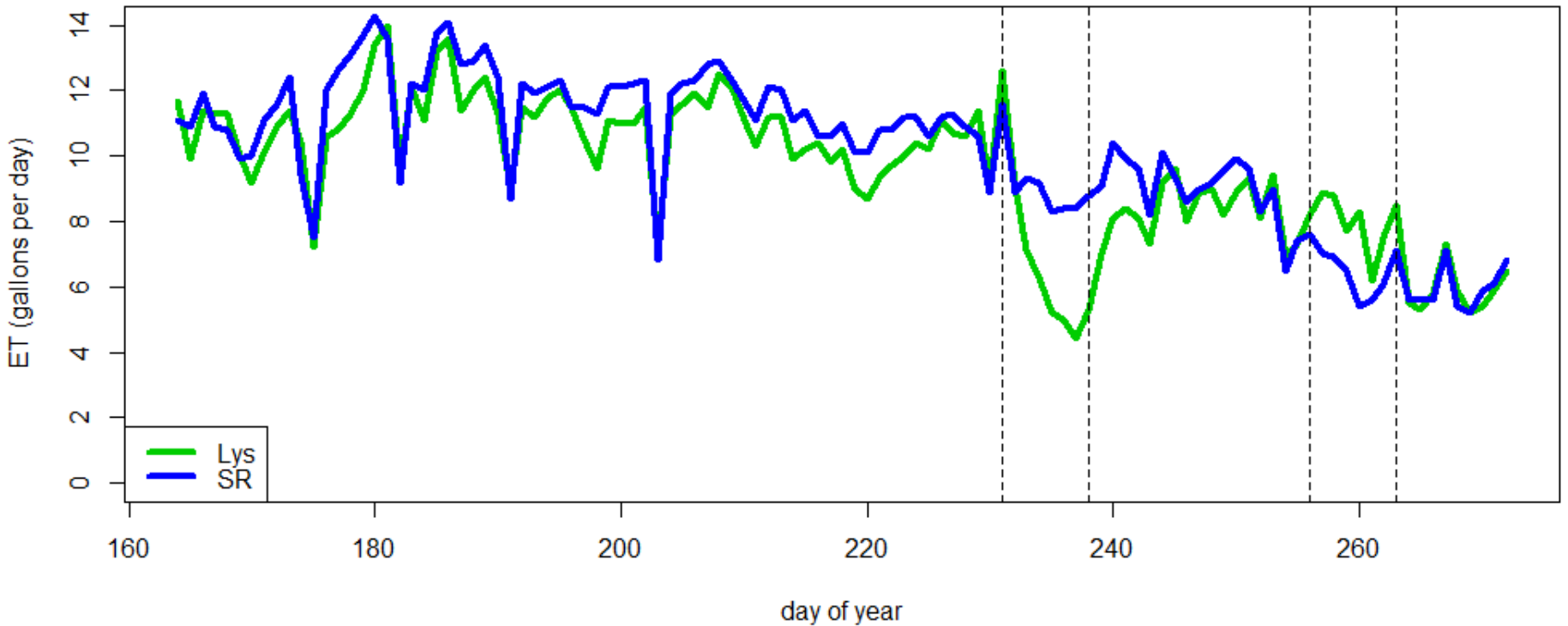
$$T_I(t) = T_O(t) + \tau \frac{dT_O}{dt}$$

$$RSNR = \frac{a^2}{S^2(r)_r} = \frac{a^2}{S^2(r) + \frac{S^3(r)}{a}}$$

$$\left(\frac{r}{d_1} \right)^3 - \frac{4(R-b^3)}{(R-b^4)} \left(\frac{r}{d_1} \right)^2 + \frac{6(R-b^2)}{(R-b^4)} \left(\frac{r}{d_1} \right) - \frac{4(R-b)}{(R-b^4)} = 0$$

How We Know Surface Renewal Works

Kearney Ag Center



Also, Esparto & Napa

Where we are now

- First commercial stations in 2013 season
- Installing stations for 2014 customers
- Tom Shapland: tmshapland@gmail.com