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Analysis of runoff components and water residence times in a mesoscale catchment by means of stable isotopes and modeling

TERENO, TR32 Subproject C1

25th October 2012 | Michael Stockinger
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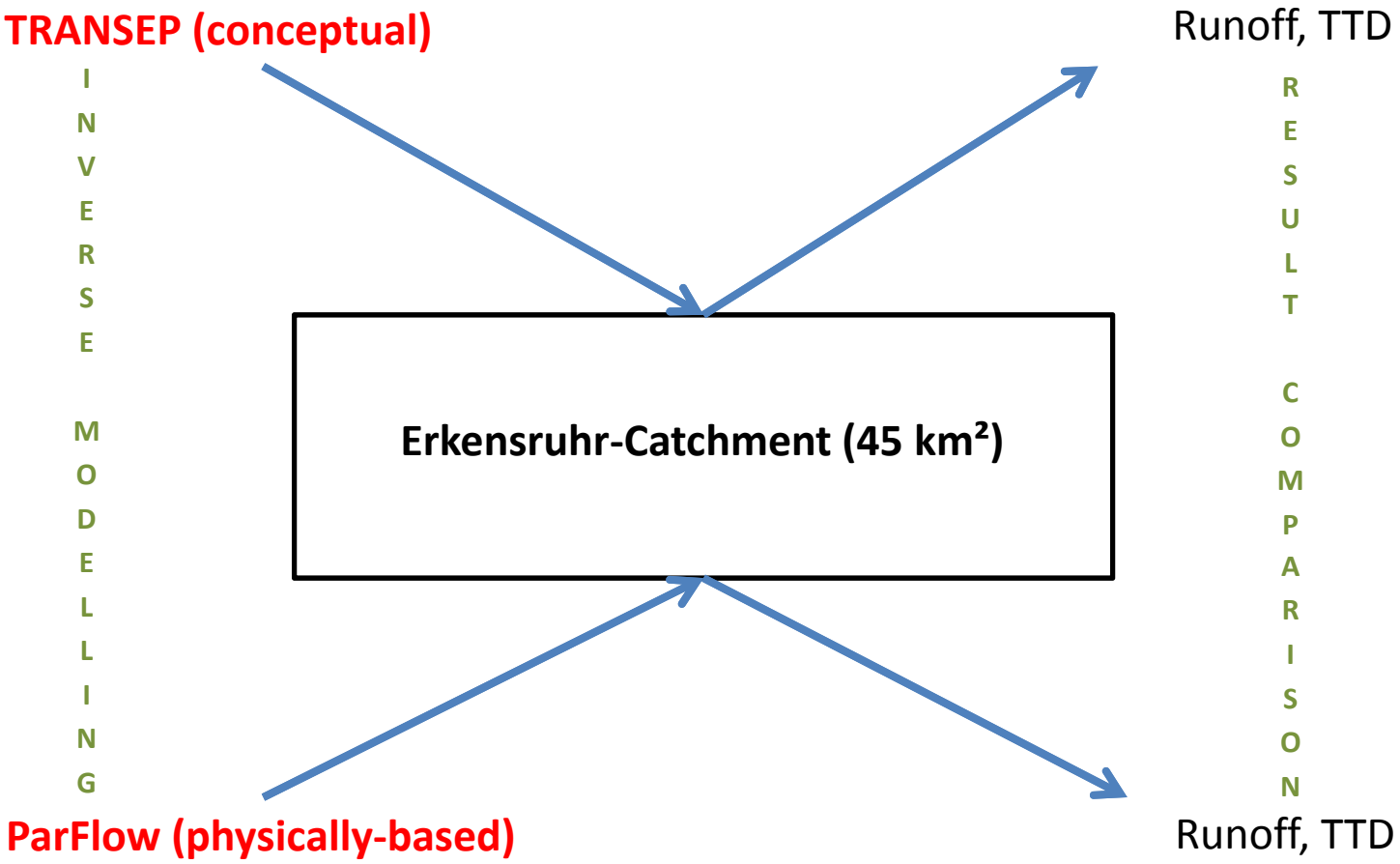
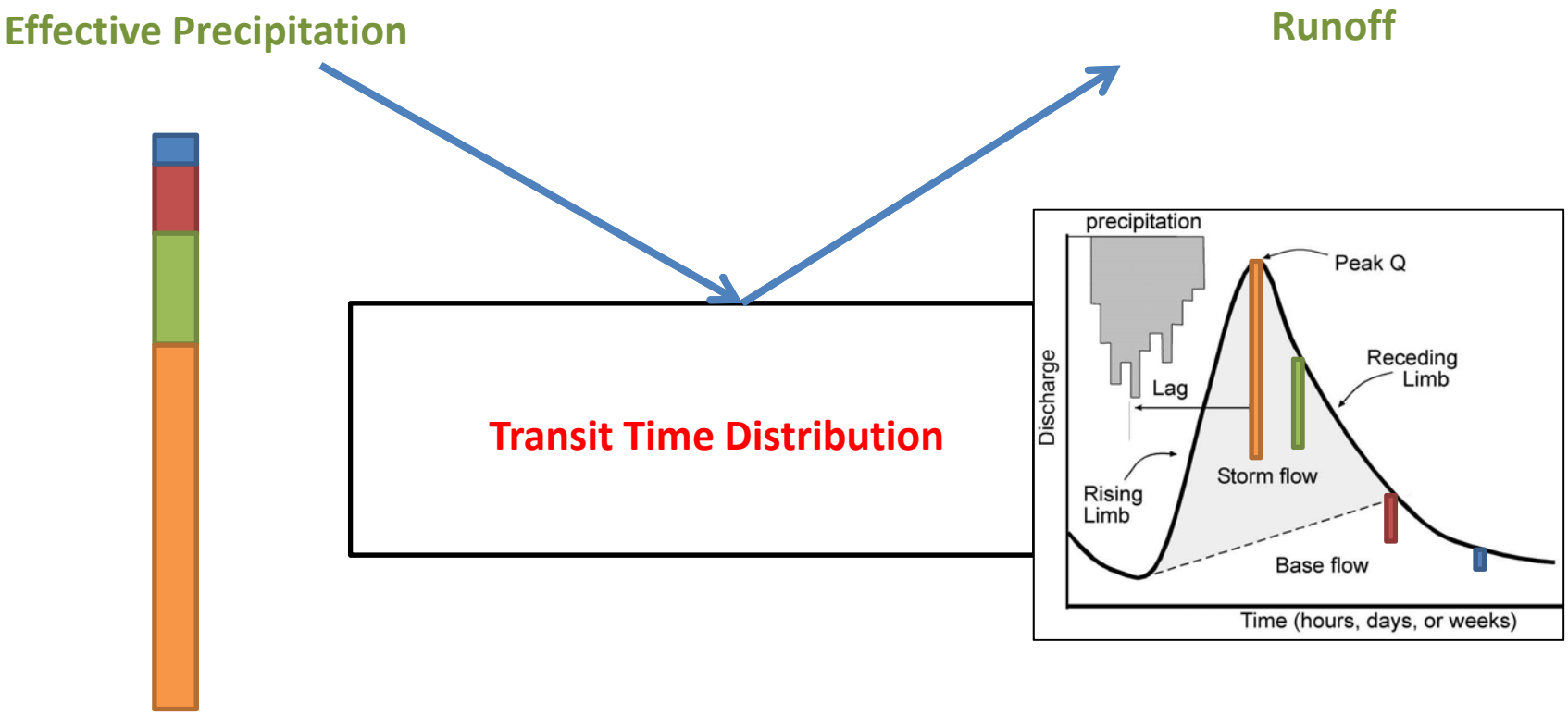
Objective



TTD



<u>Models for TTD</u>: PistonFlow, Exponential, Convection-Dispersion Equation, Linear Reservoirs, Gamma Distribution, etc…

Isotope Hydrology

Isotopes of H and O in H_2O are like a **fingerprint**

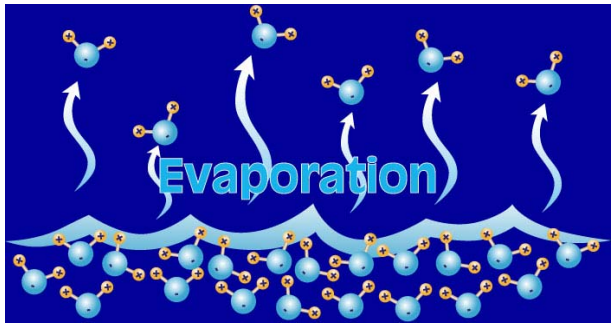
TRACER

Isotope ratios are given as δ - values

$$\delta^{18}O = \left(\frac{\left(\frac{^{18}O}{^{16}O}\right)_{sample}}{\left(\frac{^{18}O}{^{16}O}\right)_{standard}} - 1 \right) * 1000\ ^{o}/_{oo}$$

Higher temperatures (evaporation) increase δ - values

$\delta^{2}H$ ↑ $\delta^{18}O$ ↑



Erkensruhr

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

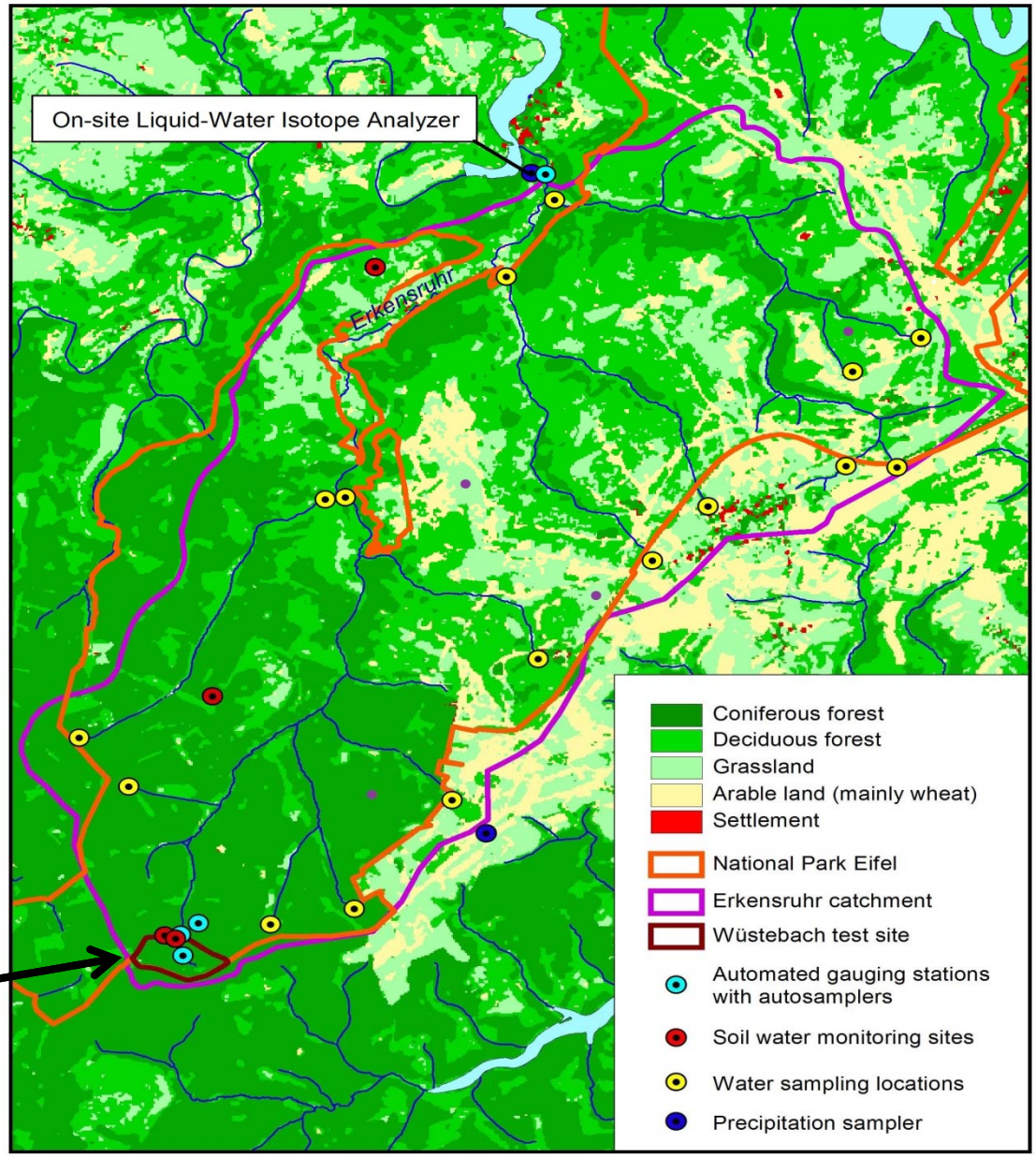
JÜLICH
FORSCHUNGSZENTRUM

Installation

- Dendro/Soil station Throughfall
- Spring & Stream samples
- Precipitation Sampler
- Measurement-Container

Infrastructure

TERENO & FZJ
Financed by TR32



Nationalpark Eifel

Area

45 km²

Sub-catchment „**Wüstebach**“:
3+ years of data

Mitglied in der Helmholtz-Gemeinschaft

Measurement Container

Picarro Isotope Analyzer

12 minutes

$\delta^{18}O$ & $\delta^{2}H$

YSI Probe

15 minutes

T, pH, O_2, EC

TriOS Probe

15 minutes

DOC, NTU, SAC, $N\text{-}NO_3$

Precipitation sampler

Samples, Amount, Time

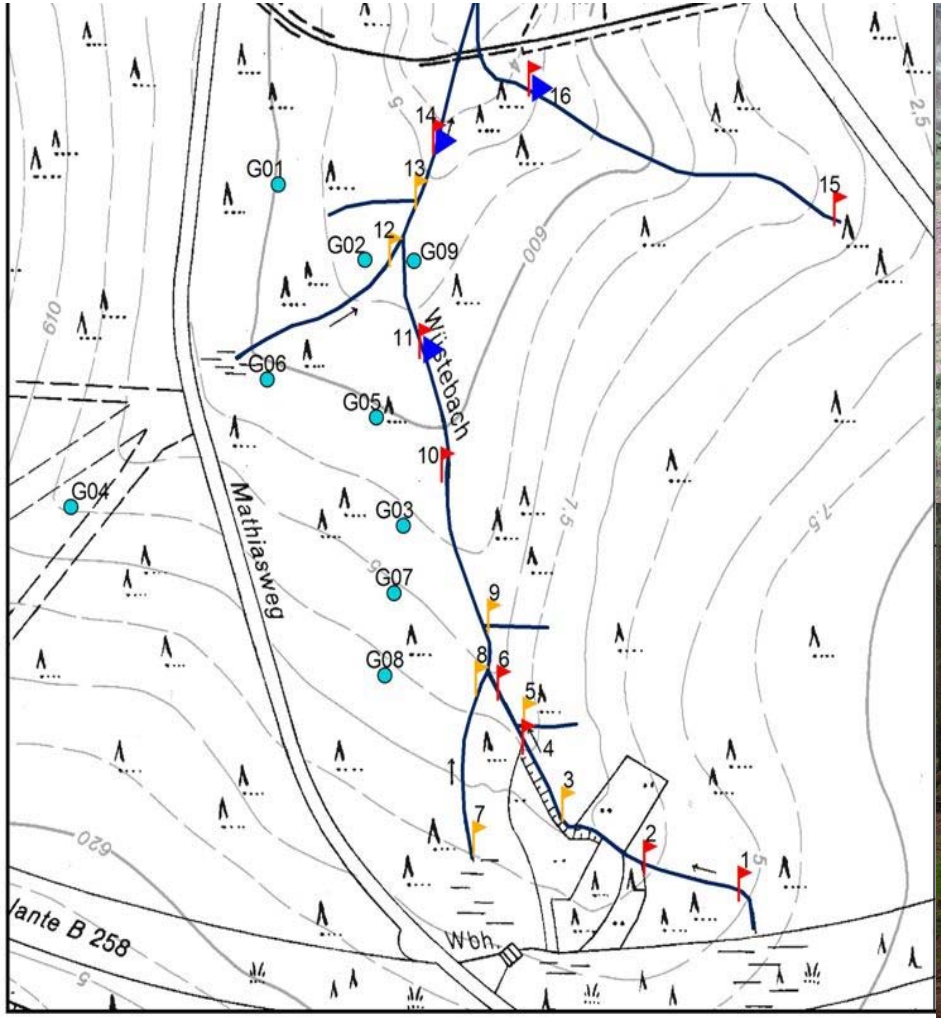
Daily & 15 minutes

Auto Sampler

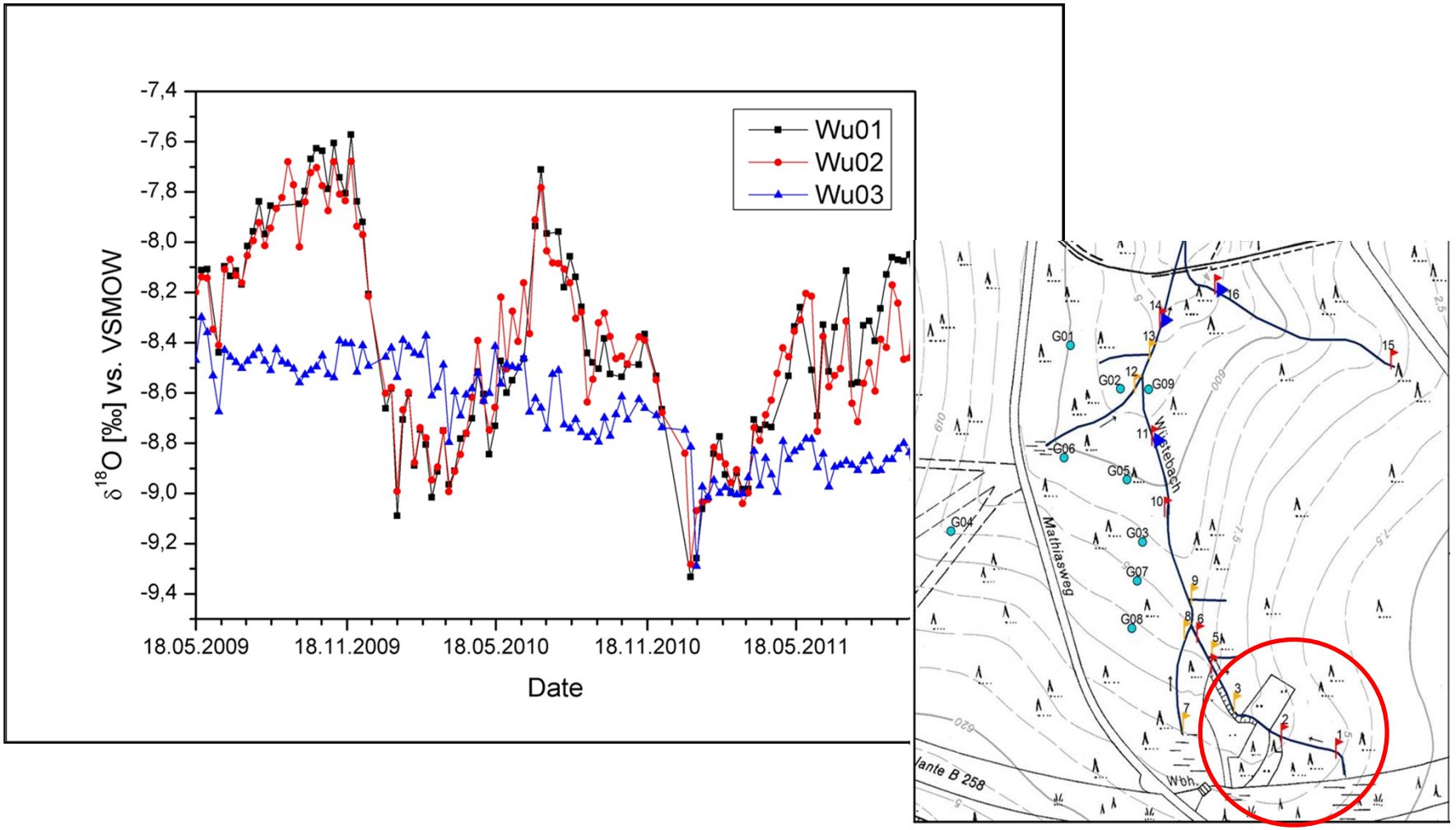
River water samples

2/4 hours

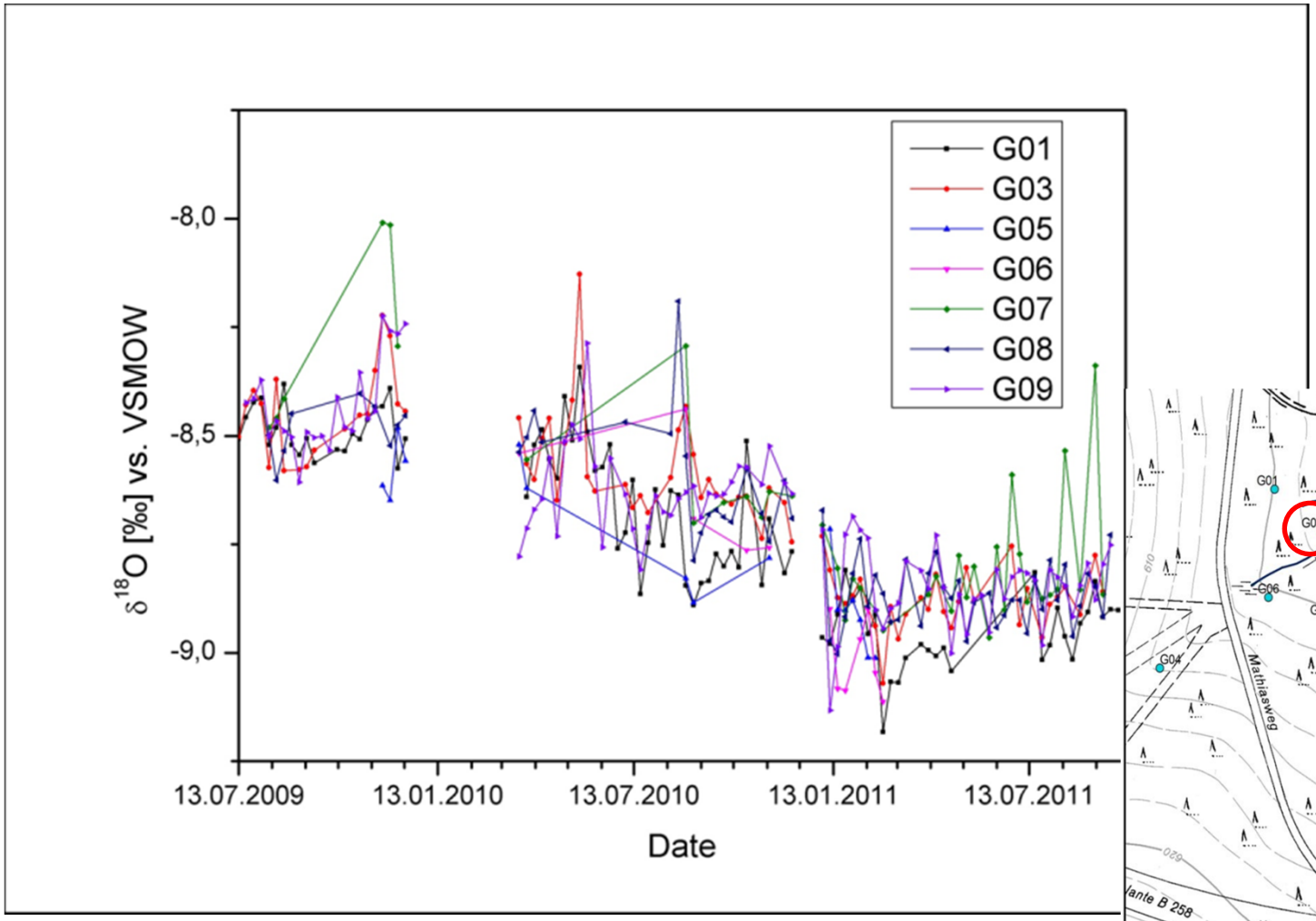
Wüstebach

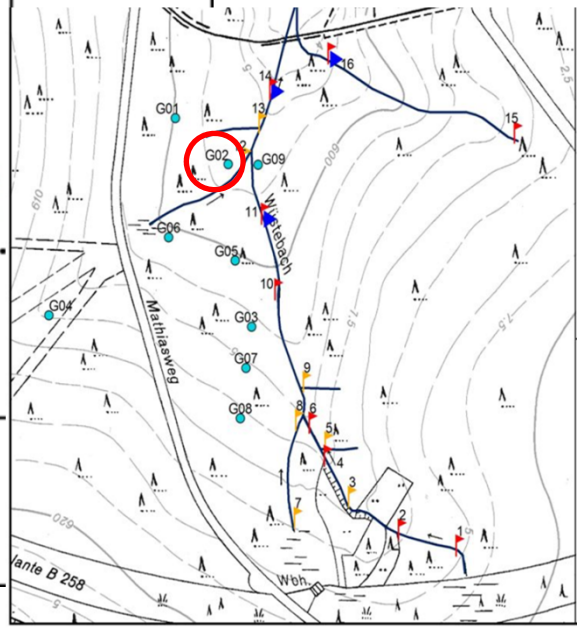


Stream water

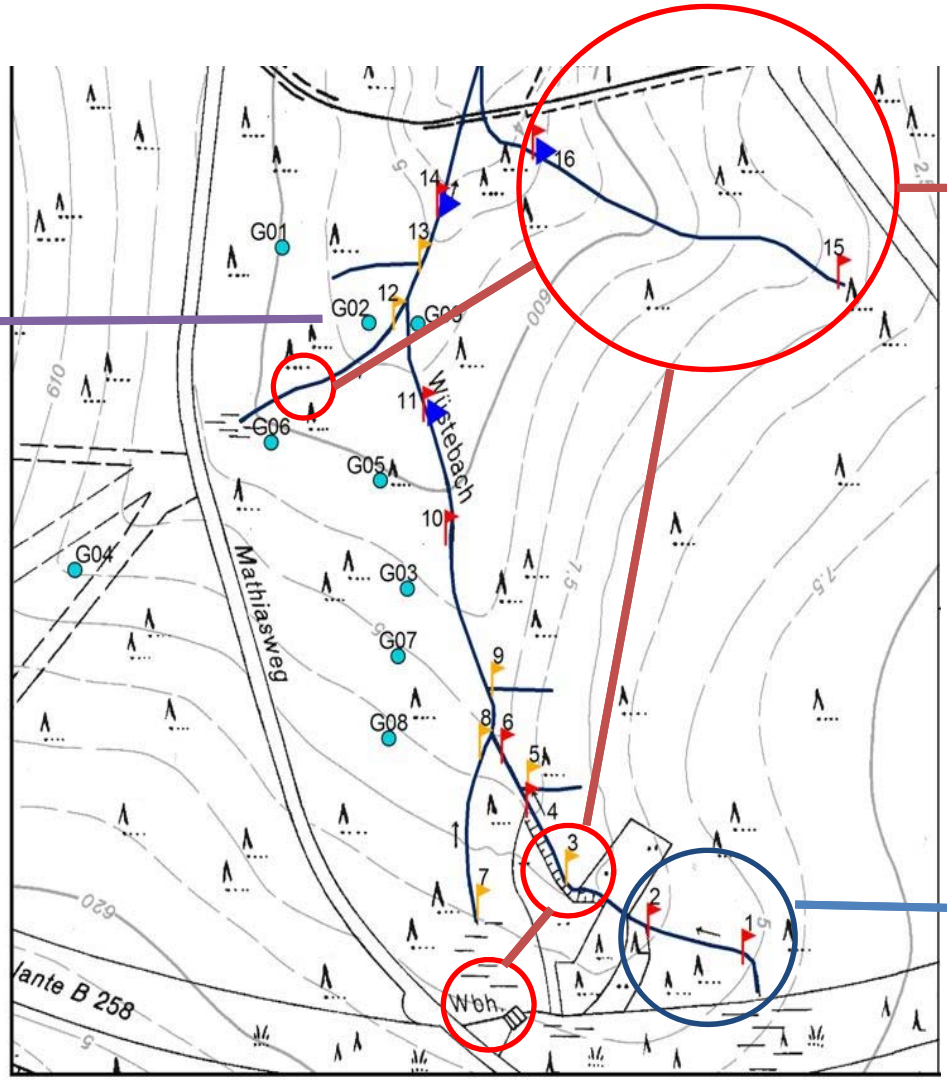


Groundwater





Summary



Seasonal effect

Precipitation
Seasonal effect

Groundwater

Strong seasonal effect

Spatial Distribution of TTD across the Wüstebach River using stable isotopes of water

Work in progress

To be published

Acknowledgments to Markus Weiler (University of Freiburg) for the idea

Q & P

P_{eff}

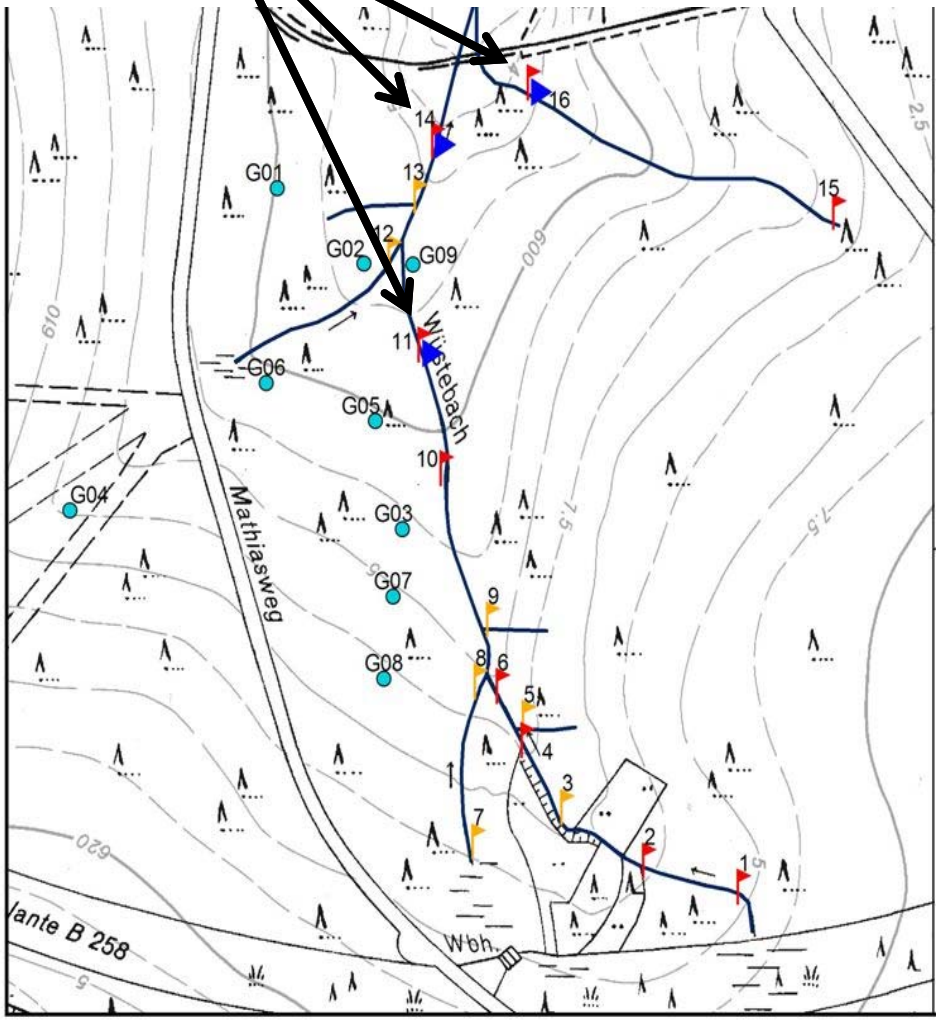
<u>Assumption</u>

P_{eff} const. over catchment

+ Isotopes

Calculation of TTD along all isotope measurement points (un/gauged)

Gauged



<u>Data Limitation</u>

Weekly Isotope values

Event Isotope Loads will be missed

Base Flow

Convolution Function

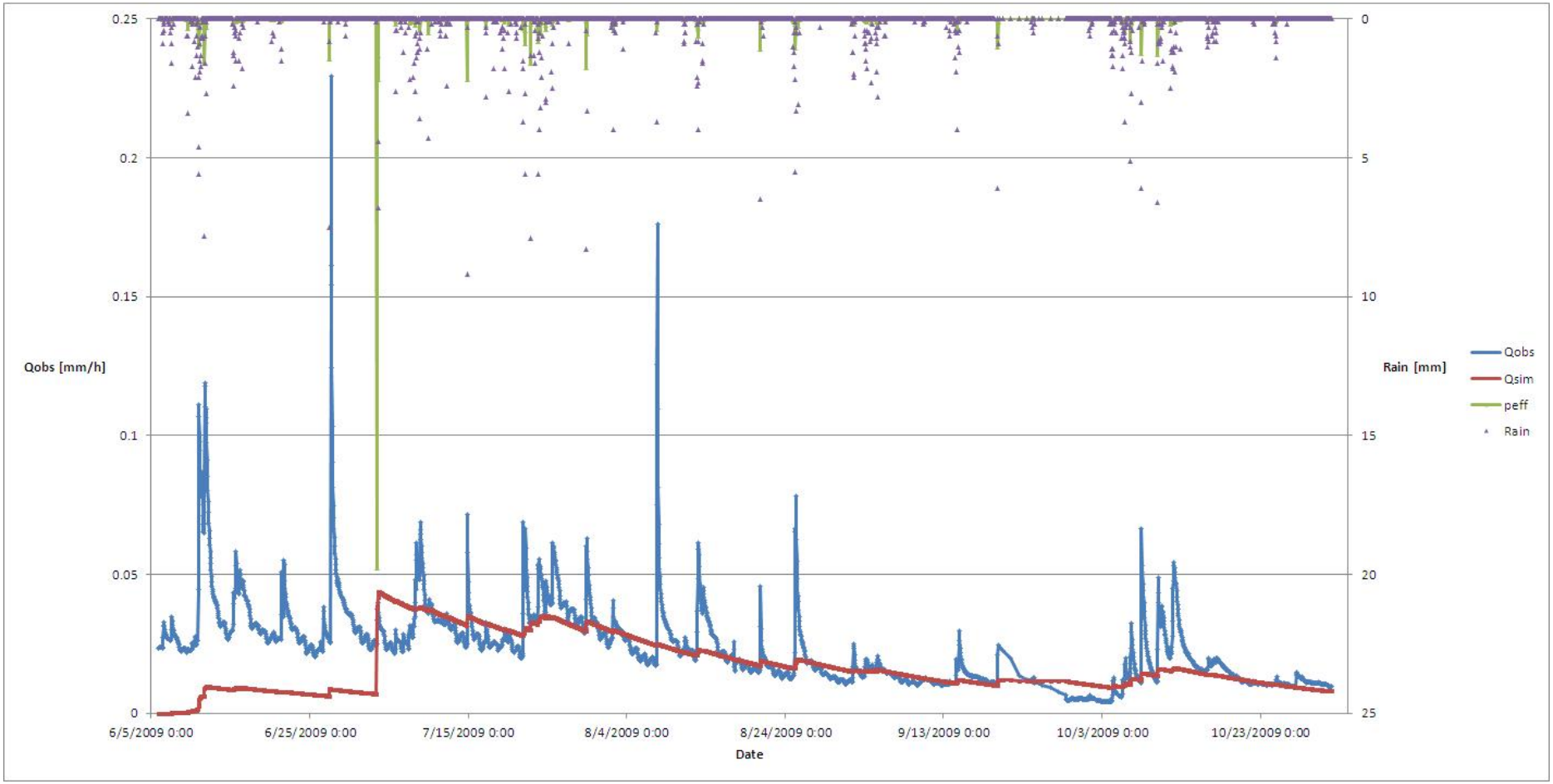
$$Q(t) = \int_0^t g(\tau)\, p_{\text{eff}}(t-\tau)\, d\tau$$

p_{eff}

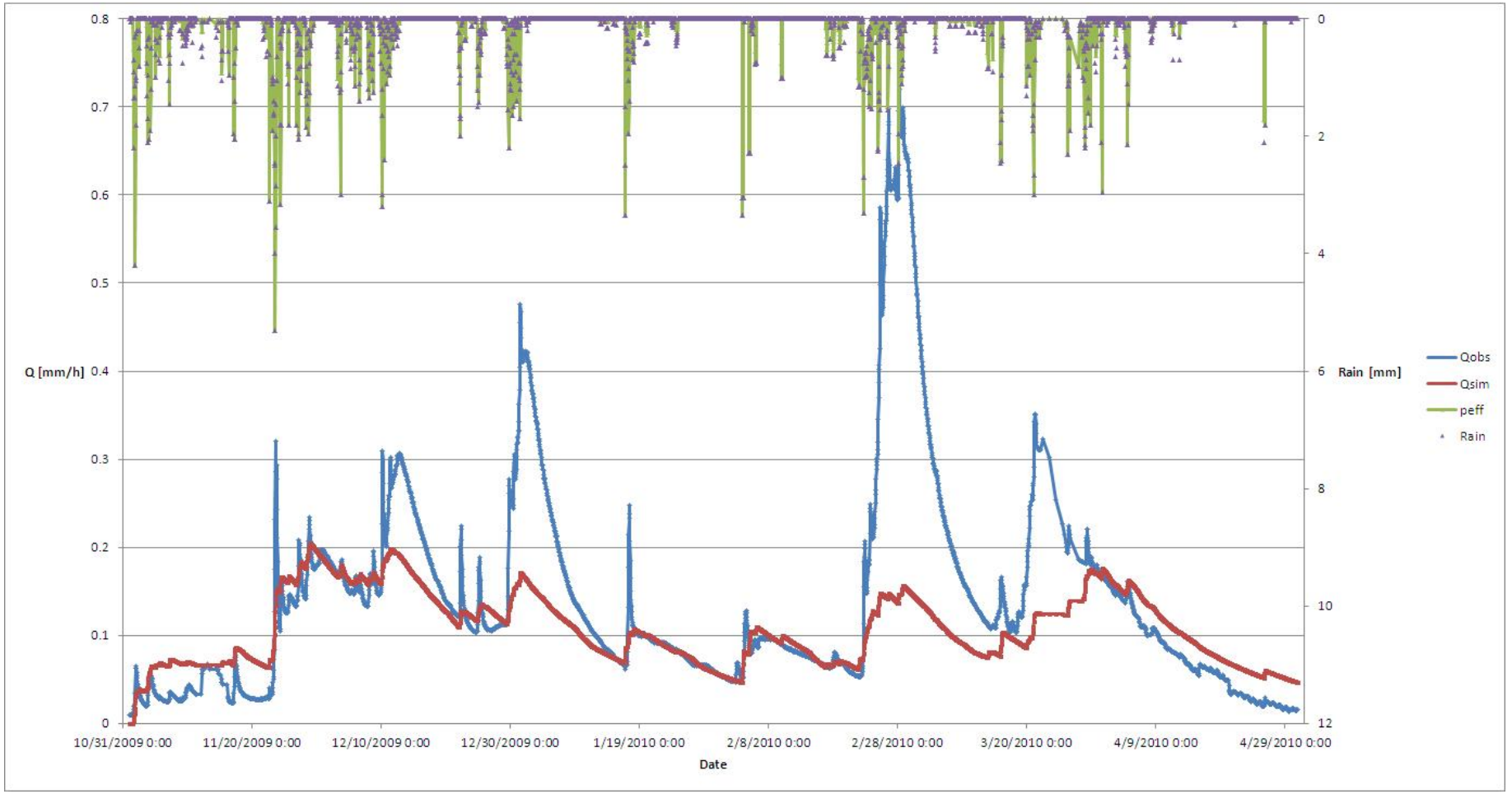
Streamflow Isotopes

$$C(t) = \frac{\int_0^t C_{\text{in}}(t-\tau)\, p_{\text{eff}}(t-\tau)\, h_b(\tau)\, d\tau}{\int_0^t p_{\text{eff}}(t-\tau)\, h_b(\tau)\, d\tau}$$

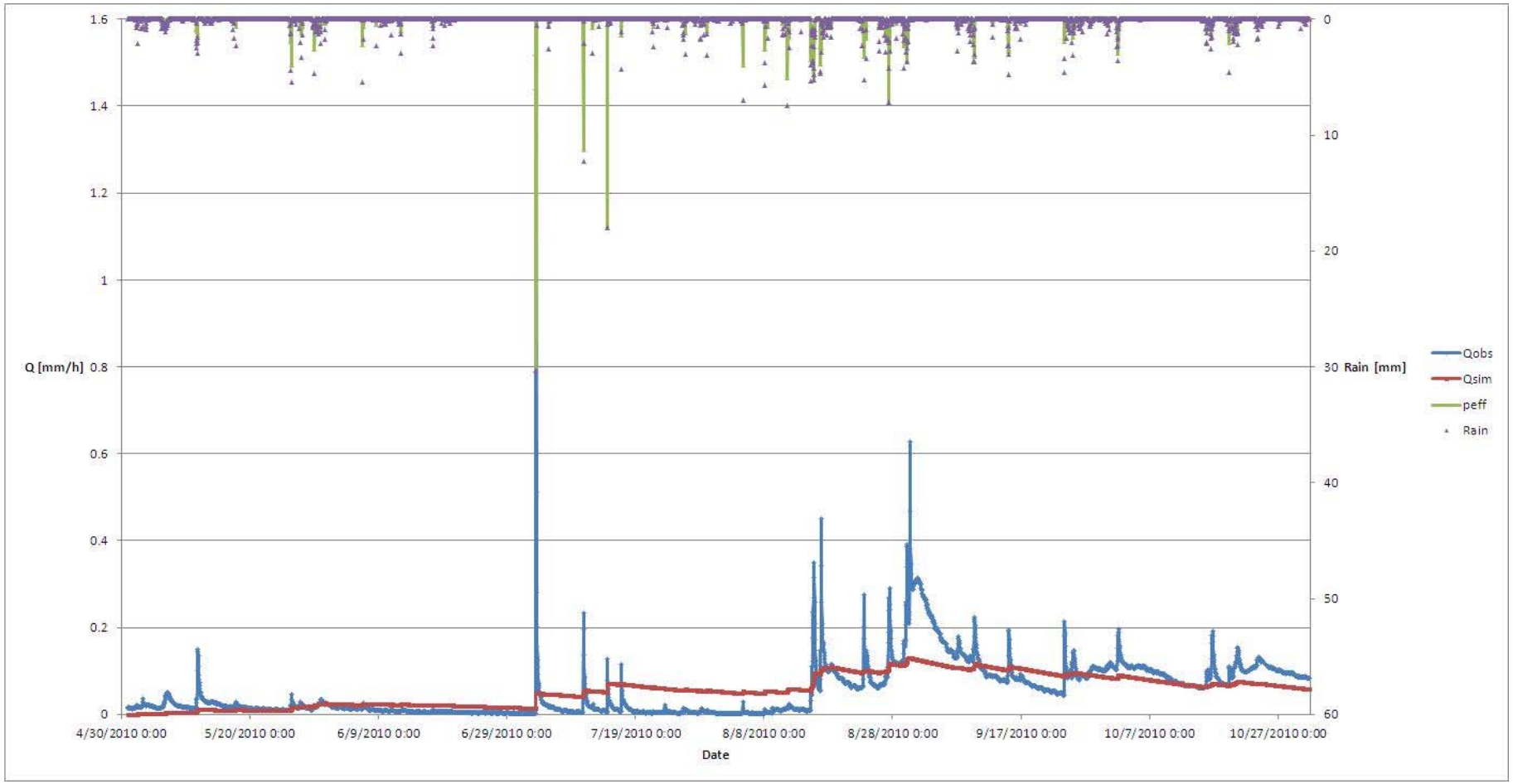
Summer 09



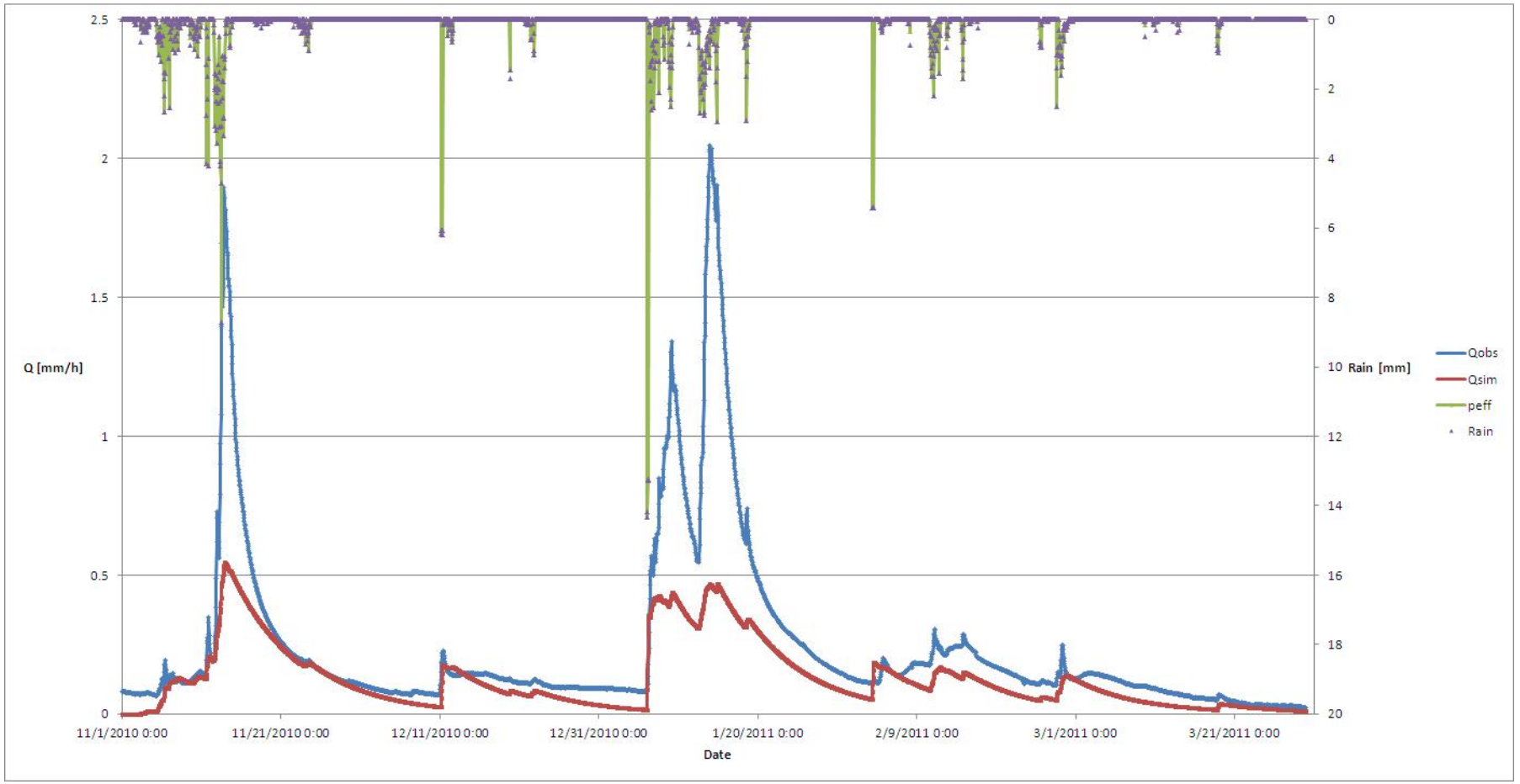
Winter 09/10



Summer 10



Winter 10/11



Missing 200 mm rainfall → storage term in water balance equation?

Thank you for your attention!

Terrestrial Environmental Observatories

Eifel/Niederrheinische Bucht

TR 32 – Subproject C1

Acknowledgements to Transregional Collaborative Research Centre 32 (TR32)

More information at http://www.tr32.de