Pollutant emission reductions deliver decreased PM2.5-caused mortality across China during 2015–2017

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Ben Silver et al.

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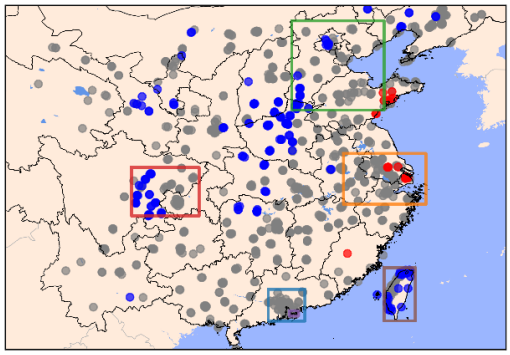
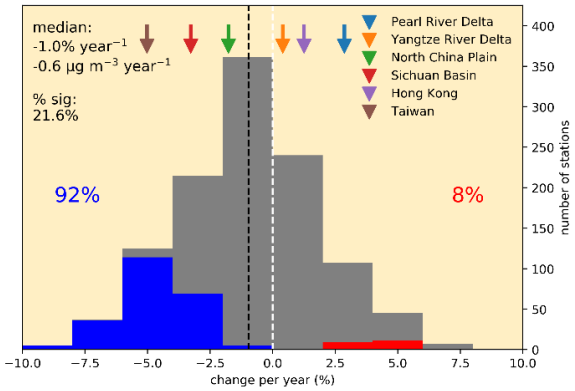
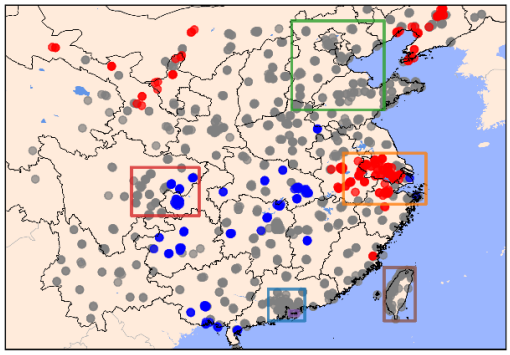
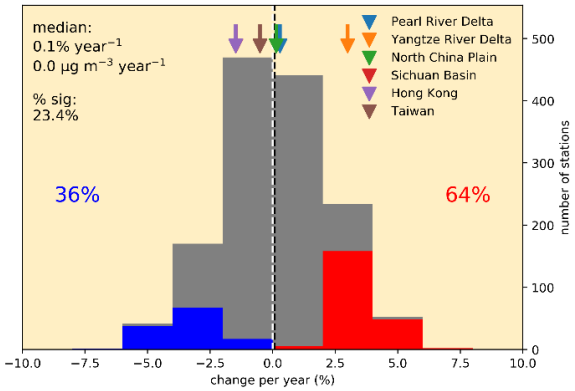
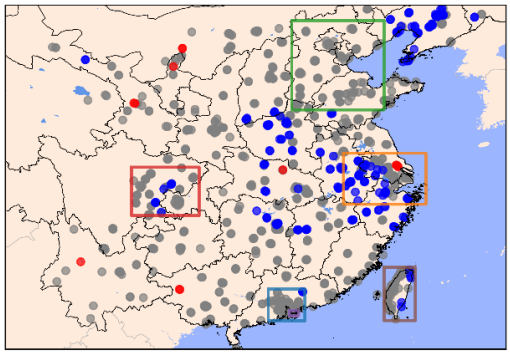
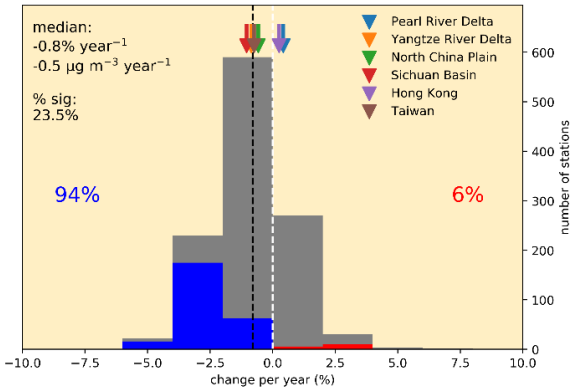


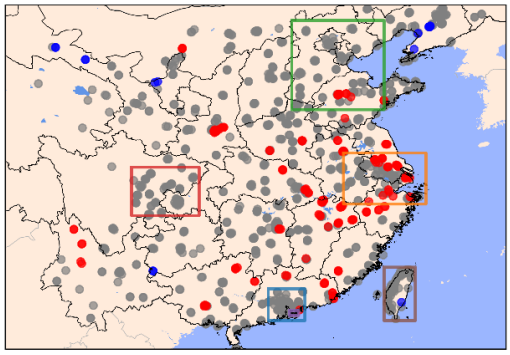

median:
-1.0% year^{-1}
-0.6 µg m^{-3} year^{-1}
% sig:
21.6%
92%
8%
Pearl River Delta
Yangtze River Delta
North China Plain
Sichuan Basin
Hong Kong
Taiwan
number of stations
change per year (%)




median:
0.1% year^{-1}
0.0 µg m^{-3} year^{-1}
% sig:
23.4%
36%
64%
Pearl River Delta
Yangtze River Delta
North China Plain
Sichuan Basin
Hong Kong
Taiwan
number of stations
change per year (%)




median:
-0.8% year^{-1}
-0.5 µg m^{-3} year^{-1}
% sig:
23.5%
94%
6%
Pearl River Delta
Yangtze River Delta
North China Plain
Sichuan Basin
Hong Kong
Taiwan
number of stations
change per year (%)



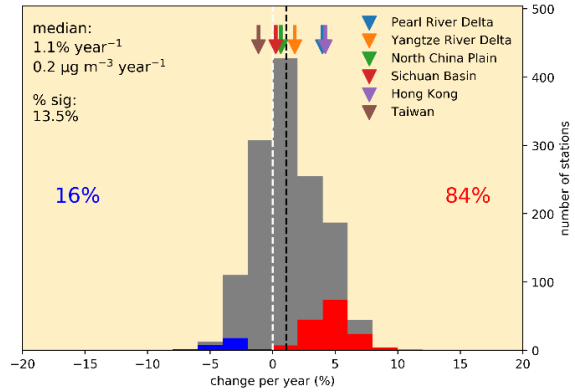
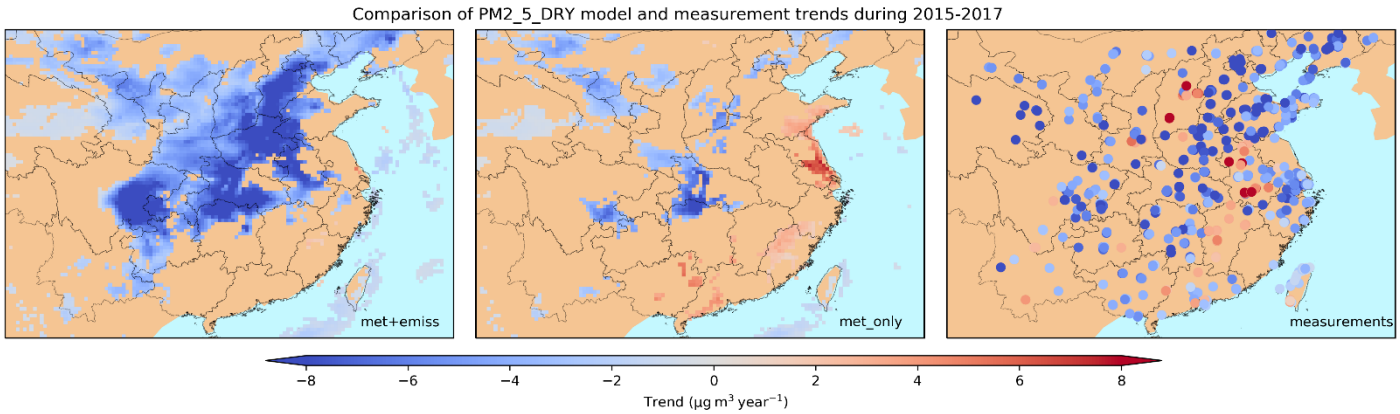
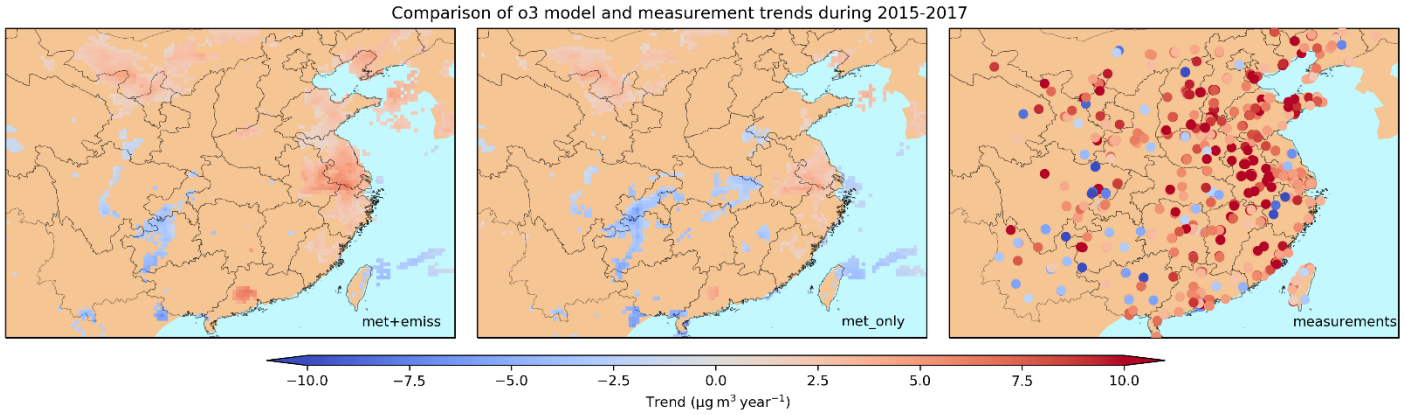

median:
1.1% year^{-1}
0.2 µg m^{-3} year^{-1}
% sig:
13.5%
16%
84%
Pearl River Delta
Yangtze River Delta
North China Plain
Sichuan Basin
Hong Kong
Taiwan
number of stations
change per year (%)

Figure S1. Maps and histograms showing the frequency distribution of trends in concentrations of (a,b) $PM_{2.5}$, (c,d) O_3MDA8, (e,f) NO_2, (g,h) SO_2 across China and Taiwan during 2015–2017 using the model data from the fixed emissions run, sampled at the locations of stations in the measurement dataset. The median relative and absolute trend as well as the percentage of stations with significant trends is shown on each panel. The percentage of significant trends that are negative (blue) or positive (red) are also shown. The black dotted line shows the median trend across all sites, while the white dotted line shows zero. Arrows show the median trend for the regional domain: Pearl River Delta (PRD), Yangtze River Delta (YRD), North China Plain (NCP), Sichuan Basin (SCB), Hong Kong (HK), Taiwan (TW) and the Fenwei Plain (FWP).

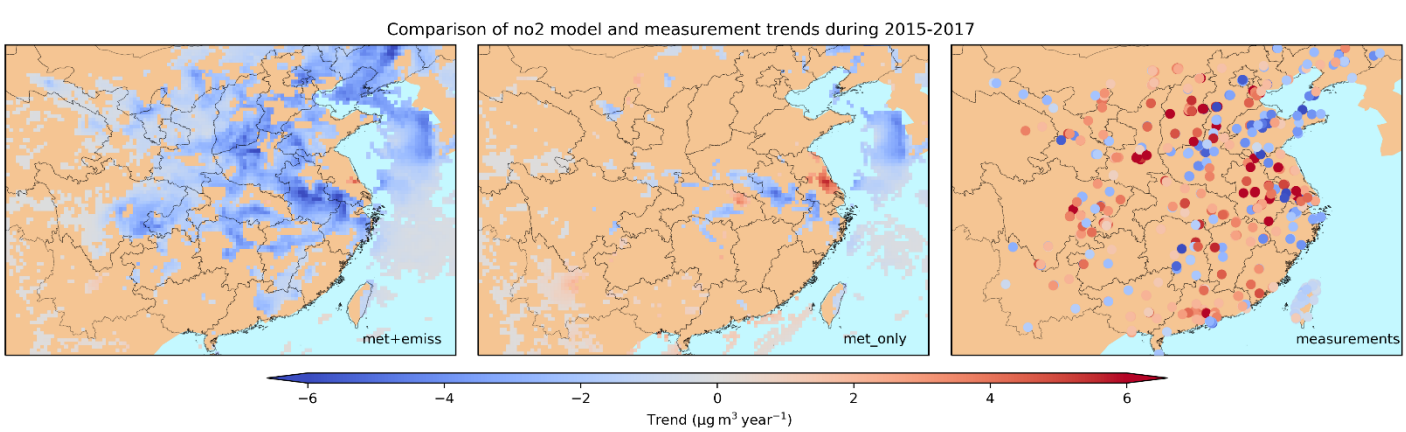
(a)


Comparison of PM2_5_DRY model and measurement trends during 2015-2017
met+emiss
met_only
measurements
−8
−6
−4
−2
0
2
4
6
8
Trend (μg m³ year⁻¹)

(b)


Comparison of o3 model and measurement trends during 2015-2017
met+emiss
met_only
measurements
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
Trend (μg m³ year⁻¹)

(c)


Comparison of no2 model and measurement trends during 2015-2017
met+emiss
met_only
measurements
−6
−4
−2
0
2
4
6
Trend (μg m³ year⁻¹)

(d)

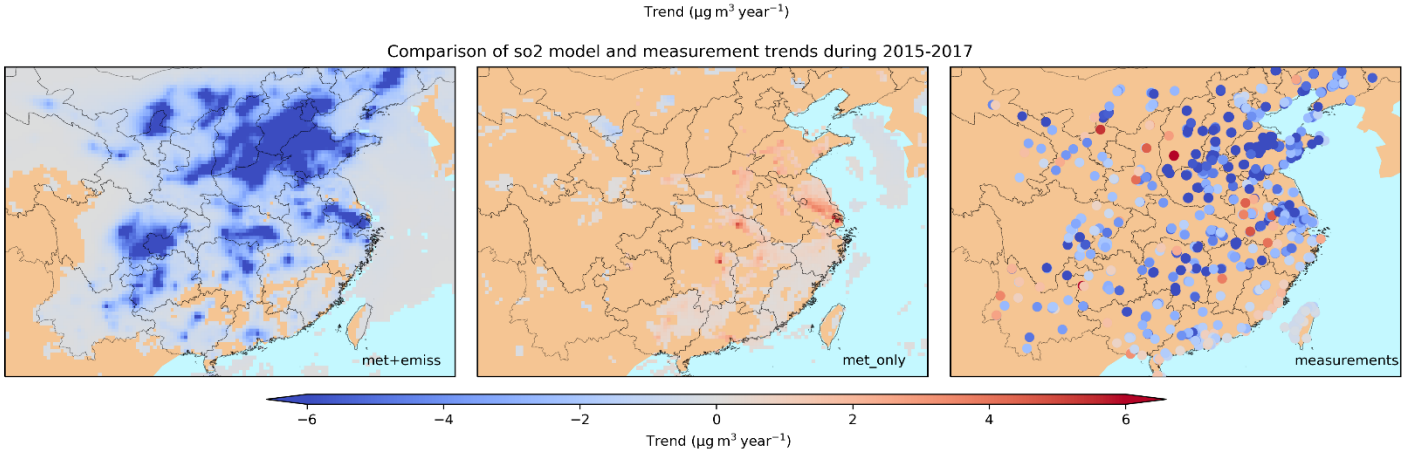

Comparison of so2 model and measurement trends during 2015-2017
met+emiss
met_only
measurements
−6
−4
−2
0
2
4
6
Trend (μg m³ year⁻¹)

Figure S2. Maps comparing the calculated trends in the control model run (left) the fixed emissions model run (centre), and the measurement data (right) for (a) $PM_{2.5}$, (b) O_3, (c) NO_2, (d) SO_2 across China and Taiwan during 2015–2017 . The trend was calculated at each grid cell in the model runs, and at each station in the measurements dataset. Only statistically significant trends are shown.

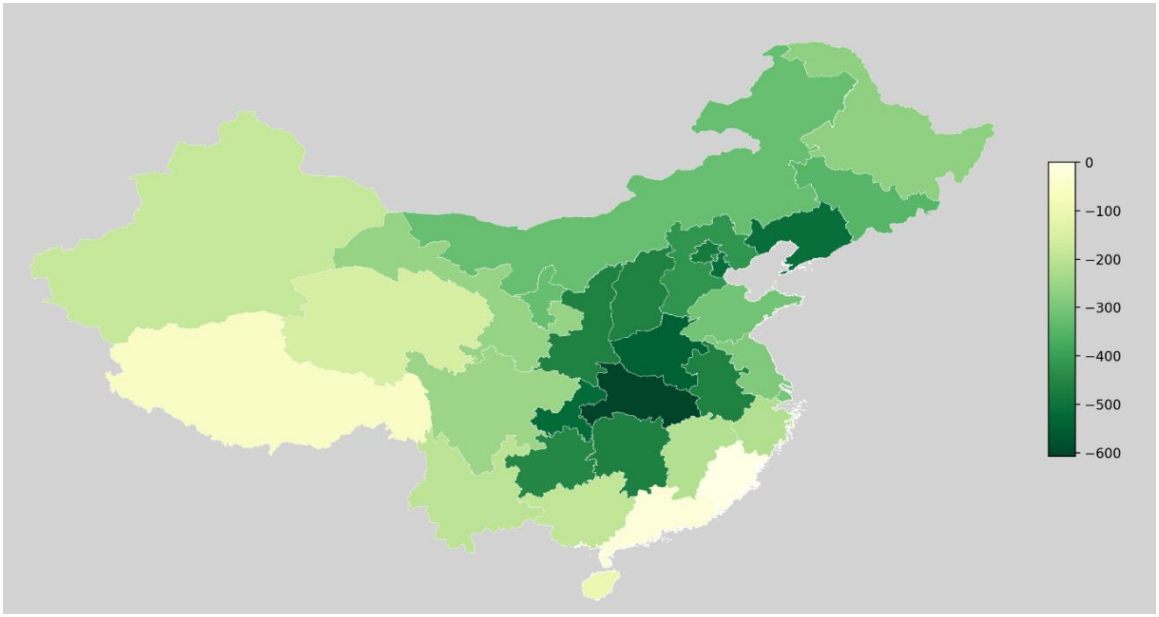


Figure S3. Simulated change during 2015-2017 in disability adjusted life years rate (per 100000 population, per year) due to changes in exposure to ambient $PM_{2.5}$. Results are shown at the province scale.

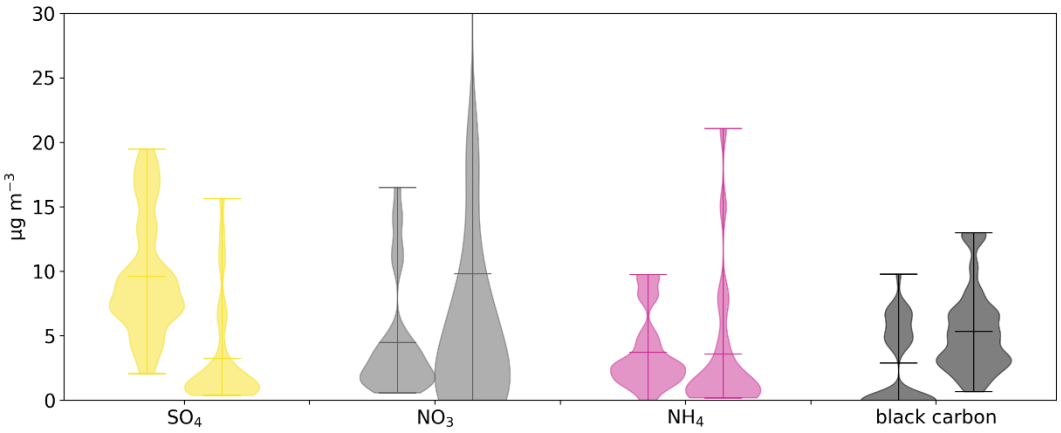


Figure S4. Comparison between measured (left violin) and simulated (right violin) aerosol species concentrations during 2015-2017. Measurements are from the SPARTAN site in Beijing (available at https://www.spartan-network.org/beijing-china).

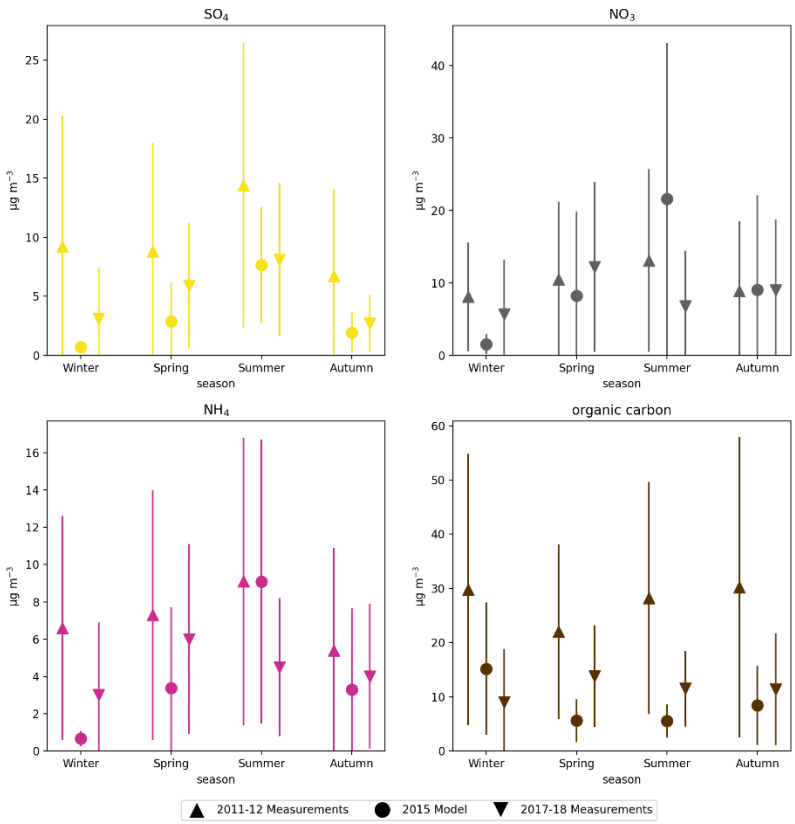


Figure S5. Comparisons between measured (triangles) and modelled (circles) aerosol species concentrations. The bars show the standard deviation of the seasonal means. Measurements are taken using an Aerodyne Aerosol Chemical Speciation Monitor and are taken from Zhou et al. (2019). The measurements had a time resolution of around 15 minutes and averaged by season.

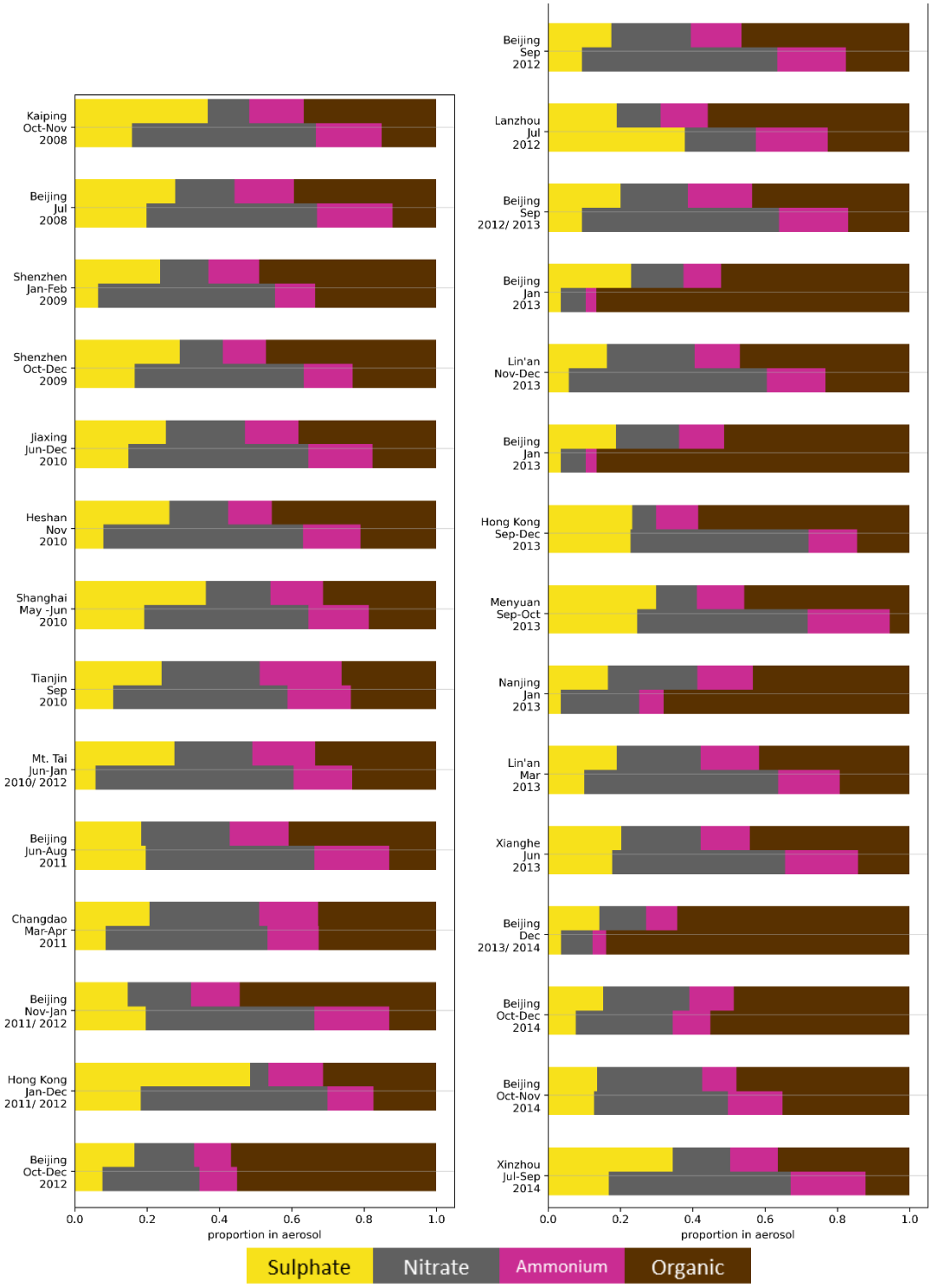


Figure S6. Comparison between measured (upper bars) and simulated (lower bars) aerosol species concentrations reported as a fraction. Measurements are from Li et al. (2017) and span 2006 to 2013. Simulated concentrations are from 2015.

Table S1 Comparison of normalised mean bias (NMB) evaluation statistics from studies simulating the air quality in China using the WRF-Chem model (excludes studies that assimilate chemical data).

	$PM_{2.5}$	PM_{10}	O_3	NO_2	SO_2	CO
Zhang et al. (2016) (Hong Kong)		-0.47 to -0.07	0.88 to 1.6	-0.88 to -0.83	-0.84 to -0.59	-0.72 to -0.55
Zhang et al. (2016) (China)		-0.38 to -0.03			-0.8 to -0.72	
(Wang et al., 2016) (N China, January)	0.28 to 0.47	0.00 to 0.08		0.09 to 0.27	0.33 to 0.91	0.01 to 0.12
Zhou et al. (2017) (forecast)		-0.36		-0.05	-0.18	-0.4
This paper	0.49	-0.09	-0.15	1.2	0.09	-0.35