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Seasonal hyporheic temperature dynamics over riffle bedforms

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There is growing interest in riverbed temperature due to the ecological and biogeochemical significance of the hyporheic zone, and its potential to moderate river temperature. Riffles exhibit complex thermal behaviour, hypothesised to be caused by local alteration of groundwater-surface water (GW-SW) interactions; but hitherto most research has been in upland/ gravel-bed/ hard rock catchments. Accordingly, this article aims: (1) to characterise spatio- temporal variability in hyporheic temperature over two riffles (R1 and R2) in a lowland river basin (Tern, Shropshire, UK) underlain by sandstone; and (2) to explain thermal dynamics by inferring hyporheic processes and the influence of GW-SW interactions. Hyporheic [riffle head, crest and tail at 0.1, 0.2 and 0.4 m], water column, spring water and air temperature were collected at 15 min resolution over 22 months and used to explore seasonal variations. Borehole water levels and temperature provide insight into groundwater variability over a hydrological year. Hyporheic temperature is cooler (warmer) than water column in summer (winter), with convergence in spring and autumn. Riffle heads and R2 crest yield small thermal gradients; and R1 tail larger vertical difference. R1 crest temperature is similar and attenuated (cf. water column) at all depths. R2 tail temperature differs markedly from surface water. Thus, hyporheic temperature varies temporally across and between riffles, reflecting: (1) hydroclimatological controls on river and groundwater temperature, and (2) hydrological, local morphological and sedimentary controls on surface water and groundwater flux. This research demonstrates the utility of depth-related riverbed temperature time-series in understanding hyporheic zone processes and groundwater-surface water interactions.