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Research poster: Measuring the aerosol asymmetry parameter g instrument description and initial measurements

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Measuring the Aerosol Asymmetry Parameter g Instrument
Description and Initial Measurements
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Introduction

✓ In addition to aerosol scattering and absorption coefficients, the angular distribution of light scattered by aerosol particles is needed to determine the aerosol contribution to radiative forcing. This angular distribution is commonly parameterized into a single value, the asymmetry parameter g. It is defined as the intensity-weighted average cosine of the scattering angle with values ranging from –1 for pure backscattering to +1 for pure forward scattering.
✓ No instruments for the direct measurement of aerosol g in the atmosphere are available. Commonly the asymmetry parameter g is determined from measurements of the aerosol size distribution and refractive index using Mie calculations under the assumption of spherical particles. The problem is that size distribution and refractive index are often poorly known and the particles may not be spherical.
✓ Here a g-meter which can measure aerosol g directly is introduced. It is made of a quadrant detector conjunction with a laser beam. An accurate g value can be achieved by the signals of four detectors. The initial measurement will be discussed.

1) Concept of Asymmetry parameter g

The angular distribution of light scattered by aerosol is needed to determine the aerosol contribution to radiative forcing. Phase function from Mie theory for spherical particles (Needs size parameter x = na^2, and complex refractive index) gives the angular distribution of the scattered light.

\[ \text{Normalized Sg} = \frac{S_{g1} + S_{g2} - S_{g3} - S_{g4}}{S_{g1} + S_{g2} + S_{g3} + S_{g4}} \]

where θ is the angle between incident light and scattering direction and P(θ) is the phase function giving the angular distribution of the scattered light.

The g-meter reads the scattered light from the four detectors and calculates the g value using the Mie theory. The aerosol size distribution and refractive index are not needed. The size distribution is parameterized into a single value, the asymmetry parameter g. It is defined as the intensity-weighted average cosine of the scattering angle with values ranging from –1 for pure backscattering to +1 for pure forward scattering.

4) Schematic diagram and picture of the g-Meter

System diagram

An SMPS is used to measure the size distribution of salt particles from the aerosol generator. We can calculate the g value with Mie theory and measure it with g-meter.

5) Calibration and truncation angle analyze

Calibration (1): angular response
1. Mount the cylindrical detector on a rotation stage and rotate it around the cylinder axis.
2. Illuminate the detector with a plane wave (e.g., expanded laser beam) propagating perpendicular to the cylinder axis.
3. Record the angular response and normalize the angular response to sinθ/|cosθ|.

Calibration (2): sensitivity
Calibrate the reciprocal nephelometer with two gases ( Clean Air and CO2).

6) Initial measurement

Initial measurement of salt particle

The aerosol is generated by the Grimm Particle Generator. The g-meter gets the scattered light from the four detectors and calculates the aerosol g value. The size distribution is measured by the SMPS. The g value is measured by the g-meter. The aerosol generator is calibrated with two gases (Clean Air and CO2).

| Size distribution 1 | Measured g value: 0.82 | Calculated g value: 0.74 |
| Size distribution 2 | Measured g value: 0.78 | Calculated g value: 0.69 |

Directly measuring the aerosol g value by the g-meter (having measured g value) can be achieved by the signals of four detectors. The initial measurement will be discussed.