ATMOSPHERIC CORRECTION OF GROUND-BASED THERMAL INFRARED IMAGERY OF URBAN SURFACES ACQUIRED IN OBLIQUE-VIEWING GEOMETRY

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Surface temperature is a key variable in urban climatology. Satellite, aerial and ground-based Thermal Infrared (TIR) remote-sensing approaches addressing the energy exchange of urban surfaces measure the spatial distribution of upwelling long-wave radiation and associated surface temperatures, and discuss them in the context of sun geometry, atmospheric transmittance and emittance, urban morphometry, radiative material properties, heat storage, and anisotropy effects.

Embedded into the experimental framework of the scientific program EXCUSE (Energy Exchange of Urban Structures and Environments), a TIR camera located on a 120 m high-rise building in Berlin (Steglitzer Kreisel) continuously records long-wave radiation emitted from natural and anthropogenic surfaces of an urban neighbourhood showing strong spatial heterogeneity. The instrument (VarioCam Head, InfraTec) delivers radiance images of 320 by 200 pixels at a maximum frequency of 50 Hz. Both single-shots and temporarily integrated (accumulated) TIR images can be acquired by the camera. Optionally, the camera is able to record images of four-time higher spatial resolution at the cost of much lower temporal resolution (less than 1 s). The field of view (FOV) of the instrument approximately covers 0.1 km² in oblique view (-15 to -70° angle of inclination). The measurements are planned to continue as long as possible (many years, at least).

During routine operation a sequence of partly overlapping radiance images of different viewing geometry is recorded. Data are georeferenced, converted to absolute values for the at-sensor surface temperature, and then merged into one large compound image stored at 5 min intervals. A comprehensive atmospheric-correction procedure working on a pixel-by-pixel basis is applied for deriving ground surface temperatures from the at-sensor values. The atmospheric-correction procedure takes both the atmosphere between the sensor and the surface element and the viewing geometry of each individual pixel into account, while anisotropic effects are not considered in this step. A second mode of operation is to fix the viewing geometry for taking high-frequency measurements over time periods of a view hours. A third mode of intermediate frequency and duration will be tested in the future.

In the presentation, the instrumental set-up, the data acquisition and processing procedures are explained and discussed with respect to the scientific questions addressed by EXCUSE. Special attention is given to the atmospheric-correction procedure, which will be discussed in detail based on a theoretical study showing the sensitivity of the correction results on atmospheric conditions as well as on viewing geometry. The latter is particularly important for urban surfaces characterized by their three-dimensional topography that has to be taken into account for each pixel individually.