

# SCIENTIFIC ASSESSMENTS FOR AN O<sub>3</sub> SPANISH NATIONAL PLAN

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**6<sup>th</sup> May 2024, TFMM Annual Meeting**



# 2019-2024 STRATEGY TO BUILD UP THE SCIENTIFIC BASIS FOR A NATIONAL OZONE PLAN

## Interpretation of O<sub>3</sub> 2008-2023 trends (AQMN and remote sensing)

- 2008-2019
- 2020-2021 (COVID lockdown)
- 2022-2023 (current situation)

## Regionalisation of the problem in 4 types

## Phenomenology of episodes in hotspot regions (July, 2015, 2016, 2017, 2019)

- Tethered balloons,
- Microlite flights
- Surface and remote sensing data

## Ambient measurements of speciated VOCs and PMFO, July 2019, 2020, 2021, 2022, 2023

## Evaluation of the BATs implemented in emission sources of hotspot areas

- Visiting emission sources
- Checking emission data
- Determine potential for reductions

## Improvement of emission inventories and comparing PMFO with ambient measurements

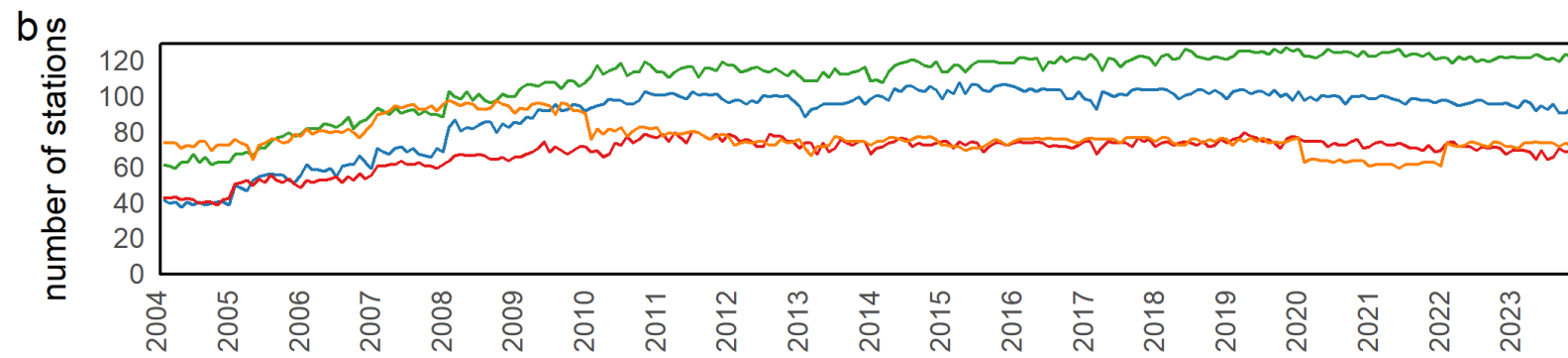
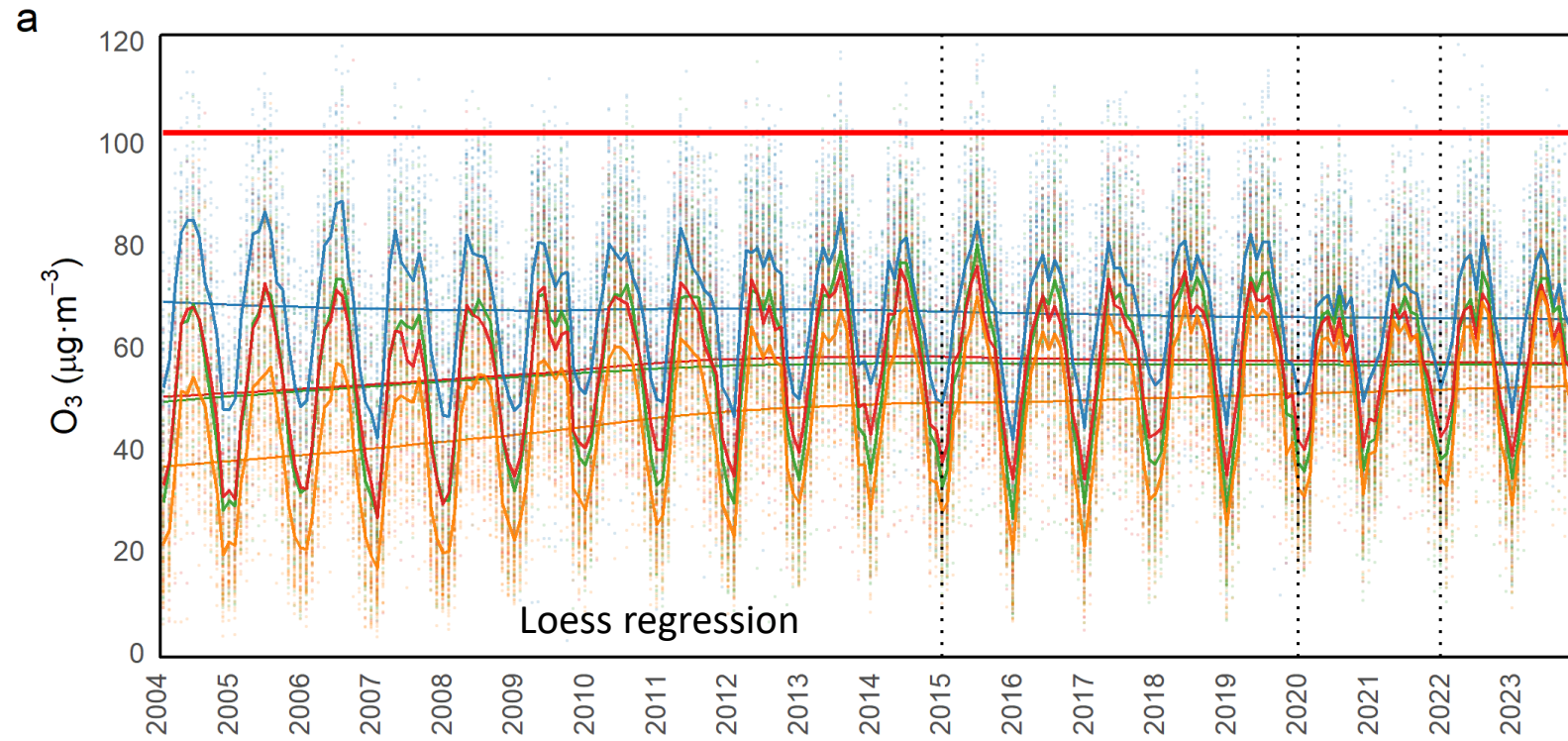
## Modelling of acute episodes

- Key atmospheric/meteo patterns
- Surface concentrations
- Vertical profiles

Sensitivity modelling studies for scenarios

Suggested policy actions

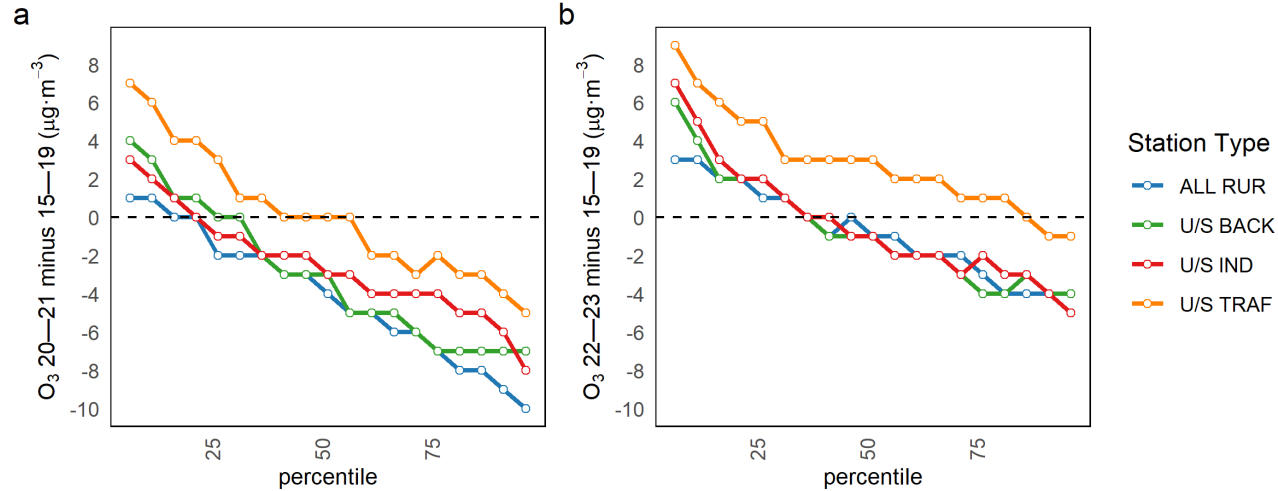
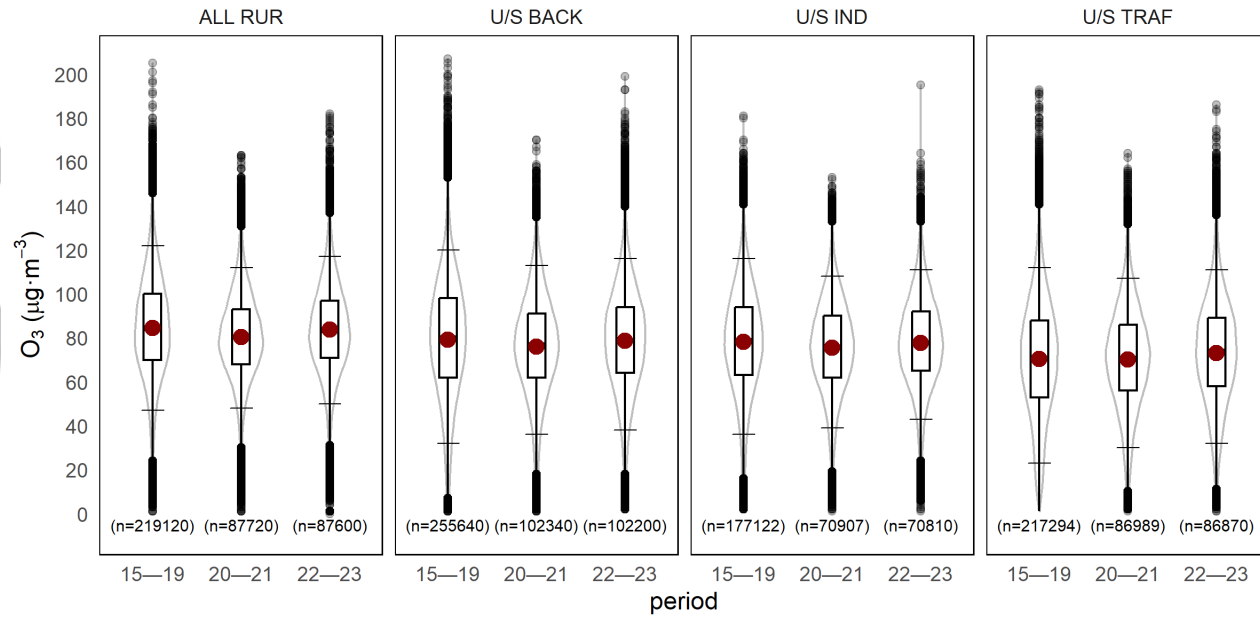
# 2008-2023 TRENDS OF SURFACE OZONE



Station Type — ALL RUR — U/S BACK — U/S IND — U/S TRAF

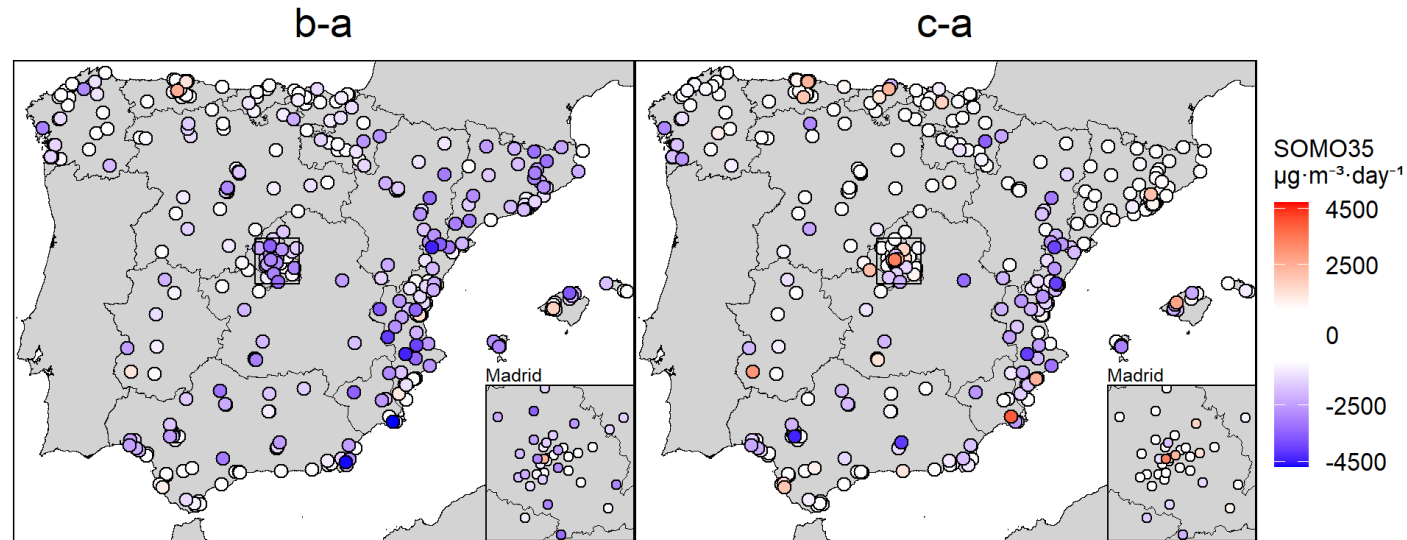
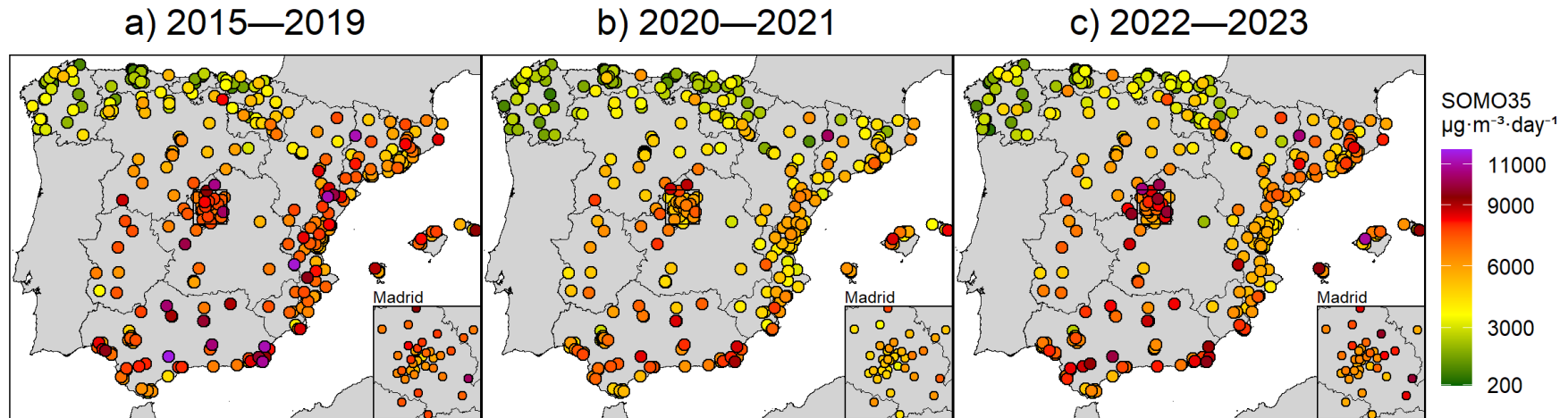
# 2015-2023 TRENDS OF SURFACE OZONE

All MDA8s (2015–2023)



# 2015-2023 TRENDS OF SURFACE OZONE

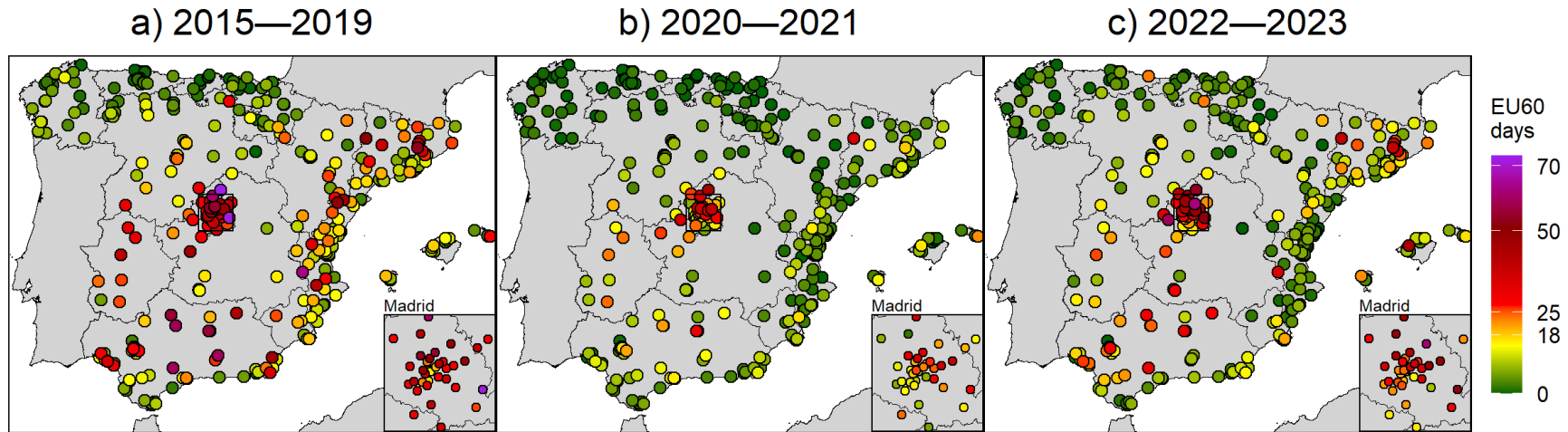
SOMO35





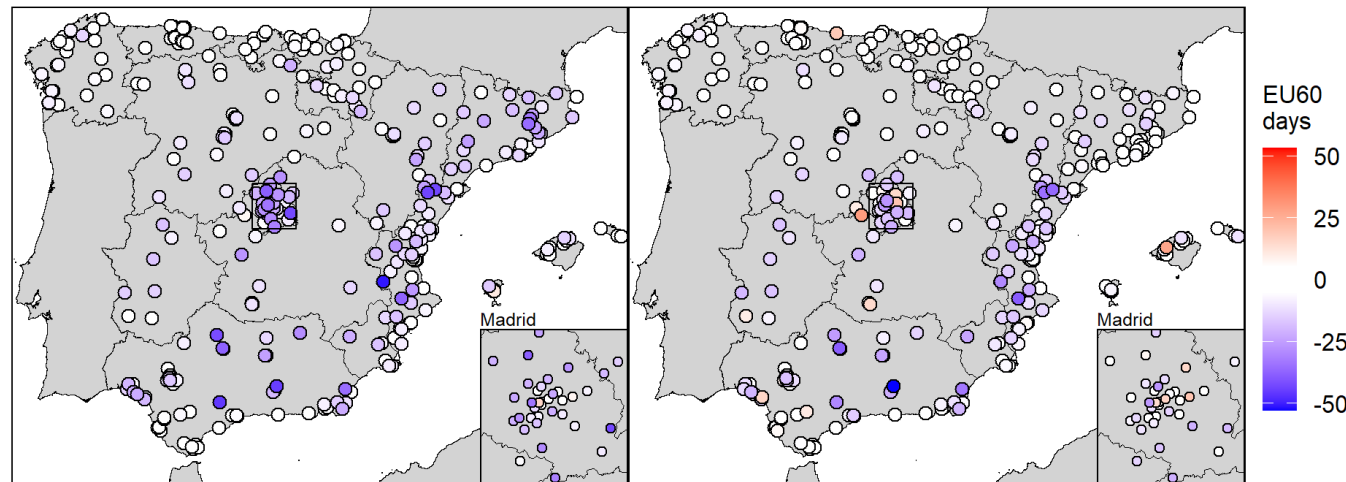
# 2015-2023 TRENDS OF SURFACE OZONE

Days of LTO exceed.  
(MDA8 > 120  $\mu\text{g}\cdot\text{m}^{-3}$ )



b-a

c-a



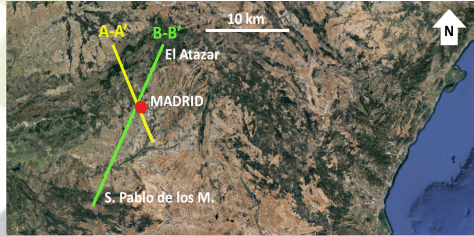
# PHENONEMOLOGY OF OZONE EPISODES



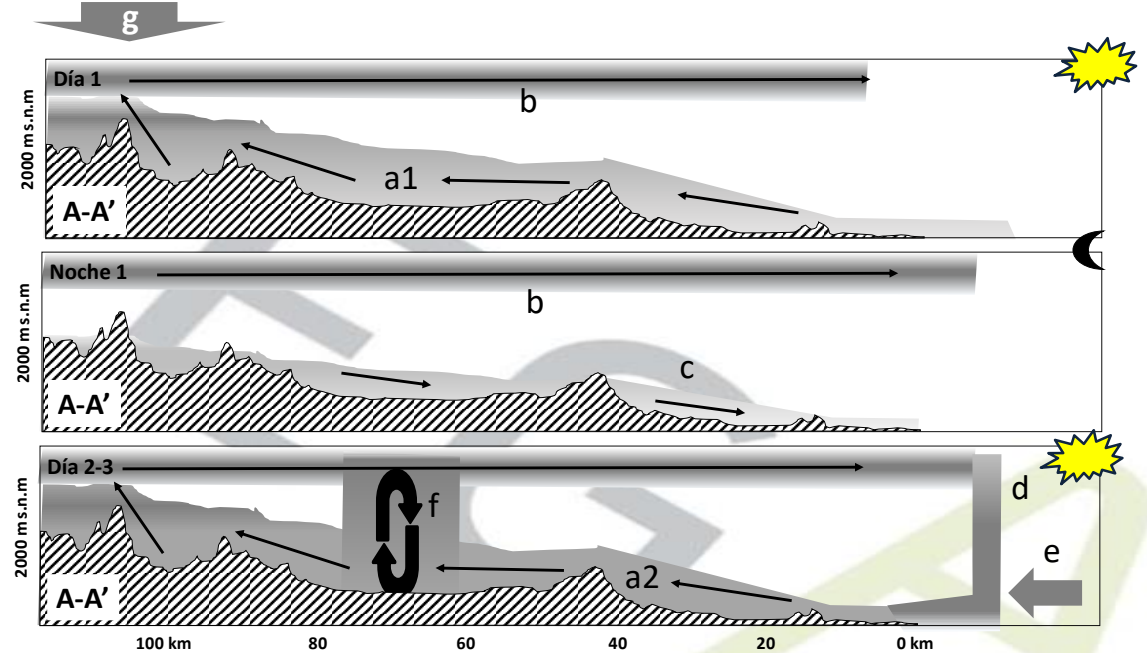
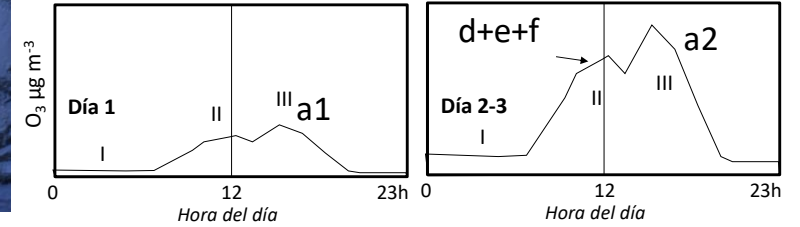
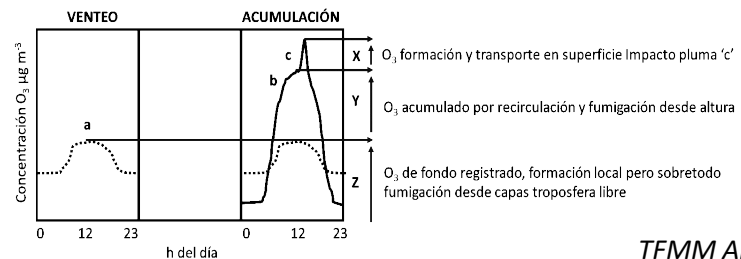
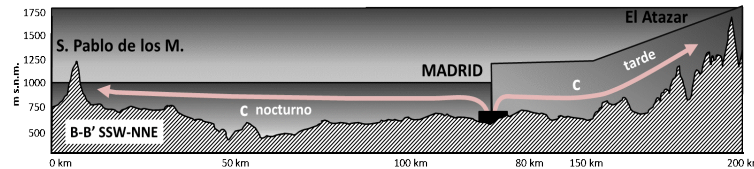
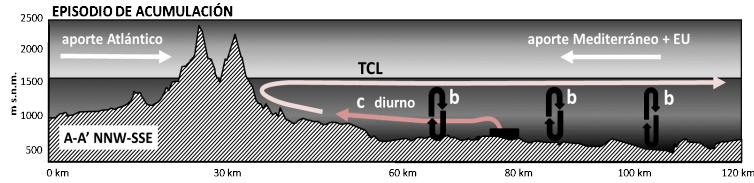
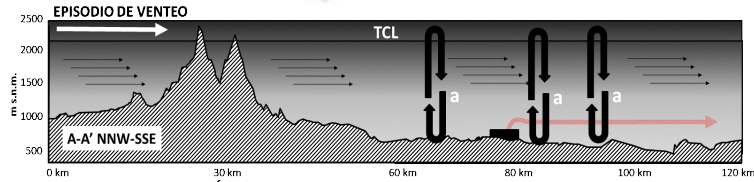
## Madrid Basin

## HOTSPOTS

## Barcelona Basin



- a) Formación local y fumigación de capas de la troposfera libre con aportes de O<sub>3</sub> del Atlántico o del Mediterráneo + EU
- b) Formación local y fumigación de estratos de reserva generados por recirculación de masas de aire de la cuenca con capas límite a mediodía relativamente delgadas
- c) Impacto de la pluma de Madrid en diferentes periodos del día  
TCL Techo de la capa límite a mediodía



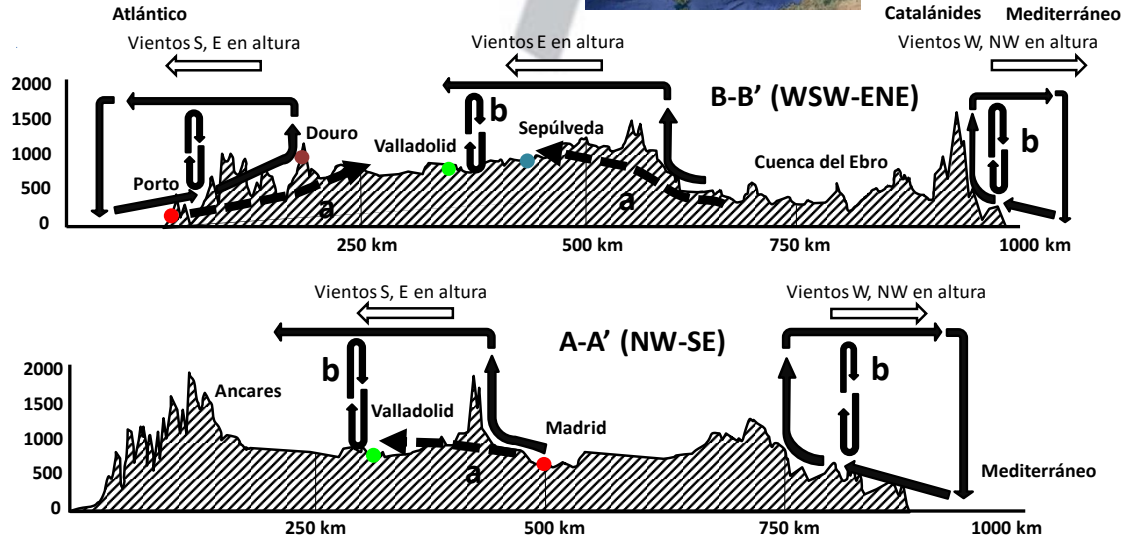
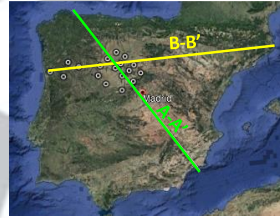
# PHENONEMOLOGY OF OZONE EPISODES

## Castilla y León

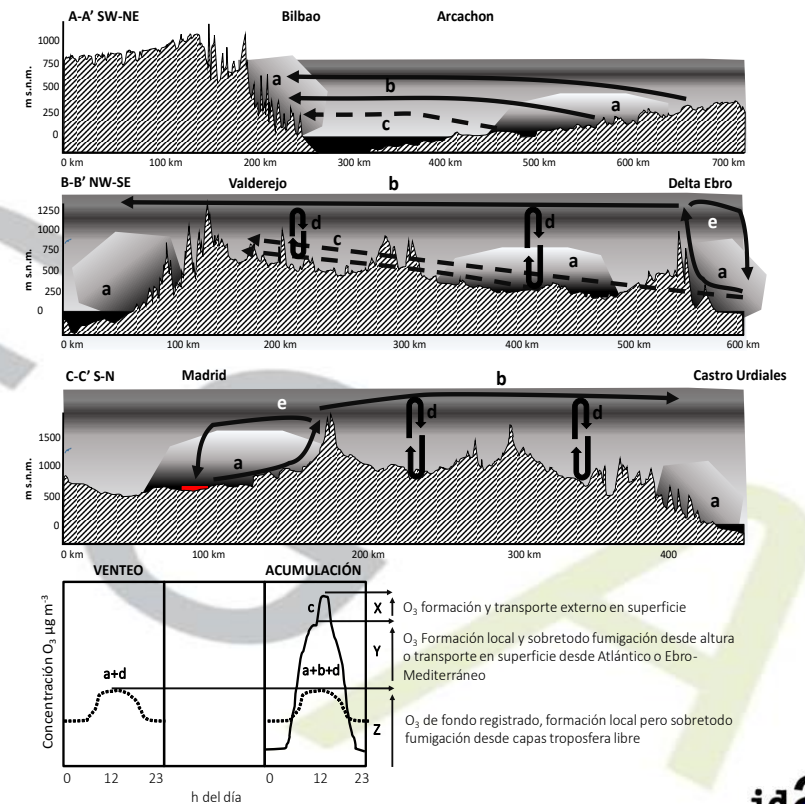
## AFFECTED BY HOTSPOTS

## Basque Country

- a. Transporte por superficie
- b. Transporte en altura y fumigación desde allí



- a. Generación local/regional de O<sub>3</sub>
- b. Inyección y transporte de O<sub>3</sub> en altura
- c. Transporte de O<sub>3</sub> en superficie
- d. Fumigación desde capas altas
- e. Recirculación vertical de masas de aire





# REGIONALISATION OF THE OZONE POLLUTION

( $\mu\text{g m}^{-3}$  p93.2 of the site with the highest records/number of days per year exceeding the TV)

|   |   |  |                              |                  |
|---|---|--|------------------------------|------------------|
| <p><b>Madrid (141/72)</b><br/> <b>Cataluña (135/54)</b><br/> <b>Comunidad Valenciana (131/64)</b><br/> <b>Andalucía (131/59)</b><br/> <b>Castilla La Mancha (127/47, R4, Puertollano)</b></p> | <p>Largely exceed the target values, with also large local emissions of precursors</p>                          | <p><b>R3 &amp; R4</b></p>                      | <p><b>Non-compliance</b></p> |                  |
| <p><b>Extremadura (125/40)</b><br/> <b>Castilla y León (123/32)</b><br/> <b>País Vasco (122/30)</b><br/> <b>Baleares (122/27)</b><br/> <b>Aragón (121/26)</b></p>                             | <p>Exceed target values or are close to, with lower local emission of precursors than R3 and affected by R3</p> |  |                              | <p><b>R2</b></p> |
| <p><b>Navarra (120/24)</b><br/> <b>Murcia (119/25)</b><br/> <b>La Rioja (114/15)</b></p>  | <p>Climate regions not favouring O3 formation, with lower local emission than R3</p>                            |  |                              | <p><b>R1</b></p> |
| <p><b>Galicia (111/14)</b><br/> <b>Asturias (106/5)</b><br/> <b>Canarias (105/7)</b><br/> <b>Cantabria (103/3)</b></p>  |   | <p><b>Compliance but exceeding WHOAQGs</b></p> |                              |                  |

The whole Spanish territory receives external contributions of transboundary O<sub>3</sub>, even external to EU, R1 receives also diluted contributions from other Spanish basins, and relatively low local ones (low emissions of precursors and specific low O<sub>3</sub> climate patterns):

- Asturias
- Canarias
- Cantabria
- Galicia

AS reported for R1 but contributions of neighbouring O<sub>3</sub> hotspot basins (C. Madrid, Portugal, Barcelona, Tarragona) are higher:

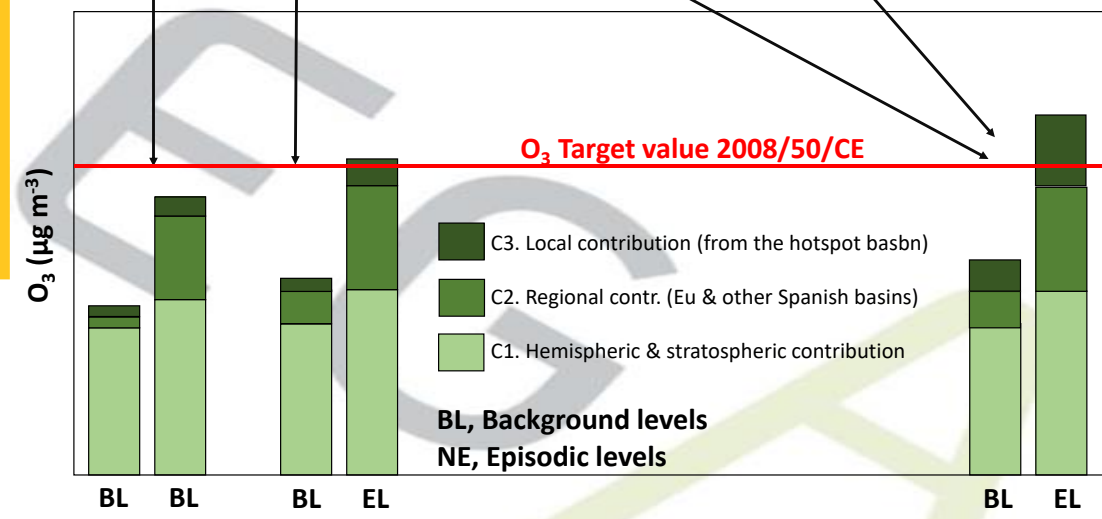
- País Vasco
- Extremadura
- Murcia
- Navarra
- CyL
- CLM
- Aragón
- Baleares
- Rioja

O<sub>3</sub> Hotspot basins with very relevant contributions of O<sub>3</sub> generated into the basin from local precursors:

- Madrid
- N Barcelona, N Tarragona
- Guadalquivir B.
- Inner C. Valenciana

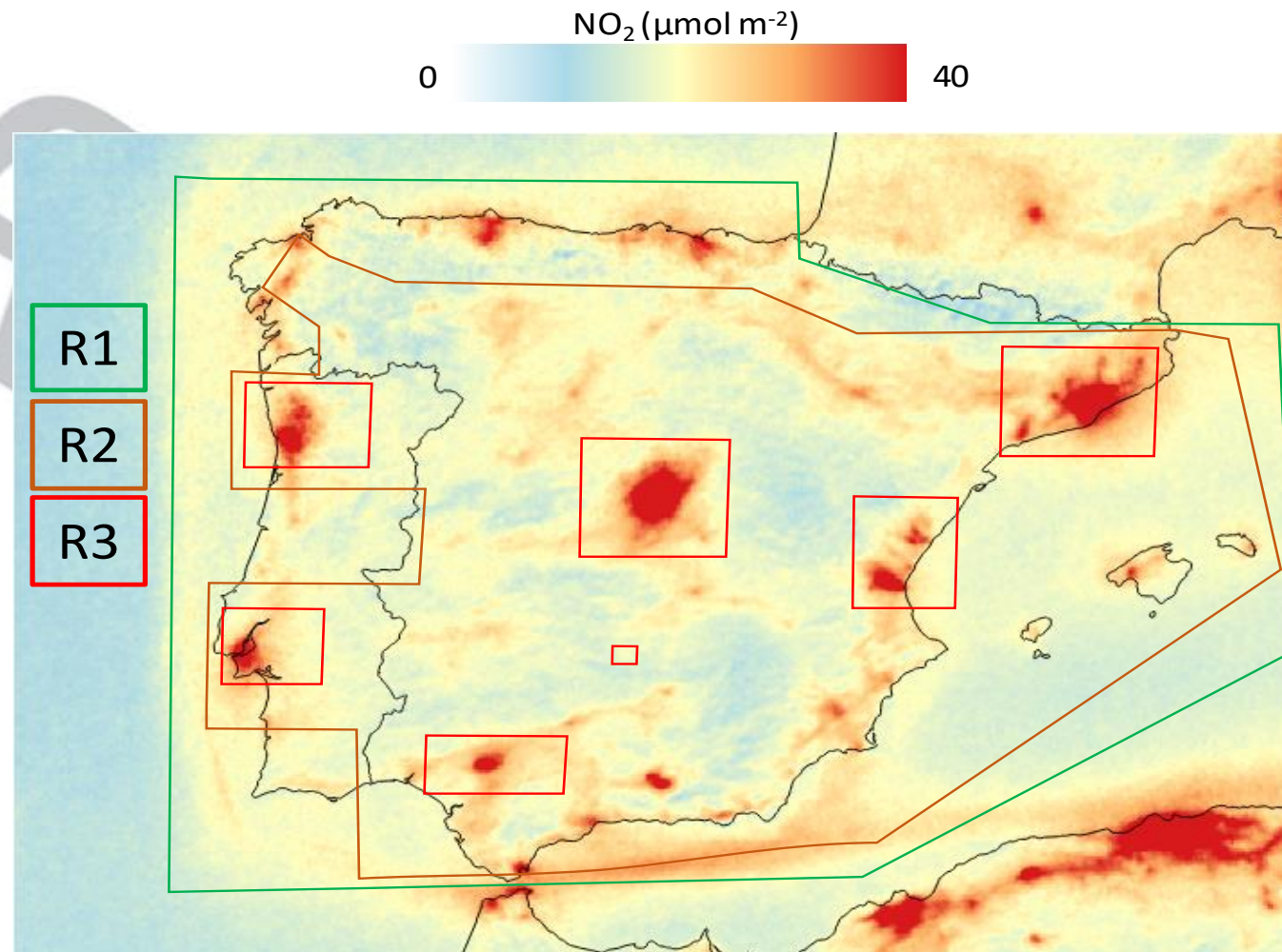
As for R3, but very specific local emissions of precursors causing the problem.:

- Puertollano



# REGIONALISATION OF THE OZONE POLLUTION

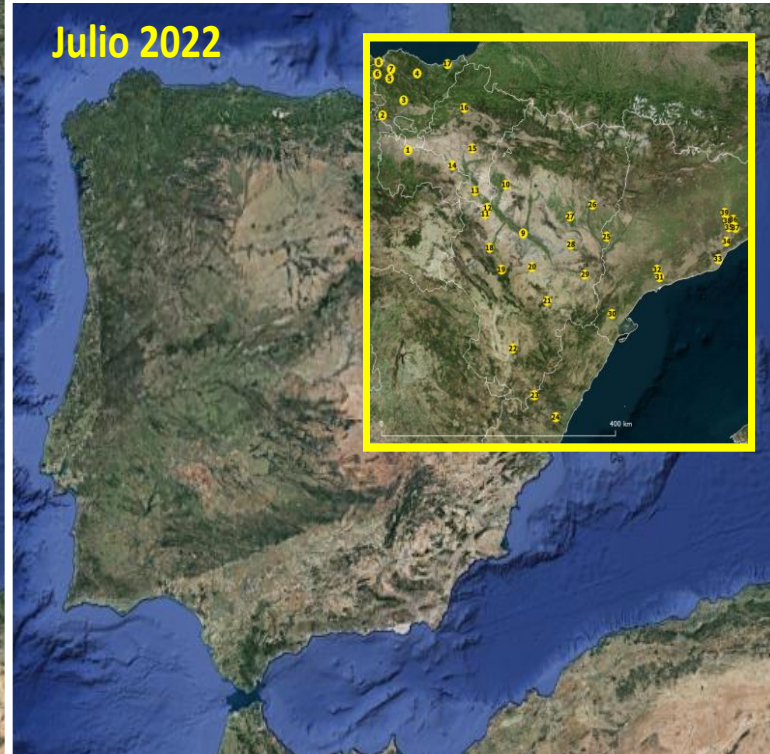
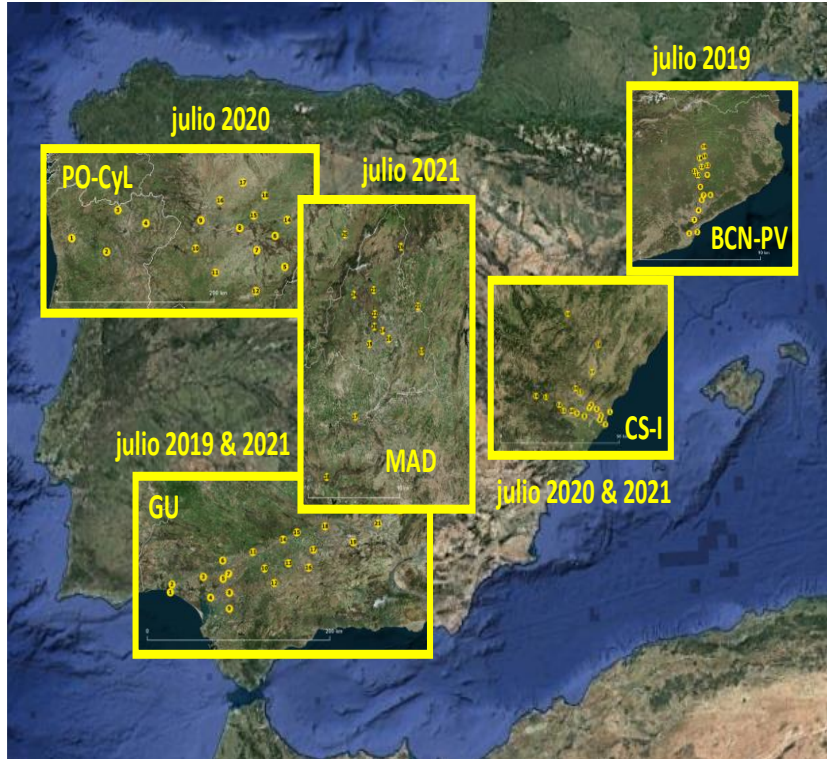
TROPOMI –ESA- NO<sub>2</sub> COLUMN JJA 2019



AREA WITH NO<sub>2</sub>  $\geq$  40  $\mu\text{mol m}^{-2}$  Madrid 2733 km<sup>2</sup>  
Barcelona 2043 km<sup>2</sup>



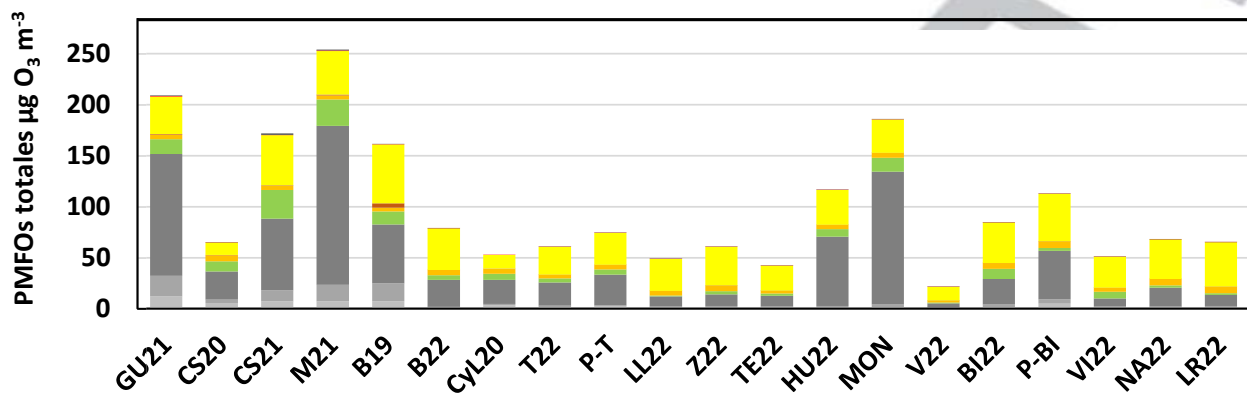
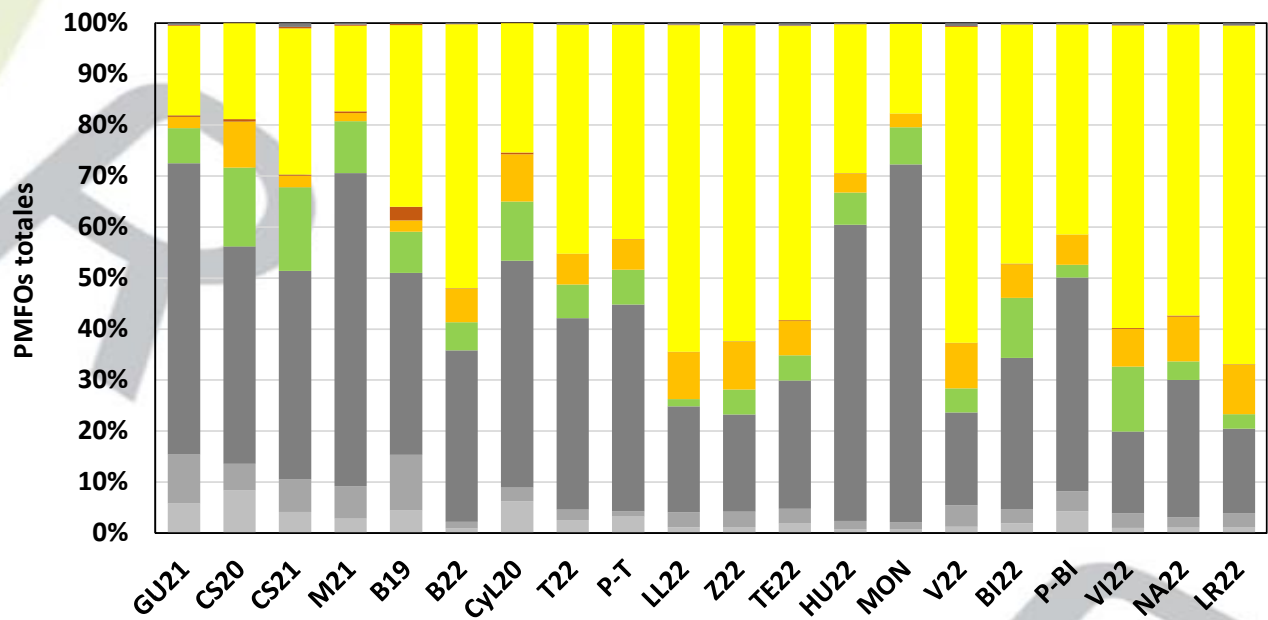
# AMBIENT VOCs CONCENTRATIONS IN SPAIN 2019-2023



## Close to emissions sources

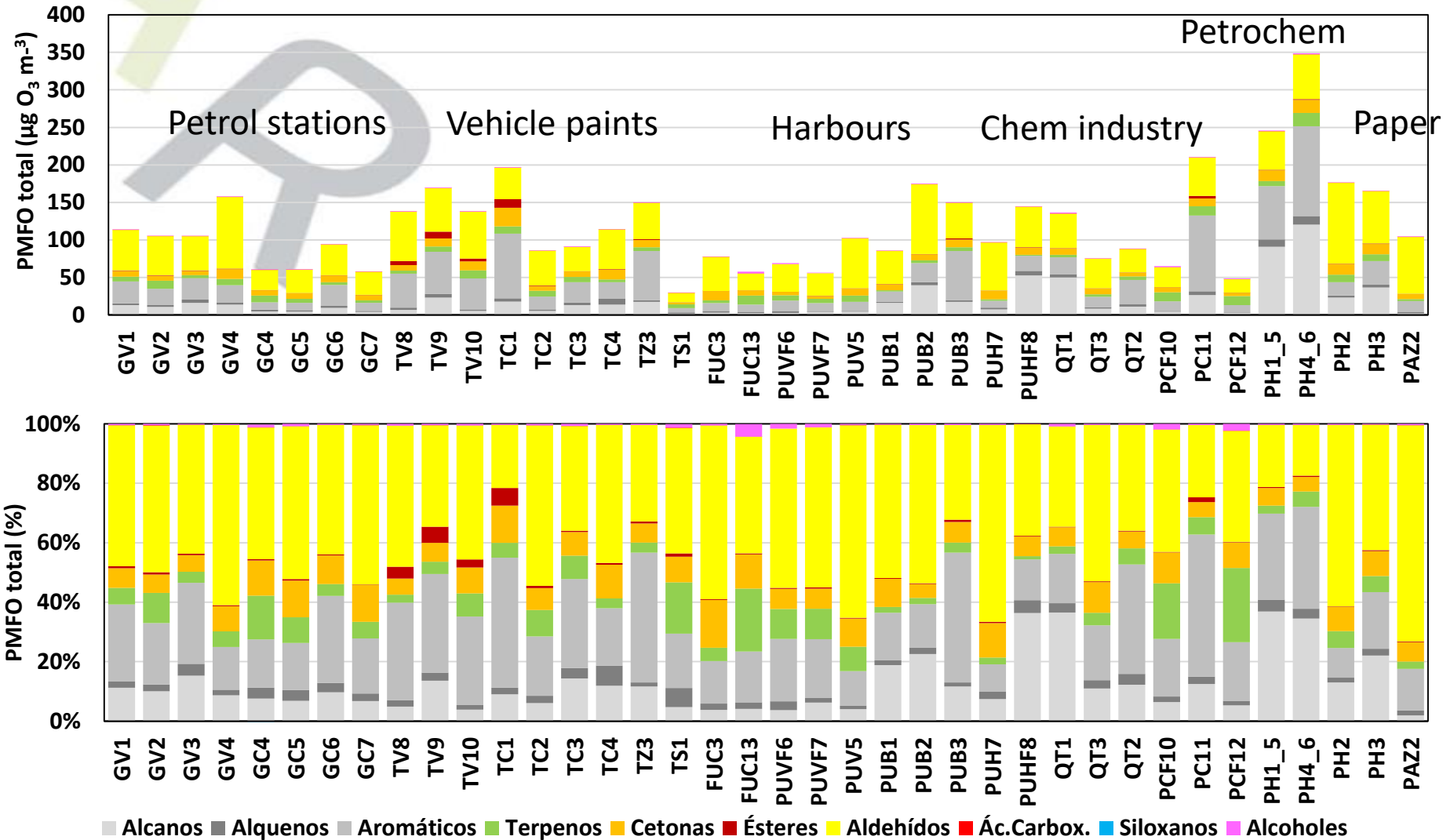


# MOFP VOCs AMBIENT CONCENTRATIONS JULY 2019-2022

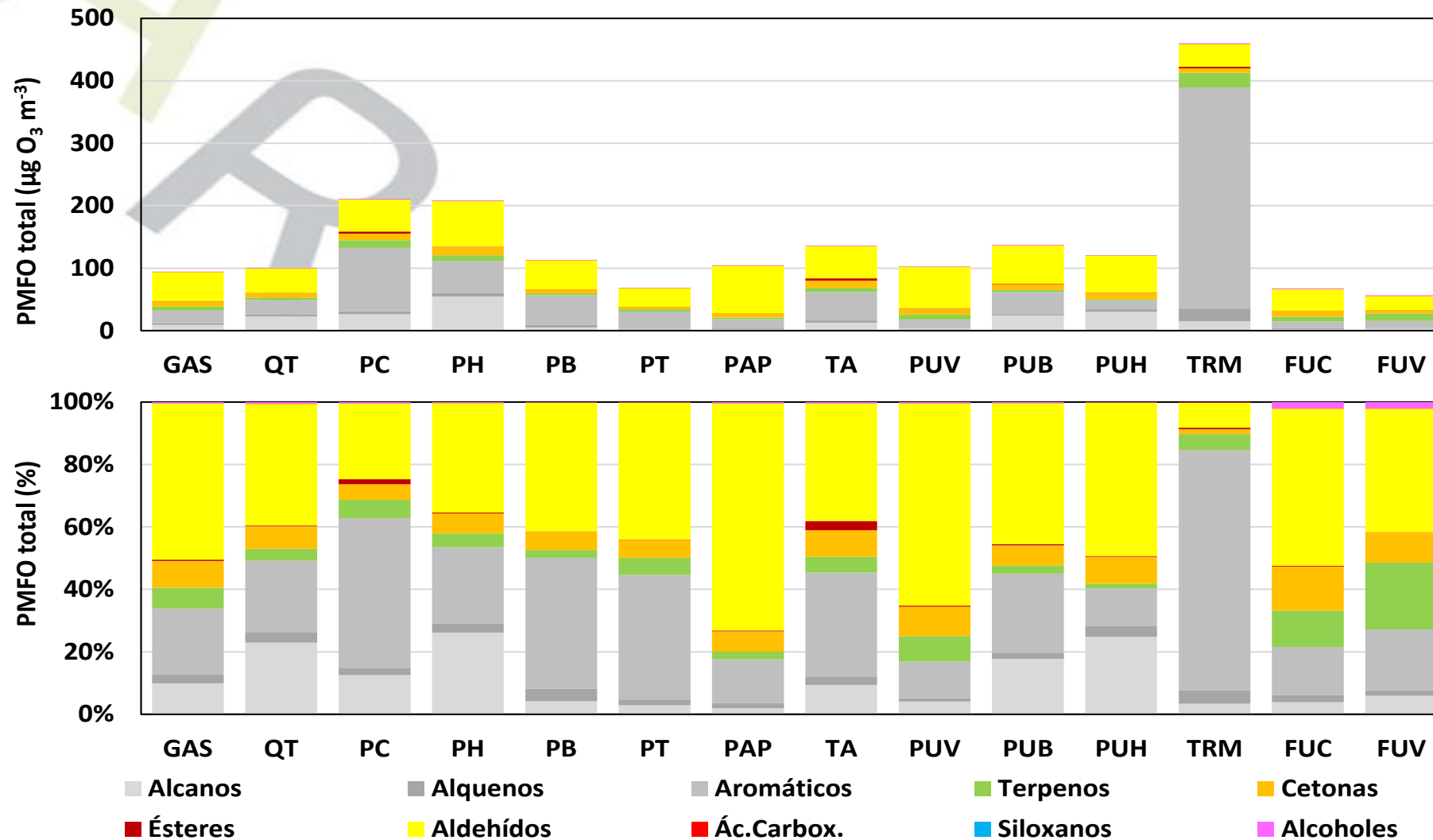




# MOFP VOCs CONCENTRATIONS CLOSE TO EMISSION SOURCES JULY 2023



# MOFP VOCs CONCENTRATIONS CLOSE TO EMISSION SOURCES JULY 2019-2023



# MOFP SYNTHESIS AMBIENT MEASUREMENTS AND SPECIATED VOCs EMISSION INVENTORIES

| Ranking PMFO               | MAD | BCN                        | CS | GUA                        | CyL |
|----------------------------|-----|----------------------------|----|----------------------------|-----|
| o, m, p xileno             | 1   | <b>Propeno</b>             | 1  | <b>Eteno</b>               | 1   |
| Etilbenceno                | 2   | Etanol                     | 2  | Etanol                     | 2   |
| Tolueno                    | 3   | <b>Eteno</b>               | 3  | <b>Propeno</b>             | 3   |
| Formaldehído               | 4   | Tolueno                    | 4  | o, m, p, xileno            | 4   |
| Acetaldehído               | 5   | o, m, p xileno             | 5  | Tolueno                    | 5   |
| <b>Eteno</b>               | 6   | <b>Heptanal</b>            | 6  | Etilbenceno                | 6   |
| Ciclopentano               | 7   | Etilbenceno                | 7  | <b>Formaldehído</b>        | 7   |
| <b>Estireno</b>            | 8   | Butanal                    | 8  | Acetaldehído               | 8   |
| Butano                     | 9   | <b>Formaldehído</b>        | 9  | Butanal                    | 9   |
| Butanal                    | 10  | <b>Estireno</b>            | 10 | Metilciclohexano           | 10  |
| <b>Etiltolueno</b>         | 11  | <b>Butil/Etil acetato</b>  | 11 | <b>1,2,4-trimetilbenc.</b> | 11  |
| <b>Propilbenceno</b>       | 12  | Acetaldehído               | 12 | <b>Etiltolueno</b>         | 12  |
| <b>1,2,4-trimetilbenc.</b> | 13  | <b>Nonanal</b>             | 13 | Butano                     | 13  |
| <b>1,2,3-trimetilbenc.</b> | 14  | Butano                     | 14 | Biacetil                   | 14  |
| Dodecano                   | 15  | <b>1,3, butadieno</b>      | 15 | <b>Propeno</b>             | 15  |
| Decano                     | 16  | <b>1,3,5-trimetilbenc.</b> | 16 | <b>Propilbenceno</b>       | 16  |
| <b>Butil/Etil acetato</b>  | 17  | Ciclopentano               | 17 | 2,2, Dimetil butano        | 17  |
| <b>Propeno</b>             | 18  | <b>Hexanal</b>             | 18 | <b>Hexanal</b>             | 18  |
| <b>1,3,5-trimetilbenc.</b> | 19  | <b>1,2,4-trimetilbenc.</b> | 19 | Dodecano                   | 19  |
| Isobutano                  | 20  | <b>Propilbenceno</b>       | 20 | <b>Etiltolueno</b>         | 20  |
|                            |     |                            |    | <b>1,3,5-trimetilbenc.</b> |     |
|                            |     |                            |    | <b>Etanol</b>              |     |
|                            |     |                            |    | <b>1,3-butadieno</b>       |     |
|                            |     |                            |    | <b>Eteno</b>               |     |
|                            |     |                            |    | <b>o,m,p xileno</b>        |     |
|                            |     |                            |    | <b>Etilbenceno</b>         |     |
|                            |     |                            |    | <b>1,2,3-trimetilbenc.</b> |     |
|                            |     |                            |    | <b>Formaldehído</b>        |     |
|                            |     |                            |    | <b>Tolueno</b>             |     |
|                            |     |                            |    | <b>1,3,5-trimetilbenc.</b> |     |
|                            |     |                            |    | <b>1,2,4-trimetilbenc.</b> |     |
|                            |     |                            |    | <b>Butanal</b>             |     |
|                            |     |                            |    | <b>Estireno</b>            |     |
|                            |     |                            |    | <b>Propeno</b>             |     |
|                            |     |                            |    | <b>Biacetil</b>            |     |
|                            |     |                            |    | <b>Etiltolueno</b>         |     |
|                            |     |                            |    | <b>Dodecano</b>            |     |
|                            |     |                            |    | <b>Acetaldehído</b>        |     |
|                            |     |                            |    | <b>Hexanal</b>             |     |
|                            |     |                            |    | <b>2-Fenil-isopropanol</b> |     |
|                            |     |                            |    | <b>Hexano</b>              |     |

Toluene, o,m,p-xylene, formaldehyde, ethanol, ethylbenzene, acetaldehyde, ethene, 1,2,3- trimethylbenzene, styrene, butane, 1,2,4-trimethylbenzene, cyclopentane, methyl-isobuthyl-cetone, propene, propylbenzene, 1,3-butadiene. Además, butanal and heptanal,

## FURTHER WORK

1. Updating reports on trends, current situation, phenomenology of episodes
2. Last VOCs campaigns on traffic sites in different cities
3. Finishing reports on VOCs
4. Visiting relevant VOCs and NOx emission sources (ITC)
5. **Sensitivity analyses for episodes (BSC)**
6. Final report (December 2024)





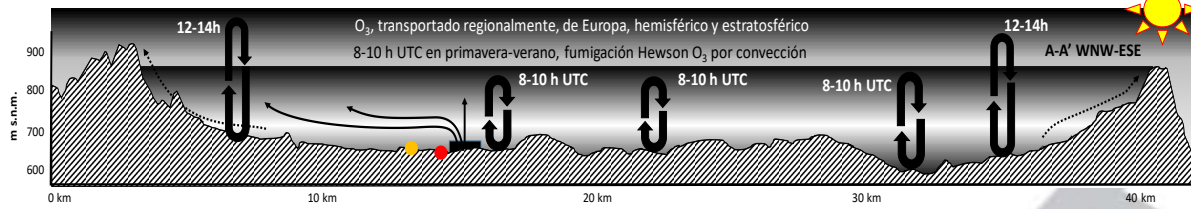
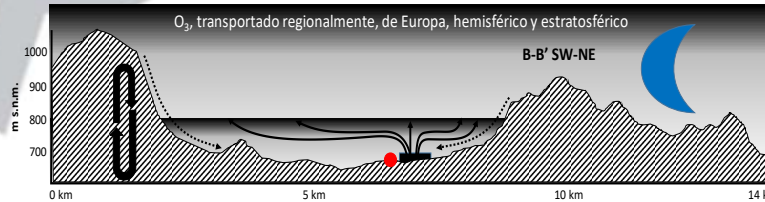
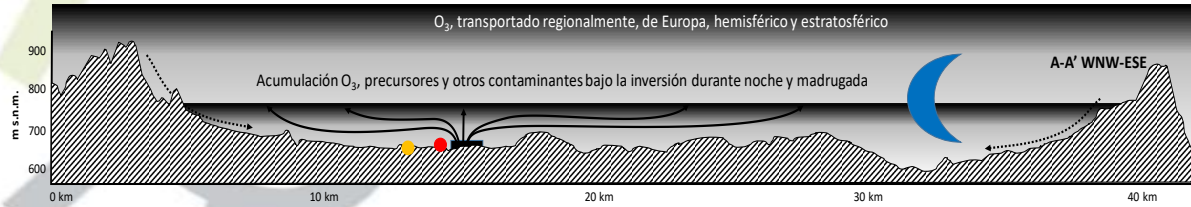
Thank you very much for your attention!!

[xavier.querol@idaea.csic.es](mailto:xavier.querol@idaea.csic.es)

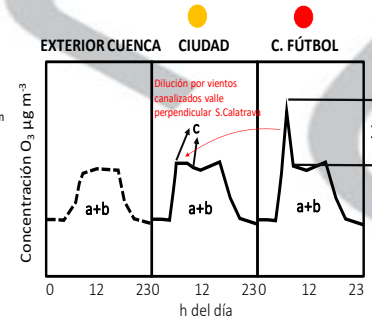
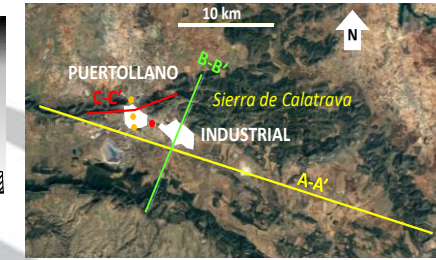


# PHENONEMOLOGY OF OZONE EPISODES VERY LOCAL HOTSPOT

## Puertollano



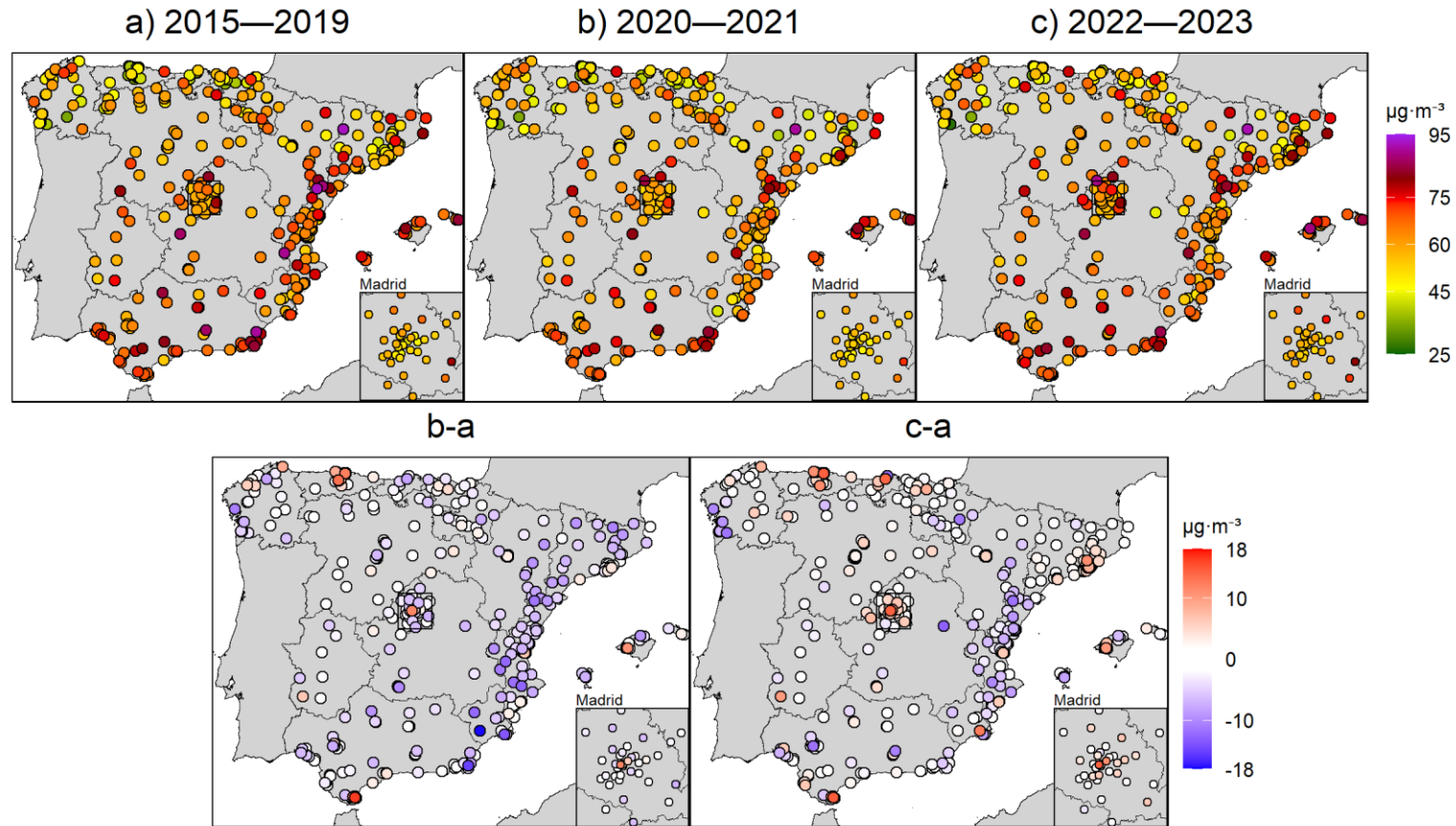
- Fumigación desde base de la inversión
- Circulaciones horizontales por el valle
- Estaciones urbanas en el valle perpendicular S. Calatrava
- Estación Campo de Fútbol



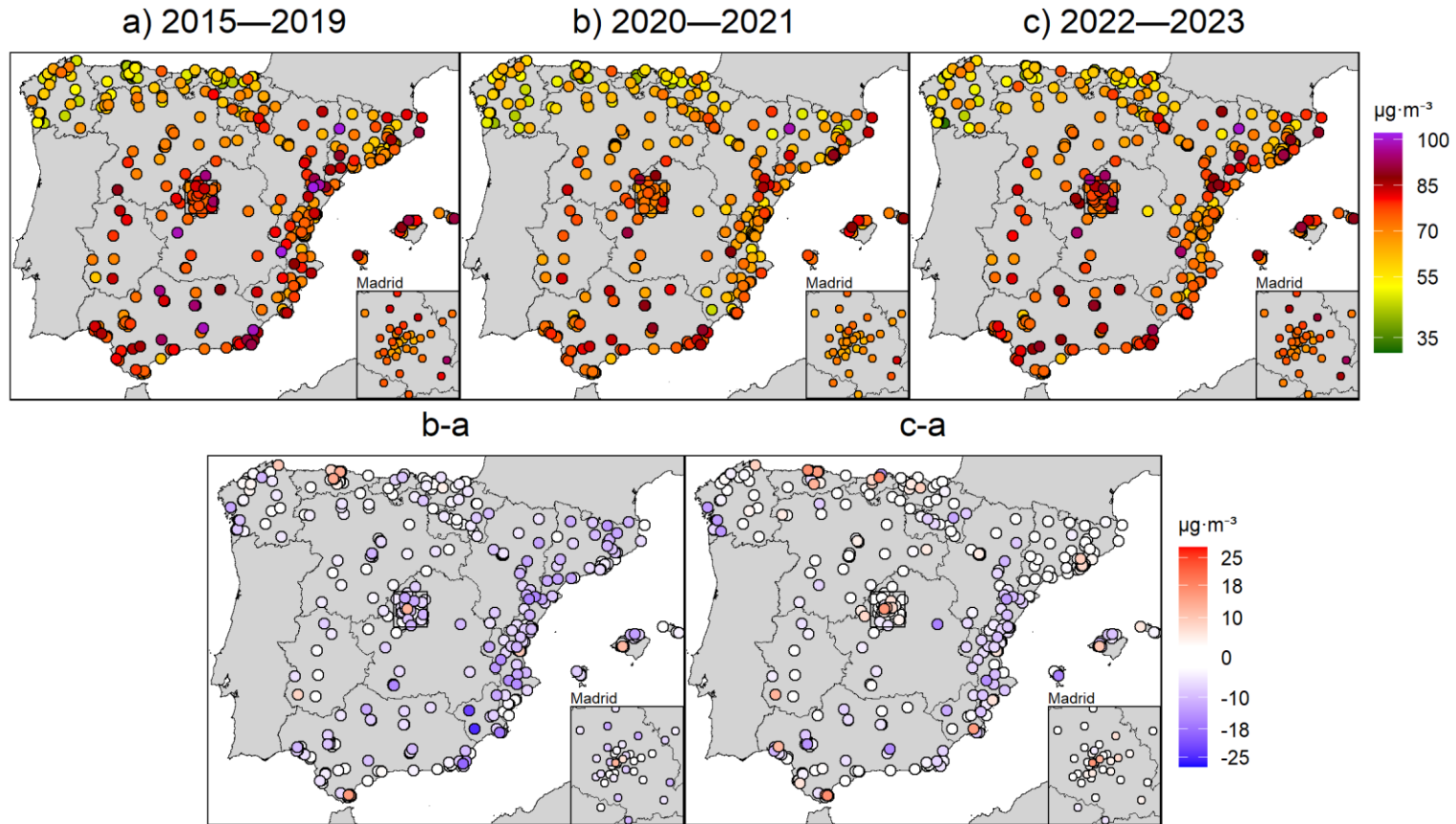
$O_3$  de fondo registrado, formación local pero sobretudo fumigación desde capas troposfera libre con  $O_3$  externo y regional, y transporte en superficie (incremento 17h UTC)

# O<sub>3</sub> annual mean

(Per quantificar diferències 2015-2019 vs 2020-2021 i 2022-2023, pero amb mètriques i en mapes)

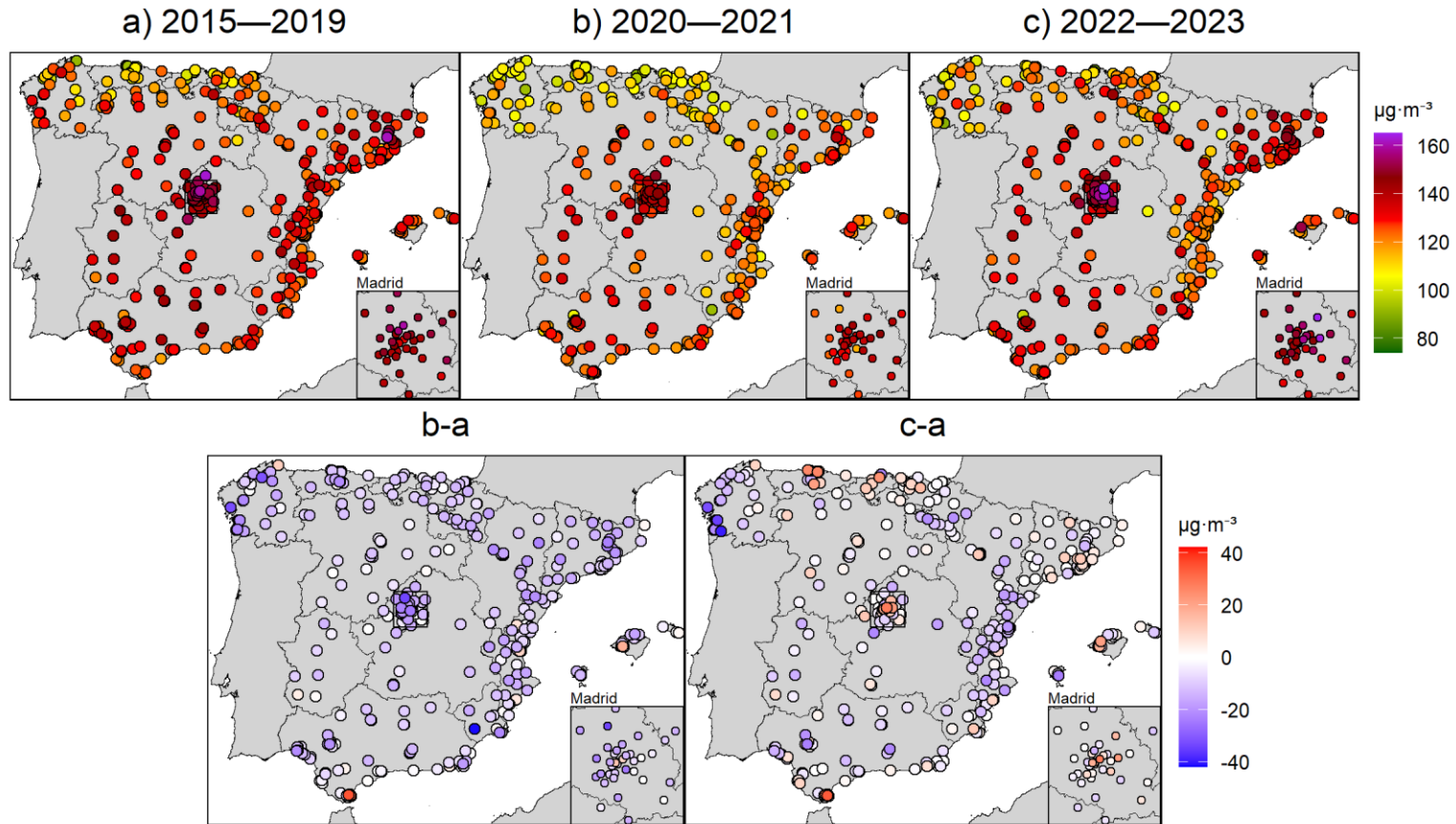


# O<sub>3</sub> April–September





# 4th MDA8 annual



# IT exceed (1h > 180 $\mu\text{g}\cdot\text{m}^{-3}$ )

