Overview

Integrating more than 10 aerosol characterization measurements and 3 different radiative models, this study quantitatively explores the dust nonsphericity issues.

Introduction

• Dust affects visibility, human health, and the Earth energy budget. However, modeling of dust distribution and quantification of its radiative effects are difficult, simply because ground-based measurements for dust aerosols are limited in both space and time.

• The satellite measurements have been considered as one of the best tools to characterize the high spatial-temporal variations of aerosols.

• However, the current dust retrievals from satellite measurements have large uncertainties, mainly because dust particles are nonspherical, and their phase functions can not be calculated/trusted properly. It has been shown theoretically that such uncertainties can be easily larger than 2.

• In the context of practical applications, few quantitative evaluations of non-spherical effect on satellite retrievals have been made, either due to the lack of in situ aerosol characterizations measurements, or because most measurements lack the capability to monitor the same dust layer from different angles with high temporal resolutions.

Objectives

Will consideration of non-spherical effects improve the satellite retrievals, if all the required data to characterize aerosol optical properties are given in the same temporal-spatial domain?

Results Using Different Phase Functions

We use the in situ datasets collected during Puerto Rico Dust Experiment (PRIDE), June 28 – July 24, 2000. The following figure shows GOES-8 ch1 image on June 28, 2000 at 1145UTC composite with a conceptual model showing how dust from Africa can be transported to continental United States. Also shown are two Sunphotometer (SP) locations. On this day, the dust aerosol optical thickness (AOT) is about 0.5, as reported by both Sunphotometers.

Quantitative Analysis of Non-spherical effect

Phase Function (All angle)

<table>
<thead>
<tr>
<th>Phase Function</th>
<th>Δε/ε</th>
<th>Δε/ε</th>
<th>Δε/ε</th>
<th>Δε/ε</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spherical</td>
<td>0.50</td>
<td>0.98</td>
<td>31%</td>
<td>41%</td>
</tr>
<tr>
<td>Non-Spherical</td>
<td>0.35</td>
<td>0.35</td>
<td>15%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Summary

Using SEM data and T-matrix calculations, the computed non-spherical phase function agrees well with synthetic phase function derived from independent measurements [Lu et al., 2003].

Applying purely non-spherical phase functions into the satellite retrieval algorithms only shows slightly improvement at certain scattering angles. However, using composite phase function by considering both spherical and non-spherical particles greatly improves the retrievals.

Further efforts are needed to combine the use of multi-angle, multi-channel, and polarization data sets to retrieve the morphologies of particles and to apply them in satellite retrievals.

References


Acknowledgments: This research is supported by NASA’s Radiation and Interdisciplinary Sciences Program. We thank Dr. Mishchenko for providing the synthetic phase functions and the T-matrix code.