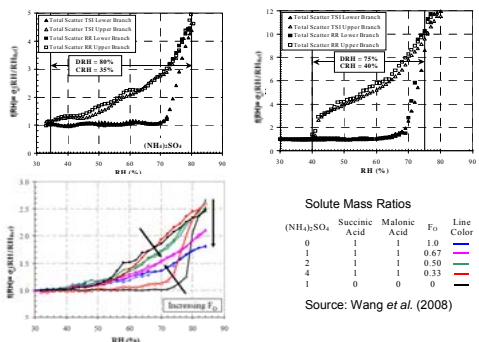


Background

- Aerosol water content and aerosol size → function of ambient RH and aerosol chemical composition
- Water content alters the optical properties of an aerosol in terms of light scattering and light absorption
- Light scattering of inorganic, certain organic and mixed aerosols as a function of RH studied in the past (e.g., $(\text{NH}_4)_2(\text{SO}_4)$, NaCl and mixtures of $(\text{NH}_4)_2(\text{SO}_4)$ with organic acids):



- Light absorption of organic and mixed organic / inorganic aerosols have rarely been examined at variable and especially high RH values (>85%)

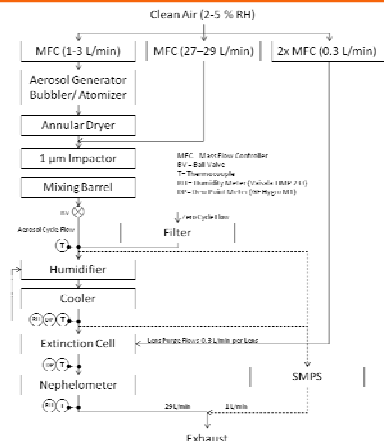
Objectives

- Determine and parameterize light scattering and absorption of organic and mixed inorganic aerosols as a function of RH
- **This work:** instrumentation benchmark with characterized non-absorbing ammonium sulfate ($(\text{NH}_4)_2\text{SO}_4$) and absorbing polystyrene latex (PSL) test aerosols, including closure evaluation between measurements and models
- **Future work:** measure light absorption of mixed organic/inorganic and brown carbon aerosols at high RH → provide parameterized results for models

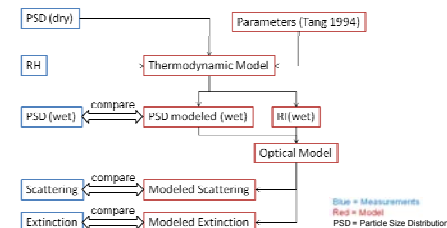
Approach

- Light scattering (σ_{sp}) → nephelometer (TSI 3563) Instrument modifications: optical band-pass filter, separated electronics (heating reduced from 4.5 to 0.6 °C)
- Light absorption (σ_{ap}) → difference method: light extinction (σ_{ext}) minus light scattering (σ_{sp})
- Light extinction (σ_{ext}) → measured with a custom-made short path extinction cell (SPEC)
- RH control → annular membrane humidifier
- RH characterization → 2 RH sensors (Vaisala, HMP-233) and 2 dew point meters (GE, Hygro M1) in combination with 4 dry bulb measurements (Omega Inc., Thermocouple)

Controlled RH Instrumentation



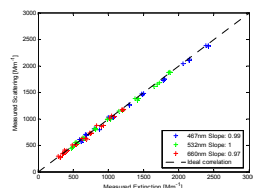
Controlled RH Data Analysis/ Modeling



- Extinction corrections: path length, temperature, pressure
- Scattering corrections: temperature, pressure, SPEC purge flow, truncation, wavelength (to match extinction)

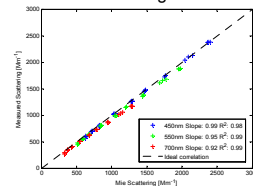
Dry Ammonium Sulfate Results

- Measured scattering vs. measured extinction



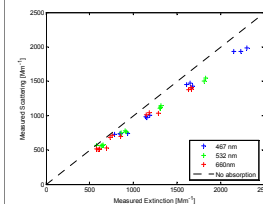
- Path length adjustment of -10% (due to purge flow and cell geometry)
- Extinction = scattering within 3%

- Measured scattering vs. modeled scattering



- Measured scattering = modeled within 8%

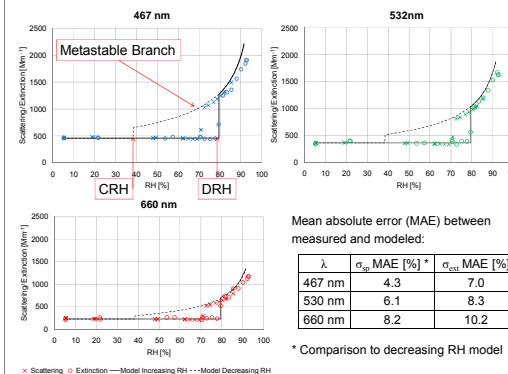
Dry Absorbing PSL Spheres Results



- Spheres diameter 378 nm
- Single scattering albedo (532 nm) = 0.849 ± 0.015
- Method detection limit: $\sigma_{ap}(532\text{nm}) = 41 \text{ Mm}^{-1}$

Humidified Ammonium Sulfate Results

- Tests performed over a range of 25 – 92% RH (at 25 °C)
- Increasing RH branch: model was assumed to be dry up to the deliquescence RH (DRH).
- Decreasing RH branch: modeling was performed until the crystallization RH (CRH)
- DRH and CRH from Tang (1994)



Current Status and Outlook

- Current method is capable to determine light absorption under dry conditions
- Extinction was measured at RH values up to 92%
- Scattering could be measured up to 86% RH due to nephelometer heating of 0.6 °C and SPEC purge flow
- Experiments with LED light source not yet successful
- Future work will focus on:
 - Improvements to reach RH values up to 96%
 - Measurement and optical parameterization of humidified brown carbon aerosols

Acknowledgement

Optical Properties of Moderately-Absorbing Organic and Mixed Organic/ Inorganic Particles at Very High Humidities
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