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Dominant controls of diel discharge fluctuations: viscosity changes vs. evapotranspiration

Michael Schwab (1,2), Julian Klaus (1), Laurent Pfister (1), and Markus Weiler (2)

(1) Catchment and Eco-Hydrology Research Group, Luxembourg Institute of Science and Technology (LIST), Belvaux, Luxembourg (michael.schwab@list.lu), (2) Hydrology, Faculty of Environment and Natural Resources, University of Freiburg, Germany

Diel fluctuations in stream discharge are a long known but rarely investigated phenomena that is known to be driven by various processes, such as precipitation, evapotranspiration, freeze-thawing cycles and sometimes viscosity fluctuations. Improving our understanding of how these processes control diel discharge fluctuations is actually key to solving other questions related to diel cycles of biogeochemicals as well as the temporal variability of fundamental hydrological functions in a catchment. In the forested Weierbach catchment (0.47 km2) in Luxembourg we showed that seasonal changes in the relative importance of viscosity fluctuations of inflowing water to the creek and evapotranspiration are the key controls of diel discharge fluctuations. In the dormant season, we observed daily discharge maxima in the afternoon, albeit temperatures remained persistently above zero and no snow cover was present, which excludes freeze-thawing cycles as the driving factor. However, we showed that diel water temperature fluctuations in the subsurface and therefore viscosity fluctuations in the upper layer of the riparian zone can be an explanation for the daily discharge maxima in the afternoon. In the transition period between dormant and growing season, the counteracting viscosity and evapotranspiration processes cancel each other out resulting in no diel discharge fluctuations. Subsequently, during the growing season, the higher relative importance of evapotranspiration is guiding the diel discharge pattern; nevertheless, the viscosity effect might still be invisibly present. We believe this finding to be of relevance for better understanding hydrological functions in catchments and for analyzing daily fluctuations of biogeochemicals in stream water.