Effect of the transport on ozone pollution episodes in North China

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Increased ozone pollution episodes in North China (NC)

Definition of ozone pollution episodes

- Observed MDA8 $\text{O}_3$ concentrations averaged over North China (36.5°-40.5°N, 114.5°-119.5°E) larger than 80 ppbv
- Persistence of over 5 days

From 2014 to 2017:

- More frequent episodes
- Higher $\text{O}_3$ concentrations
- Longer persistence

Possible reasons

- More favorable weather conditions
- Higher $\text{O}_3$ chemical production (due to changes in emissions)
- Decreased PM$_{2.5}$ (Li et al., 2019, PNAS)

Effect of $\text{O}_3$ 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 O₃ global simulation
- GEOS-Chem, tropchem nested AS simulation
- MEIC inventory over 2014-2017

Methods
- Composite analysis
- Backward trajectory
- Tagged O₃ simulations
- Sensitivity experiments
- Anomalous winds during the episodes
- Where the air comes from
- Quantifying the contributions of O₃ 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 O₃ simulation shows enhanced contribution of O₃ from CEC during the episodes in NC

Compared with the seasonal mean, O₃ concentrations are enhanced by 10.5 ppbv during the episodes, in which about 1/3 O₃ are caused by transport from central eastern China.
Transport from CEC leads to the increased ozone pollution episodes in North China

- Higher O\textsubscript{3} concentrations in central eastern China
- Stronger meridional winds in the lower atmosphere

(a) MDA\textsubscript{8} O\textsubscript{3} over central eastern China

(b) Meridional wind at southern border

(c) Tagged O\textsubscript{3} of central eastern China

Stronger ozone transports
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.
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.