Session on tropospheric O_3

15th and 16th September 2020

Introduction and major issues, summer O_3 pollution episodes in Spain, and O_3 and COVID19

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6th Joint Session of the Steering Body to EMEP and the Working Group on Effects

14-17 September 2020

Session on tropospheric O_3

Sub-session on atmospheric pollution of tropospheric O_3

- Xavier Querol, EMEP- Sci. Bureau: Introduction and major issues, O_3 in if summer acute pollution episodes in Spain, and O_3 and COVID19
- Tim Butler HTAP. Hemispheric transport of O_3, trends and hemispheric contributions to regional background levels, methane issues
- Augustin Colette, TFMM. Trends of O_3 in Europe, local/regional/hemispheric contributions
- David Simpson, on behalf of MSC-W and CCC. VOCs used for O_3 modelling and VOCs measured in EMEP. Methods used and regional coverage.

Sub-session on O_3 effects

- Dorota Jarosinska, TFH, WHO, Ozone and health effects
- Felicity Hayes, ICP- Vegetation, Effects of O_3 crops and vegetation

Session on tropospheric O_3

AIMS

Review the state of the knowledge on tropospheric O_3 pollution in the perspective of the review the Gothenburg Protocol

- Trends and changes in the last decade
- Modelling capabilities
- VOCs and NOx as precursors
- Evaluation of measured VOCs and those needed for proper modelling
- Potential for O_3 abatement strategies
- Effects on health and ecosystems

What are we learning on this issue from the COVID19?

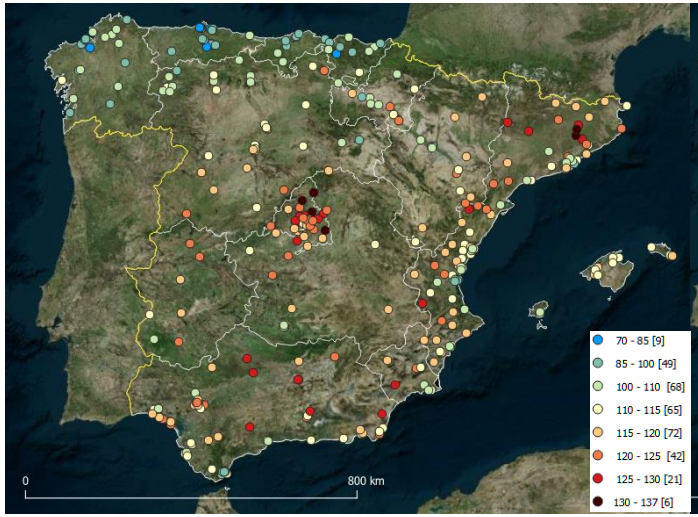
- Need for always specifying when trends, contributions, emissions and abatement policies refer to background O_3 and spring-summer O_3 pollution episodes
- What modelling and experimental tools are available to differentiate local, regional, hemispheric and stratospheric contributions and implement accurate sensitivity analysis?
- Have enough accurate information on VOC precursors covering regional variability and changes in the last decades?
- Is the EMEP strategy on VOCs measurements fully implemented. Does it cover all VOCs necessary for O_3 modelling
- What scales are required for accurately modelling local contributions and complex meteorology
- O_3 acute episodes decreased in the last decades, but are these decreasing in the last one?
- Idem for the increase of urban O_3
- What are the feedbacks of O_3 and climate?
- What are the expected impacts of climate warming on both BACKGROUND AND LOCAL/REGIONAL O_3 pollution episodes?
- And on other pollutants, such as PM2.5, in urban areas where O_3 increases
- What are the major effects of O_3

TO WHAT EXTEND CAN BE TROPOSPHERIC O_3 COTS-EFFECTLY REDUCED AT BACKGROUND AND PEAK LOCAL/REGIONAL POLLUTION

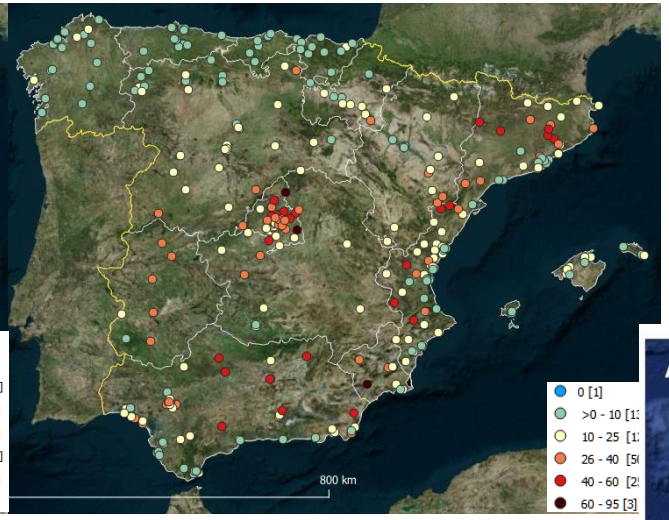
1. Local/regional/hemispheric contributions during intensive O_3 episodes: A general mismatch between modelling & experimental approaches

O_3 2010–2019 Spain

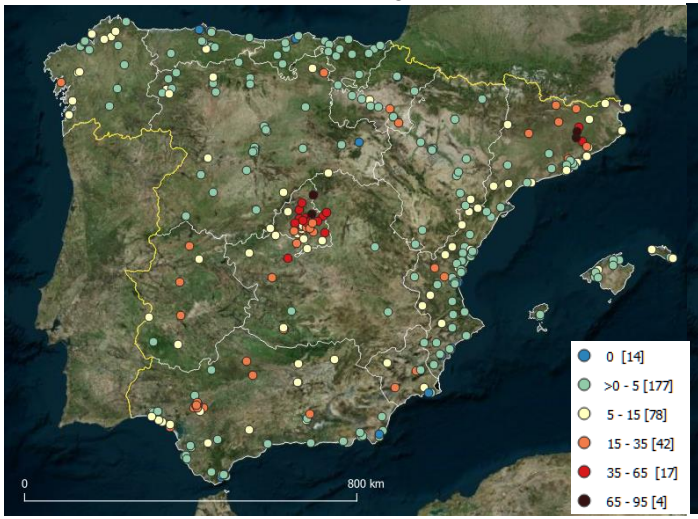
93,2 of 8hDM averages



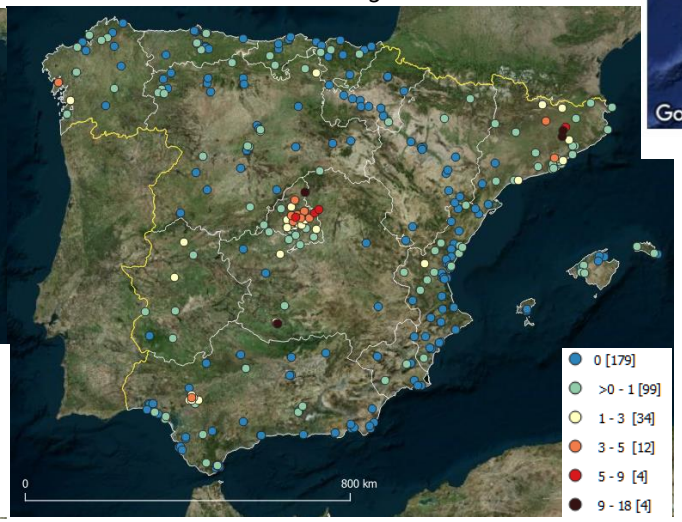
N of daily 8hDM ≥ 120 µg m^{-3}



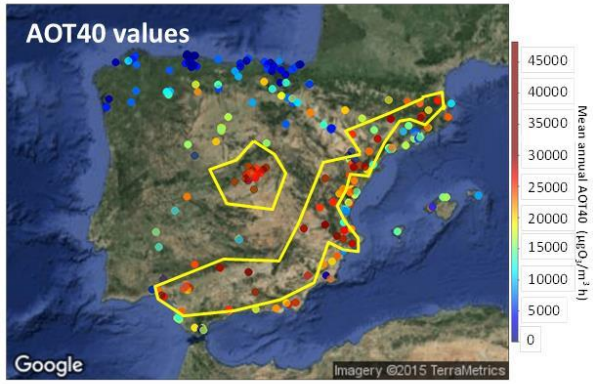
N of days hourly O_3> 150 µg m^{-3}



N of days hourly O_3> 180 µg m^{-3}



O_3 2000–2015 Spain



Updated from Querol X. et al., 2016 Science of the Total Environment

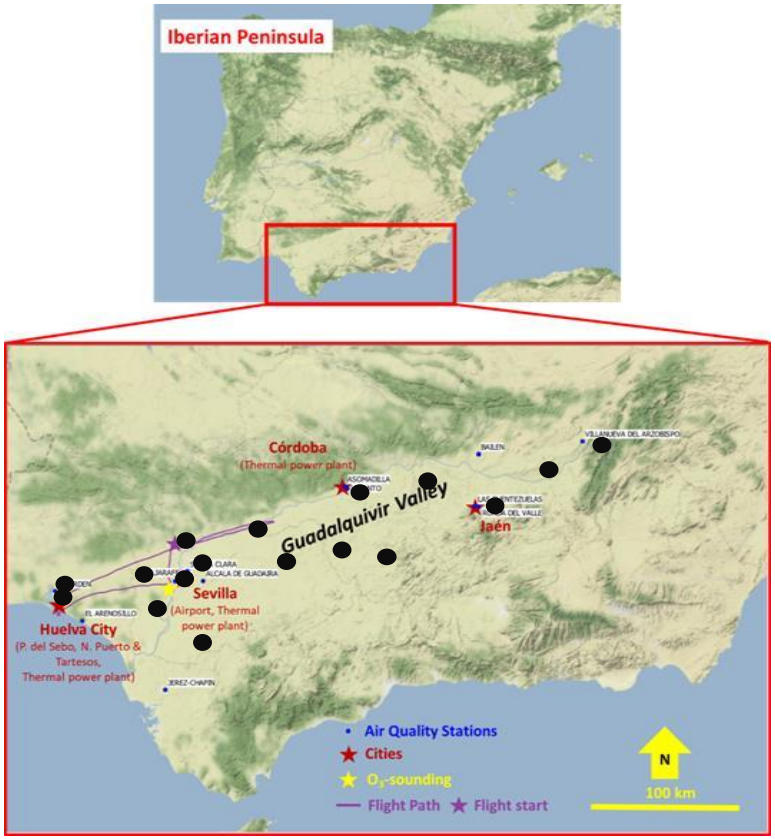
N = 332 (excluding Canary Isd.), sites with >7 years, ≥75% data coverage 2010–2019, and in operation 2018-2019

1. Local/regional/hemispheric contributions during intensive O_3 episodes: A general mismatch between modelling & experimental approaches

09-11/07/2019, 8, 14, 20 hLT

Airborne, microlight O_3 (PO3M), BC, PM2.5, UFP, meteo

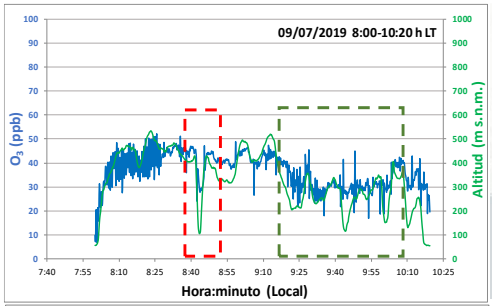
O_3 & meteo free-soundings 09-11/07/2019

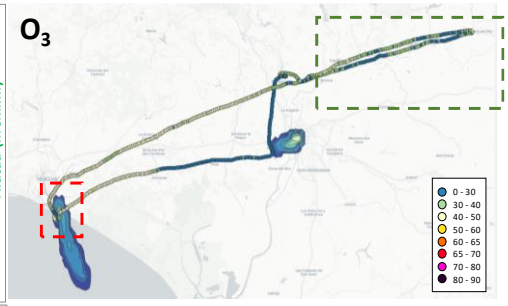


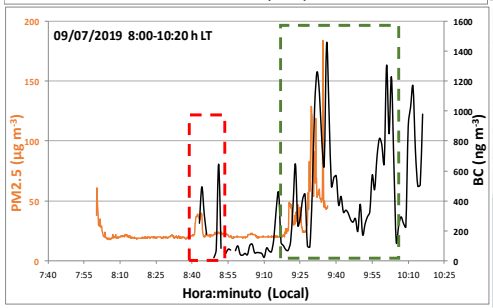
OVOCs, HVOCs 27/06/2019 to 12/07/2019

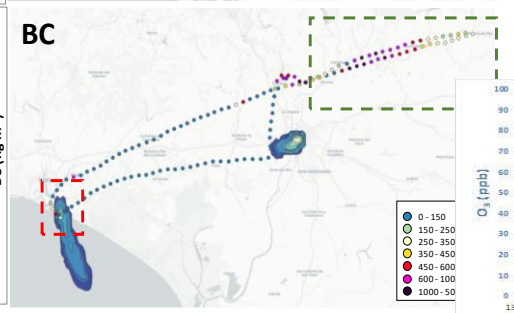
1. Local/regional/hemispheric contributions during intensive O_3 episodes: A general mismatch between modelling & experimental approaches

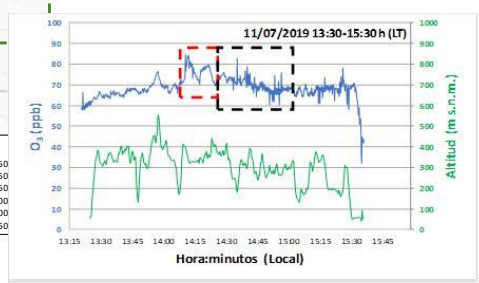
Results of the field campaign: Microlight flights (09-11/07/2019)

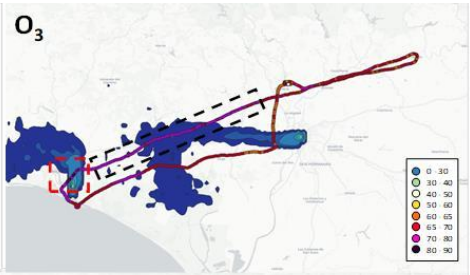


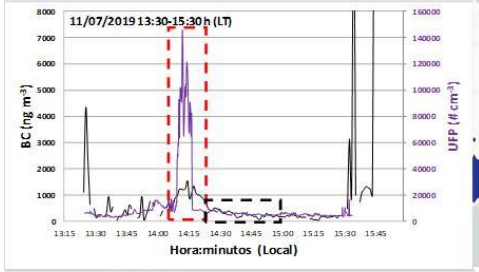


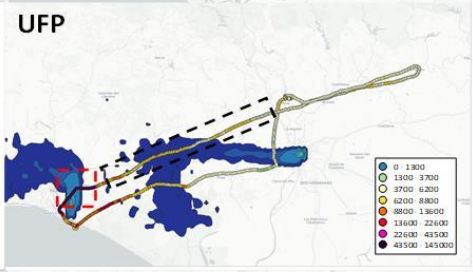


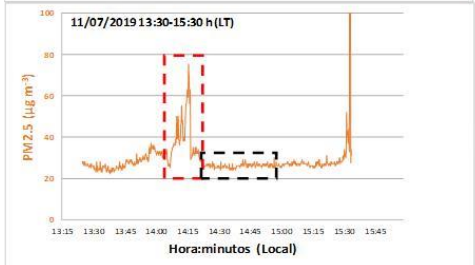






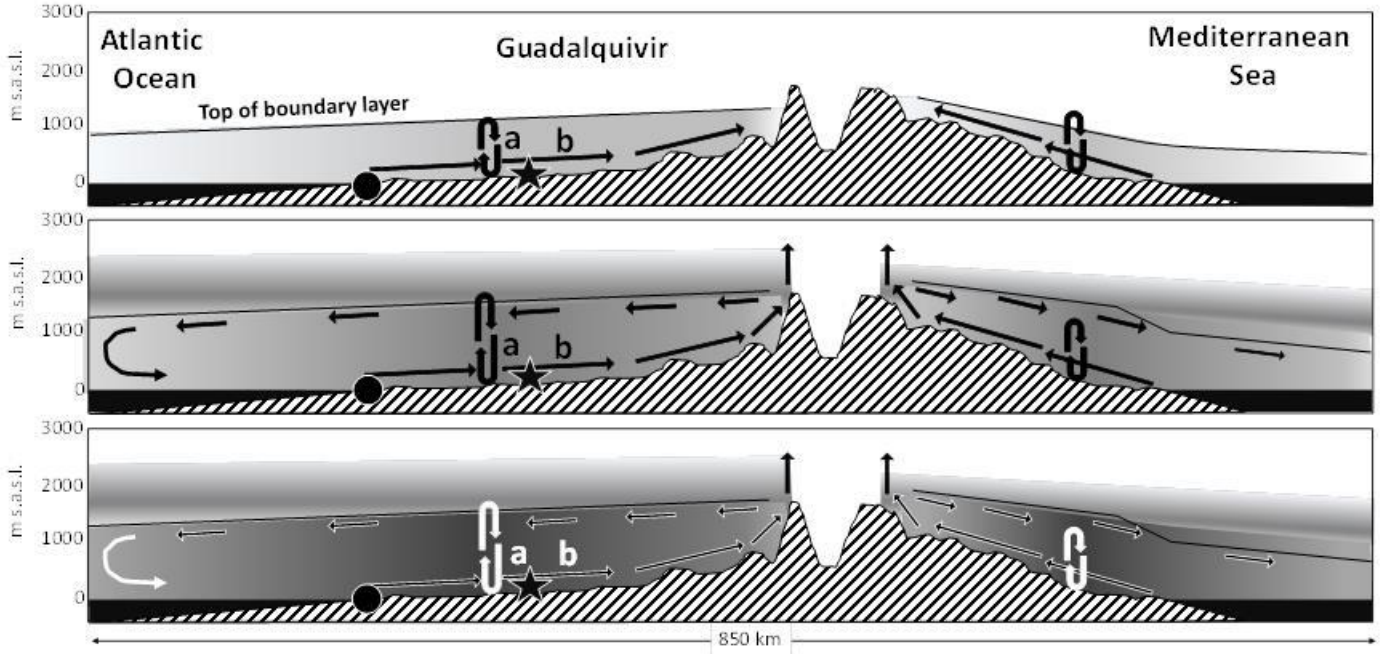




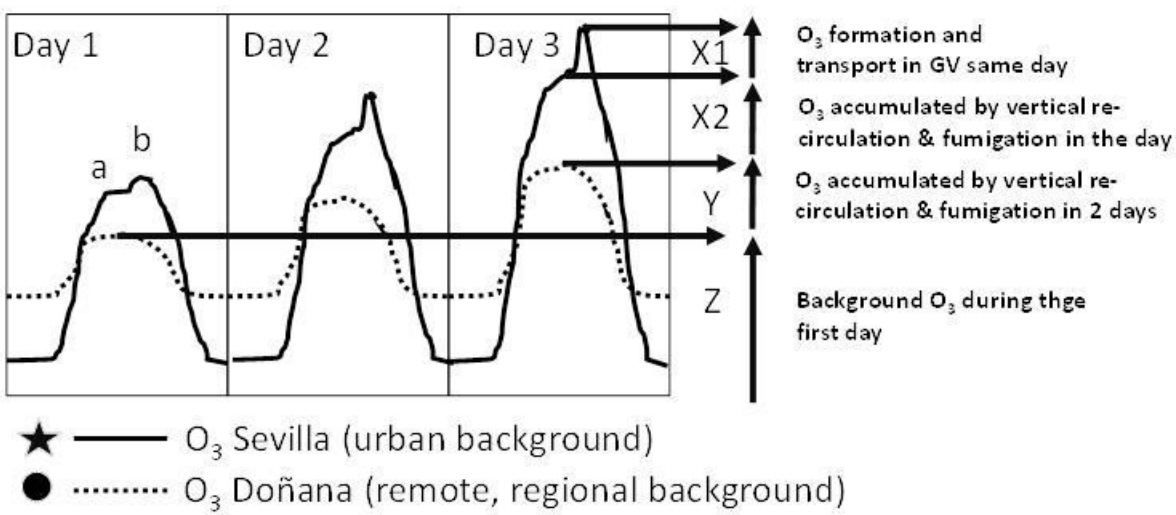


1. Local/regional/hemispheric contributions during intensive O_3 episodes: A general mismatch between modelling & experimental approaches

Results of the field campaign: Conceptual model O_3 episodes VdG



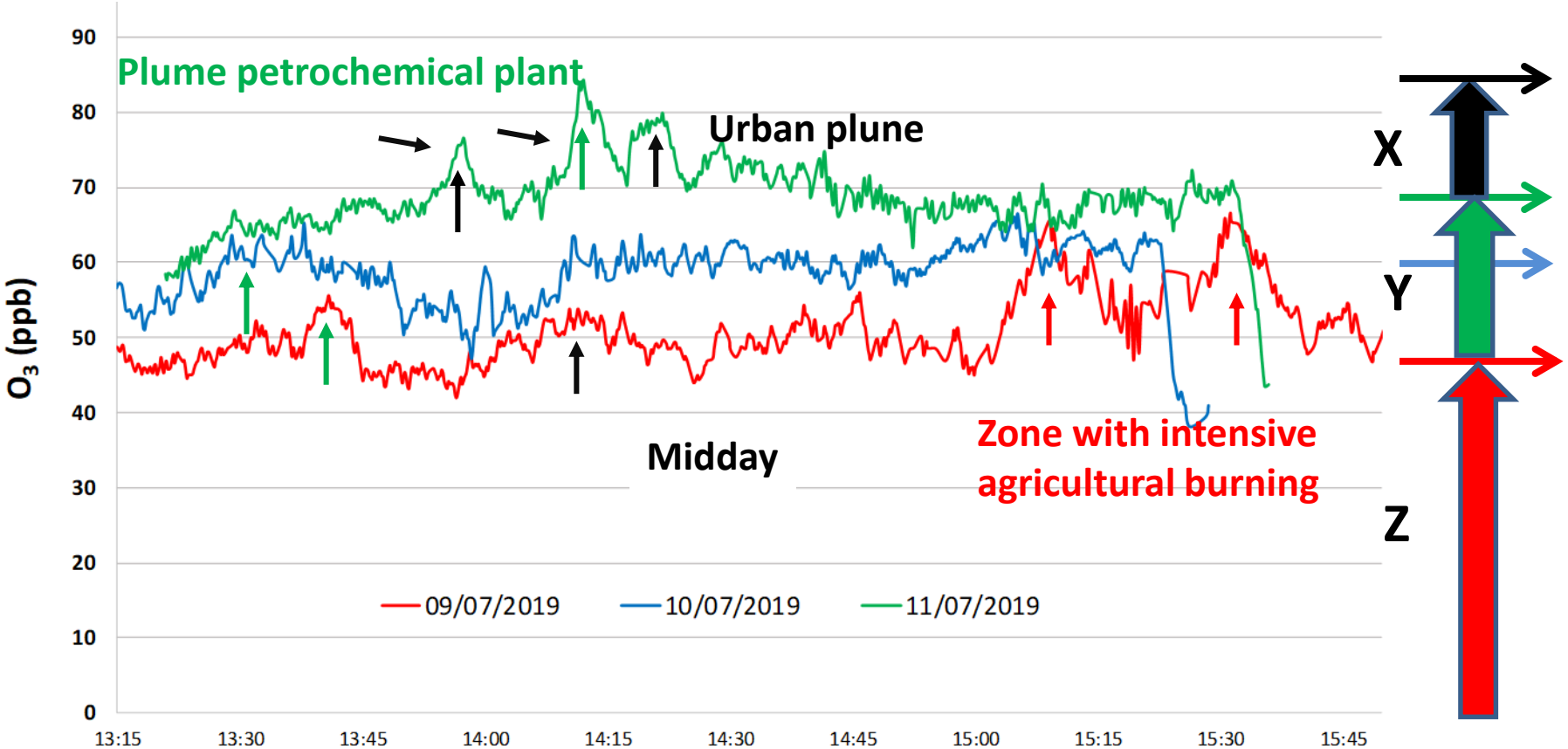
a) Vertical re-circulation & fumigation b) Formation & transport into GV

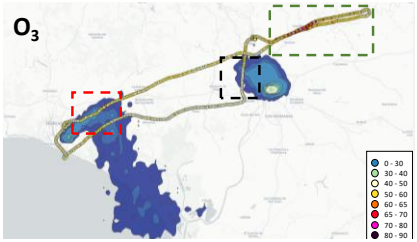


In 't Veld et al., 2020
STOTEN
Submitted

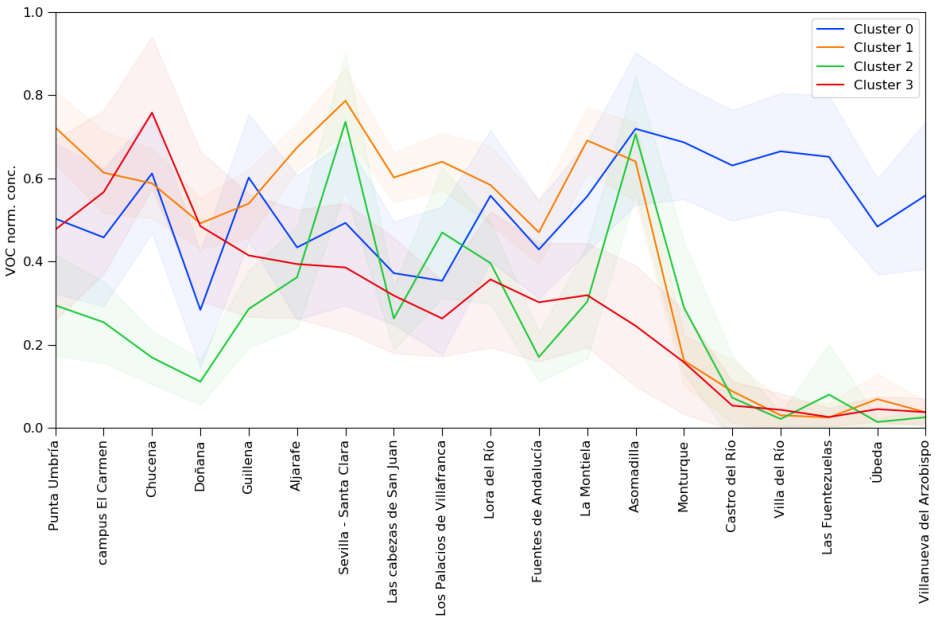
1. Local/regional/hemispheric contributions during intensive O_3 episodes: A general mismatch between modelling & experimental approaches

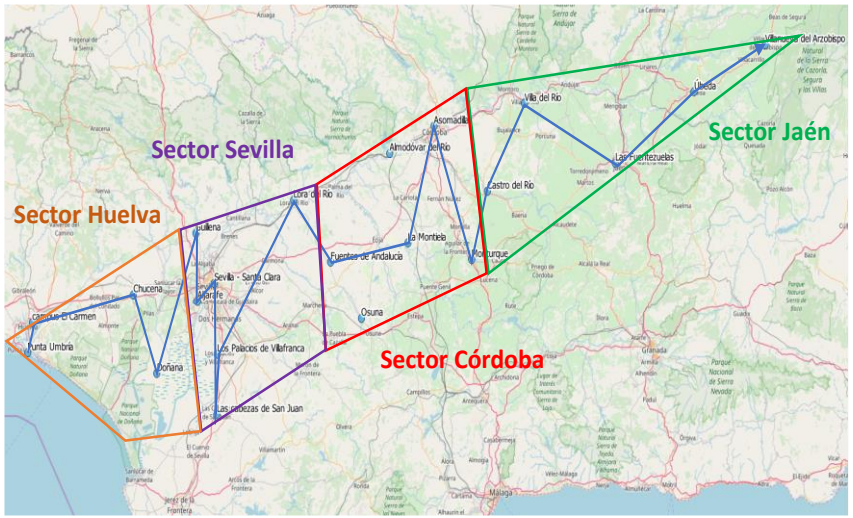
Results of the field campaign: Microlight flights (09-11/07/2019)





Results of the field campaign: VOCs (27/06/2019 to 12/07/2019)



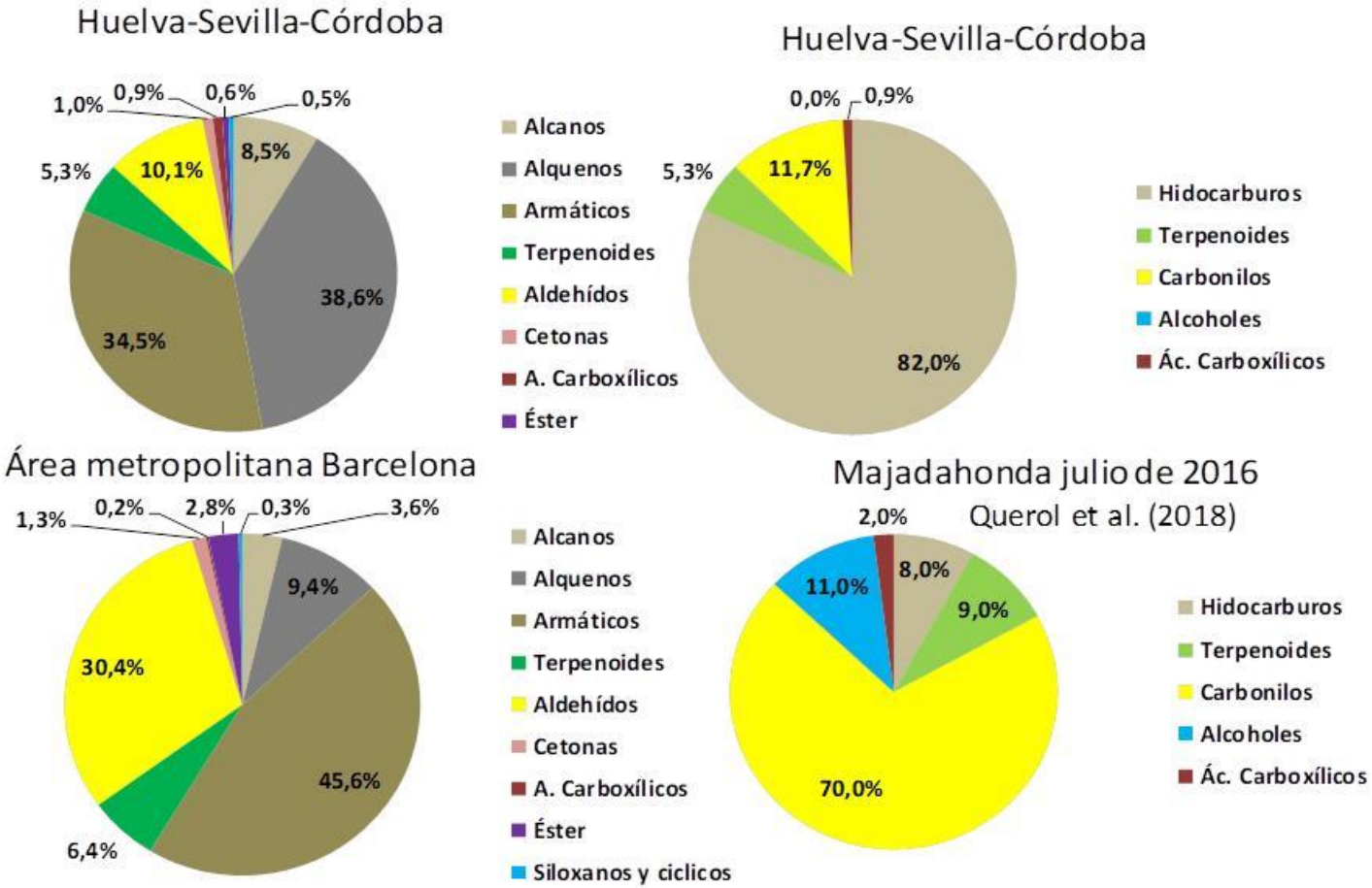


Cluster 0	Cluster 1	Cluster 2	Cluster 3
2-Pentanona	1,2,4-Trimetilbenceno	1,2,3-Triclorobenceno	a-pineno
Acetaldehído	1-Hepteno	1,3,5-Trimetilbenceno	Benzoquinona
Butiraldehído	1-Octeno	2,2-Dimetilbutano	b-pineno
Formaldehído	4-Etiltolueno	2-Butanona	Dimetilestireno
Hexanal	Acetona	Benzonitrilo	Glicolaldehído
Hexanona	Acetofenona	Butilacetato	Sabinketona
Hidroxiacetona	Benceno	Etilbenzeno	Limoneno
Metacroleina	Camfeno	Heptano	m-Cimeno
Nonanal	Decano	Hexano	Metilciclohexano
Pivaldehído	Dodecano	m,p-Xileno	Pinonaldehído
Ácido pirúvico	Heptanal	o-Tolualdehído	Tetradecano
Valeraldehído	Hexametilciclotrisiloxano	o-Xileno	Valerolactona
	Indano	Ácido propanoico	
	m-Propiltolueno	Estireno	
	Nonano	Tetracloroetileno	
	Octametilciclotetrasiloxano	Tolueno	
	Octanal		
	Octano		
	o-Cimeno		
	o-Propiltolueno		
	Propilbenceno		
	Tribromometano		
	Trimetilbenceno isómero_1		
	Trimetilbenceno isómero_2		
	Undecano		

2. The issue of VOCS

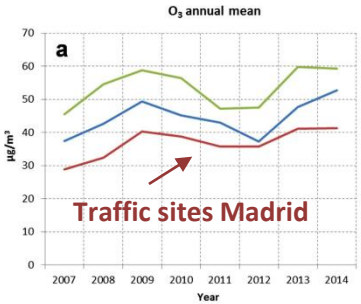
Results of the field campaign: (27/06 to 12/07/2019 VdG, 03 to 17/07/2019, Vic-BCN)

Maximum O_3 Formation Potential by aggregating [concentrations x MIR (Carter, 2009) *maximum incremental reactivity*]



3. Impact on urban O_3 rising on oxidative patterns and secondary PM formation

The issue of the origin of organic carbon in PM: Increasing oxidizing patterns



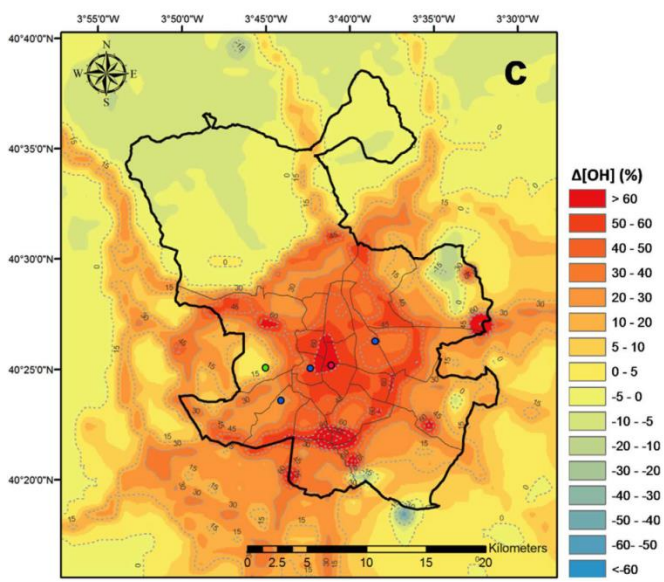
O_3

- Urban O_3 levels are increasing in many urban areas of the EU
- Causes:
  - Urban NOx decreased very smoothly, but NO more steeply
  - Saturated areas in NOx and VOCs sensitive
- Net effect: increasing oxidizing capacity of the urban atmosphere: higher PM (nitrate and SOA)

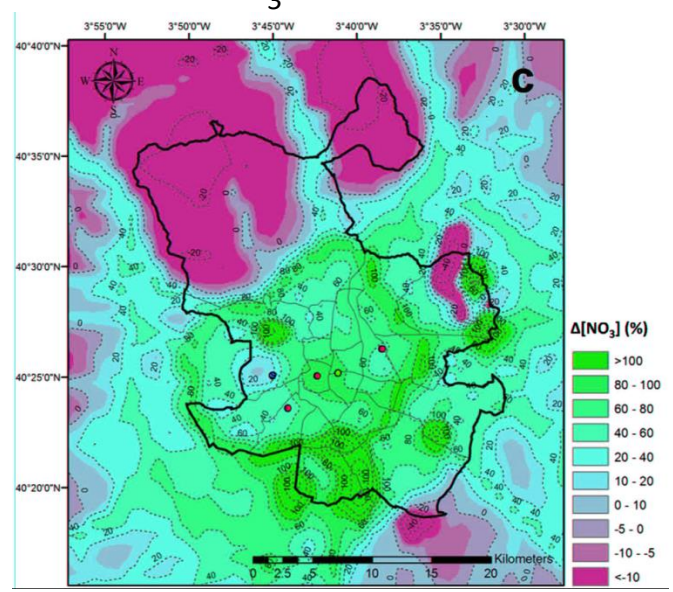
Madrid city: Modelled 2004-2007 averaged annual increase in %

Saíz-López A. et al. (2017) Scientific Reports 7, 45956

OH radical



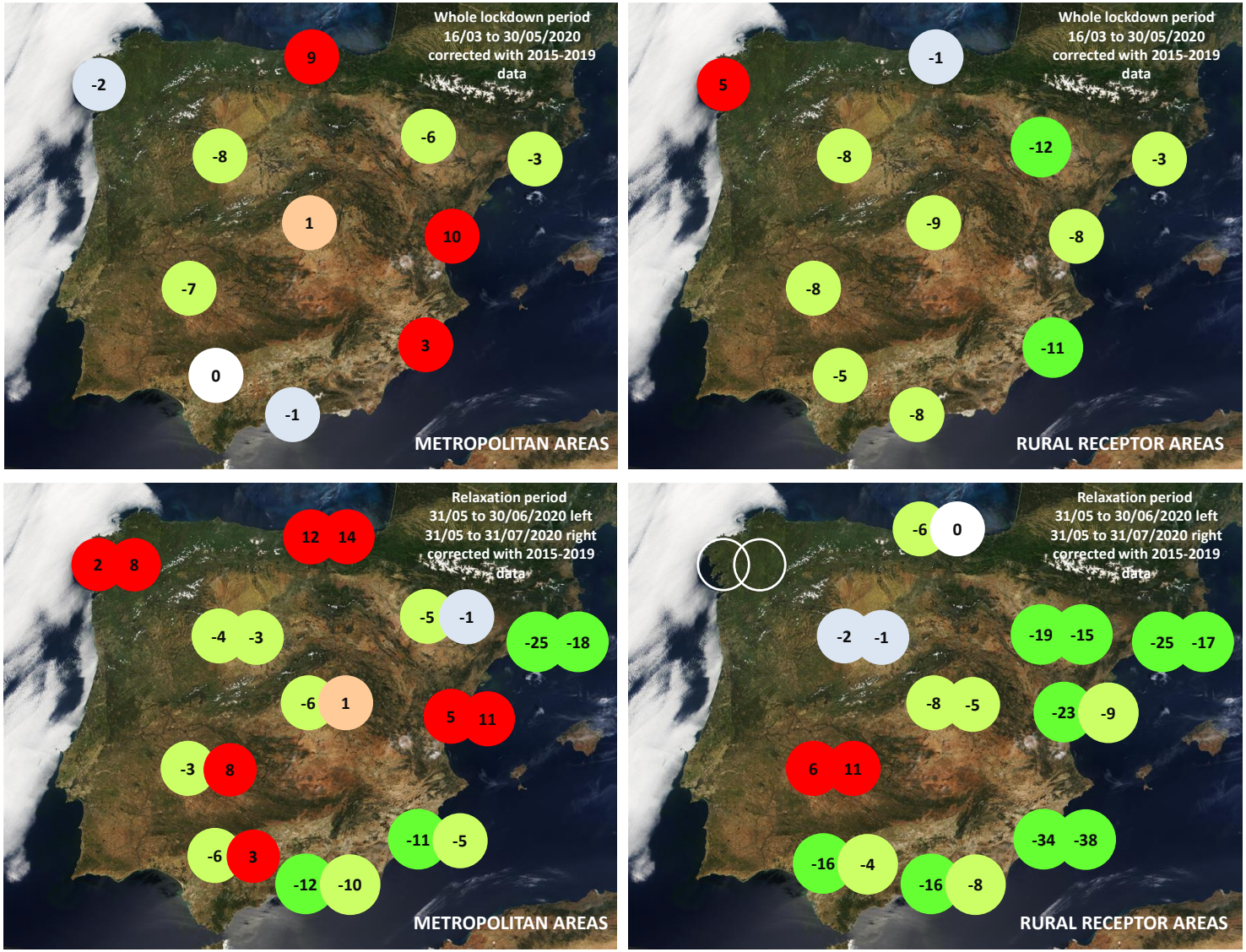
NO_3 radical



4. COVID19 and O_3 in Spain

% O_3 8hDMA REDUCTION

(2020 LOCKDOWN/PRE-PANDEMIC)-(2015-2019 LOCKDOWN/PRE-PANDEMIC)
(2020 RELAXATION/PRE-PANDEMIC)-(2015-2019 RELAXATION/PRE-PANDEMIC)
PRE-PANDEMIC: 14/02 TO 15/03; LOCKDOWN: 16/03 TO 30/05, RELAXATION: 31/05 TO 30/06 AND 31/05 TO 31/07



Road traffic reduction

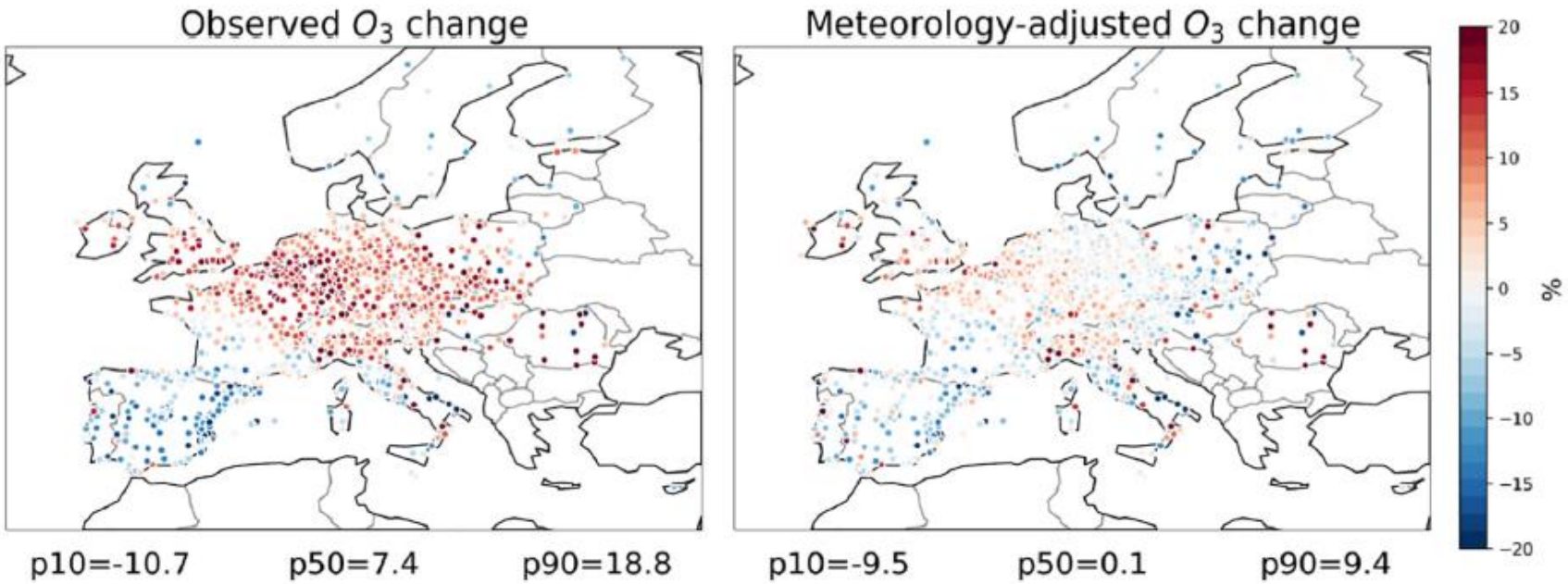
in Barcelona
64% whole lockdown
80% full lockdown
22% relaxation June
17% relaxation JunJul

in Madrid
62% whole lockdown
80% full lockdown
34% relaxation June
19% relaxation JunJul

Querol et al. 2020.
In preparation

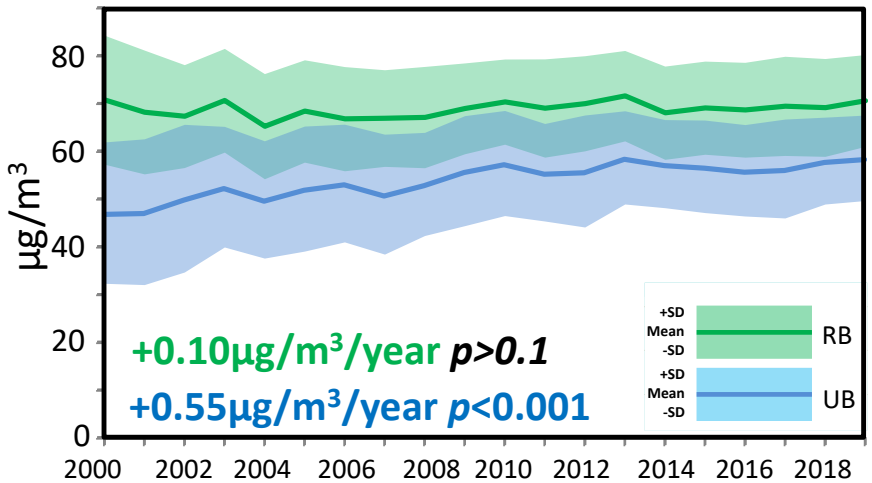
4. COVID19 and O_3 in Spain

8hDMA O_3 change 15th March to 30th April

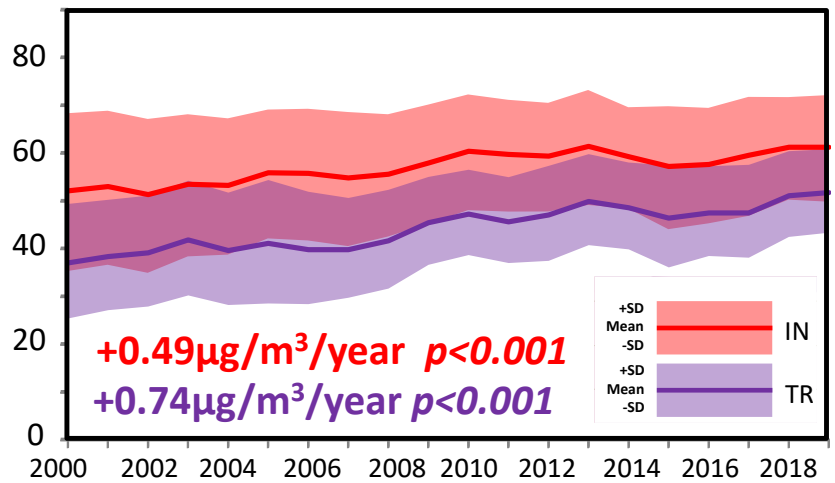


Ordóñez C. et al. (2020) STOTEN, 747, July 2020

2000-2019 Mean O_3 µg/m³

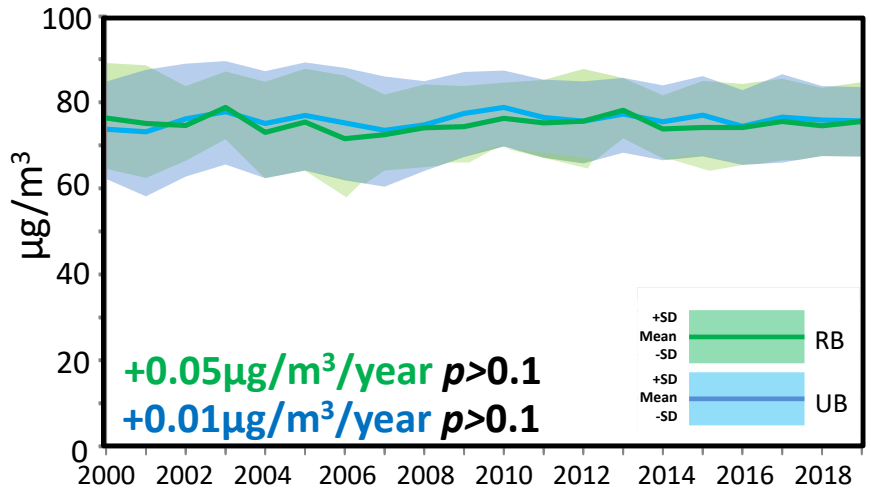


2010-2019 +0.02µg/m³/year p>0.1
+0.13µg/m³/year p>0.1

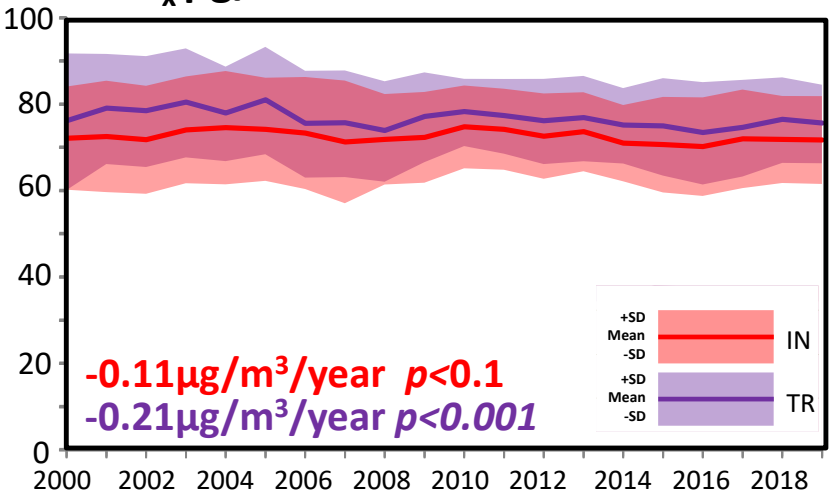


2010-2019 +0.00µg/m³/year p>0.1
+0.48µg/m³/year p<0.1

2000-2019 Mean O_x µg/m³

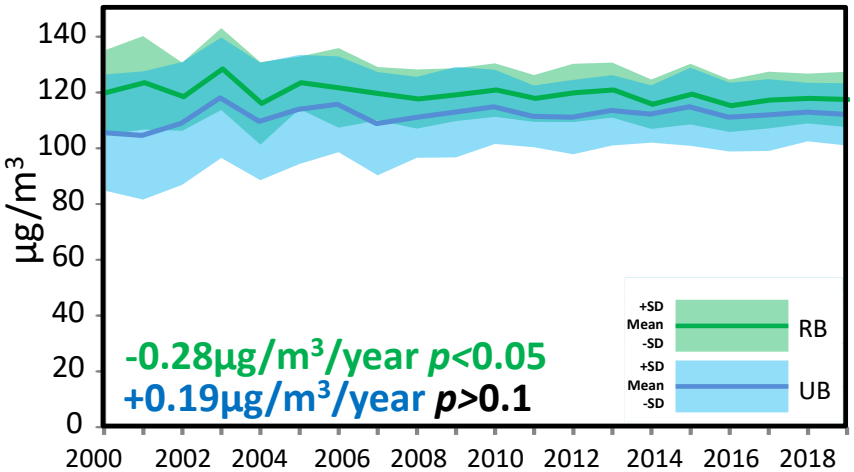


2010-2019 -0.08µg/m³/year p>0.1
-0.26µg/m³/year p>0. 1

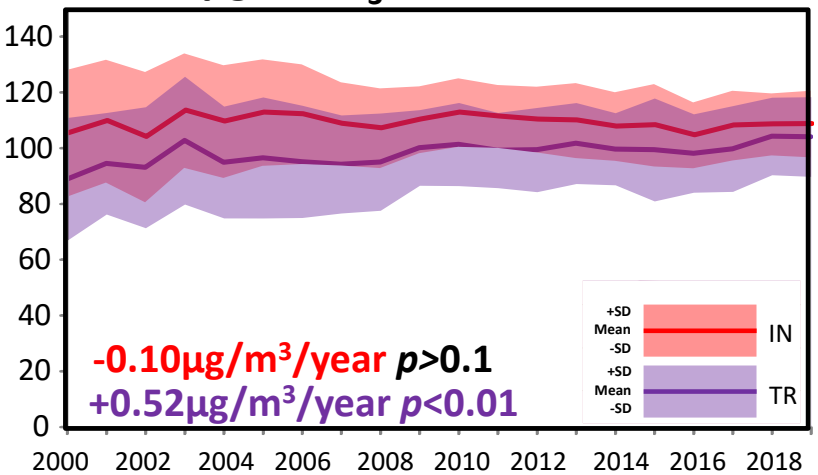


2010-2019 -0.36µg/m³/year p<0.05
-0.31µg/m³/year p<0.1

2000-2019 Percentile 93.2 8h µg/m³ O_3

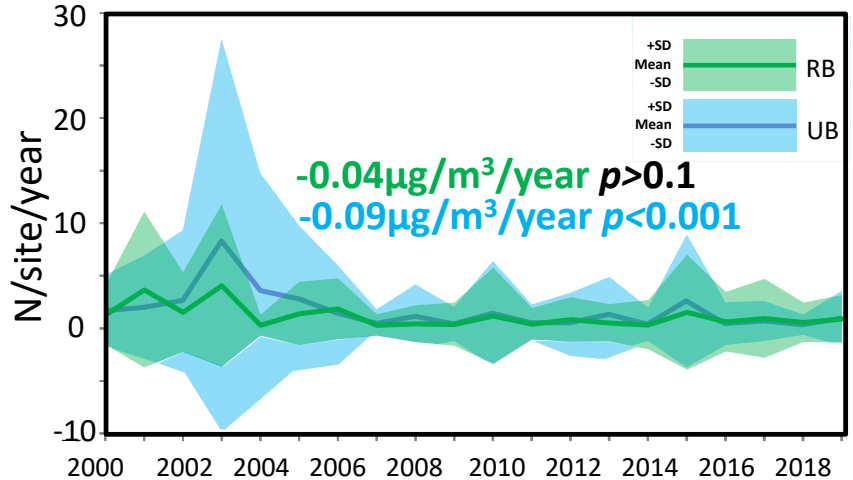


2010-2019 -0.28µg/m³/year $p<0.05$
-0.03µg/m³/year $p>0.1$

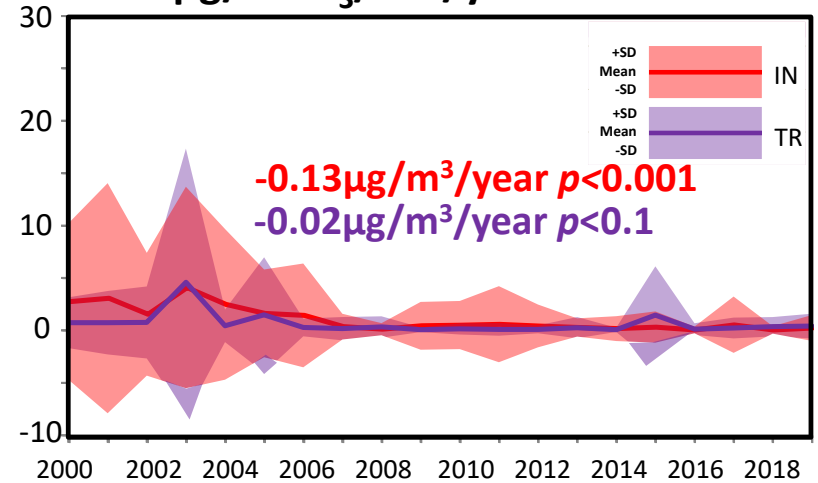


2010-2019 -0.46µg/m³/year $p>0.1$
+0.52µg/m³/year $p<0.01$

2000-2019 N exceedances 1h>180µg/m³ O_3/site/year

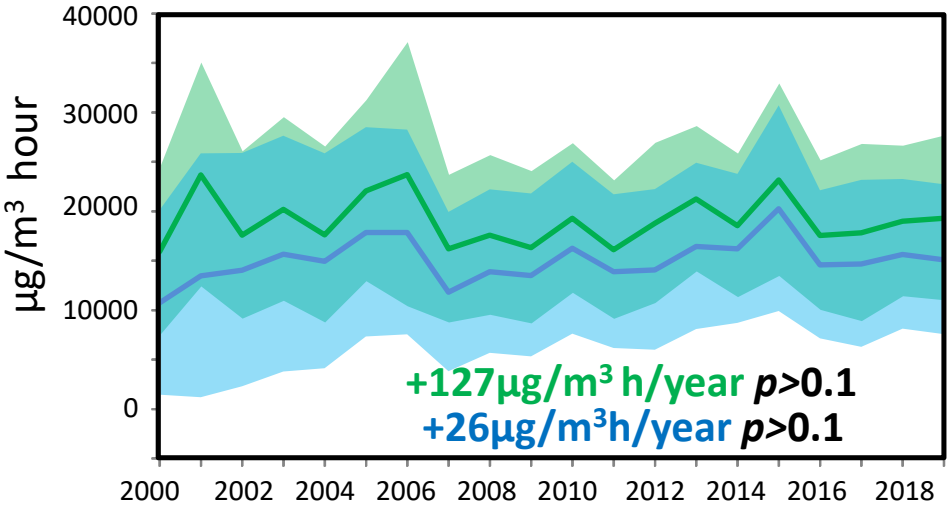


2010-2019 -0.01µg/m³/year $p>0.1$
-0.03µg/m³/year $p>0.1$

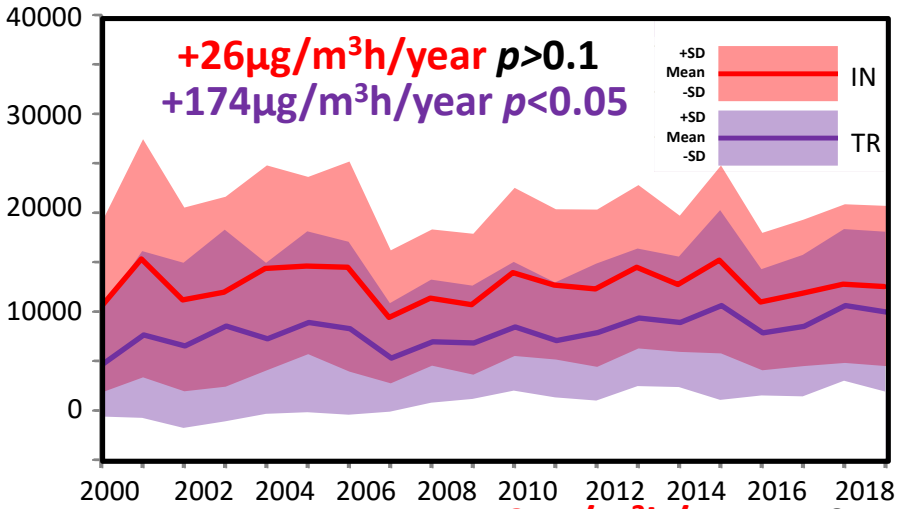


2010-2019 -0.04µg/m³/year $p<0.1$
+0.03µg/m³/year $p<0.05$

2000-2019 AOT40 µg/m³ O_3 hour

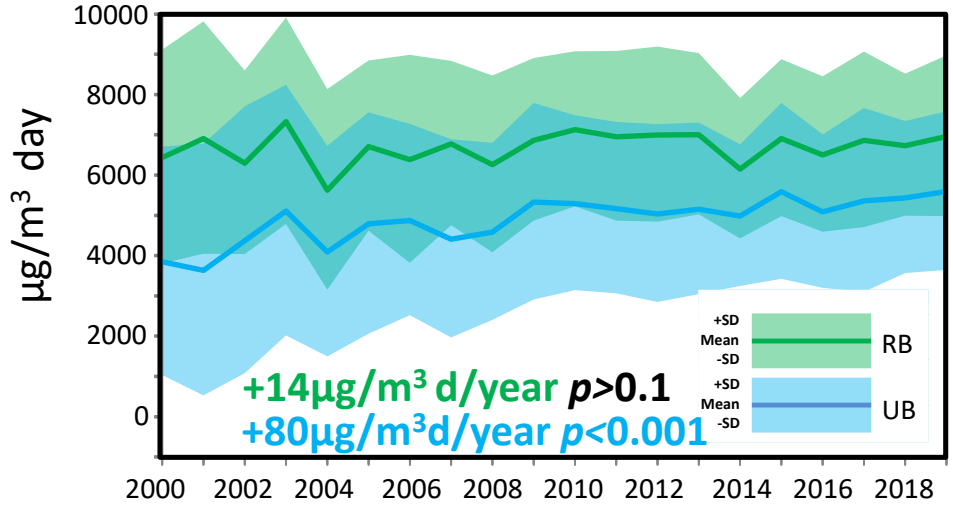


2010-2019 +72µg/m³h/year $p>0.1$
+96µg/m³h/year $p>0.1$

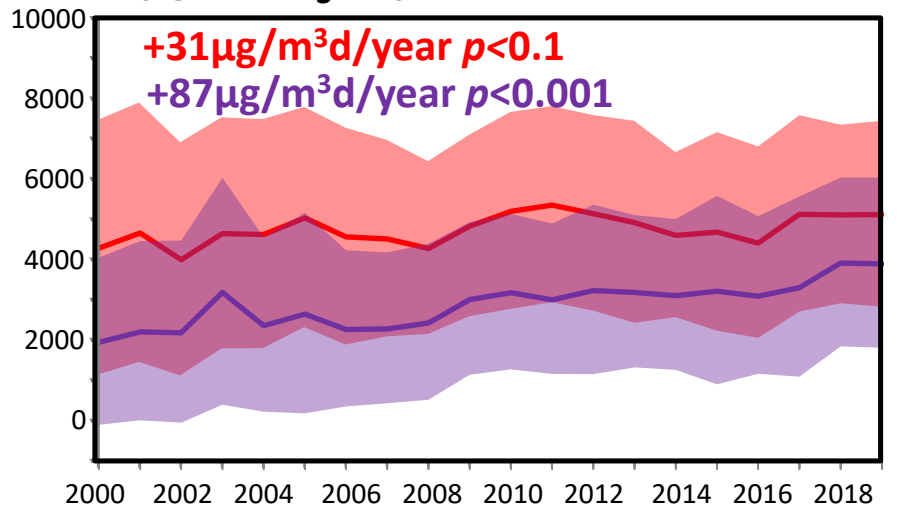


2010-2019 -143µg/m³h/year $p>0.1$
+251µg/m³h/year $p<0.01$

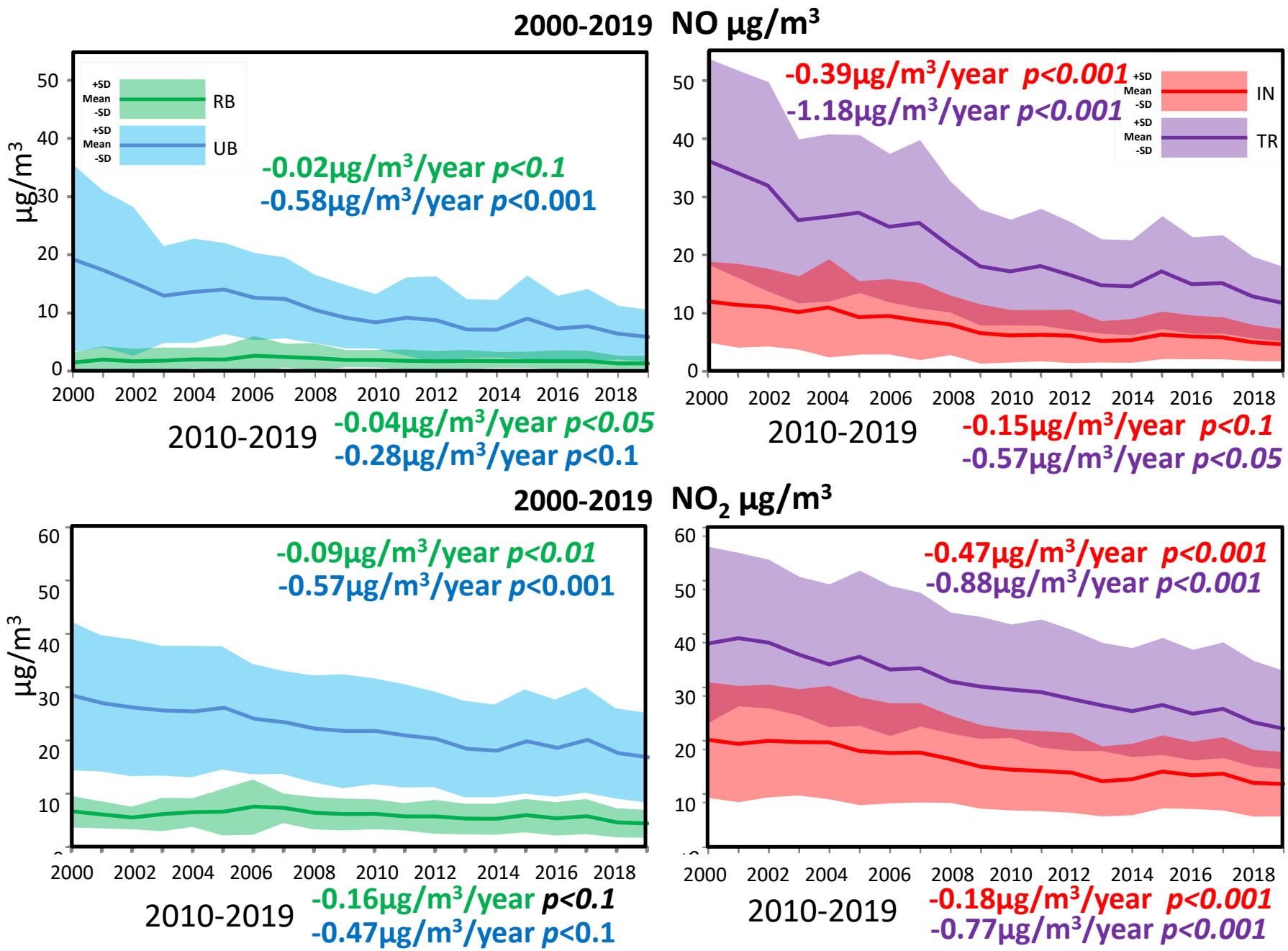
2000-2019 SOMO35 µg/m³ O_3 day



2010-2019 -26µg/m³ d/year $p>0.1$
+49µg/m³d/year $p>0.1$



2010-2019 -16µg/m³d/year $p>0.1$
+50µg/m³d/year $p>0.1$


2000-2019 NO µg/m³
+SD
Mean
-SD
RB
UB
-0.02µg/m³/year p<0.1
-0.58µg/m³/year p<0.001
µg/m³
2010-2019
-0.04µg/m³/year p<0.05
-0.28µg/m³/year p<0.1
-0.39µg/m³/year p<0.001
-1.18µg/m³/year p<0.001
IN
TR
2010-2019
-0.15µg/m³/year p<0.1
-0.57µg/m³/year p<0.05
2000-2019 NO2 µg/m³
-0.09µg/m³/year p<0.01
-0.57µg/m³/year p<0.001
2010-2019
-0.16µg/m³/year p<0.1
-0.47µg/m³/year p<0.1
-0.47µg/m³/year p<0.001
-0.88µg/m³/year p<0.001
2010-2019
-0.18µg/m³/year p<0.001
-0.77µg/m³/year p<0.001