2n Congrés

Qualitat de l'aire

14-15 d'octubre 2021

#CongresAire
#AireNet

SESIÓN: Ozono troposférico, episodios, precursores y comportamiento durante el confinamiento COVID19

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SESIÓN: Ozono troposférico, episodios, precursores y comportamiento durante el confinamiento COVID19

Moderat per:

XXXXX, nom d l'organització.

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GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

CSIC

idaea

EXCELENCIA SEVERO OCHOA

GOBIERNO DE ESPAÑA MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Generalitat de Catalunya Departament de Territori i Sostenibilitat

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Junta de Andalucía

¡MADRID! ÁREA DE GOBIERNO DE MEDIO AMBIENTE Y MOVILIDAD

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O_3 PLAN TEAM

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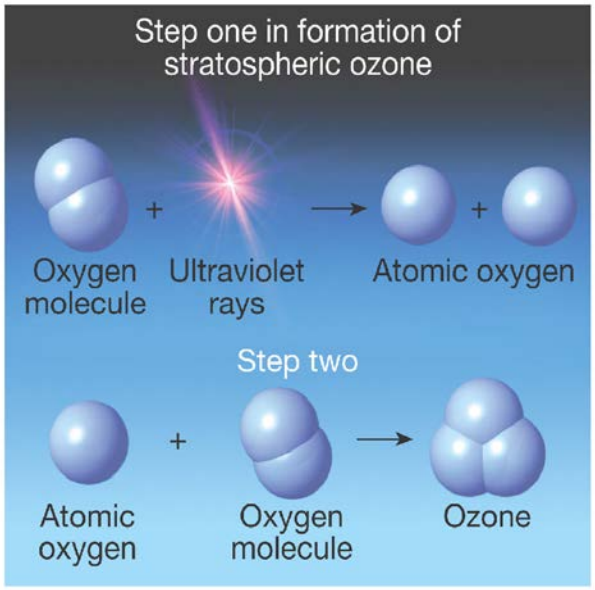
[8]*Universidade de Aveiro (UA), Portugal*

OUTLINE

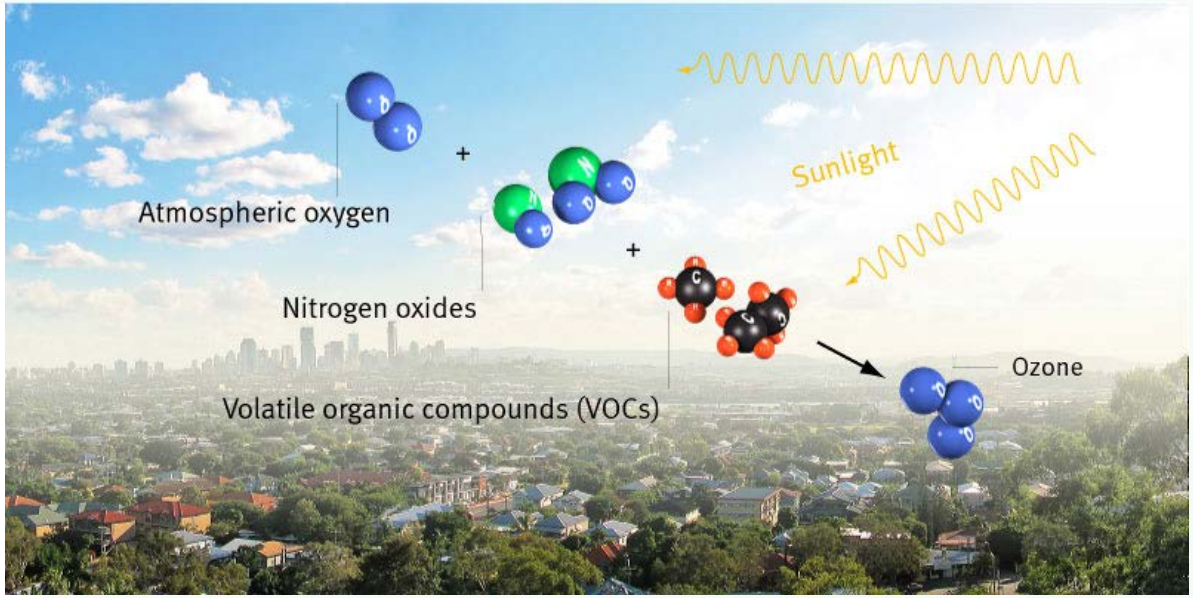
- O_3 in the atmosphere
- Levels of O_3 in Spain
- Phenomenology of O_3 episodes in Spain
- VOCs Precursors in Spain
- O_3 and COVID19 pandemic

O_3 in the stratosphere



http://www.geo.hunter.cuny.edu

O_3 in the troposphere



https://www.qld.gov.au/environment/pollution/monitoring/air-pollution/ozone/
Queensland State Gorvernment, Australia

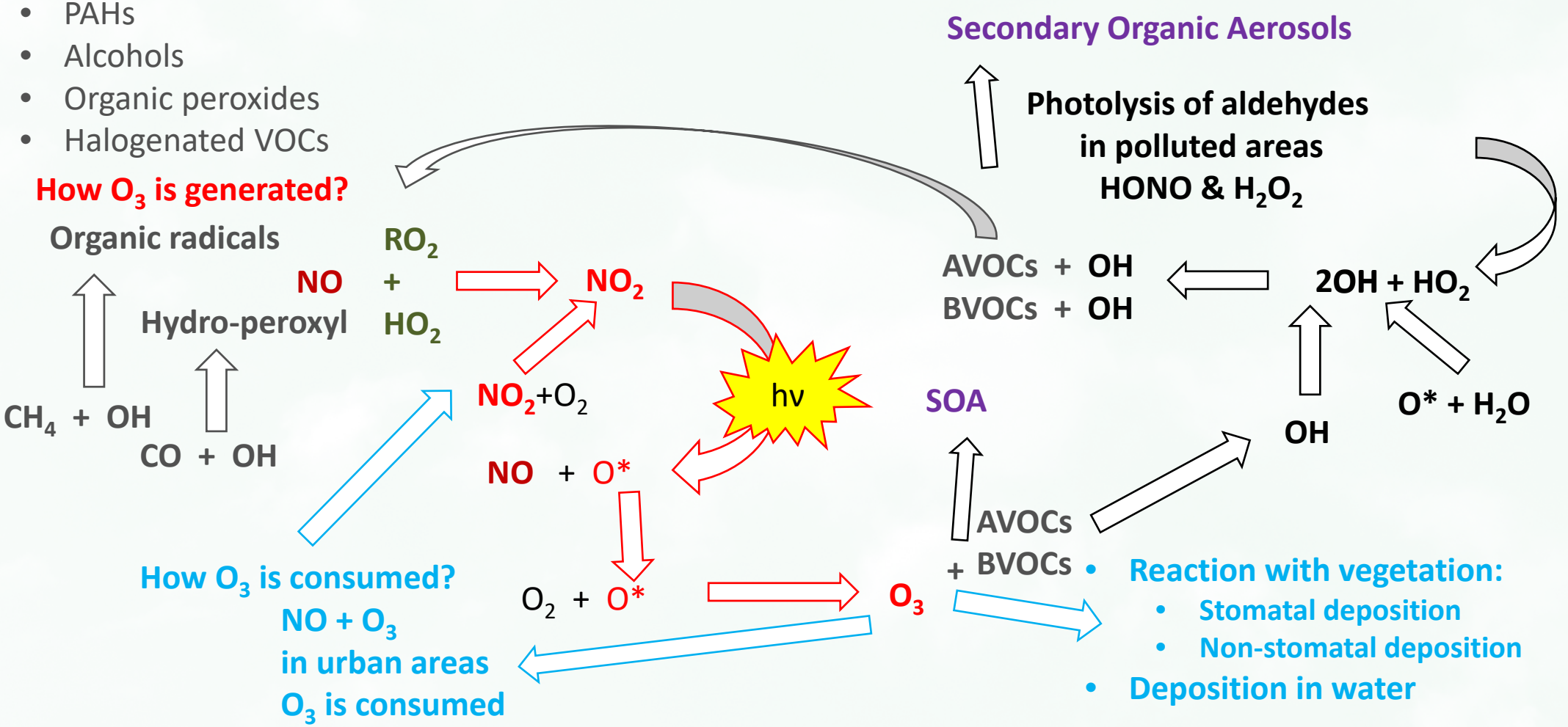
O_3 IN THE ATMOSPHERE

Relevant VOCs for the formation of O_3

- Alkanes
- Alkenes
- Carbonyls (aldehydes & ketones)
- PAHs
- Alcohols
- Organic peroxides
- Halogenated VOCs

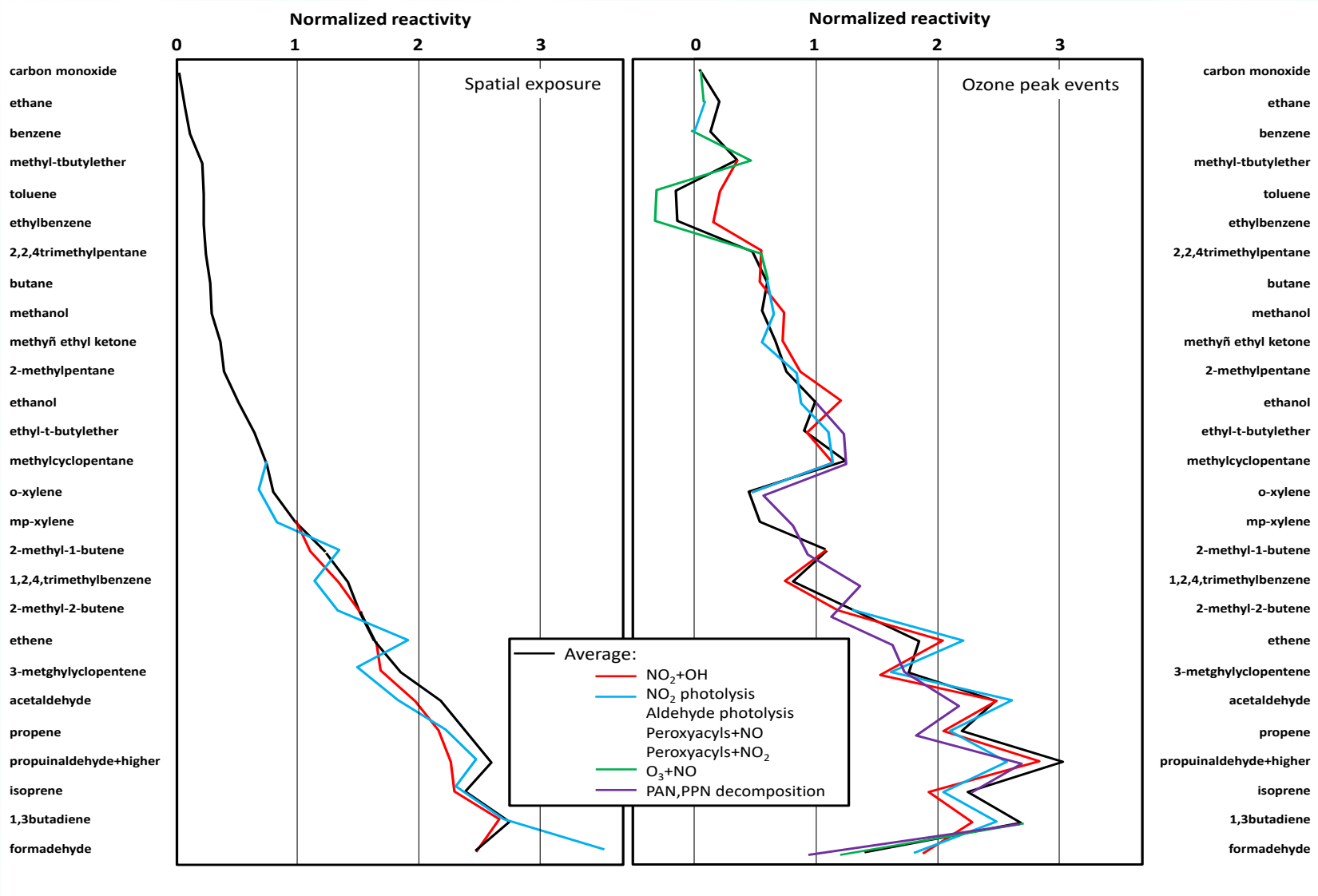
Atmospheric lifetime

- Isoprene 1h
- Methane 10 yr



O_3 IN THE ATMOSPHERE

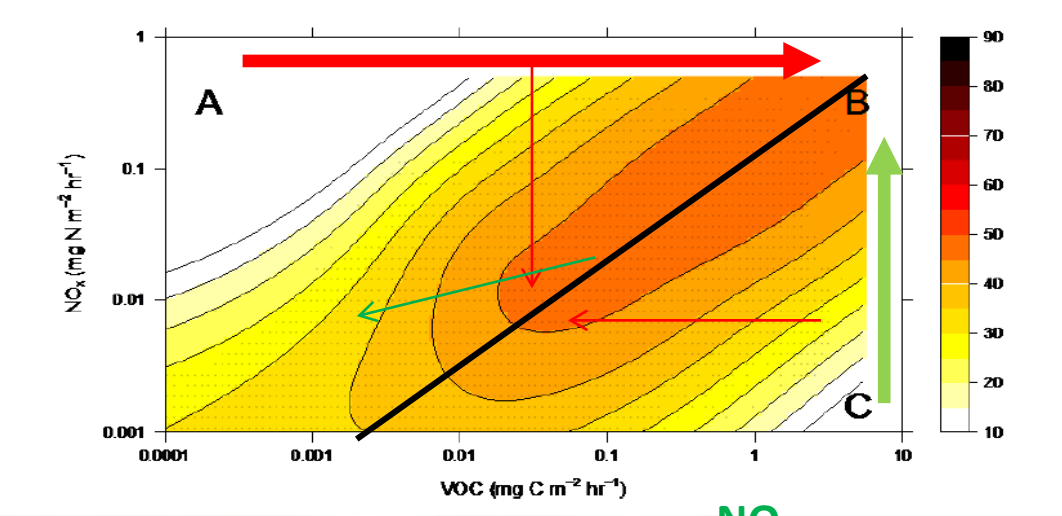
VOCs reactivity for O_3 formation



Bergin M.S. et al., 1998. Environ. Sci. Technol. 32 (5), 694-703

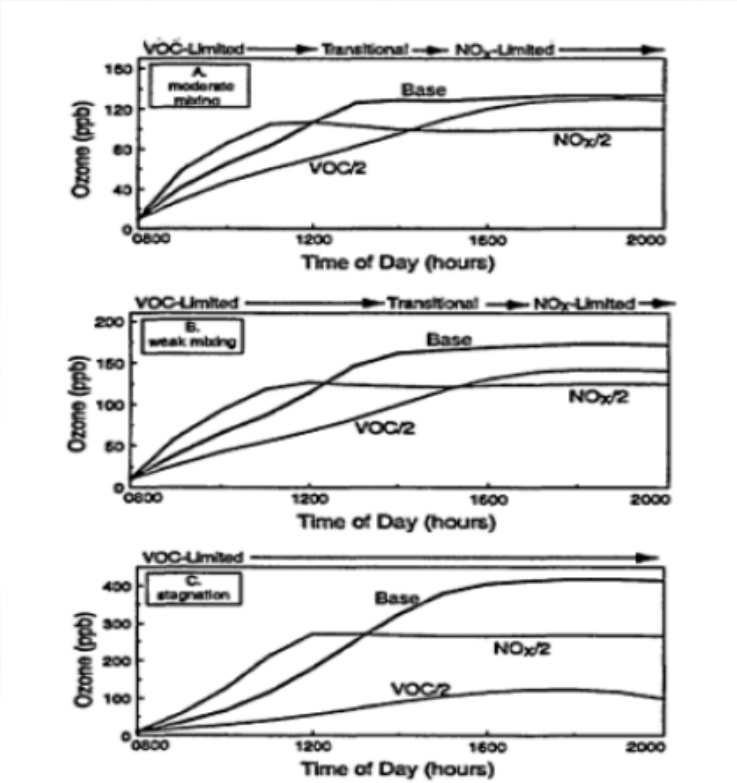
O_3 IN THE ATMOSPHERE

VOCs limited OH<NO_X



Monks et al., 2015, ACP

NO_X
OH>NO_X



Bergin M.S. et al., 1998. Environ. Sci. Technol. 32 (5), 694-703

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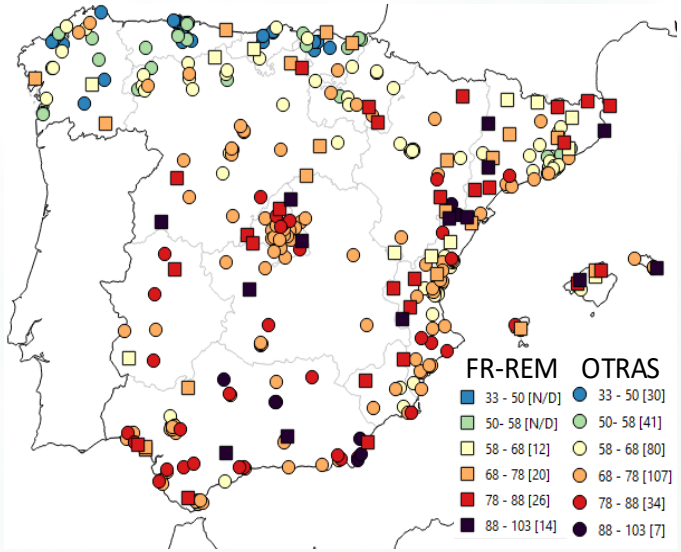
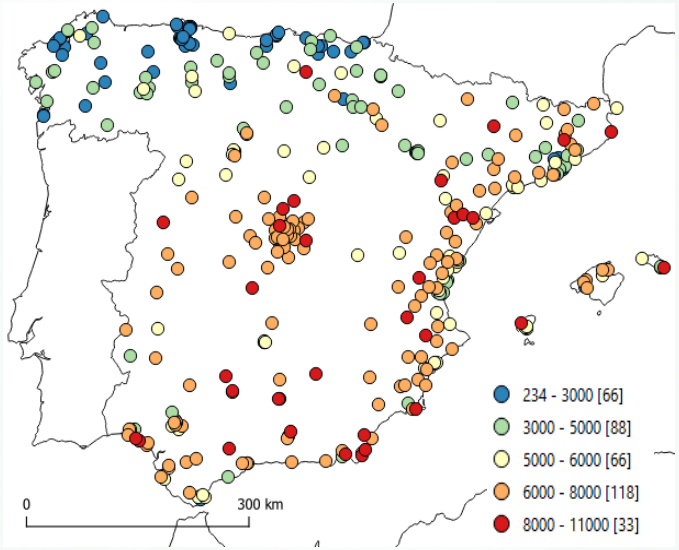
LEVELS OF O_3 IN SPAIN

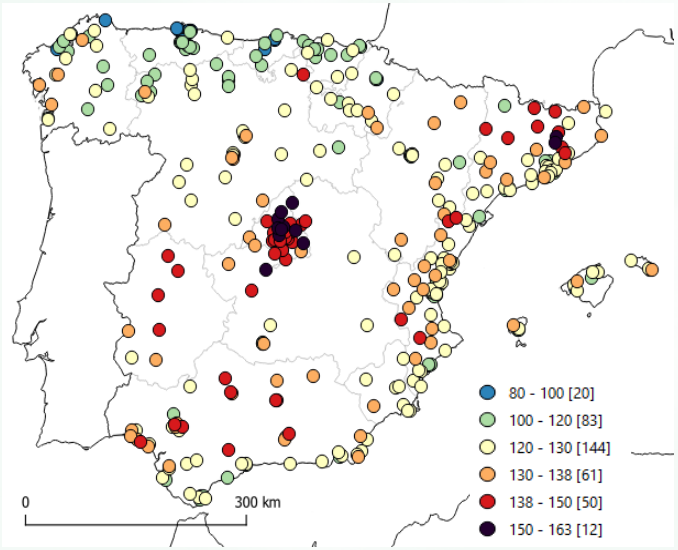
Media O_3 Abr-Sep (µg m^{-3})



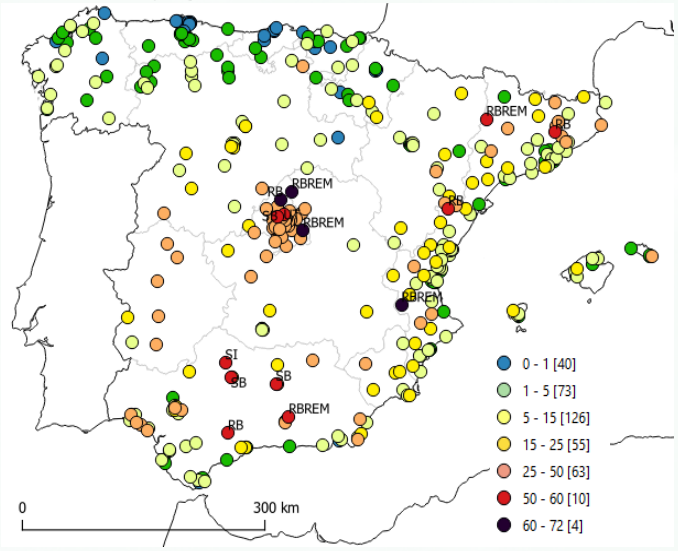
SOMO35 (µg m^{-3} día)



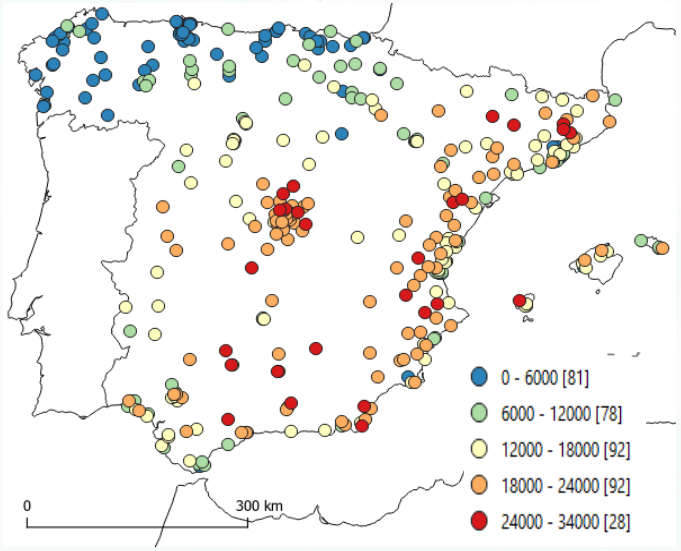
P98 MD8h (µg m^{-3})



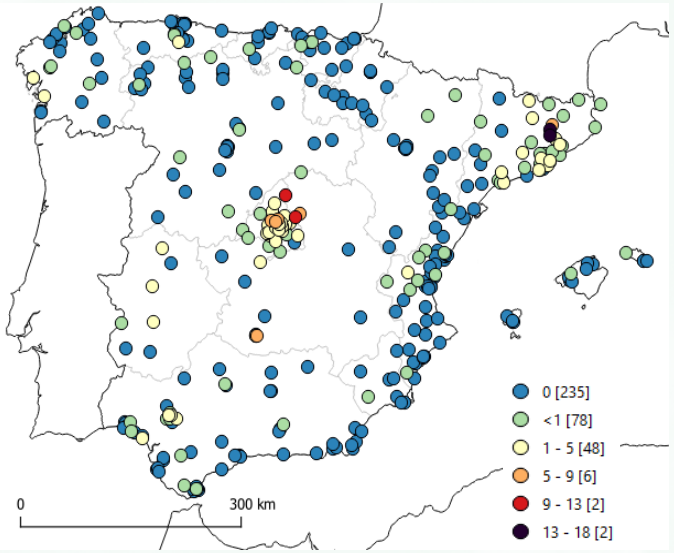
> 120 µg m^{-3} MD8h año^{-1}



AOT40 VEG (µg m^{-3} h)



> 180 µg m^{-3} (h año^{-1})



LEVELS OF O_3 IN SPAIN

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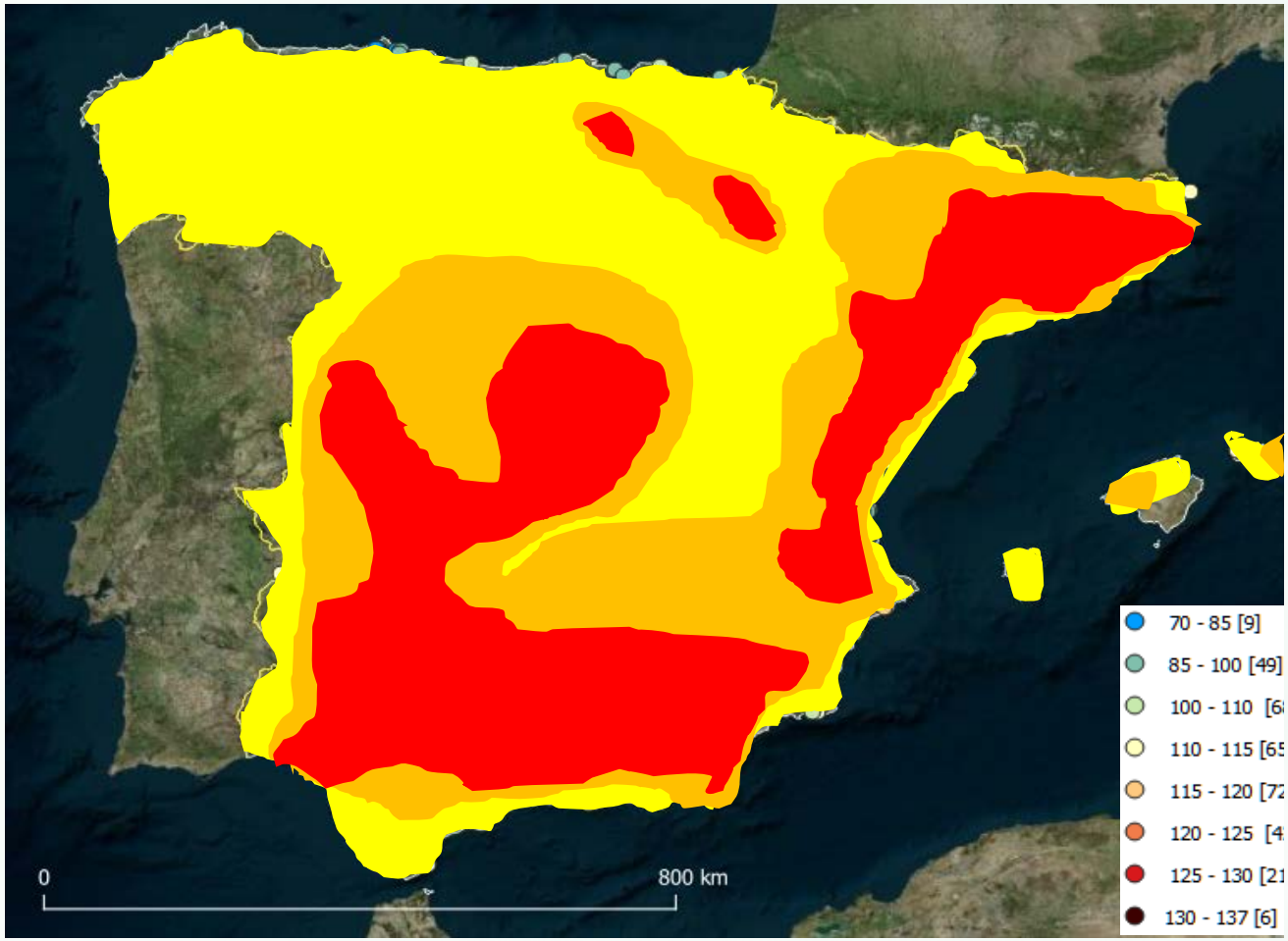
Averages 2010-2019

Exceedance of the EU AQ Health protection target value Close to EU AQ target value

Exceedance of the WHOAQG

Averaged 93.2 percentile 8h-DM O_3



TYPE 1 O_3 REGIONS

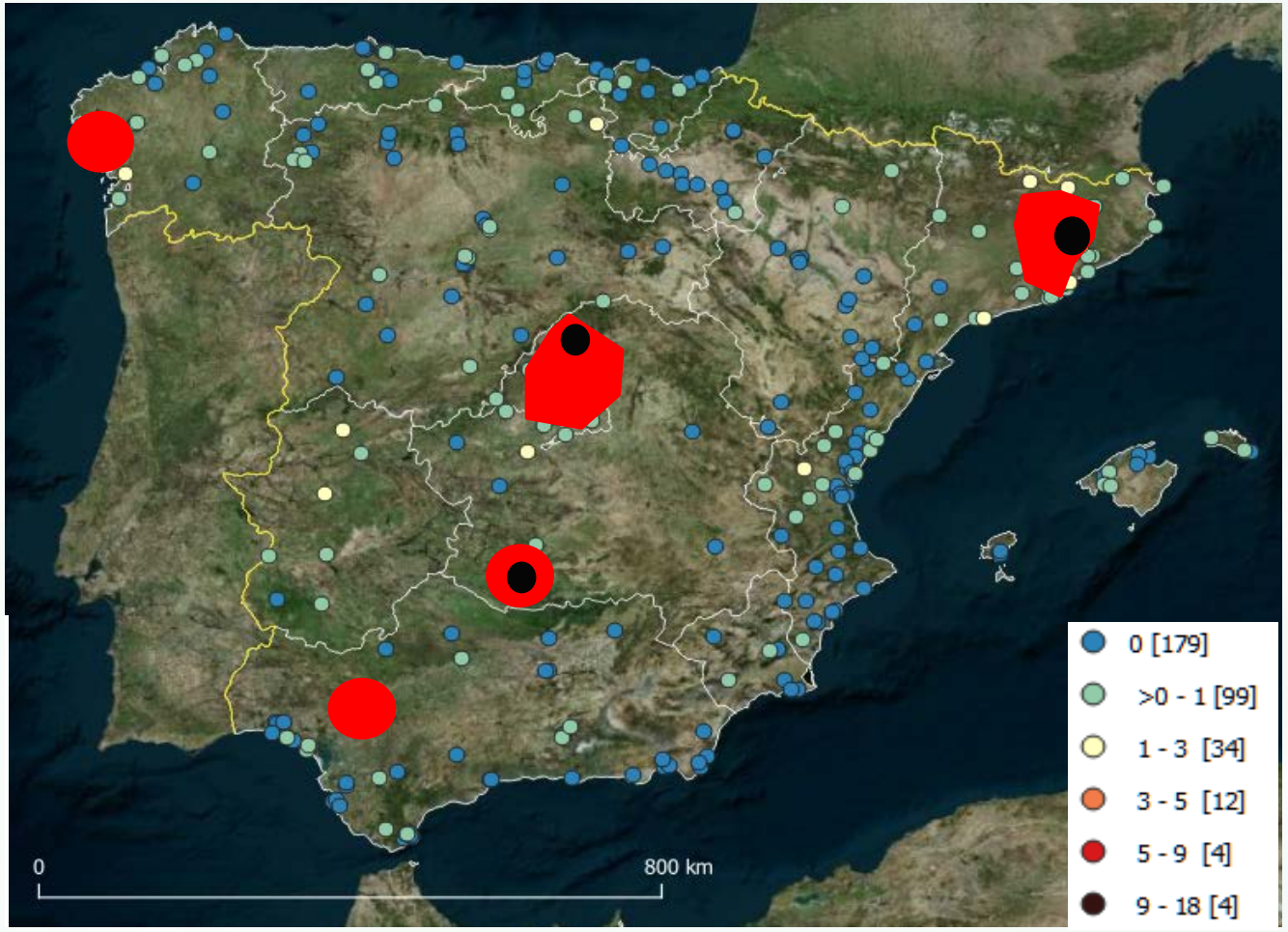
TYPE 2 O_3 REGIONS

TYPE 3 O_3 REGIONS

LEVELS OF O_3 IN SPAIN

Averages 2010-2019

Daily exceedances >180 µg m-3



TYPE 3 O_3 REGIONS

PHENOMENOLOGY OF O_3 EPISODES

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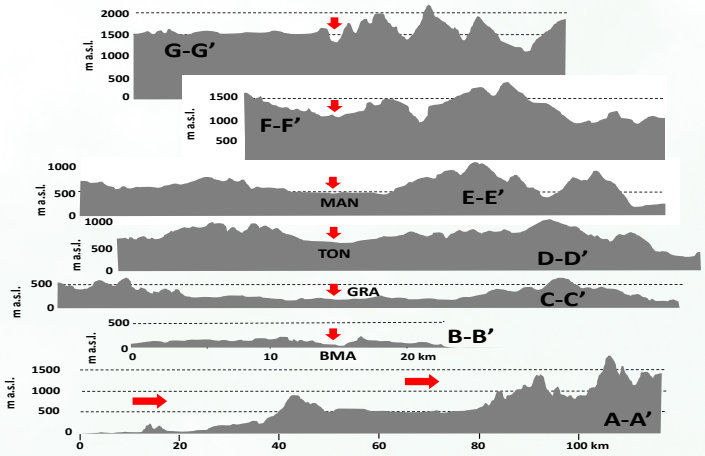
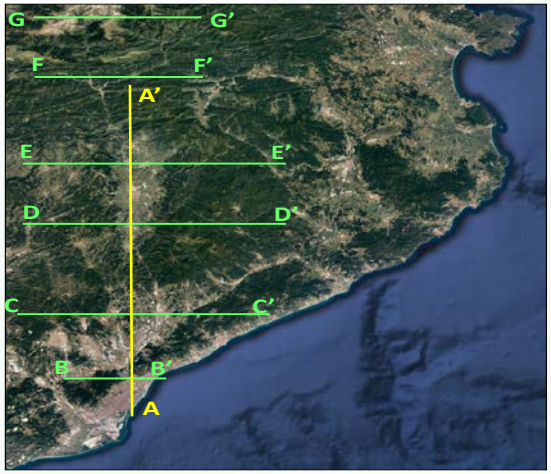
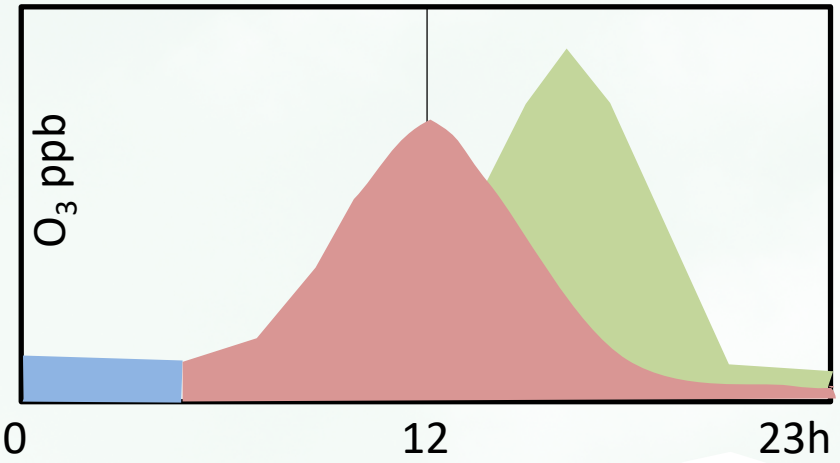
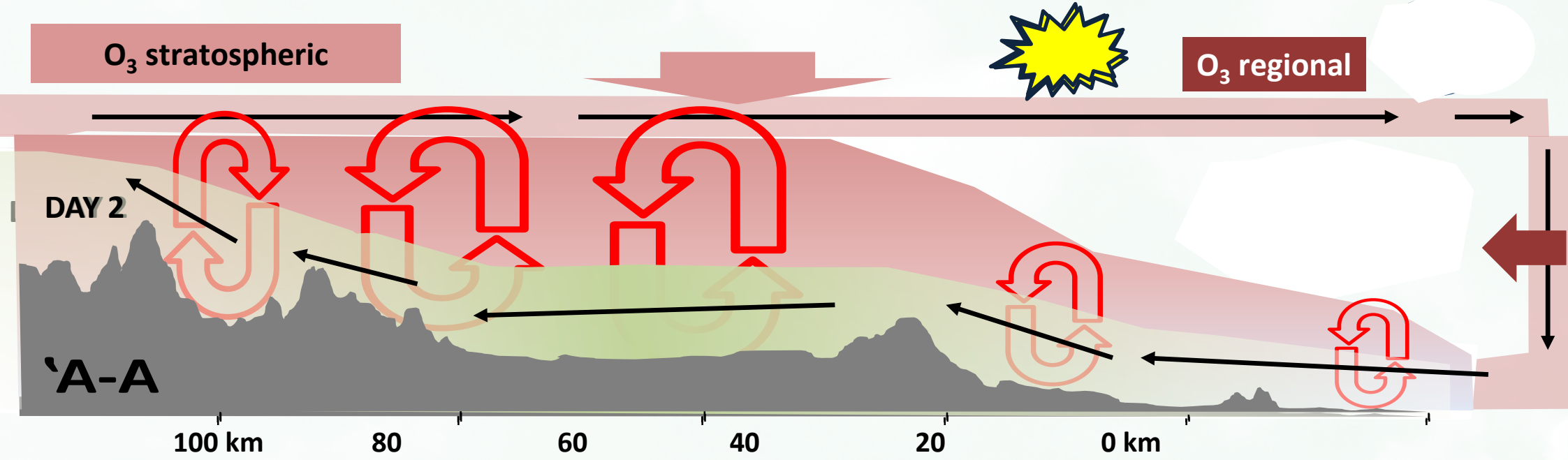
TYPE 3 O_3 REGIONS: NORTH OF BARCELONA









PHENOMENOLOGY OF O_3 EPISODES

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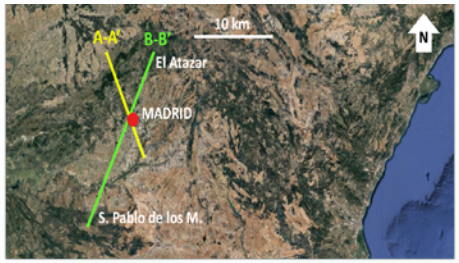
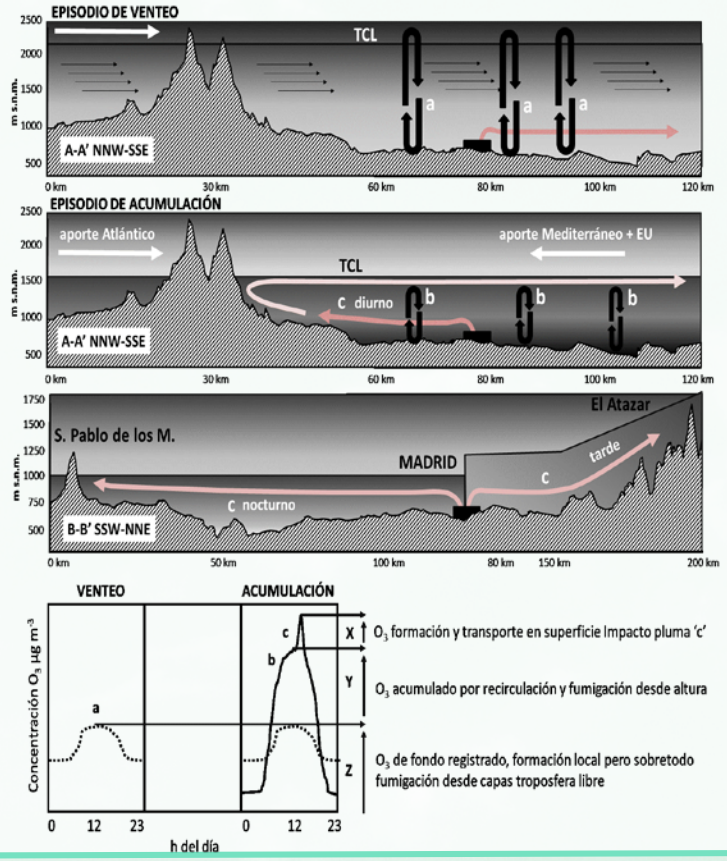


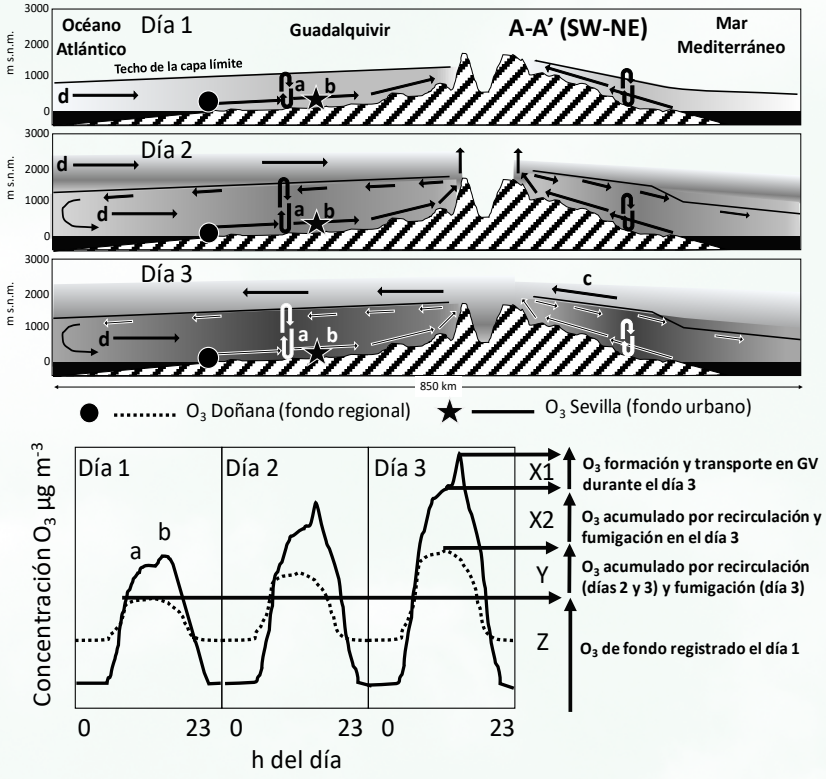
a) Formación local y fumigación de capas de la troposfera libre con aportes de O3 del Atlántico o del Mediterráneo + EU
b) Formación local y fumigación de estratos de reserva generados por recirculación de masas de aire de la cuenca con capas límite a mediodía relativamente delgadas
c) Impacto de la pluma de Madrid en diferentes periodos del día
TCL Techo de la capa límite a mediodía



TYPE 3 O_3 REGIONS:

- **MADRID**
- **GUADALQUIVIR**

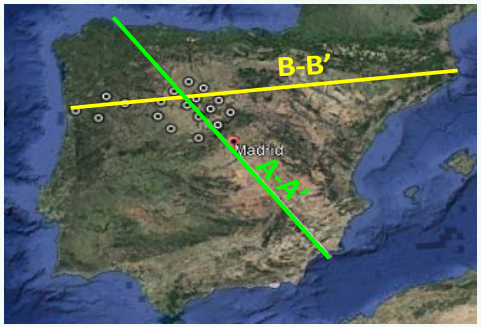
a) Recirculación vertical y fumigación
b) Formación local y transporte en el valle
c) Transporte en altura des del Mediterráneo afectado por fumigación
d) Transporte desde Atlántico

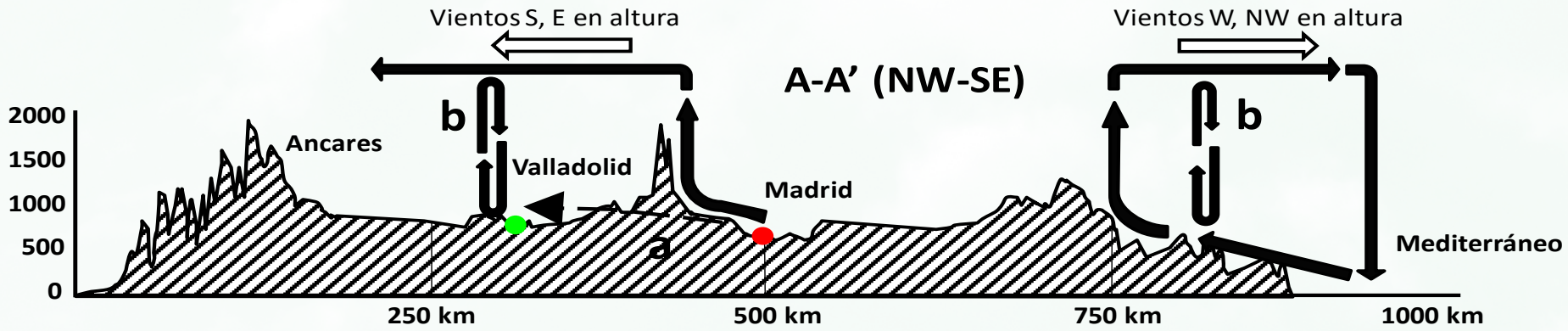


PHENOMENOLOGY OF O_3 EPISODES

TYPE 2 O_3 REGIONS: CASTILLA Y LEÓN

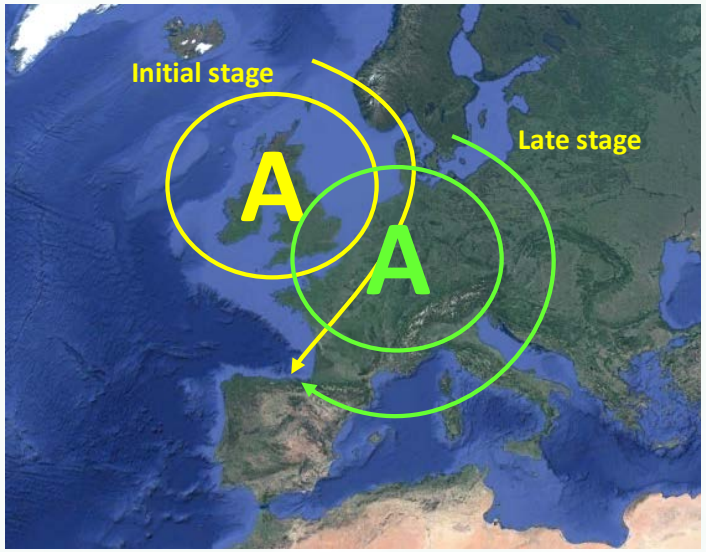
a. Transporte por superficie
b. Transporte en altura y fumigación desde allí

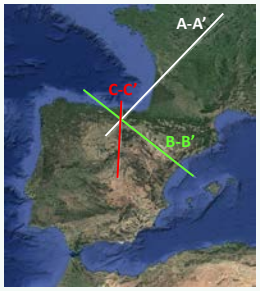




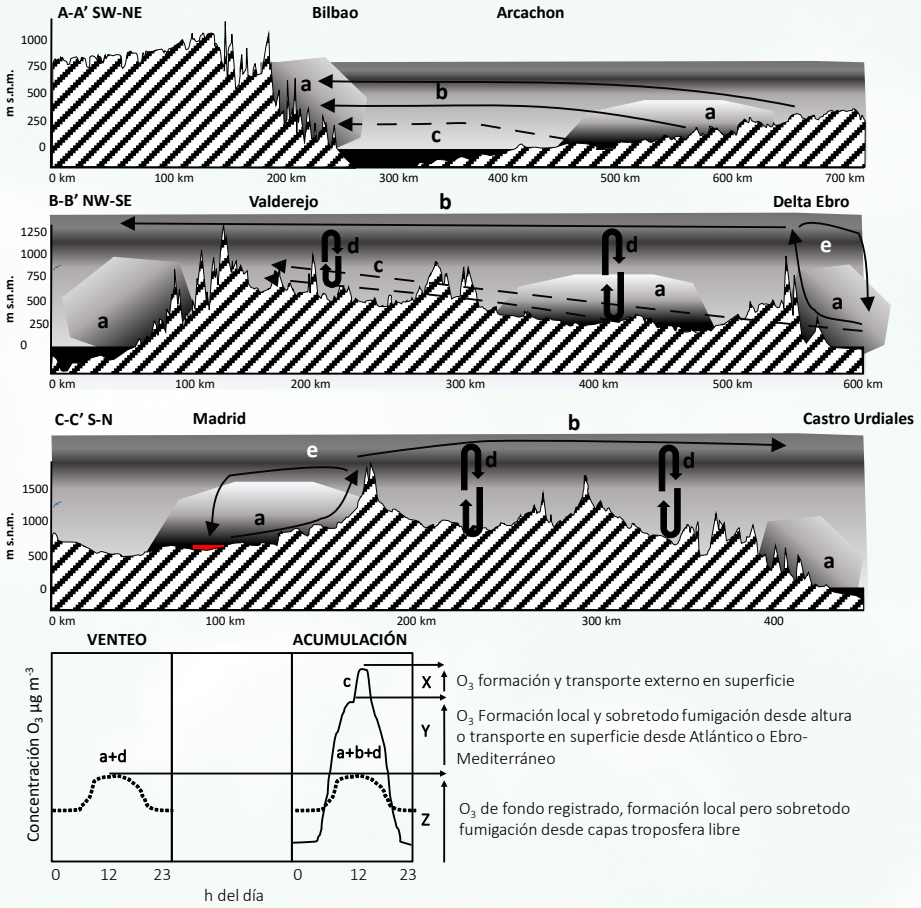
PHENOMENOLOGY OF O_3 EPISODES

TYPE 1 O_3 REGIONS: EUSKADI



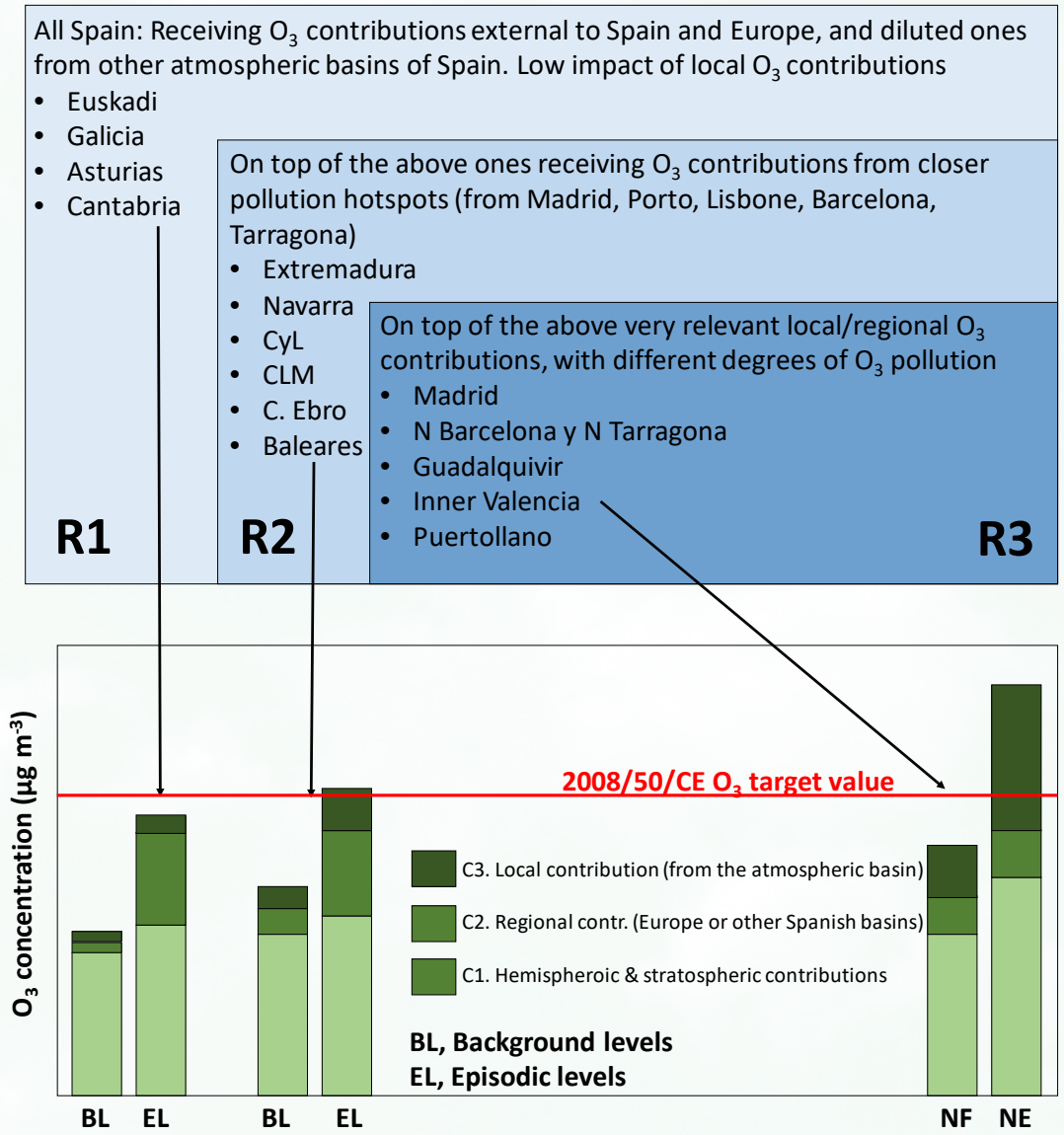


a. Generación local/regional de O_3
b. Inyección y transporte de O_3 en altura
c. Transporte de O_3 en superficie
d. Fumigación desde capas altas
e. Recirculación vertical de masas de aire



PHENOMENOLOGY OF O_3 EPISODES

A POSSIBLE STRATEGY FOR A SPANISH O_3 PLAN



PHENOMENOLOGY OF O_3 EPISODES

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THE HIGHEST O_3 AQ MONITORING SITE IN EACH AUTONOMOUS REGION 2025-2019

Autonomous regions	O_3 Apr.-Sep. ($\mu g\ m^{-3}$)	OMS AQG level O_3 peak season ($\mu g\ m^{-3}$)	AOT40 veg. ($\mu g\ m^{-3}$ hour)	SOMO35 ($\mu g\ m^{-3}$ day)	Exc. TVHP (day yr^{-1})	p93.2 ($\mu g\ m^{-3}$)	4th highest 8hDM ($\mu g\ m^{-3}$)	Exc. Info. Tresh. (hours yr^{-1})
Andalucía	99	115	31633	10776	59	131	145	2.4
Aragón	92	106	22902	8336	26	121	134	0.4
Asturias	75	88	6367	5091	5	106	124	1.0
Islas Baleares	91	104	25110	8648	27	122	133	0.2
Comunidad Valenciana	102	115	33420	10875	64	131	144	1.2
Islas Canarias	75	83	6397	5096	7	105	116	0.2
Cantabria	67	81	5096	4392	3	103	119	0.2
Cataluña	101	111	29800	10434	54	135	161	17.6
Castilla La Mancha	99	111	24332	9664	47	127	153	10.4
Castilla y León	88	106	21964	8537	32	123	138	0.4
Extremadura	84	107	19465	7182	40	125	147	3.6
Galicia	73	87	7626	5191	14	111	136	4.2
Madrid	95	116	27597	10607	72	141	163	9.8
Murcia	84	104	21911	8236	25	119	134	0.3
Navarra	82	101	18902	6677	24	120	136	0
País Vasco	81	102	16151	8034	30	122	140	0.8
La Rioja	73	94	15256	5365	15	114	127	0

O_3 PRECURSORS IN SPAIN

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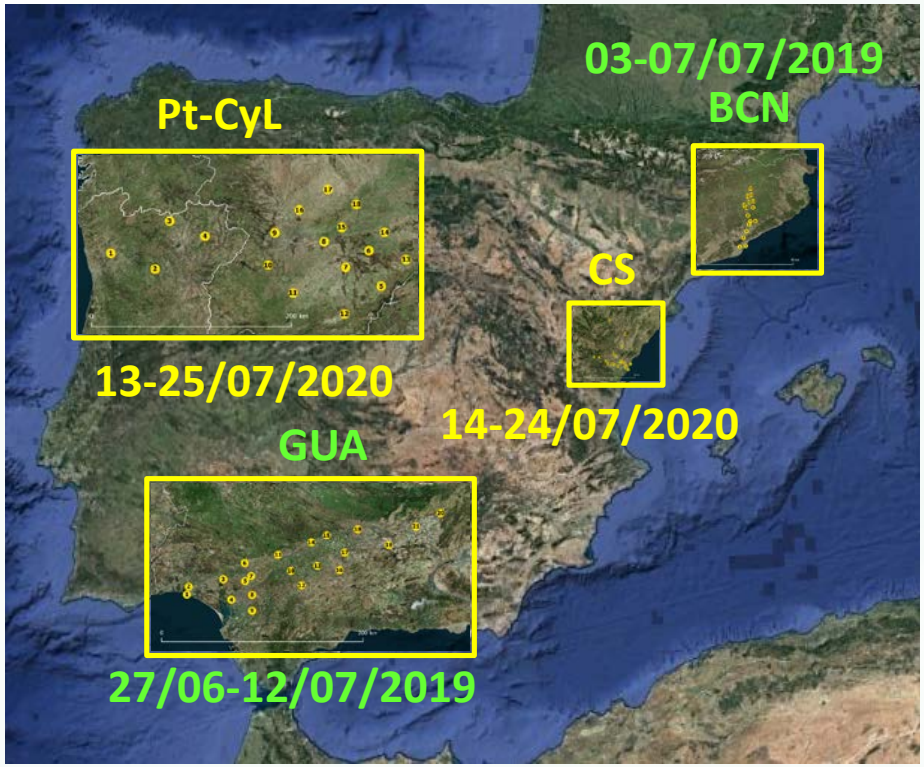
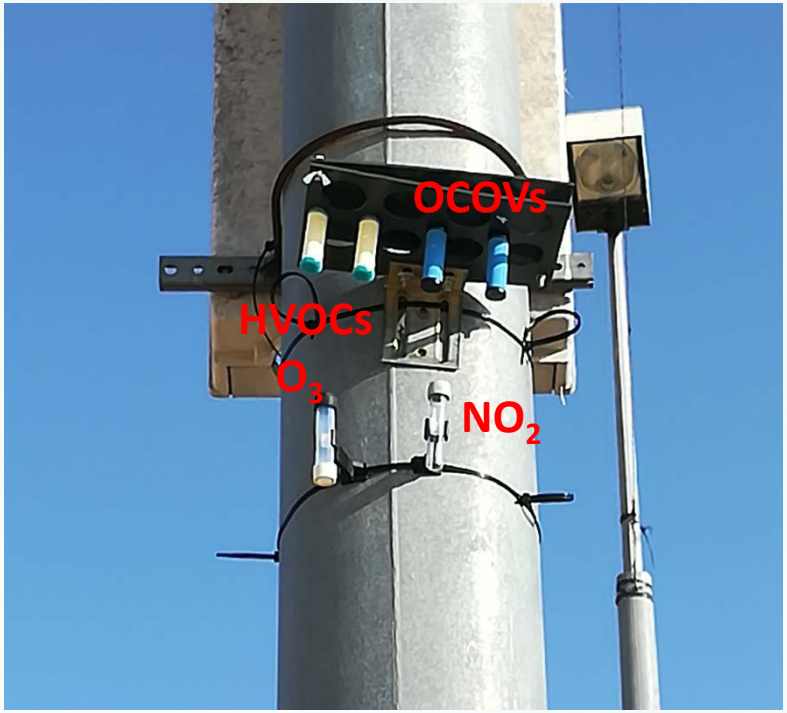
VOCs MEASURMENT CAMPAIGNS JULY 2019 & 2020



GC-MS



Limitations

- Passive dosimeters
- <C5 not measured
- Isoprene not measured
- Indicative method
- 15 days averages

Pros

- Easily deployed
- Spatial variations

GUA 19 sites, 78 VOCs detected (45 HVOCs & 33 OVOCs)
BCN 16 sites, 65 VOCs (36HVOCss & 29 OVOCs
Pt-CyL 18 sites, 52 VOCs (39 HCOVs y 13 OVOCs)
CS 19 sites, 44 VOCs (30 HVOCs y 14 OVOCs)

O_3 PRECURSORS IN SPAIN

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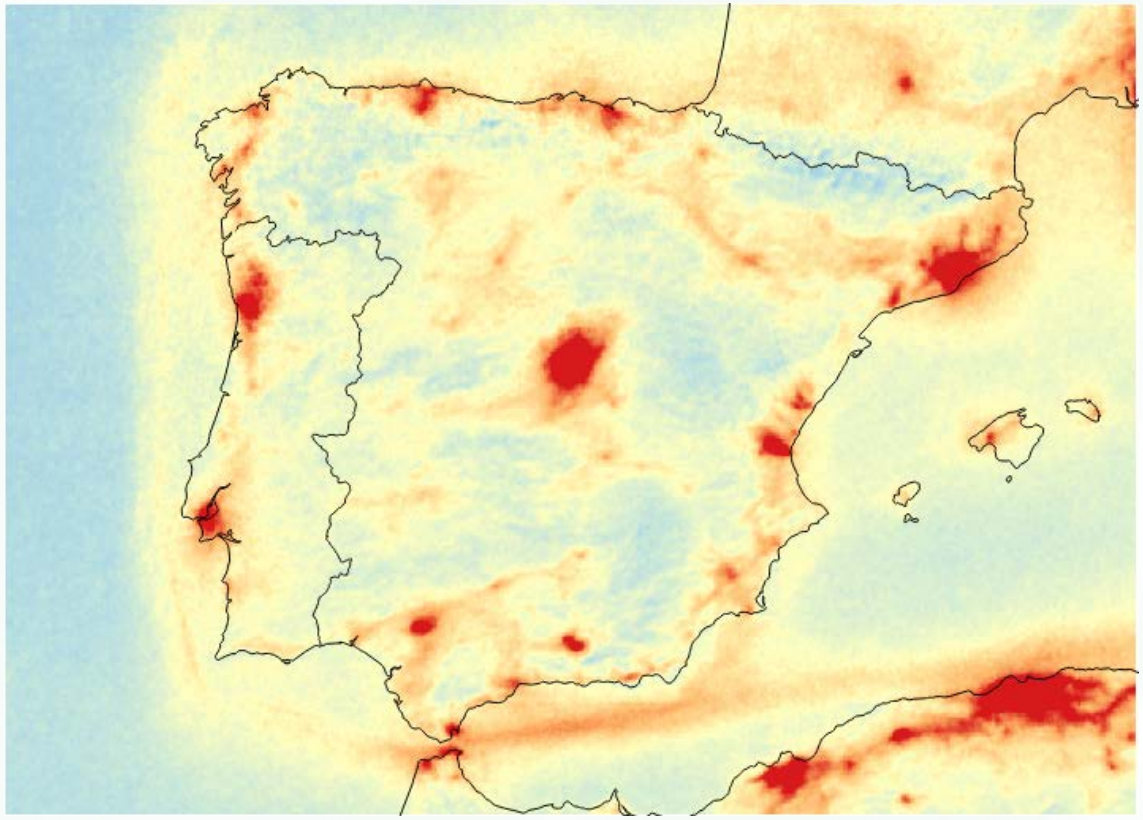
TROPOMI –ESA- NO2 COLUMN JJA 2019

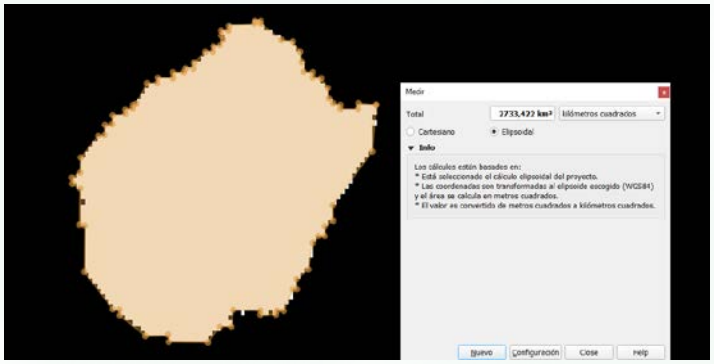
NO_2 (µmol m^{-2})

0 — 40

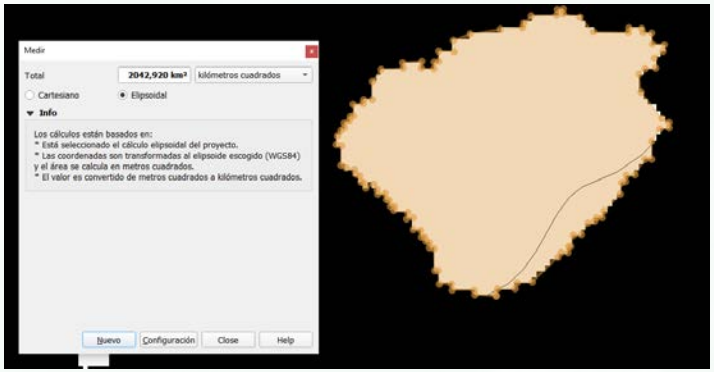


AREA WITH $NO_2 \geq 40$ µmol m^{-2}

Madrid 2733 km^2 elipsoidal
(4730 km^2 cartesian)



Barcelona 2043 km^2 elipsoidal
(3649 km^2 cartesian)



O_3 PRECURSORS IN SPAIN

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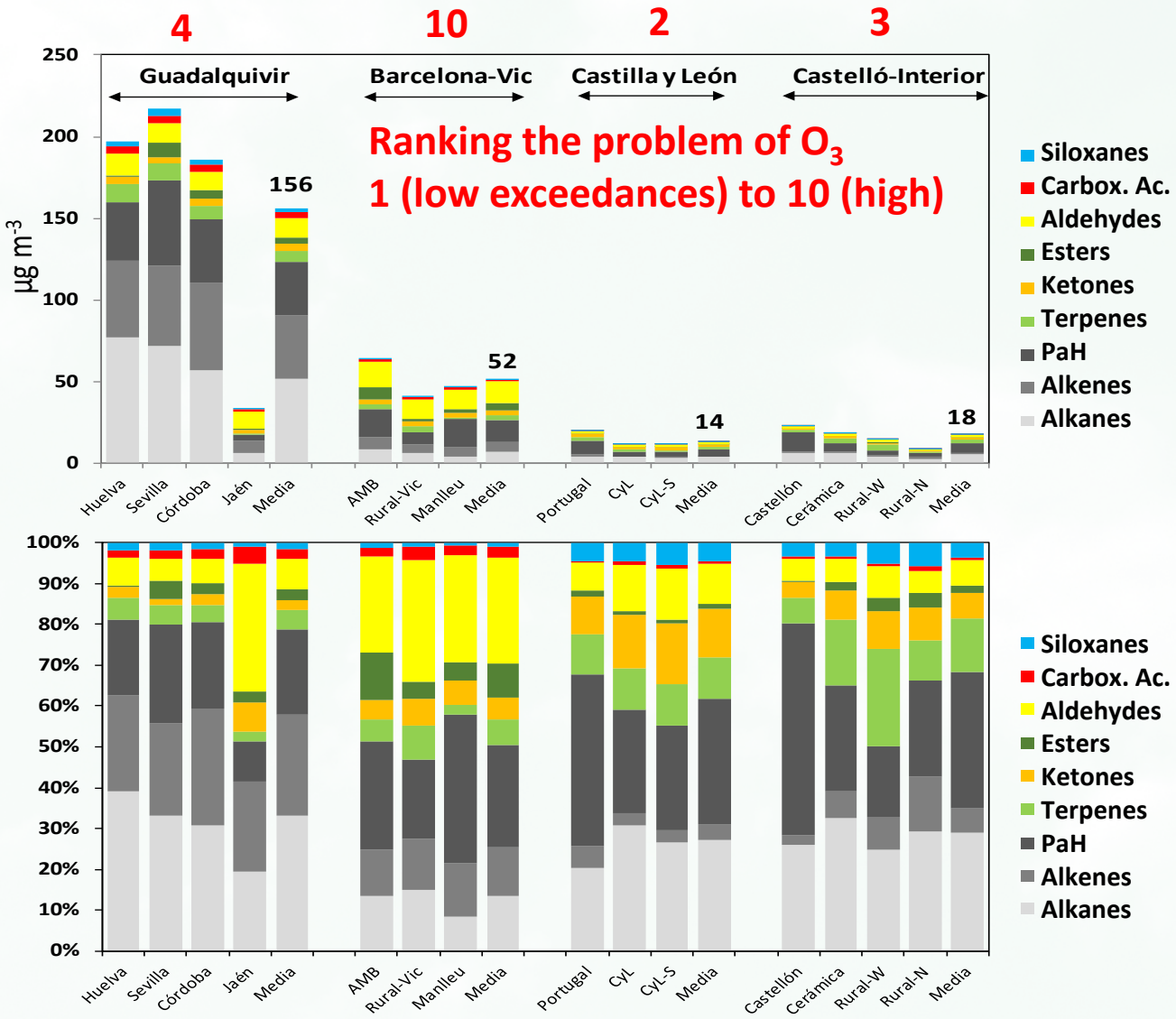
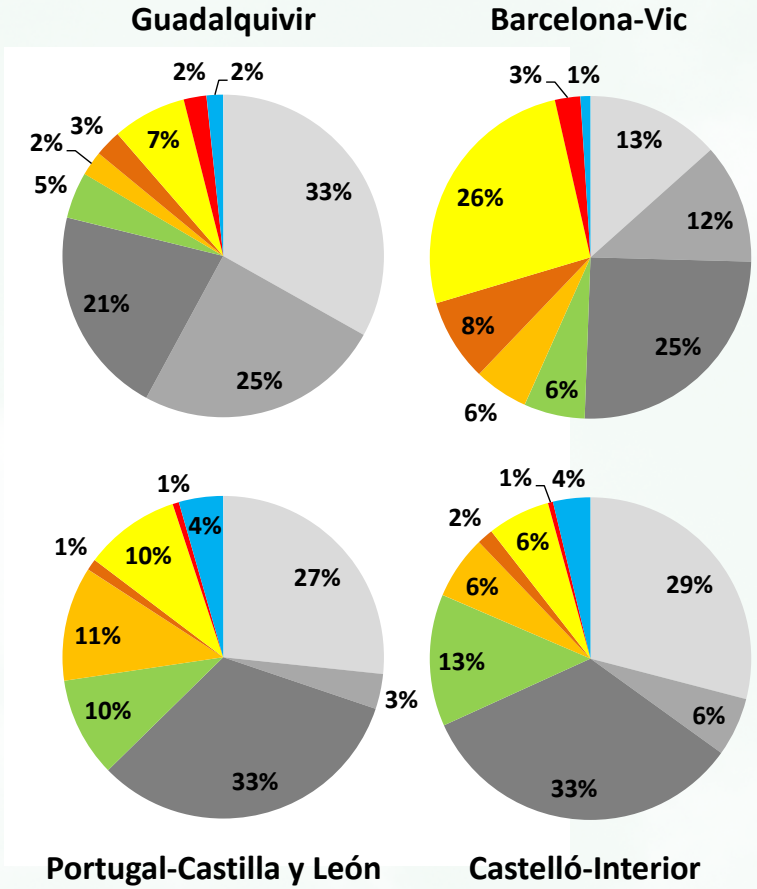
VOCs MEASURMENT CAMPAIGNS JULY 2019 & 2020





O_3 PRECURSORS IN SPAIN

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VOCs MEASURMENT CAMPAIGNS JULY 2019 & 2020

TY - JOUR
AU - Carter, William
PY - 2010/01/01
SP - 07
EP - 339
T1 - Updated maximum incremental reactivity scale and hydrocarbon bin reactivities for regulatory applications
VL - 1
JO - California Air Resources Board Contract
ER -

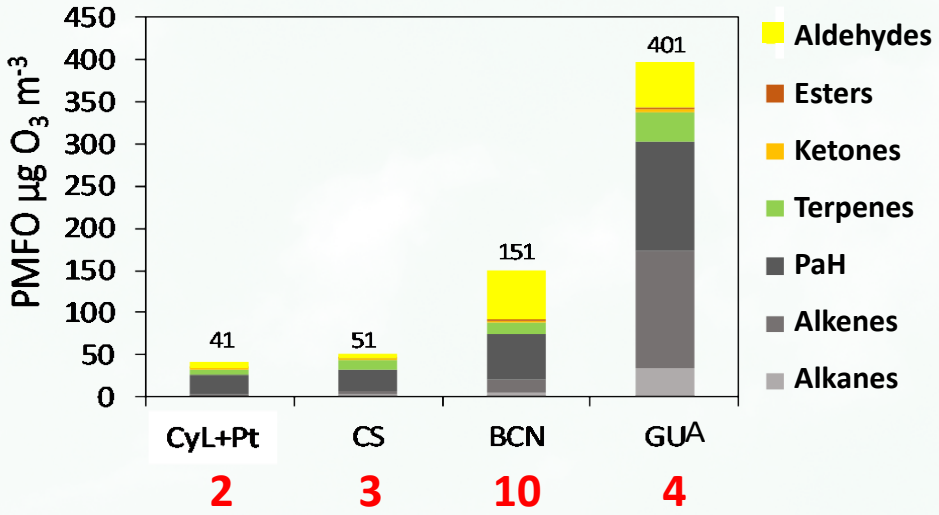
Maximum O_3 Formation Potential (MOFP)
Maximum incremental reactivity (Carter 2009&2010)

$$MIR_i = \frac{\Delta O_3}{\Delta COV_i} \quad (gO_3/gVOC_i)$$

$$MOPF_i = VOC_i * MIR_i \quad (\mu gO_3/m^3)$$

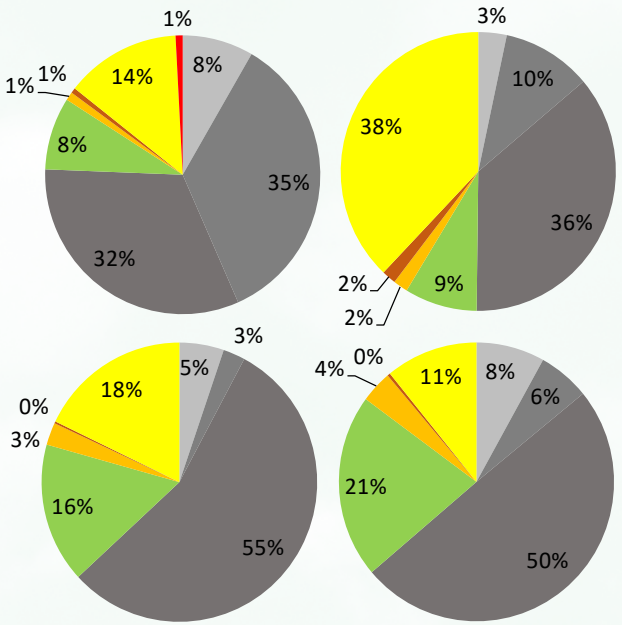
$$MOPF_{TOT} = MOFPa+b+c+.....i$$

Maximum O_3 Formation Potential



2 3 10 4

Ranking of O_3 problem



O_3 PRECURSORS IN SPAIN

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GUADALQUIVIR **MAXIMUM O3 FORMATION POTENTIAL**

Alkenes	heptene 100 µg O_3 m^{-3}
	octene 41 µg O_3 m^{-3}
Aromatic Hy.	Toluene 40 µg O_3 m^{-3},
	1,3,5,-trimetylbenzene 21 µg O_3 m^{-3},
	o- & m,p-xylene 17 & 14 µg O_3 m^{-3}
Terpenes	camphene & a-pinene 16 & 11 µg O_3 m^{-3}
Aldehyde	butaldehyde 10 µg O_3 m^{-3}
Alkanes	decane & dodecane 5 & 9 µg O_3 m^{-3}

BCN

Aromatic Hy.	toluene 21 µg O_3 m^{-3}
	m,p- & o-xylene 9 & 8 µg O_3 m^{-3}
	1,3,5 trimetylbenzene 5 µg O_3 m^{-3}
Alkenes	heptene 11 µg O_3 m^{-3}
	octene 5 µg O_3 m^{-3}
Aldehydes	heptanal 10 µg O_3 m^{-3}
	formaldehyde 8 µg O_3 m^{-3}
	butanal 8 µg O_3 m^{-3}
	glycolaldehyde 7 µg O_3 m^{-3}
	pivaldehyde 7 µg O_3 m^{-3}
	nonanal 5 µg O_3 m^{-3}
Terpenes	a-pinene 6, µg O_3 m^{-3}
	camphene 6 µg O_3 m^{-3}

CASTELLÓ (very similar PORTO-CASTILLA Y LEÓN)

Aromatic Hy.	o,m,p-xylenes & toluene 17 µg O_3 m^{-3} together,
	etylbenzene, trimetylbenzene 4 µg O_3 m^{-3} together
Terpenes	camphene & m-cymene 6 µg O_3 m^{-3}
	β-pinene µg O_3 m^{-3}
Alkenes	octene 3 µg O_3 m^{-3}
Alkanes	dimetylbutane (3 µg O_3 m^{-3})
Aldehydes	formaldehyde & butiraldehyde 4 µg O_3 m^{-3} together
Ketones	sabinketona 2 µg O_3 m^{-3}

O_3 PRECURSORS IN SPAIN

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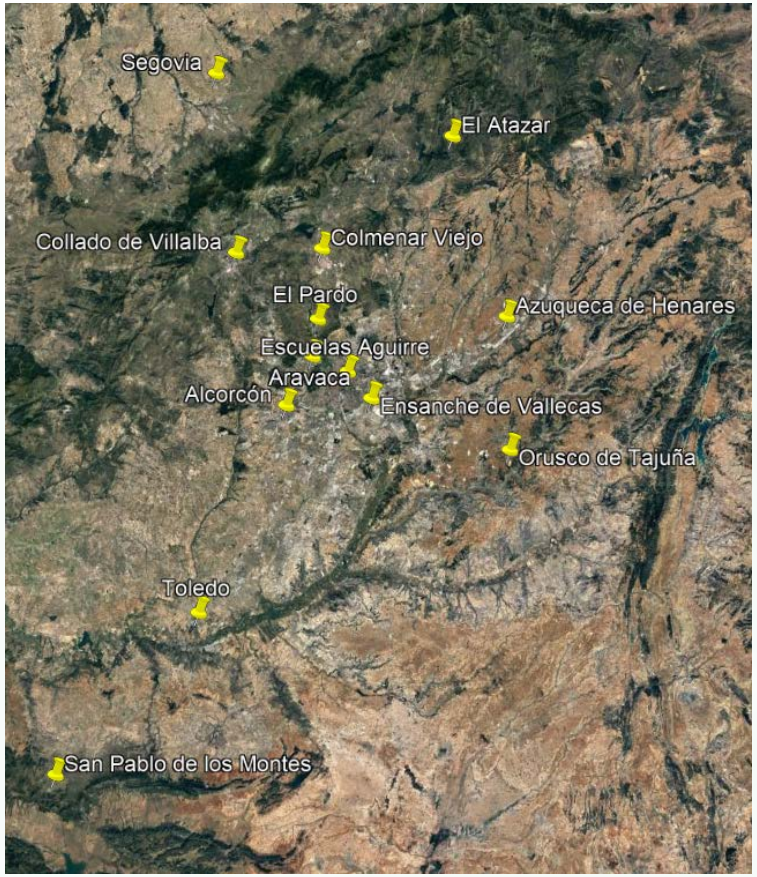
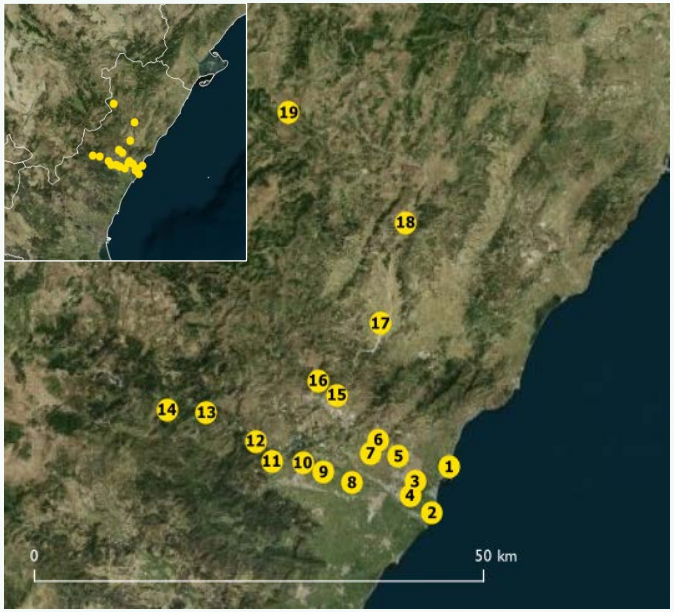
JULY 2021 MADRID



JULY 2021 GUADALQUIVIR

JULY 2021 CASTELLÓ (CEAM)



JULY 2022: PUERTOLLANO, EUSKADI, VALENCIA

O_3 & COVID19 PANDEMIC

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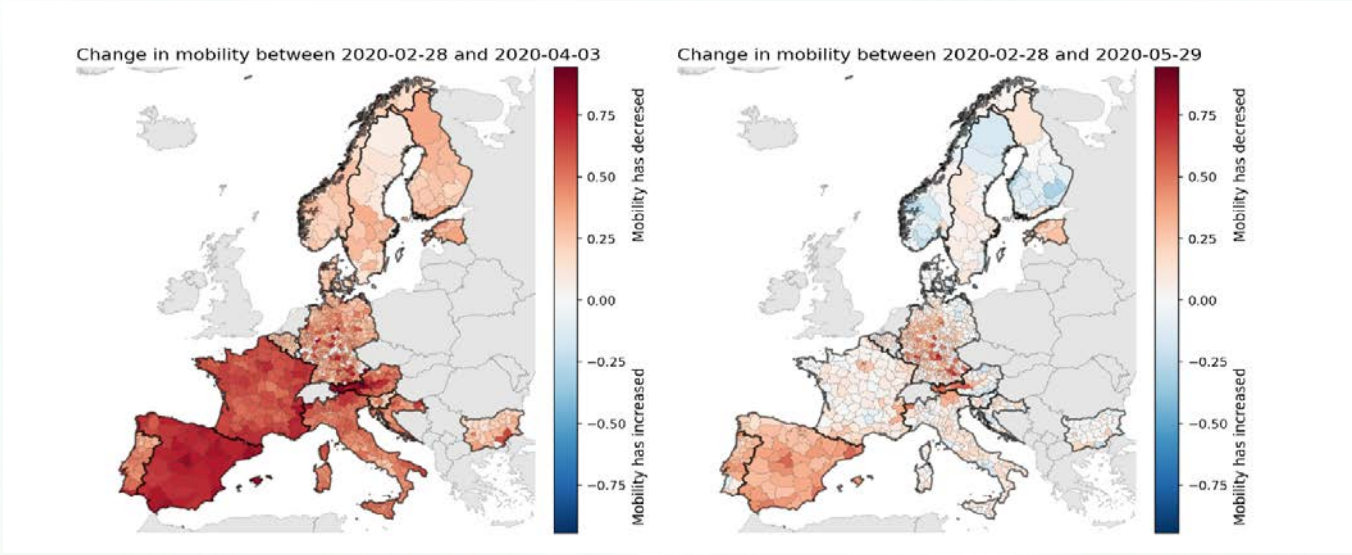
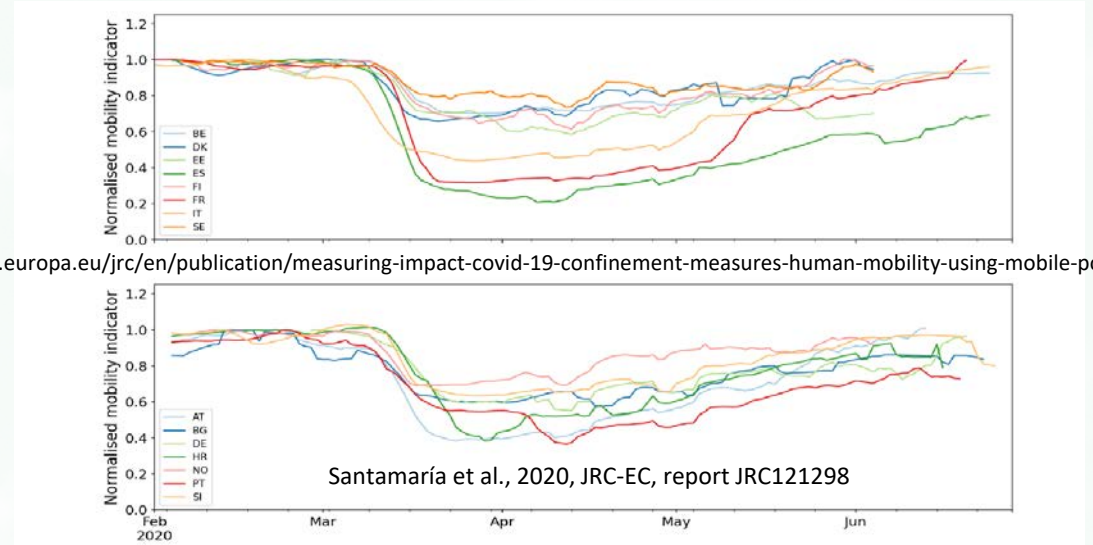
Changes in total mobility caused by COVID19 lockdown in Europe





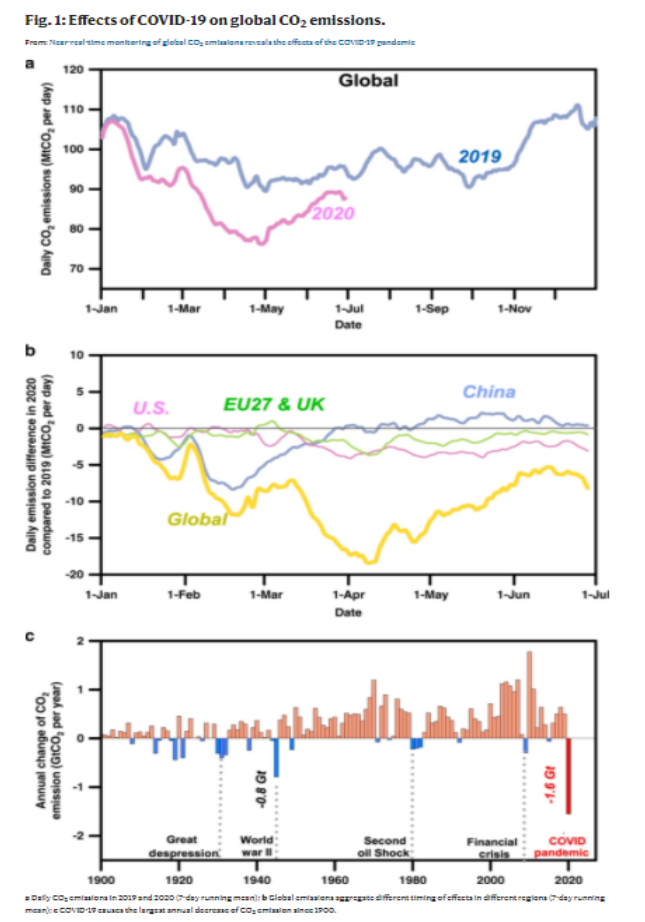
https://ec.europa.eu/jrc/en/publication/measuring-impact-covid-19-confinement-measures-human-mobility-using-mobile-positioning-data

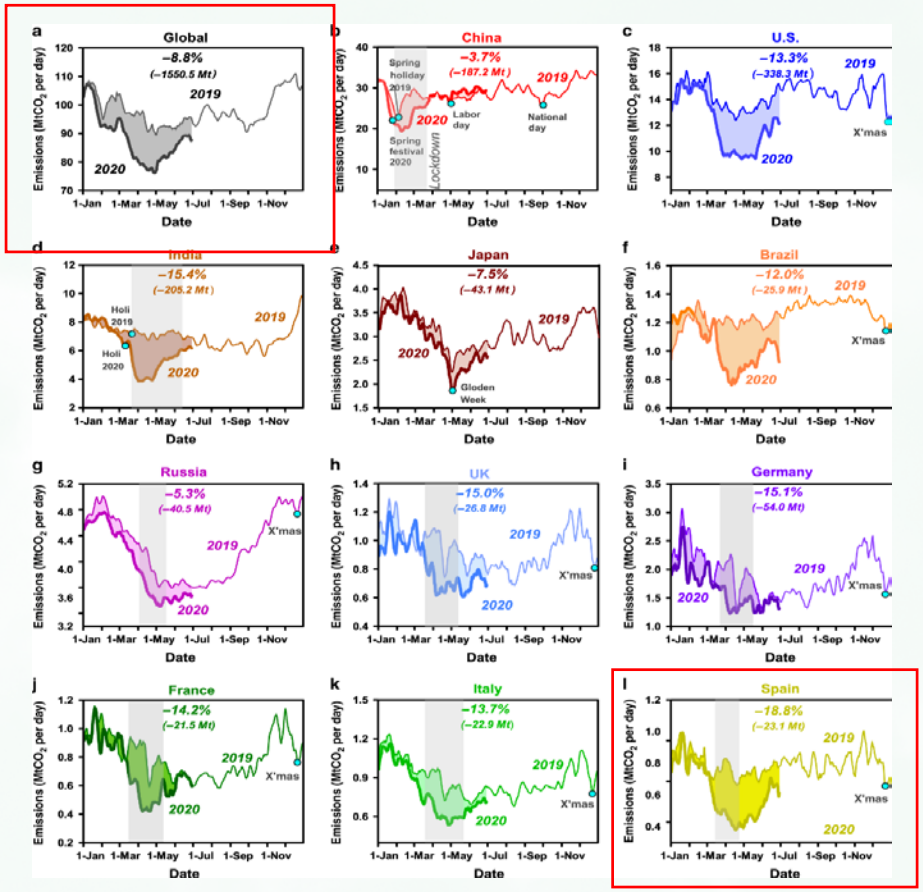
Santamaría et al., 2020, JRC-EC, report JRC121298

O_3 & COVID19 PANDEMIC

Change in worldwide fossil fuel combustion CO_2 emissions

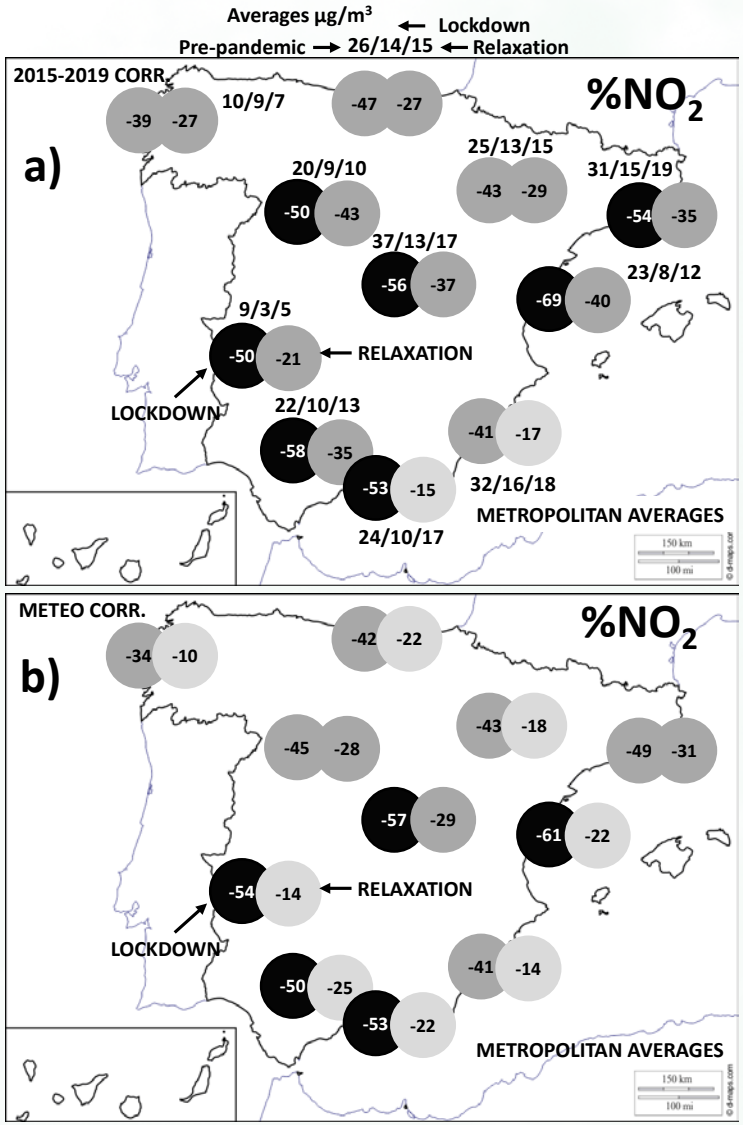
Liu, Z., Ciais, P., Deng, Z. *et al.* Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic. *Nat Commun* **11,** 5172 (2020). Published 14 October 2020

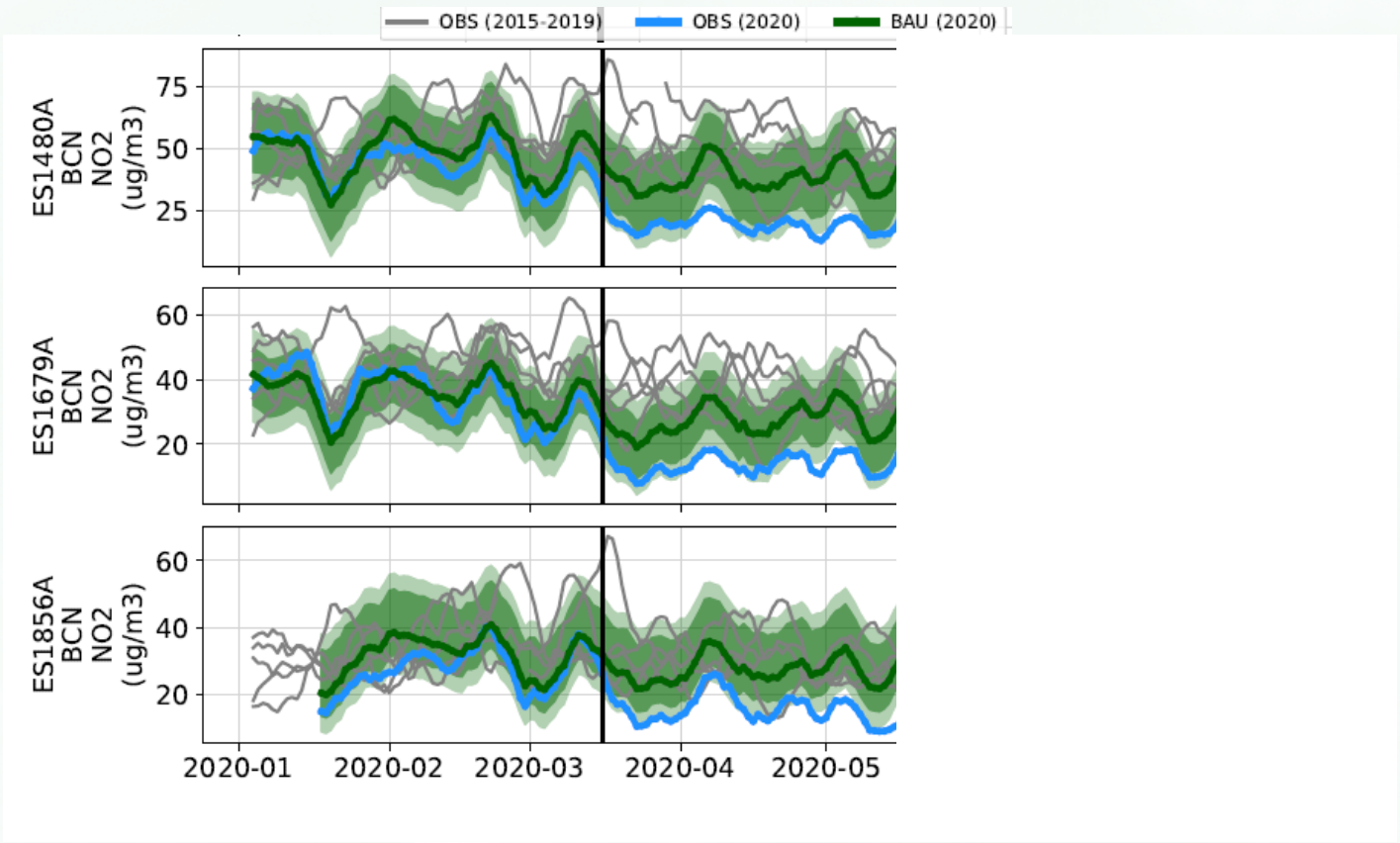




The key result is an abrupt 8.8% decrease in global CO_2 emissions (−1551 Mt CO_2) in the first half of 2020 compared to the same period in 2019.

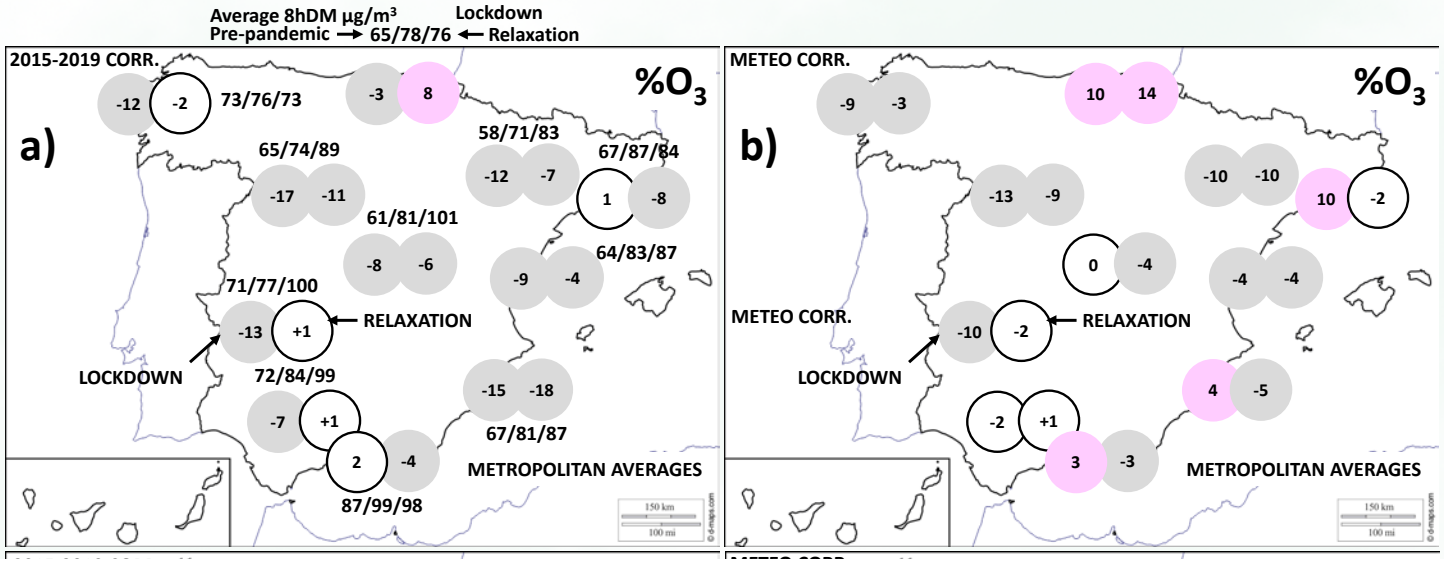
O_3 & COVID19 PANDEMIC





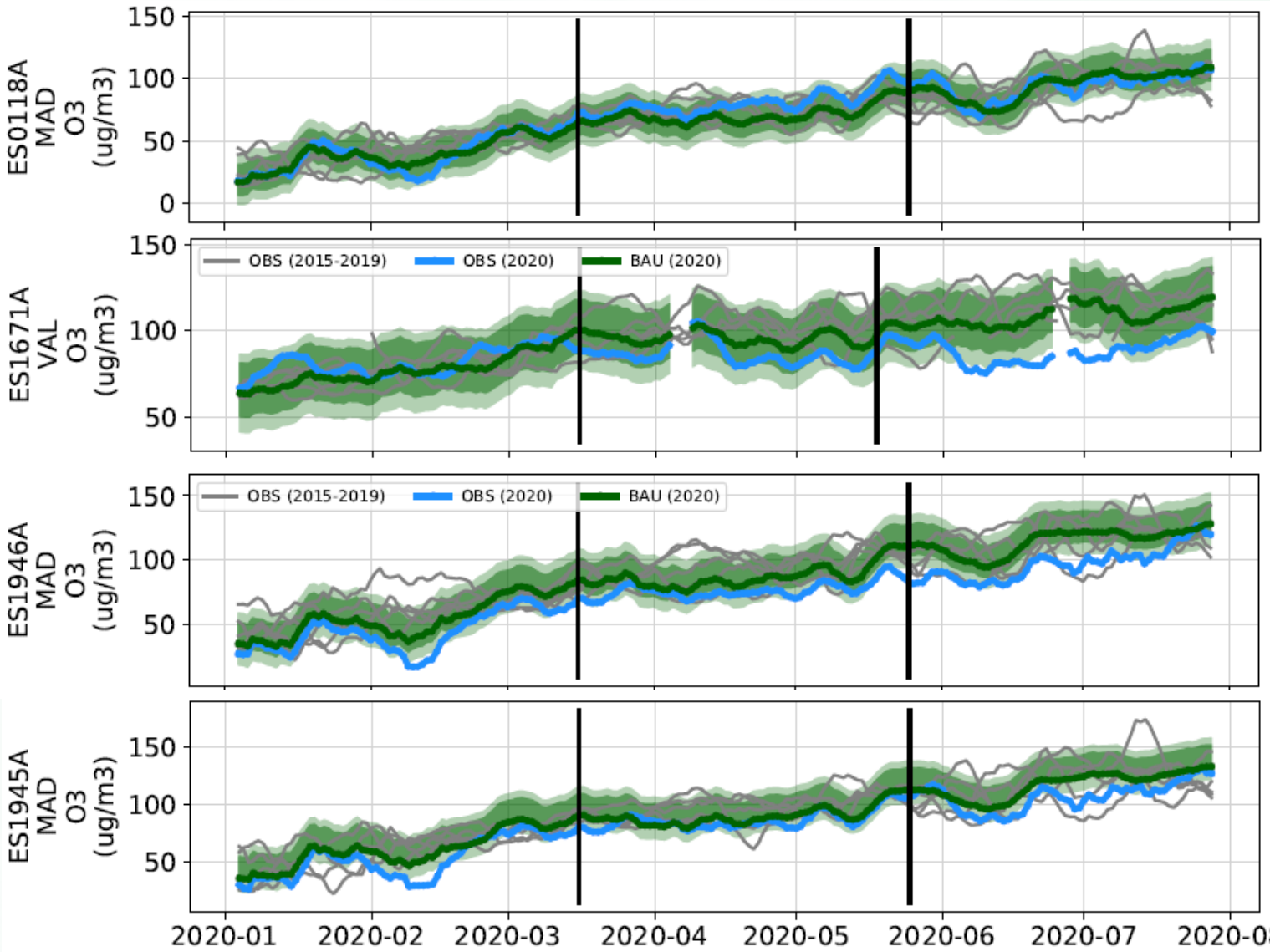
Querol X., et al., 2021. Sci Total Environ.

O_3 & COVID19 PANDEMIC



Querol X., et al., 2021. Sci Total Environ.

O_3 & COVID19 PANDEMIC



Traffic site Madrid E. Aguirre

Rural receptor Valencia Villar Arz.

Sub urban receptor Madrid-J.Carlos I

Sub urban receptor Madrid-El Pardo

Querol X., et al., 2021. Sci Total Environ.

O_3 & COVID19 PANDEMIC

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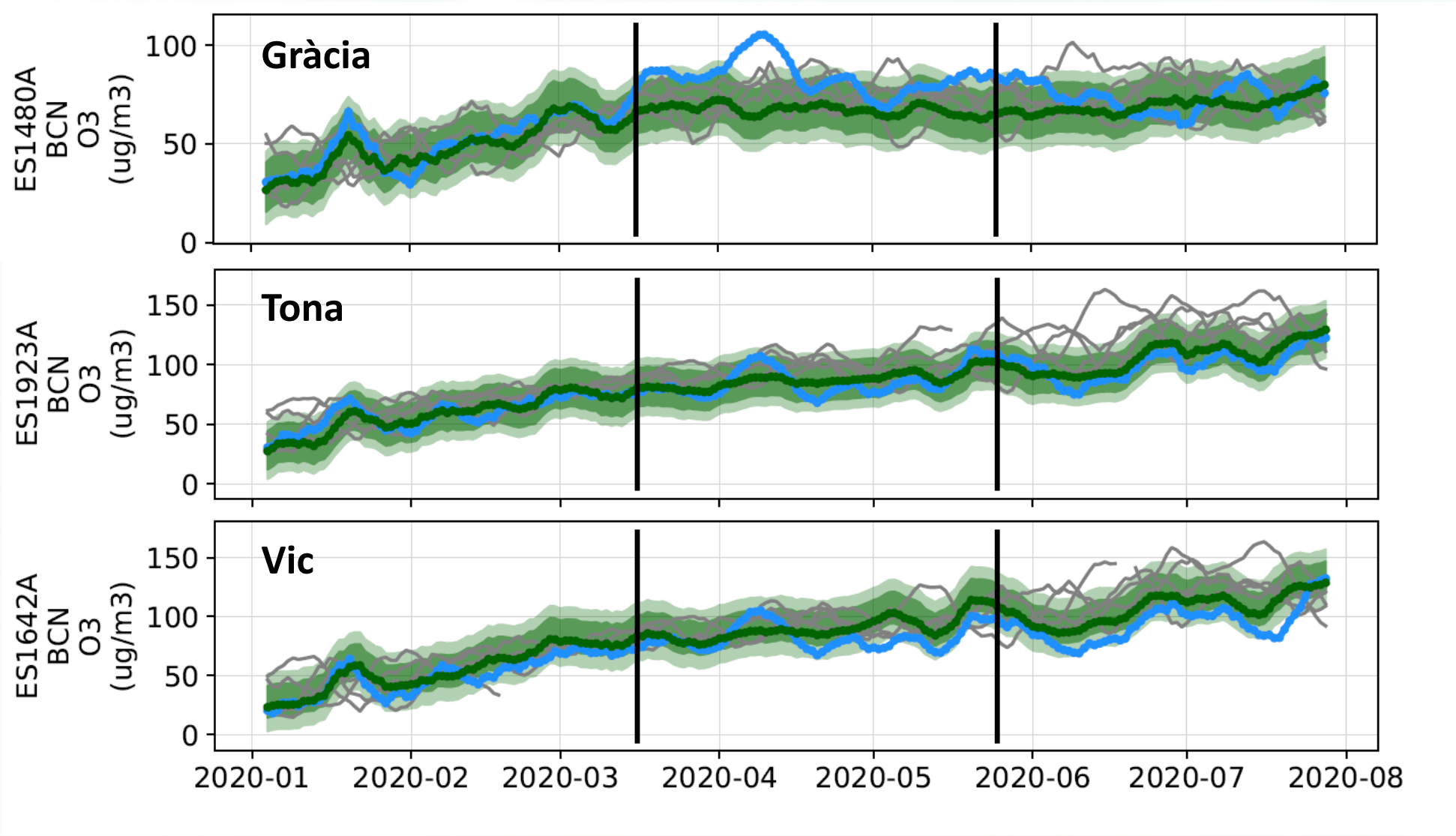
PRECURSORS ABATEMENT MEASURES IMPLEMENTED FROM MAY TO JULY MAY BE EFFECTIVE IN R3 ZONES



MAJOR LESSONS LEARNT

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1. Complex O_3 phenomenology known since 1990s (**Millán et al. 1997 and successive studies**)
2. Basins of Madrid, N-Barcelona, N-Tarragona, València-Castelló, Puertollano, Guadalquivir tend to record the highest O_3 for specific parameters and environments
3. Specific VOCs with high O_3 formation potential are identified in each basin. Emission abatement should focus on these
4. COVID19 lockdown reduced O_3 during June-July (high O_3 season) in 4% as an average for cities and 10% as an average for the receptor areas, with road traffic being reduced by 20-25%: May-July measures can have an effect
5. We need to use critical loads criteria: Many sources of precursors in a given region, all them meeting emission standard requirements, might still cause a problem due to the high emissions density and mor stringent emission limit values should be implemented in the O_3 season
6. These measures are very relevant in R3 zones, but also in R1 and R2 contributing to the O_3 background
7. Spring-Summer biomass burning (agricultural and forest fires) can also contribute importantly to rise O_3

MOLTES GRÀCIES !

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xavier.querol@idaea.csic.es

CSIC idaea EXCELENCIA SEVERO OCHOA

GOBIERNO DE ESPAÑA
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

Junta de Andalucía

¡MADRID!
ÁREA DE GOBIERNO DE MEDIO AMBIENTE Y MOVILIDAD

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

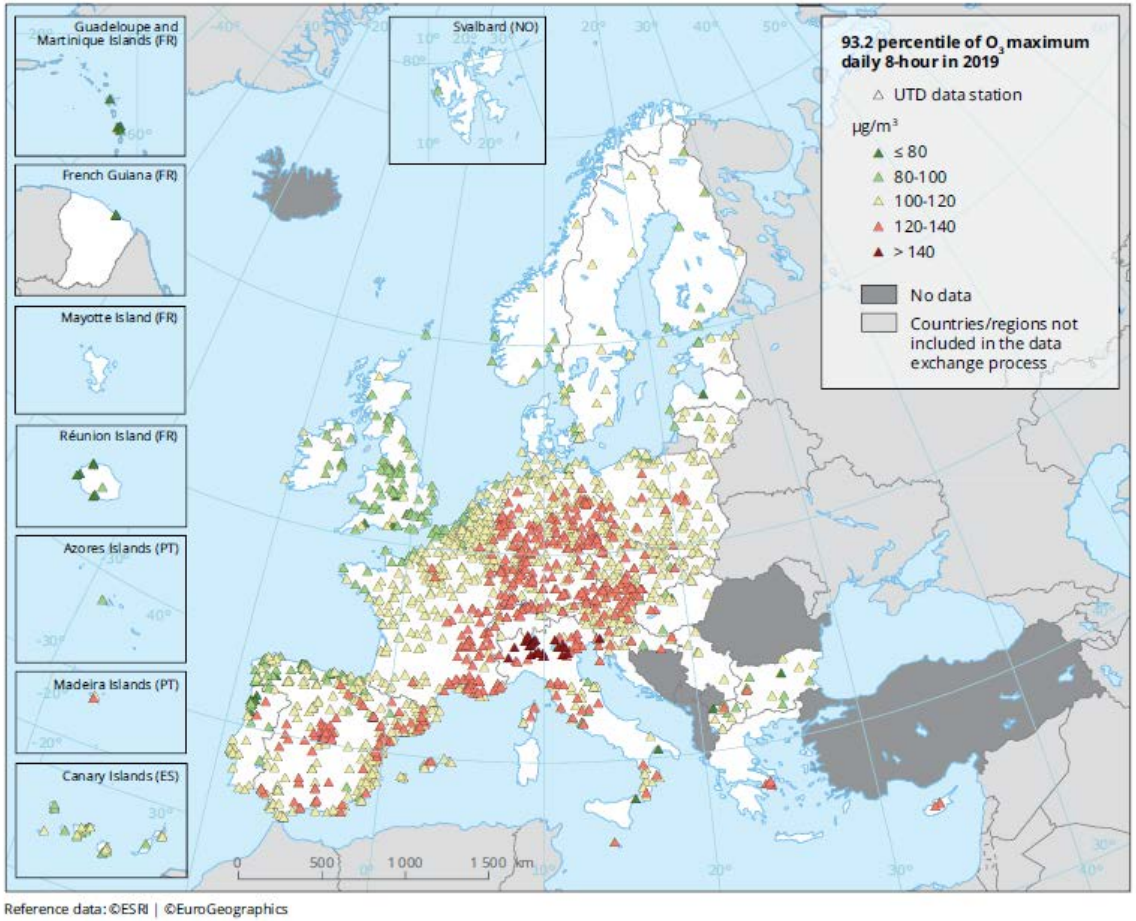
LEVELS OF O_3 IN SPAIN

O_3 triennial target value 2019

EEA Report | No 09/2020

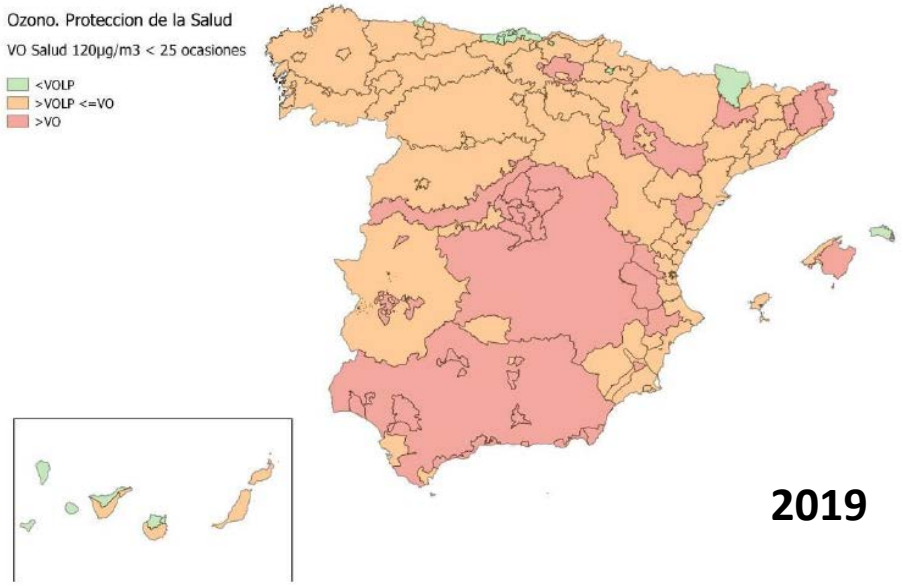
23/11/2020

European Environment Agency



Reference data: ©ESRI | ©EuroGeographics

MINISTERIO
PARA LA TRANSICIÓN ECOLÓGICA
Y EL RETO DEMOGRÁFICO



2019