

# Impacts of relative humidity and temperature on heavily polluted events in the North China Plain in February 2014

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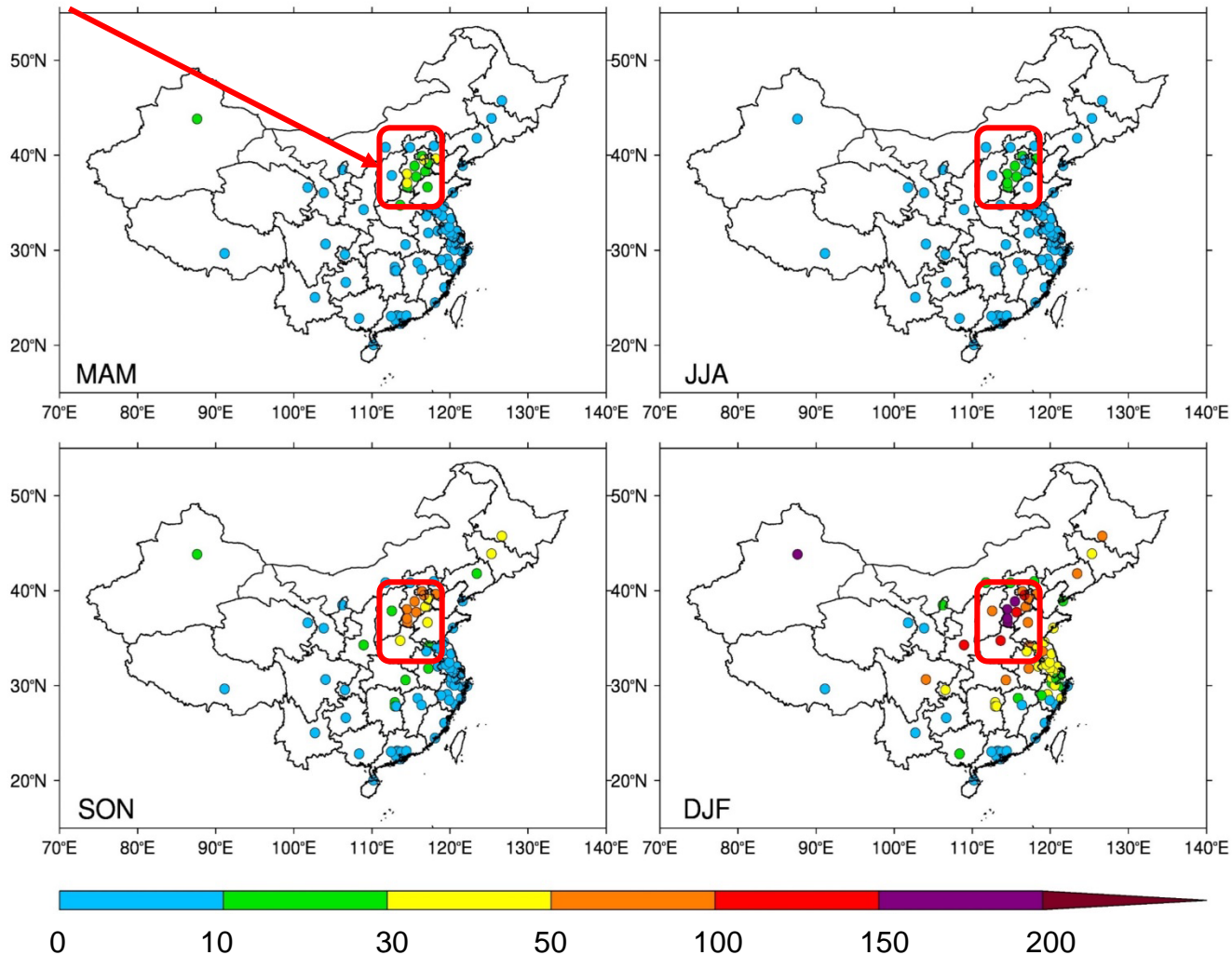
# Outline

- Motivations
- Numerical experiments
- Objectives
- Model evaluation
- Impacts of  $\Delta RH$  and  $\Delta T$  on  $PM_{2.5}$
- Summary

# Motivations: (1) Severe haze events occurred frequently over North China Plain

North China Plain

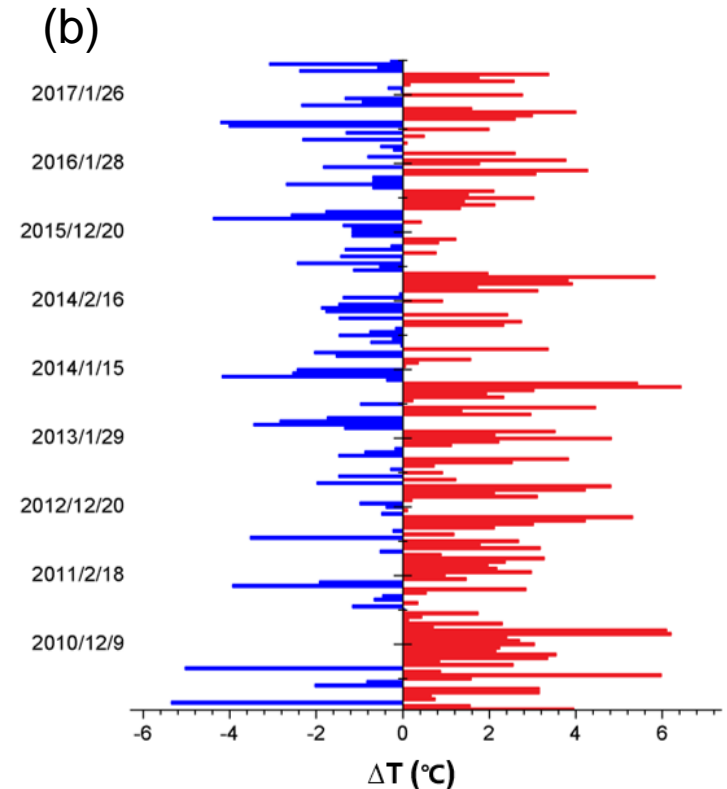
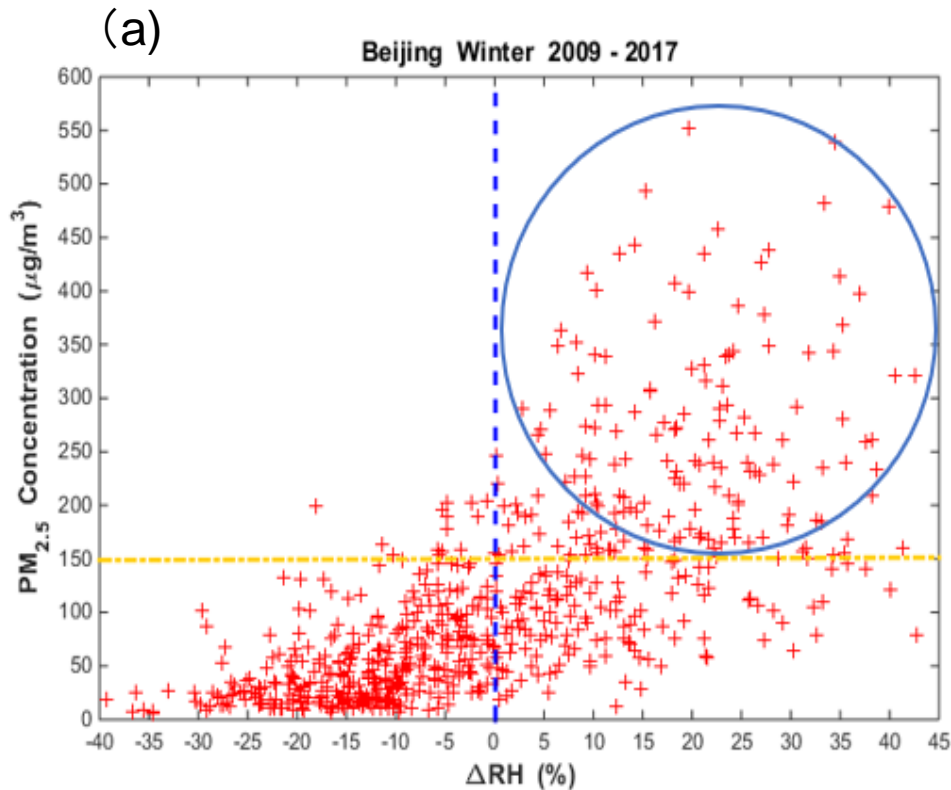
(severe haze days in China from 2013 to 2016)



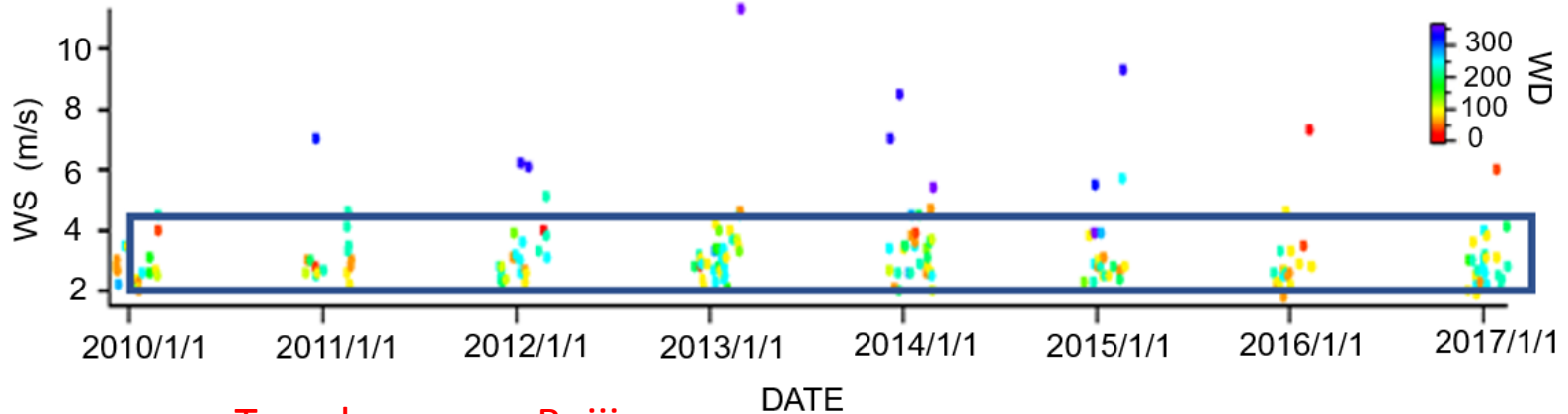
Haze days( $PM_{2.5}>150\mu g/m^3$ )

Jiandong Li et al.

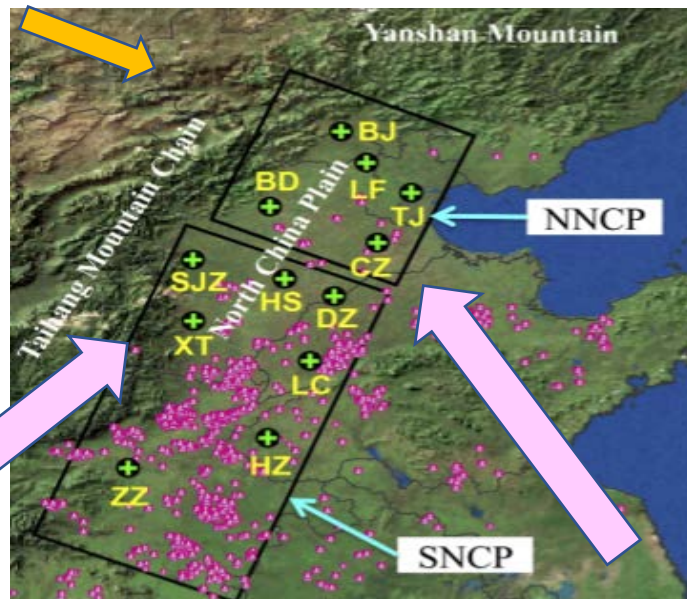
Motivations: (2) Observed relative humidity and temperature showed positive anomalies during wintertime heavy haze events in Beijing



# Motivations (3):



Trap haze over Beijing



X.Long et al., 2018

**Observed** high frequency of **southerly** wind brings sufficient water vapor and warm advection from the south during **wintertime heavy haze events** in Beijing

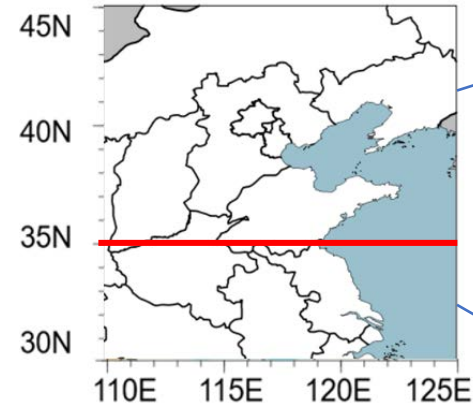
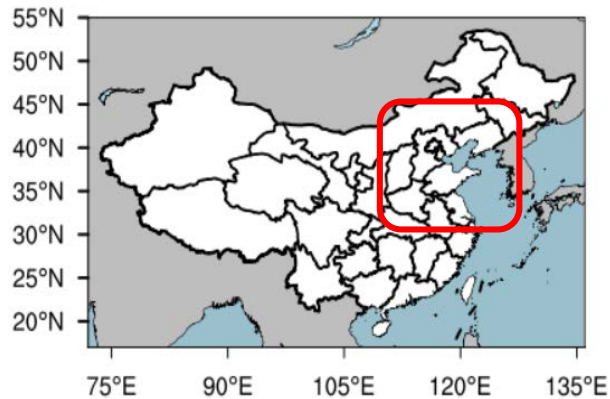
NCP (North China Plain)

# Objectives

- To quantify the **impacts of relative humidity and temperature anomalies** on  $PM_{2.5}$  in the studied domain during a heavily polluted event in Feb. 20-28, 2014

# Numerical experiments

- GEOS-Chem model, v11-01, nested over Asia ( $0.5^\circ \times 0.625^\circ$ )
- All simulations conducted with MERRA2 meteorology for year 2014



**Northern  
studied  
domain (NSD)**

**Southern  
studied  
domain (SSD)**

## Experiments

- (1) CTRL
- (2) CTRL\_ΔRH
- (3) CTRL\_ΔT

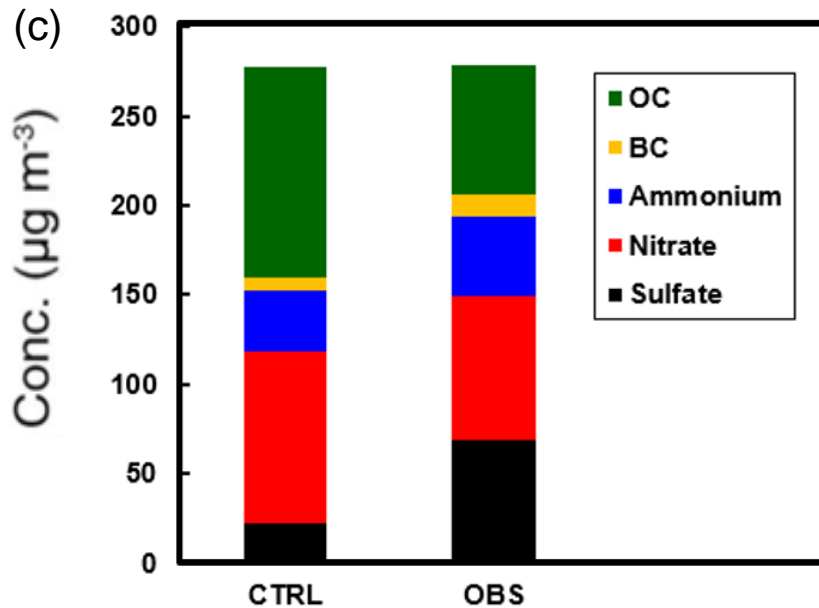
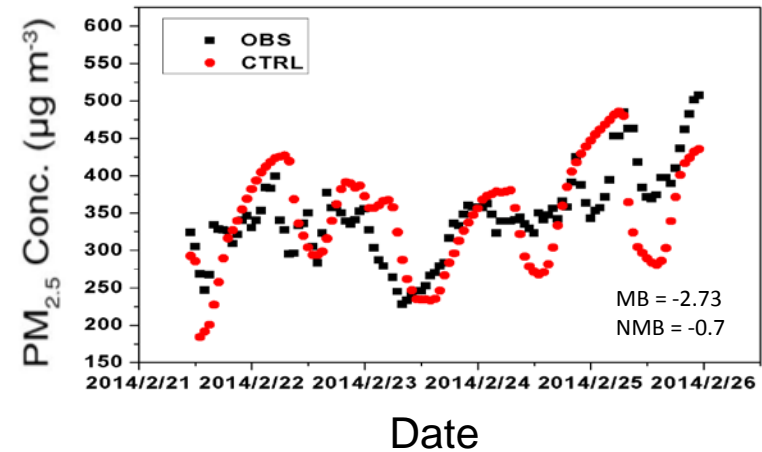
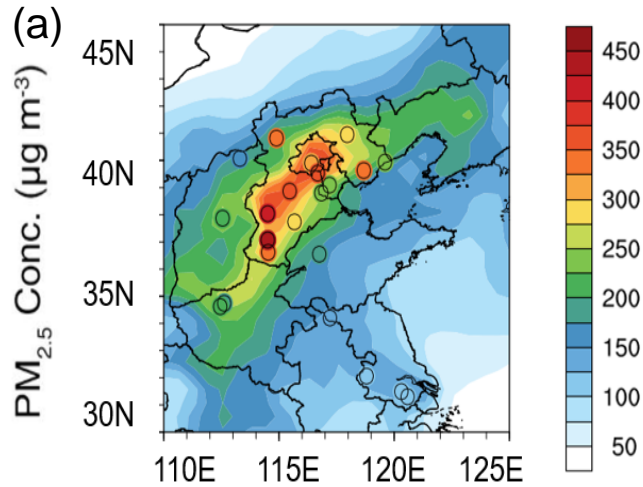
## Meteorology

Default meteorology

Same as CTRL, except that values of **RH** in the studied domain are set to the mean values of February from **the surface to 0.015 hPa** during Feb. 20–28.

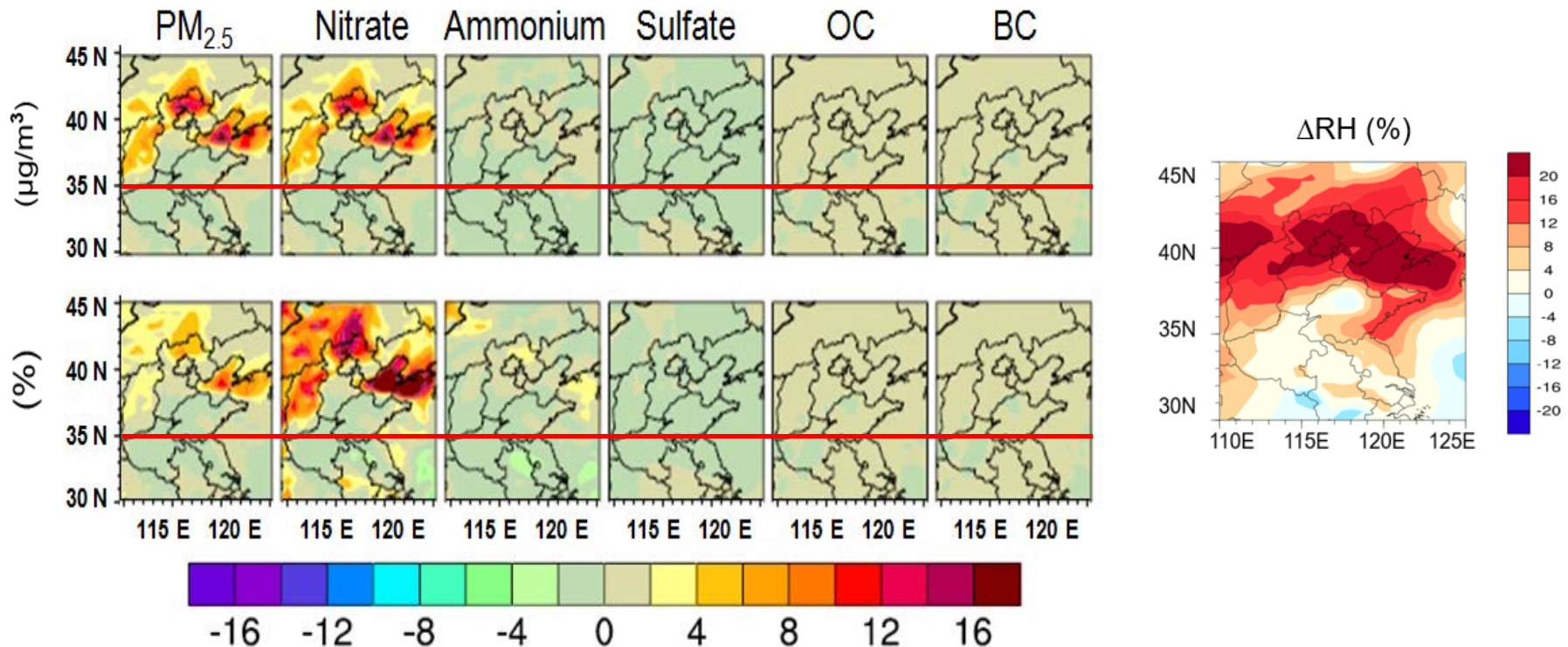
Same as CTRL, except that values of **T** in the studied domain are set to the mean values of February from **the surface to 898.7 hPa** during Feb. 20–28.

# Model evaluation



Spatial and temporal variations  
are fairly well captured

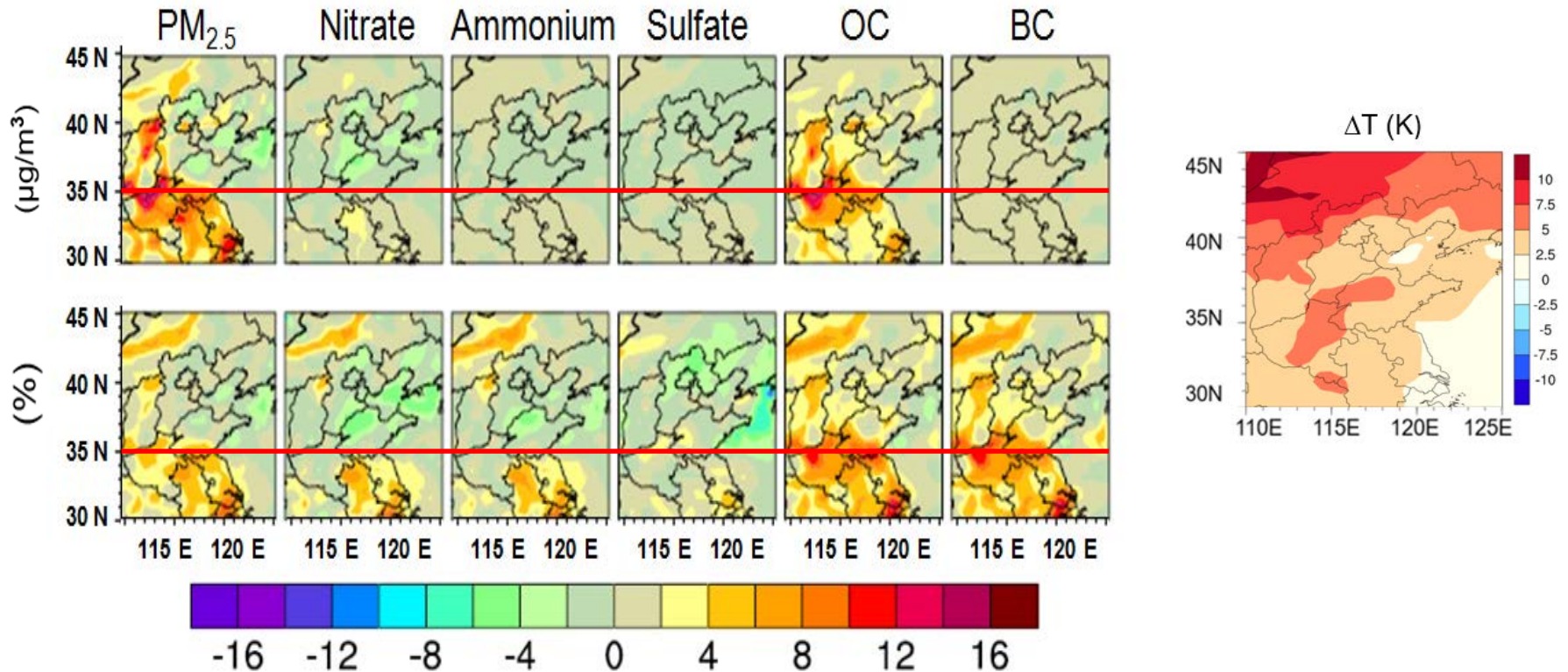
# Impacts of $\Delta RH$ on surface aerosol concentrations (averaged over Feb. 21-25)



**Over northern studied domain, with positive RH anomalies**

- $\text{PM}_{2.5}$  concentrations increased by 8 –16  $\mu\text{g}/\text{m}^3$  (6 -12%)
- Nitrate concentrations increased by 8 –16  $\mu\text{g}/\text{m}^3$  (8 -16%)

# Impacts of $\Delta T$ on surface aerosol concentrations (averaged over Feb. 21-25)



**Over northern studied domain, with positive T anomalies**

- $\text{PM}_{2.5}$  concentrations decreased by  $2 - 6 \mu\text{g}/\text{m}^3$  ( $2 - 4\%$ ) in the eastern studied domain (decomposition of nitrate)

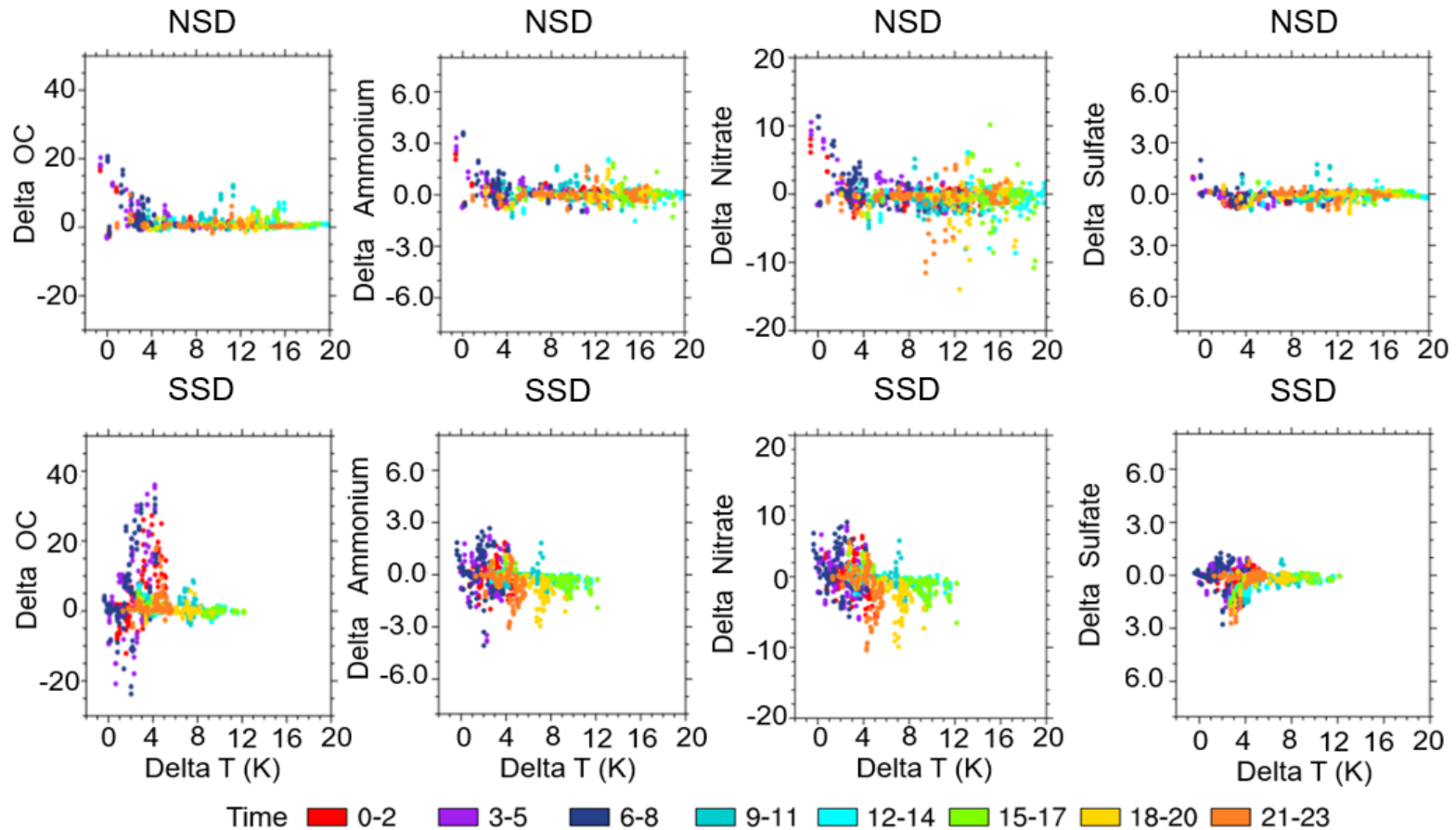
# Sensitivity of aerosol concentrations in Beijing to $\Delta RH$

Date	$\Delta PM_{2.5}$	%	$\Delta SO_4^{2-}$	%	$\Delta NO_3^-$	%	$\Delta NH_4^+$	%	$\Delta BC$	%	$\Delta OC$	%
21	0.85	0.39	0.01	0.08	0.77	0.98	0.07	0.25	0	0	0.01	0.01
22	13.01	3.86	-0.01	-0.04	12.46	9.76	0.54	1.29	0	0	0.01	0.01
23	13.97	4.79	-0.03	-0.14	13.59	12.49	0.38	1.06	0	0	0.01	0.01
24	11.48	3.84	0.01	0.04	10.72	10.03	0.74	1.99	0	0	0.01	0.01
25	17.58	5.30	-0.02	-0.08	16.19	13.21	1.40	3.36	0	0	0.01	0.01

Unit :  $\mu g/m^3$

**During severe haze events in Beijing, on average,** with a  $\Delta RH$  of **24%**,  $PM_{2.5}$  concentrations increased by **11.4  $\mu g/m^3$  ( 3.9% )**, because **nitrate** concentrations are sensitive to  $\Delta RH$ .

## Hourly impacts of $\Delta T$ on surface aerosol concentrations (Feb. 21 – 25)



**During local time 3-8 pm**, ammonium nitrate **decomposes** with an positive  $\Delta T$  varying from **8 – 12K**.

**During local time 0-8 am**, positive  $\Delta T$  varying from **0 – 4K** is beneficial to the **accumulation** of all pollutants.

# Summary

- During severe winter haze events in Beijing, observed  $\Delta RH$  was 17.3% as averaged over 2009 – 2017.
- $PM_{2.5}$  concentrations during a severe haze event in Beijing increased by 11.4  $\mu g/m^3$  ( 3.9% ) with an averaged increase of RH of 24%. Nitrate concentrations are most sensitive to  $\Delta RH$ .
- In the eastern NSD,  $PM_{2.5}$  concentrations decreased by 2 – 6  $\mu g/m^3$  (2 – 4%) with an averaged increase of T of 2.5K.

Thanks for your attention!

