The SSFM Dataset and Applications

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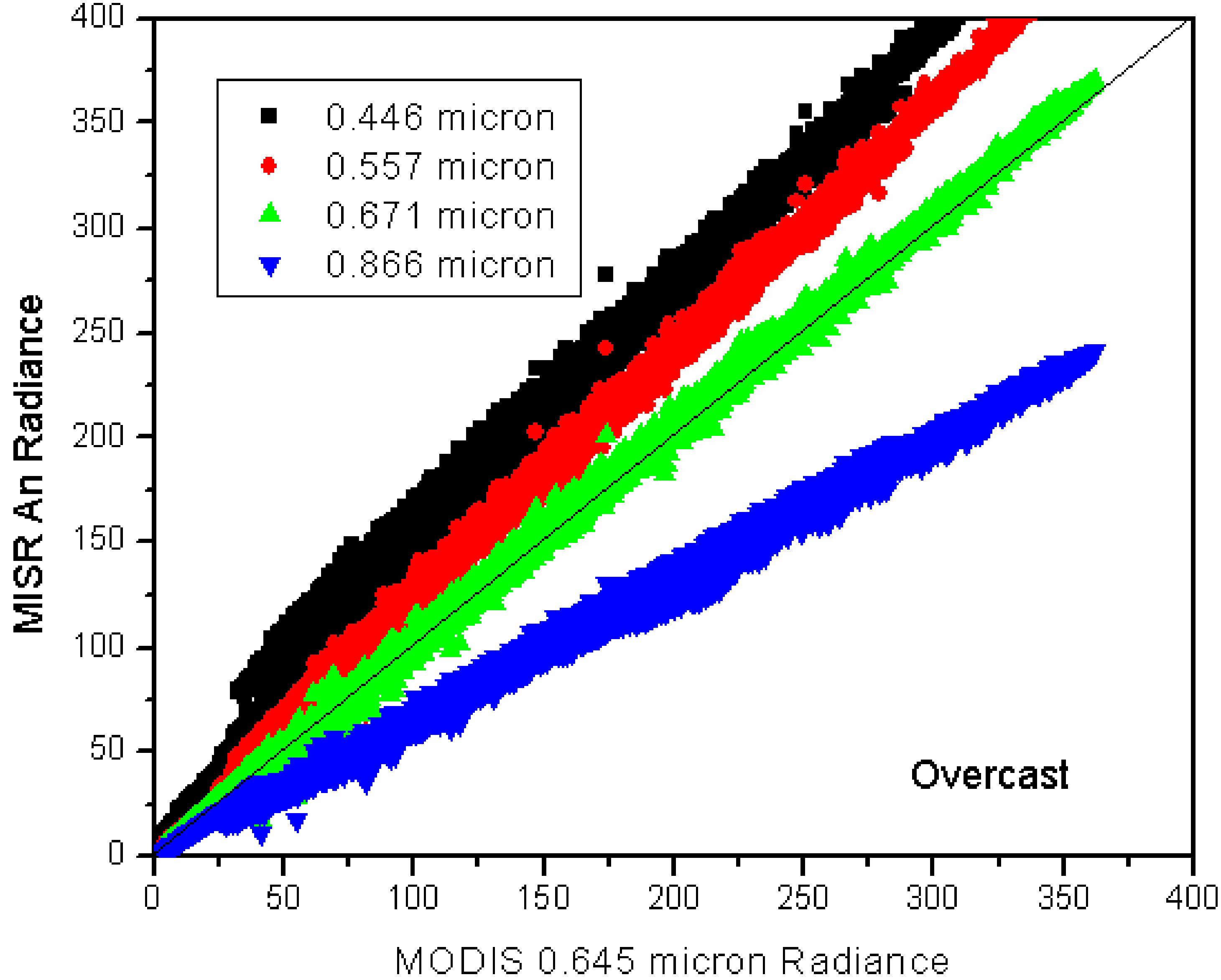
1. Introduction to the SSFM Dataset

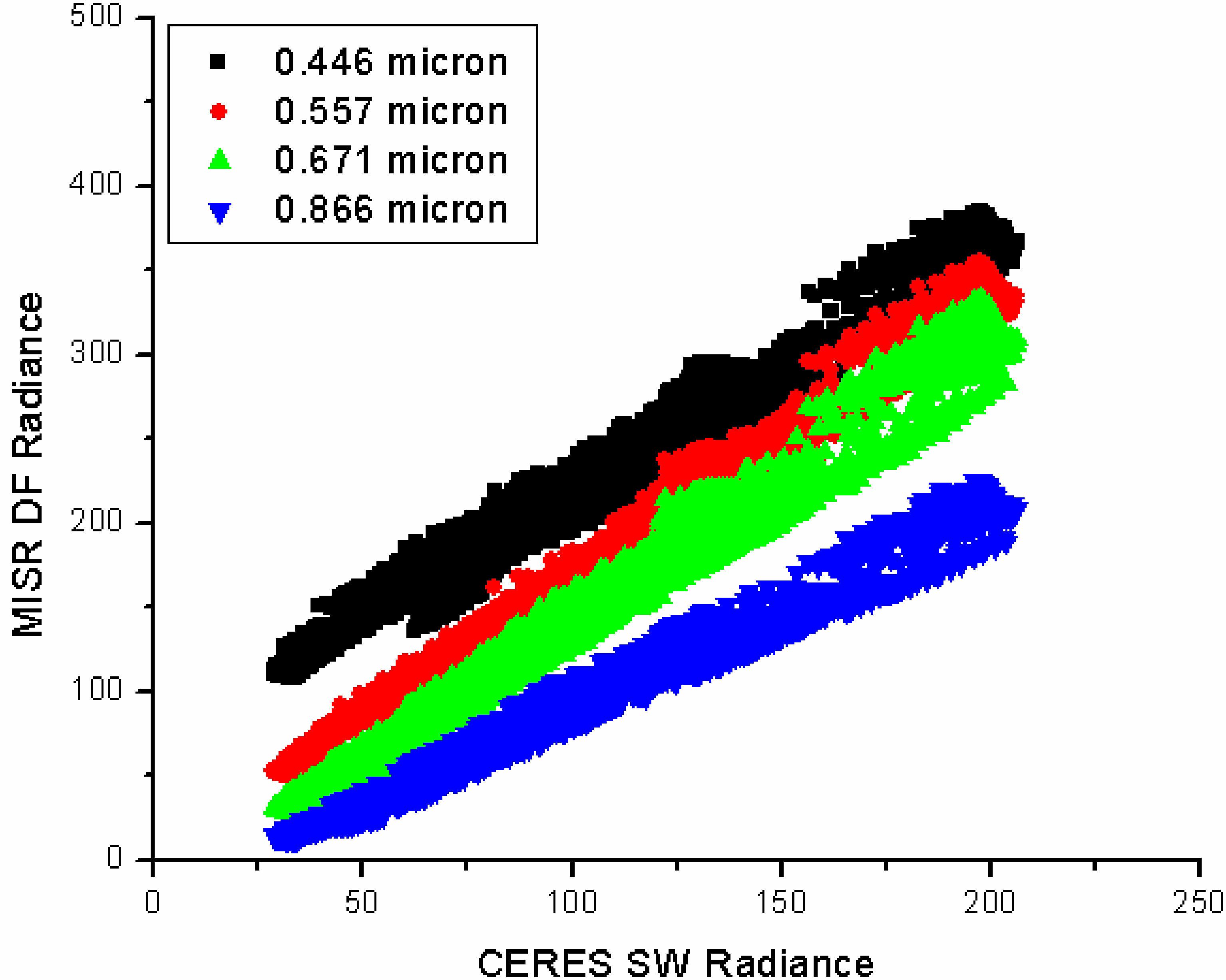
Installed on the EOS flagship Terra, viewing the sunlit earth simultaneously at nine widely-spaced angles, MISR provides radiances in four spectral bands at each of the nine angles. The multidirectional measurements of MISR offer an opportunity to study the radiation anisotropy of each scene along-track.

In this work, the multi-angle and multi-channel radiances of the MISR Level 1B2 ellipsoid-projected data are merged into the CERES SSF dataset by convolving the MISR radiances with the CERES Point Spread Function (PSF) over the CERES footprints.

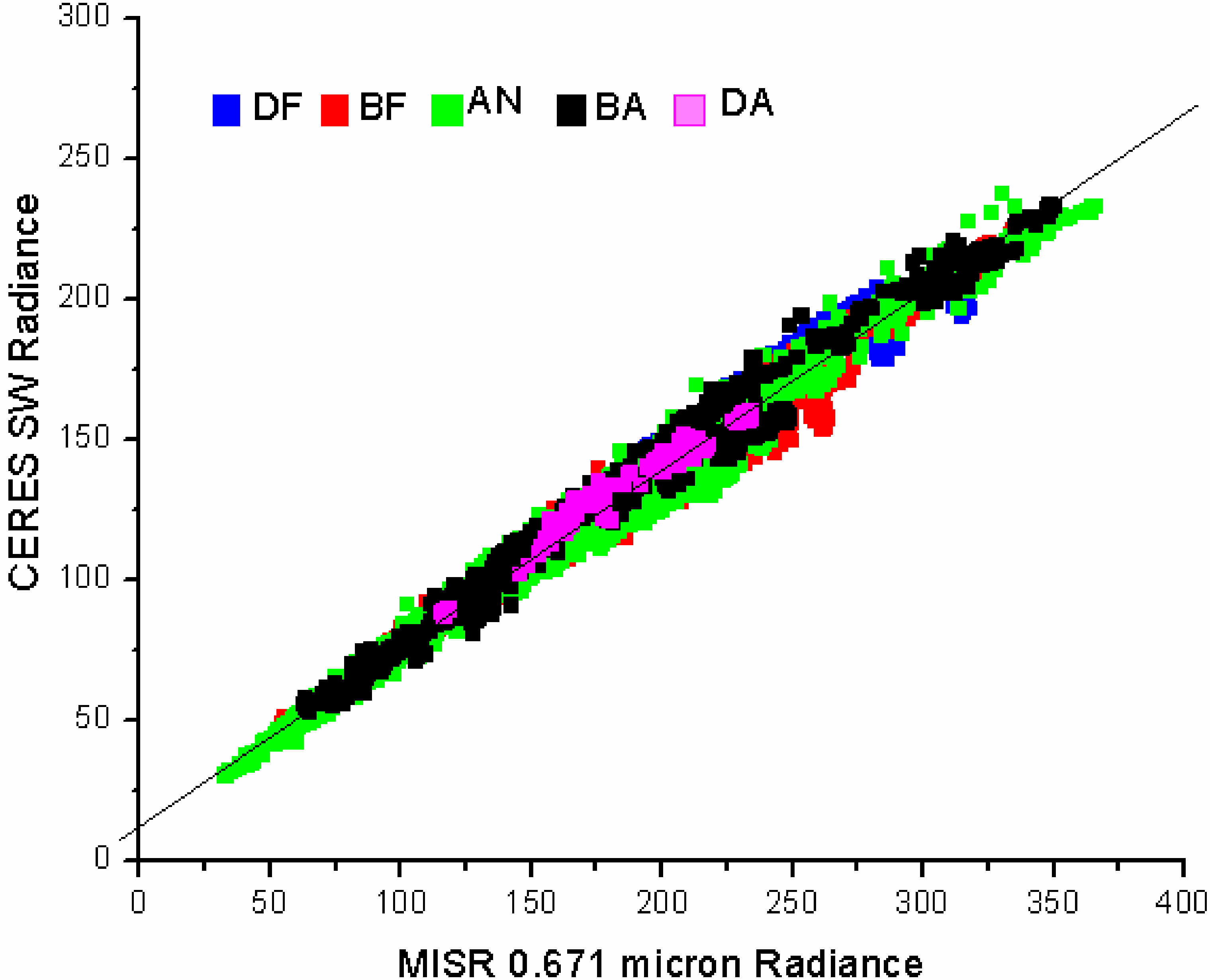
The merged SSF and the MISR dataset (SSFM) with coincident measurements of spectral and broadband shortwave radiances from the MISR, the MODIS, and the CERES is an important extension to the CERES SSF and may have extensive applications in various climate and remote-sensing research fields.



MISR An Radiance
MODIS 0.645 micron Radiance
0.446 micron
0.557 micron
0.671 micron
0.866 micron
Overcast
0
50
100
150
200
250
300
350
400



0.446 micron
0.557 micron
0.671 micron
0.866 micron
MISR DF Radiance
CERES SW Radiance
0
100
200
300
400
500
0
50
100
150
200
250



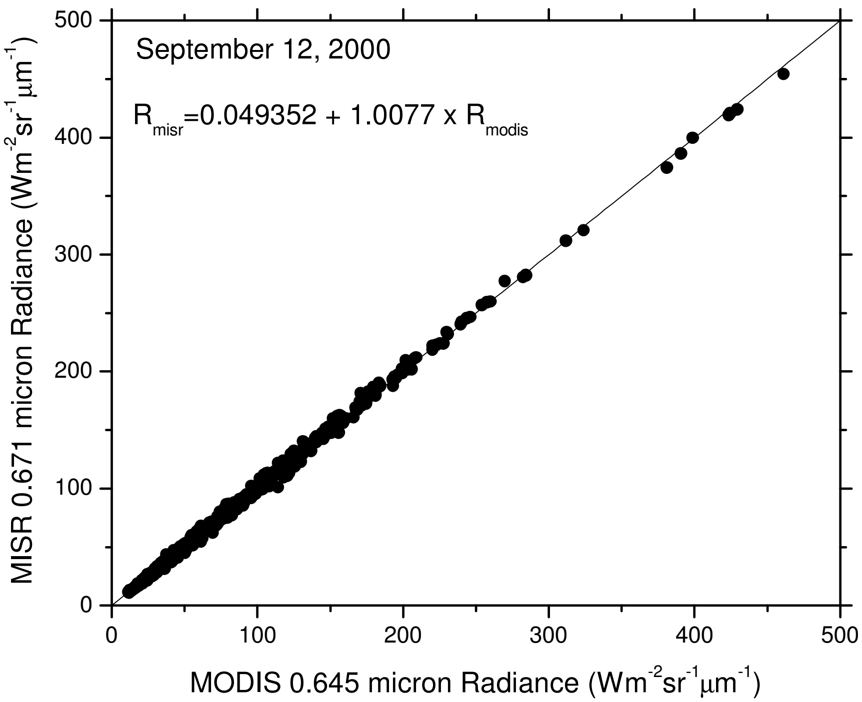
DF
BF
AN
BA
DA
CERES SW Radiance
MISR 0.671 micron Radiance
0
50
100
150
200
250
300
350
400

2. Cross-calibration of MISR Red Radiances with MODIS

Calibration drift of sensors is a known error source for remote-sensing. Assessment of the calibration drift of an instrument is important for accurate analysis of the measured data.

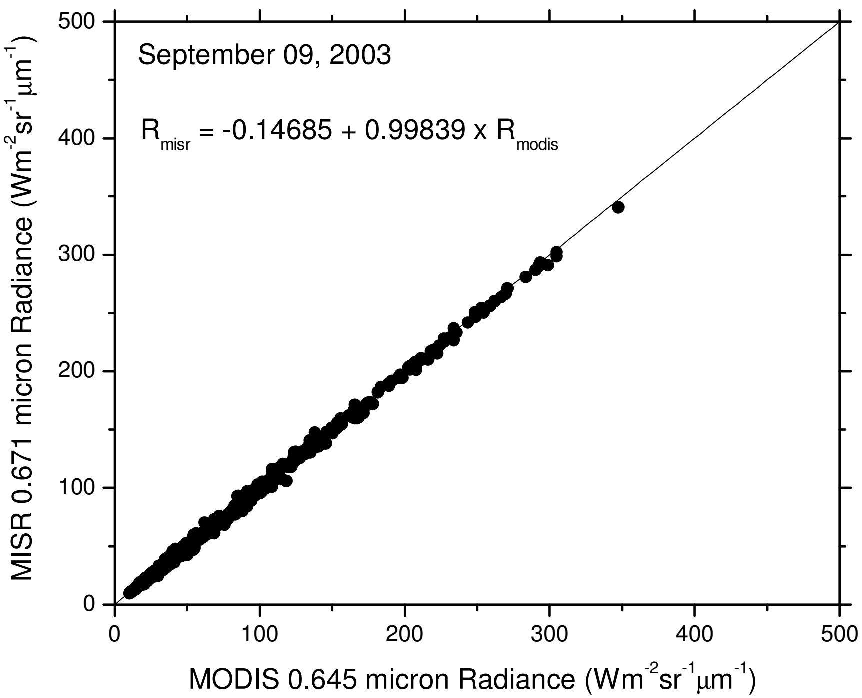
Although the MISR cameras are calibrated every month onboard, a long-term cross-calibration of the MISR sensors with other well-calibrated instruments is also important for examination of the accuracy of the MISR data.

In this work, as an example for application of the SSFM dataset, we assess the calibration drift of the MISR instruments using the MODIS radiances over the CERES footprints.



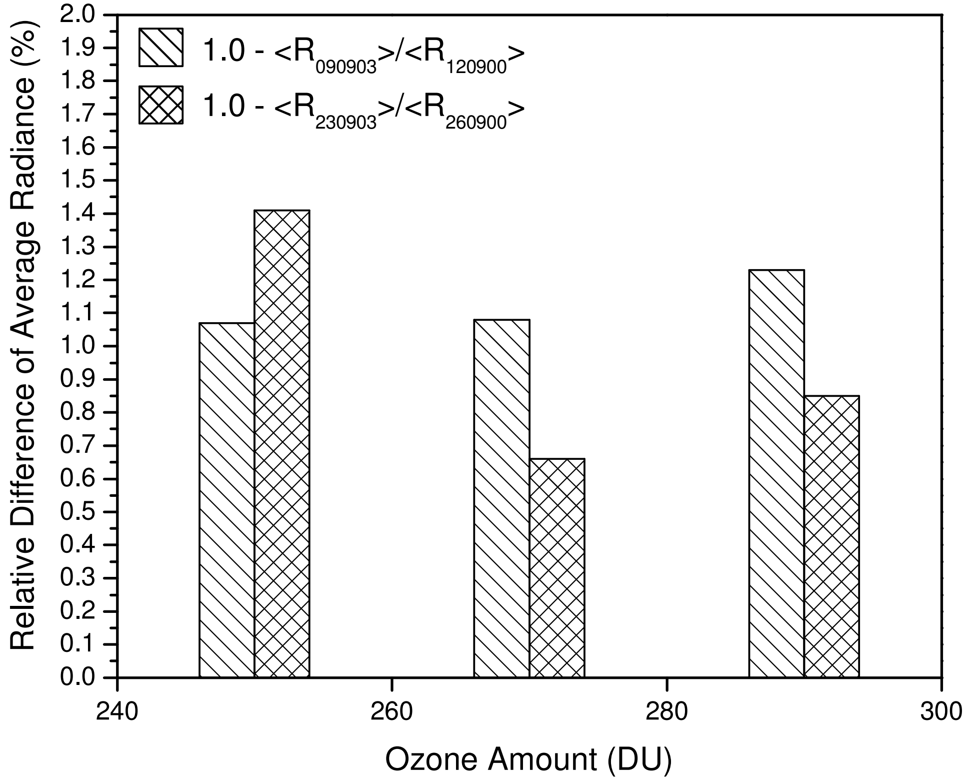
The comparison of the MISR 0.671 μm radiances and the MODIS 0.645 μm radiances for the CERES footprints over the tropic ocean on September 12, 2000.

The viewing angle difference between the MISR AN and the MODIS is limited to be smaller than 0.5 degree and the solar zenith angle is smaller than 85 degree.



The comparison of the MISR 0.671 μm radiances and the MODIS 0.645 μm radiances for the CERES footprints over the tropic ocean on September 09, 2000.

The viewing angle difference between the MISR AN and the MODIS is limited to be smaller than 0.5 degree and the solar zenith angle is smaller than 85 degree.



Relative differences of the averaged MISR 0.671 µm radiances as function of ozone amount calculated from the 4-day (September 12, 2000, September 9, 2003, September 26, 2000, and September 23, 2003) MODIS 0.645 µm radiances using the MODIS to the MISR radiance regression coefficients of each of the 4 days. In this figure, <Rddmmyy> denotes the averaged radiances and the subscript “ddmmyy” denotes the date of the MODIS to MISR regression coefficients.

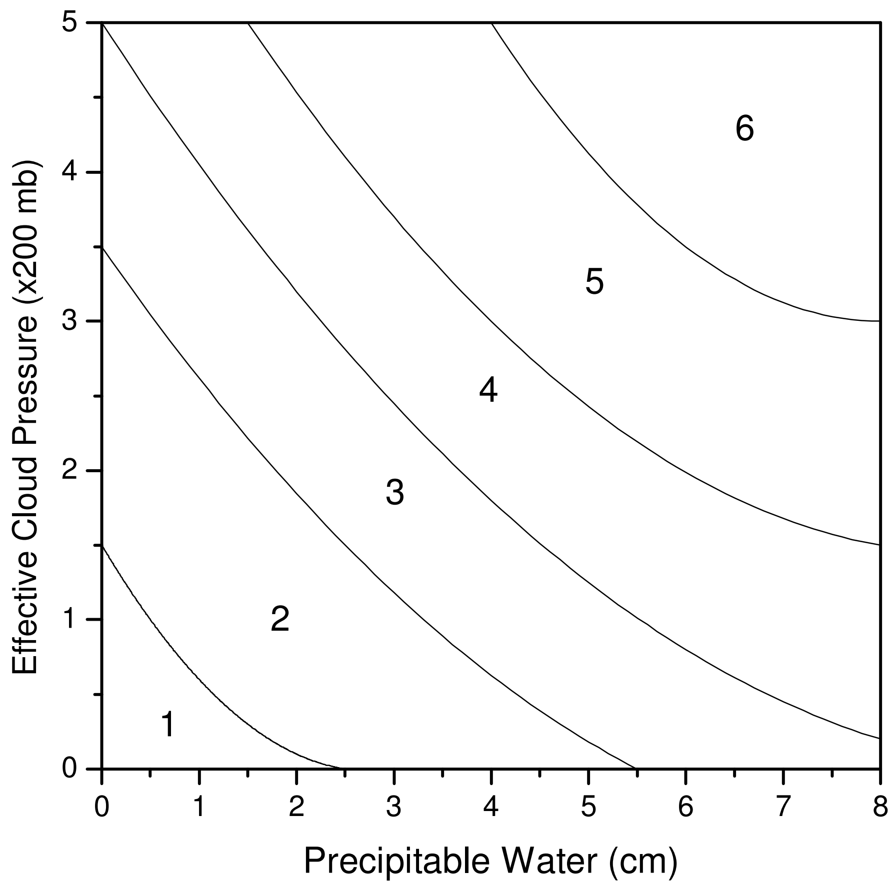
3. Estimation of CERES SW Radiances at MISR Viewing Angle

Linear regression of 9-day MISR and CERES along-track data in the SSFM produces the NB to BB conversion coefficients a0, a1, and a2 as functions of sza, vza, vaz, cloud coverage, **cloud pressure, precipitable water**, and ground scene-type.

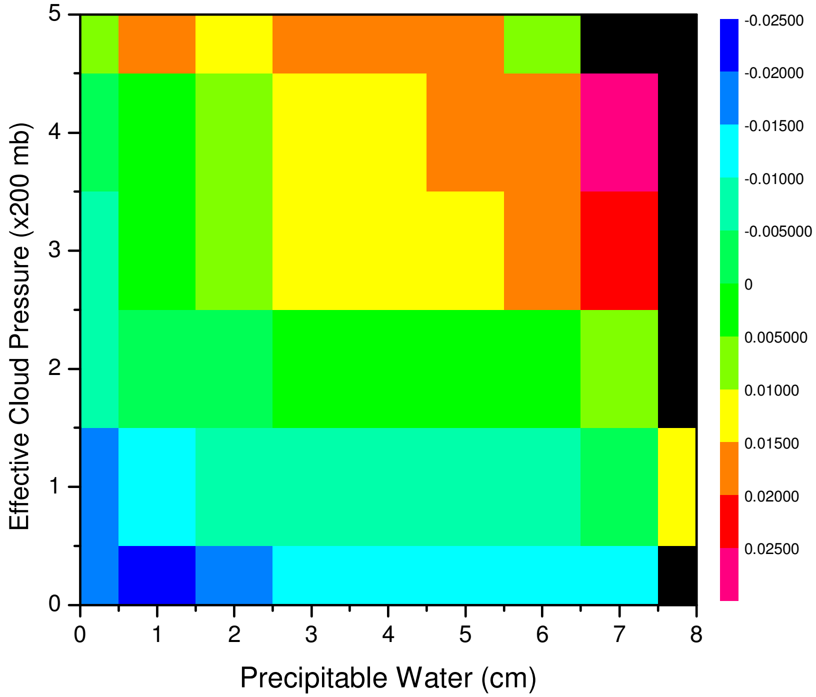
$$ceresSW = a0 + a1*misrRed + a2*misrNIR$$

Application of the NB-BB coefficient tables to MISR Red and NIR radiances converts the MISR NB radiances into CERES BB radiances.

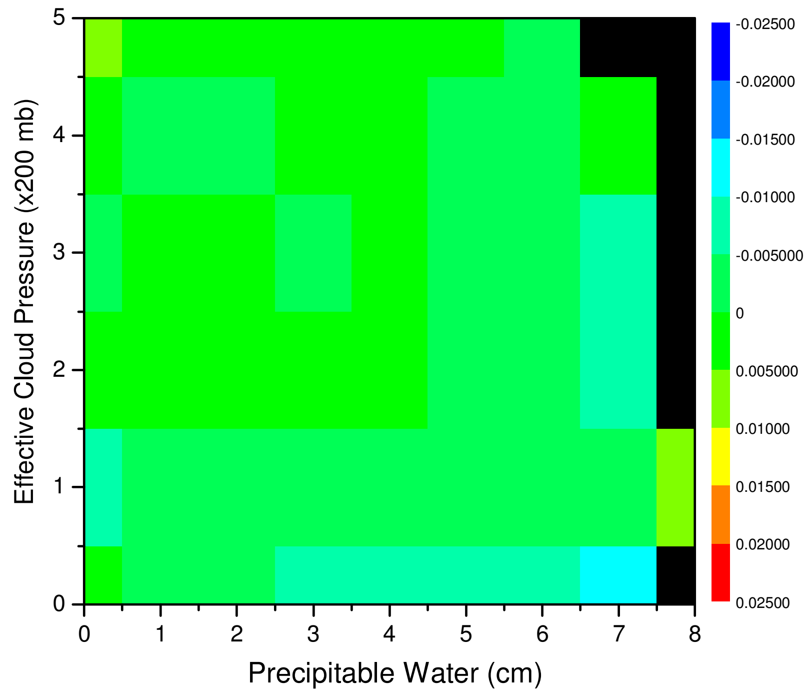
The MISR NB-converted CERES SW radiances at 9 viewing angles for each CERES footprint will help in the CERES ADMs study and will help in converting the MISR L2 NB albedo into BB albedo.



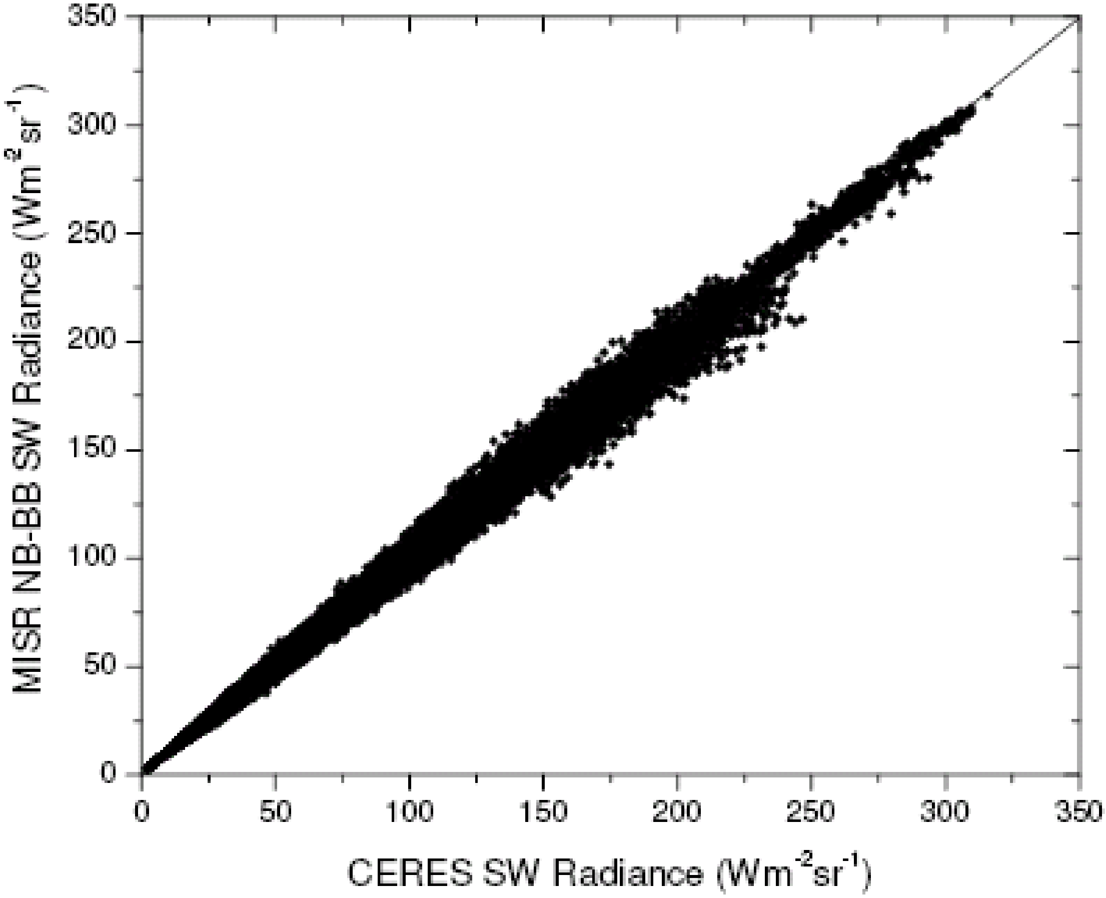
The empirical separation curves and sub-domains for the narrowband to broadband reflectance conversion stratification by the effective cloud top pressure and the precipitable water.



SW reflectance bias error for MODIS NB to CERES BB algorithm without cloud pressure and precipitable water stratification. Overcast ocean.



SW reflectance bias error for MODIS NB to CERES BB algorithm with cloud pressure and precipitable water stratification. Overcast ocean.



The comparison of the CERES shortwave radiance and the MISR-converted shortwave radiance from one-day SSFM data over all-sky oceans.

The relative bias and rms errors of the narrowband to broadband radiance conversion are -0.25% and 3.83%, respectively

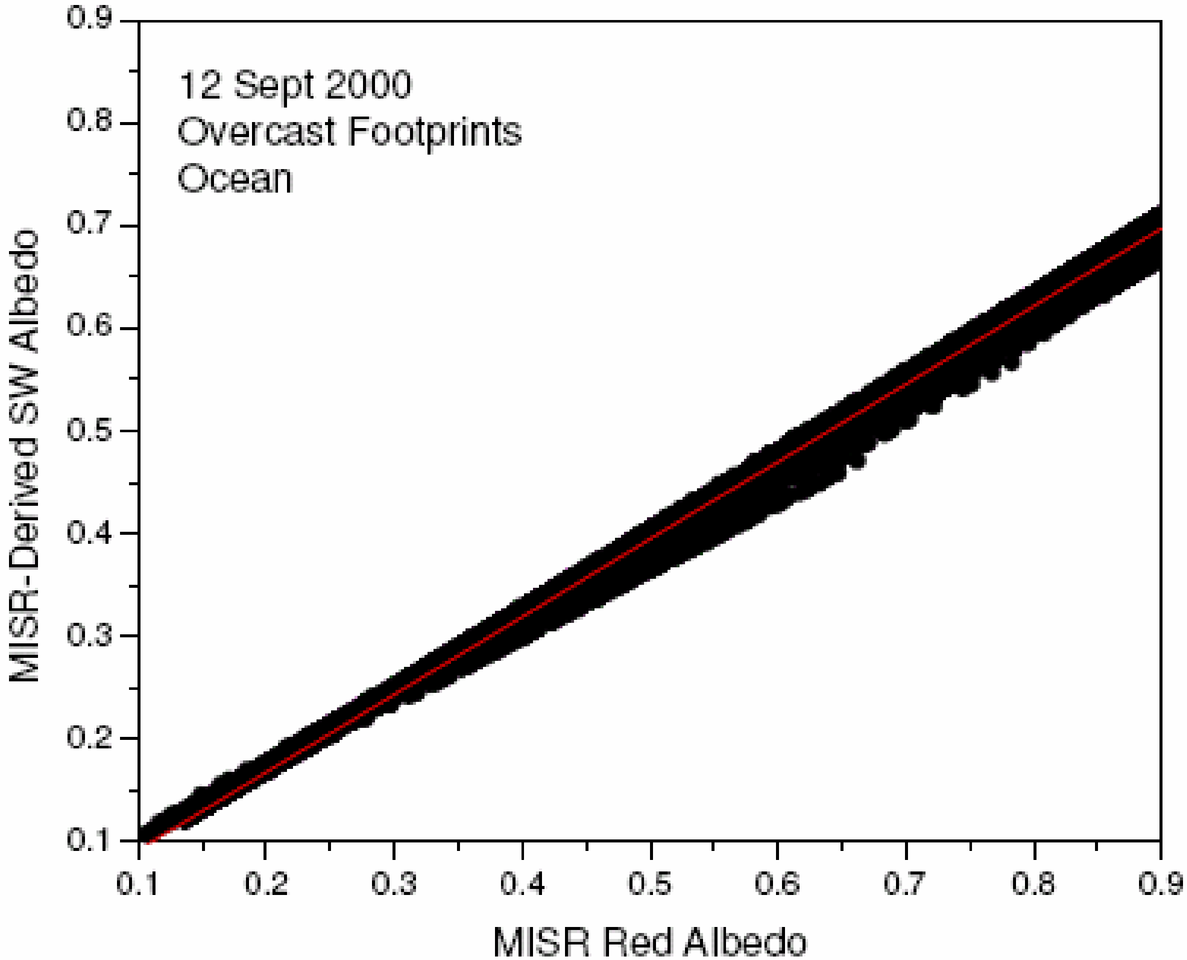
4. Overcast Footprint SW Albedo from MISR Red Radiances

1. Multiple Reflectance Matching (MRM) algorithm is used to derive Red reflectance at all angles over an overcast footprint with the MISR multi-angle measurements

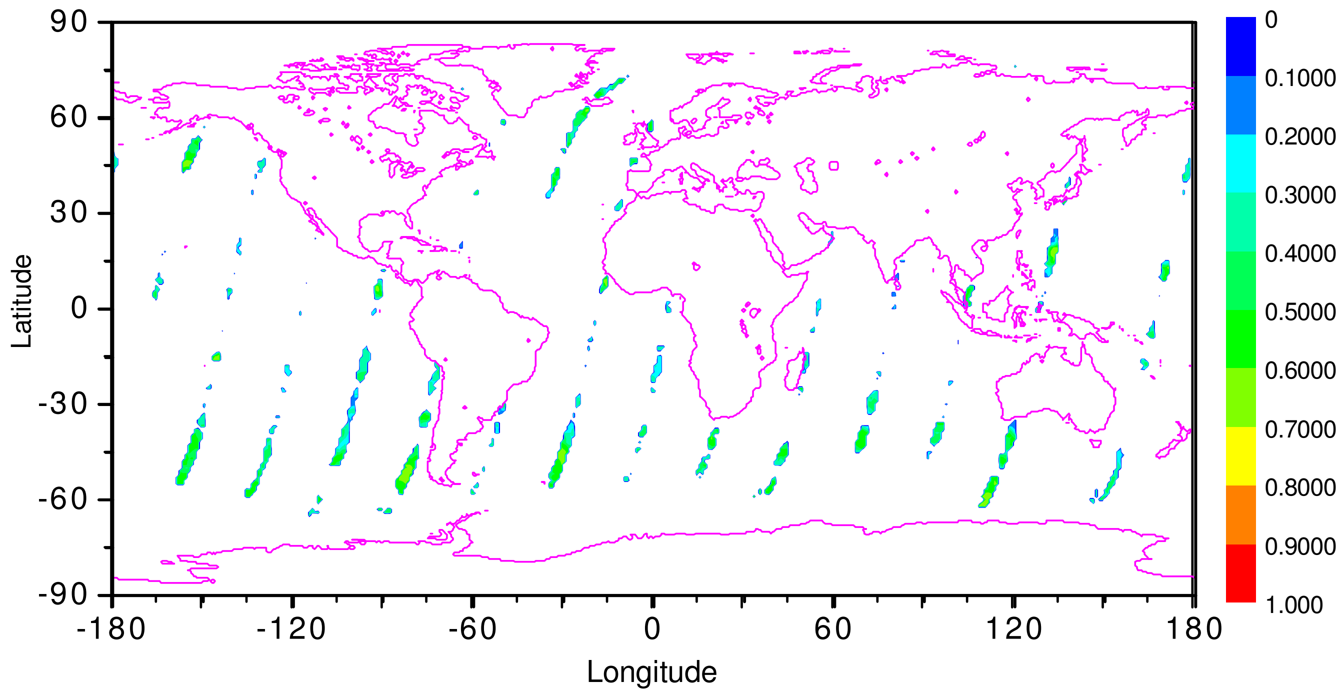
2. Every narrowband to broadband reflectance conversion coefficient is broadcasted to every angle in its Neighboring Angle Group (NAG).

3. Narrowband to broadband reflectance conversion is performed at every angle.

4. Broadband reflectance at every angle is integrated together to get the SW albedo.



MISR Red albedo and SW albedo derived from Multiple Reflectance Matching Algorithm



SW albedo derived with Multiple Reflectance Matching Algorithm from MISR Red Radiances for overcast footprints over ocean in 12 September, 2000.

5. Conclusions

1. The multi-angle and multi-channel radiances of the MISR Level 1B2 ellipsoid-projected data and the CERES SSF are merged into the SSFM dataset by convolving the MISR radiances with the CERES Point Spread Function over the CERES footprints.

2. The MISR radiances in the SSFM dataset match the MODIS radiances well in a long-term examination, which means the MISR radiances, viewing geometries, and geo-locations are correct in the SSFM dataset and the calibration drift of the MISR is small.

3. The MISR spectral radiances show linear regression to the CERES SW radiances. Using empirical relationship between the MISR narrowband radiances and the CERES broadband radiances, one can estimate the instantaneous broadband radiances at the nine MISR observational angles.

4. The SSFM dataset with coincident instantaneous measurements of spectral and broadband shortwave radiances from the MISR, the MODIS, and the CERES and ancillary parameters will not only enhance the study of cloud and aerosol effects on the solar radiation budget, but also improve the applications of these measurements in remote-sensing of surface properties.