



# RESPIRE



## RESPIRE: high-Resolution air Emissions Systems to suPport modelling and monitoRing Efforts in Spain

Paula Castesana<sup>1</sup>, Marc Guevara<sup>1</sup>, Omaira García<sup>2</sup>, Carles Tena<sup>1</sup>, Angie Albarracín<sup>1</sup>, María Allué<sup>3</sup>, Clara Arbizu<sup>3</sup>, Ernesto Barrera<sup>3</sup>, Francesco Benincasa<sup>1</sup>, Paula Camps<sup>1</sup>, Alberto Cansado<sup>3</sup>, Oscar Collado<sup>1</sup>, Antonia Frangeskou<sup>1</sup>, Alejandro García<sup>1</sup>, Johanna Gehlen<sup>1</sup>, Oliver Legarreta<sup>1</sup>, Iván Lombardich<sup>1</sup>, Yolanda Luna<sup>3</sup>, Francesca Macchia<sup>1</sup>, Karinna Matozinhos<sup>1</sup>, Calum Meikle<sup>1</sup>, Miriam Olid<sup>1</sup>, Carmen Piñero<sup>1</sup>, Elliot Rose<sup>1</sup>, Eliezer Sepúlveda<sup>2</sup>, Noemie Taquet<sup>2</sup>, Diana Urquiza<sup>1</sup>, Alba Vilanova<sup>1</sup>, Artur Viñas<sup>1</sup>, Oriol Jorba<sup>1</sup>, Carlos Pérez García-Pando<sup>1,4</sup>

<sup>1</sup> Barcelona Supercomputing Center, Barcelona; <sup>2</sup> Izaña Atmospheric Research Center (IARC-AEMET), Santa Cruz de Tenerife; <sup>3</sup> State Meteorological Agency (AEMET), Madrid; <sup>4</sup> ICREA, Catalan Institution for Research and Advanced Studies, Barcelona, Spain.

**RESPIRE** aims to enhance Spain's strategic capabilities for modelling atmospheric pollutants and monitoring greenhouse gas (GHG) emissions, structured in two specific components: **RESPIRE-AIR** and **RESPIRE-CLIMATE**. Under **RESPIRE-AIR**, we developed a high-resolution emission system that performs a spatial, temporal, and speciation processing of the official Spanish air pollutant emission inventory, producing as output gridded (up to 1kmx1km), hourly and speciated emissions maps to be used as input for the national air quality forecasting system operated by the Spanish Meteorological Agency. **RESPIRE-CLIMATE** has the aim of developing a national monitoring system for CO<sub>2</sub> and CH<sub>4</sub> emissions, combining activity- and observation-based estimates. The system is divided into four fundamental pillars: **Pillar 1**, a collection of high-resolution GHG annual emission maps (1kmx1km) consistent with the national official inventories; **Pillar 2**, a low-latency emission model that computes anthropogenic daily emissions at high spatial resolution (1kmx1km) with a 3 months latency; **Pillar 3**, a national monitoring network deriving emission fluxes from ground-based observations; and **Pillar 4**, a web application for the visualization and downloading of data derived from the first three pillars.

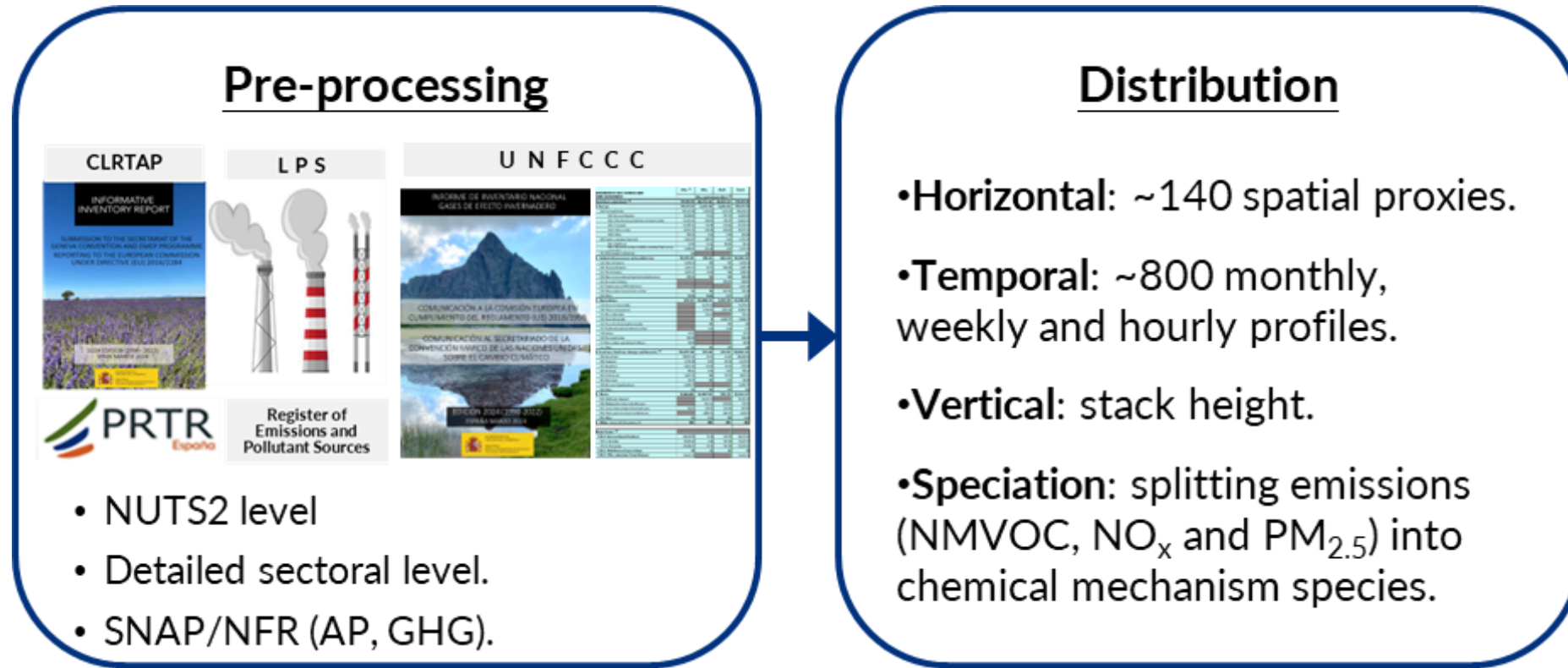


## RESPIRE AIR

**Species:** CO, NO<sub>x</sub>, NH<sub>3</sub>, NMVOC, SO<sub>2</sub>, PM<sub>2.5</sub>, (+ CO<sub>2,ff</sub>, CH<sub>4</sub>, N<sub>2</sub>O →)

**Sectors (GNFR):** A\_PublicPower, B\_Industry, C\_OtherStationaryComb, D\_Fugitive, E\_Solvents, F\_RoadTransport, H\_Aviation, I\_Offroad, J\_Waste, K\_livestock, L\_Agriother.

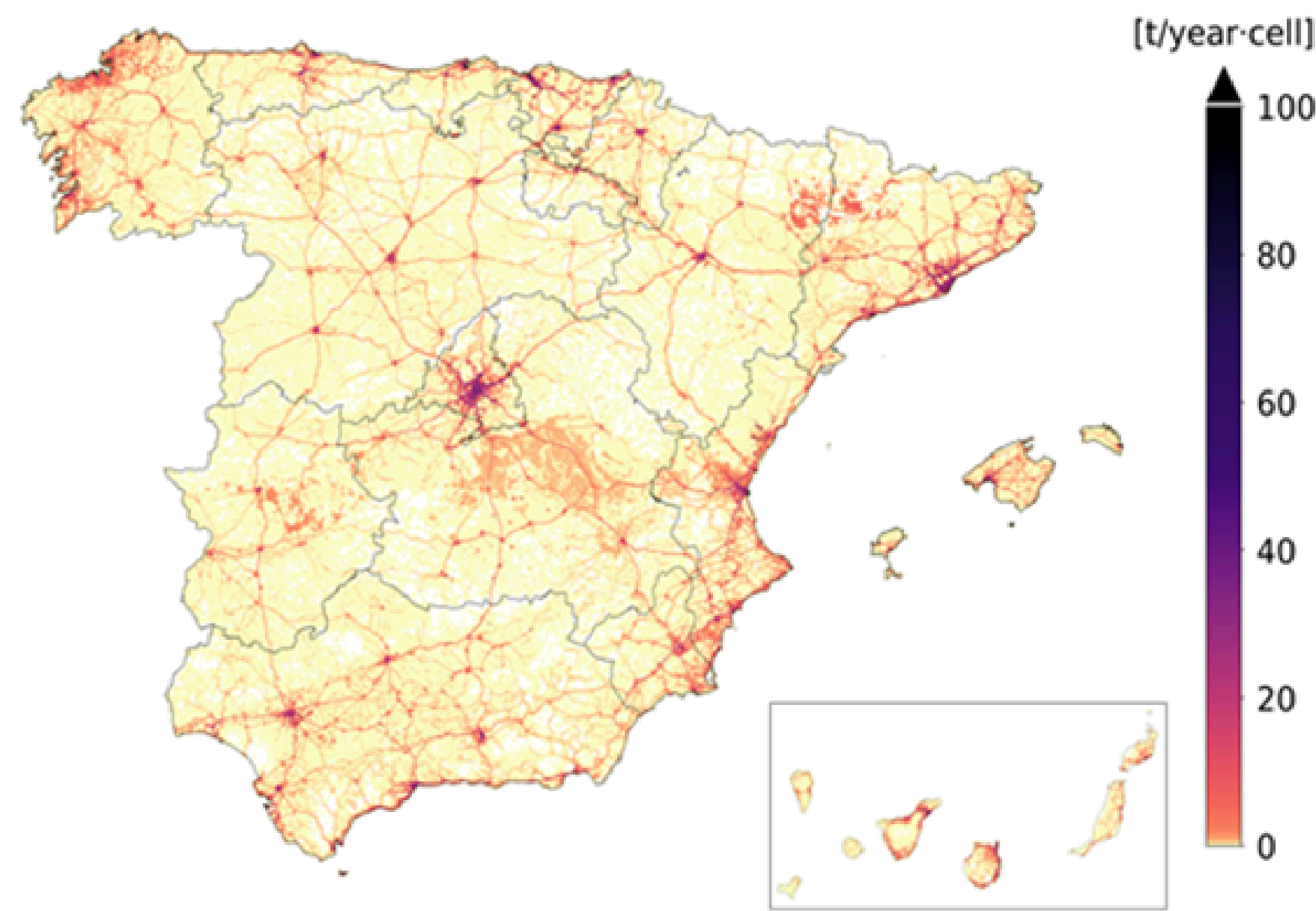
**HERMES\_Δ:** High-Elective Resolution Modelling Emission System



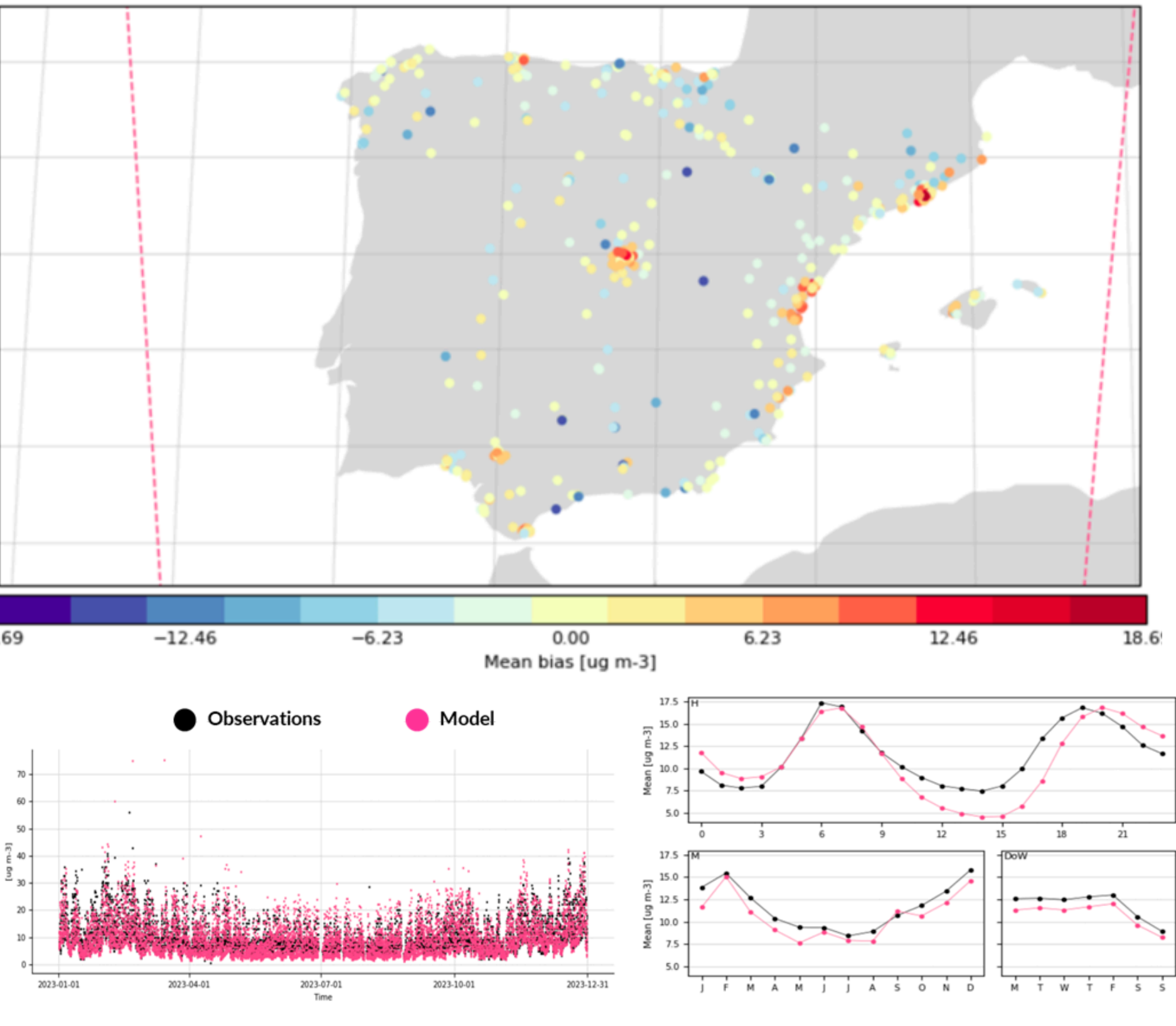
**Outputs:** High-resolution emission maps (1km, hourly) consistent with official reports to support public administration. NetCDF files ready-to-use for modelling applications.

## RESULTS

Total annual NO<sub>x</sub> emissions, 2023



NO<sub>x</sub> annual simulation with **MONARCH** (0.1° × 0.1°), 2023 (mean bias model-observations)



## RESPIRE CLIMATE

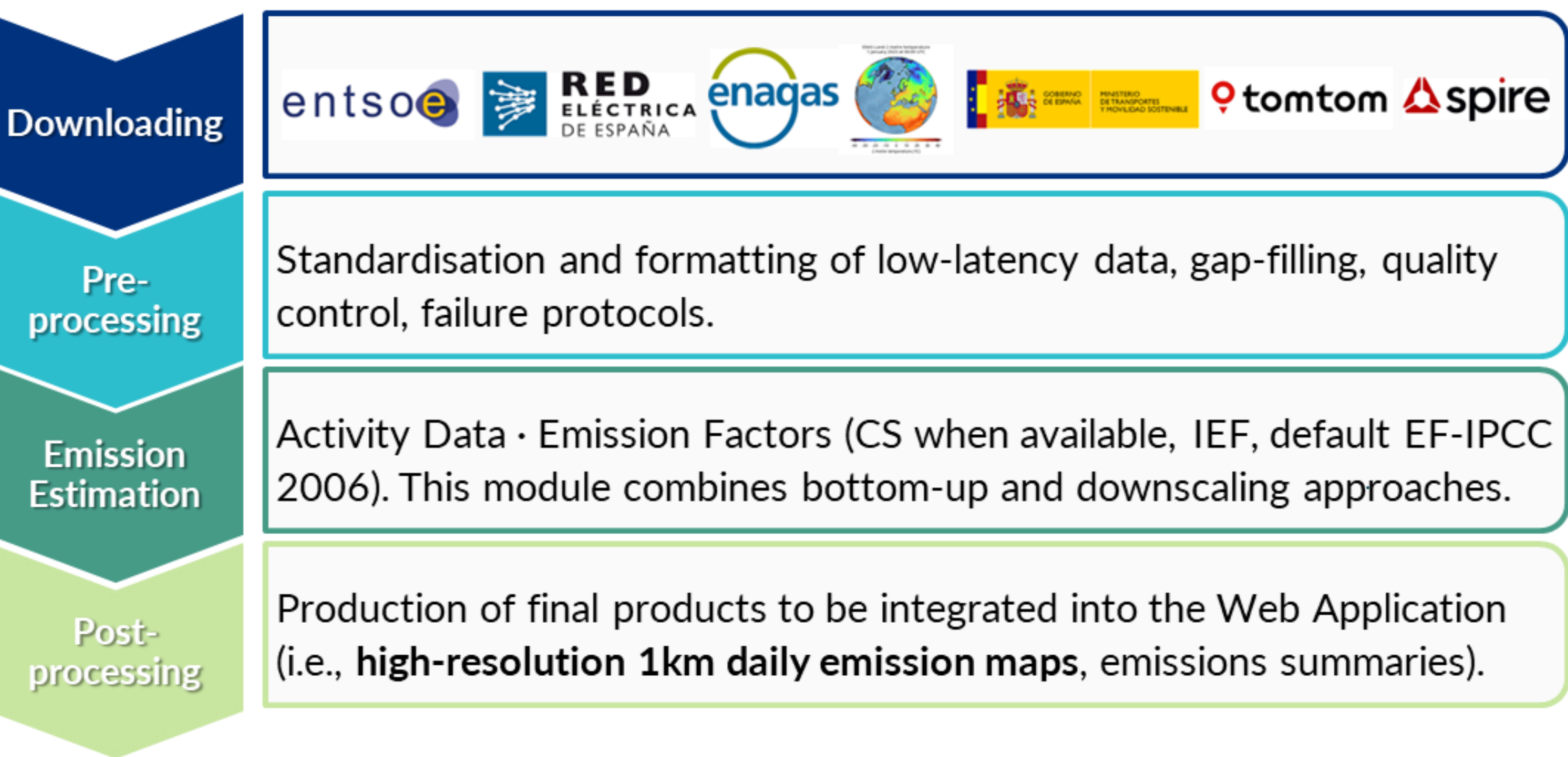
### Pillar 1:

Official inventories reported under the UNFCCC downscaled with HERMES\_Δ. **Outputs:** high-resolution (1kmx1km) CO<sub>2,ff</sub> and CH<sub>4</sub> annual emission maps, organised by GNFR sector.

### Pillar 2:

Low Latency system (delay up to 3 months)

**PHENOMENA:** sPanisH EmissioN mOnitoring systeM for grEeNhouse gAses



**Species:** CO<sub>2,ff</sub>, CH<sub>4</sub>

**Status:** 70%

**Sectors:** Electricity Generation, Industrial Processes (Cement, Iron&Steel), Residential and Commercial, Fugitives, Road Transport, Shipping, Aviation.

### Pillar 3:

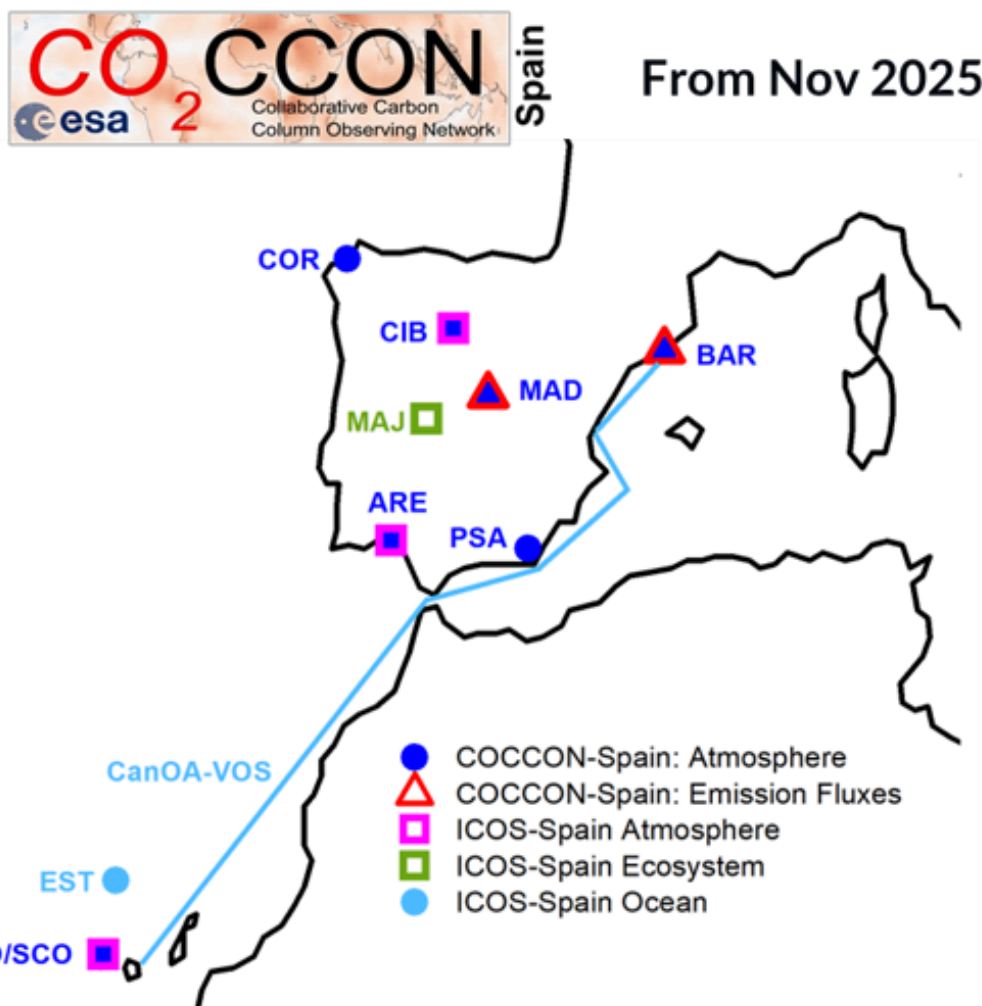
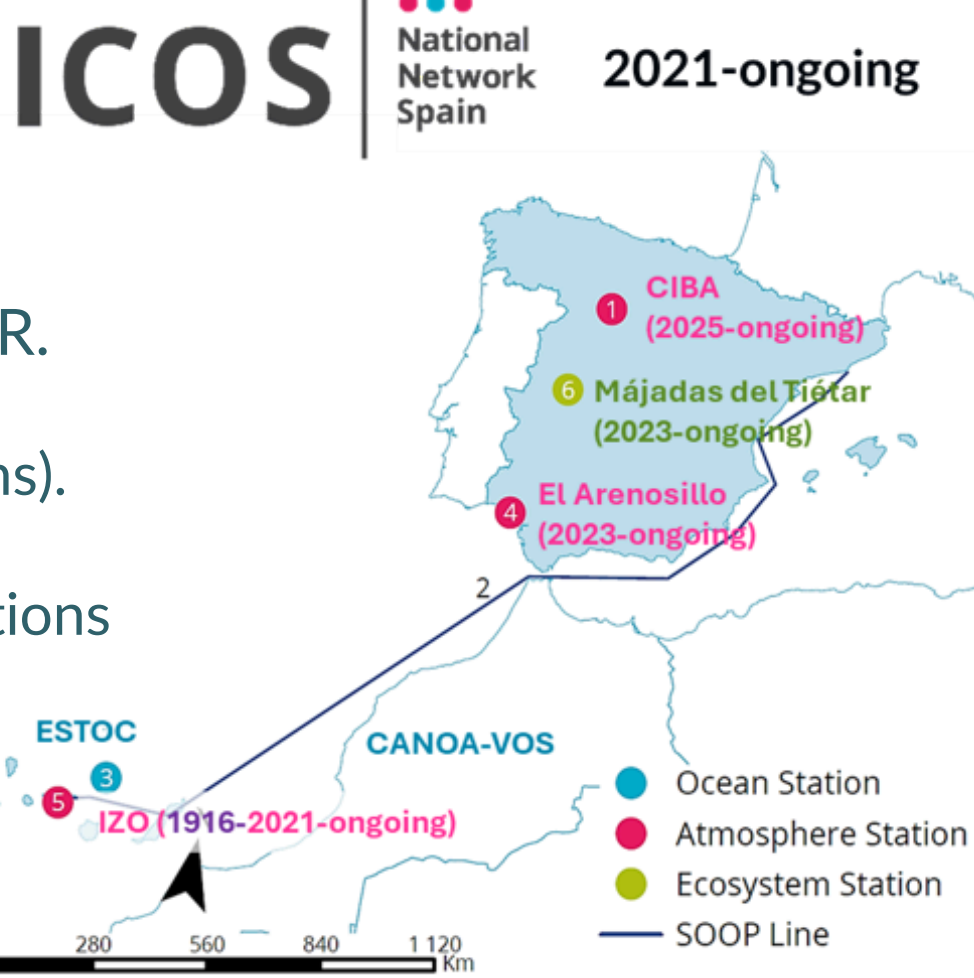
GHG Observational Monitoring Network

**Species:** CO<sub>2</sub>, CH<sub>4</sub>

**Observational capacity:**

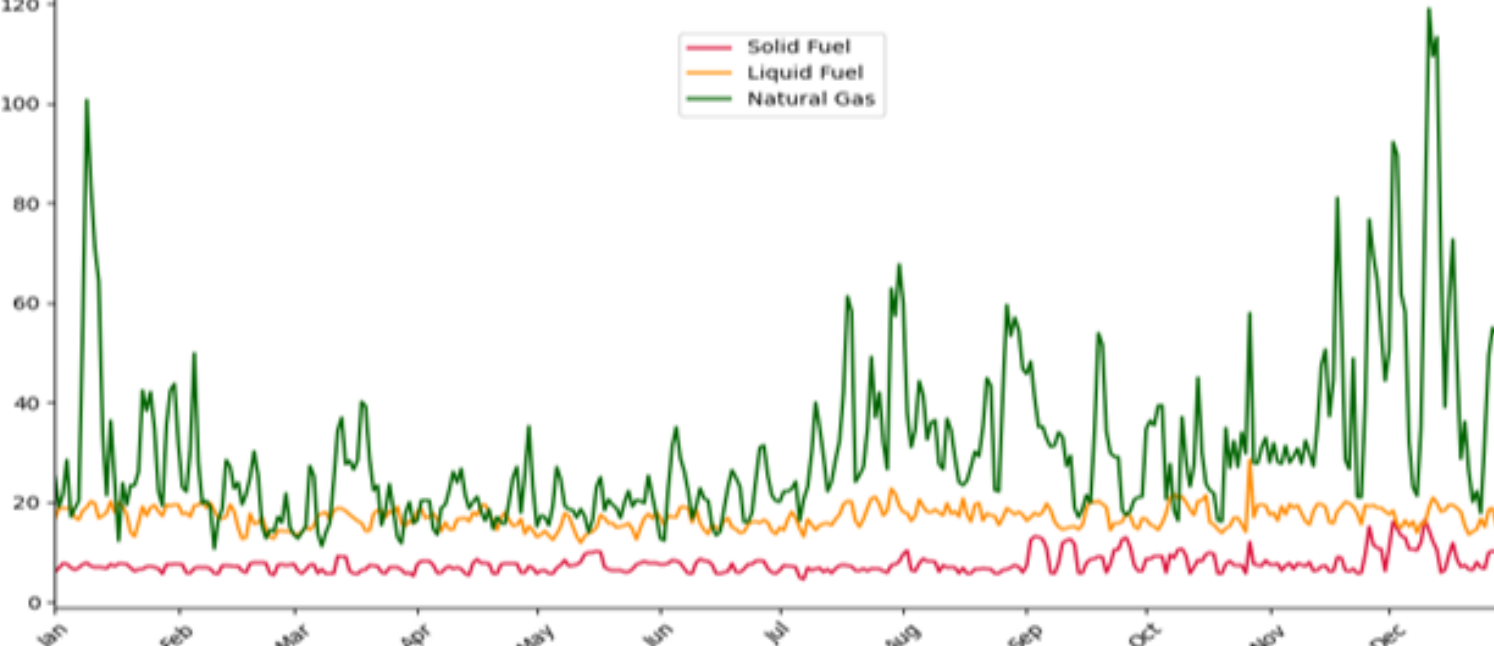
14 stations with ground-based LR-FTIR.

- Background conditions (concentrations).
- Urban-industrial hotspots (concentrations and emission fluxes).

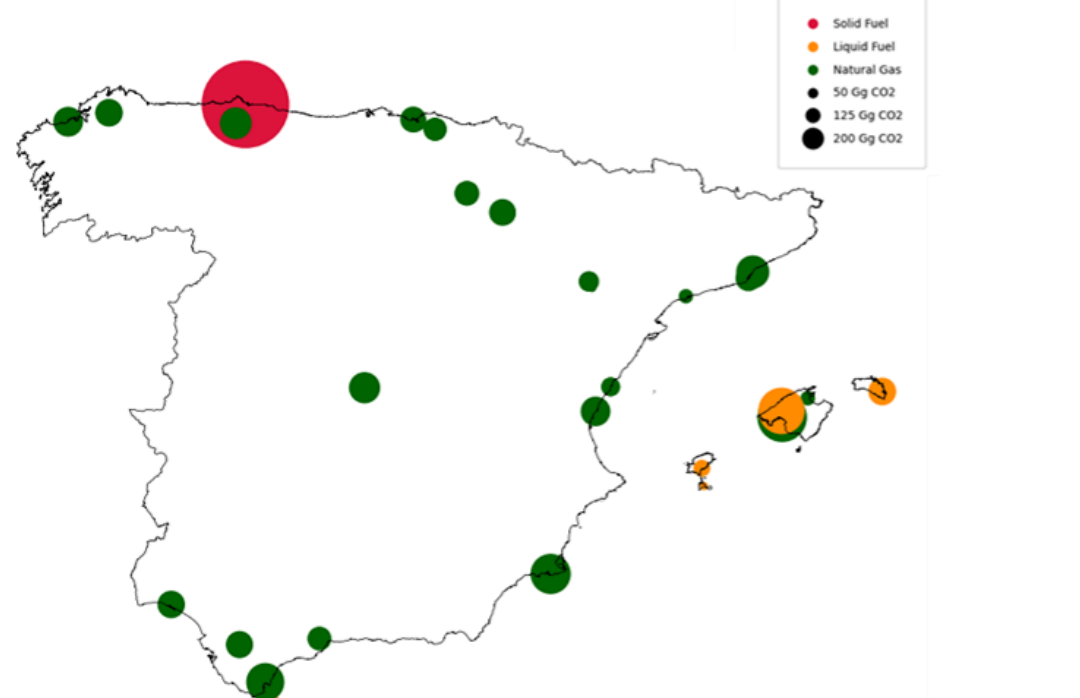


## RESULTS

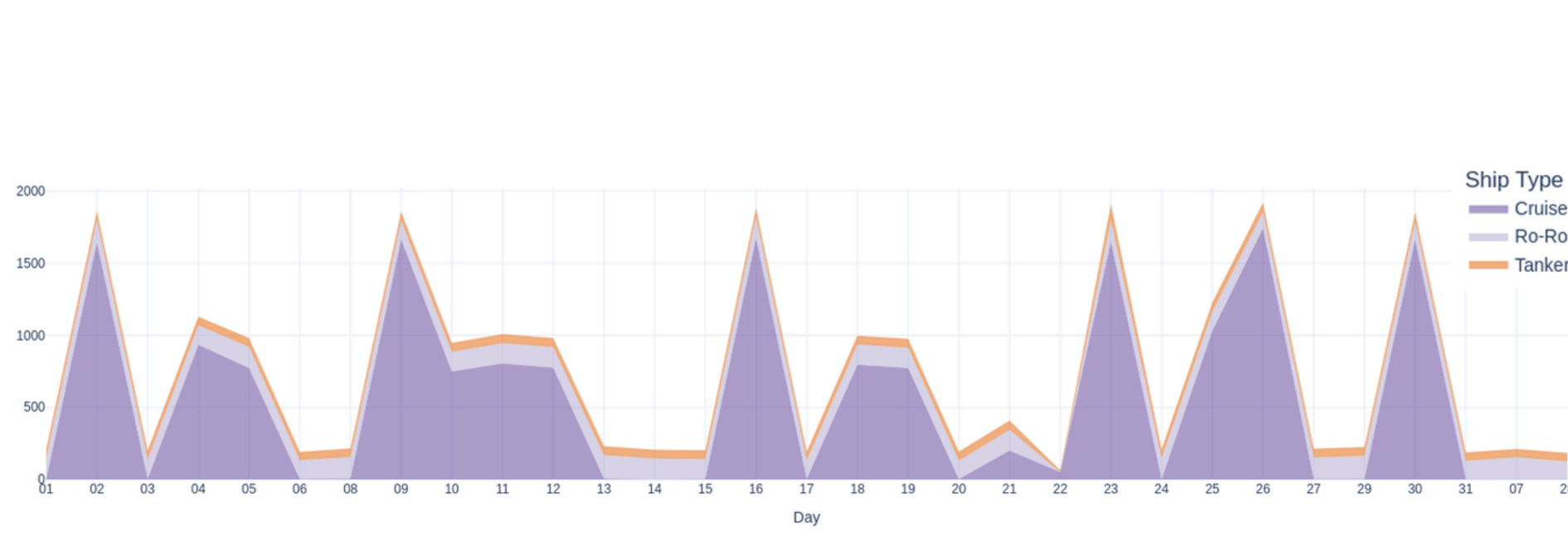
Daily CO<sub>2</sub> emissions (Gg/day) from thermal power plants in Spain



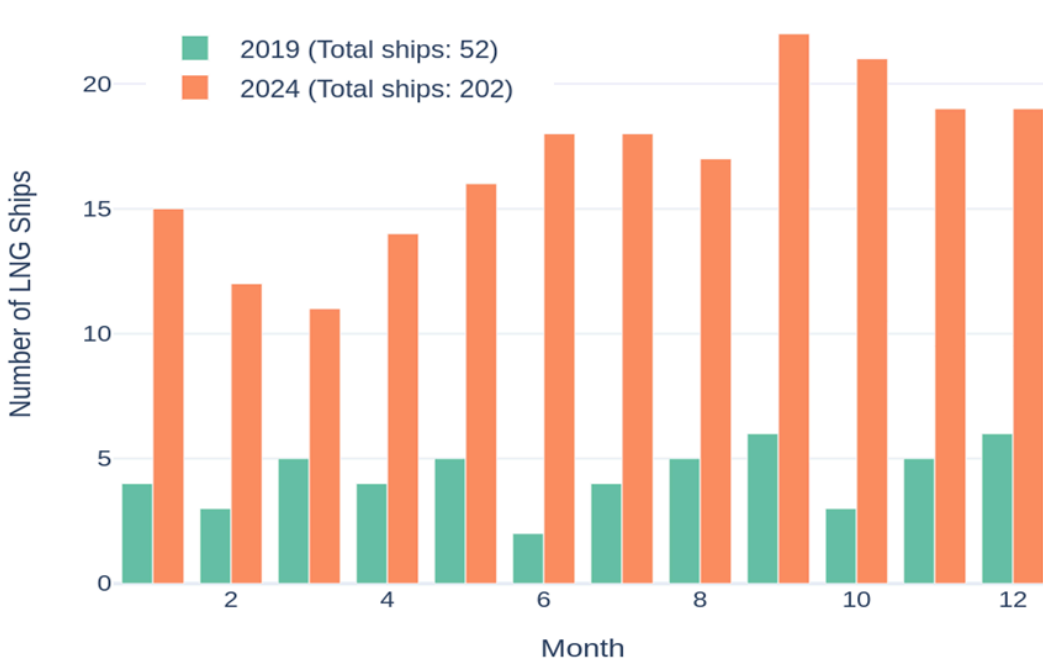
Accumulated CO<sub>2</sub> emissions (Gg) per facility



Daily CH<sub>4</sub> emissions (kg/day) by ship type in Barcelona Port, (October 2024)



LNG-fueled ships per month, (Barcelona Port, 2019 vs. 2024)



## CONCLUSIONS

This work presents the RESPIRE project, giving an overview of its two main components: RESPIRE-AIR, a system to produce high resolution emissions to support and enhance air quality modelling activities in Spain; and RESPIRE-CLIMATE, a national monitoring system that produces low latency and high-resolution estimates of GHG emission fluxes combining activity information with atmospheric observations. The expected impacts of this project include improvements in the accuracy of the national air quality forecasting system, as well as the generation of valuable emissions data to support modelling applications in line with the revised European Air Quality Directive. In terms of climate change decision-making, this initiative will provide actionable information on emissions with the spatial, temporal and sectoral resolution needed to assess and guide progress towards GHG reduction targets set for the years ahead, alongside accessible tools to support public administration, the scientific community, private entities and citizens

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