# Sacramento Valley Rice ET

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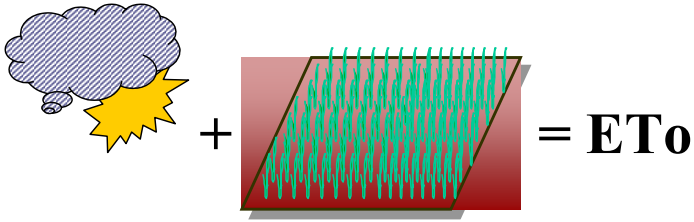
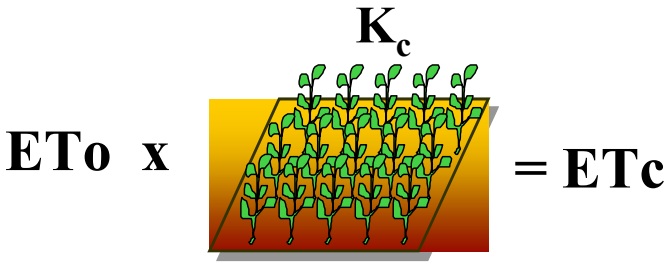
Photo East Rice 2011

# Estimating Rice ET ($ET_c$)

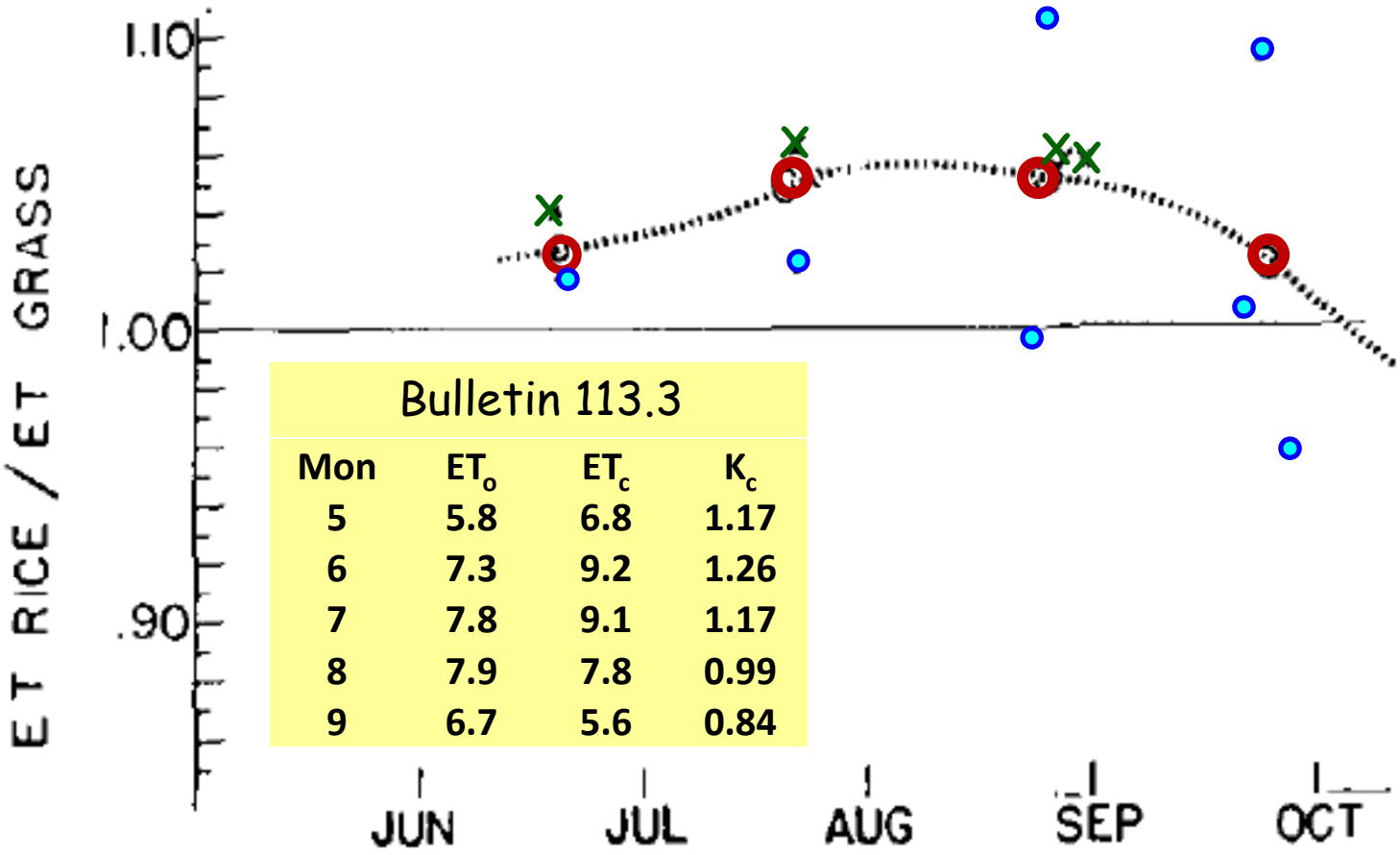



**$ET_o$ from weather**




**$ET_c = ET_o \times K_c$**

Crop Evapotranspiration is estimated as the product of reference evapotranspiration (ETo) and a crop coefficient (Kc), where the Kc is determined as Kc=ETc/ETo. ETo is an estimate of pasture ET and ETc is measured over the crop.




Bulletin 113.3

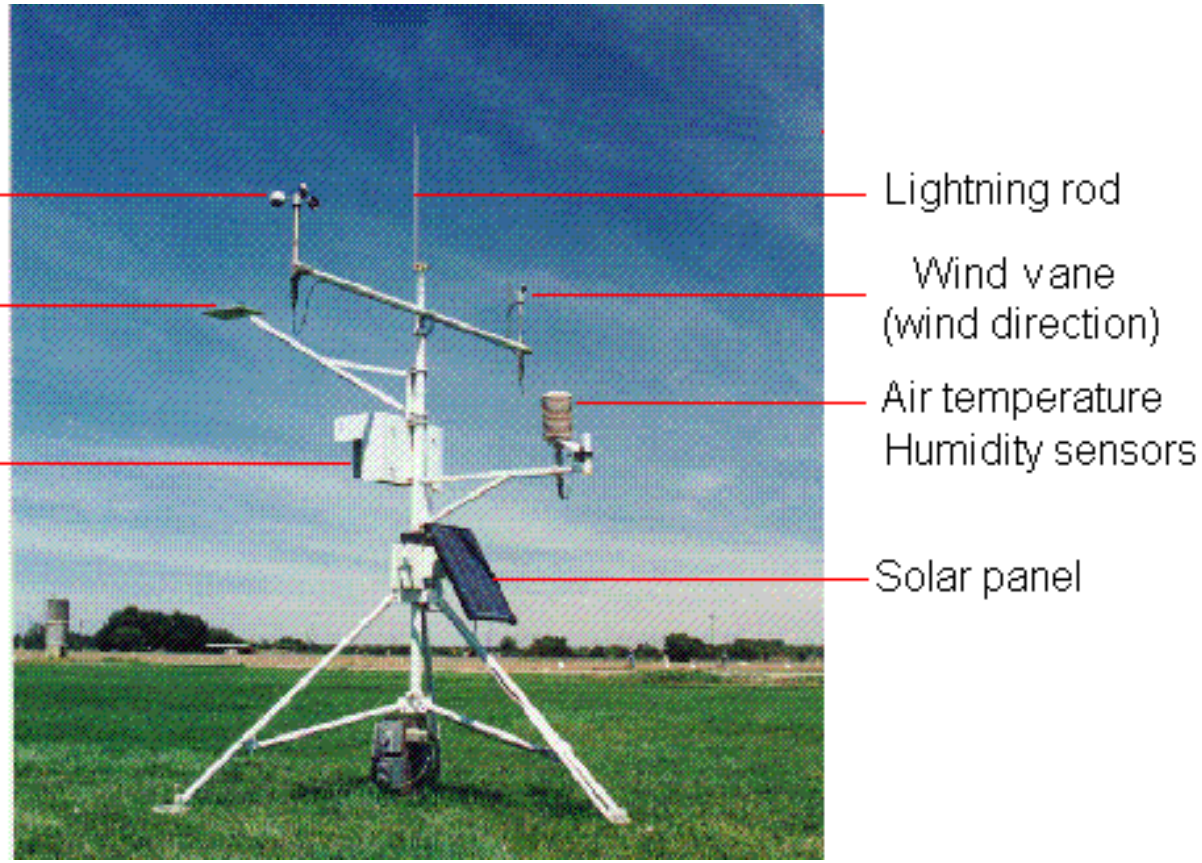
| Mon | $ET_o$ | $ET_c$ | $K_c$ |
|---|---|---|---|
| 5 | 5.8 | 6.8 | 1.17 |
| 6 | 7.3 | 9.2 | 1.26 |
| 7 | 7.8 | 9.1 | 1.17 |
| 8 | 7.9 | 7.8 | 0.99 |
| 9 | 6.7 | 5.6 | 0.84 |

**Fig. 6. Ratios of daily totals of $rice_{ET}$ to Davis $grass_{ET}$. Dots indicate 1968 ratios and "x" indicate 1969 ratios. The large open circles are the average of all the ratios for that particular month.**

Lourence and Pruitt (1970)


Chico
Z road (Butte City) 2011 & 2012
Dry Rice 2011 & 2012
East Rice (Richvale) 2011 & 2012
South Field 2008-09
North Field 2008-09
rill Seeded Plots
Williams 2011 & 2012
2000-01 Nicolaus
2007 Colusa
2008-09 Maxwell
2010 Robbins
2011-12 Richvale, REC ,
Butte City, Williams
2010 Rice Drill Plot
2000 Rice ET experiment
2001 Rice ET experiment
2010 Rice Wet seeded Plot
Knights Landing, CA

# Weather Station for $ET_o$




$ET_o$ = a measure of evaporative demand

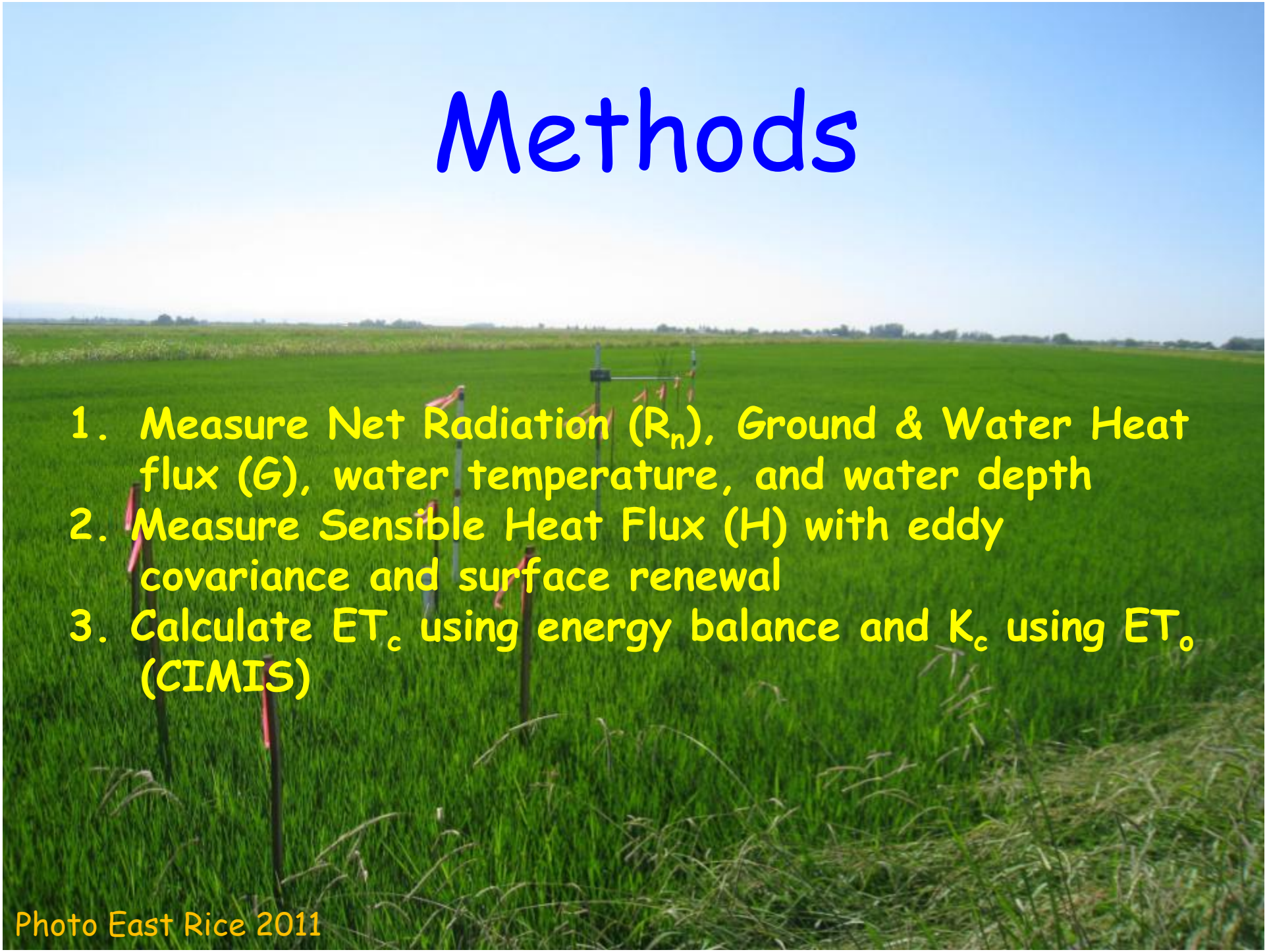
$ET_o \approx$ ET of 0.12 m tall, cool -season grass

# Research Goals

1. Validate DWR crop coefficients
2. Compare Drill vs Wet Seeded $ET_c$ (2007-10)
3. Water Temperature effects on $ET_c$ (2011-12)
4. Fallow soil evaporation (2011-12)

Photo East Rice 2011

# Methods



1. Measure Net Radiation ($R_n$), Ground & Water Heat flux (G), water temperature, and water depth
2. Measure Sensible Heat Flux (H) with eddy covariance and surface renewal
3. Calculate $ET_c$ using energy balance and $K_c$ using $ET_o$ (CIMIS)

Photo East Rice 2011

# Energy Balance

$$R_n = LE + H + G$$

$$LE = R_n - G - H$$

- **LE – Latent Heat Flux**
- **$R_n$ - Net Radiation (net radiometer)**
- **G – Water & Soil Heat Flux Density (heat flux plates, thermistors, depth)**
- **H - Sensible Heat Flux Density (sonic or surface renewal)**

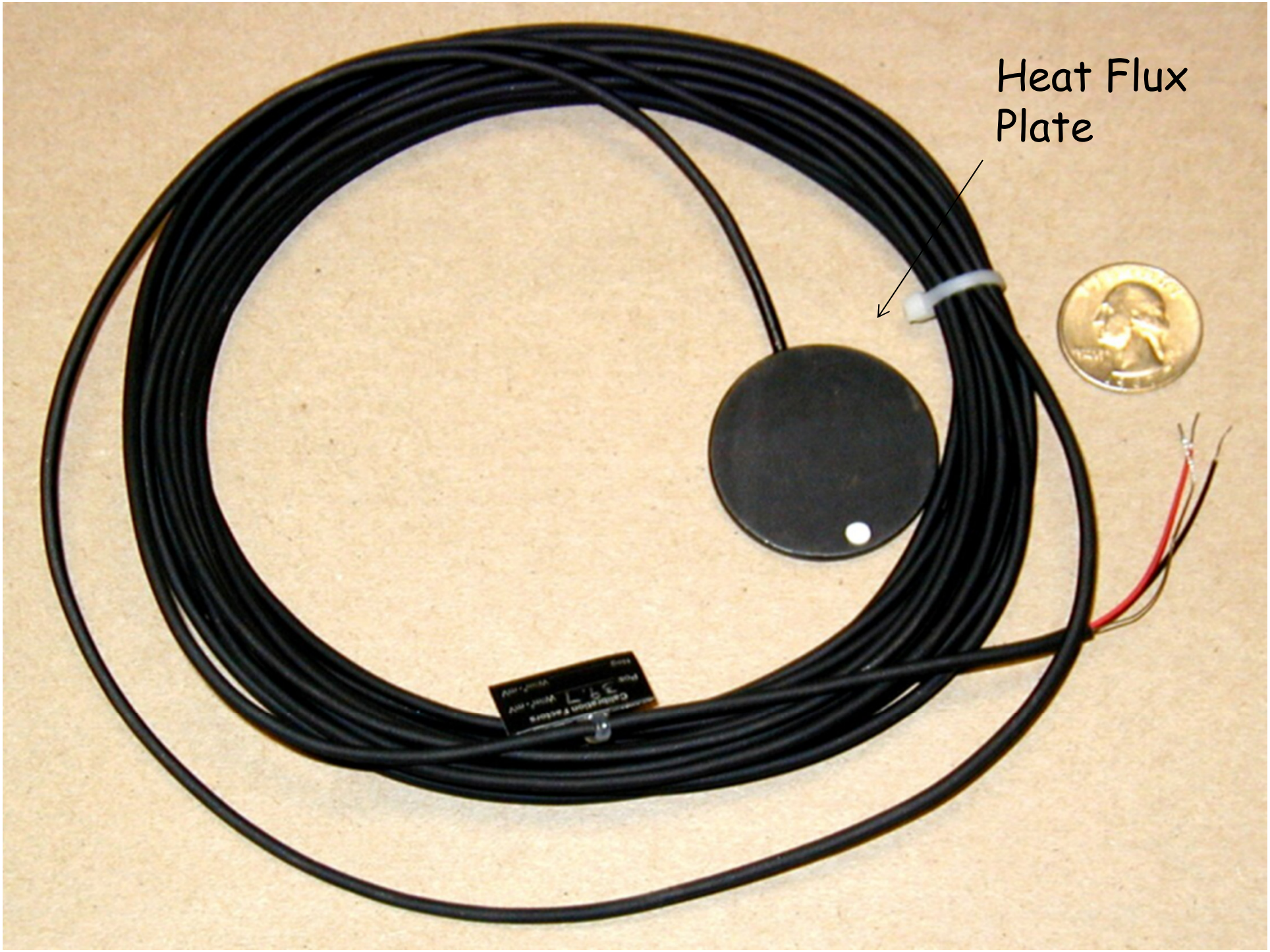
$$ET_c = LE/L \text{ where } L = 2.45 \text{ MJ kg}^{-1}$$

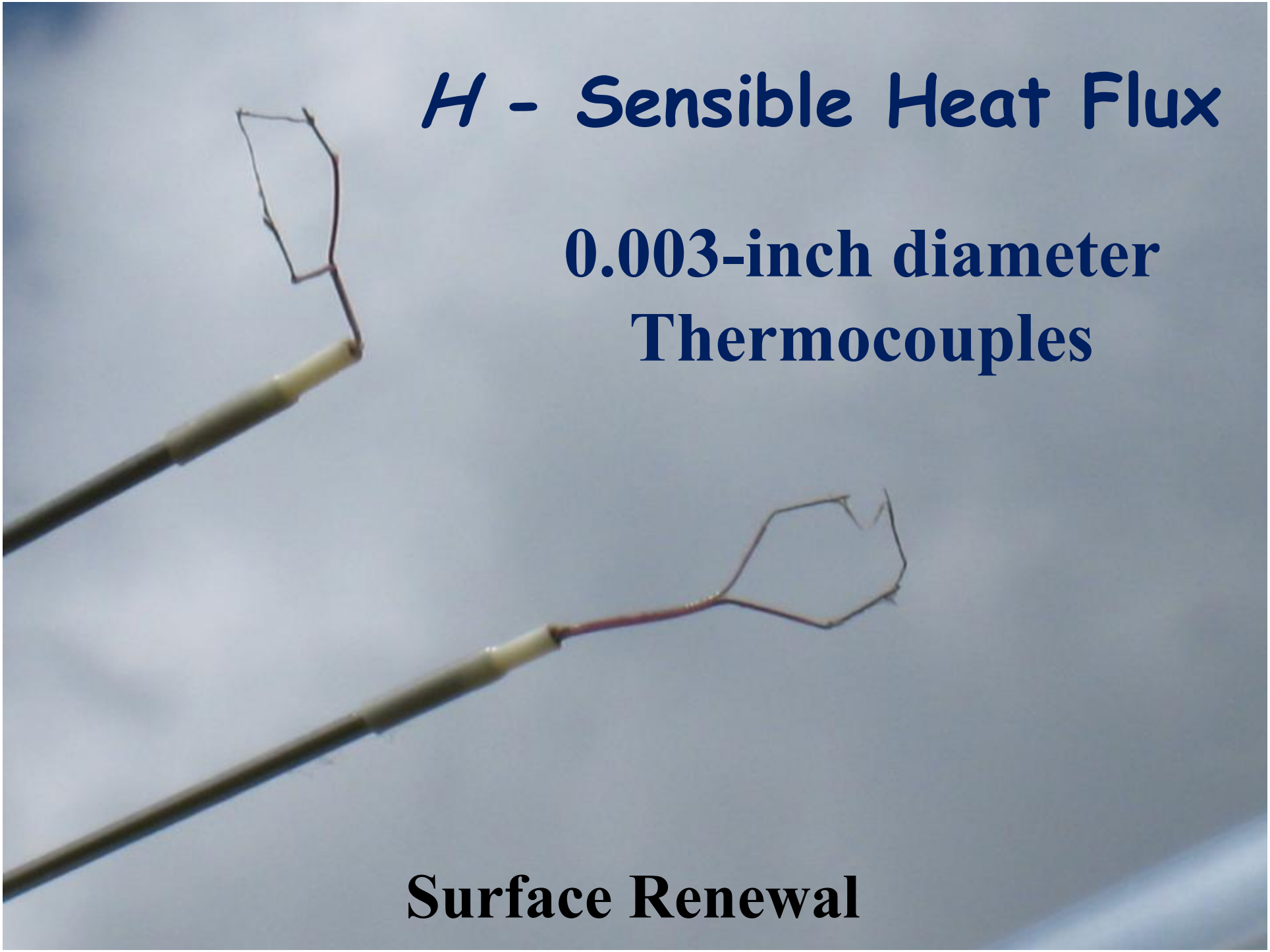

Net
Radiometer


Net Radiometer

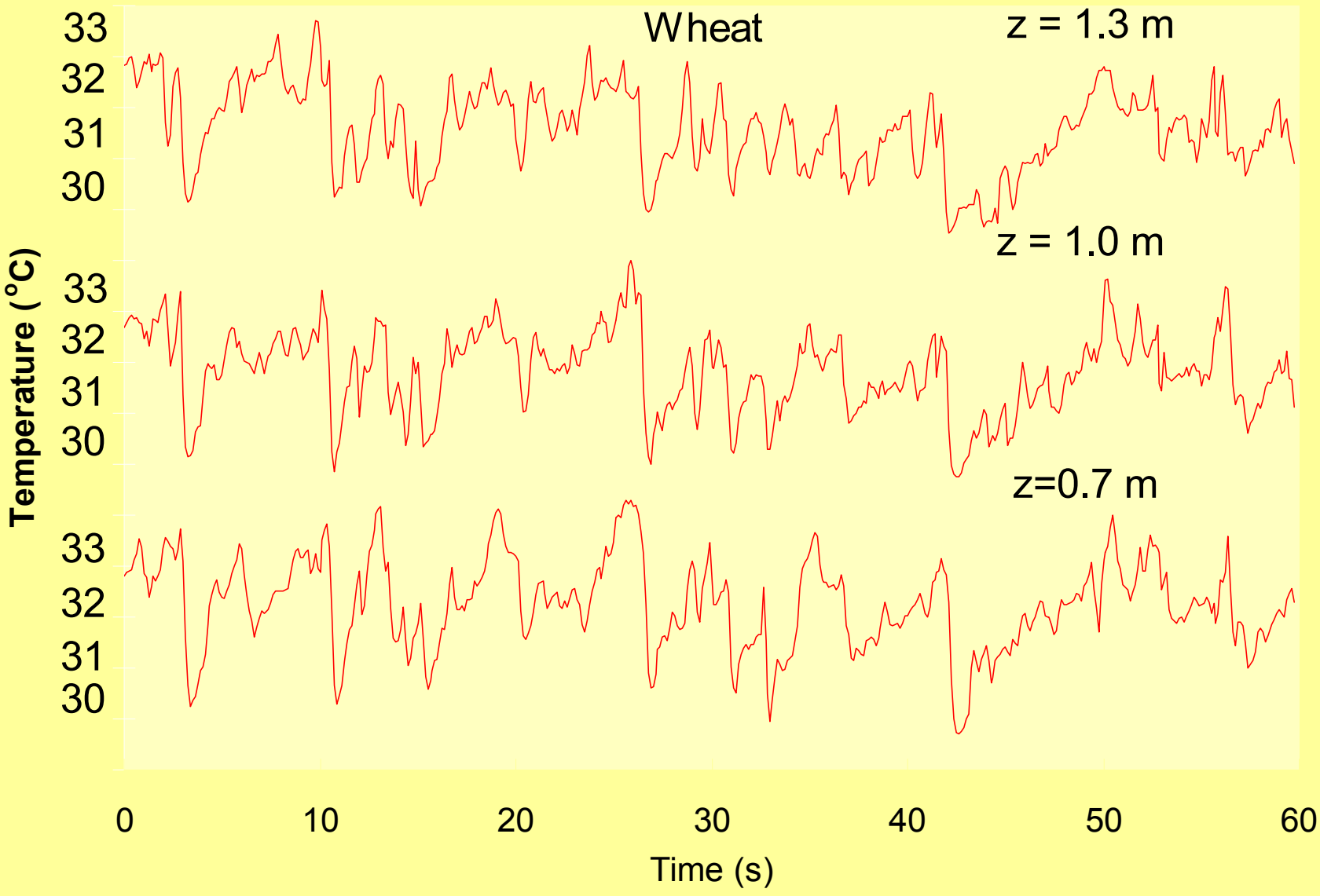
Sonic anemometer


Rotating
Water
Temperature
Recorder

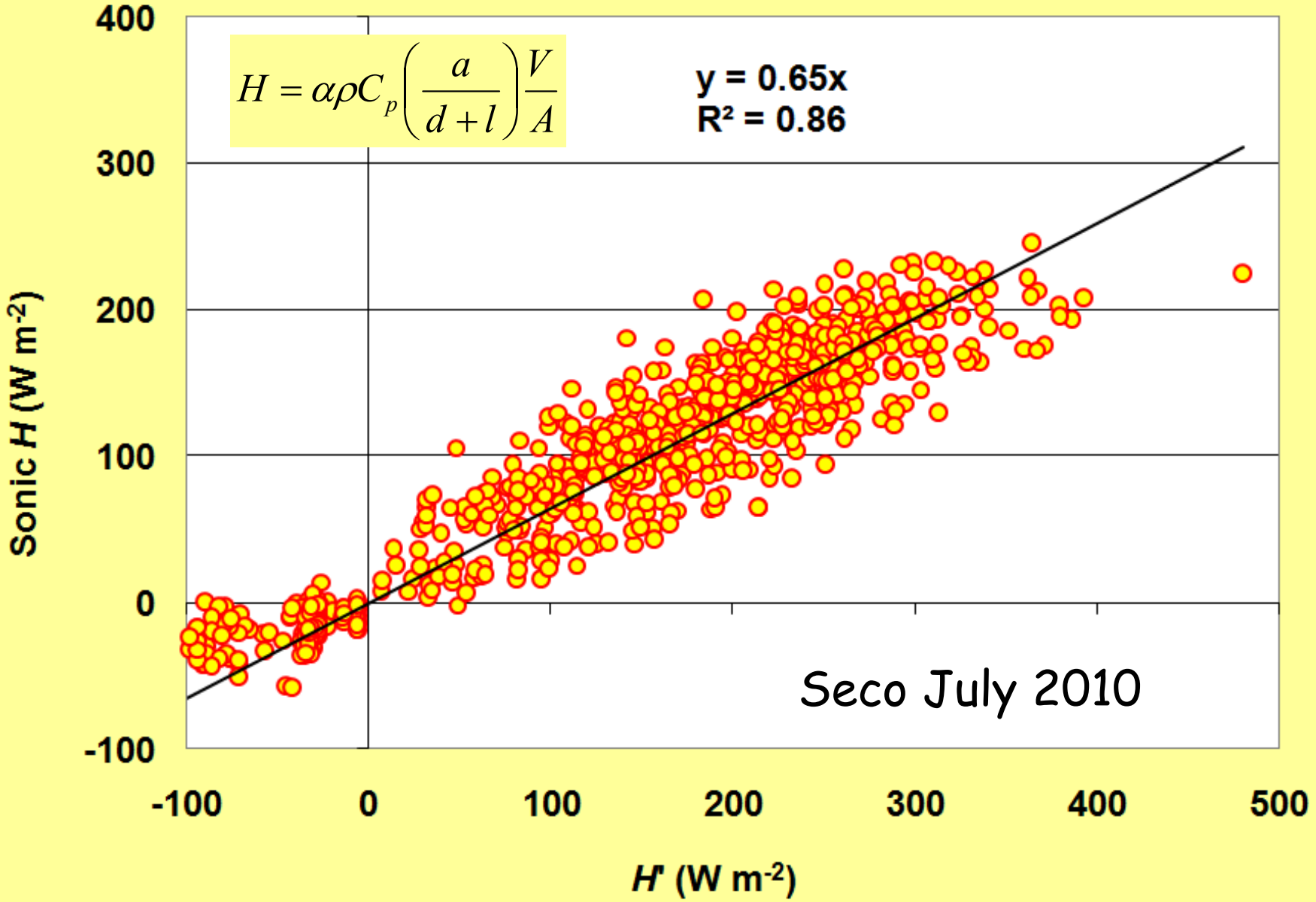

Heat Flux
Plate

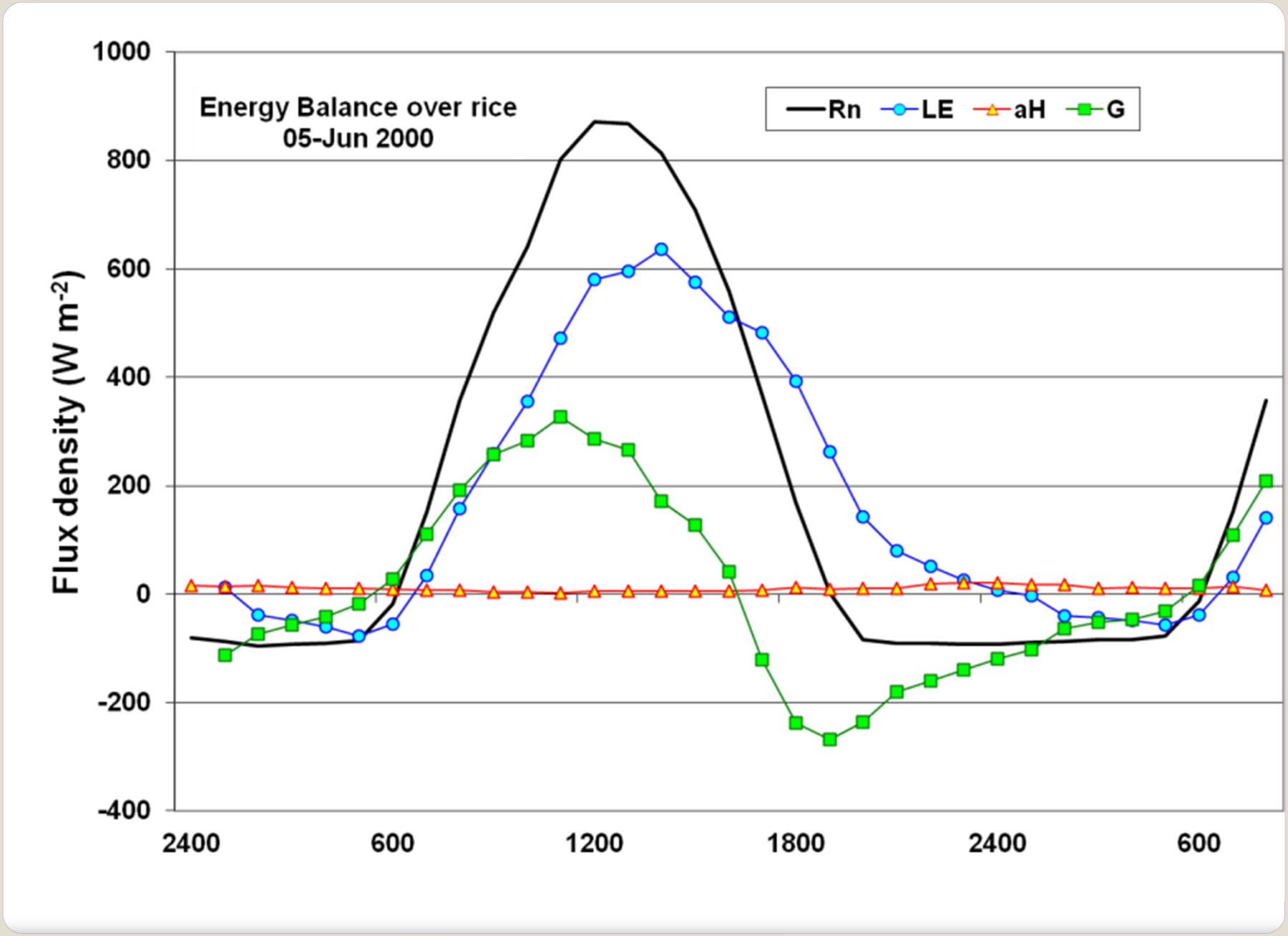

H - Sensible Heat Flux
0.003-inch diameter
Thermocouples
Surface Renewal

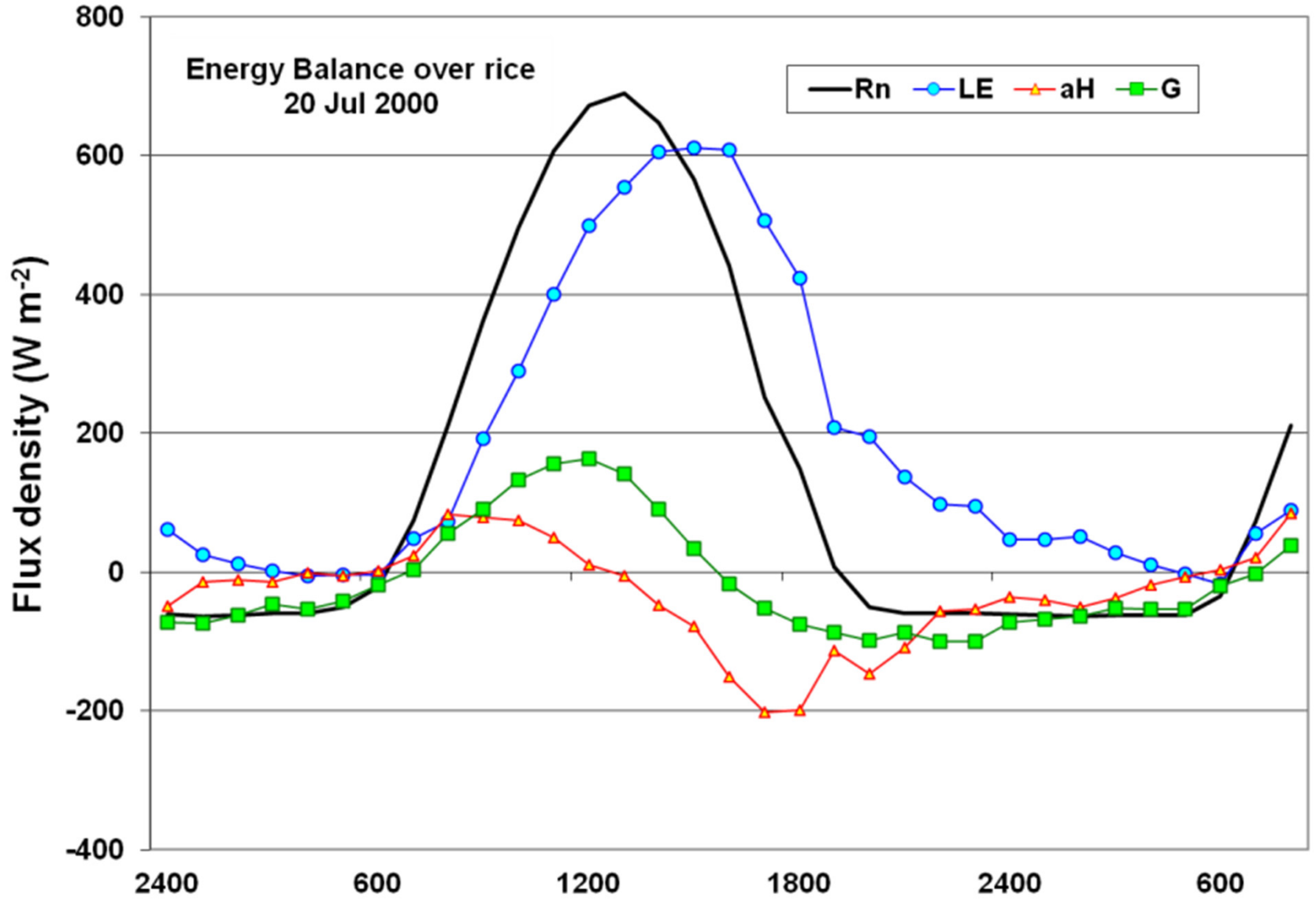
# One minute of 8 Hz temperature data



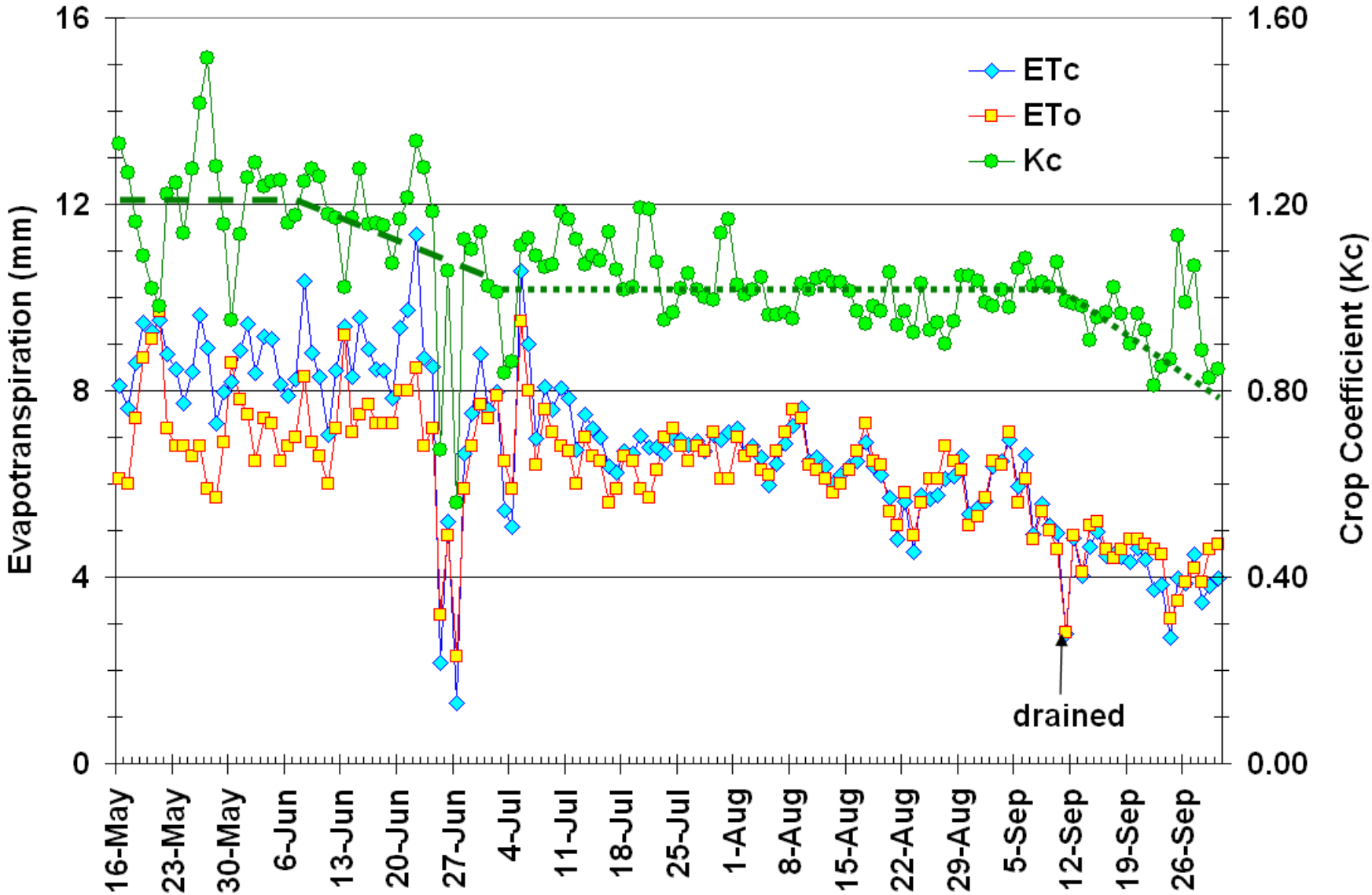
# Surface Renewal Calibration



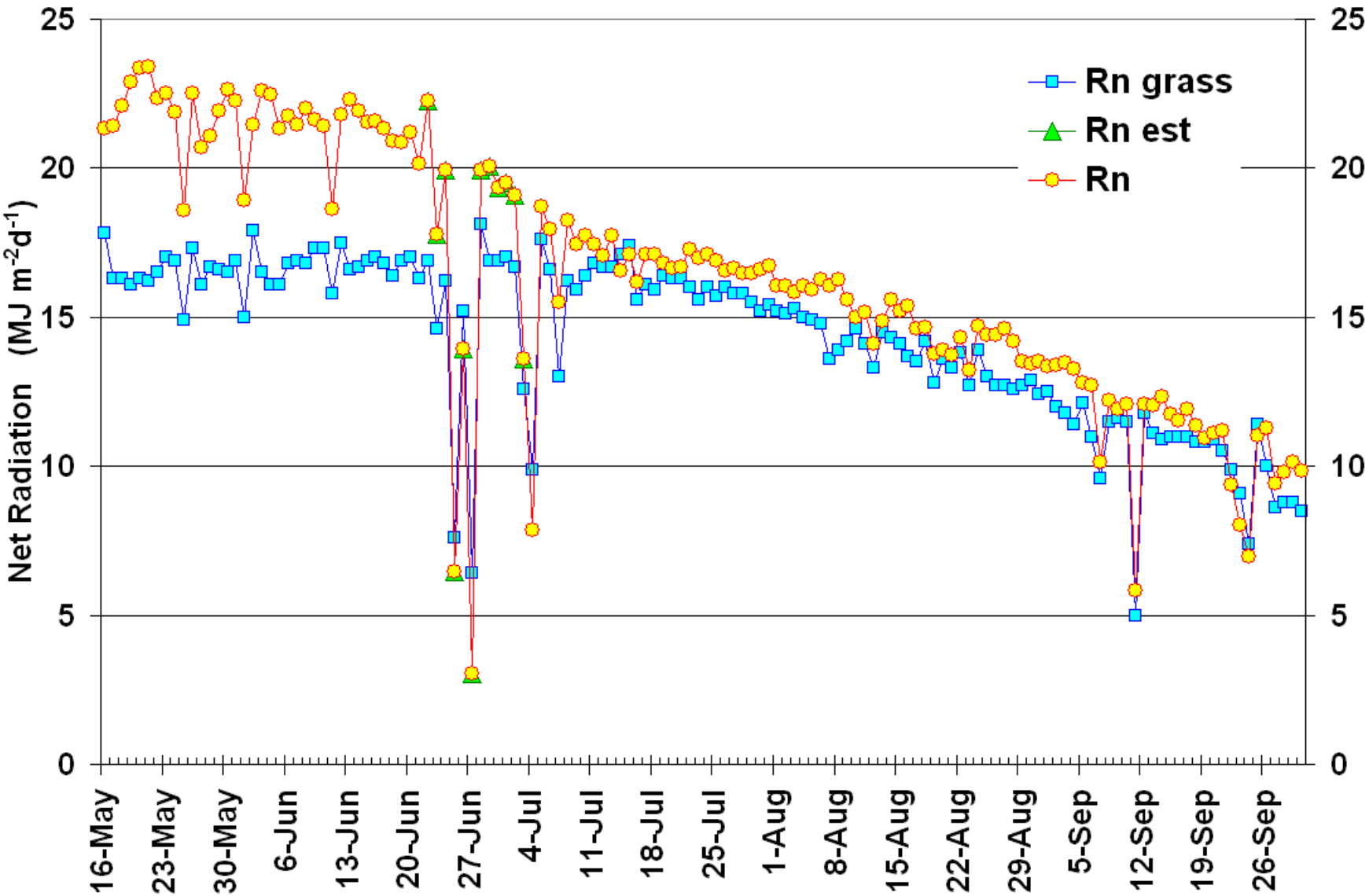

Energy Balance over rice
05-Jun 2000
Rn
LE
aH
G
Flux density (W m-2)
1000
800
600
400
200
0
-200
-400
2400
600
1200
1800
2400
600


Energy Balance over rice
20 Jul 2000
Rn
LE
aH
G
Flux density (W m-2)
800
600
400
200
0
-200
-400
2400
600
1200
1800
2400
600

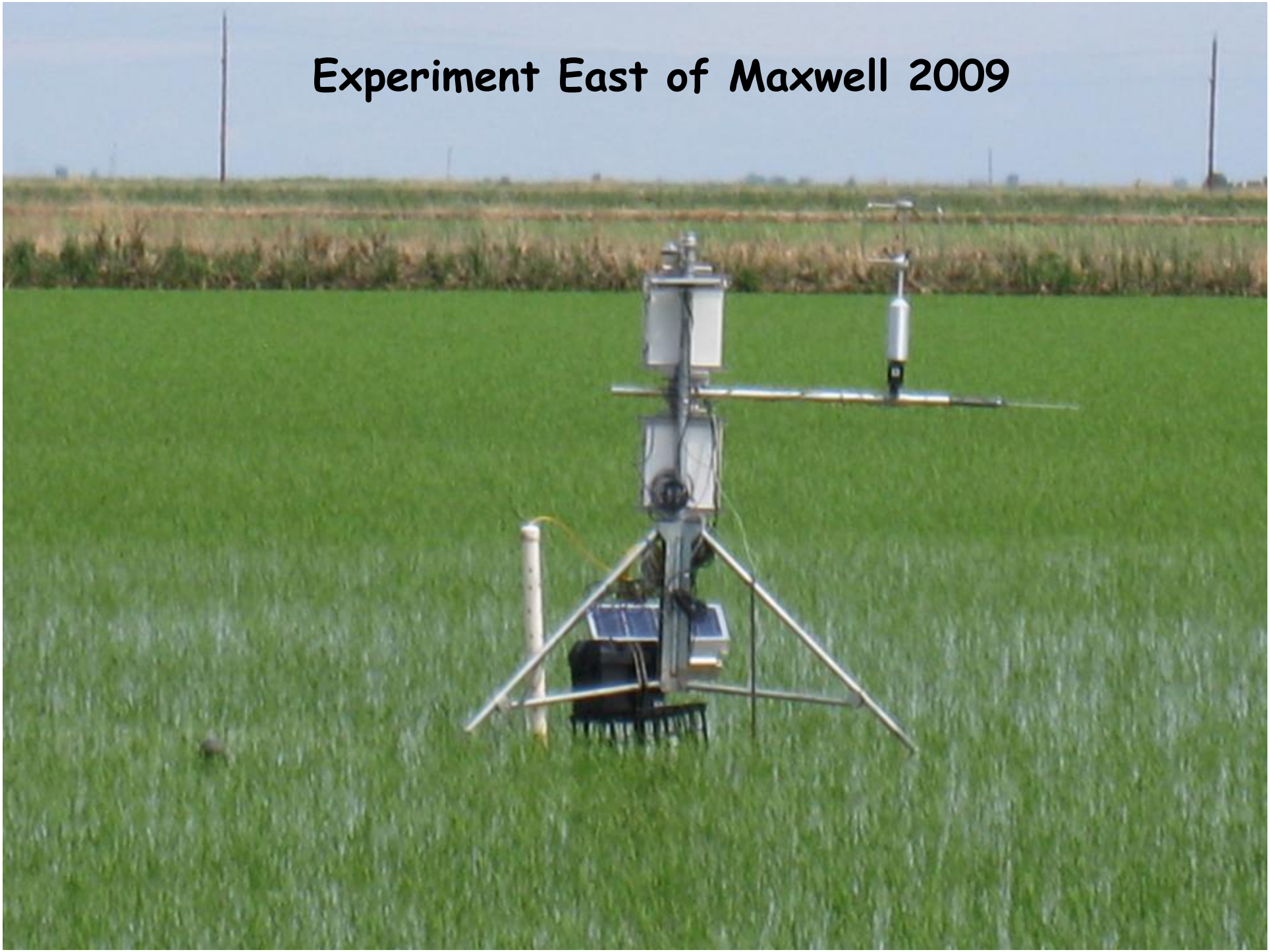
Nicolaus Rice - Snyder and Williams (2001)

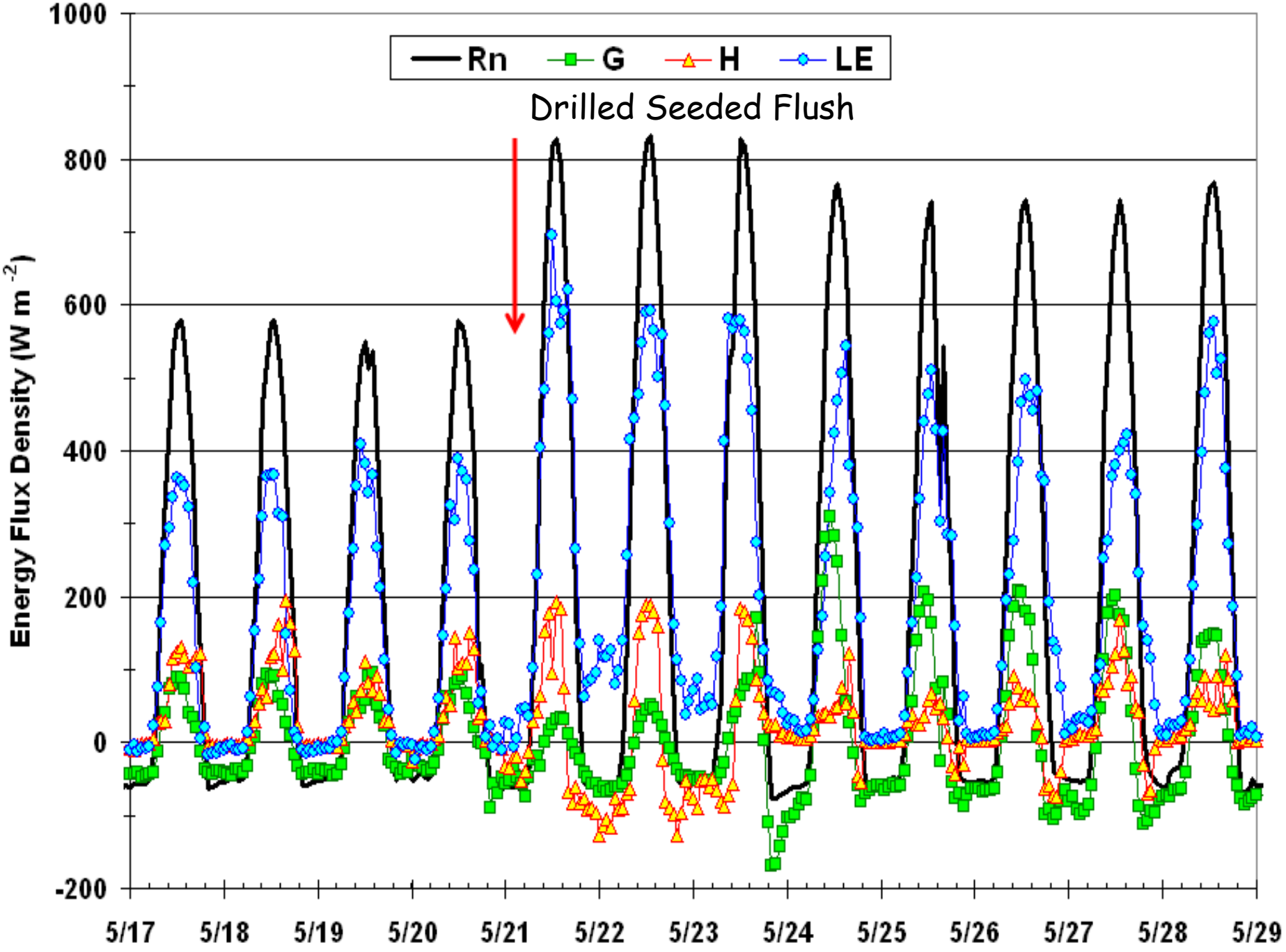


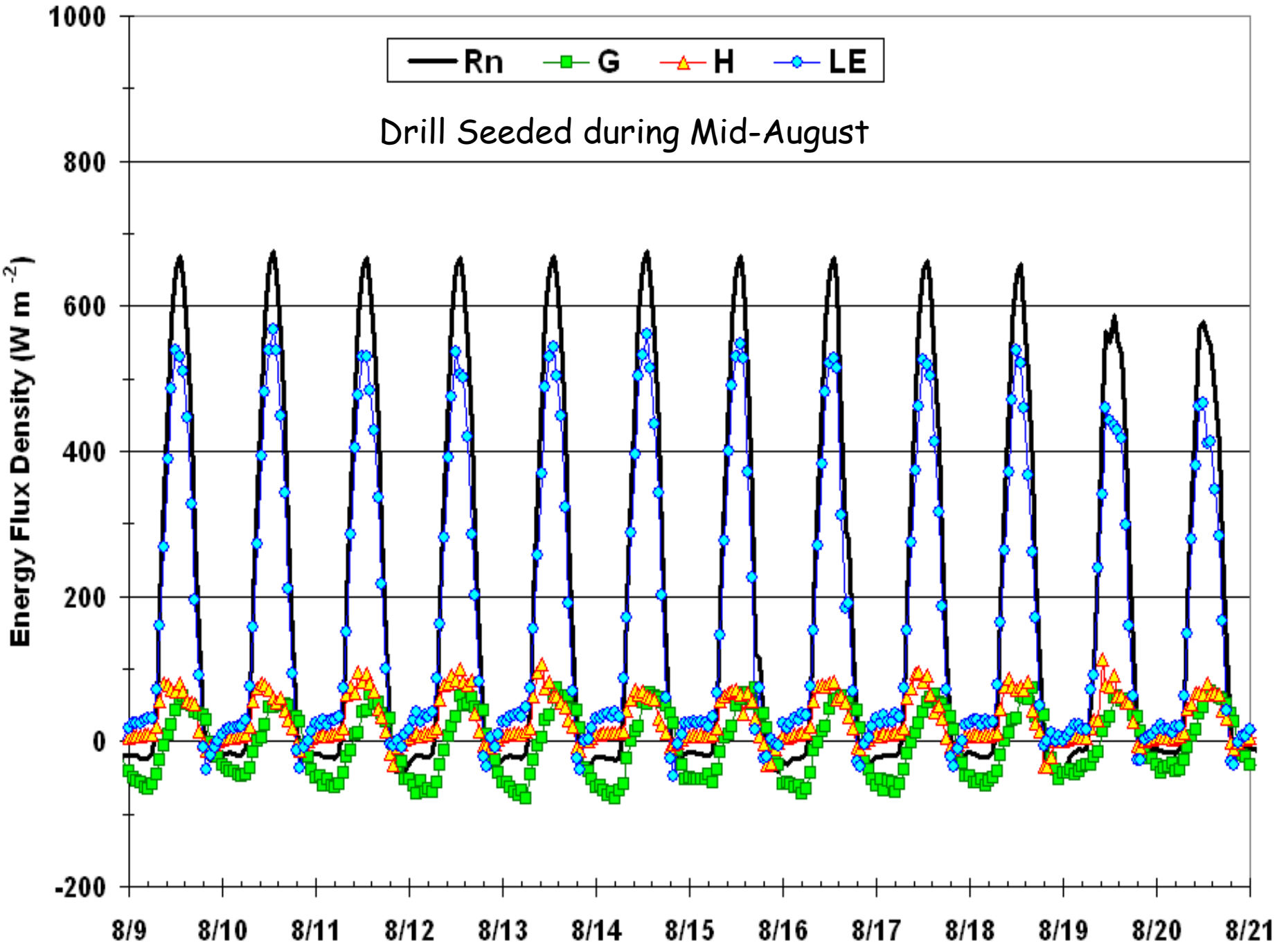
# Nicolaus Rice - Snyder and Williams (2001)

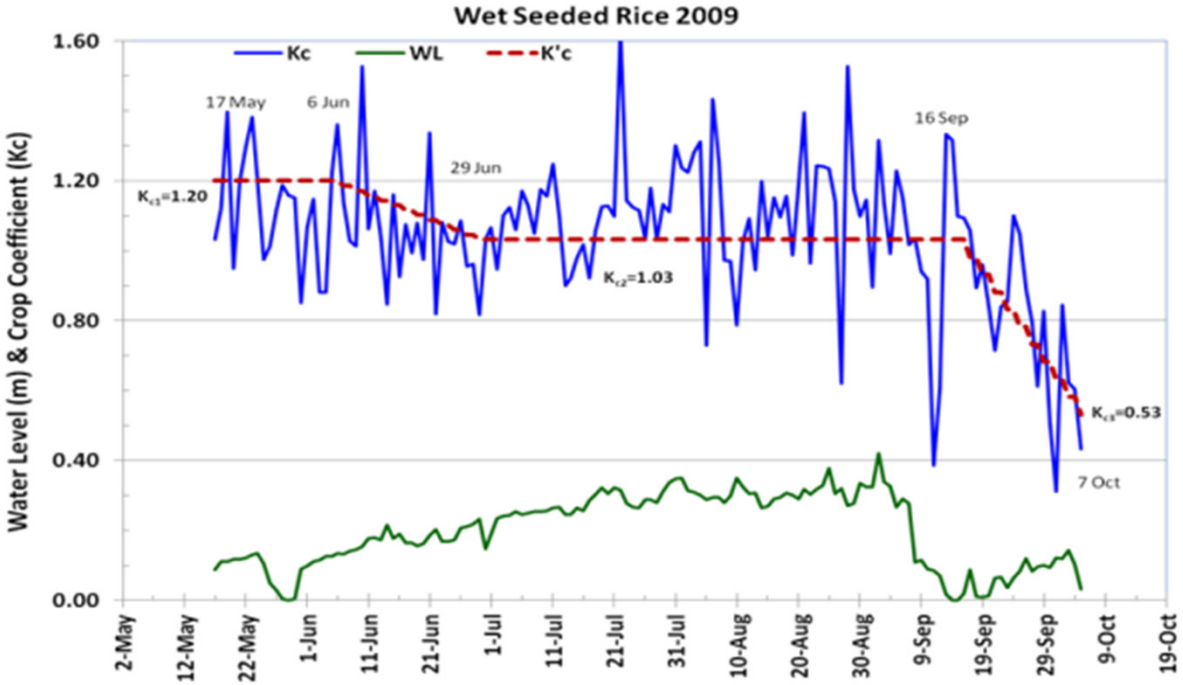


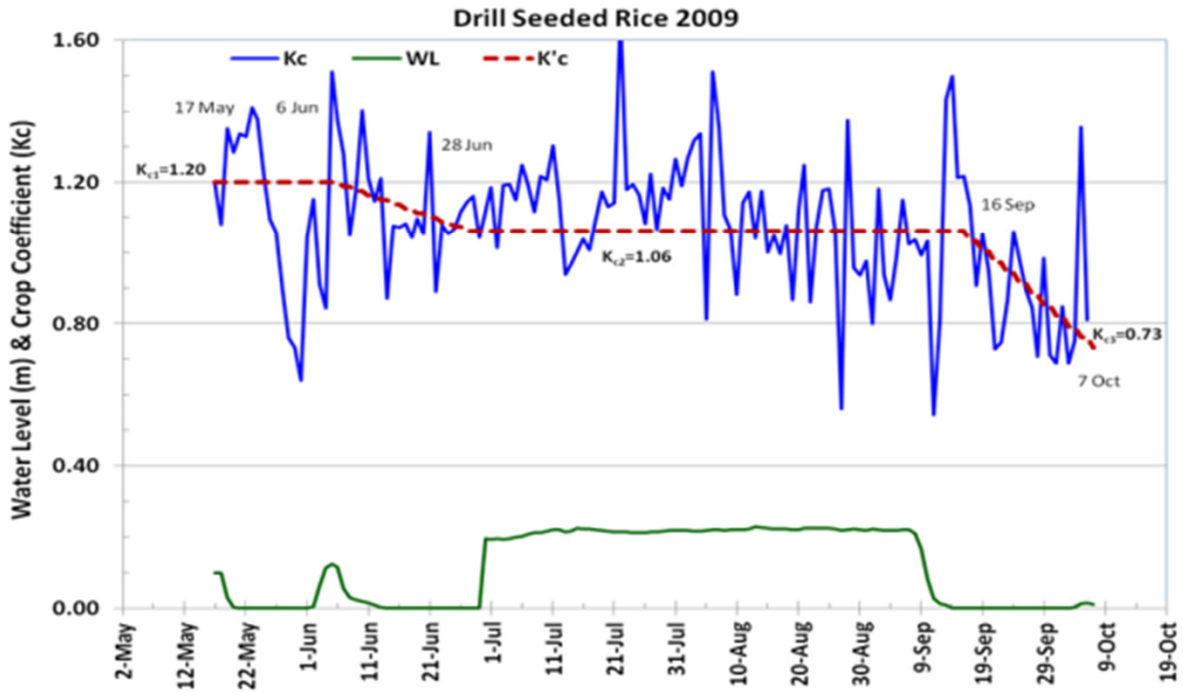
# Experiment East of Maxwell 2009




Rn
G
H
LE
Drilled Seeded Flush
Energy Flux Density (W m -2)
1000
800
600
400
200
0
-200
5/17
5/18
5/19
5/20
5/21
5/22
5/23
5/24
5/25
5/26
5/27
5/28
5/29


Rn
G
H
LE
Drill Seeded during Mid-August
Energy Flux Density (W m -2)
1000
800
600
400
200
0
-200
8/9
8/10
8/11
8/12
8/13
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21

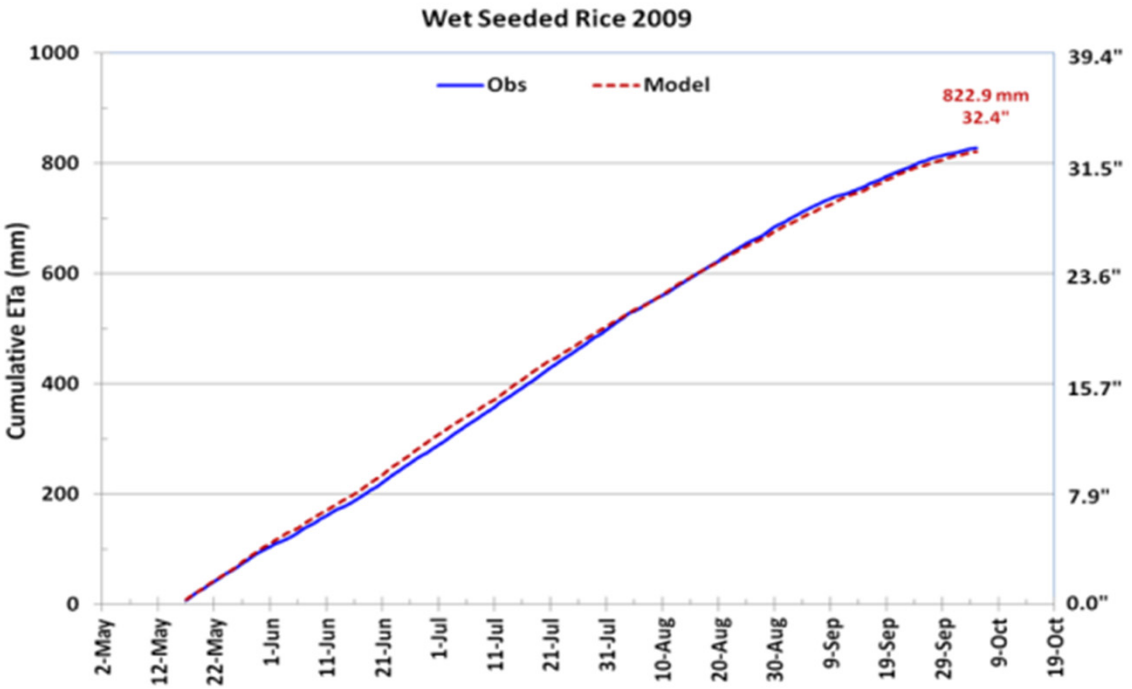



**East of Maxwell**

**Wet Seeded**

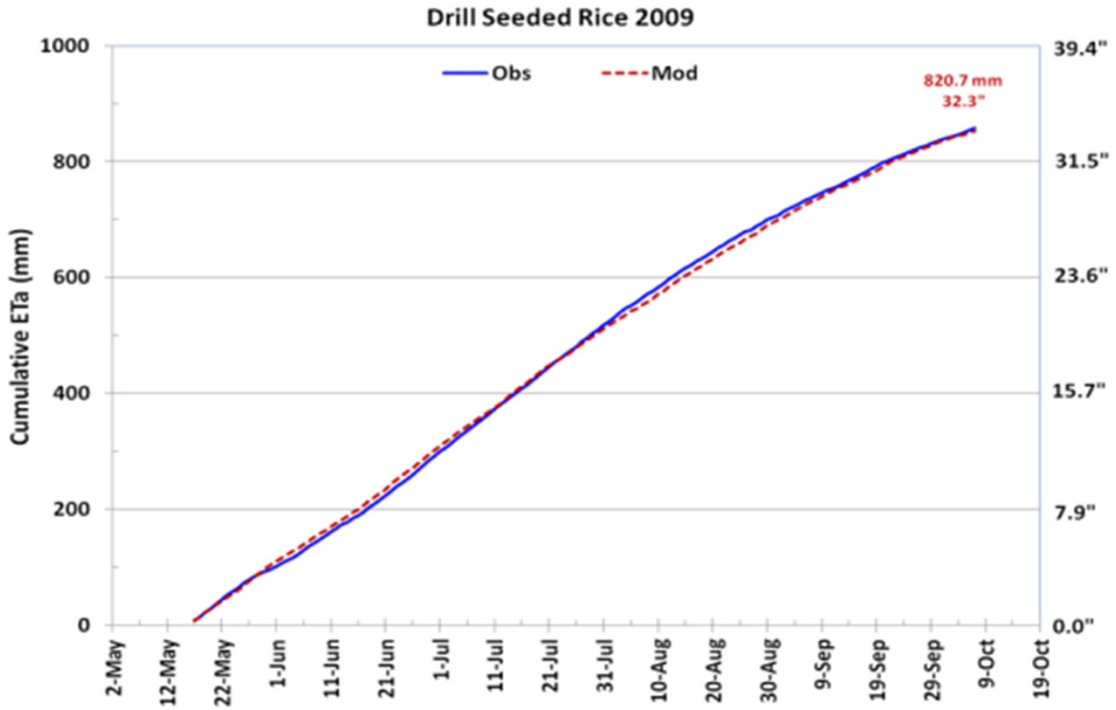
**Drill Seeded**




East of Maxwell

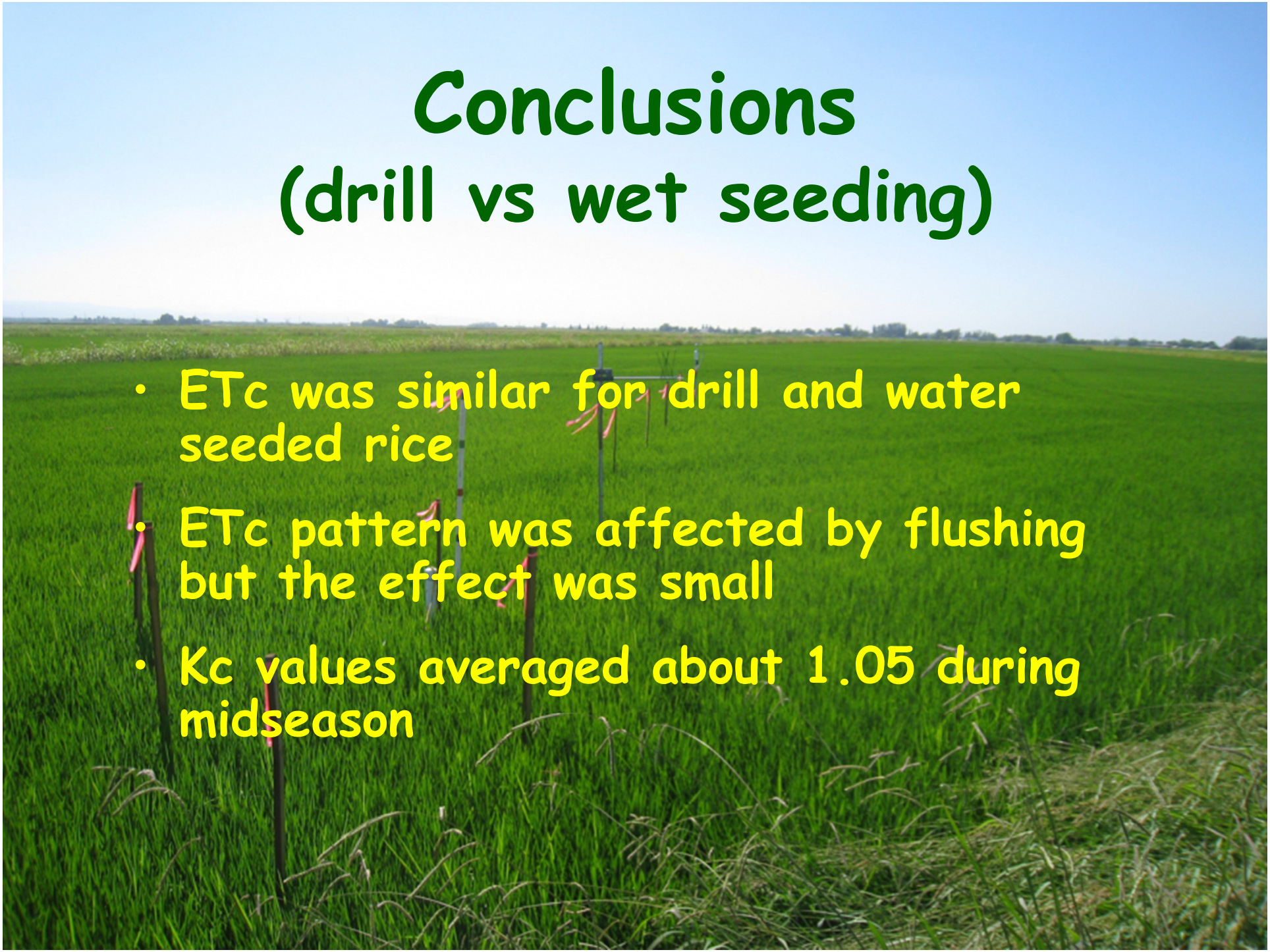
Wet Seeded

32.4 inches




Drill Seeded

32.3 inches

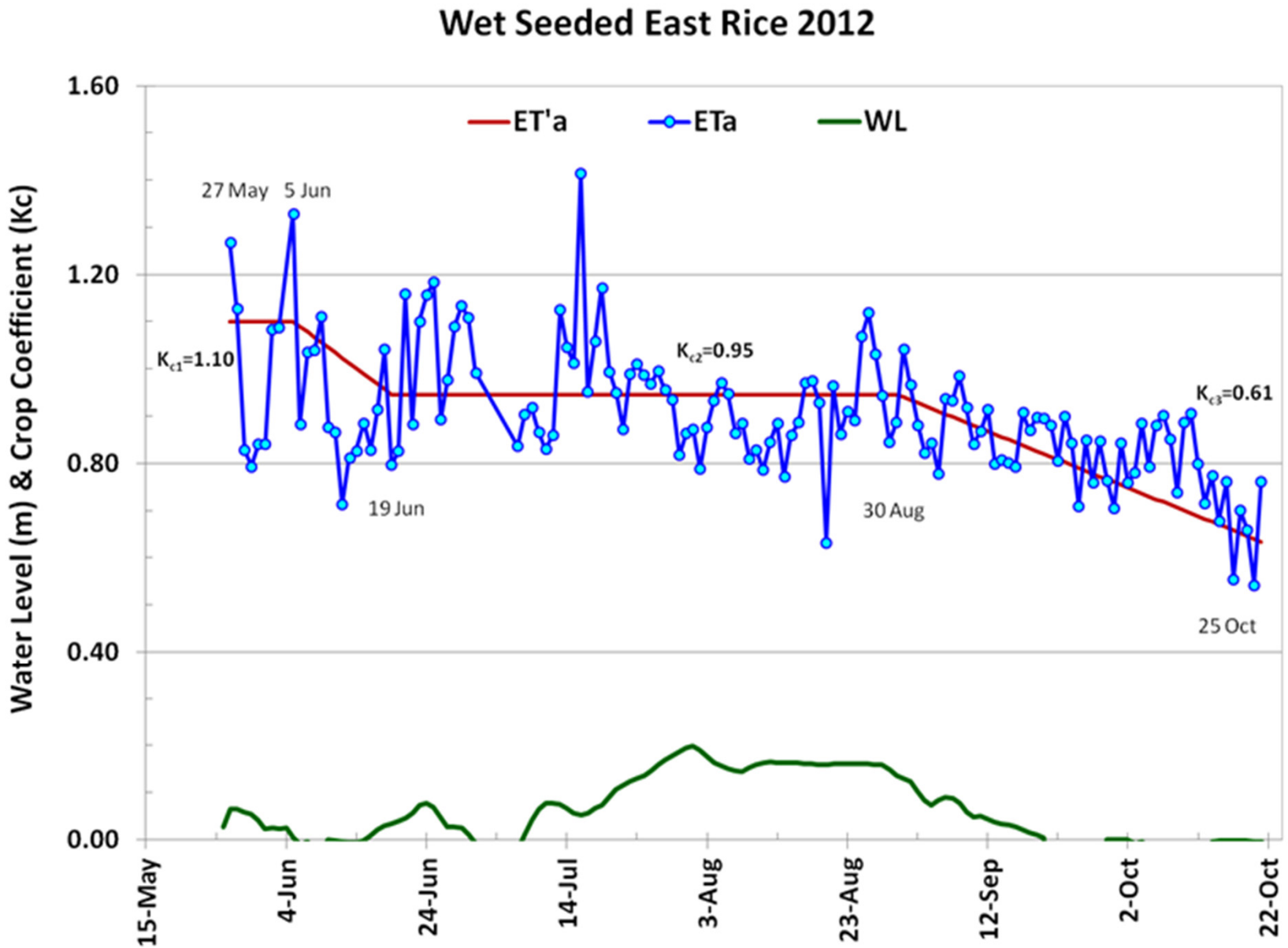


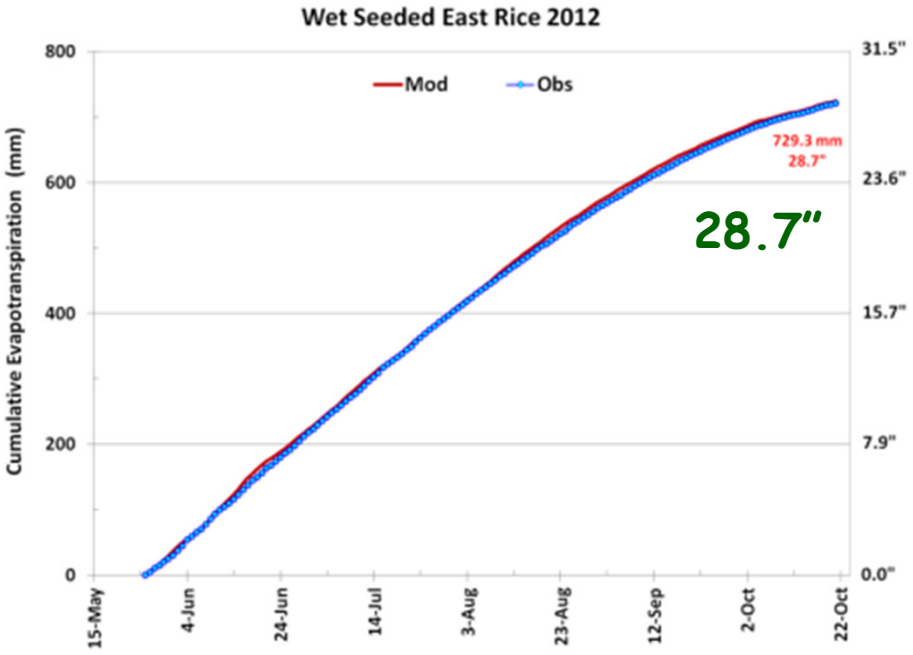
# Conclusions (drill vs wet seeding)

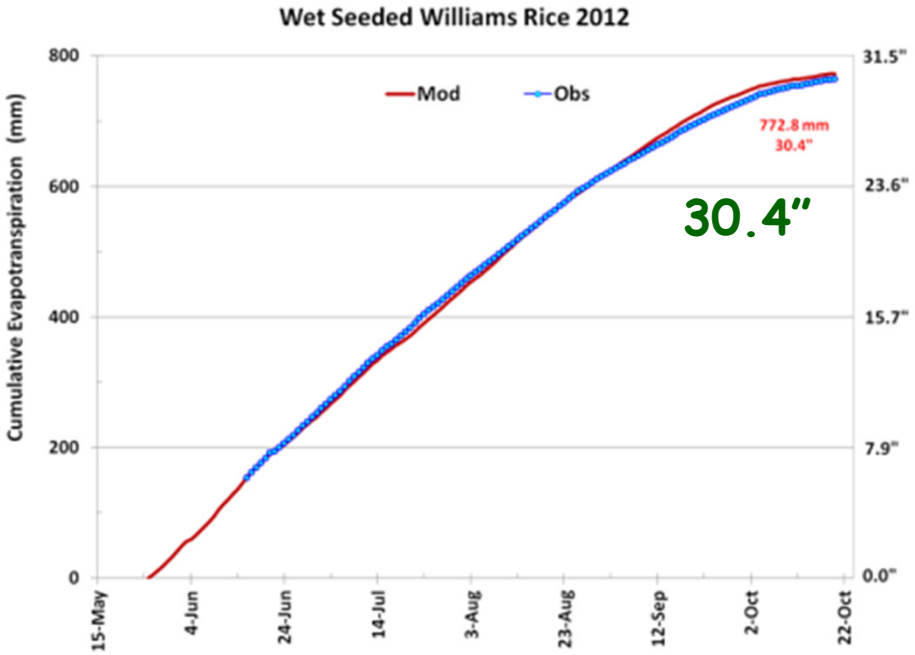
- ETc was similar for drill and water seeded rice
- ETc pattern was affected by flushing but the effect was small
- Kc values averaged about 1.05 during midseason

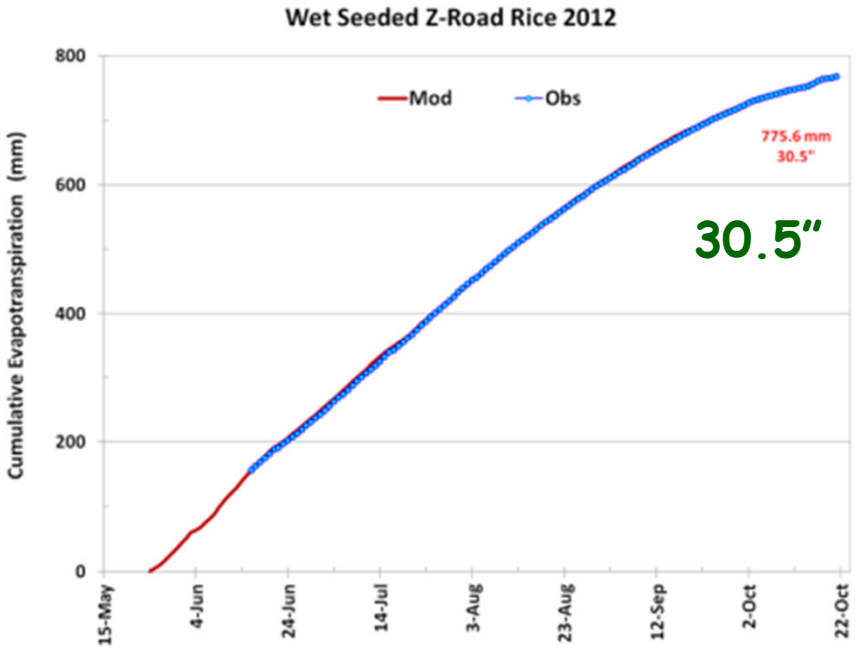
# Net Radiometer and Sonic Anemometer

## Richvale (East) 2011 and 2012

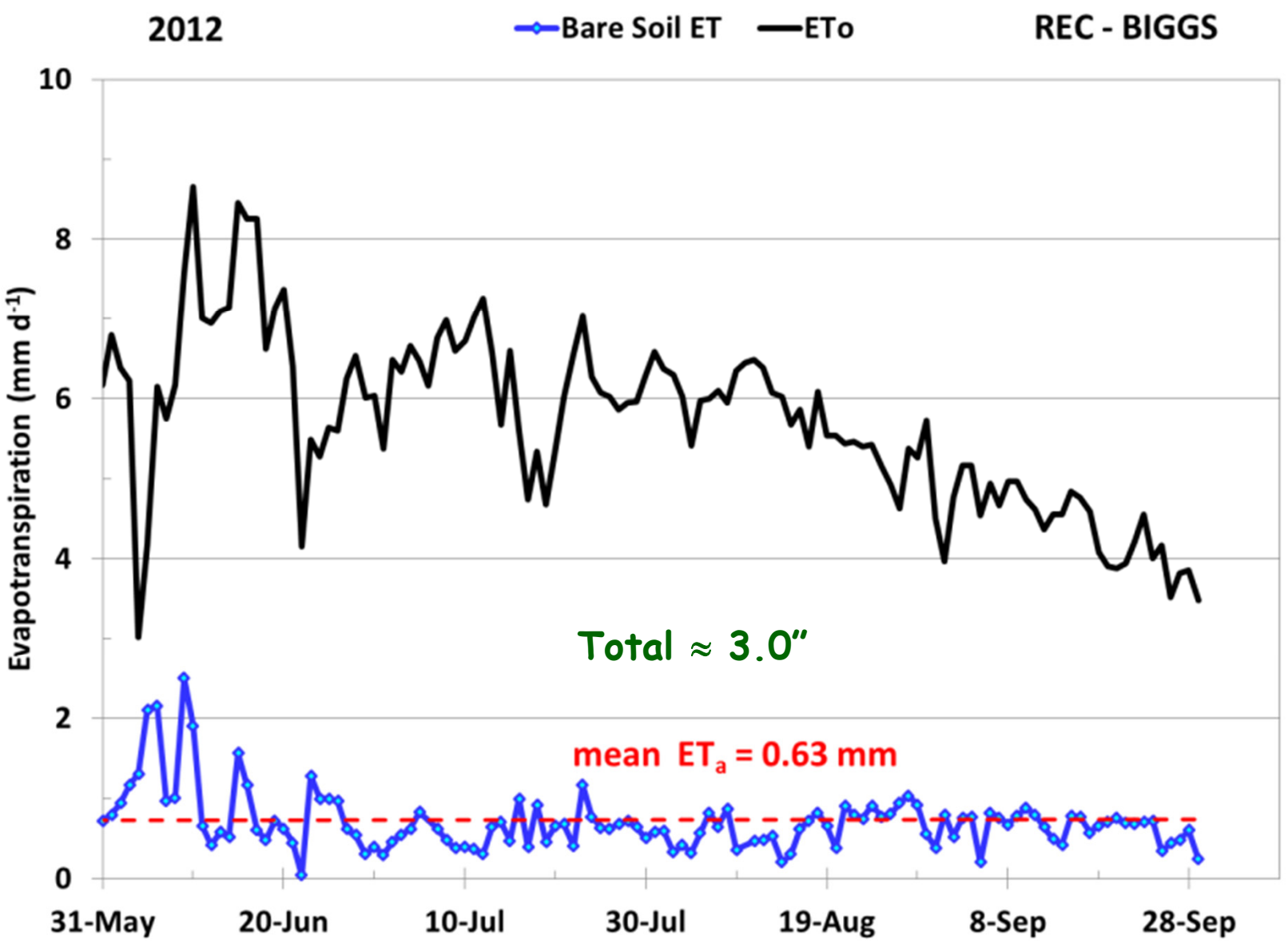

Wet Seeded East Rice 2012
ET'a
ETa
WL
Water Level (m) & Crop Coefficient (Kc)
1.60
1.20
0.80
0.40
0.00
27 May
5 Jun
19 Jun
30 Aug
25 Oct
$K_{c1}$=1.10
$K_{c2}$=0.95
$K_{c3}$=0.61
15-May
4-Jun
24-Jun
14-Jul
3-Aug
23-Aug
12-Sep
2-Oct
22-Oct


Wet Seeded East Rice 2012
Mod
Obs
729.3 mm
28.7"
28.7"
Cumulative Evapotranspiration (mm)
800
600
400
200
0
31.5"
23.6"
15.7"
7.9"
0.0"
15-May
4-Jun
24-Jun
14-Jul
3-Aug
23-Aug
12-Sep
2-Oct
22-Oct


Wet Seeded Williams Rice 2012
Mod
Obs
772.8 mm
30.4"
30.4"
Cumulative Evapotranspiration (mm)
800
600
400
200
0
31.5"
23.6"
15.7"
7.9"
0.0"
15-May
4-Jun
24-Jun
14-Jul
3-Aug
23-Aug
12-Sep
2-Oct
22-Oct


Wet Seeded Z-Road Rice 2012
Mod
Obs
775.6 mm
30.5"
30.5"
Cumulative Evapotranspiration (mm)
800
600
400
200
0
15-May
4-Jun
24-Jun
14-Jul
3-Aug
23-Aug
12-Sep
2-Oct
22-Oct


Bare Ground
REC
CAMPBELL SCIENTIFIC


2012
Bare Soil ET
ETo
REC - BIGGS
Evapotranspiration (mm d-1)
10
8
6
4
2
0
Total ≈ 3.0"
mean ETa = 0.63 mm
31-May
20-Jun
10-Jul
30-Jul
19-Aug
8-Sep
28-Sep

# The End.
# Thank You