Drip Onion Irrigation Studies

Presented by

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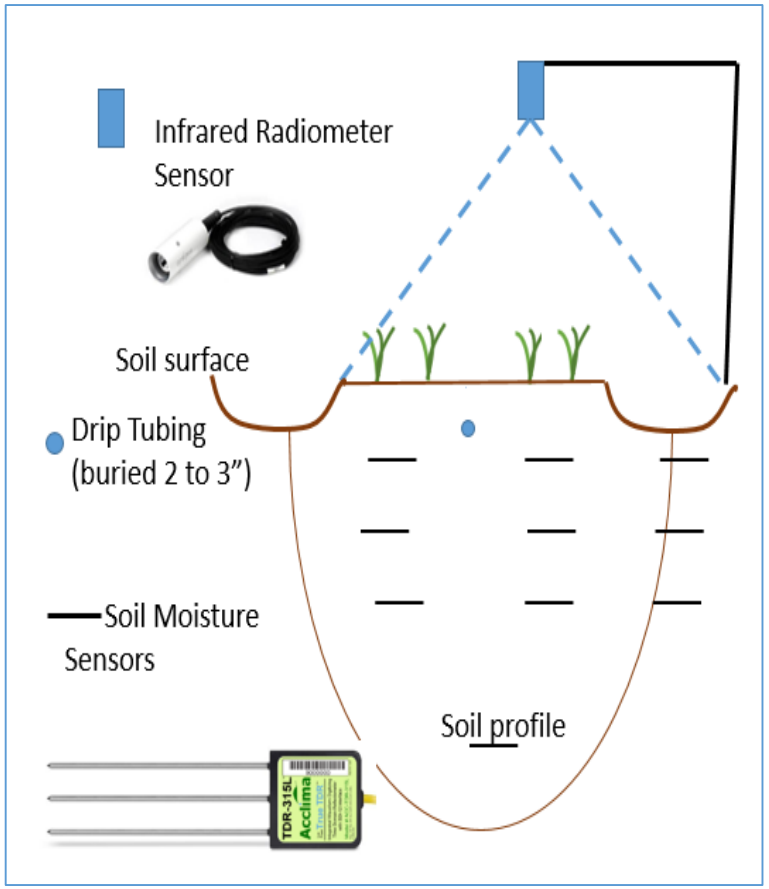
Water Use Study

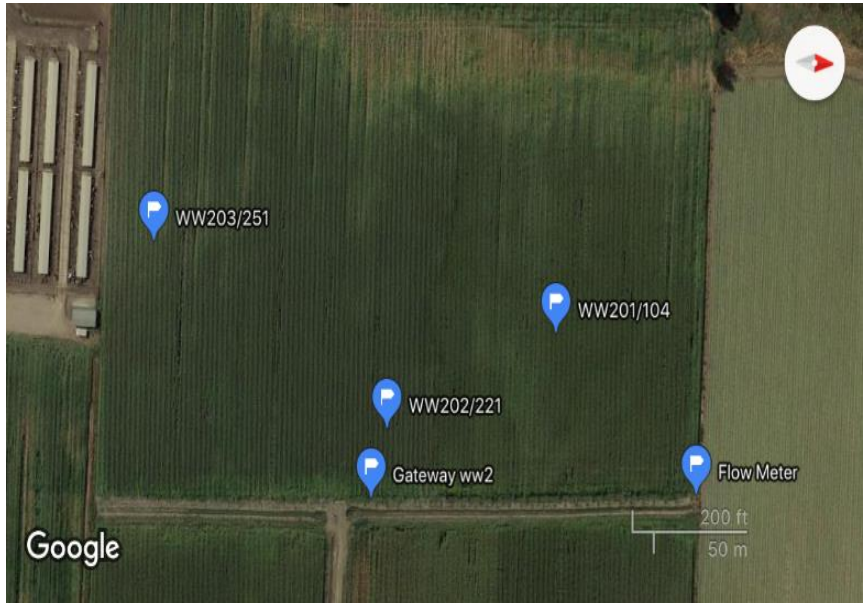
- Utah House Bill 381, Agricultural Water Optimization includes directives and funds for assessing applicable agriculture irrigation water conservation technology.
  - This study focuses on reduced irrigation consumptive use while maintaining production and profitability.
- Quantify the water depletion (consumptive use) from drip irrigation onions and compare it to the water depletion of furrow-irrigated onions.

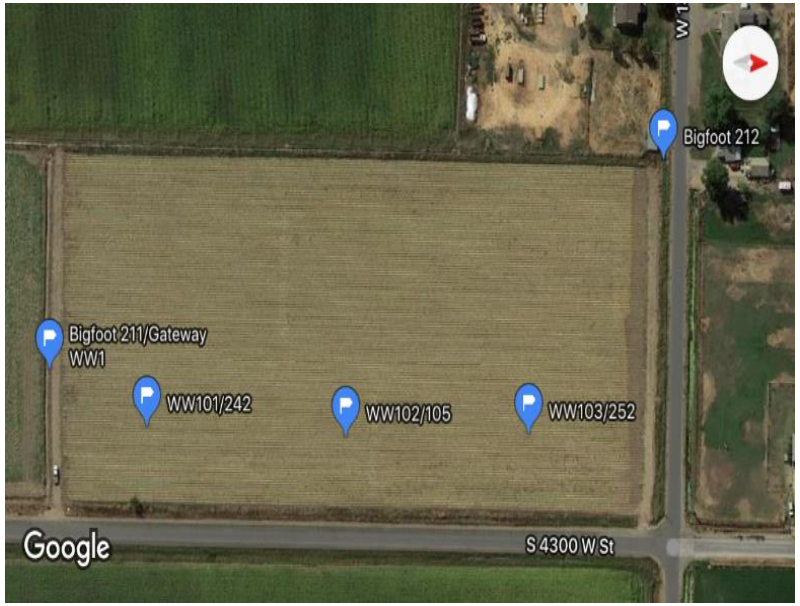
Water Use Study

- Water Use Study 2019 (Drip v. Surface Irrigation of Onions)
  - Installation of weather station and soil moisture sensors
  - Obtained soil moisture and temperature data
  - Obtained irrigation delivery and outflow data
  - Took yield samples
- Still working on economics of production
  - Costs - labor, fertilizers, irrigation equipment, energy etc.
  - Returns – sales and other economic returns.

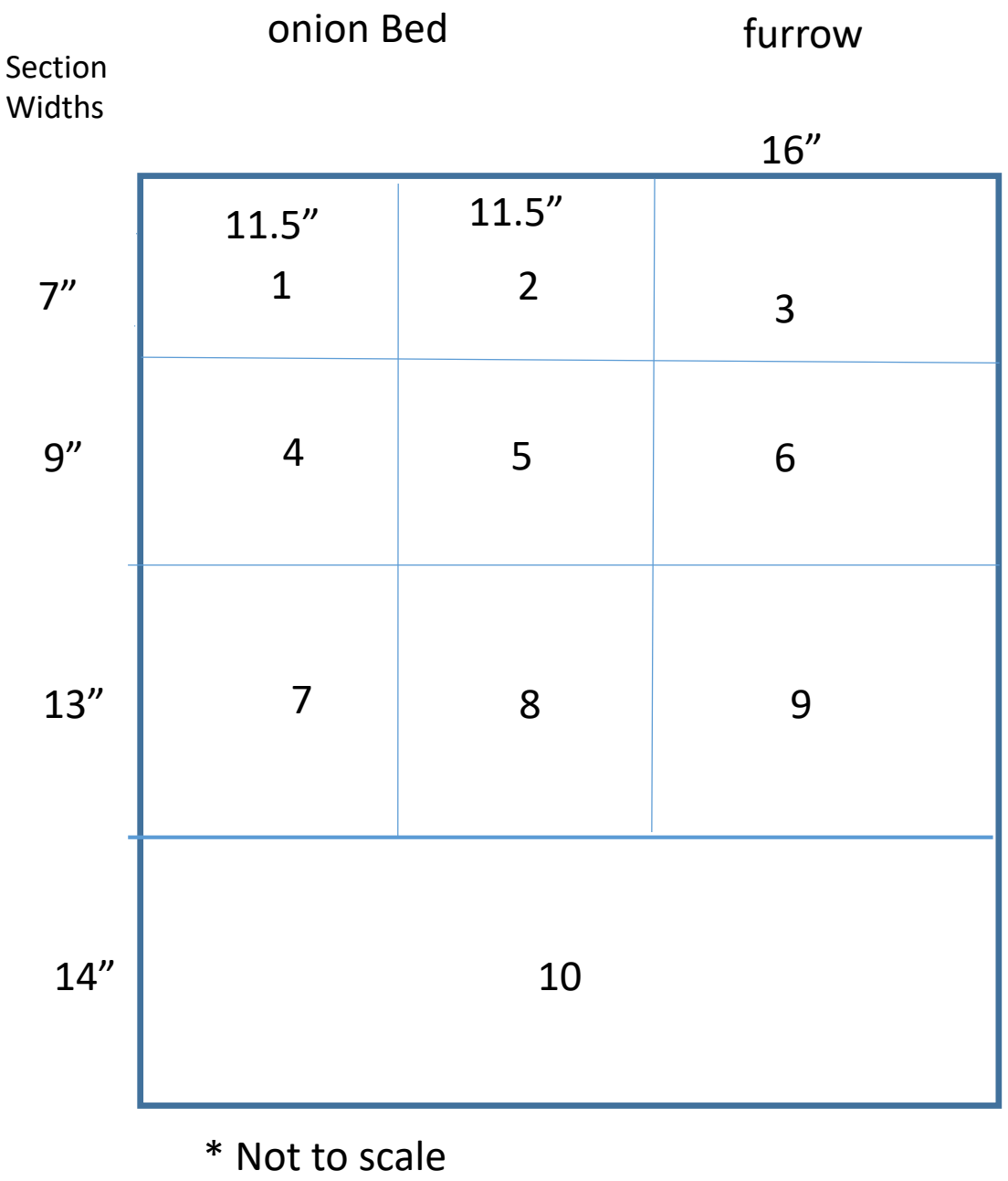
Water Depletion Study for Drip and Surface Irrigated Onions (2019)







Soil Sensor Locations (West Weber)



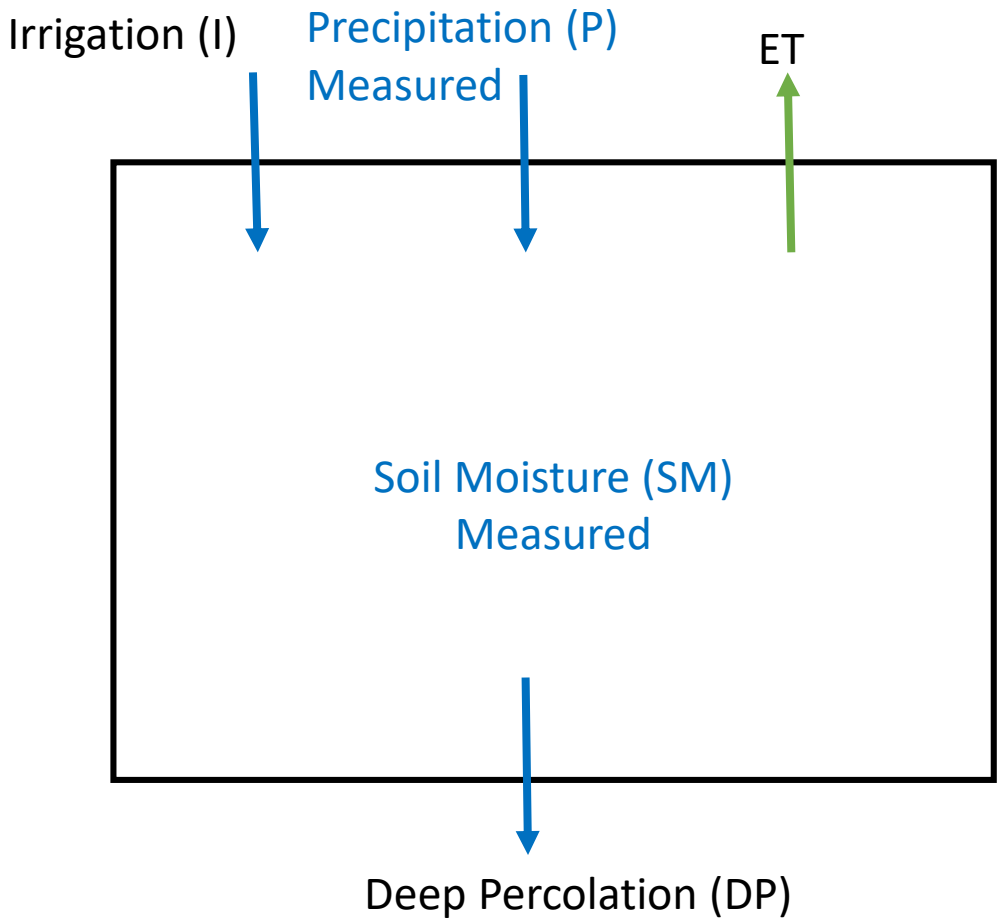
* Not to scale

Location of soil moisture sensors (1 through 10)

Each sensor represents a block of soil

Sensor reads soil moisture in % by volume (e.g. depth = % soil moisture * volume / area)

Simple Soil Water Budget (No contribution from groundwater)

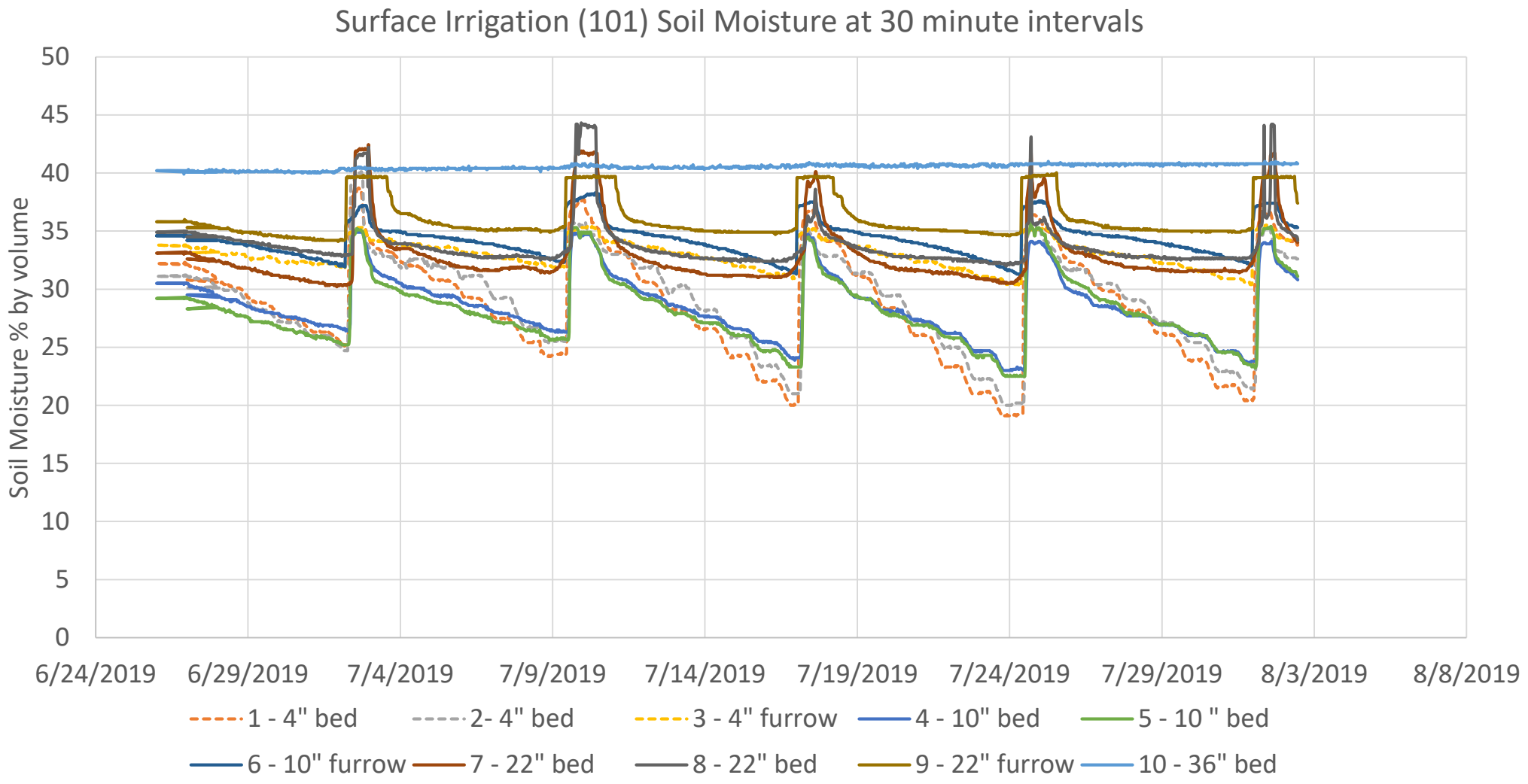


Irrigation inflow and outflow are measured, but the infiltration at any location is not known.

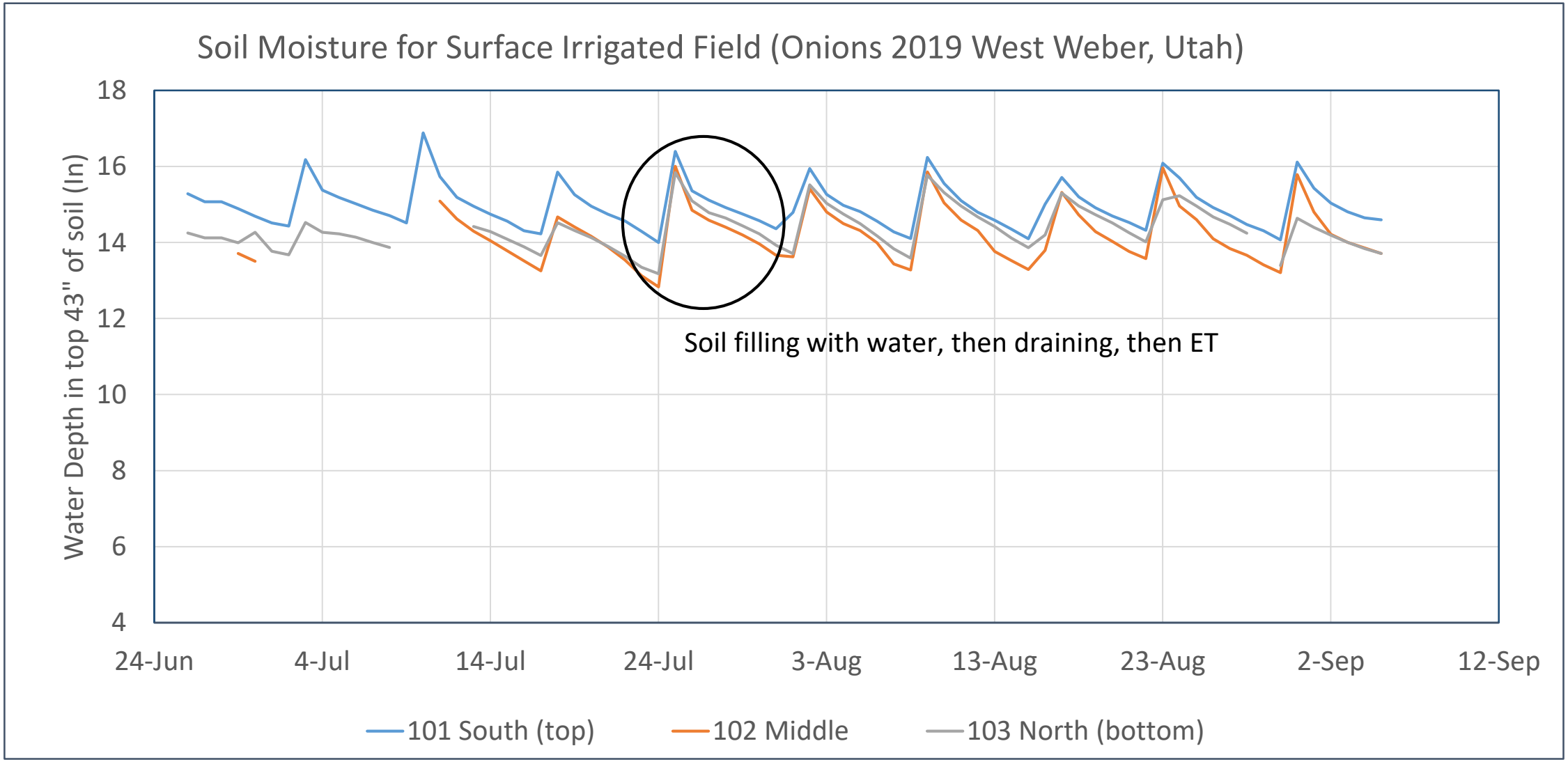
The best ET data is from days when there is no irrigation and no deep percolation.

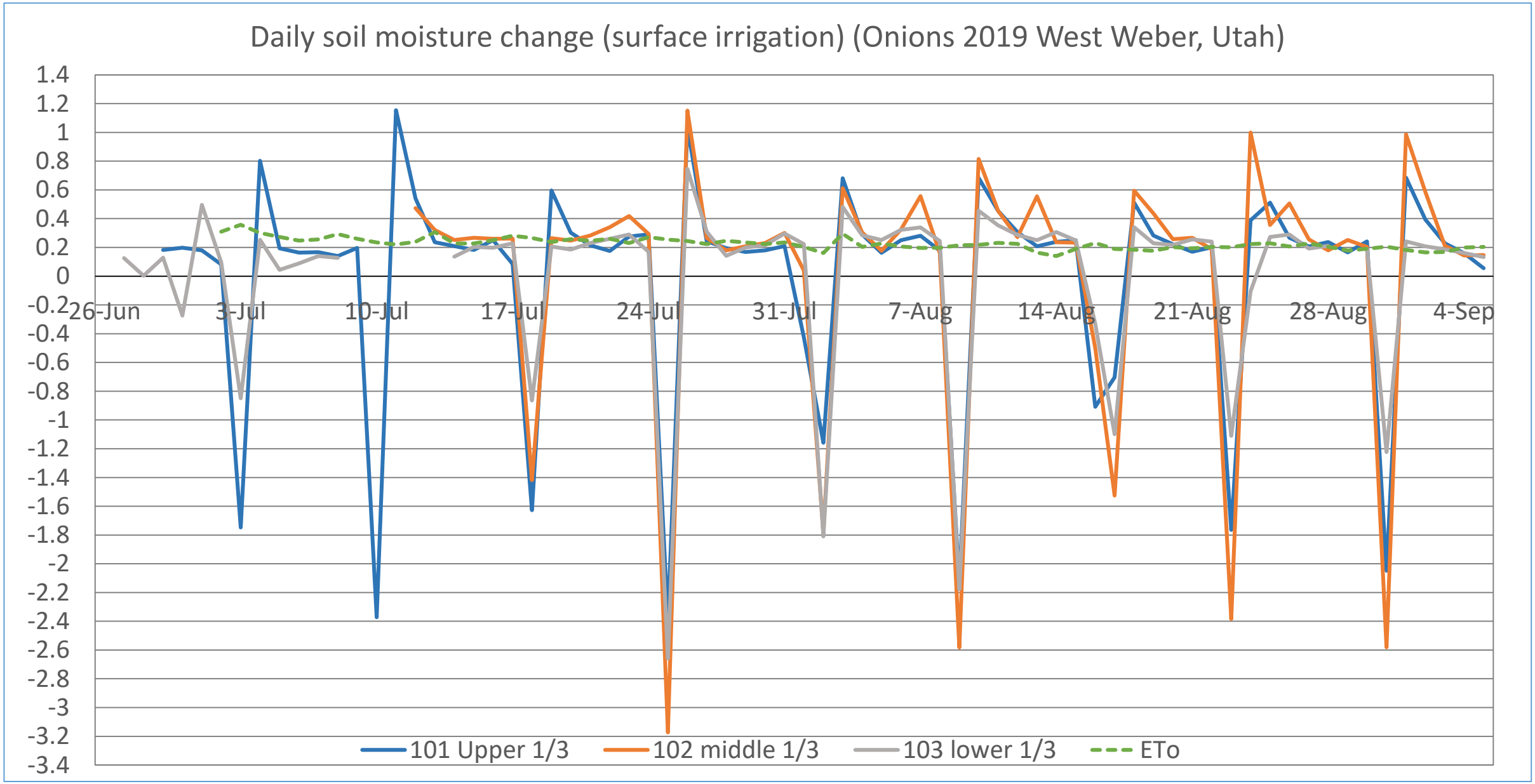
Measuring Soil Moisture to Estimate ET

Water use under the bed is the highest

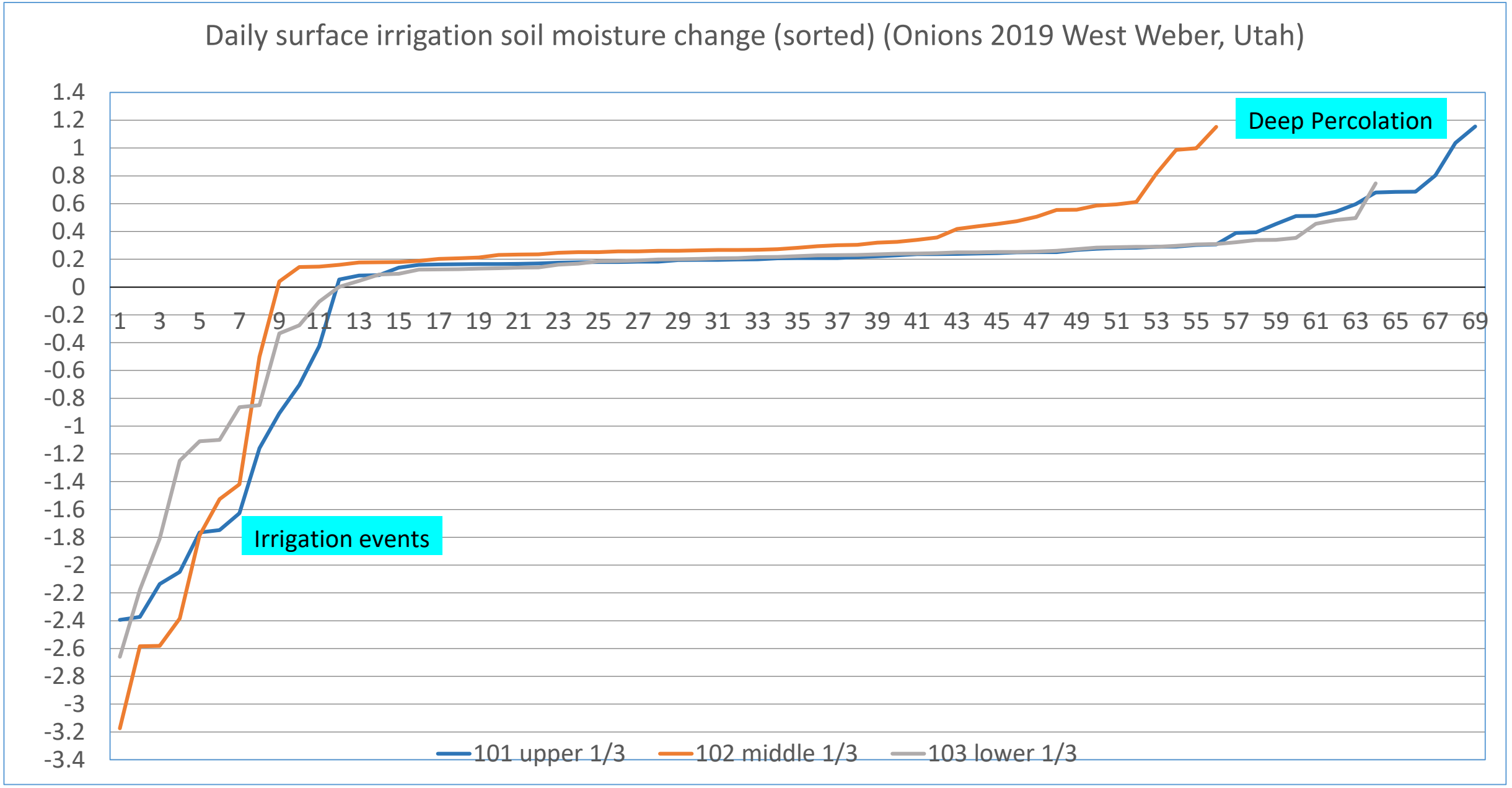


Average Daily Soil Moisture for Surface Irrigation

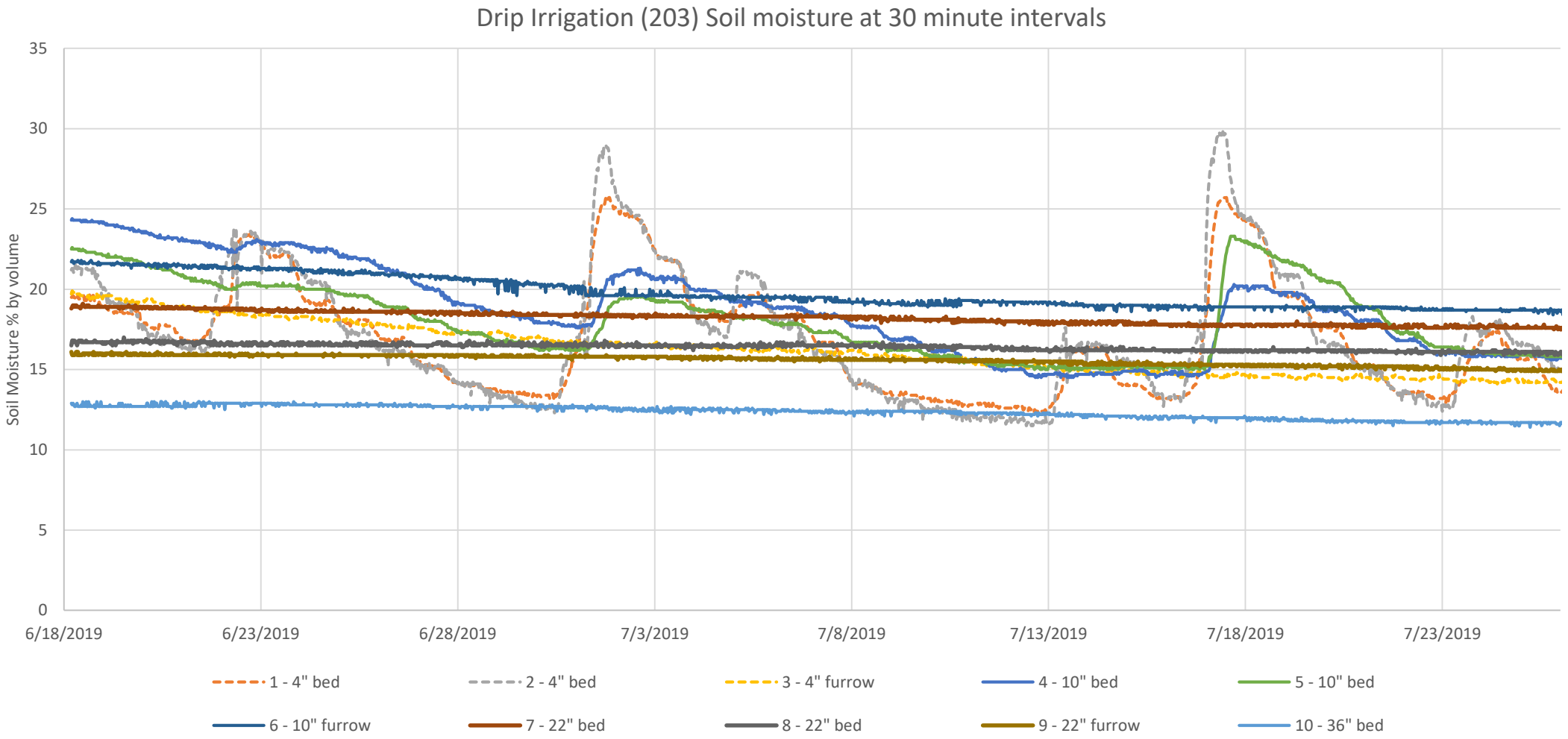




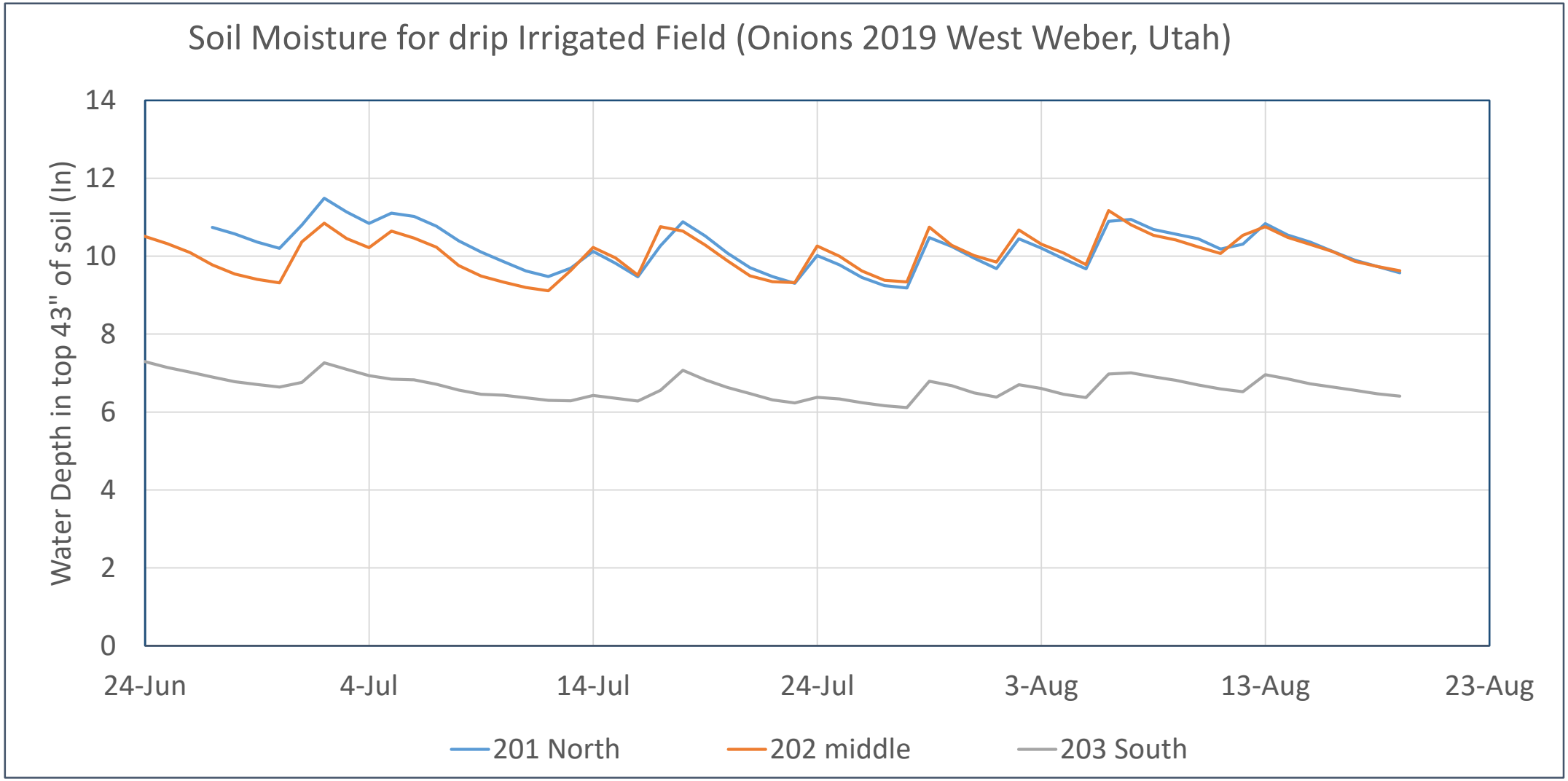
Positive values are water leaving the soil


Daily surface irrigation soil moisture change (sorted) (Onions 2019 West Weber, Utah)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
-3.2
-3.4
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69
Deep Percolation
Irrigation events
101 upper 1/3
102 middle 1/3
103 lower 1/3

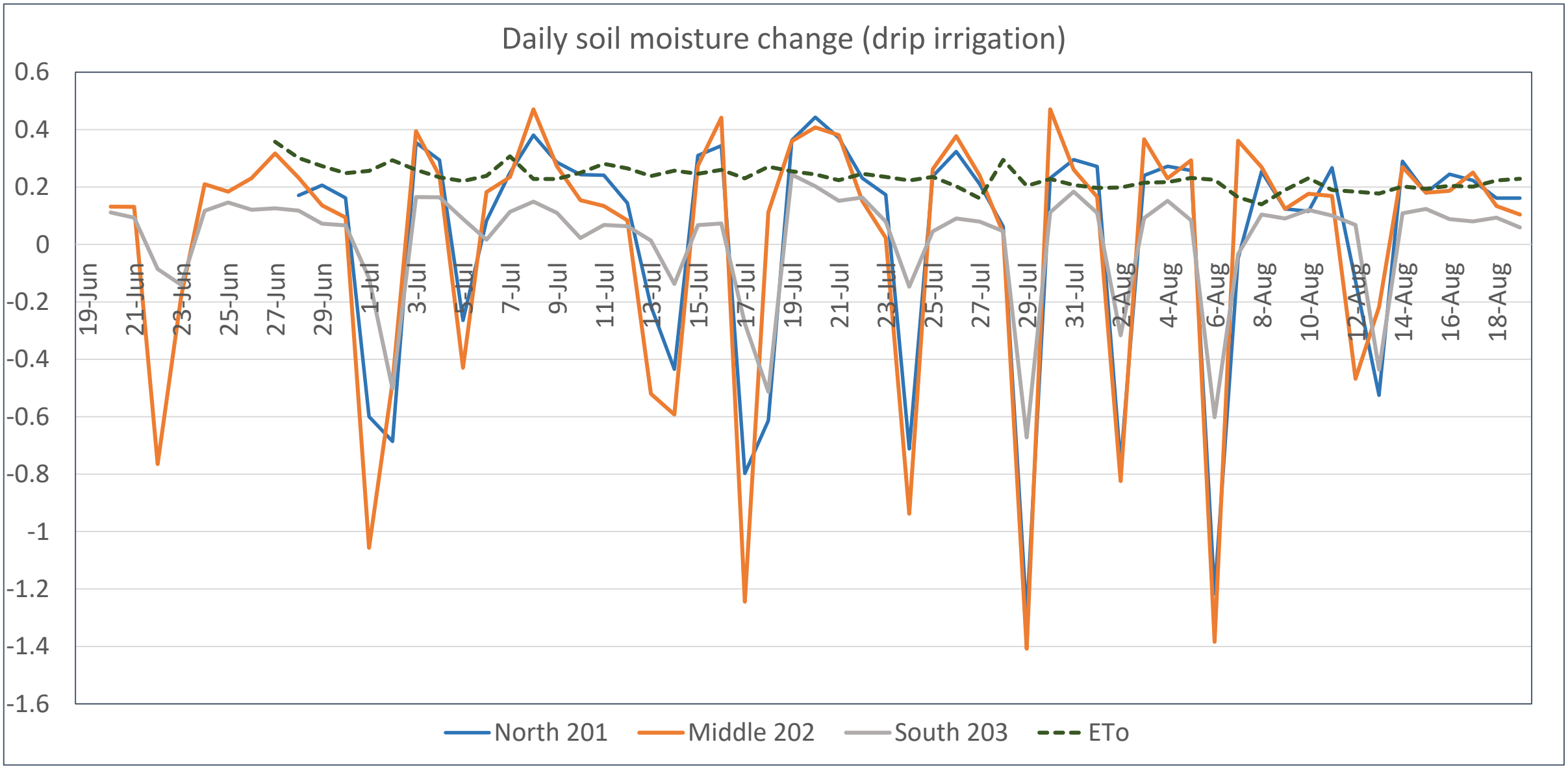
Measuring Soil Moisture to Estimate ET

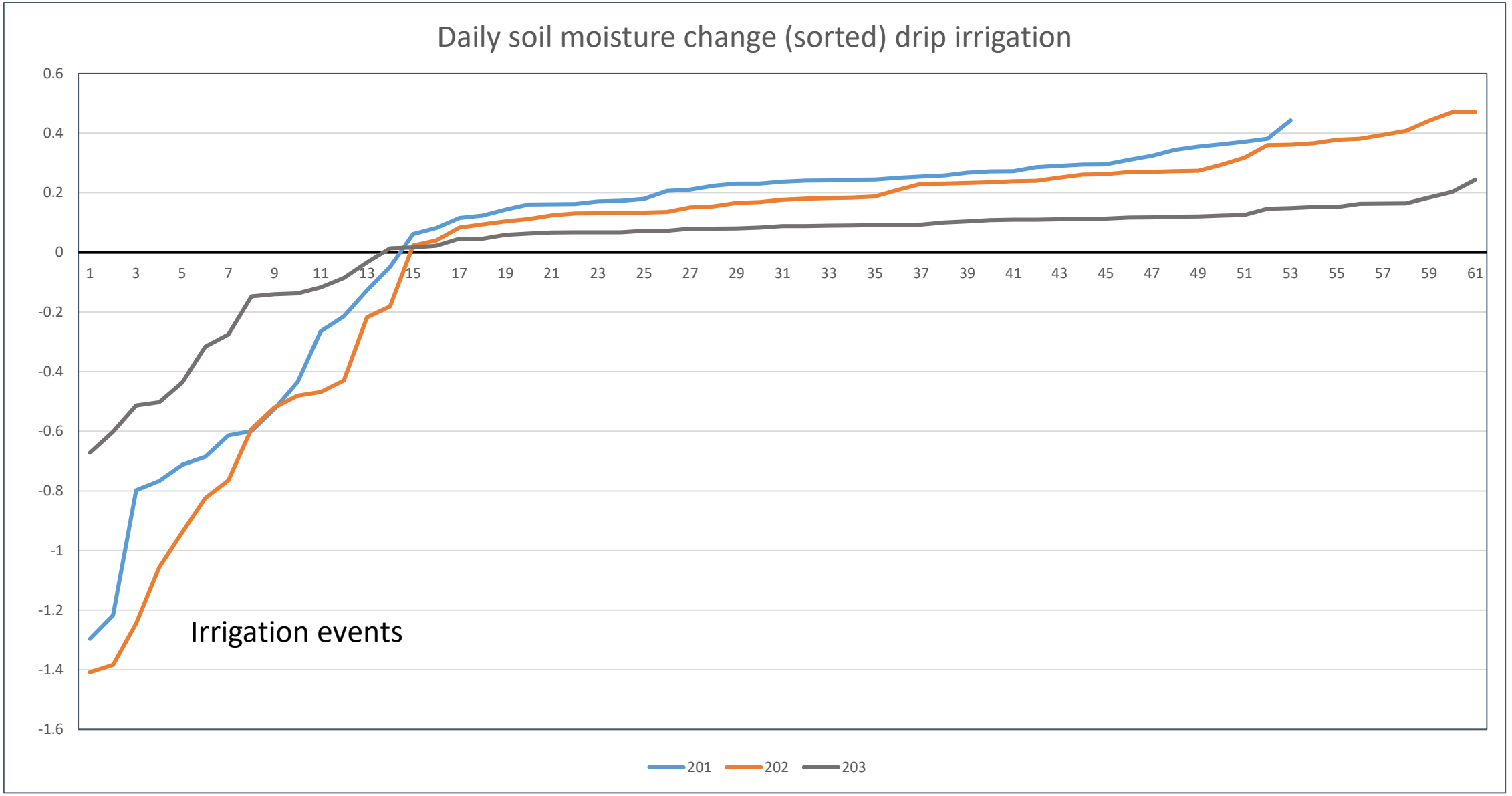


Average Daily Soil Moisture for Drip Irrigation

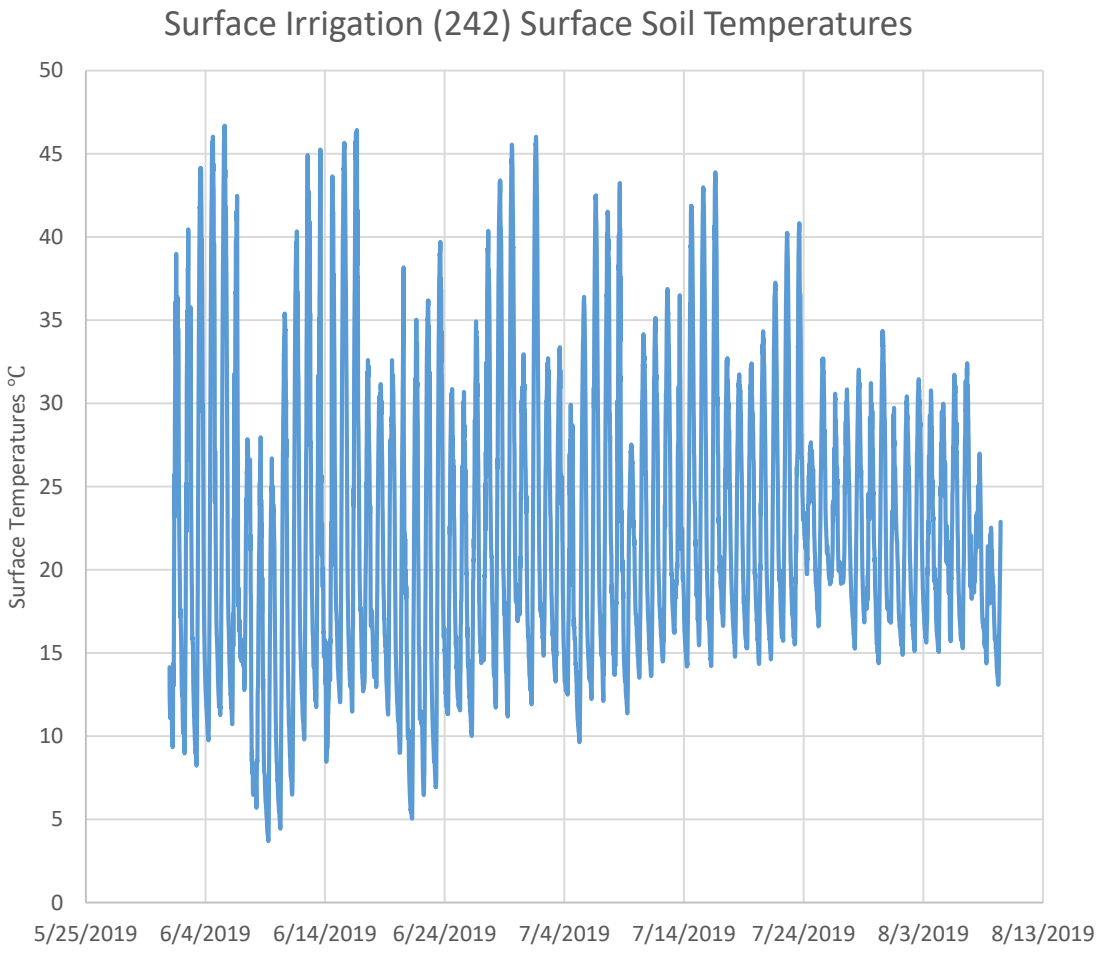


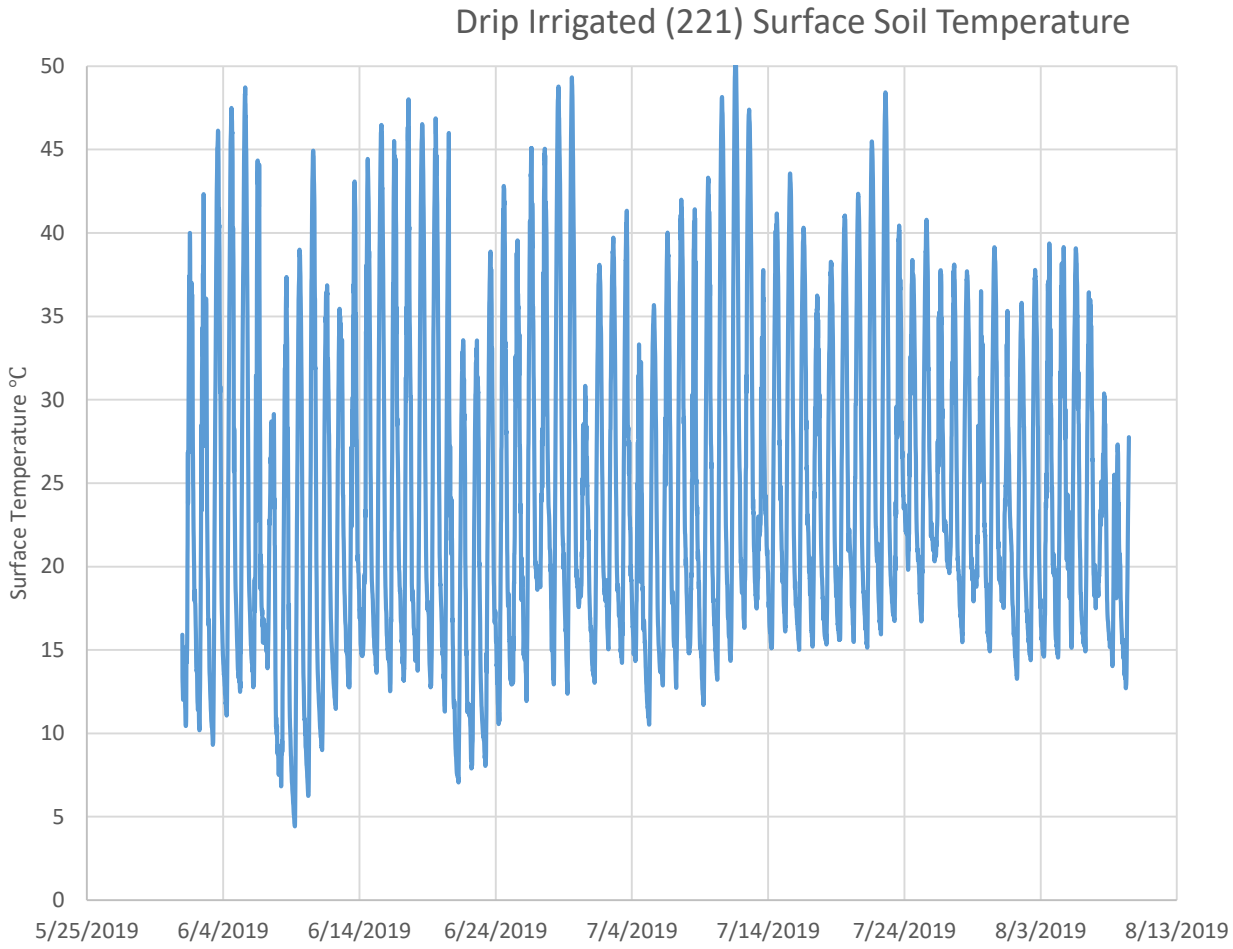
Positive values are water leaving the soil

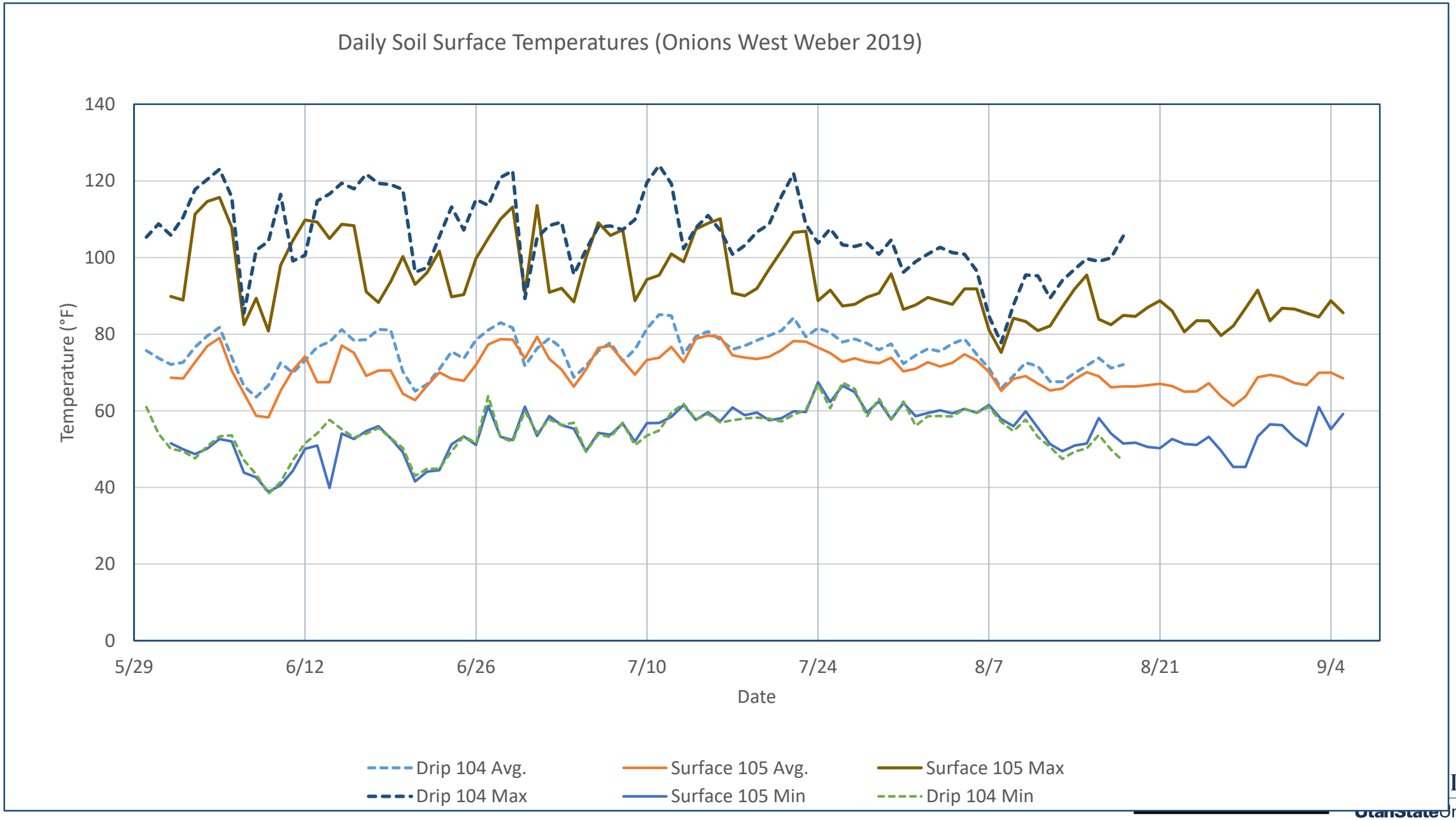

Daily soil moisture change (drip irrigation)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
2-Aug
4-Aug
6-Aug
8-Aug
10-Aug
12-Aug
14-Aug
16-Aug
18-Aug
North 201
Middle 202
South 203
ETo


Daily soil moisture change (sorted) drip irrigation
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61
Irrigation events
201
202
203

Calculating Soil Evaporation






Daily Soil Surface Temperatures (Onions West Weber 2019)
Temperature (°F)
140
120
100
80
60
40
20
0
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
Date
Drip 104 Avg.
Surface 105 Avg.
Surface 105 Max
Drip 104 Max
Surface 105 Min
Drip 104 Min

Onion Yield Surface Irrigation

Surface Irrigation (sampled September 24, 2020)							
	Units	Onion bulb diameter (inches)					
		<2.25	3	3.5	4	4.0+	Total
North	blubs/ac.	12,286	53,612	66,457	44,677	2,234	179,266
	lbs./ac.	1,958	26,697	49,355	44,134	3,103	125,246
Middle	blubs/ac.	13,962	35,742	64,223	53,054	5,026	172,006
	lbs./ac.	2,734	16,279	54,330	48,468	7,093	128,904
South	blubs/ac.	7,260	21,780	57,522	52,495	13,403	152,460
	lbs./ac.	2,044	11,157	40,833	55,660	18,126	127,820
Average	**blubs/ac.**	**11,169**	**37,045**	**62,734**	**50,075**	**6,888**	**167,911**
	lbs./ac.	**2,245**	**18,044**	**48,173**	**49,420**	**9,441**	**127,323**
	bags/ac.	**44.9**	**360.9**	**963.5**	**988.4**	**188.8**	**2,546.5**
	% size	**6.7%**	**22.1%**	**37.4%**	**29.8%**	**4.1%**	

Onion Yield Drip Irrigation

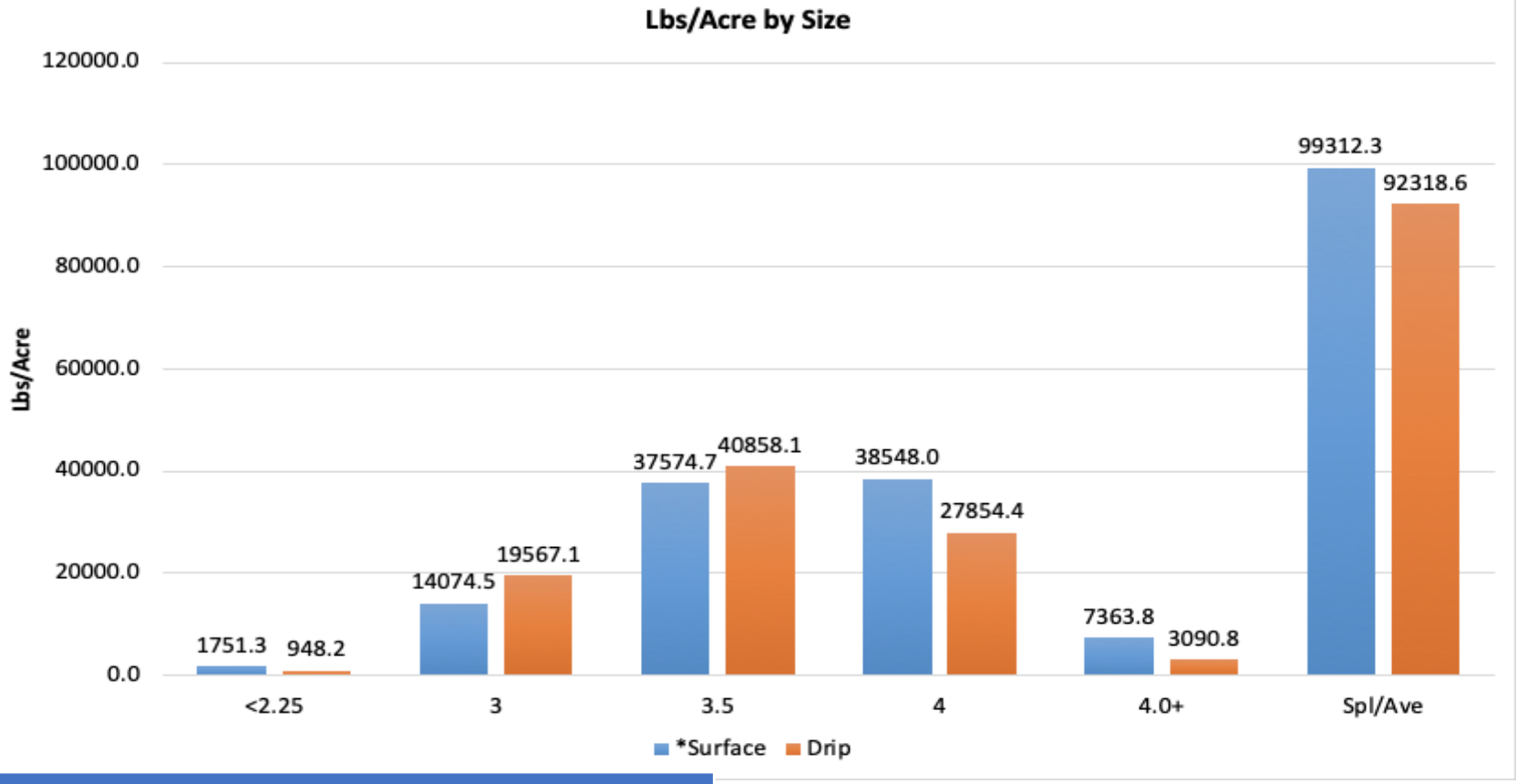
Drip Irrigation (sampled August 23, 2020)							
	Units	Onion bulb diameter (inches)					
		<2.25	3	3.5	4	4.0+	Total
North	blubs/ac.	3,909	33,508	65,898	26,806	2,792	132,914
	lbs./ac.	1,059	17,511	53,418	27,313	3,300	102,601
Middle	blubs/ac.	4,468	43,560	36,300	29,040	2,234	115,602
	lbs./ac.	837	21,624	28,298	28,396	2,881	82,036
South (not sampled)	blubs/ac.						
	lbs./ac.						
Average	**blubs/ac.**	**4,188**	**38,534**	**51,099**	**27,923**	**2,513**	**124,258**
	lbs./ac.	**948**	**19,567**	**40,858**	**27,854**	**3,091**	**92,319**
	bags/ac.	**19.0**	**391.3**	**817.2**	**557.1**	**61.8**	**1,846.4**
	% size	**3.4%**	**31.0%**	**41.1%**	**22.5%**	**2.0%**	

Onion Yields Surface Irrigation v. Drip Irrigation

	Surface Irrigation	Drip Irrigation
Planting Date	Early April (multiple dates)	April 27
Harvest Date	September 24	August 23

	Units	Onion bulb diameter (inches)					
		<2.25	3	3.5	4	4.0+	Total
Surface Irrigation Average	blubs/ac.	11,169	37,045	62,734	50,075	6,888	167,911
	lbs./ac.	2,245	18,044	48,173	49,420	9,441	127,323
	bags/ac.	44.9	360.9	963.5	988.4	188.8	2,546.5
	% size	6.7%	22.1%	37.4%	29.8%	4.1%	
Drip Irrigation Average	blubs/ac.	4,188	38,534	51,099	27,923	2,513	124,258
	lbs./ac.	948	19,567	40,858	27,854	3,091	92,319
	bags/ac.	19.0	391.3	817.2	557.1	61.8	1,846.4
	% size	3.4%	31.0%	41.1%	22.5%	2.0%	

Adjusted Yields for Seed Rate



lbs./acre						
	<2.25	3	3.5	4	4.0+	Smp/Ave
* Surface	1751.3	14074.5	37574.7	38548.0	7363.8	99312.3
Drip	948.2	19567.1	40858.1	27854.4	3090.8	92318.6
p value	0.08	0.13	0.56	0.04	0.15	0.22
* = Adjusted						

bulbs/acre						
	<2.25	3	3.5	4	4.0+	Smp/Ave
* Surface	8712.0	28894.8	48932.4	39058.8	5372.4	130970.4
Drip	4188.5	38533.8	51099.2	27923.1	2513.1	124257.7
p value	0.03	0.18	0.77	0.03	0.20	0.33
* = Adjusted						

What did we learn?

- Surface Irrigation
  - Total Application was high (irrigation every 7 ½ days with irrigation delivery of about 5-6 inches per irrigation)
  - Each irrigation had some deep percolation and runoff (11 irrigations).
  - The soil at 36 inches was saturated during the monitoring period.
  - Total irrigation depletion or ET was about 21.3 inches in 83 days (0.256 inches per day)
  - Still working on some surface evaporation analyses.

What did we learn?

- Drip Irrigation
  - Total irrigation was about 14.6 inches (some area higher than others)
  - No deep percolation and no runoff
  - The irrigation depletion or ET was about 15 inches in 70 days, (0.215 inches per day) for the two sites that were about the same.
  - One measurement site only received about half the water as the other 2 sites. The site was the furthest from the water source and may have been a pressure issue or kinked drip tube.
  - Still working on some surface evaporation analyses.

Major differences

- The difference between surface and drip irrigation depletion rate is the higher soil evaporation in the surface irrigated fields due to wet furrows.
- The surface irrigation depletion rate is about 20 percent higher than the drip irrigation rate.
- The difference in yields could be due to different harvest dates, different onion population rates, and many other items. Your experience on yield and quality is a better comparison.

Important considerations

- 2019 was a unique year – very wet spring and very dry summer.
- Yield is a combination of many factors, irrigation is only one factor.
- Differences between the fields other than irrigation system
  - Planting dates
  - Seed spacing
  - Onion variety (Surface irrigation Garnero, Drip irrigation
  - Soils (drip - Kidman fine sandy loam and surface – Airport silt loam)
  - Harvest dates
- **One year of data at two fields is not enough to full understand all the difference between surface and drip irrigated onions.**

Summary (Preliminary Results)

Description	Drip Irrigation	Surface Irrigation (approx.)
Planting Date	multiple dates (early April)	April 27, 2019
First Irrigation	June 10, 2019	June 9, 2019
Number of Irrigations	12	12
Gross Irrigation Application	14.6	Approx. 60
Runoff	0.0	Approx. 30
Deep percolation	0.0	Approx. 21
Net Irrigation (ET and soil evaporation)	14.6	22.4
Irrigation Depletion	14.6	22.4
Date Onions were lifted	August 23-25, 2019	September 24, 2019
Date Onions were harvested	September 2-3, 2019	October 16-17, 2019
Sample yield (pounds/acre)	92,300	127,800
number of onions / acre	124,257	167,900

Notes: Later planting and harvest dates of surface irrigated onions and increased soil account for the higher irrigation depletion.

Questions