Cambio climático y calidad del aire
Canvi climàtic i qualitat de l'aire

Acte commemoratiu 25è Aniversari del CEAM
València, 9 de Juny de 2016

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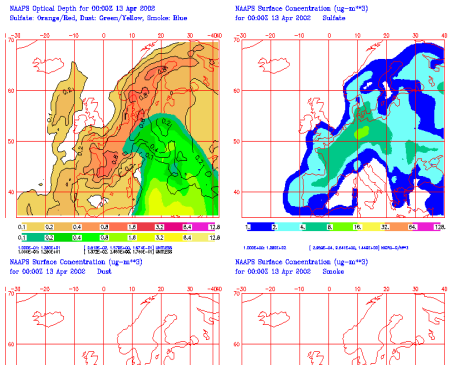
Institut de Diagnosi Ambiental i Estudis de l'Aigua, CSIC

Content

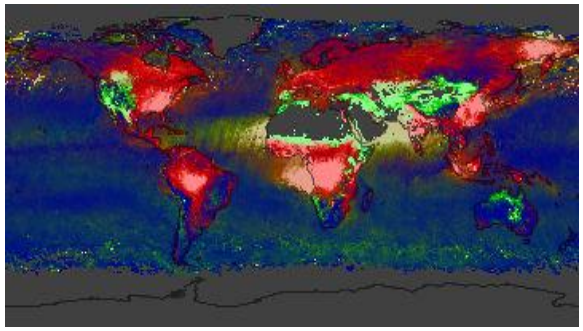
- Scales
- Effects
- Trends
- The climate effect of aerosols
- Synergies and interferences
- Wrap-up

Scales

Planetary-Global:



Global warming & Climate change
Stratospheric ozone depletion

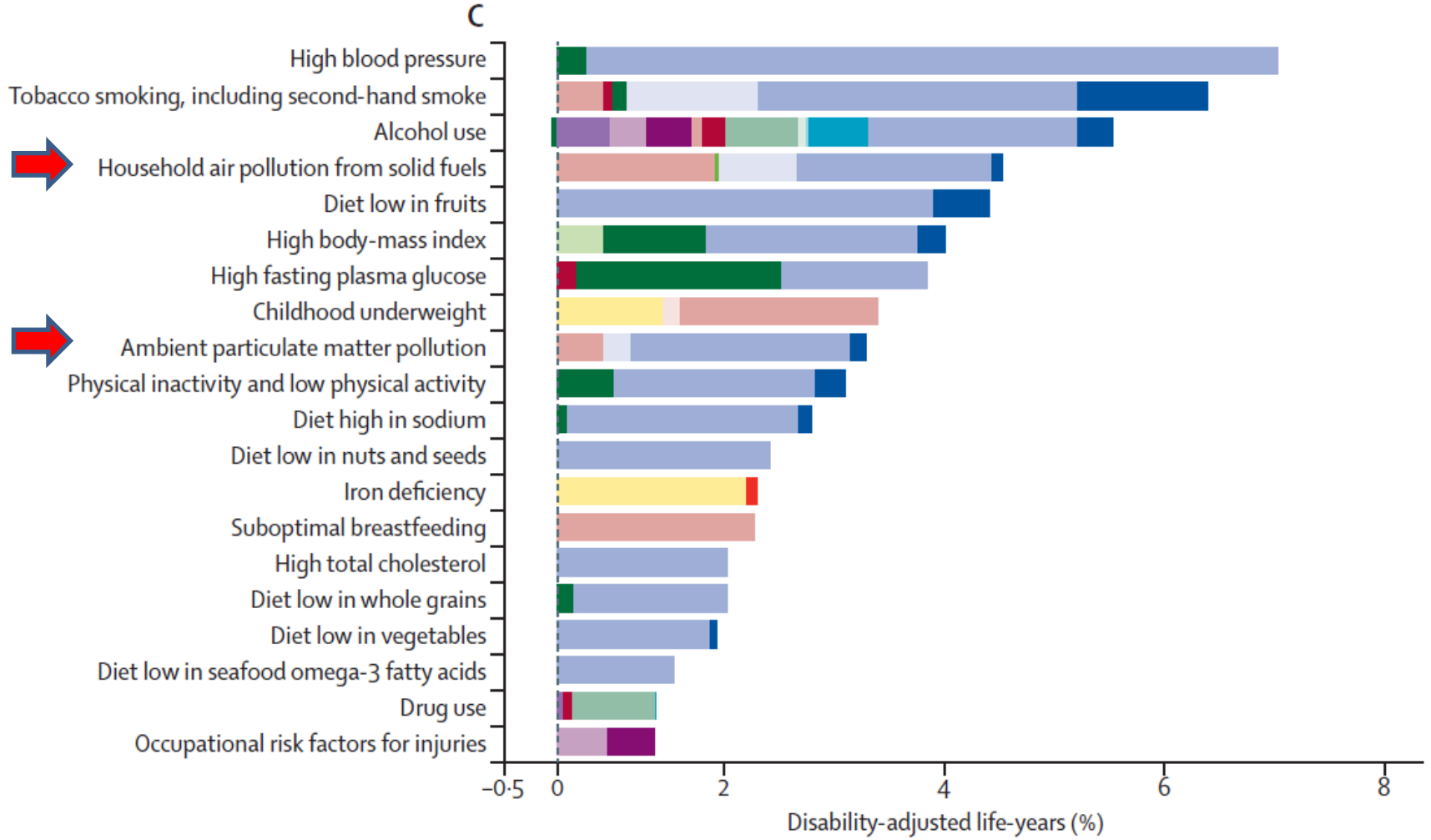


IMPORTANT: WE HAVE TO INCLUDE THE 3 SCALES TO STUDY 1 OF THESE PROCESSES

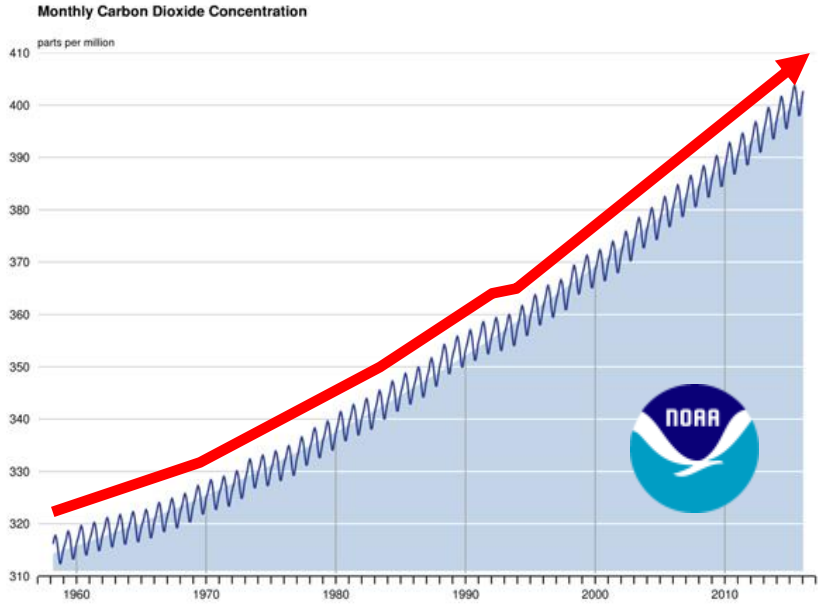
Micro-scale: Air quality, local impact from road traffic, industry, domestic,...

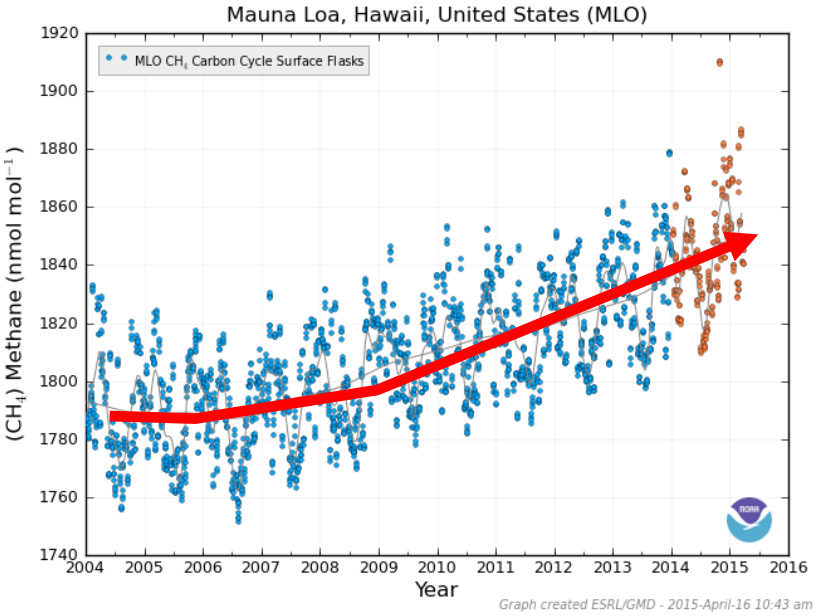
Effects

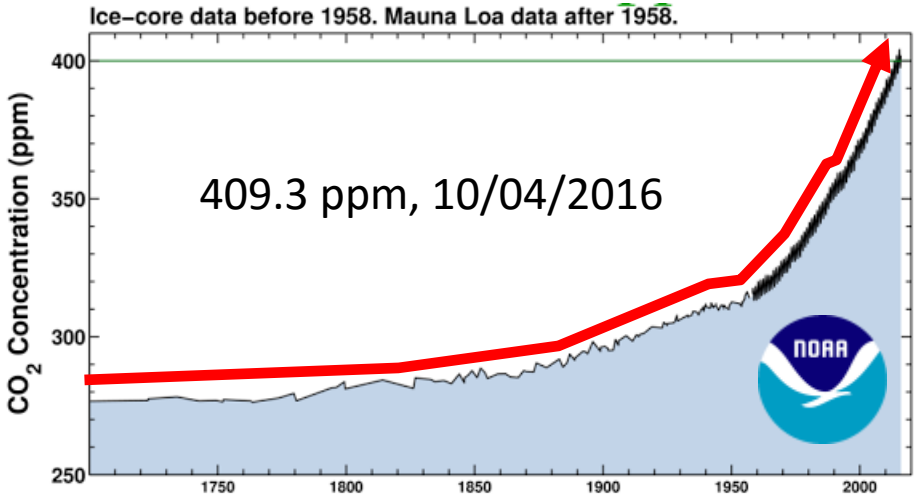
A comparative risk assessment of burden of disease and injury attributable to risk factors and risk factor clusters in 21 regions, 1990–2010 (Lancet 2012)

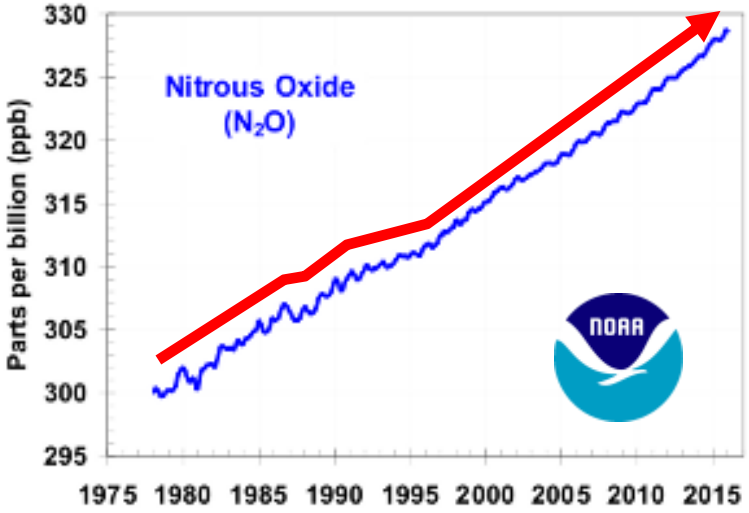


Trends


Monthly Carbon Dioxide Concentration
parts per million
410
400
390
380
370
360
350
340
330
320
310
1960
1970
1980
1990
2000
2010
NOAA


Mauna Loa, Hawaii, United States (MLO)
MLO CH4 Carbon Cycle Surface Flasks
(CH4) Methane (nmol mol−1)
1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Graph created ESRL/GMD - 2015-April-16 10:43 am


Ice–core data before 1958. Mauna Loa data after 1958.
CO2 Concentration (ppm)
400
350
300
250
1750
1800
1850
1900
1950
2000
409.3 ppm, 10/04/2016
NOAA


Nitrous Oxide
(N2O)
Parts per billion (ppb)
330
325
320
315
310
305
300
295
1975
1980
1985
1990
1995
2000
2005
2010
2015
NOAA

Trends

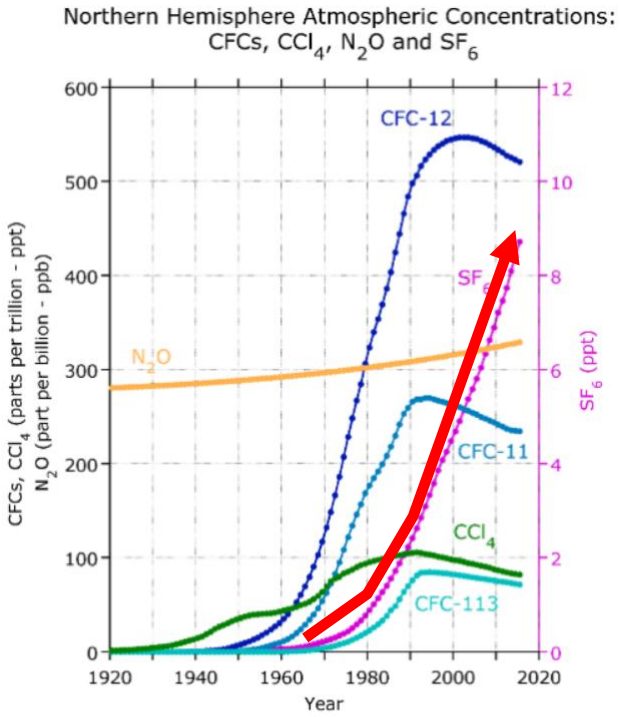


Figure 3. Mean mid-year tropospheric CFC-11, CFC-12, CFC-113, carbon tetrachloride (CCl_4), sulfur hexafluoride (SF_6) and nitrous oxide (N_2O) concentrations in the northern (NH) hemisphere for the period 1920.5 to 2015.5 The concentrations are expressed as the mixing ratio (mole fraction) of the trace gas in dry air and are reported in parts-per-trillion (ppt) for CFC-11, CFC-12, CFC-113, CCl_4, SF_6 and as parts-per-billion (ppb) for N_2O.

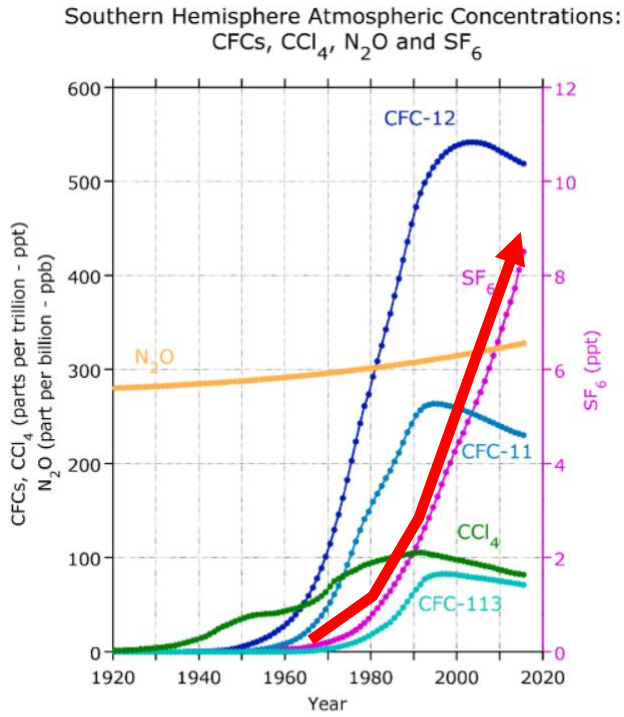
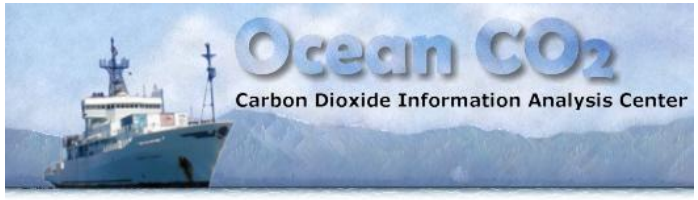
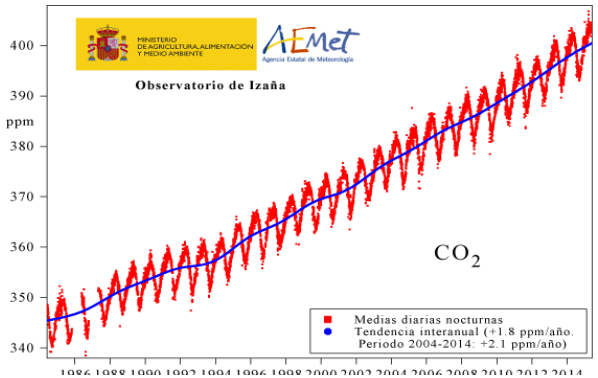
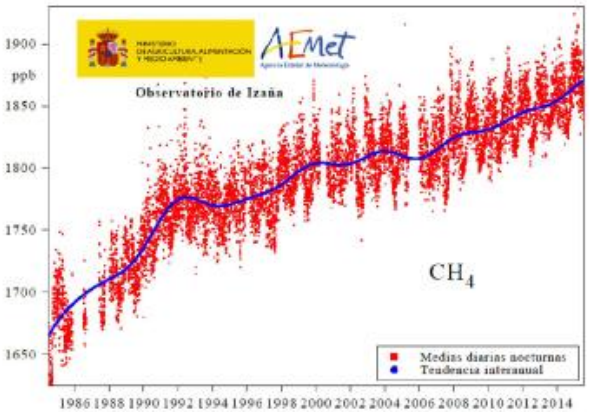


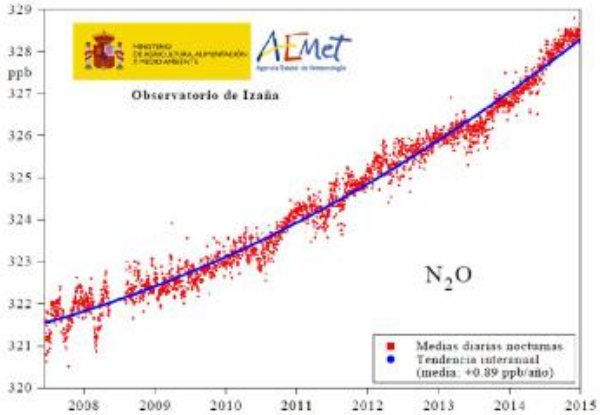
Figure 4. Mean mid-year tropospheric CFC-11, CFC-12, CFC-113, carbon tetrachloride (CCl_4), sulfur hexafluoride (SF_6) and nitrous oxide (N_2O) concentrations in the southern (SH) hemisphere for the period 1920.5 to 2015.5 The concentrations are expressed as the mixing ratio (mole fraction) of the trace gas in dry air and are reported in parts-per-trillion (ppt) for CFC-11, CFC-12, CFC-113, CCl_4, SF_6 and as parts-per-billion (ppb) for N_2O.

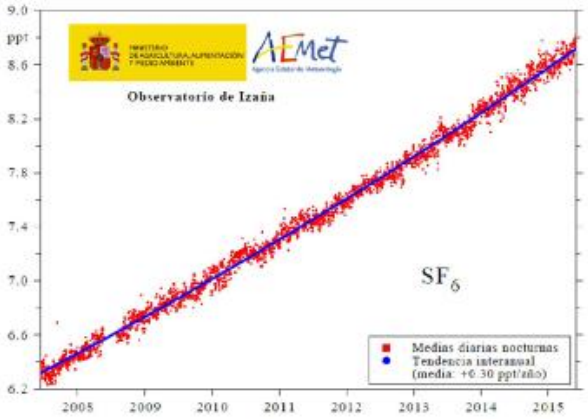


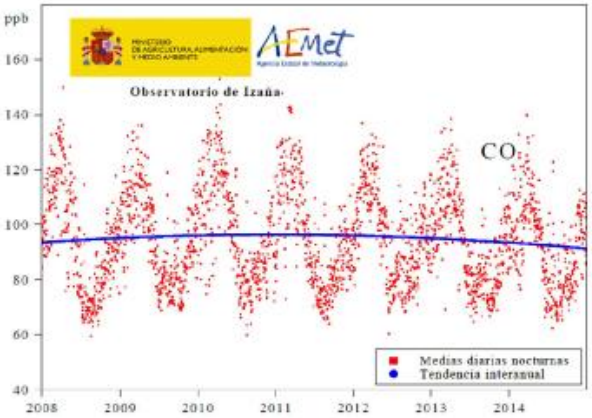
Trends


Observatorio de Izaña
ppm
CO_2
Medias diarias nocturnas
Tendencia interanual (+1.8 ppm/año.
Periodo 2004-2014: +2.1 ppm/año)


Observatorio de Izaña
ppb
CH_4
Medias diarias nocturnas
Tendencia interanual

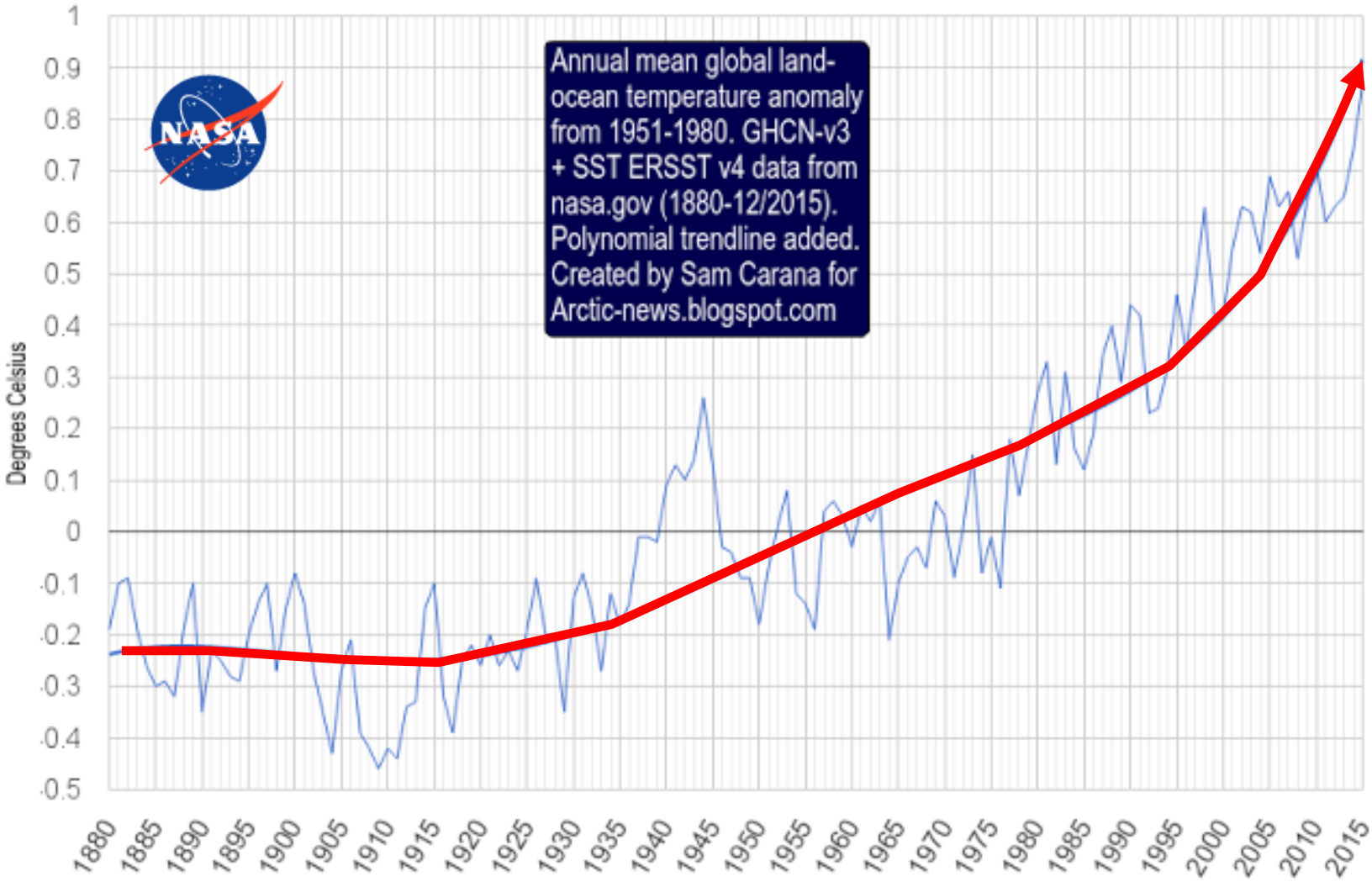

Observatorio de Izaña
ppb
N_2O
Medias diarias nocturnas
Tendencia interanual
(media: +0.89 ppb/año)


Observatorio de Izaña
ppt
SF_6
Medias diarias nocturnas
Tendencia interanual
(media: +0.30 ppt/año)

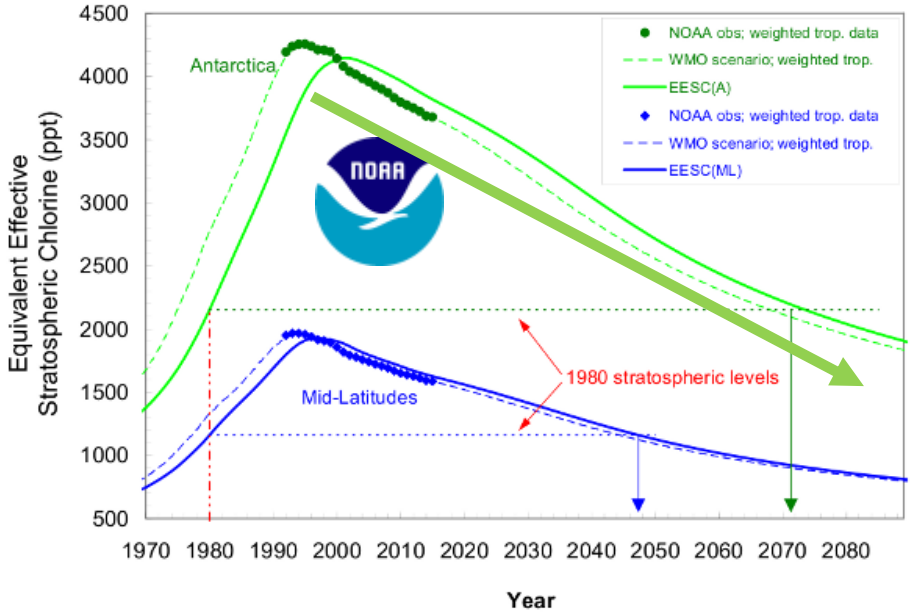

Observatorio de Izaña
ppb
CO
Medias diarias nocturnas
Tendencia interanual

Trends

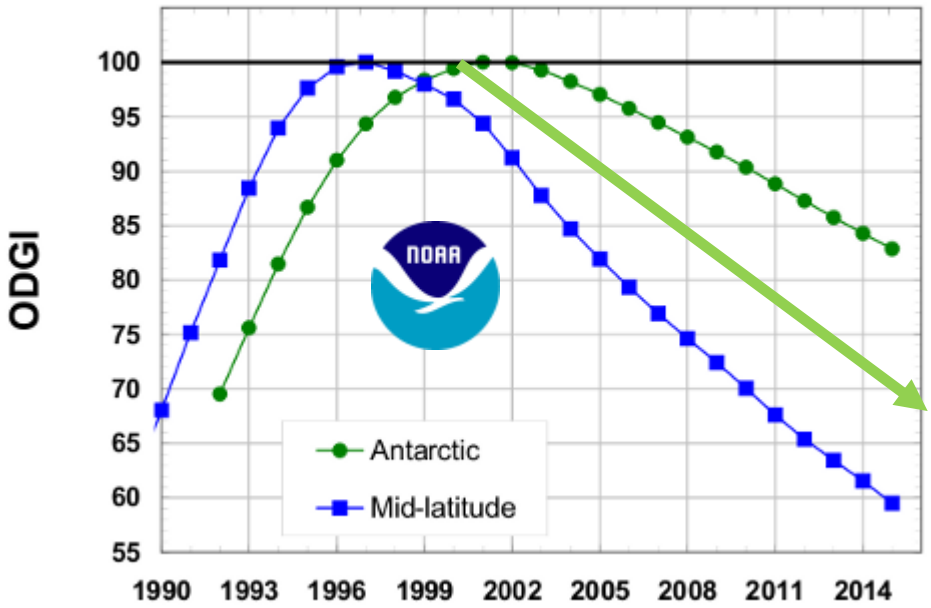
Global mean temperature in 2015 was 0.87°C higher than in 1951-1980



Trends



NOAA Ozone Depleting Gas Index



Trends

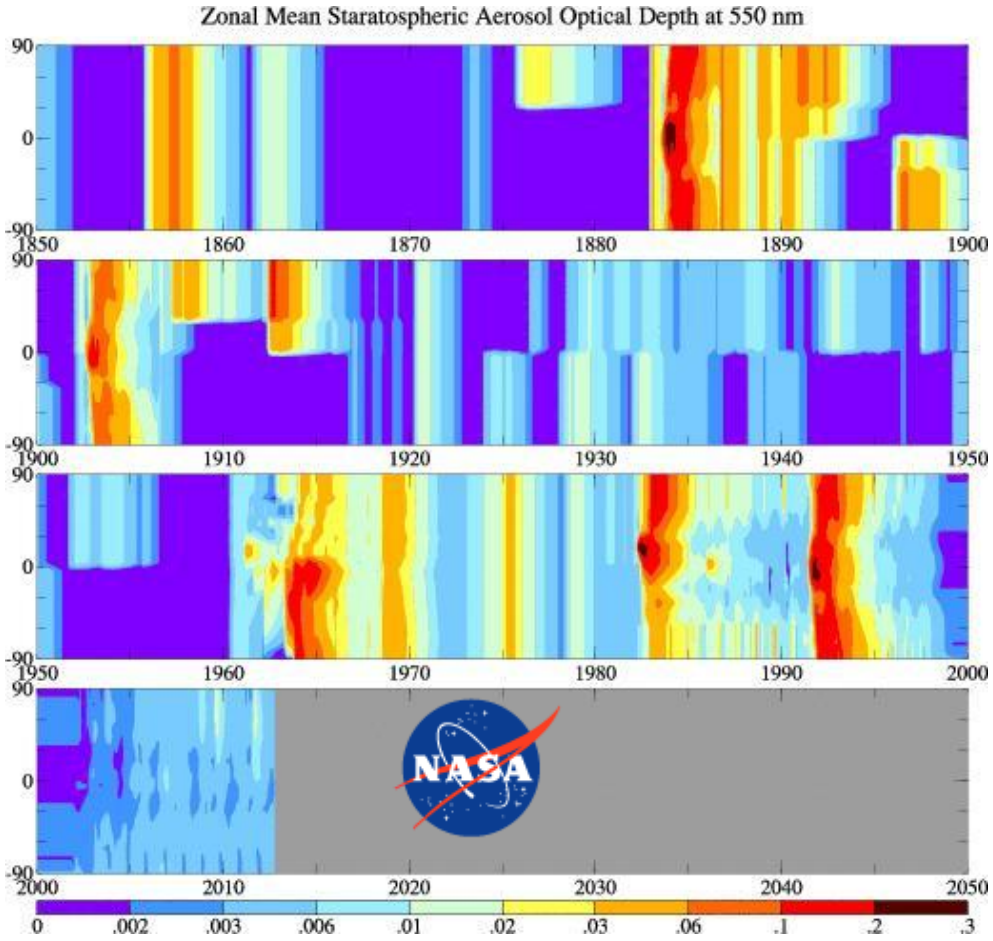
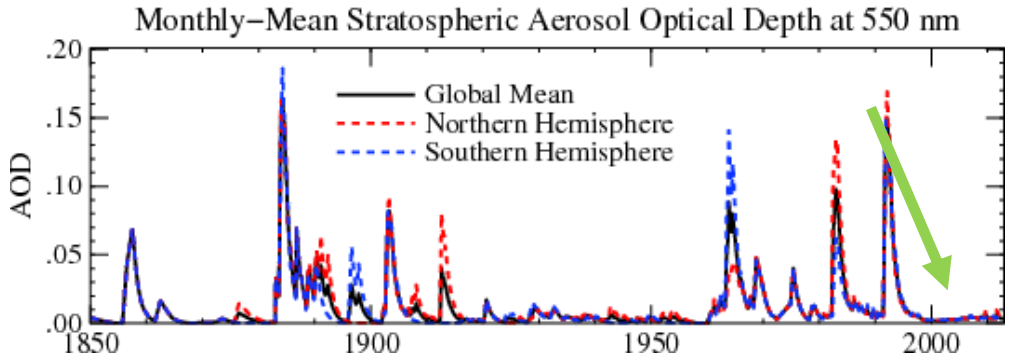
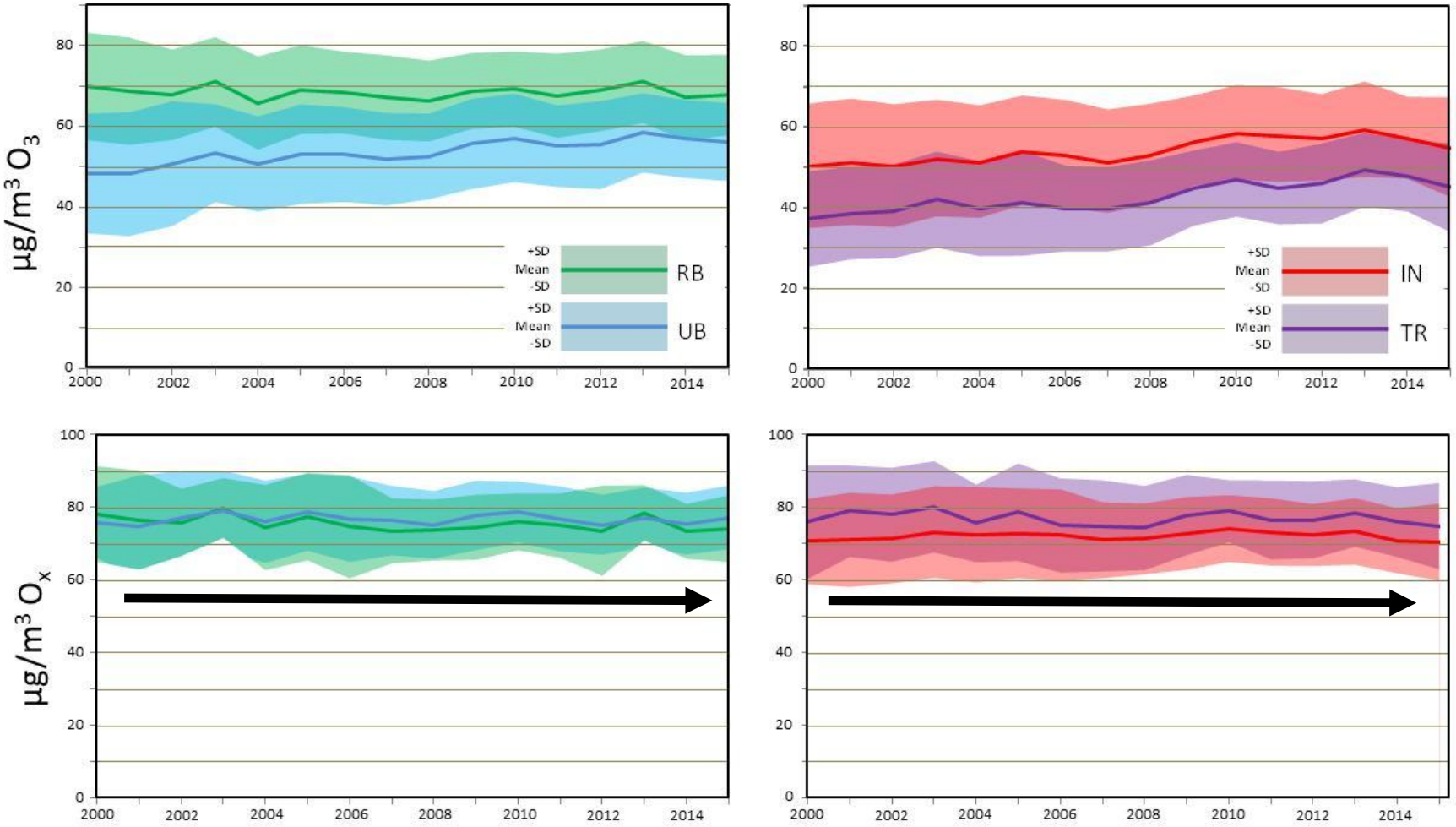


Photo by R.S. Culbreth, U.S. Air Force.
Mt. Pinatubo eruption of June 12, 1991. Height of ash cloud about 12 miles (20 km).

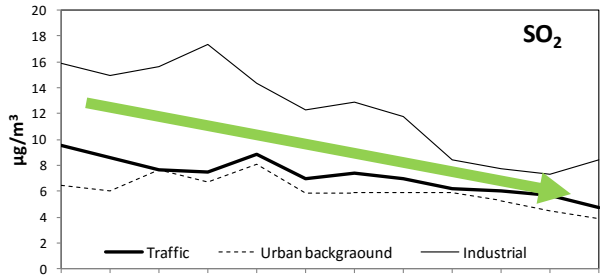


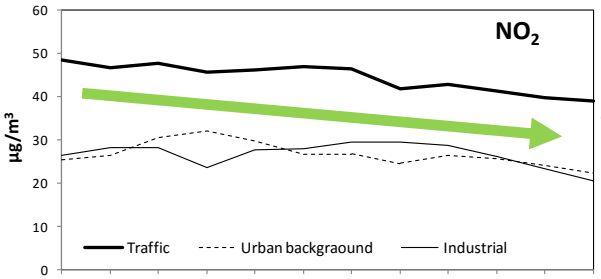
Trends

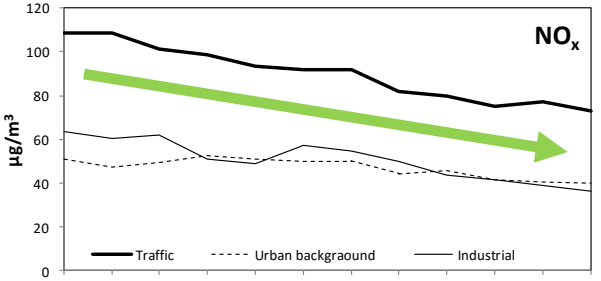
Tropospheric ozone Spain

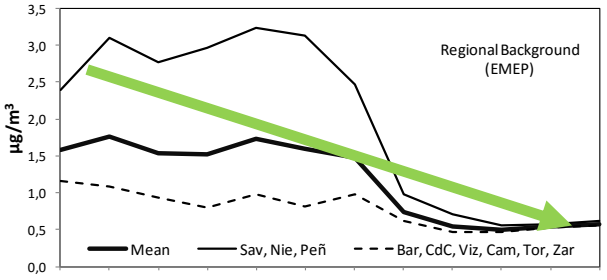


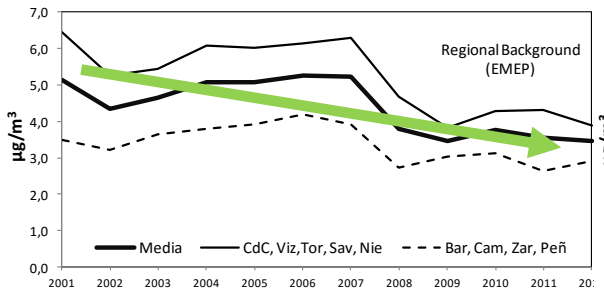
Trends

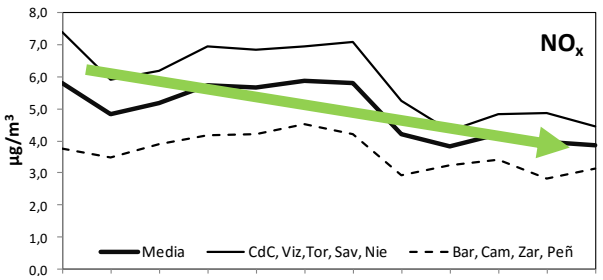


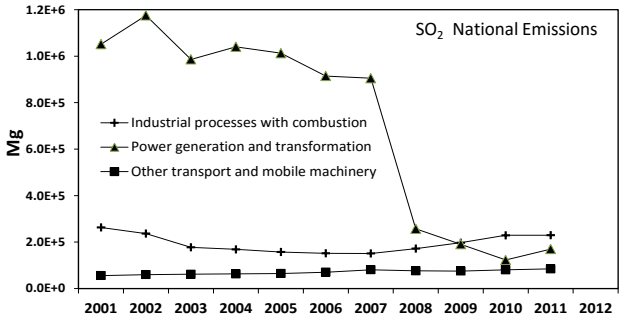


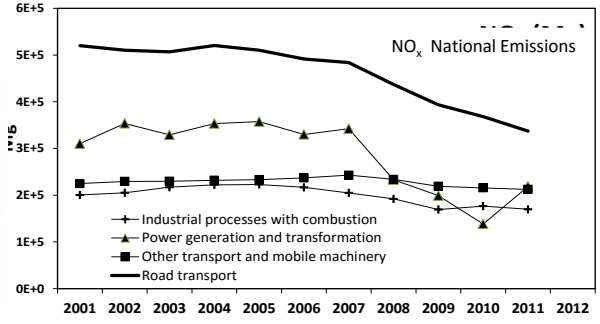








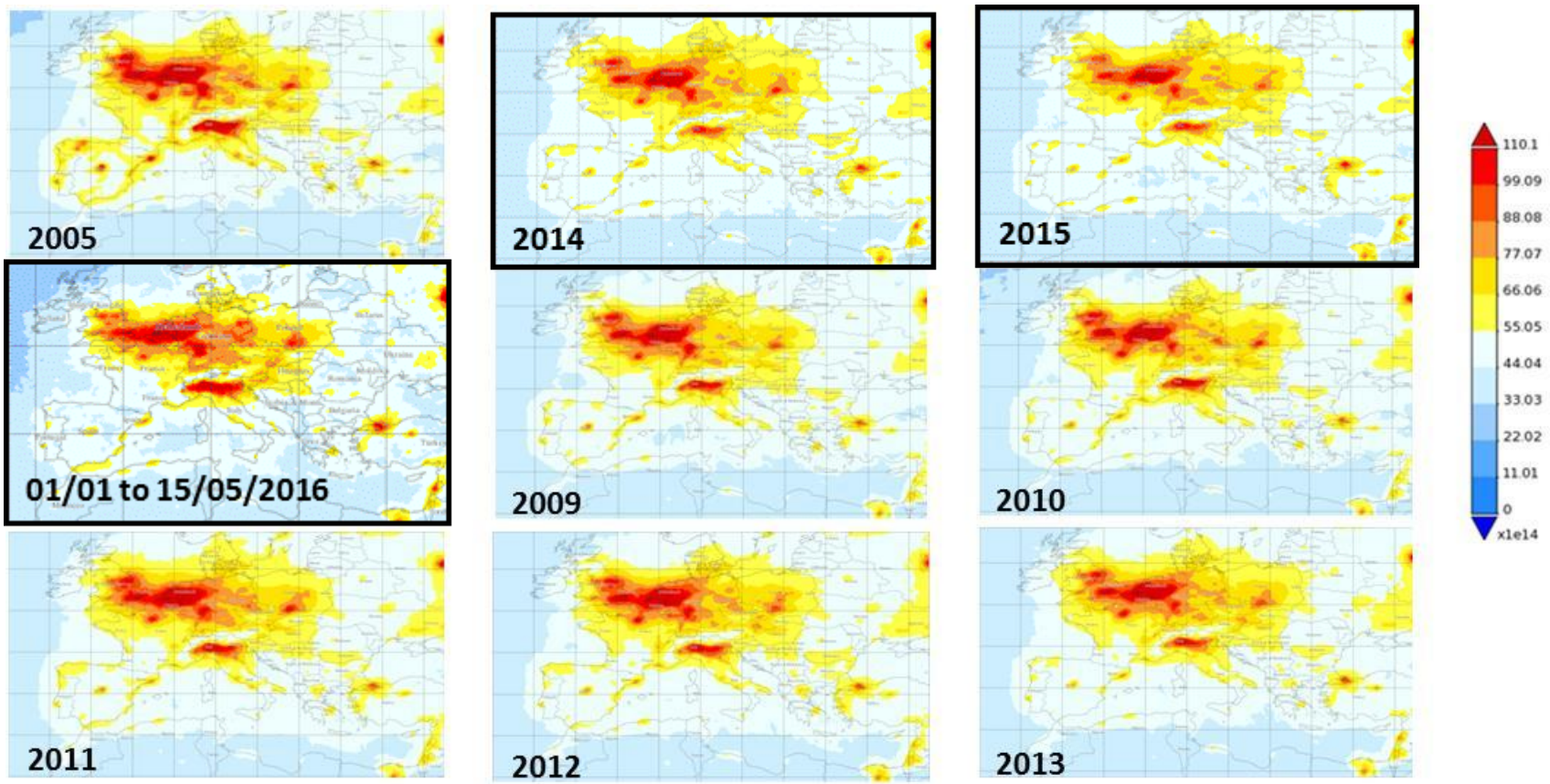




Querol et al., 2014. Science of Total Environment

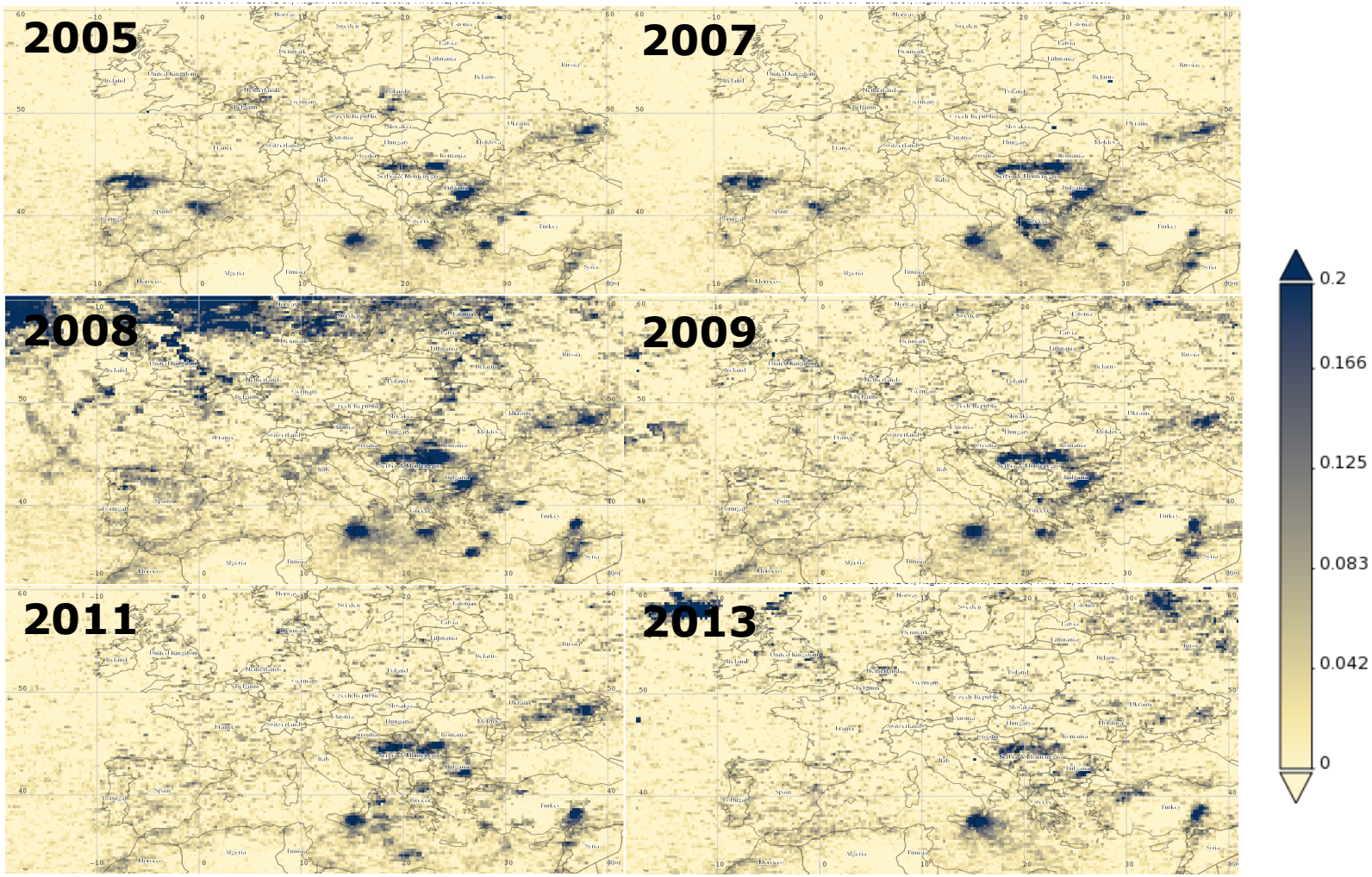
Trends

NASA NO_2 OMI level 3 Plotted using the Giovanni online data system, developed and maintained by the NASA GES DISC
Mean annual tropospheric NO_2 column (clear, 0-30% cloud) **(10^{14} molec/cm^2)**



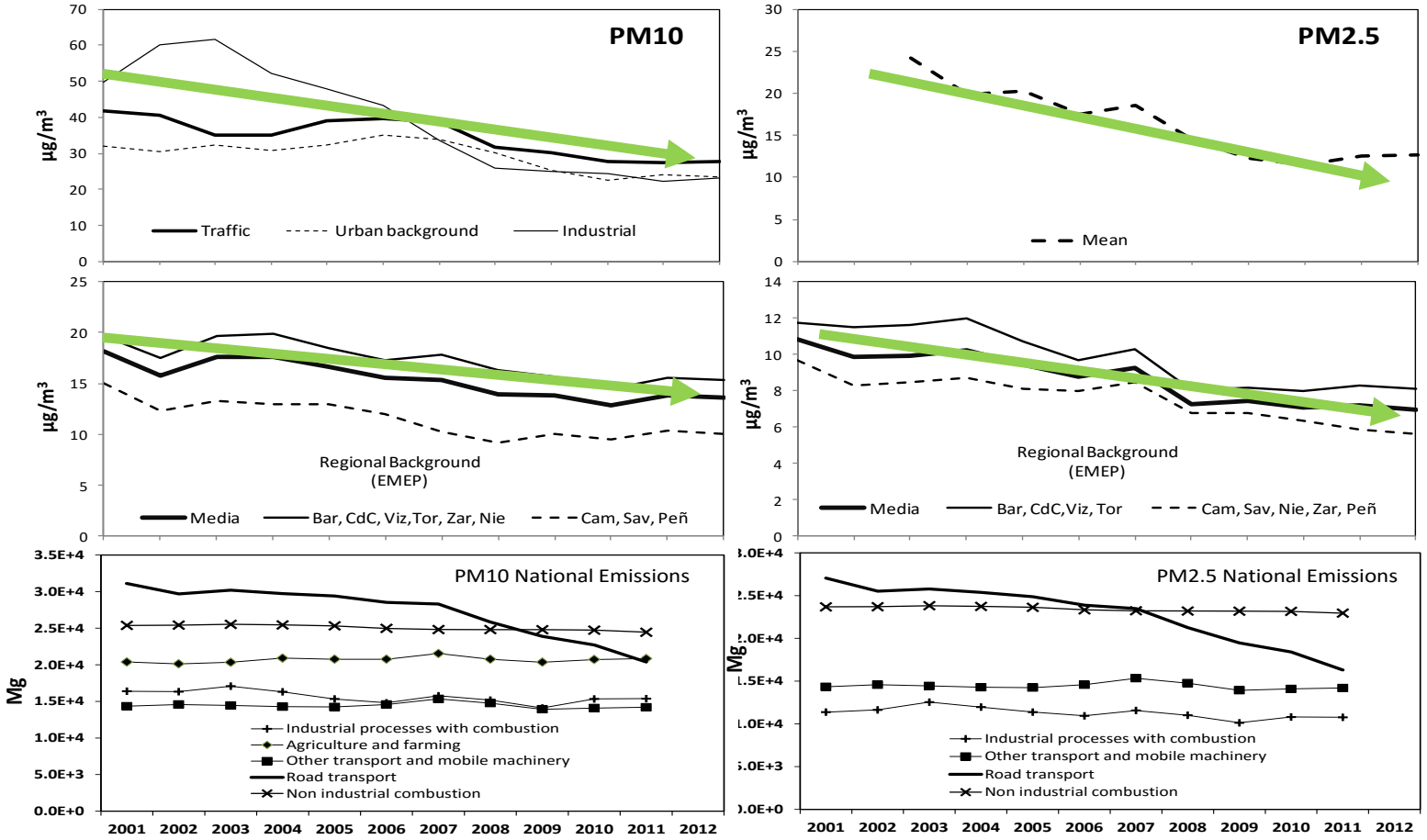
Trends

Time average map of SO_2 Column amount (PBL) (Dobson Units)



NASA SO_2 OMI level 3. Plotted using the Giovanni online data system, developed and maintained by the NASA GES DISC

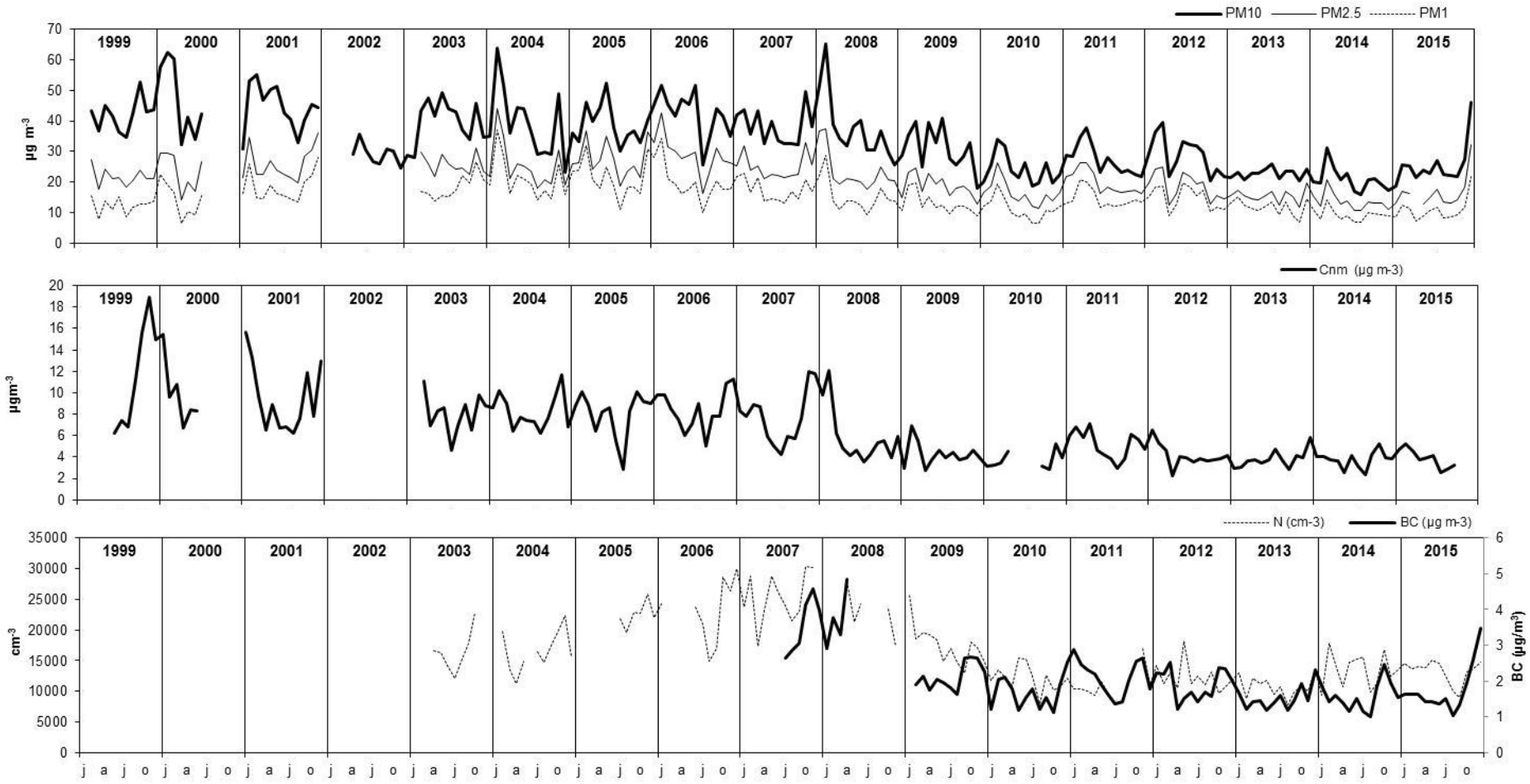
Trends



Querol et al., 2014. Science of Total Environment

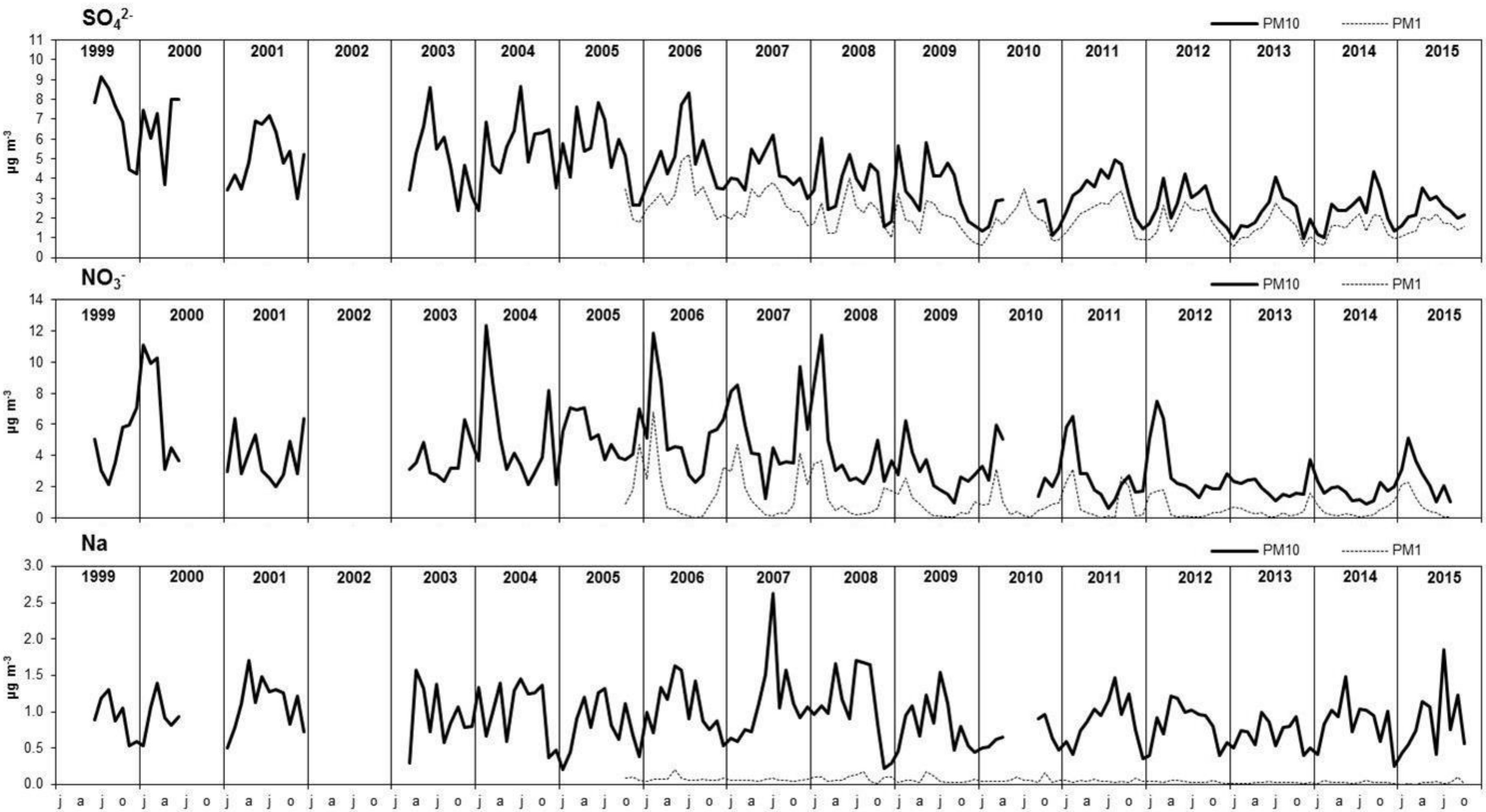
Trends

1999-2015 PM10 and PM1 source apportionment: Barcelona

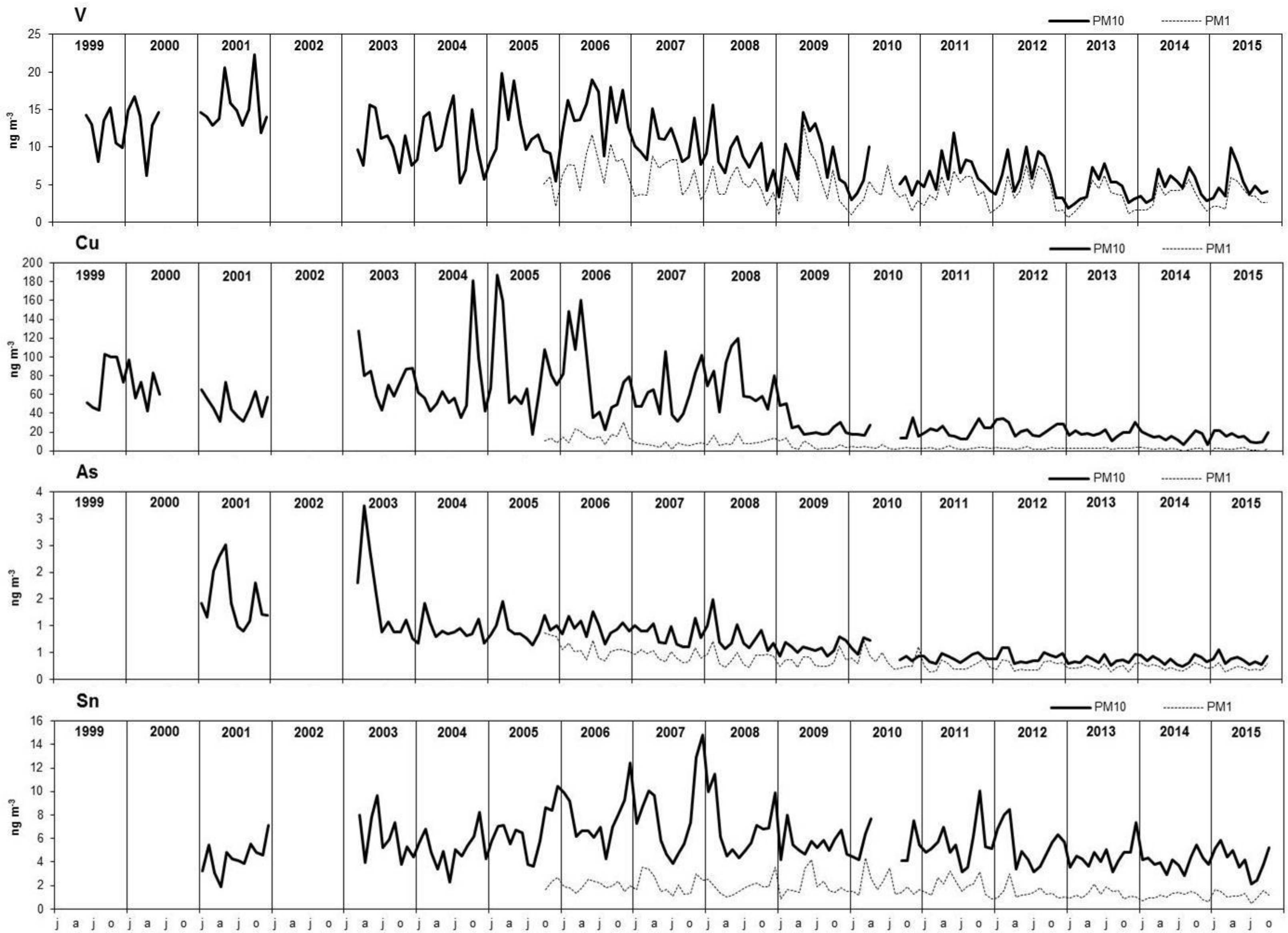


Trends

1999-2015 PM10 and PM1 source apportionment: Barcelona



Trends


V
Cu
As
Sn
PM10
PM1
ng m-3
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
j a j o

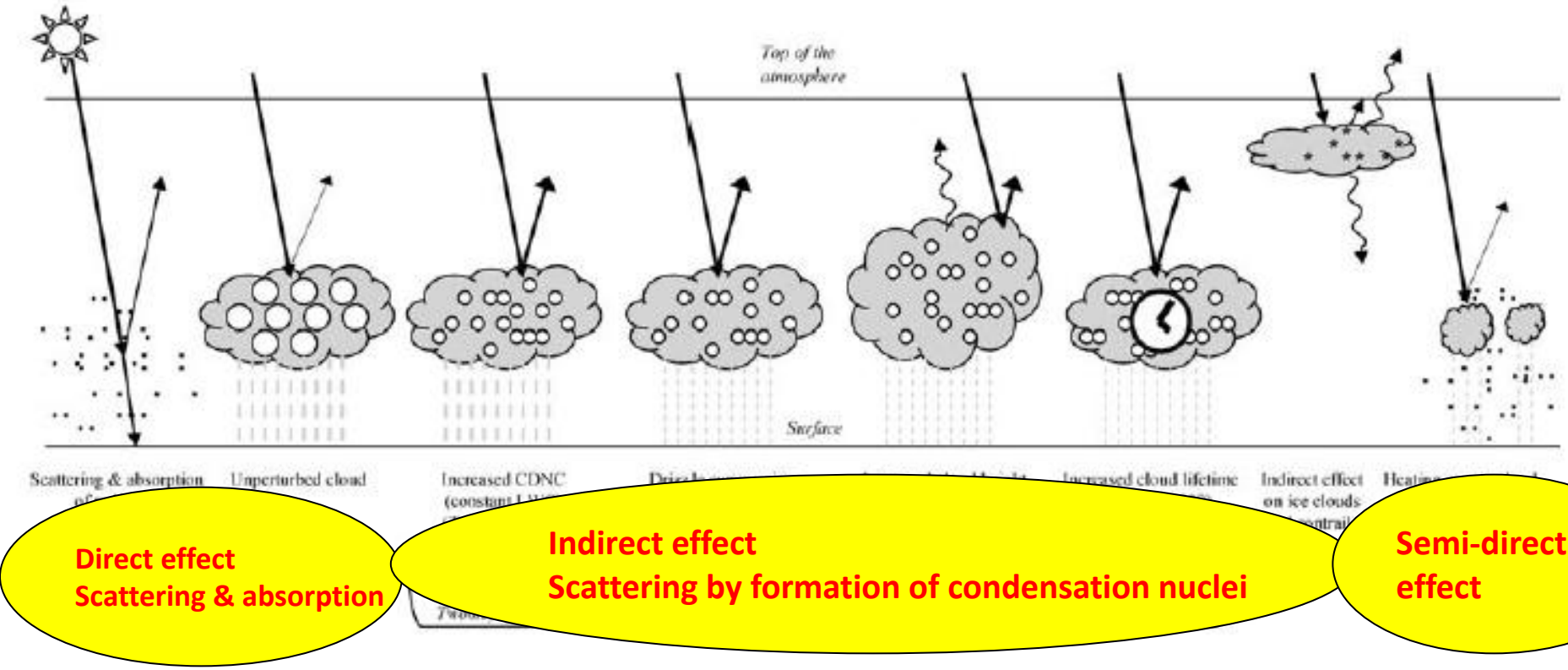
Climate effects of aerosols

Aerosols are key pollutants in air quality due to health effects but they have also major roles in climate modulation:

- **Effects: direct, indirect, 'semi-direct'**
- **Effects: positive and negative forcing**
- **BC (EC) light absorption: positive and direct**
- **Near all particles, scatter (direct and negative, i.e. sulfate)**
- **OC, sulfate indirect, negative: cloud nucleation (scattering effect)**
- **BC(EC) positive 'semi direct', light absorption in the upper troposphere causes T increase and diminish cloud nucleation**
- **Mineral dust: different effects depending on continental or oceanic locations**

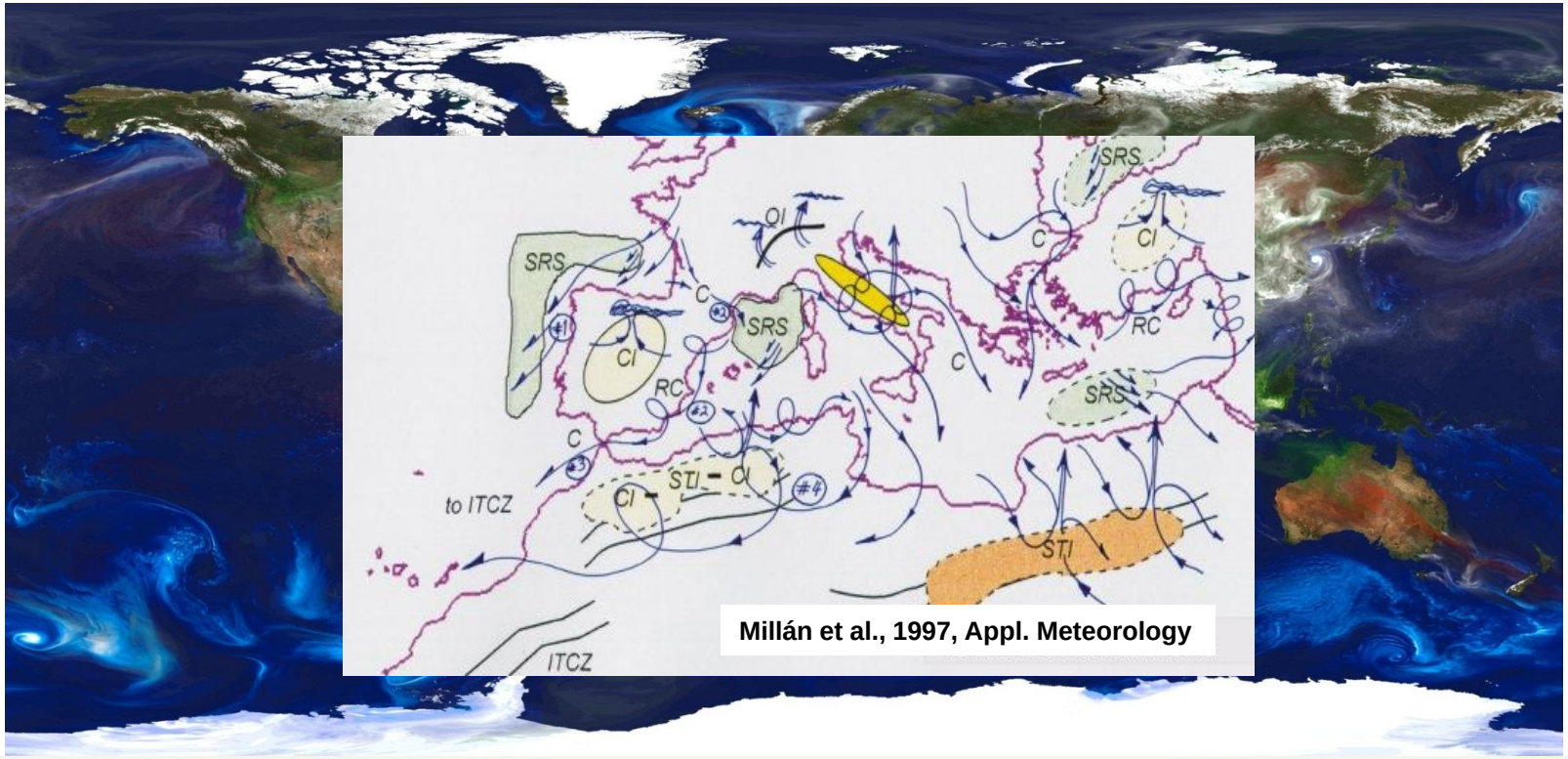
Climate effects of aerosols

Climate Modulation: influence in the radiative balance



Haywood and Boucher (2000)

Climate effects of aerosols



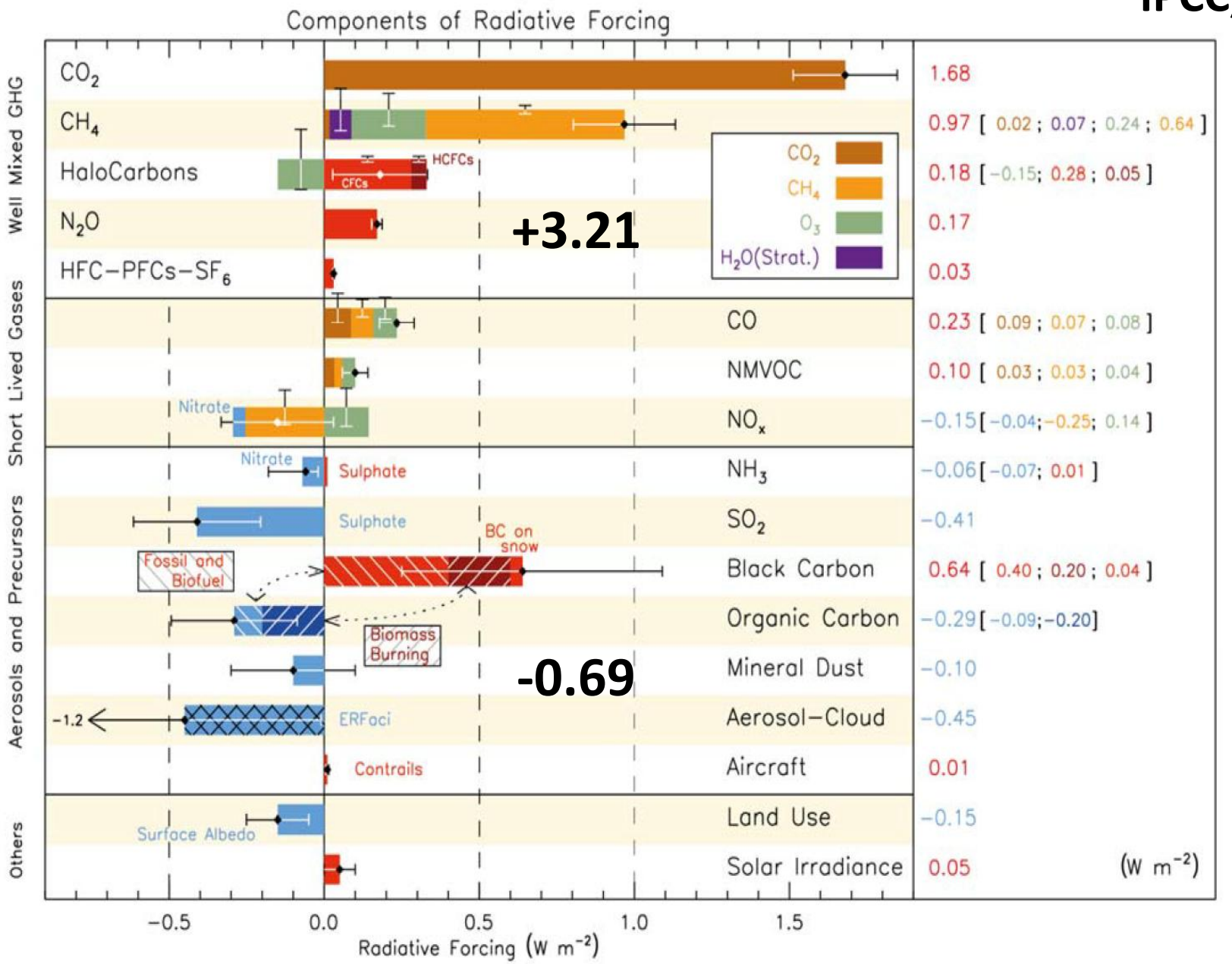
EXTINCTION OPTICAL THICKNESS OF AEROSOLS from the Goddard Earth Observing System Model, Version 5 (GEOS-5): system of models integrated using the Earth System Modeling Framework (ESMF) (2006 – 2007).

- **DUST** (red)
- **SEA SALT** (blue)
- **BC and OC** (green)
- SULPHATE (white)

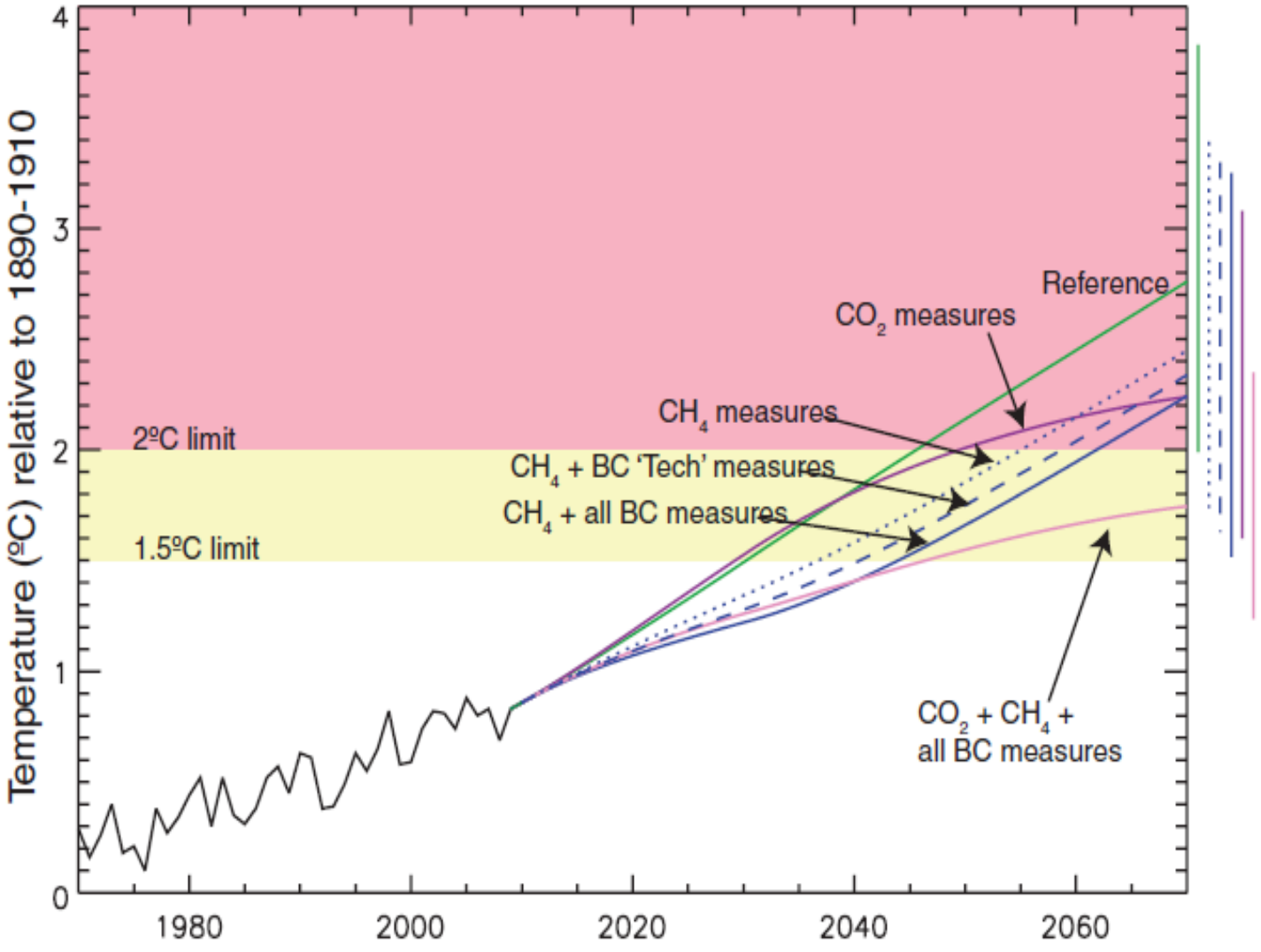
"during the Mediterranean summer, the radiative forcing of aerosols is among the highest in the world" (Lelieveld et al., Science, 2012)

Climate effects of aerosols

IPCC, 2013



Climate effects of aerosols



Shindell et al (2012) Science 315

Climate effects of aerosols

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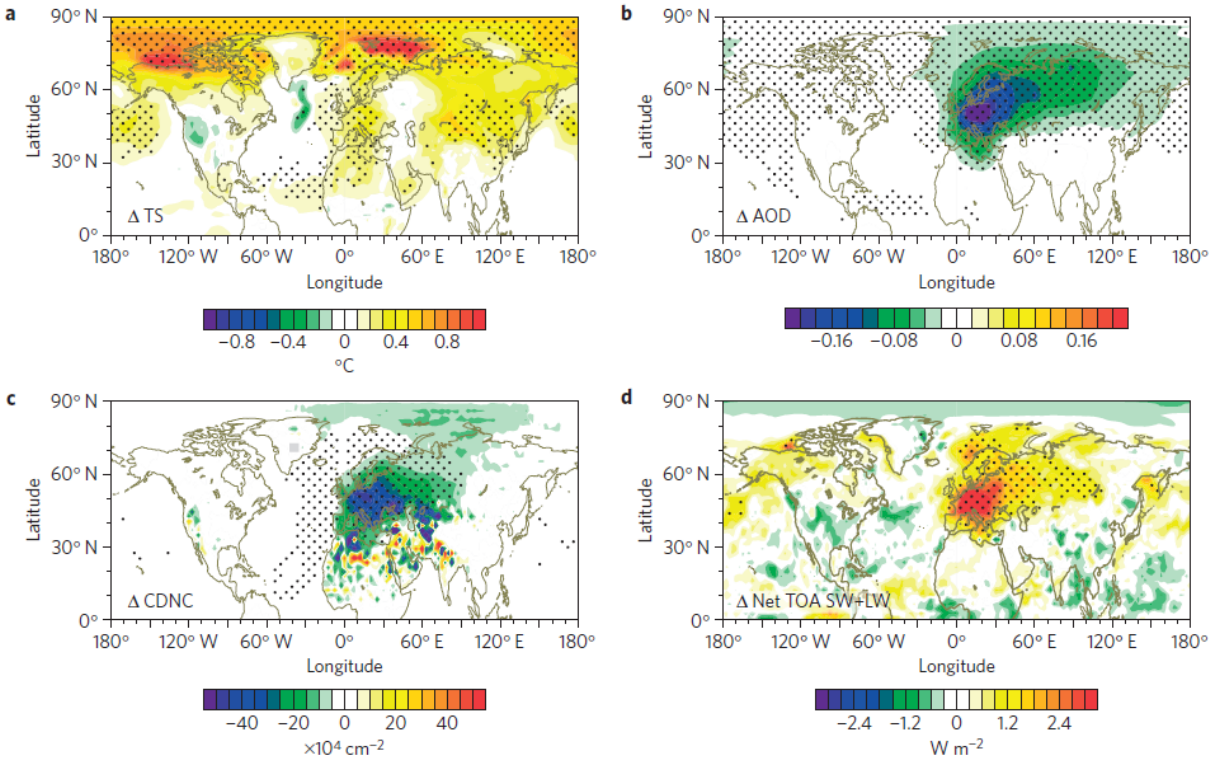
Amplification of Arctic warming by past air pollution reductions in Europe

J. C. Acosta Navarro[1,2†], V. Varma[2,3†], I. Riipinen[1,2], Ø. Seland[4], A. Kirkevåg[4], H. Struthers[1,2,5], T. Iversen[4], H.-C. Hansson[1,2] and A. M. L. Ekman[2,3*]



Positive & negative feedbacks of AQ & climate

SYNERGIES

- Reducing fuel combustion reduce emissions in AQ and of GHGs
- Both create social aware of environmental problems
- BC have positive climate and AQ effects

INTERFERENCES

AQ on climate

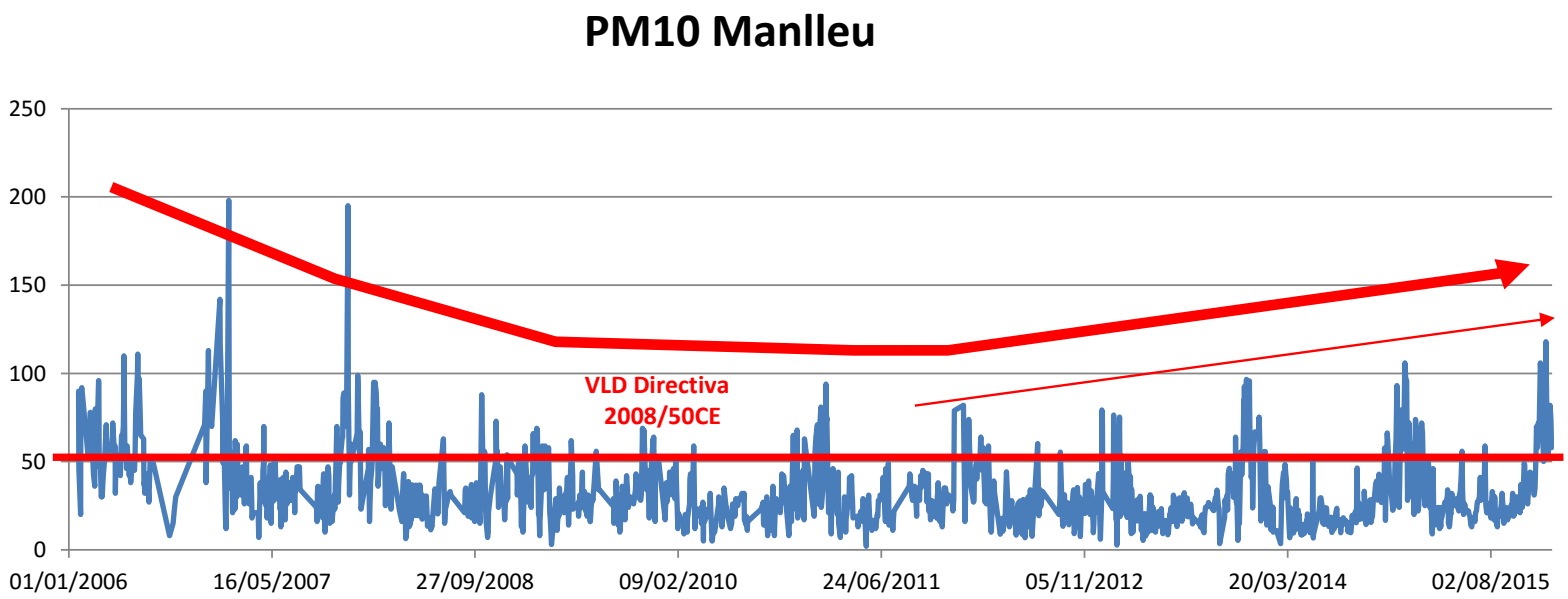
- Abating SO_2, VOCs and NO_X reduce the cooling effect of aerosols
- Abating NO_X & PM from road traffic might yield to increase CO_2 &/or CH_4
- Reducing SO_2 increases CO_2 (from flue gas desulphurisation),……..

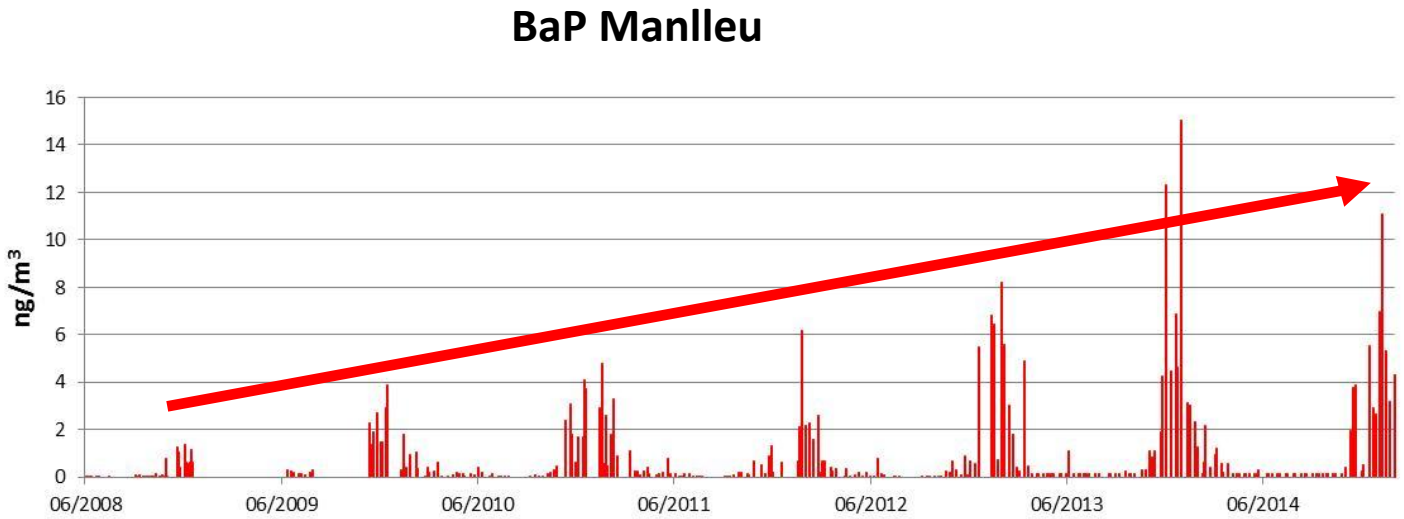
Climate on AQ

- Reducing CO_2 from road traffic implied an increase of NO_X & PM (Diesel)
- Bio – fuels to fix C, might increase NOx
- Biomass burning to fix C might increase PAHs
- O_3 episodes and higher radicals will increase

Larger social and political perception for climate issues yielded to implementation of climate measures without coordination with air quality measures!!

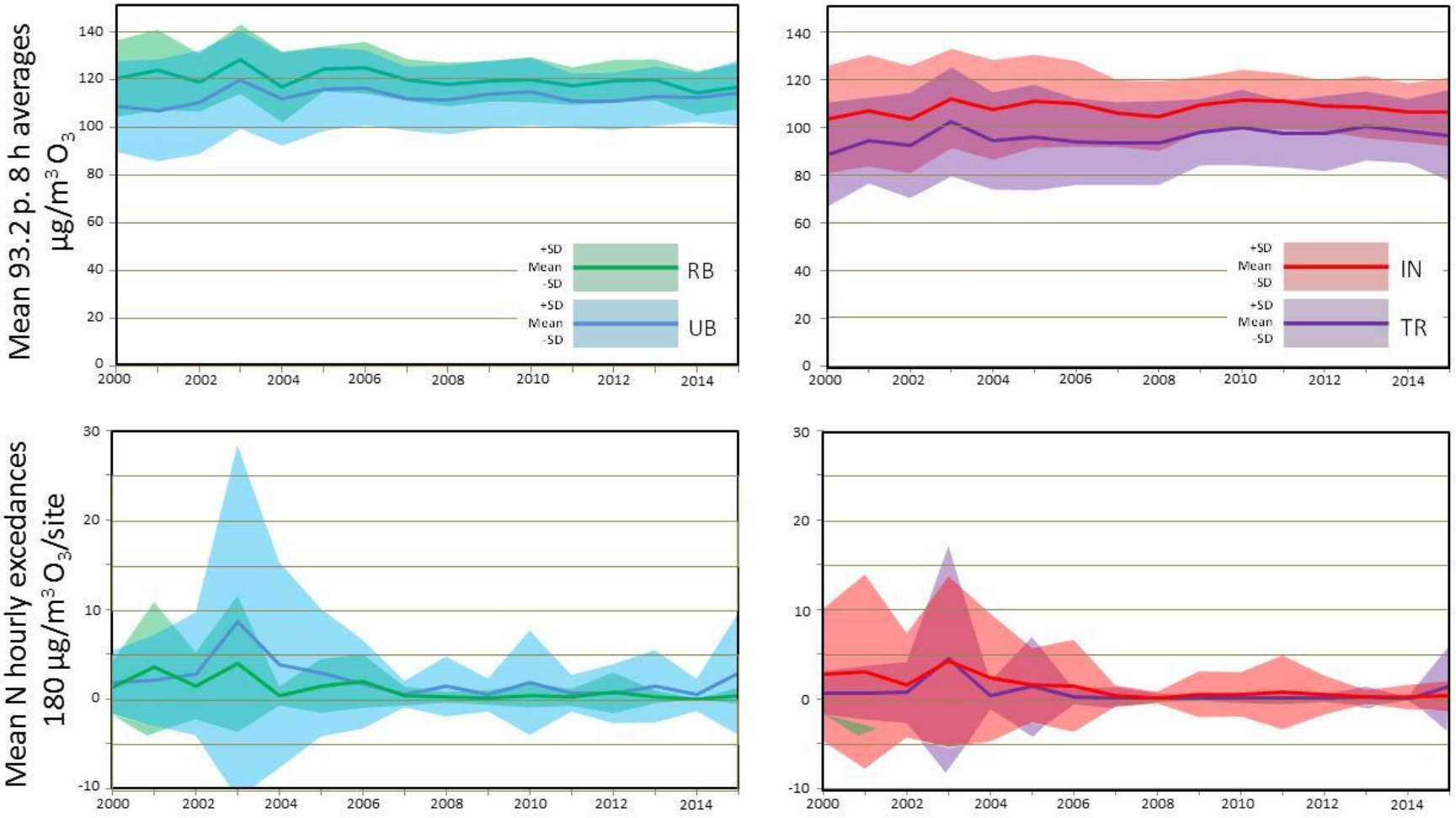
Positive & negative feedbacks of AQ & climate policies





Positive & negative feedbacks of AQ & climate

Effects of heat waves on O_3 episodes



Consideraciones finales

1. El cambio climático y la calidad del aire son problemas extremadamente complejos
2. Solamente la ciencia es capaz de abordar adecuadamente estos problemas en cuanto a estrategias de diagnosis, mitigación y adaptación
3. ONU (IPCC) y UNECE (Convenio de Ginebra) son catalizadores de interacción entre ciencia y políticas climáticas y de calidad del aire, pero la mayoría de los países llevan a estos foros su contribución de ciencia-política ya elaborada
4. La cuenca Mediterránea es especialmente vulnerable a estos cambios/impactos y tiene peculiaridades respecto a Europa central y del norte
5. Debe potenciarse mucho más esta interacción ciencia-política ambiental y desarrollar estrategias *bottom up* que defiendan nuestros intereses
6. El CEAM tiene el *know how* adecuado para tratar muchos de los temas relevantes, y la Comunidad Valenciana y El MAGRAMA deben aprovecharlo
7. Invertir en ciencia para resolver problemas ambientales ha sido, es y será muy rentable

Gràcies per la vostra atenció!!!!

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i

Per molts anys més!!!!!