

Sensitivity of China's ozone air quality to 2000-2050 global changes of climate and emissions

**Lulu Shen¹, Yuxuan Wang¹, Shiliang Wu²,
Loretta Mickley³, Jiming Hao¹**

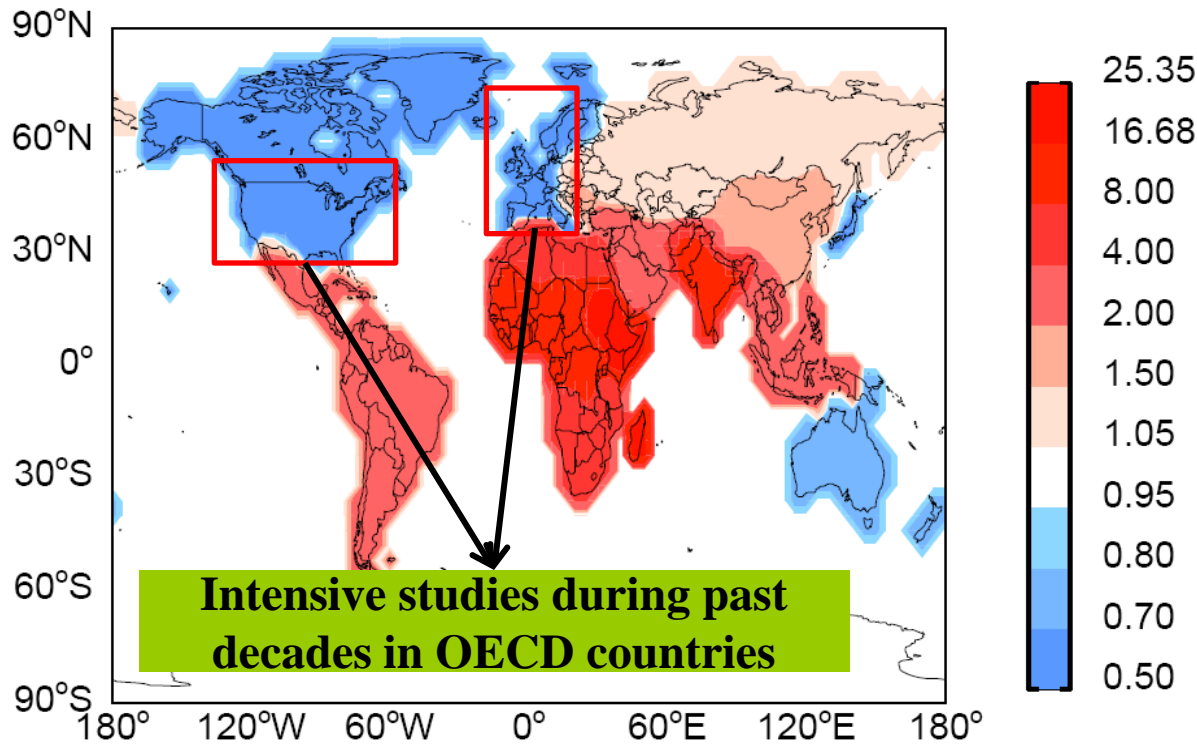
¹Center for Earth System Science and School of Environment, Tsinghua University

²Dept. Of Geological and Mining Engineering and Sciences, Michigan Technological University

³School of Engineering and Applied Sciences, Harvard University

Research Background

NO_x Emissions Ratio : 2050/2000



Economic development in **developing countries** is the driving factor for the overall global increase of emissions for 2000-2050. We should pay more attention to these regions.

GISS GCM 3

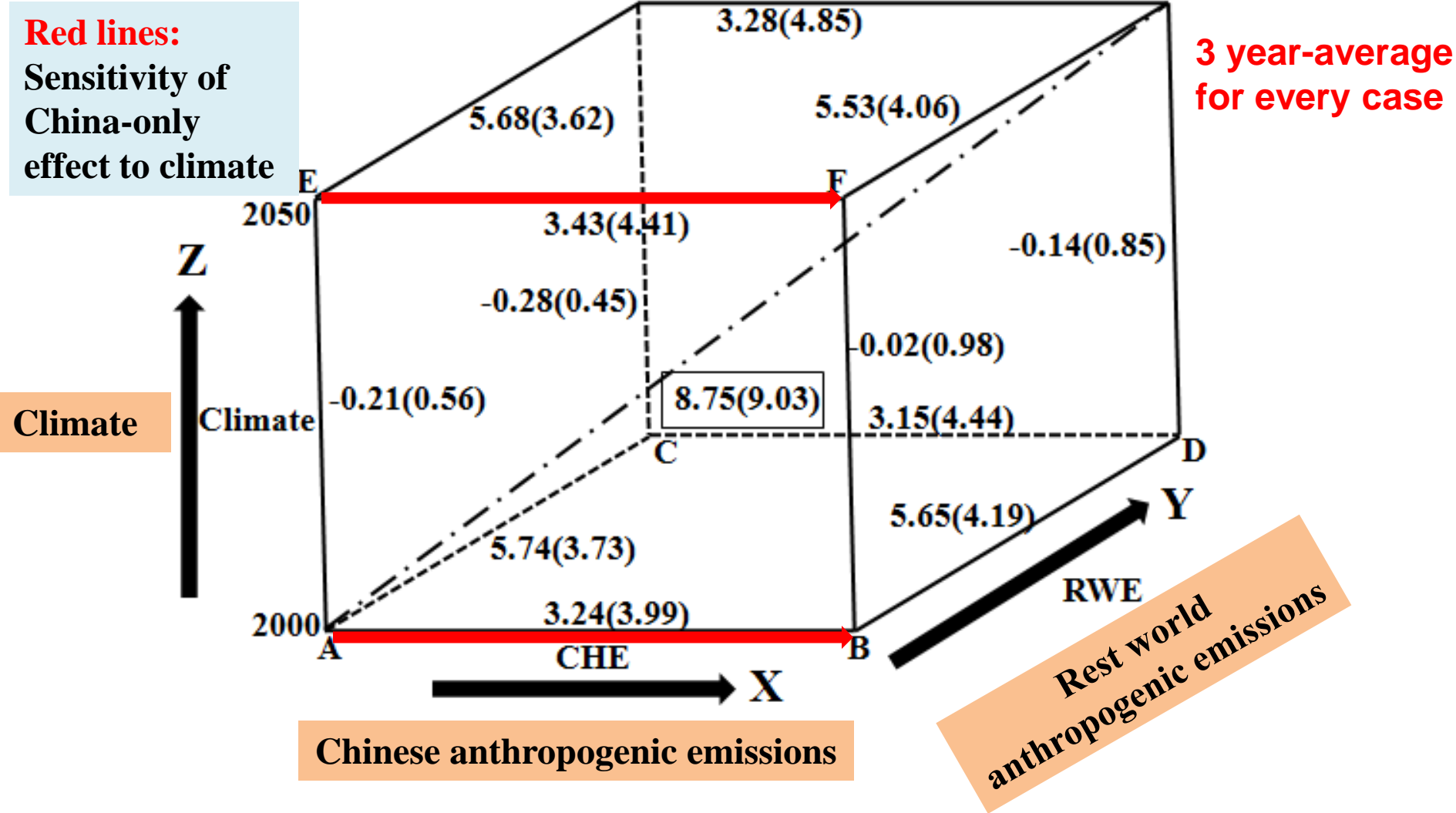
Horizontal resolution of 4° x 5°
23 vertical layers extending to 85 km

IPCC
A1B

GEOS-Chem

detailed ozone-NO_x-VOC-
aerosol chemistry

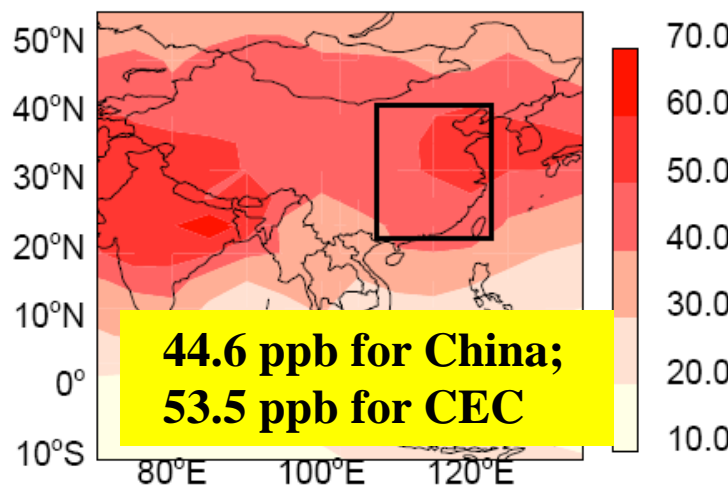
Sensitivity simulations — 8 cases



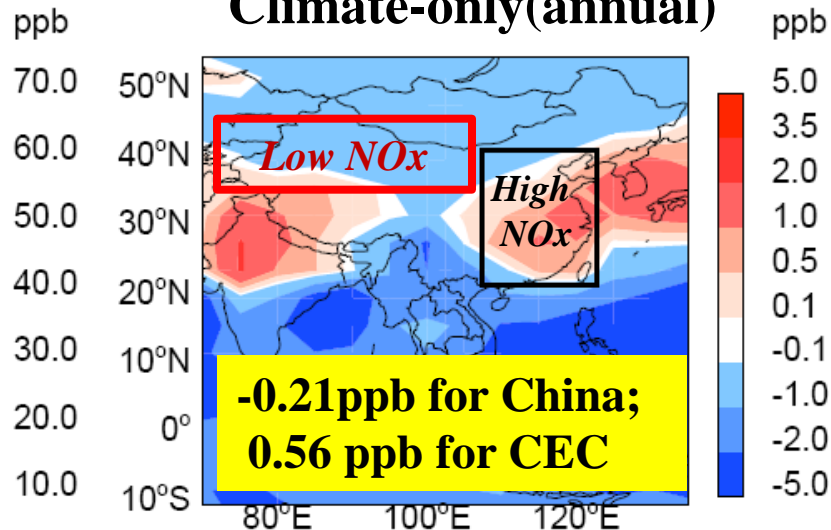
The numbers (unit: ppbv) displayed along the axes represent the differences between the cases in annual-mean afternoon ozone at the surface averaged over China and over Central East China.

Effect of 2000-2050 climate change alone

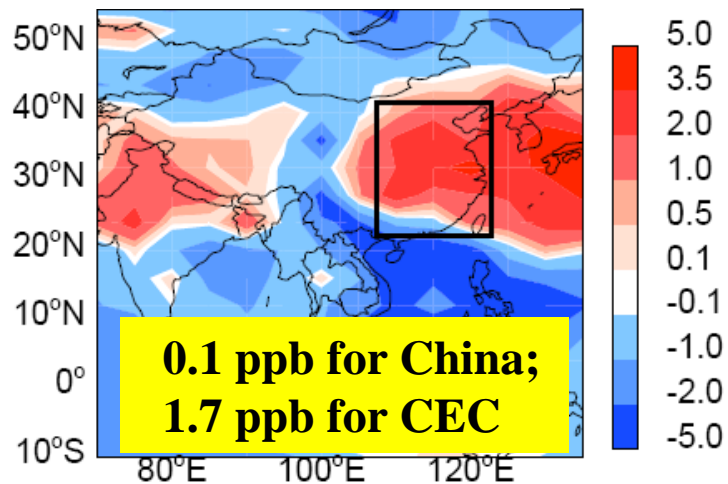
2000 base



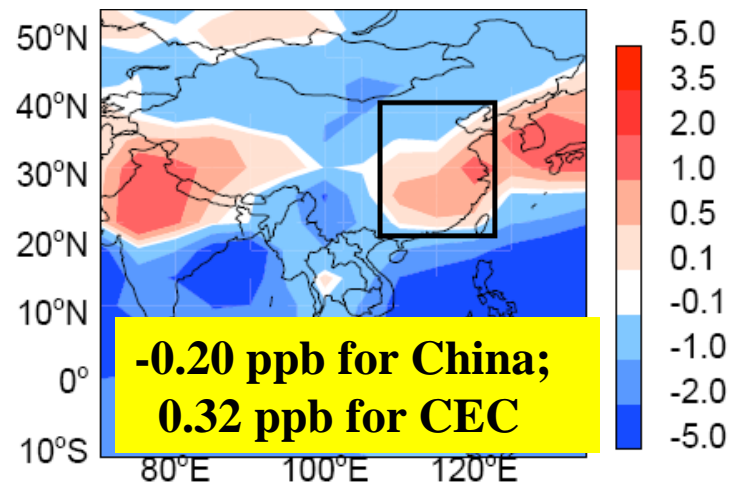
Climate-only(annual)



Climate-only(summer)



Climate-only(annual, no biogenic growth)

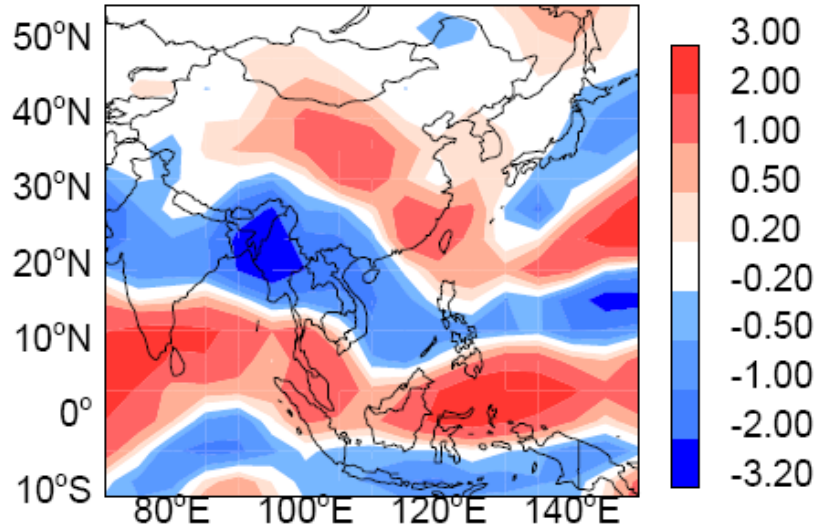


CEC: Central East China (black rectangle)
58% China's population; 76% China's GDP;
62% anthropogenic NO_x (present days)

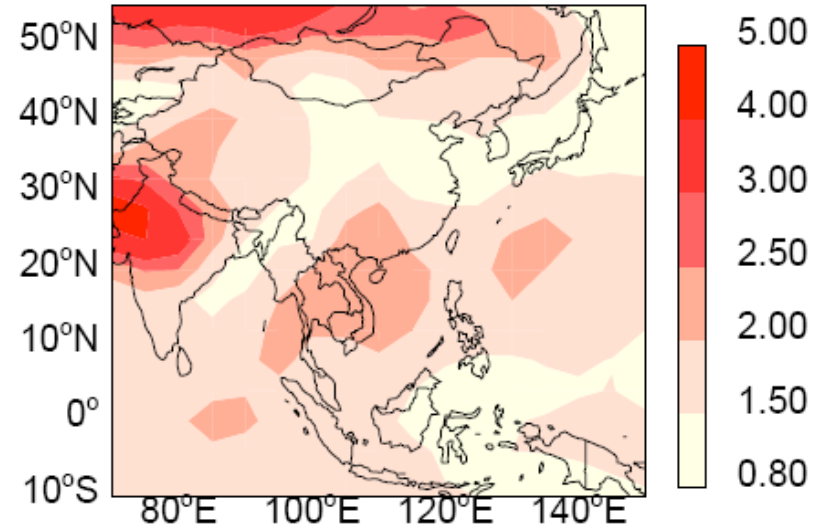
The impact from climate in CEC
43% from biogenic increase;
57% from meteorology

Meteorological Factors Changes in China

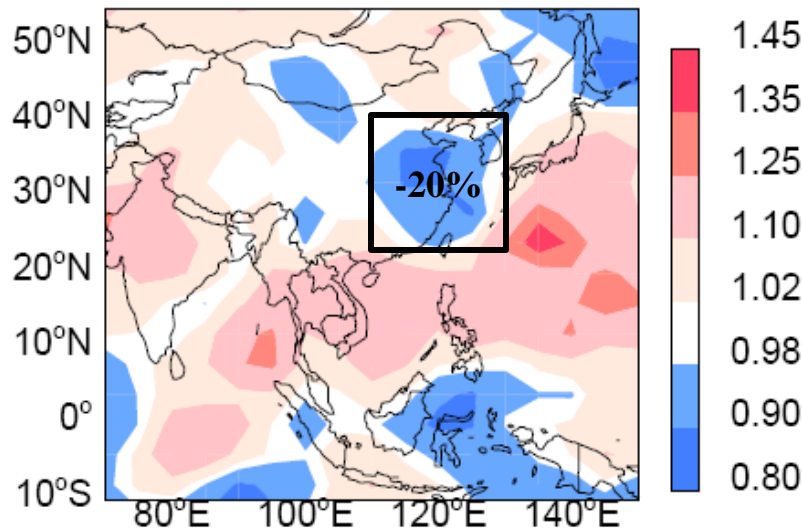
Precipitation (+5%)



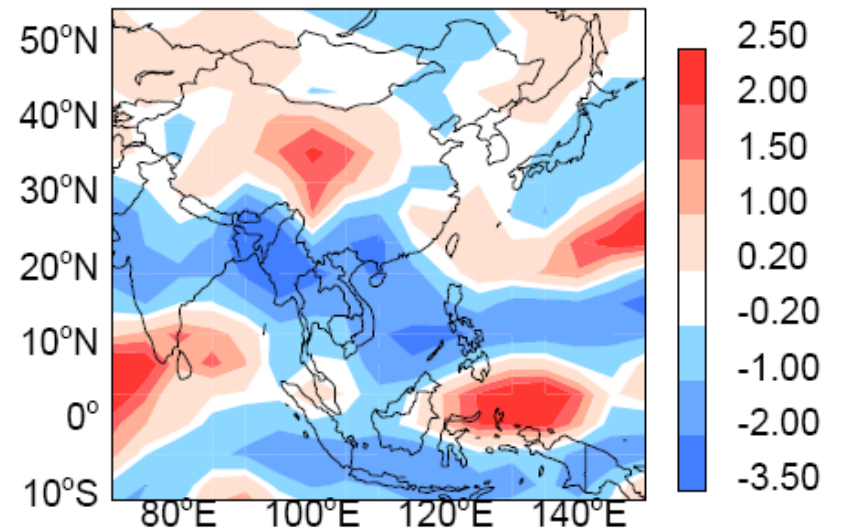
Temperature(+1.8K)



PBL

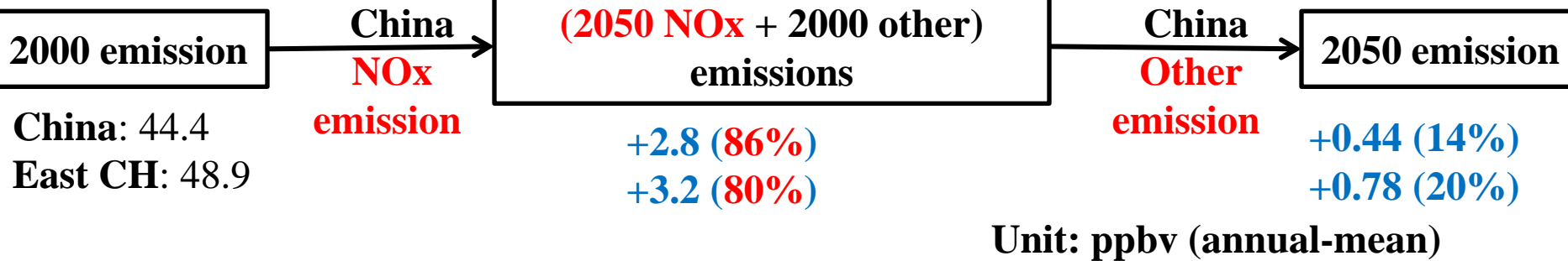
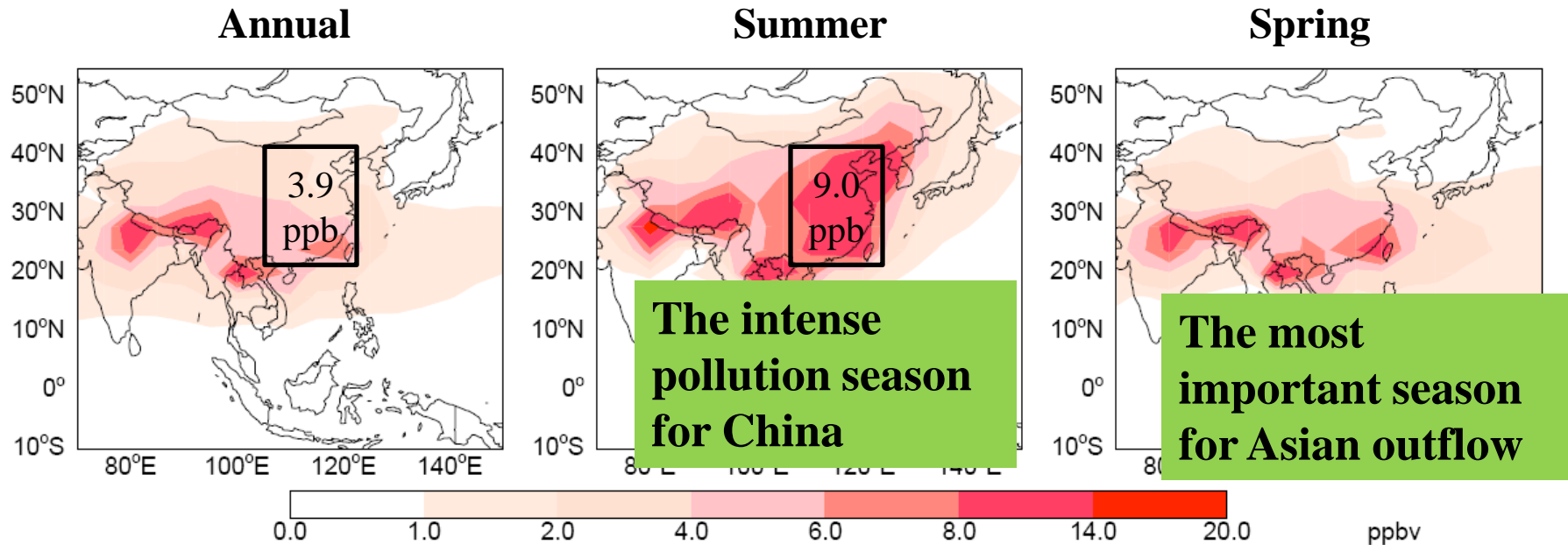


Convective Mass Flux



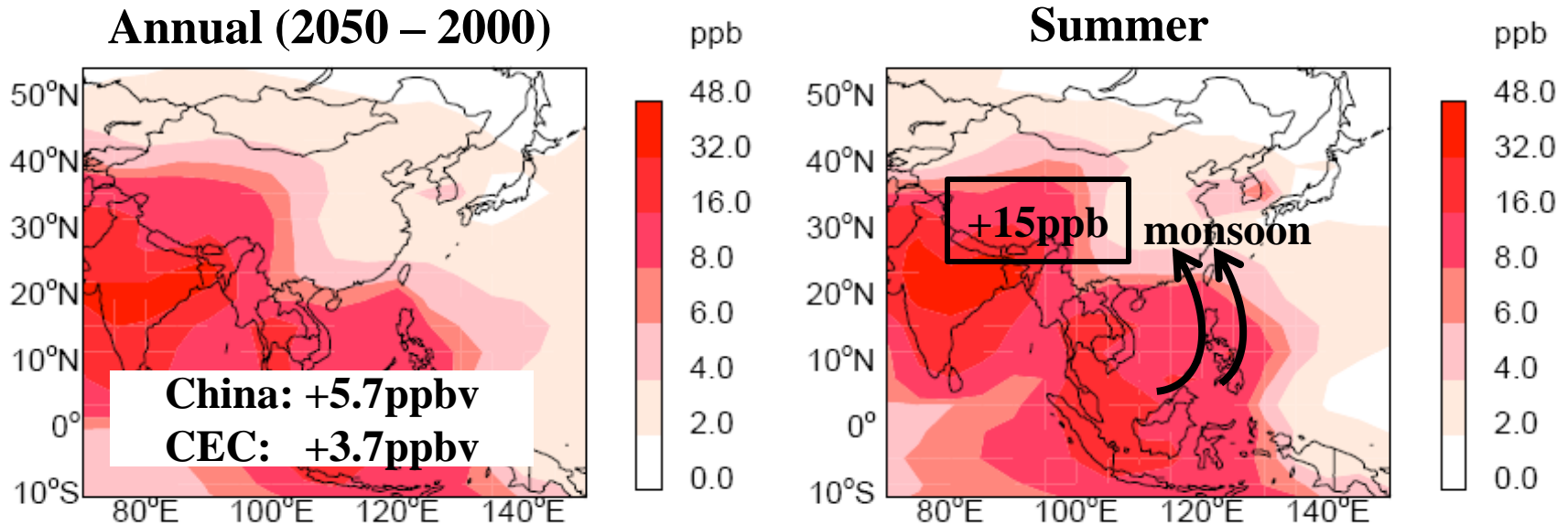
Lower ventilation rates

Effect of Chinese anthropogenic emissions alone



Control of anthropogenic NO_x emissions is the top priority for Chinese policy-makers to mitigate ozone pollution

Effect of rest world anthropogenic emissions alone

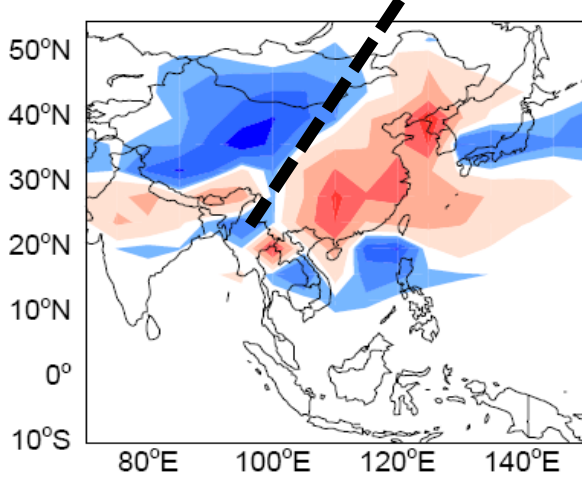


From 2000 to 2050, NO_x and VOCs anthropogenic emissions in India increase by 800% and 300% respectively.

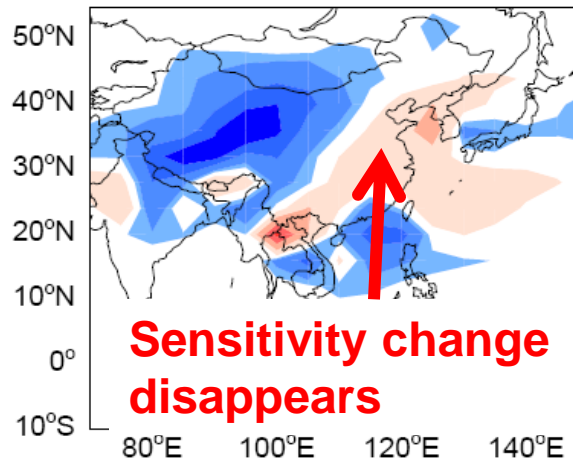
The challenge for policy-makers to protect the fragile ecosystems over the Tibetan Plateau and Himalayan Glaciers is to find an **effective trans-boundary pollution control policy** involving both China and India.

Sensitivity of China-only effect to climate

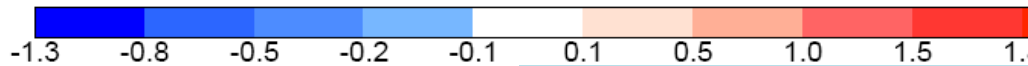
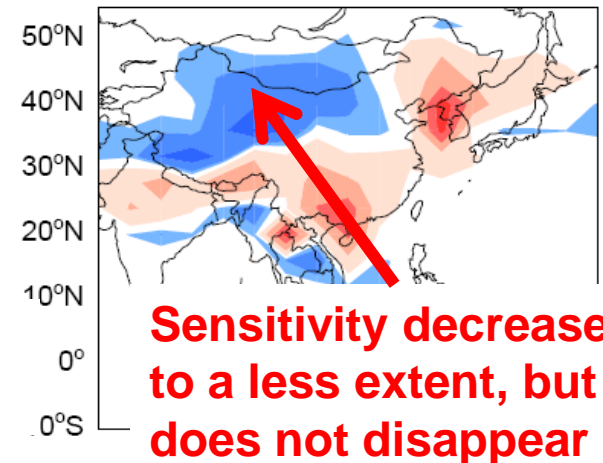
Summer-mean difference



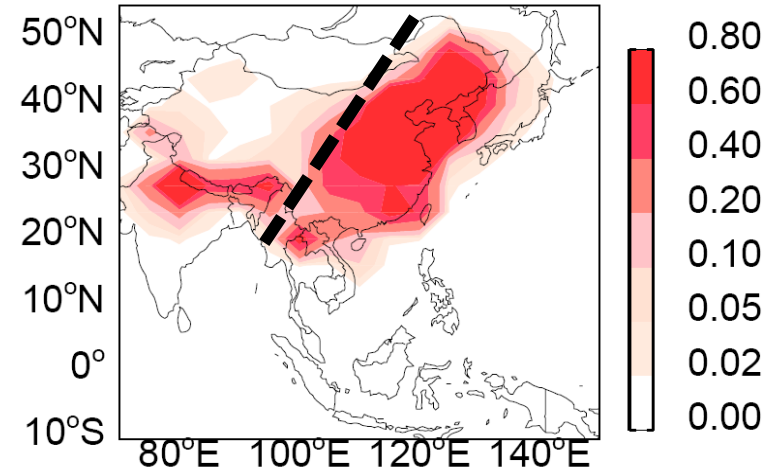
No biogenic emis change



No anth. emis change in East



Delta NO_x Brought by Emission change



East China

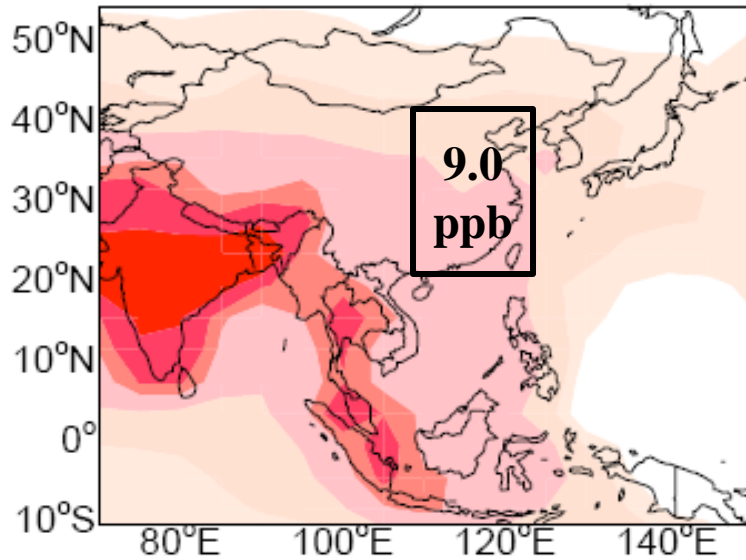
- (1) Biogenic emissions increase ozone production efficiency from NO_x;
- (2) Background ozone impact decreases in future climate

West China

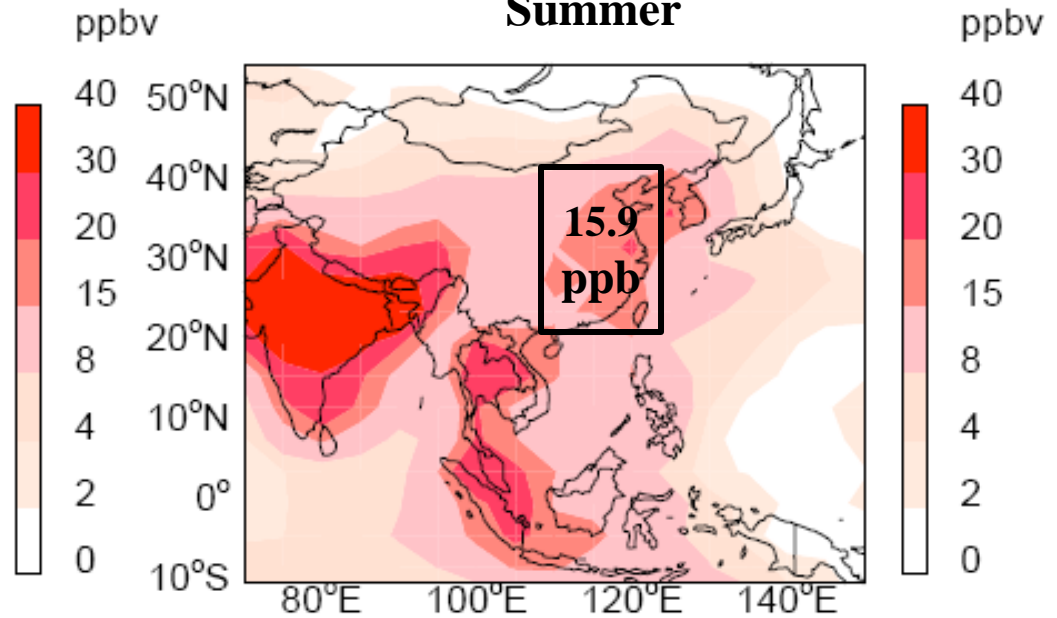
- (1) More water vapor will accelerate ozone destruction rate under low-NO_x conditions
- (2) Reduced transport of ozone from east to west

Combined effect of global change on surface ozone

Annual



Summer



The effect of the 2000-2050 global changes on annual afternoon-mean surface ozone over China and Central East China

2000-2050 change	China		Central (CEC)	
	ppbv	Percentage (%)	ppbv	Percentage (%)
China emissions	3.3	37.4	4.4	49.0
RW emissions	5.6	64.6	3.90	43.2
Climate	-0.2	-1.9	0.7	7.9
total	8.7	100	9.0	100

Conclusions

- Significant changes in surface ozone over China as a result of the 2000-2050 changes in global climate, Chinese emissions, and global emissions;
- Relative contributions from the individual factors vary by region, notably the adverse impact of climate change on ozone over the populated east China;
- The sensitivity of surface ozone to a given change of domestic emissions differs between east and west China;
- **Policy implications:** controlling domestic NO_x emissions as the first priority regardless of climate change, but more so under climate change

Thank You !

My email: sll.tsinghua@gmail.com