

MODELING ATMOSPHERIC DUST PARTICLE OPTICAL PROPERTIES USING FIRST GENERATION FRACTAL TRIANGULAR BIPYRAMID PARTICLES

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Abstract

Dust particles are a major type of aerosol in the Earth's atmosphere. Accurate modelling of dust particle optical properties can reduce the uncertainties in inferring dust particle radiative and microphysical properties from remote sensing observations. It is critical to use suitable nonspherical shapes to represent all dust particles. In this study, we introduce a possible surrogate dust shape called the first-generation fractal triangular bipyramid. In particular, we compare the optical properties of the first-generation fractal triangular bipyramid ensemble with those based on the original triangular bipyramid ensemble.

1 Introduction

We calculate the single-scattering properties of the original triangular bipyramid shaped dust ensemble displayed in Figure. 1.

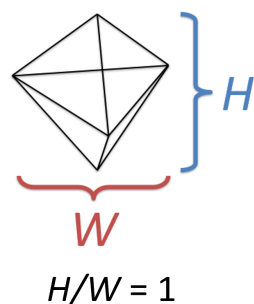


Figure 1 The original triangular bipyramid – shaped dust particle with an aspect ratio of 1.

The motivation of the present simulation is to explore if the original triangular bipyramid-shaped dust particle is a possible surrogate for dust particles in the atmosphere.

1.1 Methodology

In this study, we used a combination of the invariant imbedding T-matrix method (IITM) for small-sized particles and the physical geometric optics method (PGOM) for moderate to large-sized particles. A previous study has shown that a combination of IITM and PGOM is useful in calculating the optical properties of

nonspherical particles [1]. Then, we compare our results with laboratory measurements obtained by the Granada-Amsterdam Light Scattering Database, sphere ensemble, and prolate spheroid ensemble with an aspect ratio of 1.7.

1.2 Experimental Setup

For our preliminary study, we are interested in computing the phase matrix elements P_{11} , $-P_{12}/P_{11}$ and P_{22}/P_{11} . Note that P_{11} , and $-P_{12}/P_{11}$ describe the angular variations of the scattered intensity and the degree of linear polarization, whereas P_{22}/P_{11} is an indicator of degree of particle nonsphericity. Another note to consider is the accuracy of the degree of linear polarization and scattered intensity is very important in radiative transfer simulations. We will use Feldspar measurement data as our reference. Feldspar measurement data has the following parameters listed in Table. 1.

Refractive Index*	$1.5 + 0.001i$
Wavelength	0.6328 microns
Effective Particle Size	1.0 microns
Variance	1.0
Particle Size Range	0.075858 – 12.882 microns

Table 1 Feldspar size distribution information from the Granada-Amsterdam Light Scattering Database

Note that the refractive index is based on the optimal value, not reference values because the reference values does not consider spectral dependence [3]. The size distribution is assumed to be the lognormal distribution based on [4]. The particle size parameter of the measurements, diamond, spheroid, and sphere ensembles is determined based on the equivalent projected-area sphere. Note that, for the Feldspar measurement data, we do not know the scattered intensity in the near forward and backward scattering directions. As a result, we

must calculate the relative phase matrix element $P_{11}/P_{11}(30^\circ)$ instead of P_{11} .

2 Preliminary Results and Discussions

Based on Figure. 2, the original triangular bipyramid denoted as diamond ensemble and spheroid ensembles are more accurate than spheres in capturing the features of $P_{11}/P_{11}(30^\circ)$, $-P_{12}/P_{11}$, and P_{22}/P_{11} . In particular, the backscattering direction of the sphere ensemble. Compared to the sphere and spheroid ensembles, the original triangular bipyramid ensemble in the side scattering direction best estimates the degree of linear polarization. As for P_{22}/P_{11} , the spheroid and triangular bipyramid ensemble and measurements have the same pattern even though they overestimate P_{22}/P_{11} . This indicates that the sphericity index might be higher than measurements.

Based on the preliminary results, we will consider modifying the original triangular bipyramid by adding in first generation fractals to make the triangular bipyramid shape more irregular using the technique described in [5]. Furthermore, we will test the modified triangular bipyramid shape with the fractals added to see if it will better match the phase matrix elements of the measured data. Our hope is that the adding in first-generation fractal to the original triangular bipyramid shape will better match the measurement data.

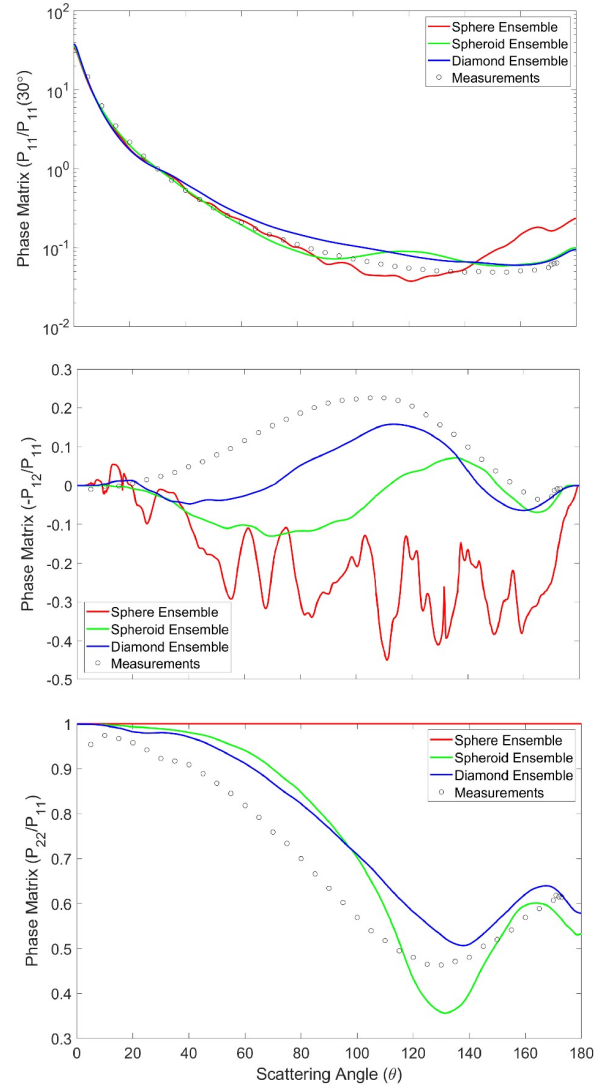


Figure 2 This figure illustrates $P_{11}/P_{11}(30^\circ)$, $-P_{12}/P_{11}$, and P_{22}/P_{11} phase matrix elements of the sphere, spheroid, original triangular bipyramid ensembles, and Feldspar measurements.

3 Acknowledgements

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4 References

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