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Effects of drainage network dynamics and subsurface connectivity on DOC spatial patterns

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Headwater drainage networks continuously follow expansion/contraction cycles driven by unsteady climatic forcing; these dynamics directly affect catchment connectivity and water quantity/quality. Data on drainage networks is typically derived from remotely sensed data that inevitably fail to identify temporary streams; on the other hand, field observations are usually labor intensive, generating sporadic datasets that miss high-frequency drainage network dynamics. Here we present the results of an intensive field campaign carried out in a small alpine catchment in northern Italy during the summer-fall of 2018 as part of the ERC funded DyNET project. We collected data on the active drainage network for 9 times (under different flow conditions) along with spatially and temporally distributed water quality measurements using a multi-parametric sonde. The maximum extent of the observed active river network was 12.5 km, with more than 50% of its length consisting of temporary streams. We identified strong geophysical heterogeneity: the upper part of the catchment presents pits with a tendency for water to seep in the soil; this water then feeds a couple of springs, creating a strong subsurface connection between the upper catchment and the main drainage network. The water quality measurements suggest that DOC is correlated to the temporariness of the corresponding stream stretch and the resulting surface/subsurface connectivity of the drainage network.
We also present a simple yet accurate conceptual model that describes the active drainage network length as function of antecedent precipitation and helps in extending the results beyond the time horizon of the monitoring period. These findings contribute to the better understanding of causes, behaviors and implications of stream network dynamics and river connectivity across scales.