Overview of J^3 Regional Campaign on Heavy Air Pollution in Winter

YH Zhang,

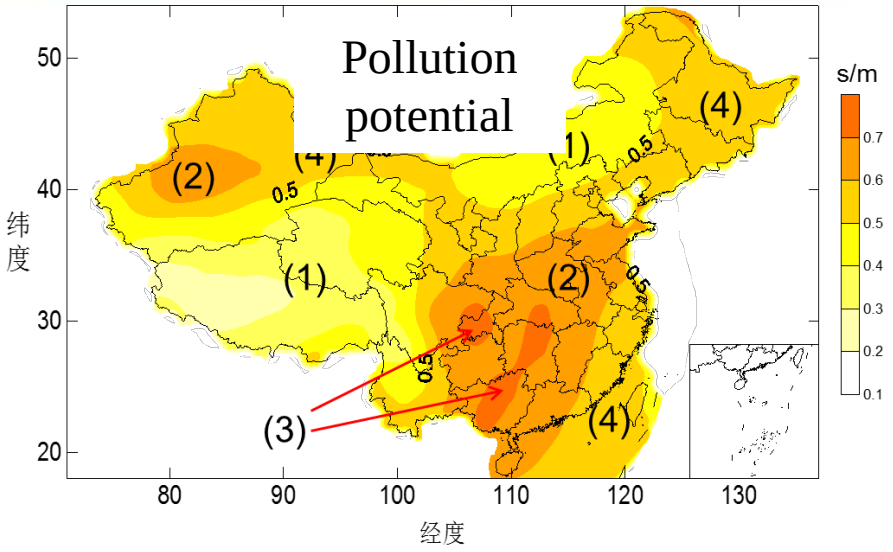
Peking University

The 1st Regional GEOS-Chem Asia Meeting,
Nanjing, 2018-05-21

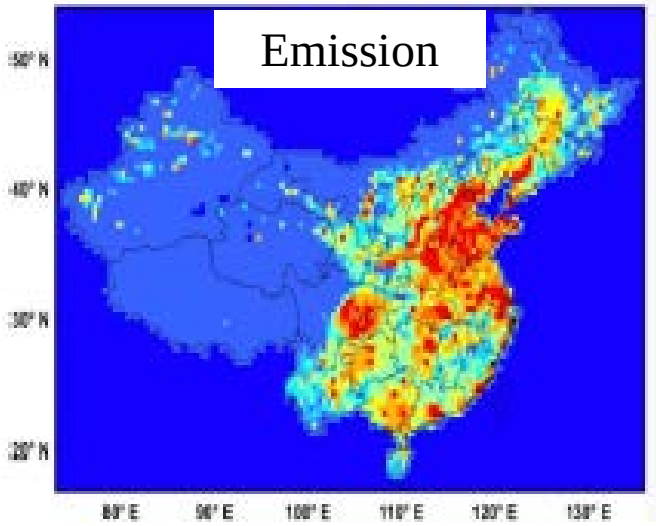
Outline

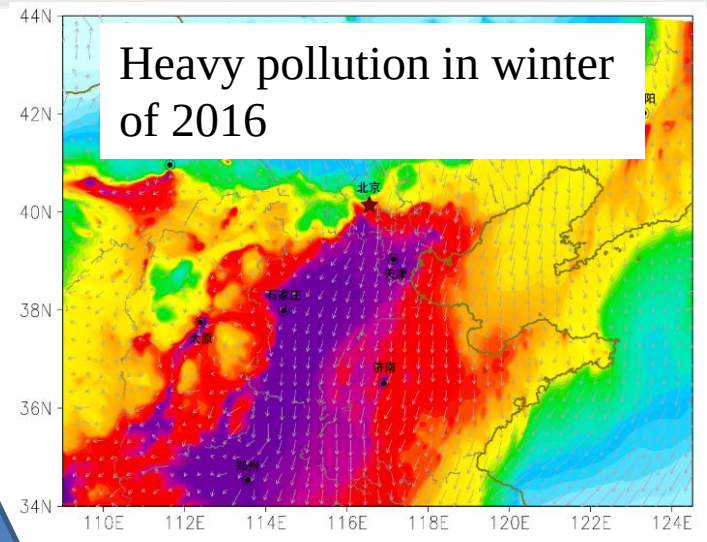
1. **Planning of J^3 integrated campaign**
2. **Characteristics of regional pollution**
3. **Preliminary data analysis of pollution episodes**

Winter haze in JJJ and surrounding area



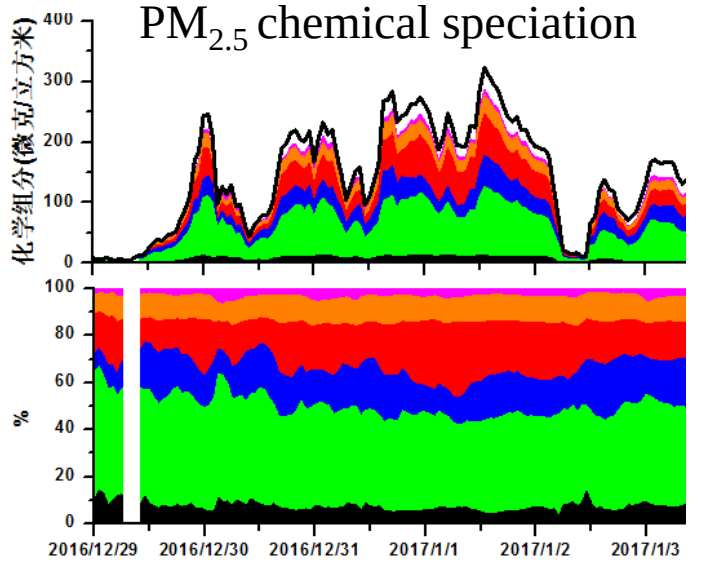
+





主要污染特征：

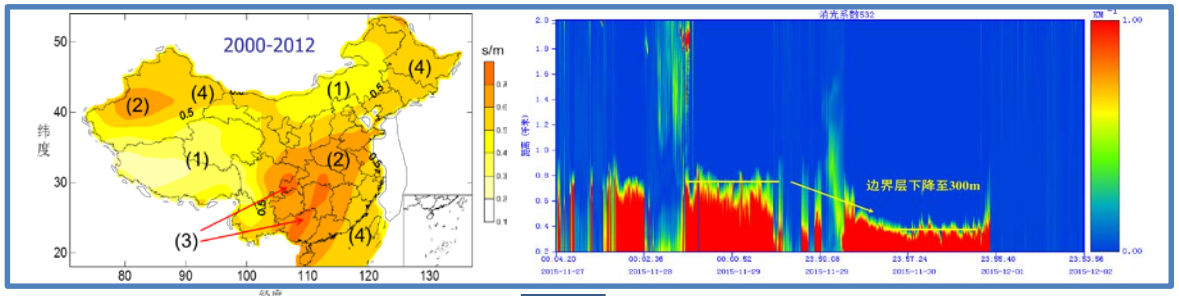
- **二次污染重**：对$PM_{2.5}$的贡献高达60-80%
- **爆发性发生**：污染在2-3小时内增加几倍
- **区域性蔓延**：超100万 km^2
- **持续时间长**： 3-7 天

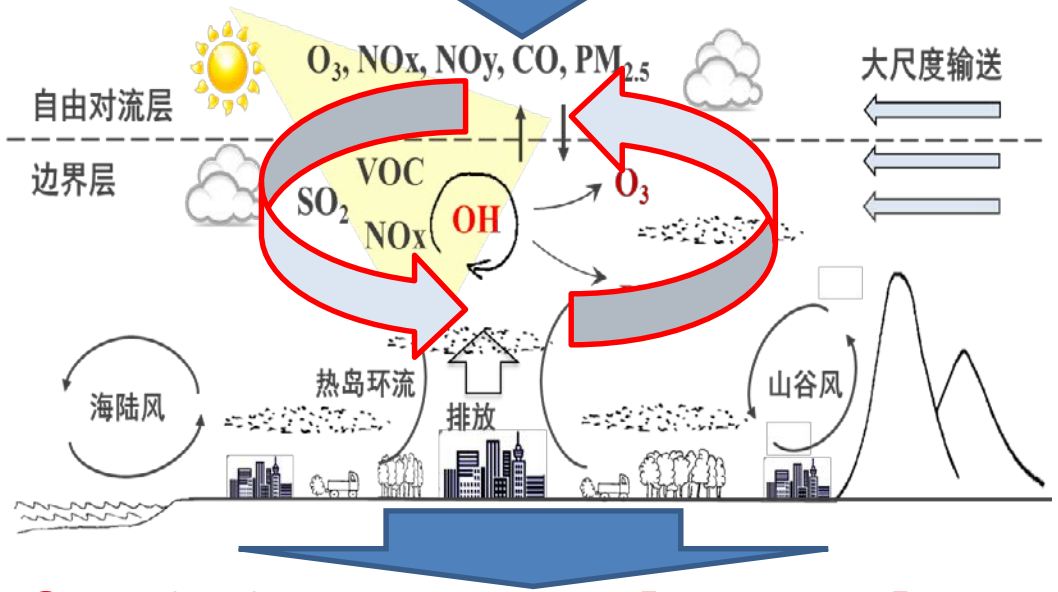


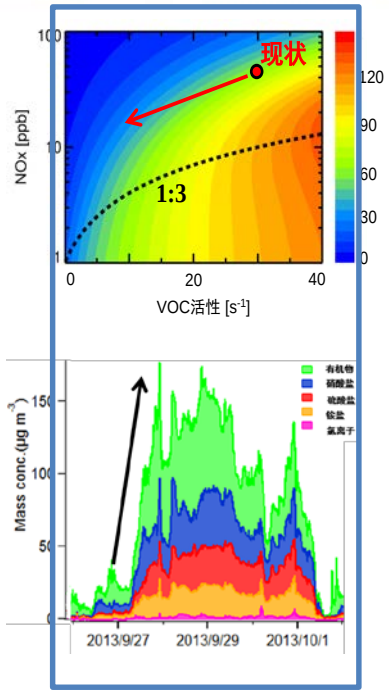
Understanding and challenge for heavy pollution

Super emission
（“排放说”）

Stagnant meteorology（“天气说”）







Strong oxidation
（“转化说”）

Quantify the role of emission, meteorology and atmospheric chemistry in the process of heavy pollution?

Scientific questions

Coupling mechanism for winter hazy explosive growth and its quantitatively analysis

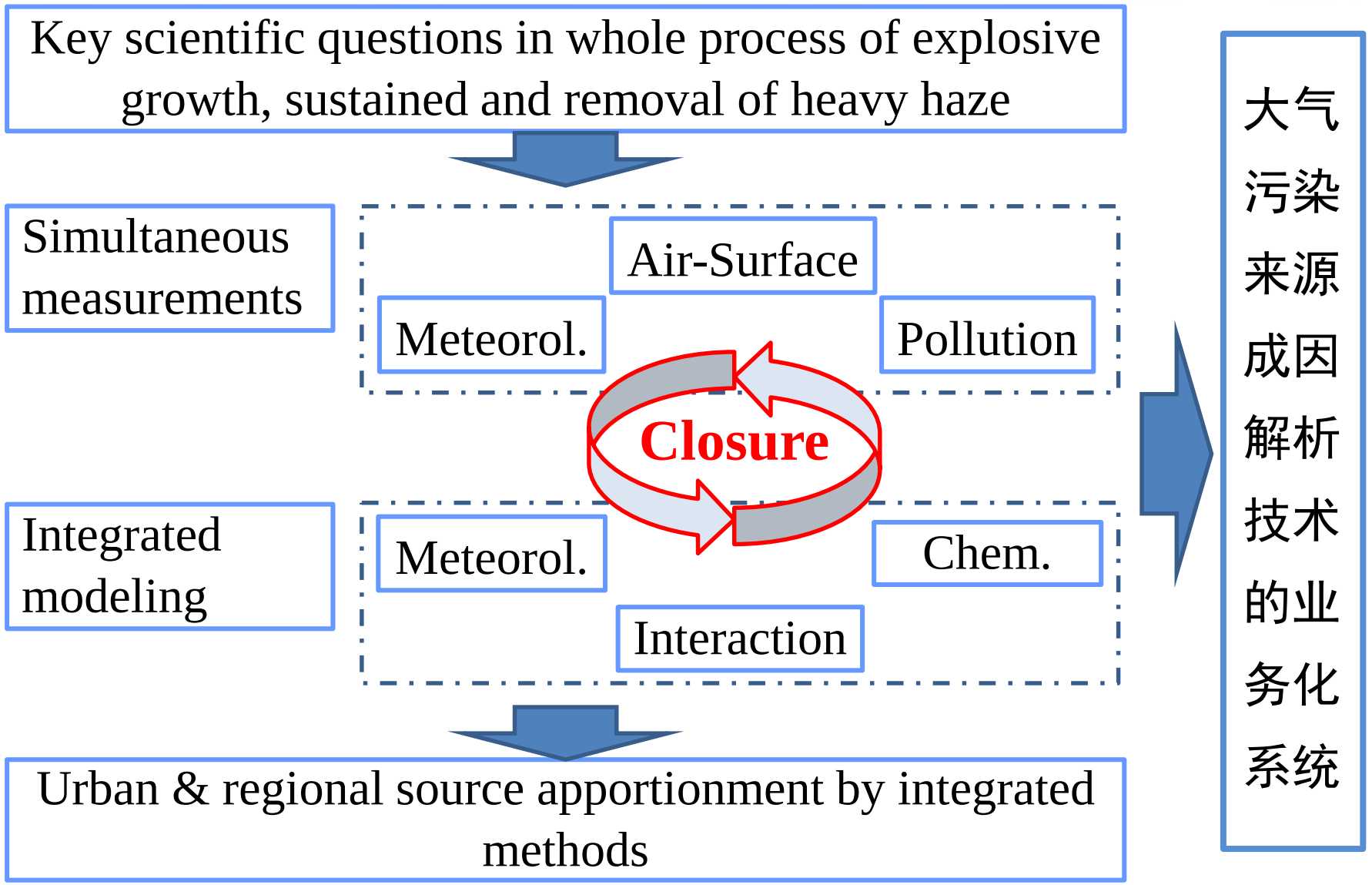
三大科学问题

1. 多尺度天气系统与大气污染的相关机制，细颗粒物爆发性增长的气象成因和主控因子
2. 区域大气氧化性的主要构成与演变规律，细颗粒物爆发性增长的化学成因和优势通道
3. 主要排放源和污染过程的示踪信息识别，一次排放、二次转化和区域输送的相对贡献

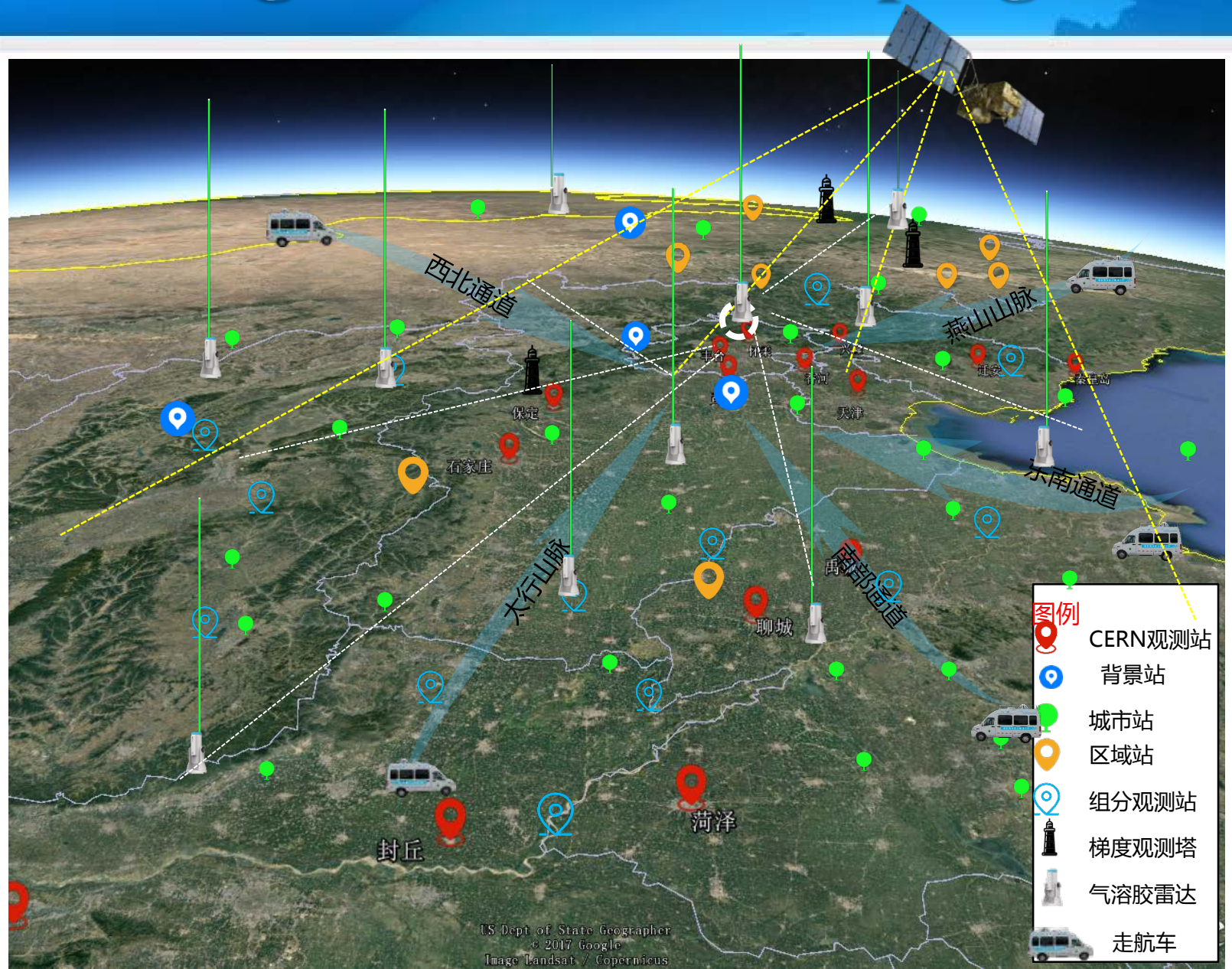
两大关键技术

1. 区域立体观测网设计和超级站闭合观测实验
2. 多视角相互印证的数据分析方法和数值模拟技术

Roadmap for in-depth study on heavy pollution



Integrated field campaign on JJJ winter haze



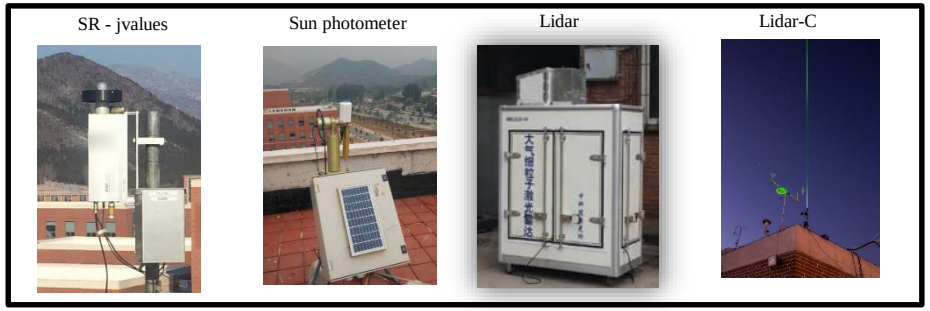
3D measurements

1. 中国环境监测总站
   - 区域站（22）、背景站（2）
   - 成分站（38）
2. 中国科学院
   - CERN（6参数、辐射、分级颗粒物采样及成分，15站）
   - Max-DOAS、 LIDAR立体网
   - 走航观测（4）
   - 卫星遥感
3. 中国气象局
   - 气象观测网
   - 成分站

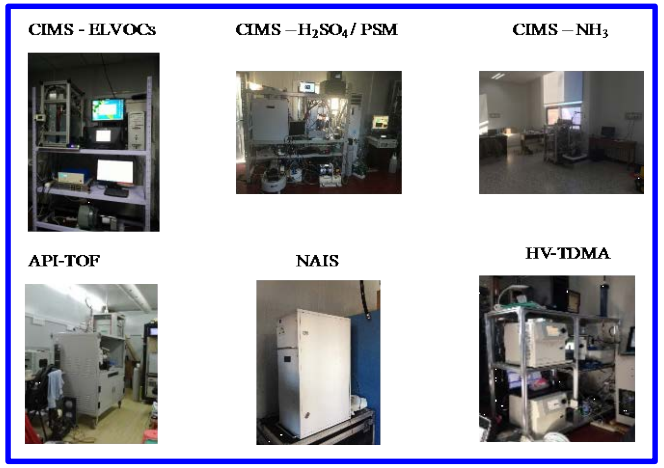
Closure measurements in 4 Super-sites

Gaseous/aerosol chemistry

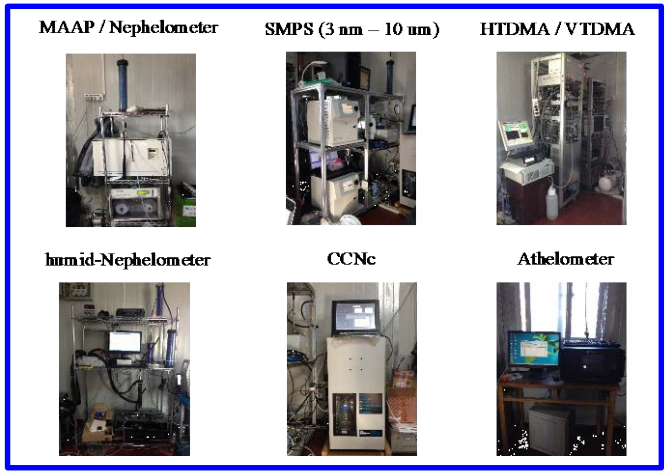
Vertical profile



Aerosol physics



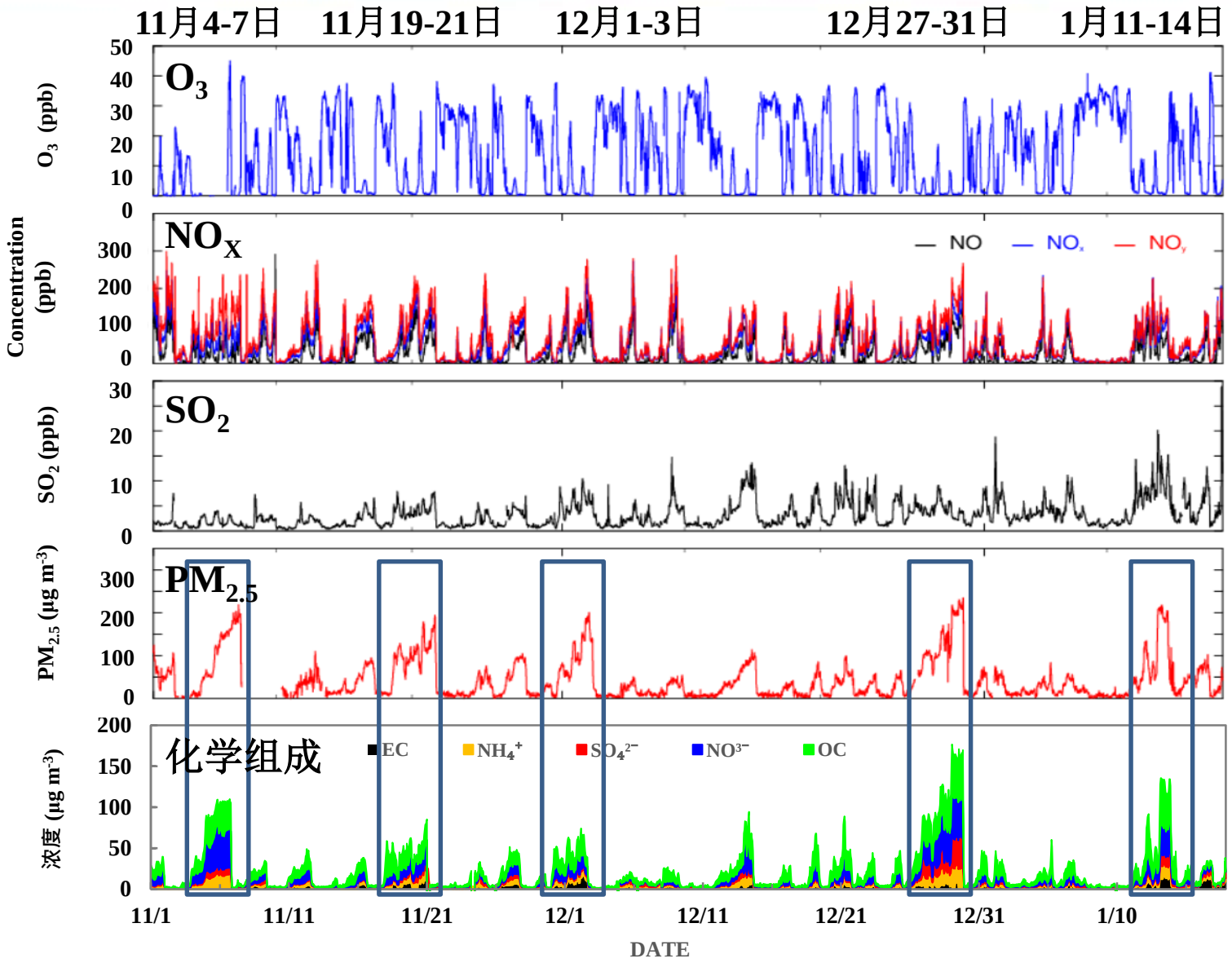
Aerosol optics



Outline

1. Planning of J^3 integrated campaign
2. Characteristics of regional pollution
3. Preliminary data analysis of pollution episodes

Temporal variation of major pollutants in PKU



- SO_2浓度较低
- NOx浓度较高
- PM污染显著下降

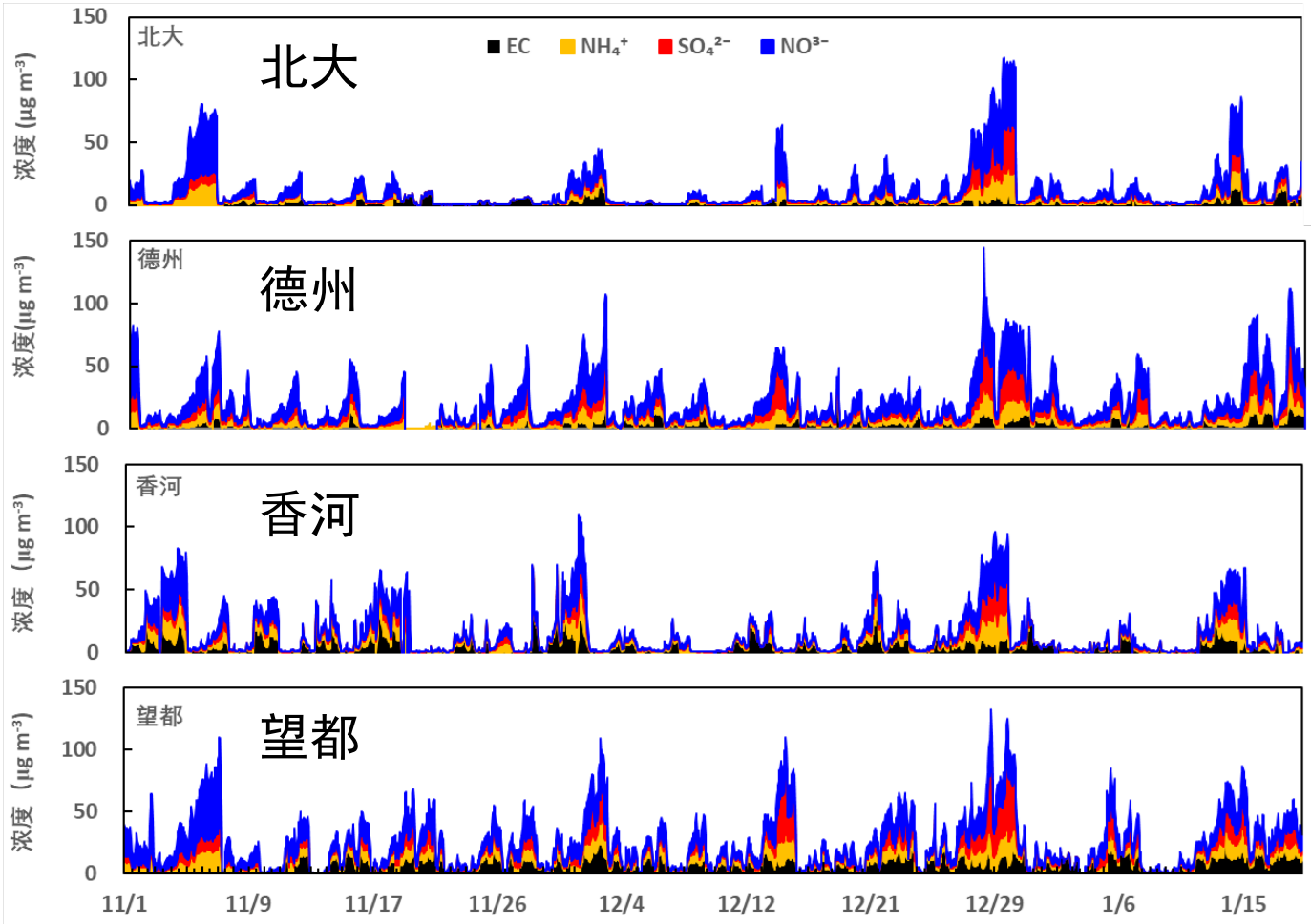
5个污染过程：

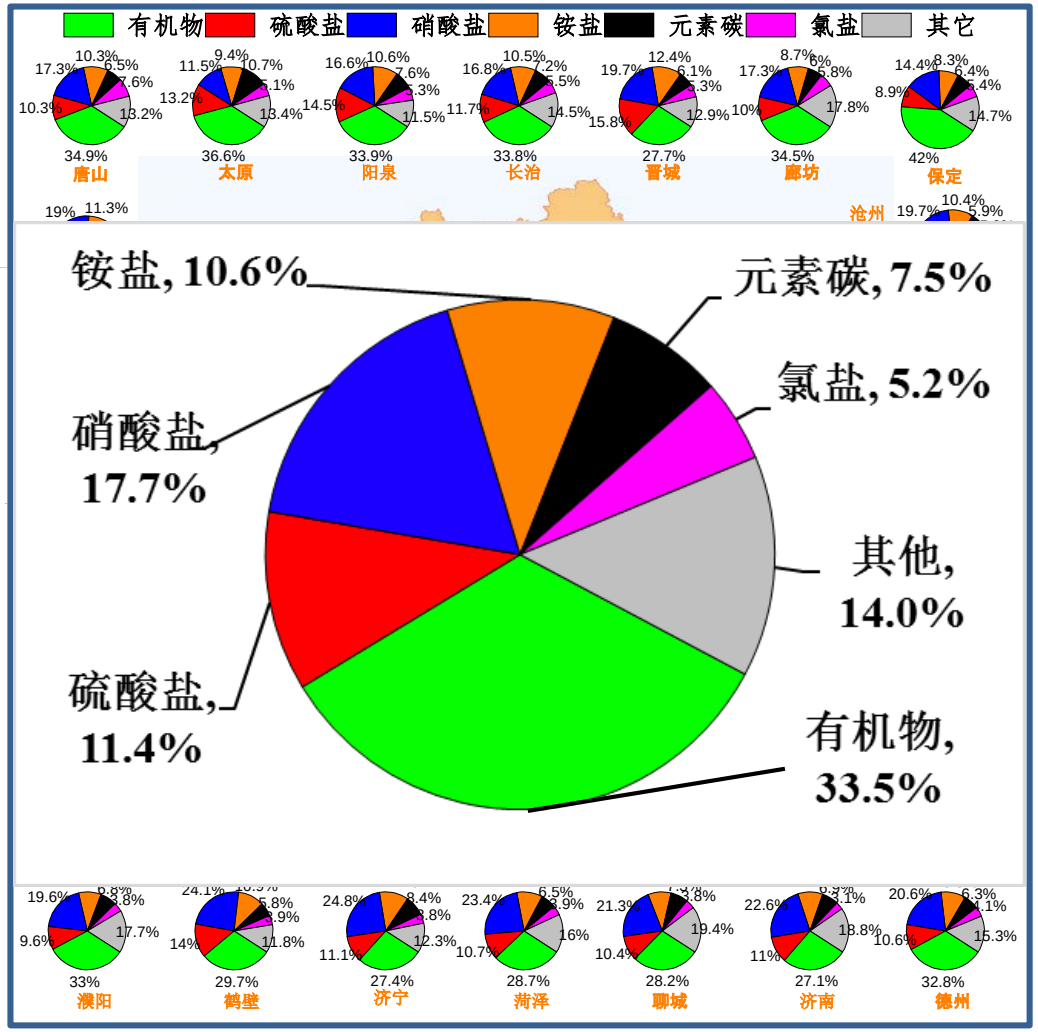
前期NO_3^-突出

后期SO_4^{2-}上升

北京大学定位站

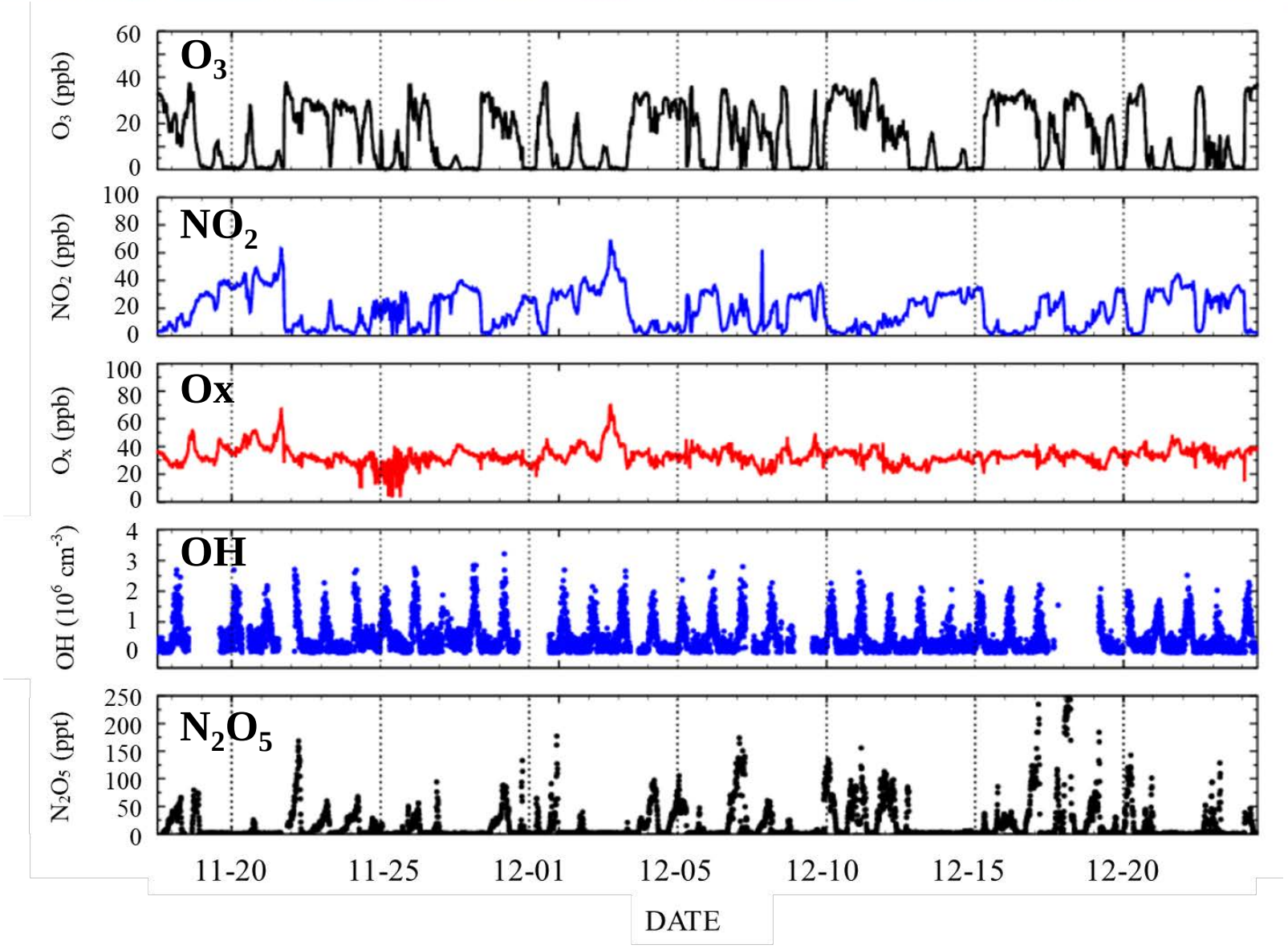
Significant Regional Nitrate Pollution



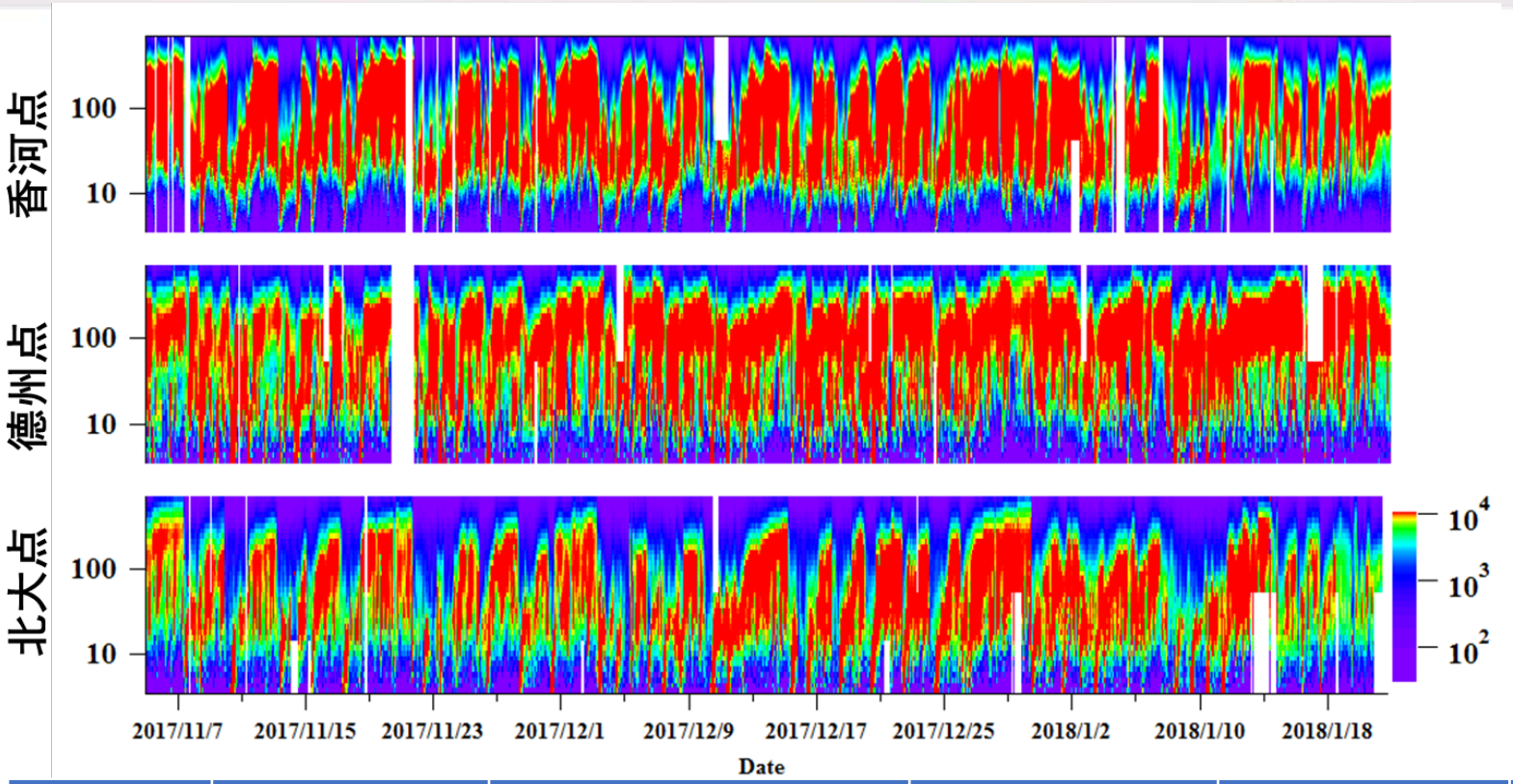


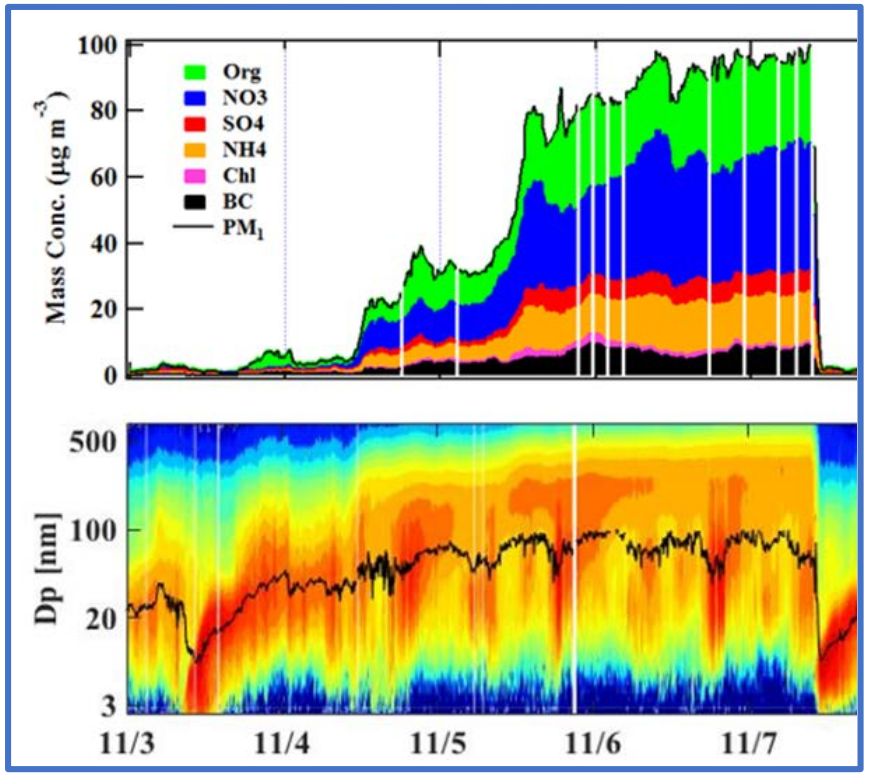
$PM_{2.5}$的主要化学构成是有机物、硝酸盐、硫酸盐和铵盐。

Relatively high oxidants during campaign



New particle formation and heavy haze





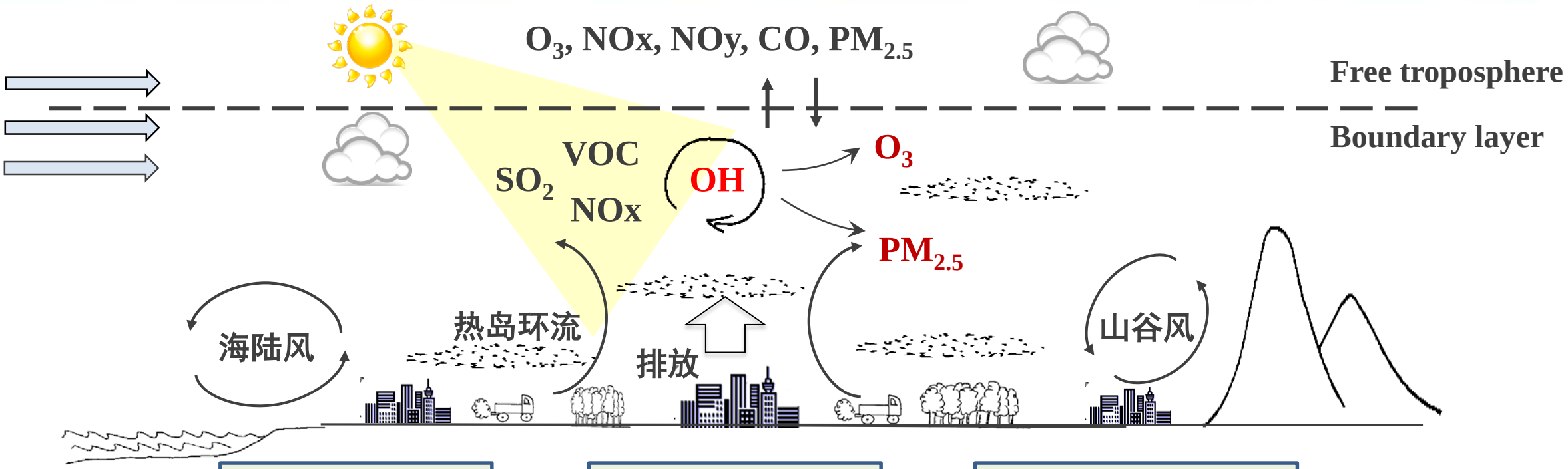
	有效天数	新粒子生成次数	发生频率	致霾次数	致霾频率
北大点	79	39	49%	9	23%
德州点	80	41	51%	11	27%
香河点	76	30	39%	10	33%

2016-2017冬季
发生频率：29%
致霾频率：54%

Outline

1. Planning of J^3 integrated campaign
2. Characteristics of regional pollution
3. Preliminary data analysis of pollution episodes

Major Processes for Air Pollution



地形地貌
气候气象

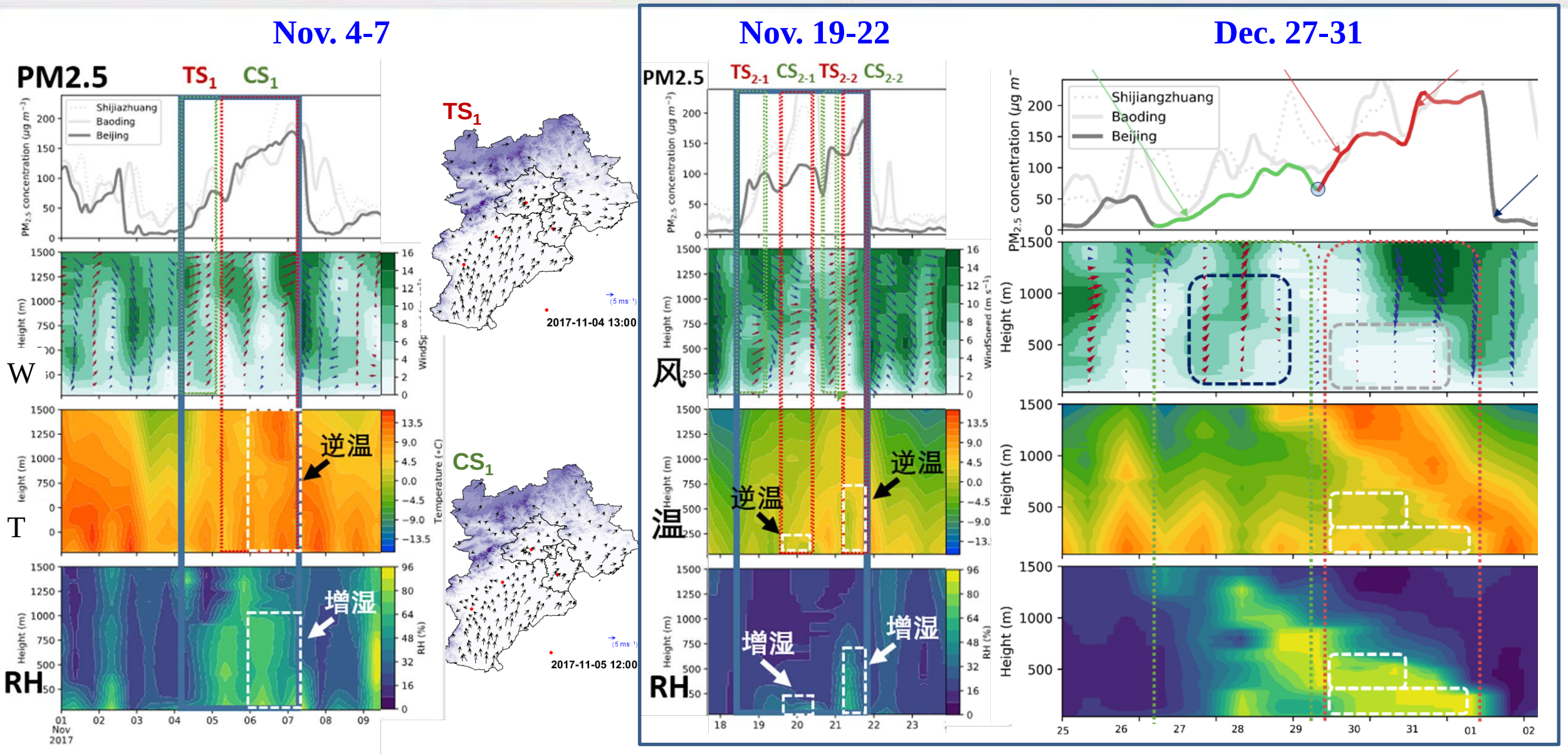
源排放
–人为、自然

大气化学反应
–气、固、液

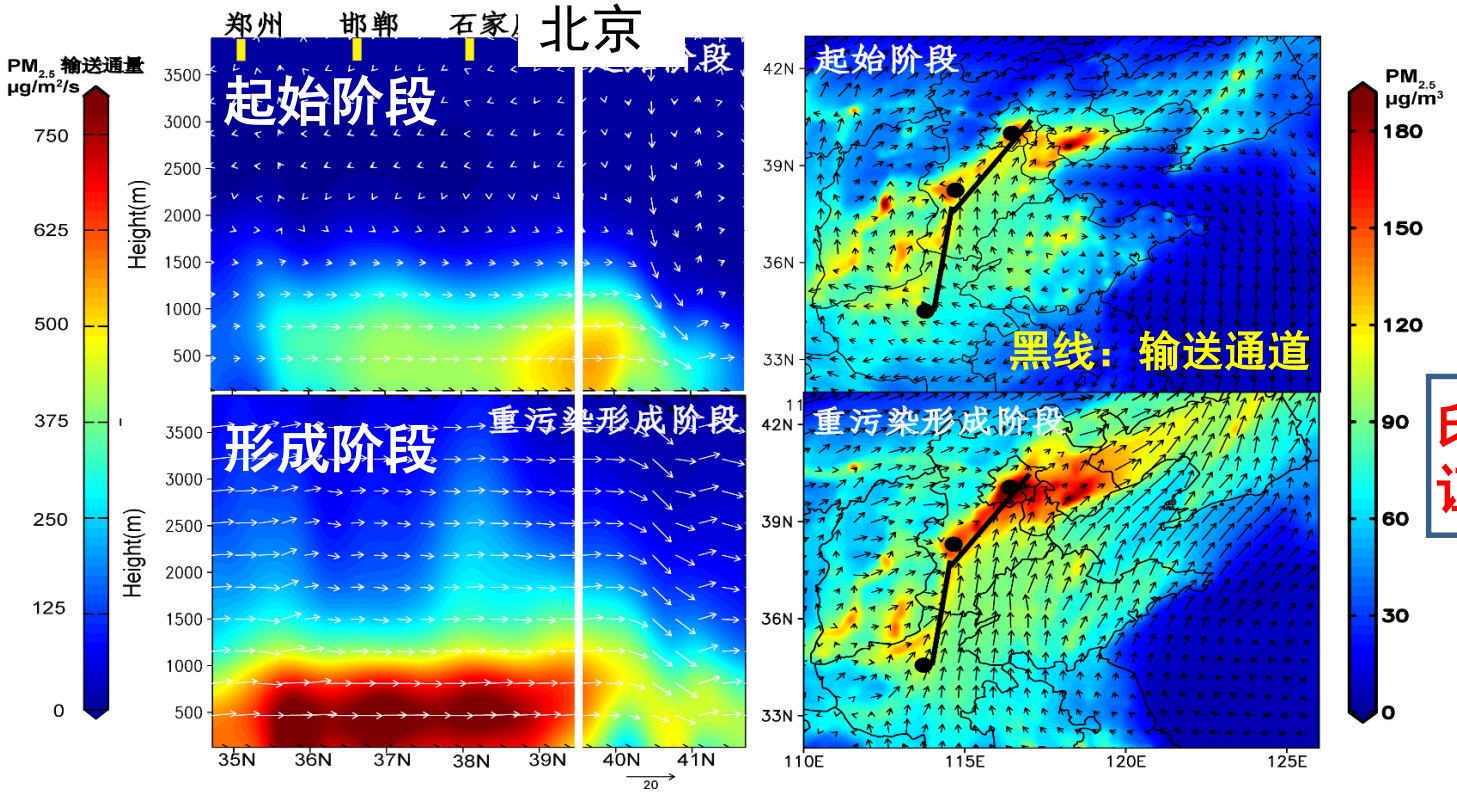
Meteorology — Scientific question — Chemistry

Regional transport

Feedback of heavy pollution and boundary meteorology



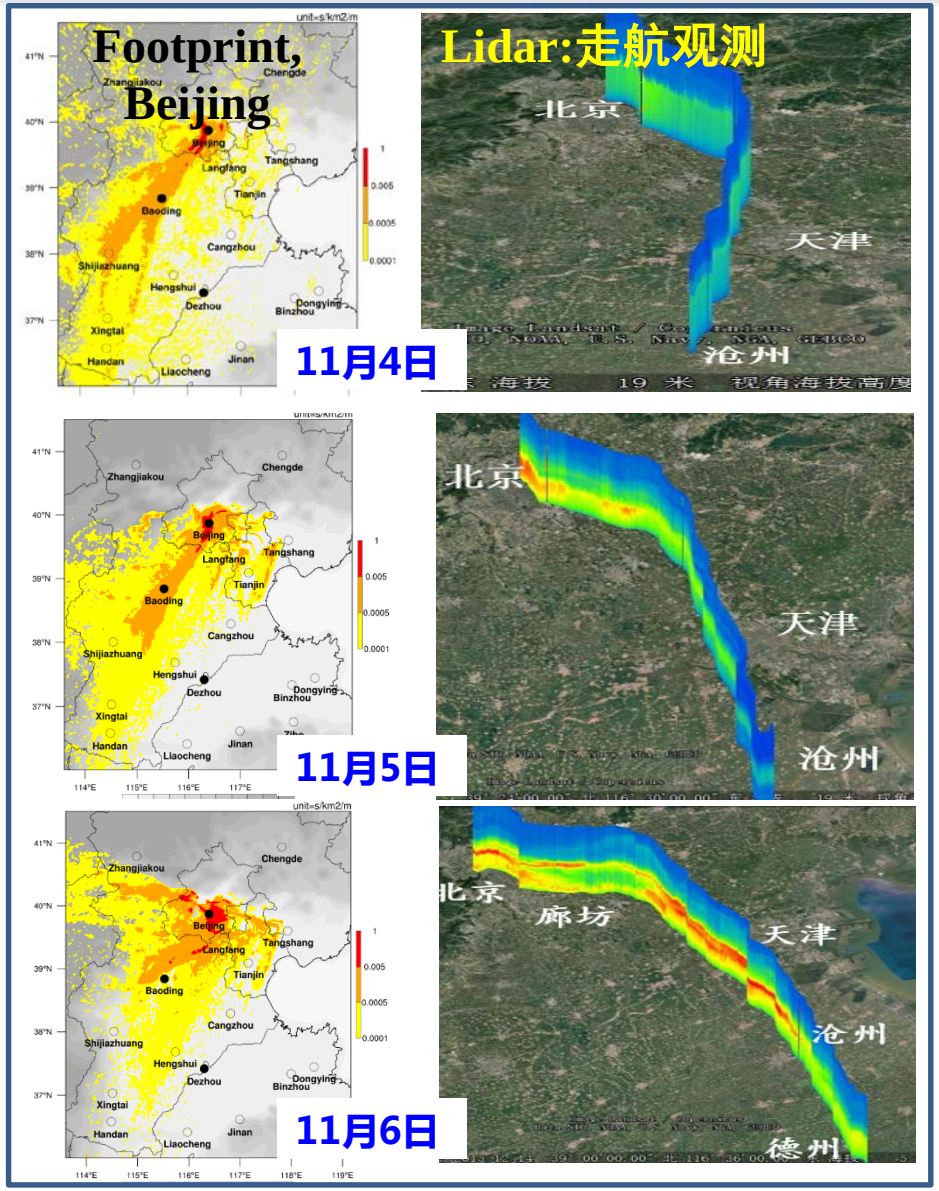
Regional Transport ~ Pollution Explosive Growth (4-7)



输送通量和风场

$PM_{2.5}$和风场

印证



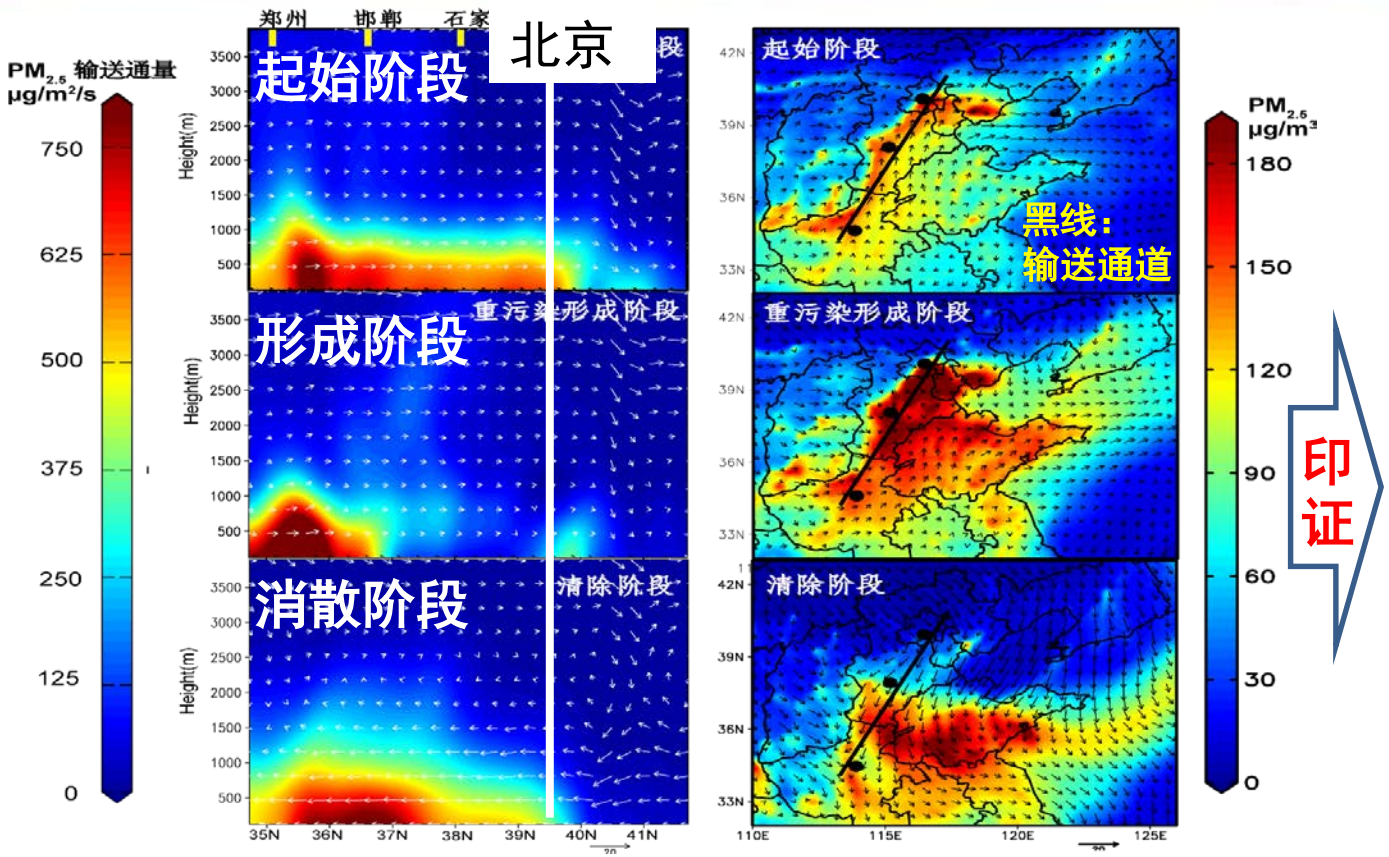
Transport flux:

Initial stage: **200- 500 μg/m²/s**

Cumulative stage: **600-1000 μg/m²/s**

增加
2-3倍

Regional transport + local emission (Dec. 1-3)



输送通量和风场

$PM_{2.5}$和风场

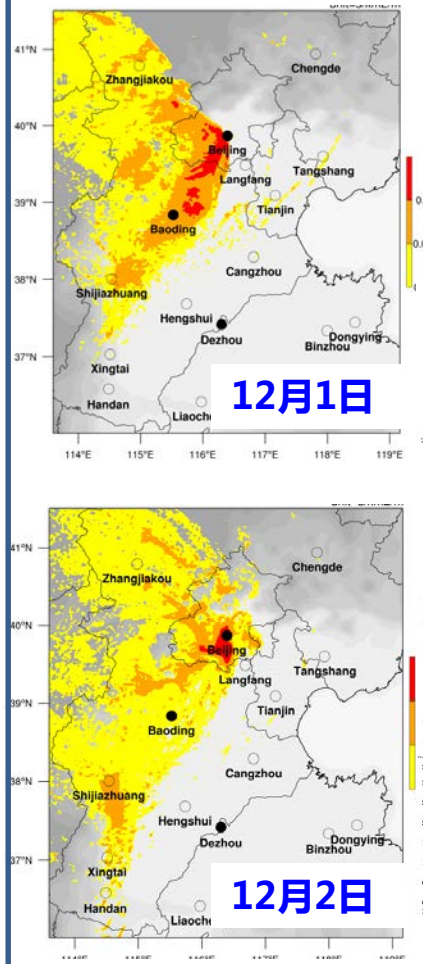
印证

污染起始阶段： **输送通量500-800 μg/m²/s**

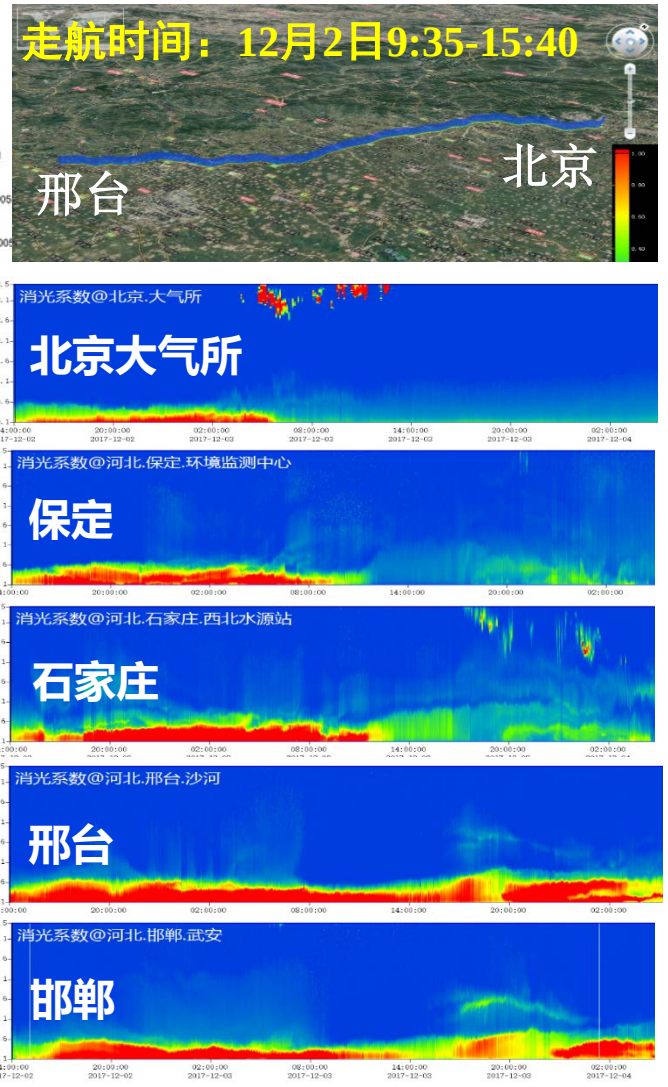
快速形成阶段： **输送通量100-200 μg/m²/s**

减少约4倍

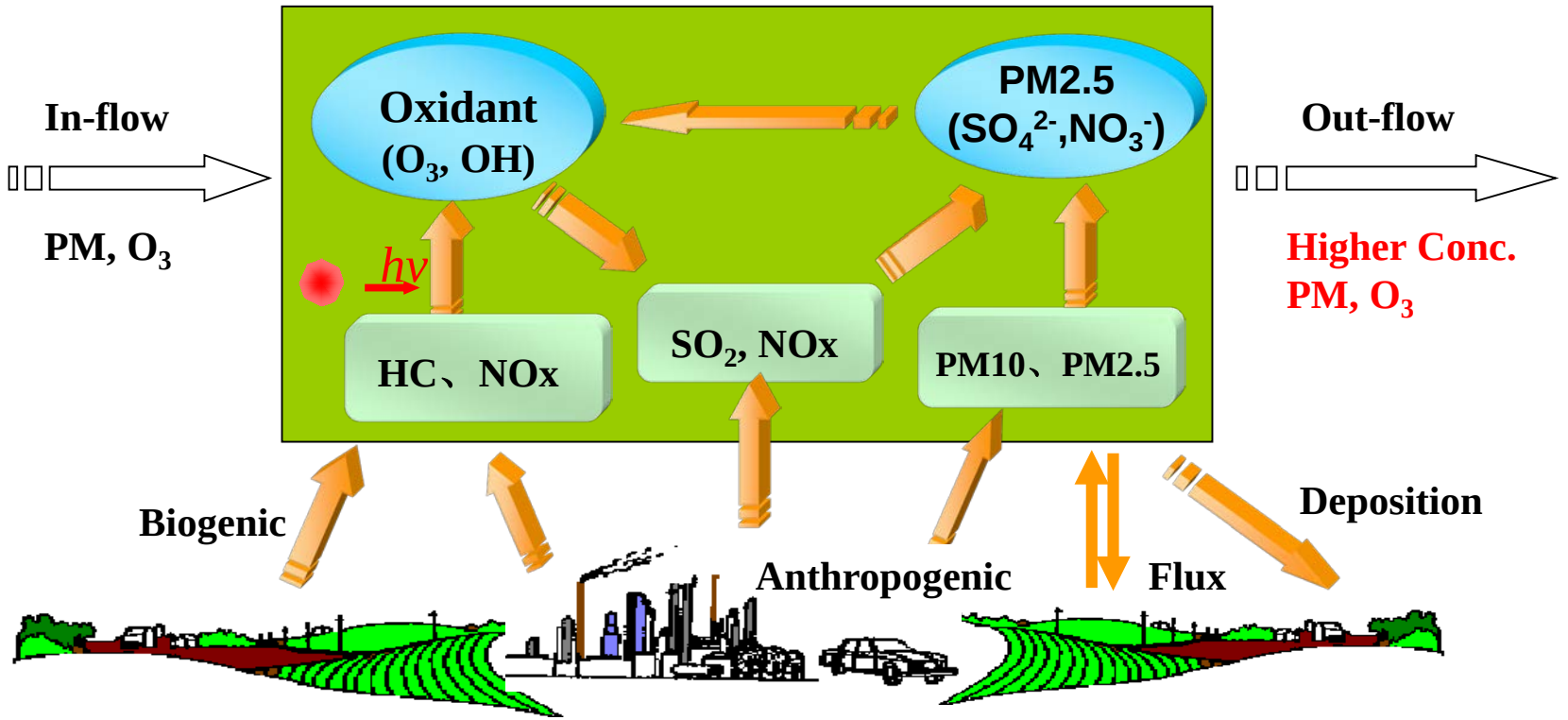
Footprint, Beijing



Lidar：定位+走航



Air Pollution Complex (1997)）



- Coupling between primary emission and photochemical process
- Coupling between gaseous and aerosol interaction,
- Coupling between local and regional air pollution.

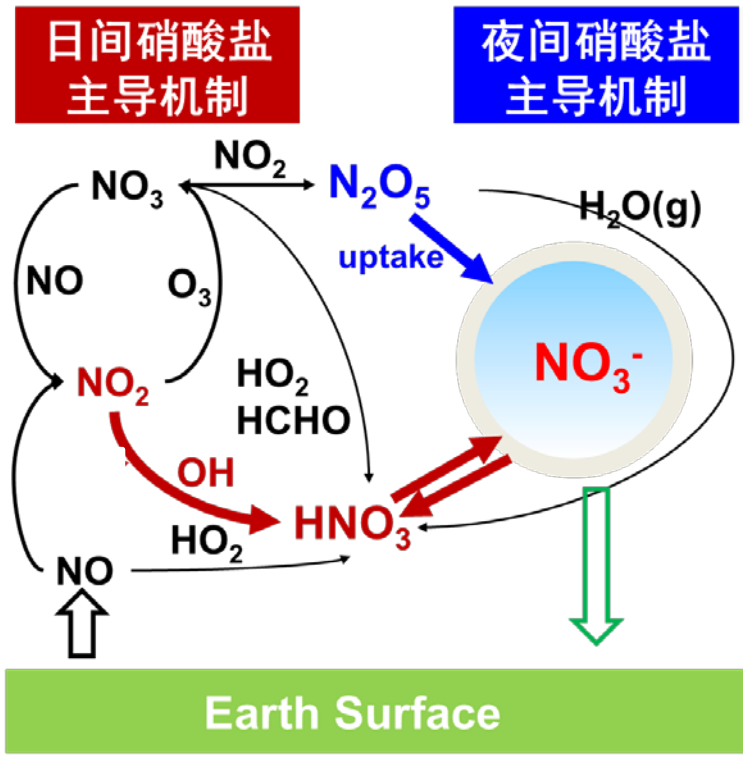
NO_3^-

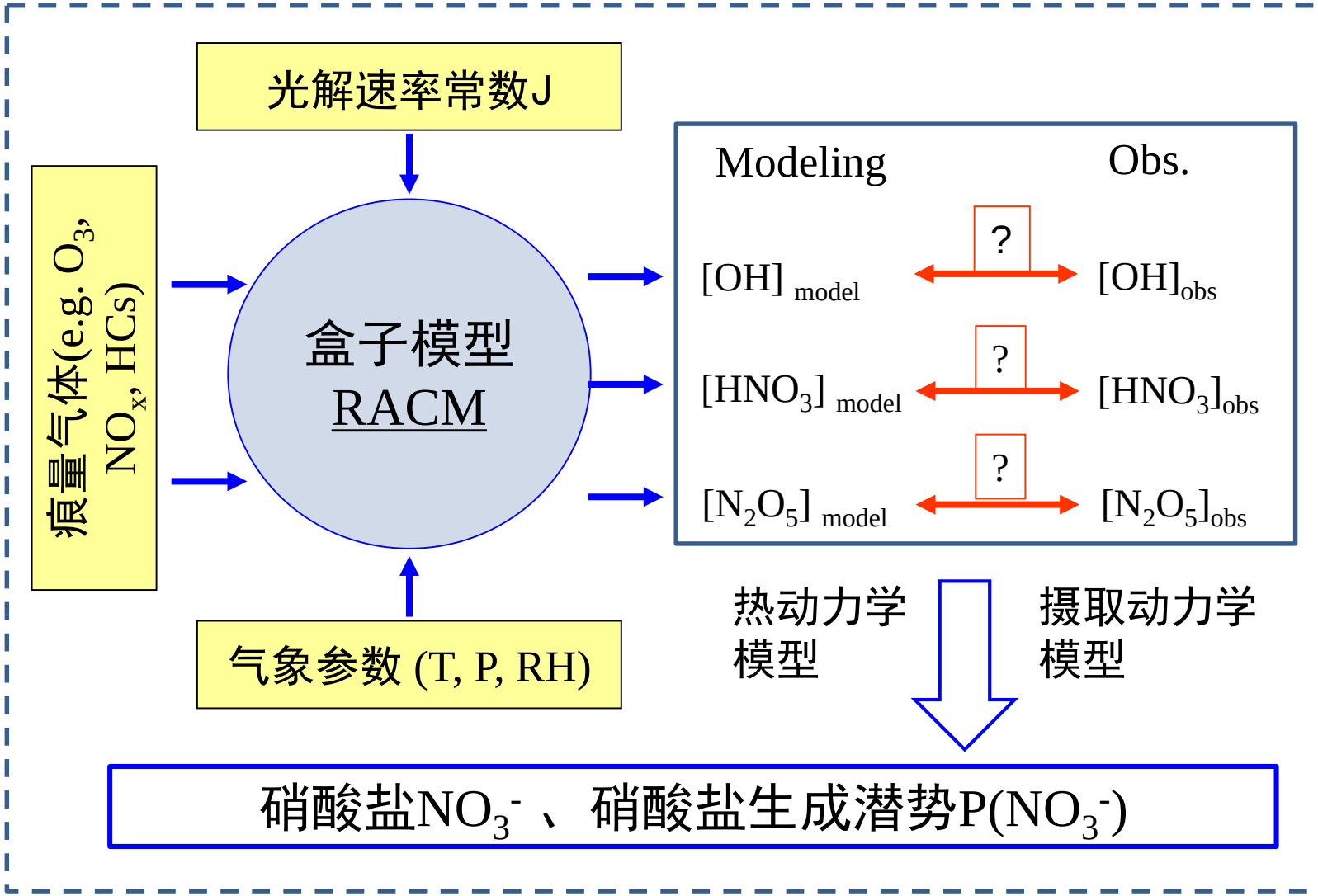
SO_4^{2-}

SOA

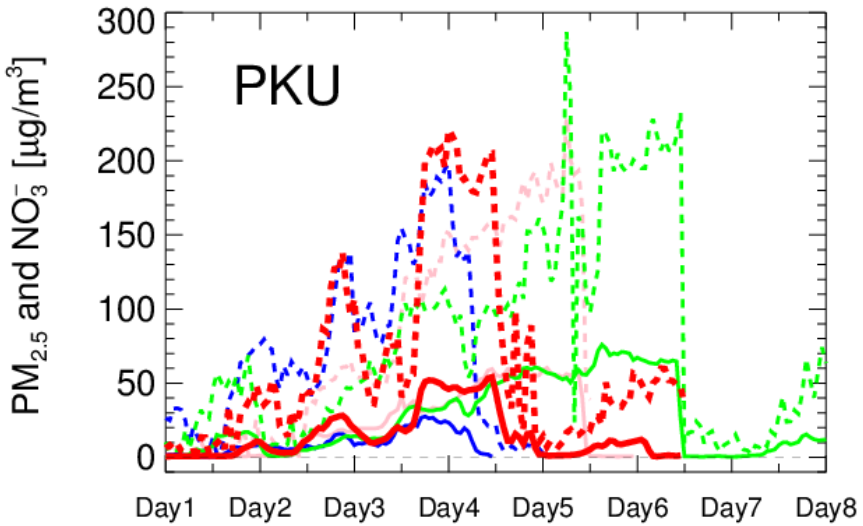
Nitrate Formation Scheme and closure modeling

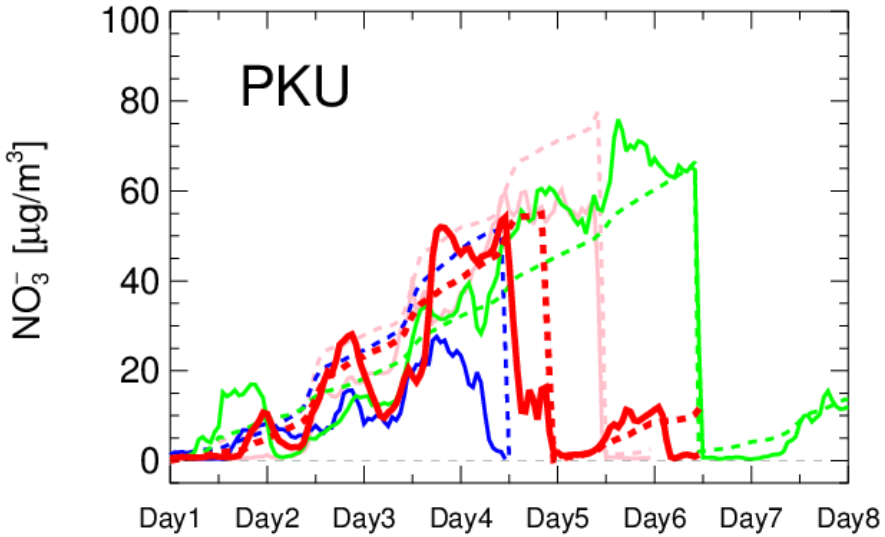
Nitrate Formation Scheme

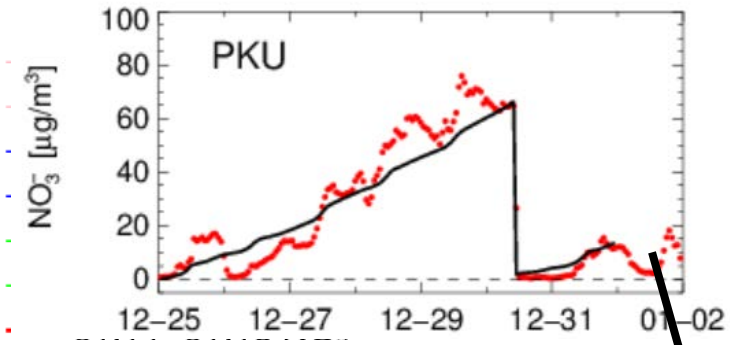


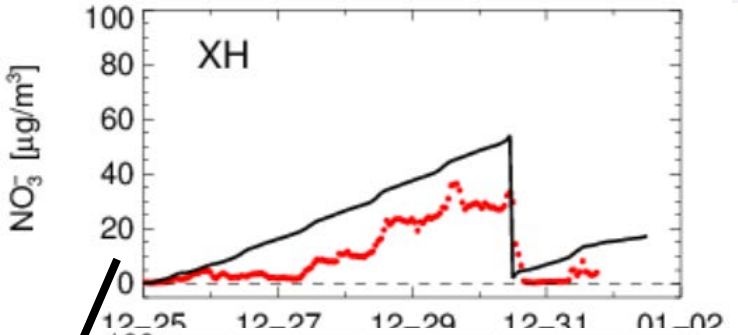


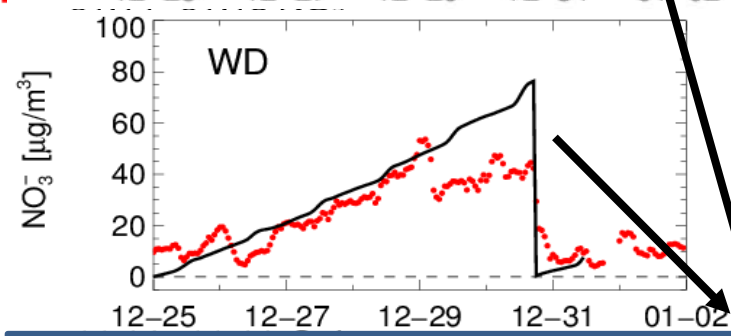
Observation and modeling for Nitrate

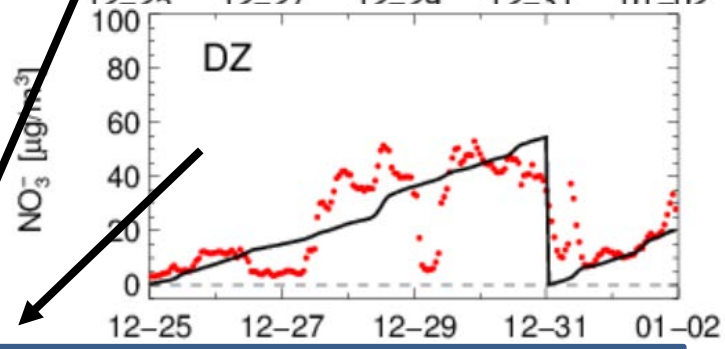


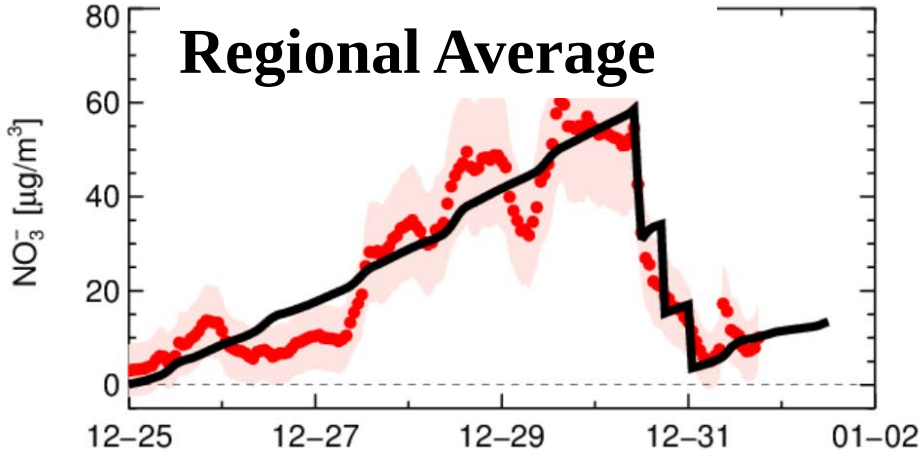






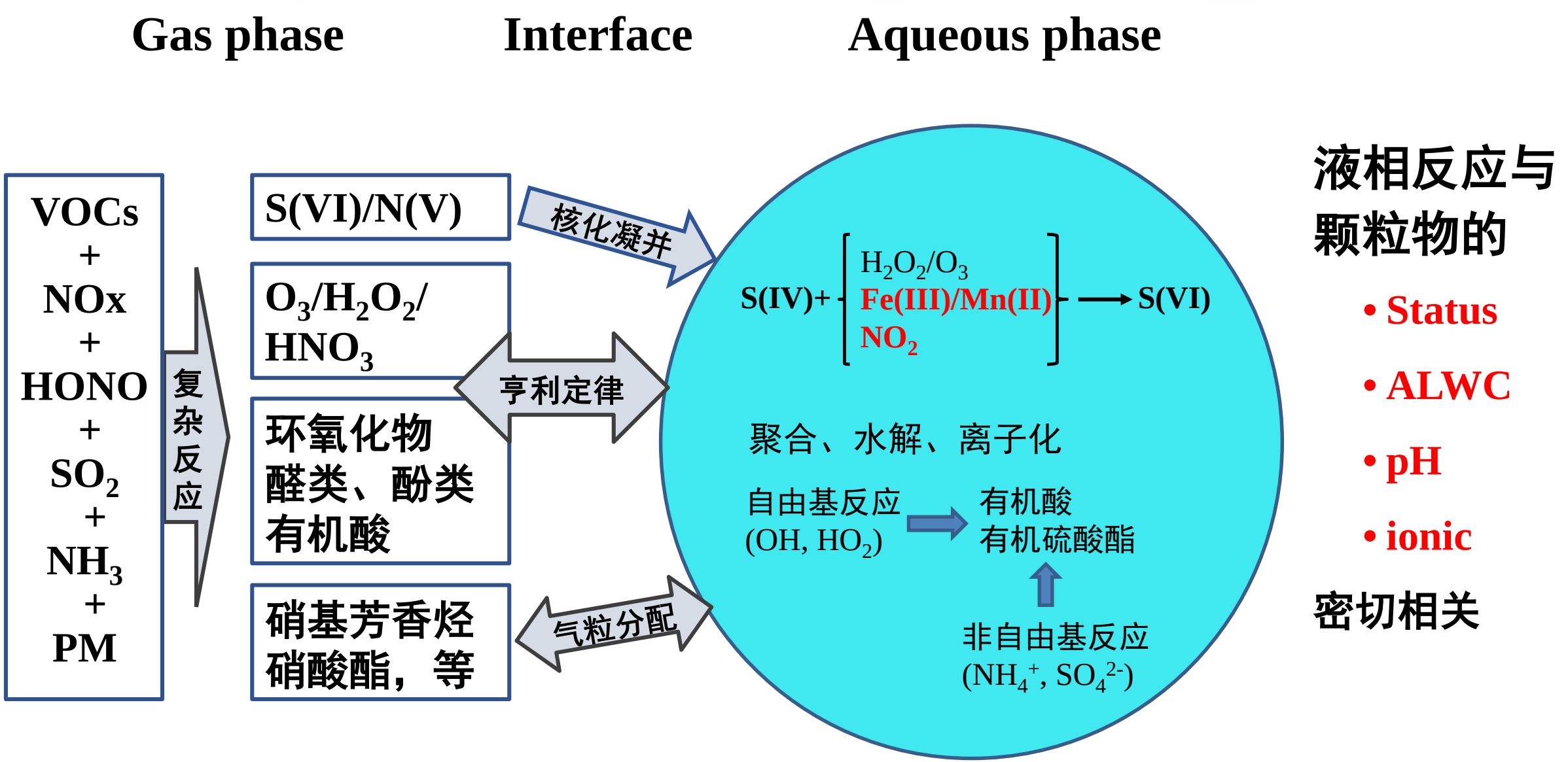






经典理论大致可以解释硝酸盐的生成过程

Formation scheme for sulfate and SOA

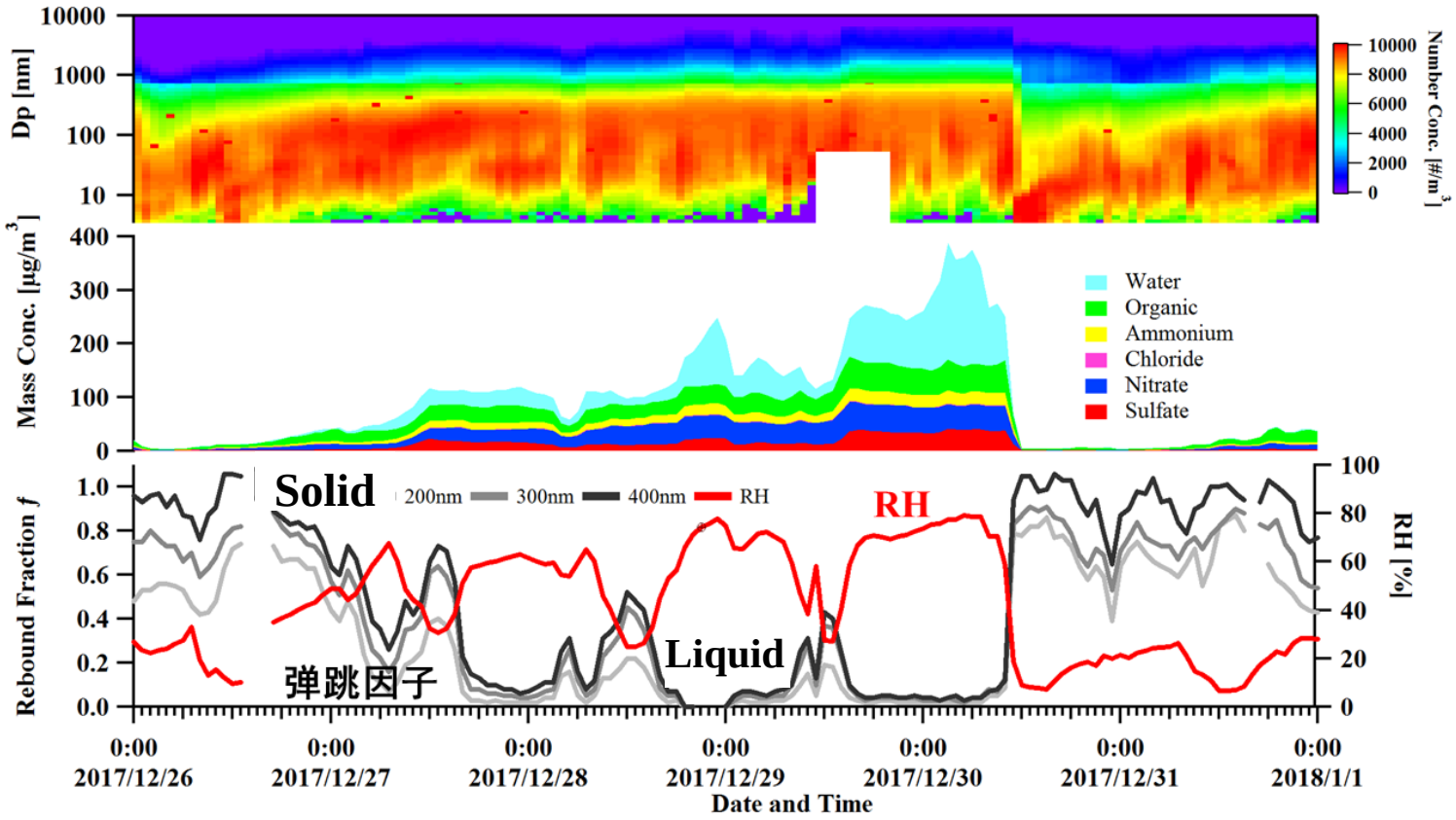


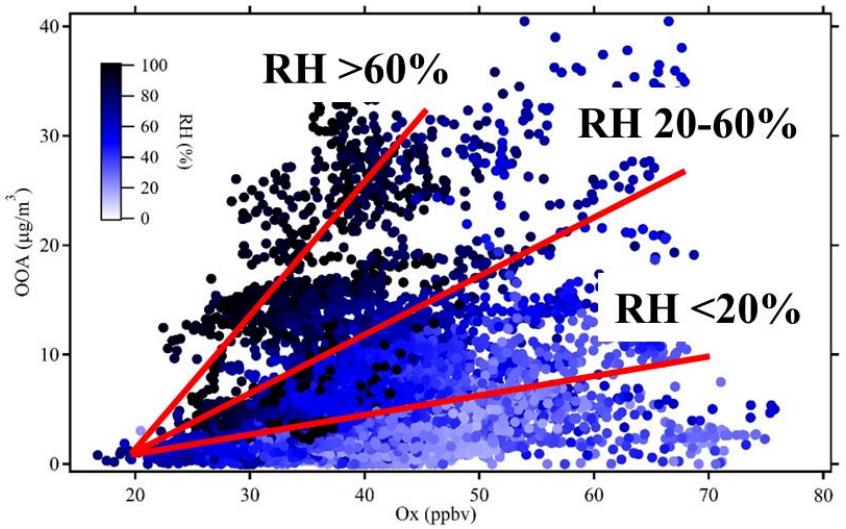
液相反应与颗粒物的

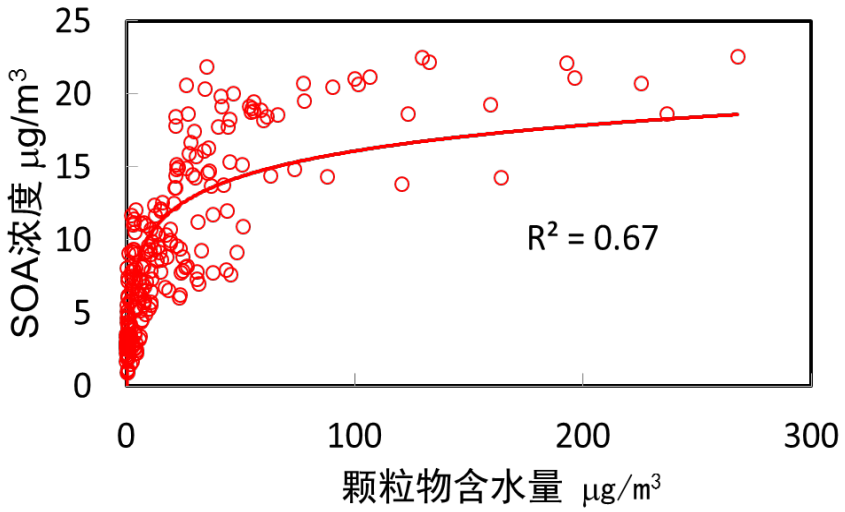
- Status
- ALWC
- pH
- ionic

密切相关

Water content and liquid aerosol in heavy pollution process







In high humidity air, aqueous chemistry might be a possible channel for SOA production ?

Summary

- **J^3 regional campaign produced massive high quality data for cross-disciplinary studies;**
- **Some new findings were indicated by the preliminary data analysis, more integrated modeling are on-going;**
- **The 2^{nd} winter campaign is in consideration and will be upgraded in basis of in-depth data analysis in next few months.**


Thanks !