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# Isotopic hydrograph separation in a small agricultural catchment

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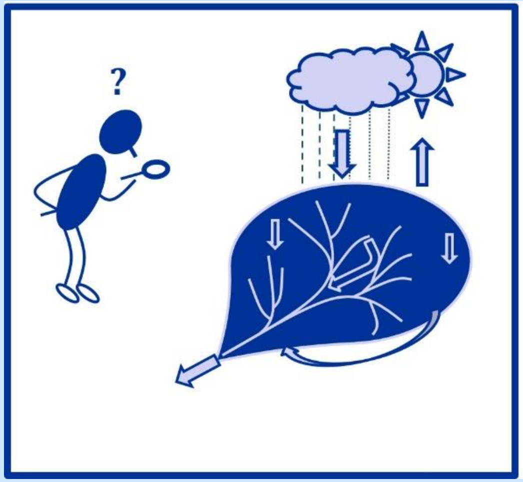
# Content

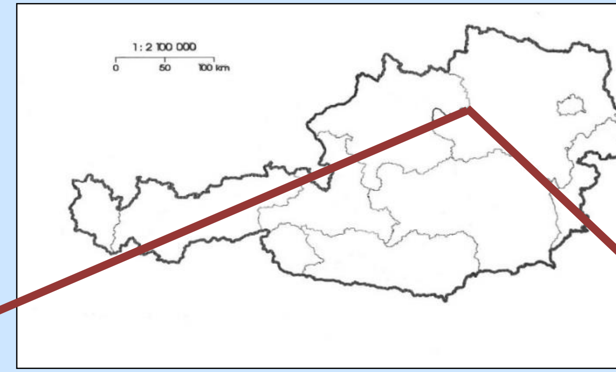
1. Research aims,
2. Study area,
3. Data and methods,
4. Preliminary results,
5. Outlook.

# Research aims

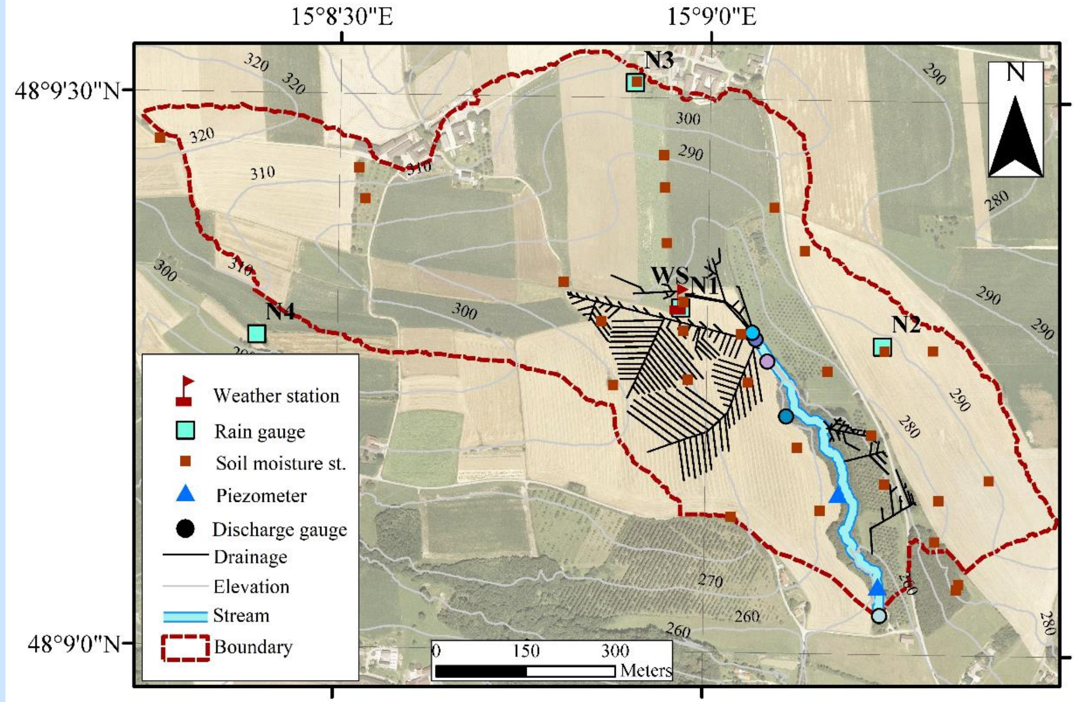



- **Exploring the isotopic composition** (oxygen and hydrogen) of precipitation and streamflow and the event and pre-event components of streamflow during precipitation events in small catchments
  → Explain overall catchment behaviour.
- **Aim**: to investigate the **origin of water** in the Hydrological Open Air Laboratory, Austria.
- **Tool**: two-component isotopic hydrograph separation ($^{18}O$ and $^{2}H$) linked with additional observations (time lapse images of overland flow, soil moisture and groundwater level changes, electric conductivity and turbidty measurements).

# Hydrological Open Air Laboratory (HOAL), Austria




→ Drainage area: **66 ha**,
→ Elevation: 268-323 m asl,
→ Land use: **agricultural**,
→ Geology: Fractured siltstone, Tertiary sediment,
→ Soils: **clayey**.




**Long-term field observations**

# Data and Methods

1. Selection of **32 precipitation events between 2013-2018**, when available
   → Isotopic composition of precipitation ($^{18}O$ and $^{2}H$),
   → Isotopic composition of streamflow ($^{18}O$ and $^{2}H$) at catchment outlet, inlet and one or both erosion gullies,
   → Precipitation amount and stream discharge.

Additionally during most events also available:
   → Isotopic composition of streamflow ($^{18}O$ and $^{2}H$) at a tile drain,
   → Soil moisture (catchment average of all stations over all depths and 1 selected station for 4 depths) and groundwater levels (1 deep and 1 shallow piezometer),
   → Time lapse photos at weather station,
   → Electric conductivity at catchment outlet,
   → Turbidity at catchment outlet and 2 erosion gullies.

2. Extraction of **properties of each event** (e.g. max runoff, sum of precipitation, precipitation intensity, time of concentration, overland flow occurrence, max soil moisture and groundwater level, etc.),
3. **Two-component isotopic hydrograph separation** (Pinder and Jones, 1969).

Precipitation

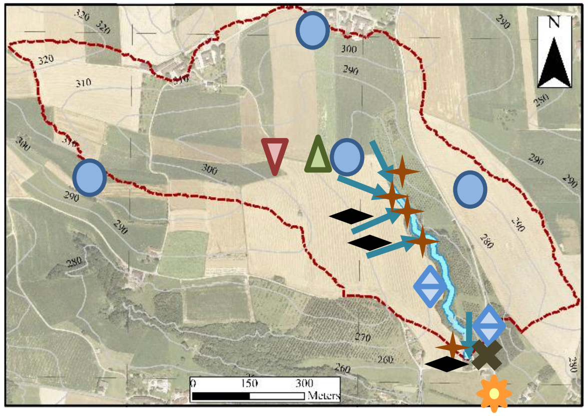
Streamflow

Isotopic composition of precipitation

Isotopic composition of streamflow

Soil moisture

Groundwater

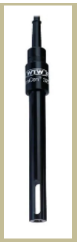





Time lapse photos at weather station

Turbidity

Data for
**32 events**



Electric conductivity

www.xylemanalytics.com

# Preliminary results: 32 Event properties I.

7 winter
8 spring
13 summer
4 autumn

**Precipitation** amount: 7÷96 mm
Max precipitation intensity: 2÷39 mm/h
Avr precipitation intensity: 0.5÷6 mm/h

23 frontal
9 convective
precipitation events

**Maximum runoff**
Outlet: 3÷557 l/s
Erosion gullies: 0÷88 l/s
Inlet: 2÷29 l/s
Tile drain: 0.2÷10 l/s

**Time of concentration**
Outlet: 1÷36 h
Erosion gullies: 0÷39 h
Inlet: 1÷35 h
Tile drain: 1÷35 h

**Runoff coefficient (Chen 2020)**
Outlet: 0.02÷0.33
Inlet: 0.01÷0.10
Tile drain: 0.004÷0.290

**Catchment average SM**
Max: 0.31÷0.41
Beg. of event: 0.29÷0.40
Time between runoff peak at outlet and Max SM: -7÷11 h

**Selected 1 SM station at catchment centroid (P06)**
Infiltration excess: 16 events
Saturation excess: 1 event
Other (no data, no reaction, reaction at the same time): 17 events

# Preliminary results: 32 Event properties II.

**Deep groundwater well (H01)**
Max: -4.8÷-0.2 m relative to ground surface
Time between runoff peak at outlet and Max GWL: -18÷46 h

**Shallow groundwater well (BP02)**
Max: -0.3÷0.2 m relative to ground surface
Time between runoff peak at outlet and Max GWL: -4÷25 h

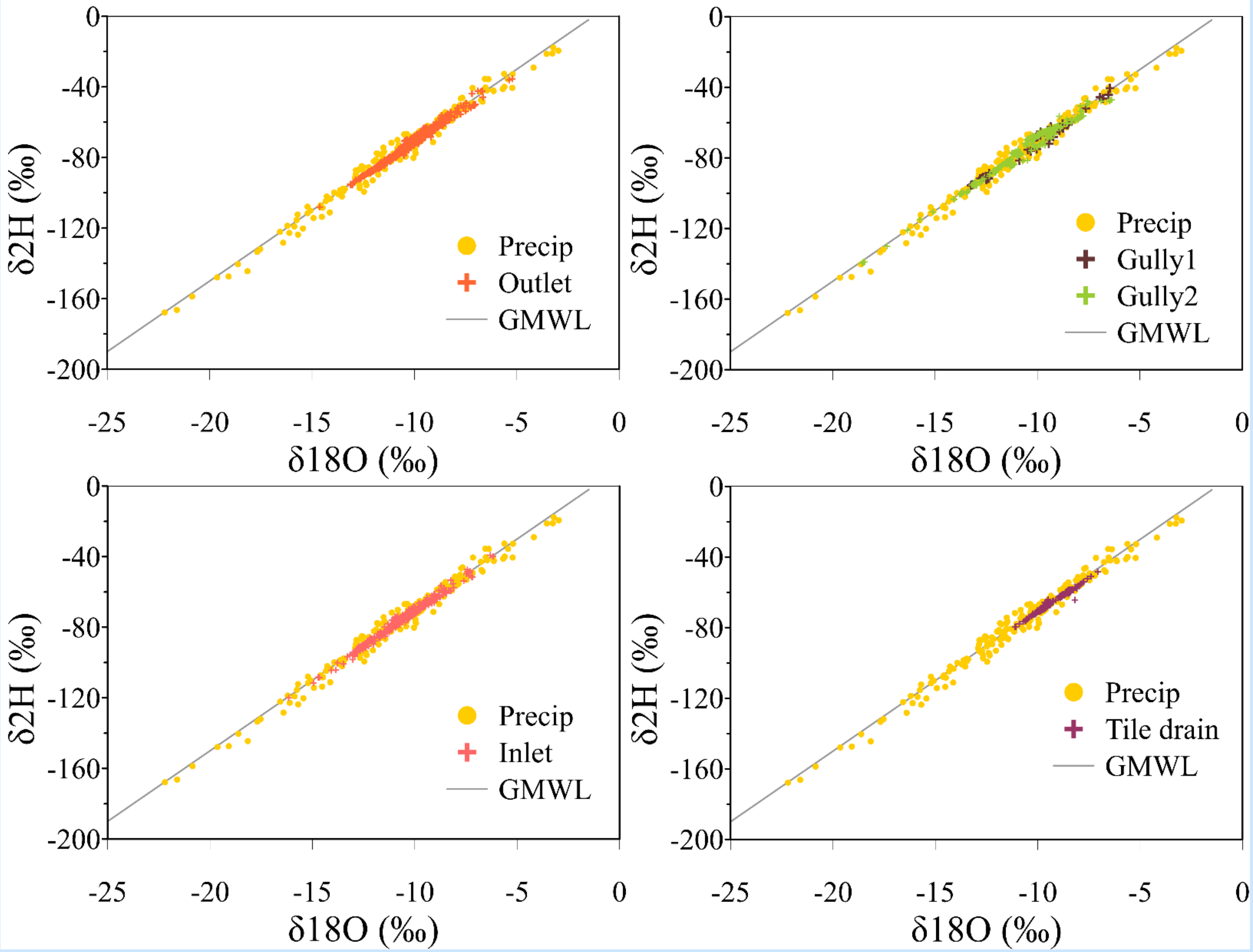
**Suspended sediment load at outlet**
Max: 0.3 kg/h÷73 t/h
Time between runoff peak at outlet and Max SSL: -17÷19 h

**Suspended sediment load at erosion gullies**
Max: 0÷20 t/h
Time between runoff peak at gullies and Max SSL: -10÷1 h

**Time lapse photos of overland flow**
Overland flow and ponding observed in the valley bottom: 6 events
Overland flow not observed: 4 events
No data/too high crops: 19 events
Snow/snow melt: 3 events

**Electric conductivity at outlet**
Min: 168÷618 uS/cm
Beginning of the event: 393÷805 uS/cm
Time between runoff peak at outlet and Max electric conductivity: -18÷1 h

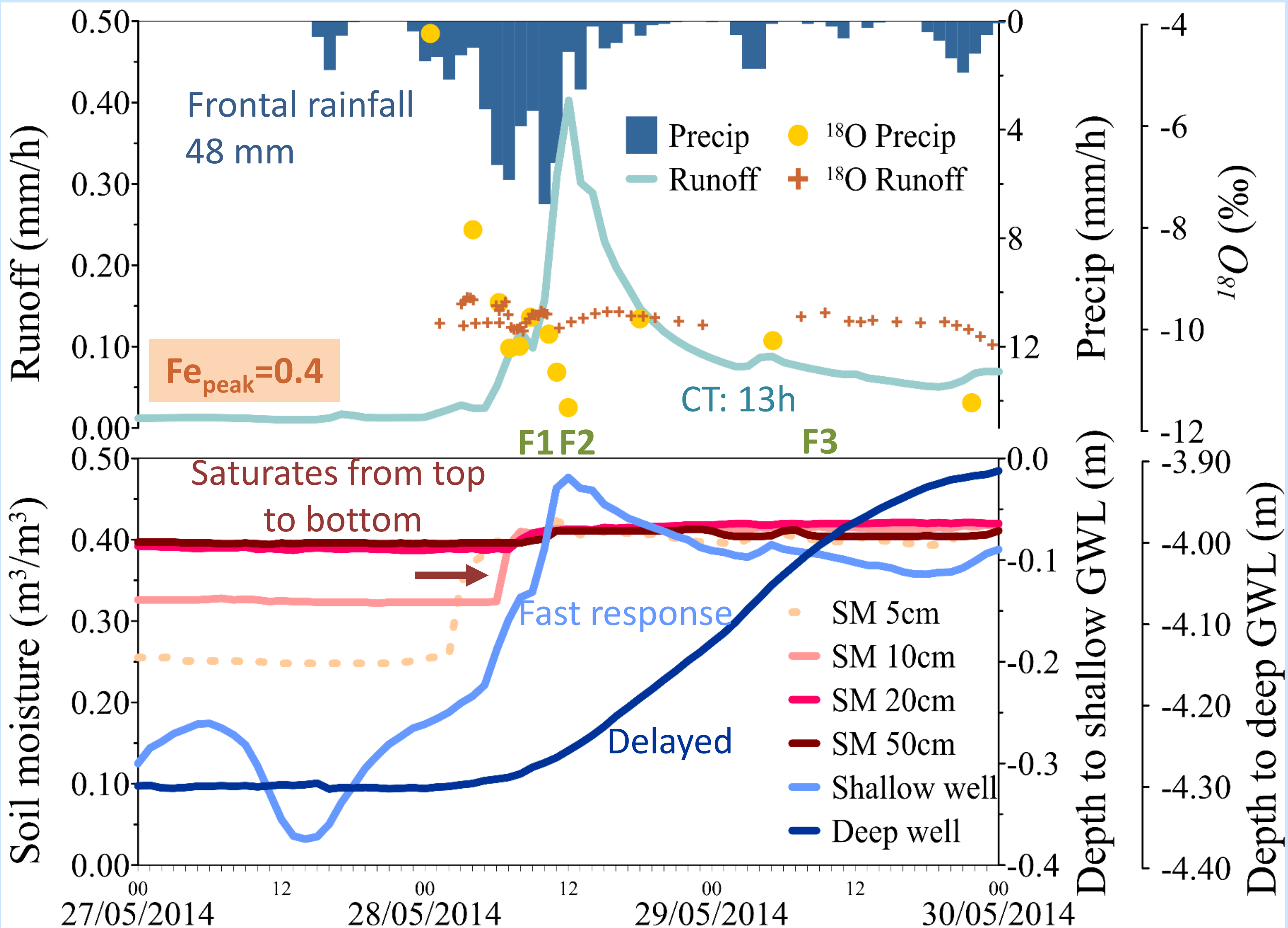
# Preliminary results: 32 Event properties III.





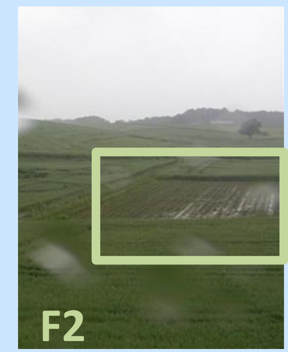

GMWL Global Meteoric Water Line

# Event on 28 May 2014 I.





28.05. 10:00



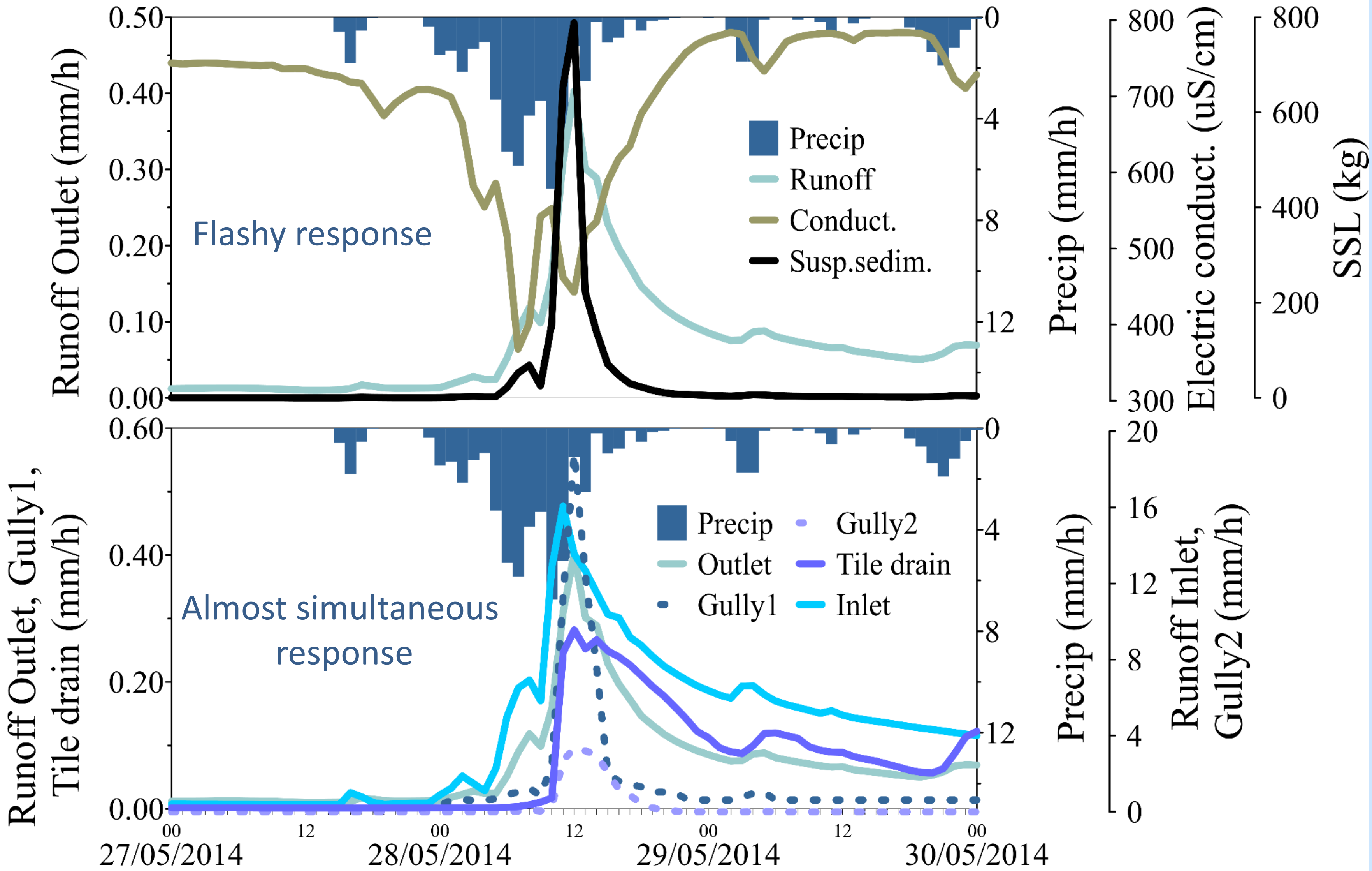

28.05. 12:00


29.05. 07:00

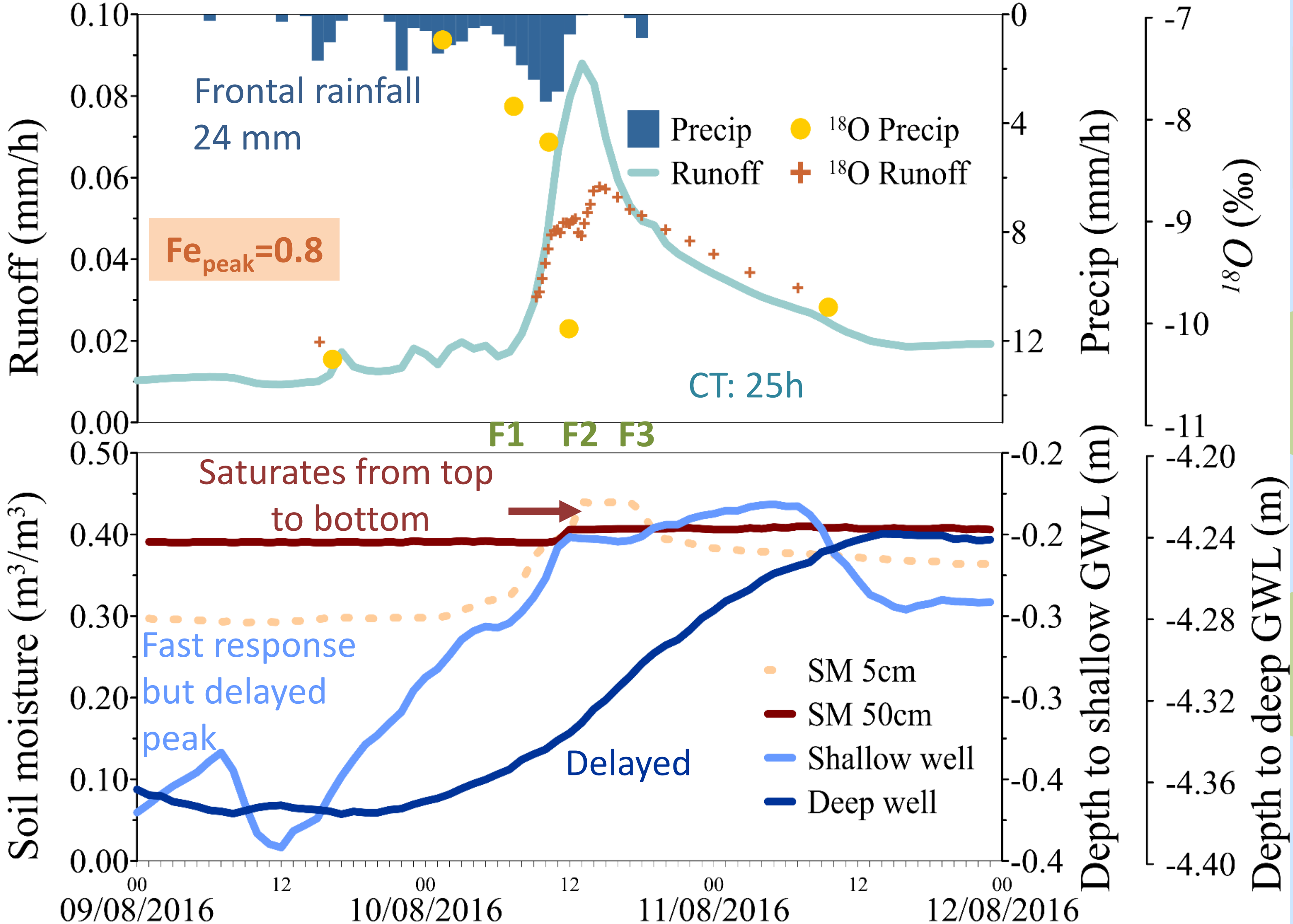


CT Time of concentration $Fe_{peak}$ Event water fraction for peak

# Event on 28 May 2014 II.



# Event on 10 August 2016 I.





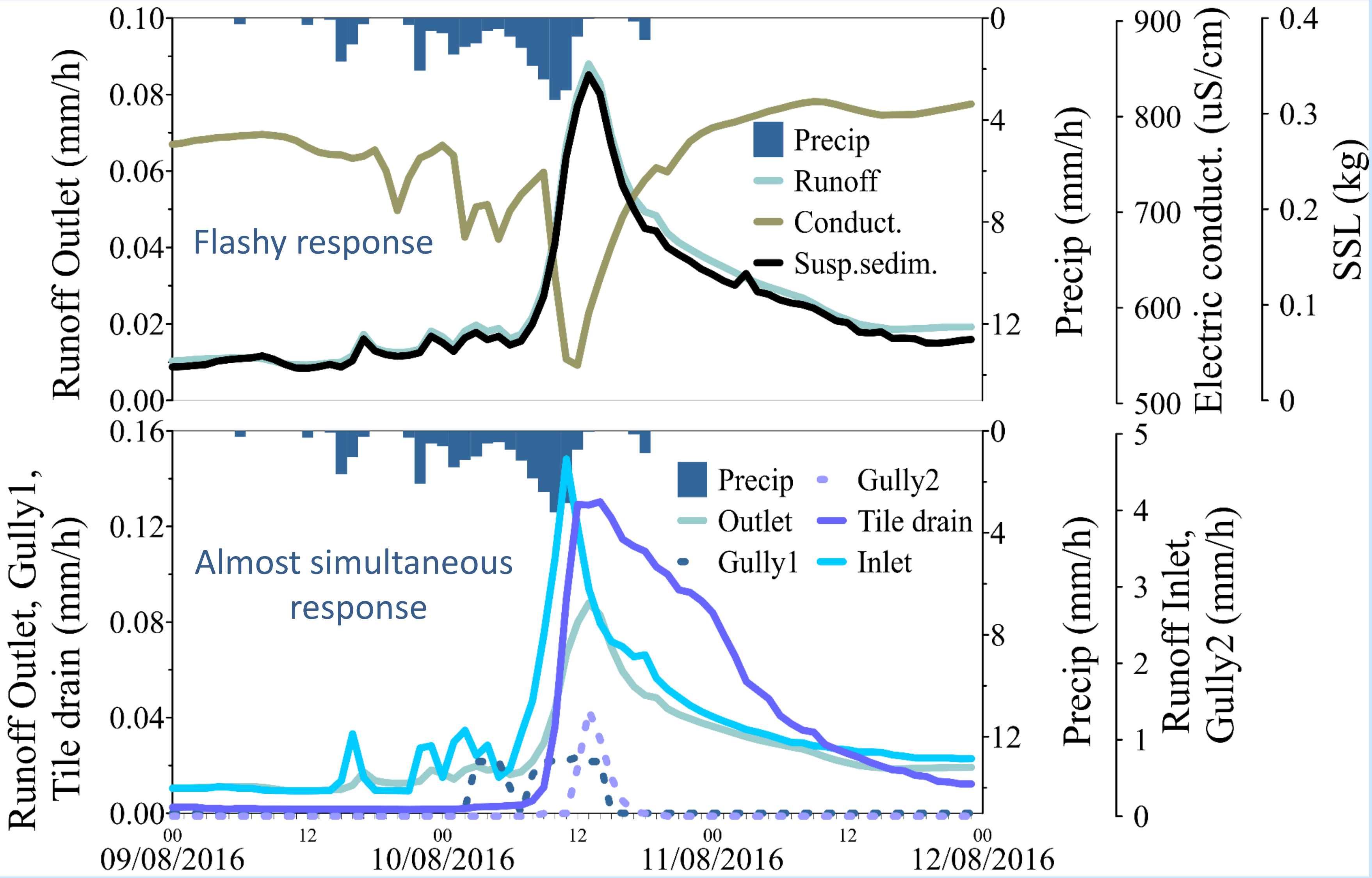
10.08. 06:00


10.08. 12:30


10.08. 18:00


CT Time of concentration Fe$_{peak}$ Event water fraction for peak

# Event on 10 August 2016 II.



# Preliminary results: Two-component isotopic hydrograph separation (IHS)

→ Out of 32 events: all winter and 1 late autumn event with snow omitted from analysis (uncertainties due to frozen soil, snow melt, etc.) → IHS for **24 events**, for peak runoff,

→ IHS with plausible results (Fe event water fraction between 0 and 1) → only for **15 events** for outlet, due to **uncertainties**:

- → Large variability in isotopic composition of rainfall within an event → incremental weighting of precipitation IC for the IHS,
- → For the erosion gullies: IHS not meaningful due to unknown pre-event component (gullies are dry except during large precipitation events with overland flow) → Fe should be close to 1 during all events,
- → 1st precipitation sample uncertain: sample bottle may contain water from the previous event.

# Outlook

→ Two-component isotopic hydrograph separation of all events for catchment outlet between 2013-18 (even when not all additional data are available, e.g. when erosion gullies did not react),
→ Estimation of transit times for the HOAL,
→ Identification of multiple thresholds (in soil moisture, groundwater levels, sediment load, etc.) during rainfall events,
→ Understanding where the water comes from during multiple events,
→ Investigation of the links among the event water contribution, precipitation characteristics and behavior of the soil moisture and groundwater table to understand better which pathways are dominant during different events.

# Thank you for the attention!

# References

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