4.14

COMPARISON OF MODIS AND MISR TROPICAL CIRRUS RETRIEVALS

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1. INTRODUCTION

This study focuses on the various techniques being used for the remote sensing of tropical cirrus properties from co−located MODIS (Moderate Resolution Imaging Spectroradiometer) and MISR (Multiangle Imaging Spectroradiometer) multispectral data. Our interests are directed primarily towards the intercomparison of cirrus properties inferred from MODIS and MISR data, and an improved understanding of their synergistic nature. Cirrus retrievals are compared to observations from the Atmospheric Radiation Measurement Clouds and Radiation Testbed (ARM−CART) Tropical Western Pacific (TWP) site. We also describe the development of new tropical cirrus microphysical models developed from in−situ measurements of both particle size and habit distributions. These cirrus microphysical models are used to develop single scattering models for use with the MODIS and MISR instruments.

2. DATA AND METHODS

Satellite data for this study are from the MODIS and MISR instruments aboard the NASA Terra platform, which is in a polar−orbiting, sun−synchronous orbit at an altitude of 705 km. MODIS has 36 spectral bands between 0.415 and 14.235 microns in four focal plane assemblies, with spatial resolutions of 250 m (2 bands), 500 m (5 bands) and 1000 m (29 bands). MISR records data at four wavelengths ranging from 0.41 to 0.91 microns from a set of 9 cameras aligned alongtrack. MODIS products used in this study include the MODIS calibrated radiance product (MOD021KM), as well as cloud mask (MOD35_L2) and cloud top products (MOD06_L2). For validation purposes, satellite data are taken from Terra overpasses of the ARM−TWP site on the island of Nauru.

Tropical cirrus microphysical models are developed from *in−situ* measurements of particle size and habit distributions from the NASA TRMM Kwajalein Experiment (KWAJEX). Average size distribution data were attained from a total of 5 aircraft missions in August and September of 1999. Size distribution data obtained from imaging probes have been discretized into 27 size bins ranging from 3 to 3500 microns. Figure 1 shows the size distribution data from KWAJEX, while Figure 2 shows data from midlatitude cirrus from the ARM−CART Southern Great Plains site (SGP) collected in March, 2000. Tropical habit distributions based on the imaging probe data are shown in Table 1.

Habit Type	KWAJEX	ARM−IOP
First size limit	**D < 100 μm**	**D < 100 μm**
Hollow column	50.00%	6.00%
Aggregate	30.00%	19.00%
Solid column	20.00%	0.00%
Hexagonal Plate	0.00%	75.00%
Second size limit	**100 μm < D < 800 μm**	**100 μm < D < 800 μm**
3D Bullet rosette	50.00%	100.00%
2D Bullet rosette	50.00%	0.00%
Third size limit	**D > 800 μm**	**D > 800 μm**
3D Bullet rosette	50.00%	75.00%
2D Bullet rosette	50.00%	0.00%
Aggregate	0.00%	25.00%

Table 1: Tropical Habit Distribution

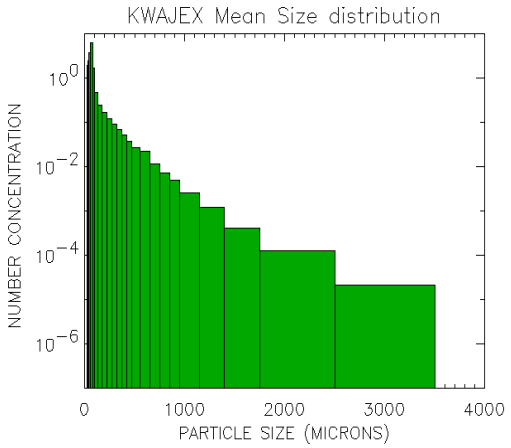

Figure 1: Size distribution discretized into 27 size bins using tropical cirrus data from KWAJEX.

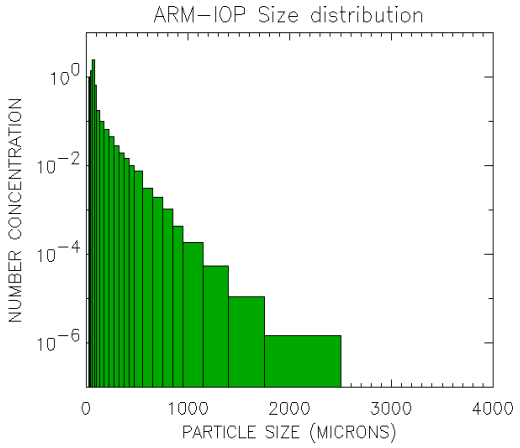

Figure 2: Size distribution discretized into 27 size bins using midlatitude distribution from ARM intensive operational period (IOP).

Bulk scattering properties from these cirrus microphysical models are used as input to a discrete ordinates radiative transfer (DISORT) model to calculate top of atmosphere (TOA) radiances for a range of clear and cloudy conditions. All MISR bands are shortwave, so the primary absorber is ozone, and Rayleigh scattering is important. Atmospheric absorption is approximated for each MISR band using correlated−k distribution routines.

Radiative transfer calculations are performed to assess the effect of habit and size distributions on TOA reflectances at the MISR wavelengths. Calculations are performed over a range of solar zenith, viewing zenith, and relative azimuth angles.

3. RESULTS

Examination of the scattering phase functions as derived using the new cirrus models reveals the need to distinguish between tropical and mid−latitude cirrus properties. Figure 3 shows the percent change in phase function between the midlatitude cirrus models (from ARM−IOP) and the tropical cirrus models (from KWAJEX). At satellite viewing angles, the most significant changes occur in MISR bands 2 and 3. These changes could be in part due to the increased number of large particles found in the tropical cirrus case.

We will show detailed results comparing results derived from both MISR and MODIS data and discuss similarities and differences.

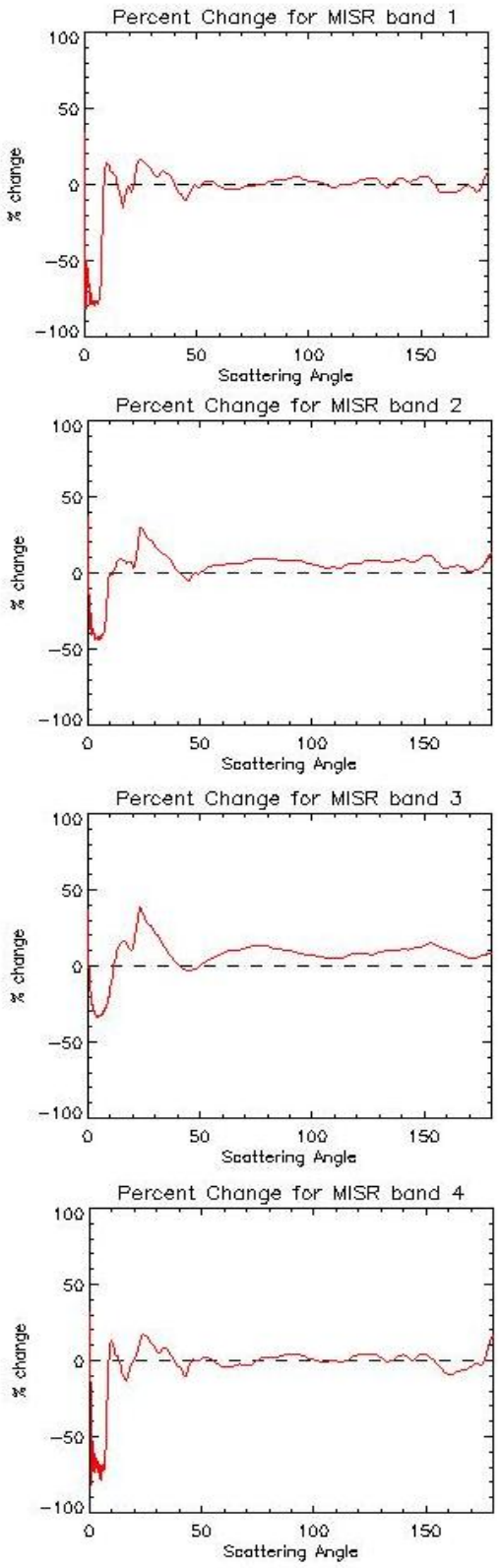

Figure 3: Percent change in phase function for tropical vs. midlatitude case.

4. REFERENCES

Baum, B.A., et. al., 2000, Remote Sensing of Cloud Properties Using MODIS Airborne Simulator Imagery During SUCCESS. I. Data and models, *J. Geophys. Res*., 105, 11767−11780.

Kratz, D. P., 1995: The Correlated k−distribution technique as applied to the AVHRR channels, *J. Quant. Spectrosc. Radiat. Transfer*,53, 501−517.

Nasiri, S.L, et. al. Development of Midlatitude cirrus Models for MODIS Using FIRE−I, FIRE−II, and ARM *in−situ* Data. In press, *J. Appl. Meteor.*

Yang, P. and K.N. Liou, 1996a: Finite−difference Time Domain Method for Light Scattering by Small Ice Crystals in Three−Dimensional Space*, J. Opt. Soc. Am.*, 13, 2072−2085.

Yang, P. and K.N. Liou, 1996b: Geometric−Optics−Integral−Equation Method for Light Scattering by Nonsperical Ice Crystals, *Appl. Op*t., 35, 6568−6584.