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Modelling the angular effects on satellite retrieved LST at global scale using a land surface classification

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Land Surface Temperature (LST) is a key climatological variable and a diagnostic parameter of land surface conditions. Remote sensing constitutes the most effective method to observe LST over large areas and on a regular basis. Although LST estimation from remote sensing instruments operating in the Infrared (IR) is widely used and has been performed for nearly 3 decades, there is still a list of open issues. One of these is the LST dependence on viewing and illumination geometry. This effect introduces significant discrepancies among LST estimations from different sensors, overlapping in space and time, that are not related to uncertainties in the methodologies or input data used. Furthermore, these directional effects deviate LST products from an ideally defined LST, which should represent to the ensemble of directional radiometric temperature of all surface elements within the FOV.

Angular effects on LST are here conveniently estimated by means of a kernel model of the surface thermal emission, which describes the angular dependence of LST as a function of viewing and illumination geometry. The model is calibrated using LST data as provided by a wide range of sensors to optimize spatial coverage, namely: 1) a LEO sensor - the Moderate Resolution Imaging Spectroradiometer (MODIS) on-board NASA's TERRA and AQUA; and 2) 3 GEO sensors - the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on-board EUMETSAT's Meteosat Second Generation (MSG), the Japanese Meteorological Imager (JAMI) on-board the Japanese Meteorological Association (JMA) Multifunction Transport SATellite (MTSAT-2), and NASA's Geostationary Operational Environmental Satellites (GOES).

As shown in our previous feasibility studies the sampling of illumination and view angles has a high impact on the obtained model parameters. This impact may be mitigated when the sampling size is increased by aggregating pixels with similar surface conditions. Here we propose a methodology where land surface is stratified by means of a cluster analysis using information on land cover type, fraction of vegetation cover and topography. The kernel model is then adjusted to LST data corresponding to each cluster. It is shown that the quality of the cluster based kernel model is very close to the pixel based one. Furthermore, the reduced number of parameters (limited to the number of identified clusters, instead of a pixel-by-pixel model calibration) allows improving the kernel model trough the incorporation of a seasonal component.

The application of the here discussed procedure towards the harmonization of LST products from multi-sensors is on the framework of the ESA DUE GlobTemperature project.