

**1st Africa/Middle East expert meeting and
workshop on the health impact of airborne dust**

2-5 Nov 2015, Amman

dust impact on health in urban areas: an overview

Sergio Rodríguez

srodriguezg@aemet.es

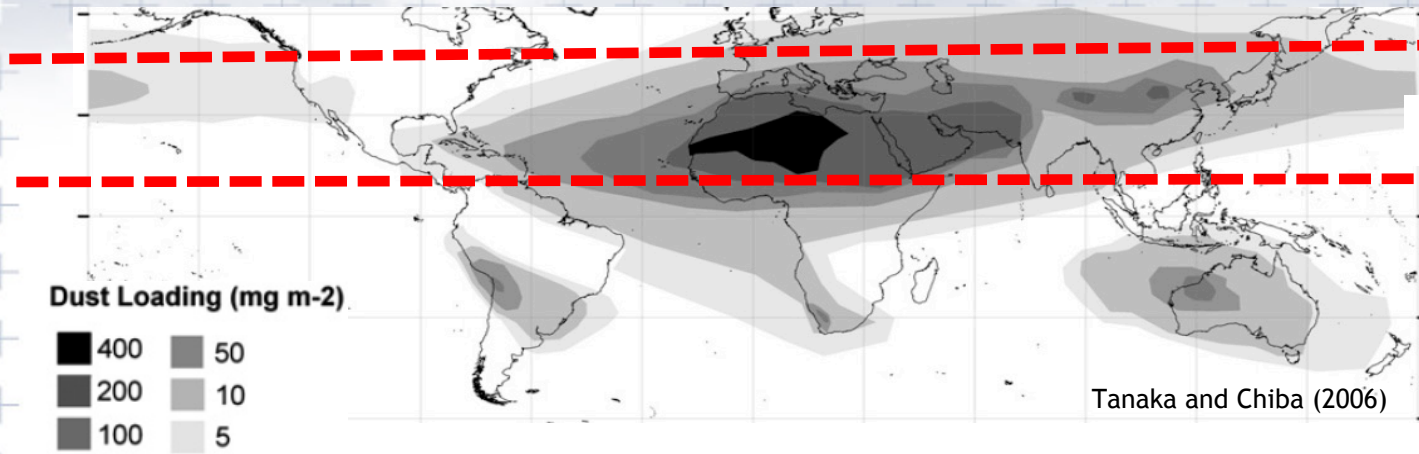
AEMET, Spain

respiratory diseases

cardiovascular diseases

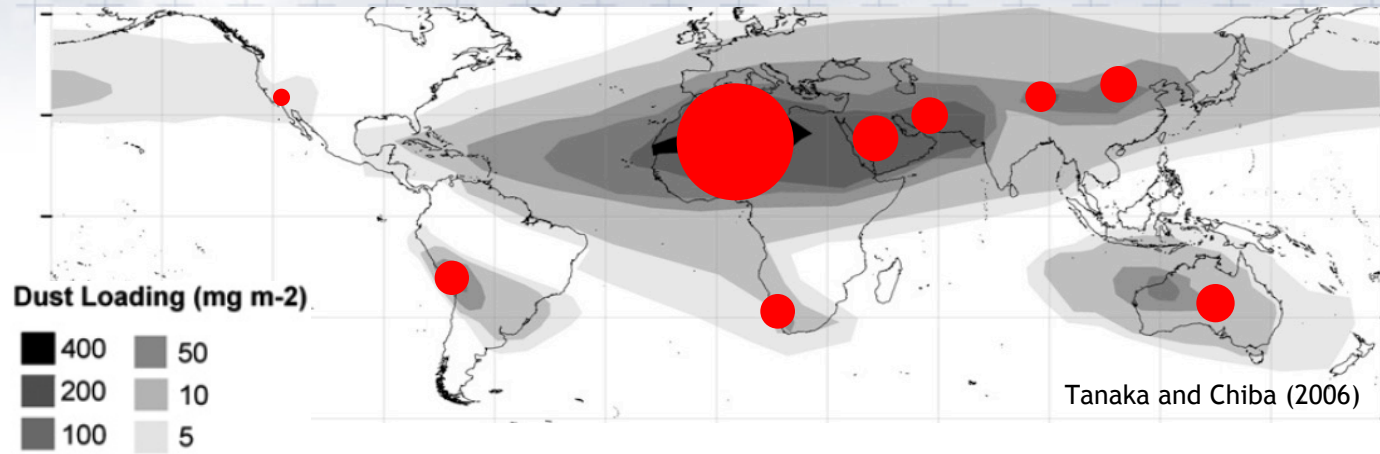
exposure to dust vs dust + pollutants in urban air

summary and recommendations



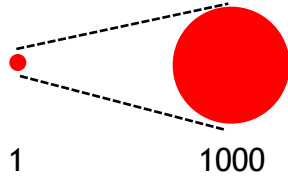
dust belt

12°N (Sahel) to 40°N (China)



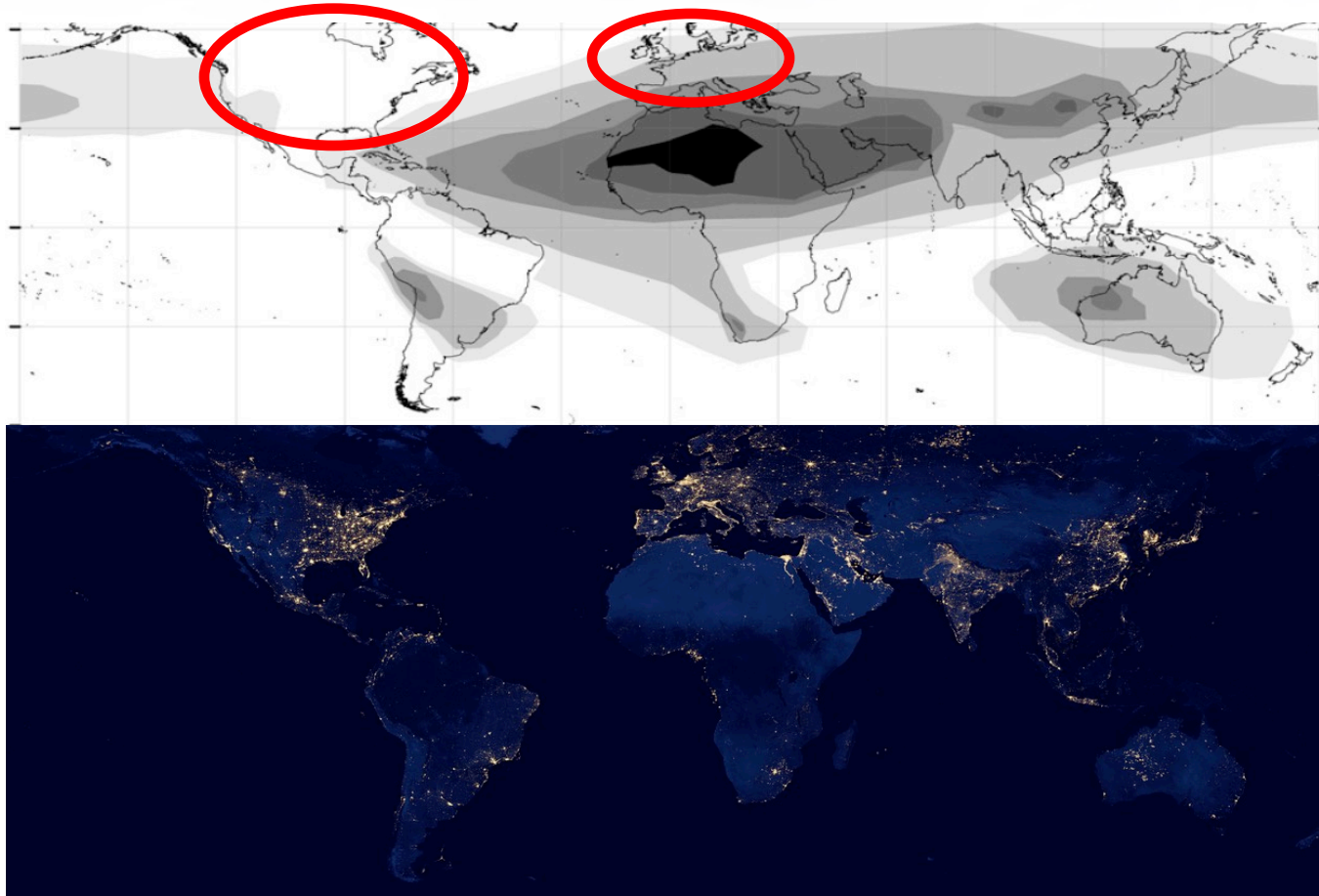
dust belt

Dust Emissions, $\text{Tg} \cdot \text{y}^{-1}$



Longueville et al. (2010)

Air Quality Standards PM_{10} and $PM_{2.5}$ health effects studies \geq 1990s



Europe & North America

WHO (2013) review of evidences on health aspects of air pollution:

PM₁₀
PM_{2.5}

short & long term exposure morbidity mortality

cardiovascular effects PM_{2.5}:

- physiological effects and biological mechanisms
- new health outcomes: atherosclerosis adverse birth outcomes respiratory diseases children



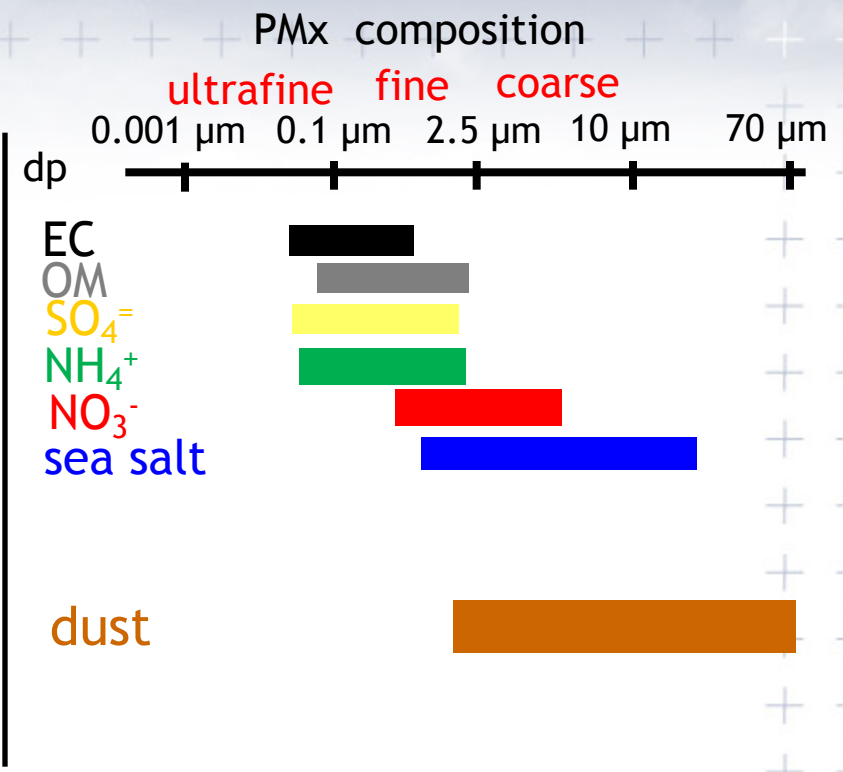
‘cities in the dust belt’



North Africa, Middle East, Asia,

PM₁₀
PM_{2.5}

health effects due to exposure to pollutants + dust mixing ?



Izaña observatory (Tenerife):

- dust₁₀, ~70% total dust
- dust_{2.5}, ~20% total dust
- dust_{2.5}, ~27% dust₁₀

Rodríguez et al. (2011)



people live in cities and breath a cocktail dust + pollutants



respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

summary and recommendations

Desert Dust Exposure Is Associated with Increased Risk of Asthma Hospitalization in Children

Kumiko T. Kanatani^{1,2}, Isao Ito³, Wael K. Al-Delaimy⁴, Yuichi Adachi⁵, William C. Mathews⁶, Joe W. Ramsdell⁷, and the Toyama Asian Desert Dust and Asthma Study Team

Environmental
Research

www.elsevier.com/locate/envres

Increasing cardiopulmonary emergency visits by long-range transported Asian dust storms in Taiwan

Chang-Chuan Chan^{a,*}, Kai-Jen Chuang^a, Wen-Jone Chen^b, Wei-Tien Chang^b,

Atmospheric Environment 68 (2013) 256–264

Assessing exposure risk for dust storm events-associated lung function decrement in asthmatics and implications for control

Nan-Hung Hsieh, Chung-Min Liao^{*}

Science of the Total Environment 408 (2010) 754–759

Asian Dust Storm and pulmonary function of school children in Seoul

Yun-Chul Hong^a, Xiao-Chuan Pan^b, Su-Young Kim^c, Kwangsik Park^d, Eun-Jung Park^d, Xiaobin Jin^b, Seung-Muk Yi^e, Yoon-Hee Kim^f, Choong-Hee Park^g, Sanghwan Song^g, Ho Kim^{f,*}

Environment International 54 (2013) 35–44

Spatial vulnerability under extreme events: A case of Asian dust storm's effects on children's respiratory health[☆]

Hwa-Lung Yu^a, Chiang-Hsing Yang^b, Lung-Chang Chien^{c,*}

Science of the Total Environment 410-411 (2011) 47–52

A case-crossover analysis of Asian dust storms and mortality in the downwind areas using 14-year data in Taipei[☆]

Chang-Chuan Chan^{*}, Huey-Ching Ng

Atmospheric Environment 68 (2013) 256–264

Assessing exposure risk for dust storm events-associated lung function decrement in asthmatics and implications for control

Nan-Hung Hsieh, Chung-Min Liao*

Air Medical Journal 30:6

Australian Dust Storm: Impact on a Statewide Air Medical Retrieval Service

Adam L. Holyoak, MBBS, BSc, BA, Peter J. Aitken, MBBS, EMDM, FACEM, and Mark S. Elcock, MBChB, FACEM, FCEM

Science of the Total Environment 408 (2010) 754–759

Asian Dust Storm and pulmonary function of school children in Seoul

Yun-Chul Hong^a, Xiao-Chuan Pan^b, Su-Young Kim^c, Kwangsik Park^d, Eun-Jung Park^d, Xiaobin Jin^b, Seung-Muk Yi^e, Yoon-Hee Kim^f, Choong-Hee Park^g, Sanghwan Song^g, Ho Kim^{f,*}

Toxicology and Applied Pharmacology 258 (2012) 237–247

Asian sand dust enhances murine lung inflammation caused by *Klebsiella pneumoniae*

Miao He^{a,1}, Takamichi Ichinose^b, Seiichi Yoshida^b, Shoji Yamamoto^{c,2}, Ken-ichiro Inoue^{c,3}, Hirohisa Takano^{c,4}, Rie Yanagisawa^{c,5}, Masataka Nishikawa^d, Ikuko Mori^d, Guifan Sun^a, Takayuki Shibamoto^{e,*}

Environmental Research 111 (2011) 1148–1155

Hospital admissions for asthma and acute bronchitis in El Paso, Texas: Do age, sex, and insurance status modify the effects of dust and low wind events? ☆. ☆ ☆

Sara E. Grineski ^{a,*}, Joan G. Staniswalis ^b, Priyangi Bulathsinhala ^b, Yanlei Peng ^c, Thomas E. Gill ^d

Int J Biometeorol (2005) 49: 371–376
DOI 10.1007/s00484-005-0257-3

ORIGINAL ARTICLE

K. Gyan · W. Henry · S. Lacaille · A. Laloo ·
C. Lamsee-Ebanks · S. McKay · R. M. Antoine ·
M. A. Monteil

African dust clouds are associated with increased paediatric asthma accident and emergency admissions on the Caribbean island of Trinidad

Int J Biometeorol (2009) 53:383–385
DOI 10.1007/s00484-009-0254-z

Reply to: African dust and asthma in the Caribbean—medical and statistical perspectives b ^b Int J Biometeorol (2009) 53:383–385 ^d **R Antoine**

DOI 10.1007/s00484-009-0254-z

Joseph M. Prospero · Edmund Blades · Raana Naidu ·
Marc C. Lavoie

The impact of airborne dust on respiratory health in children living in the Aral Sea region[†]

Polly Bennion,¹ Richard Hubbard,^{1*} Sarah O'Hara,² Giles Wiggs,³ Johannah Wegerdt,¹ Sarah Lewis,⁴ Ian Small,⁵ Joost van der Meer⁶ and Ross Upshur⁷ on behalf of the Médecins sans Frontières/Aral Sea Respiratory Dust and Disease project team



Environmental Health

Research

Open Access

A 10-year time-series analysis of respiratory and cardiovascular morbidity in Nicosia, Cyprus: the effect of short-term changes in air pollution and dust storms

Nicos Middleton^{*1,2}, Panayiotis Yiallourous², Savvas Kleanthous³, Ourania Kolokotroni², Joel Schwartz¹, Douglas W Dockery¹, Phil Demokritou^{1,2} and Petros Koutrakis¹

Cyprus

Environmental Research 111 (2011) 418–424

Acute effects of air pollution on pediatric asthma exacerbation: Evidence of association and effect modification

E. Samoli^{a,*}, P.T. Nastos^b, A.G. Paliatsos^c, K. Katsouyanni^a, K.N. Priftis^d

Greece

Air Qual Atmos Health

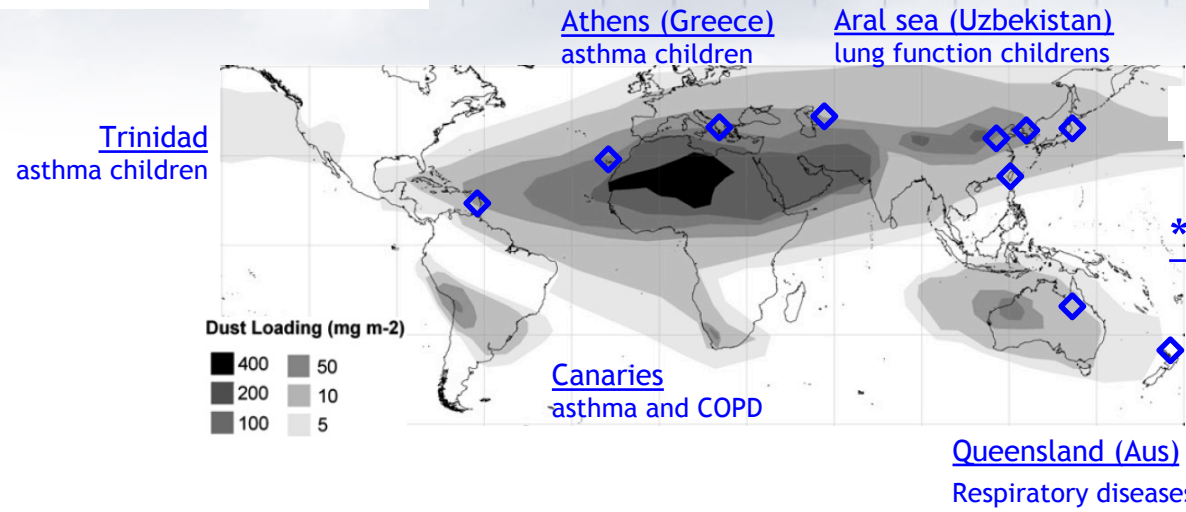
DOI 10.1007/s11869-014-0253-z

The impact of desert dust exposures on hospitalizations due to exacerbation of chronic obstructive pulmonary disease

Israel

Alina Vodonos • Michael Friger • Itzhak Katra • Lone Avnon • Helena Krasnov • Petros Koutrakis • Joel Schwartz • Orly Lior • Victor Novack

Respiratory diseases



Toyama (Japan) asthma children
Beijing (China) pulmonary function children
Seoul (S. Korea) pulmonary function children

* Taipei (Taiwan) chronic obstructive pulmonary diseases (20%)
 lung function decrease (masks)
 respiratory clinic visits after dust event of children in cities

During and a few days after dust events:
 -increase in hospitalizations due to respiratory diseases (exacerbation)
 -paediatric asthma
 -COPD: Chronic Obstructive Pulmonary Diseases
 -reduced lung functions

Gyan et al. (2005): 1 year TRINIDAD

Bennion et al. (2007): 1y UZB
 * Chang et al. (2008): 7y TW
 Cowie et al. (2010): 1 event NZ
 Holyoak et al. (2010): 1 event AUS
 Hong et al. (2010): 1 month CH & SK
 Kanati et al. (2010)
 Hsieh and Liao (2013): 9 years TW

respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

summary and recommendations

Coarse Particles From Saharan Dust and Daily Mortality

Laura Perez,^a Aurelio Tobias,^b Xavier Querol,^c Nino Künzli,^a Jorge Pey,^c Andrés Alastuey,^c
Mar Viana,^c Natalia Valero,^e Manuel González-Cabré,^e and Jordi Sunyer^a

Environment International 48 (2012) 150–155

Saharan dust, particulate matter and cause-specific mortality: A case–crossover study in Barcelona (Spain)

Laura Perez ^{a,b}, Aurelio Tobías ^{c,*}, Xavier Querol ^c, Jorge Pey ^c, Andrés Alastuey ^c, Julio Díaz ^d, Jordi Sunyer ^e

Science of the Total Environment 408 (2010) 5729–5736

Role of Saharan dust in the relationship between particulate matter and short-term daily mortality among the elderly in Madrid (Spain)

E. Jiménez ^a, C. Linares ^b, D. Martínez ^c, J. Díaz ^{d,*}

Díaz et al. Environmental Health 2012, 11:11
<http://www.ehjournal.net/content/11/1/11>



RESEARCH

Open Access

Saharan dust and association between particulate matter and case-specific mortality: a case-crossover analysis in Madrid (Spain)

Julio Díaz¹, Aurelio Tobías^{2*} and Cristina Linares^{3,4}

Science of the Total Environment 412–413 (2011) 386–389

Short-term effects of particulate matter on total mortality during Saharan dust outbreaks: A case-crossover analysis in Madrid (Spain)

Aurelio Tobías ^{a,*}, Laura Pérez ^b, Julio Díaz ^c, Cristina Linares ^d, Jorge Pey ^a,
Andrés Alastruey ^a, Xavier Querol ^a

Occup Environ Med. 2011 Jun;68(6):446-51. doi: 10.1136/oem.2010.058156. Epub 2010 Dec 16.

Saharan dust and daily mortality in Emilia-Romagna (Italy).

Zauli Sajani S, Miglio R, Bonasoni P, Cristofanelli P, Marinoni A, Sartini C, Goldoni CA, De Girolamo G, Lauriola P.

Regional Center for Environment and Health, ARPA Emilia-Romagna, Via Begarelli 13, 41121 Modena, Italy. szauli@arpa.emr.it

Environmental Health Perspectives • VOLUME 119 | NUMBER 10 | October 2011

Saharan Dust and Associations between Particulate Matter and Daily Mortality in Rome, Italy

Sandra Mallone,¹ Massimo Stafoggia,² Annunziata Faustini,² Gian Paolo Gobbi,³ Achille Marconi,⁴ and Francesco Forastiere²

Environmental Health

Research

Open Access

A 10-year time-series analysis of respiratory and cardiovascular morbidity in Nicosia, Cyprus: the effect of short-term changes in air pollution and dust storms

Nicos Middleton^{*1,2}, Panayiotis Yiallourous², Savvas Kleanthous³, Ourania Kolokotroni², Joel Schwartz¹, Douglas W Dockery¹, Phil Demokritou^{1,2} and Petros Koutrakis¹

Science of the Total Environment 409 (2011) 2049–2054

Does the presence of desert dust modify the effect of PM₁₀ on mortality in Athens, Greece?

Evangelia Samoli^{a,*}, Evgenia Kougea^a, Pavlos Kassomenos^b, Antonis Analitis^a, Klea Katsouyanni^a

Environment International 47 (2012) 107–114

Health effects from Sahara dust episodes in Europe: Literature review and research gaps

A. Karanasiou^{a,*}, N. Moreno^a, T. Moreno^a, M. Viana^a, F. de Leeuw^b, X. Querol^a

Occup Environ Med 2012;**69**:908–915. doi:10.1136/oemed-2012-100797

Asian dust and daily all-cause or cause-specific mortality in western Japan

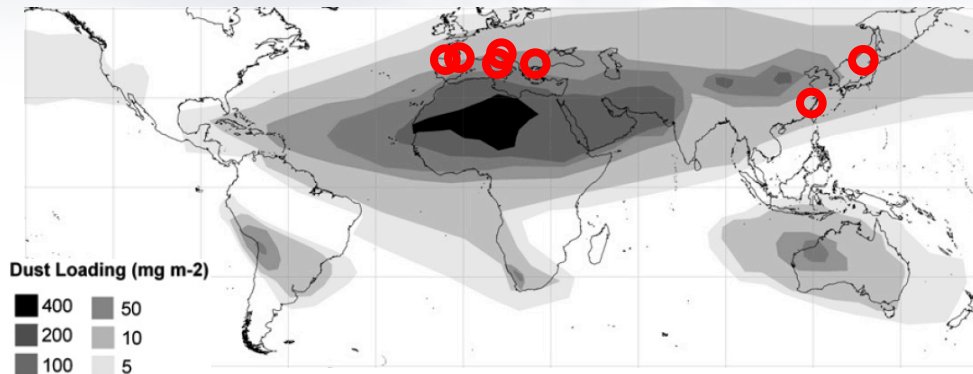
Saori Kashima,¹ Takashi Yorifuji,² Toshihide Tsuda,² Akira Eboshida¹

EFFECT OF ASIAN DUST STORMS ON MORTALITY IN KOREA DURING 2001-2009

Hyewon Lee¹⁾, Ho Kim¹⁾, Youn-Hee Lim²⁾, Seungmuk Yi¹⁾

...there more studies

Mortality & cardiovascular diseases



Increase (↑)

Barcelona

- ↑ 10 $\mu\text{g}/\text{m}^3$ of $\text{PM}_{10-2.5}$
- ↑ mortality by:
 - 8.4% Saharan dust days
 - 1.4% non-Saharan dust days

cardiovascular mortality:

- associated with $\text{PM}_{2.5-10}$
- no associated with $\text{PM}_{2.5}$

~25000 deaths
Pérez et al. (2008)
Pérez et al. (2012)

Madrid

- ↑ 10 $\mu\text{g}/\text{m}^3$ of $\text{PM}_{10-2.5}$
- ↑ mortality by:
 - 2.8% in Saharan dust days
 - 0.6% non-dust days

respiratory & cardiovascular mortality is associated with:

- PM_{10} Saharan dust days,
- $\text{PM}_{2.5}$ not Saharan dust days,

Jiménez et al. (2010)
Jiménez et al. (2012)
Tobias et al. (2011a)

Rome

- ↑ 10.8 $\mu\text{g}/\text{m}^3$ $\text{PM}_{2.5-10}$
- ↑ cardiovascular mortality:
 - 9.73% Saharan dust days
 - 0.86% no dust days

- ↑ 19.8 $\mu\text{g}/\text{m}^3$ PM_{10}
- ↑ cardiac mortality:
 - 9.55% Saharan dust days
 - 3.50% no dust days

4 years
Mallone et al. (2011)

Emilia Romagna

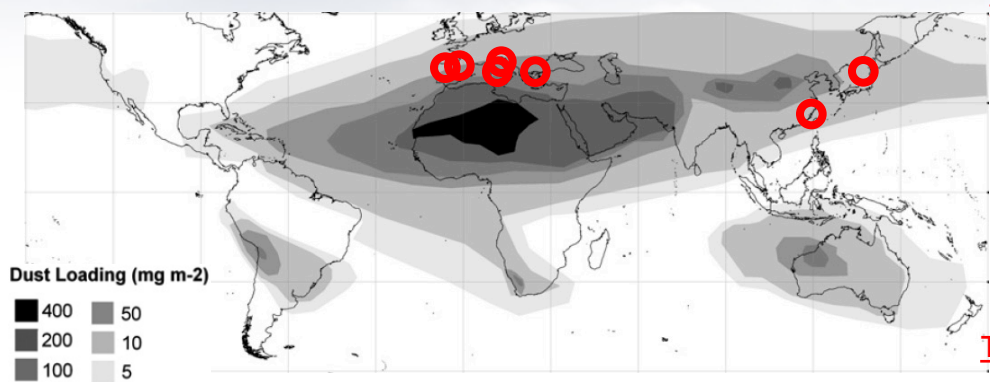
- ↑ respiratory mortality for elderly people ($\geq 75\text{y}$) during Saharan dust events with respect no dust events.

22% in the whole year
34% in summer

no modification of dust events on the concentration-response relationship between PM_{10} and daily deaths

4 years
Sajani et al. (2011)

Mortality & cardiovascular diseases



Cyprus

Compared to no dust events, hospitalizations during Saharan dust events were:
 -4.8% higher for all-causes
 -10.4% higher for cardiovascular diseases

bulk PM₁₀
 10 years
 Middleton et al. (2008)

Athens

association between PM₁₀ and mortality is higher during no - Saharan dust days

 Traffic related particles have more toxic effects than Saharan dust.

bulk PM₁₀
 6 years
 Samoli et al. (2011)

47 cities (Japan) Asian dust did not modify the response of mortality to PM.
 > 65y

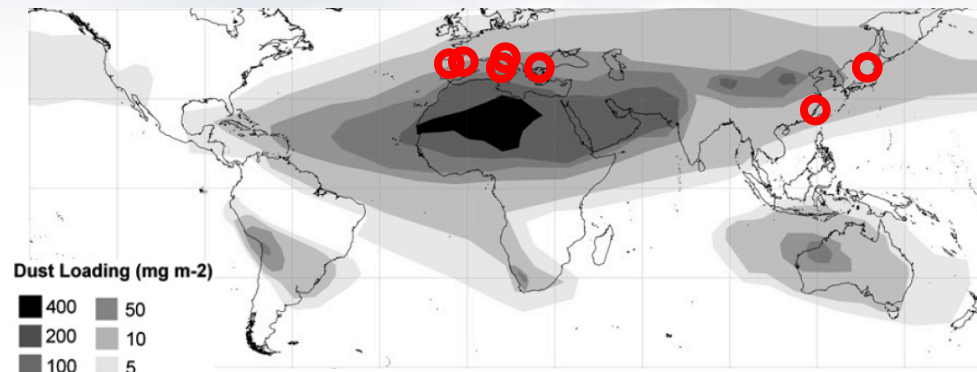
10 µg/m³ PM₈ increase:
 0.6% heart disease
 0.8 % ischemia hearth diseases
 2.1% arrhythmia

Kashima et al. (2012): 5y
 1.4 million targeting people

Taipei (Taiwan) Asian dust increased cardiovascular effects when PM₁₀ > 90 µg/m³

compared to pre-dust conditions, observed increases in hospital visits:
 35 % for ischemic heart diseases
 20% for cerebrovascular diseases
 67% for cardiovascular diseases

Chang et al. (2008): 7y
 Chang and Ng (2011): 14y



Mortality & cardiovascular:

During dust events in urban areas:

short term exposure

PM_{10} , $PM_{2.5-10}$ → association with cardiovascular mortality

$PM_{2.5}$ → no association with mortality

response of mortality to increases in PM_{10} and/or $PM_{2.5-10}$ during dust changes city to city

-What is the origin of the relationship between dust and cardiovascular mortality ?

(disease, mechanism)

respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

Summary and recommendations

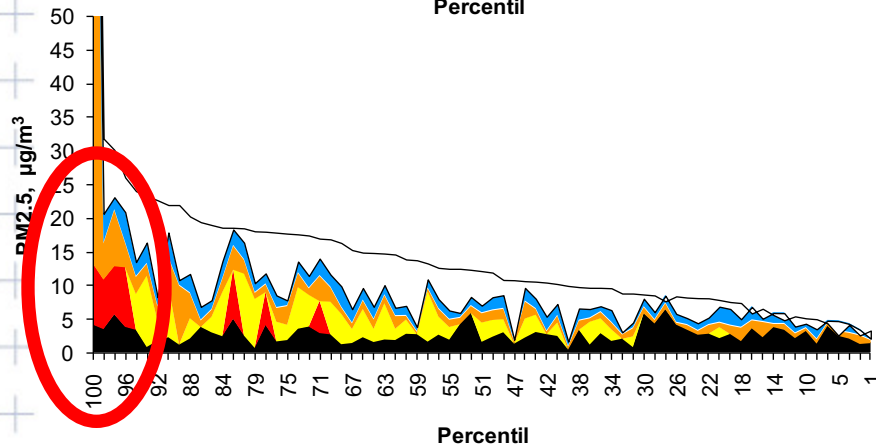
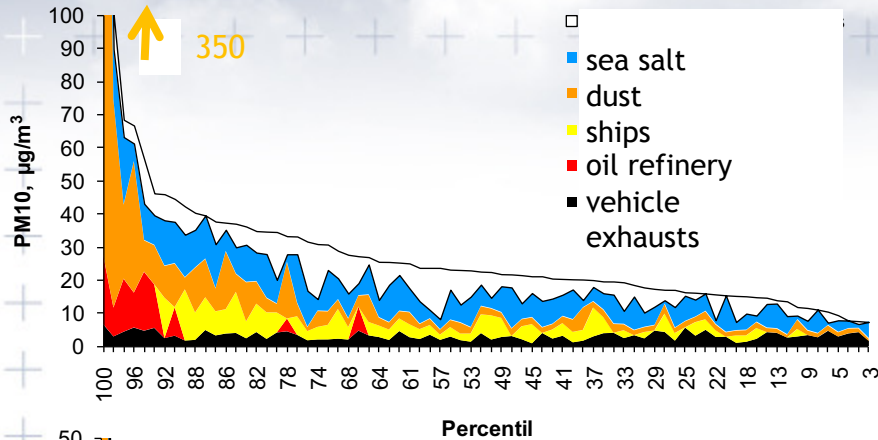


people live in cities and breath a
cocktail **dust + pollutants**

Some considerations:



1. Levels of local urban & industrial pollutants may be higher during dust-days than during none-dust-days
2. Exposure to **dust+pollutants** may be worse than simple exposure to **dust**



PM_x = pollutants + dust

there is more pollution when there is dust due to:

- Adverse meteorological conditions for dispersion of pollutants during dust events (observed in Mediterranean and Atlantic ~~cities~~)
- Reaction of local urban/industrial pollutants with dust, resulting in dust coating by pollutants (sulphate, nitrate, etc.)

Science of the Total Environment 494–495 (2014) 283–289

Effect of atmospheric mixing layer depth variations on urban air quality and daily mortality during Saharan dust outbreaks

M. Pandolfi ^{a,*}, A. Tobias ^a, A. Alastuey ^a, J. Sunyer ^{b,c}, J. Schwartz ^d, J. Lorente ^e, J. Pey ^{a,f}, X. Querol

heterogeneous reactions between dust and pollutants
 $\text{HNO}_3 + \text{CaCO}_3 [\text{dust}] \rightarrow \text{CaNO}_3 + \dots$
 $\text{H}_2\text{SO}_4 + \text{CaCO}_3 [\text{dust}] \rightarrow \text{CaSO}_4 + \dots$
 coating of fine and coarse dust particles by pollutants
 reactivity of the surface of dust particles



people live in cities and breath a
cocktail **dust + pollutants**

Some considerations:

1. Levels of local urban & industrial pollutants may be higher during dust-days than during none-dust-days
- ➔ 2. Exposure to **dust+pollutants** may be worse than simple exposure to **dust**

2 example studies

Study 1

a 7y study:

In Taiwan, an increase in children respiratory clinic visits is observed just after Asian dust events. However, the relative increase is higher in urban than in rural areas.

Yu et al. (2013). Environ. Int (54), 35-44.

Does the presence of pollutants increase the sensitivity to dust exposure ?

Then, emissions of urban and industrial pollutants should be reduced during dust days

Study 2

ehp

ENVIRONMENTAL
HEALTH
PERSPECTIVES

<http://www.ehponline.org>



MINISTERIO
DE MEDIO AMBIENTE
Y MEDIO RURAL Y MARINO

Aemet
Agencia Estatal de Meteorología

Desert Dust Outbreaks in Southern Europe: Contribution to Daily PM₁₀ Concentrations and Short-Term Associations with Mortality and Hospital Admissions

Results: On average, 15% of days were impacted by desert dust at ground level (desert PM₁₀ > 0 µg/m³). Most episodes occurred in spring-summer, with increasing gradient of both frequency and intensity North-South and West-East of the Mediterranean basin. We found significant associations of both PM₁₀ concentrations with mortality. Increases of 10-µg/m³ in non-desert and desert PM₁₀ (lag 0-1 days) were associated with increases in natural mortality of 0.55% (95% CI: 0.24, 0.87%) and 0.65% (95% CI: 0.24, 1.06%), respectively. Similar associations were estimated for cardio-respiratory mortality and hospital admissions.

Conclusions: PM₁₀ originated from desert was positively associated with mortality and hospitalizations in Southern Europe. Policy measures should aim at reducing population exposure to anthropogenic airborne particles even in areas with large contribution from desert dust advections.

Milan

Turin

Emilia-Romagna

Bologna

Marseille

Rome

Barcelona

Thessaloniki

Madrid

Palermo

Athens

respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

Summary and recommendations

Health effects

1. health effects in the context of air quality

Europe, North America and Asia → PM_{10} and $PM_{2.5}$ = pollutants

dust belt (North Africa, Middle East, West Asia to Asia)

→ PM_{10} and $PM_{2.5}$ = dust + pollutants

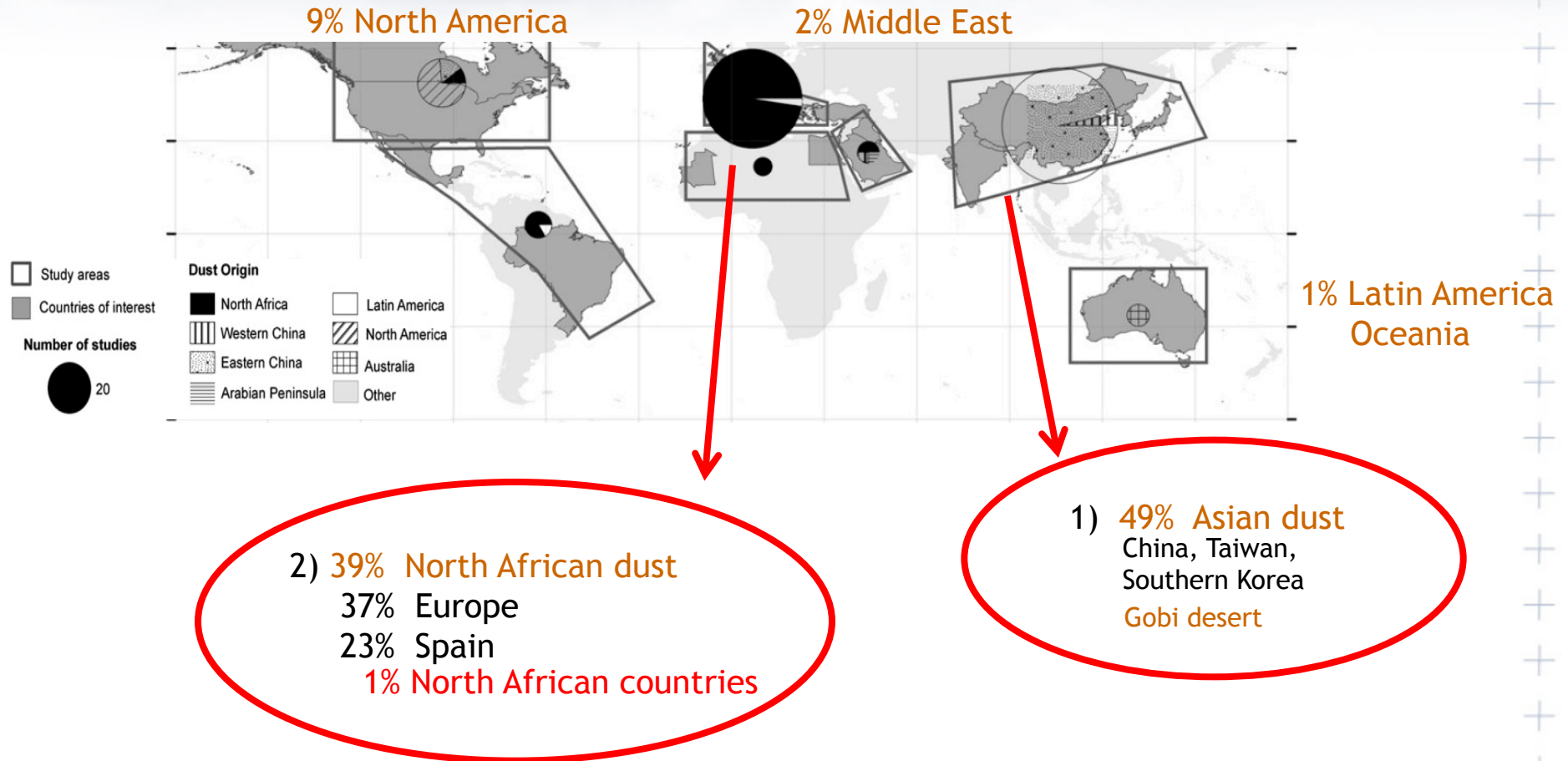
2. Respiratory diseases. Short time effects

- increase in hospitalizations due to respiratory diseases (exacerbation)
- paediatric asthma
- COPD: Chronic Obstructive Pulmonary Diseases
- reduced lung functions

3. Heart diseases observed in urban areas of European-Mediterranean and Asia.

- increase in hospitalizations due to cardiovascular diseases
- PM_{10} and $PM_{2.5-10}$: association with cardiovascular mortality
- response of mortality to increases in PM_{10} and/or $PM_{2.5-10}$ during dust changes city to city
- mechanisms by which dust exposure increase cardiovascular mortality is still unknown.
More Research is needed → countries of the dust belt plays a key role

number of scientific papers on the impact of dust on air quality 1999-2009

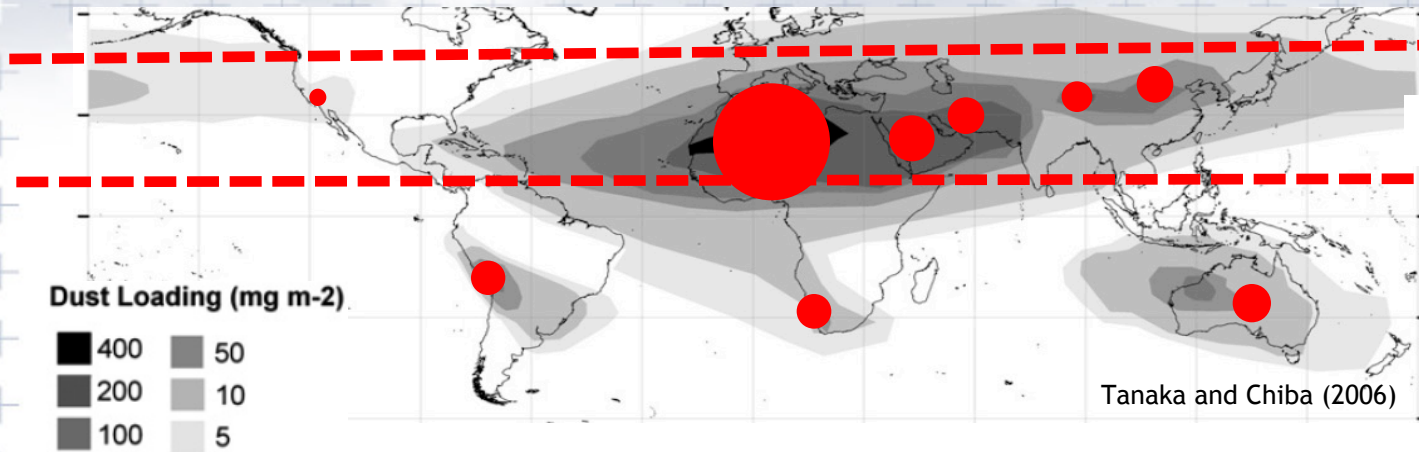


Longueville et al. (2010)

Review **Science of the Total Environment 409 (2010) 1-8**

What do we know about effects of desert dust on air quality and human health in West Africa compared to other regions?

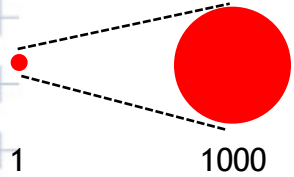
Florence De Longueville ^{a,*}, Yvon-Carmen Hountondji ^b, Sabine Henry ^a, Pierre Ozer ^c



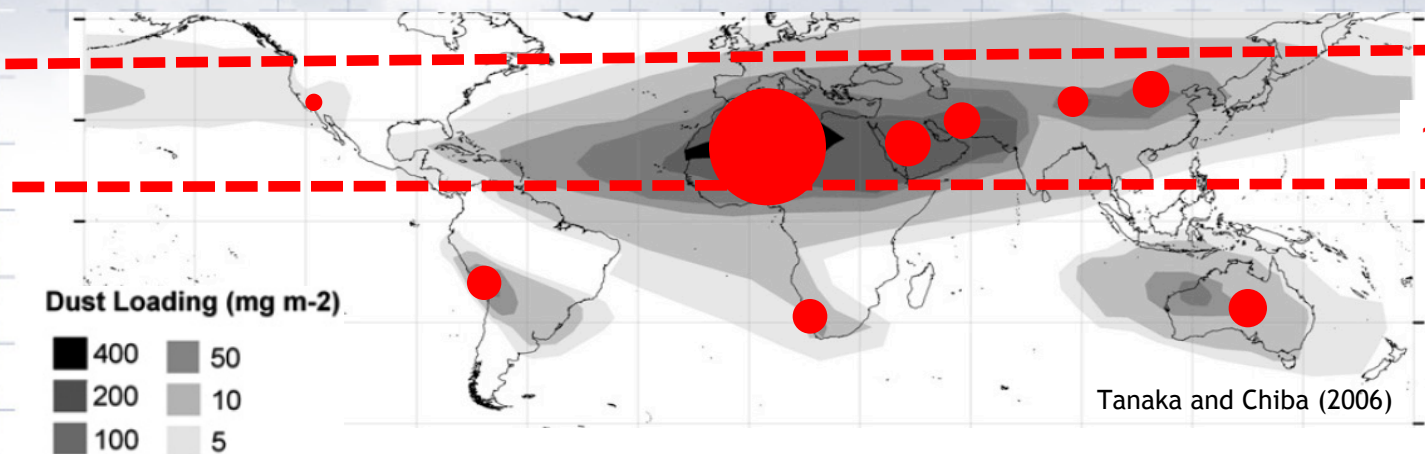
dust belt

12°N (Sahel) to 40°N (China)

Dust Emissions, Tg · y⁻¹



Longueville et al. (2010)



dust belt
12°N (Sahel) to 40°N (China)

Longueville et al. (2010)

European part of the Mediterranean: pollutants + dust (20 - 30 $\mu\text{g}/\text{m}^3$)

Asia: pollutants + dust (80 - 100 $\mu\text{g}/\text{m}^3$)

North Africa + Middle East + West Asia: pollutants + dust (100 - 1000 $\mu\text{g}/\text{m}^3$)

Dust concentrations are much higher in North Africa, Middle East and Western Asian cities

- ➔ Implication to health effects, differentiated with respect to Europe
- ➔ More research and measurements needed in the dust belt

What we know about the impact of air pollutants and anthropogenic - PM

Comparison to dust



7 million premature deaths annually linked to air pollution

Outdoor air pollution-caused deaths – breakdown by disease:

- 40% – ischaemic heart disease;
- 40% – stroke;
- 11% – chronic obstructive pulmonary disease (COPD);
- 6% - lung cancer; and
- 3% – acute lower respiratory infections in children.

Indoor air pollution-caused deaths – breakdown by disease:

- 34% - stroke;
- 26% - ischaemic heart disease;
- 22% - COPD;
- 12% - acute lower respiratory infections in children; and
- 6% - lung cancer.

What we know about the impact of air pollutants and anthropogenic - PM

Comparison to dust

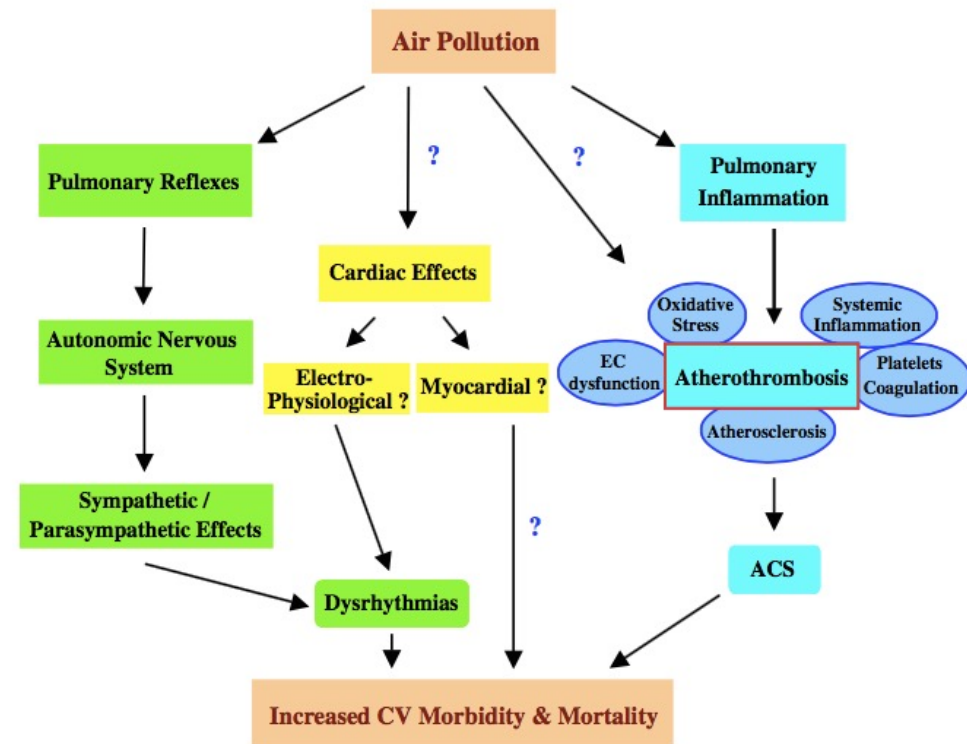
1. Studies focused on understanding the mechanisms by which PM-pollution cause hearth diseases:

Circulation Research
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association
 Learn and Live™

Ambient Particulate Pollutants in the Ultrafine Range Promote Early Atherosclerosis and Systemic Oxidative Stress

Jesus A. Araujo, Berenice Barajas, Michael Kleinman, Xuping Wang, Brian Bennett, Ke Wei Gong, Mohamad Navab, Jack Harkema, Constantinos Siout, Aldons J. Lusis and Andre E. Nel



Particle and Fibre Toxicology

Particulate matter and atherosclerosis: role of particle size, composition and oxidative stress

Jesus A Araujo*¹ and Andre E Nel*²

BioMed Central

What we know about the impact of air pollutants and anthropogenic - PM Comparison to dust

2. Studies focused on identifying the profile of people that may suffer a cardiovascular disease in the short term exposure due to air pollution:

Med Clin (Barc). 2013;**141**(12):529–532

Impact of air pollution on inflammation, oxidative stress and 1-year prognosis in patients hospitalized for acute coronary syndrome: Design of the AIRACOS study

Alberto Dominguez-Rodriguez ^{a,b,c,*}, Sergio Rodríguez ^d, Pedro Abreu-Gonzalez ^{c,e} y Pablo Avanzas ^f

International Journal of Cardiology 188 (2015) 47–49

Black carbon exposure, oxidative stress markers and major adverse cardiovascular events in patients with acute coronary syndromes

Alberto Dominguez-Rodriguez ^{a,b,*}, Sergio Rodríguez ^c, Pedro Abreu-Gonzalez ^d, Pablo Avanzas ^e, Ruben A. Juarez-Prera ^a

Patients that had suffered an cardiovascular event, and were then exposed to high levels of black carbon, suffered an new event in the next 30 days and presented high levels of Serum malondialdehyde -a bio marker indicative of oxidative stress-

patients with acute coronary syndromes may be especially vulnerable to black carbon exposure

This research is needed for dust in the the dust belt cities



thank you