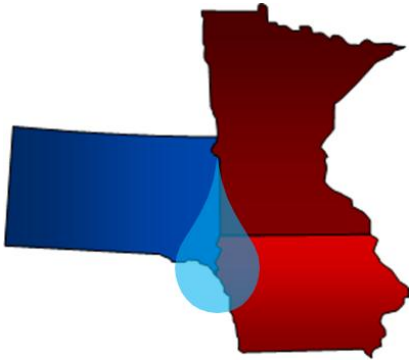
A Presentation of the 2012 Drainage Research Forum

November 20, 2012
Farmamerica, Waseca MN



IOWA STATE UNIVERSITY
University Extension

SDSU Extension

Cover Crop Evapotranspiration and Water Management

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20 November 2012

South Dakota State University
Water Resources Institute

SDSU Extension

Cover crops are increasingly being promoted as a sustainable agricultural practice

Photo: Andrea Parrish-Geyer

Building soil quality

Photo: Collette Kessler, USDA NRCS

Erosion protection

Photo: Lynn Betts, USDA NRCS

Residue cycling

Photo: Jason Miller, USDA NRCS

Nutrient cycling

Photo: Jason Johnson, USDA NRCS

Nitrogen fixation

Photo: USDA NRCS SD

Reducing compaction

Photo: Jason Miller, USDA NRCS

Salinity management

Photo: USDA NRCS SD

Grazing

Photo: Abby Bischoff

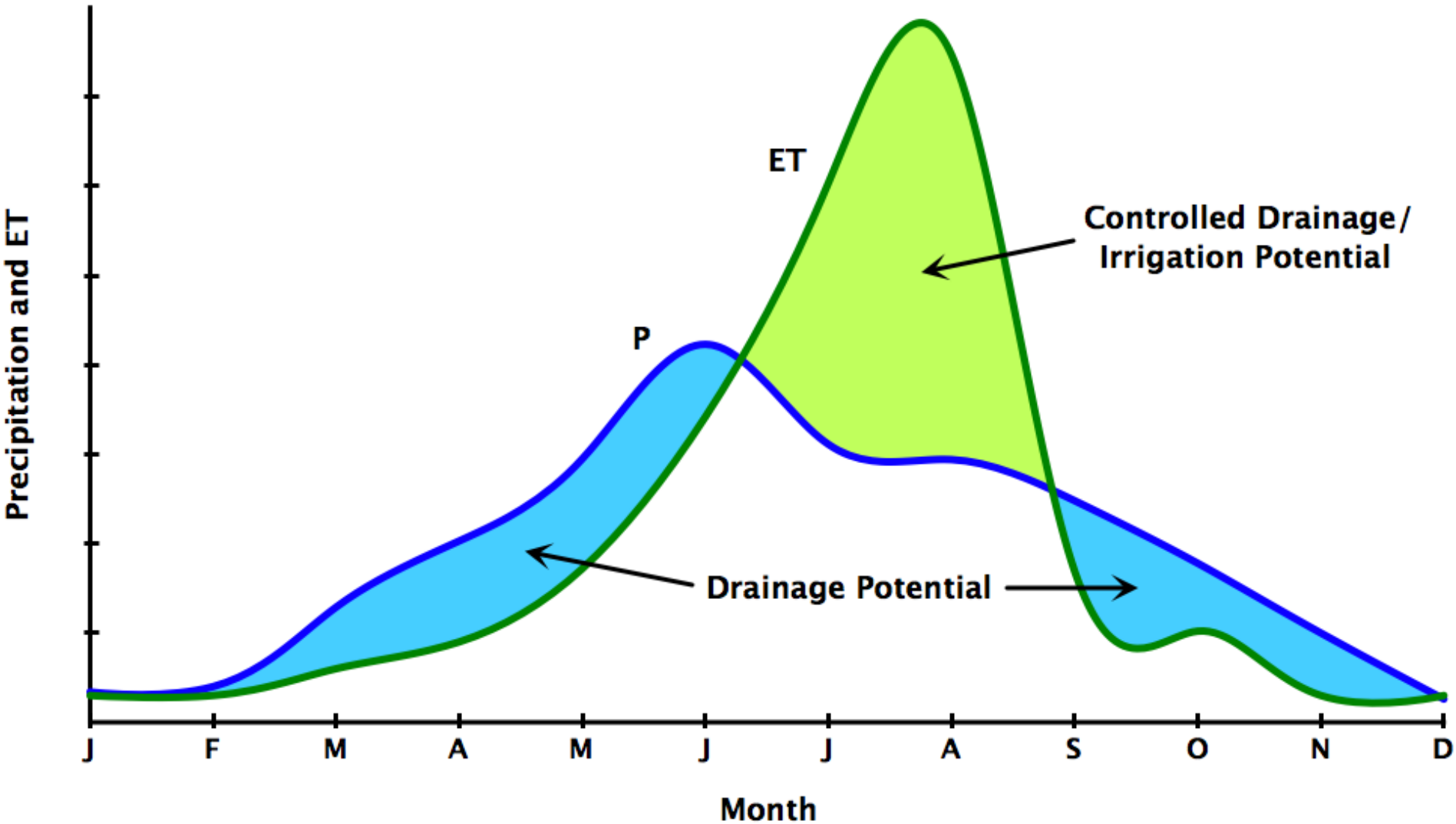
To get multiple benefits, a cover crop “cocktail” is used

Photo: Michael Stevens, USDA NRCS

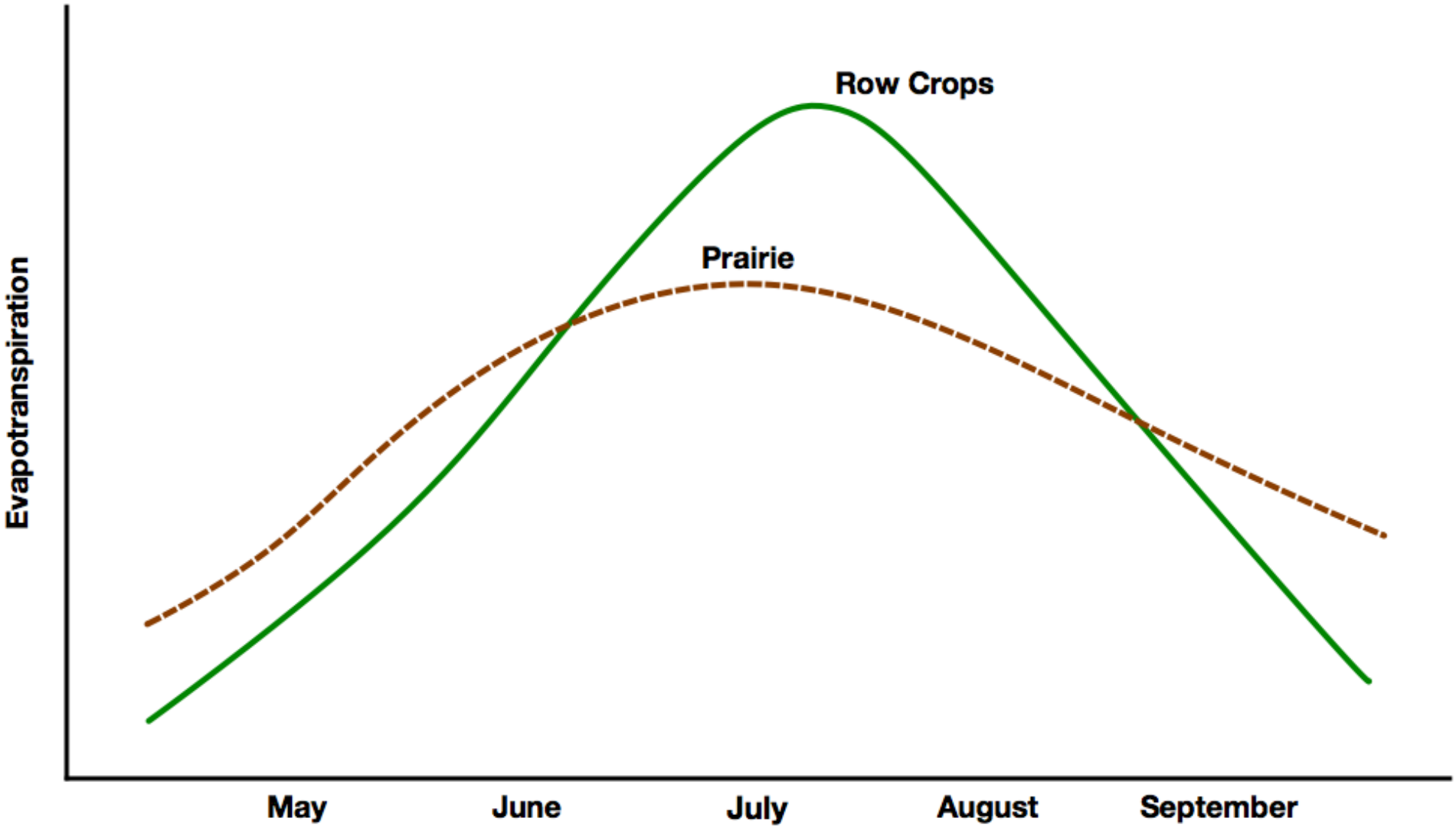
Cover crops are also being promoted as a water management tool

Photo: Chris Hay

Cover crops provide additional transpiration beyond the cash crop growing season



This better approximates historic fall and spring ET



Cover crops will also increase infiltration

Photo: USDA NRCS SD

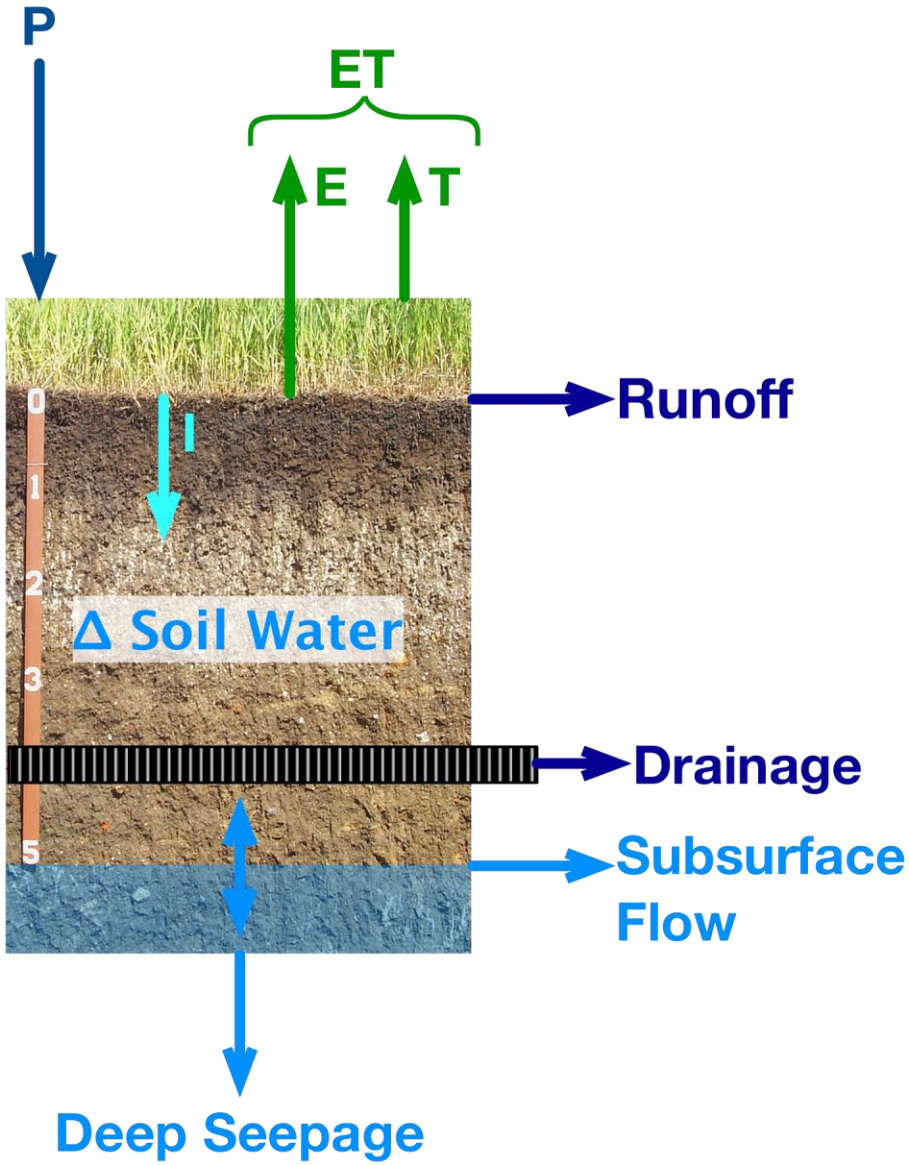
Cover crops will reduce soil evaporation

Photo: Jason Miller, USDA NRCS

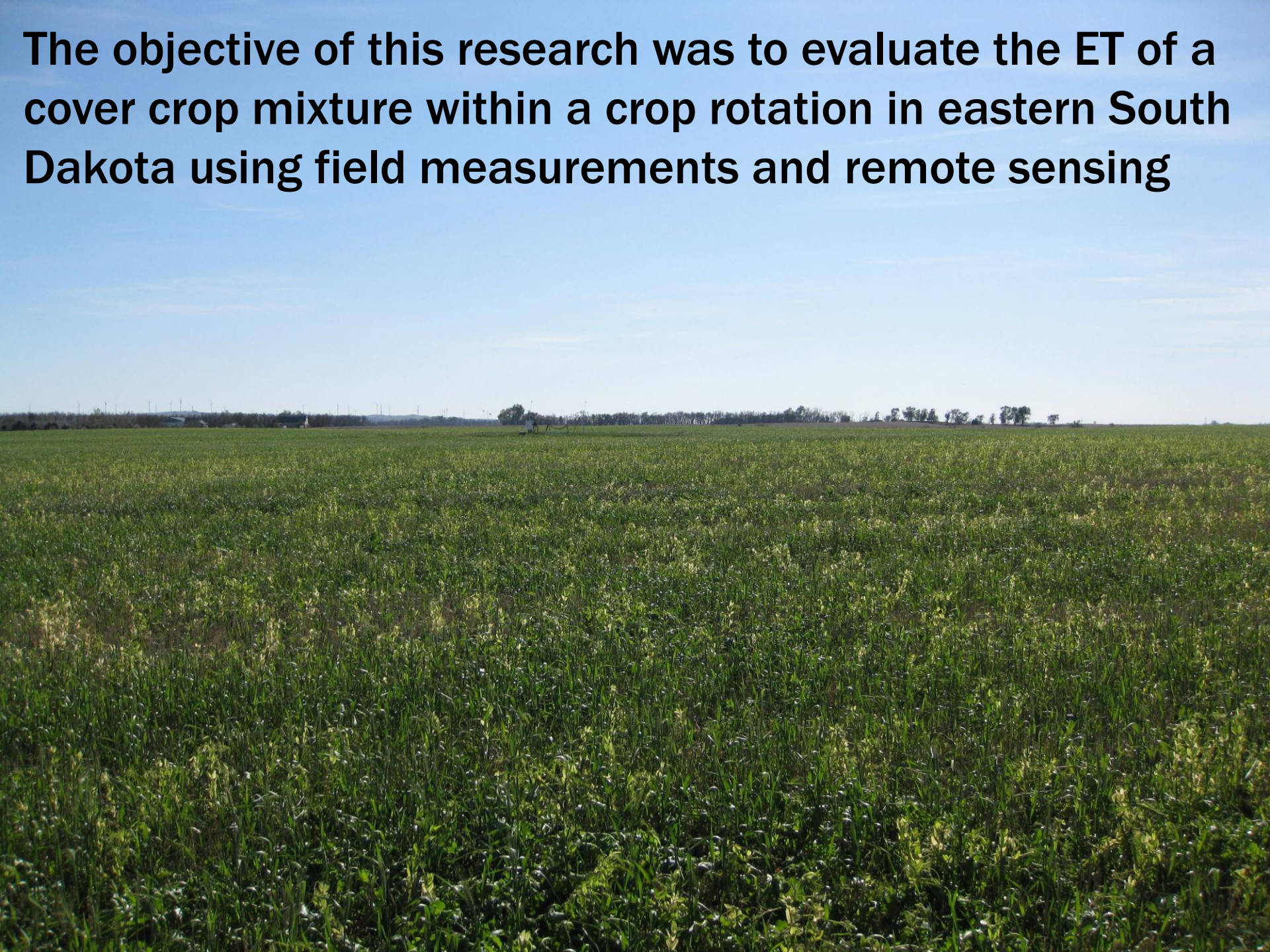
Cover crops can provide increased trafficability

Photo: USDA NRCS NY

What is the net impact of cover crops on the water balance of the soil?



The objective of this research was to evaluate the ET of a cover crop mixture within a crop rotation in eastern South Dakota using field measurements and remote sensing



The study site is near Andover, SD

Google earth miles 3 km 6

The field is in a spring wheat, cover crop, corn, soybean rotation

Photo: NDSU Ag Comm.

Photo: Jason Johnson, USDA NRCS

Photo: Collette Kessler, USDA NRCS

The cover crop was a mixture of radishes, field peas, and winter rye

The study season was from 24 May to 19 Oct 2011

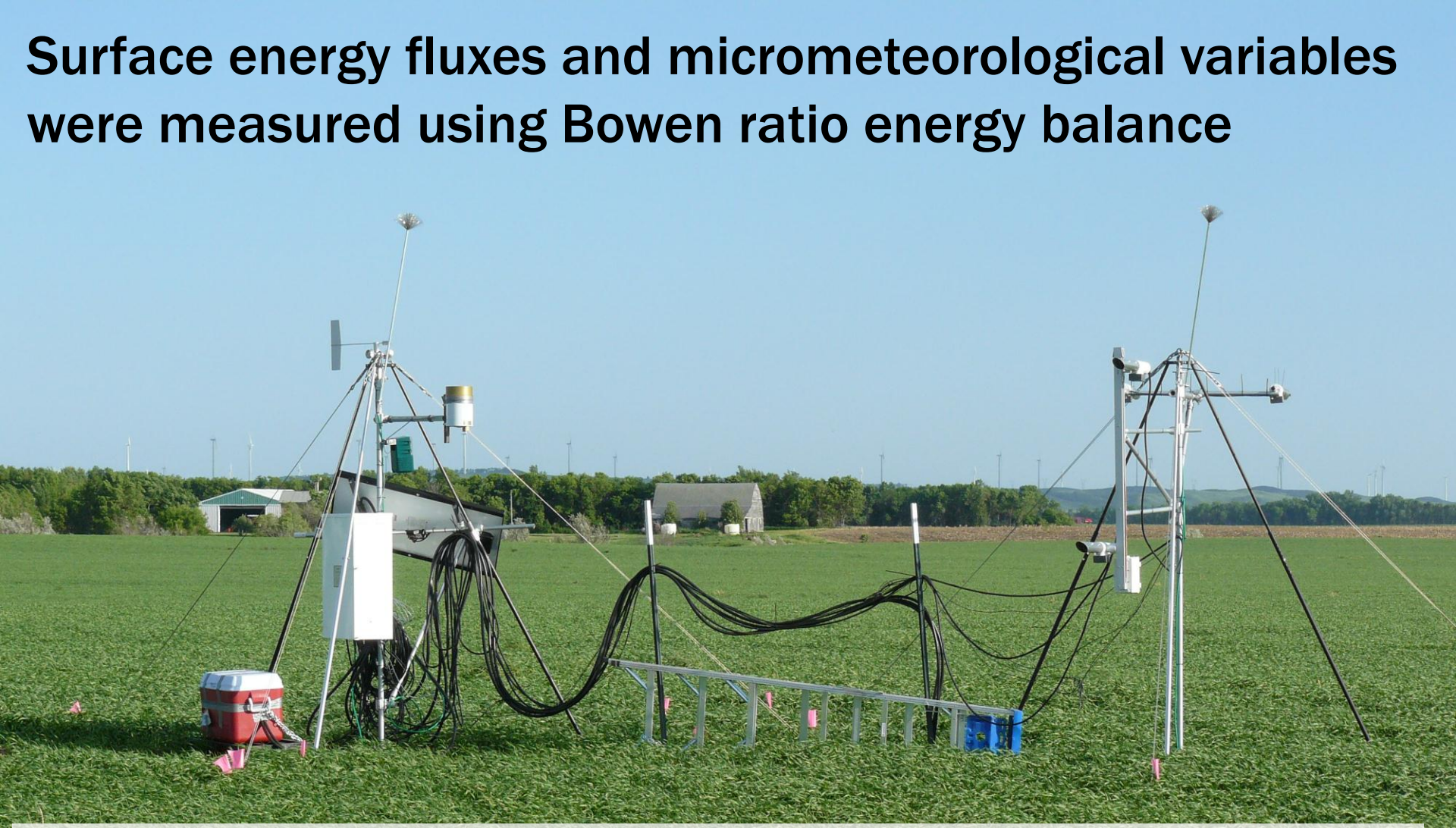
24 May

4 Aug

12 Aug

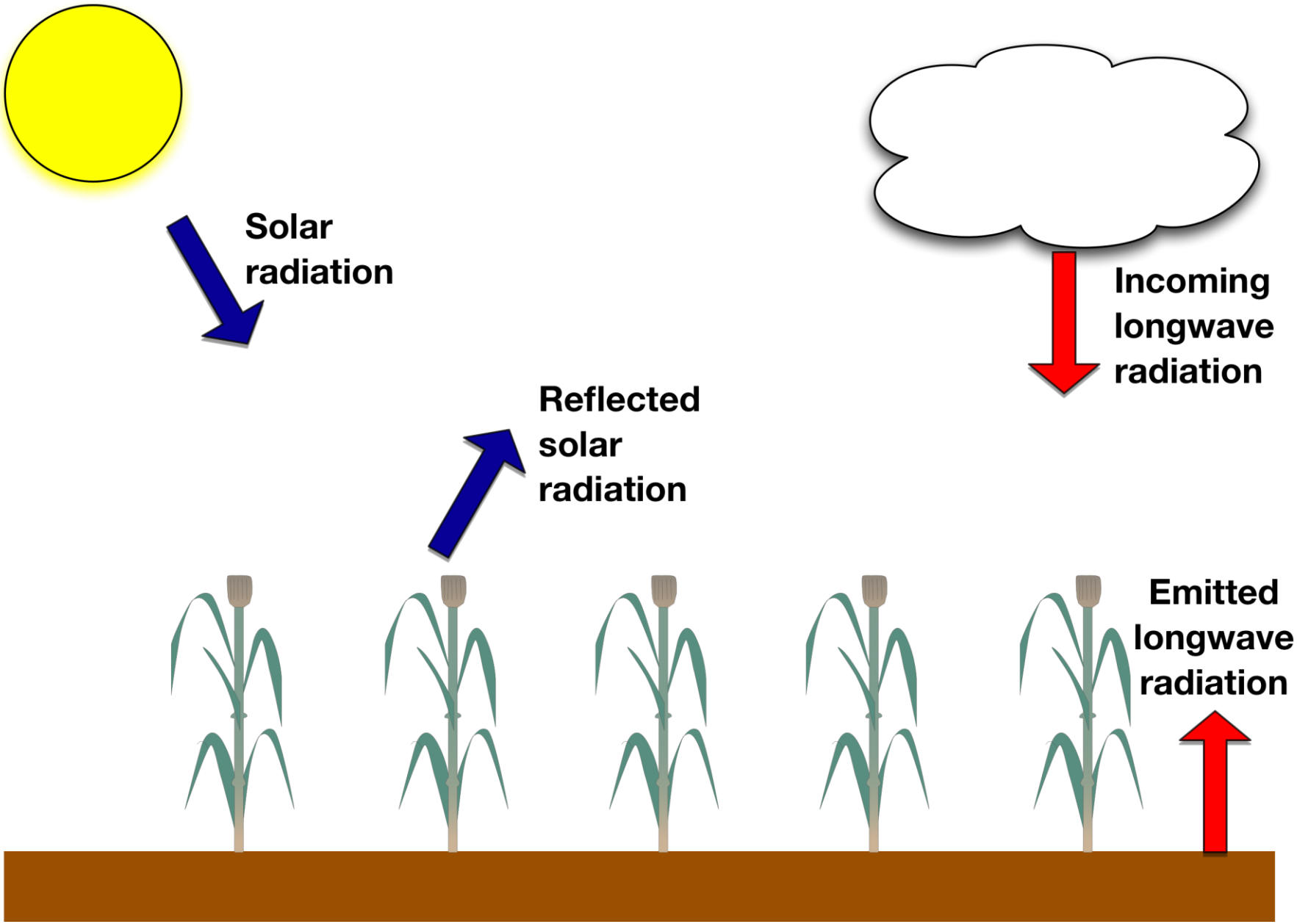
19 Oct

Surface energy fluxes and micrometeorological variables were measured using Bowen ratio energy balance

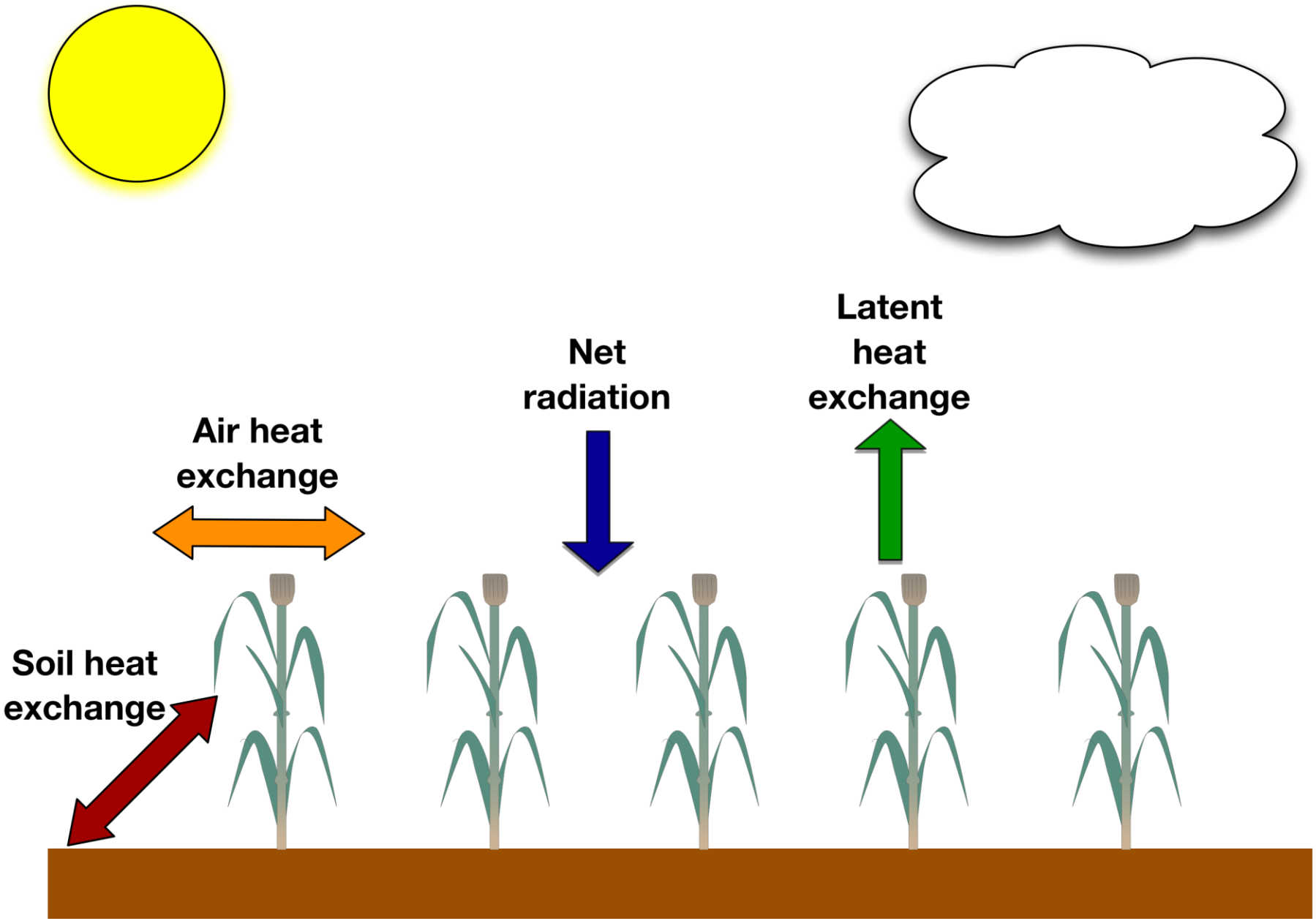


- Air temperature
- Relative humidity
- Shortwave radiation
- Longwave radiation
- Net radiation
- Soil moisture
- Soil temperature
- Soil heat flux
- Barometric pressure
- Wind speed
- Wind direction
- Precipitation

Radiation drives the energy balance



Solving the surface energy balance gives us ET



Reference ET is the estimated ET from a hypothetical reference surface with specified characteristics

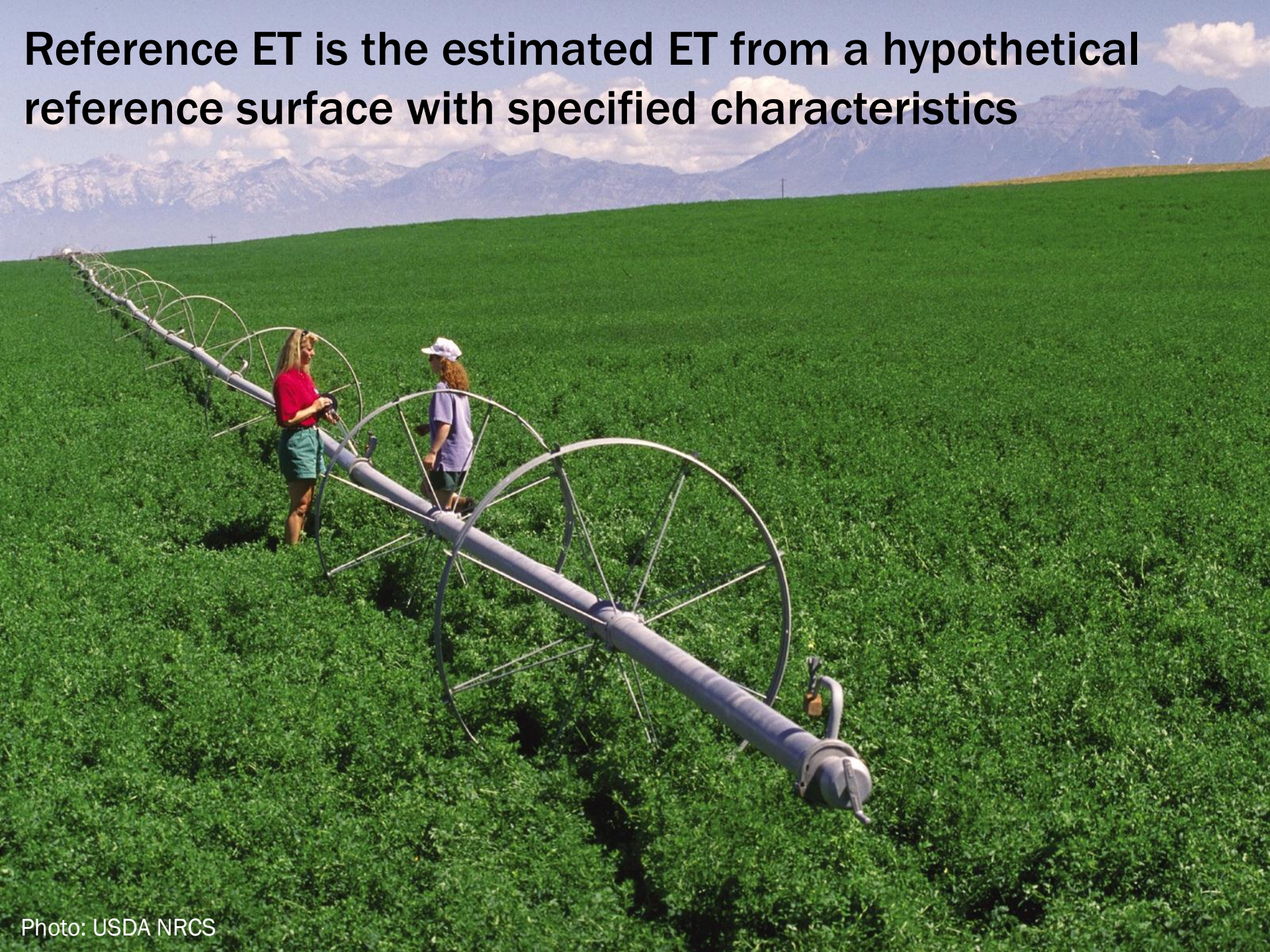


Photo: USDA NRCS

Reference ET was calculated using the ASCE standardized reference evapotranspiration equation

$$ET_{sz} = \frac{0.408\Delta(R_n - G) + \gamma \frac{C_n}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + C_d u_2)}$$

ET_{sz} = reference ET (mm d^{-1} or mm h^{-1})
R_n = net radiation (MJ m^{-2} d^{-1} or MJ m^{-2} h^{-1})
G = soil heat flux (MJ m^{-2} d^{-1} or MJ m^{-2} h^{-1})
T = mean air temperature (°C)
u_2 = mean wind speed at 2 m (m s^{-1})
e_s = saturation vapor pressure (kPa)
e_a = actual vapor pressure (kPa)
Δ = slope of the SVP-T relationship (kPa °C^{-1})
γ = psychrometric constant (kPa °C^{-1})
C_n = numerator constant (K mm s^3 Mg^{-1} d^{-1} or K mm s^3 Mg^{-1} h^{-1})
C_d = denominator constant (s m^{-1})

To calculate ET_{ref} we need:

Location
(altitude, latitude)

Solar radiation

Air temperature

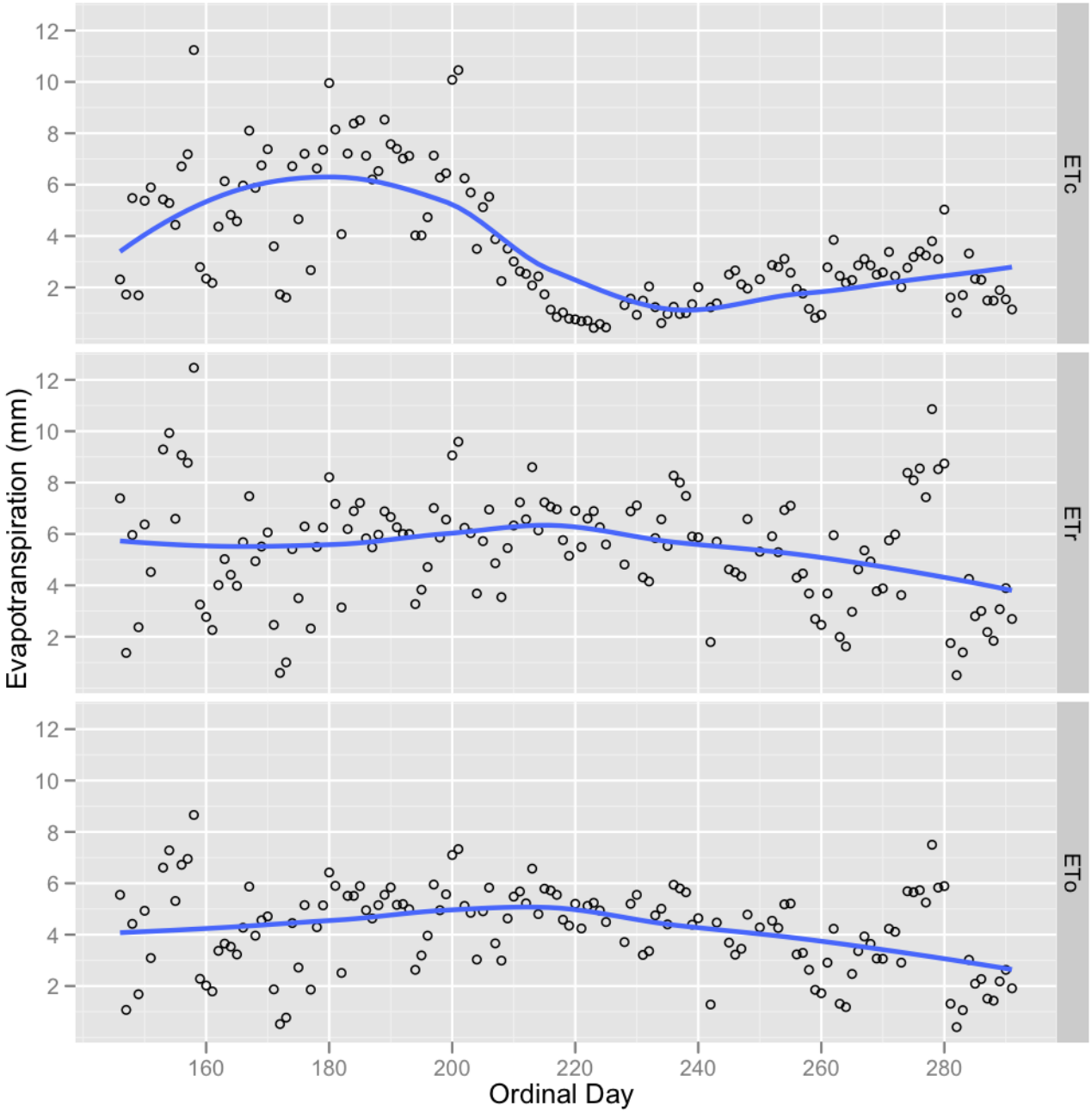
Humidity

Wind speed

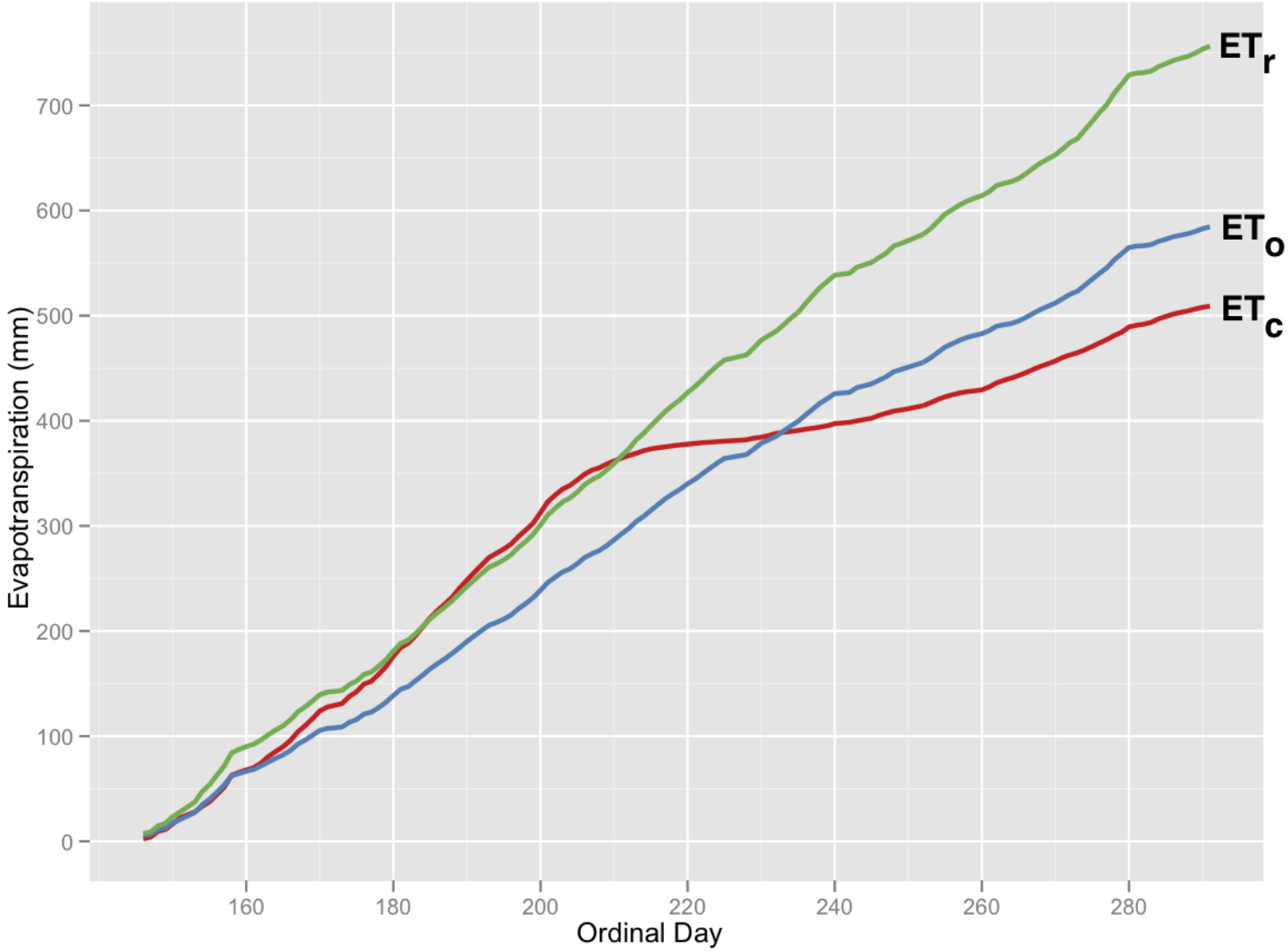
Cover crop ET was 26% of the overall study season ET

Variable	Wheat	Cover Crop	Combined
Solar radiation (MJ/m^2)	1574	1101	2834
Net radiation (MJ/m^2)	1007	550	1646
Precipitation (mm H_2O)	194	75	269
Average temperature (°C)	20.7	16.1	18.6
Average vapor pressure (kPa)	1.89	1.24	1.58
Average wind speed (m/s)	3.58	3.59	3.55
ET_{BREBS} (mm H_2O)	382	136	523

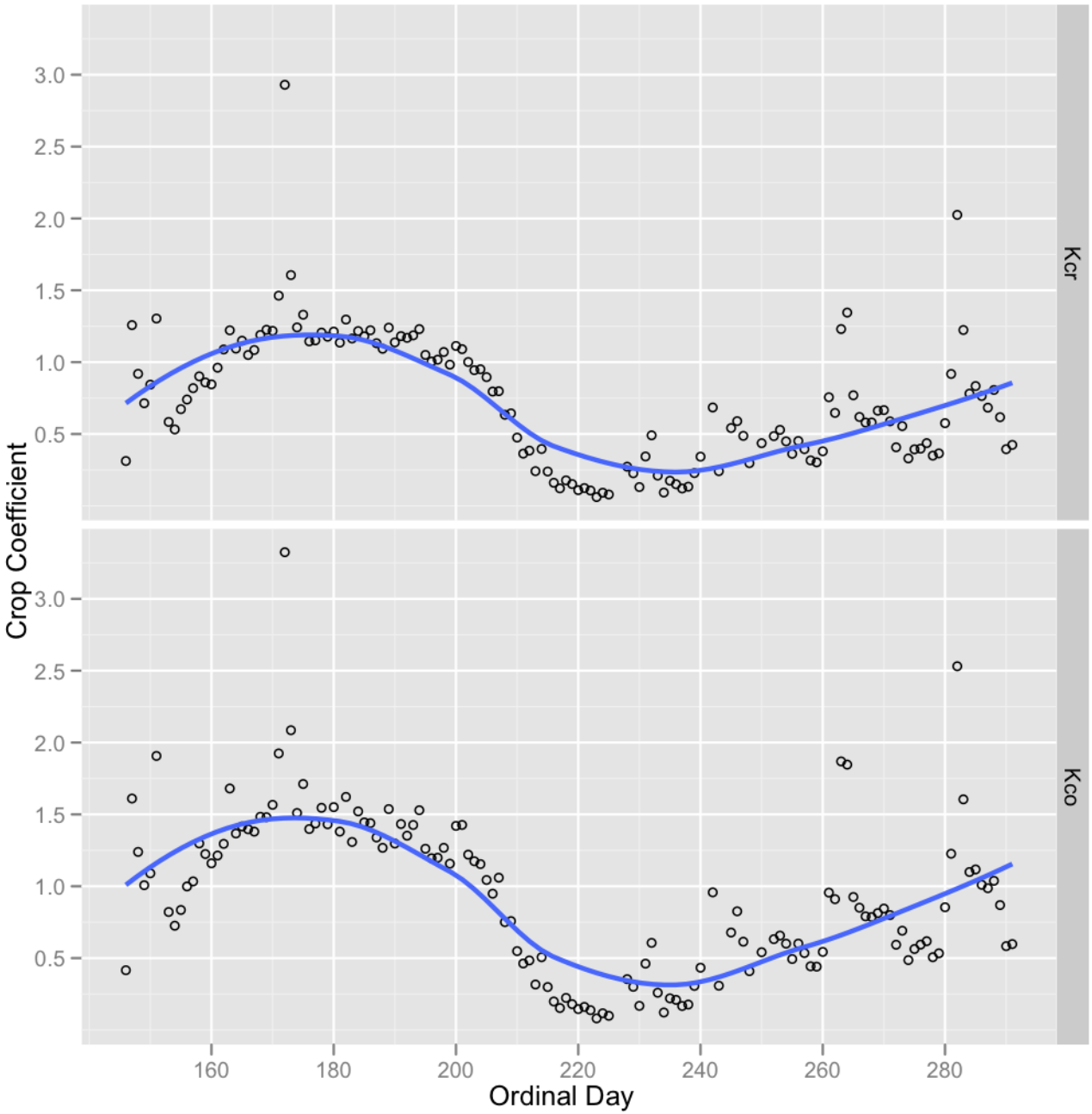
Daily ET


ETc
ETr
ETo
Evapotranspiration (mm)
Ordinal Day
12
10
8
6
4
2
160
180
200
220
240
260
280

Cumulative ET



Crop coefficients



In summary, cover crop ET was a smaller but significant portion of the overall seasonal ET

Lack of precipitation limited the ET of the cover crop

More research is needed on the impacts of cover crops on water balance in crop rotations