



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



EXCELENCIA
SEVERO
OCHOA

O₃ sensitivity by reducing emissions of precursors in Barcelona

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Madrid, Nov 20-21,
2018

Workshop on air quality policy implementation
related to ozone

The CALIOPE air quality forecast system

www.bsc.es/caliope

METEO

- **WRF-ARWv3.5** (RRTM/WSM3/YSU/NoahLSM)
- Ver. Res.: $37\sigma/50\text{hPa}$ (top)
- Hor. Res: 12km (EU) - 4km (IP) - 1km (CAT,MAD,etc)
- IC/BC (EU12/IP4): GFS (NCEP) / nesting EU12

EMIS

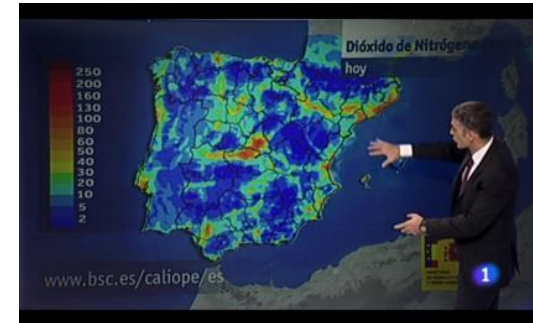
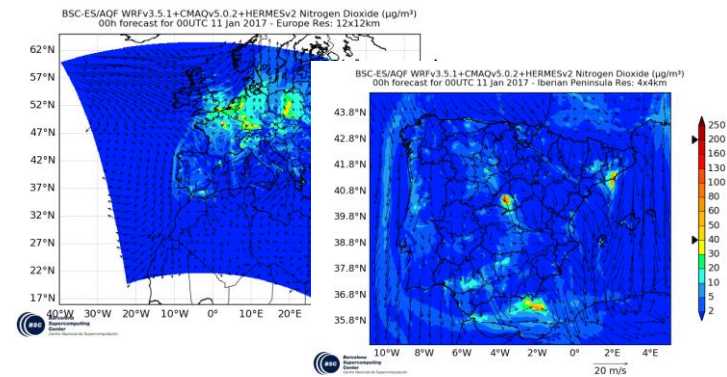
- **HERMESv2.0 and v3.0**
- EU12: HERMES-DIS (EMEP, TNO-MACC)
- IP4: **HERMES-BOUP (Spain) + HERMES-DIS(Europe)**
- Biogenic emission MEGANv2.0.4

CHEM

- **CMAQv5.0.2** (ISAM, CB05TUCL, AERO6)
- Ver. Res: $37\sigma/50\text{hPa}$ (top)
- Hor. Res: 12km (EU) - 4km (IP) - 1km (CAT,MAD,etc)
- BC (EU12/IP4): MOZART4-GEOS-5 & CAMS
- MCIPv4.0

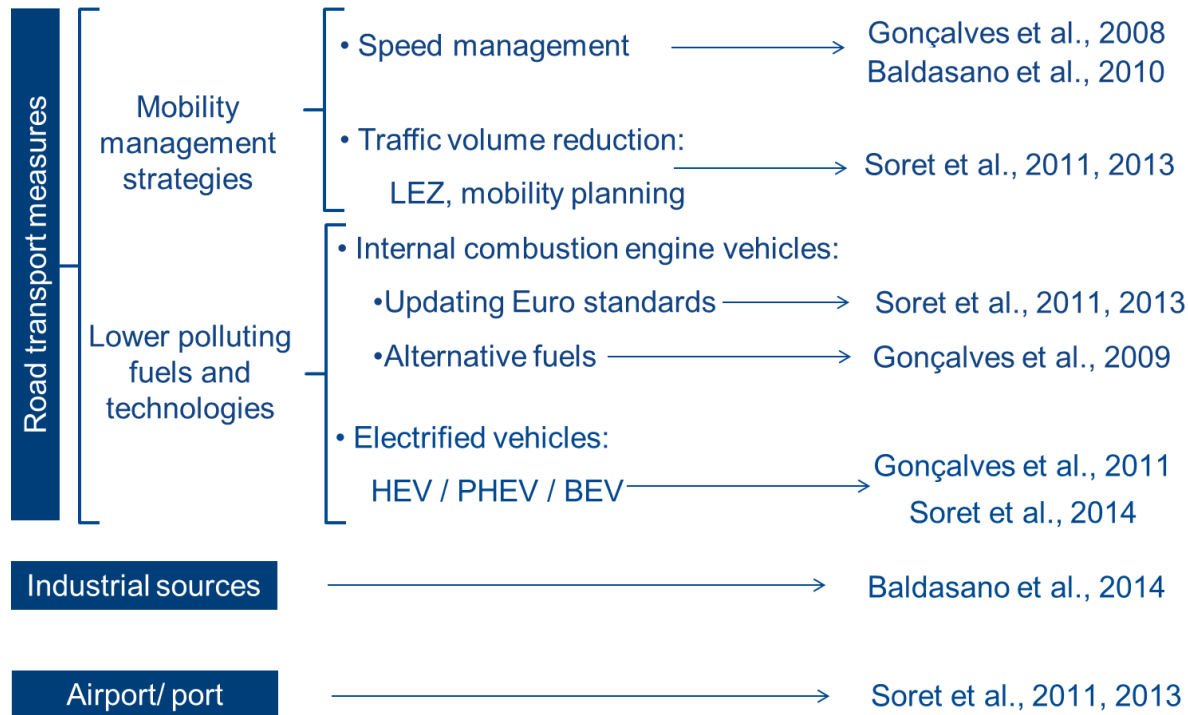
Short-term: CMAQ+WRF == MONARCH (in-house)

Air quality products



CALIOPE for mitigation strategies

Modelling approach – Earth Science Department @BSC



- Targeting Barcelona & Madrid cities: different regimes (chemical, meteorological).
- Focused on the road traffic sector (PM10, PM2.5 and NO₂).
- Impact on NO₂ and PM: “effectively” reduced in the conurbations (up to 30%).
- Impact on O₃: slightly increase in the urban area (~1-4%) and low and negligible changes downwind.

What remains? Diagnosis of O₃ problem

1

STATE

- Which are the economic activities (**sectors**) responsible for high O₃?
- Where do the precursors responsible for O₃ exceedances come from (**regions**)?

Source apportionment

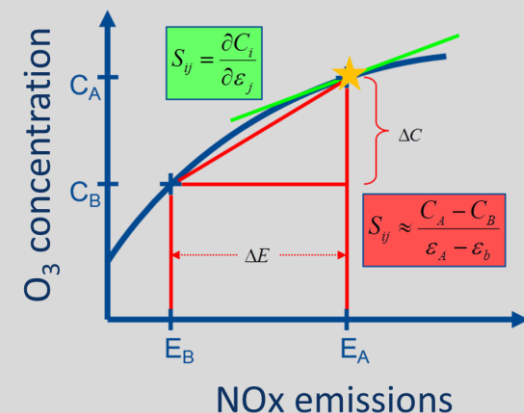


2

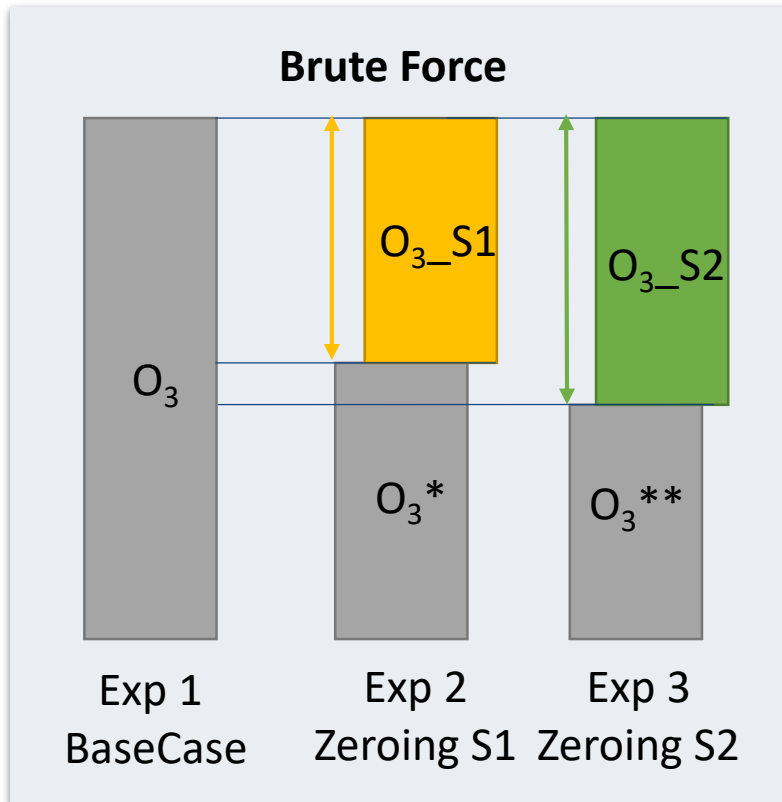
RESPONSE

- Which sources (sectors/regions) are more efficient to reduce?
- Counterpart of NO_x/VOC reduction on O₃

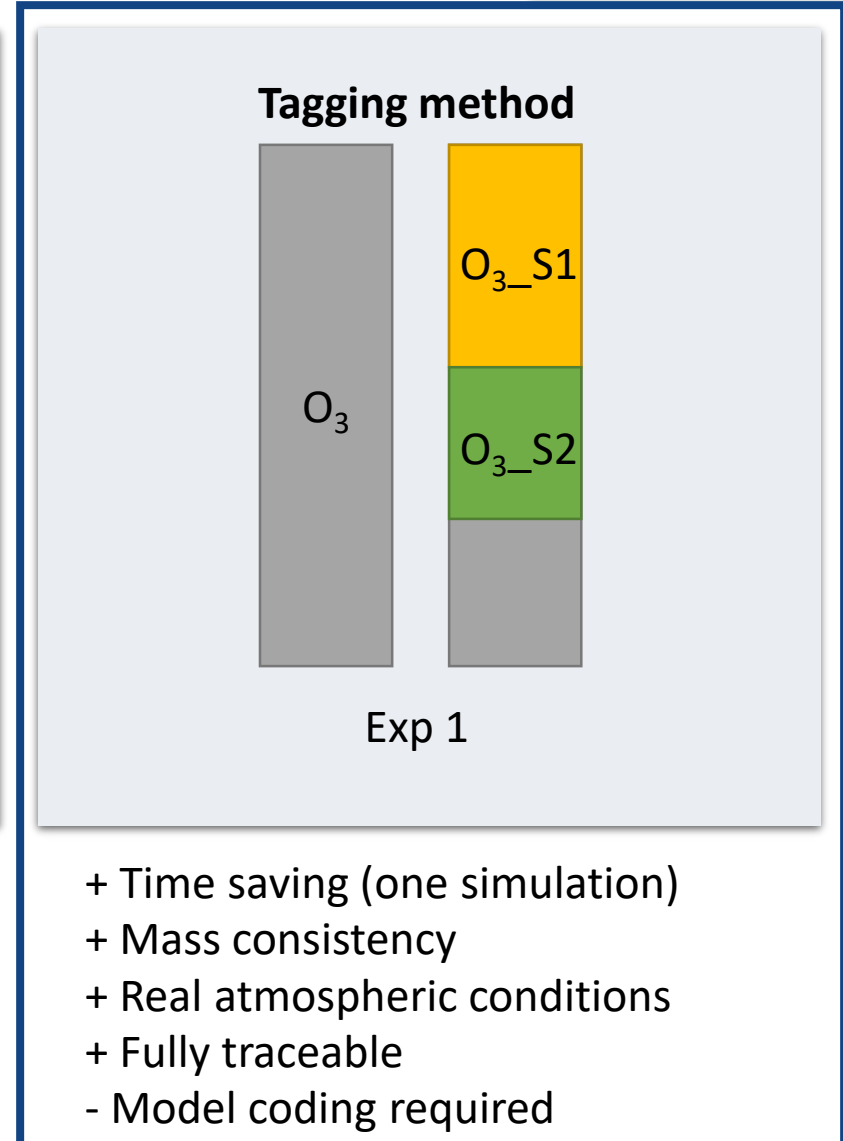
Source sensitivity



Source apportionment



- + Straightforward for any CTM
- Mass inconsistency
- Not real atmospheric conditions
- High computational resources



- + Time saving (one simulation)
- + Mass consistency
- + Real atmospheric conditions
- + Fully traceable
- Model coding required

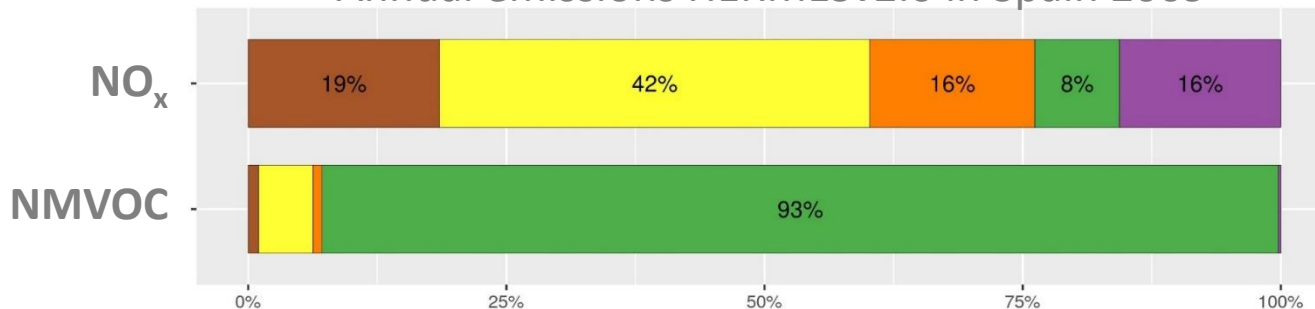
Exp: sector emissions + imported O₃

Pay et al., 2018. Atmos. Chem. Phys. Diss.

Experiment set-up

Which sources?

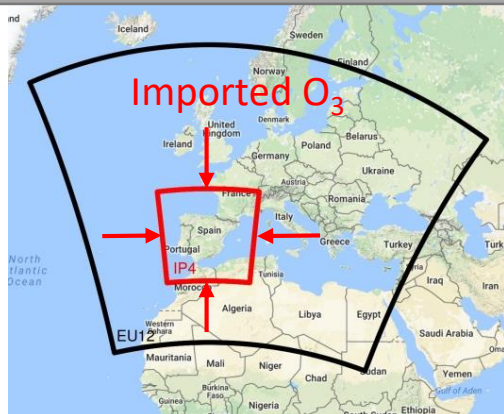
Annual emissions HERMESv2.0 in Spain 2009



Sectors that account 92% of the total NO_x

- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

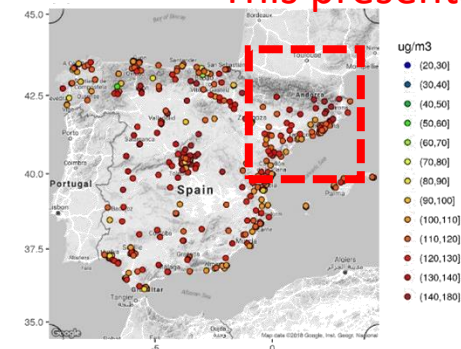
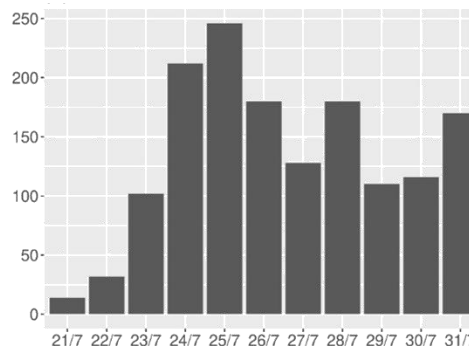
Imported O₃ from where?



The episode

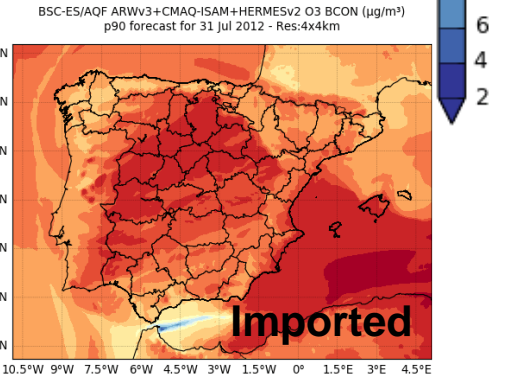
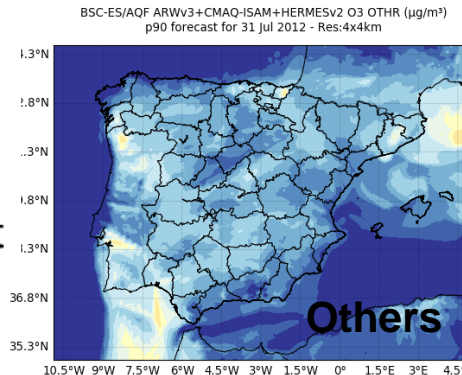
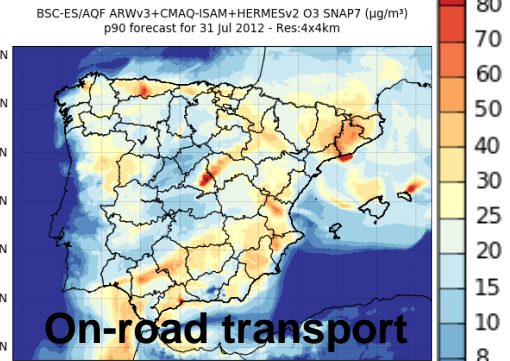
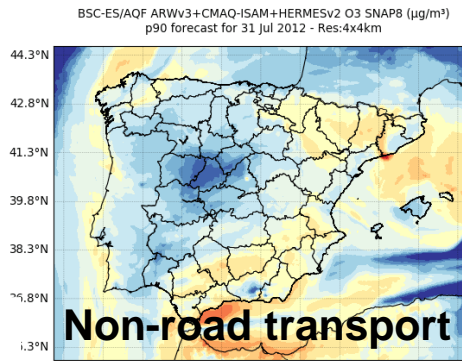
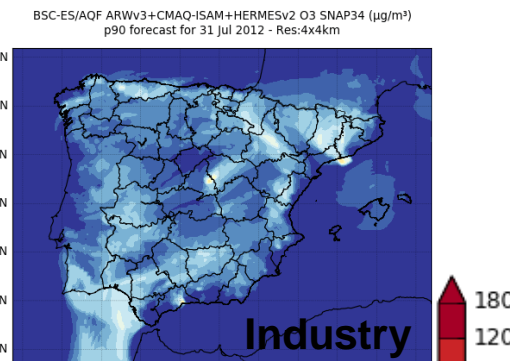
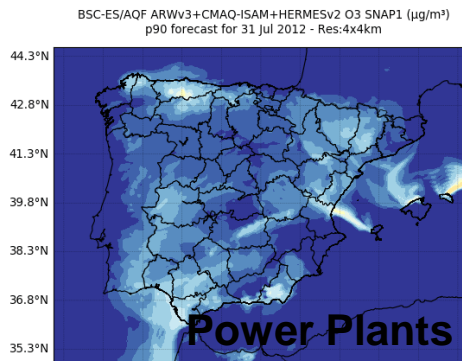
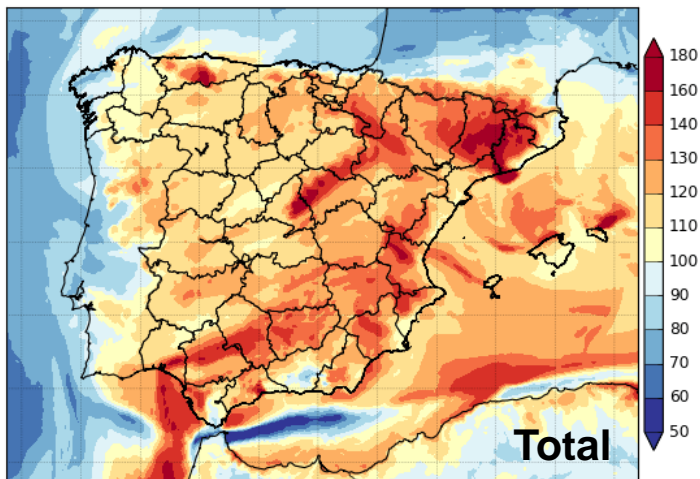
21-31 July 2012

This presentation

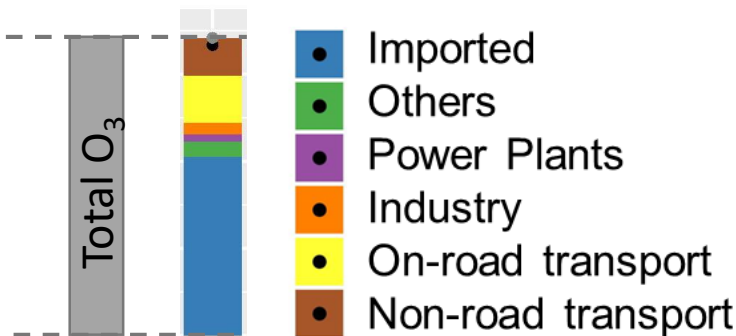


Exp: sector emissions + imported O₃

Pay et al., 2018. Atmos. Chem. Phys. Diss.

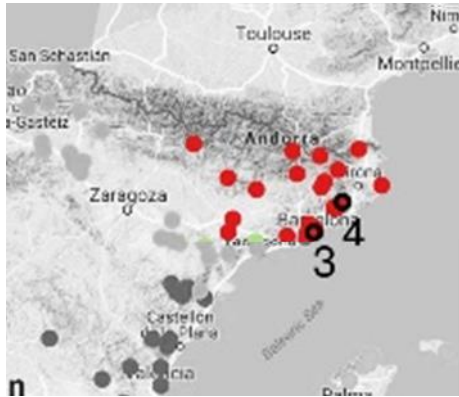


Tagging method



Exp: sector emissions + imported O₃

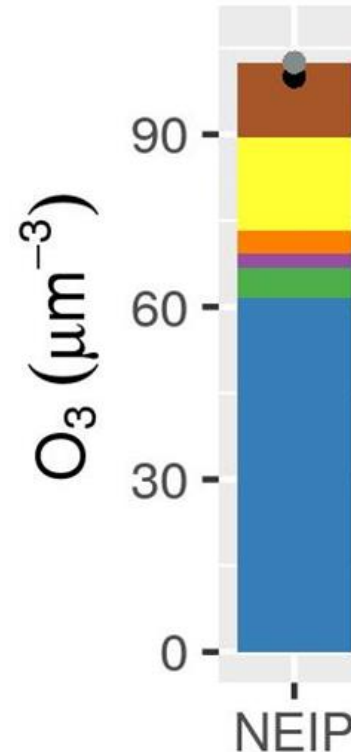
Pay et al., 2018. Atmos. Chem. Phys. Diss.



**Daily mean contribution during exceedances
(DMA8 > 120 μ/m³)**

- Imported
- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

- obs
- cmaq

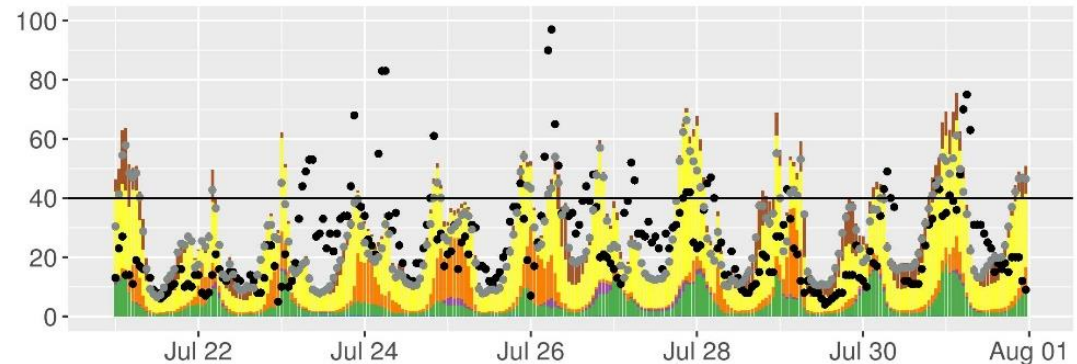
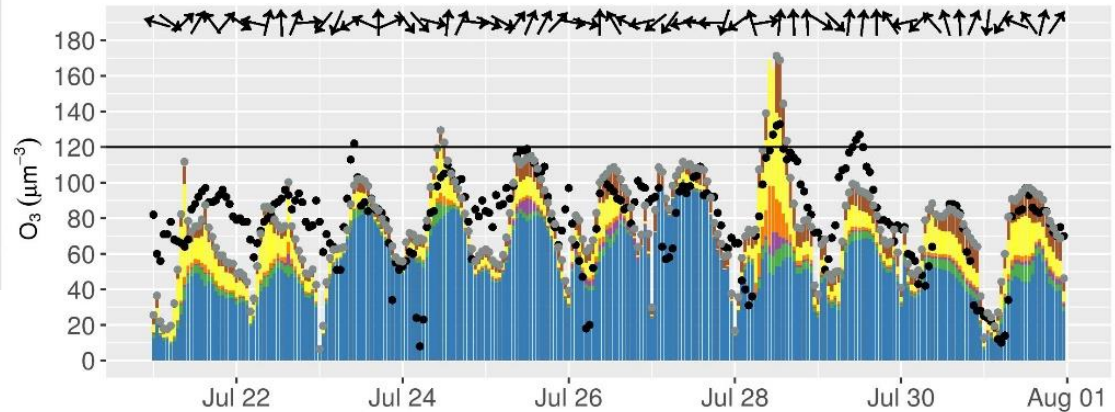


Exp: sector emissions + imported O₃

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Receptor: **urban station (3)**

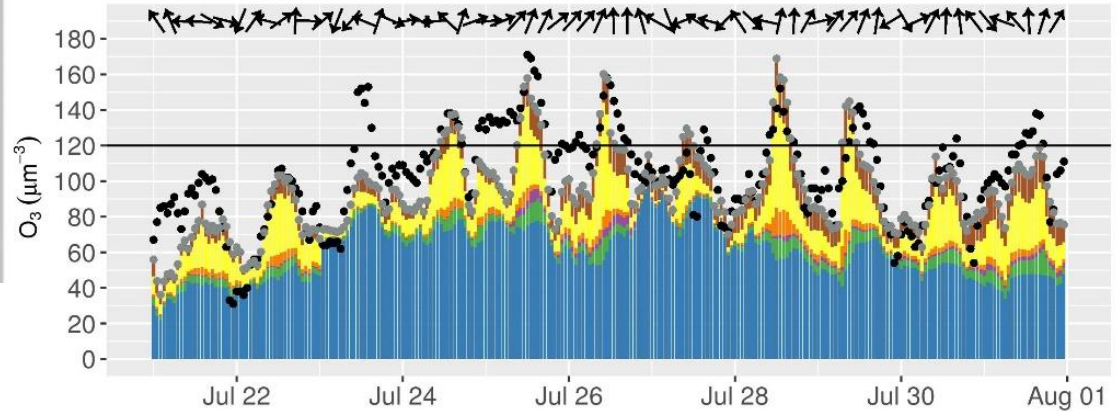


Exp: sector emissions + imported O₃

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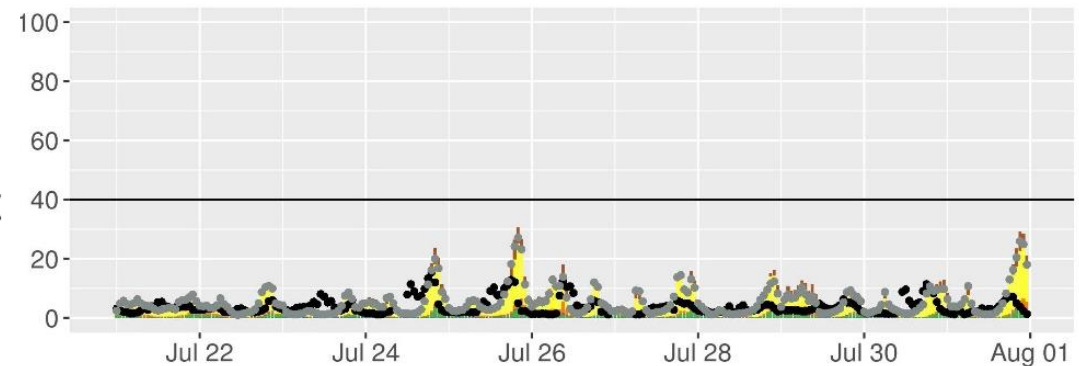


Receptor: **rural station (4)**



- Imported
- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

- obs
- cmaq

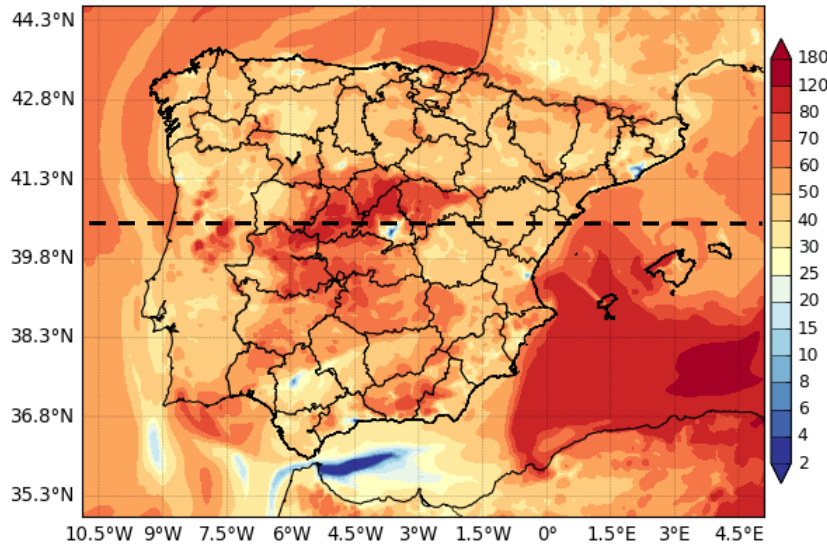


Exp: sector emissions + imported O₃

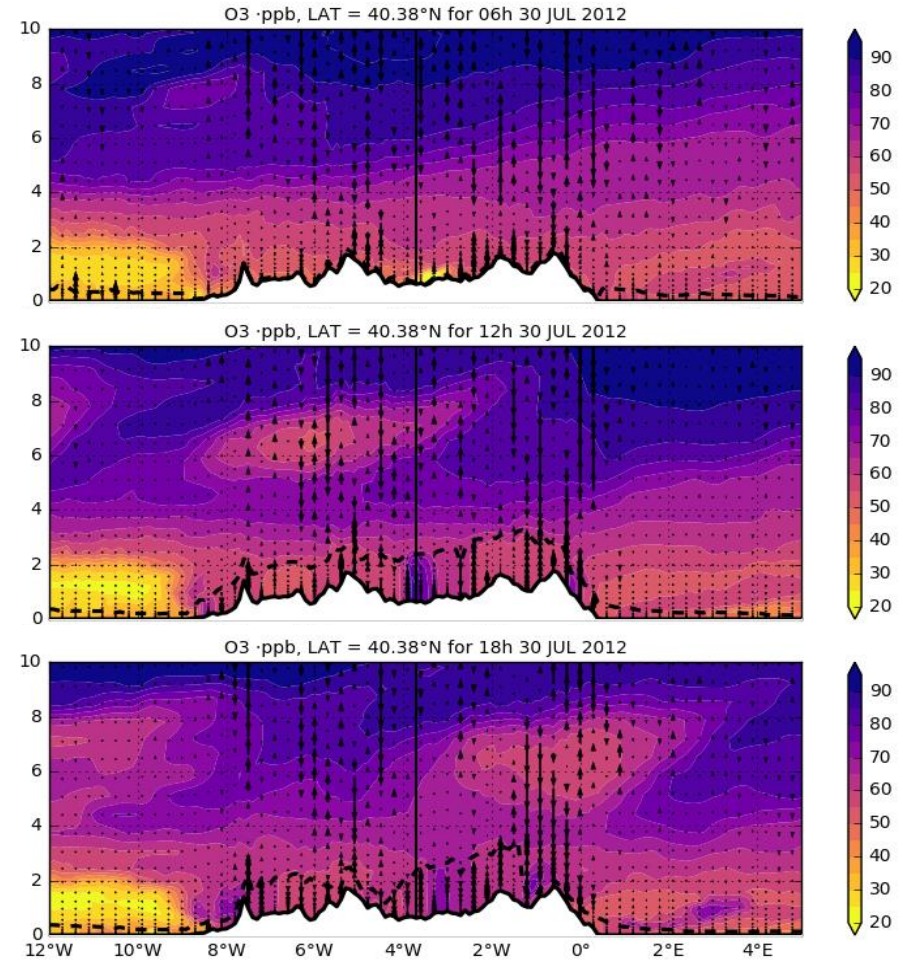
Pay et al., 2018. Atmos. Chem. Phys. Diss.

Imported O₃

00h forecast for 00UTC 31 Jul 2012 - Res:4x4km

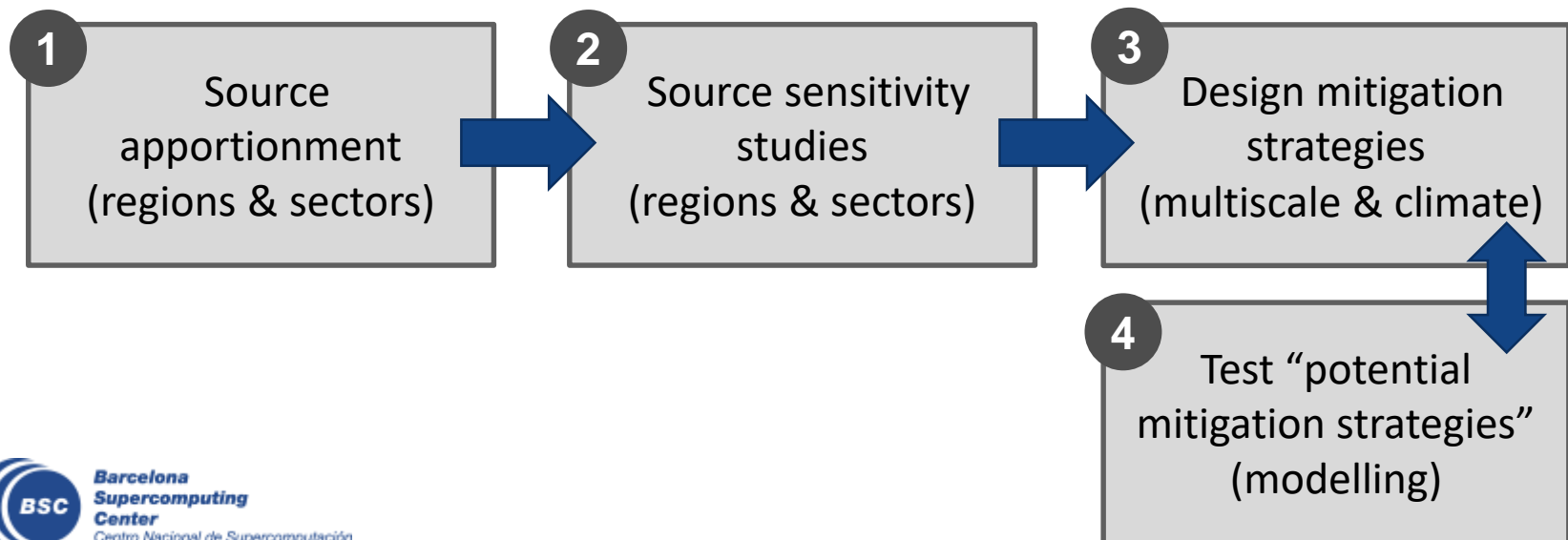


- Main contributor to concentration overall (background levels).
- Processes: advection + vertical mixing.
- High model performance at rural background stations (bias = $4.5\mu\text{g}/\text{m}^3$ and $r=0.7$)



Conclusions and next steps

- **Regional/local source** contributions dominate O_3 during peaks
 - Next: Quantify the relative importance of imported vs. regional/local O_3 .
 - Next: Identify key emissions sectors.
- **Imported O_3** to the IP is a main contributor to ground-level O_3 concentration overall in summer in Spain (background levels).
 - Next: Design mitigation strategies should be coordinated at different scales.
- **Modelled mitigation strategies** have been designed mostly for targeting primary pollutants and the traffic sector.
 - Next: define air quality plan targeting O_3 . Main elements:



Thank you!



Acknowledgments

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- Computational Earth Science team - BSC

References:

- Pay, M.T., Gangoiti, G., Guevara, M., Napelenok, S., Querol, X., Jorba, O., Pérez García-Pando, C. *A source apportionment assessment of ozone concentrations in peak summer events over the Iberian Peninsula*. Atmos. Chem. Phys., Diss.