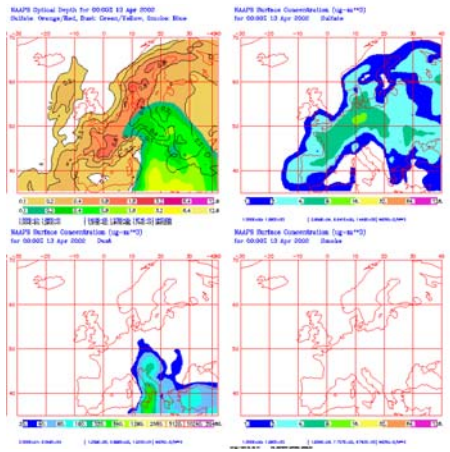
La qualitat de l'aire a les ciutats

Observatori Ambiental Litoral-Besòs

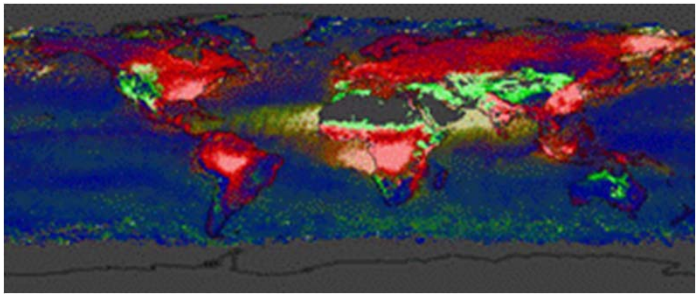
EBE Campus Diagonal-Besòs, Sant Adrià de Besòs, 11 octubre 2022

Xavier Querol
Institut de Diagnosi Ambiental i Estudis de l'Aigua, CSIC

Contaminació atmosfèrica



Planetaria-global: Escalfament global, canvi climàtic, capa d'ozó estratosfèric



Meso-escala: Acidificació, ozó troposfèric, la pols dels deserts (calima)

Micro-escala: Impacte local i regional del trànsit rodat, industria, residencial, agricultura, ...

Qualitat aire interior: Habitatges, escoles, oficines, in itinere, ….

Qualitat de l'aire

2008/50/CE i RD, 102/2011, 28 Gener, per la Quialitat de l'Aire I la Protecció de l'atmosfera:

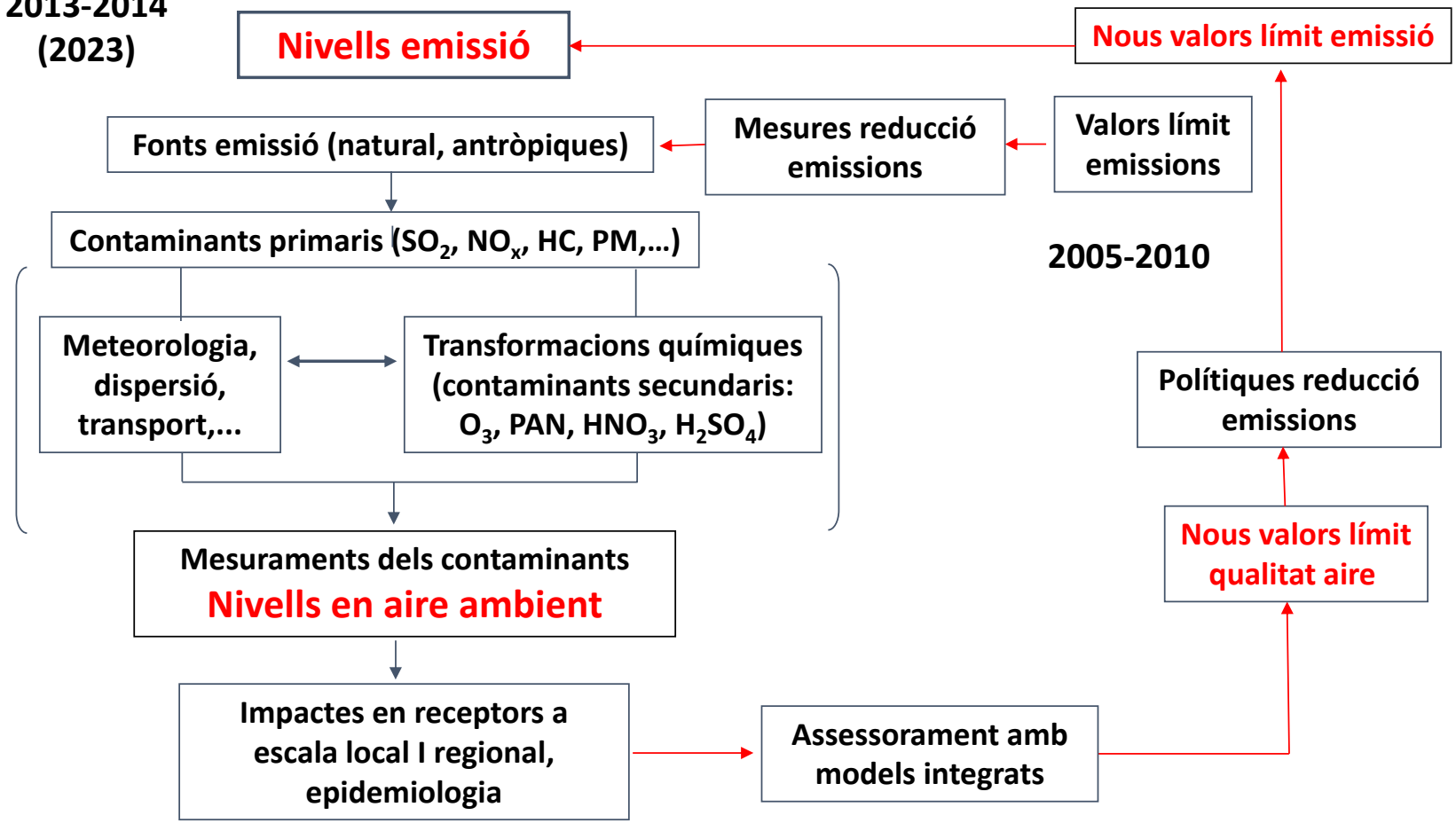
"Contaminació atmosfèrica": presencia a l'atmosfera de matèria, substàncies o energia que pot implicar risc o danys per a la seguretat o la salut de l'ésser humà, el medi ambient ... "

A tenir en compte que:

- **No coneixem tots els efectes ni substancies amb efectes**
- **Per molts contaminants no hi ha llindar de protecció**
- **Molts processos (antròpic i naturals) emeten contaminació**

Qualitat de l'aire

Estratègia Temàtica Europea



Qualitat de l'aire

Normativa Europea en matèria de qualitat de l'aire i emissions

Emissions

DIRECTIVES
1996/61/EC, 2008/1/EC, 2010/75/EC
2002/51/EC, 2006/120/EC
1998/69/EC, 2002/80/EC, 2007/715/EC
2001/80/CE
2016/2284/EU
2015/2193/EU

- **IPPC Prevenció I Control de la Contaminació, IED Directiva Emissions Industrials**
- **Valors límit emissió vehicles: EURO**
- **Grans Instal·lacions de Combustió**
- **Directiva de Sostres Nacionals Emissions**
- **Directiva Instal·lacions Mitjanes de Combustió**

Aire ambient

Revisió de la directiva de qualitat de l'aire retardada fins 2023, a pesar de que OMS (REVIHAAP+HRAPIE PROJECTS, 2005, 2013) recomanà canviar valors límit PM2.5 i convertir valors objectiu a límit

MOTHER DIRECTIVE
1996/62/CE

Directiva 1999/30/EC	*** SO_2, NO_2, NOx, PM_{10}, Pb ($PM_{2.5}$??)**
Directiva 2000/69/EC	*** C_6H_6, CO**
Directiva 2002/03/EC	*** O_3**
Directiva 2004/107/EC	*** PAH, Cd, As, Ni, Hg**

(PM2.5) → Directive Clean Air for Europe and Air Quality, 2008/50/EC & 2004/107/EC
Deadlines: 2005-2010, 2015, 2023

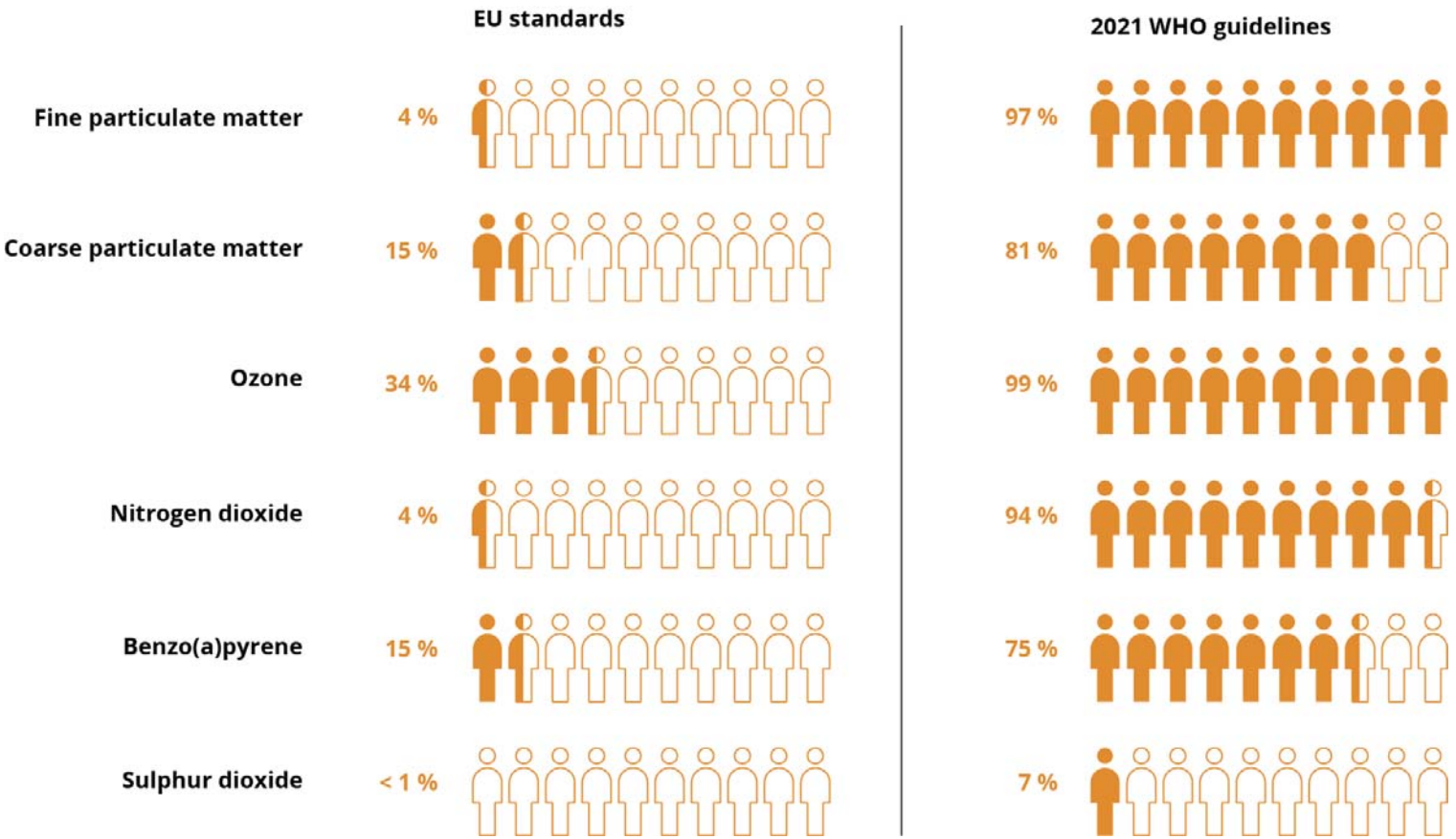
RD, 102/2011 (RD 39/2017) (España)

Qualitat de l'aire

GUIDELINES WHO (2005 & 2021)

	2008/50/EC & 2004/107/EC RD 102/2011	WHO (2005) guidelines	WHO (2021)	
Hourly	350* µg/m³ SO_2	500 µg/m³ SO_2		*24 hours/year
Daily	125* µg/m³ SO_2	20 µg/m³ SO_2	40 µg/m³	*3 days/year
Hourly	200 µg/m³ NO_2	EC-WHO coincide		18 hours/year
Annual	40 µg/m³ NO_2	EC-WHO coincide	10 µg/m³	not exceeding
Annual	5 µg/m³ C_6H_6	EC-WHO coincide		not exceeding
Mean 8-h max. in a day	10 mg/m³ CO	EC-WHO coincide		not exceeding
Annual	500 ng/m³ Pb	EC-WHO coincide		not exceeding
Annual	40 µg/m³ PM10	20 µg/m³ PM10	15 µg/m³	not exceeding
Annual	25 µg/m³ PM2.5	10 µg/m³ PM2.5	5 µg/m³	not exceeding
Daily	50* µg/m³ PM10	50** µg/m³ PM10	45 µg/m³	3** or 35* days/year
Daily			PM2.5 15 µg/m³	3 days/year
Max 8 h means of a day mean for 3 years	120 µg/m³ O_3	100 µg/m³ O_3	100 µg/m³	25 days/year
Annual	1 ng/m³ BaP	0.12 ng/m³ BaP		not exceeding

Qualitat de l'aire



https://www.eea.europa.eu/publications/air-quality-in-europe-2021/air-quality-status-briefing-2021

European Environment Agency

Qualitat de l'aire

Table 1. Theoretical health benefits, in terms of reductions in premature deaths, that would have been attained for the EU-27 in 2019 if the different EU limit values and WHO guidelines for $PM_{2.5}$ had been met across Europe

EU-27	Premature deaths due to $PM_{2.5}$	Reduction in premature deaths on 2019 levels	% reduction in premature deaths on 2019 levels	% reduction in premature deaths on 2005 levels
2019 concentrations	306,700	-	-	33%
EU limit value 25 µg/m^3	306,500	200	0%	33%
EU indicative limit value 20 µg/m^3	303,500	3,200	1%	33%
2021 WHO interim target 3 15 µg/m^3	289,200	17,500	6%	37%
2021 WHO interim target 4 (2005 WHO air quality guideline) 10 µg/m^3	241,400	65,300	21%	47%
2021 WHO air quality guideline 5 µg/m^3	129,400	177,300	58%	72%

Note: The WHO interim targets and guidelines are drawn from the updated guidelines published in 2021.

Health impacts of air pollution in Europe in 2019

Estimations of the mortality in 2019 linked to exposure to the air pollutants deemed most harmful for human health are presented in this final section.

In 2019 in the EU-27:

- 307,000 premature deaths were attributed to exposure to $PM_{2.5}$
- 40,400 premature deaths were attributed to exposure to nitrogen dioxide (NO_2)
- 16,800 premature deaths were attributed to exposure to ozone (O_3)

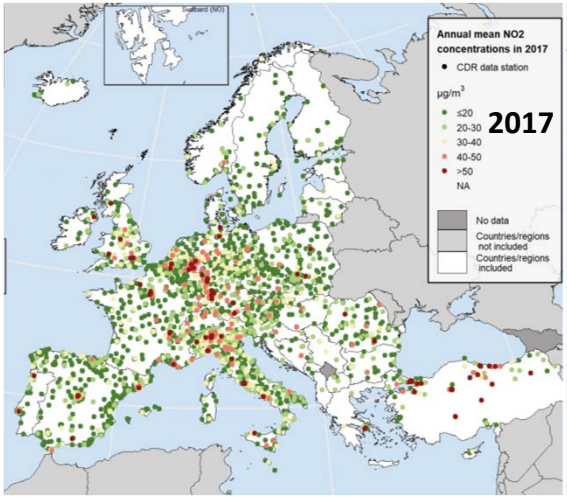
In 2019 in the 41 European countries considered:

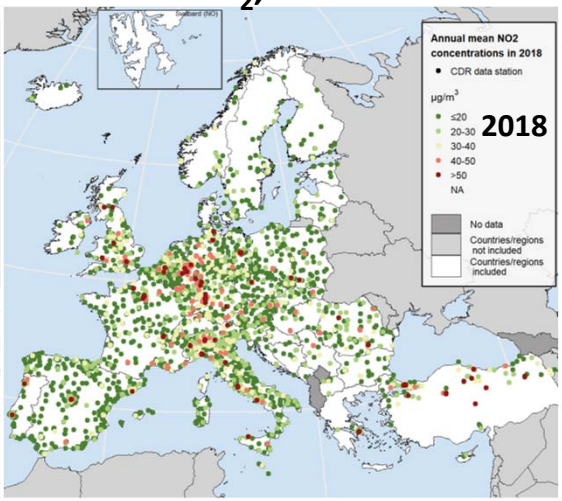
- 373,000 premature deaths were attributed to exposure to $PM_{2.5}$
- 47,700 premature deaths were attributed to exposure to NO_2
- 19,070 premature deaths were attributed to exposure to O_3

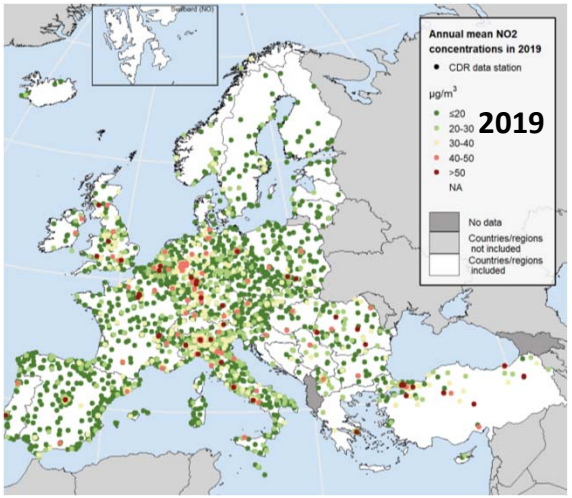
https://www.eea.europa.eu/publications/air-quality-in-europe-2021/air-quality-status-briefing-2021

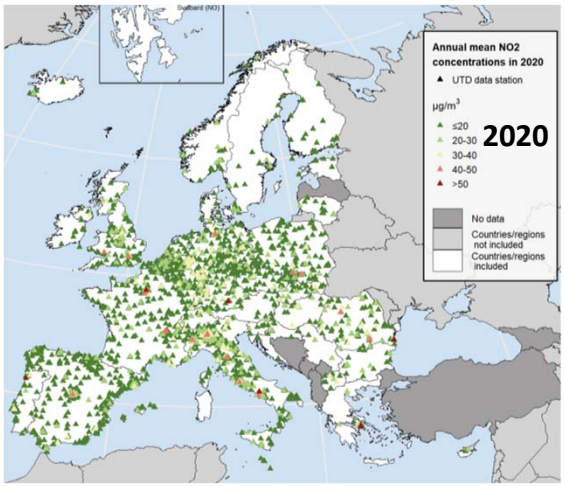
Contaminants crítics: NO_2

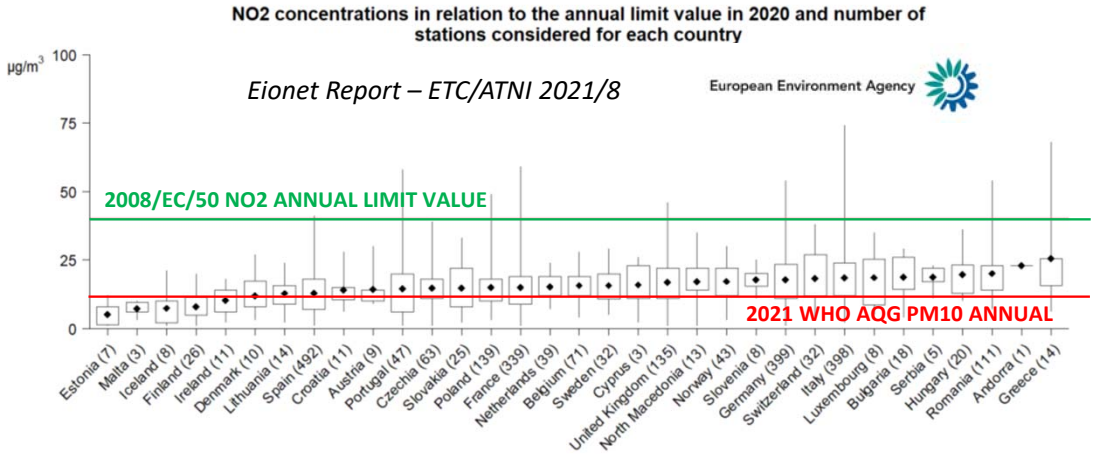
NO_2, anual











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European Commission

HORIZON 2020

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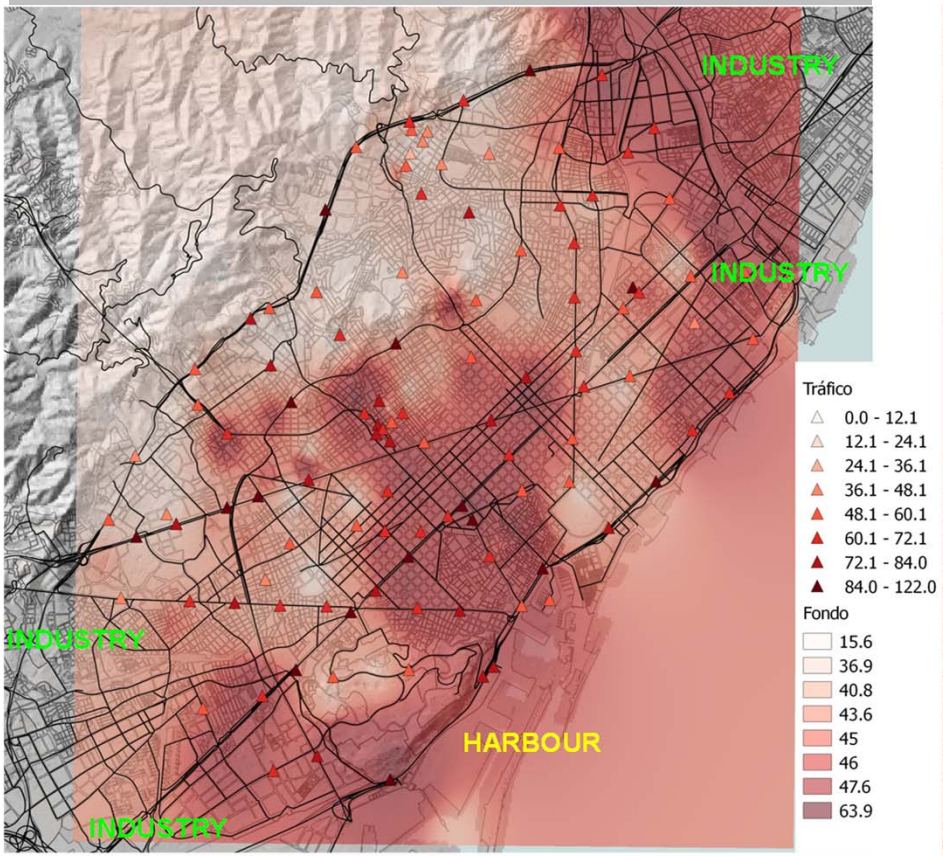
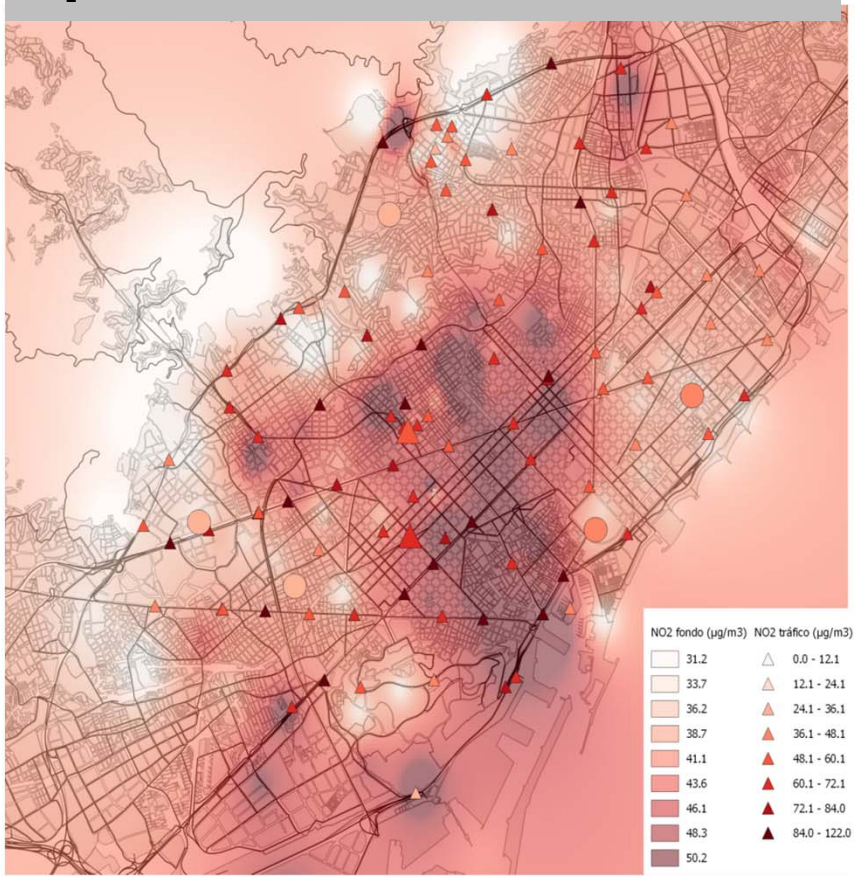
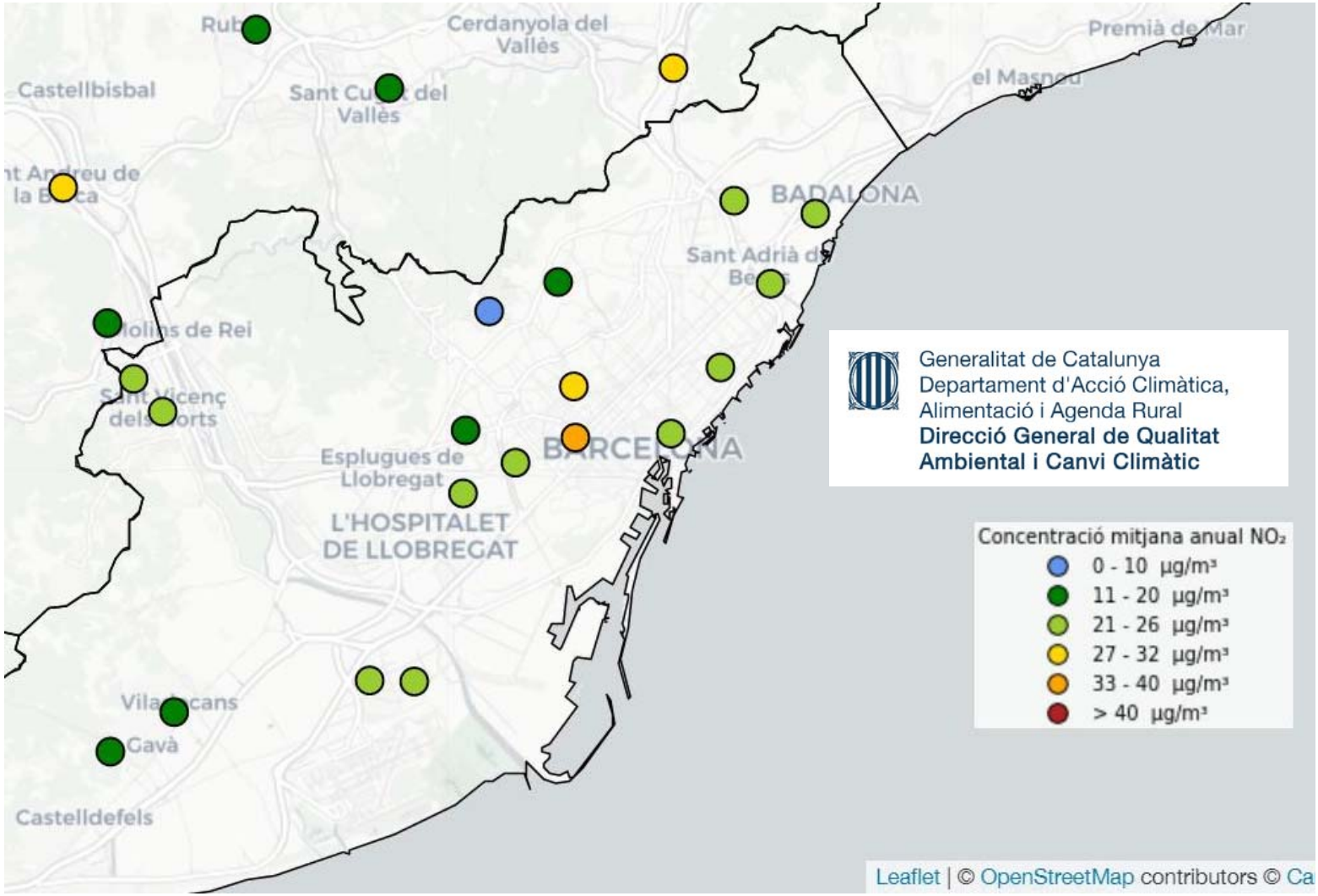
Contaminants crítics: NO_2

NO_2 FEBRUARY-MARCH 2017, 225 PASSIVE DOSIMETERS



NO_2 JUNE 2018, 233 PASSIVE DOSIMETERS




Cerdanyola del Vallès
Premià de Mar
el Masnou
Castellbisbal
Sant Cugat del Vallès
BADALONA
Sant Adrià de Besòs
Esplugues de Llobregat
BARCELONA
L'HOSPITALET DE LLOBREGAT
Vilafranca
Gavà
Castelldefels
Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural
Direcció General de Qualitat Ambiental i Canvi Climàtic
Concentració mitjana anual NO₂
0 - 10 µg/m³
11 - 20 µg/m³
21 - 26 µg/m³
27 - 32 µg/m³
33 - 40 µg/m³
> 40 µg/m³
Leaflet | © OpenStreetMap contributors © Ca

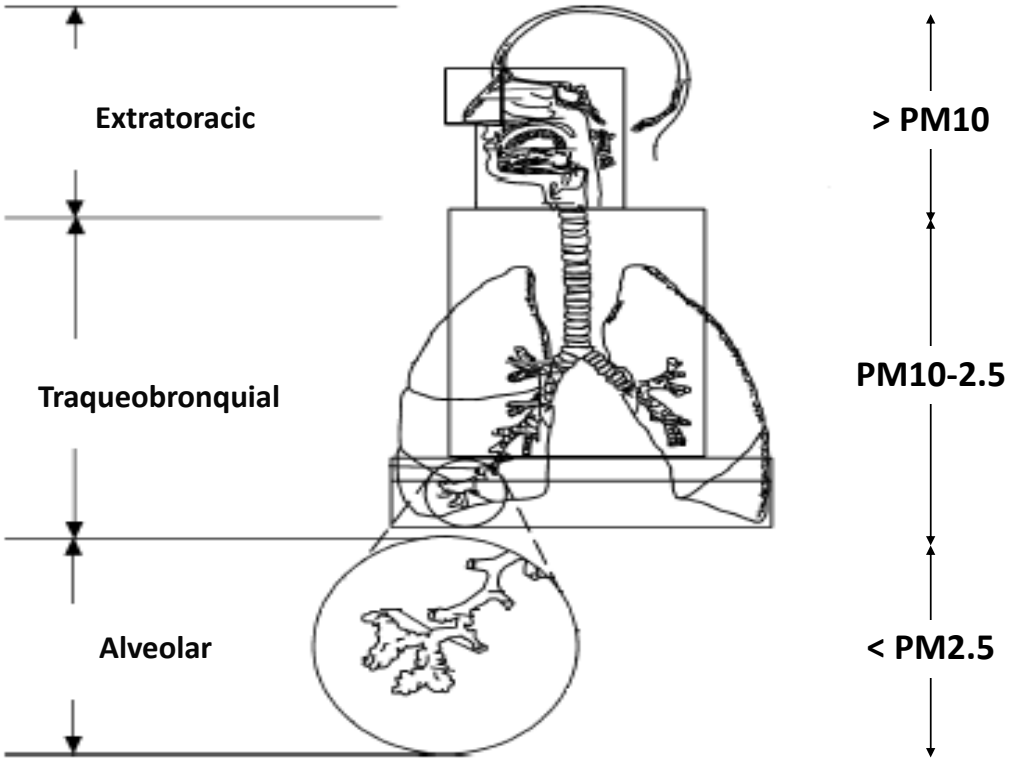
Contaminants crítics: Partícules en suspensió

El material particulat atmosfèric (PM): Material heterogeni sòlit i/o líquid present en suspensió l'atmos

- **Impacte en salut**
- **Ecosistemes**
- **Clima**
- **Materials de construcció**
- **Visibilitat**

Contaminants crítics: Partícules en suspensió

PM EFFECTS



PM10-2.5
Allergens,
inflammation, oxidative stress
Happo et al., 2008
Javala et al., 2008
Pérez et al., 2009

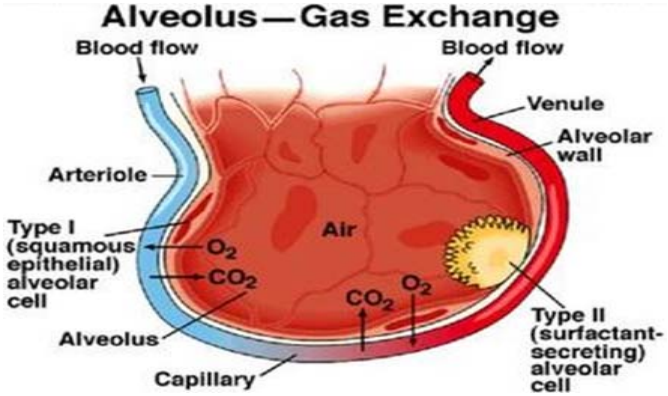
PM2.5-0.1
Additional lung physical effect

PM0.1
Cardiovascular, UFPM
Reaching all important organs

Contaminants crítics: Partícules en suspensió

Micro-particles <2.5µm

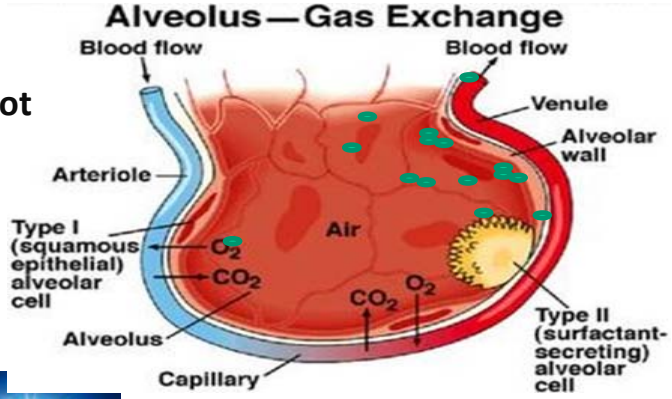
Clearance within 6-14 hr



Modified after https://birdrespiratory.weebly.com/gas-exchange.html

Ultrafine-particles <0.1µm

Stadium size= pollen
Football ball = diesel soot

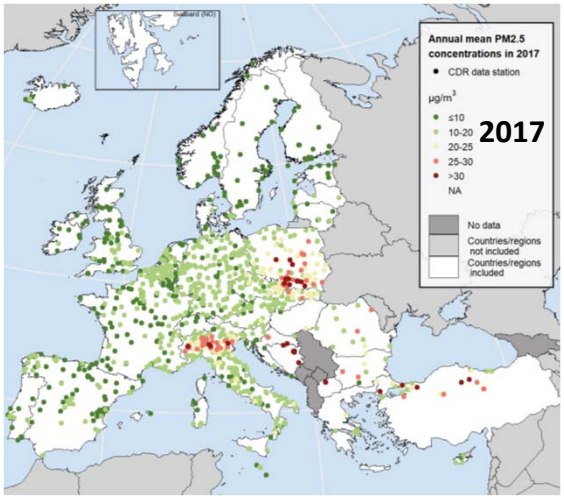


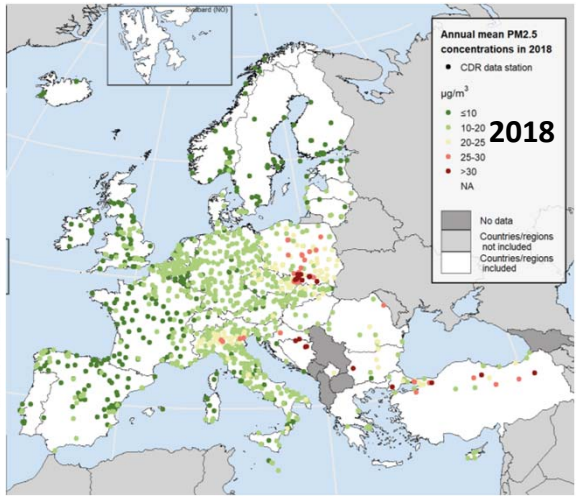
UFP uptake by epithelial cells +
interstitial translocation +
lack of macrophage recognition

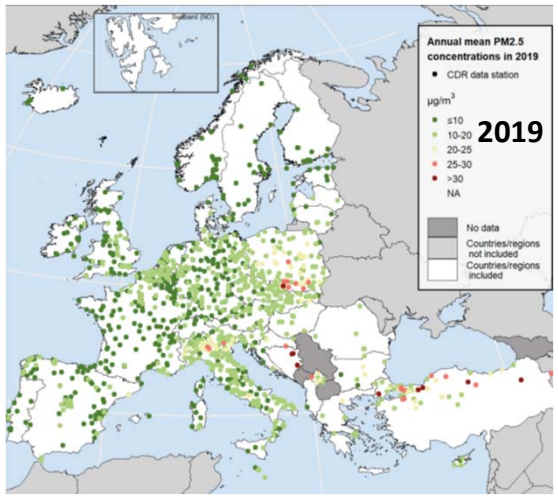
F.R. Cassee | AAAR 2019

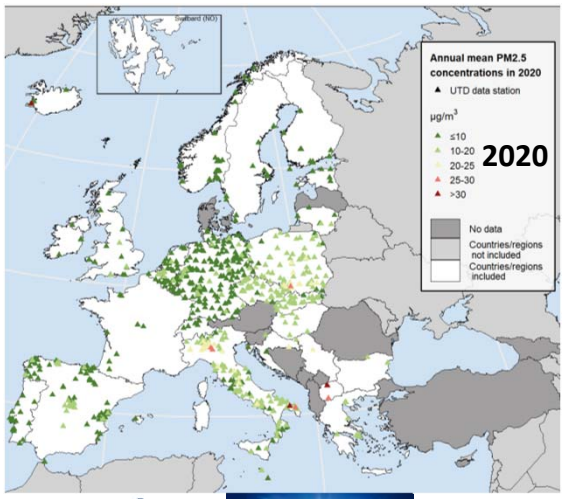
Contaminants crítics: Partícules en suspensió

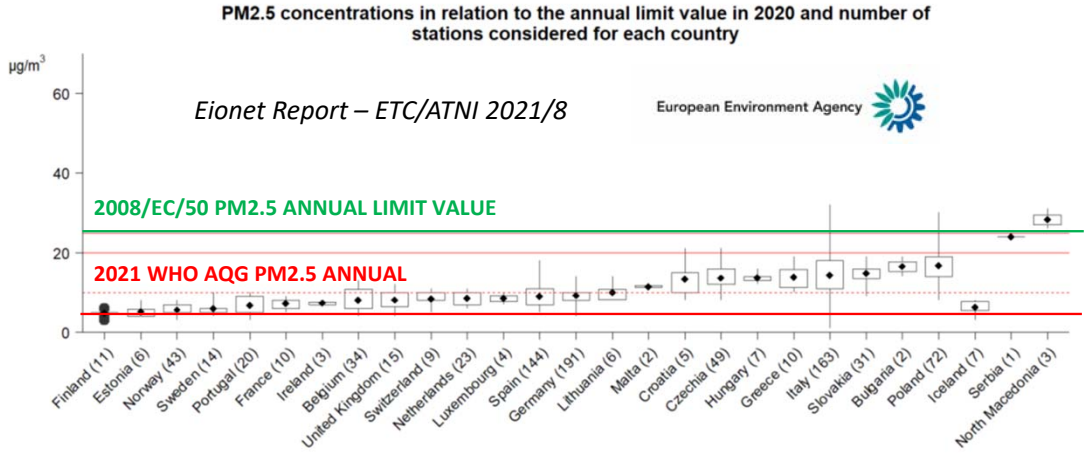
PM2.5, anual











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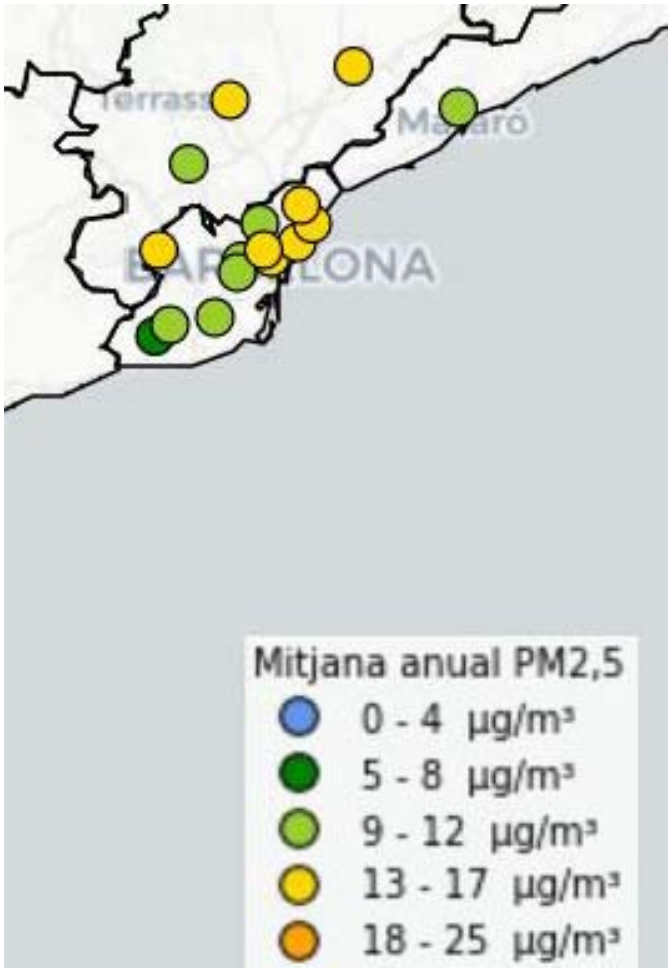
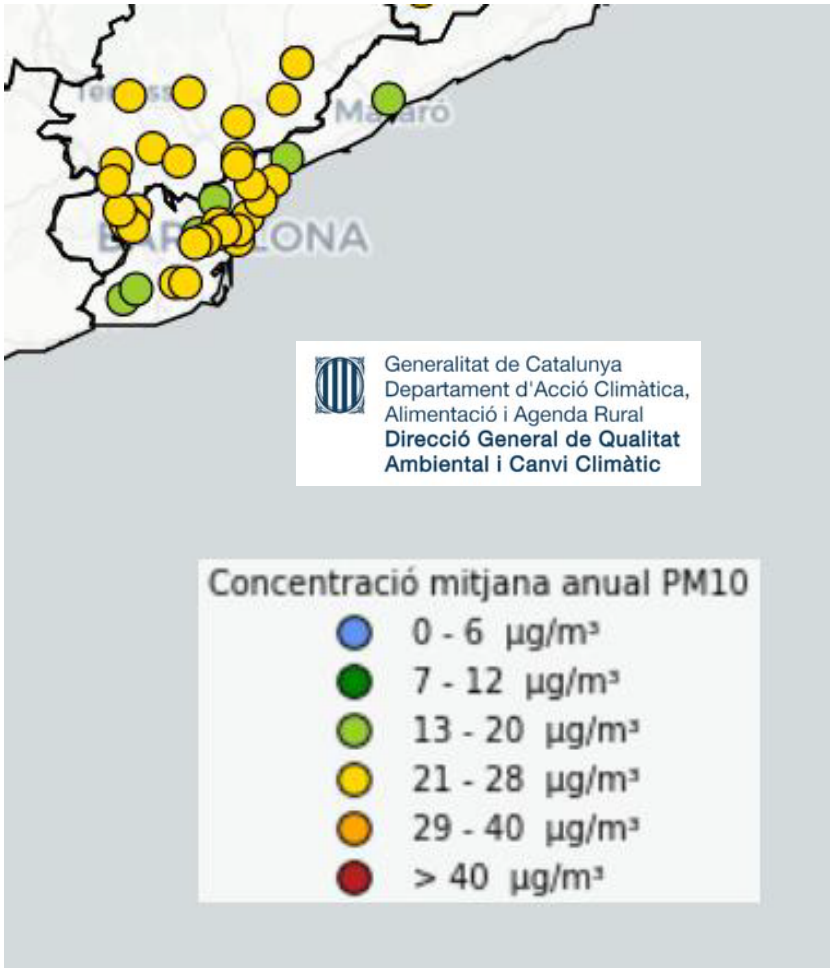
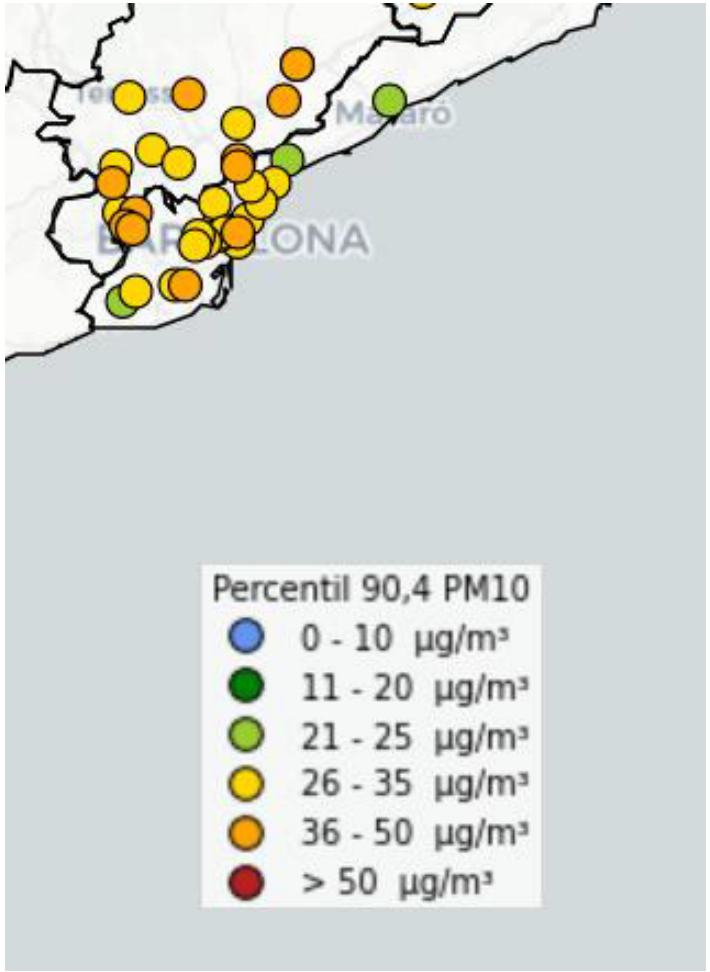
HORIZON 2020

Observatori Ambiental Litoral-Besòs, X. Querol, 11 octubre 2022

RI URBANS


Mitjana anual PM2,5
0 - 4 µg/m³
5 - 8 µg/m³
9 - 12 µg/m³
13 - 17 µg/m³
18 - 25 µg/m³


Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural
Direcció General de Qualitat Ambiental i Canvi Climàtic
Concentració mitjana anual PM10
0 - 6 µg/m³
7 - 12 µg/m³
13 - 20 µg/m³
21 - 28 µg/m³
29 - 40 µg/m³
> 40 µg/m³


Percentil 90,4 PM10
0 - 10 µg/m³
11 - 20 µg/m³
21 - 25 µg/m³
26 - 35 µg/m³
36 - 50 µg/m³
> 50 µg/m³

Contaminants crítics: Partícules en suspensió

PM10 (annual mean)	PM10 (days of exceedance)
1. Road Traffic is the main source contributing to PM10: 31-38% (ATH 23%)	36-45% (ATH 15%)
1.1. Vehicle exhaust + traffic related NO_3^- are the main causes: 21-29% (ATH 15%)	30-34% (ATH 6%)
1.2. Non-exhaust vehicle emissions are also relevant: 8-11%	18-29% (ATH 3%, POR 6%)
2. Regional OC and/or SO_4^{2-} dominated pollution: 20-26% (POR-TR 10%)	BCN 19%, 2-6%
3. Local dust : 10-19%	POR 27%, 1-4%
4. Biomass burning very relevant in POR & FI (14-16%), less in ATH (7%) and negligible in BCN	POR & FI (25-30%), ATH 1%, negligible in BCN
5. Industry BCN 11%, 4-5%, ATH <1%	BCN 17%, <1-3%
6. Non traffic-NO_3^- 6-8% (2% POR)	BCN & FI 7-9% (1-2% POR & ATH)
7. Shipping 4% in coastal sites	3-4% in coastal sites
8. African dust ATH 14%, 1-4%	ATH 52%, 1%
9. Sea salt POR 13%, 4-8%	ATH 7%, 1-3%
10. Anthropogenic dust (Local dust + Non exhaust) reaches 19-25%	11-33%, ATH 4%

PM2.5 (annual mean)	PM2.5 (days of PM10 exceedance)
1. Road Traffic is the main source contributing to PM2.5: 28-39% (ATH 22%)	32-42% (ATH 11%)
1.1. Vehicle exhaust + traffic related NO_3^- are the main causes: 25-34% (ATH 17%)	31-40% (ATH 10%)
1.2. Non-exhaust vehicle emissions are also relevant: 5-9% (BCN&FI 1-2%)	1-7%
2. Regional OC and/or SO_4^{2-} dominated pollution: 19-37% (POR 13%)	BCN & MLN 11-22%, 2-6%
3. Local dust: POR 16%, 2-6%	POR 22%, 1-2%
4. Biomass burning very relevant in MLN, FI & POR (18-21%), less in ATH (10%) and negligible in BCN	POR, FI & MLN (26-33%), <2%
5. Industry 5-12%, ATH <1%	BCN 18%, <1-3%
6. Non traffic-NO_3^- 3-6% (POR 1%)	BCN, FI & MLN 6-9% (1-3% POR & ATH)
7. Shipping 5-7% in coastal sites	6-10% in coastal sites
8. African dust: ATH 6%, <1%	ATH 45%, 1%
9. Sea salt POR 5%, <1-3%,	<1%-1%
10. Anthropogenic dust (Local dust + Non exhaust) reaches 10-21%, BCN 7%, FI 4%	POR 15, 3-9%

European Commission

HORIZON 2020

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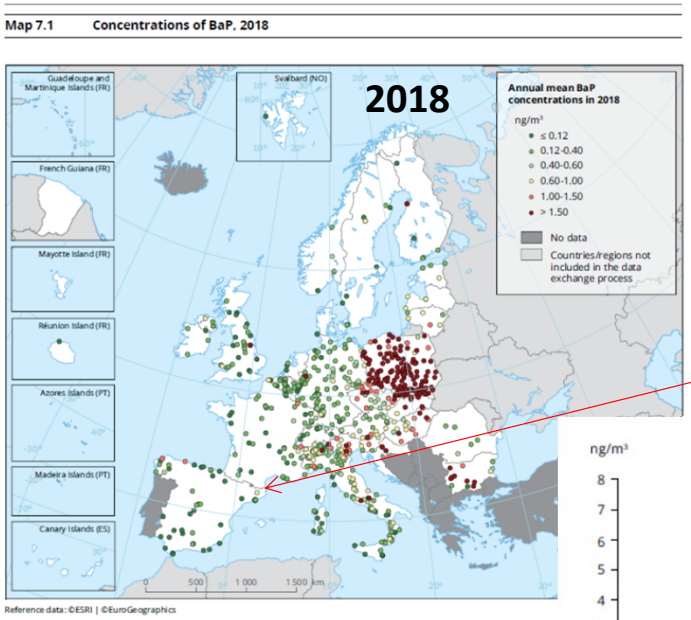
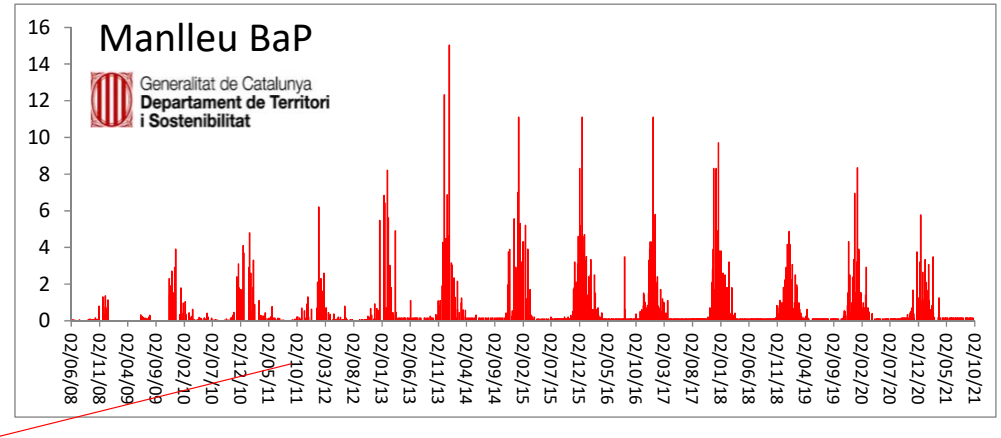
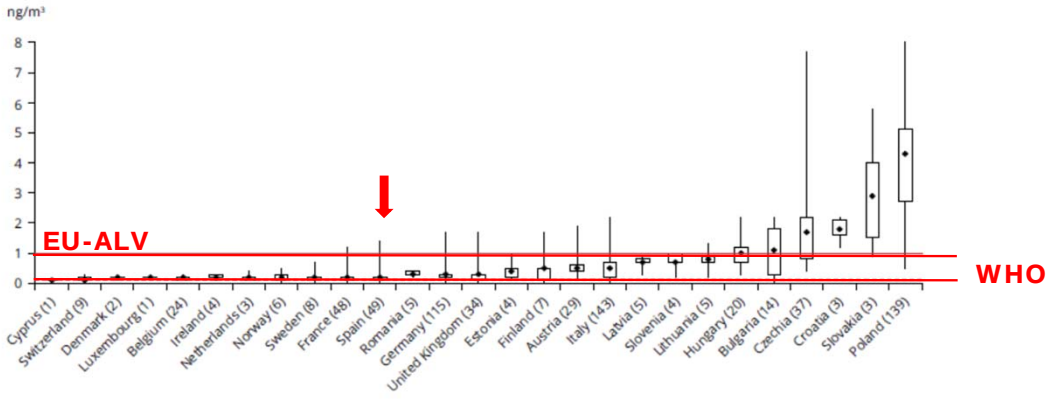
Contaminants crítics: Benzo[a]pirè

BaP, annual target value







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23/11/2020

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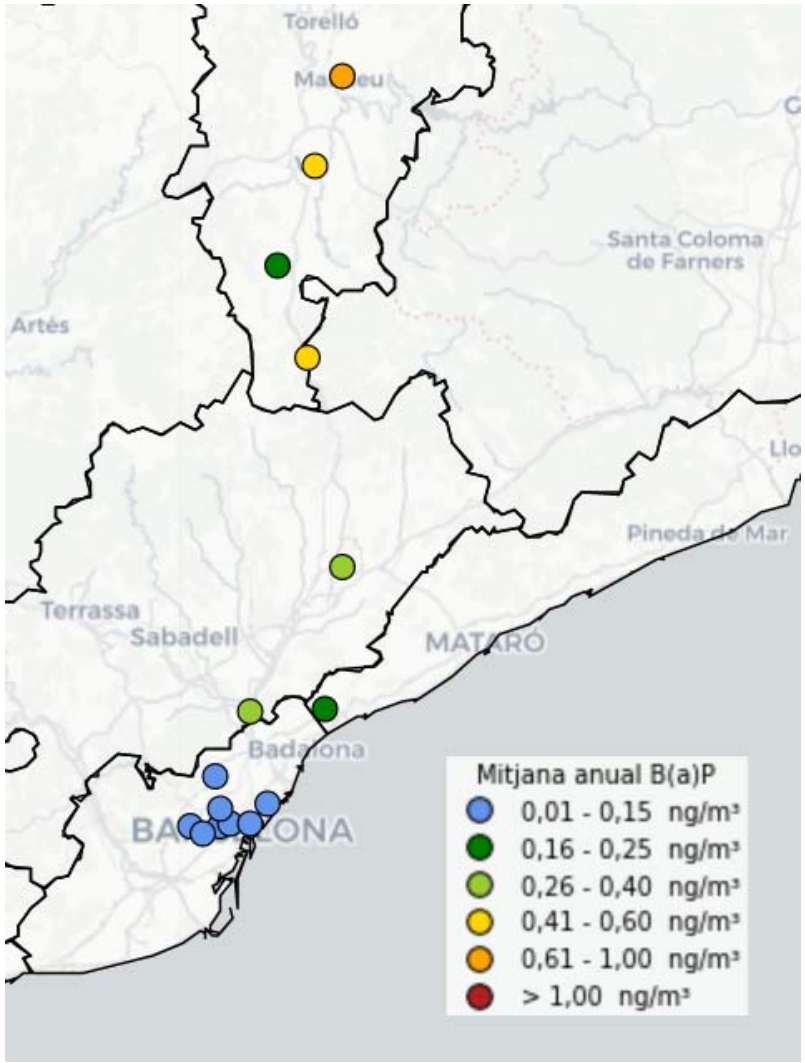
Generalitat de Catalunya
Departament d'Acció Climàtica,
Alimentació i Agenda Rural
Direcció General de Qualitat Ambiental i Canvi Climàtic



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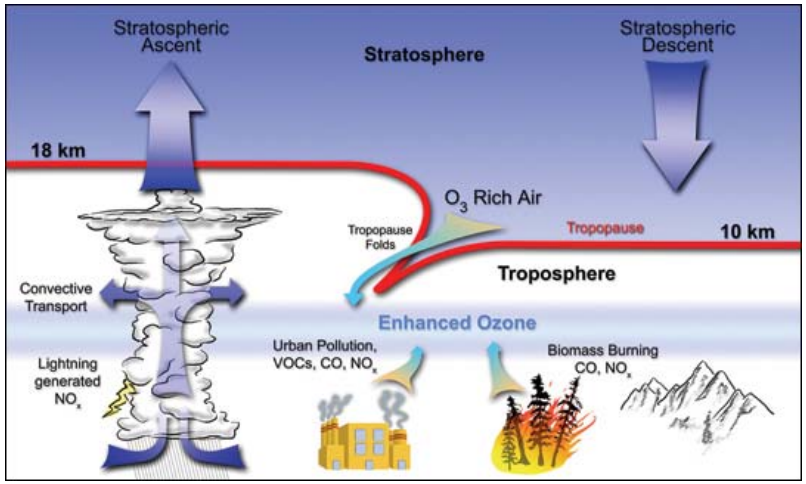
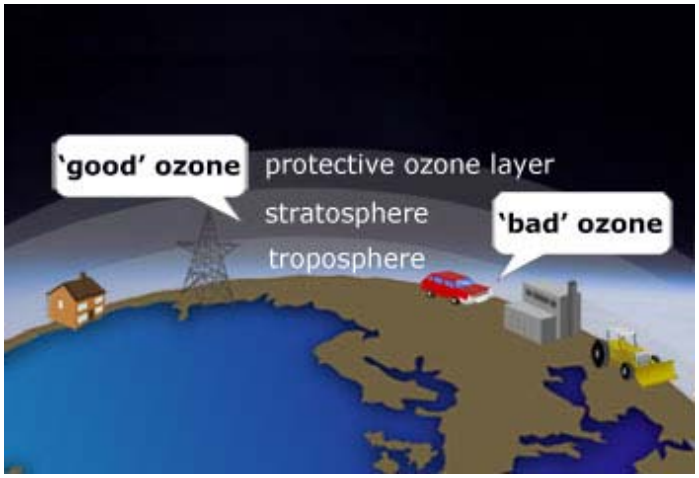
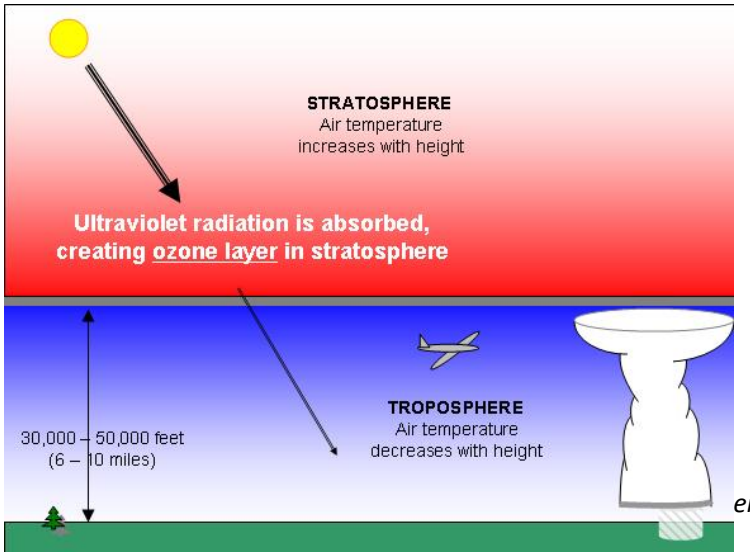
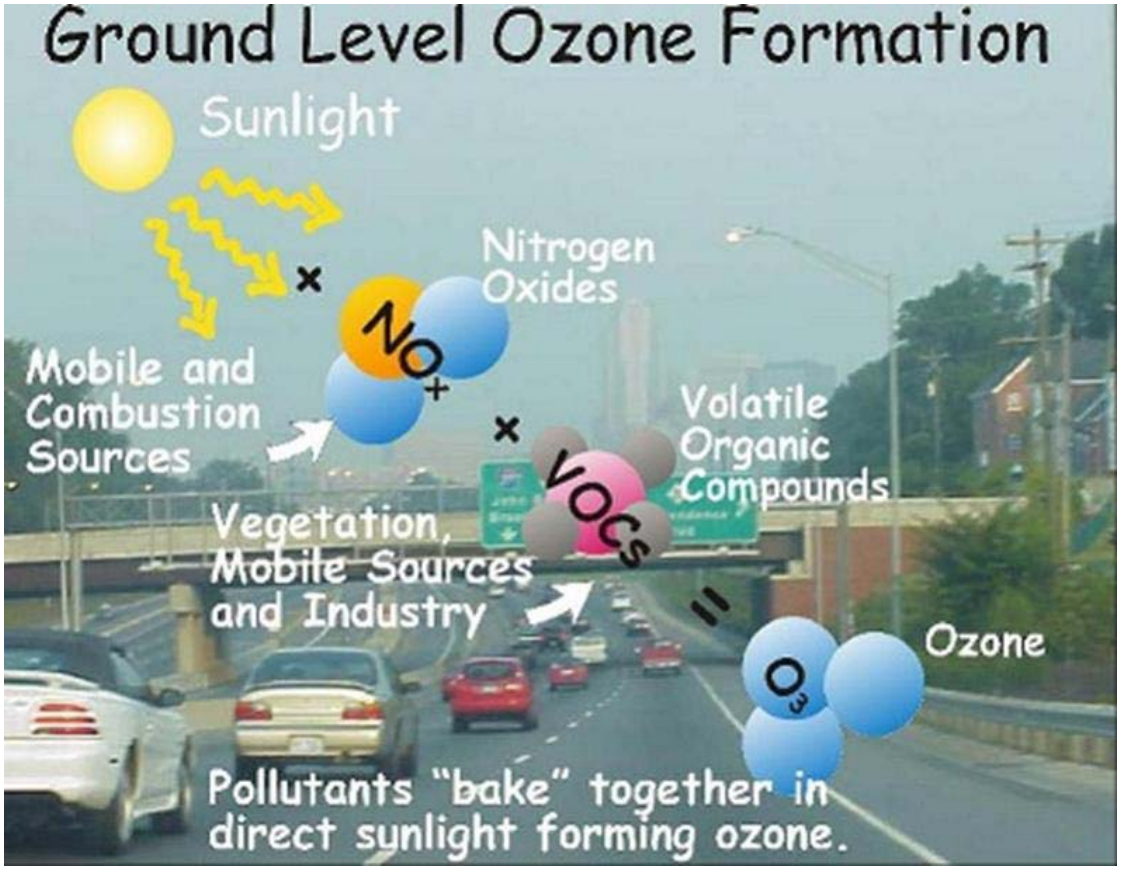
Contaminants crítics: Ozó troposfèric





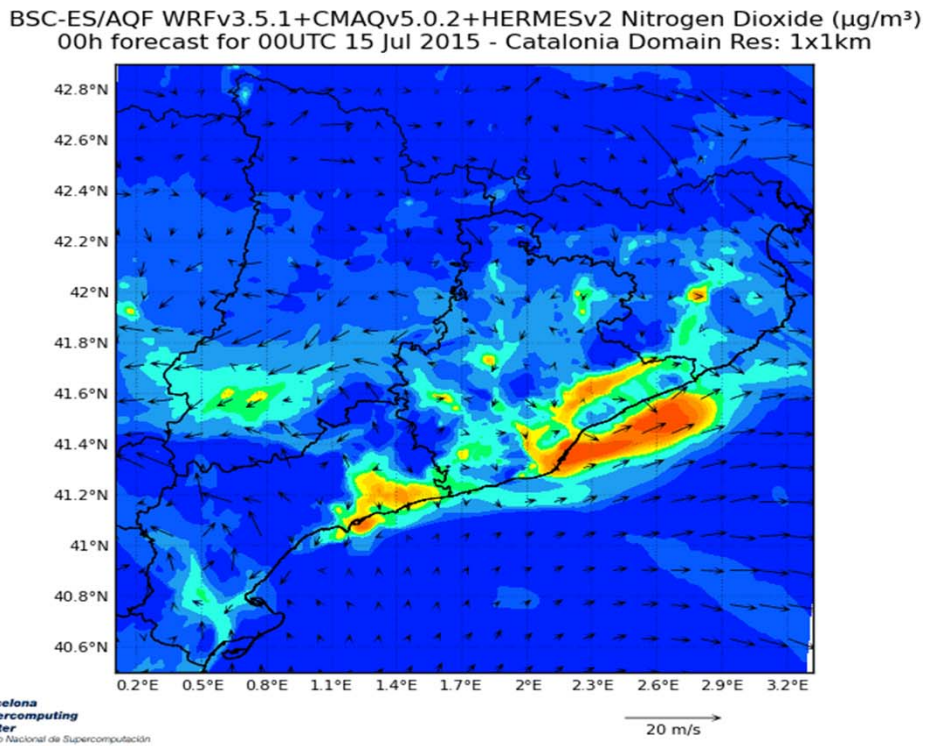


Contaminants crítics: Ozó troposfèric

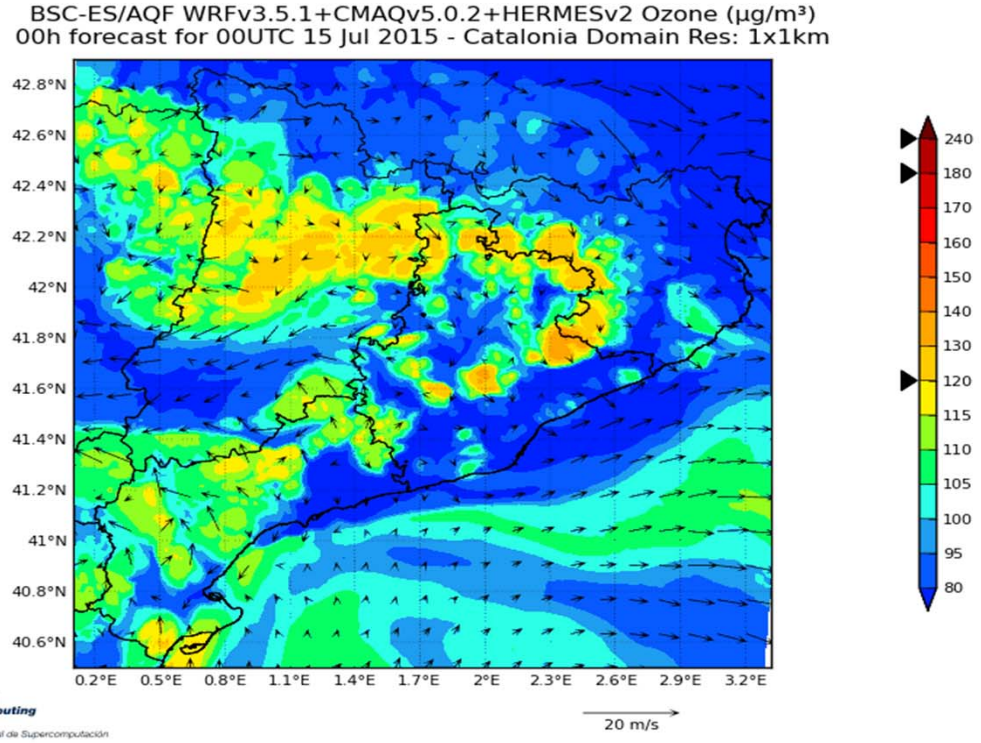


http://www.geo.sunysb.edu/ess-workshops/lesson-plans.html

NO_2

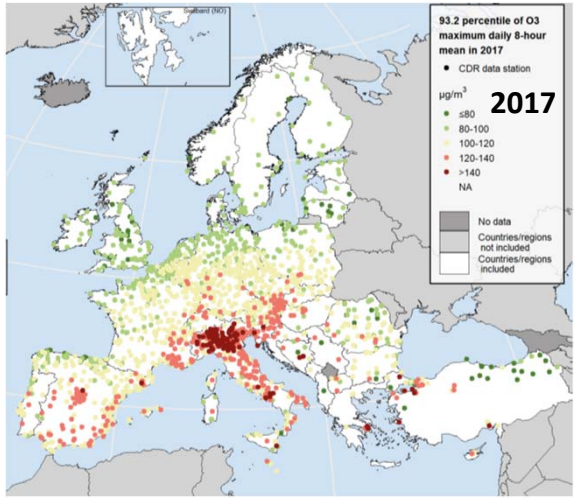

BSC-ES/AQF WRFv3.5.1+CMAQv5.0.2+HERMESv2 Nitrogen Dioxide (µg/m³)
00h forecast for 00UTC 15 Jul 2015 - Catalonia Domain Res: 1x1km
42.8°N
42.6°N
42.4°N
42.2°N
42°N
41.8°N
41.6°N
41.4°N
41.2°N
41°N
40.8°N
40.6°N
0.2°E
0.5°E
0.8°E
1.1°E
1.4°E
1.7°E
2°E
2.3°E
2.6°E
2.9°E
3.2°E
20 m/s

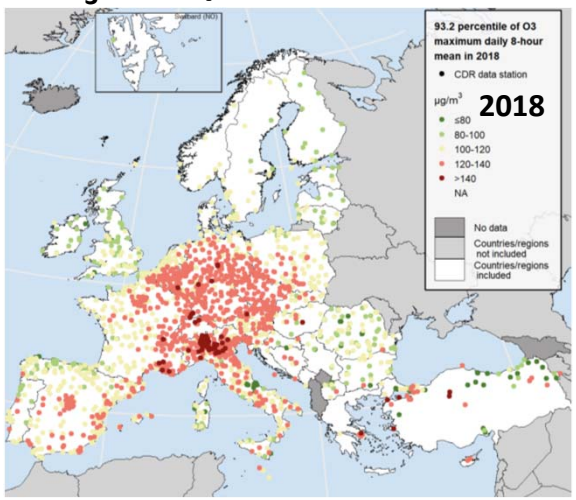
O_3

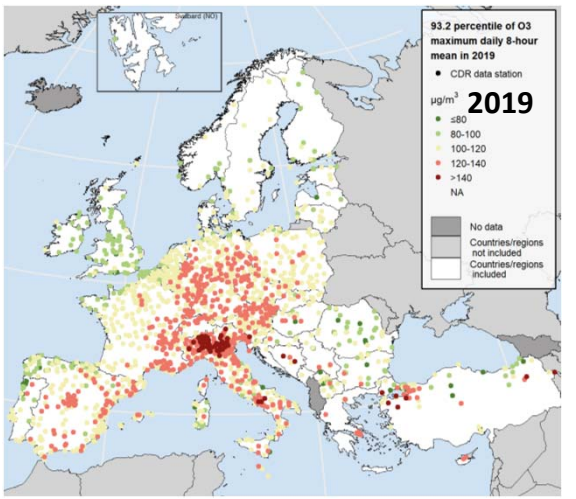

BSC-ES/AQF WRFv3.5.1+CMAQv5.0.2+HERMESv2 Ozone (µg/m³)
00h forecast for 00UTC 15 Jul 2015 - Catalonia Domain Res: 1x1km
42.8°N
42.6°N
42.4°N
42.2°N
42°N
41.8°N
41.6°N
41.4°N
41.2°N
41°N
40.8°N
40.6°N
0.2°E
0.5°E
0.8°E
1.1°E
1.4°E
1.7°E
2°E
2.3°E
2.6°E
2.9°E
3.2°E
20 m/s
240
180
170
160
150
140
130
120
115
110
105
100
95
80

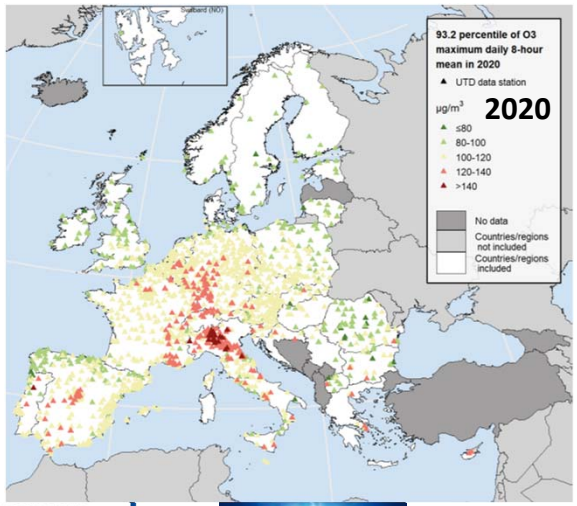
Contaminants crítics: Ozó troposfèric

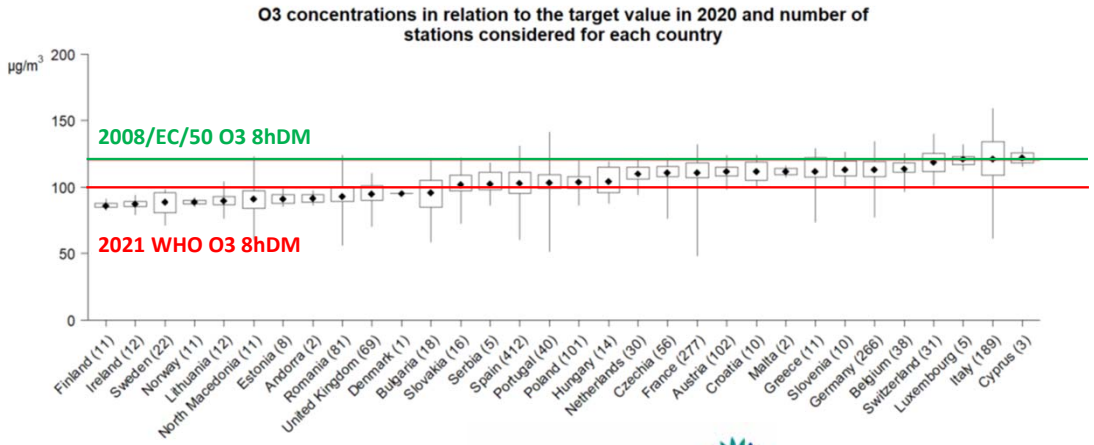
O_3, 92.3 percentile 8hDM











Eionet Report – ETC/ATNI 2021/8

European Environment Agency

Observatori Ambiental Litoral-Besòs, X. Querol, 11 octubre 2022

European Commission

HORIZON 2020

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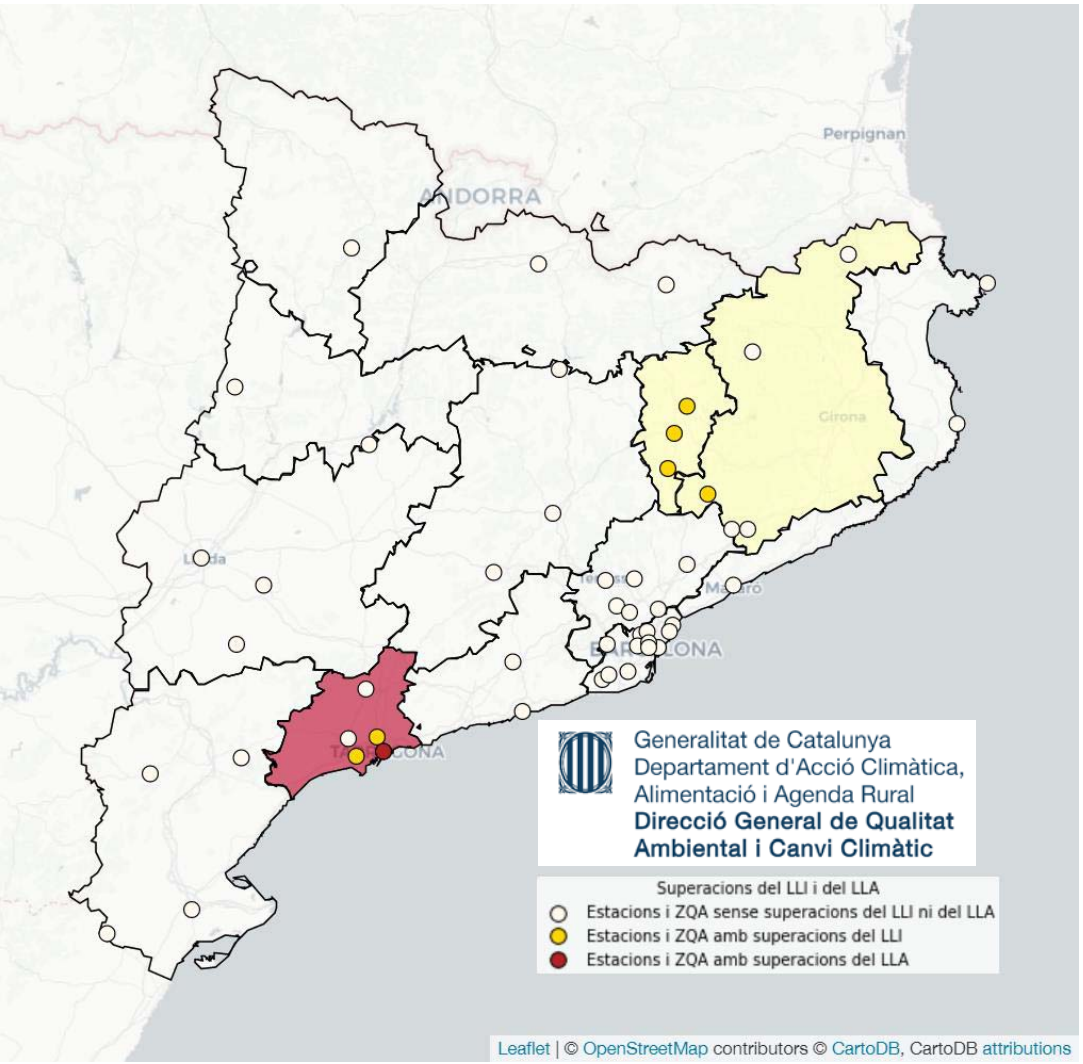
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ANDORRA
Girona
Lleida
Terrassa
Manresa
BARCELONA
TARRAGONA
Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural
Direcció General de Qualitat Ambiental i Canvi Climàtic
Superacions del LLI i del LLA
Estacions i ZQA sense superacions del LLI ni del LLA
Estacions i ZQA amb superacions del LLI
Estacions i ZQA amb superacions del LLA
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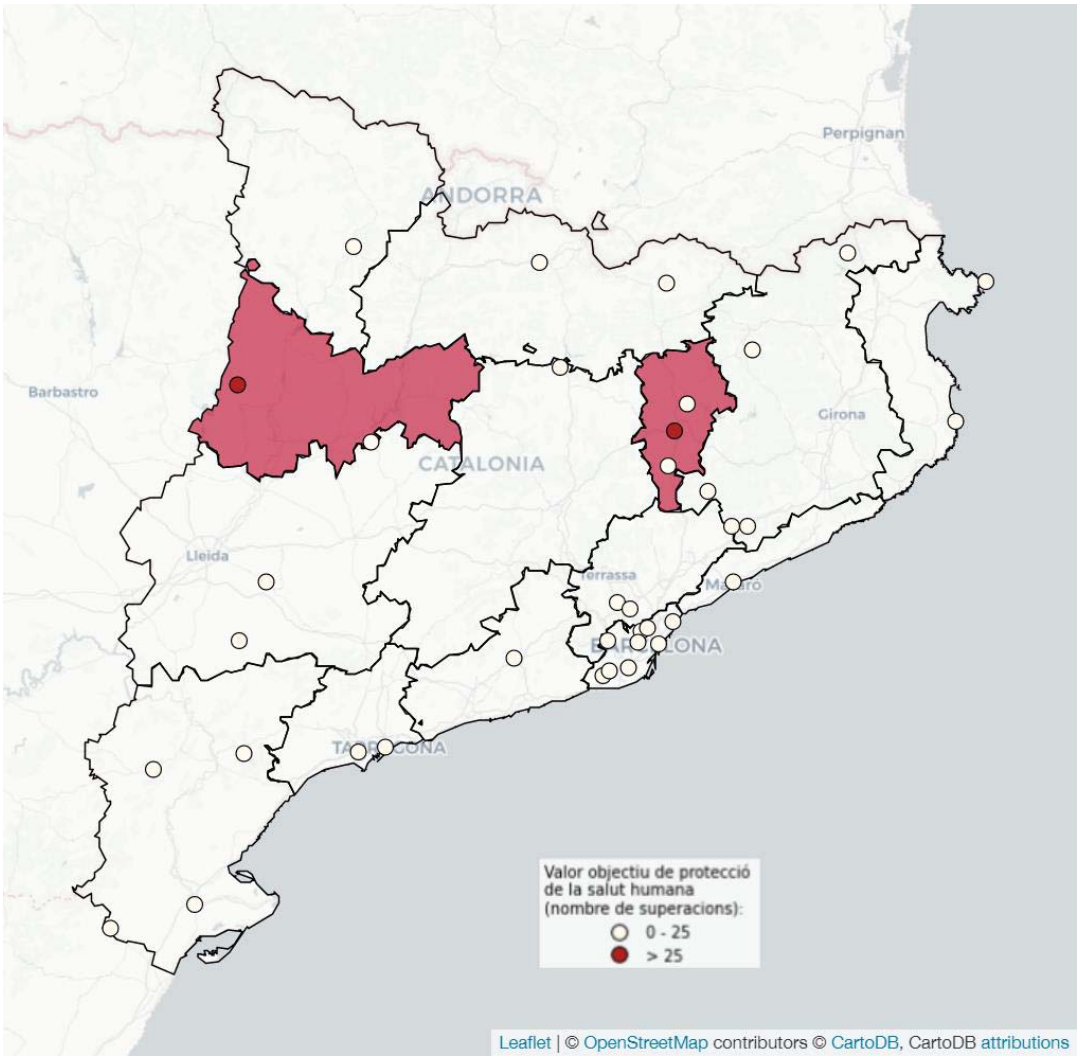
Perpignan
ANDORRA
Barbastro
Girona
CATALONIA
Lleida
Terrassa
Manresa
BARCELONA
TARRAGONA
Valor objectiu de protecció de la salut humana (nombre de superacions):
0 - 25
> 25
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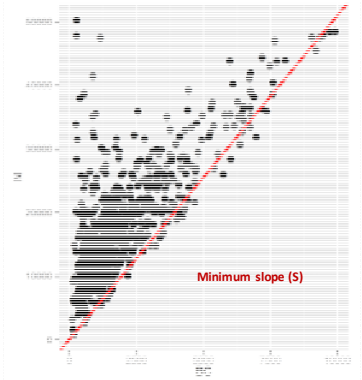
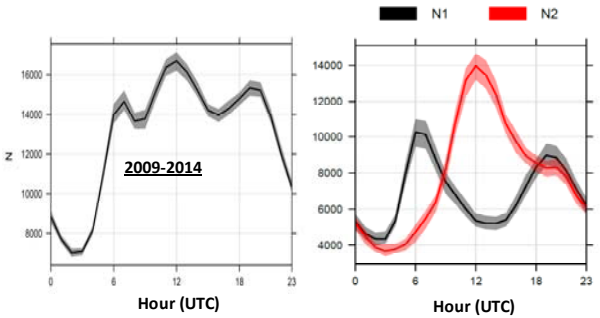
RI-URBANS: Els contaminants a regular en un futur

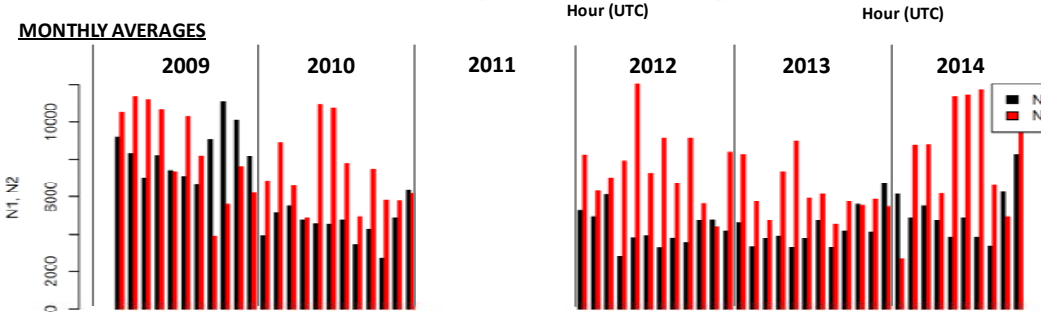
DAILY MORTALITY AND PRIMARY AND SECONDARY UFP IN BARCELONA 2009-2014

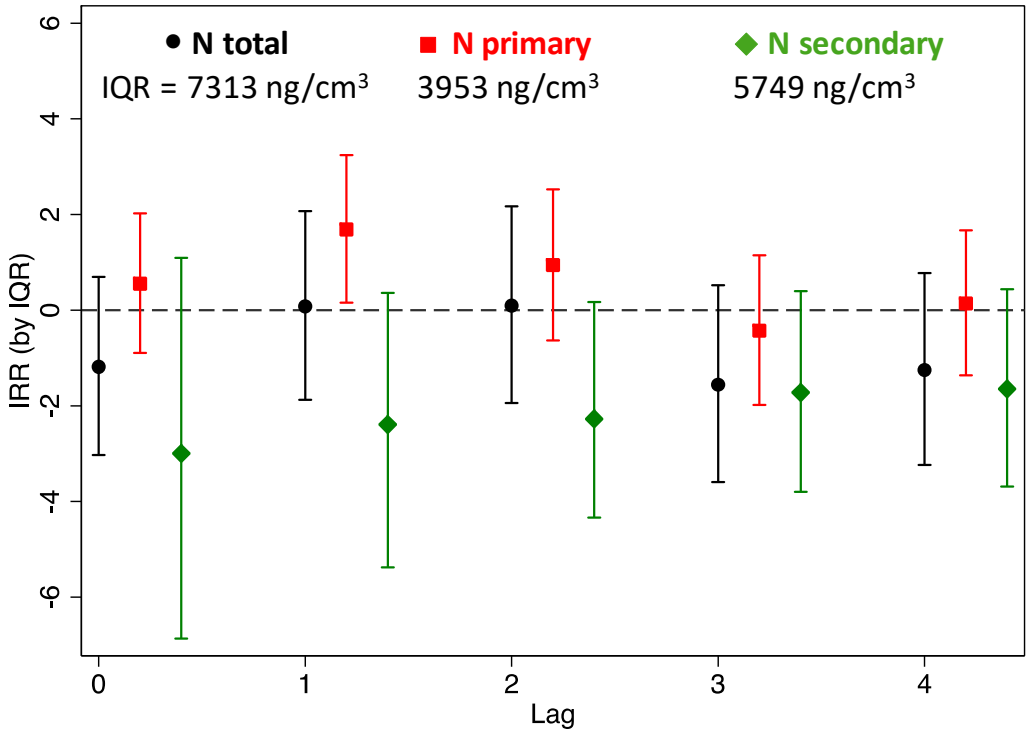
Tobias A. et al., 2018. Environment International, 111, 144-151



UFP Contribution of minimum primary emissions (N1) and new particle formation enhancements (N2) in Barcelona urban environment







consorcibesòs Observatori Ambiental Litoral-Besós

Gràcies per la seva atenció!!!!

European Commission

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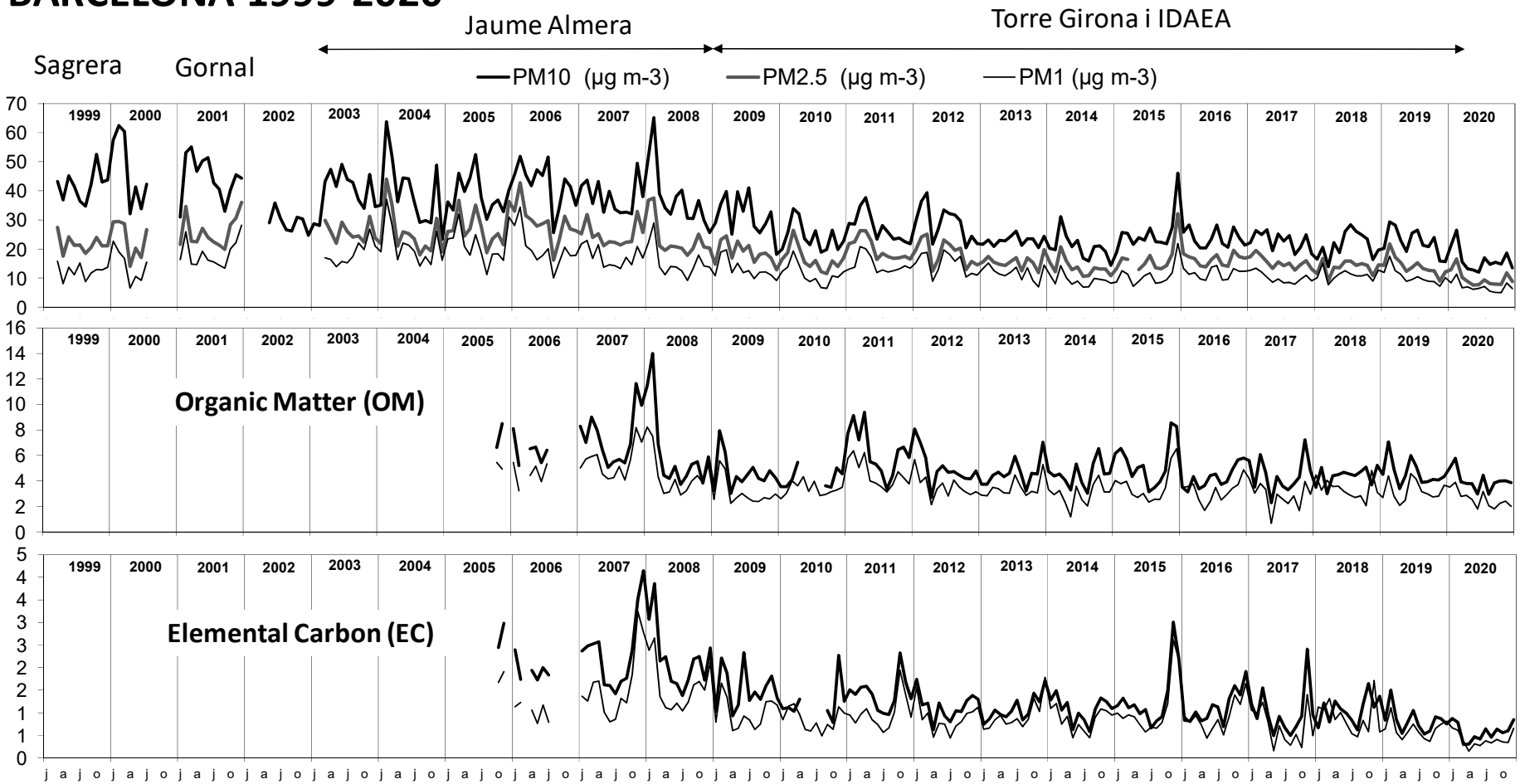
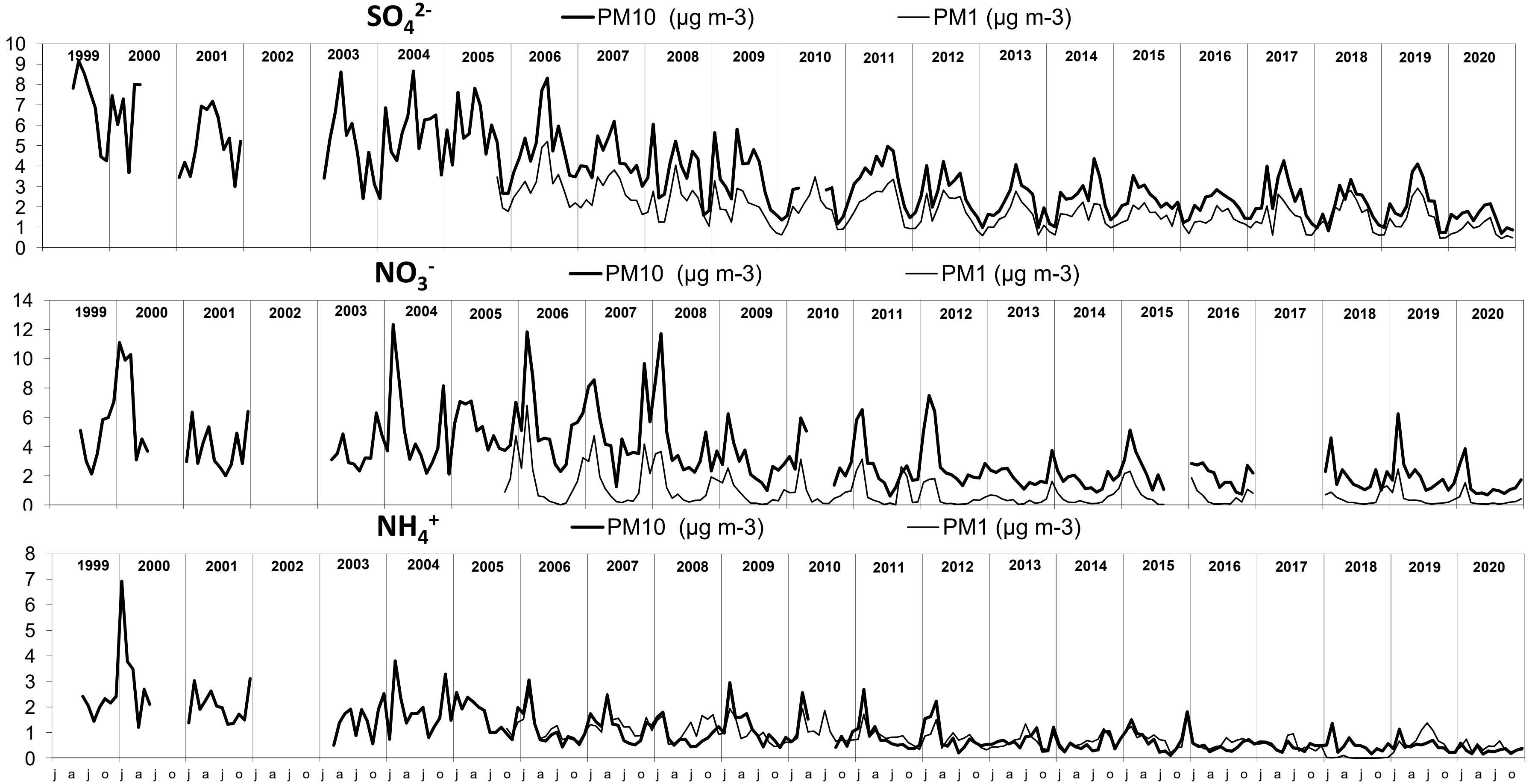
Contaminants crítics: Partícules en suspensió

BARCELONA 1999-2020



Contaminants crítics: Partícules en suspensió

BARCELONA 1999-2020



European Commission

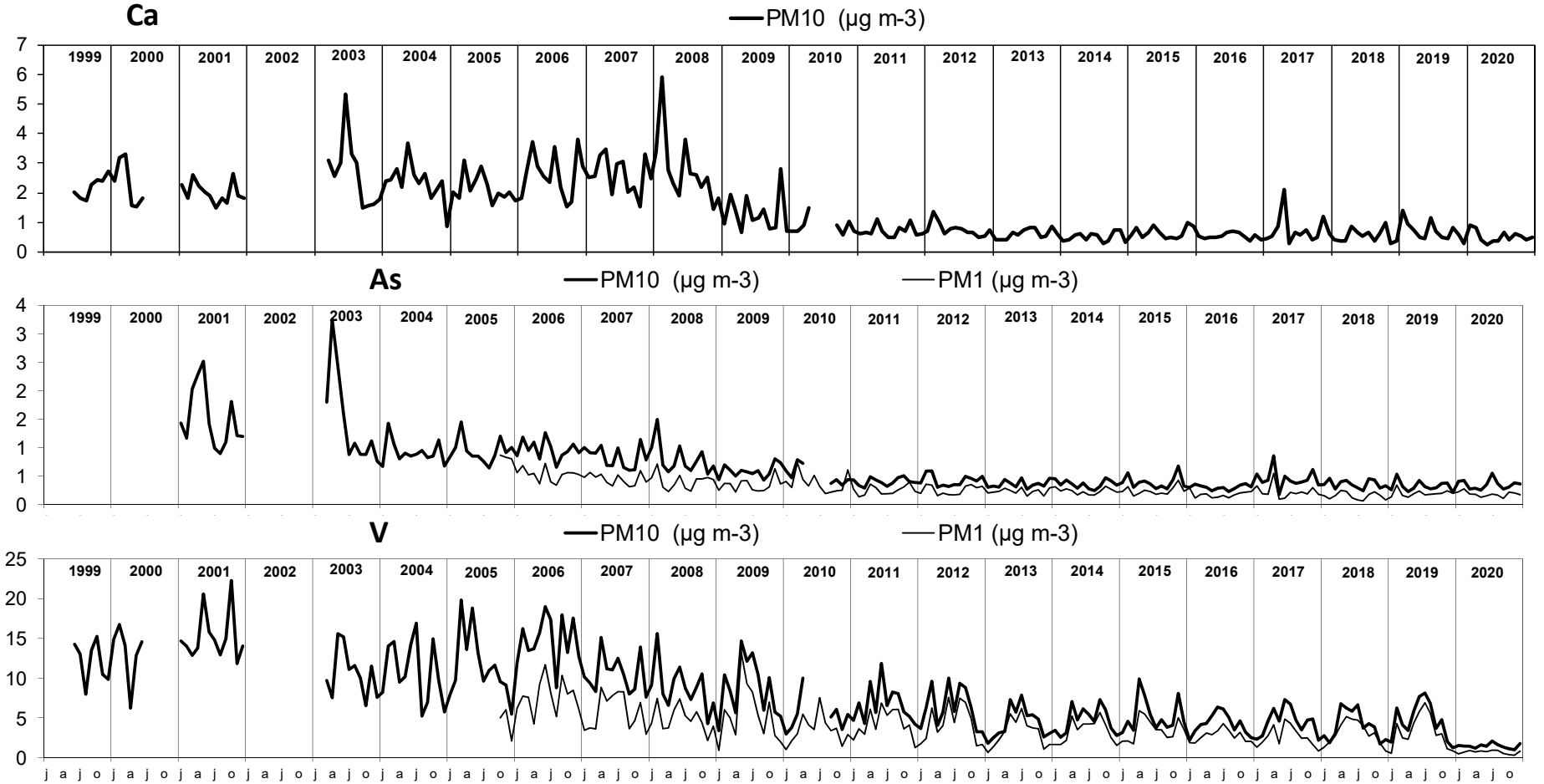
HORIZON 2020

Observatori Ambiental Litoral-Besòs, X. Querol, 11 octubre 2022

RI URBANS

Contaminants crítics: Partícules en suspensió

BARCELONA 1999-2020



Contaminants crítics: Partícules en suspensió

BARCELONA 1999-2020