TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

JÜLICH
FORSCHUNGSZENTRUM

Seasonal Soil Moisture Patterns Control Transit Time Distributions in a Forested Headwater Catchment

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Motivation

Estimation of a catchment's travel time of water molecules (**Transit-Time Distribution, TTD**) with a tracer needs a **gauged river**.

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

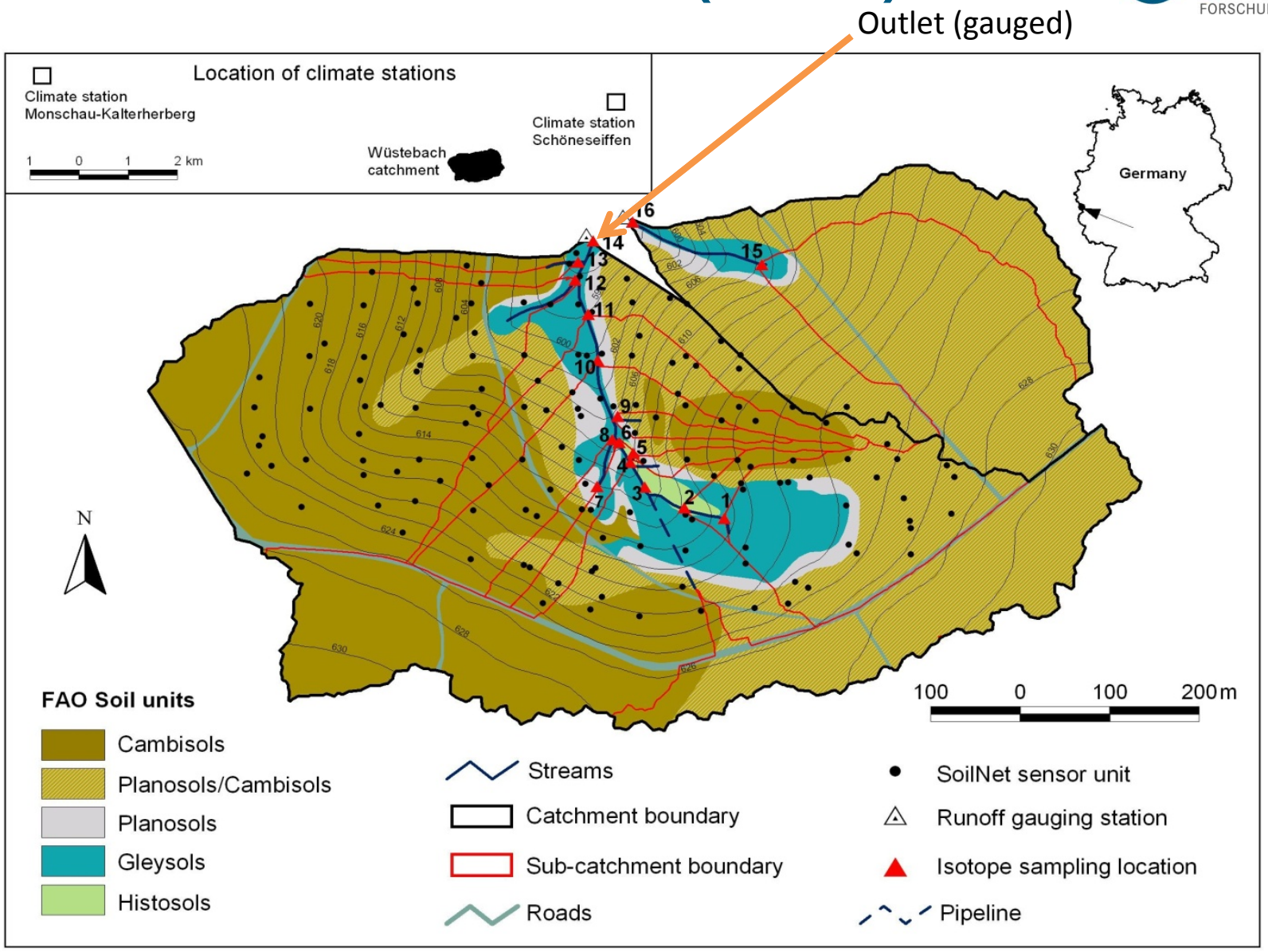
TRANSEP

***Weiler et. al (2003)**, How does rainfall become runoff? A combined tracer and runoff transfer function approach, Water Resources Research*

Hypothesis

- Use one gauged river location to derive p_{eff}
- Assume p_{eff} = constant in a small catchment
- Use this p_{eff} time series for ungauged river locations with tracer time series ($\delta^{18}O$) to derive **TTD**.

TERENO Test-Site: Wüstebach (38.5 ha)



Points 1 – 16: Isotope tracer data

Hydrograph Simulation

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

Q_{obs}

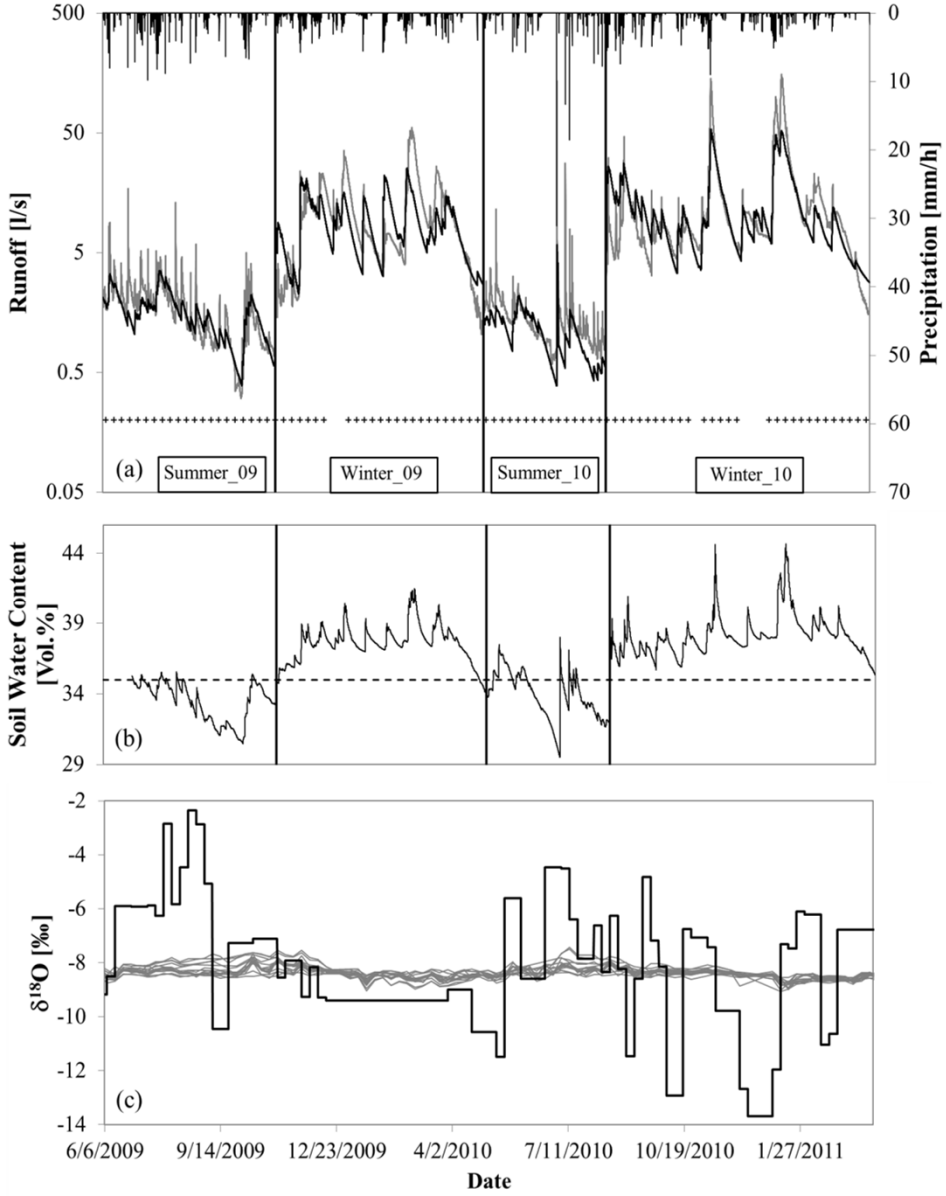
Q_{sim}

SWCm … Mean Soil Water Content

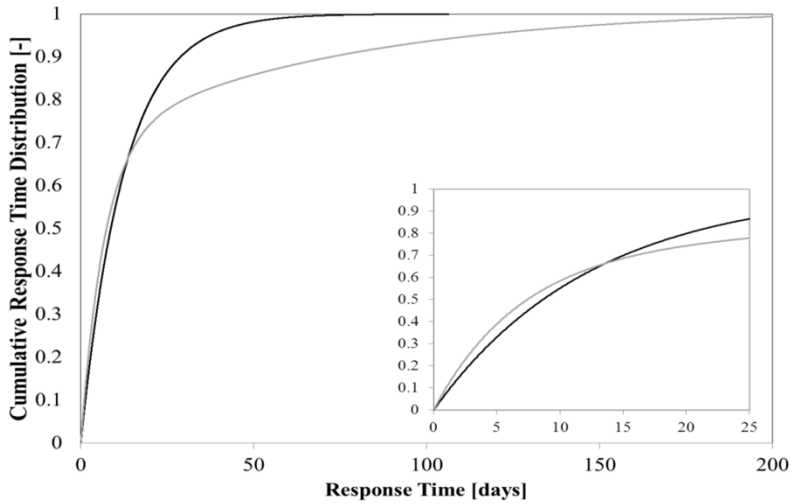
Tracer Data

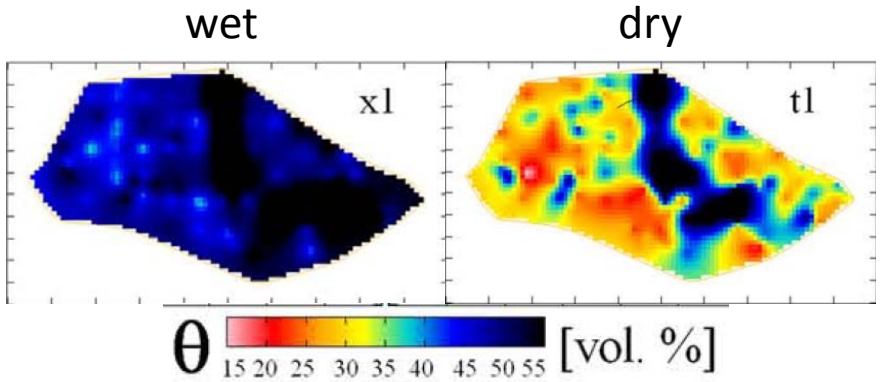
Stream Water

Precipitation

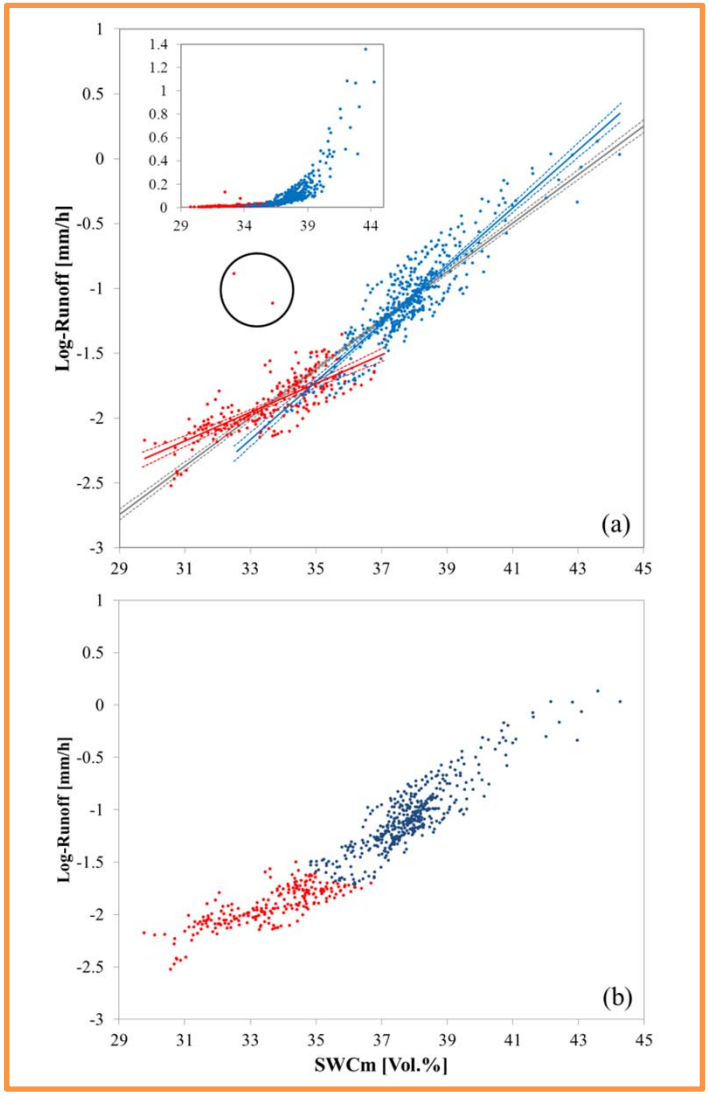


Riparian Zone – Hillslope Disconnection



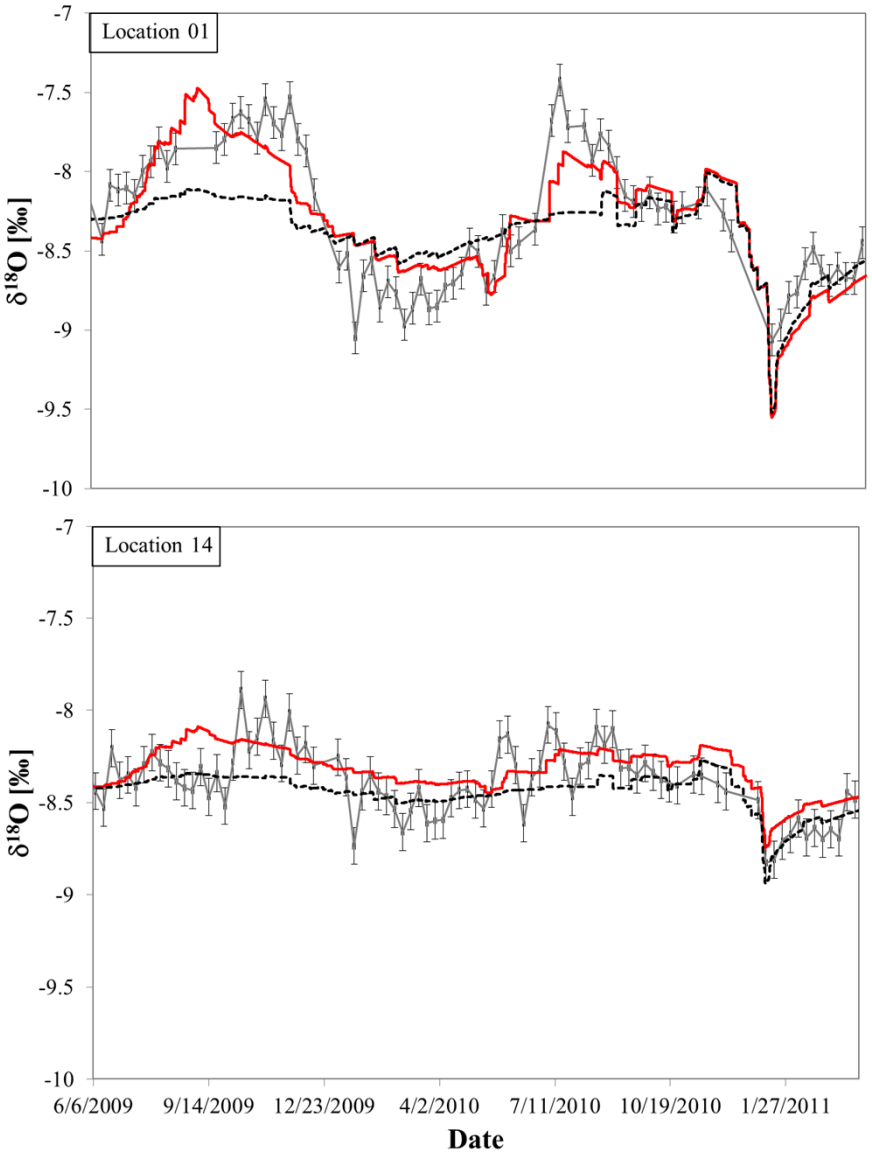


***Rosenbaum et. al (2012)**, Seasonal and event dynamics of spatial soil moisture patterns at the small catchment scale, Water Resources Research*



Isotope Simulation

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



near the source

NSE = 0.74

outlet

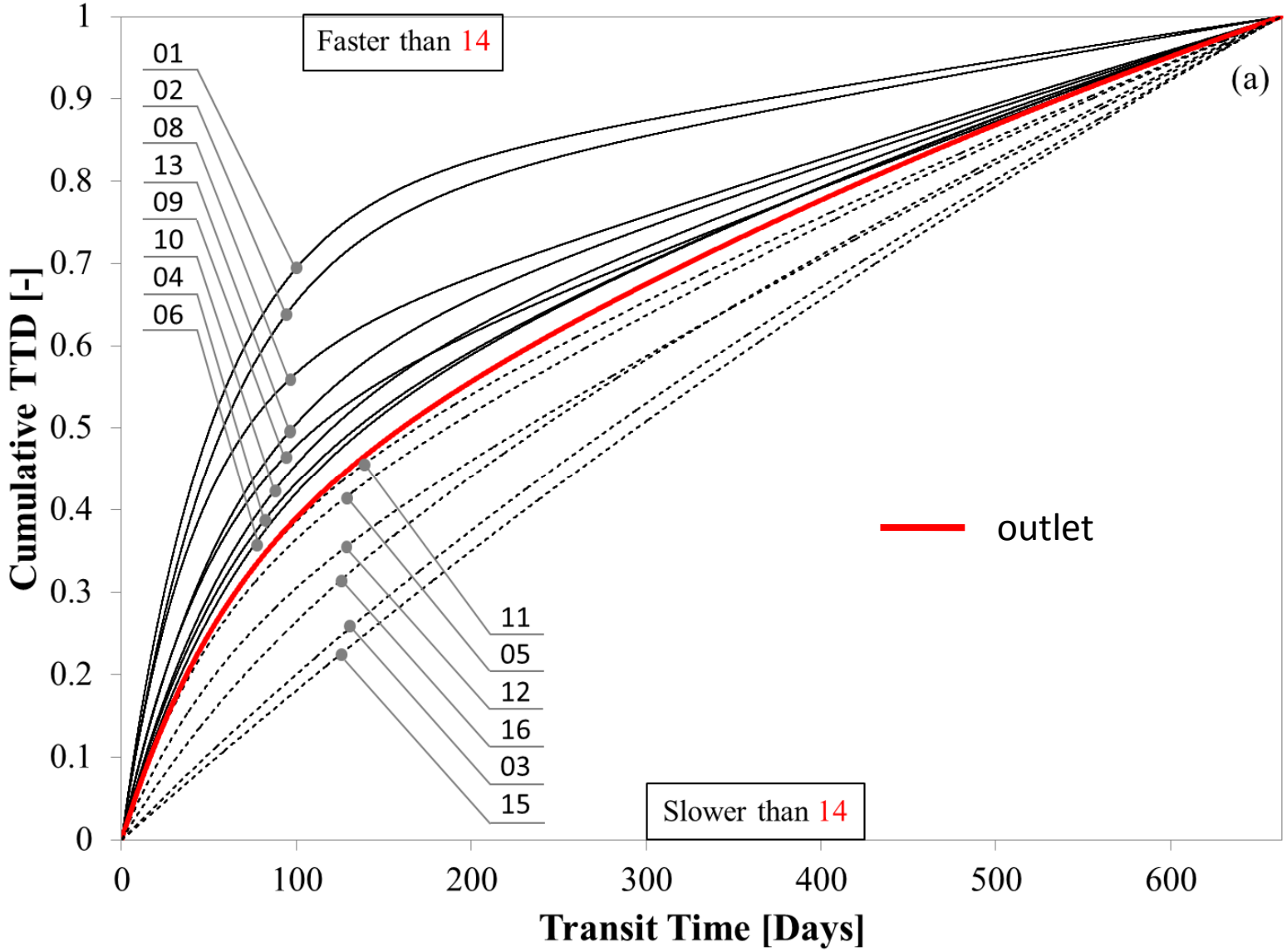
NSE = 0.34

$\delta^{18}O$ Obs

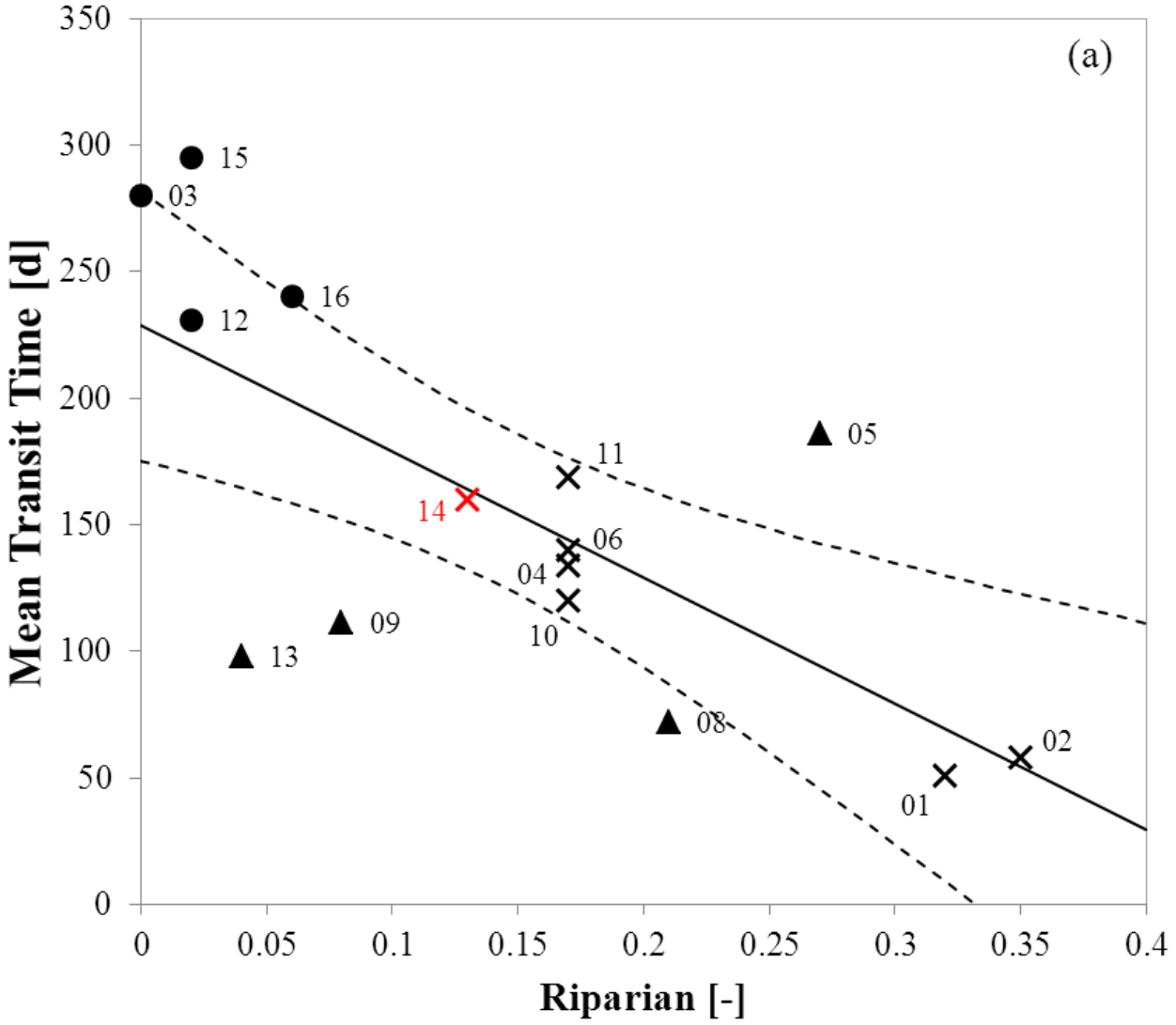
$\delta^{18}O$ Sim

38.5 ha only

Isotope Simulation



Isotope Simulation



Conclusions

- Hydrograph simulation with TRANSEP indicates that the runoff active-catchment area changes with overall wetness condition
- During wet state the full catchment (38.5 ha) is active, whereas during dry state only appr. 13% (5 ha) of the catchment remains active
- Taking this into account allowed for succesful modelling of non-event isotope tracer time series and determination of TTDs
- The outlet integrated the diverse TTDs of the catchment

Thank you for your attention.

Terrestrial Environmental Observatories

Eifel/Niederrheinische Bucht

More information and data at **http://www.tereno.net**

TR 32 – Subproject C1

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