

ÀREA DE CIÈNCIA I TECNOLOGIA

**SOSTENIBILITAT
I MEDI
AMBIENT.
PLANETA TERRA**

Coordinadora: Nùria Ferrer i Anglada

Professors: Francesc Castells, Xavier Obradors, José M. Baldasano, Jofre Carnicer, Joandomènec Ros i Arnau Queralt

Situació actual del canvi climàtic. La qualitat de l'aire en les grans ciutats

Dr. José M^a Baldasano Recio

**Catedrático emérito de Ingeniería Ambiental, UPC
Research Fellow, ex-director Earth Sciences dpt. BSC**



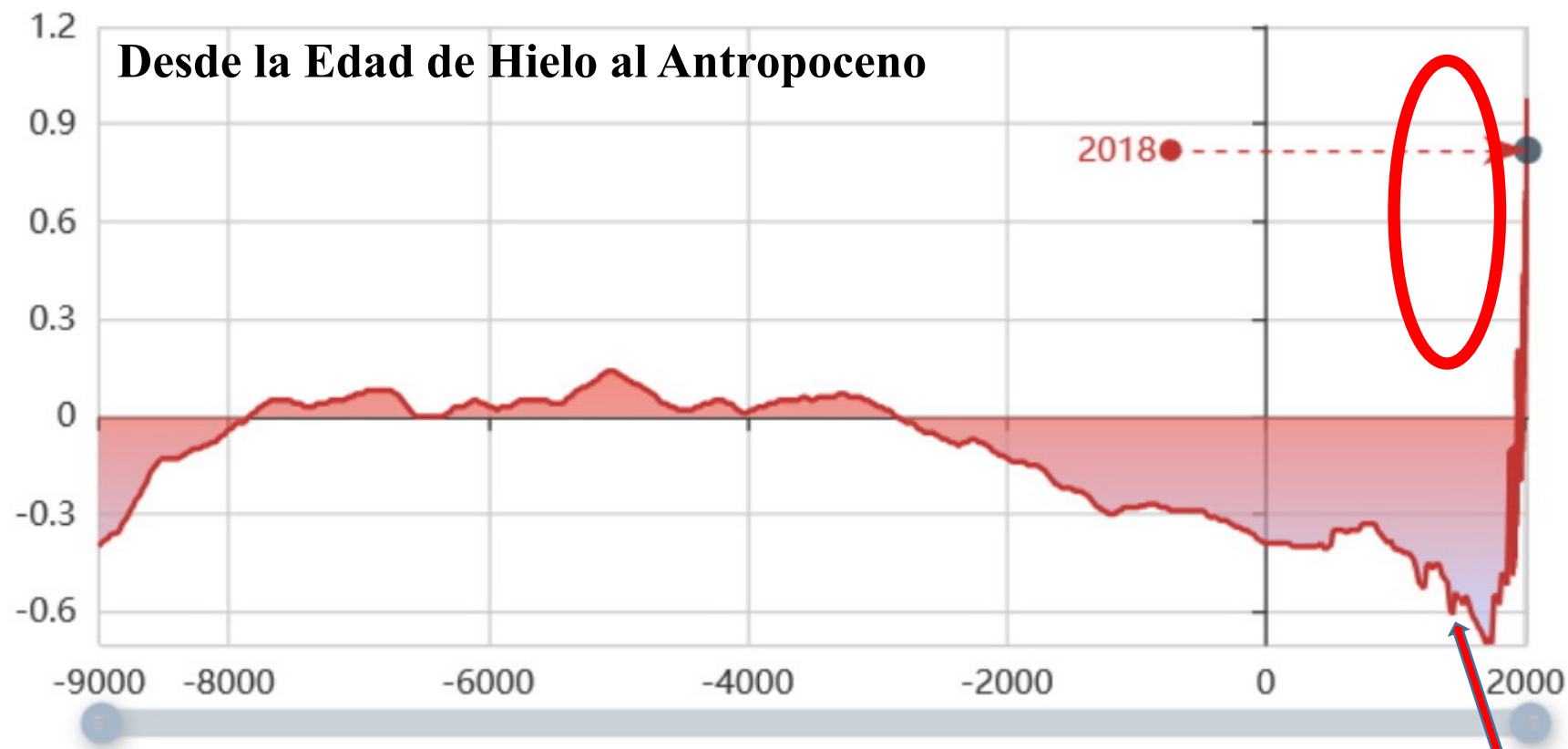
jose.baldasano@upc.edu



22.8.2020

Temperature anomalies in the last 11 000 years

°C compared to 1951-1980 average



Source: A Reconstruction of Regional and Global Temperature for the Past 11,300 Years (data) before 1880, NASA's Goddard Institute for Space Studies (GISS) (data) after 1880

Período Cálido Medieval: 800-1200

Pequeña Edad de Hielo: 1200-1860

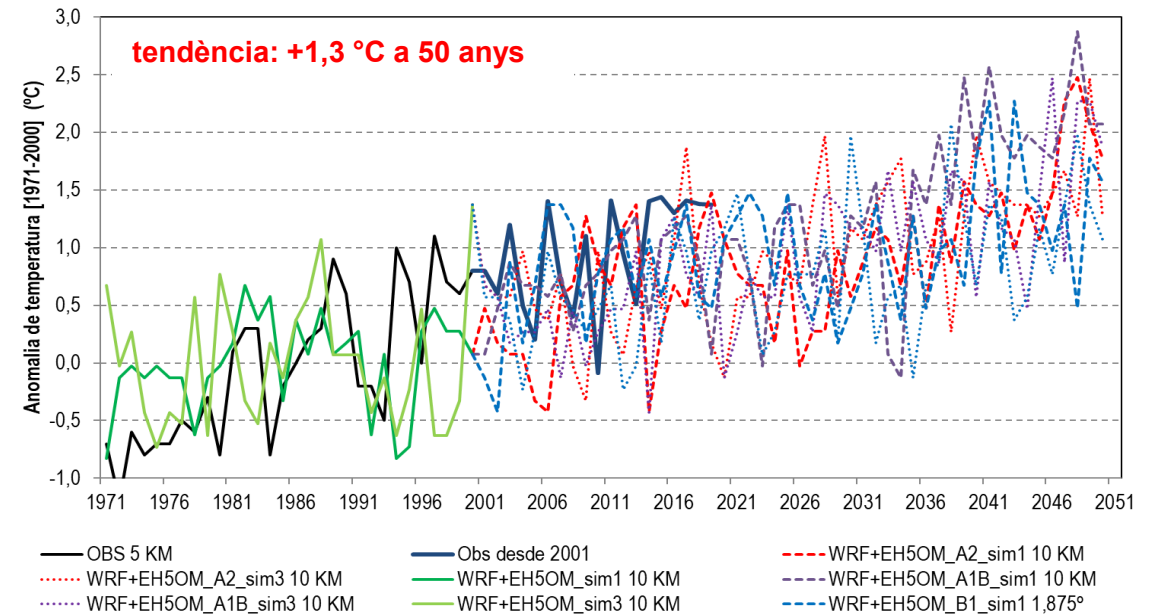
Anàlisi regional per a Catalunya: Present i Projectió CC

Projectió de l'anomalia Δt ($^{\circ}$ C) de la temperatura mitjana anual període 2001 – 2050

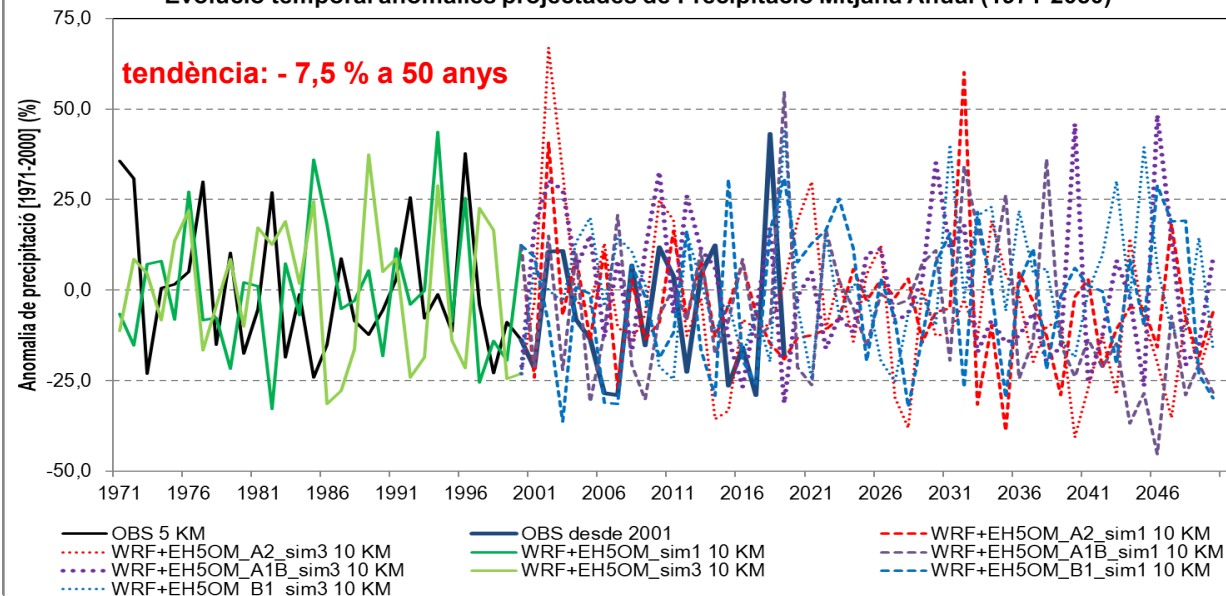
(Les anomalies són respecte del període 1971-2000)



Evolució temporal anomalies projectades Temperatura Mitjana Anual (1971-2050)



Evolució temporal anomalies projectades de Precipitació Mitjana Anual (1971-2050)



Projectió de l'anomalia Δp (%) de la precipitació mitjana anual període 2001-2050

(Les anomalies són respecte del període 1971-2000)



Lifetime of the GHG in the atmosphere

Emit until
2050, then
stop....

Lifetime of N_2O \approx
110 years

Lifetime of CH_4 \approx 10
years

Warming due to CO_2
persists for more
than 1000 years;
for N_2O several
hundred years;
for methane many
decades.

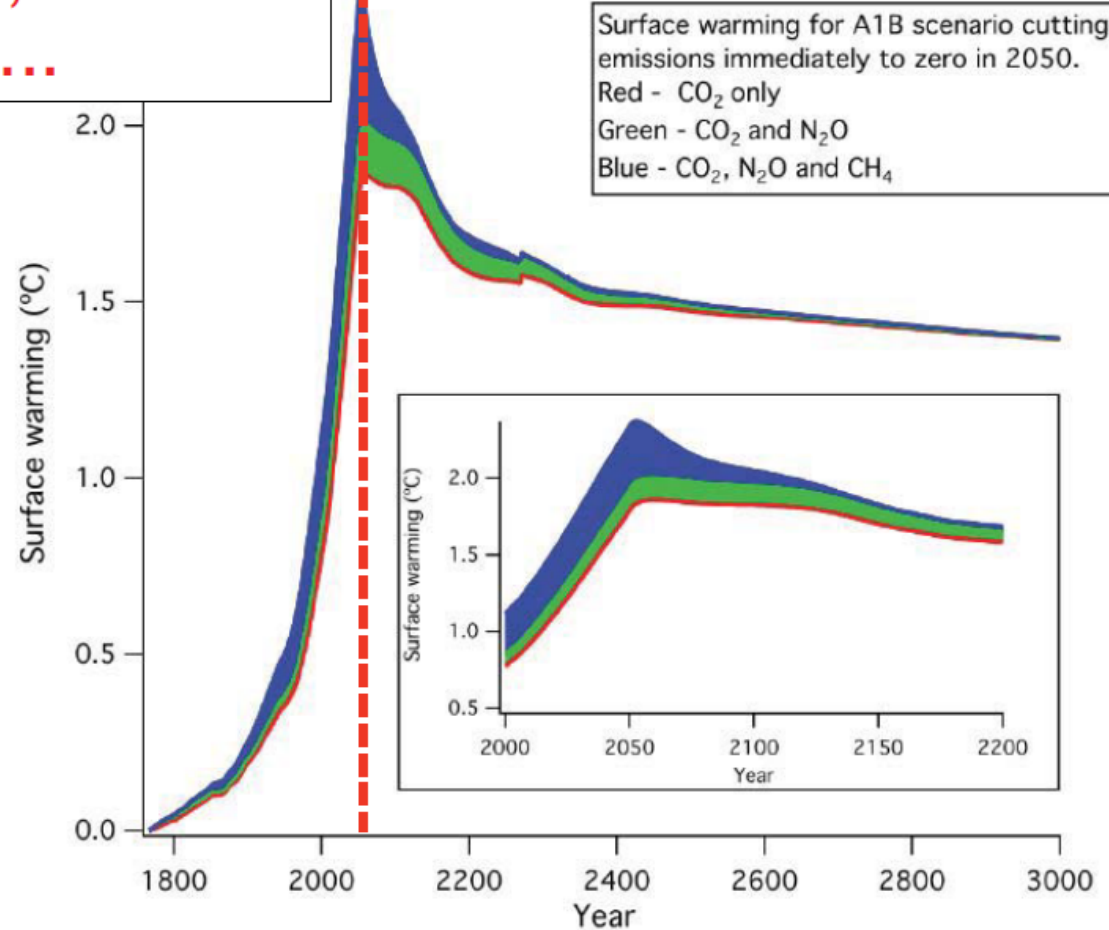
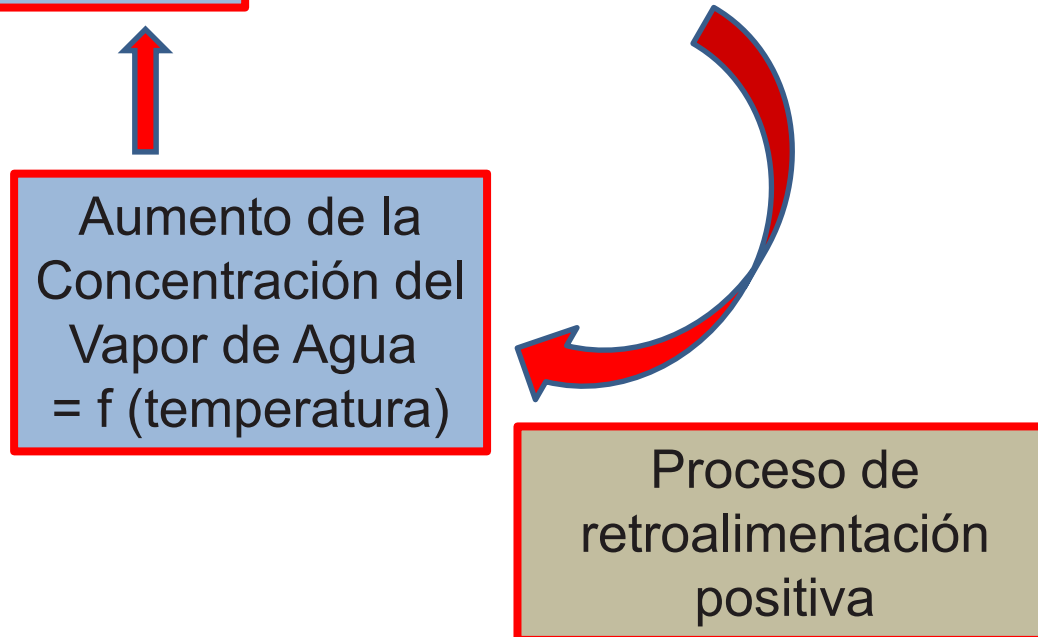
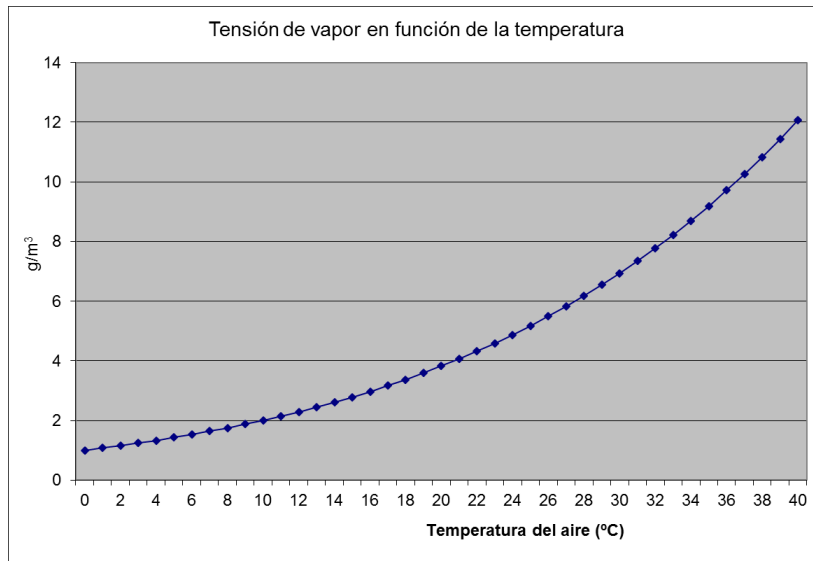


Image courtesy of Susan Solomon. Used with permission.

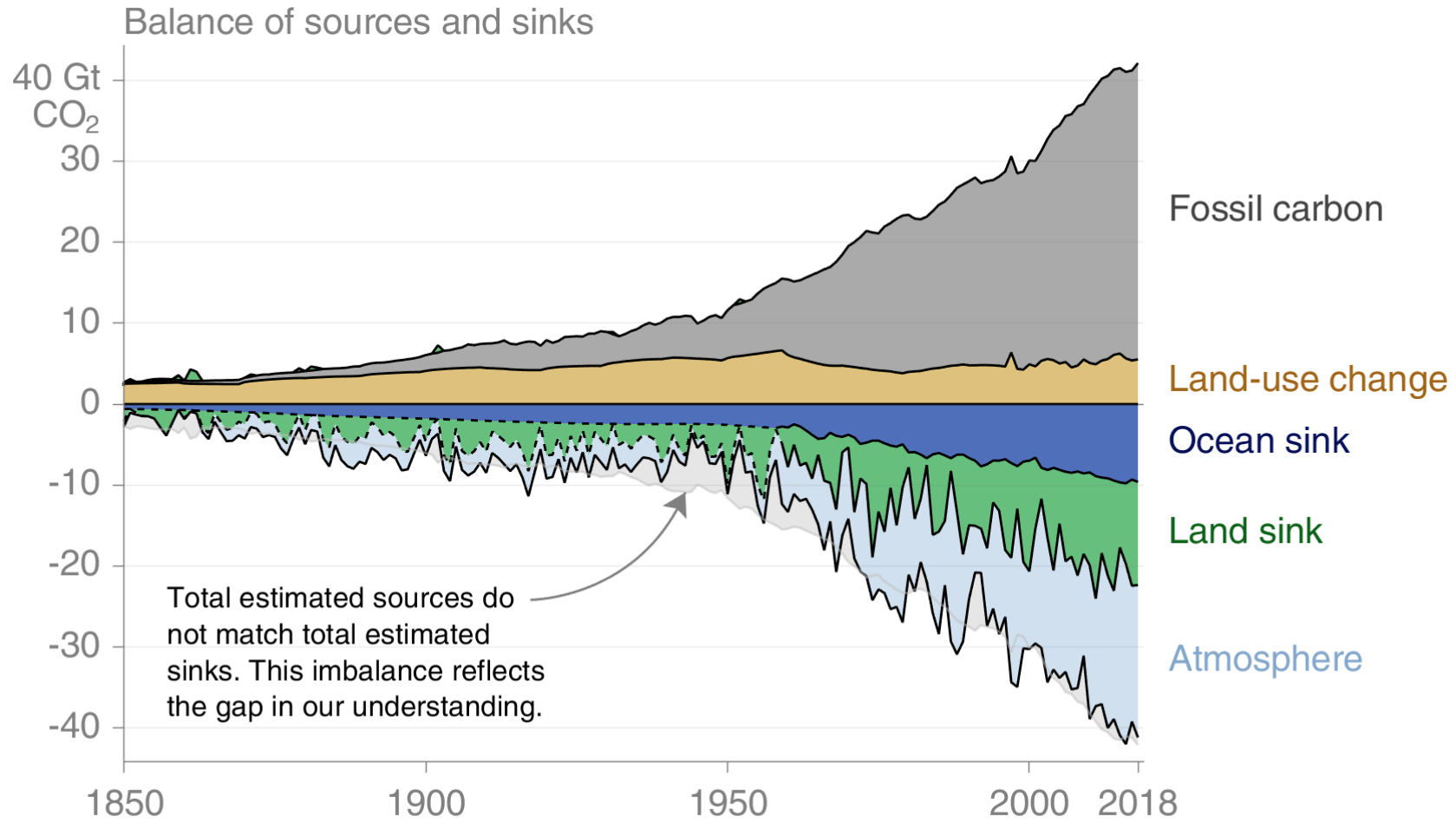
Bern 2.5CC EMIC runs - Solomon et al., PNAS, 2010.



Papel del vapor de agua (GEI) f(temperatura del aire)



Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean
 The “imbalance” between total emissions and total sinks reflects the gap in our understanding



© Global Carbon Project • Data: CDIAC/GCP/NOAA-ESRL/UNFCCC/BP/USGS

Source: [CDIAC](#); [NOAA-ESRL](#); [Houghton and Nassikas 2017](#); [Hansis et al 2015](#); [Joos et al 2013](#); [Khaliwala et al. 2013](#); [DeVries 2014](#); [Friedlingstein et al 2019](#); [Global Carbon Budget 2019](#)

Aumento de la concentración media de los GEI's

Table 1. Global annual surface mean abundances (2018) and trends of key greenhouse gases from the GAW global GHG monitoring network. Units are dry-air mole fractions, and uncertainties are 68% confidence limits [12]. The averaging method is described in the GAW Report No. 184 [11]. A number of stations are used for the analyses: 129 for CO₂, 127 for CH₄ and 96 for N₂O.

	CO ₂	CH ₄	N ₂ O
2018 global mean abundance	4078±0.1 ppm	1869±2 ppb	331.1±0.1 ppb
2018 abundance relative to year 1750*	147%	259%	123%
2017–2018 absolute increase	2.3 ppm	10 ppb	1.2 ppb
2017–2018 relative increase	0.57%	0.54%	0.36%
Mean annual absolute increase over the last 10 years	2.26 ppm yr ⁻¹	7.1 ppb yr ⁻¹	0.95 ppb yr ⁻¹

* Assuming a pre-industrial mole fraction of 278 ppm for CO₂, 722 ppb for CH₄ and 270 ppb for N₂O.

WMO GHG BULLETIN, Nº 15 Nov. 2019

<https://public.wmo.int/en/media/press-release/greenhouse-gas-concentrations-atmosphere-reach-yet-another-high>

Velocidades del cambio

	Desglaciación	Cambio abrupto	Presente
TEMP °C/dec	0.026	0.05-0.1	0.3 (1.3-5.3) IPCC
CO ₂ ppm/año	0.005-0.009	0.01	>2-3



Lo más importante, es la velocidad temporal del proceso de cambio

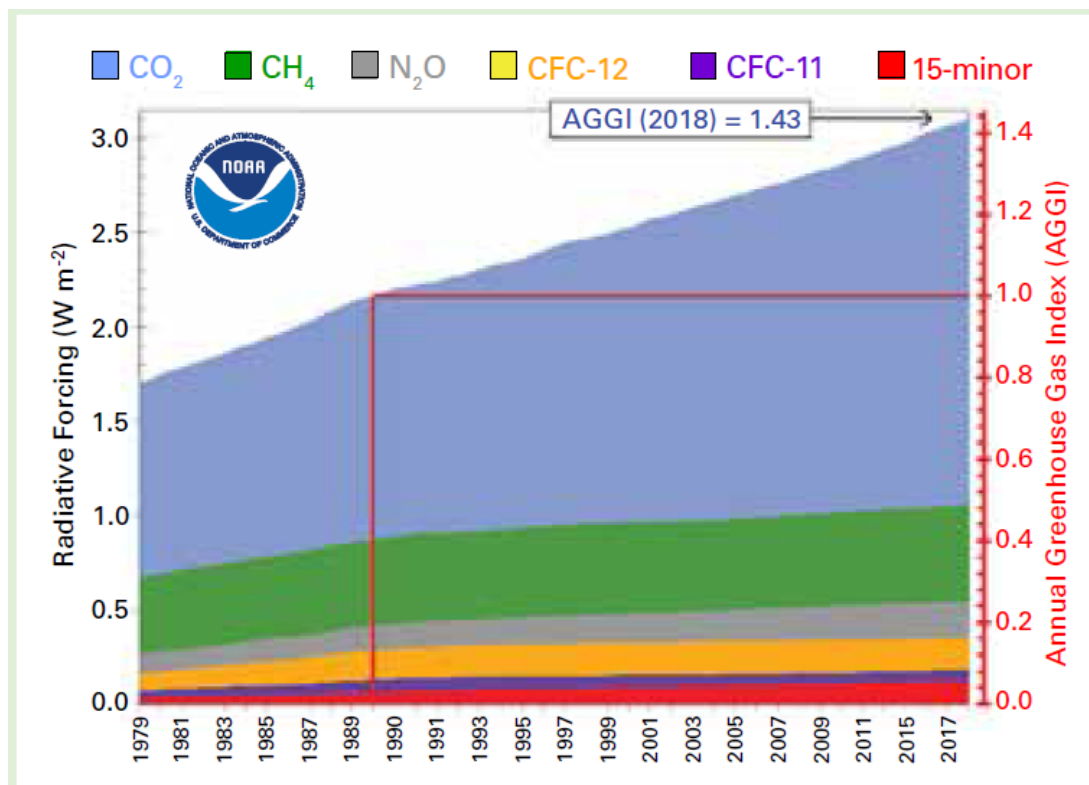


Figure 1. Atmospheric radiative forcing, relative to 1750, of LLGHGs, and the 2018 update of the NOAA AGGI [9].

WMO 2019 GHG 2017_Bulletin_No.15

Lovejoy, S. (2014), Return periods of global climate fluctuations and the pause, *Geophys. Res. Lett.*, 41

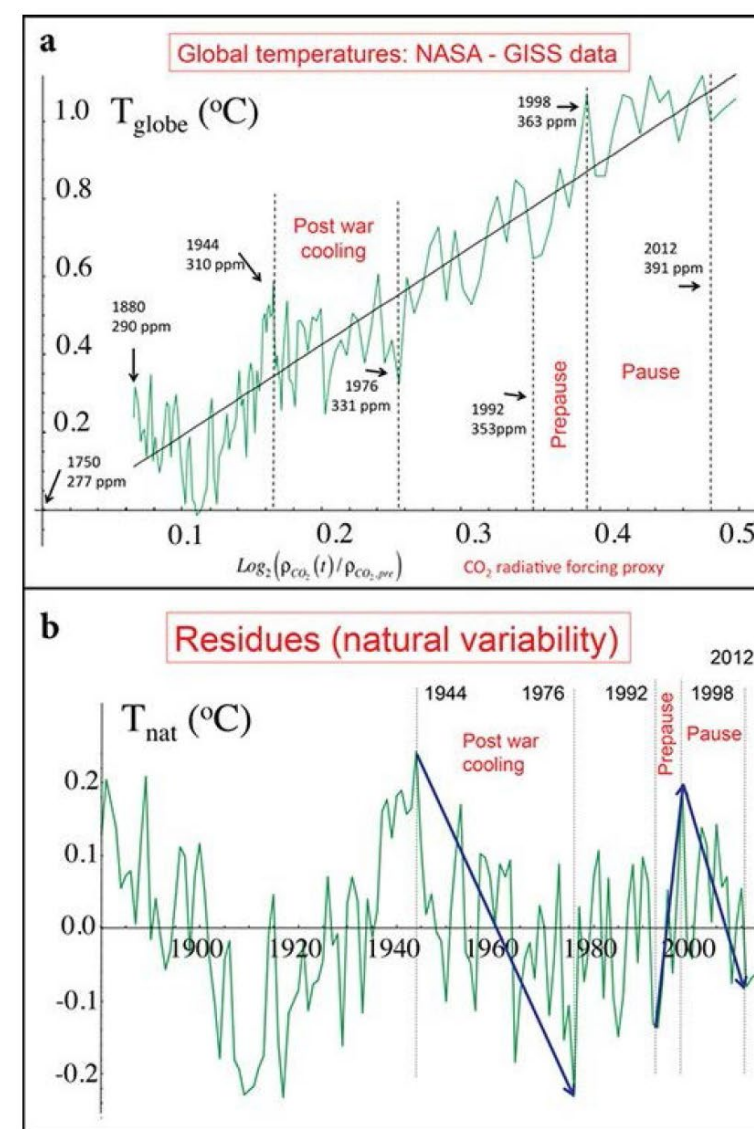
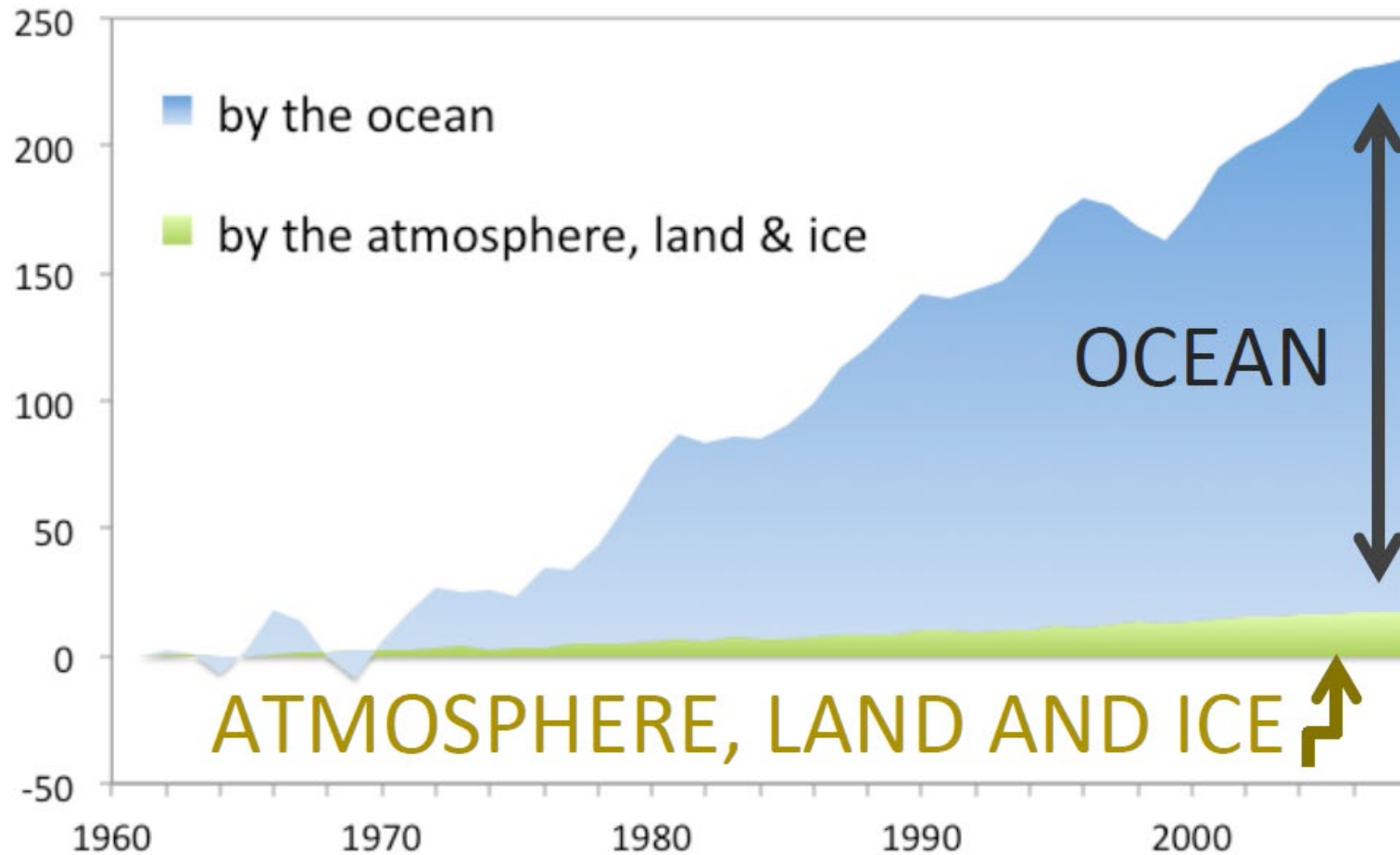


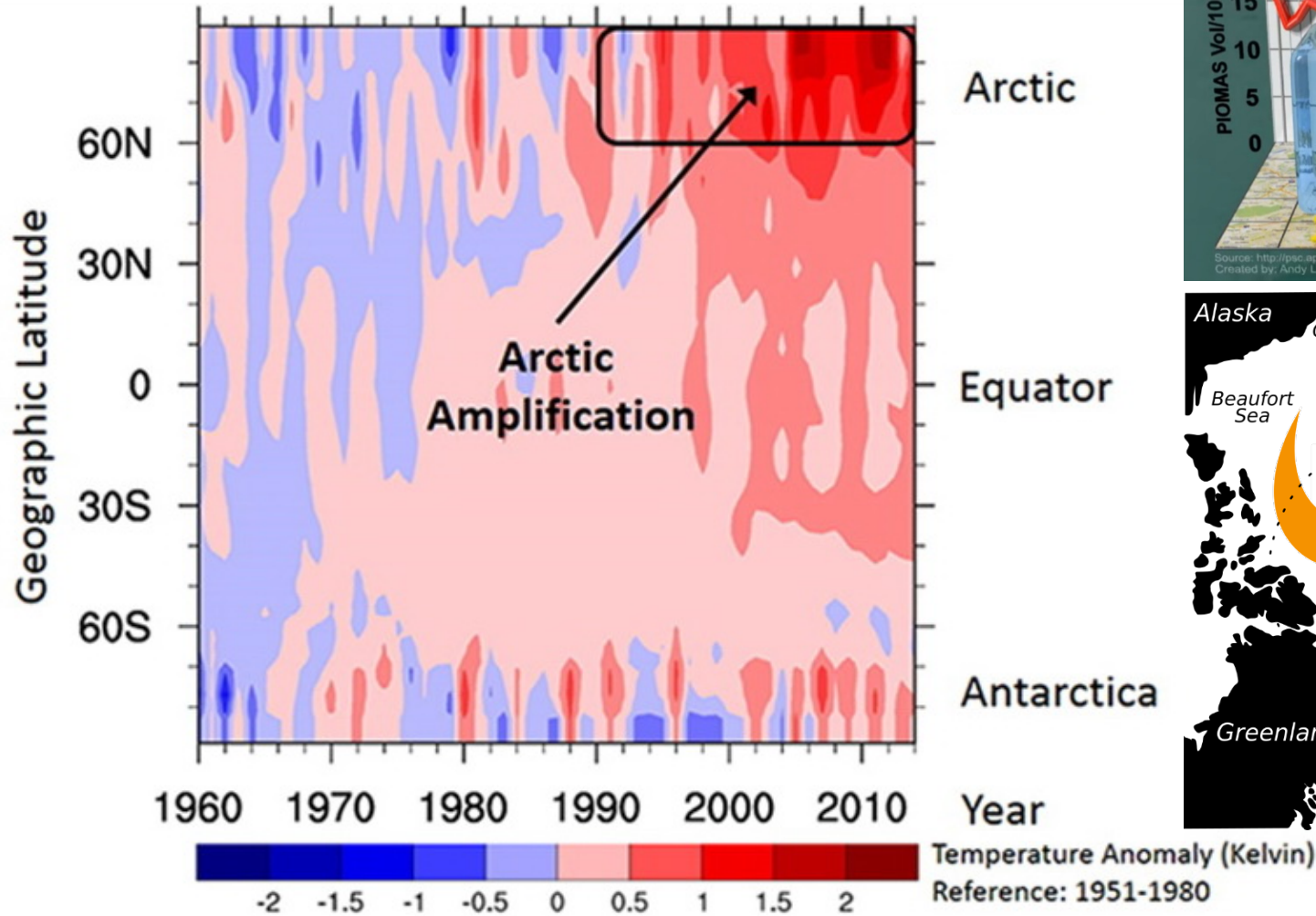
Fig. 1. (a) Global temperature anomalies (NASA, 1880–2013) as functions of radiative forcing using the carbon dioxide (CO₂) forcing as a linear surrogate. The line has a slope of 2.33°C per CO₂ doubling. Some dates and corresponding annually, globally averaged CO₂ concentrations are indicated for reference. GISS, Goddard Institute for Space Studies; ppm, parts per million. Adapted from Lovejoy [2014b, Figure 1a]. (b) The residuals from the straight line in Figure 1a; these are the estimates of the natural variability. The vertical dashed lines are the same as in Figure 1a. The arrows indicate notable events. Adapted from Lovejoy [2014b, Figure 1c].

Air temperature is the tip of the iceberg of global warming

Increased Heat Absorbed by the Earth (10^{21} J)



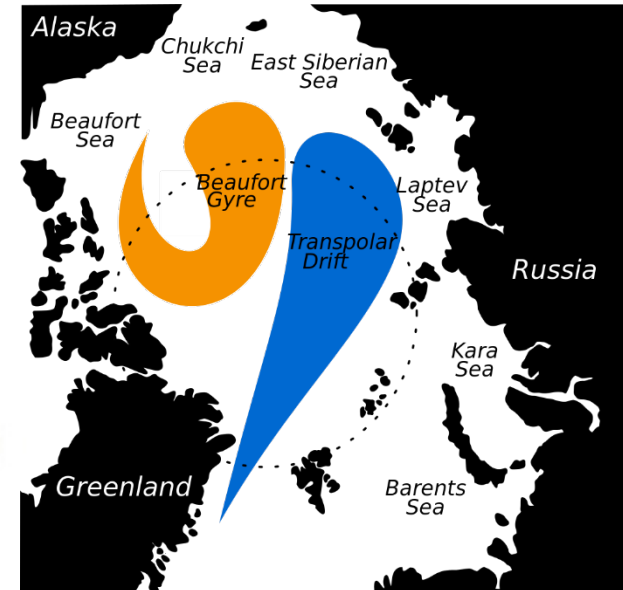
The Arctic is warming more rapidly than the rest of the world, a process referred to as the **Arctic amplification**



Arctic

Equator

Antarctica





GLOBAL WARMING EFFECTS AND IMPACTS

A multitude of Climate Change trends became:

- Air temperature rise, warmer nights
- Increase in sea temperature and its heat content
- Ice sheet mass loss: Arctic, Greenland, Antarctica, glaciers
- Permafrost thaw
- Sea level rise, ocean water acidification
- Increase in storm surge, with more powerful waves
- Drought, Fires
- Heat waves: continental and marine
- Changes in Precipitation, flooding
- Changing patterns of extreme weather events
- Freeze and thaw dates of lakes
- Changes in the phenological processes
- Migrations
- ...

Another vision of the impacts due to climate change

Climate Change Impacts by Sector

Climate change impacts many different sectors. Click the links below for information about impacts on each sector, or learn about climate change impacts [by region](#) or [by state](#).



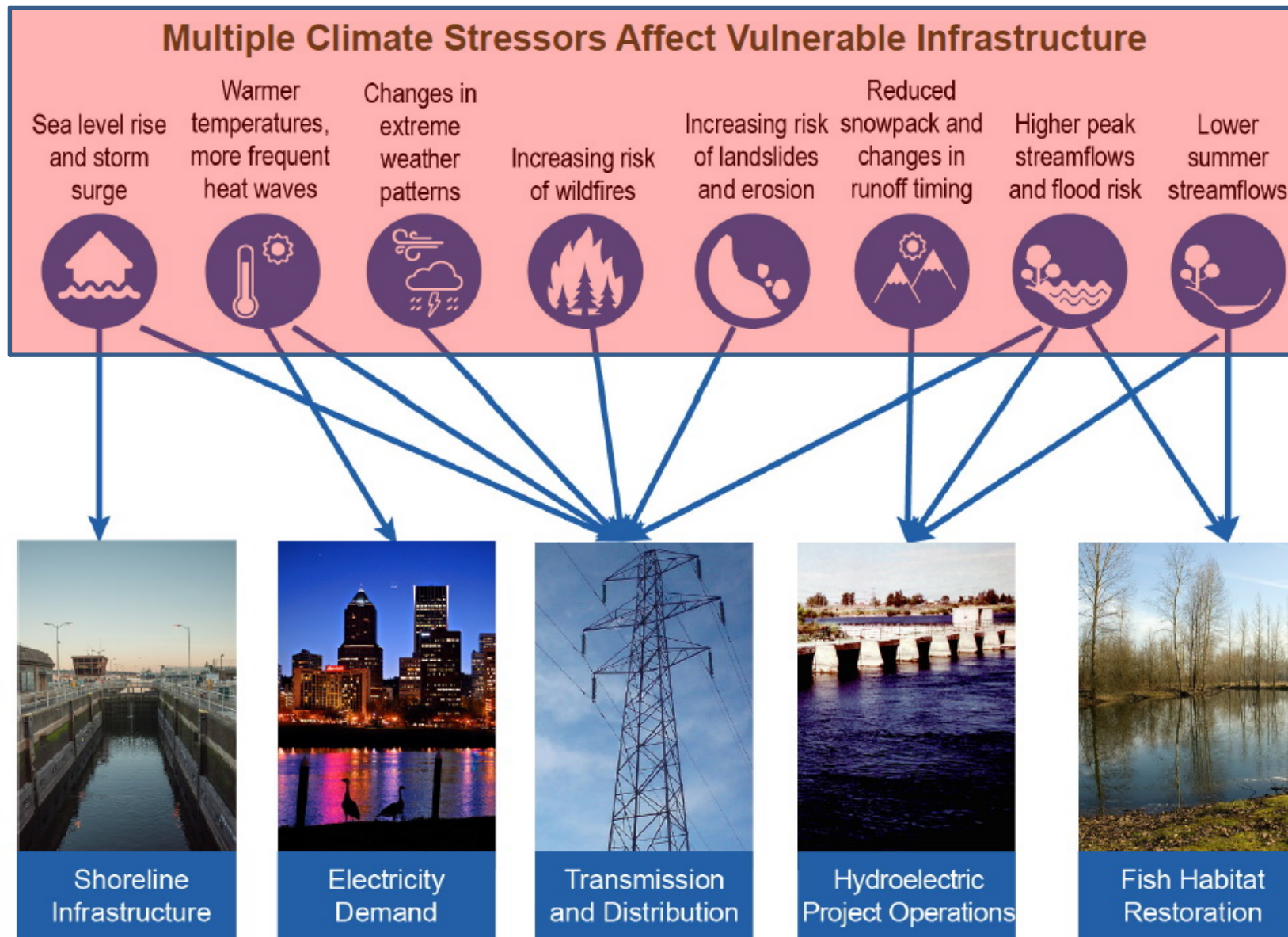


Figure 24.11: Extreme events such as floods, heat waves, wildfires, landslides, and drought play an important role in the vulnerability of infrastructure. The figure, from Seattle City Light's Vulnerability Plan,¹³³ illustrates how the utility's assets, operations, and management goals are affected by a broad range of climate impacts and extreme events. Adaptation strategies to increase the resilience of the energy system must focus on multiple potential risks as well as environmental considerations. Source: adapted from Raymond 2015.¹³³ Photo credits (from left to right): Emmet Anderson (Flickr, [CC BY-NC 2.0](#)), Justin Miller (Flickr, [CC BY-NC 2.0](#)), photojojo3 (Flickr, [CC BY 2.0](#)), U.S. Department of Energy, Rick Swart, Oregon Department of Fish & Wildlife.

The hard numbers on climate change

https://www.nature.com/immersive/d41586-019-02711-4/index.html?utm_source=Nature+Briefing&utm_campaign=093e3be58a-briefing-dy-20200820&utm_medium=email&utm_term=0_c9dfd39373-093e3be58a-43796237

<https://gcos.wmo.int/en/global-climate-indicators>

<https://ourworldindata.org/new-co2-data-explorer>

NOAA climate state: <https://www.climate.gov/news-features/understanding-climate/reporting-state-climate-2019>

NASA Effects of Climate Change: <https://climate.nasa.gov/effects/>

EPA Effects of Climate Change: <https://archive.epa.gov/epa/climate-impacts/climate-change-impacts-sector.html>

EU Copernicus: <https://climate.copernicus.eu/ESOTC/2019>

<https://experience.arcgis.com/stemapp/5f6596de6c4445a58aec956532b9813d>

EU IS-ENES: <https://climate4impact.eu/impactportal/general/index.jsp>

¿Qué es *Clima*?

El Clima es diferente del Tiempo atmosférico !!!

Tiempo atmosférico: estado de la atmósfera sobre un lugar en un momento concreto



Clima: Una descripción estadística del estado y la variabilidad del tiempo, en promedio de al menos 30 años



Esta es una definición humana del Clima

Another important concept **iii** Time scales can be anything from intra-seasonal to decadal.

CLIMATE VARIABILITY vs. CLIMATE CHANGE

The climate system oscillates on many different time scales. What causes short and long term climatic changes of very different frequencies.

Variabilidad Climática y Cambio Climático: Lenguaje

"Variabilidad Climática"

- 2-3 meses
- 6 meses – 1 año
- Década(s)

"Cambio Climático"

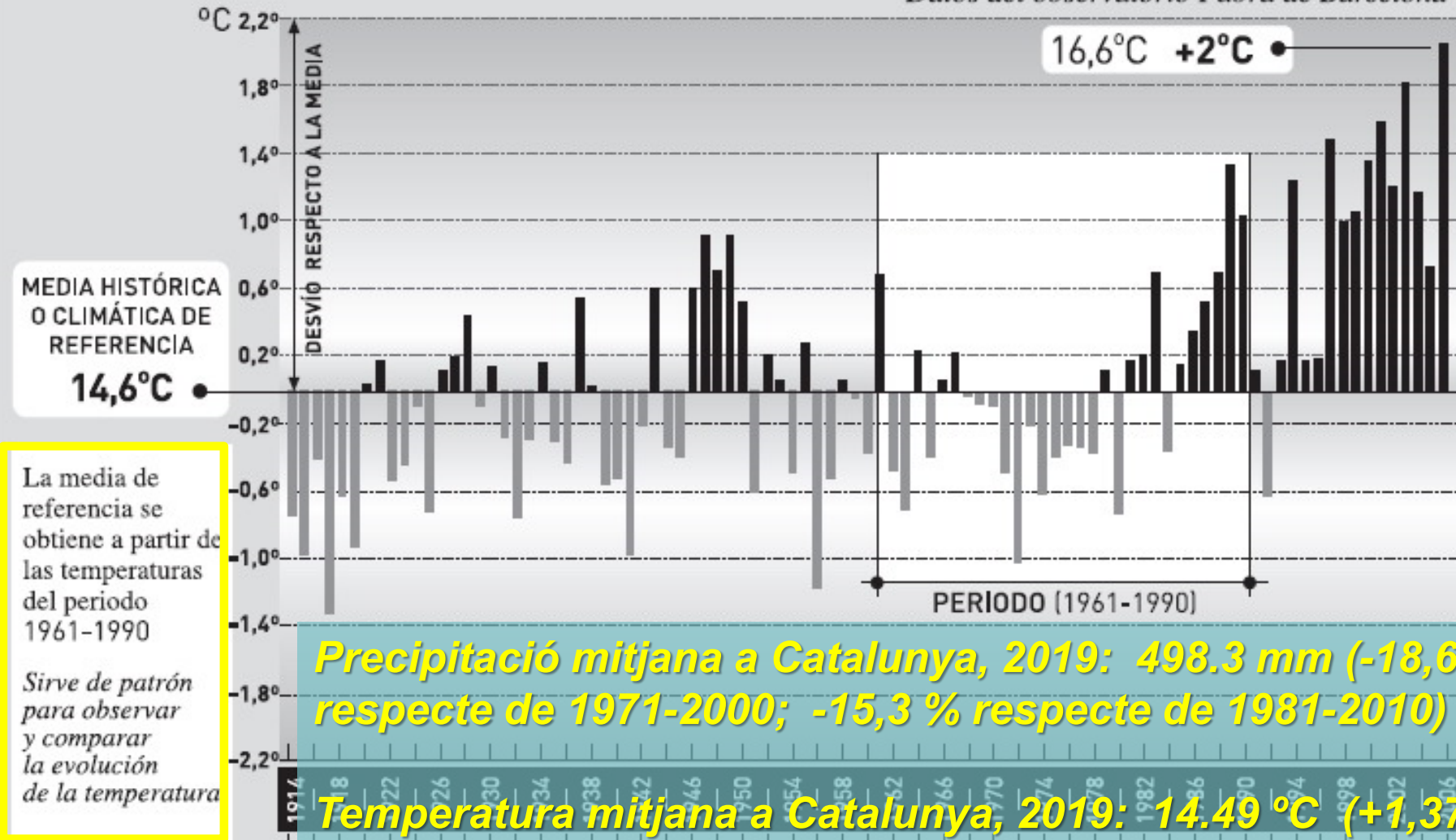
- Varias Décadas
- Siglos



Temperature anomaly vs 30 years-WMO

El año más cálido de Barcelona

Datos del observatorio Fabra de Barcelona

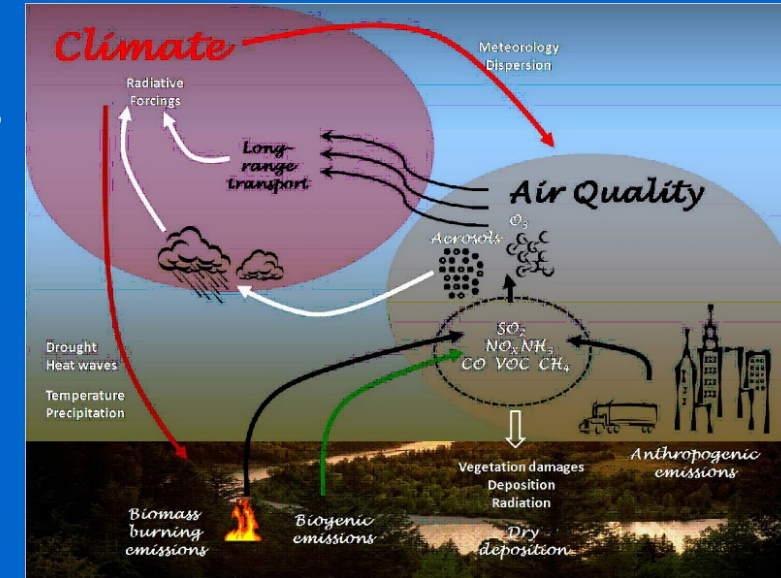


Precipitació mitjana a Catalunya, 2019: 498.3 mm (-18,6 % respecte de 1971-2000; -15,3 % respecte de 1981-2010)

Temperatura mitjana a Catalunya, 2019: 14.49 °C (+1,37 °C respecte de 1971-2000; +0,91 °C respecte de 1981-2010)

No es lo mismo **CAMBIO CLIMÁTICO** que **CALIDAD DEL AIRE** Mismo tubo de la emisión → diferentes consecuencias

Causa común: → la emisión de contaminantes y GEI's, es debido principalmente al uso de combustibles fósiles



→ **Efectos-Consecuencias** → diferentes:

1. Diferentes contaminantes:

➤ **CA:** SO₂, NO_x (NO, NO₂), MP, COV, CO, Metales Pesados, etc.

➤ **CC:** [GEI's] CO₂, CH₄, N₂O, CFC's/HFC's

2. *Espacio:* **CA:** local-regional vs. **CC:** global

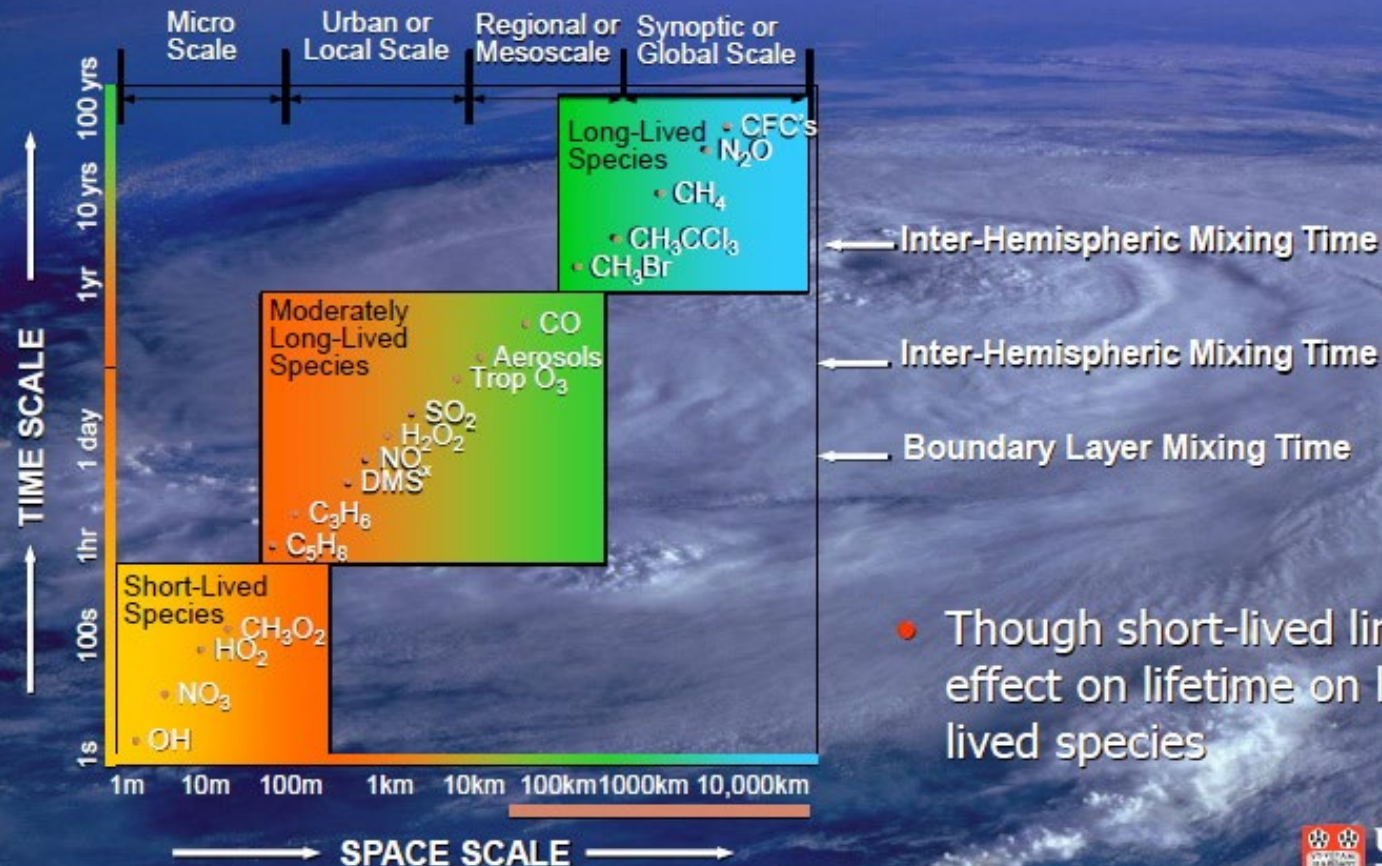
3. *Tiempo:* **CA:** horas-días vs. **CC:** años/siglos

CA:
Impacto Local-regional
Calidad del aire

CC:
Impacto Global
Cambio Climático

Greenhouse gases (GHG): CO₂, CH₄, N₂O, CFCs, H₂O

Spatial and temporal scale of atmospheric pollutants (Seinfeld and Pandis, 1998/2016)



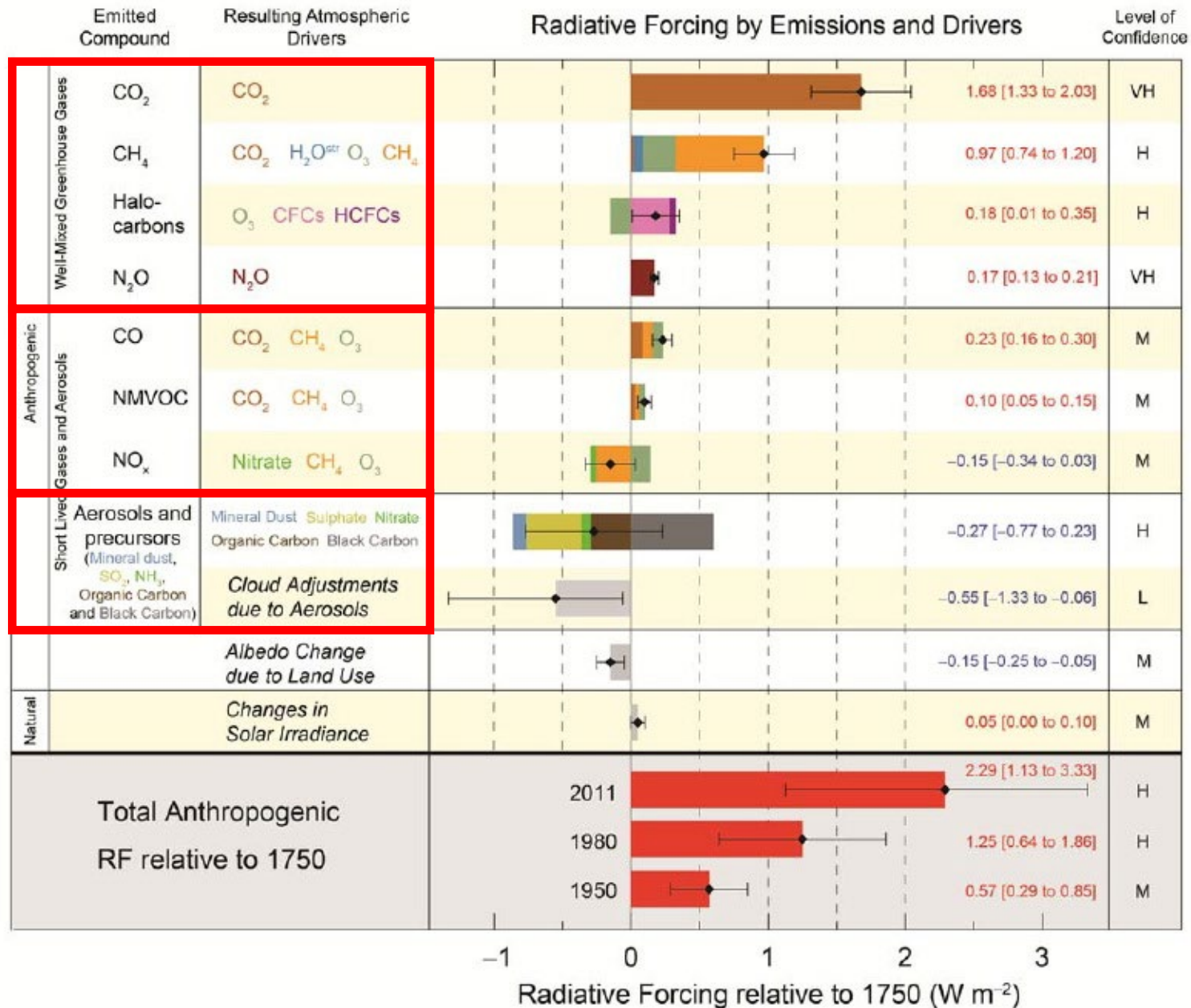
Dynamically
Controlled → **Climate Change**

Photochemically
Controlled → **Air Quality**

Table 2. Near-term climate forcing air pollutants (and precursors) with CO₂ shown for comparison; although emissions for SLCPs are much smaller than CO₂, they have much larger GWPs^a over 100 years.

Pollutant	Lifetime	Major sources	Anthropogenic emissions ^b	GWP ^c ₁₀₀
Methane (CH ₄)	~10 years	Agriculture (livestock, rice production), oil and gas systems, coal mining, waste management	350 Tg CH ₄	29
Tropospheric ozone (O ₃)	Days (near-surface, summer) to months (free troposphere, winter)	Multiple sources of precursors (see Figure 2) CH ₄ (above) Carbon monoxide (CO) Nitrogen oxides (NO _x) Nonmethane volatile organic compounds (NMVOC)	1040 (Tg yr ⁻¹) 39 (Tg N yr ⁻¹) 210 (Tg yr ⁻¹)	1.9 -11 ^d 4.5 ^h
Black carbon (BC)	Days to weeks	Open biomass burning, residential cooking and heating with biomass and coal, industrial coal, diesel engines	8.2 (Tg yr ⁻¹)	660 900 ^e
Organic carbon (OC)	Days to weeks	Same as BC for directly emitted OC; secondary organics from some biogenic and anthropogenic precursor gases	36 (Tg yr ⁻¹)	-66 ^f
Sulfur oxides (SO _x)	Days	Energy-related fossil fuel combustion, industrial processes such as metal smelting, marine shipping	54 (Tg S yr ⁻¹)	-38
CO ₂	100 to >>1000 years	Fossil fuel combustion, cement production, land-use change ^g	10 (Pg C yr ⁻¹)	1

Global-average radiative forcing estimates and ranges (IPCC: AR5, 2013)



Atmospheric linkages between climate change (CC) and air pollution (AP)

AP such as O_3 and particles contribute substantially to the radiative forcing of the atmosphere.

Particularly relevant for the linkages between CC and AP is tropospheric O_3 . CC influences O_3 concentrations through dynamical and chemical changes in the atmosphere. AP increasing background O_3 concentrations affect CC because O_3 is a potent GHG itself and indirectly influences the lifetime of other GHG such as CH_4 .

CH_4 is a GHG and a precursor for tropospheric O_3 ; its lifetime is determined by the OH radical, a key trace gas in removing air pollutants and GHG from the troposphere.

Important feedbacks and interrelations between the gases (e.g. NO_x – O_3 – N_2O – CO_2 cycle) and their effects on each other exist. However, they are quite complex and are often not well understood.

CC induced stratospheric cooling is likely to delay the recovery of the stratospheric O_3 layer by approximately 20 years. In turn stratospheric O_3 determines tropospheric OH levels, and the amount of UV radiation arriving at the earth's surface.

Particles have important health effects and are direct and indirect contributors to radiative forcing. The climatic effects of aerosols are dependent on their composition. Black carbon (soot) enhances warming, while other aerosol constituents (sulphates, nitrates, organic compounds) generally have a cooling effect. The net effect of reducing particulate matter is probably leading to a further enhancement of the greenhouse effect. However, the issue of a net cooling/warming by aerosol critically depends on the highly uncertain effect of black carbon aerosol, which is at present strongly under debate.

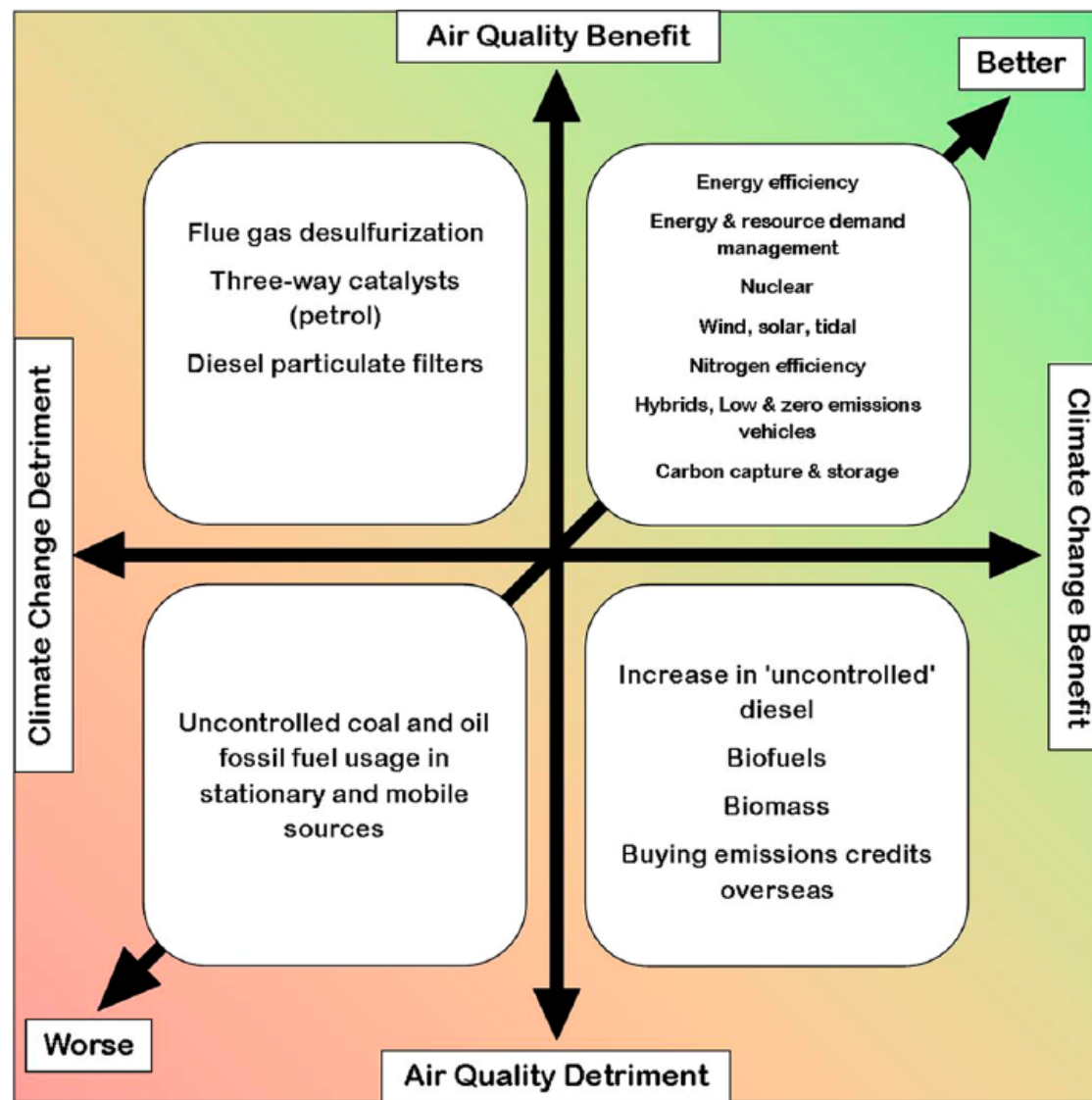


Figure 14. Synergies and trade-offs from policies and technologies to address climate change and air quality. Adapted from Williams,⁸ as in von Schneidmesser and Monks.³⁷³ Adapted with permission from refs 8 and 373. Copyright 2012 Taylor & Francis and 2013 Royal Society of Chemistry.

Urban air quality

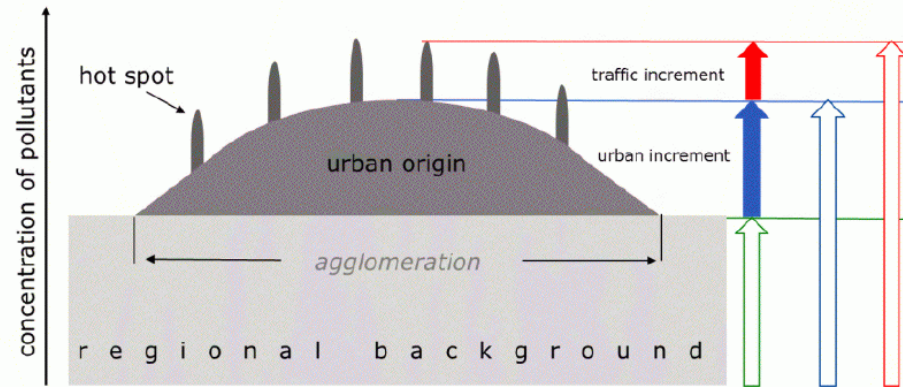
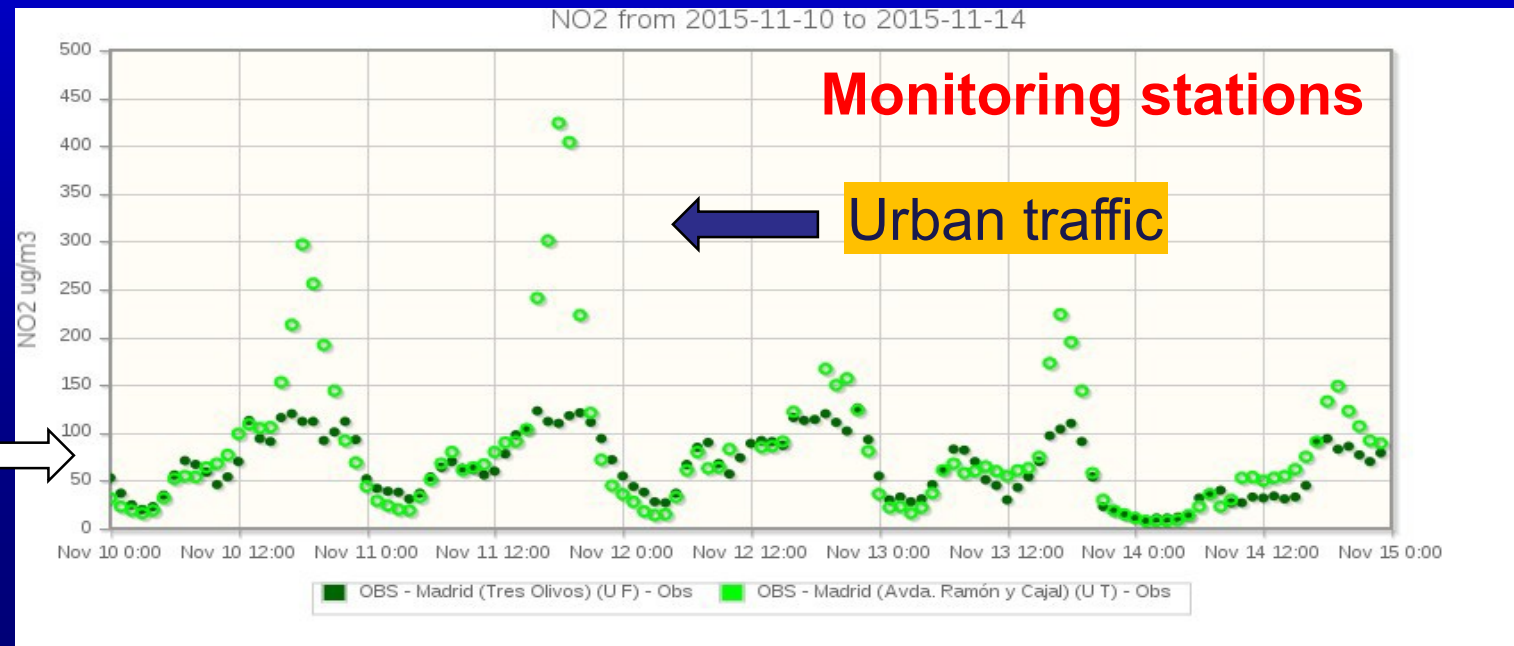
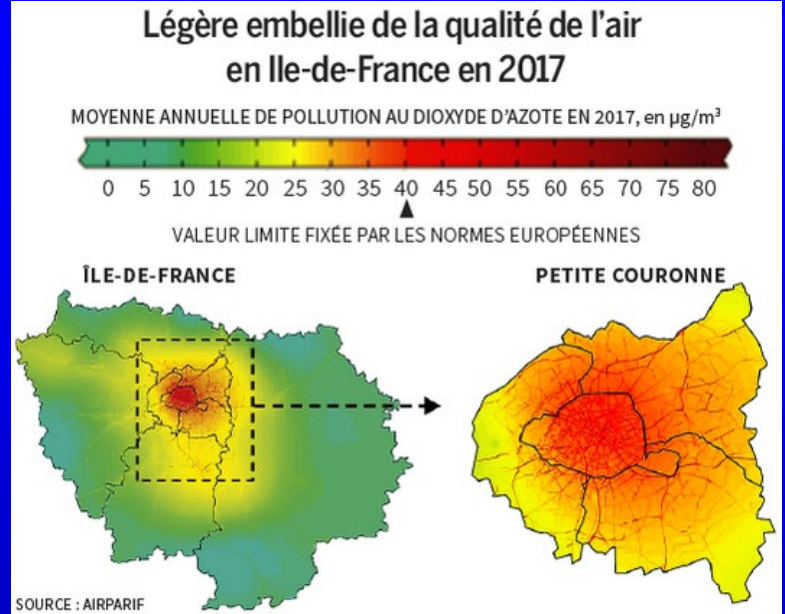
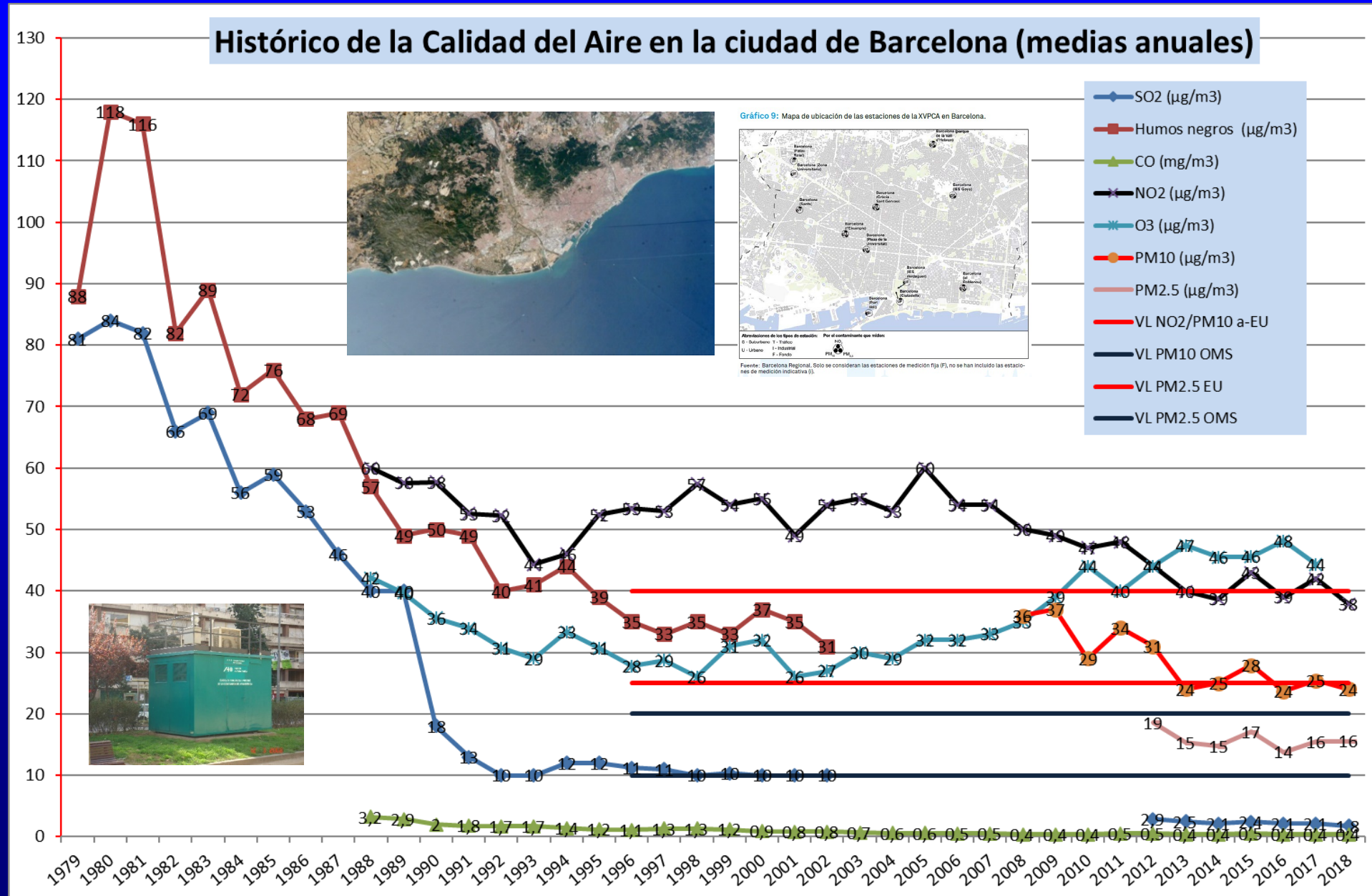
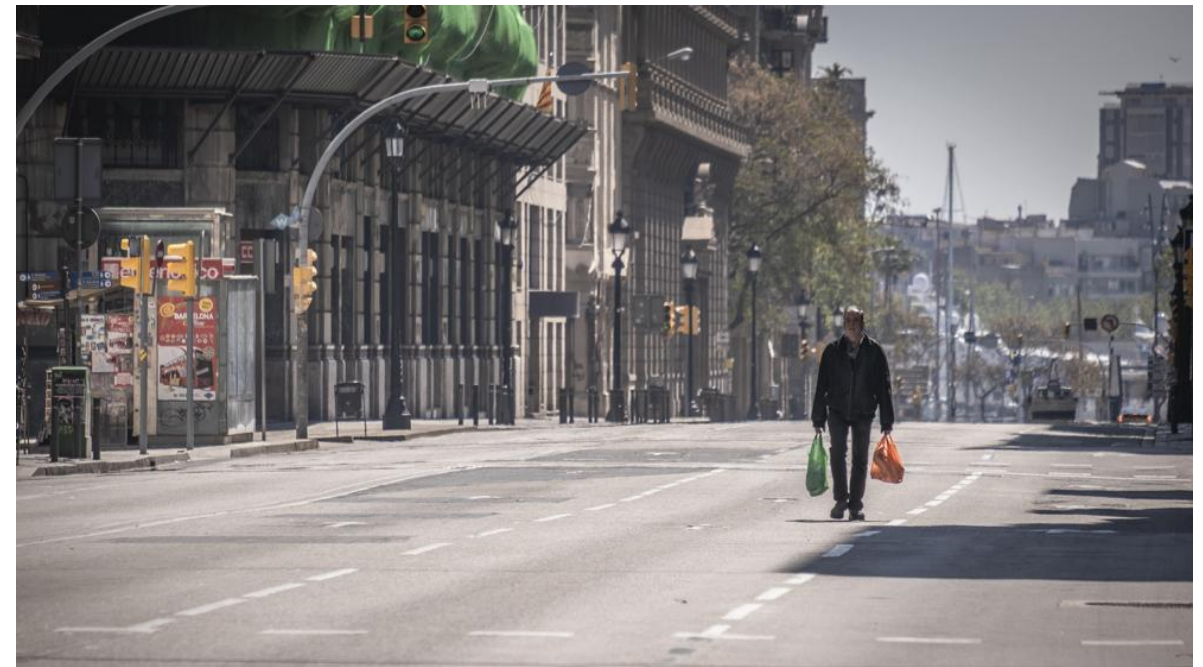
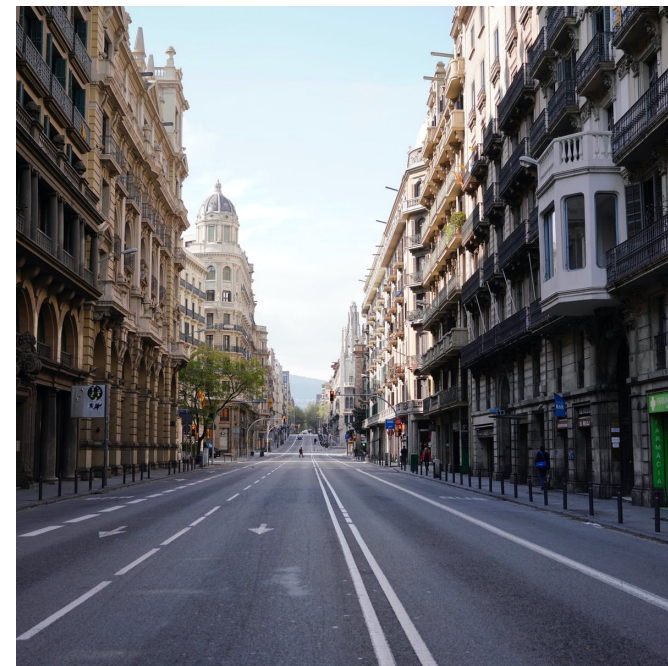
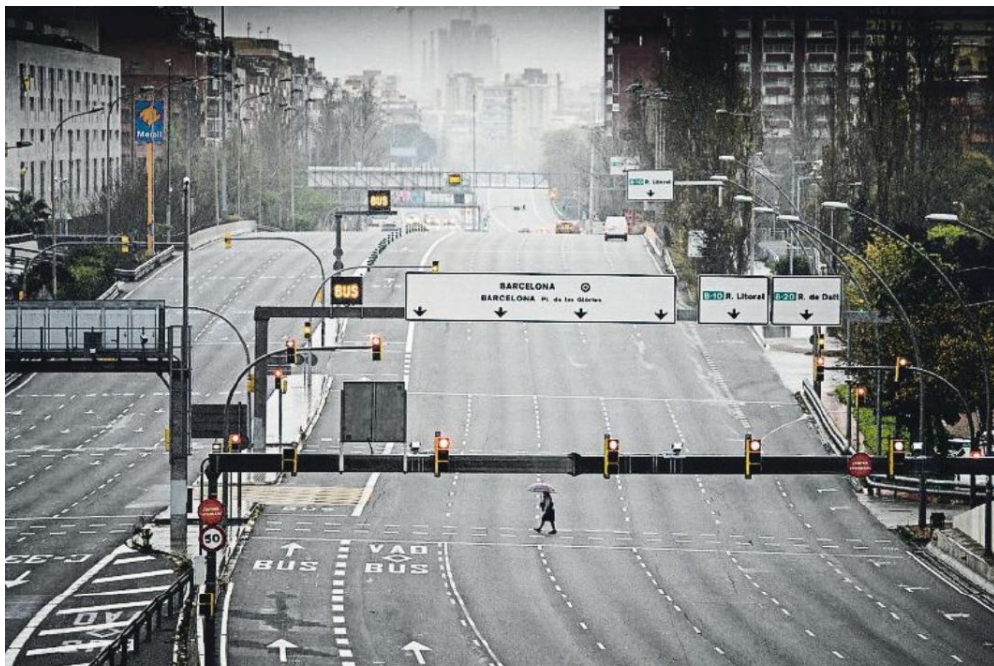


Figure 2. Schematic representation of the incremental approach (modified from Lenschow et al., 2001) The empty arrows represent concentrations and the filled arrows represent increments.



BCN air quality temporal evolution: 1979-2018







Vista panorámica de Barcelona con Mallorca de fondo /
@alfons_pc

Así ha amanecido Barcelona, con Mallorca de fondo

La isla de las baleares era visible desde el Observatori Fabra de la ciudad



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COVID-19 lockdown effects on air quality by NO₂ in the cities of Barcelona and Madrid (Spain)

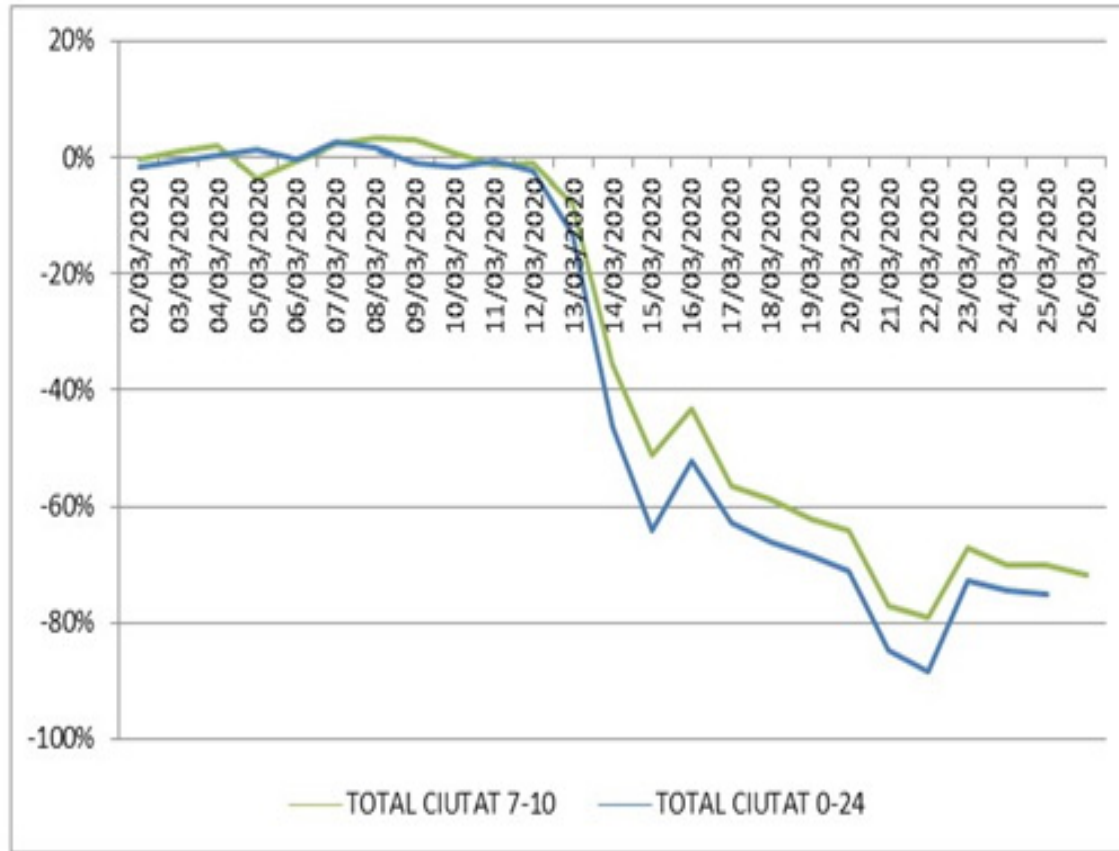
José M. Baldasano

Technical University of Catalonia (UPC), Barcelona Supercomputing Center (BSC), Edificio Nexus II, c/Jordi Girona 29, E-08034 Barcelona, Spain



<https://doi.org/10.1016/j.scitotenv.2020.140353>

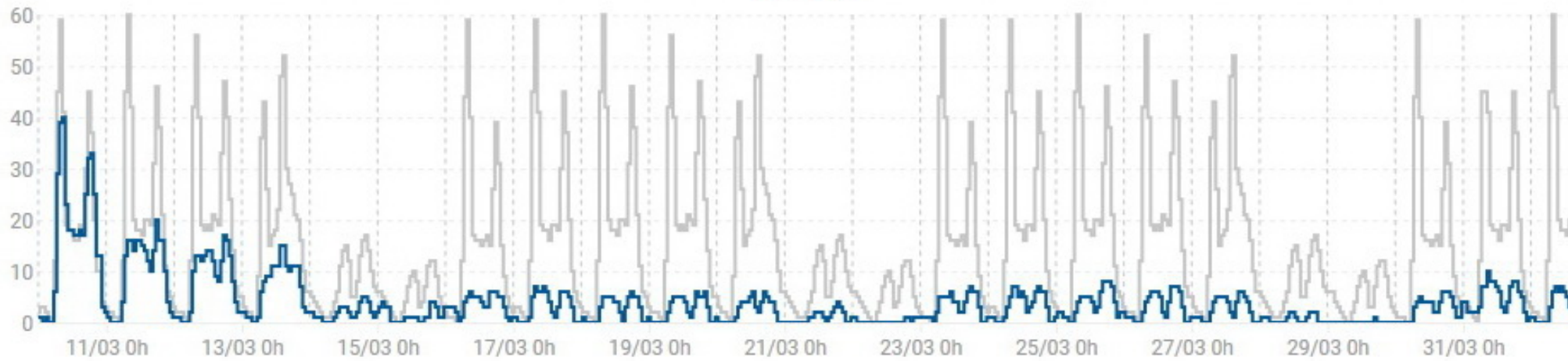
Barcelona ciudad: TRÁFICO



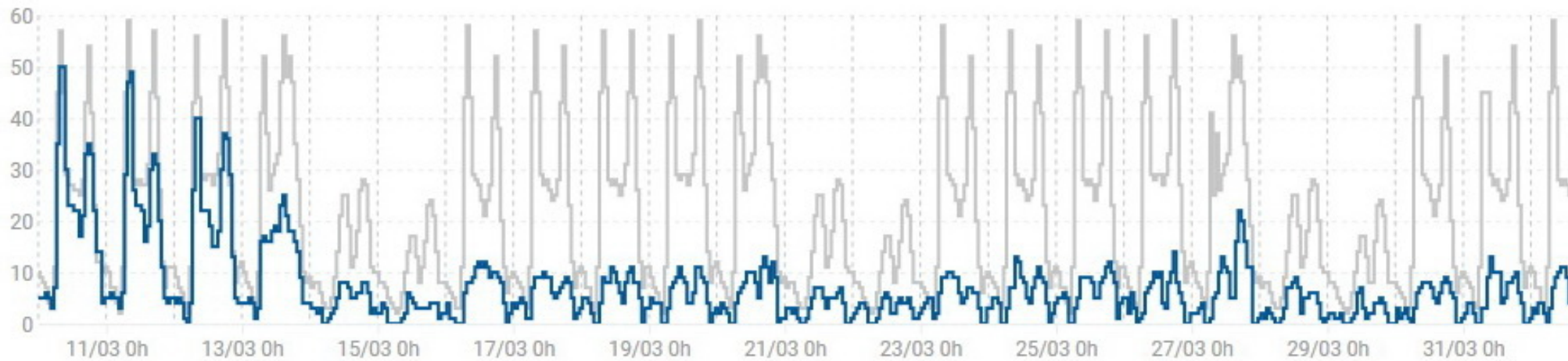
En Barcelona durante la segunda quincena del mes de marzo desde la declaración del Estado de Alarma (14.3.2020), el tráfico bajó alrededor de un -75% respecto de un día laborable del mes de febrero; y hasta un 82% en sus accesos y salidas.

Las reducciones de tráfico se han registrado tanto en los accesos como en el interior de la ciudad. Se han hecho 1,24 millones de viajes menos en vehículo privado que en un día laborable normal.

Madrid



Barcelona



Tráfico de acceso a las ciudades de Barcelona y Madrid: entrada y salida

ACCESOS BARCELONA	A-2		B-20		B-23		C-16		C-17		C-31		C-31S		C-32		C-33		C-58		TOTAL	
	p.k. 602+670	p.k. 602+405	p.k. 21+050	p.k. 21+050	p.k.7+610	p.k.7+610	p.k. 5+800	p.k. 5+800	p.k. 6+050	p.k. 6+050	p.k. 215+570	p.k. 215+570	p.k. 188+430	p.k. 188+430	p.k. 54+060	p.k. 54+060	p.k. 79+230	p.k. 79+230	p.k. 5+970	p.k. 5+970	SALIDA	ENTRADA
% respecto febrero 2020	-75%	-76%	-80%	-82%	-75%	-77%	-93%	-92%	-71%	-70%	-83%	-83%	-84%	-85%	-78%	-79%	-85%	-84%	-76%	-74%	-80%	-80%

ACCESOS MADRID	A-1		A-2		A-3		A-4		A-42		A-5		M-501		A-6		M-607		TOTAL	
	Alcobendas		Madrid		Madrid		Getafe		Madrid		Madrid		Boadilla		Pozuelo		El Goloso			
	p.k. 13+650	p.k. 15+360	p.k. 8+500	p.k. 8+500	p.k. 8+480	p.k. 8+480	p.k. 13+050	p.k. 12+300	p.k. 5+800	p.k. 5+800	p.k. 7+850	p.k. 7+850	p.k. 6+000	p.k. 6+000	p.k. 10+420	p.k. 10+000	p.k. 16+650	p.k. 16+650	SALIDA	ENTRADA
% respecto febrero 2020	-85%	-84%	-86%	-84%	-80%	-84%	-76%	-72%	-78%	-79%	-78%	-79%	-86%	-86%	-83%	-85%	-83%	-83%	-82%	-82%

<http://www.dgt.es/Galerias/covid-19/Evolucion-Intensidades-dia-02-04-2020-Periodo-Coronavirus.pdf>, 20200406

	General	Pesados	Ligeros
Movimientos de largo recorrido	-72,41%	-43,71%	-83,14%
	Total	Francia	Portugal
Movimientos fronterizos	-81,23%	-83,18%	-72,28%
Movimientos en accesos a ciudades: entradas/salidas	General	Barcelona	Madrid
	-78%	-80%	-82%

Source: DGT (2020)

	Retail & recreation	Grocery & pharmacy	Parks	Transit stations	Workplaces	Residential
Spain	-94%	-76%	-89%	-88%	-64%	+22%
Catalonia	-94%	-75%	-90%	-88%	-64%	+21%
Community of Madrid	-94%	-72%	-92%	-89%	-65%	+22%

Source: March 14 and 29 (Google, 2020)

Catalonia

Retail & recreation

-94% compared to baseline



Grocery & pharmacy

-75% compared to baseline



Parks

-90% compared to baseline



Community of Madrid

Retail & recreation

-94% compared to baseline



Grocery & pharmacy

-72% compared to baseline



Parks

-92% compared to baseline



Transit stations

-88% compared to baseline



Workplace

-64% compared to baseline



Residential

+21% compared to baseline



Transit stations

-89% compared to baseline



Workplace

-65% compared to baseline



Residential

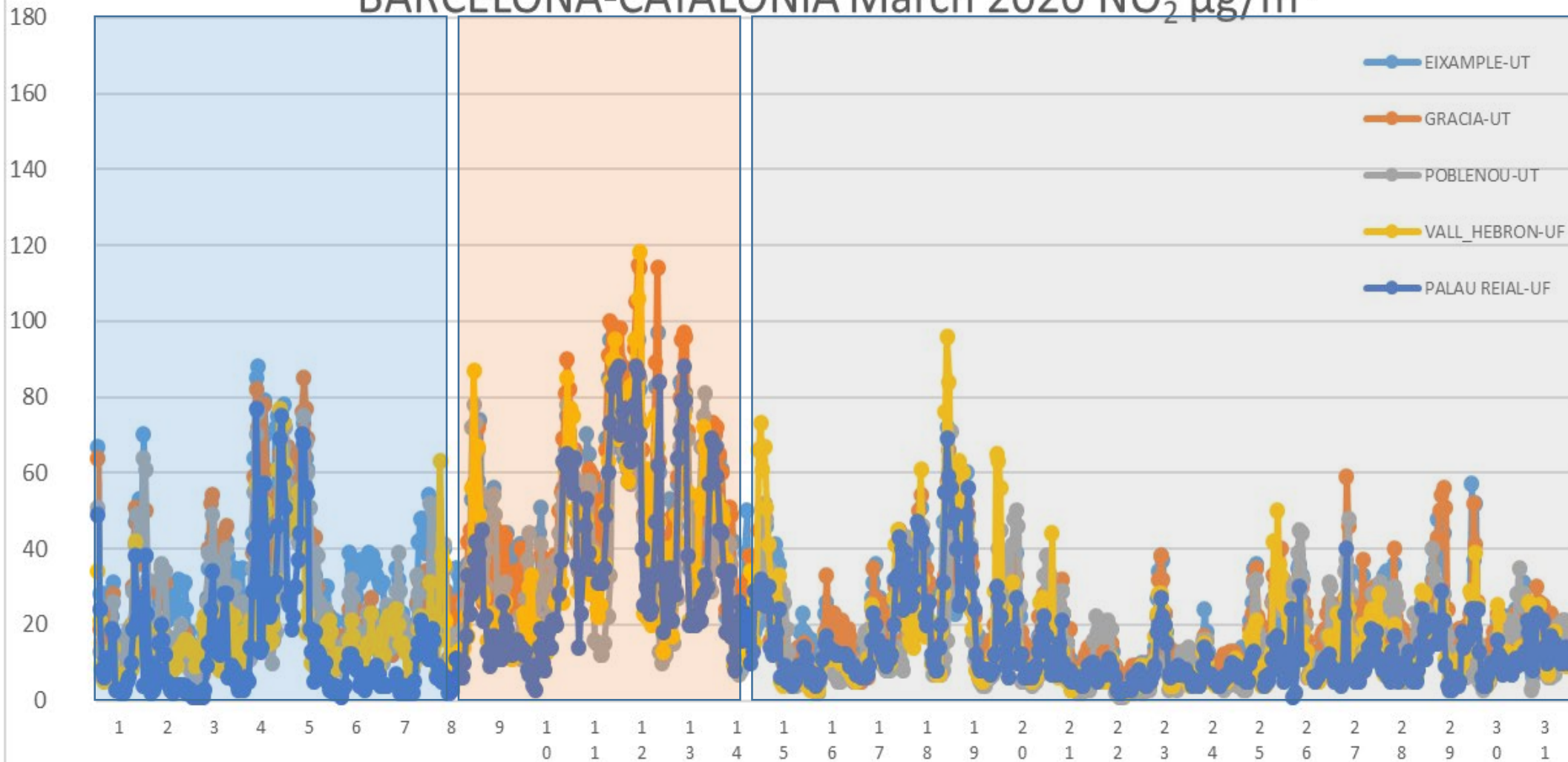
+22% compared to baseline



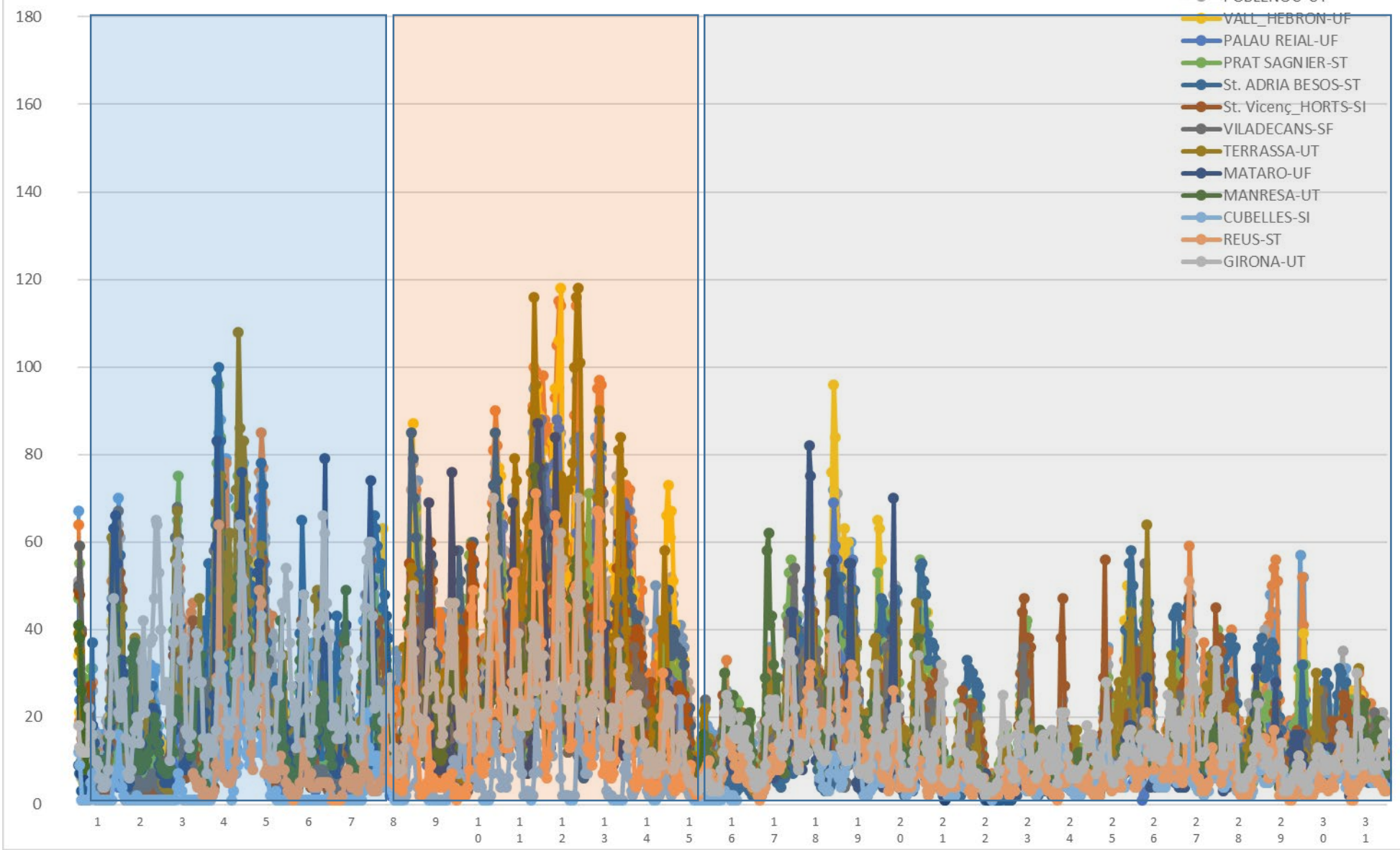
Source: March 14 and 29 (Google, 2020)



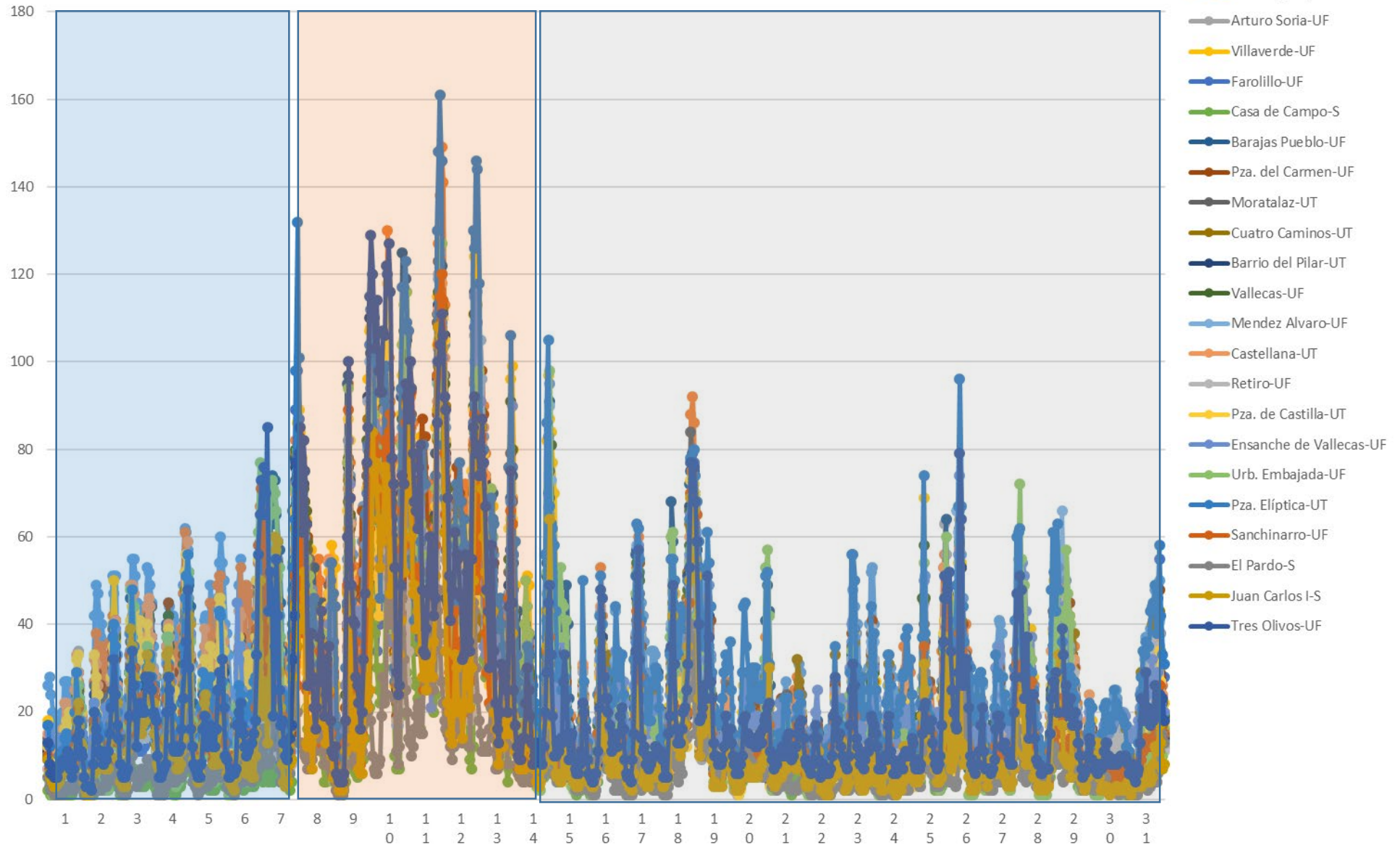
BARCELONA-CATALONIA March 2020 NO₂ μg/m³



BARCELONA-CATALONIA March 2020 NO₂ µg/m³



MADRID March 2020 NO2 $\mu\text{g}/\text{m}^3$

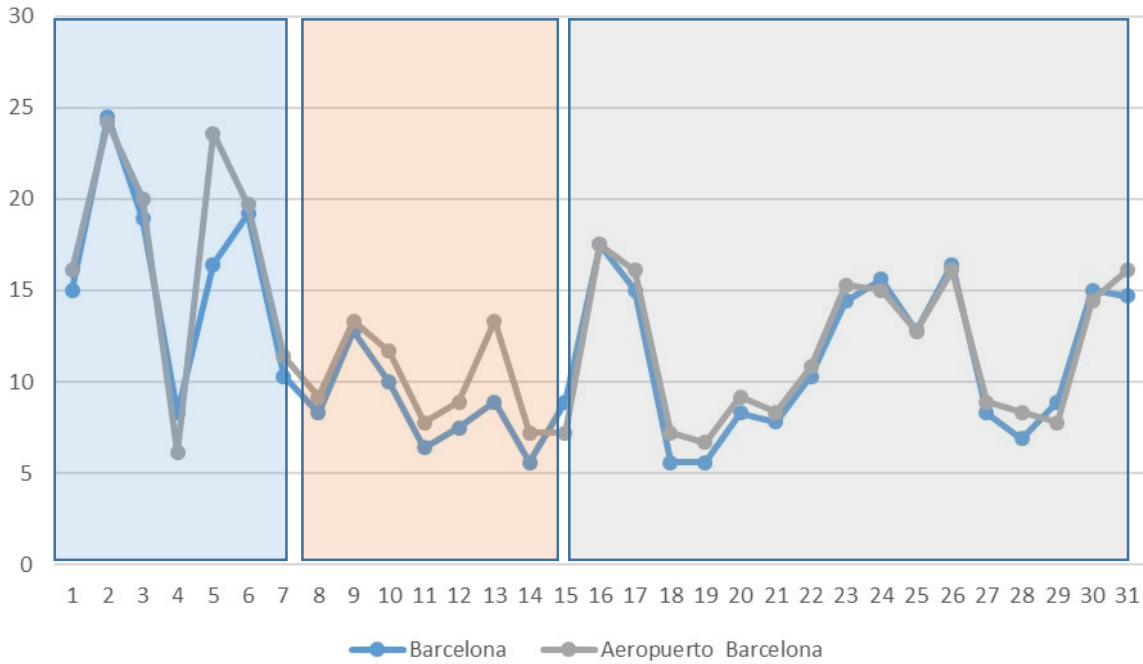


It is well known that the air quality problem is a combination result of:

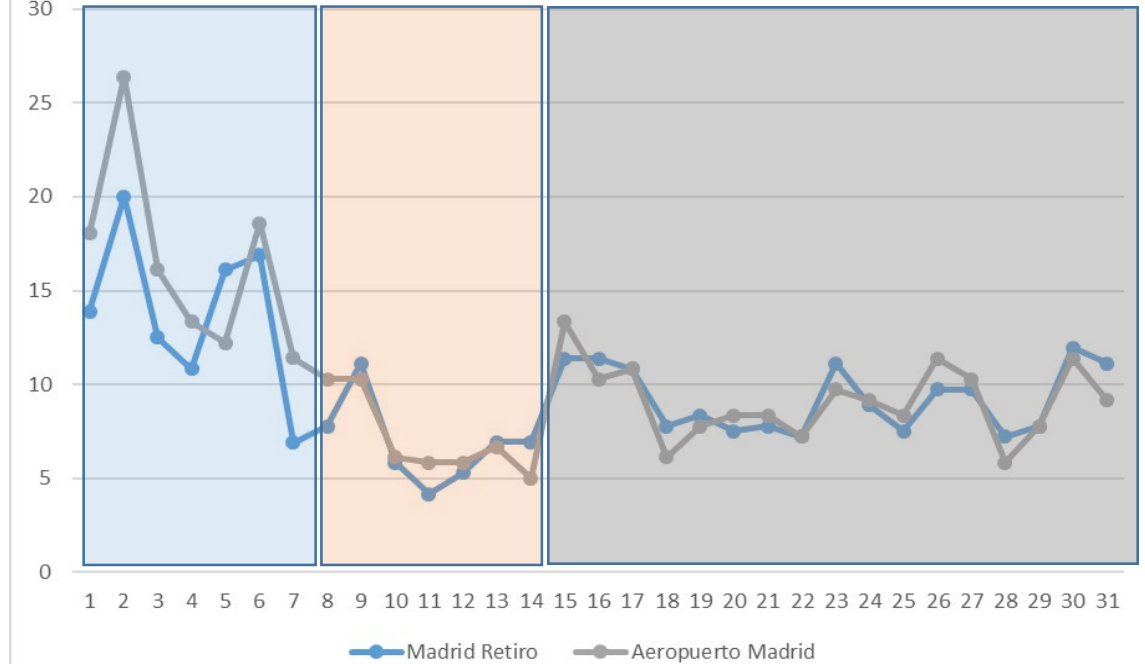
- 1. Pollutant emissions:*** ¿what? ¿when? ¿how much?
- 2. Location:*** ¿where? → Topography (plains, mountains, valleys, coast area, urban area, ...)
- 3. Meteorology*** that regulates the dispersion and transport of pollutants (wind speed, temperature inversion, and height of the planetary boundary layer as the dominant meteorological factors)
- 4. Atmospheric chemistry:*** from primary to secondary pollutants

Condiciones METEOROLÓGICAS: Marzo 2020

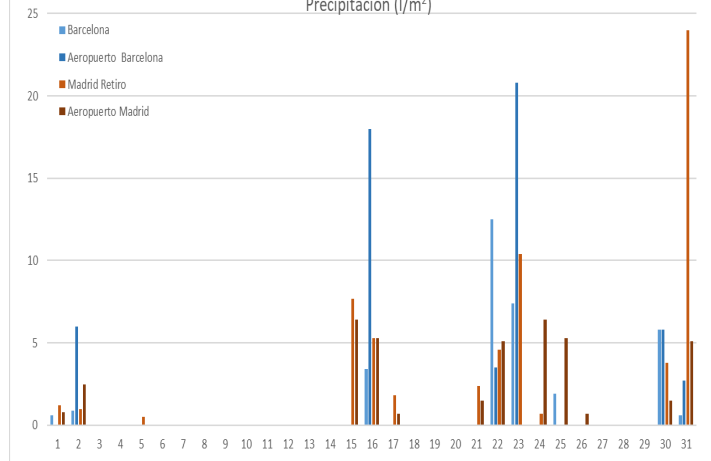
Barcelona VIENTO (M/S)



Madrid Retiro VIENTO (m/s)



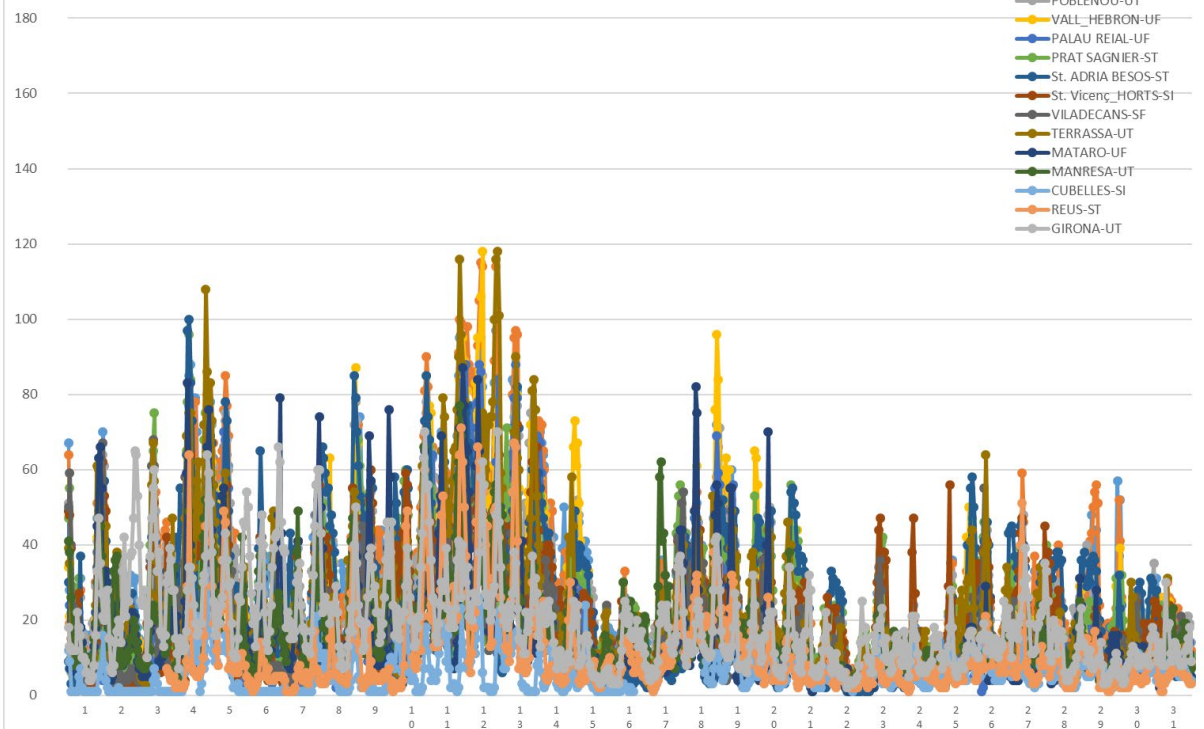
Precipitación (l/m²)



NO₂: Marzo 2020 vs. 2019 y 2018

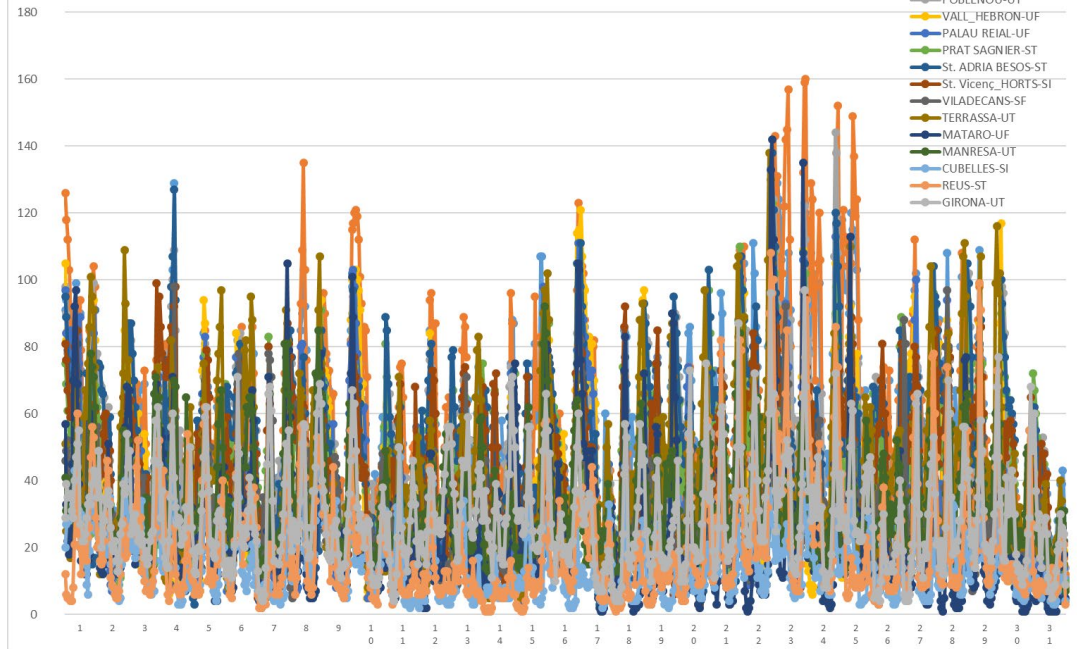
BARCELONA-CATALONIA March 2020 NO₂ µg/m³

- EIXAMPLE-UT
- GRACIA-UT
- POBLENOU-UT
- VALL_HEBRON-UF
- PALAU_REIAL-UF
- PRAT_SAGNIE-ST
- St. ADRIA_BESOS-ST
- St. Vicenç_HORTS-SI
- VILADECANS-SF
- TERRASSA-UT
- MATARO-UF
- MANRESA-UT
- CUBELLES-SI
- REUS-ST
- GIRONA-UT



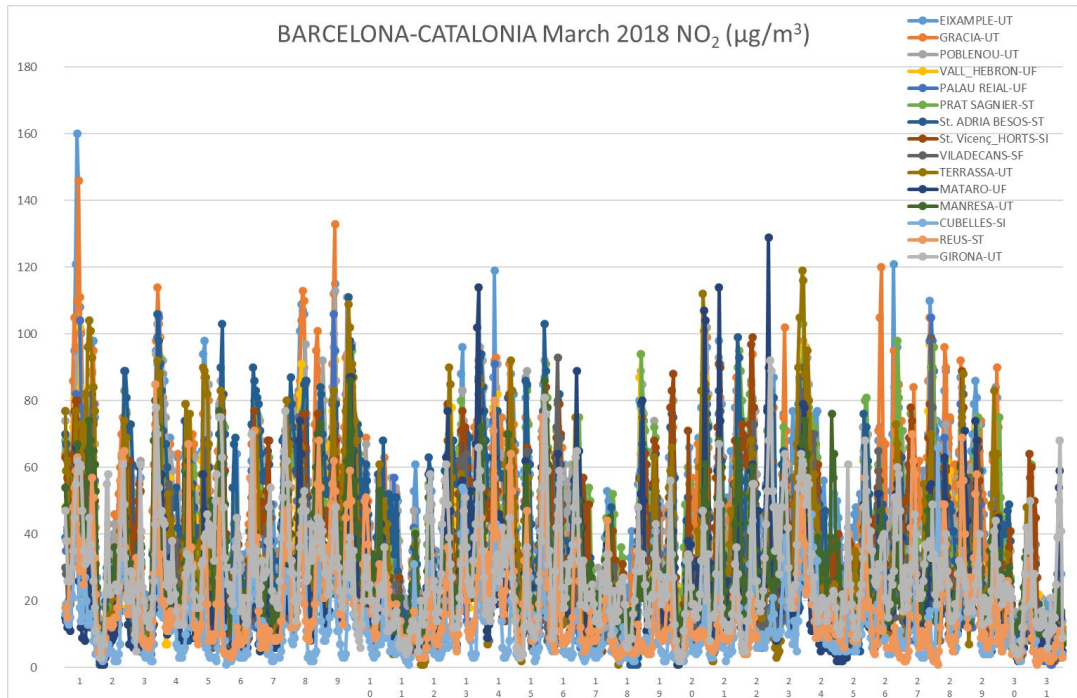
BARCELONA-CATALONIA March 2019 NO₂ (µg/m³)

- EIXAMPLE-UT
- GRACIA-UT
- POBLENOU-UT
- VALL_HEBRON-UF
- PALAU_REIAL-UF
- PRAT_SAGNIE-ST
- St. ADRIA_BESOS-ST
- St. Vicenç_HORTS-SI
- VILADECANS-SF
- TERRASSA-UT
- MATARO-UF
- MANRESA-UT
- CUBELLES-SI
- REUS-ST
- GIRONA-UT



BARCELONA-CATALONIA March 2018 NO₂ (µg/m³)

- EIXAMPLE-UT
- GRACIA-UT
- POBLENOU-UT
- VALL_HEBRON-UF
- PALAU_REIAL-UF
- PRAT_SAGNIE-ST
- St. ADRIA_BESOS-ST
- St. Vicenç_HORTS-SI
- VILADECANS-SF
- TERRASSA-UT
- MATARO-UF
- MANRESA-UT
- CUBELLES-SI
- REUS-ST
- GIRONA-UT



Concentraciones medias, relación de valor máximo y reducciones en NO₂ debido al bloqueo, marzo de 2020, 2019 y 2018 en Madrid y Barcelona (España)

March 2020	Madrid				Barcelona			
NO ₂ (µg/m ³)	Average	UT (8)	UF (12)	S(3)	Average	UT(3)	UF (3)	S(3)
month conc.	23.0	23.3	23.5	12.3	22.1	26.4	20.4	19.8
1st week	19.2	21.3	18.6	8.6	22.2	28.4	18.5	19.7
2nd week	40.9	40.2	42.5	23.4	33.4	40.7	31.3	28.3
1st-15 days	30.7	31.3	31.3	16.4	28.2	34.9	25.3	24.4
2nd-15 days	15.8	15.9	16.2	8.5	16.4	18.0	15.7	15.5
2nd-15 days vs 1st-week %	-18%	-26%	-13%	-2%	-23%	-37%	-15%	-21%
2nd-15 days vs 2nd-week %	-62%	-61%	-62%	-64%	-50%	-56%	-50%	-45%
1st-week vs 2nd-week %	-53%	-47%	-56%	-63%	-34%	-30%	-41%	-30%
2nd-15 days vs 1st-15 days %	-49%	-49%	-48%	-48%	-42%	-49%	-38%	-36%
Maximum value ratio								
1st week vs 2nd-15 days	1.06	1.05	1.11	0.91	1.26	1.19	1.21	1.37
2nd week vs /2nd-15 days	1.65	1.62	1.70	1.53	1.33	1.43	1.28	1.30
Comparison with the years 2019 and 2018								
month conc.	36.1	42.7	35.0	20.7	40.3	49.1	34.4	37.4
2nd-15 days 2020 vs month 2019 %	-56%	-63%	-54%	-59%	-59%	-63%	-54%	-59%
month conc.	29.4	37.7	28.5	14.2	36.1	44.6	30.6	34.4
2nd-15 days 2020 vs month 2018 %	-46%	-58%	-43%	-40%	-55%	-60%	-49%	-58%

Confinamiento vs Buenas condiciones dispersivas

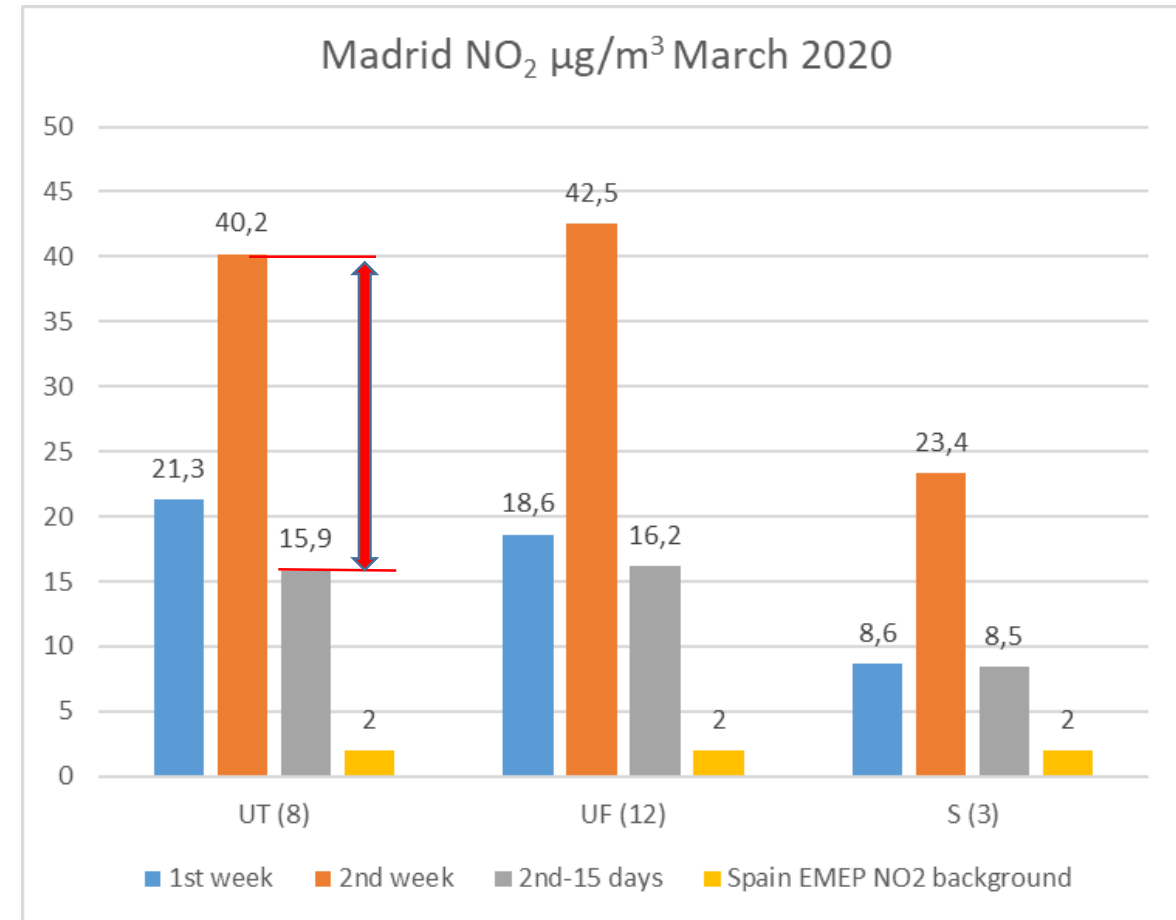
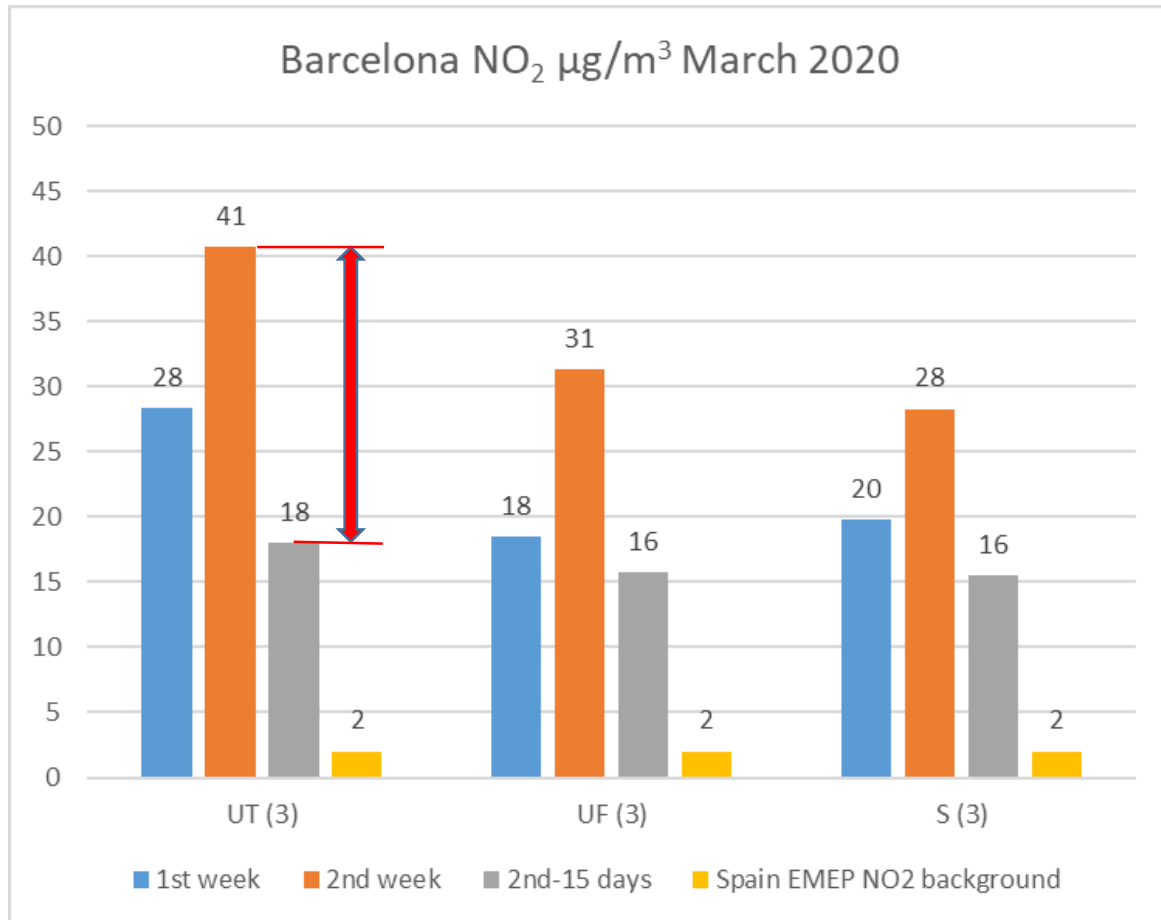
Confinamiento vs Malas condiciones dispersivas

Buenas vs Malas condiciones dispersivas

Con “confinamiento” los picos son menores

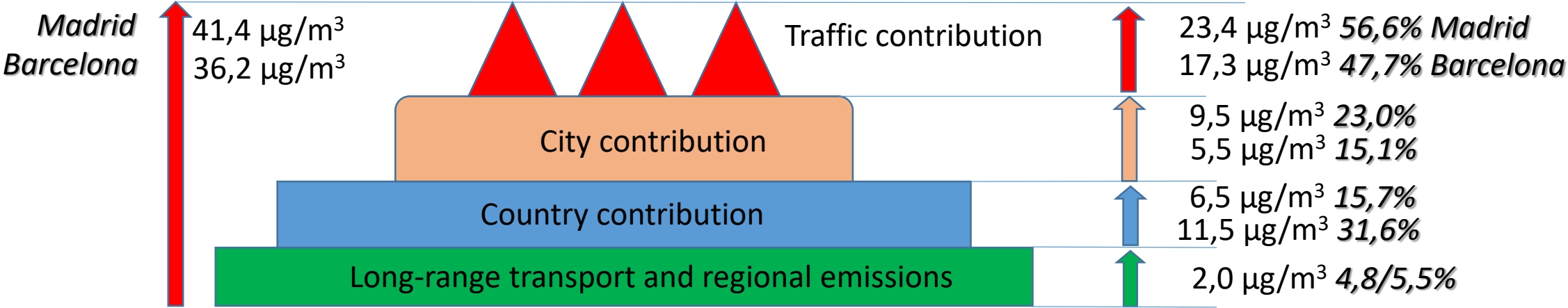
La comparación con otros años viene condicionada por las condiciones de tráfico y de meteorología específicas de cada año

NO₂ concentration levels in Barcelona and Madrid according to the station type, meteorological and emission reduction situation



Contributions of Traffic, City, Country and Long-range transports to NO₂ pollution levels in Madrid and Barcelona

March 2020 NO ₂ (µg/m ³)	Madrid			Barcelona		
	accumulated	specific		accumulated	specific	
Traffic contribution	41,4	23,4	56,5 %	36,2	17,3	47,7%
City contribution	18,0	9,5	23,0 %	18,9	5,5	15,1%
Country contribution	8,5	6,5	15,7 %	13,5	11,5	31,6%
Long-range transport and regional emissions	2	2	4,8%	2	2	5,5%



Alcance esperable de las medidas planificadas y adoptadas

En el caso de Barcelona, se espera que la implementación de la ZBE, de acuerdo con el trabajo de modelización realizado para el año 2020, reduzca la concentración en un 11% de NO₂, esto implica que esto implica una reducción entre 3.1 y 7.7 µg/m³ de NO₂, dependiendo del área de la ciudad (BR, 2019).

El Ayuntamiento de Madrid lanzó el Plan de Calidad del Aire y Cambio Climático para la ciudad de Madrid (Plan A), una estrategia local aprobada en 2017, su implementación solo implicaría una reducción en la media anual de la ciudad de Madrid de 4 µg/m³ para NO₂ (Izquierdo et al., 2020).

Los resultados de la aplicación de la ZBE: Madrid Central en 2019 muestran una reducción de 10 µg/m³ para esta área específica en comparación con los promedios anuales de los últimos 9 años, y para toda la ciudad de Madrid la reducción fue de solo 4 µg / m³ (Ayt Madrid, 2020, EeA, 2020a).

Las diferencias son de 20 a 3.1-7.7 µg/m³ en Barcelona y de 23.4 a 4 µg/m³ en Madrid

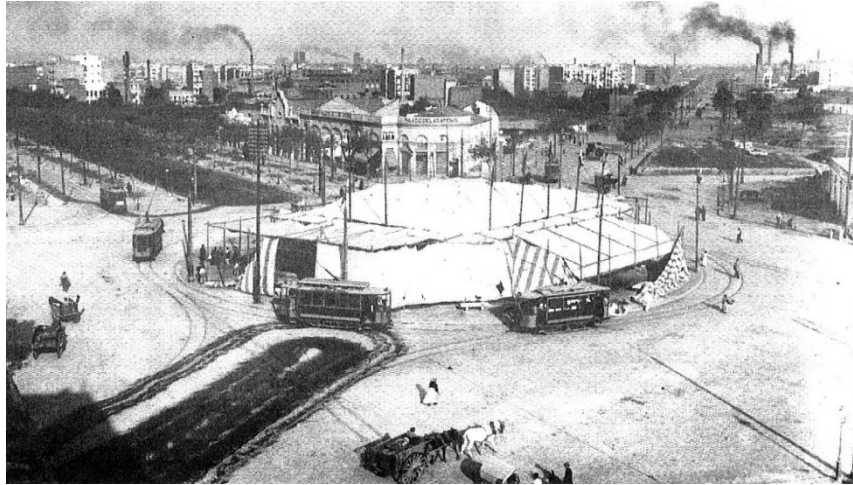
*¿Que **BARCELONA** queremos?*



BARCELONA 1908 → 2020 ...



Plaça Espanya, Barcelona (1908)



Plaça Espanya, Barcelona (2014)



C/ Gran de Gràcia, Barcelona (1908)



C/ Gran de Gràcia, Barcelona (2014)



Barcelona city, is presently taking measures to improve their air quality until 2010:

1. Introducing **blue** and **green** parking toll areas.



2. Increase the pedestrian area.



3. Define areas of low speed circulation < 30 km / h inside of the city.



4. Bicing introduction.



5. 2007 General AQ plan with 73 measures for the Barcelona Metropolitan Area (BMA), especially one, 80 km/h speed limit in the main entrance freeways in the city.



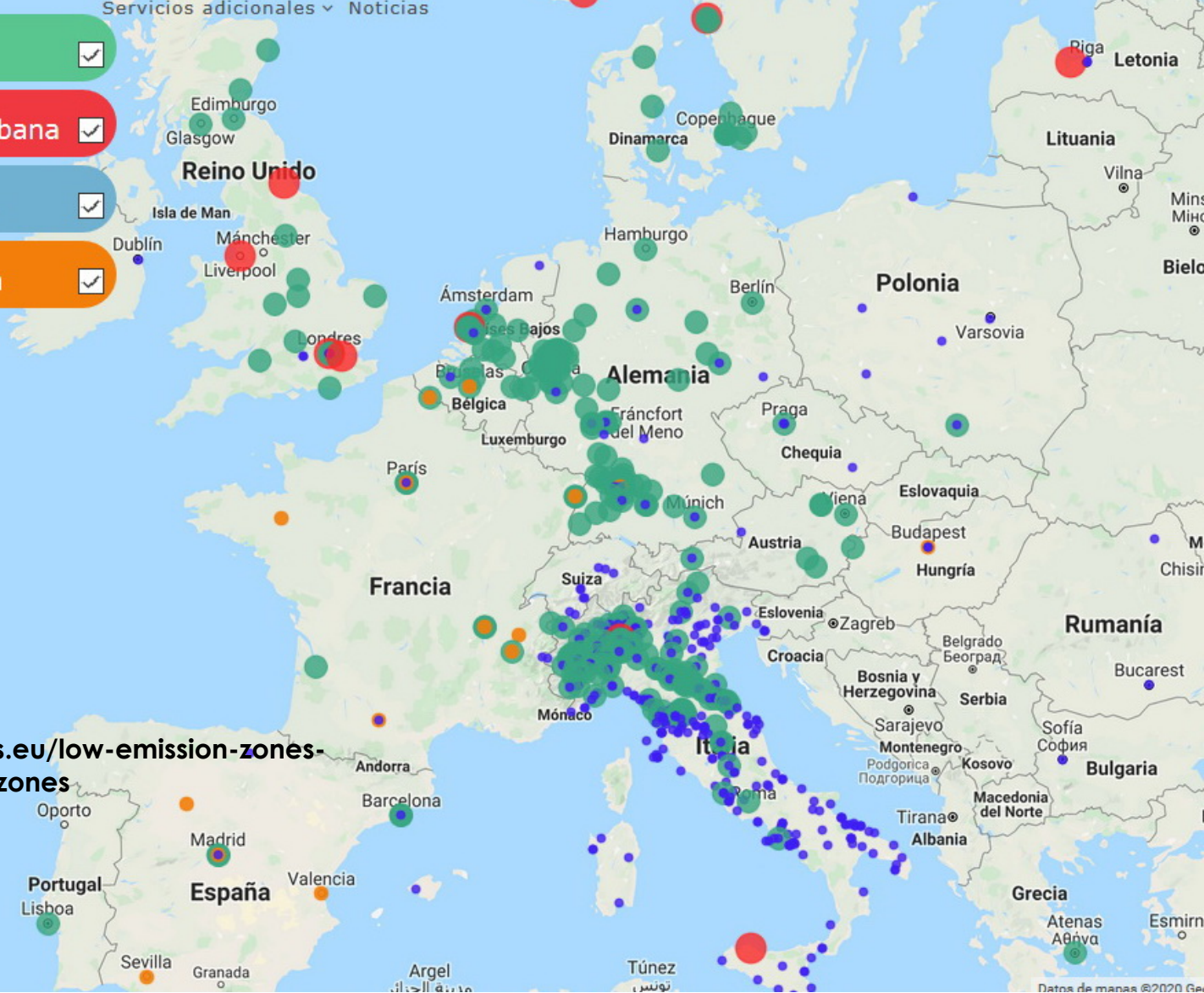
Tafels a 80. Píndoles que indican la limitación de velocidades de la velocidad a 80 km/h en un acceso a Barcelona por autopista, en Molins de Rei.

-  Zona de Baja Emisión
-  Los peajes de carretera urbana
-  Otra regulación de acceso
-  Emergencia contaminación



<https://urbanaccessregulations.eu/low-emission-zones-main/impact-of-low-emission-zones>
<http://urbanaccessregulations.eu/userhome/map>

Google



Una **zona de emisión cero (ZBE)** es un área en el que sólo se permiten vehículos de emisión cero (**LZE Low Emission Zone**).

El territorio restringido tiene 95 km², 20 veces más que el área de Madrid Central

Zona donde no podrán circular los vehículos que no tienen etiqueta ambiental de la DGT

Zonas y vías donde sí podrán circular



Municipios parcialmente afectados

Barcelona, l'Hospitalet de Llobregat, Esplugues de Llobregat, Cornellà de Llobregat y Sant Adrià de Besòs

Horario restringido

Laborables de lunes a viernes de 7 h a 20 h



Parque censado de vehículos en el área metropolitana de Barcelona en junio del 2019

Categoría	L	M	N
Etiqueta			
0	1.508	1.361	688
ECO	0	16.044	262
C	190.372	320.959	6.904
B	96.778	420.714	53.095
Sin determinar	2.033	6.783	759
Sin etiqueta	90.694	324.013	63.505

Otras zonas de bajas emisiones

No todas las ciudades tienen las mismas restricciones: en **Barcelona** pueden entrar coches con etiquetas B o C, mientras que en **Madrid** estos vehículos solo pueden acceder si van a un 'parking'. En **Londres** los coches contaminantes tienen que pagar una tasa para circular y en **París** los vehículos más antiguos tienen prohibido acceder de 8.00 a 20.00.



LOS NUEVOS DISTINTIVOS AMBIENTALES



B

- Turismos y furgonetas ligeras
 - de gasolina matriculados a partir de enero del 2000.
 - de diésel, a partir del 2006
- Vehículos de más de 8 plazas y pesados tanto de gasolina como de diésel, matriculados a partir del 2005



C

- Turismos y furgonetas ligeras
 - de gasolina matriculados a partir de enero del 2006.
 - de diésel, a partir del 2014.
- Vehículos de más de 8 plazas y pesados, tanto de gasolina como de diésel, matriculados a partir del 2014



ECO

- Vehículos híbridos enchufables con autonomía <40km
- Híbridos no enchufables (HEV)
- Propulsados por gas natural
- Propulsados por gas natural (GNC y GNL) o gas licuado del petróleo (GLP).



Cero emisiones

- Vehículo eléctrico de batería (BEV)
- Vehículo eléctrico de autonomía extendida (REEV)
- Vehículo eléctrico híbrido enchufable (PHEV) con una autonomía mínima de 40 kilómetros o vehículos de pila de combustible.

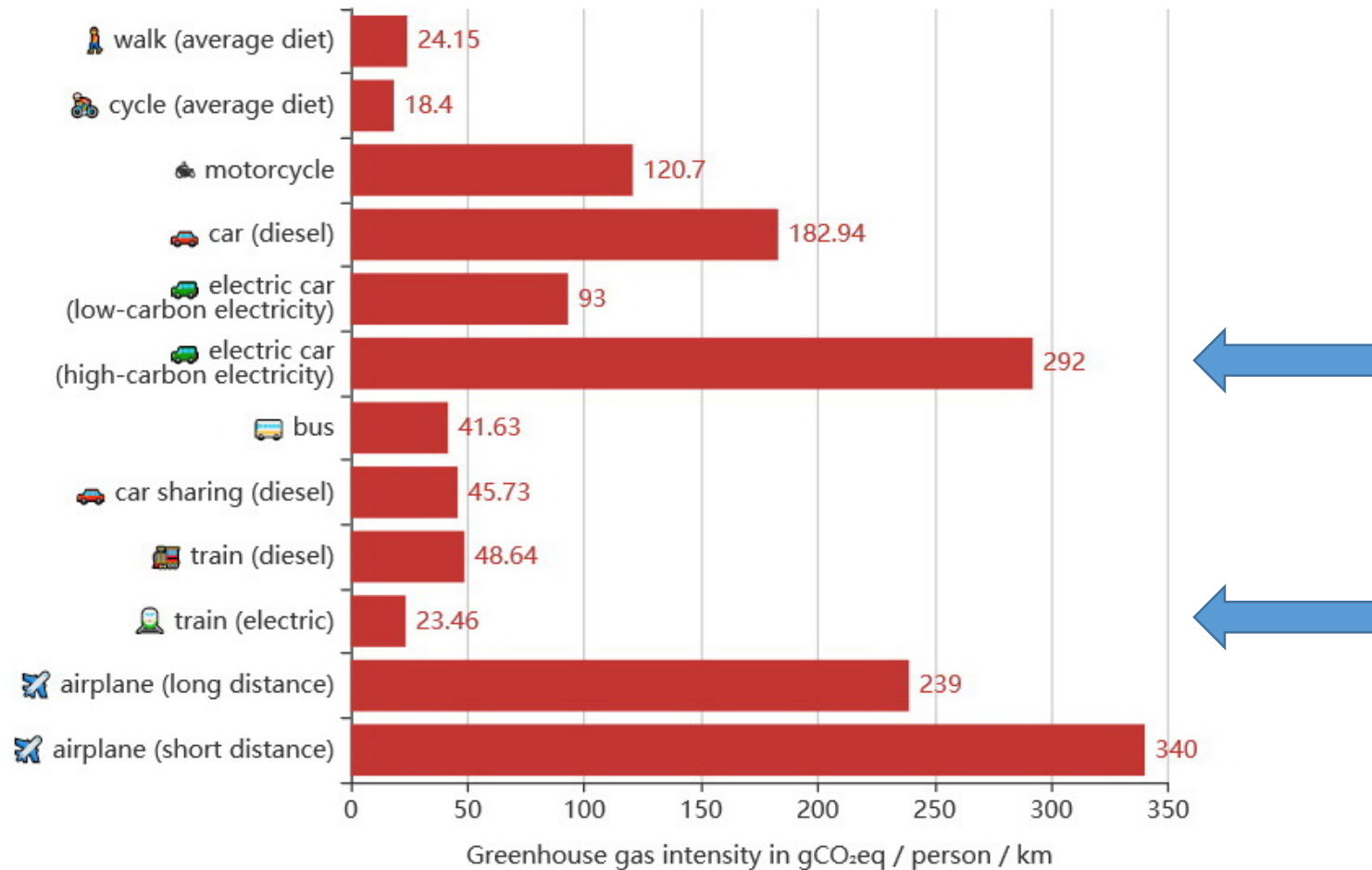
FUENTE: AMB, Ayuntamiento de Barcelona y Generalitat de Catalunya

LA VANGUARDIA

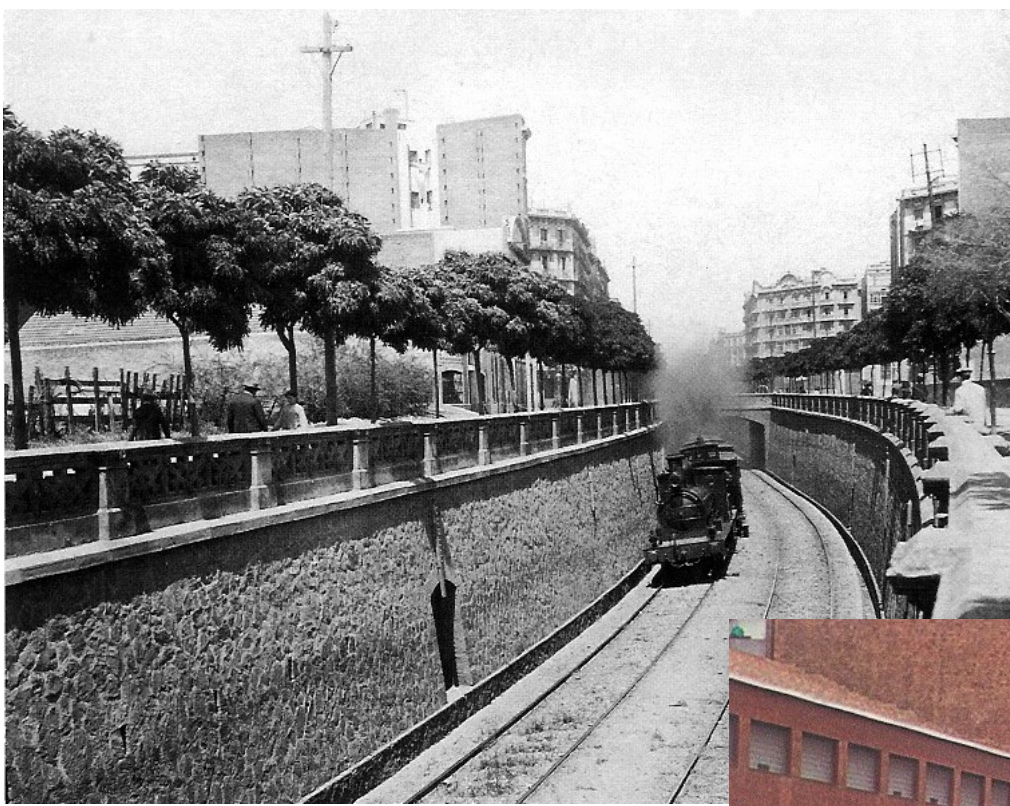
Categoría	L	M	N		
Etiqueta	Motos	Coches	Furgonetas	Total	
0 azul	1508	1361	688	3557	0,2%
ECO verde	0	16044	262	16306	1,0%
C verde	190372	320959	6904	518235	30,8%
B amarila	96778	420714	53095	570587	33,9%
	288658	759078	60949	1108685	65,9%
Sin etiqueta	90694	420714	63505	574913	34,1%
Total	379352	1179792	124454	1683598	100,0%
	23%	70%	7%		
Ratio E/SE	3,2	1,8	1,0		
% SE	24%	36%	51%		

How do we move? What model of mobility do we adopt?

Greenhouse gas intensity of transportation modes
in gCO₂eq / person / km



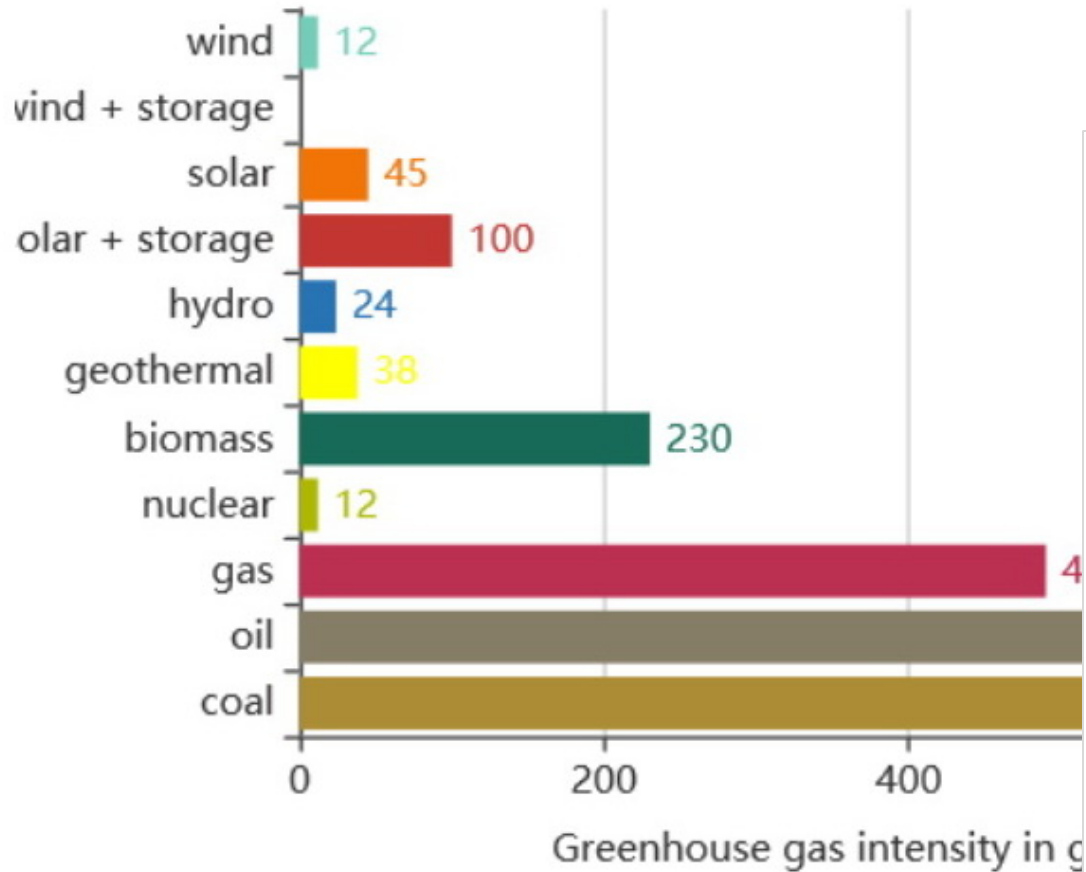
Source: [Ecoinvent 3](#) through [ducky.no](#), [Shrink that footprint](#) and [The Guardian](#). Bus assumes urban use with 75% occupancy. Motorcycle is assumed 250-750cc. Car sharing assumes driver + 3 passengers. Low-carbon electricity assumes France and high carbon Australia.



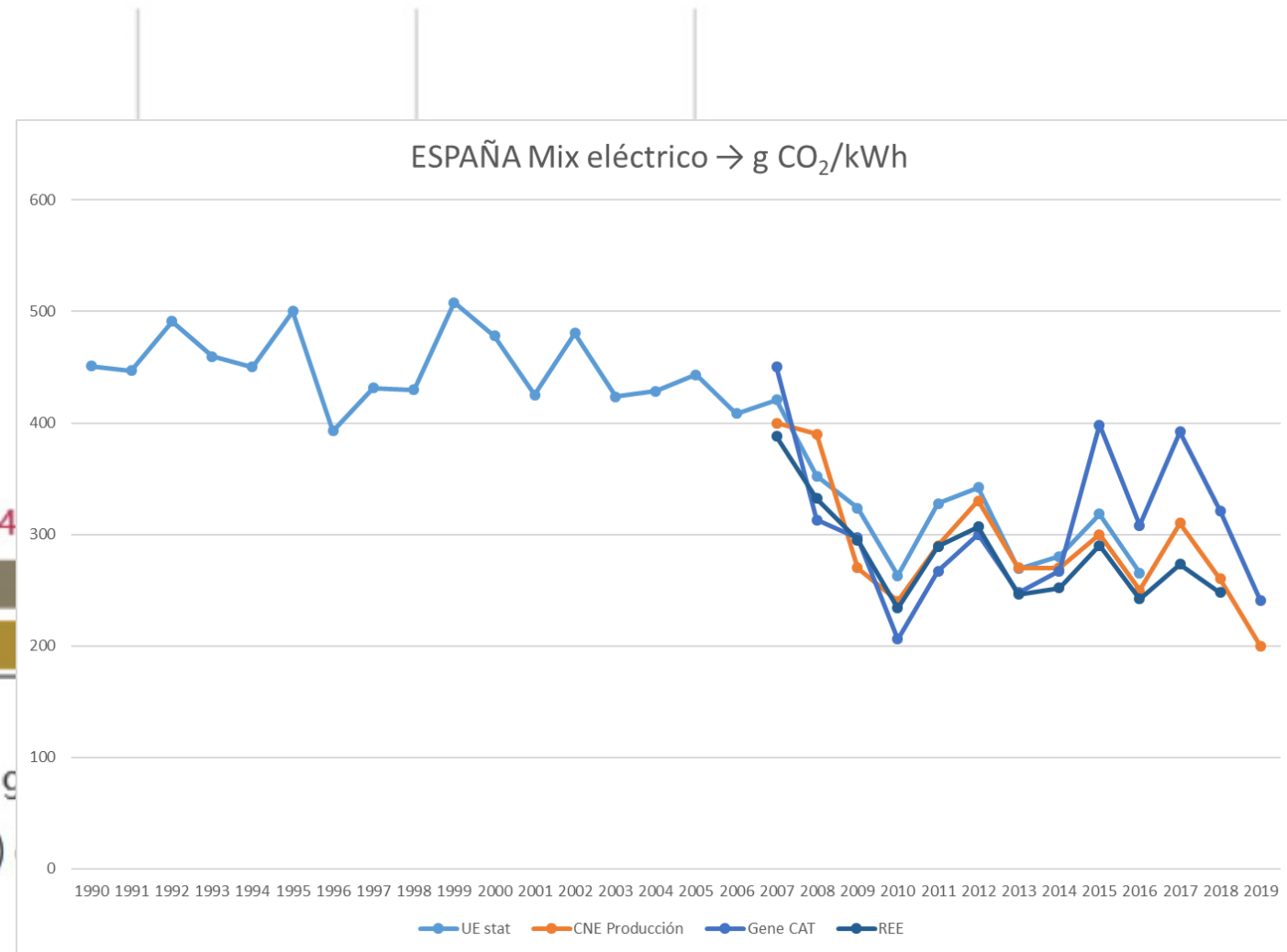
How do we generate electricity?

Greenhouse gas intensity of electricity production modes

in gCO₂eq / kWh consumed



Source: Life cycle emissions from [Electricity Map \(data\)](#) + storage intensity estimations.

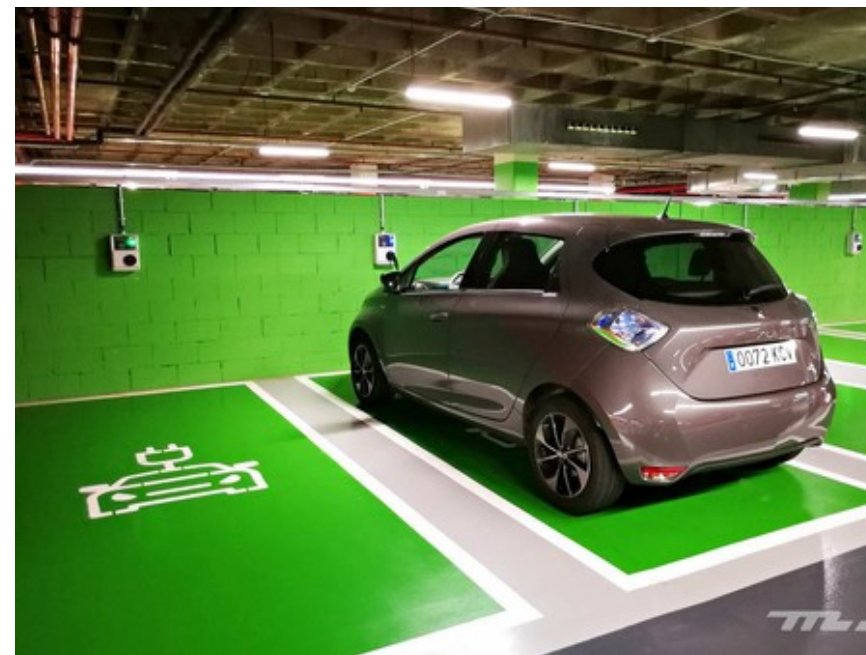


The electric car challenge



#RenaturalitzemBCN

Signa el Manifest del Verd i la Biodiversitat



BARCELONA, por un aire limpio y una movilidad sostenible:

- 1. Potenciar el máximo el transporte público: más frecuencia y conectividad**
- 2. Mejorar la red metropolitana de cercanías**
- 3. Potenciar el sistema de transporte compartido (share mobility): bicicletas, patinetes, motos y coches eléctricos**
- 4. Implementación de las “superislas”/”supermanzanas”**
- 5. Implementar una ZBE ambiciosa**
- 6. Plan Renove: solo para coches eléctricos, con énfasis especial en taxis y vehículos de reparto**
- 7. Potenciar cargadores eléctricos, en los garajes privados y públicos**
- 8. Regular el reparto, especialmente el “último km”**
- 9. Zonas de aparcamiento en las entradas a la ciudad: gratuito y vigilado**
- 10. Fomentar el teletrabajo**

Aie Quality vs. Climate Change

- ✓ In the late 1960s, specially in the US, choking smog descend over New York City and Los Angeles. These grim images sparked the modern environmental movement, the first Earth Day, and a decade of extraordinary environmental lawmaking and rulemaking (much of it under a Republican president, Richard Nixon).
- ✓ From the '70s through the end of the 20st century, the fight against fossil fuels was a fight about air pollution.
- ✓ In the two last decades, the focus has shifted to global warming, and fossil fuels have largely been reframed as a climate problem. And that makes sense, given the enormous implications of climate change for long-term human well-being.

AQ AND CC IS THE SAME WAR BUT DIFFERENT BATTLE

AIR POLLUTION - THE SILENT KILLER

Every year, around **7 MILLION DEATHS**

are due to exposure from both outdoor and household air pollution.

Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce:



Stroke



Heart disease



Lung cancer, and both chronic and acute respiratory diseases, including asthma

REGIONAL ESTIMATES ACCORDING TO WHO REGIONAL GROUPINGS:



● **Over 2 million** in South-East Asia Region

● **Over 2 million** in Western Pacific Region

● **Nearly 1 million** in Region of the Americas

CLEAN AIR FOR HEALTH

#A

Cost contaminació atmosférica

(World Bank 2016):

Espanya: el 2013 va representar

49331 10⁶ \$, ~ 3,4% PIB

CAMBIO CLIMÁTICO Y SALUD HUMANA

Fuente: OMS. The Lancet Countdown

11%

Este ha sido el aumento de la capacidad de transmitir enfermedades en algunos mosquitos, gracias a temperaturas más altas en el planeta.

7 millones

Muertes prematuras vinculadas a la contaminación ambiental en el hogar y en el exterior.

175.000.000

Este es el aumento de población expuesta a olas de calor en los últimos 15 años.

10%

Caída de la producción de arroz por cada grado celsius que aumenta la temperatura ambiental.

14%

Aumento del número de eventos meteorológicos desde el año 2000.

Serem capaços de realitzar una

Transició energètica

i que seguí també una

Transició justa i social

????

**No hi ha pla B,
NOMÉS TENIM AL NOSTRE PLANETA TERRA**



Moltes gràcies

jose.baldasano@upc.edu