Soil EC mapping technologies (EM38 and Veris) for identifying soil management zones

Shelley Woods
Soil and Water Research Scientist
Irrigation & Farm Water Division
Alberta Agriculture and Rural Development

Agronomy Update
January 16, 2013
Lethbridge, AB

Government of Alberta

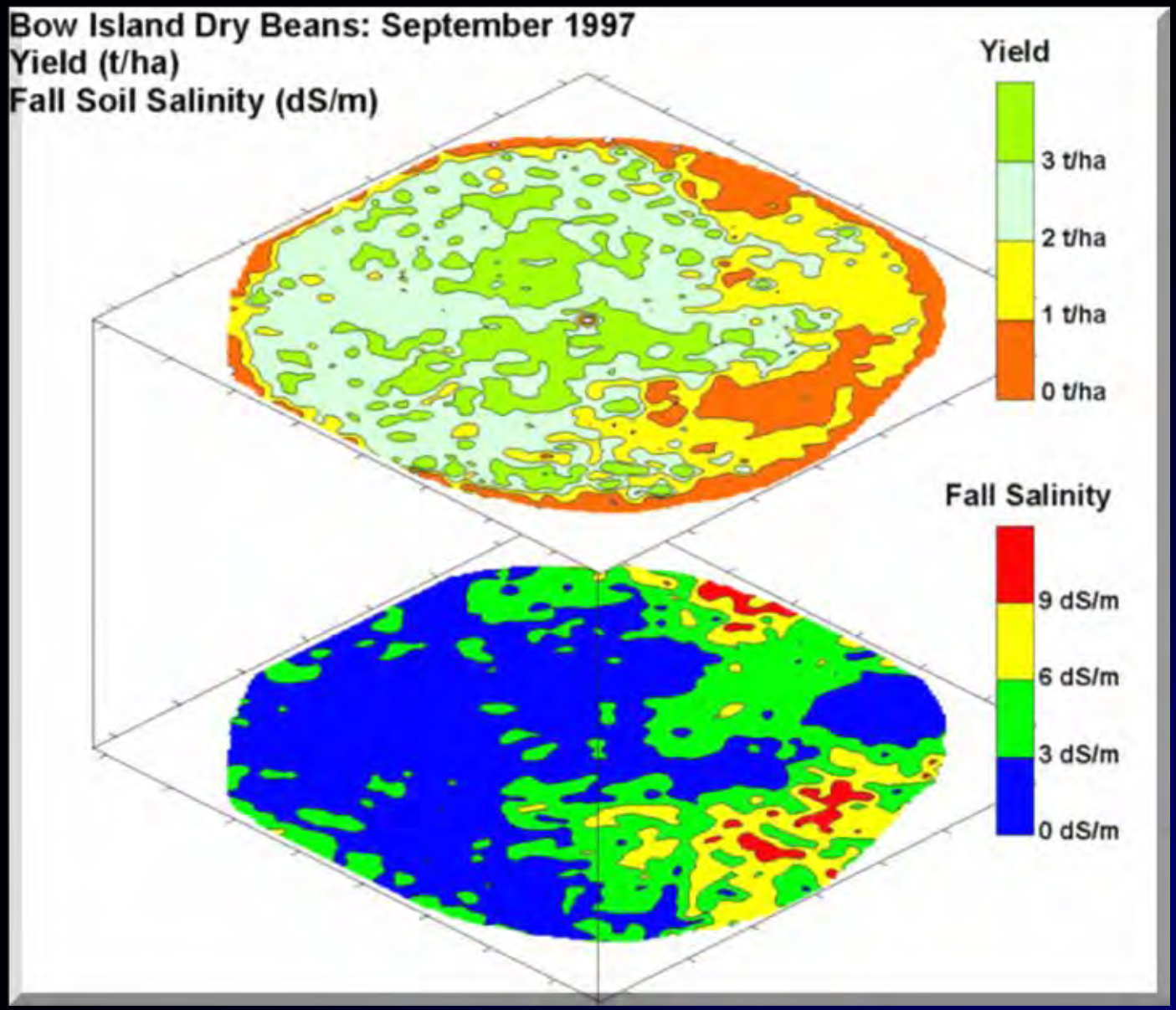
Outline

- Electrical Conductivity (EC)
- EC Sensor Types
  - Contact (Veris)
  - Non-Contact (EM38)
    - How They Work
    - Factors Affecting Readings
- Tips for Collecting EC Data and for Choosing a Mapper

Agricultural Uses for Soil EC_a Maps

1. Delineation of management zones (variable rate seeding, nutrients, herbicides, irrigation)
2. Directed soil sampling and other on-farm tests
3. Interpretation of yield maps
4. Fine-tuning soil maps
5. Salinity diagnosis
6. Drainage remediation planning

Example of Yield & Soil EC_a Maps



Electrical Conductivity (EC)

- Ability of a material to transmit (conduct) an electrical current (dS/m = mS/cm)
  - pure silver = 621,000,000 dS/m
  - sea water = 48 dS/m
  - drinking water = 0.005-0.5 dS/m
  - silicon = 0.0156 dS/m (insulator)

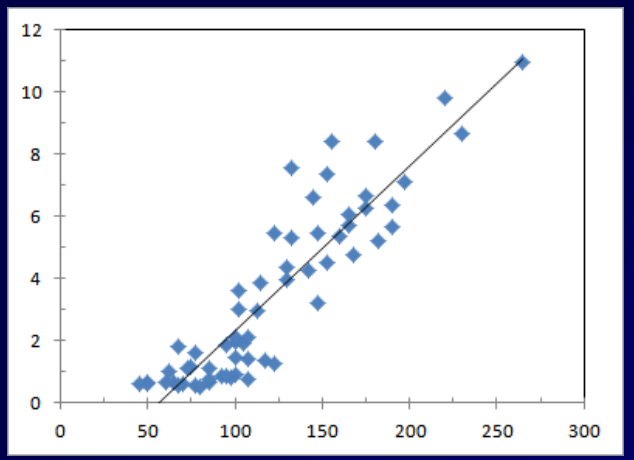
Electrical Conductivity (EC)

- In soils, materials in the pore space can be conductive (water, dissolved salts)
  - Alberta soil = 0-12 dS/m
    - non-saline top soil < 2 dS/m
    - non-saline subsoil < 4 dS/m

Electrical Conductivity (EC) vs. Apparent EC (EC_a)

EC Analysis of soil samples done as an electrical conductivity of a saturated paste extract

EC_a An easily-measured soil property that is related to EC and can be converted with a formula



Factors Affecting Soil EC_a

1. Soil texture (clay content and mineralogy, porosity, cation exchange capacity (CEC), compaction, depth to hardpans)
2. Water content (texture ~ water holding capacity)
3. Salinity level (dissolved salts)
4. Temperature

Types of EC_a Sensors

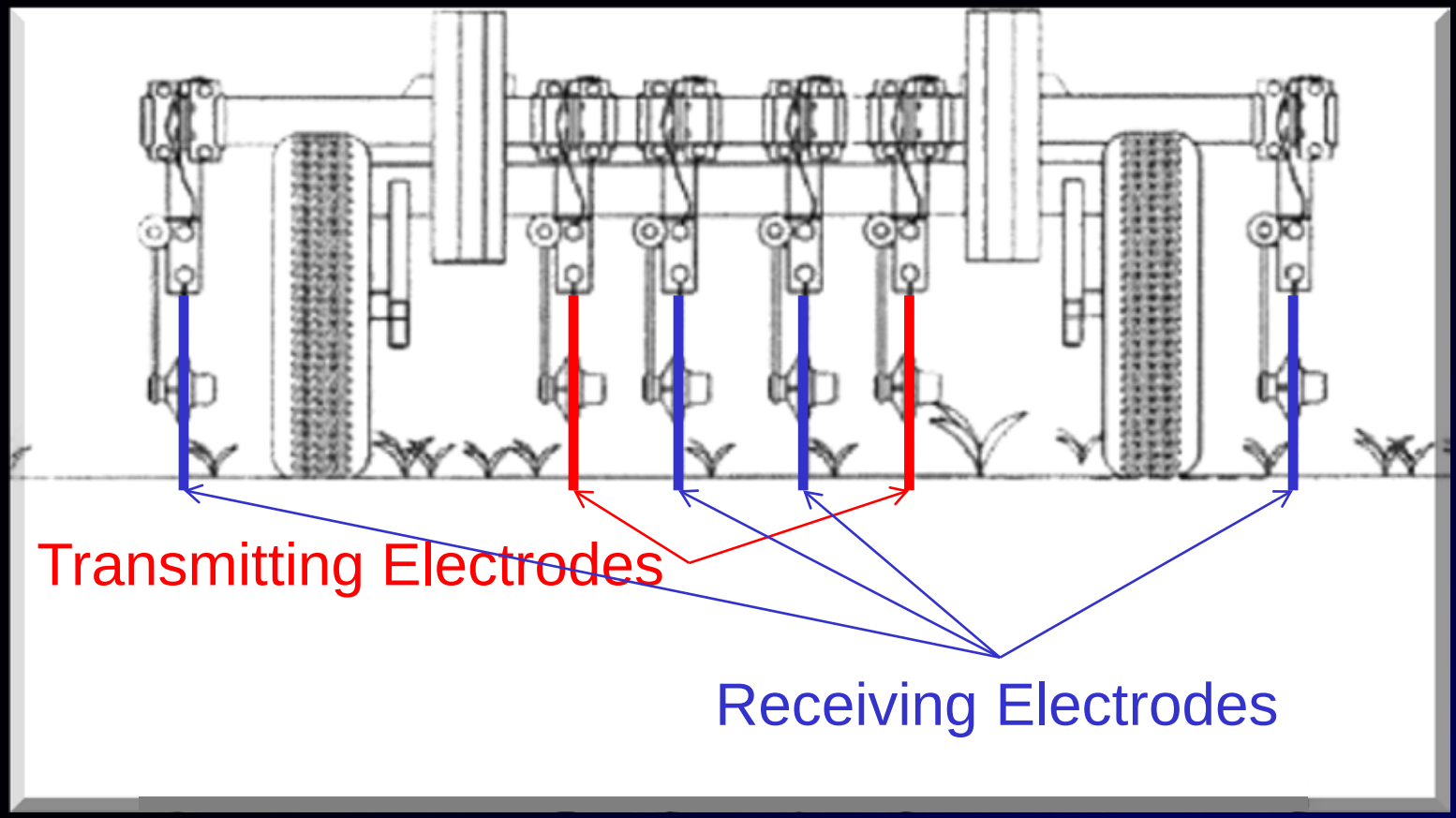
1. **Contact**: uses electrodes (e.g. coulters); measures voltage
   - Veris
2. **Non-Contact**: sits at or above the soil surface; measures electromagnetic inductance
   - EM38
   - DUALEM
   - GEM-2

1. Contact Sensor: Veris 3100

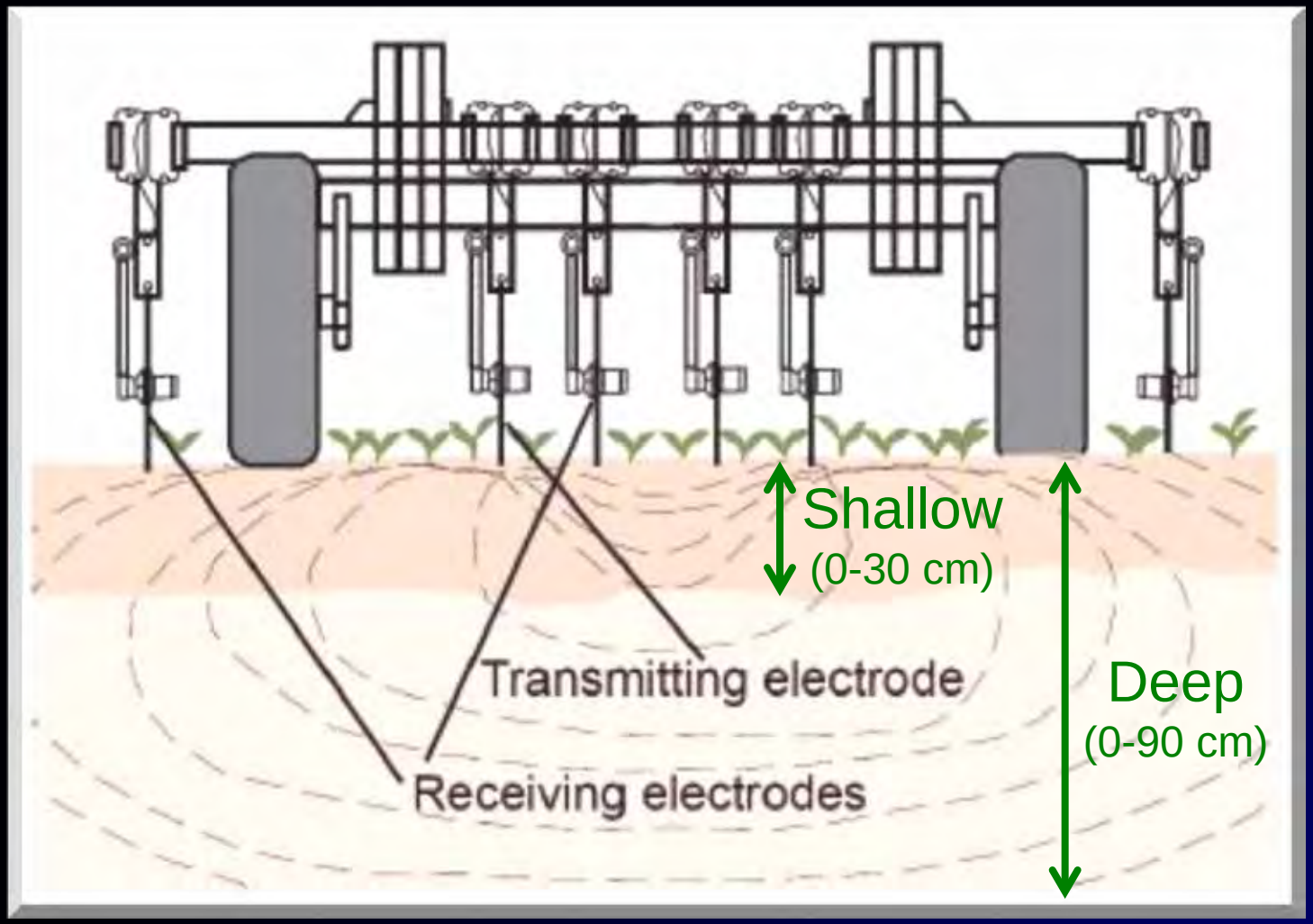
How Contact Sensors Work

- electrical current is supplied between two electrodes
- voltage is measured
- calculate a value for apparent soil resistivity
- converted to EC_a

Veris: Schematic



Veris: Measurement Depths



Factors Affecting Veris Readings

1. Soil Texture (Moisture)

(heavy clays > coarse sands)

2. Salinity (Dissolved Salts)

(higher salinity > lower salinity)

(saline spots >> heavy clays)

3. Electrode/coulter penetration

Veris "Pointers"

- coulter penetration should be 1-2" and uniform (affected by speed, soil moisture, texture, temperature (frozen), surface trash/thatch, ridges, etc.)
- requires some soil moisture (>10% above wilting point)
- soil core samples should be collected for calibration (same day)
- signal testing and maintenance should be routine

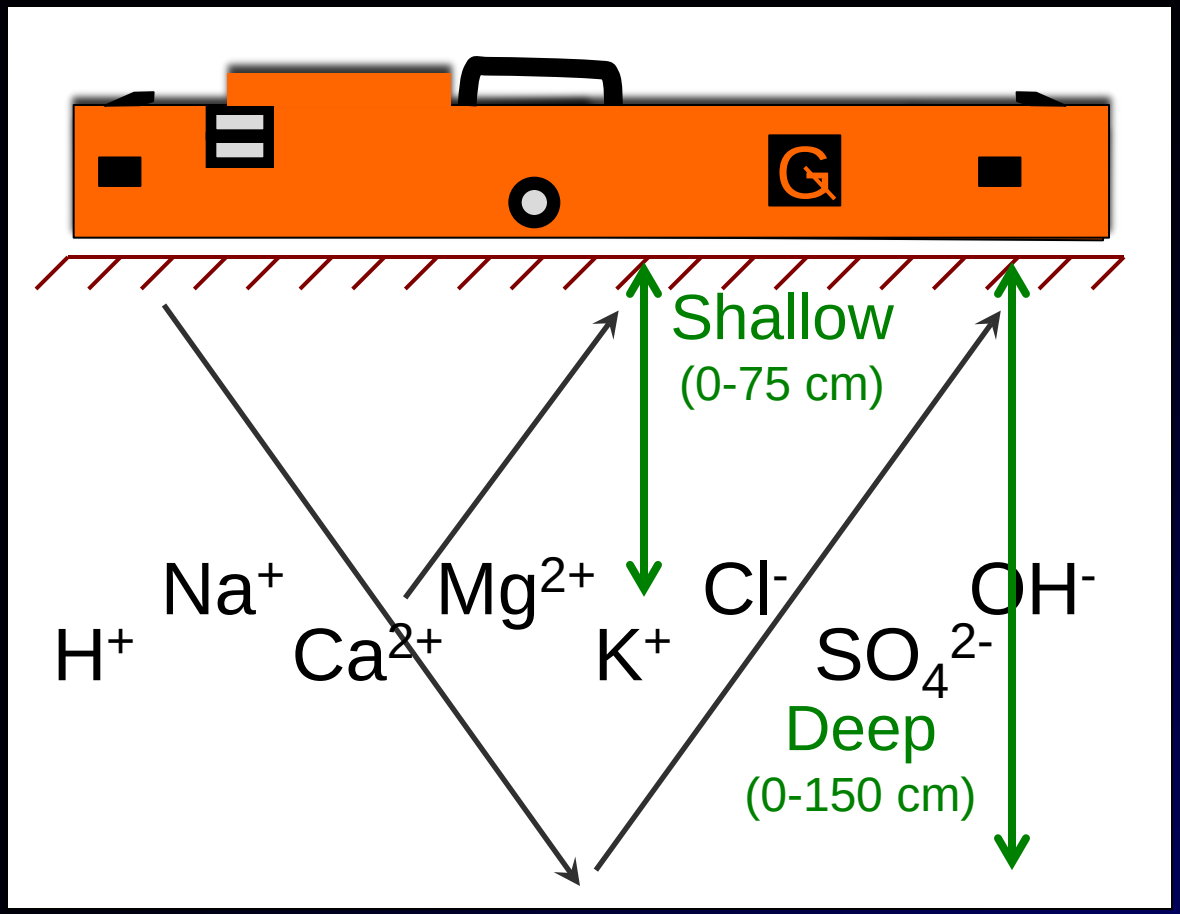
2. Non-Contact Sensors:

How Non-Contact Sensors Work

- instrument emits an EM field, which is propagated through the ground
- conductive anomalies induce alternating currents which travel to the receiver
- instrument measures intensity of secondary EM field
- converted to EC_a using soil sample data

EM38, EM38-DD, EM38-MK2 (Geonics Ltd.)

EM38: Schematic



soluble salts water texture temperature metal

EM38 Measurement Depths

Vertical position 0-150 cm

Horizontal position 0-75 cm

EM38-MK2 Meas. Depths

Vertical position
0-75 cm
0-150 cm

Horizontal position
0-38 cm
0-75 cm

EM38 and GPS Mapping System

circa 1991

Factors Affecting EM38 Readings

1. Soil Texture (Moisture)

(heavy clays > coarse sands)

2. Salinity (Dissolved Salts)

(higher salinity > lower salinity)

(saline spots >> heavy clays)

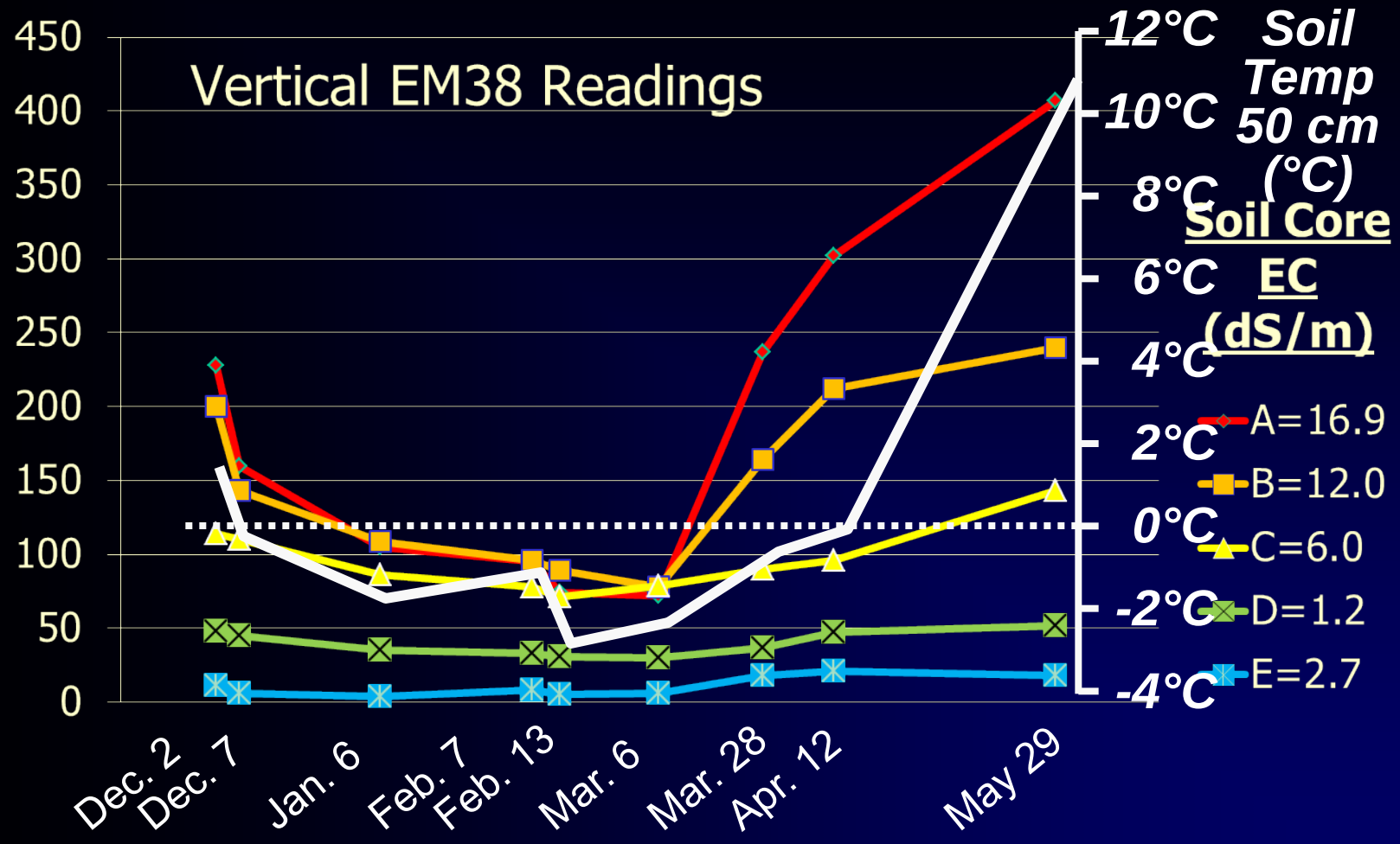
3. Metal
4. Distance from Soil Surface

EM38 "Pointers"

- requires nulling and zeroing for each field
- sled materials must be non-metallic and distance from vehicle must be sufficient
- speed should be consistent and reasonable
- avoid frozen soils (0°C at 50 cm)
- should be calibrated with same-day core samples from each field

EM38 and Frozen Soil

- Geonics literature indicates that the instrument functions to -40°C



Tips for Collecting Soil EC_a Data

1. Take EC measurements when soil is neither too wet nor too dry
2. Smooth, firm (but non-compacted) field surface
3. Avoid interference metal (EM38)
4. Conduct EC mapping when soils are not frozen (Veris and EM38)
5. Spacing no greater than 60 feet (half or full seeder, sprayer width)
6. Collect soil samples at same time as soil EC data are collected

Tips for Choosing a Mapper

1. What do I want from the maps?
2. Are they experienced?
   - Instrument use (nulling, zeroing, calibrating)
   - Interpreting results (zones)
3. Is their equipment well-maintained?
4. What pass width are they using?
5. Will they be collecting soil samples? comparing to soil maps/air photos?
6. Will results (zones) be given in a timely manner?

Acknowledgements

- Jeff Bronsch, Sunrise Ag, Taber
- Rob Dunn, ARD, Lethbridge

Contact information:

Shelley Woods
Research Scientist – Soil & Water
Irrigation and Farm Water Division
ARD, Lethbridge
Phone: 403-381-5839
shelley.a.woods@gov.ab.ca

Government of Alberta