

Potential Health and Economic Impacts of Shifting Manufacturing from China to Indonesia or India

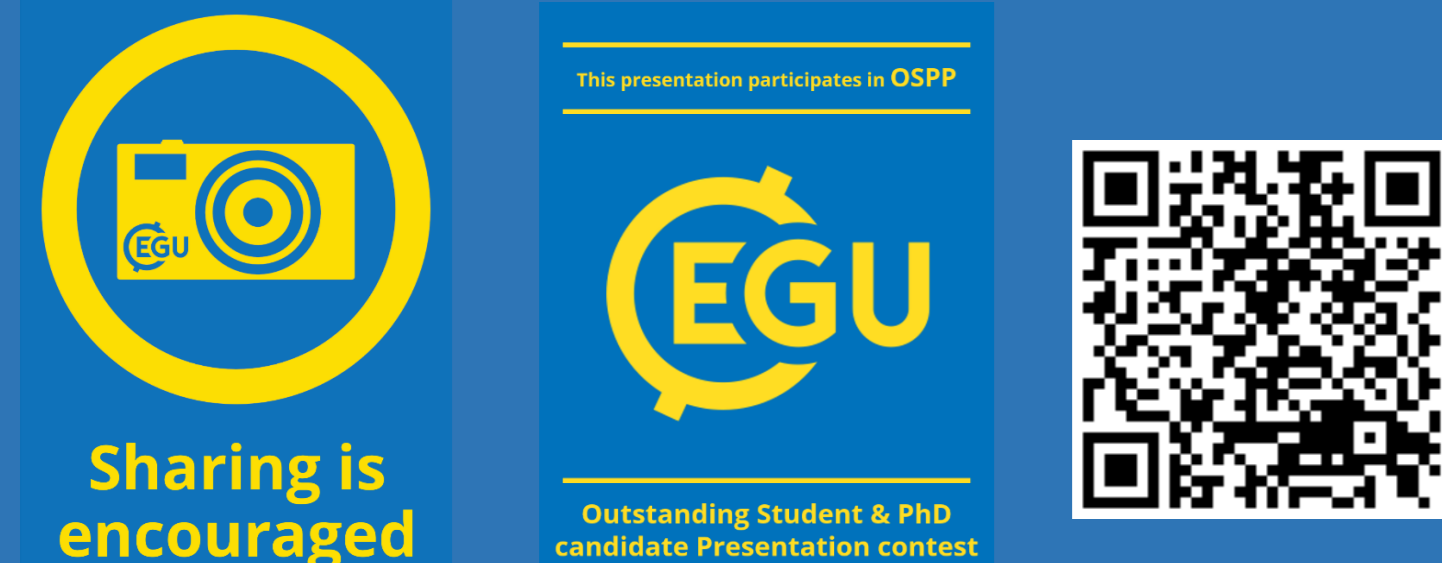
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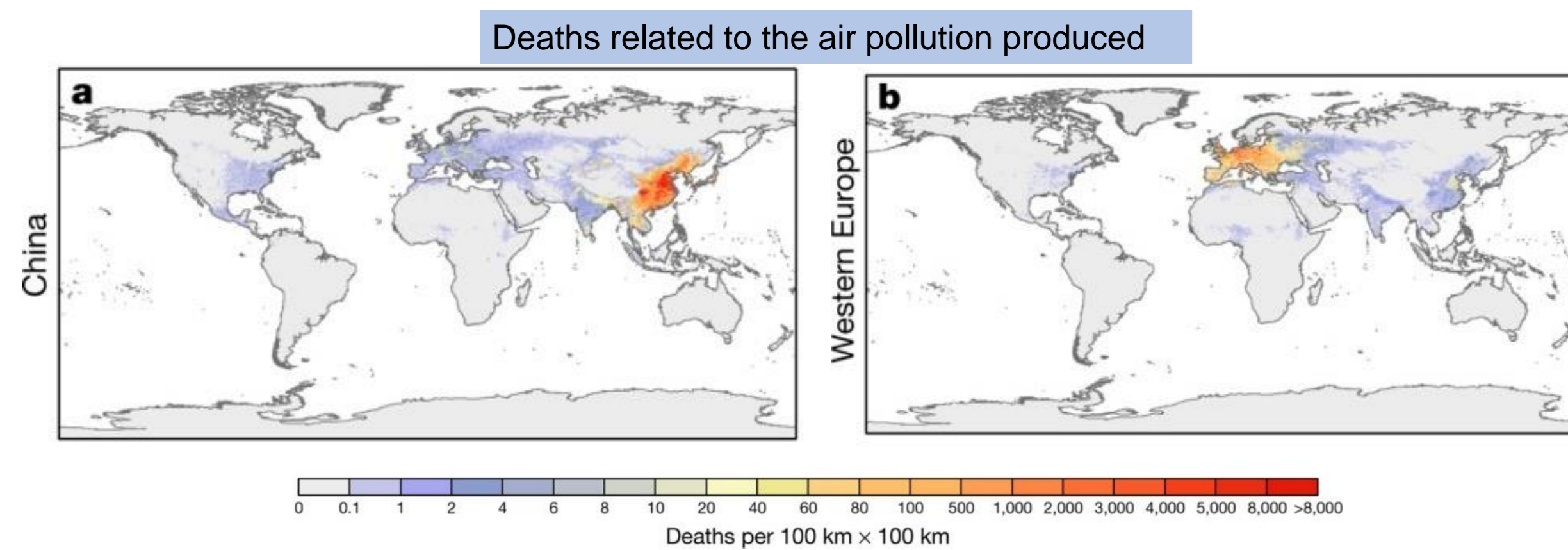
Motivation

• The COVID-19 pandemic is reshaping the global trade and supply chains. (Sherman, E., 2020; Hayakawa and Mukunoki, 2021)

94% of the Fortune 1000 are seeing coronavirus supply chain disruptions: Report

Japan helps 87 companies to break from China after pandemic exposed overreliance

• Health impacts of PM_{2.5} attributed to international trade are significant. (Zhang et al., 2017)



Objective

This study aims to explore the potential risks and benefits to human health and social economy of reshaping global manufacturing, using the Community Earth System Model, the Integrated Exposure-Response (IER) model and Willingness To Pay (WTP) method.

Conclusion

- Significant effects on PM_{2.5} related mortality and economic cost for these deaths were seen in many **East, Southeast and South Asian countries**, particularly those immediately downwind of China, Indonesia and India.
- Shifting manufacturing to India impacts more countries than shifting to Indonesia.
- The changes in economic costs of China, Indonesia and India were much smaller than that in **economic benefits** due to the manufacturing shift.

Morally, part of the benefits of economic activity should be used to compensate the neighboring communities where mortality increases occur.

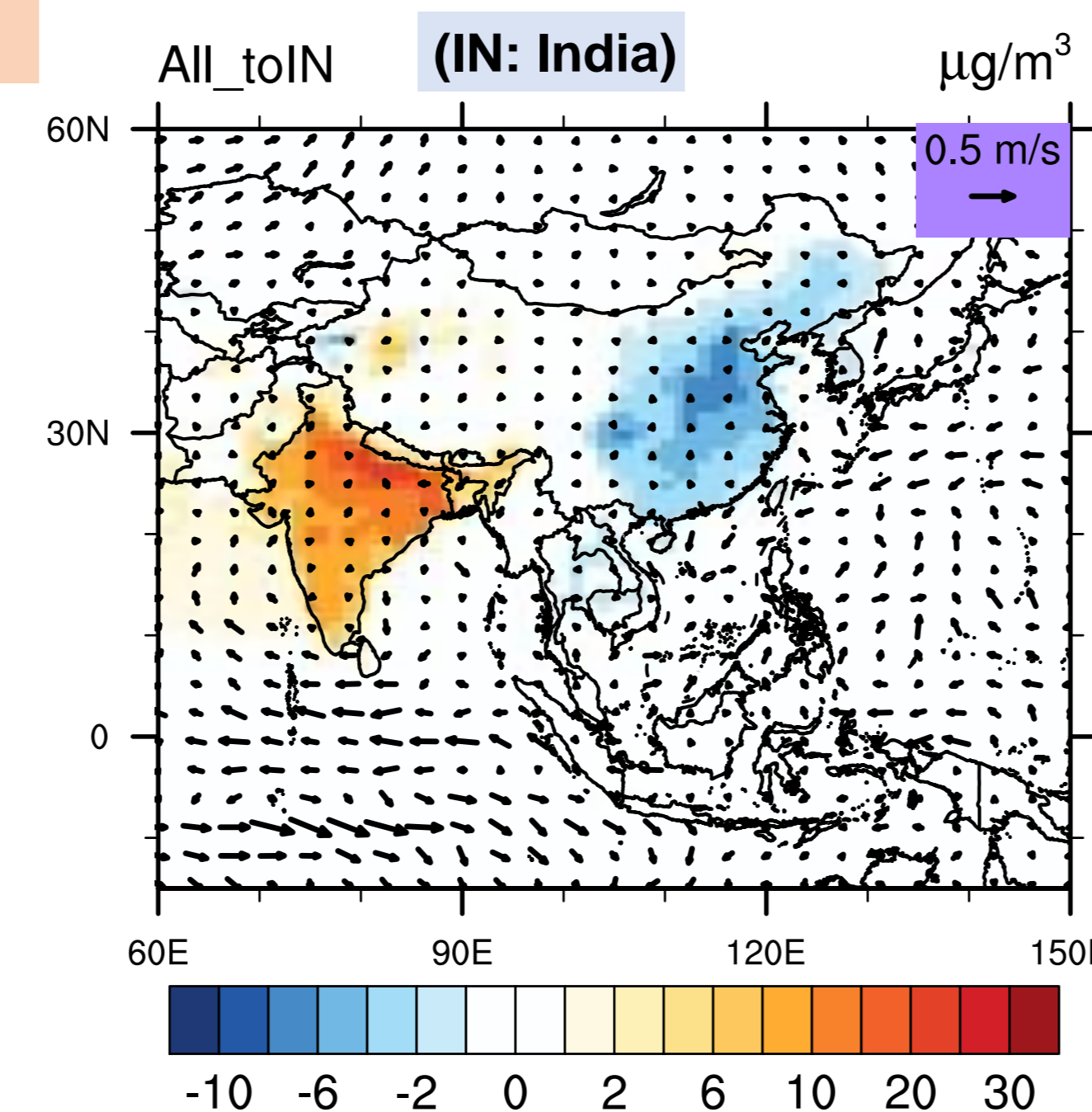
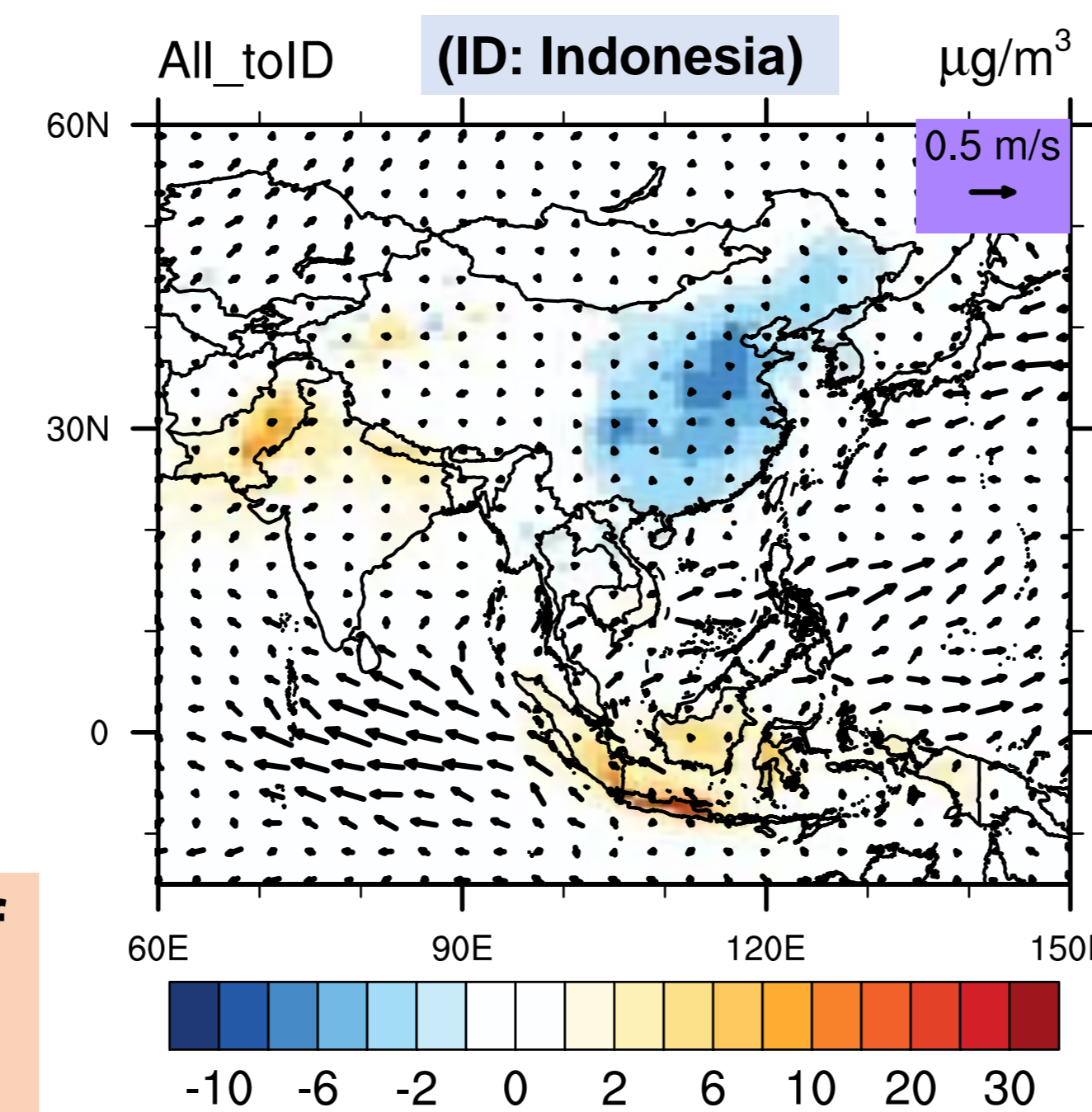
Results

Indonesia

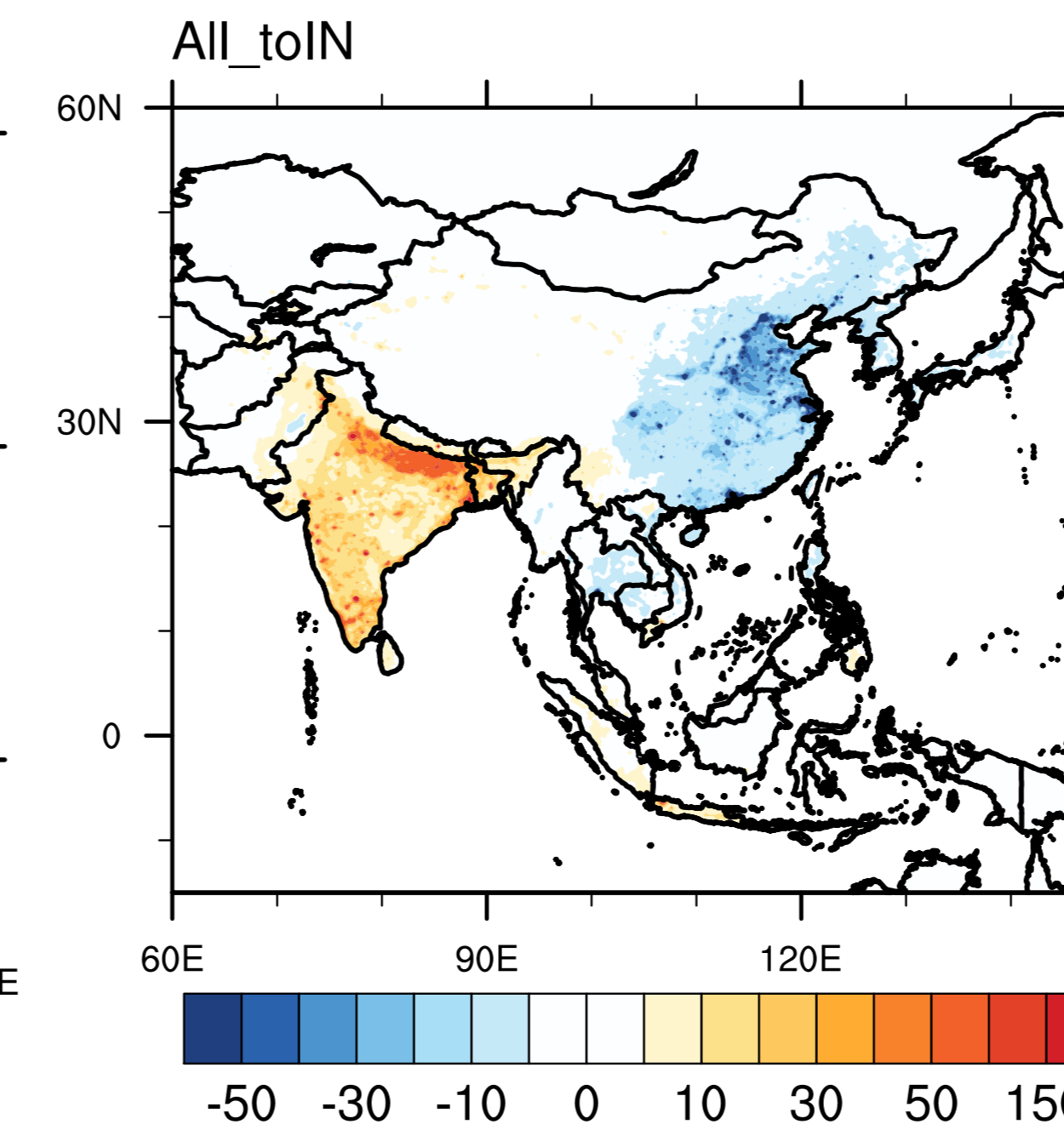
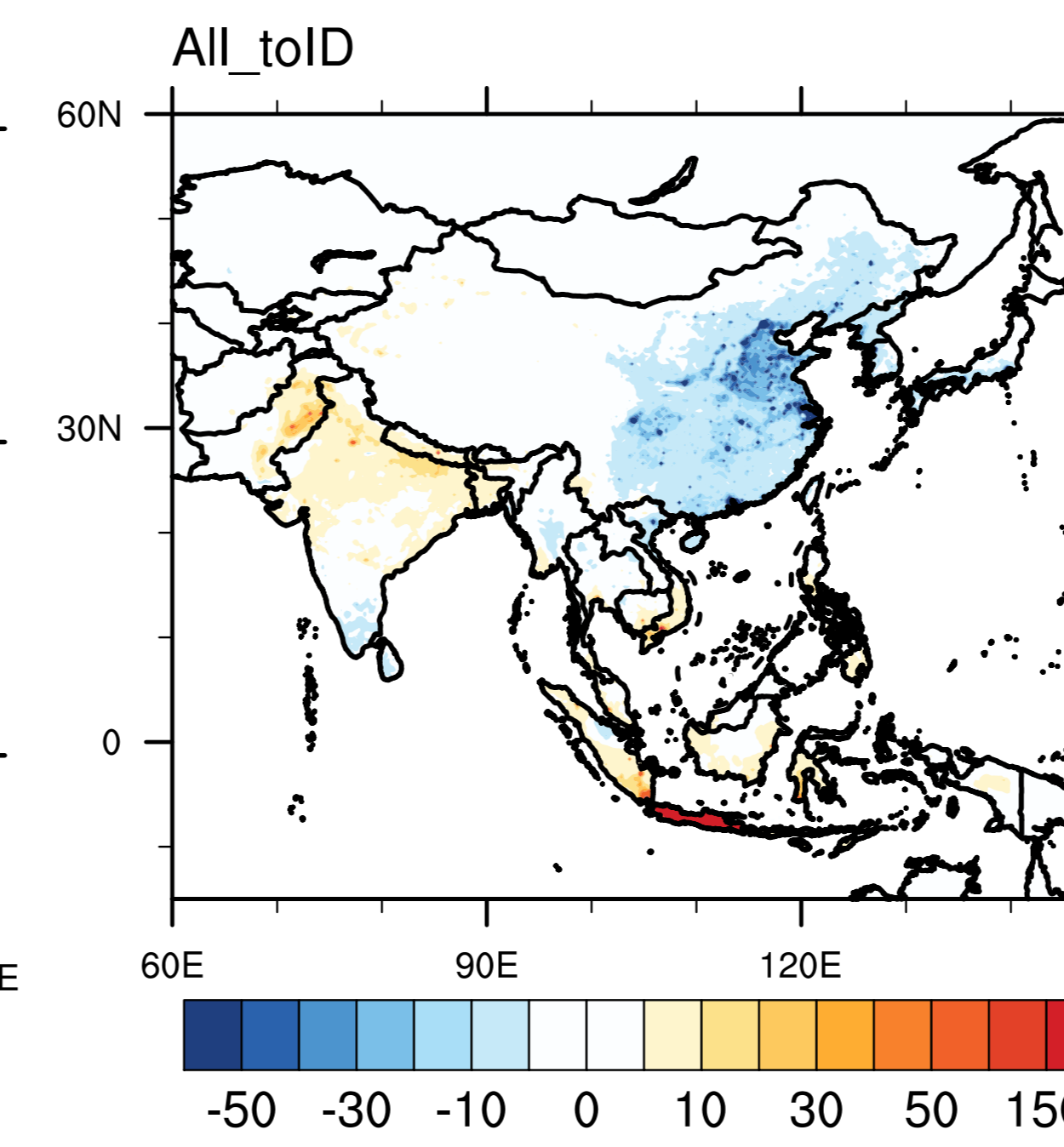
Transferring all of export-related production lines from China to

India

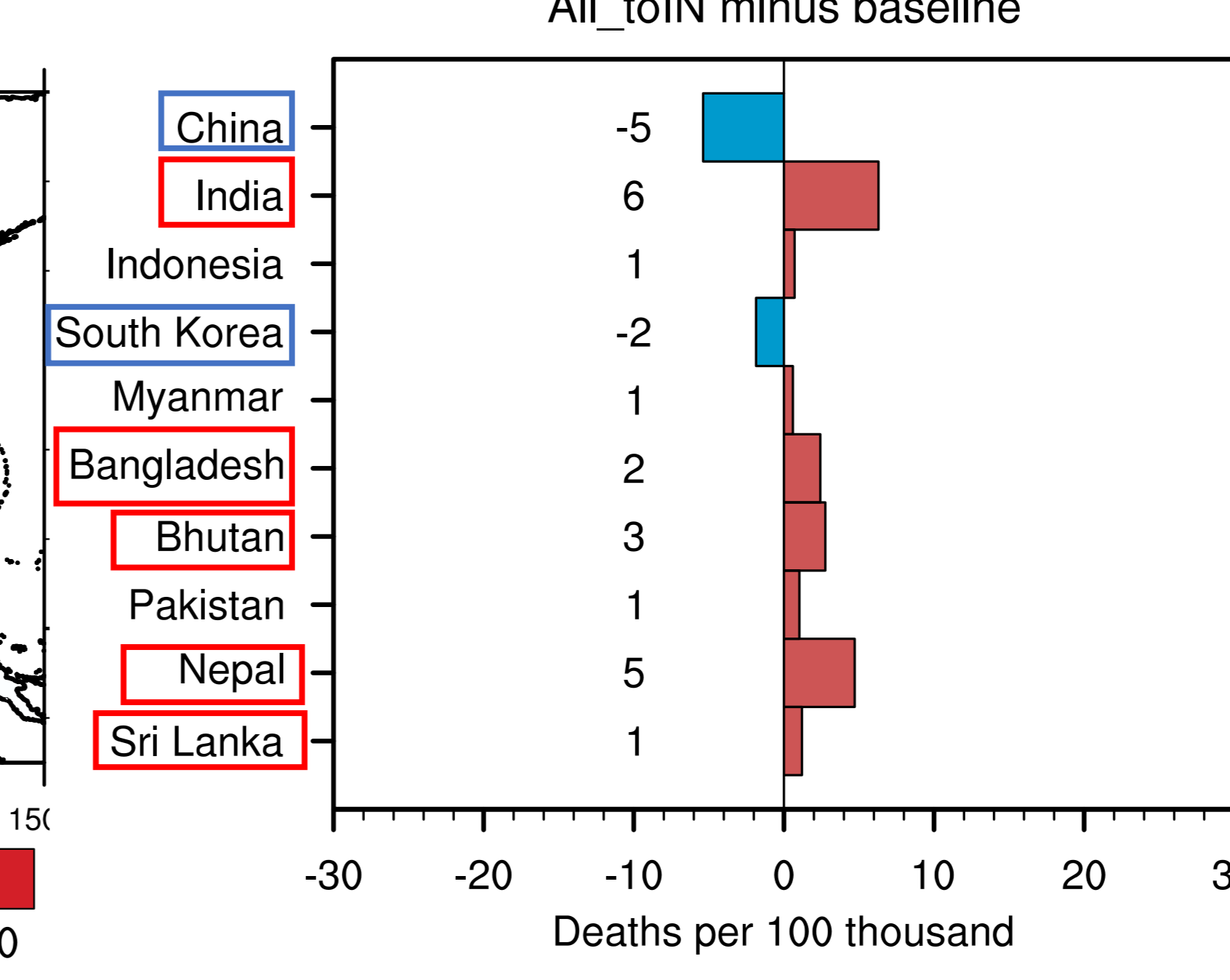
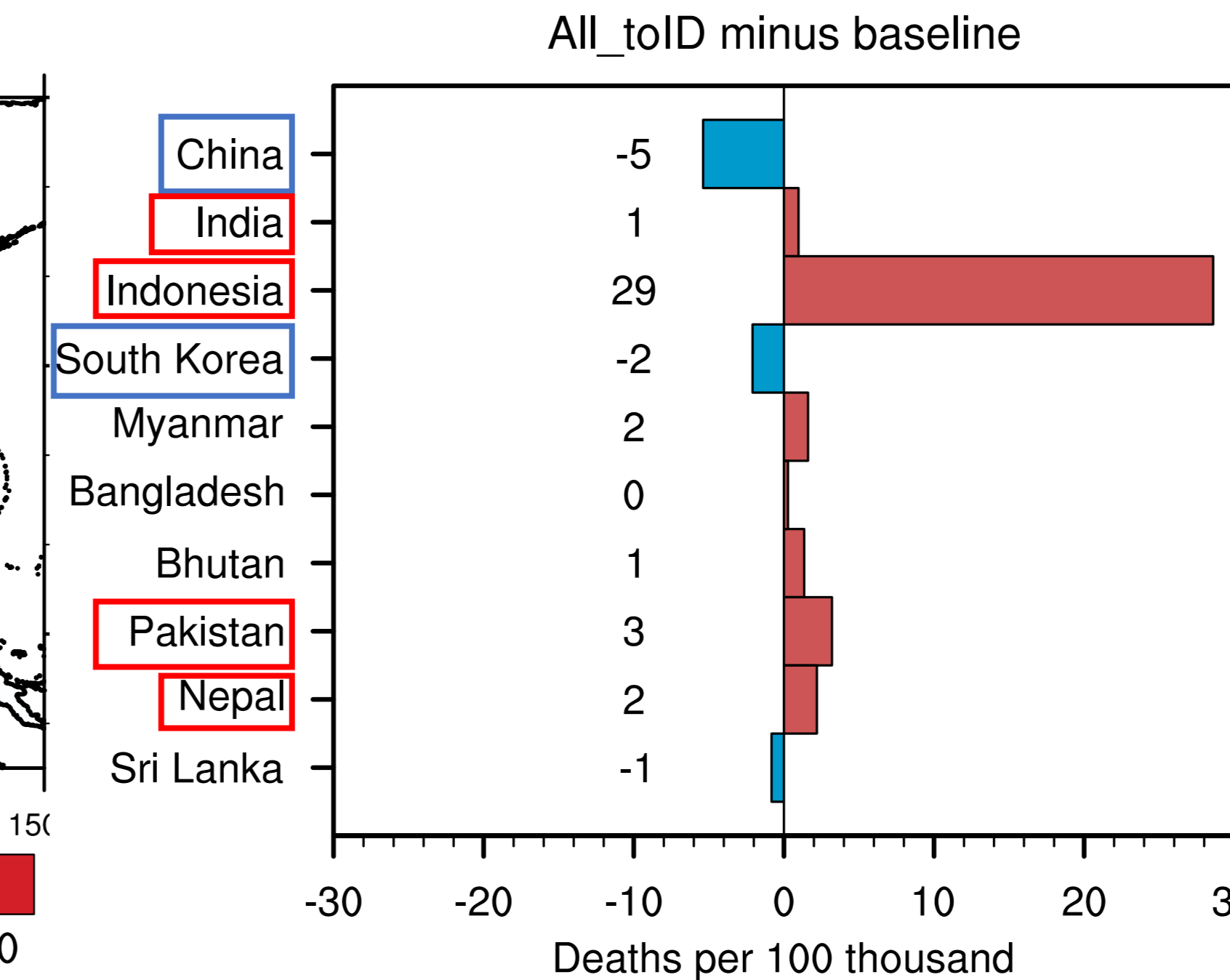
PM_{2.5} changes & Annual mean wind



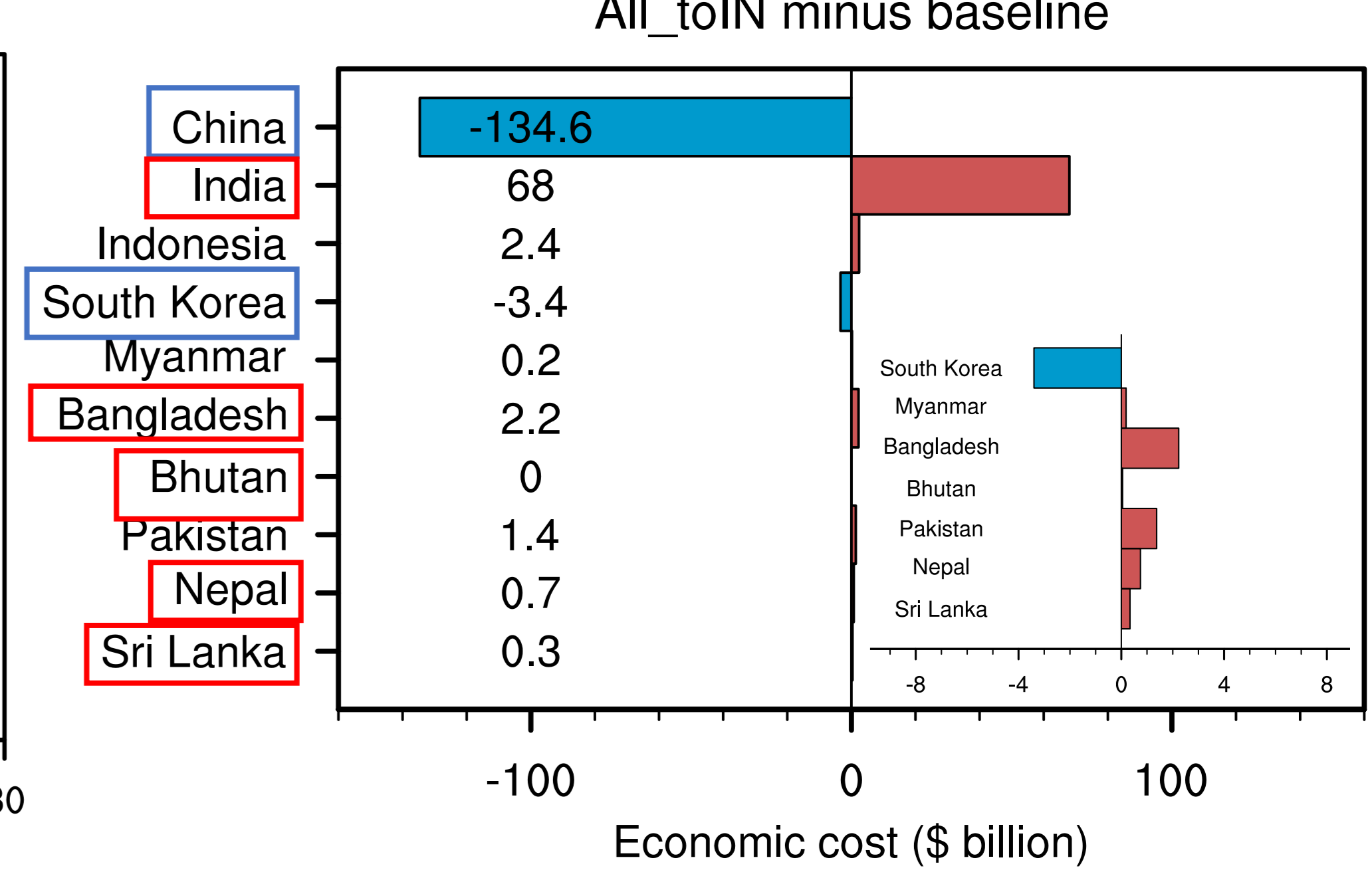
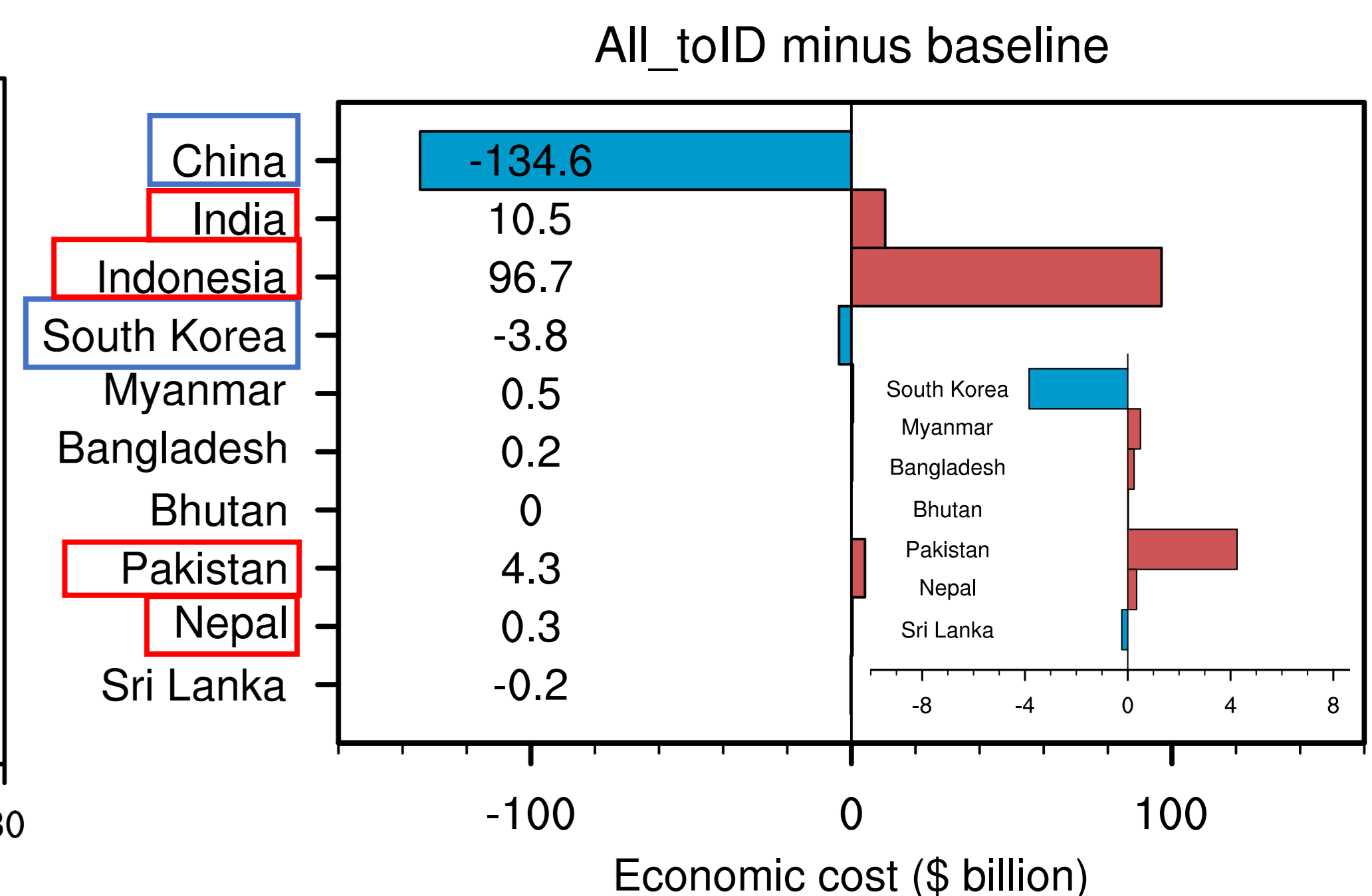
Changes in attributable mortality for PM_{2.5}



Changes in deaths per 100,000



Changes in attributable economic cost

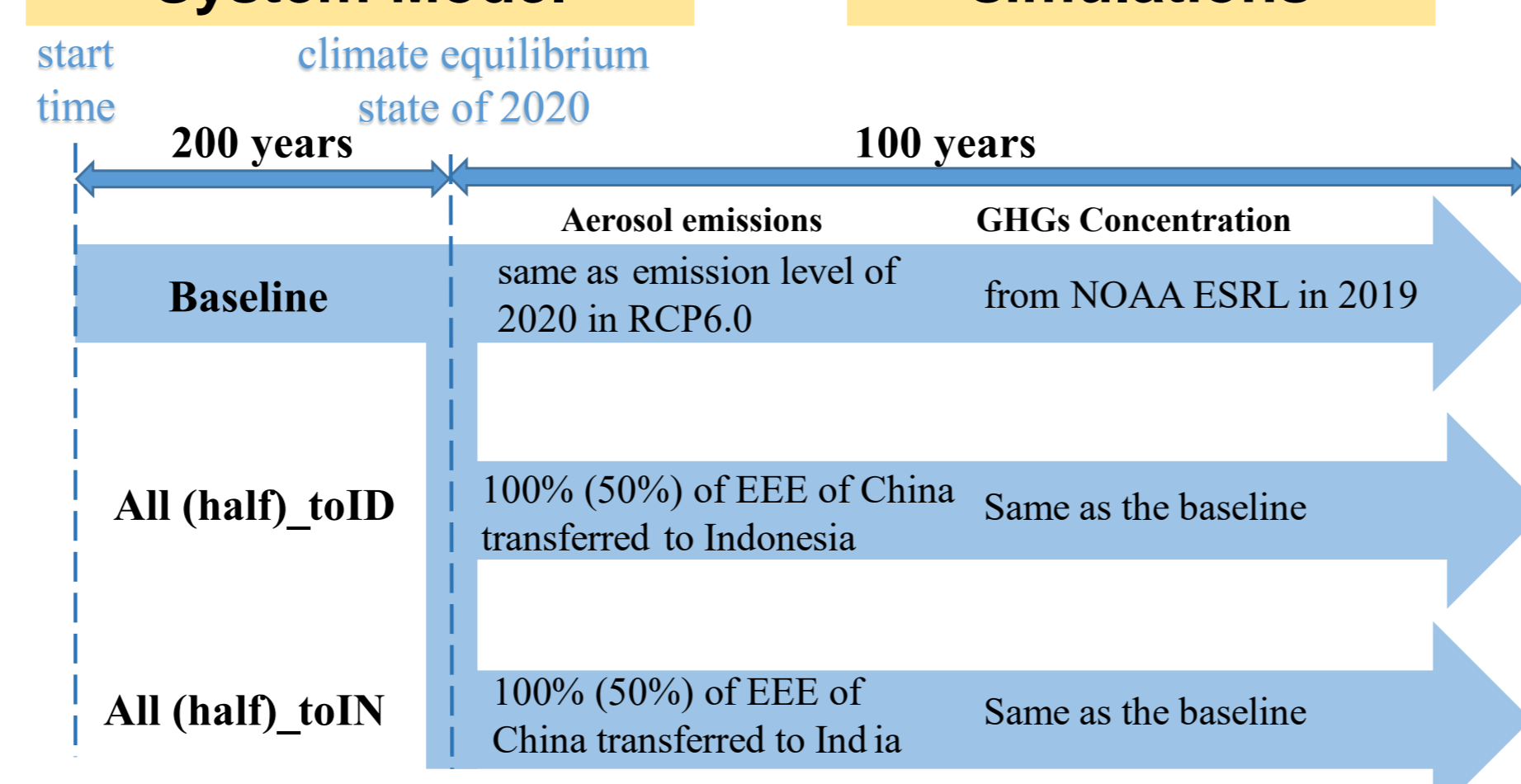


Economic assessment

Country	Economic benefits (billion USD)		Economic cost for PM _{2.5} related mortality (billion USD)	
	Shift to Indonesia	Shift to India	Shift to Indonesia	Shift to India
China	-2680 (18.3% of GDP)	-2680 (18.3% of GDP)	-134.6 (0.9% of GDP)	-134.6 (0.9% of GDP)
Indonesia	3460 (337% of GDP)	/	96.7 (9.4% of GDP)	2.4 (0.2% of GDP)
India	/	2091 (84.3% of GDP)	10.5 (0.4% of GDP)	68 (2.7% of GDP)

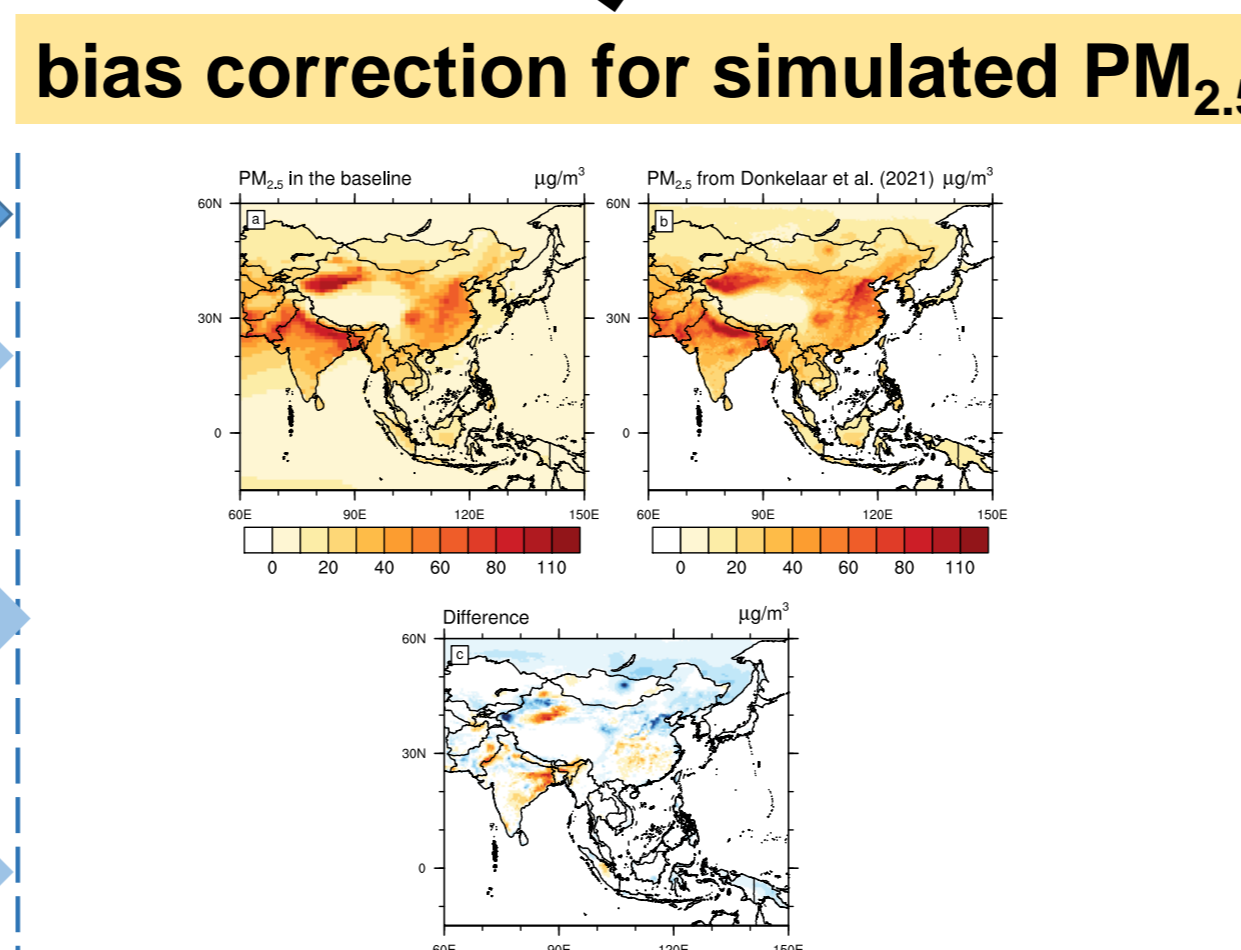
Method

Community Earth System Model



PM_{2.5} & wind simulations

Multiple Linear Regression



Integrated Exposure-response Functions

$$RR(C) = 1 + \alpha[1 - \exp(-\gamma(C - C_0)^\delta)] \text{ for } C > C_0$$

$$RR = 1 \text{ for } C \leq C_0$$

(Burnett et al., 2014)

RR(C): relative risks attributed to exposure of PM_{2.5} concentration C
C₀: theoretical minimum-risk concentration
α, γ, and δ: determine the overall shape of the concentration-response relationship

Willingness To Pay

$$VSL = \frac{\partial WTP}{\partial R}$$

(Braathen et al., 2009)

VSL: the marginal value of a reduction in the risk of dying
R: the risk of dying
∂WTP: an individual's "Willingness To Pay" to reduce mortality risk by ΔR

Acknowledgments

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