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Capturing spatial and temporal variability in soil moisture and soil heat flux with Distributed Temperature Sensing.

In Distributed Temperature Sensing (DTS) fiber-optic cables are used as thermal sensors, capable of yielding temperature measurements every 25cm along cables several kilometers in length. Coupling of the energy and water balances in many hydrological processes means that temperature observations, like those from DTS, can provide valuable insight on both the transfer of energy and water. Thus, DTS has been used in a wide range of hydrology and environmental monitoring applications. Here, I will focus on SoilDTS, in which one or more fiber-optic cables are ploughed in to the soil and used to observe spatial and temporal temperature dynamics. We use two different approaches: In passive SoilDTS, cables at several depths are used to monitor the temperature profile of the soil as it varies in response to the net radiation cycle. The thermal conductivity and heat capacity of soil depend on its moisture content. By monitoring temperature dynamics we can infer soil thermal properties and hence soil moisture. In Active SoilDTS, the metal armor on the cable is heated and the cable temperature response is related to the moisture content or thermal properties of the surrounding soil. Combining the thermal properties and temperature measurements, we can estimate soil heat flux. I will use data collected in Oklahoma and Delft to illustrate how a combination of Passive and Active SoilDTS can be used to monitor soil moisture and soil heat flux with unprecedented coverage and resolution making it a powerful tool for process understanding, model calibration, and validation of remote sensing observations.