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What is my soil moisture sensor trying to tell me?

Colin Campbell, Decagon Research Scientist
Chris Chambers, Application Support Specialist
Lauren Crawford, Soil Moisture Product Manager

Why are we doing this?

- We get requests to help interpret data sets all of the time
- It's much more efficient to discuss our ideas with 200 people instead of each person one on one

Are we the most qualified people to be discussing soil moisture data?

Colin Campbell

- Developed most of our soil moisture sensors
- Extensive experience in his own research

Chris Chambers

- Troubleshoots and interprets soil moisture data every day

Lauren Crawford

- Learned from her many mistakes making soil moisture measurements

How to use today's seminar

Make comments, ask questions, challenge our assumptions

Use what you learn to make better conclusions about your soil moisture data

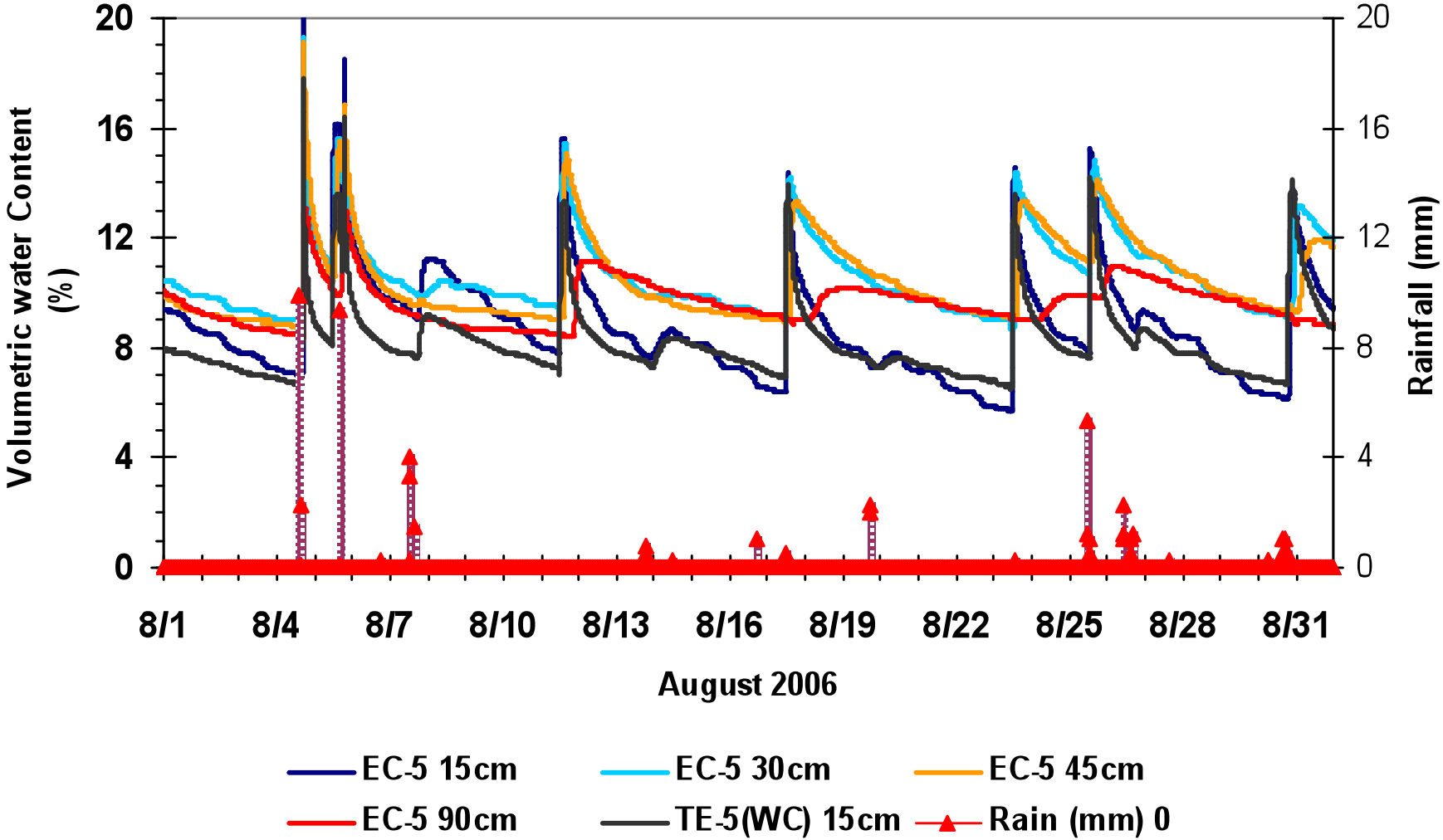
Poll questions 1

What is your primary interest in soil moisture measurements?

1. Field Irrigation
2. Nursery/Greenhouse/Turf Irrigation
3. Rangeland
4. Forestry
5. Other ecological work
6. Other work not listed here

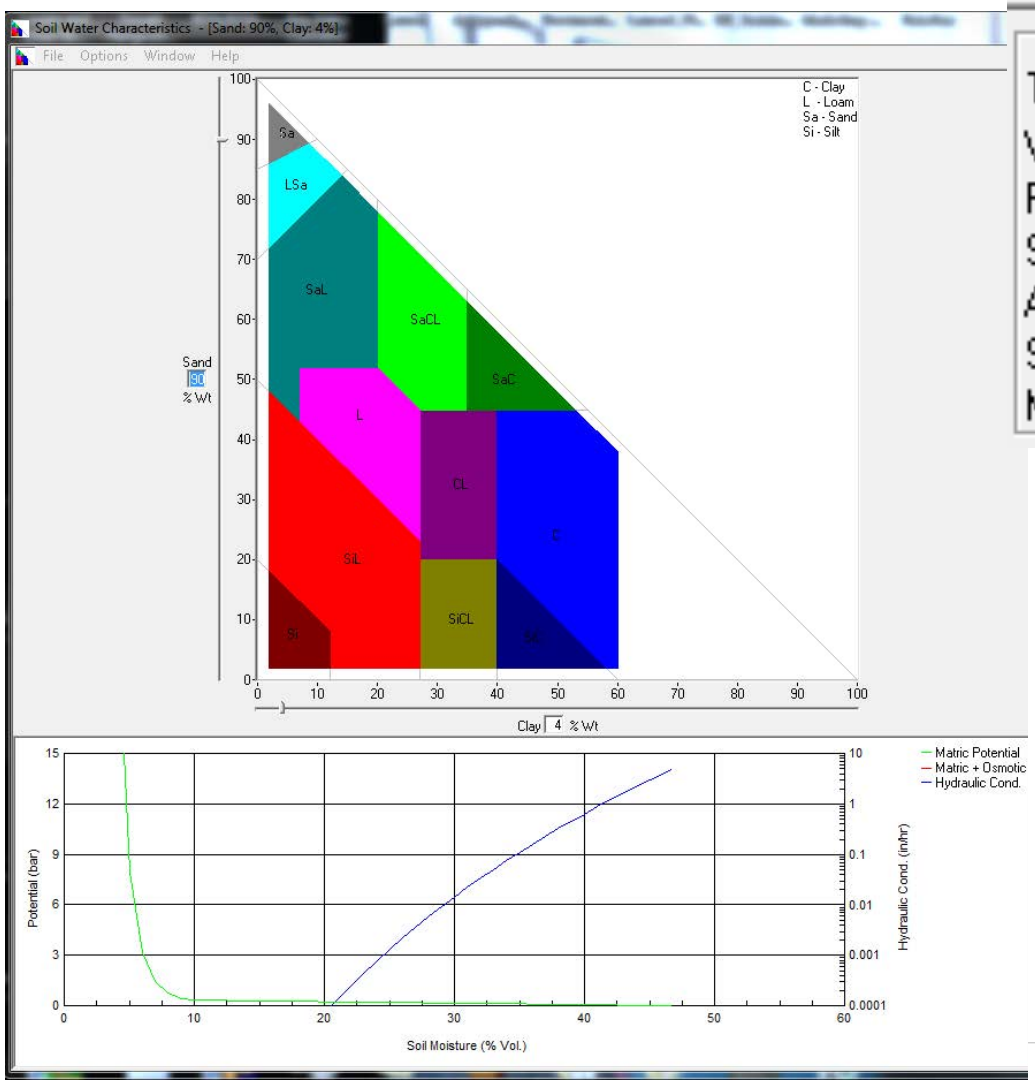
Citrus irrigation

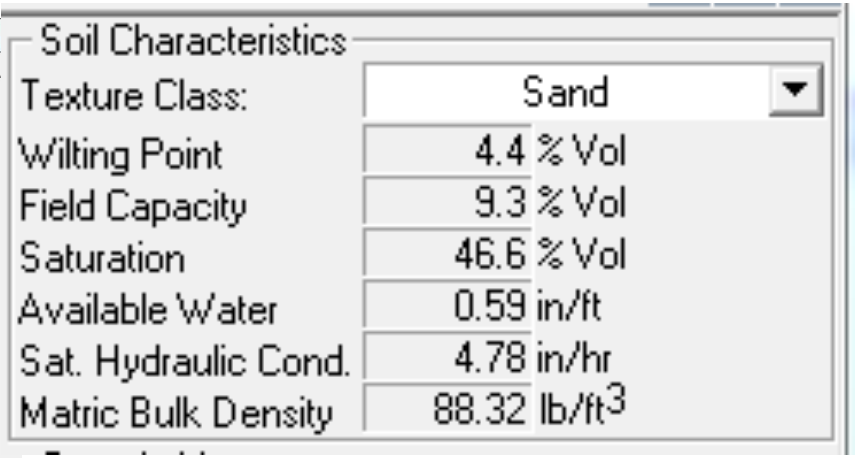
- Orange grove grown in 97% sand soil
- Precipitation measured by rain gauge but irrigation is unknown
- Local meteorological data available for ET calculation
- Decagon EC-5 probes buried through root zone

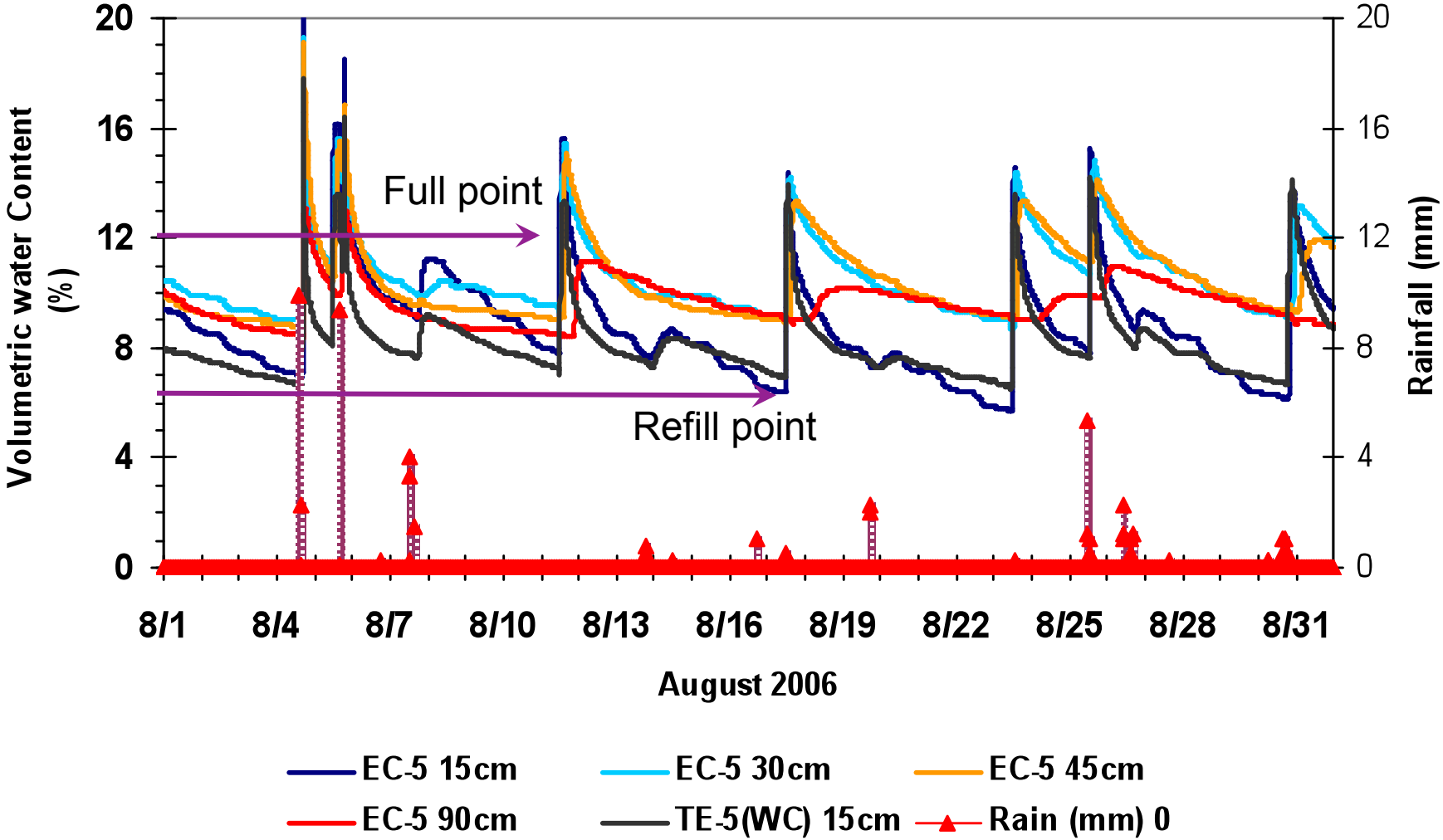


Data courtesy of W. Bandaranayake and L. Parsons, Univ. of Florida Citrus Research and Education Center

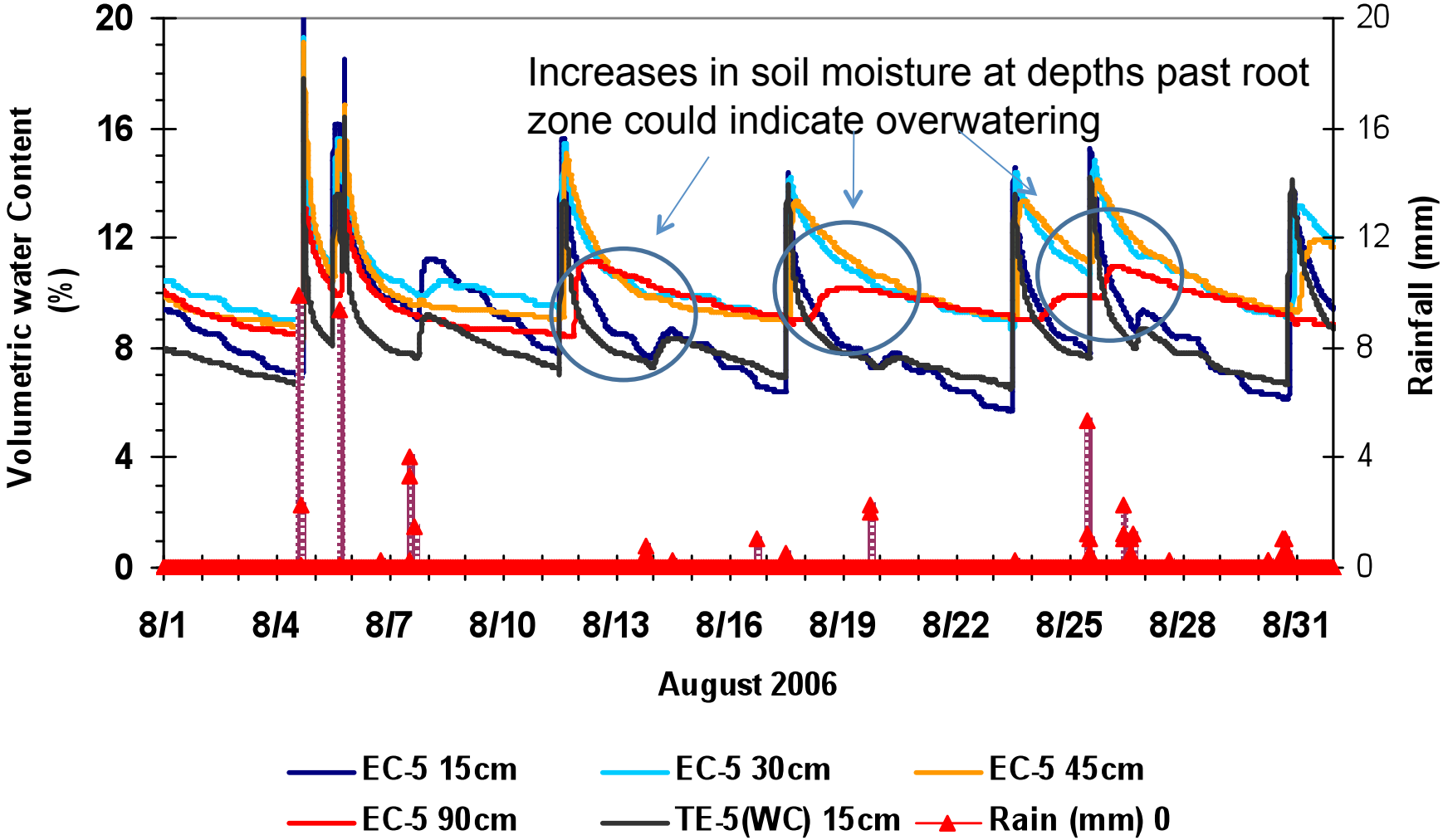
Modelling field capacity and permanent wilting point



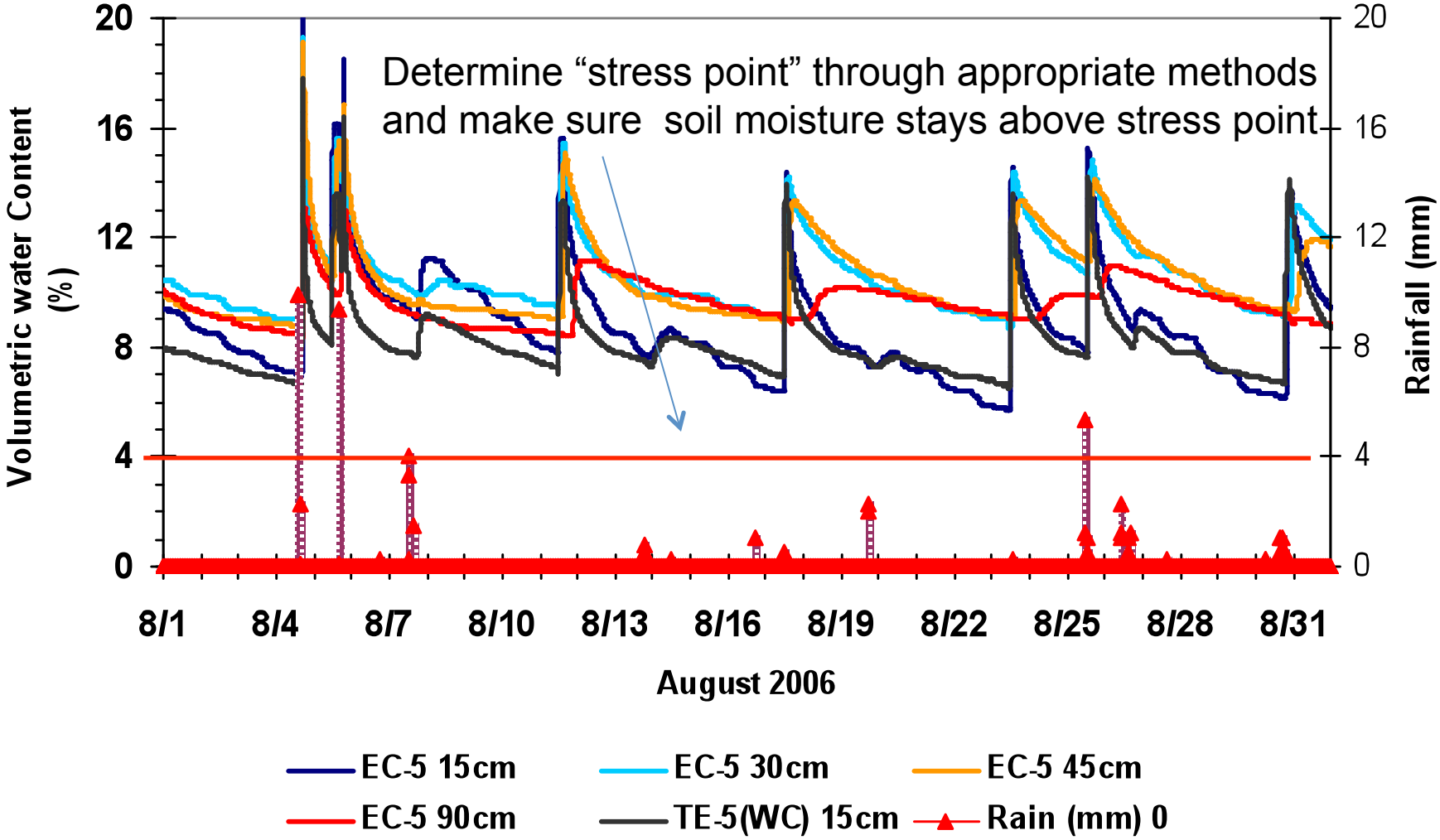




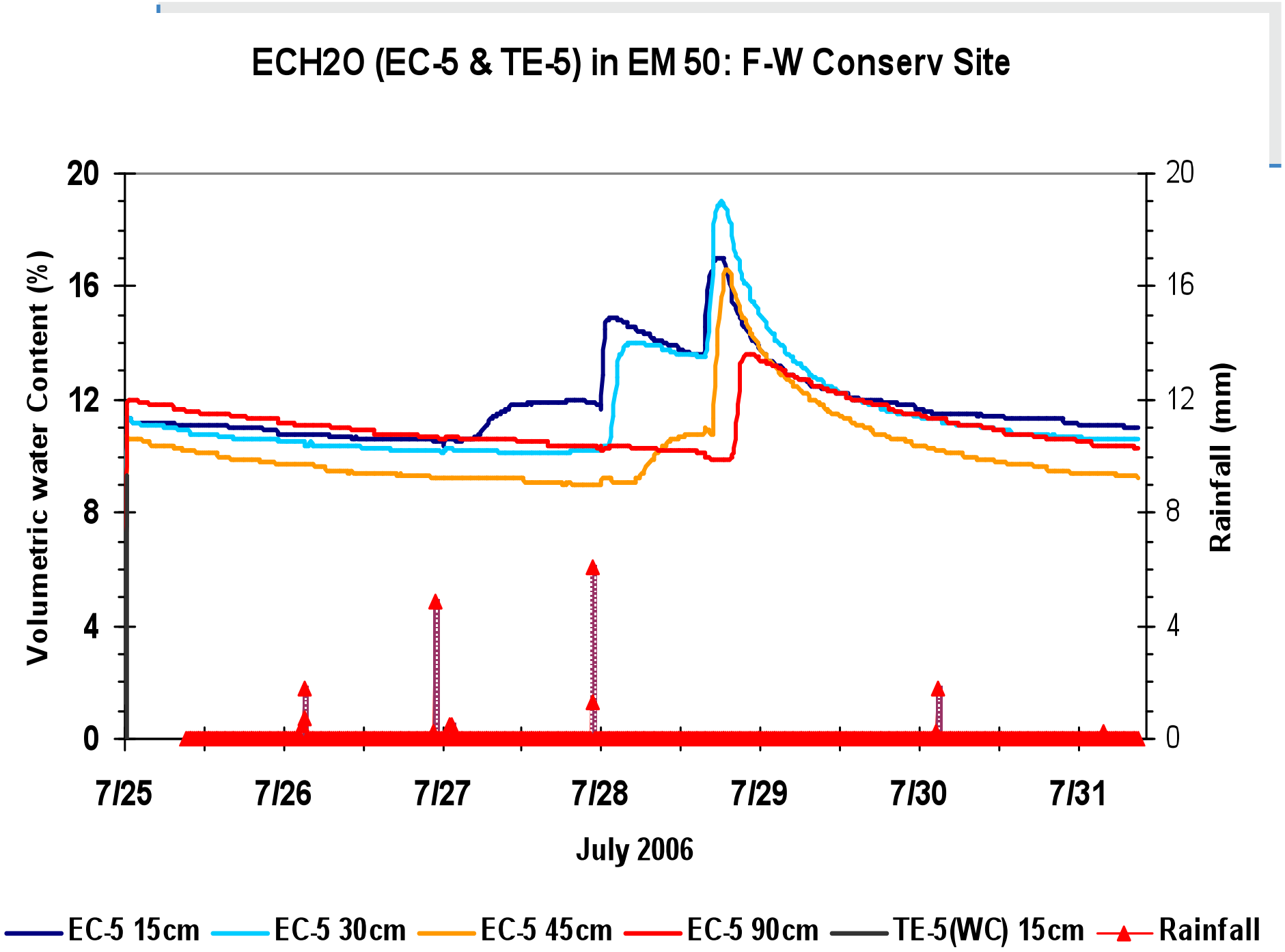
Data courtesy of W. Bandaranayake and L. Parsons, Univ. of Florida Citrus Research and Education Center



Data courtesy of W. Bandaranayake and L. Parsons, Univ. of Florida Citrus Research and Education Center



Data courtesy of W. Bandaranayake and L. Parsons, Univ. of Florida Citrus Research and Education Center


ECH2O (EC-5 & TE-5) in EM 50: F-W Conserv Site
Volumetric water Content (%)
Rainfall (mm)
20
16
12
8
4
0
7/25
7/26
7/27
7/28
7/29
7/30
7/31
July 2006
EC-5 15cm
EC-5 30cm
EC-5 45cm
EC-5 90cm
TE-5(WC) 15cm
Rainfall

Citrus irrigation (part 2)

- Sensors installed in sandy soils at two different sites
- 10HS water content sensor installed between 4-6 inches
- EC-5 water content sensor installed between 20-22 inches
- Irrigation and precipitation monitored using ECRN-50 rain gauges

Data courtesy of Kyle Kirkner, Water & Earth Sciences, Lake Wales, Florida

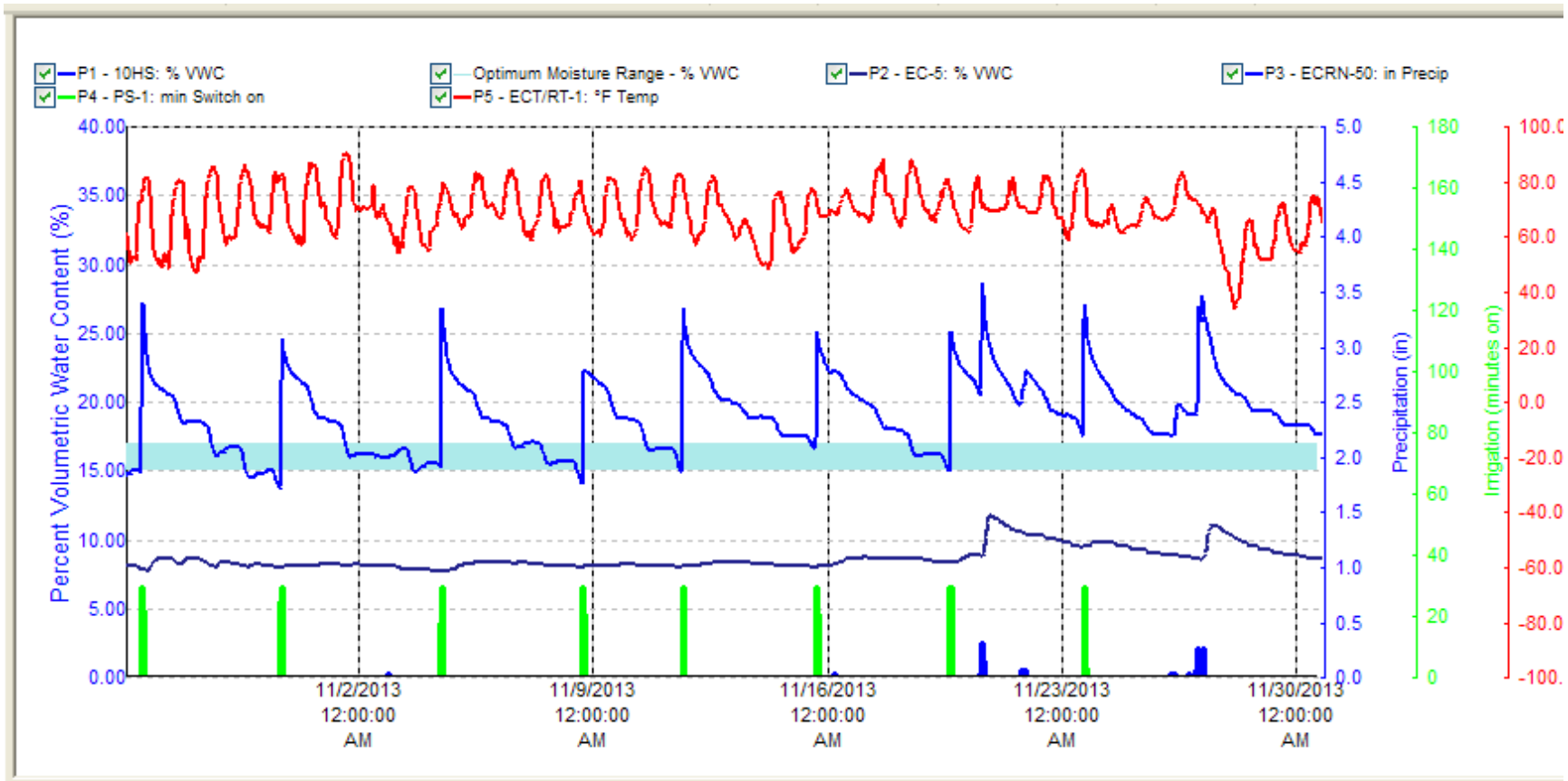
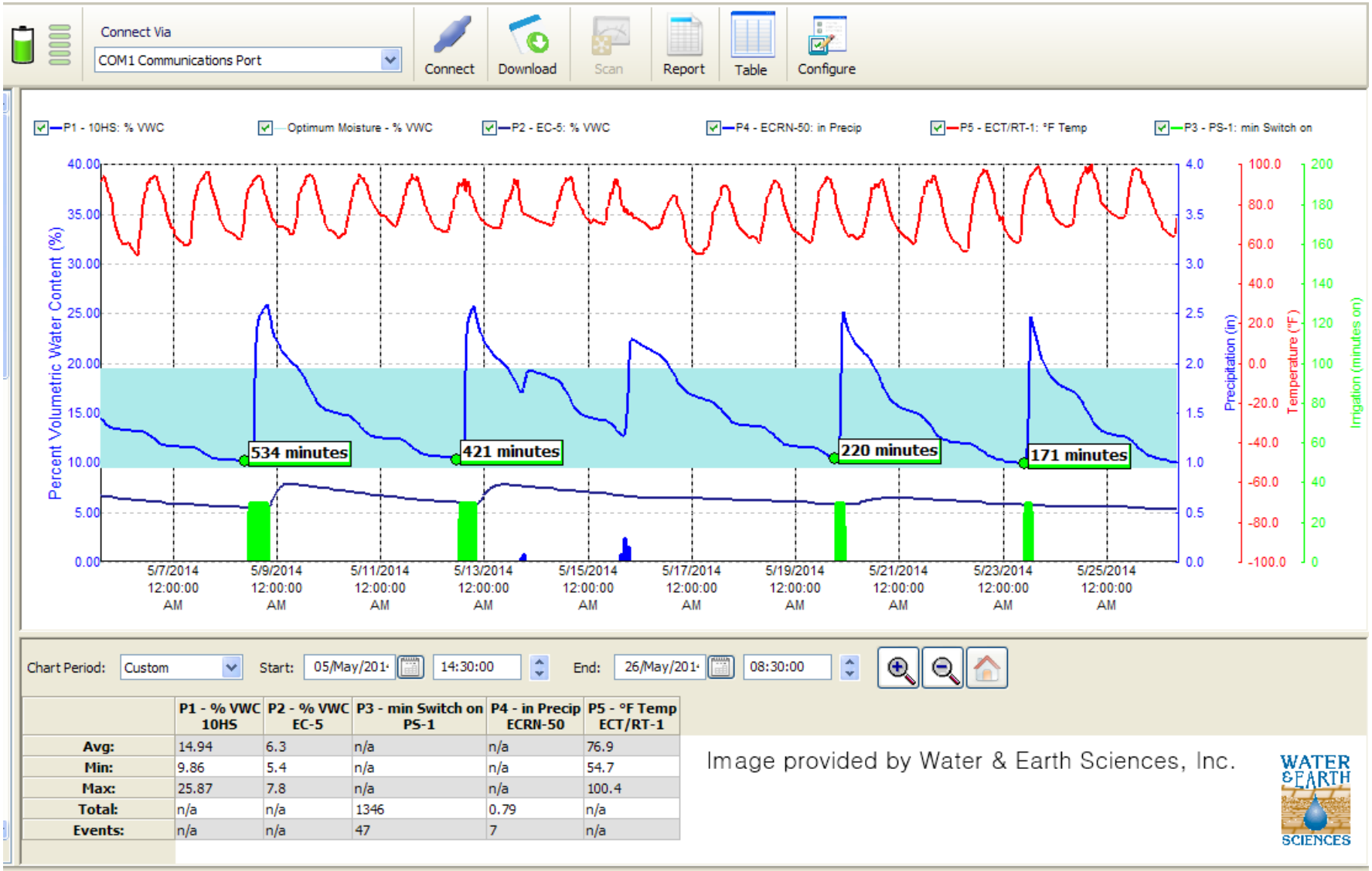


Chart Period: Custom Start: 26/Oct/2013 00:51 End: 30/Nov/2013 15:20

	P1 - % VWC 10HS	P2 - % VWC EC-5	P3 - in Precip ECRN-50	P4 - min Switch on PS-1	P5 - °F Temp ECT/RT-1
Avg:	19.09	8.7	n/a	n/a	68.5
Min:	13.70	7.7	n/a	n/a	34.4
Max:	28.62	11.8	n/a	n/a	90.6
Total:	n/a	n/a	1.97	658	n/a
Events:	n/a	n/a	20	29	n/a

Image provided by Water & Earth Sciences, Inc.

WATER & EARTH SCIENCES



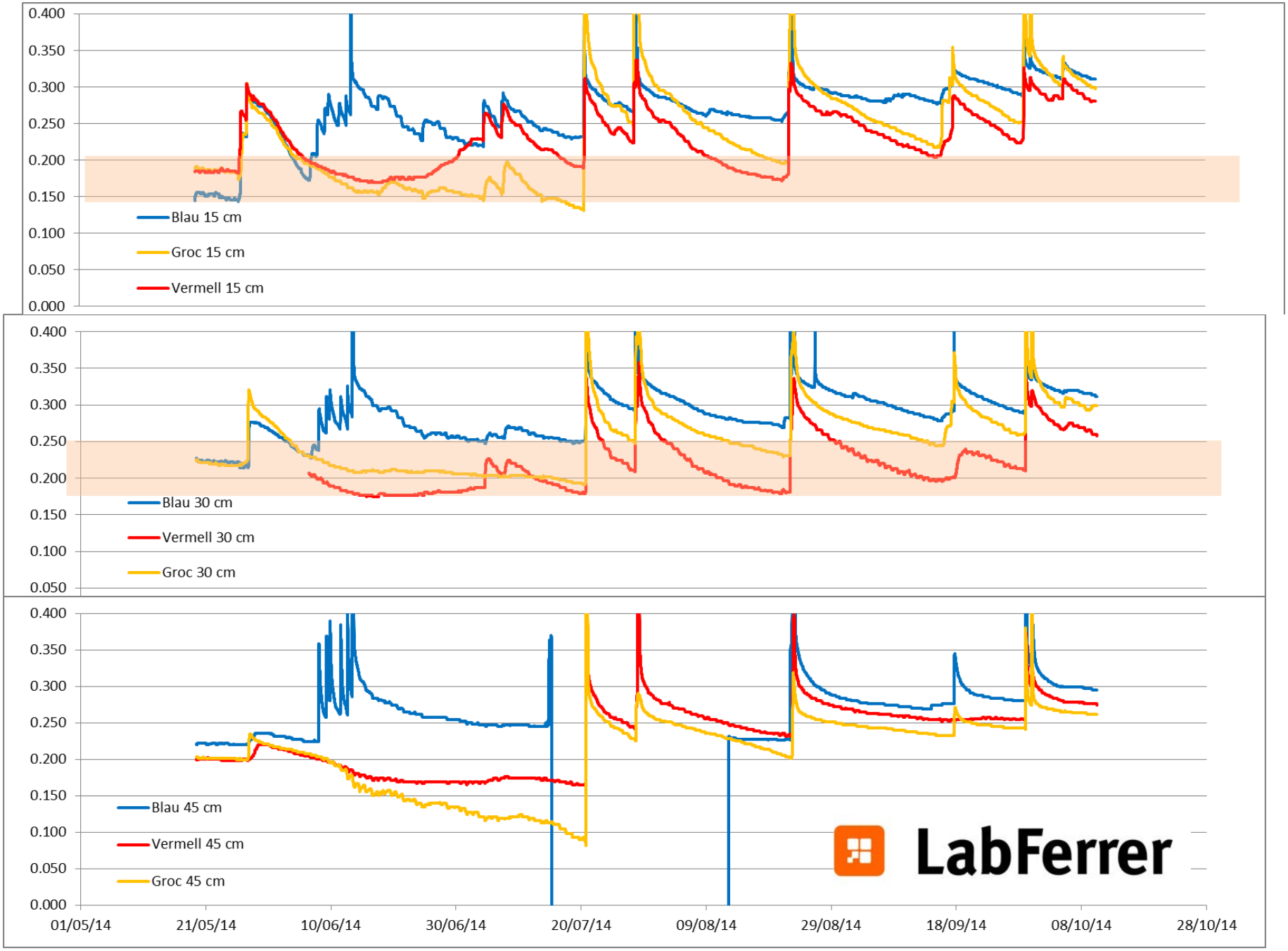
	P1 - % VWC 10HS	P2 - % VWC EC-5	P3 - min Switch on PS-1	P4 - in Precip ECRN-50	P5 - °F Temp ECT/RT-1
Avg:	14.94	6.3	n/a	n/a	76.9
Min:	9.86	5.4	n/a	n/a	54.7
Max:	25.87	7.8	n/a	n/a	100.4
Total:	n/a	n/a	1346	0.79	n/a
Events:	n/a	n/a	47	7	n/a

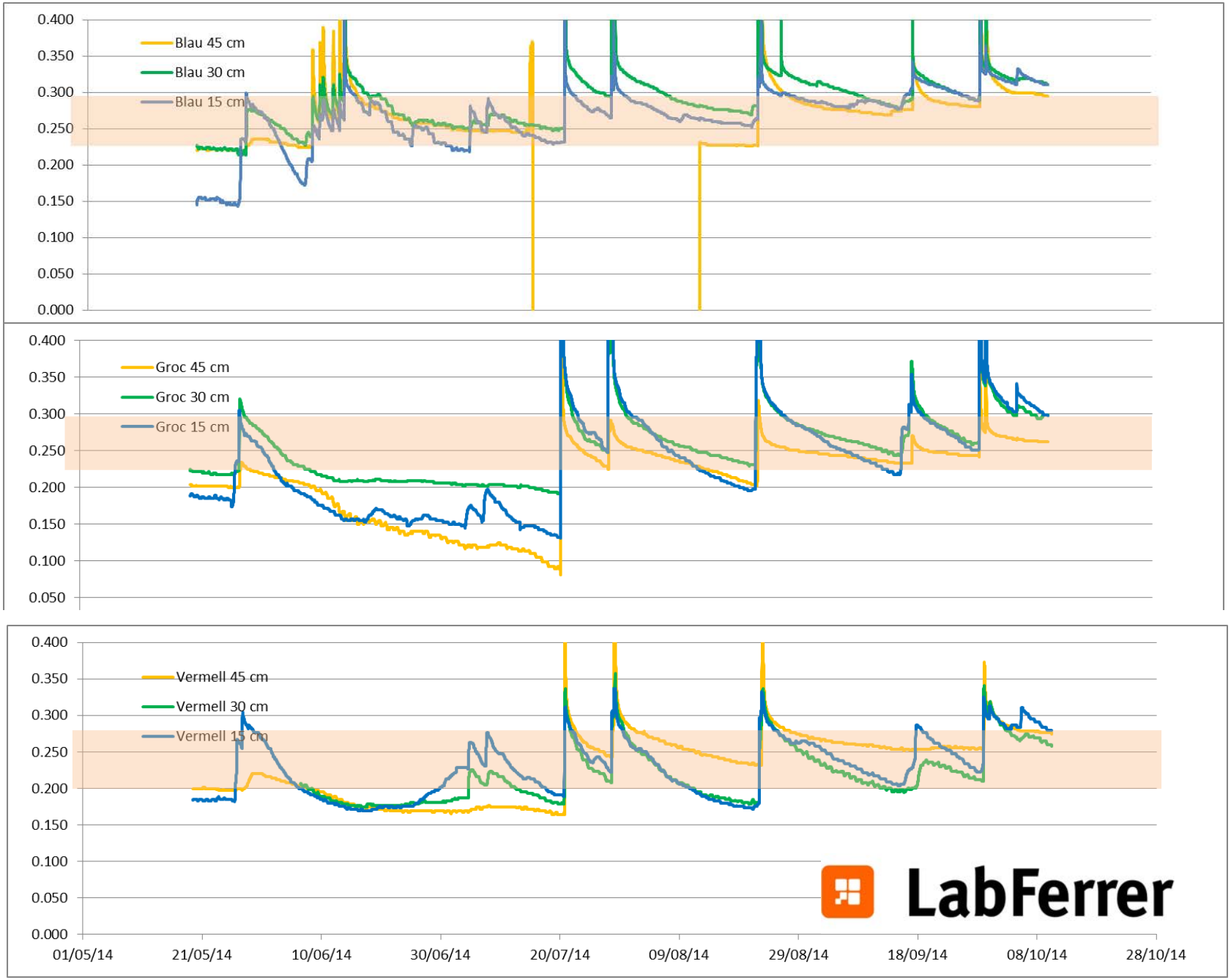
Image provided by Water & Earth Sciences, Inc.

Corn irrigation

- Well-characterized silt-loam soils
- 3 - 10HS sensors installed at 15, 30 and 45 cm
- Irrigated using a drip system

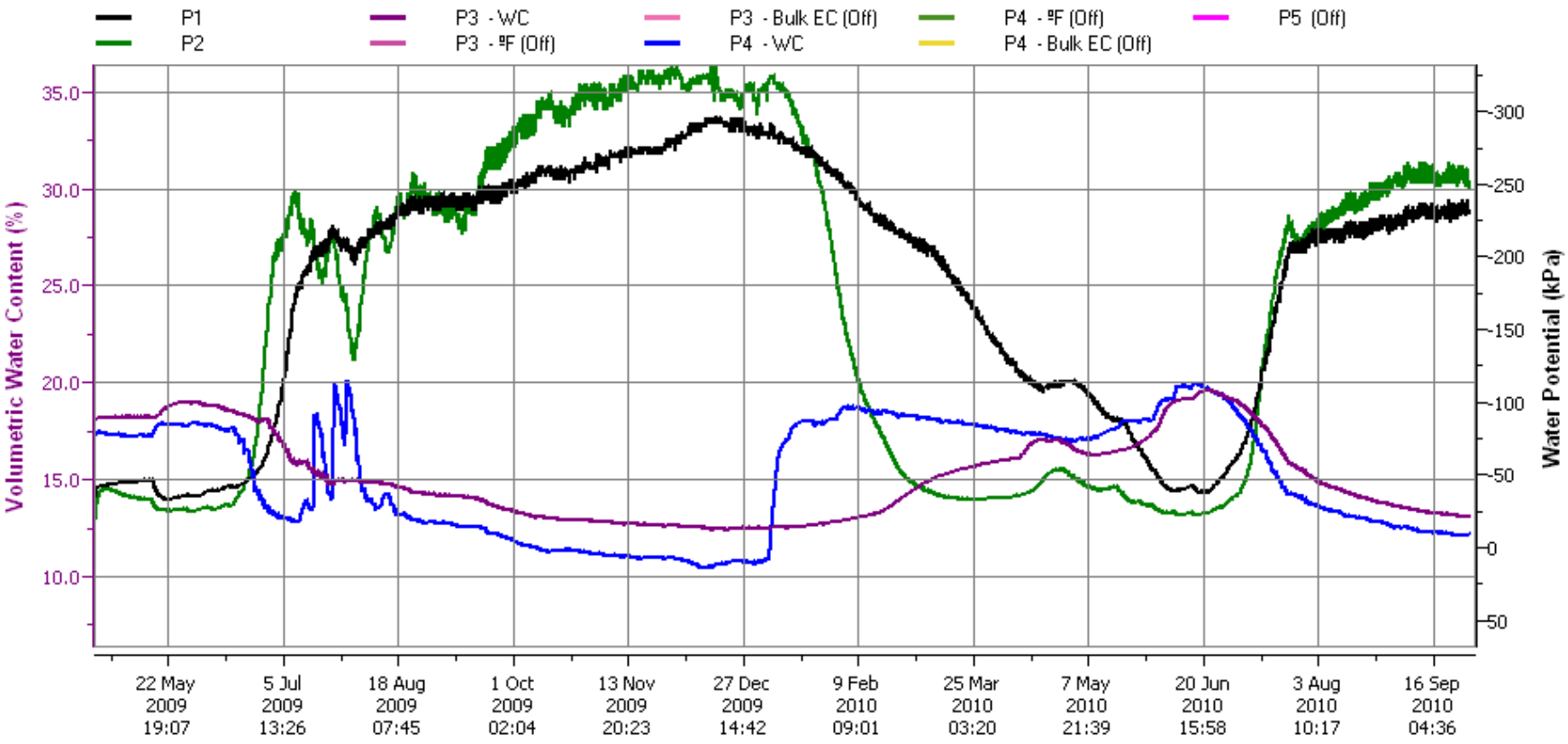
Data courtesy of Mireia Fontanet, Lab Ferrer, Lleida, Spain


0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Blau 15 cm
Groc 15 cm
Vermell 15 cm
Blau 30 cm
Vermell 30 cm
Groc 30 cm
Blau 45 cm
Vermell 45 cm
Groc 45 cm
01/05/14
21/05/14
10/06/14
30/06/14
20/07/14
09/08/14
29/08/14
18/09/14
08/10/14
28/10/14
LabFerrer


0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Blau 45 cm
Blau 30 cm
Blau 15 cm
Groc 45 cm
Groc 30 cm
Groc 15 cm
Vermell 45 cm
Vermell 30 cm
Vermell 15 cm
01/05/14
21/05/14
10/06/14
30/06/14
20/07/14
09/08/14
29/08/14
18/09/14
08/10/14
28/10/14
LabFerrer

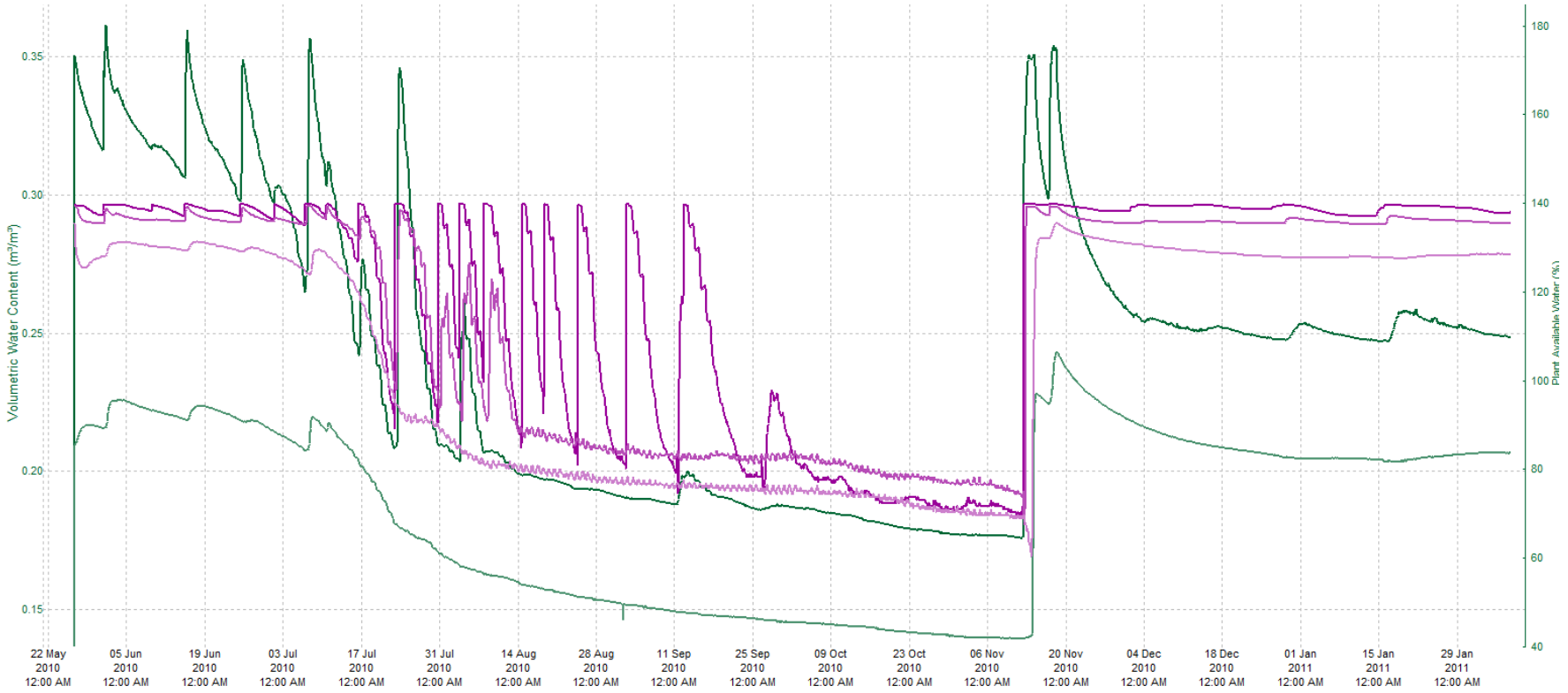
Wine grape irrigation

- 1.6 ha vineyard, red and white
- Irrigation scheduled using ET,
- After bloom complete, irrigated at 80% ET for deficit irrigation
- VWC, EC, and temperature were measured at depths of 0.6 and 1.2 m using Decagon model 5TE sensors.
- WP was measured at depths of 0.6 and 1.2 m using Decagon model MPS-1 sensors.
- Grower did not use soil data during Y1.

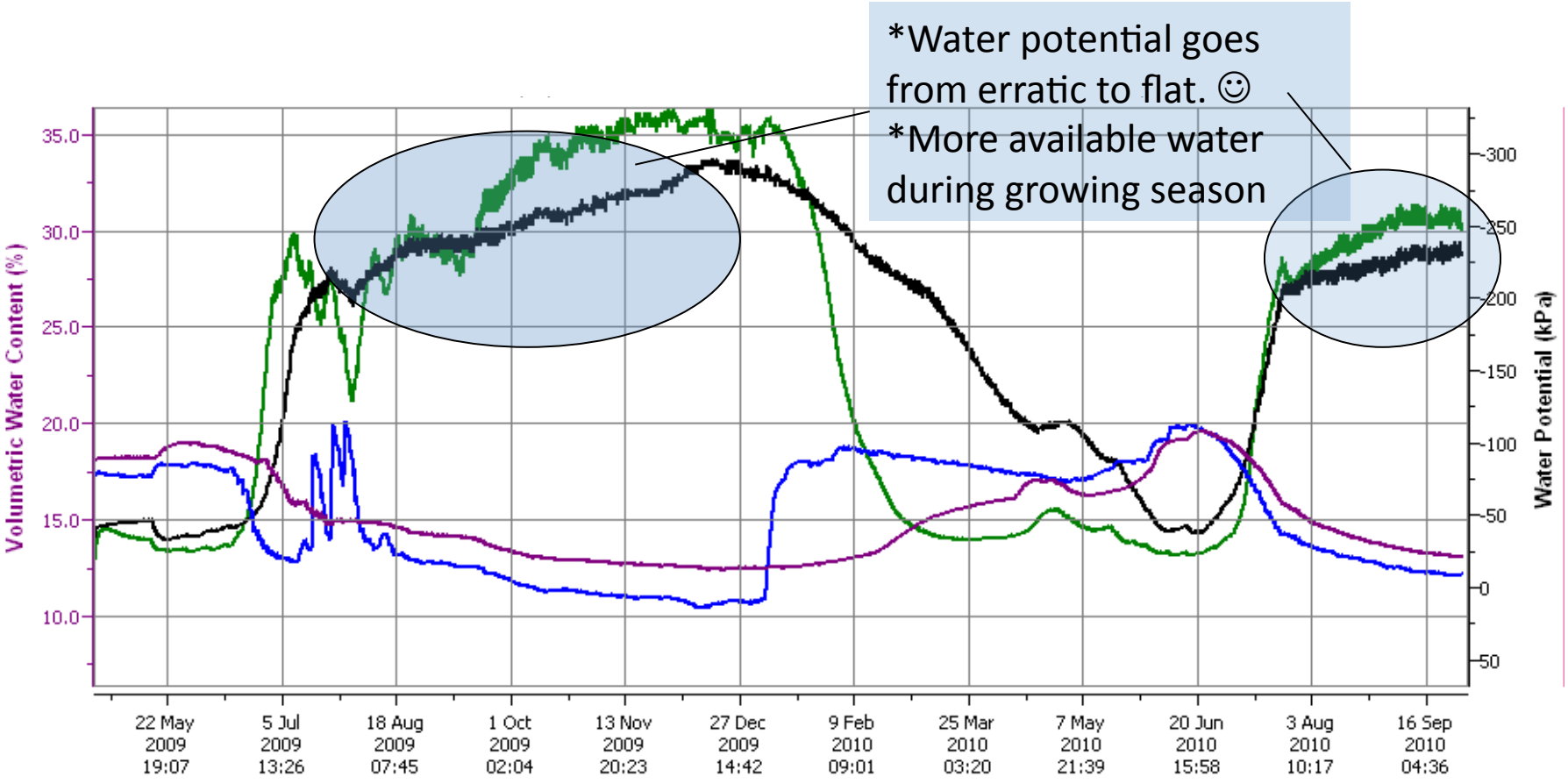

P1
P2
P3 - WC
P3 - ºF (Off)
P3 - Bulk EC (Off)
P4 - WC
P4 - ºF (Off)
P4 - Bulk EC (Off)
P5 (Off)
Volumetric Water Content (%)
35.0
30.0
25.0
20.0
15.0
10.0
Water Potential (kPa)
300
250
200
150
100
50
0
-50
22 May 2009 19:07
5 Jul 2009 13:26
18 Aug 2009 07:45
1 Oct 2009 02:04
13 Nov 2009 20:23
27 Dec 2009 14:42
9 Feb 2010 09:01
25 Mar 2010 03:20
7 May 2010 21:39
20 Jun 2010 15:58
3 Aug 2010 10:17
16 Sep 2010 04:36

Wine grape irrigation changes

- Install additional sensors with Em50G Remote data logger
- Grower to use soils data in addition to ET data to schedule irrigation
- 5TE sensors installed at 0.6 m and 1.2 m.
- MPS-1 sensors installed at 0.3, 0.6, and 1.2 m.

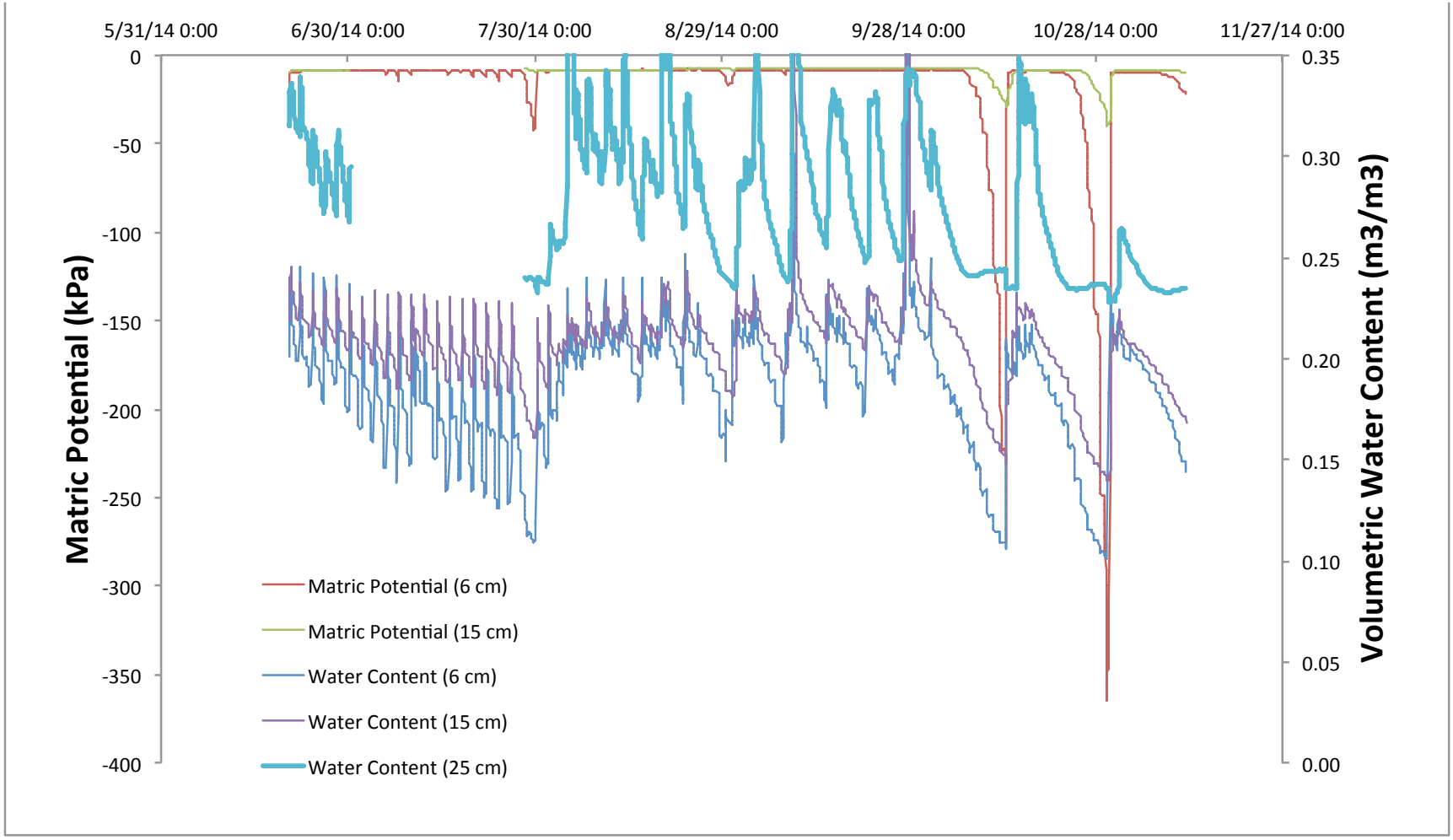

Volumetric Water Content (m³/m³)
0.35
0.30
0.25
0.20
0.15
Plant Available Water (%)
180
160
140
120
100
80
60
40
22 May 2010 12:00 AM
05 Jun 2010 12:00 AM
19 Jun 2010 12:00 AM
03 Jul 2010 12:00 AM
17 Jul 2010 12:00 AM
31 Jul 2010 12:00 AM
14 Aug 2010 12:00 AM
28 Aug 2010 12:00 AM
11 Sep 2010 12:00 AM
25 Sep 2010 12:00 AM
09 Oct 2010 12:00 AM
23 Oct 2010 12:00 AM
06 Nov 2010 12:00 AM
20 Nov 2010 12:00 AM
04 Dec 2010 12:00 AM
18 Dec 2010 12:00 AM
01 Jan 2011 12:00 AM
15 Jan 2011 12:00 AM
29 Jan 2011 12:00 AM

Year to year changes



Turf irrigation

- Turf grown on a playing field in sandy soil
- VWC and WP monitored at 6 cm and 12 cm (using GS3 sensors and MPS-6 sensors)
- VWC monitored at 25 cm using GS3 sensor.


5/31/14 0:00
6/30/14 0:00
7/30/14 0:00
8/29/14 0:00
9/28/14 0:00
10/28/14 0:00
11/27/14 0:00
0
-50
-100
-150
-200
-250
-300
-350
-400
Matric Potential (kPa)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Volumetric Water Content (m3/m3)
Matric Potential (6 cm)
Matric Potential (15 cm)
Water Content (6 cm)
Water Content (15 cm)
Water Content (25 cm)

Poll questions #2

If you are monitoring soil moisture for irrigation management, do your data sets resemble the ones that we've discussed?

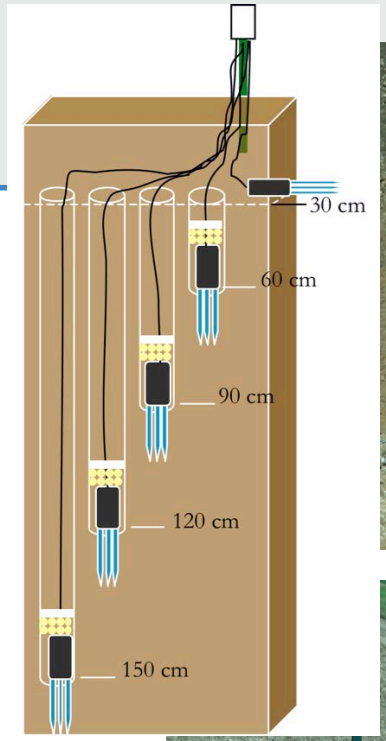
1. Yes
2. No

Dryland wheat soil moisture profile

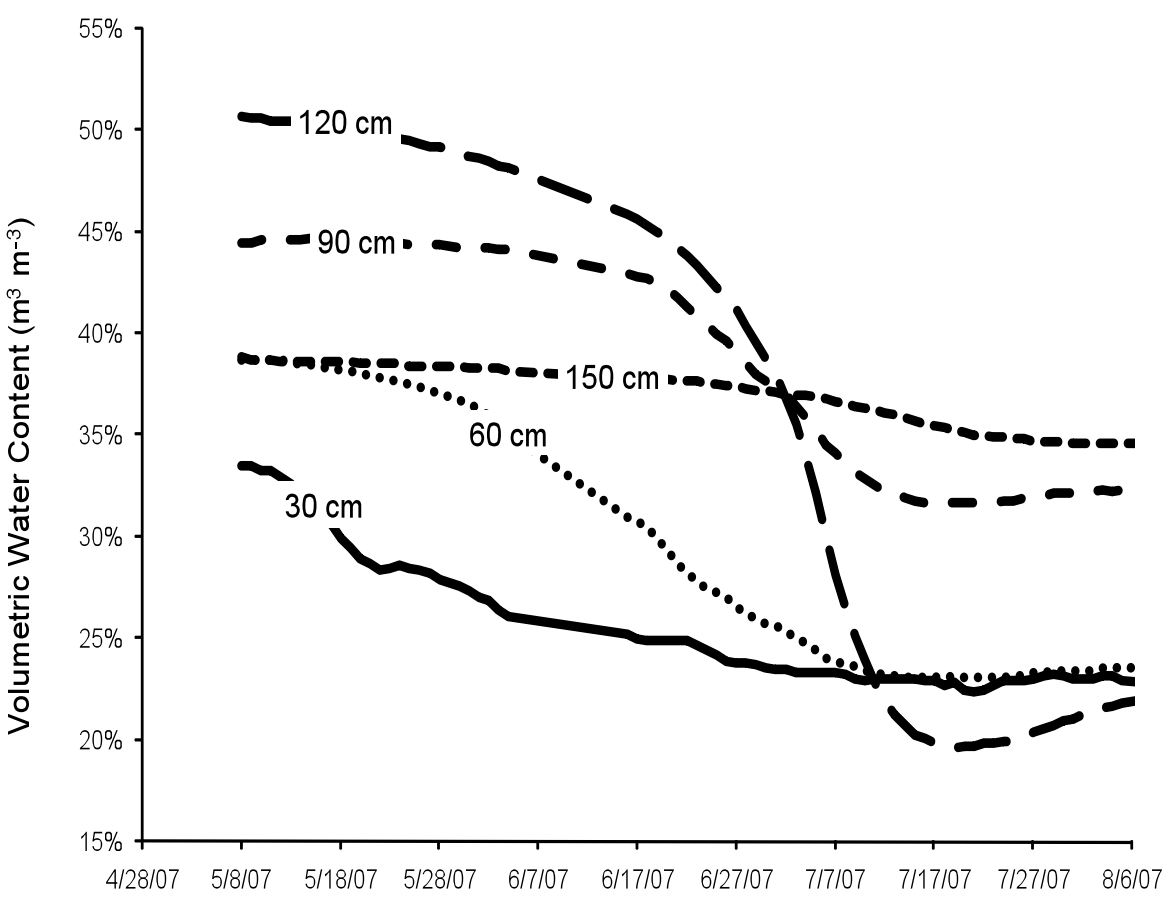
- 37 ha dry-land farm, wheat, barley, legume rotation
- Palouse silt loam, hard pan in places
- 510 mm average precipitation (primarily winter/spring)
- Continuous rotation
- Rolling hills (40 m elevation differences)

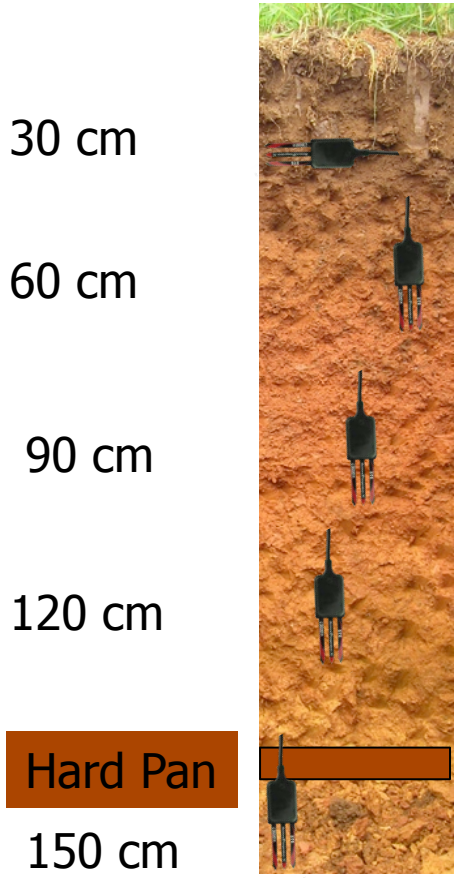
Site description

- Setup
  - 12 sites (expanded to 42 in 2009)
  - 5 depths at 30 cm increments
  - VWC, EC, temperature sensors
- Installation
  - 30 cm sensor: trench sidewall
  - 60 – 150 cm sensors: Inserted into bottom of 5 cm auger hole
  - Soil repacked

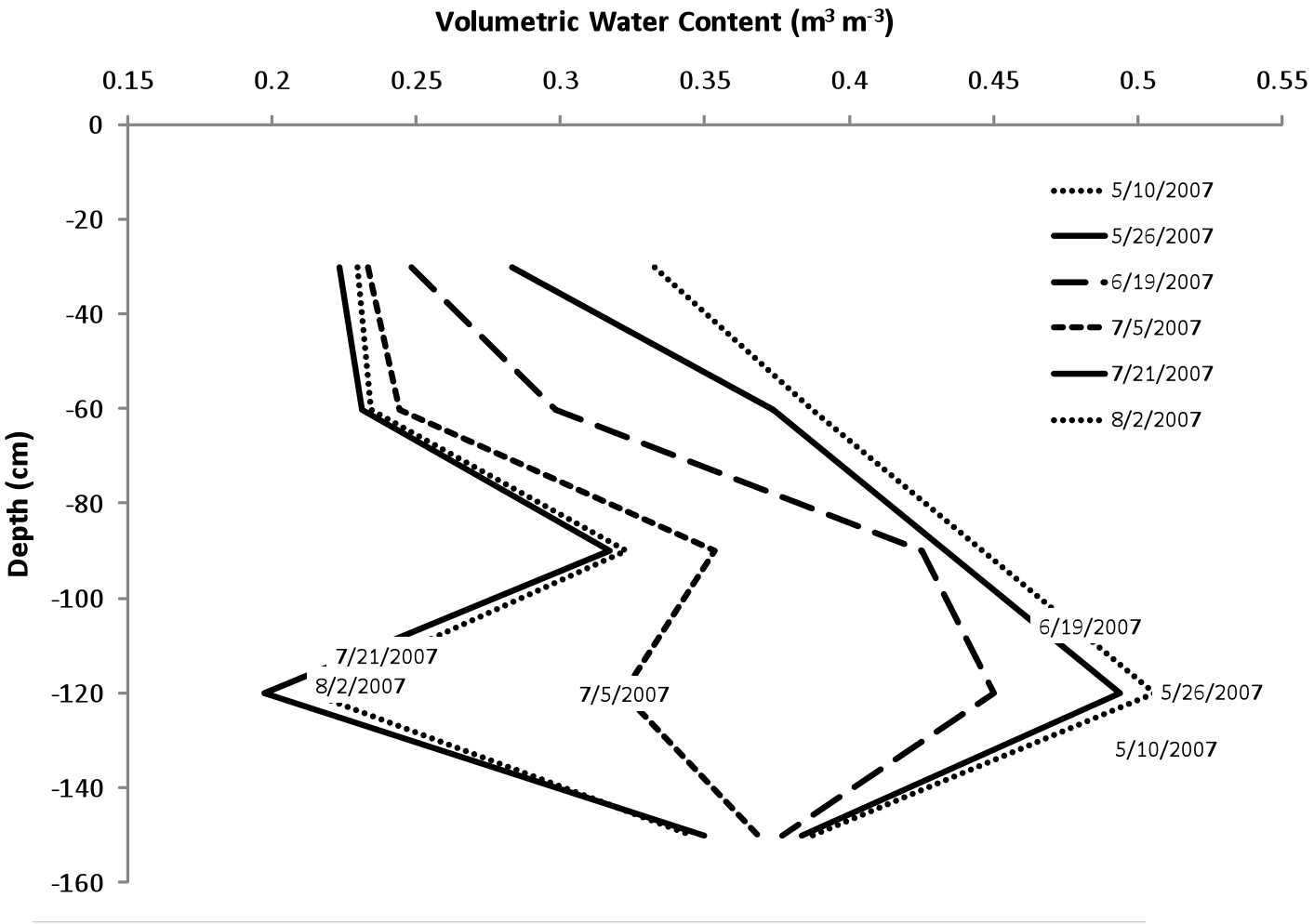


Site 1 Dry-down: Winter wheat, hilltop site

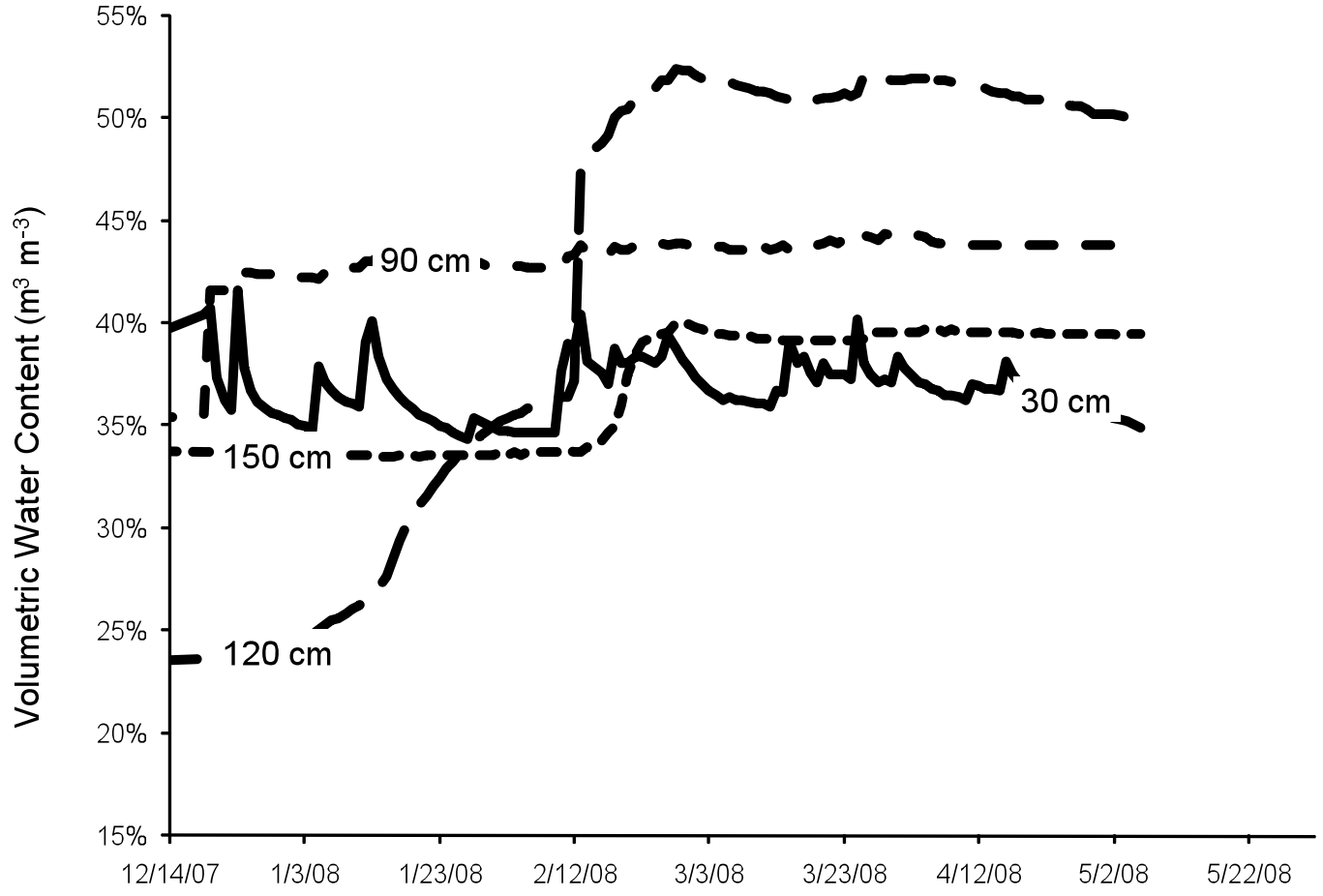




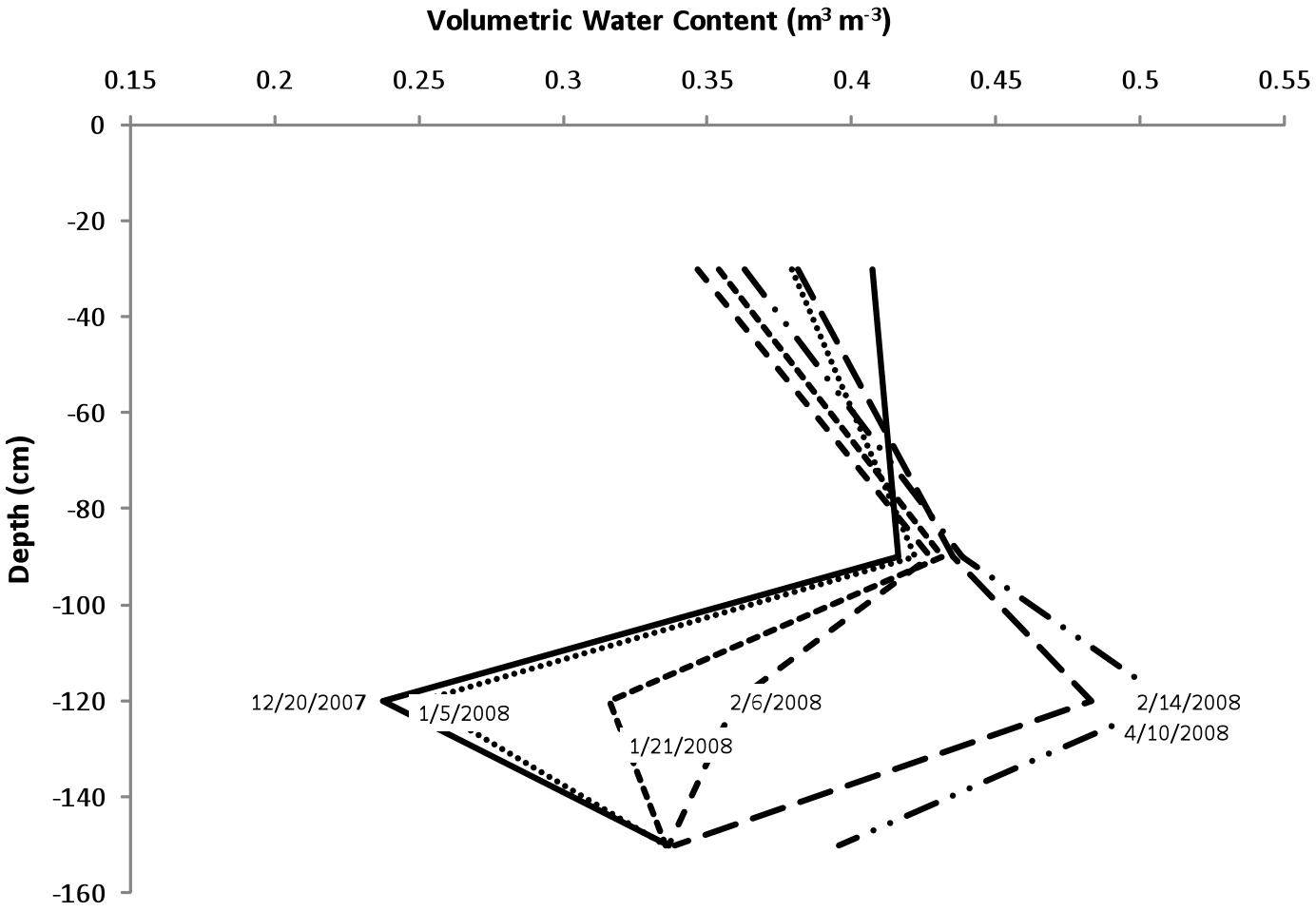
Site 1 Dry-down: Water use by depth



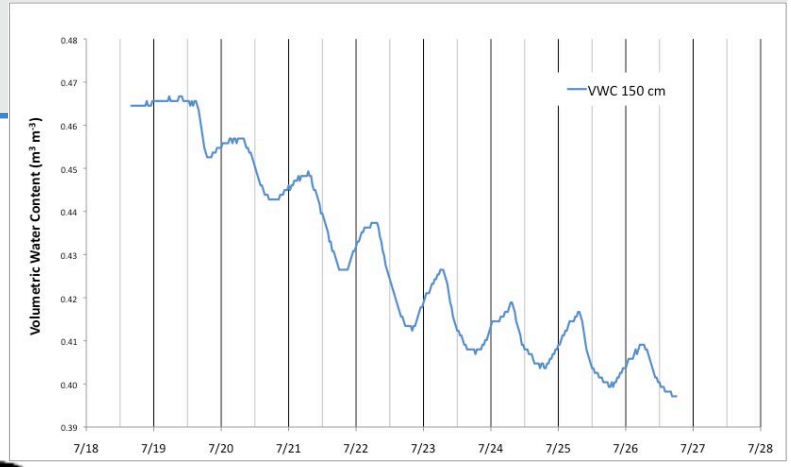
Site 1 Wet-up

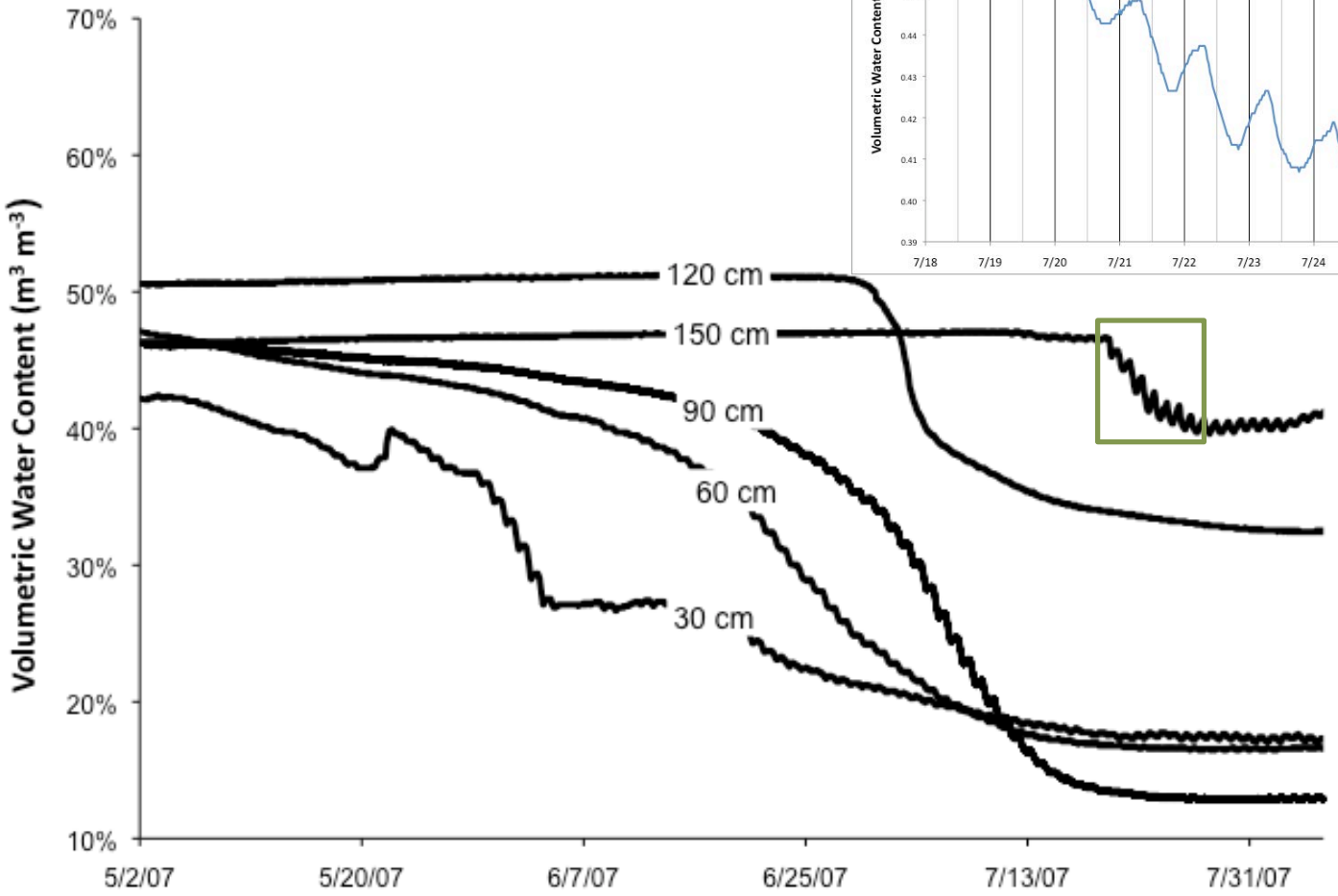

Volumetric Water Content (m3 m-3)
55%
50%
45%
40%
35%
30%
25%
20%
15%
12/14/07
1/3/08
1/23/08
2/12/08
3/3/08
3/23/08
4/12/08
5/2/08
5/22/08
90 cm
30 cm
150 cm
120 cm

Wet-Up: Water use by depth



Site 3: Diurnal fluctuations at toe slope site)



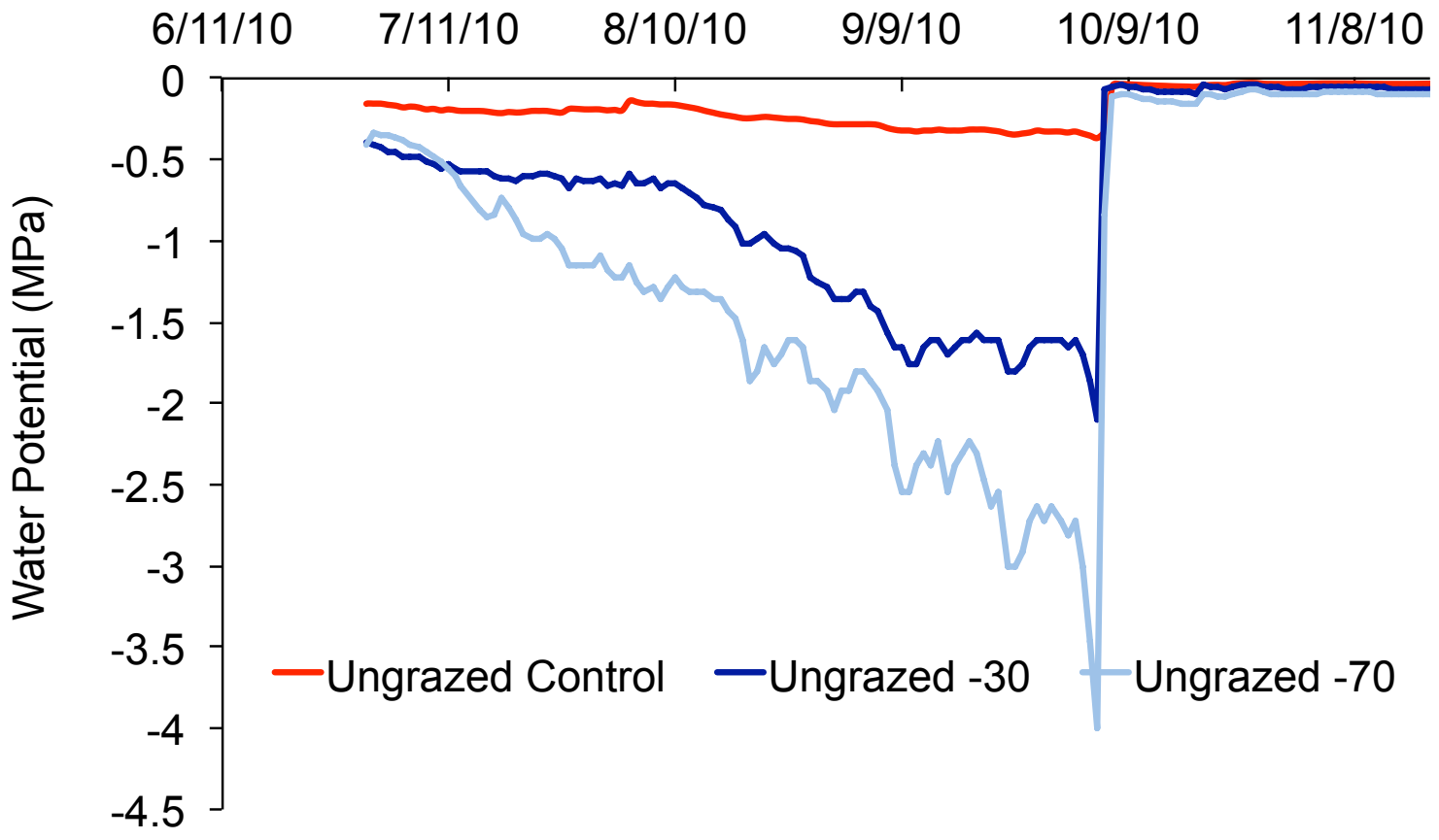


Rangeland soil moisture on the Wasatch Plateau (Utah)

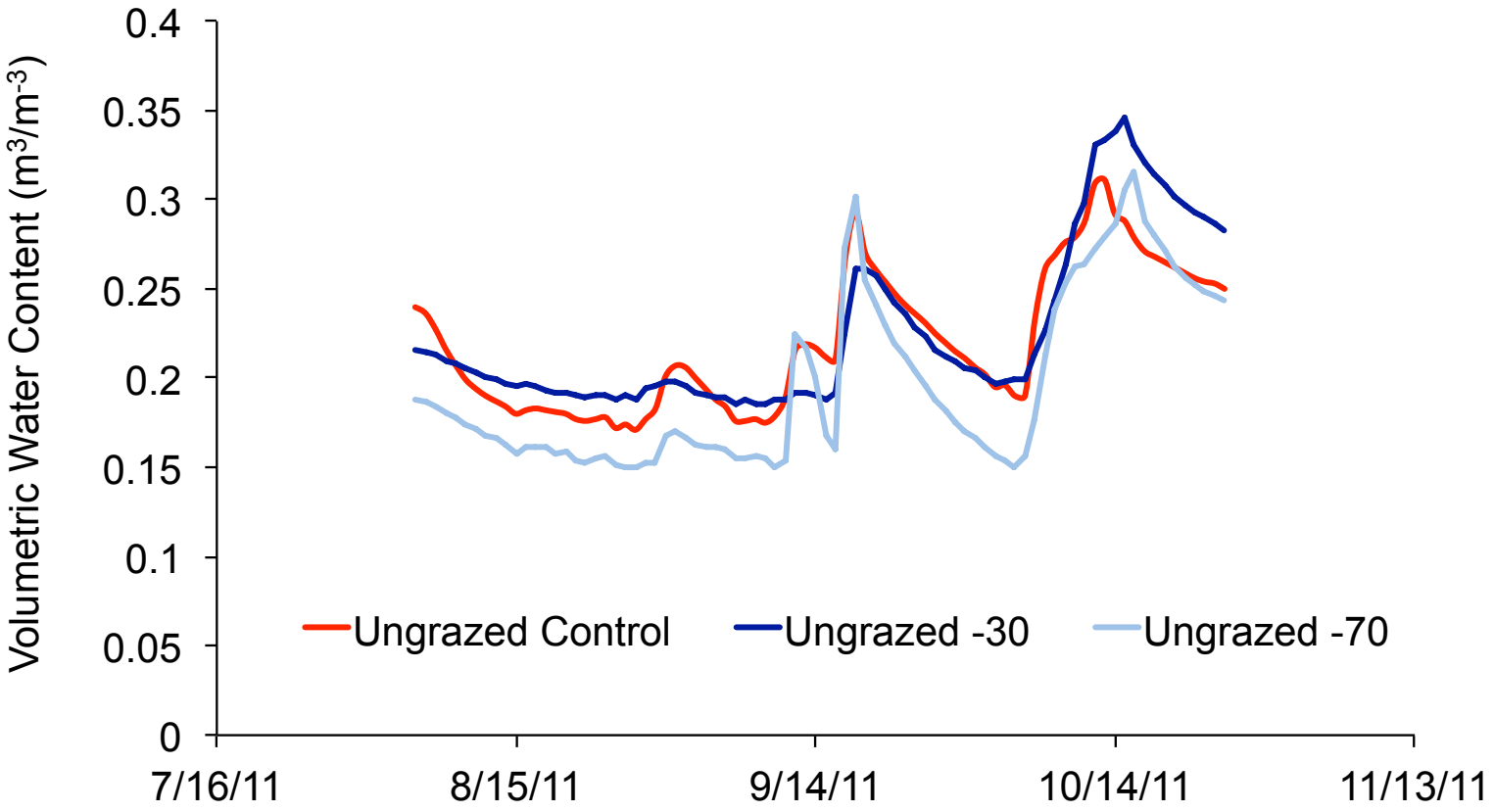
- Grazing exclosures and rainout shelters
- Volumetric water content and water potential monitored at each site (using GS3 and MPS-2 senors)

Data courtesy of Richard Gill, Brigham Young University

Precipitation treatment effect on water potential (2010)



Precipitation treatment effect on water content (2011)



Poll question #3

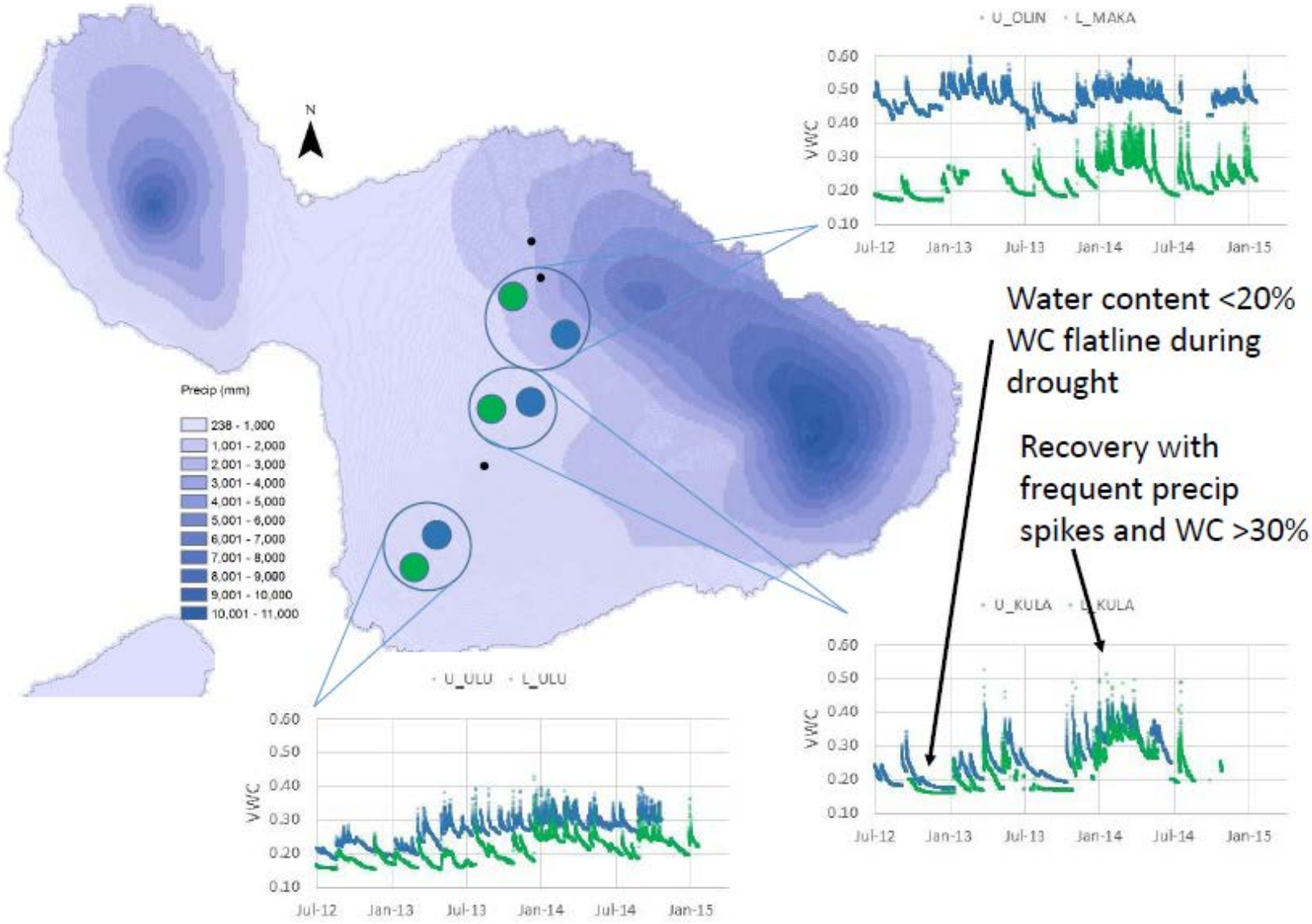
Do you have a preference for monitoring soil moisture?

1. Volumetric water content
2. Water potential

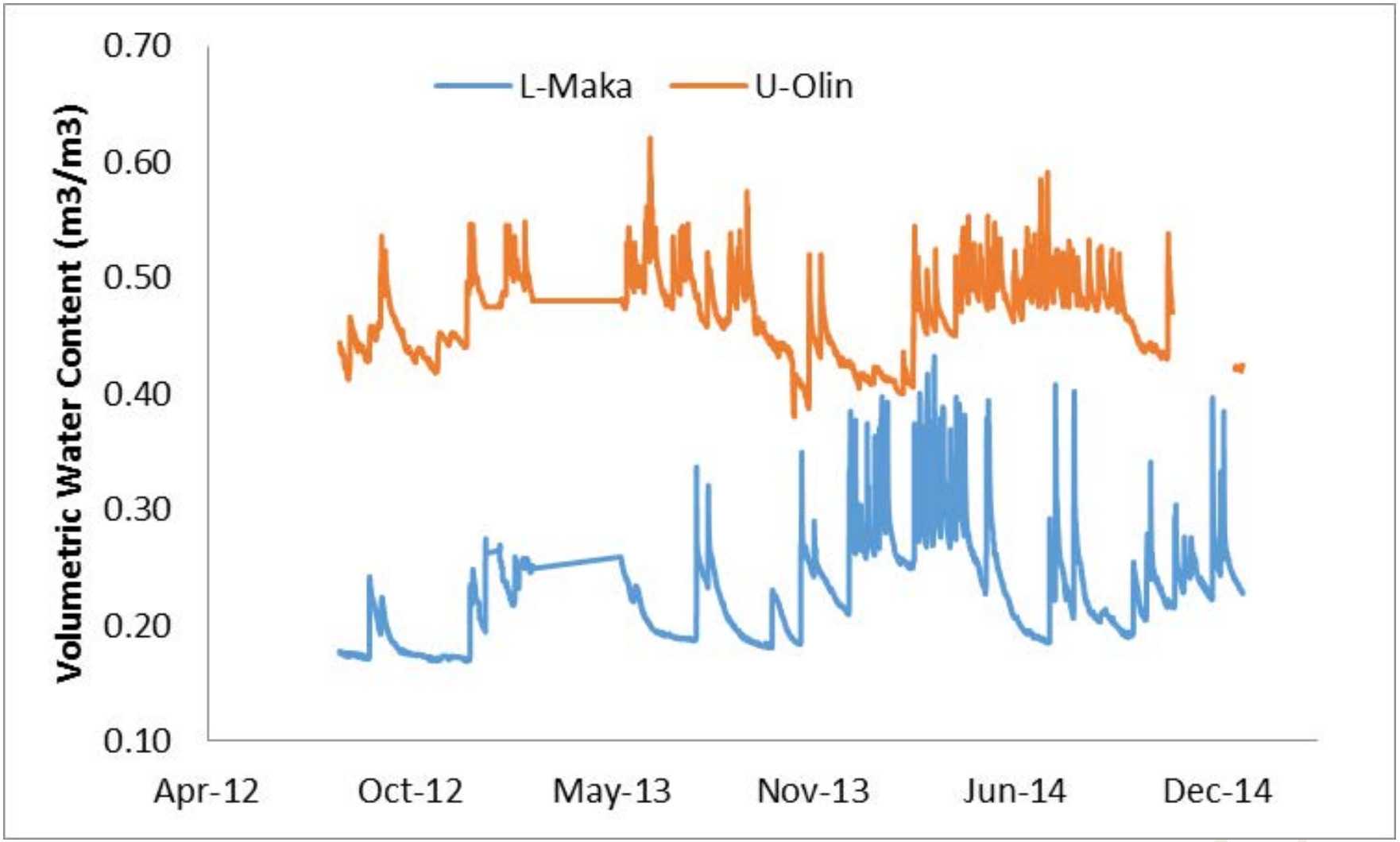
Rangeland soil moisture along the Kula belt (Hawaii)

- Andisols at lower elevation sites with hydric soils at higher elevation sites
- Kikuyu grass growing as primary forage source for domestic grazing
- Monitoring to help determine best times to graze animals without causing overgrazing
- VWC sensors placed under grass in areas that are protected from grazing.

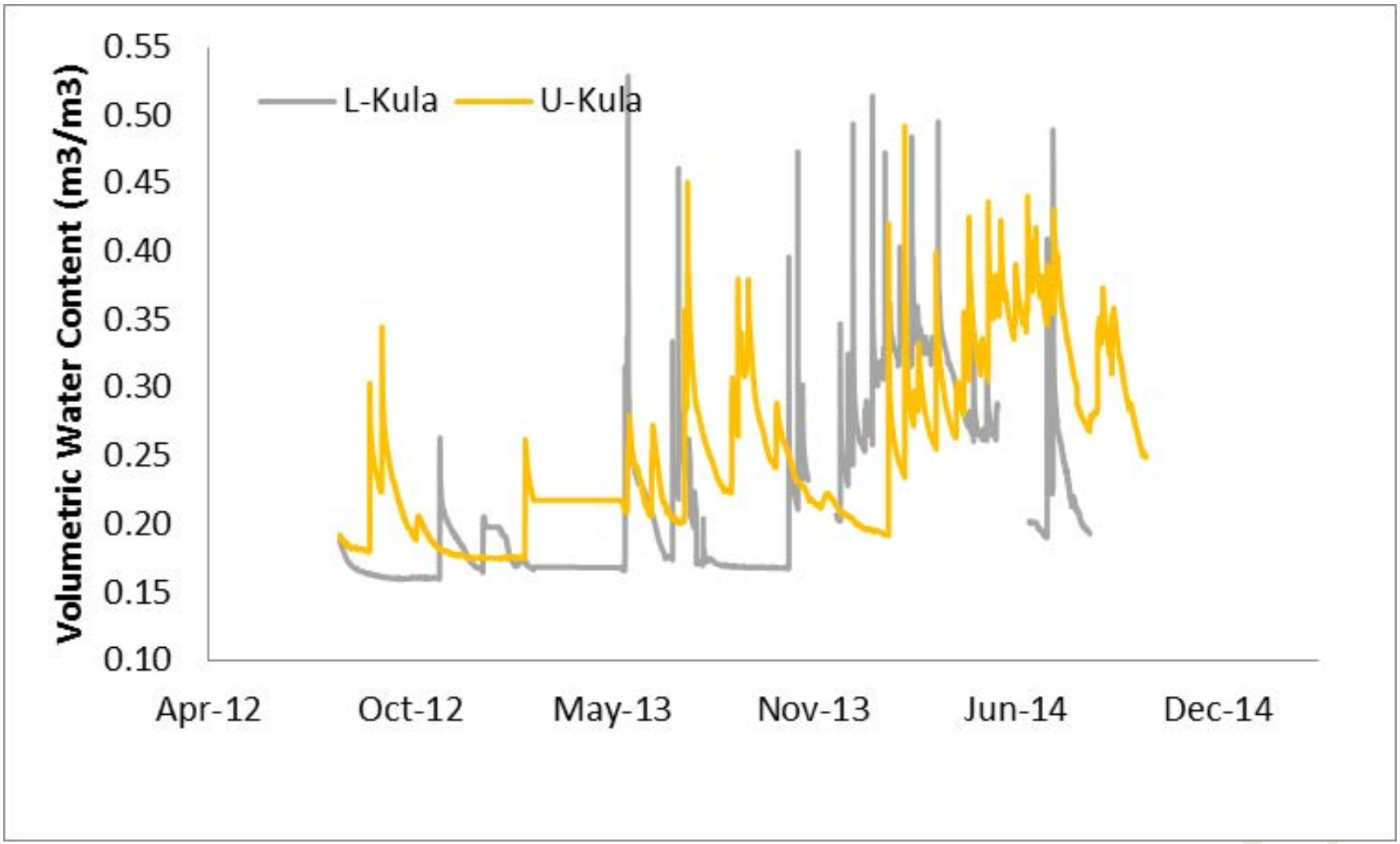
Data courtesy of James Leary and CTAHR Maui County Cooperative Extension Service


N
Precip (mm)
238 - 1,000
1,001 - 2,000
2,001 - 3,000
3,001 - 4,000
4,001 - 5,000
5,001 - 6,000
6,001 - 7,000
7,001 - 8,000
8,001 - 9,000
9,001 - 10,000
10,001 - 11,000
U_OLIN
L_MAKA
VWC
0.60
0.50
0.40
0.30
0.20
0.10
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Water content <20%
WC flatline during drought
Recovery with frequent precip spikes and WC >30%
U_KULA
L_KULA
U_ULU
L_ULU

Temperature gradient



Drought recovery



Thank you for sharing!

- Larry Parsons and University of Florida
- Water & Earth Sciences (www.waterearthsciences.com)
- Lab Ferrer (www.lab-ferrer.com)
- Umiker Vineyards (www.clearwatercanyoncellars.com)
- Richard Gill and Brigham Young University
- James Leary and CTAHR Maui County Cooperative Extension Service

QUESTIONS?

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