Atmos. Meas. Tech. Discuss., 3, C2896–C2898, 2011
www.atmos-meas-tech-discuss.net/3/C2896/2011/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Atmospheric correction of thermal-infrared imagery of the 3-D urban environment acquired in oblique viewing geometry" *by* F. Meier et al.

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Received and published: 3 March 2011

General reply

We are thankful to the Referee #1 for reviewing our manuscript and for the helpful comments and suggestions, which we will consider in a revised version of the manuscript.

Reply to specific comments

RC: The discussion of contributions due to environmental thermal radiation scattered from a ground surface element observed by the camera is not fully self-consistent. If

in the end you omit this contribution, this implicates emissivity eps = 1, so no need to have eps in equation 3. The authors start from the full equation (1) which includes the scattered contribution. As the final target is to derive thermodynamic temperatures of ground elements, it would be instructive to estimate how the neglected scattered contributions compare to the atmospheric corrections for a plausible range of surface element emissivities.

AC: The inconsistency between the full equation (1) and equation (3) was already resolved during the proof reading. In the final version of our AMTD paper the emissivity term is no longer included in equation (3). However, we intend to expand Section 2 in order to estimate the error caused by the assumption eps = 1 for a plausible range of surface emissivities and downward long-wave radiation.

RC: It would be interesting to estimate the atm corrections as function of the camera's spectral bandpass to decide whether the strategy of introducing a narrower spectral bandpass (by inserting a bandpass filter) might be a useful approach to minimise the correction term due to atm self-emission.

AC: This is an interesting and important question, however this should be analysed in a separate study.

RC: As the authors state correctly, vignetting is a reduction of optical throughput of the camera as function of field height (or angle between optical axis and line of sight (LOS) for selected pixel). So this effect reduces the sensitivity of the system for an oblique LOS, which is a multiplicative effect. Therefore, a flat-field correction is required (divide the scene by a sensitivity function which is normalized to unity on the LOS), subtracting a radiance is incorrect. Moreover, the vignetting behaviour shown in Fig. 3 looks quite strange. Typically, a curve starting with zero slope and falling off more steeply towards maximum field height is observed (the authors themselves refer to the cosine fourthlaw). I believe that actually a superposition of two effects is observed: narcissus, which is frequently met in IR camera systems (the central hot spot is radiation emitted by or reflected via the detector element and backreflected onto the detector by the lens system) and a true vignetting further out. A proper characterisation of vignetting would require an emitter which covers several pixels and should be moved across the observed field. The narcissus contribution might be comprised of additive (backreflected radiation emitted by the sensor) and / or multiplicative (incoming scene radiation reflected by the sensor and backreflected by the lens, proportional to the scene radiance).

AC: We have moved the TIR camera from the high-rise building in order to perform further measurements regarding the radiometric characteristics and error sources of the TIR camera system. Currently, we are carrying out an experiment in a temperature-controlled chamber at our Department in which we are varying the air temperature in the chamber between zero and thirty degree Celsius in discrete steps of 5 K, and we are measuring the surface temperature of a homogenous plate using the TIR camera, two thermocouples and two pyrometers. First measurements with and without the polyethylene foil protecting the camera show that the foil produces an effect which is different from lens vignetting, which contributes to the observed pattern described in Section 3.2.1. The foil's spectral transmissivity is already taken into account in the radiometric pre-processing. The new measurements will be taken to improve radiometric correction of the camera system including the foil by using an optimized flat-field correction procedure combing additive and multiplicative error effects.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 5671, 2010.