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Evolution of Superficial Lake Water Temperature Profile Under Diurnal Radiative Forcing

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In still water bodies such as lakes, the water temperature near the surface typically increases during the day, and decreases during the night as consequence of the diurnal radiative forcing (solar and infrared radiation). These temperature variations penetrate vertically into the water transported mainly by heat conduction enhanced by eddy diffusion (which may vary due to atmospheric conditions and internal dynamics of the water body). These two processes can be described in terms of an effective thermal diffusivity, which can be experimentally estimated. However, the transparency of the water (depending on turbidity) also allows solar radiation to penetrate below the surface into the water body, where it is locally absorbed (either by the water or by the deployed sensors). This process makes the estimation of effective thermal diffusivity from experimental water temperature profiles more difficult. In this study, we analyze water temperature profiles in a lake with the aim of estimating the effective thermal diffusivity. To this end we investigate the propagation of diurnal water temperature fluctuations with depth. We try to quantify the effect of locally absorbed radiation and assess the impact of atmospheric conditions (wind speed, net radiation) on the estimation of the thermal diffusivity. The whole analysis is based on the use of fiber optic distributed temperature sensing, which allows unprecedented high spatial resolution measurements (about 4mm) of the temperature profile in the water and near the water surface.