

Urban greenery – an important component of citizens well-being



Functions and ecosystem services of urban greenery, human perception

Role and potential of RS in gathering data/information for urban planners

Global Change Research Institute

Czech Academy of Sciences

Brno, Czech Republic

František Zemek, Miroslav Píkl

Development of instruments for planning and assessment of ecological benefit of greenery in towns

interdisciplinary approach to assessment of urban greenery EF/ES

- I. **cooling effect** - latent heat (evapotranspiration)
- II. **carbon sequestration (CO₂)** - annual biomass growth
- III. **capture of particle matters** - (PM₁₀, PM_{2.5}, O₃, NO_x, SO₂)
- IV. **noise reduction** - dB per units of greenery
- V. **cultural and aesthetic effects** – hedonic function

Outputs

methodology: [https://www.czechglobe.cz/wp-content/uploads/2022/04/Metodika TACR TH04030496 cert.pdf](https://www.czechglobe.cz/wp-content/uploads/2022/04/Metodika_TACR_TH04030496_cert.pdf)

software: www.ekobenefit.cz.

CzechGlobe

doc. Ing. Mgr. František Zemek, Ph.D.

Ing. Miroslav Píkl, Ph.D.

MSc. Mgr. Marian Pavelka, Ph.D.

doc. Ing. Miloš Zapletal Dr.

MSc. Helena Duchková

Ing. Lukáš Kokrda

Mgr. Davina Elena Vačkářová, Ph. D.

MSc. Lenka Foltýnová, Ph. D.

Ing. Jan Novotný, Ph.D.

Ing. Kateřina Máčová, Ph.D.

doc. RNDr. Pavel Cudlín, CSc.

SAFE TREES, s.r.o.

Ing. Jaroslav Kolařík, Ph.D.

Ing. Hana Holešová

Mgr. Olga Chalupová

Ing. Barbora Vojáčková

Mgr. Jiří Mikulášek



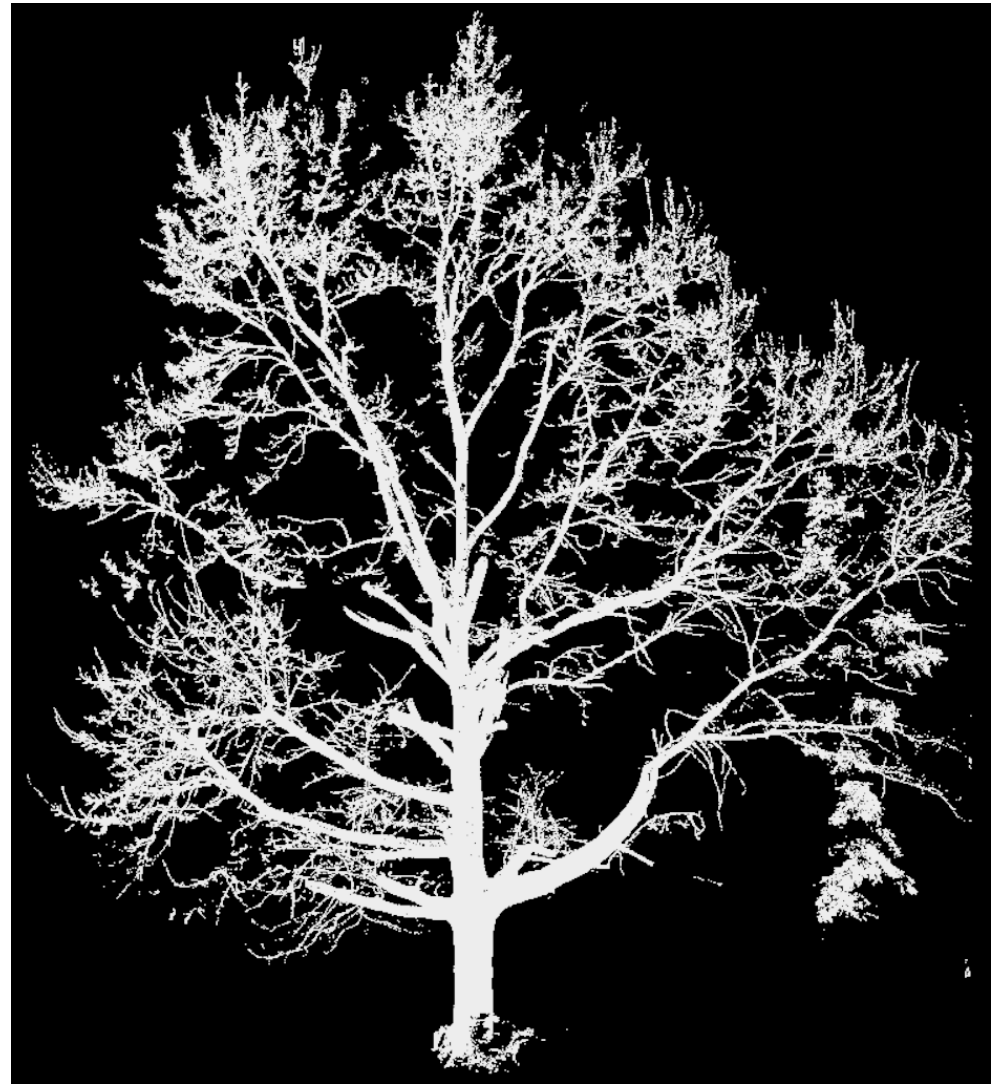
Transpiration subflow

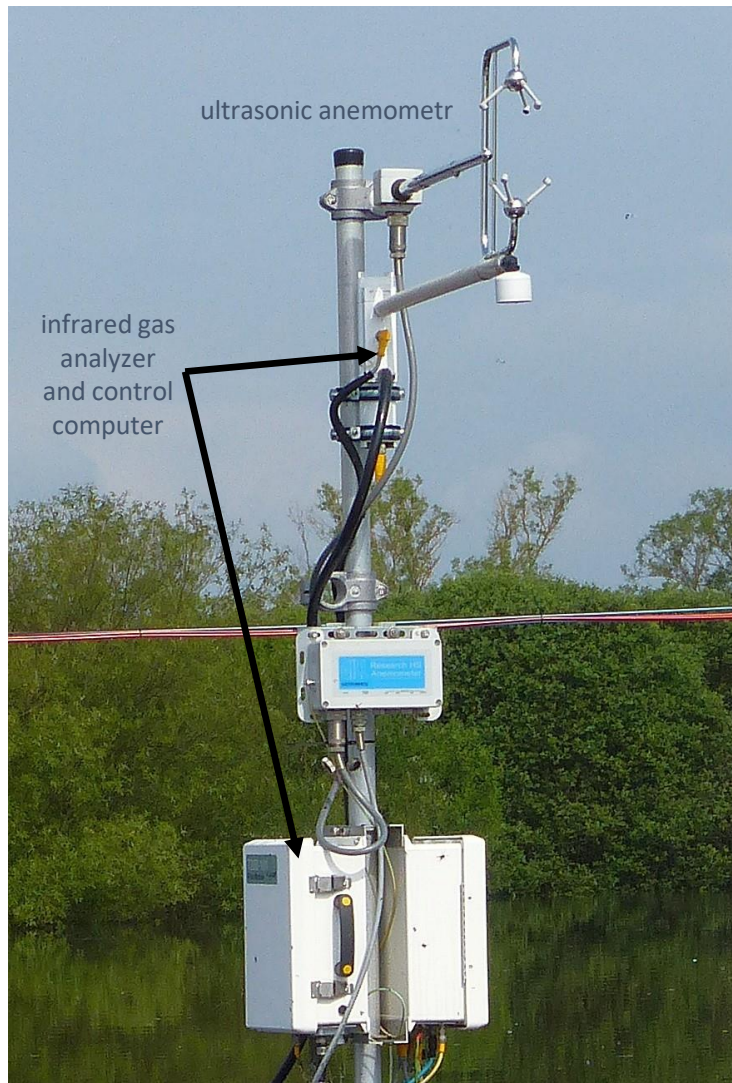


Dendrometer – change in perimeter of tree trunk



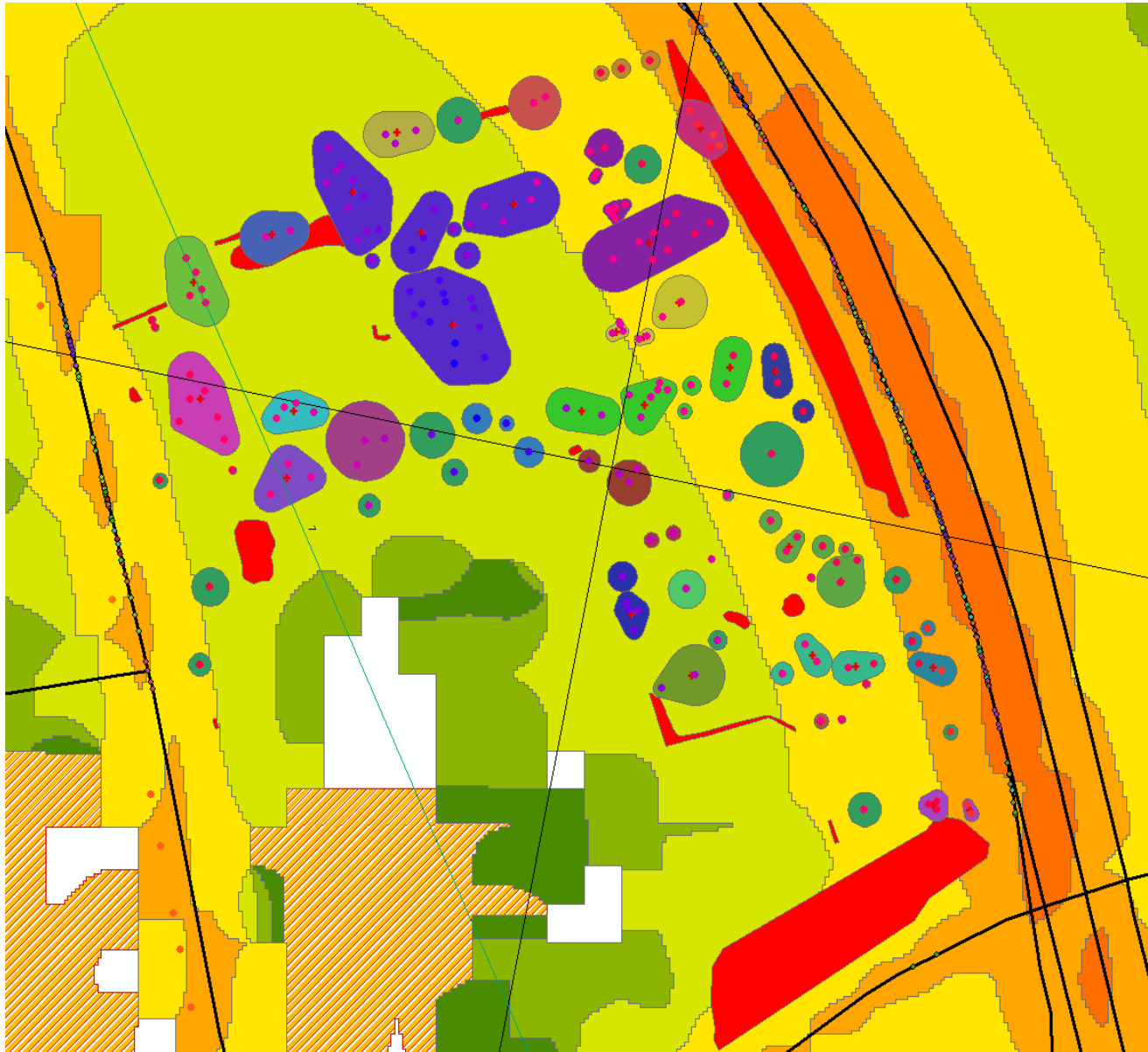
Diurnal spiration of oak cca 100
year (June – August)
dendrometer: 70 – 140 l
subflow: 120- 200 l

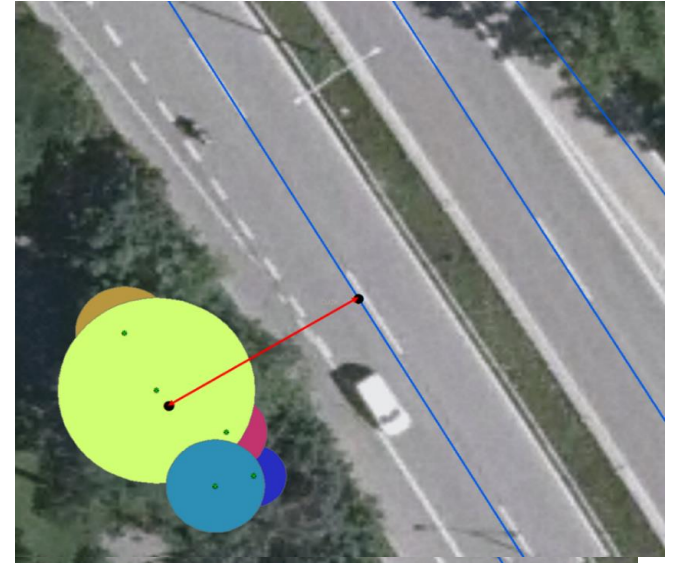
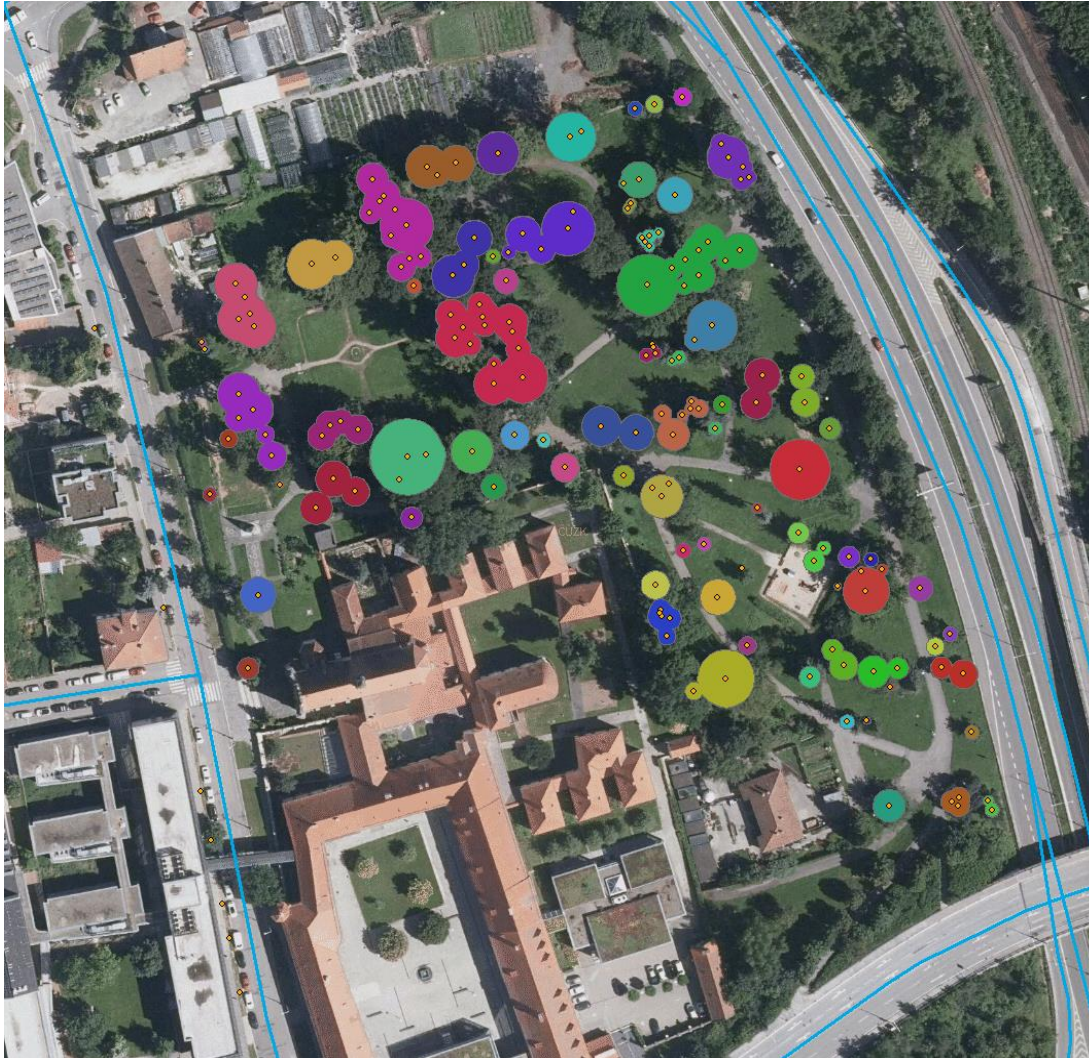




Eddy co variance tower







Thermal comfort in urban areas: human perception, physics based reality, role of greenery

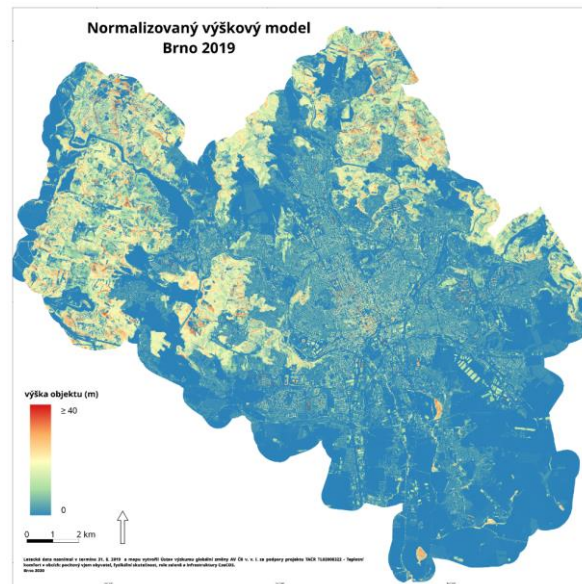
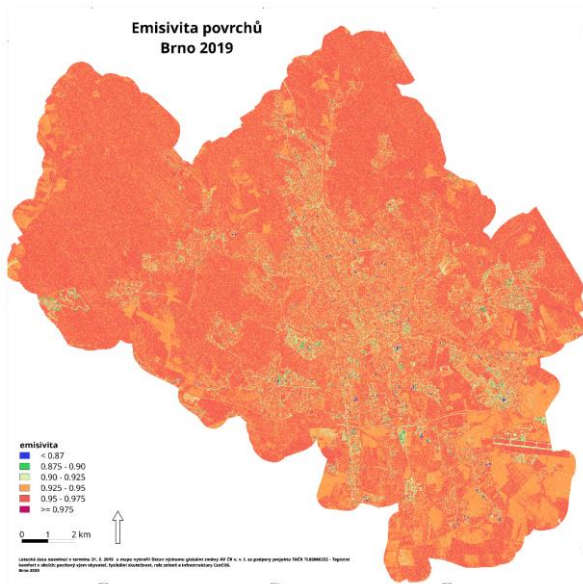
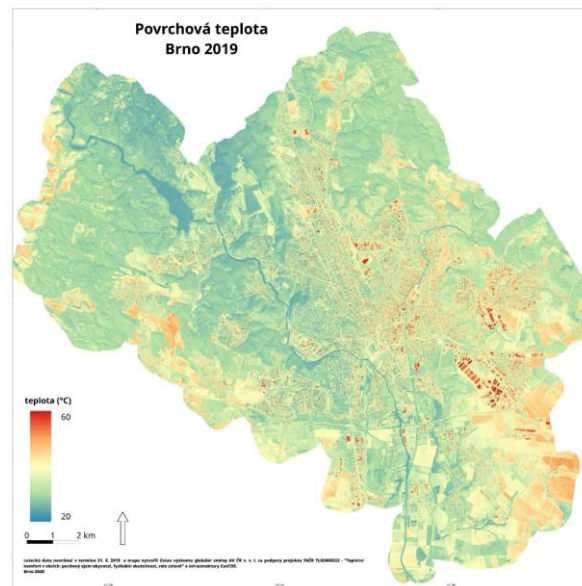
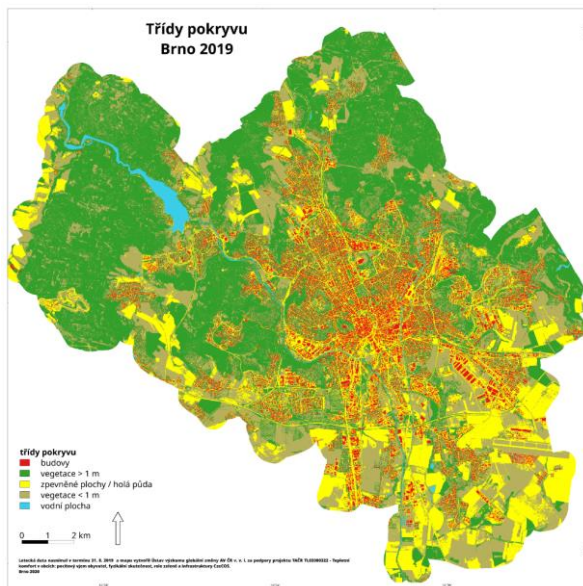
combination

- **physical based data (RS airborne and ground scanning/measurements)**
- **socio data – questionnaire survey**

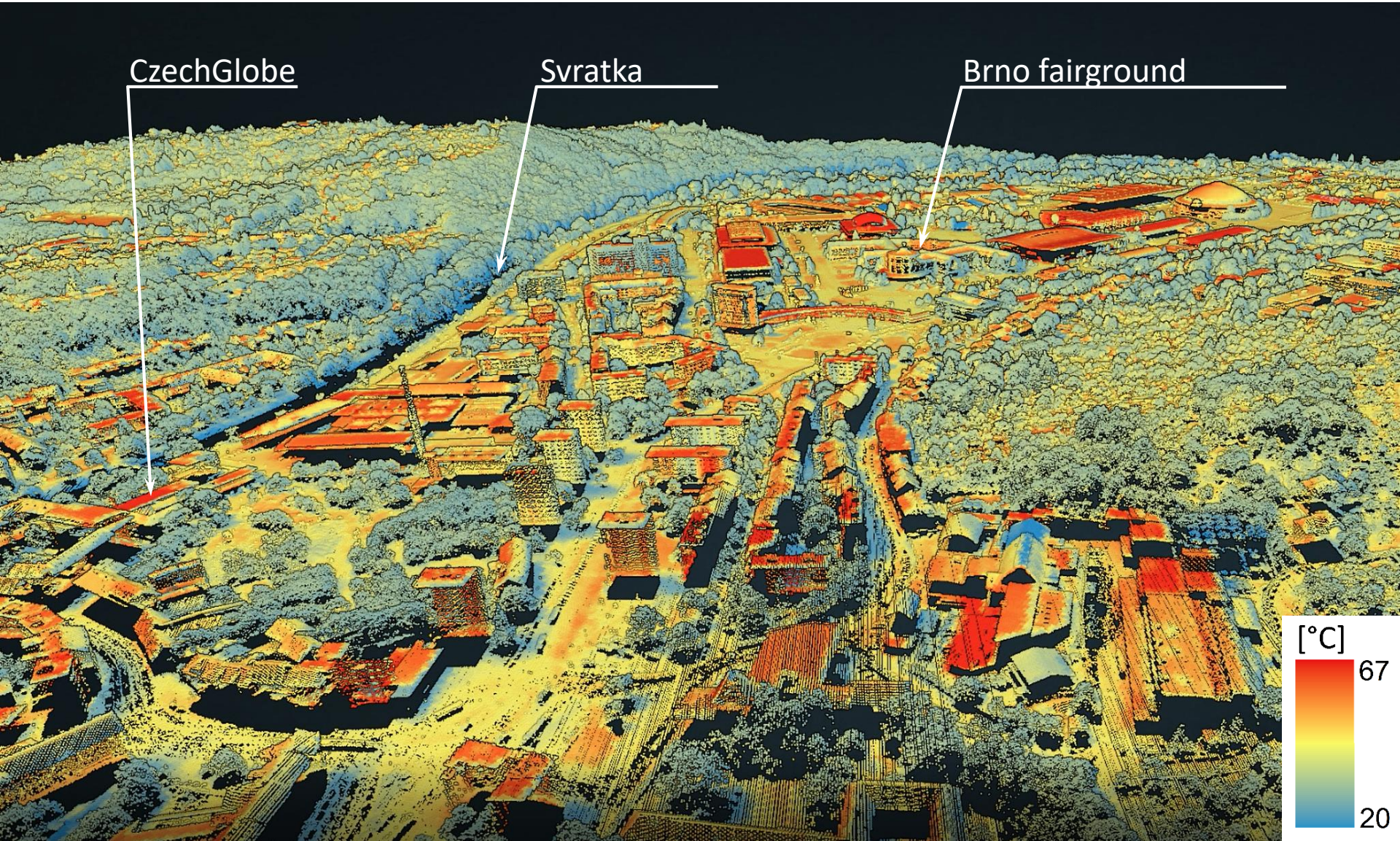
Outputs

- **Town maps of structure and surface temperatures**
- Education materials (pupils, students, population) – roles of greenery, special focus on trees
- Sci paper
- Workshops

<http://tekob.czechglobe.cz>



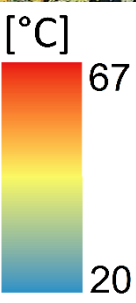
Multisource data fusion (TASI, LiDAR)



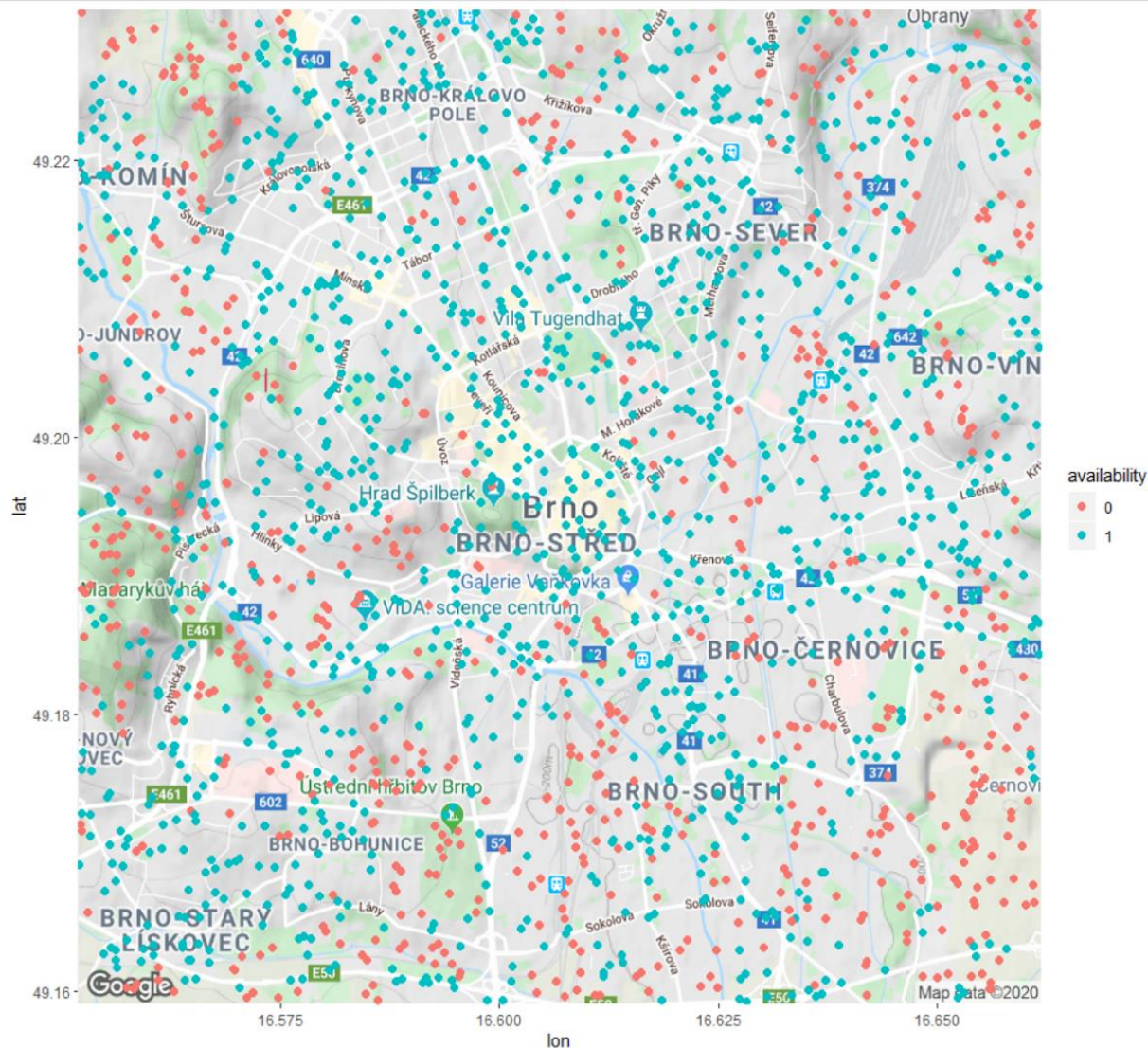
CzechGlobe

Svratka

Brno fairground



Google Street View points



Sociological survey via Google Street View photographs





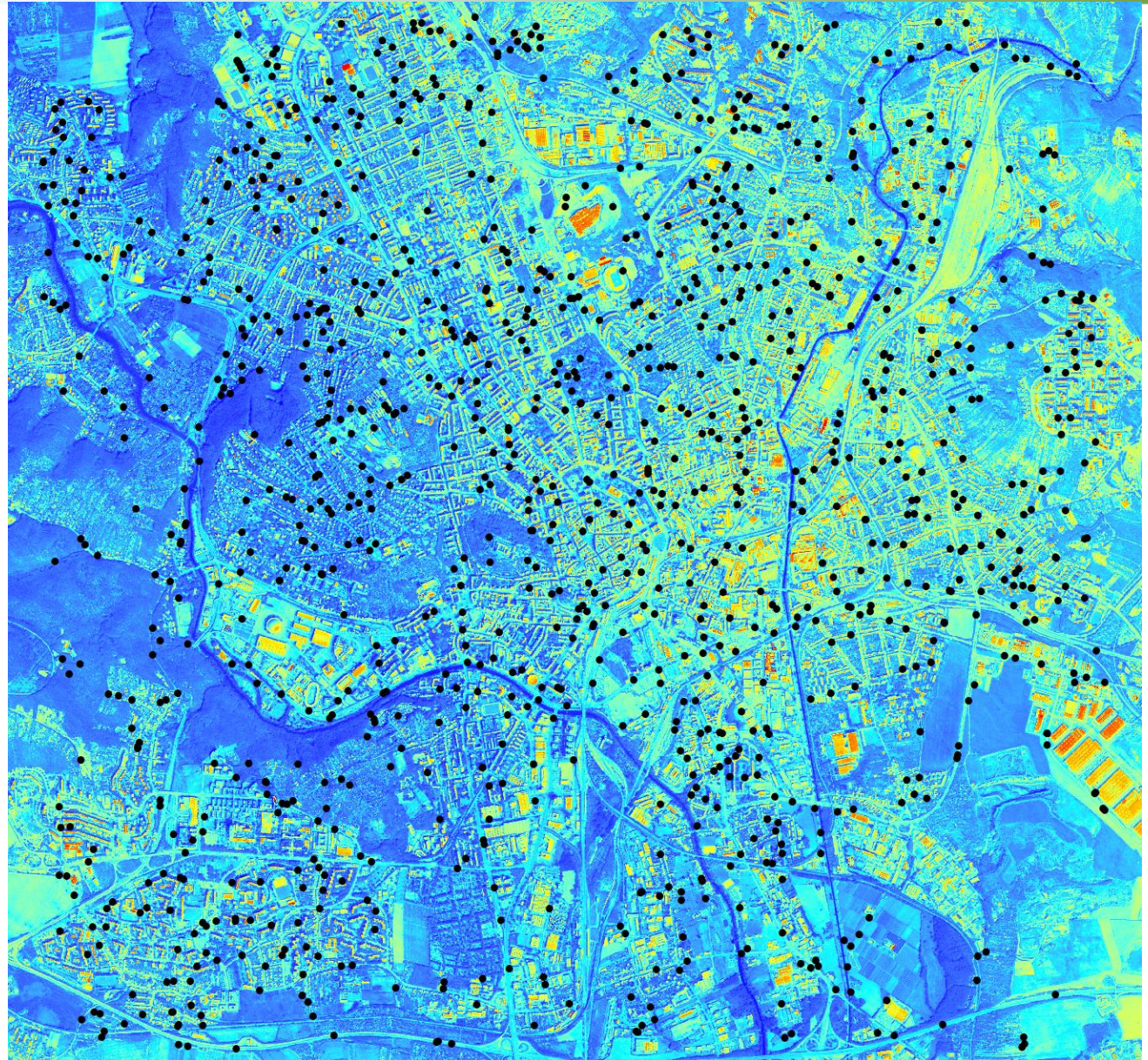
CASI RGB



Landcover classification from FLIS data



-  roofs
-  high vegetation
-  roads and solid surface
-  low vegetation
-  water

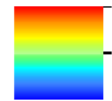


Brno TASI 20190831

C deg

75

14



Sociological survey related to conditions around each point – buffer 30 m).

From airborne data:

Surface temperature, Sky-view factor, Height of objects, Land cover (water, bare surface, high vegetation, low vegetation), Irradiation (direct, diffused)

J. Urban, M. Píkl, F. Zemek, J. Novotný

Using Google Street View photographs to assess long-term outdoor thermal perception and thermal comfort in the urban environment during heatwaves, *Frontiers in Environmental Science*, DOI [10.3389/fenvs.2022.878341](https://doi.org/10.3389/fenvs.2022.878341)

RS thermal data for urban planners, heating island

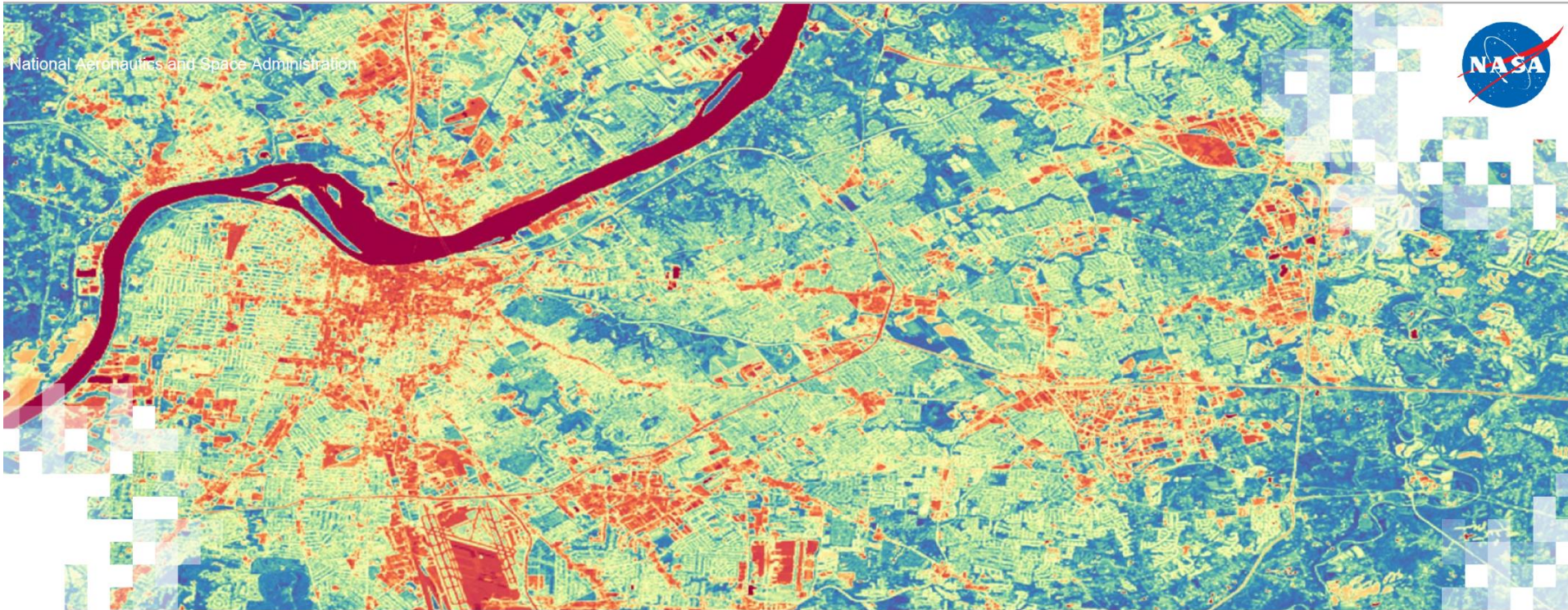
Remote Sensing of Land Surface Temperature



Satellite	Sensor	Temporal Coverage	Orbit & Swath	Spectral Bands (μm)	Spatial Resolution	Temporal Resolution
Landsat 4 Landsat 5 Landsat 7 Landsat 8 Landsat 9	Thematic Mapper (TM) Thematic Mapper (TM) Enhanced Thematic Mapper Plus (ETM+) Thermal Infrared Sensor (TIRS) Thermal Infrared Sensor-2 (TIRS-2)	07/1982 – 12/1993 03/1984 – 01/2013 04/1999 – Present 02/2013 – Present 11/2021 – Present	Landsat 4–9 Orbit: Polar, 10 am/pm (local time) Swath: 185 km	10.40 – 12.50 10.40 – 12.50 10.60 – 11.19 11.50 – 12.51 11.50 – 12.51	120 m 60 m 100 m 100 m	16 days
Terra Aqua	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) & MODIS MODerate-resolution Imaging Spectroradiometer (MODIS)	12/1999 – Present 04/2002 – Present	Terra/Aqua Orbit: Polar, 10:30 (Terra) am/pm & 13:30 (Aqua) am/pm (local time) Swath: 2330 km	10.78 – 11.28 11.77 – 12.27	1 km	12 hours

N. Malakar, G. Hulley, S. J. Hook, K. Laraby, M. Cook, J. Schott (2018)
**An Operational Land Surface Temperature Product for Landsat
Thermal Data: Methodology and Validation, IEEE Transactions on
Geoscience and Remote Sensing. DOI:[10.1109/TGRS.2018.2824828](https://doi.org/10.1109/TGRS.2018.2824828)**

Ermida, S.L., Soares, P., Mantas, V., Göttsche, F.-M., Trigo, I.F., (2020)
**Google Earth Engine open-source code for Land Surface
Temperature estimation from the Landsat series. Remote Sensing,
12 (9), 1471; <https://doi.org/10.3390/rs12091471>**



Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices

Part 1: Land Surface Temperature-Based Urban Heat Island Mapping

Sean McCartney & Amita Mehta – August 2, 2022

Bookmarks

- Speed Dial
- Bookmarks
- Czechglobe-JCU
- Intranet
- Pošta - František Zemek - Outl...
- Google
- CzechGlobe
- Úvod - Jihočeská univerzita
- Projekty
- GIS a Stat
- RS
- Software
- Počasí
- Kultura
- Český rozhlas
- Novinky.cz
- Česká televize
- Internetová jazyková příručka...
- Daňový portál
- Brno - oficiální web statutár...
- Prémiové jakostní sypané ča...
- Sport - Česká televize
- Otevírací doby Vlíčnov - Ofic...
- Mapy.cz
- Překladač Google
- Google Scholar
- Mapy Google
- AV ČR - FIS

Scripts Docs Assets

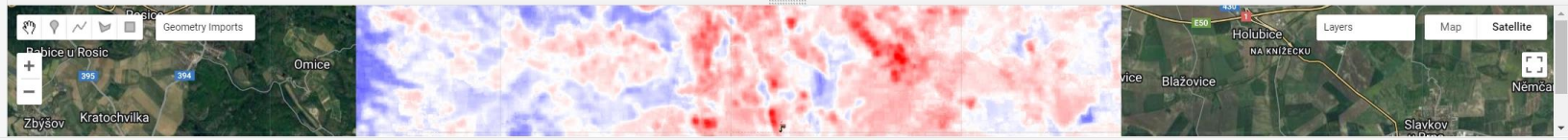
- ee.Image
- ee.ImageCollection
- ee.Join
- ee.Kernel
- ee.List
- ee.Model
- ee.Number
- ee.PixelType
- ee.Projection
- ee.Reducer
- ee.String
- ee.Terrain
- ee.data
- Chart
- Export
 - Export image
 - Export.image(image, taskName, params)
 - Export.image.toAsset(image, description, assetId, pyr...
 - Export.image.toCloudStorage(image, description, buc...
 - Export.image.toDrive(image, description, folder, fileNa...
 - Export.map
 - Export.table
 - Export.video
- Map
- ui
 - ee.apply(func, namedArgs)
 - ee.call(func, var_args)
 - ee.initialize(baseurl, tileurl, successCallback, errorCallback, ...)
 - ee.reset()
 - print(var_args)
 - require(path)

```
SUHI_mesta
Imports (3 entries)
  var aoi: Polygon, 4 vertices
  var Rural: MultiPolygon, 11 vertices
  var Urban: MultiPolygon, 16 vertices

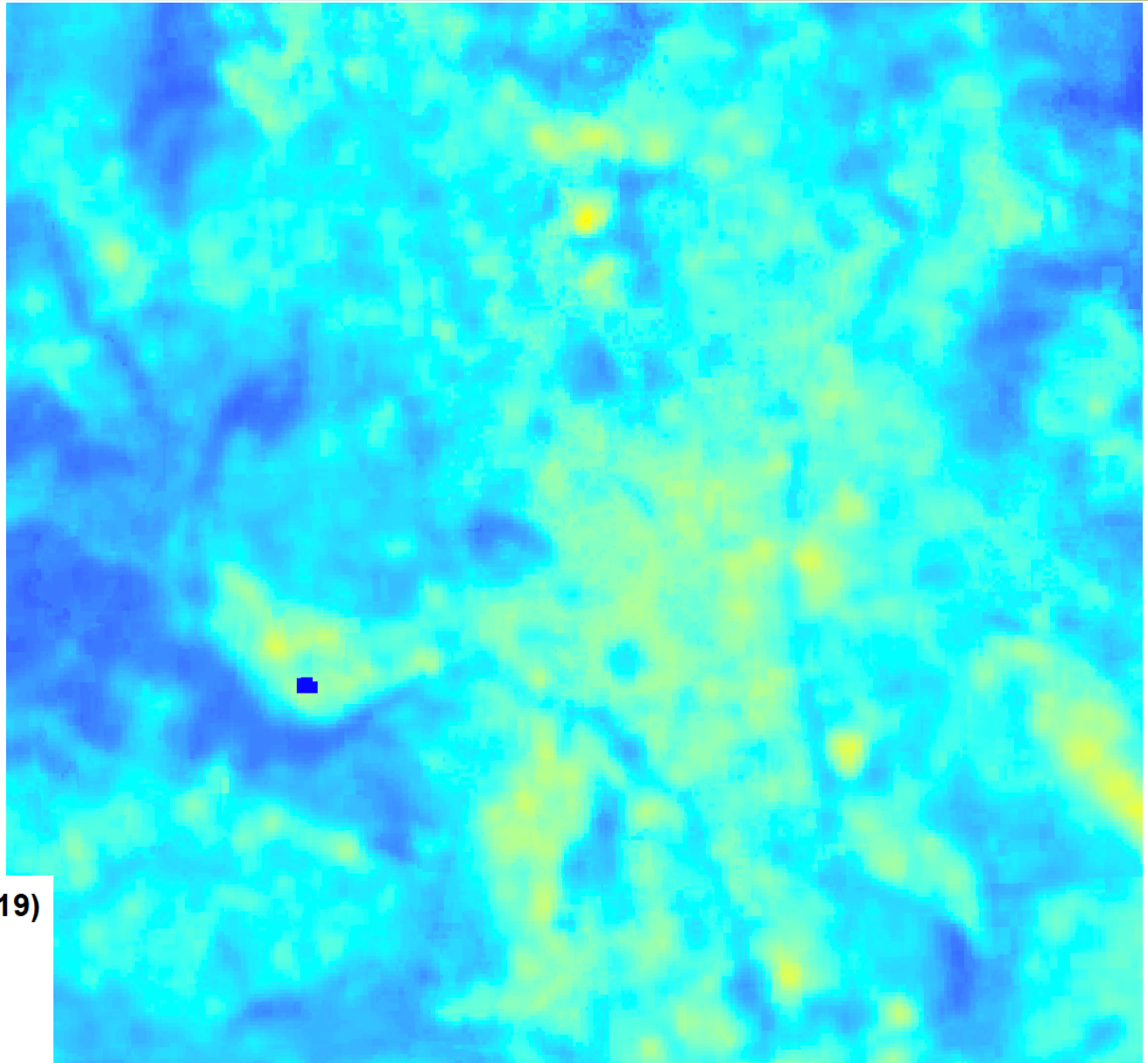
1 - /*
2 Author: Sean McCartney (sean.mccartney@nasa.gov)
3 ARSET Training: Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability
4 August 2, 2022 - August 11, 2022
5
6 This code is free and open.
7 By using this code you agree to cite the following reference in any publications derived from them:
8 NASA Applied Remote Sensing Training (ARSET) program
9
10 This example shows how to analyze and visualize Landsat surface temperature (ST) time series
11 from Landsat 8 over Washington, DC (USA) from a defined area of interest (aoi).
12
13 Parameters:
14 In: DATE_RANGE
15     YEAR_RANGE
16     STUDYBOUNDS
17     DISPLAY
18 aoi: delineated rectangle for area of interest
19 Rural: delineated polygons for rural areas
20 Urban: delineated polygons for urban areas
21
22 Out: clipped image of mean daytime surface temperature (ST) and surface urban heat island (SUHI).
23 */
24
25
26 //***** DEFINE THE STUDY AREA *****/
27 // Use the "Draw a rectangle" tool in the map window to define your
28 // area of interest (aoi) for filtering the image collection.
29
30
31 // Assign a variable to filter the day of year from July 1 to August 31.
32 // Adjust the DATE_RANGE for your own UHI study.
33 var DATE_RANGE = ee.Filter.dayOfYear(182, 243);
34 // Assign a variable to filter years from 2010 - 2022.
35 // Adjust the YEAR_RANGE for your own UHI study.
36 var YEAR_RANGE = ee.Filter.calendarRange(2014, 2029, 'year');
37 // Assign a variable to delineate your area of interest
38 // Create your own aoi using the Geometry tools in the map window. Rename your geometry to match the assigned
39 var STUDYBOUNDS = aoi;
40 // Assign a variable to display images in the map window
41 var DISPLAY = true;
42
43 // Set the basemap to display as satellite.
44 // Map.setOptions('SATELLITE');
45 // Other basemap options are below
46
```

Inspector Console Tasks

- features: List (1 element)
 - 0: Feature 0 (MultiPolygon, 6 properties)
 - type: Feature
 - id: 0
 - geometry: MultiPolygon, 18 vertices
 - type: MultiPolygon
 - coordinates: List (2 elements)
 - properties: Object (6 properties)
 - QA_PIXEL_max: 24004.666666666668
 - QA_PIXEL_mean: 22191.974373539375
 - QA_PIXEL_min: 21816.70588235294
 - ST_B10_max: 52.288049982500034
 - ST_B10_mean: 42.55709303944157
 - ST_B10_min: 37.43488490000002
- ... Mean/Min/Max ST for rural Brno JSOIN
- FeatureCollection (1 element, 7 columns) JSOIN
 - type: FeatureCollection
 - columns: Object (7 properties)
 - QA_PIXEL_max: Float<0.0, 65535.0>
 - QA_PIXEL_mean: Float<0.0, 65535.0>
 - QA_PIXEL_min: Float<0.0, 65535.0>
 - ST_B10_max: Float<-124.14999999999998, 99.8499...
 - ST_B10_mean: Float<-124.14999999999998, 99.849...
 - ST_B10_min: Float<-124.14999999999998, 99.8499...
 - system:index: String
- features: List (1 element)
 - 0: Feature 0 (MultiPolygon, 6 properties)
 - type: Feature
 - id: 0
 - geometry: MultiPolygon, 13 vertices
 - type: MultiPolygon
 - coordinates: List (2 elements)
 - properties: Object (6 properties)
 - QA_PIXEL_max: 21856.333333333332
 - QA_PIXEL_mean: 21824.391380232068
 - QA_PIXEL_min: 21813.666666666668
 - ST_B10_max: 31.048926849099925
 - ST_B10_mean: 28.25318433728461
 - ST_B10_min: 26.52116379500002

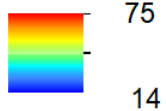


Temperature
range 24-52 °C

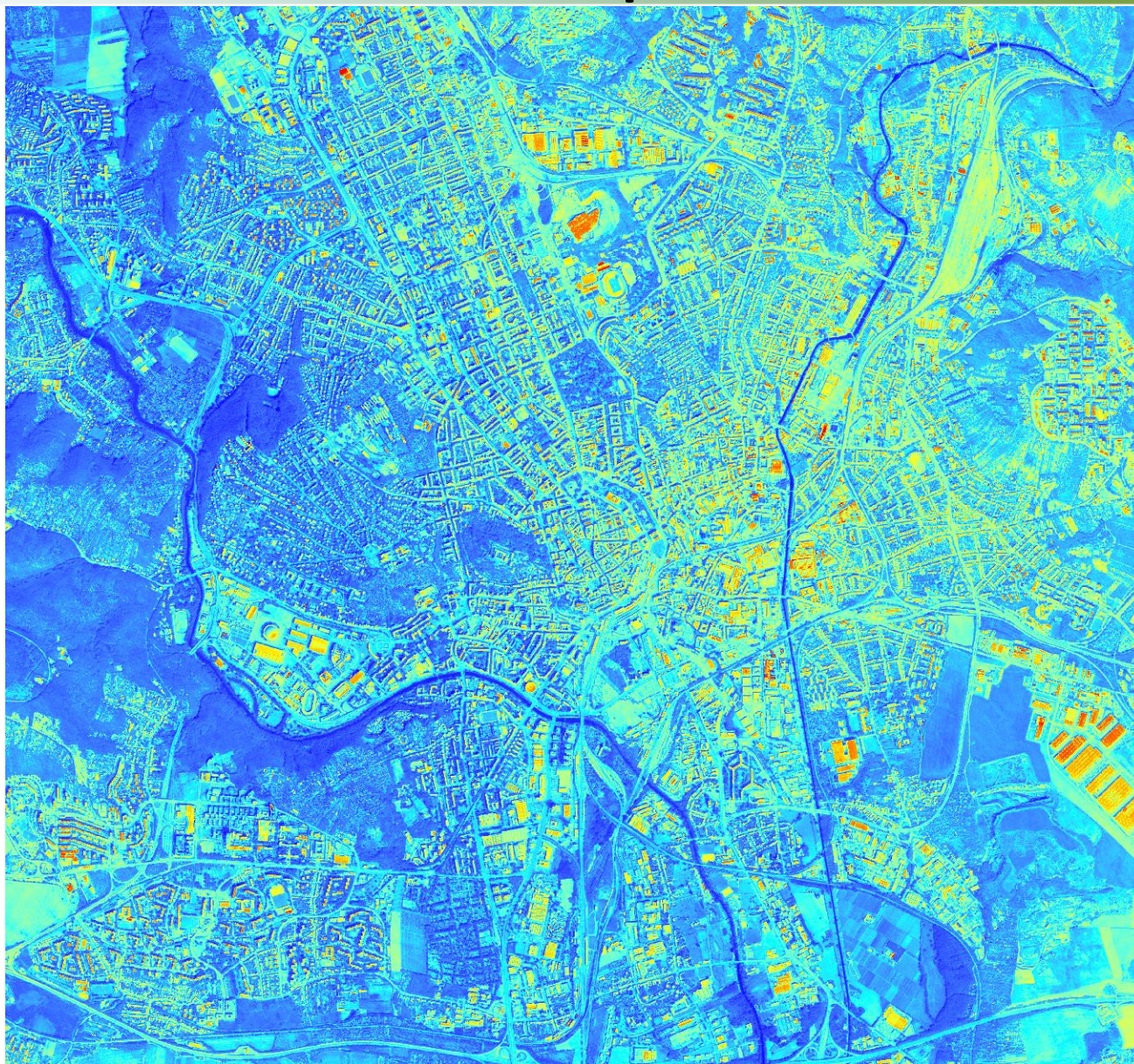


Brno Landsat 8 SUHI (2017-19)

C deg



Current surface temperature

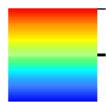


Brno TASI 20190831

C deg

75

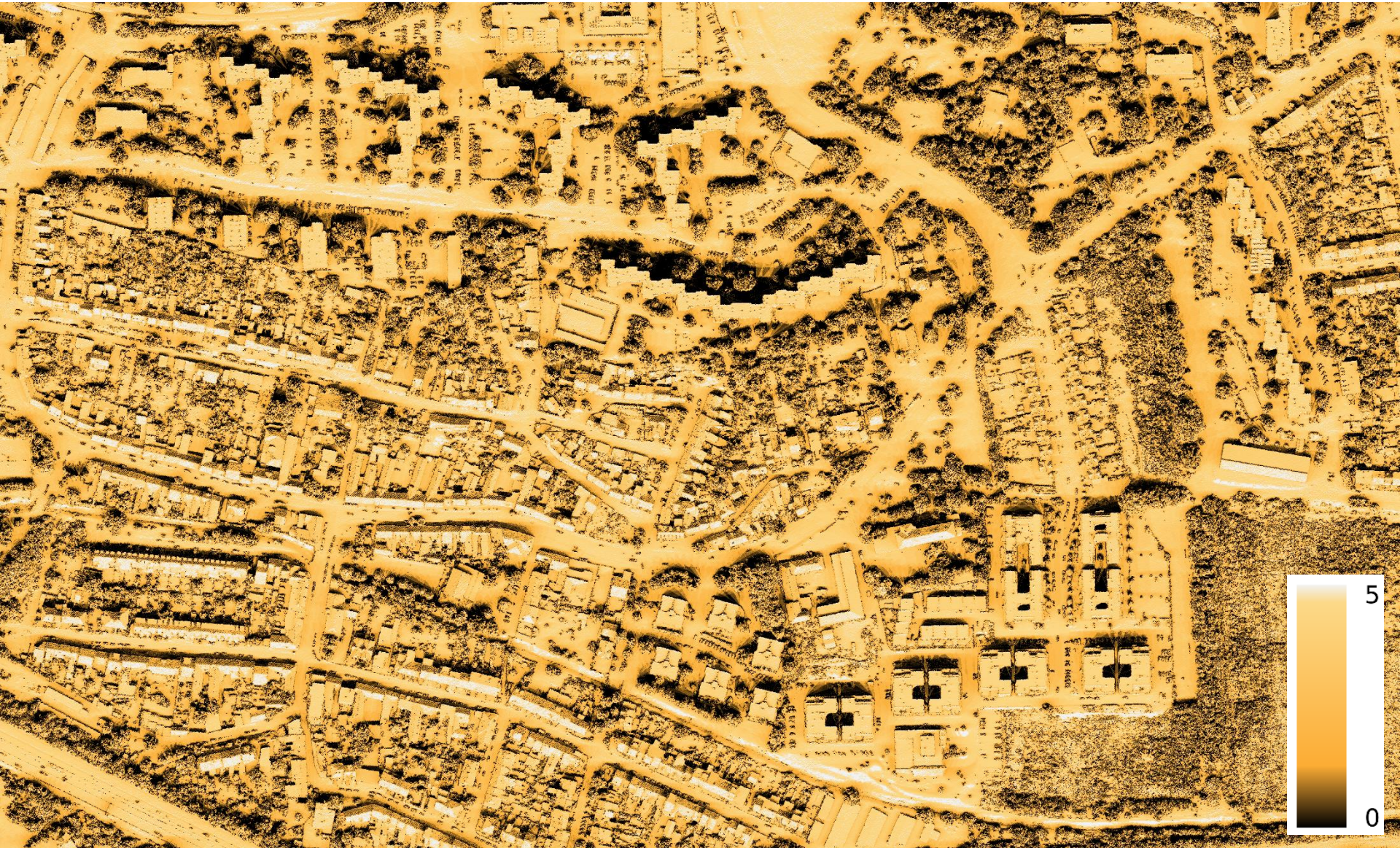
14







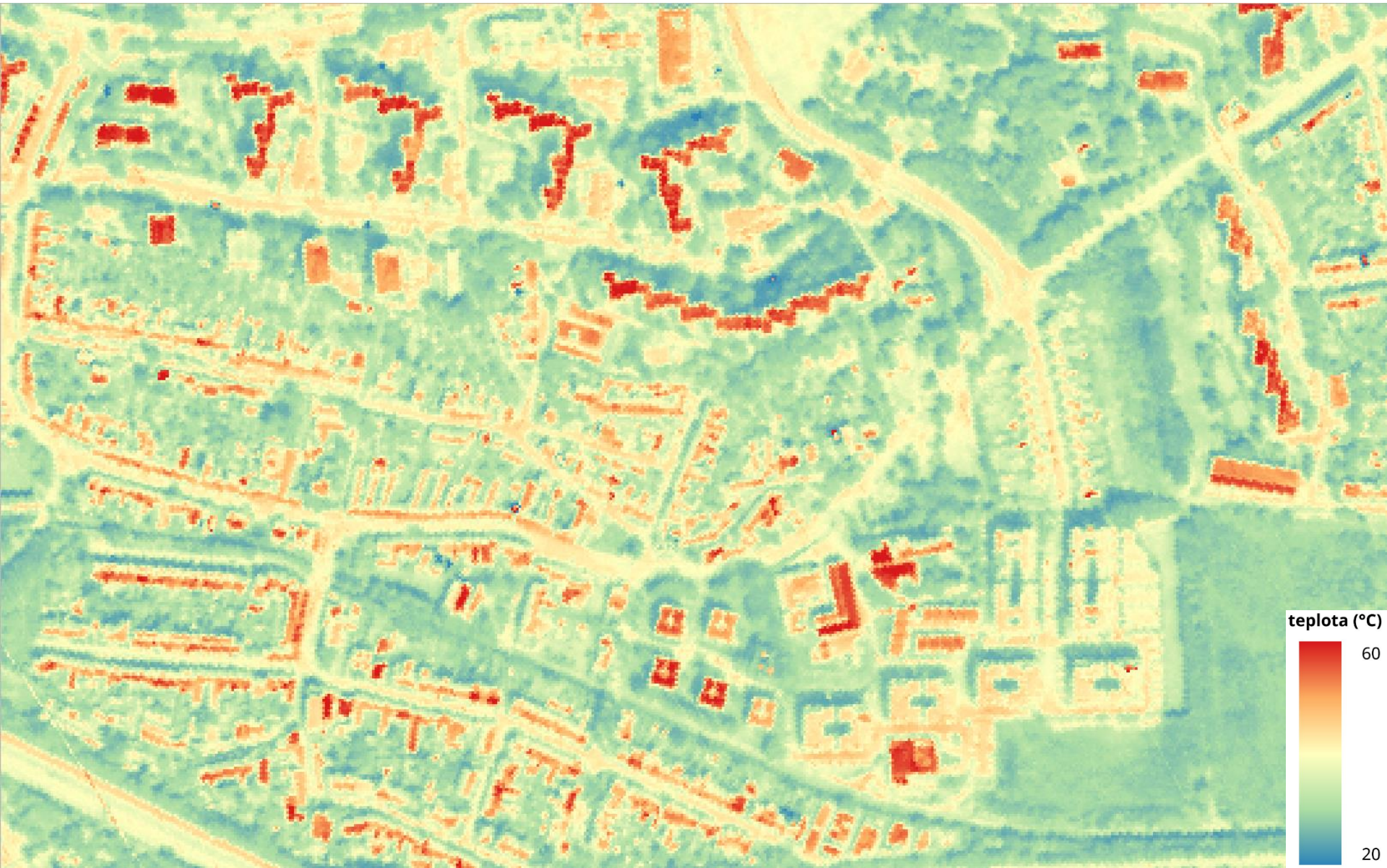
Daily direct radiation [kWh/m²]



Daily difused radiation [kWh/m²]



Current surface temperature



Thank you for your attention

zemek.f@czechglobe.cz