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Practical considerations for coil-wrapped Distributed Temperature Sensing setups

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Fiber-optic Distributed Temperature Sensing (DTS) has been applied widely in hydrological and meteorological systems. For example, DTS has been used to measure streamflow, groundwater, soil moisture and temperature, air temperature, and lake energy fluxes. Many of these applications require a spatial monitoring resolution smaller than the minimum resolution of the DTS device. Therefore, measuring with these resolutions requires a custom made setup. To obtain both high temporal and high spatial resolution temperature measurements, fiber-optic cable is often wrapped around, and glued to, a coil, for example a PVC conduit. For these setups, it is often assumed that the construction characteristics (e.g., the coil material, shape, diameter) do not influence the DTS temperature measurements significantly. This study compares DTS datasets obtained during four measurement campaigns. The datasets were acquired using different setups, allowing to investigate the influence of the construction characteristics on the monitoring results. This comparative study suggests that the construction material, shape, diameter, and way of attachment can have a significant influence on the results. We present a qualitative and quantitative approximation of errors introduced through the selection of the construction, e.g., choice of coil material, influence of solar radiation, coil diameter, and cable attachment method. Our aim is to provide insight in factors that influence DTS measurements, which designers of future DTS measurements setups can take into account. Moreover, we present a number of solutions to minimize these errors for improved temperature retrieval using DTS.