Analisi di interazione tra ambiente urbano e caratteristiche climatiche a scala locale tramite dati spaziali multisorgente e software open source

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The ICARO Project

traff**I**c and urbanization effe**C**t on temper**A**ture in the u**R**ban envir**O**nment

Promoted by the United Nations Global Pulse, the challenge *"harnesses the power of big data and data science to catalyze action on climate change"*

http://dataforclimateaction.org

Outline

1. Project Objectives

2. Case Study

3. Data Collection and Preprocessing:

   ➢ *Satellite Imagery*

   ➢ *Temperature and Traffic time series*

4. Analysis and Preliminary Results:

   ➢ *Local Climate Zone (LCZ) maps*

   ➢ *Traffic and Thermal Anomalies*

5. Ongoing studies

6. Conclusions

1. Project Objectives

The ICARO project aims to exploit **geodata** available from new and <u>heterogeneous sources</u> to provide insights in the study of **urban heating issues**, which are typically linked to anthropogenic factors such as Urban Heat Islands (UHIs)

Two main analyses are performed:

- exploitation of <u>Sentinel-2 and PlanetScope imagery</u> to derive Local Climate Zone (LCZ) maps & **surface energy maps** through the Local Scale Urban Parameterization Scheme (LUMPS)

- identification of the <u>correlation</u> between **temperature and traffic anomalies**, recorded from environmental sensors

ICARO makes exclusive use of **FOSS**

2. Case Study

The city of **Milan (Northern Italy)** is chosen as the test site for the analyses because of its environmental peculiarities, which favour the persistency of an **UHI**, and the new governmental **open data policy** which has made a vast amount of datasets available for the work
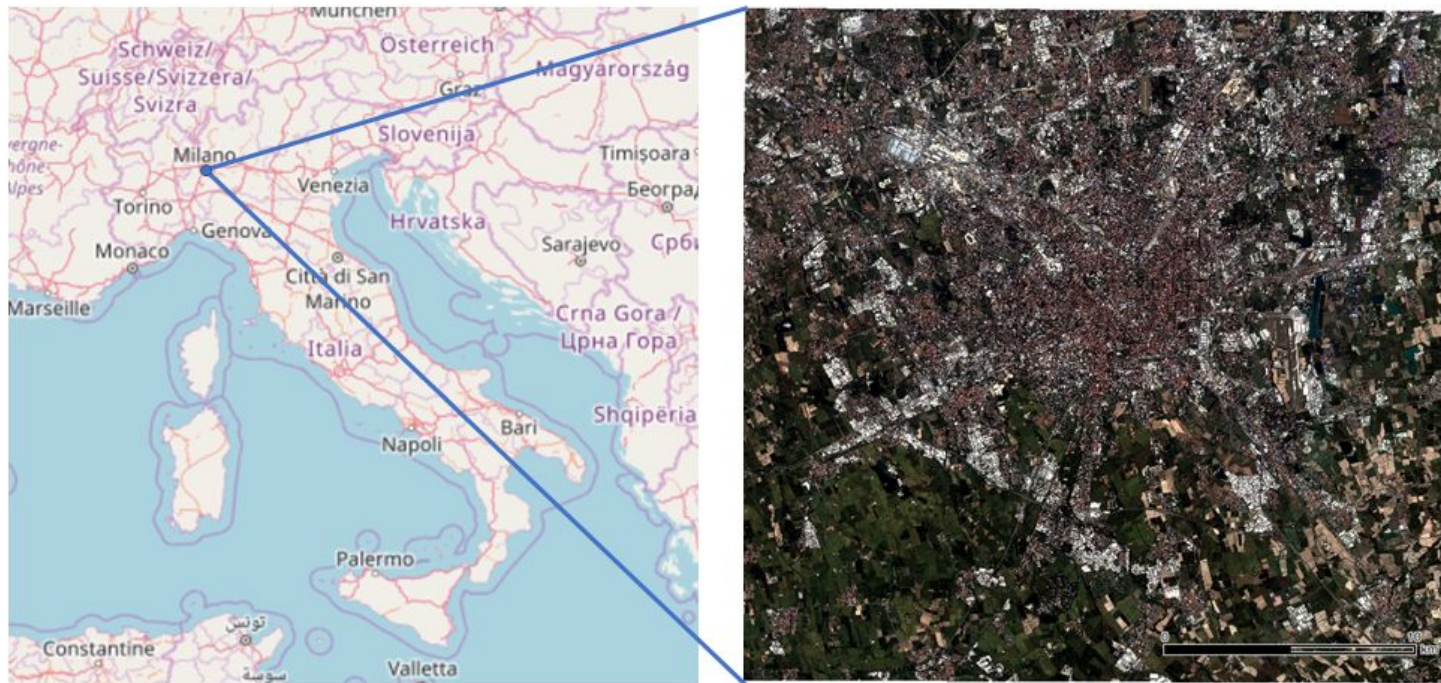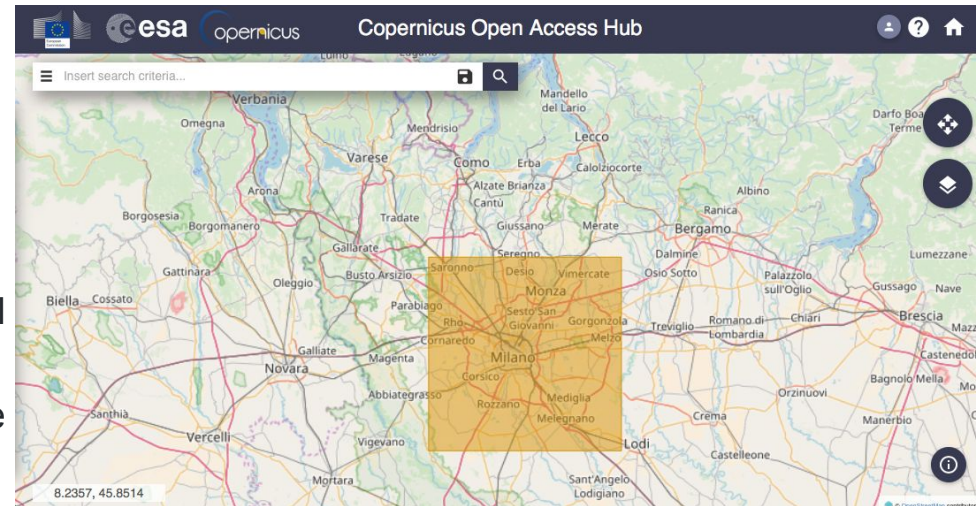

Year 2016

3. Data Collection

- ## Sentinel-2

  - ➤ 2 twin satellites (same orbit but phased at 180°)
  - ➤ High revisit frequency (5 days at the Equator)
  - ➤ Swath width of 290 km
  - ➤ 13 spectral bands (VIS, NIR, SWIR) with spatial resolution varying between 10 m and 60 m
  - ➤ Distributed under a fully open license through the Copernicus Open Access Hub interface

- ## PlanetScope

  - ➤ Constellation composed of approximately 120 CubeSat 3U micro-satellites
  - ➤ Daily revisit time (at nadir)
  - ➤ Swath width of 16.4 km
  - ➤ 4 spectral bands (Red, Green, Blue, NIR) at 3 m spatial resolution
  - ➤ Distributed under commercial fee by PLANET LABS INC. through its Explorer platform as well as a dedicated API (D4CA)
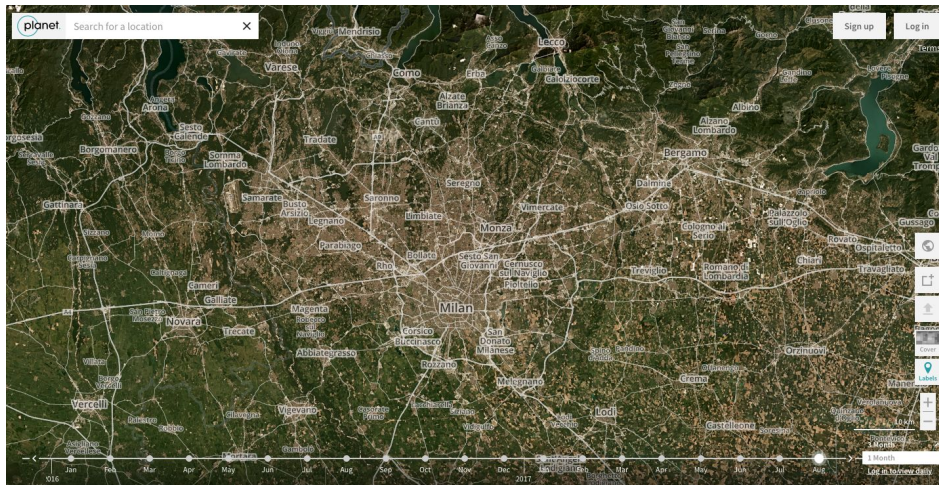
3. Data Preprocessing

- **Sentinel-2**

  ToA reflectance values corrected to obtain _real surface reflectance_ values and _pansharpened_: Python script (French agency: Office National des Forêts)

- **PlanetScope**

  Atmospheric disturbances adjusted by exploiting the _band reflectance coefficients_ in the metadata (XML or Json format) of each tile and by applying a _Dark Object Subtraction_ (DOS) procedure: Python script based on GDAL
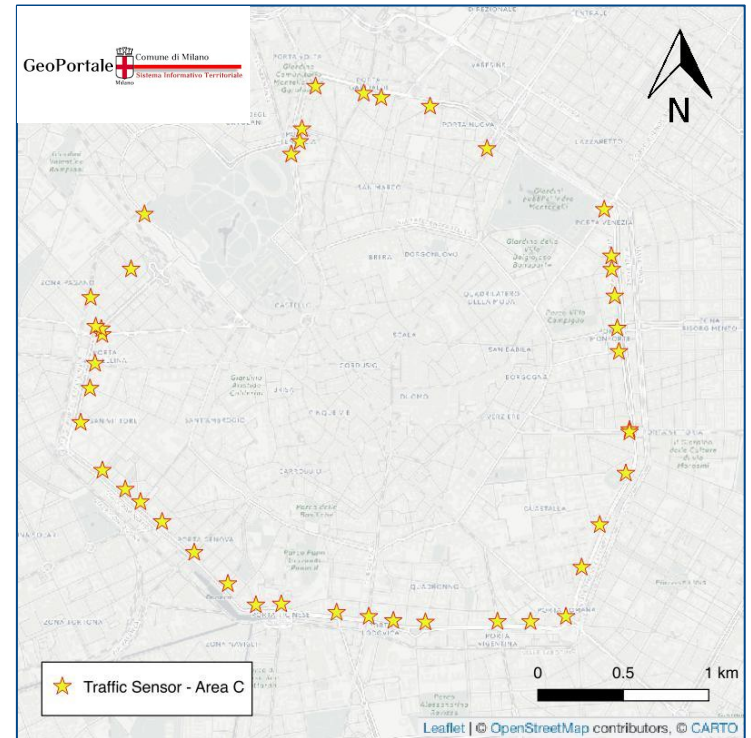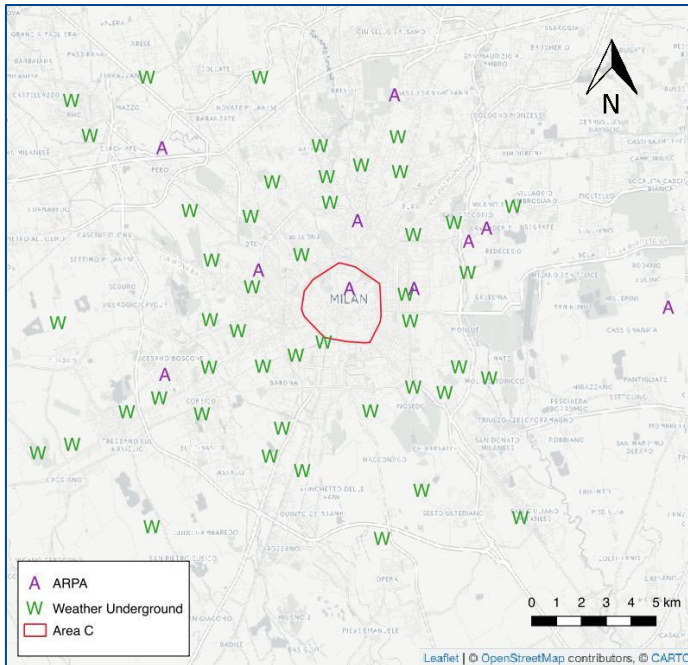
  https://github.com/danioxoli/ICARO_D4CA/blob/master/sat _imagery/planet_dos.py

3. Data Collection

- **Traffic Data**
  - ➤ Vehicle access to the city centre (Area C): *open data*
  - ➤ Waze platform: *D4CA challenge (Work in progress...)*
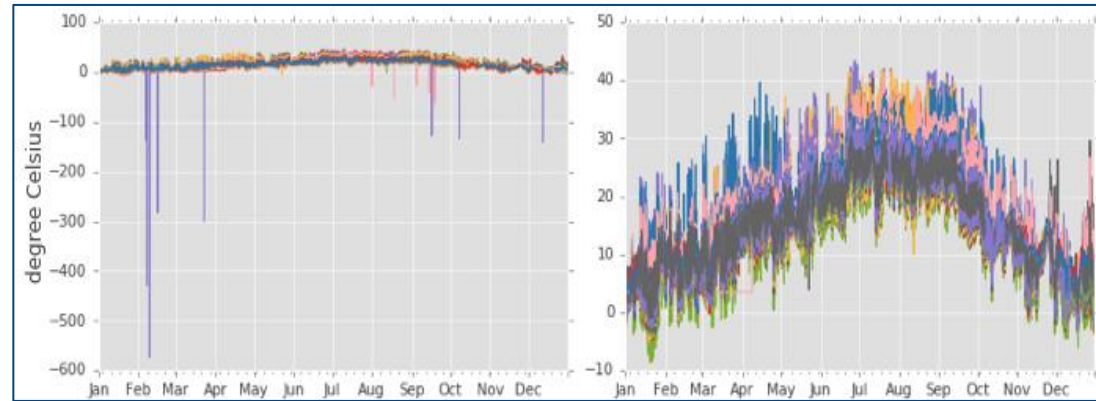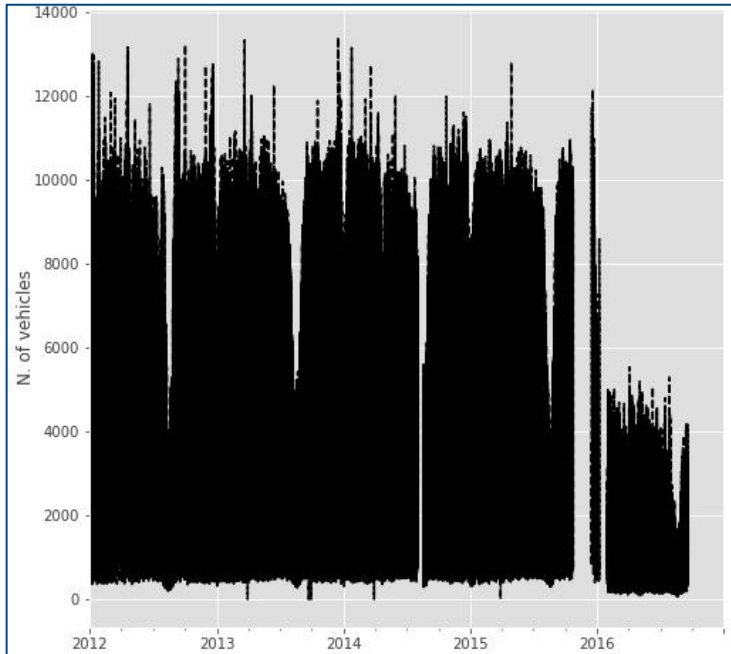

Traffic Sensor - Area C

- **Temperature Data**
  - ➤ Regional Agency for Environmental Protection (ARPA): *governmental data*
  - ➤ Weather Underground platform: *crowdsourced data*

A ARPA
W Weather Underground
Area C

3. Data Preprocessing

- **Traffic Data**
  - ➢ Aggregated hourly observations
  - ➢ *No filtering* operations required
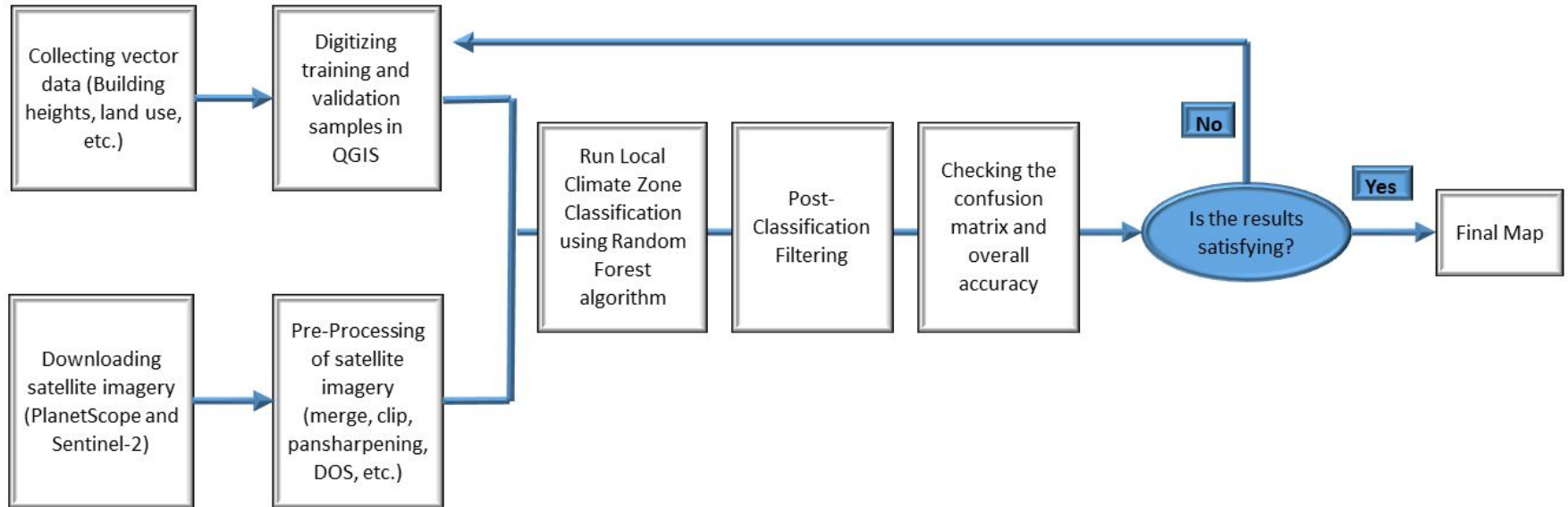

- **Temperature Data**
  - ➢ Aggregated in hourly observations
  - ➢ Quality check: data *completeness* and *correlation* with other stations
  - ➢ *Python Data Analysis Library*

4. Analysis & Preliminary Results

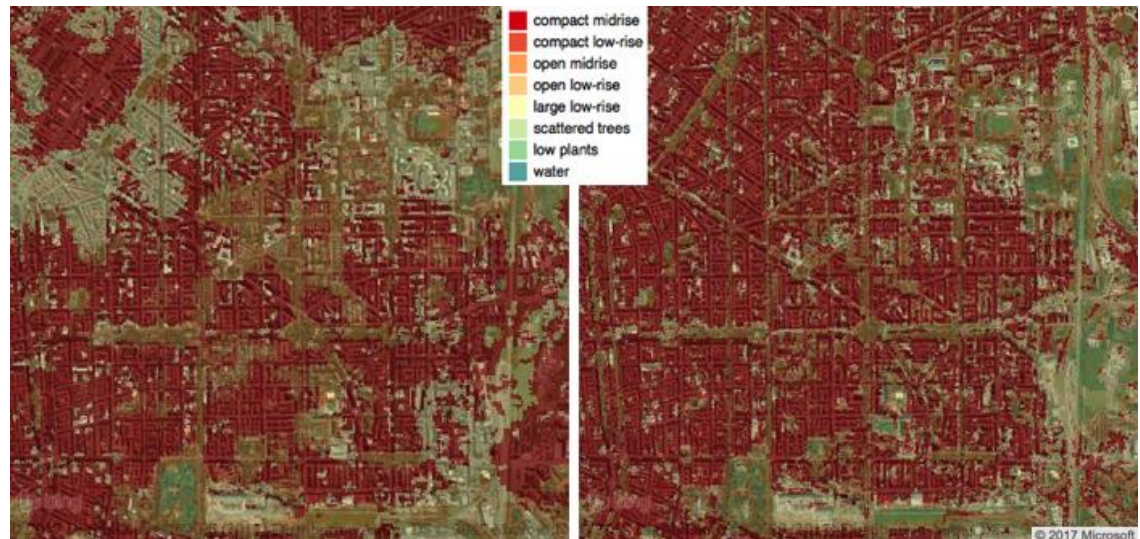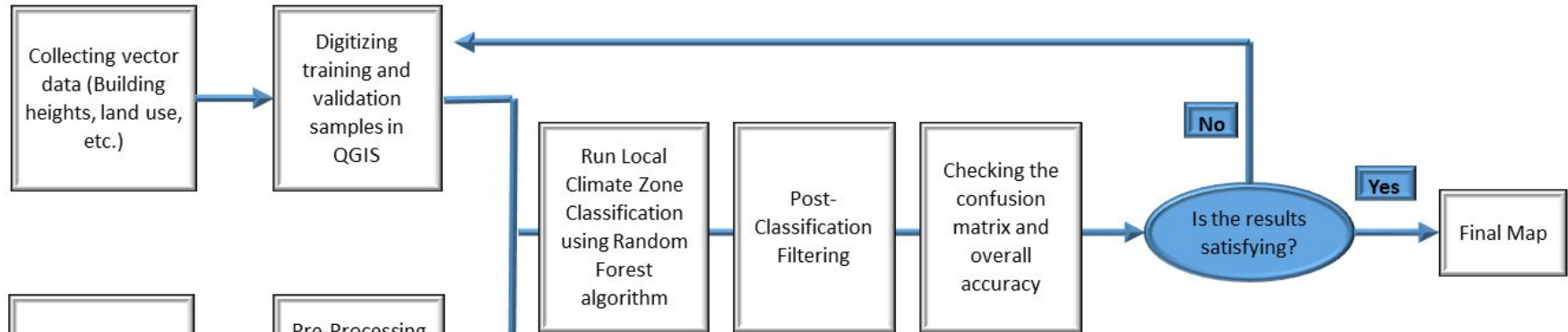## Local Climate Zone (LCZ) maps

Contribution of urban surface characteristics to heat fluxes

4. Analysis & Preliminary Results
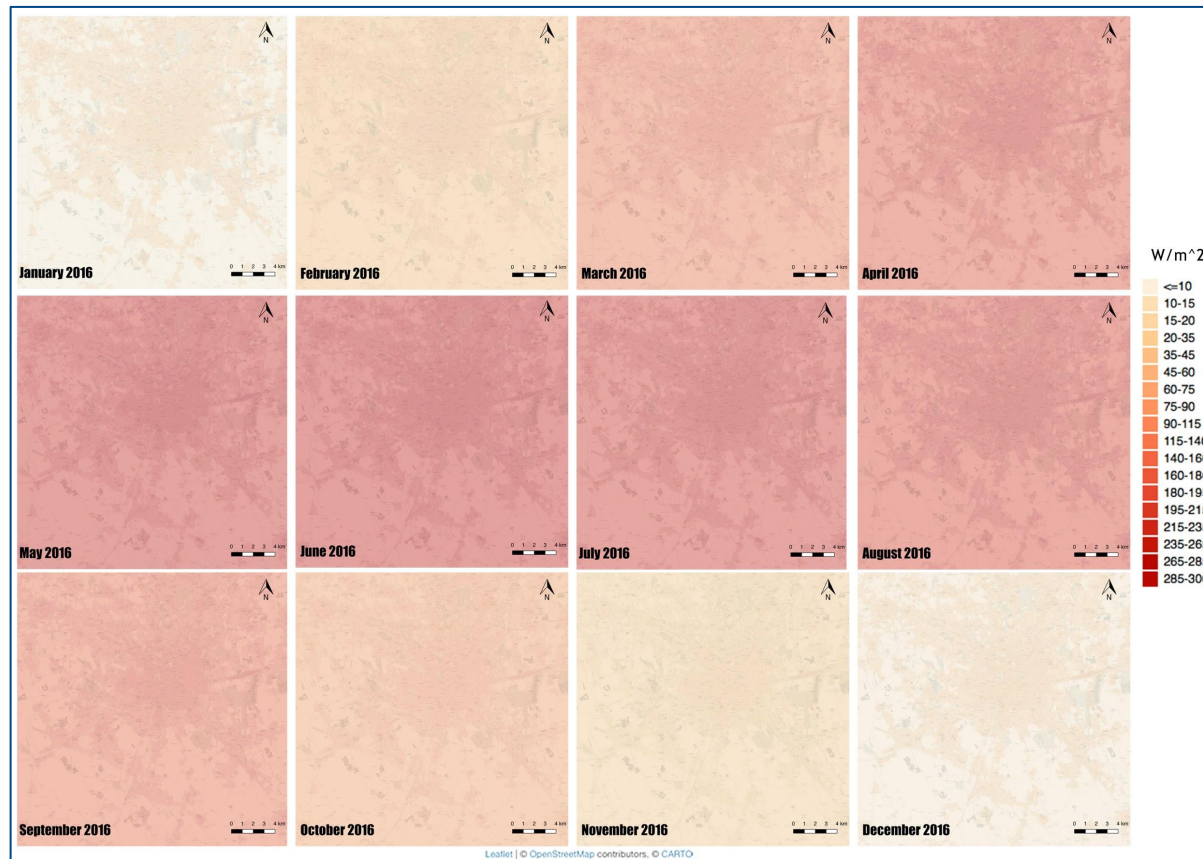
Local Climate Zone (LCZ) maps

Contribution of urban surface characteristics to heat fluxes

4. Analysis & Preliminary Results

Local Climate Zone (LCZ) maps

Conversion into surface energy maps with **LUMPS** (model for simulating energy exchange between surface and atmosphere, at local scale).

4. Analysis & Preliminary Results

Traffic and Thermal Anomalies

First test carried out for the Area C:

1) **detect anomalies** by defining thresholds:
   - ➤ <u>Traffic</u>: > 0.98 quantile
   - ➤ <u>Temperature</u>: > 2xStd (after seasonal detrending)
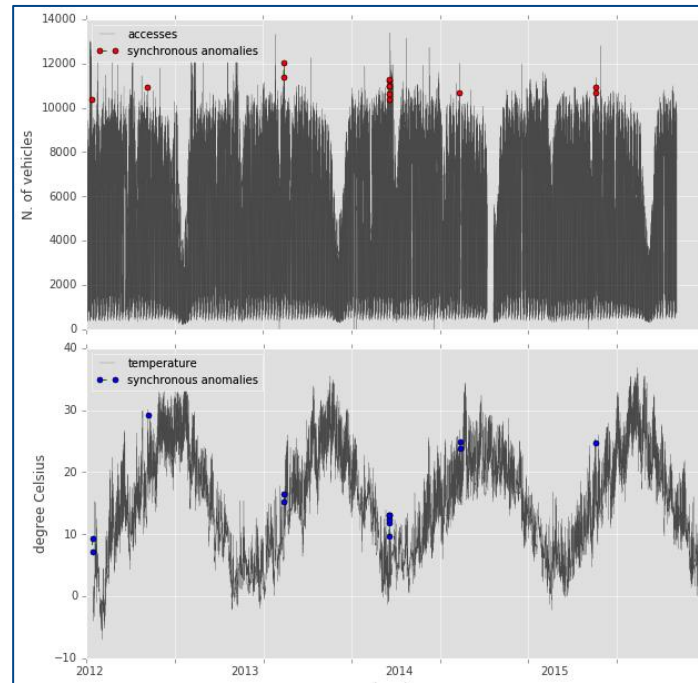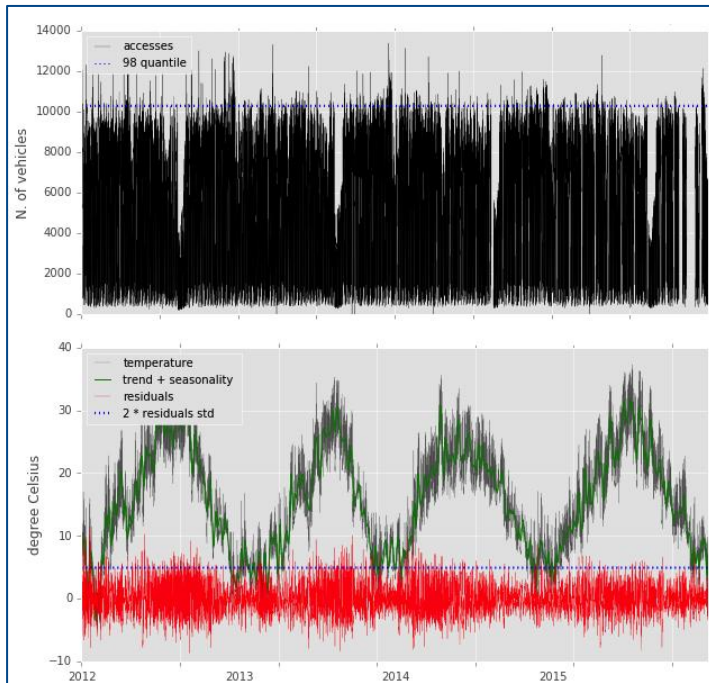2) **identify synchronous anomalies**

4. Analysis & Preliminary Results

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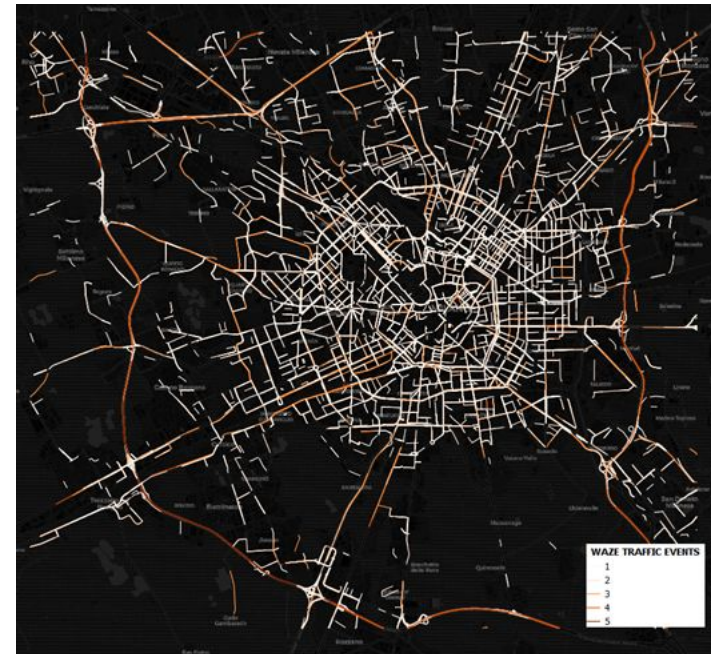*Non-significant cause-effect relationship*

5. Ongoing studies

➢ Waze Traffic Jam data time series collection
➢ Robust traffic hotspot identification (both in space and time)

➢ Repetition of traffic and thermal anomalies correlation analysis
➢ Improve of thermal anomalies detection by accounting for the LCZ

Traffic Jam Hotspots – Milan (Aug – Sept 2017)

6. Conclusions

- Promising approach to investigate urban climate at micro-scale:
  - ➢ underlying interaction with urban climate feature (e.g. traffic and surfaces)

- Observe and explain urban heat fluxes through maps, useful for:
  - ➢ urban planning
  - ➢ impact assessment of climate mitigation strategies

- Replicable and improvable analysis thank to the use of:
  - ➢ global geospatial datasets
  - ➢ FOSS tools

...Thank you!

http://dataforclimateaction.org

https://github.com/danioxoli/ICARO_D4CA/wiki

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