Options for Estimating Plant Water Requirements for Irrigation Scheduling in Louisiana

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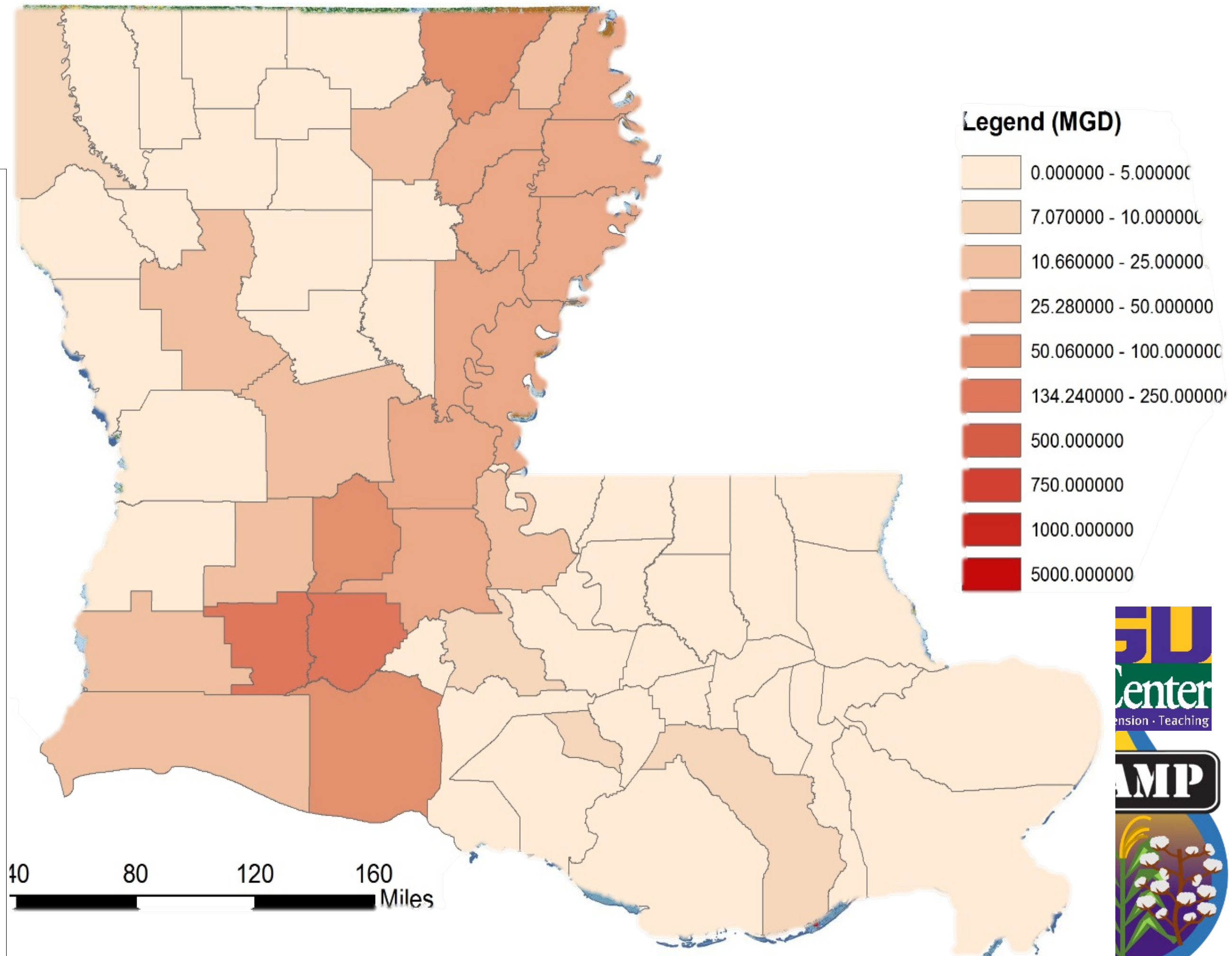
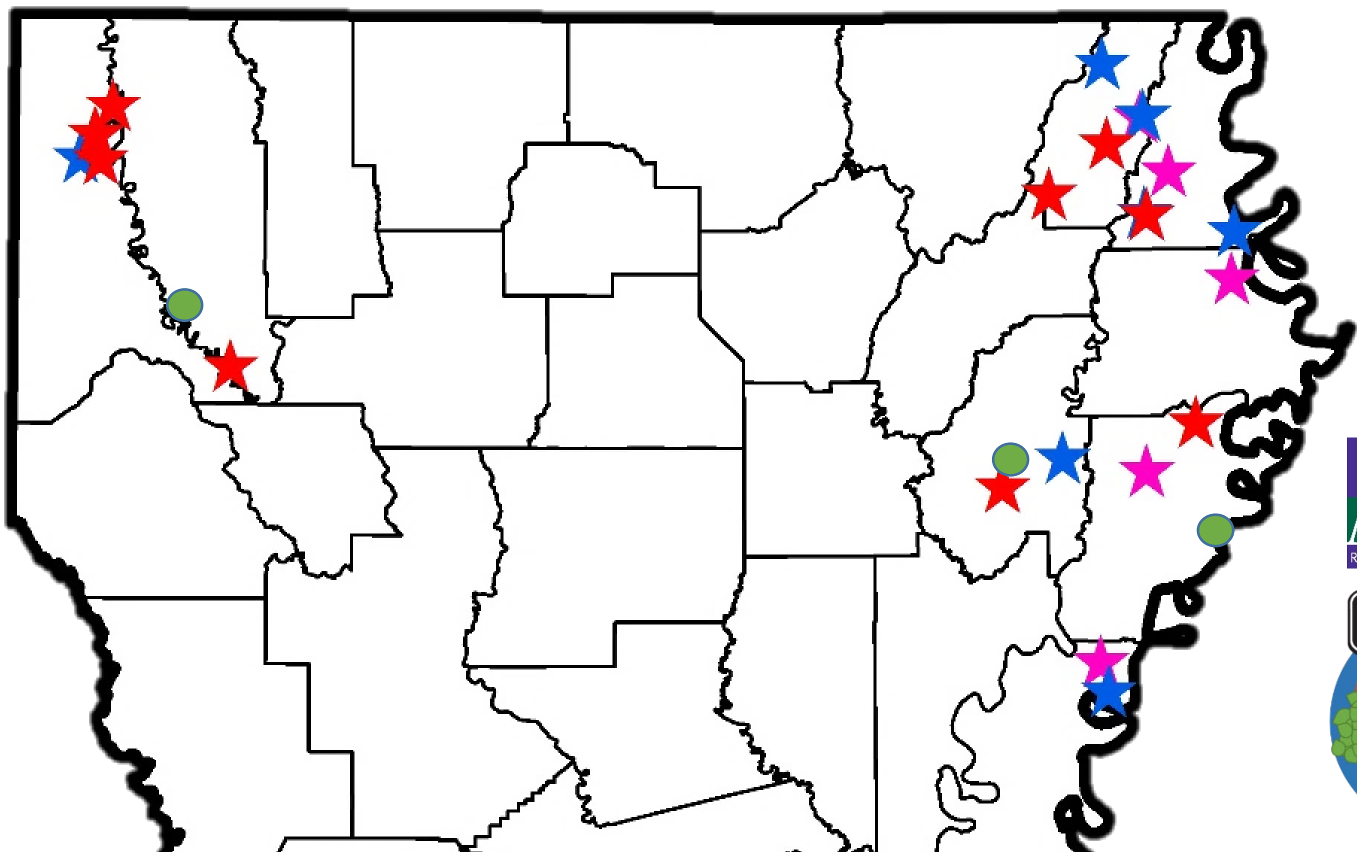
Introduction

- Water use continues to increase across all sectors
- Pattern exists between cultivated cropland and water use for irrigation



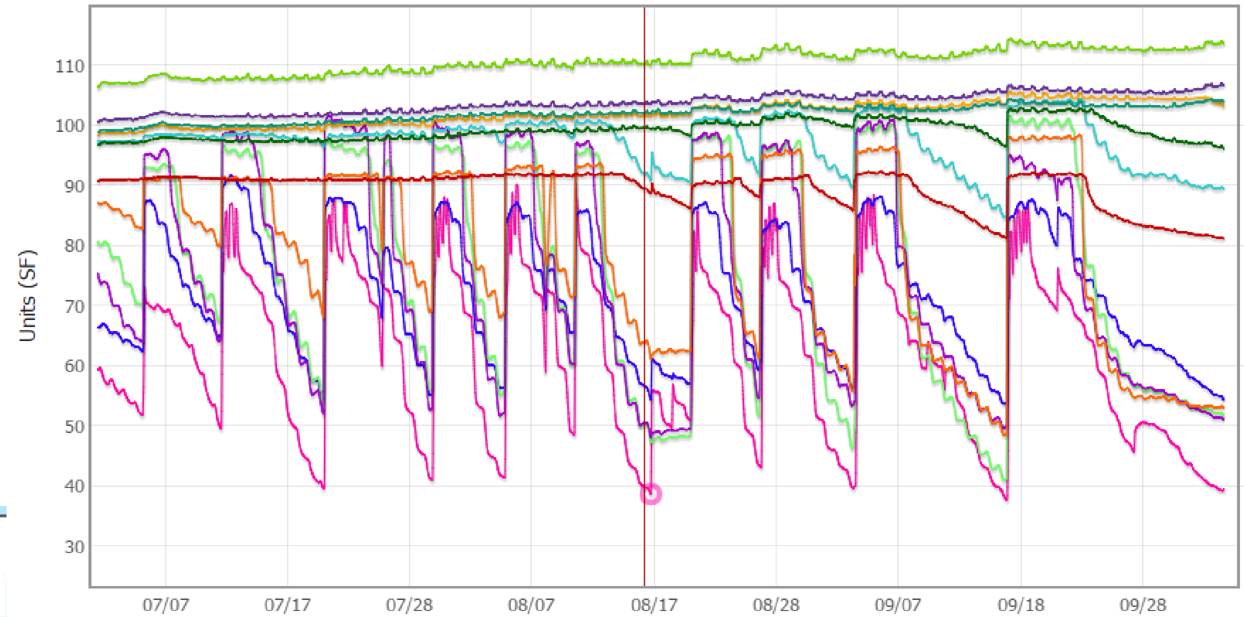
Introduction

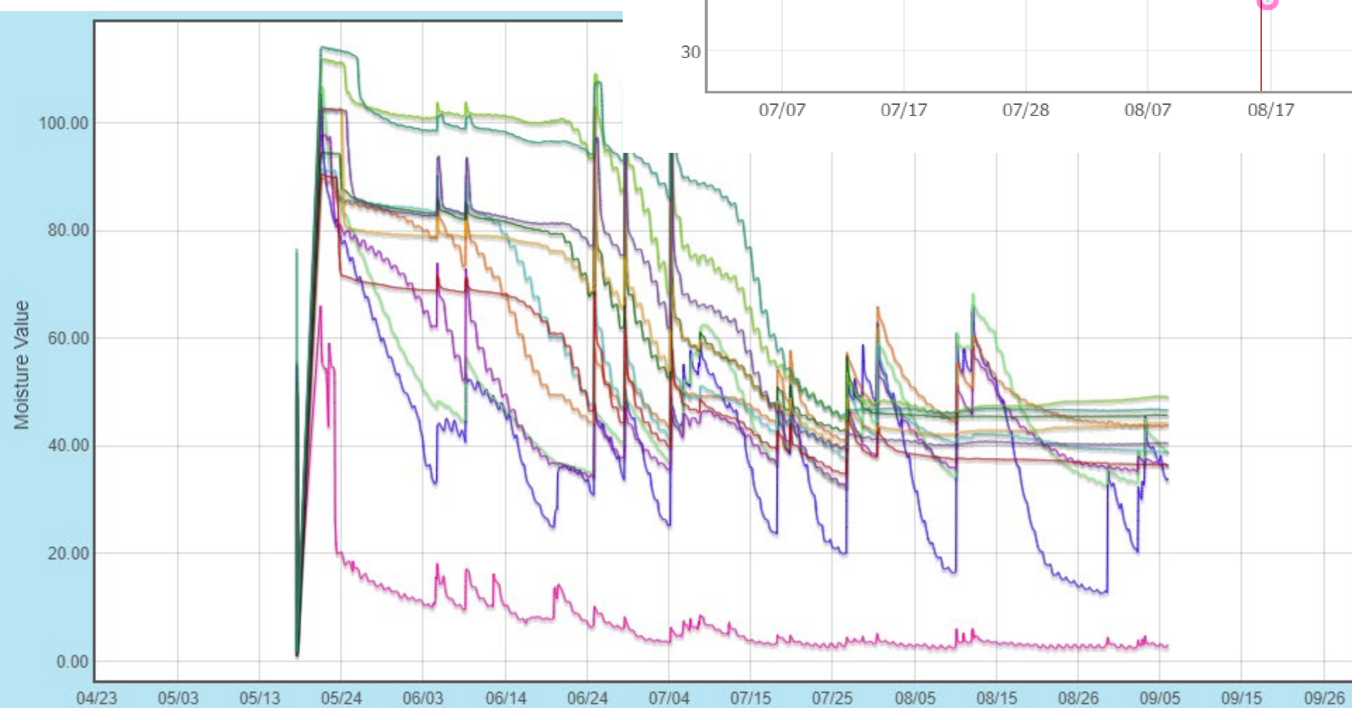
- Mid-South put focus on soil moisture sensors
  - Louisiana’s efforts
    - Plot studies repeated on three soil types using two sensor types in 2015/2016
    - Various demonstrations conducted with farmers across the state



Introduction

- Example sensor data from on-farm demonstrations





Introduction

- What needs to be considered?

Soil sensor-based system	Weather-based system
Soils information • Available water holding capacity • Compaction • Irrigation threshold • Sensor selection	Soils information • Available water holding capacity • Compaction • Irrigation threshold
Types of readings	Reliable weather data
Processing infrastructure	Processing infrastructure
Communication infrastructure	Plant variety information • Planting date • Growth stages • Crop coefficients
Installation methods/requirements	

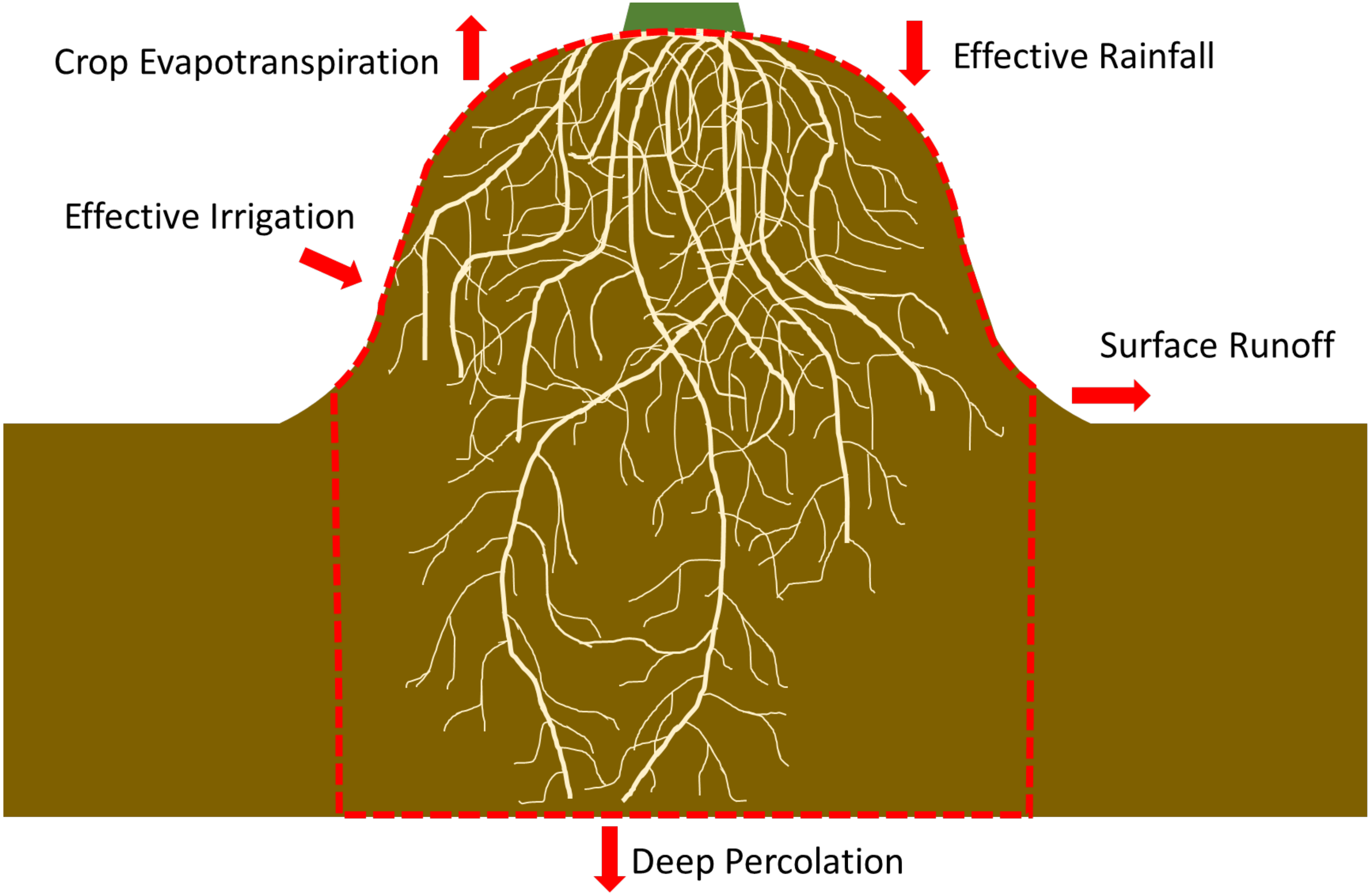
Introduction

- Hypothesis: A soil water balance can be used to schedule irrigation in the mid-south

Objective 1: Develop a basic decision tool to determine when to trigger furrow irrigation events based on plant water requirements for agronomic crops

Objective 2: Determine the availability and quality of publically available ETo and rainfall data for use in the decision tool

Objective 1: Soil Water Balance



Objective 1: Soil Water Balance

- Soil water balance

Blue: User inputs

Red: Mandatory information

Soil Water Balance for
Crop Irrigation Management
Version 1.3 (Last Updated 8/30/2016)
Created By Stacia L. Davis, Ph.D.
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		Suggested
Field Size (acres) =		
Crop Type =	Soybean	
Soil Type =	Fine sandy loam	
Initial Moisture Conditions =	Really Wet	
Planting Date =	4/1/16	
Season Length (days) =		140
Field Capacity (in./in.) =		0.30
Permanent Wilting Point (in./in.) =		0.14
Maximum Allowable Depletion (%) =		50
Maximum Root Depth (in.) =		30

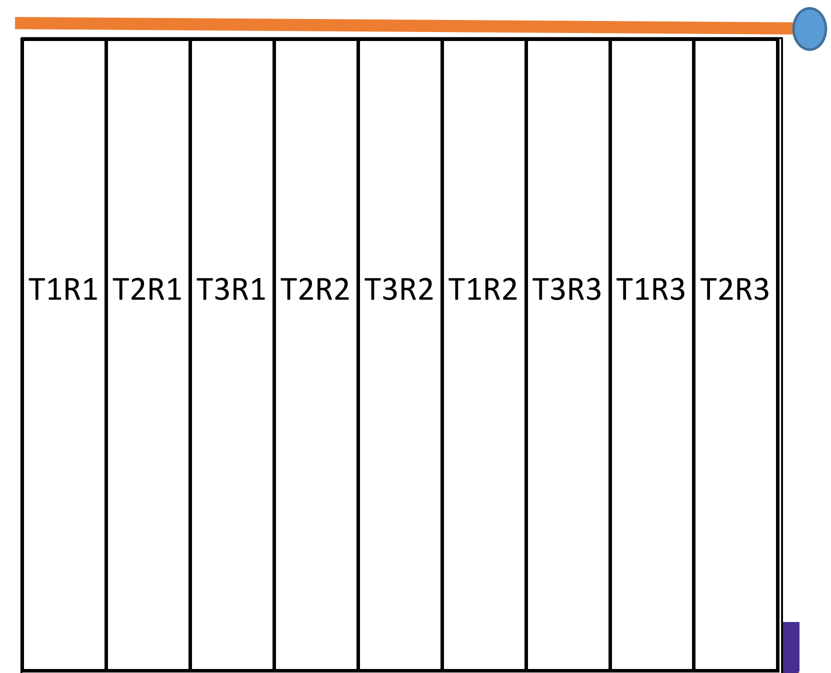
Period	DAP	Suggested DAP	Crop Coefficient	Suggested Kc
Early		0		0.30
Development		35	No Input	Linear
Mid		61		1.22
Late		92	No Input	Linear
Last Irrig. Event		96		0.56

Flow meter units = Acre-inch

Date	Days After Planting	Root Depth (in.)	Field Capacity [FC] (in.)	Permanent Wilting Point [PWP] (in.)	Refill Point (in.)	Starting Water Level [SWL_{i-1}] (in.)	Reference ET [ET_O] (in.)	Reference ET with Projections [ET_O] (in.)	K_C	Crop ET ET_C [ET_O*K_C] (in.)	Total Rainfall [R_T] (in.)	Effective Rainfall [R_e] (in.)	Effective Irrigation [I_e] (in.)
4/1	0	10.0	3.0	1.4	2.21	3.03		0.00	0.30	0.00		0	0
4/2	1	10.3	3.1	1.4	2.29	3.03		0.00	0.30	0.00		0	0
4/3	2	10.7	3.2	1.5	2.36	3.03		0.00	0.30	0.00		0	0
4/4	3	11.0	3.3	1.5	2.43	3.03		0.00	0.30	0.00		0	0
4/5	4	11.3	3.4	1.6	2.51	3.03		0.00	0.30	0.00		0	0
4/6	5	11.7	3.5	1.6	2.58	3.03		0.00	0.30	0.00		0	0
4/7	6	12.0	3.6	1.7	2.66	3.03		0.00	0.30	0.00		0	0
4/8	7	12.3	3.7	1.7	2.73	3.03		0.00	0.30	0.00		0	0
4/9	8	12.7	3.8	1.8	2.80	3.03		0.00	0.30	0.00		0	0
4/10	9	13.0	3.9	1.8	2.88	3.03		0.00	0.30	0.00		0	0
4/11	10	13.3	4.0	1.9	2.95	3.03		0.00	0.30	0.00		0	0
4/12	11	13.7	4.1	1.9	3.02	3.03		0.00	0.30	0.00		0	0
4/13	12	14.0	4.2	2.0	3.10	3.03		0.00	0.30	0.00		0	0
4/14	13	14.3	4.3	2.0	3.17	3.03		0.00	0.30	0.00		0	0

Objective 1: Measured Soil Moisture

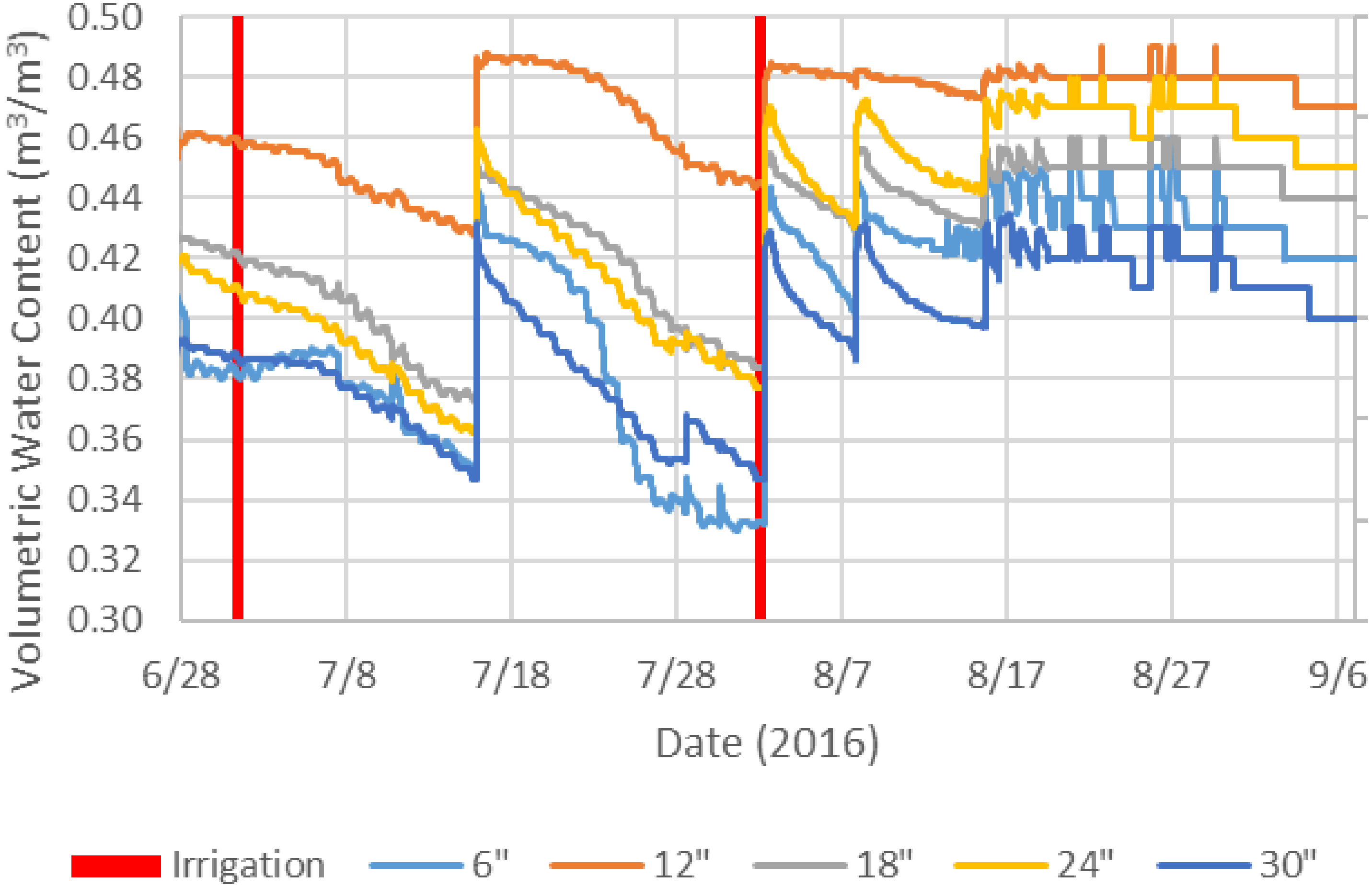
- Treatment 1 – Irrometer Watermark
- Treatment 2 – Decagon GS1 → 5 sensor depths
- Treatment 3 – Weekly irrigation



- Cotton, sandy clay loam – Bossier City
- Soybean, silt loam – Winnsboro
- Soybean, cracking clay – St. Joseph

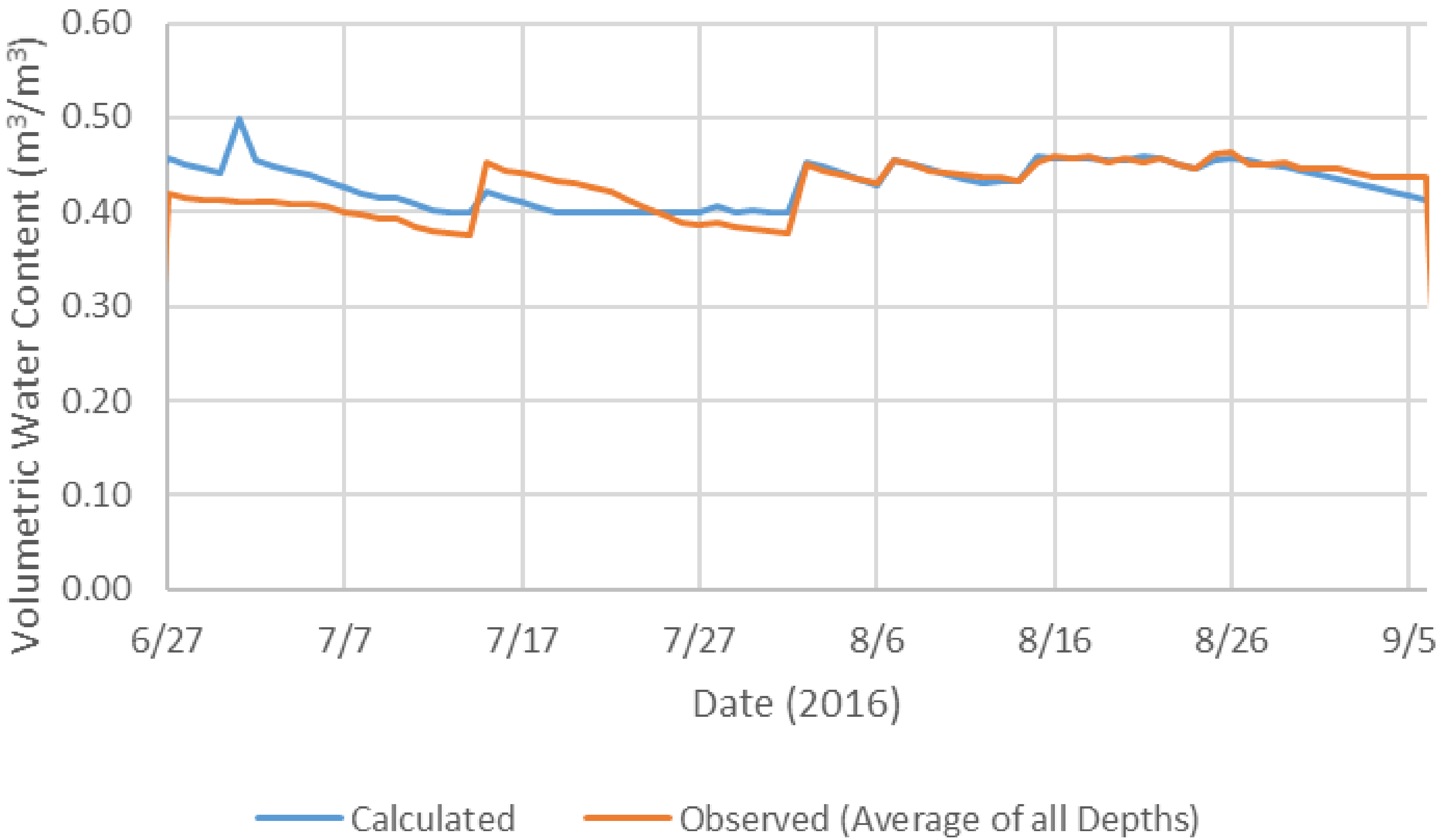
Objective 1: Measured Soil Moisture

- Measured soil moisture



Objective 1: Results

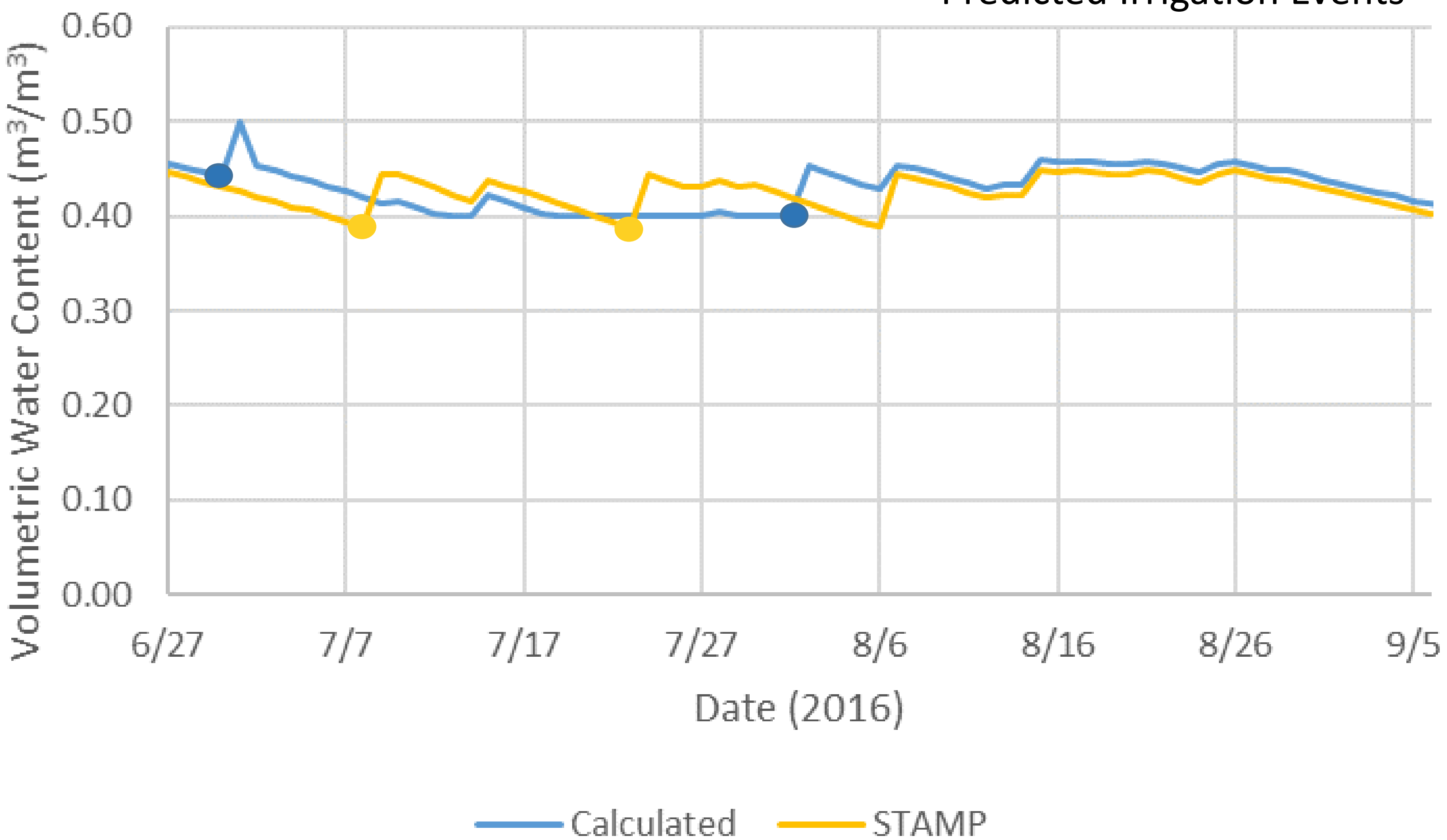
- Comparison of soil moisture sensor estimates and soil water balance
  - 2016 Cotton on sandy clay loam



Objective 1: Results

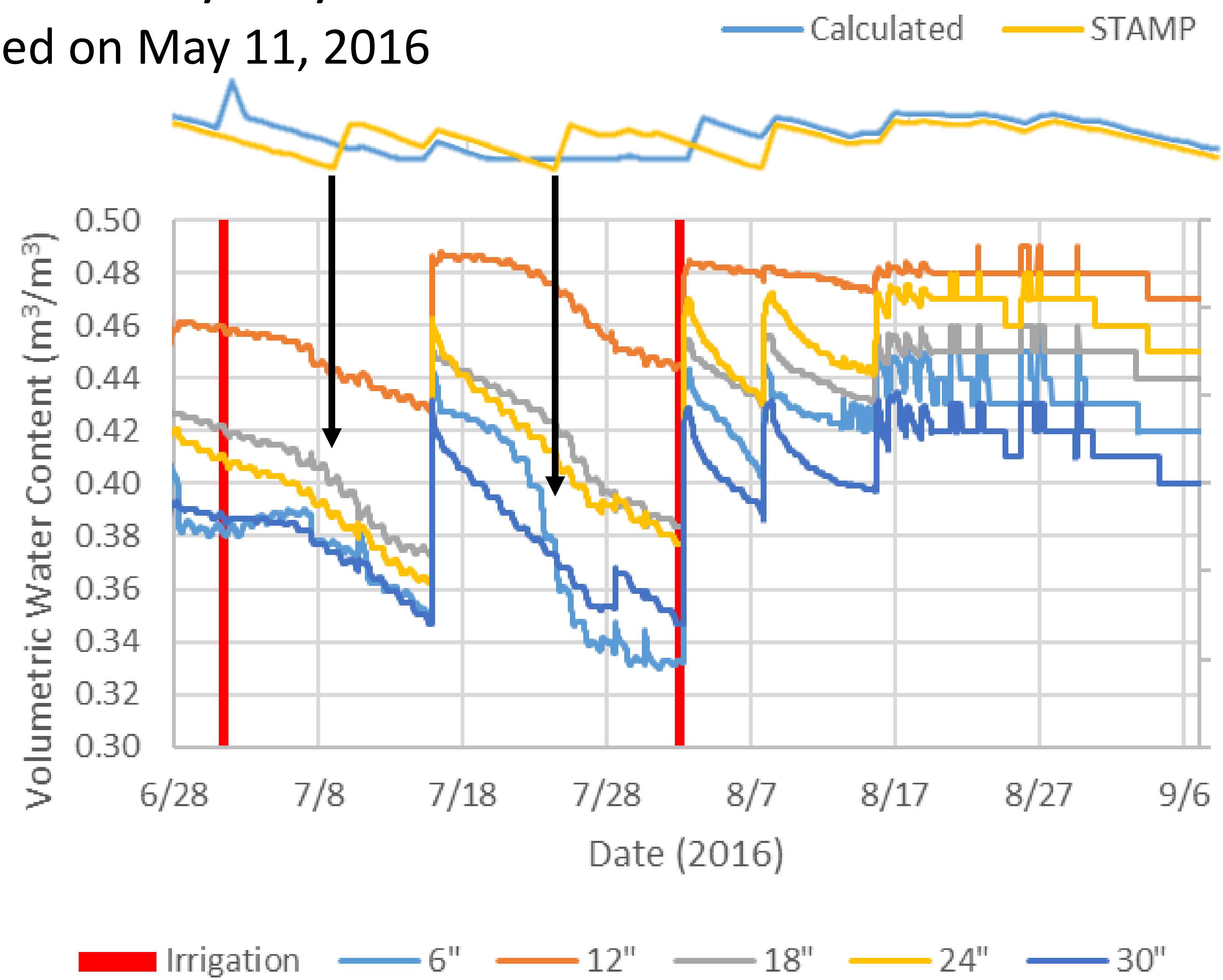
- Comparison of soil moisture sensor estimates and soil water balance
  - 2016 Cotton on sandy clay loam

Actual Irrigation Events = 2
Predicted Irrigation Events = 2



Objective 1: Results

- Cotton on sandy clay loam
  - Planted on May 11, 2016



Summary

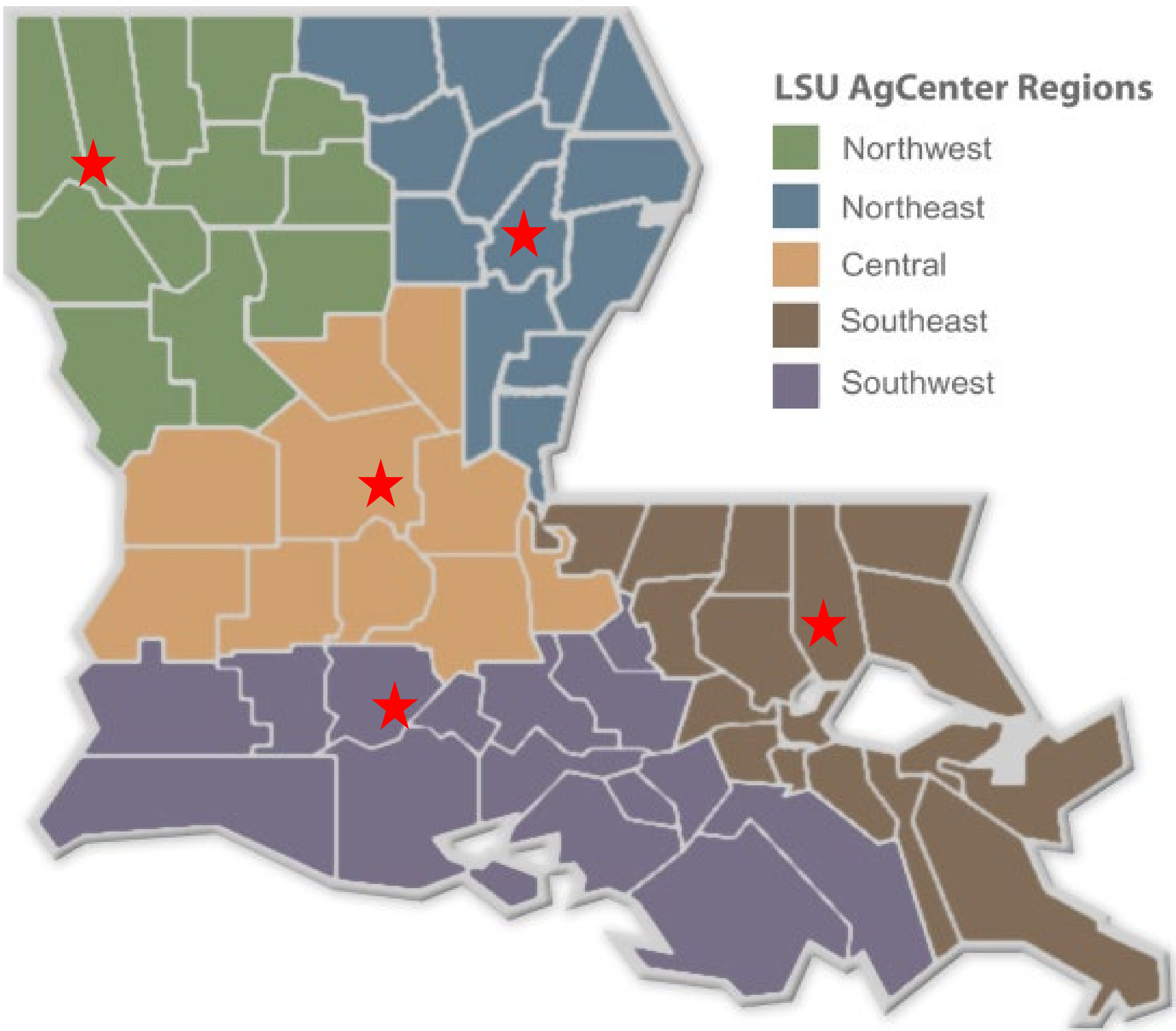
- Hypothesis: A soil water balance can be used to schedule irrigation in the mid-south

Objective 1: Develop a basic decision tool to determine when to trigger furrow irrigation events based on plant water requirements for agronomic crops

Objective 2: Determine the availability and quality of publically available ETo and rainfall data for use in the decision tool

Objective 2: Available Data

- LSU AgCenter Weather Station Network - LAIS



Objective 2: Available Data

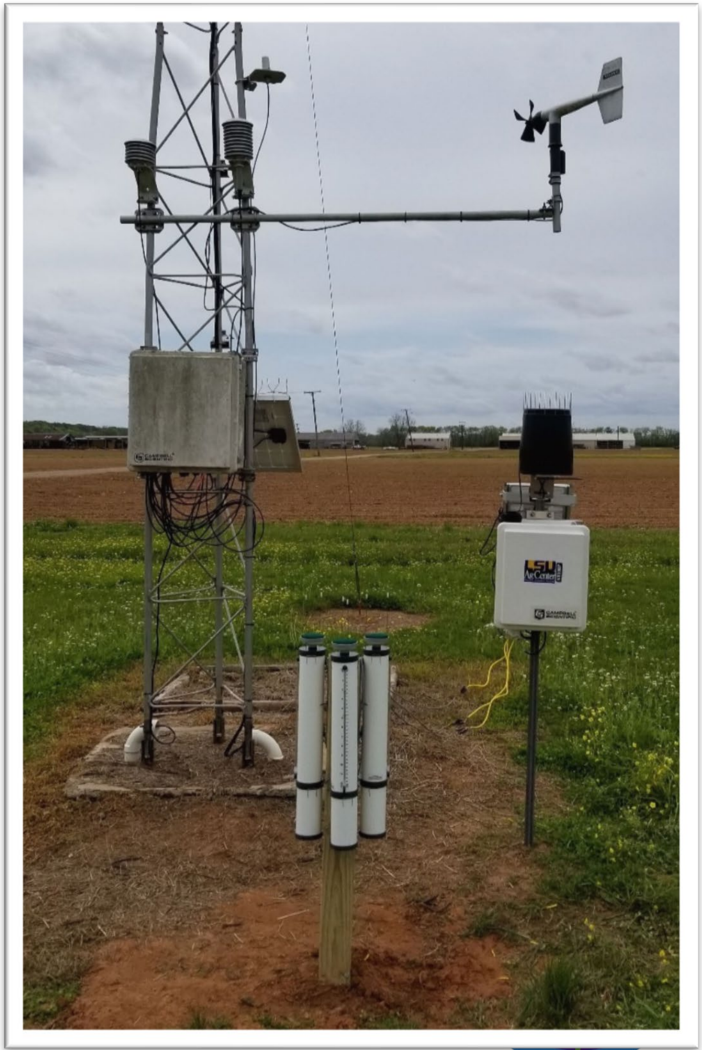
- ASCE Standardized ETo Equation
  - Temperature
  - Relative Humidity
  - Solar Radiation
  - Windspeed

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

Objective 2: Atmometer Study

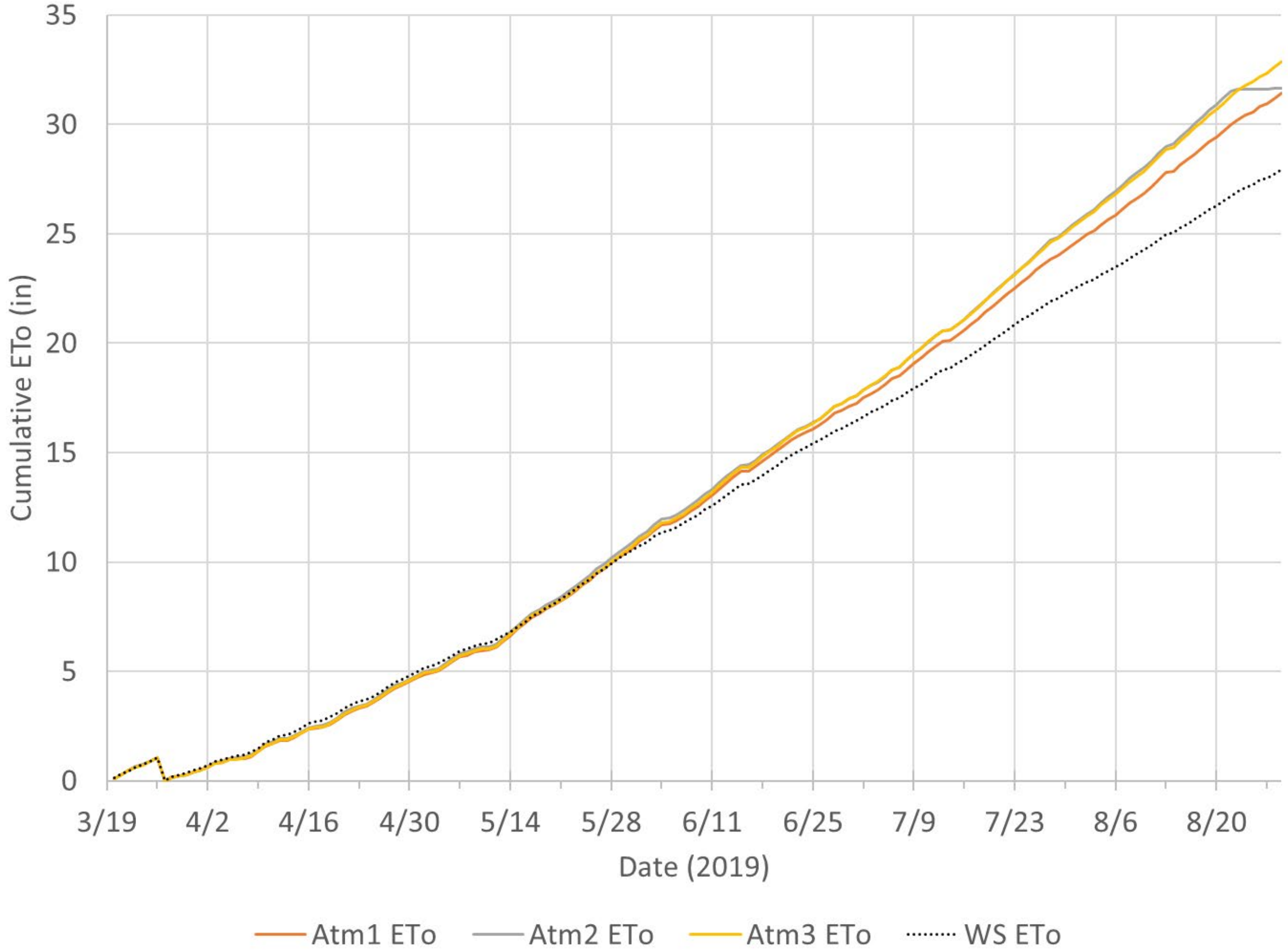
Red River Research Station
Bossier City, LA

Dean Lee Research Station
Alexandria, LA



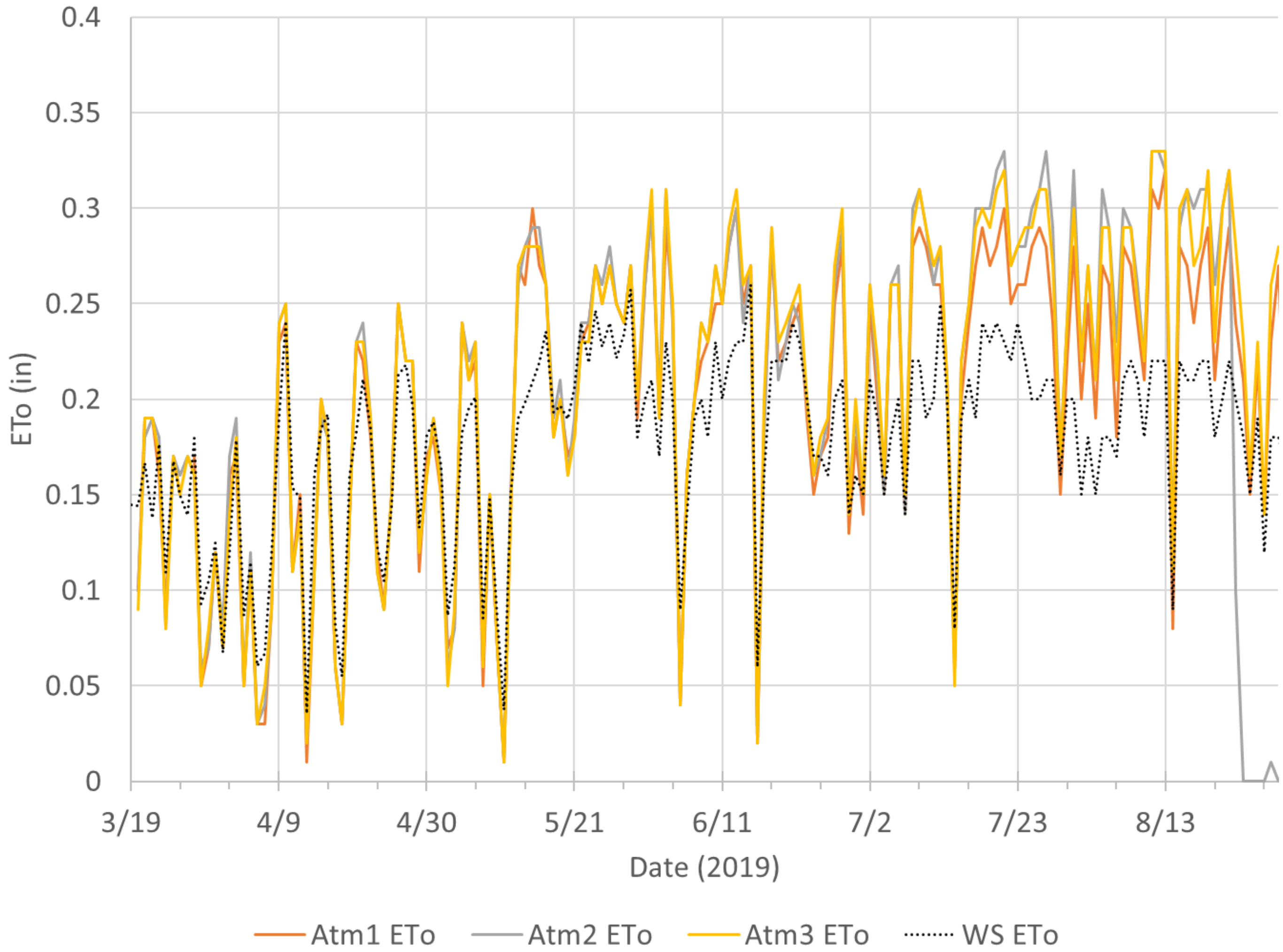
Objective 2: Results

- Red River Research Station, Bossier City, LA
  - Cumulative totals



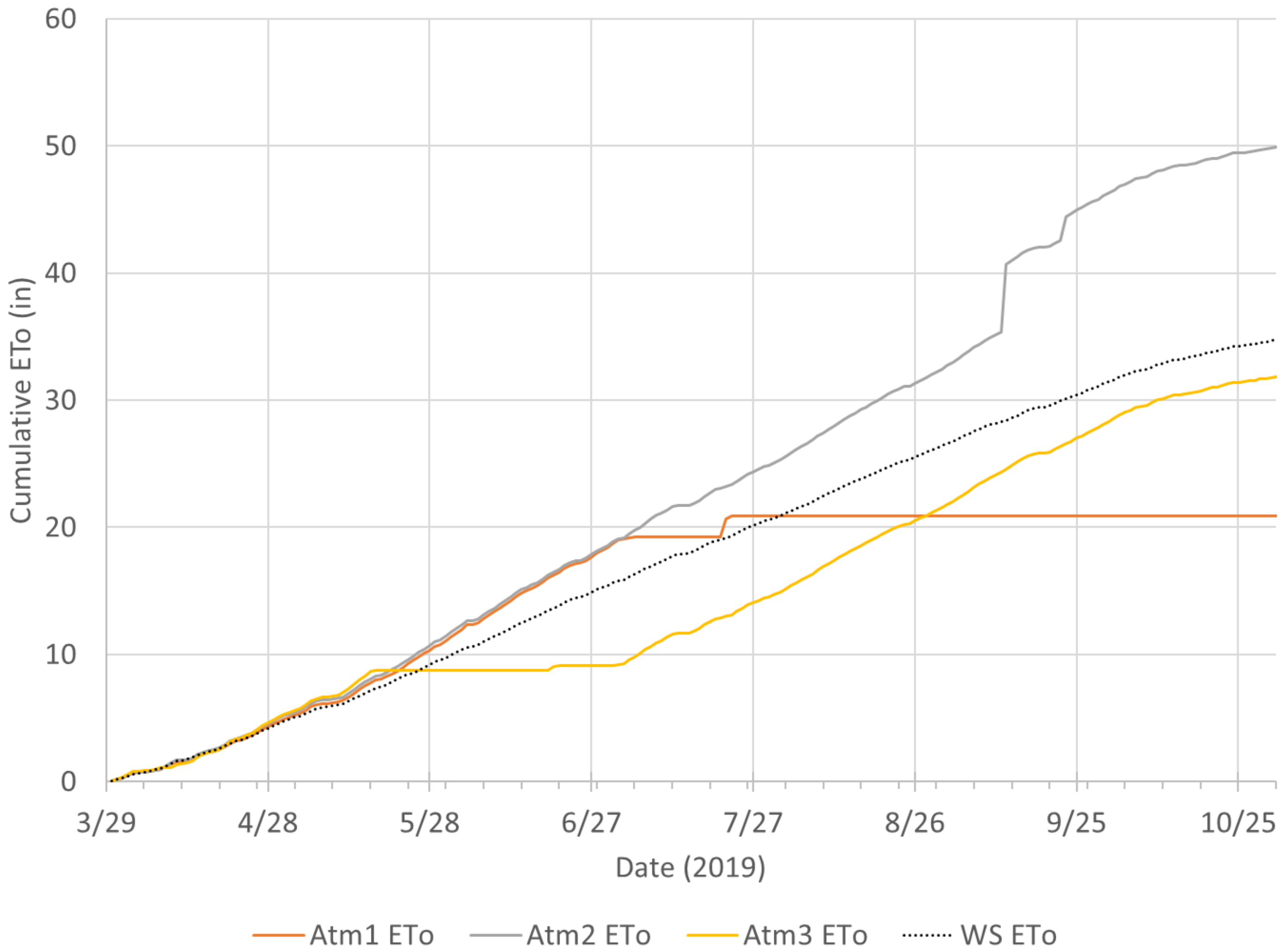
Objective 2: Results

- Red River Research Station, Bossier City, LA
  - Daily summary



Objective 2: Results

- Dean Lee Research Station, Alexandria, LA
  - Cumulative totals



Objective 2: Results

- Dean Lee Research Station, Alexandria, LA
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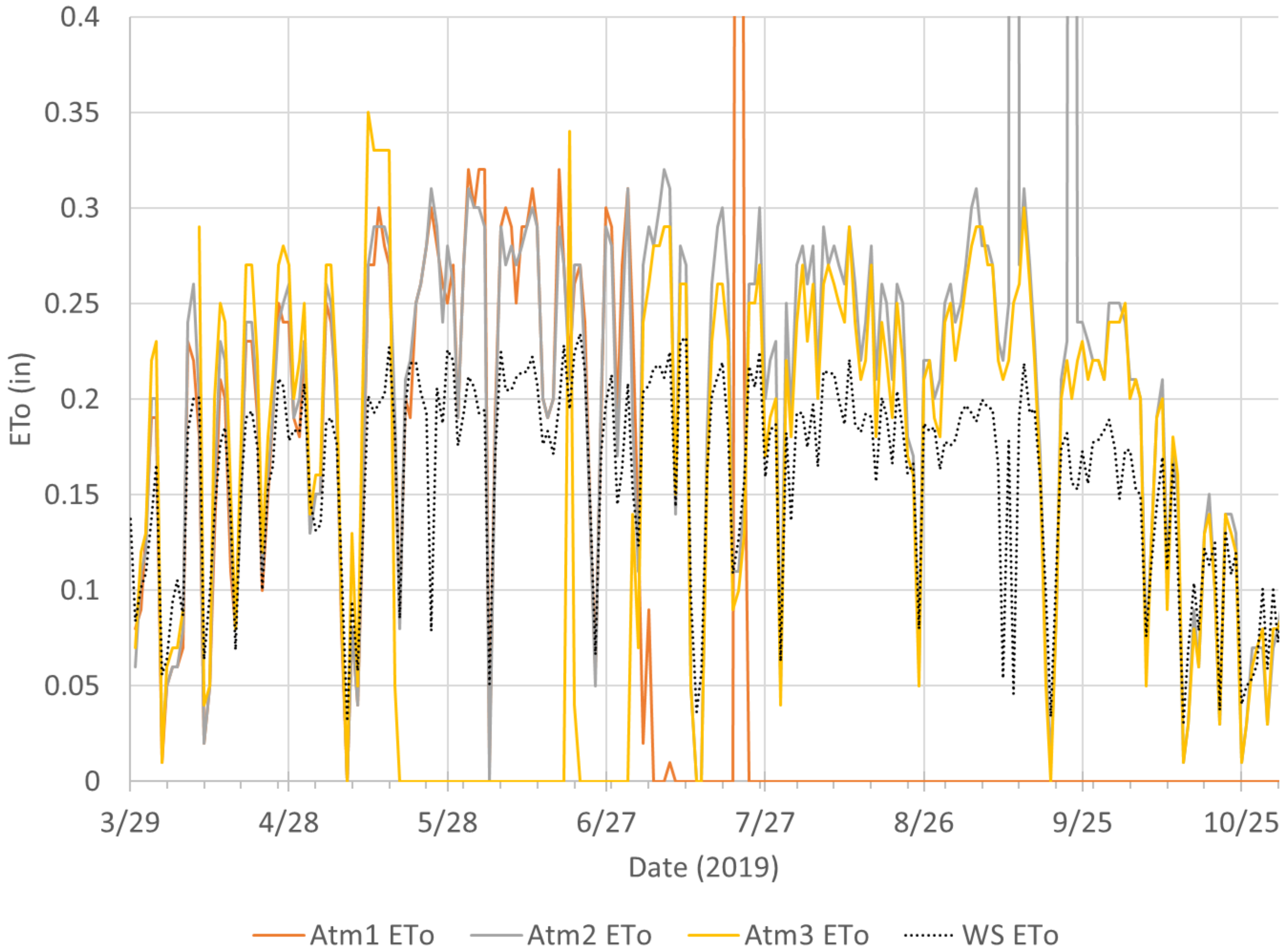
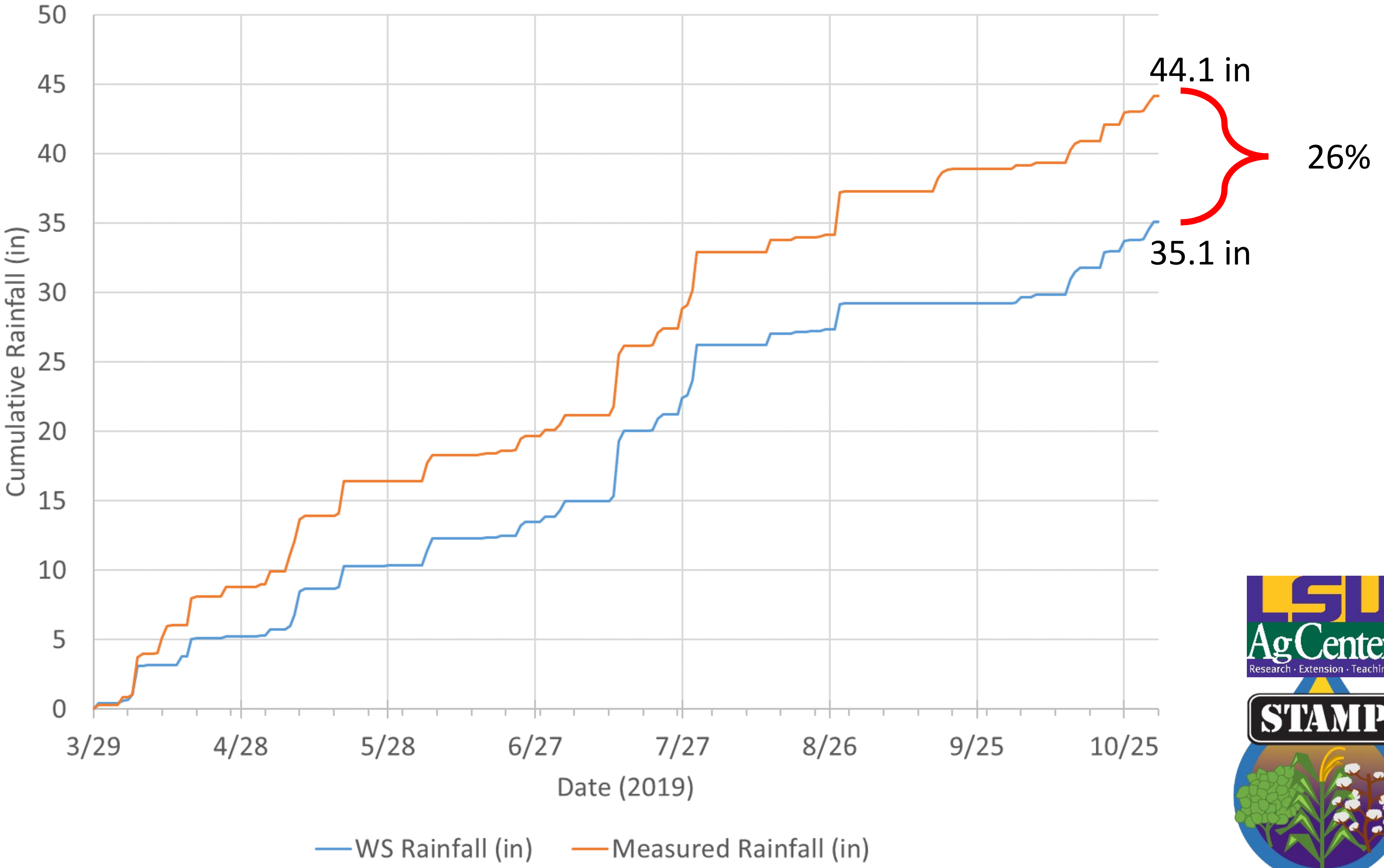


Objective 2: Results

- Rainfall comparison to weather station



Summary

- The soil water balance may be a good, free option for timing irrigation events. Considerations include:
  - Soil characteristics that affect infiltration and soil water holding capacity
  - Best used on a healthy soil system
  - Availability of good ET and rainfall estimates

- Still determining the quality of economical localized ETo and rainfall estimations
  - May need to adjust crop coefficients to handle higher ETo measured by atmometers
  - Localized rainfall estimations still very important

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Summary

- Next steps
  - Estimate ETo and rainfall using NOAA data collected from around the state to determine data availability and quality
  - Estimate ETo using alternative equations for comparison to atmometers
  - Expand atmometer study to include more irrigated regions

Thank you!

Questions?

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