Assessment of the effects of the *1st Spanish National Air Pollution Control Programme* on air quality and health

Air quality modelling:

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Effects on health and costs:

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Measures & emission reductions estimated by:

Subdirección General de Calidad del Aire y Medio Ambiente Industrial. Ministerio para la Transición Ecológica y Reto Demográfico**. In collaboration with TRAGSATEC**

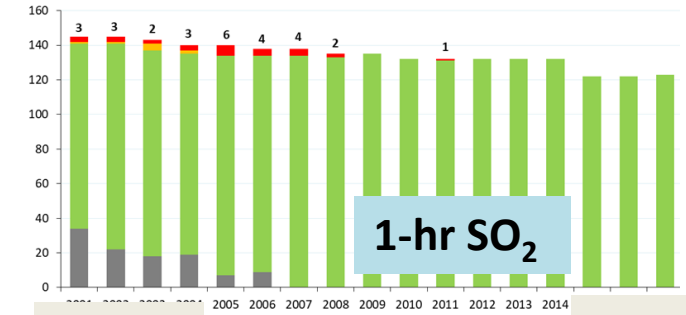
49th TFIAM meeting 20-22 April 2020

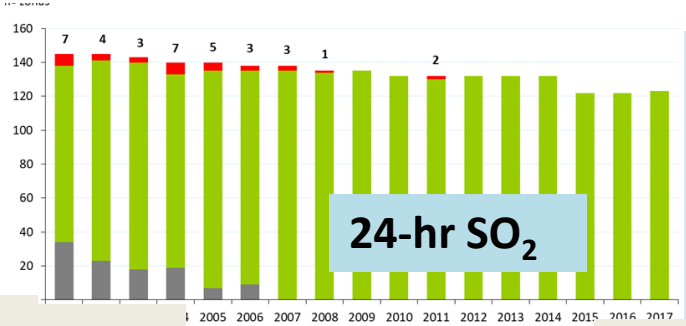
Outline

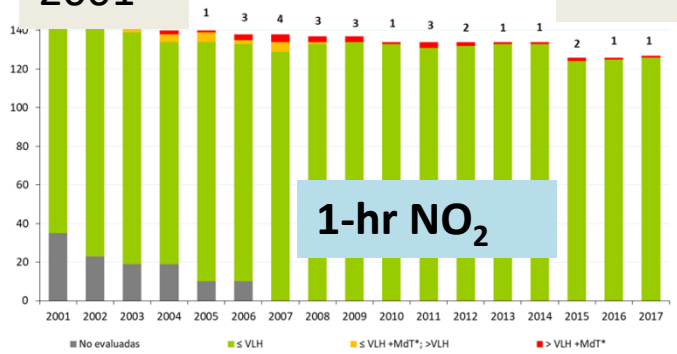
- Brief overview of the objectives for Spain in the NEC Directive (EU 2016/2284) and main air quality problems
- Measures in the 1st Spanish National Air Pollution Control Programme (S-NAPCP)
- Expected effects of the S-NAPCP on air quality
- Expected (preliminary) effects of the S-NAPCP on health and the associated costs
- Conclusions

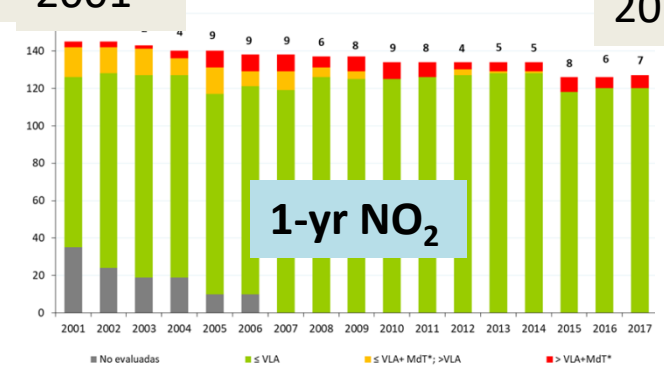
Brief overview of the objectives for Spain in the NEC Directive (EU 2016/2284) and main air quality problems

Overview of the areas with non-compliance during the period 2001-2017



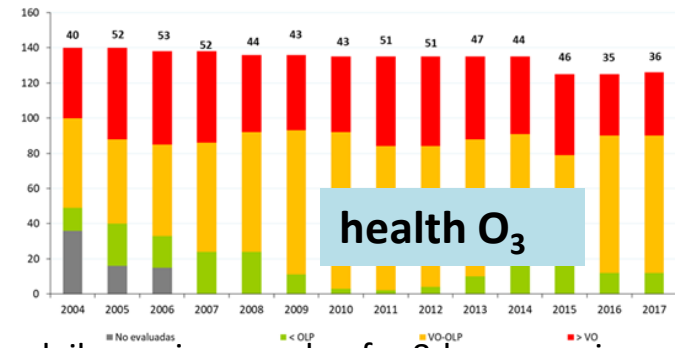


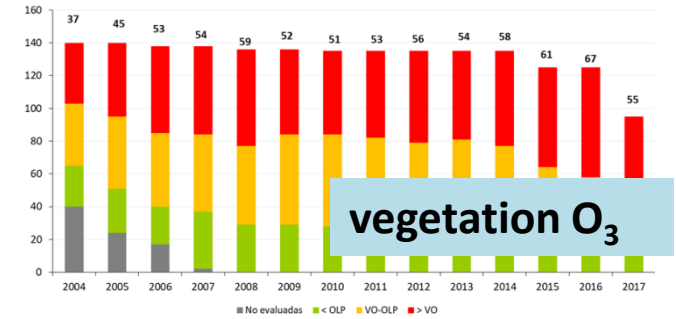




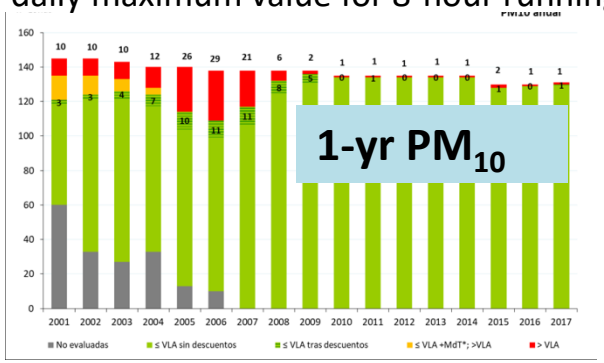
Reference: Air quality Database (Ministry for the Ecological Transition, MITECO)

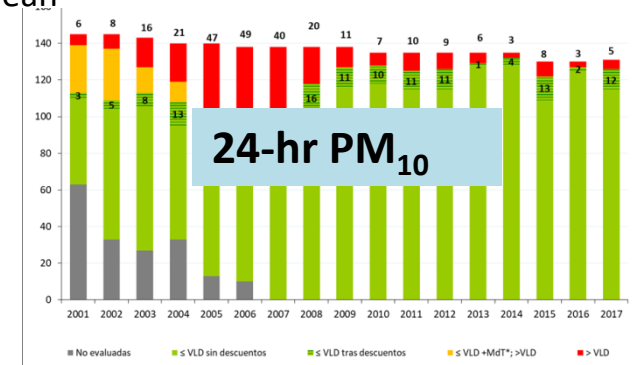
Based on observations

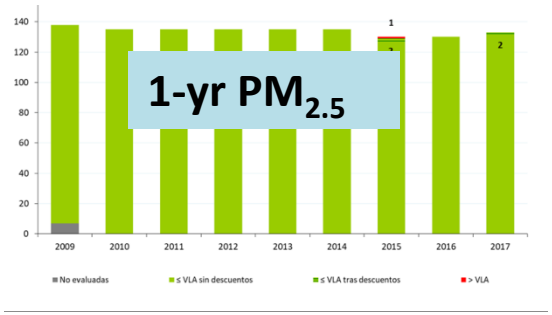




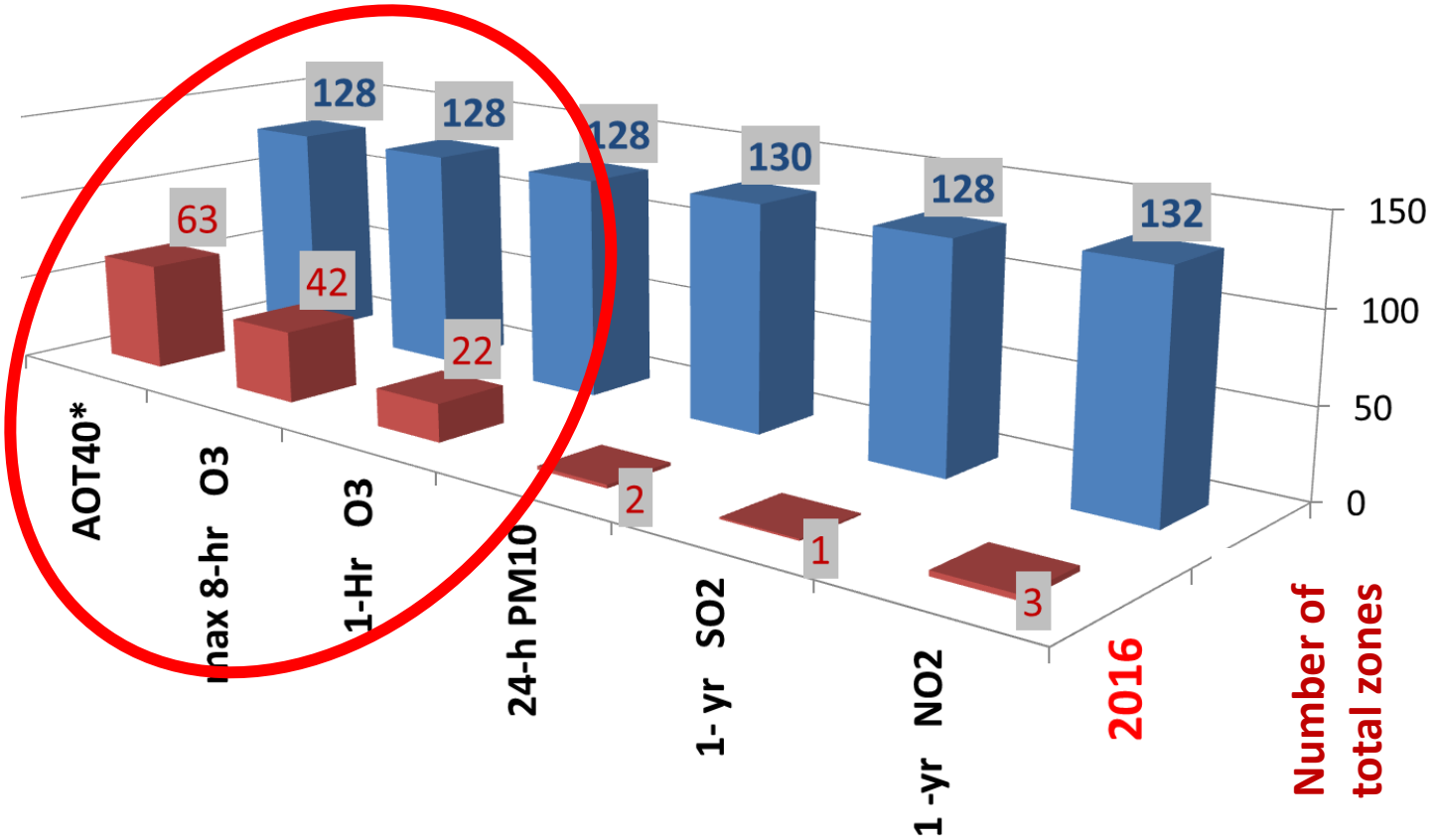
daily maximum value for 8-hour running mean





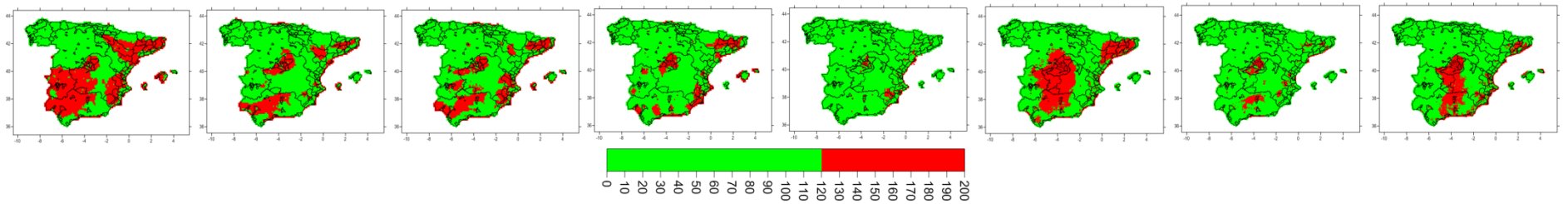


According to **model & observations** (M+O) estimates



26th highest daily maximum value for 8-hour running mean for O_3

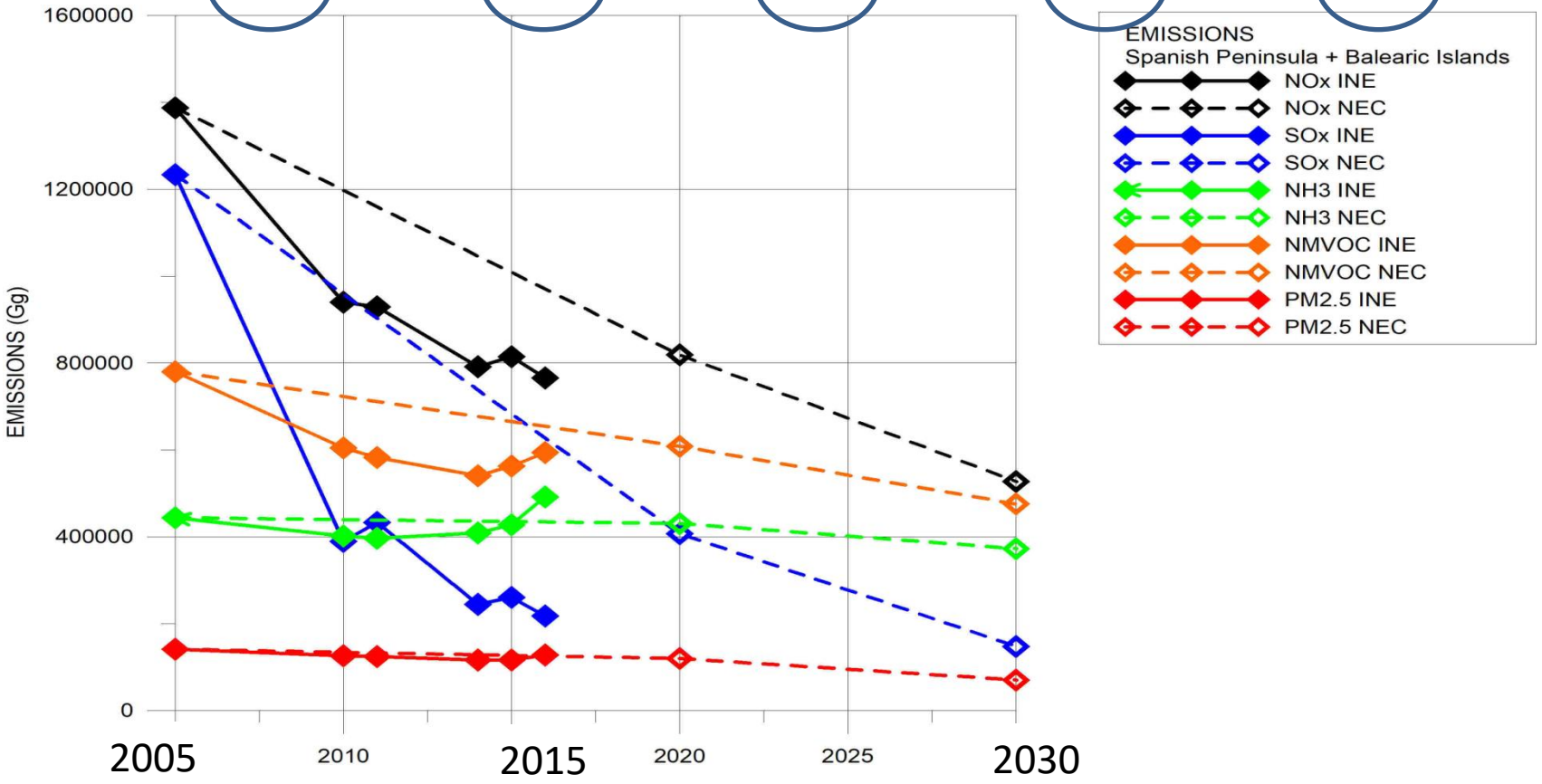
2010	2011	2012	2013	2014	2015	2016	2017



Evolution of **NOx**, **SOx**, NH_3, **NMVOC** and **PM2.5** emissions (% 2005 emissions)

- set in the **National Emissions Ceilings Directive(NEC)** (**dashed lines**) for Spain in 2020 and 2030.

SO2		NOx		NMVOCs		NH_3		PM2.5	
2020-29	2030-	2020-29	2030-	2020-29	2030-	2020-29	2030-	2020-29	2030-
67%	88%	41%	62%	22%	39%	3%	16%	15%	50%



Measures in the 1st Spanish National Air Pollution Control Programme (S-NAPCP)

SERVICE CONTRACT TO CIEMAT FROM TRAGSATEC FOR SUPPORT ON AIR POLLUTION IMPACTS

CONTRATO DE PRESTACIÓN DE SERVICIOS DE TRAGSATEC AL CENTRO DE INVESTIGACIONES ENERGÉTICAS, MEDIOAMBIENTALES Y TECNOLÓGICAS (CIEMAT) PARA EL APOYO EN MATERIA DE EFECTOS DE CONTAMINACIÓN ATMOSFÉRICA

Impacto sobre la calidad del aire de la reducción de emisiones de contaminantes proyectadas para 2020, 2025 y 2030 en el Programa Nacional de Control de la Contaminación Atmosférica

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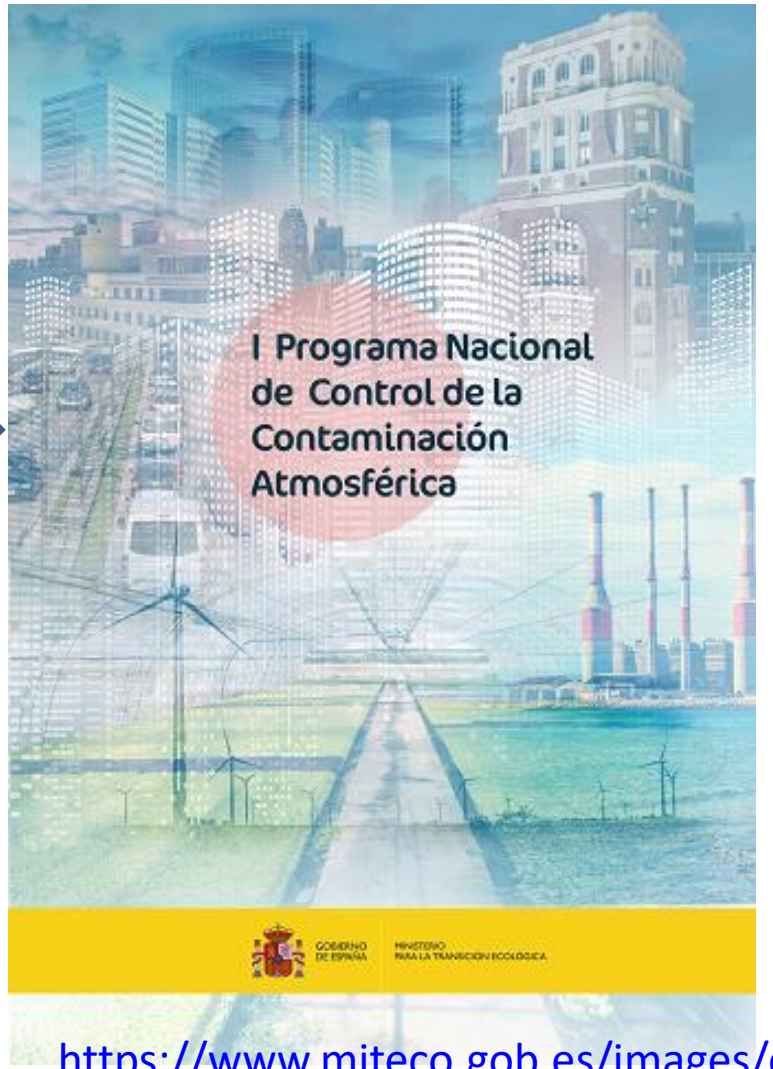
Marzo 2019

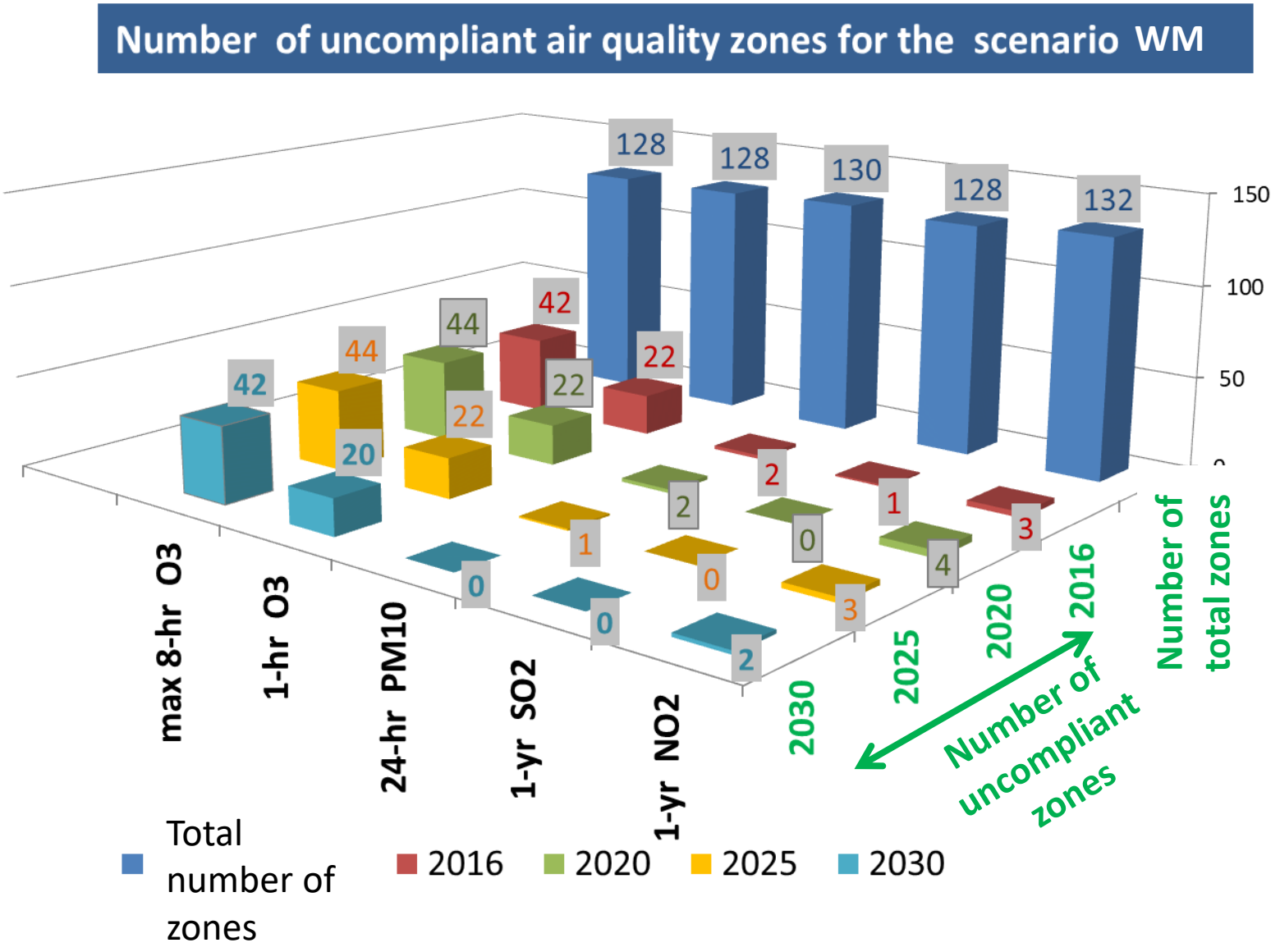
1st Spanish National Air Pollution Control Programme for the period 2019-2022 (Approved on September, 27th, 2019)



https://www.miteco.gob.es/images/es/primerpncca_2019_tcm30-502010.pdf

Marta G. Vivanco, Mark Theobald, Juan Luis Garrido, Victoria Gil, Fernando Martín (2019). ***Impact of the reduction of pollutant emissions for 2020, 2015 and 2030 in the Spanish National Control of emissions Programe on air quality***

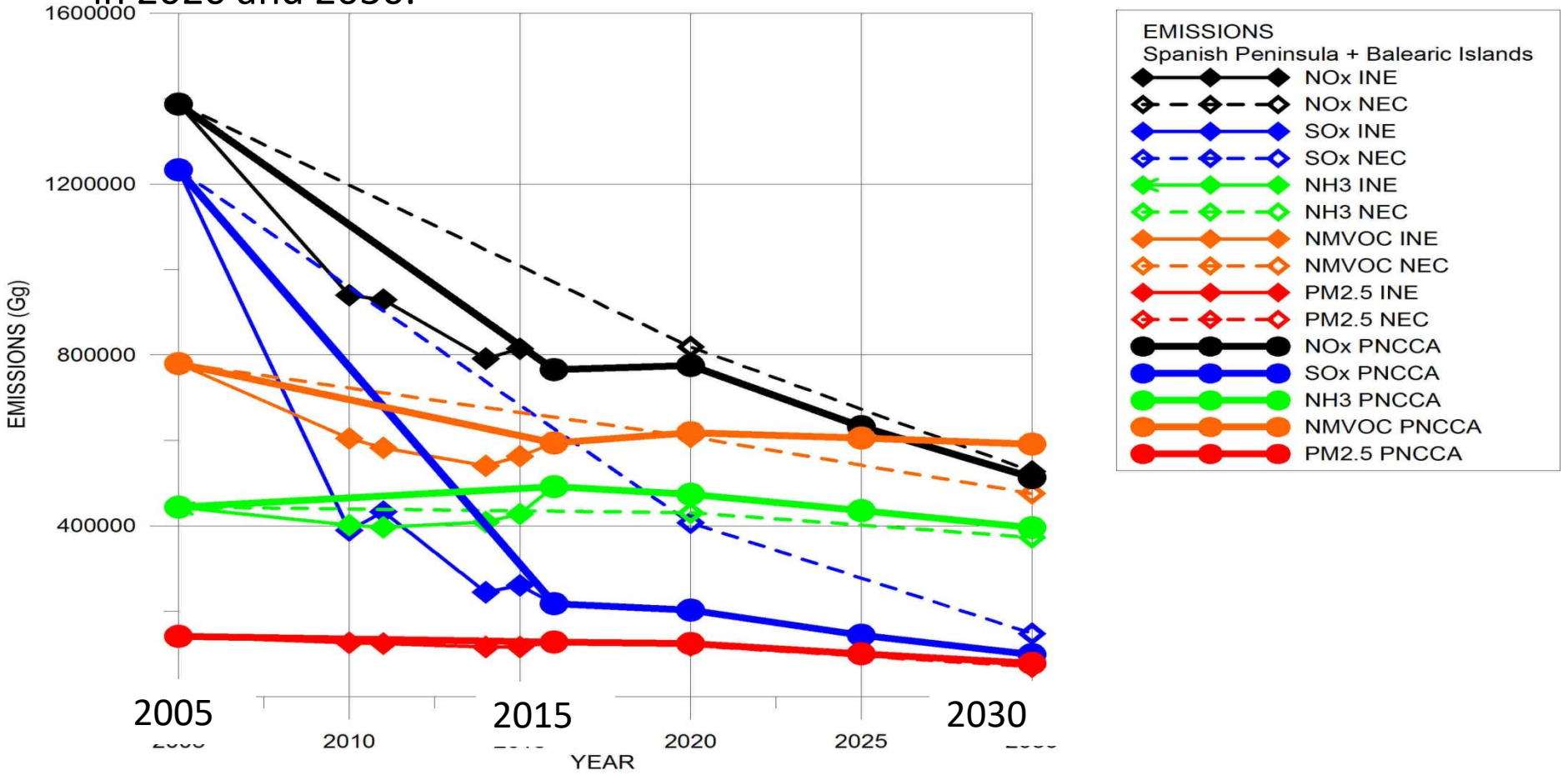
Scenario WM: assuming no change to already adopted policies and measures



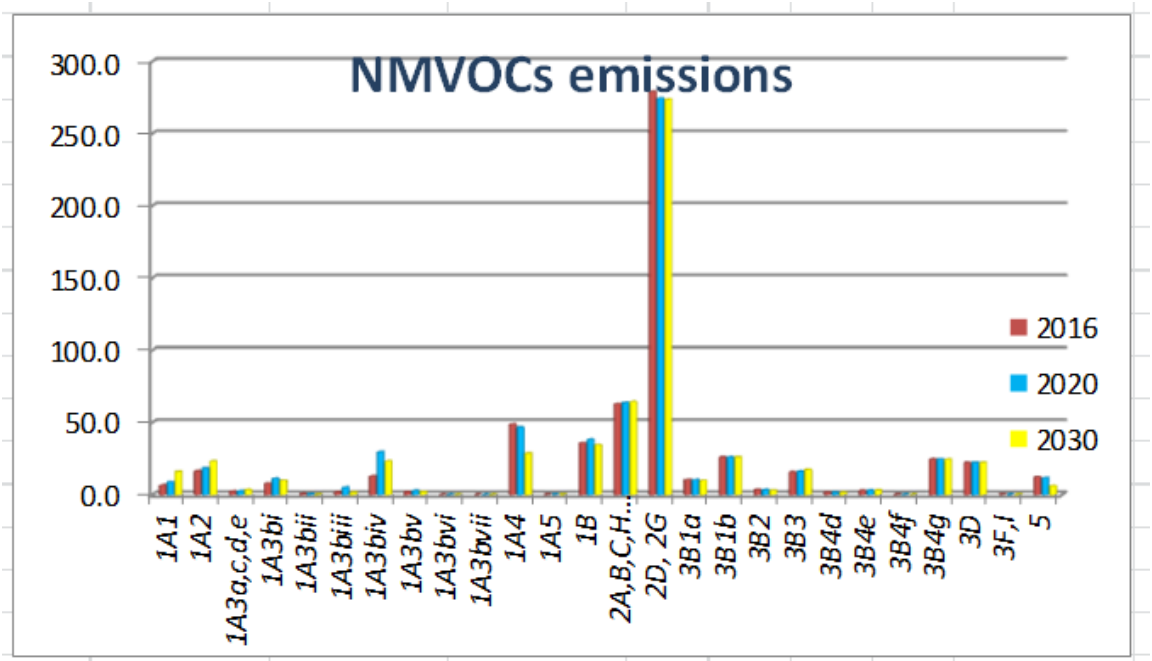
Evolution of **NOx**, **SOx**, NH_3, **NMVOC** and **PM2.5** emissions (% 2005 emissions)

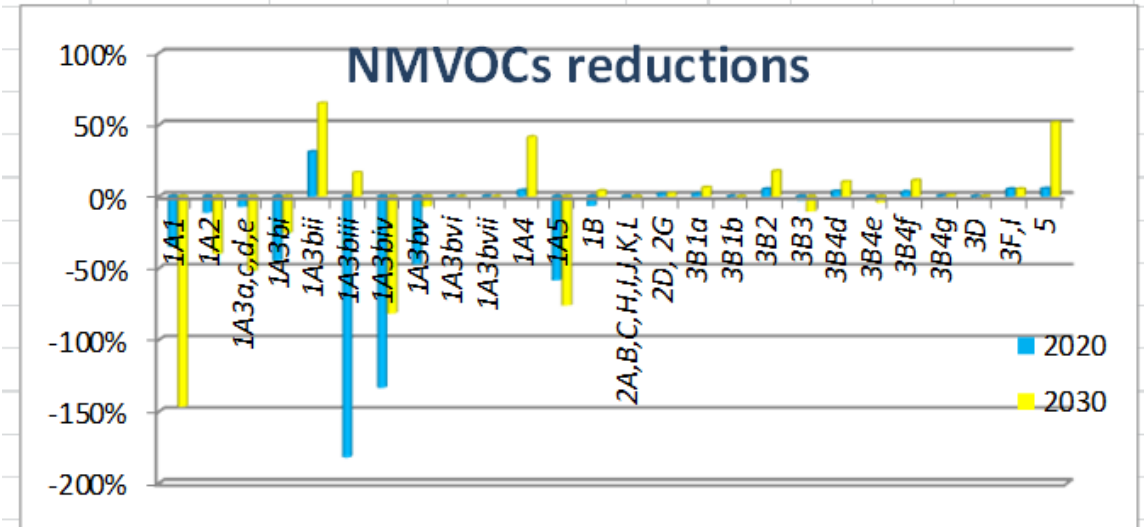
- according to the **Spanish National Inventory** (INE) (2005, 2010, 2011, 2014, 2015, 2016) and in the **S-NAPCP for 2020, 2025 and 2030 (scenario WAM)** (**solid lines**)

- set in the **National Emissions Ceilings Directive(NEC)** (**dashed lines**) for Spain in 2020 and 2030.



2D, 2G : Solvent and other product use





PACKAGE OF MEASURES	
E.1	Energy mix
T.1	Emission reductions for road transport, rail, aviation and shipping
I.1	Improved energy efficiency in the industrial and manufacturing sectors
EE.1	Improved energy efficiency in the residential, commercial, institutional and other sectors
RS.1	Waste
A.1	Use of fertiliser plans
A.2	Reduction of emissions from 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	Analysis of the potential pollution from small and medium combustion plants
O.4	Reduction of harbour emissions
O5	Public awareness raising

The Spanish National Air Pollution Control Programme considers 13 packages with 57 measures (8 of these packages are included in the projected emissions; for 5 of them the emission reductions are not yet estimated)

E.1 	**Energy mix**	• **New renewable energy installations** • **Integration of renewable energy into the grid** • **Self-production and distributed generation** • **Increased use of renewable gases** • **Refurbishment of existing renewable energy installations** • **Power purchase agreements between energy provider and consumer** • **Specific programs for biomass use** • **Unique projects and renewable energy for islands**
T.1	Emission reductions for road transport, rail, aviation and shipping	• Advanced biofuels for transport • Changes in mode of transportation • More efficient use of transport • Fleet renewal • Promotion of electric vehicles • Refueling/recharging points for alternative fuels

I.1 	**Improved energy efficiency in the industrial and manufacturing sectors**	• **Support for industry** • **Framework for the development of renewable thermal technologies** • **Improvement of the technology and management systems for industrial processes**
EE.1 	Improved energy efficiency in the residential, commercial, institutional and other sectors	• Integration of renewable thermal technologies • Subsidies for installations in buildings and heating networks • Improved energy efficiency in the residential sector • Renewal of installations in residential buildings • Improved energy efficiency in public buildings and the tertiary sector • Improved energy efficiency of large heating/air conditioning systems in the tertiary sector and public infrastructure • Improved energy efficiency of agricultural installations, irrigation communities and agricultural machinery

RS.1	**Waste**	• **Increased domestic and community composting** • **Renovation of composting infrastructure** • **Separation of biowastes for biomethanisation** • **Reduction of food waste** • **Increased paper collection in the municipal channel** • **Increased collection of domestic cooking oil** • **Increased collection of textiles** • **Use of oxidising covers on landfill sites**
A.1	Use of fertiliser plans	• Set a limit of 30% of plant N requirements by urea • Set conditions for urea application • Ban the surface application of slurries and other substances with a water content > 40% • Low emission application technologies • Incorporation of solid organic fertilisers following application • Use of fertilizer plans • Soil nitrogen balance calculations • Inclusion of environmental objectives in fertiliser plans • Registro de operaciones en el cuaderno de explotación • Registering activities in the farm log book

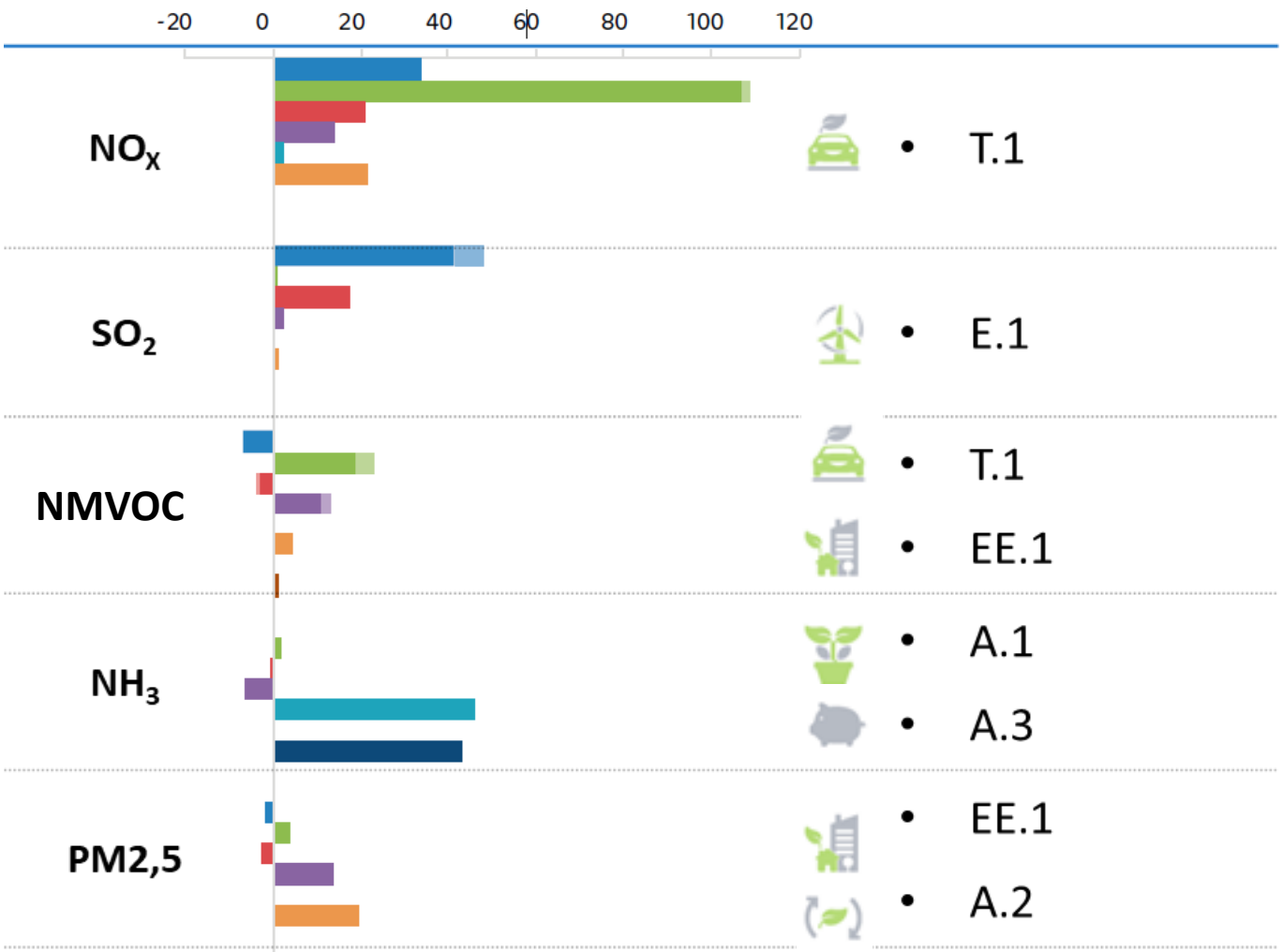
A.2	**Reduction of emissions from burning prunings**	• **Incorporation of prunings into vineyard and orchard soils instead of burning them** • **Reduction of the burning of olive prunings**
A.3	Manure and housing management for cattle, pigs and poultry	• Multiphase feeding of livestock • Frequent manure removal (twice per week) in existing breeding quarters of pigs and cattle • Reduction of ammonia emissions by at least 60% with respect to the reference technology in new and highly-modified pig and cattle installations • Reduction of ammonia emissions by at least 30% with respect to the reference technology in existing poultry installations • Reduction of ammonia emissions by at least 70% with respect to the reference technology in new and highly-modified poultry installations • Reduction of ammonia emissions by at least 40% with respect to the reference technology in existing pig and cattle installations • Reduction of ammonia emissions from manure storage by at least 80% with respect to the reference technology in new and highly-modified pig and cattle installations

Target measures (not included yet in the WAM scenario)

O.1 	**Reduction of emissions from residential wood burning**	• **Reduce fine particulate emissions from fire and stove wood burning in rural areas**
O.2 	Reduction of emissions from the domestic use of solvents and paints	• Responsible use of domestic of solvents and paints
O.3 	Analysis of the potential pollution from small and medium combustion plants	• Analysis of the potential pollution reduction for small and medium combustion plants (between 500 kW and 50 MW)
O.4 	Reduction of harbour emissions	• Reduction of harbour emissions
O.5 	Public awareness raising	• Public awareness raising

2030

- E.1
- T.1
- I.1
- EE.1
- RS.1
- A.1
- A.2
- A.3



Expected effects of the S-NAPCP on air quality

Methodology

- **CHIMERE model**. Domain covering the Iberian Peninsula at **0.1 ° x 0.1 °** (extending to the North) nested in a European domain at 0.15° x 0.15°
- Simulation of **2016 (base),** 2020, 2025 and 2030.
- ECMWF-IFS meteorology for 2016
- Fixed global model conditions for all the scenarios
- Estimation of **non-compliant zones**:

Correction of model results ; example for 2030

$$MC_{2030,c} = MC_{2030} + R_{2016} \frac{MC_{2030}}{MC_{2016}}$$

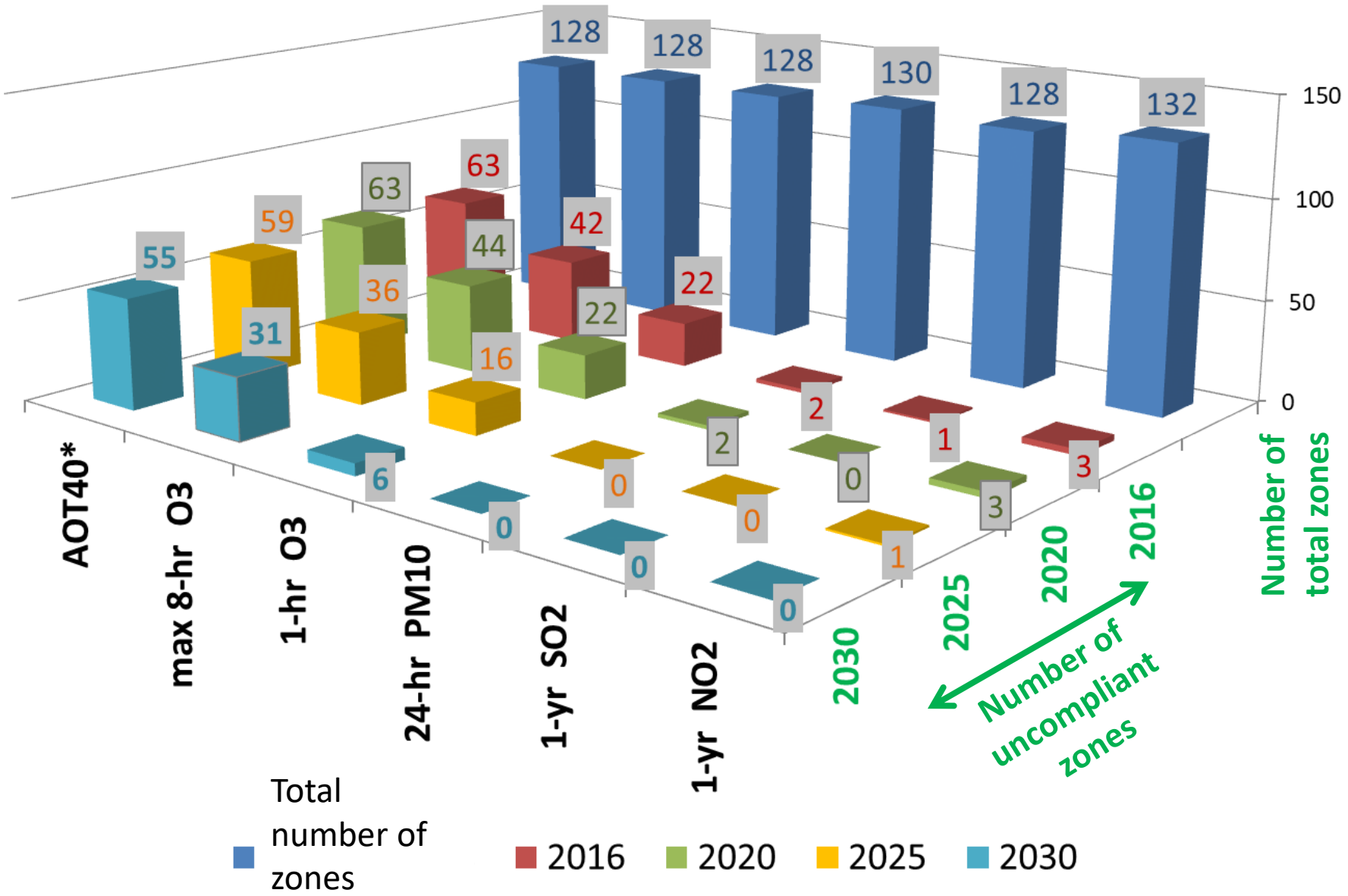
MC: model concentration

R_{2016} *: MC – OC* *OC: observed concentration*

Limitations

- Model resolution (~10kmx10km)
- Fixed meteorology (2016)
- Fixed boundary conditions; Fixed emissions for other countries, international maritime traffic
- Emissions reduction applied at 3rd level of SNAP categories uniformly on the national territory
- PM10: reductions only for the fine fraction (PM2.5)
- Correction of model results in future scenarios to estimate non-compliant zones: potential overestimation of **future concentration**

Number of uncompliant air quality zones for the scenario WAM



26th highest daily maximum value for 8-hour running mean for O_3 (M+O)

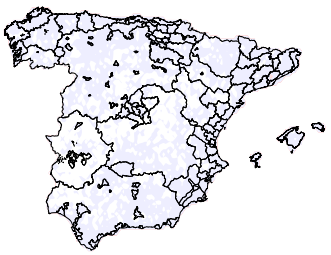
Relative differences

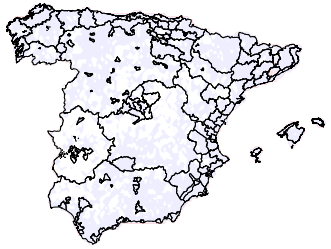
Total differences

26ª concentración de la máxima diaria de las medias móviles octohorarias de O3 en 2020

2020

26º máximo 8-hr de O3 (M+O)

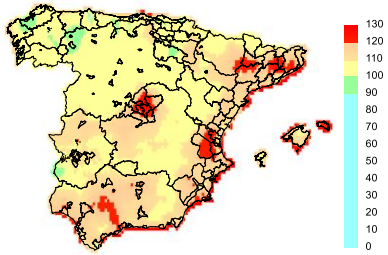




Scenario WAM

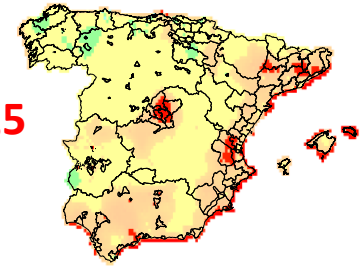
2016

26ª concentración de la máxima diaria de las medias móviles octohorarias de O3 en 2016



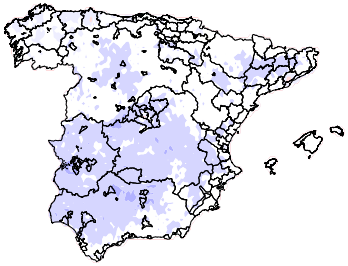
26ª concentración de la máxima diaria de las medias móviles octohorarias de O3 en 2025

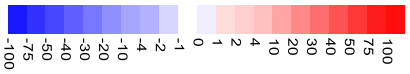
2025



Diferencias relativas 2025-2016

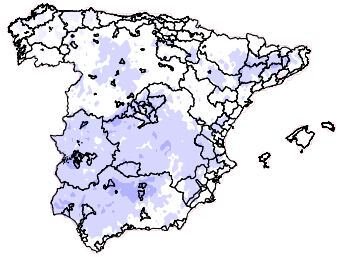
26º máximo 8-hr de O3 (M+O)

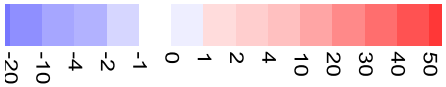




Diferencias 2025-2016

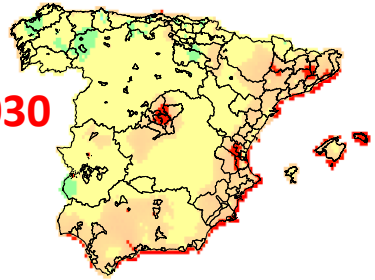
26º máximo 8-hr de O3 (M+O)





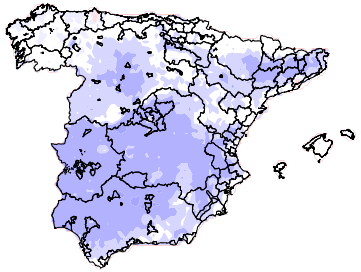
26ª concentración de la máxima diaria de las medias móviles octohorarias de O3 en 2030

2030



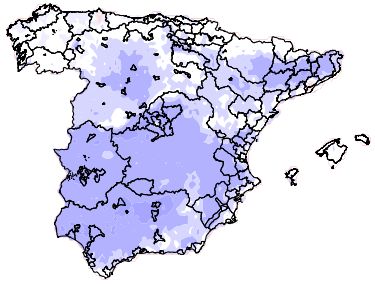
Diferencias relativas 2030-2016

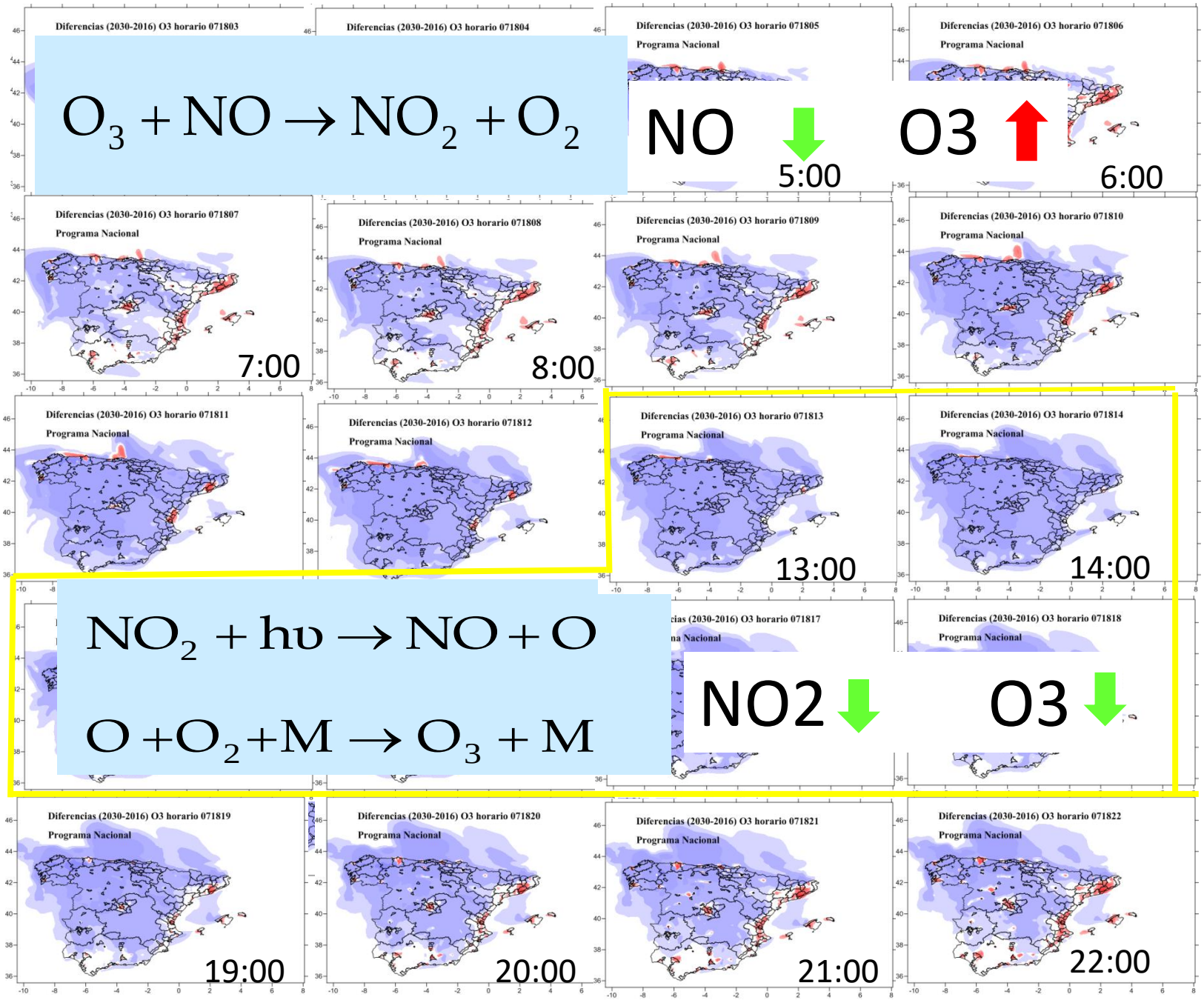
26º Máximo 8-hr de O3 (M+O)

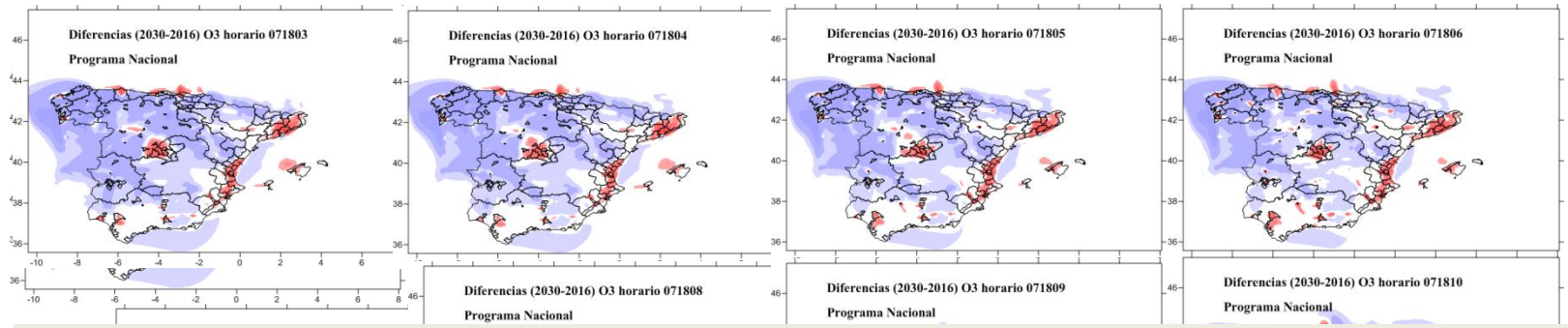


Diferencias 2030-2016

26º máximo 8-hr de O3 (M+O)



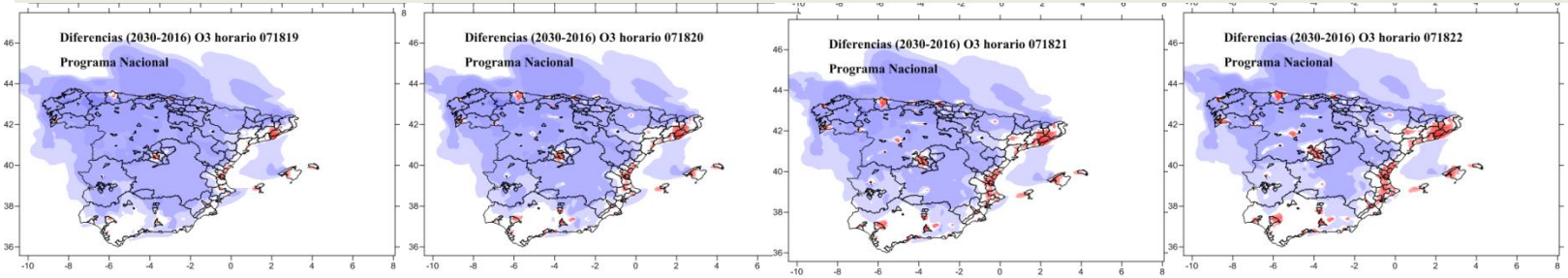

$O_3 + NO \rightarrow NO_2 + O_2$
NO
O3
5:00
6:00
7:00
8:00
13:00
14:00
$NO_2 + h\upsilon \rightarrow NO + O$
$O + O_2 + M \rightarrow O_3 + M$
NO2
O3
19:00
20:00
21:00
22:00



Annual terms: In areas with high NOx levels and with an important titration effect (that reduces O_3), a decrease of NOx emissions will reduce titration reaction, **which can lead to higher O_3 levels in the night**, and thus higher annual levels of O_3 (less O_3 destroyed in the night) . Also affecting max 8-hr, SOMO35

Not for the max 1-hr : the reduction of NOx emissions at higher-radiation hours reduces O_3 formation, so an improvement of air quality is more frequently found.

More in depth in the TFMM. Check with another chemical mechanism.



Expected (preliminary) effects of the S-NAPCP on health and the associated costs

Retos-AIRE: Ai**R** pollution mitigation actions for **E**nvironmen**T**al p**O**licy **S**upport. **AIR** quality multiscale modelling and evaluation of h**E**alth and vegetation impacts

RTI2018-099138-B-100
Plan Nacional I+D+i

Effects on health & Cost Benefit Analysis

2 scenarios: 1) 2016 2) WAM-2030

MODEL

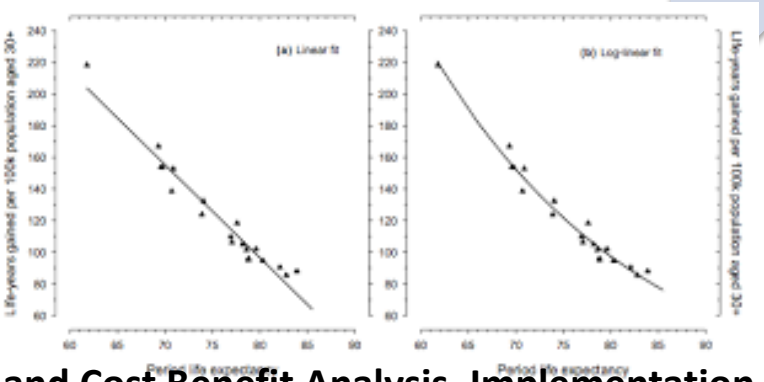
Pollutants concentration

PM, NO2, O3

Estimation of effects Concentration Response Functions (WHO)

External Costs

Benefit WM2030 WAM2030



Health Impact Assessment and Cost Benefit Analysis. Implementation of the HRAPIE Recommendations for European Air Pollution CBA. M. Holland - EMRC (2014)

GIS Analysis for Population data

Spatial distribution/allocation (model grid)

Health Staticstics and National Health Survey (INE, 2026), data by regions, 2 administrative levels

Other data: WHO DB database

Population (spatial distribution)

Mortality >30 years

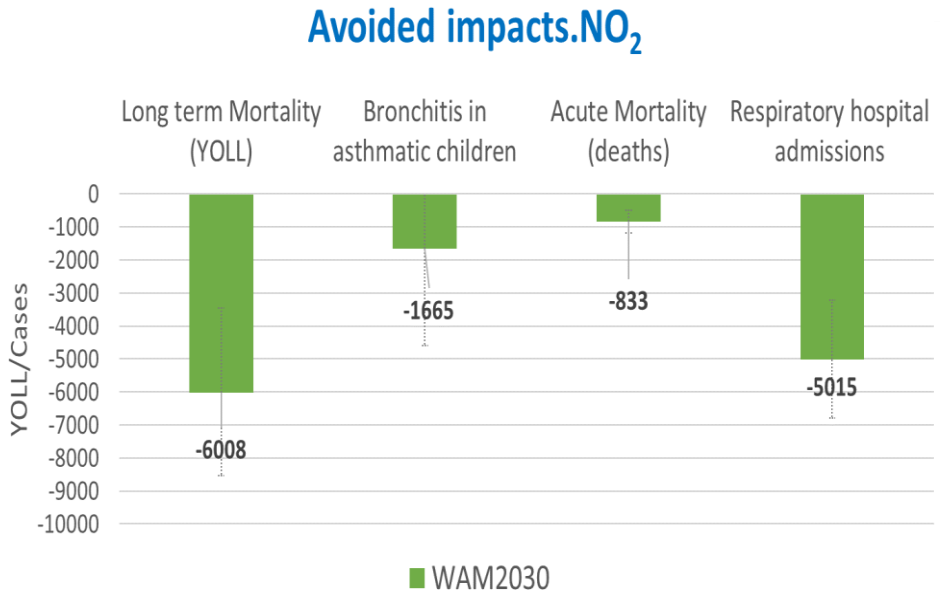
+

Prevalence of asthma in children 5-14 years

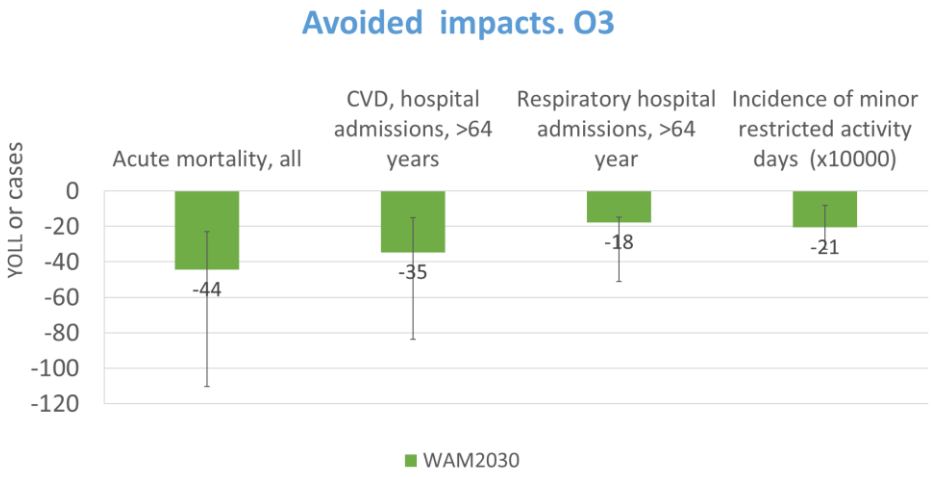
+ ...

Health effects

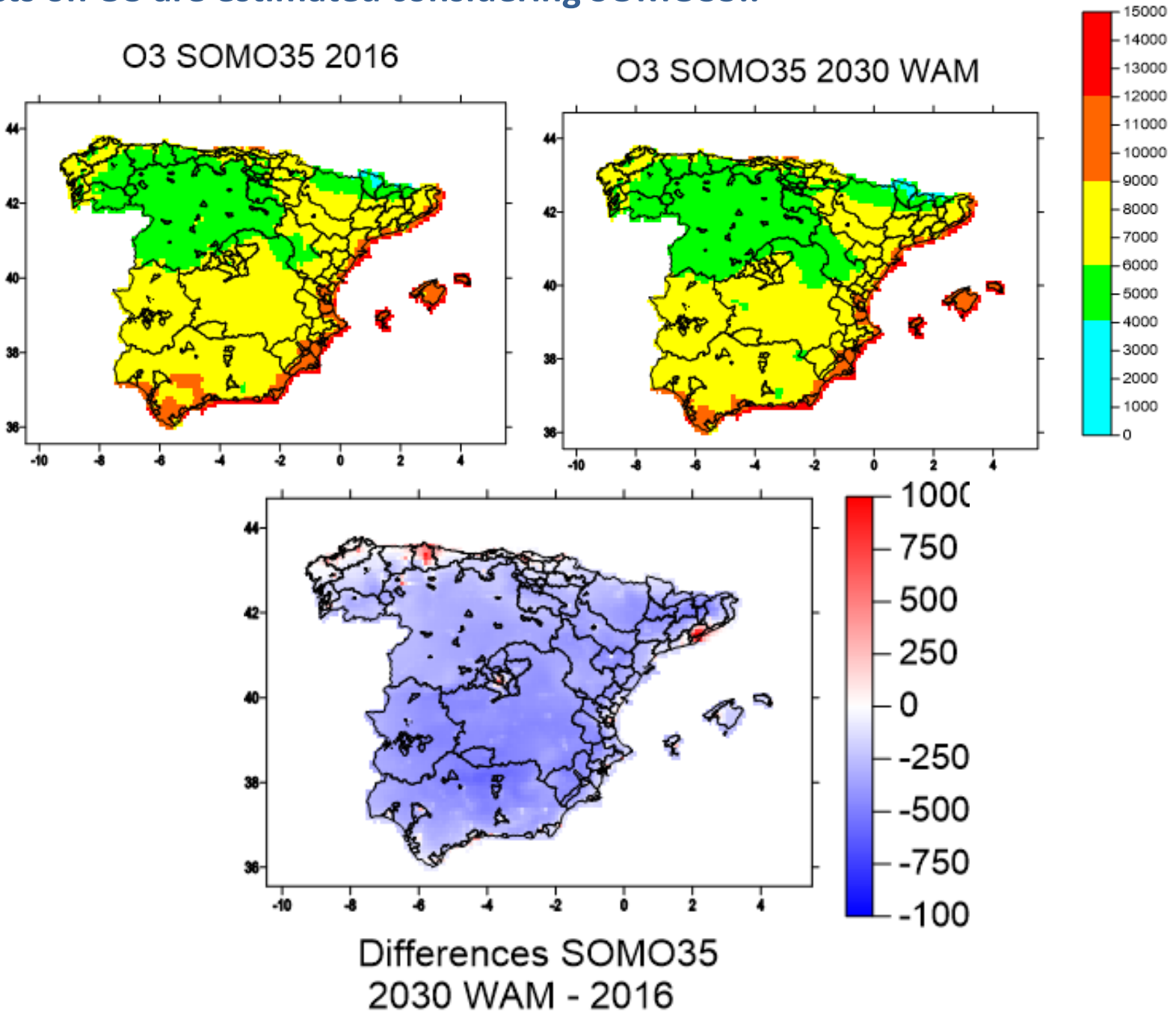
NO_2



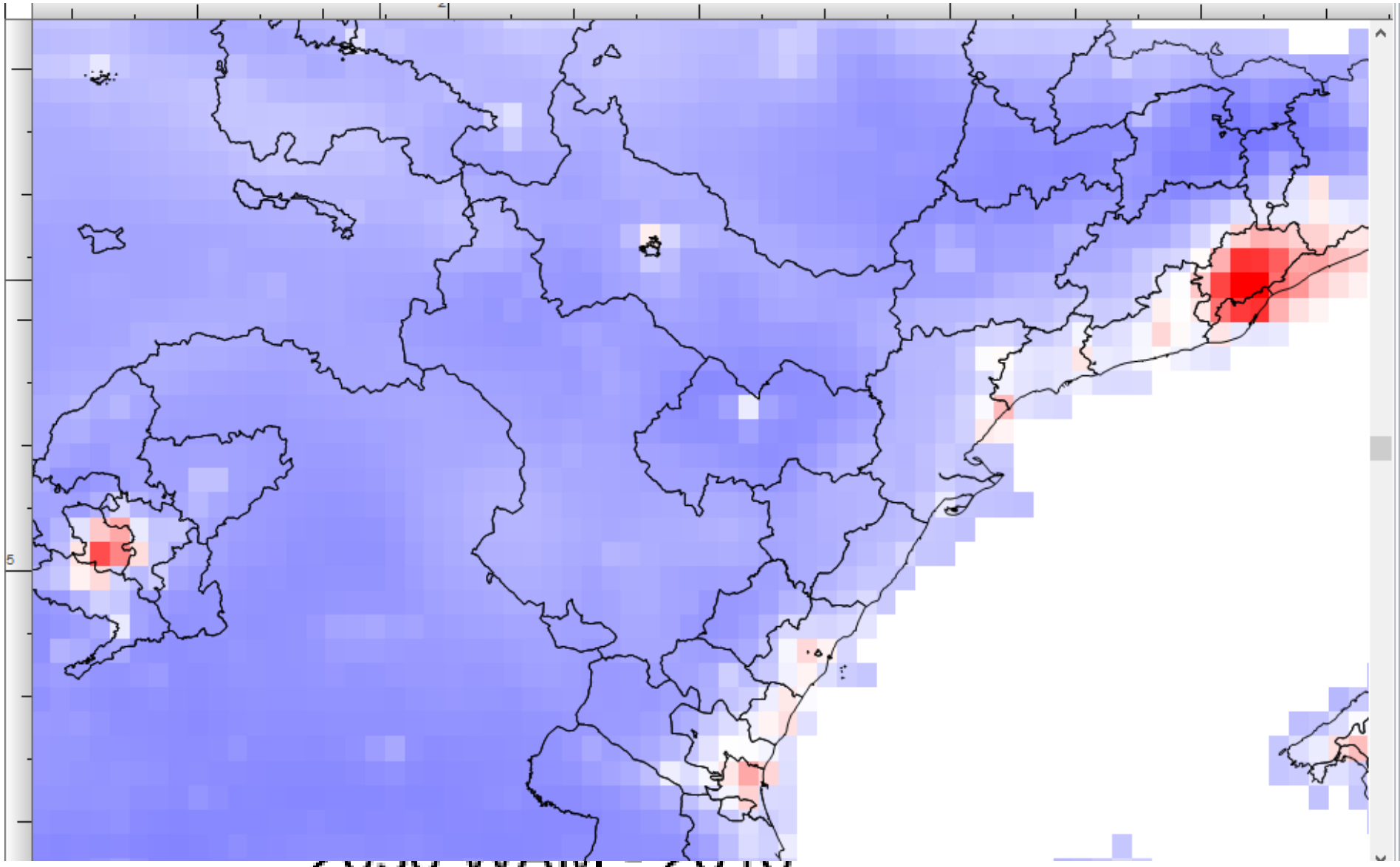
O_3



Impacts on O3 are estimated considering SOMO35..



Impacts on O3 are estimated

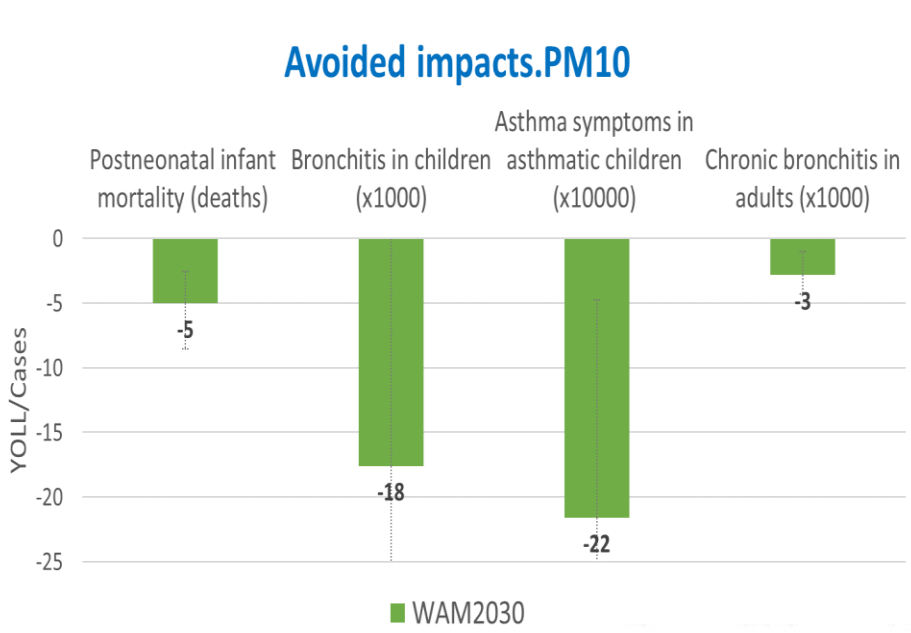


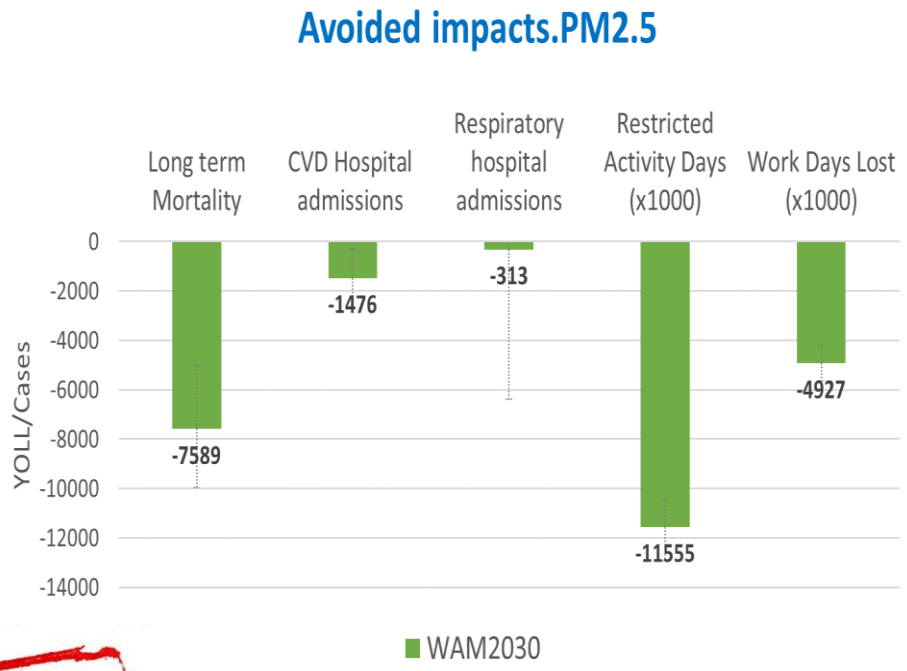
Health effects

PM_{10}

$PM_{2.5}$

WAM 2030



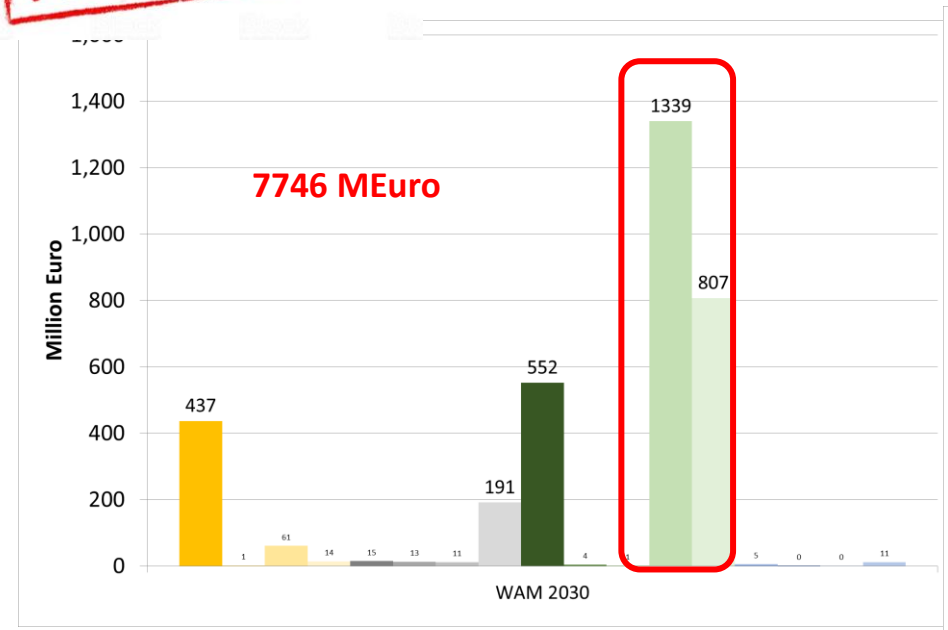


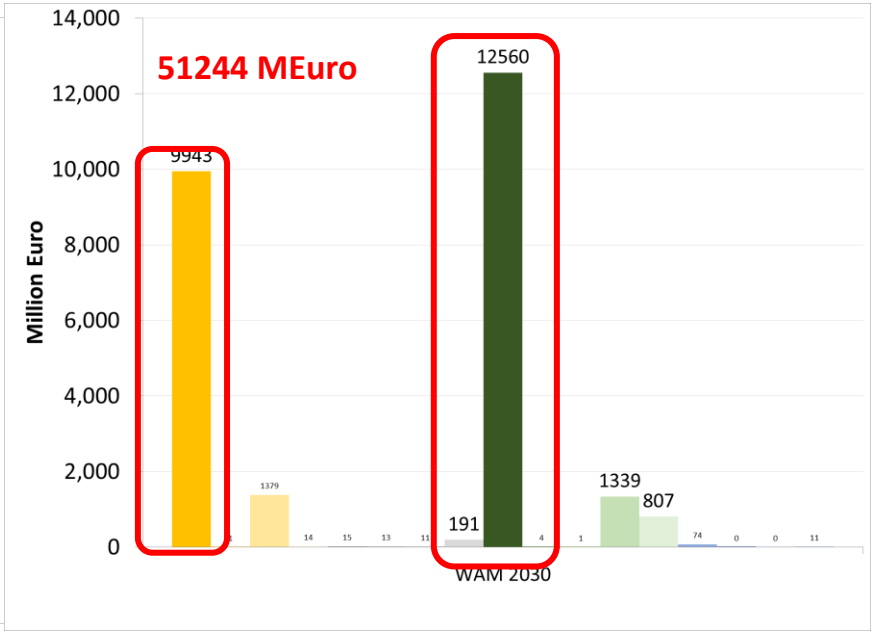
PRELIMINARY

WAM 2030

PRELIMINARY

Avoided costs





VOLY approach

Value of Life year Lost

- NO2 Long term Mortality (YOLL)
- NO2 Acute Mortality (deaths)
- PM10 Infant mortality
- PM10 Asthma symptoms in asthmatic children
- PM2.5 Long term Mortality (YOLL)
- PM2.5 Hospital admissions respiratory diseases
- PM2.5 Work Days Lost
- O3 Hospital admissions CVD
- O3 Minor restricted activity days

VSL approach

Value of a Statistical Life

- NO2 Bronchitis symptoms in asthmatic children
- NO2 Hospital admissions respiratory diseases
- PM10 Bronchitis in children
- PM10 Chronic bronchitis in adults
- PM2.5 Hospital admissions CVD
- PM2.5 Restricted Activity Days (RADs)
- O3 Acute mortality (deaths)
- O3 Respiratory hospital admissions

Some conclusions I

Emissions and impacts on air quality:

- The scenario WAM achieves the target emissions reductions set in the NEC Directive for Spain in 2030 for all the pollutants except for NMVOCs, for which there is a reduction of 30% versus the 39% in NEC Directive.

- General improvement of air quality for the WAM scenario. No further non-compliant air quality zones for **annual NO_2 and PM_{10} indicators**.

- Ozone will still produce non-compliant areas (from 42 in 2016 to 31 in WAM-2030 (max 8-hr); from 22 to 6 (O_3 1-hr)), with reductions of 32.9% of NOx emissions)

- The reduction of NOx reduces the removal of O_3 by titration, leading to increased concentrations of O_3 over areas with high NOx emissions in the night (Madrid, Barcelona). During the hours with high solar radiation, there is a reduction of O_3 over these areas. Thus there are different net effects depending on the O_3 metric.

Some conclusions II

Impacts on health:

PRELIMINARY

- There is an improvement of impacts on health for the scenario WAM 2030 for the whole studied area, specially considering NO2 and PM2.5. Nevertheless, for specific cities (Madrid, Barcelona) health effects for O3 could present worse results, as the SOMO35 presents higher values in WAM 2030 (more studies on-going to study these cities individually).

- Monetary valuation of total health effects shows benefits from adopting the additional measures in WAM 2030 ranging from around 7746 to 51244 Million Euro (depending on how mortality impacts are valued).

Limitations:

- **Variation of meteorology has not been considered**. We are addressing this point in the Retos-AIRE project (other years, climate meteo for 2030)

- **Reductions of other countries should be considered** to account for 2030 boundary conditions. Also for the international maritime traffic (high in the Mediterranean area)

Some conclusions III

- The correction applied to address the underestimation of peaks over urban areas could be producing an overestimation of O3 peaks in 2030 and consequently an overestimation of impacts on health.

- Benefis from PM10 emission reductions (air quality , health, costs) are underestimated due to the lack of information about the emission reduction in the PM2.5-10 fraction (the inventory includes emissions for this fraction in the agriculture sector.

- Population has not been extrapolated. Benefits could be overestimated.

- **The use of Concentration Response Functions adapted to the Spanish conditions could be benefitial** (collaboration with the ISCIII, Spain)

Some conclusions IV

- **Higher resolution should be used for urban areas** (**Retos-Aire project**) to estimate air quality and population exposure more accurately.

Retos-AIRE: Ai**R** pollution mitigation actions for **E**nvironmen**T**al p**O**licy **S**upport. **AIR** quality multiscale modelling and evaluation of h**E**alth and vegetation impacts

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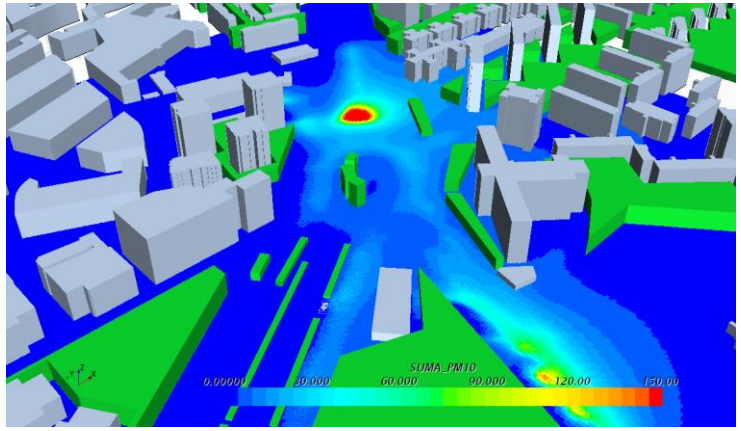

- Zooms in some cities**, at 1km x 1km** with CHIMERE and with **CFD models**
- Assessment of **individual measures**
- Risk assessment of N deposition in **the Natura 2000 network**

Thank you for your attention!

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Please contact me if you want to participate

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