Effect of Saharan Dust on Air Pollution in Turkey

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Layout

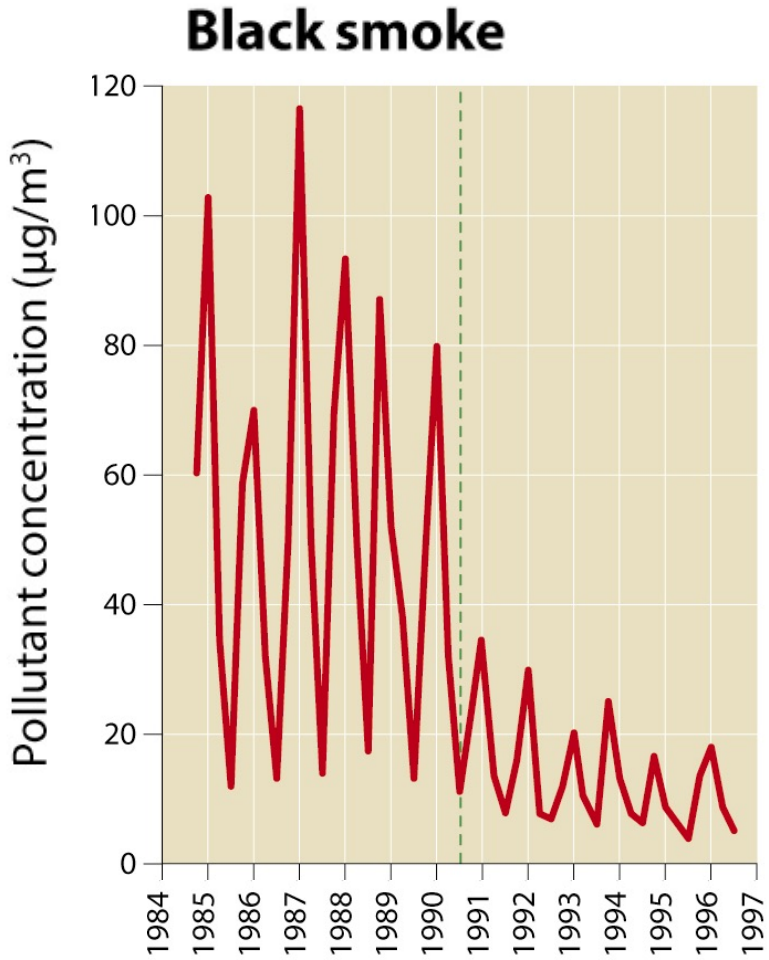
- Motivation: Health and Environmental Effects of Air Pollution
- Air Pollution in Turkey
- Saharan Dust Transport to Turkey (Anatolian Peninsula) (7-8)
  - Long-term evaluation
  - Model approach for episodic events

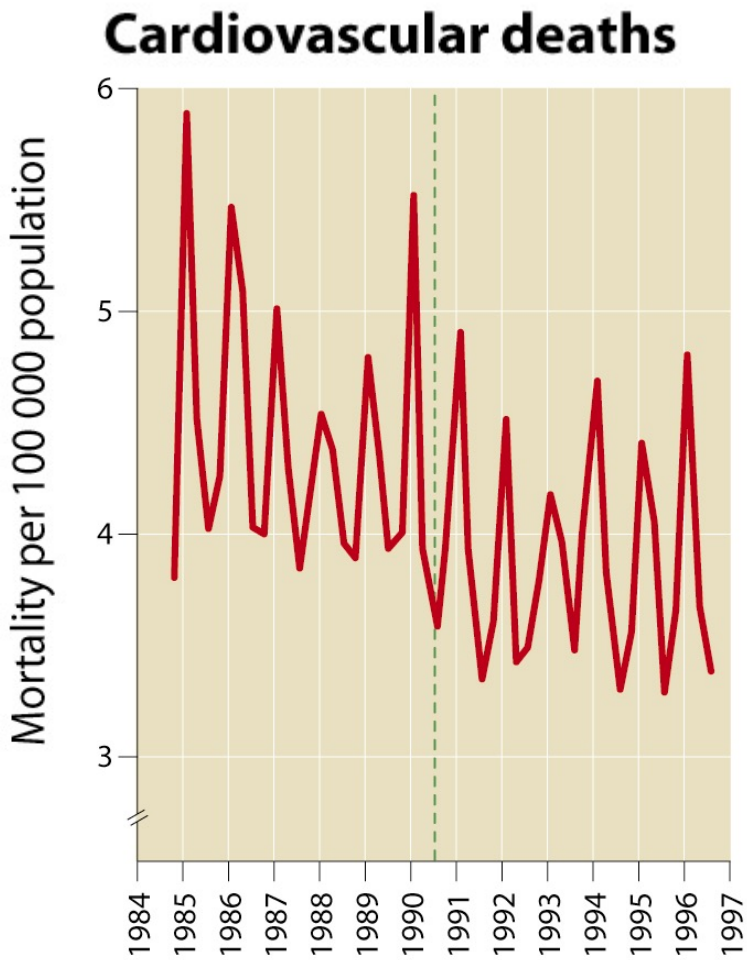
Health Effects

Pollutant	Health Effects	References
PM_{10}	Decreasing 70 µg to 20µg, 15% reduction in deaths due to air pollution Loss of lung function in children	WHO Guaderman, 2000
PM_{10}	10 µg increase causes %0.6-1.2 increase in daily deaths	Pope, 2006
PM_{10}	10 µg increase causes %0.6 increase in overall deaths %1 increase in applicants over the age of 65 asthma-COPD	Atkinson, 2001
$PM_{2.5}$	10 µg increase causes %1-17 increase in overall deaths 10 µg increase causes %5-42 increase in mortality in cardio 10 µg increase causes %1-17 increase in deaths due to lung cancer	Pope, 2006

Air Pollution in Dublin

Dr. Michal Krzyzanowski, Regional Adviser, Air Quality and Health
WHO Regional Office for Europe





WORLD HEALTH ORGANIZATION
EUROPE

Air Pollution Impacts: Acid Rain

www.adirondackcouncil.org/

FIGURE 2.6
An example of acid precipitation damage to an outdoor statue. The statue, made of porous sandstone, was erected in 1702 as part of the gable of the
ken in 1908, shows some stains and the loss of the left hand, but most
, taken in 1969, shows the loss of most of the detail of the statue over 61
lege.)

www.fws.gov

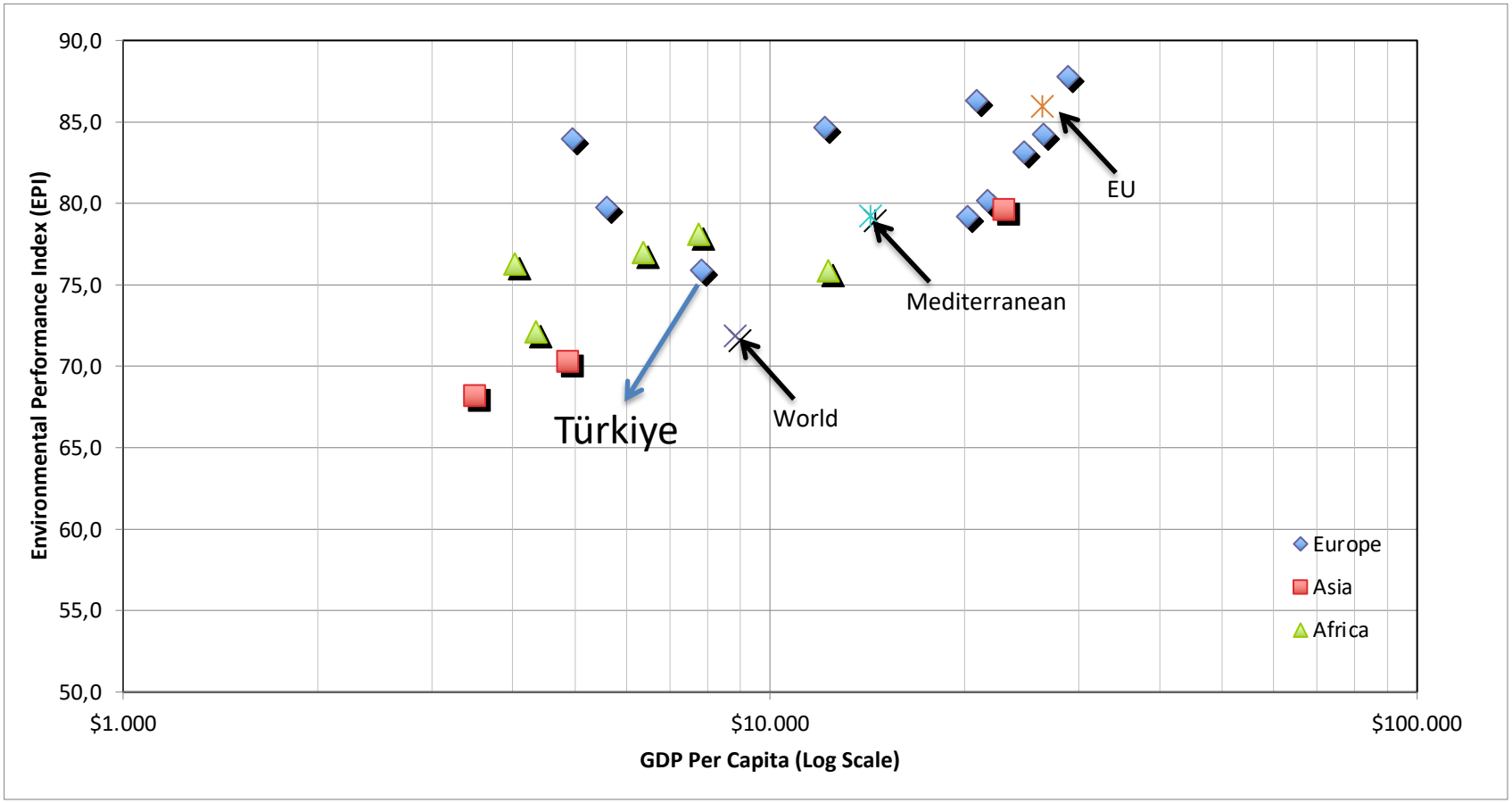
www.dnr.cornell.edu/.../current_research.htm

Air Pollution Impacts: Particulate Matter

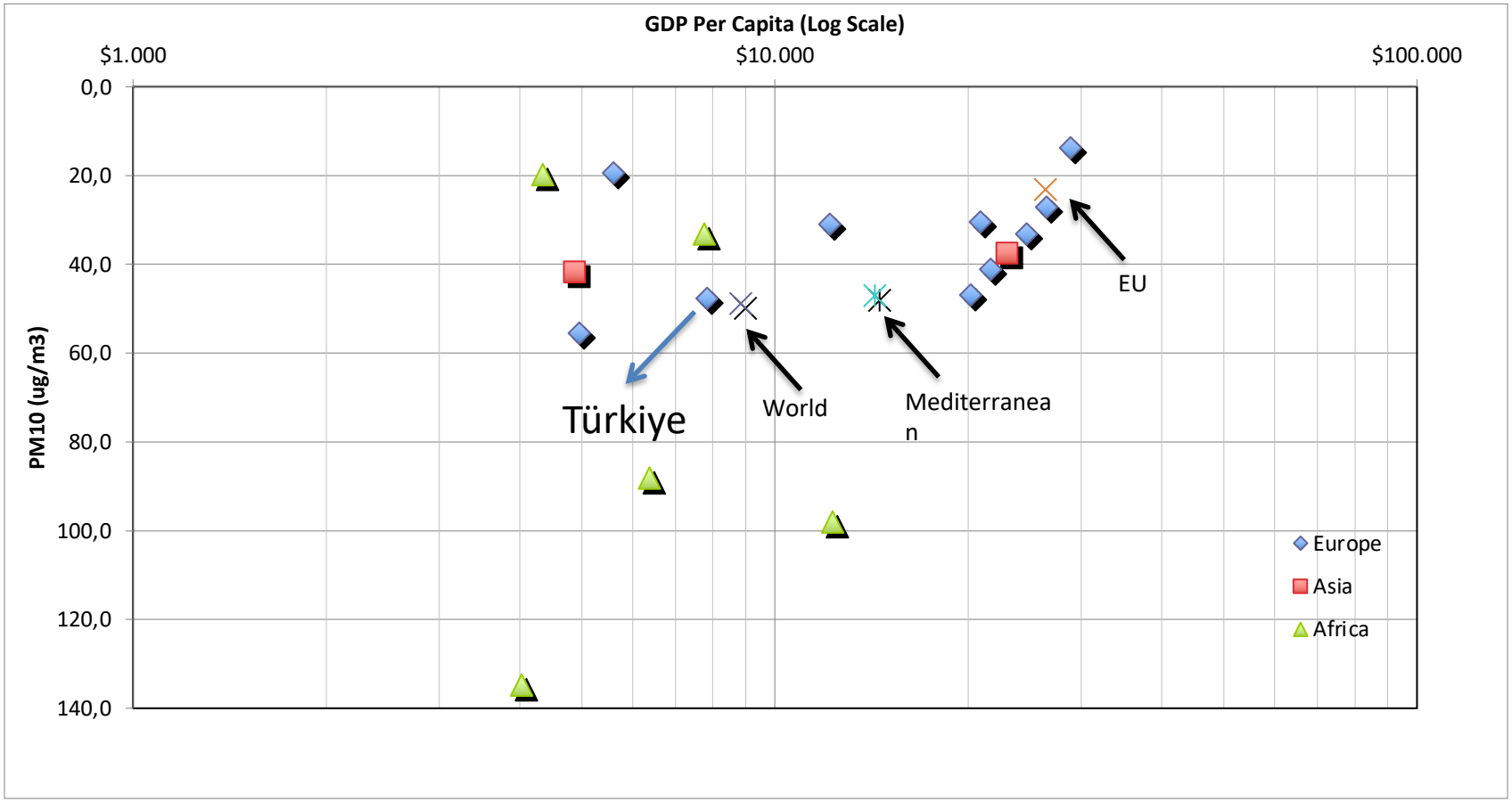
High-visibility conditions in the Smoky Mountains-
100 miles (top) and low-visibility-20 miles (bottom)
www.ornl.gov/.../v38_1_05/article02.shtml

Clear and Hazy Days in Houston
www.utexas.edu/.../texaqs/visitors/photos.html

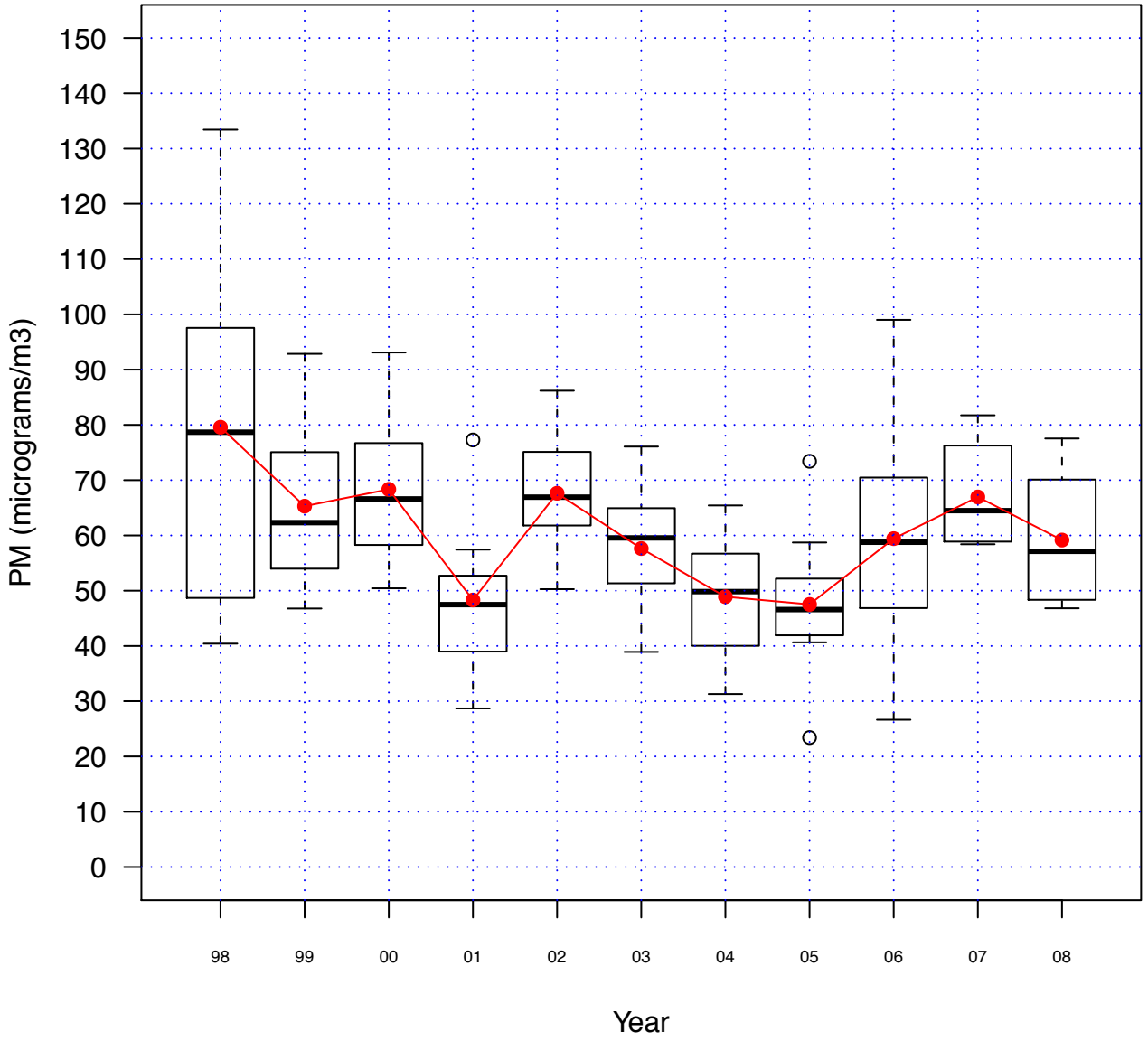
Environment Indicators

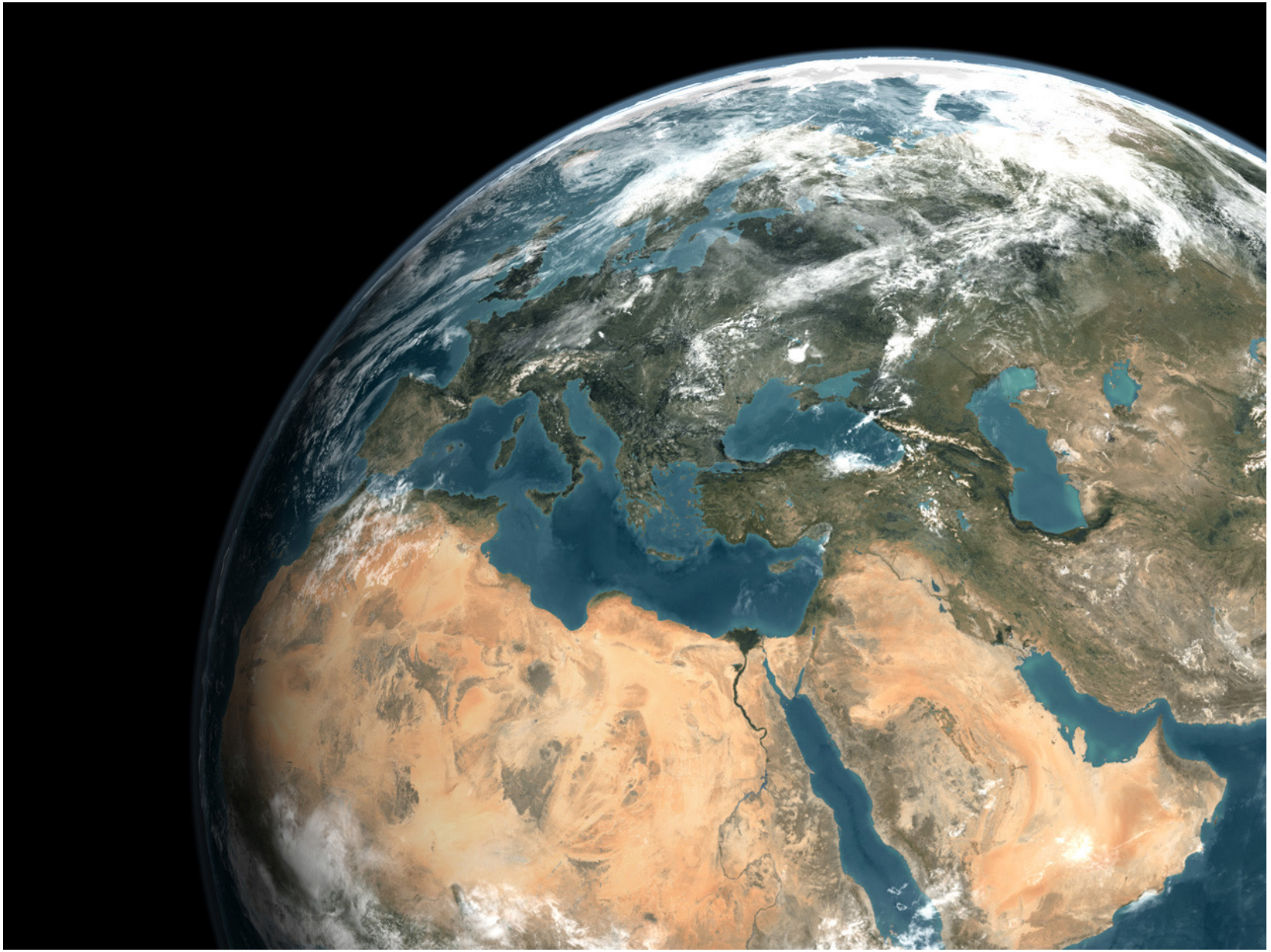


Particulate Matter



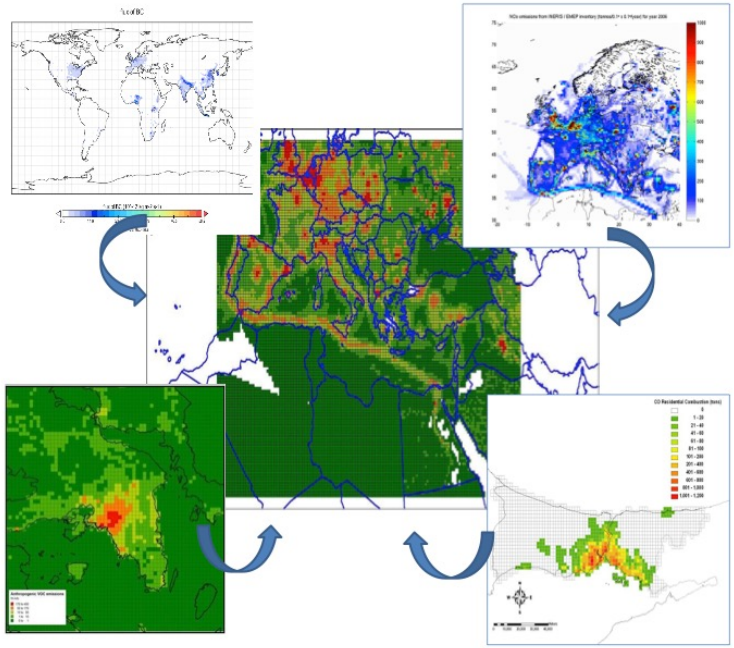
PM10 Levels in Istanbul, Turkey





MODIS Data, NASA

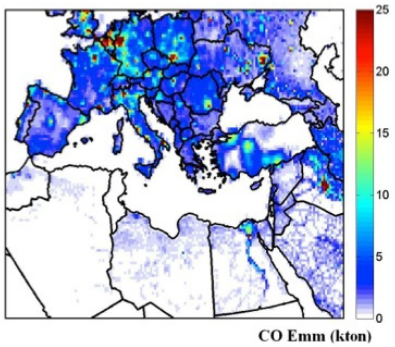
ANTHROPOGENIC EMISSIONS



Emission inventories used to compile the anthropogenic emissions for the model domain include:

- INERIS 10 km inventory for Europe (https://wiki.met.no/cityzen/page2/emissions)
- CIRCE global emissions for remaining parts around the Mediterranean and Asia (van Aardenne et al., 2009)
- 2 km emissions for Istanbul (Im, 2009) and Athens (Markakis et al., 2010a and b)
- These inventories are merged using the MOSSES emission model (Markakis et al., 2010a and b)

Fig.3. Global, regional and urban emission inventories used for the compilation of CityZen-ECPL anthropogenic emissions.



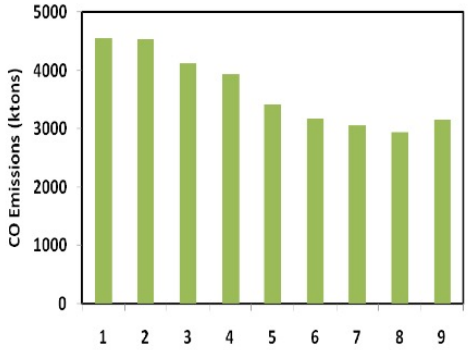


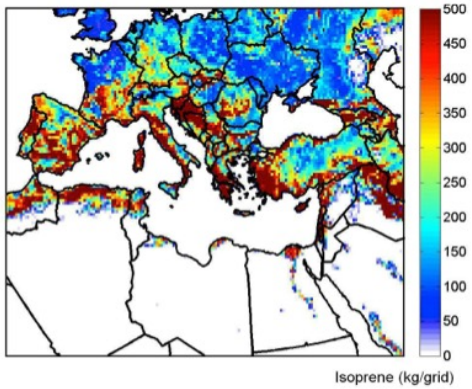
Fig.4. Spatial (*) and temporal (ktons/month) distribution of anthropogenic CO emissions compiled for The CityZen-ECPL model domain.

(*) ktons/grid integrated over the simulation period (1/1/08-30/9/08)

NATURAL EMISSIONS

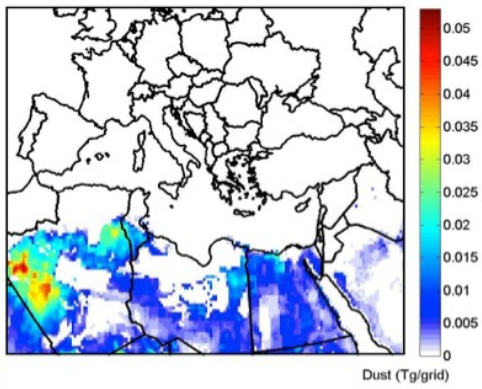
Temporally and spatially varying natural emissions for the studied region are calculated using the WRF-CHEM MEGAN and GOCART modules.

ISOPRENE



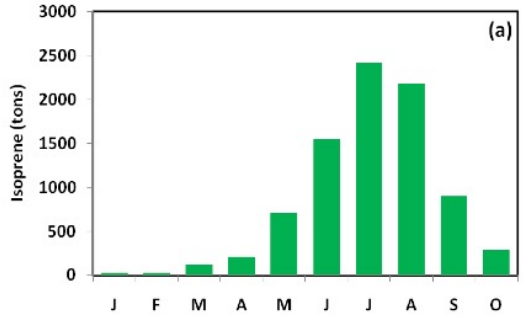
JULY

DUST



APRIL

Fig.5. Spatial distribution of isoprene emissions (kg/grid) in July (left panel) and dust emissions (Tg/grid) in April (right panel).



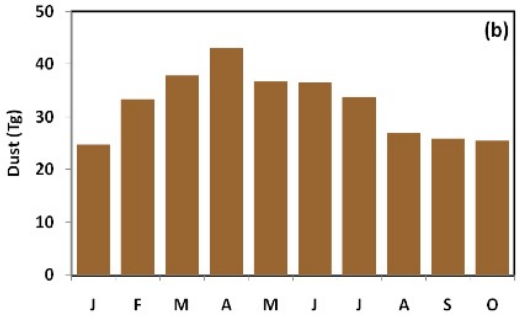
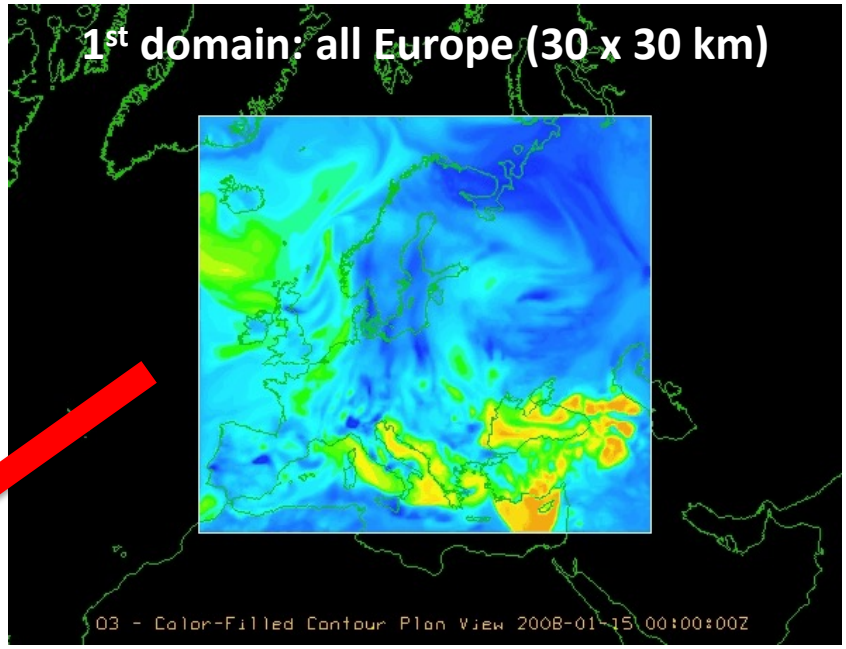
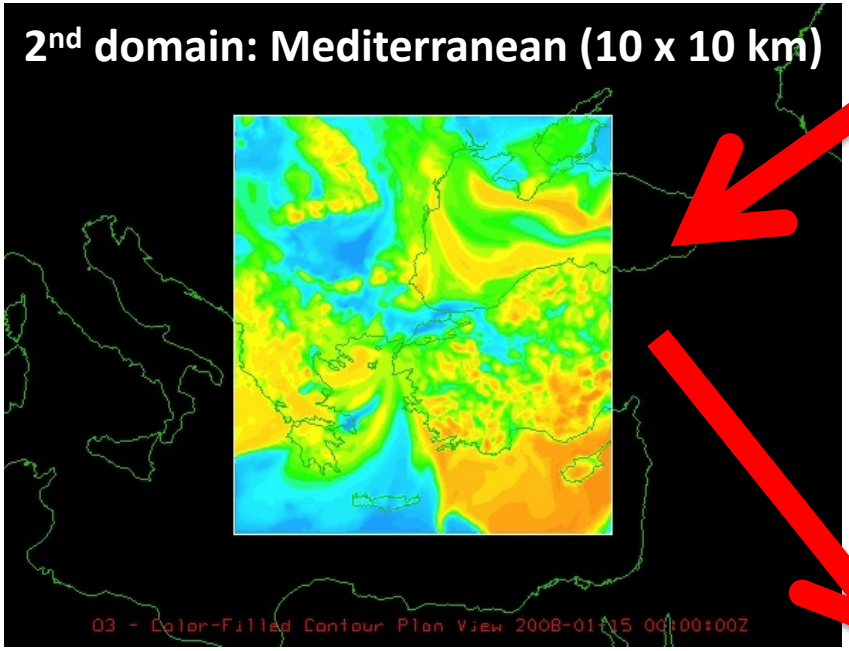
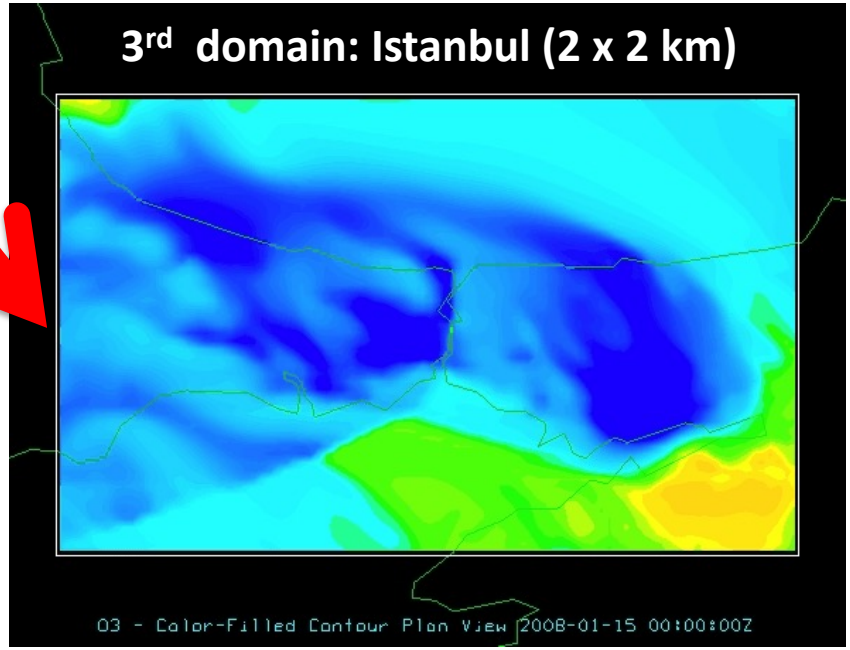


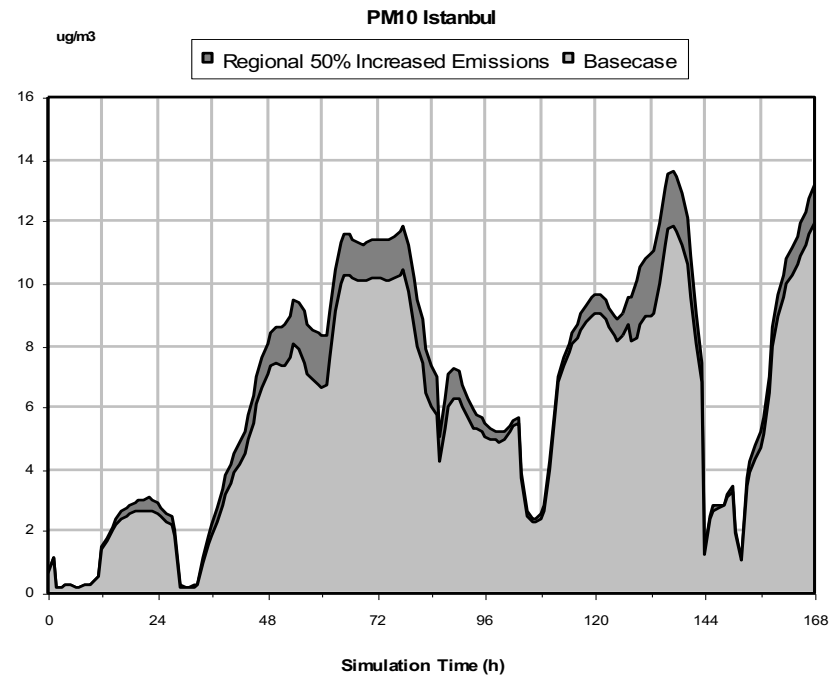
Fig.6. Monthly variation of a) isoprene (tons) and b) dust (Tg) emissions in the model domain.

WRF/CMAQ Air Quality Modeling System

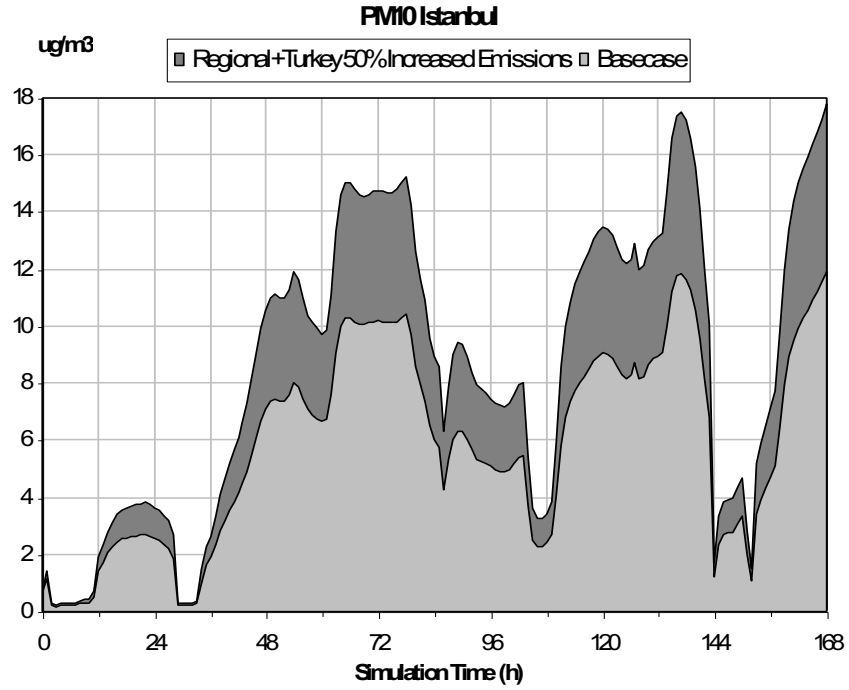








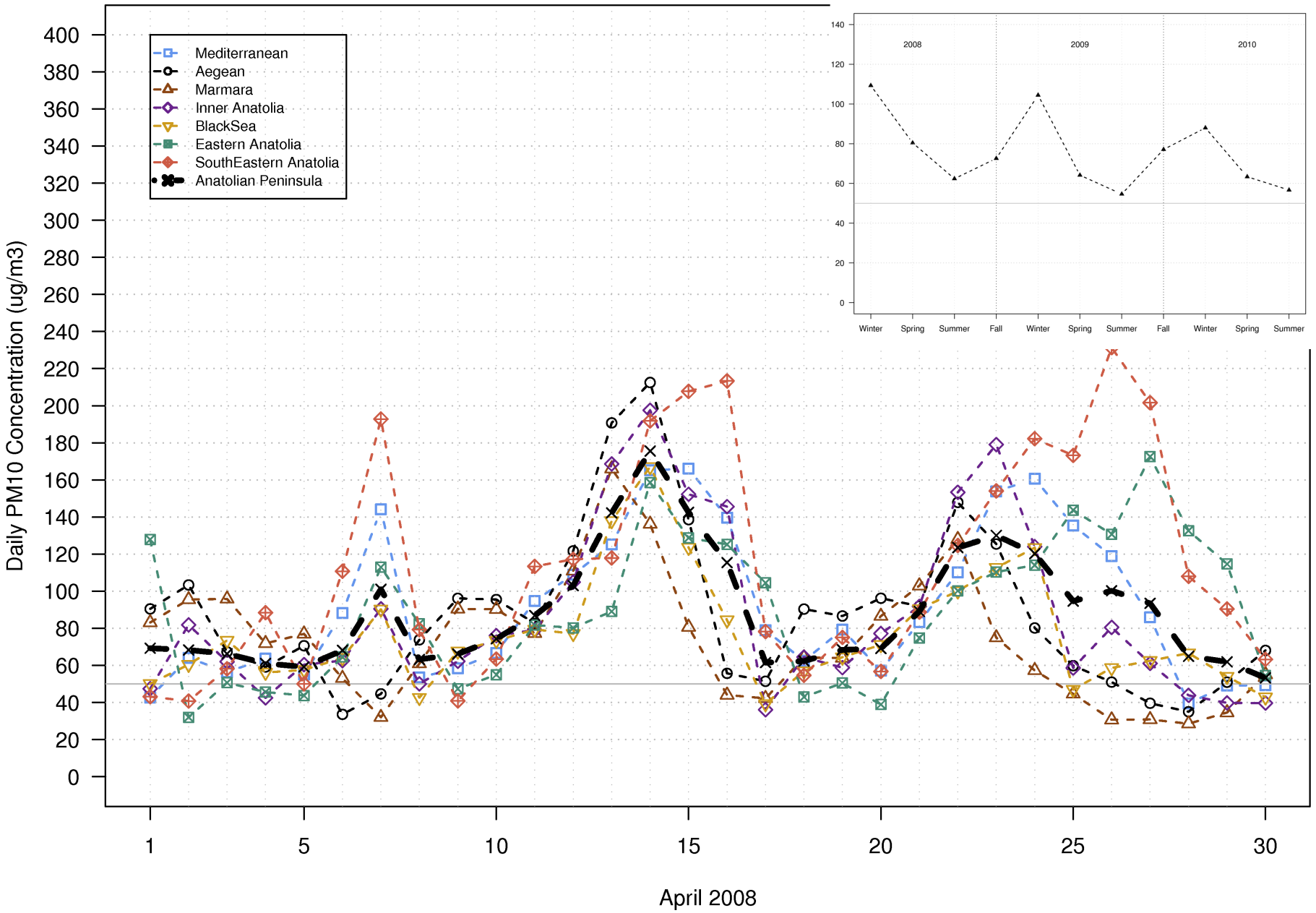
Istanbul Change in PM10	%50 Increase		%50 Decrease	
	Ave	Max	Ave	Max
Regional*	%12	%24	%9	%26
Regional + Turkey	%45	%50	%46	%50



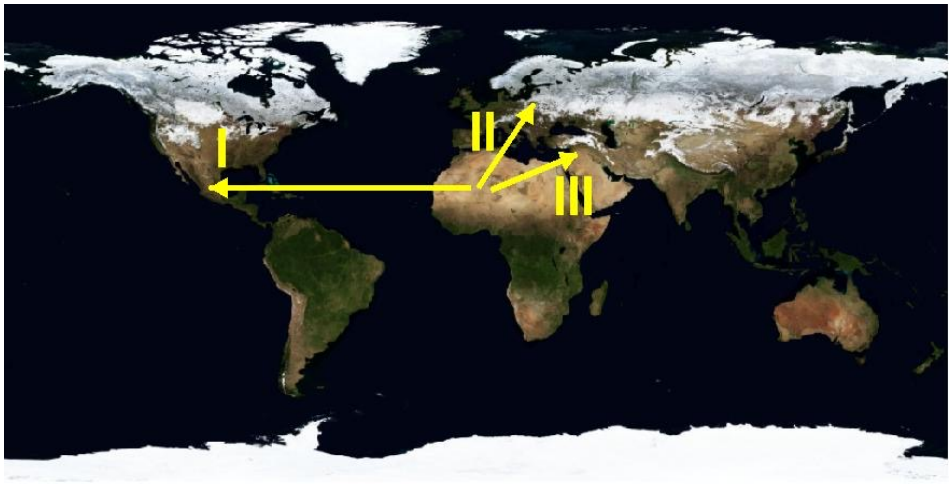
***Regional**

Bulgaria
Romania
Poland
Ukraine
Russia
Hungary
Slovakia
Moldova
Belarus
Lithuania
Latvia
Estonia

PM10 Levels in Turkey: April 2008



Transport Pathways of Saharan Dust

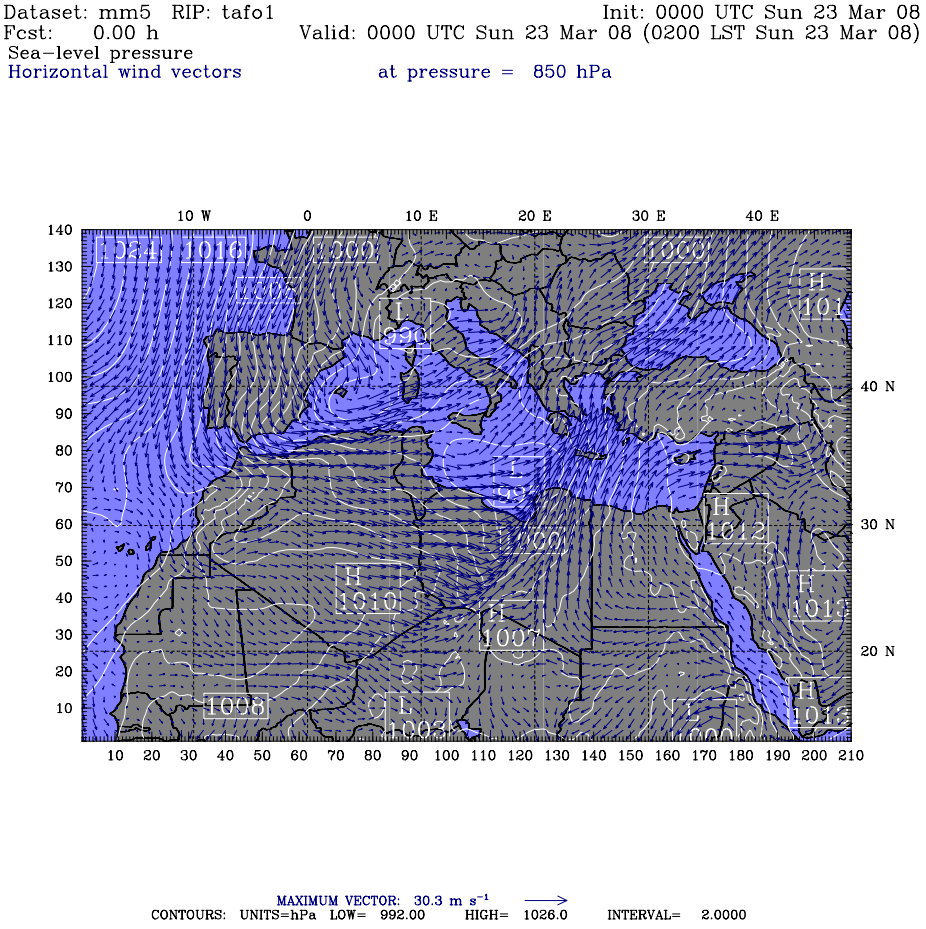


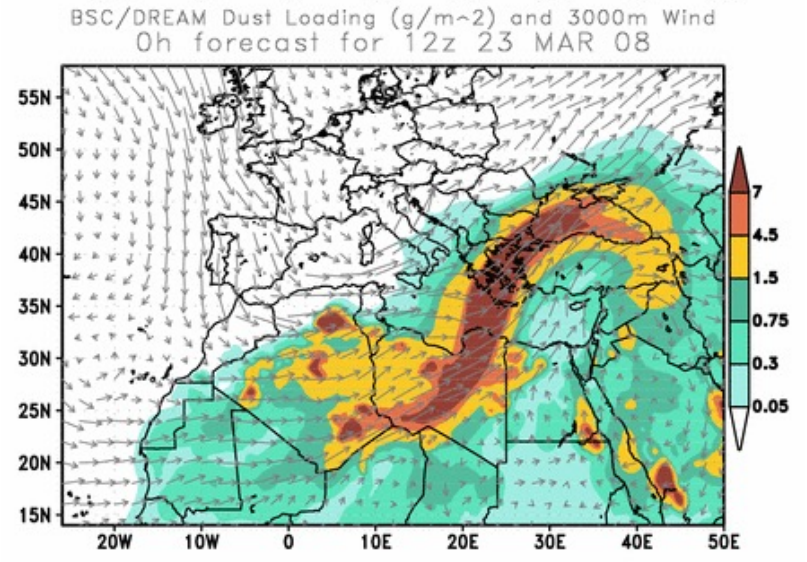
1. Transport across the Atlantic Ocean to **the USA, the Caribbean** and **South America**
(travel time: for summer 3-5 days, for winter 1 week)

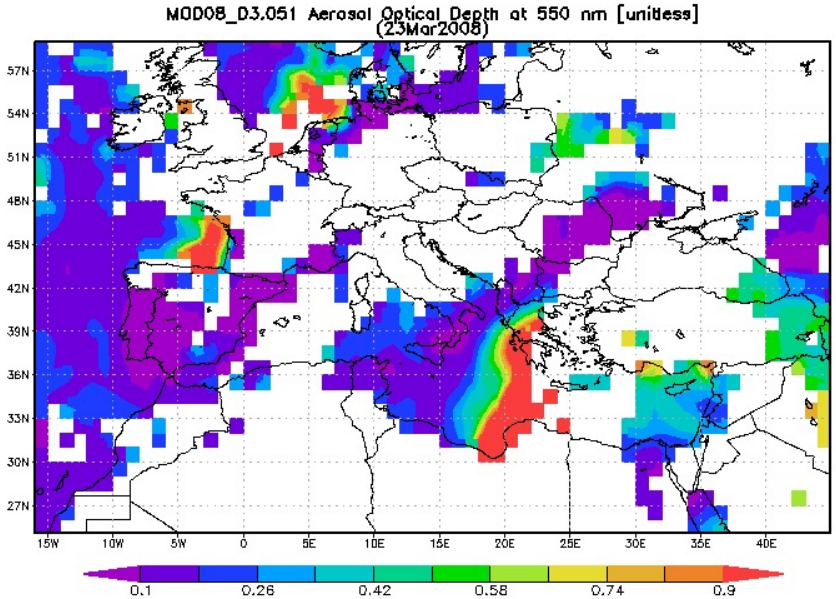
2. Transport towards **the Mediterranean** and **Europe**
(travel time: 7-8 days)

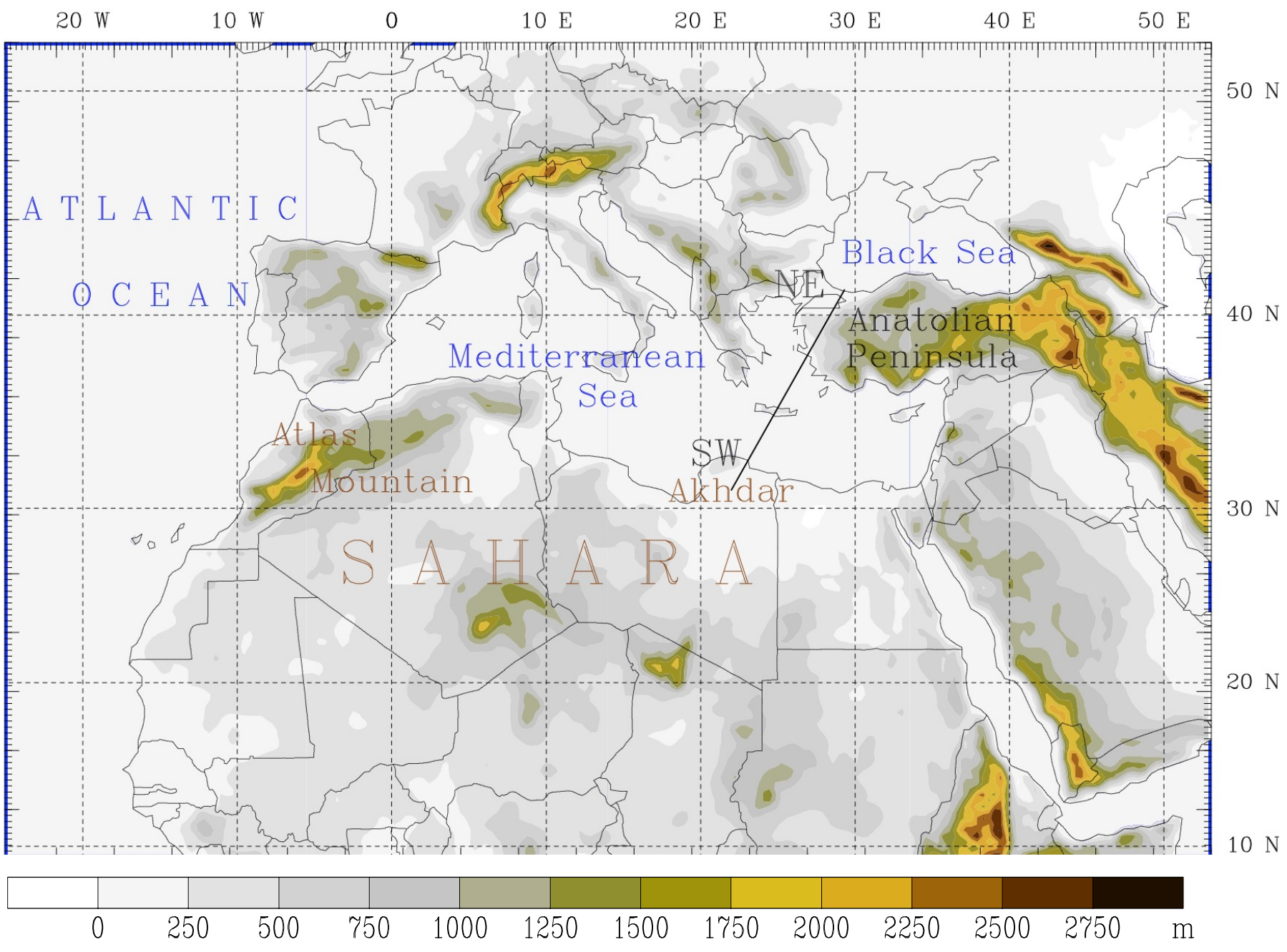
3. Transport towards **the eastern Mediterranean** and **the Middle East**
(Engelstaedter et al., 2008)

March 23, 2008





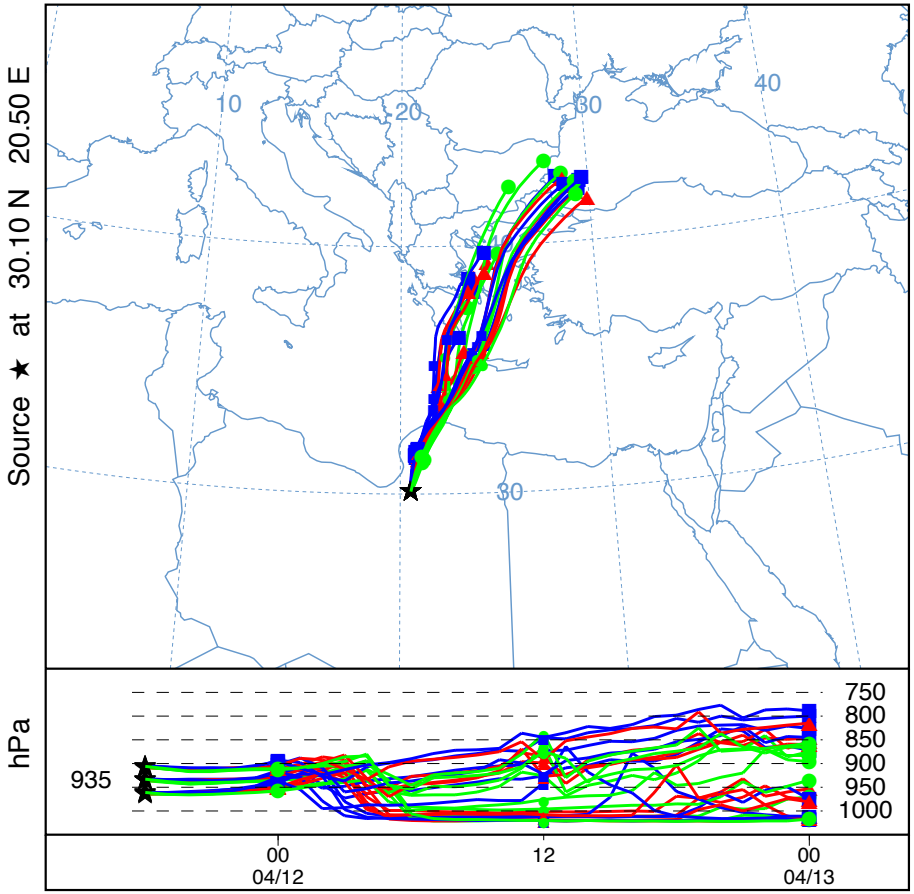



20 W
10 W
0
10 E
20 E
30 E
40 E
50 E
50 N
40 N
30 N
20 N
10 N
ATLANTIC
OCEAN
Black Sea
NE
Anatolian
Peninsula
Mediterranean
Sea
Atlas
Mountain
SW
Akhdar
SAHARA
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
m

Contributions from the selected Source

Forward trajectories starting at 1800 UTC 11 Apr 08

AWRF Meteorological Data



Contributions from the selected Source

Backward trajectories ending at 1800 UTC 13 Apr 08

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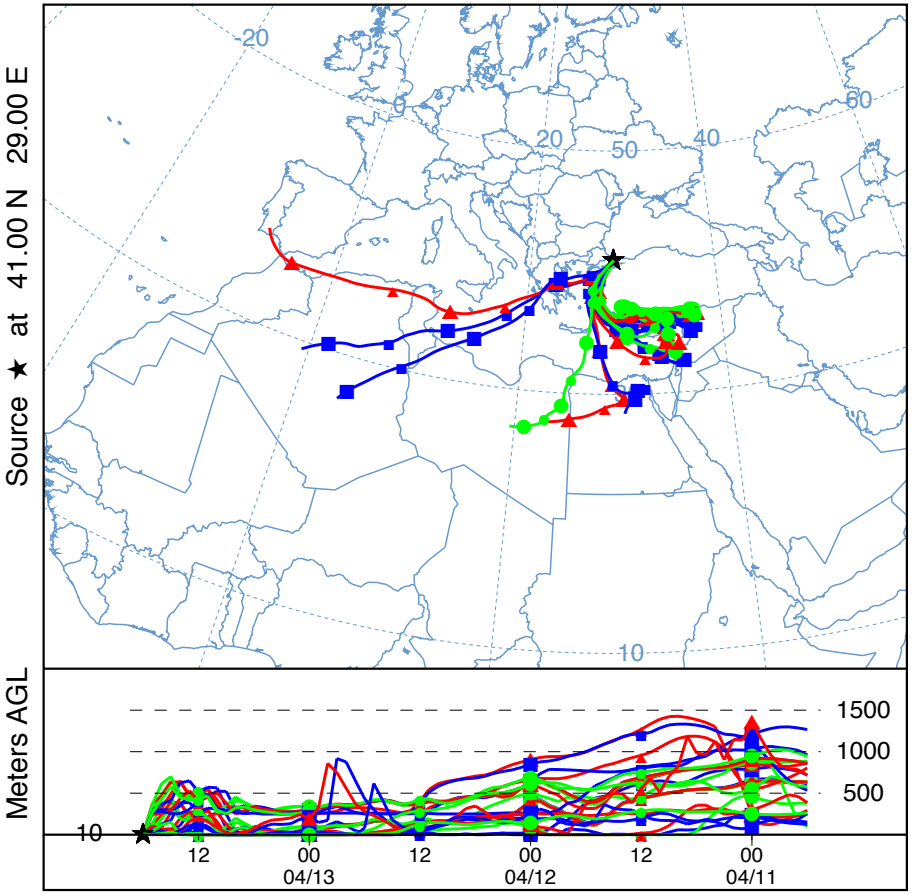
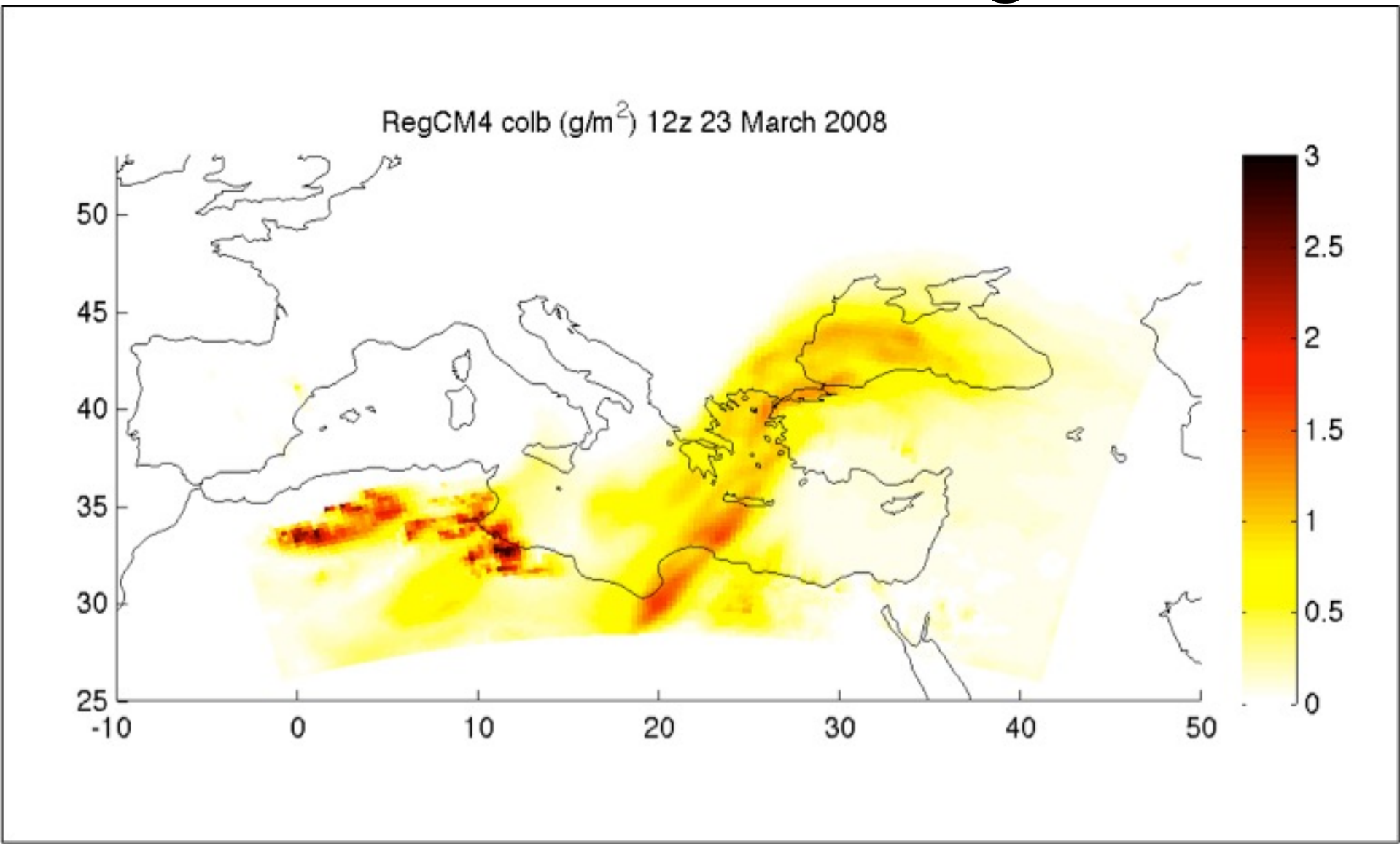


ISTANBUL

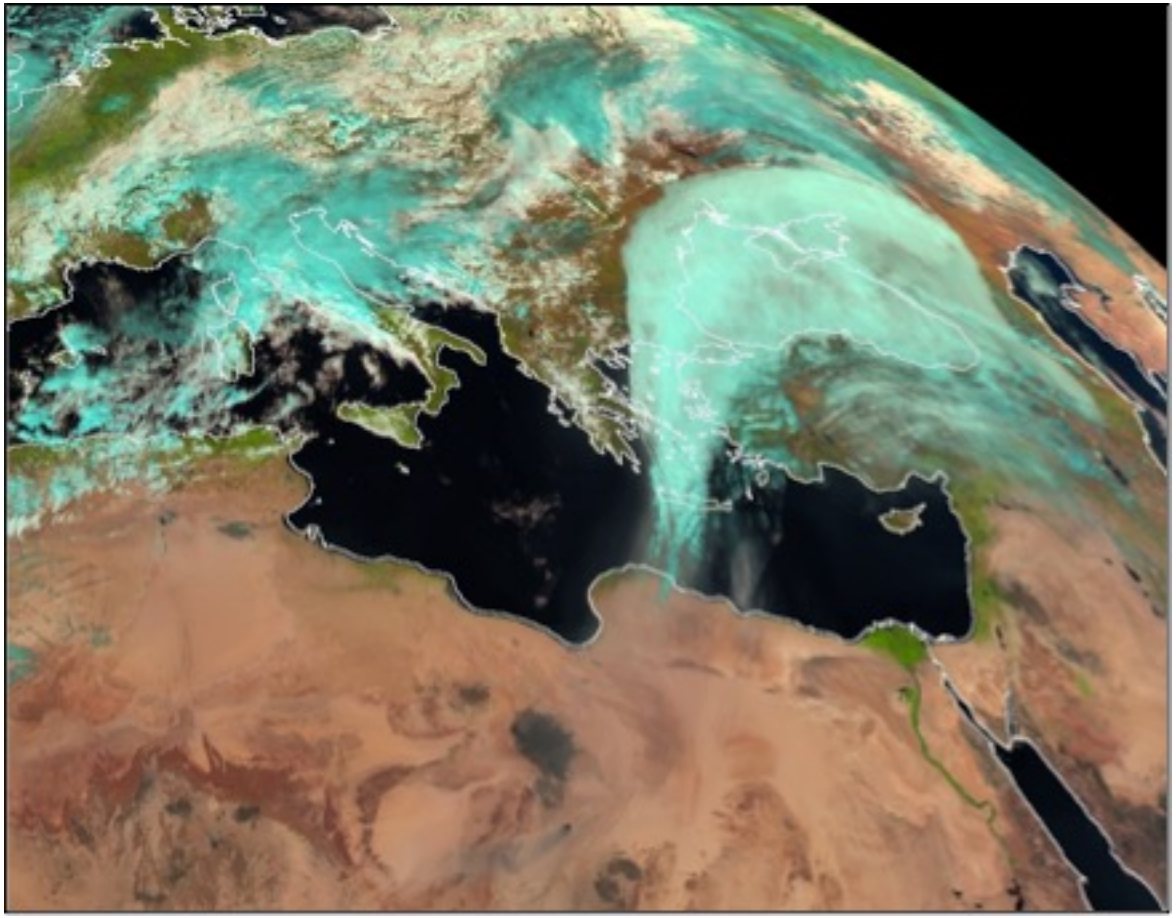
Days with PM10 over 50 μg/m3: Spring 2004-2010

Years	Days with PM10 over 50 ug/m3	Sahara Event (%)	Intensive Sahara* (%)	Non Sahara Event (%)	IntensiveNon Sahara* (%)
2004	37	78.4	37.9	21.6	37.5
2005	43	53.5	0.0	46.5	15.0
2006	52	63.5	42.4	36.5	36.8
2007	71	52.1	40.5	47.9	29.4
2008	68	76.5	42.3	23.5	18.8
2009	44	72.7	50.0	27.3	25.0
2010	42	57.1	29.2	42.9	33.3
Average		64.8	34.6	35.2	28.0

REGCM4 Modeling



REGCM4 Modeling



Cyclone Detection and Tracking

- 30-yr climatology (1961-90)
- ECMWF (ERA40) & NCEP/NCAR $2.5^0 \times 2.5^0$
- RegCM3
- Mean sea level pressure (MSLP) and 850-hPa relative vorticity (RVOR)
- Tracking Algorithm (*Hotkins and Sardeshmukh -1984; Hodges -1995, 1996, 1999-*)
  - Lifetime: *at least 1 day (4 time steps) and 2 day (8 time step).*
  - Distance: *1000 km for 2-day case and 500 km for 1-day case.*
- Cluster Algorithm (*Gaffney, 2004*)
  - CCToolbox

Cyclone Sources	Total 2914 cyclone
Sahara	%30
Genoa	%23
Adriatic	%19
Basra	%4
Black Sea	%5
Aegean	%16
Cyprus	%4