Global Air Quality: Challenges and Opportunities

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Some things to remember…

- Air quality is relevant to everyone
- Air Pollution is not one thing
- Different pollutants have different origins and cause different problems
- Great advances have been made – and many opportunities lie ahead

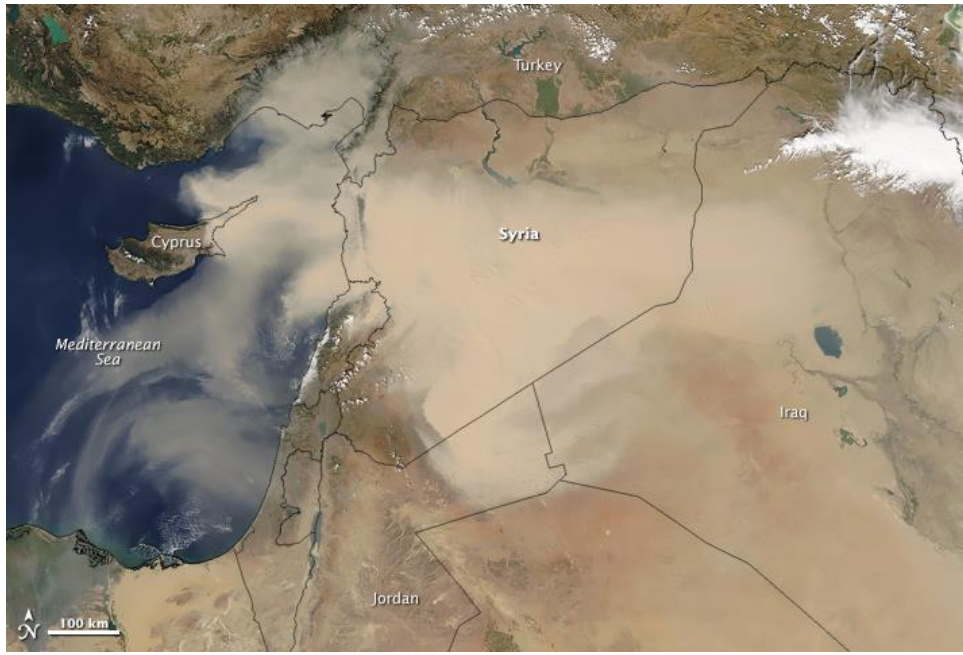
A few definitions…

Primary pollutants – directly released from a source into the air in a harmful form.

Secondary pollutants – modified to a hazardous form after they enter the air (acid rain or smog) or are formed by chemical reactions as components of the air mix & interact.

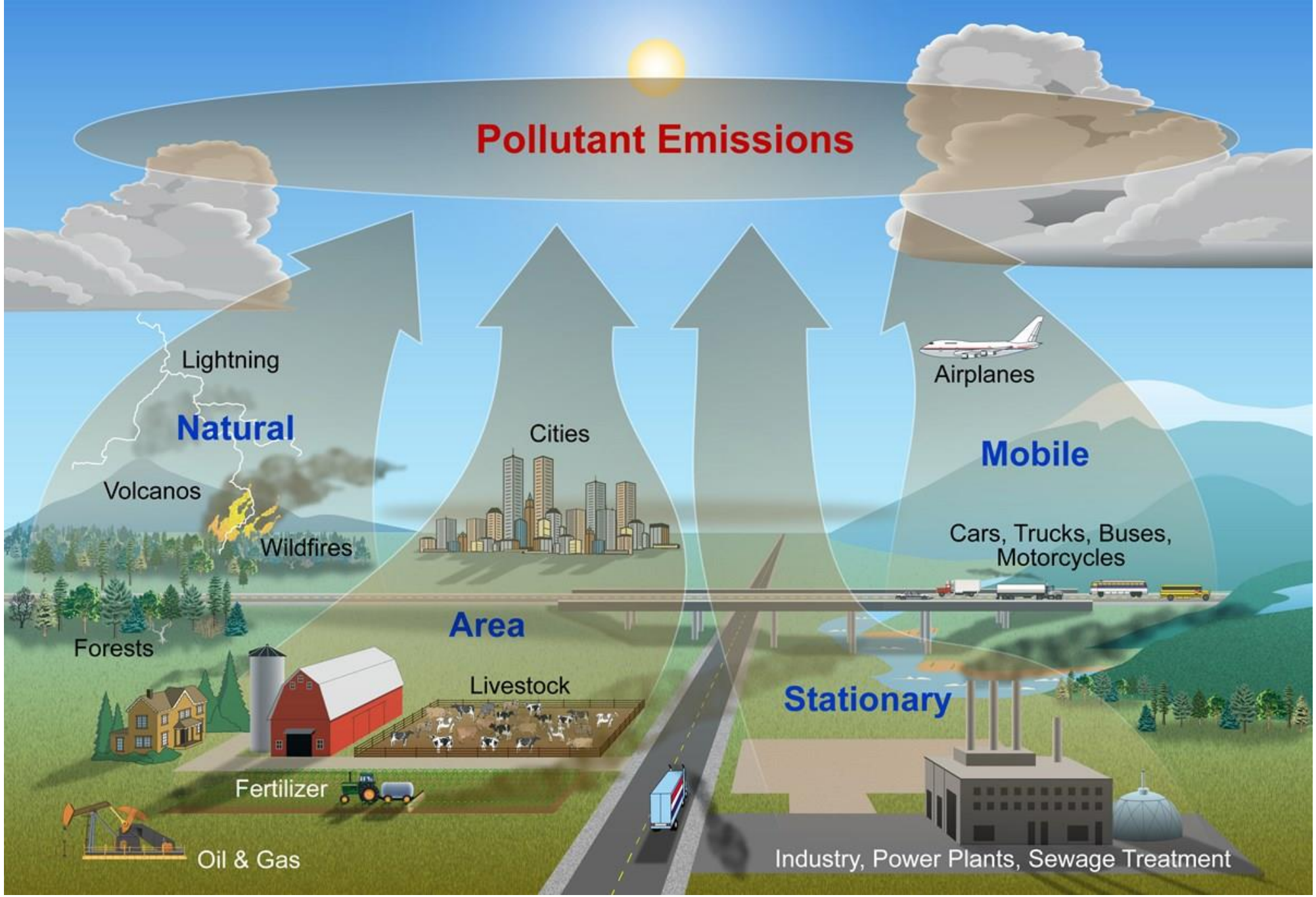
Sources of Air Pollutants

<u>Natural (Biogenic):</u>
Emissions from natural sources



Sources of Air Pollutants

Anthropogenic:
Caused by human activities



https://www.nps.gov/subjects/air/sources.htm

Criteria Air Pollutants

- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Lead
- Ozone (O_3)
- Particulate Matter (PM)

All have bad health effects

WHO Guidelines for PM, O_3, NO_2, SO_2

OZONE (O_3)

Why is it regulated?

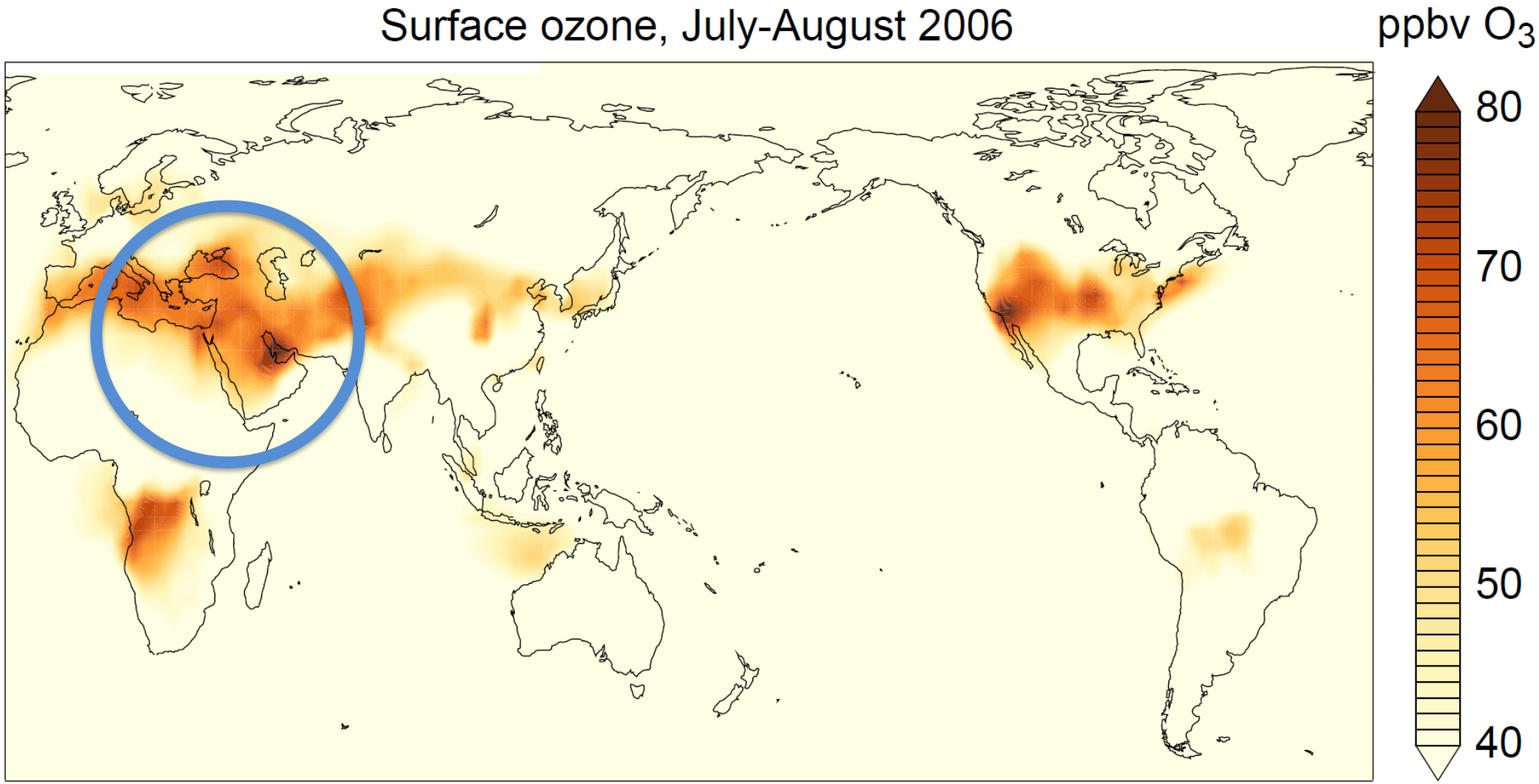
- unhealthy to breath
- harmful to materials
- destroys plants (agriculture)

Health Impacts of Ozone Exposure

- Respiratory symptoms
  - Cough
  - Sore or scratchy throat
  - Pain with deep breath
  - Fatigue
- ↓ lung function & lung growth
- ↑emergency room visits
- ↑ hospitalizations

- Linkages to:
  - Cardiovascular disease
  - Metabolic disease (diabetes)
  - Autoimmune diseases

Lelieveld et al., Severe ozone air pollution in the Persian Gulf region, *Atmospheric Chemistry & Physics,* 2009



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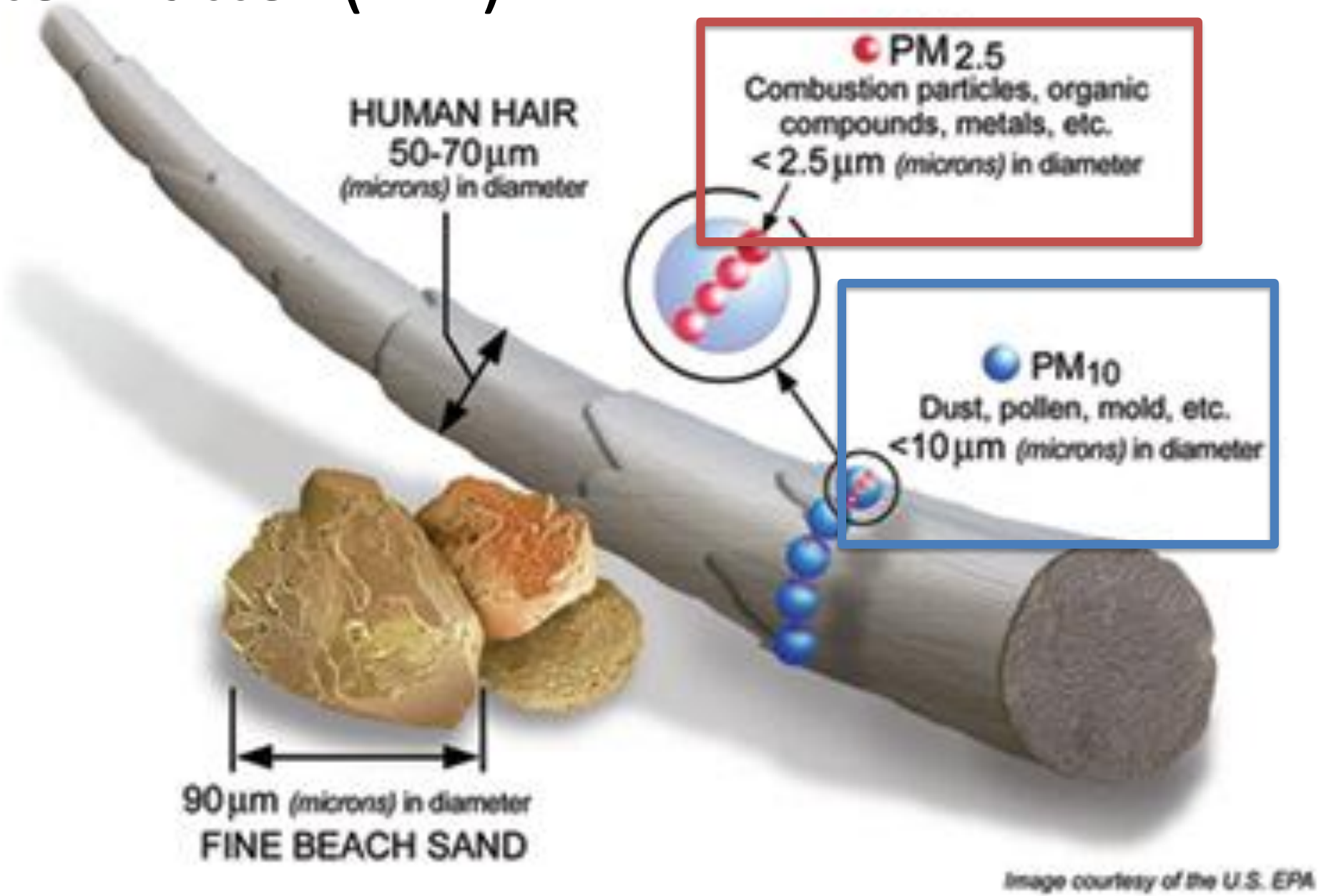
Particulate Matter (PM)



Health Effects of PM Exposure

- Premature mortality
- Nonfatal heart attacks
- Irregular heartbeat
- Aggravated asthma
- Decreased lung function
- Increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

- Immune responses
- Links to neurological diseases

World Health Organization Statistics

In 2016,

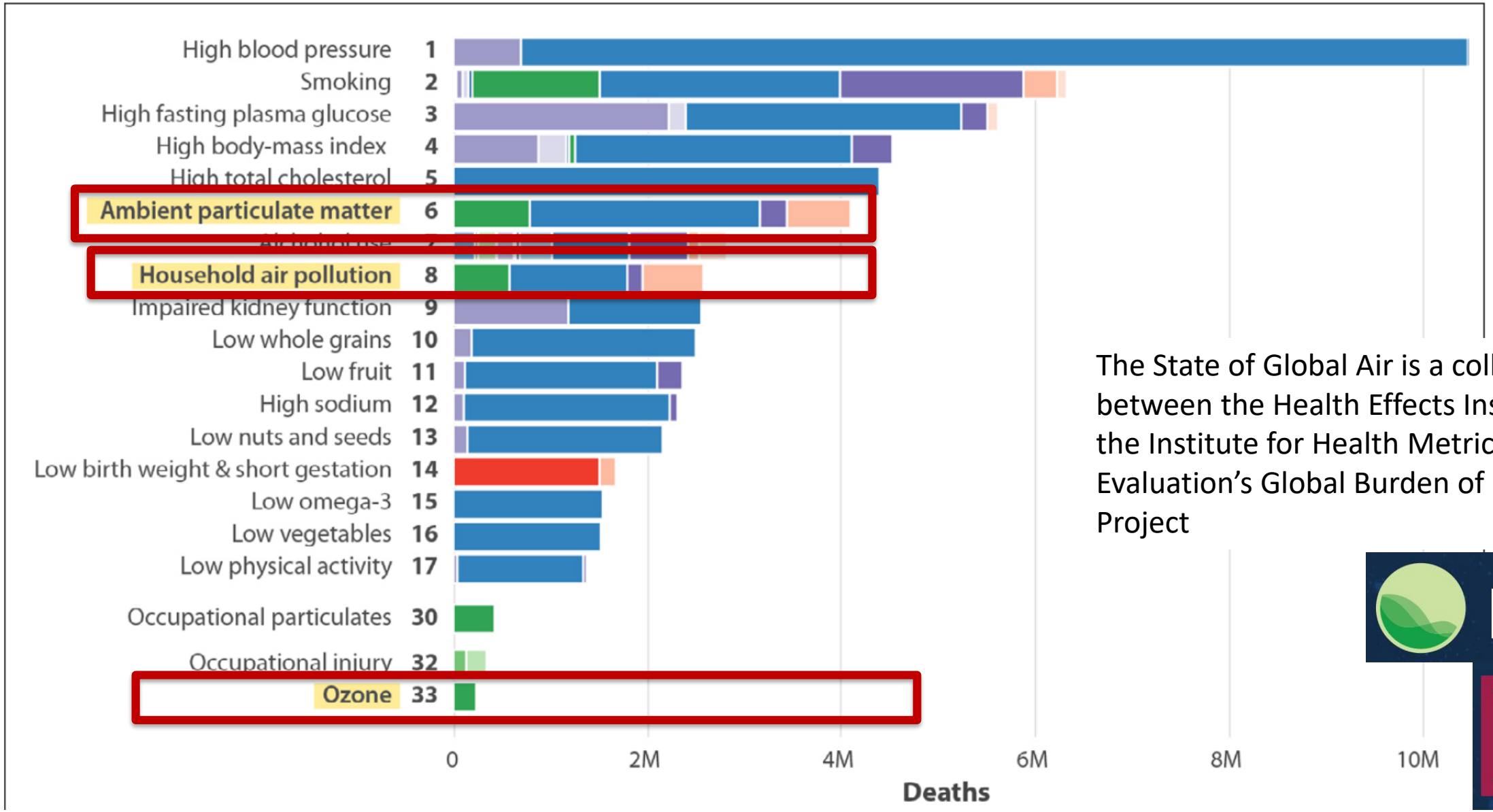
- Worldwide, **ambient (outdoor air pollution)** in both cities and rural areas was estimated to cause **4.2 million premature deaths worldwide**

- Some **91% of those premature deaths** occurred in **low- and middle-income** countries, and the greatest number in the WHO South-East Asia and Western Pacific regions.

- Household air pollution was responsible for **3.8 million deaths.**

Figure 1. Global ranking of risk factors by total number of deaths from all causes for all ages and both sexes in 2016.

State of the Air Report (2018)



The State of Global Air is a collaboration between the Health Effects Institute and the Institute for Health Metrics and Evaluation's Global Burden of Disease Project

IHME

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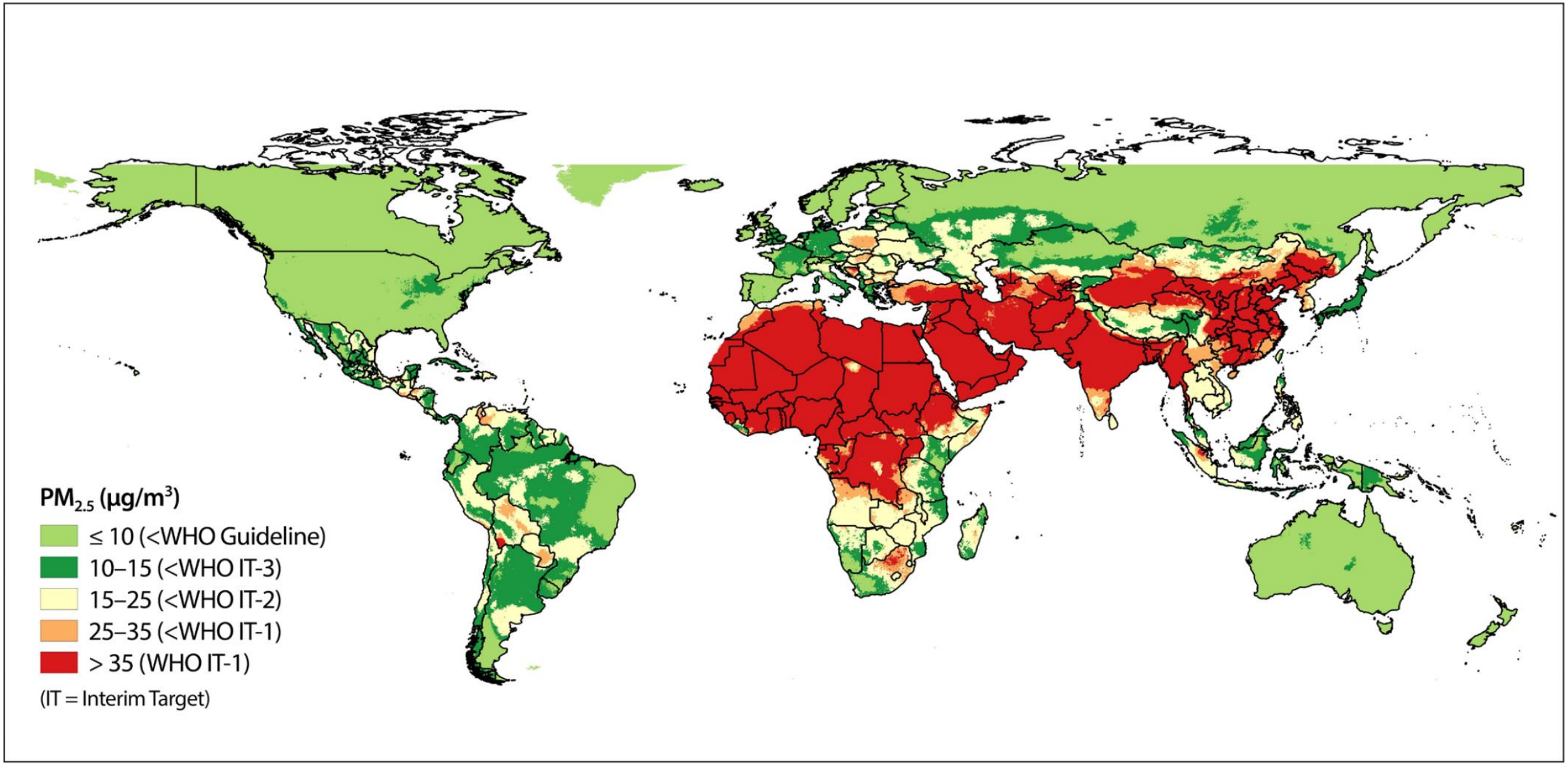
Figure 2. Comparison of 2016 annual average $PM_{2.5}$ concentrations to the WHO Air Quality Guideline.



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Opportunities

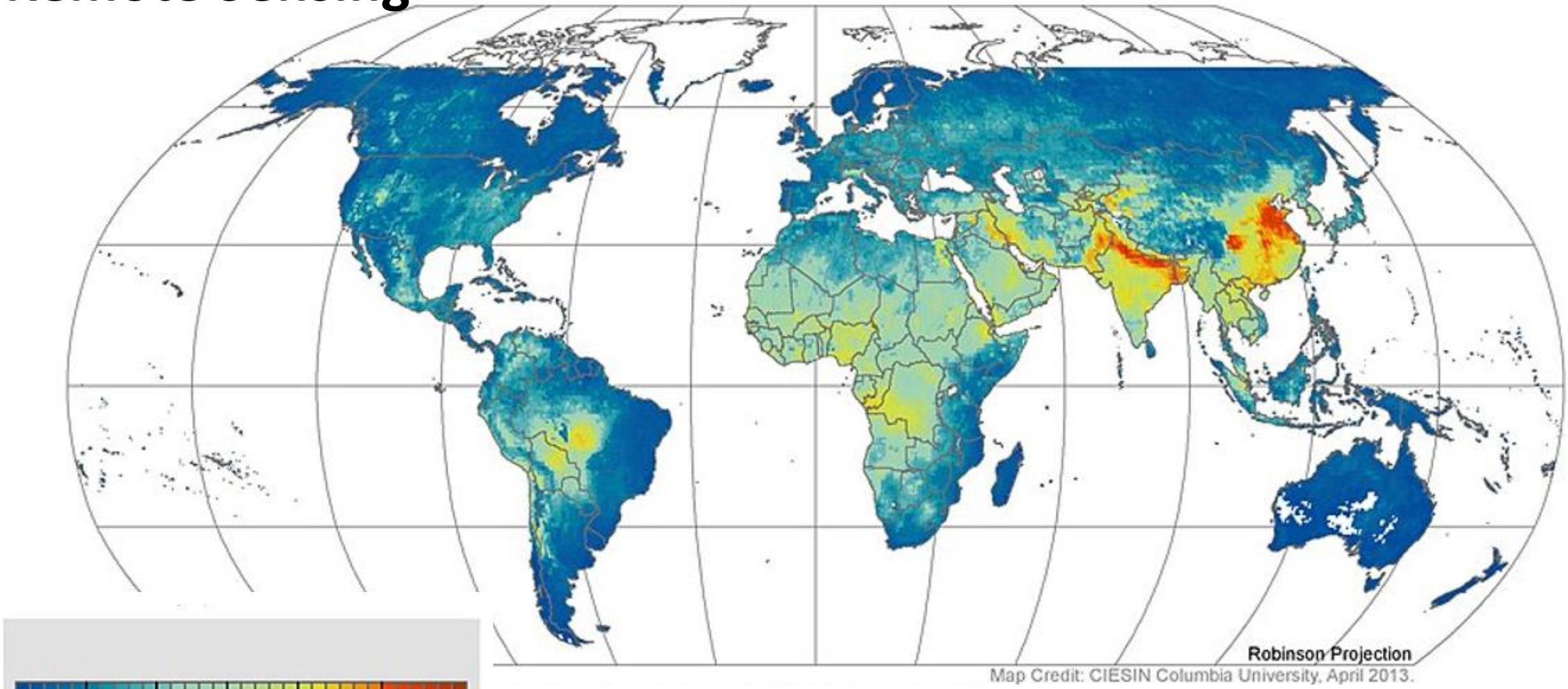
- Incredible advances in:
  - Observations
  - Modeling tools
  - Analytics
  - Data sharing
- Innovative solution strategies
- Multi-disciplinary research activities
- International Collaborations (IGAC)

Sensors

Unique Instrumentation

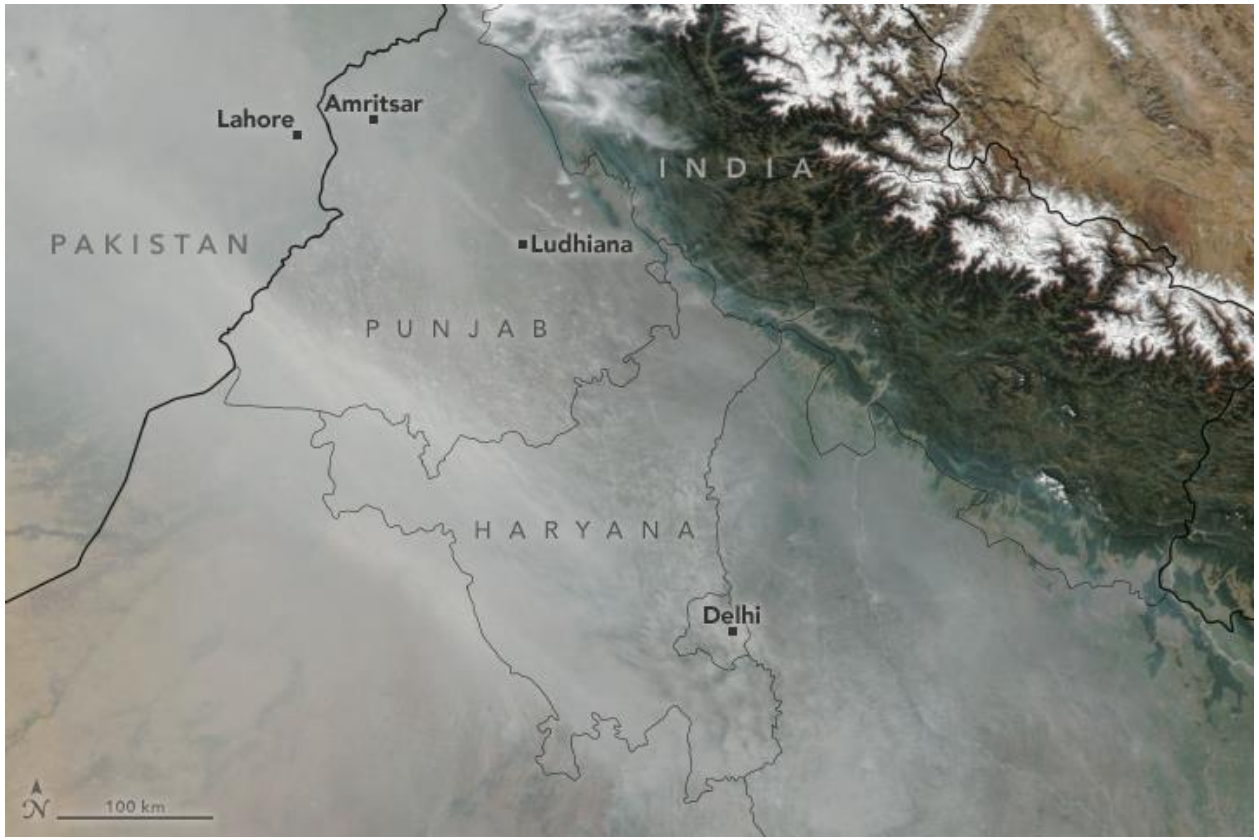
COST

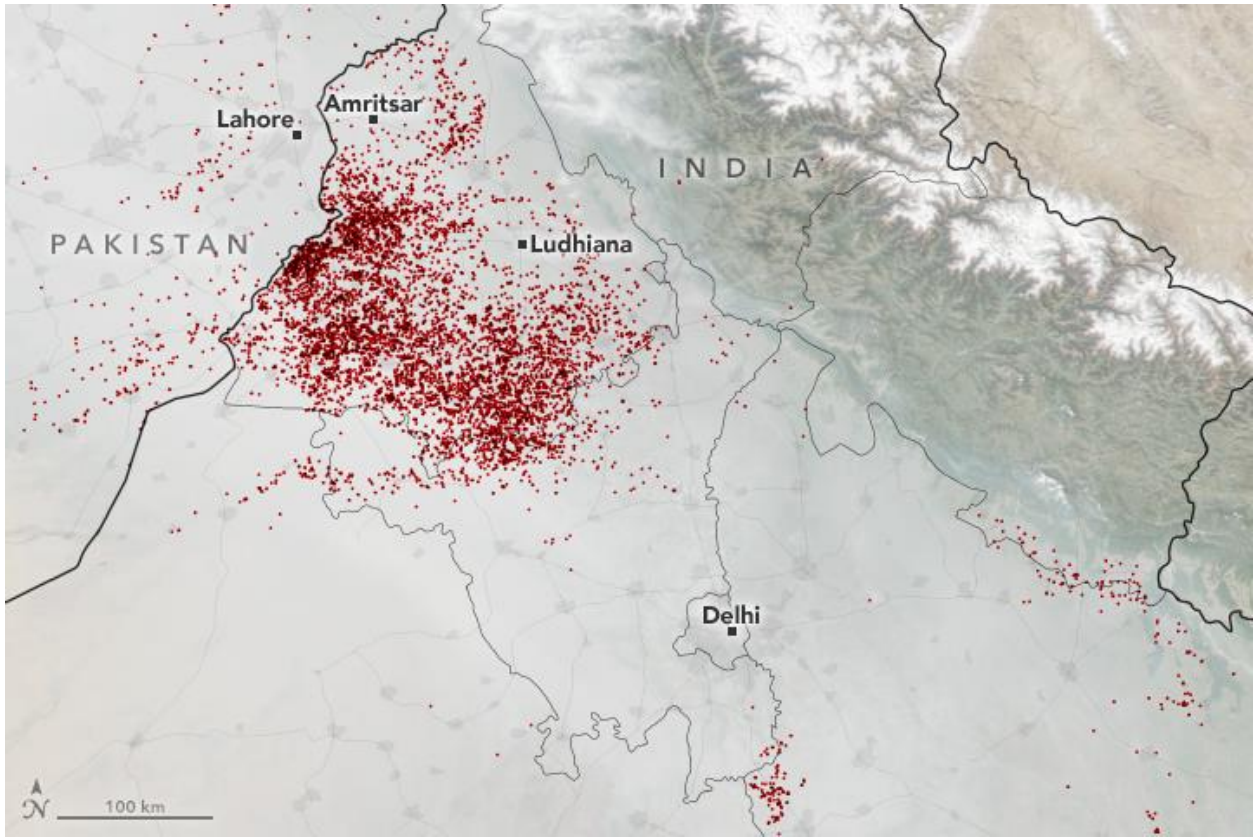
Remote Sensing



Data Source: Battelle Memorial Institute, and Center for International Earth Science Information Network (CIESIN)/Columbia University. 2013. Global Annual Average PM2.5 Grids from MODIS and MISR Aerosol Optical Depth (AOD), 2001–2010. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://sedac.ciesin.columbia.edu/data/set/sdei-global-annual-avg-pm2-5-2001-2010.

Remote Sensing





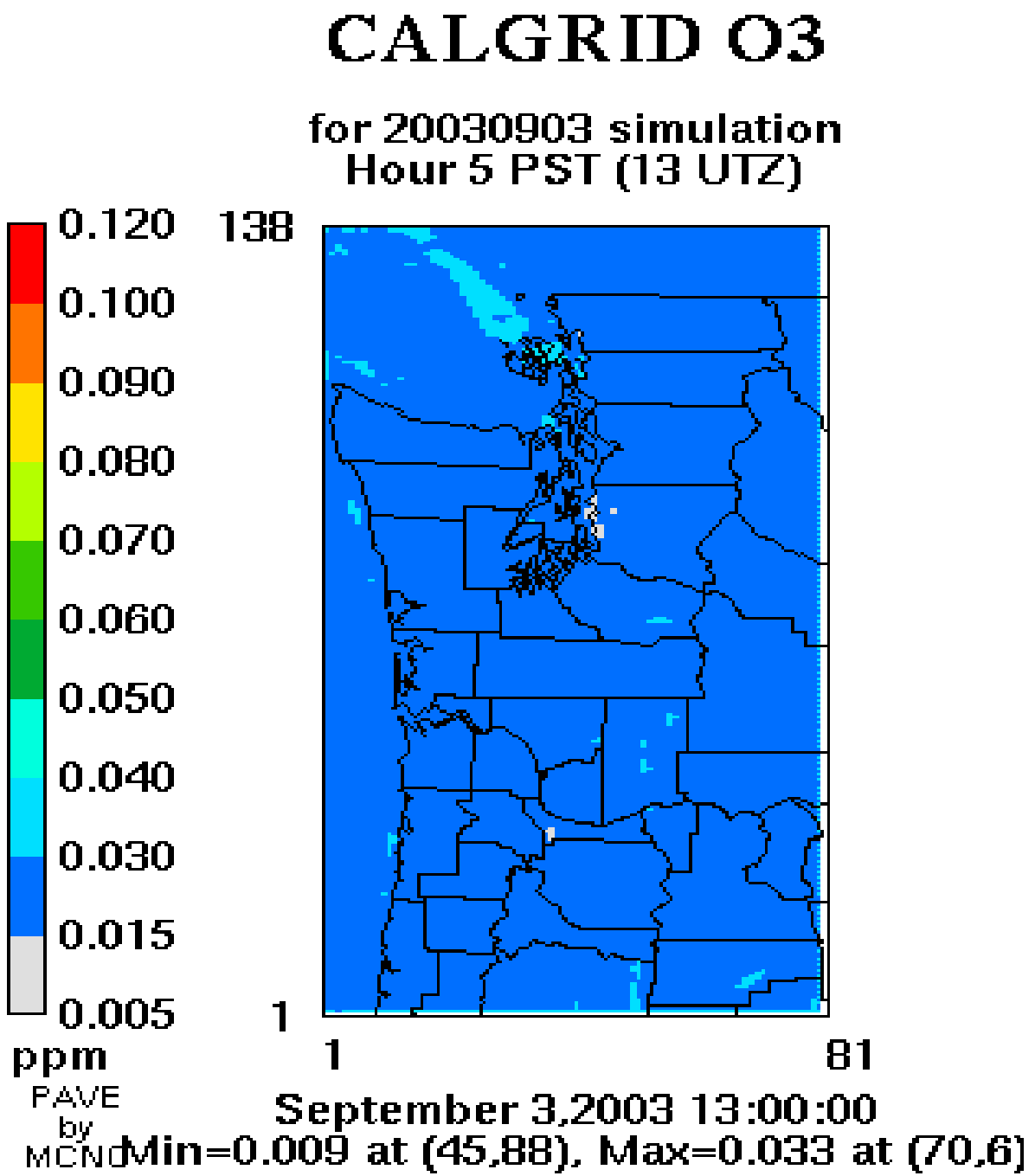
31 October 2018

https://earthobservatory.nasa.gov/images/144181/smokier-and-smokier-skies-in-india

MODELING TOOLS

- Effective way to study regional and global air quality

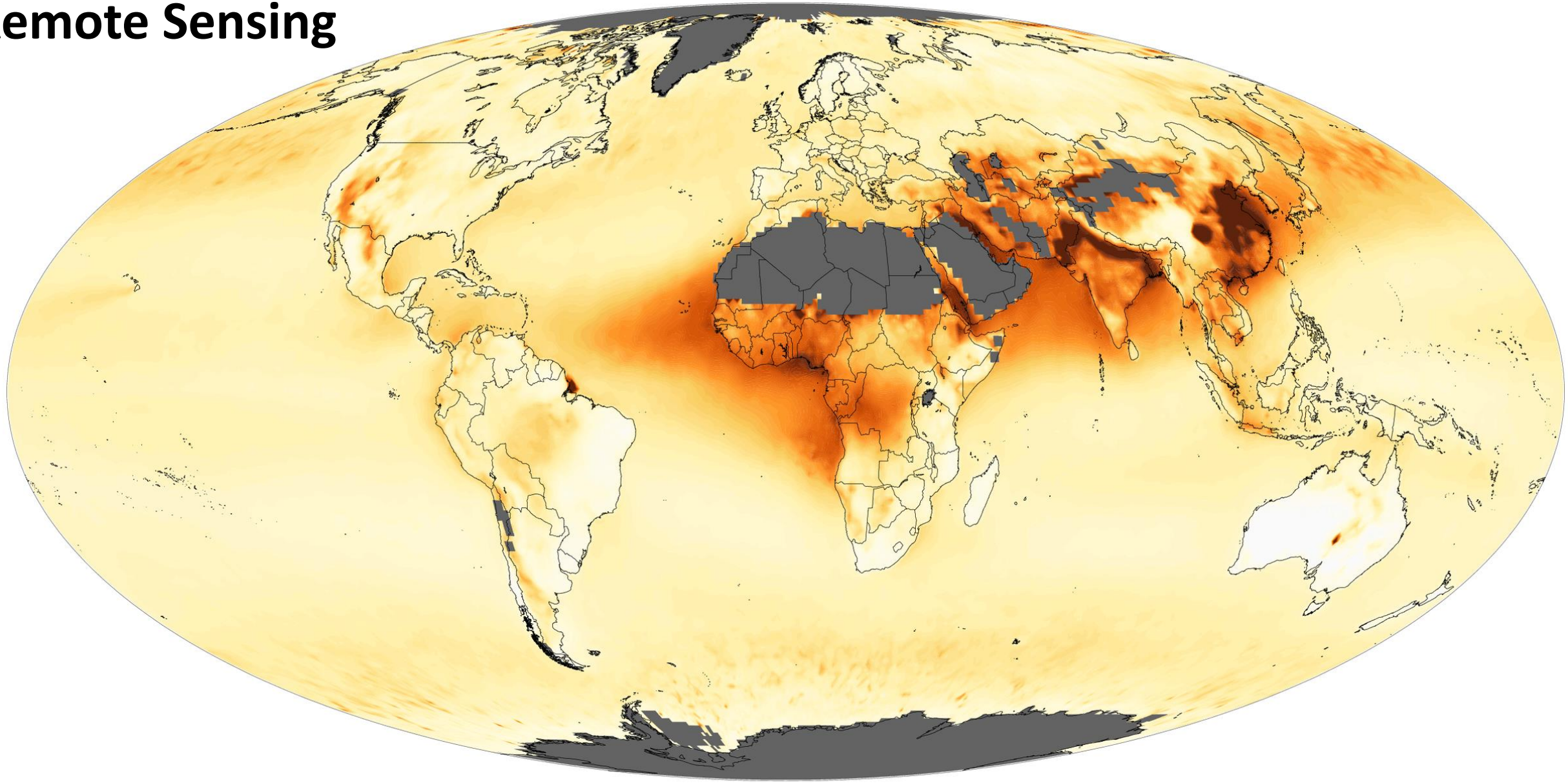
- Used to develop air quality management strategies



Challenges

- Measurements difficult to access or not located in all places
- Observations may not give the whole
- Identifying sources
- Utilizing different data sources together
  - (models, monitors, remote sensing)
- Connecting air pollution to health outcomes
- Rapidly changing areas

Remote Sensing



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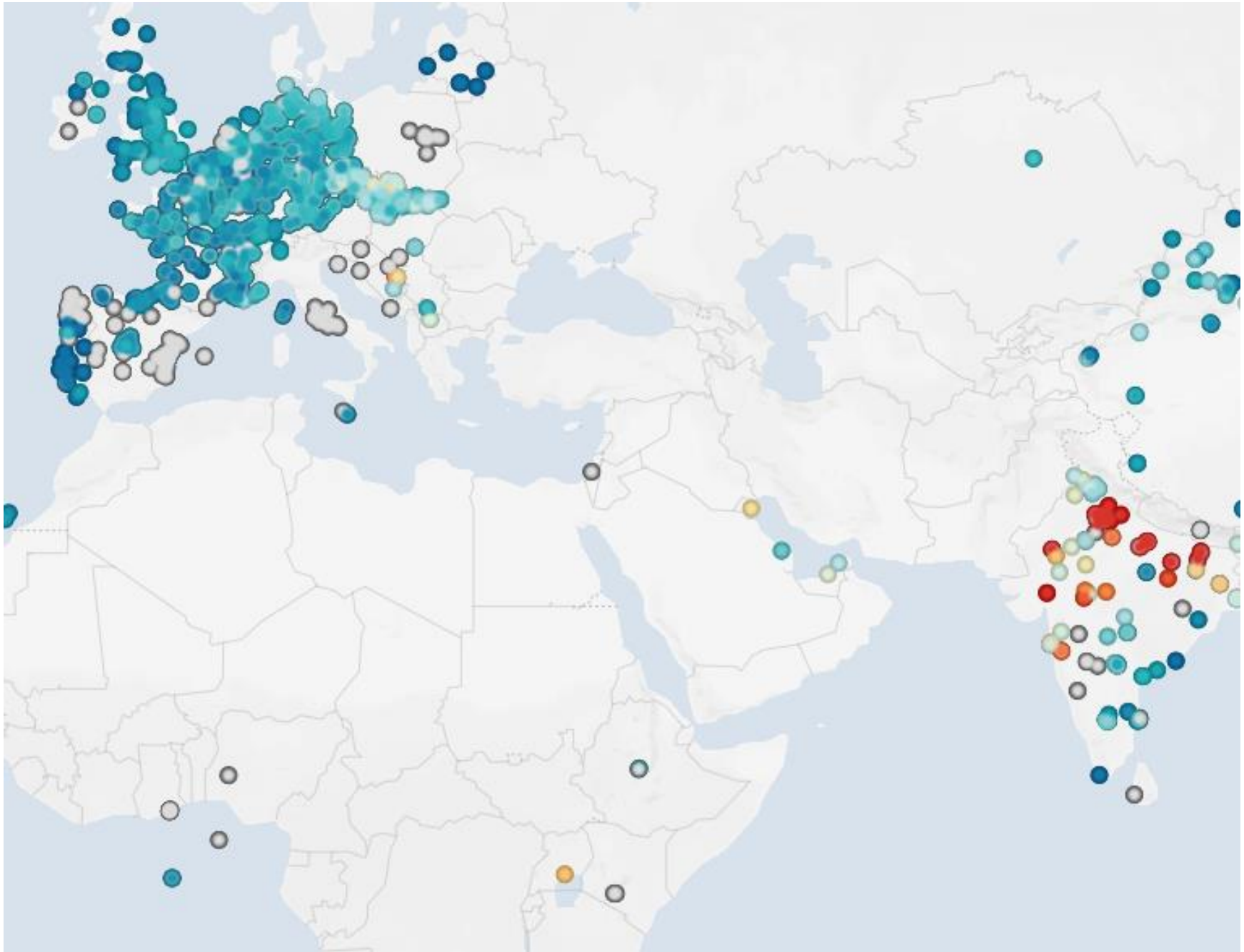

Air Quality is impacted by climate, human behavior, changing technology, markets, …

The Guardian International edition

Middle East conflict 'drastically altered' air pollution levels in region – study

Fri 21 Aug 2015 19.54 BST

Rise of Isis led to substantial decrease in NO2 emissions in Baghdad and central Iraq since 2013, say researchers, with similar trends seen in Egypt and Syria

Abrupt recent trend changes in atmospheric nitrogen dioxide over the Middle East

Jos Lelieveld[1,2,3,*], Steffen Beirle[1], Christoph Hörmann[1], Georgiy Stenchikov[4] and Thomas Wagner[1]
+ See all authors and affiliations

Science Advances 21 Aug 2015:
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Please remember…

- Air Pollution impacts us all
- Air pollution is not one thing
  - Sources
  - Impacts
  - Mitigation
- Incredible advancements in tools
- Great success stories and many challenges ahead

THANK YOU

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