Quantifying health benefits of emission reduction over New York State using multiple $PM_{2.5}$ products

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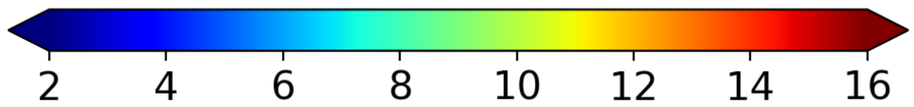
Which long-term (2002 to 2012) $PM_{2.5}$ products are available for health studies?

	Dataset	Spatial Resolution	Spatial Coverage	Temporal Resolution	In-situ	Remote Sensing	Model
1	**Global Geophysical Satellite-Based $PM_{2.5}$ (Dalhousie)**	0.01 ° x 0.01 °	Global	Annual/ 3-month running average	GBD annual ground-based PM2.5	MODIS, MISR and SeaWIFS AOD	GEOS-Chem (v9-01-03)
2	**Global Geophysical Satellite-Based $PM_{2.5}$ without GWR (Dalhousie_noGWR)**	0.1 ° x 0.1 °	Global	Annual	x	MODIS, MISR and SeaWIFS AOD	GEOS-Chem (v9-01-03)
3	**Statistical Satellite-Based $PM_{2.5}$ (Emory)**	1 km x 1 km	New York State	Daily	US EPA AQS	MAIAC AOD	x
4	**Fused Air Quality Surface using Downscaling (FAQSD)**	12 km x 12 km	USA	Daily	US EPA AQS	x	CMAQ (v4.7)
5	**CMAQ Simulation**	12 km x 12 km	USA	Daily	x	x	CMAQ (v4.7)
6	**Inverse Distance Weighed AQS $PM_{2.5}$ (IDW)**	12 km x 12 km	New York State	Daily	US EPA AQS	x	x
7	**AQS and Remote Sensing Merged $PM_{2.5}$ (CDC WONDER)**	County	USA	Daily	US EPA AQS	MODIS AOD	x

How do these $PM_{2.5}$ products differ?

	Dalhousie	Dalhousie_noGWR	Emory	FAQSD	CMAQ	AQS IDW
2002						
Population Weighted average (µg/m³)	14.0	13.2	12.7	13.3	17.4	10.9
2012						
Population Weighted average (µg/m³)	9.8	9.0	8.5	8.7	12.9	6.9
Relative Change	-30%	-32 %	-33%	-34 %	-25 %	-36%



- The annual population weighed average $PM_{2.5}$ over NYS vary by **6 µg/m³ (44%)**, but the decreasing trends are consistent across all products.

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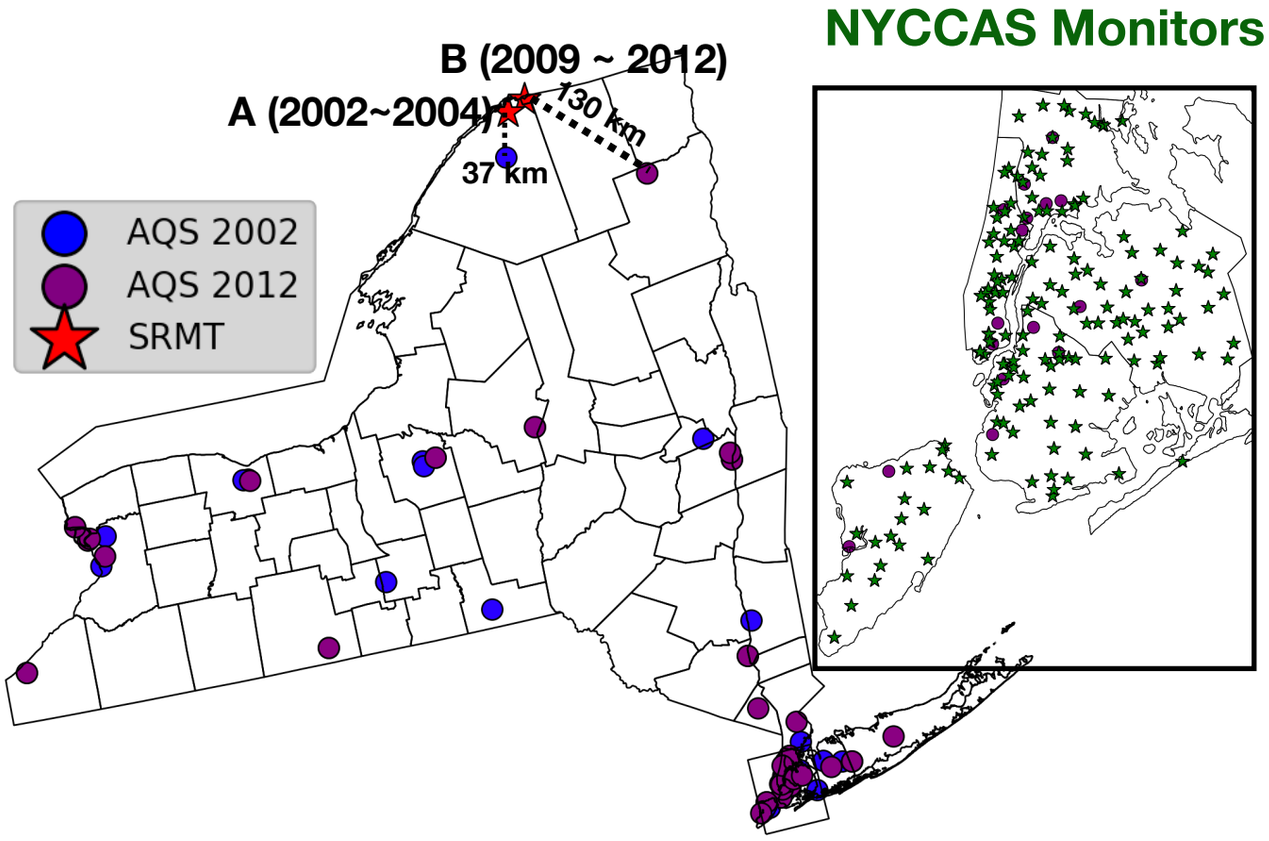
Which $PM_{2.5}$ product is the best?

Independent ground-based observations:

- **Urban Area:** NYC Community Air Quality Survey (NYCCAS) Program.
- **Remote Area:** St. Regis Mohawk Tribe (SRMT) Air Quality Program



Pearson Correlation Coefficient (R)

Dataset	NYC CAS		SRMT A (37 km)	SRMT B (130 km)
	Spatial	Temporal	Temporal	
Dalhousie (1km)	0.11	0.60	0.74	**0.58**
Emory (1km)	**0.65**	**0.94**	**0.87**	0.54
FAQSD (12 km)	0.59	0.92	0.69	0.35
CMAQ (12 km)	0.49	0.38	0.58	0.41
AQS IDW (12 km)	0.60	0.91	**0.90**	0.41

- **Emory** product performs best over areas **near** AQS monitors (< 40 km), but **Dalhousie** product performs best over areas **far** from AQS monitors (> 100 km).

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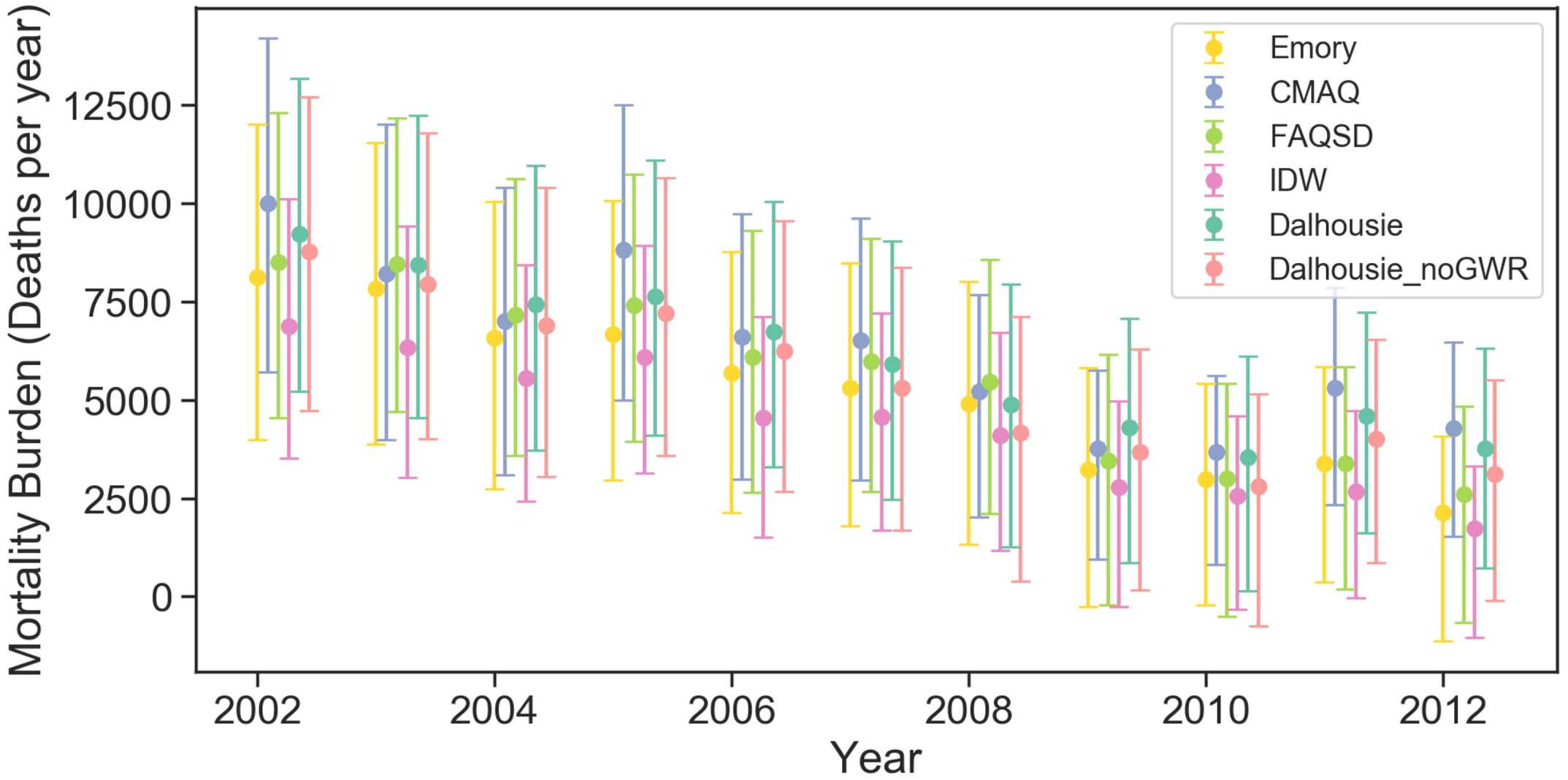
$PM_{2.5}$-related mortality burden over NYS decreased by 66% from 2002 to 2012

Mortality burden = Baseline Mortality × Attributable Fraction (annual $PM_{2.5}$) × Population

Baseline Mortality: County-level mortality rate from CDC WONDER
Attributable fraction (1- 1/RR): relative risk (RR) factors from the GBD 2010 study (Burnett et al., 2014)
Population: Gridded Population of the World (GPW, v4) data from SEDAC scaled by county population from CDC WONDER.



- Uncertainty in mortality burden due to choice of $PM_{2.5}$ products: **42%**
- Uncertainty of concentration-response functions (relative risk): **130%**

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Take-aways

- While $PM_{2.5}$ products differ in spatial patterns and the absolute levels, they show consistent decreasing trends (~ -30%) from 2002 to 2012.

- The statistical satellite-based $PM_{2.5}$ product (Emory) performs best over areas with nearby monitors, while the geophysical satellite-based product (Dalhousie) performs best over remote areas.

- We estimate **42%** uncertainty in mortality burden due to choice of $PM_{2.5}$ products, but such uncertainty is **much smaller** than the uncertainty in the relative risk factor (**130%**).

Thank you!