TOWARDS A COMPREHENSIVE NOISE ASSESSMENT IN SPAIN: OPEN DATA, OPEN SOURCE, SUPERCOMPUTING

Noise-Planet
umr ae
Université Gustave Eiffel
Cerema
cnrs
GOBIERNO DE ESPAÑA
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
Plan de Recuperación, Transformación y Resiliencia

Lack of a Comprehensive View on Noise Pollution in Spain

In Spain (and likely across Europe), there is no full understanding of how **noise pollution** impacts citizens' quality of life and terrestrial ecosystems.

Strategic Noise Maps (SNMs – 4th Round) only cover:

- Agglomerations > 100,000 inhabitants (**64**)
- Roads > 3 million vehicles/year (**21,000** km)
- Railways > 30,000 trains/year (**1,800** km)
- Airports > 50,000 operations/year (**13**)

Missing data in cities below END scope

- **87** cities (50k–100k people)
- **613** cities (10k–50k)
- **2,381** towns (1k–10k)
- **4,986** towns (<1k)

Other sources excluded from END

- **154,000** km of roads
- **21,770** km of railways
- **1,136** aircraft facilities
- **9,067** industrial facilities
- **22,000** wind turbines
- **49** state ports

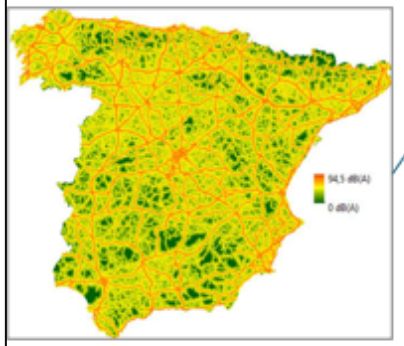
Supra-strategic Assessment of Global Noise in Spain

SNM END

Reference Dataset

Calibration

CALIBRATED MAP



Sources below END Threshold

Agg<100,000

Inf<END

Roads <3M

Railway <30mil

Airports <50mil

Other

Industry

Ports

Wind turbines

?

CALCULATED MAP

OWN SOFTWARE

CALCULATED MAP

RECEIVERS

Natural habitats

Human population

Other sensitive receptors

RECEIVERS

No Modellable sources

Results and conclusions

NoiseModelling Days 2025

ROAD MAP

Cartographic Source Data

All from CNIG official datasets:

- **Road Network**
- **BTN (Topographic DB)**
- **DTM**: Digital Terrain Model (1:25,000 scale)
- **DSM (MDSnE2.5)**: for building heights

Emission Source Data

Ministry of Transport's **open traffic datasets** (main roads)

Good Practice Guide used for roads lacking traffic data

CNOSSOS-EU **reference pavement** assumed for all roads

Calculation Process

- Area split into **1,058 subdomains** (scale 1:25,000)
- NoiseModelling + custom **Python automation scripts**
- **Triangulation mesh**: max 50 m spacing (2,500 m^2)
- **Delaunay algorithm**: denser near buildings
- Output: **Raster noise maps** via interpolation of results

- Intel® Xeon® w9-3475X @2.21 GHz
- 512 GB RAM

3 months

Calibration Process

Calibration using **official SNMs** from 12 Spanish cities

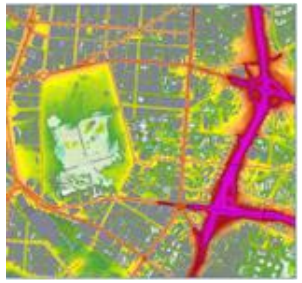
- 8.7 million matched point-pairs used

Linear regression applied to adjust model output

- **Original model overestimated by ~3.6 dB on average**

Result: Calibrated LAEQCal closely aligns with reference values

- **Calibrated model underestimated by ~1.96 dB on average**



Statistic	LAEQ_Ref (dB)	LAEQ (dB)	LAEQ_Cal (dB)
Mean	56.17	59.75	54.22
Median	57.00	58.98	53.51
Std. Dev	10.60	11.85	10.41
Min	31.00	30.00	30.00
Max	101.00	96.80	86.68
	Mean error:	3.6 dB	→ 1,96 dB

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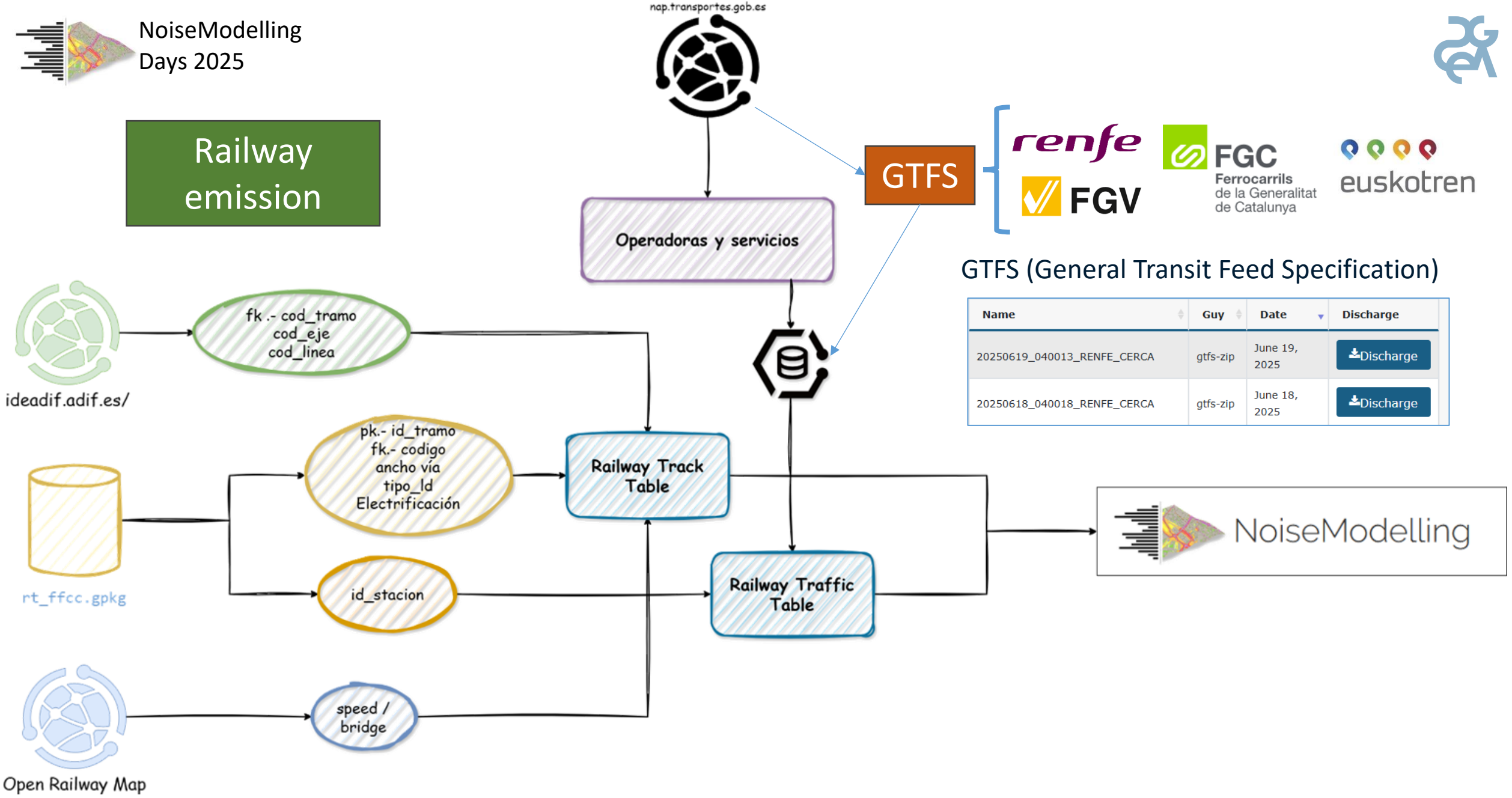
NoiseModelling
Days 2025

Railway emission



GTFS (General Transit Feed Specification)

Name	Guy	Date	Discharge
20250619_040013_RENFE_CERCA	gtfs-zip	June 19, 2025	Discharge
20250618_040018_RENFE_CERCA	gtfs-zip	June 18, 2025	Discharge

AIRCRAFT NOISE

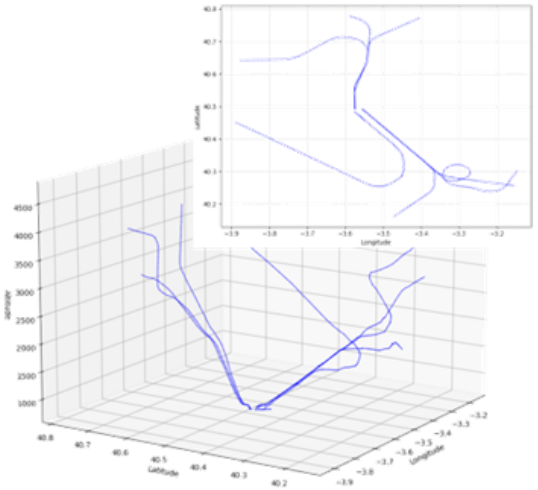
Flight data

ADS-B Exchange

OPENSKY NETWORK

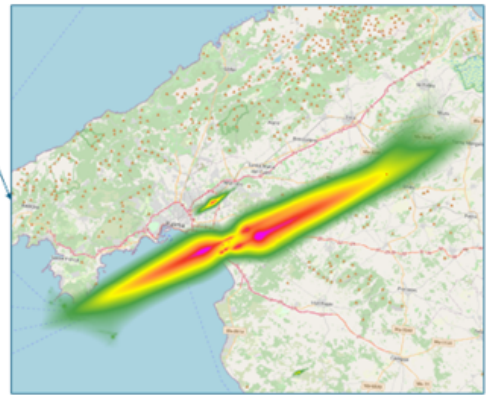
Field	OpenSky	ADSB Exchange
icao24 / icao	✅	✅
callsign / flight	✅	✅
latitude	✅	✅
longitude	✅	✅
baro_altitude	✅	✅
geo_altitude	✅	✅
velocity / gs	✅	✅
heading / track	✅	✅
vertical_rate	✅	✅
on_ground	✅	✅
timestamp	✅	✅
origin_country	✅	❌
category	❌	✅

Segmentation



Variable	r	Mean Diff.
λ (ft)	1.000	0.000
d_p (ft)	1.000	0.063
d_1 (ft)	1.000	0.343
d_2 (ft)	1.000	0.349
q (ft)	1.000	-0.171
Lat_displ (ft)	1.000	0.058
d_NPD (ft)	1.000	0.065
$Thrust_p$ (lb/e)	0.993	-42.960
β (°)	0.950	1.315
γ (°)	1.000	0.000
ϕ (°)	0.947	1.281
θ_bank (°)	1.000	0.000

Noise calculation



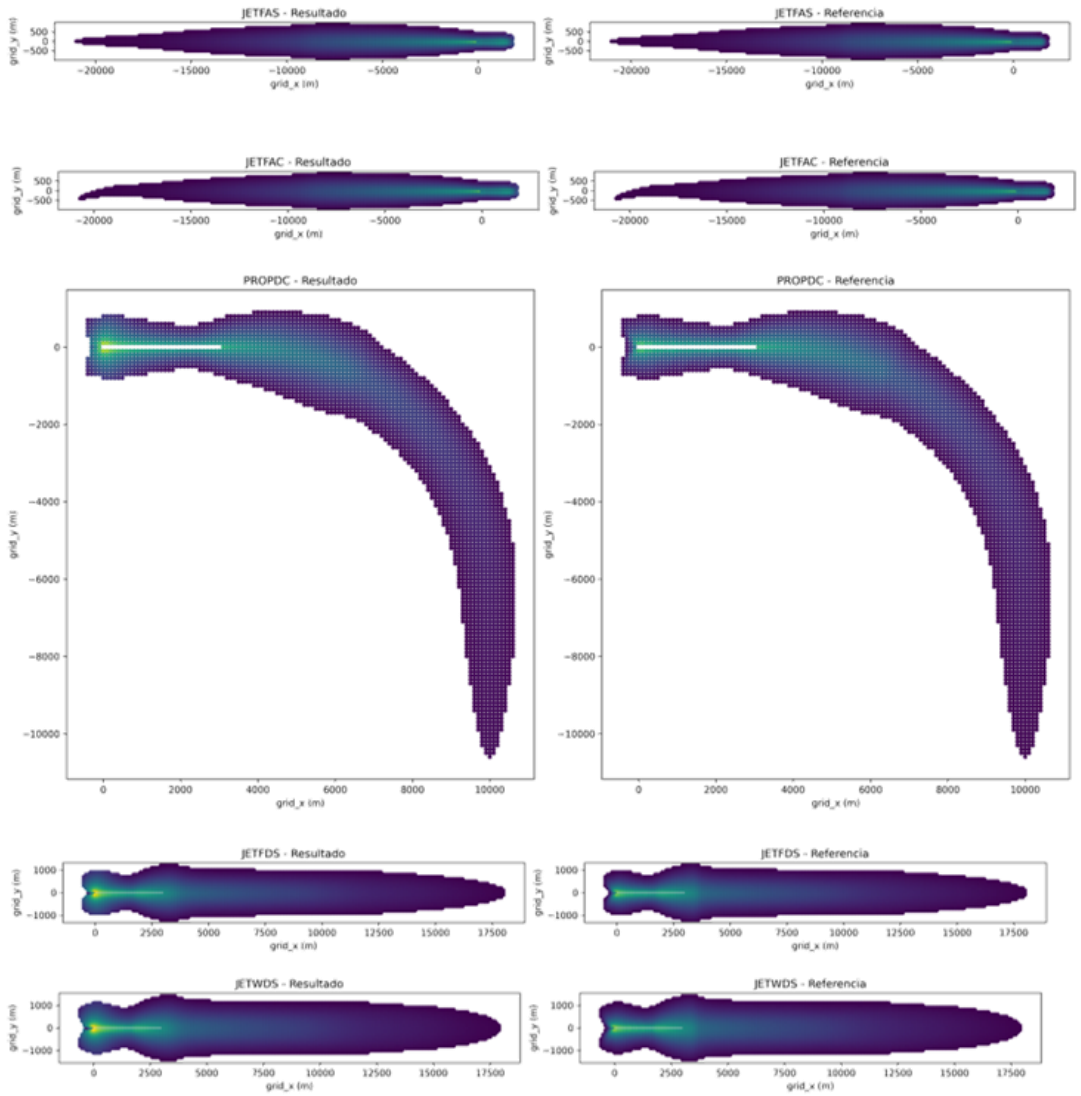
Variable	r	Mean Diff.
SEL_base (dB)	0.997	0.245
ΔI(ϕ) (dB)	0.822	0.148
Λ(β, ℓ) (dB)	0.943	-0.245
ΔV (dB)	0.976	0.740
ΔF (dB)	0.985	-0.979
ΔSOR (dB)	–	0.255
ΔImp (dB)	–	-0.070

Variable	r	Mean Diff.
δ_RMS (dB)	0.986	2.4883
Mean Diff. (dB)	–	0.333
Std Dev. (dB)	–	2.462

AIRCRAFT NOISE

MODELLED

REFERENCE ECAC 29



Case ID	r	Mean dB Diff.	δ_{RMS}
Global results	0.9738	0.1591	1.1897
JETFAC	0.9945	-0.1153	0.5211
JETFAS	0.9934	-0.1406	0.5774
JETFDC	0.9576	0.3253	1.6169
JETFDS	0.9579	0.3191	1.6150
JETWAC	0.9940	-0.0387	0.5292
JETWAS	0.9939	-0.0408	0.5305
JETWDC	0.9581	0.3975	1.6350
JETWDS	0.9583	0.3766	1.6332
PROPAC	0.9982	-0.0013	0.2805
PROPAS	0.9982	-0.0040	0.2805
PROPDC	0.9688	0.3343	1.4129
PROPDS	0.9686	0.2947	1.4131

Globally, an RMS Difference (δRMS) of 1.1897 dB for the entire set of cases, with a correlation of 0.9738 and a mean difference of 0.1591 dB.

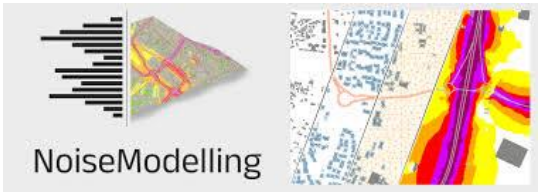
Next Steps

Access to Supercomputing (we have applied)

If granted, we will:

- **Refine the Digital Terrain Model (DTM)**
- **Increase the receptor point density**

  → Higher spatial resolution and modelling accuracy



Traffic Modelling Improvements (ongoing)

Development of a **more precise traffic model, with open data available.**

Tools in use:

- **OSMnx**: for extracting and analysing road networks from OpenStreetMap
- **SUMO** (**S**imulation of **U**rban **MO**bility): for traffic simulation and dynamic assignment, from Open Data MITMA

Thank you very much

Ignacio Soto Molina

Program Director - Environmental Noise

General Directorate of Environmental Quality and Assessment

Ministry for Ecological Transition and the Demographic Challenge, Spain

isoto@miteco.es