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Conference Abstract

Observing Unseen Flowlines in Forested Headwater Catchments

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Abstract

Understanding solute transport and vertical hydrological connectivity in headwater catchments is essential for advancing hydro-biogeochemical theories within the Critical Zone (CZ). This study explores the physical and biogeochemical processes that drive variations in stream discharge endmembers, focusing on “unseen flowlines”—subsurface pathways that significantly influence solute evolution. Using a decade-long biweekly groundwater chemistry dataset from the Weierbach Experimental Catchment (WEC) in Luxembourg, we applied multivariate analysis techniques to identify distinct water pools in the catchment and their control near-stream endmember variation during different hydrological states making use of data from 27 flood events.

The results refine the existing perceptual model for the catchment by incorporating vertical connectivity and transient solute fluxes. High-frequency data reveal that solute dynamics, particularly for calcium and sulphate, are driven by processes such as carbonate dissolution and cation exchange, with distinct behaviours during flood events. Furthermore, the transient barium ratio analysis offers a novel perspective on the interplay between shallow and deep flow contributions.

This research highlights the importance of combining data-driven modelling and geochemical process-based approaches to decipher the complexities of solute transport.

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By integrating these insights, the study advances the understanding of c–Q relationships, providing critical implications for CZ studies and catchment management practices.

Keywords

Solute transport, Vertical hydrological connectivity, Critical Zone (CZ), Multivariate analysis

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Conflicts of interest

The authors have declared that no competing interests exist.