



The CARES cloud-based database platform, City and Science Apps

CARES
CITY AIR REMOTE EMISSION SENSING

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ITS, University of Leeds



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 814966

CONSORTIUM PARTNERS

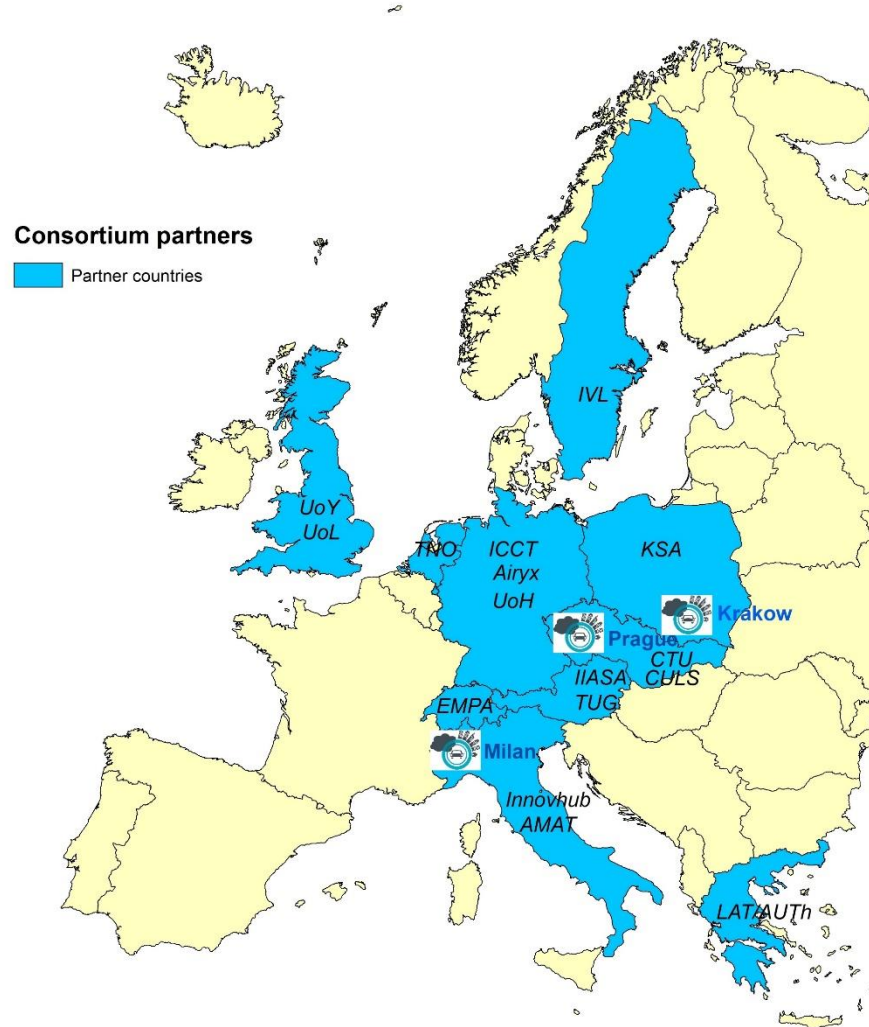
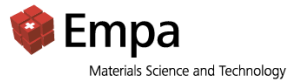




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CITY AIR REMOTE EMISSION SENSING

an H2020 flagship project bringing together remote emission sensing expertise worldwide



Consortium partners

Partner countries

Commercial remote sensing service providers:



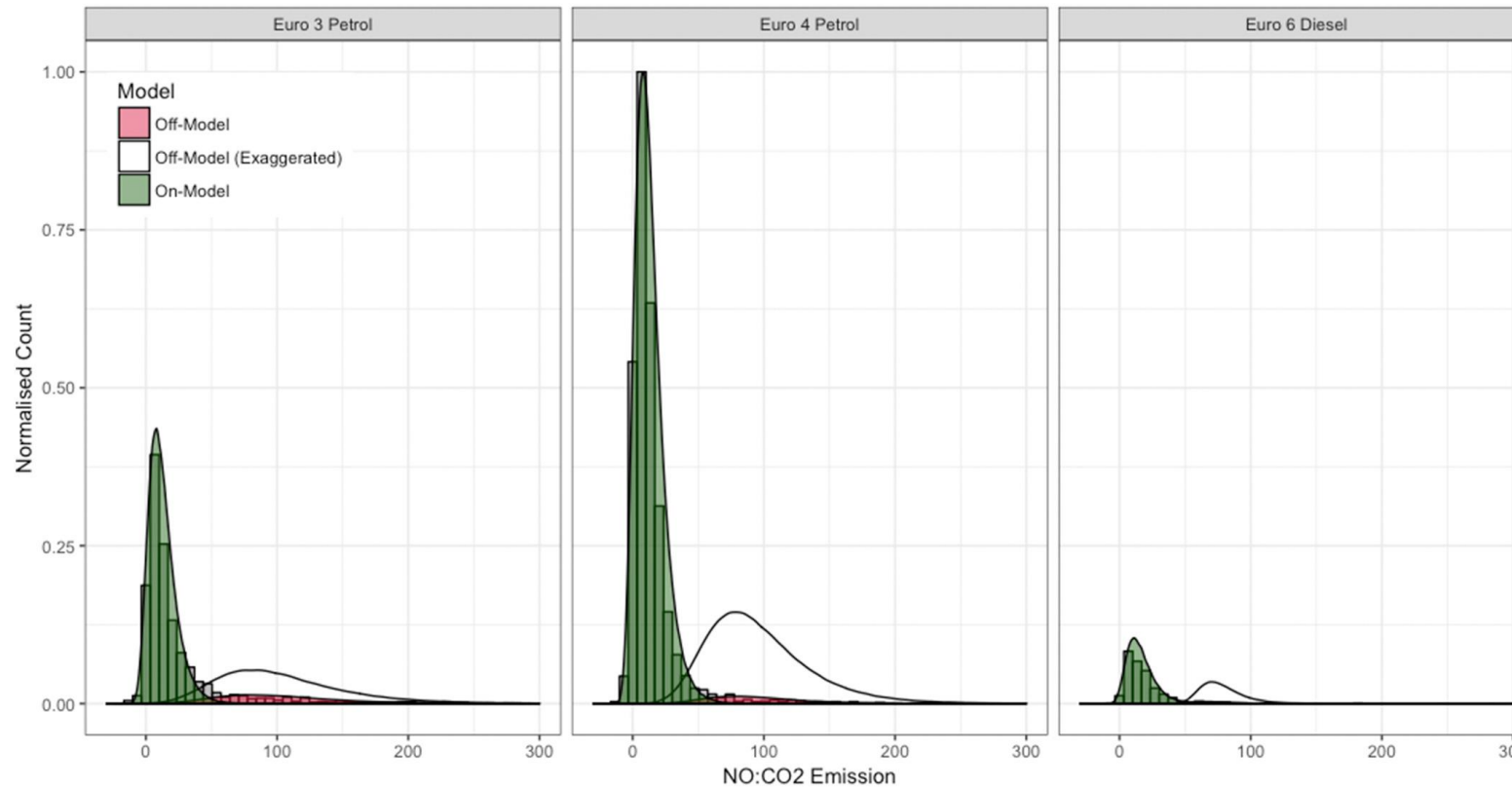
Prior work



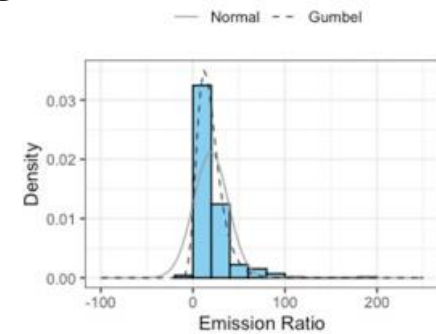
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Prior work at University of Leeds showed the ability of RS to identify candidate “gross-emitter” vehicles but cannot identify the cause

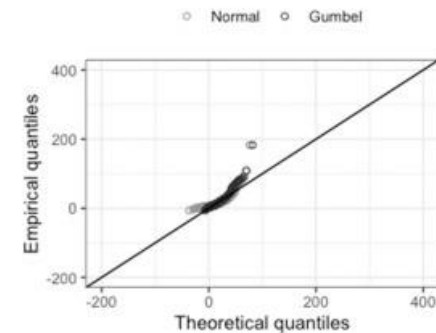
Decomposition of Fleet Emission Ratios



UK Euro 6 Diesel Passenger Car



UK Euro 6 Diesel Passenger Car



Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



A novel method for comparing passenger car fleets and identifying high-chance gross emitting vehicles using kerbside remote sensing data

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Institute for Transport Studies, University of Leeds, 34-40 University Rd, Leeds LS2 9JT, United Kingdom of Great Britain and Northern Ireland

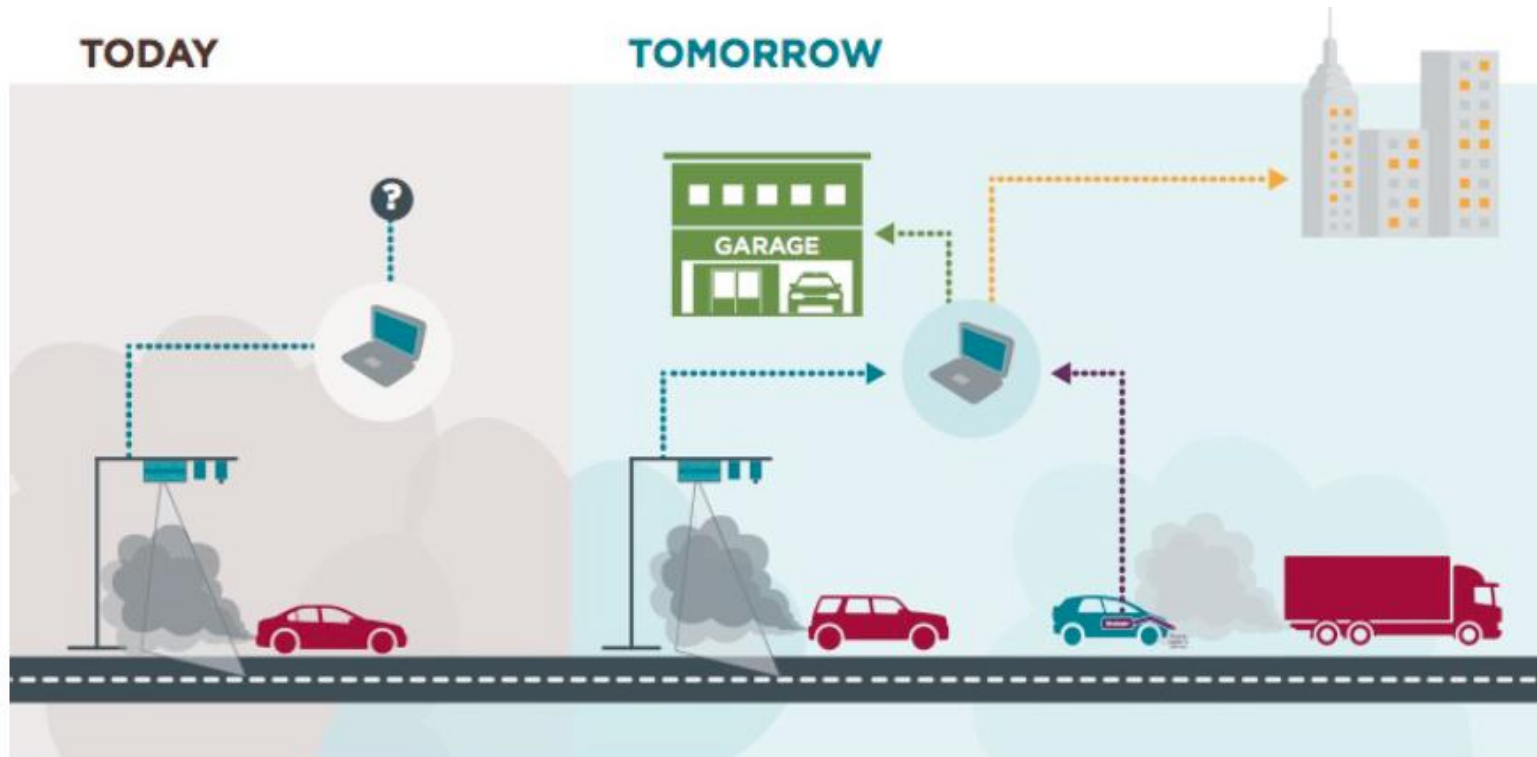


Overall objective



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“Reduce the hurdles for practical applications of remote emission sensing (RES) and to make it a widespread means of both monitoring and enforcing improvements in road vehicle emissions.”

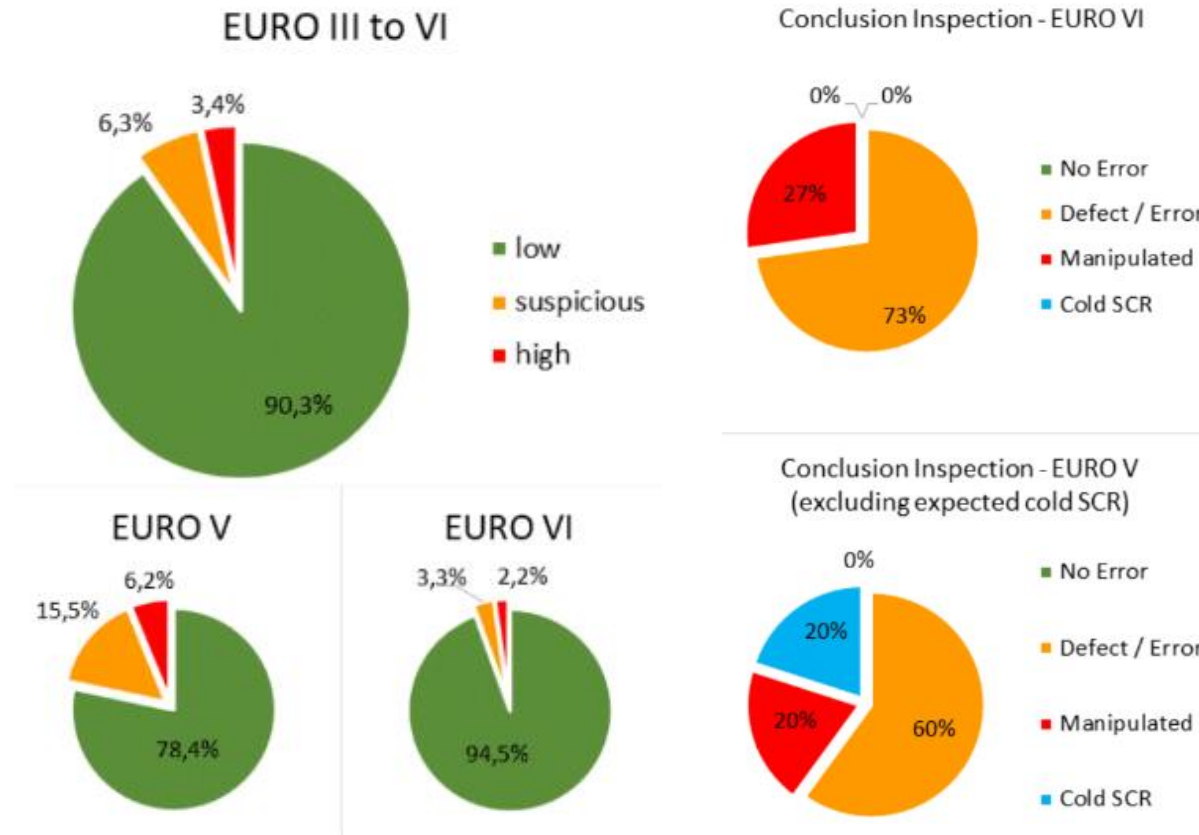


Prior work



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Preliminary research using plume chasing method reports between 20% and 27% of suspicious to high emitting vehicles have been tampered with





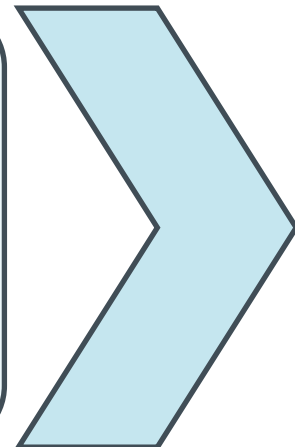
DATA INFRASTRUCTURE

Current Practice



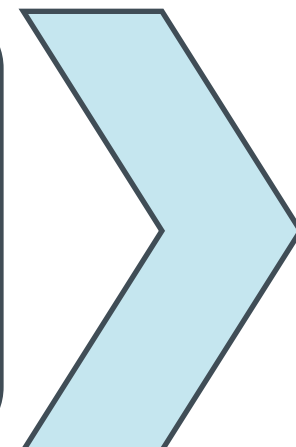
Measurement Data (Flat):

As provided by commercial RS providers (fixed format?)
e.g. CSV file format.
Straight-forward data solution / sharing.



Relational Database:

Fixed schema forces conformity but lacks flexibility.
e.g. MySQL is a well understood enterprise level database solution.



CONOX:

Comprehending
Combining
COMparing Real Driving Emissions
COLlaborating on NOx RDE and Remote Sensing measurements.

ERMES Remote Sensing database

1368609 vehicle passages in database

- Manage campaigns
- Manage sites
- Manage instruments
- Manage institutions
- Search VehiclePassages

Borken-Kleefeld, J., Bernard, Y., Carslaw, D., Sjödin, A., Tate, J., Gian-Marco, A., De la Fuente, J., McClintock, P., Gentala, R., Hausberger, S., Jerksjö, M. 2019. Contribution of vehicle remote sensing to inservice/real driving emissions monitoring - CONOX Task 3 report. Commissioned by the Federal Office for the Environment (FOEN), Switzerland.
<https://www.ivl.se/download/18.34244ba71728fcb3f3fa5b/1591705759730/C295.pdf> [Accessed 12/05/2021]



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Remote Sensing



Plume Chasing



Point Sampling





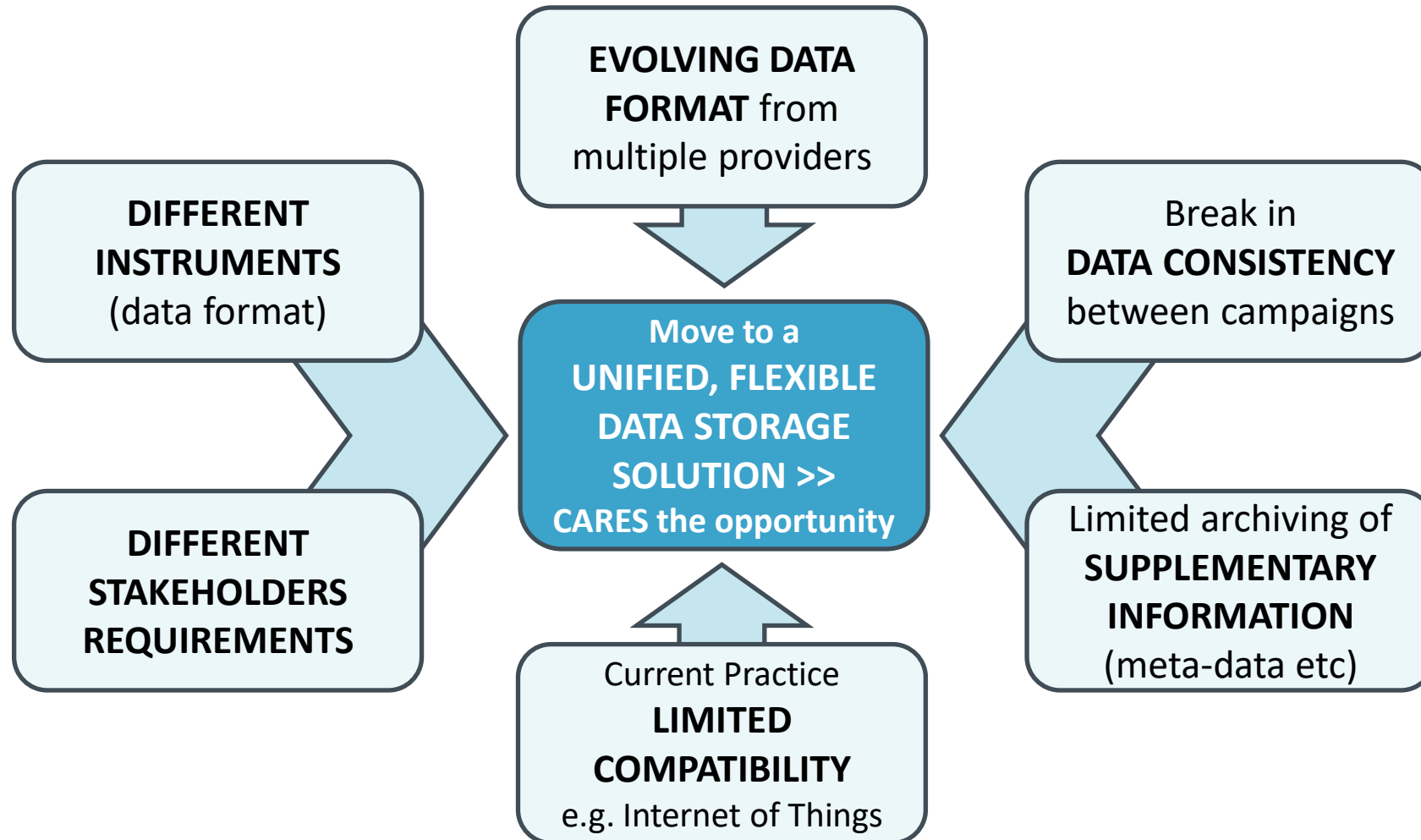
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DATA INFRASTRUCTURE

The challenge



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System Overview

- ➡ Hidden, encrypted
- ➡ Institution Password secure
- ➡ Human error
- ➡ Least secure

User's Computer

Project Website:
Accessed by Office 365 credentials;
Content specific to user

Analysis scripts, e.g., R:
Access granted user by user, not preferred
approach

Data Devices

**Data collected during
CARES project**

Data

Data

**Legacy data (e.g.,
CONOX)**

Data

Data

Secure MS Azure Platform manages access

Secure Virtual Machine

**Science
App**

City App

**Additional
apps (tbd)**

**CARES Database
(Cosmos DB)**

CONOX test set

Test Track
Experiment

Test City 1
Experiment

Encrypted database environment

Data Types (Test Track Experiment)

observation_data

point_sampling_passthrough

point_sampling_data

co2_ppm

pn_mean_concentration_cm3

bc_ngm3

plume_chase_data

duration_s

speed

chco_ppb

bg_nox_ppb

no2_co2_ppb

emission_mg_kwh

h2o_bbp

co2_ppm

nox_co2

bg_no2_ppb

no2_ppb

rsd_data

GasMain_Percent_CO

GasMain_PPM_HC

GasMain_PPM_NO2

GasMain_IR_Smoke

GasMain_Percent_CO2

GasMain_PPM_NO

GasMain_UV_Smoke

GasMain_Ratio_CO_CO2

GasMain_Ratio_HC_CO2

GasMain_Ratio_NO_CO2

GasMain_Ratio_NO2_CO2

GasMain_Average_CO2

GasMain_Max_CO2

Vehicle

Wind

DB_DATA_TYPE

MEASUREMENT_DESCRIPTION



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Putting real-world locally collected data at the heart of decision making

Flexible database that can accept data from a range of sources

Modern cloud-based data platform

Engaging front-end apps for different stakeholders

Managed security and user access

Compatible with established methods

Apps hosted on secure virtual machines, no need to code share

Futureproof database that can adapt to future changes

Integration with PowerBI, Synapse and other big-data tools

IoT capable

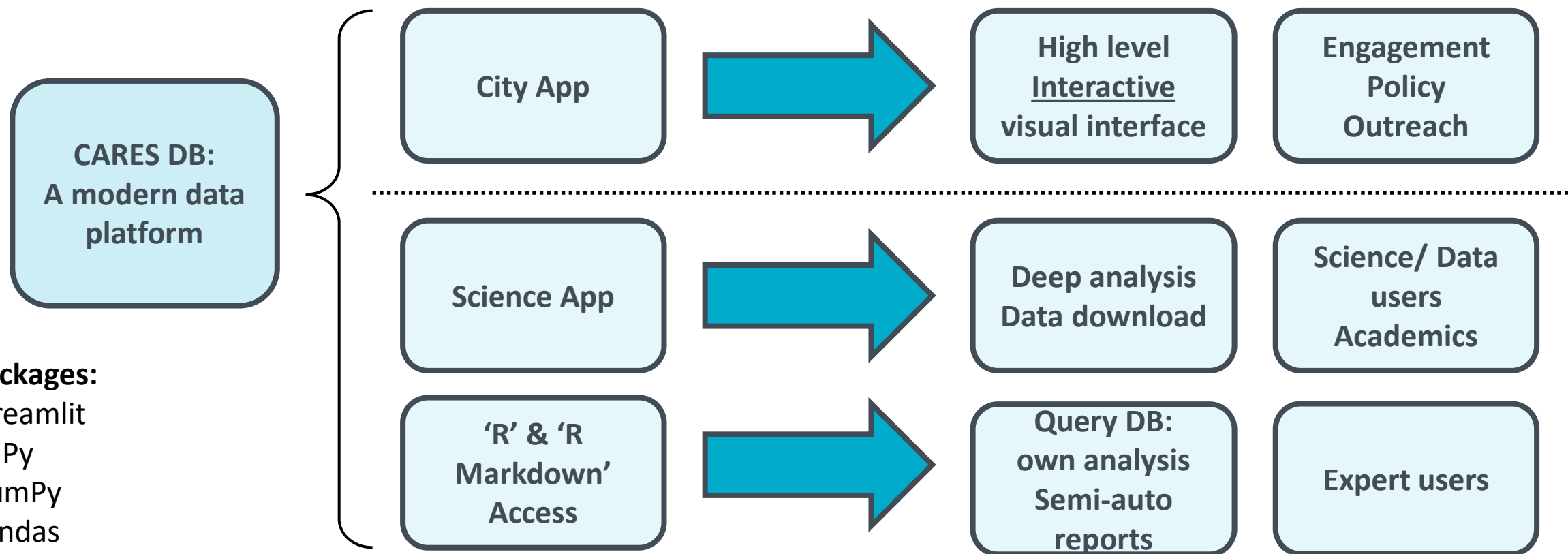


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Developing New Data Platforms - Objectives



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Packages:

Streamlit
SciPy
NumPy
Pandas
Altair
Azure.Cosmos



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City App – Examples (from “LIVE” demo)



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Configuration:

Select Plot Mode

Vehicle Type Filter

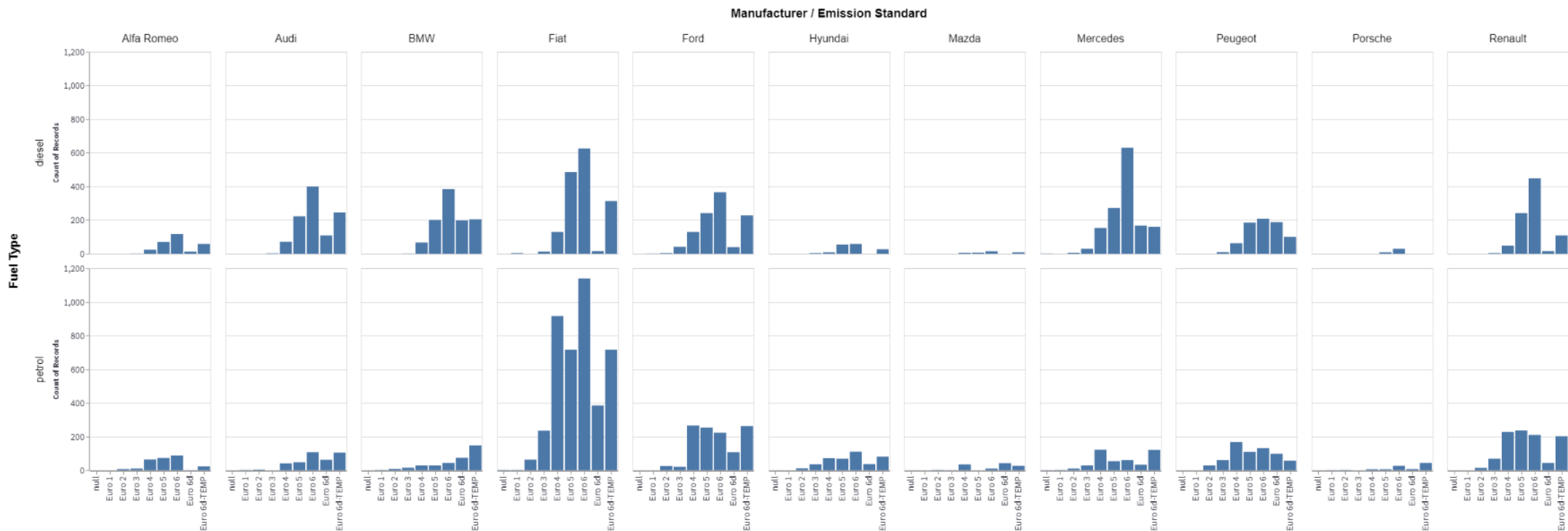
Vehicle Fuel Filter

Fleet Breakdown by Manufacturer

Audi x BMW x Fiat x Ford x Mazda x Renault x Peugeot x
Alfa Romeo x Porsche x Mercedes x Hyundai x

diesel x petrol x

Fleet Breakdown by Manufacturer





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City App – Examples (from “LIVE” demo)



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Select Plot Mode

Vehicle Site Filter

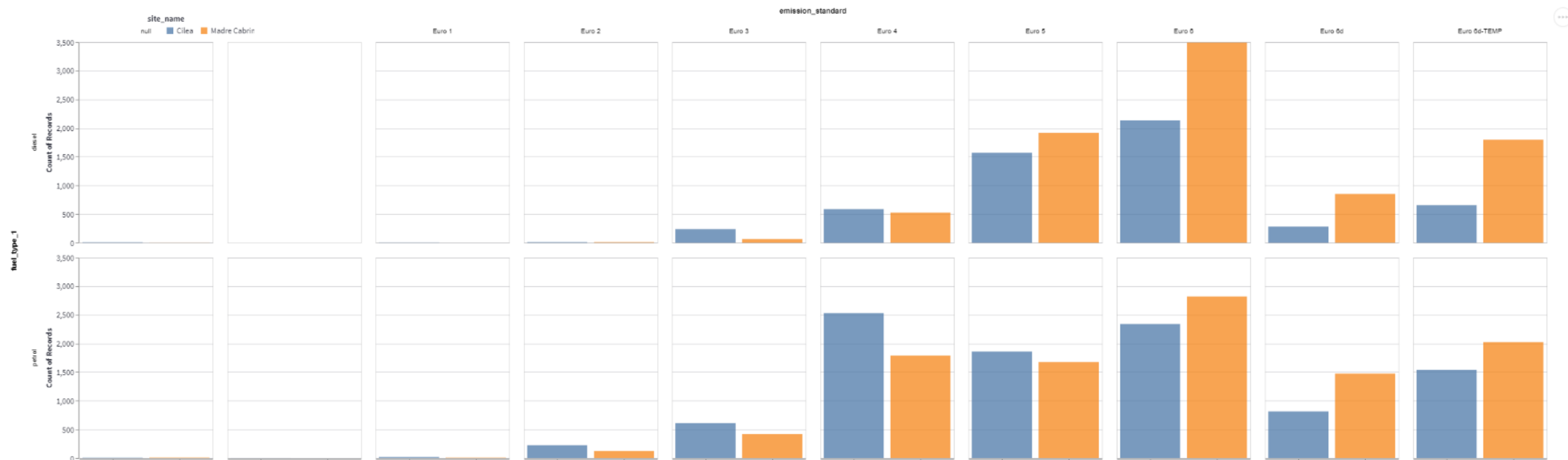
Vehicle Fuel Filter

Fleet Breakdown by Location

Madre Cabrini x Cilea x

diesel x petrol x

Fleet Breakdown by Location





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City App – Examples (from “LIVE” demo)



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Select Plot Mode

Vehicle Type Filter

Vehicle Fuel Filter

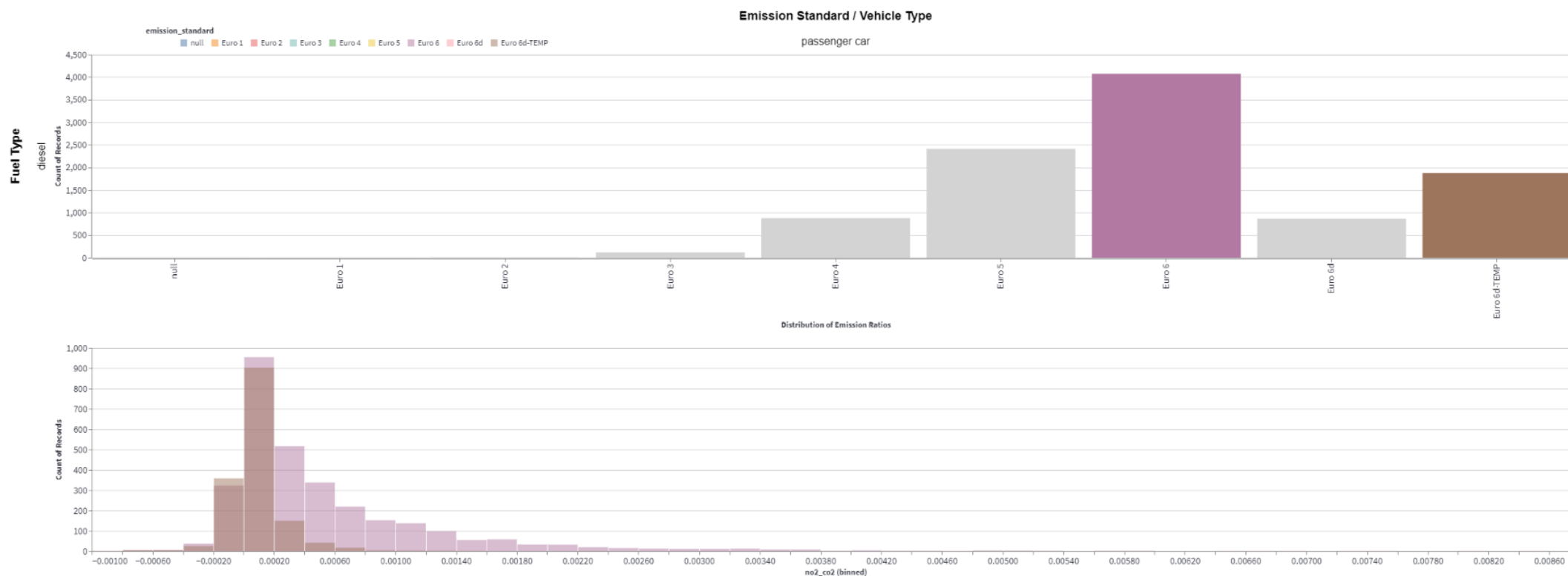
Interactive Fleet Breakdown by Fuel and Euro Class

passenger car x

diesel x

Select parameter to view in more depth:

no2_co2





Further analysis

Select types for further analysis:

point_sampling_da... X



Set peak threshold

0.82

- +

Select horizontal separation

5

- +

Select peak width

3

- +

Peak analysis for point_sampling_data_co2_ppm

Peak analysis is performed using the SCIPY package

| | index | Peak Width | Normalised Width Value | Peak Start | Peak End | Peak Centre | Human Date Time | TIMESTAMP_MS |
|---|-------|------------|------------------------|------------|----------|-------------|---------------------|------------------------|
| 0 | 0 | 10.1556 | 0.8055 | 23.6027 | 33.7583 | 32 | 2021-06-22 11:13:02 | 1,624,360,382,000.0000 |
| 1 | 1 | 6.5544 | 0.8095 | 58.1289 | 64.6833 | 60 | 2021-06-22 11:13:30 | 1,624,360,410,000.0000 |
| 2 | 2 | 13.2121 | 0.8072 | 80.0298 | 93.2419 | 86 | 2021-06-22 11:13:56 | 1,624,360,436,000.0000 |
| 3 | 3 | 5.7240 | 0.8049 | 112.1004 | 117.8244 | 114 | 2021-06-22 11:14:24 | 1,624,360,464,000.0000 |
| 4 | 4 | 5.2392 | 0.8232 | 139.1693 | 144.4085 | 140 | 2021-06-22 11:14:50 | 1,624,360,490,000.0000 |

Background analysis

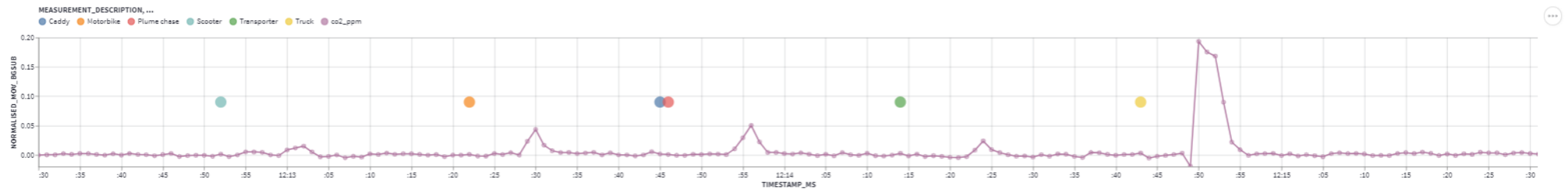
The local background value is calculated using values that are not part of a peak. The values selected for calculating the background are shown below:

▶ [. . .]

The mean value of the background values is 0.80674 and the standard deviation of the background is 0.00198

Plot for type point_sampling_data_co2_ppm

The y-axis of this plot has been normalised against its local maximum value and a background subtraction of 0.807 has also been applied





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Future Outlook



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| <div>PROGRESS</div> <div>DEVELOPMENT</div> | |
|--|--|
| Proof of concept of cloud-based DB technology & administration (£) | Expand data sets & users: seek feedback |
| Demonstrated multiple technologies in the field | Investigate potential of IOT, PowerBI and other modern ways of working |
| Understanding the potential of new platforms and methods | Expand capabilities and features of apps |

Thank you for your attention!

For more information

- Check our website: <https://cares-project.eu>
- Follow us:



<https://www.linkedin.com/company/city-air-remote-emission-sensing-cares>

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