Sensitivity of thermal infrared directional anisotropy to canopy and meteorological conditions

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SENSITIVITY OF THERMAL INFRARED DIRECTIONAL ANISOTROPY TO CANOPY AND METEOROLOGICAL CONDITIONS

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Land Surface Temperature measurements are prone to important directional anisotropy and hot spot effects. These are governed by the coupled energy and radiative transfer within canopies, and therefore depend on the viewing angles, on the Sun position (i.e. time and season), on the canopy (structure and water status), and on micrometeorological conditions. The future missions combining both high spatial resolution and revisit capacities in the thermal infrared (TIR) such as THIRSTY (Crebassol, et al. 2014) require the directional anisotropy (defined as the difference between oblique and nadir temperatures) to be correctly assessed. That's why we must develop correction algorithms simple and robust enough to be compatible with the processing of data from space and the elaboration of final products. The development, calibration and validation of these algorithms require large amounts of data. For this purpose we use the SCOPE (Soil Canopy Observation, Photochemistry and Energy fluxes, Van der Tol et al. 2009) model. It is a soil vegetation atmosphere transfer (SVAT) multilayer model coupling radiative transfer (4SAIL) and energy balance able to simulate energy fluxes and directional brightness temperatures.

We first briefly describe the model and its validation against experimental data over wheat and forest canopies, and illustrate its ability to simulate the directional anisotropy of brightness surface temperatures in a large range of zenithal and azimuthal viewing directions.

The model is then used to evaluate the sensitivity of anisotropy to different canopy structure and meteorological variables. Among the parameters tested, the wind speed, the LAI and the stomatal conductance reveal to have major impact as expected because they directly govern the sensible and latent heat fluxes and therefore surface temperature. Results show that the anisotropy significantly decreases with wind speed, LAI increase and especially when water needs are satisfied (i.e. increase of stomatal conductance). These will have to be introduced in TIR data processing algorithms for either correcting temperatures from directional anisotropy effects or normalizing them into a given reference viewing geometry. Their determination from complementary data obtained from meteorological networks or from remote sensing (such as vegetation indices or water stress indices) is discussed and guidelines provided.

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