Using Satellite Data in Air Pollution Health Effects Research

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Outline

- Benefits and challenges of using satellite data to study $PM_{2.5}$ health effects
- Examples of using satellite-based PM2.5 products in exposure assessment and epidemiology
- How can future satellite aerosol products benefit $PM_{2.5}$ health effects research?

Benefits of Using Satellite Data

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- Spatial coverage
  - Satellite data allow us to study people not covered by monitors, e.g., rural populations
- Temporal coverage
  - Satellite data allow us to use historical health data, e.g., cohorts established before ground monitoring
- Spatial and temporal resolution
  - Fill data gaps in space and time

Application example: MAIAC AOD

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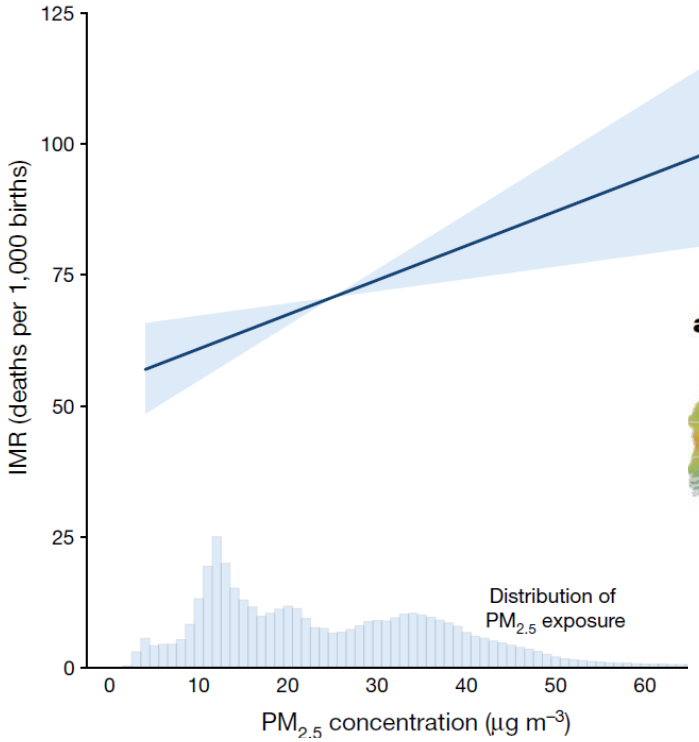
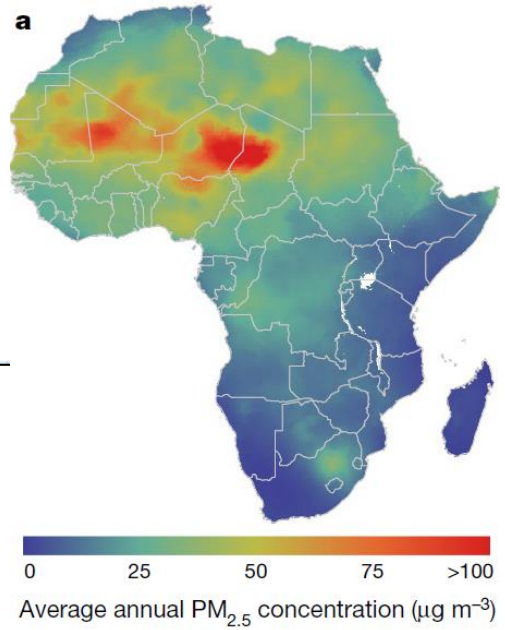
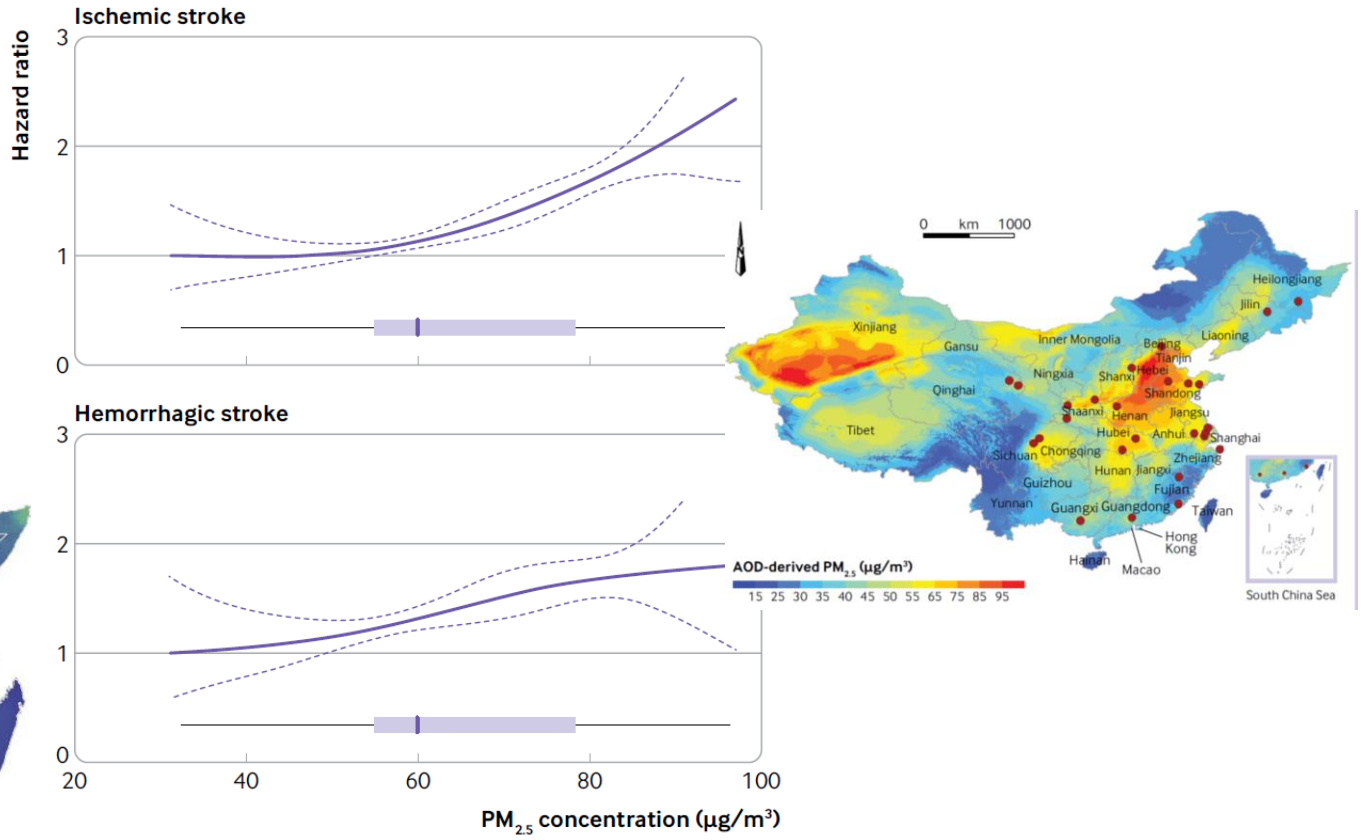
Long time series, global coverage, 1km resolution



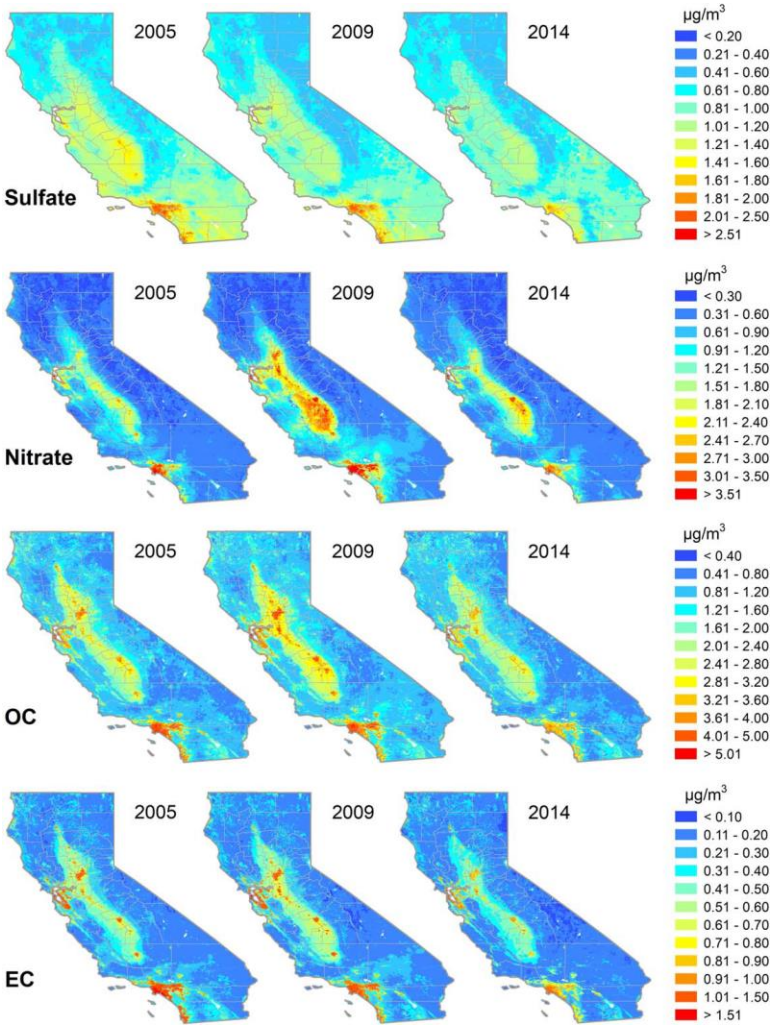
Heft-Neal et al. 2018





Huang et al. 2019

Application example - MISR aerosol product



Geng et al. 2019

Long time series, 4.4 km resolution, aerosol type information, poor temporal coverage.

		FEV_1			FVC		
Source	**Exposure**	**Estimate ***	**95% CI**	***p***	**Estimate ***	**95% CI**	***p***
Central site	$PM_{2.5}$	−41	(−161, 80)	0.521	−21	(−162, 119)	0.775
MISR-derived	$PM_{2.5}$	−131	(−232, −35)	**0.013**	−122	(−260, 25)	0.103
	SO_4^{2-}	−158	(−273, −43)	**0.008**	−175	(−310, −29)	**0.015**
	NO_3^-	−75	(−265, 124)	0.447	−212	(−391, −28)	**0.026**
	EC	−161	(−446, 128)	0.289	−218	(−547, 106)	0.206
	Dust	−177	(−306, −56)	**0.011**	−106	(−305, 95)	0.316

Effect estimates are the difference in FEV1 and FVC from the highest to the lowest concentration of each air pollutant in μg/m3

Chau et al. 2020

Challenges of Using Satellite Data

- All current satellite aerosol products need “translation” to air pollution levels using complex models for public health applications

- The impact of non-random missingness of exposure estimates due to missing satellite data on health effect estimates has not been well characterized

Gap-filling Techniques to Address AOD Missingness

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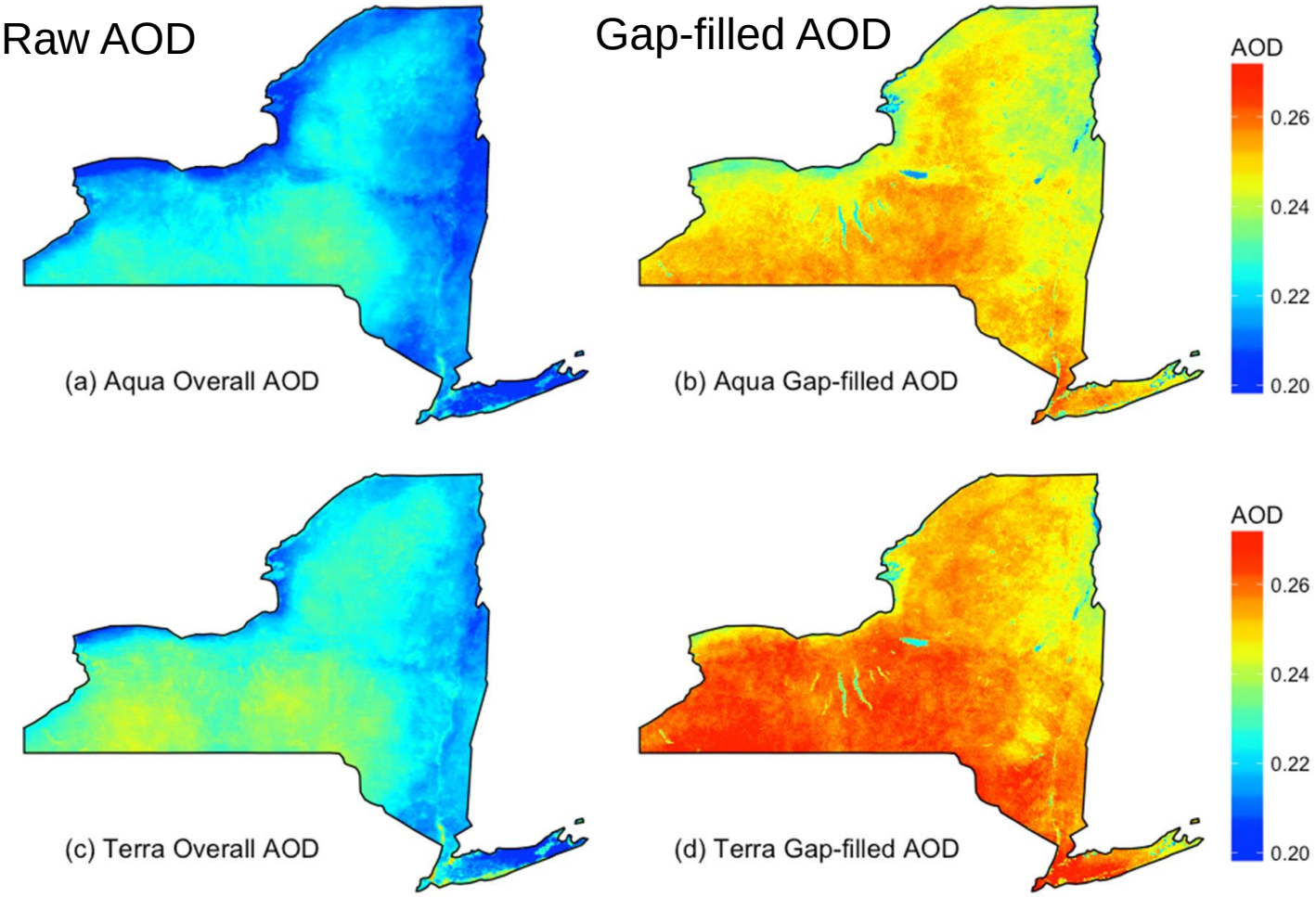
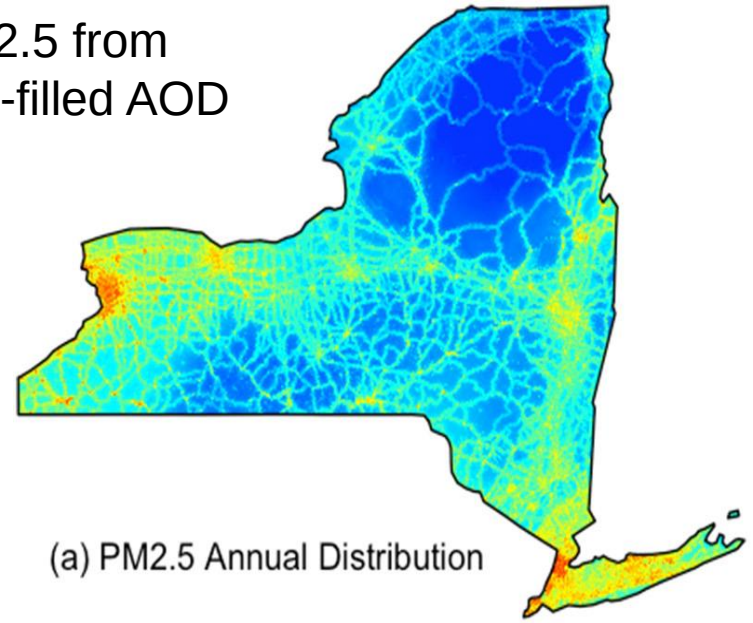
Raw AOD

Gap-filled AOD



PM2.5 from gap-filled AOD



Bi et al. 2019

Challenges of Using Satellite Data – Missing Data and Uncertainty

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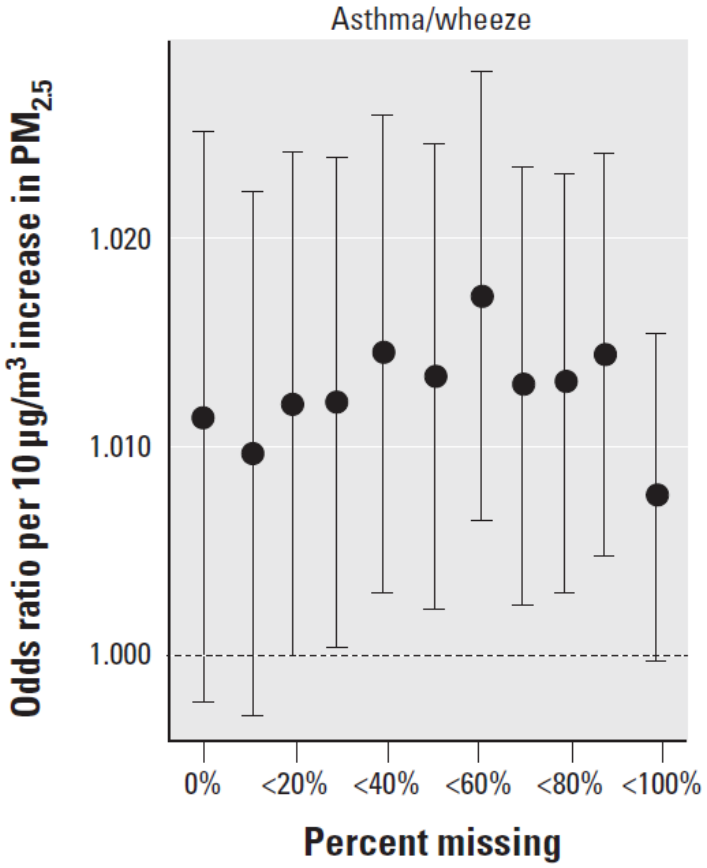

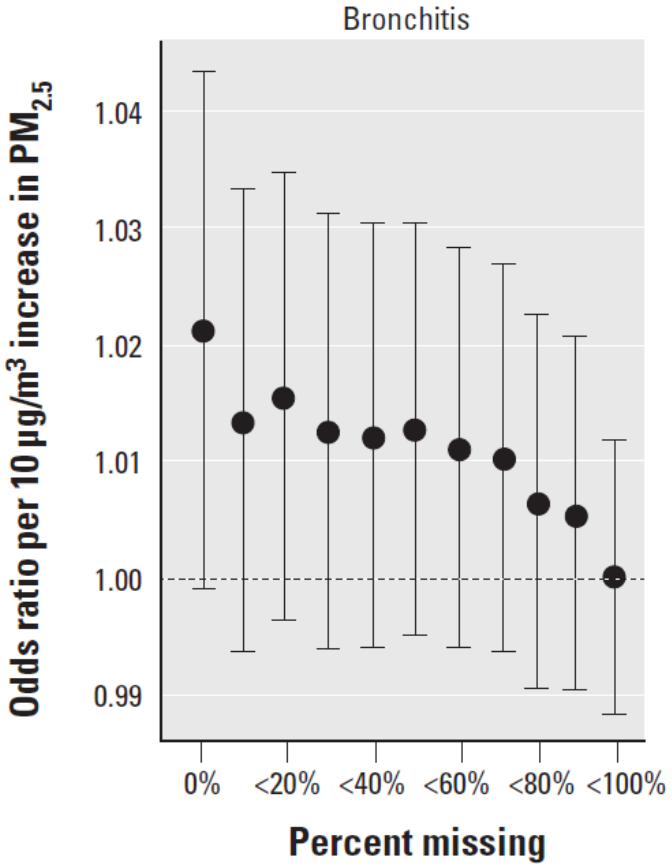

Exposure error caused by data missingness may or may not have strong impact on health effect estimates

Strickland et al. 2016

Desired New Satellite Data Products

- Particle type information is crucial to understand differential toxicity (e.g., different species, smoke vs. dust), but very sparse

- Aerosol vertical profiles alone are hard to use directly in health effects research, but can better constraint air quality models to provide gridded, ready-to-use air quality products