Yale 耶鲁大学-南京信息工程大学大气环境心
Yale-NUIST Center on Atmospheric Environment

A WRF-Chem modeling study of a $PM_{2.5}$ episode over Yangtze River Delta region

Presented by Cui Jian

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Outline

- Introduction
- Objectives
- Method and Data
- Preliminary results
- Summary and future work

Introduction

- $PM_{2.5}$:

✓ Solid particles or liquid droplets with diameter less than or equal to 2.5 micrometers in size.(Raes et al.,2000)

- Source:

✓ Industrial, biomass combustion, wind-blown (mineral dust), and natural.

- Components:

✓ Elemental carbon, organic carbon, sulfate, nitrate, and so on.

Introduction(con.)

- Impact on climate changes:

✓ Direct radiative forcing: scattering of solar radiation and absorption/emission of terrestrial radiation.

✓ Indirect radiative forcing: effects of aerosols on cloud properties.

- Impact on human health:

✓ One of major air pollutants.

Motivation and objectives

- Motivation

- $PM_{2.5}$ is becoming more and more serious in YRD; the transparency of atmosphere is getting worse; there is long-standing aerosol cloud.

- Modeling $PM_{2.5}$ and other species is challenged because an accurate and comprehensive emission inventory is lacking.

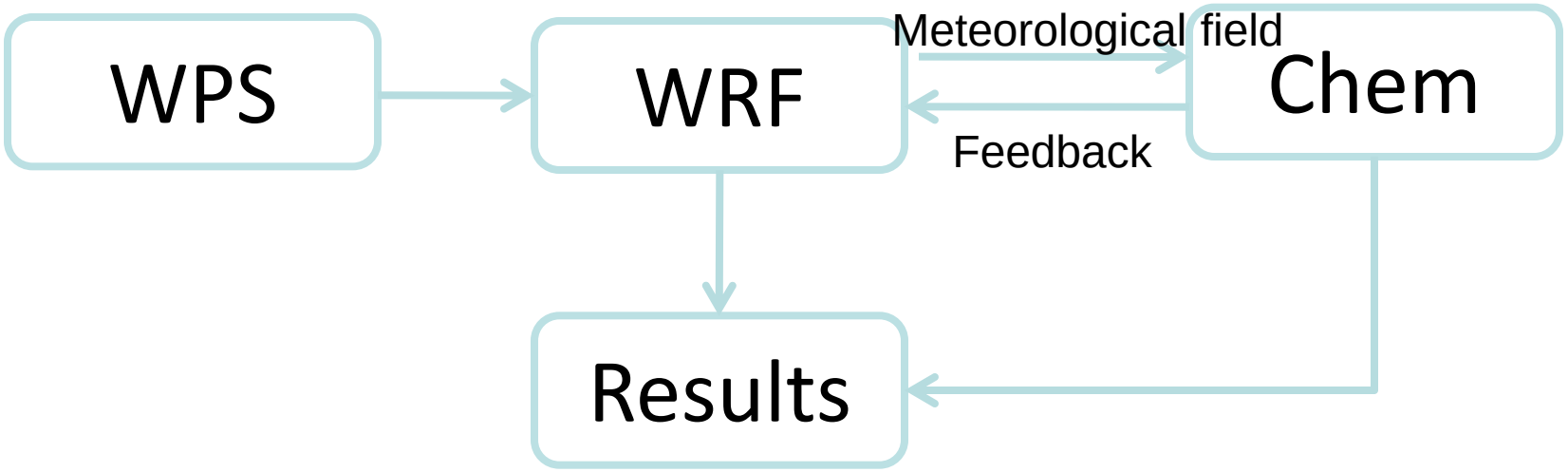
- Objectives:

To set up WRF/Chem simulation for better understanding of $PM_{2.5}$ episodes' mechanism in Yangtze River Delta Region.

Method and Data

- Brief description of WRF-Chem
- Configurations of the simulation
- The emission of David Street

WRF-Chem model



Chemical mechanisms

- Four choices for gas-phase chemical mechanisms :RADM2,RACM,CB-4 and CBM-Z
- Three choices for photolysis schemes:Madronich，Fast-J,F-TUV
- Four choices for aerosol schemes: MADE/SORGAM,MADE/VBS,MOSAIC and GOCART
- Three scheme match:

  RADM2&MADE/SORGAM,

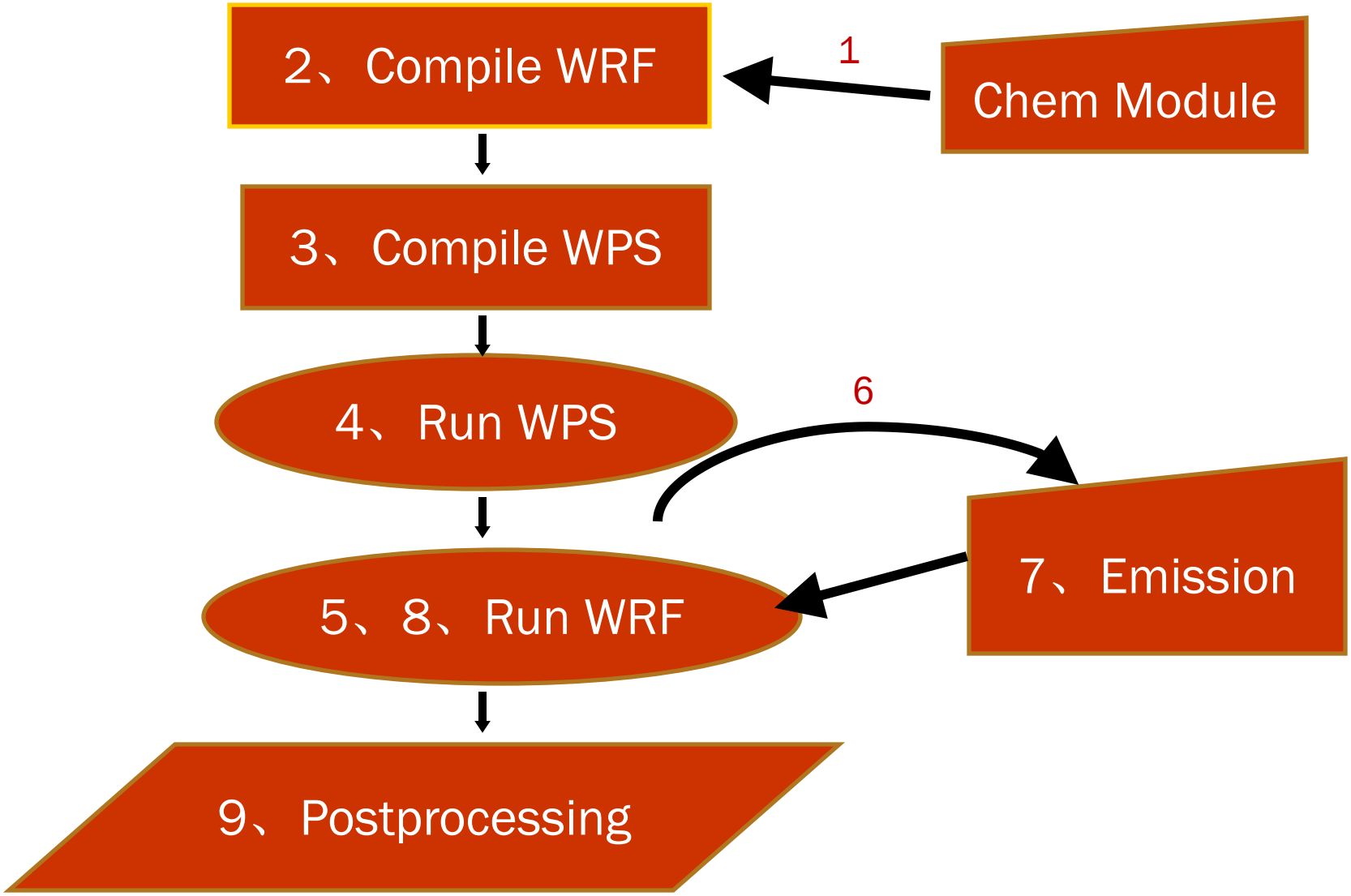
  RACM & MADE/SORGAM and CBMZ & MOSAIC
- I used CBM-Z and MOSAIC

(From WRF-Chem Version 3.4 User's Guide)

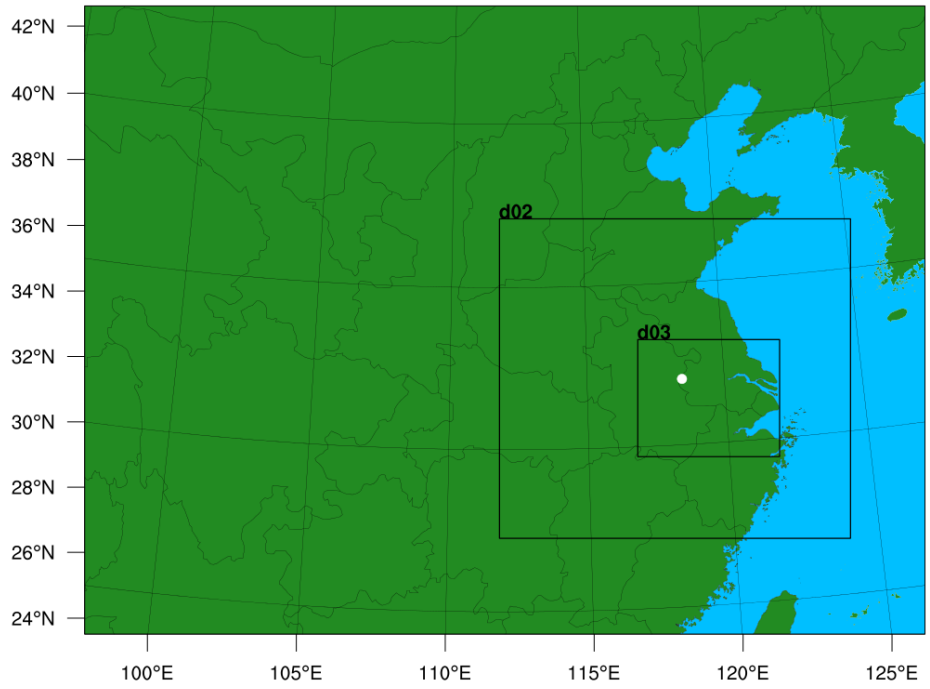
Chemical Modules

- emissions_driver
- optical_driver
- photolysis_driver
- dry_dep_driver
- grelldrvet
- mechanism_driver
- cloudchem_driver
- aerosols_driver
- wetscav_driver
- sum_pm_driver

Steps to run WRF-Chem



Model configurations



d1:36km
d2:12km
d3:4km
Vertical levels:40
Simulated time:
20120508-20120509

The emission of David Street

- A new inventory of air pollutant emissions in Asia in the year 2006 is developed to support the Intercontinental Chemical Transport Experiment-Phase B (INTEXB) funded by the NASA.(D.G. Streets et al.2003)

Definition of the inventory domain

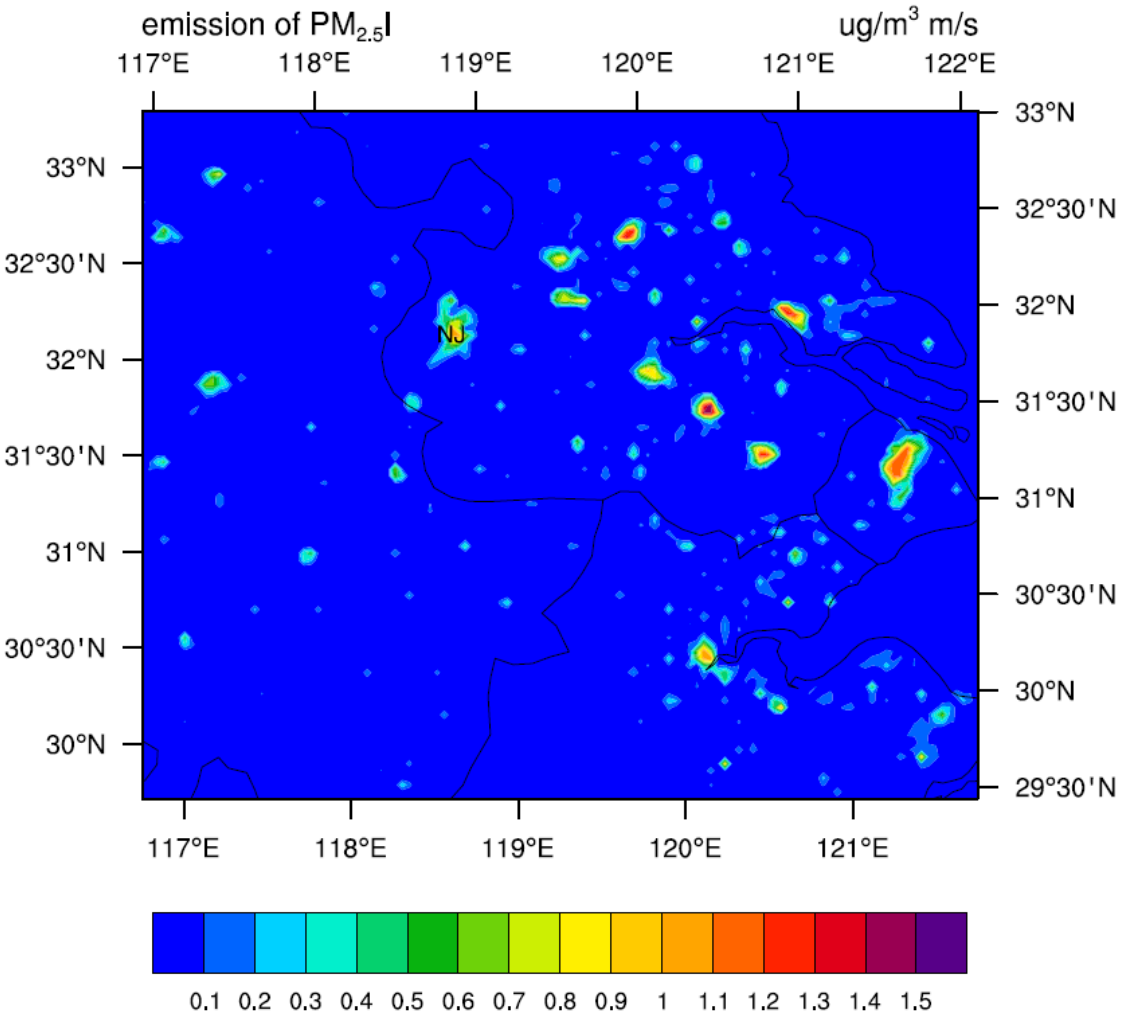
Source: D.G. Streets et al.2003

Summary of the INTEX-B Asia emission inventory dataset

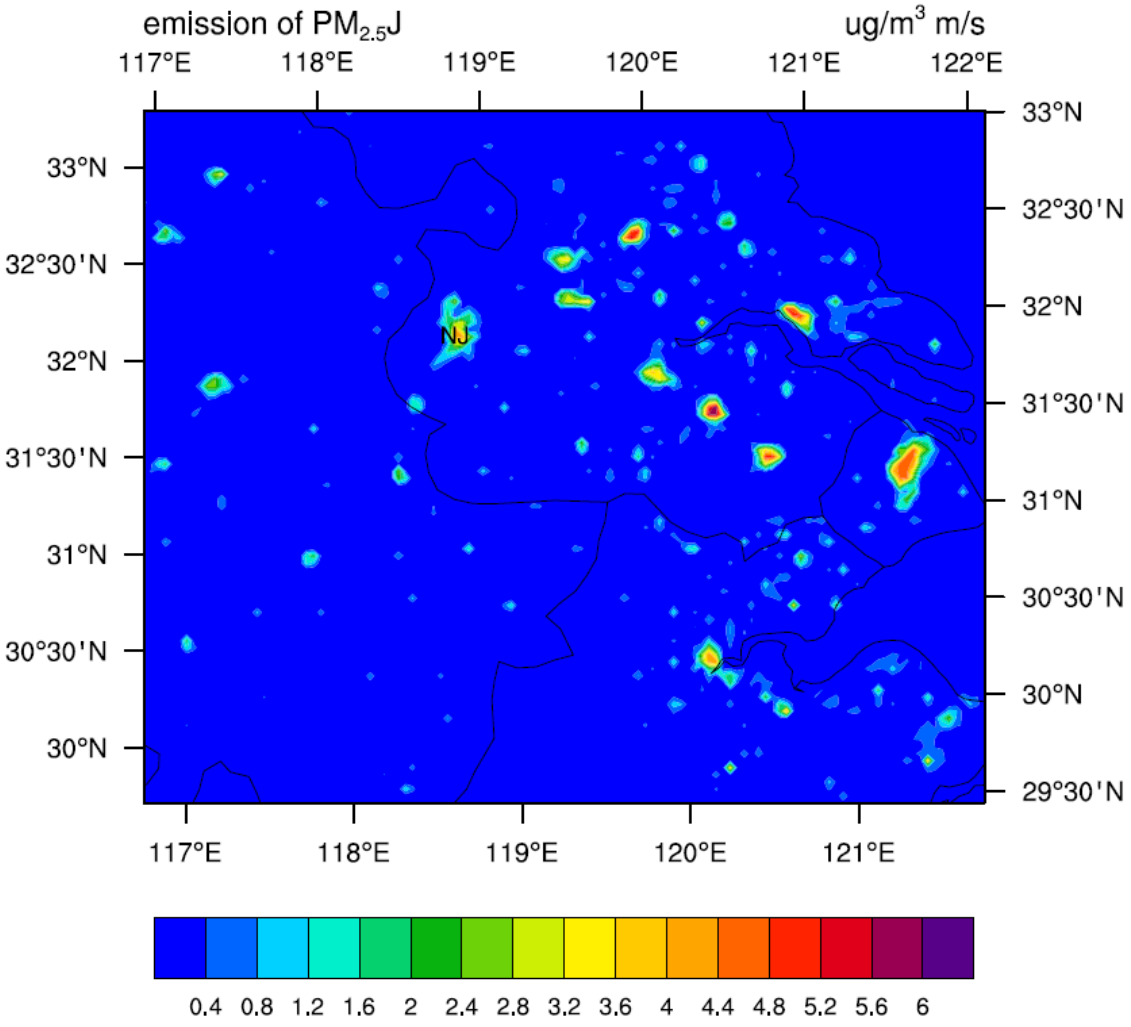
Item	Description
Domain	22 countries and regions in Asia, see Fig. 1
Species	SO_2, NO_x, CO, NMVOC, PM_{10}, $PM_{2.5}$, BC, OC
VOC speciation	by mechanism: CB04, CB05, RADM2, SAPRC99, SAPRC07
Sectors	power plants, industry, residential, transportation
Representing Year	2006
Spatial resolution	30 min × 30 min
Seasonality	monthly
Data availability	available online at http://mic.greenresource.cn/intex-b2006 http://www.cgrer.uiowa.edu/EMISSION_DATA_new/index_16.html

(Source: D.G. Streets et al.2003)

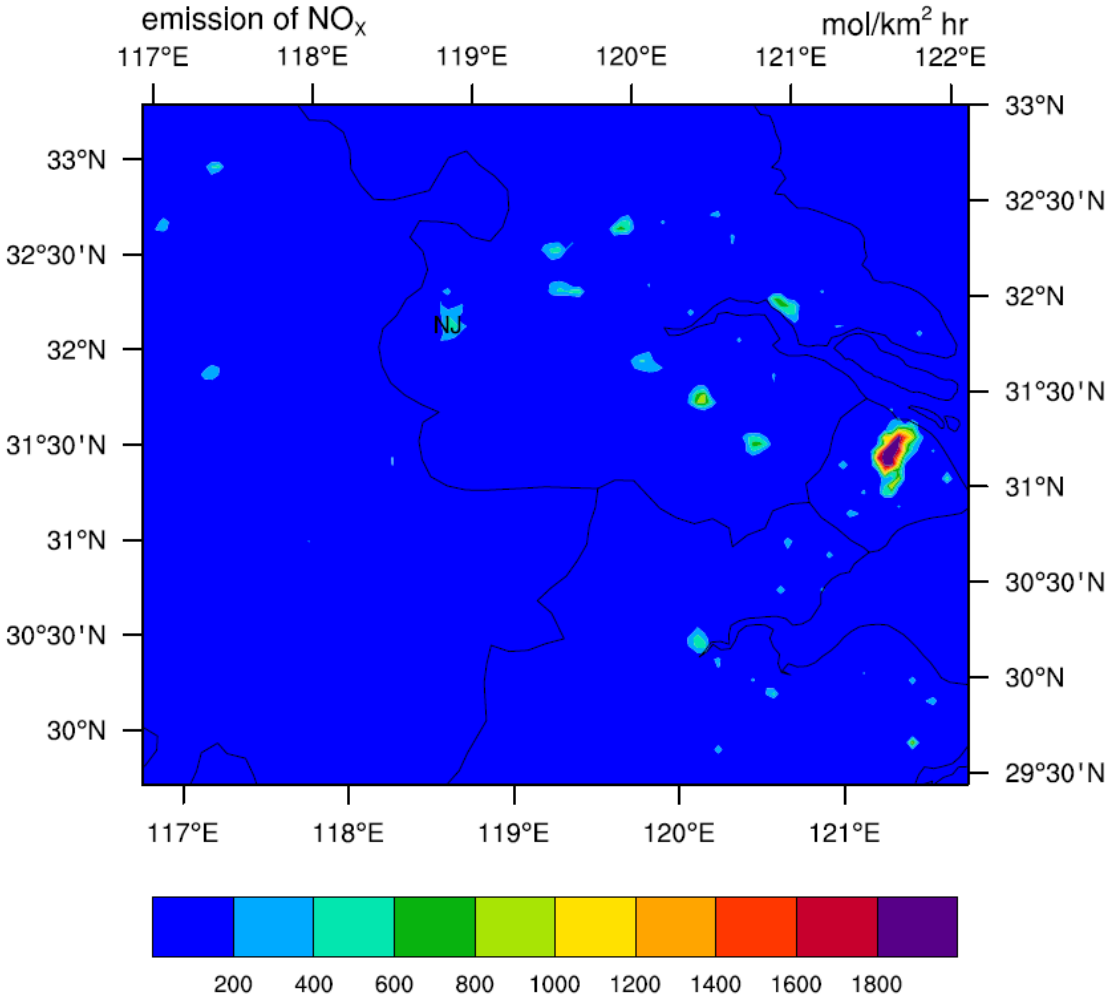
Emission of $PM_{2.5}$I



Emission of $PM_{2.5}J$



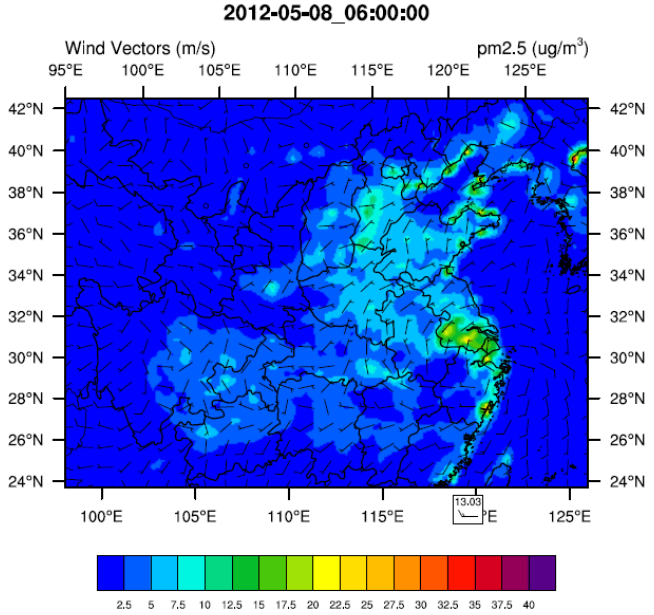
Emission of NO_X

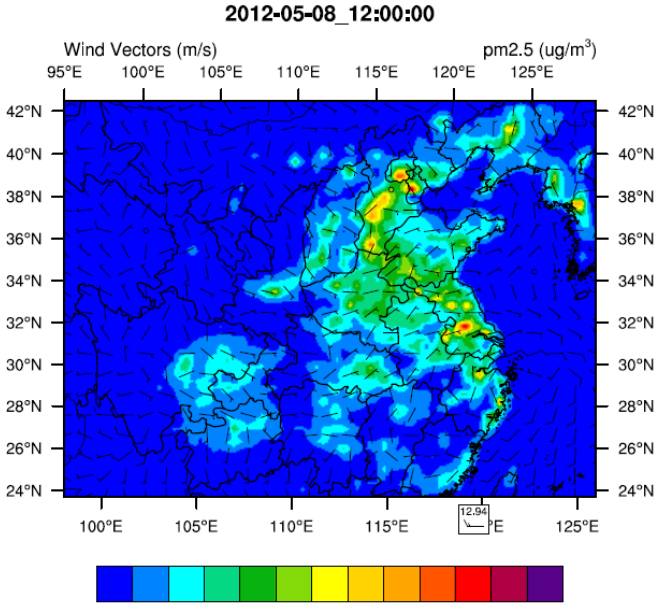


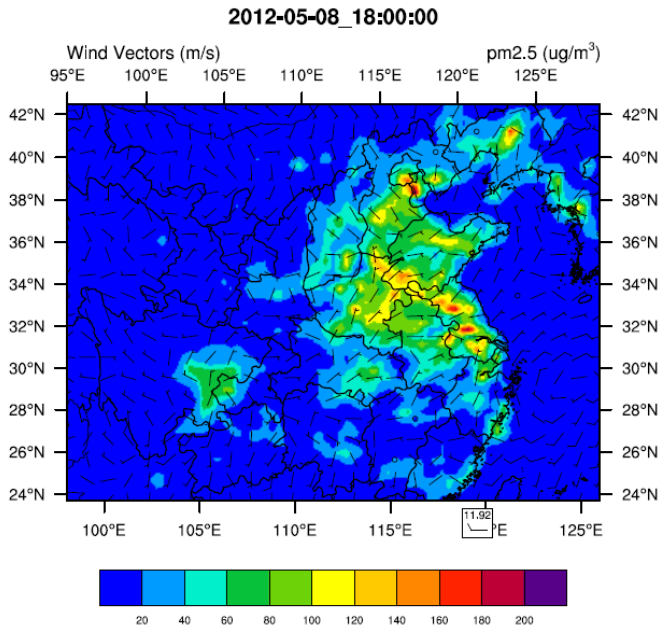
Preliminary results

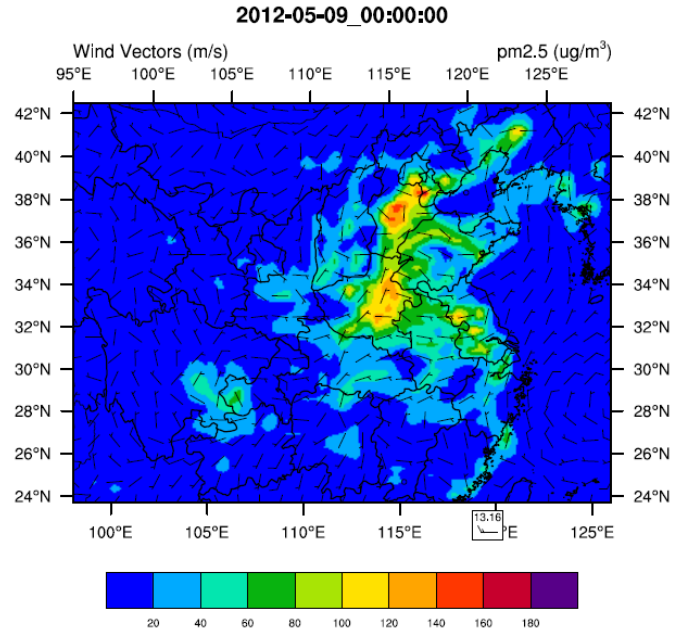
- Spatial patterns
- Comparison with observation

Simulated $PM_{2.5}$ of Domain 1

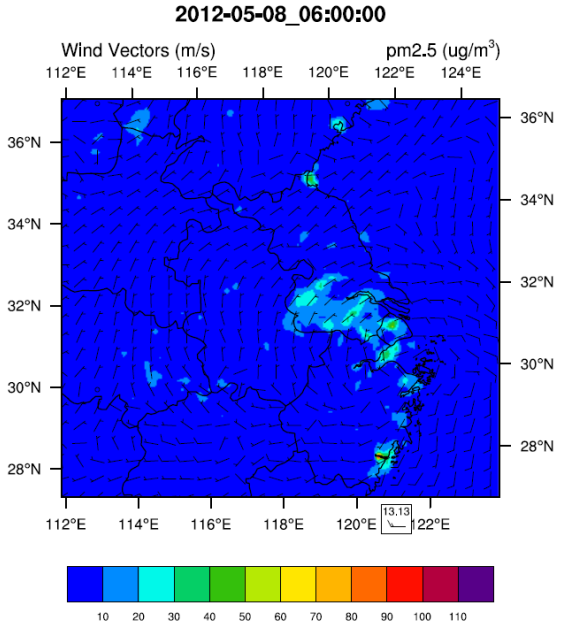


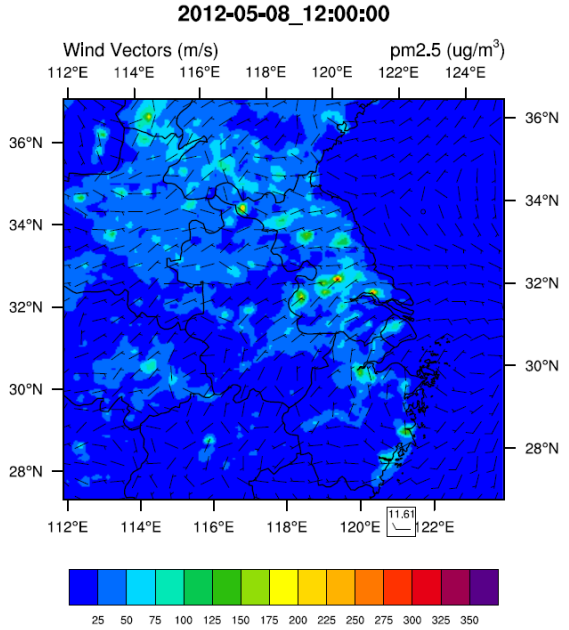


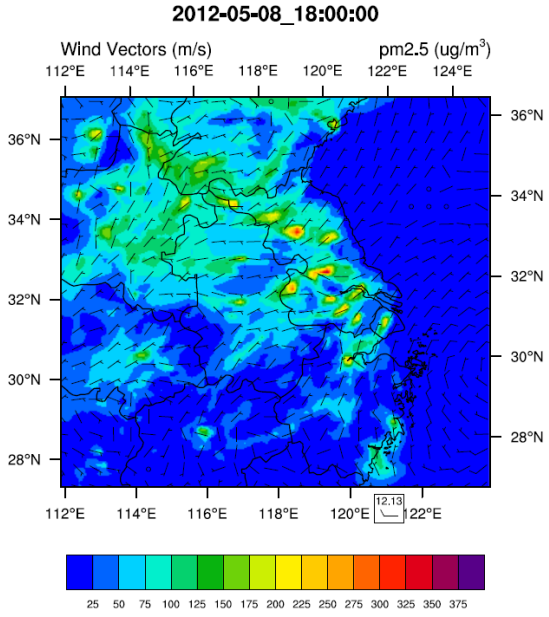


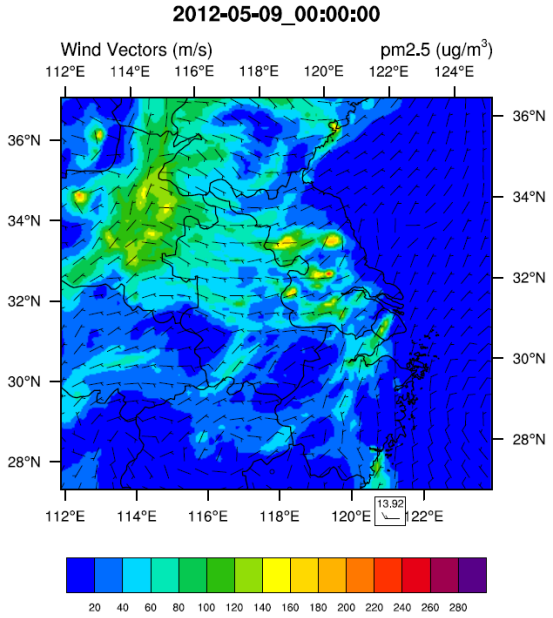


Simulated $PM_{2.5}$ of domain 2

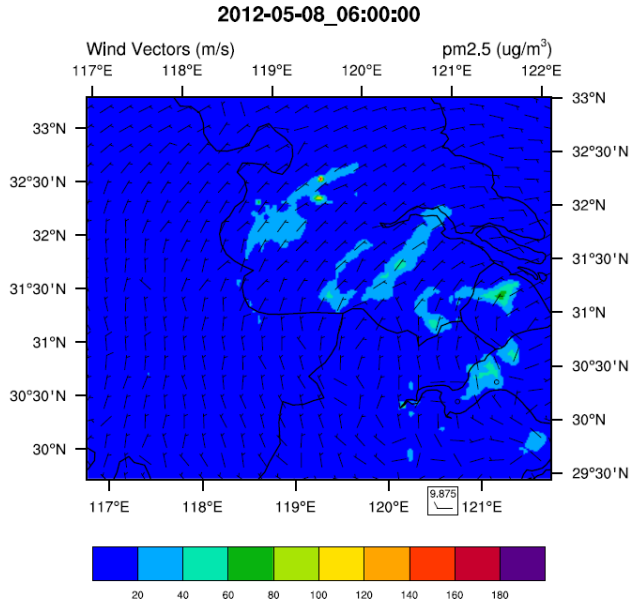


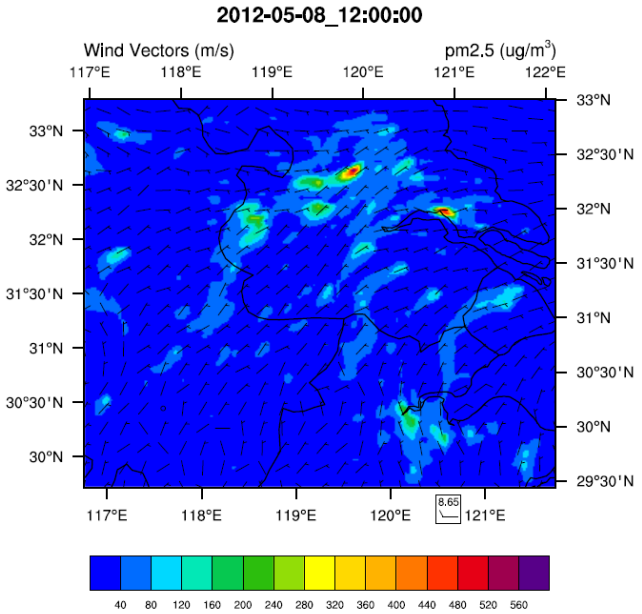


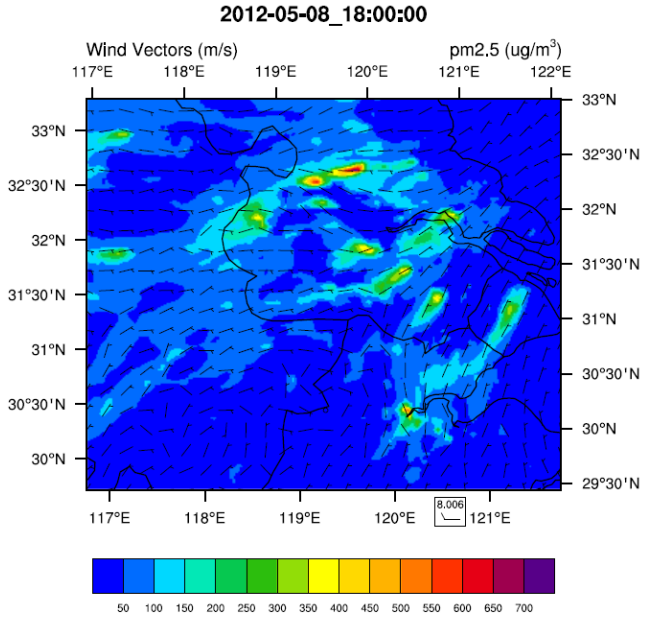


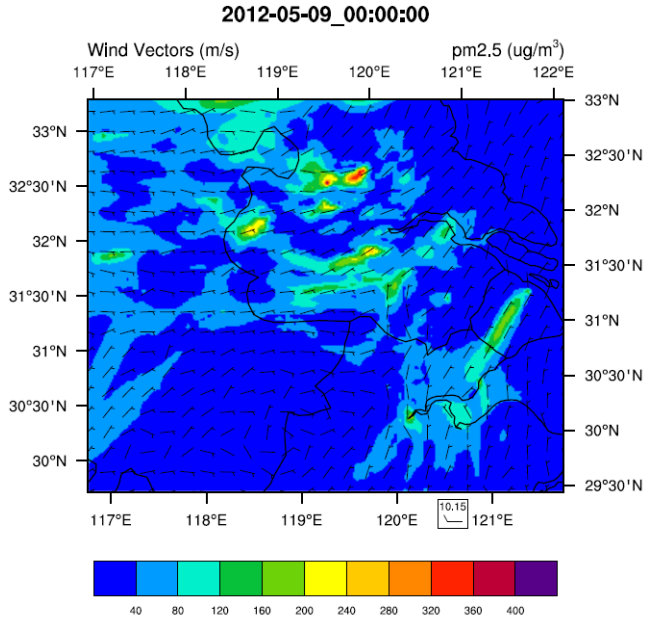


Simulated $PM_{2.5}$ of Domain 3

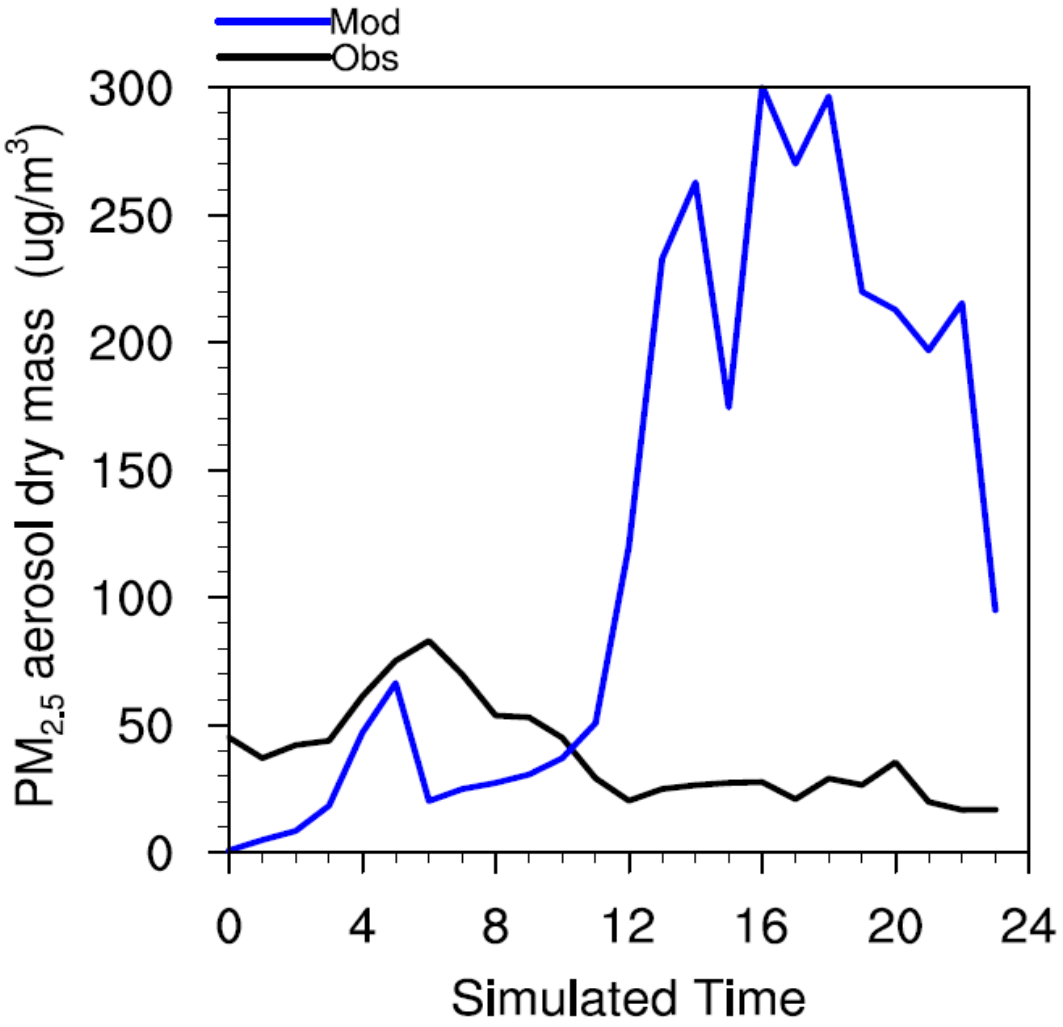




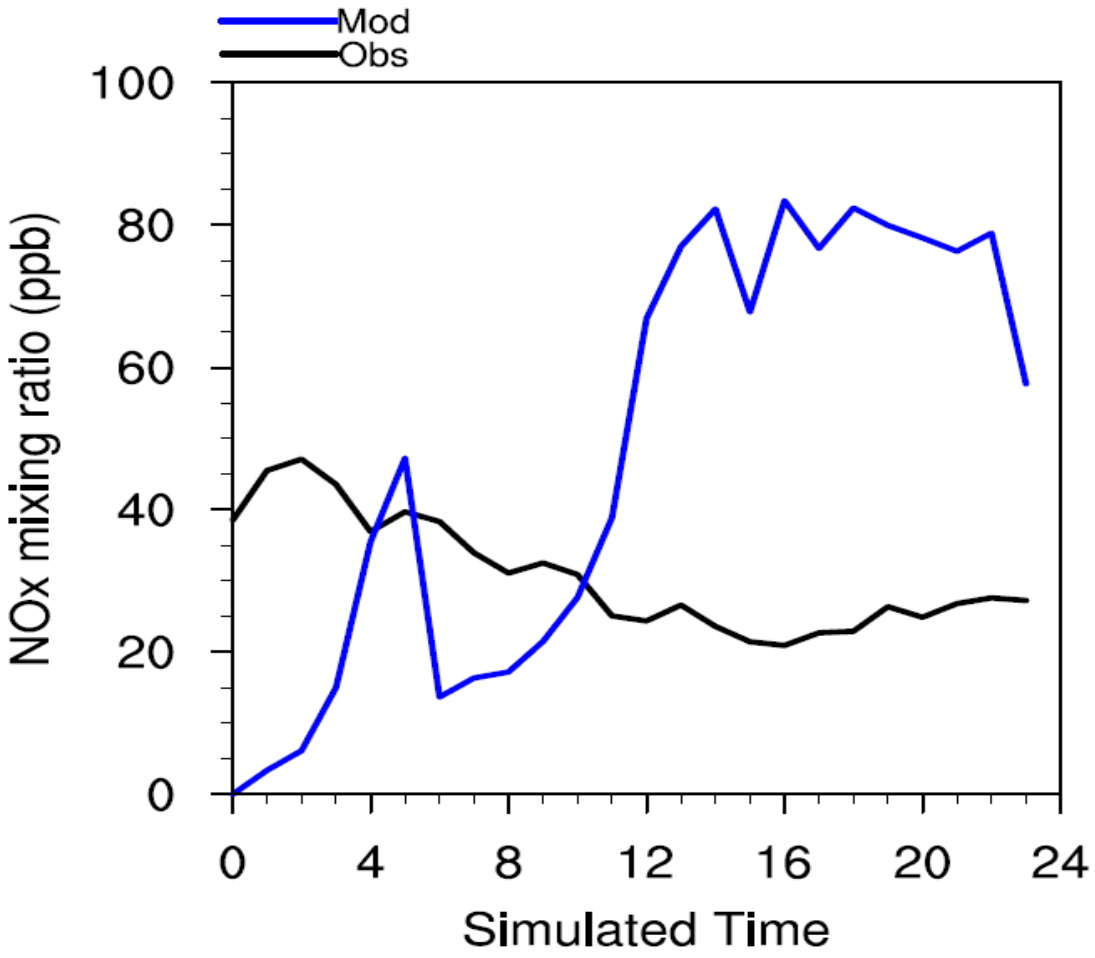




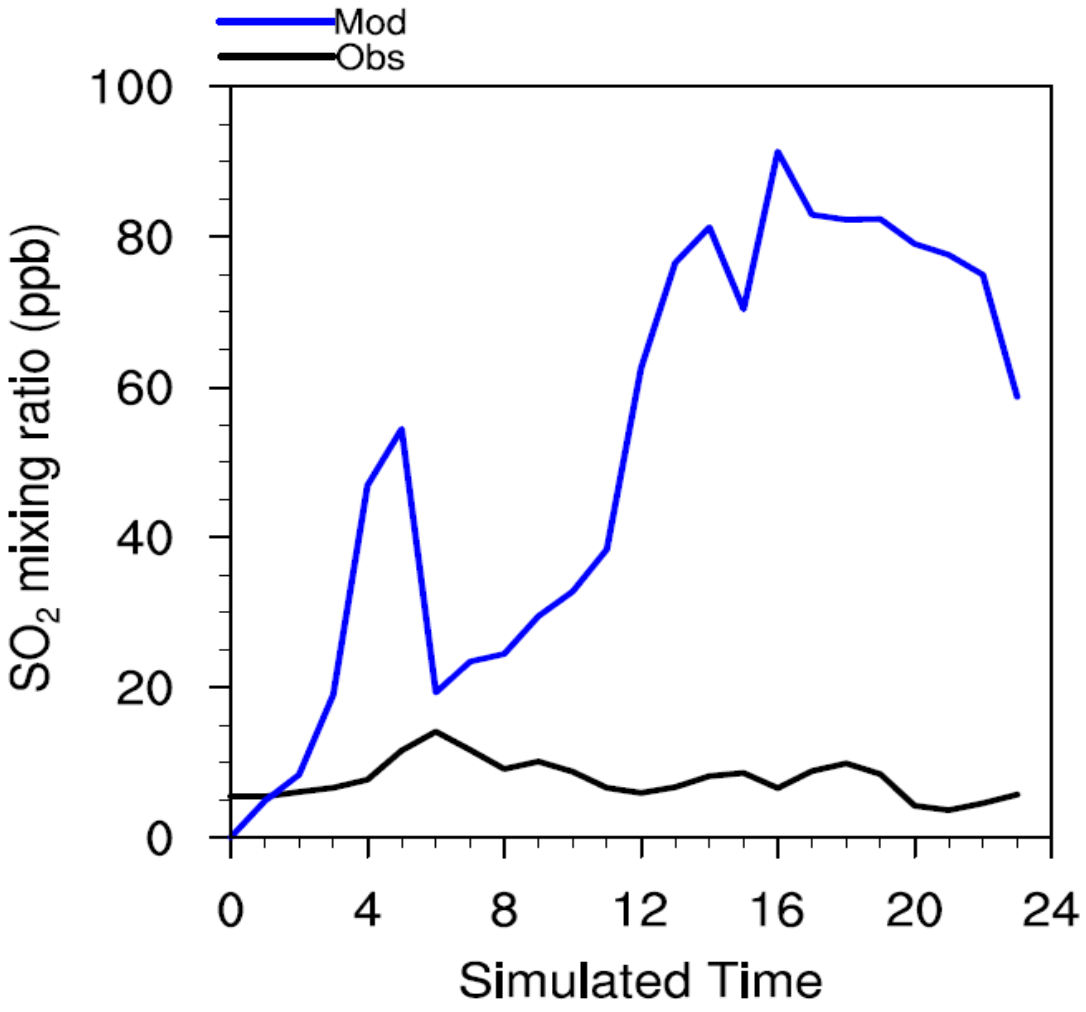
Comparison of simulated $PM_{2.5}$ with observed in SuZhou



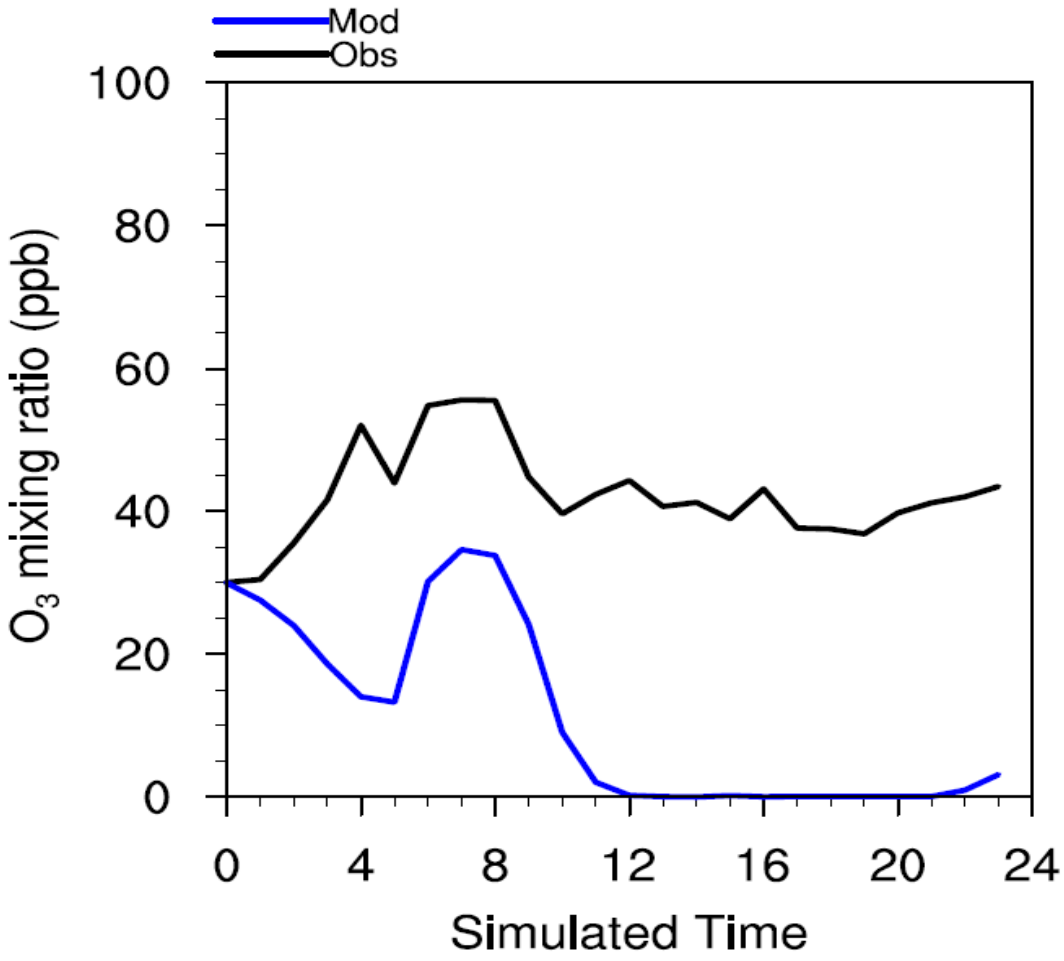
Comparison of simulated NOx with observed in SuZhou



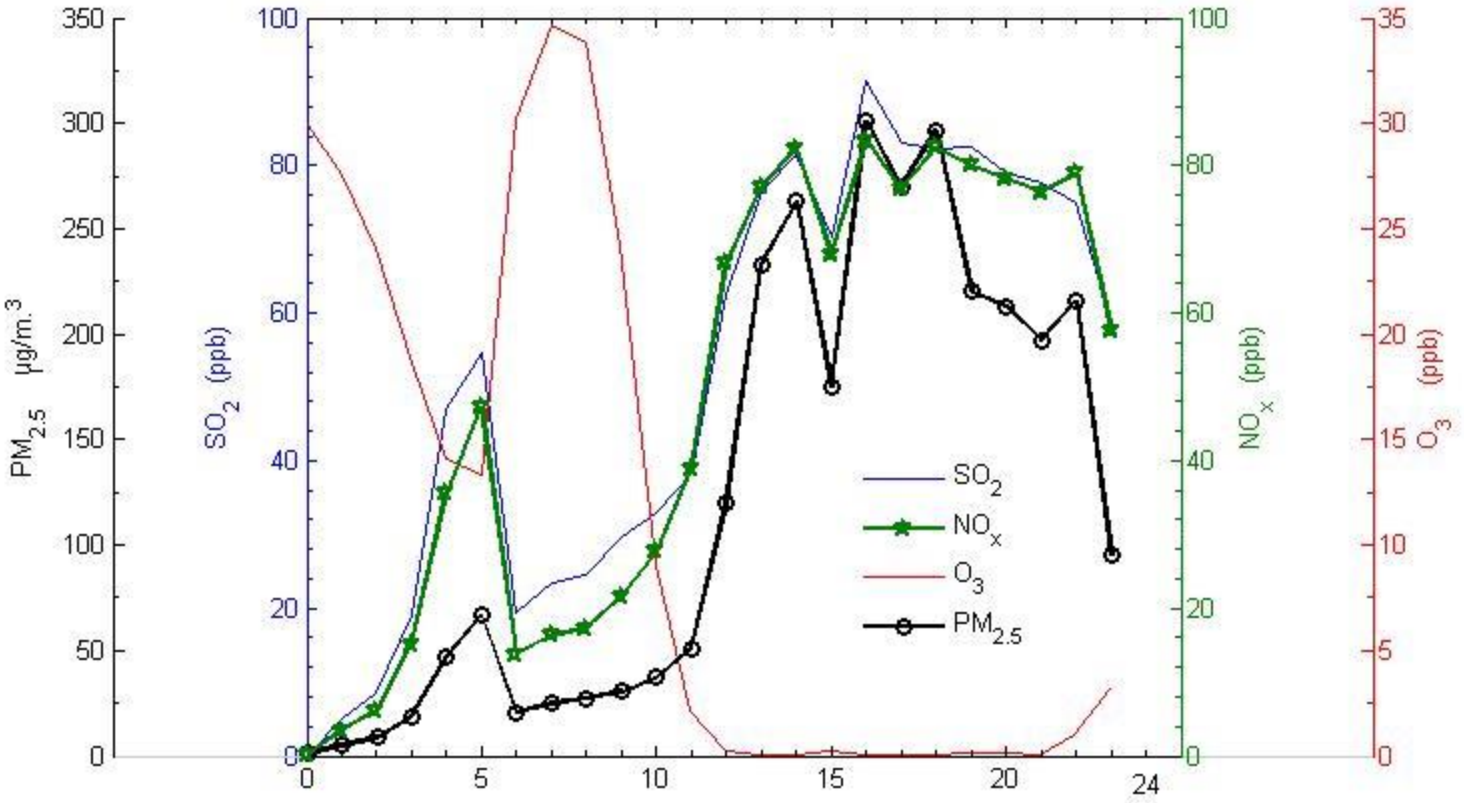
Comparison of simulated SO_2 with observed in SuZhou



Comparison of simulated O_3 with observed in SuZhou



Comparison of four simulated matters



Summary

- WRF-Chem has been set up to simulate particulate matter and other species over the Yangtze River Delta region. A 24-hour simulation was completed.
- The results show that the $PM_{2.5}$ was significantly overestimated by our simulations, especially for time after 12:00 (possible causes need to be investigated)

Future Work

- To investigate the reasons causing the over-predictions such as emission issue, initial/boundary conditions for chemical species.

- To improve our simulations by including other emission sources

Thank you!