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Multi-resolution Emission Inventory for PRC and Applications in Policy

Qiang Zhang, Guannan Geng, Bo Zheng, Qingyang Xiao, Yuxi Liu, Jing Cheng, Qinren Shi, and Kebin He Tsinghua University

> Better Air Quality 2023 Nov. 15-17, Manila

Multi-resolution Emission Inventory for PR China (MEIC)

- Understand magnitudes, trends, and driving forces of anthropogenic emissions in China
- Speed up the development process and update inventories timely
- Provide a rich emissions dataset to the community with constant methodology and underlying data
- Support climate and air quality modeling at different spatial resolution and time scale





http://meicmodel.org.cn

Trends in PR China's anthropogenic emissions 1990-2020

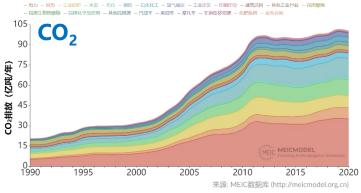
3,500

2,800-

(サ/ 2,100-(**1**)

SO₂

中国分部门CO2排放



SO2排放 1,400 700 1990 1995 2000 2005 2010

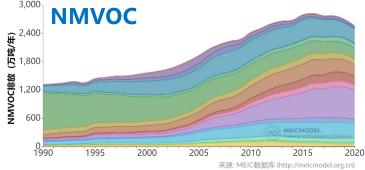
中国分部门NMVOC排放

中国分部门SO2排放

- 电力 - 供热 - 工业级炉 - 水泥 - 焦化 - 钢铁 - 石化化工 - 油气龋运 - 工业涂装 - 印刷印染 - 建筑涂料 - 其他工业行业 - 风用燃煤

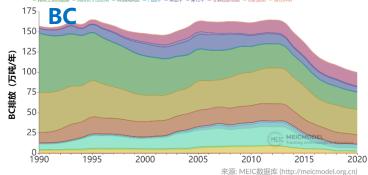
- 民用生物质燃烧 - 民用化学品使用 - 其他民用源 - 汽油车 - 柴油车 - 摩托车 - 非道路移动源 - 化肥施用 - 畜牧养殖

- 电力 - 供热 - 工业锅炉 - 水泥 - 焦化 - 钢铁 - 石化化工 - 油气能运 - 工业涂装 - 印刷印染 - 建筑涂料 - 其他工业行业 - 民用燃煤 - 民用生物质燃烧 - 民用化学品使用 - 其他民用源 - 汽油车 - 柴油车 - 摩托车 - 非道路移动源 - 化肥施用 - 畜牧养殖

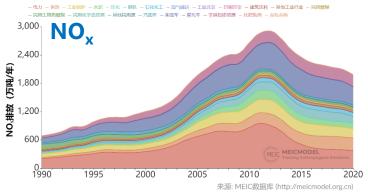


中国分部门BC排放



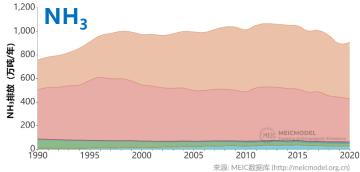


中国分部门NO₃排放



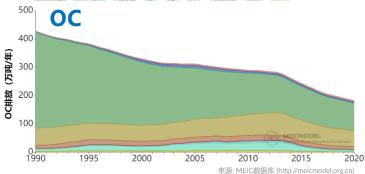
中国分部门NH₃排放

- 电力 - 供热 - 工业设护 - 水泥 - 焦化 - 钢铁 - 石化化工 - 油气储运 - 工业涂装 - 印刷印染 - 建筑涂料 - 其他工业行业 - 民用燃煤 - 民用生物质燃烧 - 民用化学品使用 - 其他民用源 - 汽油车 - 柴油车 - 摩托车 - 非道路移动源 - 化肥施用 - 畜牧养殖

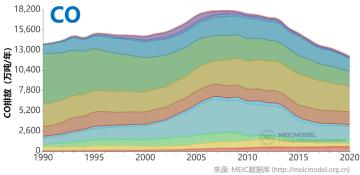


中国分部门OC排放

- 电力 - 供热 - 工业规矩 - 水泥 - 焦化 - 铜铁 - 石化化工 - 油气碱运 - 工业涂装 - 印刷印染 - 建筑涂料 - 其他工业行业 - 民用燃煤 - 民用生物质燃烧 - 民用化学品使用 - 其他民用源 - 汽油车 - 柴油车 - 摩托车 - 非道路移动源 - 化肥施用 - 畜牧养殖

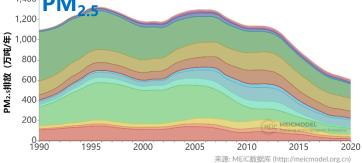


中国分部门CO排放 - 电力 - 供热 - 工业级炉 - 水泥 - 焦化 - 钢铁 - 石化化工 - 油气罐运 - 工业涂装 - 印刷印染 - 建筑涂料 - 其他工业行业 - 民用燃煤 - 民用生物质燃烧 - 民用化学品使用 - 其他民用源 - 汽油车 - 柴油车 - 摩托车 - 非道路移动源 - 化肥施用 - 畜牧养殖



中国分部门PM2.5排放



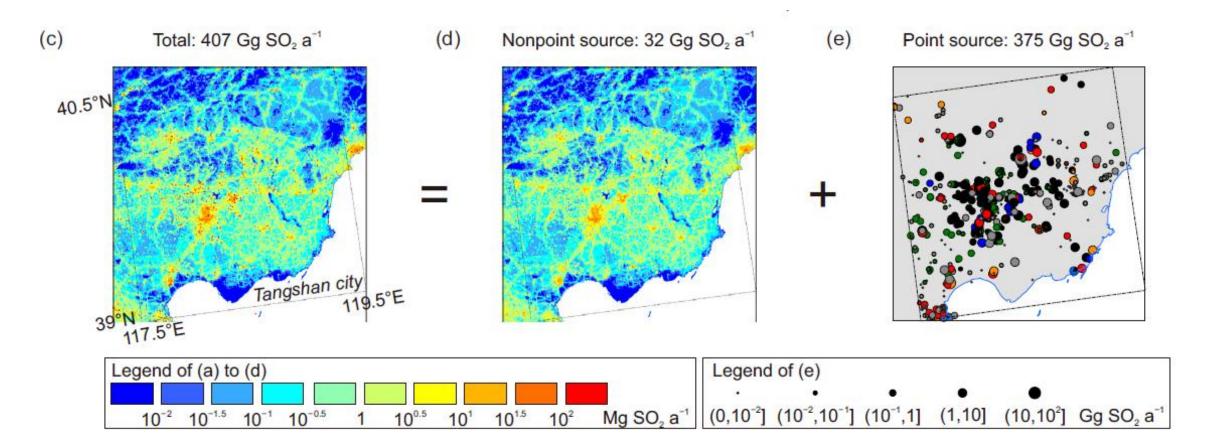


3,000

2015 来源: MEIC数据库 (http://meicmodel.org.cn)

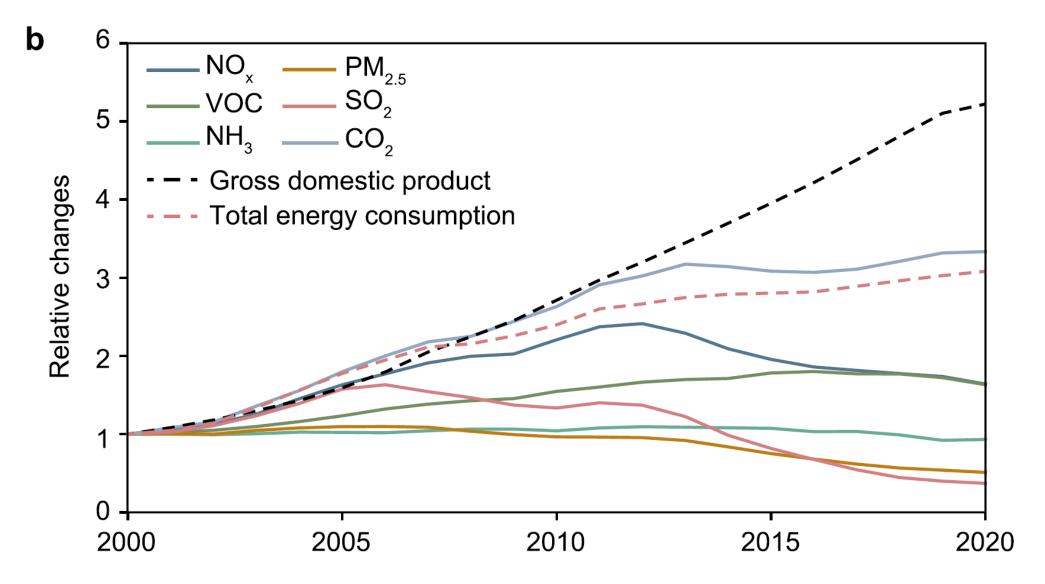
2020

High-resolution mapping of anthropogenic emissions



High-resolution SO₂ emission maps at the horizontal resolution of 1km

Relative changes in anthropogenic CO_2 and air pollutant emissions 2000-2020



Zhang et al., ESE, 2023

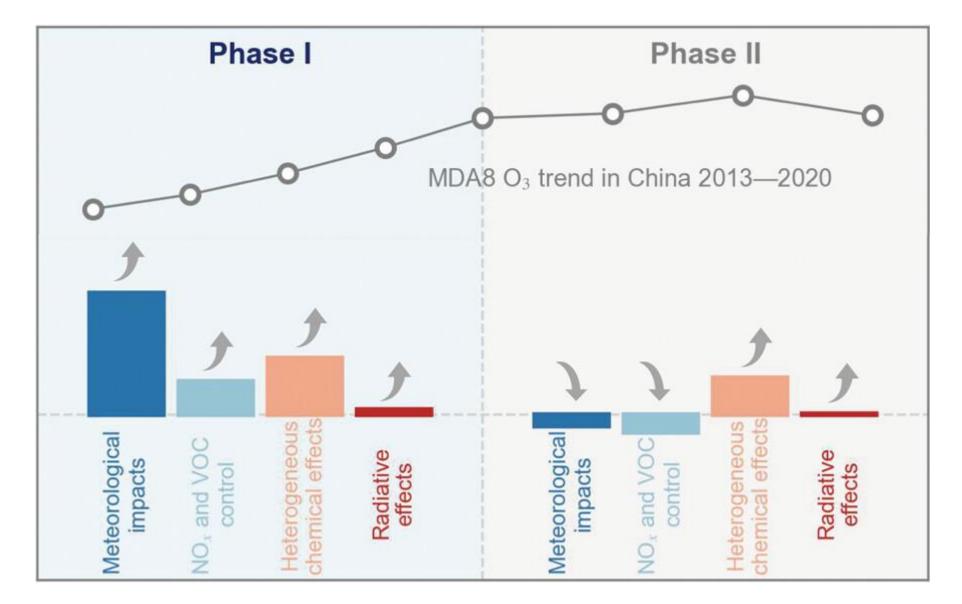
Progress in PR China's air pollution control 2013-2020

	2013	2014	2015	2016	2017	2018	2019	2020
Ultralow emission retrofitting of coal-fired power plants		f desulfurization, in the power ind		Accomplishr ultralow emis			omplishment of 8 alow emission reta	
Deep pollution control of nonpower industries	and dec	f desulfurization, dust in the steel, glass industries	cement,				The iron and ste performed ultra retrofitting for tons of crude s	alow emission 620 million
Comprehensive control of VOC pollutions		Мс	pre than 50,000 V	OC control proje	ects had been co	mpleted nationwi	de	
Comprehensive management of coal-fired boilers	Pr	nased out more t	than 200,000 sma	all coal-fired boile	ers	boilers, and l	out around 100,0 basically eliminat elow 35 t h ⁻¹ in ke	ed coal-fired
Clean heating in rural areas						heating during and had ach	mented a pilot pr winter in the north ieved raw coal su nouseholds in all	nern provinces, ubstitution in
Control of emissions from mobile sources					standards	China VI sta		
Integrated management of agriculture sources	The app		esting and formul nd the open burni					onwide,
fugitive dust emissions	the machi	ne sweeping rat),000 cases of co e for urban roads otred, and more t	in key areas ha	s exceeded 90%	, more than 30,0	00 hectares of mi	ined land

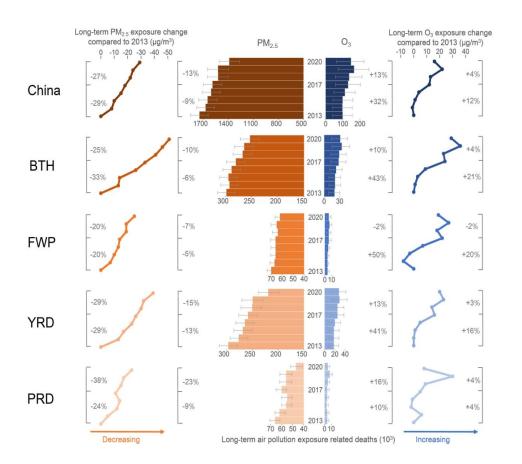
Measure-specific contribution to PM_{2.5} reduction during 2013-2020

2.24 (1.81, 2.66)	Promote clean fuels in the residential sector								
1.98 (1.67, 2.30)	Strengthen industrial emission standards								
1.10 (0.94, 1.26)	Upgr <mark>ades on ind</mark>	ustrial boilers				4.4 (3.8, 4.9)			
0.42 (0.35, 0.50)	Control of mobile source emissions								
0.39 (0.32, 0.46)	Management of VOC emissions								
0.37 (0.31, 0.44)	Phase out outdated industrial capacity								
0.31 (0.26, 0.35)	Management of agriculture source								
0.23 (0.19, 0.27)	Phase out small and polluting factories								
Population-weighted mean PM _{2.5}									
0	.0 2.0	4.0	6.0	8.0	10	.0			

Drivers of increasing ozone during the two phases of clean air actions

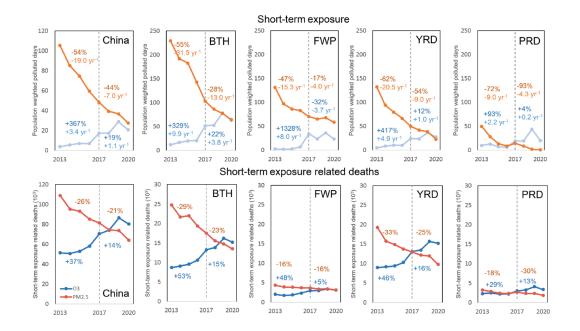


Health impacts of $PM_{2.5}$ and O_3 pollution during 2013-2020



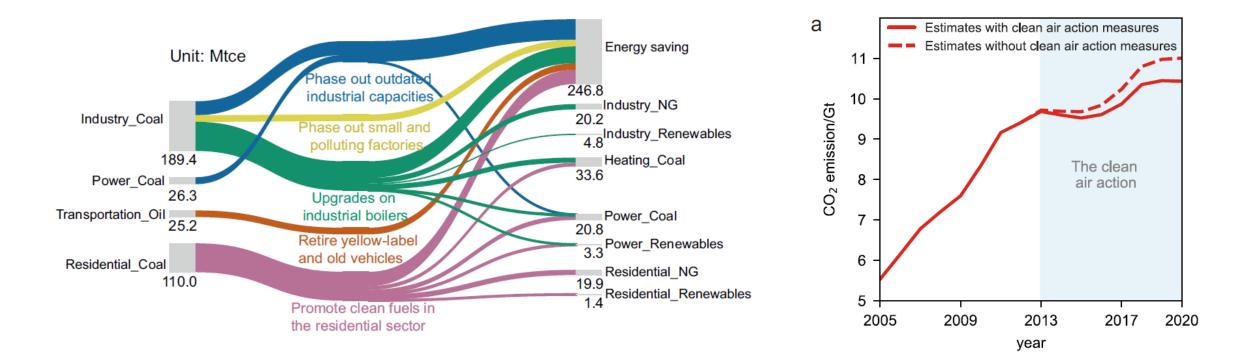
Health impacts of long-term exposure

Health impacts of short-term exposure



Xiao et al., Environ. Sci. Tech., 2022

Co-benefits of CO₂ emission reduction from PR China's clean air actions



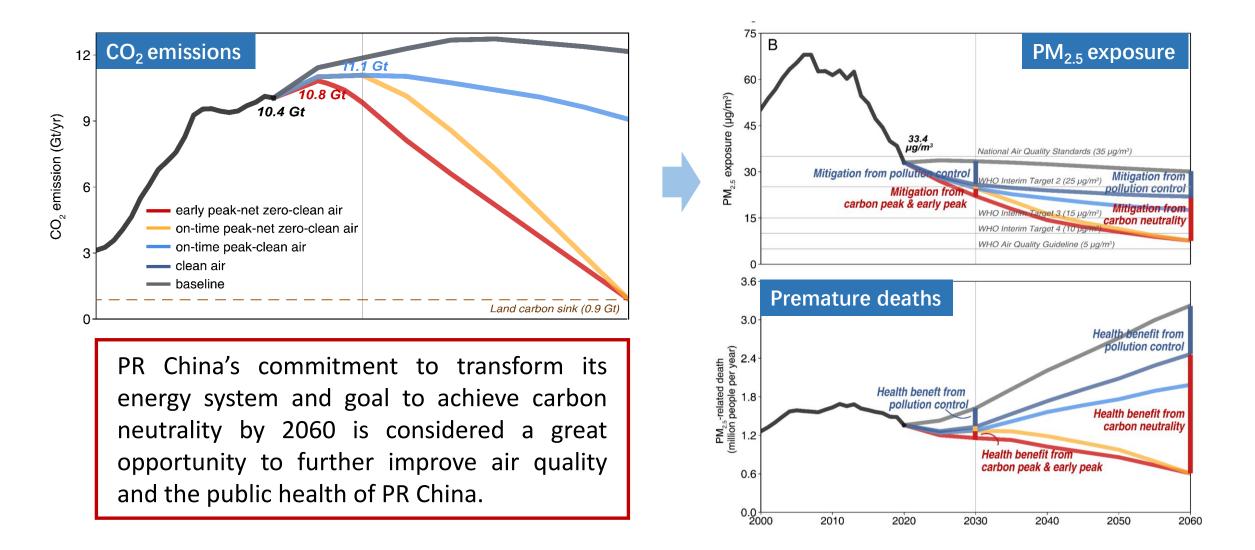
Accumulative energy saving:

1.06 billion tce

Accumulative CO₂ emission reduction:

2.43 billion tons

Carbon mitigation as the key driver of future air quality improvement



Cheng et al., One Earth, 2023



Thanks!

http://meicmodel.org.cn

References:

Liu, Y. X., G. N. Geng, J. Cheng, Y. Liu, Q. Y. Xiao, L. K. Liu, Q. R. Shi, D. Tong, K. B. He, and Q. Zhang (2023), Drivers of increasing ozone during the two phases of clean air actions in China, Environ. Sci. Tech.

Zhao, H. Y., R. L. Wu, Y. Liu, J. Cheng, G. N. Geng, Y. X. Zheng, H. Z. Tian, K. B. He, and Q. Zhang (2023), Air pollution health burden embodied in China's supply chains, Environ. Sci. Ecotech., 16, 100264.

Shi, Q. R., B. Zheng, Y. X. Zheng, D. Tong, Y. Liu, H. C. Ma, C. P. Hong, G. N. Geng, K. B. He, and Q. Zhang (2022), Co-benefits of CO2 emission reduction from China's clean air actions during 2013-2020, Nat. Comm., 13, 5061.

Liu, S. G., G. N. Geng, Q. Y. Xiao, Y. X. Zheng, X. D. Liu, J. Cheng, and Q. Zhang (2022), Tracking daily concentration of PM2.5 chemical composition in China since 2000, Environ. Sci. Tech.

Xiao, Q. Y., G. N. Geng, S. G. Liu, J. J. Liu, X. Meng, and Q. Zhang (2022), Spatiotemporal continuous estimates of daily 1-km PM2.5 from 2000 to present under the Tracking Air Pollution in China (TAP) framework, Atmos. Chem. Phys.

Geng, G. N., Y. X. Zheng, Q. Zhang, T. Xue, H. Y. Zhao, D. Tong, B. Zheng, M. Li, F. Liu, C. P. Hong, K. B. He, and S. J. Davis (2021), Drivers of PM2.5 air pollution deaths in China 2002-2017, Nat. Geosci., 14, 645-650.