

Data assimilation & Dynamic noise mapping for the city of Geneva

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- I. Presentation of the project
- II. Objectives
- III. Materials and Methods
- IV. Results
- V. Conclusion and Discussion

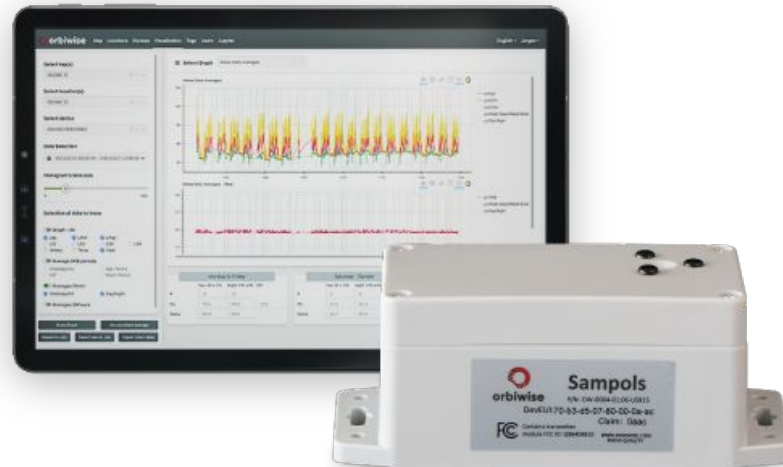
- 03/2024 - 07/2025
- Eureka funding, led by Orbiwise
-

UMRAE objectives:

- NM 5.0
- Data assimilation (15 min.)

Also but without UMRAE:

- New sensors
- Source detection and localization



NoiseModelling 5.0

Noise-Planet

Outils scientifiques pour l'évaluation du bruit dans l'environnement



NoiseCapture

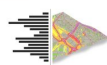
100 31.5k 48

Une application Android gratuite & open-source pour mesurer et partager les environnements sonores



Carte de bruit communautaire

Une carte interactive, pour afficher les données sur le bruit collectées par la communauté des utilisateurs.



NoiseModelling

100 31.5k 48

Une librairie gratuite & open-source (compatible avec les SIG) pour calculer des cartes de bruit



Les effets du bruit

Selon l'Organisation Mondiale de la Santé, le bruit excessif nuit gravement à la santé humaine et interfère avec les activités quotidiennes des gens à l'école, au travail, à la maison et pendant les loisirs. Il peut perturber le sommeil, avoir des effets cardiovasculaires et



Visualiser les cartes

Explore noise maps produced within the project. See maps [at this page](#).



Télécharger des données

Certaines des données produites dans le cadre de ce projet sont distribuées de manière ouverte selon les termes de la licence ODbL. Jetez un oeil à la section :

[Download data](#)

NoiseModelling 5.0

Search docs

NOISEMODELLING PRESENTATION

- Architecture
- Numerical Model
- Validation
- Scientific production

INPUT TABLES & PARAMETERS

- Buildings
- Roads
- Sound source
- Railways
- Ground surfaces
- DEM
- Directivity
- Receivers
- Acoustic parameters

TUTORIALS

- Requirements
- Get Started - GUI
- Noise Map from OSM - GUI
- Noise Map from Point Source - GUI
- MATSim - GUI
- Dynamic Tutorial - GUI
- Pilot NoiseModelling with scripts
- Tutorials - FAQ

USER INTERFACE

- WPS Blocks
- WPS Builder

FOR ADVANCED USERS

- Create your own WPS Block
- Access NoiseModelling database
- Use NoiseModelling with a PostGIS

NoiseModelling v5.0 User Guide

View page source

NoiseModelling v5.0 User Guide

Welcome on the official NoiseModelling v5.0 User Guide.

NoiseModelling is a library capable of producing noise maps. It can be freely used either for research and education, as well as by experts in a professional use.

A general overview of the model (v3.4.5 - September 2020) can be found in this video.

- for more information on NoiseModelling, visit the official NoiseModelling website
- to contribute to NoiseModelling source code, follow the "Get Started" page
- for more information for the final results with the reference results in ISO/TR 17534-4: 2020 follow the "Conformity to ISO 17534-1:2015" page
- to contact the support / development team,
 - open an issue or a write a message (we prefer these two options)
 - send us an email at contact@noise-planet.org

What's new with the v5.0?

Since the release v5.0, NoiseModelling validate the "CNOSSOS-EU" standard method for the noise emission (road and rail (for France)) and with noise propagation (read "Numerical Model" and "Validation" "Cnossos_report" pages for more information).

Time periods are not limited to Day Evening and Night anymore. You can provide the sound source emission for any period you want. You can also define a specific atmospheric condition for each time period now.

The computation time has been decreased. The separation between path finding and attenuation has been done in preparation to the implementation of more noise propagation model (ex. Harmonical).

Depuis 2010

Open-Source

Cartographie du bruit
routier
ferroviaire

CNOSSOS-EU

- Release 21 mars 2025
- Tutoriel intégration trafic dynamique
- Des petits bugs résolus

Program

Below is the first version of the program. Note that three slots are still free and the rest may be updated if needed.

NoiseModelling Days 2025



Day 1 (June 26th 2025)

French, UTC+2	Type	Title	First speaker	Affiliation(s)
15h00 - 15h20		Welcome coffee		
15h20 - 15h40	Presentation	Introduction	NoiseModelling Team	
15h40 - 16h00	Presentation	Open Research in acoustics	Judicaël Picaut	UMRAE, Univ Gustave Eiffel, Cerema
16h00 - 16h40	Presentation	Toward a collaborative room acoustics simulation software community	Maarten Hornikx	Eindhoven University of Technology
16h40 - 17h00		Break		
17h00 - 17h20	Presentation	Open source data & software for noise and vibration modelling in the Netherlands	Arnaud Kok, Rob Van Loon	National Institute for Public Health and the Environment
17h20 - 17h30	Presentation	CHOSOS EU & Open source	Pierre Aumond	UMRAE, Univ Gustave Eiffel, Cerema
17h30 -		Brainstorm Open Research for environmental acoustics		

Day 2 (June 27th 2025)

French, UTC+2	Type	Title	First Speaker	Affiliation(s)
09h00 - 09h30		Welcome coffee		
09h30 - 10h00	Presentation	NoiseModelling - What's new?	Pierre Aumond	UMRAE, Univ Gustave Eiffel, Cerema
10h00 - 10h15	User presentation	xxxx	xxxx	xxxx
10h15 - 10h30	User presentation	xxxx	xxxx	xxxx
10h30 - 10h45	User presentation	Data assimilation for dynamic urban noise mapping	Nolde Maguette Diagne	UMRAE, Univ Gustave Eiffel, Cerema
10h45 - 11h00	User presentation	Applying EU standards to noise mapping in emerging countries	Alexandra L. Montenegro	Università di Pisa, ARPAT
11h00 - 11h30	Tutorial	NoiseModelling in action	NoiseModelling team	
11h30 - 12h00		Break (coffee + snacks)		
12h00 - 12h15	User presentation	xxxx	xxxx	xxxx
12h15 - 12h30	User presentation	From road traffic volumes to individual vehicle representation	Yu Gao, Sacha Baclet	UMRAE, KTH Royal Institute of Technology
12h30 - 12h45	User presentation	Synthetic population & NoiseModelling	Valentin Le Bescond	UMRAE, Univ Gustave Eiffel, Cerema
12h45 - 13h00	User presentation	Towards a comprehensive noise assessment in Spain	Ignacio Soto Molina	Spanish ministry of the Environment
13h00 - 13h15	User presentation	NoiseCapture vs. NoiseModelling : a test case on Sherbrooke university campus	Léonor Rimani	Université de Sherbrooke
13h15 - 13h30		Break (coffee + snacks)		
13h30 - 14h00	Discussion	Whishlist for NoiseModelling Days 2026		



noise-planet.org/noisemodelling_days.html

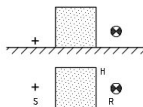
Hybride, inscriptions toujours possibles !

Table 71 — Partial and total sound pressure levels for all three propagation paths

f/in Hz	63	125	250	500	1 000	2 000	4 000	8 000	Total
$L_{p,i}$ in dB over top	4,18	12,34	17,41	20,04	20,11	17,25	9,60	-10,99	25,32
$L_{p,i}$ in dB right	-11,56	-4,54	-0,19	0,58	1,91	-1,23	-9,56	-33,31	6,94
$L_{p,i}$ in dB left	2,27	10,29	15,24	17,77	17,79	14,90	7,22	-14,29	23,05
$L_{p,i}$ in dB	6,41	14,50	19,52	22,09	22,16	19,28	11,62	-9,31	27,39

6.2.11 TC10 — Flat ground with homogeneous acoustic properties and cubic building — Receiver at low height

The aim of this test case is to check the correct consideration of objects like buildings in the diffraction calculation. The ground factor is spatially constant with $G = 0,5$. The scenario is shown in Figures 17 and 18.



Key
S source
R receiver
H object

Figure 17 — Screening cubic building between source and receiver at low height

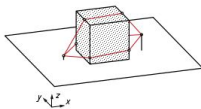


Figure 18 — 3D-presentation of scenario TC10

Tables 72 and 73 contain the modified and additional input parameters, and Tables 74 to 83 show the intermediate and final results.

Table 72 — Coordinates of source S and receiver R

Point	x (m)	y (m)	z (m)
S	50	10	1
R	70	10	4



Conformity to ISO 17534-1:2015

Conformity table

Conform - Do not deviate more than $\pm 0,1$ dB

NLD Conform - Do not deviate more than $\pm 0,1$ dB neglecting lateral diffraction

Test Case	Conform ?	NLD Conform ?	Largest Deviation	Details
TC01	☑	☑	0.00 dB @ 2000 Hz	TC01
TC02	☑	☑	0.07 dB @ 1000 Hz	TC02
TC03	☑	☑	0.05 dB @ 500 Hz	TC03
TC04	☑	☑	0.07 dB @ 1000 Hz	TC04
TC05	☑	☑	0.00 dB @ 1000 Hz	TC05
TC06	☑	☑	0.06 dB @ 500 Hz	TC06
TC07	☑	☑	0.02 dB @ 1000 Hz	TC07
TC08	☑	☑	0.02 dB @ 1000 Hz	TC08
TC09	☑	☑	0.01 dB @ 250 Hz	TC09
TC10	☑	☑	0.02 dB @ 250 Hz	TC10
TC11	☑	☑	0.02 dB @ 125 Hz	TC11
TC12	☑	☑	0.04 dB @ 500 Hz	TC12
TC13	☑	☑	0.01 dB @ 500 Hz	TC13
TC14	☑	☑	0.04 dB @ 8000 Hz	TC14
TC15	☑	☑	0.06 dB @ 250 Hz	TC15
TC16	☑	☑	0.00 dB @ 2000 Hz	TC16
TC17	☑	☑	0.05 dB @ 500 Hz	TC17
TC18	☑	☑	0.02 dB @ 500 Hz	TC18
TC19	☐	☑	0.77 dB @ 250 Hz	TC19
TC20	☑	☑	0.00 dB @ 8000 Hz	TC20
TC21	☐	☑	0.81 dB @ 63 Hz	TC21
TC22	☑	☑	0.00 dB @ 125 Hz	TC22

Data Assimilation

Measurements:

- Integration / multi-source
- Temporal finesse

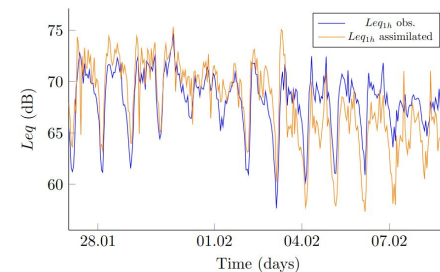


Figure III.9. – time evolution of the observed $LA_{eq,1h}$ and the leave-one-out data assimilation process output for the sensor point colored in black in figure IV.1

Measurements:

- Integration / multi-source
- Temporal finesse

Models :

- Mono-source (road traffic)
- Spatial finesse

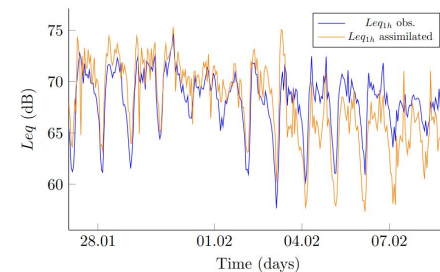


Figure III.9. – time evolution of the observed $L_{eq,1h}$ and the leave-one-out data assimilation process output for the sensor point colored in black in figure IV.1



Figure III.2. – L_{day} level distribution over the study area

Measurements:

- Integration / multi-source
- Temporal finesse

Models :

- Mono-source (road traffic)
- Spatial finesse

Assimilation :

- **Spatial finesse**
- **Temporal finesse**
- **Extraction of the difference between the particular source (road traffic) and the overall sound level - Focus on this difference**

Continuation of work by Antoine Lesieur, 2021, INRIA, UMRAE:

- Optimization calculation
- More applied, transposable to a territory

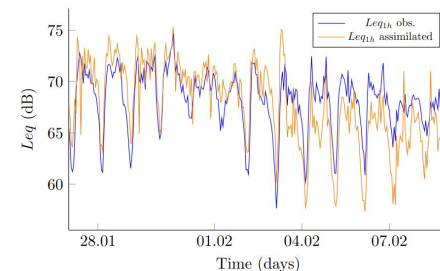
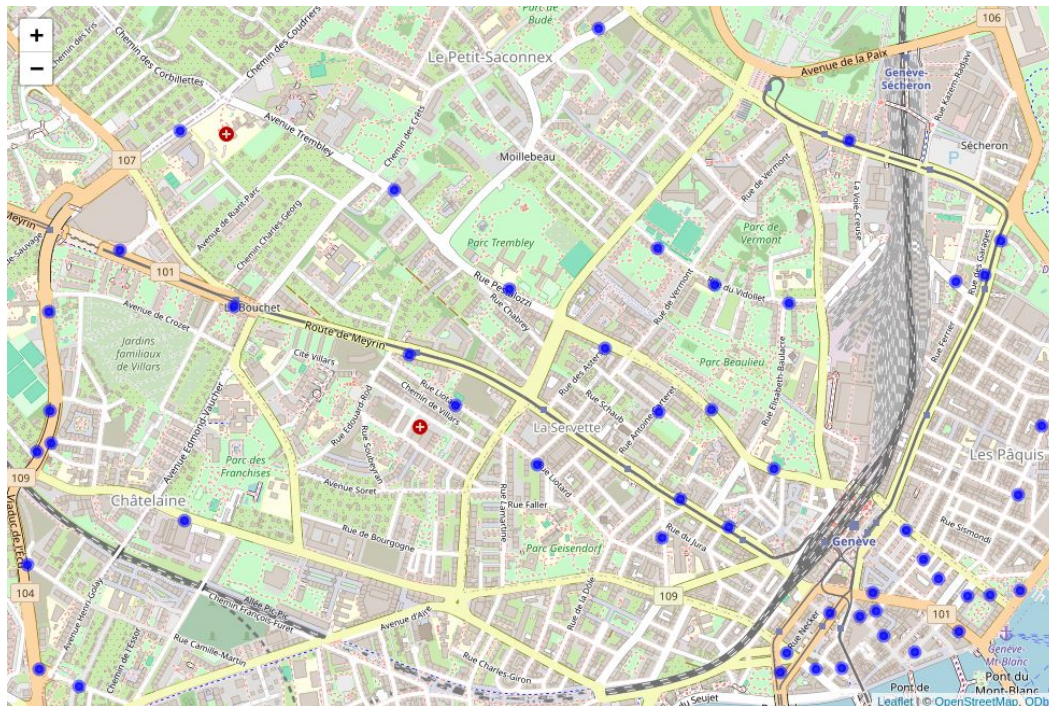


Figure III.9. – time evolution of the observed Leq_{11} and the leave-one-out data assimilation process output for the sensor point colored in black in figure IV.1



Figure III.2. – L_{day} level distribution over the study area

- City of Geneva
- 50 Sampols sensors



Generate a set of 1000 maps with NM

- 4 road types: “primary”, “secondary”, ‘tertiary’, “other”
 - variation (%) around fixed values:
[0.0001, 0.001, 0.005, 0.01, 0.02, 0.04, 0.06, 0.08, 0.10, 0.20, 0.40, 0.80, 1.6, 3.0]
- Temperature: [5, 10, 15, 20, 25]
- This set is generated only on 80% of the **50 sensors/receivers**.

- Total possible combinations: $14^4 \times 5 = 38416 \times 5 = 192080!$
- Removal of incoherent combinations:
 - Smaller road with traffic >> to larger road
 - ex. : “tertiary” >> “primary”
- Latin Hypercube Sampling (LHS) technique:
 - better explore all combinations
 - avoid pure randoms

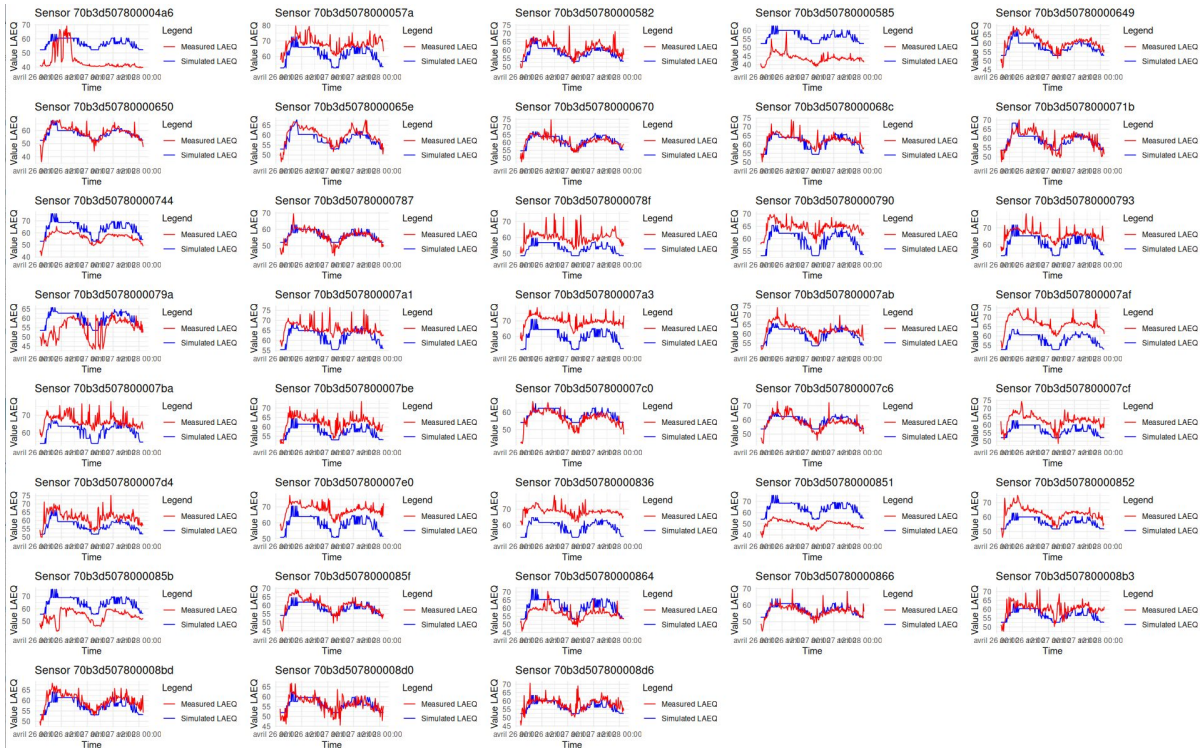
“those that minimize the difference between measurement and simulation.”

$$\min(\text{median}(|\text{simulation} - \text{measurement}|))_{\text{every 15 minutes}}$$

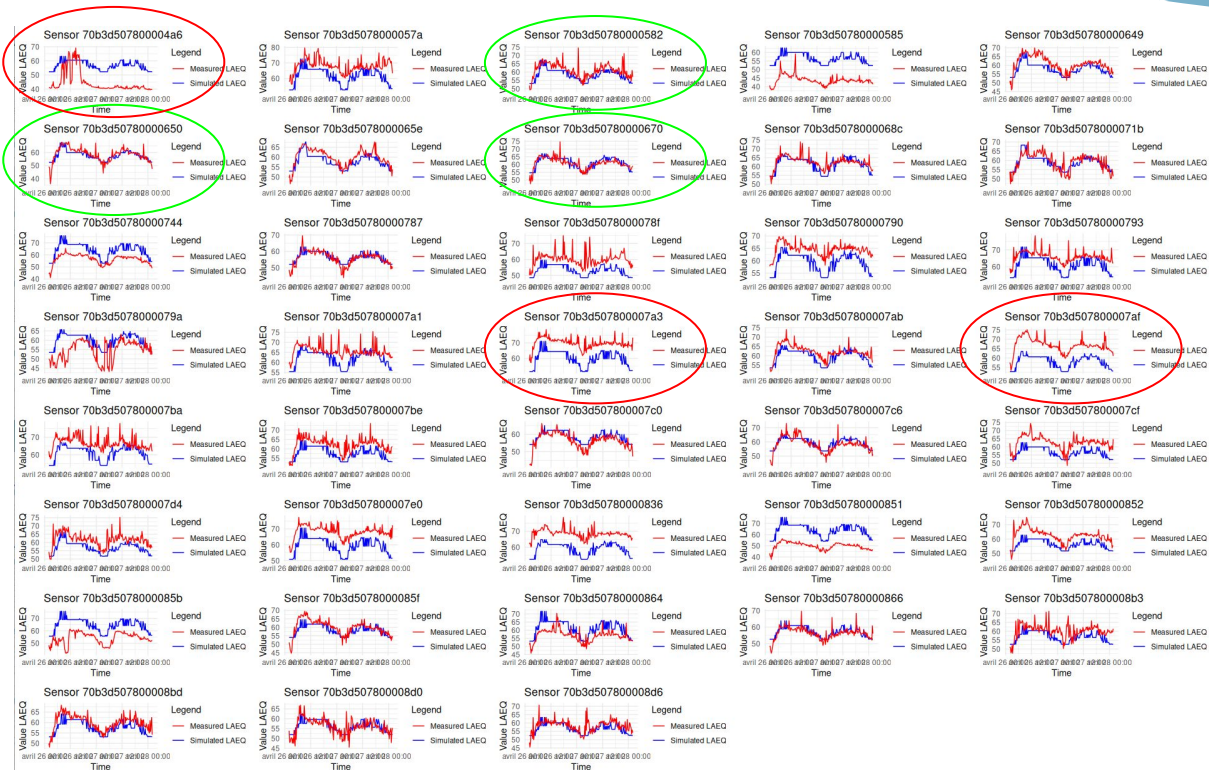
if $T_s^* \in [T_r - \text{seuil}, T_r + \text{seuil}]$

- **step 1:** selection of combinations that minimize the deviation from the 80% of the 50 sensors/receivers
- **step 2:** generation of 192 maps on 34,000** receivers, including the 50 sensors (48h ÷ 15 min)
 - No recalculation of the propagation matrix

Results



Friday midnight to Sunday midnight



Friday midnight to Sunday midnight

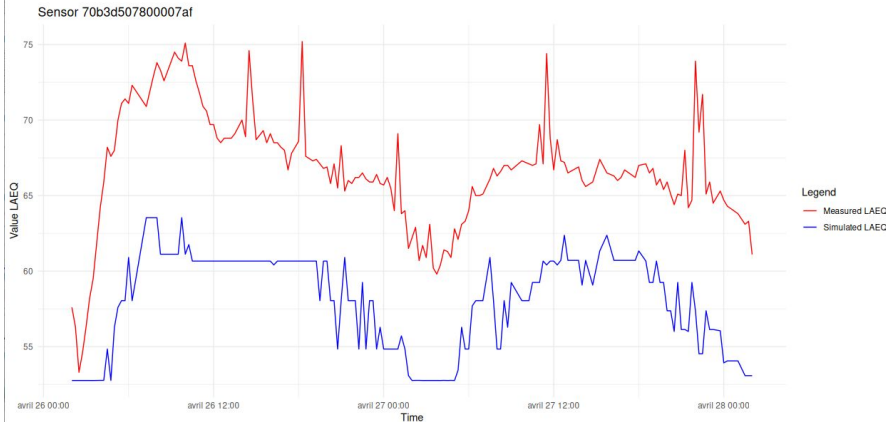
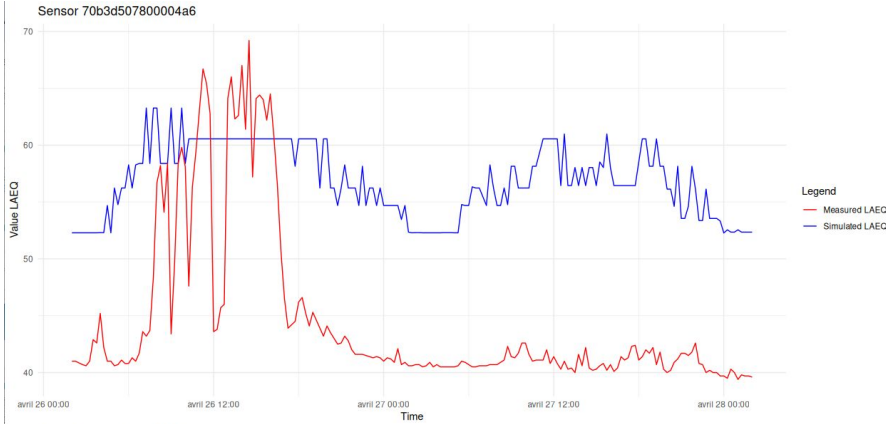
- > Don't worry
- > I'll zoom in!



- Temporal dynamics respected by measurement & simulation
- Lower noise levels at night on Saturday
- ...



- Identification of interesting moment on sensors
Not modelled, therefore probably not in road traffic
Ambulance? Party? Construction work?
- Points of attention for a community
Zooming possible via source recognition, for example

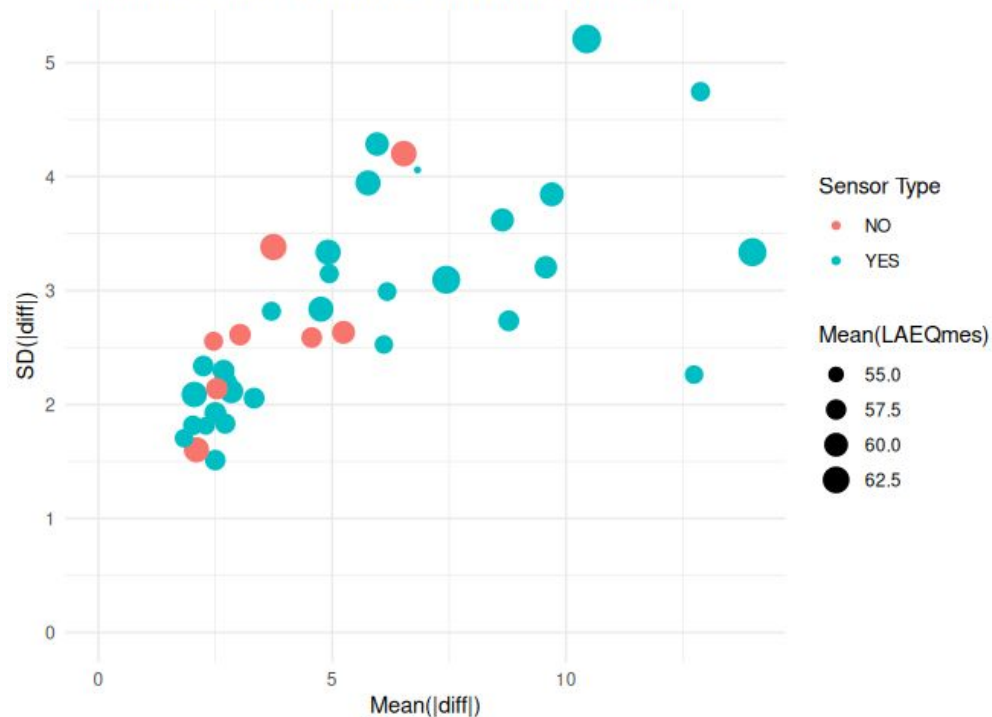


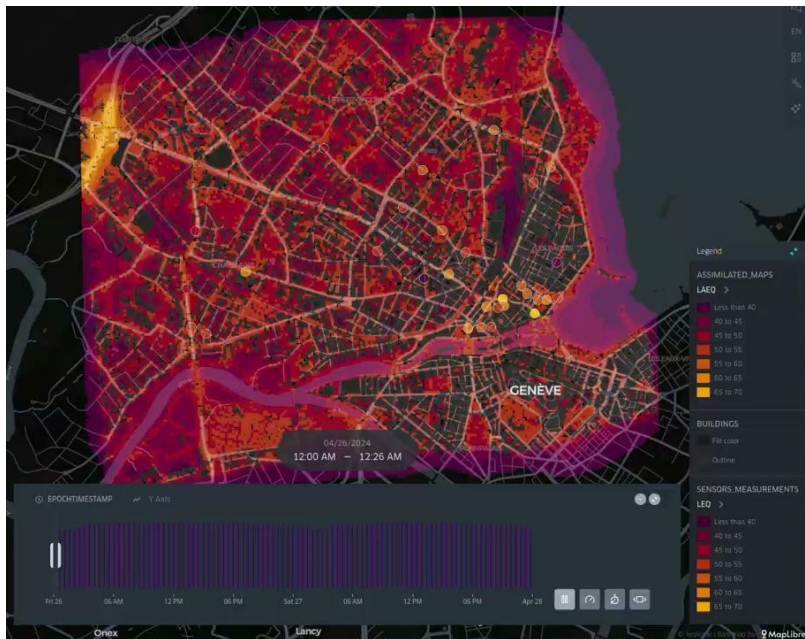
Sensor fault?

Wrong positioning of receiver/sensor?

More detailed analysis required...

Mean vs. SD of $|LAEQ_{mes} - LAEQ_{mod}|$ by Sensor



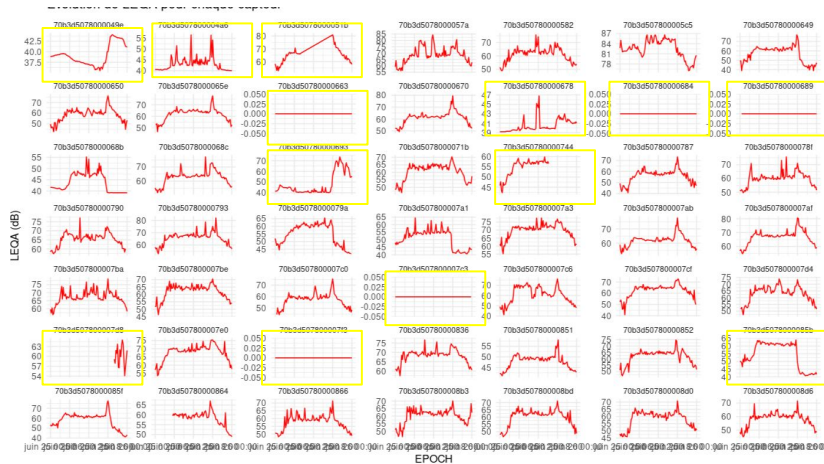


Temporal variations across the city

Approximately 30 minutes on a desktop PC for 48 hours of simulation, 50 sensors and 1000 maps to explore (500 m propagation).

Conclusion and discussion

Data sets: a few sensors sometimes fail!



Sampols 2.0 sensors (in progress)

Optimization of calculation and exploration times

- Improving exploration:
 - more variety in parameters by sector
 - more parameters (ex: % heavy vehicles)
 - Minimization by frequency band between measurement deviations
- Use of calculation server (Slurm protocol)
- Focus on performance evaluation (testing, training)

Everything is directly integrated into NoiseModelling, and the tutorial has already been published.

Thank you all
for listening!

Any questions?

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