eLICHENS

Air Quality API: **contribution of** signal processing **to the development of a platform of** local and robust real-time **air quality data based on the combination of** air quality sensors **and a** dispersion model

Atmos'Fair 2021

La Région
Auvergne-Rhône-Alpes

Introduction

Imagine and prioritize local actions in favor of air quality

Prioritize local urban planning and mobility actions

The impact of actions or events on air quality and the health

Communicate and raise awareness of citizens

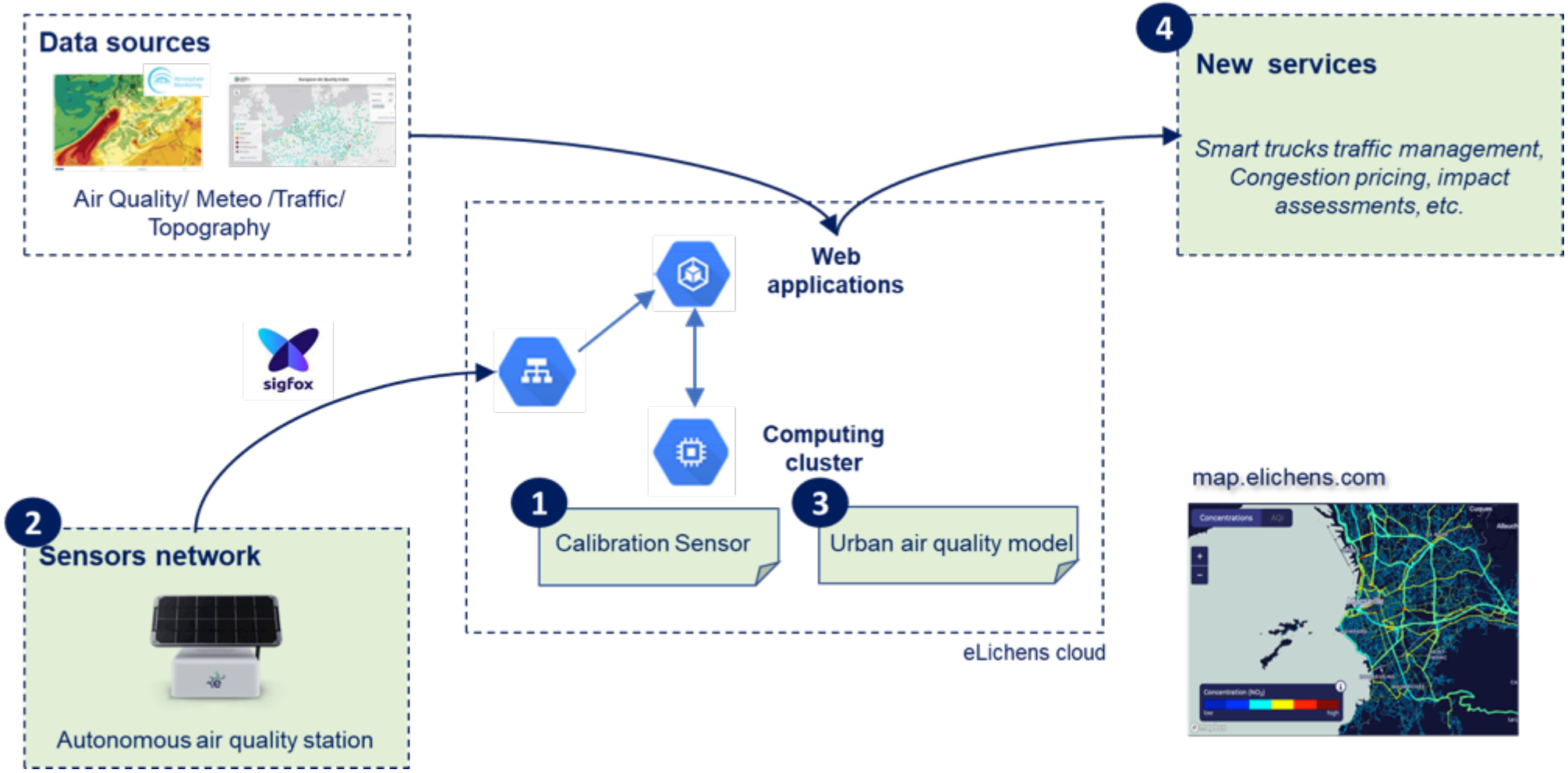
High-resolution air quality data

in cooperation with reference air quality network

Challenge:

Ensure the **reliability of data** from sensors and from combination with other data or model to allow **easy and fast access** to high-resolution data at **affordable cost**

Presentation content



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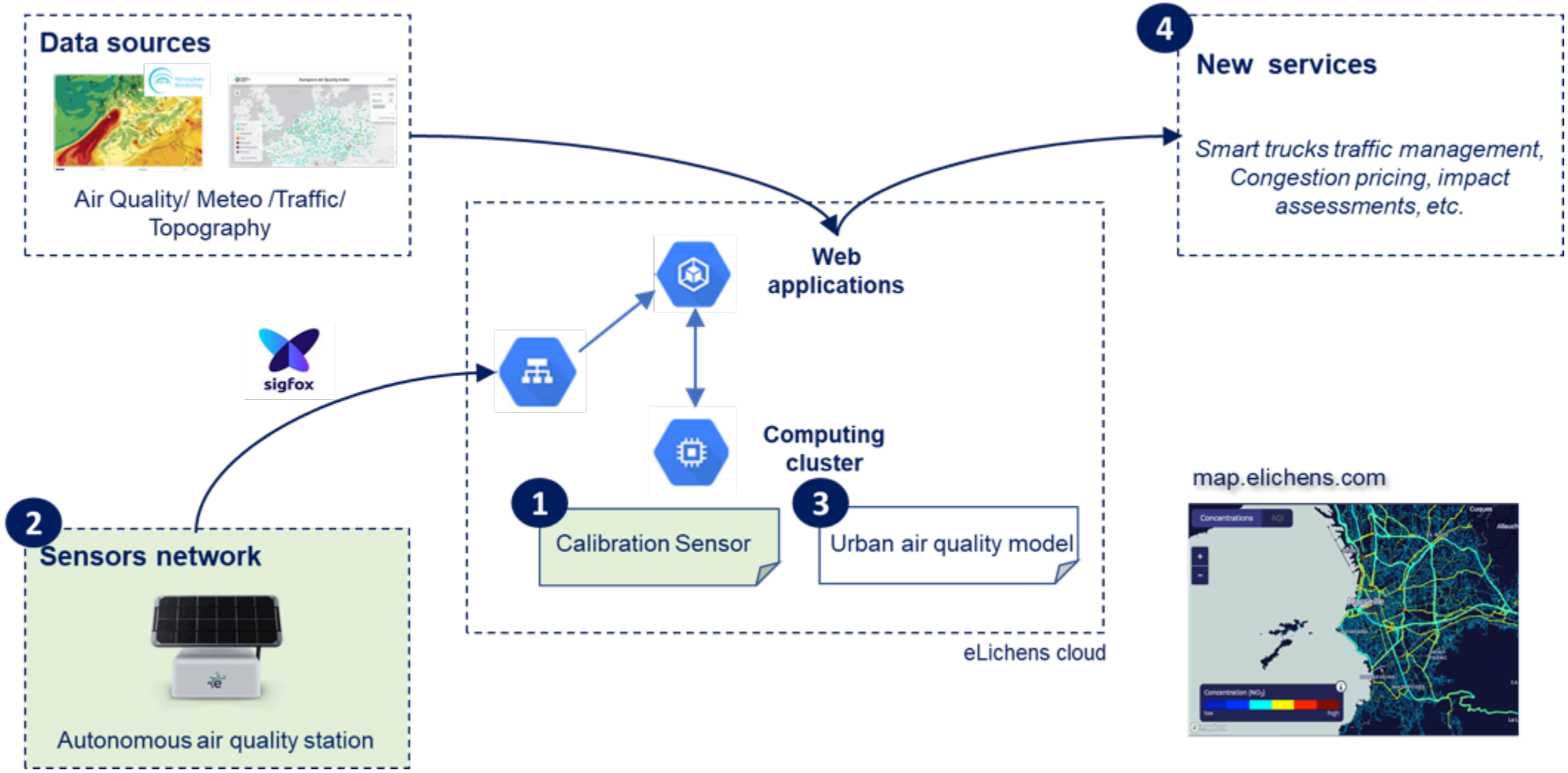
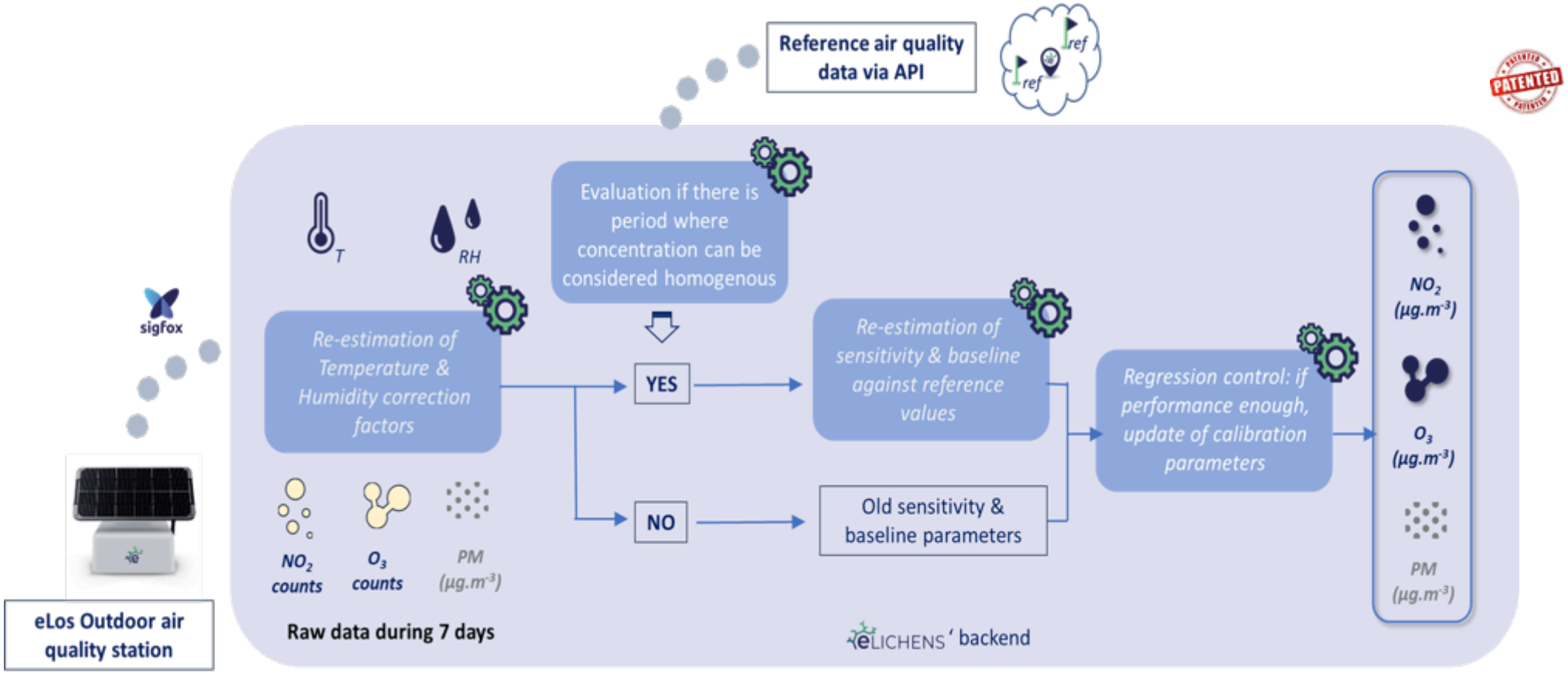


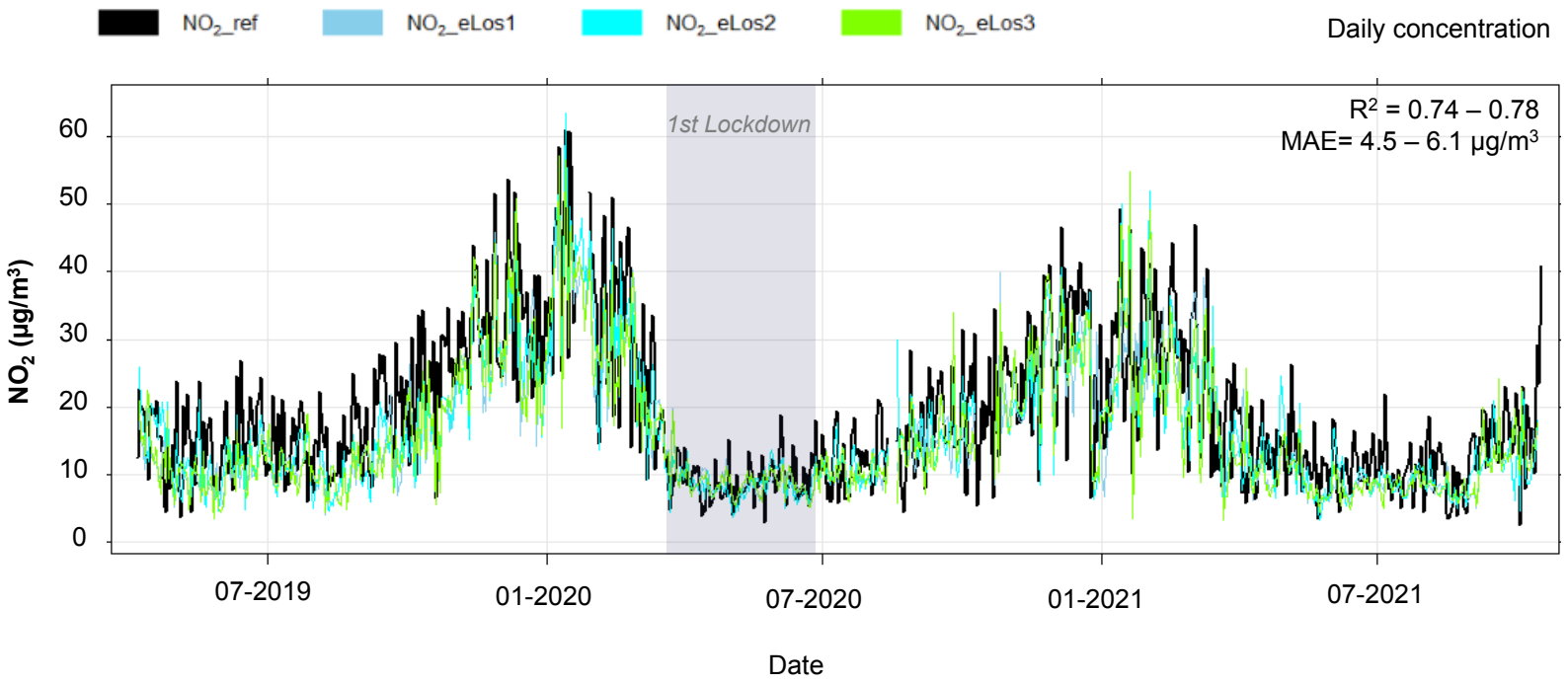
Process 1: Real-time calibration of air quality sensors

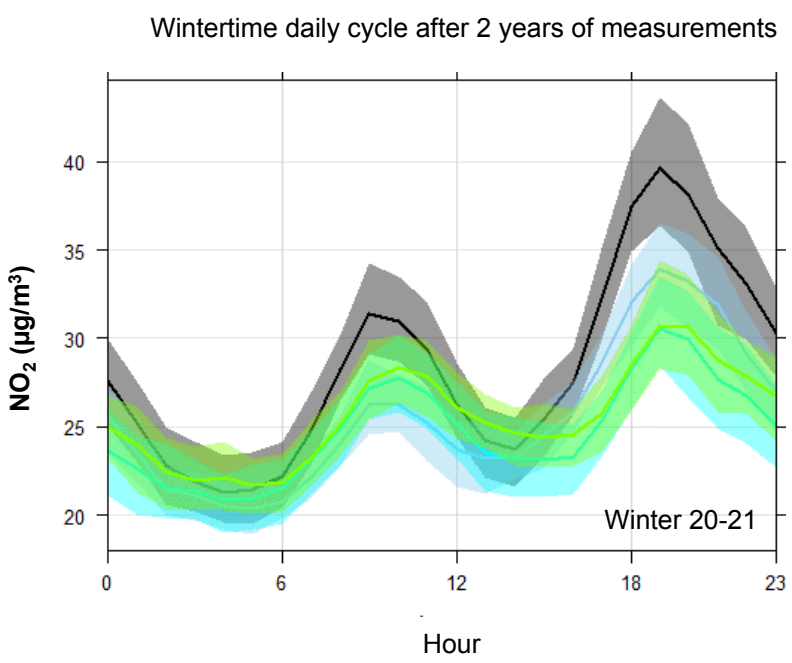
Based on reference network knowledge and the hypothesis of existence of periods when pollutant concentration can be considered as homogenous over the city



Process 1: Long term colocalization measurements

Colocalization of 3 eLos at urban background site (Grenoble) since early 2019.





The recalibration system allows to obtain robust measurements over long-term **without station maintenance**.

Sensor network deployments

San Francisco, USA

20 eLos stations deployed from sept- dec 2019

Criteria for deployment:

- Distribution according street type*:
  12 residential + 8 traffic streets
- Microenvironment homogeneity (elevation) as much as possible

Grenoble, Fr

16 eLos stations deployed by volunteers between May 2020 – Oct 2021

No real criteria for deployment:

- Diverse microenvironments (roof, garden, 6th floor, etc.)
- Mainly residential streets (“urban background” site)

** OpenStreetMap road category*

Sensor network deployments: data quality

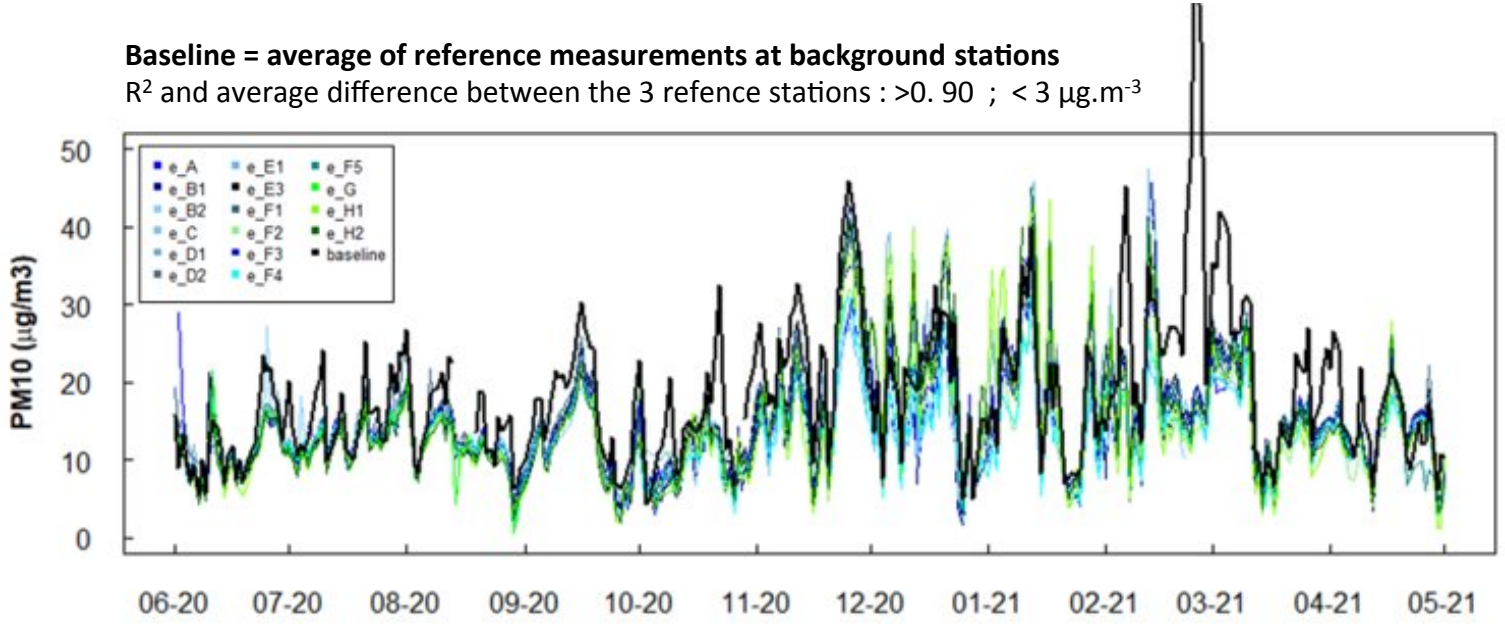
~ 95% of values available

Main issues faced:

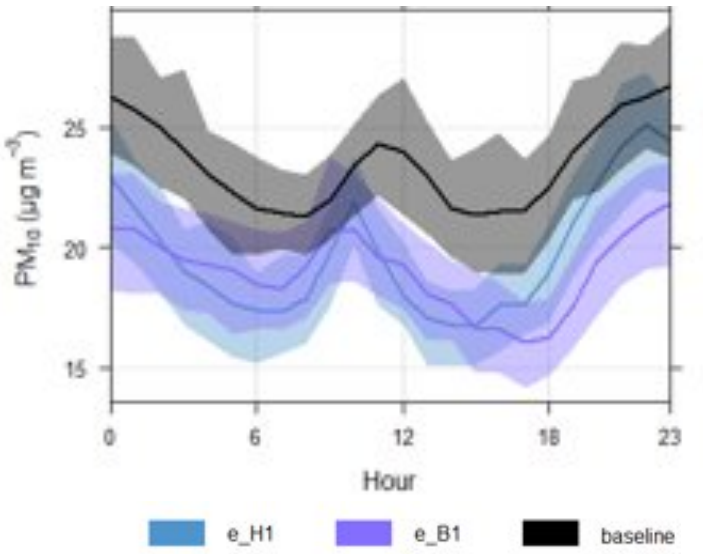
- Low batterie charge in winter for 20% of eLos in SF
- Problem of humidity and temperature sensor drift of 5 eLos in SF and 3 eLos in Grenoble
- Necessary return to lab of 2 eLos out of 46 deployed for maintenance

Baseline = average of reference measurements at background stations

R^2 and average difference between the 3 refence stations : >0. 90 ; < 3 µg.m^{-3}



PM_{10} _ Winter 2020



Sensor network deployments: spatial variability (1 / 2)

Detection of an $PM_{2.5}$ increase due to a warehouse fire by 2 eLos stations located at less 3 km away

Reference station did not detect this ponctual event.

23 May 2020 – 8:00 AM

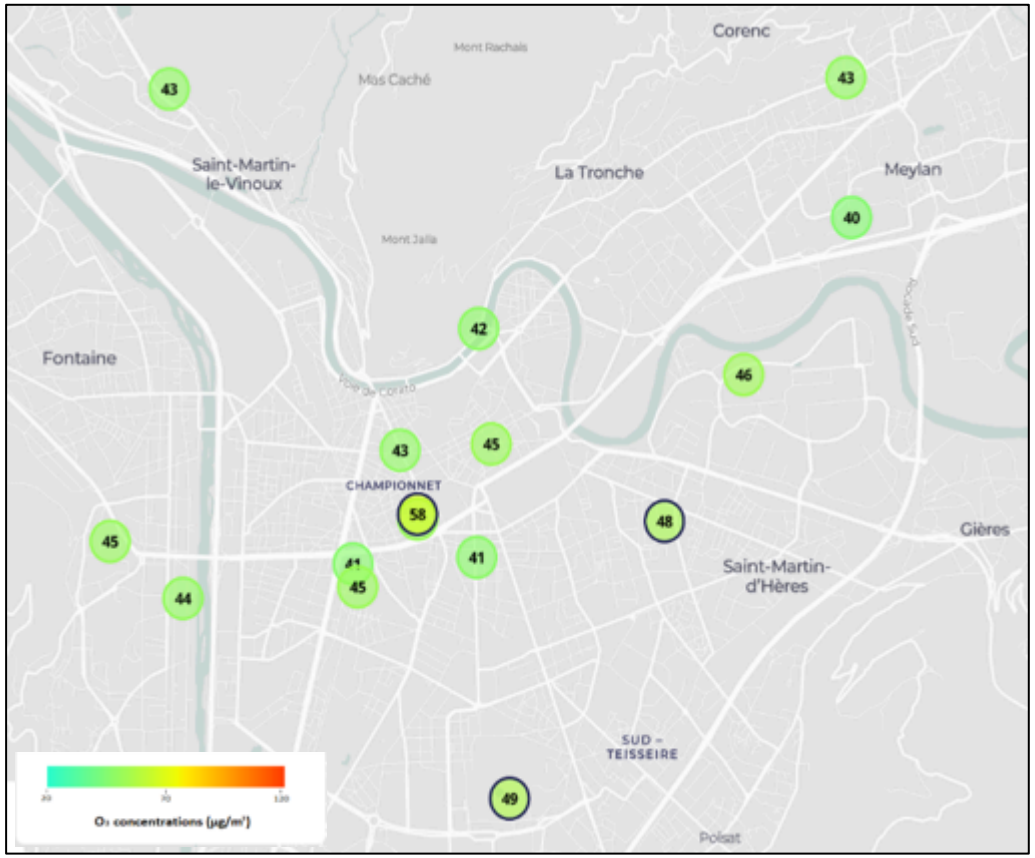
23 May 2020 – 10:00 AM

23 May 2020 – 11:00 AM

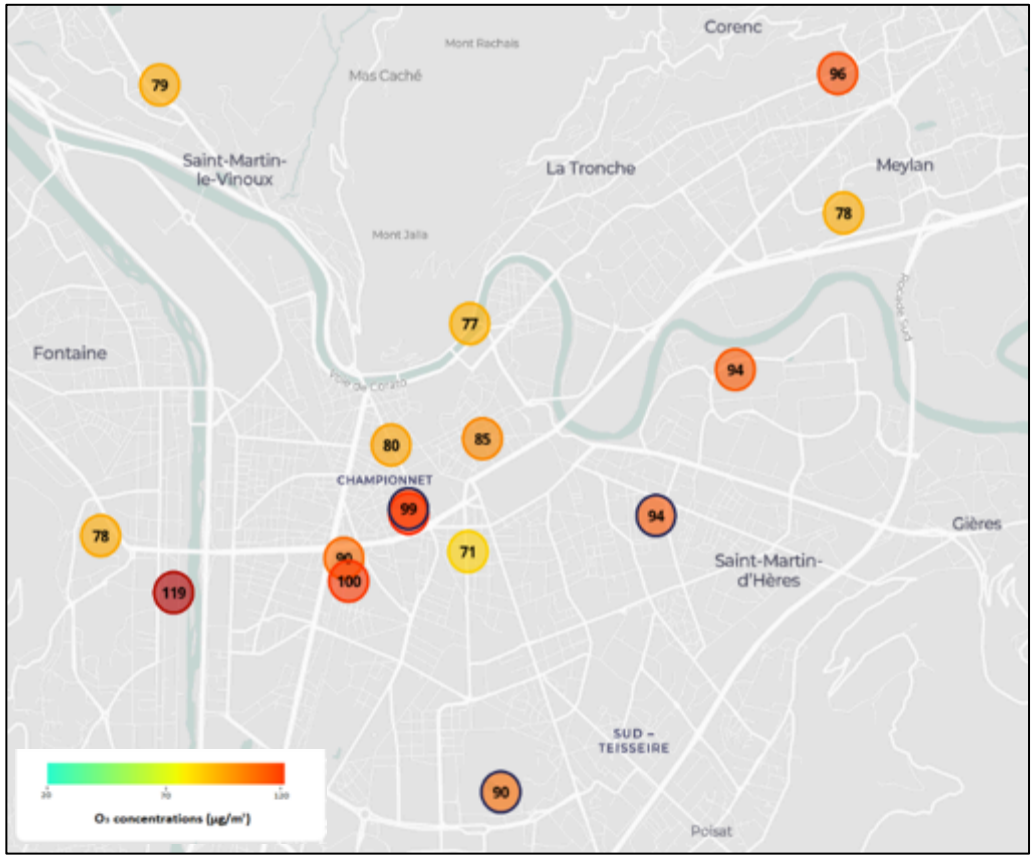
https://vimeo.com/425552041

Sensor network deployments: spatial variability (2 / 2)

6h UTC_ O_3 concentration average of summer 2020

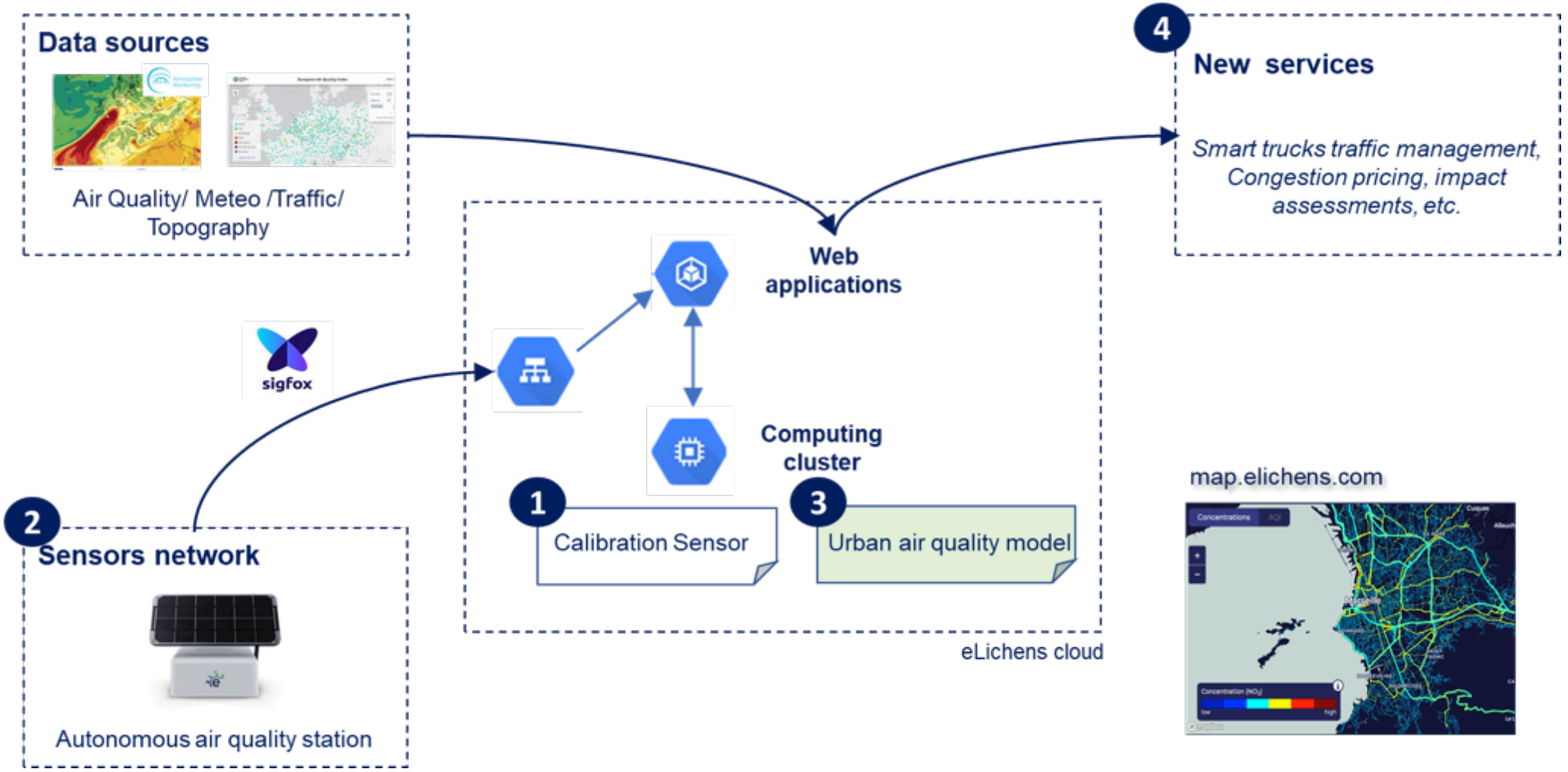


18h UTC_ O_3 concentration average of summer 2020

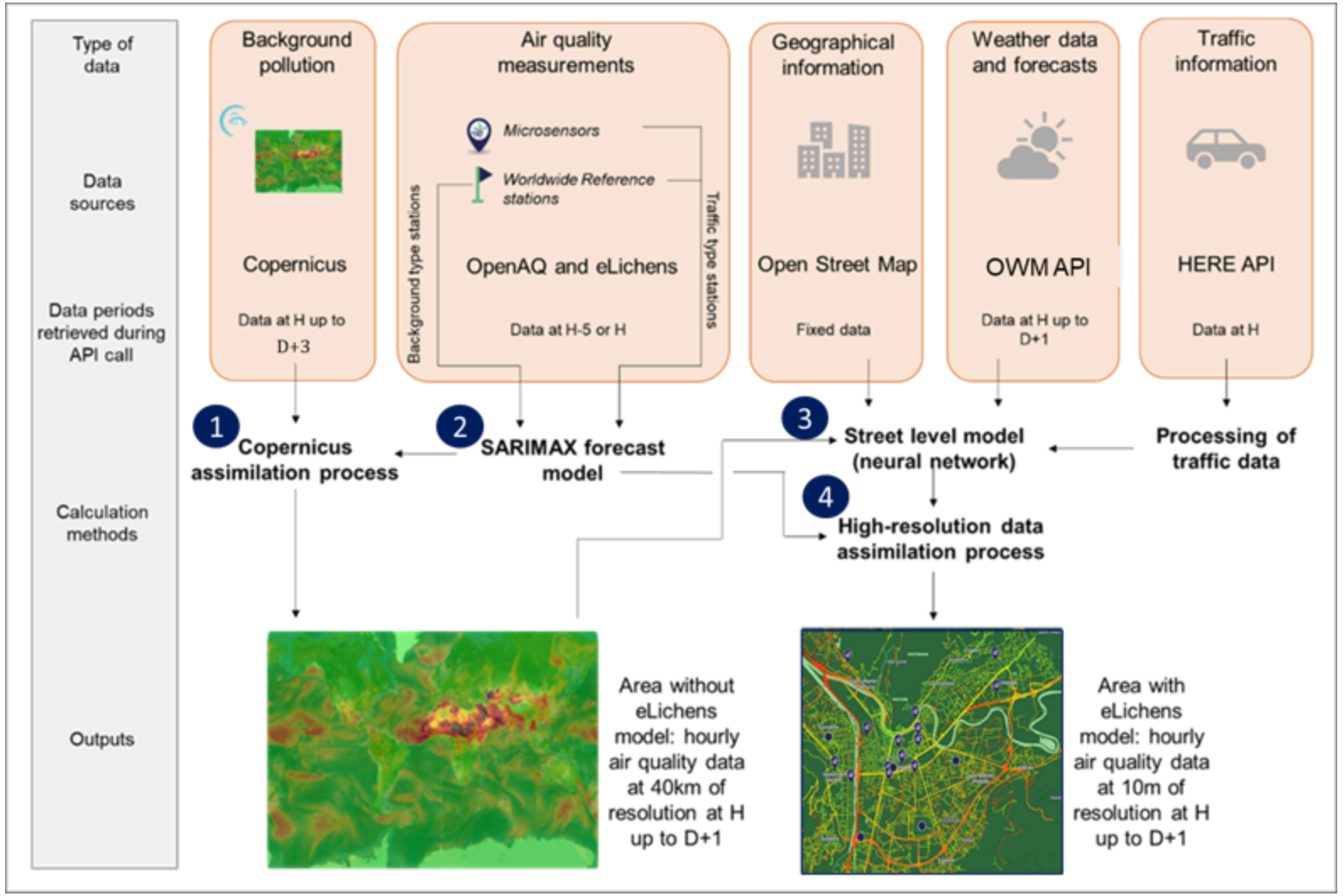


O_3 shows disparities over the city during daytime in summer with lower concentration nearer high traffic road

Presentation content



Process 2: high-resolution data



1. To correct CAMS biases with reference data
2. To obtain reference data at H
3. CNN= model easily scalable & fast computing

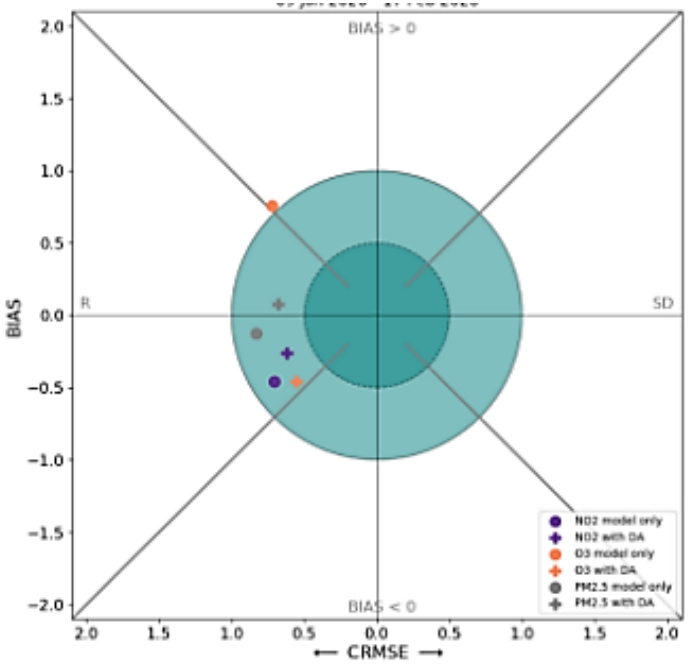
   compared with OSPM* model
4. Assimilation of sensors data

*Aarhus university model

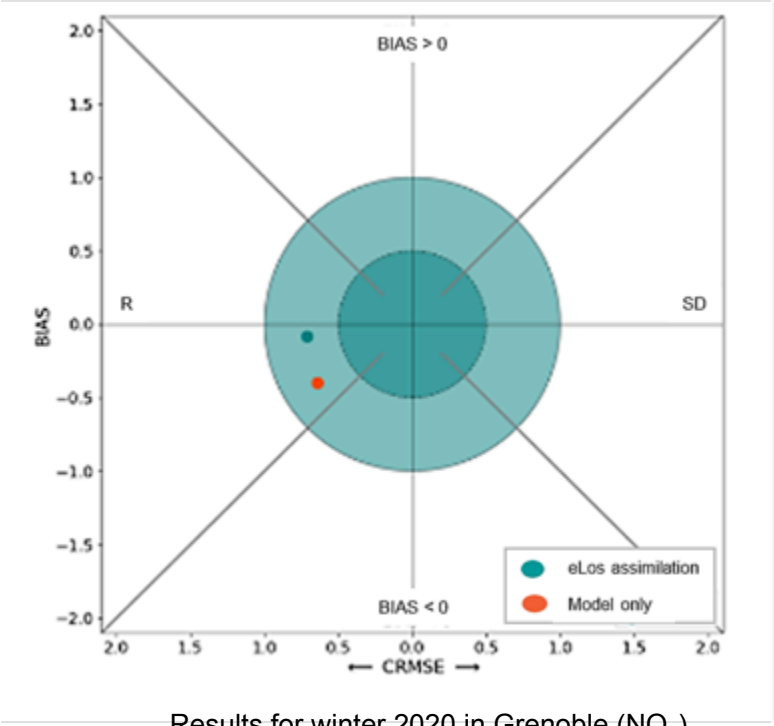
Process 2: evaluation performance (1 / 3)

Assessment of AQ model and AQ model with assimilation of measurements against reference measurements

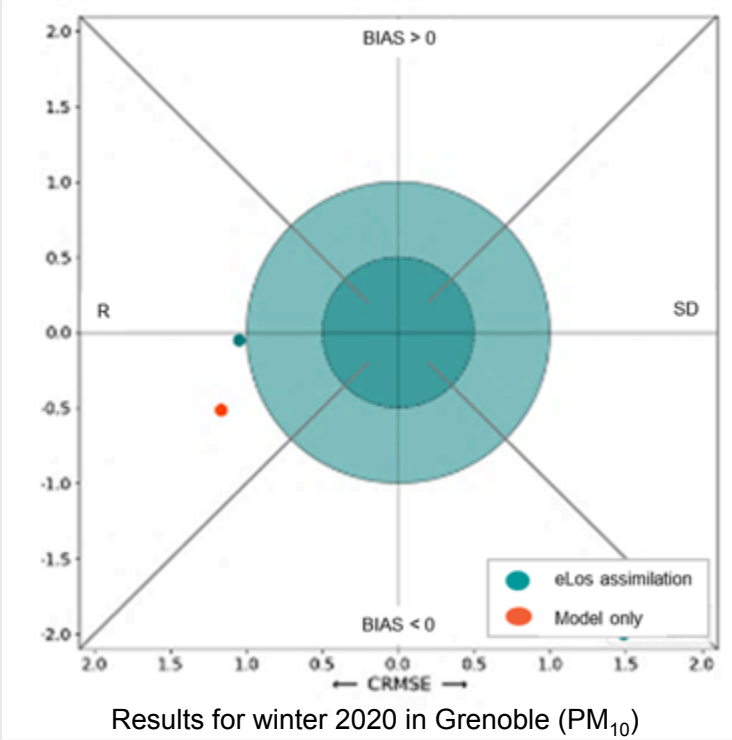
Target Plot* use (European tool) to check if global quality is acceptable (green circles)



Results for winter 2019 in San Francisco ($PM_{2.5}$, O_3, NO_2)



Results for winter 2020 in Grenoble (NO_2)

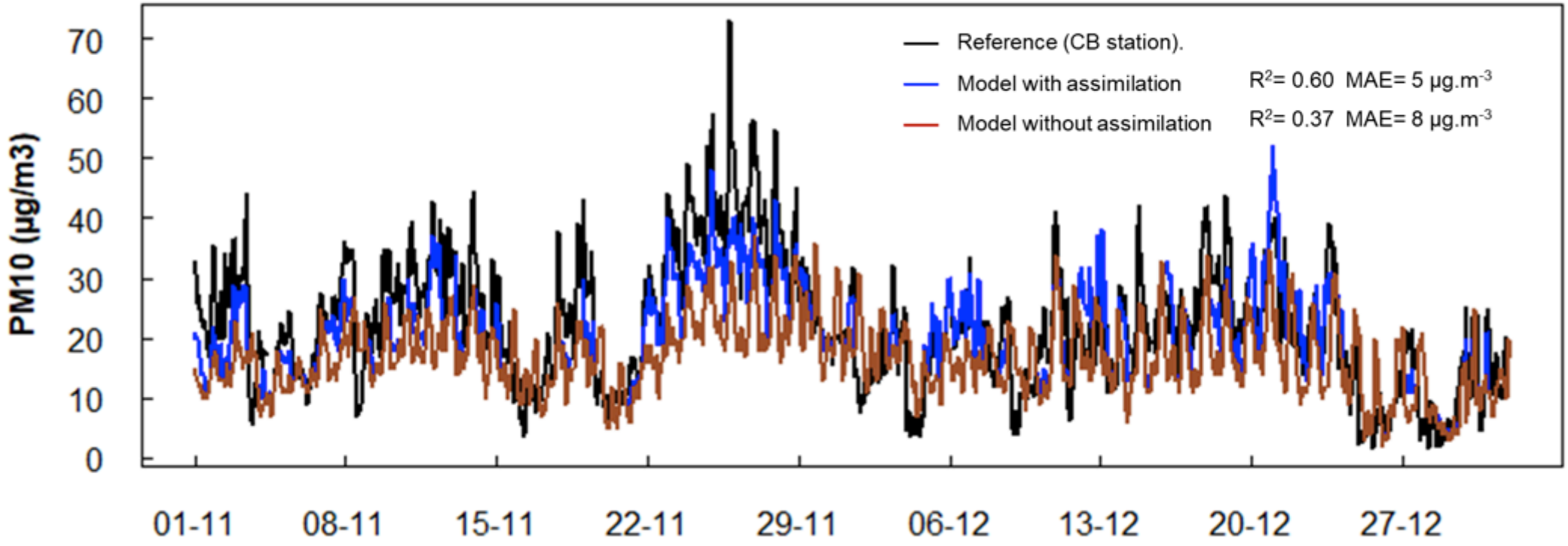


Results for winter 2020 in Grenoble (PM_{10})

*Target Plot From the Forum for air quality modelling in Europe
https://fairmode.jrc.ec.europa.eu/document/fairmode/WG1/Guidance_MQO_Bench_vs2.1.pdf

Process 2: evaluation performance (2 / 3)

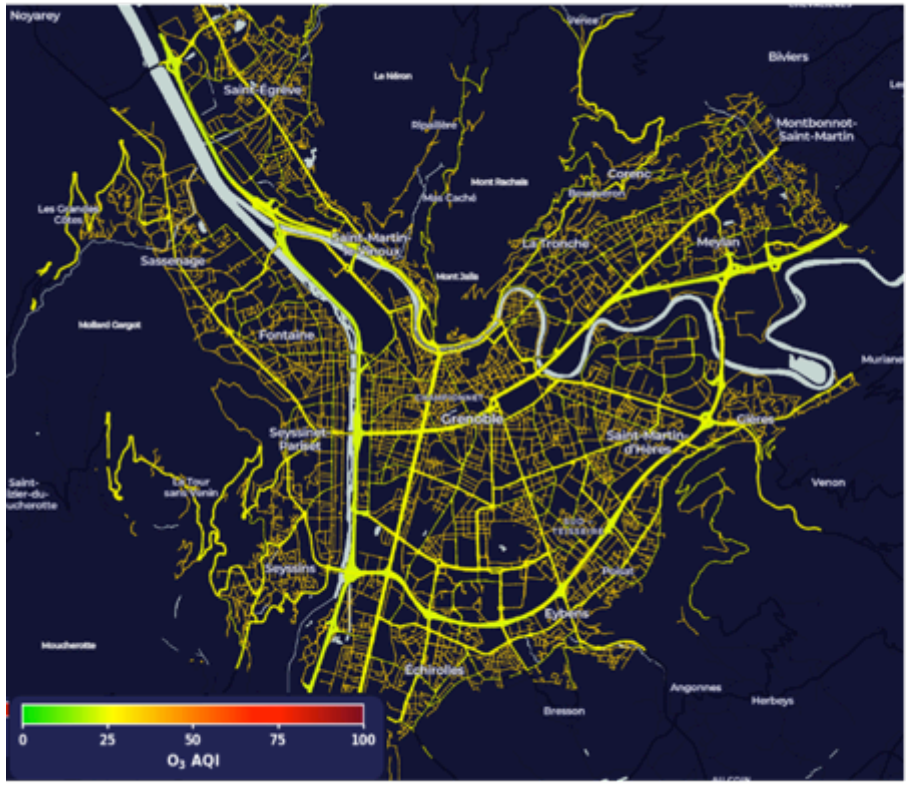
Time evolution of PM_{10} reference measurement, modelized concentration with and without sensor assimilation during winter 2020 in Grenoble



Process 2: evaluation performance (3 / 3)

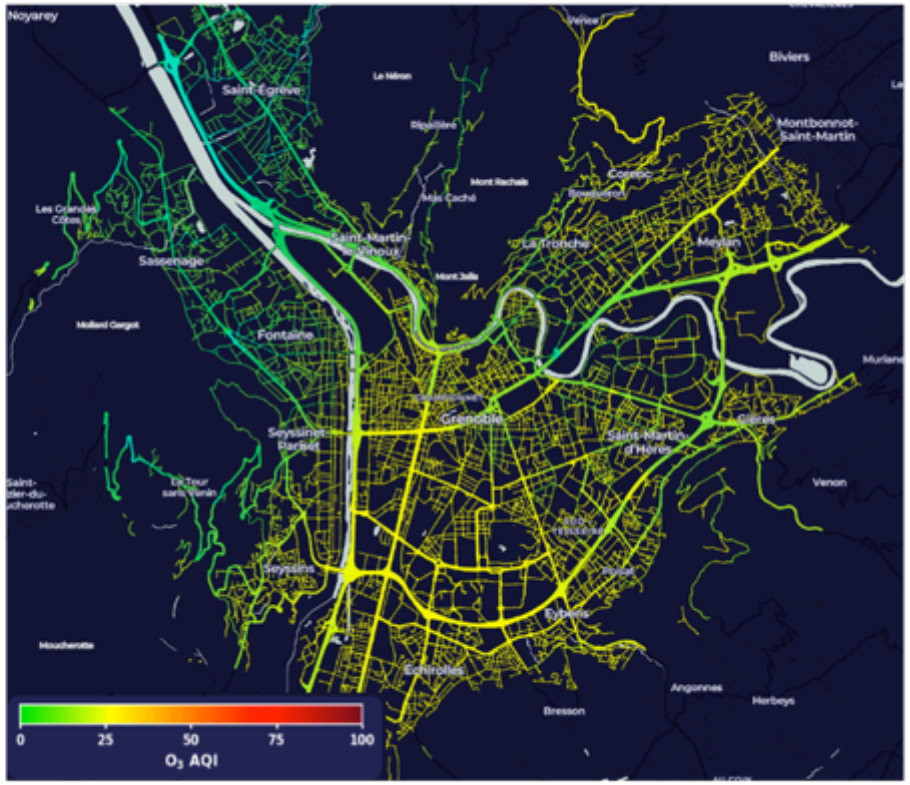
Map of O_3 modelized concentration with and without sensor assimilation for a summer day in Grenoble

O_3 concentration map based the air quality model



14/09/2020 _ 17h

O_3 concentration map with eLos data assimilation



14/09/2020 _ 17h

eLos data assimilation corrects modelled concentration overestimation in some areas

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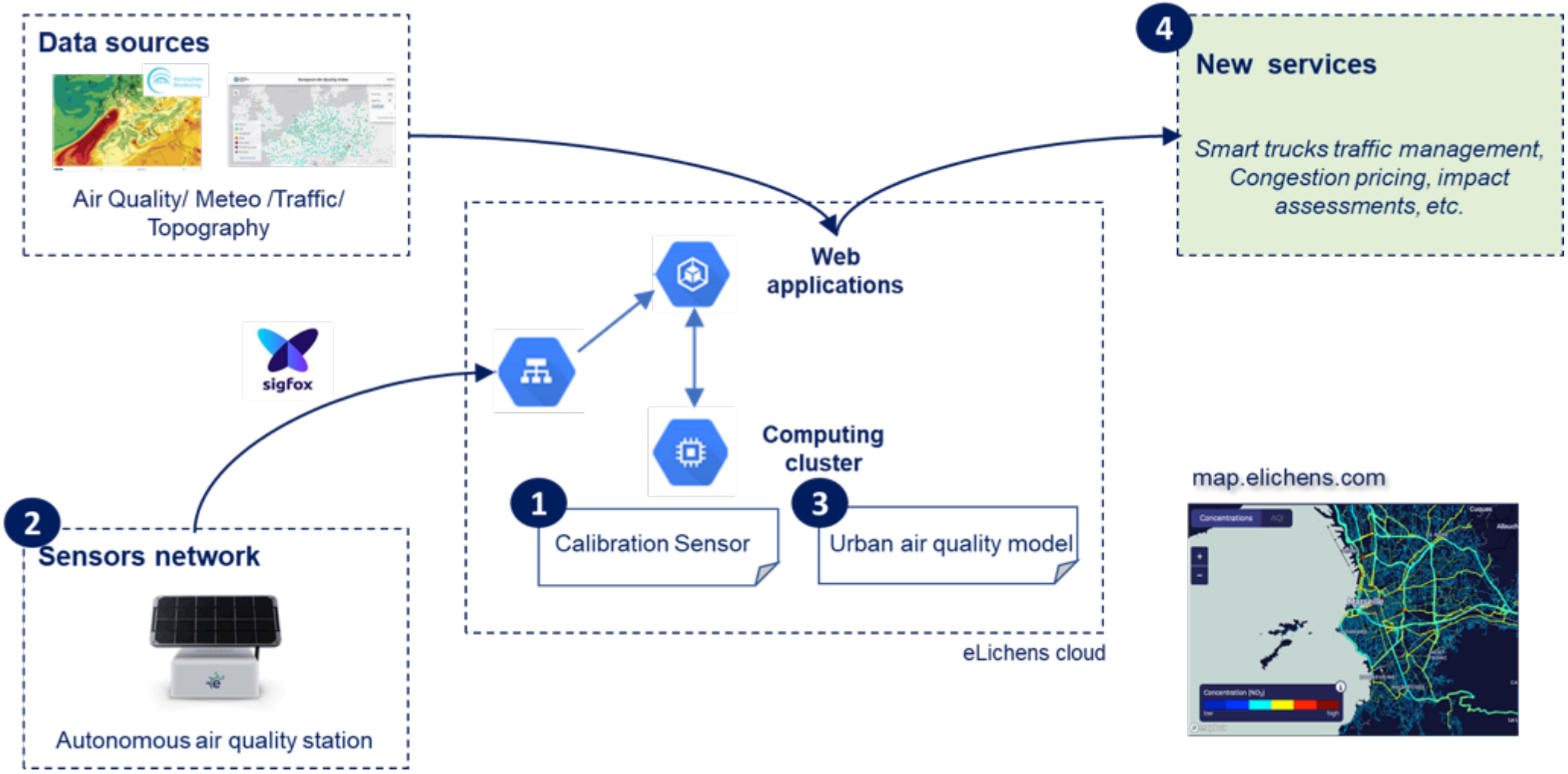


Example of mobility planning service (1 / 2)

Tool to visualize the impact of different mobility scenarios on the measured air quality

Based API and inverse modelling (eLichens model)

AQI level based on sensors & model

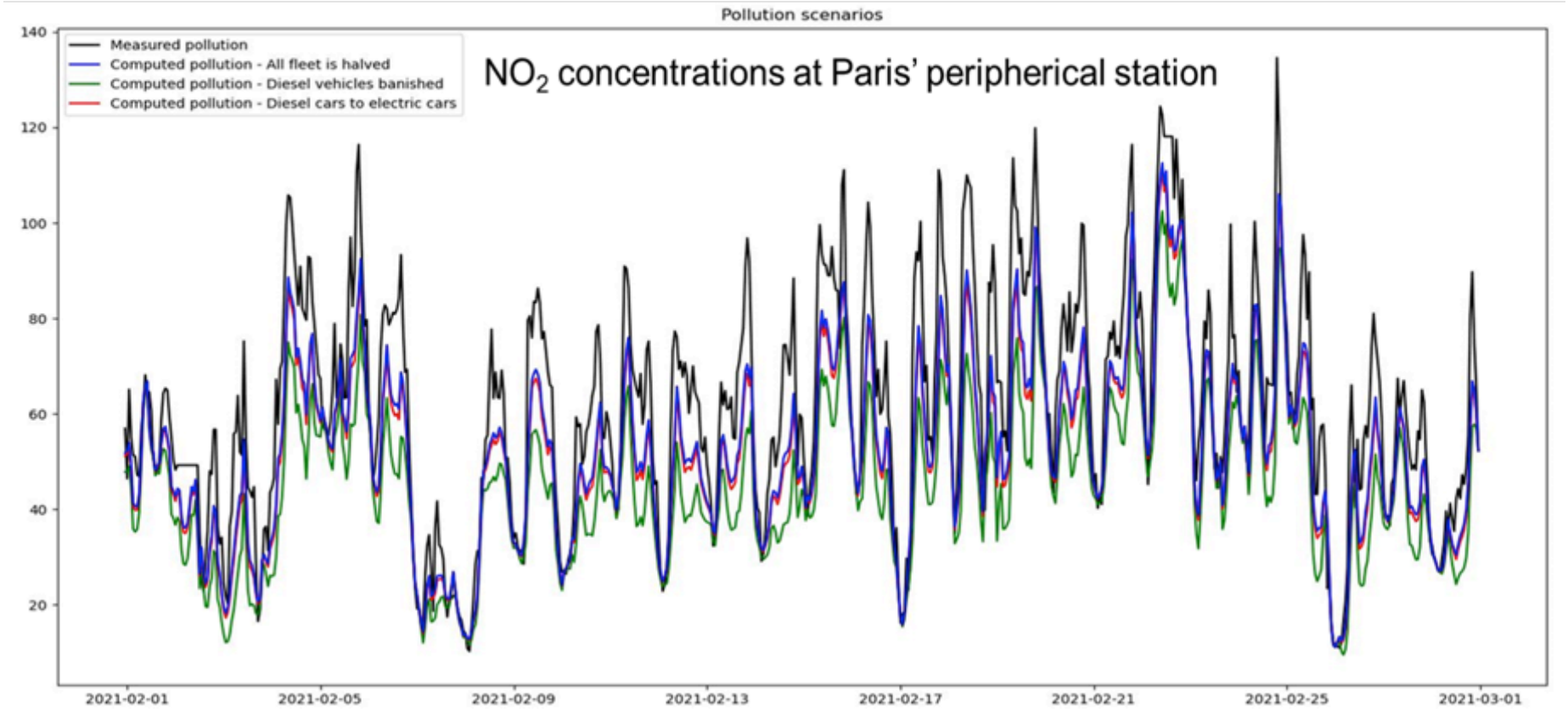
AQI level if whole traffic were avoided

http://usecases.elichens.com/demo/how-trafic-impacts-pollution-level

Example of mobility planning service (2 / 2)

Based ponctual pollutant approach and inverse modelling (OSPM model*) with more detailed traffic emission

Real measurements | Half reduction car fleet | Diesel banished | Diesel become electric

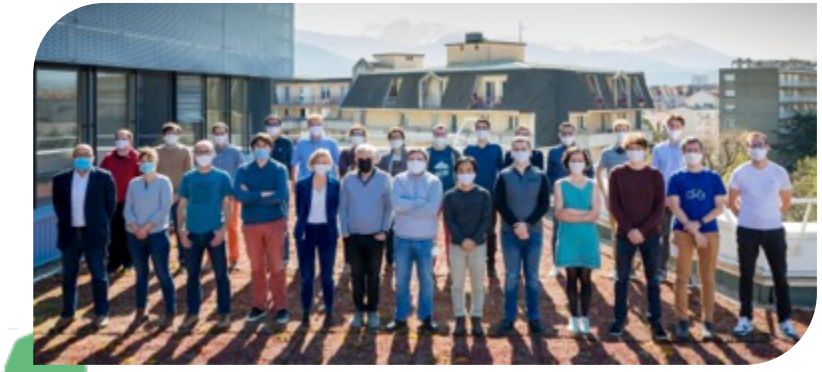


*Aarhus university model – M. Ketzel

http://usecases.elichens.com/demo/mobility-policy-and-pollution-level-in-paris

Conclusions & Perspectives

- Air Quality API: solution to obtain high-resolution data with fast access based on AQ sensors and model
- Several signal processing approaches to obtain robust AQ data, notably real-time recalibration for sensors
- API can become the basis for the creation of new APIs and services such as for local impact assessment of mobility policies
- *To know more:* *www.map.elichens.com* *www.usecases.elichens.com*



Thank you !

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