New Jersey Institute of Technology

Heterogeneous nucleation of a non-wetting vapor on NaCl aerosol nanoparticles and its implications on cloud forming and optical properties

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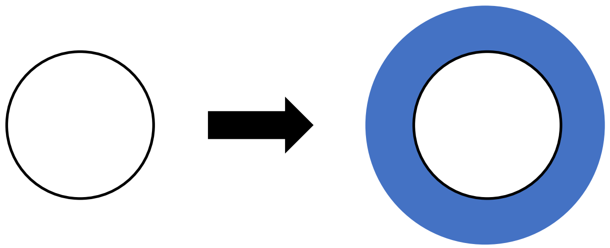
Background

- Atmospheric aerosols contribute to climate forcing in two ways:
  - Through directly scattering and absorbing sunlight
  - By modifying the clouds
- A common path for atmospheric aerosol processing is condensation of various chemicals on particle surfaces
- Geometry of the coating layer depends on wettability of the particle surface by the coating material



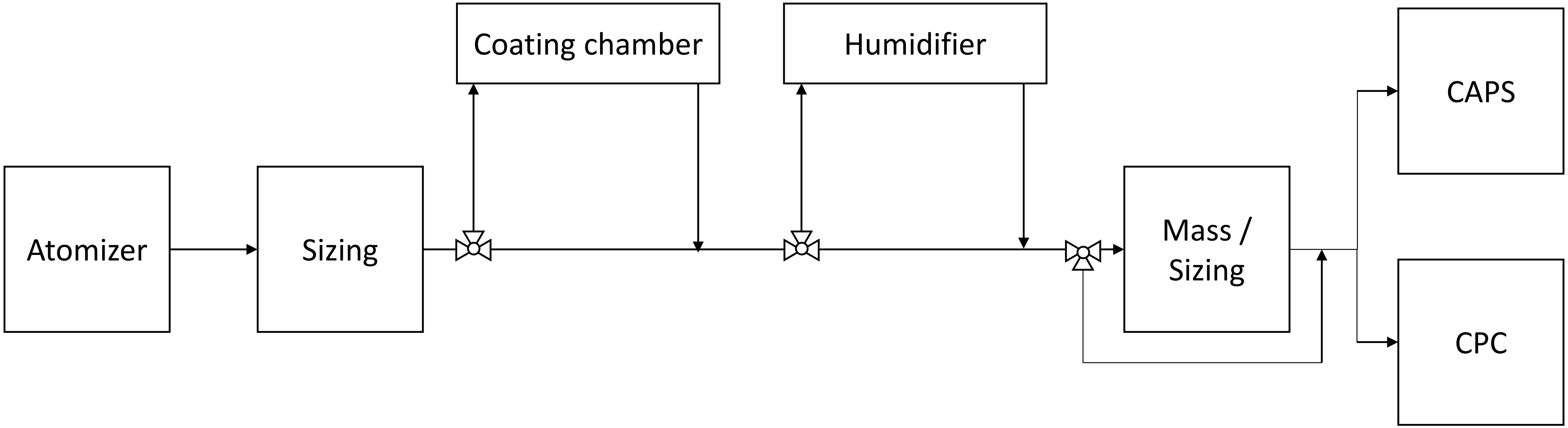
Significance

- It is important to know the impact of coating on optical properties for climate modeling
- Typically, volume-equivalent spheres are assumed for climate modeling
- We wanted to quantify the error introduced by this assumption when coating morphology deviates from spherical

Experimental

- Sodium chloride aerosol was generated with a constant output atomizer
- Particles with 150 nm mobility diameter were selected and were coated with dioctyl sebacate (DOS)
- It is expected that a non-wetting liquid will nucleate on a surface defect and the droplet will grow around the defect without fully encapsulating the particle
- Aerosol was passed through a humidifier to check if particles would deliquesce
- If deliquescence did not occur, then particles were not fully encapsulated in DOS, which is immiscible with water

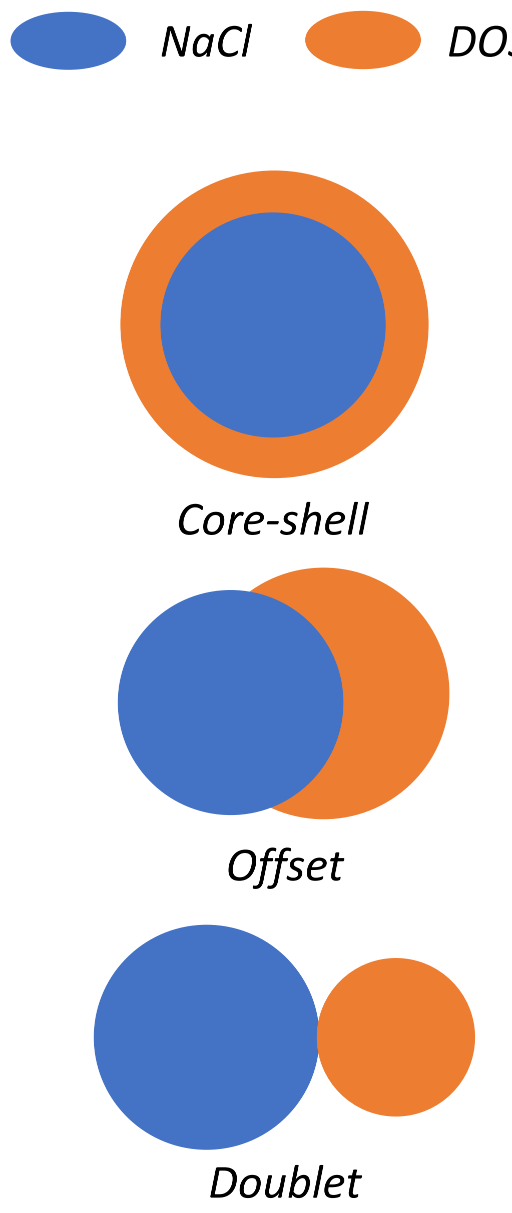
Experimental



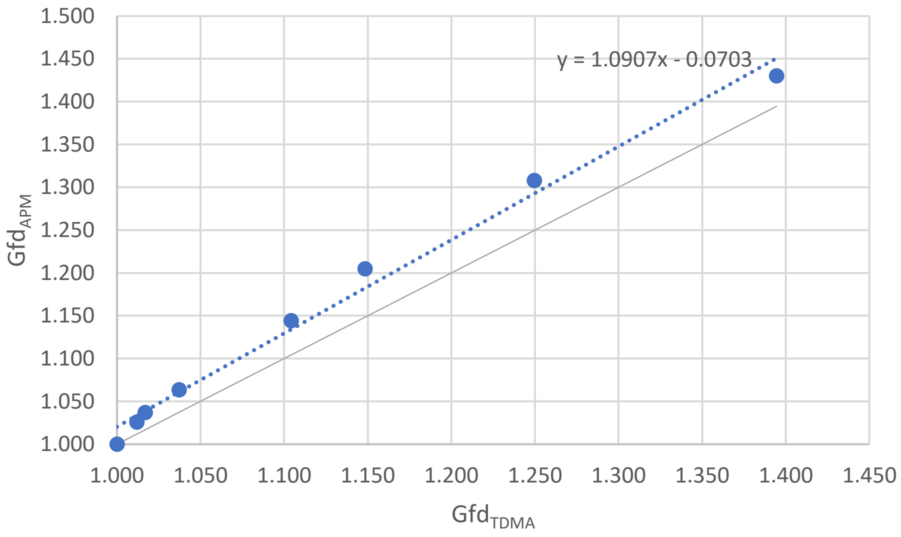
Aerosol generation and processing system

Calculations

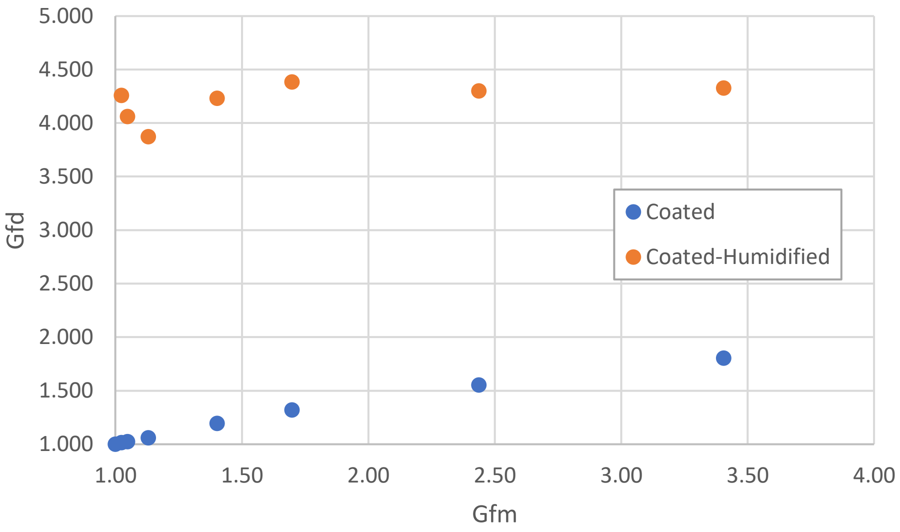
- Scattering enhancements were calculated for three morphological configurations: core-shell, offset, and doublet.
- Discrete Dipole Approximation (DDA) was used for offset morphology and Multiple Sphere T-Matrix (MSTM) was used for other morphologies
- Experimental results were compared to calculations for different morphologies.



Results

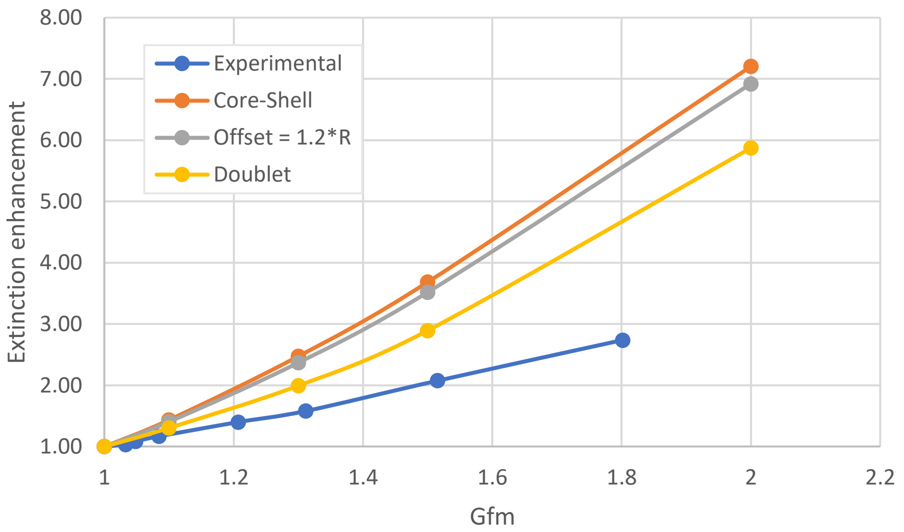


Volume-equivalent diameter vs mobility diameter (in the form of growth factors)



Mobility diameter growth factor vs. mas growth factor for coated and coated-humidified particles

Results



Measured and calculated extinction enhancements vs. mass growth factor

Conclusion and Future Work

- Heterogeneous nucleation of non-wetting coatings affects optical properties of aerosols differently than wetting coatings
- In some cases, the deviation is significant and should be accounted for in climate models
- In future, the experiment will be repeated with a larger coating mass to reach full encapsulation of particles
- At the point where full encapsulation is reached, it is expected that scattering enhancement will be closer to the core-shell model than the doublet model

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