Effect of the transport on ozone pollution episodes in North China

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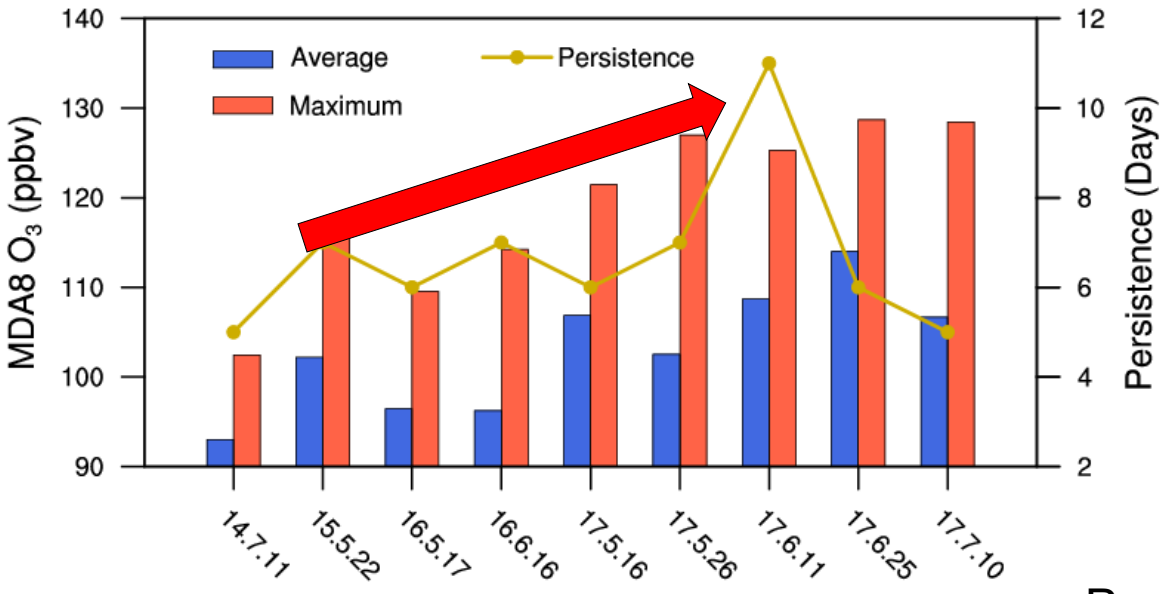
Increased ozone pollution episodes in North China (NC)



From 2014 to 2017:

- More frequent episodes
- Higher O_3 concentrations
- Longer persistence

Definition of ozone pollution episodes

- Observed MDA8 O_3 concentrations averaged over North China (36.5°-40.5°N, 114.5°-119.5°E) larger than 80 ppbv
- Persistence of over 5 days

Possible reasons **Local**

- More favorable weather conditions
- Higher O_3 chemical production (due to changes in emissions)
- Decreased $PM_{2.5}$ (Li et al., 2019, PNAS)

Effect of O_3 transports?

Data and methods

Data and model

- National air quality monitoring network of China
- MERRA2 reanalyzed data of 0.5x0.625 in Asia Region
- GEOS-Chem, tagged O_3 global simulation
- GEOS-Chem, tropchem nested AS simulation

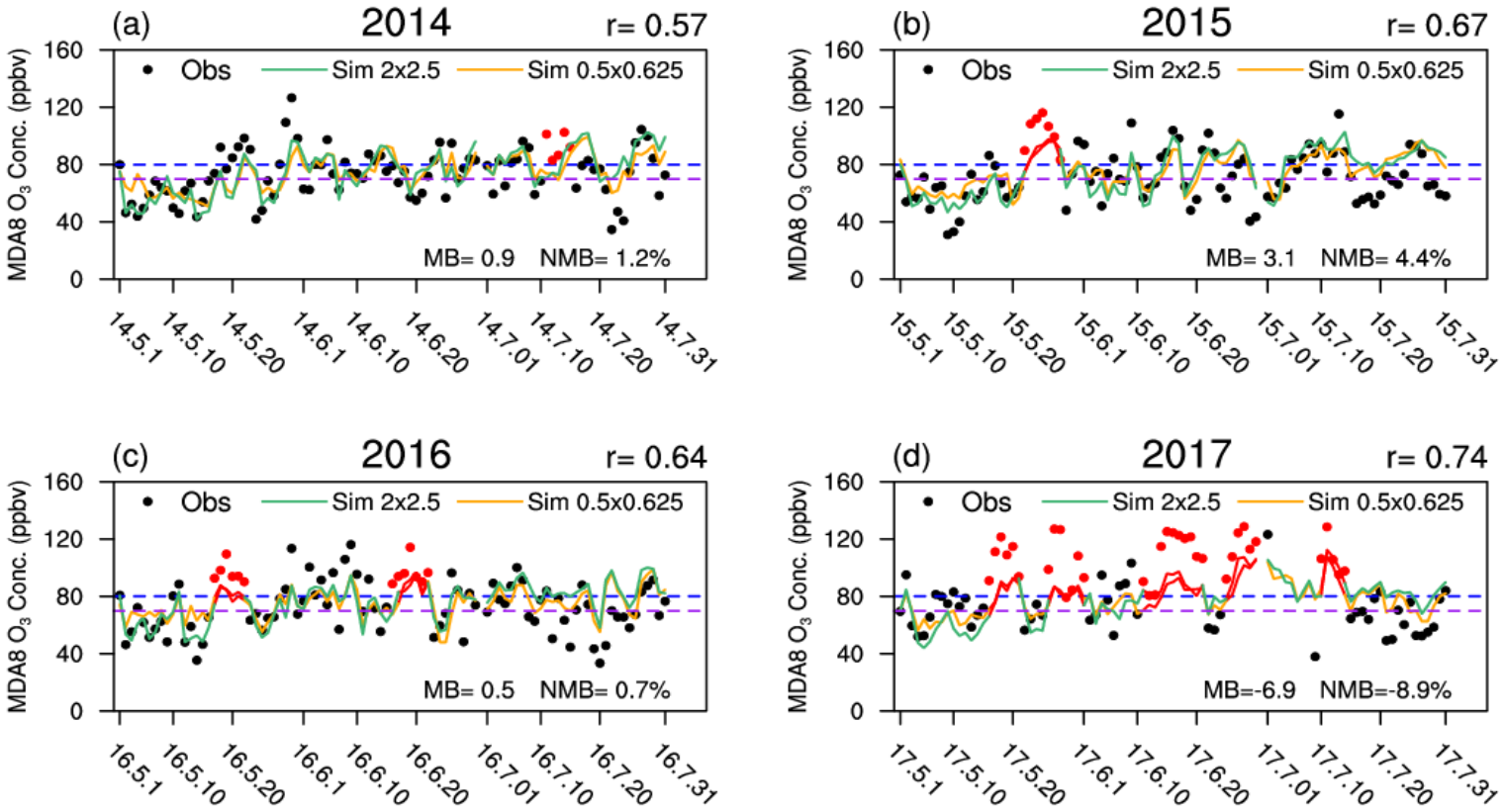
MEIC inventory over 2014-2017

Methods

- Composite analysis
- Backward trajectory
- Tagged O_3 simulations
- Sensitivity experiments

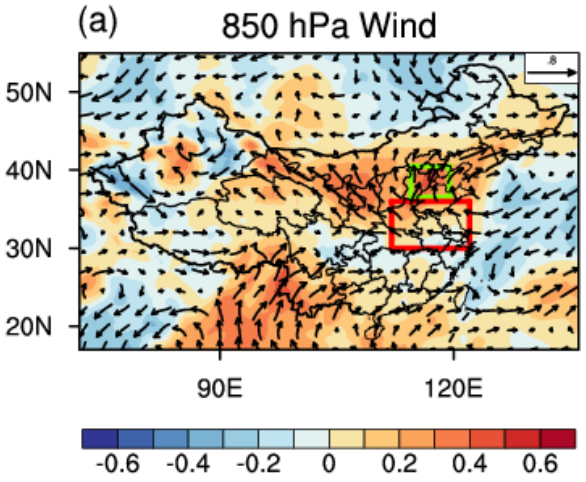
- Anomalous winds during the episodes
- Where the air comes from
- Quantifying the contributions of O_3 from other regions
- Evaluating effects of emission reduction on the episodes

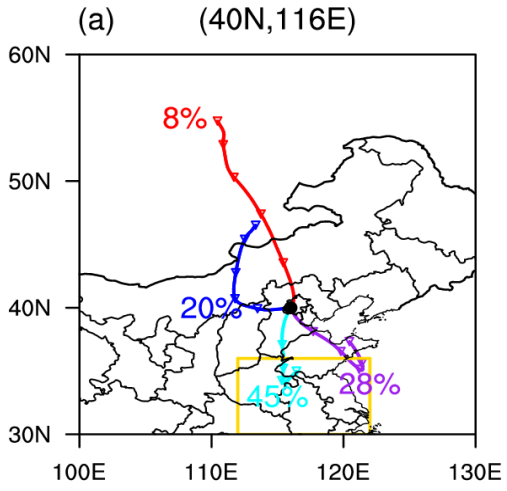
Model evaluation

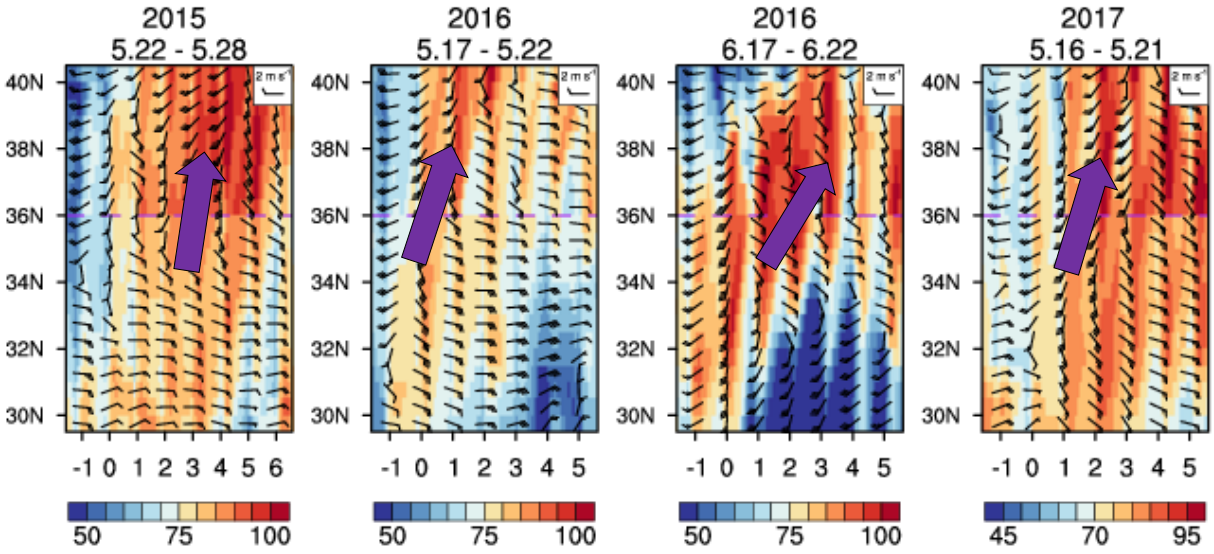


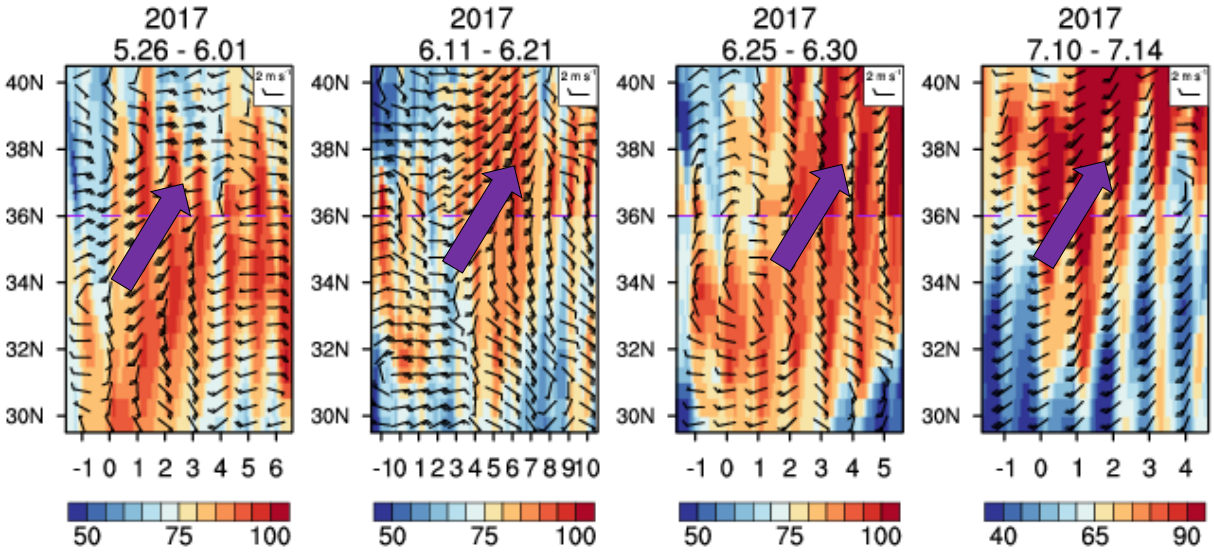
- Model underestimates O_3 concentrations during episodes
- Reduced threshold (69.8 ppbv, 80*NMB) is applied in the model
- 8 of 9 episodes can be captured

Southerlies transport ozone from central eastern China (CEC) during the episodes in NC

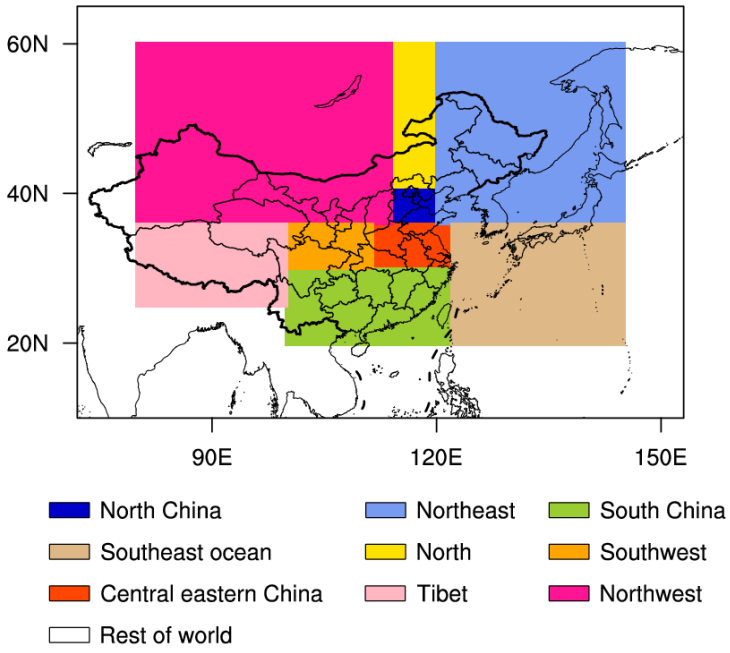








Tagged O_3 simulation shows enhanced contribution of O_3 from CEC during the episodes in NC

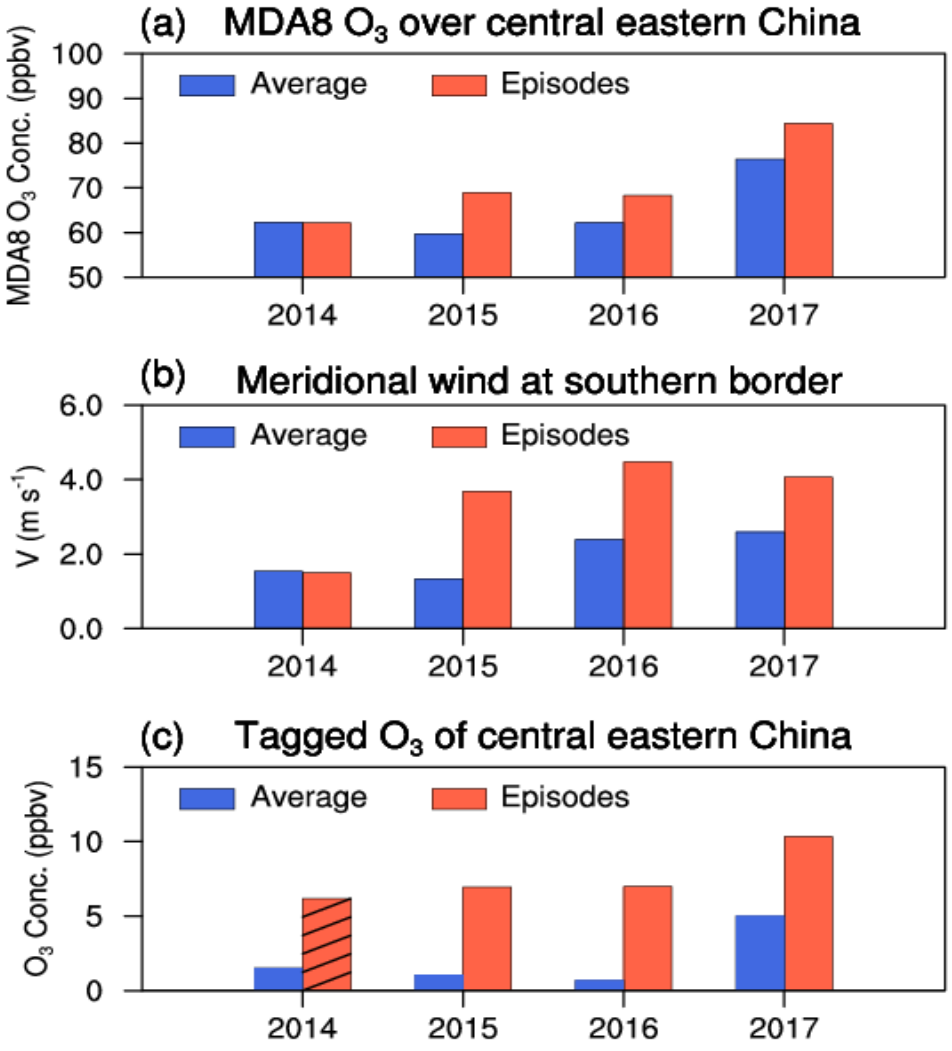


	Total	North China	Central eastern China
Episodes (ppbv)	69.1	53.4	8.7
Seaonal mean (ppbv)	58.6	46.6	5.0
Enhancement (ppbv)	10.5	6.8	3.7

Compared with the seasonal mean, O_3 concentrations are enhanced by 10.5 ppbv during the episodes, in which about 1/3 O_3 are caused by transport from central eastern China.

	North China	North east	South China	Southeast ocean	North	South west	Central eastern China	Tibet	North west	Rest of world
Episodes (%)	76.80	3.46	0.02	0.08	0.84	0.06	13.00	0.01	5.34	0.39
Seasonal mean (%)	79.49	4.06	0.03	0.14	1.73	0.05	7.62	0.02	5.82	1.05

Transport from CEC leads to the increased ozone pollution episodes in North China



- Higher O_3 concentrations in central eastern China
- Stronger meridional winds in the lower atmosphere

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Stronger ozone transports

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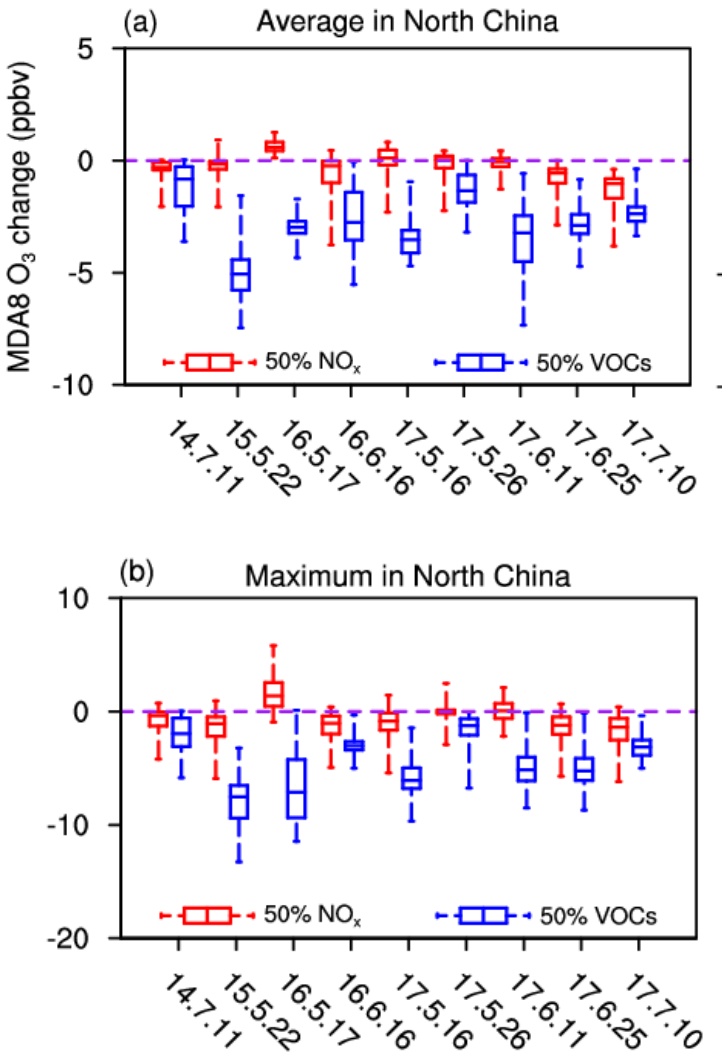
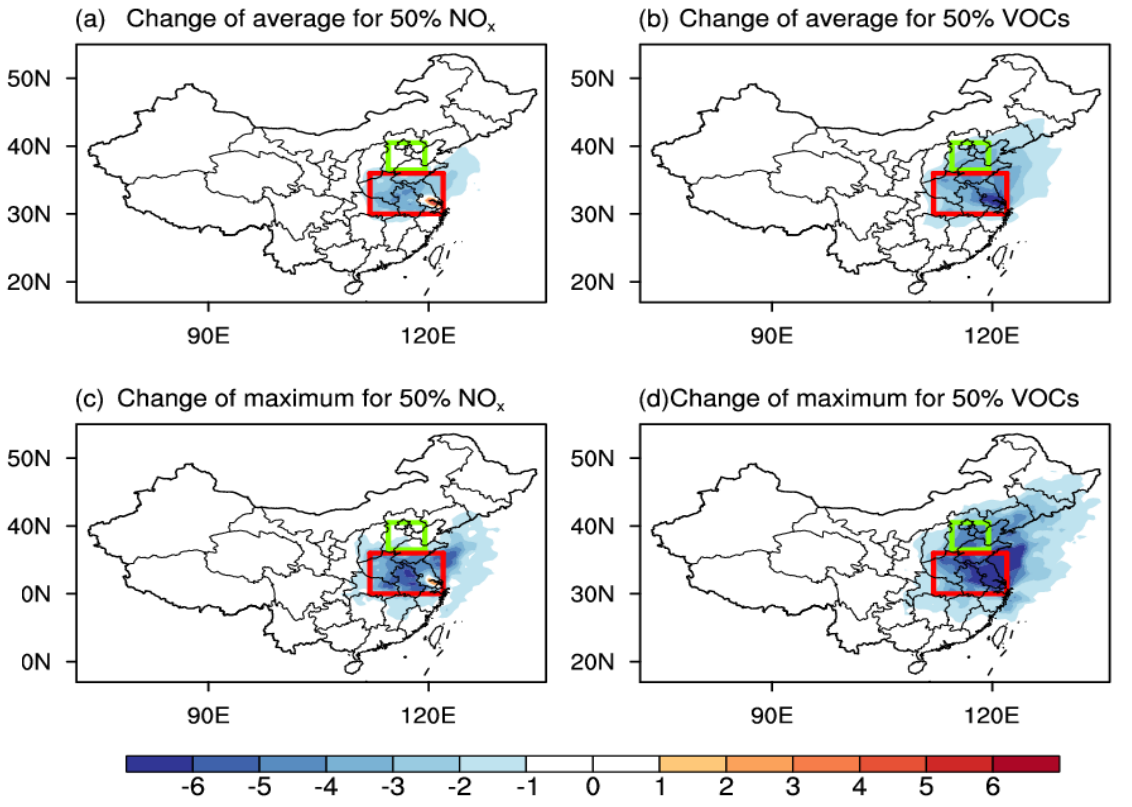
Increase of ozone pollution episodes

Reductions in VOCs in CEC help to reduce peak O_3 concentrations of the episodes in NC





- Reductions in VOCs in central eastern China are more efficient than reductions in NO_x
- Emission reductions in central eastern China are helpful for reducing the peak O_3 concentrations during episodes in North China

Summary

- We highlight the importance of the regional transport from central eastern China to the occurrence of ozone pollution episodes in North China.
- **O_3 transport from central eastern China can contribute 1/3 to the O_3 enhancement** during episodes compared with the rest 2/3 contributed by local chemical production.
- **The transport of O_3 from CEC is increasing, which leads to the increases in observed O_3 pollution episodes in NC.**
- Sensitivity experiments reveal that the **reductions in VOCs in central eastern China are efficient to alleviate O_3 pollution episodes in North China, especially for the peak O_3 concentrations.**