Characteristics of Aerosol formed from the Photooxidation of Dimethyl Sulfide

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Outline

1. Background
2. methods
3. Results

1. Background

- Dimethyl sulfide (DMS, CH_3SCH_3):
  - The **predominant volatile sulfur compound** in the marine atmosphere;
  - Mixing ratios in the air over the open ocean range from **20 to 400 pmol·mol^{-1}**;
  - Global sulfur flux associated with DMS range from **16-35Tg·year^{-1}**.
- Oxidation of DMS in the atmosphere:

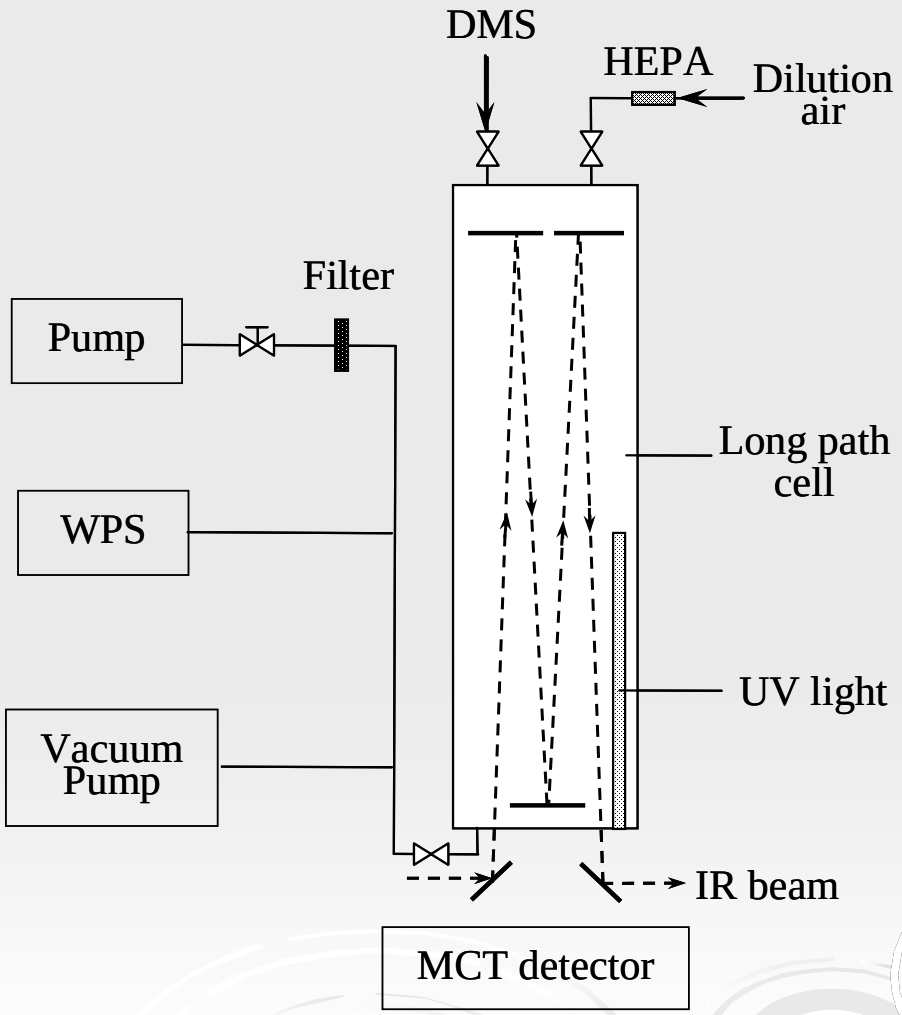
Compound	k_{298} (10^{-12} cm^3 molecule^{-1} s^{-1})				
	OH O_2 absent	OH O_2 present	O_3	O	Lifetime in the troposphere
CH_3SCH_3	4.4	6.3	1×10^{-18}	50	2.2 days

- Climate significance: **CLAW hypothesis**
  - A principal precursor of cloud condensation nuclei (**CCN**) in the marine troposphere;
  - Potentially important in regulating the **cloud optical properties**, **Earth's radiation budget** and **climate.**

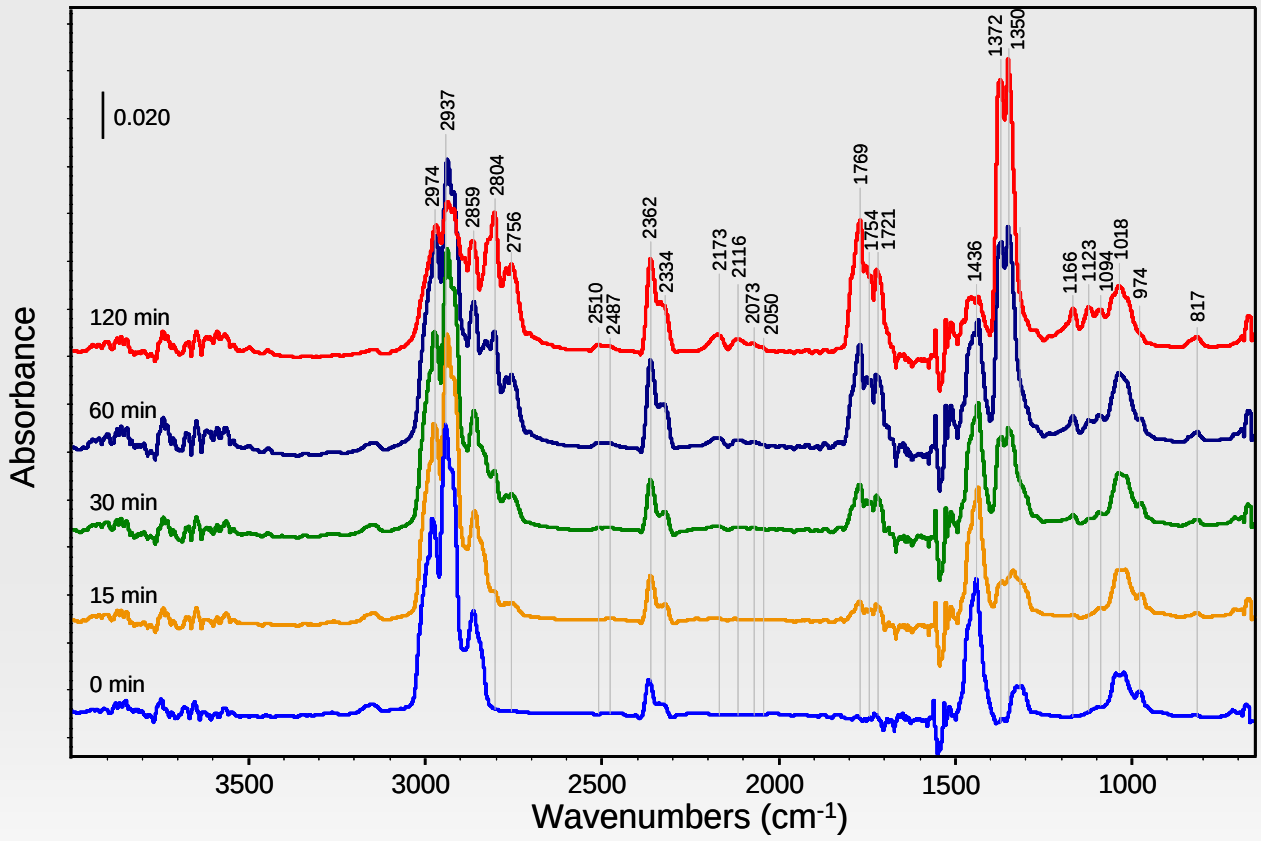
2. Experiment methods

- Chamber Experiments:
  - 14 L borosilicate glass reaction chamber
  - 15 W low-pressure mercury lamp , λ_{max} = 254 nm
  - Background and dilution gas: High-purity air
- Reaction monitoring:
  - Gaseous products monitoring: White-cell combined with FTIR
    - 31.1 m optical path length
    - 4000 to 650 cm^{-1} at a resolution of 4 cm^{-1}
  - Particulate products characterization: WPS
    - DMA and CPC: 10 - 500 nm, 60 particle-size channels
    - LPS: 350 - 10000 nm, 24 particle-size channels
    - sample flow rate: keep constant at 1.00 L min^{-1}

2. Experiment apparatus



3.1 FTIR Study of DMS Photooxidation with UV Exposure

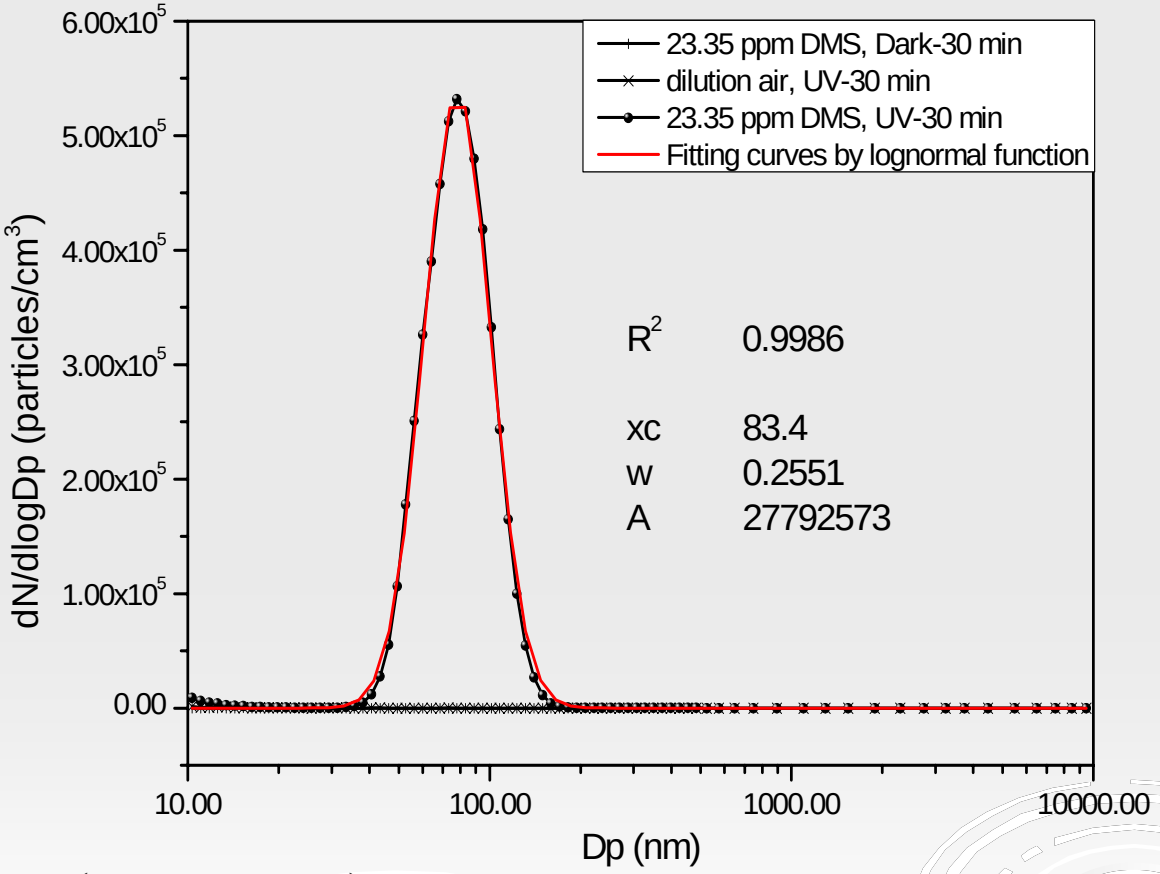


- DMS was oxidized
  - 2974, 2937, 2859, 1436, 1320, 1042, 1018 and 974 cm^{-1}
- S-contained gases was produced:
  - SO_2
  - COS
  - DMSO
  - $DMSO_2$
- HCHO, CO, CO_2, H_2O was formed.

3.2 **WPS Study of DMS Photooxidation with UV Exposure**

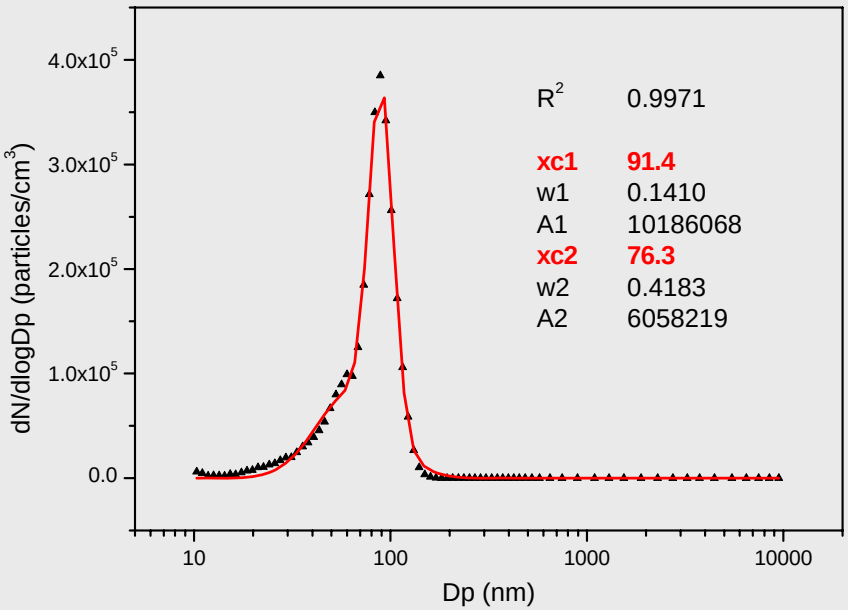
1) Excellent unimodal or multimodal exhibited

- 30 min

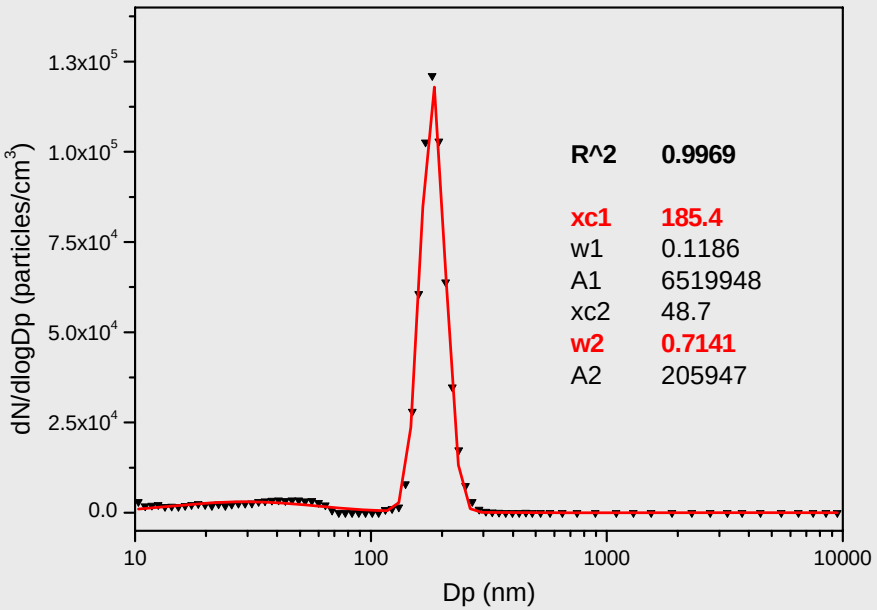


$$\frac{dN}{d(\log D_p)} = \sum_{i=1}^{n} \frac{Ni}{(2\pi)^{1/2} \log \sigma_i} \exp\left(-\frac{\left(\log D_p - \log \overline{D}_{pi}\right)^2}{2 \log^2 \sigma_i} \right)$$

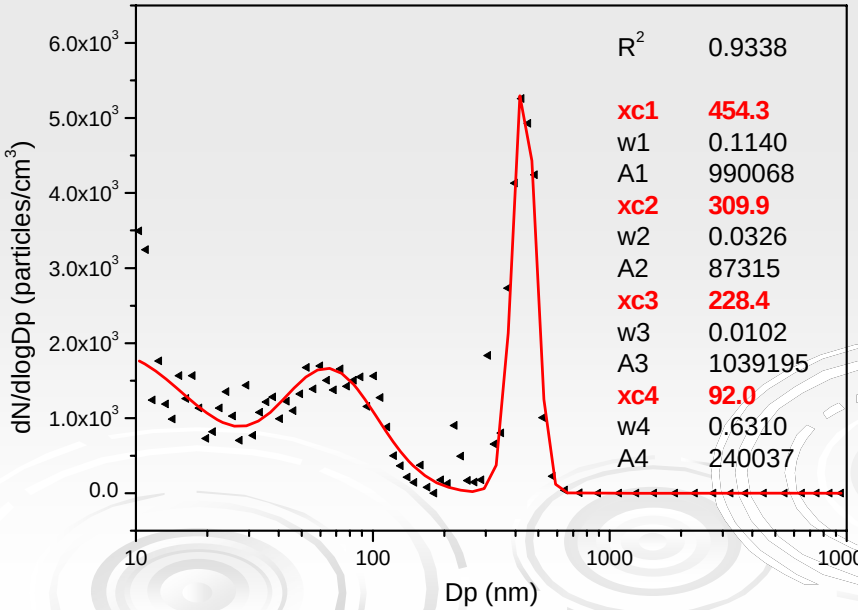
- 60 min



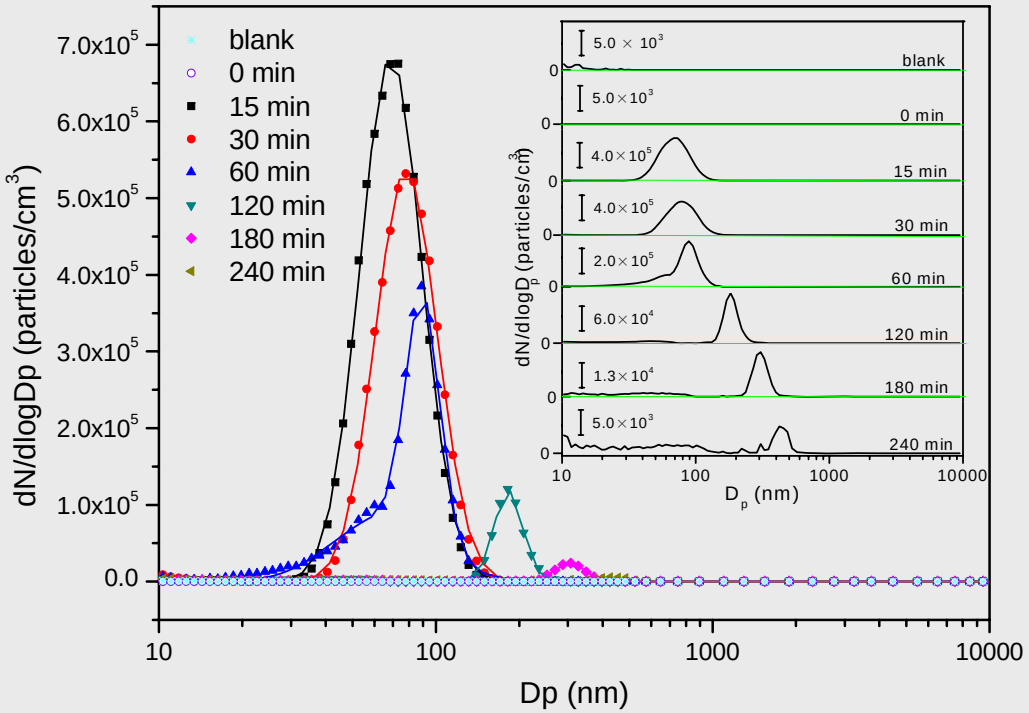
- 120 min

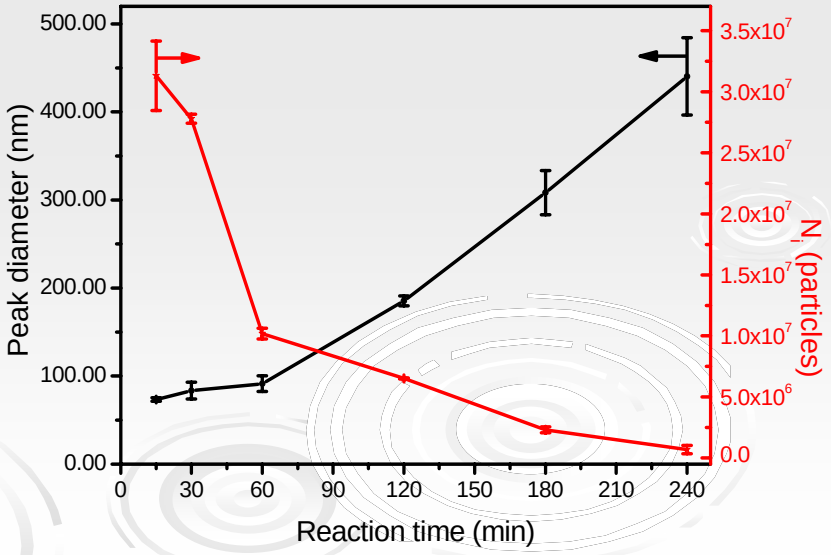


- **240 min**

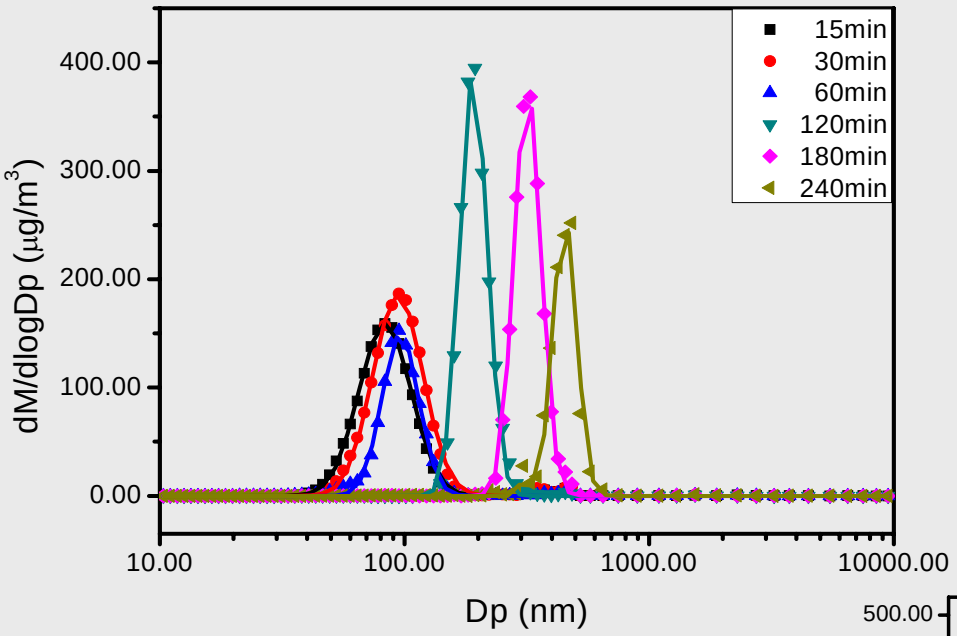


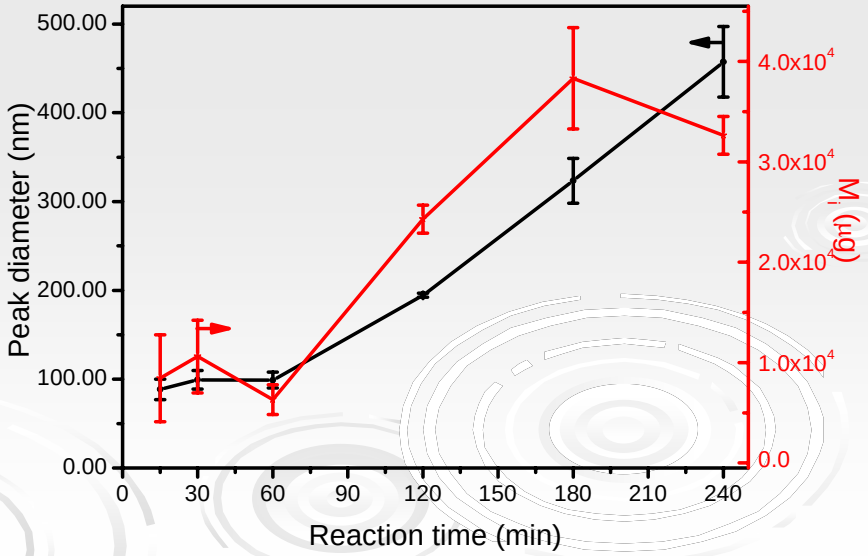
2) Count distributions of **Fresh Aerosol Particles Formed from the Photooxidation of DMS**





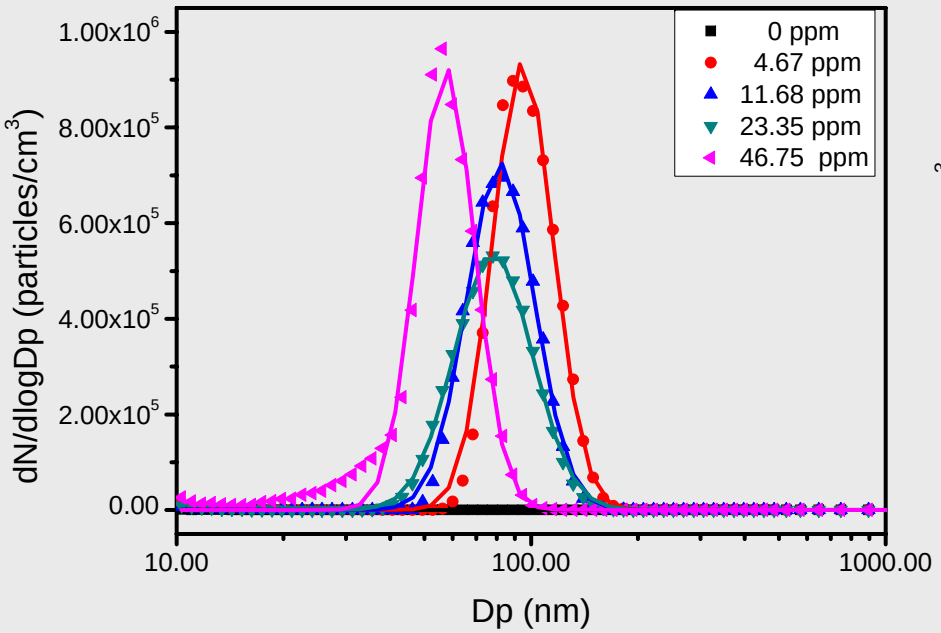
3) Mass distributions of the fresh aerosol particles formed



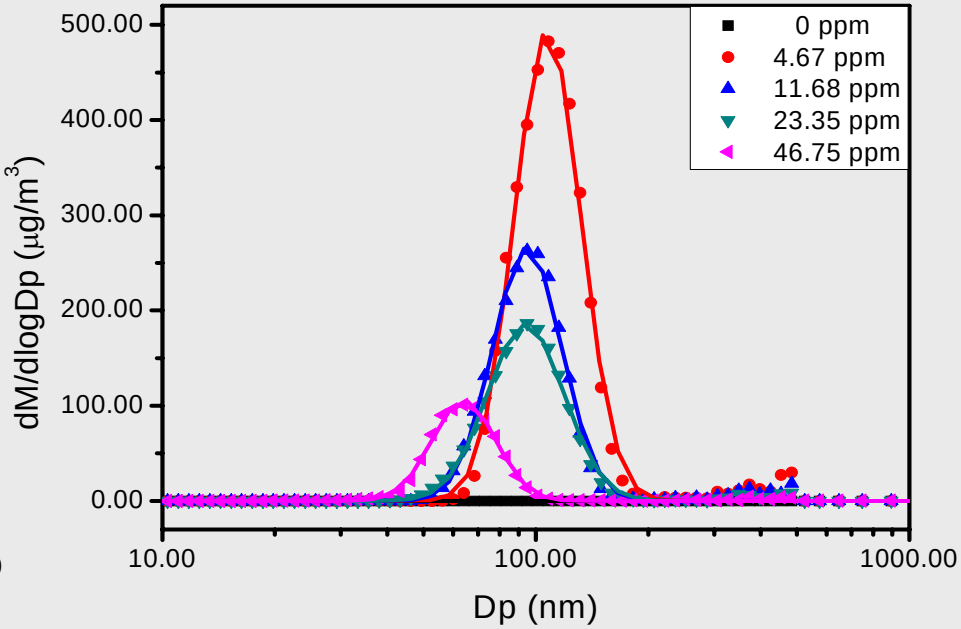


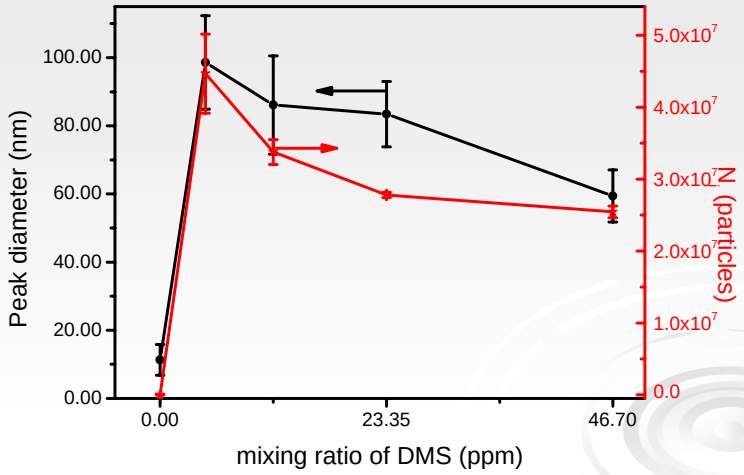
4) Relationship of the secondary aerosol with the initial mixing ratio of DMS

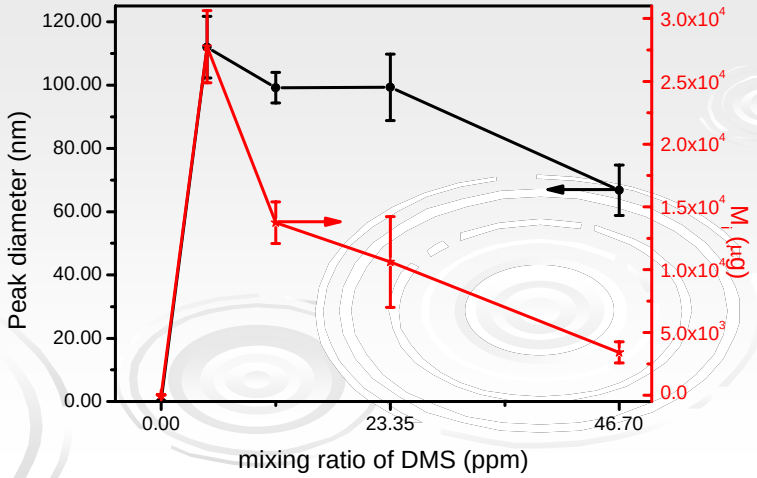
- Count distributions



- Mass distributions

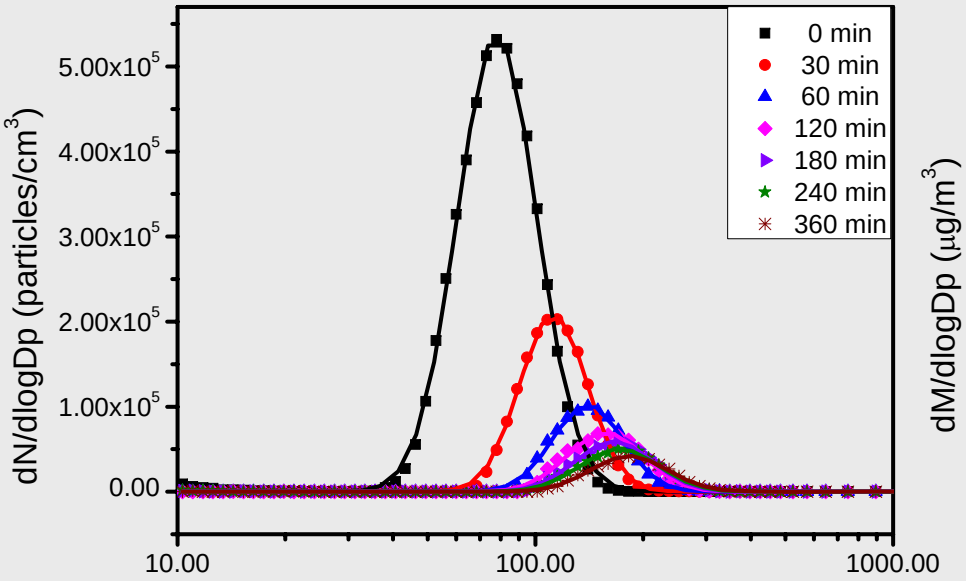




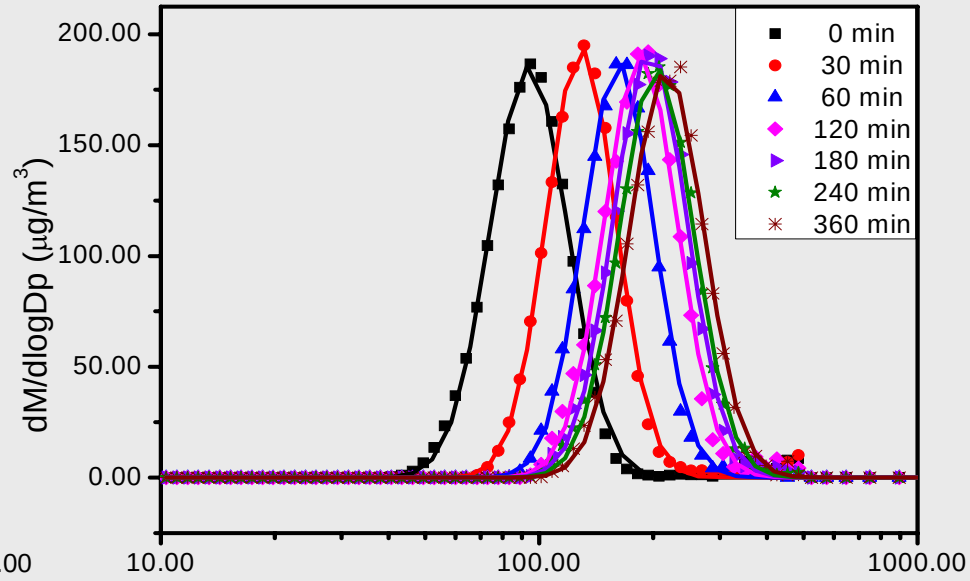


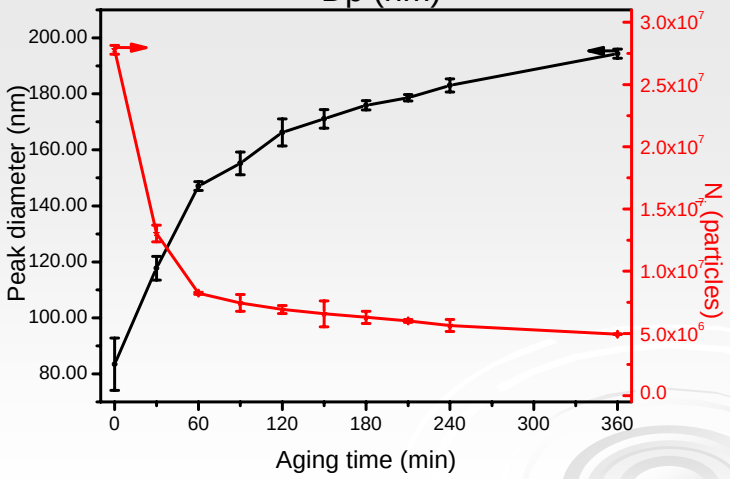
5) Aging process of the aerosol from DMS photooxidation (30 min)

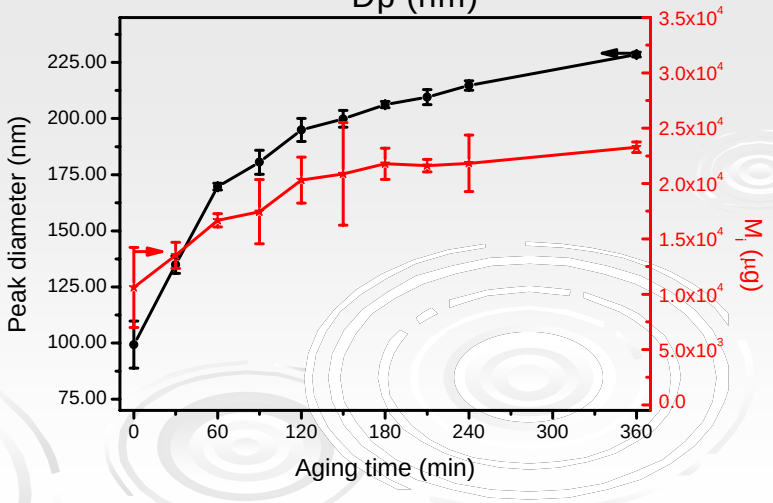
- Count distributions



- Mass distributions

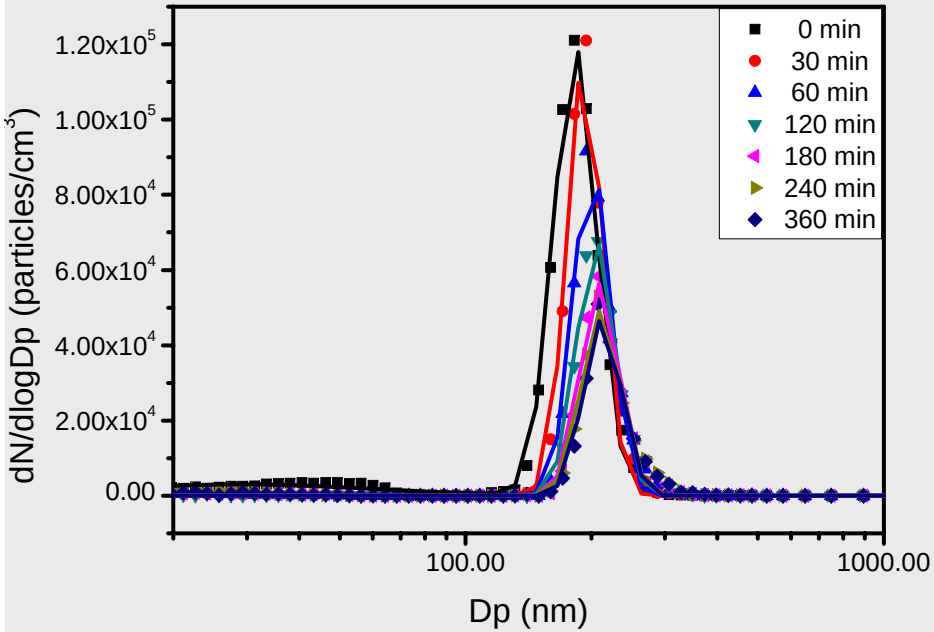




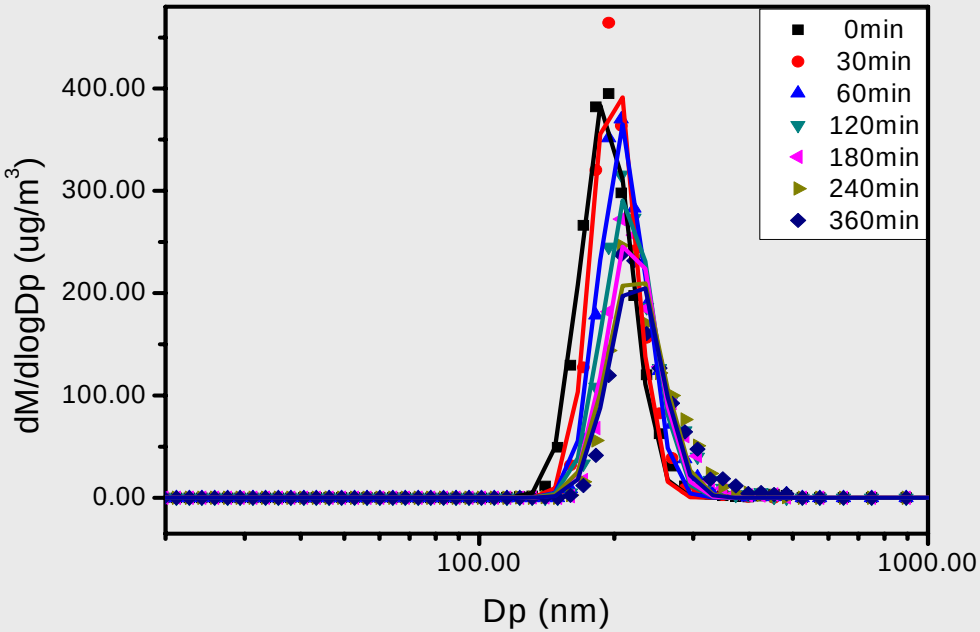


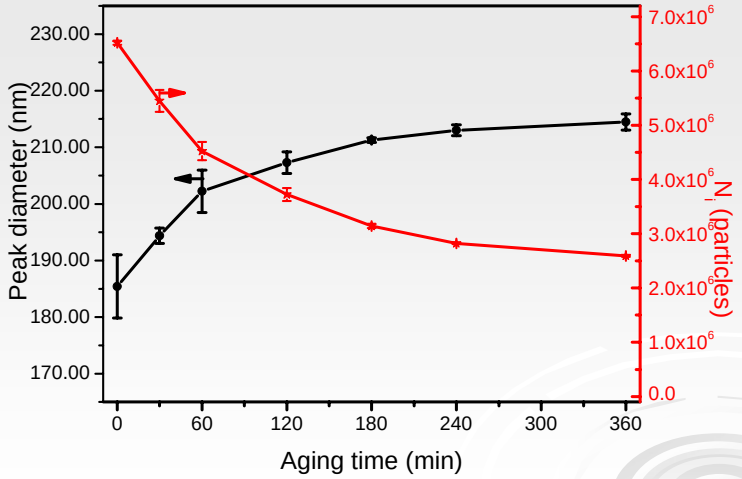
5') Aging process of the aerosol from DMS photooxidation (120 min)

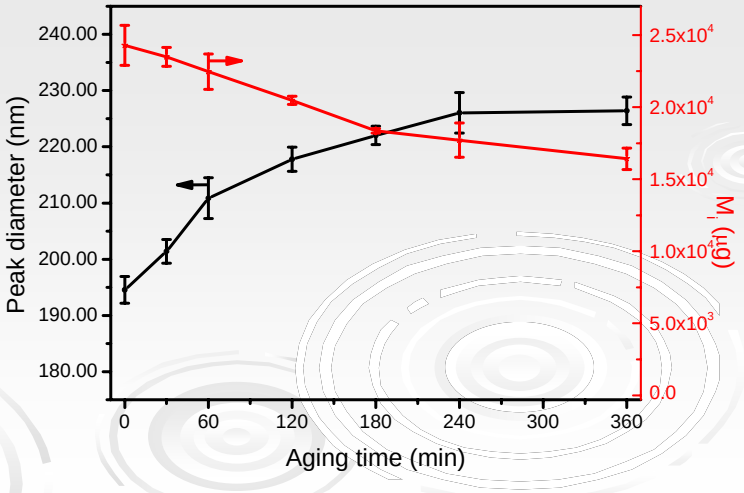
- Count distributions



- Mass distributions







Conclusion

- SO_2, DMSO and COS were the major sulfur-containing gas products in the process of DMS photooxidation.
- Secondary aerosol can be formed while DMS was oxidized. And the size distribution of the formed aerosols can be well characterized by lognormal function.
- With reaction undergoing in averaged experiments, the count distributions varied from unimodal to multimodal, and its coarse median diameter moved to 440.4 nm after 240 min.
- Aging of 360 min can cause the median diameter of 30min-photoreacted aerosols increasing from 83.4 nm to 194.4 nm, and its the number concentrations decreased from 2.8×10^7 to 4.9×10^6 particles/cm^3.
- Compared experiment DMS mixing ratio of 46.7 ppm with 4.67 ppm, the median diameter and number concentration decreased from 98.6 to 59.4 nm, and from 4.5 to 2.5×10^7 particles/cm^3, respectively.

Thank you!