

Monitoring and Controlling Substrate Water Content in Controlled Environments

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Why bother?

- Not part of minimum guidelines
 - Watering: frequency, amount, and type of water
- Plants do not respond to amount of water supplied
- Plants respond to water availability

Vinca grown at different substrate water contents



A background image showing a water droplet falling into a pool of water, creating ripples. The image is in shades of blue and green.

Capacitance sensors

- Based on same principle as TDR
- Measurements are simplified
- No expensive electronics needed

Soil Moisture Probes (Decagon)



EC-5



EC-10



EC-20



EC-TE

Soil Moisture Probes (Delta T)



ThetaProbe
(IL-2)

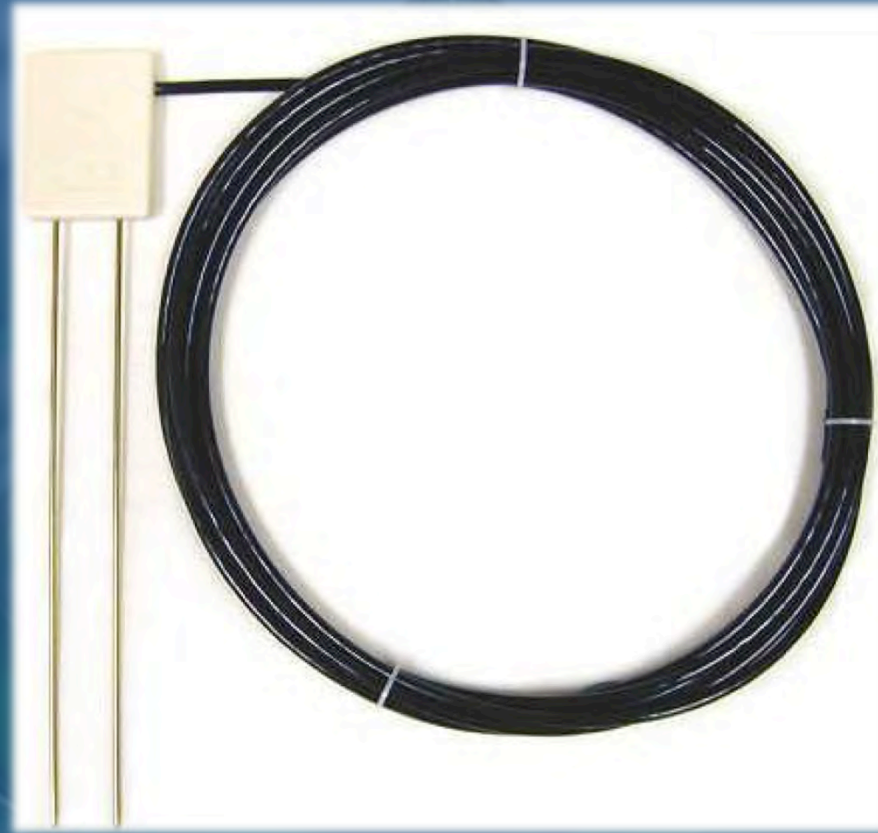


W.E.T sensor



SM200

Soil moisture probes (Campbell Sci.)

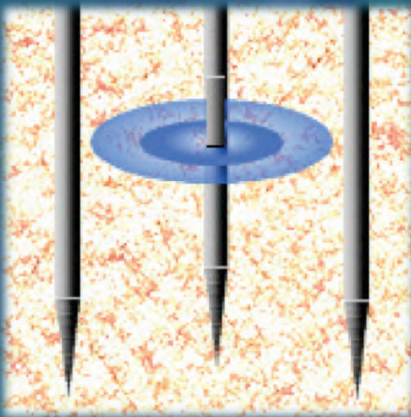


CS616/CS625

General principle



Install or insert probe in
soil or substrate



Sensor generates
electromagnetic field

General principle



Water, soil particles, and EC affect electromagnetic field

Dielectric permittivity:

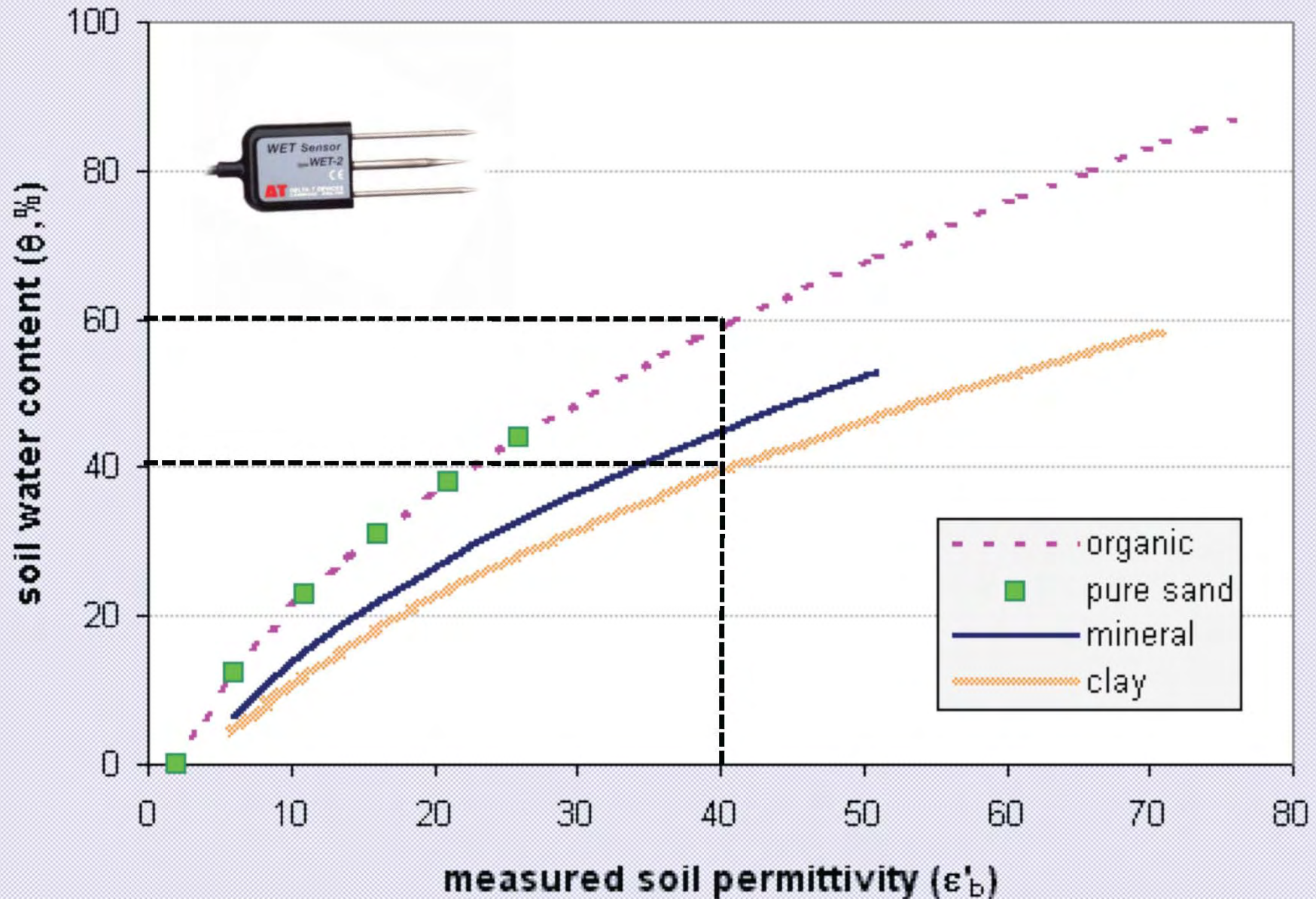
- Soil : 2-8
- Air: 1
- Water: 80.4
- Also affected by EC

Probe frequencies

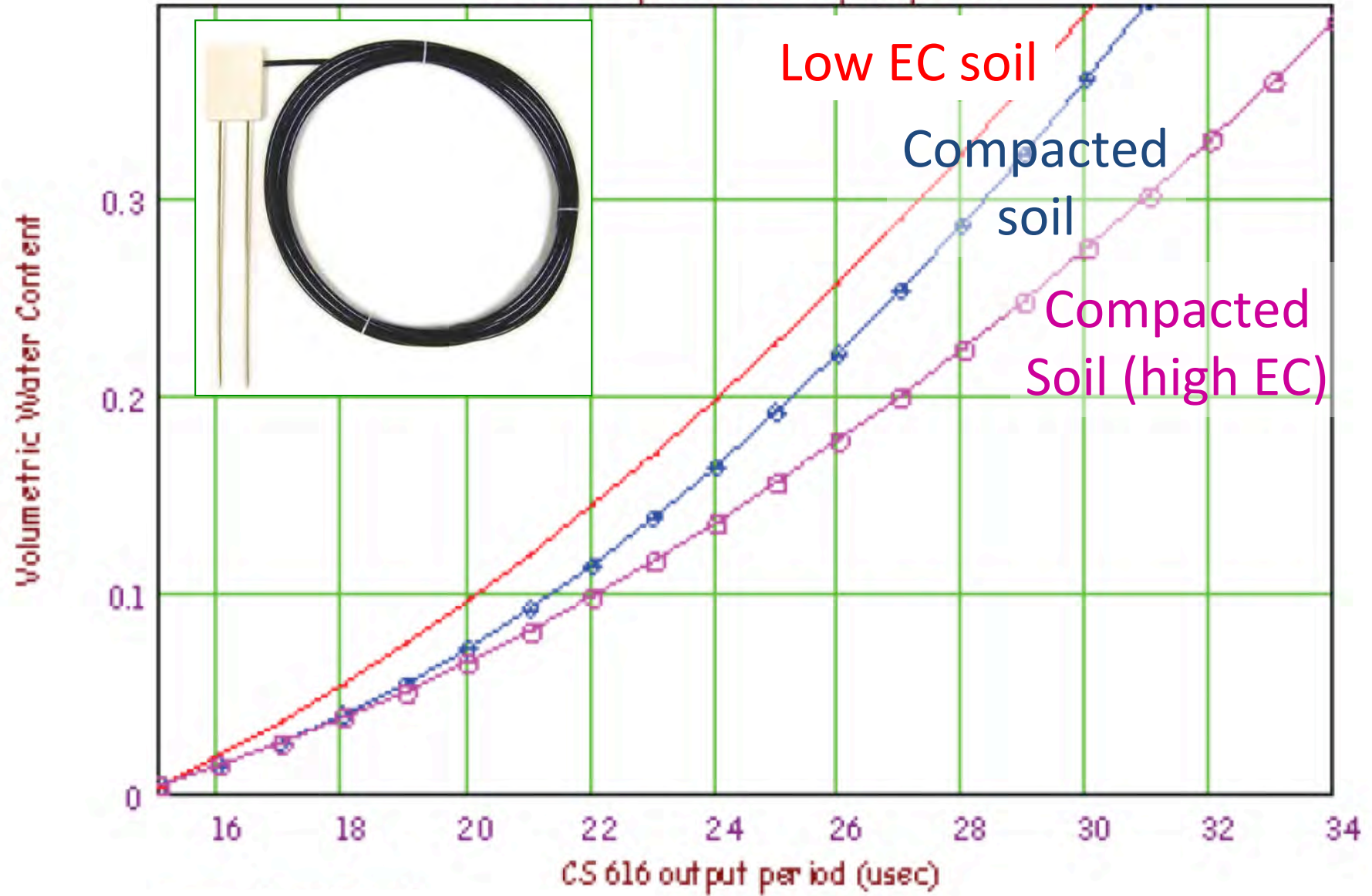
ECHO-5	70 MHz
ECHO-10	20 MHz
ECHO-20	20 MHz
ECHO-TE	70 MHz
ThetaProbe	100 MHz
SM200	100 MHz
W.E.T sensor	20 MHz
CS616/625	70 MHz

Higher frequencies minimize the effect of soil texture and salinity

Soil permittivity versus water content (W.E.T sensor)

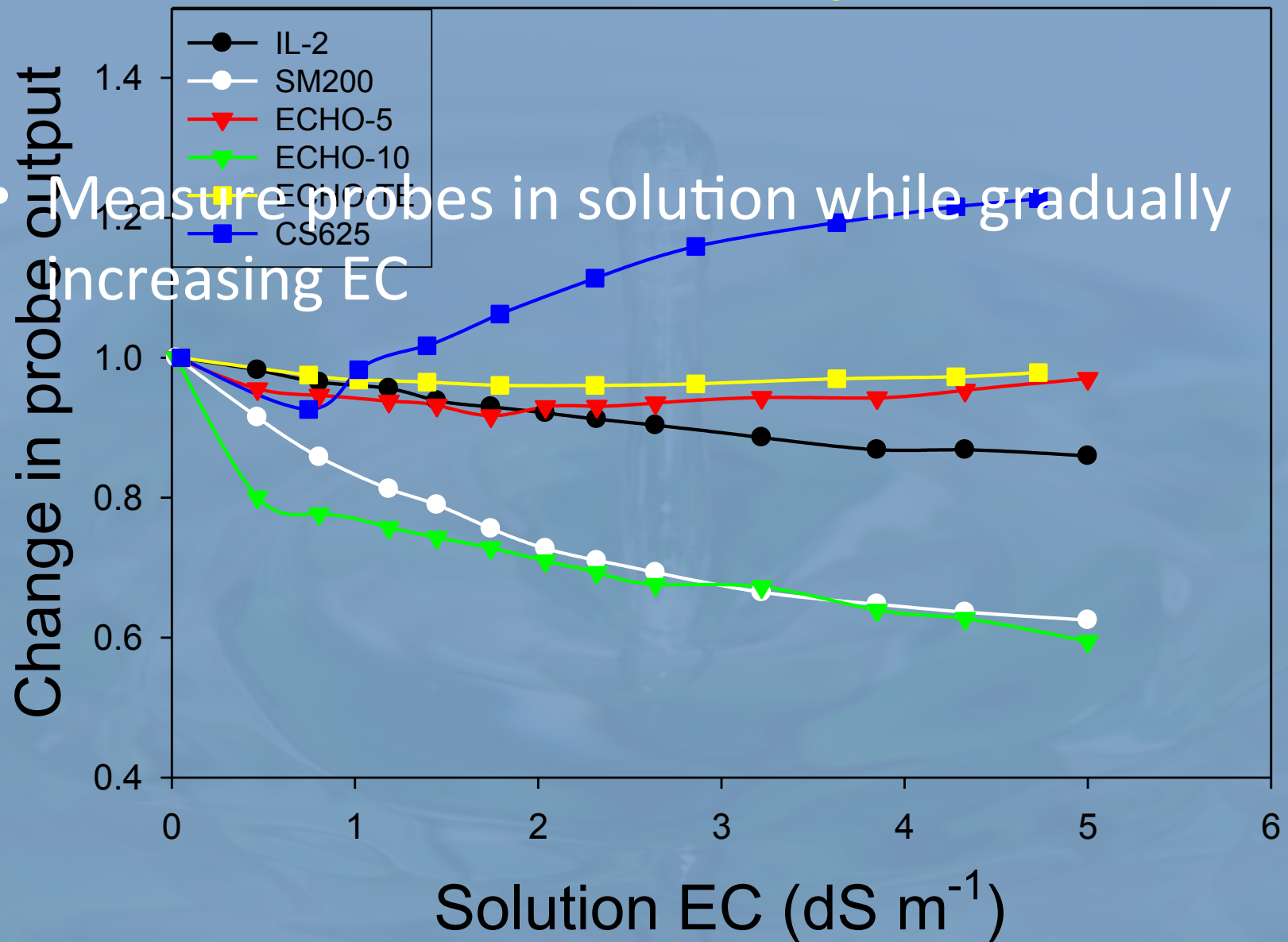


CS616 response in sandy clay loam

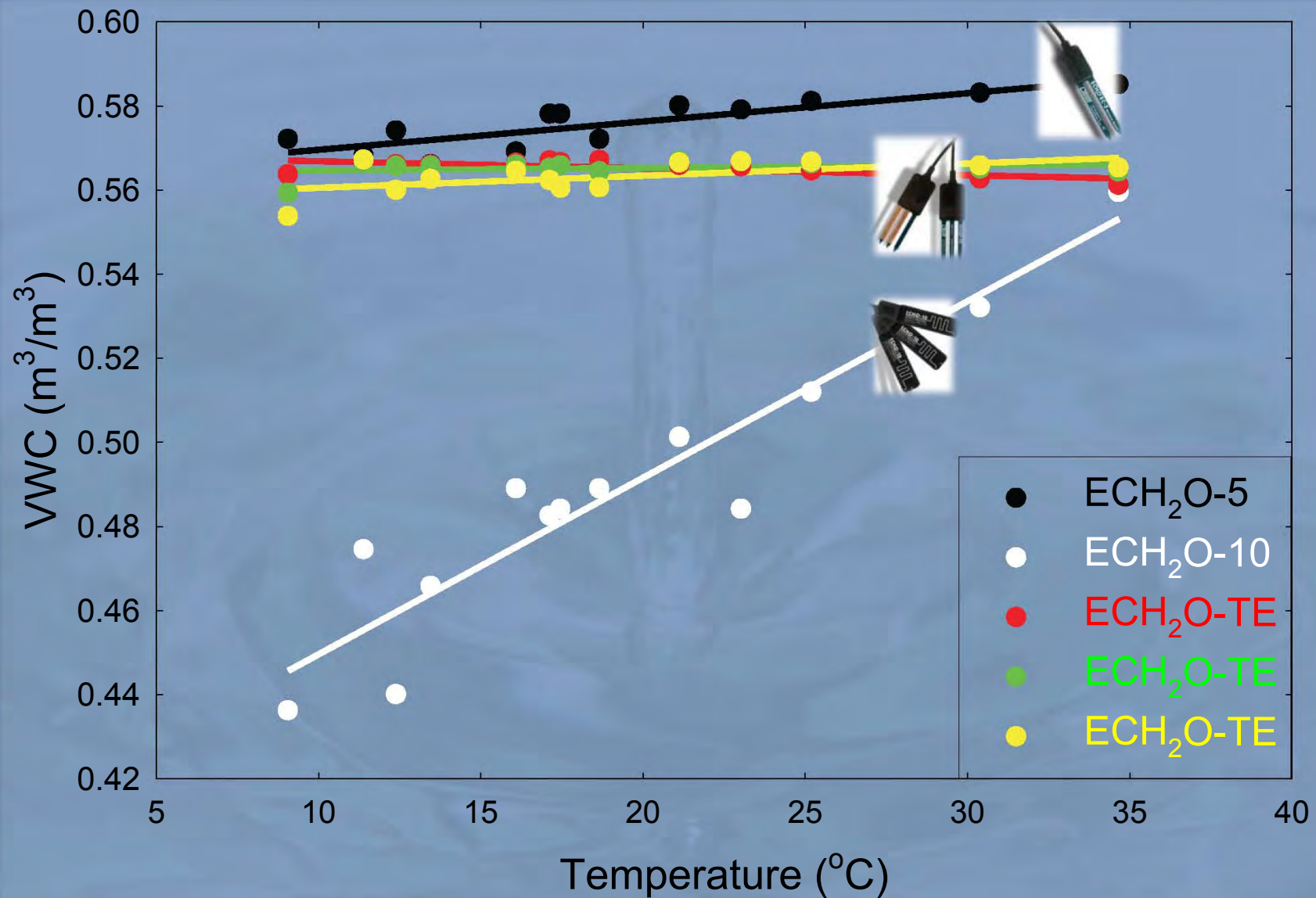


Probe sensitivity to EC

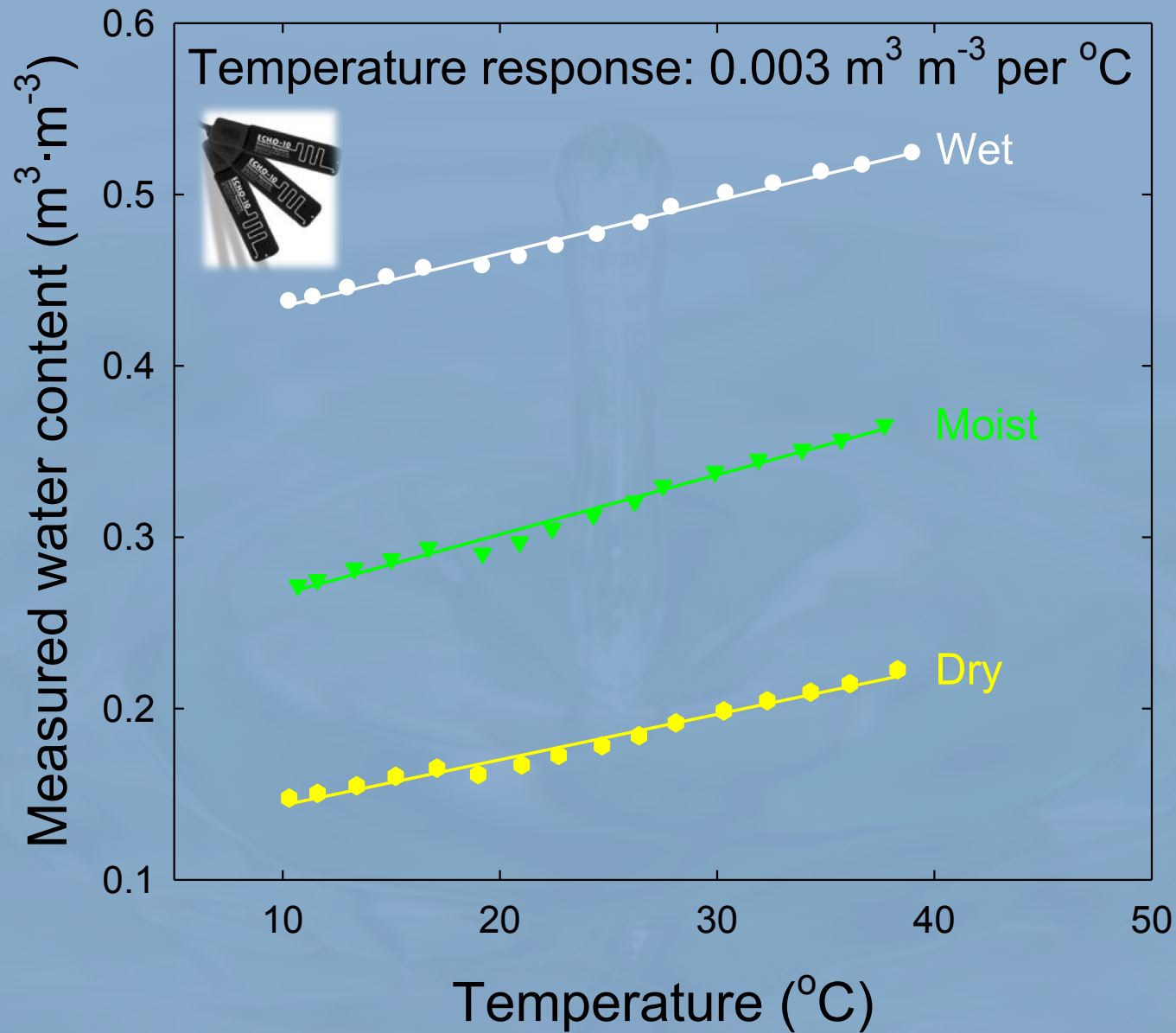
- Measure probes in solution while gradually increasing EC



Temperature sensitivity of different ECHO probes



Temperature sensitivity of ECHO-10 probes



Soil moisture probes (summary)

- Great advances during the last few years

- Decide between:
 - handheld, insertable probes



- *in situ* probes



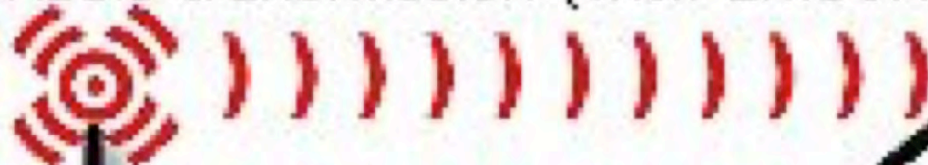
- Substrate specific calibrations needed

Soil moisture probes (summary)

- How important is:
 - Temperature sensitivity
 - EC sensitivity
 - Sampling volume (W.E.T sensor \approx ECHO-5 \approx ECHO-TE \approx SM200 $<$ ThetaProbe \approx ECHO-10 $<$ ECHO-20 $<$ CS625)
 - Price
- Interfacing sensors:
 - Handheld meter/logger: Delta T and Decagon sensors
 - Datalogger: all sensors
 - Greenhouse control systems: depends on system

Remote monitoring

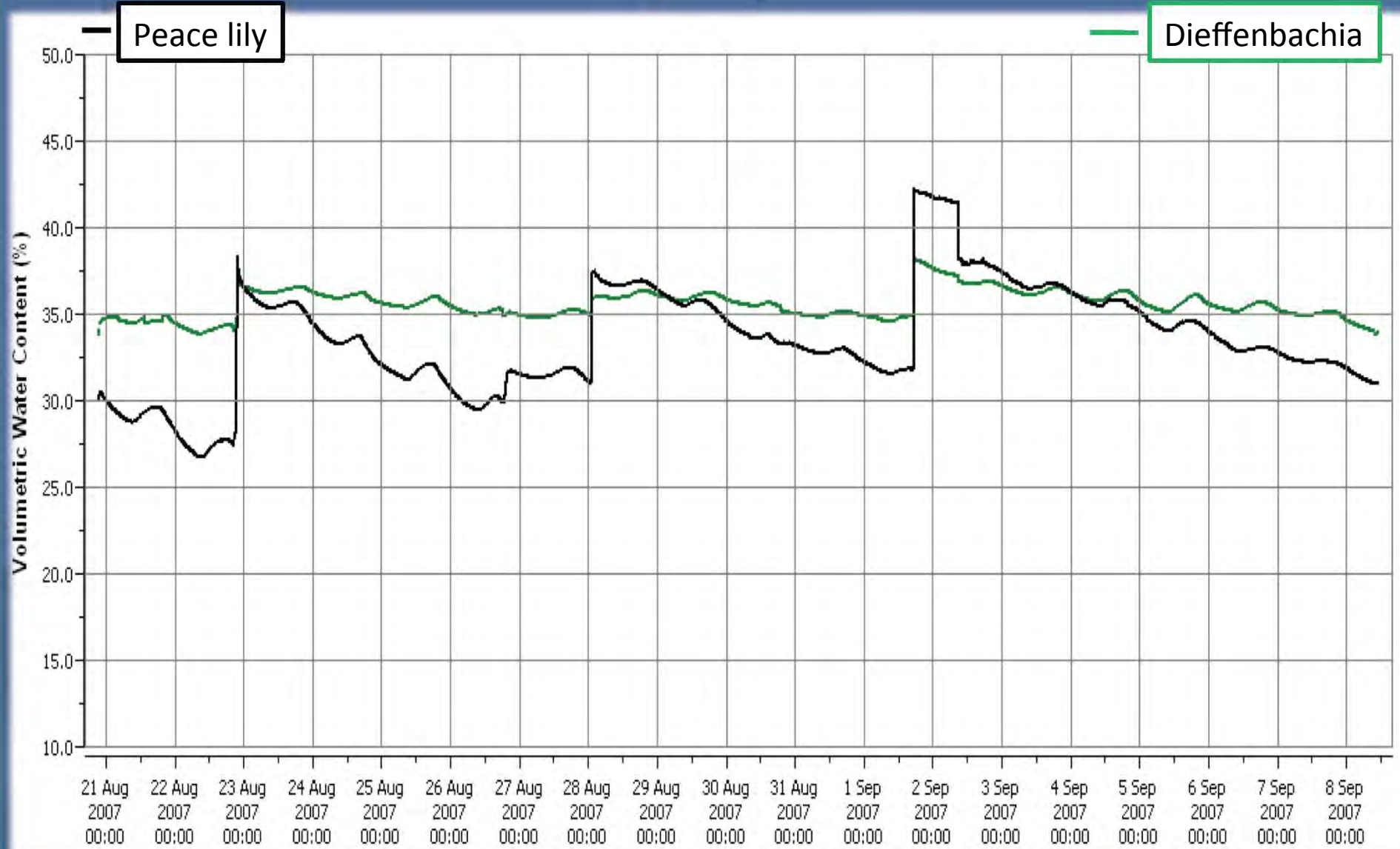
Radio transmission (with Em50R)

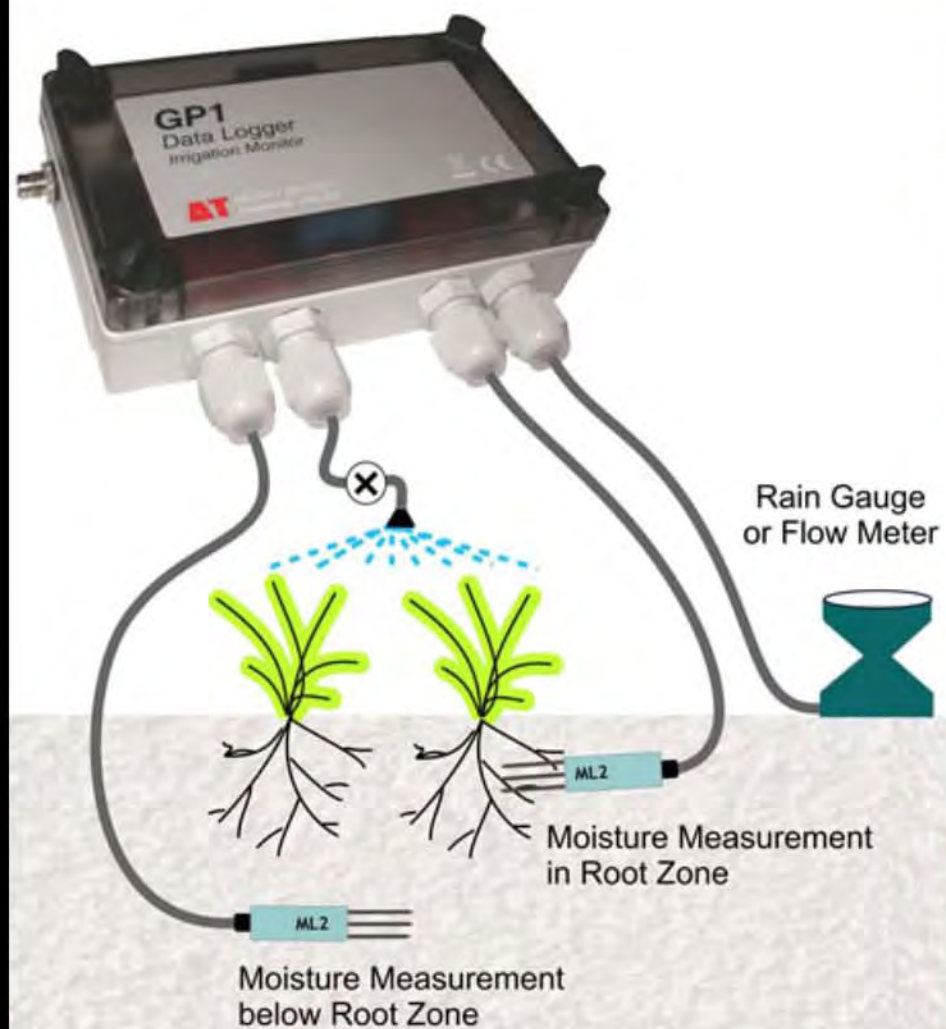


Receiver



DataTrac Graphing Software



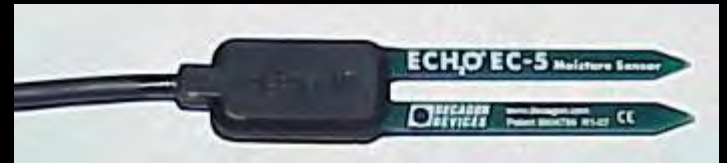


Automated watering system

Datalogger and control system



Nemali and van Iersel, 2006
Scientia Horticulturae



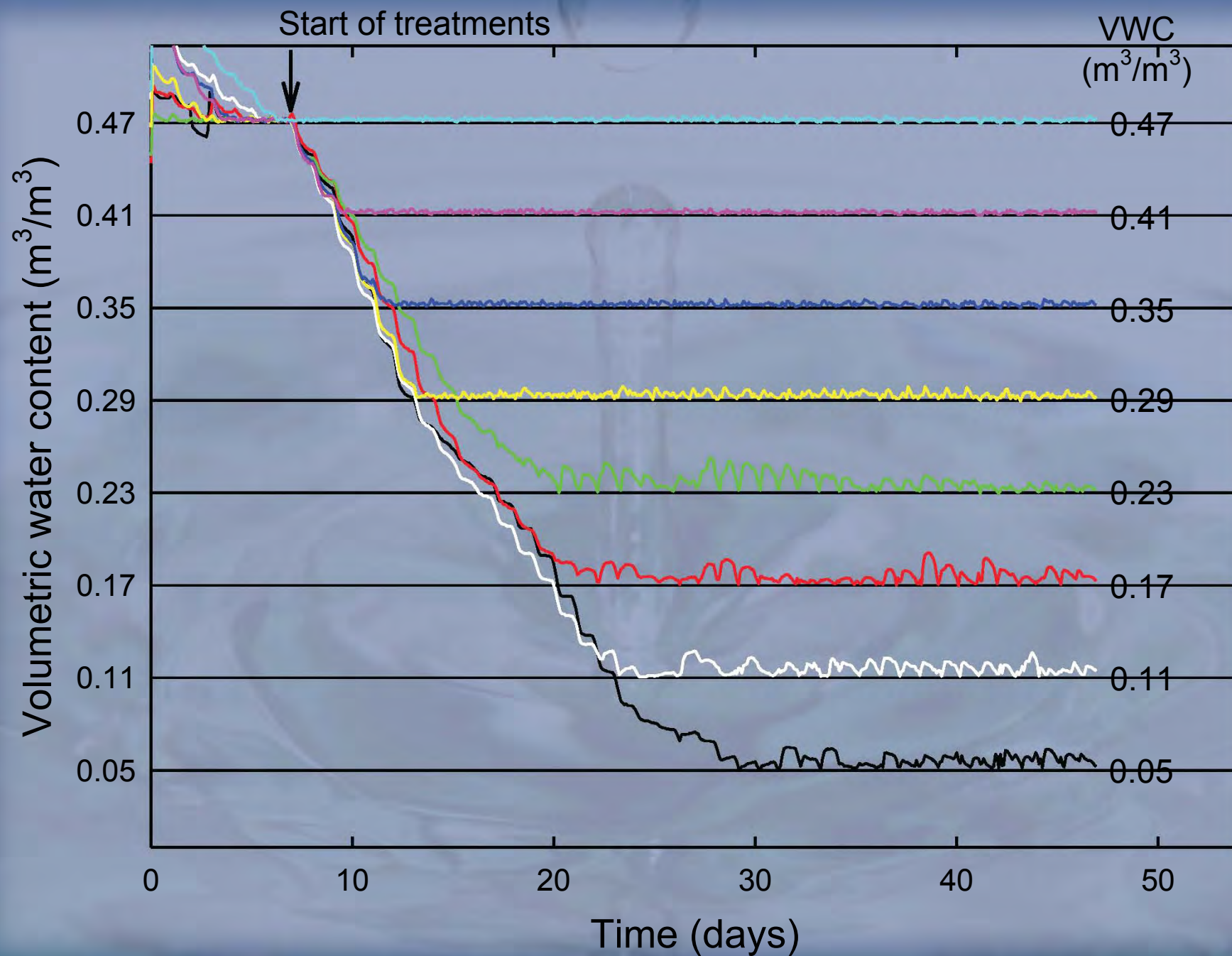
EC-5 probes



Probe in container

Solenoid unit





A photograph of a pond with purple lotus flowers and green lily pads. The text "Thanks to:" is overlaid in the top left corner in a yellow, sans-serif font. The background shows a close-up of a purple lotus flower in full bloom, with its yellow stamens visible. Other lotus flowers and lily pads are visible in the background, creating a serene pond scene.

Thanks to:

Krishna Nemali, JongYun Kim, Sue Dove,
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