Comparison of CERES and MISR Top-of-Atmosphere Broadband Albedo

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Introduction

- The Clouds and the Earth's Radiant Energy System (CERES) and the Multi-angle Imaging Spectroradiometer (MISR) on Terra satellite both seek to obtain accurate albedo of the Earth, but one is in broadband and the other in narrowbands.

- In this study, MISR spectral albedo in the MISR Level 2 TOA/Cloud Albedo Data is converted into broadband albedo and compared with CERES albedo over 1x 1 deg latitude and longitude region quasi-instantaneously and in monthly mean.

- The CERES and MISR top-of-atmosphere broadband albedo are also compared zonally and globally. Cloud types are considered in the comparison. The bias difference between the MISR and the CERES SW albedo over different seasons is estimated.

Conversion of MISR Level 2 narrowband albedo to broadband albedo

1. Radiance NB-to-BB conversion using MISR Level 1B2 data and CERES data in SSFM

   Linear regression: Rbb = a + b*Rnb(0.671um)+c*Rnb(0.866um)

   SZA and VZA bins: 0 [0-10), 1 [10-20), 2 [20-30), 3 [30-40), 4 [40-50), 5 [50-60), 6 [60-70), 7 [70-80), 8 [80-90]

   AZA bins: 0 [0-20), 1 [20-40), 2 [40-60), 3 [60-80), 4 [80-100), 5 [100-120), 6 [120-140), 7 [140-160), 8 [160-180]

   Cloud Fraction bins: 0 [0-10%), 1 [10-20%), 2 [20-30%), 3 [30-40%), 4 [40-50%), 5 [50-60%), 6 [60-70%), 7 [70-80%), 8 [80-90%), 9 [90-100%]

   Conversion coefficients a, b, and c are functions of SZA, VZA, VAZ, and cloud fraction and are from linear regression of 24-day SSFM data for 24 CERES along-track days across a year.

2. MISR Level 2 albedo NB-to-BB conversion algorithm

Using radiance nb-to-bb conversion coefficients, we can get, at the 9 MISR viewing angles, MISR broadband radiances.

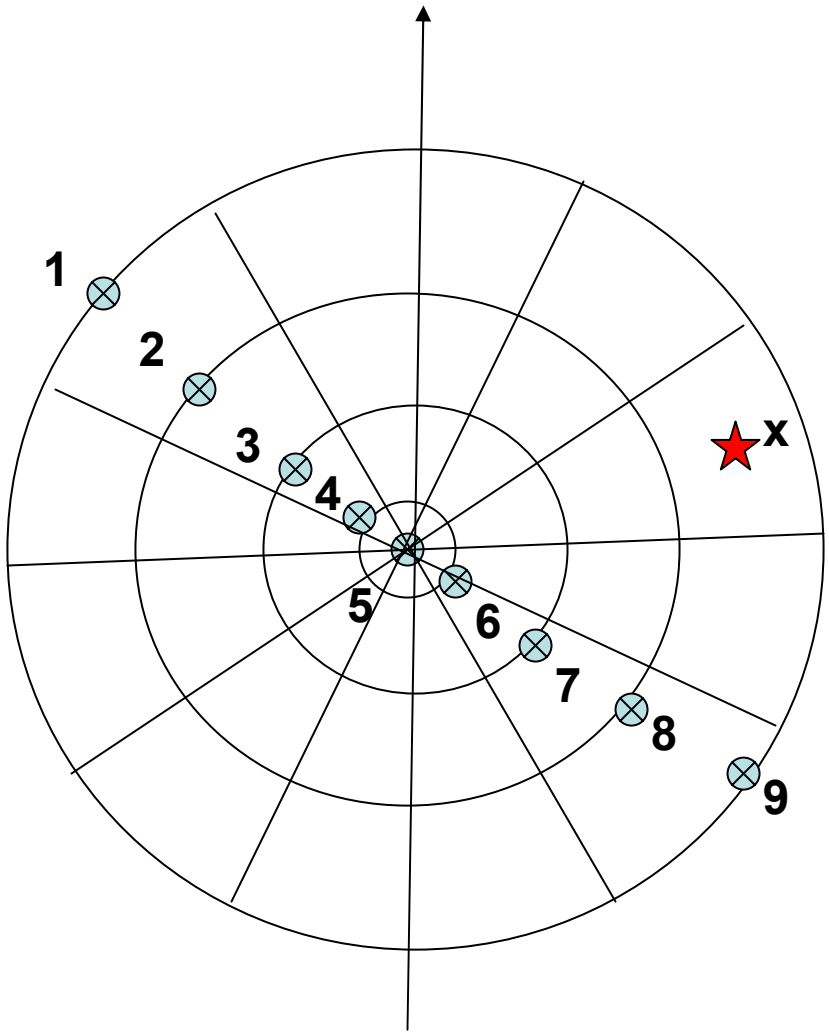
The narrowband and broadband radiances at the 9 viewing angles are "BROADCASTED" to their close-neighbor angles (CNA). The reflectances are integrated to get generic narrowband and broadband albedoes.

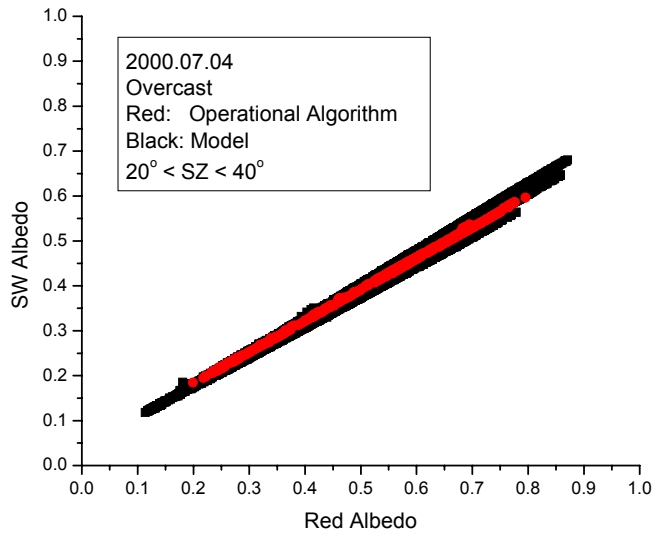
The generic albedoes may be very different from true values. Our assumption here is: the linear regression coefficients from the generic albedoes are close to the exact values. For limit situations (overcast oceans), the following figure gives validation for this assumption!

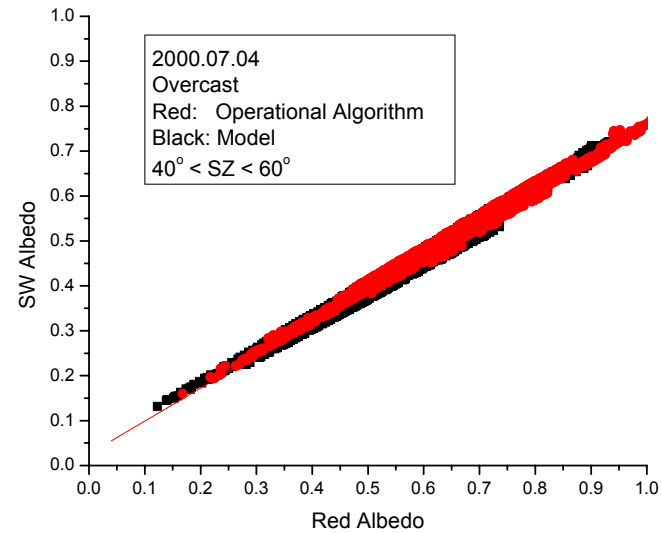
$$Abb = a + b*Anb(0.671um)+c*Anb(0.866um)$$

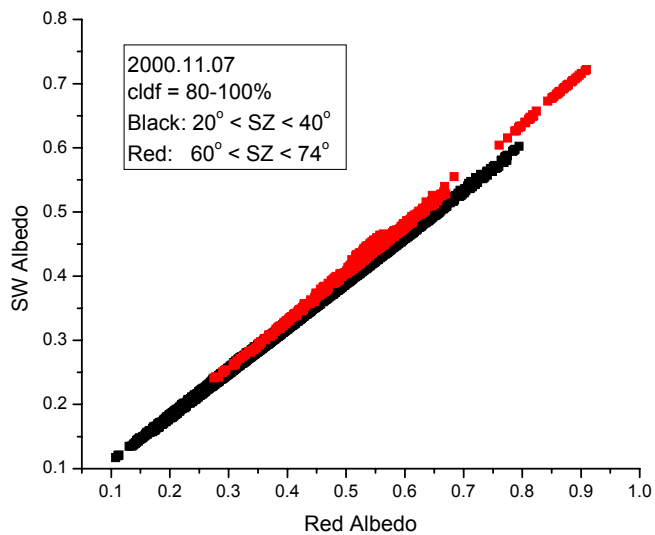
Conversion coefficients a, b, and c are functions of SZA only and from 17-day SSFM data for CERES along-track days. The dependence of the coefficients on cloud fraction is weak.

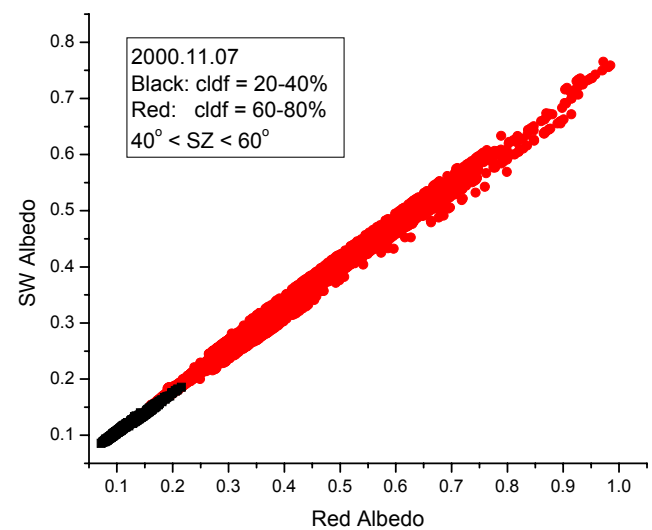
Assume angle between x and MISR camera I (I = 1, …, 9) is Ang(x,I), if camera J makes Ang(x,J) smallest among all Ang(x,I), R(x) = R(J).




2000.07.04
Overcast
Red: Operational Algorithm
Black: Model
20° < SZ < 40°
SW Albedo
Red Albedo


2000.07.04
Overcast
Red: Operational Algorithm
Black: Model
40° < SZ < 60°
SW Albedo
Red Albedo


2000.11.07
cldf = 80-100%
Black: 20° < SZ < 40°
Red: 60° < SZ < 74°
SW Albedo
Red Albedo


2000.11.07
Black: cldf = 20-40%
Red: cldf = 60-80%
40° < SZ < 60°
SW Albedo
Red Albedo

Spatial and temporal fusion of MISR Level 2 data with CERES data

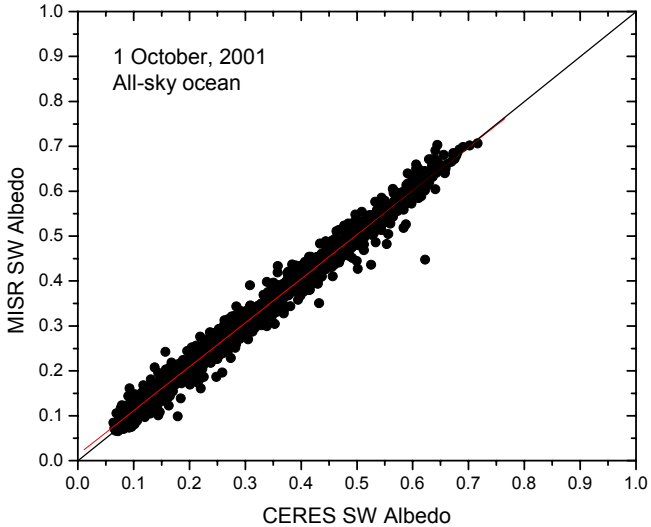
Using the albedo nb-to-bb conversion coefficients, MISR spectral albedo in the MISR Level 2 TOA/Cloud Albedo Data is converted into broadband albedo and compared with CERES albedo over 1 x 1 deg latitude and longitude region.

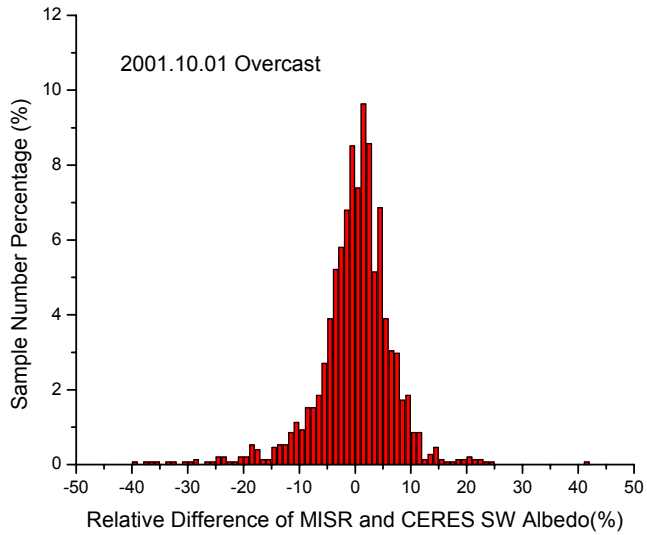
1. For each MISR path, CERES cross-track footprints falling more than one footprint off the MISR swath are disregarded in the fusion with MISR data.

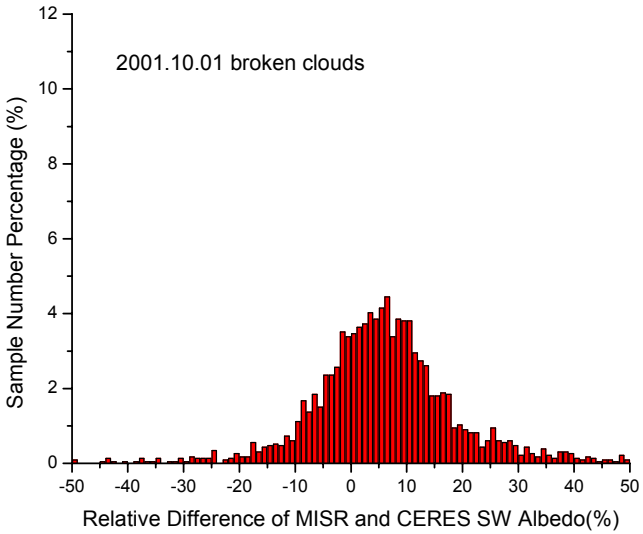
2. Over each 1x1 deg region, albedoes of each MISR super-pixel and CERES footprint are averaged. The comparison of instantaneous albedoes can then be done.

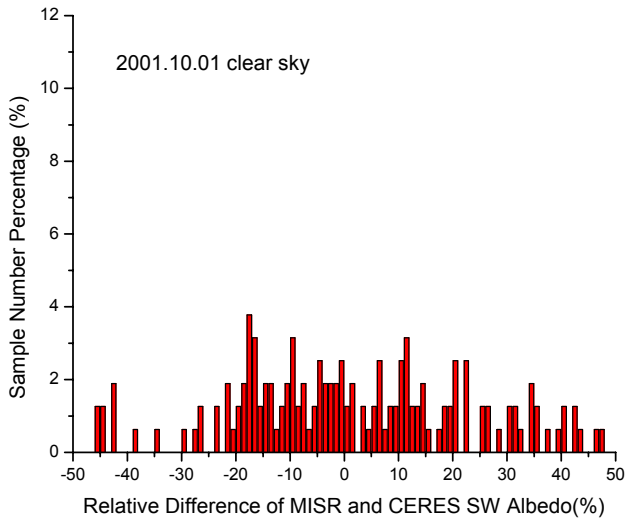
3. To ensure a quasi-instantaneous fusion of MISR and CERES albedoes, the difference between the cosine of MISR's and CERES' s solar zenith angles are limited to be smaller than 0.005

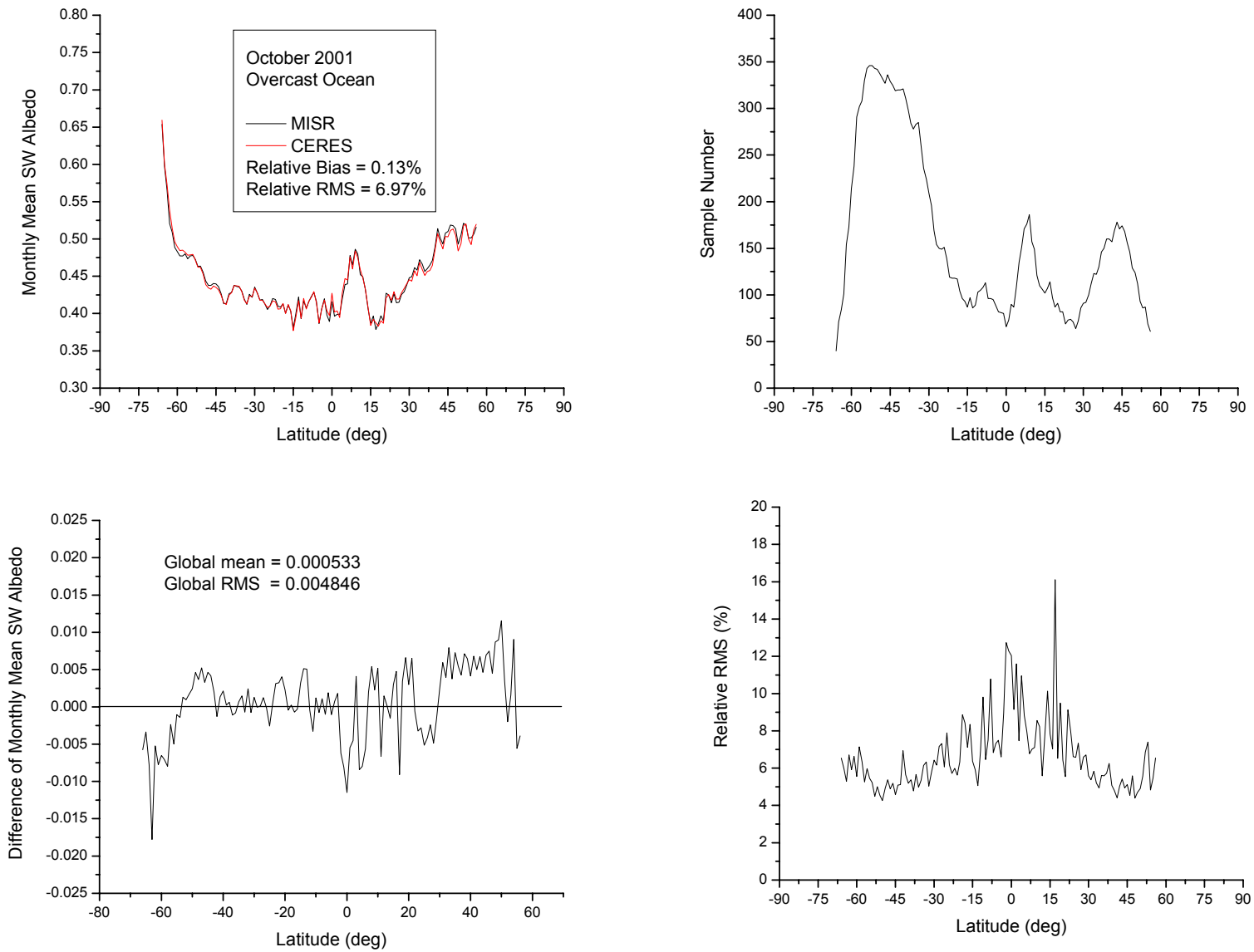
Comparison of MISR and CERES albedoes

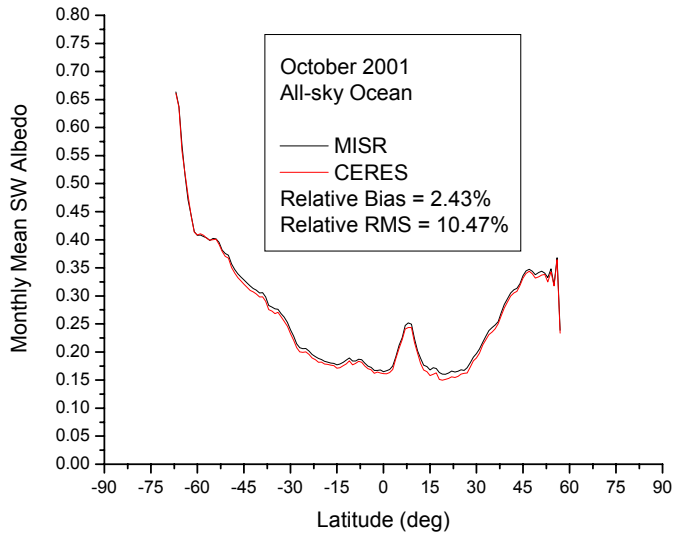


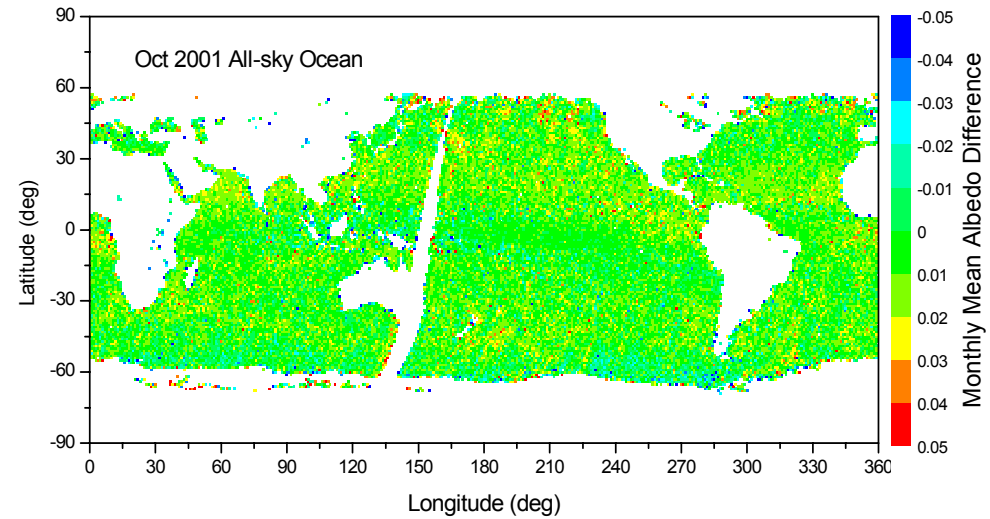


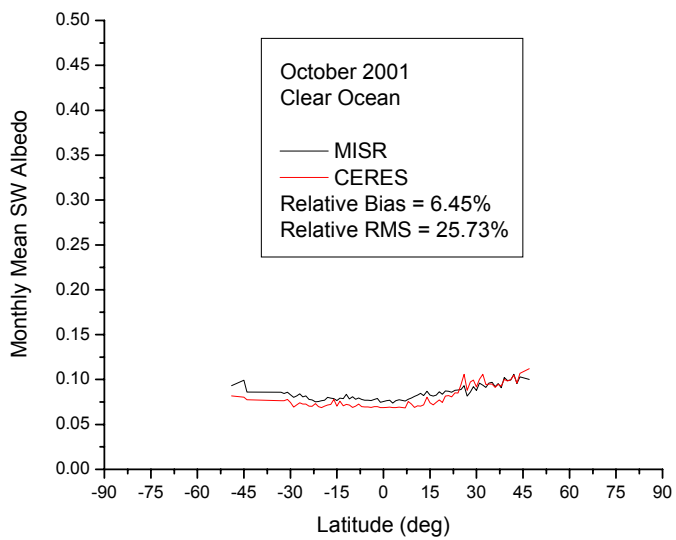


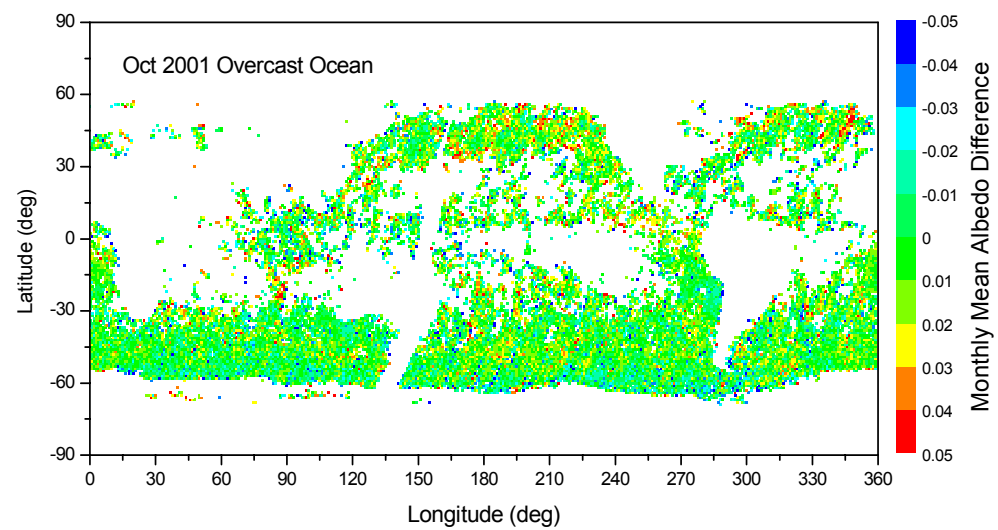


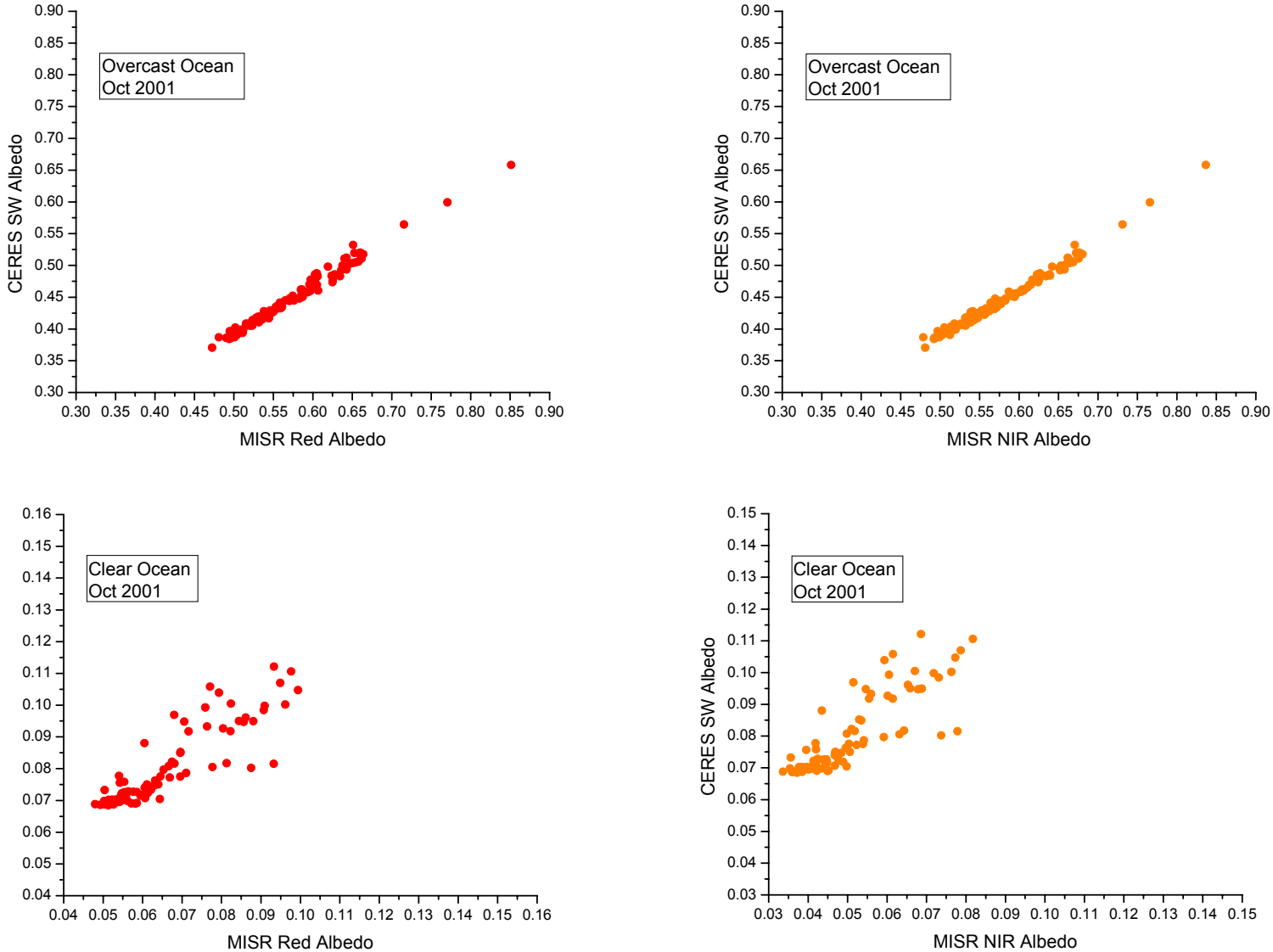

October 2001
Overcast Ocean
MISR
CERES
Relative Bias = 0.13%
Relative RMS = 6.97%
Monthly Mean SW Albedo
Latitude (deg)
Sample Number
Latitude (deg)
Global mean = 0.000533
Global RMS = 0.004846
Difference of Monthly Mean SW Albedo
Latitude (deg)
Relative RMS (%)
Latitude (deg)

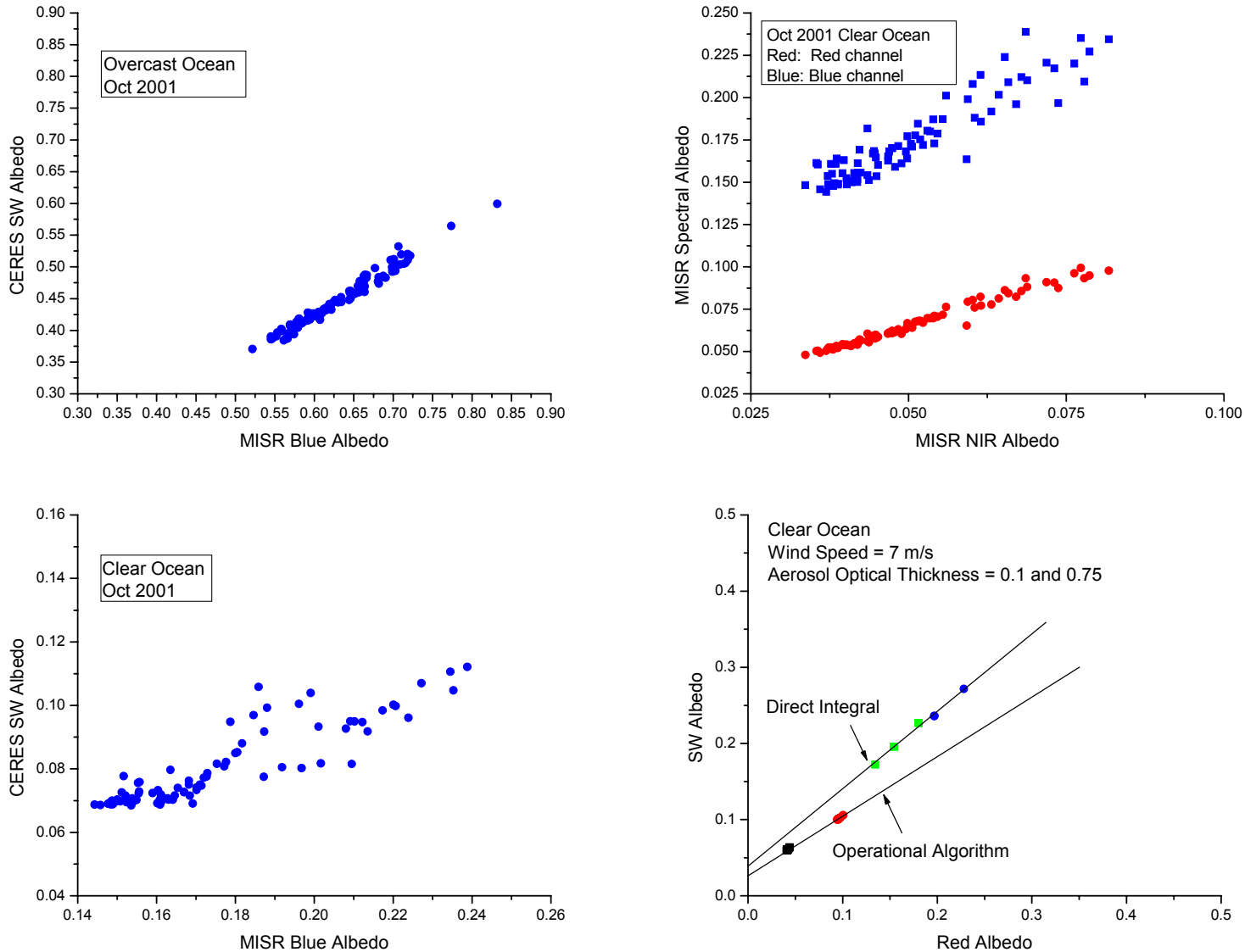

October 2001
All-sky Ocean
MISR
CERES
Relative Bias = 2.43%
Relative RMS = 10.47%
Monthly Mean SW Albedo
Latitude (deg)

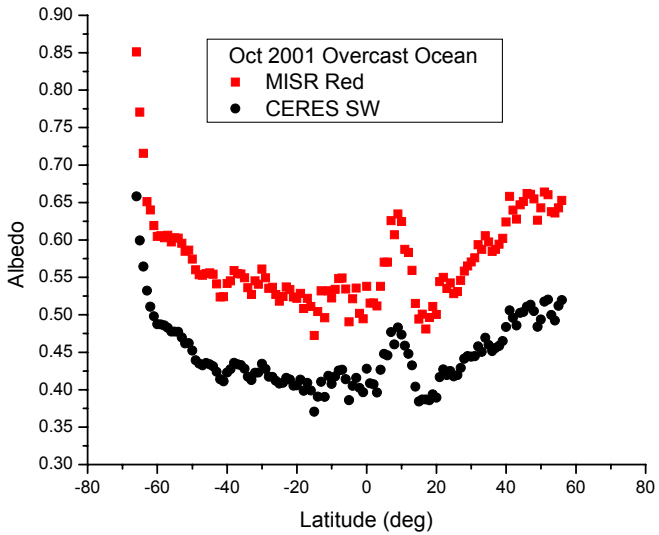

Oct 2001 All-sky Ocean
Latitude (deg)
Longitude (deg)
Monthly Mean Albedo Difference

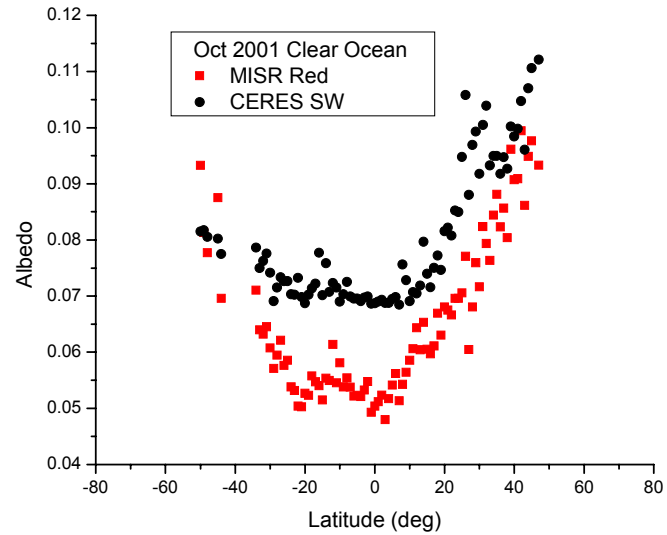

October 2001
Clear Ocean
MISR
CERES
Relative Bias = 6.45%
Relative RMS = 25.73%
Monthly Mean SW Albedo
Latitude (deg)

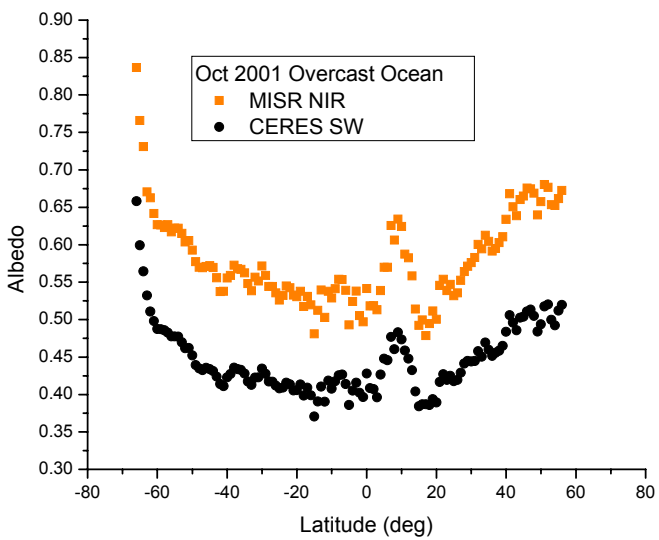

Oct 2001 Overcast Ocean
Latitude (deg)
Longitude (deg)
Monthly Mean Albedo Difference

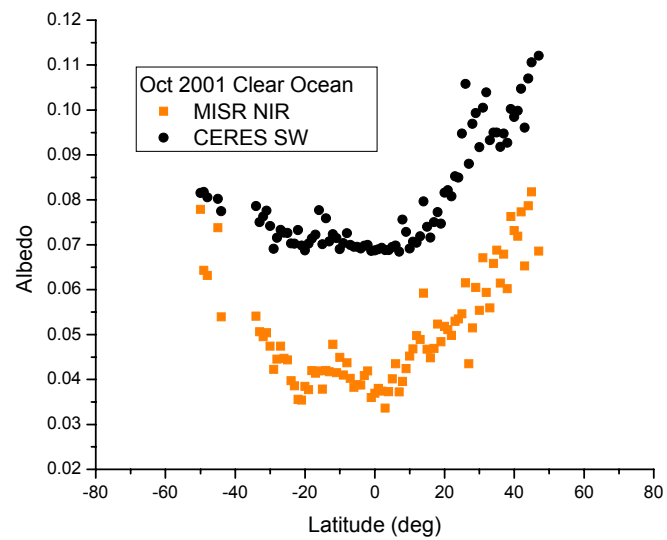

Overcast Ocean
Oct 2001
CERES SW Albedo
MISR Red Albedo
Overcast Ocean
Oct 2001
CERES SW Albedo
MISR NIR Albedo
Clear Ocean
Oct 2001
MISR Red Albedo
Clear Ocean
Oct 2001
CERES SW Albedo
MISR NIR Albedo

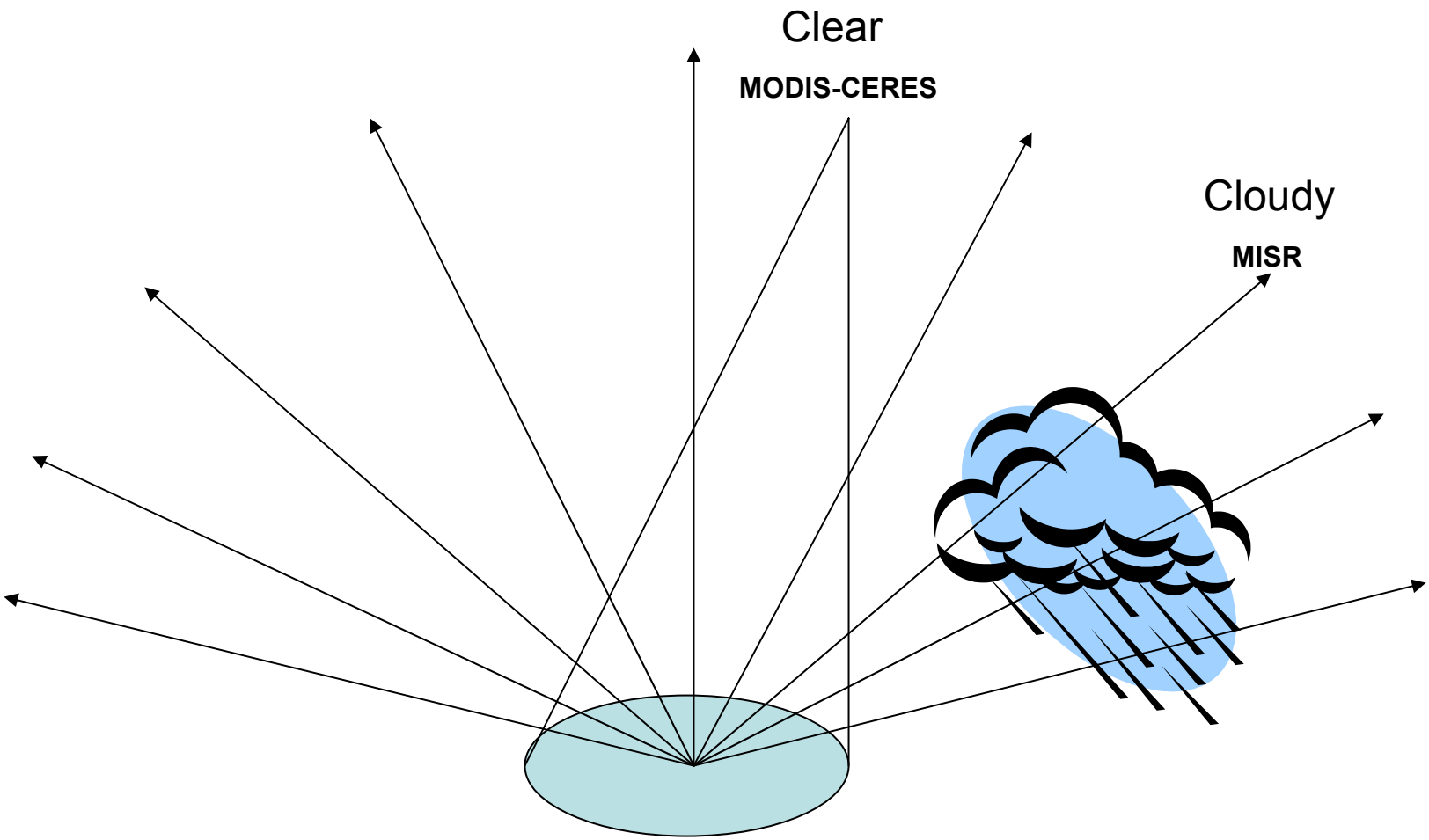

Overcast Ocean
Oct 2001
CERES SW Albedo
MISR Blue Albedo
Oct 2001 Clear Ocean
Red: Red channel
Blue: Blue channel
MISR Spectral Albedo
MISR NIR Albedo
Clear Ocean
Oct 2001
CERES SW Albedo
MISR Blue Albedo
Clear Ocean
Wind Speed = 7 m/s
Aerosol Optical Thickness = 0.1 and 0.75
Direct Integral
Operational Algorithm
SW Albedo
Red Albedo


Oct 2001 Overcast Ocean
MISR Red
CERES SW
Albedo
Latitude (deg)


Oct 2001 Clear Ocean
MISR Red
CERES SW
Albedo
Latitude (deg)


Oct 2001 Overcast Ocean
MISR NIR
CERES SW
Albedo
Latitude (deg)


Oct 2001 Clear Ocean
MISR NIR
CERES SW
Albedo
Latitude (deg)


Clear
MODIS-CERES
Cloudy
MISR

Conclusions

1. The MISR Level 2 narrowband albedo is converted to broadband albedo and compared with CERES SW albedo over 1 x 1 degree ocean region.
2. For overcast clouds, MISR broadband albedoes are very close to those of CERES with a bias difference of 0.13%.
3. The difference of MISR albedo and CERES albedo for all-sky ocean is larger than that for overcast case, but still about 2.43%.
4. The difference of MISR albedo and CERES albedo for clear-sky ocean is significantly larger than that for overcast case. No linear relationship between clear sky NB and SW albedo. What is the reason for it? Aerosol effect? Cloud contamination?Albedo-derivation algorithm problem?
5. The difference of MISR albedo and CERES albedo does not show a significant dependence on geo-locations.