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RESPIRE

HERMES_Δ: bridging the gap between official inventories and model-ready emissions for air quality modelling applications

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TFEIP 2026 Meeting (Copenhagen, 11-13 May 2026)

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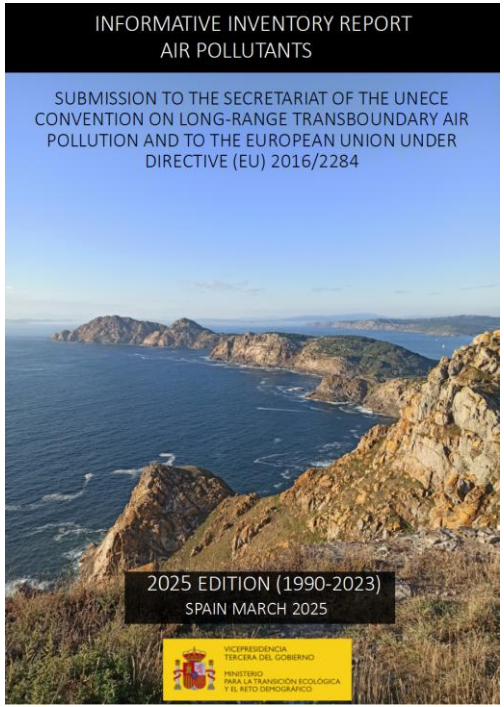
high-Resolution air Emissions System to suPport modelllng and monitoRing Efforts

Spanish Emissions Inventory System

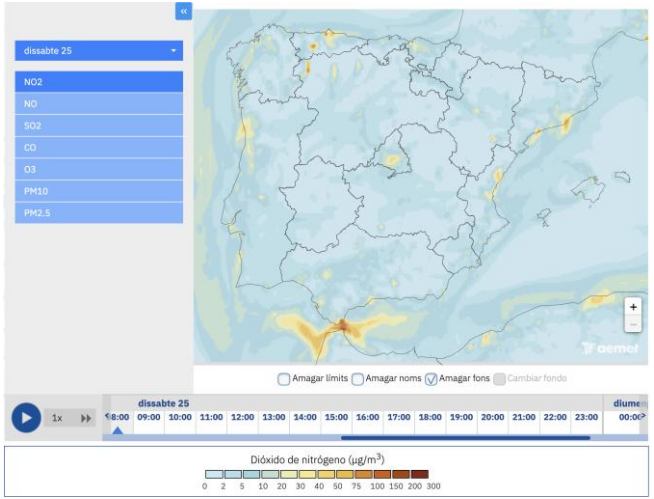


Fulfil air quality modelling input requirements (gridded, vertical, temporal, speciated)

HERMES_Δ

Provide feedback to inventory compilers (modelled versus observed concentration)

AEMET national air quality forecast



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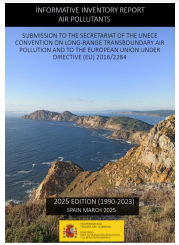
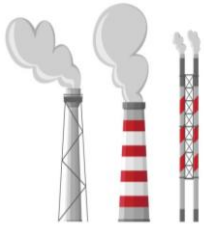
HERMES_Δ: High-Elective Resolution Modelling Emission System, version Delta

Official inventories

CLRTAP



L P S



PRTR España — Pollutant Release and Transfer Register

- NUTS-2 & facility level
- Refined SNAP/NFR* sectorial classification (~ 630 emission sources)
- NO_x, NMVOC, SO_x, CO, NH_3, PM_{10}, $PM_{2.5}$, BC, BaP

Proxies & profiles

- **Horizontal**: ~140 spatial proxies
- **Temporal**: ~650 monthly, weekly and hourly profiles
- **Vertical**: stack height and sector-dependent vertical profiles
- **Speciation**: splitting NMVOC, NO_x and $PM_{2.5}$ into chemical mechanism species

Ready-to-use emissions for modelling

Compatible with MONARCH, CHIMERE, MOCAGE, CMAQ, WRF-CHEM 3D air quality models + R-LINE gaussian model

Iberian Peninsula

Canary Islands

(*) Shipping, other countries and forest fires: processing of CAMS emissions using HERMES_GR (Guevara et al., 2019)

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* *Use of the EMEP-CEIP mapping table*

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Spatial mapping

Processing of the LPS and PRTR-Spain official point source databases:

- Review of the original geographical coordinates (feedback to MITECO)
- Assignment of SNAP/NFR code to each PRTR-Spain facility (via Integrated Environmental Authorizations)
- Gapfilling of missing PRTR-Spain emissions (pollutants below information threshold)
- Remove duplicates between LPS y PRTR-Spain (giving preference to LPS)

Share of total GNFR_A + GNFR_B emissions directly allocated to specific industrial facilities

	NO_x	$PM_{2.5}$
EMEP	69%	23%
HERMES_Δ	94%	69%

EMEP: LPS
HERMES_Δ : LPS+PRTR+in-house point source catalogue

LPS+PRTR-Spain NOx (2023)

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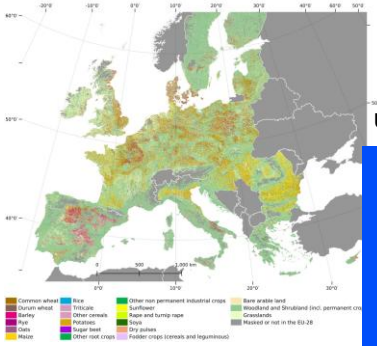
Spatial mapping

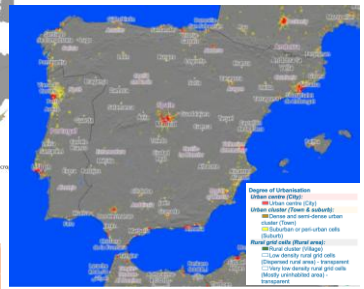
- Building on state-of-the-art global and European + national (existing and in-house) georeferenced proxies
- HERMES_Δ allows a flexible mapping to multiple:
  - Projections (regular lat-lon, rotated lat-lon, lambert conformal conic)
  - Resolutions (recommended up to 1km + link-level for road transport emissions)

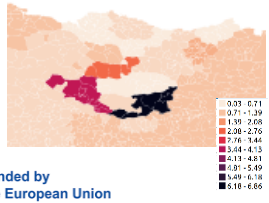
Global-EU proxies

EUCROPMAP
21 crop types at 10m



GHSL
Population density & urbanisation degree (1km)

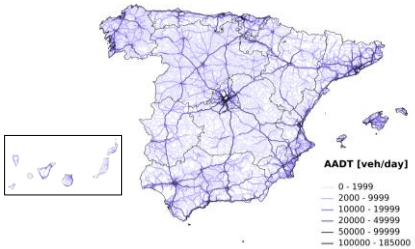




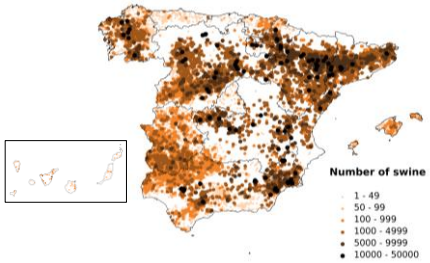
Households using biomass as main domestic heating fuel

National existing proxies

Interurban & rural road network (AADT)



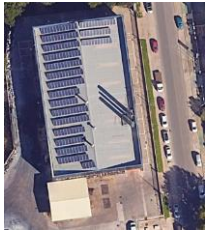
REGA Farms (n° animals)



National in-house proxies

Biogas plants

District heating plants



Fuel storage

Composting plants

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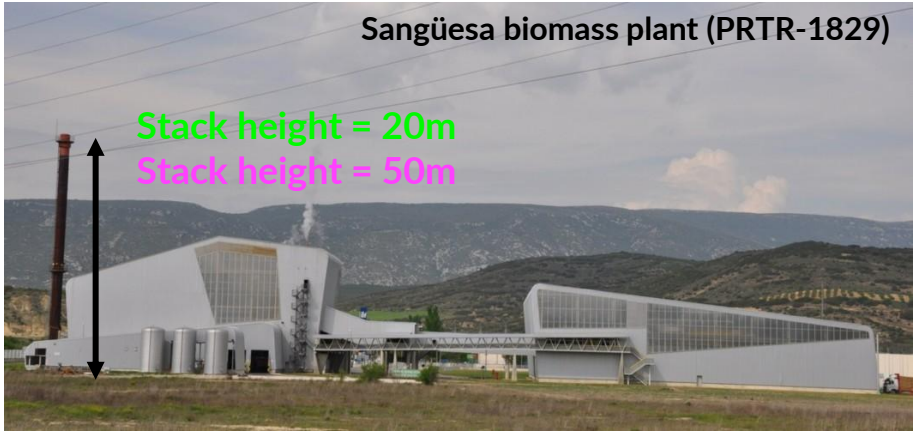
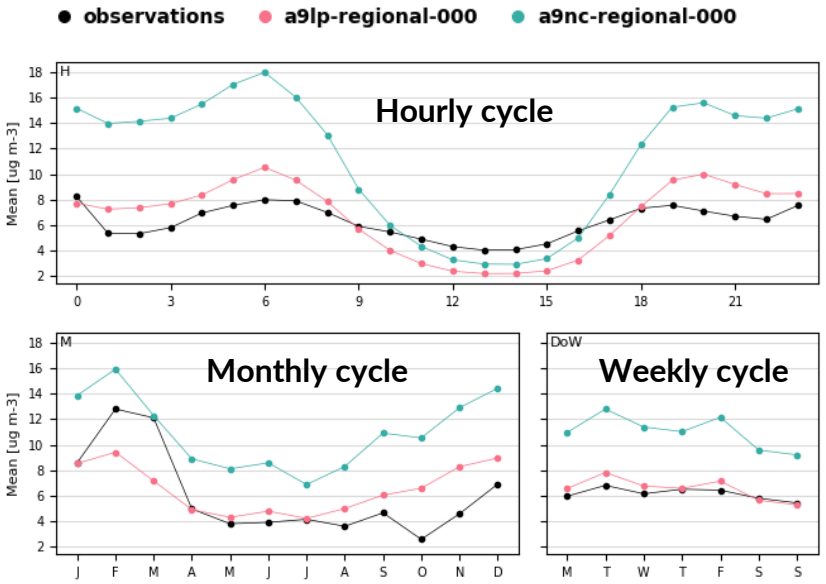
Vertical distribution

- **Point sources**: stack height[1] × plume rise factor[2]
- **Diffuse sources**: vertical profiles from literature
  - Guevara et al. (2020) for LTO cycles in airports
  - Bieser et al. (2011) for industrial diffuse sources
  - Grythe et al. (2019) for residential combustion



NO_2 mod vs obs levels (ES1755A , 2023)



[1] *Facility-dependent*
[2] *Based on Pregger and Friederich (2009)*

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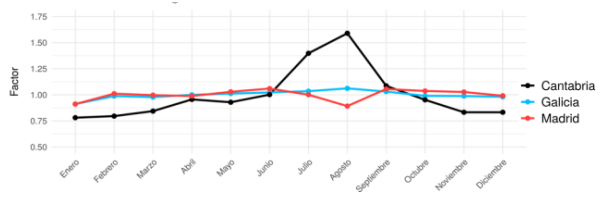
Temporal distribution

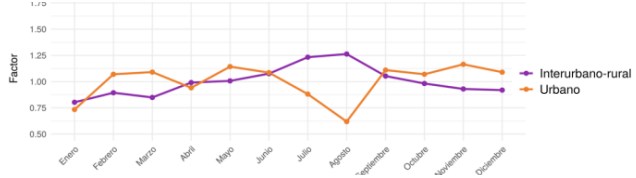
Original annual emissions broken down into hourly resolution

- Use of NUTS2 and sector-dependent monthly/weekly/hourly profiles to represent sociodemographic & climatological influences
- Possibility of using day-of-the-year profiles (e.g., based on heating degree days for residential combustion emissions)
- Automatic identification of **national** and **regional** holidays (treated as Sunday day type)

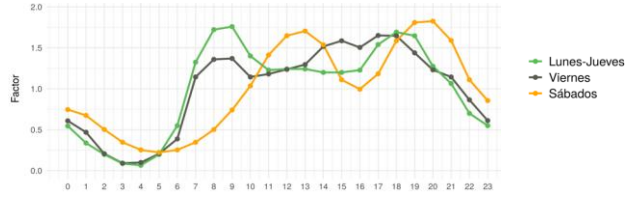
NUTS2-dependent monthly interurban profiles



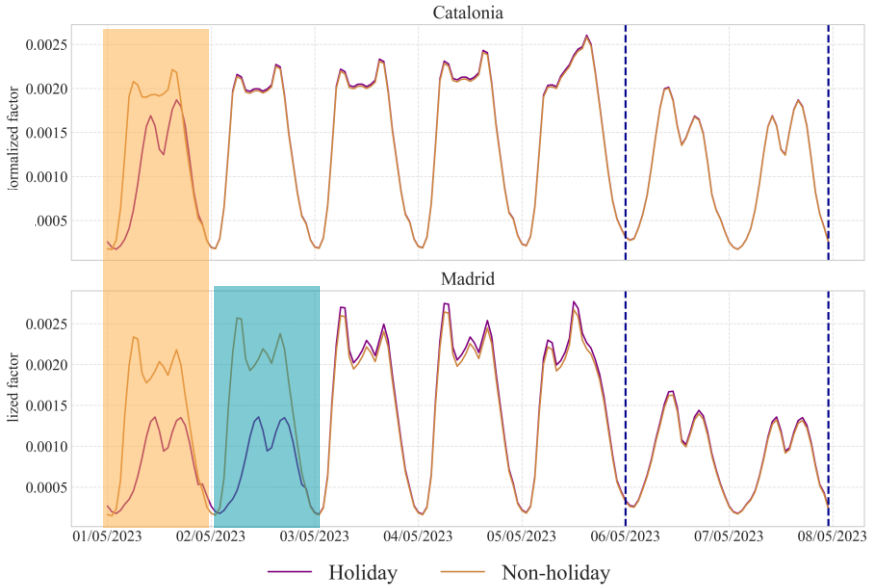
Interurban versus urban monthly profiles (Valencia)



DoW-dependent urban hourly profiles (Catalonia)



Hourly temporal weight factors for road transport



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Speciation

A flexible two-step approach to go from reported pollutants to chemical mechanism species

Reported emission pollutants

- NMVOC
- NO_x
- $PM_{2.5}$

1. Split to individual chemical species

- Nitrogen monoxide
- Nitrogen dioxide
- Black carbon
- Organic carbon
- Ethylbenzene
- Toluene
- Benzene
- n-butane

.... (> 800 species)

Use of ~150 sector-dependent NMVOC speciation profiles (Oliveira et al., 2025)

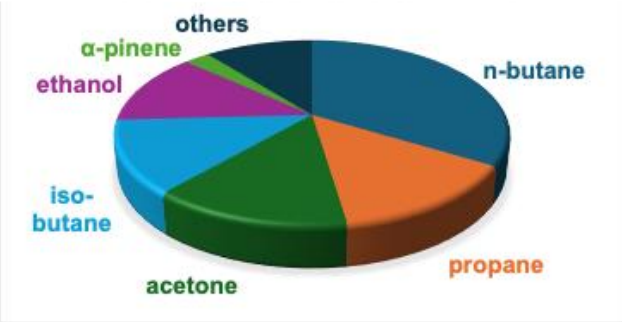
2. Mapping to chemical mechanism species

- Carbon Bond 5 & 6
- MELCHIOR
- CRACMM 1 & 2
- RACM
- explicit

Use of mapping tables (e.g., Carter et al., 2010)

Possibility to add additional chemical mechanisms

NMVOC split: Domestic use of solvents



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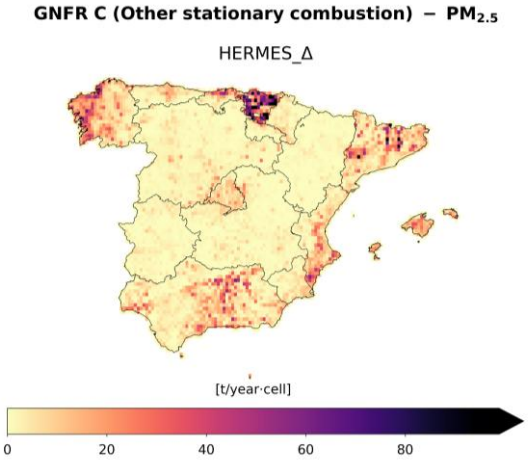
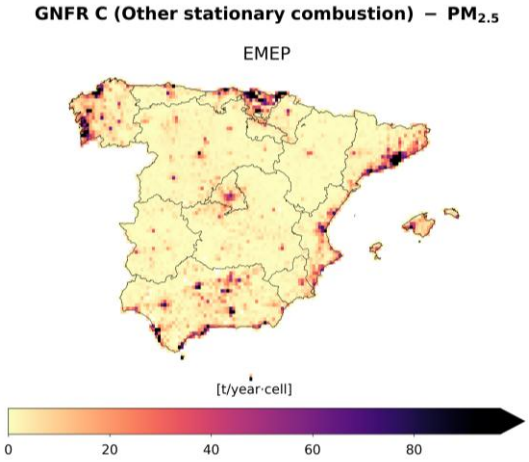
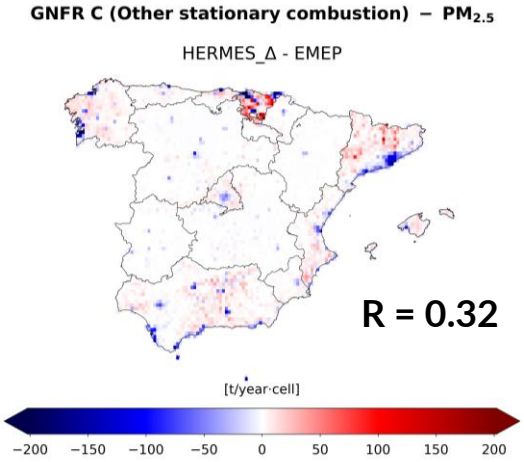
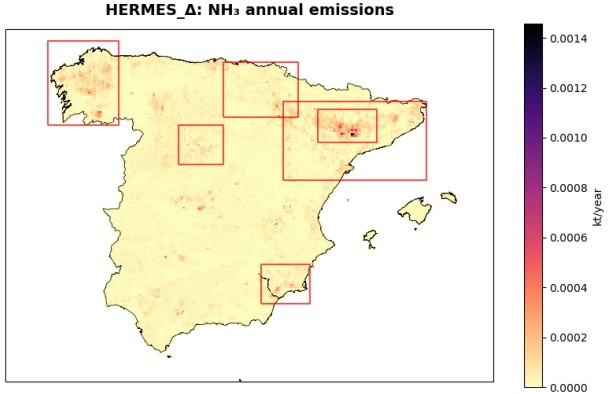
Comparison against state-of-the-art bottom-up and satellite-based inventories

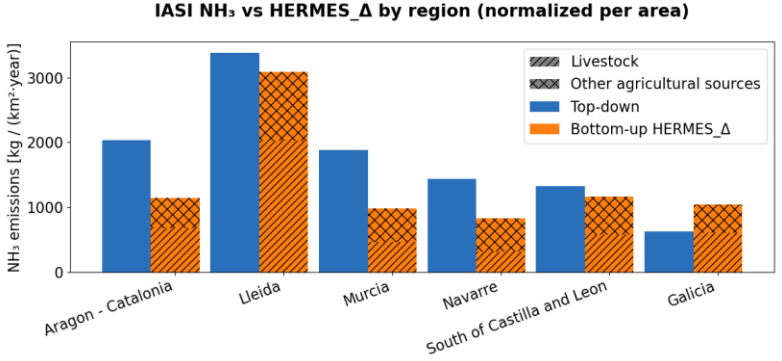






R = 0.32





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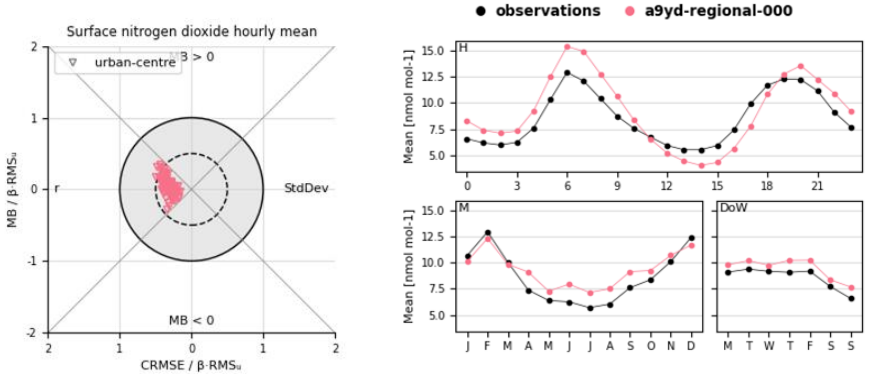
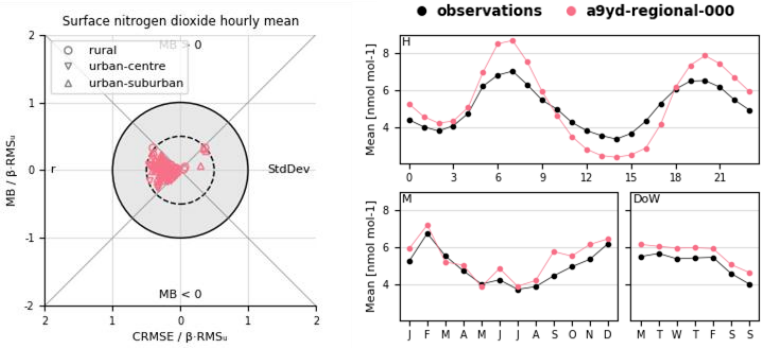
Indirect evaluation using air quality models and observations

NO_2

Urban background stations (n = 75)

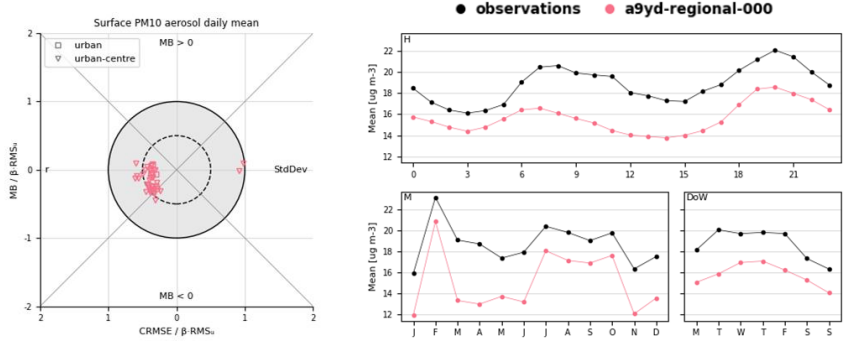


Industrial stations n = 122

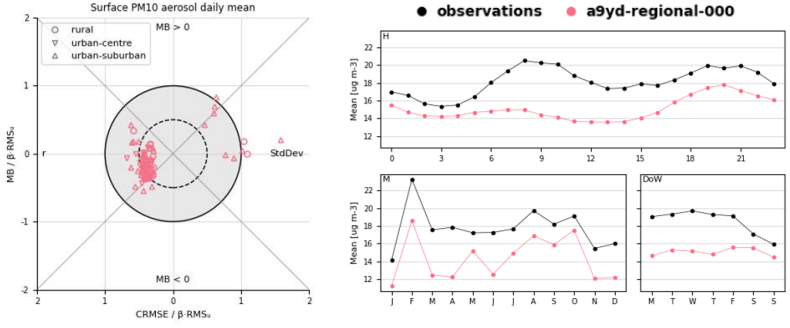


PM_{10}

Urban background stations (n = 50)



Industrial stations (n = 100)



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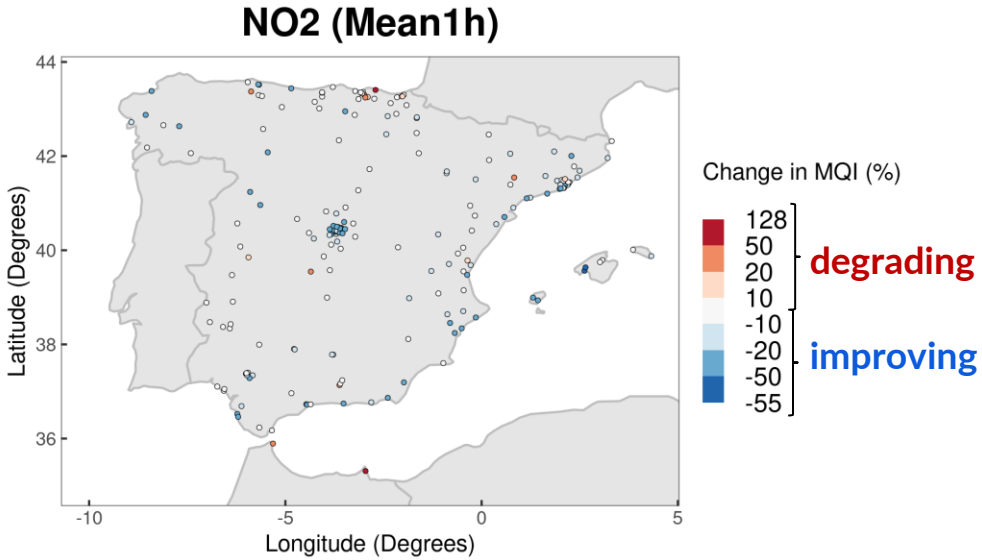
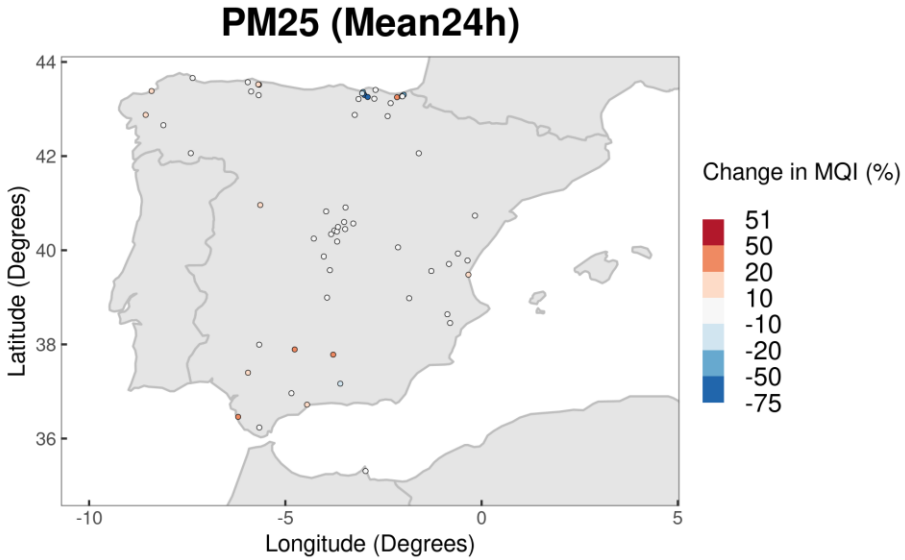
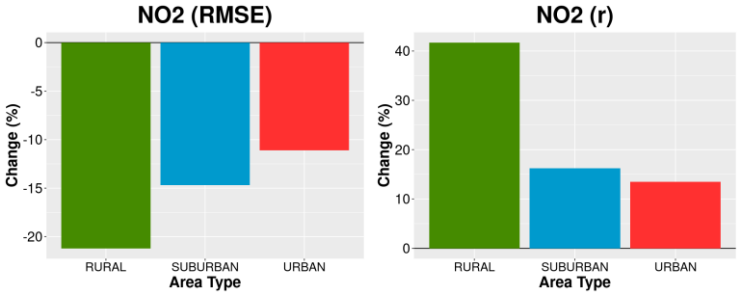
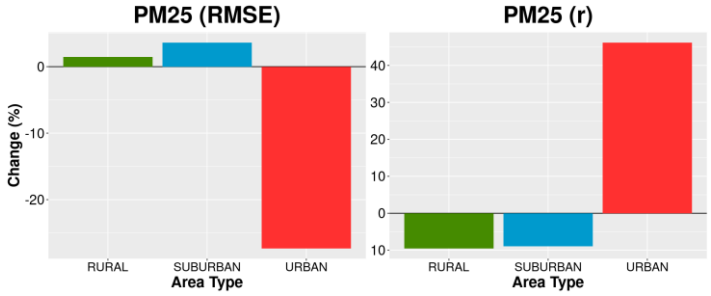
Indirect evaluation using air quality models and observations

Is the performance of the model improving or degrading when compared to the use of the EMEP inventory?







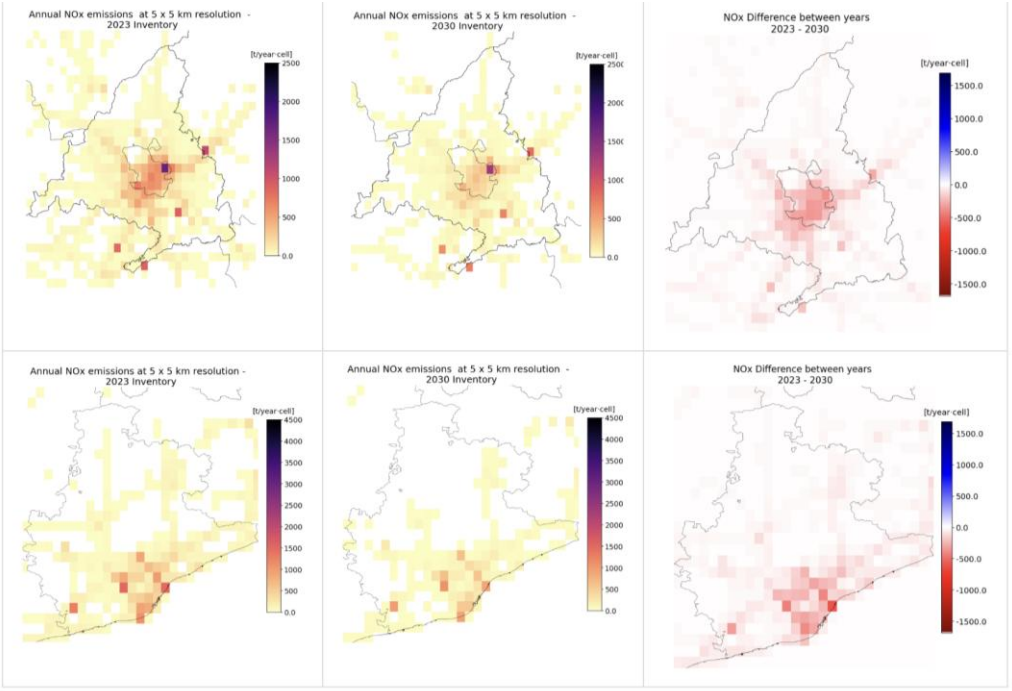


Courtesy of M. Theobald

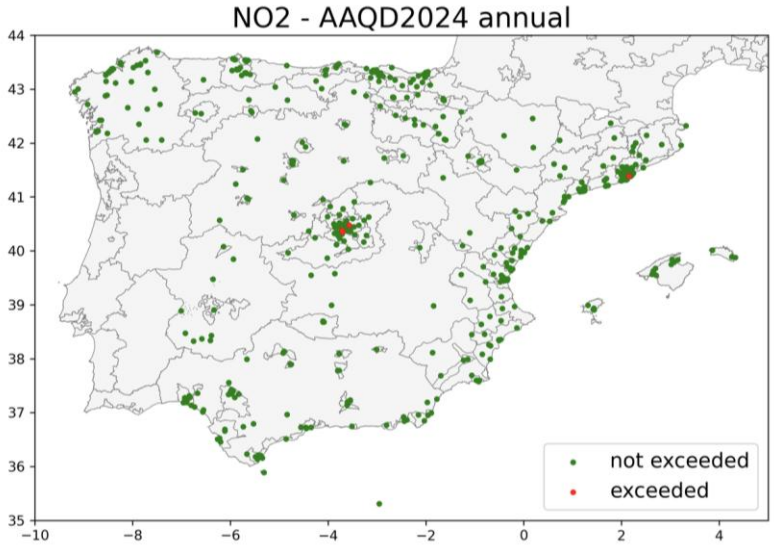
Support modelling efforts for air quality planning purposes

Flexible framework to prepare future emission scenarios consistent with official projections

2023 baseline | **2030 WaM** | **Differences**



2030 air quality scenario



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Take home messages

- Generation of **robust emission data** to support air quality modelling applications in line with the European Air Quality Directive 2024/2881:
  - Emission core of the national & Catalan air quality forecast systems (pre-operational mode)
  - Input to modelling exercises to support preparation of 2028-2035 air quality road maps
- Facilitate a **two way communication** between national inventory agencies and air quality modellers (”win-win”: receive the most refined emission data + provide feedback & QA)
- Effort to **collect, integrate and process** multiple EU, national and subnational proxies and profiles to accurately reflect key spatio-temporal and speciation aspects of emissions
- In line with other efforts and initiatives:
  - At the national level: Germany (GRETA), US (SMOKE)
  - At the EU level: TFEIP guidance for emission inventory users
- HERMES_Δ software in **open access** (Tena et al., 2026) – scientific paper under preparation
- **Next steps**: continue validation works and refinement of proxies + addition of missing sources (road dust resuspension)

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Thanks for your attention!

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