CALIBRATION FOR HISTORICAL CROP ET ESTIMATES

Introduction and Issues

Thomas W. Ley, PhD, PE

COLORADO DIVISION OF WATER RESOURCES
DEPARTMENT OF NATURAL RESOURCES

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Why Calibration?

- Most historical consumptive use analyses based on long evaluation period
- Long periods of record available at many NOAA Coop Observer network (max/min/precip) stations
- Simple temperature-based methods
- Limited period of record at electronic weather stations (20 years or less)

Why Calibration?

- Published studies have generally shown the simpler temperature-based ET estimation methods are inaccurate, especially in arid and semi-arid climates
- Local calibration/verification is strongly recommended to obtain more accurate historical crop ET estimates

Approach

- **Compute calibration coefficients for some specific time interval during growing season (e.g., 10-days, monthly)**

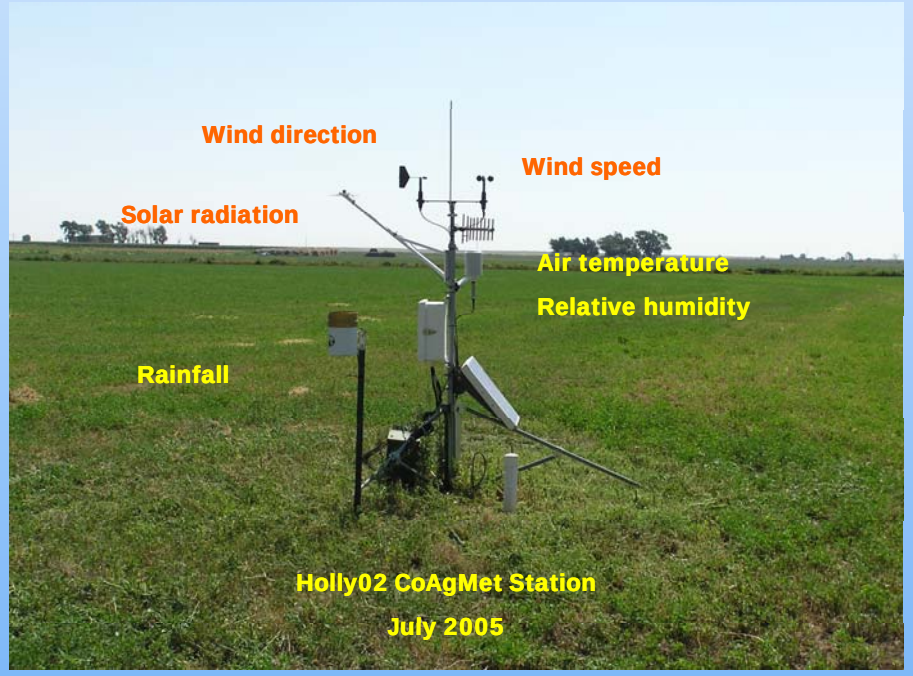
$$\text{Calibration coeff.} = \frac{\text{Measured Crop ET}}{\text{Crop ET by method being calibrated}}$$

- **In the absence of measured ET (i.e., lysimeter), use crop ET based on ASCE Std Ref-ET Eqn**

Measured Crop ET

- **Lysimetry**

- **ASCE Std Reference ET**



Approach

- Compute average calibration coefficient values for overlapping period of record
  - Monthly time step
- Minimum 5-7 years of overlapping record

Modified Blaney-Criddle Method (TR-21)

$$u = k_c (k_t) (t \times p) / 100$$

u = monthly consumptive use (inches)

k_t = climatic coefficient

= 0.173 * t - 0.314

k_c = crop growth stage coefficient

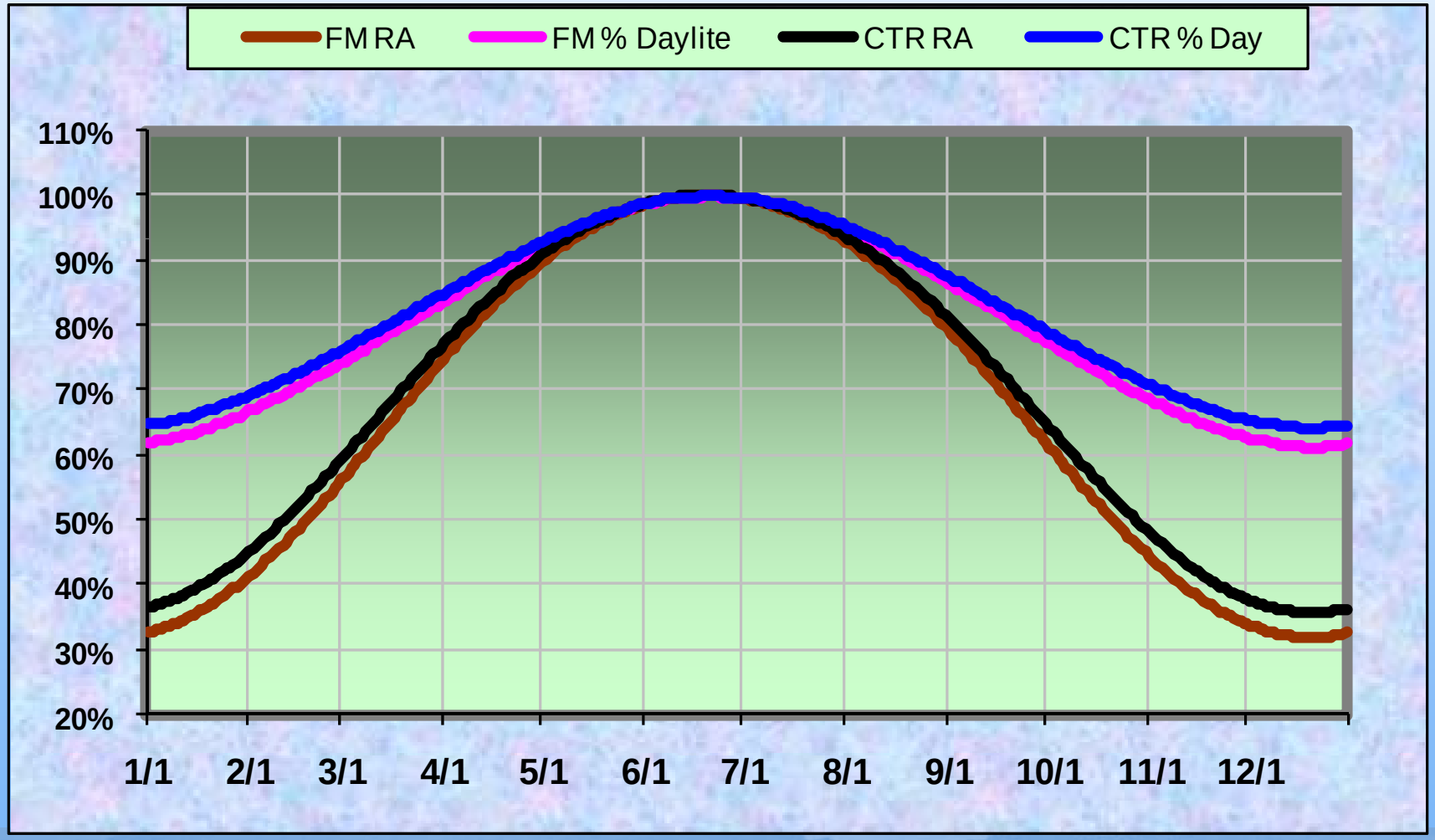
t = mean monthly air temperature (°F)

p = monthly percentage of annual daylight hours

Modified Blaney-Criddle Method

- Data required--mean monthly temperature
- 100's of max/min/precip stations in Colorado
- Developed for irrigation planning
- k_t (t * p) / 100 not representative of the impact of meteorological elements

Extraterrestrial Radiation & Percent of Daylight as a Percentage of Maximum



Modified Blaney-Criddle Method

- Crop factor, k_c , is not a crop coefficient in the same sense as the reference ET-crop coefficient approach
- Contains a meteorological component
  - location bias
  - values not geographically transferable (ASCE Manual 70, 1990; USDA-NRCS, 1993)
- Ignore k_c and calibrate just the factor:

$$k_t\ (t * p)\ /\ 100$$

1985 Hargreaves Method

$$ET_o = 0.0023(T_{max} - T_{min})^{0.5}\ (T_{mean} + 17.8)\ R_a$$

ET_o = grass reference ET (mm/day)
T_{max} = maximum daily air temperature (°C)
T_{min} = minimum daily air temperature (°C)
T_{mean} = mean daily air temperature
= $(T_{max} + T_{min}) / 2$
R_a = extraterrestrial radiation (mm/day)
R_a (mm/day) = R_a (MJ/m²/day) / 2.45

1985 Hargreaves Method

- Originally developed in 1975
  - solar radiation and temperature data inputs
- Updated in 1982 and 1985
  - solar radiation estimated from extraterrestrial radiation, R_A
- Grass reference ET
- May be used to compute daily estimates, but more accurate over longer time steps: 10-days, monthly

1985 Hargreaves Method

- Simple, easy to use
- Data required—maximum and minimum air temperature
- Better predictive accuracy in arid climates than modified Blaney-Criddle
  - Max-min temperature difference
  - Extra-terrestrial radiation
- Underpredicts in windy or high advection conditions—requires local calibration

1985 Hargreaves Method

- Grass reference ET method
- Directly calibrate:

$$K = \frac{\text{ASCE std ref } ET_r}{\text{Hargreaves } ET_o}$$

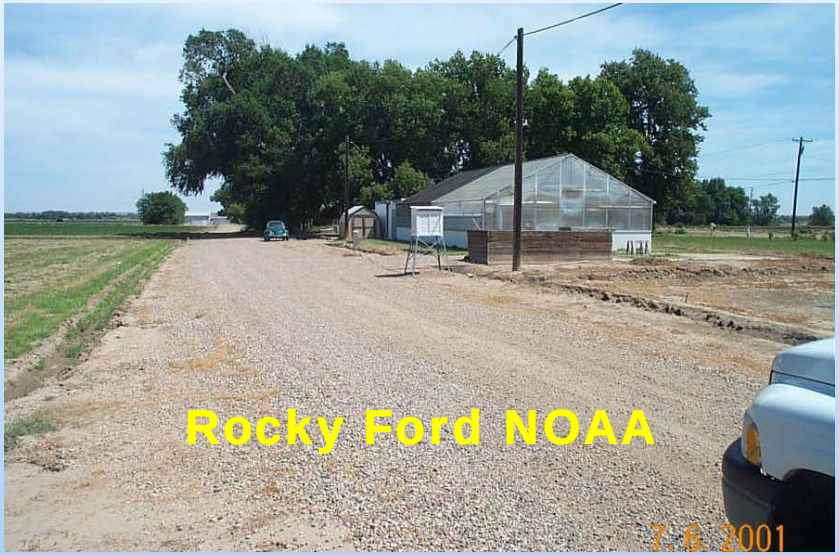
- Use alfalfa reference crop coefficients

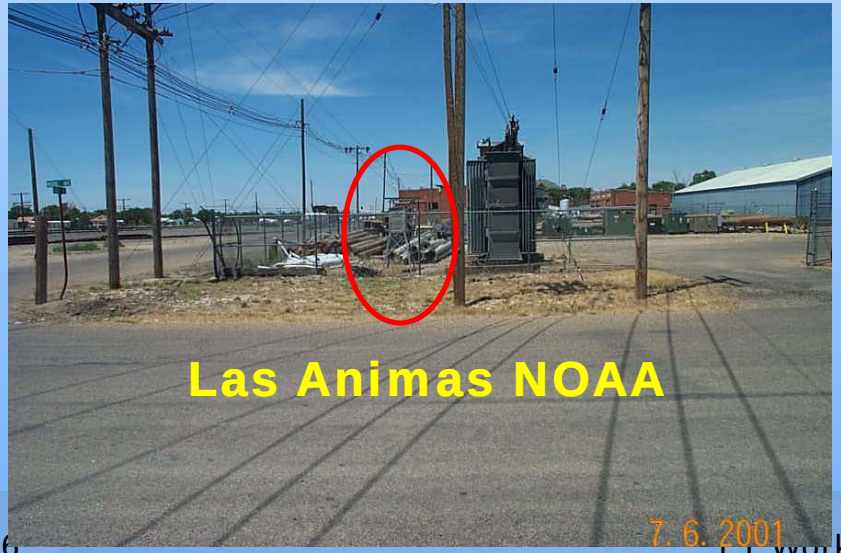
$$ET_c = K_{cr} (K * ET_o)$$

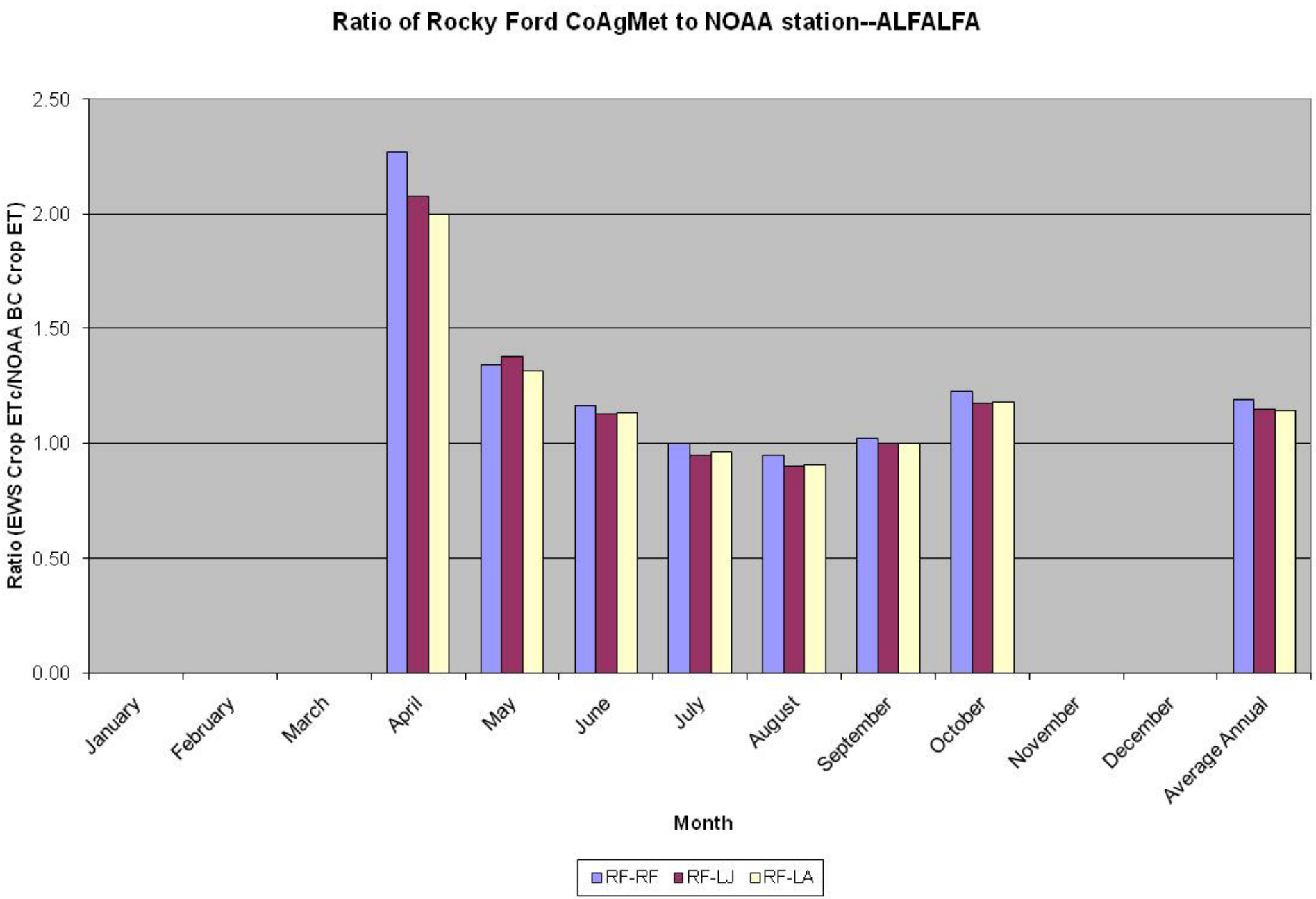
Calibration Precautions/Limitations

- Extent of areal representation ?
- Weather station pairing
  - Compute calibration coefficients by pairing each NOAA station of interest with electronic weather station
  - Site bias at the NOAA site may not be properly captured
  - Bigger problem with SCS BC than 1985 Hargreaves

Coefficients for one EWS-NOAA station pair generally not applicable at other NOAA stations when conditions at the NOAA sites are dissimilar






Ratio of Rocky Ford CoAgMet to NOAA station--ALFALFA
Ratio (EWS Crop ETc/NOAA BC Crop ET)
2.50
2.00
1.50
1.00
0.50
0.00
January
February
March
April
May
June
July
August
September
October
November
December
Average Annual
Month
RF-RF
RF-LJ
RF-LA