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# Causes and effects of the decrease in coarse mode mass concentrations observed in Cyprus

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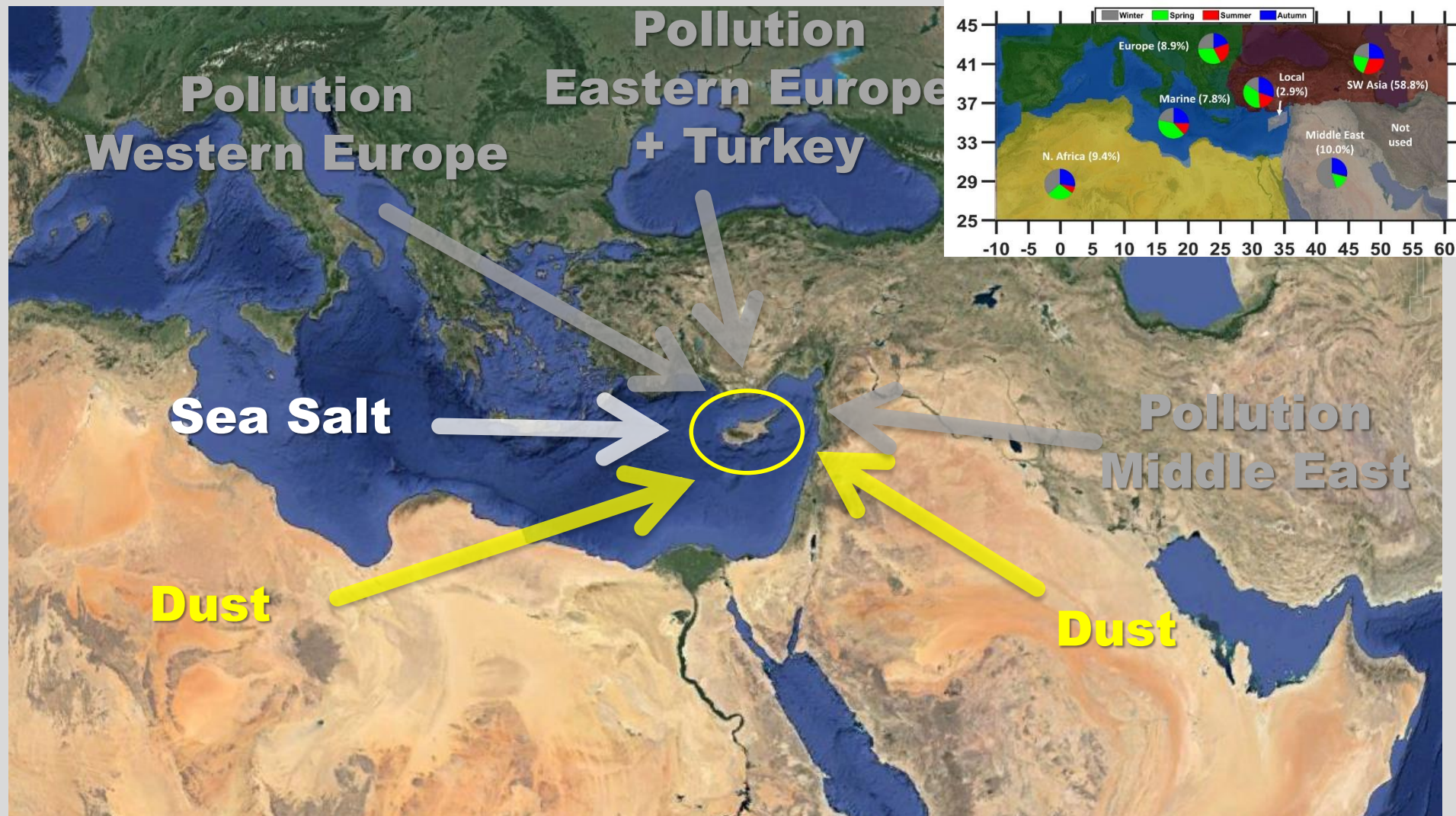
<sup>5</sup>*Department of Labour and Social Insurance, Department of Labour Inspection (DLI), Nicosia, Cyprus*

**17 May 2018**

[www.cyi.ac.cy](http://www.cyi.ac.cy)

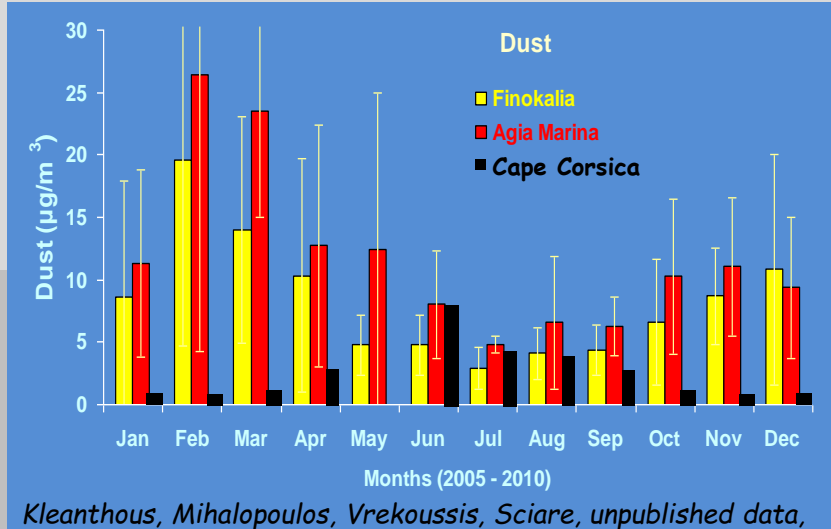
# At the crossroad of 3 continents

Air Pollution in Cyprus : Long-range transported natural/anthropogenic sources

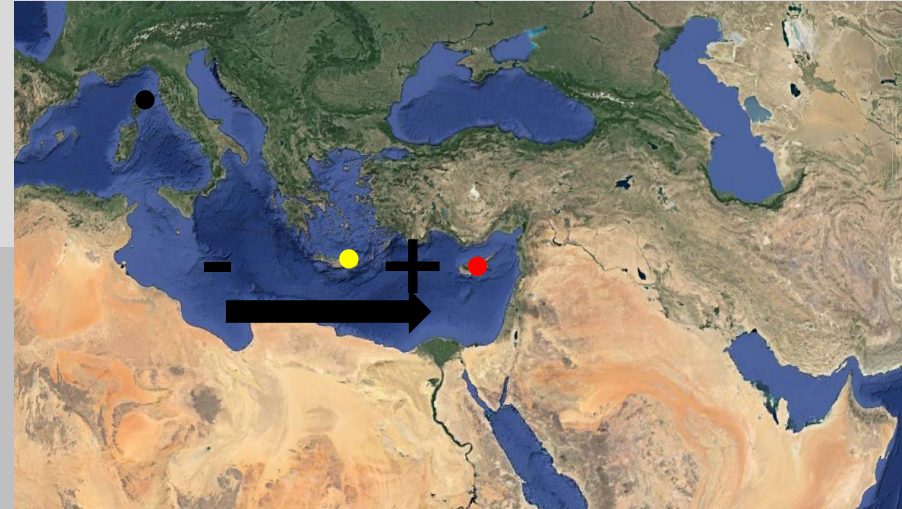


# PM<sub>10</sub> across the Mediterranean

## Dust Concentrations in PM<sub>10</sub>



Kleanthous, Mihalopoulos, Vrekoussis, Sciare, unpublished data, 2019



$$\frac{\text{PM}_{2.5}}{\text{PM}_{10}} = 0.52 \Rightarrow \text{Half of PM}_{10} \text{ is made of dust}$$

A clear West-to-East gradient of dust aerosols  $\Rightarrow$  Cyprus is located in the mostly dust-impacted region of the Mediterranean (from Middle East & Sahara)

# Local Monitoring Network

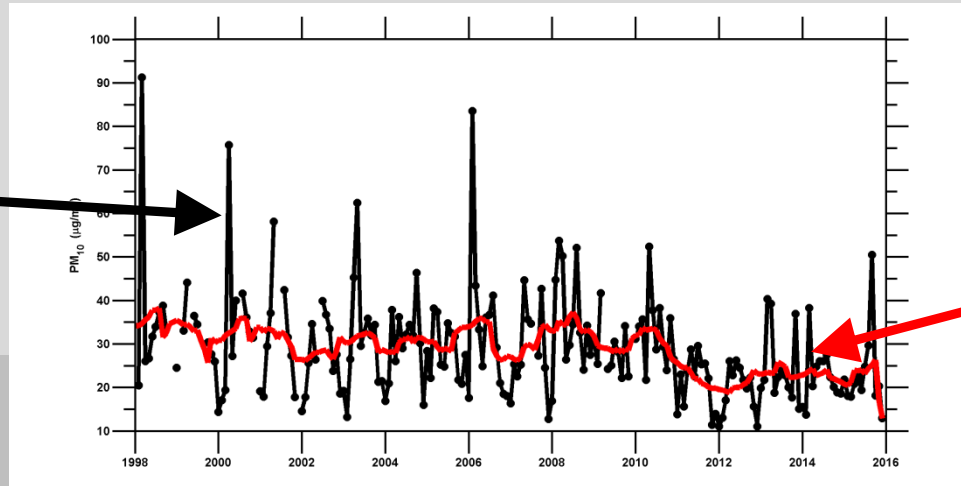
20 years of PM monitoring  
in the easternmost edge of  
Europe

- Traffic Site
- Urban Background Site
- Remote Site
- Industrial Area



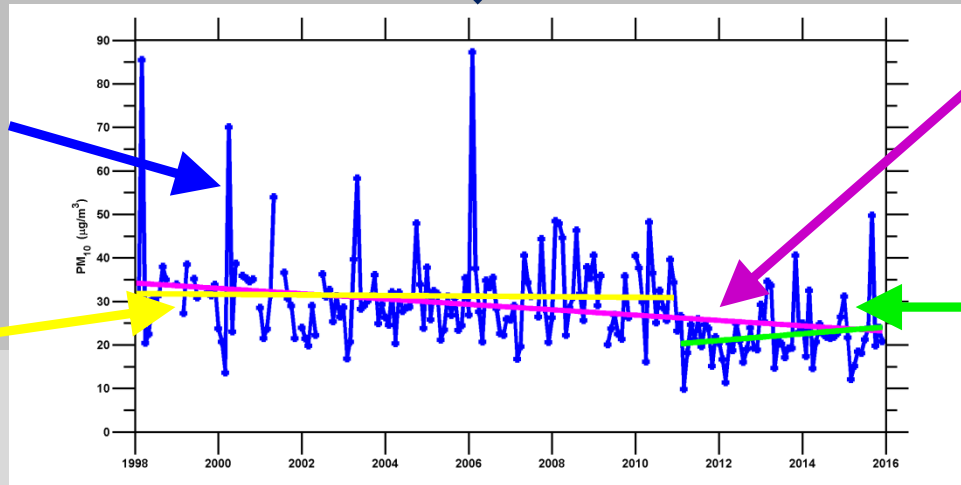
# 20 years of monitoring PM<sub>10</sub>

PM<sub>10</sub>  
Observed  
Monthly  
Means



12-month  
smooth to  
guide the eye

Deseasonalized  
Monthly  
Means



Linear  
Regression  
1997-2010

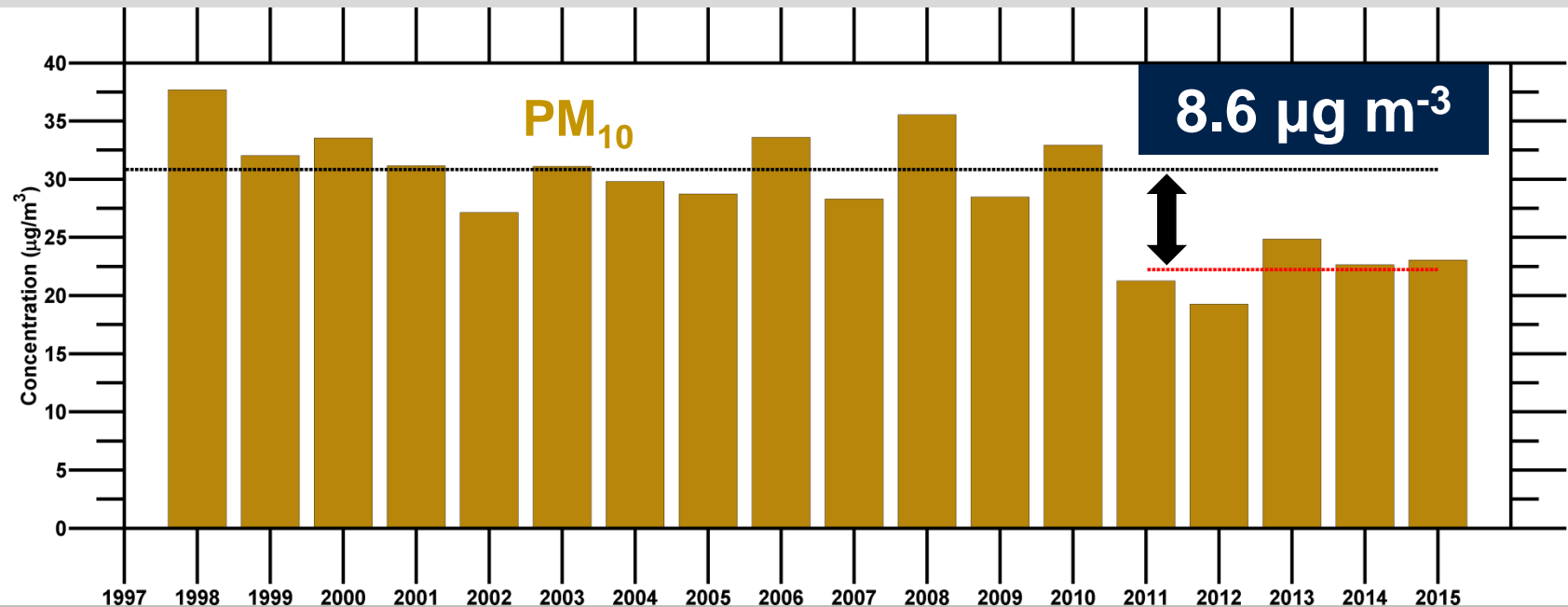
Linear  
Regression  
(all years)

Linear  
Regression  
2011-2015



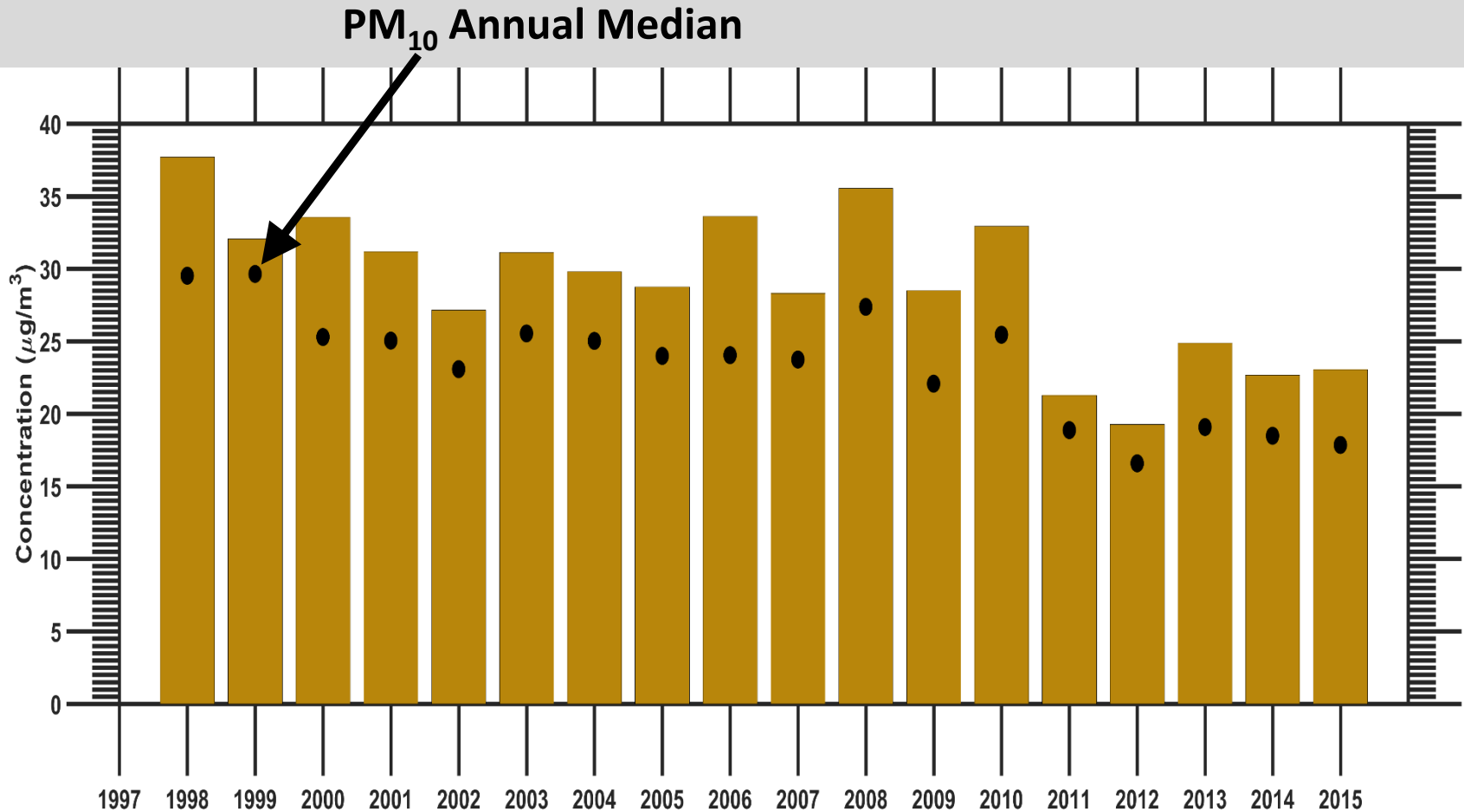
# PM<sub>10</sub> Annual Trend (Agia Marina)

Since 2010 PM<sub>10</sub> has decreased



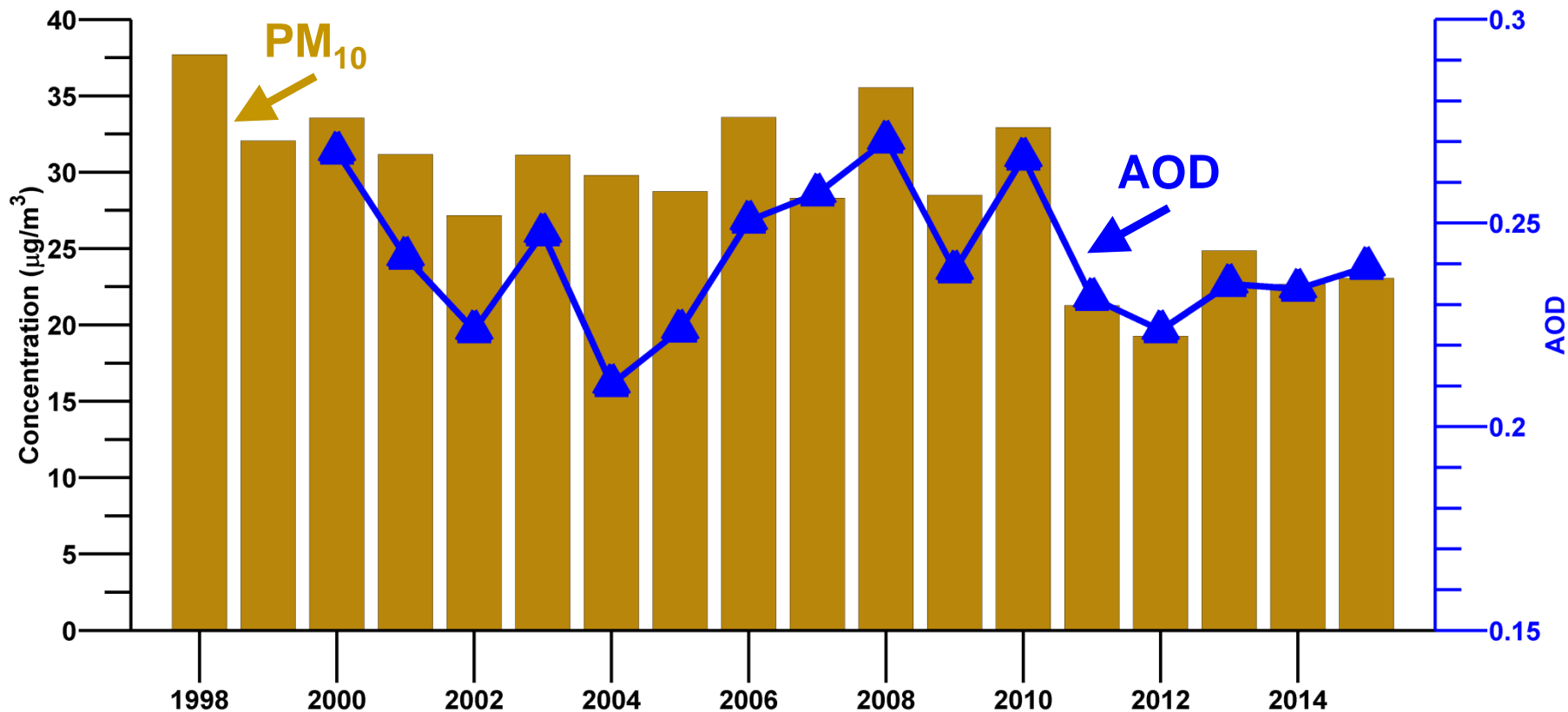
# PM<sub>10</sub> Annual Trend (Agia Marina)

Episodic events do not change the pattern



# Satellite Validation

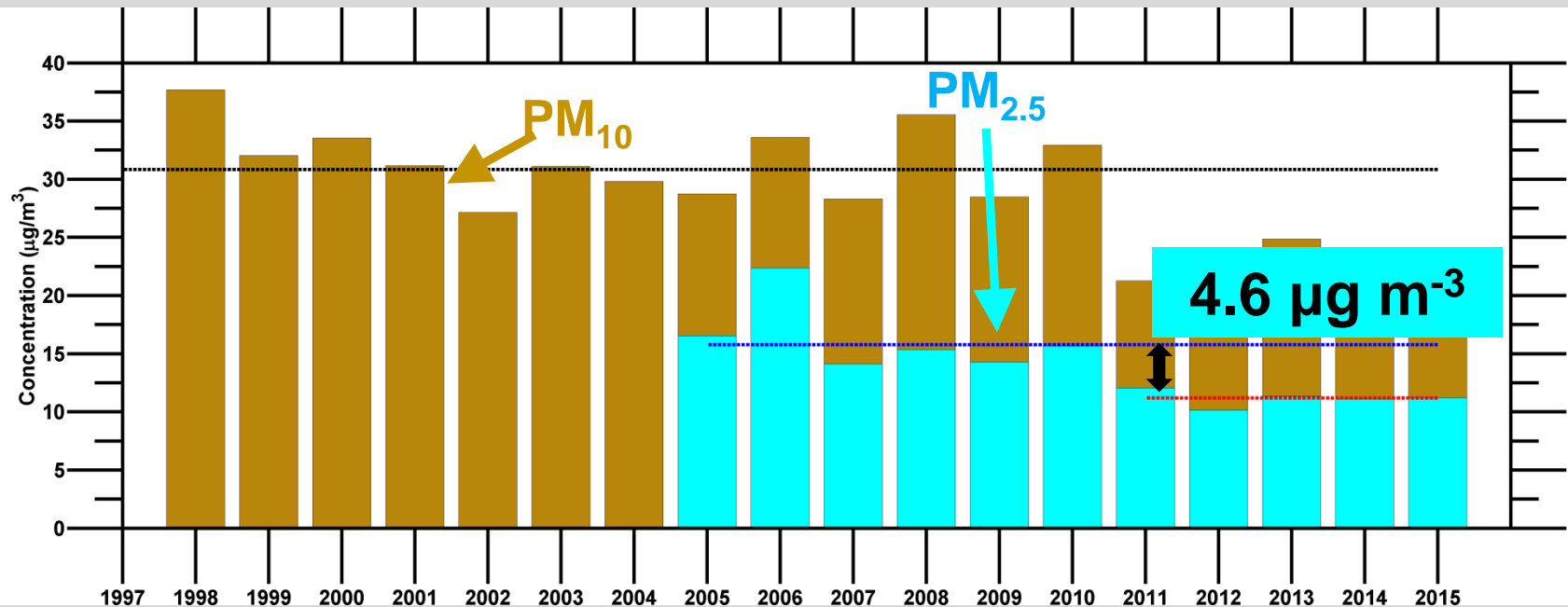
Satellite (MODIS) AOD product suggests it is not due to systematic bias



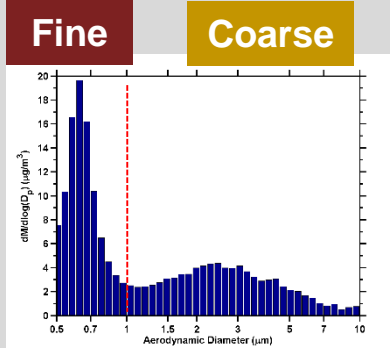


# PM<sub>2.5</sub> Annual Trend (Agia Marina)

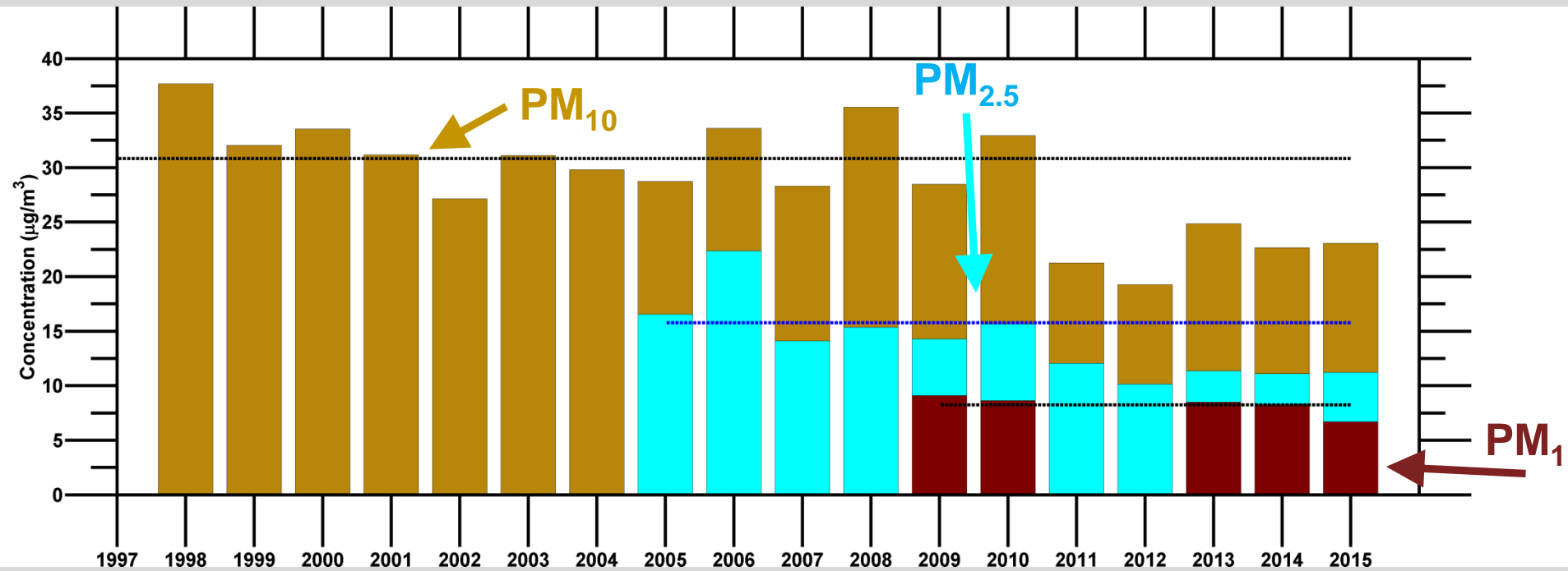
PM<sub>2.5</sub> were also reduced



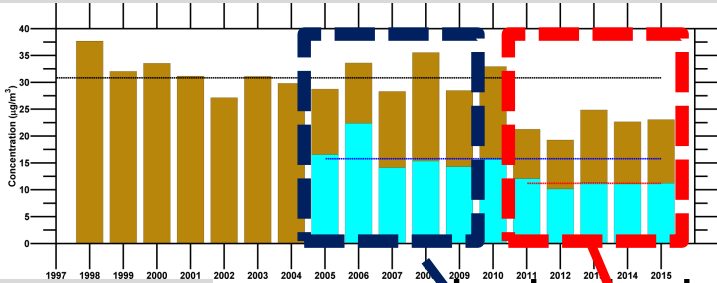
# PM<sub>1</sub> Annual Trend (Agia Marina)



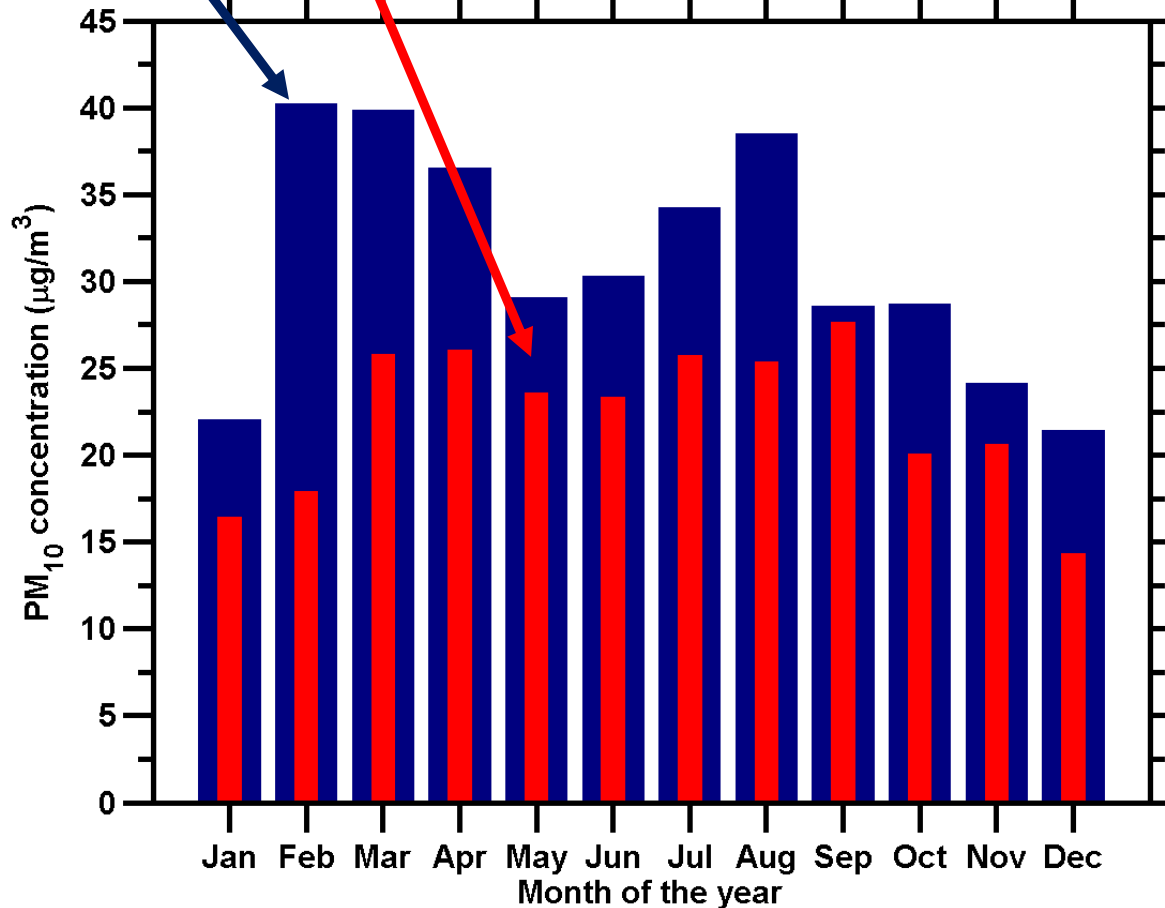
PM<sub>1</sub> remained stable suggesting no anthropogenic influence



# PM<sub>10</sub> Seasonal Trend (Agia Marina)



Reduction in PM<sub>10</sub> throughout the year



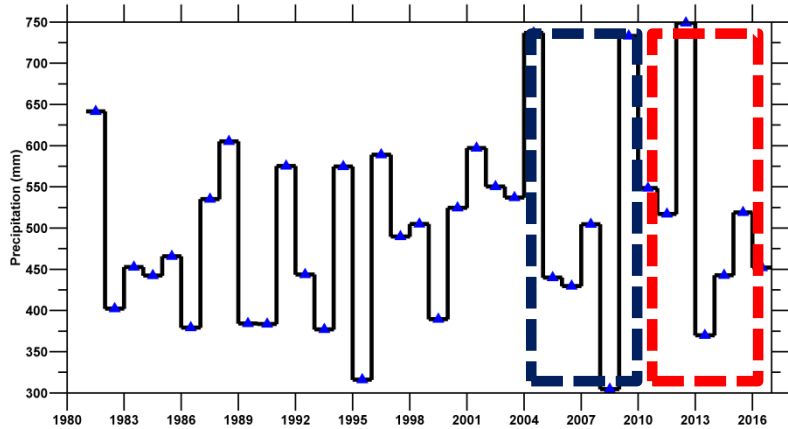
2005-2009

2011-2015

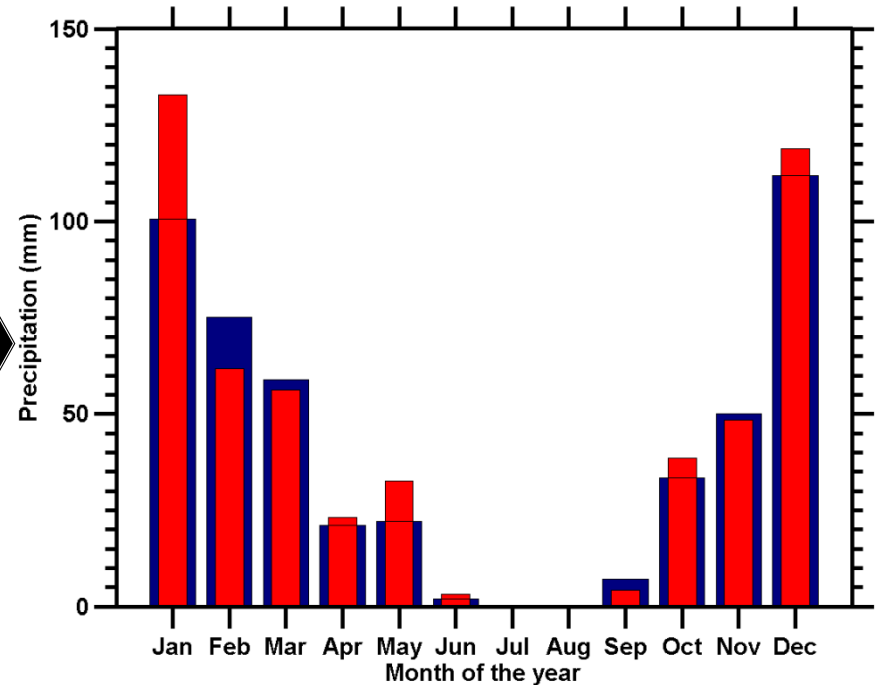


# Precipitation in Cyprus

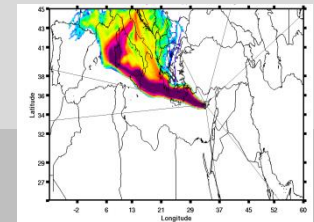
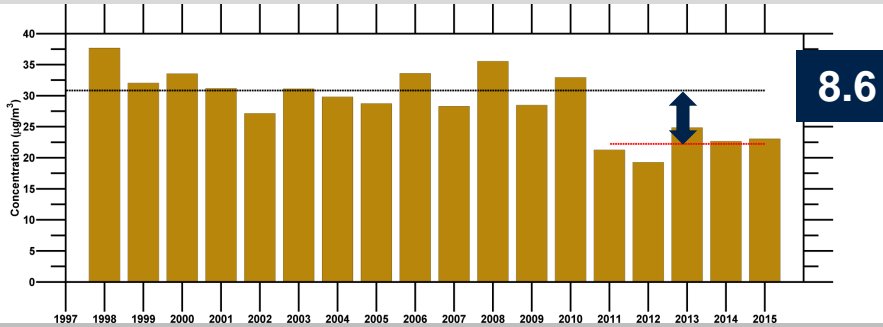
Annual variation cannot explain observed reduction



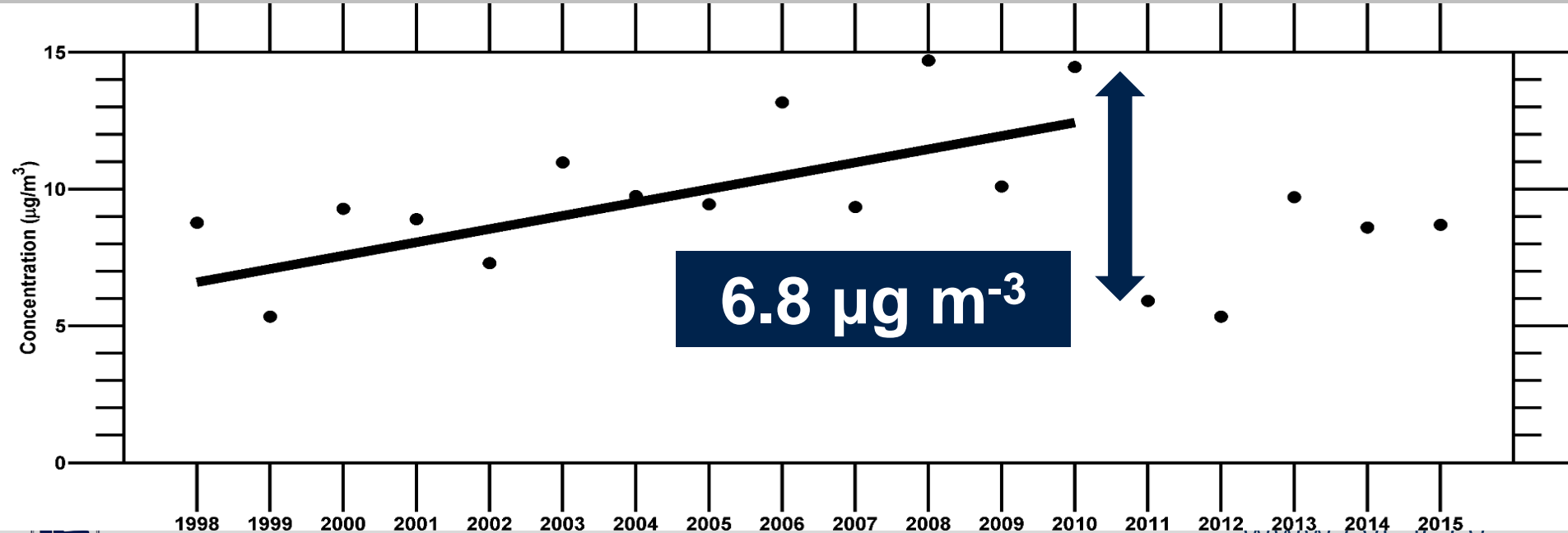
Seasonal pattern in the last decade has largely remained unaltered



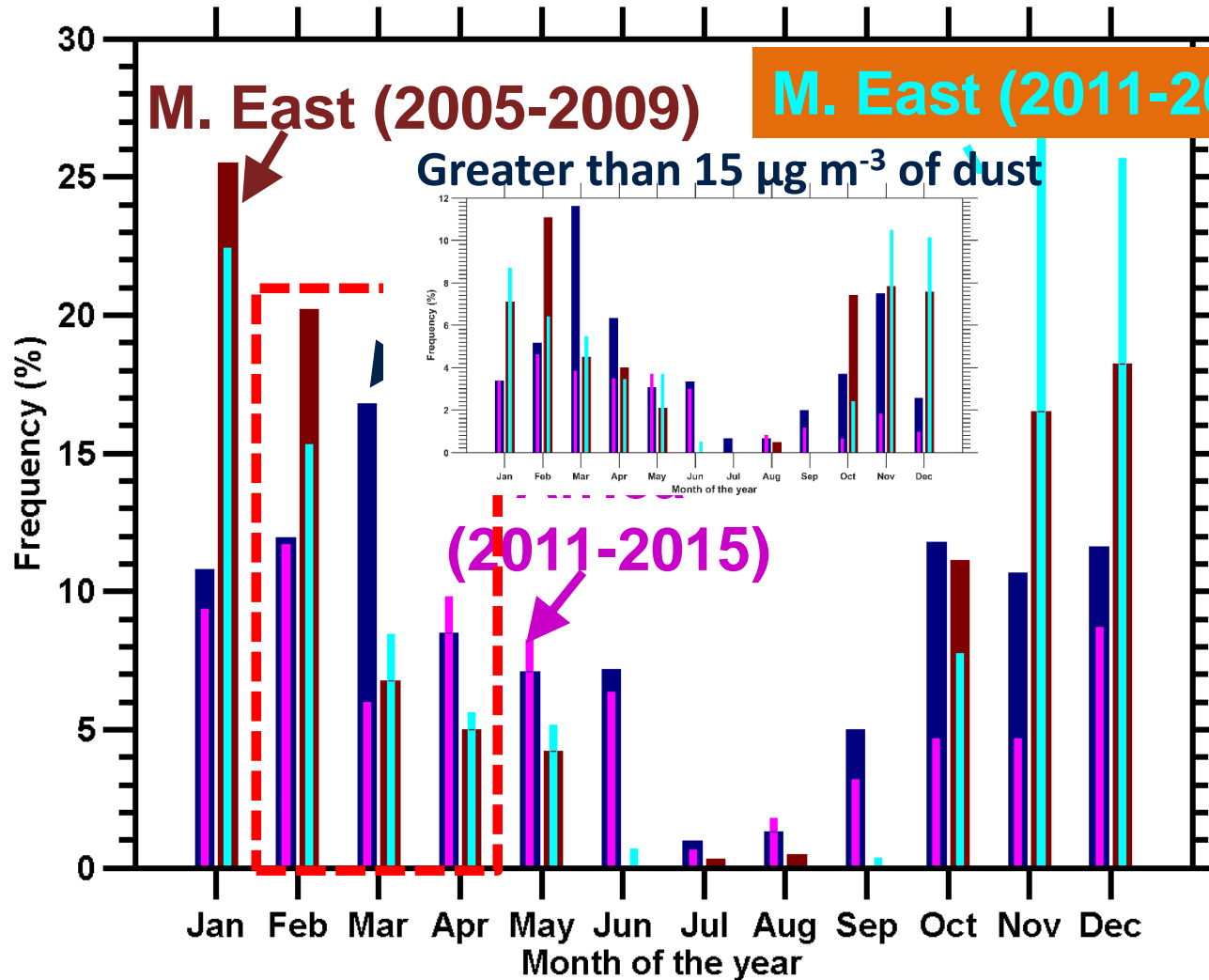
# Apportioning dust



Based on the method introduced by Querol et al. (2009)



# Dust Frequency



How often  
air masses  
from Africa  
and M. East  
reached  
Cyprus



M. East (2011-2015)

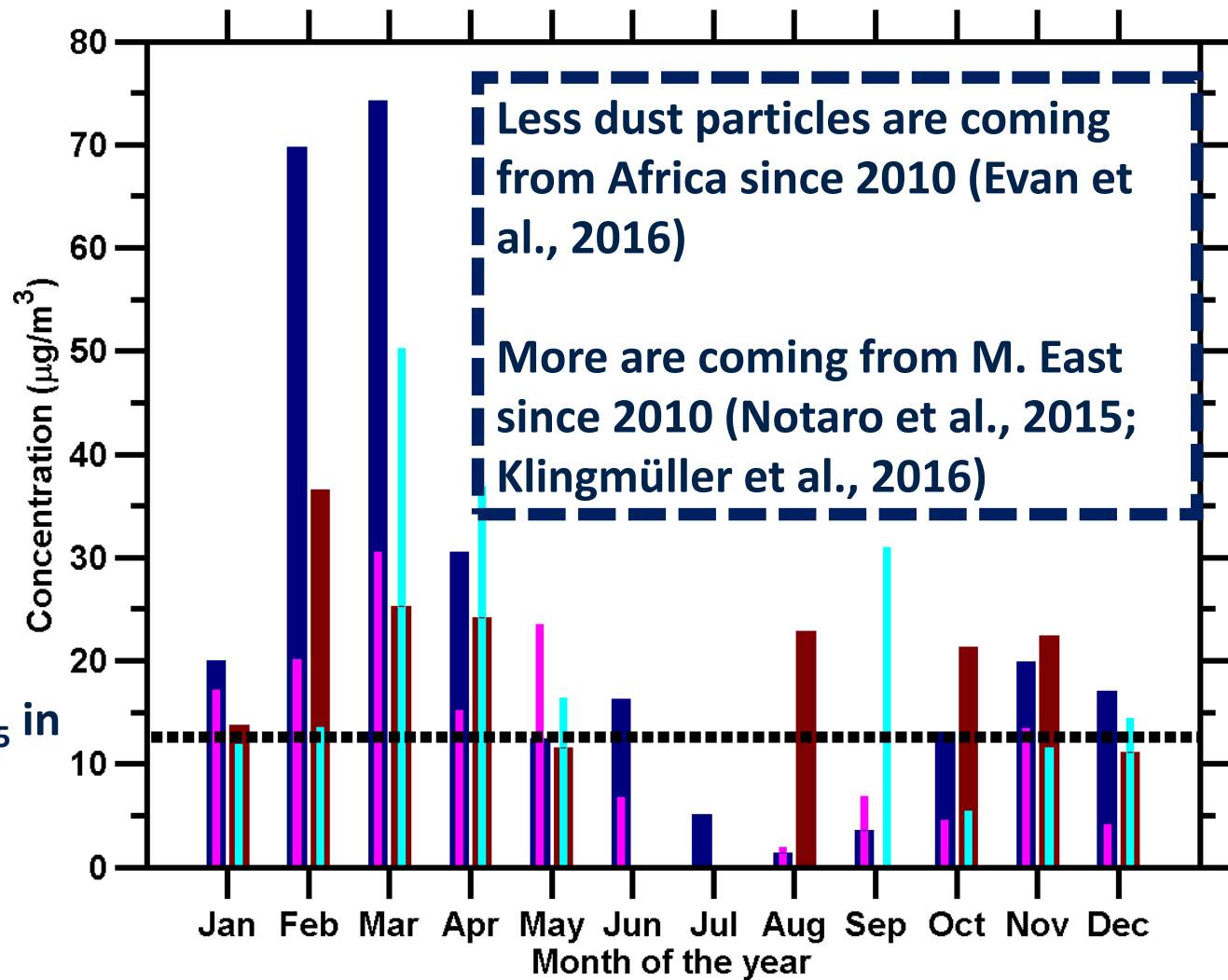
M. East (2005-2009)

Africa (2005-2009)

Africa (2011-2015)

# Dust Concentration

Average PM<sub>2.5</sub> in Cyprus



**Wind patterns in Cyprus have changed**

**+ Less dust particles from the Sahara are reaching Cyprus**

**+ More dust particles from the M. East are reaching Cyprus**

**Net effect: PM coarse has decreased**



Thank you for your attention !



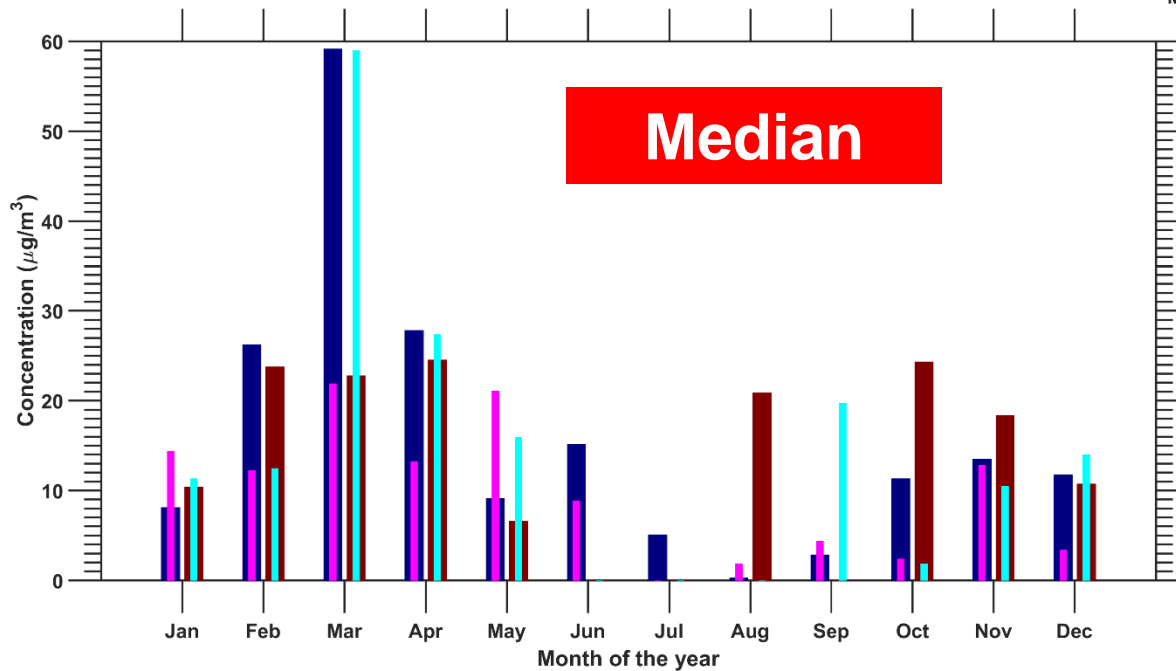
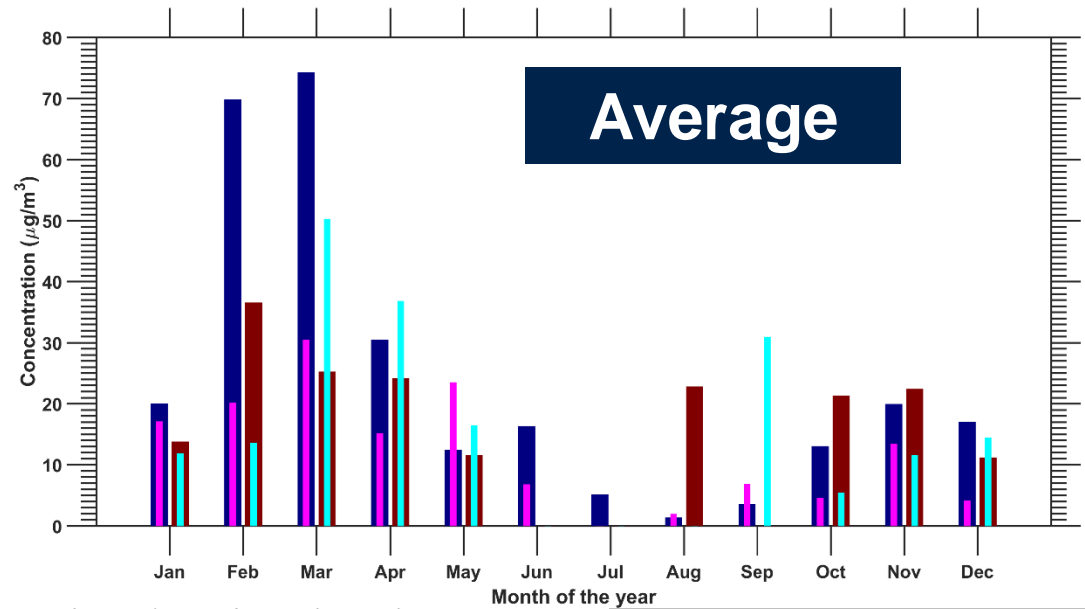
M. East (2011-2015)

M. East (2005-2009)

Africa  
(2005-2009)

Africa  
(2011-2015)

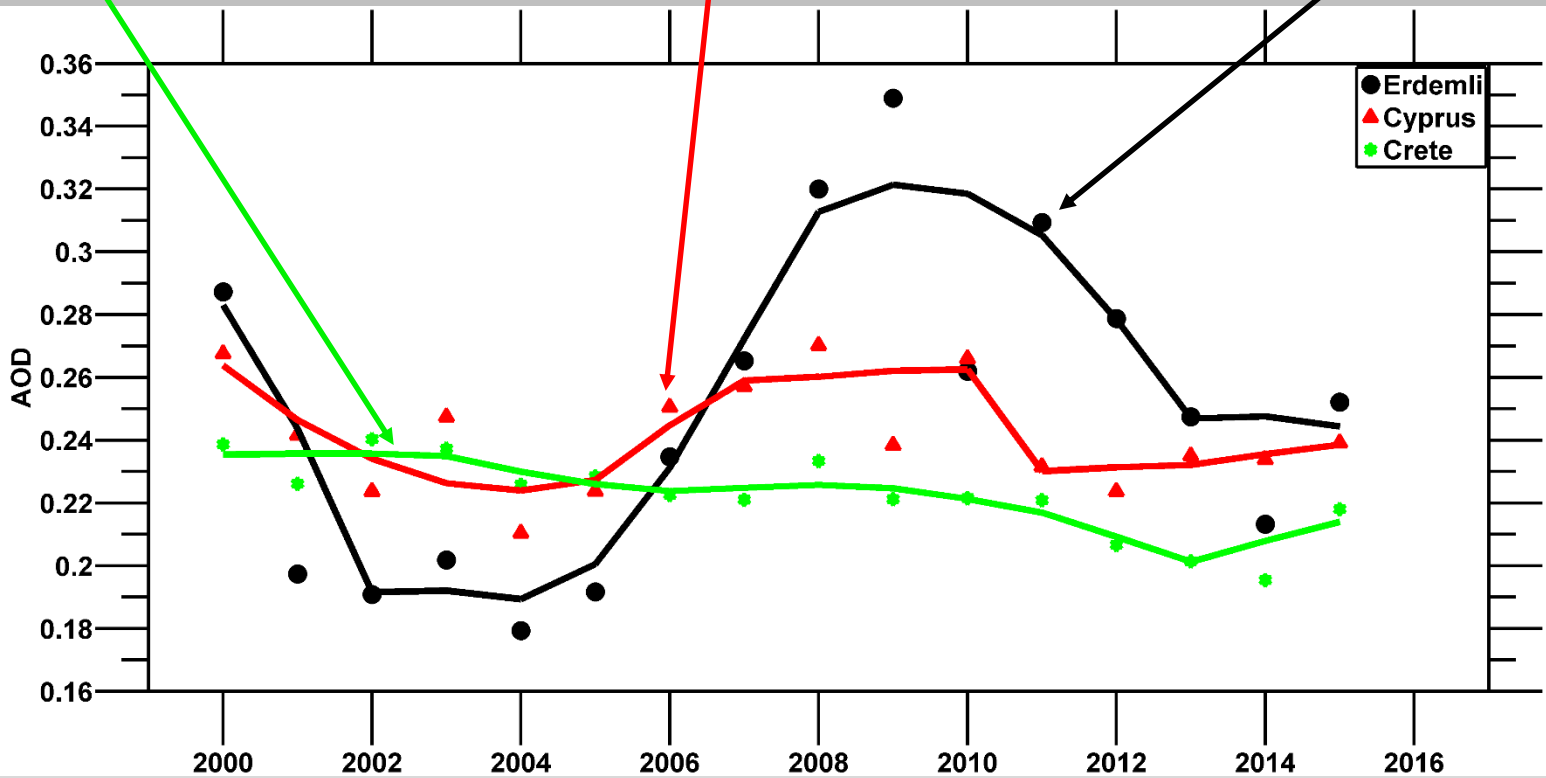
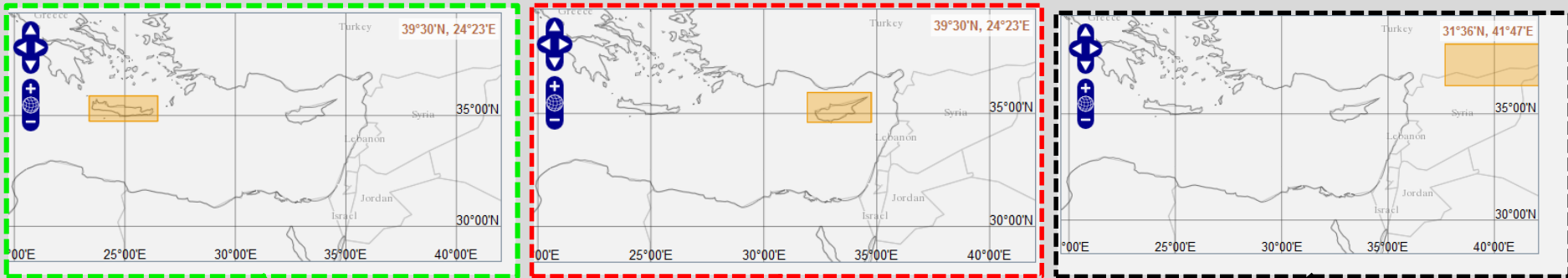
# Dust Concentration



**Is this phenomenon only observed in  
Cyprus?**

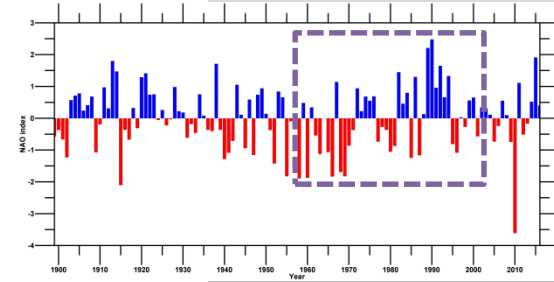
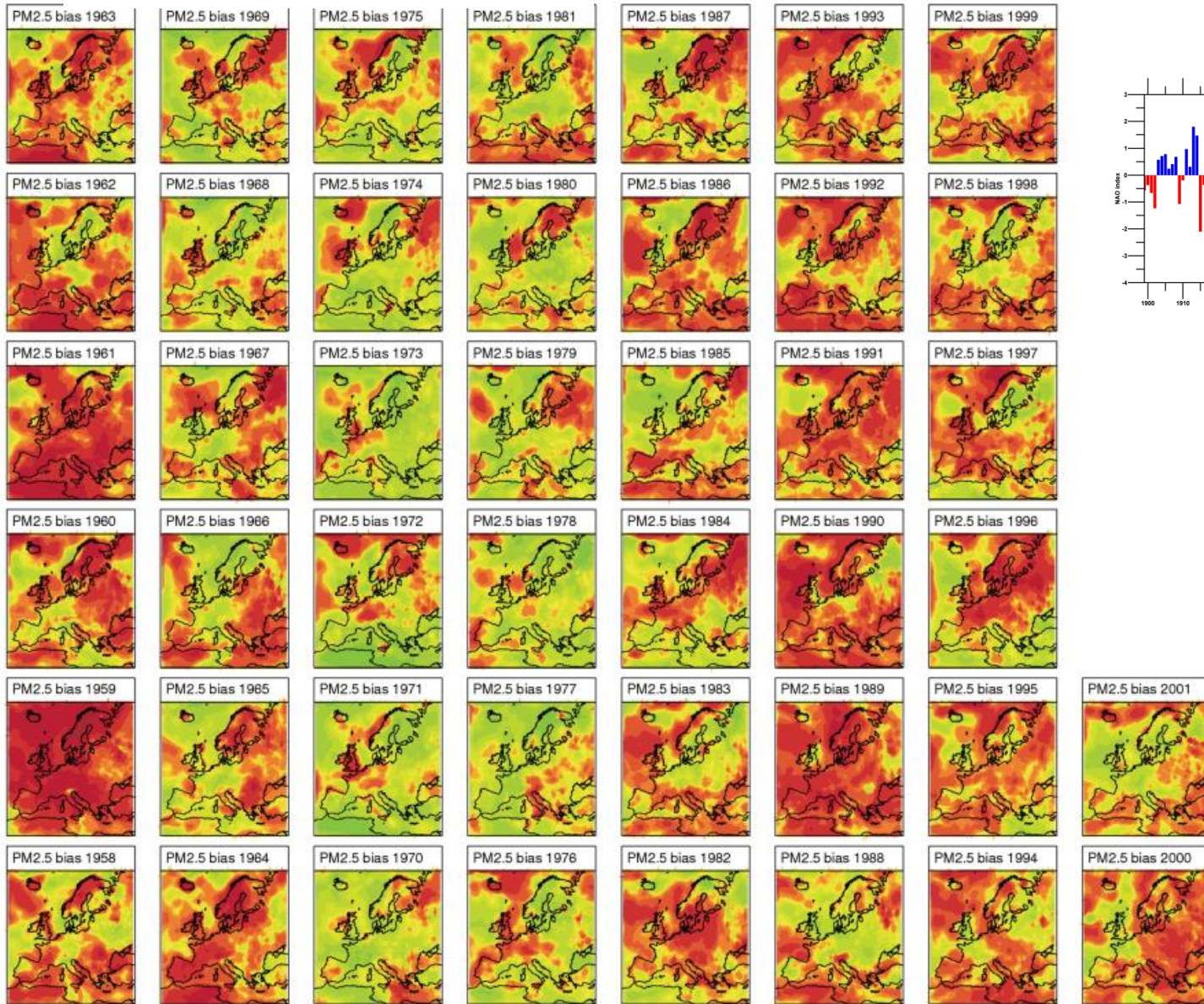


# AOD in the E. Mediterranean



# Modeled decadal variation of PM<sub>2.5</sub> (1958-2001)

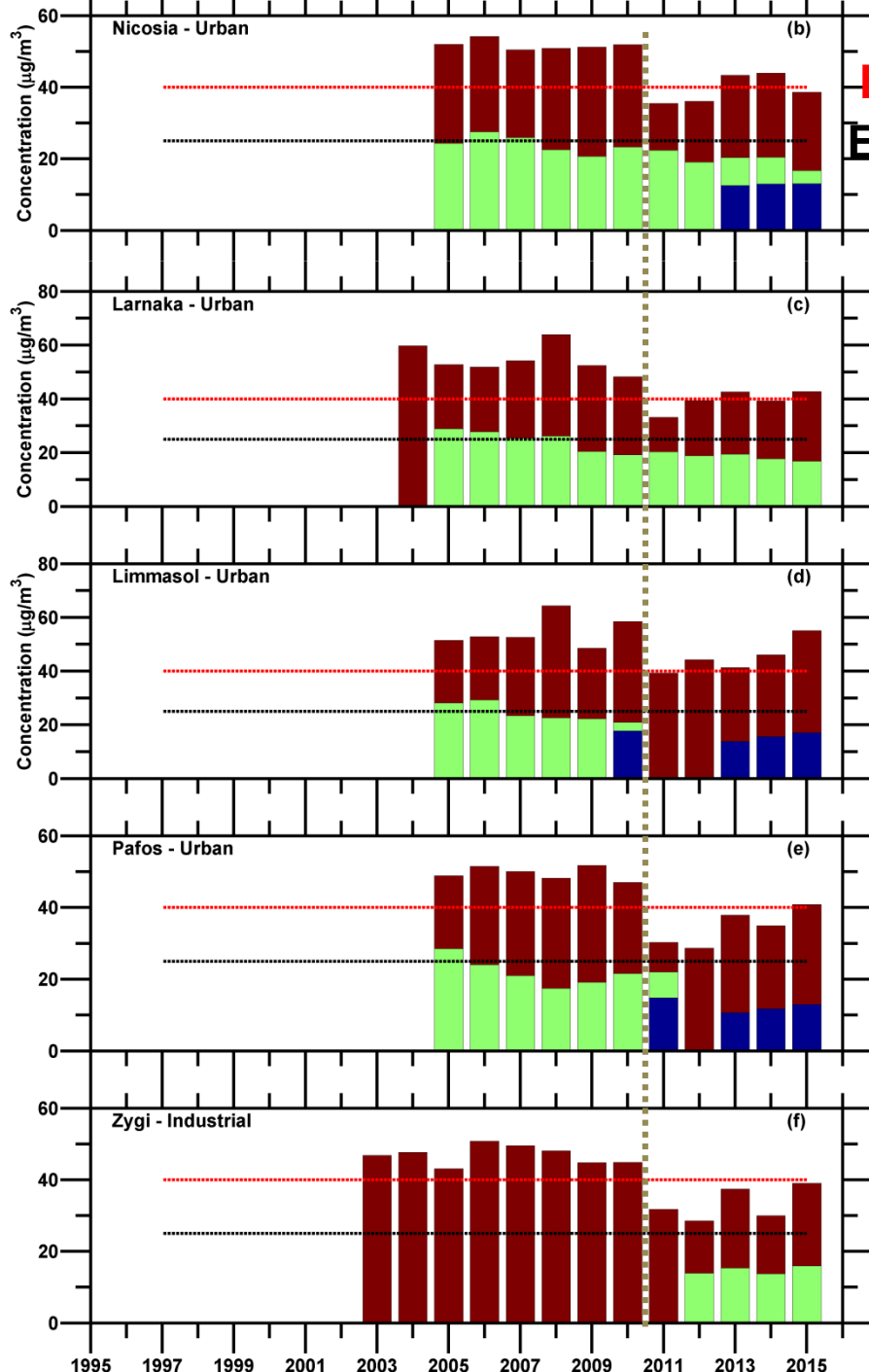
# Decadal PM<sub>2.5</sub> Variability



Andersson et al., 2007, Tellus

# Urban Centers

EU PM<sub>10</sub> threshold  
EU PM<sub>2.5</sub> threshold

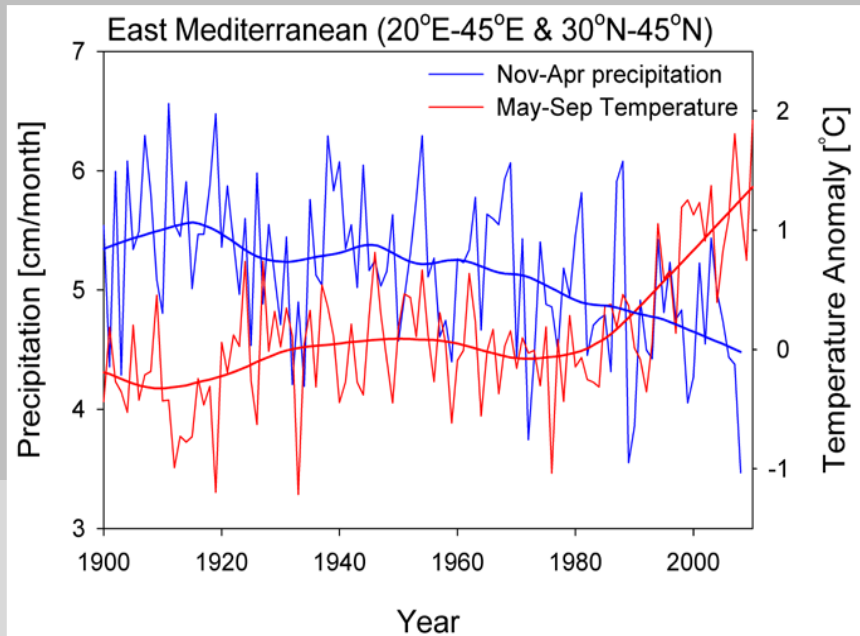


## Important differences in PM levels since 2010

- Before 2010 all cities violated EU PM<sub>10</sub> legislation
- Since 2010 only Limmasol consistently violates.
- Level of decrease is not the same in all cities and background sites.
- The EU PM<sub>2.5</sub> legislation is no longer violated

# Possible causes

**Temperature increase and precipitation decrease suggest it is not local particles that triggered the decrease**



**No significant change in land use**



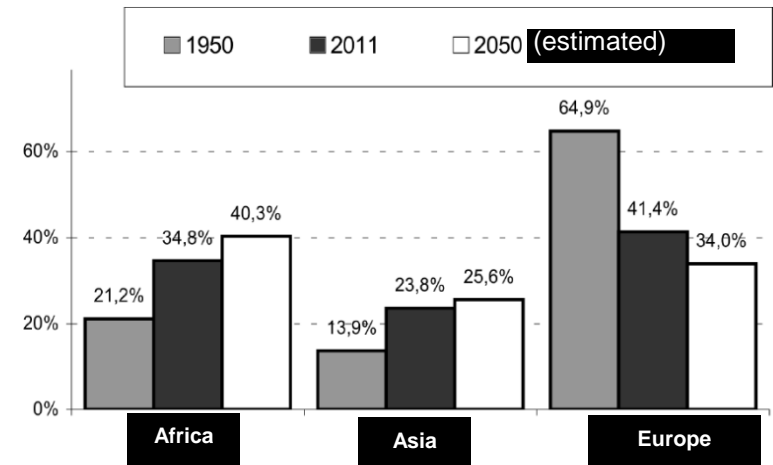
# Climate change hotspot

## Population around the Mediterranean (2000)



(Source: Géopolis)

## Fraction of population per continent in the Mediterranean



© Gérard-François Dumont - Chiffres PRB 2012.

- ✓ A high anthropogenic pressure around the Mediterranean with almost half a billion of inhabitants
- ✓ A strong increase of the population in the Southern and Eastern Basin with today more than half of the Mediterranean population leaving out of Europe (N. Africa and Middle-East)





# Local Monitoring Network

**4** are background  
**1** of which in the free  
troposphere

Northern part of the  
island is inaccessible



**1** is at an industrial  
site

**12** stations operating  
**NOW**

**2** at each city  
(kerbside and urban  
background)



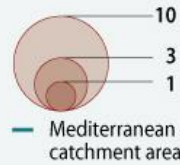
# Anthropogenic Pressure in the Mediterranean

## Population density and urban centres in the Mediterranean basin

Population density, 2008  
Inhabitants per square kilometre



Population in urban centres, 2010  
Millions



Sources: personal communication with Blue Plan, data collected from national sources, 2011; UNDESA, Population Division, online database, accessed in August 2011.

High concentration of people in coastal area:  
Inhabitants: ~450 millions in 2000 → 550 millions in 2025

# PM<sub>10</sub> Annual Trend (Agia Marina)

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