InterAir 1: Air Quality in The Urban Environment: Public Health and Other Impacts

## Air pollution, public health and changing weather

Prof. David Parsons, Professor, Emeritus University of Oklahoma

InterAIR Asia

Building resilience & adaptability to extreme weather & climate change in Asia, Africa and the Pacific Islands
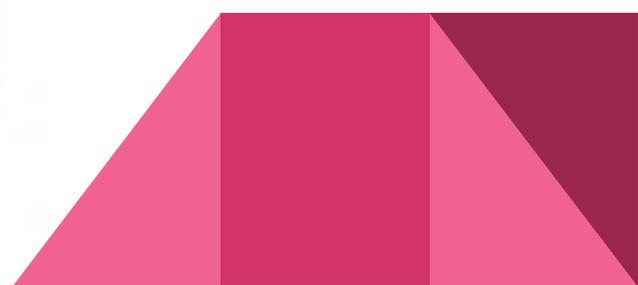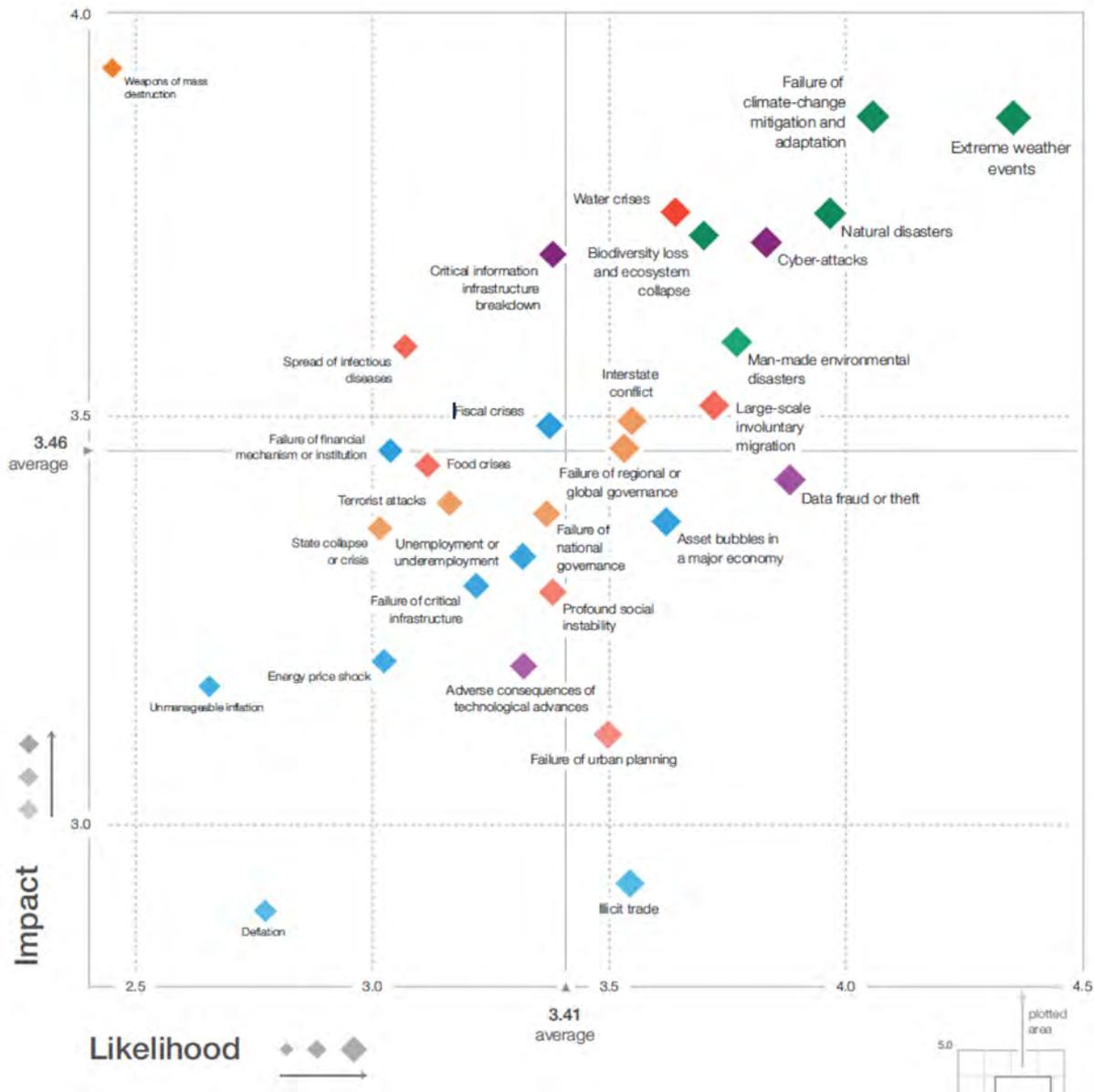
Air Pollution: Public Health Impacts and the Status of and Need for Observations

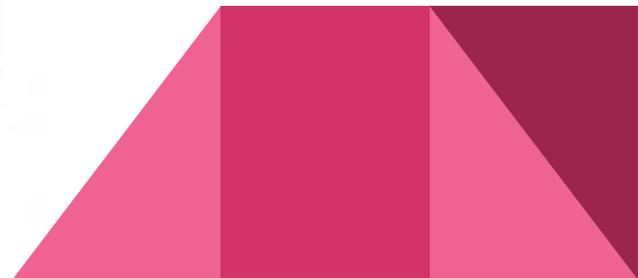David B. Parsons and Ella S. Parsons
University of Oklahoma
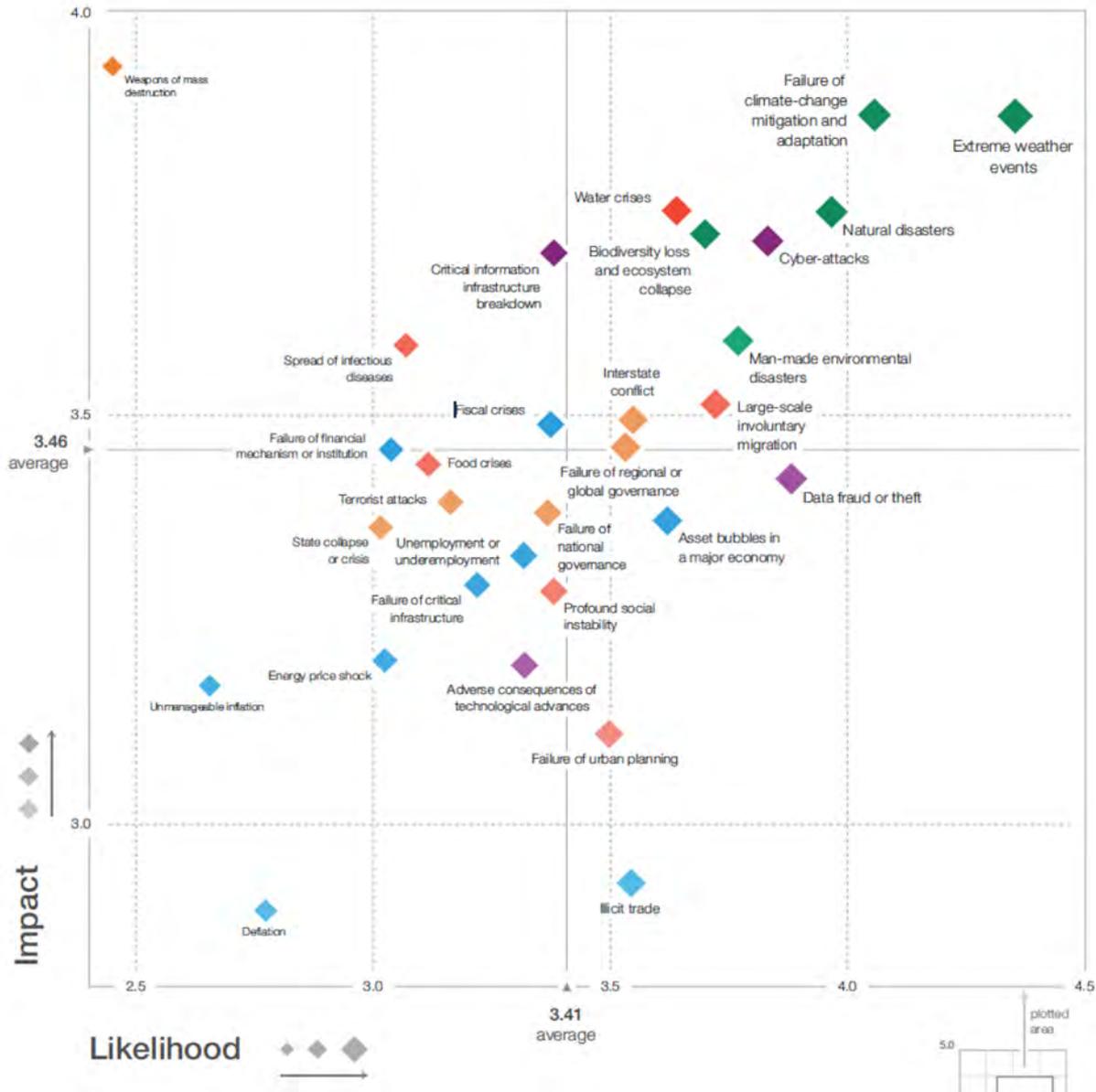
Global Risk Report
2019,
World Economic
Forum

Where is
air quality?

Global Risk Report
2019,
World Economic
Forum

Decrease in life expectancy is correspondingly higher in
SE Asia, western Pacific, and Africa

Negative Health Outcomes

- Shortened life expectancy

- Stroke

- Ischaemic heart disease

- Worsened COPD

- Asthma

- Lung tissue irritation and swelling

- Lung cancer

- Pneumonia

- Decrease in cognitive function > dementia in elderly

- Increase in hospitalization and emergency room visits

- Developmental damage in children

- Susceptibility to infections, esp. in children

- Low infant birth weight

- Mental health issues

- Decrease in happiness
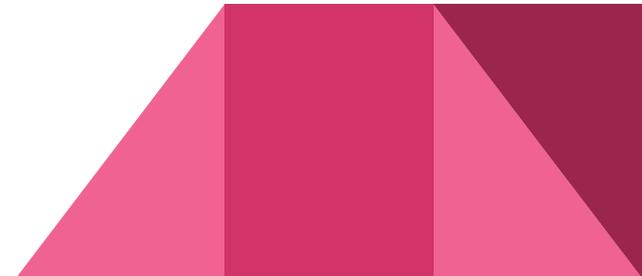
What are some of the challenges in measuring and predicting air pollution?

Need to measure many different quantities (i.e., NO_2, O_3, $PM_{2.5}$, PM_{10}, ultrafine particles, particle composition)

Extremely large spatial gradients, challenging to simulate

Need to get the weather right (rain, transport, inversions, reduction in short wave radiation)

Complex and diverse natural and anthropogenic sources)

Politics and controversy – health, commerce, development, and climate change are all involved
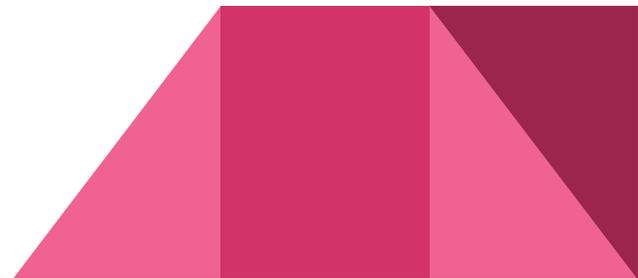
Satellite-Based Remote Sensing

- Visible imagery useful for tracking plumes of pollution

- Global coverage of columnar optical depth is useful and critical for climate studies. However, intermittent in time and space.

- Surface concentrations are desired, but determination of an accurate relationship between optical depth and surface $PM_{2.5}$ is sometimes difficult (Lori'a-Salazar et al. 2017) due to inversion depth and elevated aerosol layers

Predicting Air Quality

Smoke from agricultural fires in Sumatra

June 10, 00 UTC

GEOS-Chem model
[Kim et al., 2015]

0   16   33   50   66   83   100   ppbv

Smoke in Singapore, June 20 2013

WMO OMM

GAW

From WWRP, Jones and Roti, CBS TECO Presentation
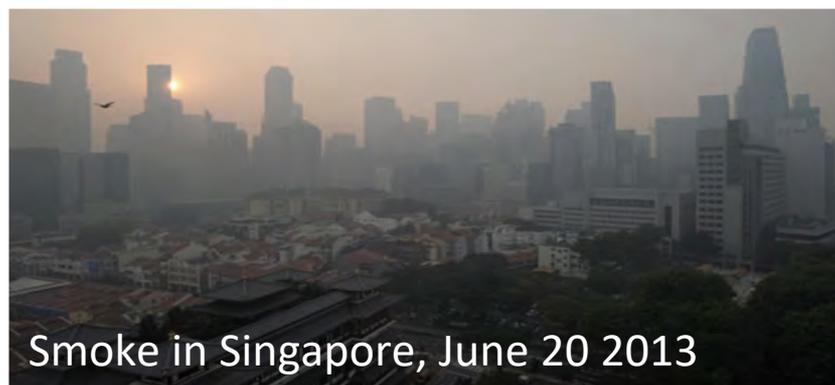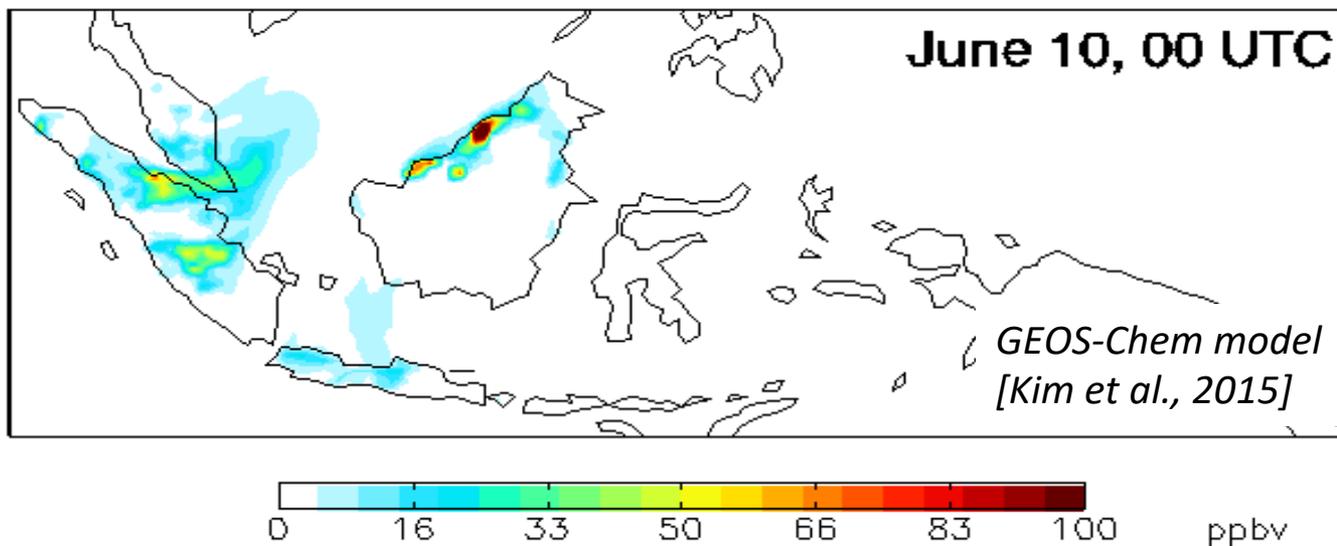
# Lidar Remote Sensing

- Differential absorption lidar (DIAL) (i.e., research quality estimates of O_3)

- Scanning backscatter lidar – can provide vertical and horizontal coverage of aerosol particles

- Less lidar costly approaches are to utilize ceilometers to estimate mixed layer height and concentration through attenuation of backscatter measurements. Promising results in obtaining estimates surface $PM_{2.5}$ (Tang et al. 2015)
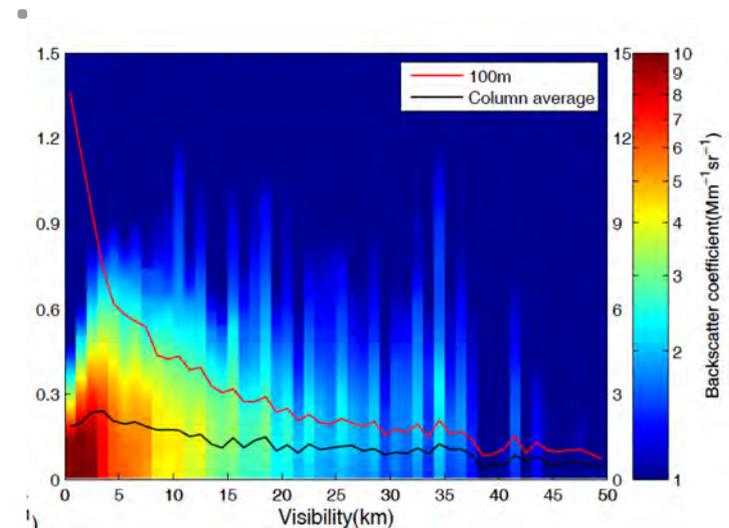
(Tang et al. 2015)

SUNSET NEIGHBORHOOD, VANCOUVER, BC

Courtesy of Scott Salesky, U Oklahoma
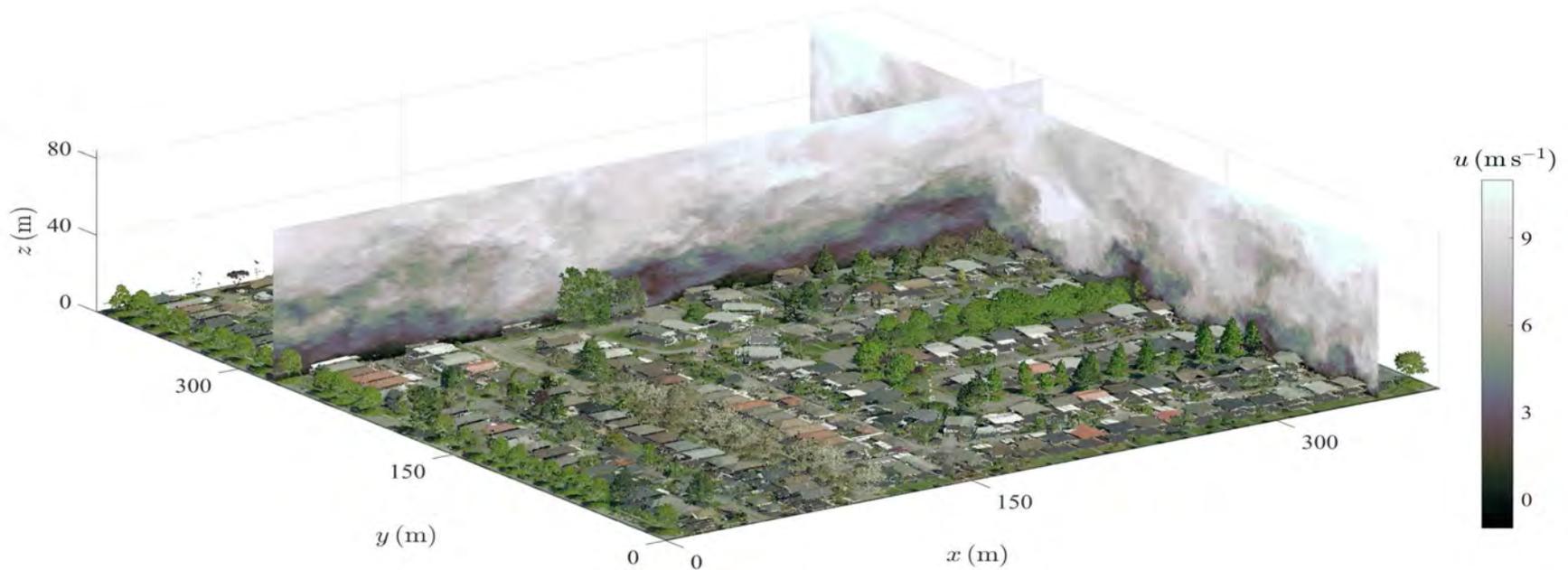
Momentum equation

$$\frac{\partial \widetilde{u}_i}{\partial t} + \widetilde{u}_j \left(\frac{\partial \widetilde{u}_i}{\partial x_j} - \frac{\partial \widetilde{u}_j}{\partial x_i} \right) = -\frac{\partial \widetilde{\pi}}{\partial x_i} - \frac{\partial \tau_{ij}}{\partial x_j} - \frac{1}{\rho}\Pi\delta_{i\alpha} + \widetilde{f}_i^b + \widetilde{f}_i^v$$

**Force from buildings
(immersed boundary method)**

Drag force from vegetation

$$\widetilde{f}_i^v(\boldsymbol{x}, t) = -C_d \, \mathrm{LAD}(\boldsymbol{x}) \, \widetilde{u}_i |\widetilde{\boldsymbol{u}}|$$

From LIDAR scans

Surface In-situ Sensing

- Wide variety of approaches to often concentrating on $PM_{2.5}$

- Challenge representing spatial gradients within a city, maintaining calibrations and drop-outs during periods of high pollution

- Perhaps the Met Norway example of using crowd source data is way forward, with public sector leadership
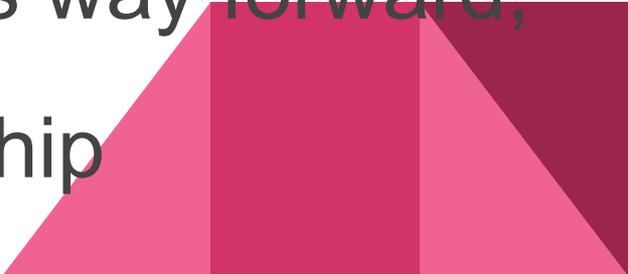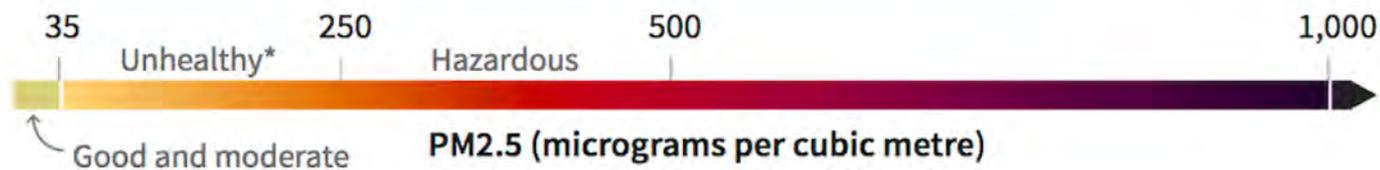
Palette of Pollution

The changing colours of Delhi's air quality

Reuters

DECEMBER 31, 2018

By **Prasanta Kr Dutta, Rajshree Deshmukh, Simon Scarr** and **Gurman Bhatia**

Each winter, a thick blanket of smog settles over vast swathes of northern India, including the capital, New Delhi. As wind speeds drop and nights get cooler, the problem is exacerbated as polluted air is pushed closer to the ground.

35		250		500		1,000

Unhealthy*   Hazardous

↳ Good and moderate   **PM2.5 (micrograms per cubic metre)**

Please see this article, several of these challenging issues are visually in illustrated in this wonderful and readily available Reuters article.

Conclusions

- A grand challenge for the coming decades.

- For observations, the challenge is greater than obtaining meteor. measurements

- An underestimated problem that is growing in importance with urbanization and development. A particular challenge for Asia and Africa.

- Will require locally-led solutions and partnerships