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Upwelling of warm water in lakes due to lacustrine groundwater discharge

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Detection of lacustrine groundwater discharge (LGD) is still a challenge. The buoyancy of warm groundwater during winter and early spring when lake water is colder and heavier than groundwater can be used for identification of groundwater upwelling related hotspots in surface waters by FO-DTS. FO-DTS has been successfully used to locate groundwater contributions at the sediment-water interface of lakes and rivers. Yet, FO-DTS has not been used to study 3D temperature patterns in lake water bodies. Still, qualitative and quantitative interpretations of groundwater fluxes are hampered by the lack of understanding how the groundwater upwelling signal propagates from the sediment-water interface through the water column to the water-air interface and what perturbations and signal losses occur along this pathway. In the present study, groundwater discharge to a surface water body was simulated in a mesocosm experiment. Under winter conditions water of 14° C to 16°C was discharged at the bottom of a 10x2.8 m mesocosm where surface water varied from 4°C –7.4°C. Four layers (20, 40, 60 and 80 cm above the sediment) of the 81 cm deep mesocosm were equipped with fibre-optic distributed temperature sensing (FO-DTS) for tracing thermal patterns in the mesocosm in order to: (1) analyze the propagation of the temperature signal through the water column by FO-DTS and (2) characterize the spatial distribution of groundwater-borne hot spots close to the pond surface by FO-DTS. Different LGD rates were simulated in order to establish the minimum rate of GW upwelling that can be reliably detected at the water surface by FO-DTS. The experiments also allow us to benchmark scale dependencies and adequacy of FO-DTS method. It also reveals that weather conditions can have important impacts on the detection of LGD at surface water-atmosphere interfaces at larger scales.