Short-term health effects of desert dust

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inDust webinar programme
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Contents

- Background
- Types of health effects
- Time-series design
- Short-term effects of desert dust
- Conclusions & future research

Timeline

- **1996 –** Health effects of air pollution. The AHEA study

…

- **2008 –** Health effects of Saharan dust in Barcelona
- **2009-2011 –** The Spanish study on health effects of Saharan dust
- **2011-2013 –** The MED-PARTICLES Life project
- **2017 –** WHO systematic review on health effects of desert dust
- **2018-2021 –** inDust COST Action

Background

- Evidence on health effects **remains unclear** *(Hashizume et al. 2010, Karanasiou et al. 2012, Longeville et al. 2013, Zhang et al. 2014, Hashizume et al. 2020)*
- Systematic Review with **standardized protocol** commissioned by WHO *(Tobías et al. 2019)*
- Main **differences** on,
  - **Study design** and statistical analysis
  - **Health outcomes** and lagged effects
  - **Methods to identify dust events** and their contribution to particulate matter
  - **Role of desert dust** based on a binary metric or as continuous exposure

Type of health effects

- **Health effects** are the changes in health status resulting from exposure to a given risk factor
  - **Short term effects –** Acute impact on health after an immediate exposure (time-series studies)
  - **Long term effects** – Chronic health effect after a cumulative exposure (cohort studies)
- **Health impact assessment** is the evaluation of potential health effects of proposed actions relative to a given exposure. The aim of HIA is to provide recommendations for decision-making process that will protect health

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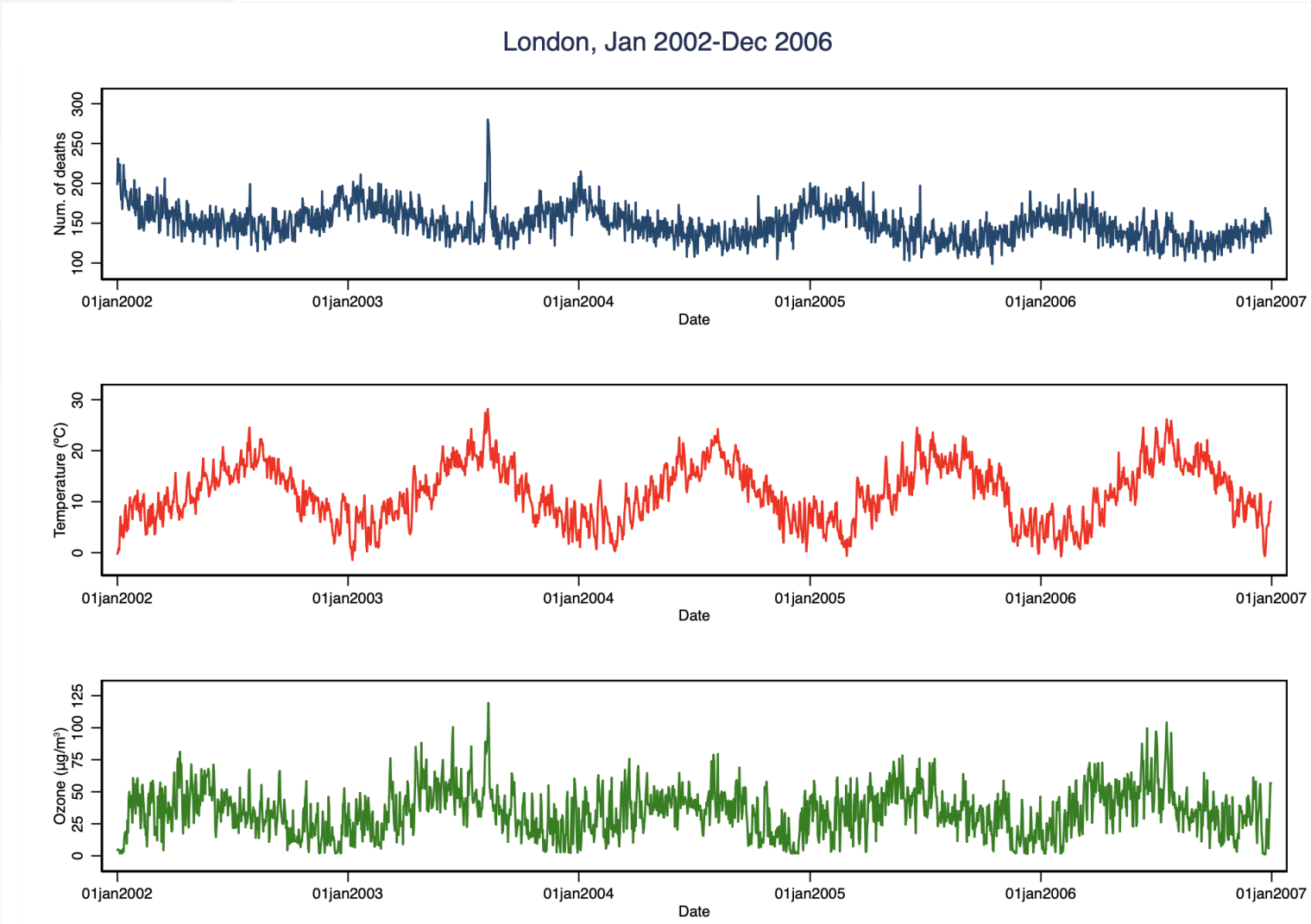
Time-series design

- **Research question** – *"Is there an association between day-to-day variation in the environmental exposure and daily risk of health outcome"?*
  - Health outcomes and environmental exposures are characterized by **similar time-trends**


London, Jan 2002-Dec 2006
Num. of deaths
100
150
200
250
300
01jan2002
01jan2003
01jan2004
01jan2005
01jan2006
01jan2007
Date
Temperature (°C)
0
10
20
30
01jan2002
01jan2003
01jan2004
01jan2005
01jan2006
01jan2007
Date
Ozone (µg/m³)
0
25
50
75
100
125
01jan2002
01jan2003
01jan2004
01jan2005
01jan2006
01jan2007
Date

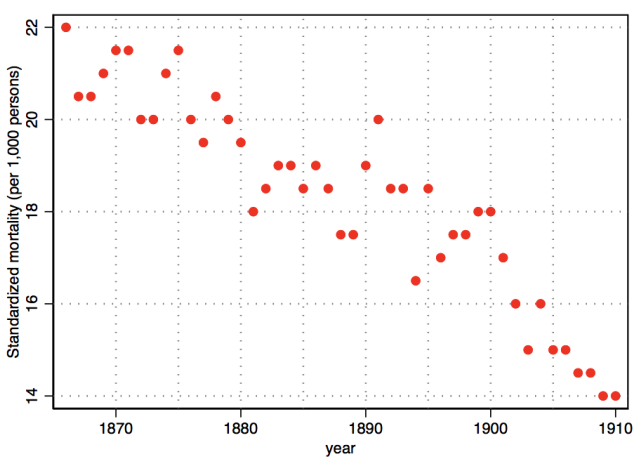
Time-series design

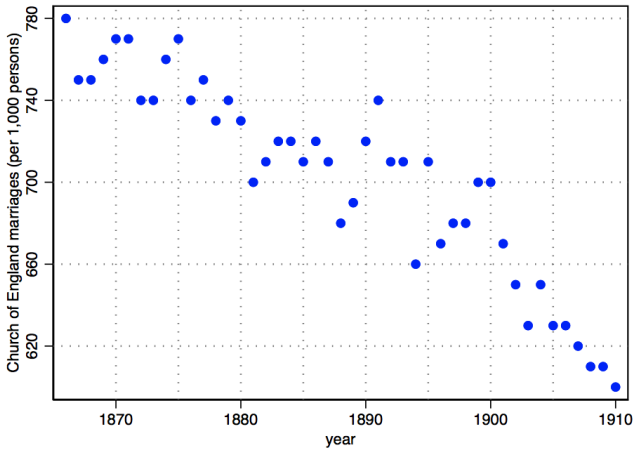
- **Research question** – *"Is there an association between day-to-day variation in the environmental exposure and daily risk of health outcome"?*
  - Health outcomes and environmental exposures are characterized by **similar time-trends**
  - Measures of **individual predictors are usually not available**
  - We need a study design that relies on **between-day comparison within the same population** and able to control for time-trends
  - **Time-series should be long enough** to identify day-to-day variation necessary to disentangle short-term effects from time-trends (e.g., at least 3 consecutive years for daily data)

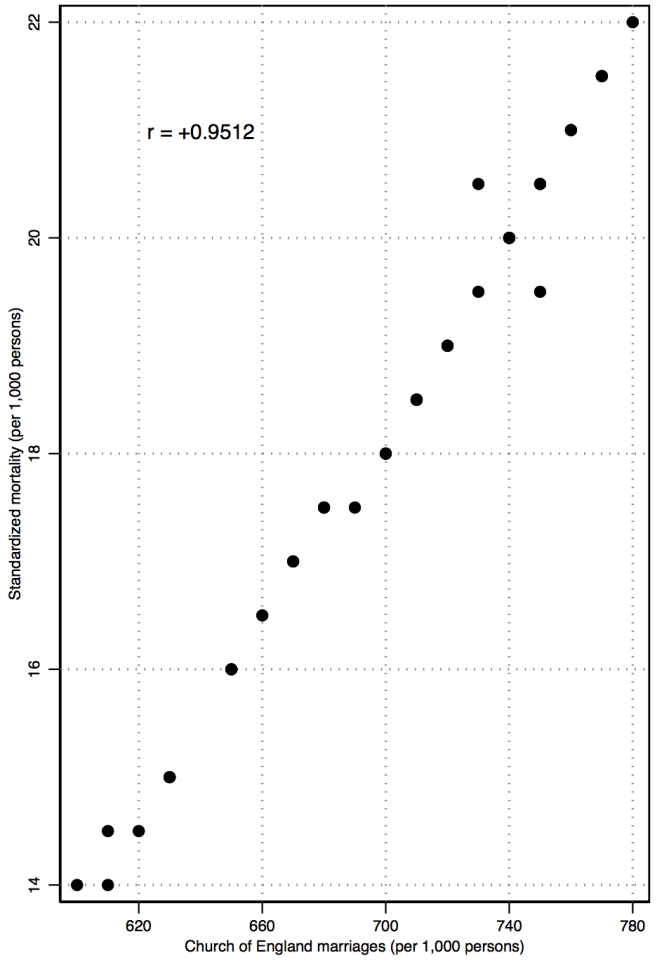
Time-series design

- Strengths
  - Use of administratively collected data
  - Same population is compared with itself, focus is day-to-day variation
  - Time-invariant or slowly varying individual risk factors controlled by design (e.g., age, gender, smoking)
- Limitations
  - Ecological design based on aggregated, not individual data
  - Not applicable to estimate log-term (chronic) effects
  - Sensitive to choices for modelling time-trends

Yule GU. **Why do we sometimes get nonsense correlations between time series?** J Royal Stat Soc Sci. 1926;89:1-64.

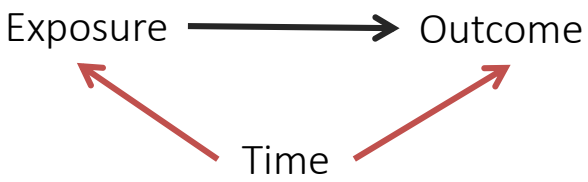






Confounding

- It must be associated with the exposure
- It must be independently associated with the outcome
- It must not be on the causal pathway between exposure and outcome



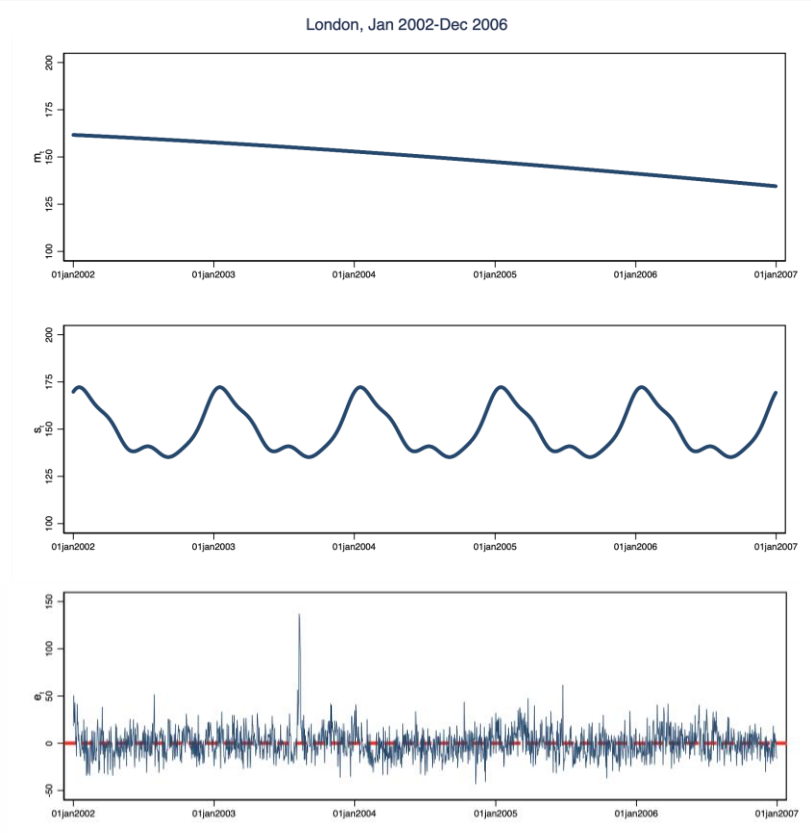
Modelling framework

- Temporal decomposition

$$Y_t = m_t + s_t + e_t$$

  - *with m_t and s_t as time components (long trend and seasonality) and e_t as residual series*

- Underlying trends are filtered-out from the time-series, allowing the inspection of associations at shorter time scale



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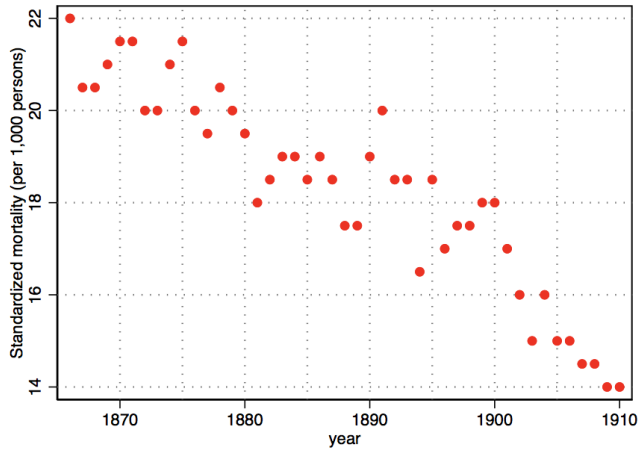

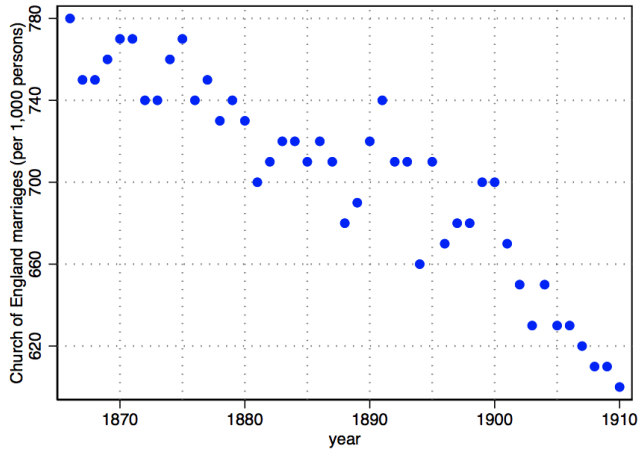

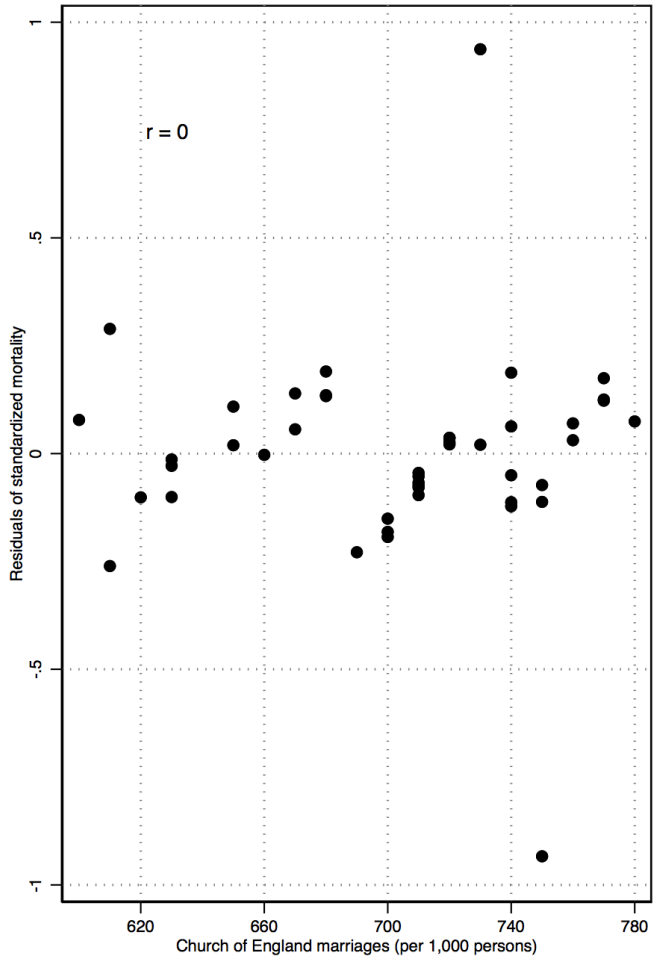

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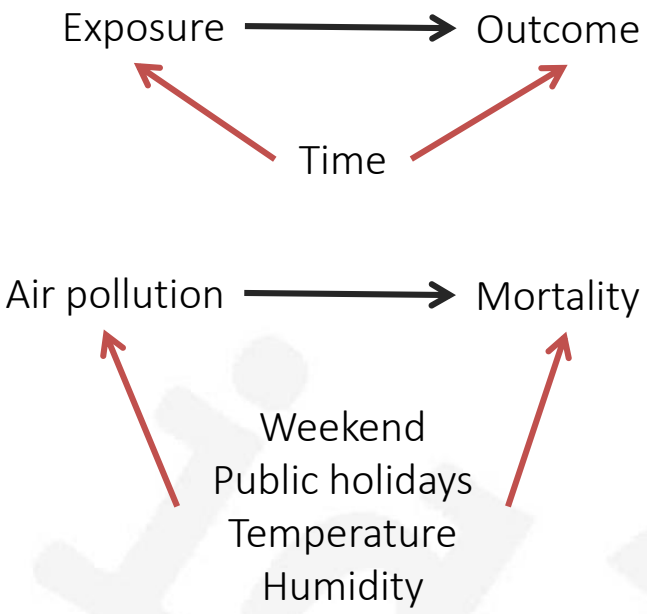
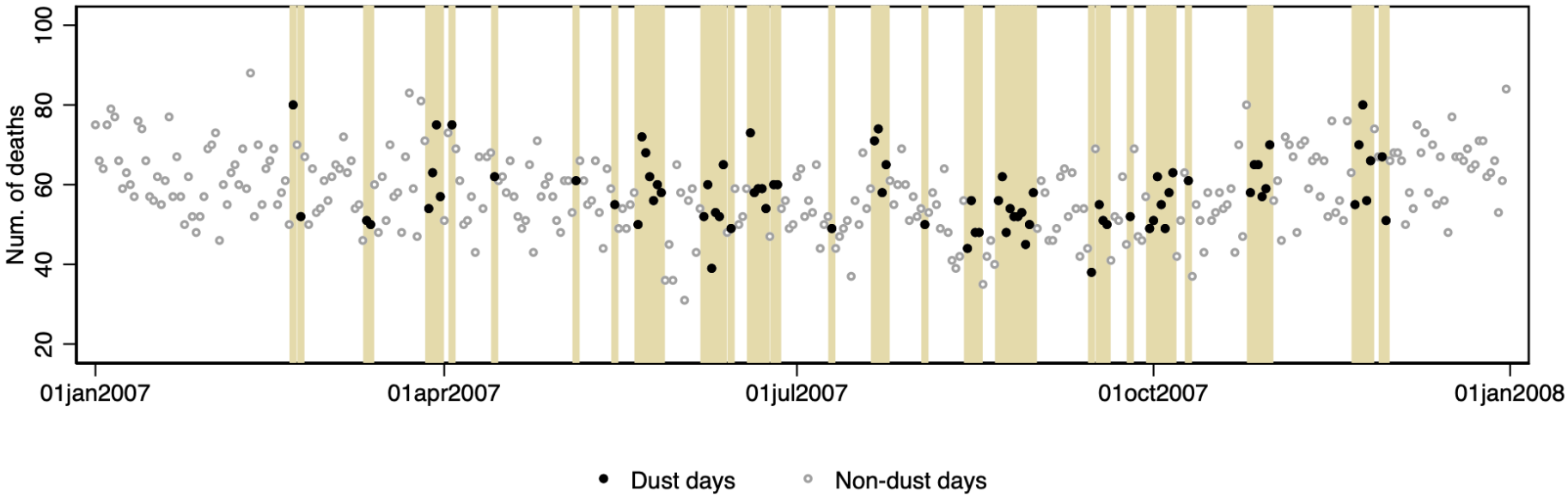


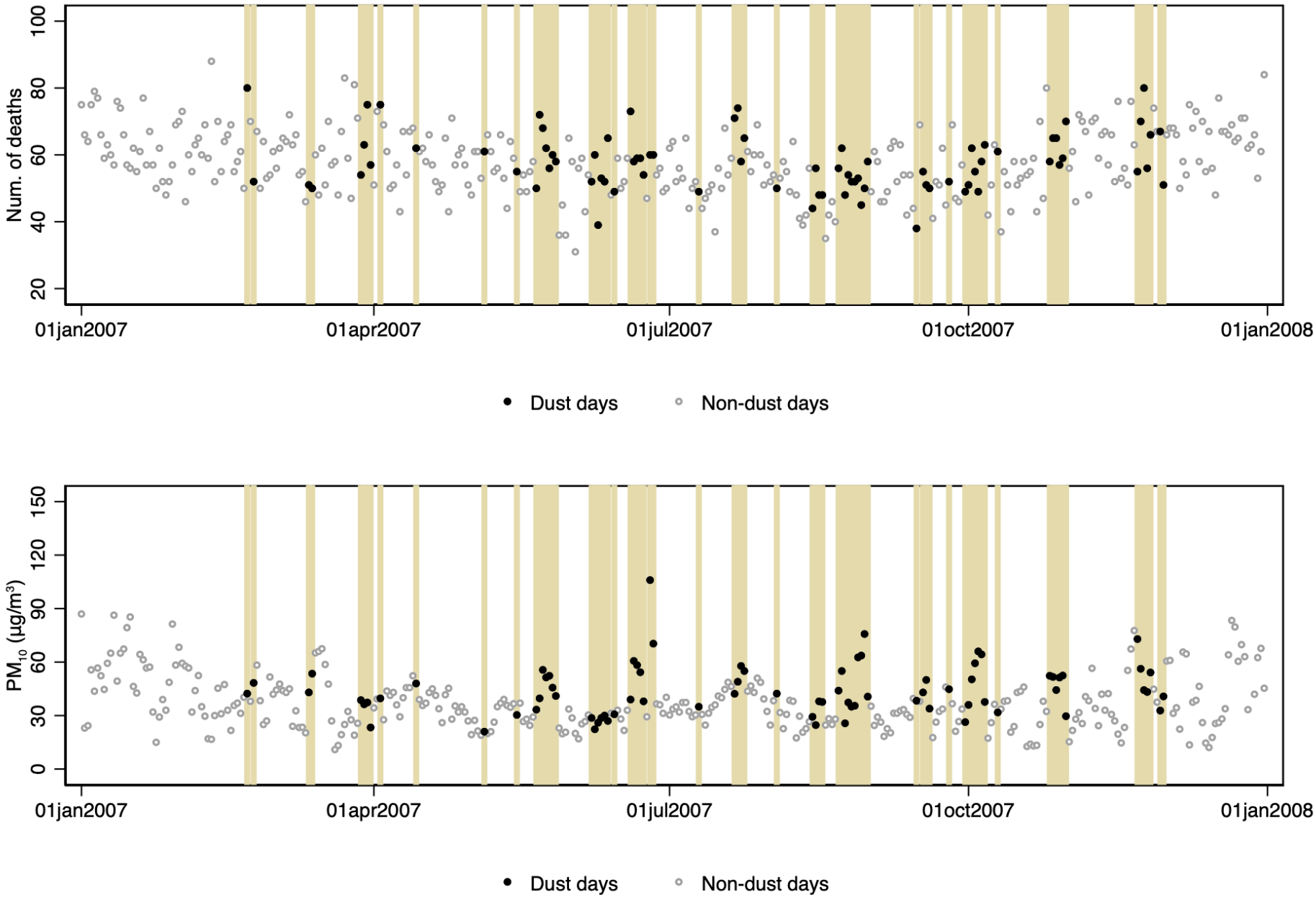
Exposure-response and lagged effects

- Associations between environmental exposures and health outcomes can show different **type of shapes**, and are often characterized by **lagged effects**
- We need to model potentially **complex temporal patterns of risk** due to time-varying exposures
- It requires a **previous knowledge** about the shape of the exposure-response function and the lagged effects

Dust exposure as binary metric

- **Research question –** *"Is the occurrence of a health outcome higher on dust days compared to non-dust days?"*

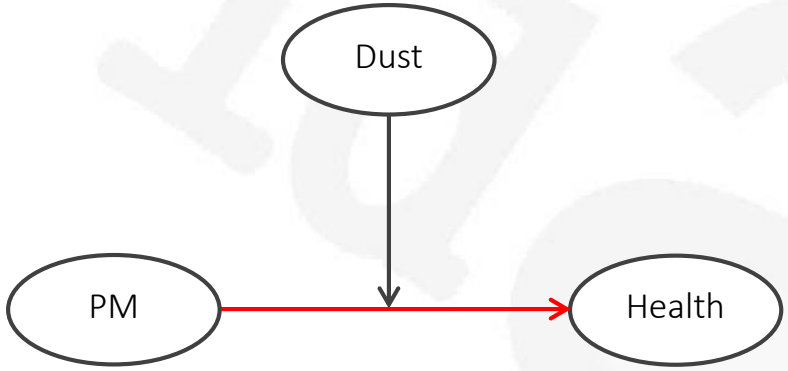

Num. of deaths
20
40
60
80
100
01jan2007
01apr2007
01jul2007
01oct2007
01jan2008
Dust days
Non-dust days


Num. of deaths
20
40
60
80
100
01jan2007
01apr2007
01jul2007
01oct2007
01jan2008
Dust days
Non-dust days
PM10 (µg/m3)
0
30
60
90
120
150
01jan2007
01apr2007
01jul2007
01oct2007
01jan2008
Dust days
Non-dust days

Dust exposure as binary metric

- **Research question –** *"Is the occurrence of a health outcome higher on dust days compared to non-dust days?"*

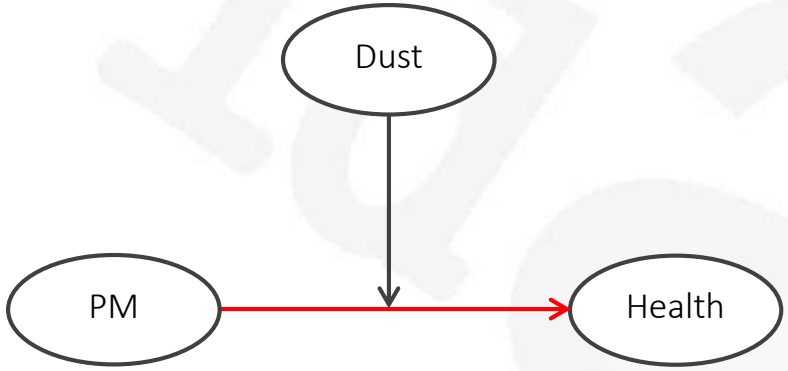
- **Research question –** *"Is the association between PM and a health outcome different between dust days and non-dust days?"*



Dust exposure as binary metric

- During dust days hospital admissions for respiratory causes increase by 7% during dust days
- Mortality for cardiovascular causes increases by 1.5%
- It can also increase medical visits for rhinitis, conjunctivitis and meningitis

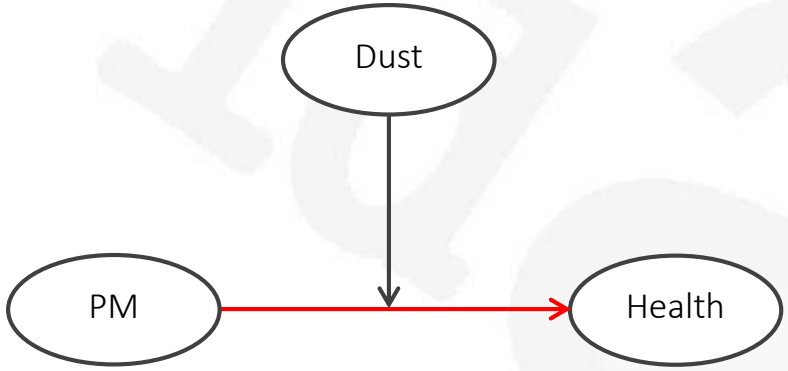
- The risk of hospital admissions for respiratory causes associated with the coarse PM is larger during dust days than non-dust days
- Similarly for cardiovascular mortality



Dust exposure as binary metric

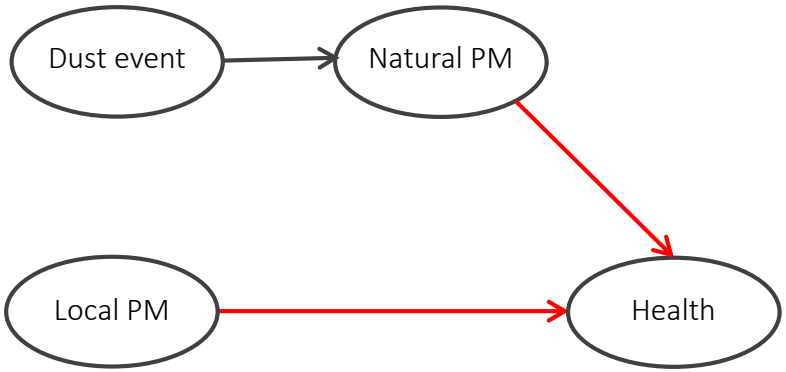
- The **most intuitive approach**
- **Variety of methods** to identify dust events
- All dust events are **treated in the same way** not providing information on the exposure-response relationship

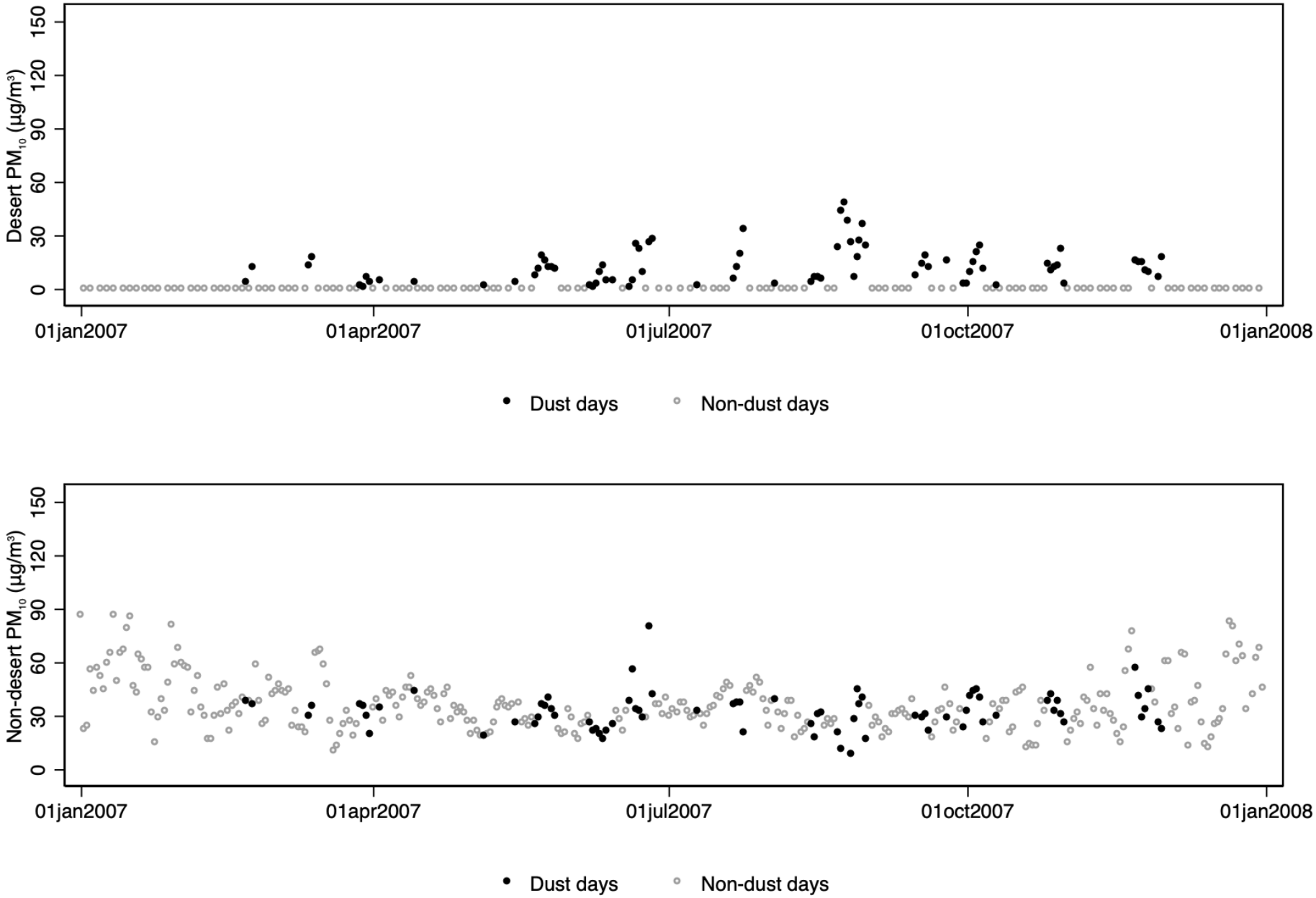
- The dust cycle includes the **emission, transport and deposition** of particles which might increase the local pollution by PM
- But it is not possible to attribute the health effects to a **given source**



Dust exposure as continuous metric

- **Research question –** *"Are natural and local sources of PM independently associated with a health outcome?"*




Desert PM10 (µg/m³)
0
30
60
90
120
150
01jan2007
01apr2007
01jul2007
01oct2007
01jan2008
Dust days
Non-dust days
Non-desert PM10 (µg/m³)
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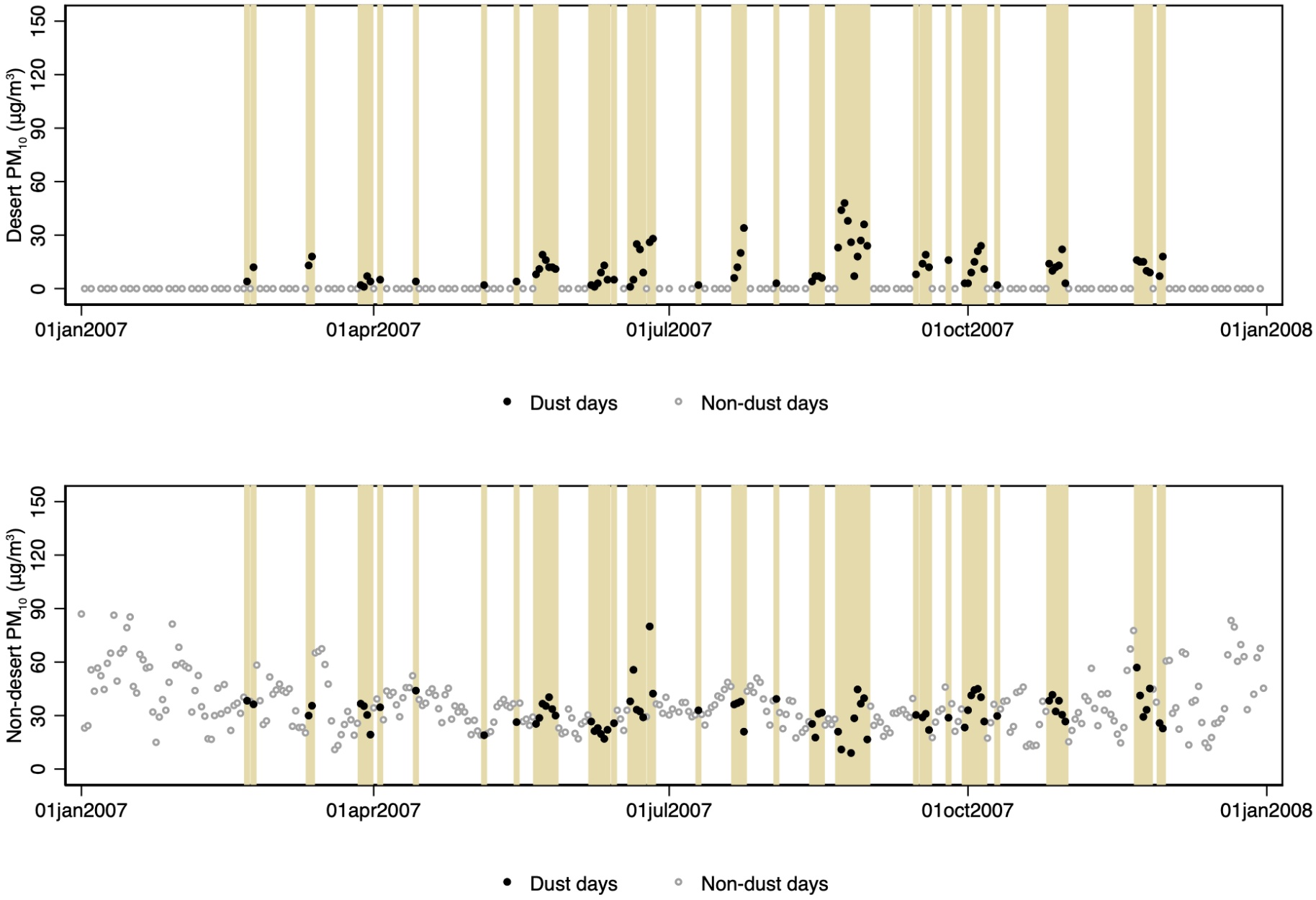
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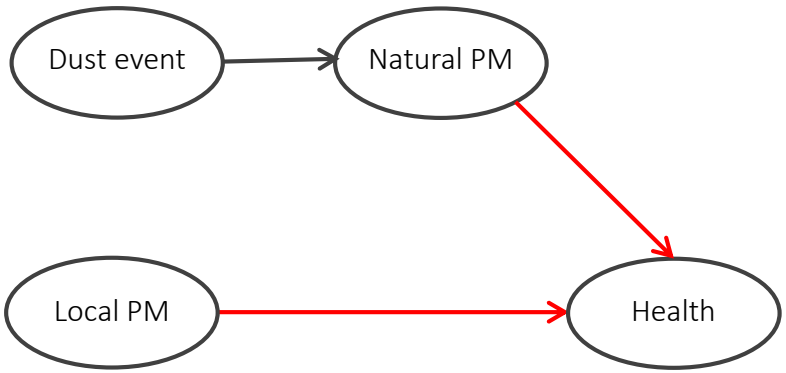
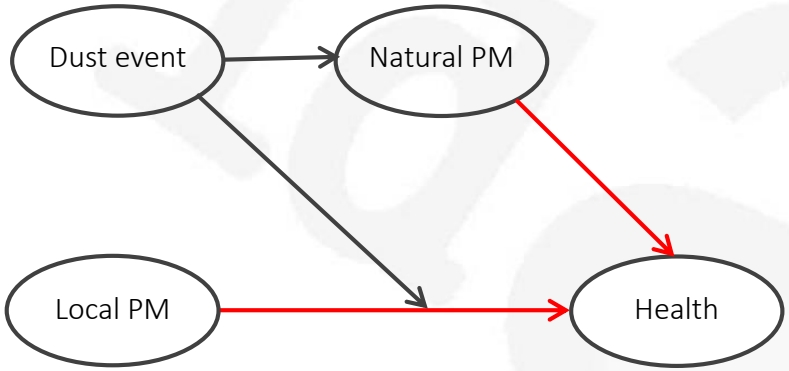


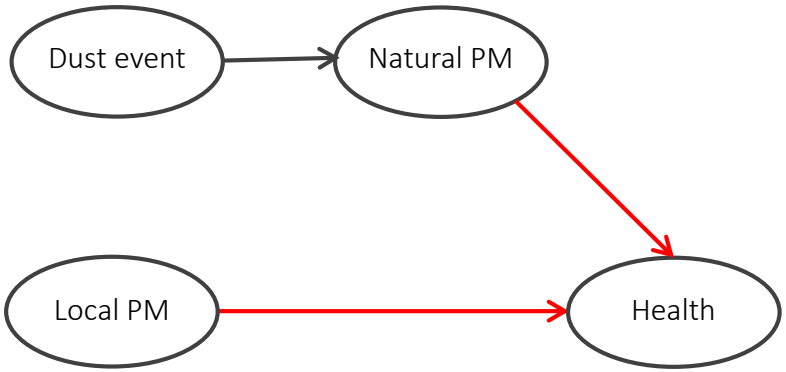
- **Research question –** *"… and is the association between local sources of PM with a health outcome different between dust days and non-dust days?"*

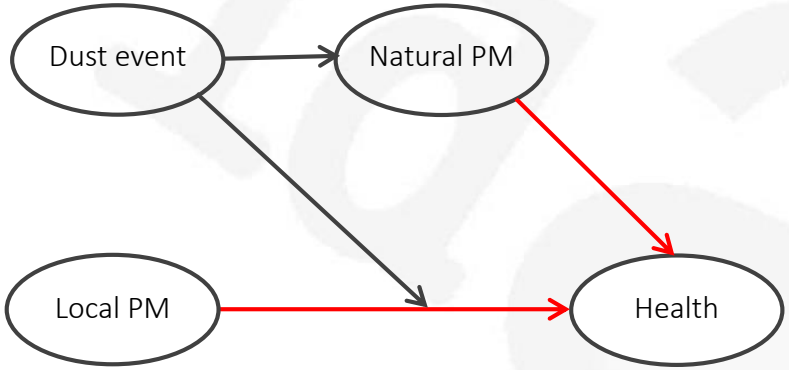


Dust exposure as continuous metric

- **Asian dust has larger effect than SPM** on cardiovascular mortality and ambulance calls for respiratory causes
- **Similar effects of PM_{10}** from local and natural (Saharan) sources

- PM_{10} from local sources during dust days are more harmful to health than in absence of dust intrusions, and than natural (Saharan) sources

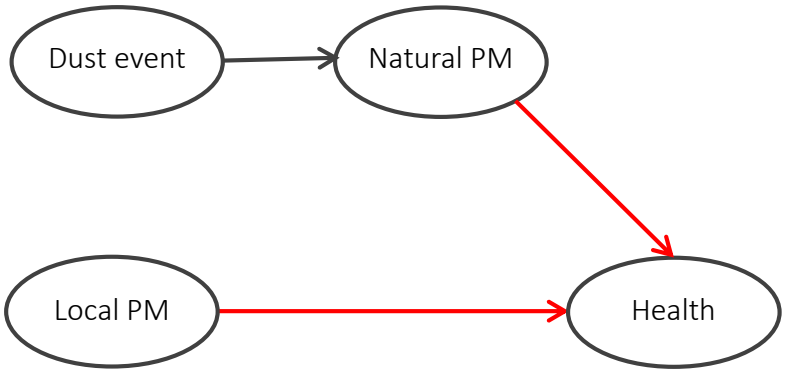


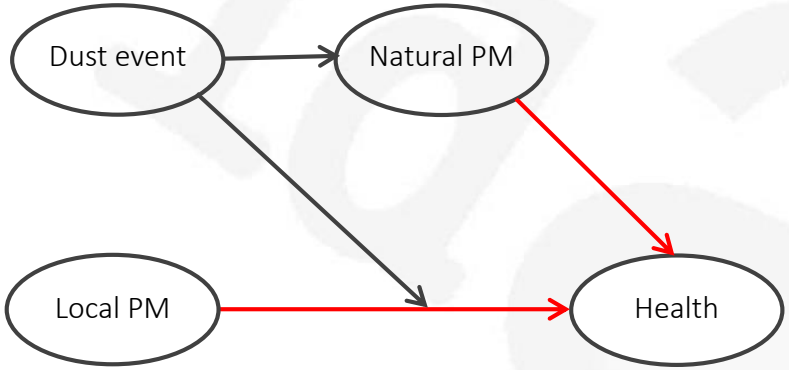


Dust exposure as continuous metric

- Suitable to estimate **exposure-response functions** between PM sources and health outcomes, **applicable in health impact assessment** studies

- **PM is a mixture** of natural and local sources, even within the dust days
- It might not be useful in hot-spots with high concentrations of local pollution





Conclusions

- The (apparently simple) question *"does desert dust affect health?"* requires a **proper understanding on how dust exposures have been modelled** in epidemiological studies
- Need to **standardize epidemiological studies** with same methodological characteristics to **make health effects comparable** in and near to hot spots
- This would help understanding differences in the health effects between **dust affected areas and hot spots**
- Urgent requirement to develop an appropriate epidemiological study design to assess for the **long-term effects** of desert dust

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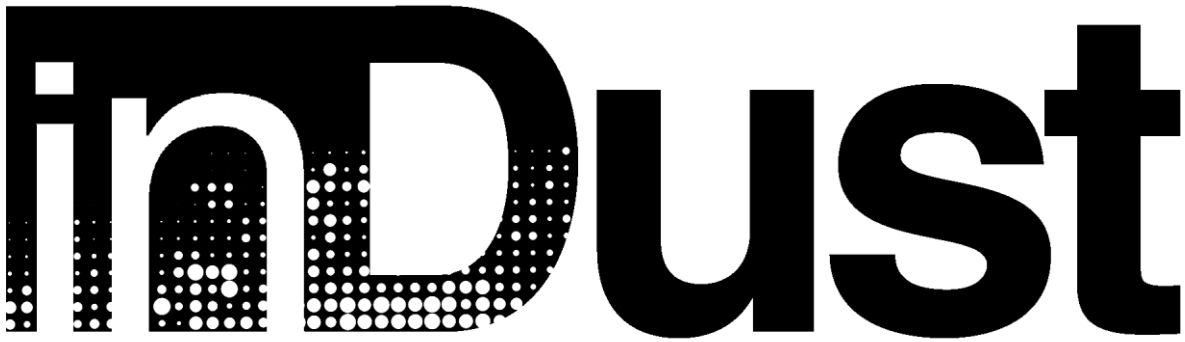
http://www.cost-indust.eu/

International Network to Encourage the Use of Monitoring and Forecasting Dust Products



COST Action CA16202

Chair: Sara Basart (Spain)
Vice-Chair: Slobodan Nickovic (Serbia)

Period: 14 Nov 2017 – 14 Nov 2021

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

inDust

inDust-Health group

- Barcelona (9-10 Jan 2019) & Rome (24 Feb 2020)
- **Availability of measurements and products to identify dust events** and sources for natural and local contributions to particulate matter
- **Methodological characteristics to help developing standardized study protocols** for the short- and long-term health effects
- **Provide guidelines** for policy-making

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Current research

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

MCC Collaborative Research Network

An international research program on the associations between weather and health

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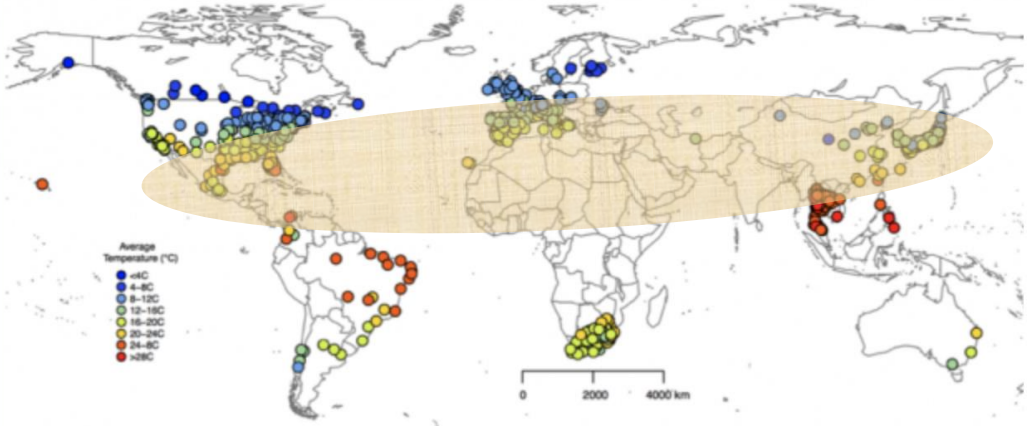

The MCC network

Currently including data on environmental stressors and daily mortality on 750 cities from 45 countries, representing a wide range of climates worldwide

http://mccstudy.lshtm.ac.uk/

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MCC-inDust study

- Daily mortality, PM_{10}, $PM_{2.5}$ and re-analysis data in areas **affected by dust events** and **hot spots** (36 cities in 18 countries, from 4 regions)
- Check **agreement between data** for dust exposure
- Feasibility to **standardized definition** for dust events and dust exposure at the global scale
- Explore **heterogeneity** for the short-term effects of desert **attributable to sources, transport and composition**

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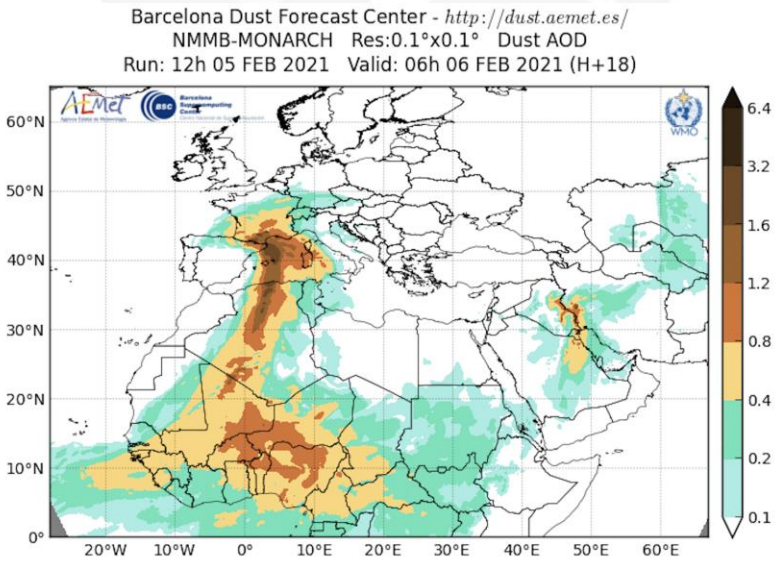
Thanks for your attention



Acknowledgements

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Other outcomes

- Cardiovascular system
  - **Not significant increase** in cerebrovascular morbidity, heart failure, hypertension & cardiac arrest
  - **Significant increase** in myocardial infraction, acute coronary syndrome
  - **Conflicting evidence** in ischaemic heart disease & stroke
- Respiratory system
  - **Significant increase** in upper respiratory track infection
  - **Conflicting evidence** in COPD & pneumonia
- Other outcomes
  - **Not significant increase** in allergic rhinitis, conjunctivitis & pregnancy outcomes
  - **Conflicting evidence** in respiratory symptoms and PEF