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Landscape scale thermography – from simple to sophisticated atmospheric data correction

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Surface temperature is a key variable in the study of energy and mass exchange at the surface-atmosphere interface. Surface temperatures are typically measured onsite by infrared radiometers, by infrared scanners mounted on aircrafts or on satellite platforms. While onsite measurements provide data at a high temporal resolution they cannot capture surface temperatures at the landscape scale. In contrast remotely sensed data provide surface temperature measurements on a wide area but relatively low temporal and/or spatial resolution - or in case of airborne measurements at very high costs. Recent technical advances and the improved accessibility of mobile thermal-infrared (TIR) cameras provide an instrument that can produce surface temperature measurements from close proximity to an object right up to distances of several kilometres. This measurement system provides spatial resolutions of some millimetres up to some meters at a temporal resolution down to some seconds covering areas of several square kilometers. Due to this available range of spatio-temporal resolutions this method perfectly closes that gap between point measurements onsite by infrared radiometers and remotely sensed data at relatively low costs. Therefore this method gains more and more popularity in ecological research. While remotely sensed surface temperature data are routinely corrected for atmospheric influences by this time such corrections are often neglected or waived for data retrieved with TIR cameras. This practice is defensible for short distance measurements. But for measurements on landscape-scales taken from a distance of kilometres, the bias caused by atmospheric distortion becomes highly relevant for the accuracy of the surface temperature data.

In this study we compared different approaches for atmospheric correction of thermal infrared images. 2500 TIR surface temperature measurements that were retrieved during several campaigns in summer 2012 were compared with continuous on-site surface temperature measurements using a thermal infrared radiometer at 10 field sites in the alpine basin around the city of Bozen/Bolzano (Italy). Measurement path lengths (line of sight TIR camera to field-sites) varied from three up to nine kilometres. Data were corrected using (i) a simple regression approach, modelling the error as a function of solar radiation, (ii) an atmospheric transmissivity correction based on water, carbon dioxide and aerosol concentrations, and (iii) the well-established MODTRAN model.

The uncorrected data were clearly influenced by atmospheric distortion. Despite their differences in complexity all corrections produced good results and their efforts and benefits are discussed.