Insights Into Subsurface Stormflow (SSF) Dynamics Using Multitracer Approaches

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Intro

Subsurface Stormflow (SSF):

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

Methods

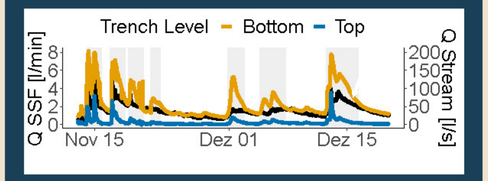
Trenched Hillslope:

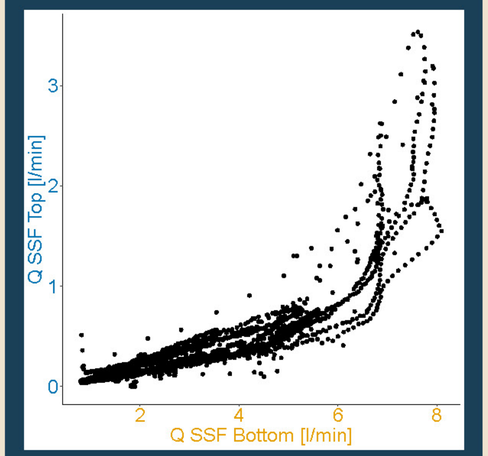
- Forested hillslope in a first order catchment; Freiburg, Germany
- SSF collected from a **Top** and from a **Bottom** layer
- SSF channeled to tipping buckets, thermometer and autosamplers
- Lab Analysis: isotopes, dissolved organic carbon (DOC), major ions

Fieldwork Photos

Where does Subsurface Stormflow occur? What is its origin?

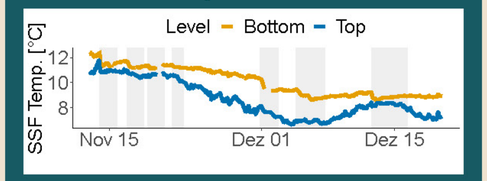
Volume

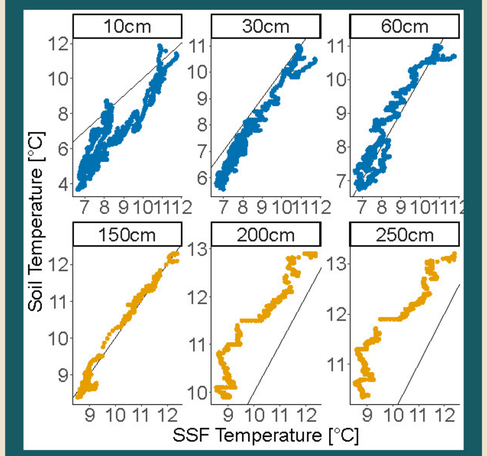




- Most flow occurs in lower trench section
- High flows in Top level only occur during high Bottom flows

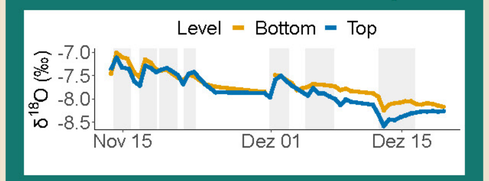
Temperature

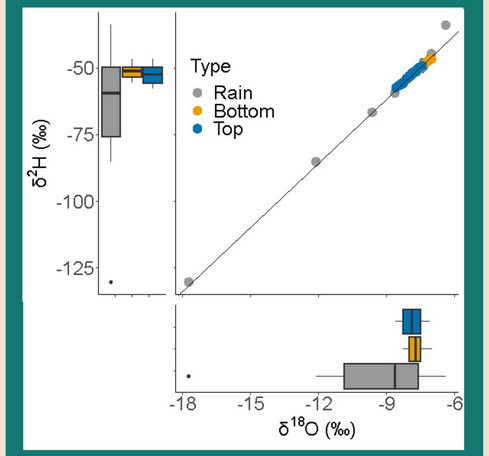




- Top flow matches temperatures in 30-60 cm depth
- Bottom flow closely resembles temperatures in 150 cm depth

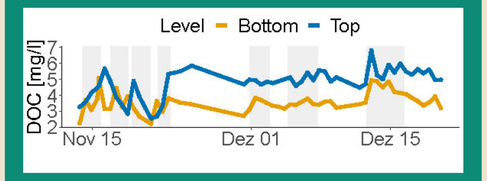
Stable Water Isotopes

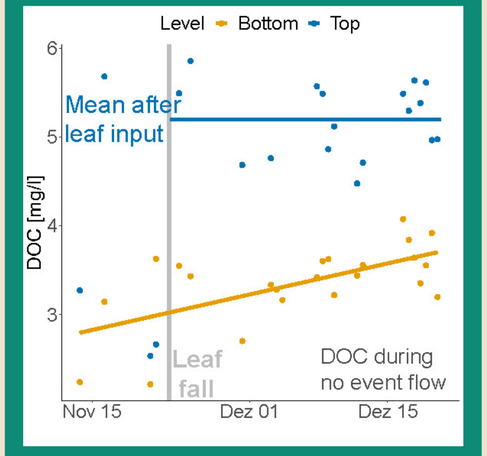




- Top isotopic variation is larger than in the lower section
- Precipitation is isotopically lighter and more variable

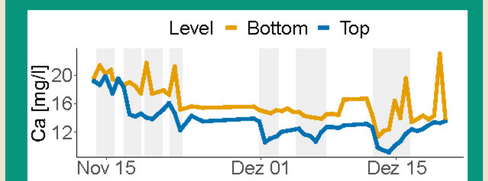
DOC

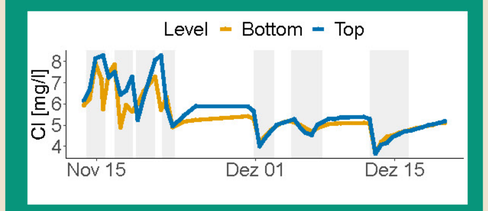


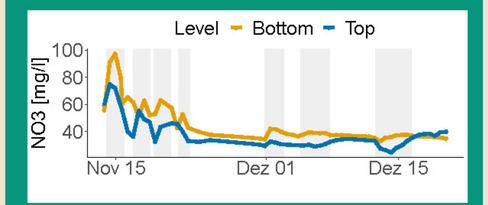


- Bottom DOC regression predicts concentrations to reach Top mean DOC in three months after leaf fall

Major Ions

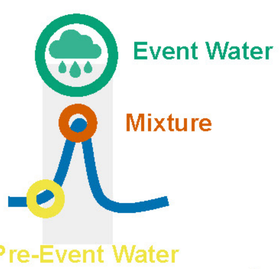


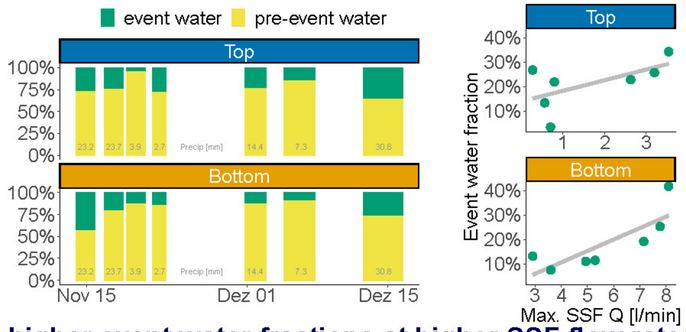




- Major Ions respond differently during SSF events
- Dilution effects continue until mid-December

Mixing Models





- higher event water fractions at higher SSF flow rates

Conclusion

- At the researched hillslope, most SSF occurs between 30-150 cm depth
- DOC might be a tracer suitable for deriving longer transit times
- SSF is mostly pre-event water
- Larger SSF events have a higher event water fraction

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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

[4] GFZ Helmholtz-Zentrum Potsdam
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