Data assimilation
&
Dynamic noise mapping for the city of Geneva

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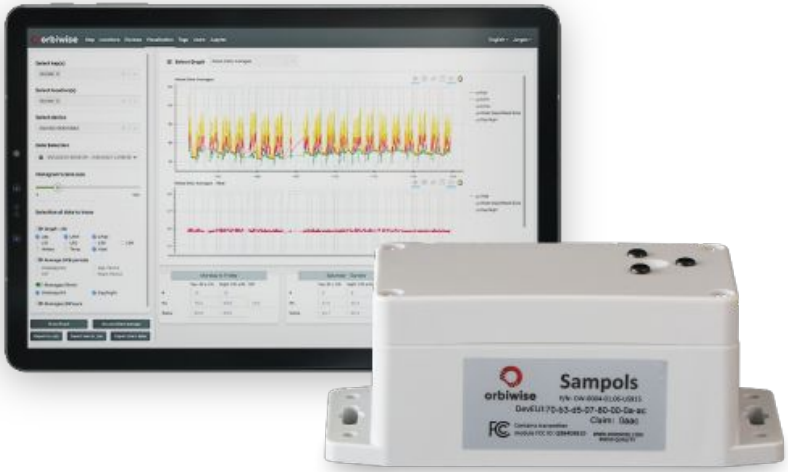
Sommaire

Eureka **SIREN**

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

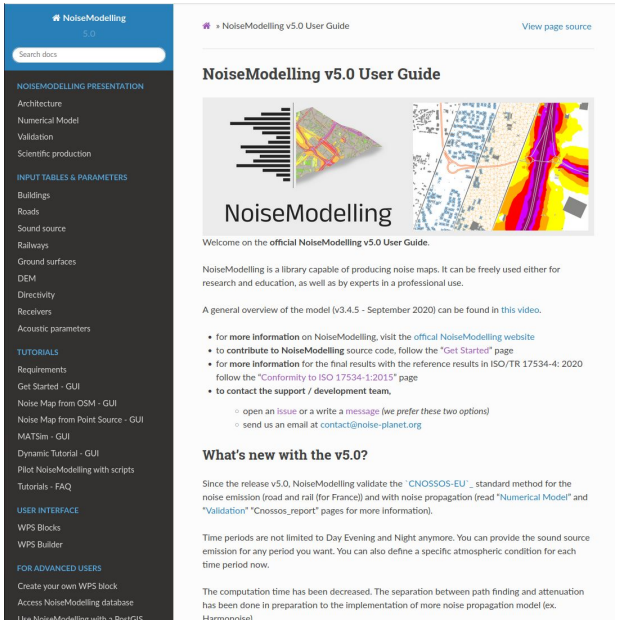
  UMRAE objectives:
  - NM 5.0
  - Data assimilation (15 min.)

  Also but without UMRAE:
  - New sensors
  - Source detection and localization



NoiseModelling 5.0

NoiseModelling



Depuis 2010

Open-Source

Cartographie du bruit
routier
ferroviaire

CNOSSOS-EU

NoiseModelling 5.0

- 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	CNOSSOS 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	Ndeye 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 vehicule 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 !

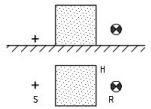
vs ISO/TR 17534-4:2020

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_A in dB over top	4,18	12,34	17,41	20,04	20,11	17,25	9,60	-10,99	25,32
L_A in dB right	-11,56	-4,54	-0,19	0,58	1,91	-1,23	-9,56	-33,31	6,94
L_A in dB left	2,27	10,29	15,24	17,77	17,79	14,90	7,22	-14,29	23,05
L_A 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

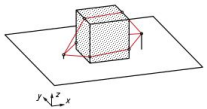


Figure 18 — 3D-presentation of scenario TC10

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 the deviate more than ±0,1 dB
NLD Conform - Do not the deviate more than ±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

https://noisemodelling.readthedocs.io/en/latest/Cnossos_Report.html

Data Assimilation

Context

Measurements:

- Integration / multi-source
- Temporal finesse

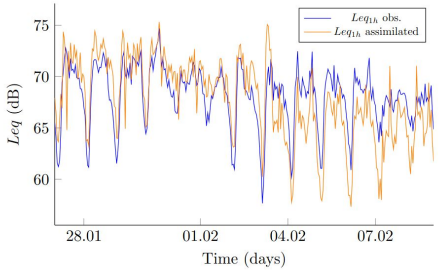


Figure III.9. – time evolution of the observed $LA_{eq,1h}$ and the leave-one-out data assimilation process output for the sensor point colored in black in figure IV.1

Context

Measurements:

- Integration / multi-source
- Temporal finesse

Models :

- Mono-source (road traffic)
- Spatial fineness

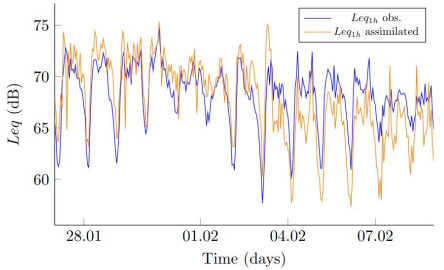


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Figure III.2. – L_{day} level distribution over the study area

Context

Measurements:

- Integration / multi-source
- Temporal finesse

Models :

- Mono-source (road traffic)
- Spatial fineness

Assimilation :

- **Spatial fineness**
- **Temporal fineness**
- **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*

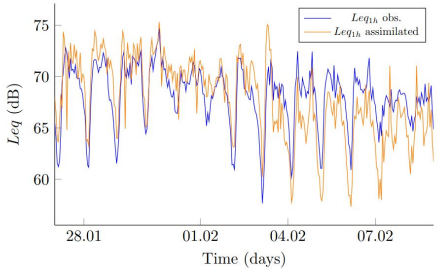

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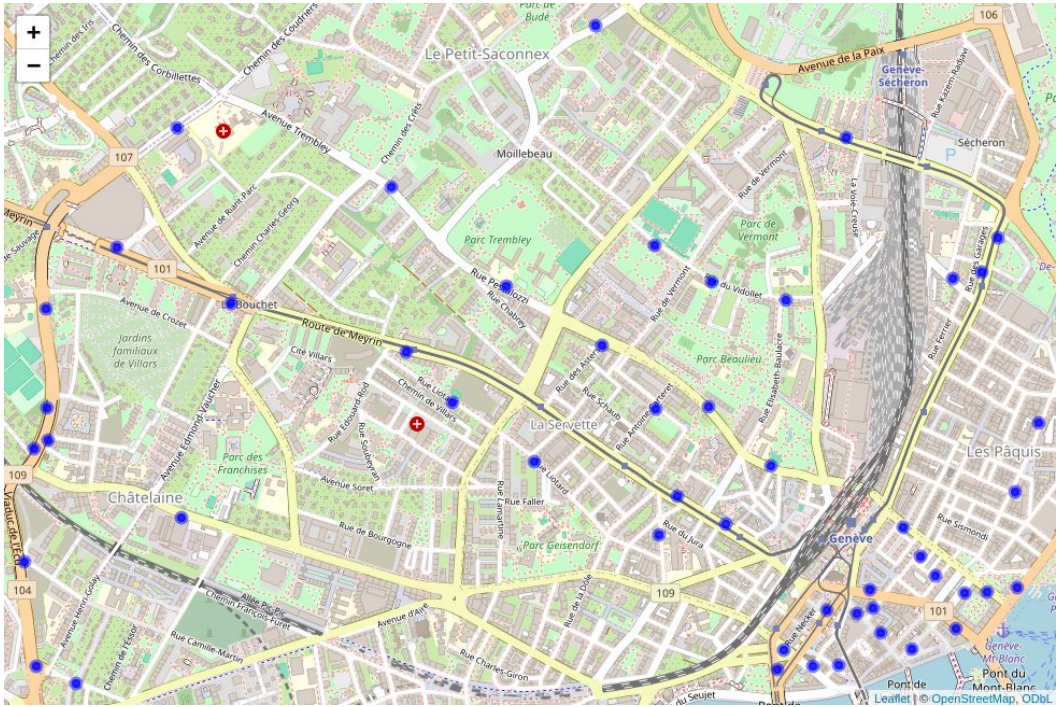
Figure III.2. – L_{day} level distribution over the study area

Study case

- City of Geneva
- 50 Sampols sensors



Set of maps

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**.

Choose from 1000 combinations

- Total possible combinations: $14^4 \times 5 = 38416 * 5 = 192080$!

- 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

Choosing the best card / 15 min.

"those that minimize the difference between measurement and simulation."

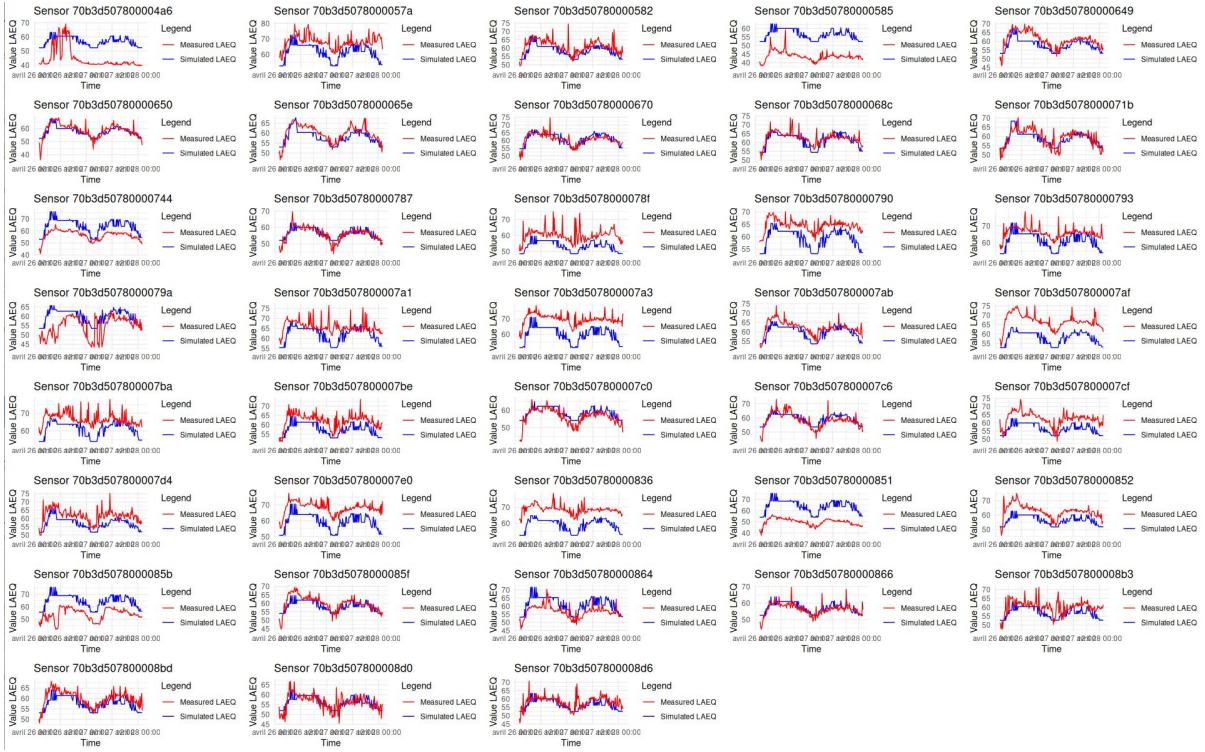
min(median(|simulation - measurement|))every 15 minutes
if Ts* ∈ [Tr−seuil,Tr+seuil]

- **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

** Ts = simulated temperature; Tr= real temperature*
*** every 20 m + at station locations*

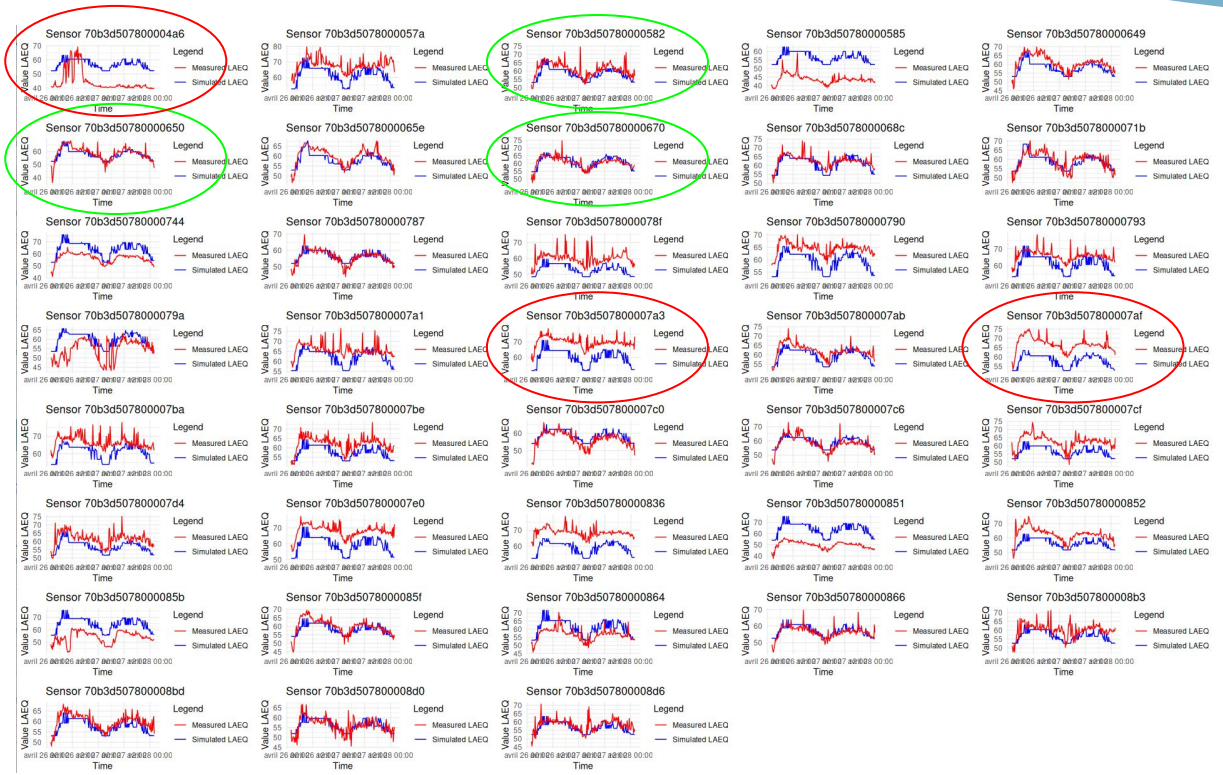
Results

On all sensors



Friday midnight to Sunday midnight

On all sensors



Friday midnight to Sunday midnight

> Don't worry

> I'll zoom in!

Fine Receivers !

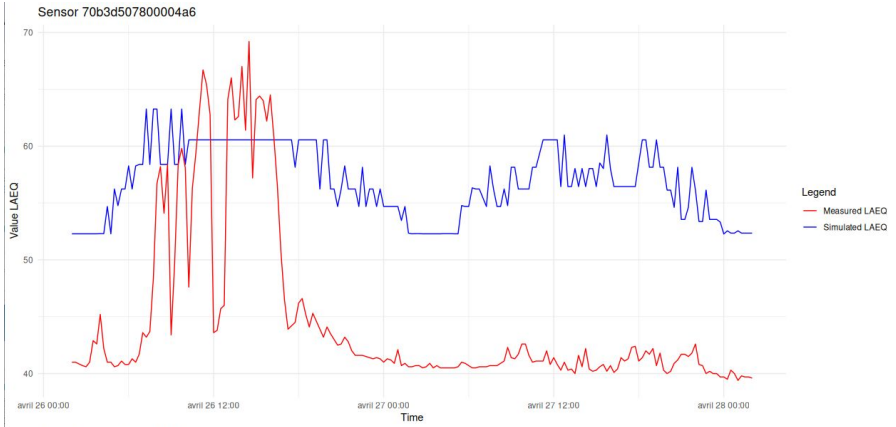
- Temporal dynamics respected by measurement & simulation
- Lower noise levels
  at night
  on Saturday
  ...

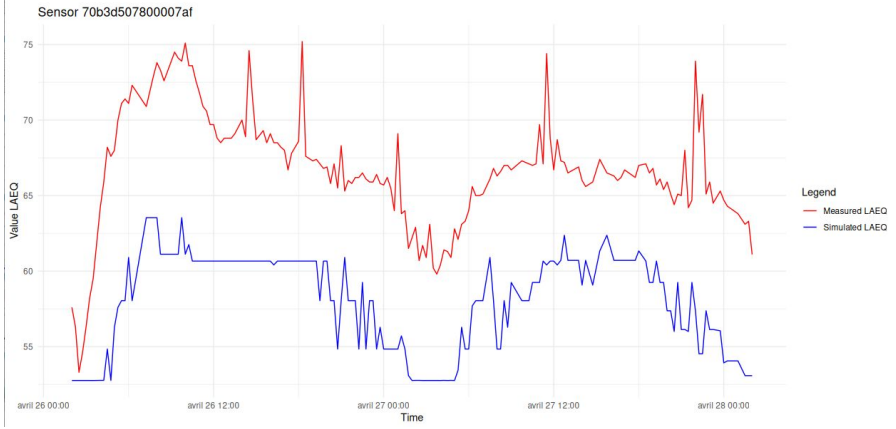
Fine Receivers!

- 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

Receivers much less ok!



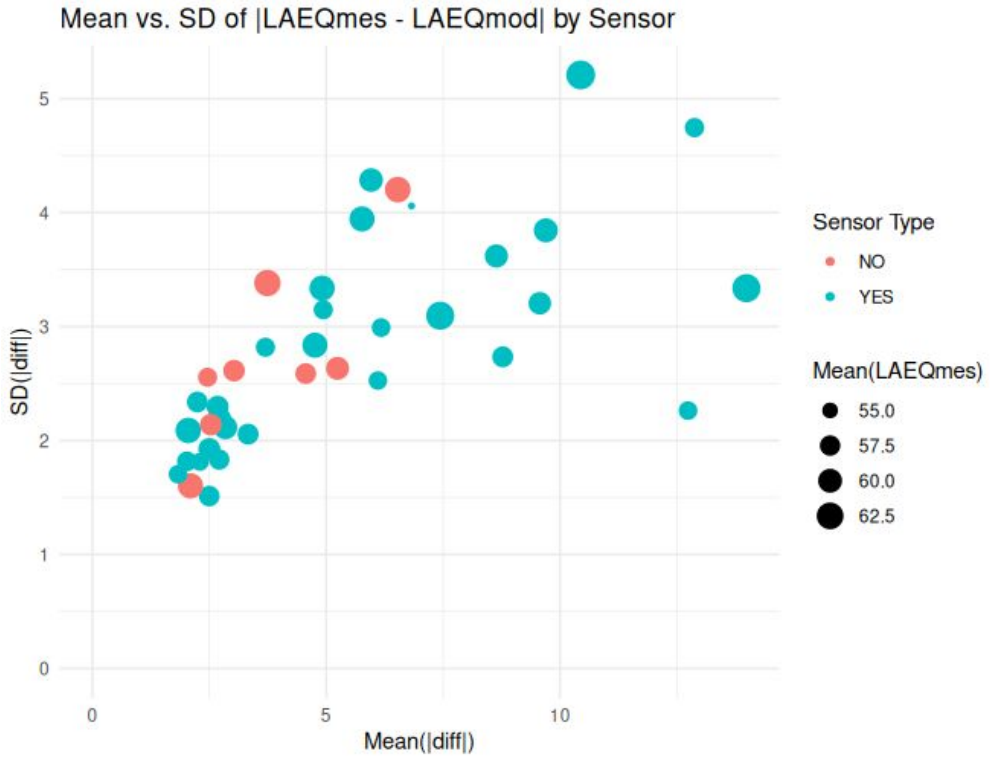


Sensor fault?

Wrong positioning of receiver/sensor?

More detailed analysis required...

Training vs Test



- 80% Training data (YES)
- 20% Test data (NO)

- Good news: no particular behavior for test data

- But: need to better understand what's happening sensor by sensor

Dynamic noise map

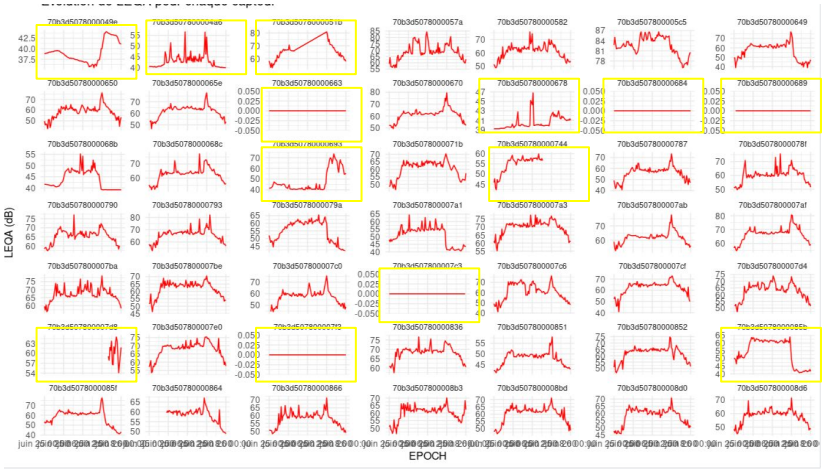
Temporal variations across the city

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

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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