ID: 5
Oral presentation
Topics: Regional to National Products & Applications

Mapping urban surface characteristics for urban energy flux modelling

Wieke Heldens[1], Fabio del Frate[2], Fredrik Lindberg[3], Zina Mitraka[4], Daniele Latini[2], Nektarios Chrysoulakis[4], Thomas Esch[1]

[1]DLR, Germany; [2]GEO-K, Italy; [3]University of Gothenburg, Sweden; [4]FORTH, Greece

Climate surface parameters in urban areas and the urban energy budget are influenced by the urban spatial characteristics. Thus, to model the urban energy budget, a characterization of the urban surface is required. Within the H2020 Project URBANFLUXES it is aimed model the urban energy budget and especially the anthropogenic heat flux using earth observation (EO) data. EO data is especially valuable for the mapping of the urban surface characteristics. The main advantage to do so is the transferability to any city, because objective input data can be generated. The EO methods for URBANFLUXES are developed and applied to three cities: Basel, London and Heraklion.

A requirements catalogue has been defined to ensure the EO products are adapted to the needs of the subsequent energy budget models. The required products are divided in morphological parameters and surface parameters. The morphological parameters describe the vertical structure of the urban area and require a detailed digital surface model. For URBANFLUXES, in addition to the surface and elevation models also the building height, sky view factor, building fraction (plan area index) and frontal area index are derived. The surface parameters describe characteristics such as land cover fractions, phenology (NDVI, LAI), albedo and surface temperature. The parameters that are related to vegetation have a higher variability through the year than the built up area. Therefore these parameters are derived multiple times per year, but also at a lower spatial resolution. All products are transferred to the same spatial grid. Various sources of EO data at different spatial and temporal resolution are used, depending on the requirements.

As basis for the morphological parameters a lidar DSM and derived DEM is available for the city of Basel and London. For Heraklion a DSM and DEM derived from stereo imagery is available. From the DEM and DSM, the sky view factor, plan area index and frontal area index are calculated according to Lindberg and Grimmond (2010) and Grimmond and Oke (1999). The results are aggregated to a 100 m grid. For the calculation of the surface parameters of Basel it is made use of data of Landsat 8 and Spot 5. The land cover fractions are calculated using a neural network approach (Del Frate et al. 2007)To describe the phenology time series of NDVI are calculated on the Landsat data. Also the albedo is calculated on the Landsat 8. Surface temperature is derived in local scale from the synergistic use of Landsat and MODIS acquisitions (Mitraka et al., 2015). All methodologies are implemented in a way that enables switching to the Sentinel 2/3 data as soon as the data becomes available.

The resulting EO products are the input for urban climate models to enable the estimation of anthropogenic heat flux. But they are also used as input for the classification of Local Climate Zones (LCZ). Stewart and Oke (2012) formally defined LCZ as regions of uniform surface cover, structure, material, and human activity that span hundreds of meters to several kilometers in horizontal scale. After successful classification and combination with the modelling results of the URBANFLUXES project, the LCZ could be used as an indicator for regions with certain anthropogenic heat flux characteristics.

References

Del Frate, F. , F. Pacifici, G. Schiavon, C. Solimini, 2007. Use of neural networks for automatic classification from high resolution imagery. IEEE Transactions on Geoscience and Remote Sensing, 45, 800-809

Grimmond, C.S.B., Oke, T.R.,1999. Aerodynamic Properties of Urban Areas Derived from Analysis of Surface Form. Journal of Applied Meteorology, 38, 1262-1292

Lindberg, F. and Grimmond, C. S. B., 2010,. Continuous Sky View Factor from High Resolution Urban Digital Elevation Models. Climate Res., 42, 177 - 183.

Mitraka, Z., Chrysoulakis, N., Doxani, G., Del Frate, F., Berger, M., 2015. Urban Surface Temperature Time Series Estimation at the Local Scale by Spatial-Spectral Unmixing of Satellite Observations. Remote Sensing, 7(4), 4139–4156.

Stewart, I. D. and Oke, T. R., 2012. Local Climate Zones for Urban Temperature Studies. Bulletin of the American Meteorological Society, 93, 1879 - 1900