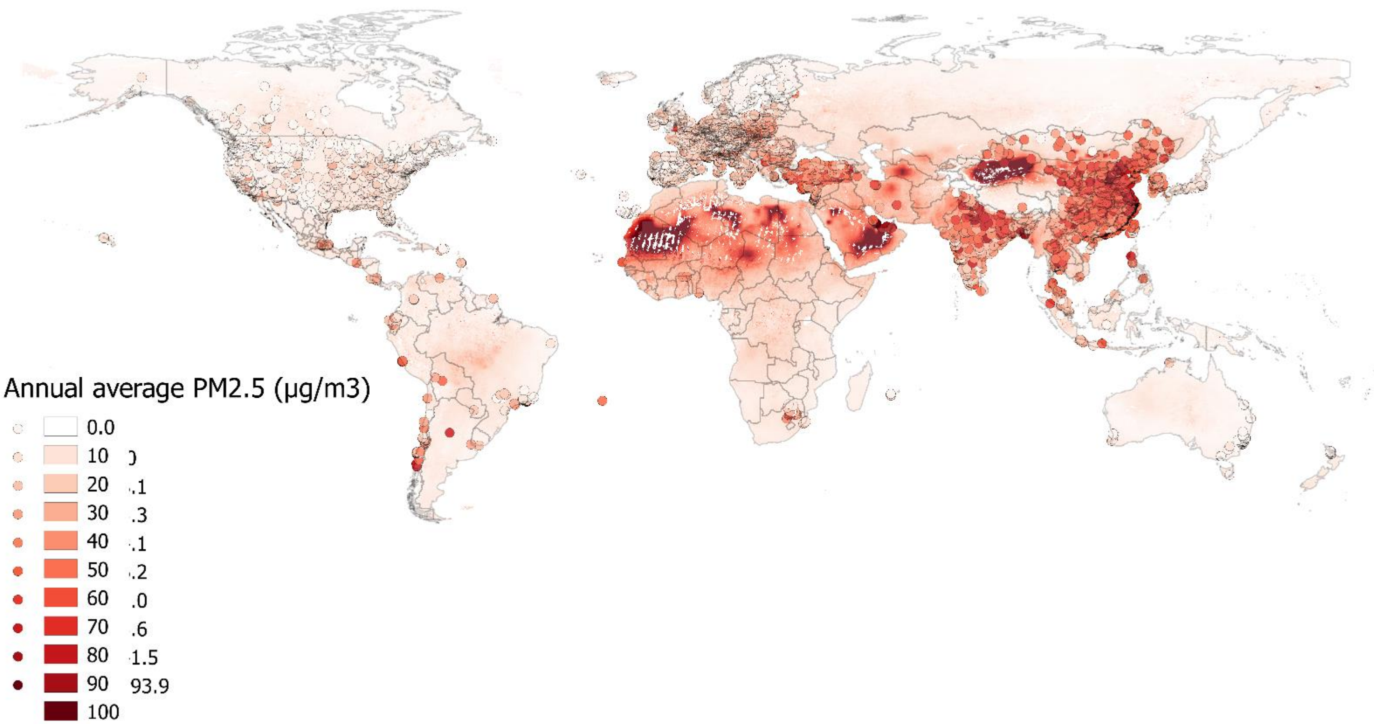
I Review of Evidence on Dust and Health

II Exposure assessment in the GBD 2013



Michael Brauer

IHME
Institute for Health Metrics and Evaluation

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THE UNIVERSITY OF BRITISH COLUMBIA

1st AFRICA/MIDDLE-EAST EXPERT MEETING AND WORKSHOP ON THE HEALTH IMPACT OF AIRBORNE DUST
AMMAN, JORDAN, 2-5 NOVEMBER 2015

Coarse PM

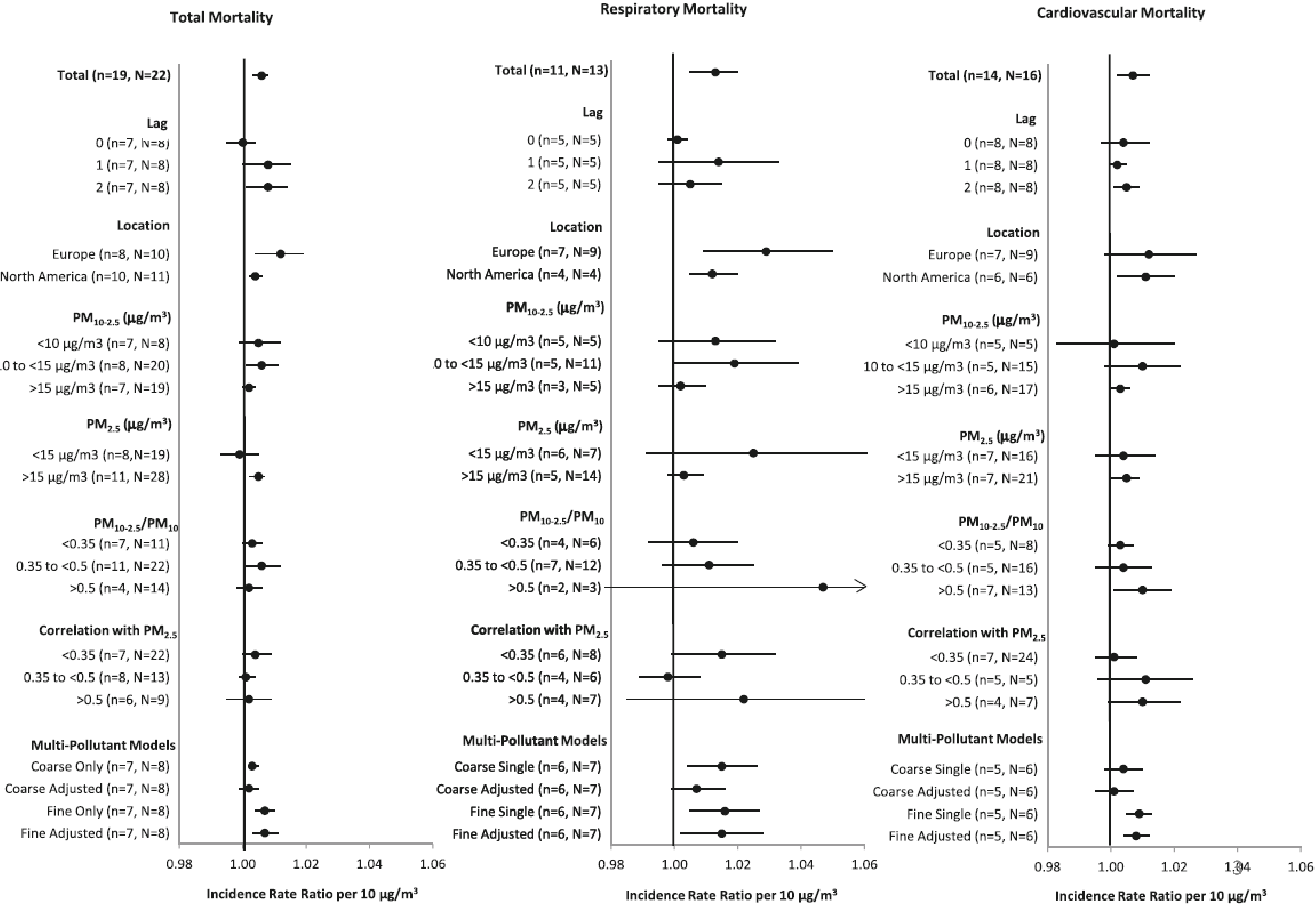
- "**suggestive evidence of a causal relationship between short-term exposure to coarse PM and cardiovascular and respiratory health effects and mortality**". "not sufficient evidence to draw conclusions on the health effects of long-term exposure to coarse PM". (EPA ISA, 2009)
- "…**short-term exposures to coarse particles (including crustal material) are associated with adverse respiratory and cardiovascular effects on health, including premature mortality**…hardly any long-term studies are available for coarse particles." (REVIHAAP*, 2013)

  "**toxicological studies report that coarse particles can be as toxic as $PM_{2.5}$ on a mass basis**. The difference in risk between coarse and fine PM can, at least partially, be explained by differences in intake and different biological mechanisms." (REVIHAAP, 2013)
- "**Suggestive evidence of increased morbidity and mortality in relation to higher short-term $PM_{10-2.5}$ concentrations**, with stronger relationships for respiratory than cardiovascular endpoints…. **While suggestive evidence was found of increased mortality with long-term $PM_{10-2.5}$ concentrations, these associations were not robust to control for $PM_{2.5}$."** (Adar et al., 2014)

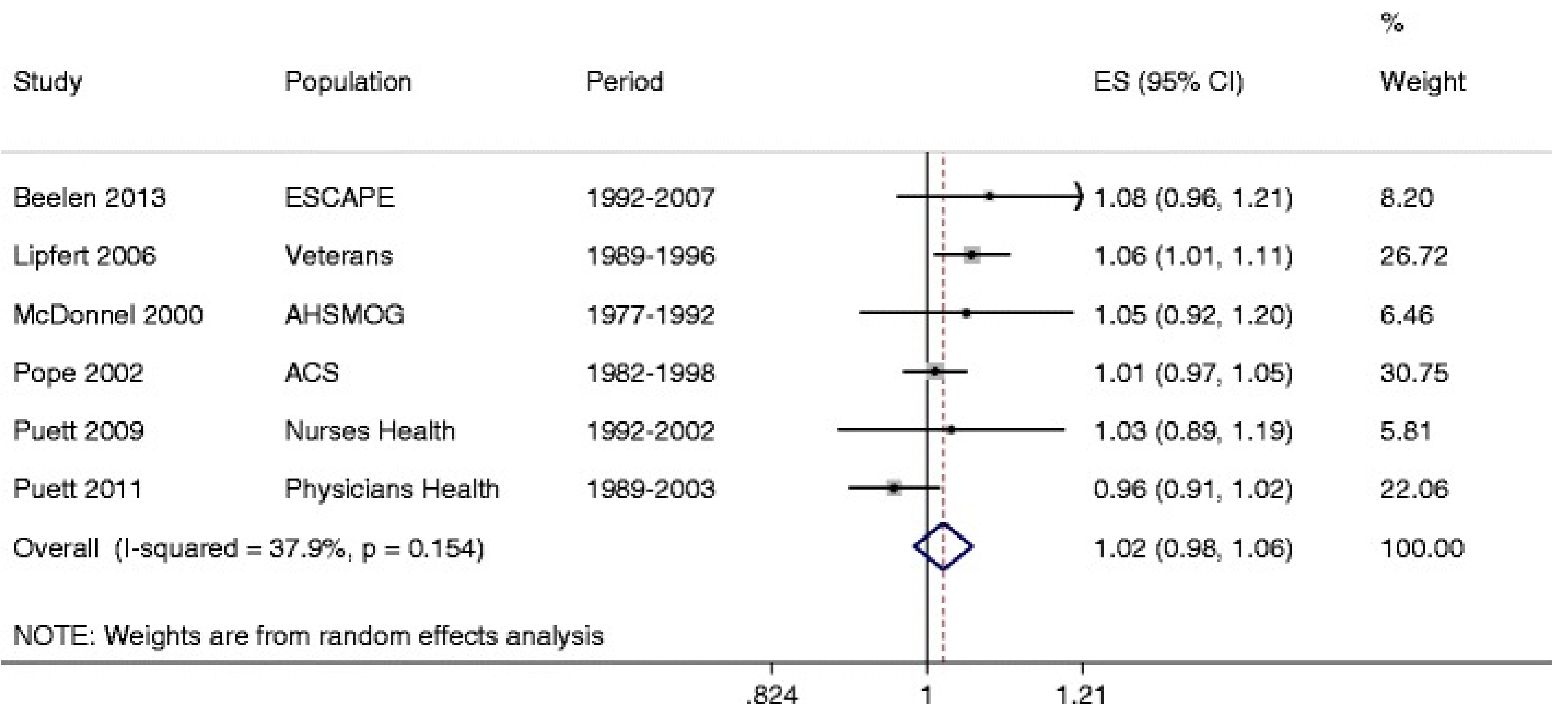
Adar SD, Filigrana PA, Clements N, Peel JL. Ambient Coarse Particulate Matter and Human Health: A Systematic Review and Meta-Analysis. Curr Environ Health Rep. 2014 Aug 8;1:258-274:

*Review of EVIdence on Health Aspects of Air Pollution, 2013

Coarse PM – Short Term Studies

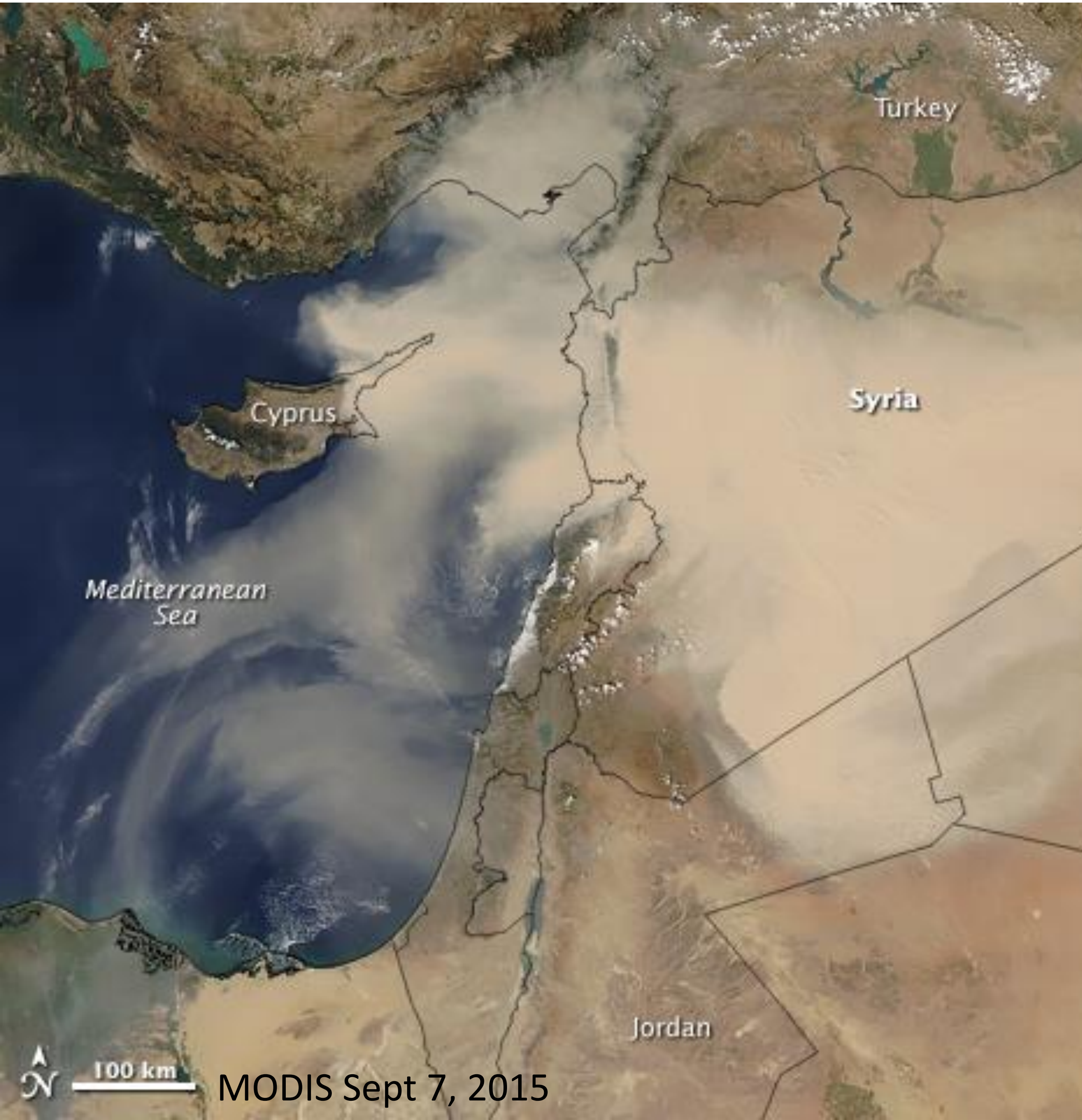


Coarse PM – Long Term Studies

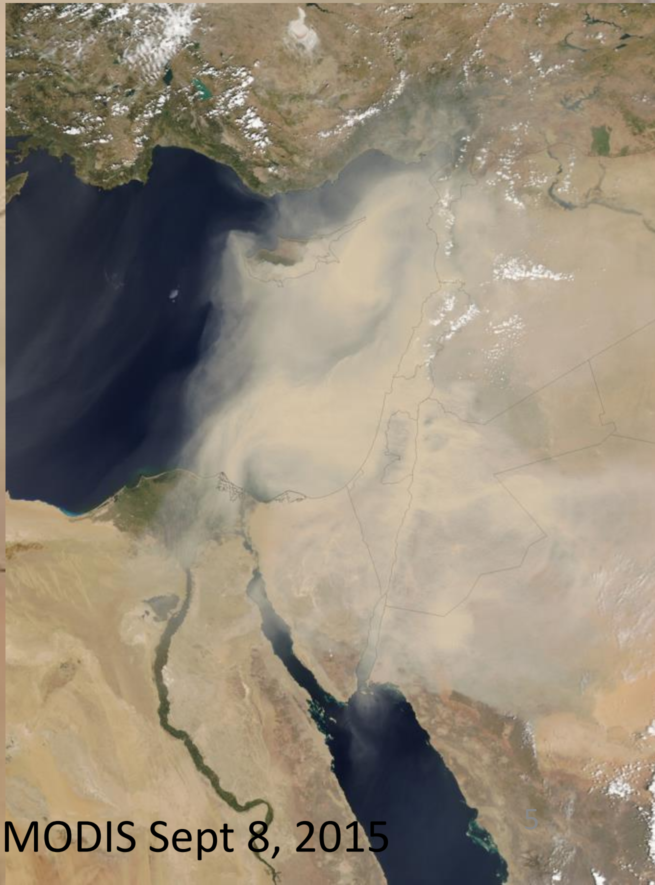


Adar SD, Filigrana PA, Clements N, Peel JL. [Ambient Coarse Particulate Matter and Human Health: A Systematic Review and Meta-Analysis.](#)
Curr Environ Health Rep. 2014 Aug 8;1:258-274

Windblown Mineral Dust



MODIS Sept 7, 2015



MODIS Sept 8, 2015

REVIHAAP – Desert Dust

- **Several studies report associations between short-term exposure to PM_{10} or $PM_{10\text{-}2.5}$ and mortality during desert dust episodes.**
- The results for cause-specific mortality have not been fully consistent for $PM_{10\text{-}2.5}$:
  - Taiwan: + cardiovascular (and natural); - respiratory
  - Rome: + cardiovascular; + respiratory.
- In most studies, **PM_{10} or $PM_{10\text{-}2.5}$ (but not $PM_{2.5}$) more strongly associated with mortality during desert dust episodes compared to other times**
- Only two studies evaluated desert dust days and admissions.
  - Hong Kong: increased COPD (but not pneumonia or influenza) hospitalization during desert dust days
  - Cyprus: increased CVD (but nor respiratory) hospitalization during desert dust days
- Evidence for an effect of desert dust on human health is increasing, but at the moment it is not clear whether crustal, anthropogenic, or biological components of dust are most strongly associated with the effects.

REVIHAAP, WHO 2013.

Saharan Dust effects in Europe (2011)

Reference	Location	Population	Outcome	Identification of Sahara dust days	PM fraction	Causes	% Risk per 10 μg/m^3 (95% CI) p-value	% Risk per 10 μg/m^3 IR% (95% CI)
							Sahara dust days	Non-Sahara dust days
Tobías et al. (2011a)	Madrid, Spain	All ages	Mortality	Back trajectoty analysis	$PM_{2.5}$	TotM	2.9 (−1.1, 6.9) 0.0812	2.6 (0.6, 4.6)
					$PM_{2.5-10}$	TotM	2.8 (0.1, 5.8) 0.016	0.6 (−1.1, 2.4)
Sajani et al. (2011)	Emilia–Romagna, Italy, Aug 2002–Dec 2006	All ages	Mortality	PM number concentrations, back-trajectory analysis	PM_{10}	TotM	0.0 (−3.5, 3.6) 0.55	0.8 (0.0–1.6)
						CVD	−0.8 (−5.9, 4.6) 0.61	0.3 (−0.9, 1.5)
						RESP	−0.2 (−10.8, 11.5) 0.69	1.6 (−0.9, 1.4)
Mallone et al. (2011)*	Rome, Italy, Feb 2001–Dec 2004	Age > 35	Mortality	Lidar observations, $PM_{10}/NO_2 > 0.6$	$PM_{2.5}$	TotM	2.5 (−0.9, 6.1) 0.31	0.7 (−0.9, 2.3)
						CAR	1.1 (−4.6, 7.2) 0.92	0.8 (−1.7, 3.4)
						CER	−2.5 (−9.1, 4.8) 0.51	−0.1 (−3.4, 3.4)
						CIRC	−0.7 (−5.5, 4.4) 0.53	0.9 (−1.3, 3.2)
						RESP	6.6 (−10.0, 27.0) 0.37	−1.7 (−9.9, 7.6)
					PM_{10}	TotM	3.0 (−0.0, 6.0) 0.91	2.8 (1.2, 4.4)
						CAR	8.9 (3.5, 14.5) 0.02	1.9 (−0.7, 4.6)
						CER	1.6 (−4.7, 8.4) 0.72	3.0 (−1.7, 7.9)
						CIRC	5.5 (0.9, 10.2) 0.13	1.7 (−0.6, 4.0)
						RESP	2.5 (−11.9,19.3) 0.80	4.6 (−2.6, 12.4)
					$PM_{2.5-10}$	TotM	1.1 (−0.6, 2.7) 0.50	1.7 (0.7, 2.7)
						CAR	4.9 (2.2, 7.8) 0.01	0.5 (−1.3, 2.2)
						CER	3.5 (0.6, 6.7) 0.53	2.3 (−0.1, 4.8)
						CIRC	4.0 (1.6, 6.5) 0.04	1.1 (−0.4, 2.7)
						RESP	9.8 (0.2, 21.3) 0.35	4.4 (−2.1, 11.7)
Samoli et al. (2011a)	Athens, Greece, 2001–2006	All ages	Mortality	Aerosol optical depth, back-trajectory analysis, $PM_{10\ remote}/PM_{10\ urban}$ > annual median	PM_{10}	TotM	−0.1 (−0.6, 0.4) $p<0.005$	1.0 (0.7, 1.4)
						CVD[a]	0.2 (−0.4, 0.9) $p<0.005$	1.4 (1.8, 2.9)
						RES[a]	0.2 (−0.5, 2.7) $p<0.005$	1.5 (0.3, 2.8)
Jiménez et al. (2010)	Madrid, Spain, Jan 2003–Dec 2005	Age > 75	Mortality	Events identified by the Spanish Ministry for the Environment and Rural & Marine Habitats	$PM_{2.5}$	TotM	No statistical significant effects	2.0 (1.0, 4.0)
					PM_{10}	CIRC	2.7 (1.4, 4.1) <0.05	3.0 (3.0, 4.0)
						RES	4.0 (1.7, 6.3) <0.05	3.0 (0.0, 6.0)
						TotM	3.5 (0.9, 6.1) <0.05	No statistical significant effects
						CIRC		
						RESP		
Pérez et al. (2008)	Barcelona, Spain, Mar. 2003–Dec. 2004	All ages	Mortality	Back-trajectory analysis, $PM_{10\ remote} \geq 0.5 \times PM_{10\ urban}$	$PM_{2.5}$	TotM	5.0 (0.5, 9.7) 0.56	3.5 (1.6, 5.5)
					$PM_{2.5-10}$	TotM	8.4 (1.5, 15.8) 0.05	1.4 (0.8, 3.4)
Middleton et al. (2008)	Nicosia, Cyprus, Jan 1995–Dec 2003	All ages	Morbidity	Meteorological observations (visibility), PM_{10} criteria ($PM_{10} \geq 100$ μg/m^3)	PM_{10}	MORD	4.8 (0.7, 9.0) NA	5.5 (3.5, 7.6) for the highest PM_{10} levels observed
						CVD-MORD	10.4 (−4.7, 27.9) NA	6.3 (0.0, 15.0) for the highest PM_{10} levels observed
Samoli et al. (2011b)	Athens, Greece, 2001–2004	Age: 0–14	Morbidity	Same as Samoli et al. (2011b)	PM_{10}	PAA	4.1 (0.1, 8.3) 0.41	2.1 (−1.0, 5.2)
Tobías et al. (2011b)	Barcelona, Spain	All ages	Morbidity	NA	NA	MENG	39.2 (15.2, 68.1) <0.05	NA
Dadvand et al. (2011)	Barcelona, Spain, 2003–2005		Pregnancy	PM_{10}, NO_2 trends, back-trajectory analysis	PM_{10}	BW[b]	−2.1 (−5.8, 1.7) 0.28	NA
						GAD[b]	0.5 (0.4, 0.6) <0.01	NA

Karanasiou et al. Health effects from Sahara dust episodes in Europe: Literature review and research gaps. Environment International 47 (2012) 107–114. doi:10.1016/j.envint.2012.06.012

Saharan dust effects in Europe (2011)

- 9 studies (4 with estimates for $PM_{2.5}$)
- Diverse approaches to characterize dust events; different covariate adjustments
- Saharan (north/west vs south/central) origin
- Morbidity: Increased hospitalization on dust vs non-dust days
- Mortality: Inconsistent (especially PM_{10}, $PM_{10-2.5}$) but some evidence of slightly elevated risks on dust vs non-dust days

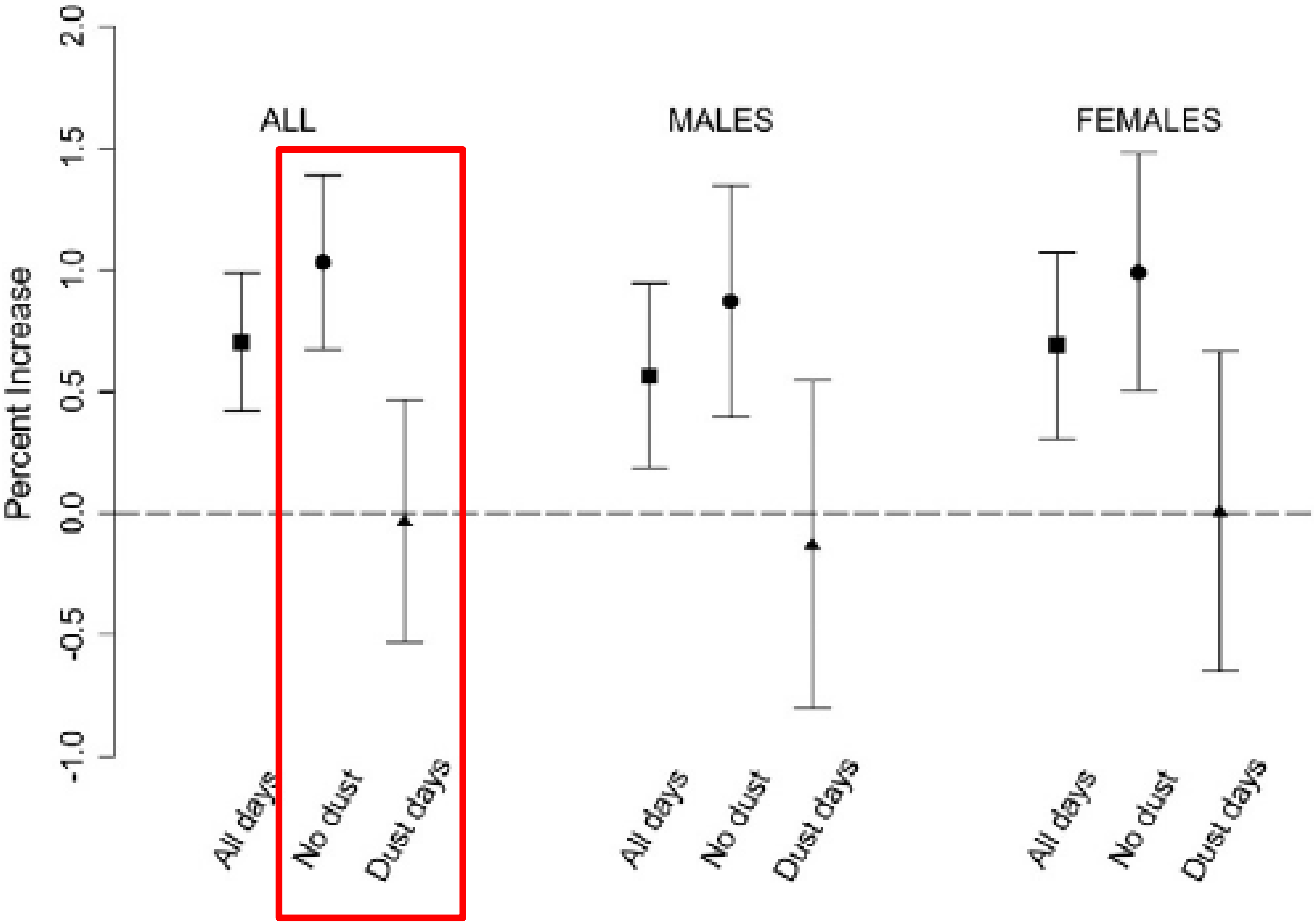
Karanasiou et al. Health effects from Sahara dust episodes in Europe: Literature review and research gaps. Environment International 47 (2012) 107–114. doi:10.1016/j.envint.2012.06.012

Athens - Mortality

Dust days (N=141; 2001-2006):

- Back-trajectories (Sahara/Arabian peninsula)
- High regional PM
- High AOD
- Median PM_{10}: 47 µg/m^3

Non-dust days (N=2050)
Median PM_{10}: 39 µg/m^3



Samoli et al. Does the presence of desert dust modify the effect of PM10 on mortality in Athens, Greece. Science of the Total Environment. 2011. 409:2049–2054. doi:10.1016/j.scitotenv.2011.02.031

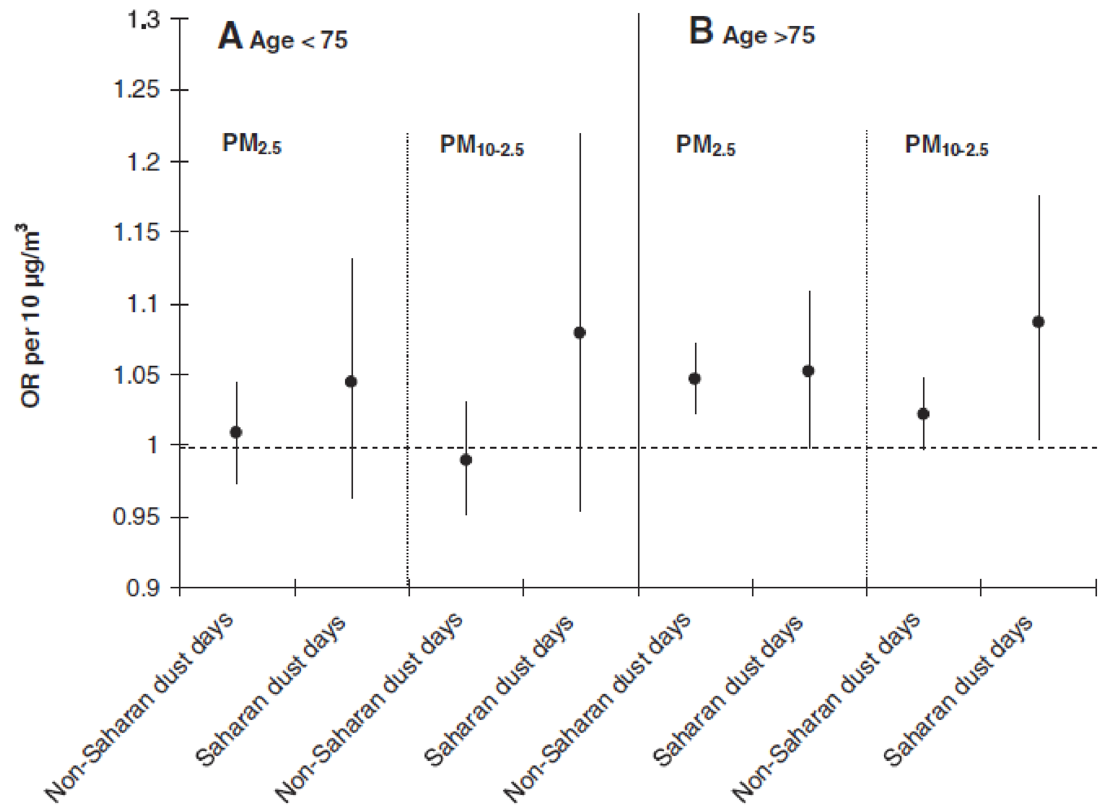
Barcelona - Mortality

Dust days (N=90; 2001-2006):

- Back-trajectories
- Satellite images
- High regional PM
- Median $PM_{2.5}$: 29 μg/m^3
- Median $PM_{10-2.5}$: 14.8 μg/m^3

Non-dust days (N=512)
Median $PM_{2.5}$: 21 μg/m^3
Median $PM_{10-2.5}$: 12.6

	$PM_{2.5}$	$PM_{10-2.5}$
Non dust days	1.035 (1.016 -1.055)	1.013 (0.992, 1.034)
Dust days	1.05 (1.005, 1.097)	1.084 (1.015, 1.158)



Perez et al. Coarse Particles From Saharan Dust and Daily Mortality. *Epidemiology* 2008;19: 800–807. doi:10.1097/EDE.0b013e31818131cf

Rome - Mortality

Dust days identified by LIDAR, CTM, PM_{10}:NO_2 ratio

Dust days (no dust): Median PM_{10}=44 (35) µg/m³. $PM_{2.5}$ = 24 (21). $PM_{2.5–10}$ = 18 (14)

Cause of death	$PM_{2.5}$ (IQR = 12.8 µg/m³) IR% (95% CI)	*p*-Value	$PM_{2.5–10}$ (IQR = 10.8 µg/m³) IR% (95% CI)	*p*-Value	PM_{10} (IQR = 19.8 µg/m³) IR% (95% CI)	*p*-Value
Natural causes (lag 0–2) (ICD-9 codes 1–799)	1.24 (–0.65 to 3.17)		2.96 (1.23 to 4.72)		3.04 (1.53 to 4.56)	
Dust free	0.91 (–1.09 to 2.94)	—	3.33 (1.29 to 5.40)	—	3.01 (1.29 to 4.75)	—
Dust affected	3.22 (–1.13 to 7.75)	0.316	2.07 (–1.07 to 5.31)	0.502	3.20 (–0.04 to 6.55)	0.914
Cardiac diseases (lag 0–2) (ICD-9 codes 390–429)	1.38 (–1.68 to 4.55)		3.72 (0.78 to 6.73)		4.04 (1.49 to 6.65)	
Dust free	0.97 (–2.24 to 4.29)	—	0.86 (–2.47 to 4.31)	—	2.09 (–0.76 to 5.02)	—
Dust affected	1.37 (–5.92 to 9.21)	0.920	9.73 (4.25 to 15.49)	0.005	9.55 (3.81 to 15.61)	0.019
Cerebrovascular diseases (lag 0) (ICD-9 codes 430–438)	–0.32 (–4.26 to 3.78)		5.41 (1.74 to 9.22)		2.64 (–1.26 to 6.68)	
Dust free	–0.07 (–4.29 to 4.33)	—	4.58 (–0.18 to 9.58)	—	3.24 (–1.78 to 8.51)	—
Dust affected	–3.22 (–11.72 to 6.10)	0.514	7.03 (1.22 to 13.18)	0.526	1.71 (–5.05 to 8.95)	0.720
Diseases of the circulatory system (lag 0–2) (ICD-9 codes 390–459)	1.23 (–1.42 to 3.95)		4.06 (1.50 to 6.69)		2.99 (0.82 to 5.19)	
Dust free	1.19 (–1.60 to 4.05)	—	2.21 (–0.74 to 5.25)	—	1.82 (–0.61 to 4.32)	—
Dust affected	–0.91 (–7.04 to 5.62)	0.531	7.93 (3.20 to 12.88)	0.039	5.91 (1.02 to 11.03)	0.134
Diseases of the respiratory system (lag 0–5) (ICD-9 codes 460–519)	0.25 (–9.90 to 11.54)		12.65 (1.18 to 25.42)		4.97 (–2.18 to 12.63)	
Dust free	–2.17 (–12.72 to 9.66)	—	8.67 (–4.14 to 23.19	—	5.00 (–2.80 to 13.43)	—
Dust affected	8.38 (–12.66 to 34.49	0.368	19.43 (0.34 to 42.15)	0.349	2.66 (–12.78 to 20.83)	0.798

Mallone et al. Saharan dust and associations between particulate matter and daily mortality in Rome, Italy. Environ Health Perspect. 2011 Oct;119(10):1409-14. doi: 10.12989/ehp.1003026.

Israel - Asthma

- Dust storm day: PM_{10} > 2SD above background
  - Verified by review of synoptic meteorology
    - Non-dust days (N=2126), mean PM_{10}=38
    - Dust storm days (> 71 μg/m^3, N=289), mean PM_{10}=170
    - Moderate/Severe days: > 200 μg/m^3, N=58)

Asthma reliever medication dispensation	Mild dust storms#	p-value	Moderate-to-severe dust storms¶	p-value
All available data				
Dust storm day	1.05 (1.00–1.10)	0.029	0.94 (0.86–1.02)	0.162
1 day after the dust storm	1.00 (0.96–1.05)	0.678	0.94 (0.87–1.02)	0.201
2 days after the dust storm	1.00 (0.96–1.05)	0.713	0.96 (0.88–1.04)	0.344
3 days after the dust storm	1.04 (1.00–1.09)	0.035	0.92 (0.85–0.99)	0.041

Asthma hospitalization	Mild dust storm#	p-value	Moderate-to-severe dust storm¶	p-value
All available data				
Dust storm day	1.10 (0.97–1.25)	0.145	1.01 (0.80–1.28)	0.889
1 day after the dust storm	1.15 (1.02–1.30)	0.021	0.88 (0.69–1.13)	0.338

Yitshak-Sade et al. Non-anthropogenic dust exposure and asthma medication purchase in children. Eur Respir J 2015; 45: 652–660. DOI: 10.1183/09031936.00078614

Kuwait – Asthma hospitalization

- 569 dust storm days (PM_{10} > 200 μg/m^3)
- 39 very severe dust storm days (PM_{10} > 1000 μg/m^3)
- Asthma (lag 0): RR = 1.07 (1.02–1.12)
- Respiratory (lag 0): RR = 1.06 (1.04–1.08)

Thalib et al. **Dust storms and the risk of asthma admissions to hospitals in Kuwait.** Sci Total Environ. 2012 Sep 1;433:347-51. doi: 10.1016/j.scitotenv.2012.06.082.

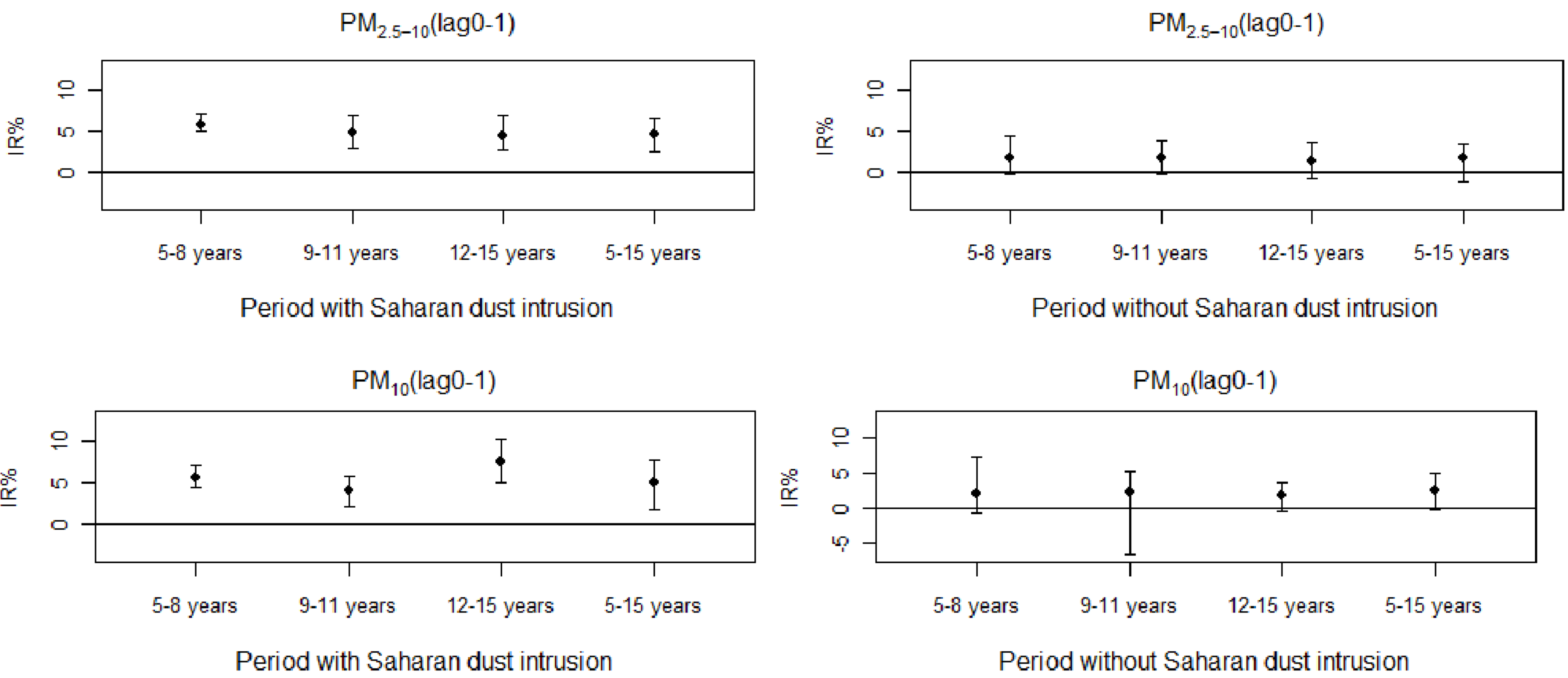
Caribbean - Asthma

Dust days (N=52; Satellite images. 2001-2006)

- Median $PM_{2.5}$: 13 µg/m^3
- Median $PM_{10\text{-}2.5}$: 32 µg/m^3

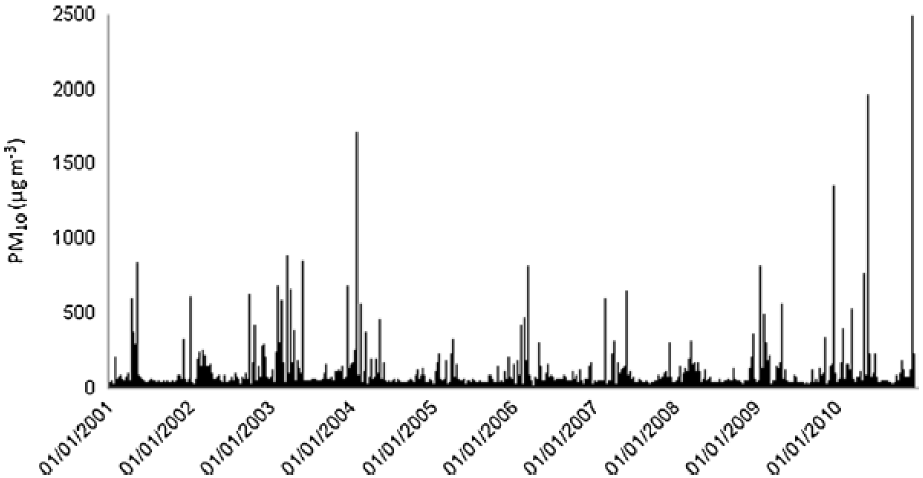
Non-dust days (N=285)

- Median $PM_{2.5}$: 9 µg/m^3
- Median $PM_{10\text{-}2.5}$: 10 µg/m^3



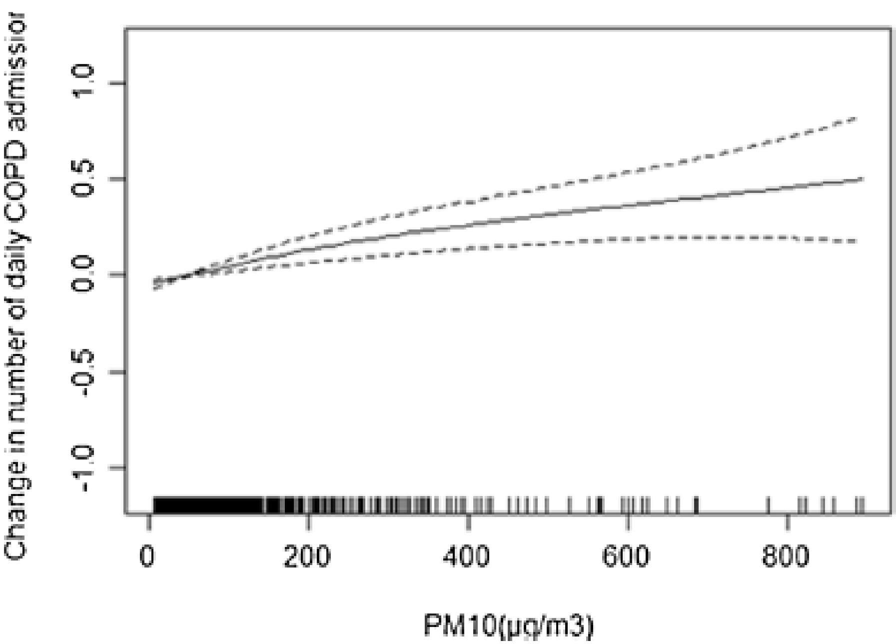
Cadelis et al. Short-Term Effects of the Particulate Pollutants Contained in Saharan Dust on the Visits of Children to the Emergency Department due to Asthmatic Conditions in Guadeloupe. PLoS ONE 2014. 9(3): e91136. doi:10.1371/journal.pone.0091136

Israel – COPD Hospitalization



Dust storm days: 1.16 (1.08 -1.24)

- **Mild days : 1.12 (1.03–1.21)**
- **Severe days: 1.27 (1.12–1.43)**



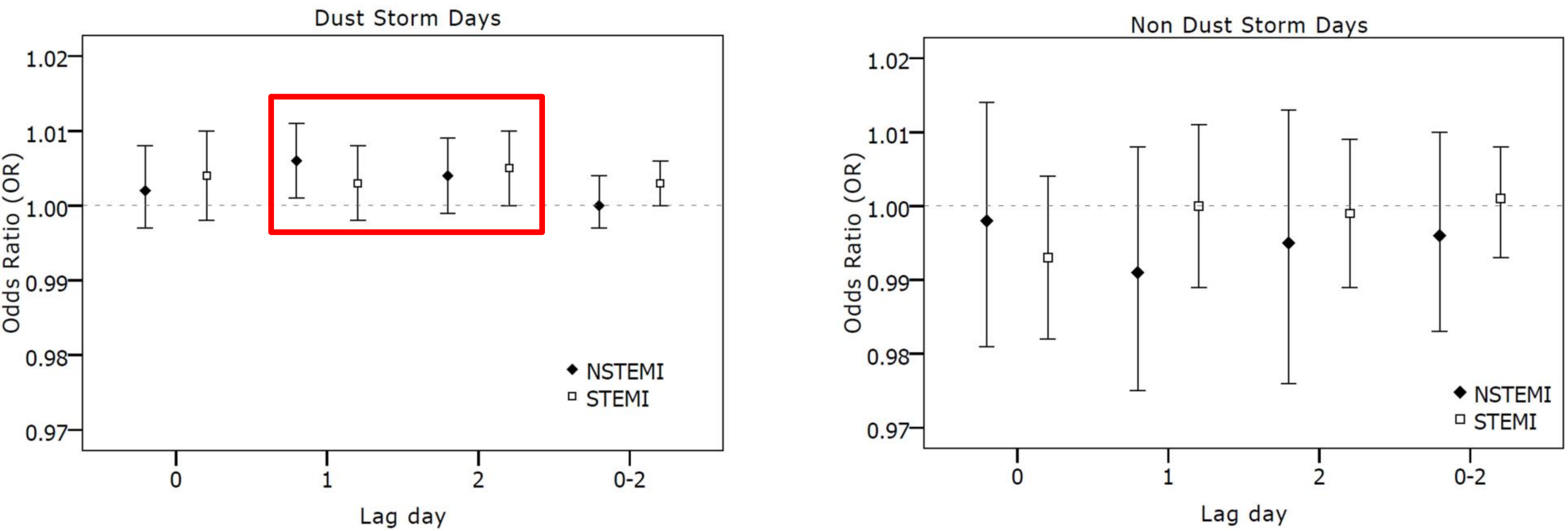
Subgroup analysis within age and gender groups	IRR of a dust storm[a]	95 % confidence interval for IRR		p value
		Lower	Upper	
Age				
Age <50	1.011	0.751	1.360	0.940
Age 50–70	1.110	1.008	1.222	0.032
Age >70	1.167	1.059	1.285	0.002
Gender				
Male	1.053	0.963	1.151	0.251
Female	1.278	1.148	1.427	<0.001

Vodonos et al. The impact of desert dust exposures on hospitalizations due to exacerbation of chronic obstructive pulmonary disease. Air Qual Atmos Health (2014) 7:433–439. DOI 10.1007/s11869-014-0253-z

Israel – Acute Coronary Hospitalization

Dust storm days: 1.05 (1.00–1.10)

- Increased OR for older women, Bedouin



Vodonos et al. Individual Effect Modifiers of Dust Exposure Effect on Cardiovascular Morbidity. PLoS ONE. 2015.10(9): e0137714.
DOI:10.1371/journal.pone.0137714

Taiwan – Acute MI Hospitalization

Dust days (N=46, 2000-2009)

- High regional PM and $PM_{10-2.5}$
- Mean duration 2.89 days

	Number of daily AMI admissions											
	<45			45–64			65–74			>74		
	B	SE	p value	B	SE	p value	B	SE	p value	B	SE	p value
Intercept	1.8333	0.432	0.000***	9.6809	1.091	0.000***	10.9600	0.980	0.000***	7.6033	1.179	0.000***
Trend	0.0003	0.000	0.000***	0.0019	0.000	0.000***	0.0004	0.000	0.000***	0.0029	0.000	0.000***
Temperature	0.0005	0.010	0.957	−0.0223	0.025	0.380	−0.0994	0.023	0.000***	−0.1159	0.027	0.000***
CO	0.2761	0.454	0.544	−0.6921	1.153	0.548	−0.4351	1.036	0.674	0.0310	1.258	0.980
NO_2	0.0012	0.015	0.936	0.0204	0.038	0.594	0.0422	0.034	0.219	0.1064	0.042	0.011*
Time since dust storm												
Day of dust storm	0.1206	0.149	0.419	−0.2248	0.374	0.548	−0.1962	0.336	0.559	0.0868	0.397	0.827
Postdust day 1	0.1845	0.236	0.434	0.2634	0.578	0.649	0.2090	0.518	0.687	0.7300	0.589	0.216
Postdust day 2	−0.0370	0.259	0.887	−0.6158	0.634	0.331	0.2141	0.568	0.707	0.2642	0.644	0.682
Postdust day 3	−0.0380	0.263	0.885	1.3276	0.642	0.039*	0.2850	0.576	0.621	1.6532	0.653	0.011*
Postdust day 4	0.0565	0.274	0.837	1.4168	0.668	0.034*	−0.2787	0.599	0.642	0.3444	0.680	0.612
Postdust day 5	−0.4432	0.277	0.110	−0.6423	0.677	0.343	0.1344	0.607	0.825	0.4283	0.687	0.533
Postdust day 6	0.1626	0.204	0.426	−0.6487	0.507	0.201	−0.4905	0.455	0.281	−0.1937	0.529	0.714
Spring	−0.0897	0.116	0.438	0.6411	0.293	0.029*	0.2622	0.263	0.319	0.2768	0.319	0.386
Autumn	−0.1190	0.092	0.194	0.2837	0.232	0.222	0.1915	0.209	0.359	0.0639	0.254	0.801
Winter	−0.1297	0.137	0.344	1.3687	0.347	0.000***	1.5119	0.312	0.000***	2.0982	0.376	0.000***
AR1	0.0087	0.017	0.602	0.0481	0.017	0.004**	0.0505	0.017	0.002**	0.1222	0.017	0.000***
AIC		3.7992			5.5813			5.3627			5.5983	
SC		3.8264			5.6085			5.3899			5.6255	
R^2		0.0449			0.2321			0.0966			0.4161	

Teng et al. Influence of Asian dust storms on daily acute myocardial infarction hospital admissions. Public Health Nursing 0737-1209. 2015. doi: 10.1111/phn.12209

Rome - Hospitalization

Dust days (19%) identified by LIDAR, CTM, PM_{10}:NO_2 ratio

Dust days (no dust): Mean PM_{10}=52 (37) µg/m³. $PM_{2.5}$ = 26 (23). $PM_{2.5–10}$ = 21 (15)

Cause	$PM_{2.5}$ (IQR=12.8 µg/m³) IR% (95% CI)	p-Interaction*	$PM_{2.5-10}$ (IQR=10.8 µg/m³) IR% (95% CI)	p-Interaction*
Cardiac diseases (lag 0–1) (ICD9: 390–429)	2.41 (−0.21 to 5.09)		3.93 (1.58 to 6.34)	
Saharan dust-free days	1.93 (−0.82 to 4.76)	–	3.83 (0.77 to 6.98)	–
Saharan dust-affected days	5.07 (−1.61 to 12.21)	0.378	4.03 (0.26 to 7.94)	0.934
Cerebrovascular diseases (lag 0) (ICD9: 430–438)	−2.14 (−4.73 to 0.53)		1.68 (−0.70 to 4.11)	
Saharan dust-free days	−2.85 (−5.62 to 0.00)	–	1.20 (−1.98 to 4.49)	–
Saharan dust-affected days	0.93 (−5.16 to 7.42)	0.250	1.86 (−1.85 to 5.72)	0.792
Diseases of the respiratory system (lag 0–5) (ICD9: 460–519)	−0.52 (−5.33 to 4.53)		4.77 (−0.57 to 10.40)	
Saharan dust-free days	−1.03 (−6.18 to 4.40)	–	−0.32 (−6.33 to 6.07)	–
Saharan dust-affected days	−1.45 (−11.58 to 9.85)	0.942	14.62 (5.34 to 24.72)	0.006
Diseases of the respiratory system 0–14 (lag 0–5) (ICD9: 460–519)	−2.14 (−9.09 to 5.35)		−1.20 (−8.52 to 6.71)	
Saharan dust-free days	−3.30 (−10.56 to 4.55)	–	−4.71 (−13.07 to 4.46)	–
Saharan dust-affected days	−1.50 (−16.59 to 16.31)	0.833	2.87 (−9.10 to 16.41)	0.299

*p Value of interaction term PM×Dust Index.

Dust also increased effect of PM_{10} on cerebrovascular diseases (5.04% vs 0.90%, p-Interaction=0.143)
No $PM_{2.5}$ dust effect modification.

Alessandrini et al. Saharan dust and the association between particulate matter and daily hospitalisations in Rome, Italy. Occup Environ Med 2013;70:432–434. doi:10.1136/oemed-2012-101182

Taiwan – Stroke hospitalization

Dust days (N=46, 2000-2009)

- High regional PM and $PM_{10\text{-}2.5}$
- Mean duration 2.89 days

	Number of daily stroke admissions		
	Total		
Independent variable	β	SE	p Value
Intercept	310.368	21.255	0.000***
Trend	−0.010	0.002	0.000***
Temperature	−3.674	0.404	0.000***
SO_2	14.289	2.272	0.000***
CO	−71.498	21.107	0.000***
Time since dust storm			
Day of dust storm	1.371	7.159	0.848
Post-dust day 1	24.863	9.069	0.006**
Post-dust day 2	19.438	10.139	0.048*
Post-dust day 3	15.540	10.474	0.138
Post-dust day 4	3.049	10.676	0.775
Post-dust day 5	5.258	10.547	0.618
Post-dust day 6	−7.829	8.795	0.373
MA1	0.553	0.016	0.000***
MA2	0.263	0.016	0.000***
AIC	10.8850		
SC	10.9094		
R^2	0.4239		

Kang et al. Asian dust storm events are associated with an acute increase in stroke hospitalisation. J Epidemiol Community Health 2013;67:125–131. doi:[10.1136/jech-2011-200794](https://doi.org/10.1136/jech-2011-200794)

J Epidemiol 2015;25(4):289-296
doi:10.2188/jea.JE20140179

Original Article

The Relationship Between Asian Dust Events and Out-of-Hospital Cardiac Arrests in Japan

Takahiro Nakamura[1], Masahiro Hashizume[2], Kayo Ueda[3], Tatsuhiko Kubo[4], Atsushi Shimizu[5], Tomonori Okamura[6], and Yuji Nishiwaki[1]

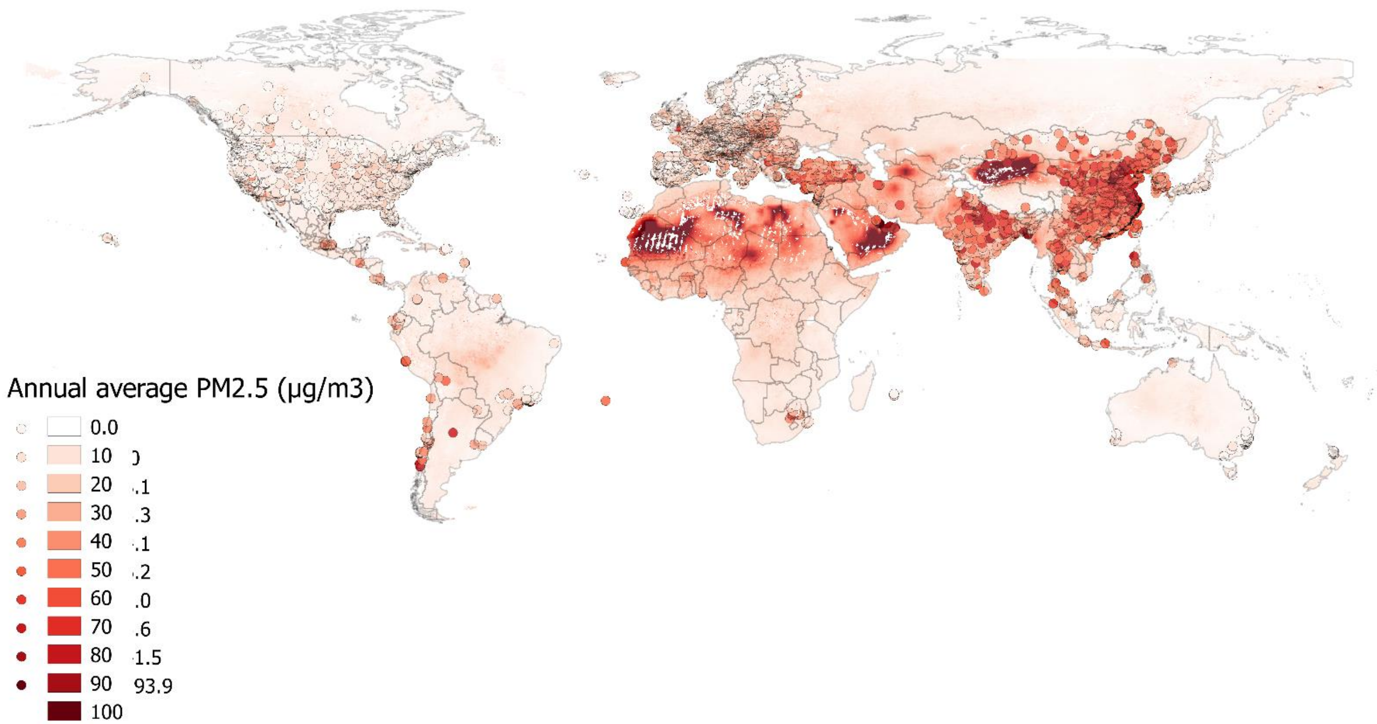
No evidence of association with out of hospital cardiac arrest

Summary

- Short-term effects of $PM_{10\text{-}2.5}$ on respiratory morbidity and mortality. Suggestive effects for cardiovascular disease
- Recent studies:
  - consistent impacts of **$PM_{10\text{-}2.5}$, PM_{10} (but not $PM_{2.5}$) during dust events** on asthma exacerbation/hospitalization
  - COPD hospitalization
  - **Growing evidence for CVD hospitalization (MI, stroke)**
    - **Delayed effect (3 days)**
- Limited studies from Middle East
  - Possibility of varying impacts by PM source area, aerosol age, co-factors

I Review of Evidence on Dust and Health

II Exposure assessment in the GBD 2013



Michael Brauer

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

IHME
Institute for Health Metrics and Evaluation

1st AFRICA/MIDDLE-EAST EXPERT MEETING AND WORKSHOP ON THE HEALTH IMPACT OF AIRBORNE DUST
AMMAN, JORDAN, 2-5 NOVEMBER 2015

Global air pollution assessments

- Global coverage
  - fine spatial resolution
  - consistent temporal trends
- GBD estimates also basis for
  - World Bank, World Health Organization, EPA BenMAPs, (OECD)
  - Source sector contributions
    - Motor vehicles
    - Solid fuel cooking, heating
    - Coal
    - Dust?

Risk factor definition: Outdoor air pollution

- Air pollution exposures are mixtures
- Relative contribution of different pollutants a function of location-specific
  - Economic/development, social, technological factors
  - meteorology, topography, geography (transport)
- Literature (measurements) for small number of selected pollutants
  - PM (TSP, PM_{10}, $PM_{2.5}$), O_3, NO_x, SO_2, CO…

Air pollution metrics: $PM_{2.5}$

- Most robust indicator in epidemiologic studies
- Biological plausibility supported by toxicology, dosimetry, studies of acute exposures, controlled exposures
- General indicator of combustion source air pollution
- Also incorporates respirable fraction of crustal PM ("dust")
- **Evidence does not support differential risk based on $PM_{2.5}$ mixture composition**

Health impacts of PM constituents

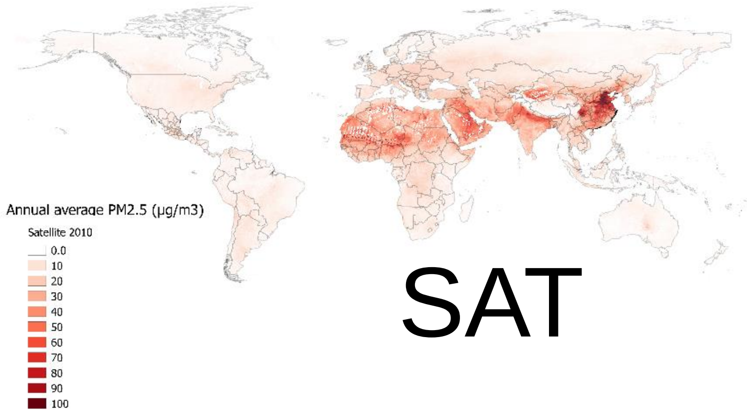
Insufficient information to differentiate the health impacts of different PM constituents

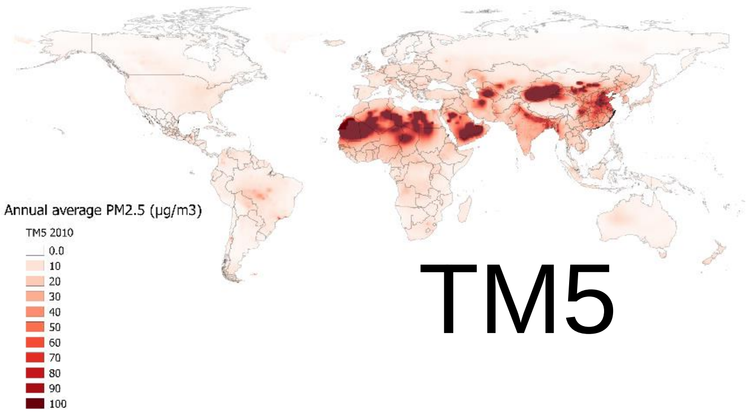
- WHO, USEPA,IARC, GBD

<u>WHO REVIHAAP*</u>

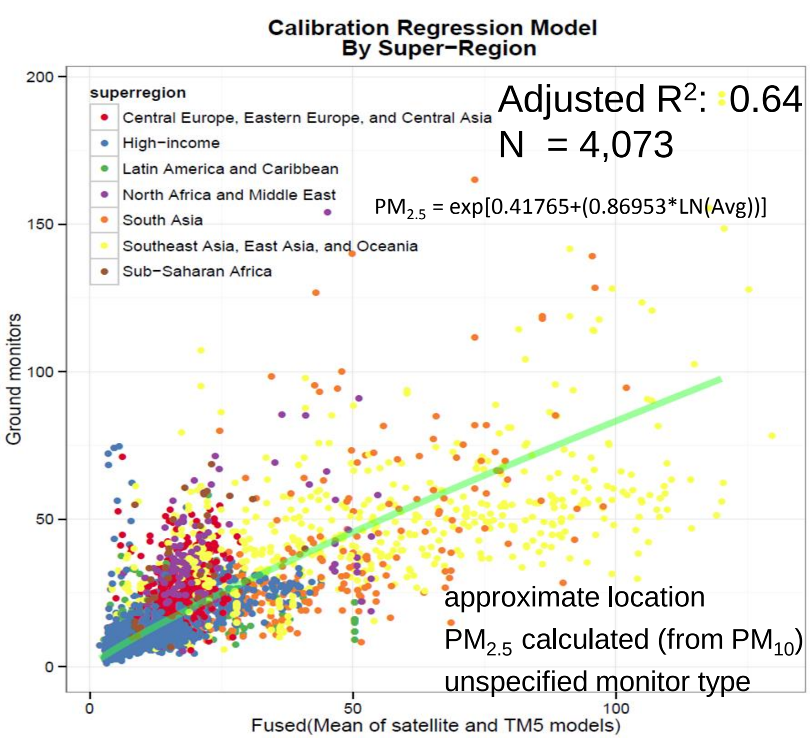
- **Carbonaceous** material from **traffic**
- **traffic**-generated dust including **road, brake and tyre wear**
- **coal** combustion (**sulfate**-contaminated particles)
- **shipping** (**oil** combustion)
- **power** generation (**oil and coal** combustion)
- **metal** industry (**nickel**)
- **biomass** combustion (residential wood combustion, landscape fires)
- **desert dust** episodes (CVD hospitalizations, mortality)

*Review of EVIdence on Health Aspects of Air Pollution, 2013

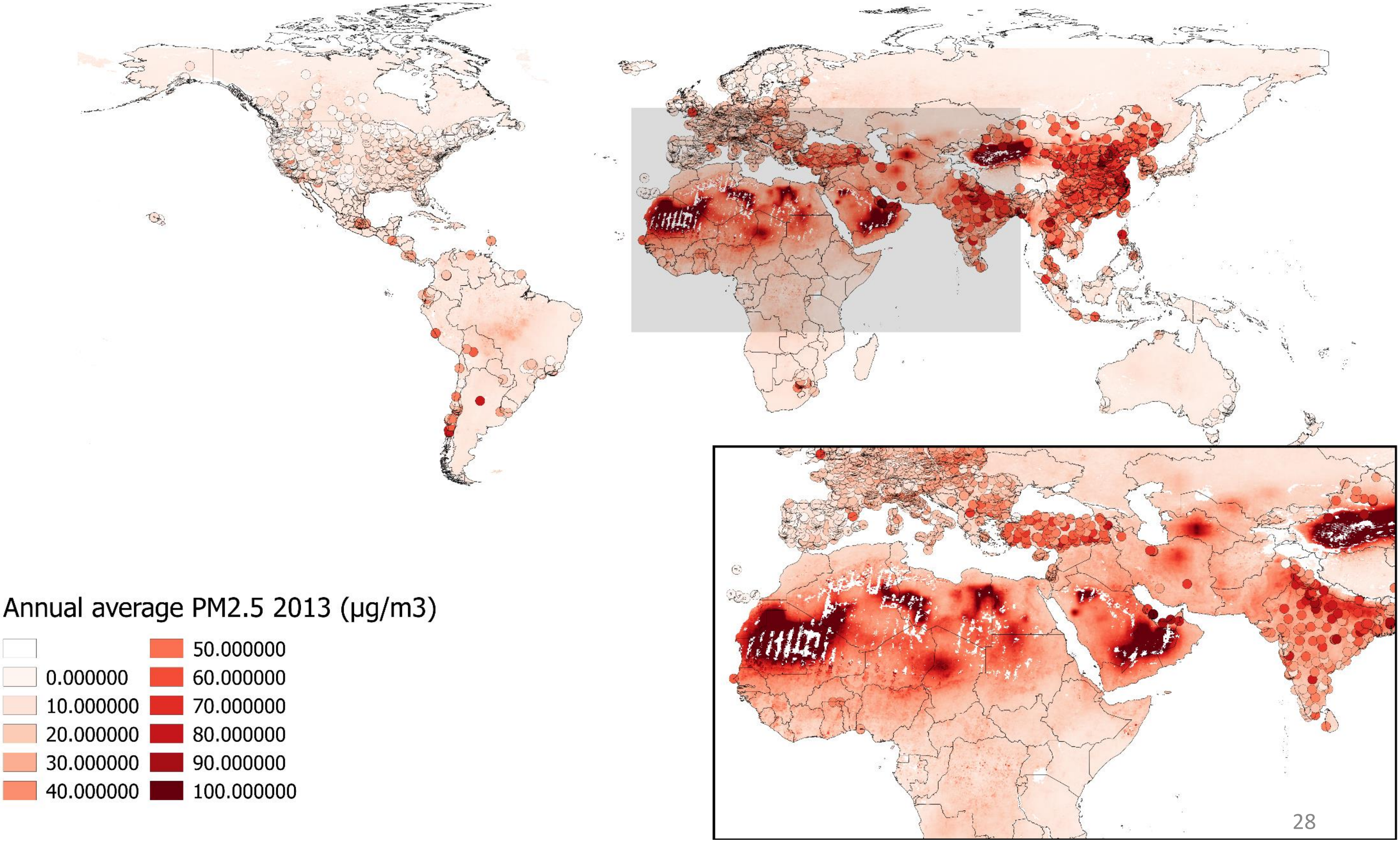




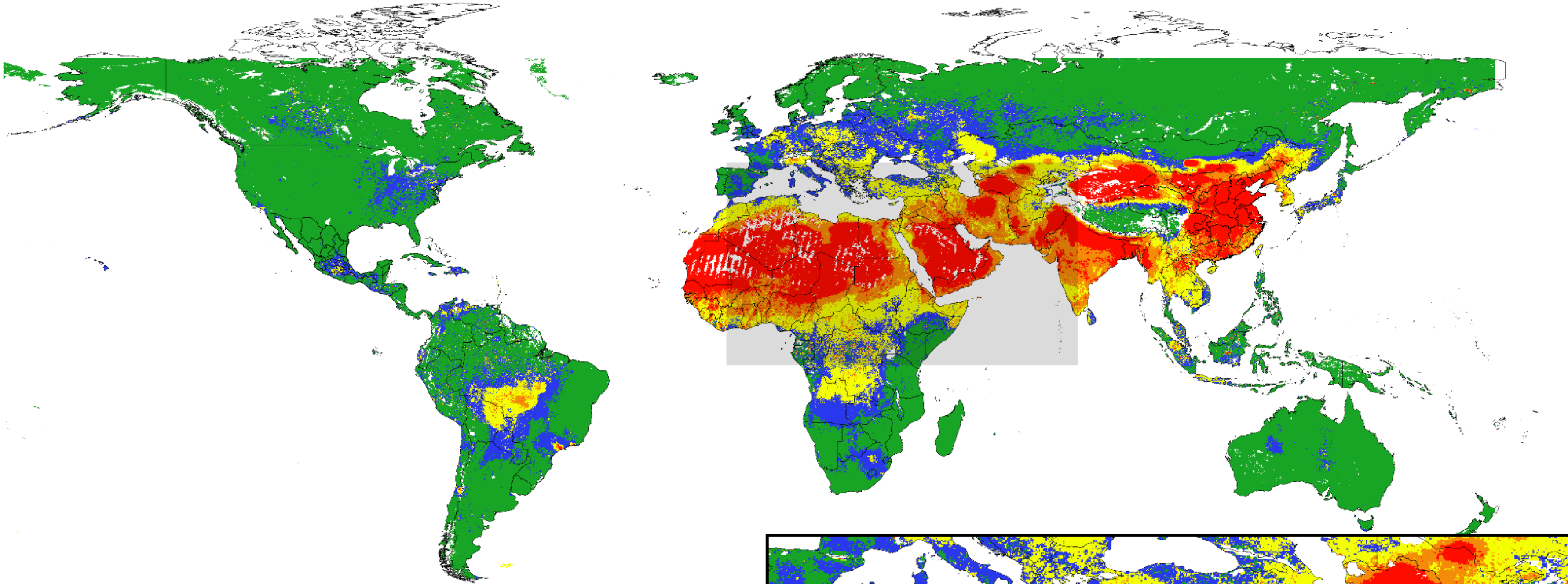
- Final estimates based on average of (1.4 million) grid cell values (SAT, TM5) and calibrated (regression model) with measurements
  - 0.1° x 0.1° resolution
  - extrapolated to 2013 using 2010-2011 trend in SAT
- Incorporate variance between two estimates and measurements in uncertainty assessment
- Unique contributions from each approach

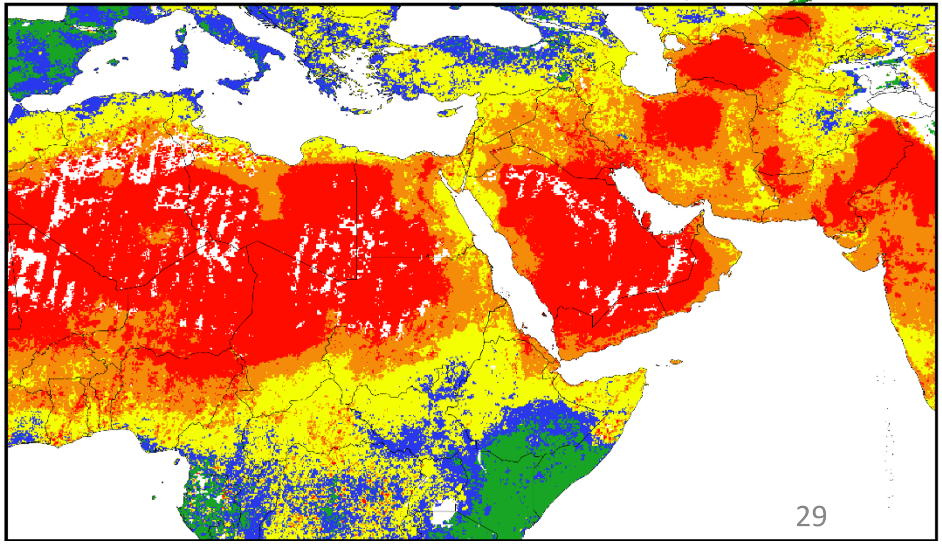


2013 Annual Average $PM_{2.5}$



2013 Annual Average $PM_{2.5}$



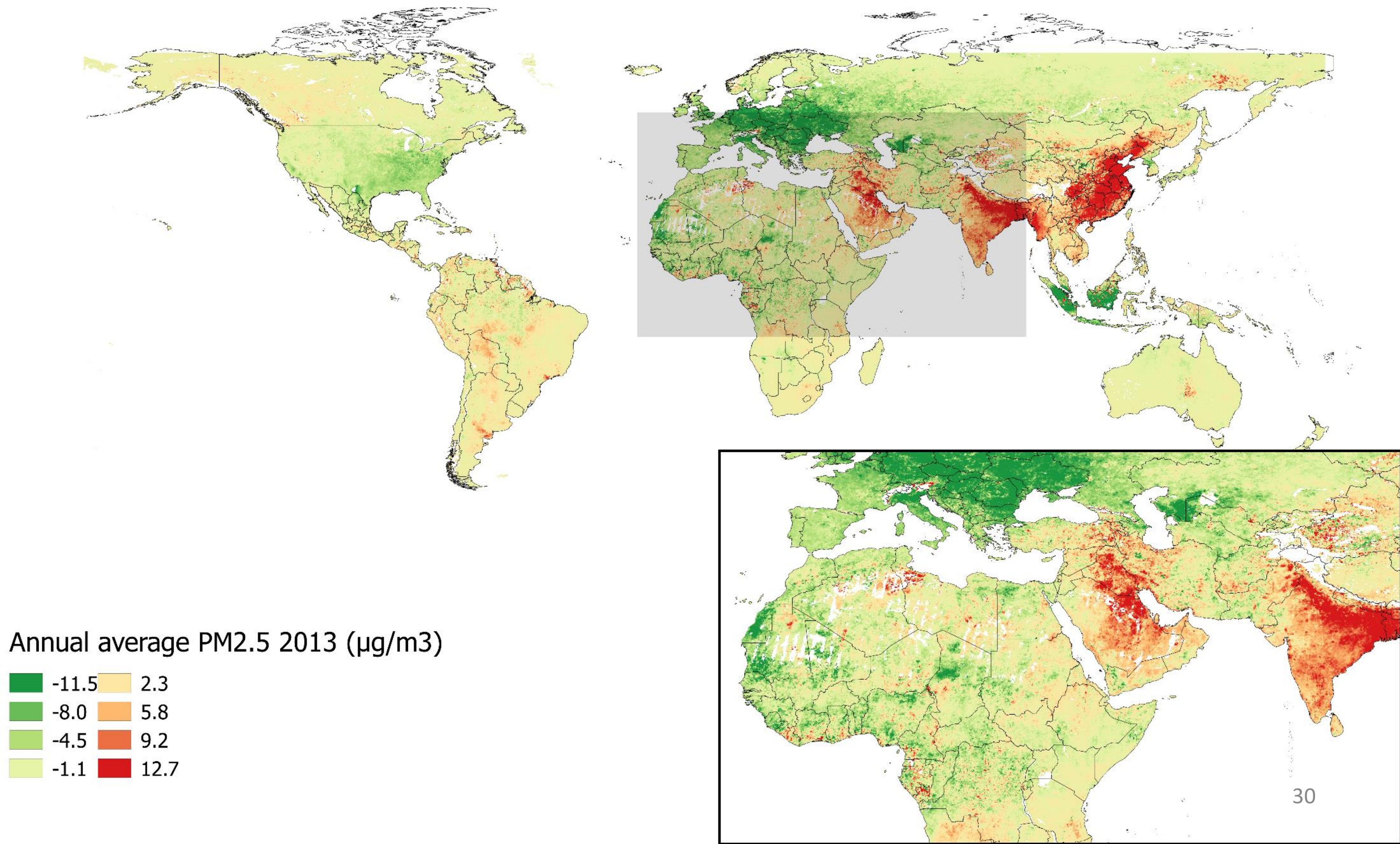


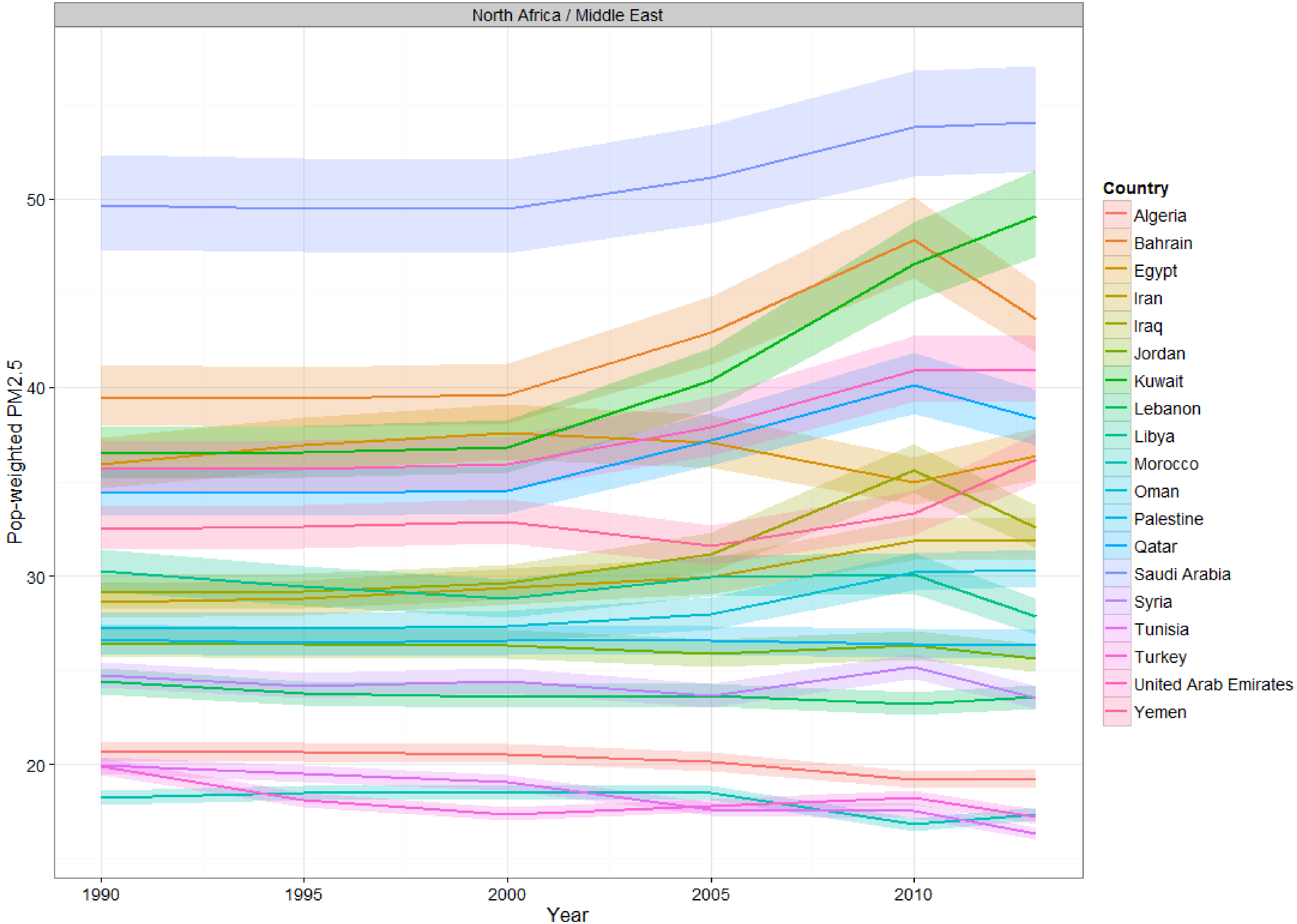
Annual average PM2.5 2013 (µg/m3)

FusedCal2013

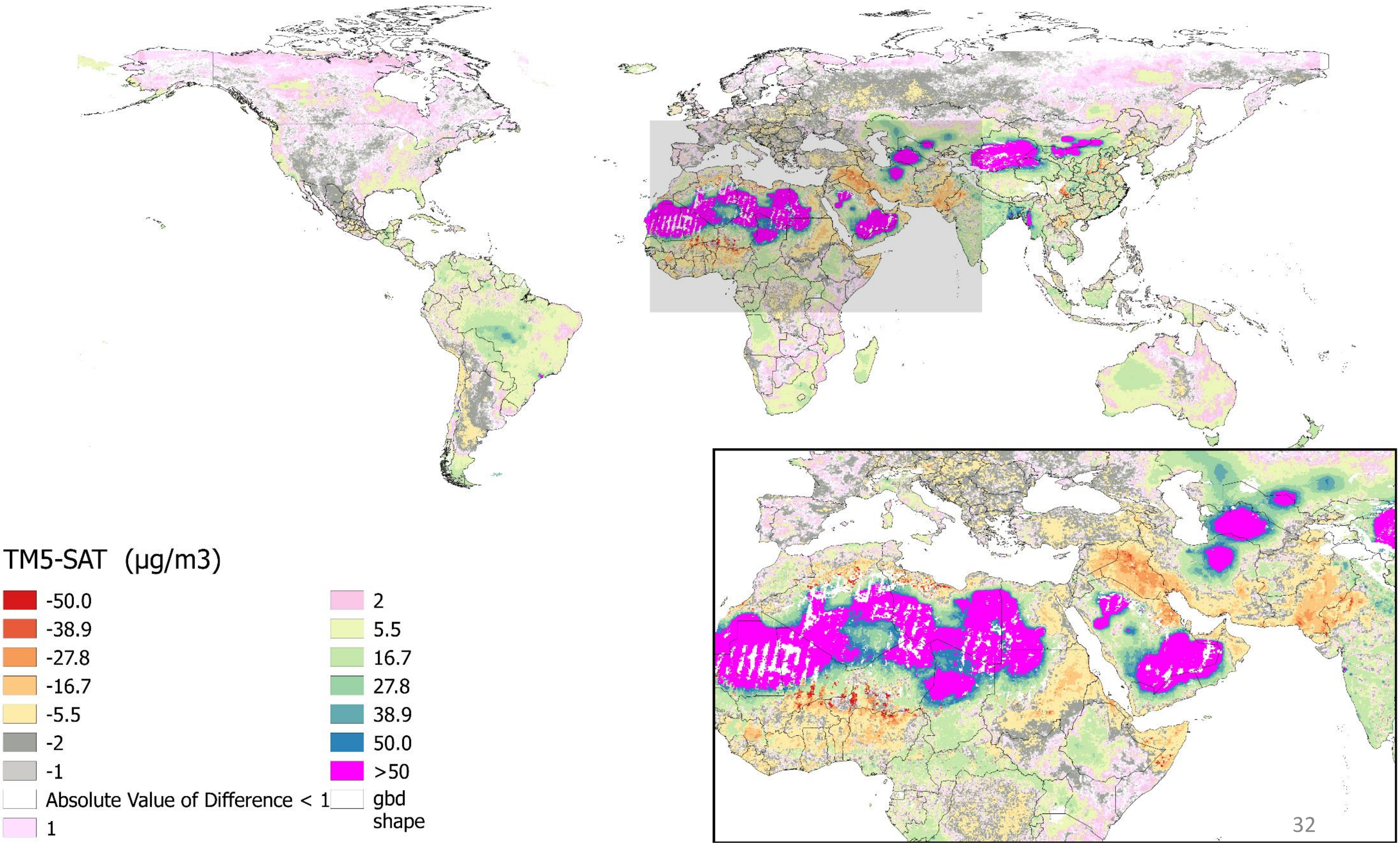
<10 (meets WHO Guideline)
≥10 (WHO Guideline)
≥15 (WHO Interim Target 1)
≥25 (WHO Interim Target 2)
≥35 (WHO Interim Target 3)

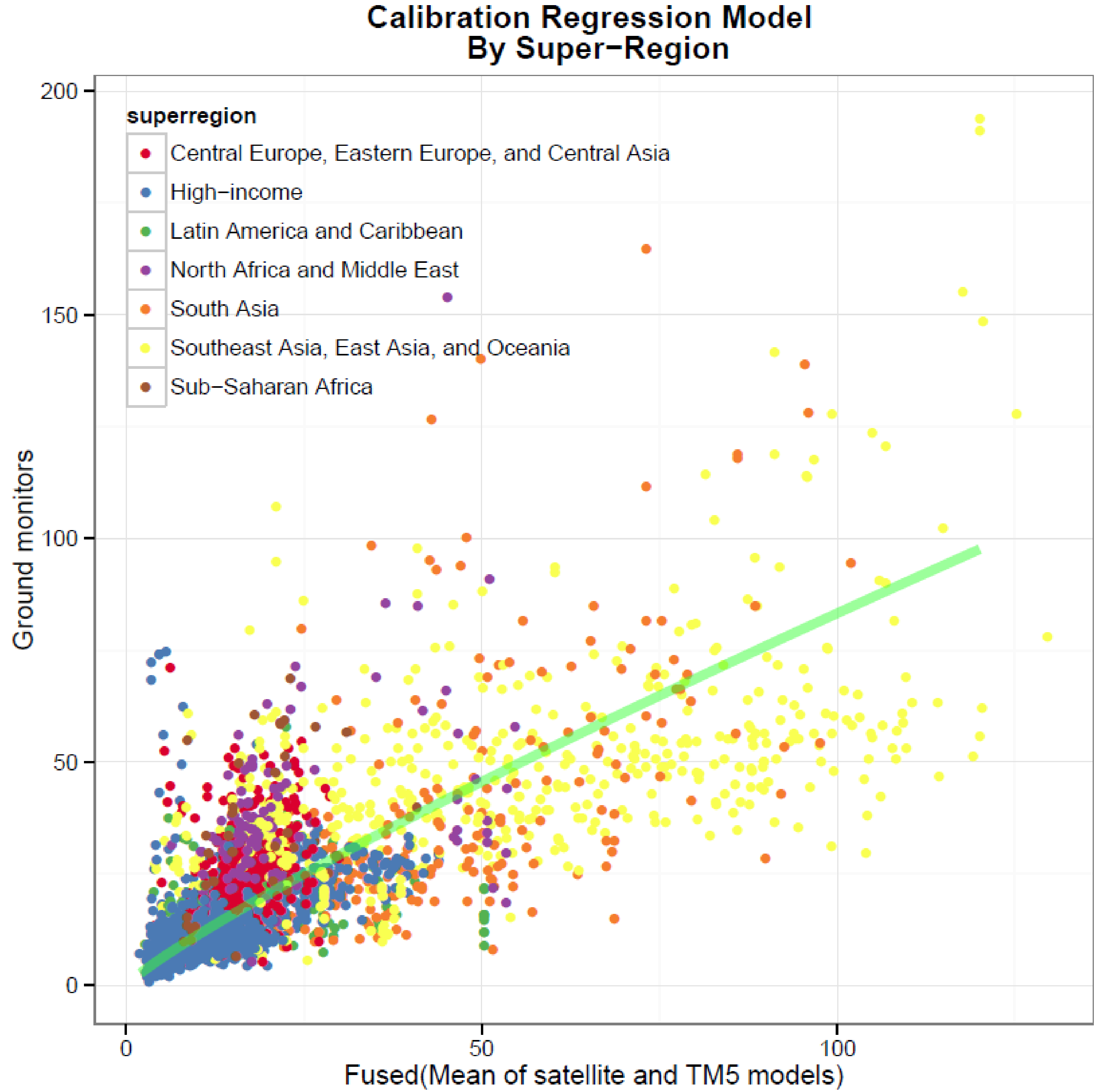
1990 – 2013 Change in Annual Average $PM_{2.5}$




North Africa / Middle East
Pop-weighted PM2.5
50
40
30
20
1990
1995
2000
2005
2010
Year
Country
Algeria
Bahrain
Egypt
Iran
Iraq
Jordan
Kuwait
Lebanon
Libya
Morocco
Oman
Palestine
Qatar
Saudi Arabia
Syria
Tunisia
Turkey
United Arab Emirates
Yemen

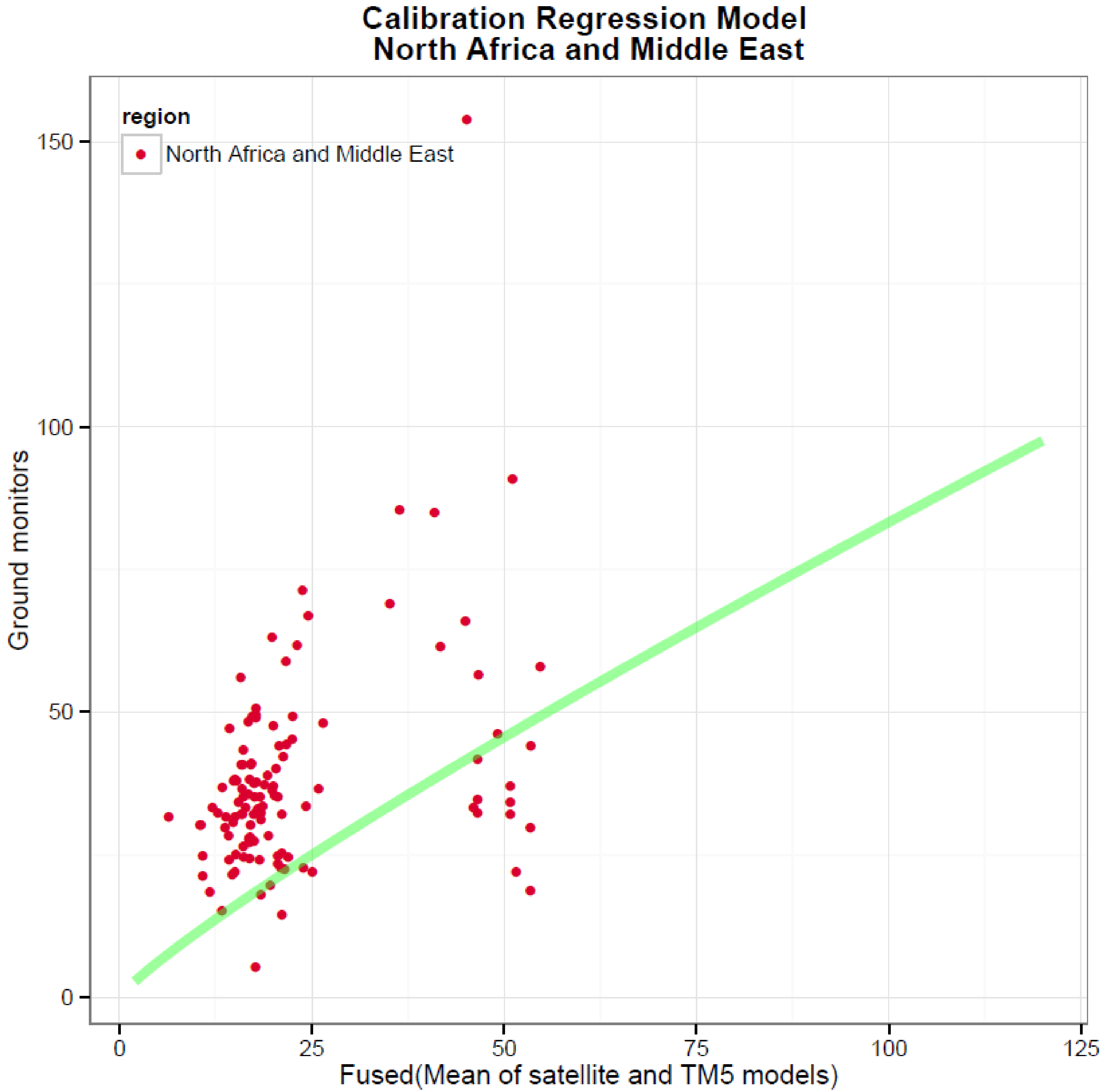
TM5 - SAT


TM5-SAT (μg/m3)
-50.0
-38.9
-27.8
-16.7
-5.5
-2
-1
Absolute Value of Difference < 1
1
2
5.5
16.7
27.8
38.9
50.0
>50
gbd shape


Calibration Regression Model
By Super−Region
superregion
Central Europe, Eastern Europe, and Central Asia
High−income
Latin America and Caribbean
North Africa and Middle East
South Asia
Southeast Asia, East Asia, and Oceania
Sub−Saharan Africa
Ground monitors
0
50
100
150
200
Fused(Mean of satellite and TM5 models)

Available Measurements from N.Africa/Middle East

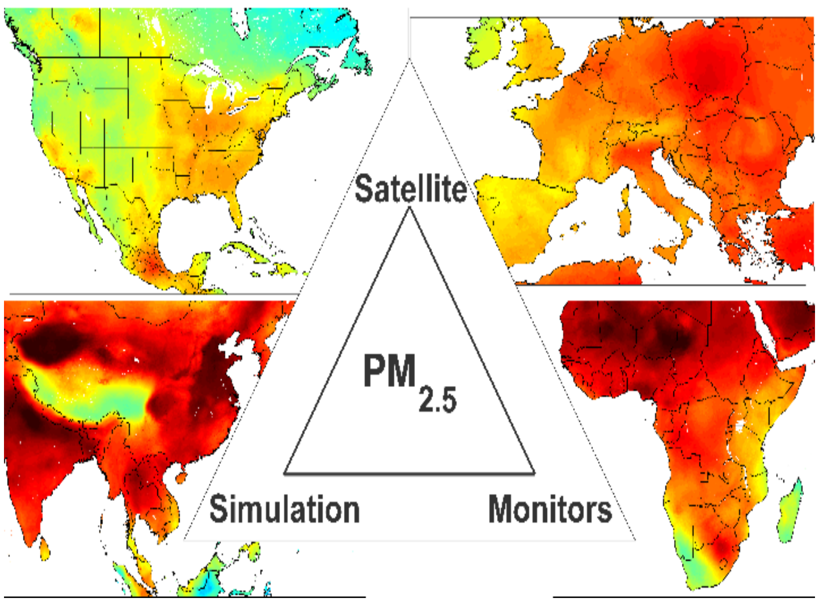
	GBD2013		GBD2015	
Country	PM2.5	EST	PM2.5	EST
(Turkey)		94	1	94
Iran	6	10	6	14
Bahrain	2		5	
Qatar		3	2	3
UAE		3		17
Afghanistan			2	
Egypt				2
Jordan			3	12
Kuwait			2	9
Lebanon			2	
Morocco			1	
Oman				1
Pakistan			7	
Saudi Arabia				7
Tunisia				4



Calibration Regression Model
North Africa and Middle East
region
North Africa and Middle East
Ground monitors
150
100
50
0
0
25
50
75
100
125
Fused(Mean of satellite and TM5 models)

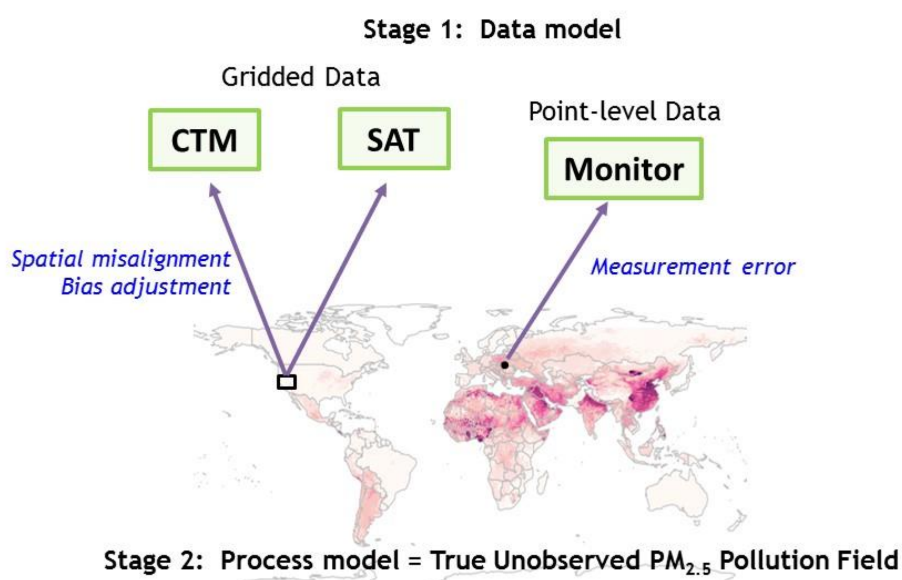
GBD2015 improvements to better capture regional differences & incorporate ground measurements

Geographically Weighted Regression



A. Van Donkelaar

Bayesian Melding



G. Shaddick

Summary

- GBD estimates for $PM_{2.5}$ (and not other size fractions)
  - Evidence from dust storms, generally does not identify effects of $PM_{2.5}$ (vs $PM_{10-2.5}$, PM_{10})
- Global, high spatial resolution, internally consistent
- Temporal trends / temporal consistency
- Reflect chronic exposure: not sensitive to episodes (dust storms, landscape fires)
  - Capture contribution of dust to long term average $PM_{2.5}$