

# Tracing Subsurface Stormflow (SSF): Insights into Preferential Flow and Pre-Event Water Contributions from Controlled Sprinkling Experiments

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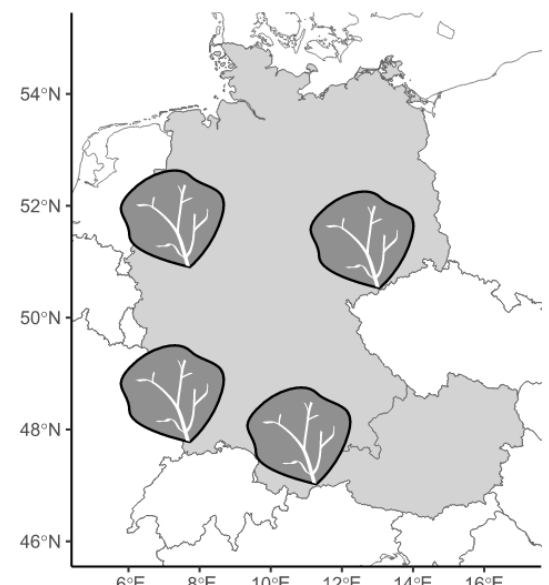
## Intro

- SSF may account for up to 90% of rainfall input in stream discharge [a]
- Occurs below ground, therefore difficult to observe and measure
- High spatial variability and different activation thresholds [b]

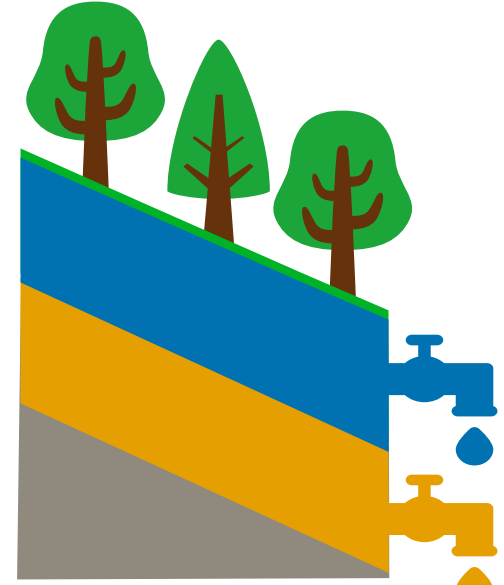
HYDROLOGY

How does precipitation become SSF?  
SSF is a fast event response - so does it mainly consist of event-water?

## Methods



Four low mountain/  
alpine catchments



1-3 dual layer  
Trenches sprinkled



Two Reservoirs  
One labeled  $\delta^2\text{H}$



Sprinkled with  
~16 mm/h for >3h



Continuous outflow  
monitoring



Manual samples  
every 20 min

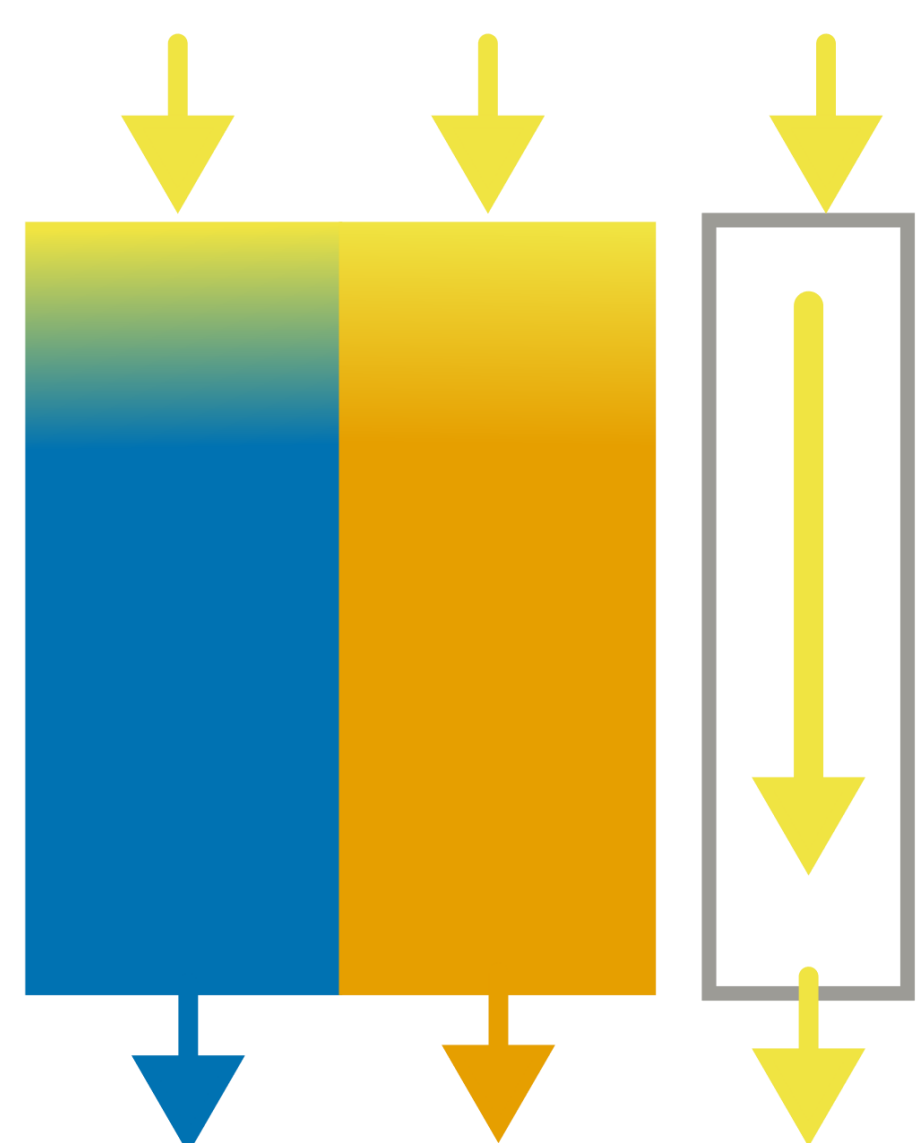


Drilling to  
refusal depth



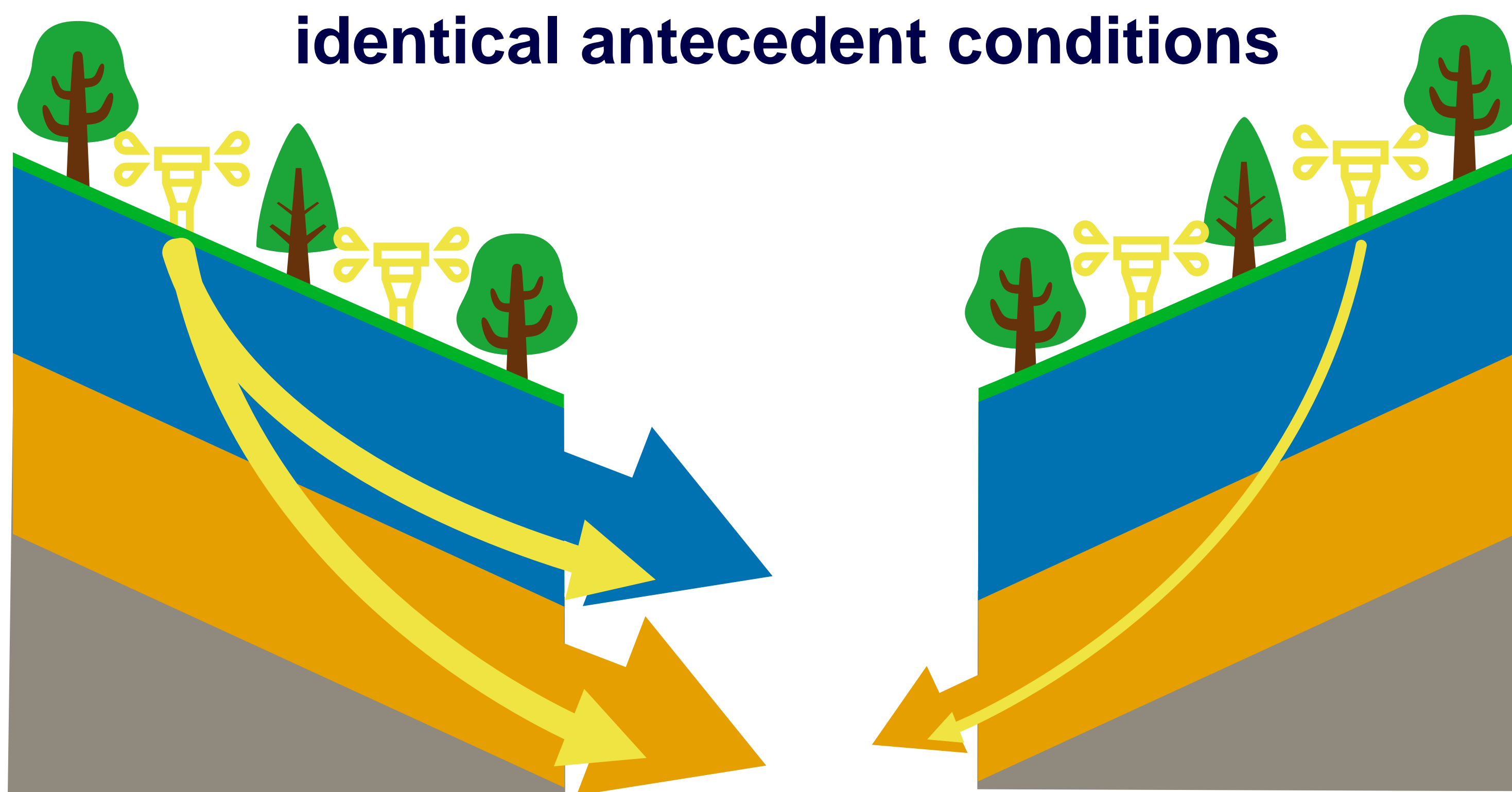
Sampling for Direct  
Vapor Equilibration

## Flow Mechanisms



- **Piston flow** remobilizing stored water
- **Preferential flowpaths** transport quick but little traced water

Hillslope SSF reaction is highly variable,  
even in the same catchments with  
identical antecedent conditions

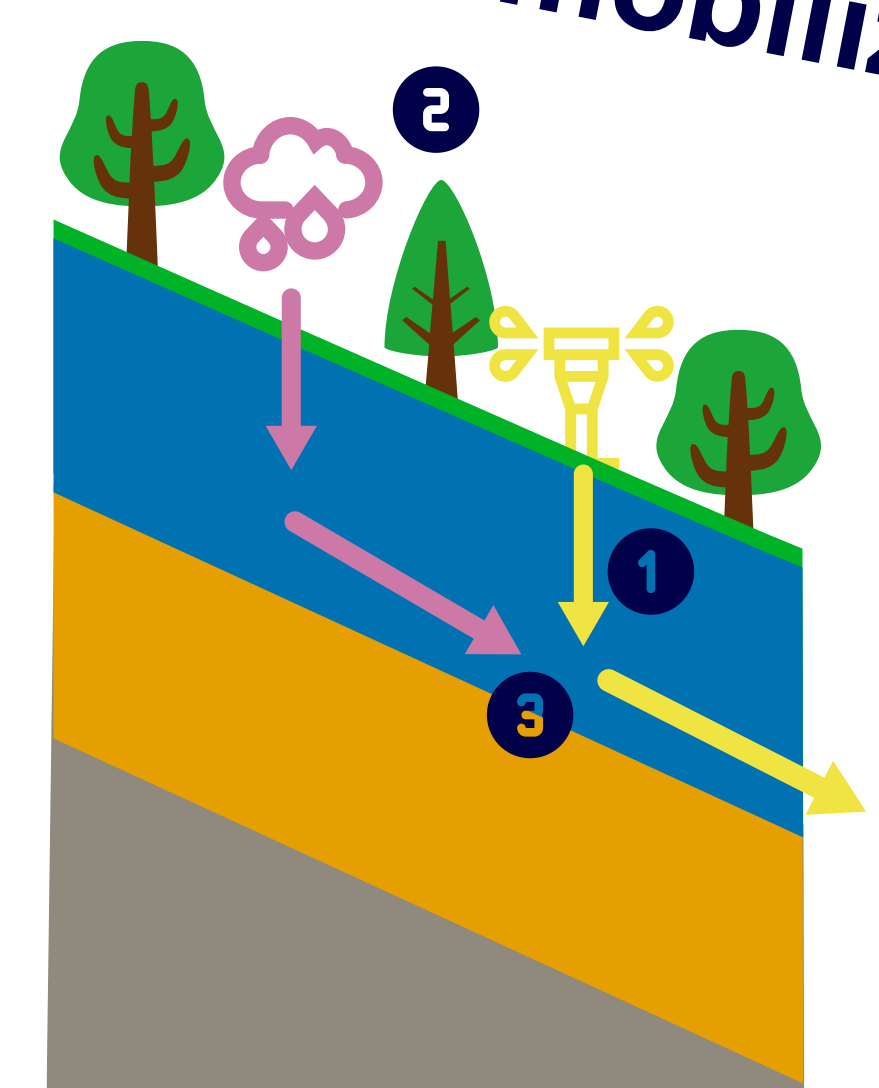


Time to 1% traced water in SSF: **1 min to 71 min**

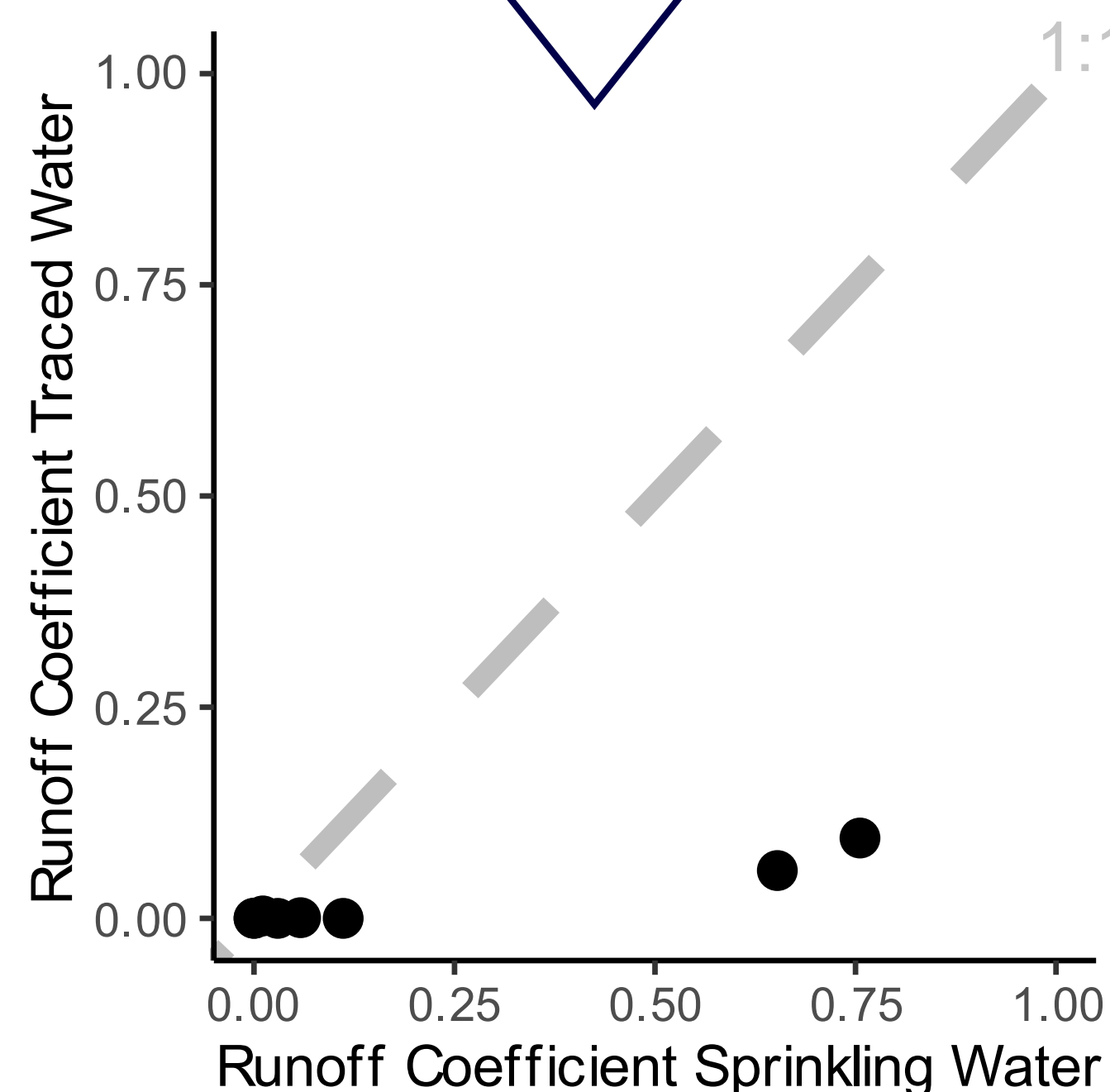
Maximum traced water: **4% to 61%**

Traced water at discharge peak: **0.5% to 17.5%**

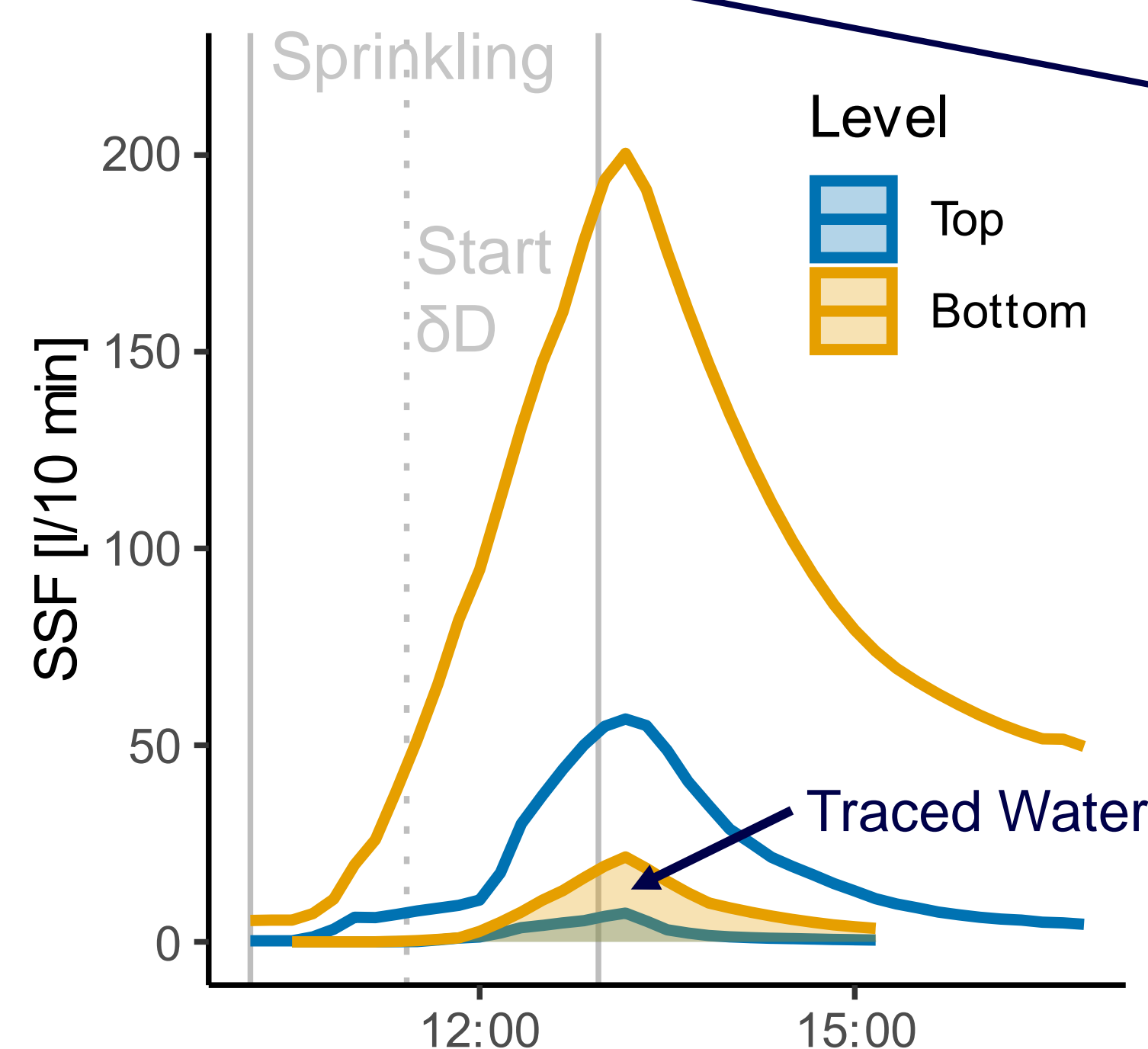
## Storage & Remobilization



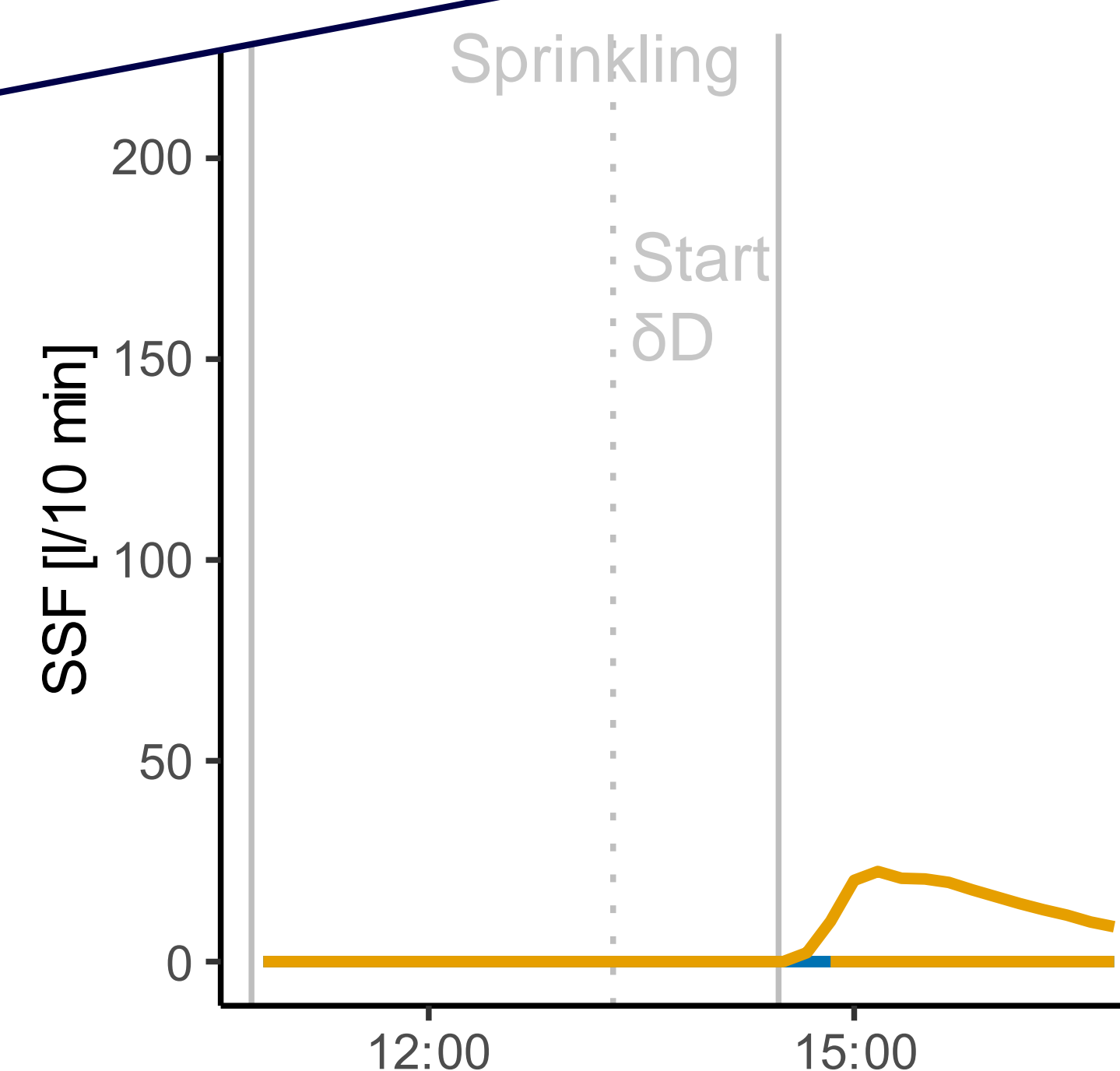
- 1 Traced water infiltrates & is stored in soil
- 2 Next rainfall infiltrates & remobilizes water
- 3 Traced water contributes to SSF



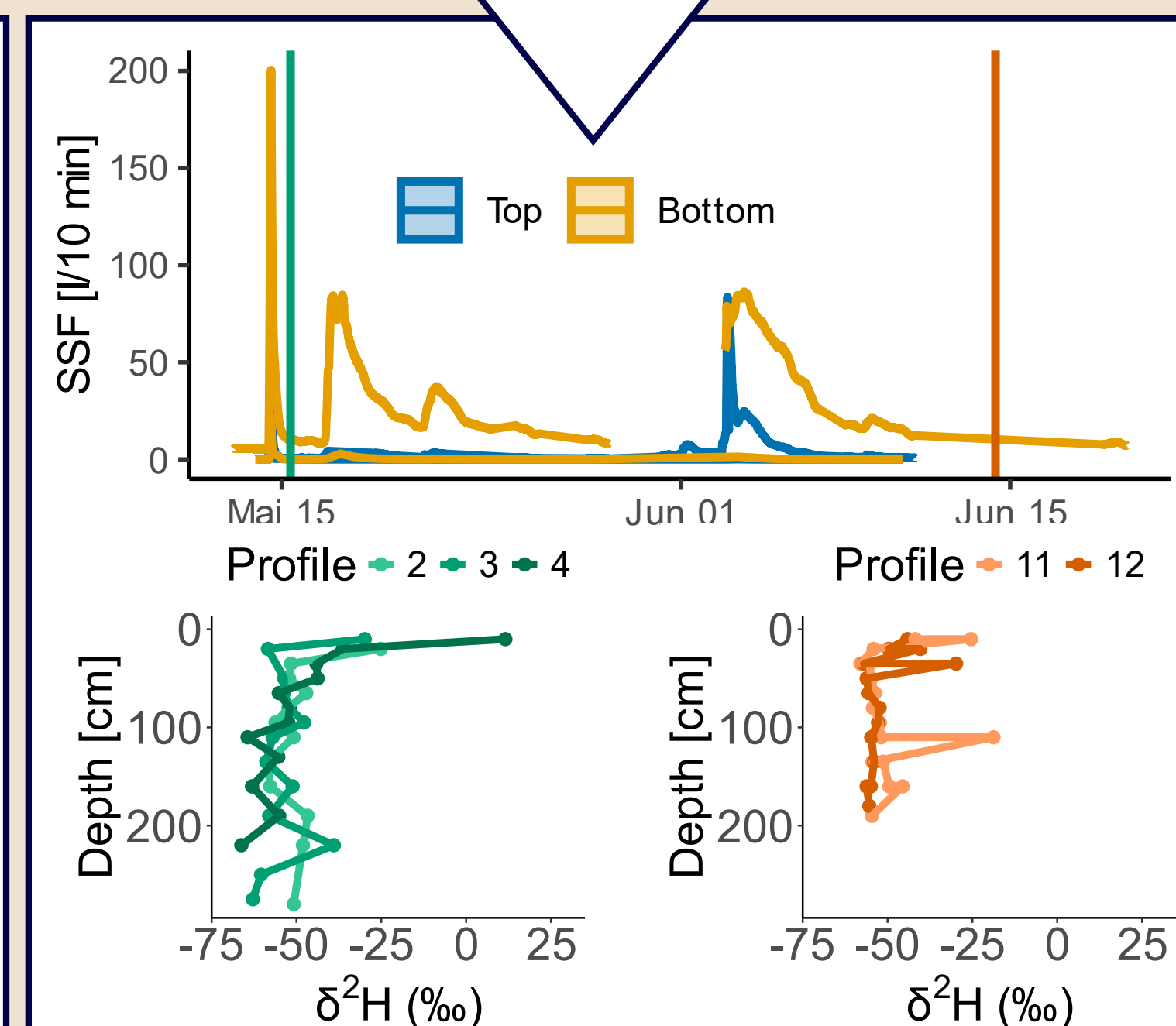
- Trench SSF reaction is only fraction of sprinkling input
- Traced water contributes substantially lower to SSF



- Bottom trench section has substantially higher SSF, also more traced water discharged
- No steady state was reached



- Only Bottom section reacted after irrigation was stopped
- No traced water was detected within the day



- 7.5% traced water discharged on the same day, min. 70% water stored in topsoil
- 27% traced water discharged in the first month

## Conclusion

- Precipitation infiltrates into hillslope soils where a small portion is directly discharged as SSF while the rest seeps into soil storage
- The majority of SSF water was in the hillslope previous to precipitation

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Acknowledgments:  
This research is funded by DFG FOR 5288. The authors thank Barbara Herbstritt for analyzing the isotope samples

Sources:  
[a] Beasley (1976). Contribution of Subsurface Flow from the Upper Slopes of Forested Watersheds to Channel Flow  
[b] Woods & Rowe (1996). The Changing Spatial Variability of Subsurface Flow Across a Hillside

[3]

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