Eidgenössische Technische Hochschule Zürich
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The SwissSMEX/-Veg soil moisture network

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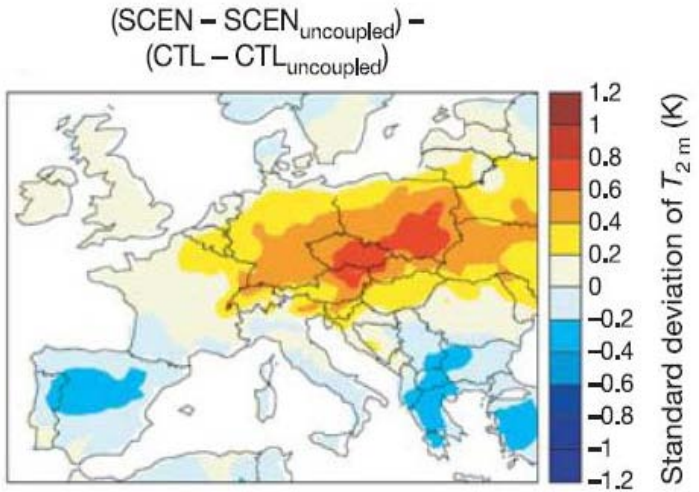
Motivation



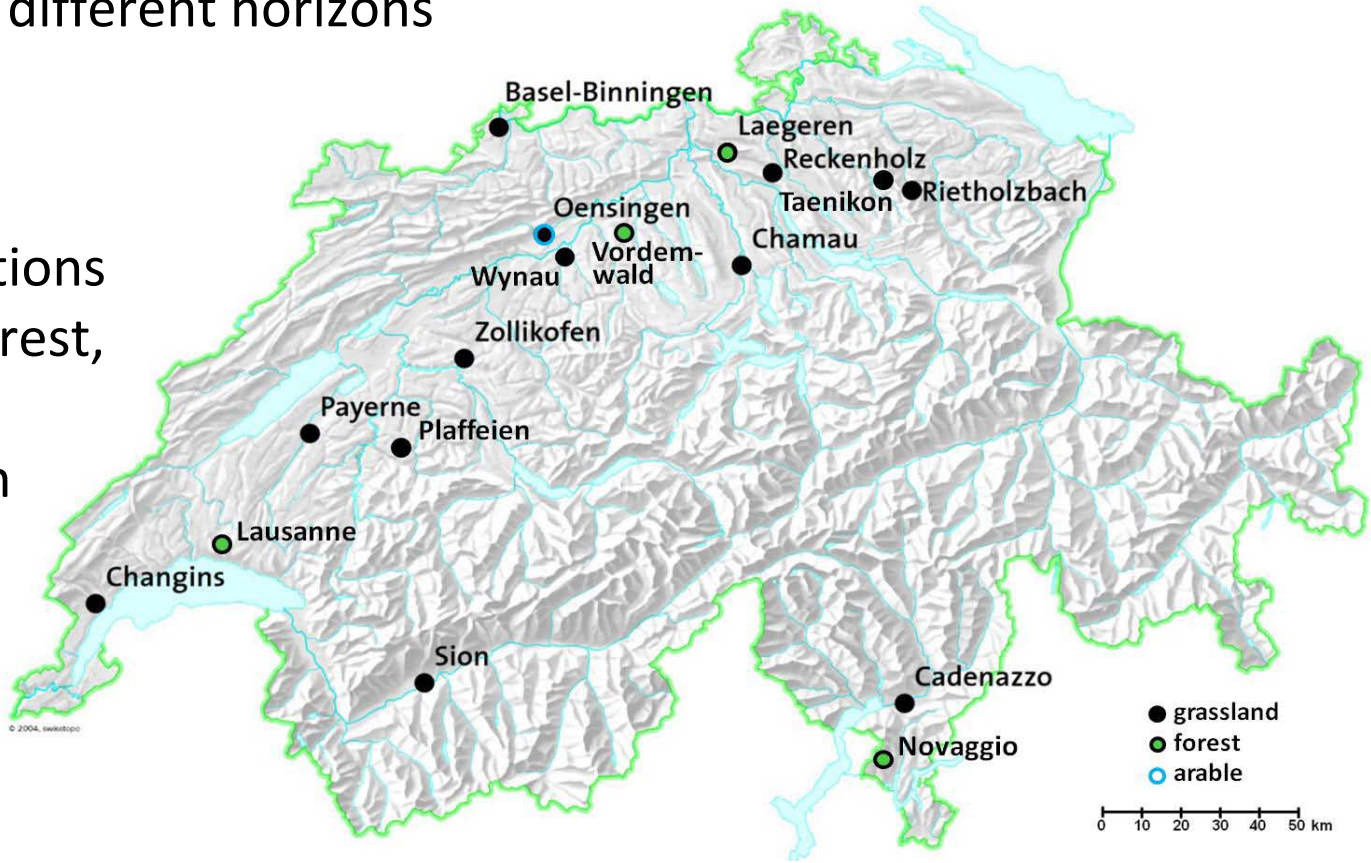
- Investigate land-atmosphere interactions
  - Changes in soil moisture are expected to have significant impact on regional climate (Seneviratne et al. 2006, Nature)
  - Importance of feedback in soil moisture-limited regime confirmed from observations (Hirschi et al. 2011, Nature Geoscience)
  - Feedbacks varies for different land cover (Teuling et al. 2010 , Nature Geoscience)
- Assess spatial and temporal variability of soil moisture in Switzerland
- Establish a large scale and long-term soil moisture observational network in Switzerland

Where to measure?

- < 1000 m a.s.l
- Meteorological variables
- Soil moisture and soil temperature in 5, 10, 30, 50, 80 and 120 cm
- Soil texture for different horizons

Since 2008/2009:

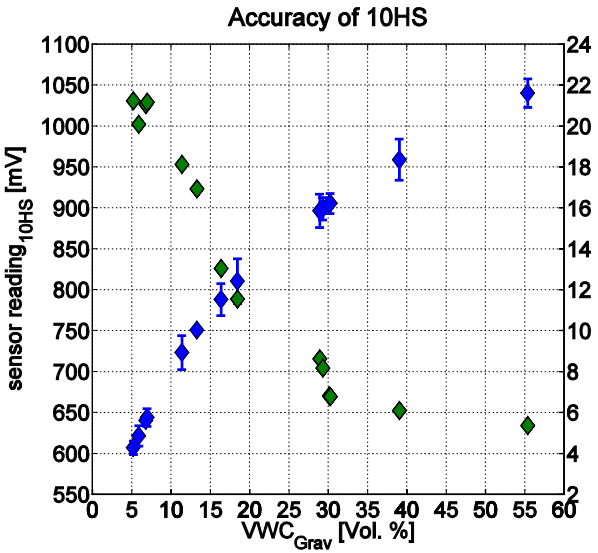
19 sites at 17 locations (14 grassland, 4 forest, 1 arable) with soil moisture in 10 min resolution



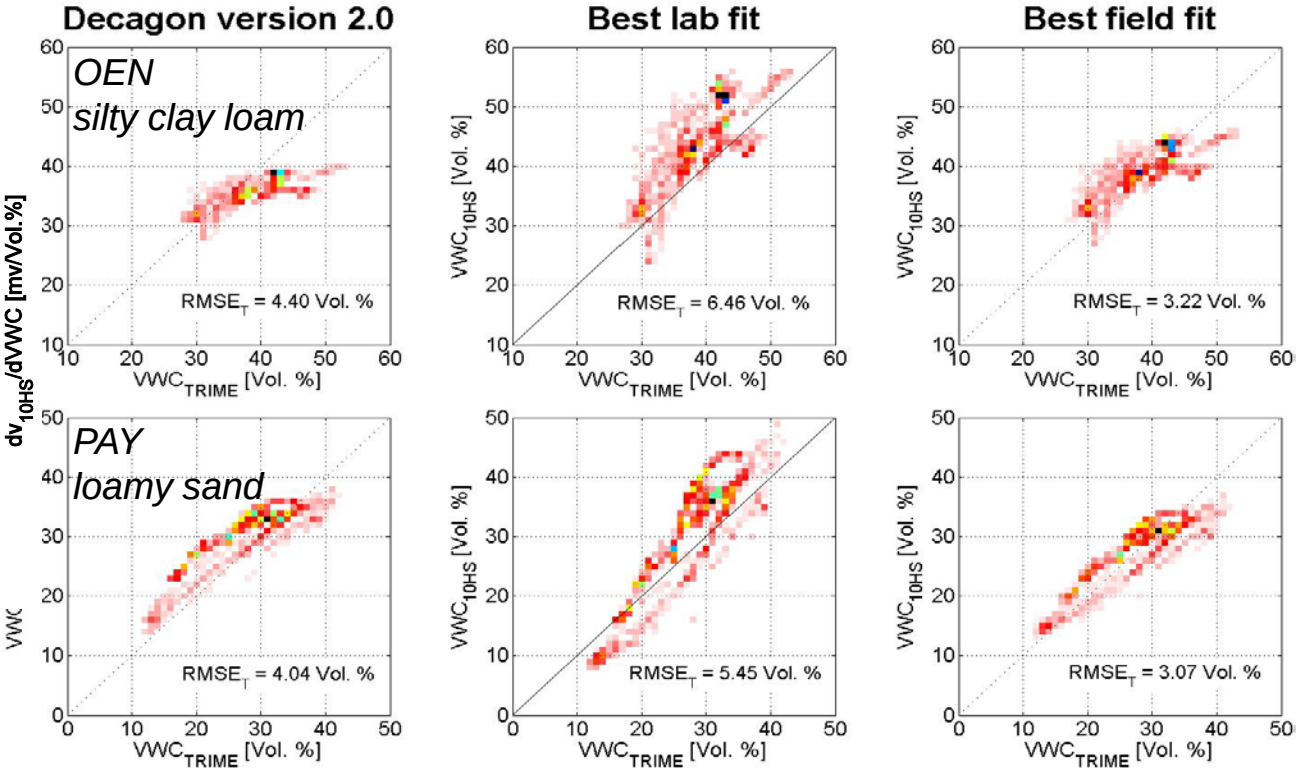
How to set up a site?

Which sensor type?

- Low cost sensor 10HS (capacitance, Decagon Devices, USA) in all 6 depths
- Parallel measurements with TRIME (TDR, IMKO GmbH, Germany) in 10 and 80 cm depth
- Site specific calibration using parallel TDR and soil information



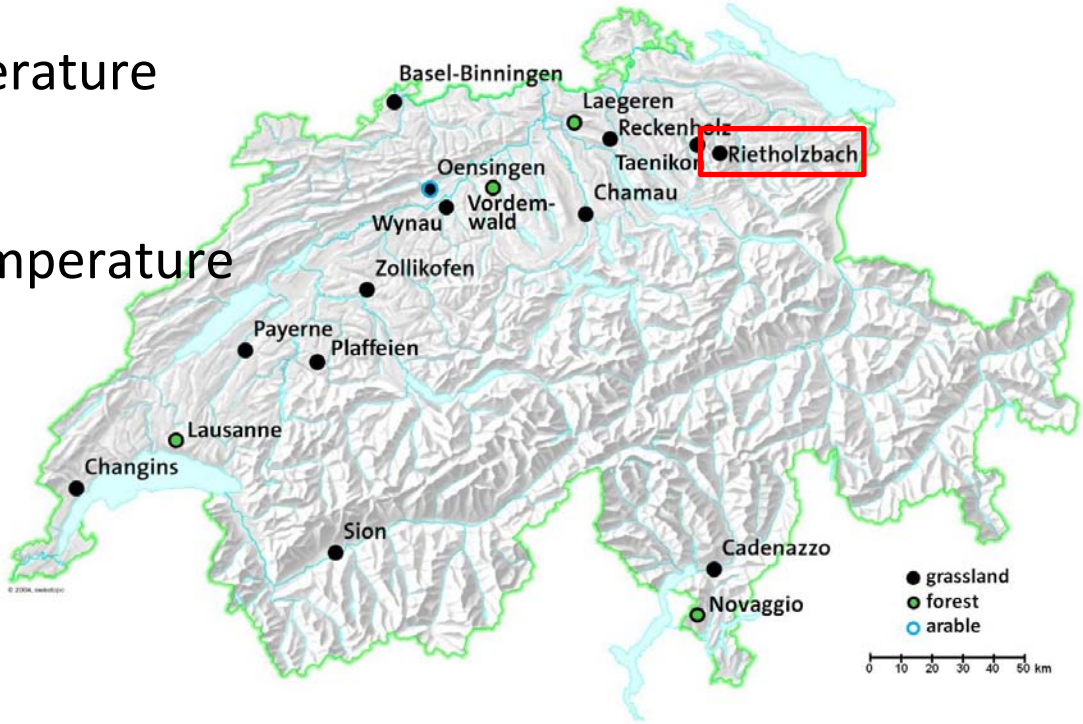
(Mittelbach et al. 2011, JGR)



Field measurements

SwissSMEX/-*Veg* site Rietholzbach RHB (http://www.iac.ethz.ch/url/rietholzbach)

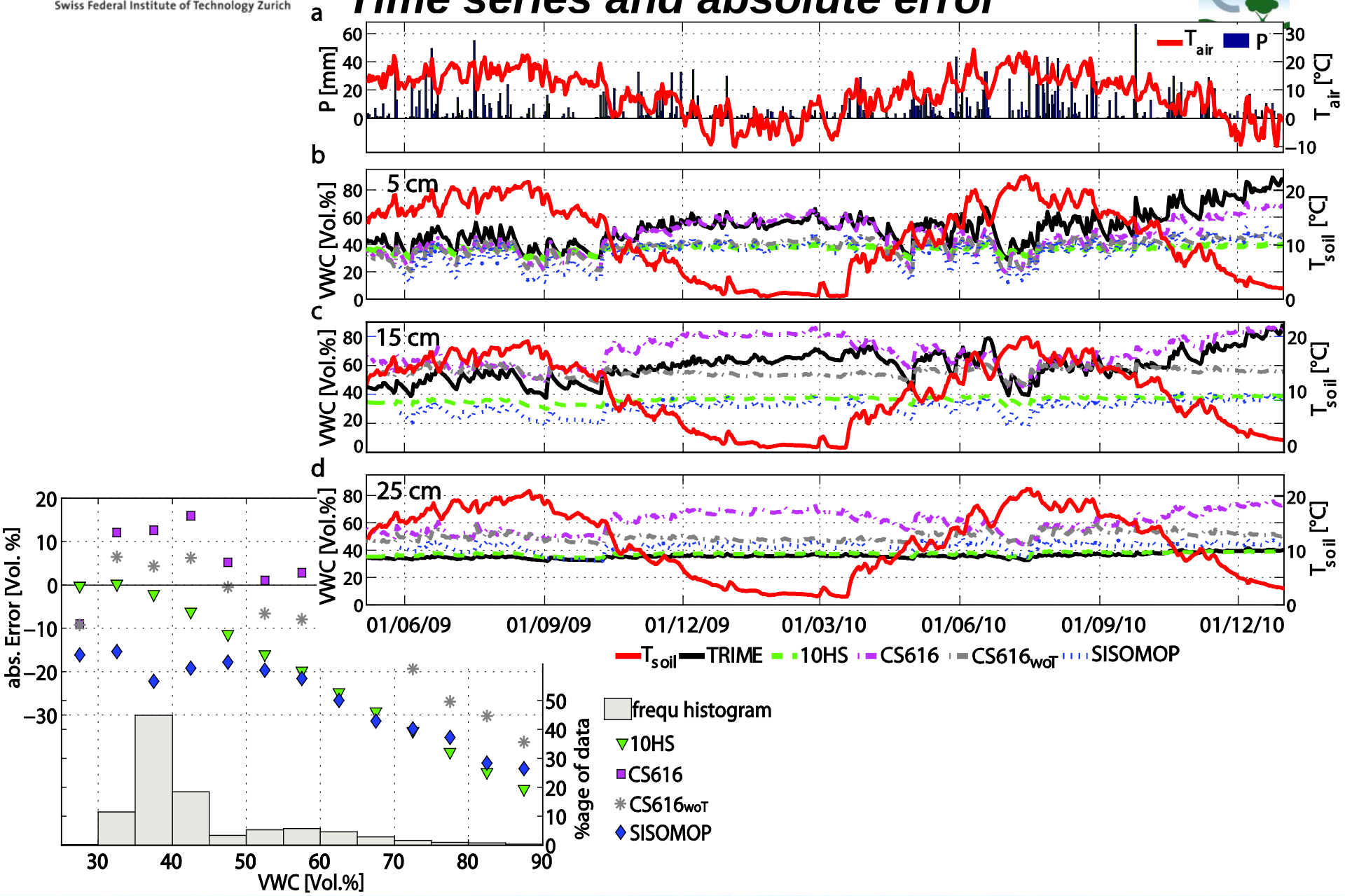
- Parallel installation of all four sensor types (10HS, CS616, SISO, TRIME)
- Calibration function provided by manufacturer
- Daily data for time period 7 May 2009 to 31 December 2010
- Soil moisture and soil temperature in 5 to 110 cm depth
- Precipitation and 2 m air temperature
- Soil type: clay loam to loam (USDA soil taxonomy)
- TDR is reference sensor



Sensor evaluation II

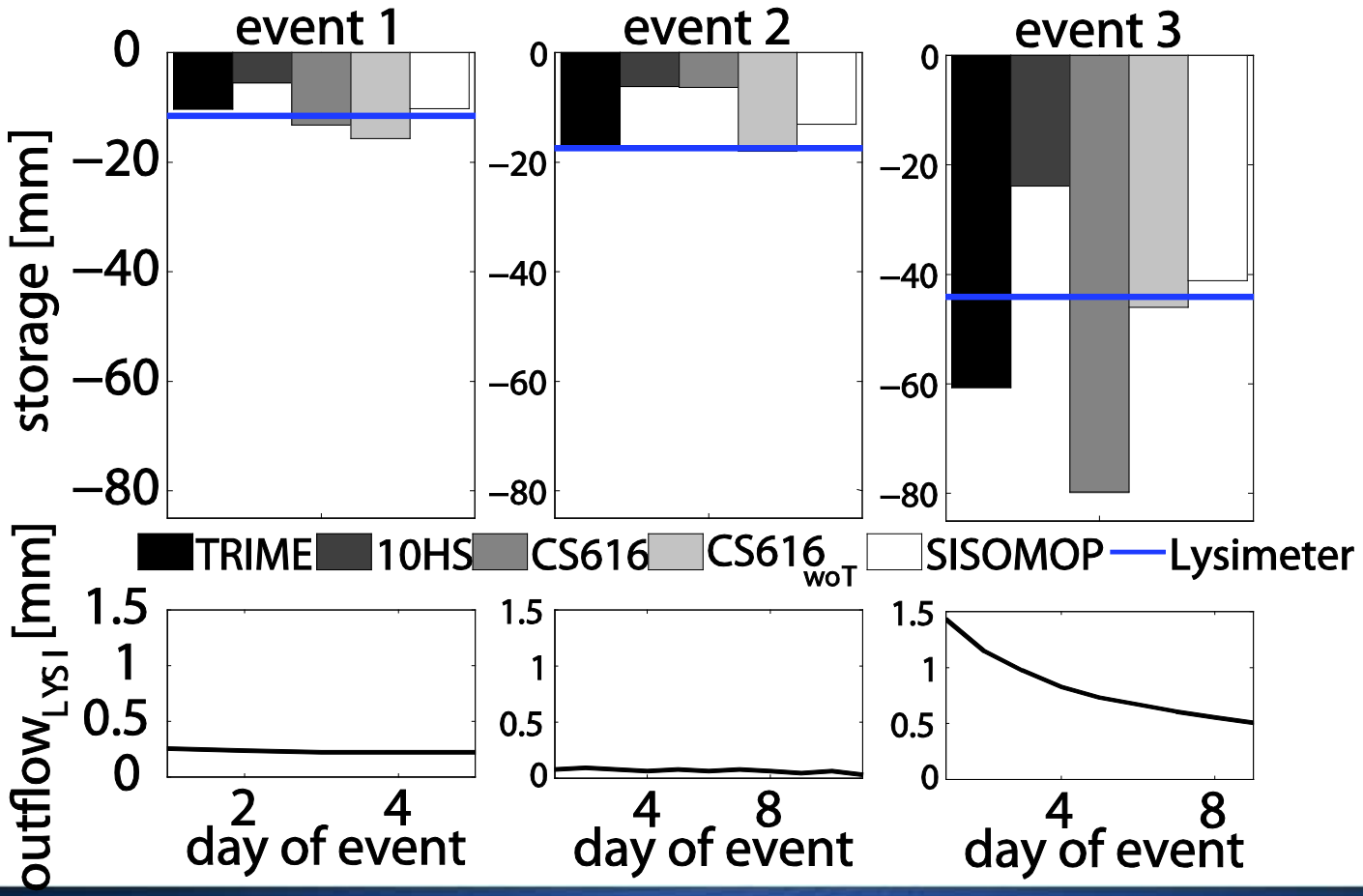
Sensor type	Technique	Range of VWC [Vol.%]	Power [mA] Dimension of rods [mm]	Accuracy
Low Cost 10HS (Decagon Devices, US)	capacitance	0 to 57	power: 15 length: 100 width: 9.8 spacing: 12.1	± 3 Vol.% (standard) ± 2 Vol.% (soil specific)
SISOMOP (Uni Karslruhe, Germany)	FDR	not given	power: 65 length: 300 width: 3	site specific
Medium Cost CS616 (Campbell Scientific, US)	FDR	0 to 100	power: 65 length: 300 diameter: 3.2 spacing: 32	± 2.5 Vol.% (standard) temp. correction recommended
High cost TRIME-IT/-EZ (IMKO GmbH, Germany)	TDR	0 to 100	power: 150 length: 160 diameter: 6 spacing: 40	±1 Vol.% to 40 Vol.% ±2 Vol.% to 70 Vol.%

Time series and absolute error



Application – estimation of ET

- Three P-free periods (6, 12 and 10 day)
- Integration over 110 cm (SISOMOP 55 cm)
- Reference: weighted lysimeter



Lessons learned

- Procedure of demonstrated site set up is suitable
- Beside costs and accuracy: the selection of sensors depend also on power consumption and its dimension

- TDR perform well at all sites
- Sensor to be tested using calibration function provided by the manufacturer have problem to
  - capture accurately the absolute volumetric water content
  - capture variability in absolute volumetric water content
- Temperature dependency also affects applications using daily resolution
- Site / soil specific calibration is highly recommended → additional time and manpower necessary

Thanks

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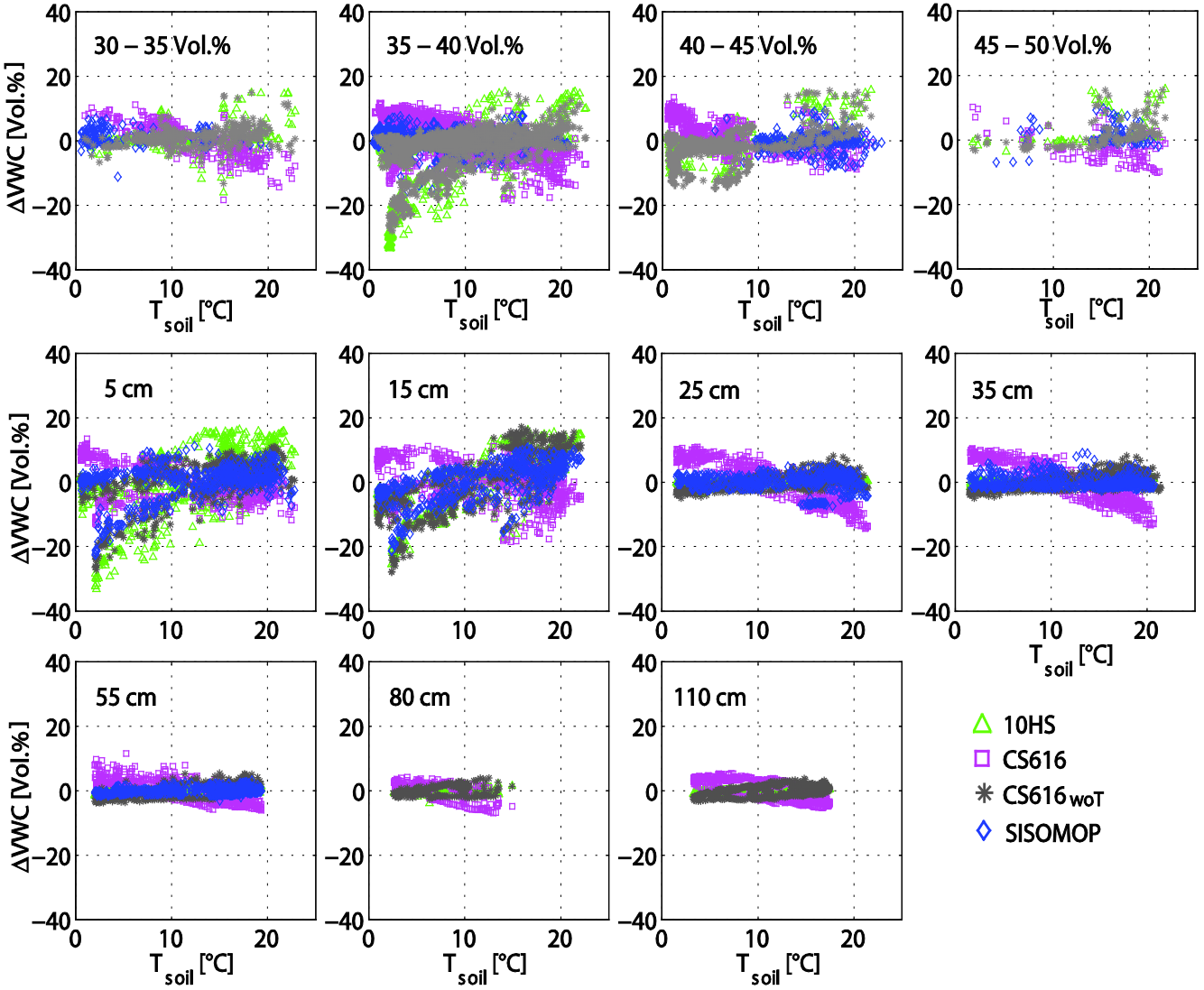
Temperature dependency



$$\Delta VWC = (VWC_{test} - VWC_{ref}) - \overline{(VWC_{test} - VWC_{ref})}$$