Model-data synthesis for predicting soil moisture under wheat cropland

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MOISST Workshop

4-5 June 2014

Project funded by NRCS-CIG project

Systems-based cropping 2.0: leveraging soil health demonstrations through web-based tools.

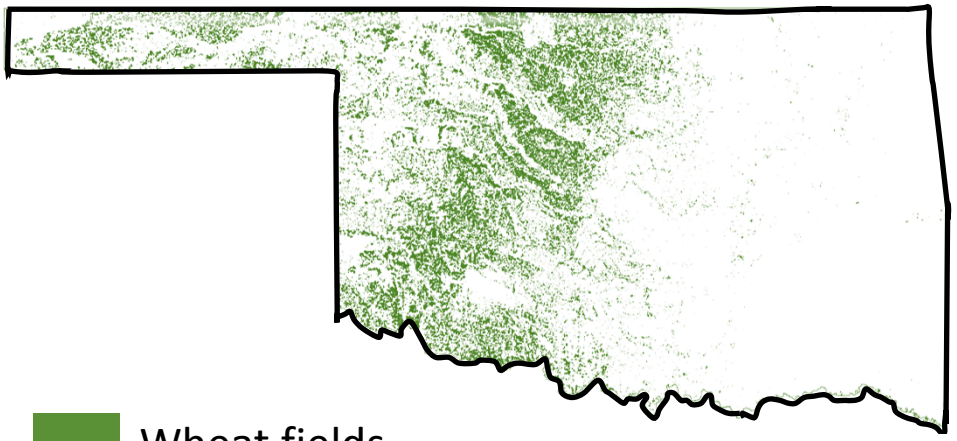
Soil Physics

The idea

Develop a wheat cropland soil moisture monitoring system for the state of Oklahoma.

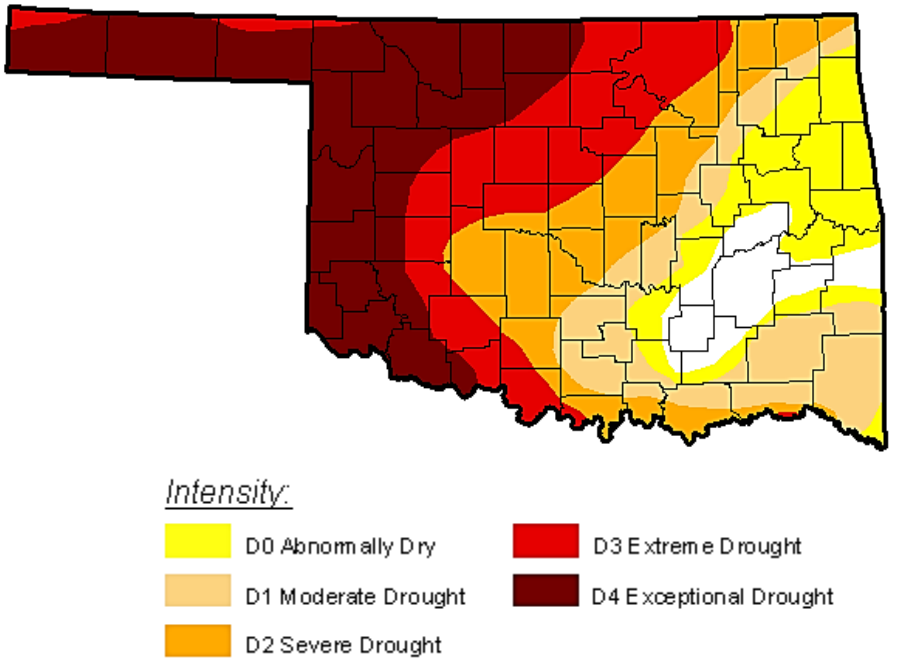
But why…

Wheat cropland fields, 2010.



Wheat fields

May, 20th, 2014
US Drought Monitor archive.



http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx

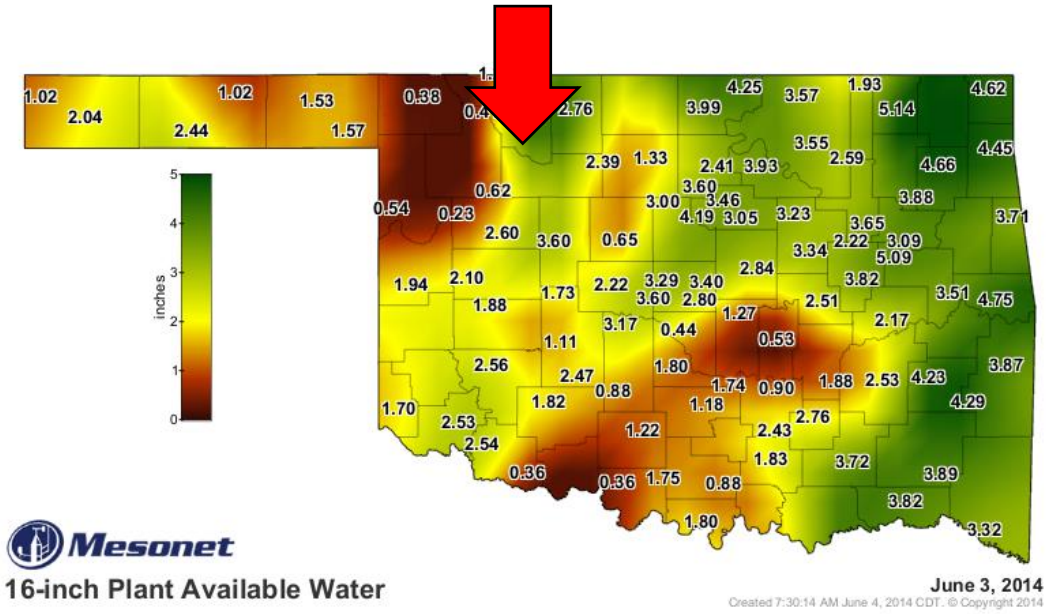


Figure showing state-wide plant available water in top 40 cm (16 in) under sod.

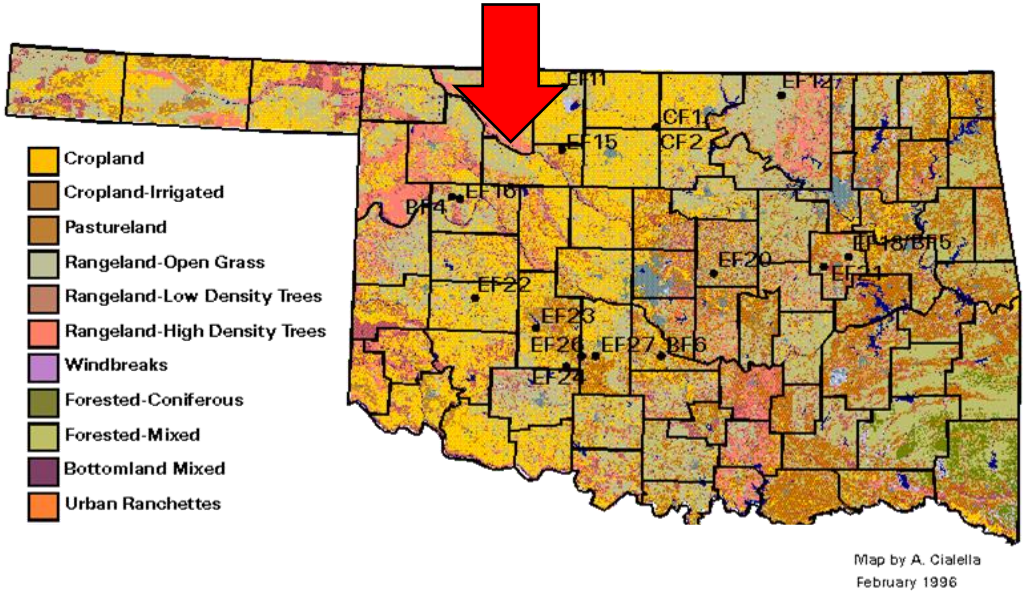


Figure showing different land covers across the state of Oklahoma.

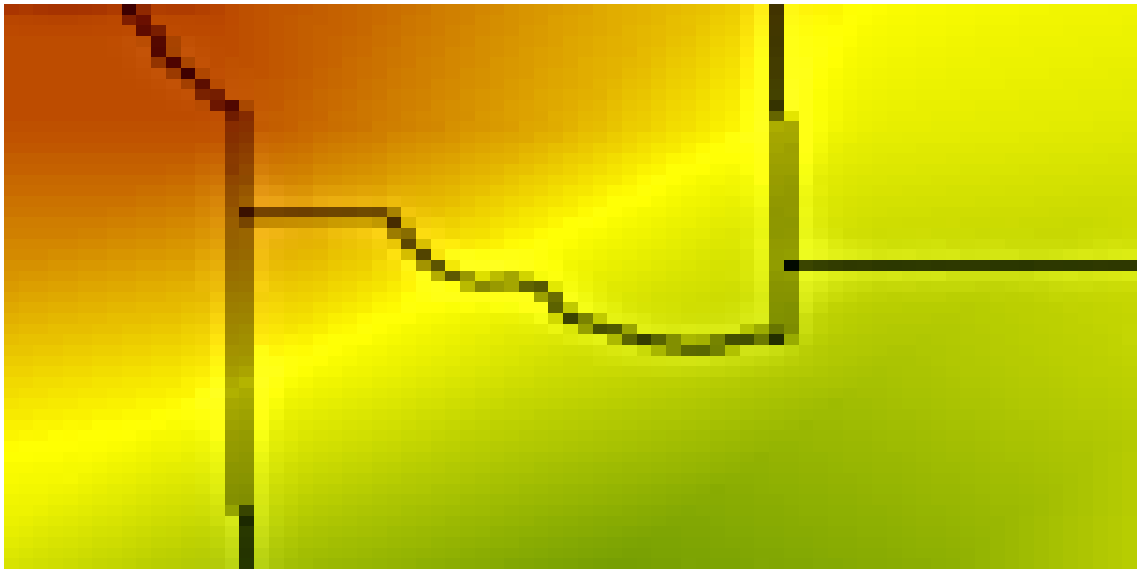


Figure showing a zoomed-in map of plant available water in top 40 cm (16 in) under sod.

References:

Wheat

Grass

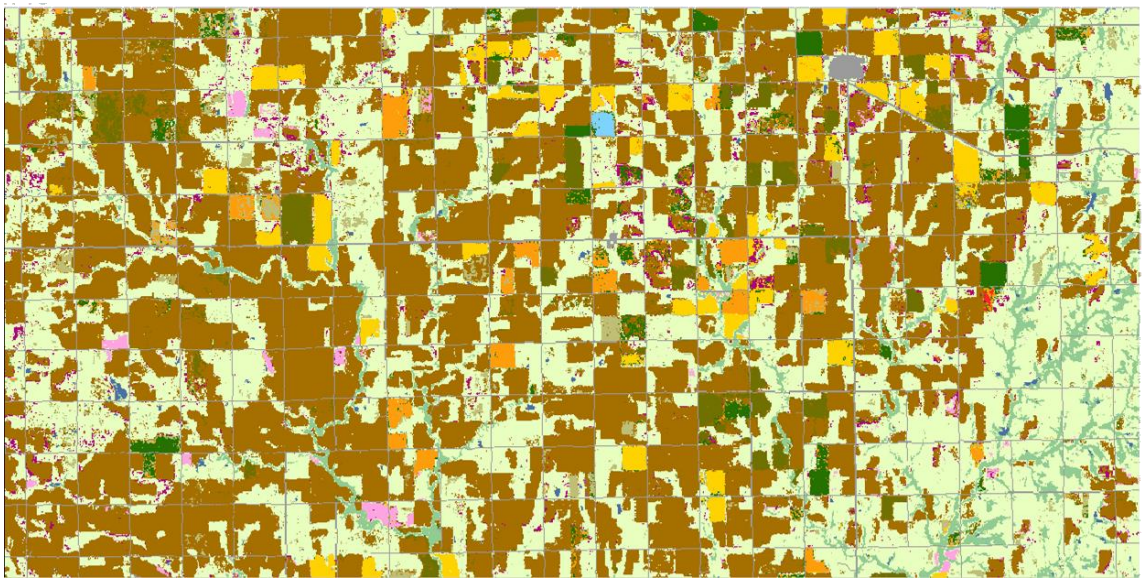
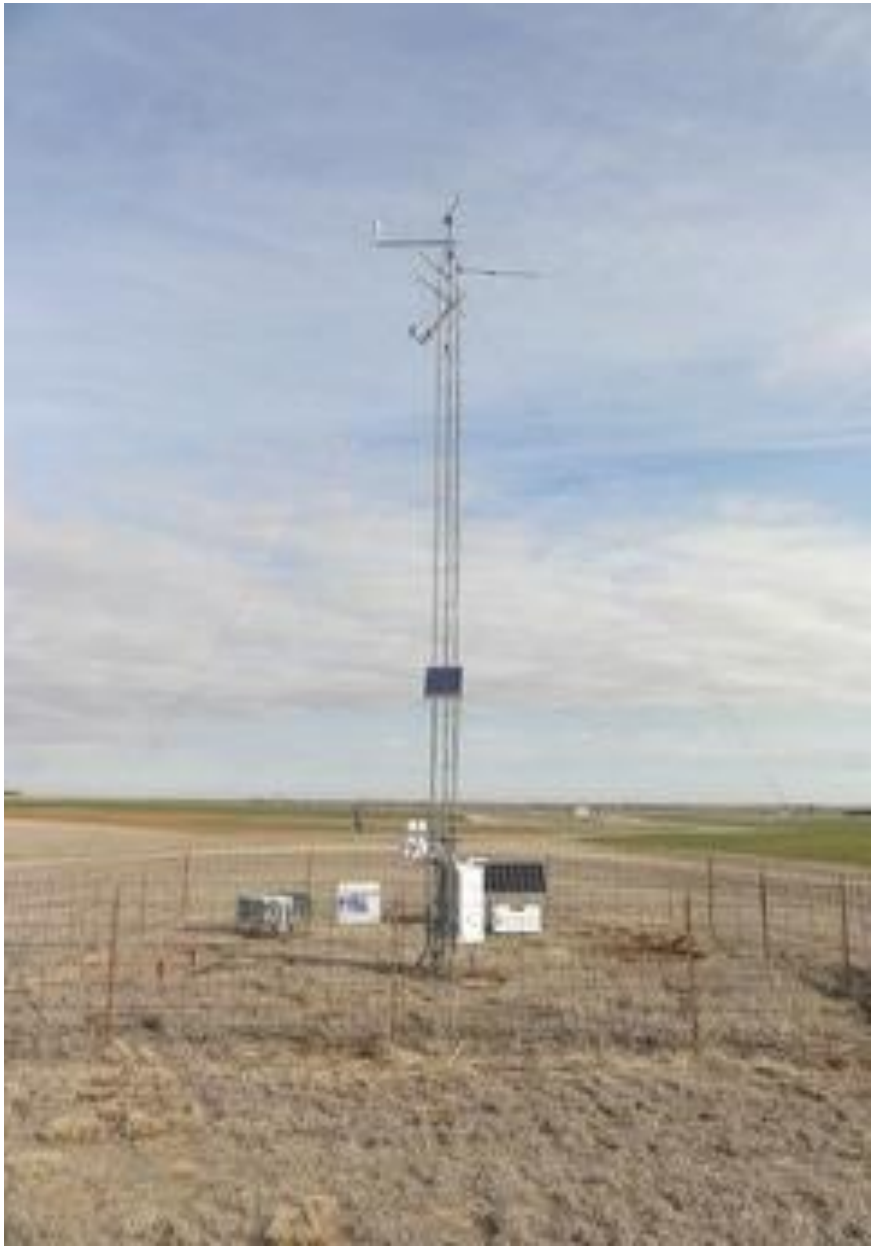
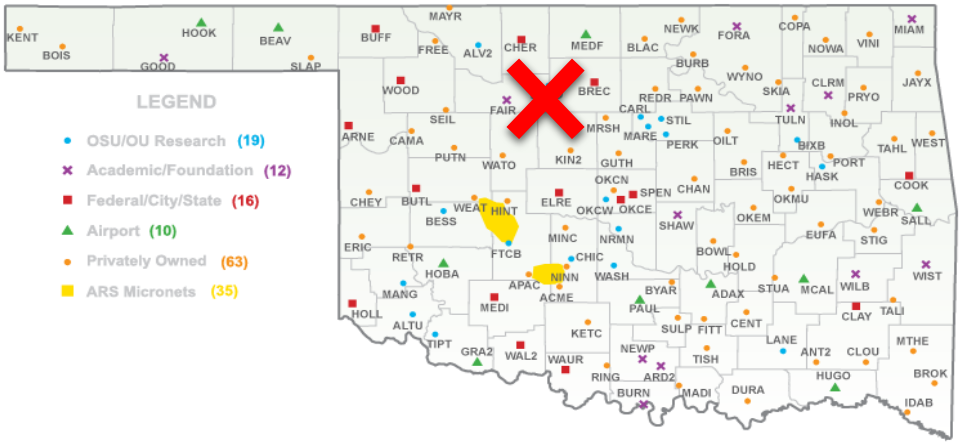


Figure of wheat (brown) as the dominant land cover over grassland (light green) in this region.

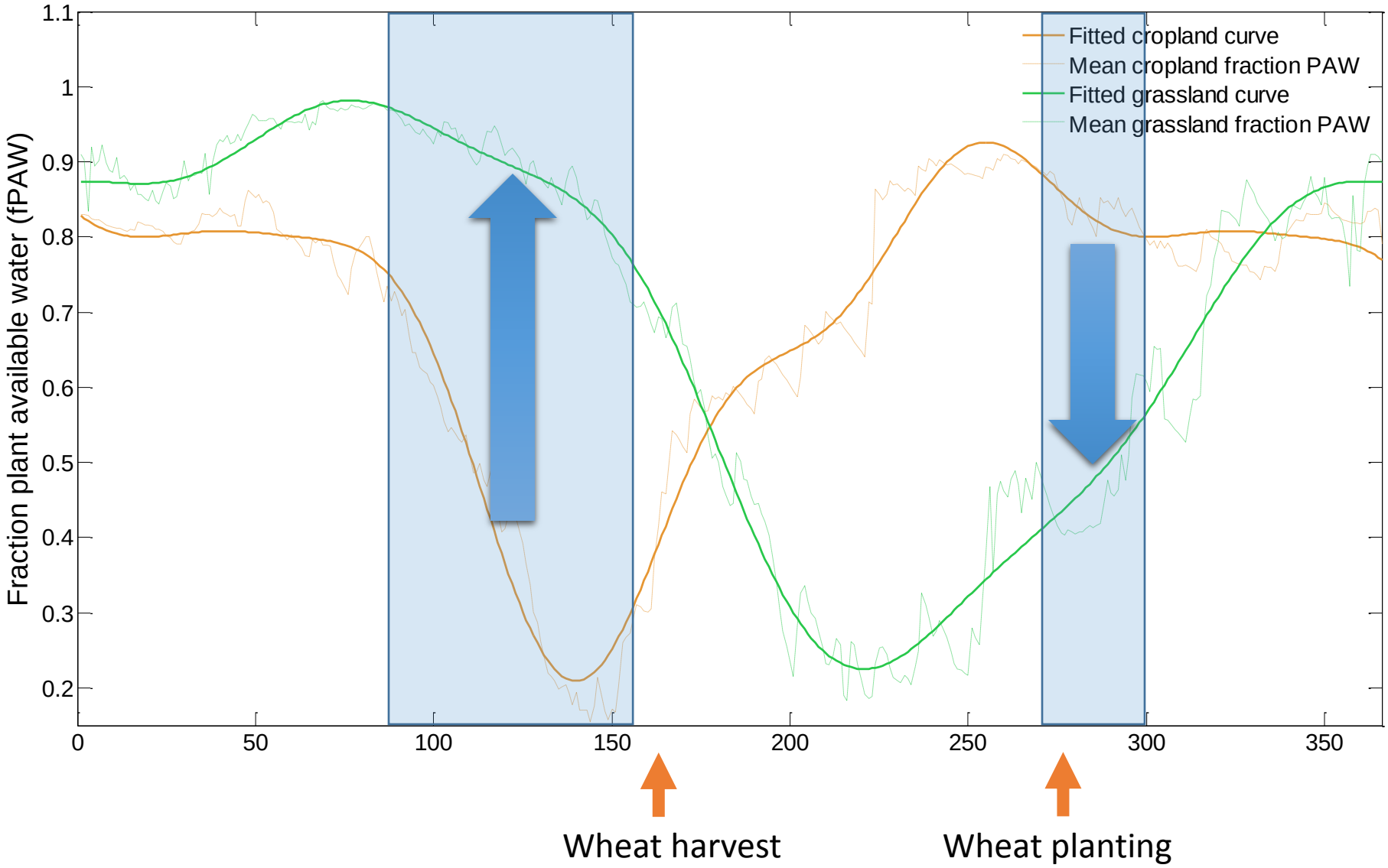


Mesonet station at Lahoma, OK (Winter)

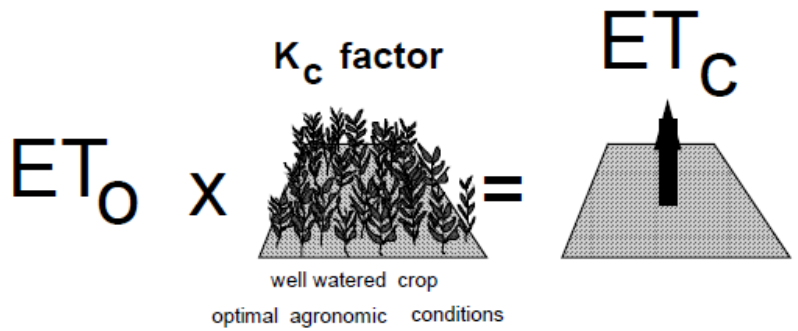


Geographic location of the Mesonet station at Lahoma, OK.

Mesonet station at Lahoma, OK (Summer)


Fitted cropland curve
Mean cropland fraction PAW
Fitted grassland curve
Mean grassland fraction PAW
Fraction plant available water (fPAW)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
50
100
150
200
250
300
350
Wheat harvest
Wheat planting

The soil water balance model



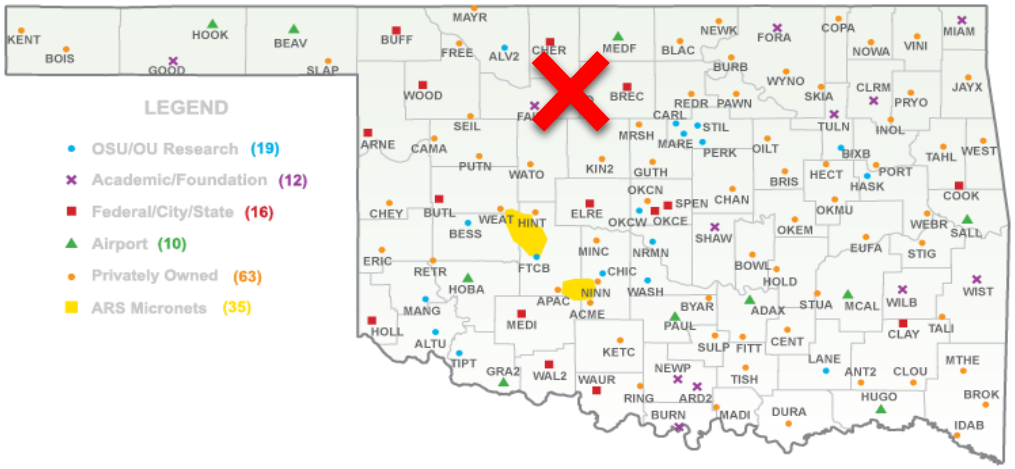
Name: FAO-56 Dual crop coefficient model (Allen, et al., 1998).

Advantage Driven by green canopy cover instead of LAI.

Cal/Val

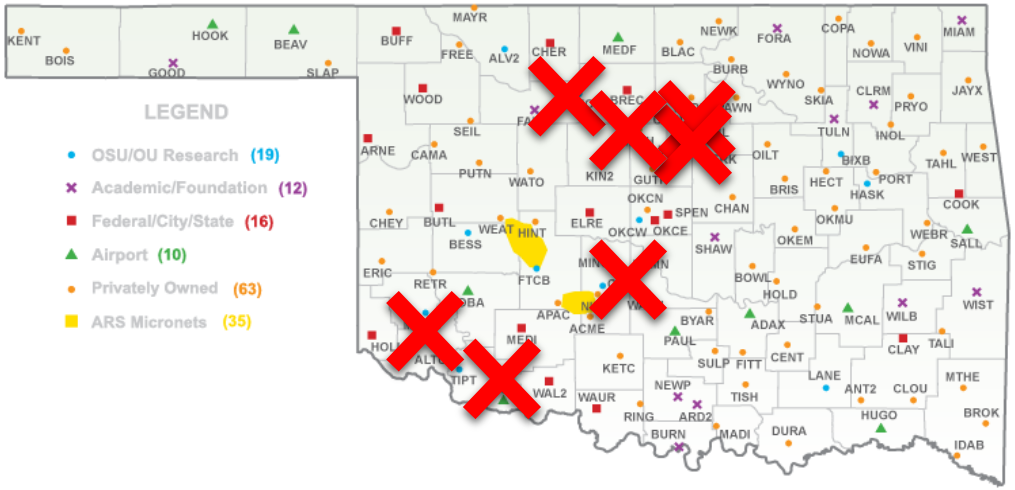
Cal: Lahoma Jul 2009 to Jun 2011.

Val 1: Lahoma Jul 2011 to June 2013



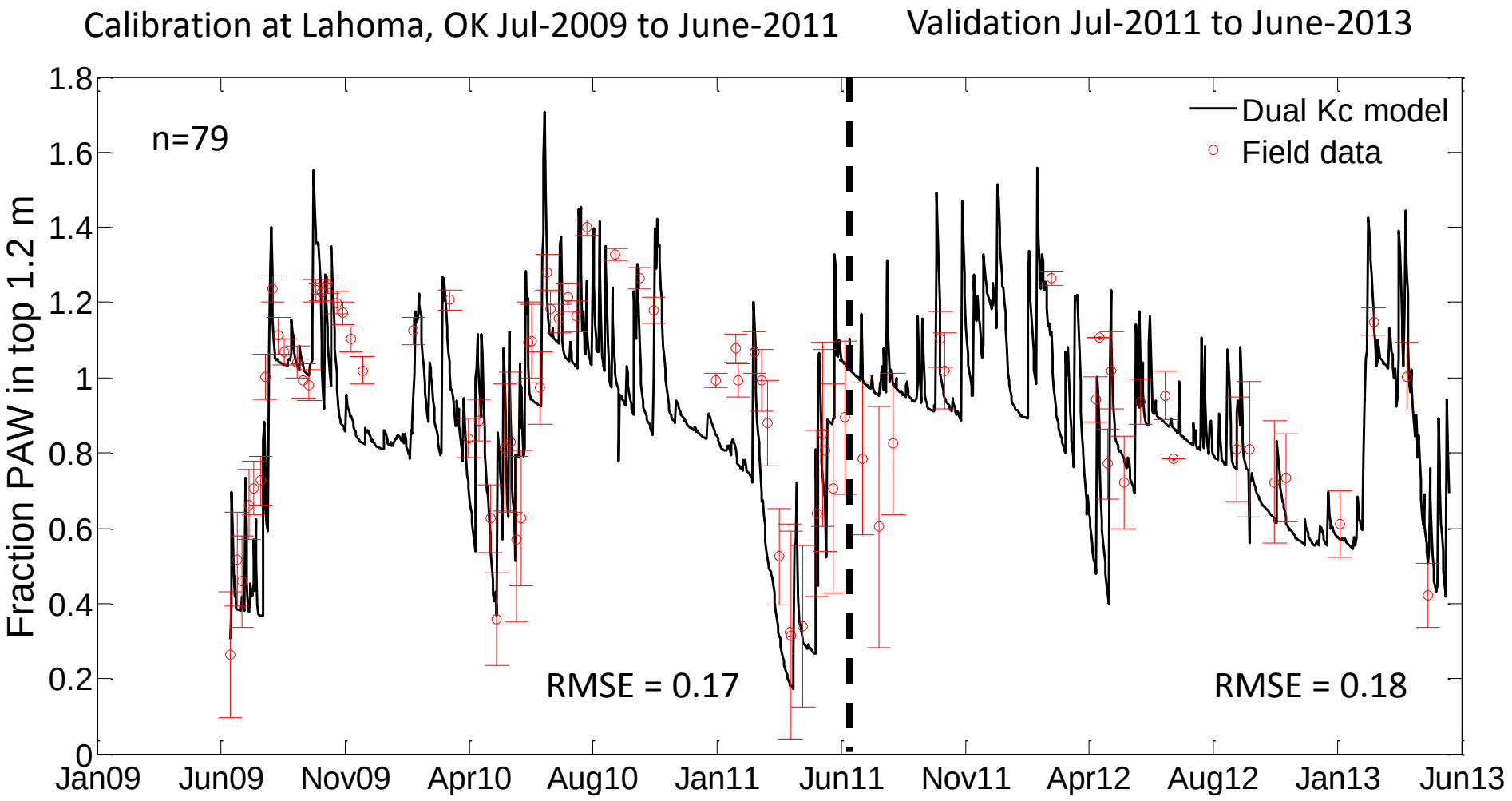
Neutron probe depths:
10, 30, 50,…,190 cm.

Val 2: Nine locations across the state in 2014.



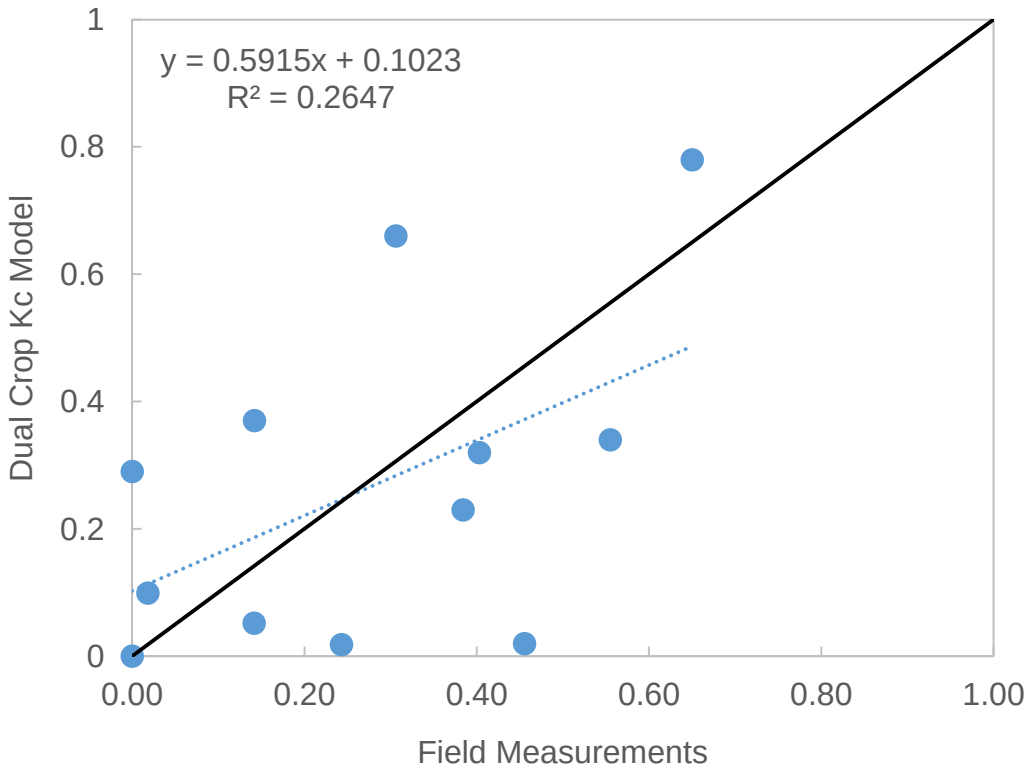
Manual auger and theta probe

Calibration and Validation for one location



No-till Continuous wheat. About 75% Residue cover during growing season and 95-100% at the beginning of the fallow.

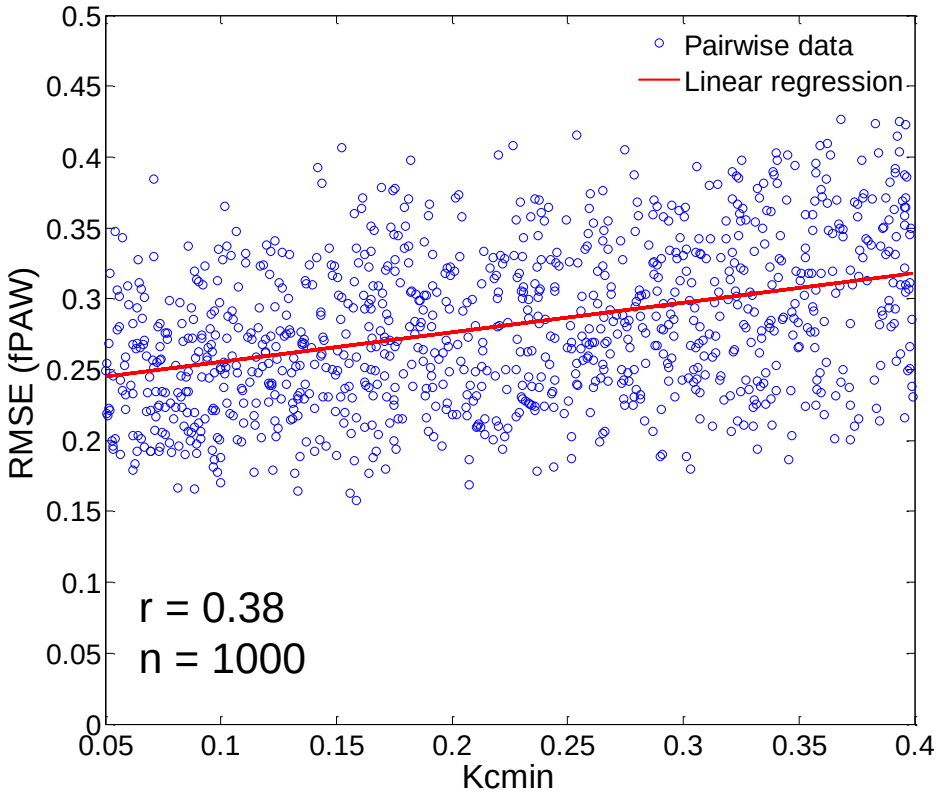
Validation across the state (in progress)

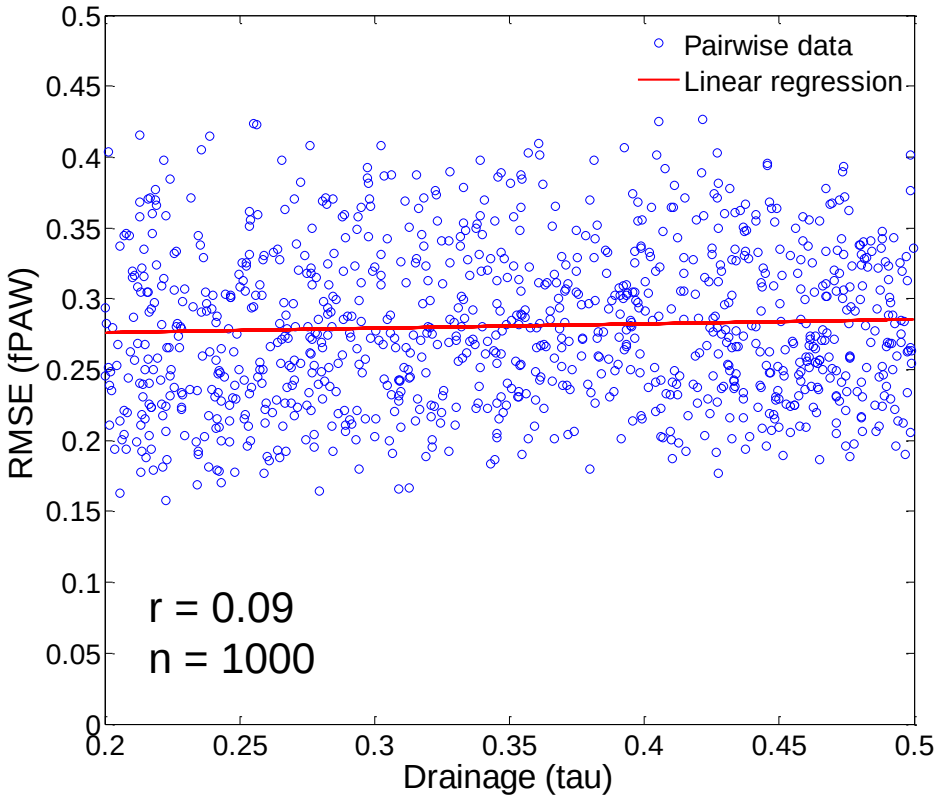


Locations: Stillwater, Lake Carl Blackwell, Perkins, Lahoma, Chickasha, Altus, Chattanooga

Challenge with model parameters

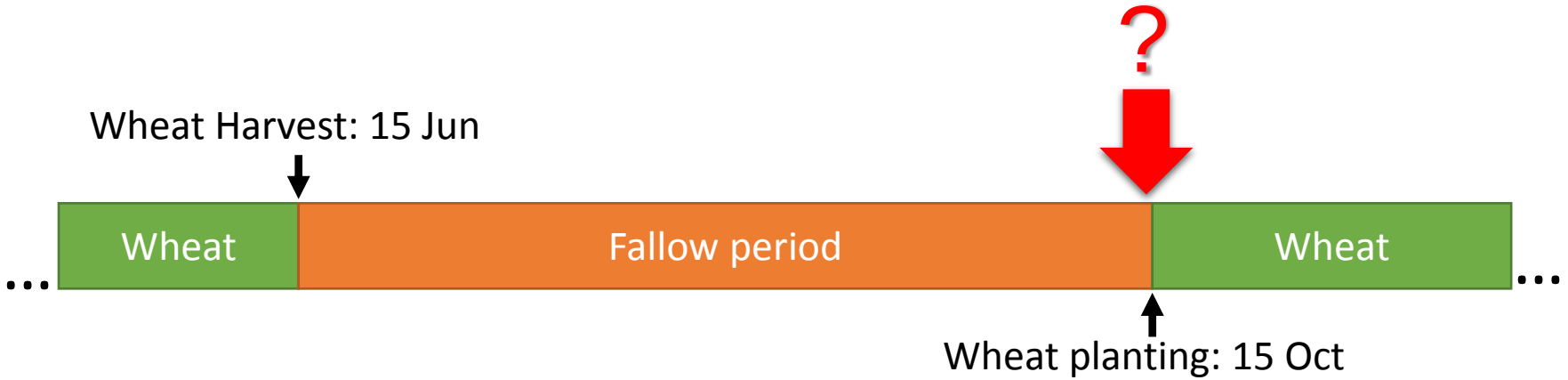
- Sensitivity analysis (Intensive sampling method). Use of coefficient of correlation as sensitivity indicator.
- Total of 20 coefficients

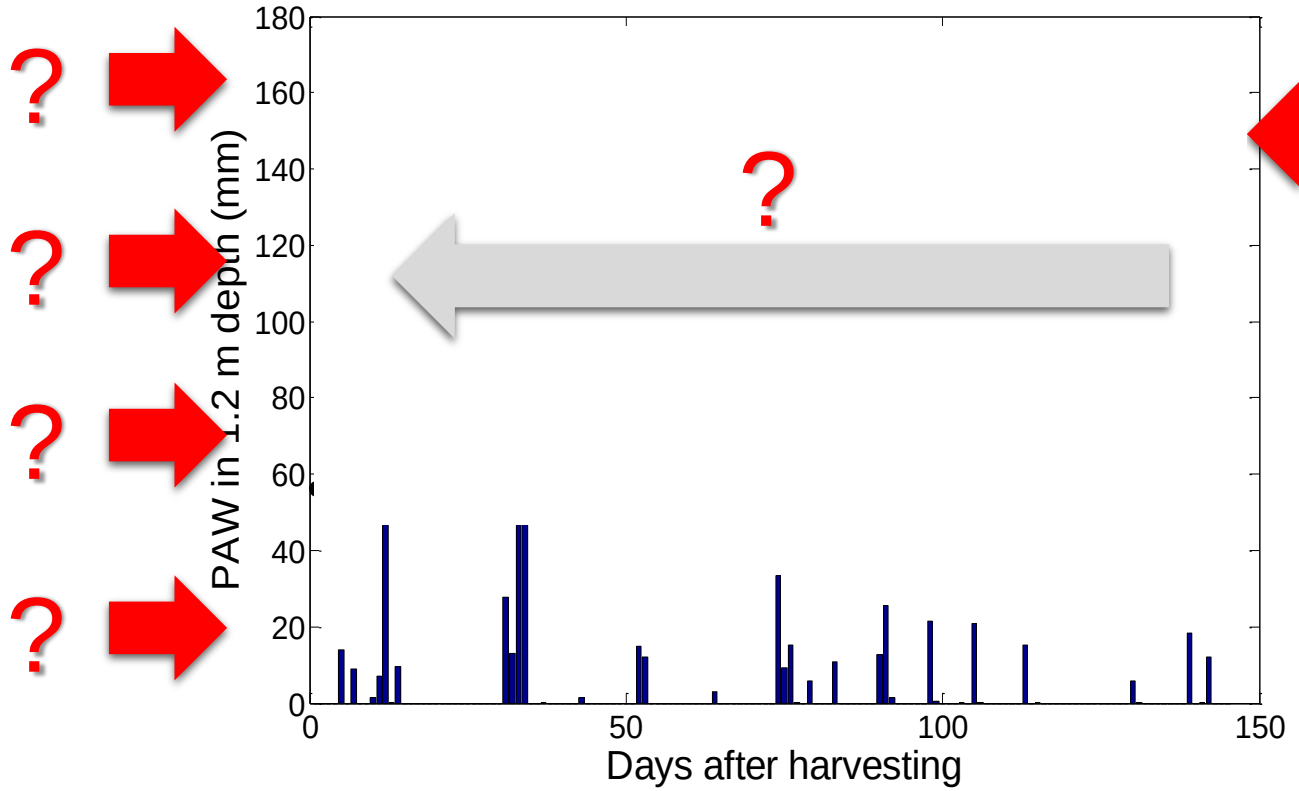




Need for more? Latin Hypercube? Fourier amplitude sensitivity test?

Initializing the balance

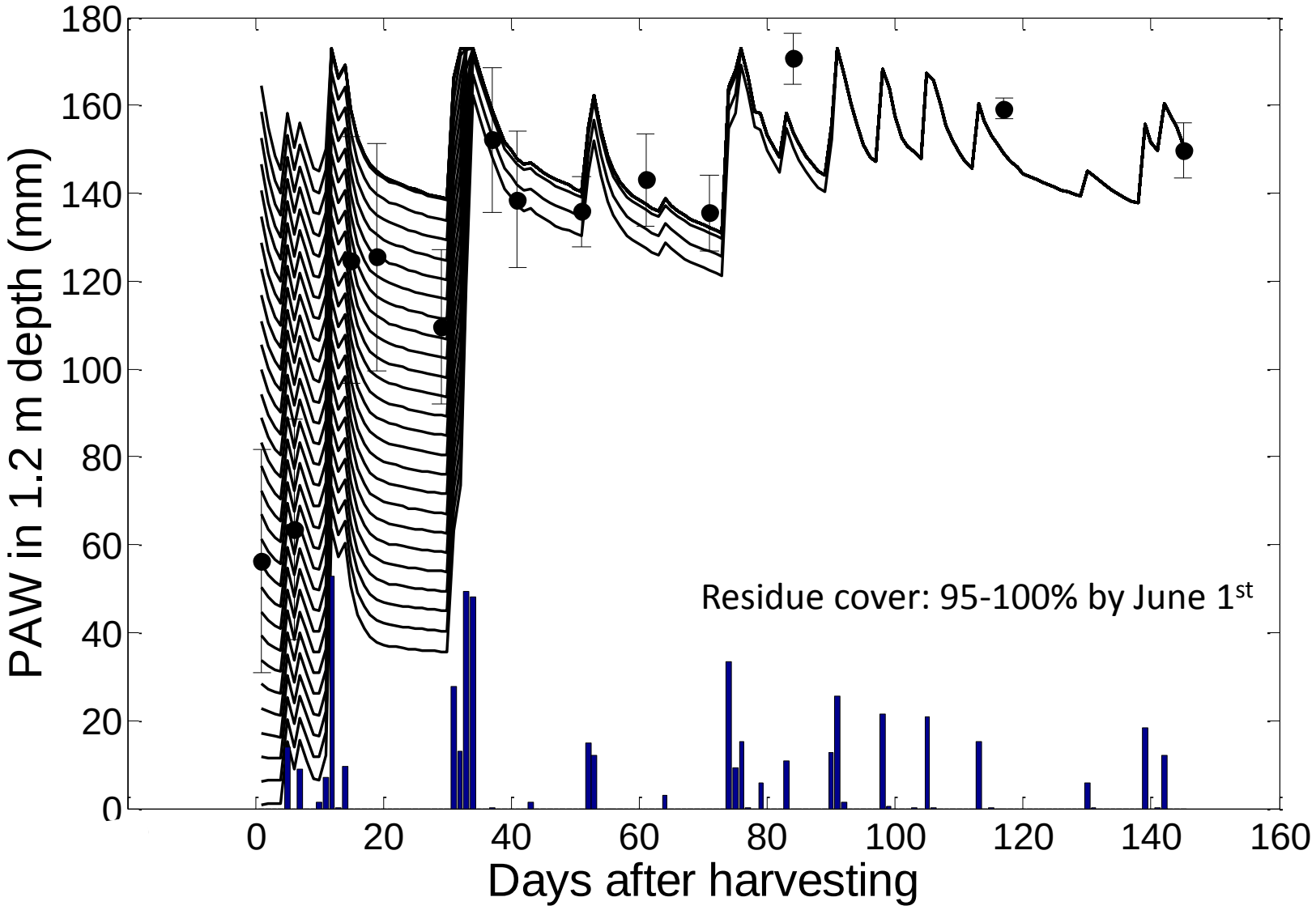




Lahoma, 2012
NT Wheat

Courtesy of Romulo Lollato

No-till fallow period 2012 (June 1st to Oct-15th) at Lahoma, OK

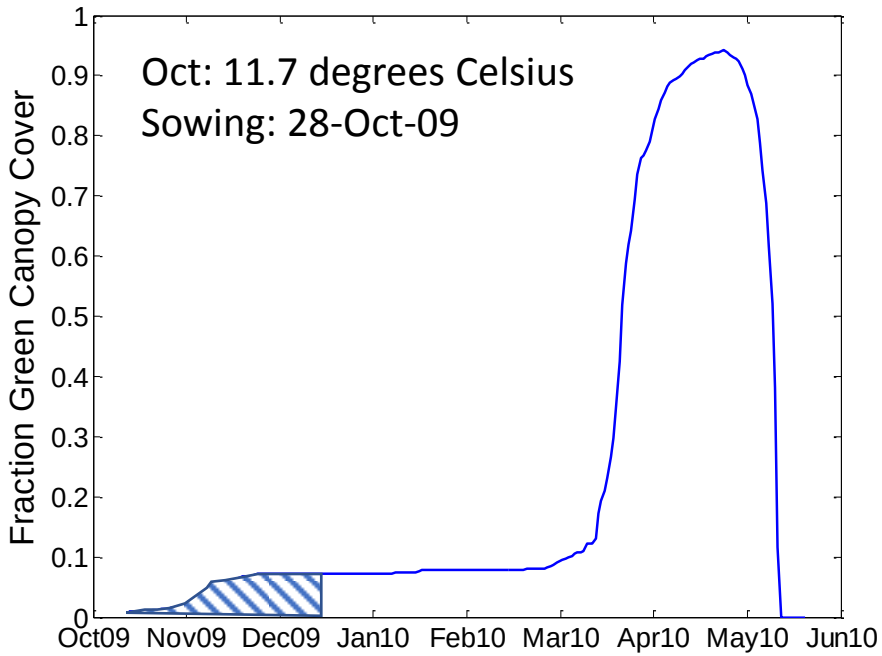


Courtesy of Romulo Lollato

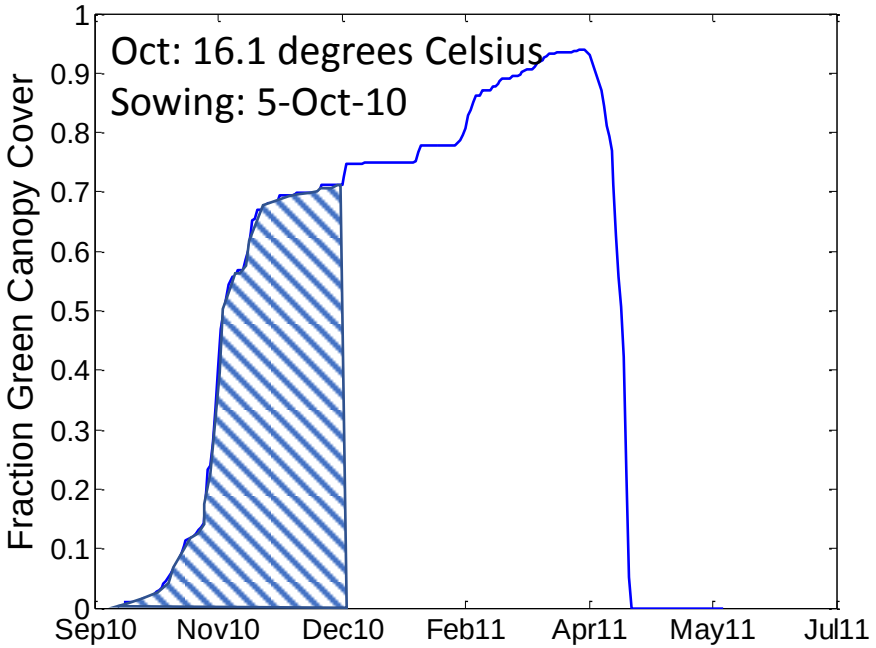
Other challenges

- Planting date and vernalization effects on canopy cover dynamics.

No-till continuous wheat Lahoma 09-10

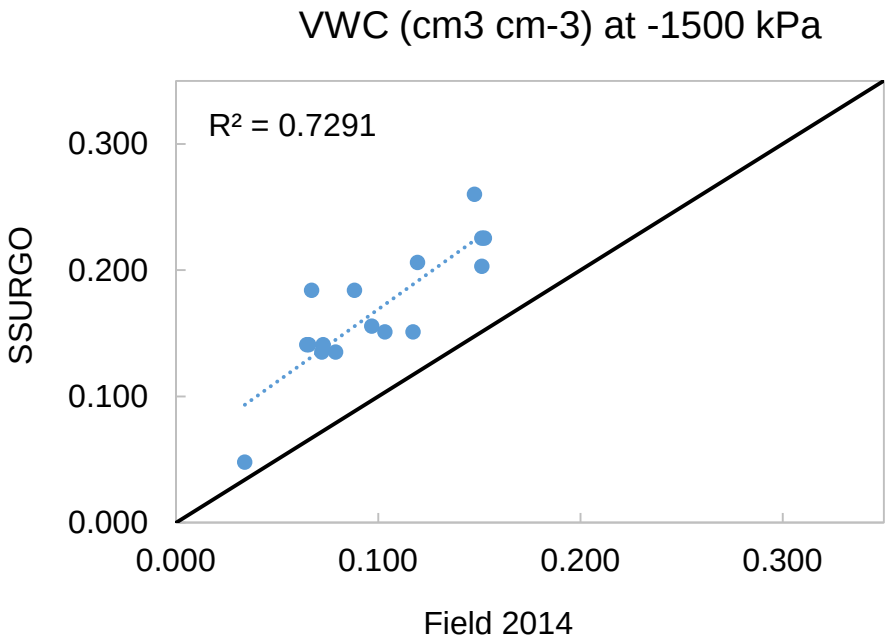


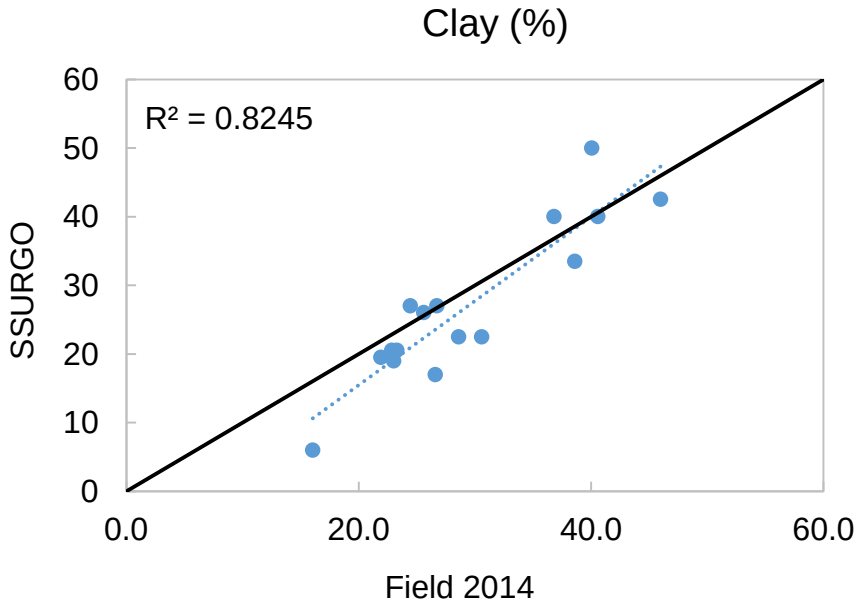
No-till continuous wheat Lahoma 10-11

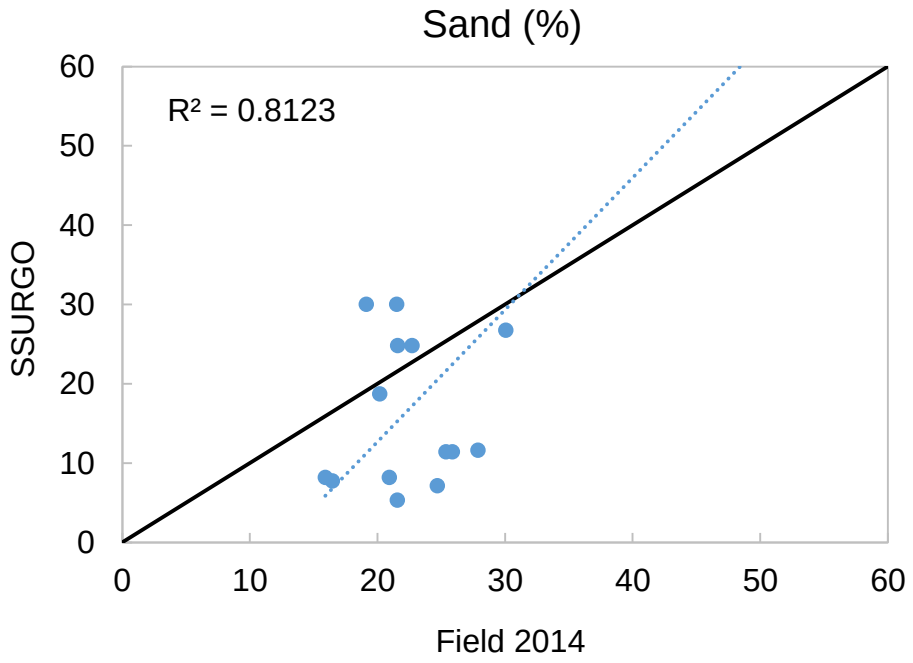


How can we improve our wheat cropland moisture estimations?

- Canopy cover assimilation?
  - Developing tools to obtain near real-time information from farmers
  - Using remote sensing?
- Mesonet soil moisture data assimilation?
  - Trying to incorporate soil moisture from the Mesonet?
  - Neural networks?
- Assimilation of soil physical properties from Soil Survey Geographic Database (NRCS SSURGO)?


VWC (cm3 cm-3) at -1500 kPa
R² = 0.7291
SSURGO
Field 2014
0.000
0.100
0.200
0.300


Clay (%)
R² = 0.8245
SSURGO
Field 2014
0
10
20
30
40
50
60
0.0
20.0
40.0
60.0


Sand (%)
R² = 0.8123
SSURGO
Field 2014
0
10
20
30
40
50
60

SSURGO

Canopeo: Green Canopy Analyzer Tool