Landscape scale thermography

measurements, modelling and implications

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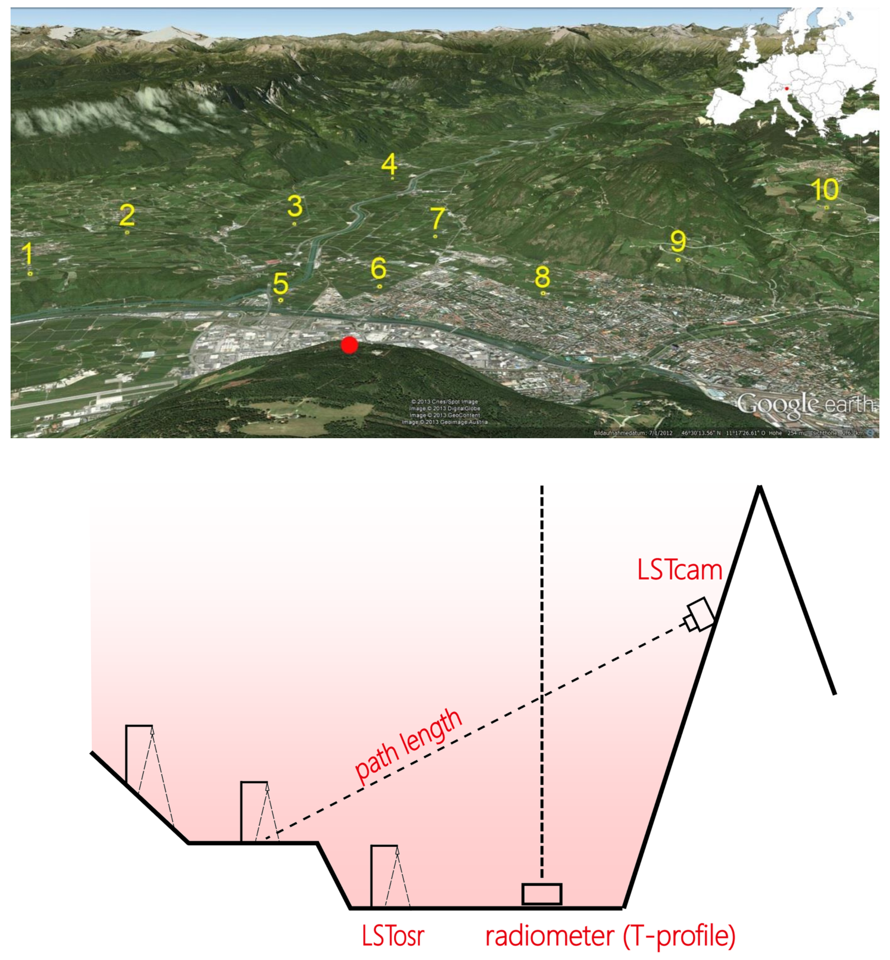
Land surface temperature (LST) is a key variable for numerous environmental functions. It represents the combined result of all energy exchange processes between the atmosphere and the land surface. Thermal infrared (TIR) cameras have gained increasing popularity in ecosystem research due to their big range of spatio-temporal resolution.
While corrections for atmospheric influences are commonly applied in TIR remote sensing such corrections are not yet routinely applied in ground based thermal imaging at landscape scales.



Sites around Bozen/Bolzano (Ita). On-site radiometry (OSR; yellow) and the site of ground-based infrared thermography (red). Schematic setup shown below

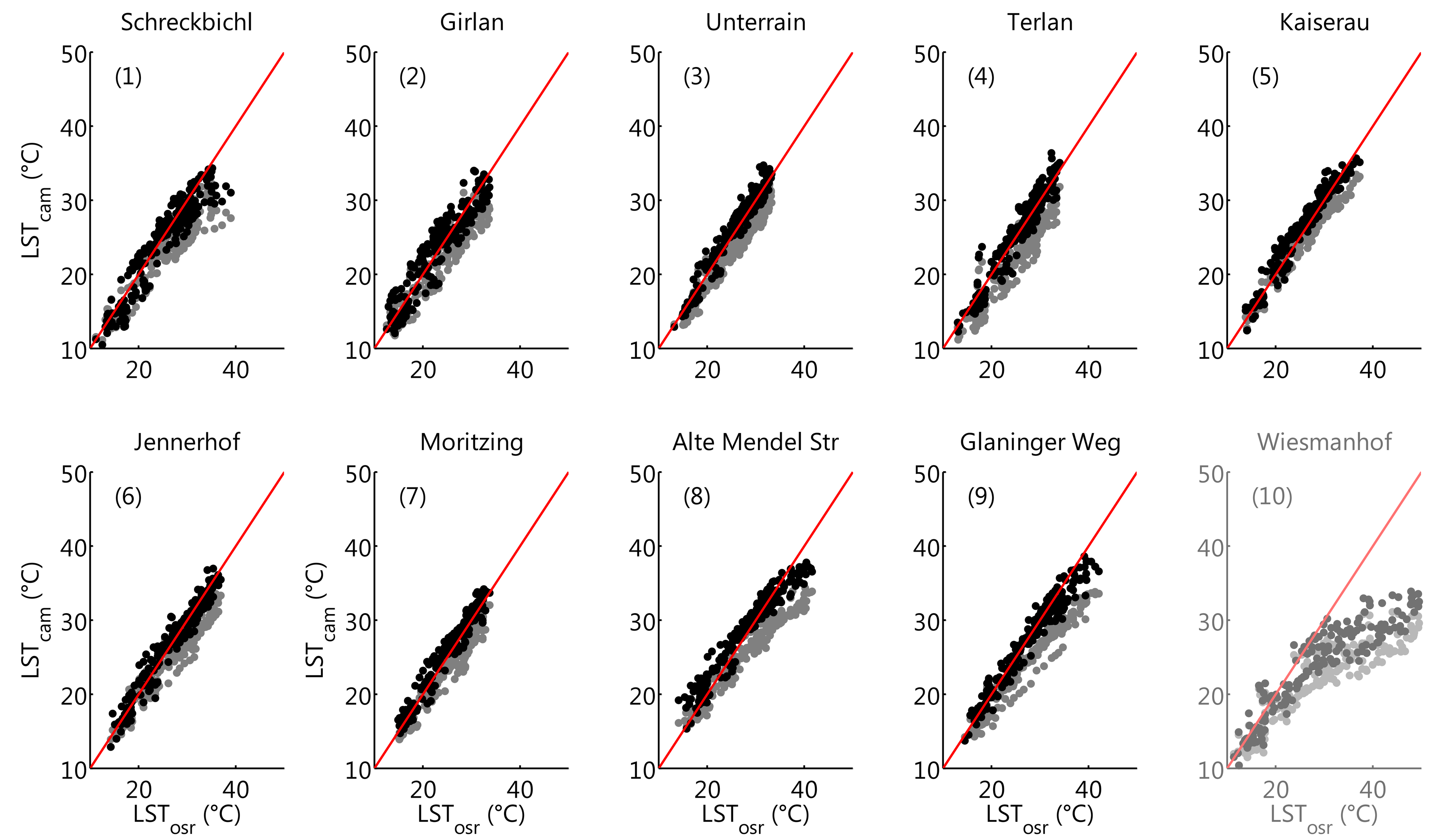
Thus we …

(I) present a comparison of LST measured by on-site radiometry (LSTosr) and by infrared thermography (LSTcam) over different path lengths (3000 – 9000m)

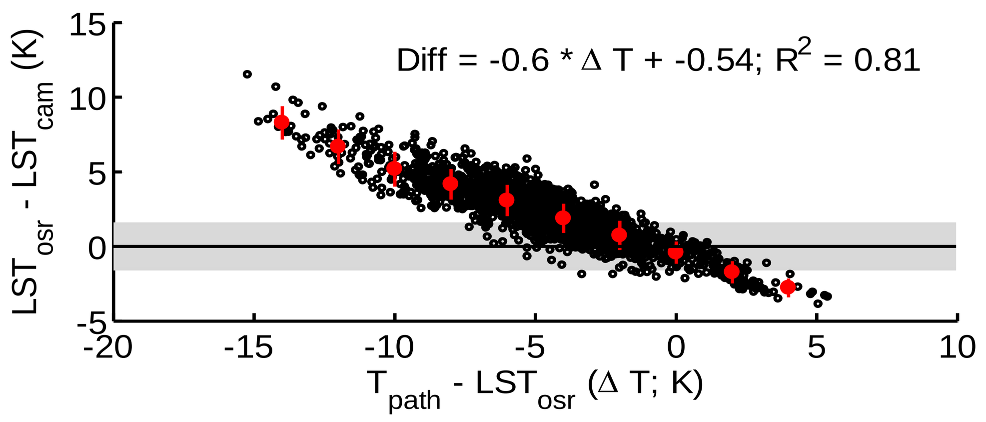
(II) show the effect of path-temperature (Tpath) on the difference of these two methods

(III) developed a multiple linear regression model to account for these effects

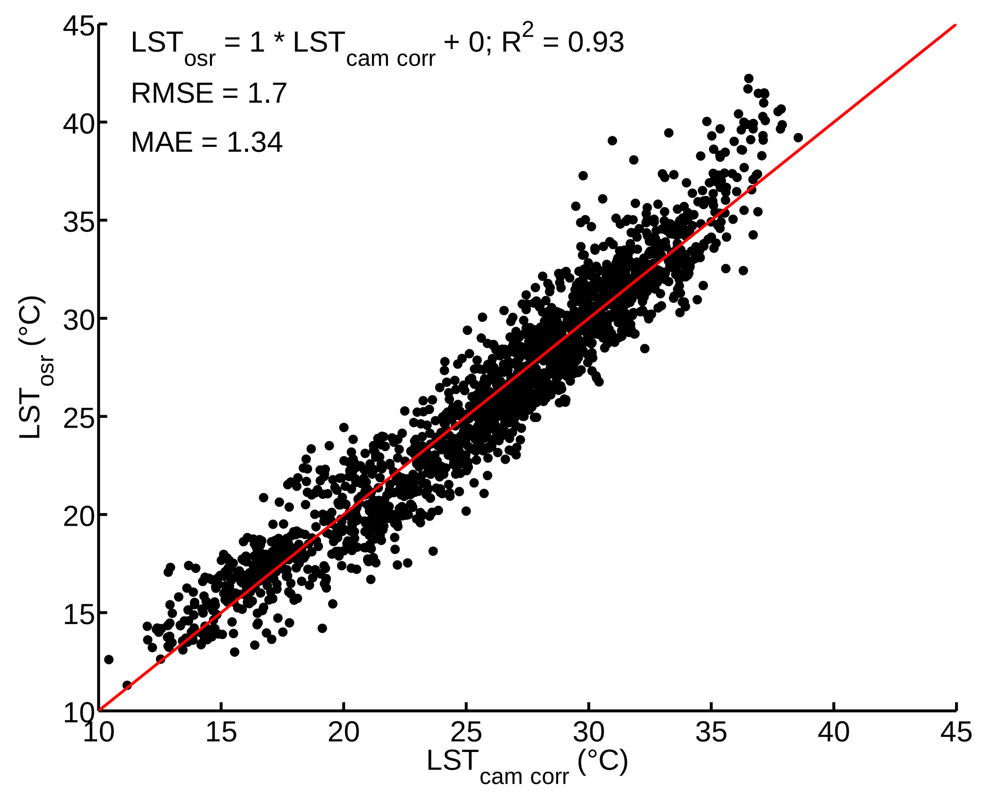
(IV) show the consequences of not accounting for atmospheric effects on LST-estimates by ground based infrared thermography



(I) Correlations of LSTosr and LSTcam per site – gray: uncorrected data (LSTcam); black: modelled data (LSTcam corr) (see (III)). Red line: 1:1 line. Numbers refer to site figure on the left. Site (10) discarded as outlier in analysis due to wilting right below OSR sensor in contrast to fresh conditions surrounding the station.



(II) Correlation of the differences between LSTosr and LSTcam vs. the difference between Tpath and LSTosr including bin-averages and correlation statistics for raw data.

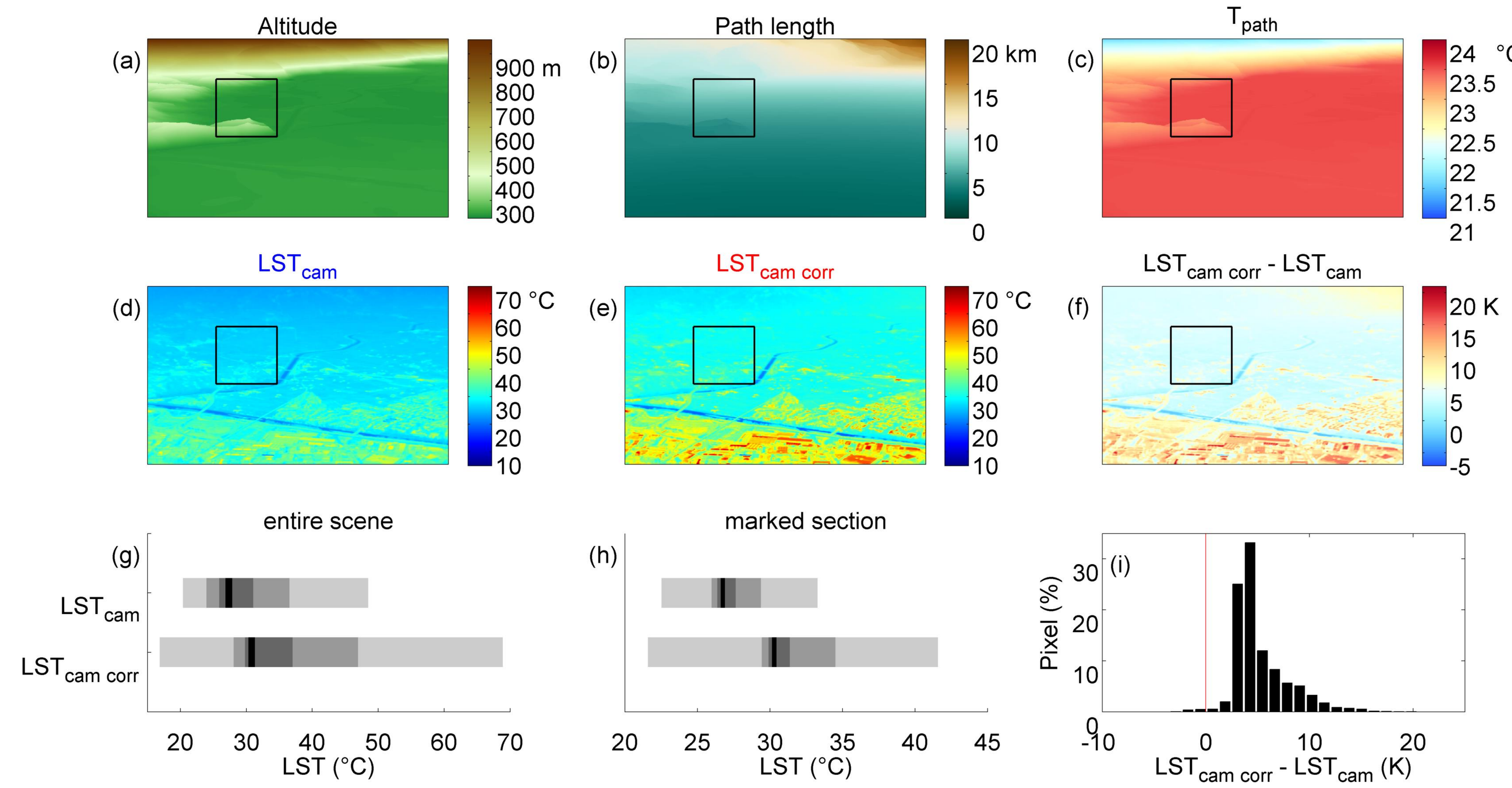


(III) Correlation of measured LST (LSTosr) vs modelled LST (LSTcam corr) including correlation statistics and 1:1 line (red). Equation of multiple linear regression model shown below x-axis.

$$LST_{cam\,corr} = -3.97 + 1.09\,LST_{cam} + 0.77\,(LST_{cam} - T_{path}) + 0.00047\,d$$

We could demonstrate that, depending on the temperature difference between the land surface and the overlying air masses, the errors on LSTcam are relevant even at relatively short measurement paths.

Not accounting for the atmospheric effects in landscape-scale thermography results in an underestimation of both, spatial and temporal variability in land surface temperatures, due to the dampening effect of the atmosphere on the LSTcam measurements.



(IV) (a) Elevation model, as seen by LSTcam (b) Path lengths for each pixel (c) Average Tpath (d) Land surface temperatures as measured by LSTcam (e) Resulting LSTcam from model application (LSTcam corr) (f) Difference between LSTcam and LSTcam corr (g) Temperature ranges of LSTcam and LSTcam corr for the entire scene (h) Temperature ranges of LSTcam and LSTcam corr for the marked section in panels (a)-(f). Grey shadings in (g) and (h) refer to min-max-range, 90% percentile, 50% percentile (IQR) and the median (black line), respectively. (i) Histogram of the differences in panel (f) for the entire scene

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