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Thermal variability within the hyporheic zone of an Alpine stream gravel bar is influenced by solar radiation and other climatic factors

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Gravel bars with largely unsubmerged surface areas exposed to the atmosphere are recipient to high levels of incoming radiation during the day, particularly during summer months. Transfer of heat from the atmosphere downward into the hyporheic zone (HZ) below a gravel bar (GB) can thus possibly lead to the alteration of the vertical temperature profile within its HZ, with implications for physical and biogeochemical processes therein. Here we present results from the analysis of seasonal, high frequency spatio-temporal data including, vertical hyporheic temperature, physical parameters and climatic data for a GB located within an Alpine cold water stream (Oberer Seebach, Austria). Vertical temperature profiles throughout the GB were analyzed together with corresponding climatic data for different seasons to elucidate the spatio-temporal variability of HZ temperature gradients in relation to air temperature, incoming global radiation and stream discharge.Initial analyses indicate a clear seasonal difference between Summer and Autumn temperature profiles throughout the GB, with a strongly developed, exponentially decreasing temperature-depth gradient throughout the GB during summer months. In contrast, this observed gradient substantially weakened or collapsed during autumn months. Furthermore, the highest absolute temperatures and steepest depth gradients within the HZ occurred during summer days, coinciding with the falling hydrograph,where hyporheic temperatures exceeded that of both surface water and groundwater. These findings point to the effect of solar radiation and/or air temperature as a contributor to GB temperatures, possibly influencing diurnal and seasonal GB temperature profiles.Overall, our results suggest that not only the mixing of groundwater and streamwater, but also heat transfer associated with solar radiation and/or air temperature may act as an important driver of HZ temperature, particularly during summer months. This may have implications for physical and biogeochemical hyporheic processes in cold water streams .