

## Chinese emissions reductions deliver reduced PM2.5-caused mortality across China during 2015-2017

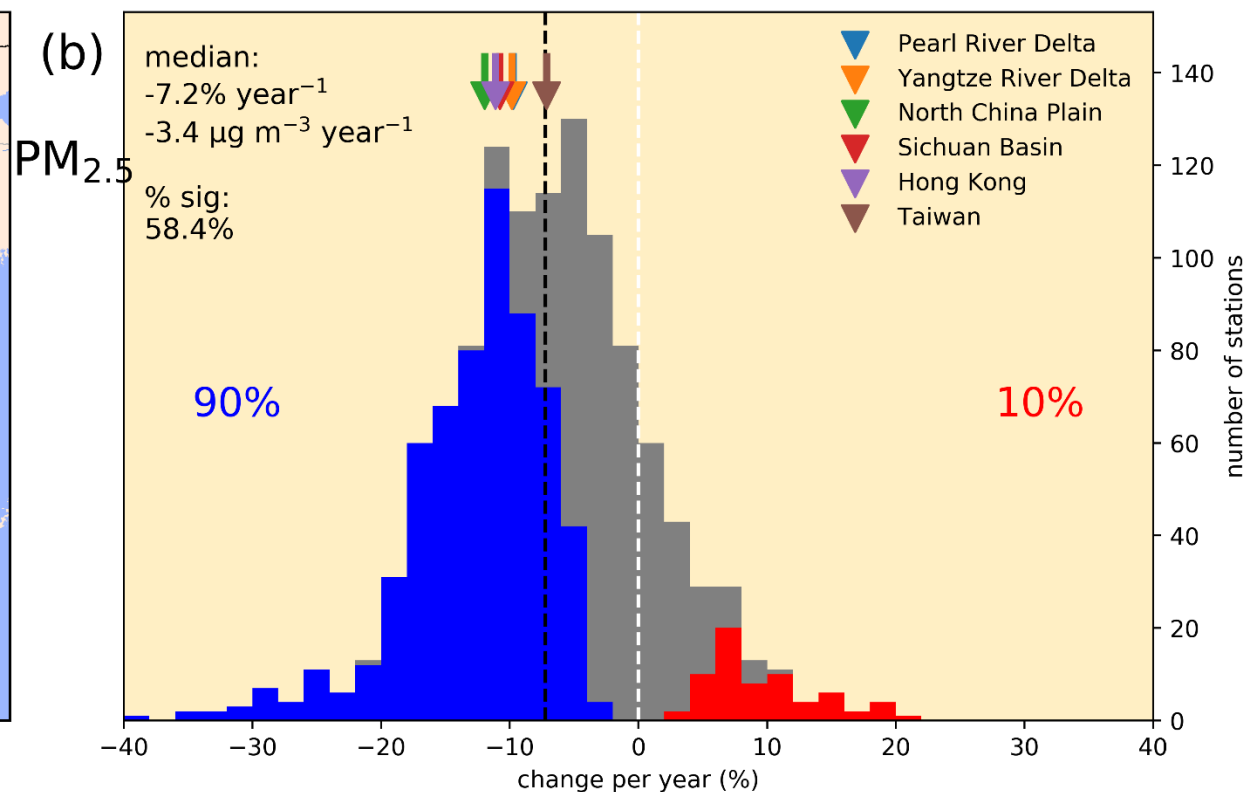
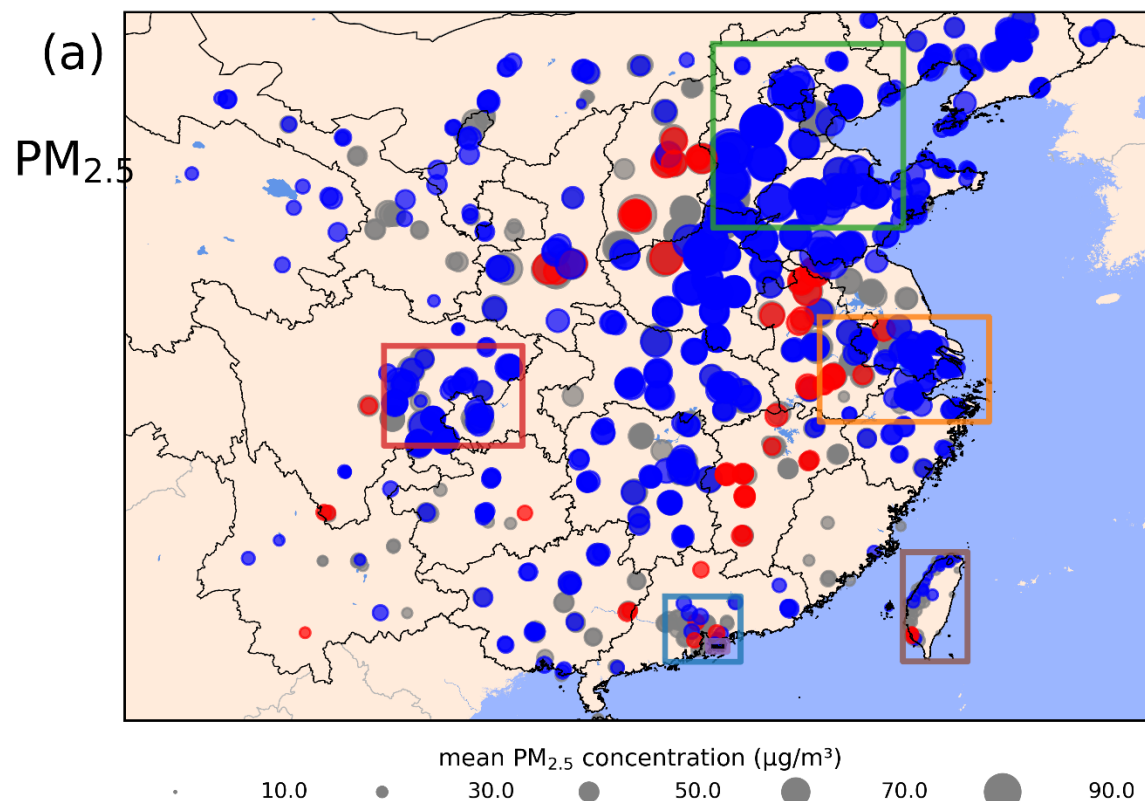
**Ben Silver**, Luke Conibear, Carly Reddington, Christophe Knote, Steve Arnold, and Dominick Spracklen

# Measured PM<sub>2.5</sub> trends (2015-2017)



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Median trend:  $-7.2\% \text{ year}^{-1}$  or  $-3.4 \mu\text{g year}^{-1}$



● significant positive trend      ● significant negative trend      ● insignificant trend

--- median significant trend      --- zero

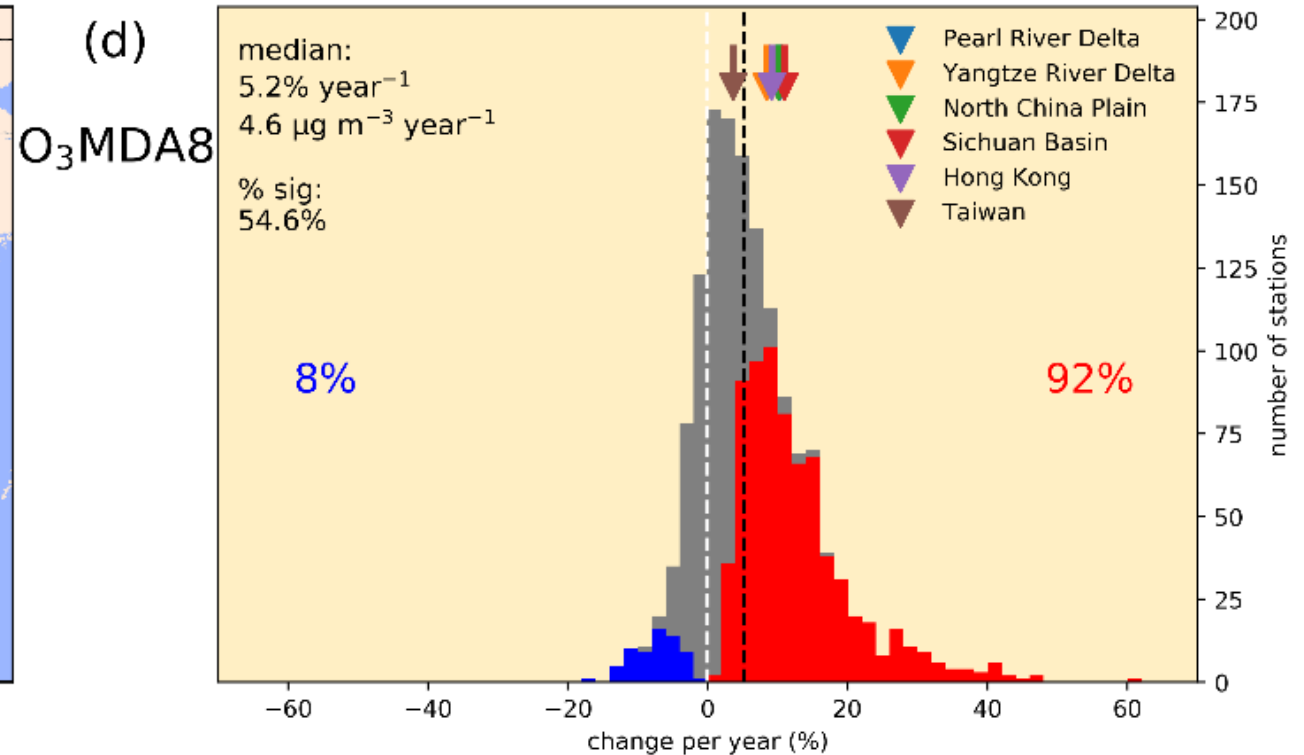
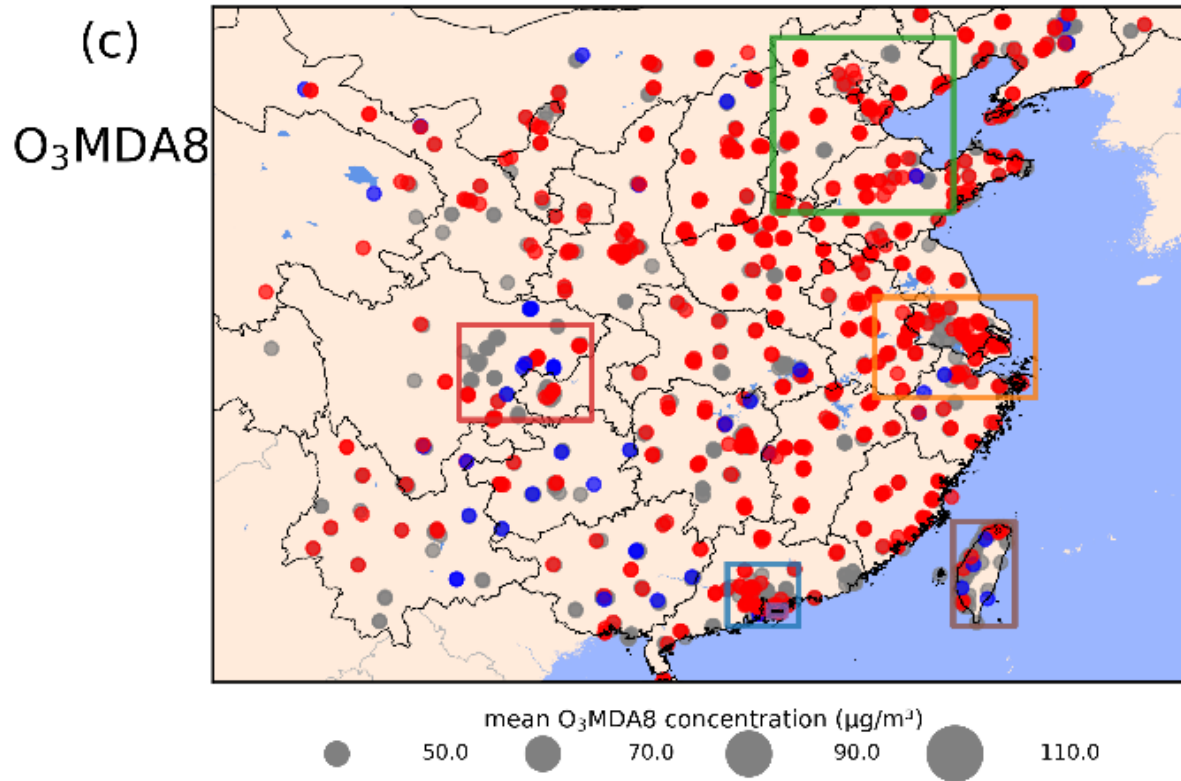
Silver *et al.*, *ERL* (2018)

# Measured O<sub>3</sub> (MDA8) trends (2015-2017)



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Median trend: 5.2% year<sup>-1</sup> or 4.6 µg year<sup>-1</sup>



● significant positive trend      ● significant negative trend      ● insignificant trend

--- median significant trend      --- zero

Silver *et al.*, *ERL* (2018)

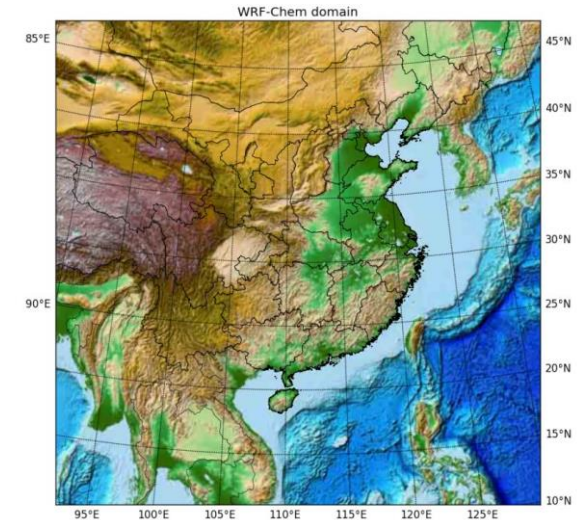
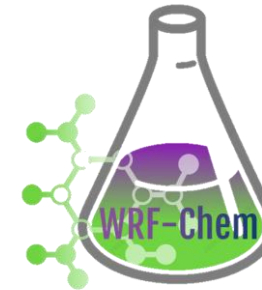


# Are the trends driven by emissions or meteorology?



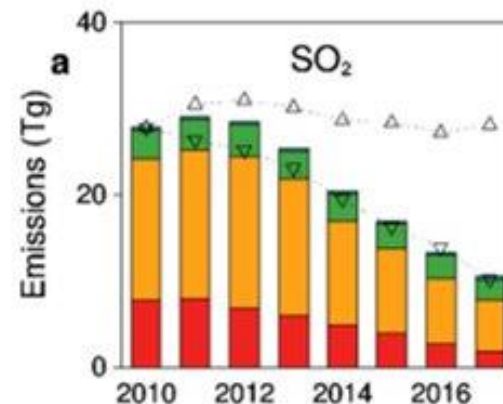
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- Using WRF-Chem, we simulate air quality over China during 2015-2017
- ECMWF ERA-Interim fields used for initial and boundary conditions, and to nudge the meteorology.
- MOZART-4 chemistry with MOSAIC 4-bin aerosol scheme
- Multiresolution Emission Inventory for China (MEIC) 2015



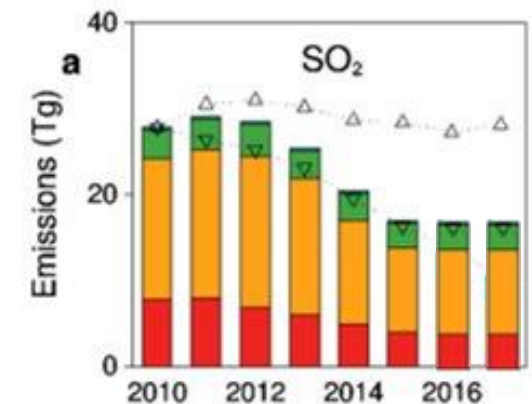
## Control simulation

Varying emissions using MEIC 2015 scaled by Zheng *et al* (2018) for 2015-2017

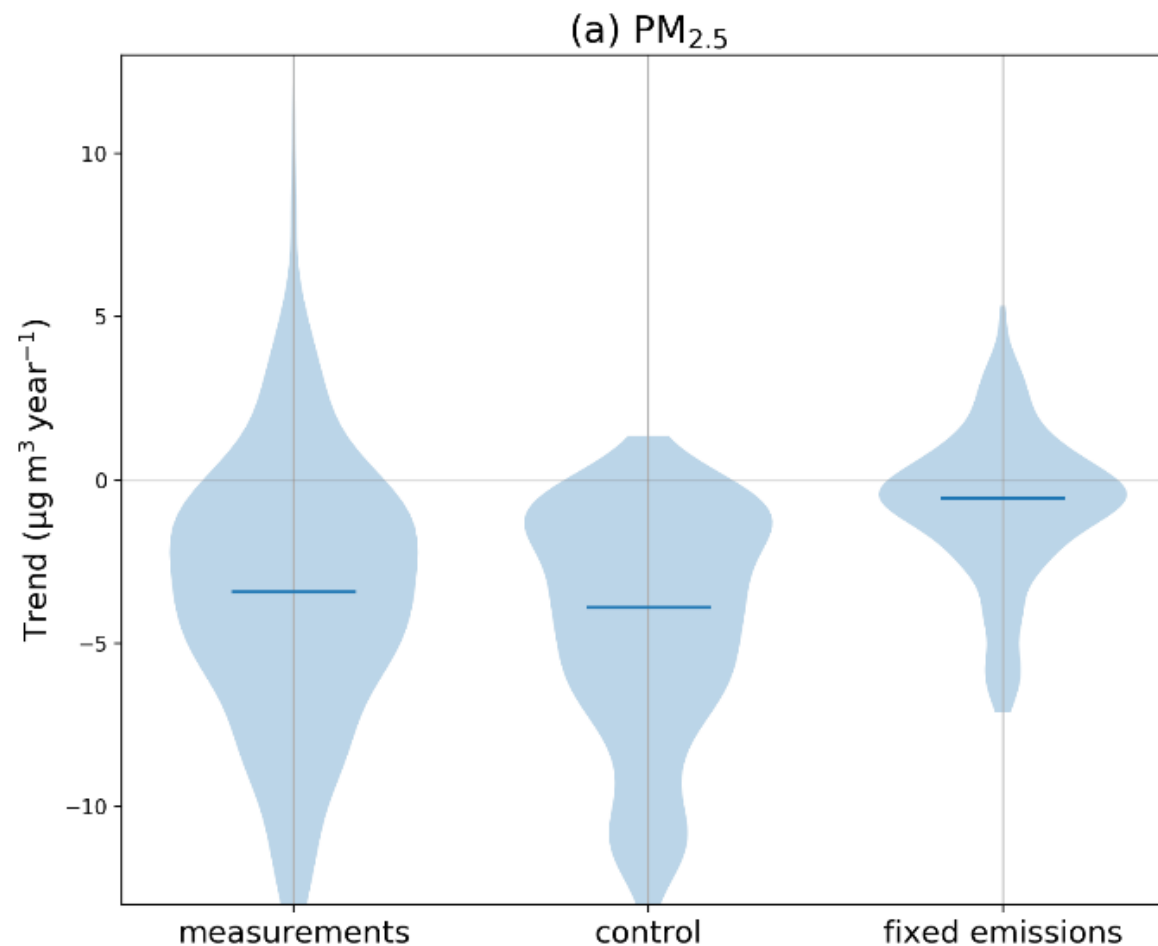


## Fixed emissions simulation

MEIC 2015 emissions used for all simulation years

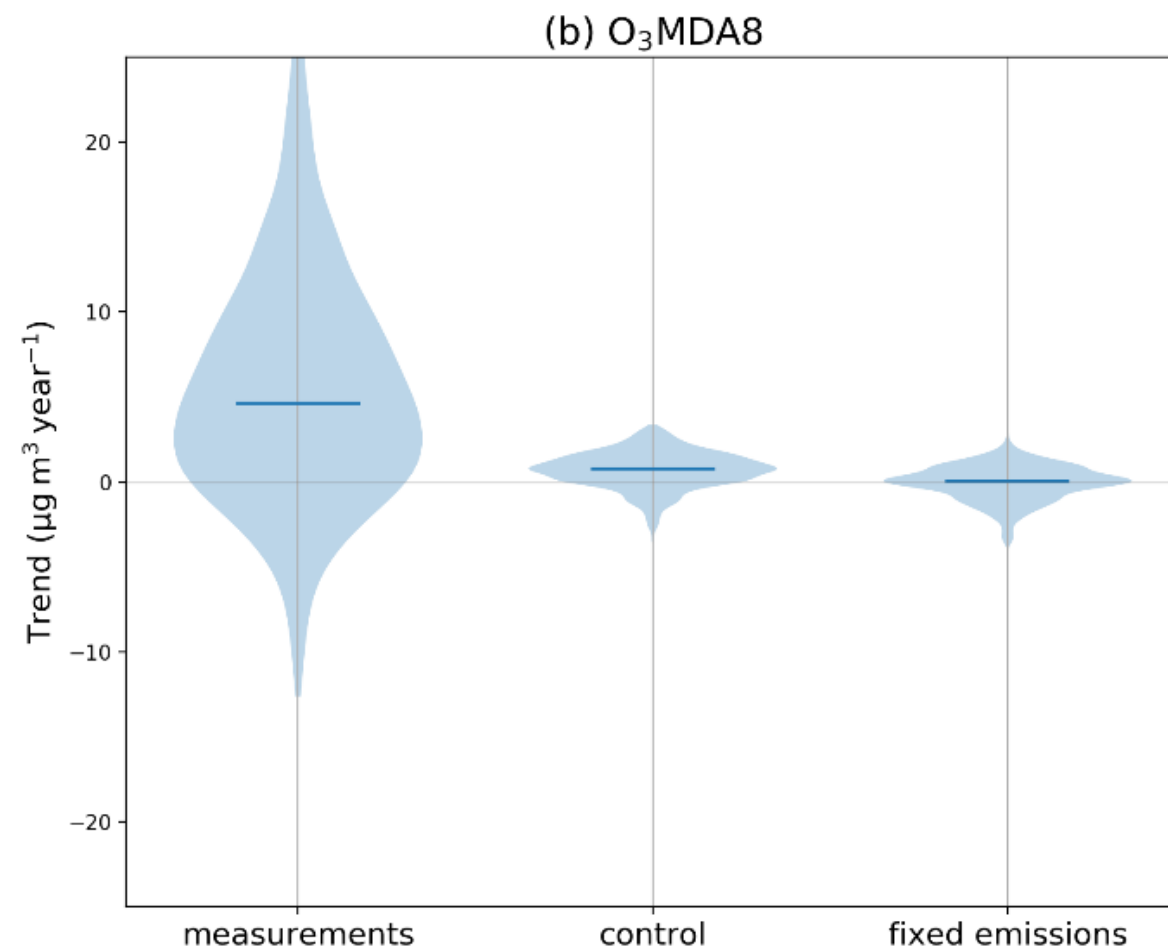


- At the location of each measurement station, the trend in the **measurement data**, **control**, and **fixed emissions** simulations are calculated
- The **control** run matches the **measurement** run reasonably well
- There is no overall trend in the **fixed emissions** run
- This suggests that the trend in PM<sub>2.5</sub> was primarily driven by changes in emissions, with little overall contribution from meteorology
- Using GBD 2017, we calculated that between 2015 and 2017 annual premature mortalities decreased by 150 000 (129 000 – 170 000)



Median trend:    - 3.4 µg m<sup>-3</sup> year<sup>-1</sup>    - 3.9 µg m<sup>-3</sup> year<sup>-1</sup>    - 0.6 µg m<sup>-3</sup> year<sup>-1</sup>

- At the location of each measurement station, the trend in the **measurement data**, **control**, and **fixed emissions** simulations are calculated
- The **control** run records a median positive trend, but underestimates compared with the measurements
- There is no overall trend in the **fixed emissions** run
- Based on the measurement trend, we estimate an increase of 21 000 annual premature mortalities caused by O<sub>3</sub> between 2015 and 2017.



	measurements	control	fixed emissions
Median trend:	$4.6 \mu\text{g m}^{-3} \text{ year}^{-1}$	$-0.7 \mu\text{g m}^{-3} \text{ year}^{-1}$	$0.0 \mu\text{g m}^{-3} \text{ year}^{-1}$



## Thank you for your attention

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### References:

Silver, Ben, C. L. Reddington, S. R. Arnold, and D. V. Spracklen. "Substantial changes in air pollution across China during 2015–2017." *Environmental Research Letters* 13, no. 11 (2018): 114012.

Silver, B., Conibear, L., Reddington, C. L., Knote, C., Arnold, S. R., and Spracklen, D. V.: Pollutant emission reductions deliver decreased PM<sub>2.5</sub>-caused mortality across China during 2015–2017, *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2019-1141>, in review, 2020.

Zheng, B., Tong, D., Li, M., Liu, F., Hong, C., Geng, G., ... & Yan, L. (2018). Trends in China's anthropogenic emissions since 2010 as the consequence of clean air actions. *Atmospheric Chemistry and Physics*, 18(19), 14095-14111.

