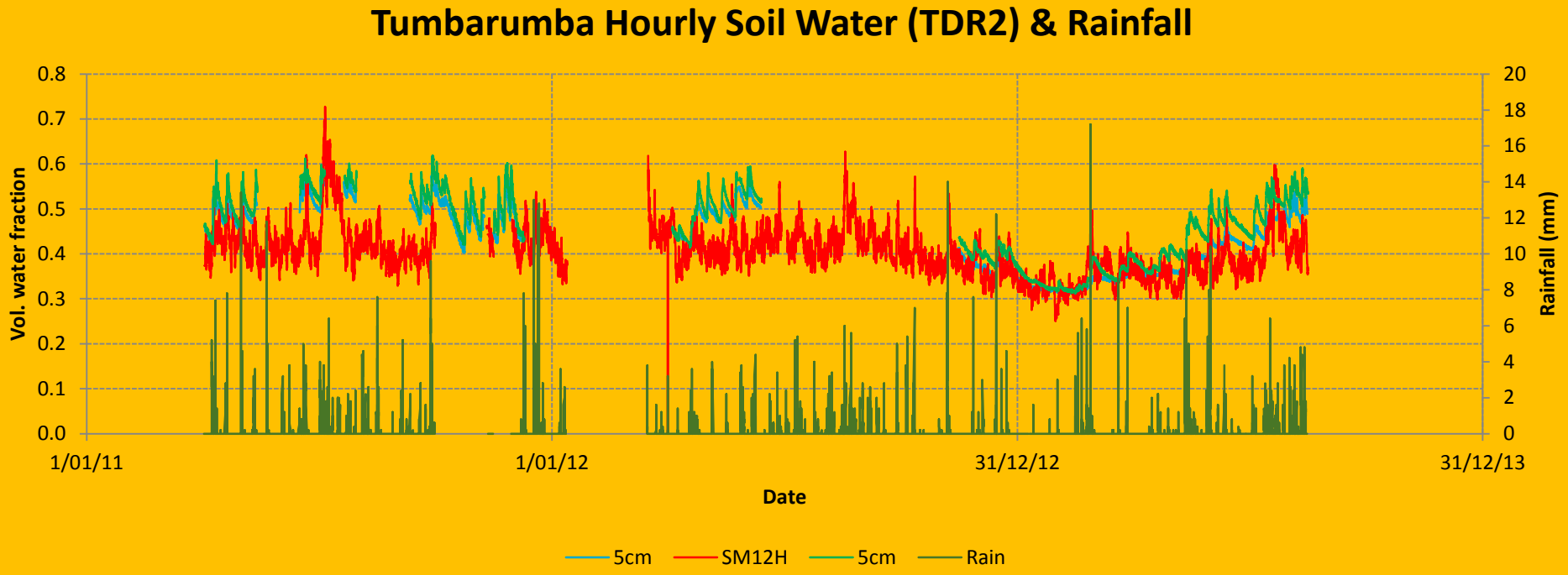


Soil Water – Indirectly Estimated

The elusive quantification of 'water' in soil

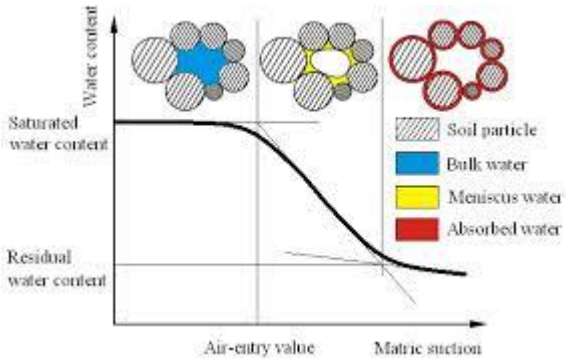
Steve Zegelin | OzFlux Alice Springs

29 Sep – 1 Oct 2014

Measuring soil water is not easy

It’s in there, I want to know how much!

- Soil & water interact in physical, chemical and biological regimes:
  - Physical
    - water occupying pore volume (solid, liquid, vapour)
    - water bound to soil particulate surfaces
  - Chemical – solutions of dissolved minerals & salts
  - Biological – flora and fauna



- The distribution and state of water in soil can be highly variable both spatially and temporally

Direct Measurement: Gravimetric sampling

- When performed properly gives good spatial soil water data
- Destructive process, cannot track temporal changes
- Labour & time intensive

Direct Measurement: Lysimeter

- Lysimeters can accurately track temporal changes in soil water
- Major effort to construct and maintain
- Site disturbance
- Can be instrumented for detailed soil measurements

Indirect Measurement: many choices

- Neutron scattering
- Gamma ray attenuation
- Tensiometers
- Resistance blocks
- Psychrometers
- Remote sensing
- Soil water dielectrics
  - Frequency domain (capacitance)
  - Time domain (TDR)

OzFlux Soil Water: Use Dielectric

- Dielectric advantages
  - Fast (~1 second measurement)
  - Inexpensive (frequency)
  - Excellent for measuring temporal changes
  - Multiple sites & depths via multiplexing
- Dielectric disadvantages
  - Soil calibration – not universal
  - Affected by soil electrical conductivity
  - Essentially a point measurement
  - Measure soil T to correct for relative permittivity of water dependence on T

OzFlux Soil Water: Use COSMOS

- COSMOS advantages
  - Large spatial average
  - Inexpensive
  - Excellent for temporal changes
  - Minimal maintenance
- COSMOS disadvantages
  - Soil calibration is complex
  - Affected by vegetation (could be useful)
  - Soil depth measured varies with water content
  - Developing technology

OzFlux Soil Water Using CS616

- These are 2-wire probes which measure the average relative permittivity of soil in a small annulus around the wires
- CS616 outputs a frequency which requires a dedicated logger input channel – large numbers of probes (>10) pose logging difficulties
- Relatively cheap and robust
- Soil temperature should be measured to apply corrections to measurements

OzFlux Soil Water Using CS65x

- These are 2-wire probes which measure the average relative permittivity of soil in a small annulus around the wires
- CS65x incorporates a thermocouple in the head to measure soil temperature
- Uses SDI which allows larger number of probes per logger

OzFlux Soil Water – probe location

Choose a representative site (or sites)

Locate probes at depths of interest:

- Vegetation rooting depth
- Organic layer (leaf litter)
- Soil texture changes

As many replicates of each depth as possible – these are point measurements!

OzFlux Soil Water – calibration

You are not measuring water content!

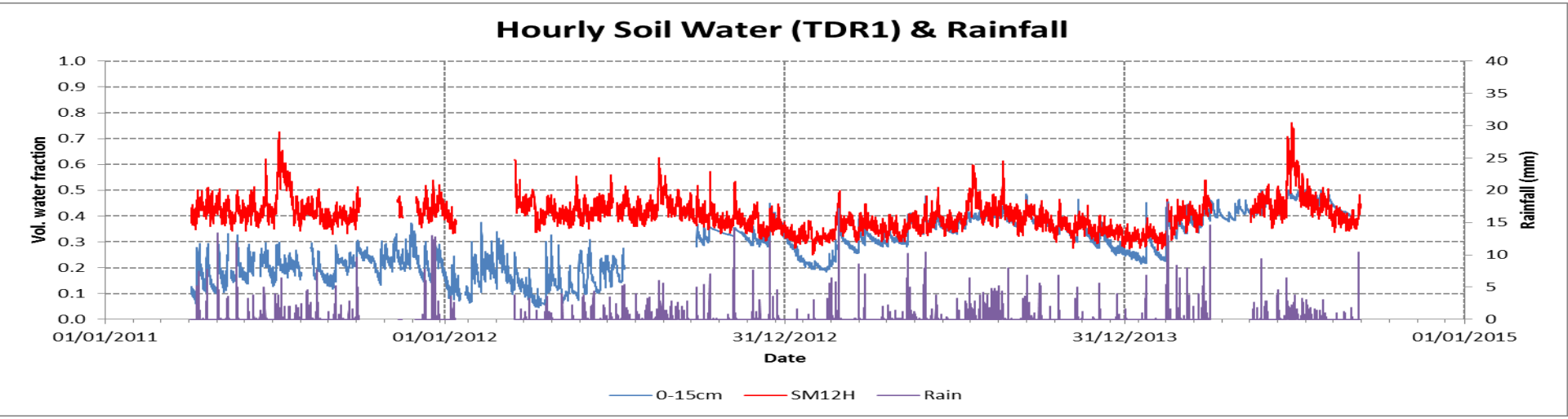
Measurement of bulk soil relative permittivity is directly related to volumetric water content

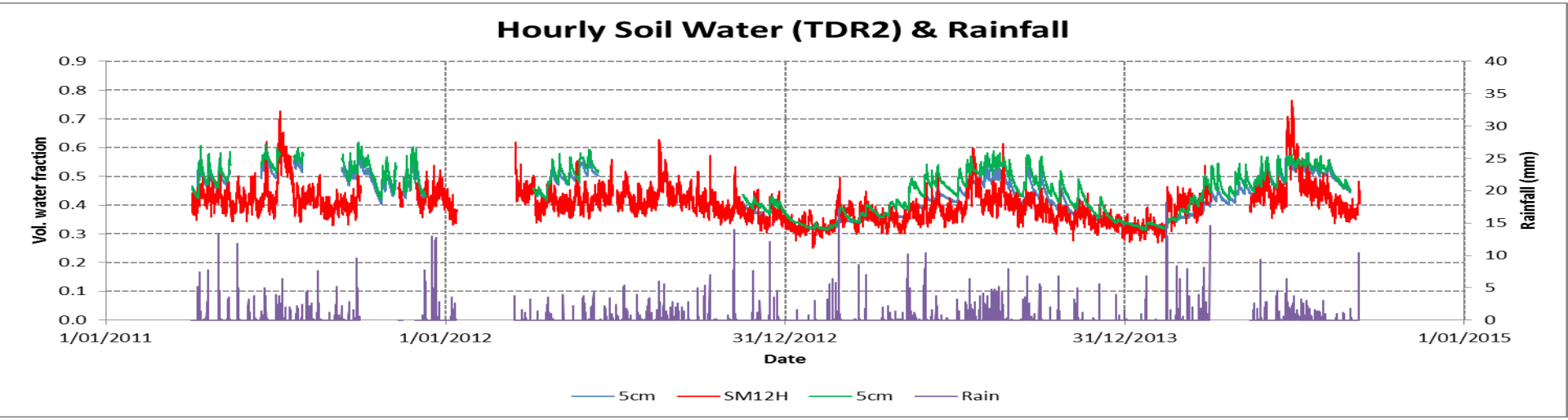
Relative permittivity of water is temperature dependent (87.7 @ 0degC to 70.0 @ 50degC)

Gravimetric sampling at least once to confirm absolute water content is in ball park

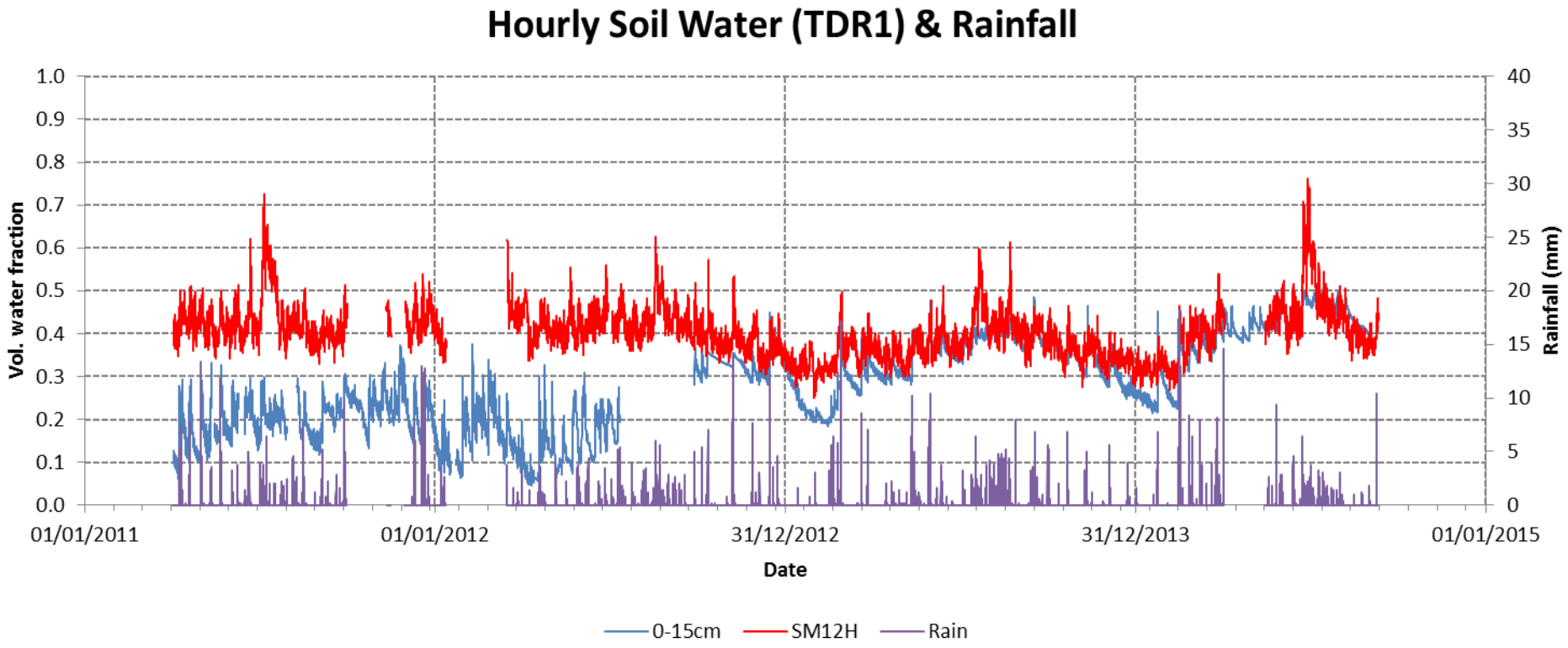
If possible calibrate over a range of water contents

OzFlux Soil Water – TDR & COSMOZ



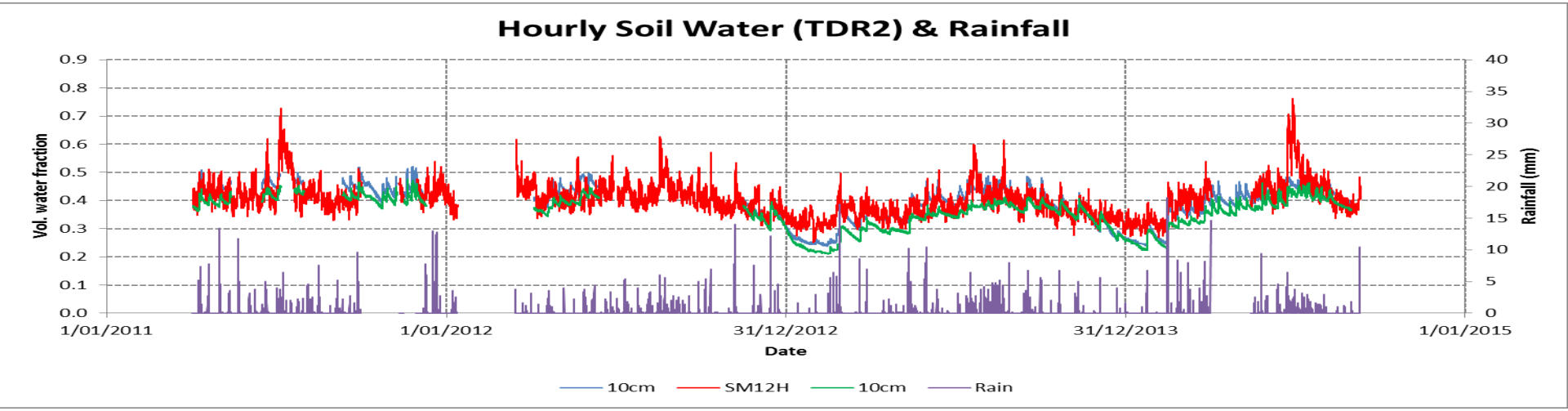


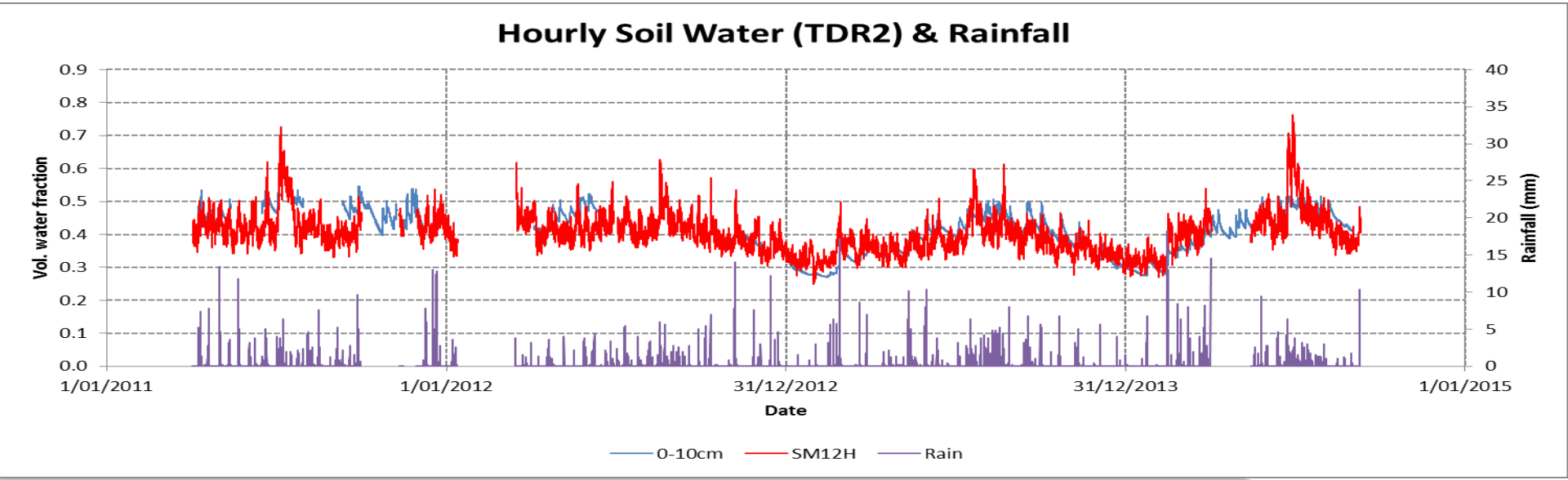
OzFlux Soil Water – TDR & COSMOZ



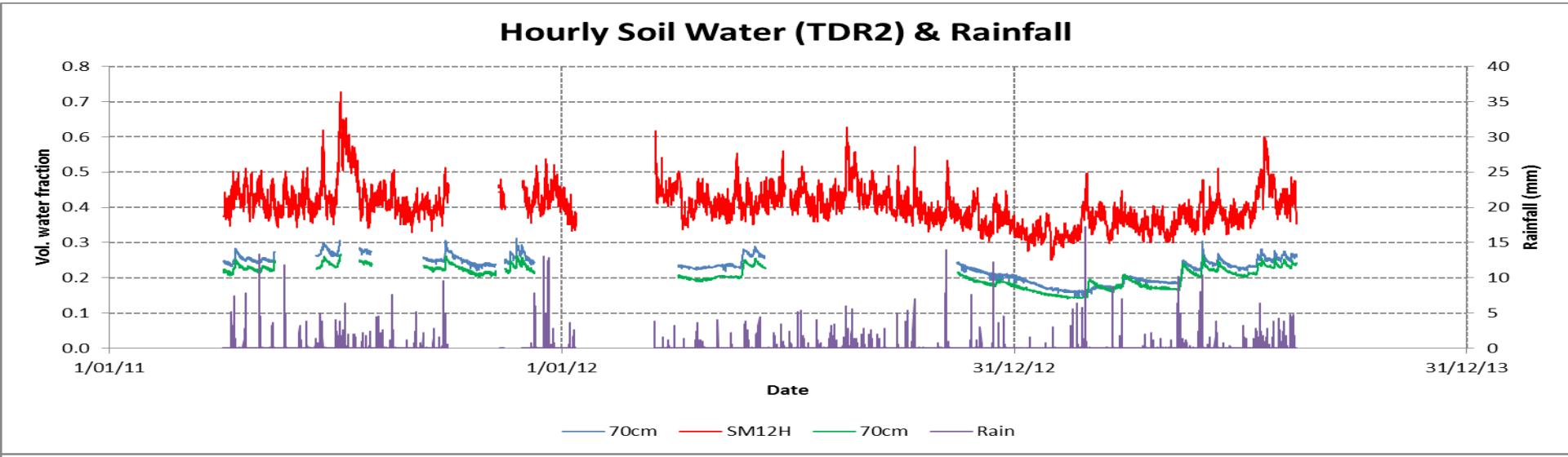
Air gap around probe rods can have dramatic consequences

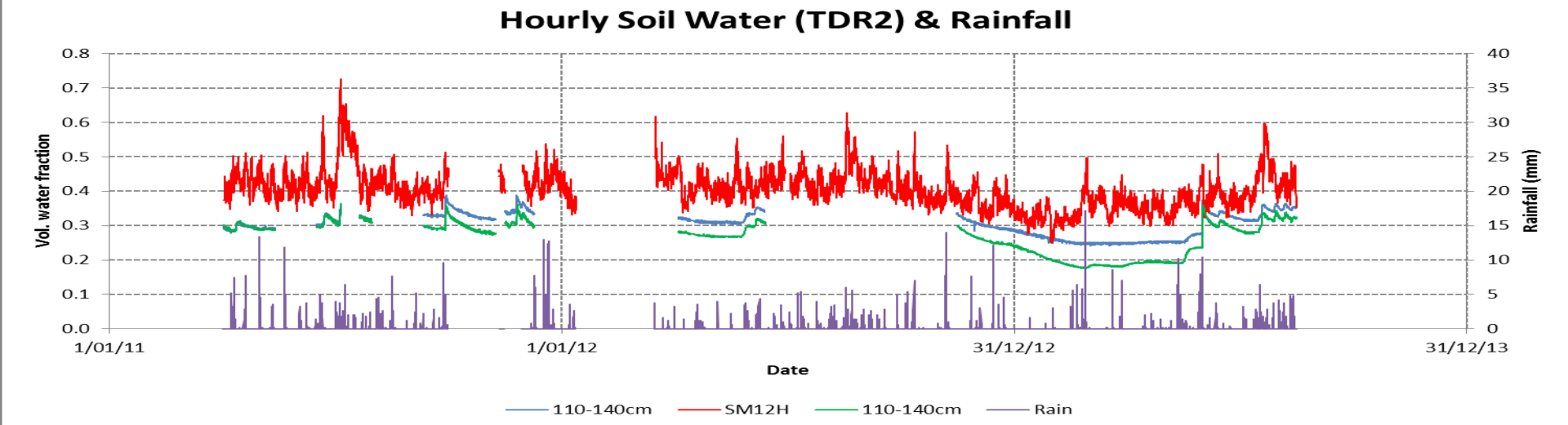
OzFlux Soil Water – TDR & COSMOZ





OzFlux Soil Water – TDR & COSMOZ





OzFlux Soil Water – summary

Choose representative site(s)

Locate probes to obtain water content at depths appropriate for your objectives

Replicate, replicate, replicate

Calibration is important (for all instruments)!!!