

A Satellite-Based Global Health Air Quality Index (HAQI)*: Development and Assessment

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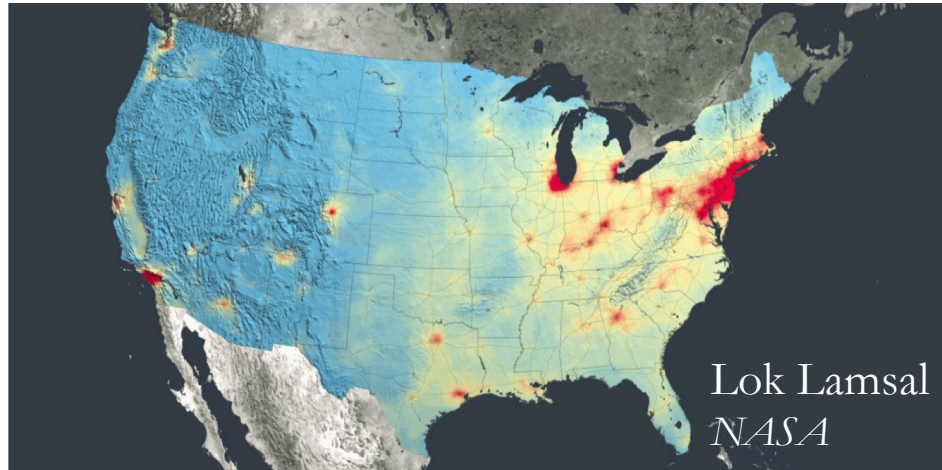
²NYU, NYC, NY

***Based on:** Cooper, M., R.V. Martin, A. van Donkelaar, L. Lamsal, M. Brauer, and J. Brook, A satellite-based multi-pollutant index of global air quality, *Env. Sci. and Tech.*, 46, 8523-8524, 2012.

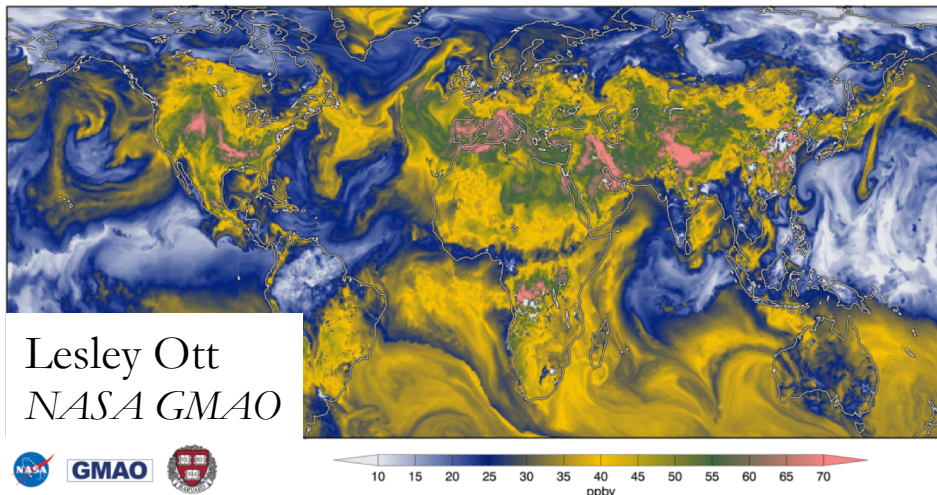
Advantages of Satellite Observations

→ The unique advantages of satellites is 1) global spatial coverage & 2) co-located observations of multiple pollutants.

Aura/OMI NO₂

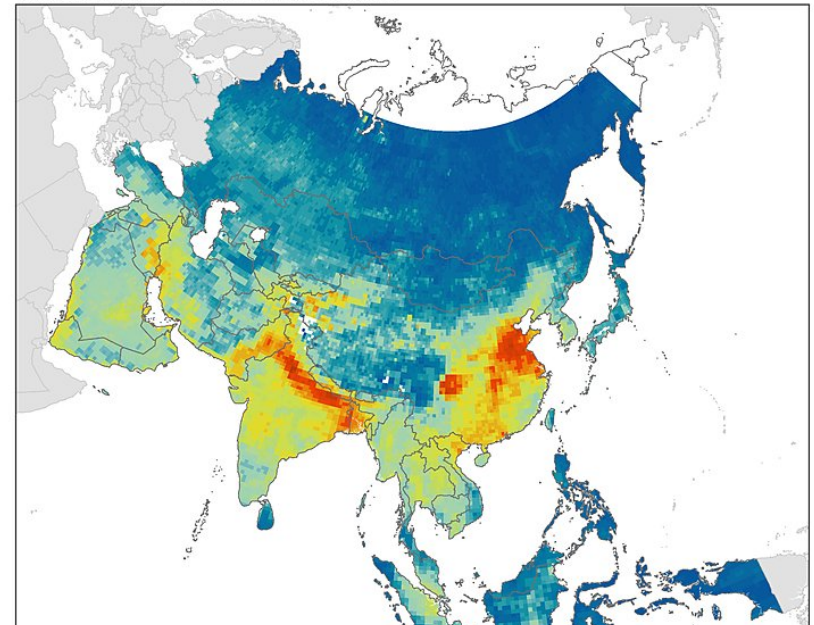


NASA GEOS-5 Model



Multi-Satellite: AOD → PM_{2.5}

Global Annual Average PM_{2.5} Grids from MODIS and MISR Aerosol Optical Depth (AOD), 2010: Asia
Satellite-Derived Environmental Indicators

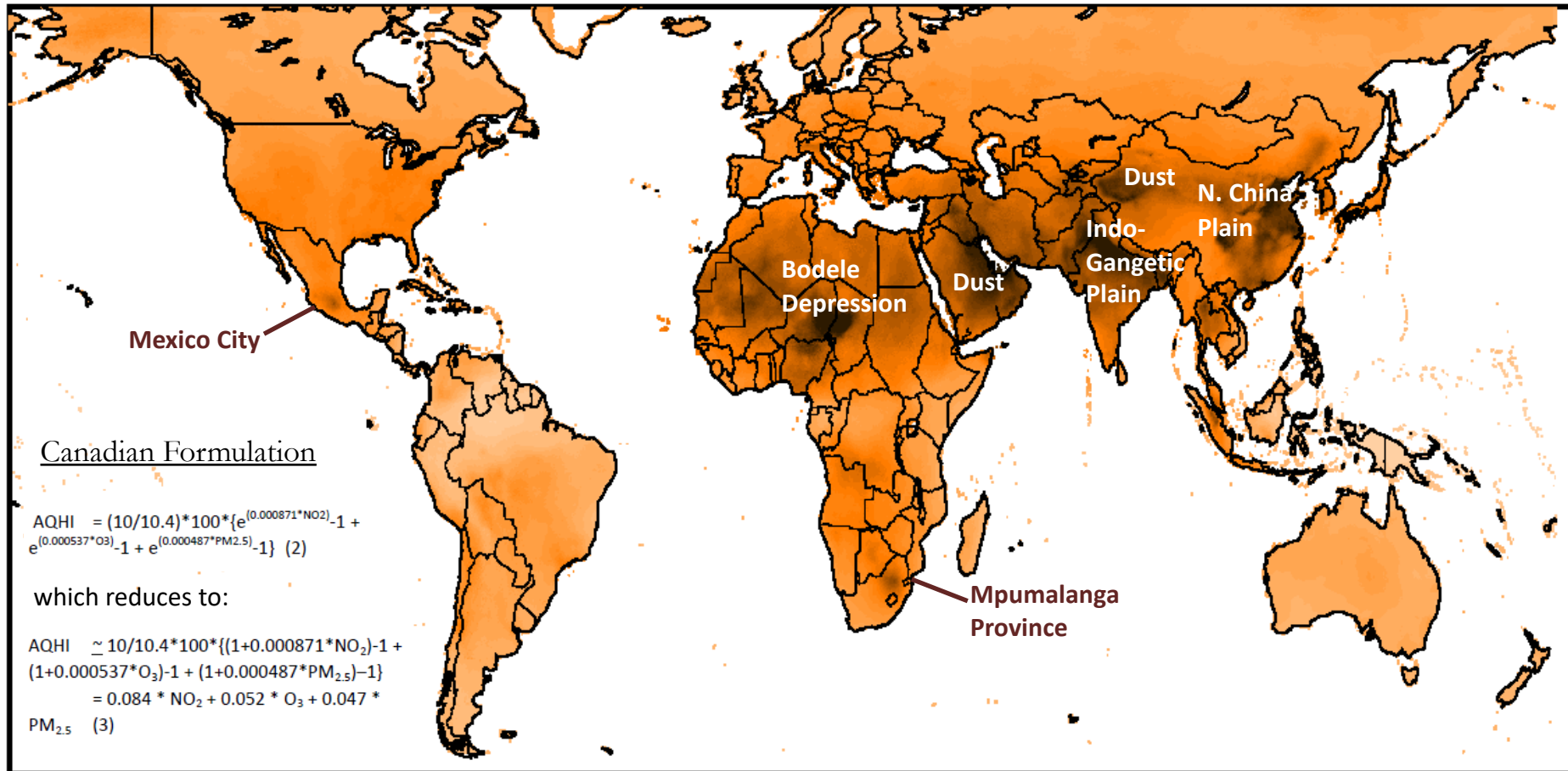


Aaron van Donkelaar & Randall Martin
Dalhousie University

Monthly/Annual HAQI for now with
goal of Near-Real Time in future.

Formulation of Health Air Quality Index (HAQI)

Historical HAQI



Low risk: 0-3
Medium risk: 3-6
High risk: >6

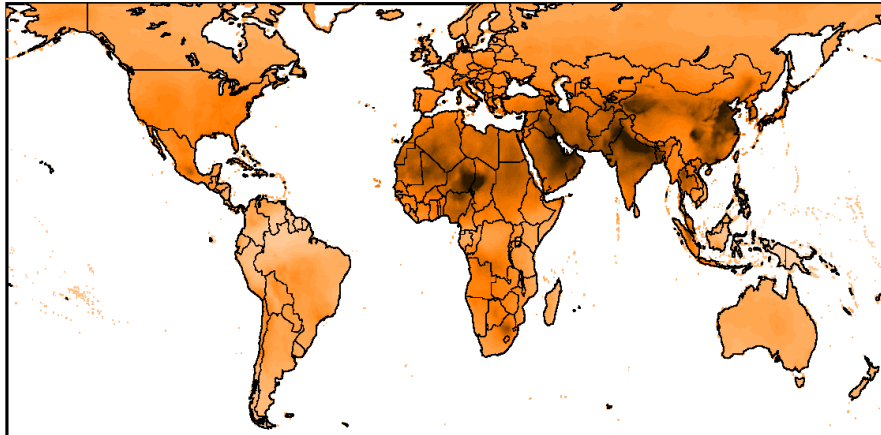
*Annual Mean & Based on **Canadian HAQI** formulation.

* $PM_{2.5}$, O_3 , & NO_2 correlated with morbidity and mortality.

Formulation of Health Air Quality Index (HAQI)

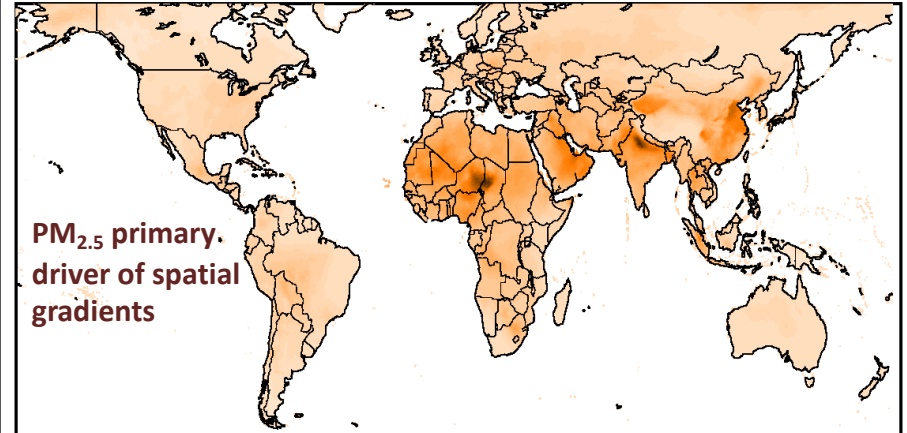
Breakdown of Individual Pollutant Contributions

AQHI ($\text{PM}_{2.5} + \text{O}_3 + \text{NO}_2$)



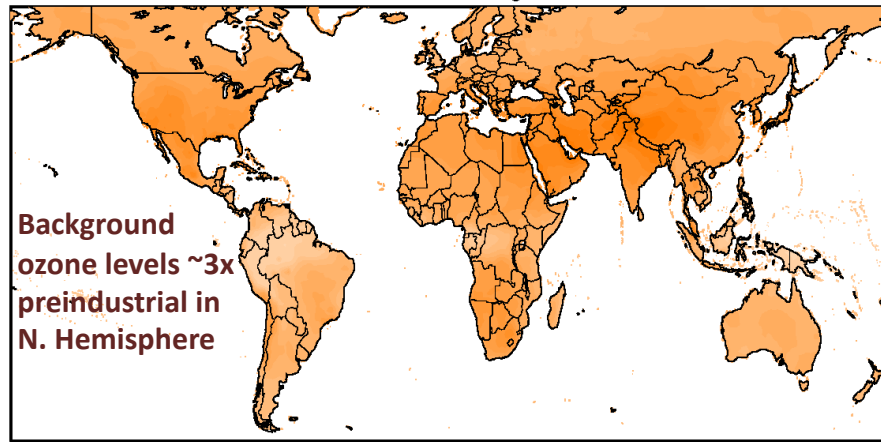
0.2 1.6 3.0 4.4 5.8

AQHI ($\text{PM}_{2.5}$)



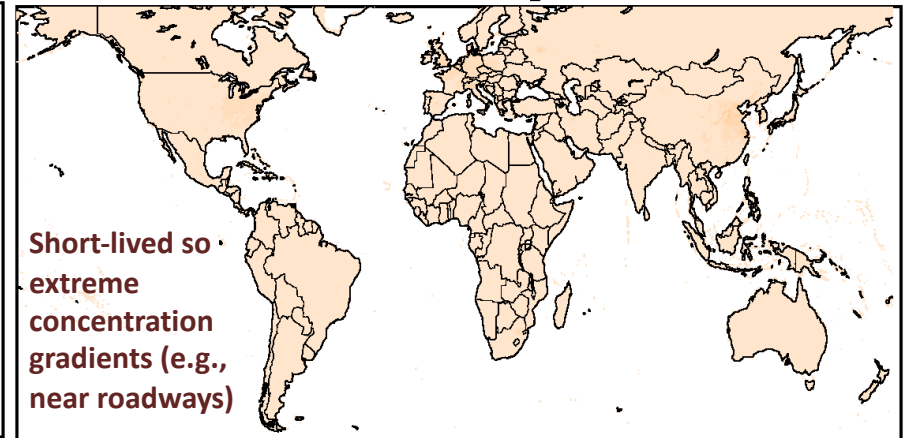
0.2 1.6 3.0 4.4 5.8

AQHI (O_3)



0.2 1.6 3.0 4.4 5.8

AQHI (NO_2)

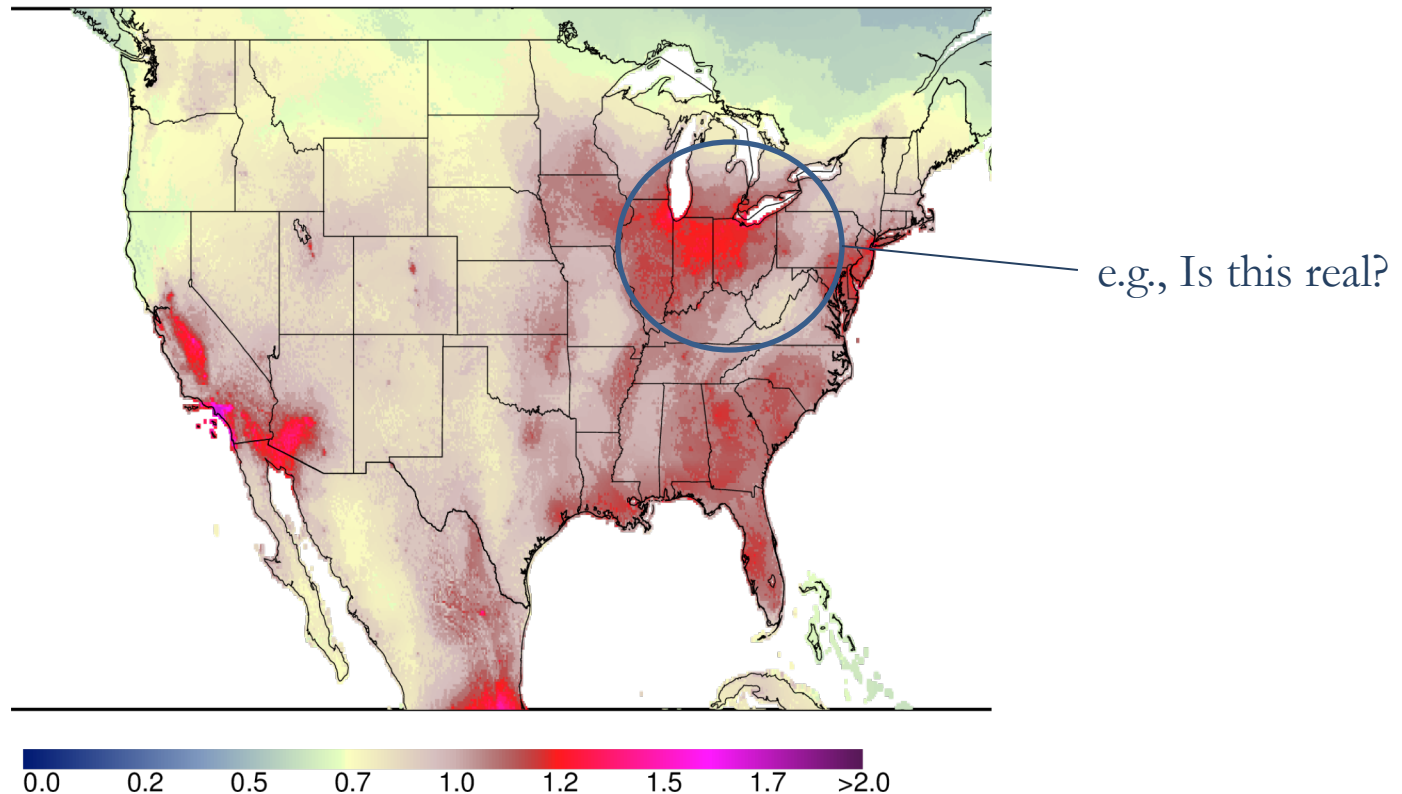


0.2 1.6 3.0 4.4 5.8

**** Day-to-day HAQI variations may tell a different story than an annual mean.**

Exploring Alternate Formulations of the HAQI

- Different formulations have varying sensitivities to inputs.
Which formulation to use? Are they valid for diverse regions?
- We need help inferring monthly PM from AOD!
Only have annual now.



NASA Goddard Air Quality & Health Showcase (Nov. 17th, 2016)

An Idea Emerges!

Meeting leads to UNICEF – NASA – NYU Partnership

UNICEF: Mark Anthony, Nick Rees, and Toby Wicks

NYU: Kevin Cromar

NASA: Steven Pawson (GMAO), Bryan Duncan

→ UNICEF wants AQ alert system to warn guardians of children with respiratory diseases (e.g., asthma)

- GMAO: augmenting their existing forecasts of PM, CO, & SO₂ to include O₃ & NO₂.
- UNICEF: Developing telephone app, website, etc. for distributing alerts.
- NYU: Developing HAQI formulations for specific childhood respiratory illnesses.
- NASA: Historical HAQI (context for forecasts) & validating forecasted HAQI.

Follow-up Meeting at UNICEF HQ, NYC (Jan. 23rd, 2017)

UNICEF: Toby Wicks + graphic designers/web developers

NYU: Kevin Cromar

NASA: Bryan Duncan

UNICEF wants August rollout!
Publicity Gala!

→ Refined plan of action.

NYU funding/deploying ~150 low-cost AQ monitors to be placed at UNICEF country HQs. Will use in multiple ways, including validating HAQI.

→ As an aside: Several UNICEF personnel expressed interest in using other NASA satellite datasets for a variety of applications.

NASA GMAO GEOS-5 Forecast Model

Example

Red dots = detected fires

**Excessive Exposure =
Seasonal Agricultural Burning
+ Air Pollution +
Air Stagnation**

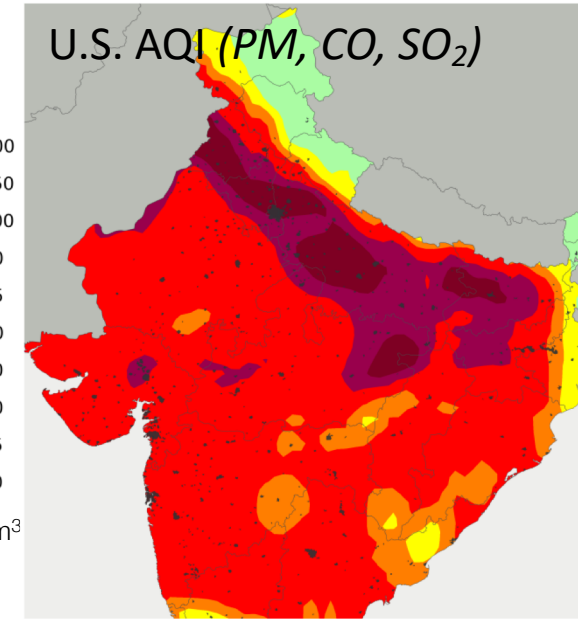
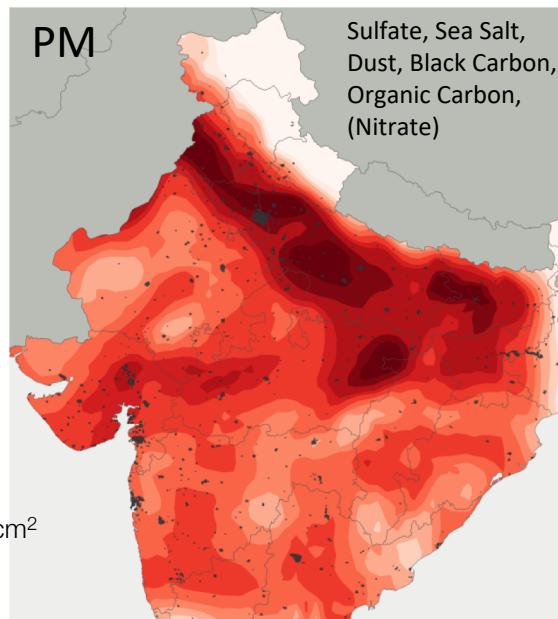
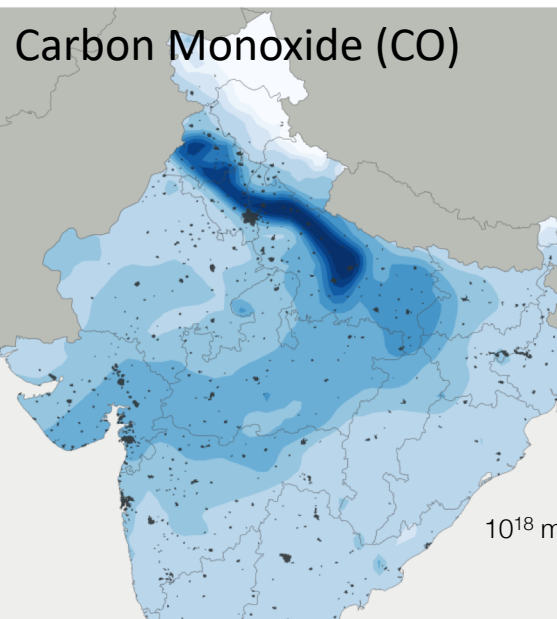
Provided by Anton Darmenov (NASA GMAO)

November 02, 2016

Forecast model output:
~12x12 km²

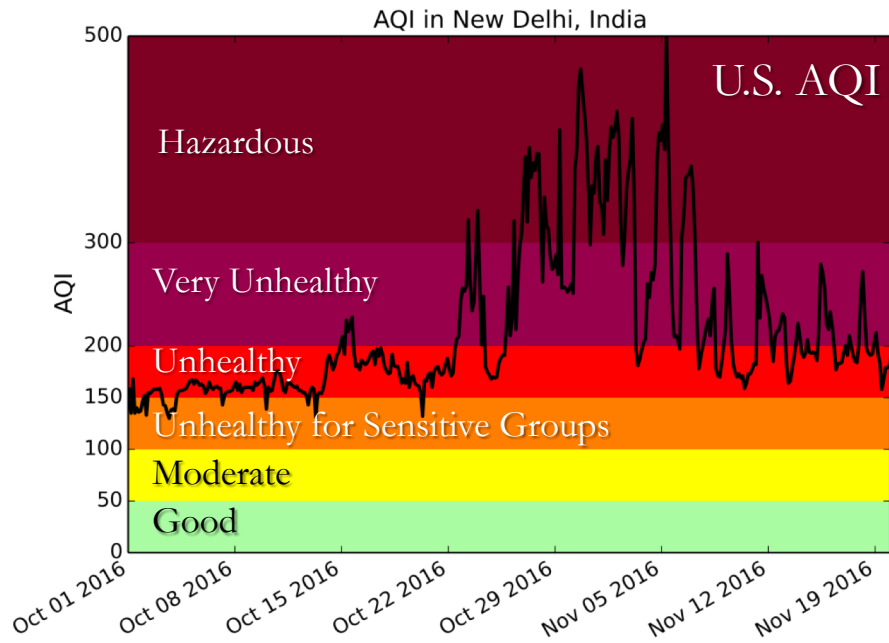
now: Carbon Monoxide (CO), PM_{2.5} (speciated) & Sulfur Dioxide (SO₂)

future: Ozone (O₃), Nitrogen Dioxide (NO₂)

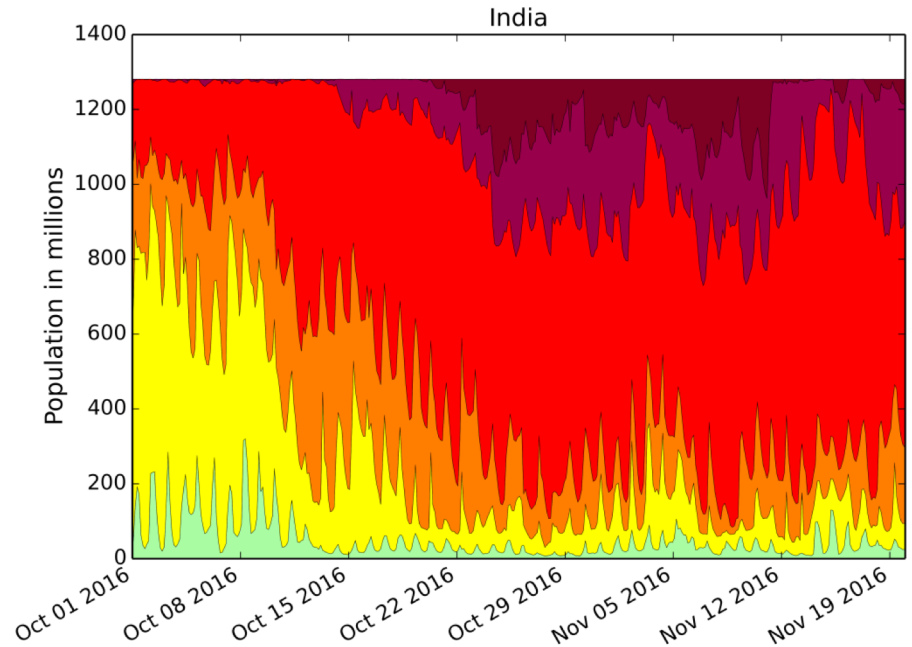


NASA GMAO GEOS-5 Forecast Model

Exposure in New Delhi



Population Exposure in India



Other Stuff

SatSummit (Jan. 31st, 2017 in DC): Lightning talk, entitled
“Satellite Data for Health & Air Quality Applications”

Upcoming American Thoracic Society Workshop (May 20th, 2017 in DC):
Co-organizer with Kevin Cromar (NYU)
“Air Pollution Monitoring for Health Research and Patient Care”
Goal: Bring together a range of experts to discuss ways to collect air pollution data
from personal monitors to satellites.

Aura Satellite Senior Review Proposal (due March 3rd):
In the last few years, Aura data (NO₂, AI, UV, HCHO) used for health
applications.

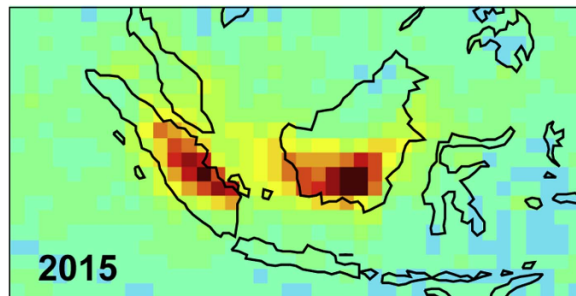
Application: Mitigation Strategy Development

Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure

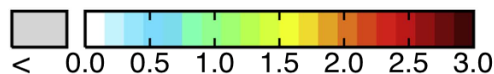
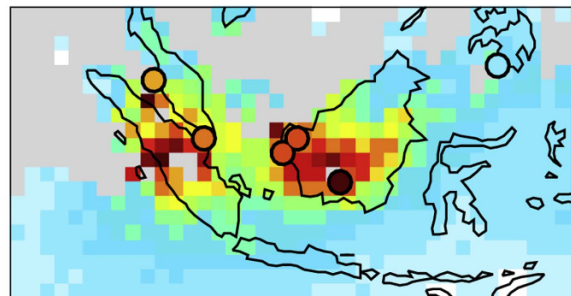
Shannon N Kopplitz^{1,9}, Loretta J Mickley², Miriam E Marlier³, Jonathan J Buonocore⁴, Patrick S Kim¹, Tianjia Liu⁵, Melissa P Sulprizio², Ruth S DeFries³, Daniel J Jacob^{1,2}, Joel Schwartz⁶, Montira Pongsiri⁷ and Samuel S Myers^{6,8}

- ~100,000 Excess Deaths
- Used satellite data for short and long-term mitigation strategy development

Aerosol Index



Aerosol Optical Depth



Kopplitz, S. N., et al., Public health impacts of the severe haze in Equatorial Asia in September–October 2015: Demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure, *Environ. Res. Lett.*, doi: 10.1088/17489326/11/9/094023, 2016.