MISR Level 1 Products Quality Statement
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Quality Designator:

- **Stage 3 Validated:** L1B2 Terrain Radiance (Global/Local), L1B2 Ellipsoid Radiance (Global/Local), Geometric Parameters.

MISR maturity level definitions

This statement applies to MISR Level 1 Products (Ellipsoid and Terrain) with a version number of 0024, and the Geometric Parameters with version number 0013. See the Versioning Page for an in-depth explanation of the differences between various MISR product versions. Quality statements covering earlier time periods may be accessed through links at the bottom of this page.

NOTE: The Radiometric Camera-by-Camera Cloud Mask is now considered to be part of Level 2, so the paragraph detailing the RCCM quality has been moved to the L2TC Quality Statement.

The MISR Level 1 software which generated these products is believed to be functioning quite well except where noted below. This statement lists known problems with Level 1 Products and clarifies issues which have confused some users.

Geometric Parameters (a.k.a GP_GMP, MIB2GEOP) (from MISR PGE7) (Validated) Version 0013

There are no known problems with the current release of PGE7 software. Analysis of isolated case studies indicates that the software is meeting all of its requirements.

The Geometric Parameters exhibit one algorithmic quirk which has surprised some users. Solar zenith and azimuth angles near the swath edge occasionally appear to jump around. This inconsistency is the result of an intentional choice of algorithm whereby solar angles are computed at the mean time at which MISR cameras viewed the ground point in question. Adjacent points are not always visible to the same set of cameras. This can cause a bias in solar angle towards cameras which acquired that point.

L1B2 Terrain (a.k.a. GRP_TERRAIN_GM, MI1B2T) (from MISR PGE22) (Stage 3 Validated)
L1B2 Ellipsoid (a.k.a. GRP_ELLIPSOID_GM, MI1B2E) (from MISR PGE22) (Stage 3 Validated)
L1B2 Terrain Local Mode (a.k.a. GRP_TERRAIN_LM, MI1B2T) (from MISR PGE6) (Stage 3 Validated)
L1B2 Ellipsoid Local Mode (a.k.a. GRP_ELLIPSOID_LM, MI1B2E) (from MISR PGE6) (Stage 3 Validated)

This portion of the list is lengthy, so the sub-headings are listed for quick reference.

Update: The Ellipsoid and Terrain radiance products are now in their final state (version 0024), and the Level 1 software to produce these products will not be changed any further barring discovery of previously unknown problems. The MISR radiances are now Stage 3 validated. The DAAC will soon complete reprocessing the Level 1 data for the entire mission with this version of the software. Previous versions of the products should not be used.

RADIOMETRIC CALIBRATION

The MISR band-relative radiometric calibration was last improved in version 0022 of the Level 1 product. Red band radiances have been

reduced by 3% for all cameras, and NIR band radiances have been reduced by 1%. The need for a change was discovered during analysis of data from several MISR vicarious calibration experiments. Results from MISR vs MODIS, MISR vs MERIS, and Terra lunar calibration studies supported the decision to make this change.

Another significant improvement in Radiometric accuracy was made in versioned 0015. The improvment was achieved by discovering and correcting an error in the code used to derive the radiometric calibration coefficients. A-Nadir camera data produced before this version may have had absolute errors as large as 10% (too bright) at the left/western edge of the scene, and -5% (too dim) at the right/eastern edge. Radiometry at the swath center, and for other cameras has been in error to a lesser degree.

A history of the calibration changes can be found on the Calibration Page. The current uncertainties are listed below.

- The ***absolute uncertainty*** in MISR radiances is estimated to be within 4% (1 sigma level of confidence) for bright uniform targets.
- ***Camera and band-relative uncertainties*** are within 2%.
- ***Pixel-relative uncertainties*** are within 0.5%. It is noted that vertical striping has been displayed in selected scenes, such as highly contrast-enhanced images of uniform snow, ocean, and desert regions. It has been verified that the peak-to-valley radiance difference for these scenes is less than 0.5%.
- ***Early mission data*** (February - March, 2000) have increased uncertainties. During this time period, the MISR radiometric response was rapidly changing, due to an initial instrument on-orbit settling effect. This change has been noticed in most other on-orbit sensors, and is generally attributed to the browning of the optics in the space environment. Thus, products generated prior to the ARP T002 time era (April 27, 2000) may contain radiometric errors as large as 10%.
- ***Scene-dependent errors***. Although MISR radiometric accuracy is predictable over uniform targets, this is not so for contrast scenes. Improved radiometry for these cases is achieved through the use of a point-spread-function (PSF) correction for products versioned 0016 or greater. Additional scene-dependent errors may result from ghost-image effects. Here, a secondary image, reflected about the lens optical axis may appear, The magnitude of this ghost is estimated to be 0.3% of the scene brightness. Although small, a ghost image of a bright target can reflect into a dark ocean body, causing undesirable errors over the dark water. Table 1 elaborates on known sources of scene-dependent errors.

Table 1. Sources of scene-dependent effects

PSF effects refer to scene-contrast reductions due to local scene inhomogeneity. The radiometry of one pixel is affected in proportion to the contrast difference and proximity of another pixel. This is a camera optical effect, and is measurable for objects that are within 6 km crosstrack distance of each other. The downtrack PSF effect is believed to be negligible. A deconvolution algorithm is now exercised in the software to minimize PSF effects.
Ghost-image refers to the presence of a secondary image, created as a reflection of a given target through the lens optical axis. This secondary ghost has been measured to be 0.3% of the primary image, and thus results in a negligible error except where the image of a bright target falls on a very dark scene.
L1B2 resampling is implemented by bilinear interpolation, and thus errors in this process are a function only of a sample's radiance value as compared to that of its immediate neighbors.
Illumination-level dependent errors are attributable to the goodness-of-fit of camera response data to a mathematical equation. The MISR cameras are described as having a linear relationship between incident radiance and camera output. For radiance levels less than 2% in equivalent reflectance, this assumption is valid to within 5% uncertainty. The error is considered negligible for larger input signals.
Detector uniformity of response errors occur when a set of detector elements are non-uniform in response (10% non-uniformity or greater), are image inhomogeneous scenes, and are DN-averaged as part of the on-board data compression (Global Mode) algorithm. Only a dozen detector regions (out of 13,000 such pixel blocks) are non-uniform, and these are identified by data quality indicators in the products. For conditions where bright scenes are adjacent to dark scenes, an additional radiometric error of 6% may result in pixel regions where the Data Quality Indicator level is given a value of 2.

GEORECTIFICATION and COREGISTRATION

Update: MISR Level 1B2 products exhibit as expected georectification and coregistration accuracy. In the nominal case, the expected mean geolocation error for all nine cameras is below 20 meters. Standard deviations range between 30 meters for A-Nadir camera, and 70 meters for most oblique D's cameras. The final operational version of the processing algorithm along with the globally validated georectification and coregistration performances is described by Jovanovic, V., Moroney, C., & Nelson, D. in "Multi-angle geometric processing for globally geo-located and co-registered MISR image data", Remote Sensing of Environment, Special Issue, Volume 107, 2007.

Also, all camera data acquired during occasional spacecraft maneuvers is of degraded accuracy. Data products generated during these times contain an Orbit Quality flag which indicates this problem. The nominal value of the Orbit Quality flag in the File Metadata (Global Attributes) is 0.0. Degraded data has an Orbit Quality flag value of -1.0. See the Georectification Page for more details, including a link to the list of degraded orbits.

EXCEPTIONS/ANOMALIES

- **GAPS:** The raw MISR data contains occasional gaps. These gaps usually consist of a few lost lines. Straight lines of raw data are

resampled to gentle curves in the SOM map projection. Radiances in the gap regions are filled in with pre-defined fill values. Gaps then usually look like narrow, curved, bright, horizontal stripes in the L1B2 image. There is at least one small gap in almost every swath. In rare cases, data gaps of many lines have been observed.

- **INSTRUMENT OUT-OF-SYNC:** The MISR instrument tends to go out-of-sync momentarily if the data rate from the hardware exceeds the real-time flight computer's capacity to write data out. This condition can occur whenever a change of camera state is commanded. Image lines acquired while the MISR instrument was out-of-sync may contain sporadic fill and/or repeats of previous lines. The resulting image contains a brief vertical smear across the swath. Normally, this phenomenon only lasts for a handful of lines. In order to avoid geolocation errors, interpolated time values are inserted for these lines.
- **TERRAIN TOPOGRAPHIC OBSCURATION:** The line-of-sight between an off-nadir camera and a ground point is sometimes blocked by a topographic feature, such as a mountain. In such cases, fill values are reported instead of radiances in the terrain product. Large patches of obscuration fill can be seen in the D cameras over mountainous regions.
- **TERRAIN OCEAN FILL:** Blocks which encompass no land at all get entirely filled with ocean-fill values in the terrain product. Terrain algorithms are wasteful over ocean since height variation is negligible there. The Ellipsoid product already contains radiances for these blocks. If ocean blocks are required, blocks from the Ellipsoid product may be substituted.
- **INTERMITTENT INTENSITY FLUCTUATIONS IN DA CAMERA DATA:** Occasional fluctuations in image intensity within each image line have been observed on a subset of DA camera data. All four bands of this camera are affected. No other camera shows this effect. These fluctuations, which are manifested in intensity discontinuities between image lines, are mostly visible in the highest 1x1 resolution mode which is the nominal mode for red band Global Mode data, and all bands in Local Mode data. The magnitude of the fluctuations averages to negligible levels once data are averaged to 4x4 resolution mode, which is the primary resolution of data inputs to Level 2 science retrievals. This anomaly is noted only in two time periods since the beginning of the mission: 1) November 2001 through January 2002, and 2) December 2002 through October 2003. Out of the nine cameras, the DA camera electronics are the most environmentally exposed, and solar activity effects on offset and/or bias voltages in the CCD detectors are considered the most probably cause of this anomaly. At 4x4 resolution the DA camera data from these two periods is considered adequate for those Level 2 science retrievals that do not require finer resoluton. All acquired data are being monitored for this type of anomaly on a regular basis.

ELLIPSOID COLOR BROWSE

The Nadir, single-band L1A browse product has been replaced with a new Ellipsoid-based color product. The new browse product is generated for all 9 cameras at 2.2 km resolution (sub-sampled). MISR Red, Green and Blue bands are used to create the color image, which is intentionally clipped and gamma-stretched in order to make cloud, ocean and land features visible. The jpeg compression is performed at 75% quality, which means that compression artifacts are occasionally visible.

L1A CCD (a.k.a. FM_SCI, MIL1A) (from MISR PGE1) (Stage 3 Validated)

The MISR Level 1A product is a reformatted version of the raw L0 data packet stream from the spacecraft. In this format, the CCD Data Numbers (DNs) may be viewed as an unregistered image with data quality indicators occupying the two low-order bits. By design, L1A does not differ greatly from the raw data except that gaps are filled in with appropriate fill values.

L1B1 (a.k.a. RP_GM, MI1B1) (from MISR PGE1) (Stage 3 Validated)
L1B1 Local Mode (a.k.a. RP_LM, MI1B1LM) (from MISR PGE1) (Stage 3 Validated)

The MISR Level 1B1 product has been radiometrically corrected, but it has not been registered. The quality of L1B1 radiances is equivalent to that of L1B2 radiances discussed above, except that L1B1 pixels correspond directly to instrument CCD detector samples.

The L1B1 Local Mode product consists of the L1B1 output acquired when the MISR instrument is put into Local Mode in which all nine cameras view a scene at 275 m resolution in all four bands.

Also see the

- Statement dated June 5, 2005 for MISR Level 1 Products from June 05, 2005 to November 30, 2005.
- Statement dated March 10, 2004 for MISR Level 1 Products from March 10, 2004 to June 04, 2005.
- Statement dated December 1, 2003 for MISR Level 1 Products from December 01, 2003 to March 09, 2004.
- Statement dated September 24, 2003 for MISR Level 1 Products from September 24, 2003 to November 30, 2003.
- Statement dated November 12, 2002 for MISR Level 1 Products from November 12, 2002 to September 23, 2003.
- Statement dated October 24, 2002 for MISR Level 1 Products from October 24, 2002 to November 11, 2002.
- Statement dated July 31, 2002 for MISR Level 1 Products from July 31, 2002 to October 24, 2002.
- Statement dated April 15, 2002 for MISR Level 1 Products from April 15, 2002 to July 26, 2002.
- Statement dated February 05, 2002 for MISR Level 1 Products from February 05, 2002 to April 14, 2002.
- Statement dated December 03, 2001 for MISR Level 1 Products from December 03, 2001 to February 4, 2002.
- Statement dated September 27, 2001 for MISR Level 1 Products from September 27, 2001 to December 02, 2001.
- Statement dated March 30, 2001 for MISR Level 1 Products from March 30, 2001 to September 26, 2001.
- Statement dated February 16, 2001 for MISR Level 1 Products from December 21, 2000 to March 29, 2001.
- Statement dated August 24, 2000 for MISR Level 1 Products from August 1 to December 20, 2000.
- Statement dated June 15, 2000 for MISR Level 1 Products from June 1 to July 31, 2000.