Development of hyperspectral thermal infrared mapping capabilities at field and airborne level within MOSES heat wave event chain

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Heat waves have tremendous ecological and socioeconomic consequences for many countries and initiate complex event chains that reach from the land surface to the upper atmosphere. Although it is well known that global change affects the Earth and environment on many different time and length scales, currently, only very limited knowledge is available on the importance of such distinct dynamic events for the long-term development of the Earth system. To investigate the impact of extended heat periods and droughts on our terrestrial ecosystems and natural resources, the Helmholtz MOSES project implements a modular infrastructure that is designed to capture such highly dynamic events in event-driven campaigns. As part of this infrastructure initiative a new hyperspectral thermal instrument, the Telops Hyper-Cam LW, was recently acquired at the Potsdam German Research Centre for Geosciences (GFZ) and capabilities for airborne surveys, laboratory and field deployment, as well as data processing in the context of heat wave impacts are currently developed.

The Telops Hyper-Cam LW is a Fourier-transform imaging spectrometer (~8–12 μm) with adjustable spectral resolution from 0.25 to 150 cm⁻¹ that can be operated at various scales from ground and airborne platforms. The hyperspectral longwave infrared shows great potential for the characterization of soil and vegetation properties and their variability related to heat wave impacts. However, this spectral imagery can only be used to fullest advantage when the signal is corrected, e.g. path radiance of the atmosphere, as well as the downwelling radiance component have been removed from the measured signal and temperature is separated from emissivity.

In this context, this contribution describes the recent developments at GFZ toward (i) The development of suitable field sampling strategy & protocols related to the acquisition of field thermal hyperspectral data including calibration and validation measurements, (ii) Establishment of preliminary protocols for field data processing to temperature and emissivity, (iii) Test and mounting of the Hyper-cam on the Cessna-T207A airborne platform from the Free University Berlin (FUB) and (iv) Flight testing and calibration, and establishment of preliminary protocols and
strategies for the development of a processing chain from raw data to temperature and emissivity imagery and extraction of relevant thematic parameters.

In particular, first results will be shown based on the MOSES/ScaleX-2019 campaign where field Hyper-Cam measurements were acquired in different configurations at the Fendt grassland test site located in the German Pre-Alpine foreland. Different approaches for temperature emissivity separation are tested and compared, e.g. normalization emissivity method and spectral smoothness based emissivity separation. Furthermore, calibration and validation activities are presented in the frame of several airborne surveys over different targets to correct and validate the thermal signal. Preliminary airborne results will be shown over different locations in Germany and Greece that indicate good geometric and radiometric data accuracy, as well as high potential for the differentiation of surface materials from the spectral emissivity and surface temperature.