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Landscape scale thermography – measurements, modelling and implications

Albin Hammerle (1), Fred Meier (2), Michael Heinl (1), and Georg Leitinger (1)

(1) University of Innsbruck, Ecology, Innsbruck, Austria (albin.hammerle@uibk.ac.at), (2) TU Berlin, Berlin, Germany

Land surface temperature (LST) is a key variable for numerous environmental functions. It represents the combined result of all energy exchange processes between the atmosphere and the land surface and has thus become a basic requirement for model validation or model constraining in surface energy and water budget modelling on various scales. Since their broad commercial launch in the early 1990s thermal infra-red (TIR) cameras have been continuously refined and have found wide application since the 2000s due to low costs and their high spatial and thermal resolution. Given this available range of spatiotemporal resolution, this method perfectly closes gaps between on-site point measurements by infrared radiometers and remotely sensed satellite data at relatively low costs. Furthermore their operational simplicity and increasing data storage capabilities has led to an increasing popularity of this system in many (ecological) research areas. While corrections for atmospheric conditions are commonly applied to data derived from satellite or airborne systems, such corrections are not yet routinely applied in ground based thermal imaging at landscape scales. The lack of such corrections is mainly justified by comparatively short measurement paths.

Here we present the results of a study, conducted in the basin of Bozen/Bolzano (Italy), where we compared LST measured (i) by on-site radiometry (OSR), (ii) by infrared thermography (CAM) over different path lengths, and (iii) from satellite platforms (SAT). 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 around Bozen/Bolzano. Additionally, air temperature profiles within the basin were retrieved from a vertical temperature profiler and used for calculating average air temperatures of the measurement path.

We present the TIR image processing and data filtering scheme, compare the results retrieved from different platforms and demonstrate the consequences of not accounting for atmospheric influences on TIR imaging by the use of a multiple linear regression model.

We could clearly show the influence of the path-temperature on the CAM measurements. We found that the measurement error (difference between OSR and CAM data) increases proportionally with the difference between LST and path-temperature. Subsequently we applied a multiple linear regression model to correct thermal infrared images taken over different path-lengths. Applying these corrections we can show, that not accounting for atmospheric effects does lead to an underestimation of LST-ranges within a thermal infrared image and it does dampen LST-amplitudes, despite comparatively short measurement paths.