Urban Energy Budget Estimation from Sentinels: The URBANFLUXES Project

Chrysoulakis N.[1], Heldens W.[2], Gastellu-Etchegorry J.-P.[3], Grimmond C.S.B.[4], Feigenwinter C.[5], Lindberg F.[6], Del Frate F.[7], Klostermann J.[8], Mitraka Z.[1], Esch T.[2], Albitar A.[3], Gabey, A.[4], Parlow E.[5] and Olofson, F.[6]

[1] *Foundation for Research and Technology Hellas (FORTH), Greece, zedd2@iacm.forth.gr*

[2] *German Aerospace Center (DLR), Germany, thomas.esch@dlr.de*

[3] *Centre d'Etude Spatiale de la Biosphère (CESBIO), France, jean-philippe.gastellu-etchegorry@cesbio.cnes.fr*

[4] *University of Reading, UK, c.s.grimmond@reading.ac.uk*

[5] *University of Basel, Switzerland, eberhard.parlow@unibas.ch*

[6] *University of Goeteborgs, Sweden, fredrikl@gvc.gu.se*

[7] *GEO-K s.r.l., Italy, delfrate@disp.uniroma2.it*

[8] *ALTERRA, Netherlands, judith.klostermann@wur.nl*

Abstract

The recently launched H2020-Space project URBANFLUXES (URBan ANthrpogenic heat FLUX from Earth observation Satellites) investigates the potential of Copernicus Sentinels to retrieve anthropogenic heat flux, as a key component of the Urban Energy Budget (UEB). Temperatures in cities are predicted to rise even more in the future, resulting in increased energy demand for cooling systems in low and mid-latitude cities, modifying UEB. A positive feedback cycle occurs in many urban areas, where higher temperatures result in more energy being used for cooling, which in turn adds to heat emissions and increases temperatures further during periods with increased heat wave risk. It is expected that without mitigation measures, energy demand will continue to increase during the warmest months. URBANFLUXES advances the current knowledge of the impacts of UEB fluxes on urban heat island and consequently on energy consumption in cities. This will lead to the development of tools and strategies to mitigate these effects, improving thermal comfort and energy efficiency. In URBANFLUXES, the anthropogenic heat flux is estimated as a residual of UEB. Therefore, the rest UEB components, namely, the net all-wave radiation, the net change in heat storage and the turbulent sensible and latent heat fluxes are independently estimated from Earth Observation (EO), whereas the advection term is included in the error of the anthropogenic heat flux estimation from the UEB closure. A dense network of conventional meteorological stations is used in each case study city: London, Basel and Heraklion. EO data is initially analysed to map urban surface morphology and cover, whilst a new approach has been developed to define Local Climate Zones (LCZ). Using the LCZ as a framework, advanced EO-based methods are used to estimate UEB fluxes: a sophisticated radiative transfer model (Discrete Anisotropic Radiative Transfer) is employed to simulate the net all-wave radiation; the computation of the storage term is based on the Element Surface Temperature Method, supported by the auxiliary datasets; and the estimation of the turbulent heat fluxes is based on the Aerodynamic Resistance Method, supported by standard meteorological measurements. In-situ flux measurements (Eddy Covariance, scintilometry) and bottom-up approaches (inventories, building energy models) are used to evaluate URBANFLUXES outcomes, whereas uncertainties are specified and analysed. The project exploits Sentinels observations, which provide improved data quality, coverage and revisit times and increase the value of EO data for scientific work and future emerging applications. These observations can reveal novel scientific insights for the detection and monitoring of the spatial distribution of the urban energy budget fluxes in cities, thereby generating new EO opportunities. URBANFLUXES thus exploits the European capacity for space-borne observations to enable the development of operational services in the field of urban environmental monitoring and energy efficiency in cities. It is therefore expected to prepare the ground for further innovative exploitation of European space data in scientific activities (climate variability studies at local and regional scales) and future and emerging applications (sustainable urban planning, mitigation technologies) to benefit climate change mitigation/adaptation and civil protection.