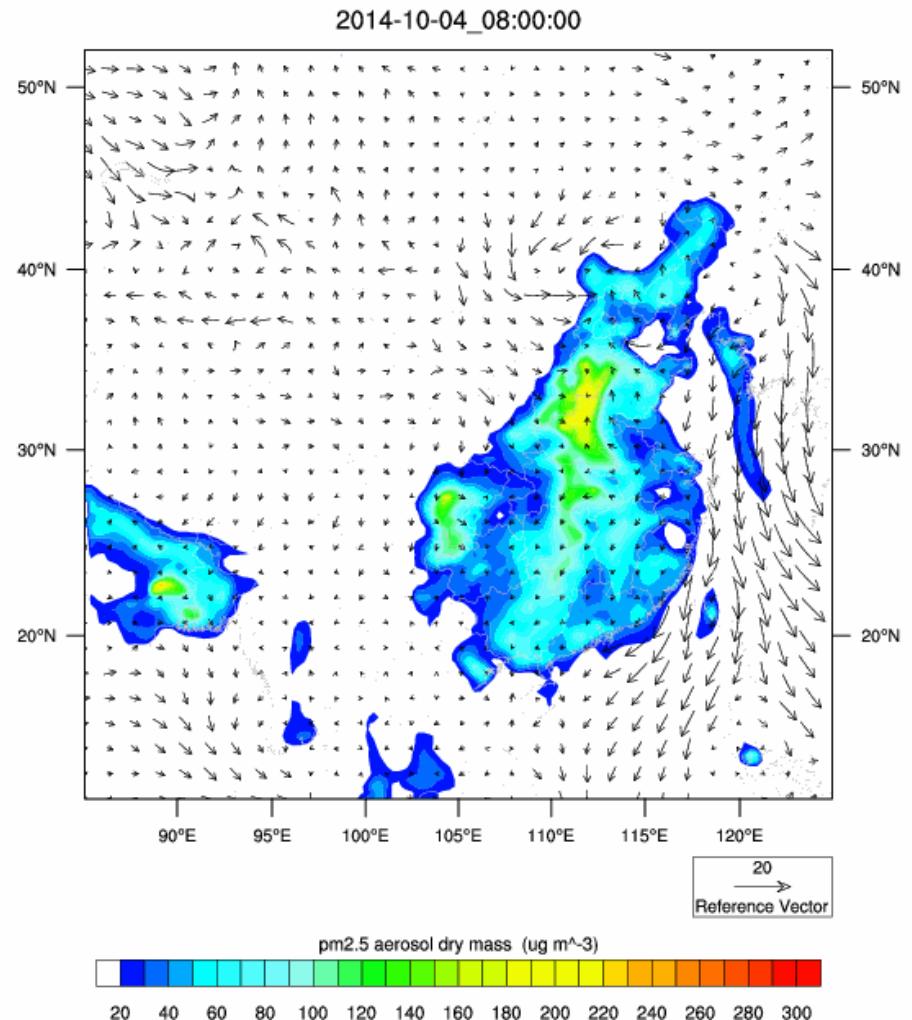


WRF/Chem simulations of Sulfate-Nitrate-Ammonium (SNA) aerosols during the continuous extreme hazes over Northern China

Dan Chen and Zhiquan Liu

Mesoscale and Microscale
Meteorology Laboratory
NCAR

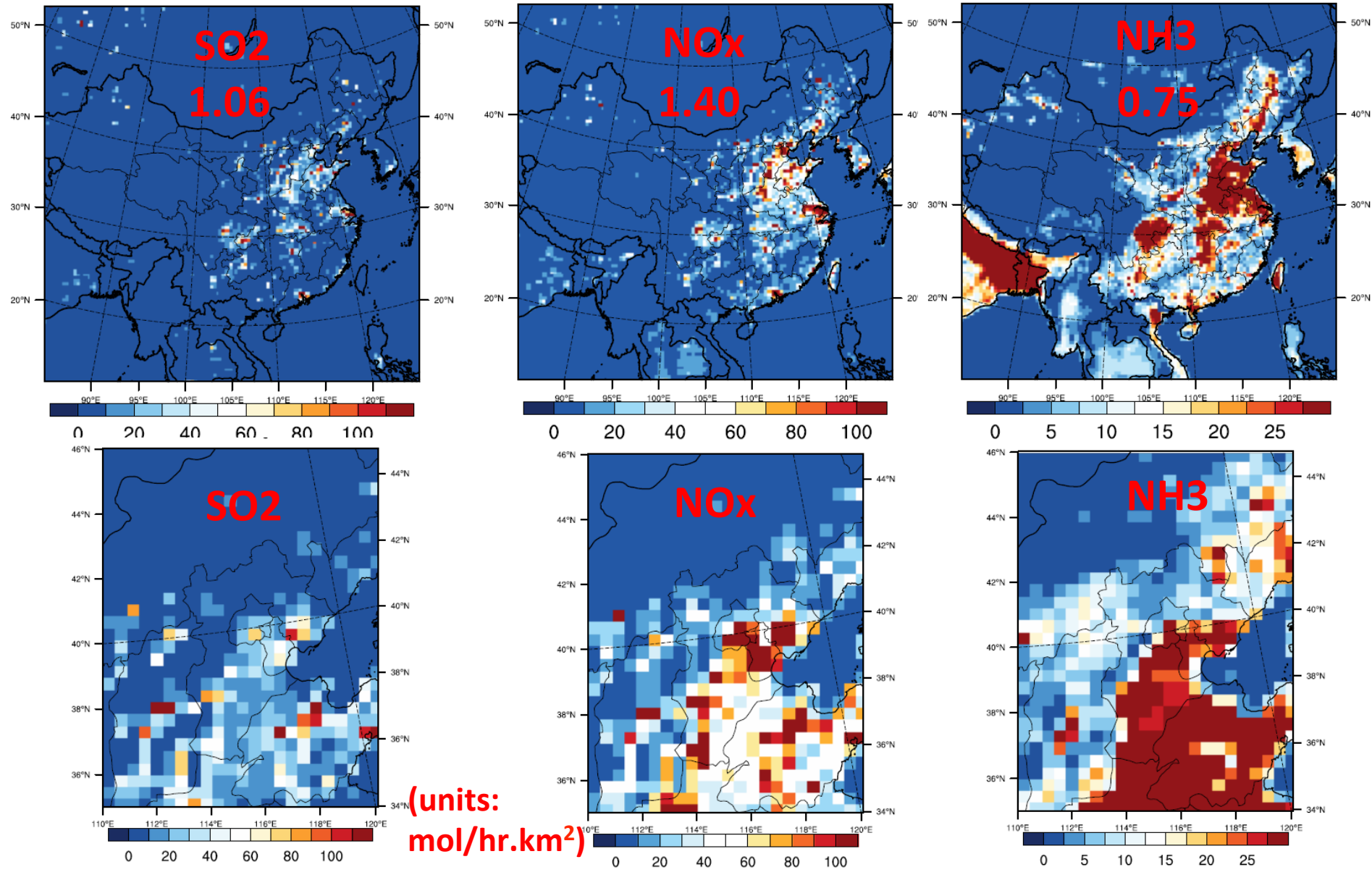
2015-6-18



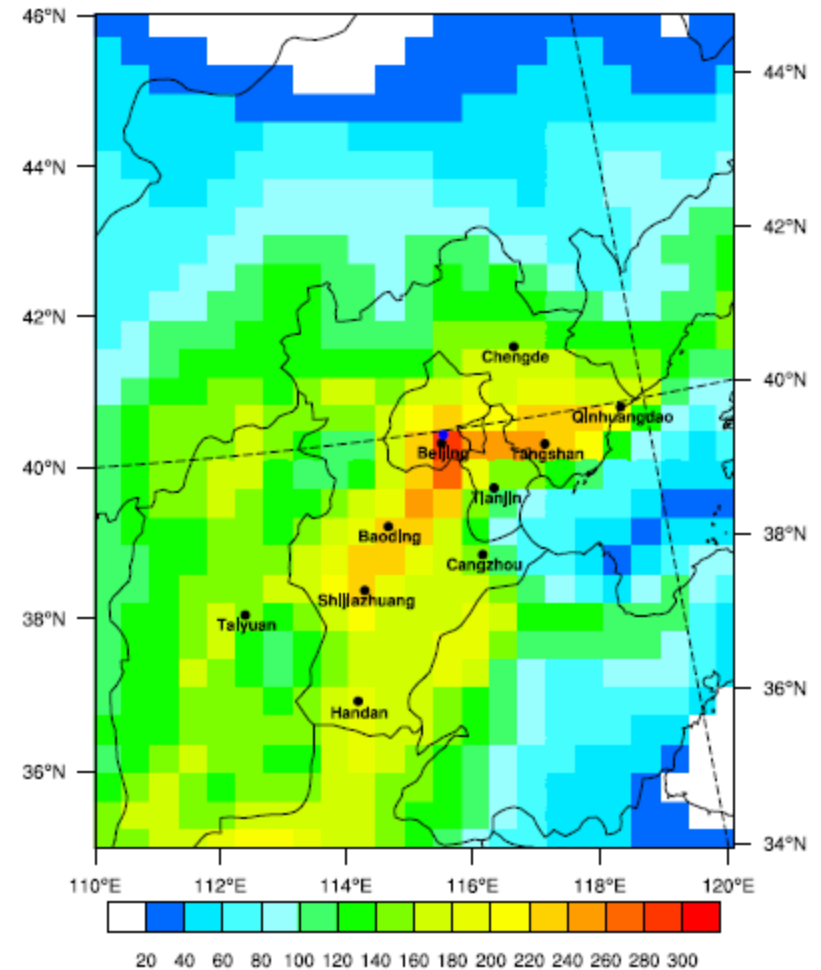
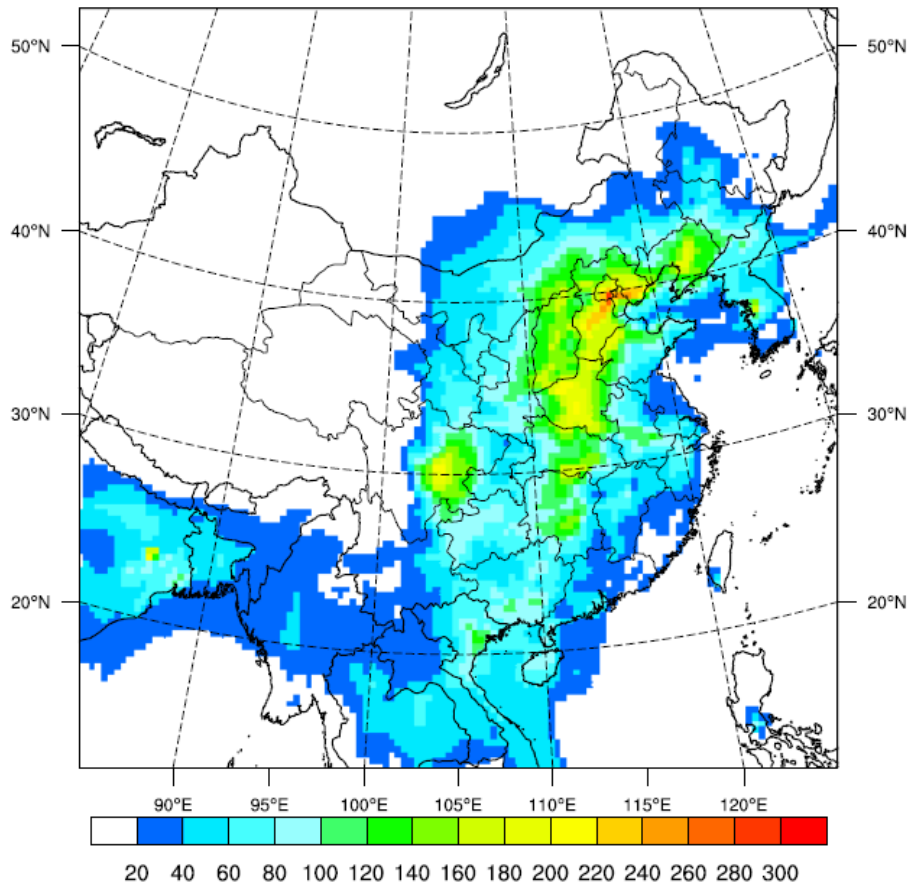
WRF-CHEM v3.6.1 Configurations

Gas-phase chemistry	Carbon Bond Mechanism (CBM-Z)
Photolysis	Fast-J
Land-surface model	NOAH
Boundary layer scheme	YSU
Aerosol scheme	MOSAIC(4 bin)
I.C. and B.C. for meteorological variables	GFS Forecast (6h cycling)
Initial condition for chemical species	3-day spin-up
Chemical boundary conditions	Default in the model
Aerosol and trace gas emissions	MEIC_Tsinghua_2010
Vertical layers	57

Emissions of SO₂, NO_x and NH₃



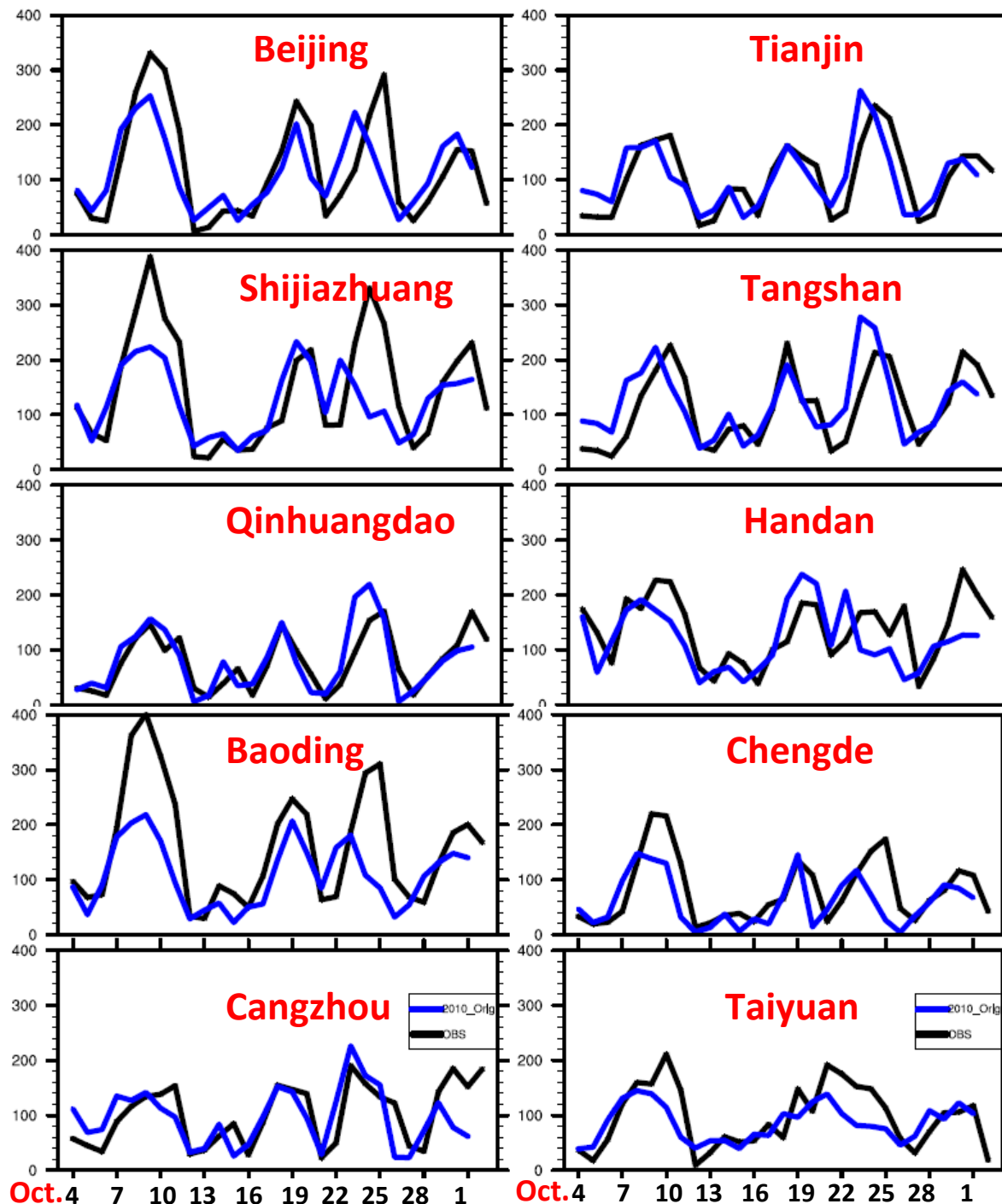
Regional Hazes over Northern China in Oct. 2014



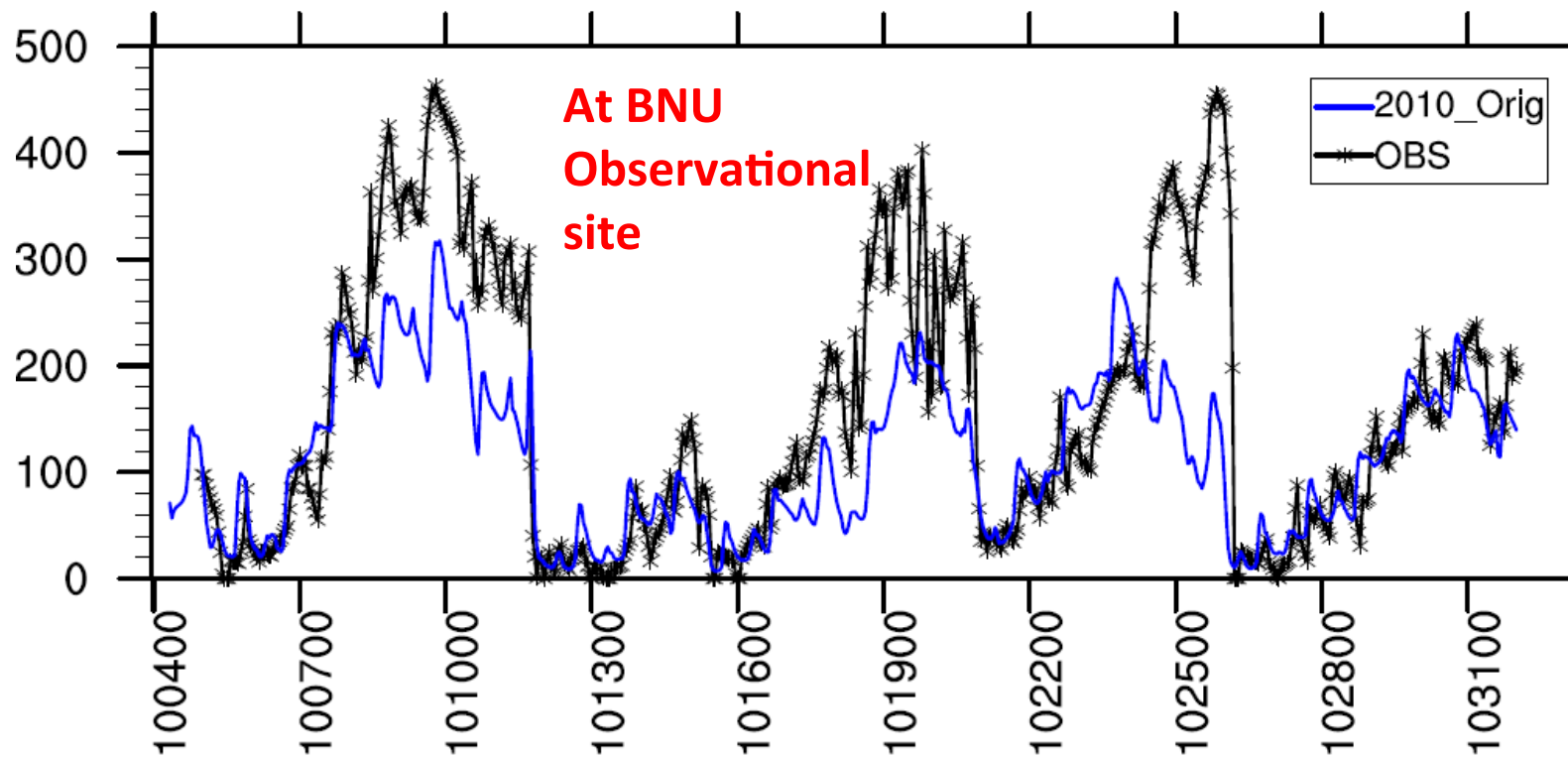
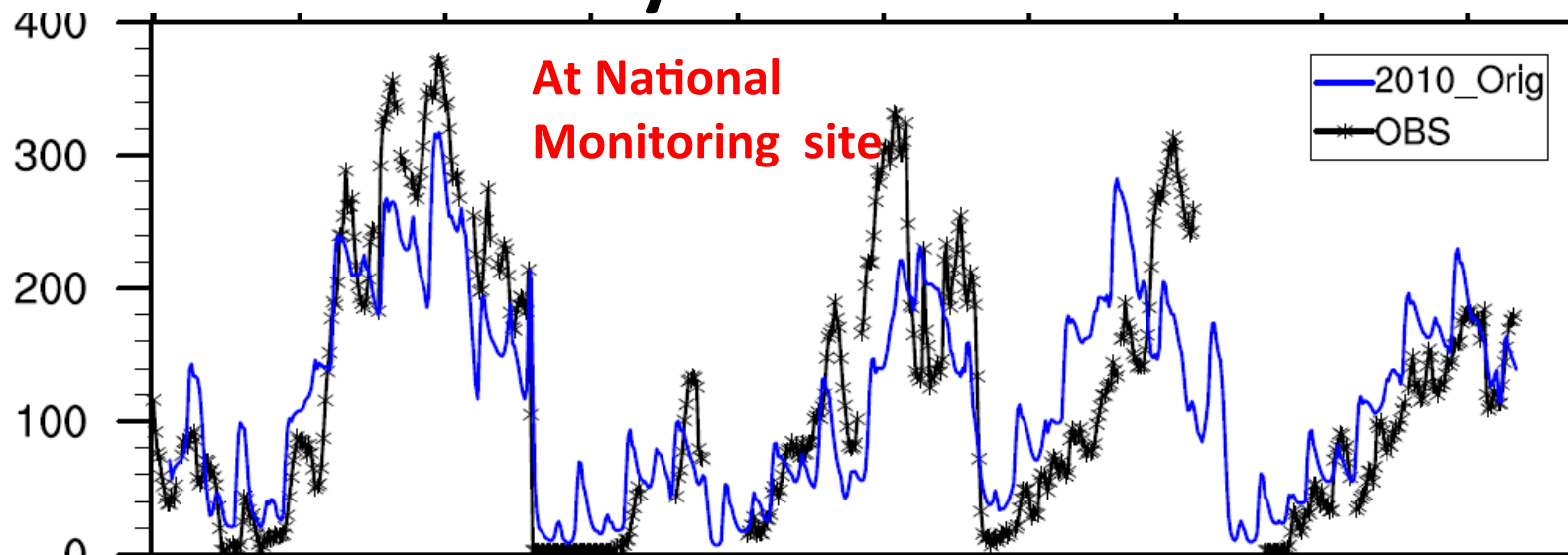
Daily Mean PM2.5 Simulations

(units:
 $\mu\text{g}/\text{m}^3$)

Black- Observations
Blue - Simulations

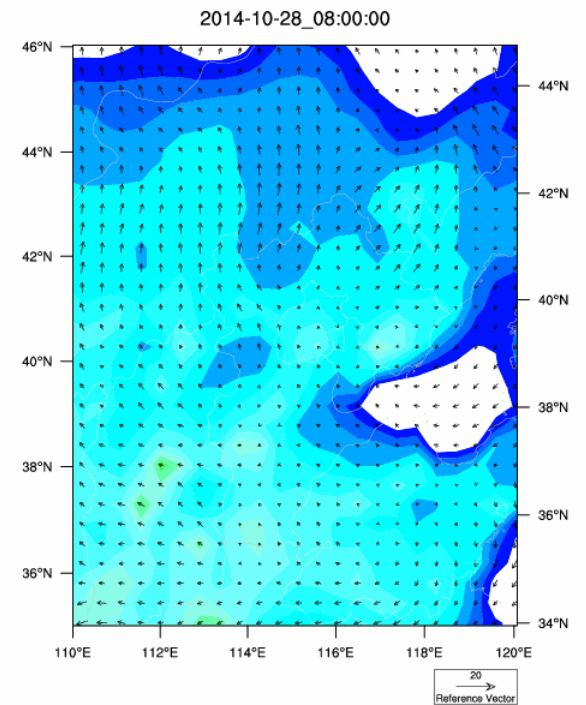
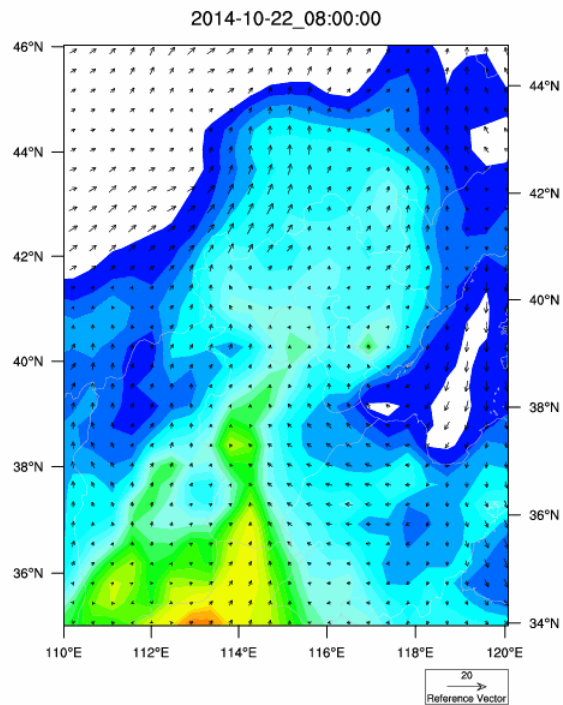
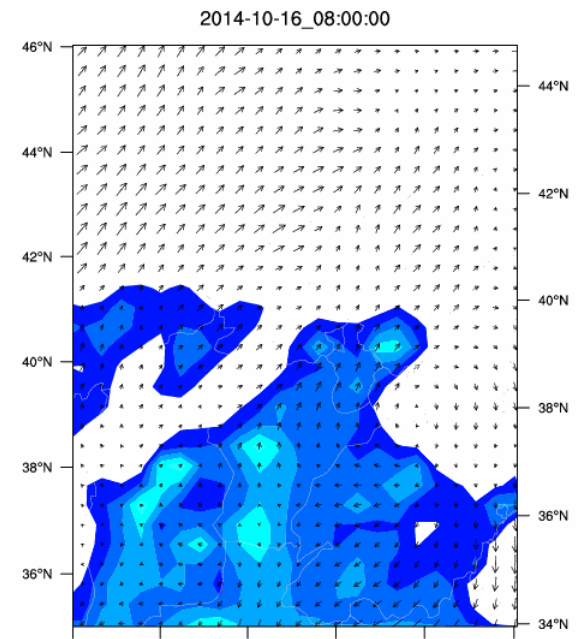
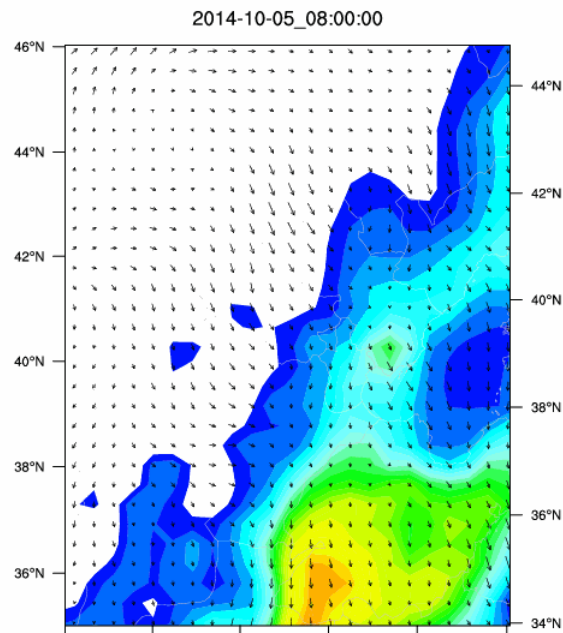


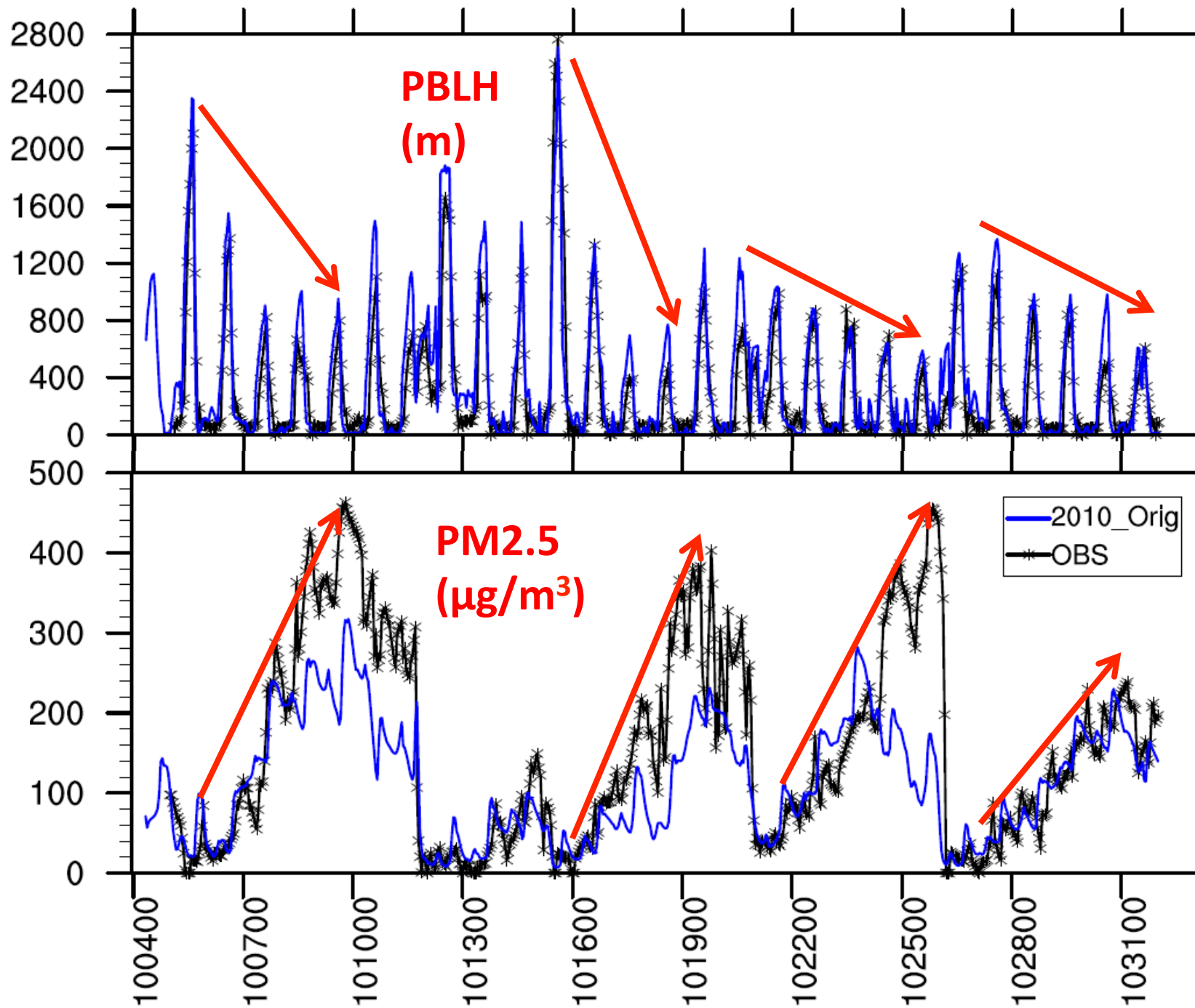
Hourly PM2.5 simulations

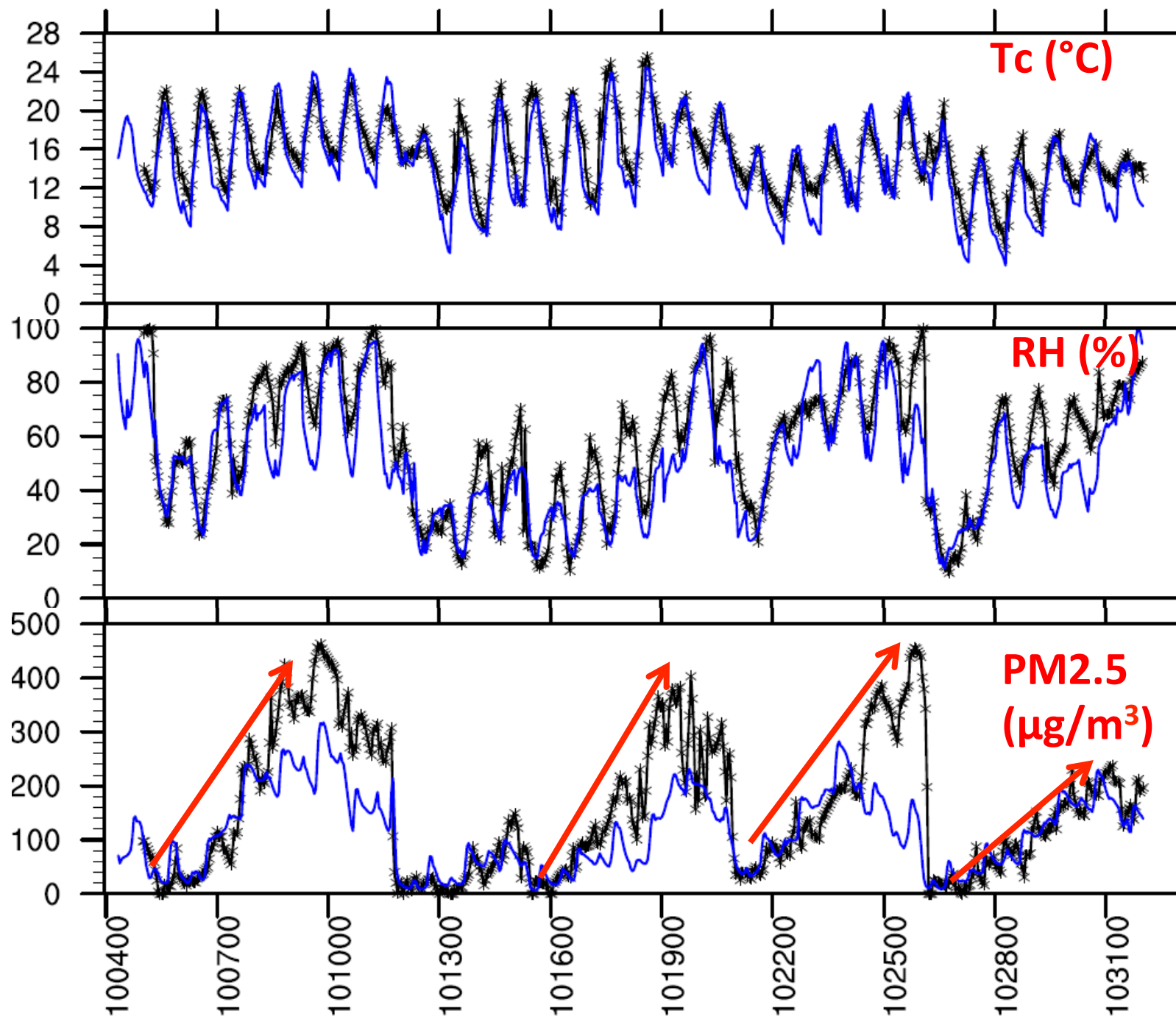


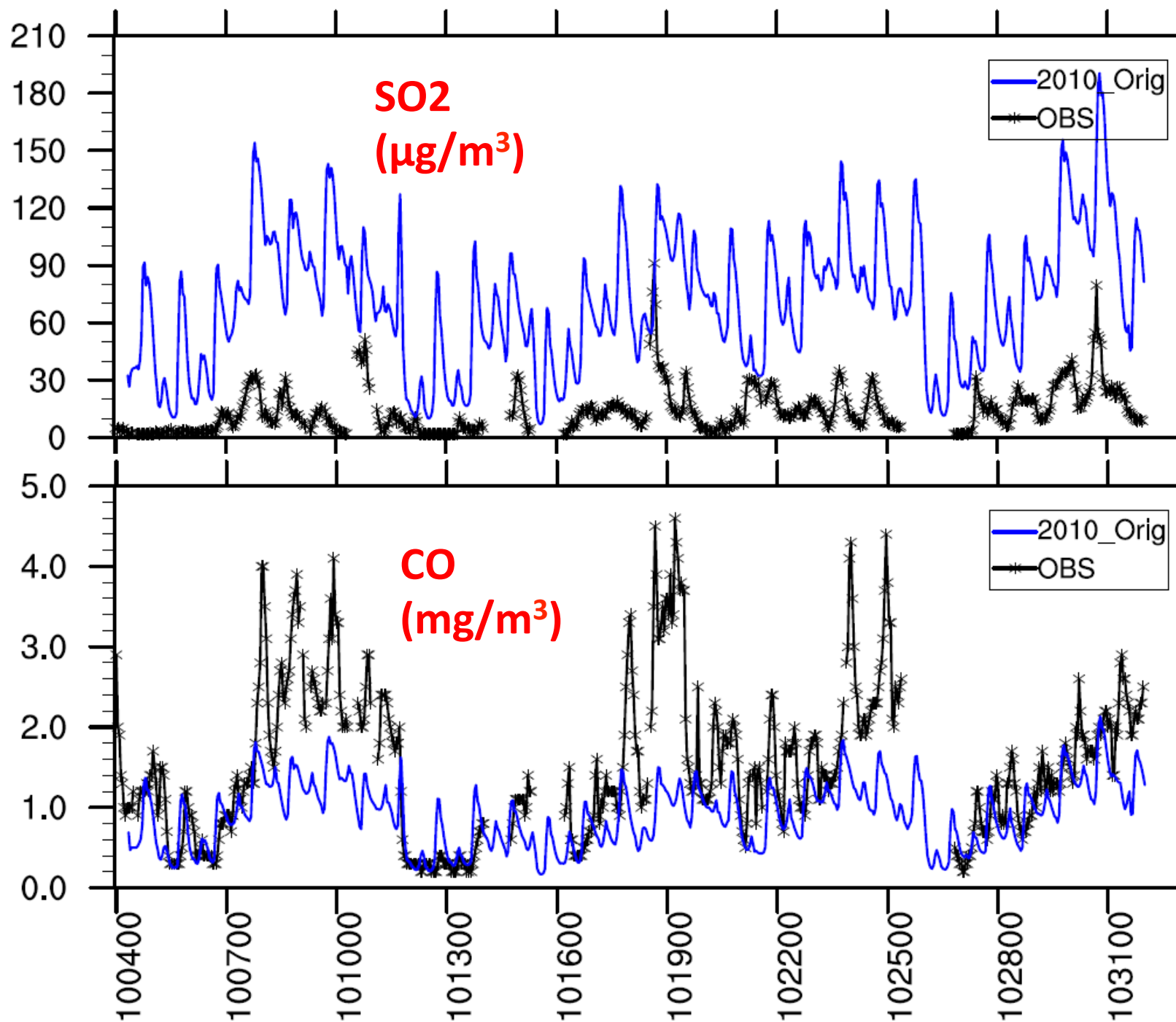
(units:
 $\mu\text{g}/\text{m}^3$)

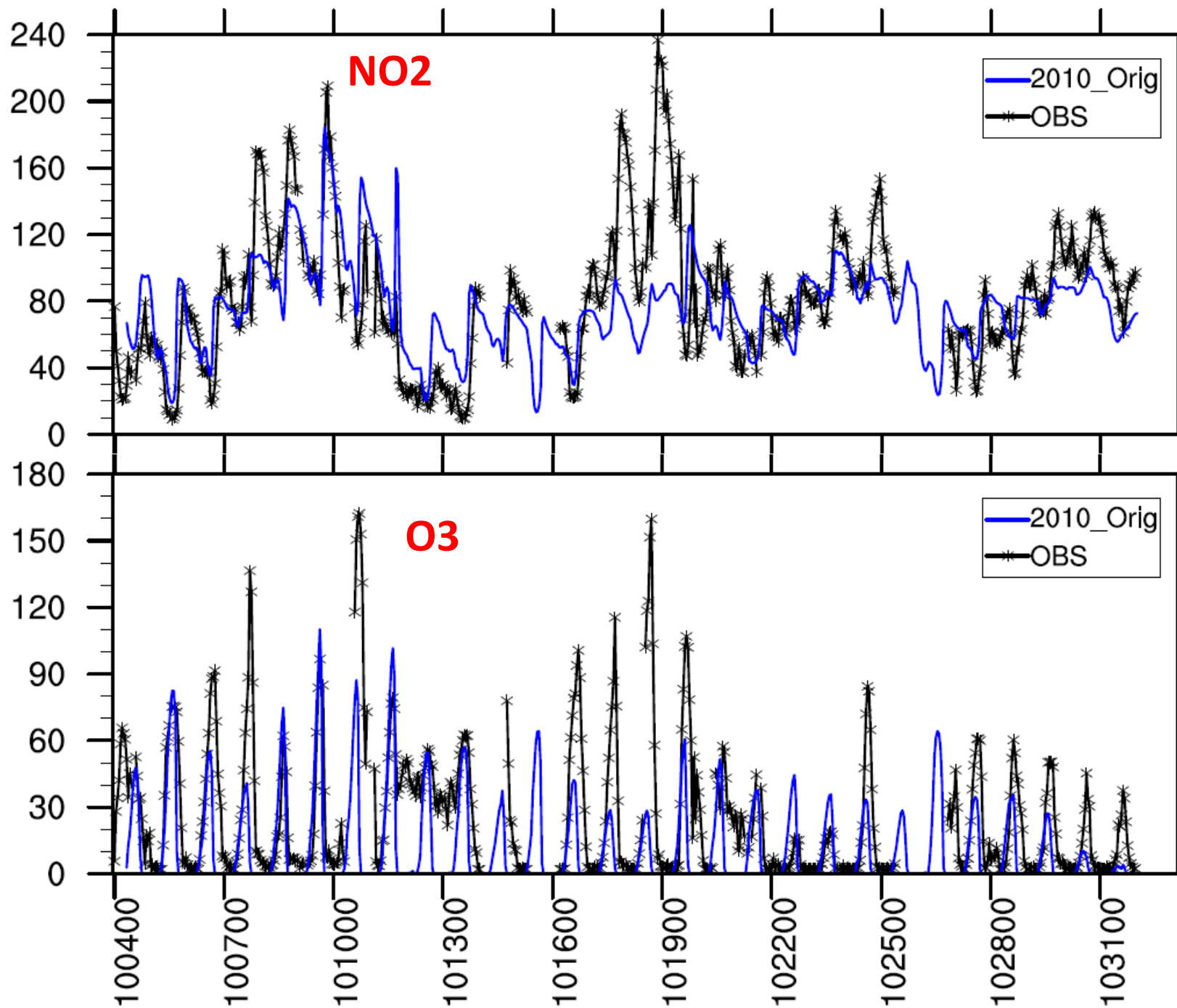
Meteorology - large patterns



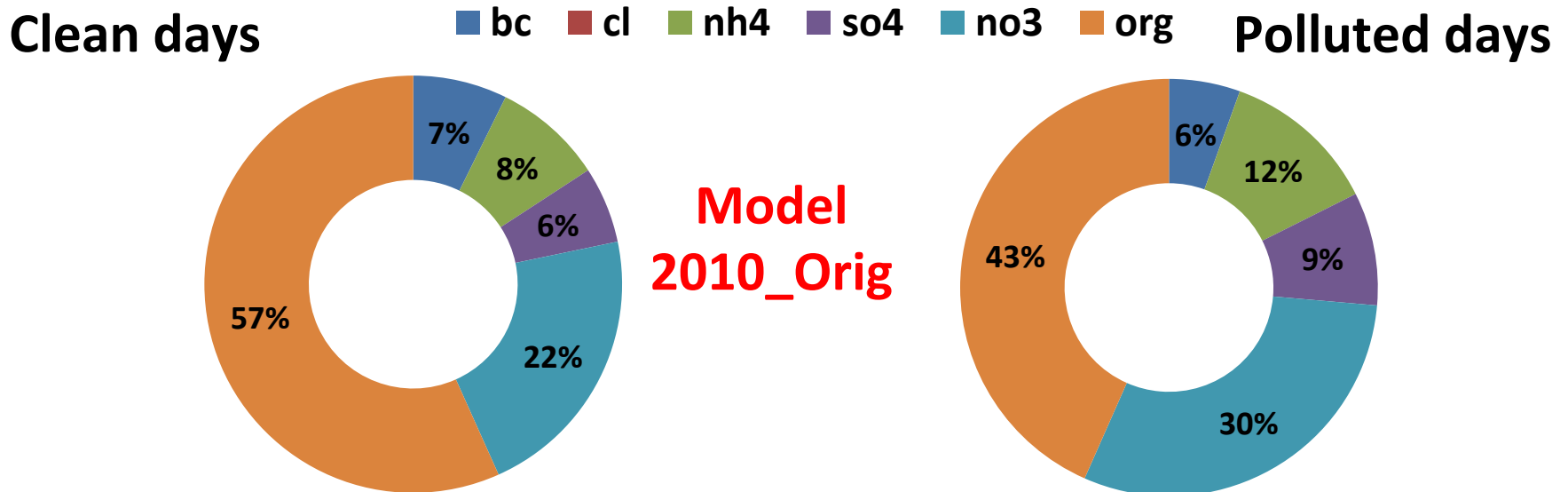
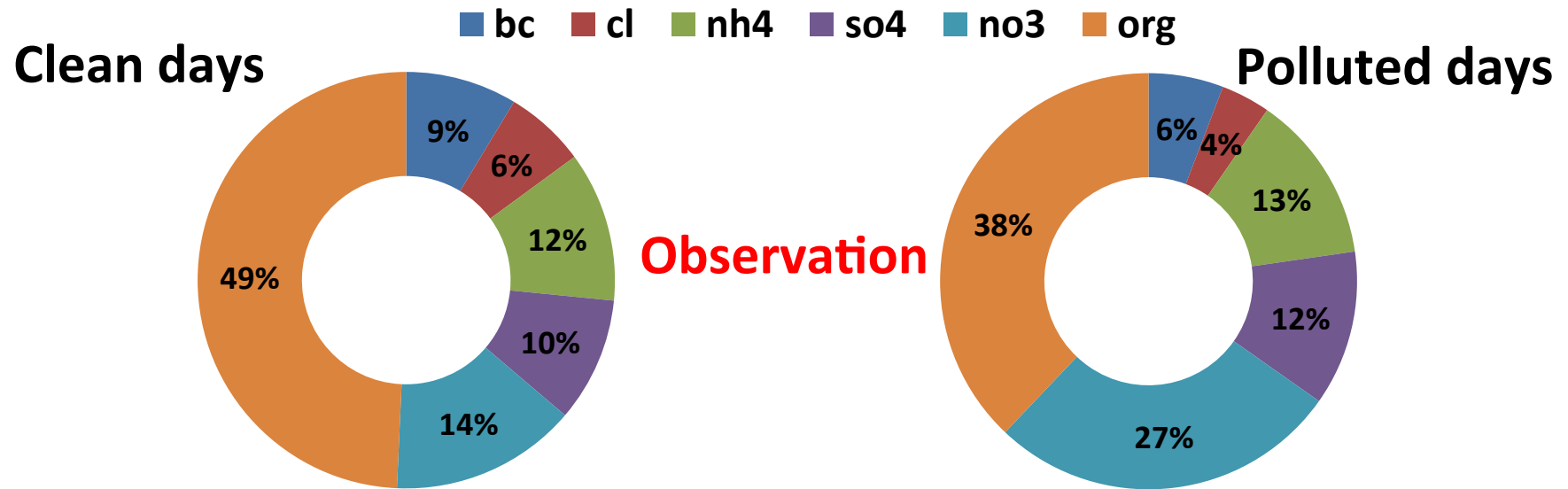


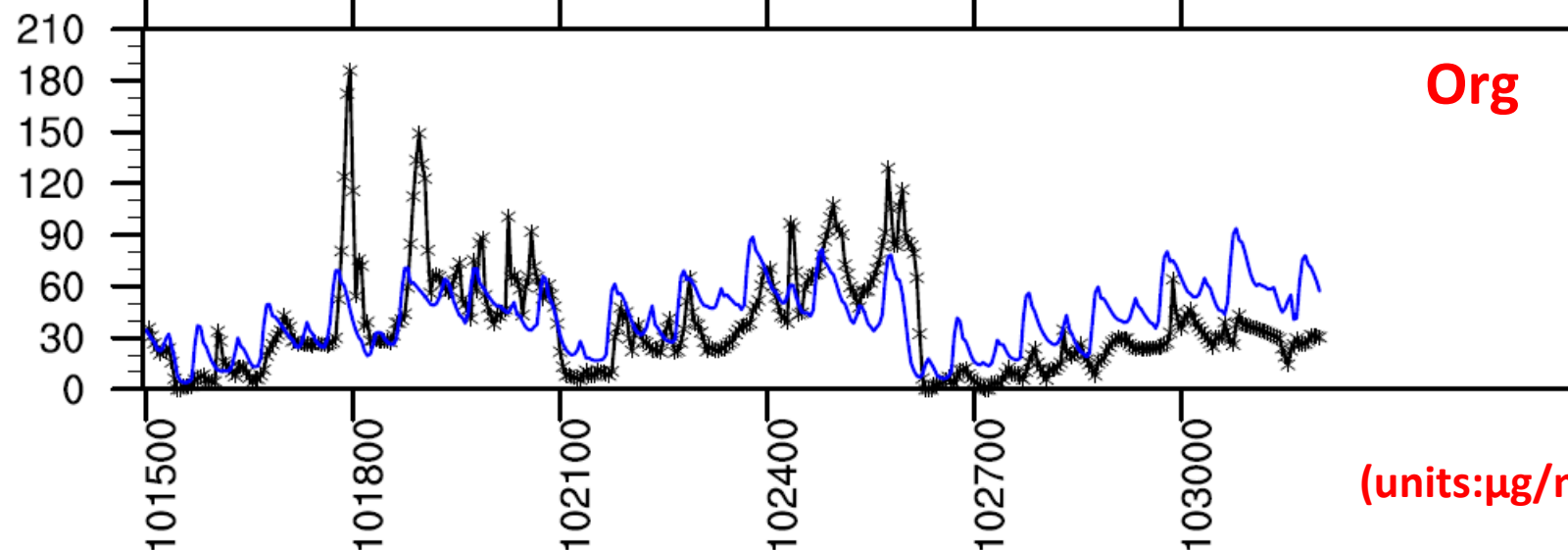
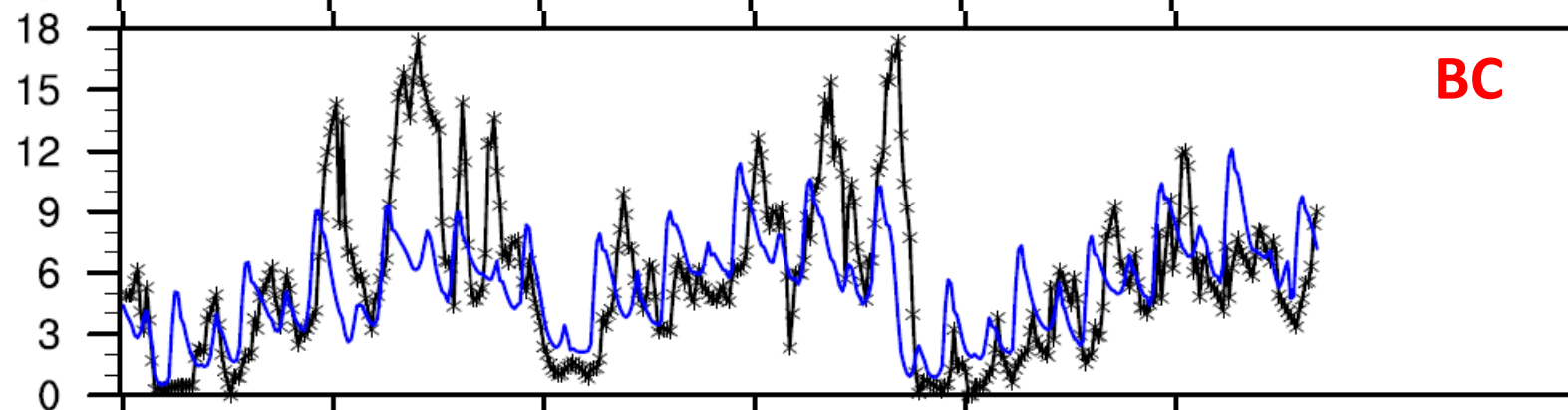
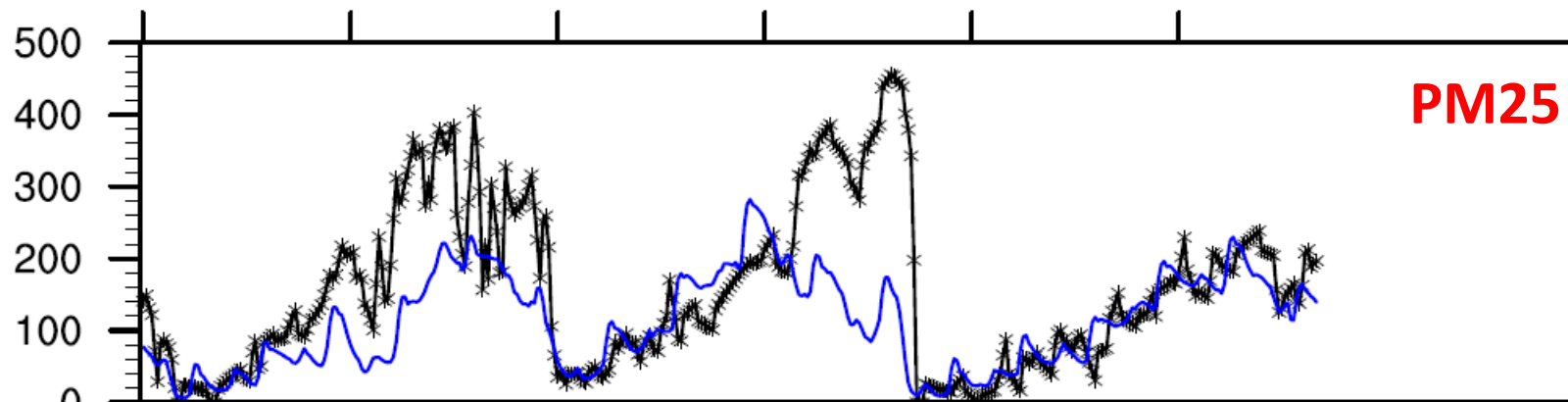


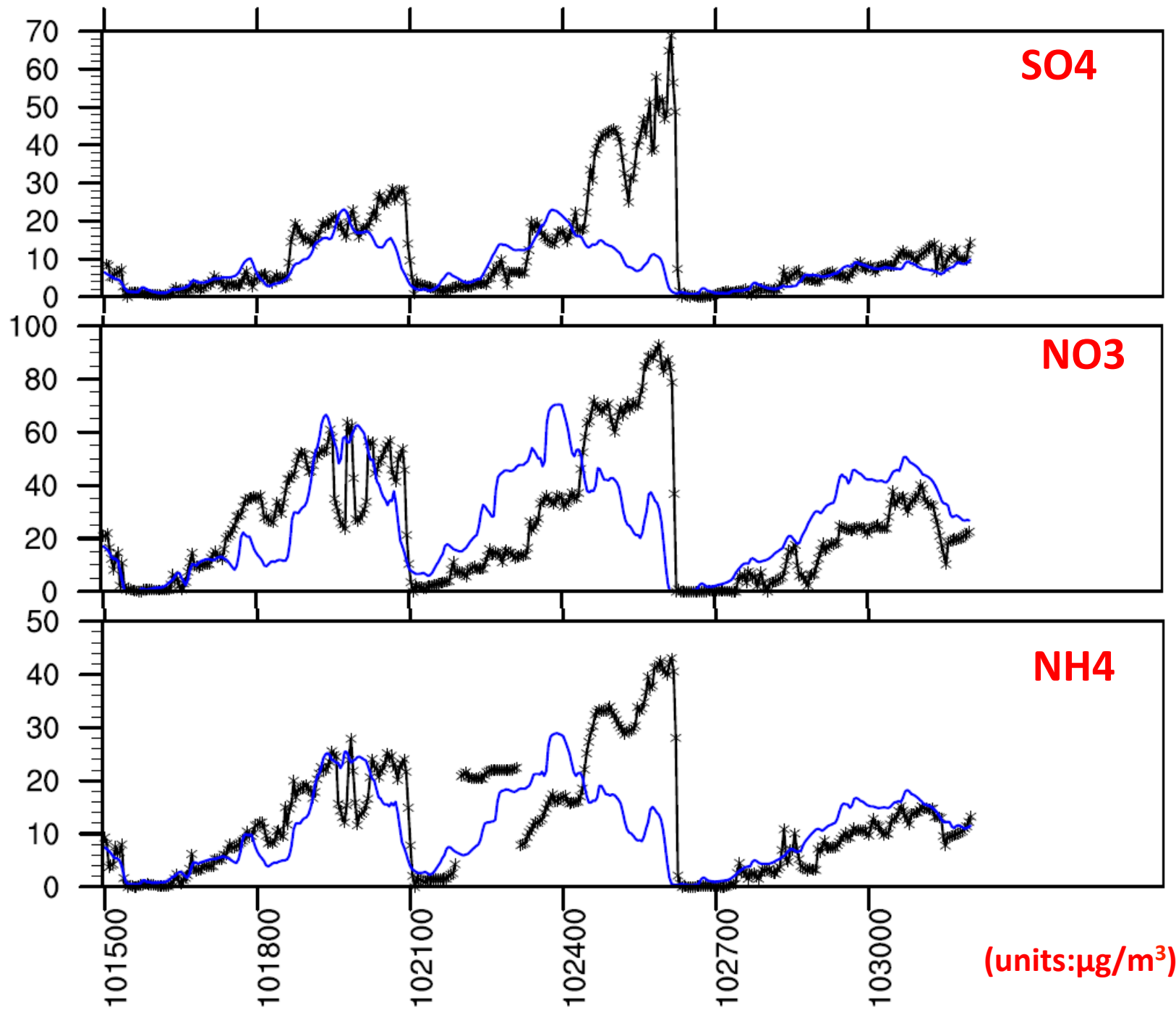




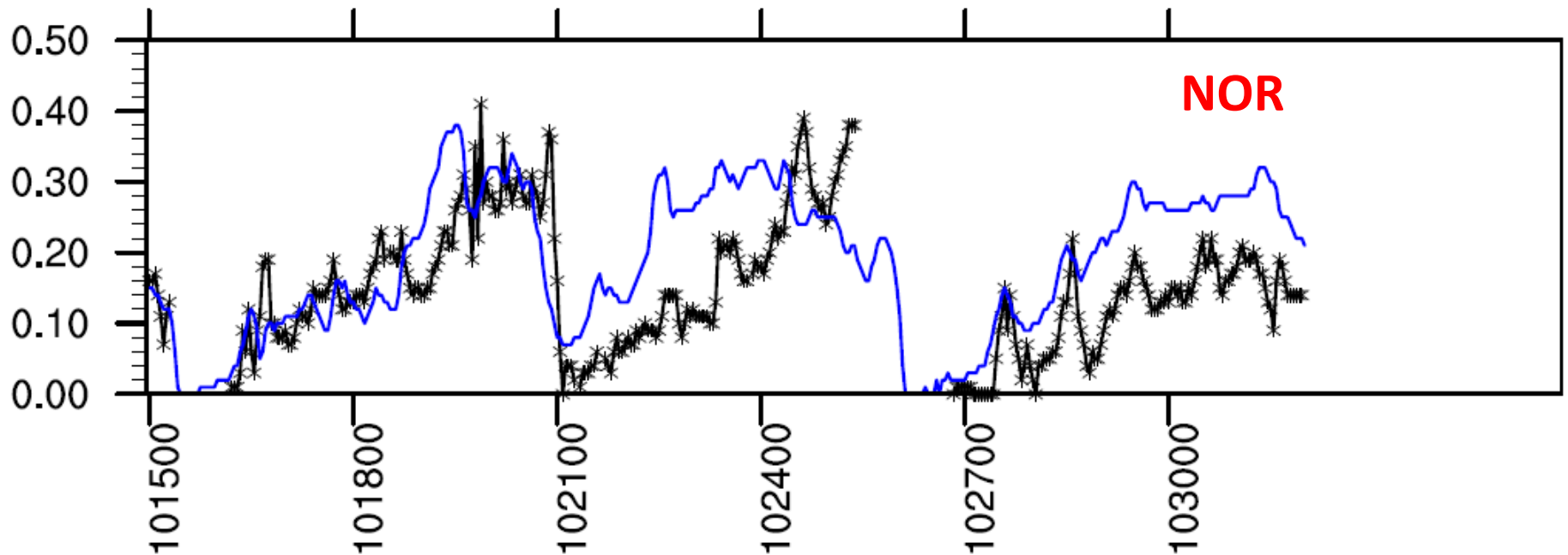
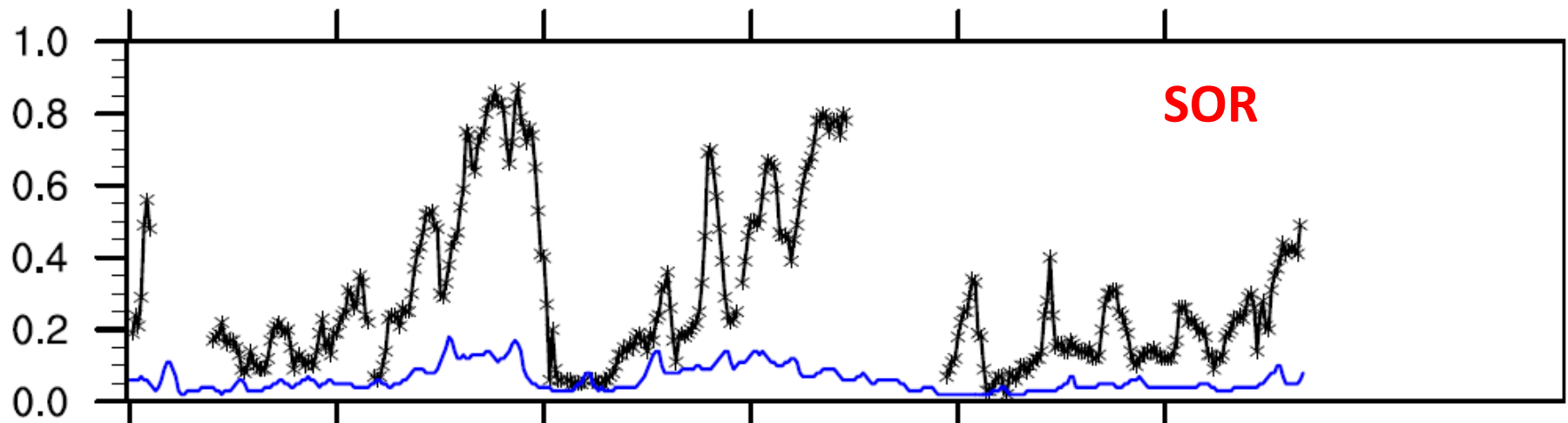
PM1 compositional species



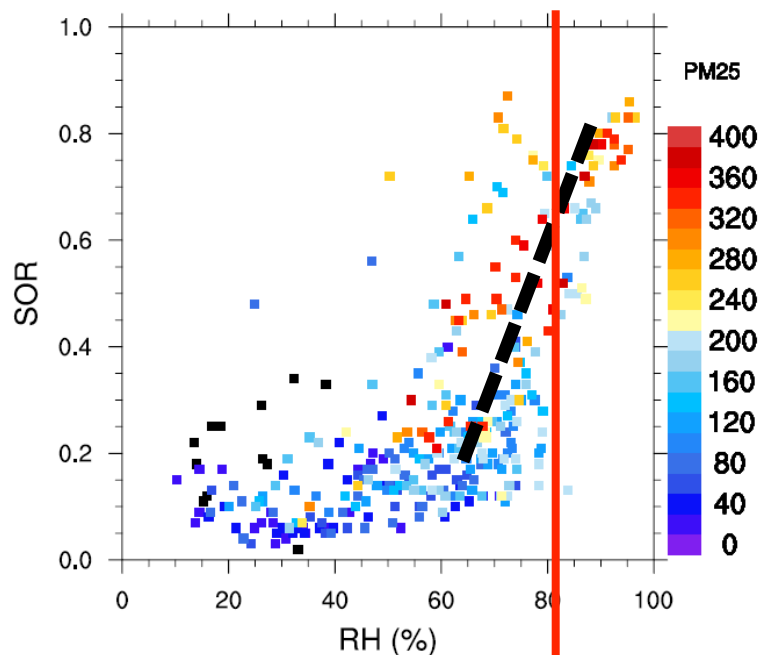




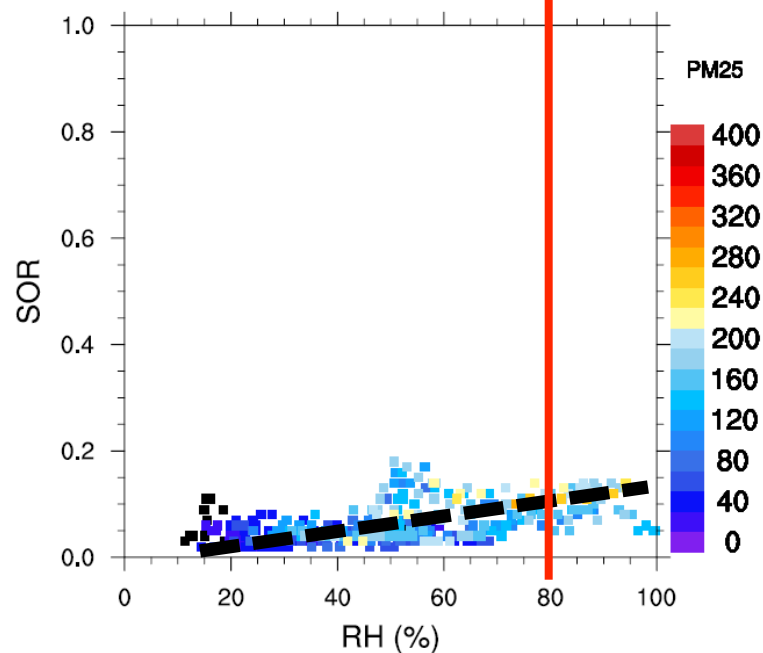
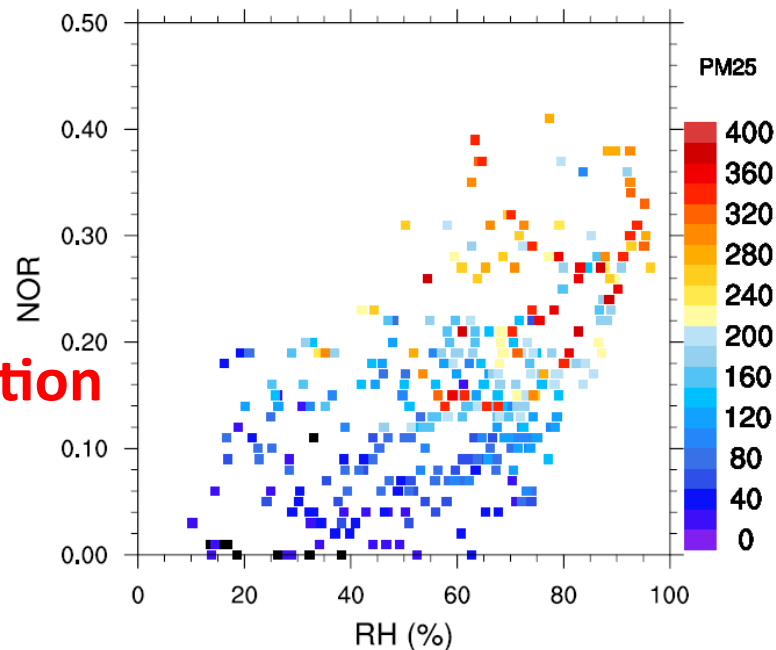
Sulfur and Nitrogen Oxidation Rate



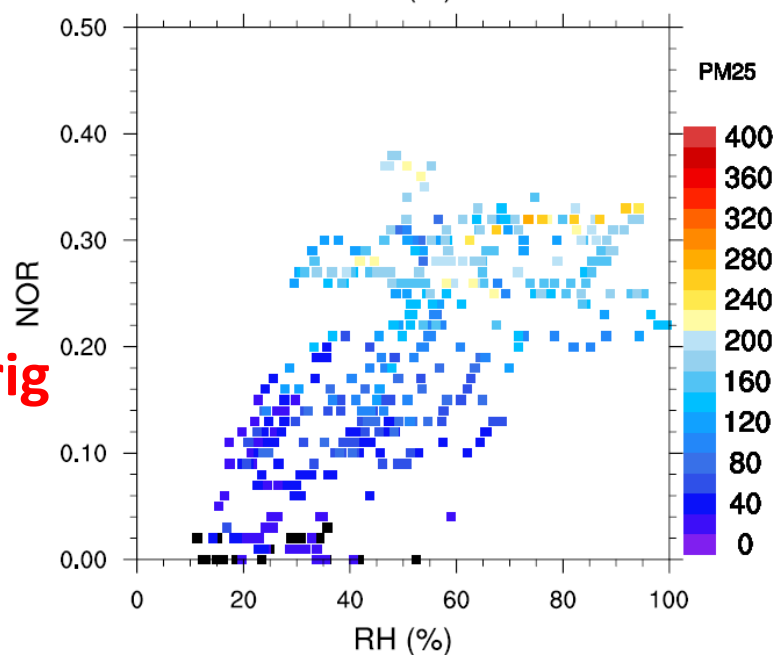
Sulfur and Nitrogen Oxidation Rate versus RH



Observation

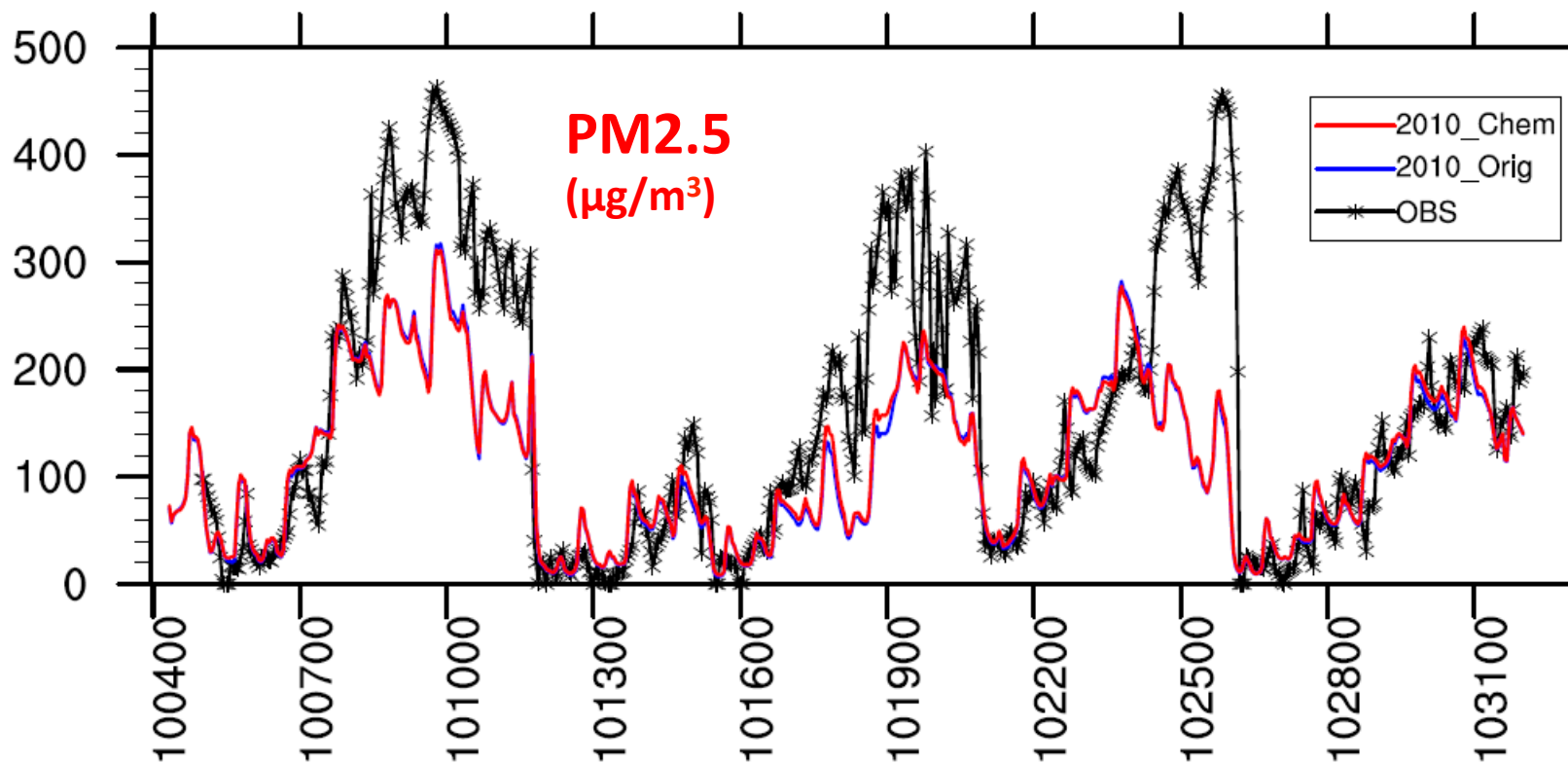


Model
2010_Orig

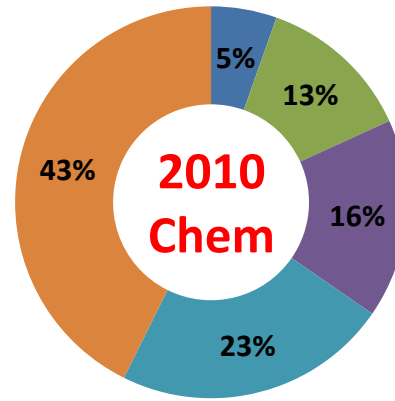
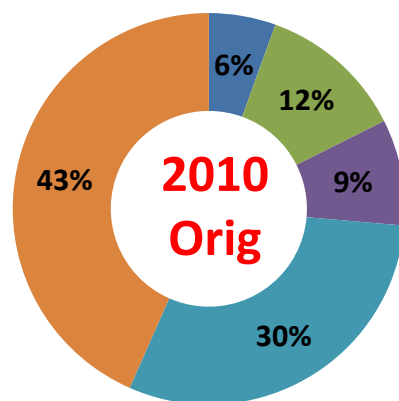
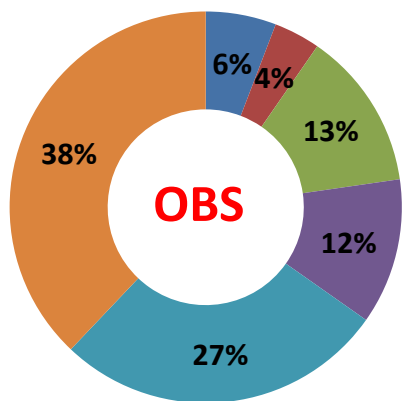


Two sensitivity simulations

- 2010_Chem
 - Considering the SOR and NOR increase with RH, arbitral induce the observed/modeled scaling factors of SOR and NOR respectively to following two reaction rates
 - $\text{SO}_2 + \text{OH} \rightarrow \text{H}_2\text{SO}_4$
 - $\text{NO}_2 + \text{OH} \rightarrow \text{HNO}_3$

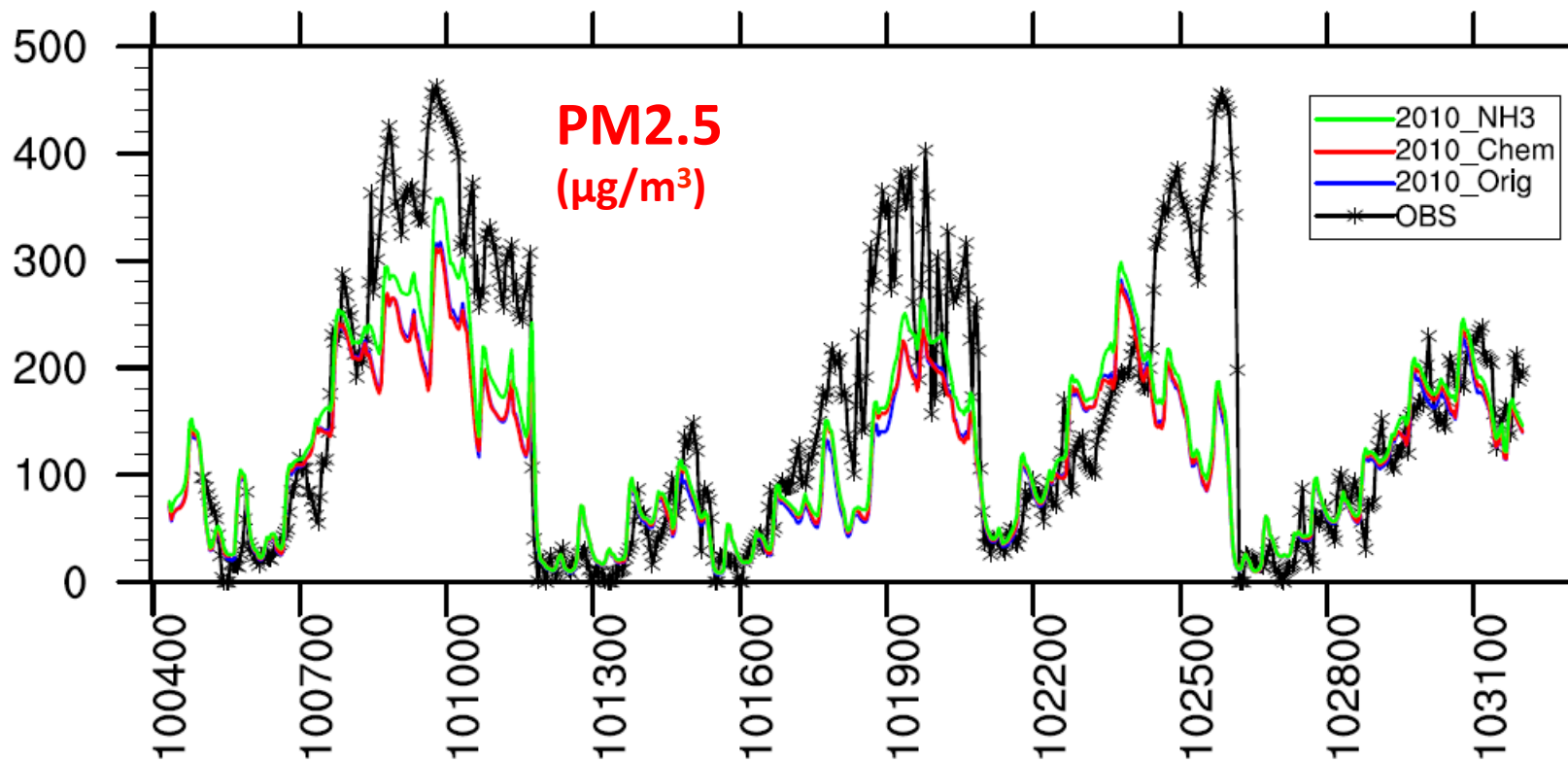


bc cl nh4 so4 no3 org

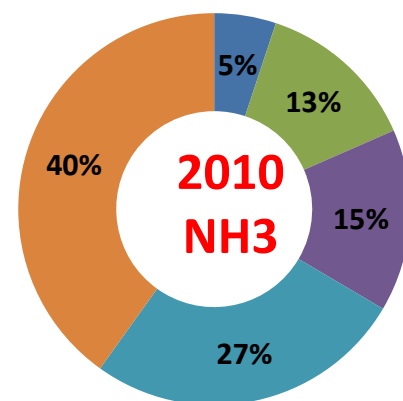
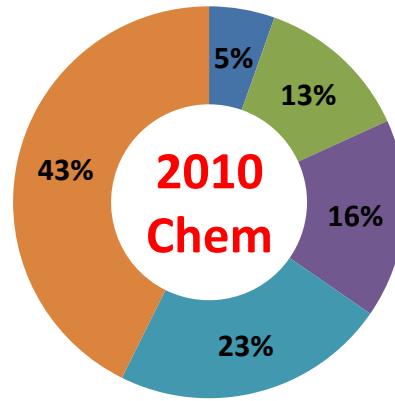
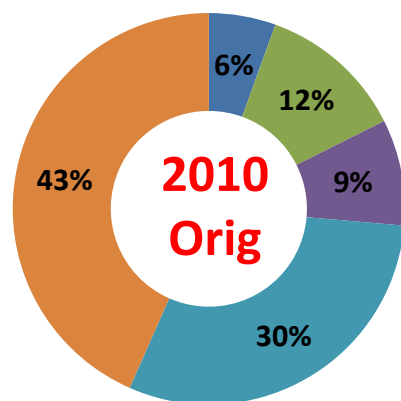
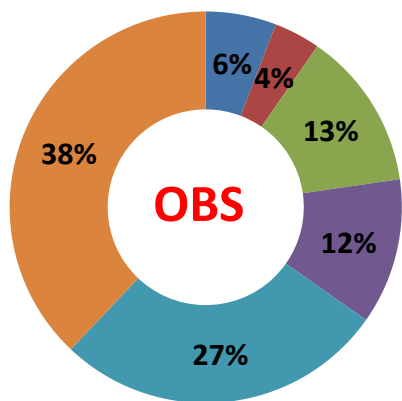


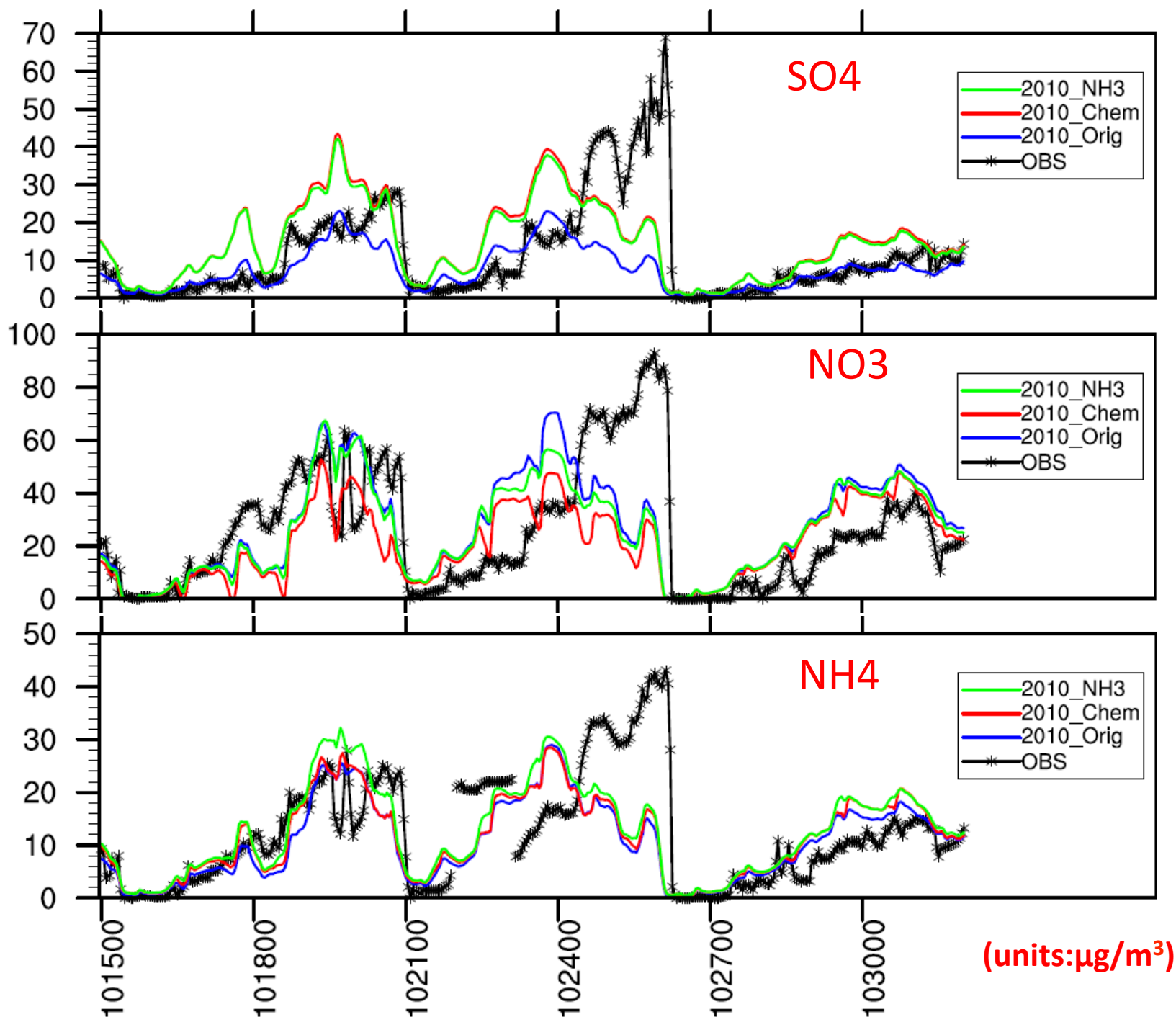
Two sensitivity simulations

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 - $\text{NO}_2 + \text{OH} \rightarrow \text{HNO}_3$
- 2010_NH3
 - 30% increase of NH3 emission in addition to 2014_Chem

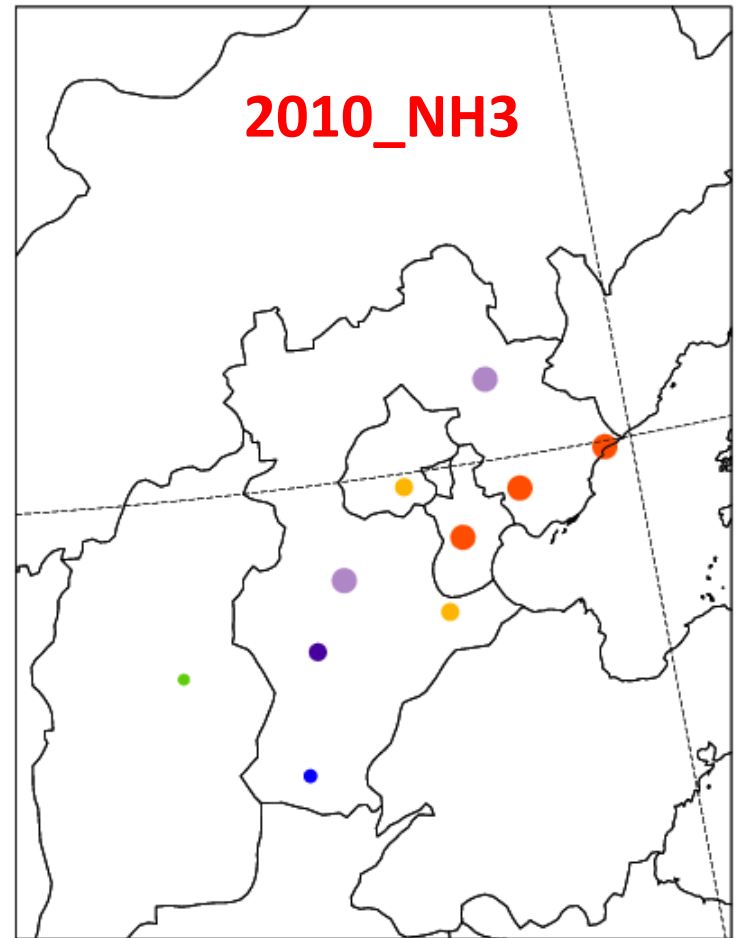
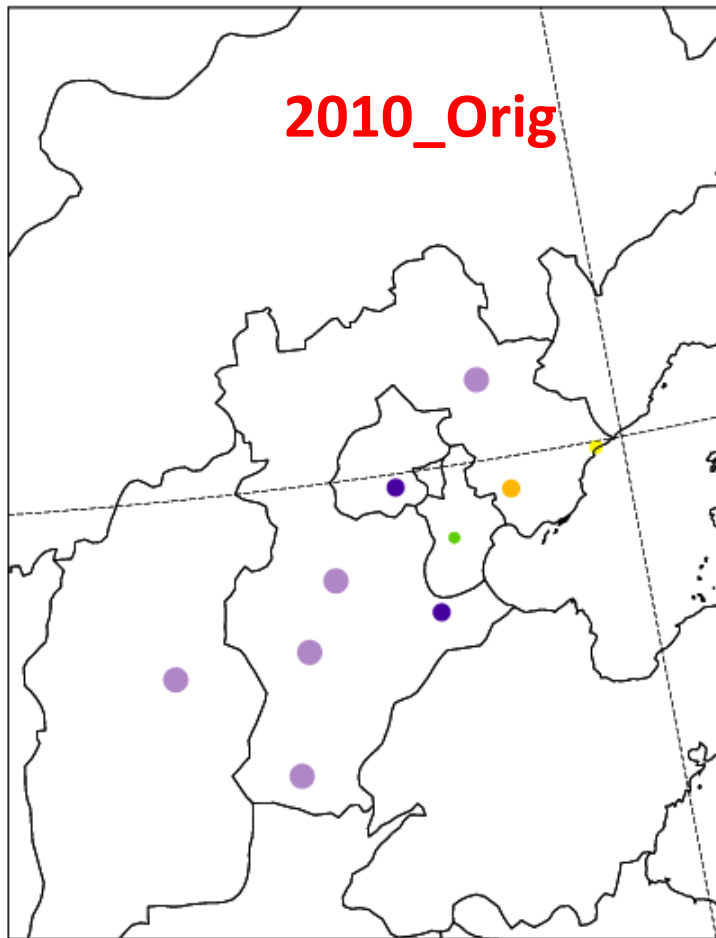


bc cl nh4 so4 no3 org





Average bias of daily mean PM_{2.5} (Mod – Obs)



Next step

- Meteorology
 - DA for more accurate RH simulations
- Emission
 - SO₂ emission changes
 - Dynamic precursor emissions
- Chemistry
 - Heterogeneous reactions