Heraklion air-temperature and surface fluxes dynamics at local scale

This web-application provides real time, as well as time series of high-spatial resolution maps and analytics for air temperature and surface energy fluxes for the city of Heraklion, Greece, based on the Surface Urban Energy and Water Balances Scheme (SUEWS), that has been developed by the University of Reading (Sun et al., 2020; Ward et al., 2016).

The application uses inputs from RSLab sensors network that includes the Wireless Sensors Network (WSN) of meteorological stations (Chrysoulakis et al., 2018; Nikoloudakis et al., 2020) and the two Flux Towers deployed in the center (HECKOR) and in a residential area (HECMAS) of Heraklion (Stagakis et al., 2019). It uses data from the last 24 hours to model the urban surface energy balance in hourly basis. The last hour data are used to create air temperature at 2 m, net all-wave radiation and turbulent sensible heat flux maps, at 100 m x 100 m spatial resolution, resampled to 10 m x 10 m.

The web-application also uses remote sensing products such as land cover map that describes the surface type at 1 m x 1 m resolution and digital surface model (DSM) one for buildings and one for trees at 1 m x 1 m resolution. All remote sensing products that application uses were produced for the URBANFLUXES project (Chrysoulakis et al., 2018). Population density data were provided from the National Statistical Service.

The model is parameterized according to Ward et al. (2016) with some modification in irrigation, the characteristics of vegetation classes and Objective Hysteresis Model (OHM) coefficients for building fraction that used for storage heat flux calculation.

I. The profile of irrigation was modified to 0.2 mm of water per hour for 5 hours for weekdays.
II. Vegetation cover variation has been taken into account by considering seasonal changes of vegetation using NDVI timeseries. The characteristics of deciduous trees class have been parameterized depending on leaf-on/ leaf-off period inside the model.
III. A set of several OHM coefficients for each fraction is included to the model files. Heraklion is a dense city with high buildings and the urban canyon effect is intense so for the buildings fraction was selected the set of "Canyon (E-W), Japan" Yosheida (1990/91) with cod “10” (Ward et al., 2016)

The application was evaluated using WSN temperature observations and HERCOR turbulent heat flux and net all-wave radiation flux observations. The model run for the August of 2021 and the results were compared with the measurements of 5 sensors in different areas of Heraklion. The RMSE was ranged from 0.5 C to 1.0 C. Turbulent sensible heat flux and net all-wave radiation were evaluated using HERCOR observations data for the same period and the RMSE was found at 38 W/m^2 and23 W/m^2, respectively.

The application has a user-friendly interface, includes a manual, that provide the produced maps according the selected date and time. The user has the option to select a point or draw/load a polygon inside the map for further statistical analysis such as the last 24 hours values or the value of the specific hour for the past week/month/3 months period. The percentage for values and min/max/mean is generated for the drawn area of the polygon.

The underlying algorithm runs in three stages:

1. **Parsing input data:** meteorological data (air temperature, relative humidity, air pressure and wind speed) and net all-wave radiation from the two Flux Towers HECKOR or HECMAS, precipitation data from OpenWeather station. RSLab WSN observations are used to fill any the gaps.
2. **Performing simulations:** using the parsed data for the last 24-hour period, SUEWS-based simulations are performed.
3. **Creating maps for selected outputs:** for each selected variable, date and time, a shapefile is created from a two-dimensional table (pixel ID, value) at 100 m x 100 m. The image is interpolated using 2D convolution with a 2D Gaussian generated moving window and then resampled at 10 m x 10 m by bilinear interpolation.

References

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