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Impacts on air quality of the Spanish National Air Pollution Control Programme (NAPCP-2023) and selected measures

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1. Update of the Spanish National Air Pollution Control Programme (NAPCP-2023): summary of the impacts on air quality and uncertainties

Updated National Air Pollution Control Programme – 2023 (NAPCP-2023)

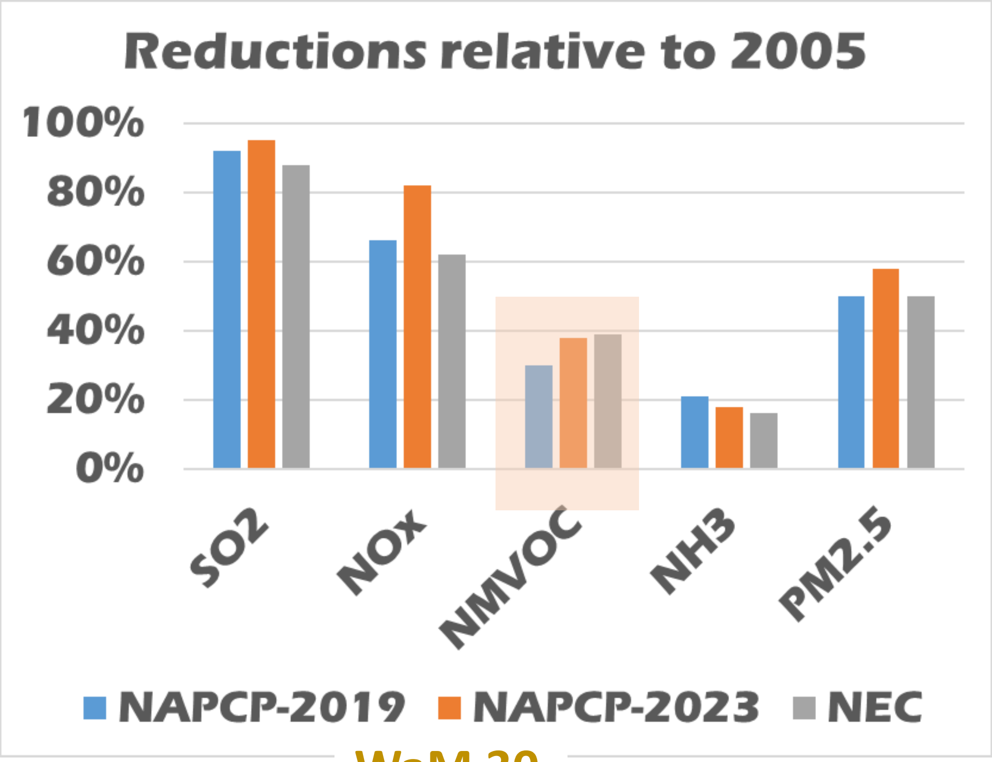
Developed by the Ministry for the Ecological Transition and Demographic Challenge (MITECO)

NAPCP-2023 contains emission reduction measures to meet the objectives for 2030 in the National Emission Ceilings Directive for Spain

NEC Objetives for Spain:

SO_x	88%
NO_x	62%
COVNM	39%
NH_3	16%
PM2.5	50%

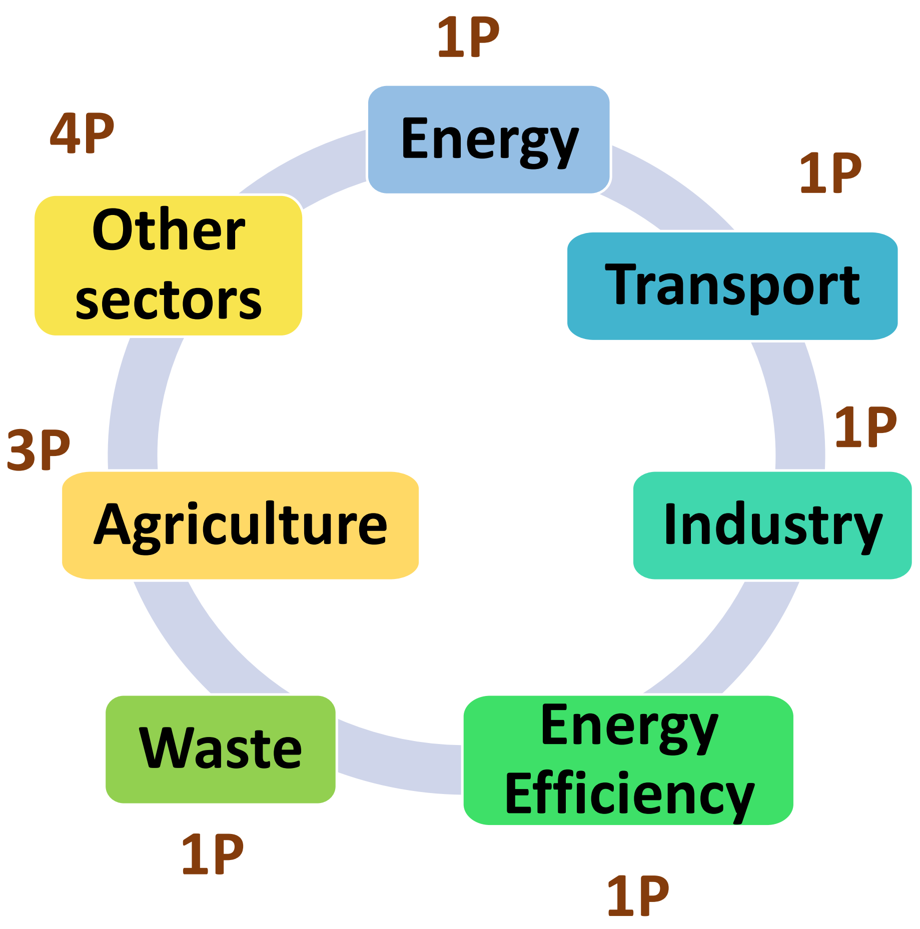
Relative to 2005



WaM 30

E.1	Energy mix
T.1	Emission reductions for road transport, rail, aviation and shipping
I.1	Industrial Sector
EE.1	Improved energy efficiency in the residential, comercial, institutional and other sectors
RS.1	Waste
A.1	Use of fertiliser plans
A.2	Reduction of emissions form burning prunings
A.3	Manure and housing management for cattle, pigs and poultry
O.1	Reduction of emissions from residential wood burning
O.2	Reduction of emissions from the domestic use of solvents and paints
O.3	Public awareness campaigns
O.4	Reduction of tropospheric ozone precursors

12 packages of 61 measures



- **6 more measures in the Energy sector (compared with PNCCA-2019)**
- **A change in O packages (target)**
- **Some of them slightly modified**

NAPCP-2019

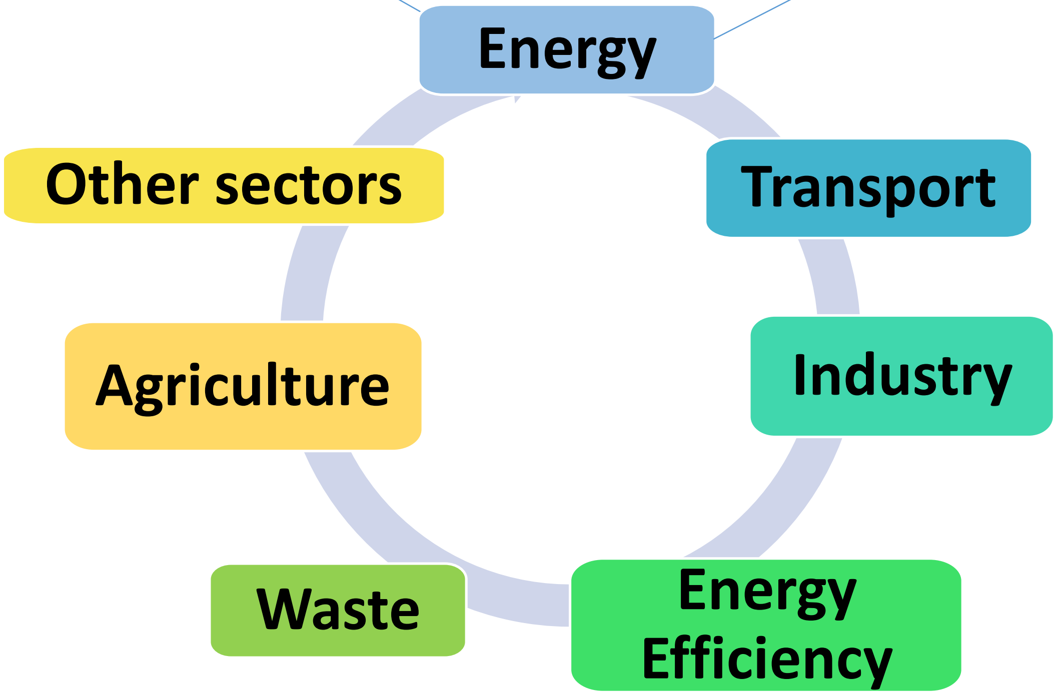
13 packages of 57 measures

8 measures

NAPCP-2023

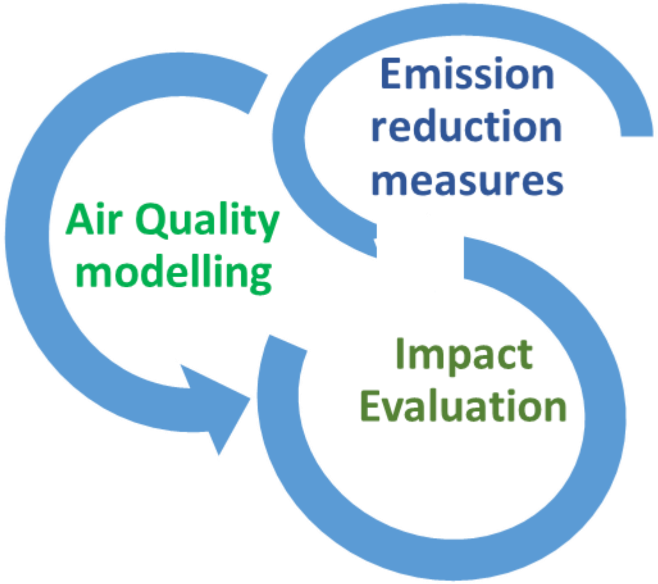
12 packages of 61 measures

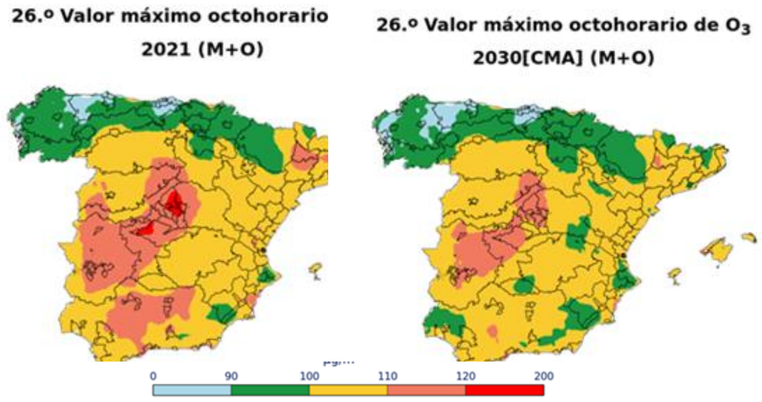
8 + 6 measures



- Development of innovative renewable energy facilities
- Energy storage
- Demand management and flexibility
- Energy communities
- Development of green hydrogen
- Development of new hydropower storage capacity

The Atmospheric Modelling Unit (CIEMAT) carried out the evaluation of the impacts on air quality for the NAPCP-2023 (and 2019)





Methodology

- **CHIMERE chemistry and transport model**
- **0.08º x 0.08º (within a European domain: 0.15º x 0.15º)**
- **Boundary conditions (European domain): from LMDZ-INCA and GOCART global model climatology.**
- **Reference year: 2021→Emissions: Spanish Inventory and EMEP for Europe (2021); Reductions WAM 2030 estimated relative to 2021 by the Spanish Ministry (MITECO)**
- **Meteorology: 2021 ECMWF-IFS (With thanks to AEMET for Access to the MARS archive of ECMWF)**
- **Correction applied to 2021 base case (using observations) and scenarios (relative to the base case)**

Evaluation of the accomplishment of European legislation (AAQD)

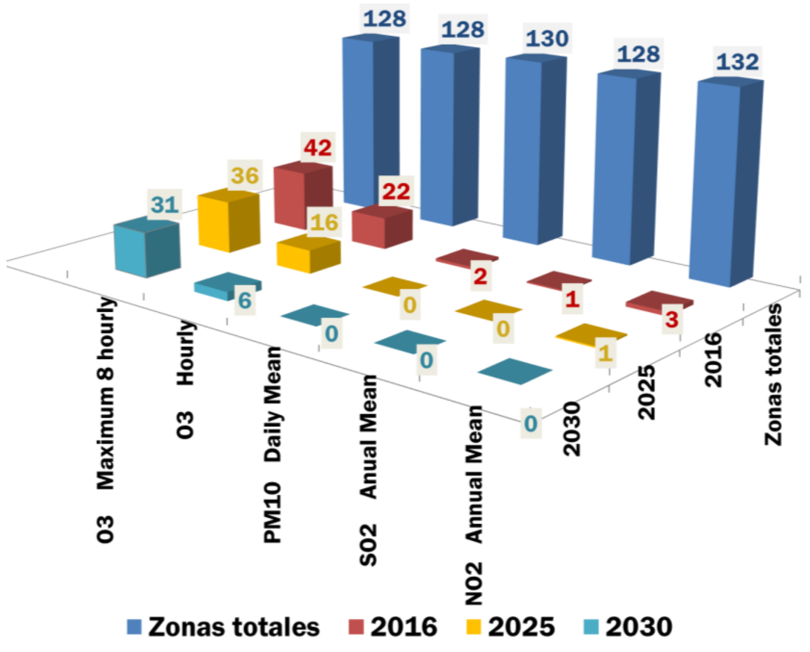
NAPCP-2019

- Meteorology for 2016
- Reference case (emissions and reductions): 2016
- Resolution: 0.1º
- Combination model + obs: separately for rural and urban sites

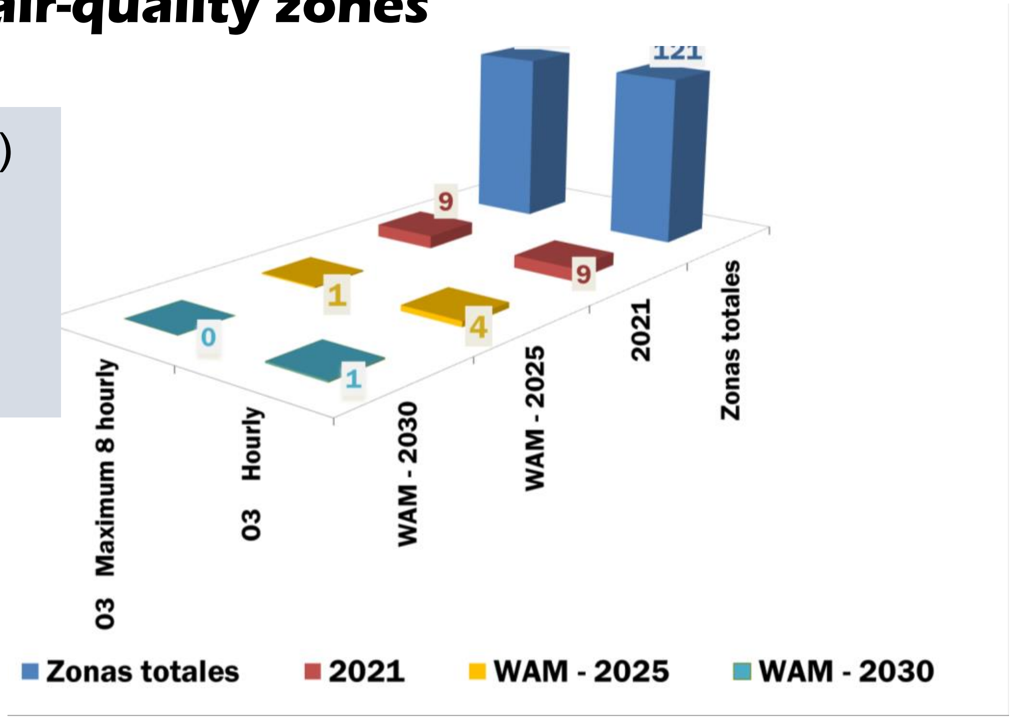
NAPCP-2023

- Meteorology for 2021
- Reference case (emissions and reductions): 2021
- Resolution: 0.08º
- Combination model + obs: all sites

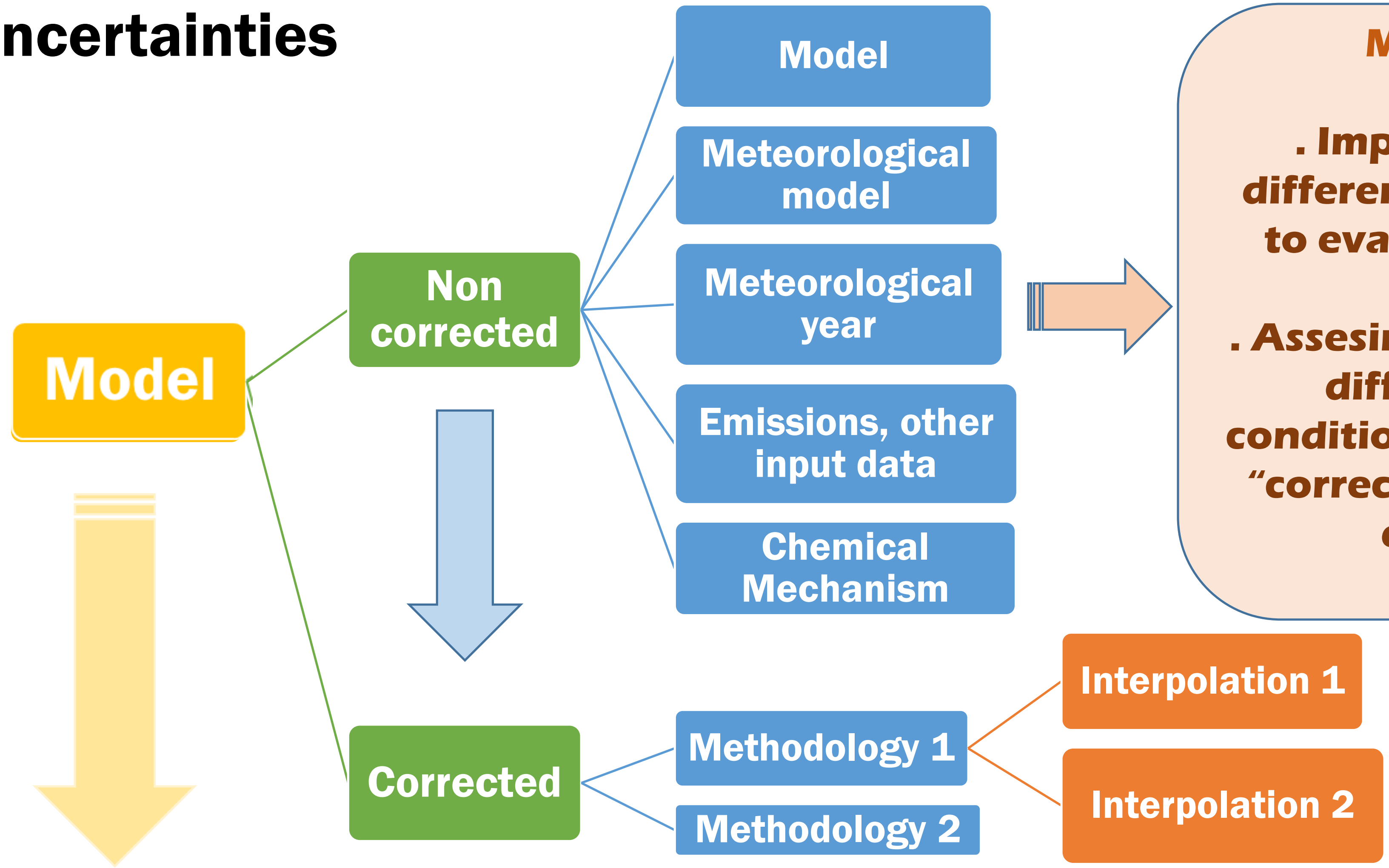
Number of non-compliant air-quality zones



O_3 (inf. thresh, max8h)
NO_2 (ann. mean, h)
SO_2 (ann. mean, h, d)
PM10 (ann. mean, d)
PM2.5 (ann. mean)



Estimation of the number of non-compliant air quality zones: Uncertainties



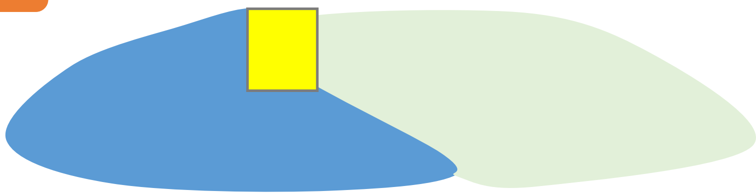
Meteorological year:

. Impacts on air quality with different meteorologies are easy to evaluate with models , BUT

. Assesing the non-compliance for different meteorological conditions is very complex (with a “corrected model” – how do you do the correction?)

CONCENTRATION

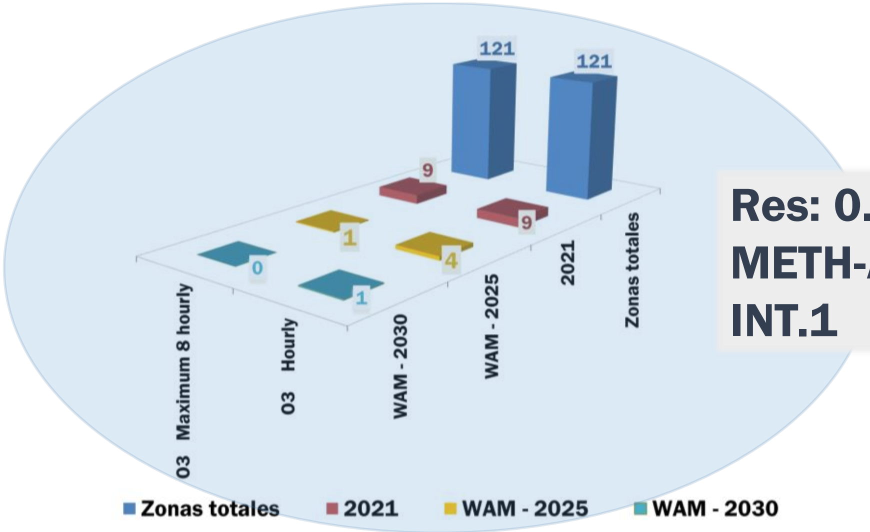
In addition, how to assign an uncompliant cell to an air quality zone



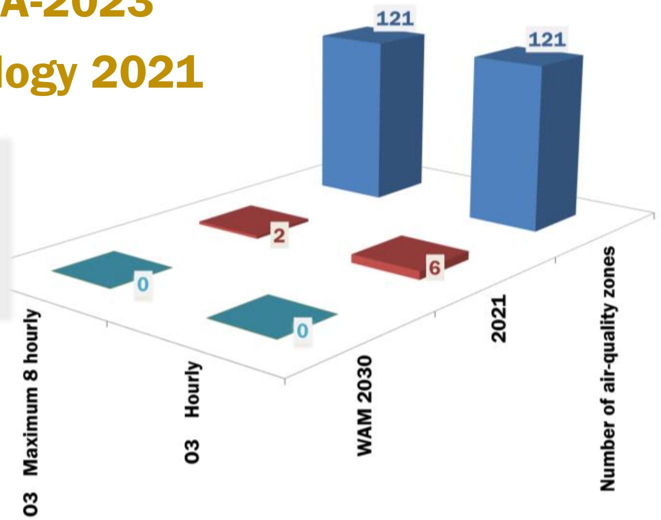
Evaluation of the accomplishment of European legislation (AAQD)

PNCCA-2023

Meteorology 2021

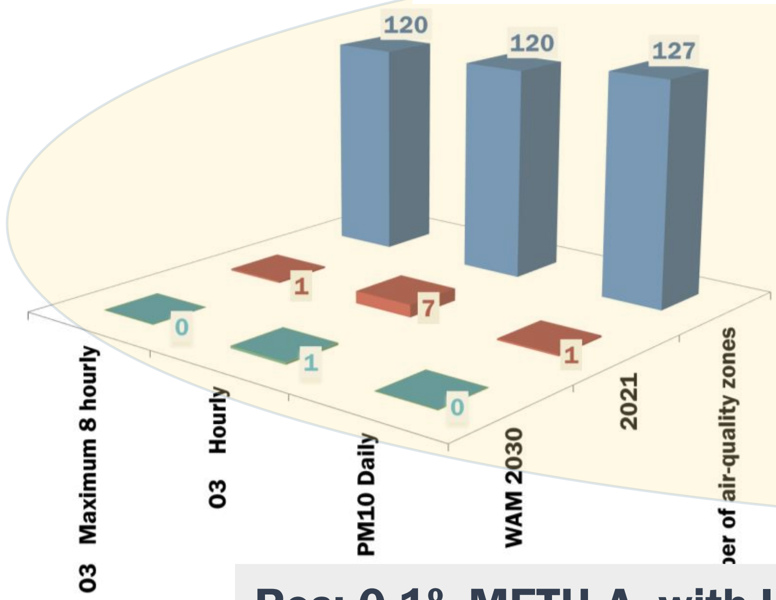


Res: 0.08º; METH-A with INT.1



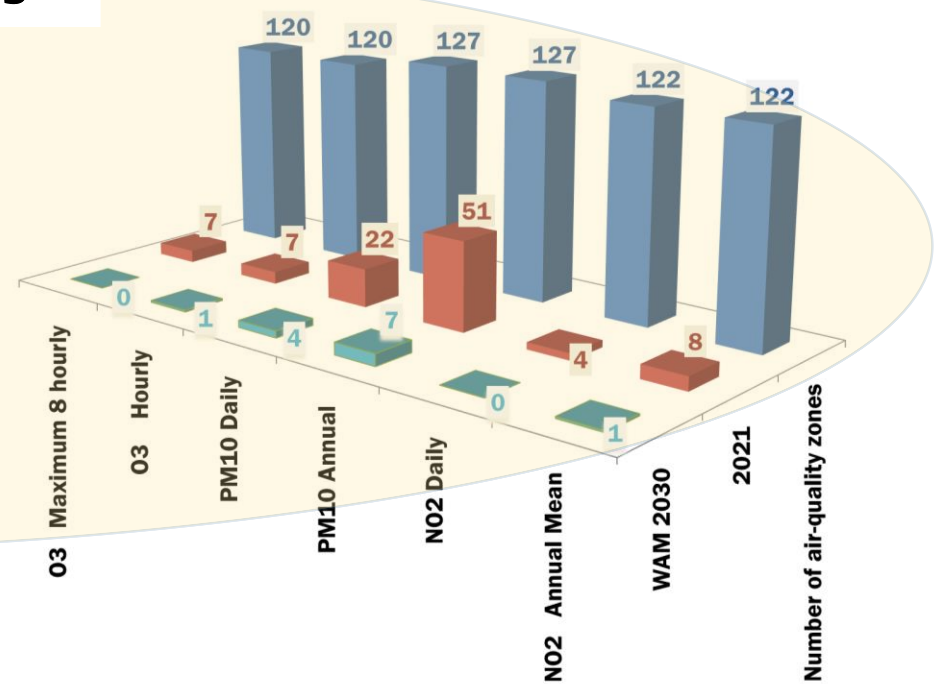
Res: 0.08º; METH-A WITH INT.2

Number of uncompliant air-quality zones



New AAQD

Annual mean NO_2:	20 µg/m³
Daily NO_2(18 times):	50 µg/m³
Annual mean PM10:	20 µg/m³
Daily PM10 (18 times):	45 µg/m³
Max. 8hour O3: (18 t):	120 µg/m³



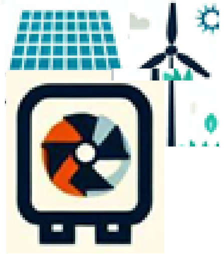
Res: 0.1º, METH-A with INT.2

2. Evaluation of Selected Measures

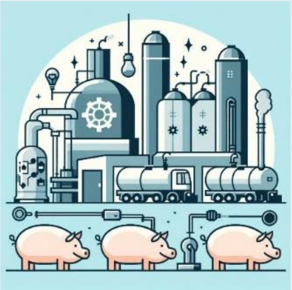
Some images produced with Bing Image Creator DALL-E 3

We have evaluated some individual measures. **Emission reductions estimated by CIEMAT (Energy Systems Analysis Unit)**

Measure	Scenario
Increased Energy efficiency in buildings: **Residential Sector**  *Emission factors and methodology according to the EMEP guidance specific to "Small Combustion Plants" for residential uses*	**Replacement of boilers by more efficient models**
	Improvement of the thermal envelope of buildings. Electricity mix foreseen for 2030
	Improvement of the thermal envelope of buildings. Current electricity mix
	Replacement of fossil fuel boilers by electric heat-pumps. Electricity mix foreseen for 2030
	Replacement of fossil fuel boilers by electric heat-pumps. Current electricity mix



Images produced with Bing Image Creator DALL-E 3

Measure	Sector	Scenario
Use of electric vehicles	**Transport (Passenger)** 	Scenario A, electricity mix foreseen for 2030, Substitution of 5.500.000 fossil-fuelled passenger cars
		Scenario B, electricity mix foreseen for 2030, Substitution of 11.000.000 fossil-fuelled passenger cars
		Scenario C, electricity mix foreseen for 2030, Substitution of 22.000.000 fossil-fuelled passenger cars
Use of slurry for biogas production	**Agriculture and Energy** 	Use of slurry from the pig sector (porcino blanco) for biogas production (without reduction of combustion emissions)
		Use of slurry from the pig sector (porcino blanco) for biogas production (with reduction of combustion emissions)

Images produced with Bing Image Creator DALL-E 3

Use of surplus renewables for the production of H_2 (green hydrogen)

Industrial and HDV Sectors

EMEP/EEA air pollutant emission inventory guidebook 2023

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- **For use as raw material** (e.g. NH_3 production)
- **High T heat production in the iron and steel industry**
  - Average EMEP EF for NOx (same value as natural gas, NG)
  - Highest EMEP EF for NOx (3 times higher than NG)
- **High T heat production in the cement industry**
  - Average NOx EF
  - High NOx EF
- **High T heat production in the refinery and petrochemical industry**
  - Average NOx EF
  - High NOx EF
- **Introduction of 5% H_2 in industrial NG supply**

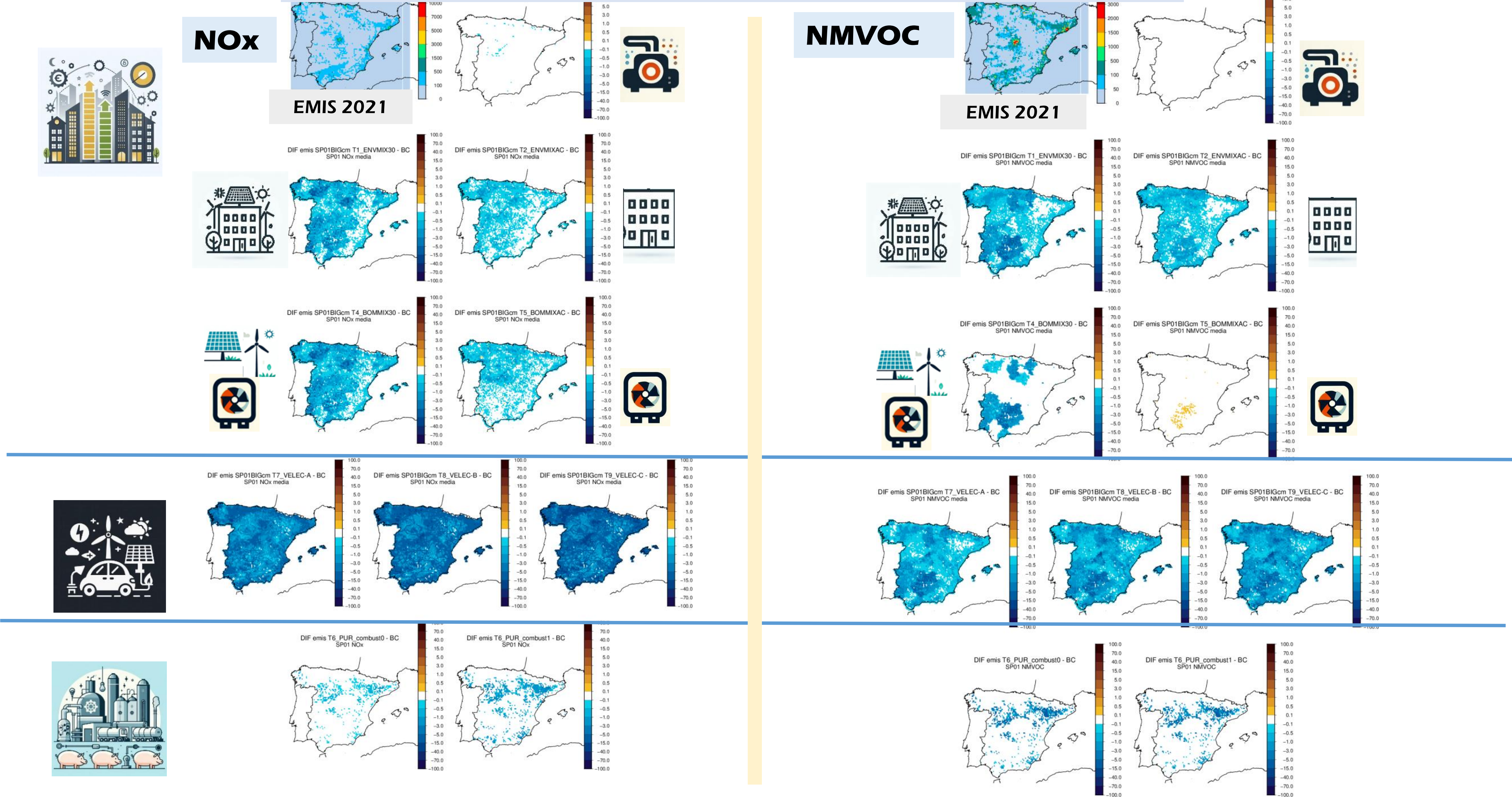
(NOx EF for low mixing values). Reductions due to lower NG use and variation of emissions in pipelines

- **Introduction of 5% H_2 in domestic NG supply**

(NOx EF for low mixing values). Reductions due to lower NG use and variation of emissions in pipelines

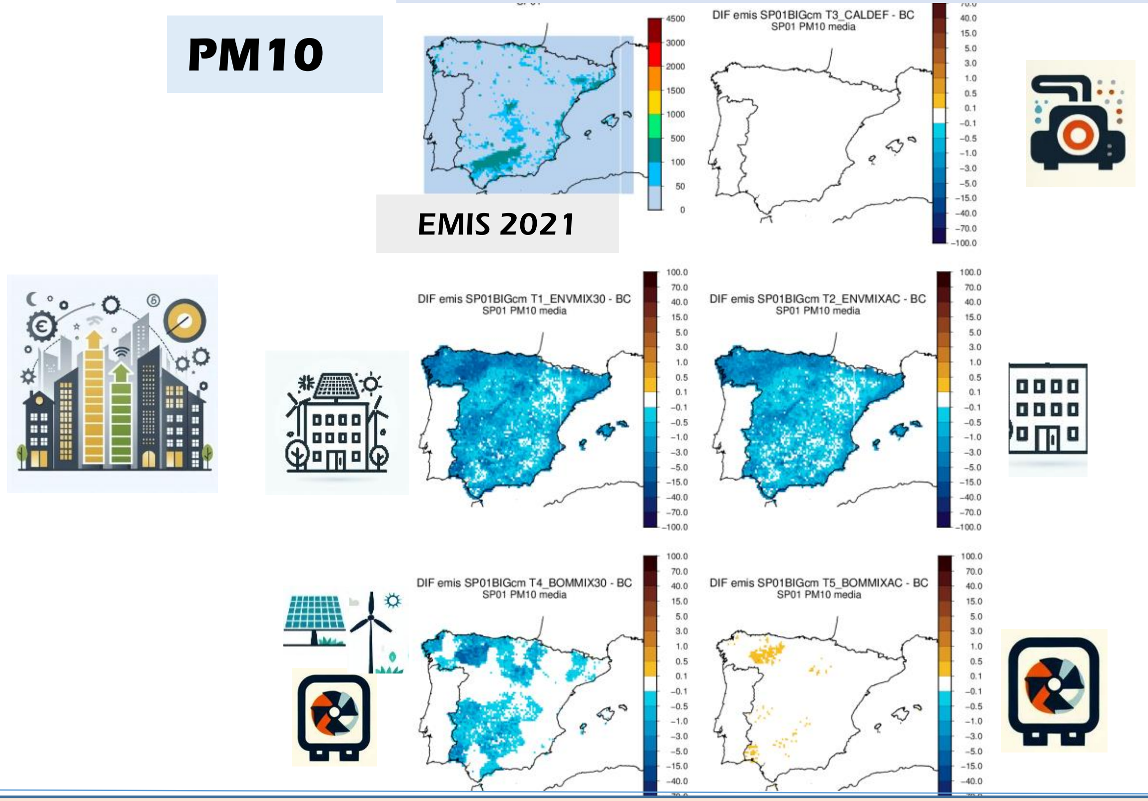
- **Hydrogen for heavy duty FCEVs (Fuel-cell electric vehicles).** 5000 diesel HDVs replaced by FCEVs (in terms of vehicle.km). **(Not yet)**

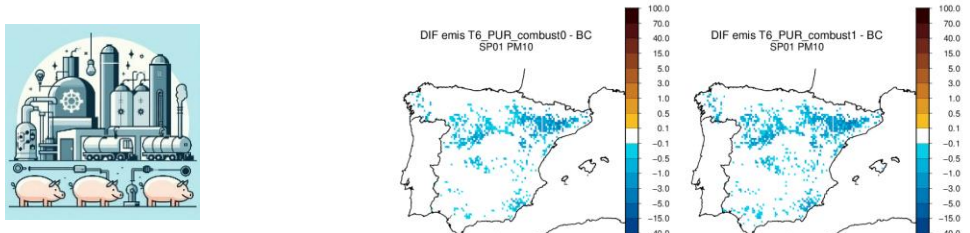
EMISSION DIFERENCES (WITH RESPECT TO 2021)



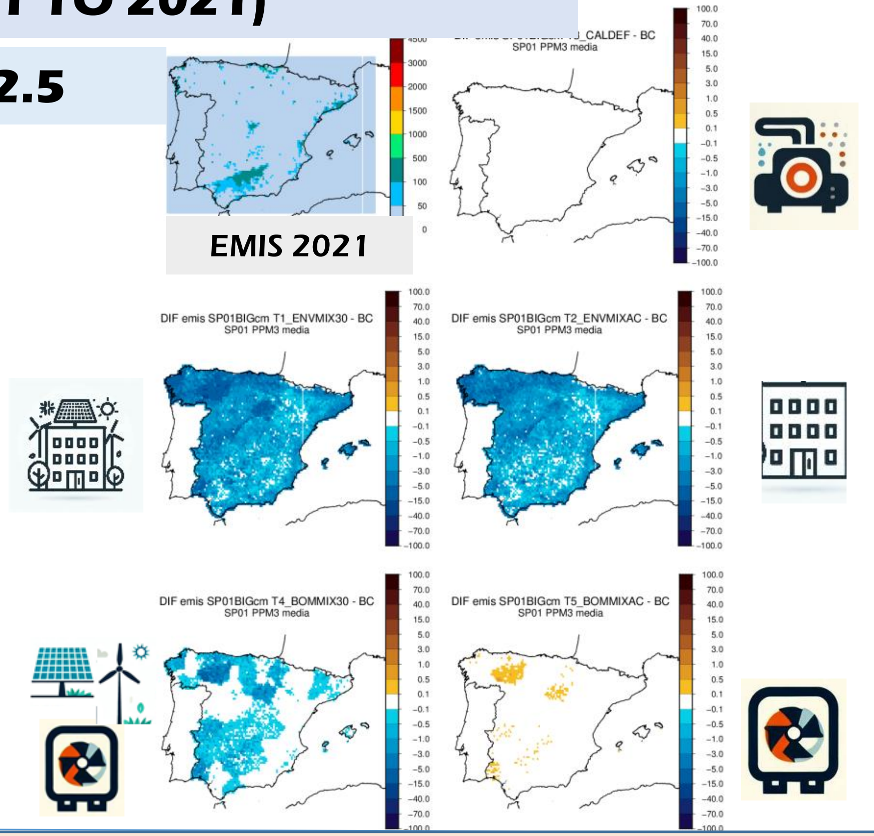
EMISSION DIFERENCES (WITH RESPECT TO 2021)

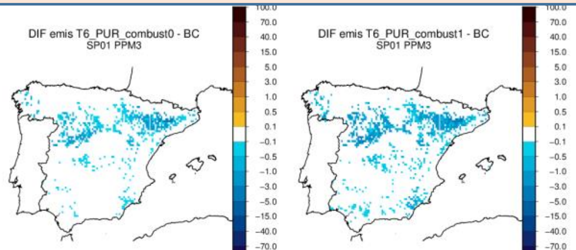
PM10



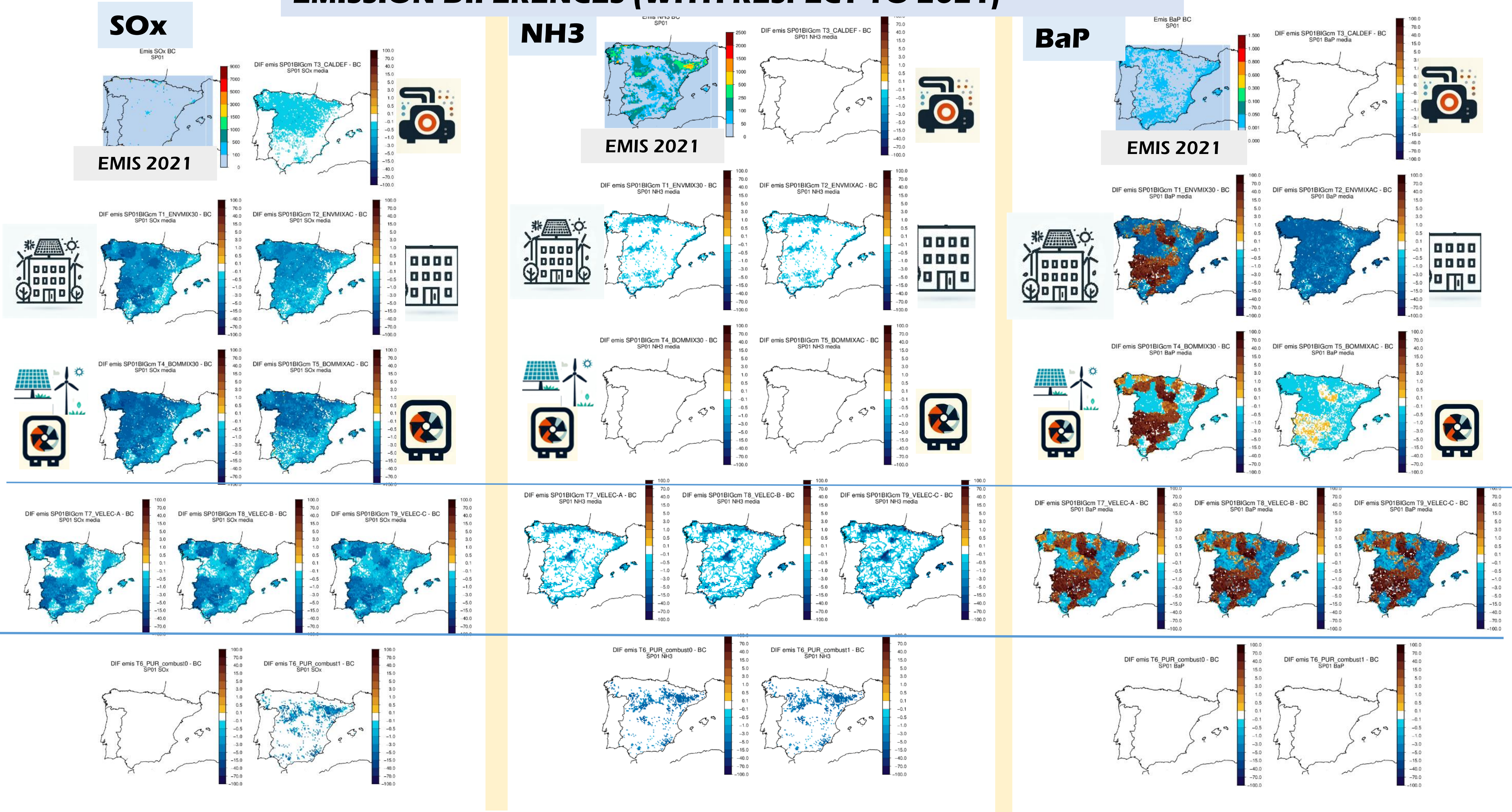


PM2.5

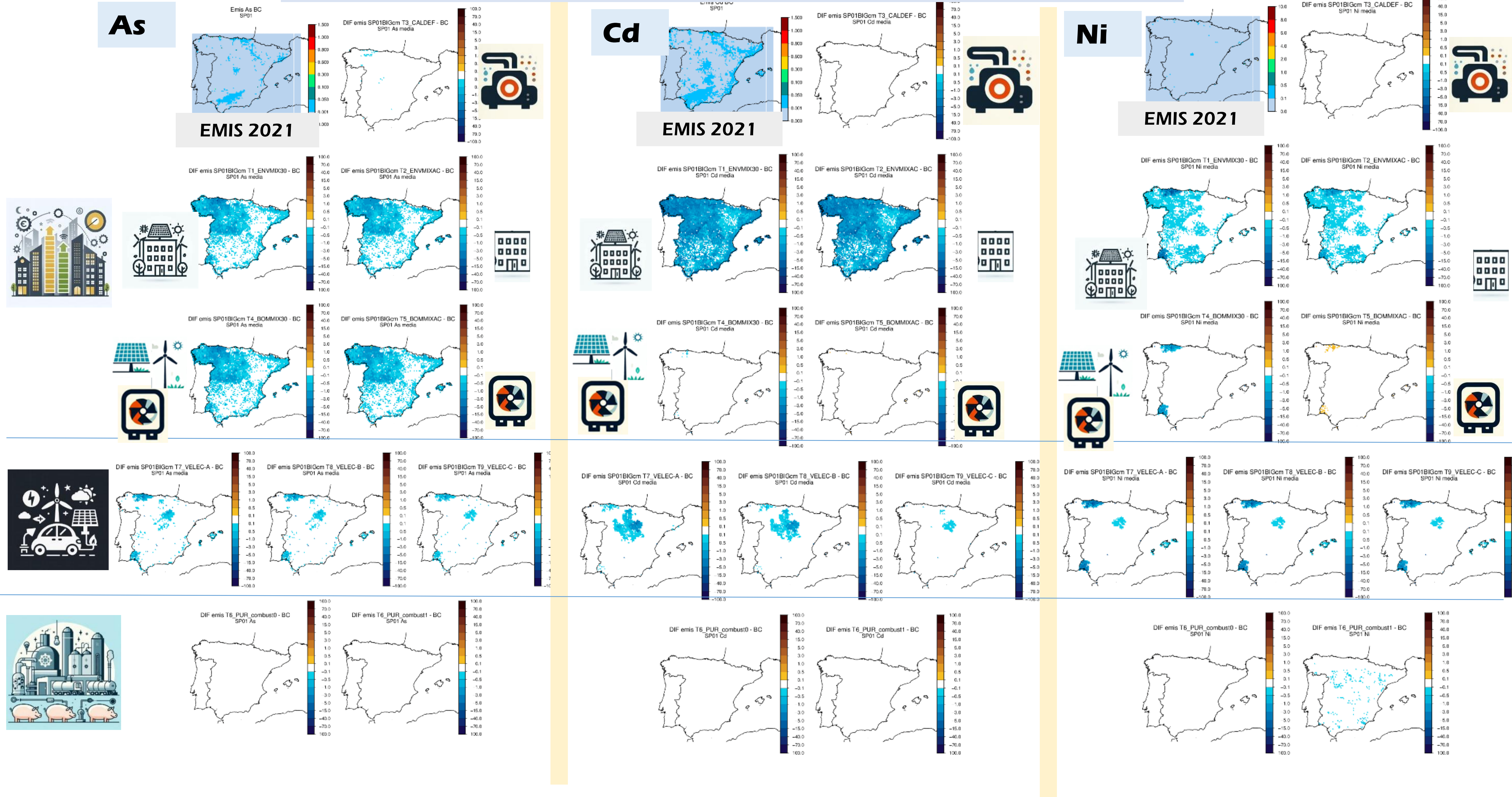




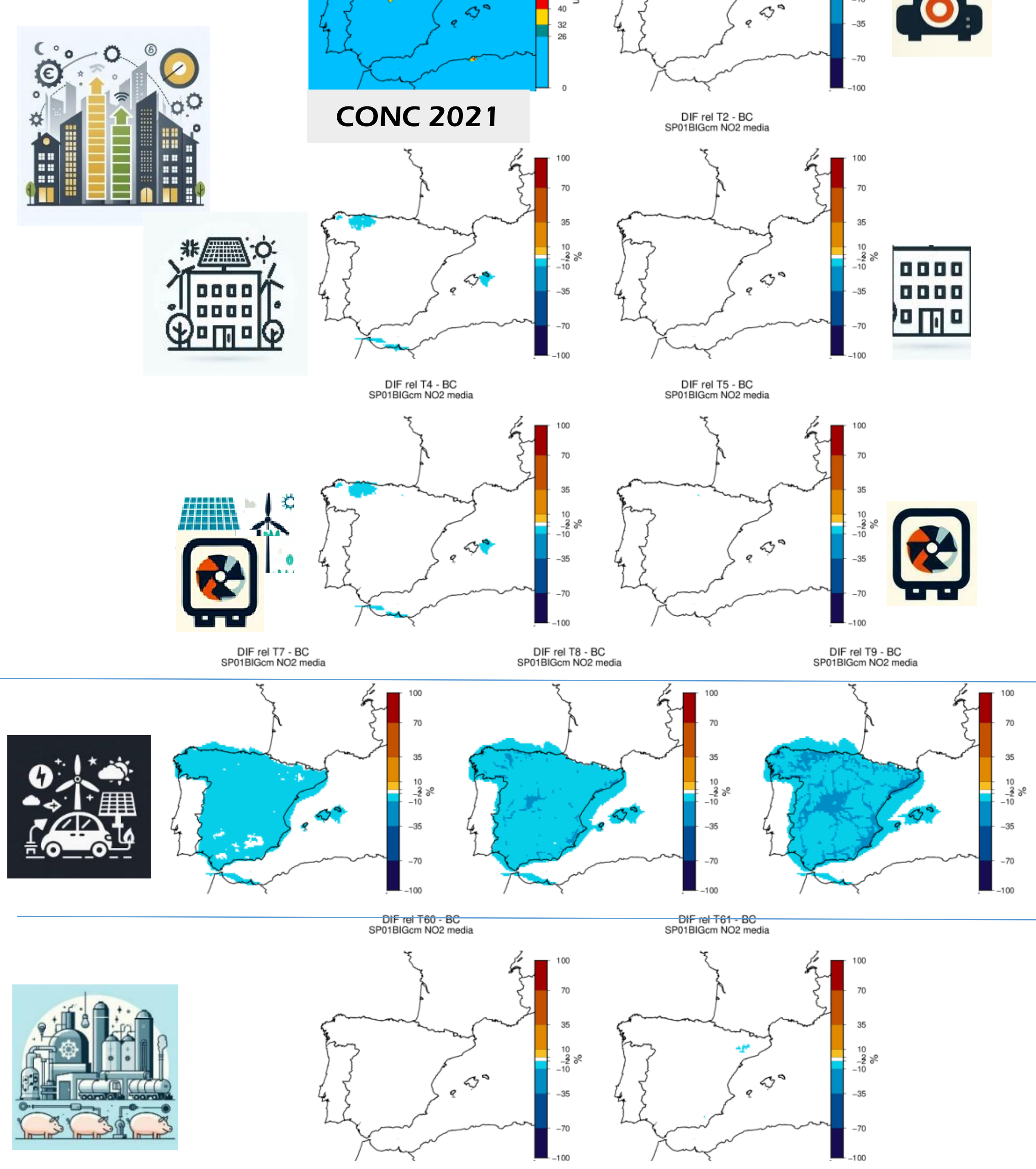
EMISSION DIFERENCES (WITH RESPECT TO 2021)



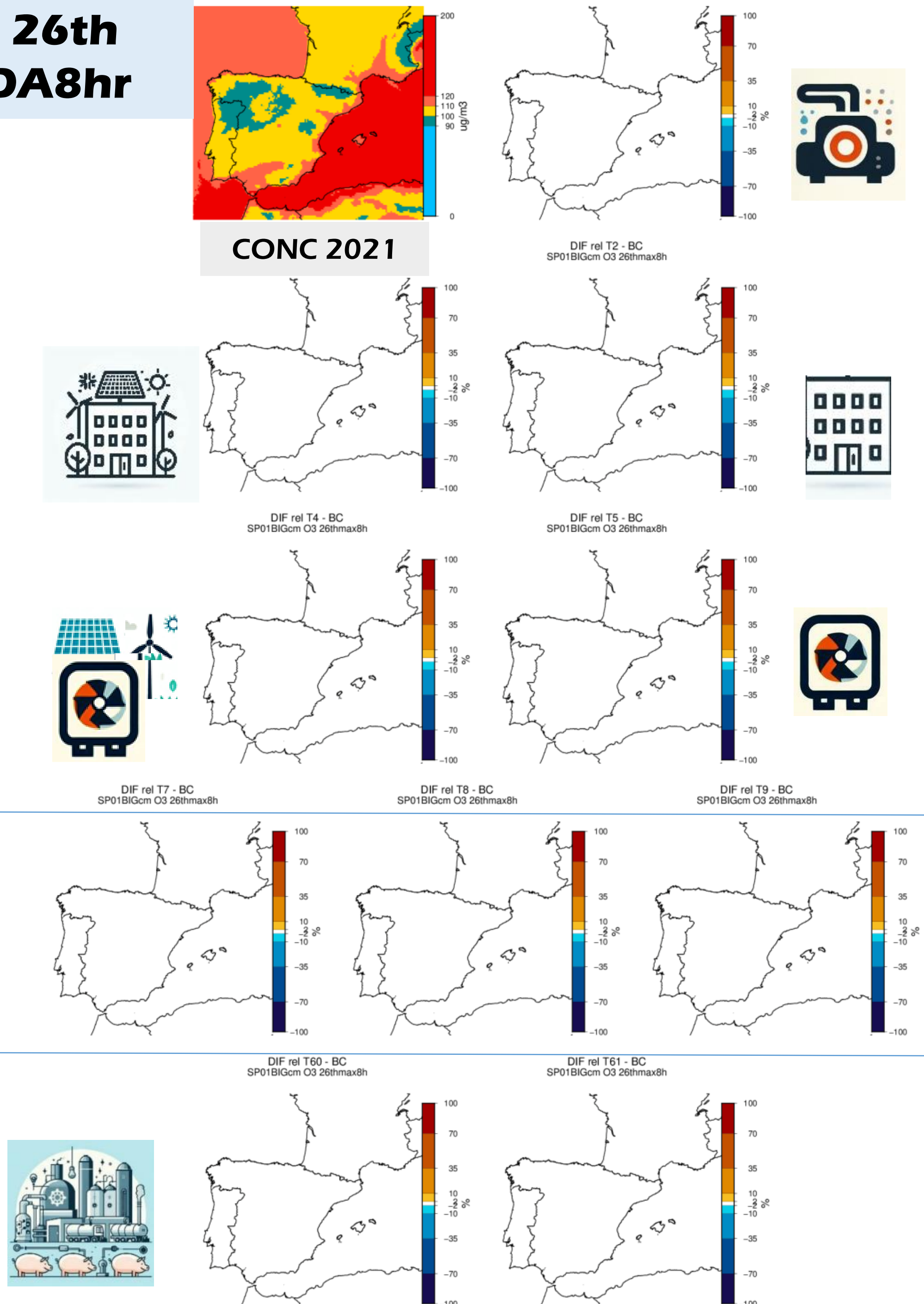
EMISSION DIFERENCES (WITH RESPECT TO 2021)



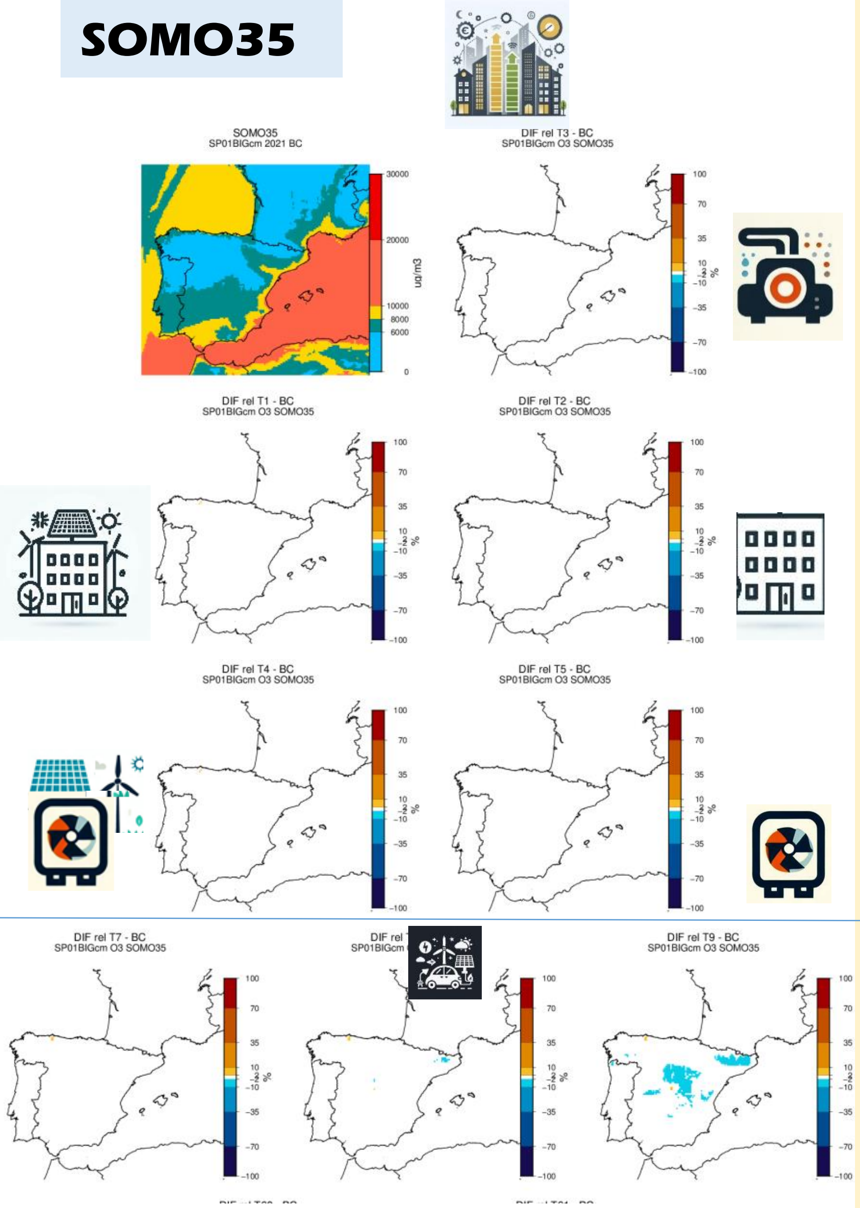
NO_2 anual MEAN



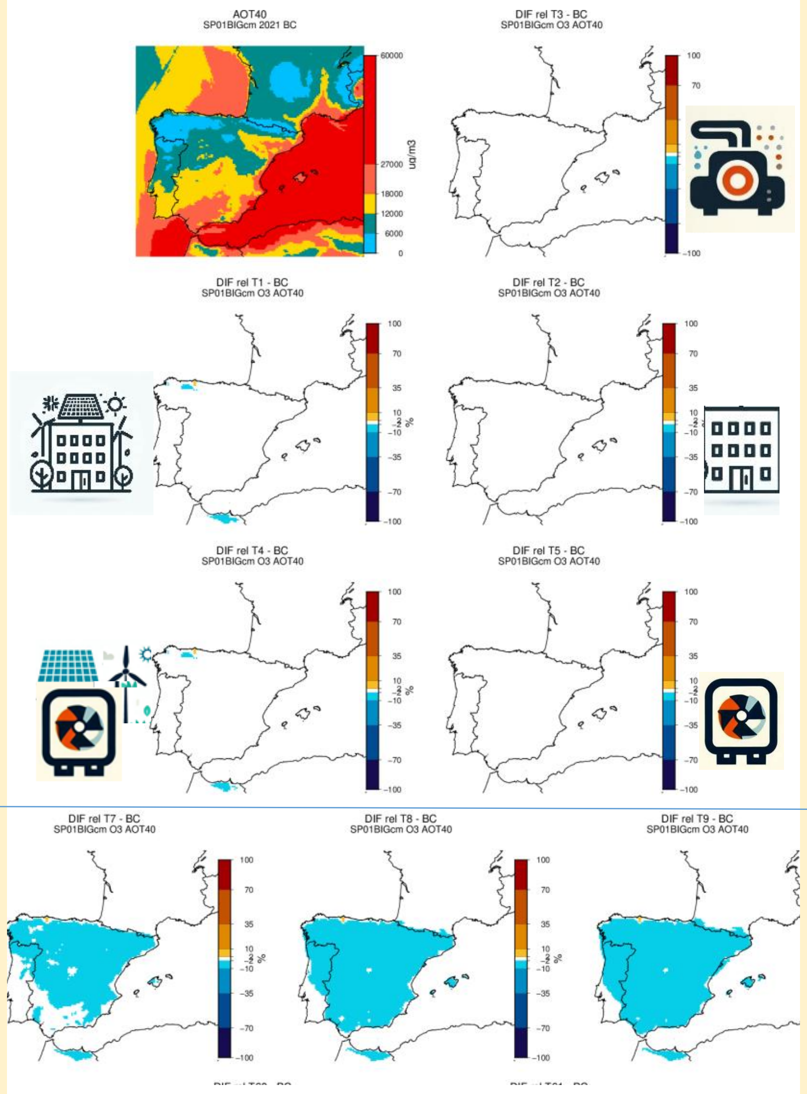
O_3 26th MDA8hr



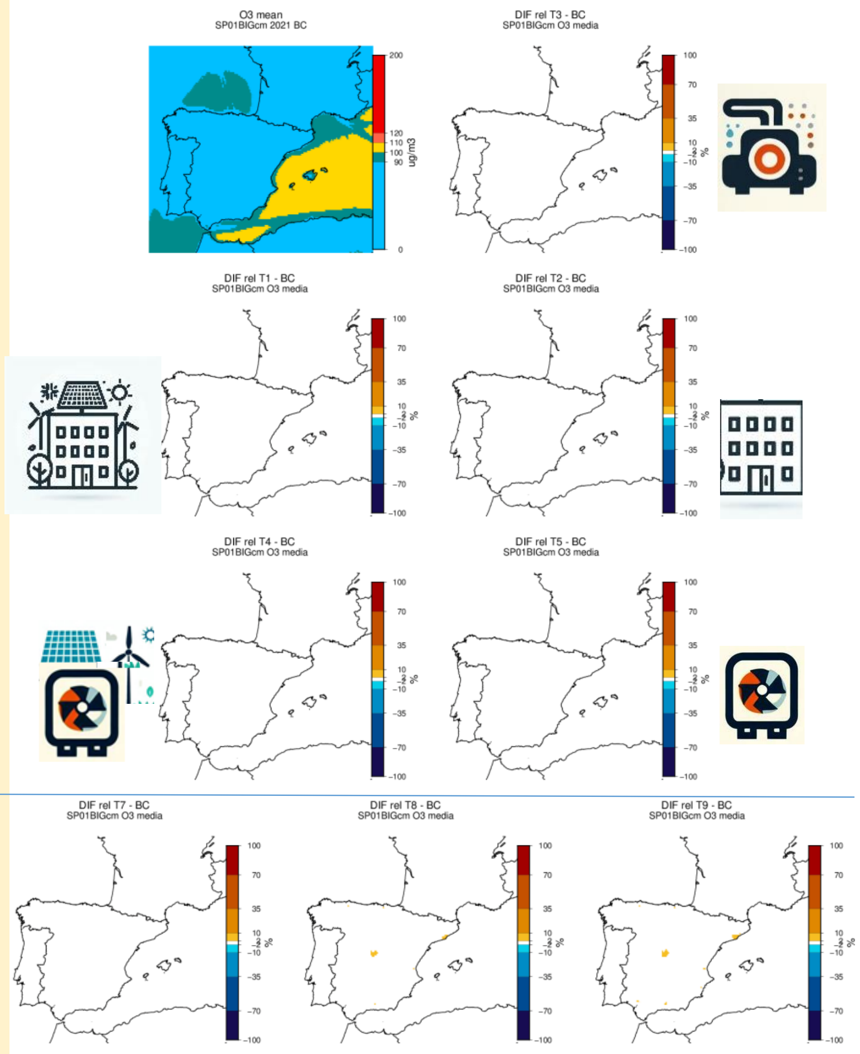
SOMO35

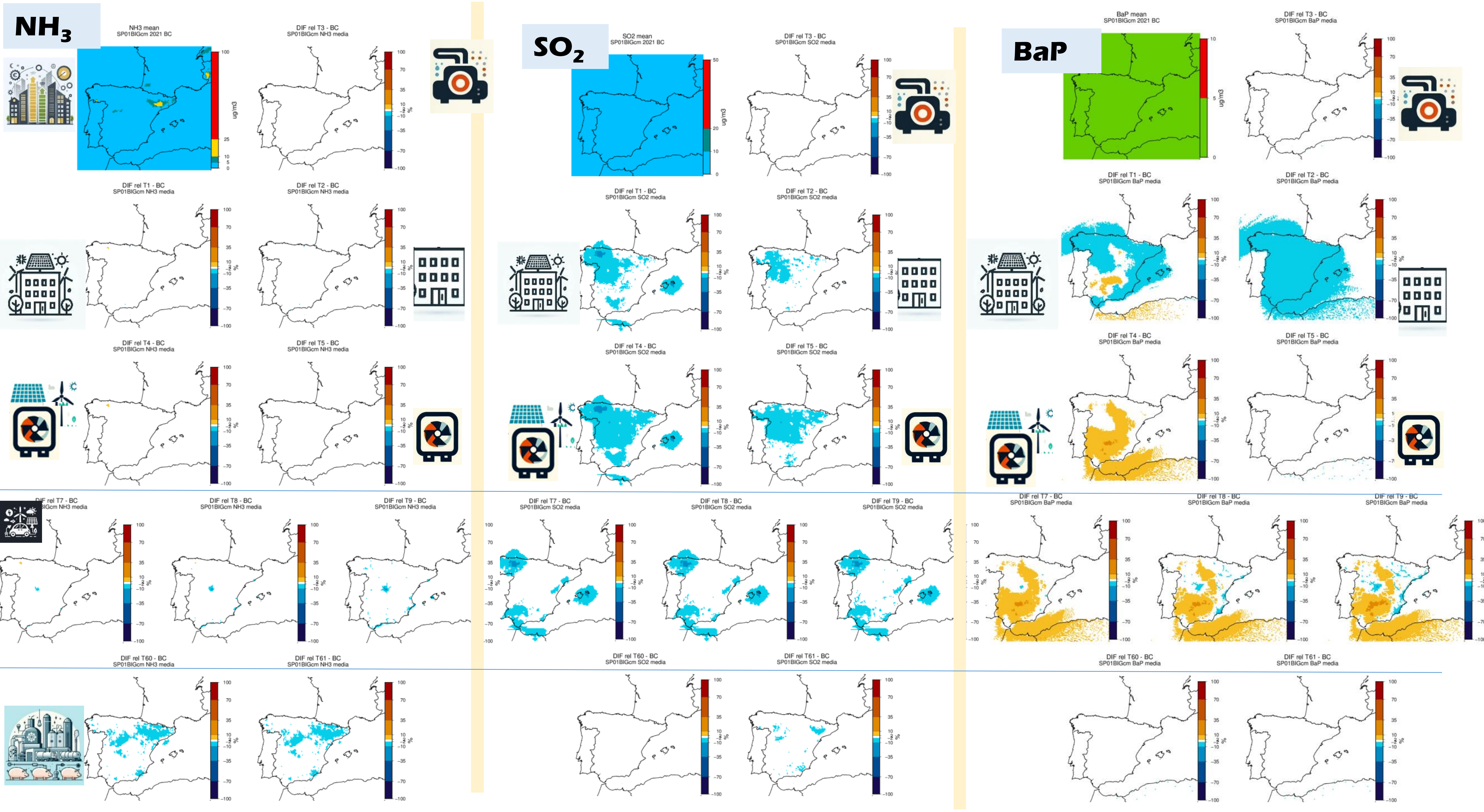


AOT40



O_3 Annual Mean




NH3
NH3 mean
SP01BIGcm 2021 BC
ug/m3
DIF rel T3 - BC
SP01BIGcm NH3 media
DIF rel T1 - BC
SP01BIGcm NH3 media
DIF rel T2 - BC
SP01BIGcm NH3 media
DIF rel T4 - BC
SP01BIGcm NH3 media
DIF rel T5 - BC
SP01BIGcm NH3 media
DIF rel T7 - BC
DIF rel T8 - BC
SP01BIGcm NH3 media
DIF rel T9 - BC
SP01BIGcm NH3 media
DIF rel T60 - BC
SP01BIGcm NH3 media
DIF rel T61 - BC
SP01BIGcm NH3 media
SO2
SO2 mean
SP01BIGcm 2021 BC
ug/m3
DIF rel T3 - BC
SP01BIGcm SO2 media
DIF rel T1 - BC
SP01BIGcm SO2 media
DIF rel T2 - BC
SP01BIGcm SO2 media
DIF rel T4 - BC
SP01BIGcm SO2 media
DIF rel T5 - BC
SP01BIGcm SO2 media
DIF rel T7 - BC
SP01BIGcm SO2 media
DIF rel T8 - BC
SP01BIGcm SO2 media
DIF rel T9 - BC
SP01BIGcm SO2 media
DIF rel T60 - BC
SP01BIGcm SO2 media
DIF rel T61 - BC
SP01BIGcm SO2 media
BaP
BaP mean
SP01BIGcm 2021 BC
ug/m3
DIF rel T3 - BC
SP01BIGcm BaP media
DIF rel T1 - BC
SP01BIGcm BaP media
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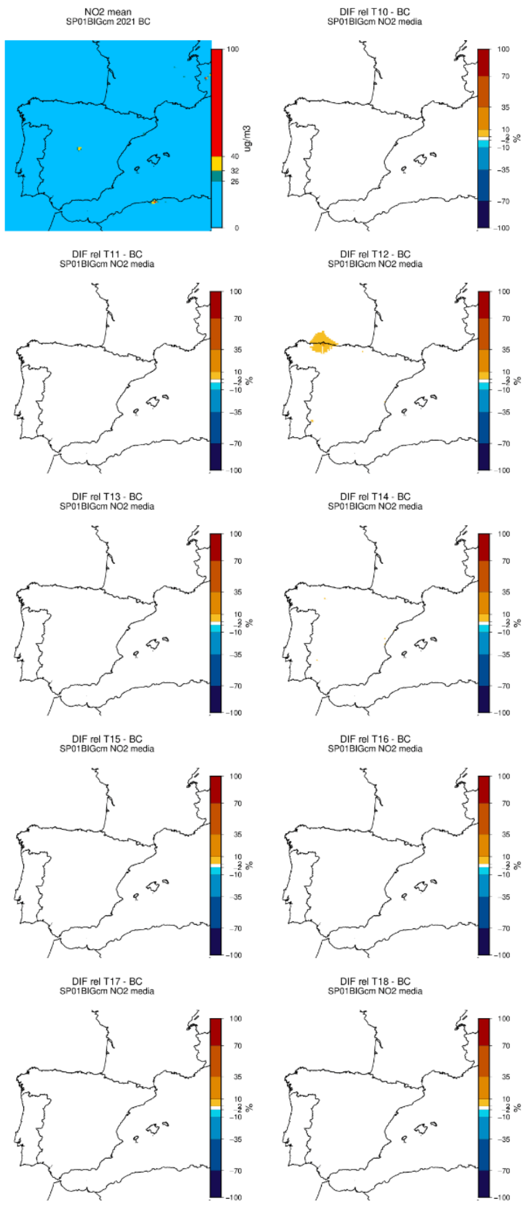
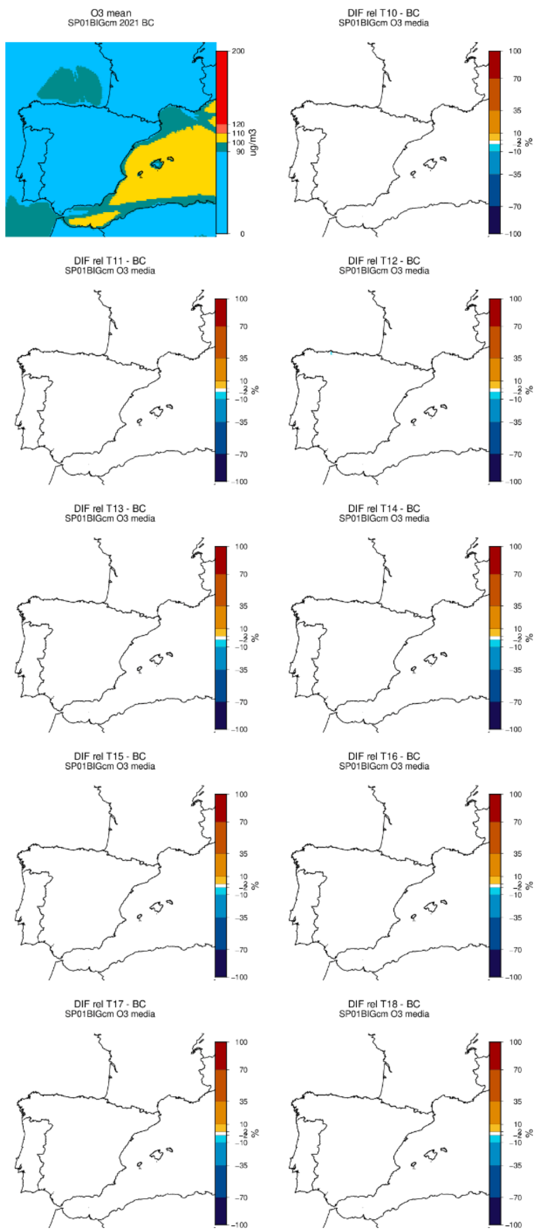
SP01BIGcm BaP media

NO_2 annual mean

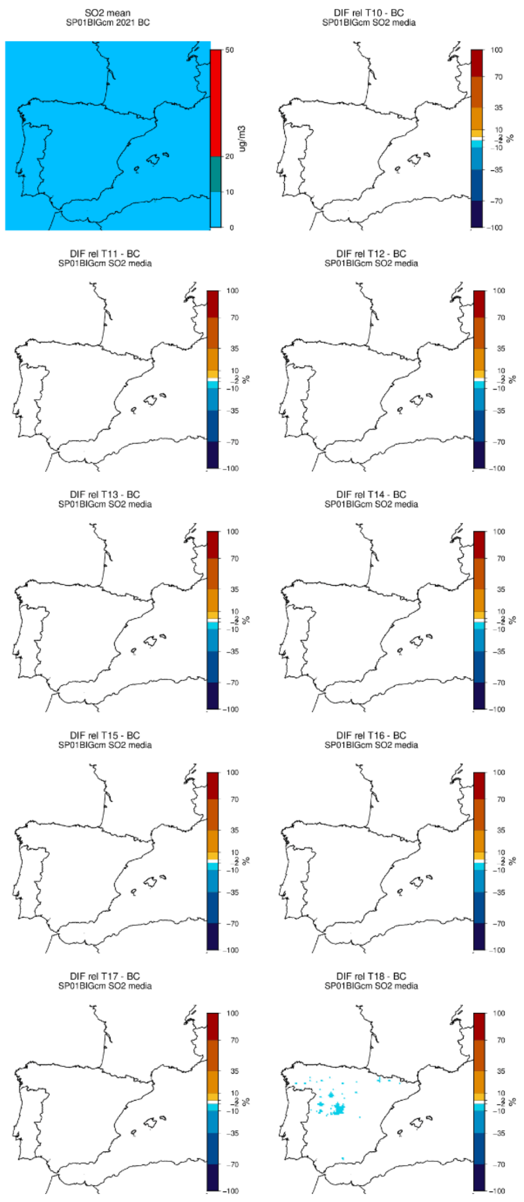


H_2 IRON AND STEEL (HIGH NOx EF)

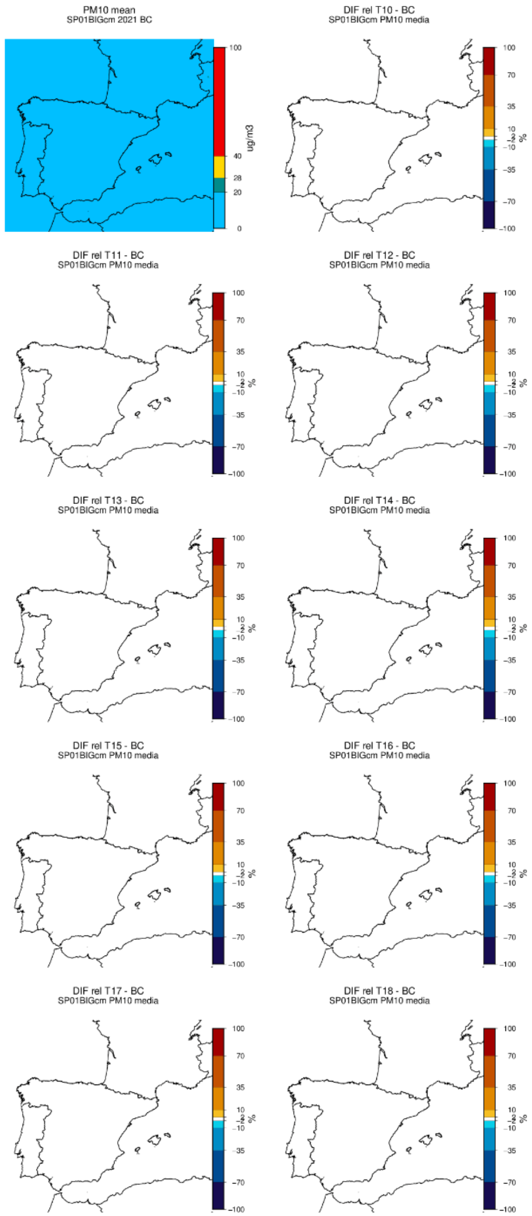
O_3 annual mean



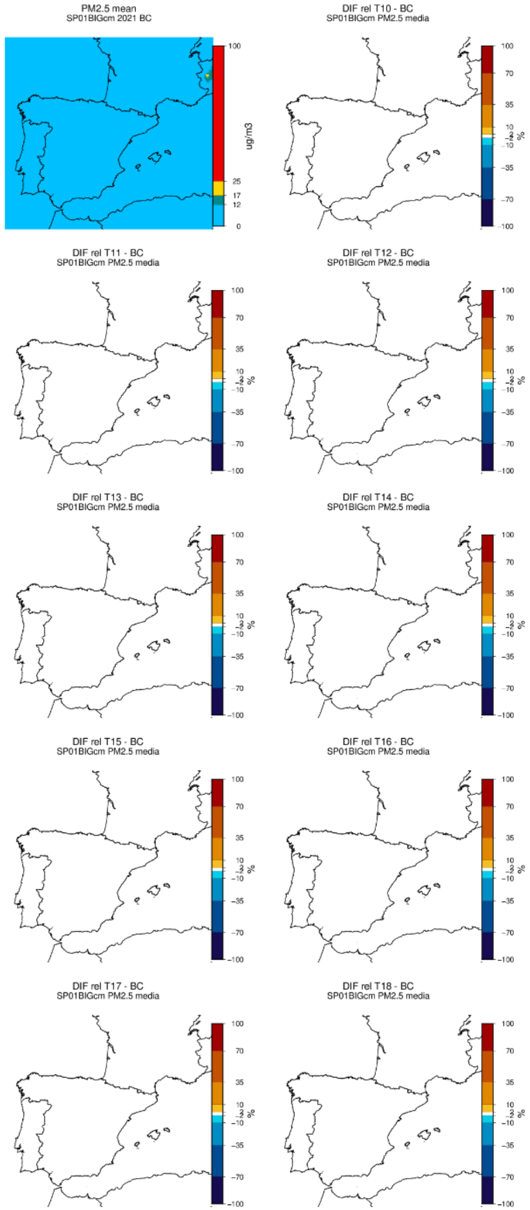
SO_2 annual mean



PM10 annual mean



PM2.5 annual mean



Conclusions – Part 1

The updated NAPCP-2023 improves previsions estimated in NAPCP-2019 for Spain, although asessing air quality non-compliance with models is a complex task due to:

A. Several factors in model application: resolution, meteorological model, emissions
B. Model correction (many methods) For a given method, there are different options (e.g. different interpolation methods)
C. How to assign an uncompliant cell to an air quality zone (affected by the methodology of assignment, model resolution, number/size of zones)
D. More complicated in future/hypothetical scenarios. For instance, considering different meteorological years; while impacts are easy to evaluate with models, assesing the non-compliance for different meteorological conditions is very complex

Conclusions – Part 2

- Electric vehicles, highest emission reductions (NOx, ..). Also: thermal envelopes of buildings.
- An increase of biomass burning in foreseen electric mix for 2030 could produce higher concentrations of BaP. (difficulties in locating future biomass burning installations, important for model simulations)
- Small impacts on air quality for scenarios considering Green Hydrogen
- Need for incorporating increases of PM emissions due to heavier vehicles (higher non-exhaust emissions)

Thanks!

- Thanks to the European Center for Medium-Range Weather Forecasts (ECMWF), including the provision of meteorological modelling data with thanks also to AEMET for managing access to this information.

- Project TED2021-132431B-I00 (TRANSAIRE: Transition to cleaner air in Spain) funded by MCIN/AEI/ 10.13039/501100011033 and by the European Union NextGenerationEU/PRTR

- We thank the Ministry for the Ecological Transition and Demographic Challenge (MITERD) for the provision of the emission inventory and reductions for the measures in the NAPCP. We also acknowledge MITERD for providing data from air quality stations.

Some images were produced with Bing Image Creator DALL-E 3

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