BEST PRACTICES

Soil Moisture Field Measurements

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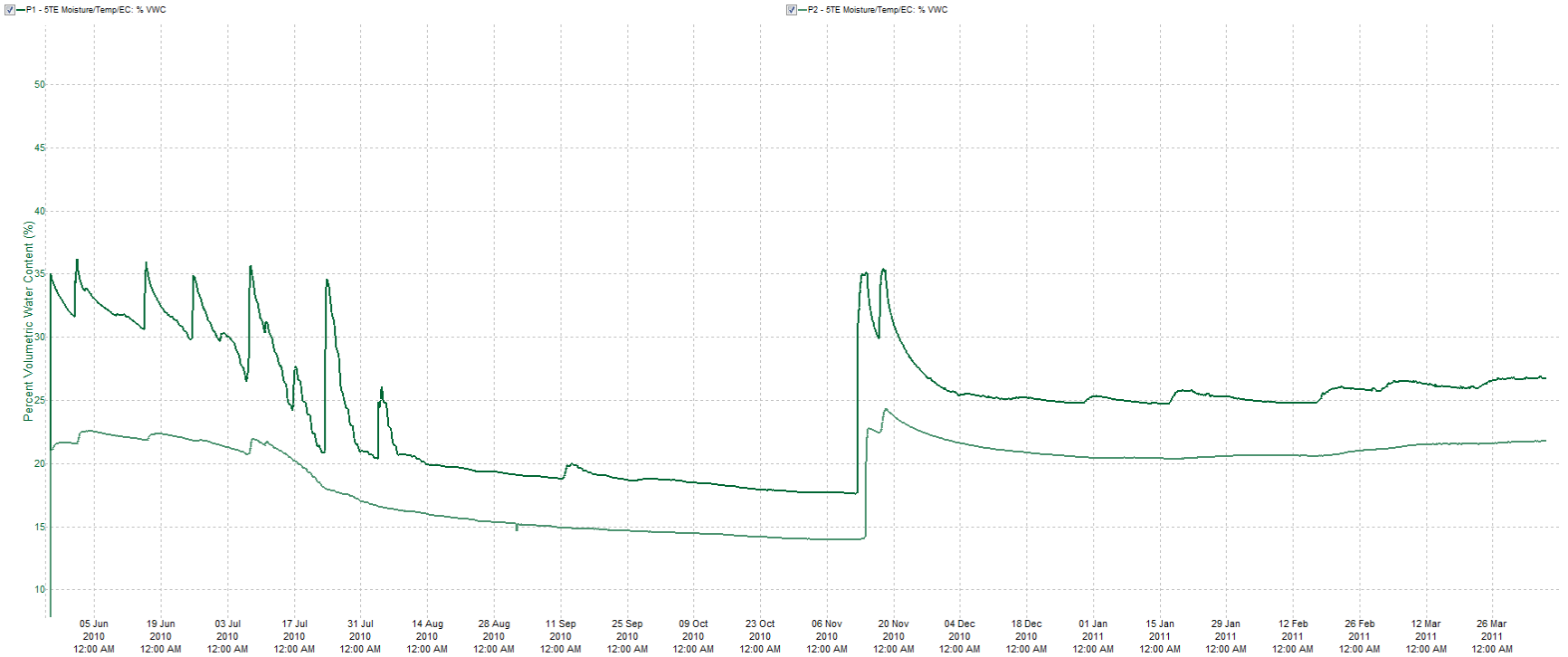
Goal: Usable data for the duration of the study



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What is “usable”?

- **Site characterization:** Enough is known about the site to interpret the data
- **Sensor location:** Sensors are installed in a location to address goals (both in a location and in the profile)
- **Sensor installation:** Sensors are installed properly to measure water content of the soil
- **Data collection:** Sensors and logger are protected to maintain continuous data record
- **Data dissemination:** data can be understood by other scientists

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How do we make sure we're going to have "usable" soil moisture data?

- Pre-installation sensor testing
- Proper site selection for soil moisture measurements
- Necessary site data
- Installation techniques
- Maintenance and data collection
- Data interpretation
- Sharing data

Poll question #1

What's the most important consideration in getting "usable" soil moisture data?

- Good installation- no air gaps between the soil and the sensor
- Necessary site data
- Maintenance and data collection
- Type of calibration used

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Pre-installation

- **Sensor output**
  - Play with sensors and data loggers with some soil in your lab- *do you need to do a custom calibration?*
  - Become familiar with the type of data the sensors take
- **Logger function**
  - Configure the logger in the lab to make sure you have everything you need

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Site Selection

- Clearly define your goals for data collection
  - Irrigation scheduling or purely monitoring?
- **What causes spatial variability in soil moisture?**
  - **Treatment to treatment variations**
  - **Land forms**
  - **Depth variation**
  - **Soil type and soil density**
  - **Proximity to roots vs open spaces**
  - **Canopy effects (both for evaporation and precipitation interception)**
  - **“Random”**
- Data retrieval considerations
  - Wireless retrieval may require line of site or cellular coverage
  - Can you get the data when you need the data

Sources of Variation: How many sites?

Sources of Variation: What depths?

Things to remember

- Moisture dynamics in the profile
- Soil type and density changes over depth
- Root depth

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Help determining where and how much to monitor

- Make a plan BEFORE you go out into the field
- It never hurts to monitor more; you may just not use all of your data (which is amazingly common)
- Call our application support specialist at Decagon or talk to your local representative if you have questions or want some additional advice

Chris Chambers, our application support specialist and resident good listener can be reached at support@decagon.com.

Necessary Site Data

Follow the Site Characterization Worksheet

- Soil type
- Soil density
- Cover type
- Is there an irrigation system? What type? How much water is applied?
- Notes on why site was picked
- Upcoming events that may affect data collection
- Which sensors at what depths

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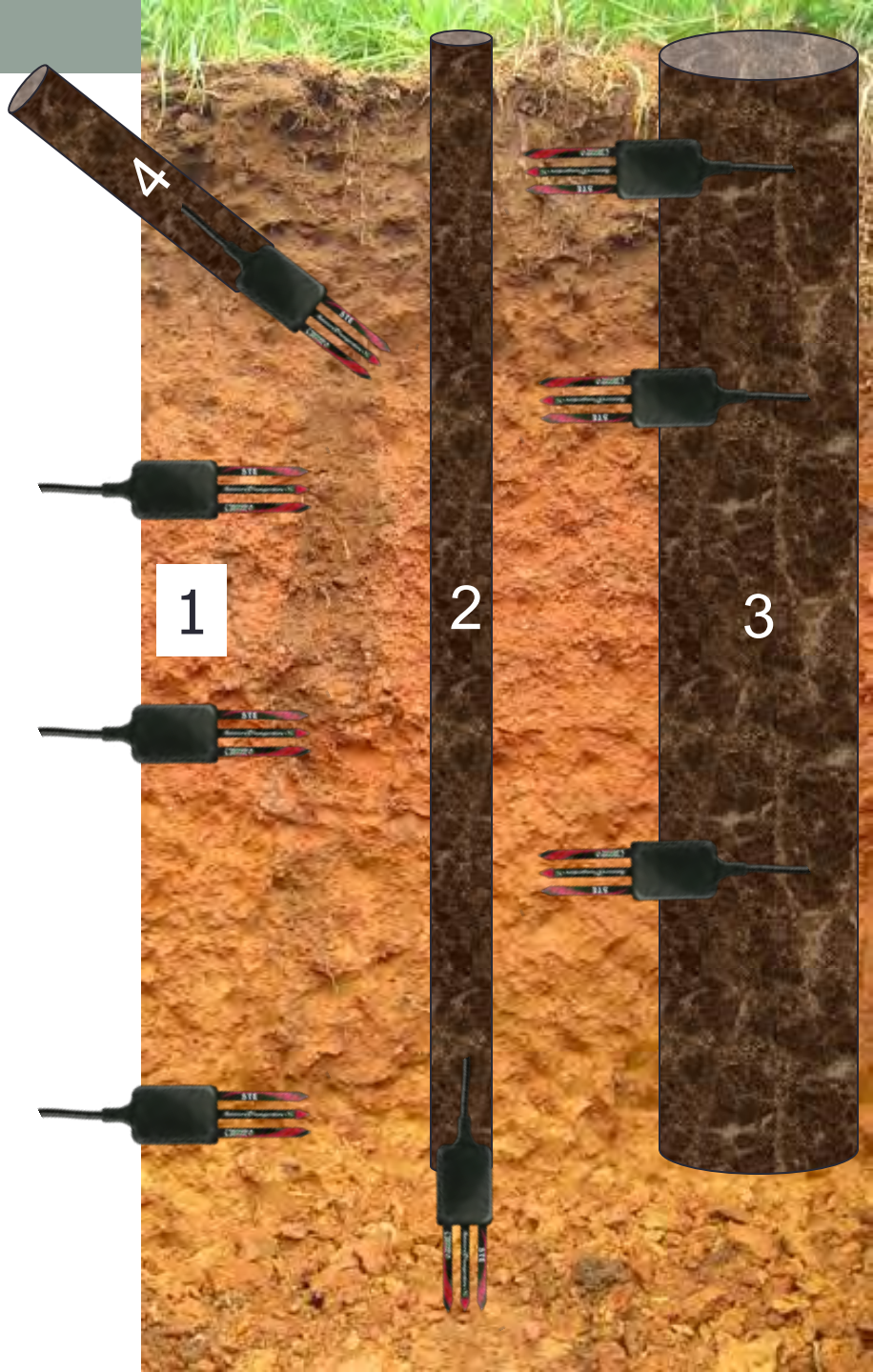
Installation

(the most important step in getting usable soil moisture data)

Goal: Good soil-to-sensor contact

- Many techniques for sensors installation
  1. Trench wall
  2. 5 cm auger hole: bottom
  3. 10 cm auger hole: side wall
  4. 45^{o} angled 5 cm auger hole: bottom
- Sensor insertion
  - Sensor width must be vertical not horizontal
- Avoid:
  - Air gaps
  - Big rocks
- Use a ProCheck device (instantaneous sensor readings) to check readings to confirm a good installation/no air gaps



Installation Documentation

On each sensor include:

- Type of sensor
- Depth sensor installed
- Any other information that you feel may be relevant

Sensors labels can be hand-written or electronically generated

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Maintenance and data collection

Maintenance and Data Collection

- Make a plan for checking up on your data
  - Newer cellular capabilities (Em50G logger) allow you to automatically receive data daily
  - Get out in the field often if you can't receive the data remotely
  - Remember Murphy's law and plan accordingly

Current Status

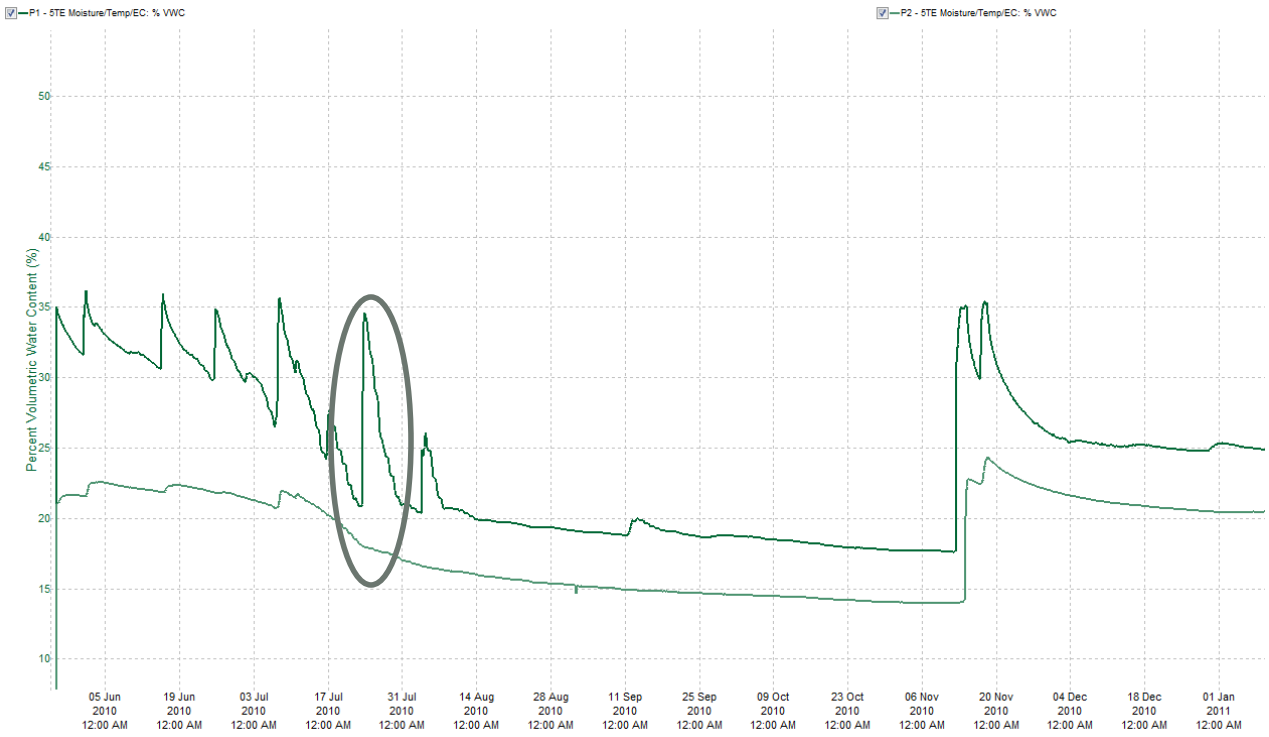
- *Pre-installation sensor testing*
- *Proper site selection for soil moisture measurements*
- *Necessary site data*
- *Installation techniques*

Coming…

- Maintenance and data collection
- Data interpretation
- Sharing data

Data interpretation

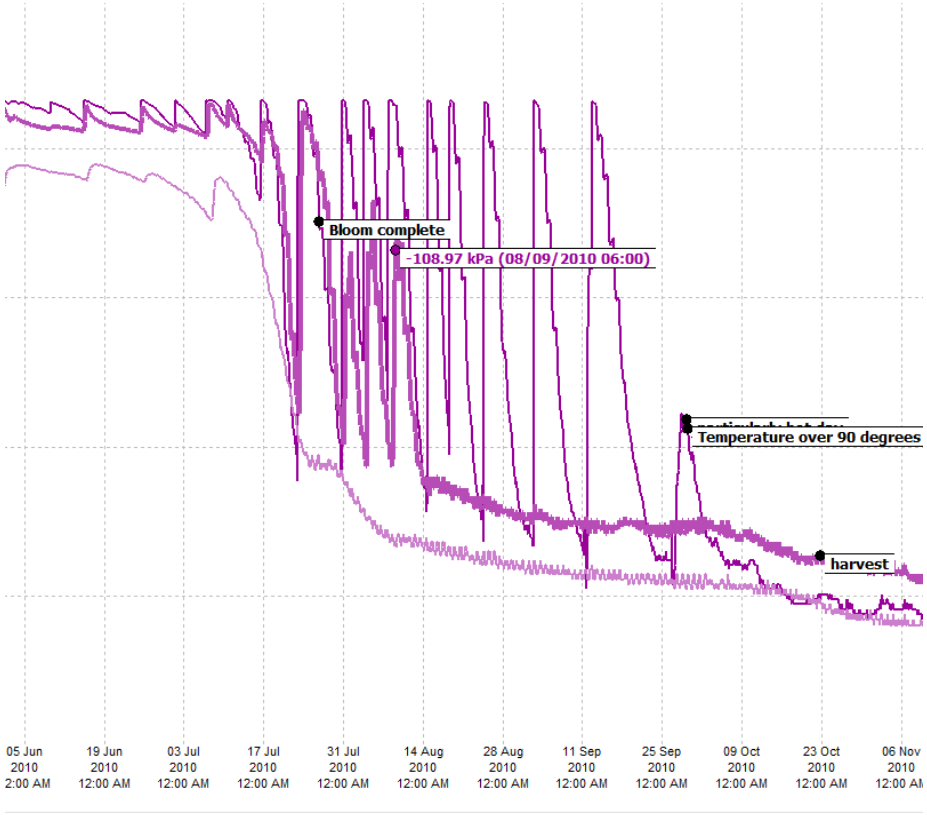
- Sensors installed in a vineyard with drip irrigation
- Both soil moisture sensors are directly under 4.2 liter/hr
- Dark green soil moisture sensor is at **30 cm depth**
- Light green soil moisture sensor is at **60 cm depth**
- Peak in oval was irrigated 30 hours



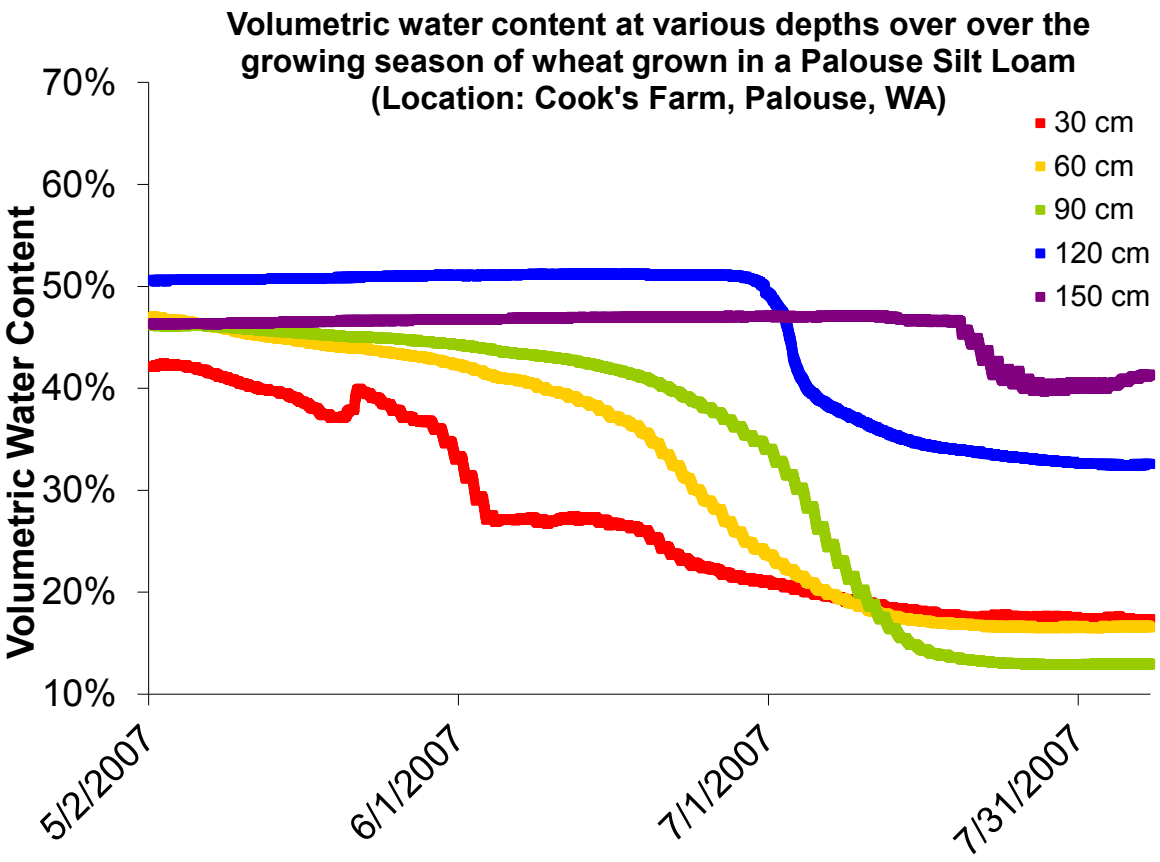
Poll Question #3: Why does soil moisture at 60 cm never change?

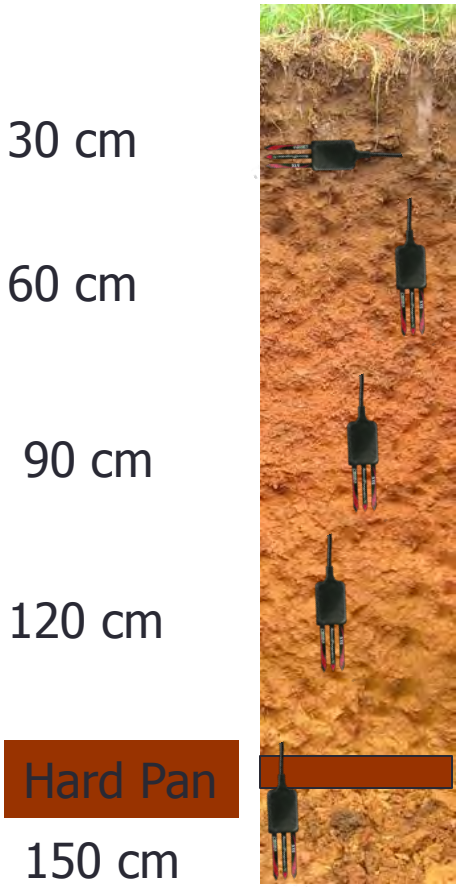
Data interpretation

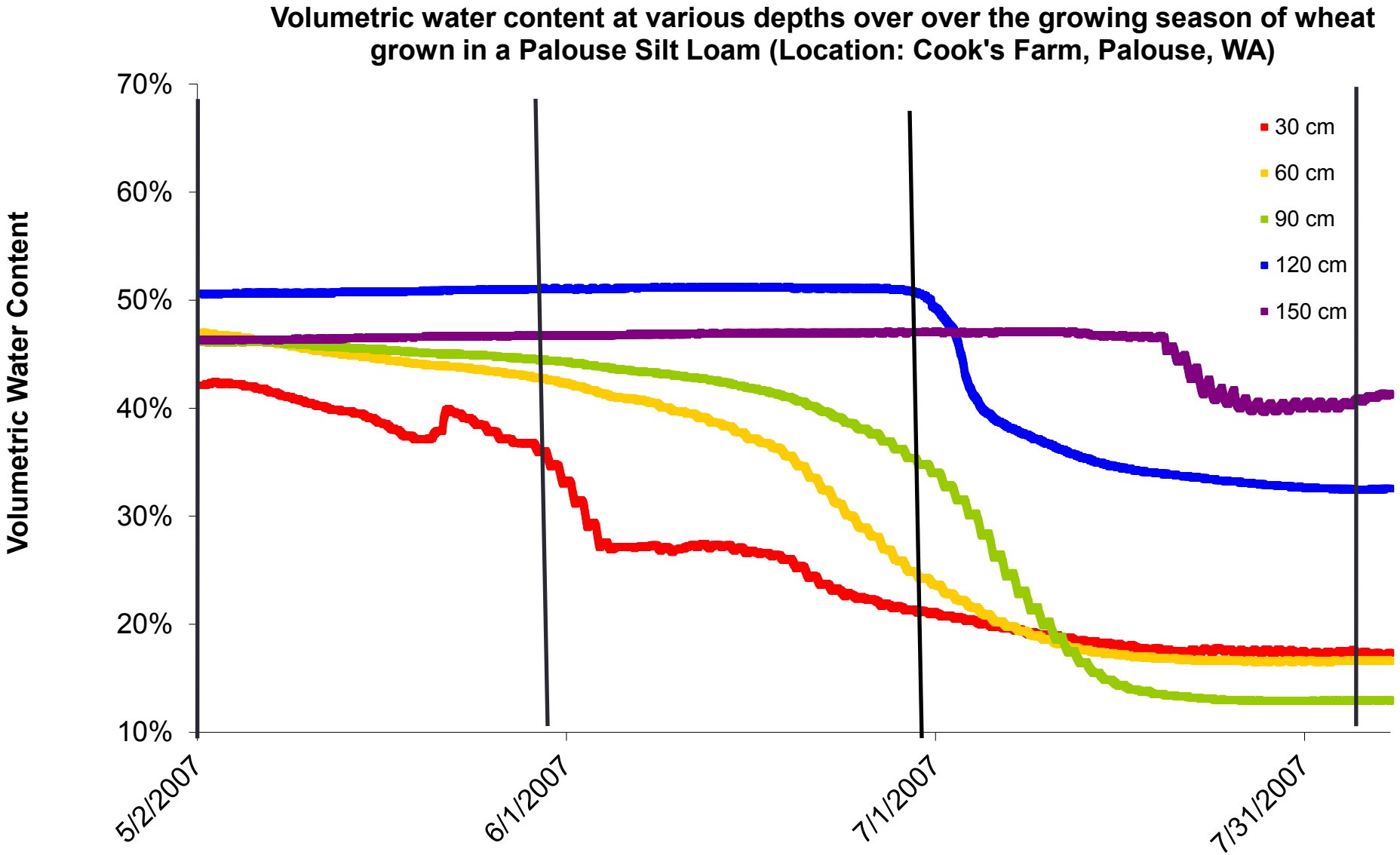
- Many different interpretations for the same data set
- Don’t wait until the end of the season
- Revisit your goals and see what you can learn from the data
- Think of different ways to view the data

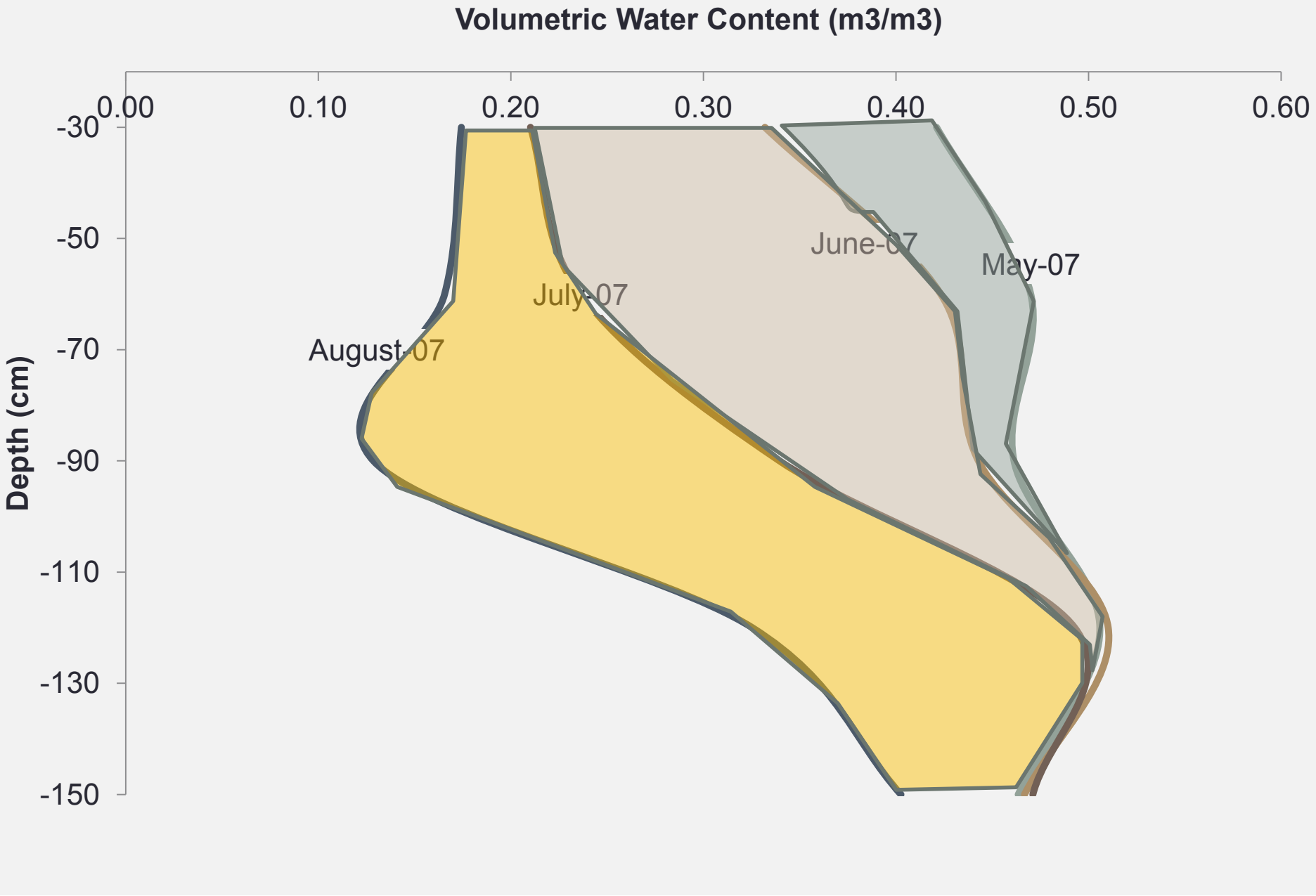


Data interpretation: Traditional temporal data

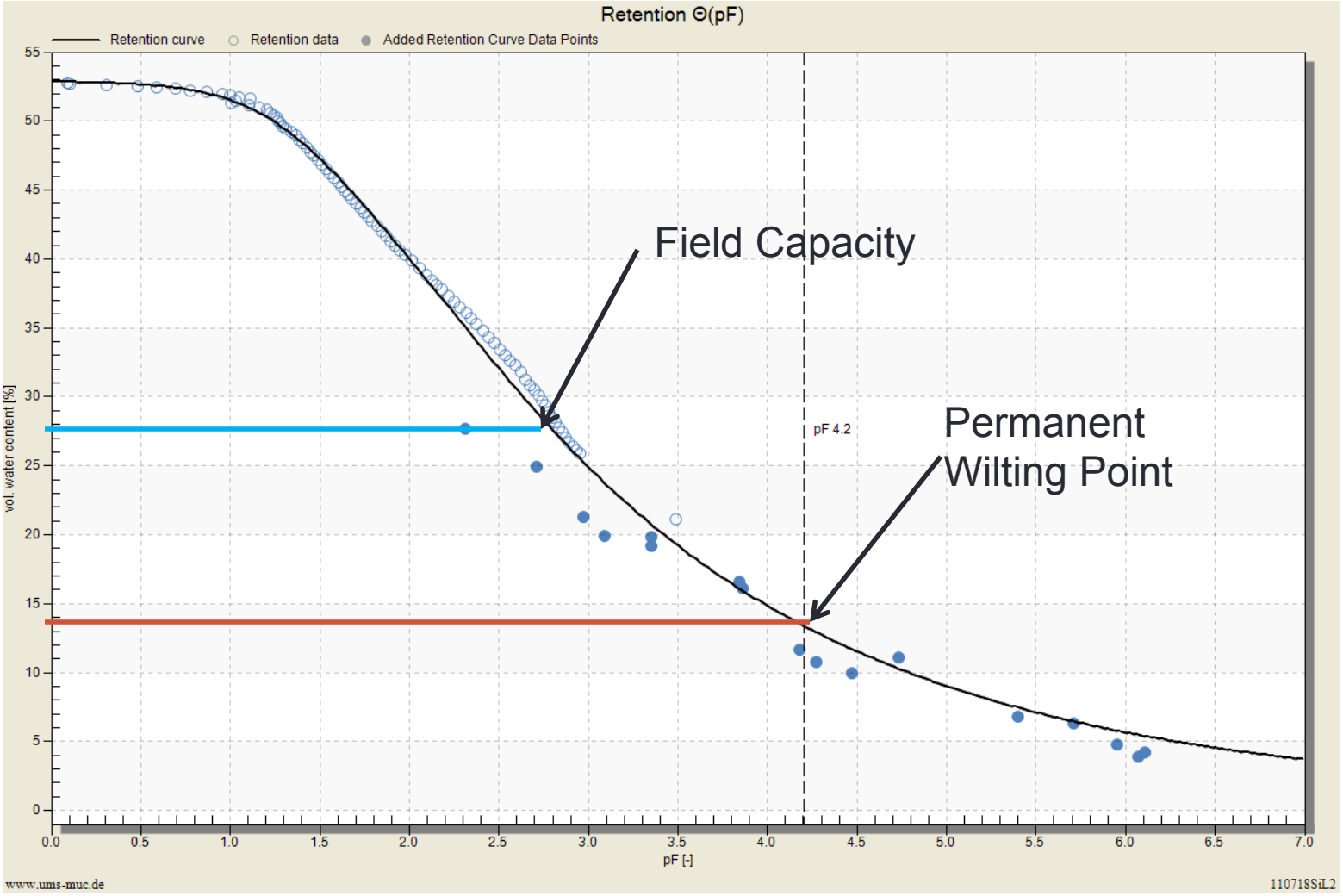


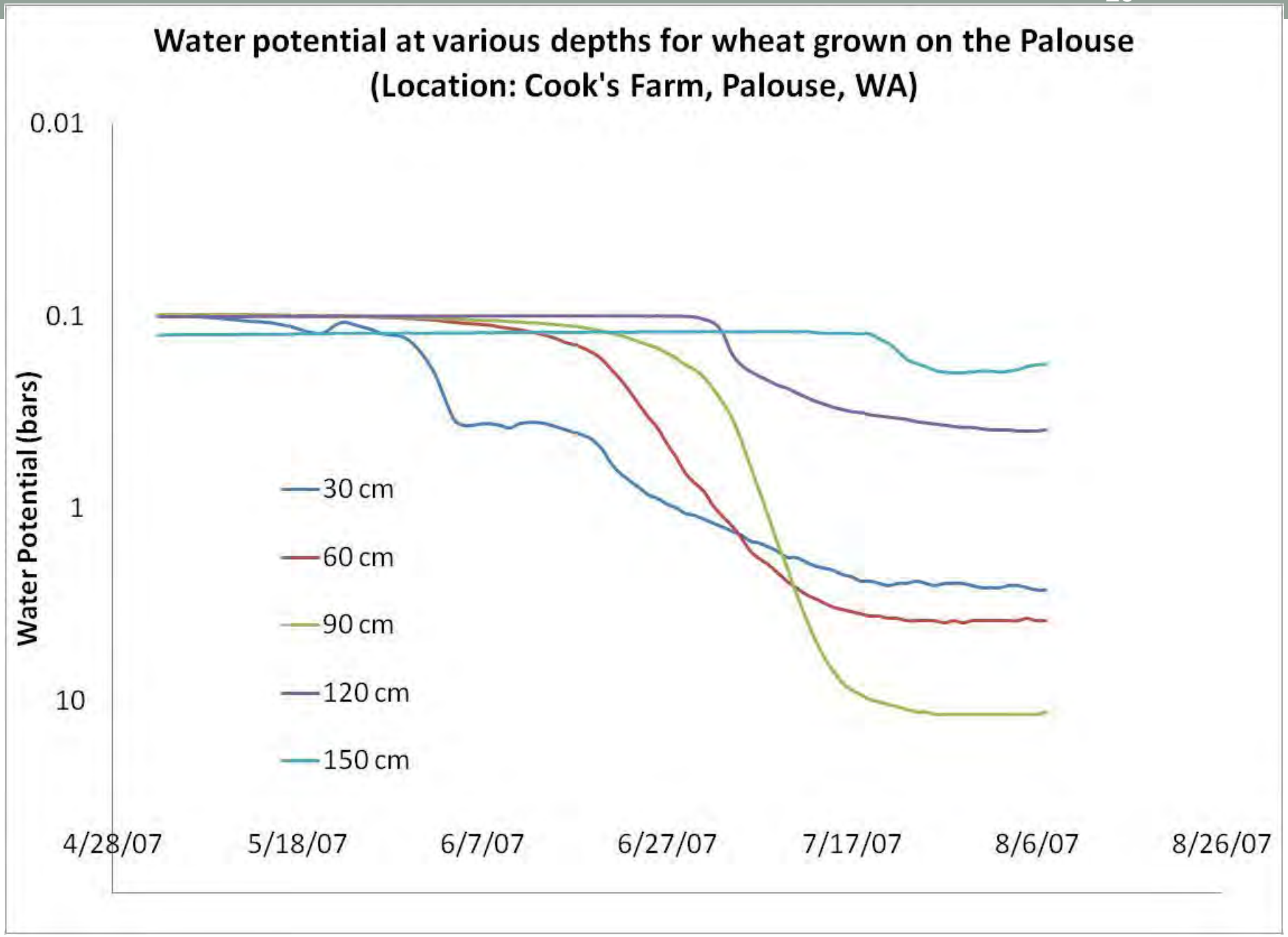



Volumetric water content at various depths over over the growing season of wheat grown in a Palouse Silt Loam (Location: Cook's Farm, Palouse, WA)
Volumetric Water Content
70%
60%
50%
40%
30%
20%
10%
5/2/2007
6/1/2007
7/1/2007
7/31/2007
30 cm
60 cm
90 cm
120 cm
150 cm


Volumetric Water Content (m3/m3)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Depth (cm)
-30
-50
-70
-90
-110
-130
-150
May-07
June-07
July-07
August-07

Moisture Characteristic Curve-Palouse Silt Loam (made with HyProp and Wp4C)




Water potential at various depths for wheat grown on the Palouse
(Location: Cook's Farm, Palouse, WA)
Water Potential (bars)
0.01
0.1
1
10
30 cm
60 cm
90 cm
120 cm
150 cm
4/28/07
5/18/07
6/7/07
6/27/07
7/17/07
8/6/07
8/26/07

Sharing Data or Publishing Data

What information would another scientist need to replicate or use your data?

- Type of sensor used
- Measurement interval
- Soil information (which was recorded on your site characterization worksheet)
- Depth of sensors
- Raw data and calibration used to get water content

Conclusions

- A good installation is the most important component of good sensor data
- Play with instrumentation before you go out into the field
- Document site and installation characteristics
- Protect your logger and sensor cables
- Have a plan for data collection; utilize wireless data collection when possible for easy data collection and assurance that you'll catch problems
- Don't get discouraged if you can't initially understand the data; ask for help from colleagues or experts
- End results will be data you can make decisions with

Questions?

Contact me at lauren@decagon.com

Applications and data interpretation questions can go to either myself or support@decagon.com

Questions will be posted on our forum under “soil moisture”

www.decagon.com/forums

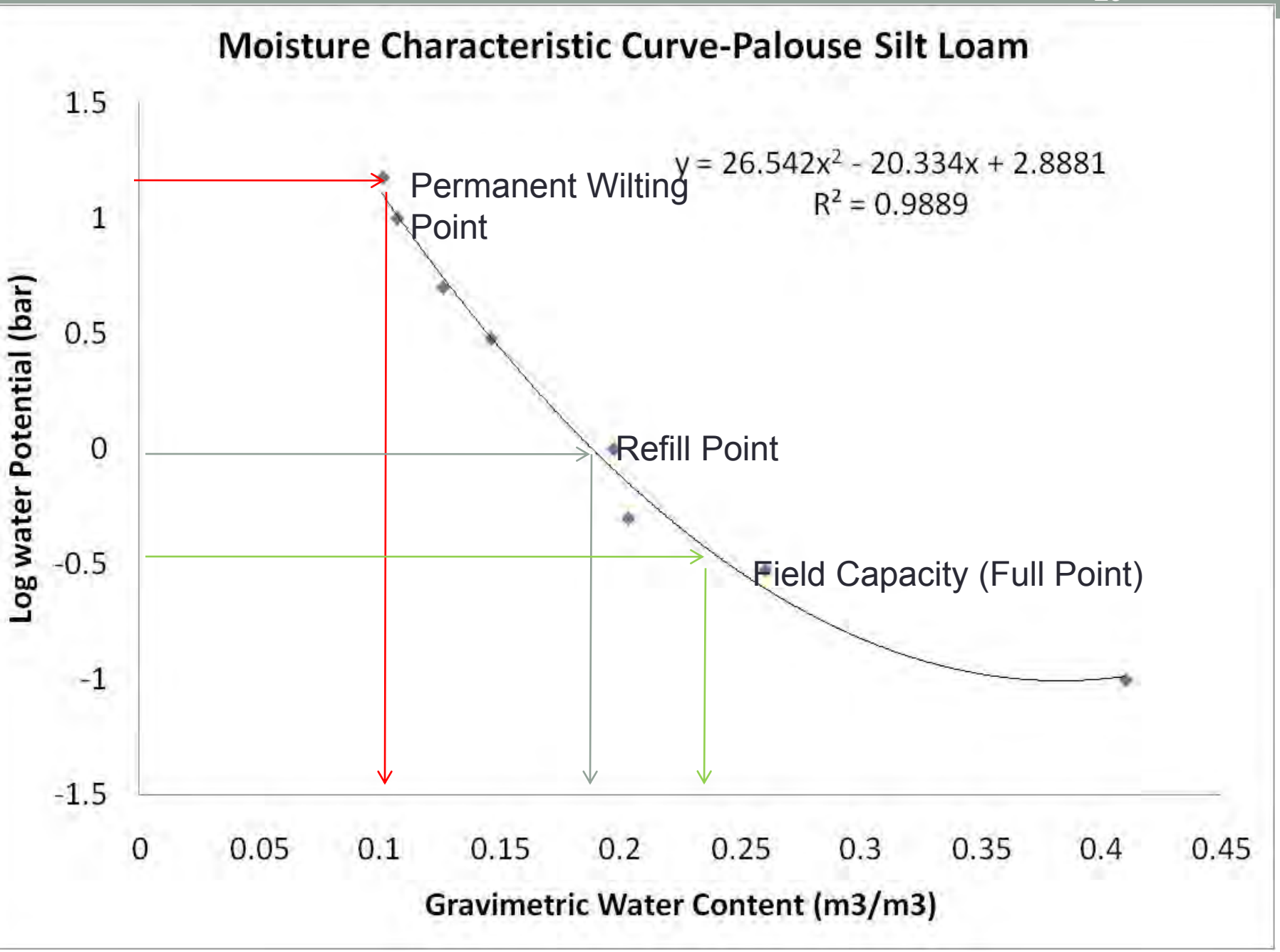
Example: Monitoring Irrigation

Goal: Determine when to turn the water on and when to turn the water off?

- Drip Irrigation, carrot crop
- Independent irrigation zones by organized by crop

Example: Irrigation study

- Goal: When do I turn the water on and when do I turn it off?
  - Sources of variation:
    - **Land forms: I only want to monitor what I can control. One monitoring site per zone**
    - **Depth variation: one sensor in root zone and another below If irrigation water is getting below root zone, too much is being added**
    - **Soil type and soil density: will matter in data interpretation, but you can't change the amount of water added to different areas with different soil types I don't worry too much about monitoring areas with different soil types if I can't do anything about it**
    - **Proximity to roots vs open spaces: Only care about water in the root zone, not in open spaces I don't worry about monitoring in open spaces**
    - **Canopy effects (both for evaporation and precipitation interception): temporal data will factor in these effects I don't worry about monitoring canopy effects**
    - **"Random": temporal data will factor in these effects, but may be useful. I'll monitor three sensors in root zone, two below root zone.**
- **Final monitoring:**
  - **One logger, five sensors per crop**
  - **Sensors installed directly under dripper**


Moisture Characteristic Curve-Palouse Silt Loam
y = 26.542x² - 20.334x + 2.8881
R² = 0.9889
Permanent Wilting Point
Refill Point
Field Capacity (Full Point)
Log water Potential (bar)
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Gravimetric Water Content (m3/m3)