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Evaluation of thermal infrared imagery acquired with an unmanned aerial vehicle for studying hydrological processes

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Thermal infrared imagery might improve understanding of many facets of the hydrological cycle. Specifically for studies at the hillslope and headwater catchment scale, much process knowledge could be obtained about which areas saturate and how various flow processes contribute to flood formation. This would require acquisition of thermal infrared images with high spatial resolution, preferably with a simple system that permits to freely choose the time of acquisition. At present, no such system is operational and therefore we decided to develop a prototype based on readily available techniques.

The main parts of the prototype are a high resolution thermal infrared (TIR) camera (FLIR tau 640) that is mounted on an unmanned aerial vehicle (Falcon 8, Ascending Technologies). The system is designed to fly up to 100 m high and acquire TIR images of 1 cm to 20 cm spatial resolution. We acquired images at three mountainous sites and over sprinkling experiment on a flat grass land site. Here, we present an evaluation of the whole acquisition chain, from preparation and field campaign to processing of the images and interpretation.

The images may give detailed qualitative insights into hydrological processes if contrasts in temperature are high, for example when water is flowing or when groundwater exfiltrates into the stream. However, if water temperature has adapted to its surroundings, like in areas of moist soils or standing water, the temperature signal may be lost. To overcome this problem and explore the potential for more quantitative analyses, we aimed at obtaining TIR images at various times that can be subtracted from each other to obtain images of temperature change. The temperature change data may be used to estimate water content, because the high heat capacity of water causes wet areas to respond much slower to changes in energy inputs than dry areas.

Mainly due to limitations of the camera, we were unable to acquire timeseries of TIR images with stable temperature calibration. Therefore, no datasets of temperature change were obtained and evaluation of the interpretative power of such dataset cannot yet be presented. However, the experiments gave us insight into what improvements are needed and what other technical problems need to be solved. Also, minor technical issues with the processing of the images were identified and directions for solving them were explored. In conclusion we present what costs and efforts we expect such improvements to our first prototype entail and argue that further development should be pursued.