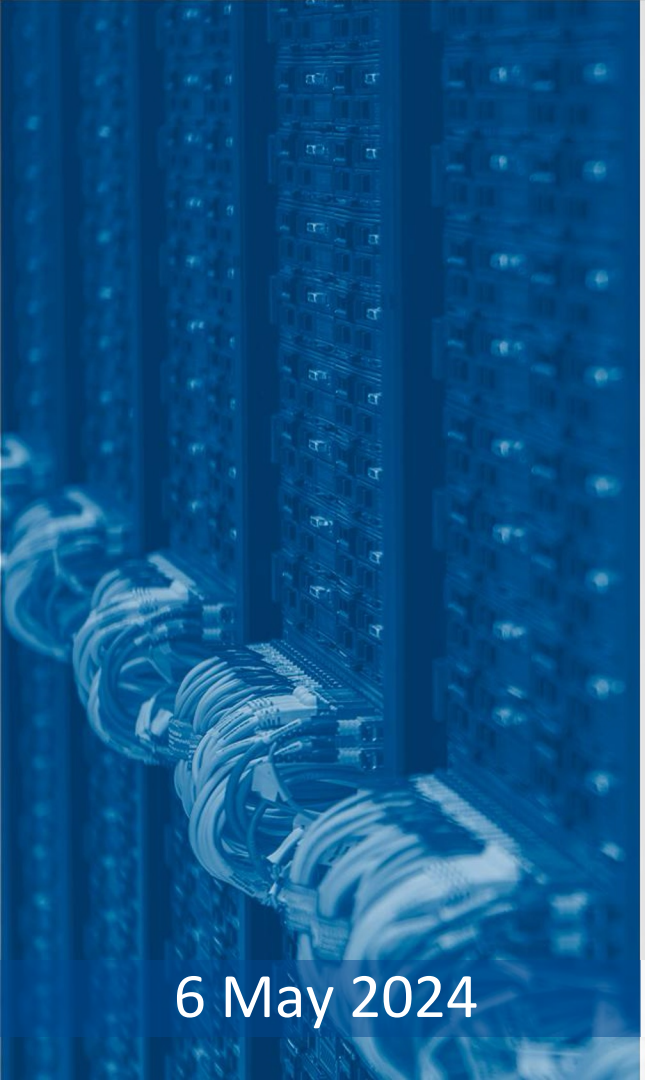

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Updates on the modelling activities in support of the Spanish Ozone Mitigation Plan

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Barcelona Supercomputing Center, Earth Sciences department, Atmospheric Composition group

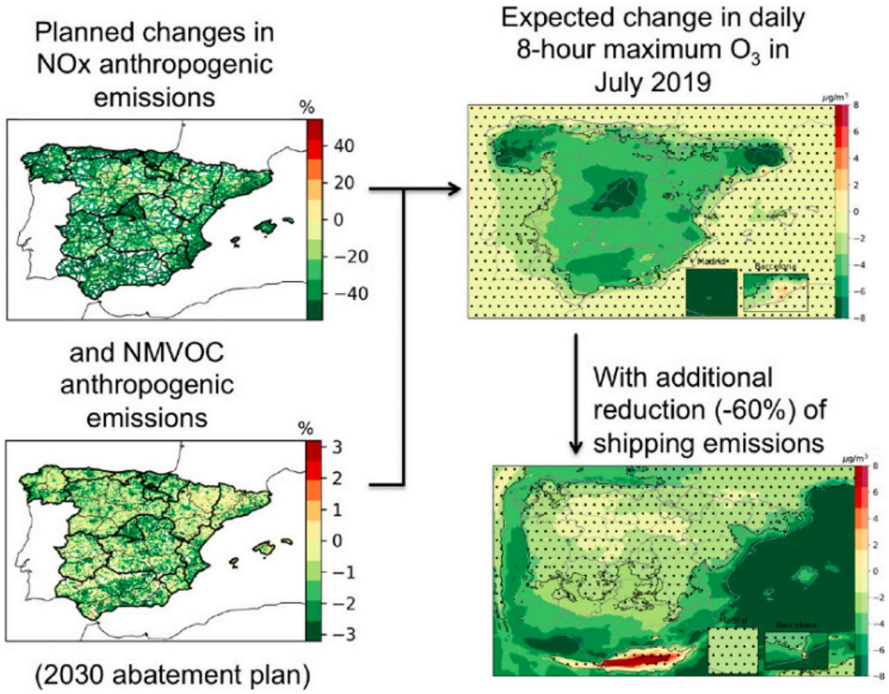
6 May 2024

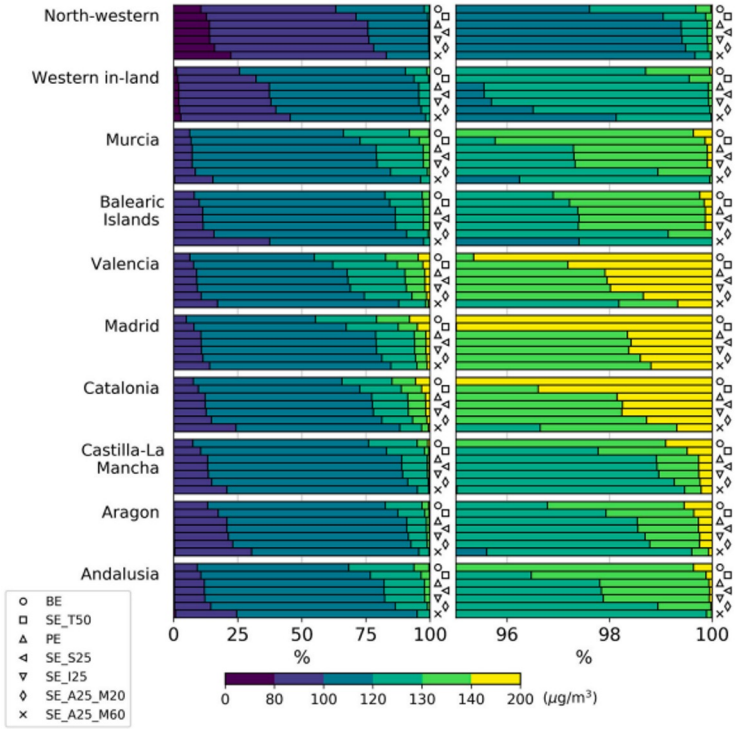
25th EMEP Task Force on Measurement and Modelling Meeting

Outline

- Updates on activities for Spanish O_3 Plan
  - Evaluation activities: O_3-NO_2-HCHO-VOCs
- Source Apportionment of O_3 and PM2.5
- Complementary activities

Emission scenario analysis for the Spanish O_3 mitigation plan: Phase 1





Ozone in Spain strongly driven by road transport and shipping emissions

Petetin et al. (2023) - Assessing ozone abatement scenarios in the framework of the Spanish ozone mitigation plan

Revised baseline emission scenario: version 2

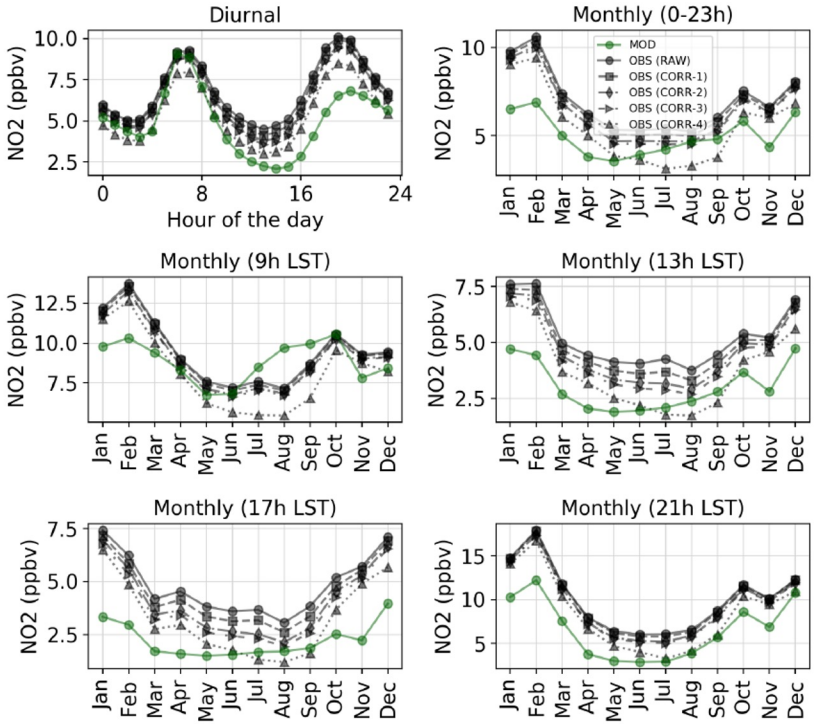
- Increased NO-NO_2 emissions
- Strong variability NMVOC emissions due to revised speciation profiles

Updates on emissions for 2019 based on official reporting in Spain (2022):

- Improved NMVOC speciation profiles (Oliveira et al., 2023)
- Added NMVOC emissions from organic chemistry industry
- Added NMVOC emissions derived from the extraction, storage and distribution of fossil fuels
- Update agricultural machinery (temporal profiles and fleet)
- Update on NOx road transport emissions (30% increase)
- Use of solvents: updates reported emissions edition 2022 and speciation

Ongoing work: preparation new emission scenarios

Bias in surface NO_2: interferences in measurements

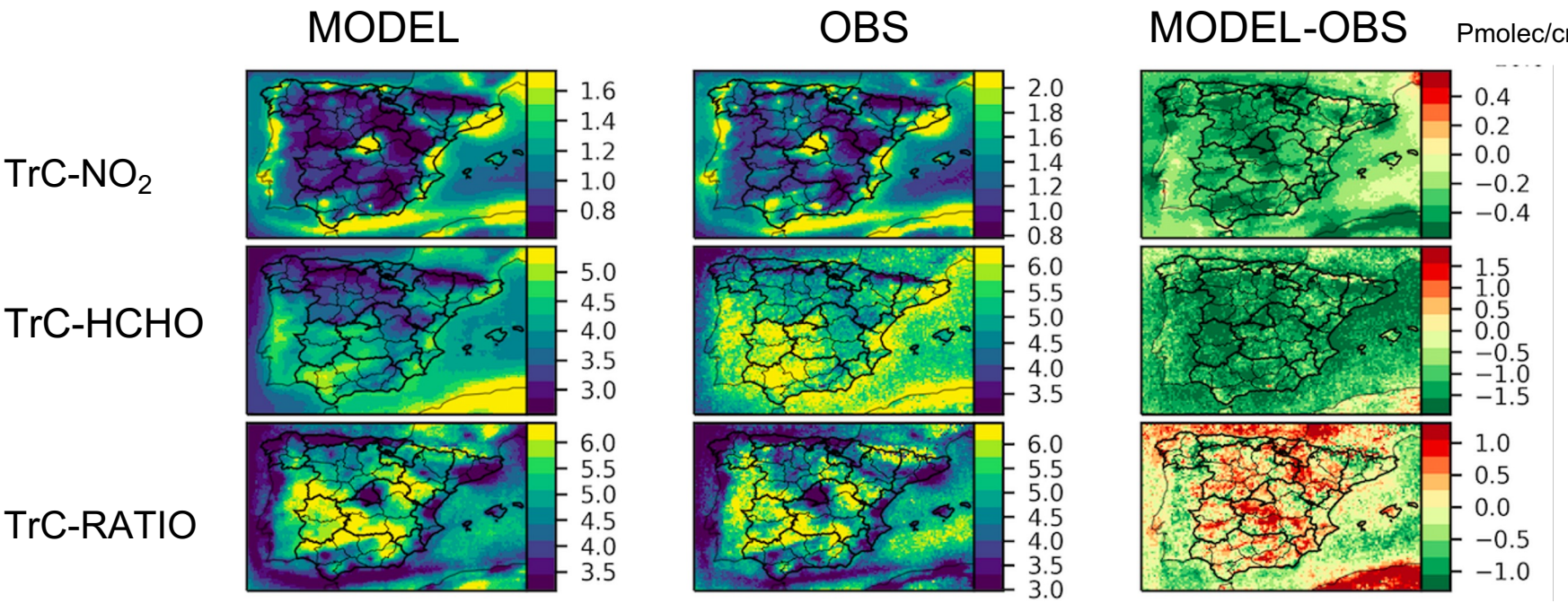


Systematic underestimation in simulated NO_2

- Limitations from monitoring data
- Interferences in chemiluminescence monitors with molybdenum oxide converters
  - Partially measuring NOz
- Impact of correcting the measure following Lamsal et al. (2008)

$$\text{CORR-1}=NO_2/(NO_2 + 0.35 \cdot HNO_3)$$
$$\text{CORR-2}=NO_2/(NO_2 + 0.95 \cdot PAN)$$
$$\text{CORR-3}=NO_2/(NO_2 + 0.95 \cdot PAN + 0.35 \cdot HNO_3)$$
$$\text{CORR-4}=NO_2/(NO_2 + 0.95 \cdot PAN + 0.35 \cdot HNO_3 + \Sigma AN)$$

NO_2 and HCHO tropospheric columns (TROPOMI) against MONARCH



- Larger TrC-NO2 underestimation over hotspot urban areas
- Missing NOx sources in rural environments (soil NOx, other activities?)
- TrC-HCHO dominated by biogenic sources, patterns captured but underestimated
- Consistent spatial distribution of TrC-Ratio($HCHO/NO_2$) general overestimation

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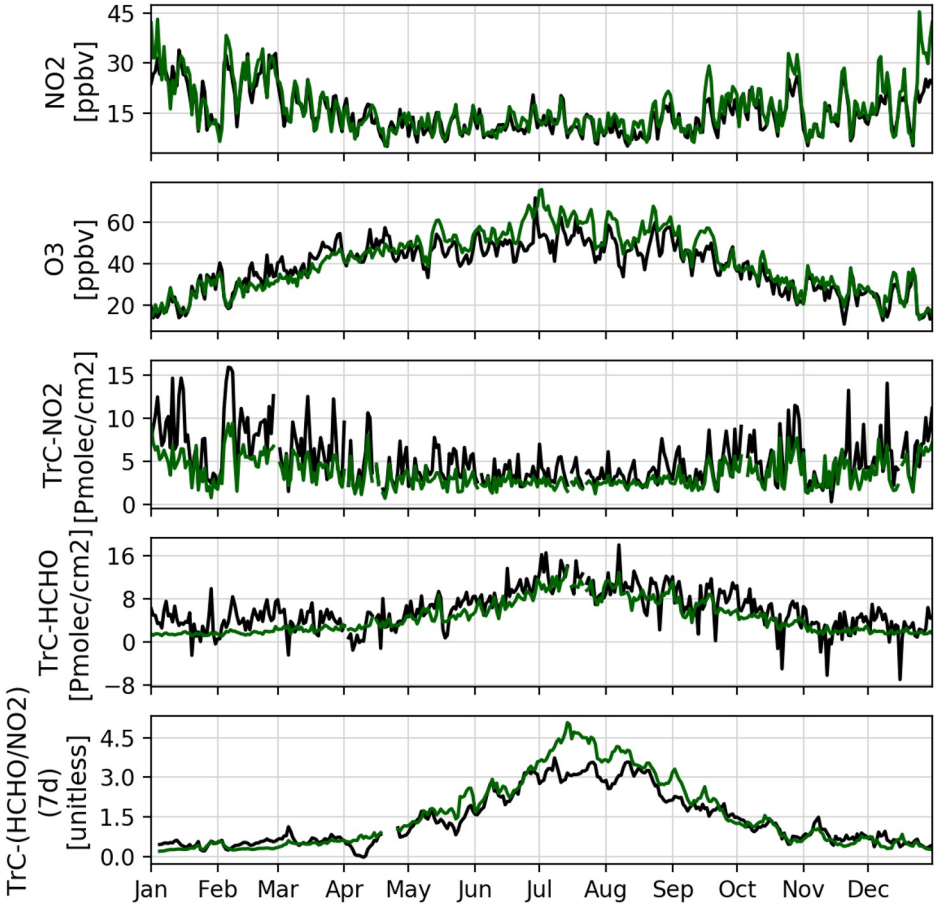
Potential of TROPOMI for investigating O_3 regime

TROPOMI observations of NO_2 and HCHO useful for better assessing the ability of our models to correctly represent the sensitivity of O_3 to its NOx and VOC precursors



Green: model
Black: obs.

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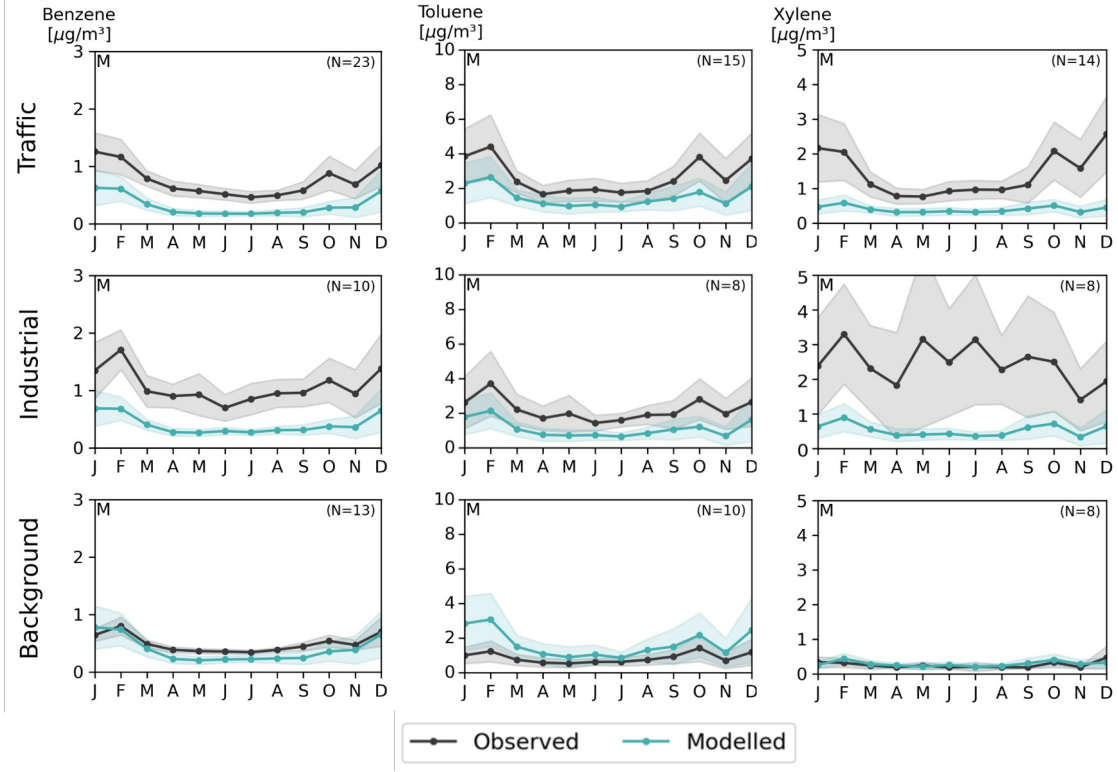
Evaluation of NMVOCs: Benzene, Toluene, Xylene

- Traffic stations show underestimations. Stations using GC-FID measured larger values than the ones using GC-MS
- Largest underestimations were identified in industrial stations near refineries, car manufacturing facilities, and coke ovens
- Background stations slightly overestimate, mainly due to inaccurate spatial proxies, especially from the solvent sector (i.e. paint application)



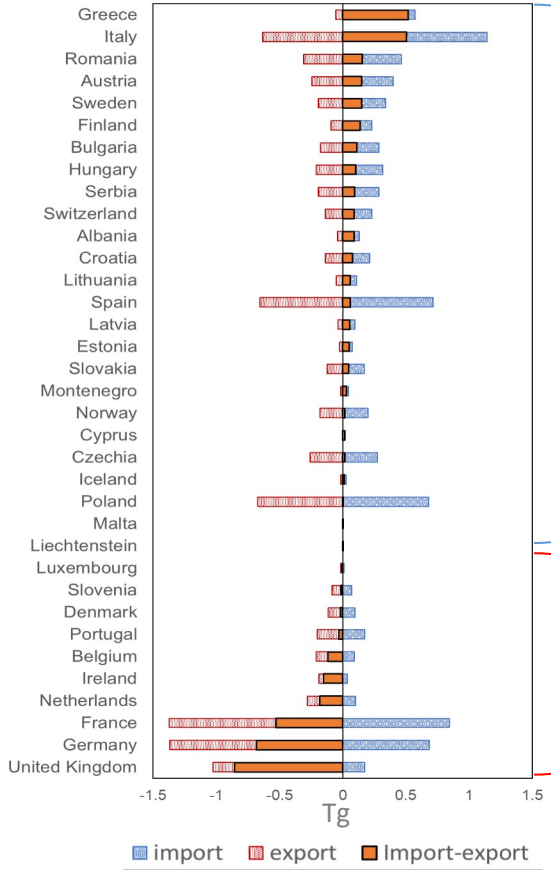
Oliveira et al. (2024 ACPD) - On the uncertainty of anthropogenic aromatic VOC emissions: model evaluation and sensitivity analysis

Source apportionment

Source contribution by country to surface O_3: imported/exported and health impacts

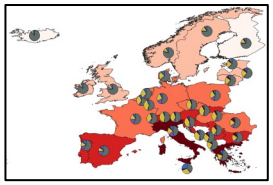
Behavior of each country:

Import-Export



Net importers O_3

Net exporters O_3



$$AF = 1\text{-}\exp(-\beta \times O_3)$$

AF -> Attributable fraction

β -> Mortality risk =-0.00018 μg/m^3

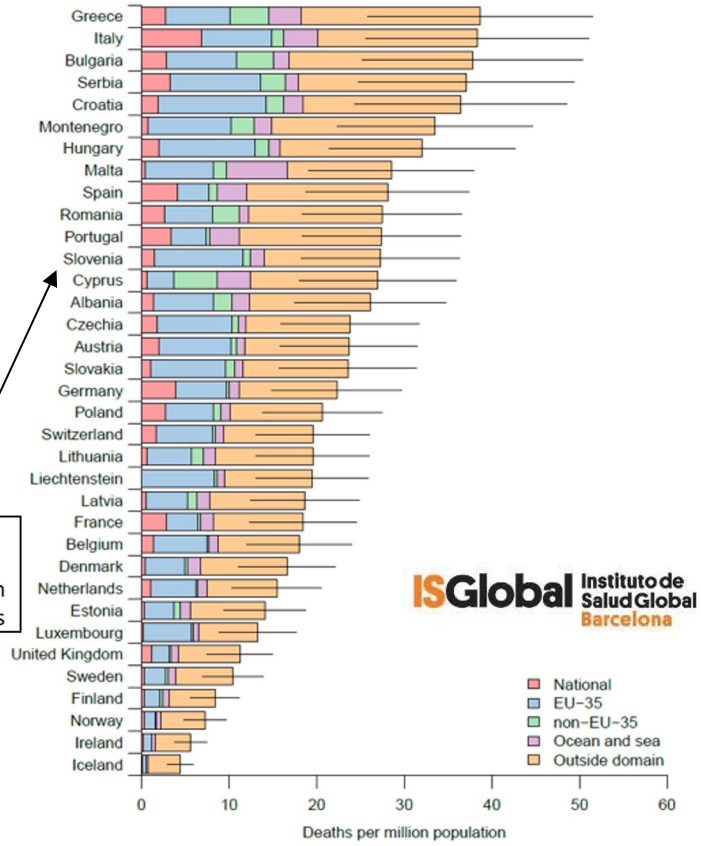
(Vicedo-Cabrera et .al, 2020)

AF weighted by population

$$M = D \times AF_w$$

M->Mortality burden

D-> Total number of deaths



ISGlobal Instituto de Salud Global Barcelona

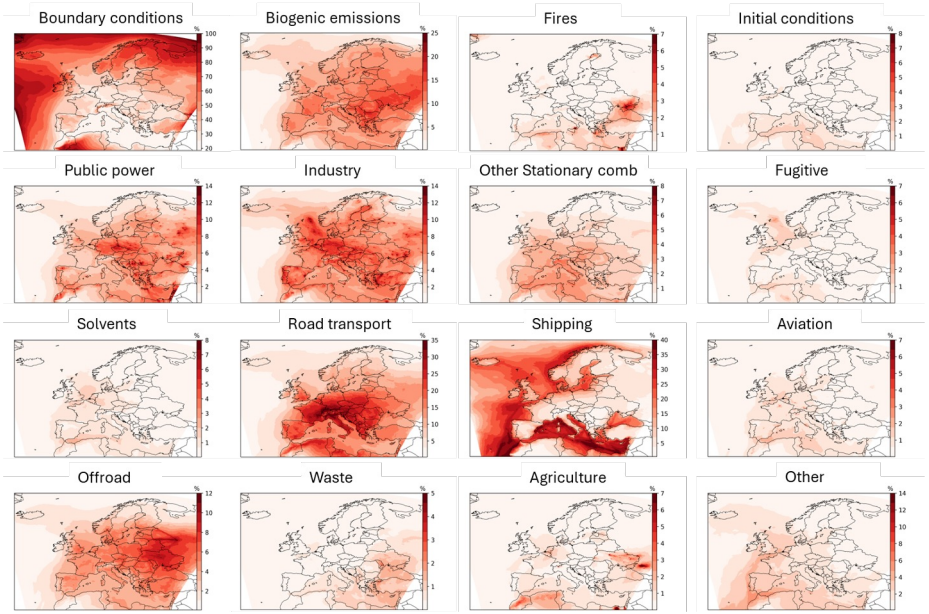
* BCON, SEA and NOEU35 are not considered in these graphs.

CMAQ-ISAM tagging method

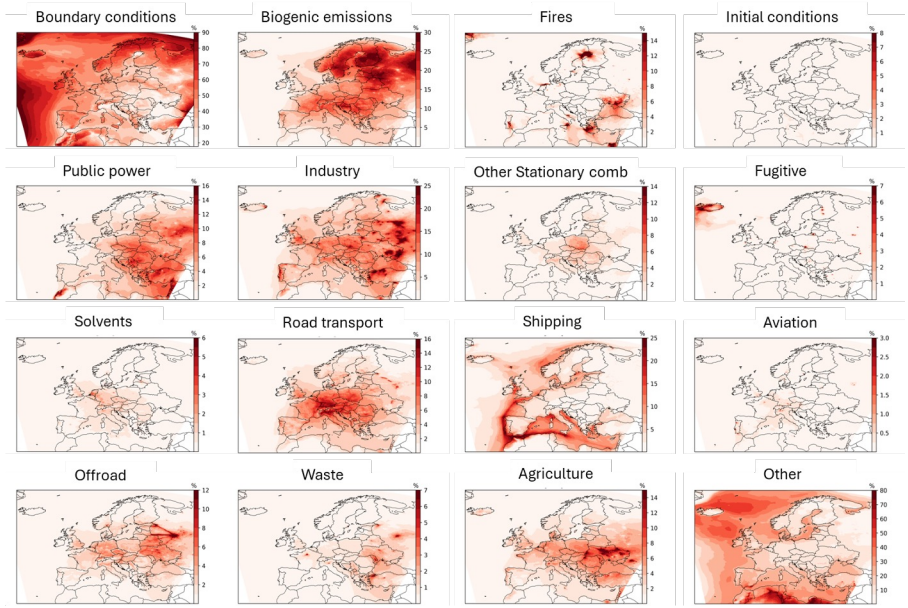
Garatachea et al. (2024)
Acheback et al. (2024)

Source contribution by sector to surface O_3 and PM2.5 - July 2019

O_3



PM2.5

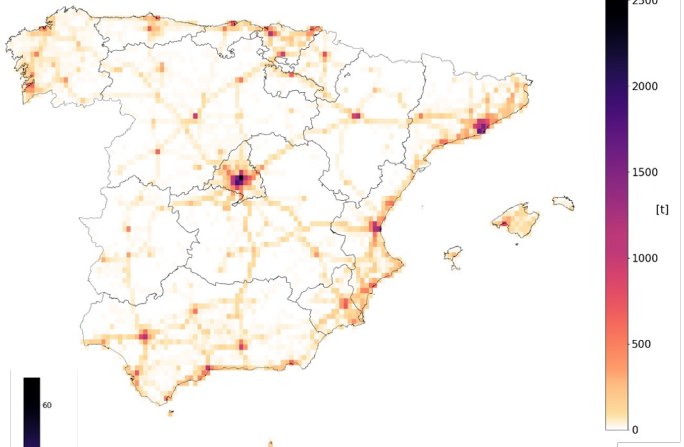


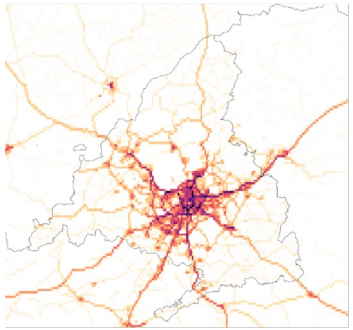
- CMAQ-ISAM tagging method
- CAMS-REGv6.1
- Tagging full multiphase mechanism (stochiometry approach)

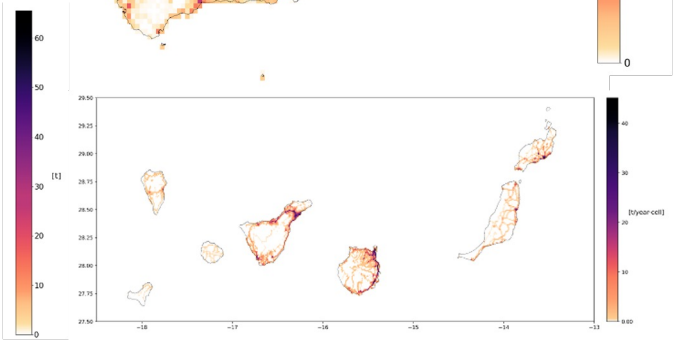
Complementary activities

HERMES_DOW: national system to process official reported emissions and support AQ modelling efforts

Road transport NOx (2021)

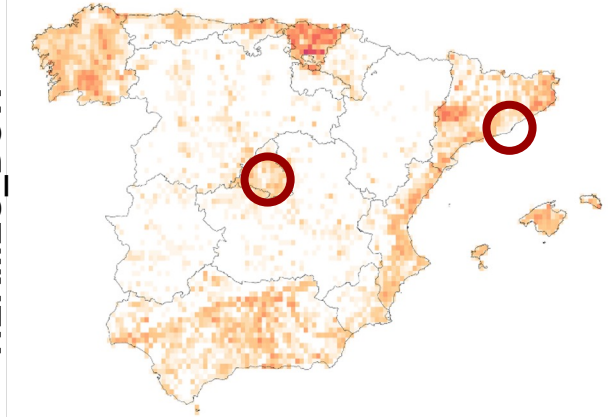




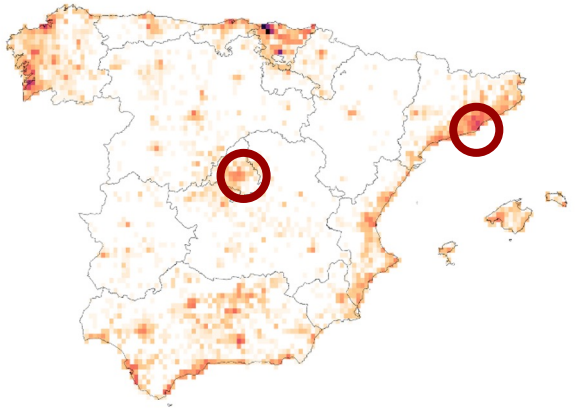


Residential Combustion PM2.5 (2021)

HERMES_DOW



EMEP



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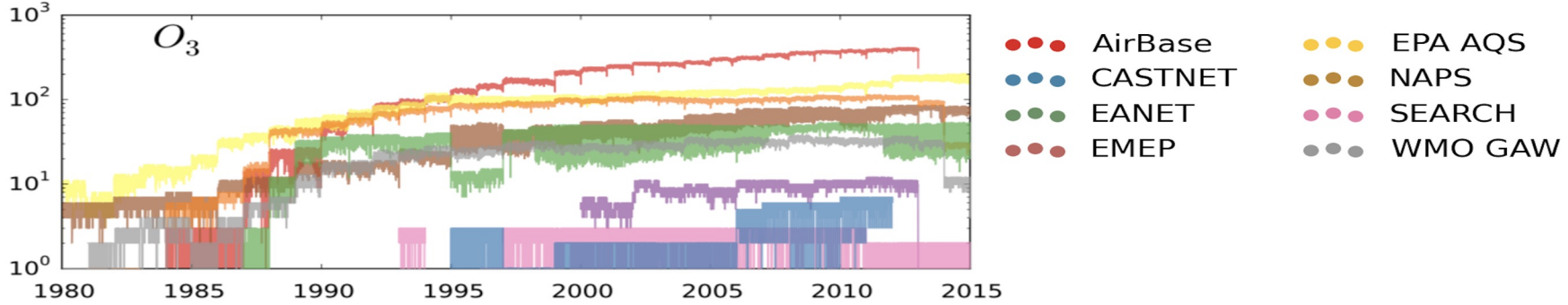
AEMet Agencia Estatal de Meteorología

Plan de Recuperación, Transformación y Resiliencia

GHOST: Globally Harmonised Observations in Space and Time

- With time, more and more observations from different reporting networks are becoming available to the atmospheric chemistry community.

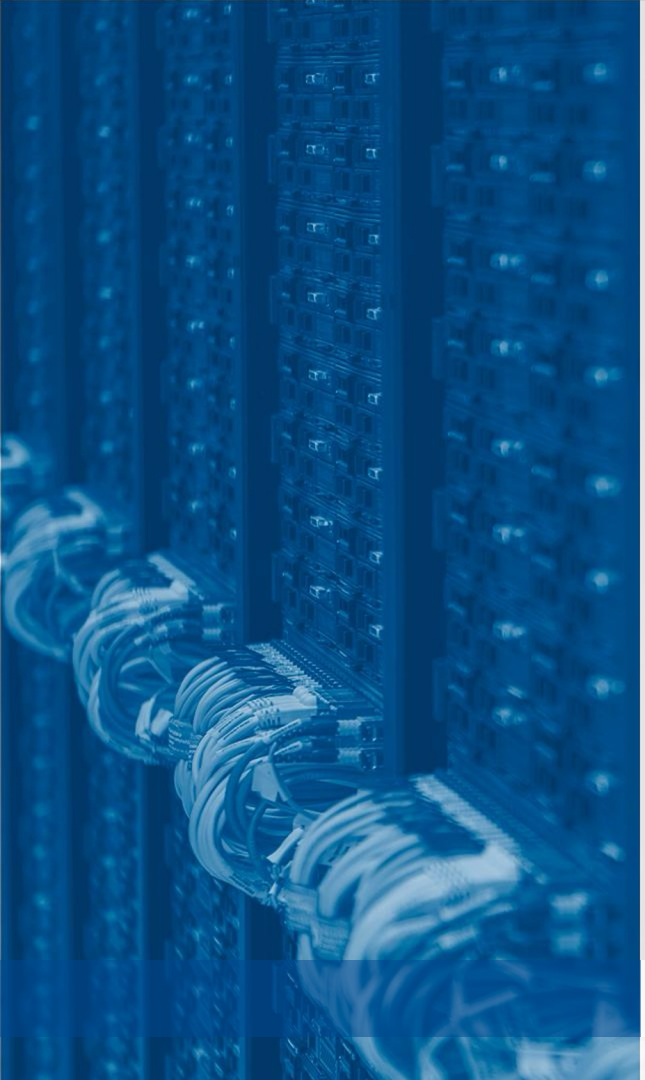


- GHOST provides a framework for the harmonisation of an exhaustive number of data/metadata fields that may provide some use to scientists when using the observations in analyses.

Bowdalo et al. (2024 ESSD discussion) https://essd.copernicus.org/preprints/essd-2023-397/

Summary

- **Modelling works to support the Spanish O_3 plan**
  - Updated baseline scenario
  - Evaluation works
  - Ongoing activities finalizing new emission scenarios
- **Source contribution analysis**
  - Transboundary analysis and health impact assessments
  - Towards country and sector contributions for O_3 and PM2.5
- **Observations**
  - How to deal with interferences in measurements (NO_2, VOCs)?
  - Harmonisation of databases (GHOST)



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Thank you!

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MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

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