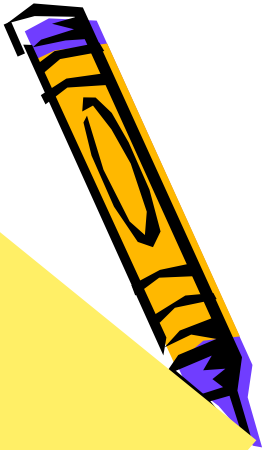

Measuring Evapotranspiration of Rice

R.L. Snyder
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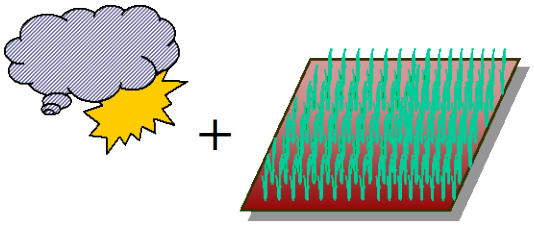
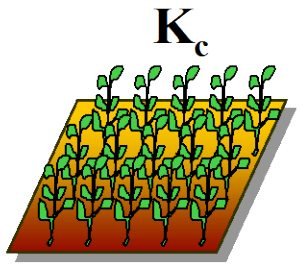
Estimating Crop ET (ET_c)



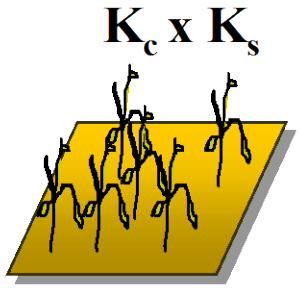
+ = ETo

ET_o from weather



ETo x = ETc

$ET_c = ET_o \times K_c$



ETo x = ETa

$ET_a = ET_c \times K_s$

K_c factors could change with climate

$$LE = R_n - G - H$$

- R_n - Net Radiation
  (net radiometer)
- G – Ground Heat Flux Density
  (heat flux plates & thermistors)
- H - Sensible Heat Flux Density
  (thermocouples & surface renewal)

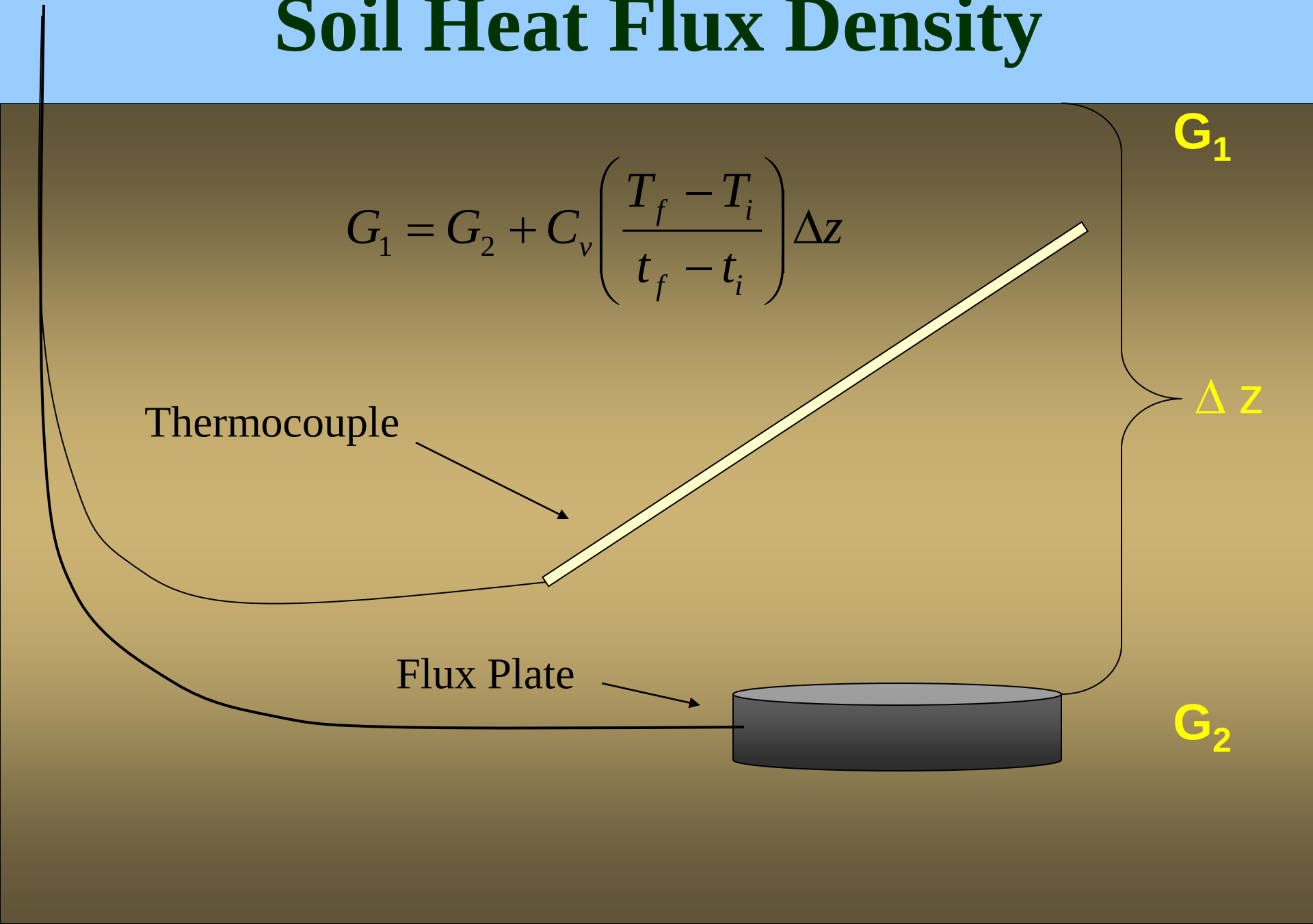
$$E = \frac{LE}{2.45\,MJ\,liter^{-1}} = ET$$

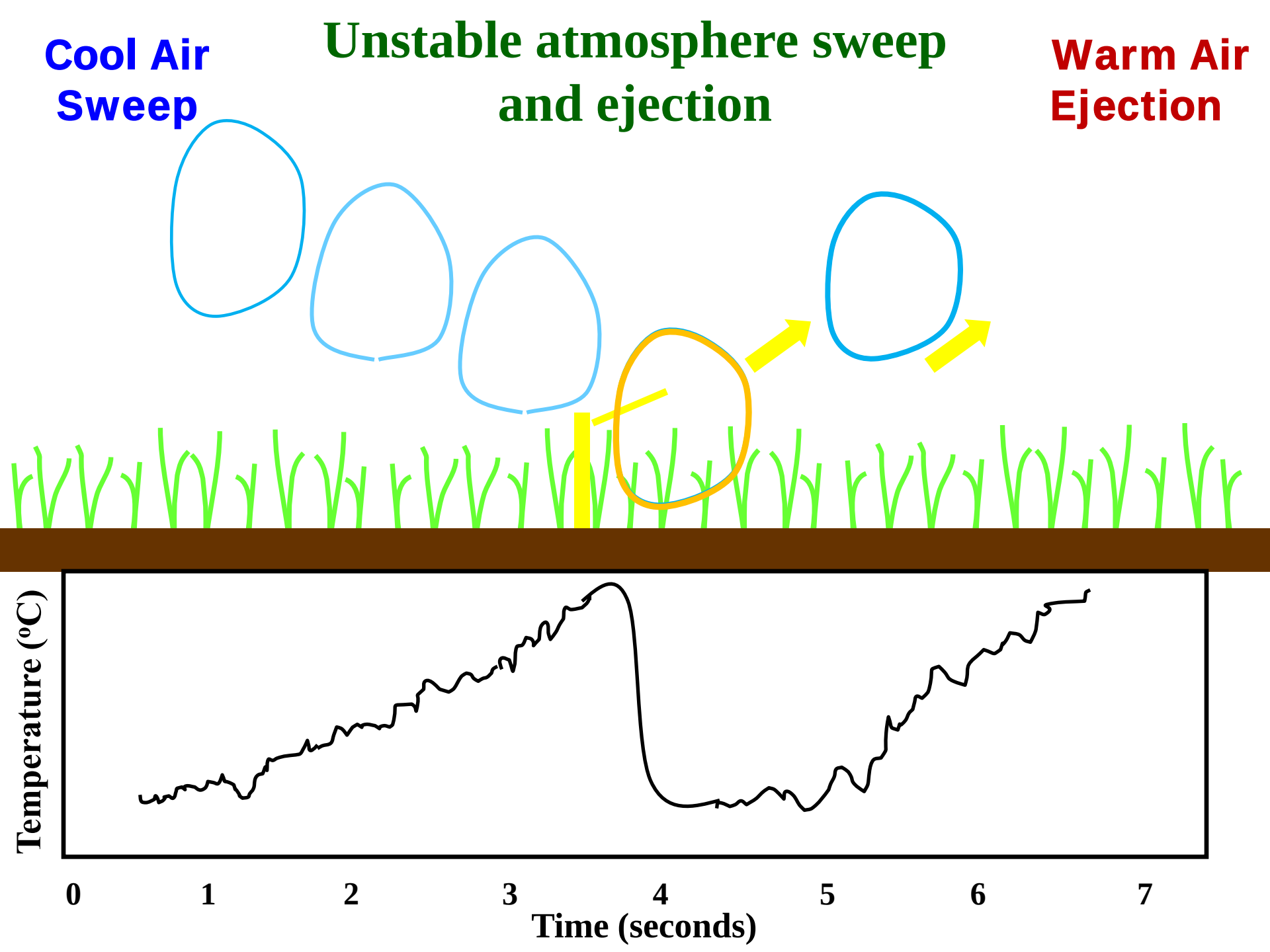
Anemometer

Net Radiometer

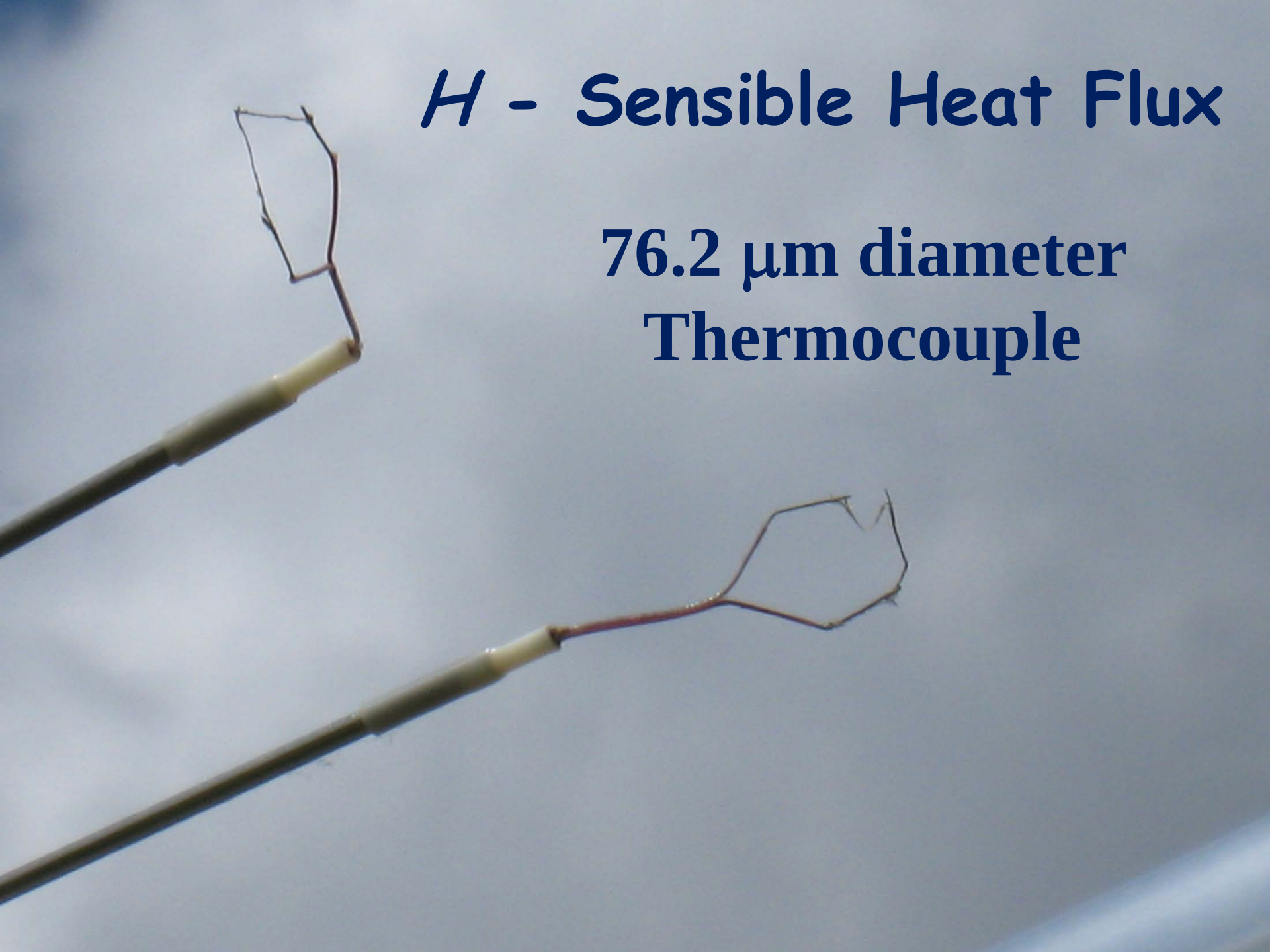
Soil Heat Flux Density

$$G_1 = G_2 + C_v \left(\frac{T_f - T_i}{t_f - t_i} \right) \Delta z$$




Cool Air Sweep
Unstable atmosphere sweep and ejection
Warm Air Ejection
Temperature (°C)
0
1
2
3
4
5
6
7
Time (seconds)

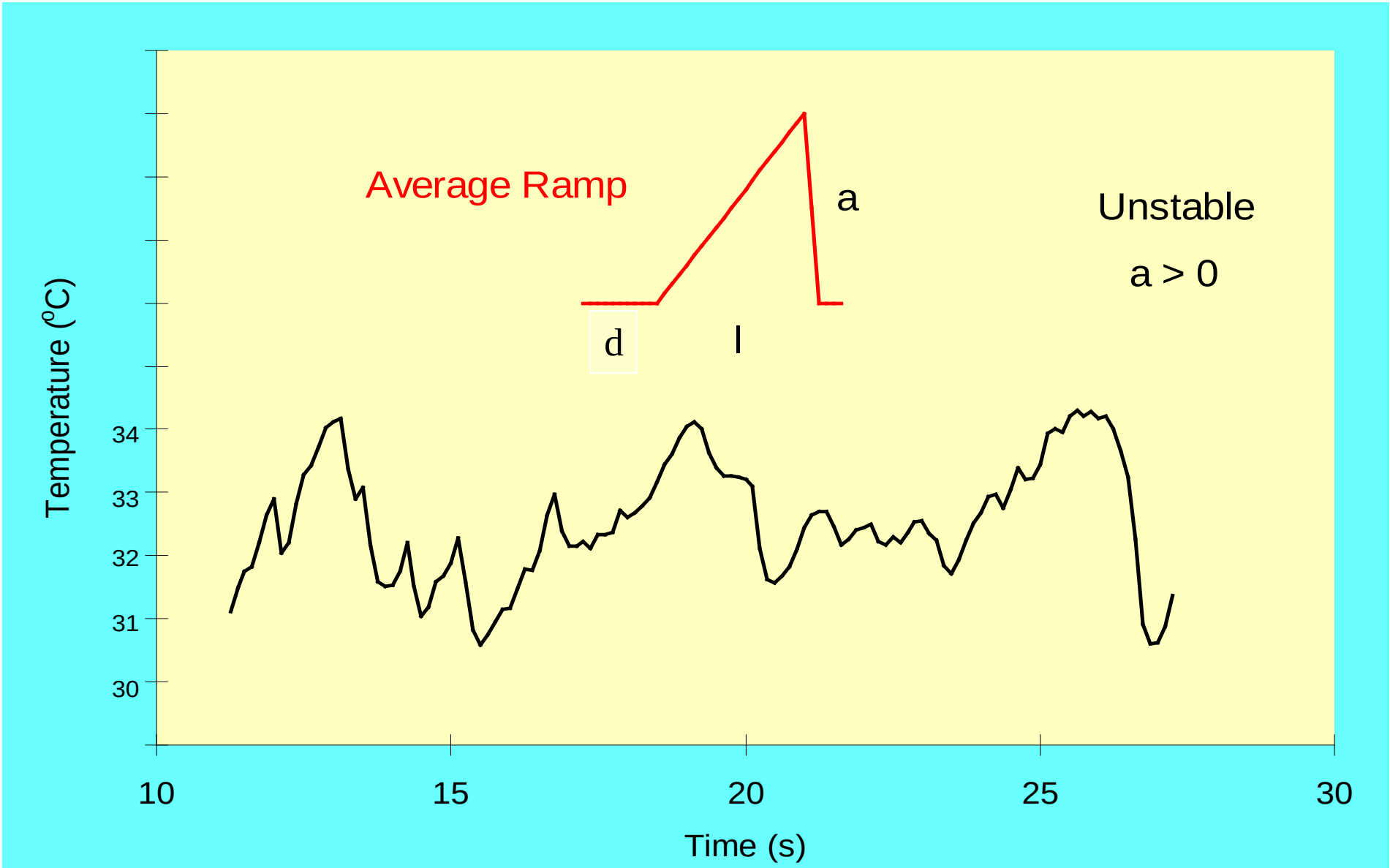
H - Sensible Heat Flux



76.2 μm diameter Thermocouple

One minute of 8 Hz temperature data

Average Ramp Characteristics

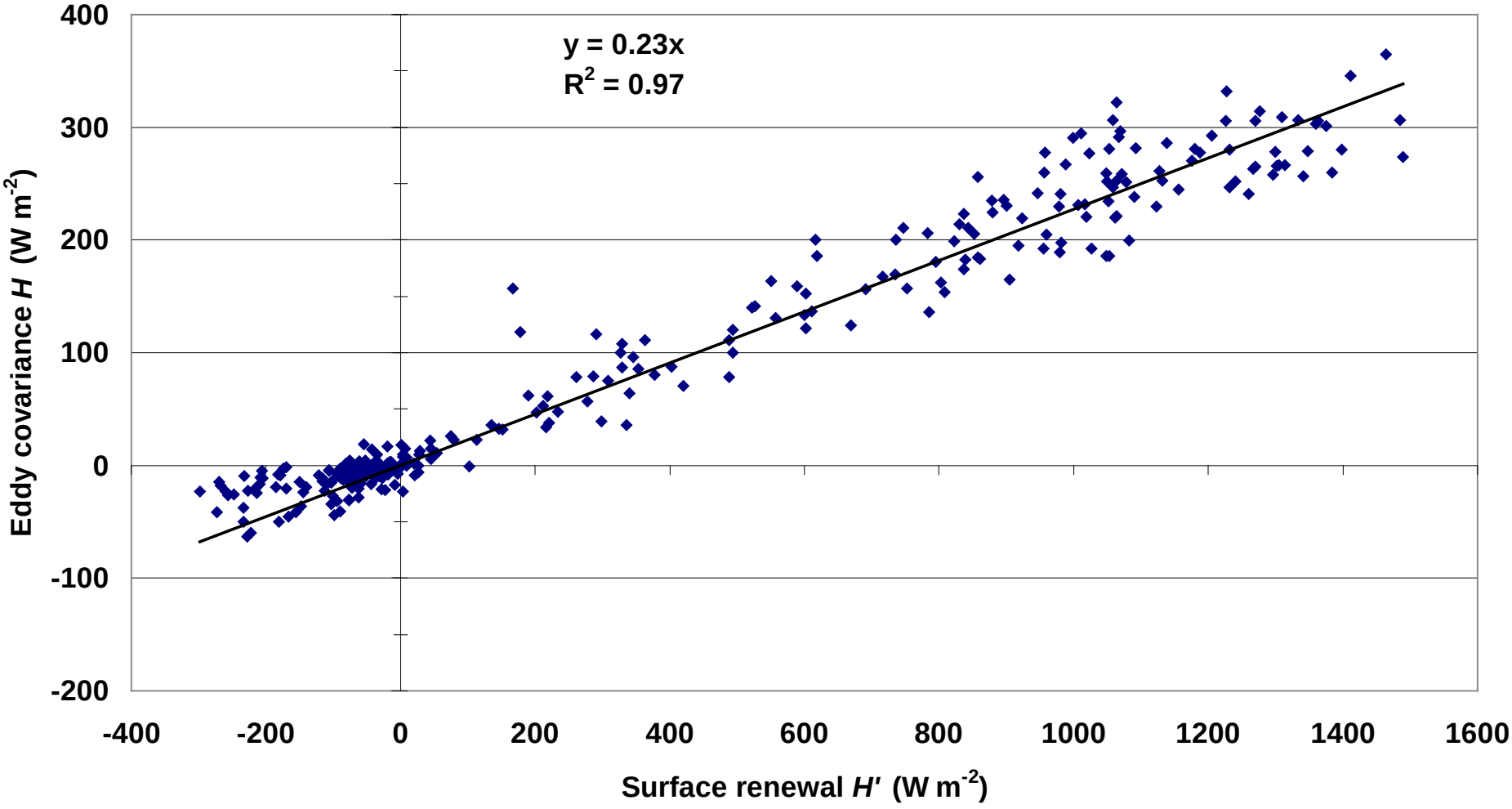


Surface Renewal (H)

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

$$\frac{Energy}{Area \times Time} = \left(\begin{matrix}Calibration\\Factor\end{matrix}\right)\left(\frac{Energy}{Volume \times Degree}\right)\left(\Delta\frac{Degrees}{Time}\right)\left(\frac{Volume}{Area}\right)$$

Surface Renewal Calibration



Citrus 2001

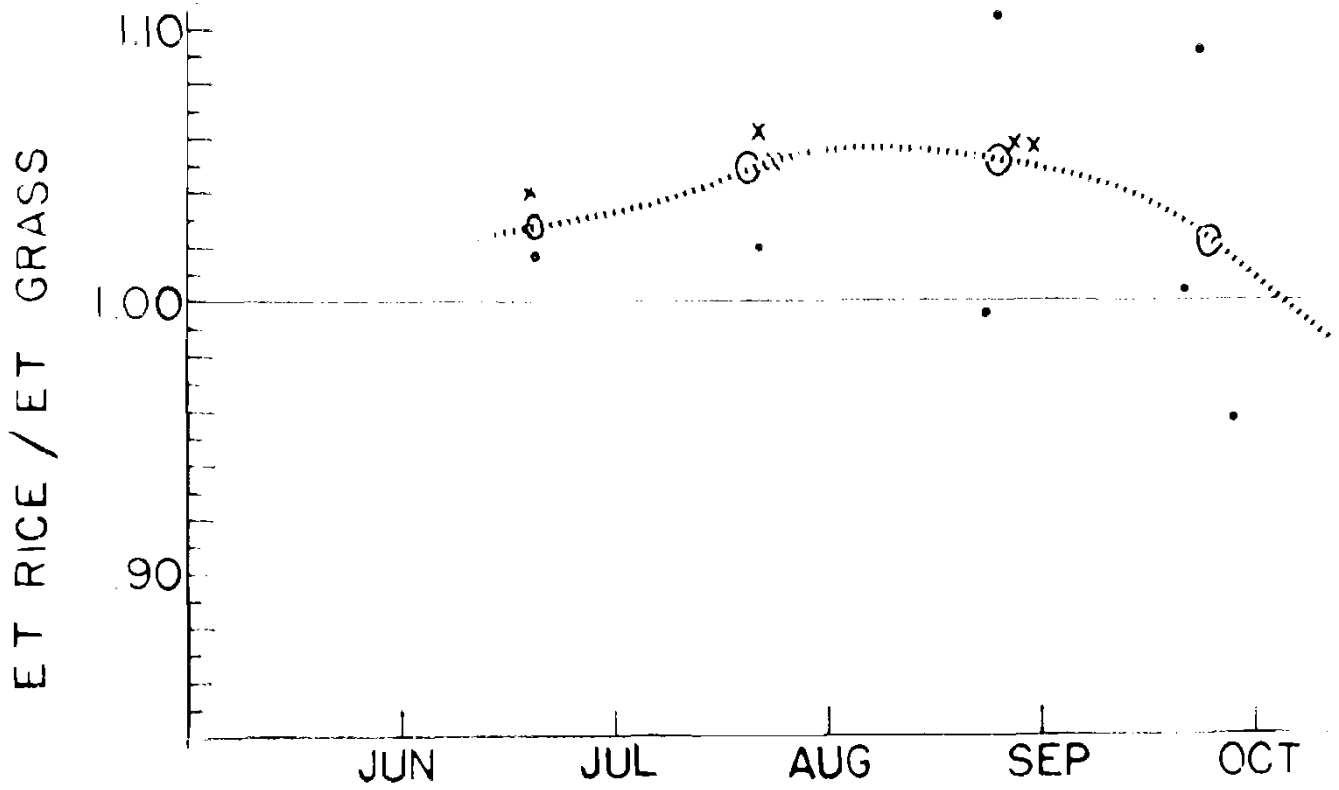
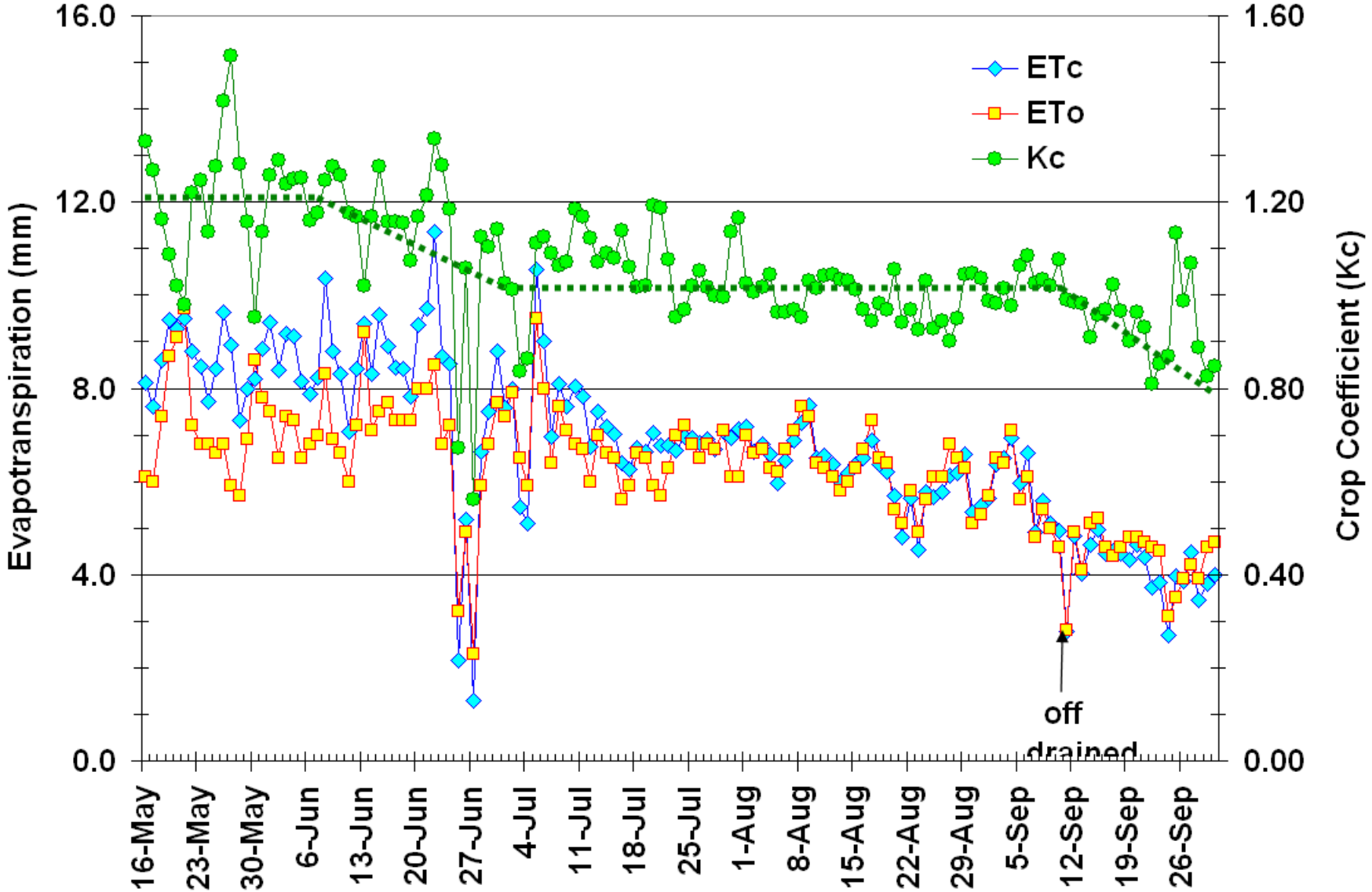
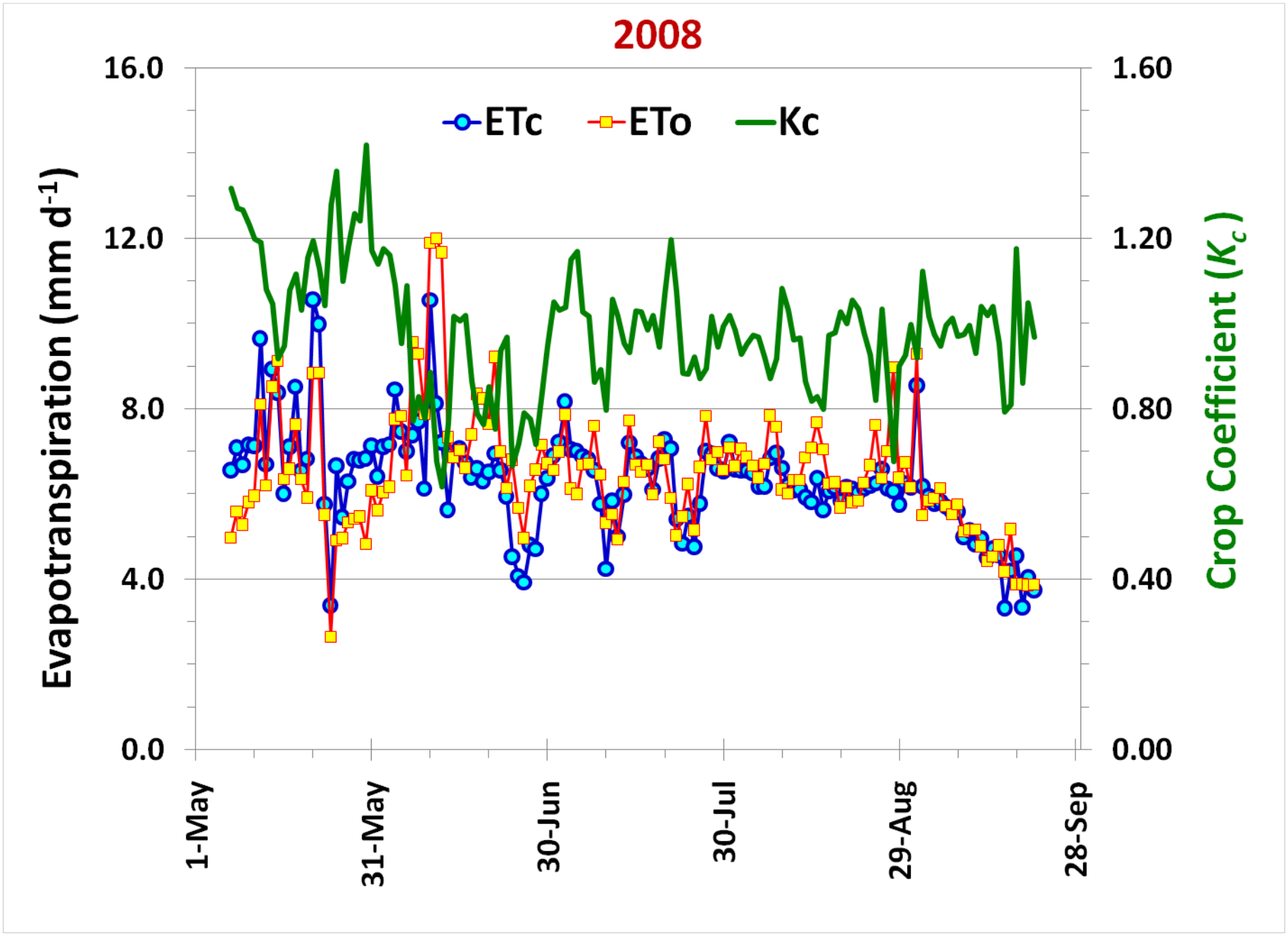


Fig. 6. Ratios of daily totals of $rice_{ET}$ to Davis $grass_{ET}$. Dots indicate 1968 ratios and "x" indicate 1969 ratios. The large open circles are the average of all the ratios for that particular month.

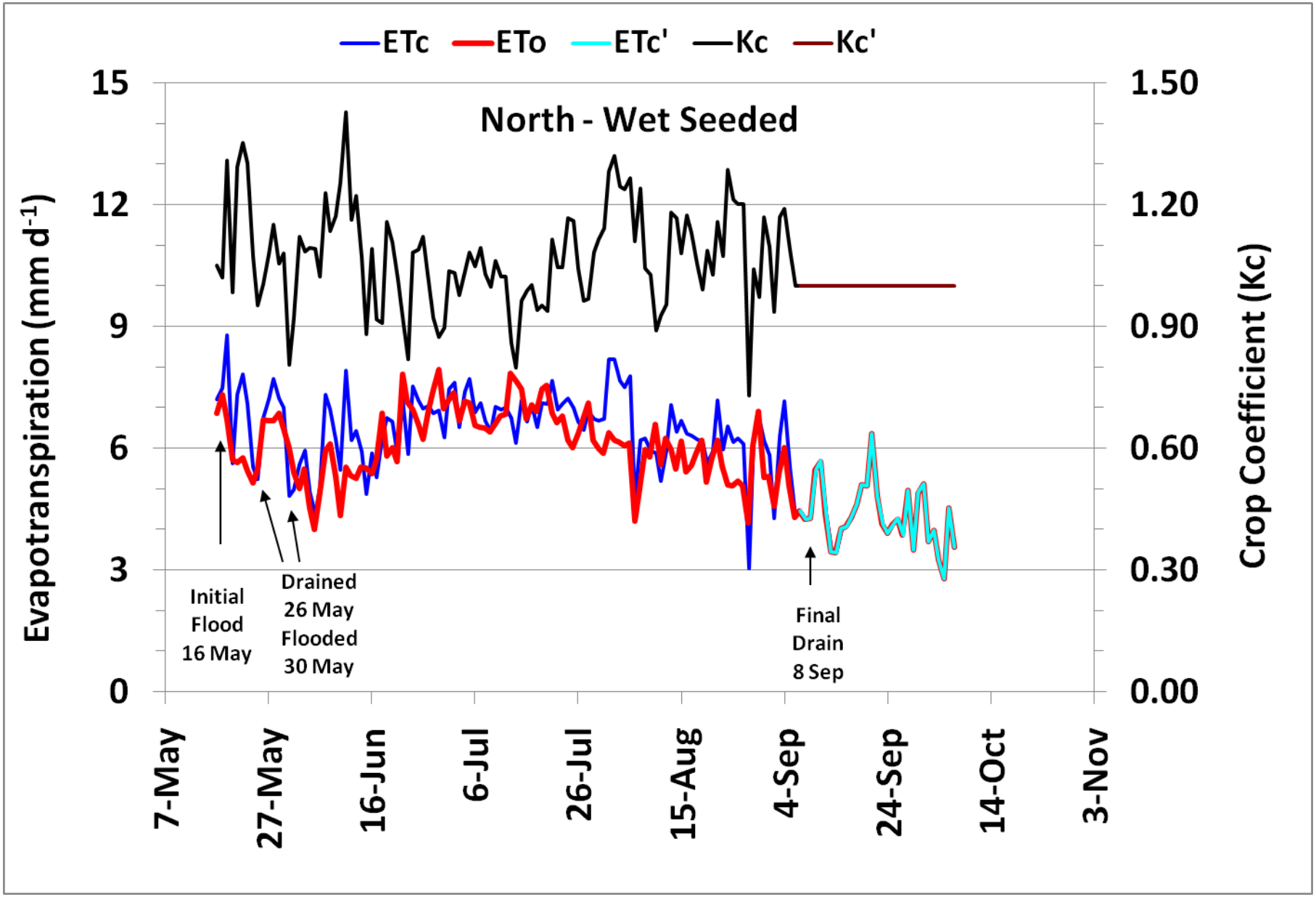
Lourence F.J. and Pruitt, W. 0. 1971. Energy Balance and Water Use of Rice Grown in the Central Valley of California. Agron. J. 827-832

2001 - Rice ET_c, ET_o, and K_c

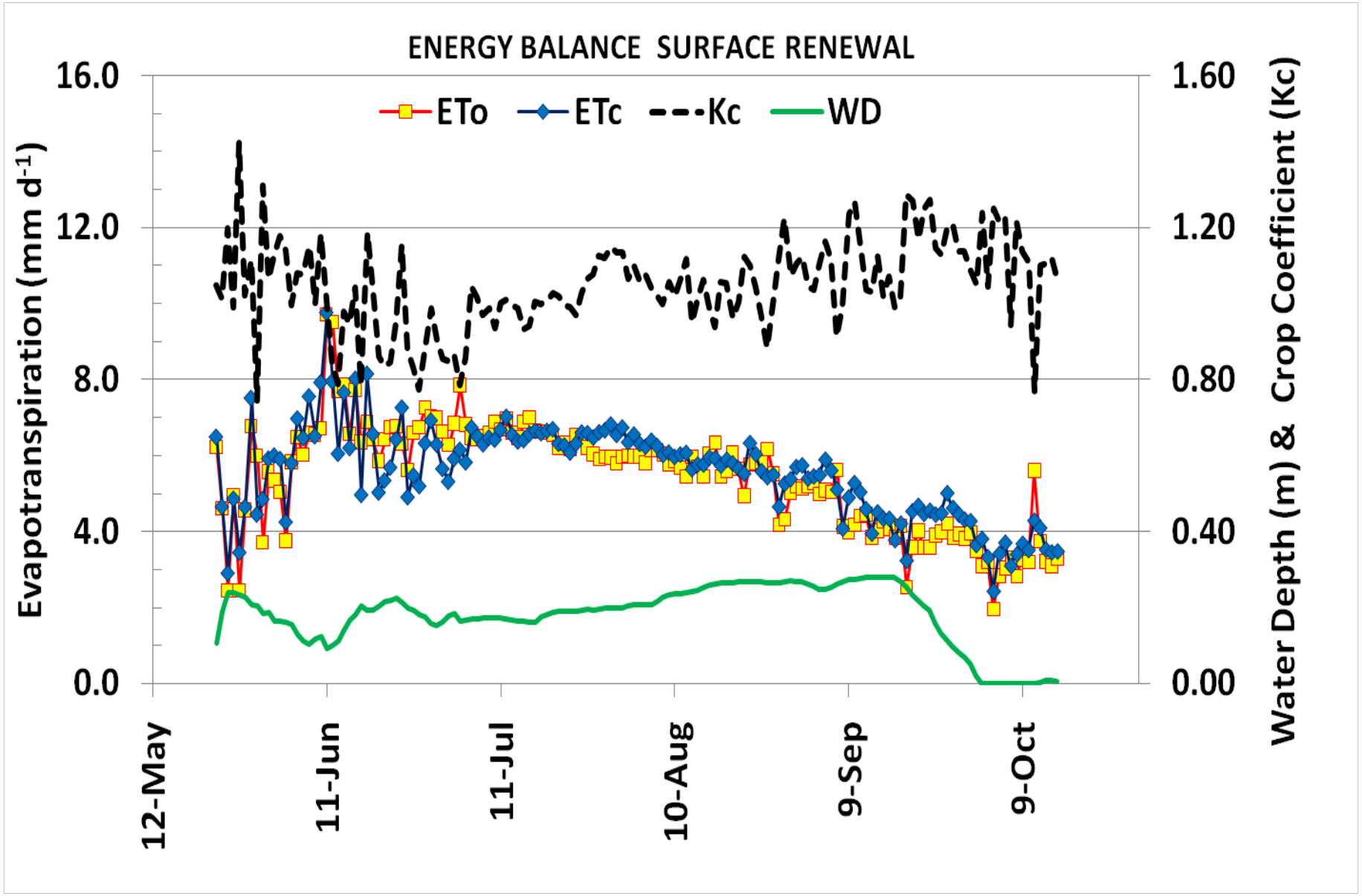



2008
ETc
ETo
Kc
Evapotranspiration (mm d-1)
Crop Coefficient (Kc)
16.0
12.0
8.0
4.0
0.0
1.60
1.20
0.80
0.40
0.00
1-May
31-May
30-Jun
30-Jul
29-Aug
28-Sep

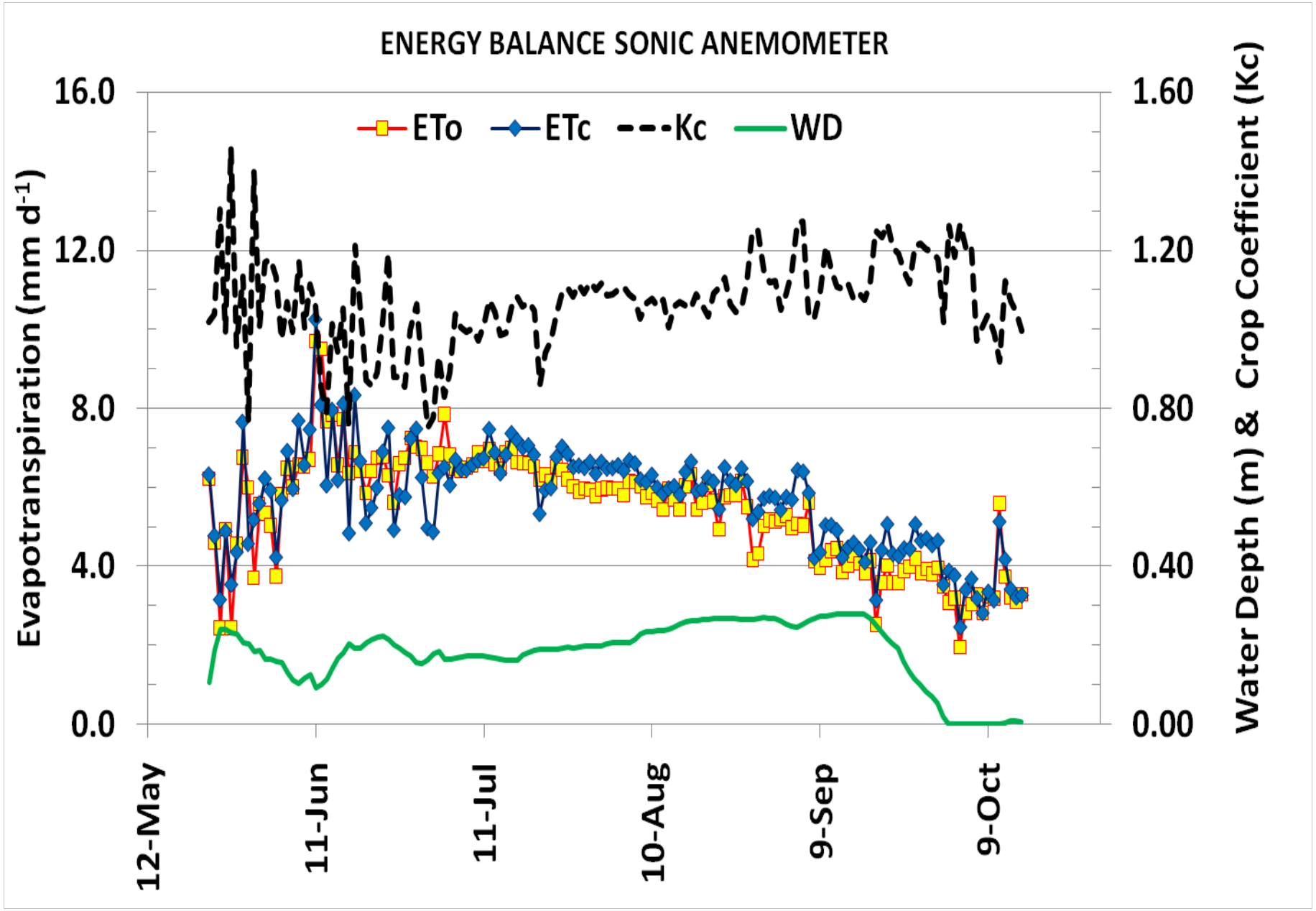
2009


ETc
ETo
ETc'
Kc
Kc'
North - Wet Seeded
Evapotranspiration (mm d-1)
Crop Coefficient (Kc)
15
12
9
6
3
0
1.50
1.20
0.90
0.60
0.30
0.00
Initial Flood 16 May
Drained 26 May Flooded 30 May
Final Drain 8 Sep
7-May
27-May
16-Jun
6-Jul
26-Jul
15-Aug
4-Sep
24-Sep
14-Oct
3-Nov

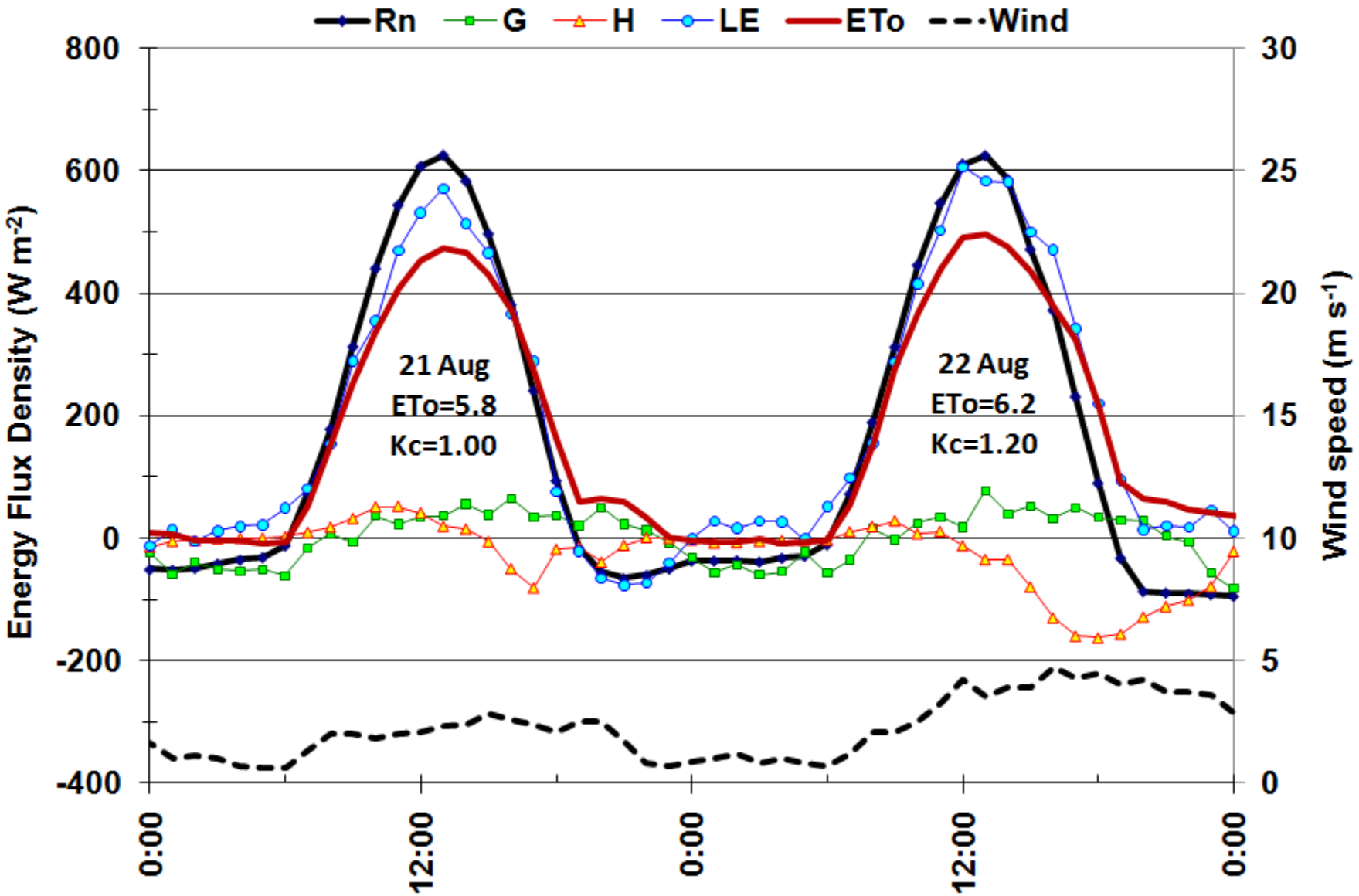
2010

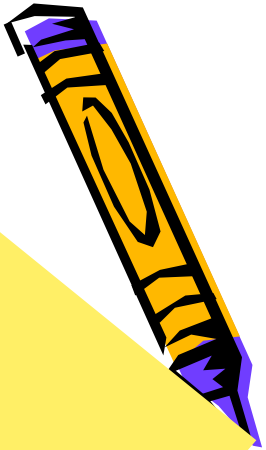

ENERGY BALANCE SURFACE RENEWAL
ETo
ETc
Kc
WD
Evapotranspiration (mm d-1)
Water Depth (m) & Crop Coefficient (Kc)
16.0
12.0
8.0
4.0
0.0
1.60
1.20
0.80
0.40
0.00
12-May
11-Jun
11-Jul
10-Aug
9-Sep
9-Oct

2010


ENERGY BALANCE SONIC ANEMOMETER
ETo
ETc
Kc
WD
Evapotranspiration (mm d-1)
Water Depth (m) & Crop Coefficient (Kc)
16.0
12.0
8.0
4.0
0.0
1.60
1.20
0.80
0.40
0.00
12-May
11-Jun
11-Jul
10-Aug
9-Sep
9-Oct

2009


Rn
G
H
LE
ETo
Wind
Energy Flux Density (W m-2)
Wind speed (m s-1)
800
600
400
200
0
-200
-400
30
25
20
15
10
5
0
21 Aug
ETo=5.8
Kc=1.00
22 Aug
ETo=6.2
Kc=1.20
0:00
12:00
0:00
12:00
0:00



Questions

Thanks

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