Source apportionment using the brute force method to estimate sector impacts on air pollution episodes in Spain

Mark R. Theobald, Marta García Vivanco, Victoria Gil,
Juan Luis Garrido and Coralina Hernández

Atmospheric Modelling Unit:
CIEMAT. Madrid, Spain

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Outline

1. *Identification of pollution episodes*
2. *Brute force source apportionment method*
3. *Model evaluation*
4. *Impacts:*
   - *Boundary concentrations*
   - *Transboundary*
   - *Biogenic emissions*
5. *Impacts of Spanish source sectors*
6. *Episode analysis*
7. *Conclusions*

Methods – Identification of pollution episodes

Criteria used :

- *Exceedance of the daily limit/target value*
- *At >1 background monitoring site*
- *During >1 day*

***O_3** : Maximum daily 8-hour mean (MDA8): 120 µg m^{-3}*

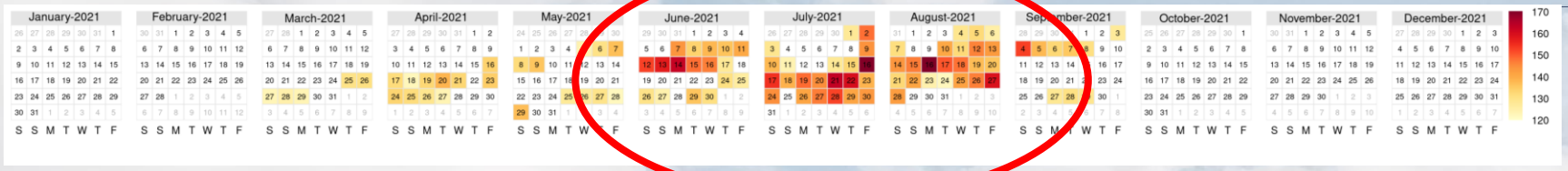
***NO_2** : Daily mean: 50 µg m^{-3}*

***$PM_{2.5}$** : Daily mean: 25 µg m^{-3}* (New AAQD)

***PM_{10}** : Daily mean: 45 µg m^{-3}*

Pollution Episodes (2021)

O_3 : Maximum Daily 8-hour mean (MDA8)



NO_2 : Daily mean

$PM_{2.5}$: Daily mean

PM_{10} : Daily mean

Brute Force Source Apportionment

Base scenario (BS)

Reduction scenario (RS)

Small reduction to one of the sources

S_3 : Una reducción de X%

$$\text{Potential impact of } S_3 = (BS\text{-}RS) \times (100/X) = \text{Contribution of } S_3 \text{ for linear species}$$

(But not for non-linear species such as O_3 and secondary PM)

Method application in this study

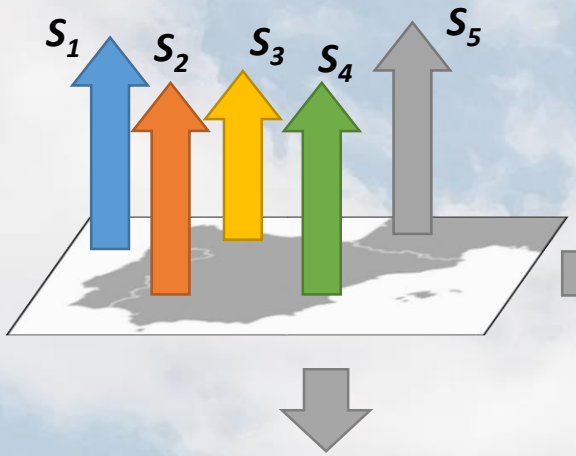
Three levels of detail

European simulations

Reductions applied to:

- *Spain*
- *Neighbouring countries (FR, PT)*
- *Resto of SW Europe*
- *International shipping*
- *Biogenic emissions*
- *Boundary concentrations (O_3 / non O_3)*

Spanish simulations (nested within European Base Case)



Episode runs (1-2 months):

With reductions for:

- *Source sectors in Spain and emitted species (e.g. NOx from SNAP7)*
- *All other anthropogenic emissions*

Annual runs:

With reductions for:

- *Source sectors in Spain (SNAP 1-10)*
- *Rest of SW Europe*
- *International shipping*
- *Biogenic emissions (VOC, NOx, PM)*
- *Boundary concentrations (O_3 / non O_3)*

Reductions of 10% and 25%

Method application in this study

Three levels of detail

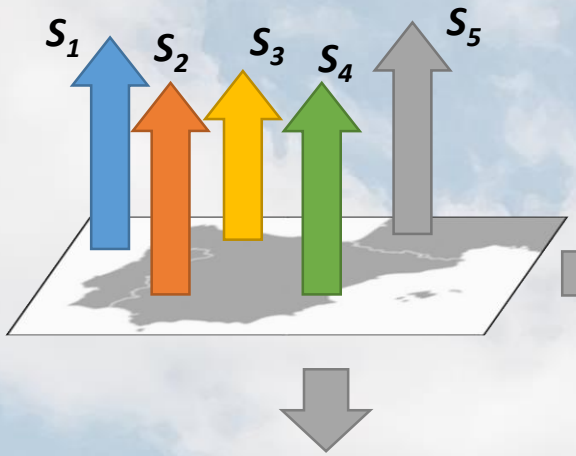
European simulations

Reductions applied to:

- Spain
- Neighbouring countries (FR, PT)
-
-
- Biogenic emissions
- Boundary concentrations (O_3 / non O_3)

19 simulations

Spanish simulations (nested within European Base Case)



Episode runs (1-2 months):

With reductions for:

- So… …itted sp…
- All other anthropogenic emissions

83 simulations

Annual runs:

With reductions for:

- Source sectors in Spain (SNAP 1-10)

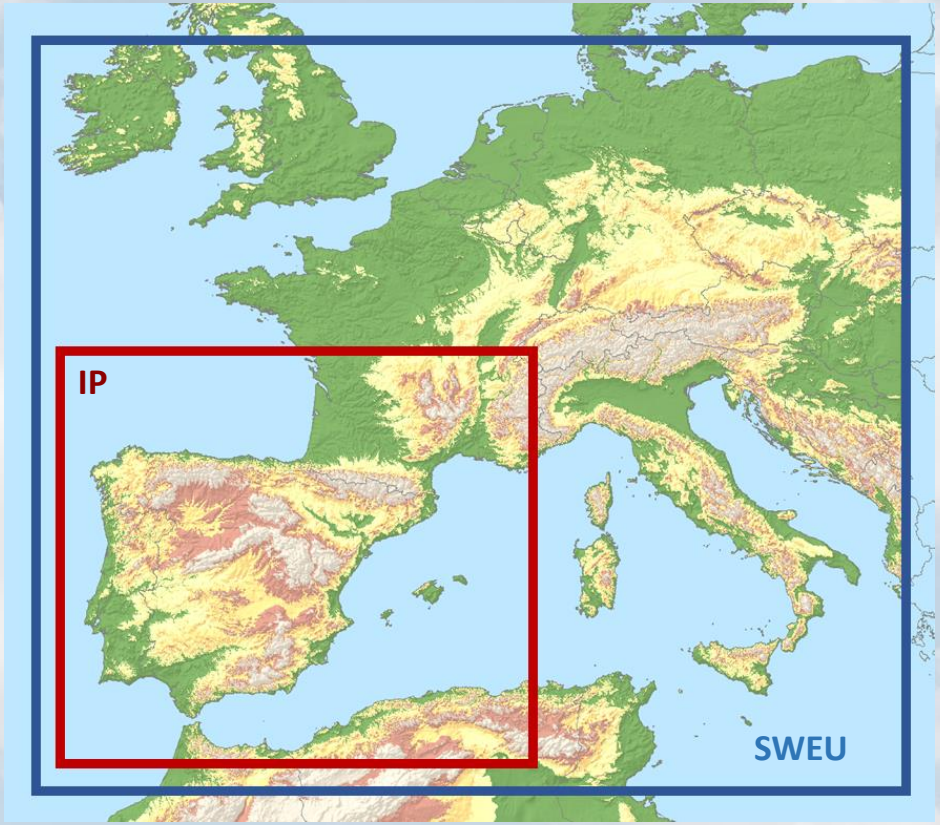
35 simulations

- Biogenic emissions (VOC, NOx, PM)
- Boundary concentrations (O_3 / non O_3)

Reductions of 10% and 25%

Model set-up

- **Chemistry and Transport Model:**
  - **CHIMERE (v2013)**
- **Spatial Resolutions:**
  - **0.15º x 0.15º (SW Europe; SWEU)**
  - **0.1º x 0.1º (Iberian Peninsula; IP)**
- **Emissions (2021):**
  - **Spain: National Emission Inventory**
  - **Rest of Europe: EMEP**
- **Meteorology: ECMWF - IFS 2021**
- **Boundary conditions: LMDZ-INCA and GOCART (climatological)**
- **Biogenic emissions: MEGAN**



Simulation of episodes (at background station locations)

O_3 : Maximum Daily 8-hour mean (MDA8)

OBS

MOD

NO_2 : Daily mean

OBS

MOD

$PM_{2.5}$: Daily mean

OBS

MOD

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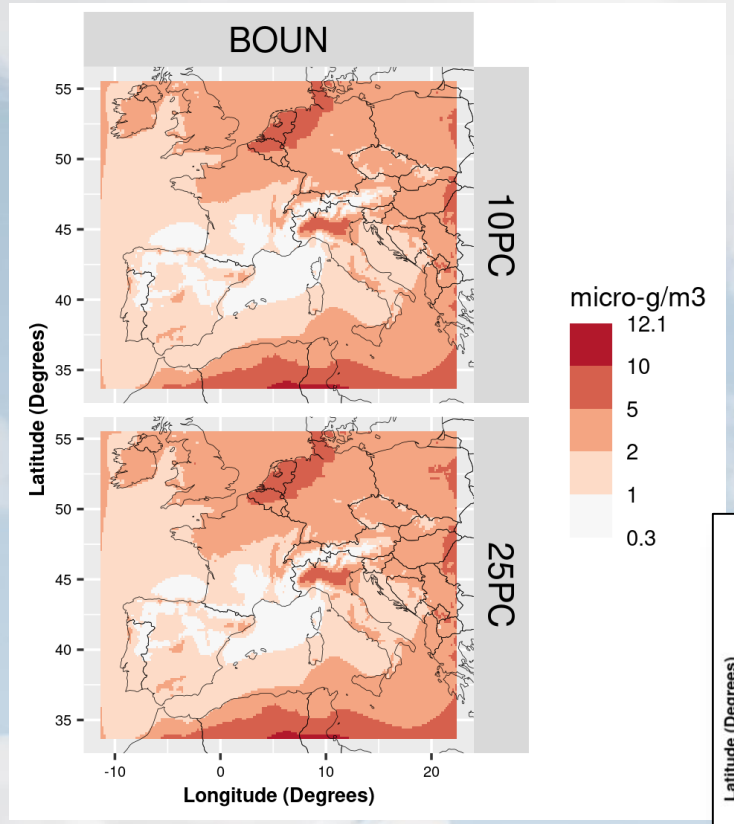
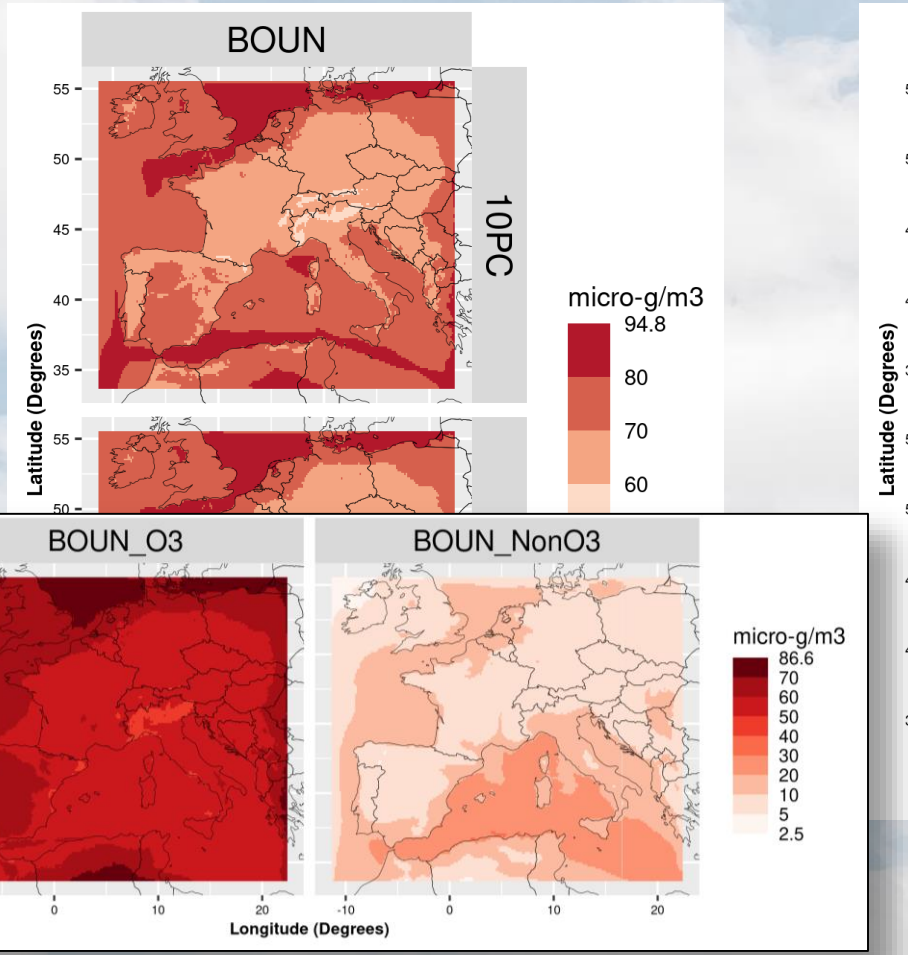
Potential Impact maps (SWEU)

Impact of Boundary Concentrations

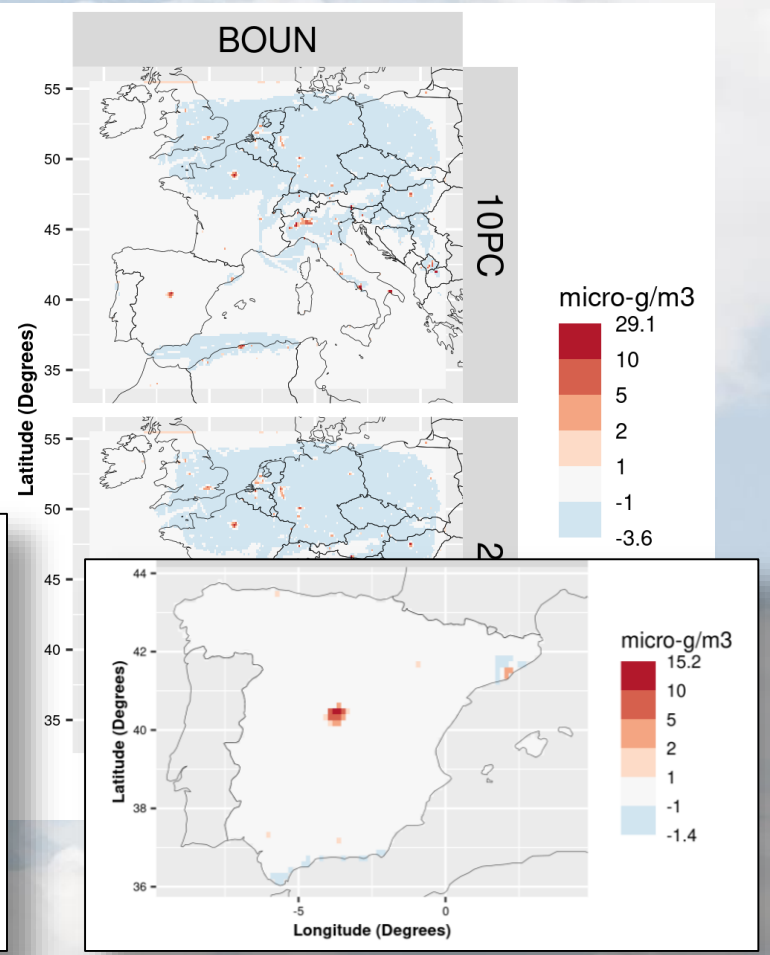
$PM_{2.5}$: Annual mean



O_3 MDA8 : 6 mth mean (Apr-Sep)



NO_2 : Annual mean



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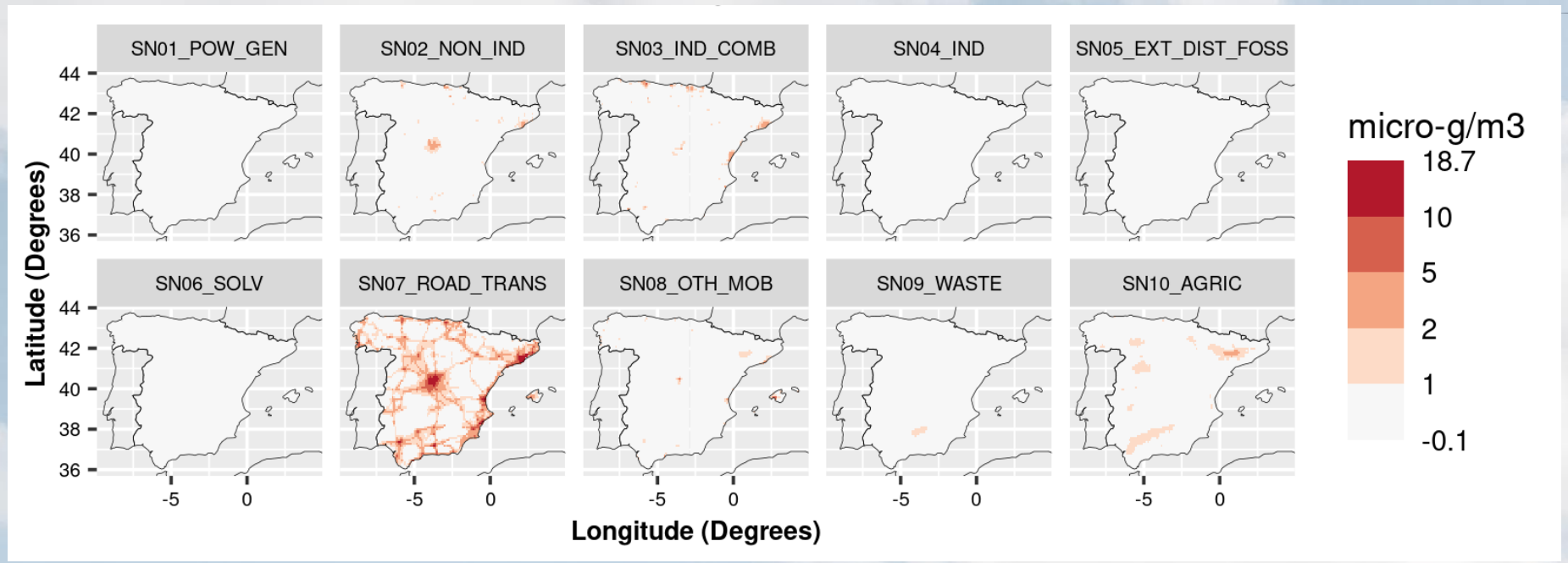
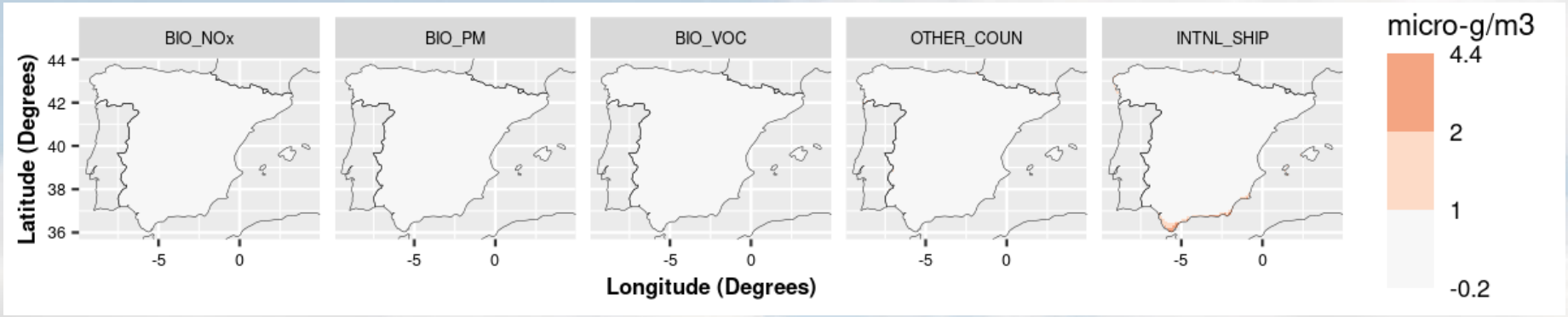
Potential Impact maps (IP)

NO_2 : Annual mean





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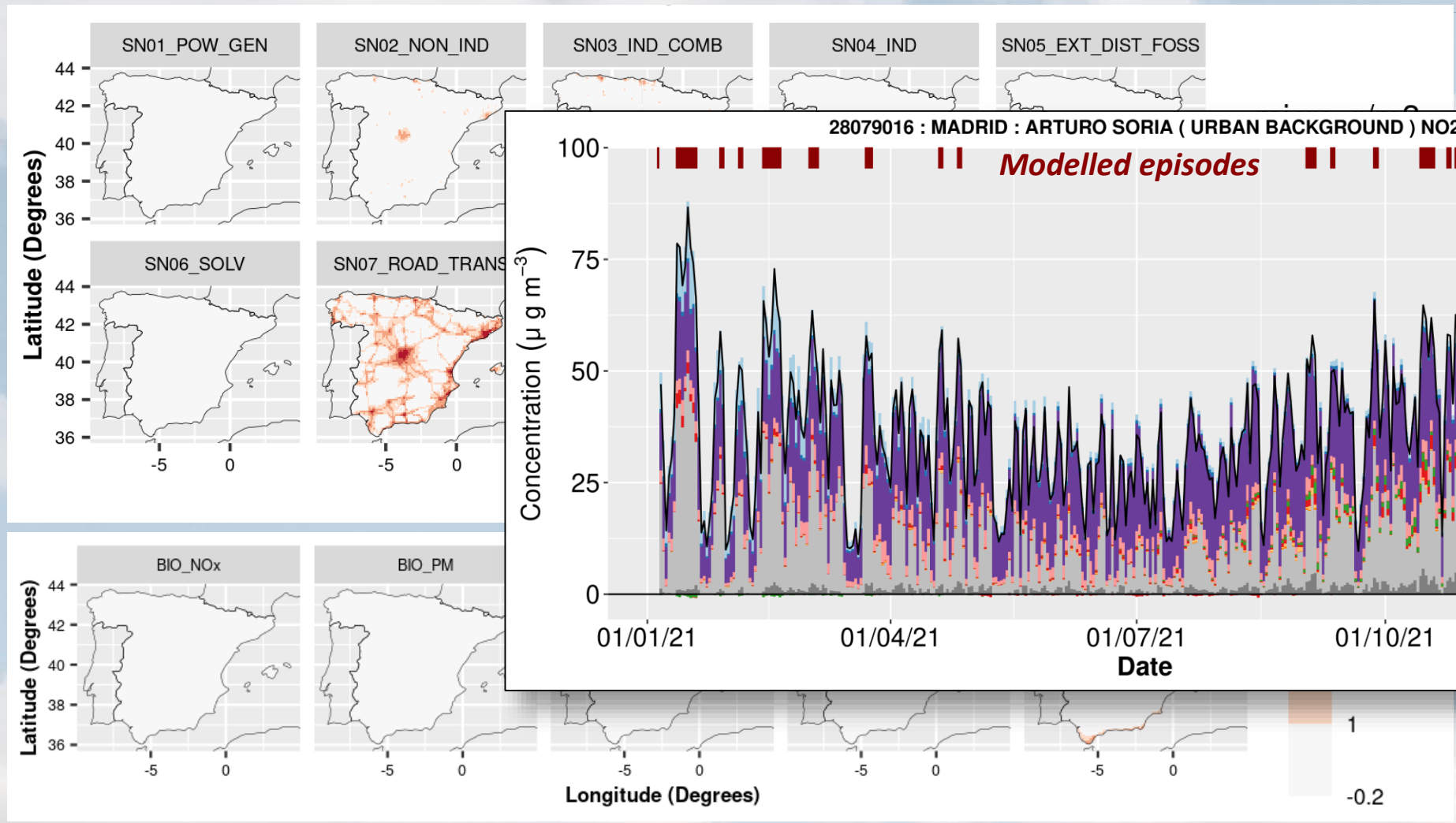
Potential Impact maps (IP)

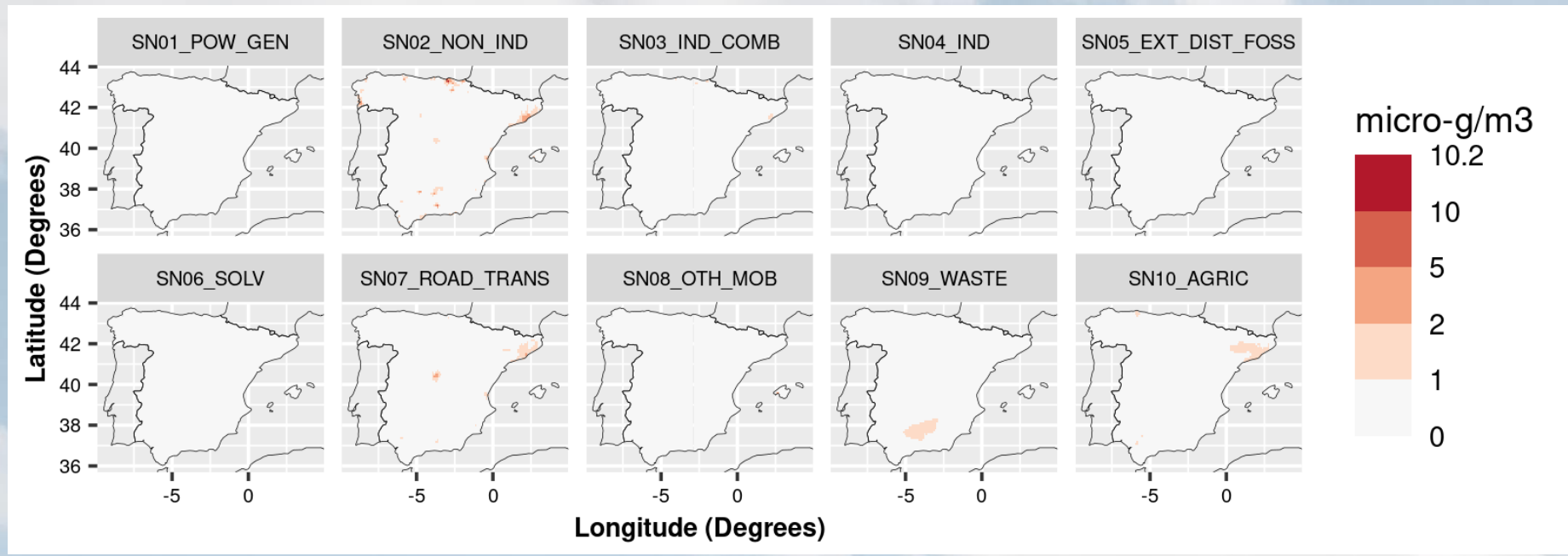
NO_2 : Annual mean

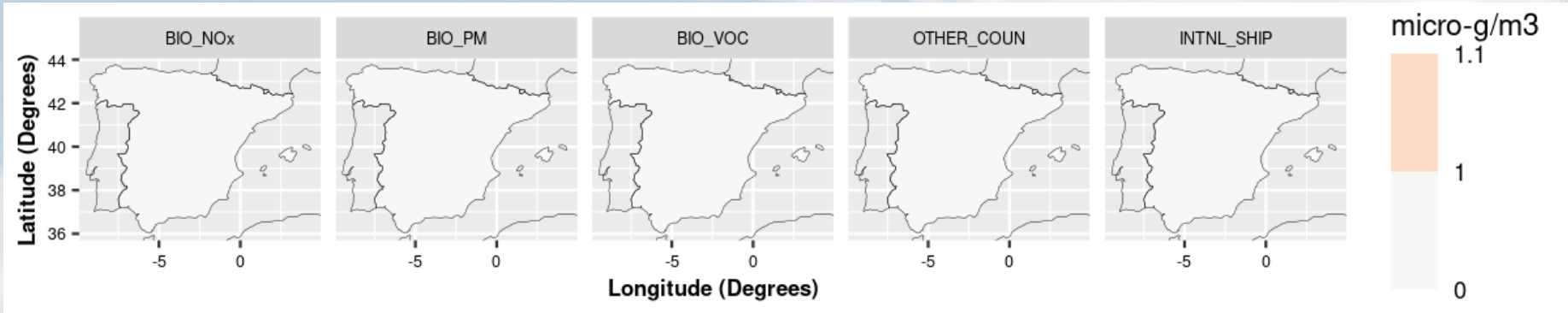


Large impact of background O_3

Potential Impact maps (IP)

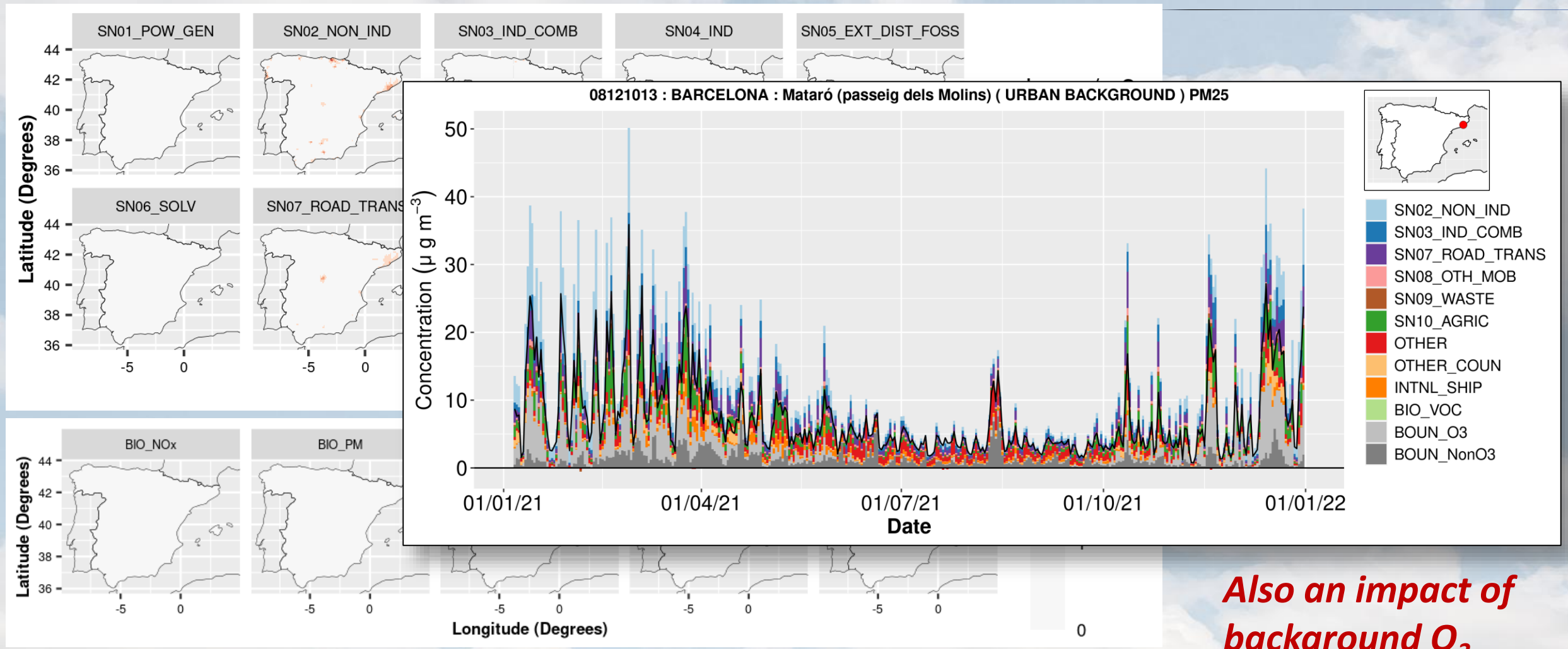
$PM_{2.5}$: Annual mean





Potential Impact maps (IP)

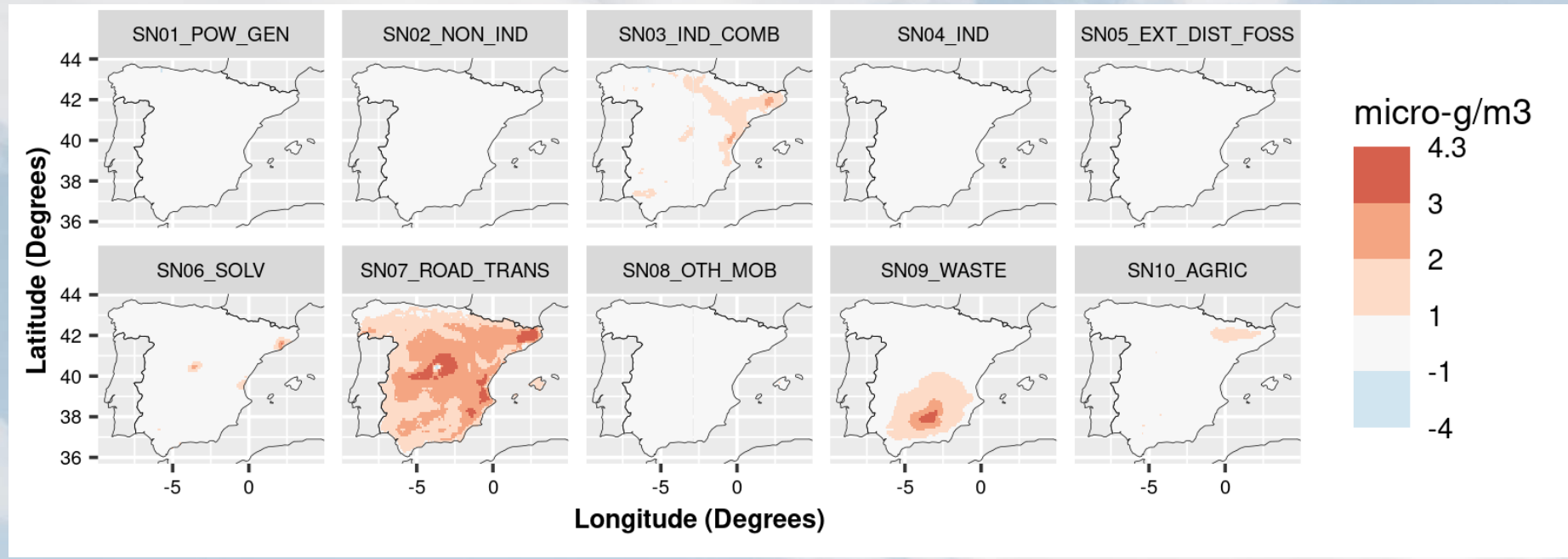
$PM_{2.5}$: Annual mean

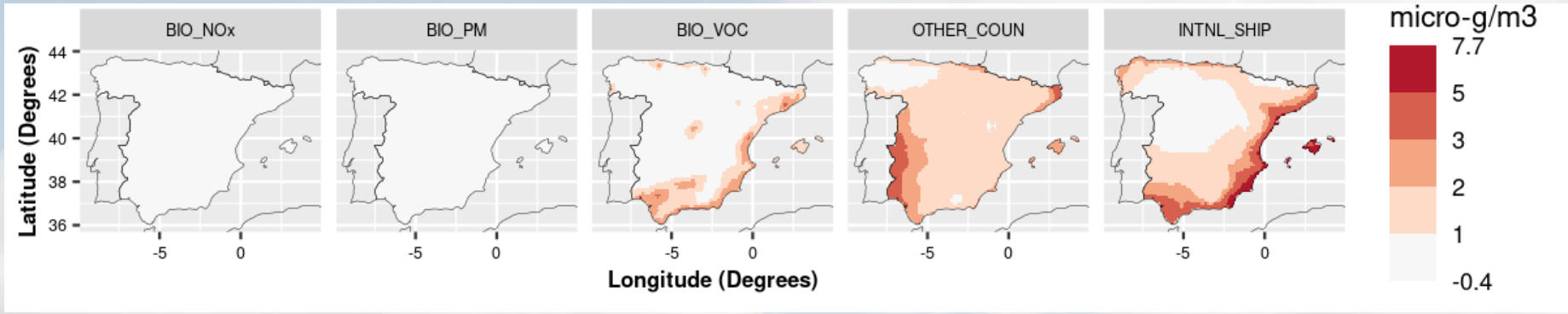


Also an impact of background O_3

Potential Impact maps (IP)

O_3 MDA8 : 6 mth mean (Apr-Sep)





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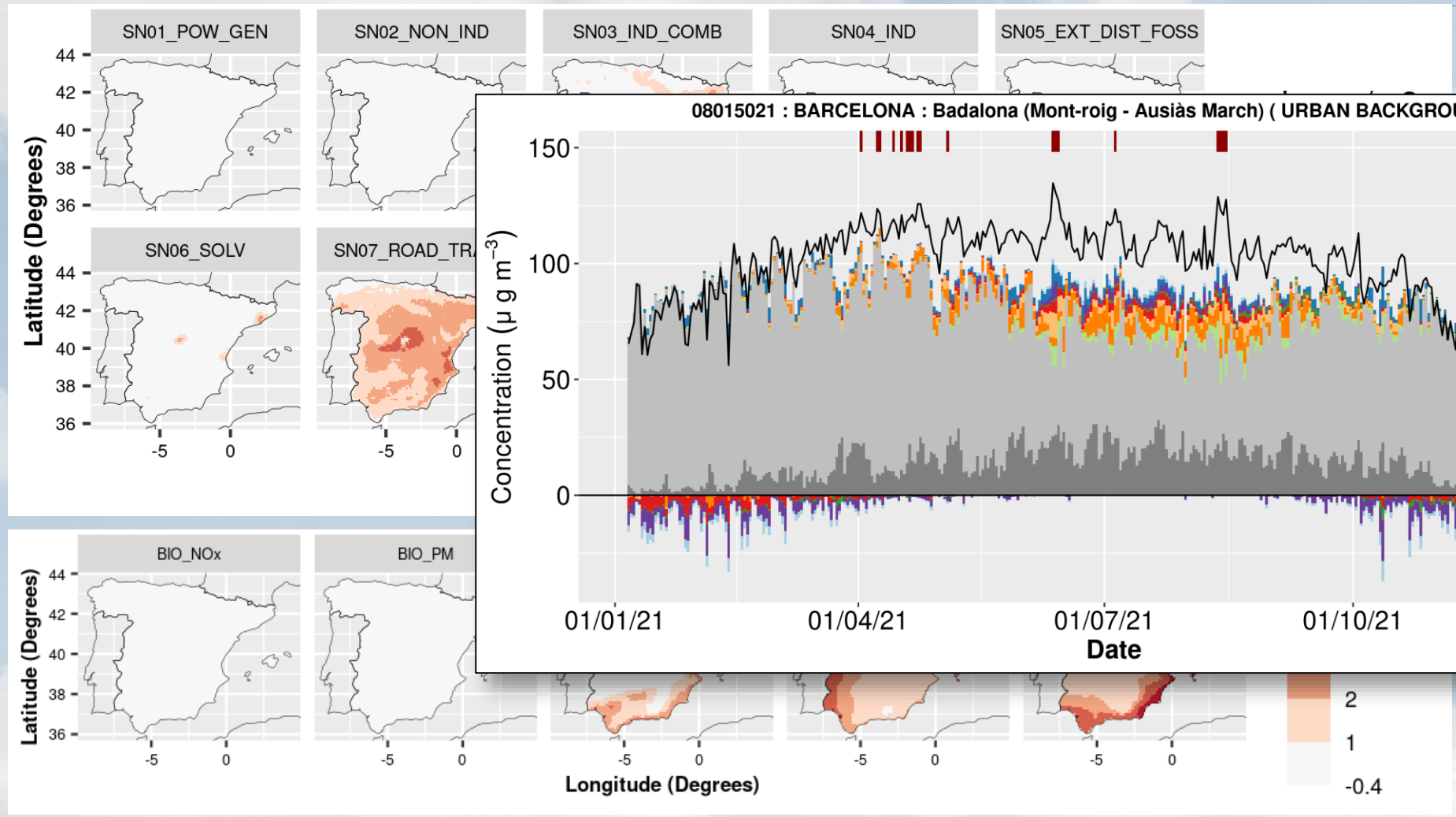
Potential Impact maps (IP)

O_3 MDA8 : 6 mth mean (Apr-Sep)



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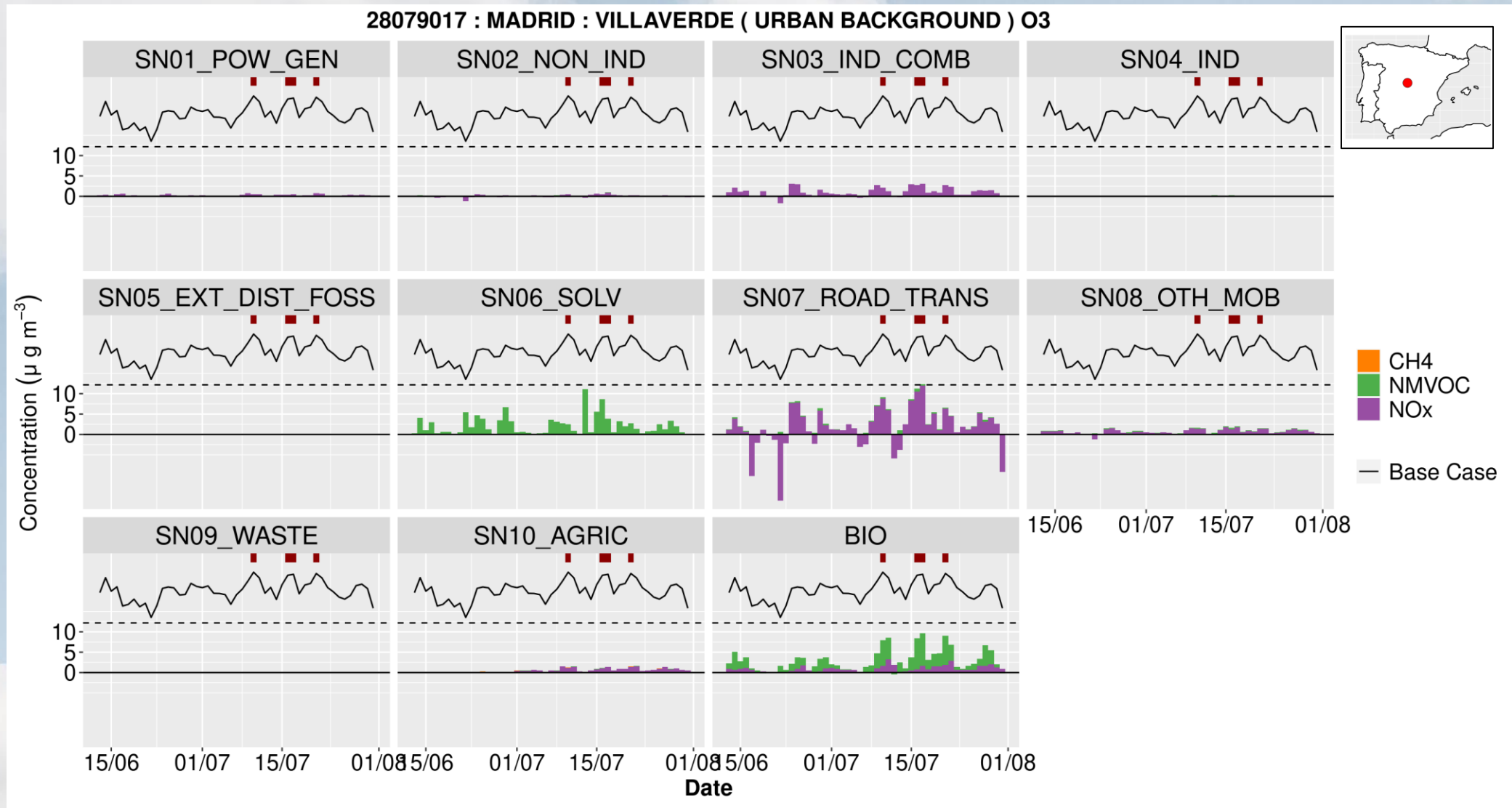
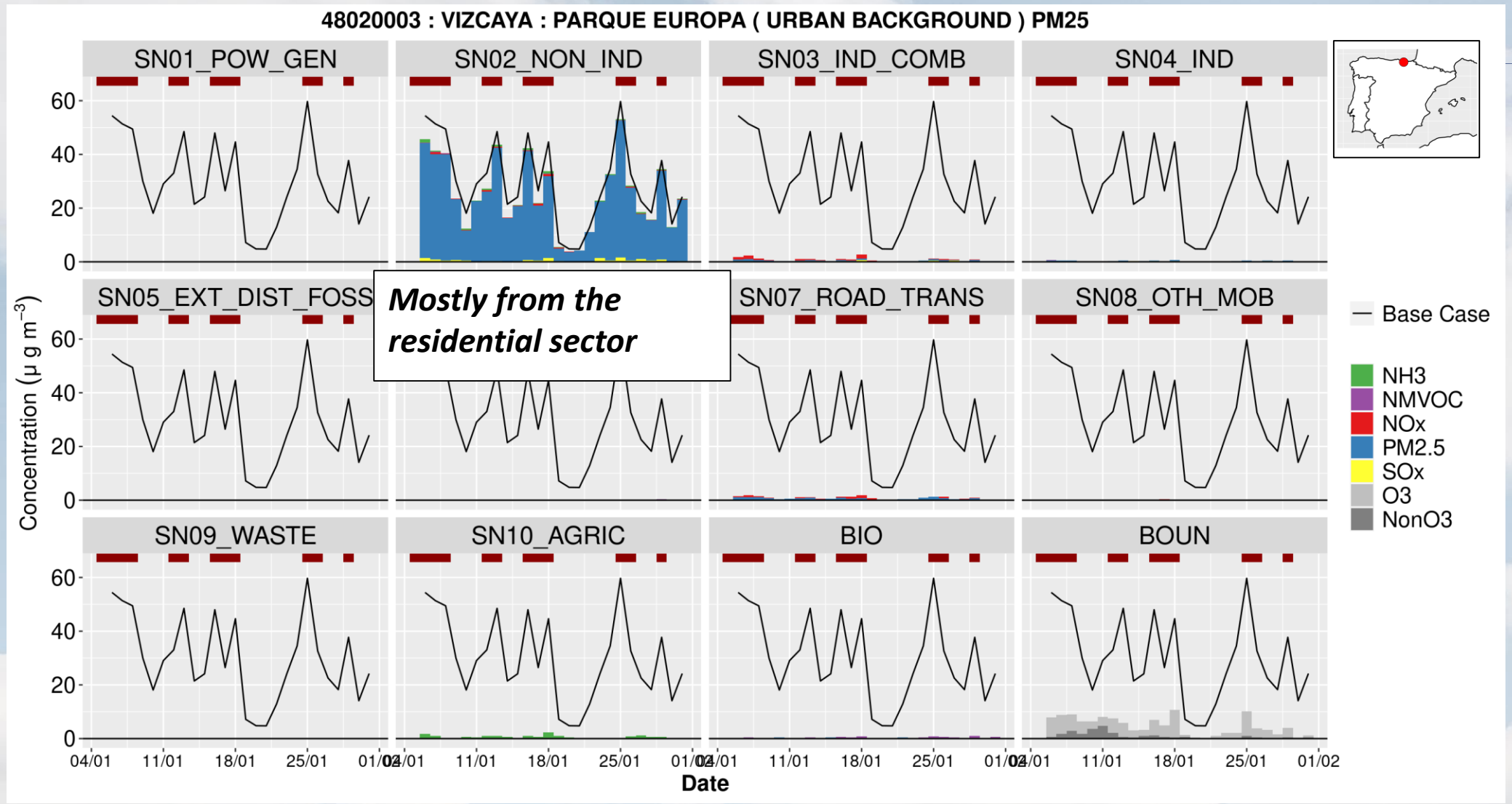
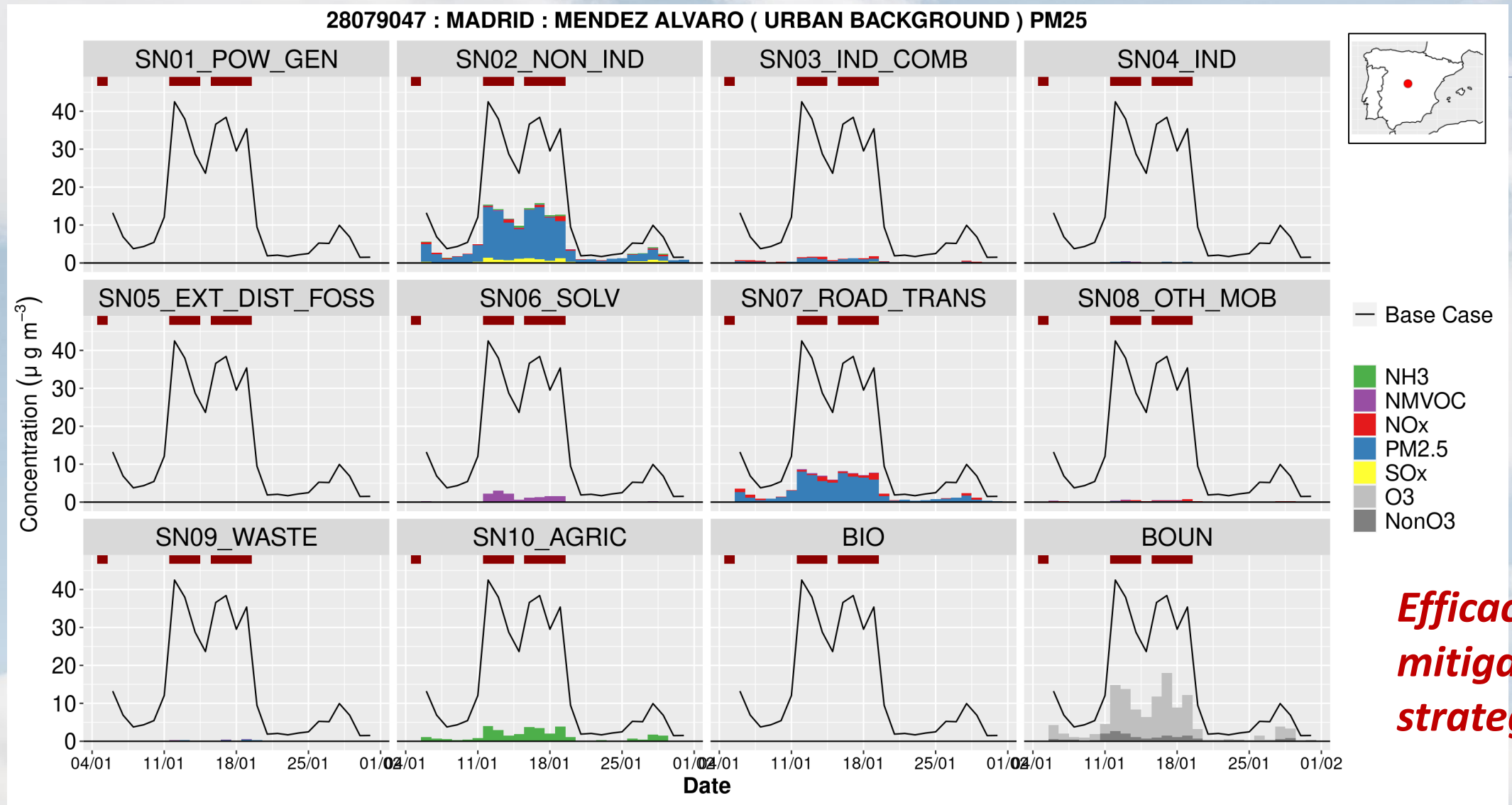
Detailed impact analyses of episodes: O_3 MDA8 (June-July)



Detailed impact analyses of episodes: $PM_{2.5}$ daily mean (January)



Detailed impact analyses of episodes: $PM_{2.5}$ daily mean (January)



Efficacy of mitigation strategies?

Conclusions

1. *Brute force source apportionment is a useful tool for estimating source impacts at different temporal and spatial scales*
2. *Background O_3 not only has an impact on O_3 concentrations but also influences NO_2 and $PM_{2.5}$ concentrations*
3. *Biomass burning of agricultural waste can have an impact on O_3 concentrations*
4. *Mitigation strategies should take into account the spatial variability of source impacts*

Thanks!

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mark.theobald@ciemat.es