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Distributed Temperature Sensing as a tool for measuring Soil Moisture and Soil Heat Flux

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Measuring spatial patterns in soil moisture and soil heat flux has always been a time-consuming and labour-intensive undertaking. A range of sensors for performing point measurements are widely available, but we are often more interested in spatial patterns than in values at a single point. With the use of Distributed Temperature Sensing (DTS) as an environmental temperature sensor, a new tool is introduced to measure spatial as well as temporal temperature variability.

While soil temperature variation is interesting in itself, recent studies have shown that temperatures at multiple depths can yield great insight into soil moisture and heat flux processes. Using a moleplow with a custom-built plow, several fiber optic cables can be plowed at different depths within the top 15 centimeters of the soil. DTS is then used to gather temperatures with a spatial resolution up to 1 meter and a temporal resolution of up to 10 seconds along cables up to 20km in length. This yields information on the spatial variability in the temperature profile along the length of the cable.

Soil moisture and soil heat flux can be determined through either inverse modeling of the diffusion equation or data assimilation. DTS can thus be used to yield new insight on the temporal and spatial variability of temperature, soil moisture and soil heat flux at high resolution over large areas. Furthermore, it is relatively inexpensive compared to large-scale field campaigns based on point sensors.